Why Buy from TTI?

Founded in 1971, TTI has steadily grown to become the world’s leading interconnect, passive, electromechanical and discrete component distributor in the industry. The company was founded on the premise that passive component purchasing could be made more efficient by offering product specialization, customer-driven service and proprietary supply chain solutions.

Product Experts

Our unique specialization enables us to provide significantly better product knowledge to support manufacturing from design through production. TTI’s commitment to this specialty and our customers is as dedicated today as always.

Broader and Deeper Inventories

TTI maintains extensive inventories, stocking more than 500,000 part numbers in North America and over 850,000 globally – that’s more interconnect, passive, electromechanical and discrete inventory available than from any one other source.

Advanced Inventory Management (AIM) Platform

TTI’s proprietary system is specifically designed for managing IP&E products and partnerships with premier manufacturers. This allows us to provide the BOM coverage necessary to deploy comprehensive supply chain solutions that reduce total cost of ownership and mitigate line down risk.

Quality and Reliability

TTI was the first distributor to have all global warehouse locations ISO registered and currently are rated ISO 9001:2008 and AS9100C in North America, ISO 9001:2008, EN 9100C and EN 9120:2009 in TTI Europe and ISO 9001:2008 in TTI Asia.

Year after year, customers rate our inventory availability, on-time delivery and accuracy among the very best in the industry – call 1.800.CALL.TTI or visit us at www.ttiinc.com and discover why.
Table of Contents

- What is Circuit Protection? ................................................................. 4
- Common Circuit Protection Threats .................................................. 6
- Electrostatic Discharge (ESD) ............................................................ 8
  - AVX .......................................................... 10
  - BOURNS* .................................................. 12
  - Bussmann by Eaton ................................................................. 14
- Applications ..................................................................................... 16
  - KOA SPEER ELECTRONICS, INC. ........................................ 18
  - Littelfuse® ............................................................................... 20
  - muRata ...................................................................................... 22
  - Panasonic .................................................................................. 24
  - TDK ........................................................................................ 26
  - EPCOS ..................................................................................... 28
  - TE Connectivity ......................................................................... 30
Circuit protection is an insurance policy. Most customers buy circuit protection never planning to use it, but it is critical to protect circuits from unexpected, damaging surges of current and voltage. Two types of circuit protection are available: overcurrent and overvoltage.

What is Overcurrent Protection?
An overcurrent condition is caused by excessive current (more than the maximum amount of current a product is designed to withstand under normal conditions) passing through a circuit. Overcurrent conditions have the potential to cause severe damage to a circuit, possibly leading to fire. Overcurrent protection is placing a component, usually a standard fuse or a Polymer Positive Temperature Coefficient (PPTC) resettable fuse or a Positive Temperature Coefficient (PTC) thermistor, in series with the device being protected. Standard fuses interrupt the current flow and PPTC resettable fuses and PTC thermistors limit the current to an acceptable level during overcurrent conditions, thus preventing catastrophic events. When no overcurrent condition exists, these products lie dormant within the circuit with a minimal amount of resistance to the circuit.

What Technologies are Available to Provide Overcurrent Protection?
TTI carries three technologies classified as overcurrent devices to provide protection to customers: 

- **Fuses**, PPTC resettable fuses and PTC thermistors.

How Overcurrent Protection Products Operate?
- **Standard Fuses**: Fuses are an intentionally weak link in a circuit. A standard, one-time fuse with the correct rating will open or “blow” before the circuit reaches a damaging level or fire hazard. The event of the opening breaks the circuit and prevents current from flowing past that point. A standard fuse will open once and then must be replaced.

- **Resettable Fuses**: A resettable fuse does not open like a standard fuse. Rather it creates a very high resistance that prevents most of the current from flowing past it into the device on the circuit being protected. The resettable fuse then “resets,” as the name implies, once the overcurrent condition subsides.

- **PTC Thermistor**: Similar in function to a resettable fuse, a PTC thermistor creates a very high resistance to the current at a particular temperature caused by additional current. This temperature (called “switching temperature”) shelters the device from overheat or overcurrent. Once the overheat or overcurrent event is removed, the thermistor will cool down and reset, just like a resettable fuse.

Why is Overcurrent Protection Important?
There are three main reasons why overcurrent protection is needed in a circuit: **safety, reliability and compliance**.

- **Safety**: Using circuit protection helps guarantee safety as it protects from catastrophic events such as large surges of current that could cause fires.

- **Reliability**: Using overcurrent protection provides the reliability that components will be protected in the event that an overcurrent condition occurs. It also provides assurances that when the condition is cleared; the product will continue to function.

- **Compliance**: Many agencies (e.g. UL, CSA, VDE, etc.) now require circuit protection in electronic devices.

Where is Overcurrent Protection Needed?
All circuits and applications need overcurrent protection.
What is Overvoltage Protection?
Like overcurrent protection, overvoltage protection is the safeguarding of products from overvoltage conditions. Overvoltage conditions are often called “transients,” and are defined as short duration spikes in voltage resulting from a sudden release of previously stored energy. overvoltage conditions can be short or prolonged. Most applications will require both overvoltage and overcurrent protection for the circuit.

What Causes an Overvoltage Condition?
An overvoltage condition is caused by a variety of factors, including but not limited to: transformers converting energy from one voltage to another, lightning, electrostatic discharge (ESD), motor start-ups, and automotive load dumps.

Why is Overvoltage Protection Important?
There are many factors that require overvoltage protection. They include, but are not limited to the following:
- 75% of field equipment failure is caused by Electrical Overstress (EOS)
- With increasing speeds, semiconductor devices are becoming increasingly sensitive to voltage transients
- Lightning strikes even several miles away can induce transient voltages into equipment
- ESD events at 8kV or higher can be damaging to ICs that are internally protected to 2kV

What Overvoltage Protection Devices are Offered by TTI?
TTI offers several options to limit excessive voltage experienced in today’s circuits. These are: metal-oxide varistors (MOV), multi-layer varistors (MLV), protection thyristors, TVS diodes, diode arrays, gas discharge tubes (GDT) and polymer suppression devices.

How do Overvoltage Protection Devices Work?
These devices can either clamp or crowbar the undesired voltage to protect the circuit.

Clamping devices are devices placed parallel to components being protected. When an overvoltage condition arises, the device goes from an extremely high impedance to one of almost zero, permitting the transient to follow the path of least resistance through the clamping device. The device then clamps at a voltage above the standard operating voltage, but below the level that would damage the device being protected. This additional voltage is dissipated by absorbing part and shunting the rest to ground. TTI offers clamping devices that include MOVs, MLVs, TVS diodes, diode arrays and polymer suppression devices.

Crowbar devices are placed parallel to components being protected and change from very high impedance to very low impedance during an overvoltage event, but energy is dissipated differently. During an overvoltage condition, these devices operate like a switch, turning on to a low voltage state that is well below the normal operating voltage of the circuit. All energy is then shunted straight to ground and dissipated. TTI offers two crowbar devices, GDTs and protection thyristors.

CIRCUIT PROTECTION COMPONENTS AVAILABLE FROM TTI

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Resettable Fuse</th>
<th>Standard Fuse</th>
<th>Thermistors</th>
<th>Varistors</th>
<th>Thyristors</th>
<th>GDT</th>
<th>TVS Diodes</th>
<th>Diode Arrays</th>
<th>ESD Suppression</th>
<th>Polymer Suppression</th>
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</thead>
<tbody>
<tr>
<td>AVX</td>
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<td>TDK EPCOS</td>
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<td>TE Connectivity / Raychem</td>
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</table>
Common Circuit Protection Threats

**Overcurrent**

**Product Safety**

<table>
<thead>
<tr>
<th>Threat</th>
<th>Description</th>
<th>Solution Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Faults</td>
<td>Occur when electricity travels to ground outside the design’s intended pathway.</td>
<td>Fuses, Resettable Fuses, Thermistors</td>
</tr>
<tr>
<td>Current Transients</td>
<td>Occur momentarily in response to a change in the equilibrium of a circuit and frequently when power is applied to, or removed from, a circuit.</td>
<td>Protection Thyristors, Varistors, TVS Diodes, Gas Discharge Tubes</td>
</tr>
<tr>
<td>Circuit Overload</td>
<td>Occurs when an electric circuit is carrying more current than it’s designed to handle, potentially creating a fire hazard due to overheating.</td>
<td>Polymer ESD suppressors, ESD Diode Arrays, Multi-Layer Varistors</td>
</tr>
</tbody>
</table>

**Overvoltage**

**Product Reliability**

<table>
<thead>
<tr>
<th>Threat</th>
<th>Description</th>
<th>Solution Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightning Transients</td>
<td>Can produce direct or more commonly “induced” current and voltage transients.</td>
<td>Protection Thyristors, Varistors, TVS Diodes, Gas Discharge Tubes</td>
</tr>
<tr>
<td>Electrostatic Discharge (ESD)</td>
<td>The sudden and momentary flow of electricity between objects with different electrical potentials caused by direct contact or induction.</td>
<td>Polymer ESD suppressors, ESD Diode Arrays, Multi-Layer Varistors</td>
</tr>
<tr>
<td>Inductive Load Switching</td>
<td>Switching of inductive loads within motors, generators, relays and transformers can create damaging current and voltage transients.</td>
<td>Varistors, GDTs, TVS Diodes</td>
</tr>
</tbody>
</table>

**Circuit Protection Threat Solution Matrix**

<table>
<thead>
<tr>
<th>Circuit Threats</th>
<th>Applications</th>
<th>Protection Needs</th>
<th>Protection Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overcurrent and Ground Faults</td>
<td>Grounded circuits and circuits near AC power lines</td>
<td>Current interrupting and voltage capability</td>
<td>Fuses, Resettable Fuses, Thermistors</td>
</tr>
<tr>
<td>Lightning</td>
<td>Any circuit connected to the outside environment</td>
<td>Quick responsiveness, switching, and surge capabilities</td>
<td>Protection Thyristors, Varistors, TVS Diodes, Gas Discharge Tubes</td>
</tr>
<tr>
<td>Electrostatic Discharge (ESD)</td>
<td>Circuits with human interfaces</td>
<td>Quick response with high peak voltage rating</td>
<td>Polymer ESD suppressors, ESD Diode Arrays, Multi-Layer Varistors</td>
</tr>
<tr>
<td>Electrical Fast Transients (EFT)</td>
<td>Circuits with inductive loads</td>
<td>Repetitive fast rise time and recovery</td>
<td>TVS Diodes, Varistors</td>
</tr>
<tr>
<td>Inductive Load Switching</td>
<td>Motors, pumps, compressors, relays &amp; AC distribution</td>
<td>High energy rating</td>
<td>Varistors, GDTs, TVS Diodes</td>
</tr>
<tr>
<td>Datacom Voltage Transients</td>
<td>Ethernet, DSL, data bus, telecom</td>
<td>Quick response, low parasitic capacitance</td>
<td>ESD Diode Arrays, Protection Thyristors</td>
</tr>
<tr>
<td>Current Switching</td>
<td>Various electronic and electrical circuits</td>
<td>Proper blocking voltage and current carrying capacity</td>
<td>Switching Thyristors</td>
</tr>
</tbody>
</table>
Overcurrent Events

Excessive current events can lead to catastrophic failures in electronic circuits. These failures can result in safety hazards such as fire, shock or explosion. Common types of overcurrent threats include:

Overload
Overloads can occur when more current is allowed to flow through a circuit path than it was designed to carry. This excess current can generate and accumulate heat and result in complete circuit destruction and possible fire, electrocution or explosion. Sources of overload include:

- Construction hazards cutting across power lines
- Equipment failure in the power grid
- Environmental hazards in the power grid
- Short spikes of energy within the circuit as a result of turning equipment on and off

Short Circuit
Short circuits occur when one conducting path comes in contact with another conducting path or with ground, such as may occur due to a loose wire, insulation breakdown or contact with water. These conditions can increase the likelihood of arcs, shock or fire hazards.

The principle forms of protection against overcurrent conditions include standard fuses, resettable fuses and PTC thermistors.

Their function is to limit current to acceptable levels and prevent catastrophic events, and during acceptable conditions act dormant with a minimal amount of resistance to the circuit.

Fuses will completely stop the flow of current when opened, which may be desired with sensitive, expensive or critical applications.

PTC resettable fuses and PTC thermistors offer the ability to reset and withstand most common and recurring overcurrent events. They will allow safe levels of current to pass continuously, and during major overcurrent events, increase in resistance as they heat to restrict the flow of current. When the overcurrent event ends, the device resets to its normal operating state.

Voltage Transient Events

Voltage transients are temporary short duration shortages or spikes. Unsuppressed, they may damage circuits and components and result in complete system failure. Below are descriptions of common types of voltage transients and technologies to reduce their effects:

Electrostatic Discharge (ESD)
Damage from ESD is generally caused by the transfer of static electrical charge from a human body to an electronic circuit. It may result in faulty circuit operation, latent defects and even catastrophic failure of sensitive components. ESD suppressors must have very fast response times and handle high peak voltages and currents for short durations.

Many modern ICs are ESD tested for protection using the human body model (HBM), otherwise known as MIL-STD-883.

Inductive Load Switching
Switching of inductive loads, such as those that occur with transformers, generators, motors and relays, can create transients up to hundreds of volts and amps, and can last as long as 400 milliseconds, affecting both AC and DC circuits.

Lightning Induced Transient
Most transients induced by nearby lightning strikes result in an electromagnetic disturbance on electrical and communication lines connected to electronic equipment. Devices that protect against these transients must have a fast response time and must be able to dissipate a large amount of energy.

Automotive Load Dump
Load dump refers to what happens to the supply voltage in a vehicle when a load is removed. If a load is removed rapidly (such as when the battery is disconnected while the engine is running), the voltage may spike before stabilizing and damage electronic components. In a typical 12V circuit, load dump can rise as high as 120V and take 400 milliseconds to decay – more than enough to cause serious damage.
Electrostatic Discharge (ESD) is an electrical transient that poses a serious threat to electronic circuits. As integrated circuits continue to shrink in size, they become more susceptible to less powerful transients and require additional circuit protection to guard against ESD. The threat of ESD is also greater as data communication rates continue to increase in speed, therefore requiring more specific ESD suppression solutions to ensure signal integrity.

Inherent capacitance of a device will disrupt data and can be a determining factor when selecting a device or the technology (silicon, polymer, etc.) for use.

ESD Protection Solutions

Ceramic
Multilayer Varistors (MLVs) are examples of ceramic-based electronic components used to protect circuits from transient voltages. MLVs are capable of handling significant surge energy for their size with wide operating voltages and are best suited for low to medium speed data signals (<125Mbps). MLVs higher capacitance rating is useful in applications that may have EMI filtering problems.

Silicon
TVS Diodes and Diode Arrays are silicon-based ESD protection components. Silicon solutions are typically used when board space is critical and multi-line protection is necessary. Silicon has properties of very low capacitance and leakage and are suited for both ESD and other transients such as lightning. Silicon ESD components cover the full range of data signals from 0-5 Gbps.

Polymer
Polymer-based ESD components are known for their extremely low capacitance, low leakage current and fast turn on time. Ultra-fast applications with high-speed data signals between 125 Mbps and 5 Gbps are targets for a polymer-based solution. Polymer-based solutions have lower capacitance and are currently less expensive than silicon-based solutions.

Protect the Connection

<table>
<thead>
<tr>
<th>Interconnect</th>
<th>Data Rate Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td>1.5 to 12 Mbit/s</td>
</tr>
<tr>
<td>USB 2.0</td>
<td>480 Mbit/s</td>
</tr>
<tr>
<td>USB 3.0</td>
<td>Up to 5 Gbps</td>
</tr>
<tr>
<td>Coaxial Port</td>
<td>Up to 10 Gbps</td>
</tr>
<tr>
<td>MIDI Port</td>
<td>Below 1 Mbit/s</td>
</tr>
<tr>
<td>HDMI (Type C&amp;D)</td>
<td>800 Mbit/s - 8.16 Gb/s</td>
</tr>
<tr>
<td>RJ11</td>
<td>Up to 1.1 Mbit/s</td>
</tr>
<tr>
<td>Display Port</td>
<td>1.6 Gb/s - 2.7 Gb/s</td>
</tr>
<tr>
<td>IEEE 1394 FireWire</td>
<td>400-3200 Mbit/s</td>
</tr>
<tr>
<td>DVI</td>
<td>3.9 Gb/s</td>
</tr>
<tr>
<td>RJ45</td>
<td>75 - 320 Mbit/s</td>
</tr>
<tr>
<td>D-Subminiature</td>
<td>1 - 7 Mbit/s</td>
</tr>
<tr>
<td>S-Video</td>
<td>.1 - .5 Mbit/s</td>
</tr>
<tr>
<td>DIN 41612</td>
<td>10 - 100 Mbit/s</td>
</tr>
<tr>
<td>Tactile Switch</td>
<td>Human interface</td>
</tr>
<tr>
<td>SIM Card</td>
<td>Human interface</td>
</tr>
</tbody>
</table>
AVX is a worldwide, leading supplier of circuit protection components for automotive, professional, industrial and commercial applications.

**Overcurrent**

**Fuses**

**AccuGuard® - Highly Accurate Surface Mount Thin Film Fuses**

In addition to the varied overvoltage solutions, AVX offers overcurrent solutions. AVX offers a line of highly accurate surface mount fuses with the lowest currents in the industry. These UL approved devices, manufactured using a highly repeatable thin film technology, are offered in case sizes from 0402 through 1206, and current ratings from 0.05A to 5A.

General applications include mobile phones, two-way radios, computers, LCD screens, digital cameras, battery chargers and rechargeable battery packs.

**Thermistors**

**NTC Thermistors**

AVX also offers a broad line of Negative Temperature Coefficient (NTC) thermistors suitable for automotive (AEC-Q 200 qualified) and commercial/industrial applications. AVX NTC thermistors include SMT thermistors in case sizes from 0603 to 1206, leaded disc thermistors, high accuracy radial thermistors, leadless disc and high accuracy chip thermistors. AVX can offer customized solutions to meet customer requirements such as specific resistance values and resistance tolerance, customized R-T characteristics, configurable coating and wires.

General applications include: outside temperature, air conditioning/heating systems, oil temperature, evaporator probe, water temperature, electric pump module, air intake temperature, seat heating, mobile phones, battery packs, battery chargers, LCD compensation, base stations, home appliances, industrial equipment and consumer electronics.
Varistors

**Multilayer Varistors**

AVX multilayer varistors with unique high-energy, multilayer construction represent state-of-the-art, overvoltage circuit protection and provide reliable protection from voltage transients caused by ESD, lightning, Electromagnetic Pulse (EMP), inductive switching, automotive related transients and more.

AVX varistors are available in standard EIA surface mount case sizes from 0201 to 3220, 2-element arrays in 0405 and 0508 cases, 4-element arrays in 0612 configuration, as well as a conformally coated axial and radial leaded configurations for use in through-hole applications.

AVX varistors are an ideal choice for a wide range of automotive, professional, industrial and commercial applications thanks to a broad range of voltage and energy rating options. In addition to the TransGuard® varistors, AVX also offers:

- Low capacitance and Sub-pF varistors for high speed data lines, RF circuits and other capacitance sensitive applications
- Communication Bus varistors for CAN Bus, Flexray and other capacitance sensitive applications
- Low leakage varistors
- Varistors for AC applications and LC resonant circuits
- Controlled capacitance varistors for targeted EMI/RFI filtering
- High temperature +150°C varistors
- High energy varistors
- Glass encapsulated varistors for harsh environment
- TransFeed Varistors – varistors with feedthru construction for ESD protection and enhanced EMI/RFI filtering

**AVX Varistors for Automotive Applications**

AVX automotive varistors are AEC-Q 200 qualified and provide unsurpassed reliability compared to other options used in transient voltage protection such as diodes.

AVX automotive AEC-Q 200 qualified varistors are the ideal choice for automotive circuit protection thanks to a wide range of automotive qualified components covering applications from low capacitance varistors for high speed data lines/RF circuits, up to high energy varistors for load dump and jump start requirements. The automotive qualified range of AVX varistors provides protection from voltage transients caused by ESD, inductive switching and automotive transients such as:

- Load Dump (ISO 7637-2-5)
- Jump Start
- ISO 7637 Pulse 1-3
- AEC-Q200-002
- ISO 10605
- ISO 16750-2
- CI-220
- CI-260

**TVS Diodes**

**TVS Diodes**

AVX TVS diodes for commercial and industrial applications are available in unidirectional and bi-directional configurations in industry standard sizes: SMA (400W), SMB (600W) and SMC (1500W). AVX TVS diodes are designed for general purpose transient inductive load protection in consumer, industrial and telecommunication applications and reverse power supply protection.

**Schottky Barrier Rectifier Diodes**

AVX’s innovative range of low profile surface mount Schottky diodes range from 0402 to 3220 case sizes with low-profile, high current capability, low VF design for commercial and industrial applications. Additional advantages compared to standard SOT Schottky diodes include: top-bottom symmetry for easier mounting, higher current density capability, high thermal dissipation and are mechanically robust. For use in switch mode power supplies, high frequency rectification, battery powered devices and reverse bias protection.
Bourns delivers the most comprehensive line of circuit protection technology and solutions in the industry. At our engineering centers we design a full range of overvoltage and overcurrent protection technologies. Bourns offers world-class technology and applications expertise that is the result of many years of circuit protection engineering, design and support. Bourns’ global reputation for extensive application knowledge, quality products, innovative protection strategies and a wide range of technologies ensures we can provide the right circuit protection solution for your needs. Bourns now offers the first and newest revolutionary circuit protection technology in a decade, enabling surge protection for sensitive electronic systems.

Overcurrent

**TBU® High-Speed Protectors (HSPs)**

Bourns® TBU® HSPs are circuit protection devices constructed using MOSFET semiconductor technology. When placed in series in the system, the TBU® HSP monitors the current flowing through the line. If the current exceeds a preset level, the TBU® HSP device triggers, providing an effective barrier to large, destructive voltages or currents during surge events, thereby protecting sensitive electronics. TBU® HSP devices are available in the following families: TBU-CA, TBU-CX, TBU-DT, TBU-KE, TBU-PK, TBU-PL, P40, P-G (P500-G, P850-G), C (C650 and C850), and P-U (P650-U and P850-U).

**Transient Current Suppressors (TCS™)**

Bourns® TCS™ HSPs are typically used in conjunction with low capacitance TVS devices to form an extremely low let-through energy barrier to excessive voltages or currents during surge events which may damage high-speed, low voltage driver and receiver components. By limiting the maximum current to a safe level, Bourns® TCS™ HSPs offer superior protection for very high data rate differential lines against faults caused by short circuits, induction and lightning surges.

The Bourns® TCS™ DL series products contain a dual, well-matched, low resistance, bidirectional and high-speed TCS™ device. The Bourns® TCS™ HSPs are provided in a space-saving, surface mount DFN package, meeting industry standard requirements such as RoHS and Pb Free solder reflow profiles.

**Multifuse® PPTC Resettable Fuses**

Protection for overcurrent is essential to the reliability and lifetime of electronics in a wide range of applications. The simplicity with which Bourns® Multifuse® Polymer Positive Temperature Coefficient (PPTC) devices fit into overcurrent protection circuits and freeXpansion™ technology make it an obvious choice. Bourns® Multifuse® PPTC resettable fuse is armed with Ohm’s law, interface standards and a powerful selection for a wide range of current and voltage requirements.

**SinglFuse™ Thin Film Chip Fuses**

The SinglFuse™ product line is designed to provide overcurrent protection for a wide range of circuits. These parts are offered in three industry standard sizes (0402, 0603 and 1206), and two fusing types (fast acting and slow blow).
Thyristor Surge Protectors
Bourns® offers a comprehensive portfolio of TISP® Thyristor Surge Protectors designed to provide excellent circuit protection against overvoltage conditions. Types available include unidirectional, bidirectional and programmable. Bourns® TISP® Thyristor Surge Protectors are designed to meet Telcordia GR-1089, UL 60950, FCC (TIA), ITU-T, IEC and YD/T compliance standards. Typical applications include Subscriber Line Interface Circuits (SLICs), 2-wire telecommunication equipment, xDSL and integrated linecards and VOIP protection.

Power TVS Products
Bourns® Power TVS (PTVS) products are high current bidirectional Transient Voltage Suppressor (TVS) diodes designed for use in AC line protection and high power DC bus clamping applications. These devices offer bidirectional port protection from 58 volts to 470 volts, and are RoHS and UL listed while also meeting IEC 61000-4-5 8/20μs current surge requirements. The use of silicon technology in the Power TVS products offer lower clamping voltage under surge compared to competing MOV technology. The devices are provided in through-hole and surface mount packages and meet industry standard requirements such as RoHS and Pb Free solder reflow profiles.

TVS Diodes
Chip diodes 0603, 1005, 1206, 1408, 2010 are leadless, allowing designers to make real estate savings on PCB layouts. The CDDFN2-TxxC series provides ESD and EFT protection for external ports of electronic devices such as cellular phones, hand held electronics and other portable electronic devices. The device is available in a DFN-2 package and will fit an 0402 footprint. Bourns® chip diodes conform to JEDEC standards, are easy to handle on standard pick and place equipment and their flat configuration minimizes rollaway.

Steering Diode Arrays
A new generation of chip diodes from Bourns® has emerged that offers the capability to provide a silicon diode with minimal packaging overhead. The SOT23 and SOT23-6 packages use 100% tin terminations. All Bourns® diodes are compatible with lead free manufacturing processes, conforming to many industry and government regulations on lead free components. Bourns® chip diodes conform to JEDEC standards, are easy to handle on standard pick and place equipment and their flat configuration minimizes rollaway.

LED Shunt Protectors (LSPs)
In LED lighting applications, solid-state lighting luminaries are commonly configured with long strings of multiple series LEDs driven from a relatively high voltage compliance, constant current power supply. The LSP product is designed to make the open LED failure mode tolerable. An open LED will cause a complete LED string to go dark, rendering the application useless or markedly compromised. This can lead to warranty returns or maintenance calls.

Gas Discharge Tube (GDTs) Surge Arrestors
Bourns® GDTs are used in primary and secondary applications and can withstand multiple applications of high surge current energy in excess of 25 KA. Bourns offers standard 8mm GDTs and a 5mm miniseries GDT in two and three electrode versions featuring long service life and low capacitance and insertion loss. An optional, proprietary switch-grade fail-short is offered on the three electrode versions to provide superior protection from thermal runaway.

Metal Oxide Varistors (MOVs)
Bourns® MOV product portfolio offers 7, 10, 14 and 20mm radial leaded varistor devices which protect against overvoltage transients such as lightning, power contact and power induction. The metal oxide varistors offer a choice of varistor voltages from 18 V to 1800 V and Vrms voltages from 11 V to 1100 V. The devices have high current handling, high energy absorption capability and fast response times to protect against transient faults up to rated limits.
Bussmann is now part of Eaton. Eaton is a diversified power management company providing energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power. A global technology leader, Eaton acquired Cooper Industries plc in November 2012. The 2012 revenue of the combined companies was $21.8 billion on a pro forma basis. Eaton has approximately 103,000 employees and sells products to customers in more than 175 countries. For more information visit, www.eaton.com.

With nearly a 100-year history of innovation, Bussmann – now Eaton Electronics has set the standard for circuit protection in many markets around the globe. Eaton Electronics has the right products to fit your application. With a constantly increasing portfolio including Bussmann branded fuses, ESD overvoltage devices and resettable overcurrent protection, Eaton Electronics is committed to continuous innovation to solve your circuit protection needs.

Overcurrent

**Brick Fuses**
Eaton Electronics offers a wide range of Bussmann brick fuses designed to carry high levels of current without excessive heat rise or efficiency losses. These fuses meet the market trend for increasingly smaller, higher current applications. The TCP series is designed to protect telecom equipment from overcurrents. It meets telecom regulatory standards including UL1959/60850.

**Chip Fuses**
Eaton Electronics provides 0603 and 1206 size chip fuses designed for high power, high pulse current applications. Our high melting energy designs reduce the chance of nuisance opens, maintain their performance over many pulse cycles and ensure reliable protection against fault conditions. The CC06H line now has current ratings up to 8 Amps while the CC12H line supports currents up to 12 Amps. Applications include LED lighting with radial fuses, input power protection with chip fuses and high speed signal port protection with our TVS diodes.

**Cartridge/Ferrule Fuses and Clips**
Eaton Electronics has a wide array of ferrule fuses for AC and DC primary side input power protection. Each fuse has leaded options for through-hole mounting or can be paired with a variety of PC board mountable clips. The large number of fuse clip options available ensure a solution for your specific application. A full line of panel mount and in-line fuse holders for wiring harness protection are also available. Available sizes include ¼", 5mm and 3mm.

**Radial Fuses**
The radial fuse line provides reliable fault protection for cost sensitive applications like LED lighting and white goods. A full line of SS-5 and SS-R products are available in both fast acting and time delay versions. Now available in 300Vac/100A rating, (SS-5H) for higher voltage and breaking capacity needs.

**Resettable (PPTC) Devices for Overcurrent and Over-temperature Protection**
The Eaton Electronics family of Bussmann branded PolyTron™ PTC devices is ideally suited for protecting applications sensitive to high ambient operating temperatures or subject to frequent overcurrent conditions. PTCs operate as a positive temperature coefficient device. High temperatures and excessive current will cause the device resistance to increase until it limits the unsafe current level. PTCs are commonly used in applications where constant uptime is required and/or in circuits not easily accessible by a user or service technician. PPTCs are available in surface mount and radial packages.
ESD Suppression

As communication speeds increase, so does the need for low capacitance ESD protection solutions. Eaton Bussmann provides a full line of TVS and Polymer based ESD solutions to protect your USB 2.0/3.0, HDMI, FireWire and Thunderbolt ports.

**TVSA Series**
TVSAs are discrete devices available in 0201 and 0402 sizes. These are silicon avalanche technology based ESD protection devices with low capacitance and sub-nanosecond response times for superior protection in a very small footprint.

**PolySurg™**
PolySurg™ ultra-low capacitance ESD suppressors are available in discrete and array solutions. Discrete devices are available in 0402 sizes with capacitance values down to 0.05pf. Our 412510ESDA is a four channel array providing <1ns response times, typical capacitance of only 0.1pf and leakage currents below 0.01μA.

**Multi-layer Varistor (MLV)**
Multilayer varistors are designed to protect electronic circuits from ESD damage. The MLVB series has the low capacitance necessary to protect a wide range of data speeds, including protection against high speed transient voltages, while the MLVA is available in 0201, 0402 and 0603 packages.
We've Got You Covered

Telecom
- Cellular / Consumer Telephones
- RF / Microwave
- Telecommunication Switches
- Other Communication Equipment

Consumer
- Security Equipment
- Retail Transaction / Inventory Equipment
- Office Equipment

Commercial
- Audio / Video / Mobile Devices
- White Goods
- Switch Mode Power Supplies (SMPS)
- Automotive System and Electronics

Computer
- Mainframe/Mini/Super Computer
- PCs, Workstations and Interfaces
- Data Storage
- Peripherals / SMPS

Alternative Energy
- Smart Grid / Smart Meter
- Solar Power
- Wind Power
Transportation
- Off Road Truck / Bus / RV
- Heavy Truck / Construction / Agriculture
- Emergency & Rescue
- ATV / Snowmobile

Medical
- Test & Measurement
- Life Support
- Imaging
- Medical Telemetry

Military

Aerospace
- Commercial Avionics / Marine
- Military Avionics / Marine / Space
- Guidance / Control / Navigation
- Communications

Industrial & Instrumentation
- Process Controls
- Instrumentation
- Production Equipment / Motors
- Test & Measurement
- SMPS (Switch Mode Power Supply)
- TVSS (Transient Voltage Surge Suppression)
- Lighting
- Medical Telemetry

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Koa Speer Electronics’ circuit protection components include thermal sensors, chip fuses and varistors. The company’s thermistors are available in a range of sizes, including 0402, 0603, 0805, and 1206. Fuse components are offered in a number of styles and sizes including fusing flat chip resistors, chip fuses and thin film chip fuses. Metal oxide varistors are available in surface-mount and leaded styles, offering higher surge current ratings in a number of sizes to fit your application.

Overcurrent

Fuses

**Fusing Flat Chip Resistors - RF73**
- RF73 is a fusing flat chip resistor available in a resistance range of 0.2Ω~510Ω and ±5% tolerance
- Sizes available 0603~2512
- UL1412 approved in 0805~2512 sizes
- Maximum open circuit voltage of 50V~100V

**Thin Film Chip Fuses - TF**
- The TF series chip fuses are current rated from 0.2A~5.0A in both 24 and 32 voltage ratings
- Sizes available are 0402 and 0603
- TF16VN for automotive applications (under development)
- UL248.14, c-UL(CSA)C22.2 approved
- Low power consumption and less voltage drop

**Chip Fuse - CCP**
- The CCP chip fuse series are current rated from 0.4A~5.0A in both 24 and 72 voltage ratings
- Available in sizes 1206 and 1210
- UL248.14, c-UL(CSA)C22.2 approved

**Primary Circuit Chip Fuse - CCF**
- Up to 12V AC and 60V DC
- UL248.14, c-UL(CSA)C22.2 approved
- New CCF1F series IEC60127-4 fast acting fuse
- Current Rating 0.4A~15.0A
- Size 2410

**Thermal Fuse, Power Type - WF**
- Current rating 2A and 10A
- 250V voltage rating
- UL14 approved (4.7Ω~100Ω)
- Resistance range 1Ω~10kΩ

**Temperature Protection Resistor - TPR**
- Quickly fuses to the overload
- Terminal temperature under rated load: +125°C or less
- Power rating 1W
- Resistance range: 2Ω~10kΩ
- Lightning surge test (IEC61000-4-5) effective
Thermistors

**Thin Film Flat Chip Linear – Positive Temperature Coefficient – LT73/LP73**
- LT73 is a tempco thermistor with anti-leaching nickel barrier terminations, has various TCRs and an operating temperature range of -40°C to +125°C
- LP73 is a thin film resistance thermal chip sensor available in a wide range of TCRs with an operating temperature of -40°C to +125°C. LP73 is suitable for control of temperatures in various industrial equipment
- LT73V is designed for automotive use with resistance range of 51Ω~22kΩ and temperature range of -55°C to +155°C. Available in 0805 and 1206 sizes. AEC-Q200 data is available

**Thick Film Flat Chip Linear – Positive Temperature Coefficient – LA73**
- Available in 13 specifiable temperature characteristics
- Resistance range of 22Ω~10kΩ
- Available in sizes 0603, 0805, and 1206
- ±5% tolerance

**Chip Positive Thermistor – PT72**
- Ideal for resettable over-temperature protection
- Three curie temperatures: 70°C, 80°C, and 100°C
- Resistance range: 50Ω, 120Ω, 470Ω, and 1kΩ
- Available in 0603 and 0805 sizes

**Flat Chip Negative Temperature – NT73**
- Negative tempco thermistor
- 19 standard resistance values available
- ±5%~±15% tolerances
- Available in sizes 0603~1206

Overvoltage

Varistors

**Metal Oxide Varistors – Chip Type – NV73**
- Protects against static electricity (ESD), switching and incoming surges
- Varistor voltage: 8V~150V
- Sizes available: 0201~2220
- Capacitance ratings as low as 3pF available
- Maximum energy: 0.005J~12.0J

**Metal Oxide Varistors – Disc Type – NVD**
- Higher surge current
- Absorbs positive and negative surges
- Varistor voltage: 18V~1800V
- Disc diameters of 05, 07, 10, 14, and 20
- Maximum energy 0.3J~360J
- UL 149 3rd edition approved
- UL1414 approved
Littelfuse is recognized around the world as the number one brand in circuit protection. With the industry’s broadest and deepest portfolio of circuit protection technologies, backed by unparalleled design support, Littelfuse is the company that engineers trust to answer their most critical circuit protection questions.

**Overcurrent**

**Fuses**

Fuses

Littelfuse is the world leader in the design and manufacturing of fuses for the automotive, industrial, handheld, computer and telecom markets. Operating characteristics of our electronic application fuses include current ranges from 0.010A–40A, maximum voltage ranges from 24V–600V, and interrupting ratings from 24A–50,000A. Our comprehensive line of lead-free and RoHS devices are perfect for environmentally friendly designs. Fuse installation and replacement is easy with our comprehensive line of fuse blocks, fuse holders, and fuse accessories for automotive, electronic and industrial applications.

**Resettable PTCs**

Littelfuse offers a full range of surface mount, radial leaded and axial leaded (battery strap) PTC resettable overcurrent suppression devices. Surface mount PTCs are available with a broad range of hold currents from 0.05A to 7.0A while footprints vary from 0402 to 2920. Radial PTCs are rated from 6VDC to 600VDC and are designed for use in higher voltage applications that require minimal maintenance and are subject to repetitive overcurrent conditions.

**Overvoltage**

**Varistors**

**MOVs/TMOV®s**

Littelfuse Metal Oxide Varistors (MOVs) are designed to suppress transient voltages such as lightning and other high level transients found in industrial and AC line applications or lower level transients found in automotive DC line applications. With peak current ratings ranging from 40A to 70,000A and peak energy from 0.1J to 10,000J, Littelfuse varistors are available in radial leaded, axial leaded, surface mount and bare-disc options.

**TMOV® and iTMOV® Varistor Series**

This device uses a patent pending thermal element internal to the MOV. The TMOV® and iTMOV® varistor’s integrated thermal element, in conjunction with appropriate enclosure design, helps facilitate SPD module compliance to UL1449 for both cord connected and permanently connected applications. Overall, the integrated MOV-thermal fuse technology reduces part count, saves space and is UL1449 recognized not only to the normal UL1449 MOV requirements, but also to the abnormal overvoltage testing. It performs better than the other methods when subjected to a limited current overvoltage condition, by clearing more quickly, at a lower temperature and with minimal to no out-gassing or charring. It has all the performance capability of a standard MOV, including peak pulse current capability, energy rating and clamping voltage. The new device can also be wave soldered which saves on assembly costs and simplifies the assembly process by eliminating most of the hand assembly required with other methods.

**MLVs**

Littelfuse Multilayer Varistors (MLVs) are designed for applications requiring protection from low to medium energy transients in computer, handheld devices, industrial and automotive markets. Available in miniature surface mount options as small as 0201 size, Littelfuse MLVs offer a low voltage range (5.5–135VDC) as well as enhanced performance and filtering characteristics in a small package.
Gas Discharge Tubes (GDTs)
Available in small footprint leaded, surface mount and cartridge configurations, Littelfuse GDTs offer fast response times to transient overvoltage events. Littelfuse GDTs have the ability to handle very high current surges – up to 40,000A – while effectively suppressing overvoltage transients. Their low capacitance (typically 1–2pF), high insulation resistance (>1G Ω) and low leakage ensure virtually no effect on the protected system during normal (non-surge) operating conditions.

ESD Protection Diodes

TVS Diodes
TVS diodes are used to protect semiconductor components from high-voltage transients. Littelfuse supplies TVS diodes with peak power ratings from 200W to 30kW, and reverse standoff voltages from 5V to 512V.

TVS Diode Arrays (SPA® Devices)
TVS diode arrays are designed to protect analog and digital signal lines from electrostatic discharge (ESD), electrical fast transients (EFT), and lightning-induced surge currents. TVS diode arrays are offered in a wide range of industry standard discrete and multi-channel SMD packages.

PLED Light-Emitting Diode (LED) Protectors
Designed to minimize the impact of losing an entire LED string due to a single LED failure, PLED devices provide a switching function that will bypass LEDs that go open circuit and allow current to flow to the remaining LEDs in the string. PLED devices also offer LED protection against electrostatic discharge (ESD) and accidental reverse power connection (PLED5 devices only).

PulseGuard® ESD Suppressors
With a capacitance value as low as 0.04 pF, PulseGuard® suppressors can protect high-speed digital I/O lines (HDMI, USB, eSata, Ethernet) without causing signal distortion. With respect to ESD testing, PulseGuard® suppressors are specified to protect against ESD transients per the IEC 61000-4-2 (Level 4) test method. Available in small surface mount form factors, they are lead-free and RoHS compliant.

SIDACtor® Devices
SIDACtor® devices are designed to suppress overvoltage transients in telecom and datacom equipment, and are able to divert currents as high as 5000A to ground within nanoseconds of reaching their breakover voltage. Littelfuse offers a wide range of configurations including DO-214AA, DO214AC, COMPAK (3-Pin DO-214), SOT23-5, QFN, MS-012 and modified MS-013 surface mount packages as well as, TO-92, TO-218, DO-15, modified TO-220, and TO-220 through-hole packages. SIDACtor devices help equipment meet U.S. and international standards such as TIA968-A, GR-1089, ITU, CNET, VDE and IEC.

Thyristors

Switching Thyristors
Switching thyristors are solid state switches that are normally open circuits (very high impedance) and are capable of withstanding rated blocking/off-state voltage until triggered to on state. Used for circuit control applications, Littelfuse offers SCRs, triacs, diacs, SIDACs and electrically isolated rectifiers. Applications include lighting controls, dimmers, motor speed controls, power supplies, smoke alarms, battery chargers, engine ignition and flash units.
Murata offers two circuit protection technologies which are ideal for thermal management in ever-shrinking portable electronic products. Positive-temperature coefficient (PTC) and negative-temperature coefficient (NTC) thermistors can serve as temperature sensors and thermal protectors in many applications.

**Overcurrent**

**Thermistors**

**PTC Thermistor**

Posistor™ is Murata’s trademark for a positive temperature coefficient (PTC) thermistor using ceramics of sintered barium titanate (BaTiO3) mixed with a trace of rare-earth metal. At specified temperatures, the resistance of PTC thermistors rises sharply. Engineers can use this characteristic to create an overheating-protection circuit. Such circuits can, for instance, raise the rotating speed of a cooling fan or limit the equipment output when the temperature of the circuit board reaches a predetermined level.

Murata Manufacturing’s Posistors™ can also detect overheating in the power transistors of step-down regulators. If the power transistor radiates unexpected heat arising from any cause, including an increase in output current or heat radiation failure, the resistance value of the thermally-coupled Posistor™ rises sharply before the transistor reaches its allowable temperature. The rise of resistance value activates the first transistor (Tr1) to stop the operation of the power transistor, and thus avoids serious failure, fuming and firing.

PTC Benefits and Varieties:

Posistors offer several advantages. Unlike thermal fuses, Positors have no parts that expand and do not have to be replaced. They also do not generate noise or suffer contact failures. Unlike bi-metal thermostats, Posistors do not have any contacts. They also exhibit large gain and can control power devices directly using transistors, including field effect transistors (FETs).

**PTC Target Applications**

- Overcurrent protection for HDMI port and USB port
- Overcurrent and over-temperature protection for LEDs
- Over-temperature protection for voltage regulator of CPU and GPU
- Over-temperature protection for battery, PCB and chassis

**NTC Thermistors**

To make thermistors with a negative-temperature coefficient (NTC), engineers create a ceramic, heat sensitive resistor consisting of a sintered body of transition metal oxide. The temperature characteristic of NTC thermistors is the opposite of that for PTC thermistors. The resistance value of NTC thermistors decreases as the temperature rises giving its temperature coefficient a negative value. NTC thermistors are often used as temperature sensors in many kinds of devices because they offer a sharp change in the resistance value, relative to the temperature change, usually about 3.0 to 5.3 percent per degree of centigrade temperature.

NTC thermistors have a relatively wide range of selectable resistance values allowing engineers to modify the value, as required. These thermistors have excellent environmental resistance, even though they are quite small, and remain physically stable for long periods. NTC thermistors are easily mass-produced, making them a cost-effective solution.
NTC Design & Simulation Tools

The NTC thermistor is a useful device for temperature sensing, but its circuit design is challenging due to its non-linear characteristic. By inputting parameters into Murata's simulation software, you can easily simulate an appropriate circuit. Software can be downloaded: http://www.murata.com/products/thermistor/design_support/index.html

NTC Target Applications

- Low cost general temperature measurement
- Temperature measurement of power amplifier or other hot running IC (like memory controller, GPU, CPU, etc.)
- Temperature monitor for Lithium Ion or NiCd batteries, LEDs and heat sinks
- Temperature measurement for product chassis that comes into regular contact with user
- Temperature compensation for control devices, photo diode or timing products

ESD Suppression

ESD Protection Devices

With increased demand for more features in mobile devices and reduced size of today's ICs, preventing damage from ESD or electrostatic discharge has become even more of a challenge. ESD protection devices are critical components in protecting sensitive circuits in electronic equipment, such as mobile phones, notebook PCs, netbooks, digital cameras and other consumer devices. An ESD event on an unprotected line can disturb the operation of an IC, or even damage or destroy it. With the addition of an ESD protection device, under normal operation, the potentially damaging excessive current is shunted to ground by the ESD protection device, protecting the system from permanent damage.

Many electronic products are tested for ESD immunity to ensure their continued reliable operation if subjected to various levels of ESD. Testing for immunity to ESD is usually done for compliance with the IEC61000–4 part 2 standard. Murata's ESD devices are manufactured to function in compliance with the highest defined severity level in this standard, Level 4, and are able to withstand up to 8kV direct contact and 15kV air discharge, making them ideal for high-speed ESD protection.

Murata's LXES series features ceramic or silicon based ESD protection devices. The ceramic product also provides bi-directional operation and is RoHS compliant, halogen free and lead free. A capacitance as low as 0.25pF can be provided with our silicon versions. These silicon versions are available in single or multi-channel configurations and offer very low trigger and clamping voltages.

Designed with ultra low capacitance, the LXES series minimizes signal loss for high-speed data and transmission lines. Due to the nature of its structural properties, the LXES ceramic series offers high repetition durability for robust design and performance. The LXES series features ultra low insertion loss and produces very little distortion, making them ideal for use in low level signal applications such as antenna ports.

Murata's broad selection of ESD protection devices are well suited for a range of end product applications and offer flexibility for use in a variety of today's IC circuits.

ESD Protection Devices Target Applications

- Mobile communications (cellphones, smart phones, PA modules, etc)
- Digital cameras, network and storage equipment
- Electronic data processing equipment
- Energy (i.e. power meters)
Panasonic Electronic Components offers a variety of solutions for circuit and thermal protection. Panasonic’s flexible PGS graphite sheet can be used in applications with limited space. Thermal cut-offs can be used in transformers, solenoids, fans, small electric motors and chargers for circuit safety. In addition, Panasonic also offers a wide range of thermistors, both surface mount and leaded, for excellent temperature compensation and detection.

Micro Chip Fuse
Panasonic Electronic Components offers one of the smallest chip fuses in the industry with 0402, 0603 and 1206 case sizes. Panasonic chip fuses withstand in-rush current and have a fast acting and one-time blow characteristic. Panasonic chip fuses are used in integrated circuits and charger lines. Panasonic also offers leaded fuse resistors in metal oxide, metal film and carbon film resistor technologies. Fuse resistors are primarily used in safety circuits.

Features
- Small size (0402, 0603, 1206)
- Fast-acting and withstanding in-rush current characteristics
- Operating temperature range: -40°C to 125°C

Applications
- Mobile devices
- Memory card
- Chargers and rechargeable battery packs

Over-Temperature and Temperature Compensation

Multilayer NTC Chip Thermistors
ERT-J multilayer NTC chip thermistors are used in a variety of applications including battery charging and LED lighting for over-temperature protection as well as temperature compensation. They are available in 0201, 0402 and 0603 case sizes.

Features
- Highly reliable multilayer / monolithic structure
- Wide temperature range (-40°C to +125°C)

Pyrolytic Graphite Sheet
High thermal-conductivity PGS material is an ultra-thin, lightweight, graphite film, developed by Panasonic engineers with a thermal conductivity four times greater than copper. This high thermal conductivity allows release and diffusion of heat generated by heat sources such as CPUs, processors, power amplifiers and cameras. PGS is extremely pliable and can be applied to heat-source shapes even in high density mounting situations.

Features:
- Thermal conductivity: 700 to 1750 W/(m-K)
- Offers thermal conductivity two to four times that of copper and three to seven times that of aluminum
- Lightweight: specific gravity of 0.85 to 2.1 g/cm3
- Flexible and easy to cut or trim
Overvoltage

Varistors

**ZNR Transient / Surge Absorber (Metal Oxide Varistor)**
The new ERZ-VS34Cxxx series protects power supply facilities and communications equipment from lightning surges and doubles the surge current capability of existing ZNRs. ZNR stands for Zinc-oxide Non-linear Resistor, also commonly known as metal oxide varistor or MOV. Panasonic invented the ZNR surge absorber in 1968 and is a pioneer in the use of zinc oxide as a surge absorber. ZNR devices are used to protect electronic equipment against voltage surges while saving board space and cost.

**Features**
- Very large surge withstand capability in a compact size of 36x47mm
- Fast response to steep impulse voltage
- Low clamping voltage for better surge protection
- No follow-on current

**Applications**
- Power supply circuits
- Automatic control devices for power distribution lines

**Multi-Layer Ceramic Varistors (MLCVs)**
Panasonic Electronic Components’ long established EZJ-P series is now extended to include nine new part numbers in the small 0201 ECA case size. The EZJ-PZ series is well suited for small or handheld electronic devices for the protection of sensitive circuitry from ESD damage.

**Features**
- Varistor voltage: 6.8 to 27 V
- Maximum allowable voltage: 3.7 to 15 VDC
- Operating temperature range: -40°C to 85°C
- Multi-layer monolithic ceramic construction

**Applications**
- ESD protection for IC inputs
- Bus lines
- LEDs

**Radial Leaded ZNR Transient/Surge Absorber (Metal Oxide Varistor)**
Panasonic’s new ERZ-E14 series of radial leaded varistors offers 20mm performance in a 14mm package. The ZNR transient/surge series offers values ranging from 200V to 1100V.

**Features**
- Exceptional withstanding surge current and energy handling capability in compact 14mm size
- Voltage range: 200V to 1100V
- Compatible with pitch and place manufacturing
- Lower insertion loss than inductor solution

**Applications**
- Power supply input protection
- Relay protection

ESD Protection

**ESD Suppressor**
Panasonic Electronic Components’ ESD suppressors are used for ESD noise suppression in high-speed signal lines with low capacitance values. They have excellent electrostatic-noise suppression and excellent ESD withstanding characteristics.

**Features**
- Small size (0201, 0402, 0603)
- Max clamp voltage of 100V
- Much lower capacitance value (down to 0.04pF) and signal degradation than varistors and zener diodes
- Lower insertion loss than inductor solution

**Applications**
- High-speed data lines (HDMI, USD3.0, SATA, etc.), antenna circuits and RF modules
TDK EPCOS manufactures a broad and deep range of high quality products to solve all of your circuit protection needs. TDK EPCOS offers overvoltage solutions to protect against ESD, lightning strikes, high voltage surges and inductive loads, as well as products to protect against current surges and over-heating. Whether your needs are thermal management, voltage management or current management, TDK EPCOS takes pride in finding a solution to solve all of your protection problems.

## Overcurrent

### Thermistors

**Surface Mount NTC Thermistors**
EPCOS NTC chip thermistors are simple but very sensitive and accurate sensing elements for temperature measurement and control circuits. Available in 0402 to 1206 case size and resistance values ranging from 1k to 680k with tolerances as low as 1%. Suitable for use in consumer, communication, industrial, medical, energy, lighting and automotive applications.

**PTC Thermistors**
EPCOS has a broad spectrum of ceramic PTC thermistors for use as overcurrent protection, motorstart protection, heating elements, telecom protection and temperature limit protection. EPCOS has thermistors for any application. Available in surface mount, leaded disk, bare disk and many custom configurations. Suitable for industrial, telecom, home appliance, consumer products, lighting, etc.

**Inrush Current Limiters**
Safe and reliable protection for capacitive loads in switching circuits and for soft starting of inductive loads. ICLs provide protection from high inrush currents but features low power consumption during continuous operation. Perfect for home appliances, consumer electronics, industrial, power supplies and motors.
Overvoltage

Varistors

**Multi-layer Varistors (MLV)**
EPCOS manufactures a broad selection of multilayer varistors including single components and multi-element arrays. Multilayer varistors are ideal for limiting surge voltage and current as well as for absorbing energy. Available in 0201 to 2220 case sizes and multi-element arrays, voltage ratings from 5V to 85V with temperature ratings up to 150°C. These varistors are suitable for all applications from automotive to consumer and communications, industrial, medical, energy, lighting, etc.

_Ceradiodes_
Ceradiodes are multi-layer semiconductor ceramic components for ESD protection and are alternatives to silicon-based semiconductor protection devices for the protection of data, audio and video lines, analog and digital interfaces, ICs and I/O ports in consumer electronic devices.

**Super High Capacitance Varistors (SHCV)**
SHCV are leaded components consisting of a multi-layer varistor and multi-layer ceramic capacitor for combined protection device and capacitor against transients and RFI suppression in a single component. SHCV replaces two components in a single device. They are used for RFI suppression in electromotors for automotive and industrial electronics.

_Metal Oxide Varistors (MOV)_
EPCOS has a complete line of disk, block and strap metal oxide varistors. The MOV products are used as transient voltage surge suppressors as they exhibit high energy absorption and current handling capability. MOVs have a wide range of use in telecom, industrial, home appliance, power supply, lighting and automotive applications.

_Surface Mount Disk Varistors (CU Varistors)_
SMD disk varistors that serve as surge current protection up to 385V. Available in 3225 and 4032 case size with voltage ratings up to 385V. Electrical equivalents to leaded SIOV-S05/S07 for applications requiring surface mount option. Used for overvoltage protection and transient suppression in automotive, home appliance, power supply, industrial and lighting applications.

_Gas Discharge Tubes_

_GDT Surge Arresters_
GDTs exhibit very high insulation resistance (GOhms) under normal conditions but low insulation resistance during operation. EPCOS GDTs cover a wide spectrum of protection from light to maximum duty, and are available in standard devices to customized solutions. Protects communications and information installations as well as power lines from failure or destruction against voltage surges caused by lightning, electrostatic or electromagnetic discharges.

_Switching Spark Gap_
A switching spark gap is a powerful switch which can transmit capacitive stored energy with low losses. Switching spark gaps have a highly reliable and robust design that is not affected by vibration or high temperature up to 170°C. Can be used in all applications where a high voltage impulse needs to be generated such as gas cookers, central heating systems, HID lamps, industrial lighting, stadium lighting, outdoor lighting, etc.

_Thermofuse Varistors_
The thermofuse varistor consists of a disk varistor and a thermo-fuse connected in series to protect domestic applications and switch mode power supplies from surge voltage and excessive heating. The thermo-fuse disconnects the varistor when damaged by excessive current. A monitor output can be used to indicate a malfunction. UL 1449 approved.
TE Connectivity’s circuit protection products are a part of your everyday life. From your cell phone battery to your car steering wheel, we are helping to make your world safer and your electronics more reliable. To date, billions of TE circuit protection devices are being used to help protect a wide range of electronic products in the computer, battery, portable electronics, consumer, automotive, industrial, home appliances, HVAC and telecommunication markets.

With its circuit protection products, TE is recognized as a leader in operational excellence, customer service and product innovation. A dedicated engineering sales force, global manufacturing and design centers, and local engineering support help us to think, manage, and share globally, yet, act locally to meet customer needs.

Overcurrent

**PolySwitch Resettable Devices**
PolySwitch devices are used to help protect against damage caused by harmful overcurrent surges and over-temperature faults. Like traditional fuses, these devices limit the flow of dangerously high current during fault conditions. The PolySwitch device, however, resets after the fault is cleared and power to the circuit is removed, thereby helping to reduce warranty, service and repair costs.

Selections include multiple formats: through-hole, surface-mounts, strap, semi-custom and custom.

**Surface Mount Fuses**
TE Circuit Protection offers the widest selection of surface-mount fuses available for addressing a broad range of overcurrent protection applications. Helping to prevent costly damage and promote a safe environment for electronic and electrical equipment, our single-use chip fuses provide performance stability to support applications with current ratings from 0.5A up to 20A.

Selections include: high-current rated chip fuses, slow-blow chip fuses, fast-acting chip fuses, telecom fuses, pulse tolerant chip fuses and very fast-acting fuses.
**ESD Suppression**
Electrostatic Discharge Protection Devices (ESD) are designed to help shunt ESD away from sensitive circuitry to improve reliability and minimize returns of electronic devices. Devices help protect mobile phones, portable electronics, LCD and plasma TVs, HDMI 1.3 / 1.4, USB 2.0 / 3.0, DisplayPort and other high-speed digital or low-voltage antenna interfaces.

Selection includes – both polymeric ESD (PESD) and silicon ESD (SESD) devices, in single-device format and multiple-array format.

**Gas Discharge Tubes**
Gas Discharge Tubes (GDT) are placed in front of, and in parallel with, sensitive telecom equipment such as power lines, communication lines, signal lines and data transmission lines to help protect them from damage caused by transient surge voltages that may result from lightning strikes and equipment switching operations. New surface-mount devices are now available for automated manufacturing applications.

**Over-temperature**
**Reflowable Thermal Protection (RTP) Devices**
The Reflowable Thermal Protection (RTP) device is a low resistance, robust surface mountable thermal protector. It has a set open temperature and can be installed using reliable, lead-free, surface mount device assembly and reflow processes. To simplify installation, improve reliability, and optimize thermal coupling with the PCB, the RTP device is surface mountable. No special SMD installation is required. Instead, after installation, the RTP device utilizes a one-time electronic arming process to become thermally sensitive. Before the arming procedure, the device can go through installation temperatures up to 260°C without going open. After arming, the device will open when the critical junction exceeds the open temperature. Arming can occur during test or in the field.

**Hybrid Protection**
**2Pro Devices**
The 2Pro devices feature integrated overcurrent and overvoltage circuit protection technology designed to help prevent damage to telecommunications equipment and power supplies. The device’s small footprint, resettable functionality and coordinated protection capabilities allow for use in a wide range of telecommunications, appliance, LED lighting and general electronics applications.

**PolyZen Devices**
PolyZen devices are polymer enhanced precision zener diode micro-assemblies. They offer resettable protection against damage caused by multi-watt fault events that require no special heat sinking. The relatively flat voltage versus current response of the PolyZen device helps clamp the output voltage, even when input voltage and source currents vary. The new PolyZen series has improved hold current to 2.6A and reduced device height to 1.0mm tall.

**Metal Hybrid PPTC (MHP) Devices**
The rapidly expanding market for high-rate-discharge lithium ion (Li-ion) batteries used in applications such as cordless power tools, e-bikes and back-up power supplies has created the need for cost-effective circuit protection devices capable of providing 30A+ hold currents at voltage ratings over 30V. To meet this need, a new hybrid device has been developed that connects a bi-metal protector in parallel with a PPTC device. The resulting Metal Hybrid PPTC (MHP) device helps provide resettable protection while also utilizing the low resistance of the PPTC device to help prevent arcing in the bi-metal protector at higher currents.

A new MHP device, the MHP-TA, offers a 9 VDC rating and a higher current rating than typical battery strap devices to meet the battery safety requirements of higher-capacity LiP and prismatic batteries found in the latest tablet and ultra-thin computing products.
Vishay’s diode-based circuit protection products cover the full spectrum of electronic systems from industrial applications to the smallest handheld multimedia devices. They include automotive and industrial-grade transient voltage suppressor families as well as a host of diode array products for ESD and EMI protection in portable electronics.

Overcurrent

Fuses

**MFU Series Thin Film Chip Fuses**
The perfect choice for most fields of modern electronics. The highly controlled manufacturing thin film process guarantees an outstanding stability of fusing characteristics. Typical applications include information technology, telecommunication, medical equipment, industrial, audio/video and automotive electronics.

Thermistors

**PTCCL Series Leaded Overcurrent Protecting Thermistors**
PTC (positive temperature coefficient) thermistors increase resistance exponentially at the so called switching temperature or Ts. This typical characteristic makes PTC thermistors very useful components for several application areas such as voltage and current overload protection, over-temperature protection, inrush current generation, time delay, energy discharge and as a ceramic self-limiting heating element.

**NTCS0603E3, NTCS0805E3, NTCSMELF Glass protected NTC SMD Thermistors**
NTC (negative temperature coefficient) thermistors decrease resistance when temperature increases. NTC thermistors are used for over-temperature protection in PCs, power supplies and motherboards; Li-ion battery protection in fast chargers, digital scan cameras, fire and smoke detectors, TCXOs, and other automotive, consumer and industrial applications.

**NTCALUG03A Mini Lug NTC Thermistor**
Surface temperature sensing and control in remote locations and for various environmental conditions.
Varistors

**VDRH Series High Surge Leaded Varistors**
Providing a reliable and efficient way to protect against high-voltage transients and surges with the capability to absorb higher transient energies and suppress both positive and negative transients.

TVS Diodes

**ABD (Avalanche Breakdown Diode) TVS TransZorb®**
Vishay’s TransZorb® Transient Voltage Suppressors (TVS) use state-of-the-art technology to offer the highest voltage range in the industry. Their design enables these avalanche breakdown diode TVS devices to absorb large amounts of energy for short time durations without sustaining damage. Vishay’s TransZorb® TVSs do not exhibit a wear-out mechanism, have extremely fast turn-on times and provide excellent clamping characteristics.

**ABD TVS PAR® Automotive TVS**
Vishay’s Automotive Transient Voltage Suppressors (TVS) using the patented PAR® process have superior stability and power handling capability over a wider temperature range (up to 185 ºC) than other avalanche TVS diodes. The product portfolio includes devices specifically designed for load dump surge protection in both axial and surface-mount packages.

ESD Protection Diodes

**ESD Protection Diodes**
With the increasing use of integrated circuits in mobile and wired communication devices and consumer products, it is more important than ever to protect sensitive electronics from high transient voltage or unintentional frequencies.

One of the most common types of transient voltages is electrostatic discharge (ESD). ESD protection diodes combined with an electromagnetic interference (EMI) filter network serve as unobtrusive but strong “bodyguards” against these hazards. Protection devices such as zener and avalanche diodes draw a very low leakage current when placed in front of sensitive electronic gates. Any transient voltage that approaches the breakdown voltage will be short-circuited by the diodes so it cannot reach the gate. Vishay offers a wide range of surface-mount, plastic packaged protection diodes, arrays and EMI filters designed especially for space-sensitive electronic products.