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## Portable and 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 parts, 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 [littelfuse.com/disclaimer-electronics](http://littelfuse.com/disclaimer-electronics).*

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



# Global power tool market statistics and drivers

## Market Trends and Drivers

The global power tool market is growing at a CAGR of 6.9% between 2021 to 2026. Cordless power tools are the fastest-growing sector of the power tool industry

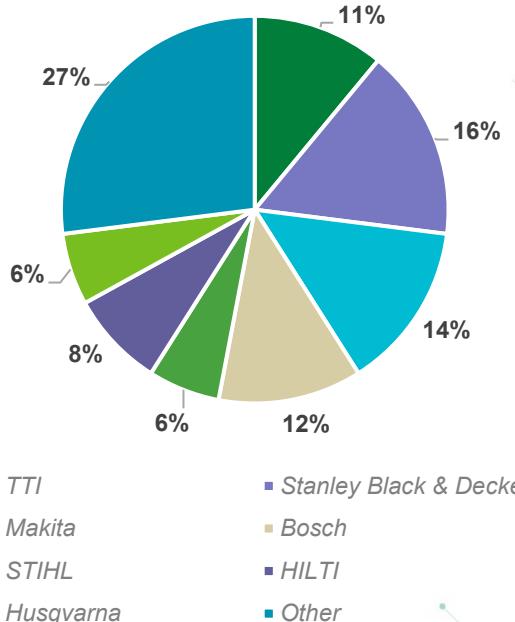
Cordless power tools are currently experiencing rapid growth and represent 50% of all power tool shipments

Cordless power tool architecture (i.e., control, battery management, and safety) is very similar across other battery-run devices

Portable tools are beginning to adopt Li-ion batteries (from NiCd & NiMH) that are more focused on electronic design / safety in chargers and battery packs

Brushless DC motors are preferred for power tools due to their better reliability / longevity, smaller size, and improved output performance

The power tool market is growing at a ~6.9% CAGR



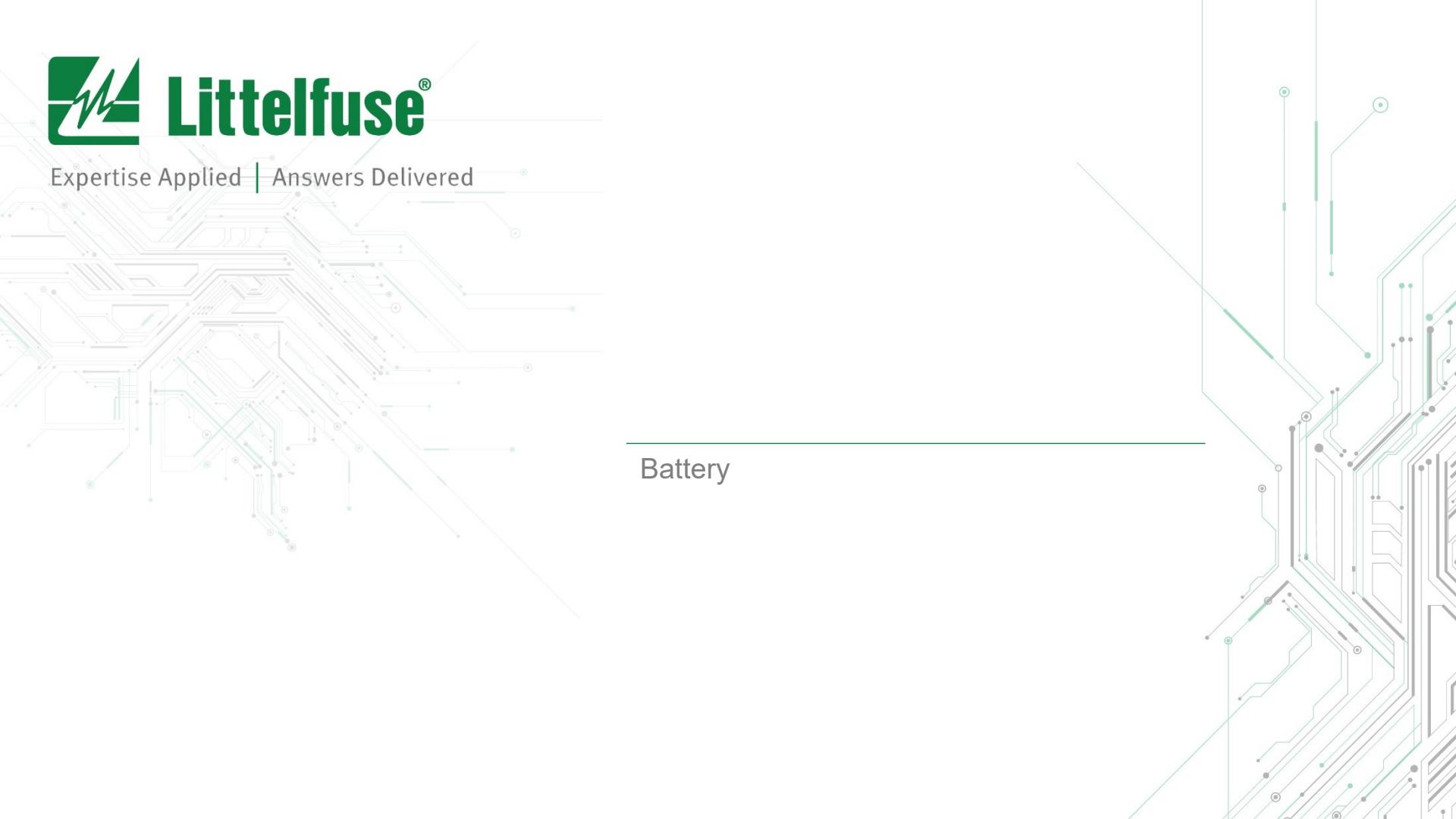
Source: [Statista](#), [alliedmarketresearch](#)



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Battery

A faint, light-green circuit board pattern serves as the background for the entire slide, with a solid green horizontal line separating the top and bottom sections.

# Battery packs used in power tools & appliances

## 1 Thermal cell protection

- Thermal cut-off
- setP™

## 2 Secondary protection

- Fuse
- Battery Protector

## 3 Battery management unit

- PPTC
- Fuse
- TVS Array



## 4 Primary protection

- TVS Diode

## 5 ID communication

- TVS Diode Array
- PPTC

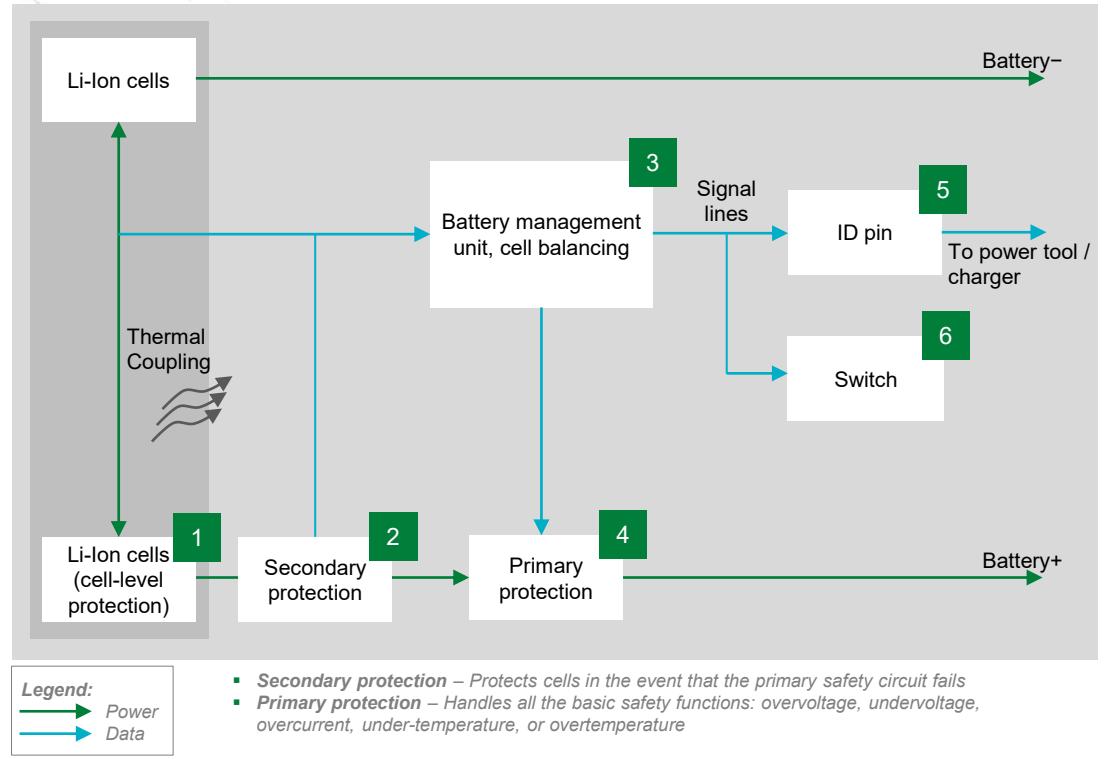
## 6 Switch

- Tactile Switch

### Acronyms:

TVS: Transient Voltage Suppressor  
PPTC: Positive Temperature Coefficient Device  
NTC: Negative Temperature Coefficient Device  
ESD: Electrostatic Discharge

# Cordless tool battery pack block diagram



	Technology	Product series
1	Thermal Cut-off Device	<a href="#">MHP-TAC</a>
	NTC	<a href="#">KC</a>
2	Fuse OR Battery Protector	<a href="#">BF1, 881, 688</a> OR <a href="#">ITV</a>
3	PPTC OR Fuse	<a href="#">0805L</a> OR <a href="#">458</a>
	TVS Diode Array	<a href="#">SP1003, SC1006</a>
4	TVS Diode	<a href="#">SMF, SMF4L</a>
5	TVS Diode Array	<a href="#">SP3021, SP1007</a>
	PPTC	<a href="#">zeptoSMDC</a>
6	Switch	<a href="#">KSC441J, PTS645V</a>

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



Click on the product series in  
the table below for more info

# Typical products for tools & appliances battery packs

	Technology	Function in Application	Series	Benefits	Features
1	Thermal Cut-off Device (Single cell device)	Resettable overtemperature protection for batteries	<a href="#">MHP-TAC</a>	Voltage rating up to (12 VDC) and smaller size offers resettable overtemperature protection	Multiple activation temperature ratings (72 °C, 77 °C, 82 °C, 85 °C, and 90 °C)
	NTC	Analog temperature monitoring of battery packs during charging and discharging cycles	<a href="#">KC</a>	Provides accurate temperature readings for enabling safe device operation	Insulated lead wires, small form factor, fast thermal response
2	Fuse <i>OR</i> Battery Protector	Non-resettable overcurrent protection	<a href="#">BF1</a> , <a href="#">881</a> , <a href="#">688</a> <i>OR</i> <a href="#">ITV</a>	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
		Non-resettable overcurrent and overcharge protection (on demand activated).		Overcurrent and overcharge protection; controlled disconnection, can be activated by BMS	Surface mountable; UL and TUV certified. 3pin device, Controlled fusible element
3	Fuse <i>OR</i> PPTC	Non-resettable protection for BMS MOSFET from high currents due to external shorts	<a href="#">0805L</a> <i>OR</i> <a href="#">458</a>	Allows space saving	Surface-mountable, UL- and TUV-certified, 3-pin device, controlled fusible element
		Resettable protection for BMS MOSFET from high currents due to external shorts		Reduces customer qualification time by complying with third-party safety standards such as UL/IEC; SMD form-factor allows for compact design	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	<a href="#">SP1003</a> , <a href="#">SC1006</a>	Protects ICs and other sensitive components	Excellent clamping capability
4	TVS Diode	Protects battery packs from over-voltage conditions due to abnormal charging conditions	<a href="#">SMF</a> , <a href="#">SMF4L</a>	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
5	PPTC	Overcurrent protection for TVS or Zener diode	<a href="#">SP3021</a> , <a href="#">SP1007</a>	Resets to normal operation after fault is cleared; smaller footprint saves space	Maximum electrical rating: 13 VDC; short circuit current: 82–200 mA; small footprint 0201 size
	TVS Diode Array	ESD protection of I2C input	<a href="#">zeptoSMDC</a>	Small, space-saving design; low capacitance to prevent signal disruption	µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage
6	Tactile switch	Indication of battery status	<a href="#">KSC441J</a> , <a href="#">PTS645V</a>	Saves space; reliable and repeatable haptic performance elevates end users' experience	Microminiature, short travel, PCB mount tactile with a minimum of 100K operations



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Cordless tool

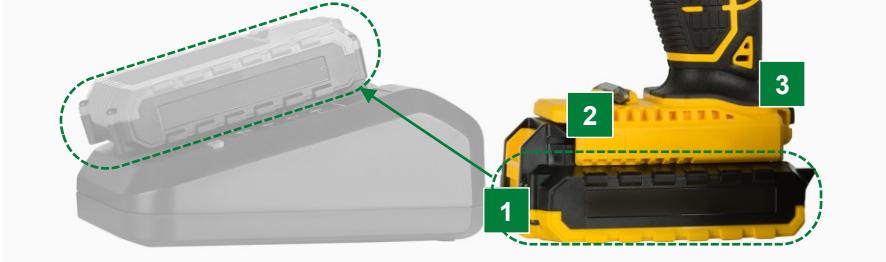
# Key elements of cordless power tool

## 1 DC input protection

- Fuse
- TVS Diode
- Reed Switch

## 2 Power bridge protection

- NTC
- setP™



## 3 Power Bridge and Gate Driver

- MOSFET

## 4 Temperature protection

- NTC

### Acronyms:

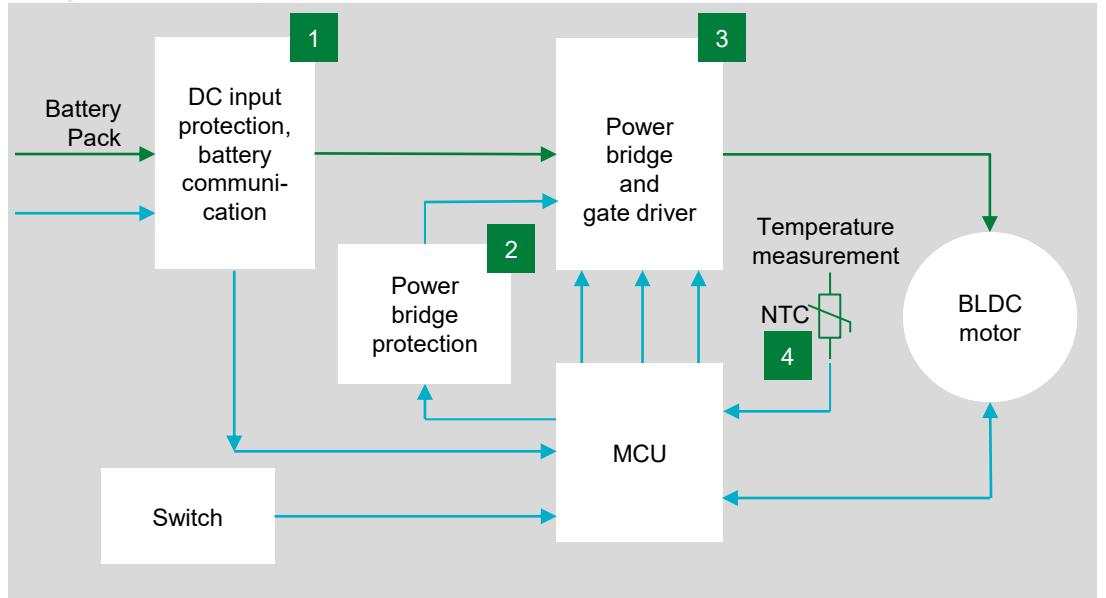
NTC: Negative Temperature Coefficient

TVS: Transient Voltage Suppressor



Click on the product series in the table below for more info

# BLDC motor protection architecture



Legend:  
→ Power  
→ Data

	Technology	Series
1	Fuse	<a href="#">501</a>
	TVS Diode	<a href="#">SMAJ, SMBJ, 5KP</a>
	Reed Switch	<a href="#">MDSR-10, 59166</a>
	NTC	<a href="#">KC</a>
2	Digital Temperature Indicator	<a href="#">setP™</a>
	MOSFET	<a href="#">Gen2 / Gen4</a>
4	NTC	<a href="#">RB</a>



Click on the product series in  
the table below for more info

# Select Littelfuse products for BLDC motor protection

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects the battery and downstream controller from damage due to inrush current, motor shorting or external shorts at contacts	<a href="#">501</a>	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	Protect battery pack from voltage transients	<a href="#">SMAJ</a> , <a href="#">SMBJ</a> , <a href="#">5KP</a>	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
	Reed Switch	Provides control signal to turn the motor on or off	<a href="#">MDSR-10</a> , <a href="#">59166</a>	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	<a href="#">KC</a>	Provides accurate temperature (component/ambient) for enabling safe device operation	High reliability; small form factor; fast thermal response
	Digital Temperature Indicator	FET overheating indication	<a href="#">setP™</a>	Reliable overheating indication, regardless of power being delivered	Compact footprint 0805; multipoint measurement (device configuration in series)
3	MOSFET	Part of the inverter of brushless DC motor for high-frequency switching	<a href="#">Gen2</a> / <a href="#">Gen4</a> (from 36 V)	Improves system efficiency and enables compact design	Very low $R_{ds(on)}$ ; high current capability
4	NTC	Temperature sensing to prevent motor damage due to overheating	<a href="#">RB</a>	Provides accurate temperature (component / ambient) for enabling safe device operation	High reliability; small form factor; fast thermal response



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Charger

# Functional elements in power tool charger

## 1 AC input primary protection

- Fuse
- MOV
- NTC

## 2 Rectification, high frequency converter

- MOSFET
- TVS Diode

### Acronyms:

MOV: Metal Oxide Varistor

NTC: Negative temperature co-efficient

TVS: Transient Voltage Suppressor



## 3 Secondary side rectification

- Schottky Diode

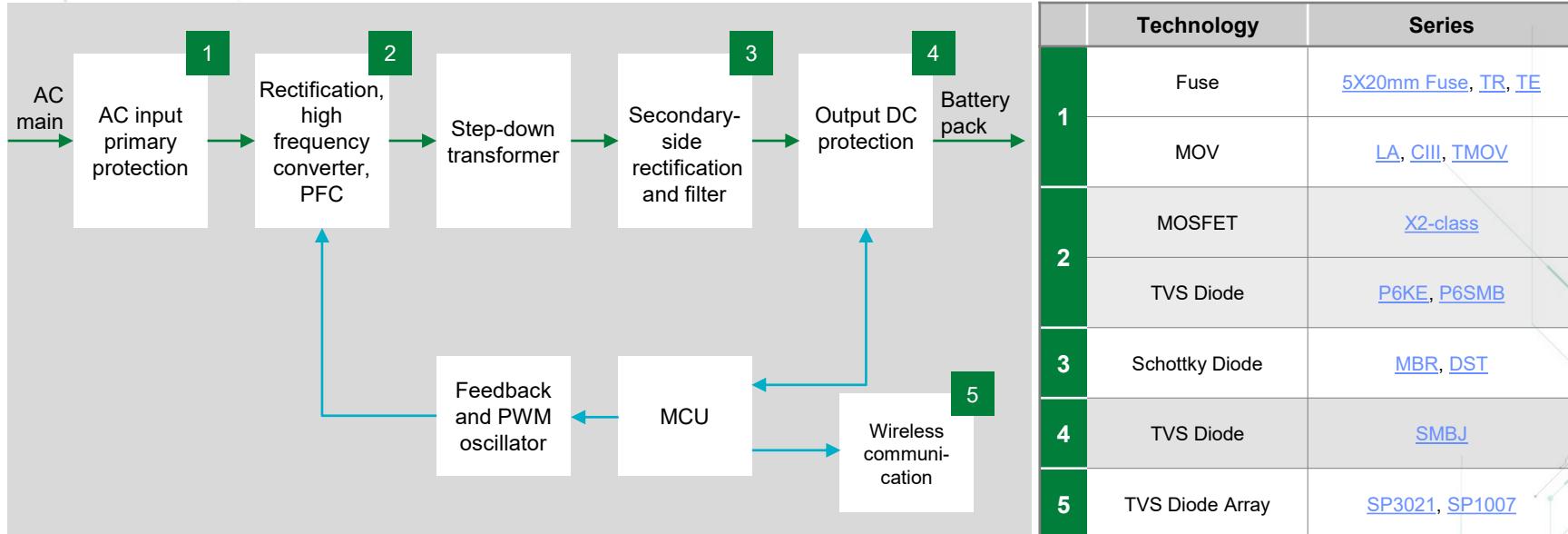
## 5 DC output protection

- TVS Diode

## 5 Wireless communication

- TVS Diode Array

# Power tool charger protection architecture



Legend:  
 Power  
 Data



Click on the product series in  
the table below for more info

# Potential Littelfuse products for power tool charger

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects the power stage from overcurrent	<a href="#">5X20mm Fuse</a> , <a href="#">TR</a> , <a href="#">TE</a>	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 lighting and transients	<a href="#">LA</a> , <a href="#">CIII</a> , <a href="#">TMOV</a>	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	High switching speed in power supply units	<a href="#">X2-class</a>	Fast response time and lower heat signature	Low $R_{ds(on)}$ , dv/dt ruggedness
	TVS Diode	Protects the power unit from voltage transients	<a href="#">P6KE</a> , <a href="#">P6SMB</a>	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	<a href="#">MBR</a> , <a href="#">DST</a>	Enables the design of high efficiency power supplies	Ultra-low forward voltage drop; high-frequency operation
4	TVS Diode	Surge protection	<a href="#">SMBJ</a>	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
5	TVS Diode Array	ESD protection of wireless communication	<a href="#">SP3021</a> , <a href="#">SP1007</a>	Small, space-saving design; low capacitance to prevent signal disruption	$\mu$ DFN-2 (0201) footprint; $\pm 30$ kV ESD withstand voltage



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Corded tool

# Corded power tool control & protection opportunities

## 1 AC primary protection

- Fuse
- MOV

## 2 Rectifier and filter

- Rectifier Bridge
- Rectifier Diode
- SCR
- NTC

## 3 Power stage, gate drive

- setP™
- Gate Driver
- IGBT



## 4 AC Switching

- TRIAC



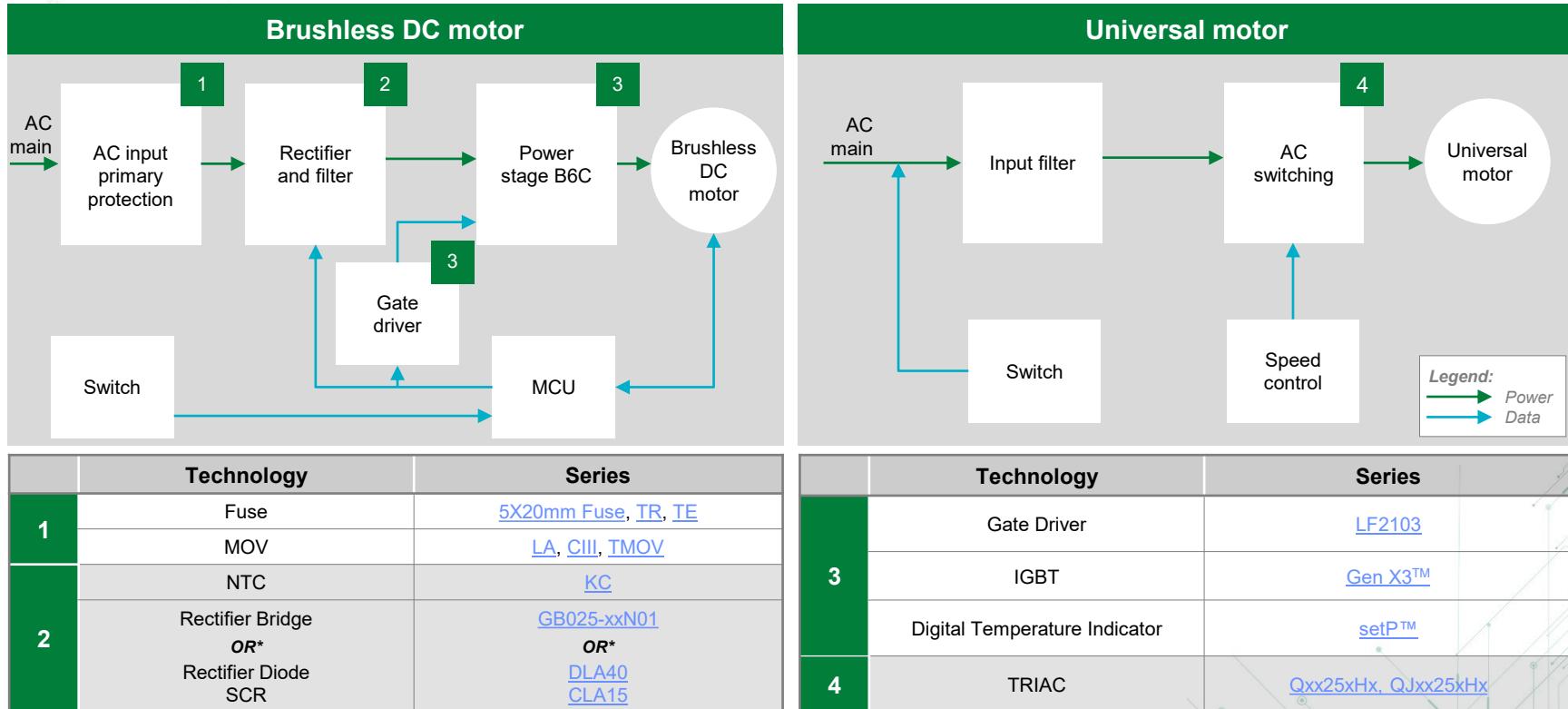
### Acronyms:

TRIAC: Triode For Alternating Current

IGBT: Insulated-gate Bipolar Transistor

MOV: Metal Oxide Varistor

# Corded power tool control & protection opportunities





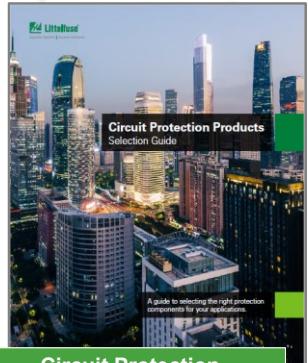
Click on the product series in  
the table below for more info

# Select Littelfuse products for tool protection

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects power stage from overcurrent	<a href="#">5X20mm Fuse, TR, TE</a>	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
	MOV	Protects the power unit from voltage surges such as lighting and transients	<a href="#">LA, CIII, TMOV</a>	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	NTC	Temperature sensing of Power MOSFET	<a href="#">KC</a>	Provides accurate temperature (component / ambient) for enabling safe device operation	High reliability; small form factor; fast thermal response
	Rectifier Bridge <i>OR</i> Rectifier diode SCR	Converts AC line voltage supplied to the drive to DC	<a href="#">GB025-xxN01</a>	Space and weight savings; low forward voltage drop	Isolation voltage: 2500 V; reduced weight; epoxy meets UL 94V-0
		Alternative using a half-controlled rectifier bridge	<a href="#">DLA40</a>	Very low leakage current, low forward voltage drop	Single thyristor with two gate polarities; RoHs compliant; TO-236 (D2Pak-HV) package
			<a href="#">CLA15</a>	Planar passivated chip; long-term stability; two gate current polarities usable	Single thyristor with two gate polarities; RoHs compliant; TO-236 (D2Pak-HV) package
3	Gate Drivers	Provides required drive current to discrete MOSFETs or IGBTs	<a href="#">LF2103</a>	Efficient and fast FET switching	1.5 A peak output current; wide operating voltage range
	IGBT	Discrete switching for power control	<a href="#">Gen X3™</a>	Lowest on-state resistances among its competitors along with low gate charges and superior dv/dt performance	Helps reduce switching losses and electromagnetic interference
	Digital Temperature Indicator	FET overheating indication	<a href="#">setP™</a>	Reliable overheating indicators, regardless of power being delivered	Compact footprint 0805; multipoint measurement (device configuration in series)
4	Triac	AC switching to control the motor	<a href="#">Qxx25xHx, QJxx25xHx</a>	Solid-state switching with no audible noise and no contact bounce during operation; compact design	Ability to withstand high voltage and high surge current

# Additional information can be found at [Littelfuse.com](https://www.littelfuse.com)

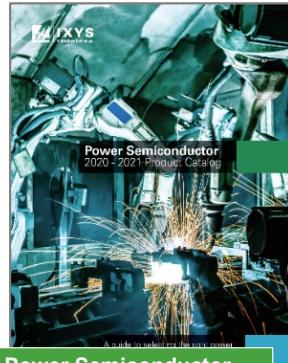
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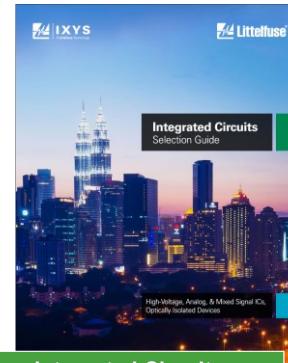
Circuit Protection Selection Guide



Sensor Selection Guide



Power Semiconductor Product Catalog



Integrated Circuits Selection Guide

Click on images for more information



Small appliances: continued evolution with more electronic content, more sensors, and battery powered

Food preparation: Electric cooker, Food processor, Blender, Coffee Machine

Improving quality of life: Humidifier, Air purifier, Portable vacuum cleaner, Robotic appliances

Small Appliances Spotlight

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