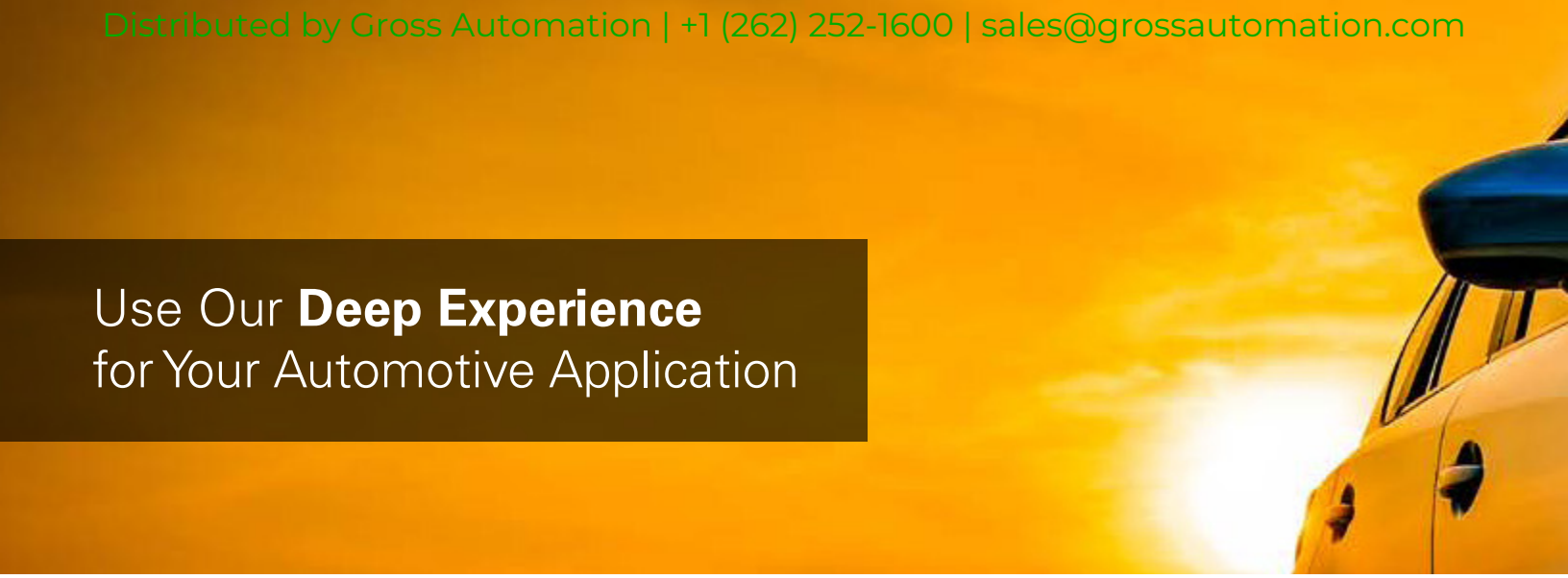
Littelfuse

Expertise Applied | Answers Delivered

Automotive Electronics
Applications Guide

A guide to selecting the right parts for your automotive applications



Use Our **Deep Experience** for Your Automotive Application

About This Guide

This guide provides an overview of the Littelfuse technologies used in various automotive electronics applications. It is designed to help you quickly find a solution appropriate to your application.

Specifications, descriptions, and illustrative material in this literature are as accurate as known at the time of publication but are subject to changes without notice. Visit **Littelfuse.com** for more information.

1930 Littelfuse invents the first automotive fuse

1950 Introduces industry's first centralized under-dash fuse block

1976 The first blade-type ATO (Autofuse®) Fast-Acting Fuse, now considered the global standard

2013 Develops automotive grade TVS Diodes TP family for transient voltage suppression

Littelfuse: Everywhere, Every Day

Founded in 1927, Littelfuse is a diversified industrial technology manufacturing company empowering a sustainable, connected, and safer world. Across more than 20 countries and with approximately 17,000 global associates, we partner with customers to design and deliver innovative, reliable solutions.

Littelfuse offers an extensive technology portfolio—fuses, semiconductors, polymers, ceramics, relays, sensors, switches, and more. Serving over 100,000 end customers, our products are found in a variety of industrial, transportation, and electronics end markets—everywhere, every day.

Your Design Challenges, Solved

Our history of innovation, combined with our customer-first culture, drives us to collaborate with you to develop safer, more reliable products that are energy efficient and compliant with global regulations. We will partner with you to solve complex problems wherever electrical energy is used, bringing design, engineering, and technical expertise to deliver business results.

Our product designs are backed by experts committed to delivering the best solutions for your specific needs. Our global organization provides:

- Custom sensor designs per customer specifications
- Vertically integrated manufacturing
- In-house magnetic sensing simulation support
- Quick turnaround for custom sensor prototypes

Customer Focus

A customer-first approach is at the heart of our company-wide culture, driving us to build long-lasting relationships and exceed expectations. Every day, it's our employees who make the difference for your business. They listen to your needs and understand your challenges. They use their knowledge and expertise to develop the best solutions and solve your problems.

Application Expertise

At Littelfuse, we partner with customers to design, manufacture, and deliver innovative solutions for a wide range of markets including automotive and commercial vehicles, industrial applications, data and telecommunications, medical devices, consumer electronics, appliances, and transportation.

Our expertise involves applying reliable and efficient product solutions, innovative technologies, and global resources to address technical challenges in a variety of applications. Our worldwide network of research teams focuses on product development and support, design-in programs, and application testing in our global labs.

Global Support

Through our network of global labs in China, Germany, Italy, Japan, Lithuania, Mexico, the Philippines, and the United States, we design innovative solutions and provide customer applications support and testing. Our unique capabilities include performance testing, material analysis, and regulatory compliance testing. The dedication of our global labs ensures the outstanding performance, safety, and reliability of our products and support services for our worldwide customer base.

With over 50 locations throughout the Americas, Europe, and Asia, Littelfuse is able to provide products, application knowledge, and technical support around the globe. Our network of regional customer support offices and hundreds of authorized distributors work to help you solve problems quickly.

Operational Excellence

With our global manufacturing footprint, Littelfuse is firmly committed to manufacturing quality products at a competitive price. We build quality into our products and services, striving for zero defects in everything we do, thereby reducing cost and increasing your total satisfaction. We strive to exceed your expectations every day.

Quality Assurance

Our global manufacturing facilities abide by strict quality assurance requirements and hold the following quality management system registrations:

- ISO 9001
- ISO14001
- IATF 16949

Standards and Compliances

Automotive 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 reliability of the next generation of circuit protection products.

The designers of automotive electronics face many technical challenges during the system design process, including designing methods of protection against a variety of electrical hazards. The major sources of electrical hazards in these systems are electrostatic discharge (ESD), lightning, and switching loads in power electronics circuits.

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. (Note: Please refer to Additional Resources Section on page 27 for further details.)

- Transient surges: JASO D001-94 and ISO 7637-2 (Surge) test
- Electrical disturbance by conduction and coupling: ISO 7637-3
- Electrical disturbances from electrostatic discharge: ISO 10605
- Environmental conditions and testing for electrical and electronics equipment: ISO 16750-2
- Load dump, switching transients, and ESD threats: SAE J1113, GM 9105, ES-F2af-1316-AA Ford (Visteon)

Electrical Component Qualification

AEC-Q100: A failure mechanism-based stress test qualification for packaged integrated circuits used in automotive applications. This specification has been established by the Automotive Electronics Council (AEC) to define qualification requirements and procedures for packaged integrated circuits used in the automotive industry. An AEC-Q100 qualified device means that the device has passed the specified stress tests and guarantees a certain level of quality/reliability.

AEC-Q101: Failure-mechanism-based stress test qualification for discrete semiconductors in automotive applications that is published by the Automotive Electronics Council (AEC) to guarantee the consistency for products quality and reliability of automotive electronics. TVS Diodes, TVS Diode Arrays, and SIDACtor® Protection Thyristors are AEC-Q101 qualified components.

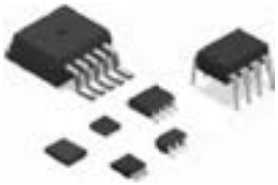
AEC-Q200: A stress test qualification for passive electrical devices. Littelfuse has contributed to the development of the new AEC-Q200 Revision E and the framework for defining the test requirements for fuses. The tests of AEC-Q200 fall into two categories: environmental and physical stresses. The environmental stress tests involve, among others, testing at high temperature and humidity. The physical stress tests include mechanical shock and vibration and other tests. Fuses, PPTCs, varistors, and Polymer ESD Suppressors are qualified components.


SIDACtors®


Digital Temperature Indicators


Gas Discharge Tubes


Polymer ESD Suppressors


Low-Side Gate Driver Driver ICs


Tactile Switches


Multilayer Varistors

Metal Oxide Varistors


PolySwitch® Resettable PPTC Devices


High-voltage DC Contactor Relays

Envisioning a Sustainable, Interconnected, And Safe Approach To Mobility

To meet zero emissions, today's mobility experience is undergoing numerous transformations and facing various challenges, including the ongoing shift towards powertrain electrification. This transition signifies our move from fossil fuels to battery power, necessitating innovative advancements in integrating drivetrain to reduce weight and cost, alongside a shift towards higher energy density and quicker charging battery chemistry. Additionally, this evolution is paving the way for the next generation of hydrogen fuel cell technology.

To keep pace with rapidly evolving trends, software-defined vehicles, built upon zonal architecture, are enhancing vehicle performance and introducing new features through over-the-air updates (OTA). To enhance driving safety, the necessity for manual driving is diminishing, with the Advanced Driver Assistance Systems (ADAS) and the progression towards Level 5 autonomous driving leading the charge. Ultimately, the emergence of the smart cockpit trend enriches our mobility experience by blending entertainment with safety and connectivity.

Littelfuse works with top-tier teams in the vehicle industry to deliver quality goods and solutions that are reliable designed to meet the demands of future trends.

COMMUNICATION & INFOTAINMENT SYSTEMS

- Audio System
- Digital Cluster
- eCall
- GPS Module
- Head Unit
- LTE/WiFi/Bluetooth
- Navigation System
- Smart Cockpit
- Telematics Box

ENERGY STORAGE & PROPULSION SYSTEMS

- Battery Charging
- Battery Electric (BEV)
- Battery Management System (BMS)
- DC–DC Converter
- Fuel Cell Electric (FCEV)
- Hybrid Electric (HEV/PHEV)
- On-Board Charger (OBC)
- Power/Battery Distribution Unit (BDU/PDU)
- Traction Inverter (Motor Drive)

COMBUSTION ENGINE SYSTEMS

- Cooling
- Electronic Fuel Injection (EFI)
- Engine Control Unit (ECU)
- Exhaust
- Ignition
- On-Board Diagnostics (OBD)
- Transmission Control Unit (TCU)
- Turbo Charger

CHASSIS AND SAFETY SYSTEMS

- Active Suspension
- Air Bag
- Battery Disconnect
- Brake Control (ABS)
- DC Power Supply
- Electric Power Steering (EPS)
- Electronic stability control (ESC)
- Pre-Collision System (PCS)
- Seat Belt Pretensioner
- Tire Pressure Monitoring System (TPMS)

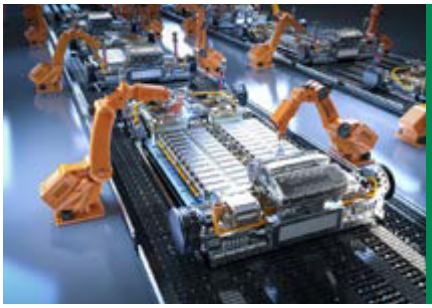
NETWORK SYSTEMS AND BODY

- Bluetooth*
- BroadR-Reach®
- CAN Bus
- Central Body Module
- Climate Control (HVAC)
- Dashboard
- Ethernet
- FlexRay*
- Keyless Entry
- Lighting
- LIN Bus
- MOST*
- Park Assistance
- Power Window
- Retracting Mirror
- Safe-By-Wire*
- Seat Control
- Wiper

* The marks BroadR-Reach®, FlexRay, MOST, Bluetooth, and Safe-By-Wire are the properties of their respective owners.

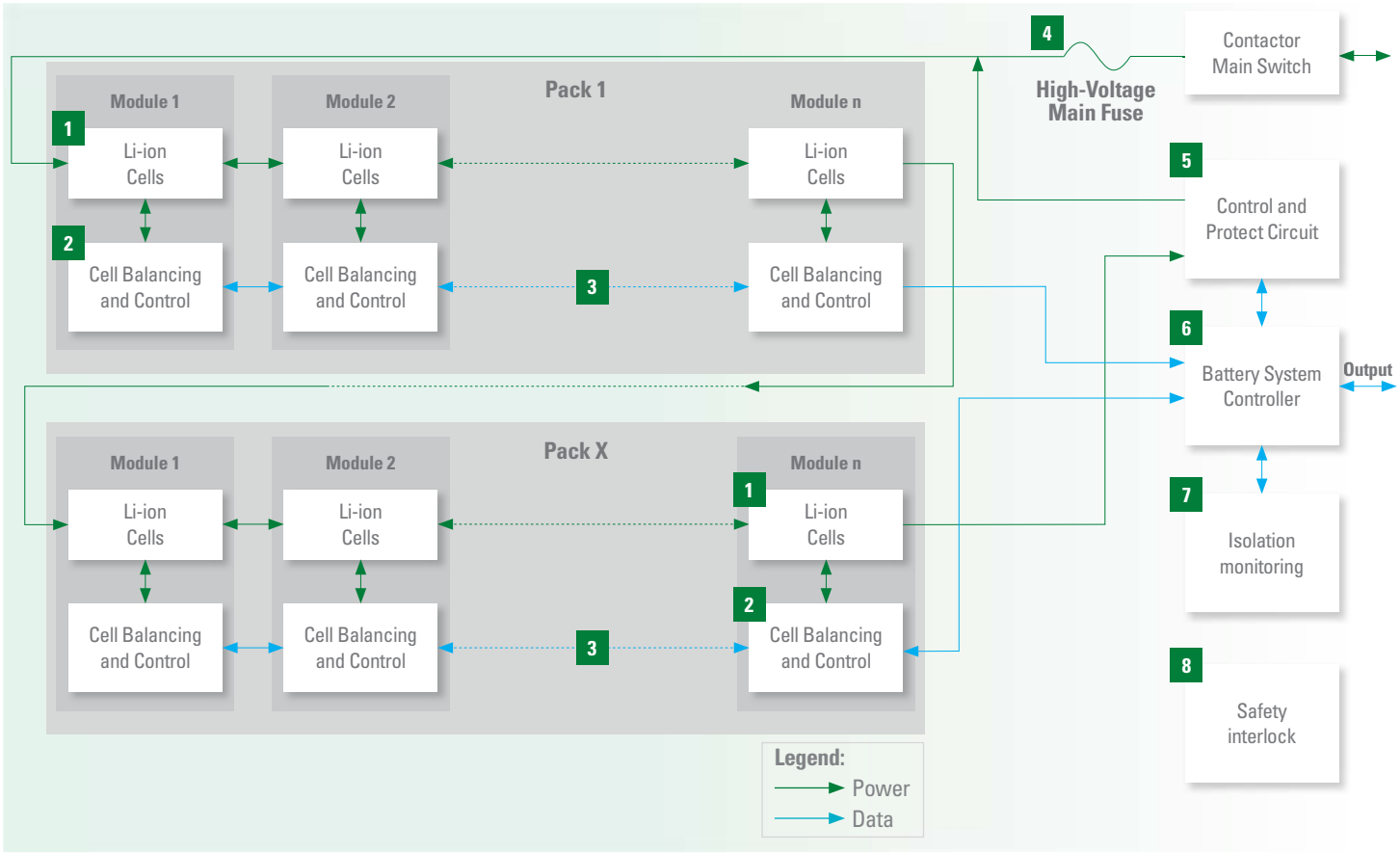
ADVANCED DRIVER ASSISTANCE SYSTEMS

- Adaptive Cruise Control (ACC)
- Adaptive Front Light (AFL)
- Automatic Emergency Braking (AEB)
- Autonomous Driving (self-driving)
- Blind Spot Detection (BSD)
- Exterior Camera – Front View
- Exterior Camera – Rear View Park Assist
- Interior Camera – Driver Monitoring (DMS)
- Lane Departure Warning (LDW)
- Night Vision
- Pedestrian Avoidance
- Radar/LiDAR/Ultrasonic Sensors
- Side Impact Assist
- Vehicle-to-Vehicle (V2V) Communication



BATTERY MANAGEMENT SYSTEM (BMS)

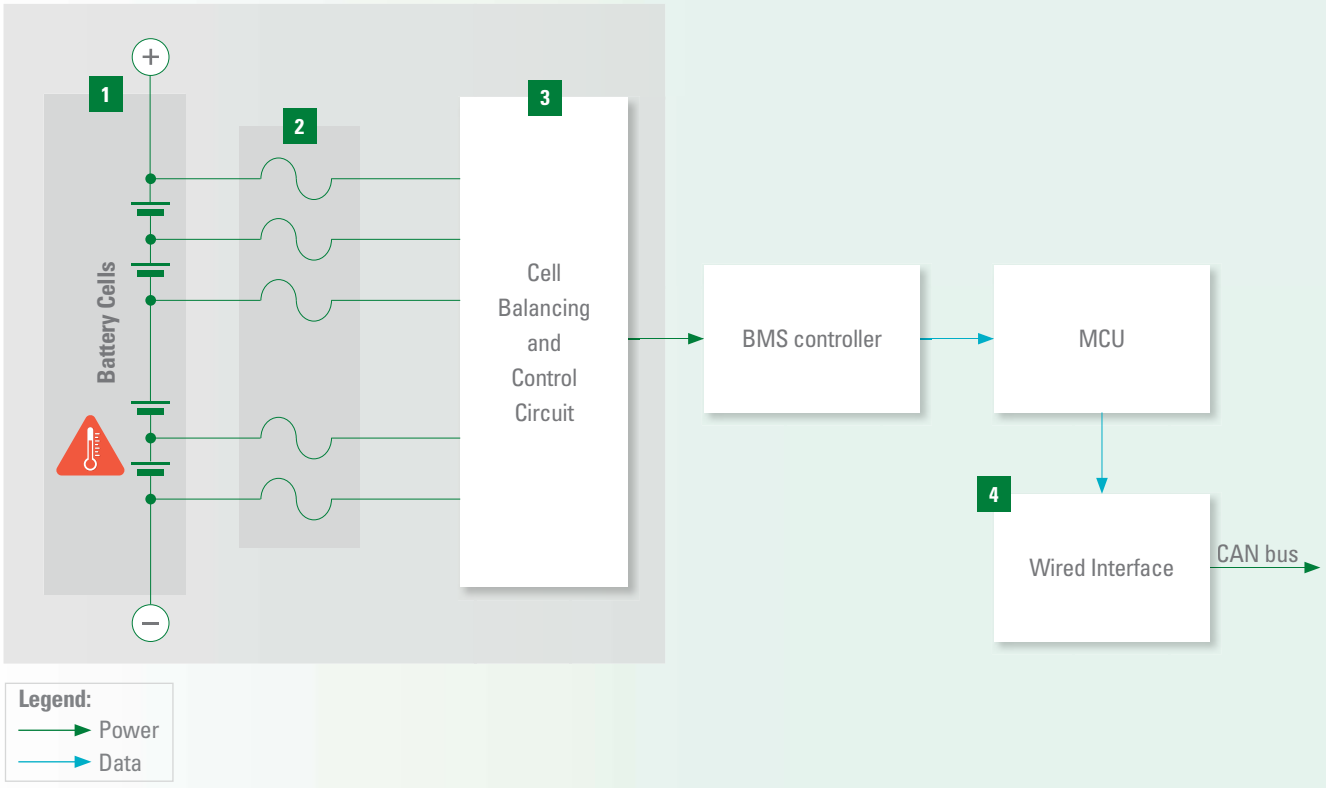
The energy storage system, which includes the battery management system, stores and supplies electric power for all vehicle needs. This system needs protection from a wide range of electrical threats, such as high fault currents, voltage transients, overcurrent, and overloads. Each threat is best countered with the right type of circuit protection technology.



	Technology	Application	Series Name	Features
1	SMD Fuse	Protects cells and downstream BMS components from high fault currents due to external shorts	501A, 881	Tested to new AEC-Q specification; fast response to fault current; surface mount device
	TVS Diode	Transient voltage suppression	TPSMC, TPSMD, TPSMB, TP5.0SMDJ	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
2	TTape™ Platform	Overtemperature monitoring of many cells or large area with single MCU input	TTP	Simple integration with existing BMS solutions complementing NTCs; no calibration or temperature look-up tables needed; pressure sensitive adhesive for simple and quick installation
	SMD or In-line Fuse	Protects cells and BMS components from overcurrent	438A, 441A, 521, 483A	Tested to new AECQ specification; fast response to fault current; surface mount device
3	TVS Diode	Transient voltage suppression	TPSMB, SZ1SMB, SZP6SMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
	TVS Diode	Transient voltage suppression	AQ05C / AQ1205	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
4	High-voltage Fuse	Short circuit protection; overload circuit protection	30EV1K, 25EV1K	Bolt down form factor; high breaking capacity; ISO 8820 qualified
5	TVS Diode Array	Protects sensitive electronic ICs from ESD, EFT, and voltage transient	TPSMA6L, SZ1SMA	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2, ISO10605; low leakage current and clamping voltage
6	Gate Driver	Controls the switching MOSFETs	IXD_6xxSI	Tight tolerance; small form factor; fast thermal response
	TVS Diode Array	Protects CAN bus from ESD, EFT, and voltage transient	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage low leakage current and clamping voltage
	SMD Fuse	Protects cells and BMS components from overcurrent	885	Tested to new AEC-Q specification; fast response to fault current; surface mount device
	TVS Diode	Transient voltage suppression	TPSMB, TPSMC	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
7	TVS Diode	Protects solid-state relays (SSRs) from voltage transients	TPSMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
8	Switch	Lid disconnection. Detect an opening of the battery pack	ZMS, ZMV, SSW	Products suitable for automotive applications; SSW series has been designed for ASIL related applications

BATTERY MODULE

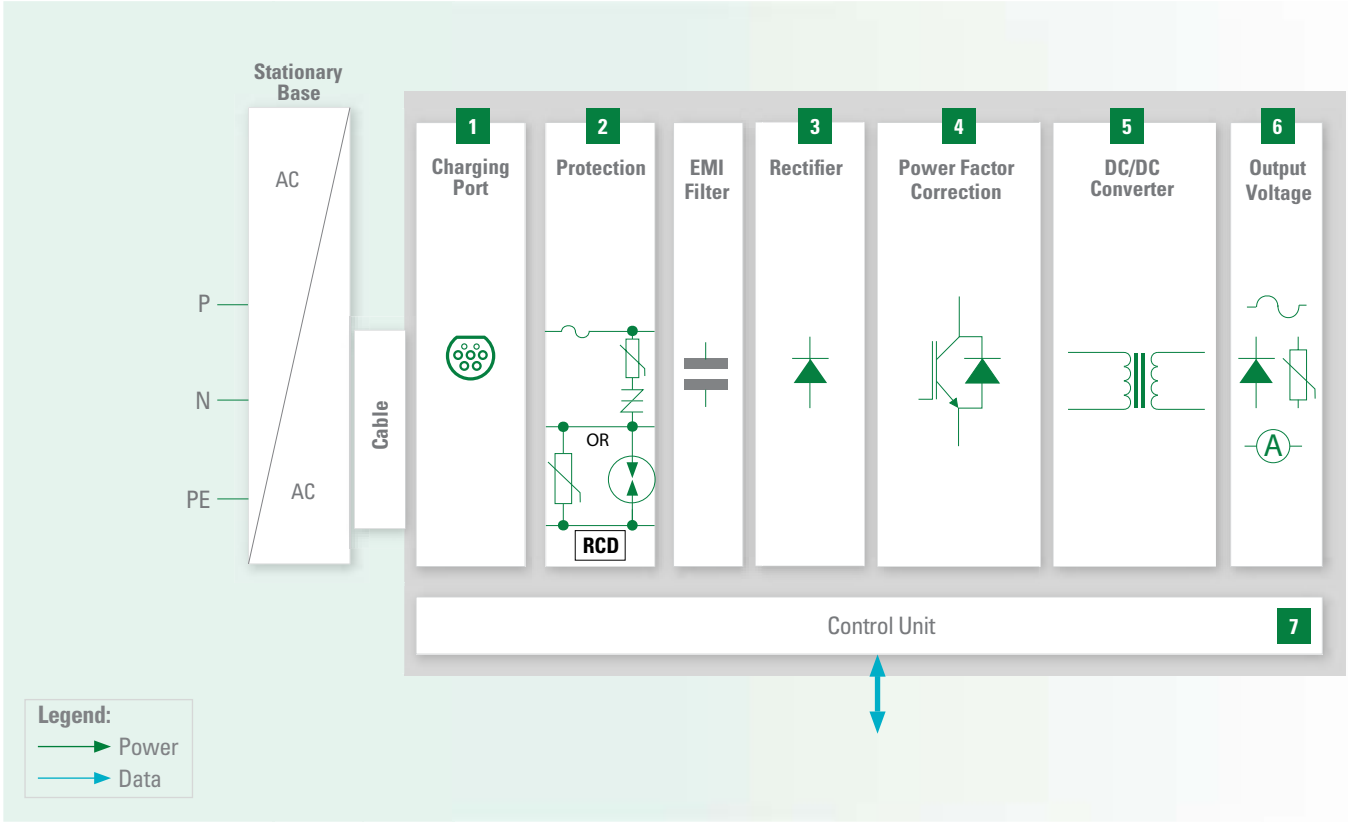
Inside the battery pack is a number of battery modules made up of individual battery cells. This architecture dictates that layers of circuit protection are required. At the module level, the battery module and cable should be protected from overcurrent and from overloads between power-sense lines. The electronics should be defended against voltage transients, and the CAN (Controller Area Network) and other communication buses should be safeguarded from ESD and voltage transients.



	Technology	Application	Series Name	Features
1	TTape™ Platform	Overtemperature monitoring of many cells or large area with single MCU input	TTP	Simple integration with existing BMS solutions complementing NTCs; no calibration or temperature look-up tables needed; pressure sensitive adhesive for simple and quick installation
	TVS Diode	Transient voltage suppression	TPSMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
2	Fuse	Analog front-end protection of user and environment in case of external short, overload between power-sense line	440A, 437A, 438A	Surface mountable; compatible with lead-free solder process per IEC standards; high reliability
3	TVS Diode	Protects sensitive electronic components from voltage transients	TPSMB, SZ1SMB, SZSMF4L	400 W / 600 W peak pulse capability; compatible with lead-free solder reflow temperature profile
4	TVS Diode Array	Protects CAN bus sensitive electronic ICs from ESD, EFT, and voltage transient	AQ24COM-02	AECQ-101 qualified; low capacitance; low leakage current

ON-BOARD BATTERY CHARGER

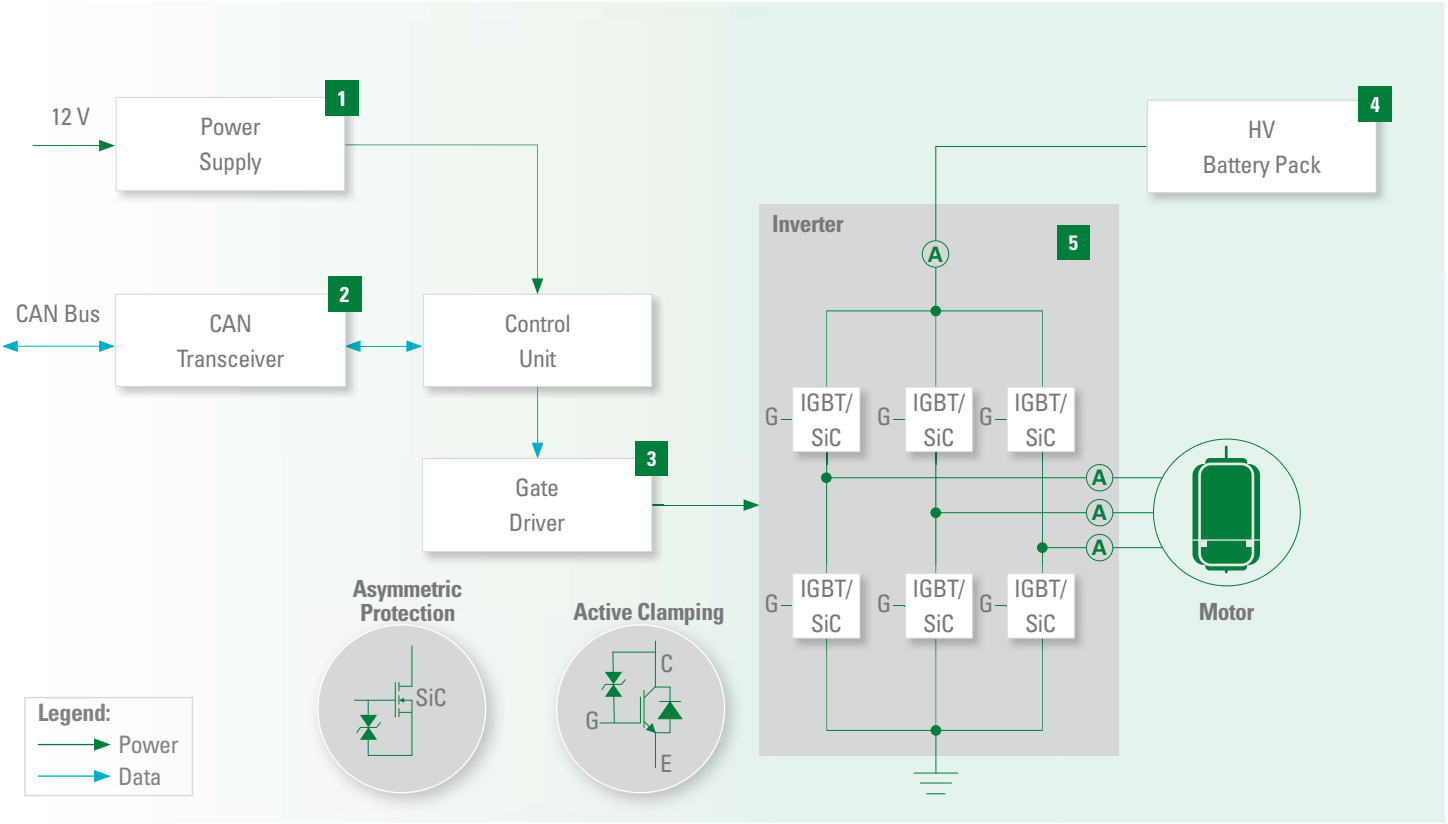
Hybrid and electric vehicle batteries can be recharged from standard power outlets by using an AC-DC converter system or directly from DC power that is covered outside of the vehicle for faster charging. Design challenges include protecting against overcurrent, overvoltage, and ESD, as well as controlling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



	Technology	Application	Series Name	Features
1	Switch	Lid disconnection; detects an opening of the charging port	ZMS, ZMV, SSW	Products suitable for automotive applications; SSW series has been designed for ASIL related applications
2	Fuse	Short circuit protection; overload circuit protection	526, 527	AEC-Q200 qualified, high voltage; ceramic body ensures compatibility with high-temperature environment
	MOV	Protects from lightning and system transient surges	AUMOV, SM10	Wide range of surge current ratings; disk sizes and lead options; surface mount available
	GDT	Ensures electrical isolation between line, neutral, and ground	CG2, CG3	Rugged, high surge current based on ceramic tube design; low leakage current
	SIDACtor®	Lightning and system transient surges	Pxxx0FNL, Pxxx0S3N-A (6kV/3kA), Pxxx0S3G-A (4kV/2kA)	Surface mount form factor; semiconductor-based design does not wear-out; used in combination with MOV; provides lower clamping voltage for sensitive circuitry. For more information see **here**
	RCD	Residual current detection	CF3P03xC	AC and DC leakage currents detection; IEC 62752 or UL 2231 versions
3	Thyristor	Rectification	S8016xA	Compact TO-220AQ and surface mount TO-263 form factors, V_{DRM} of 800 V, I_T or 25 $A_{(RMS)}$
4, 5	Gate Driver	Controls the switching IGBTs	IXD_6xxSI, IX4340NE	Tight tolerance; small form factor; fast thermal response
	TVS Diode	Active clamping	TPSMB, SZ1SMB, SZP6SMB	Small form factor DO214-AA package; low clamping voltage; products are available with voltage ratings from 150 V~650 V. For more information on 'Active Clamp' see **here**.
	TVS Diode Array	ESD protection of the gate input	AQ4022	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage
6	Fuse	Short circuit protection; overload circuit protection	526, 828	AEC-Q200 qualified; high voltage; ceramic body ensures compatibility with high-temperature environment
			10EV, 20EV, 30EV1K, 25EV1K	Bolt down form factor; high breaking capacity; qualified to ISO 8820 standard
	MOV	Transient voltage suppression	AUMOV, SM10	Wide range of surge current ratings; disk sizes and lead options; surface mount available
	TVS Diode	Transient voltage suppression	TPSMB, SZ1SMB, SZP6SMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
	Current Sensor	Measures the overall output current	CH1B02xB, CH1B04xB	Up to 2000A with analog or CAN output; functional safety ratings from ASIL QM to ASIL C available
7	TVS Diode Array	Protects CAN Bus from ESD, EFT, and voltage transient	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage

TRACTION MOTOR INVERTER

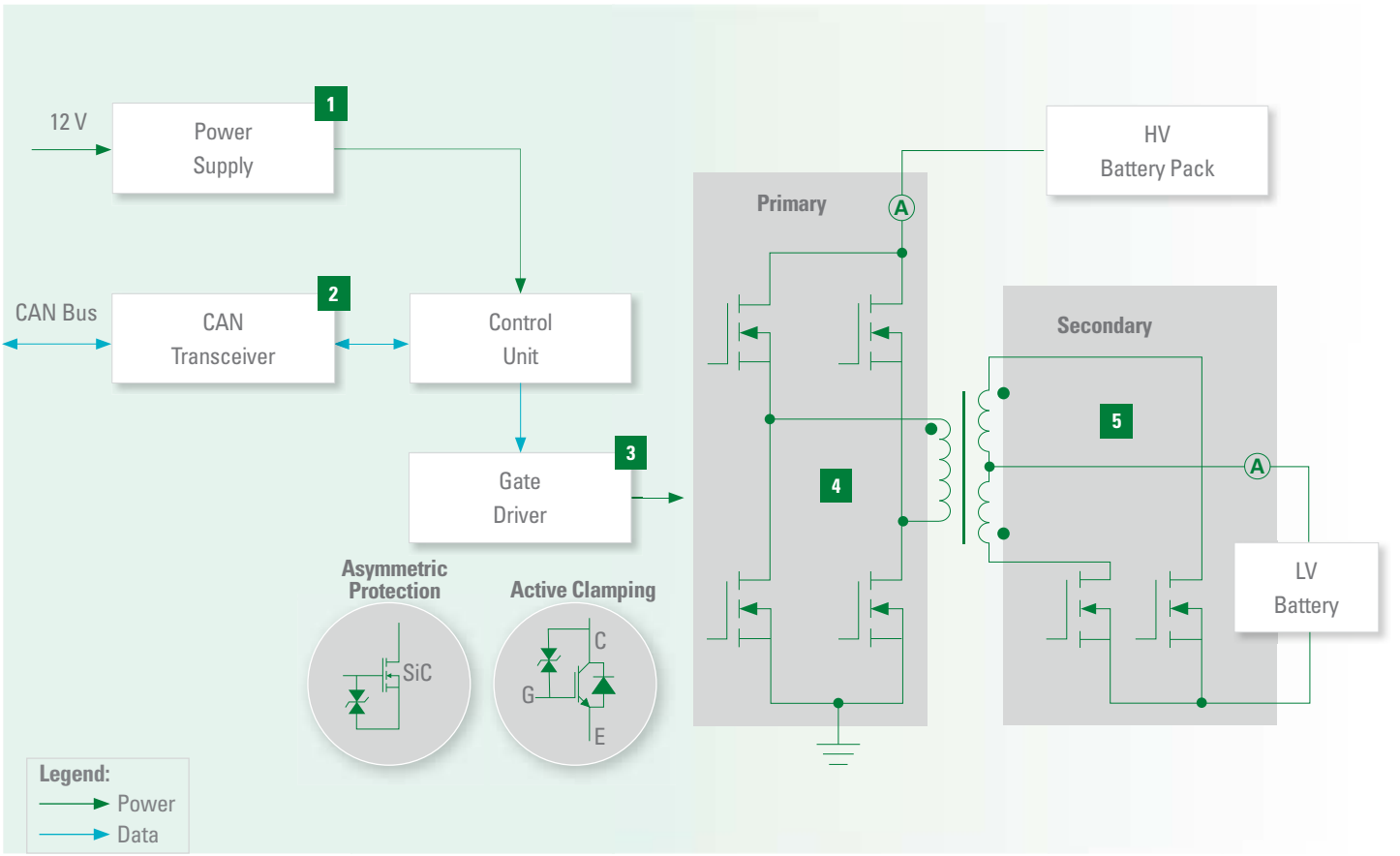
The traction motor inverter changes DC current from the battery into the AC current needed to drive the traction motor of an electric or hybrid electric vehicle. Littelfuse offers a variety of components across this system, such as a fuse on the power supply and thermal protection on the motor.



	Technology	Application	Series Name	Features
1	TVS Diode	Transient voltage suppression	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
	SMD Fuse	Short circuit protection; overload circuit protection	441A	Tested to new AECQ specification; fast response to fault current; surface mount device
2	TVS Diode Array	Protect CAN Bus from ESD, EFT, and voltage transient	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage
3	TVS Diode Array	ESD protection of the gate input	AQ4022	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage
	TVS Diode	Active clamping	TPSMB, SZ1SMB, SZP6SMB, SZSMF4L	Small form factor DO214-AA package; low clamping voltage; products are available with voltage ratings from 150 V–650 V. For more information on 'Active Clamp' see **here**.
	Gate Driver	Controls the switching IGBTs	IXD_6xxSI, IX4340NE	Tight tolerance; small form factor; fast thermal response
4	Fuse	Short circuit protection	526, 828, 30EV1K, 25EV1K	High voltage; ceramic body ensures compatibility with high temperature environment
5	TVS Diode	Active clamping for IGBT; gate protect for SiC MOSFET	TPSMB, SZ1SMB, SZP6SMB, SZSMF4L, TPSMBASY	Clamps the transient that is created when the MOSFET switches; ensuring reliability; asymmetric diodes to protect the gate of SiC transistors. For more information on 'Active Clamp' see **here**.
	Shunt Resistor	Current sensing resistor	SSA	Compact size; cost effective solution; works for AC and DC applications
	Current Sensor	Measures current on each phase of the inverter/motor and/or the DC link current	CH1P01xM, CH1B02xM, Ch3S01xM, CH3B01xM, CH1B04xB	Isolated from HV network; no additional power loss due to shunt resistor
	Thermal Protection	Thermal protection for MOSFETs	HCRTP-mini	Responds to overtemperature conditions caused by catastrophic failure of MOSFET device

DC–DC CONVERTER

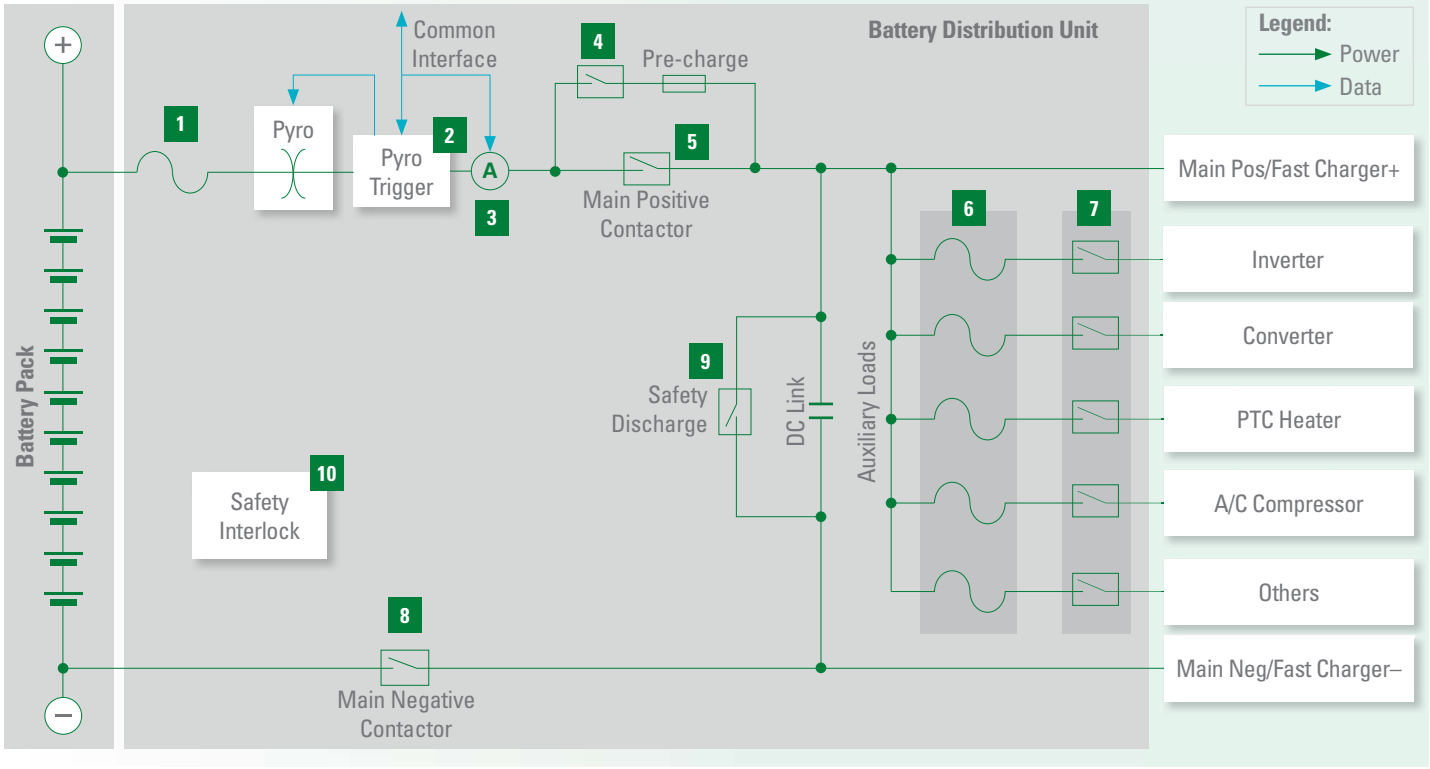
The DC–DC converter changes the high voltage from the battery to a lower level of voltage, which is needed by a wide range of onboard systems: 12 V loads, including lighting, sensors, and entertainment, and 48 V loads, including heating, powertrain, and air conditioning. Littelfuse IGBT Gate Drivers control the switching MOSFETs for energy-efficient power conversion. Power semiconductor devices are vulnerable to electrical threats, which is why circuit protection is particularly important.



	Technology	Application	Series Name	Features
1	TVS Diode	Transient voltage suppression	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
	Fuse	Short circuit and overload circuit protection	441A	Tested to new AECQ specification; fast response to fault current; surface mount device
2	TVS Diode Array	Protects CAN bus from ESD, EFT, and voltage transient	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage
3	TVS Diode Array	ESD protection of the gate input	AQ4022	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO10605; low leakage current and clamping voltage
	TVS Diode	Transient voltage suppression	TPSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
	Gate Driver	Controls the switching MOSFETs	IXD_6xxSI, IX4340NE	Tight tolerance; small form factor; fast thermal response
4	TVS Diode	Active clamping for IGBT; gate protect for SiC MOSFET	TPSMB, SZ1SMB, SZP6SMB, TP5.0SMDJ, TPSMBASY	Clamps the transient that is created when the MOSFET switches; ensuring reliability; asymmetric diodes to protect the gate of SiC transistors. For more information on 'Active Clamp' see **here**.
	Shunt Resistor	Current sensing resistor	SSA	Compact size; cost effective solution; works for AC and DC applications; power rating up to several 10s of Watts
	Current Sensor	Current measurement	CH1P01xM, CH1B02xM	Isolated from HV network; no additional power loss due to shunt resistor; up to +/-1500 A with analog output
5	Fuse	Short circuit protection	526, 527, 30EV1K, 25EV1K, 828	High voltage; ceramic body ensures compatibility with high temperature environment
	Thermal Protection	Thermal protection for MOSFETs	HCRTP-mini	Surface mountable form factor; compatible with standard reflow process; breaks current flow during overtemperature condition
	TVS Diode	Transient voltage suppression	TPSMD, TP5.0SMDJ	Small form factor DO214-AA package; low clamping voltage
	Shunt Resistor	Current sensing resistor	SSA	Compact size; cost effective solution; works for AC and DC applications; power rating up to several 10s of Watts
	Current Sensor	Current measurement	CH1P01xM, CH1B02xM	Isolated from HV network; no additional power loss due to shunt resistor; up to +/-1500A with analog output

BATTERY DISTRIBUTION UNIT

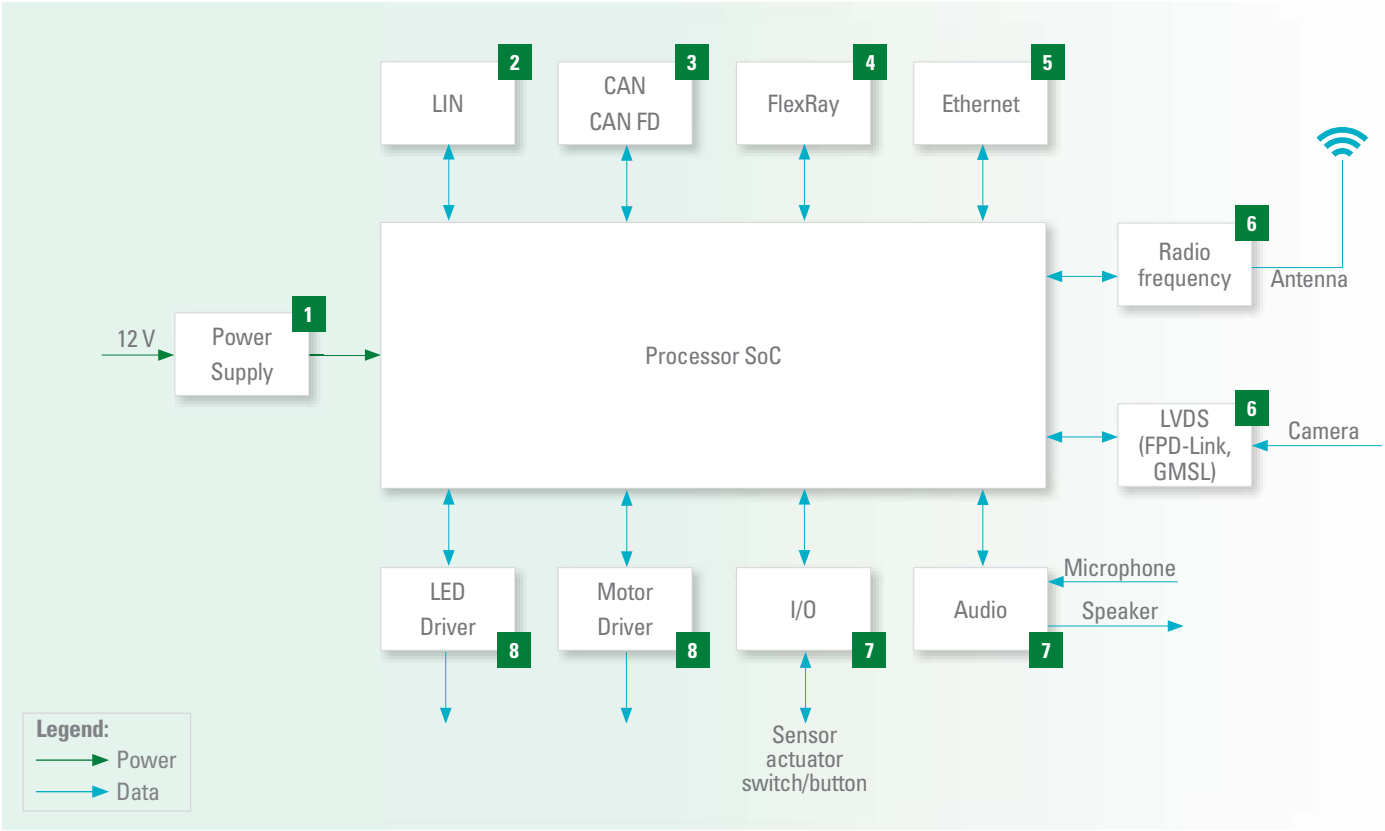
A battery distribution unit is like the vehicle's junction/panel box, delivering power to the many systems that need it. In electric vehicles, the unit relies on high-current, high-voltage fuses and contactors. Drawing upon its deep experience in the automotive industry, Littelfuse provides both fuses and contactors that are reliable and safe for this emerging application.



	Technology	Application	Series Name	Features
1	High-voltage Fuse	Short circuit and overload circuit protection	30EV1K, 25EV1K	Bolt down form factor; high breaking capacity; ISO 8820 qualified
2	Pyro Trigger	Trigger the pyro-fuse in case of overcurrent	CH1B04xP, CH1B05xP	Very fast overcurrent detection, triggering, and interruption (cut-off time <1ms): significantly reduce peak current; additional input for activation of trigger using external signal; variants with accurate current measurement available
3	Current Sensor	Measure the overall current in the system	CH1S010B, CH1B02xB, CH1B03xB, CH1B04xB	Up to 2000 A with analog or CAN output; functional Safety ratings from ASIL QM to ASIL C available
4	High Voltage DC Contactor	Protects main contactors from excess inrush current; a pre-charge contactor is used together with a pre-charge resistor to charge the capacitors of the power inverter to a level of typically 90–98% of the battery voltage	DCNHR	Wide amperage rating 30–100 A; gas-filled conact chamber and magnetic blowouts for arc suppression; available direct switched auxiliary circuit for status indication
	TVS Diode	Transient voltage suppression	TP5.0SMDJ	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
5	High Voltage DC Contactor	The main contactors connect and disconnect the traction battery from the entire electric drivetrain in the vehicle	DCNHR	Wide amperage rating; gas-filled contact chamber and magnetic blowouts for arc suppression; integrated coil economizer included in many models; available direct switched auxiliary circuit for status indication
	TVS Diode	Transient voltage suppression	TP5.0SMDJ	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for in-vehicle transient surges
6	Auxiliary Fuse	Short circuit protection; overload circuit protection	10EV, 20EV, 25EV1K, 526, 828	High voltage; ceramic body ensures compatibility with high temperature environment
7	High Voltage DC Contactor	Controls other electrical loads in the vehicle operated by the HV battery (for example, electric heater, blower, AC compressor, power steering pump, and so on)	DCNHR	Wide amperage rating; gas-filled contact chamber and magnetic blowouts for arc suppression; integrated coil economizer included in many models; available direct switched auxiliary circuit for status indication
8	High Voltage DC Contactor	The main contactors connect and disconnect the traction battery from the entire electric drivetrain in the vehicle	DCNHR	Wide amperage rating; gas-filled contact chamber and magnetic blowouts for arc suppression; integrated coil economizer included in many models; available direct switched auxiliary circuit for status indication
9	Discrete Thyristor	Fast discharge of the DC link for safety reason	SJxx40xxA	High temperature Thyristor with low gate current; available in a TO-220AB and surface mount TO-263 form factors
10	Switch	Lid disconnection; detects an opening of the battery distribution unit	ZMS, ZMV, SSW	Products suitable for automotive applications; SSW series has been designed for ASIL related applications

ZONAL CONTROL UNIT

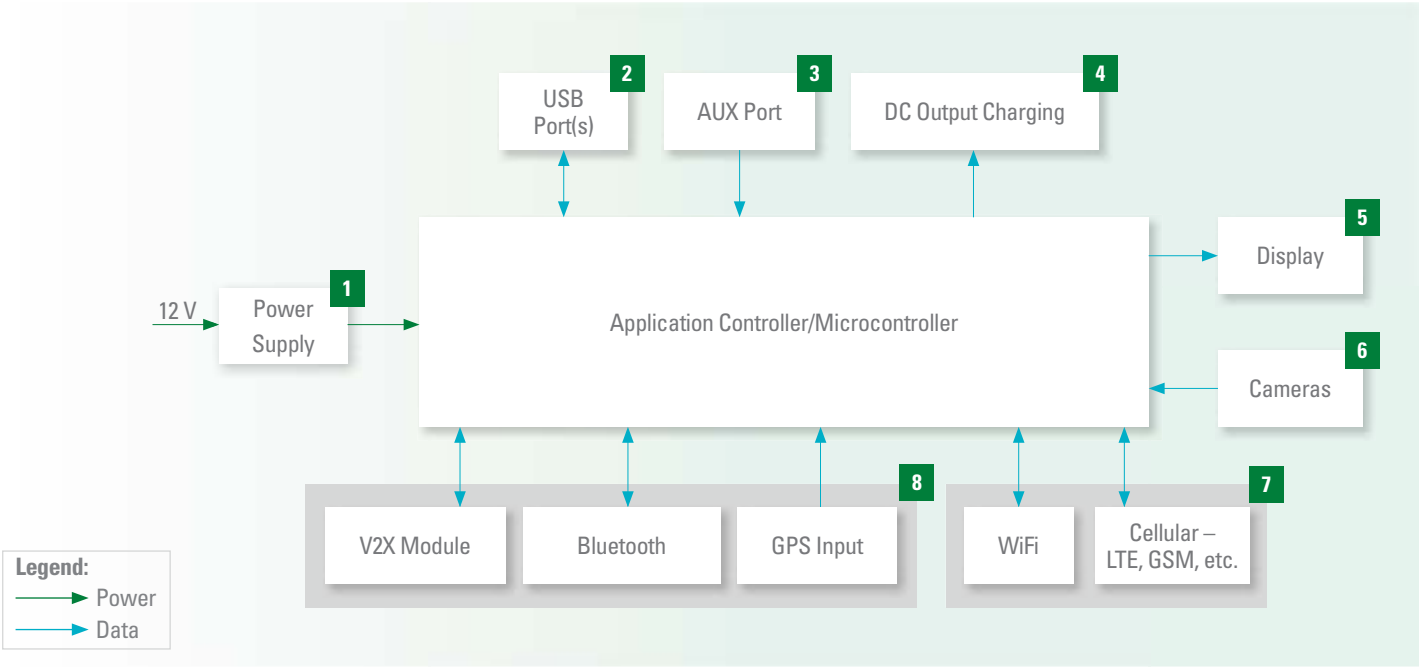
Vehicle Electric/Electronic (E/E) Architecture is migrating from distributed through domain-centralized toward zonal architecture enabling the Software-Defined-Vehicle and other system level benefits.



	Technology	Application	Series Name	Features
1	Fuse	Short circuit protection	437A, 440A, 441A	Tested to new AECQ specification; fast response to fault current; surface mount device
	PPTC		ASMD, miniASMD	AEC-Q200 qualified; small footprint 2029/1812 size
	TVS Diode	Load dump protection	TPSMC, SLD8S, SZ1SMA, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection
	MOV		AUML, MLA Auto	AEC-Q200; load dump energy rated per SAE Specification J1113; surface mount device
	Schottky Diode	Reverse blocking/output rectification	DST	Ultra-low VF; high temperature capability; low forward voltage drop to 100 V and 10 A
2	TVS Diode Array	LIN Bus protection	AQ24COM-01	Low capacitance 30 pF and leakage current (0.1 µA); small form factor SOD882
3	TVS Diode Array	CAN Bus protection	AQ24COM-02, AQ24CANFD	AEC-Q101 qualified; low leakage current and clamping voltage
4	TVS Diode Array	FlexRay protection	AQ24CANFD	AEC-Q101 qualified; low leakage current and clamping voltage
5	TVS Diode Array	Ethernet protection	AQ24ETH-02HTG	AEC-Q101 qualified; low capacitance; low leakage current; small form factor; OPEN Alliance approved for 1000BASE-T1
	Polymer ESD Suppressor		AXGD	AEC-Q200 qualified; ultra-low capacitance; low leakage current
6	Polymer ESD Suppressor	ESD protection for antenna, WiFi, and another chipset	AXGD	AEC-Q200 qualified; ultra-low capacitance; low leakage current
	TVS Diode Array		AQ3130, AQ3118	AEC-Q101 qualified; low capacitance; low leakage current; small form factor
7	TVS Diode Array	ESD protection for audio amplifier	AQ1003, AQ1005, AQ3522	Low capacitance 30 pF; leakage current (0.1 µA); small form factor SOD882
	MOV	I/O protection	MLA Auto	AEC-Q200; load dump energy rated per SAE Specification J1113; surface mount device
8	TVS Diode	Transient voltage suppression	TPSMB, TP6KE, SZSMF4L, SZ1SMA	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection

INFOTAINMENT AND SMART COCKPIT

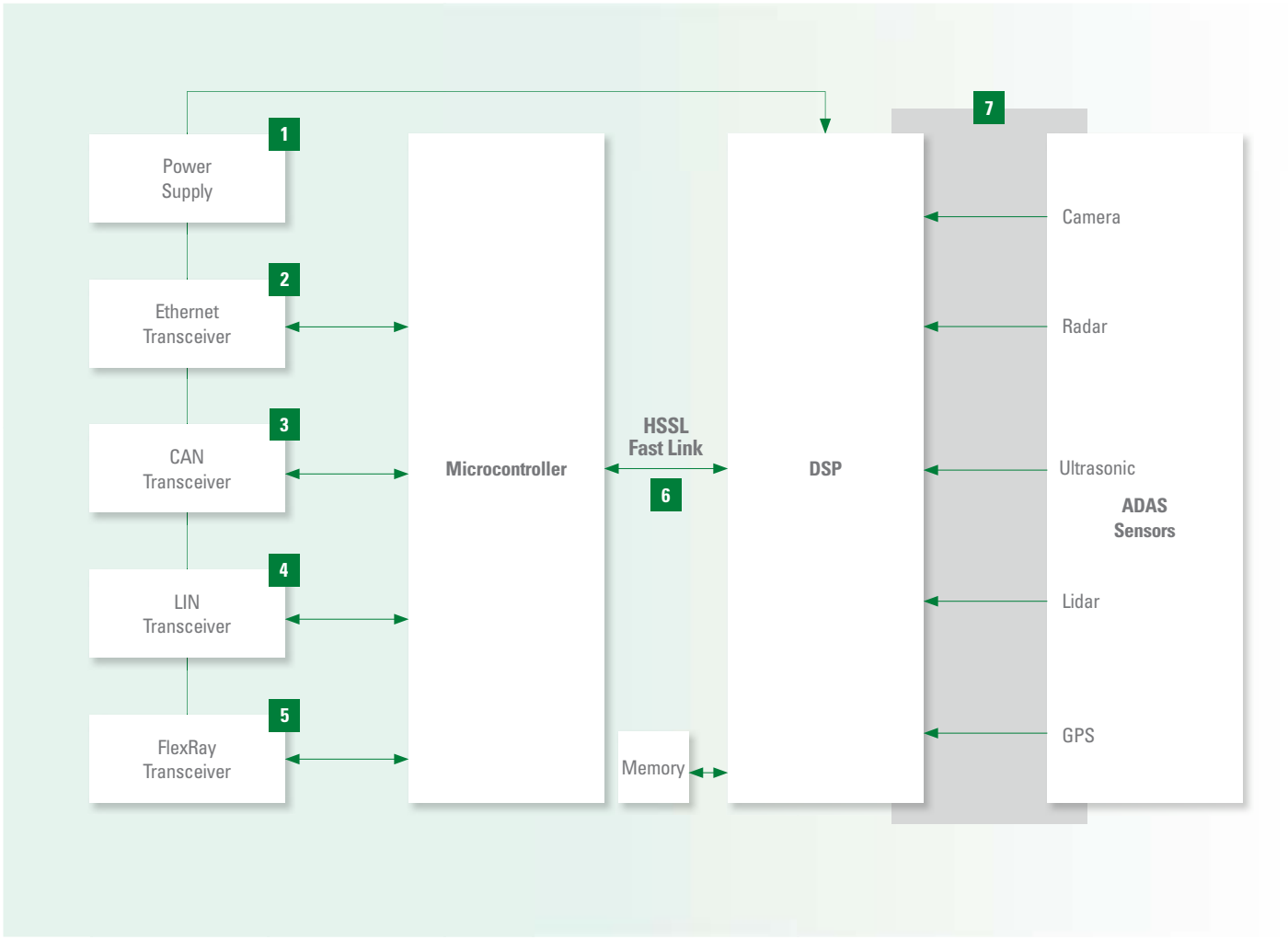
Entry-level cars today integrate advanced electronic systems that were once more typical of high-end cars, including infotainment, telematics, and connectivity. Potential threats to these advanced systems include overcurrents, ESD, and surges. Littelfuse delivers comprehensive protection solutions, including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



	Technology	Application	Series Name	Features
1	Fuse	Short circuit protection	437A, 440A, 441A	Tested to new AECQ specification; fast response to fault current; surface mount device
	PPTC		ASMD, miniASMD	AEC-Q200 qualified; Small footprint 2029/1812 size
	TVS Diode	Load dump protection	SZ1SMB, SLD8S, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection; ISO 16750 /ISO7637-2
	Varistor		AUML, MLA Auto	AEC-Q200; load dump energy rated per SAE Specification J1113; surface mount device
	Schottky Diode	Reverse blocking/output rectification	DST	Ultra-low VF; high temperature capability; low leakage; low forward voltage drop to 100 V & 10 A
2	PPTC	Protects 5 VDC power supply from over current and over temperature	ASMD, miniASMD	Ultra-low internal resistance; higher current holding in small SMD package
	TVS Diode Array	Protection of data lines against ESD	AQ3400, AQ3102, AQ1005, AQ1205	Low capacitance 30 pF and leakage current (0.1 µA); small form factor SOD882
	Varistor		MLA Auto	AEC-Q200 compliant; standard low capacitance
3	TVS Diode Array	Protection of Aux port against ESD	AQ1005, AQ1205	Low capacitance 30 pF and leakage current (0.1 µA); small form factor SOD882
	Varistor		MLA Auto	AEC-Q200 compliant; standard low capacitance
4	Fuse	Secondary overcurrent protection on DC charging port	437A, 440A, 441A	Tested to new AECQ specification; fast response to fault current; surface mount device
	TVS Diode	Transient voltage suppression	SZ1SMB, SLD8S, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection; ISO 16750 /ISO7637-2
	Varistor		AUML, MLA Auto	AEC-Q200 qualified; load dump energy rated per SAE Specification J1113; surface mount device
5	TVS Diode Array	ESD protection	AQ3045	AEC-Q101 qualified; low capacitance; low leakage current; small form factor
6	Resettable PTC	Overcurrent protection of high-speed data lines in camera	ASMD, miniASMD	AEC-Q200 qualified; small footprint 2029/1812 size
	TVS Diode Array	Protection of data lines against ESD	AQ1005, AQ3045	Low capacitance and leakage current; small form factor
	Varistor		MLA Auto	AEC-Q200 compliant; standard low capacitance
7	TVS Diode Array	ESD protection for antenna, WiFi, and another chipset	AQ3045, AQ3118E/ AQ3130E	AEC-Q101 qualified; low capacitance; low leakage current; small form factor
	Polymer ESD Suppressor		AXGD	AEC-Q200 qualified; ultra-low capacitance; low leakage current
8	TVS Diode Array	ESD protection for Bluetooth, GPS, and V2X modules	AQ1005, AQ3118E/ AQ3130E	Low capacitance and leakage current; small form factor
	Varistor		MLA Auto	AEC-Q200 compliant; standard low capacitance
	Polymer ESD Suppressor		AXGD	AEC-Q200 Qualified; ultra-low capacitance; low leakage current

SENSOR FUSION (ADAS)

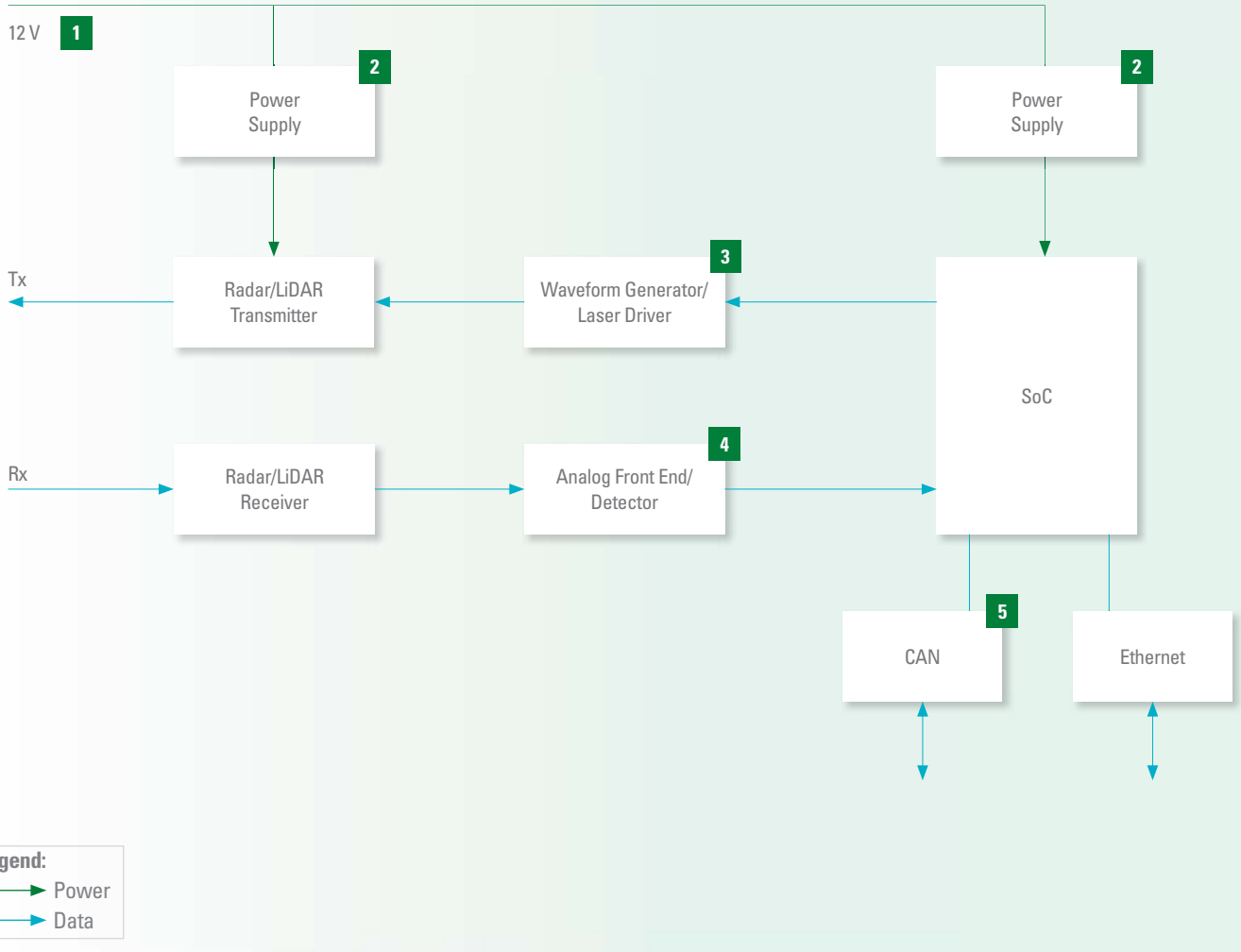
As designs advance closer to Level 4 and 5 self-driving vehicles, sensor data from cameras, radar, LiDAR, and GPS are becoming centralized in ADAS Domain Controller for more-efficient processing and decision making. Protect signal lines from ESD and power lines from voltage transients and reverse polarity conditions. Littelfuse offers a broad range of protection devices including TVS Diodes, Schottky Diodes, and TVS Diode Arrays.



	Technology	Application	Series Name	Features
1	TVS Diode	Transient voltage suppression	SZ1SMB, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO 16750/ISO 7637-2
	Schottky Diode	Reverse blocking/output rectification	DST	Ultra-low VF; high temperature capability; low leakage; low forward voltage drop to 100 V and 10 A
2	TVS Diode Array	Protects against ESD, CDE ,EFT, and lightning induced surges for high-speed data lines	AQ24ETH-02HTG	AEC-Q200 qualified; low capacitance; low leakage current; small form factor; OPEN Alliance approved for 1000BASE-T1
	Polymer ESD Suppressor		AXGD	AEC-Q200 qualified; ultra-low capacitance; low leakage current
3	TVS Diode Array	Protects CAN bus against ESD protection	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2, ISO 10605; low leakage current and clamping voltage
4	TVS Diode Array	Protects LIN bus against ESD and surge transients	AQ24COM-01	AEC-Q101 qualified; low clamping voltage and leakage current
5	TVS Diode Array	Protects FlexRay bus against ESD and surge transients	AQ24CANFD	AEC-Q101 qualified; low clamping voltage and leakage current
6	TVS Diode Array	Protects high-speed serial link against ESD and surge transients	AQ3045, SP3522, AQ3400, SESD Discrete, SESD Array	AEC-Q101 qualified; low capacitance (0.35 pF) and leakage current (100 nA); small package
7	TVS Diode Array	ESD protection of multiple sensor fusion inputs like GPS, LiDAR, radar, and camera	AQ3045, SP3522, SESD Discrete, SESD Array	AEC-Q qualified; low capacitance; low leakage current; small form factor (µDFN)

RADAR/LiDAR SYSTEMS

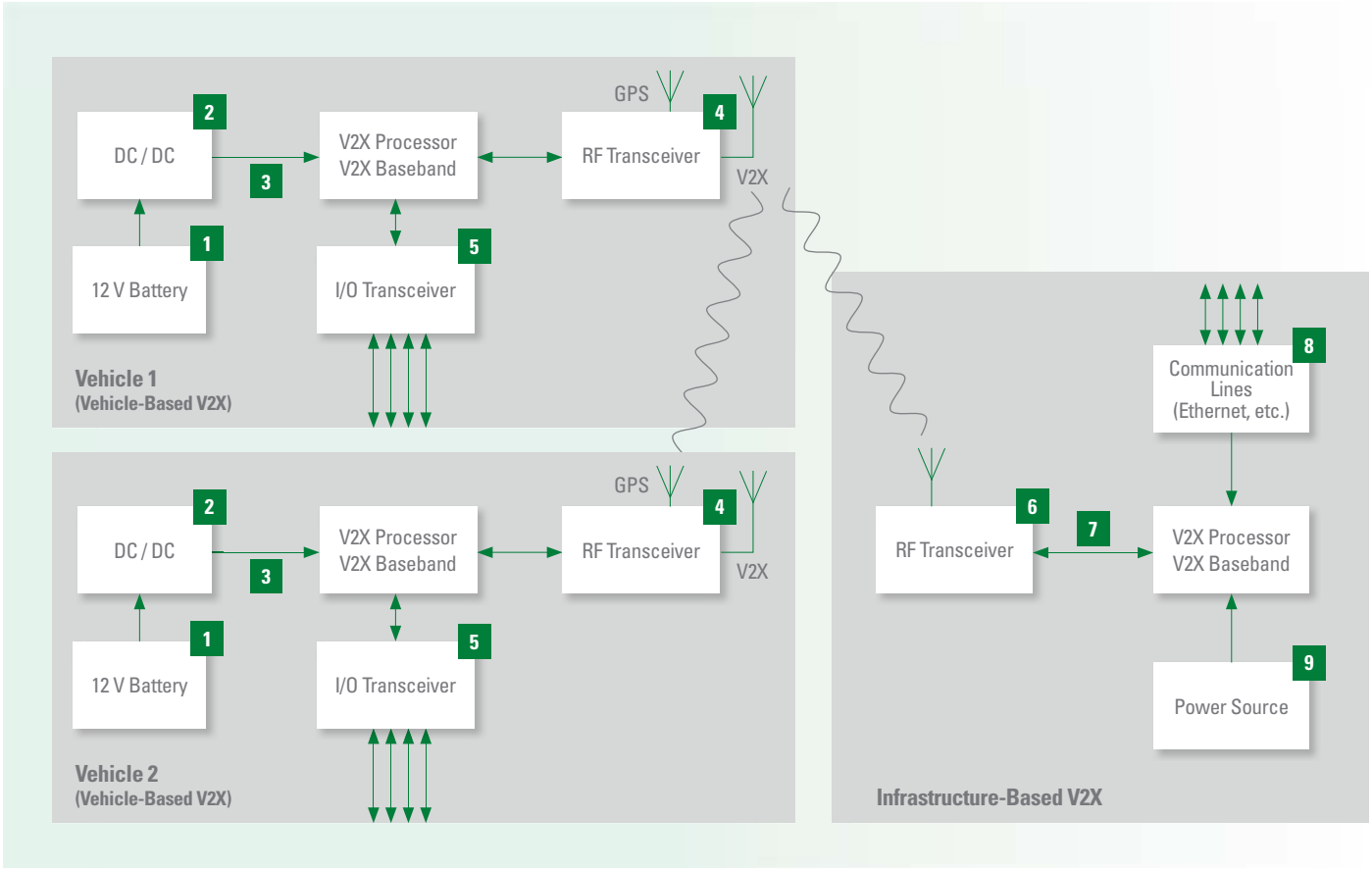
Vehicle RADAR and LiDAR have the crucial task of detecting the speed, distance, and direction of objects and then communicating that data to systems used for parking, emergency braking, and self-driving. Signal lines should have ESD protection, and the power supply should be protected from short circuit, overcurrent, and overvoltage. Automotive qualified components from Littelfuse include fuses, PPTCs, TVS Diodes, Diode Arrays, and Polymer ESD Suppressors.



	Technology	Application	Series Name	Features
1	SMD Fuse	Short Circuit Protection	437A, 440A, 441A, 501A, 881	Tested to new AEC-Q specification; fast response to fault current; surface mount device
	Resettable PTC	Overcurrent protection	ASMD, miniASMD	AEC-Q101 qualified; small footprint 2029/1812 size
	Schottky Diode	Reverse Blocking/Output Rectification	DST	Ultra-low VF; high temperature capability; low leakage; low forward voltage drop to 100 V and 10 A
2	TVS Diode	Overvoltage protection for the power supply	SZ1SMB, SLD8S, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection
3	TVS Diode Array	ESD protection for waveform generator and laser driver	AXGD, SESD	AEC-Q101 qualified; low capacitance (0.35 pF) and leakage current (100 nA); small package
4	Polymer ESD Suppressor	ESD protection for analog front end	AXGD, SESD	AEC-Q101 qualified; low capacitance; low leakage current; small form factor
5	TVS Diode Array	CAN bus ESD protection	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2, ISO10605; low leakage current and clamping voltage
	TVS Diode Array/ Polymer ESD Suppressor	Ethernet ESD protection	AQ24ETH-02HTG/AXGD	AEC-Q qualified; low capacitance; low leakage current; small form factor; OPEN Alliance approved for 1000BASE-T1

VEHICLE COMMUNICATION (V2X)

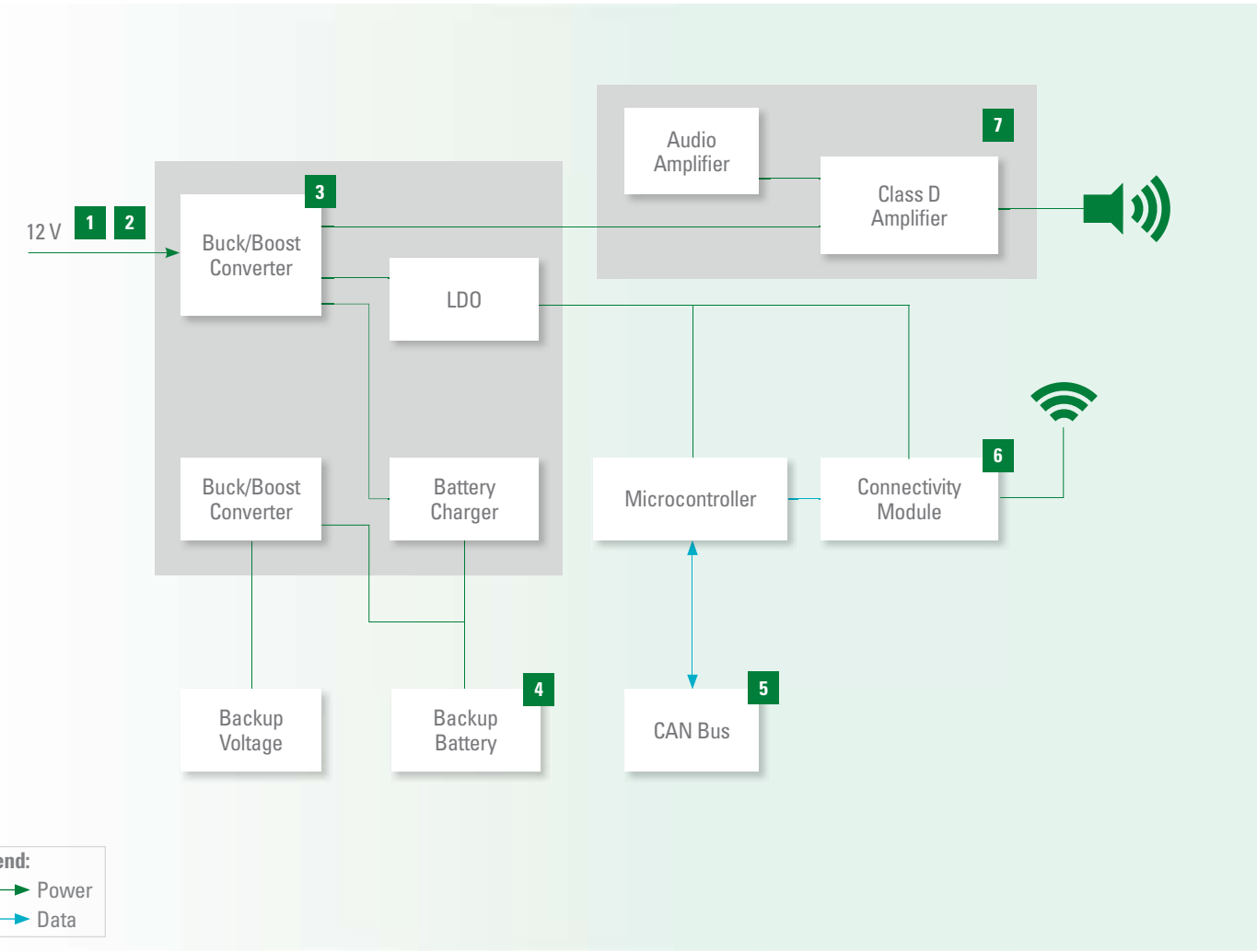
V2V and V2I (Vehicle-to-Vehicle and Vehicle-to-Infrastructure) will provide new levels of safety and efficiency by sharing data on vehicle locations and speed/direction, as well as receiving information from smart traffic signals. On-board power and communication circuits in these systems need overcurrent,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



	Technology	Application	Series Name	Features
1	SMD Fuse	Short circuit protection	437A, 438A, 440A	Tested to new AEC-Q specification; fast response to fault current; surface mount device
2	TVS Diode	Transient voltage suppression	SZ1SMB, SLD8S, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection
	SMD PPTC	Overcurrent protection	ASMD, miniASMD	AEC-Q200 qualified; small footprint 2029/1812 size
	Schottky Diode	Reverse blocking/output rectification	DST	Ultra-low V_F; high temperature capability; low leakage; low forward voltage drop to 100 V and 10 A
3	SMD PPTC	Secondary overcurrent protection	ASMD, miniASMD	AEC-Q200 qualified; small footprint 2029/1812 size
	TVS Diode	Secondary overvoltage protection	SZ1SMA, SZ1SMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection
4	Polymer ESD Suppressor	ESD protection for GPS and RF antenna	AXGD	AEC-Q200 qualified; ultra-low capacitance, low leakage current
5	TVS Diode Array	ESD protection for high-speed I/O ports (ethernet, HDBaseT)	AQ3400, AQ2555	AEC-Q qualified; low capacitance; low leakage current; small form factor µDFN
6	Polymer ESD Suppressor	ESD protection for RF antenna	AXGD	AEC-Q200 qualified; ultra-low capacitance; low leakage current
7	SMD Fuse	To protect baseband processor from short circuit	437A, 438A, 440A	Tested to new AECQ specification; fast response to fault current; surface mount device
	TVS Diode	To protect baseband processor from overvoltage	SZ1SMA, SZ1SMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection
8	TVS Diode Array	ESD protection against high-speed data lines on the V2X infrastructure side	AQ3400, AQ2555	AEC-Q qualified; low capacitance; low leakage current; small form factor µDFN
9	TVS Diode	Overvoltage protection for power supply on the V2X infrastructure side	SZ1SMA, SZ1SMB	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection

EMERGENCY CALL (eCALL)

In a crash, an eCall-equipped car will automatically call the nearest emergency center for help. Potential electrical threats to this system include load dump, overcurrent, 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.



	Technology	Application	Series Name	Features
1	SMD Fuse	Short circuit protection	437A, 438A, 440A, 501A	Tested to new AECQ specification; fast response to fault current; surface mount device
2	TVS Diode	Transient voltage suppression	SLD8S, SZ1SMA, SZ1SMB, SZSMF4L	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO for load dump protection; ISO 16750 / ISO 7637-2
	Varistor		AUML, MLA Auto	AEC-Q200; load dump energy rated per SAE Specification J1113; surface mount device
3	Schottky Diode	Reverse blocking/output rectification	DST	Ultra-Low VF; high temperature capability; low leakage; low forward voltage drop to 100 V and 10 A
4	PPTC	Overcurrent protection for battery	ASMD, miniASMD, LSP	AEC-Q200 qualified; small footprint 2029/1812 size
5	TVS Diode Array	CAN Bus ESD protection	AQ24C0M-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2, ISO10605; low leakage current and clamping voltage
6	Polymer ESD Suppressor/ TVS Diode Array	Designed to provide protection against ESD, CDE ,EFT, and lightning induced surges for high-speed data lines and antenna	AXGD/ AQ3118E, AQ3130E	AEC-Q qualified; low capacitance; low leakage current; small form factor
7	TVS Diode Array	ESD protection for audio amplifier	AQ1005, AQ1205	Low capacitance 30 pF; leakage current (0.1 µA); small form factor SOD882

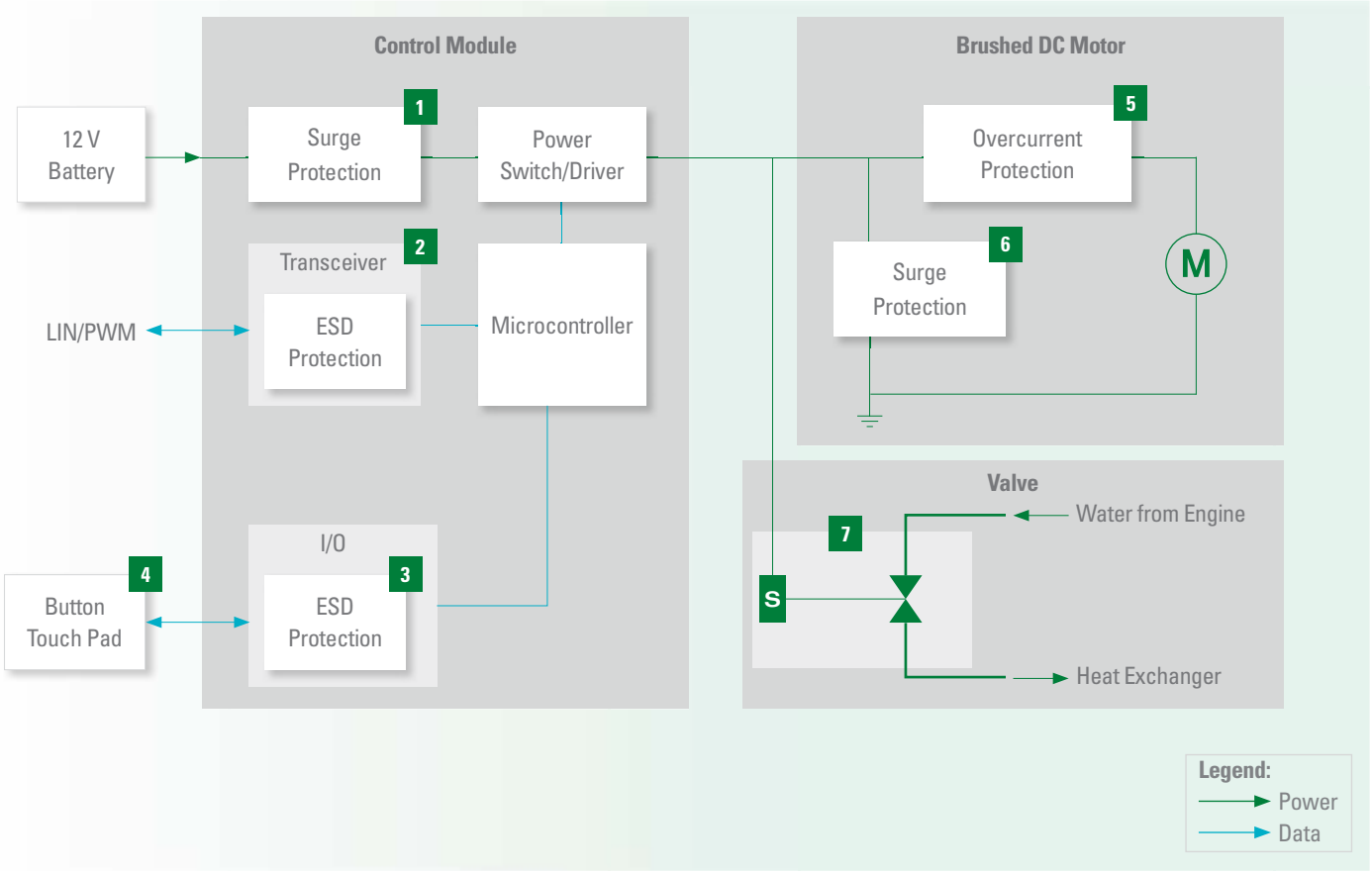
CAMERAS

External cameras support ADAS functions and autonomous driving system, while interior cameras support eye tracking to prevent accidents. In addition to protection against common electrical threats, data and communication BUS require protection that does not interfere with high-frequency video signals. Littelfuse solutions include TVS Diodes, TVS Diode Arrays, MLVs, Schottky Diodes, and SMD PPTCs.

	Technology	Application	Series Name	Features
1	SMD Fuse	Short circuit protection	437A, 438A, 440A	Tested to new AECQ specification; fast response to fault current; surface mount device
	SMD PPTC		ASMD, miniASMD	AEC-Q200 qualified; small footprint 2029/1812 size
	TVS Diode	ISO 16750 /ISO 7637-2 protection	SZ1SMB, SLD8S, SZSMF4L	AEC-Q101 qualified; meets ISO 16750 /ISO 7637-2 and IEC standards for ESD protection and ISO for load dump protection
	Varistor	Load dump protection	AUML, AUMOV	AEC-Q200; load dump energy rated per SAE Specification J1113
	Schottky Diode	Reverse polarity protection	DST	Ultra-low VF; high temperature capability; low leakage; low forward voltage drop to 100 V and 10 A
2	TVS Diode Array	CAN bus ESD protection	AQ24COM-02	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2, ISO10605; low leakage current and clamping voltage
3	TVS Diode Array/ Polymer ESD Suppressor	Ethernet ESD protection	AQ24ETH-02HTG/ AXGD	AEC-Q qualified; low capacitance; low leakage current; small form factor; OPEN Alliance approved for 1000BASE-T1
4	TVS Diode Array/ Polymer ESD Suppressor	LVDS ESD protection	AQ3130E, AQ3118E/ AXGD	AEC-Q qualified; low capacitance; low leakage current; small form factor

MOTOR AND VALVE CONTROL

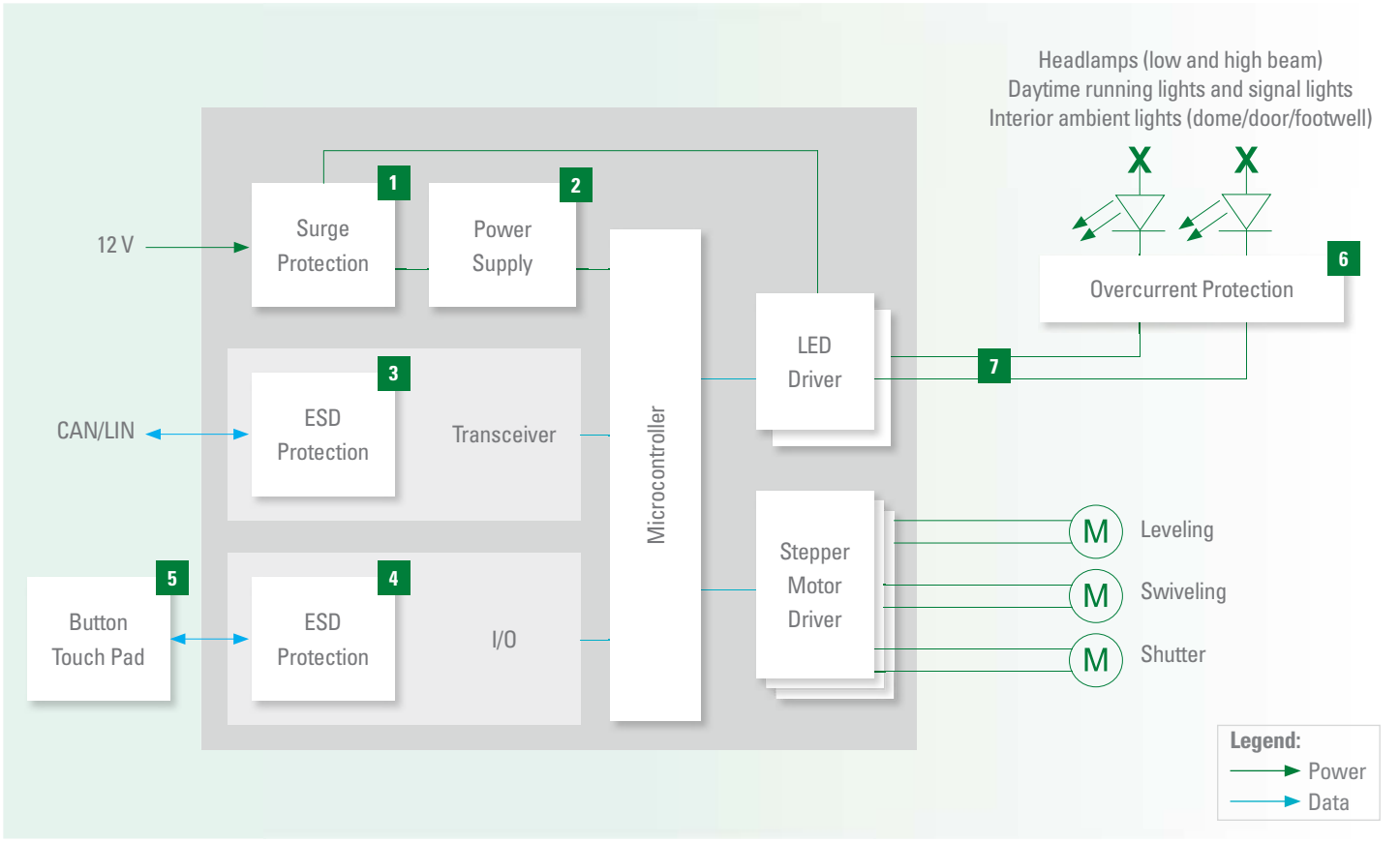
Mechanical/hydraulic actuators are replaced with electric motors, such as those for electric parking, braking, seat modules, and mirrors. Solenoid valves are used to control fluid flow of water, air, and oil. Potential threats include load dump, overcurrent, surges, and ESD. Littelfuse offers a wide range of TVS Diodes and TVS Diode Arrays, MLVs, MOVs, and PPTCs to protect motor and valve control applications.



	Technology	Application	Series Name	Features
1	TVS Diode	Load dump protection	SLD8S, SLD6S, SLD5S, SLD263, SLD	TVS Diode for ISO16750 pulse 5a load dump protection
	TVS Diode		TPSMD, TP5.0SMDJ, SZ5KASMC	TVS Diode for ISO16750 pulse 5b load dump protection
	Multilayer Varistor (MLV)		AUML	Multilayer Varistor with load dump energy rating per SAE specification J1113
	TVS Diode	Standard surge protection	SZ1SMA, SZ1SMB, TPSMA6L, TPSMB, TPSMC, TPSMD, SZSMF4L	TVS Diode for ISO7637 pulses and for secondary induced transient voltages with peak pulse capability from 400 W to 5000 W
	MOV		AUMOV	Radial-leaded MOV with up to 10 kA surge current and 2.5 kV isolation voltage capability up to 125 °C
2	TVS Diode Array	PWM (IO) protection	AQ1005, AQ3102, AQ3522	General purpose ESD Diodes in multiple package options and ESD capability of 30 kV
		LIN Bus ESD protection	AQ24COM-01	Industry-standard solution for ESD and surge protection for LIN Bus
3	TVS Diode Array	Button ESD protection	AQ1003, AQ1005, AQ1205	General-purpose ESD Diodes in multiple package options and ESD capability of 30 kV
	Multilayer Varistor (MLV)		MLA Auto	Voltage suppression Varistor up to 120 Vdc and 8/15 kV ESD capability
4	Switch	Mechanical switch	Tactile	Reliable switch provides real haptic and acoustic feedback
5	PPTC	Overcurrent protection	TD, CHIP, Rline	Normally custom made to fit into the motor housing; by mounting them close to the motor windings, they will trip more quickly when the motor windings are hot and therefore closer to being damaged, and more slowly when the motor windings are cold
6, 7	MOV	Switching element protection; transient voltage suppression	AUMOV	Radial-leaded MOV with up to 10 kA surge current and 2.5 kV isolation voltage capability up to 125 °C
	TVS Diode		SZ1SMA, SZ1SMB, TPSMA6L, TPSMB, TPSMC, TPSMD	TVS Diode for secondary induced transient voltages with peak pulse capability from 400 W to 5000 W

LIGHTING–HEADLAMPS AND INTERIOR

Advanced headlamps use LEDs and lasers for roadway illumination as well as motors to level, swivel, and shutter the high and low beams. Modern interior lighting use multicolor LEDs for cabin ambient and footwell illumination. Common threats include load dump, surges, ESD, overcurrent, and short circuit. Solutions include SMD Fuses, PPTC, TVS Diodes, TVS Diode Arrays, MLVs, and Schottky Diodes.



	Technology	Application	Series Name	Features
1	TVS Diode	Load dump protection	SLD8S, SLD6S, SLD5S, SLD263, SLD	TVS Diode for ISO 16750 pulse 5a load dump protection
	TVS Diode		TPSMD, TP5.0SMDJ, SZ5KASMC	TVS Diode for ISO 16750 pulse 5b load dump protection
	Multilayer Varistor (MLV)		AUML	Multilayer Varistor with load dump energy rating per SAE specification J1113
	TVS Diode	Standard surge protection	SZ1SMA, SZ1SMB, TPSMA6L, TPSMB, TPSMC, TPSMD, SZSMF4L	TVS Diode for ISO 7637 pulses and for secondary induced transient voltages with peak pulse capability from 400 W to 5000 W
	Metal Oxide Varistor (MOV)		AUMOV	Radial-leaded MOV with up to 10 kA surge current and 2.5 kV isolation voltage capability up to 125 °C
	PPTC	Overcurrent protection	AGRF, AHRF, AHEF, Surface Mount PPTC	Radial-leaded PPTC up to 15 A; resettable SMD overcurrent protection up to 3 A
2	Schottky Diode	Reverseblocking; output rectification; freewheeling diode	DST	High temperature capability; low leakage; low forward voltage drop; up to 100 V and 10 A
3	TVS Diode Array	CAN Bus ESD protection	AQ24COM-02	Industry-standard solution for ESD protection on CAN Bus
	TVS Diode Array	LIN Bus ESD protection	AQ24COM-01	Industry-standard solution for ESD and surge protection for LIN Bus
4	TVS Diode Array	Button ESD protection	AQ1003, AQ1005, AQ1205	General-purpose ESD Diodes in multiple package options and ESD capability of 30 kV
	Multilayer Varistor (MLV)		MLA Auto	Voltage suppression Varistor up to 120 Vdc and 8/15 kV ESD capability
5	Tactile Switch	Mechanical switch	Tactile	Reliable switch provides real haptic and acoustic feeback
6	SMD Fuse	Short Circuit protection	501A	High I^2t SMD Fuse with ratings up to 32 V and 20 A
	SMD PPTC	Overcurrent protection	miniASMD, ASMD, ASMDCH/AHS	Resettable SMD overcurrent protection up to 3 A
7	LED Protector	Open circuit and overvoltage protection	PLEDxUx-A, PLEDxS-A	Provides a switching electronics shunt path when a single LED in an LED array fails as an open circuit and can also be used for overvoltage protection in normal mode

SWITCH SOLUTIONS

Automotive switch portfolio includes four key areas:

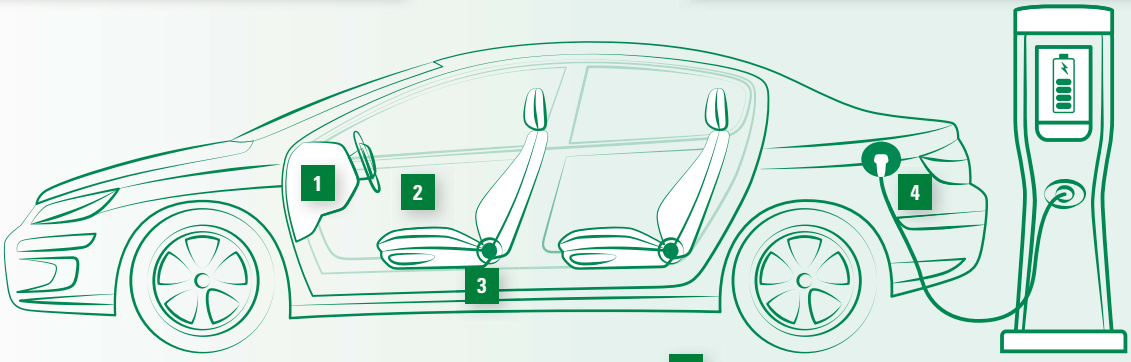
- **Human Machine Interface –** Buttons and knobs for steering wheel and interior control allow drivers to interact more naturally with their vehicles
- **Vehicle Access System –** Buttons for latches and handles as well as keyfobs
- **Comfort Seating and Motion –** seat adjustment and seat positioning
- **EV Charging Plug and Port –** detecting charging plug and port firmly connected

1 HMI (HUMAN MACHINE INTERFACE)

- Steering wheel and column
- Parking brake
- Interior control
- Window lifter

2 VEHICLE ACCESS SYSTEM

- Door handle
- Door latch
- Trunk opening
- Keyfob



3 COMFORT SEATING AND MOTION

- Seat adjustment
- Lumbar control
- Seat position detection

4 EV CHARGING

- Charging plug
- Charging port
- Charging lid

	Technology	Application	Series Name	Features
1 2 3 4	Tactile Switch	Send signal to the ECU to trigger action from the dedicated system	KSC	The Swiss army knife of the tact switches; with its versatility, KSC covers all possible integration case and can satisfy all sound and haptic requirements
			KSC DCT	When connected to an IC or other component, KSC DCT offers the possibility to verify if the signal has changed at the outputs, and, as such, to confirm the correct operation of the switch and of the connected function
			KSC XA	Soft sound for the new EV interiors; high forces suitable for applications in steering paddle and trunk opening; if potting is necessary, the raised cage will prevent the penetration of the resin
			KSC V2	The flexibility of the KSC in vertical version; ideal for application where the switch needs to be 90° to the PCB; industrialization is easier with the SMT packaging and PIP compatibility
			KSR	Well suited for applications that need emergency stop functionality should accidents occur
			KSJ	The spherical actuator with the angled actuation is perfectly suited for mechanism using came systems
			TLS	Positive tactile feedback with a soft sound; its soft actuator and pre-travel help for an easier tolerance management
	Snap Switch	Detect the position of two different elements and send information back to ECU	LCS	Its small size sealed snap-acting switch reduces the integration real estate; the construction of the LCS gives the ability to perform in harsh environmental conditions
			ZMS	More space is saved with the smaller form factor
			ZMV	Ideal for small spaces; reduced tolerances ease the switch positioning in the system; side actuation reduces design constraints
			SSW	The choice for ASIL related applications (electrical parking brake, by-wire functions); redundancy of contacts and the guaranteed change over time increase the safety level of the application
2, 4	Key Switch	Send signal to the ECU to trigger action	K12, K12S	Strong tactile feedback; integrated illumination simplifies design; double action version with extra long life saves space; double action version ideal for multi function button at the tip of the lever
3	Navigation Switch	Adjusts seat directions	SAMXD	The switch can directly drive the seat motors, eliminating the need for relays; dust protected design reducing the risk of failure
4	Rotary Switch	Navigating in menus and option, changing temperature and ventilation speed	M	Sturdy design compatible with professional environment
			ENC	The optical operation gives a longer lifetime than the mechanical versions; the strong tactile ensure user of its action without taking the eyes off the road
	Push Button	Used in the trigger mechanism to confirm movement or action	NP, PNP	Variable body styles and options covers the multiple integration cases; the million operation and sealing level makes it interface of choice for professional equipment
	Push Button	System wake-up, emergency	ATP16, 19, 22, ATPS19, 22	Anti vandal design; sealed for outdoor use and integrated illumination to simplify integration design
			APB	Perfect for outdoor use with its sealing level; numerous options for illumination and symbols simplifies the overall panel design
	Toggle Switch	Choice of two or three different functions with locking position	PT	Rugged product for the offroad environment; easy to integrate; power handling capabilities makes it suitable for all use cases
			ILT	Better suited for in cabin environment; the integrated illumination brings simplification to the panel design

Additional Resources

Scan or click to download

Circuit Protection Guide

A guide to selecting Littelfuse circuit protection components for electronic applications.

Scan or click to download

C&K Switches Product Selection Guide

This guide provides an overview of the broad range of electromechanical C&K Switches, including key selection criteria to help you quickly find the solution appropriate for your application.

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EV Charging Application Guide

A guide to selecting Littelfuse solutions for EV charging applications.

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Transportation Product Catalog

This catalog covers all of the professional technician's circuit protection needs. Littelfuse offers the most comprehensive circuit protection devices on the market today addressing the needs of Professional Service Center and Road Service Operation with genuine Littelfuse OEM fuses.

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Fuseology Design Guide

Fuses provide reliable protection for systems, components, or circuits by melting under current overload conditions. This guide makes the fuse selection process quick and easy, helping you optimize the reliability and performance of the application.

Additional Resources

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Automotive Load Dump Standards With TVS

This document is a quick reference guide about load dump protection with automotive grade TVS Diodes.

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Automotive Circuit Protection With TVS

This document is a quick reference guide about automotive circuit protection and the related TVS Diodes from Littelfuse.

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AEC-Q200 Specification Spotlight

This document is a quick reference guide for automotive AEC-Q200 standard and the related products from Littelfuse.

Visit Technical Resources at Littelfuse.com

Technical information is only a click away. The Littelfuse Technical Resources page contains datasheets, product manuals, white papers, application guides, demos, online design tools, and more.

An Extension of Your Team

Littelfuse engineers are a phone call away to help identify potential issues and provide product recommendations to solve problems.

Japan Technical Support: **+81 3-6435-0750**
Asia Technical Support: **+86 512 67613189**
North America Technical Support: **(800) 999-9445**
South America Technical Support: **+55 11 2844-4395**
Europe Technical Support: **+49 421 82 87 3 147**

For general inquiries and information:
Littelfuse, Inc.
8755 West Higgins Road, Suite 500
Chicago, IL, 60631, USA
+1 773 628 1000
Littelfuse.com

For product purchase and support: Littelfuse.com/ContactUs
For lab services: Littelfuse.com/Services
For product information: Littelfuse.com/Products

Application and Field Support

Our experienced product and application engineers work closely with our customers from design to installation to find the best solution. Contact us today: Littelfuse.com/ContactUs.aspx

Littelfuse Overview

About Littelfuse

Littelfuse is a trusted partner to engineers worldwide who seek our technical expertise to accurately conduct and analyze test results. Our global vision, team, and leadership collectively provide the strategic foundation to deliver innovations that help bolster businesses and align with global megatrends.

Littelfuse offers leading technologies in circuit protection, power control, and sensing. We continue to expand our broad and diverse portfolio of products into adjacent markets, including power semiconductors, heavy-duty switches, and magnetic, optical, electromechanical, and temperature sensors, as well as other products that provide safe control and distribution of electrical power.

Littelfuse offers a wide variety of product technologies.

Overcurrent Protection
- Fuses
- Protection ICs
- Resettable Positive Temperature Coefficient (PPTC) Devices

Overvoltage Suppression
- Gas Discharge Tubes (GDTs)
- Open LED Protectors
- PulseGuard® ESD Suppressors
- SIDACtor® Protection Thyristors
- TVS Diodes
- TVS Diode Arrays
- Varistors
- Wafer and Bare Die

Power Semiconductors
- Bare Die Devices
- Bipolar Devices
- Discrete and Module Solutions
- Fully Engineered Subsystems
- IGBTs
- MOSFETs
- Power Semiconductors and ICs
- Power Control
- Switching Thyristors
- Silicon Carbide Technology
- TRIAC Thyristors

Integrated Circuits and Solid-State Relays
- Gate Drivers
- High-Voltage ICs
- Solid-State Relays

Electromechanical Switches
- Dip Switches
- Detect Switches
- Keyswitch Switches
- Navigation Switches
- Pushbutton Switches
- Rocker Switches
- Rotary Switches
- Snap-Acting Switches
- Slide Switches
- Switchlock Switches
- Tactile Switches
- Toggle Switches

High Reliability Connectors
- D-Sub Connectors
- Harness Solutions
- Micro-D Connectors
- Wire to Wire connectors

Magnetic Sensing
- Hall Effect Sensors
- Magnetic Actuators
- Reed Switches
- Reed Sensors
- Reed Relays

Temperature Sensing
- Digital Temperature Indicators
- RTDs
- Thermistors
- TTape™ Temperature Indicators

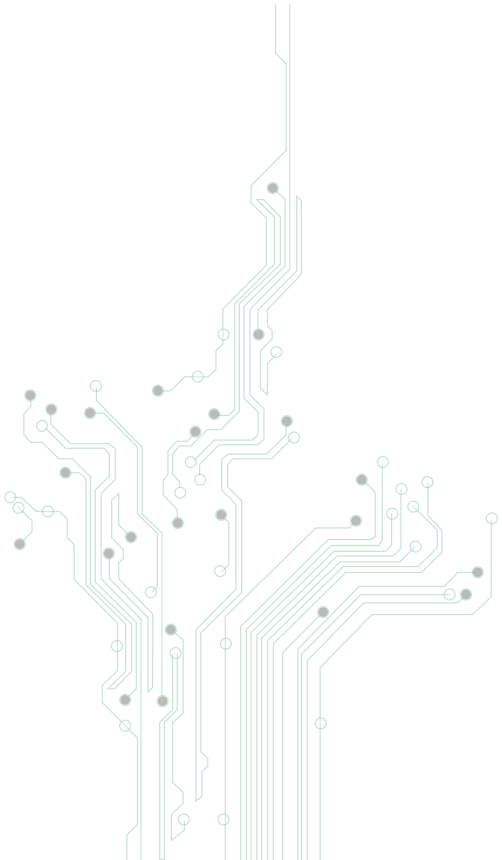
Industrial & Transportation
- Arch-Flash Relay
- Automotive Sensor
- Contactor
- DC Solinoid Relays
- Ground-Fault Relay
- Motor & Pump Protection
- Power Distribution Module
- Residual Current Monitor

Global Footprint

At Littelfuse, our mission is to develop innovative circuit protection, power control, and sensing solutions that meet our customers' unique needs. This customer-focused philosophy has helped us become the top circuit protection brand in the world.

Our industry-leading product portfolio includes reliable circuit protection, power control, and sensing products that are designed for a variety of markets and applications. We have assembled unparalleled expertise and developed a global footprint that puts our facilities close to our customers and target markets. As our global manufacturing and R&D teams objectively recommend the best circuit protection, power control, or sensing solution for each customer application, they form partnerships that will lead to the development of the next generation of advanced products.

Littelfuse provides:
- Application Expertise
- Global Support
- Operational Excellence
- Technology Innovation
- Collaboration
- Customer Focus



Global Lab Capabilities

You need to be certain that your products live up to the highest standards for performance, reliability, safety, and regulatory compliance. Working with Littelfuse, you have access to dedicated application engineers who partner with you to provide expert design consultation, perform comprehensive tests simulating the harshest environments, and confidentially evaluate the results in consultation with you.

TESTING CAPABILITIES

Environmental

- Autoclave
- Dust
- H3TRB
- HAST
- High- and Low-Temperature Storage
- High-Temperature Loading
- Ingress Protection (IP)
- HTGB
- HTRB
- Temperature and Humidity
- Temperature Cycling
- Thermal Shock
- Salt Fog

Physical-Mechanical Characteristics

- Acceleration
- Die Shear
- Leak Detection
- Mechanical Shock
- Resistance to Soldering Heat (Dip, Reflow, Wave)
- Resistance to Solvents
- Solderability
- Terminal Strength (Push, Pull, Bend)
- Vibration
- Wetting Balance
- Wire Pull

Electrical

- BCI
- Capacitance
- EFT
- ESD
- Impedance
- Insulation Resistance
- I-V
- Life
- Lightning Surge
- Overload
- Parametric Tests
- Power-Cross
- Power Cycling
- Ring Wave
- R-T
- S-Parameter Measurements (Insertion Loss, Isolation, Reflection)
- Short Circuit
- Step Current
- Surface Resistivity
- Surge
- TDR (Eye Diagram)
- Telecom
- Thermal Cut-Off
- Time-to-Trip
- TLP
- Transient
- Trip Cycle
- Trip Endurance
- Voltage Drop

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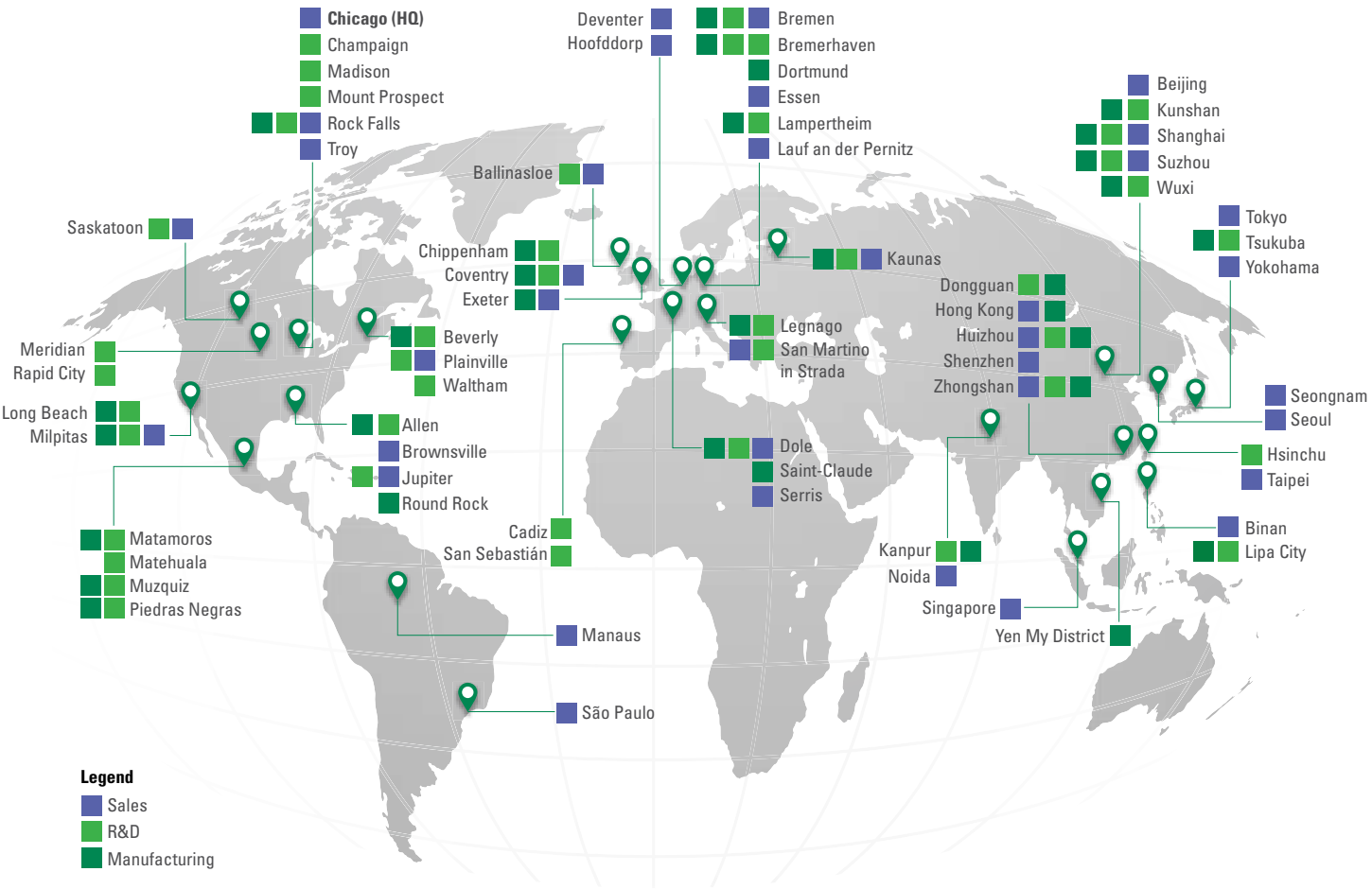
LOCAL RESOURCES FOR A **GLOBAL** MARKET



Littelfuse products are certified to many standards around the world. To check certifications on specific products, please refer to the product datasheet on Littelfuse.com.

Littelfuse®

Expertise Applied | Answers Delivered