







Lithium Battery Pack Protection and Control

- Appliances
- Energy Storage

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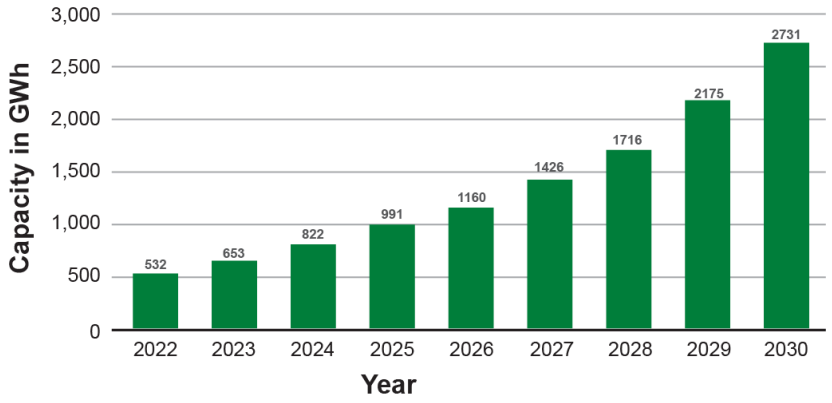
Lithium batteries market statistics and drivers

Market trends and drivers
Safety and ageing concerns in Lithium battery applications highlight the critical need for advanced protection and control solutions in the market.
adoption of electric vehicles, both in the automotive and e-mobility sectors, is driving the demand for high-performance lithium battery solutions.
Lithium batteries are widely used in energy storage applications, from residential to grid-scale systems. With the growing emphasis on renewable energy sources and the need for reliable energy storage.
Increasing environmental regulations and a growing focus on sustainability are pushing manufacturers to develop more energy-efficient and eco-friendly battery solutions.

Estimated capacity of Lithium batteries growing at a ~28% CAGR (in gigawatt hours)



Source: Statista

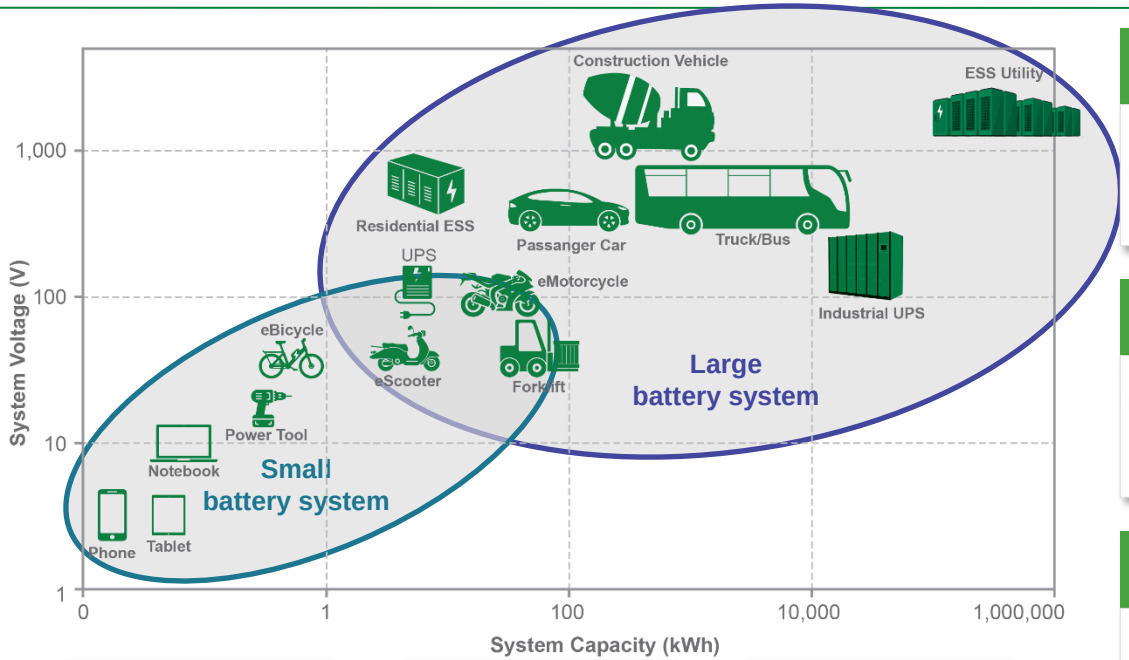
Littelfuse offers solutions for every battery system

Smart phones ➔ large eMobility batteries ➔ utility-grade systems

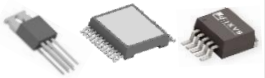
Overcurrent Protection
Fuse, PPTC, Battery Protector, Battery Mini-breaker

Overvoltage Protection
MOV, SPD, SIDACtor®, TVS Diode

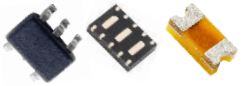
Sense Line Protection
Fuse, TVS Diode



Power Control
MOSFET/IGBT, Power Module, Gate Driver



ESD Protection
TVS Diode, TVS Diode Array, Polymer ESD



Sensing Solution
Magnetic Sensor, Temperature Sensor, TTape*

** Contact sales for details*

Isolation Monitoring
Solid State Relay, Reed Relay

Battery Disconnect
DC Disconnect Switch, HVDC Contactor Relay

Ground Fault and Arc-flash protection
Ground Fault Relay, Arc-flash Relay

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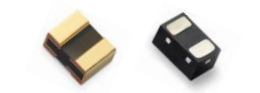
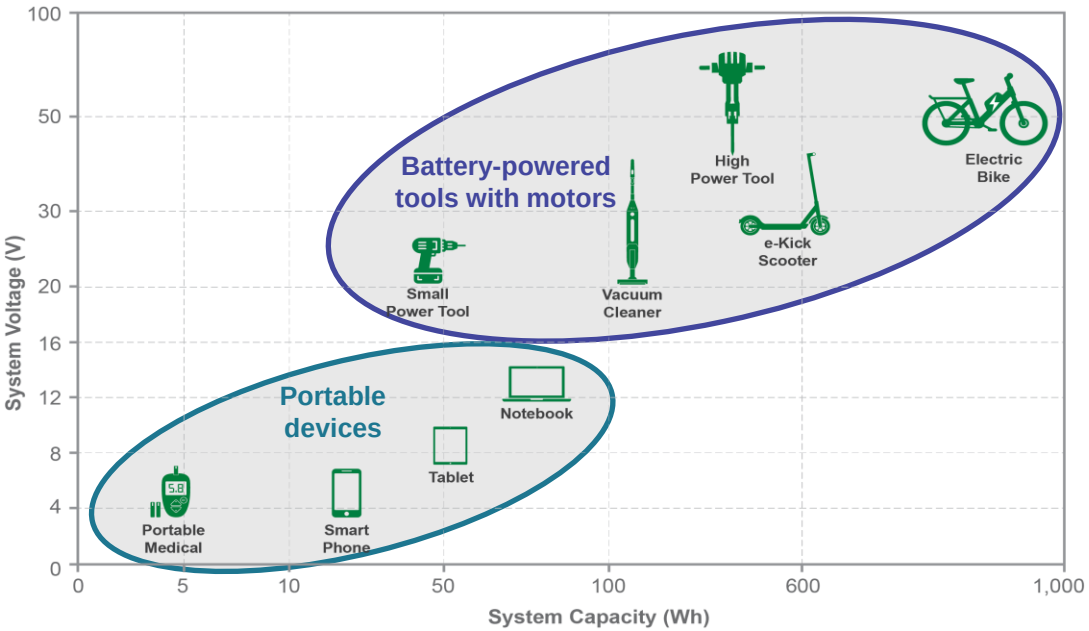
Small battery system application map

Cell-level Protection
PPTC, Battery Strap, Battery Mini-breaker

Secondary Protection (Battery-pack Level)
Fuse, Battery Protector, TVS Diode

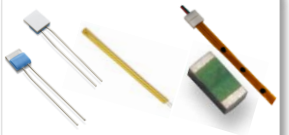
Signal Line Protection
PPTC, TVS Diode Array





USB Port Protection
eFuse, Temperature Indicator, PPTC, TVS Diode Array

Temperature Sensing
NTC, RTD, TTape



Battery Status Indicator
Tactile Switch

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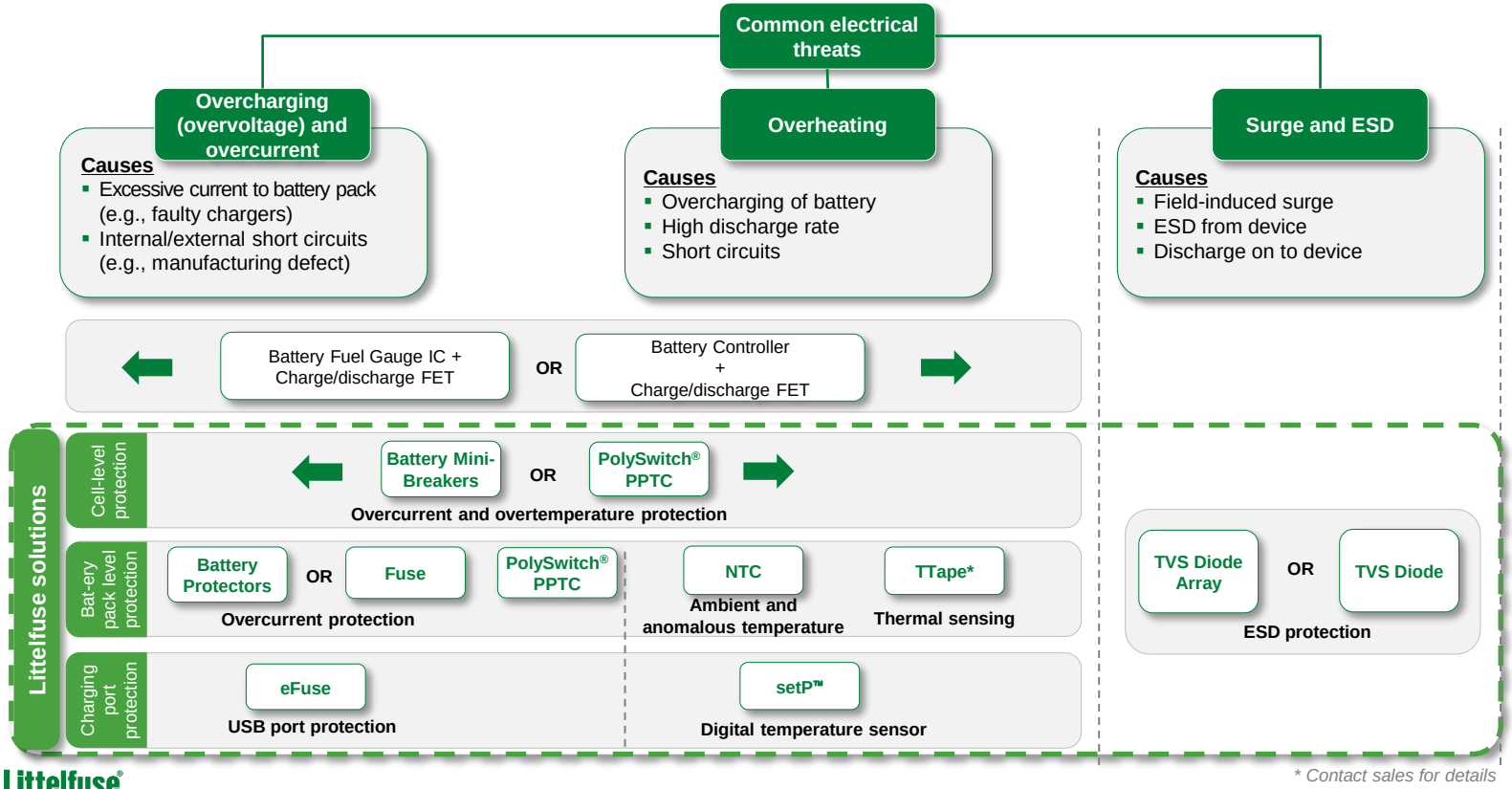
Common hazards related to Lithium battery systems



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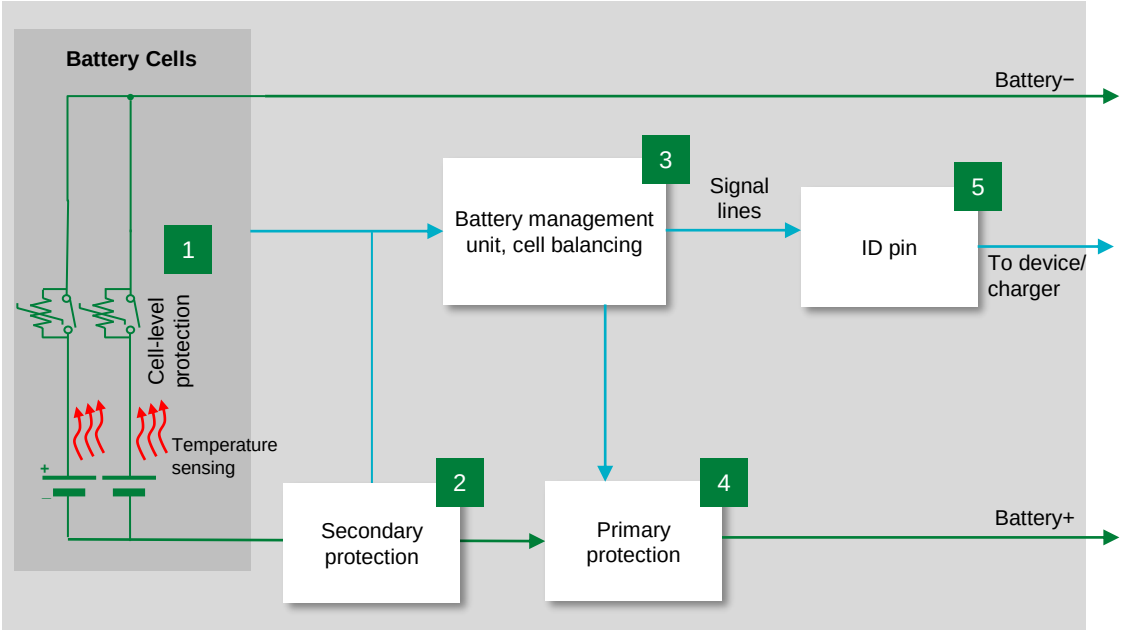
Click the product series in the table below for more info

Battery pack system architecture: small up to 60 V



Legend:
- Power
- Data

- ***Secondary protection:*** *Protects cells if 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
	TTape™	TTP
	PPTC ***OR*** MHP	LSP ***OR*** MHP-TAT18
2	Fuse ***OR*** Battery Protector	881, 688 ***OR*** ITV
3	PPTC ***OR*** Fuse	0805L ***OR*** 458
	TVS Diode Array	SP1003, SC1006
	Current Sensing Resistor	L4CL
4	TVS Diode Array	SMF, SMF4L
5	TVS Diode Array	SP3021, SP1007
	PPTC	zeptoSMDC

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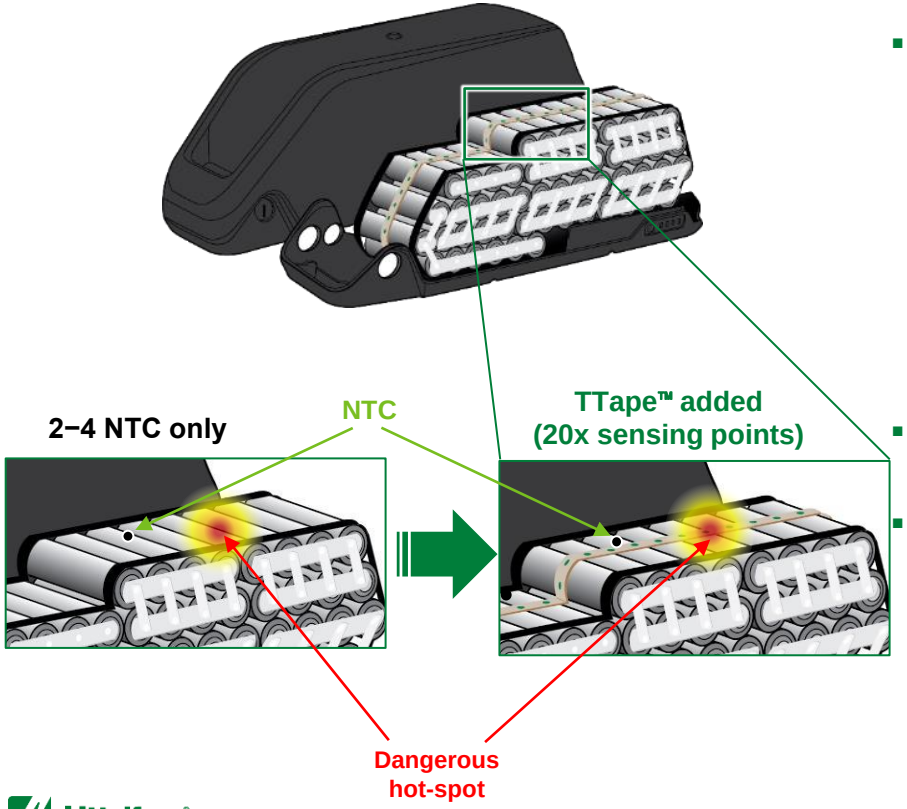
Click the product series in the table below for more info

Features and benefits of Littelfuse products

	Technology	Function in application	Product series	Benefits	Features
1	NTC	Analog temperature monitoring to facilitate functional control of batteries	KC	Provides accurate temperature readings to enable safe device operation	Insulated lead wires; small form factor; fast thermal response
	TTape™	Temperature digital monitoring	TTP	Multiple monitoring points with single devise; easy installation; wake-up function	Trip temperature of 58±3, up to 50 sensing points on one string
	PPTC ***OR*** MHP	Cell-level protection; overtemperature and overcurrent protection at the cell level	LSP ***OR*** MHP-TAT18	Low resistance to maximize battery life. Suitable for automotive applications (AEC-Q200 qualified)	Compact, space-saving size; holds a current of up to 5.5 A; RoHs-compliant
				Allows for ultra-thin battery pack designs; enhances battery safety in mobile devices; provides resettable protection, ensuring device longevity	9VDC rating and high current capacity; multiple activation temperatures; UL-, CSA-, and IEC-evaluated
2	Fuse ***OR*** Battery Protector	Non-resettable overcurrent protection	881, 688 ***OR*** ITV	Reduces customer qualification time in compliance with third-party safety standards such as UL/IEC	Third-party compliance with UL/IEC, low internal resistance; shock-safe; vibration-resistant
		Non-resettable overcurrent and overcharge protection (activated on demand)		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	Non-resettable protection for BMS MOSFET from high currents due to external shorts	0805L ***OR*** 458	Saves space with a smaller footprint	Surface-mountable; UL- and TUV-certified; three-pin device; controlled fusible element
				Reduces customer qualification time in compliance 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 as per IEC standards; PPTC 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
	Current Sensing Resistor	Part of current measurement circuitry	L4CL	Excellent performance in terms of accuracy, noise performance, and surface heat distribution ; has a lower surface temperature	Tolerance down to 0.3%; separate voltage-sensing terminals
4	TVS Diode Array	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	Low profile with a maximum height of 1 mm; low leakage of 1.0 µA
5	PPTC	Overcurrent protection for TVS or Zener diodes	SP3021, SP1007	Resets to normal operation after fault is cleared; saves space with a smaller footprint	Maximum electrical rating: 13 VDC; short circuit current: 82 ~ 200 mA; small footprint 0201 size
	TVS Diode Array	ESD protection of I2C input	zeptoSMDC	Small, space-saving design prevents signal disruption with low capacitance	µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage

Digital temperature
monitoring for battery systems
(TTape™)

TTape™: overtemperature detection at each cell



- Extends serviceable **life** of battery packs and adds **safety**
  - **Increase resolution** of temperature monitoring areas
  - Monitors many cells/large areas using a **single** TTape device, thus saving processing power
  - Can **wake** BMS in-case of overtemperature
  - **Ultra-fast responses for quicker alerts**
- **No calibration** + suitable for **simple** integration with BMS
- **Conformal** + **ultra-thin** (≤ 500 µm) for **easy installation**

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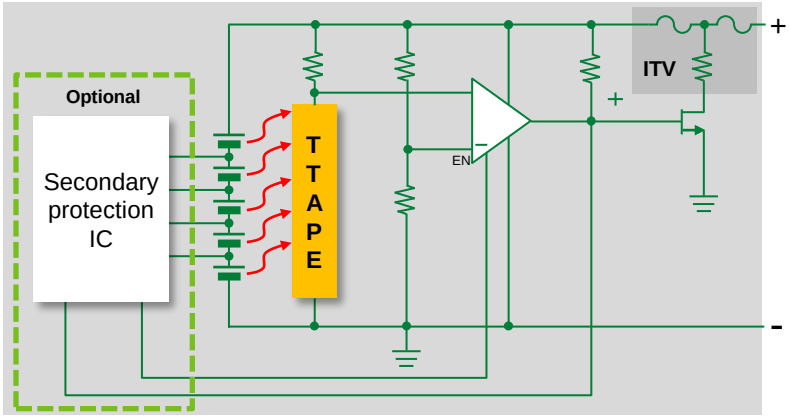
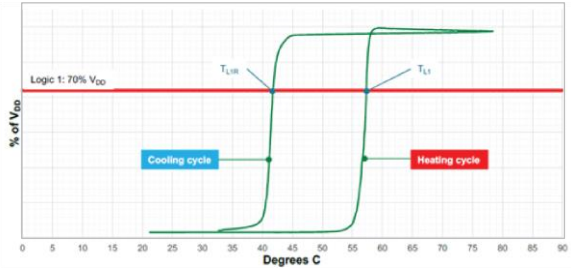
TTape™ platform and ITV: Enhanced monitoring for Alkaline and Lithium batteries



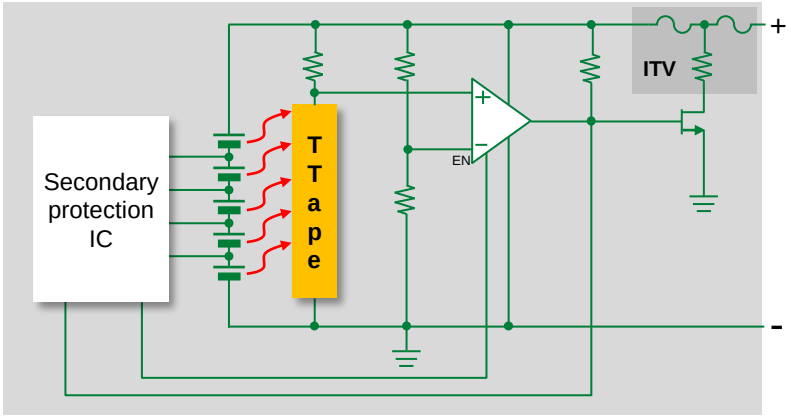
- ***ITV** – Three-terminal fuse. Third heater terminal activated by IC or TTape™ device*

V_T Output



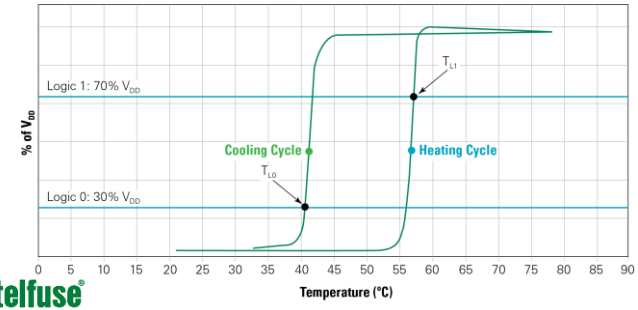
- **Redundant thermal protection:** Works independently with TTape™ for added safety, ensuring overtemperature triggers prompt response
- **Heat detection with the TTape™ platform:** Sensors next to cells detect and signal high temperatures via MOSFET activation
- **Safety-driven circuit break:** TTape™ activates ITV with MOSFET to sever cell connections during overtemperature events, thus averting damage
  - Can be combined with a BMS IC as a secondary protection
  - Open drain outputs from comparator and BMS ICs can be combined using a wired OR gate, therefore reusing the same transistor.
  - BMS may disable the TTape™ triggering if it has already taken action to mitigate issues
- **Enhanced cell monitoring:** The connection of the TTape™ device to each battery cell allows for increased resolution of monitoring points, ensuring quick responses

TTape™ platform and ITV: Enhanced monitoring for Lithium batteries



**ITV* – *Three-terminal fuse. Third heater terminal activated by IC or TTape™ device*
EN *– Comperator Enable pin*

Temperature Indication Characteristics



- **Redundand thermal protection:** Independent operation with TTape™ for quick overheating response.
- **If excessive heat is detected :** TTape™ activates ITV with MOSFET to sever cell connection during overtemperature events, thus averting damage
  - Open drain outputs from comparator and BMS ICs can be combined using a wired OR gate, therefore reusing the same transistor.
  - BMS disable the TTape™ triggering if it has already taken action to mitigate issues
  - Alternatively TTape™ could be connected to protection IC (in this case Comparator is not needed)

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**V_{DD}– Voltage supply to the drain*

Additional information can be found at Littelfuse.com

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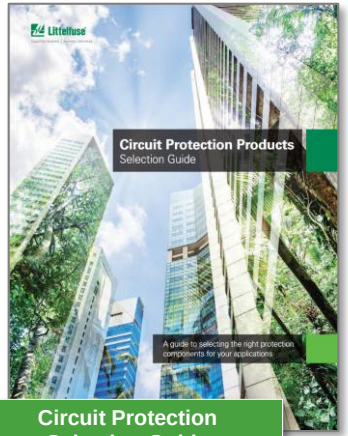
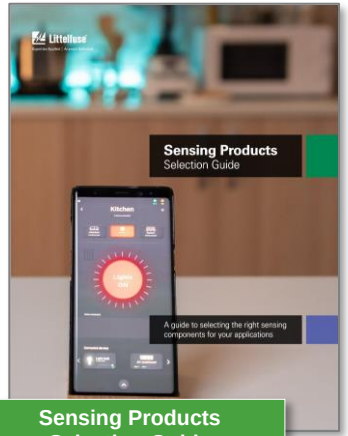
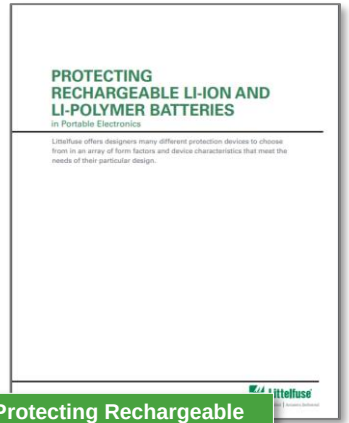


Circuit Protection Selection Guide



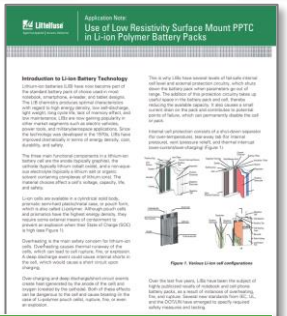
Sensing Products Selection Guide

Circuit Protection Solutions Li-Ion Cell

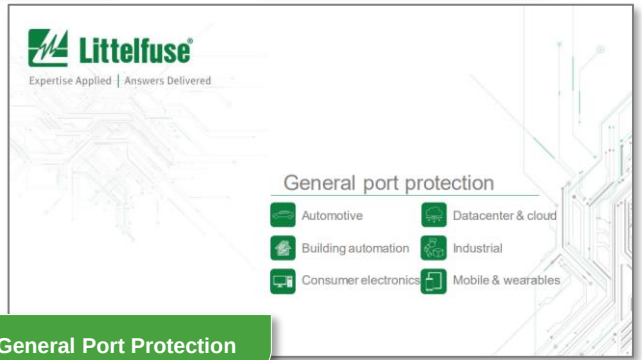


Protecting Rechargeable Li-ion Batteries

Click on the images for more information



Lithium-Ion Battery Pack Protection with PPTC



General Port Protection

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Local resources supporting our global customers

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Partner for tomorrow’s electronic systems

Broad product portfolio

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

Application expertise

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

Global customer service

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

Compliance & regulatory expertise

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

Testing capabilities

We help customers get products to market faster, and we offer certification testing for global regulatory standards

Global manufacturing

Our high-volume manufacturing is committed to complying with the strictest quality standards

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