



Expertise Applied | Answers Delivered

Portable & corded power tools



Appliances



Industrial

Users must independently evaluate the suitability of and test each product selected for their own specific applications. It is the User's sole responsibility to determine fitness for a particular system or use based on their own performance criteria, conditions, specific application, compatibility with other components, and environmental conditions. Users must independently provide appropriate design and operating safeguards to minimize any risks associated with their applications and products. Littelfuse products are not designed for, and may not be used in, all applications. Read complete Disclaimer Notice at: www.littelfuse.com/disclaimer-electronics.

Many battery powered devices, in very different applications, share similar safety and control elements



Global power tool market statistics & drivers

Market Trends and Drivers

The global power tool market is growing at a CAGR of 8.5% between 2019 to 2026 (~200 M-units).

Cordless power tools experiencing rapid growth representing 50% share of electric power tools shipments.

The major factor driving the adoption of battery power tools is their portability, which enables the user to operate them without the need for external power supply

Demand for longer run-times and lighter systems resulting in battery packs shifting to Li-ion battery chemistry similar to other mobile electronics

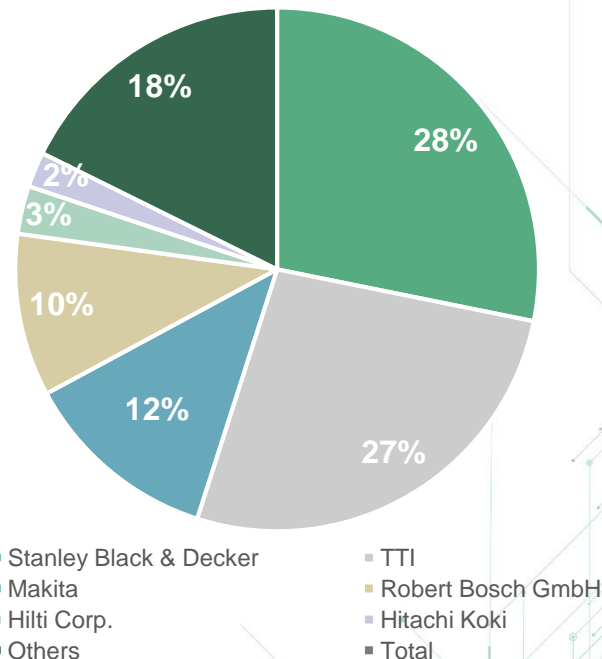
Li-ion batteries require additional safety considerations and battery management compared to NiCd & NiMH based systems

Brushless DC motors are preferred for higher Whr power tools for better reliability/longevity, smaller size and improved output performance.

Source: *PressureWashr March 2018 report Tool Industry Behemoths*

*Based on LIB market trend. Estimating an average of 5 cells/ pack, we divided total unit shipments of cells/year by 5 to get total unit shipments of power tools.

Global Power Tools Market Share



Source: [LIB market trend](#), [alliedmarketresearch](#)

Battery packs used in power tools & appliances

Battery management unit



- Battery protectors
- Fuse
- TVS diode
- PPTC

Cell protection module



- NTC

Bluetooth module



- ESD protection

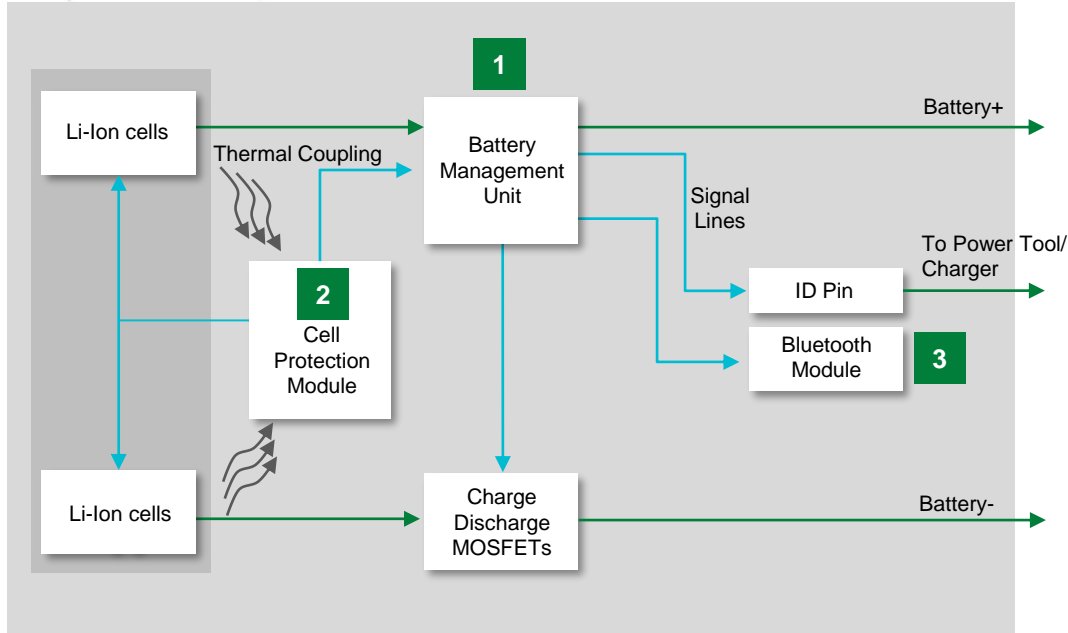


Battery-powered appliances



Hand-held appliances

Basic power tool or appliance battery pack architecture



	Technology	Series
1	Fuse	Midi Fuse, BF1, 881, 688
	TVS diode	SMF, SMF4L
	PPTC, Fuse	nanoSMD, 0805L
	Battery protectors	ITV
2	NTC*	KC series
3	TVS diode array	SP3021, SP1007

* Thermally coupled with Li-Ion cells.

Acronyms:

NTC: negative temperature co-efficient

MOV: metal oxide varistor

TVS: transient voltage suppressor

PPTC: polymeric positive temperature co-efficient

Typical products for tools & appliances battery packs

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protect cells from high currents due to external shorts	Midi Fuse, BF1, 881, 688	Reduces customer qualification time by complying with 3 rd party safety standards such as UL/IEC	3 rd party compliance UL/IEC, low internal resistance, shock safe, vibration resistant
	TVS Diode	Protects battery pack from over-voltage condition due to abnormal charging conditions	SMF, SMF4L	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
	PPTC, Fuse	Protect cells and BMS MOSFET from high currents due to external shorts	nanoSMD, 0805L	Reduces customer qualification time by complying with 3 rd party safety standards such as UL/IEC SMD form-factor allows for compact design	Surface mountable, resettable (PPTC), compatible with lead-free solder process per IEC standards,
	Battery protectors	Dual overcurrent and overvoltage protection	ITV	Increases assemble efficiency	Surface mountable; UL and TUV certified
2	NTC	Temperature monitoring of battery pack during charging & discharging cycles.	KC series	Provides accurate temperature reading for enabling safe device operation	Kynar insulated lead wires, small form factor, fast thermal response
3	TVS diode array	Protects IC from ESD	SP3021, SP1007	Protects end user from electrical shocks and physical harm	Hermetically sealed, custom designed sensitivity

Functional elements in power tool charger

AC input primary protection



- Fuse
- MOV
- NTC

High frequency converter & clamp

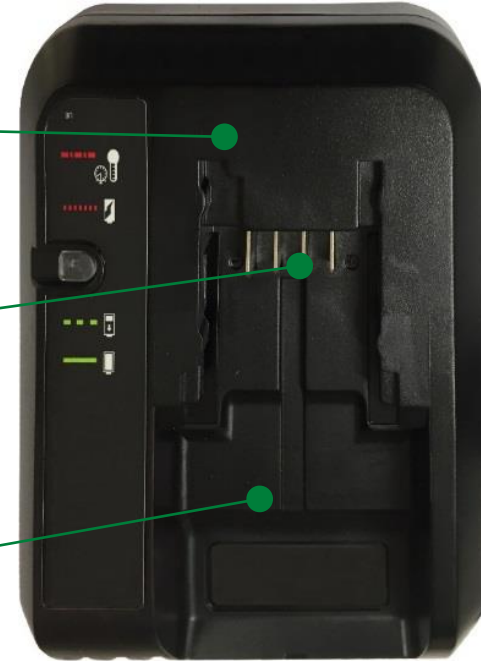


- MOSFET
- TVS diode

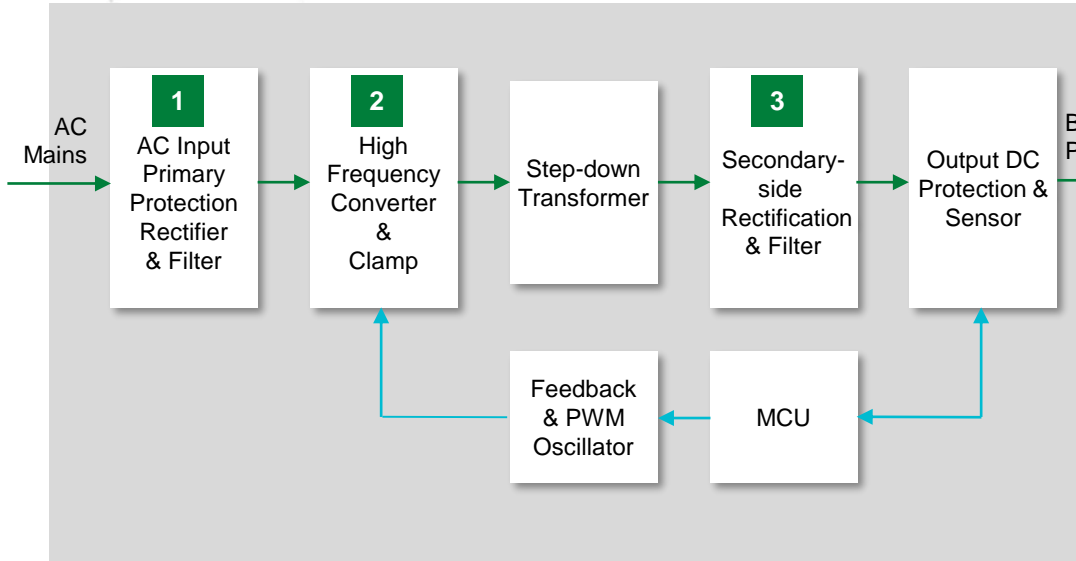
Secondary-side rectification



- Reverse blocking diode



Power tool charger protection architecture



Legend:
 → Power Line
 → Signal Line

	Technology	Series
1	Fuse	5X20mm Fuse , TR , TE
	NTC*	ST
	MOV	LA , CIII , TMOV
2	MOSFET	X2-class
	TVS Diode	P6KE , P6SMB
3	Schottky Diode	MBR , DST

* Thermally coupled to Li-Ion cells.

Acronyms:

- NTC: negative temperature co-efficient
- MOV: metal oxide varistor
- TVS: transient voltage suppressor

Potential Littelfuse products for power tool charger

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects 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 UL/IEC, low internal resistance, shock safe, vibration resistant
	NTC	Protects power stage from high inrush current	ST	Improves system reliability	Small form factor, fast thermal response
	MOV	Protects power unit from voltage surges such as lighting, transients	LA , CIII , TMOV	Reduces customer qualification time by complying with third party safety standards such as UL/IEC	High energy absorption capability: 40 J – 530 J (2 ms)
2	MOSFET	High switching speed in power supply units	X2-class	Fast response time and lower heat signature	Low Rds(on), dv/dt ruggedness
	TVS Diode	Protects power unit from voltage transients	P6KE , P6SMB	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
3	Schottky Diode	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

Key elements of cordless power tool

Temperature Sense

- NTC



Power Bridge Protection

- NTC



Trigger Input Protection

- Fuse
- TVS Diode
- Reed Switch

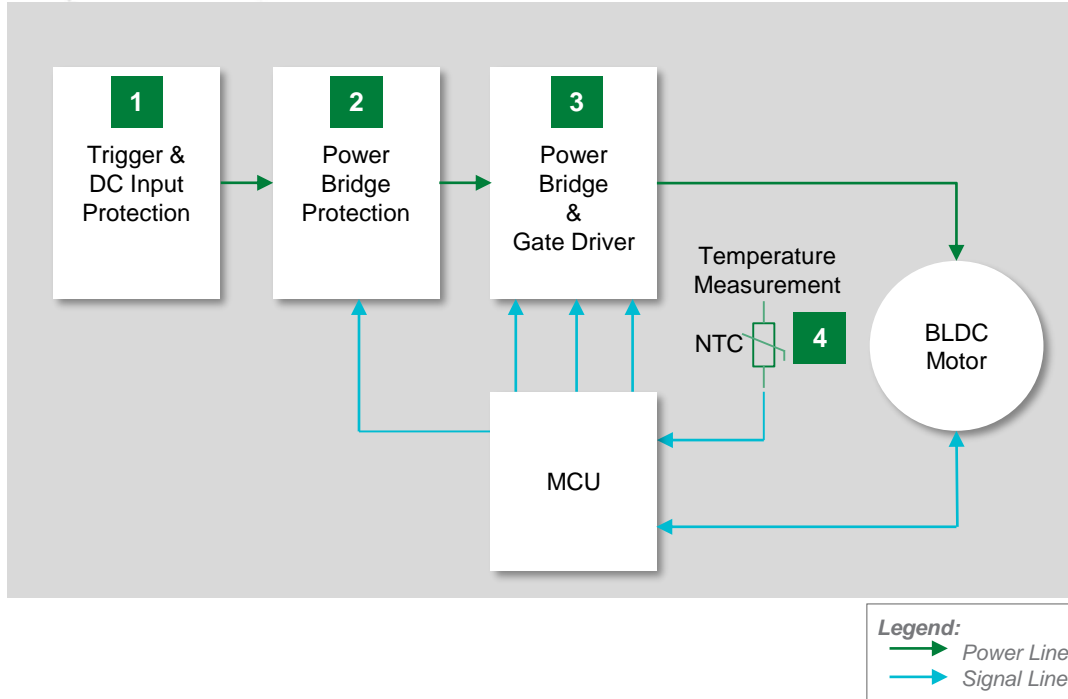


Power Bridge & Gate Driver

- MOSFET



BLDC motor protection architecture



	Technology	Series
1	Fuse	1206SFH , 501
	TVS Diode	SMAJ , SMBJ , 5KP
	Reed Switch	MDSR-10 , MDSM-10
2	NTC*	KC series
3	MOSFET	Gen2
4	NTC	KC series

* Thermally coupled to Li-Ion cells.

Acronyms:

NTC: negative temperature co-efficient

TVS: transient voltage suppressor

Select Littelfuse products for BLDC motor protection

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects battery and downstream controller from damage due to inrush current due to motor shorting or external shorts at contacts	1206SFH , 501	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
	TVS diode	Protect battery pack from voltage transients	SMAJ , SMBJ , 5KP	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
	Reed Switch	Provides control signal to turn on and off the motor	MDSR-10 , MDSM-10	Contamination resistant, compact design	Switch up to 200Vdc or 0.5A at up to 10W, 10 ¹² Ohms insulation resistance
2	NTC	Temperature sensing of Power MOSFET	KC series	Provides accurate temperature (component/ambient) for enabling safe device operation	High reliability, small form factor, fast thermal response
3	MOSFET	Part of inverter of brushless DC motor for high frequency switching	Gen2	Improves system efficiency and enables compact design	Very low Rds(on), High current capability
4	NTC	Temperature sensing To prevent motor damage due to over-heating	KC series	Provides accurate temperature (component/ambient) for enabling safe device operation	High reliability, small form factor, fast thermal response

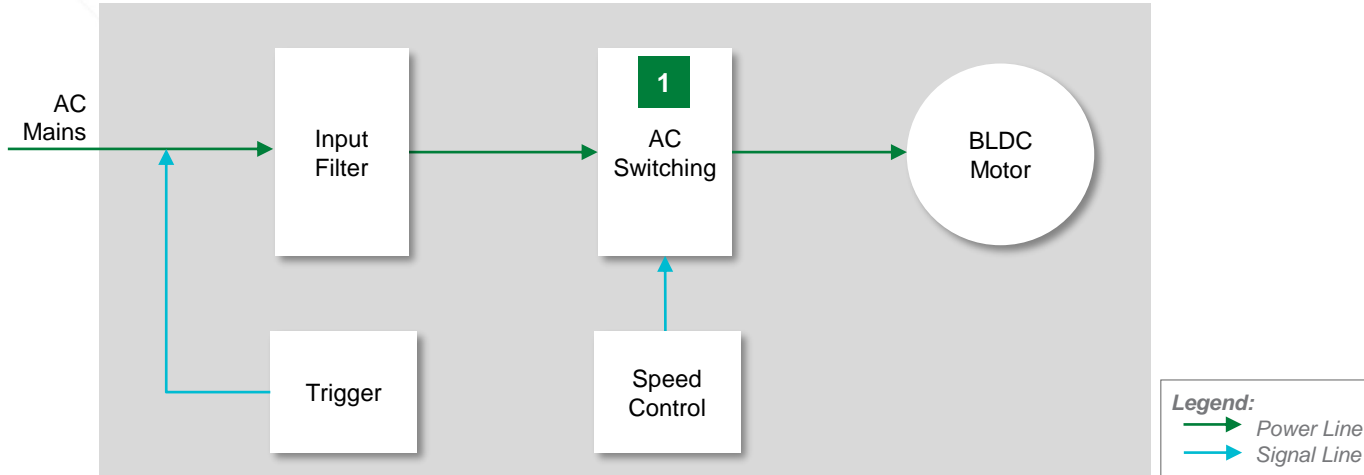
Corded power tools contain fewer electronic components

AC Switching

- TRIAC



Corded power tool protection opportunities



	Technology	Function in Application	Series	Benefits	Features
1	TRIAC	High power AC switching and speed control	Qxx25xHx/ QJxx25xHx	AC switching and efficient speed control, reduced need of heat sinking	High Tj (150°C), internally isolated packages (mechanically and thermally robust)

Standards for power tool equipment

Standard	Title	General Scope	Region
IEC/UL 62841-1	Safety standards for Transportable Hand-Held Motor Operated Electric Power Tools	IEC 62841-1 compliance testing deals with the hazards presented by tools. The standard covers tools with rated voltage is not more than 250 V for single-phase A.C. or D.C. and 480V for three-phase A.C. The rated input is not more than 3 700W”	Global/North America
IEC 62133-2/UL 62133	Safety standards for Li-Ion Secondary Cells and Batteries	Evaluating protection during various battery fault scenarios	Global/North America
UL 2595	General Requirements for Battery-Powered Appliance	The standard covers the safe functioning of lithium-ion battery systems and lithium-ion cells employed in battery systems. The maximum rated voltage for appliances and battery packs is 75 Vdc	North America
UL 1642	Lithium Batteries	Both are Safety standard that deal with cells and small portable batteries. UL1642 deals with individual cells while UL2054 is for small rechargeable battery packs.	North America
UL 2054	Household and Commercial batteries		North America
IEC 62281	Safety of Primary and Secondary Lithium Cells and Batteries during transport	This standard specifies test methods and requirements for primary and secondary (rechargeable) lithium cells and batteries to ensure their safety during transport other than for recycling or disposal.	Global
JIS C8714	Safety Tests for Portable Li-Ion secondary cells and Batteries	Covers safety testing of Li-ion storage batteries (single cell and multiple cell) for portable electronic devices	Japan
ANSI C18.2M	Portable Rechargeable Cells and Batteries	Defines safety standards for portable cells and batteries. It is specific to two distinct chemistry systems: lithium ion and nickel	North America

Additional information can be found on littelfuse.com

Circuit Protection
Selection Guide



Sensor Selection Guide



Power Semiconductor



ESD Protection



Click on each
image to open the
catalog

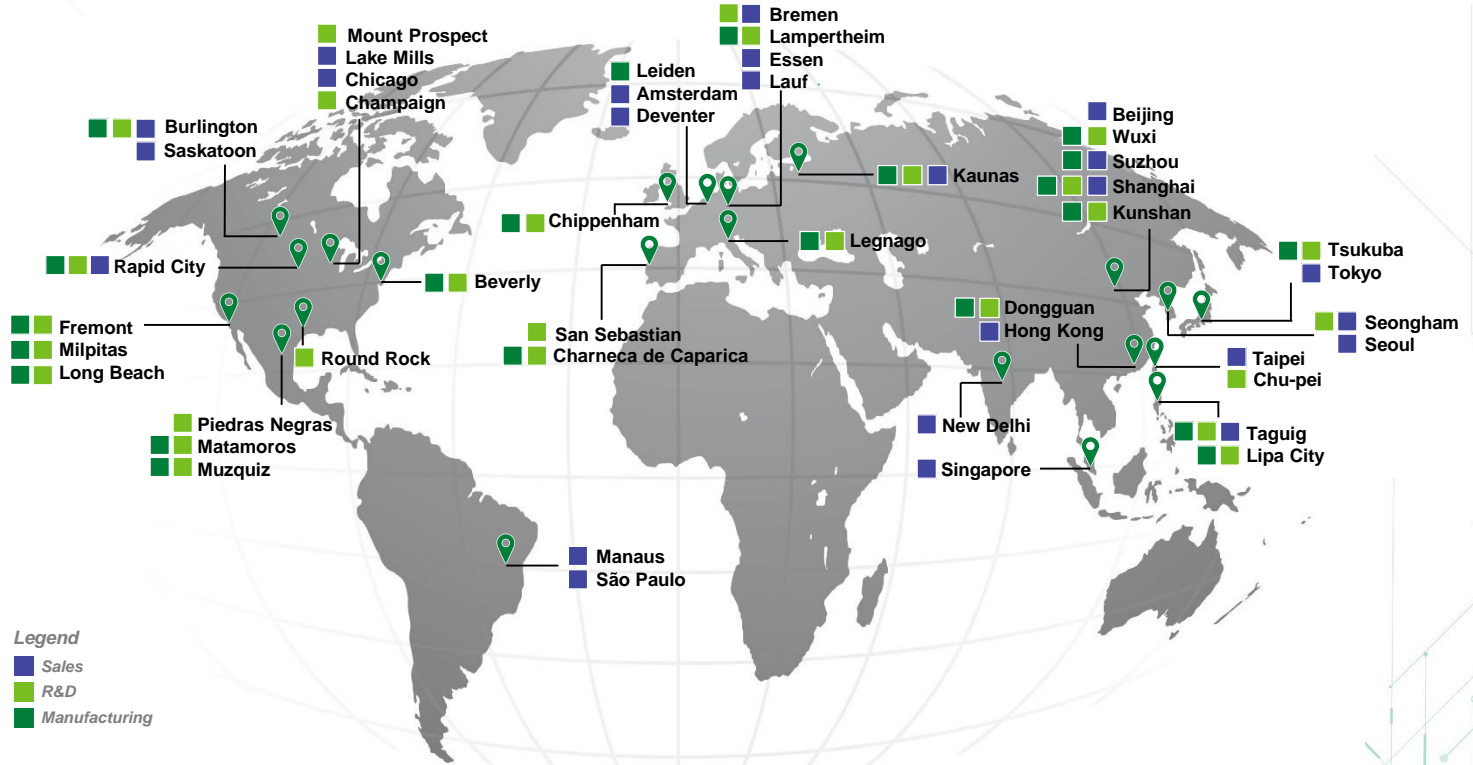
TVS Diode Array Catalog



Small appliances spotlight



Local resources supporting our global customers



Legend
 Sales
 R&D
 Manufacturing

Partner for tomorrow's electronic systems

Broad product portfolio

A global leader with a broad product portfolio, covering every aspect of protection, sensing, and control

Application expertise

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

Global customer service

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

Compliance & regulatory expertise

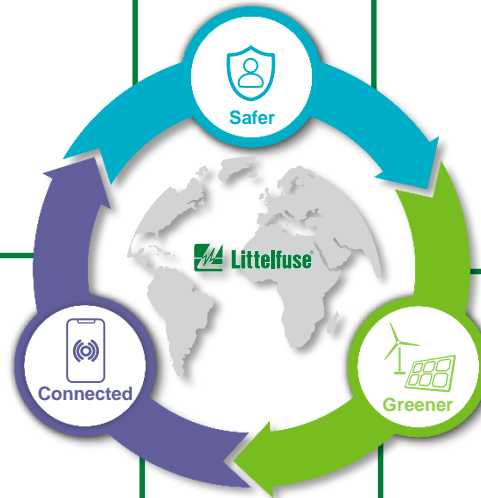
To help customers in the design process to account for requirements set by global regulatory authorities

Testing capabilities

To help customers get products to market faster, we offer certification testing to global regulatory standards

Global manufacturing

High-volume manufacturing that is committed to the highest quality standards



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