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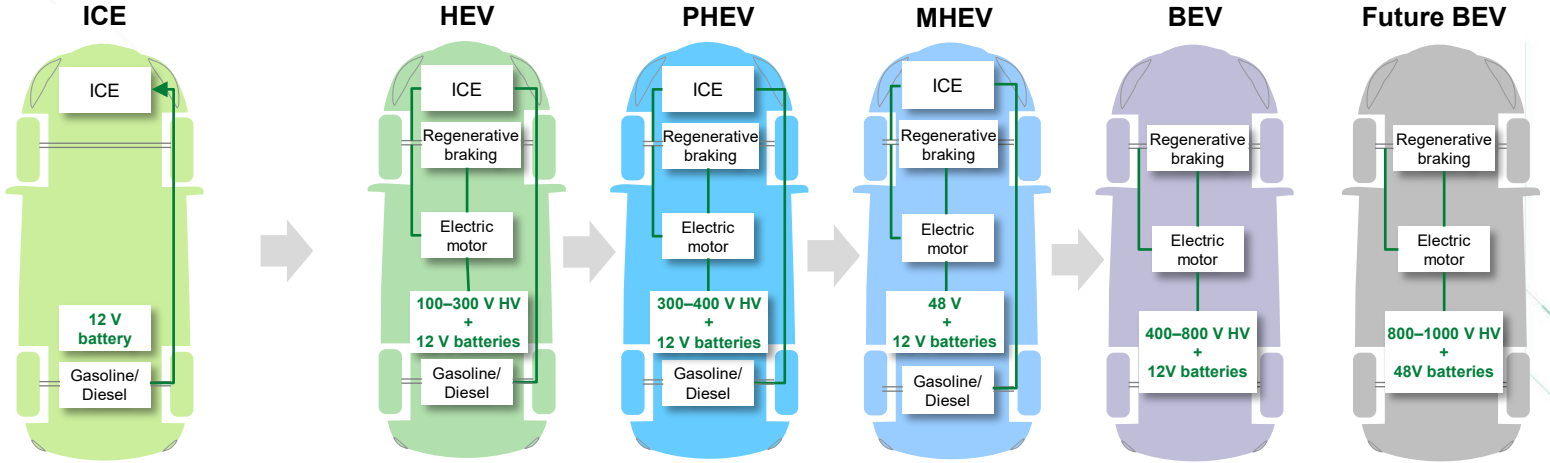
Powertrain

Passenger Vehicle

REV0625

Evolution of EV powertrain and electrical systems

Decarbonizing mobility through scalable electrification



Technical advancements

1980s

- Mechanical to ECU control
- Onboard diagnostics and electronic throttle control
- 12 V lead acid battery systems

1990s

- Introduction of EFI & catalytic convertors
- Introduction to HEVs and NiMH batteries in late 90s
- Early Integration of electric motor assist
- Foundation of electrified powertrains

2000s

- Hybrid powertrains matures
- Emergence of PHEV/early BEV in late 2000s
- Inverter, DC–DC convertor became critical
- Advance ECU + CAN Bus became industry standard

2010s

- Rise of PHEVs/BEV
- HV 400 Li-ion batteries become standard
- 48 V mild hybrid systems
- Advancement in inverter, OBC, DC-DC convertor
- Domain/zonal control; CAN + Ethernet

2020s

- Shift to pure BEVs and scalable EV Platforms
- Adoption of 800 V systems
- Gradual phase-out of 12 V lead-acid in favor of 48 V Li-ion
- Shift to zonal architecture + central compute

Future

- Modular, scalable powertrains; in-wheel motors
- Hydrogen fuel cells for fleets
- 48 V Li-ion + 800V–1000 V traction, solid-state batteries
- Central compute, software-defined, AI-based energy, and safety control

- *ICE: Internal Combustion Engine*
- *HEV: Hybrid Electric Vehicle*
- *PHEV: Plug-in Electric Vehicle*
- *MHEV: Mild Hybrid Electric Vehicle*
- *BEV: Battery Electric Vehicle*
- *FCEV: Fuel Cell Electric Vehicle*

Driving the future: EV market trends and projections

Government regulations, environmental concerns, and performance drive shift to EVs

Market trends

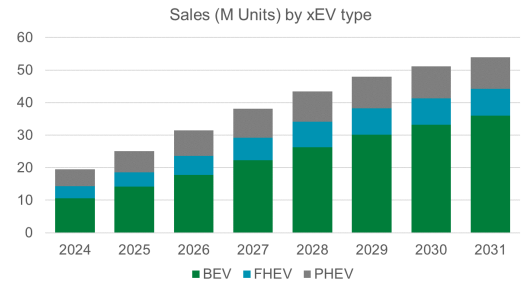
While global sales of passenger cars contracted in 2025, electric vehicles experienced double-digit growth rates. Global EV sales are expected to top 50 million units by 2030, crossing the 50% market share threshold versus traditional ICE engines.

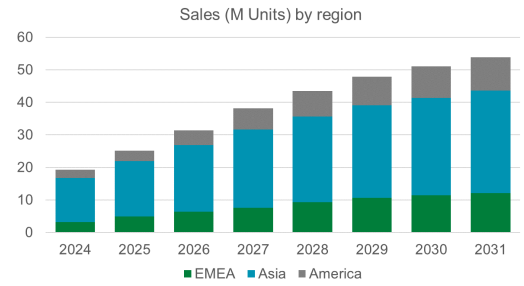
To support the growing number of EVs, there will likely be a substantial increase in the installation of public and private charging stations. Governments and private companies are expected to invest heavily in fast-charging networks.

Continuous improvements in battery technology has led to increased energy density, faster charging times, and longer driving ranges. Innovations in solid-state batteries, wireless charging, and vehicle-to-grid technology are enhancing the overall appeal and functionality of EVs.

Policies continue to support electric vehicle deployment and are evolving to a more holistic policy portfolio. Environmental and sustainability objectives drive electric vehicle policy support at all governance levels.

Sales (M Units) by xEV type and region

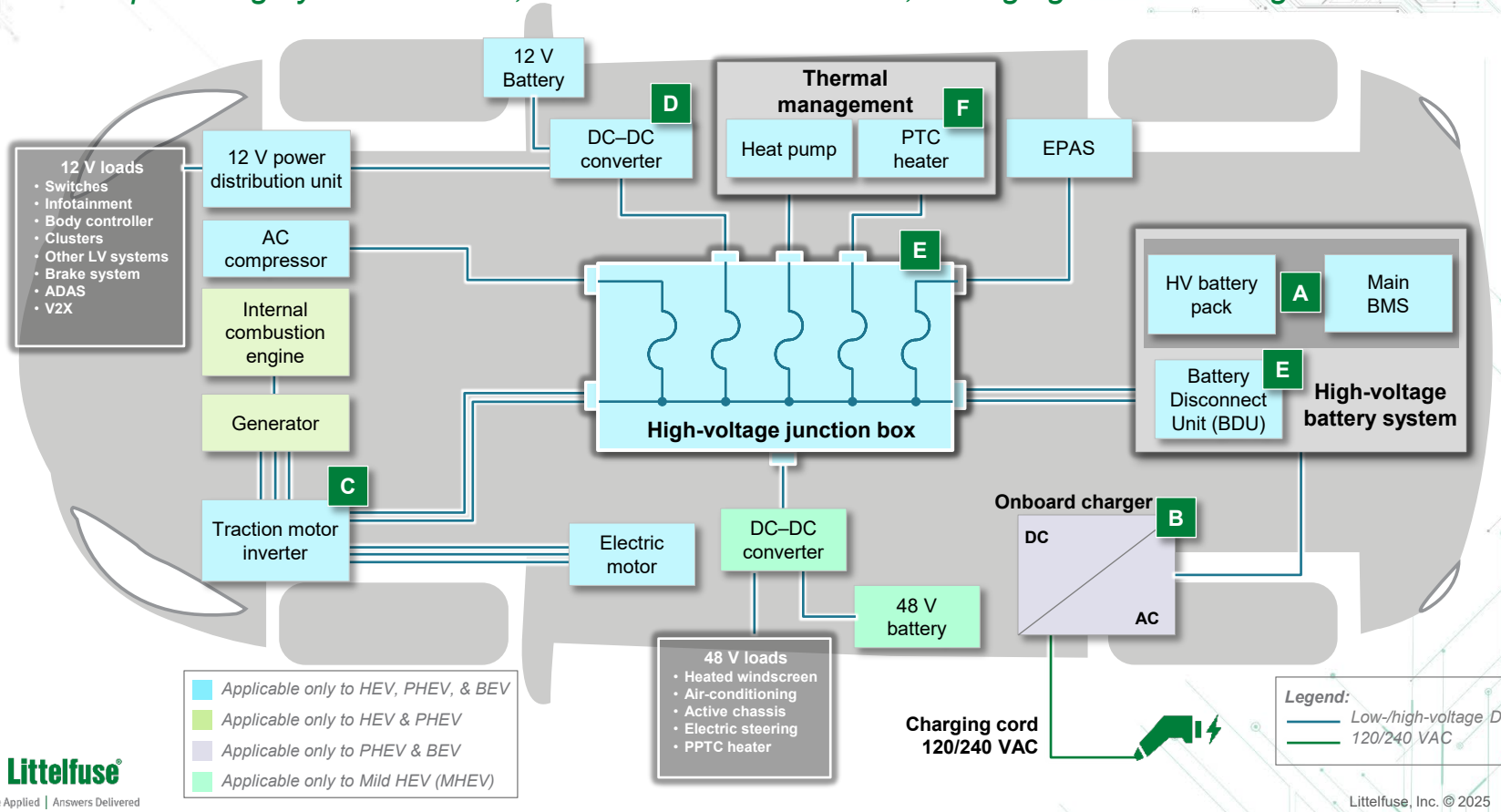




Source: *Littelfuse Estimates*

Unified powertrain architecture:

12V & HV powering hybrids & BEVs; 48V exclusive to MHEVs, emerging in BEVs alongside 12V



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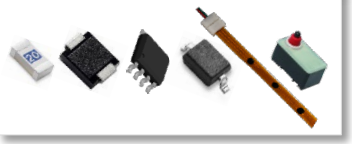
Littelfuse solutions for powertrain

Ensuring safety, efficiency, and reliability across the powertrain

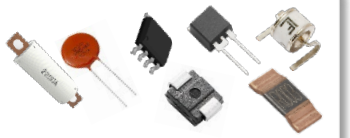
A

HV Battery Systems
Fuse, TVS Diode, Gate Driver, Diode Array, TTape™, Switch



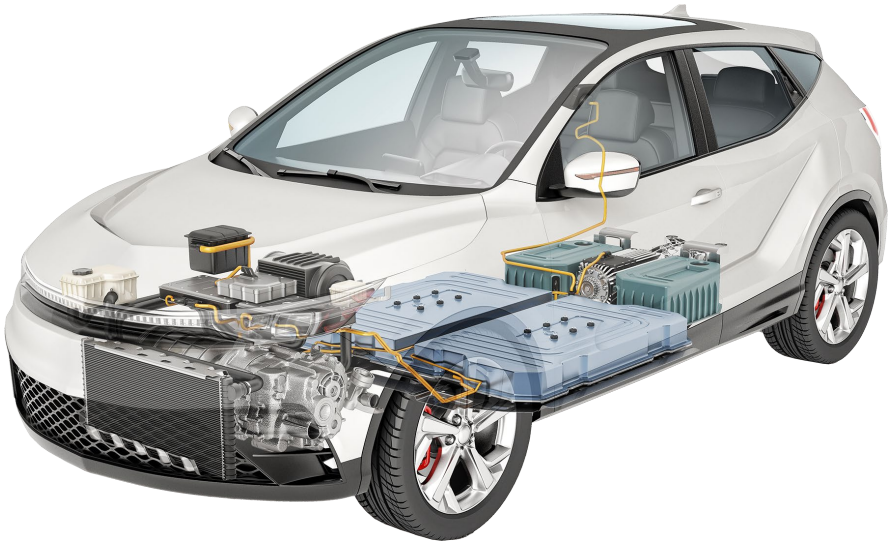
B

Onboard Charger
Fuse, MOV, Gate Driver, GDT, SIDACtor®, TVS Diode, Shunt Resistor



C

Traction Motor Inverter
Fuse, TVS Diode, Diode Array, Current Sensor, Gate Driver, Thermal Protector



D

DC–DC Converter
Fuse, TVS Diode, Diode Array, Gate Driver, Shunt Resistor

E

BDU/HV Junction Box
Contactor, IGBT, Current Sensor High Voltage Fuse, TVS Diode

F

Thermal Management
IGBT, PTC Heaters

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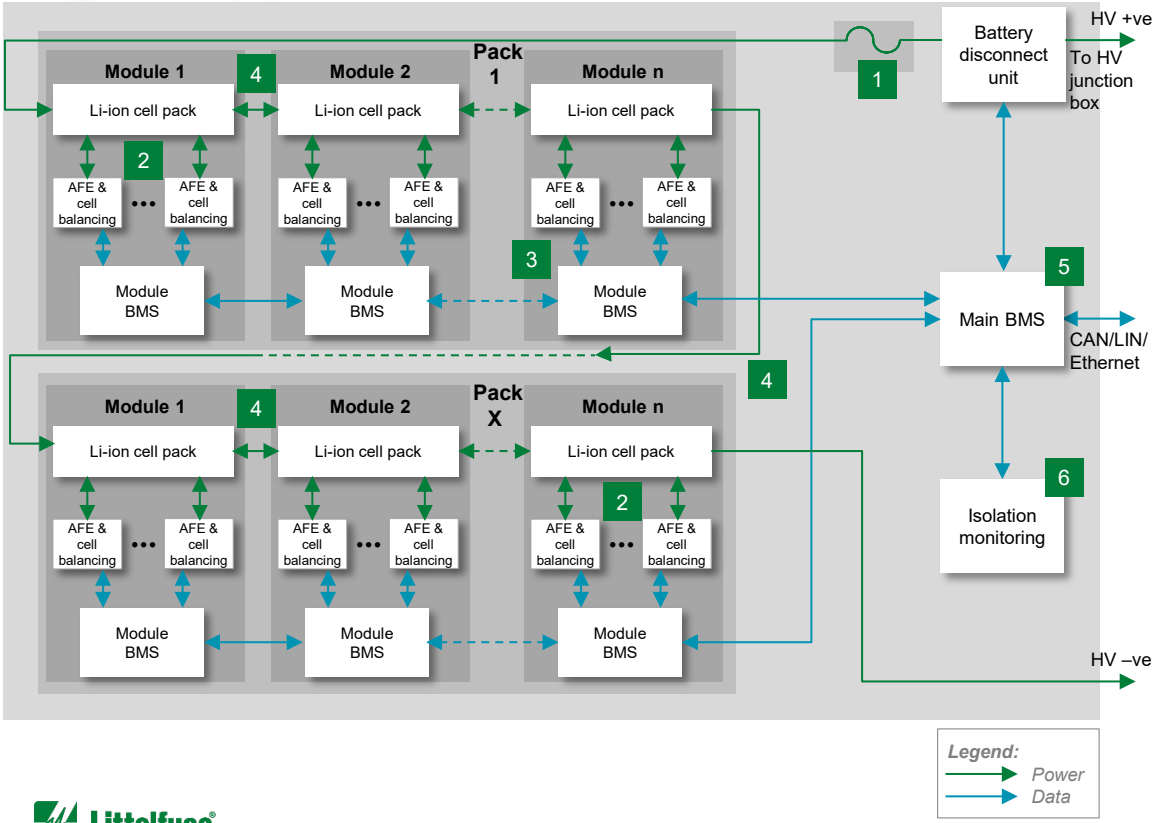
High-voltage Battery System

Click the product series in the table below for more info

High-voltage battery system block diagram



	Technology	Product Series
1	High-voltage Fuse	30EV1K, 25EV1K
2	TTape™ Platform	TTP
	SMD Fuse *OR* In-Line Fuse	437A, 483A, 438A
		521
	TVS Diode	TPSMA6L/SD05
3	TVS Diode Array	AQ05C/AQ1205/AQ12C
4	TVS Diode	TPSMC, TPSMD, TPSMB/TPSMB-L, TP5.0SMDJ
	Fuse (Optional)	501A, 881, 871
5	Gate Driver	IXD_6xxSI, IX4340NE
	TVS Diode Array	AQ24COM-02, AQ24COM-01
	Fuse	885
	TVS Diode	TPSMB, TPSMC
6	TVS Diode	TPSMB

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A

Potential Littelfuse products for high-voltage battery system

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
1	High-Voltage Fuse	Main fuse design to protect BMS system from short circuit, wiring failure, etc.	30EV1K, 25EV1K	Provides safety protection in high-voltage environments; full range fuse	Bolt-down form factor; high breaking capacity; ISO 8820 qualified
2	TTape™ Platform	Overtemperature monitoring of many cells or large area with single MCU input	TTP	Helps the MCU to wake from sleep mode at overtemperature events; <1 s response for temperature monitoring; extremely thin device suitable for conformal installation	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	437A, 483A, 438A, 521 (In-Line Fuse)	Excellent temperature stability and performance reliability; ceramic substrate ensures compatibility with high-temperature environment	Tested to new AEC-Q specification; fast response to fault current; surface mount device
	TVS Diode	Cell monitor IC sense line input overvoltage protection	TPSMA6L/SD05	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
3	TVS Diode	Transient voltage suppression	AQ05C/AQ1205/ AQ12C	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
4	TVS Diode	Protects battery from fast, high voltage transients	TPSMC, TPSMD, TPSMB/TPSMB-L, TP5.0SMDJ	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
	Fuse (Optional)	Protects battery packs or module-to-module from high fault currents due to external shorts	501A, 881, 871	Excellent temperature stability and performance reliability; compact design; ceramic substrate ensures compatibility with high-temperature environment	Tested to new AEC-Q specification; fast response to fault current; surface mount device

A

Potential Littelfuse products for high-voltage battery system

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
5	Gate Driver	Controls the switching MOSFETs	IXD_6xxSI, IX4340NE	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times lower than 10 ns	Tight tolerance; small form factor; fast thermal response
	TVS Diode Array	Protects CAN bus from ESD, EFT, and voltage transient	AQ24COM-02, AQ24COM-01	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low-leakage current and clamping voltage
	SMD Fuse	Protects cells and BMS components from overcurrent	885	High-voltage SMD form-factor enables compact design; ceramic body ensures compatibility with high-temperature environment	Tested to new AEC-Q specification; fast response to fault current; surface mount device
	TVS Diode	Transient voltage suppression	TPSMB, TPSMC	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
6	TVS Diode	Protects Solid State Relays from voltage transients	TPSMB	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges

B

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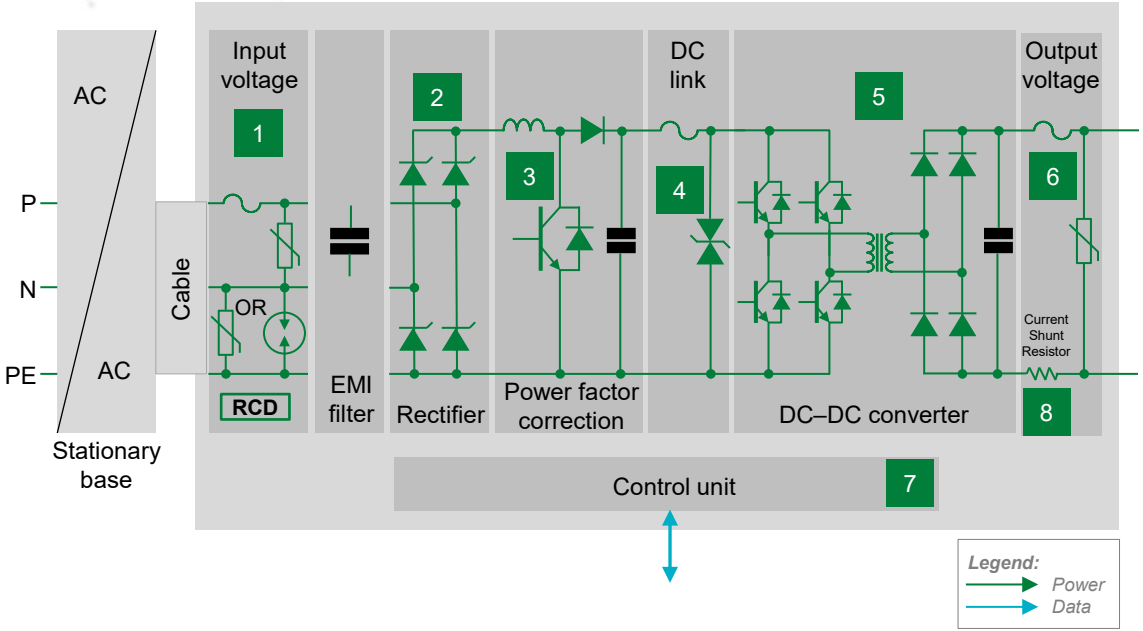
Onboard Charger

Click the product series in the table below for more info

Onboard charger block diagram



	Technology	Product series
1	Fuse	526, 527, 10EV, 20EV
	MOV	AUMOV, SM10
	GDT	CG2, CG3
	SIDACtor®	Pxxx0FNL, Pxxx0S3N-A (6 kV / 3 kA), Pxxx0S3G-A (4 kV / 2 kA)
	Residual Current Monitor	CF3P03xC*
2	Thyristor	S8016xA
3	Gate Driver	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU
4	TVS Diode	TPSMB, SZ1SMB, SZP6SMB
5	Gate Driver	IXD_6xxSI, IX4340NE, IX4351NEAU
	TVS Diode	TPSMB, SZ1SMB, SZP6SMB, TPSMBASY
	TVS Diode Array	AQ4022
6	Fuse	526, 527, 10EV, 20EV, 30EV1K, 25EV1K, 828, 38EV
	MOV	AUMOV, SM10
	TVS Diode	TPSMB, SZ1SMB, SZP6SMB
7	TVS Diode Array	AQ24COM-02
8	Current Shunt Resistor	SSA

* *Contact Littelfuse Sales for more details*

Click the product series in the table below for more info

Benefits of Littelfuse products in an onboard charger

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Short circuit protection; overload circuit protection	526, 527, 10EV, 20EV	Provides safety protection in high-voltage environments; full range fuse	AEC-Q200 qualified, high voltage; ceramic body ensures compatibility with high-temperature environment
	MOV	Protects from lightning and system transient surges	AUMOV, SM10	Clamps transient surge to ensure reliable performance of the circuitry	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	Provides safety to the system with high-resistance isolation	Rugged, high-surge current based on ceramic tube design; low-leakage current
	SIDACtor®	Lightning and system transient surges	Pxxx0FNL, Pxxx0S3N-A (6 kV / 3 kA), Pxxx0S3G-A (4 kV / 2 kA)	Used in combination with MOV; provides lower clamping voltage for sensitive circuitry	Surface mount form factor; semiconductor-based design does not wear out; used in combination with MOV; provides lower clamping voltage for sensitive circuitry
	Residual Current Monitor	Residual current detection	CF3P03xC*	Personal protection against AC and DC leakage currents according to IEC 62752/UL 2231	Modular design, thereby enabling customized configuration for PCBs
2	Thyristor	Rectification	S8016xA	Reduces the in-rush current during rectification that can damage expensive DC link capacitor	Compact TO-220 and surface mount TO-263 form factors, V_{DRM} of 800 V, IT or 16 $A_{(RMS)}$
3	Gate Driver	Controls the switching IGBTs and SiC MOSFETs	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10ns	Tight tolerance; small form factor; fast thermal response
4	TVS Diode	Active clamping	TPSMB, SZ1SMB, SZP6SMB	Clamps the transient that is created when the MOSFET device switches; ensures reliability	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
5	Gate Driver	Controls the switching of IGBTs and SiC MOSFETs	IXD_6xxSI, IX4340NE, IX4351NEAU	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10ns	Tight tolerance; small form factor; fast thermal response
	TVS Diode	Active clamping	TPSMB, SZ1SMB, SZP6SMB, TPSMBASY	Clamps the transient that is created when the MOSFET device switches; ensures reliability	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	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage

* *Contact Littelfuse Sales for more details*

Click the product series in the table below for more info

Benefits of Littelfuse products in an onboard charger

	Technology	Function in application	Product series	Benefits	Features
6	Fuse	Short circuit protection; overload circuit protection	526, 527, 10EV, 20EV, 30EV1K, 25EV1K, 828, 38EV	Provides safety protection in high-voltage environments; full range fuse	AEC-Q200 and ISO 8820 qualified; high voltage; high breaking capacity; bolt-down form factor available; ceramic body ensures compatibility with high-temperature environment
	MOV	Transient voltage suppression	AUMOV, SM10	Clamps transient surge to ensure reliable performance of the circuitry	Wide range of surge current ratings; disk sizes and lead options; surface mount available
	TVS Diode	Transient voltage suppression	TPSMB, SZ1SMB, SZP6SMB	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
7	TVS Diode Array	Protects CAN bus from ESD, EFT, and voltage transient	AQ24COM-02	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage
8	Current Shunt Resistor	Measures the overall output current	SSA	High sensing accuracy; low thermal offset drift; low thermal sensitivity drift	Isolated from HV network; no additional power loss due to shunt resistor

C

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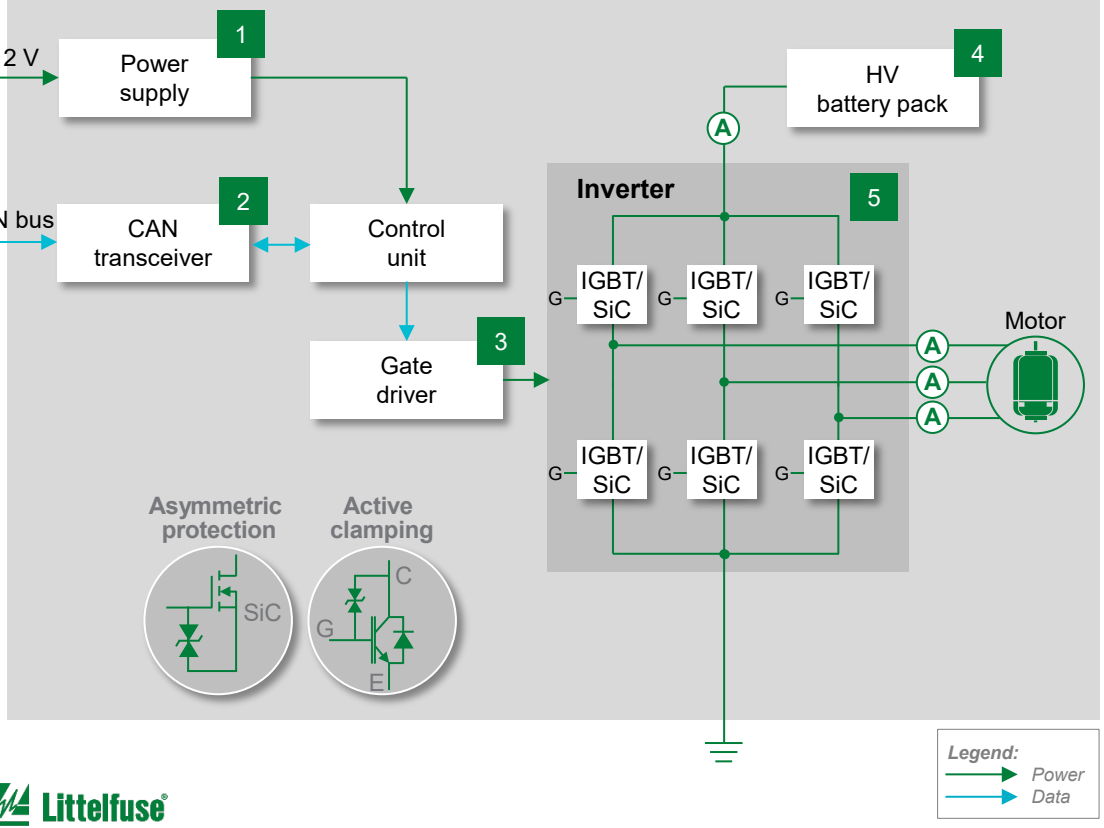
Traction Motor Inverter

Click the product series in the table below for more info

Traction motor inverter block diagram



	Technology	Product series
1	TVS Diode	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L
	SMD Fuse	441A
2	TVS Diode Array	AQ24COM-02
3	TVS Diode Array	AQ4022
	TVS Diode	TPSMB, SZ1SMB, SZP6SMB, TPSMBASY
	Gate Driver	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU
4	Fuse	526, 828, 30EV1K, 25EV1K, 823A
5	TVS Diode	TPSMB, SZ1SMB, SZP6SMB, TPSMBASY
	Current Sensor	CH1B02xM, CH1P01xM, CH3S01xM*
	Thermal Protection	HCRTP-mini

* *Contact Littelfuse Sales for more details*

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Benefits of Littelfuse products in a traction motor inverter

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
1	TVS Diode	Transient voltage suppression	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L	Excellent clamping capability; meets automotive industry standards; fast response time; compact design	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
	SMD Fuse	Short circuit protection; overload circuit protection	441A	Excellent temperature stability and performance reliability; compact design; ceramic substrate ensures compatibility with high-temperature environment	Tested as per new AEC-Q specification; fast response to fault current; surface mount device
2	TVS Diode Array	Protect CAN bus from ESD, EFT, and voltage transient	AQ24COM-02	Ensures reliability of the equipment without performance degradation	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	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage
	TVS Diode	Active clamping and gate driver protection	TPSMB, SZ1SMB, SZP6SMB, TPSMBASY	Excellent clamping capability; meets automotive industry standards; fast response time; compact design	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 and SiC MOSFETs	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10 ns	Tight tolerance; small form factor; fast thermal response
4	Fuse	Short circuit protection	526, 828, 30EV1K, 25EV1K, 823A	Provides safety protection from short circuit conditions	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, TPSMBASY	Clamps the transient that is created when the MOSFET device switches; ensures reliability	Clamps the transient that is created when the MOSFET switches; ensures reliability; asymmetric diodes to protect the gate of SiC transistors. For more information on 'Active Clamp', see here
	Current Sensor	Measures current on each phase of the inverter/motor and/or the DC link current	CH1B02xM, CH1P01xM, CH3S01xM*	High sensing accuracy; low thermal offset drift; low thermal sensitivity drift	Up to 2000 A with analog or CAN output; functional safety ratings from ASIL QM to ASIL C available
	Thermal Protection	Thermal protection for MOSFETs	HCRTP-mini	Responds to over-temperature conditions caused by catastrophic failure of the MOSFET device	Responds to over-temperature conditions caused by catastrophic failure of the MOSFET device

* *Contact Littelfuse Sales for more details*

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DC–DC Converter

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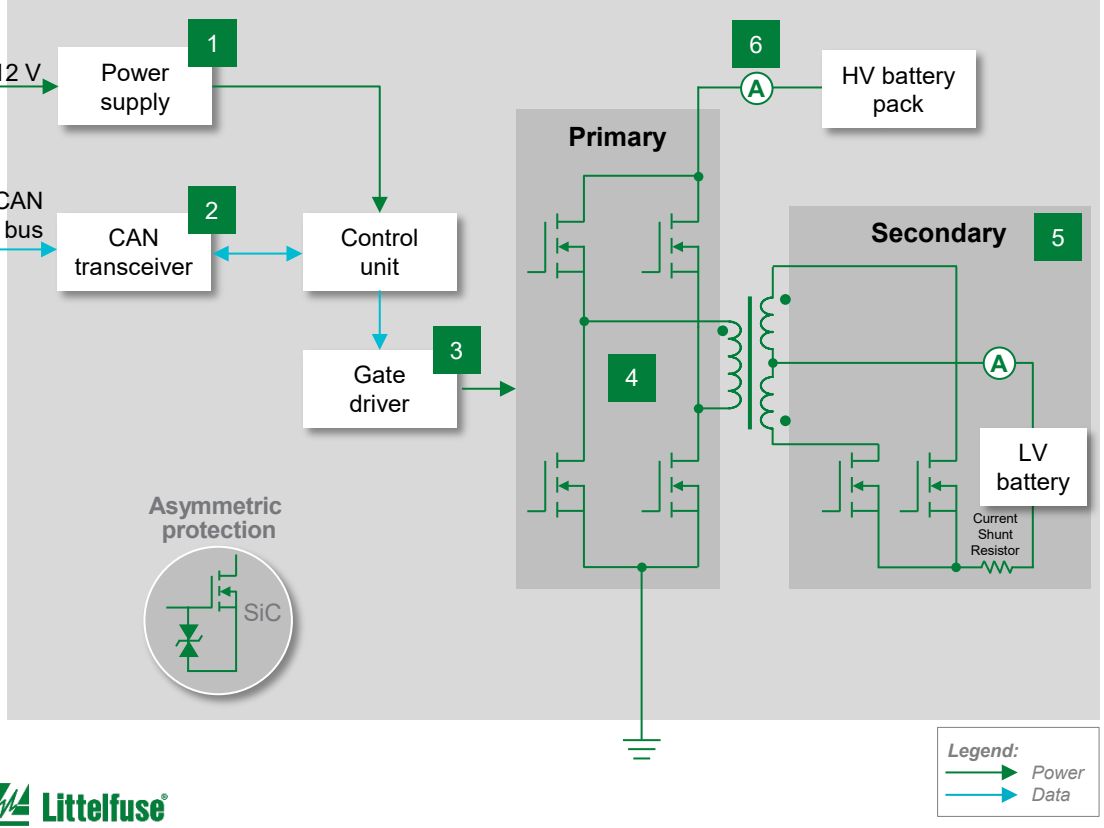
DC–DC converter block diagram



	Technology	Product series
1	TVS Diode	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L
	Fuse	441A
2	TVS Diode Array	AQ24COM-02
3	TVS Diode Array	AQ4022
	TVS Diode	TPSMF4L, TPSMBASY
	Gate Driver	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU
4	TVS Diode	TPSMB, SZ1SMB, SZP6SMB, TP5.0SMDJ, TPSMBASY
5	Fuse	526, 527, 30EV1K, 25EV1K, 828, 823A
	Thermal Protection	HCRTP-mini
	TVS Diode	TPSMD, TP5.0SMDJ
	Current Shunt Resistor	SSA
6	Current Sensor	CH1B02xM, CH1P01xM

Click the product series in the table below for more info

Benefits of Littelfuse products in a DC–DC converter

	Technology	Function in application	Product series	Benefits	Features
1	TVS Diode	Transient voltage suppression	TPSMB, TPSMA6L, SZ1SMB, SZP6SMB, SZ1SMA, SZSMF4L	Excellent clamping capability; meets automotive industry standards; fast response time; compact design	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
	Fuse	Short circuit and overload circuit protection	441A	Excellent temperature stability and performance reliability; ceramic substrate ensures compatibility with high-temperature environment	Tested to new AEC-Q specification; fast response to fault current; surface mount device
2	TVS Diode Array	Protects CAN bus from ESD, EFT, and voltage transient	AQ24COM-02	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage
3	TVS Diode Array	ESD protection of the gate input	AQ4022	Ensures reliability of the equipment without performance degradation	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage
	TVS Diode	Transient voltage suppression	TPSMF4L, TPSMBASY	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges
	Gate Driver	Controls the switching Si/SiC MOSFETs	IXD_6xxSI, IX4340NE, IX4351NEAU, IX4352NEAU	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10 ns	Tight tolerance; small form factor; fast thermal response

Click the product series in the table below for more info

Benefits of Littelfuse products in a DC–DC converter

	Technology	Function in application	Product series	Benefits	Features
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 device switches, thereby ensuring reliability	Clamps the transient that is created when the MOSFET device switches; ensures reliability; asymmetric diodes to protect the gate of SiC transistors. For more information on “Active Clamp", see here
5	Fuse	Short circuit protection	526, 527, 30EV1K, 25EV1K, 828, 823A	Provides safety protection from short-circuit conditions	High voltage; ceramic body ensures compatibility with high-temperature environment
	Thermal Protection	Thermal protection for MOSFETs	HCRTP-mini	Responds to over-temperature conditions caused by catastrophic failure of the MOSFET device	Surface mountable form factor; compatible with standard reflow process; breaks current flow during overtemperature condition
	TVS Diode	Transient voltage suppression	TPSMD, TP5.0SMDJ	Excellent clamping capability; meets automotive industry standards; fast response time	Small form factor DO214-AA package; low clamping voltage
	Current Shunt Resistor	Measures the overall output current	SSA	Small size; high voltage	Multiple case sizes: 2512, 3921, and 5931; resistance range 0.2 mΩ–4 mΩ; power up to 15 W; tolerance down to ±1.0%; TCR down to ±50 ppm/ºC
6	Current Sensor	Measures current on each phase of the inverter/motor and/or the DC link current	CH1B02xM, CH1P01xM	High sensing accuracy; low thermal offset drift; low thermal sensitivity drift	Up to 2000 A with analog or CAN output; functional safety ratings from ASIL QM to ASIL C available

E

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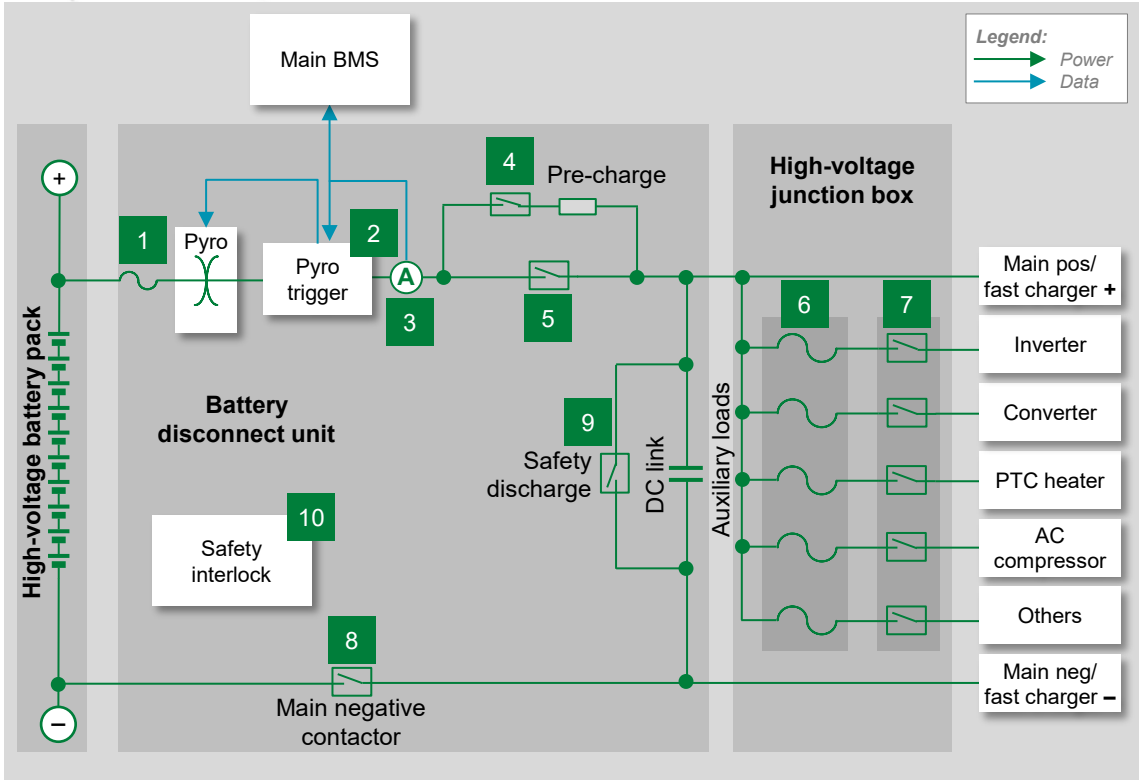
Battery Disconnect Unit (BDU)/ High-voltage Junction Box

Battery Disconnect Unit (BDU)/ HV junction box block diagram

Click the product series in the table below for more info



	Technology	Product series
1	High-Voltage Fuse	30EV1K, 25EV1K, 828, 38EV, 823A
2	Pyro Trigger	CH1B05xP
3	Current Sensor	CH1S01xB, CH1B02xB
4	High-Voltage DC Contactor *OR* IGBT*	DCNHR IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV
	TVS Diode	TP5.0SMDJ
5	High-Voltage DC Contactor	DCNHR
	TVS Diode	TP5.0SMDJ
6	Auxiliary Fuse	10EV, 20EV, 30EV1K, 25EV1K, 828, 526
7	High-Voltage DC Contactor	DCNHR
8	High-Voltage DC Contactor	DCNHR
9	Discrete Thyristor *OR* IGBT*	SJxx40xxA IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV
10	Switch	SSW

* *Contact Littelfuse Sales for more details*

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E

Benefits of Littelfuse products in the Battery Disconnect Unit (BDU)/HV junction box

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
1	High-Voltage Fuse	Short circuit and overload circuit protection	30EV1K, 25EV1K, 828, 38EV, 823A	Provides safety protection in high-voltage environments; full range fuse; can protect the entire pack's voltage and short circuit current	Bolt down form factor; high breaking capacity; ISO 8820 qualified
2	Pyro Trigger	Trigger the pyro-fuse in case of overcurrent	CH1B05xP	Fast and reliable circuit protection solution; customizable trigger labels; active protection solution; low power consumption; compact lightweight design	Very fast overcurrent detection, triggering, and interruption (cut-off time <1 ms), which significantly reduces 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	CH1S01xB, CH1B02xB	High sensing accuracy; low thermal offset drift; low thermal sensitivity drift	Up to 2000 A with analog or CAN output; functional safety ratings from ASIL QM to ASIL C available
4	High-Voltage DC Contactor *OR* IGBT	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 typically to a level of 90%–98% of the battery voltage	DCNHR	Allows a low-voltage signal to switch the contacts for a high-voltage signal	Wide amperage rating 30 A−100 A; gas-filled contact chamber and magnetic blowouts for arc suppression; available direct switched auxiliary circuit for status indication
		Controls the power delivered to the PTC heating element	IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV	Tailored for an 800 V BEV electric vehicle; optimized for low conduction losses; short-circuit rated; HV SMD packages to enhance clearance and creepage distances	Automotive qualified IGBT; higher breakdown voltage BV_{CES} (1300 V); wider range of currents IC (5 A to 85 A at 110 °C); surface mount discrete packages include TO-263HV, TO-268HV, and the through-hole TO-247
	TVS Diode	Transient voltage suppression	TP5.0SMDJ	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards 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	Allows a low-voltage signal to switch the contacts for a high-voltage signal	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	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection and ISO standards for in-vehicle transient surges

E

Benefits of Littelfuse products in the Battery Disconnect Unit (BDU)/HV junction box

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
6	Auxiliary Fuse	Short circuit protection; overload circuit protection	10EV, 20EV, 30EV1K, 25EV1K, 828, 526	Provides safety protection in high-voltage environments, full range fuse; can protect the entire pack's voltage and short circuit current	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	Allows a low-voltage signal to switch the contacts for a high-voltage signal	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	Allows a low-voltage signal to switch the contacts for a high-voltage signal	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 surge capability; offers low gate current trigger levels of 15 mA or 40 mA at approximately 1.5 V	High-temperature Thyristor with low gate current; available in a TO-220AB and surface mount TO-263 form factors; AEC-Q101 qualified
	OR				
	IGBT	Controls the power delivered to the PTC heating element	IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV	Tailored for 800 V BEV electric vehicles; optimized for low conduction losses; short-circuit rated; HV SMD packages to enhance clearance and creepage distances	Automotive qualified IGBT; higher breakdown voltage BV_{CES} (1300 V); wider range of currents IC (5 A to 85 A at 110 °C); surface mount discrete packages include TO-263HV, TO-268HV, and the through-hole TO-247
10	Switch	Lid disconnection; detects an opening of the battery distribution unit	SSW	Surface mount terminations; IP67	Products suitable for automotive applications; designed for ASIL-related applications

F

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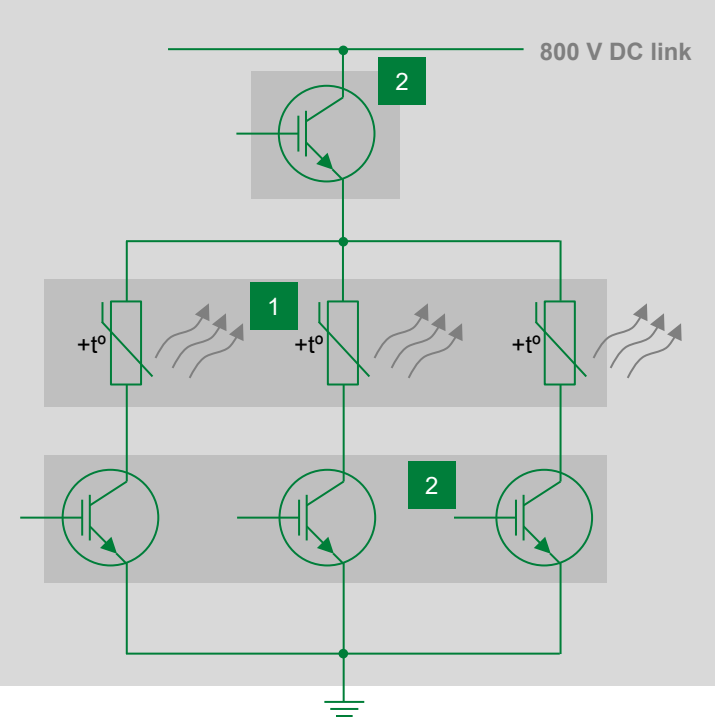
Thermal Management System with a PTC Heater for Battery Heating

Thermal management system with a PTC Heater for battery heating

Click the product series in the table below for more info



	Technology	Product series
1	PTC Heater*	Custom
2	IGBT*	IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV

* *Contact Littelfuse Sales for more details*

F

Benefits of Littelfuse products in a thermal management system

Click the product series in the table below for more info

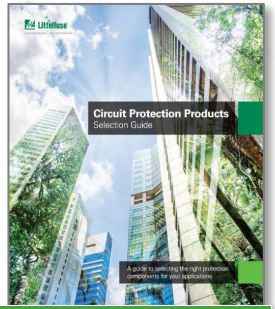
	Technology	Function in application	Product series	Benefits	Features
1	PTC Heater*	Provide a safe source of heat for all kind of applications, such as battery heating, HV coolant heater, auxiliary air heater, camera /ADAS heater, etc.	Custom	Self limiting; self regulating; no need for external control components; available in wide format (even A3 sheet size) and shape is fully customizable (by simply punching with the die tool); available in flexible and semi-rigid structure; possibility to coat the surface for increased robustness from chemical aggression	Wide power supply range: from 3 V to 1000 V; self-limiting temperature: from +35 °C up to more than +200 °C; power density: from 0.1 W/cm^2 to 150 W/cm^2; thickness: <0.4 mm (low voltage) and <1.3 mm (high voltage); suitable for clamping, welding, and soldering
2	IGBT*	Controls the power delivered to the PTC heating element	IXVA15N130A5AHV, IXVA30N130A5AHV, IXVT55N130A5AHV, IXVT85N130A5AHV	Tailored for 800 V BEV electric vehicles; optimized for low-conduction losses; short-circuit rated; HV SMD packages to enhance clearance and creepage distances	Automotive qualified IGBT; higher breakdown voltage BV_{CES} (1300 V); wider range of currents IC (5 A to 85 A at 110 °C); surface mount discrete packages include TO-263HV, TO-268HV, and the through-hole TO-247

Select standards for automotive applications

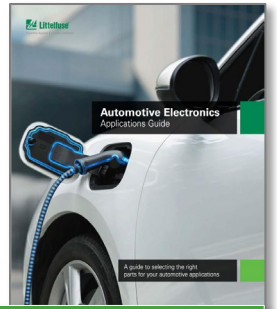
Standard	Title	General scope	Littelfuse technology	Region
ISO 7637-2	Road vehicles – Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only	Specifies test methods and procedures to ensure compatibility with conducted electrical transients of equipment installed on passenger cars and commercial vehicles fitted with 12 V or 24 V electrical systems. It describes bench tests for both the injection and measurement of transients. It is applicable to all types of road vehicles, independent of the propulsion system (For example, spark ignition, or diesel engine, and electric motor).	TVS Diode	Global
ISO 16750-2	Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads	This standard applies to electric and electronic systems/components for road vehicles. It describes the potential environmental stresses and specifies tests and requirements recommended for the specific mounting location on/in the road vehicle.	TVS Diode	Global
ISO 10605:2008	Road vehicles – Test methods for electrical disturbances from electrostatic discharge	This standard specifies the electrostatic discharge (ESD) test methods necessary to evaluate electronic modules intended for vehicle use. It includes the following sources of ESD: in assembly, by service staff, and by vehicle occupants.	Diode Array PulseGuard® (AXGD) Multilayer Varistor	Global

Additional information can be found at Littelfuse.com

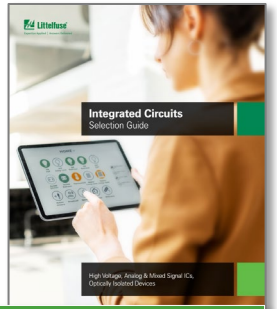
Explore the world of Littelfuse products and applications with ecatalogs (ecatalogs.littelfuse.com)



Circuit Protection Selection Guide



Automotive Electronics Application Guide



Integrated Circuit Selection Guide

C&K Switches Selection Guide

Automotive Power Relays Selection Guide

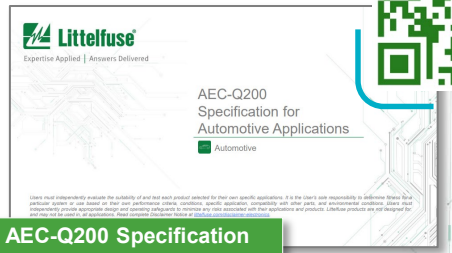
Click the images for more information

Transportation Product Catalog

Automotive Load Dump Standards With TVS

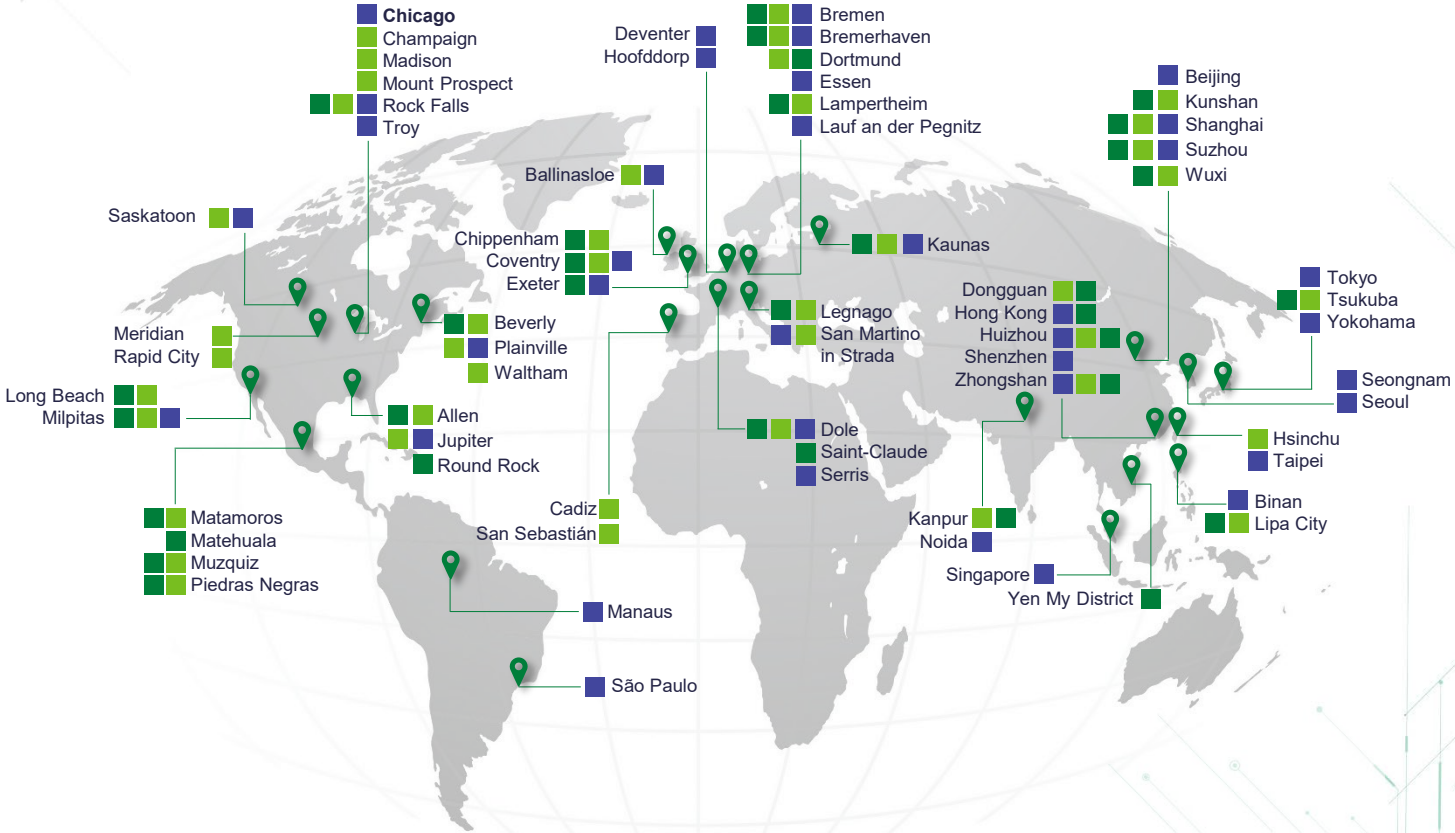
Automotive Circuit Protection With TVS

Scan the code to learn more!



AEC-Q200 Specification Spotlight

Local resources supporting our global customers



Legend

- ***Sales***
- ***R&D***
- ***Manufacturing***

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Partner for tomorrow’s electronic systems

Broad Product Portfolio

We are an industrial technology manufacturing company empowering a sustainable, connected, and safer world.

Testing Capabilities

We help customers get products to market faster, and we offer certification testing per global regulatory standards.

Application Expertise

Our engineers partner directly with customers to help speed up product design and meet their unique needs.

Compliance and Regulatory

We help customers in the design process to account for requirements set by global regulatory authorities.

Global Customer Service

Our global customer service team is with you to anticipate your needs and ensure a seamless experience.

Global Manufacturing

Our high-volume manufacturing is committed to the highest quality standards.

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