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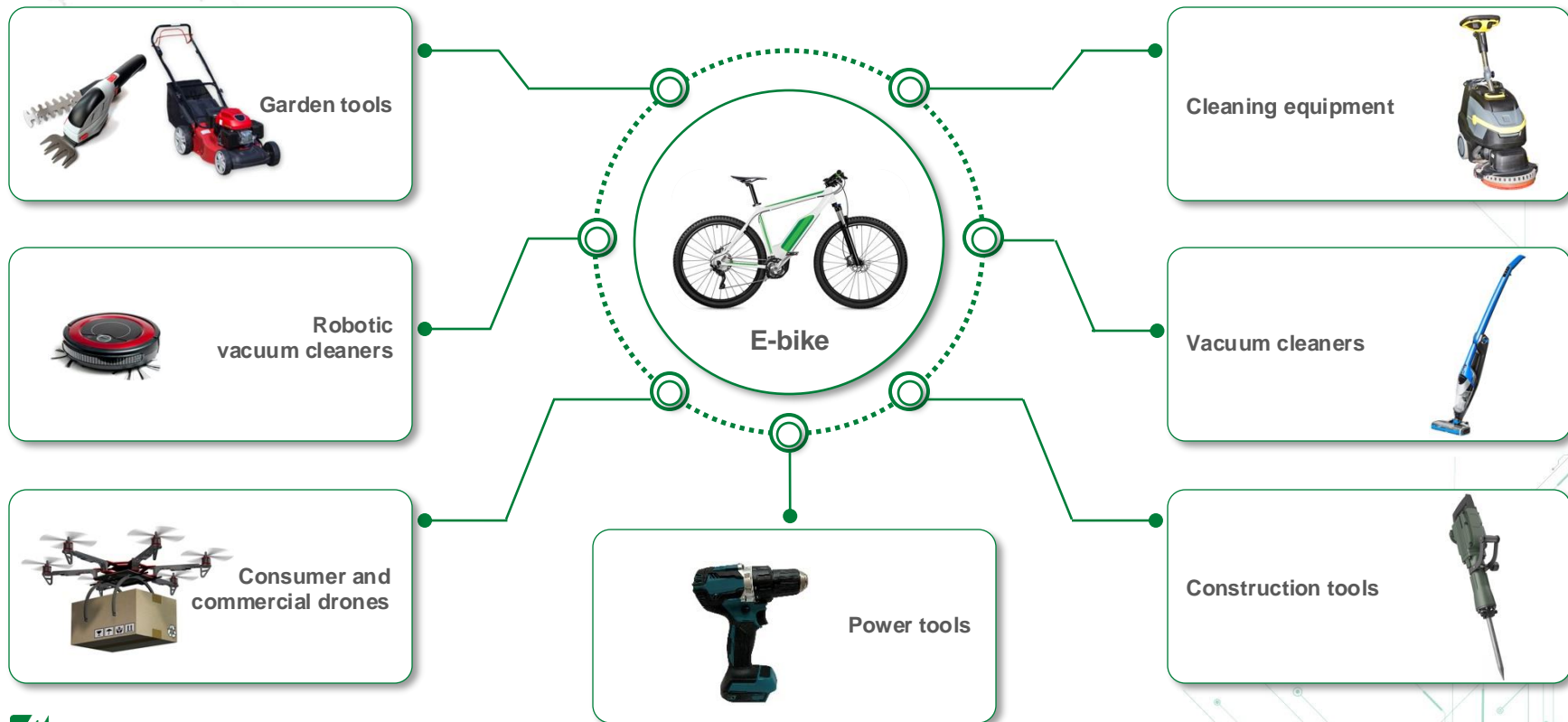
Electric bikes (e-bikes)



Transportation

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Many battery-powered devices in various applications share similar safety and control elements



E-bike market trends and drivers

Market trends and drivers

In 2022, the global e-bike (electric bike) market is expected to reach approximately 36.5 million units. It is projected to climb at a compound annual growth rate of just under 10% between 2022 and 2030 to reach 77.3 million e-bikes by 2030.

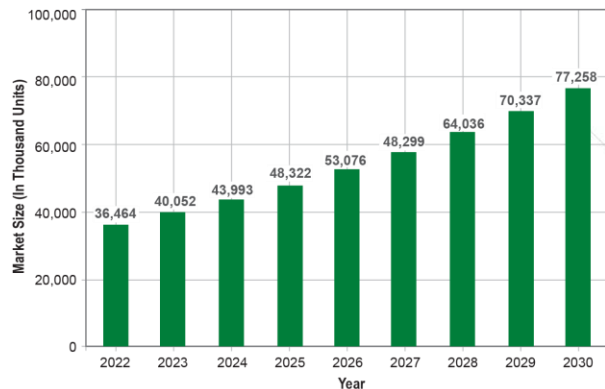
The e-bike market split by type: pedelecs, throttle on demand, scooters, and motorcycles. This presentation mostly covers pedelecs and throttle on demand bikes, which make up the majority of e-bikes. Most countries allow e-bikes on bike lanes, with limitations of 250 W and 25 km / h.

In a pedelec class of electric bikes, the drive system can be activated by the action of pedaling to reach a higher speed. A pedelec is expected to capture the largest market share in terms of market by type during the forecast period.

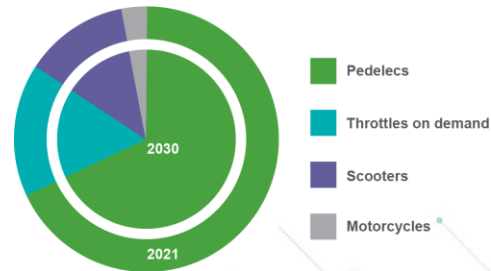
Most e-bike battery packs are 36–48 V, using lithium-ion battery cell type 18650 or 21700.

Rising urbanization and government incentives encourage the use of e-bikes. Governments worldwide are taking steps to minimize carbon emissions by encouraging the use of e-bikes.

Rapid growth of e-bikes market



Market by product



Source: [Statista Projections for the global electric bike market volume between 2022 and 2030](#)

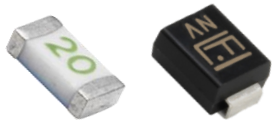
Littelfuse e-bike solutions

Motor drive

1

DC input protection

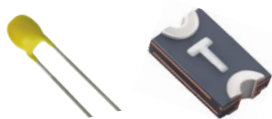
Fuse, TVS Diode



2

Power bridge protection and temperature sensing

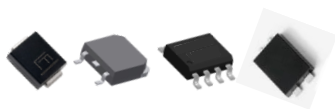
NTC, Temperature Indicator



3

Power bridge

TVS Diode, MOSFET, Gate Driver, Schottky Diode

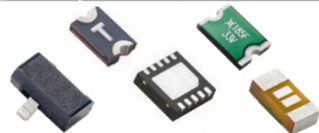


Comfort unit and display

4

USB, I / O, and charging port

Temperature Indicator, PPTC, TVS Diode Array, eFuse, Fuse



5

Side stand & handle grip control

Reed Switch, Tactile Switch



Acronyms:

DC: Direct Current

TVS: Transient-Voltage Suppression

NTC: Negative Temperature Coefficient

USB: Universal Serial Bus

I / O: Input / Output

PPTC: Polymeric Positive Temperature Coefficient



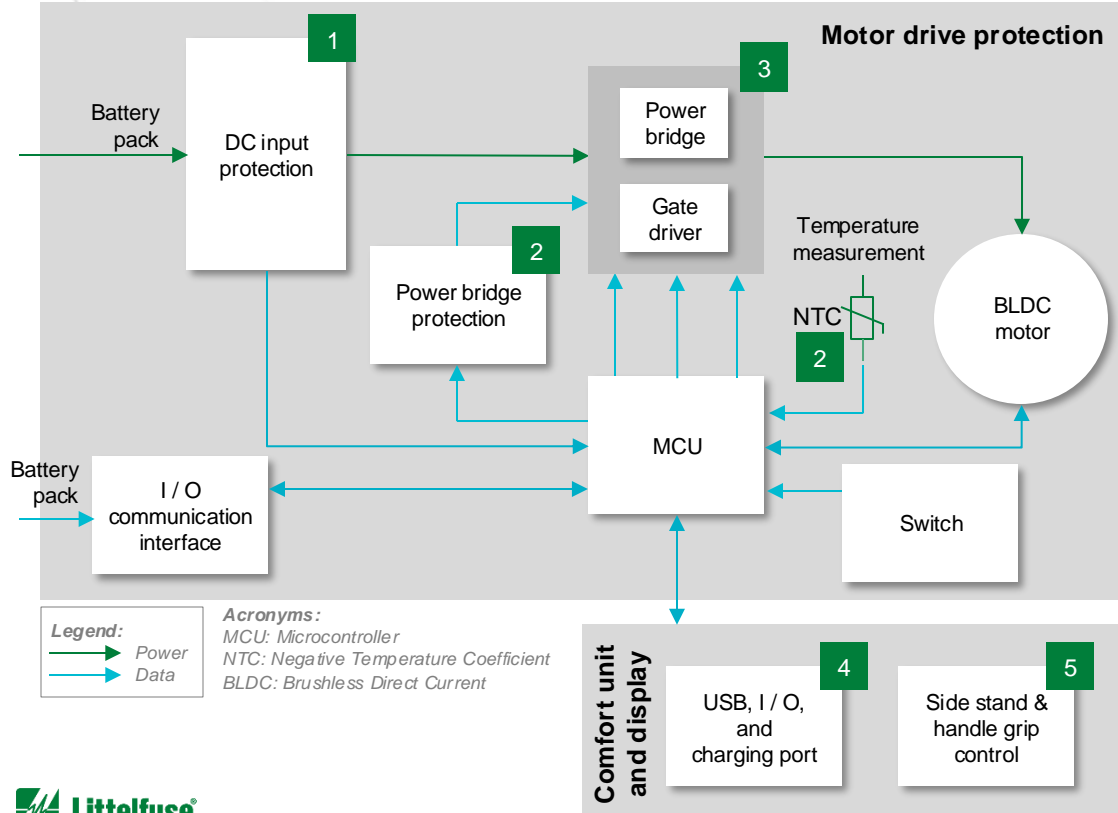
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Click the product series
in the table below for more info

Motor drive protection architecture



	Technology	Product series
1	Fuse	501
	TVS Diode	SMBJ
2	NTC	KC
	Digital Temperature Indicator	setP™
3	MOSFET	Gen2 / Module
	TVS Diode	8.0SMDJ
	Schottky Diode	DST
	Gate Driver	IXD_6xxSI , IX4340NE

	Technology	Product series
4	Temperature Indicator	setP™
	PPTC	miniASMDC
	TVS Diode Array	AQ24CANA
	Fuse	435
	Protection IC (eFuse) (USB-C)	LS1205ExD33
5	Reed Switch	MDSR-10
	Tactile Switch / Key Switch	KSC , RKX



Click the product series
in the table below for more info

Benefits of recommended Littelfuse products

Motor drive

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Protects the battery and downstream controller from damage due to inrush current, motor shorting or external shorts at contacts	501	Reduces customer qualification time by complying with third-party safety standards such as UL / IEC	Third-party compliance with UL / IEC; low internal resistance; shock safe; vibration resistant
	TVS Diode	Suppresses voltage spikes	SMBJ	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
2	NTC	Senses temperature of Power MOSFET	KC	Provides accurate temperature (component / ambient) for enabling safe device operation	High reliability; small form factor; fast thermal response
	Digital Temperature Indicator	Provides an indication signal to help prevent FET overheating	setP™	Helps improve reliability by reducing the risk of thermal damage; simple integration into signal line	Fast response to thermal events; small form-factor; zero IR loss contribution
3	Schottky Diode	Performs rectification and blocking in power supply units	Gen2 / Module	Enables the design of high efficiency power supplies	Ultra-low forward voltage drop; high-frequency operation
	MOSFET	Included in the inverter of the brushless DC motor for high-frequency switching	8.0SMDJ	Improves system efficiency and enables compact design	Very low $R_{ds(on)}$; high current capability
	Gate Driver	Controls switching MOSFETs	DST	Provides space-efficient design, high immunity to latch-up, rise / fall times < 10 ns with dual outputs	Tight tolerance; small form factor; fast thermal response
	TVS Diode	Protects against back EMF from a motor	IXD_6xxSI IX4340NE	Protects electronic equipment from voltage transients induced by a motor	8000 W, high power density in DO-214AB



Click the product series
in the table below for more info

Benefits of recommended Littelfuse products

Comfort unit and display

	Technology	Function in application	Product series	Benefits	Features
4	Digital Temperature Indicator	Provides an indication signal to help protect USB-C plugs and receptacles from overheating	setP™	Helps improve reliability and user experience by reducing the risk of thermal damage; simple integration into existing USB-C systems	Fast response to thermal events; small form-factor; zero IR loss contribution; protects systems with a 100 W or higher power rating
	PPTC	Provides resettable overload circuit protection	miniASMDC	Resets to normal operation after fault is cleared; saves space due to small footprint	Maximum electrical rating: 60 VDC; operating current up to 15 A; SMD and leaded options
	Protection IC (eFuse) (USB-C)	Offers integrated overcurrent and overvoltage protection	AQ24CANA	Offers an integrated solution with features like current limit protection, thermal shutdown, and internal soft start	5 V, 5 A eFuse with 30 V max and overvoltage protection / overcurrent protection
	Fuse	Offers overcurrent protection for power bus	435	Offers small form factor suitable for compact designs	35 A interrupt rating at 32 VDC; compact footprint (0402)
	TVS Diode Array	Protects sensitive electronic ICs from ESD, EFT, and voltage transients	LS1205ExD33	Ensures reliability of the equipment without performance degradation of communication lines	AEC-Q101 qualified; meets ESD protection levels specified under IEC 61000-4-2 and ISO 10605; low leakage current and clamping voltage
5	Reed Switch	Provides control signal for the side stand	MDSR-10	Offers contamination resistance and compact design	Switches up to 200 VDC or 0.5 A at up to 10 W; $10^{12} \Omega$ insulation resistance
	Tactile Switch	Provides handle grip control	KSC , RKX	Saves board space and offers abuse-proof design, long lifecycle, and robust design	IP67; small form factor

Battery packs used in e-bikes

1

Thermal cell protection

Temperature Indicator



2

Secondary protection

Fuse, Battery Protector



3

Battery management unit

PPTC, Fuse, TVS Diode Array



4

Primary protection

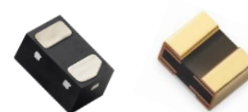
TVS Diode



5

ID communication

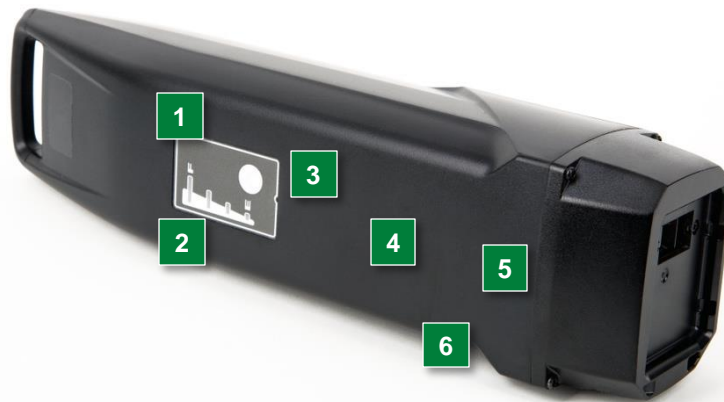
TVS Diode Array, PPTC



6

Switch

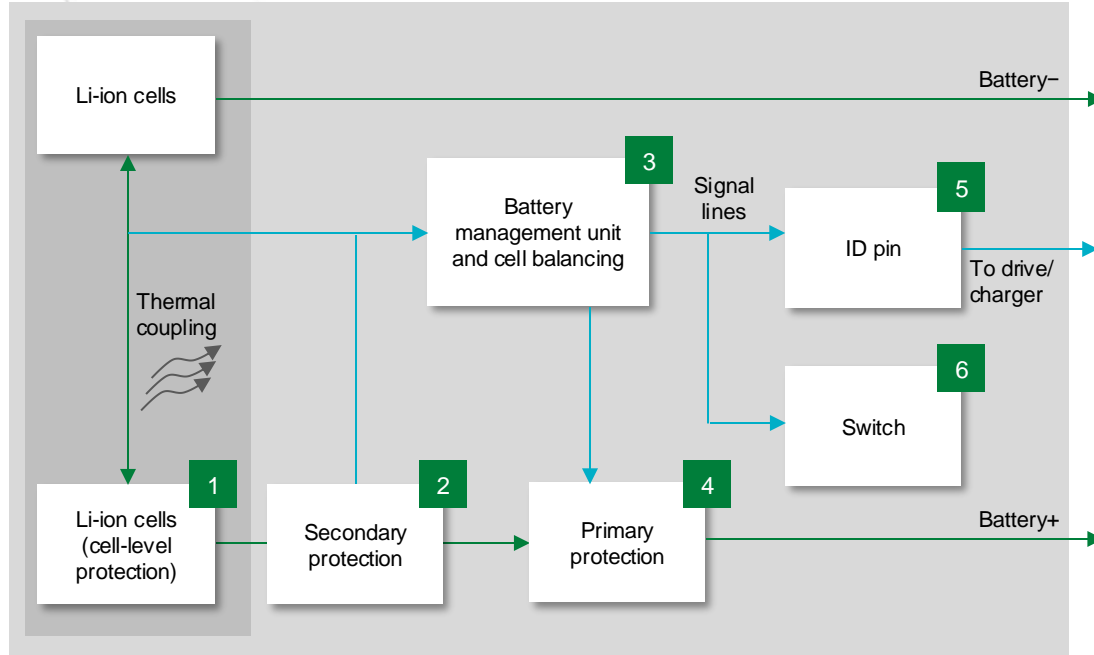
Tactile Switch





Click the product series
in the table below for more info

Battery pack block diagram



Legend:

→ Power
→ Data

- **Secondary protection** – Protects cells in the event that the primary safety circuit fails
- **Primary protection** – Handles all the basic safety functions: overvoltage, undervoltage, overcurrent, under-temperature, and overtemperature

	Technology	Product series
1	NTC	KC
2	Fuse OR Battery Protector	BF1, 881, 688 OR ITV
3	PPTC OR Fuse	0805L OR 458
	TVS Diode Array	SP1003, SC1006
4	TVS Diode Array	SME, SMF4L
	TVS Diode Array	SP3021, SP1007
5	PPTC	zeptoSMDC
6	Switch	KSC441J, PTS645V

* Suitable for premium products or large battery packs.
Contact Littelfuse for more information



Click the product series
in the table below for more info

Typical products for e-bike battery packs

	Technology	Function in application	Product series	Benefits	Features
1	NTC	Monitors analog temperature of battery packs during charging and discharging cycles	KC	Provides accurate temperature readings for enabling safe device operation	Insulated lead wires, small form factor, fast thermal response
2	Fuse OR Battery Protector	Non-resettable overcurrent protection	BF1 , 881 , 688 OR JTV	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	Third-party compliance UL/IEC, low internal resistance, shock safe, vibration resistant
		Offers non-resettable overcurrent and overcharge protection (on demand activated)		Offers overcurrent and overcharge protection and controlled disconnection; can be activated by BMS	Surface mountable; UL and TUV certified, three-pin device, controlled fusible element
3	Fuse OR PPTC	Offers non-resettable protection for BMS MOSFET from high currents due to external shorts	458 OR 0805L	Saves space with smaller footprint	Surface mountable, UL and TUV certified, three-pin device, controlled fusible element
				Reduces customer qualification time by complying with third-party safety standards such as UL/IEC; allows for compact design with SMD form factor	Surface mountable, compatible with lead-free solder processes per IEC standards; PPTC is only for single-cell applications
	TVS Diode Array	Protects control devices from voltage transients	SP1003 , SC1006	Protects ICs and other sensitive components	Excellent clamping capability
4	TVS Diode	Protects battery packs from over-voltage conditions due to abnormal charging conditions	SME , SMF4L	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
5	PPTC	Offers overcurrent protection for TVS or Zener diode	SP3021 , SP1007	Resets to normal operation after fault is cleared; saves space with smaller footprint	Maximum electrical rating: 13 VDC; short circuit current: 82~200 mA; small footprint 0201 size
	TVS Diode Array	Offers ESD protection of I2C input		Offers a small, space-saving design; prevents signal disruption with low capacitance	µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage
6	Tactile switch	Indicates battery status	KSC441J , PTS645V	Saves space; elevates end users' experience with reliable and repeatable haptic performance	Microminiature, short travel, PCB mount tactile with a minimum of 100K operations

Functional elements in e-bike charger

1

AC input primary protection

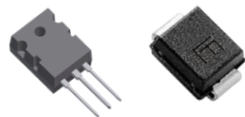
Fuse, MOV, NTC



2

Rectification, high frequency converter

MOSFET, TVS Diode

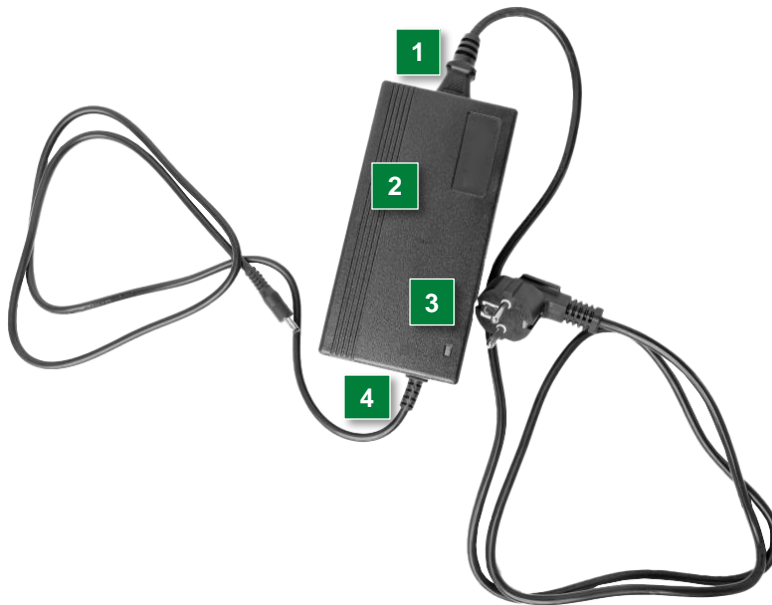


1

2

3

4



3

Secondary side rectification

Schottky Diode



4

DC output protection

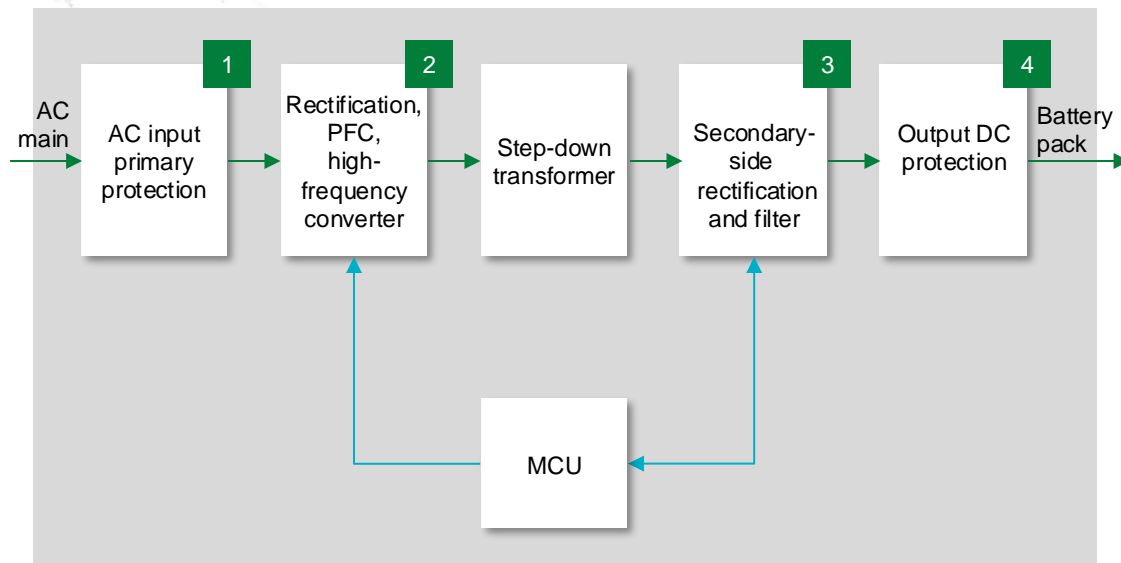
TVS Diode





Click the product series
in the table below for more info

E-bike charger protection architecture



	Technology	Series
1	Fuse	5X20mm Fuse , IR , IE
	MOV	LA , CIII , TMOV
2	MOSFET	X2-class
	TVS Diode	P6SMB
3	Schottky Diode	MBR , DST
4	TVS Diode	SMBJ

Legend:





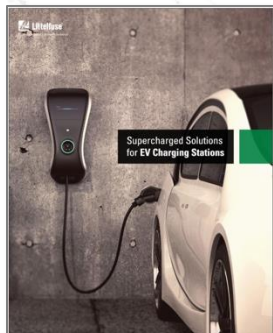
Click the product series
in the table below for more info

Potential Littelfuse products for e-bike charger

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects the power stage from overcurrent	5X20mm Fuse, TR, TE	Reduces customer qualification time by complying with third-party safety standards such as UL / IEC	Third-party compliance with UL / IEC; low internal resistance; shock-safe; vibration-resistant
	MOV	Protects power unit from voltage surges such as lightning and transients	LA, CIII, TMOV	Reduces customer qualification time by complying with third-party safety standards such as UL / IEC	High energy absorption capability: 40–530 J (2 ms)
2	MOSFET	Offers high switching speed in power supply units	X2-class	Offers fast response time and lower heat signature	Low $R_{ds(on)}$, dV/dt ruggedness
	TVS Diode	Protects the power unit from voltage transients	P6SMB	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
3	Schottky Diode	Performs rectification and blocking in power supply units	MBR, DST	Enables the design of high efficiency power supplies	Ultra-low forward voltage drop; high-frequency operation
4	TVS Diode	Offers surge protection	SMBJ	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability

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EV Charging
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Circuit Protection
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Sensor
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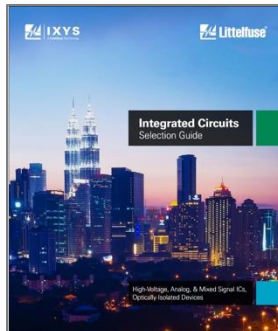


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Legend

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- R&D
- Manufacturing

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