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# Portable and Corded Power Tools

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Appliances



Industrial

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# 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

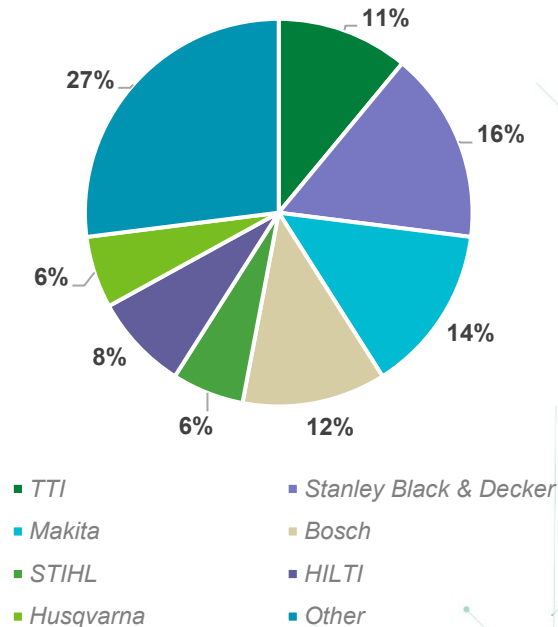
Cordless power tools are currently experiencing rapid growth and represent 50% of all power tool shipments

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

# 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

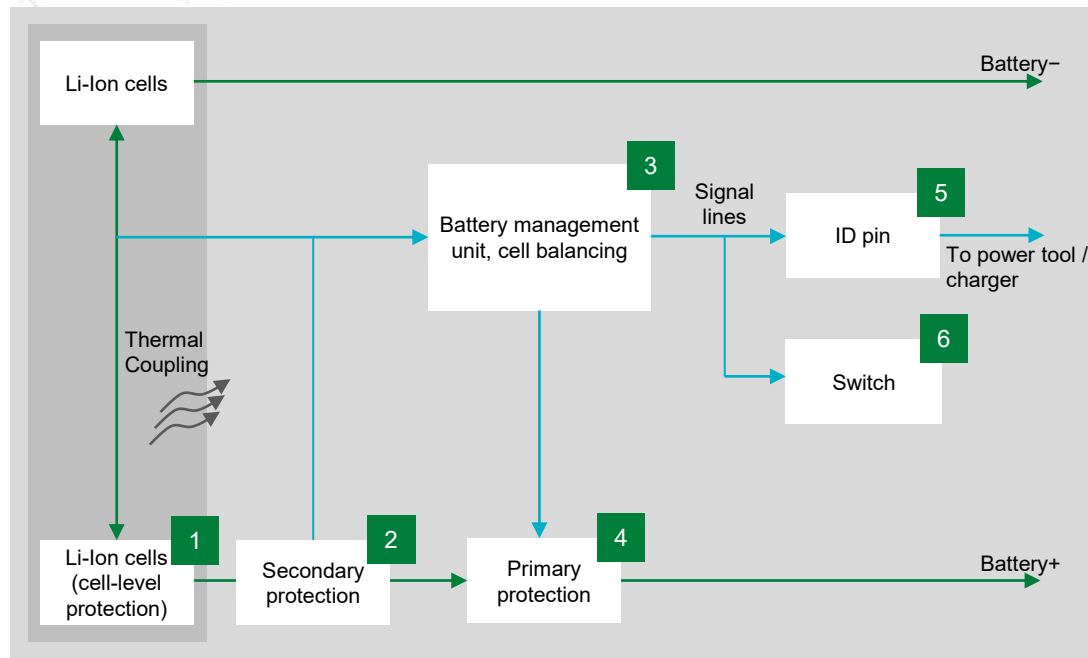
NTC: Negative Temperature Coefficient Device

ESD: Electrostatic Discharge



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

# Cordless tool 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, or overtemperature

	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>
	PPTC OR Fuse	<a href="#">0805L</a> OR <a href="#">458</a>
3	TVS Diode Array	<a href="#">SP1003, SC1006</a>
	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 <b>OR</b> Battery Protector	Non-resettable overcurrent protection	<a href="#">BF1</a> , <a href="#">881</a> , <a href="#">688</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).	<b>OR</b> <a href="#">ITV</a>	Overcurrent and overcharge protection; controlled disconnection, can be activated by BMS	Surface mountable; UL and TUV certified. 3pin device, Controlled fusible element
3	Fuse <b>OR</b> PPTC	Non-resettable protection for BMS MOSFET from high currents due to external shorts	<a href="#">0805L</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	<b>OR</b> <a href="#">458</a>	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:

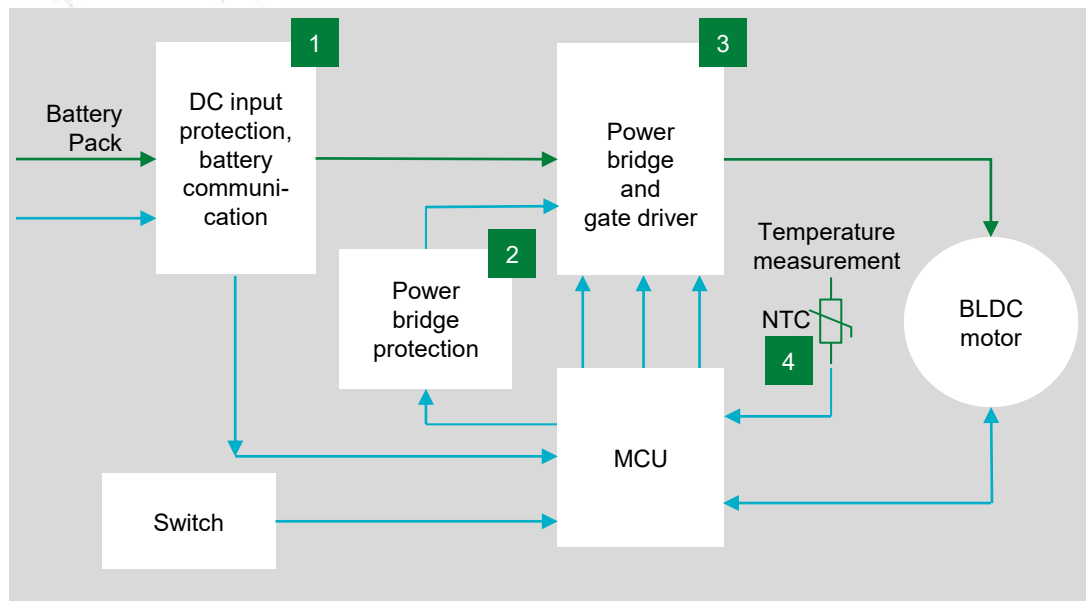
NTC: Negative Temperature Coefficient

TVS: Transient Voltage Suppressor



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

# BLDC motor protection architecture



	Technology	Series
1	Fuse	<a href="#">501</a>
	TVS Diode	<a href="#">SMAJ</a> , <a href="#">SMBJ</a> , <a href="#">5KP</a>
	Reed Switch	<a href="#">MDSR-10</a> , <a href="#">59166</a>
2	NTC	<a href="#">KC</a>
	Digital Temperature Indicator	<a href="#">setP™</a>
3	MOSFET	<a href="#">Gen2</a> / <a href="#">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 <sup>12</sup> 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 <sub>ds(on)</sub> ; 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

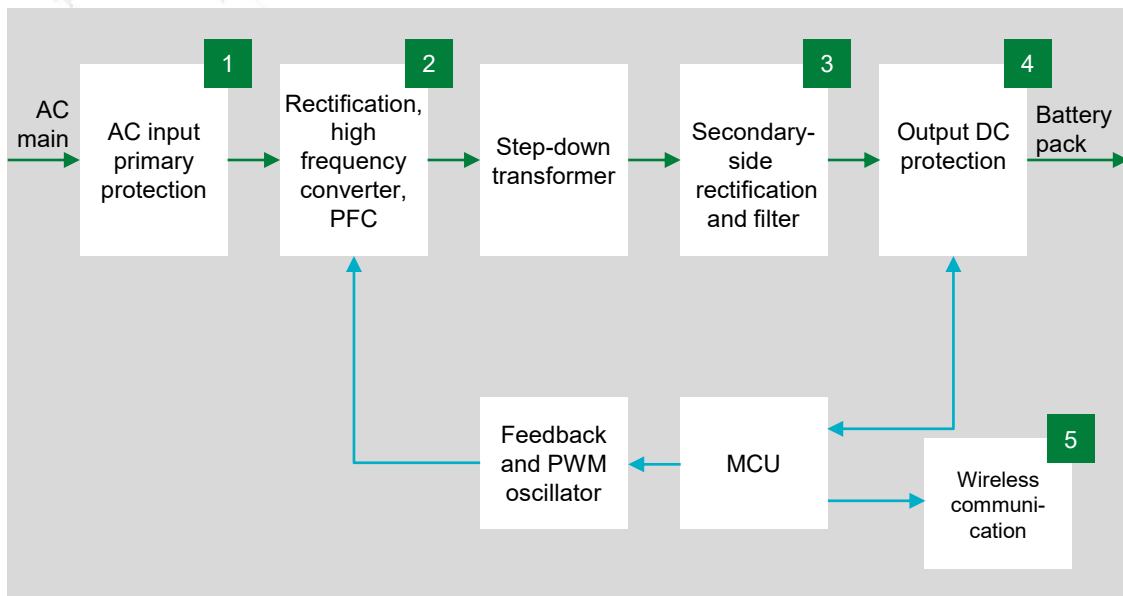
## 5 Wireless communication

- TVS Diode Array



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

# Power tool charger protection architecture



## Legend:



	Technology	Series
1	Fuse	<a href="#">5X20mm Fuse</a> , <a href="#">TR</a> , <a href="#">TE</a>
	MOV	<a href="#">LA</a> , <a href="#">CIII</a> , <a href="#">TMOV</a>
2	MOSFET	<a href="#">X2-class</a>
	TVS Diode	<a href="#">P6KE</a> , <a href="#">P6SMB</a>
3	Schottky Diode	<a href="#">MBR</a> , <a href="#">DST</a>
4	TVS Diode	<a href="#">SMBJ</a>
5	TVS Diode Array	<a href="#">SP3021</a> , <a href="#">SP1007</a>



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="#">IR</a> , <a href="#">IE</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 lightning 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

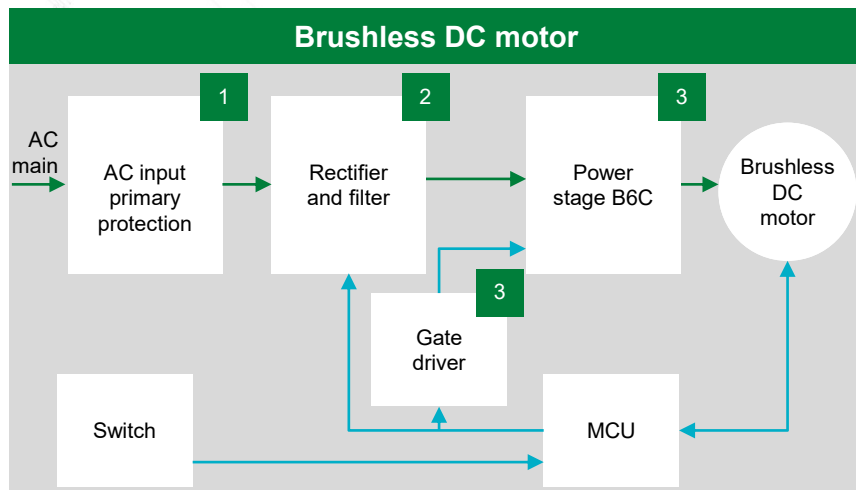


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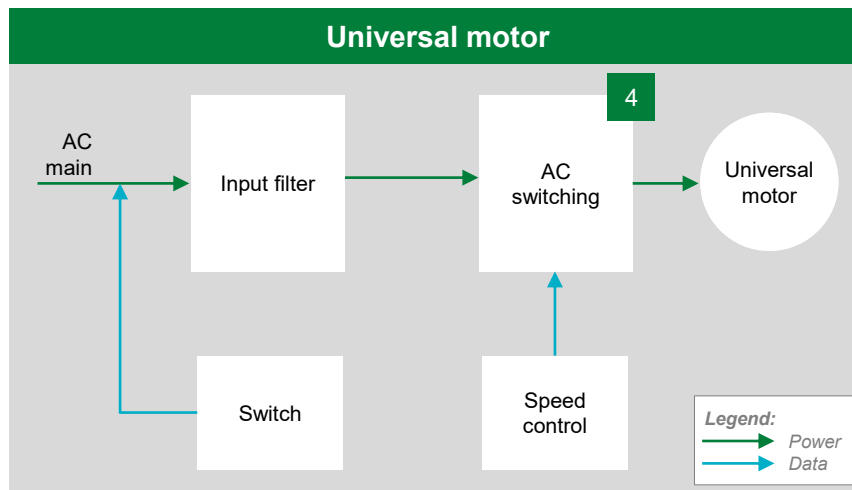


Click on the product series in the table below for more info

# Corded power tool control & protection opportunities



	Technology	Series
1	Fuse	<a href="#">5X20mm Fuse</a> , <a href="#">TR</a> , <a href="#">TE</a>
	MOV	<a href="#">LA</a> , <a href="#">CIII</a> , <a href="#">TMOV</a>
2	NTC	<a href="#">KC</a>
	Rectifier Bridge OR*	<a href="#">GB025-xxN01</a>
	Rectifier Diode SCR	OR* <a href="#">DLA40</a> <a href="#">CLA15</a>



	Technology	Series
3	Gate Driver	<a href="#">LF2103</a>
	IGBT	<a href="#">Gen X3™</a>
	Digital Temperature Indicator	<a href="#">setP™</a>
4	TRIAC	<a href="#">Qxx25xHx</a> , <a href="#">QJxx25kHx</a>



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</a> , <a href="#">IR</a> , <a href="#">IE</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</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	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 <b>OR</b> 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</a> , <a href="#">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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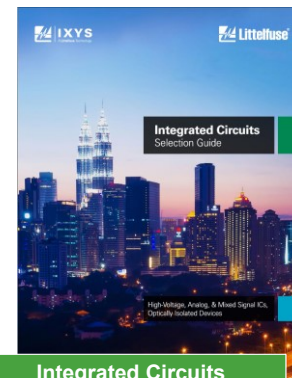
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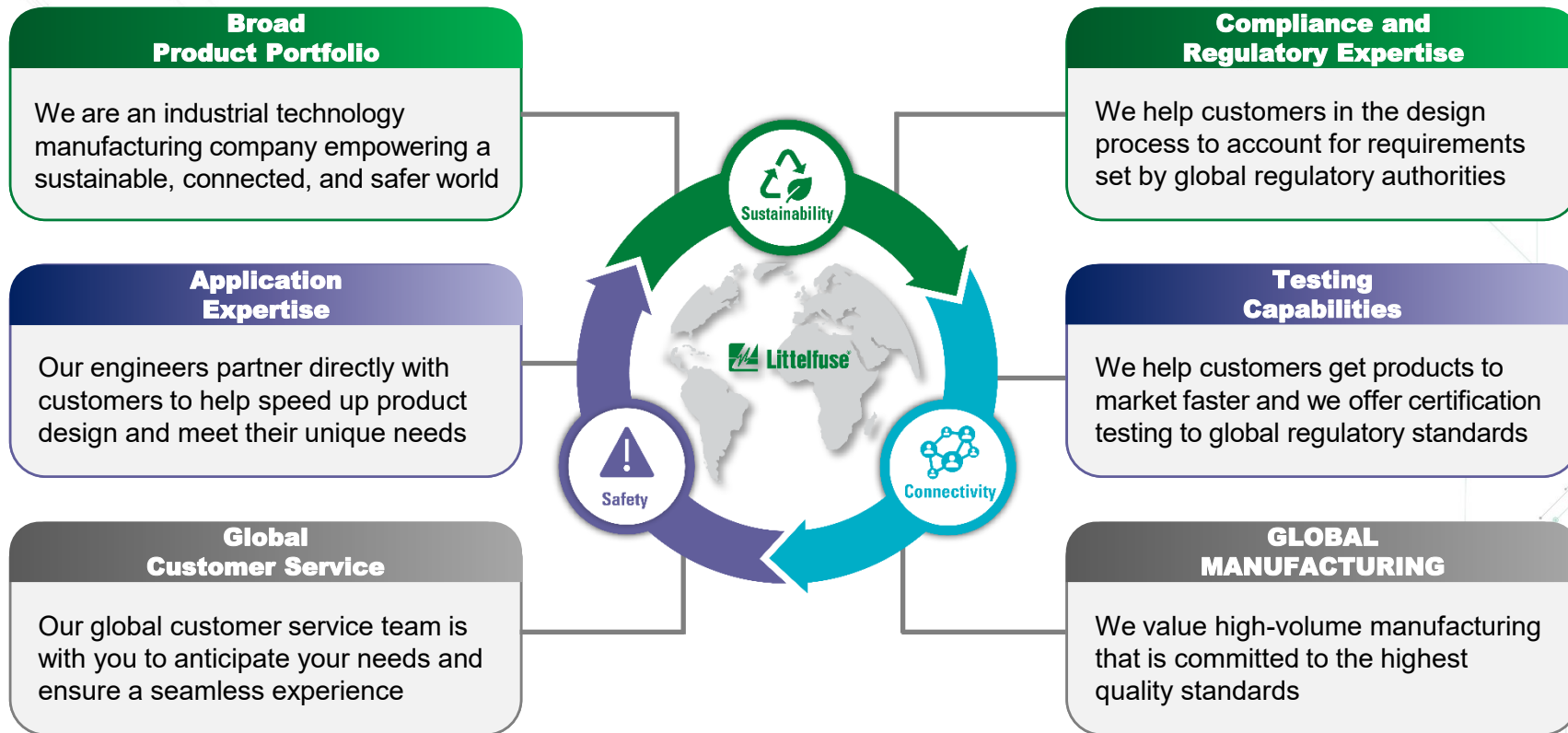
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