Littelfuse introduced the first of what would become a long line of automotive circuit protection technologies in the 1930s, with the design and development of the original automotive fuses. That commitment to the automotive industry continues today as vehicles have become increasingly dependent on high powered electronics.

**ESTABLISHED INFRASTRUCTURE**

Littelfuse supports automotive designers with a global network of test labs and design and manufacturing facilities across four continents, including China’s second-largest semiconductor fabrication facility. Our Silicon Valley Technology Center supports the complete innovation life cycle, from new materials and product concepts to product design, prototyping, testing and validation.

**INVESTED IN THE FUTURE**

In addition to our comprehensive circuit protection offering and growing line of sensing solutions, our investments in Monolith Semiconductor and ON Semiconductor allow us to take our place among power semiconductor suppliers for the automotive market.

### Littelfuse Automotive Milestones

- **1930** Littelfuse introduced first automotive fuse
- **1950** Introduces automotive switchsets, first centralized under-the-dash fuse block for automotive industry
- **1976** The first blade-type ATO (Autofuse®) Fast-Acting Fuse, now considered the global standard
- **1991** MEGA® Automotive Fuse for higher current applications
- **1996** First circuit protection regulations to receive QS 9000 certification
- **1999** Named "Best Electrical Component Supplier" by Automotive Industry magazine
- **2000** Z-Case MasterFuse fuse for the hybrid electric vehicle market
- **2009** Expands global sensor platform in automotive market with the acquisition of Accel AB
- **2011** Develops 1200V SiC MOSFET for battery charging applications
- **2012** Launches a new automotive sensor platform with the acquisition of Accel AB
- **2013** Expands global sensor platform in automotive market with the acquisition of AEC-Q101 qualified TVS Diodes and TVS Diode Arrays
- **2014** Opens Technology Center to facilitate the development of next-generation products
- **2015** Acquires a select portfolio of semiconductor products from ON Semiconductor
- **2016** Opens Silicon Valley Technology Center to accelerate the development of next-generation materials and products
- **2017** Invests in Monolith Semiconductor, a company developing silicon carbide technology for power semiconductors
- **2018** Acquires IXYS
- **2019** Develops 1200V SiC MOSFET for battery charging applications

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Today's cars include myriad systems that use semiconductors, and sophisticated hybrids have even more. Designers need a wide range of circuit protection options to safeguard all these new systems over the vehicle's expected 15-20-year lifetime.

**DRIVING FACTORS FOR AUTOMOTIVE ELECTRONICS**

A combination of powerful forces in the automotive electronics industry are spurring changes in circuit protection, power control and sensing applications.

- One wire/one fuse protection trend
- Higher power consumption
- Better space and weight efficiency
- Smarter circuit protection
- The expansion of infotainment systems
- New safety features like multiple airbags, battery disconnect controls, passenger sensing system, auto dimming mirrors, anti-rollover features, stability control, seat belt pre-tensioning and tire pressure monitoring
- Demand for higher performance and lower emissions
- The growth of hybrid, electric and alternative fuel vehicles
- Growing use of power semiconductors like Ignition IGBTs, Thyristors and Schottky Diodes

For many decades, vehicles were essentially mechanical systems supplemented by hydraulic or electrical systems for functions like steering, ignition, lights, and audio entertainment. Modern vehicles, unlike their predecessors, are literally stuffed with electronic systems.

**ADVANCING WITH THE TIMES**

With electronics controlling an ever-higher percentage of vehicle functions, the circuit protection devices that prevent hazardous overvoltages and overcurrents have evolved to keep up with the transition to what is essentially a supercomputer on wheels. In addition, electrical power control is transitioning from mechanical relays, solenoids and switches to devices like IGBTs, MOSFETs, Schottky Diodes and Thyristors.

Sophisticated electronics are now integral to vehicles sold at every price point. For example, hydraulic power steering is being superseded by steer-by-wire systems. New safety and passenger entertainment functions such as advanced driver assistance systems (ADAS), parking assist, lane departure and forward collision warning systems were once available only on high-end vehicles.

Today’s cars include myriad systems that use semiconductors, and sophisticated hybrids have even more. Designers need a wide range of circuit protection options to safeguard all these new systems over the vehicle’s expected 15-20-year lifetime.
Electrical Threats and New Automotive Technologies

THREAT: ELECTROSTATIC DISCHARGE (ESD)

ESD is characterized by fast rise times and high peak voltages and currents up to 30A, which can melt silicon and conductor traces. Even when ESDs don’t cause catastrophic failure, electrical currents due to ESD can change the state of internal logic, causing a system to latch up and behave unpredictably or cause corruption of a data stream. Without adequate protection, ESD can damage control units, infotainment electronics, sensors, fuel injectors, valves, motors, powertrains and dozens of other components. Sometimes, a component or circuit is damaged by ESD, creating latent defects that later progress to premature failures.

TVS Diode Arrays

Because of their high-speed response to overvoltages, TVS Diode Arrays are widely used for ESD protection in automotive electronics. Automotive-qualified SPA® TVS Diode Arrays from Littelfuse are available in a range of compact surface-mount packages to fit into any layout.

THREAT: OVERLOADS/SHORT-CIRCUIT CURRENTS

Sustained overloads will cause circuit components to overheat, potentially leading to catastrophic and uncontrolled failures of the vehicle’s electrical system. Short circuits can surpass the capabilities of the wires, connectors, etc. in the power circuit, which can also lead to uncontrolled failures or possibly a thermal event.

Fuses

Automotive Fuses protect components or circuits by melting under overcurrent conditions to interrupt current flow. In addition to withstanding rapid temperature cycles and vibration, they must offer long-term stability and AEC-Q test compliance. Littelfuse offers an unparalleled range of automotive Fuses, from cartridge and blade styles to surface-mount chip Fuses.

Resettable PPTC Overcurrent Protection Devices

Littelfuse Polymeric Positive Temperature Coefficient (PPTC) devices are widely used in automotive applications like wiring harness and network protection, communication and infotainment systems, and EV battery management systems. Unlike Fuses, these devices provide resettable protection for automotive electronics against damage from harmful overcurrent surges. Bladed, leaded and surface-mount form factors are available for automotive applications.

THREAT: SWITCHING LOADS IN POWER ELECTRONICS CIRCUITS

In modern automotive designs, all on-board electronics are connected to the battery and the alternator. However, the output of the alternator is unstable and requires further conditioning before it can be used to power the vehicle’s other systems. During the powering or switching of inductive loads, the power is temporarily interrupted, so that unwanted voltage spikes or transients are generated. If left unchecked, these transients would be transmitted along the power line and into the electronic modules.

Varistors

Automotive-qualified Metal Oxide Varistors (MOVs) and Multilayer Varistors (MLVs) protect against voltage transients induced by load dump and other transient events. When exposed to high-voltage transients, the varistor impedance changes by many orders of magnitude—from a near open-circuit to a highly conductive level—clamping the transient voltage to a safe level. Choose from radial-leaded MOVs in disc sizes from 5mm to 20mm. Also, surface-mounted MLVs are available.

OPPORTUNITY: ELECTRIFYING THE VEHICLES OF TOMORROW

Researchers predict that by 2022, a typical high-end vehicle will contain more than $6,000 worth of electronics. The growing interest in self-driving vehicles, vehicle-to-vehicle and vehicle-to-infrastructure communications, and on-board safety, convenience and environmental features ensures the sheer number of electronic components in a vehicle will continue to grow promptly. Additionally, as hybrid electric vehicles become increasingly popular, power semiconductors will be critical to the next generation of Battery Management Systems and on-board/off-board charging systems.

Power Semiconductors

Power semiconductor devices enable the next generation of vehicles by managing power flexibly. Fast-switching SiC technology increases power density and energy efficiency in systems like on-board battery chargers. The Littelfuse power semiconductor portfolio includes Thyristors, Rectifiers, Fast Recovering Diodes, IGBTs and wide band gap devices.
Living Up to the Industry’s Standards

Littelfuse experts support customers’ designs in accordance with worldwide automotive safety standards. By contributing their own experience to the development of new standards, Littelfuse engineers help to ensure the safety and reliability of the next generation of circuit protection products.

Littelfuse engineers help customers understand which standards apply in terms of both the application itself and the geographical location for which it is designed, as well as offer guidance on how to meet those standards. Littelfuse offers a broad line of circuit protection devices certified compliant with these standards.

- Transient surges: JASO and ISO 7637-2 (Surge) test
- Electrical disturbance by conduction and coupling: ISO 7637-2
- Electrical disturbances from electrostatic discharge: ISO 10605
- Load dump, switching transients and ESD threats: SAE J1113, GM 9105, ES-F2af-1316-AA
  Ford (Visteon)

Electrical component qualification:
- AEC-Q101: failure-mechanism based stress test qualification for discrete semiconductors in automotive applications
- AEC-Q200: stress test qualification for passive electrical devices

The Future Is Now

Whether powered by gas electric, fuel cell electric, diesel electric, Li-ion polymer, or ultra-capacitor engines, electric vehicles are challenging automakers to address higher energy applications, including Battery Management Systems and on-board charging systems. Autonomous (self-driving) vehicles are already making appearances on the road. Similarly, connected vehicles are offering Internet access for connecting with devices both inside and outside the car. A range of new protocols are emerging:

- When there is the potential for a collision, V2V (vehicle-to-vehicle) communications notify the driver or autonomous vehicle to take evasive action.
- V2I (vehicle-to-infrastructure) communications allow the traffic system to collect data that can be used to control traffic light timing, allowing more efficient traffic flow.
- BroadR-Reach technology allows multiple in-vehicle systems to access information simultaneously over unshielded single twisted-pair cable.
- HDBaseT has historically been used in the consumer and high-end A/V market to provide high-bandwidth, long-reach capabilities. A new, automotive version has been introduced to provide 6Gbps throughput for in-vehicle convergence of high-def A/V, USB, Ethernet, feature controls and power on a single pair of wires.

Littelfuse specialists can help designers develop automotive modules that meet the safety and test standards of the latest communication protocols.
MOTOR CONTROL

As mechanical/hydraulic actuators are replaced with electric motors, such as those for electric parking, braking, seat modules and mirrors, motor control circuit protection is critical to a vehicle’s overall reliability. Potential threats include load dump, overcurrents, surges and ESD. Littelfuse offers a wide range of TVS Diodes and Diode Arrays, MLVs, MOVs and PPTCs to protect motor control applications.

Applications

LIGHTING – INSIDE CABIN

Individual user settings and automatic dimming based on external light intensity are increasingly common in modern interior lighting systems. Designers must guard against load dump, surges, ESD, overcurrents and other threats. Choose resettable PPTCs for thermal protection of LEDs; MLVs and Diode Arrays offer ESD protection for user controls.
IGNITION SYSTEM

The efficiency of gasoline engines and consequently their mileage and emissions are dependent on the performance of the ignition system. The latter must be protected against various threats, including load dumps, feedback loops and overcurrents. In addition to high-performance Ignition IGBTs, Littelfuse offers a broad portfolio of protection devices like TVS Diodes, MLVs, PPTCs and Fuses.

Applications

LIGHTING – HEADLAMPS

Advanced headlamps use LEDs for roadway illumination as well as motors to level, swivel and shutter the high and low beams. Common threats include load dump, surges, ESD and short circuits. Solutions include SMD Fuses, TVS Diodes and Diode Arrays, MLVs and Schottky Diodes.
### Applications

**ECU**

Various Electronic Control Units (ECUs) are used for functions such as engine control, GPS connectivity, transmission control, door lock and eCall. They have interfaces like power input and communication. Defense against overcurrents, surges and ESD requires a range of circuit protection devices such as Fuses, PPTCs, TVS Diodes and Diode Arrays, MOVs, MLVs and Polymer ESD Suppressors.

<table>
<thead>
<tr>
<th>Function</th>
<th>Product Family</th>
<th>Product Series</th>
<th>Product Description</th>
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<tbody>
<tr>
<td>1. Overcurrent Protection</td>
<td>SMD Fuse</td>
<td>437A, 440A, 441A</td>
<td>SMD Fuses for overcurrent protection up to 63V and 8A</td>
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<tr>
<td>2. Overvoltage Protection</td>
<td>TVS Diode</td>
<td>TPMA, TPMB, TPMD</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 5000W</td>
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<tr>
<td>3. ESD/Surge Protection</td>
<td>MLA Auto</td>
<td>MLA-Auto</td>
<td>MLA Auto Multilayer Varistor with load dump energy rating per SAE Specification J1113</td>
</tr>
<tr>
<td>4. ESD Protection</td>
<td>XTREME-GUARD™</td>
<td>AXID</td>
<td>Protection of sensitive electronics against electrostatic discharges up to 30kV while adding virtually no capacitance to the circuit, which helps preserve signal integrity and minimize data loss</td>
</tr>
<tr>
<td>5. ESD Protection</td>
<td>SMD PPTC</td>
<td>437A, 440A, 441A</td>
<td>Reversable SMD overcurrent protection up to 3A</td>
</tr>
<tr>
<td>6. Load Dump Protection</td>
<td>SMD Fuse</td>
<td>437A, 440A, 441A</td>
<td>SMD Fuses for overcurrent protection up to 8A</td>
</tr>
<tr>
<td>7. Standard Surge Protection</td>
<td>TVS Diode</td>
<td>TPMA, TPMB, TPMD</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 5000W</td>
</tr>
<tr>
<td>8. Overvoltage Protection</td>
<td>Metal Oxide Varistor (MOV)</td>
<td>MLA-Auto</td>
<td>MLA Auto Multilayer Varistor with load dump energy rating per SAE Specification J1113</td>
</tr>
<tr>
<td>9. ESD Protection</td>
<td>XTREME-GUARD™</td>
<td>AXID</td>
<td>Protection of sensitive electronics against electrostatic discharges up to 30kV while adding virtually no capacitance to the circuit, which helps preserve signal integrity and minimize data loss</td>
</tr>
<tr>
<td>10. ESD Protection</td>
<td>SMD PPTC</td>
<td>437A, 440A, 441A</td>
<td>Reversable SMD overcurrent protection up to 3A</td>
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<tr>
<td>11. Reverse Polarity Protection</td>
<td>SMD PPTC</td>
<td>437A, 440A, 441A</td>
<td>SMD Fuses for overcurrent protection up to 8A</td>
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<td>12. Reverse Polarity Protection</td>
<td>TVS Diode</td>
<td>TPMA, TPMB, TPMD</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 5000W</td>
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<td>13. Reverse Polarity Protection</td>
<td>MLA Auto</td>
<td>MLA-Auto</td>
<td>MLA Auto Multilayer Varistor with load dump energy rating per SAE Specification J1113</td>
</tr>
<tr>
<td>14. ESD Protection</td>
<td>XTREME-GUARD™</td>
<td>AXID</td>
<td>Protection of sensitive electronics against electrostatic discharges up to 30kV while adding virtually no capacitance to the circuit, which helps preserve signal integrity and minimize data loss</td>
</tr>
<tr>
<td>15. ESD Protection</td>
<td>SMD PPTC</td>
<td>437A, 440A, 441A</td>
<td>Reversable SMD overcurrent protection up to 3A</td>
</tr>
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<td>16. Reverse Polarity Protection</td>
<td>SMD PPTC</td>
<td>437A, 440A, 441A</td>
<td>SMD Fuses for overcurrent protection up to 8A</td>
</tr>
<tr>
<td>17. Reverse Polarity Protection</td>
<td>TVS Diode</td>
<td>TPMA, TPMB, TPMD</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 5000W</td>
</tr>
<tr>
<td>18. Reverse Polarity Protection</td>
<td>MLA Auto</td>
<td>MLA-Auto</td>
<td>MLA Auto Multilayer Varistor with load dump energy rating per SAE Specification J1113</td>
</tr>
</tbody>
</table>

**ECALL**

In a crash, an eCall-equipped car will automatically call the nearest emergency center to summon help. Potential electrical threats to this system include load dump, overcurrents, surges and ESD. To ensure eCall systems operate at peak performance, Littelfuse offers protection devices like TVS Diodes and Diode Arrays, MLVs, MOVs, SMD Fuses, SMD PPTCs and XTREME-GUARD™ ESD Suppressors.

### Connectivity

1. **Microcontroller**
2. **TPSMA, TPSMB**
3. **CAN Bus**
4. **Power Input**
5. **V2X, etc.**
6. **Ultra-Low V F Schottky Barrier Rectifier**
7. **Low Leakage and Low Forward Voltage Drop**
8. **Backup Battery**
9. **Battery Charger**
10. **Ultra-Low V F Schottky Barrier Rectifier**
11. **Low Leakage and Low Forward Voltage Drop**
12. **Backup Battery**
13. **Battery Charger**
14. **Ultra-Low V F Schottky Barrier Rectifier**
15. **Low Leakage and Low Forward Voltage Drop**
16. **Backup Battery**
17. **Battery Charger**
18. **Ultra-Low V F Schottky Barrier Rectifier**
19. **Low Leakage and Low Forward Voltage Drop**
20. **Backup Battery**
21. **Battery Charger**
22. **Ultra-Low V F Schottky Barrier Rectifier**
23. **Low Leakage and Low Forward Voltage Drop**
24. **Backup Battery**
25. **Battery Charger**
Applications

ENGINE COOLING SYSTEM

Engines depend on a steady flow of cooling fluid to maintain optimal performance. Engine cooling systems need protection against threats such as load dump, surges, ESDs and overheating. The growing range of Littelfuse solutions includes TVS Diodes and Diode Arrays, MLVs, MOVs, Schottky Diodes and SMD PPTCs.

INFOTAINMENT AND NAVIGATION

Entry-level cars today integrate advanced electronic systems that were once more typical of high-end cars, including infotainment, telematics and connectivity. Potential threats to these advanced systems include overcurrents, ESD and surges. Littelfuse delivers comprehensive protection solutions, including SMF Fuses, SMD PPTCs, TVS Diodes and Diode Arrays, MLVs and XTREME-GUARD® ESD Suppressors.
Applications

Vehicle Communication

V2V and V2I will provide new levels of safety and efficiency by sharing data on vehicle locations and speed/direction, as well as receiving information from smart traffic signals. On-board power and communication circuits in these systems need overcurrent, ESD and surge protection using Fuses, PPTCs, TVS Diodes and Diode Arrays, MLVs and Polymer ESD Suppressors.

Cameras

External cameras support ADAS functions like Lane Departure Warning while interior cameras support eye tracking to prevent accidents due to drowsiness of the driver. In addition to protection against common electrical threats, data and communication buses require protection that does not interfere with high-frequency video signals. Littelfuse solutions include TVS Diodes and Diode Arrays, MLVs, Schottky Diodes and SMD PPTCs.
### Applications

#### BATTERY MANAGEMENT SYSTEM

The Battery Management System (BMS) maintains the safe operation of the high voltage battery and can relay information about the battery to power and energy management systems. The BMS requires protection from threats such as overcurrents, surges and ESD. Fuses, TVS Diodes and Diode Arrays keep this system reliable and safe under all conditions (assembly, maintenance and normal operation).

#### ON-BORD BATTERY CHARGER

Hybrid and electric vehicle batteries can be recharged by standard power outlets by using an AC-DC converter system, or directly from DC power that is covered outside of the vehicle for faster charging. Design challenges include protecting against overcurrents, overvoltages and ESD, as well as controlling switching of the input rectifiers. Littelfuse offers a broad range of High Voltage Fuses, Varistors, GDTs, Switching Thyristors and TVS Diodes and Diode Arrays to address these threats.

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<th>Product Series</th>
<th>Product Description</th>
</tr>
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<tbody>
<tr>
<td>Overcurrent Protection</td>
<td>SMD Fuse</td>
<td>437A, 410A, 411A, 414A</td>
<td>SMD Fuses for overcurrent Protection up to 83V and 8A, High voltage SMD fuses for overcurrent protection up to 450Vdc and 5A</td>
</tr>
<tr>
<td>Overcurrent Protection</td>
<td>Fuse in Wiring Harness</td>
<td>477A</td>
<td>Ceramic fuse up to 10A with 10kA interrupt rating up to 400Vdc and 5A</td>
</tr>
<tr>
<td>Overvoltage Protection</td>
<td>TVS Diode</td>
<td>TPSMA, TPSMB, TPSMC</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 5000W</td>
</tr>
<tr>
<td>ESD Protection</td>
<td>Diode Array</td>
<td>A01</td>
<td>Uni- and bi-directional ESD protection Diode with 30F and 30/30kV ESD capability</td>
</tr>
<tr>
<td>Overvoltage Protection</td>
<td>TVS Diode</td>
<td>TPSAC</td>
<td>Designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events</td>
</tr>
<tr>
<td>ESD Protection</td>
<td>Diode Array</td>
<td>SM8016A</td>
<td>Industry-standard solution for ESD protection on CAN bus</td>
</tr>
<tr>
<td>Main High-Voltage Battery</td>
<td>High Voltage Fuse</td>
<td>20EV, 30EV</td>
<td>High-current xEV fuse with ratings 60-200A and up to 500Vdc</td>
</tr>
<tr>
<td>Battery Fuse</td>
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</tbody>
</table>

#### Diagram

- **Module 1**: Li Cells, Temp, Cell Monitor, Sense Lines, High Voltage Main Fuse, Controller/ Main Switch
- **Module X**: Li Cells, Temp, Cell Monitor, Sense Lines, Daisy Chain/IF, Diode Monitor

**Diagram Elements**
- Li Cells
- Temp
- Cell Monitor
- Sense Lines
- High Voltage Main Fuse
- Controller/ Main Switch
- Daisy Chain/IF
- Diode Monitor

**Diagram Notes**
- Designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events
- Specifically designed for electric vehicle on-board charger applications. Its excellent AC handling capability and surge robustness makes this series an ideal switch for these input rectifiers
- Designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events
- Designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events
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- Designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events
Applications

REMOTE KEYLESS ENTRY

Remote keyless entry systems include the on-board circuitry that receives signals from a remote “fob” and unlocks the doors, sounds an alarm, starts the engine, etc. These systems are exposed to electrical threats on both the powered circuits and the communication lines. Protection includes Fuses, TVS Diodes and Diode Arrays, MOVs, MLVs and ESD Suppressors.

COMMUNICATION SYSTEMS - CAN BUS

The CAN bus provides command and control functions through a reliable, fault-tolerant sensitive interface. Typical applications include engine control, transmission control, anti-lock braking and other mission-critical systems. ESD and induced surges are the most common threats facing CAN bus systems. Littelfuse TVS Diode Arrays are specifically designed to protect sensitive I/O interfaces.

COMMUNICATION SYSTEMS - LIN BUS

The LIN bus is typically used for body control functions for applications such as power windows, seat controllers, sun roofs and trunk latches. ESD and induced surges are the most common threats. Littelfuse TVS Diode Arrays are specifically designed to protect sensitive I/O interfaces.

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</thead>
<tbody>
<tr>
<td>Overcurrent Protection</td>
<td>SMD Fuse</td>
<td>3474, 4405, 4411</td>
<td>SMD Fuses for overcurrent Protection up to 68V and 8A</td>
</tr>
<tr>
<td>Overvoltage Protection</td>
<td>TVS Diode</td>
<td>TPSMA, TPSMB, TPSMC</td>
<td>TVS Diode for secondary induced transient voltages with peak pulse capability from 400W to 600W</td>
</tr>
<tr>
<td>ESD/Surge Protection</td>
<td>TVS Diode Array</td>
<td>AD1</td>
<td>Multilayer Varistor with load dump energy rating per SAE specification J1113</td>
</tr>
<tr>
<td>ESD Protection</td>
<td>Multilayer Varistor (MLV)</td>
<td>MLA Auto</td>
<td>Voltage suppression Variator up to 120Vdc and 55kV ESD capability</td>
</tr>
<tr>
<td>ESD Protection</td>
<td>XTREME-GUARD™</td>
<td>AX10</td>
<td>Surface-mount solution for ESD and induced surge energy</td>
</tr>
</tbody>
</table>

Applications

SM24CAN TVS Diode Array
SD24C TVS Diode Array
TPSMA TVS Diode

Disclaimer: Littelfuse products are not designed for, and shall not be used for, any purpose (including, without limitation, automotive, military, aerospace, medical, life-saving, life-sustaining or nuclear facility applications, devices intended for surgical implant into the body, or any application in which the failure or lack of desired operation of the product may result in personal injury, death, or property damage) other than those expressly set forth in applicable Littelfuse product documentation. Warranties granted by Littelfuse shall be deemed void for products used in any purpose not expressly set forth in applicable Littelfuse documentation. Littelfuse shall not be liable for any claims or damages arising out of products used in applications not expressly intended by Littelfuse as set forth in applicable Littelfuse documentation. The sale and use of Littelfuse products is subject to Littelfuse Terms and Conditions of Sale, unless otherwise agreed by Littelfuse.