






Cordless Power Tools

- Appliances
- General Industrial & Electrical Equipment

Littelfuse®

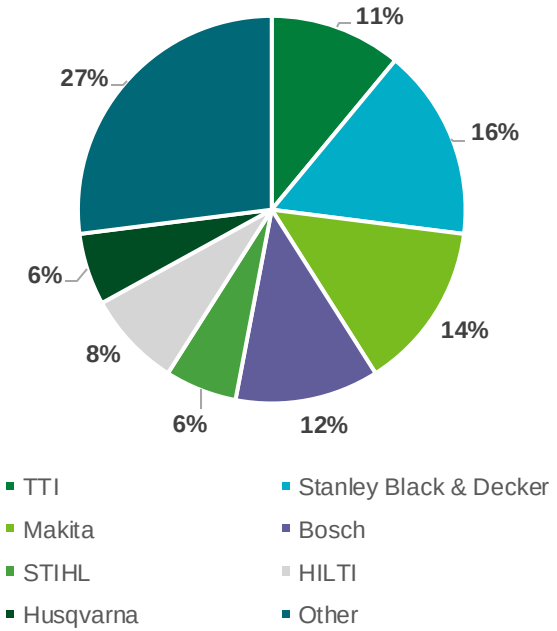
Expertise Applied | Answers Delivered

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 cordless power tools market is projected to grow at a compound annual growth rate (CAGR) of 7.5% from 2024 to 2028.
Cordless power tools dominate the market accounting for more than half of total power tool sales in 2024.
Cordless power tool architecture (i.e., control, battery management, and safety) is very similar across other battery-run devices.
Portable tools are adopting more powerful cells or different form factors. This evolution emphasizes the importance of electronic design and safety in both chargers and battery packs.
Brushless DC motors are preferred for power tools due to better reliability/longevity, smaller size, and improved output performance.

The power tool market is growing at a ~7.5% CAGR



Source: Littelfuse Estimates, Statista, alliedmarketresearch

Battery

Battery packs used in power tools and appliances

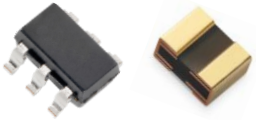
1 Thermal cell protection
TTape™, NTC

2 Secondary protection
Fuse, Battery Protector

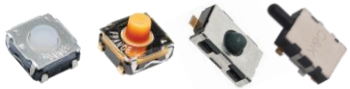
3 Battery management unit
Fuse, PolySwitch® PPTC, Current Sensing Resistors

4 Primary protection
TVS Diode

5 ID communication
TVS Diode Array, PolySwitch® PPTC

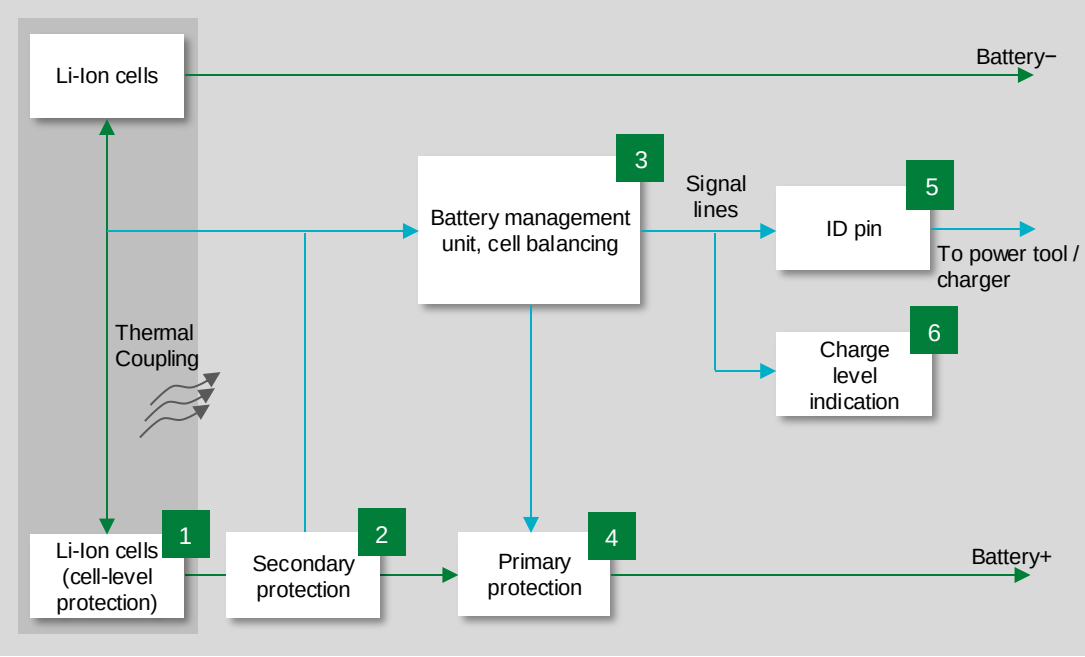


6 Charge level indication
Tactile, Detect



Click the product series in the table below for more info

Cordless tool battery pack block diagram



- ***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	TTape™ Platform	TTP
	NTC	KC
2	Fuse ***OR*** Battery Protector	BF1, 871 ***OR*** ITV
3	PolySwitch® PPTC ***OR*** Fuse	0805L ***OR*** 438
	Current Sensing Resistor	SSA
4	TVS Diode	SMF, SMF4L
5	PolySwitch® PPTC	zeptoSMDC
	TVS Diode Array	SP3021, SP1007
6	Tactile Switch	KSC441J, PTS645V, KSC2, KSC DCT

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Click the product series in the table below for more info

Typical products for tools & appliances battery packs

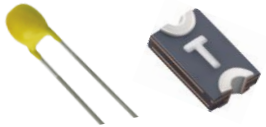
	Technology	Function in Application	Series	Benefits	Features
1	TTape™ Platform	Managing battery lifetime and helping identify hazardous temperature levels	TTP	Simple integration with existing BMS architectures + enables enhanced BMS control systems	Trip temperature of 58±3 °C, up to 50 sensing points on one string; enable BMS wakeup and single GPIO port usage
	NTC	Analog temperature monitoring 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, 871 ***OR*** ITV	Space saving solutions. SMD-type fuses improve reliability in environments with significant mechanical vibrations	supports higher power requirements with a single fuse design; current ratings up to 200 A
		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; 3-pin device; controlled fusible element
3	Fuse ***OR*** PolySwitch® PPTC	Non-resettable protection for BMS from high currents due to external shorts	438 ***OR*** 0805L	Saves board space; excellent temperature stability and performance reliability; high I^2t values ensures high inrush current withstand capability	Operating temperature from -55 ºC to +150 ºC,
		Resettable protection for BMS from high currents due to external shorts		SMD form-factor allows for compact design, resets after fault clearance	Surface mountable; compatible with lead-free solder processes per IEC standards;
	Current Sensing Resistor	Part of current measurement circuitry	SSA	Cost-effective solution compared to competing technologies; compact size;	Tolerance down to 1%; high power ratings, up to 15 W
4	TVS Diode	Protects battery packs from overvoltage conditions due to abnormal charging conditions	SMF, SMF4L	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
5	PolySwitch® PPTC	Overcurrent protection for TVS or Zener Diode	zeptoSMDC	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 I^2C input	SP3021, SP1007	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	KSC441J, PTS645V, KSC2, KSC DCT	Saves space; reliable and repeatable haptic performance elevates end users' experience	Microminiature, short travel, PCB mount tactile with a minimum of 100K operations

Cordless tool

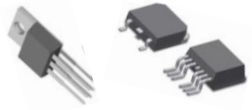
Key elements of cordless power tool

1 DC input protection
Fuse, TVS Diode, Reed Switch

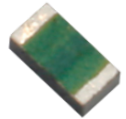
2 Power bridge protection
NTC, setP™



3 Power Bridge and Gate Driver
MOSFET



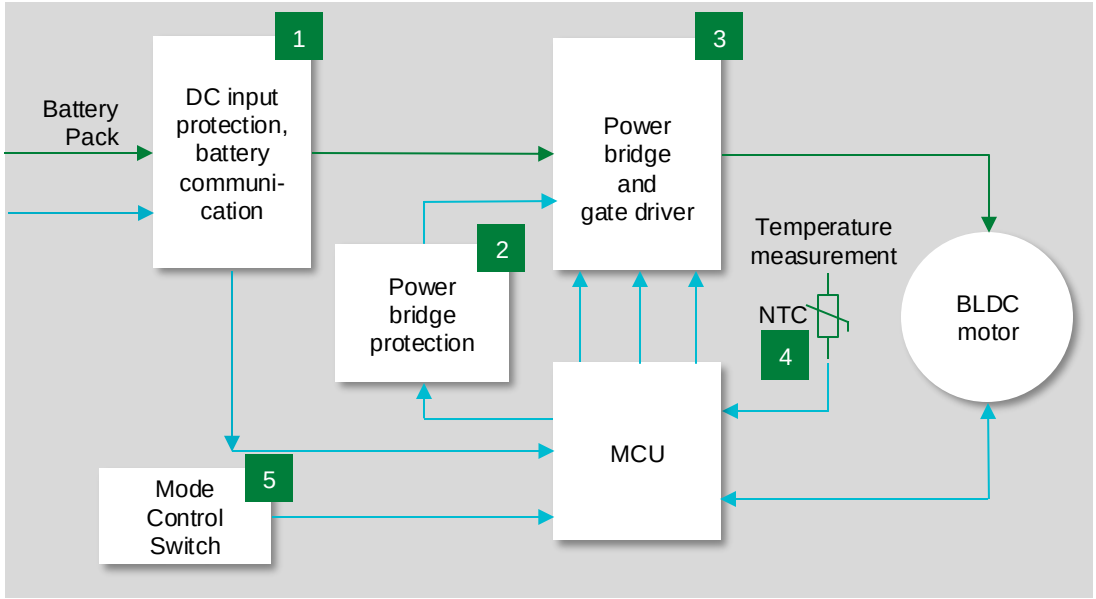
4 Temperature protection
NTC



5 Mode Control Switch
Tactile, Snap-Acting, Slide

Click the product series in the table below for more info

BLDC motor protection architecture



	Technology	Series
1	Fuse	501
	TVS Diode	SMAJ, SMBJ, 5KP
	Reed Switch	MDSR-10, 59166
2	NTC	KC
	Digital Temperature Indicator	setP™
3	MOSFET	Gen2 / Gen4
4	NTC	RB
5	Snap Acting	LCS, TF, TM, ZMS, ZMA
	Tactile Switch	KSC OF, KSC2, KSC3, KSC4, KSC7
	Slide Switch	OS, JS, L, AYZ

Click the product series in the table below for more info

Select Littelfuse products for BLDC motor protection

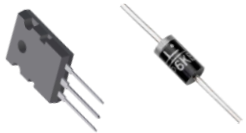
	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects the battery and downstream controller from damage due to inrush current, motor shorting or external shorts at contacts	501	Provides quick protection for circuits with minimal space requirements and reduces risk of damage from short circuits	Third-party compliance with 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 the motor on or off	MDSR-10, 59166	Contamination resistant, compact design	Switch up to 200 VDC or 0.5 A at up to 10 W; 10^{12} Ohms insulation resistance
2	NTC	Temperature sensing 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	FET overheating indication	setP™	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	Gen2 / Gen4 (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	RB	Provides accurate temperature (component/ ambient) for enabling safe device operation	High reliability; small form factor; fast thermal response
5	Snap Acting ***OR*** Tactile Switch	Actuation of the device (on/off control)	LCS, TF, TM, ZMS, ZMA	Reliable snap-acting mechanism ensures consistent performance; wide variety of actuator and terminal styles available	Reliable Snap-Acting mechanism; compact size; IP67 rating (ZMS)
			KSC OF, KSC2, KSC3, KSC4, KSC7	Long electrical and mechanical life; reliable snap-acting mechanism ensures consistent performance, making these switches suitable for critical applications	Are IP67 rated; ensuring protection against dust and water; wide variety of actuator and terminal styles
	Slide Switch	Mode control	OS, JS, L, AYZ	Reliable performance in high-vibration and high-load scenarios	Miniature and compact designs for space-saving applications; surface-mount options for modern PCB integration

Charger

Functional elements in power tool charger

1 AC input primary protection
Fuse, MOV, NTC

2 Rectification, high frequency converter
MOSFET, TVS Diode



3 Secondary side rectification
Schottky Diode

4 DC output protection
TVS Diode

5 Wireless communication
TVS Diode Array

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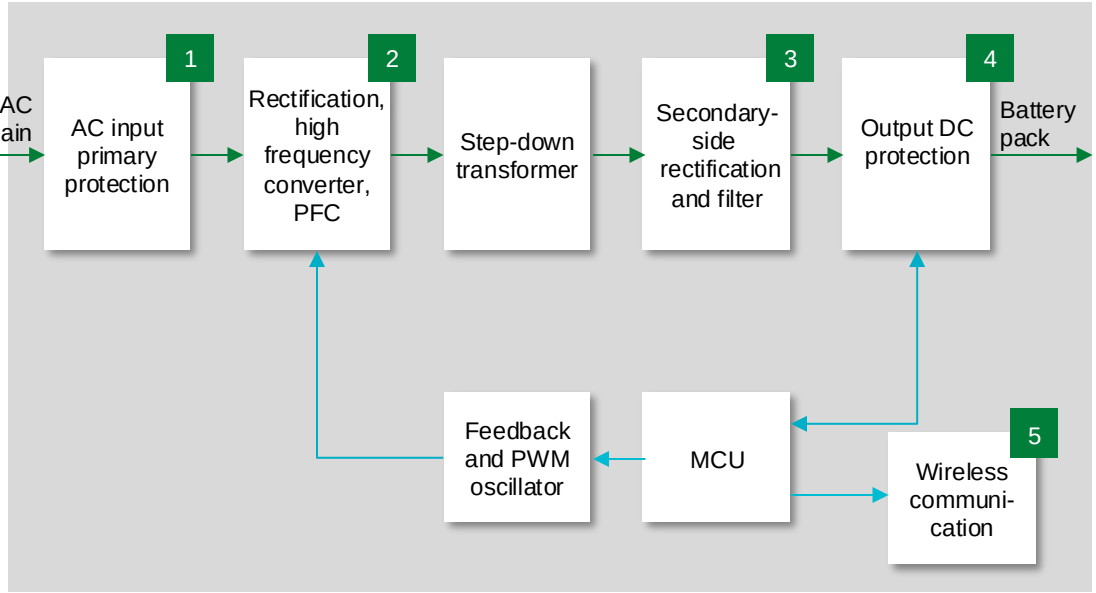
Click the product series in the table below for more info

Power tool charger protection architecture



	Technology	Series
1	Fuse	5X20mm Fuse, TR, TE
	MOV	Xtreme, TMOV
2	MOSFET	X2-class
	TVS Diode	P6KE, P6SMB
3	Schottky Diode	MBR, DST
4	TVS Diode	SMBJ
5	TVS Diode Array	SP3021, SP1007

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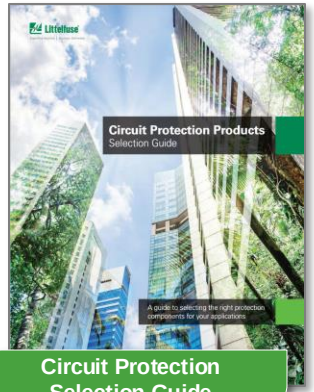
Click the product series in the table below for more info

Potential Littelfuse products for power tool charger

	Technology	Function in Application	Series	Benefits	Features
1	Fuse	Protects the power stage from overcurrent	5X20mm Fuse, TR, TE	Offers durability, saves space, and ensures safety from high fault currents	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	Xtreme, TMOV	Provides quick protection against voltage spikes, handles high energy surges, and is easy to install in various designs	Thermally protected (TMOV); best in class high energy absorption with compact size
2	MOSFET	High switching speed in power supply units	X2-class	Fast response time and lower heat signature	Low $R_{ds(on)}$, dv/dt ruggedness
	TVS Diode	Protects the 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
4	TVS Diode	Surge protection	SMBJ	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
5	TVS Diode Array	ESD protection of wireless communication	SP3021, SP1007	Small, space-saving design; low capacitance to prevent signal disruption	µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage

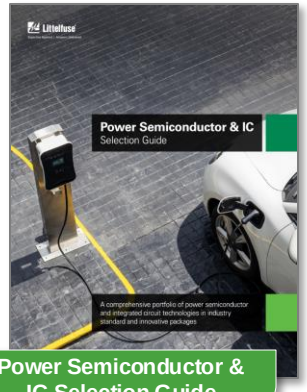
Additional information can be found at Littelfuse.com

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

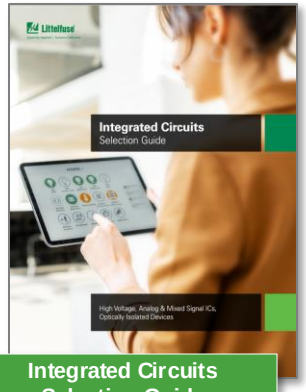


Circuit Protection Selection Guide

Sensor Selection Guide



Power Semiconductor & IC Selection Guide



Integrated Circuits Selection Guide

Click on images for more information

Small Appliances Spotlight

Scan the code to learn more!

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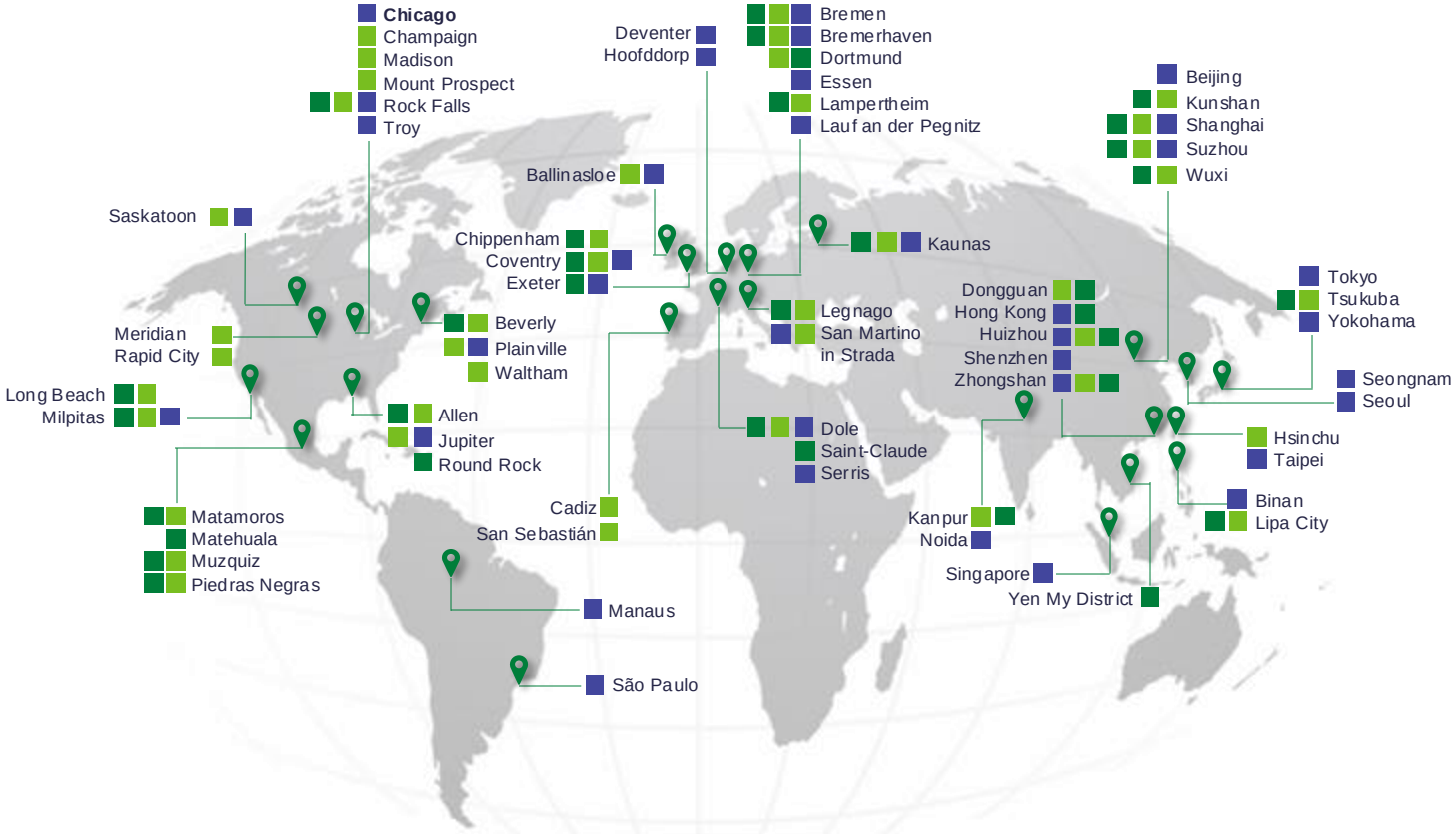
Local resources supporting our global customers



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

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We help customers get products to market faster, and we offer certification testing to 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

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

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

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Supplementary slides

Milwaukee 108 W battery charger

Milwaukee 108 W Battery Charger

Model number & specification	
Name	Milwaukee Dual Bay Rapid Charger
Model Number	M18™ (2020)
Description	Dual battery charger
Specifications	Input: 120–127 VAC, 5.5 A Output: 18 VDC, 6 ADC
Other manufacturers of similar products	Stanley Black & Decker, Bosch, Ryobi, Dewalt
Littelfuse opportunities	Fuse: 804, 392, 251, 253; MOV: V175LA5P; Schottky Diode: DSTF40150C; TVS Diode: 1.5KE250A

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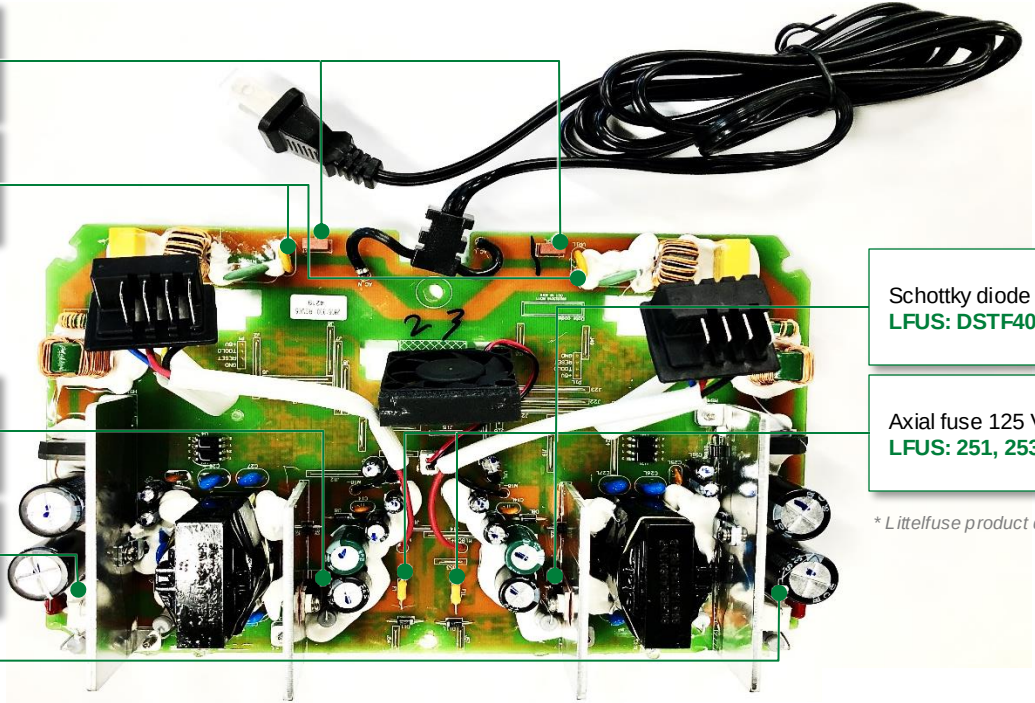
Milwaukee 108 W charger: MOV, fuse opportunities

Axial fuse 250 V, 5 A
LFUS: 804, 392

MOV 10 mm 175 V_{RMS}
LFUS: V175LA5P

Schottky diode 150 V_{RWM}, 40 A
LFUS: DSTF40150C

TVS diode 214 V_R
LFUS: 1.5KE250A



Schottky diode 150 V_{RWM}, 40 A
LFUS: DSTF40150C

Axial fuse 125 Vdc, 10 A
LFUS: 251, 253

** Littelfuse product description in the next slide*

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

Milwaukee 108 W charger: MOV, Fuse opportunities

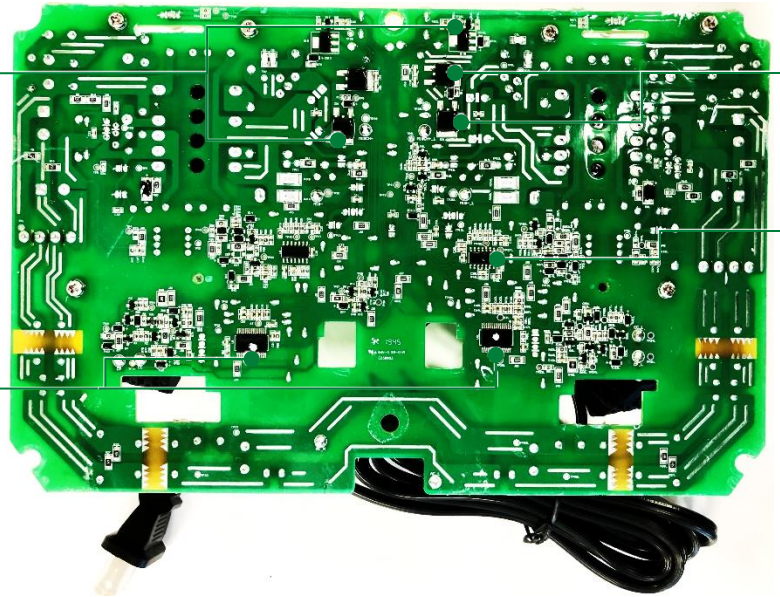
Technology	Function in application	Series	Benefits	Features
Fuse	Protects the input power stage from overcurrent events	804, 392	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	Third-party compliance with UL/IEC; low internal resistance; shock-safe; vibration-resistant
MOV	Protects the power unit from voltage surges such as lighting and transients	V175LA5P	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	High energy absorption capability: 40–530 J (2 ms)
Schottky Diode	Rectification and blocking in power supply units	DSTF40150C	Enables the design of high-efficiency power supplies	Ultra-low forward voltage drop, high frequency operation
TVS Diode	Protects the power unit from voltage transients	1.5KE250A	Improves system reliability by protecting downstream components from transients on power lines	Energy absorption capability (WTM) up to 360J; wide operating voltage range: $V_{M(AC)RMS}$ 130 to 1000 V
Fuse	Front-end protection from external shorts	251, 253	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	Very fast-acting; small form factor; wide current rating range

Milwaukee battery charger control board: rear side

P-Channel MOSFET 60 V, 3 A

P-Channel MOSFET 40 V, 60 A

PWM controller



P-Channel MOSFET 40 V, 60 A

Quad Op-Amp

Bosch cordless power drill 18 V, 1.5 Ah (27.0 Wh)

Bosch 18V Cordless Power Drill

Model number & specification	
Name	Bosch 18 V cordless power drill teardown
Model Number	DDB181 360JB7310
Description	Bosch 18 V, 1.5 Ah cordless power drill with two-speed transmission–one optimized for high-torque driving and one for high-speed drilling. This is handy for overhead applications, with its short head-length and a weight of only 2.80 lbs. (tool only, not including battery).
Specifications	Battery Chemistry: Lithium-ion Battery Voltage (V): 18 V No Load RPM: 0-450 / 0-1, 700 Torque (in. lbs.): 480 Weight: 2.8 lb Dimension: 7.8 X 3 X 8.8 inches Works With: Dust Extraction / Collection Hood
Other manufacturers of similar products	DeWalt, Milwaukee, Black & Decker, Makita, Hitachi, Ryobi
Littelfuse opportunities	Fuse: 804, 392, 251, 253; Schottky Diode: DSTF40150C; TVS Diode: 1.5KE250A; MOSFET X2-class

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

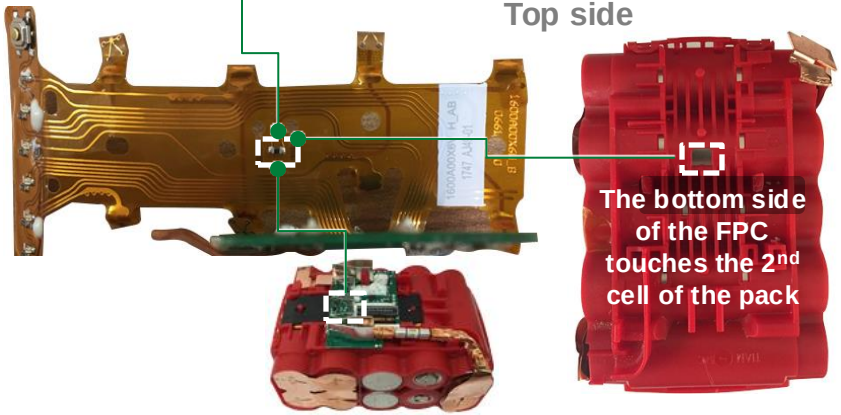
Bosch Core: 18 V / 6.3 Ah, 113 Wh

Cartridge Fuse 5 mm X 15 mm
Make: Littelfuse Inc.
LFUS: 2AG

Li-ion rechargeable 20700 Cell
3.6 V / 3.15 Ah, 5S2P configuration

SMD NTC 0603 6.7 KΩ
Make: Littelfuse Inc.
LFUS: RB

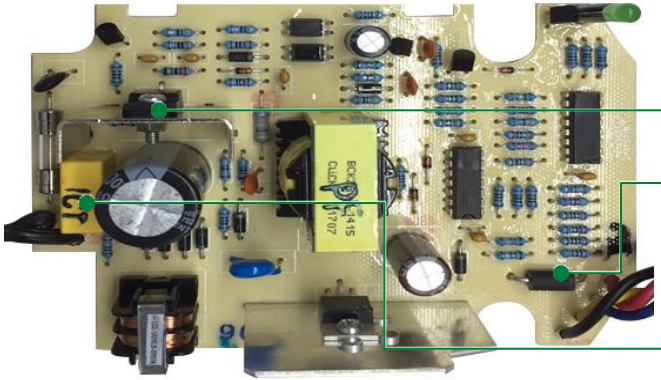
Top side



Technology	Function in application	Series	Benefits	Features
Fuse	Protects cells from high currents due to external shorts	2AG	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	Third-party compliance UL/IEC; Fast-Acting / Slo-Blo® (Time-Lag)
NTC	Temperature sensing	RB	Saves board space	Surface mountable, small size; low cost

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

Bosch charger teardown



N-Channel MOSFET (500 V / 4.4 A)
LFUS: X2-class

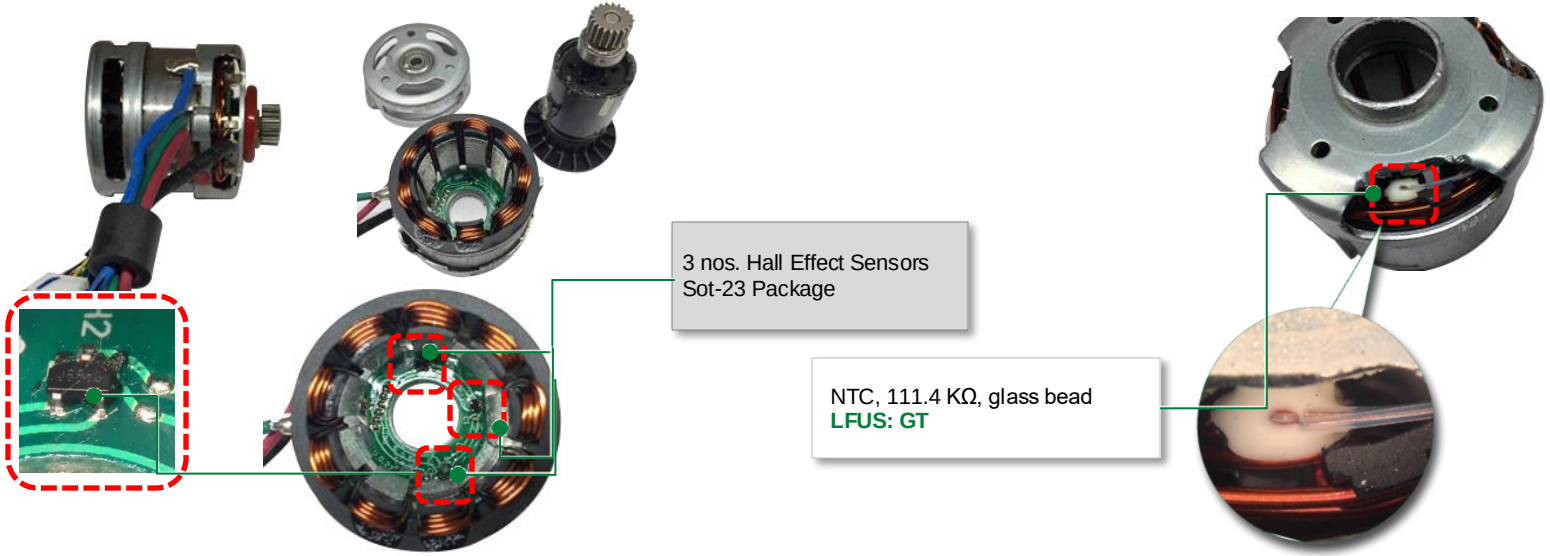
Schottky Rectifier Diode (40 V / 5 A)
LFUS: DST1040S

Fuse 5 X 20 mm, (25 V / 2.5 A)
Make: Littelfuse Inc.
LFUS: 213 Series

Technology	Function in application	Series	Benefits	Features
Fuse	Protects the power stage from overcurrent	213	Reduces customer qualification time by complying with third-party safety standards	Third-party compliance with UL/IEC; low internal resistance; shock-safe; vibration-resistant
Schottky Diode	Rectification and blocking in power supply units	DST1040S	Enables the design of high-efficiency power supplies	Ultra-low forward voltage drop; high-frequency operation
MOSFET	High switching speed in power supply units	X2-class	Fast response time and low heat signature	Low $R_{ds(on)}$, dv/dt ruggedness

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

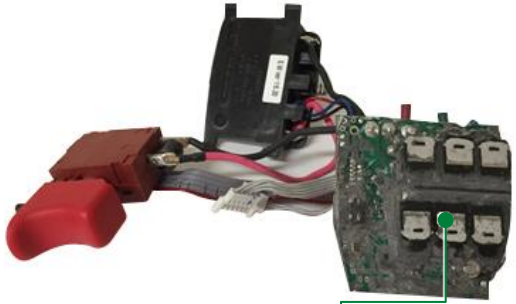
Bosch 18 V cordless drill with brushless motor



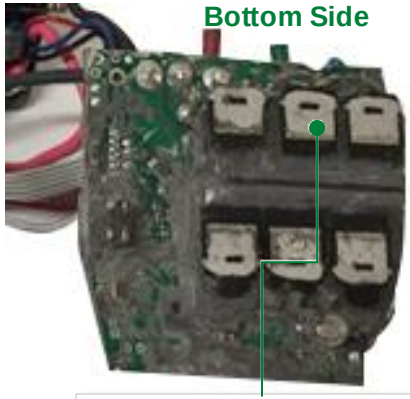
Technology	Function in application	Littelfuse Series	Benefits	Features
NTC	Temperature sensing to prevent motor damage due to overheating	GT	Provides accurate temperature (component/ambient) for enabling safe device operation	High stability; fast thermal response time

Bosch 18 V cordless drill *hammer* teardown: heavy epoxy coating

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



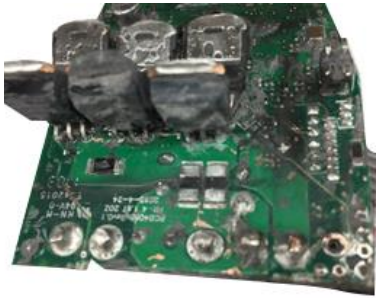
6 nos. power single N-channel HexFET



Bottom Side

N channel MOSFET, 40 V / 226 A
LFUS: Gen 4

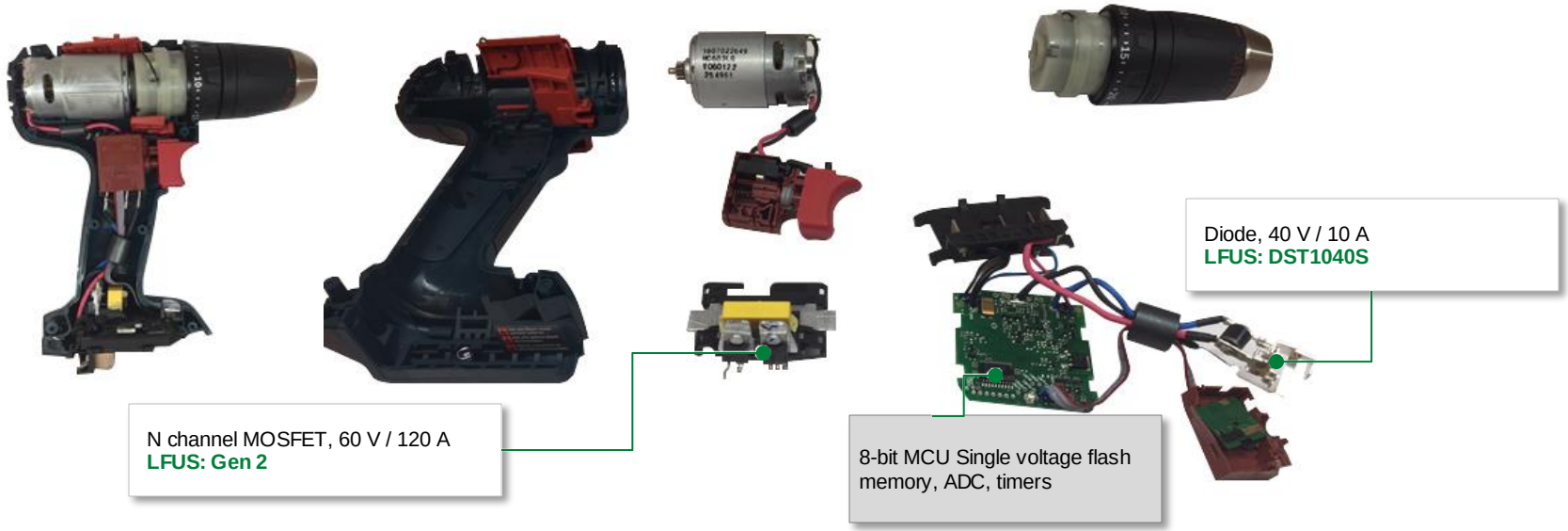
Top Side



Technology	Function in application	Littelfuse Series	Benefits	Features
MOSFET	Part of inverter of brushless DC motor for high frequency switching	Gen 4	Improves system efficiency and enables compact design	Very low $R_{ds(on)}$; high current capability

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

Bosch 18 V cordless *drill* teardown



Technology	Function in application	Littelfuse Series	Benefits	Features
MOSFET	Part of the inverter of the brushless DC motor for high-frequency switching	Gen2	Improves system efficiency and enables compact design	Very low $R_{ds(on)}$; high current capability
Schottky Diode	Protection of the DC motor from reverse polarity	DST1040S	Enables the design of high-efficiency power supplies	Ultra-low forward voltage drop; high-frequency operation

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