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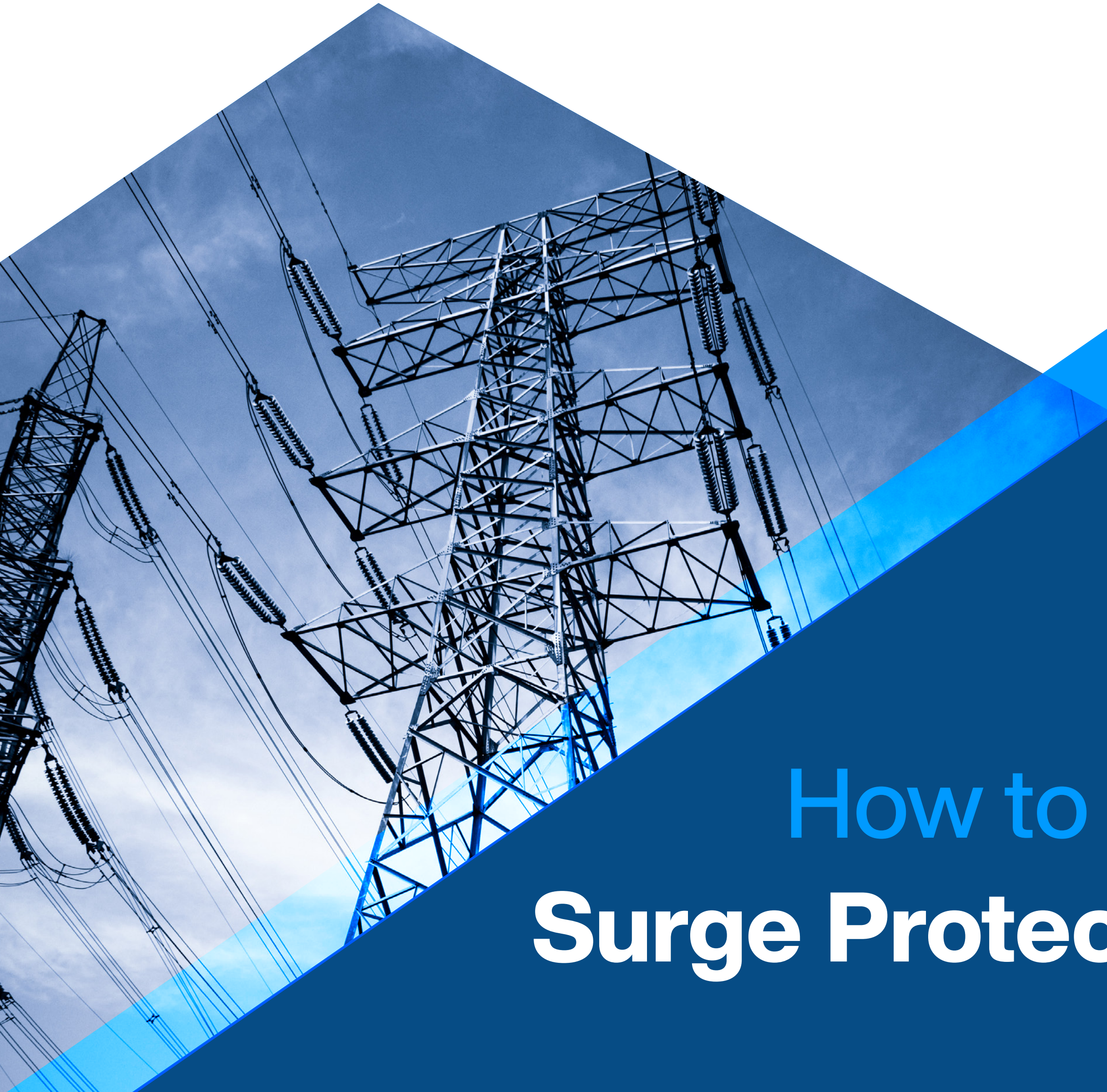

How to Choose the Right **Surge Protection Technology**

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Foreword

It is no revelation that electronic designs have become increasingly complex and sophisticated, where PCB density is a growing concern and board space is at a premium. An ongoing issue is that these smaller, denser electronics are more susceptible to damage from transients such as lightning and high voltage surges. Circuit protection must, therefore, evolve to meet board space limitations with smaller, robust designs that supply enhanced protection performance.

To meet these challenges, Bourns continues to be a leader in developing miniaturized, innovatively designed circuit protection components that deliver the higher performance necessary to protect against surge threats. A prime example is our recently introduced IsoMOV™ hybrid overvoltage protector that uniquely combines the advantages of GDTs and MOVs into a revolutionary new design. As a drop-in replacement to traditional MOVs, this space-saving single component features high performance and extended life.

This ebook is written as a useful guide to selecting surge protection components. In it, you will learn the various types of surge suppression technologies and components available and the standards and regulations that govern surge protection. Surge protection is more important than ever in helping to increase reliability in today's sensitive applications. We invite you to leverage Bourns and Mouser's knowledge and experience to help make your next design a success.

Sincerely,
Craig Shipley,
Vice President and General Manager,
Circuit Protection Division at Bourns, Inc.

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Meet Our Experts

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Surge Protection Is a Balancing Act

As consumer products and industrial equipment grow increasingly dependent on voltage-sensitive, data-driven control systems, effective surge protection has become a critical design consideration to help ensure operational reliability. For many devices and applications, the right surge-protection technology plays a key role in a product's long-term success, especially for business and industrial systems, where the cost of equipment downtime is high. Similarly, the safety and owner satisfaction of entertainment and domestic products may depend on effective surge protection.

A *power surge,* or *power transient,* is a brief increase in voltage that has the potential to damage equipment. Perhaps the most familiar and notorious power surges are caused by lightning. When lightning strikes, it typically has an electrical potential of 40,000 to 100,000 volts (V), lasts about 20 microseconds (μs), and can have a peak current of 5,000 to 200,000 amperes. Such power can create a transient power surge capable of thoroughly destroying electrical components, sometimes in a highly spectacular fashion.

Lightning is an external transient—that is, it comes from outside a facility, home, or factory—but it is only one possible cause of power transients. Such surges can also come from the power grid itself, triggered by transformer switching, capacitor switching, line switching, or fuse operation.

"Transient power surges can degrade the contacting surfaces of switches, disconnectors, and circuit breakers. Intermittent transients can produce the untimely tripping of breakers by heating them up. Then the breakers react to the non-existent current demand and burn out before their original lifespans end."

Nida Qamar,
Project and Design Engineer,
Eaton

Other types of common power transients are less visible and can be caused by events inside a facility. These internal transients come from many sources. For instance, when a heavy load, such as a refrigerator, air conditioner, or an electric motor in a piece of industrial equipment cycles on or off, it generates a power transient that can damage other equipment. Other types of transients include discharge from inductive devices such as transformers and motors, induced voltages caused by inductive coupling with high-voltage lines, switch or breaker contacts opening and closing, and electrostatic discharges. Damaging transients are not confined to power lines, however. They also show up on signal and data lines. In some cases, the transients are transferred from power lines to signal and data lines by inductive coupling.

> **There are a lot of regulatory requirements based on where the surge protection is installed. Think of the likelihood of lightning strikes on a 200-foot pole compared to that of a one-story house.**

Thomas Tran
Technical Marketing Manager, Bourns, Inc.

Although lightning and its destructive effects are highly visible, the less visible internal transients may cause more damage because they can trigger operational irregularities, degrade electrical components, and shorten the operational life of equipment. In fact, internal power transients are viewed as the most likely silent destroyers of electronic components, which is why incorporating effective surge protection can reduce the costs associated with operational disruptions and equipment failure. The surge protection technology you choose depends on the nature of the equipment that needs protection, the types of power transients against which it must be protected, and the cost of surge protection technology.

"Older machines do not have surge protection and as such are susceptible to power surges. These could shut down its operation – e.g., burn a fuse or fry its controls entirely."

George Burlacu,
Compliance Engineer,
GVA Lighting, Inc.

In many cases, surge protection specifications are regulation driven, based on the environment in which a device will operate. There is a big difference between the level of surge suppression required in a piece of low-voltage equipment mounted on top of an antenna tower where it could be struck by lightning, in a control system in a factory packed with high-voltage machinery, and in a home appliance. Applications may require compliance with a particular type of surge protection specified in the Underwriters Laboratory (UL) 1449 Standard, Edition 5, "Surge Protective Devices." (UL standards are widely used in the United States; equivalent International Electrotechnical Commission standards are commonly used in Europe.) Table 1 lists these UL 1449 surge protection types.

Table 1: UL 1449 Standard, Edition 5, Surge Protection Types. This is illustrated in Figures 1 and 2.

Type	Description
1	Surge protection is permanently connected between the secondary of the service transformer and the line side of the service equipment overcurrent device as well as the load side. For photovoltaic (PV) systems, it is connected between the PV array and the main service disconnect.
2	Surge protection is permanently connected on the load side of the service equipment overcurrent device.
3	Surge protection is installed in the protected device, which is connected to power by a plug receptacle or a power strip that has internal surge protection.
4 Component Assemblies	An assembly of type 5 components with internal or external disconnect.
1, 2, 3 Component Assemblies	Consists of a type 4 component assembly with internal or external short-circuit protection.
5	Discrete surge suppression components made from technologies such as metal oxide varistors (MOVs) and gas discharge tubes (GDTs). These components are mounted on printed circuit boards (PCBs). These components are used to create types 1, 2, and 3 surge-suppression and component assemblies.

Figure 1: Circuit breakers in relation to type 1 through 3 devices.

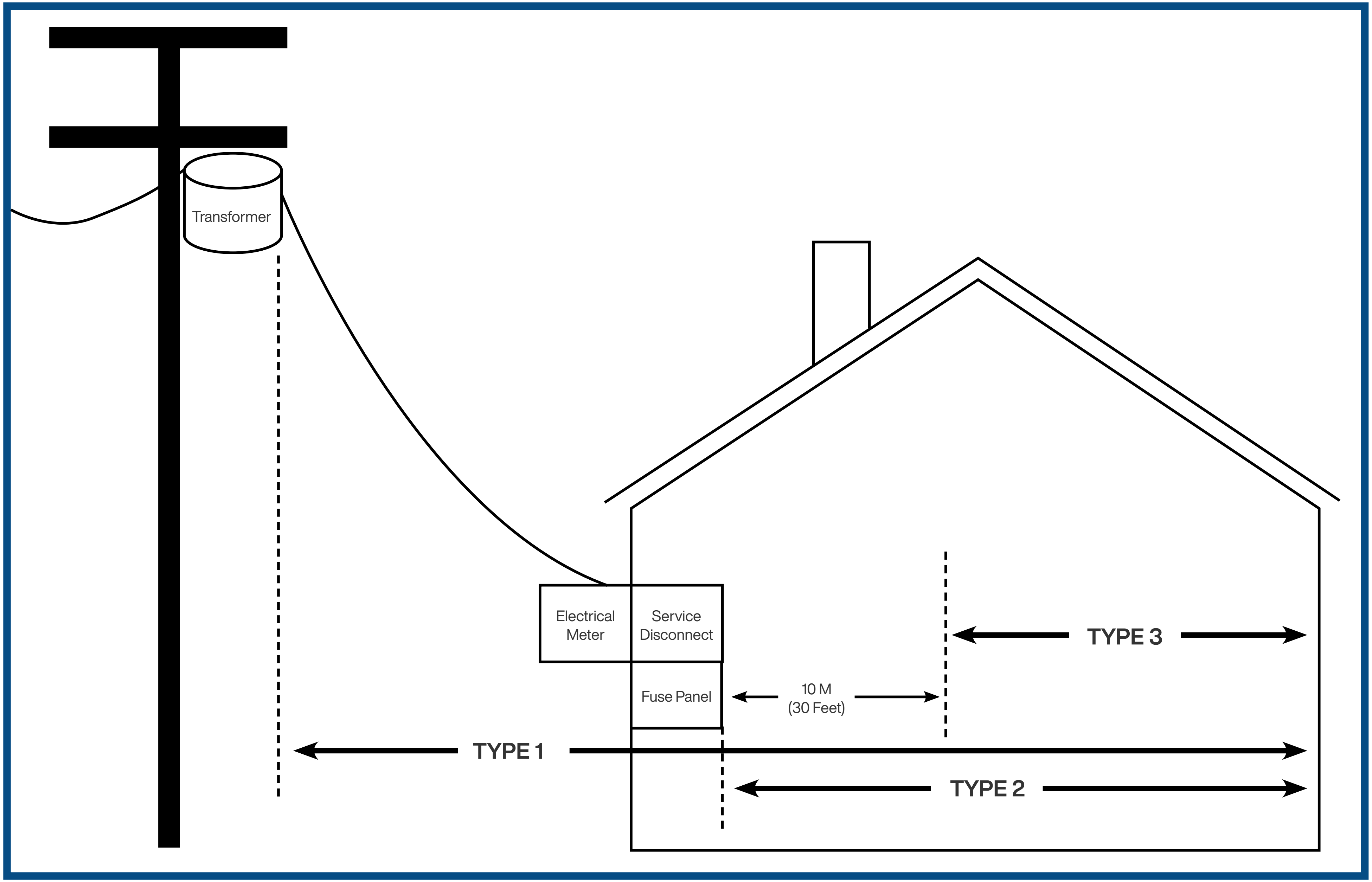
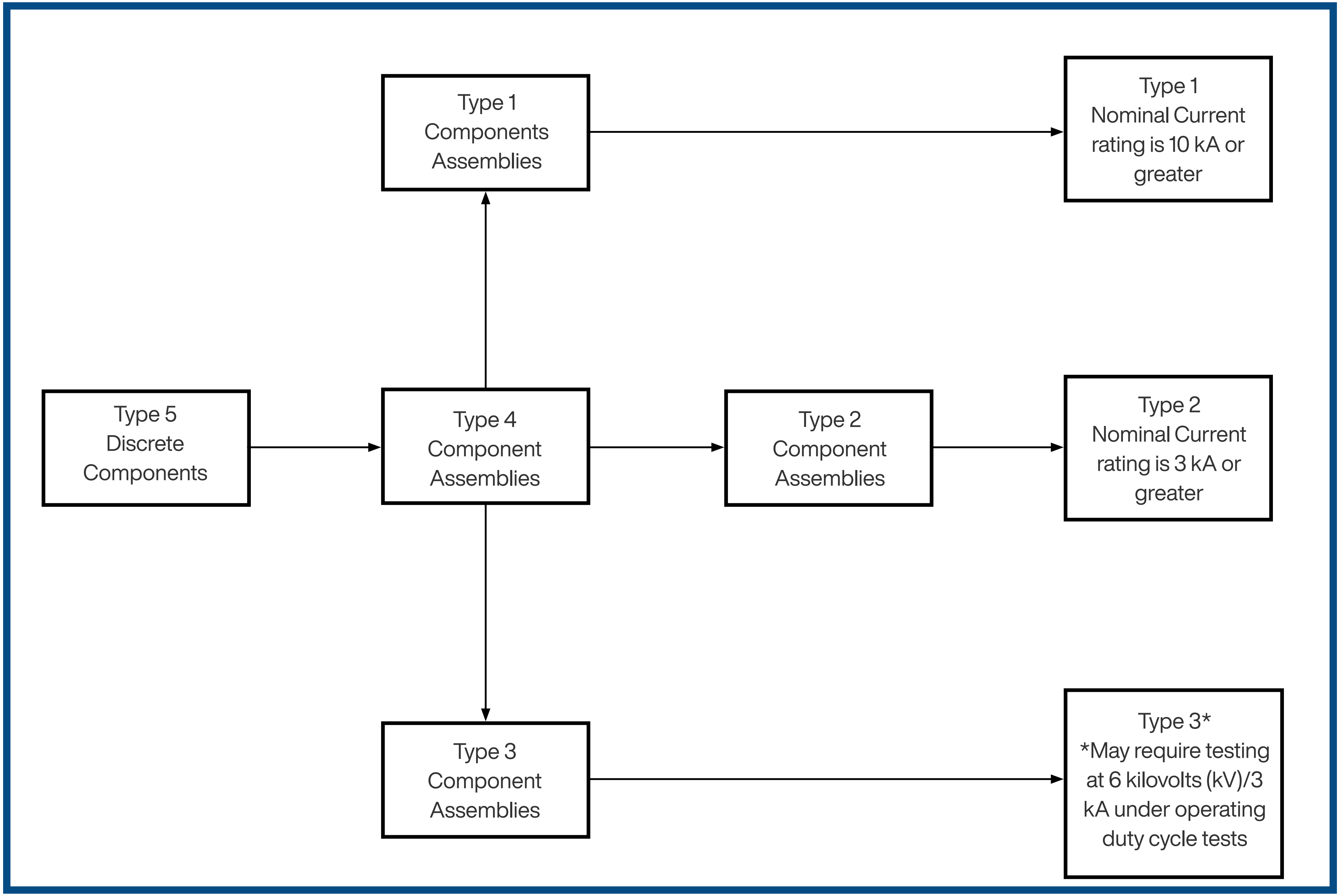


Figure 2: Breakdown of type 1 through 5 devices.



In addition to the variations of different types of surge-suppression components, regulatory standards specify ratings for voltage and power dissipation under different application scenarios.

The challenge for engineers is determining the right level of protection for a particular application, and then meeting a required specification in the most cost-effective way. These requirements can include everything from “price is no object” and “failure is not an option” to “we just want to meet the minimum requirement: Give me the lowest cost.”

Different surge-suppression technologies have different costs and performance characteristics. To further complicate the choices, a decision is often driven by mandates from procurement about component costs. Engineers often pick a solution and hope for the best, but decisions that are not well considered can have costly downstream consequences in the form of high product failure rates and an unacceptably shortened usable life.

To navigate this balancing act successfully, engineers need to understand application specifications and fully consider the benefits and trade-offs of different surge-suppression technologies. It all starts with an understanding of exactly how transient power surges can damage electronic components.

“It is possible that the lowest cost solution to surge protection is the best solution. But the chosen solution might not seem to be the lowest cost until such problems as failed unit returns are taken into account.”

Eddie Aho,
Power Supply Design Engineer,
KissAnalog

Key Points

- A *power surge*, or *power transient*, is a brief increase in voltage that has the potential to damage equipment.
- Effective surge protection has become a critical design consideration to help ensure operational reliability of consumer products and industrial equipment.
- Applications may require compliance with a particular type of surge protection specified by national or international standards.

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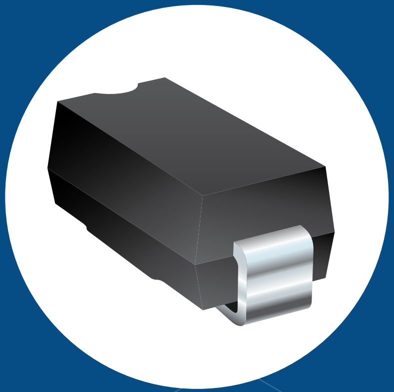

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Chapter Two

Understanding the Engineering Challenges

Electrical systems and devices are designed to work within an acceptable variance of nominal voltage, which often fluctuates based on internal and external factors. For instance, the standard voltage in a home in the United States is 120 V. That voltage will vary, but any voltage that exceeds a peak of 212 V is considered a power surge. A product designed to run on the standard 120 V must be able to handle normal voltage fluctuations, and some products are also required to survive power surges. As a general rule for most circuits, any voltage above 125 percent of nominal voltage is a power surge.

Power surges are additive or subtractive overvoltages that typically last for less than a half cycle of the normal voltage waveform. They cause a disturbance in the waveform that varies in duration from a few microseconds to milliseconds. During that time, the power surge can range from the 125 percent level to many thousands of volts.

Studies indicate that 20 percent of transient voltages are external, coming from lightning and power utilities. The other 80 percent come from internal sources, such as load switching and inductive coupling. Voltage surges often reach a circuit through a combination of coupling types, such as a direct connection of circuits (galvanic coupling) and near-field interference (inductive and capacitive coupling, also referred to as *electromagnetic interference* [EMI]). Understanding the effects of power transients is complicated because of the way different coupling mechanisms can overlap to create damaging transients.

"Most electrical components have safe working limits–be it voltage, current, power. If any of these are exceeded during a surge–overvoltage, overcurrent, overpower, etc.–then the component is destroyed."

George Burlacu,
Compliance Engineer,
GVA Lighting, Inc.

For instance, because of the magnetic field around a bolt of lightning, the lightning does not need to strike something directly to induce voltage surges. A nearby lightning discharge can induce a voltage surge in outside power lines coming into a building as well as the building's metal frame. Inductive coupling inside the building can also create voltage transients in data lines located near power lines; electrical conduits; metal building structures; or devices that emit EMI, such as fluorescent lighting.

> **A household power source can easily see surges of 600 volts. This destroys some devices, not others. But take a 10,000-volt surge during a lightning strike: this blows almost everything up–even kitchen appliances. You have to watch even those devices that have never had a problem before.**

Wayne Dossey
Strategic Marketing Engineer, Bourns, Inc.

Power surges cause damage by creating excess heat. Although large overvoltages can destroy practically any electronic component or device, it is the smaller, recurring surges that cause the most frequent damage, especially for low-voltage integrated circuits (ICs) found in control systems widely used in industrial equipment and consumer appliances. To make these controllers more compact and efficient, engineers design them to operate at lower voltages. Although this approach is good for product design, it also makes those devices more susceptible to damage from power surges.

"In household appliances, there is no guarantee against problems related to overvoltage discharges. This constitutes damage to the manufacturer's image that is not easy to assess, and in fact, is not even normally considered."

Ivan Fumagalli,
Project Manager,
Robertshaw

Power surges interfere with electronic equipment and components in several ways:

- **Operational disruption.** Industrial equipment and devices of all kinds are managed by controllers that depend on processors that use precise signaling to perform control functions. Power surges can create false signals or disrupt clock cycles in ways that many times interrupt normal control functions and can even cause software crashes in the controller. In industrial operations, reliability is everything. Failed control systems result in costly downtime and can create extremely dangerous conditions.
- **Equipment degradation.** Repeated exposure to low-level voltage surges degrades electronic components. For example, excessive heating of traces on circuit boards may cause microcracks in the boards. These tiny cracks grow over time. This kind of damage usually does not cause the component to fail immediately, but normal use of the component typically aggravates the damage, and additional power surges accelerate the degradation. These damaged components often exhibit unusual behavior that is difficult to troubleshoot or diagnose. Eventually, the component fails and must be replaced long before its expected end of life.
- **Total destruction.** High-voltage surges create heat that melts insulation between conductors, destroys PCBs, and burns out ICs. This damage is usually obvious and instantaneous and always requires replacement of the damaged components or boards.

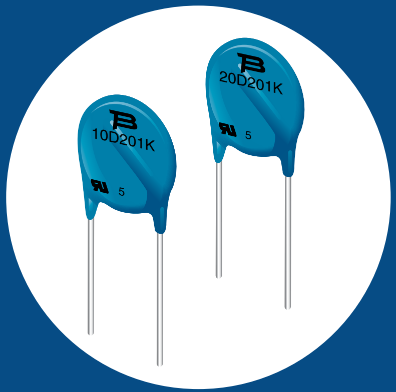
The preferred method of protecting equipment and components against power surges is to block excess voltage. That requires applying surge suppression at a point in a circuit that protects all downstream devices and equipment, such as including overall building surge suppression, incorporating surge suppression into the devices and equipment themselves, or both. Engineers tasked with designing a surge-protection solution face several technology choices. The first step in making the right surge suppression choice is to develop a good understanding of surge-suppression technologies.

"Transient power surges can affect the internal insulation of electrical machines and cause them to degrade long before their original lifespans. This is termed as 'chronic degradation.'"

Nida Qamar,
Project and Design Engineer,
Eaton

Key Points

- Electrical systems and devices are designed to work within an acceptable variance of nominal voltage. Power surges are additive or subtractive overvoltages that exceed this range.
- Understanding the effects of power transients is complicated because of the way different coupling mechanisms can overlap to create damaging transients.
- Power surges in electronic equipment and components can cause operational disruptions, equipment degradation, or total destruction.



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Chapter Three

Understanding Surge-Suppression Technologies

In the presence of normal circuit voltage, a surge-suppression component is nonconductive. When a power transient occurs, the surge-suppression device works by quickly changing state to provide a low-resistance path for diverting excess energy to ground. This process limits overshoot voltage before it has time to damage a circuit.

Surge-suppression technologies behave in different ways, and each has its advantages and disadvantages. The essential characteristics of these different approaches are described through basic surge suppression concepts:

- **Breakdown voltage.** The minimum voltage at which the surge-suppression component will conduct, typically measured at 1 milliampere.
- **Clamping voltage.** The maximum voltage the surge-suppression component will allow to pass to the downstream circuit or equipment, typically measured at maximum surge current.
- **Power dissipation.** The amount of power a surge-suppression component can withstand; exceeding this specification can destroy the surge-suppression component.
- **Leakage current.** The current drawn by a surge-suppression component when there is no surge and it is operating below its breakdown voltage.

"It is essential to look at many aspects of surge protection, such as acquiring immediate technical support, on-site support, vendor relationship management, and ensuring future improvements."

Sneha Gindodiya,
Powertrain DFM Engineer,
Lucid Motors

- **Response time.** The time it takes a surge-protection component to begin protecting after it is subjected to a power surge, typically measured in nanoseconds (ns) or microseconds (µs). Different surge-suppression technologies provide different response times; it is important that the surge-protection solution respond fast enough to prevent a voltage spike from damaging the protected circuit.
- **Maximum surge current.** The highest amount of current a surge-suppression component is rated to conduct so that the other operational specifications are met and the expected service life is attained.

> **Industrial equipment requires far more protection than consumer technology: it’s exposed to higher surge environments and requires a much higher cost to be protected.**

Wayne Dossey
Strategic Marketing Engineer, Bourns, Inc.

Table 2 lists the most common surge-suppression technologies and their general operational characteristics.

“To overcome the issue of overvoltages, engineers use components that short-circuit the voltages that exceed their working range. However, there are still problems if the right precautions are not taken to connect to the main voltage.”

Ivan Fumagalli,
Project Manager,
Robertshaw

Table 2: Common Surge-Suppression Technologies

Type	Description	Operational Characteristics
MOV	A variable-resistance resistor made from metal oxides and ceramic powders sandwiched between electrodes; resistance changes when a specific voltage is applied, opening a conductive path between electrodes and clamping line voltage at that level	Fast response times (typically 10-20 ns), with good power dissipation characteristics; MOVs connected in parallel increase current-handling capability. When connected in a series, they increase voltage rating. MOV clamping voltage rises with current. Additionally, MOV performance degrades from repeated exposure to power surges, which means that an MOV will become less effective with age. Finally, MOV capacitance typically ranges from 100 picofarads (pF) to several nanofarads (nF) (depending on sizes and voltages).
GDT	A gas-filled tube with electrodes at each end; at a specified voltage, a high current arcs between the electrodes to provide a conductive path, shunting the surge to ground	Slower response time than other surge-suppression technologies but able to conduct very high current and dissipate considerable power levels. Once a GDT is activated, it continues to conduct even when voltage drops below its activation voltage, which is an important consideration in some applications. Because of slower response times, GDTs are often used in conjunction with other surge-suppression technologies. GDTs add a small capacitance (typically < 2 pF) to a circuit.
Transient voltage suppression (TVS) diode	A particular type of junction diode with larger-than-normal junction cross-sections capable of conducting large currents; at a specific voltage, an avalanche breakdown occurs that creates a path for current across the junction between two electrodes and clamping line voltage at that level	TVS diodes have fast response times (measured in picoseconds) and can protect against high voltages, but they have lower power dissipation capabilities than other technologies. TVS diodes add moderate capacitance to a circuit, and they do not degrade over time, which gives them a long service life if operated within their specified ratings.
GDT-MOV GMOV™ and IsoMOV™ hybrid components	These devices combine a GDT and an MOV in one hybrid component; MOVs and GDTs are often used together to take advantage of their respective strengths	These devices have a moderate response time of 1 to 2 μs. A hybrid GDT-MOV component provides more effective, long-lasting surge protection in a smaller package. The GDT prevents leakage current so the MOV is protected against age degradation. The MOV provides a minimum voltage breakdown, which can prevent the GDT from entering a holdover current event and failing from excessive heat. A holdover current event occurs when enough current is available after the surge event to keep the GDT in the arc mode indefinitely.

These surge-suppression technologies are designed to block brief overvoltage power surges. They will not withstand sustained high currents. Under those conditions, the components can fail in ways that damage themselves and the protected circuit. For that reason, surge-suppression technologies are typically used along with other complementary overcurrent protection. For example, a properly rated fuse upstream from overvoltage surge protection will protect both the circuit and the surge suppressor if high current continues after the surge protection has blocked an initial voltage spike.

Overcurrent protection technologies often used in conjunction with power surge suppression include the following:

- **Fuses.** Provide slow, moderately accurate overcurrent protection against moderate to high currents. Fuses are self-sacrificial: After they do their job, they must be replaced.
- **Positive temperature coefficient (PTC) thermistors.** PTC thermistors are temperature-dependent resistors whose resistance increases with temperature. If an overcurrent condition occurs that causes the PTC thermistor's temperature to rise, its resistance will increase. The greater its resistance, the hotter it gets, effectively blocking current to the protected circuit. When the PTC thermistor cools, it will reset and conduct once again. PTC thermistors have a slow response time and low current rating, but they are relatively accurate. Under the right conditions, they can be used instead of a fuse.
- **Electronic current limiters (ECLs).** ECLs are self-contained electronic circuits that act as switches to open the series circuit when it detects a current over its maximum operating current. After the surge voltage has been removed, it returns to the low impedance conducting state.

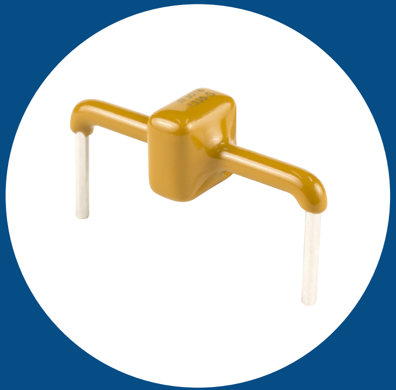
Clearly, there are many performance characteristics and technology configurations to consider when designing a surge-protection solution. Making the right choices for application-specific requirements is the essence of the engineering balancing act.

"Not only is the cost of lost time and repairs unacceptable, but the cost of customer confidence is almost the most important consideration of all. It is difficult to put a price on."

Eddie Aho,
Power Supply Design Engineer,
KissAnalog

Key Points

- When a power transient occurs, the surge-suppression device works by quickly changing state to provide a low-resistance path for diverting excess energy to ground.
- Different surge-suppression technologies behave in different ways, and each has its advantages and disadvantages.
- Surge-suppression technologies are typically used along with other complementary overcurrent protection.



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Making the Right Surge-Suppression Technology Choices

Choosing the right surge-suppression technology depends on several factors. Because so many variables come into play, no one solution fits all circumstances.

The starting point for most applications is the applicable regulatory requirement. For instance, a design requirement may come to the engineering team with a surge suppression specification based on a regulation related to the device category and use case. These regulation-based specifications are minimum specifications, typically grounded in safety considerations. The solution must meet that minimum specification to be certified or compliant.

> **Whatever the electrical device is, for as long as it has any kind of voltage, it will always be susceptible to an overvoltage event.**

Thomas Tran
Technical Marketing Manager, Bourns, Inc.

It is often desirable to exceed a minimum specification. The replacement cost of a piece of equipment may be high enough that it makes sense to build in considerably more protection than the minimum requirement. Other factors include the critical nature of a particular application, such as the risk of power surges in a particular application; the need for high reliability; or an expectation of a long service life.

> "The pricing of surge protection does matter, but there is more to the story. For instance, an organization with a strict budget allocation and temporary needs should choose a low-cost solution that meets minimum requirements."

Sneha Gindodiya,
Powertrain DFM Engineer,
Lucid Motors

Underlying all these considerations are the basic economics of the product or solution. It is important to recognize that economic considerations go well beyond the cost of building a product. One must also consider the costs of repairing and replacing failed devices, supporting a warranty program, and a possible product redesign if inadequate surge suppression results in a high failure rate. These costs can far outweigh any savings that come from economizing on surge-suppression during the initial design.

Economic and market considerations can also result in different engineering solutions to meet the same specification. For instance, hard-wired smoke detectors are designed to last 10 years, and they must meet a surge suppression specification to ensure reliability. One manufacturer may approach this problem by designing a low-cost detector with the fewest components possible and surge suppression that meets the specification for protecting those internal components. Another manufacturer may decide to make a premium smoke detector with more sophisticated processing circuitry. Because those components will be more susceptible to power surges, the design should include stronger surge-suppression. Both devices were designed to meet the regulatory standard, but because of how they are built, they meet the same standard using different surge-suppression technologies.

Table 3 lists different surge-suppression types, applications for which they are commonly used, and relative costs compared with each other.

"In a case of equal performance solutions, cost may determine which solution to adopt. But this is rarely the case, as the components likely differ in performance. The best approach is to first choose the better performance."

George Burlacu,
Compliance Engineer,
GVA Lighting, Inc.

Table 3: Surge-Suppression Technology Types and Their Typical Applications

Type	Applications	Cost
MOV	Low cost and reliability make MOVs good for many general-purpose, high-voltage, or high-current applications that require fast response time: power supplies and power systems, line voltage protection, telecom systems, and appliances. They are best for applications that see short-duration overvoltage pulses. MOVs do not stand up well to sustained overvoltage.	$
GDT	With the highest power-dissipation capabilities of available surge-suppression technologies, GDTs also have virtually no leakage current and low capacitance, but they are slow to respond to voltage spikes. GDTs are good for protecting large arrays of galvanically connected devices and other downstream surge-protection technologies. They are often installed externally to protect against lightning strikes, but they can also be made small for space-limited applications. GDTs are used to protect telecom customer premises equipment, industrial communications, and high-density PCB assemblies and are used in conjunction with other surge-suppression technologies.	$$
TVS diode	Fast response time and low to moderate capacitance make TVS diodes ideal for protecting high-speed data lines, low-voltage direct current (DC) applications, computers and peripherals, communication systems, audio and video equipment, portable instrumentation, and handheld portable devices. High-power versions are good for high-power DC bus protection. They have lower power dissipation capabilities than other surge-suppression technologies, and significant overcurrent conditions will destroy them. If they are used within their operational range, however, they should have a long life.	$$$
GDT-MOV hybrid	This type combines the advantages of the high power dissipation and low leakage that GDTs provide with the fast response time of MOVs. Alternating current (AC) applications include AC line protection, appliances, power line communications, smoke alarm systems, high-value consumer goods, and industrial equipment. DC applications include DC line protection, solar inverters, power supplies and distribution systems, and high-efficiency power systems.	$$$

Within each technology type is a range of components that vary in their voltage, power, operating temperature ranges, and other electrical specifications. To choose the right surge protection components for a given application, you must minimally determine the following elements:

- **Maximum continuous operating voltage; maximum reverse working voltage.** Choose a component with a maximum rated voltage that is higher than the line voltage.
- **Peak current.** Choose a value larger than the maximum current that will flow during a surge event; measured in amps.
- **Peak power.** Choose a value larger than the peak power that a surge event generates; measured in watts.
- **Clamping voltage.** Choose a value that is below the minimum voltage that the downstream circuitry can withstand during a surge event.

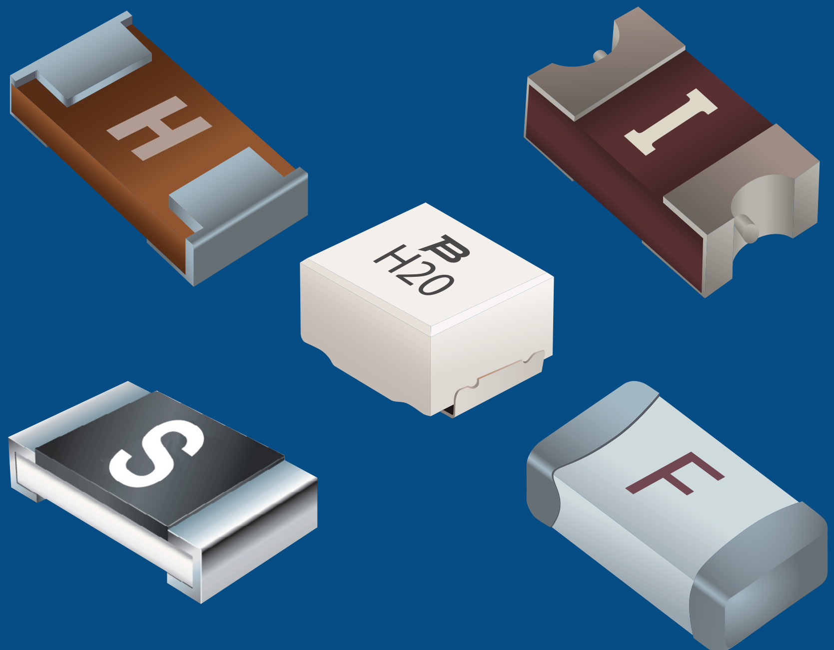
In practice, these calculations are complex. Also, most surge-suppression solutions work in conjunction with other surge- and current-limiting technologies installed internally and externally to a facility. Because of the many physical and economic factors involved in choosing the right technology, consider support from a component vendor so that you can make the best choices.

"It can be said that the production costs of inserting adequate protections should always be commensurate with the cost of returns from the field, as well as with the level of customer satisfaction."

Ivan Fumagalli,
Project Manager,
Robertshaw

Key Points

- No one solution solves all surge-protection problems.
- Economic and market considerations can result in different engineering solutions to meet the same specification.
- To choose the right surge protection components for a given application, you must consider the required voltage, current, power, and other electrical specifications.



Don’t Forget the Importance of the Vendor or Supplier

One of the big challenges in designing a solution is the amount of testing required to validate a particular surge-suppression scheme. Good tech support from a vendor can lead to a solution much faster and minimize the amount of testing needed to validate it.

Knowledgeable and supportive vendors with product offerings that span the spectrum of surge-protection technologies can do more, however. They will work with you to balance the many engineering and cost considerations that go into a surge-suppression design. There is always the risk of over- or under-designing a protection scheme. If you are willing to share certain details of your design, the component vendor can provide accurate advice about which technologies you should use and the trade-offs of different approaches to your solution.

Today’s reality is that more low-voltage control systems and sensors are integral to the function of high-value and operationally critical equipment. Designers are learning that effective surge-suppression components contribute to a positive and highly competitive foundation of improved reliability and a longer service life in a range of industrial and consumer products. A highly experienced and supportive vendor of surge-suppression components can play a key role in the design of a successful product.

“Technical support is crucial in any field. For manufacturers, it’s a chance to receive and act on feedback from those interacting with their products. For customers, it’s a chance to get real-time support on the problems that only the manufacturer can tackle.”

Sneha Gindodiya,
Powertrain DFM Engineer,
Lucid Motors

Key Points

- Good tech support from a vendor can lead to faster surge-suppression solutions with minimal testing needed to validate them.
- Knowledgeable and supportive vendors can work with you to balance engineering and cost considerations.
- Surge-suppression components from highly experienced vendors play a key role in improving the reliability and service life of a product.

Learn More About Our Experts

Thomas Tran, Technical Marketing Manager, Circuit Protection Division, Bourns, Inc.

Thomas Tran is the Technical Marketing Manager and Sr. Technical Marketing Engineer for the Circuit Protection Division at Bourns, Inc. Thomas has over 20 years of experience in circuit protection and manufacturing, equipment design, and application development. He holds a BSEE degree from the Institute of Electronic Technology in Louisiana. He is currently Vice-Chair and Secretary of the IEEE PES-SPDC. Thomas is involved with the IEC SPD in the working groups of 37A and 37B.

Wayne Dossey, Strategic Marketing Engineer, Circuit Protection Division, Bourns, Inc.

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Ivan Fumagalli is a Project Manager specializing in gas applications in the domestic product market. He focuses on finding new, innovative, solutions to improve products and make them work more efficiently. He is currently responsible for the development of many new and innovative products that he hopes will improve the consumer experience.

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Eddie graduated from Weber State University with a BS EET degree. He has worked in the Military Defense Industry and Military SPACE division and received the 'Engineering Excellence Award' from Boeing for finding a problem with the power supply used in the International Space Station. He has also designed the power supplies for the first HDTVs, medical laser devices, and lighting protection devices.

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Nida Qamar is an Electrical Engineer who designs medium-and-high voltage systems for a well-reputed organization. She has expertise in switchgears, transformers, and switchrooms. She has undertaken various large-scale projects and has managed them with cost-effective solutions. She completed her master's in controls engineering and plans to work in the field of artificial intelligence and fuzzy logic in the future.

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Sneha Gindodiya is a DFM Manufacturing Powertrain Engineer at Lucid Motors. She is responsible for leading new automotive manufacturing equipment design, installation, and process optimizations. In recent years, Sneha has emerged as a resourceful manufacturing engineer and has also worked in the aerospace industry. Sneha holds a bachelor of science in aerospace engineering from the Illinois Institute of Technology.

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