



Expertise Applied | Answers Delivered

Lithium Battery Pack Protection and Control



Appliances



Energy Storage

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](https://www.littelfuse.com/disclaimer-electronics).

Lithium batteries market statistics and drivers

Market trends and drivers

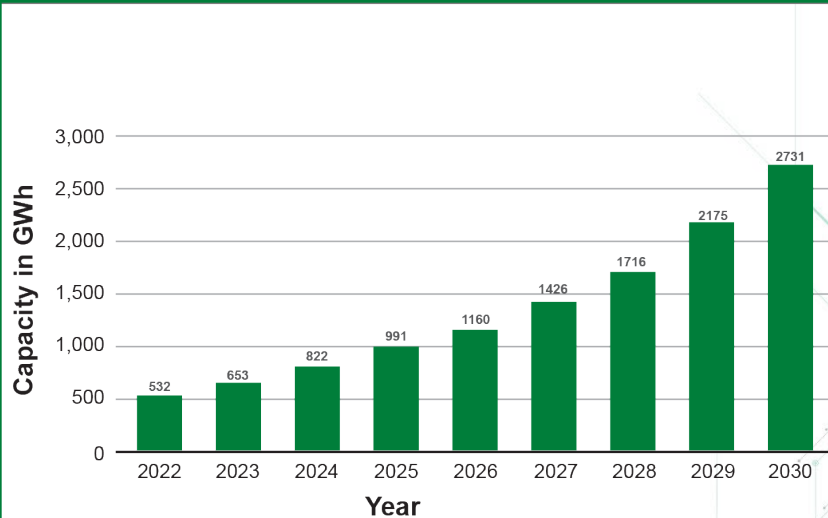
Safety and ageing concerns in Lithium battery applications highlight the critical need for advanced protection and control solutions in the market.

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)



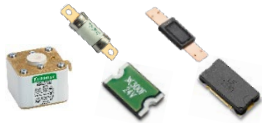
Source: [Statista](#)

Littelfuse offers solutions for every battery system

Smart phones → large eMobility batteries → utility-grade systems

Overcurrent Protection

Fuse, PPTC, Battery Protector, Battery Mini-breaker



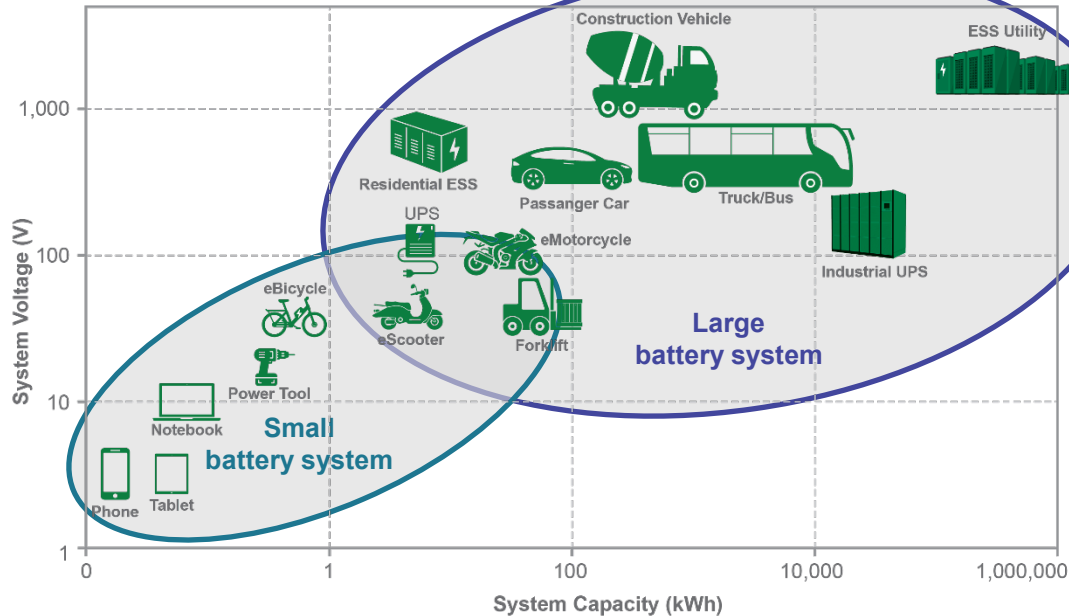
Overvoltage Protection

MOV, SPD, SIDACtor®, TVS Diode



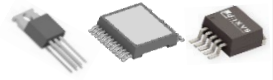
Sense Line Protection

Fuse, TVS Diode



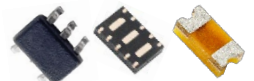
Power Control

MOSFET/IGBT, Power Module, Gate Driver



ESD Protection

TVS Diode, TVS Diode Array, Polymer ESD



Sensing Solution

Magnetic Sensor, Temperature Sensor, TTape™



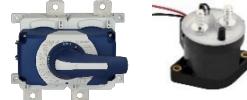
Isolation Monitoring

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



* Contact sales for details

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



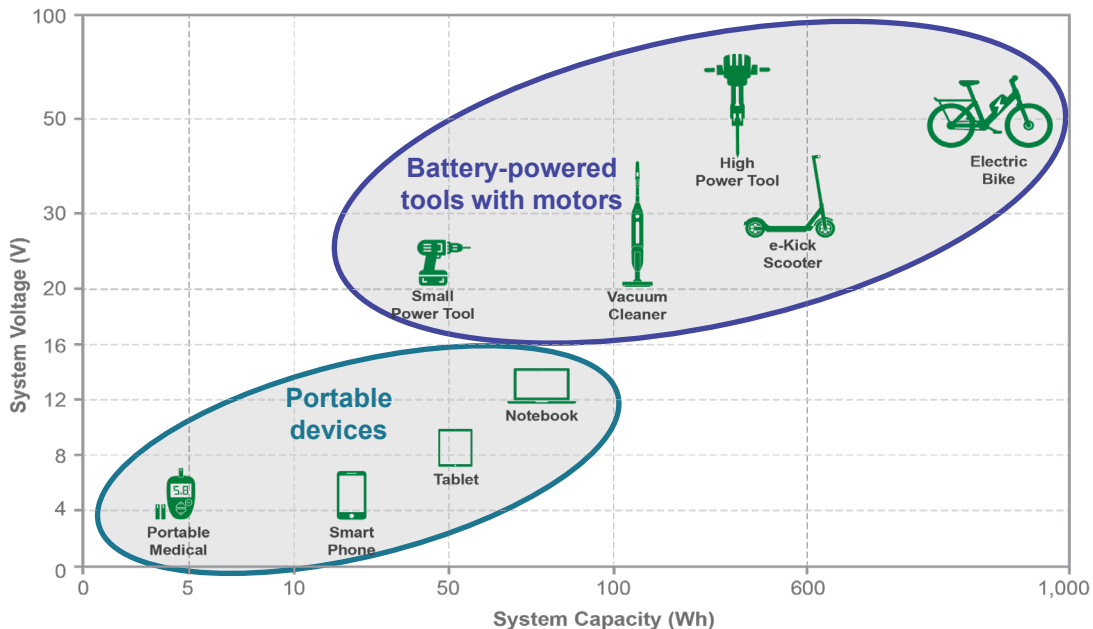
Temperature Sensing

NTC, RTD, TTape™



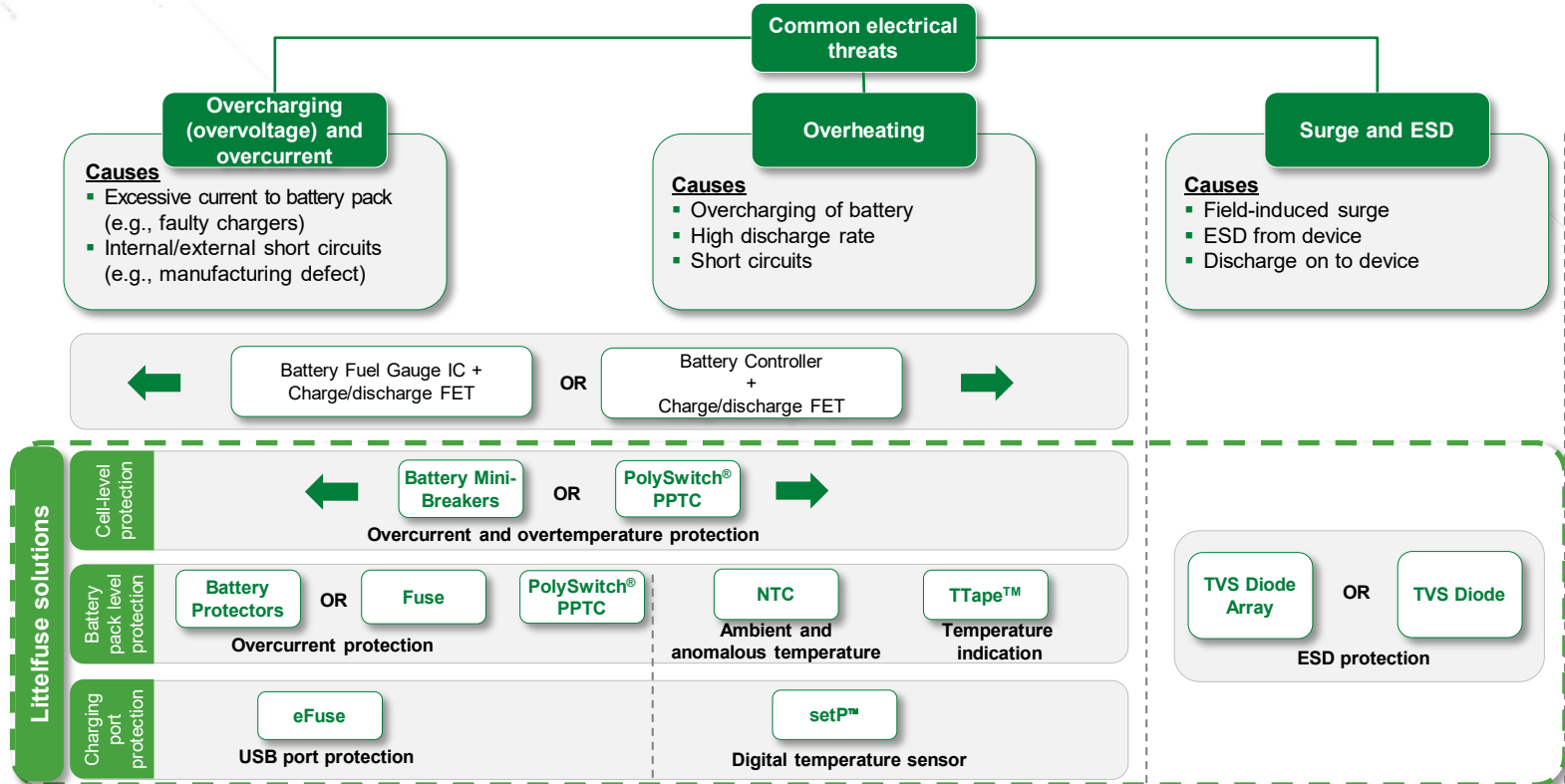
Battery Status Indicator

Tactile Switch



* Contact sales for details

Common hazards related to Lithium battery systems

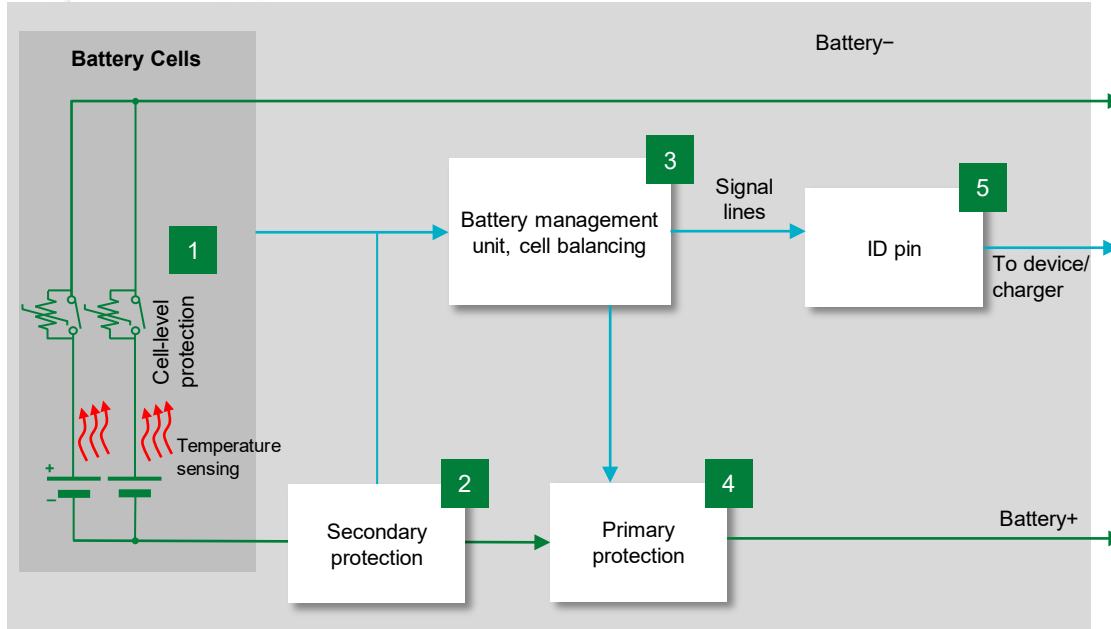


* Contact sales for details



Click the product series in the table below for more info

Battery pack system architecture: small up to 60 V



Legend:

- Green arrow: Power
- Blue arrow: 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
	Fuse OR PPTC	458 OR 0805L
3	Current Sensing Resistor	L4CL
	TVS Diode	SME, SMF4L
4	TVS Diode Array	SP1006
	PPTC	zeptoSMDC



Click the product series
in the table below for more info

Features and benefits of Littelfuse products

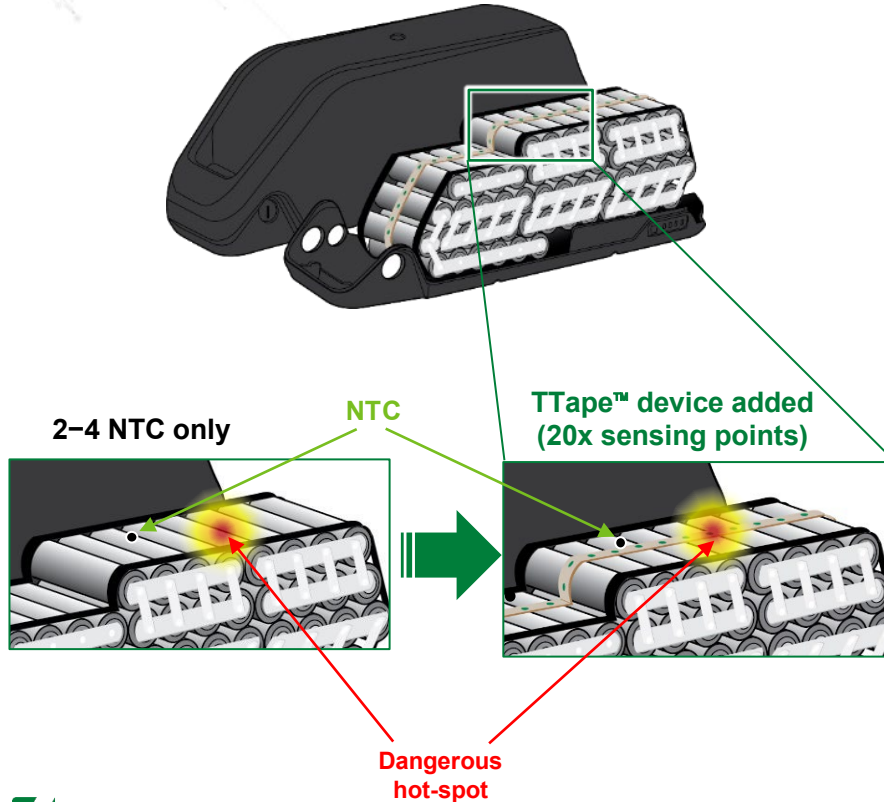
	Technology	Function in application	Product series	Benefits	Features
1	NTC	Analog temperature monitoring to facilitate functional control of batteries	KC	Provides accurate temperature readings to enable safe device operation	Insulated lead wires; small form factor; fast thermal response
	TTape™	Managing 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
	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) Allows for ultra-thin battery pack designs; enhances battery safety in mobile devices; provides resettable protection, ensuring device longevity	Compact, space-saving size; holds a current of up to 5.5 A; RoHS-compliant 9VDC rating and high current capacity; multiple activation temperatures; UL-, CSA-, and IEC-evaluated
2	Fuse OR Battery Protector	Non-resettable overcurrent protection Non-resettable overcurrent and overcharge protection (activated on demand)	881 , 688 OR ITV	Reduces customer qualification time in compliance with third-party safety standards such as UL/IEC Offers overcurrent and overcharge protection and controlled disconnection; can be activated by BMS	Third-party compliance with UL/IEC, low internal resistance; shock-safe; vibration-resistant Surface-mountable; UL- and TUV-certified; three-pin device; controlled fusible element
	Fuse OR PPTC	Non-resettable (Fuse) or resettable (PPTC) protection for BMS MOSFET from high currents due to external shorts	458 OR 0805L	Saves space with a smaller footprint 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; UL- and TUV-certified; three-pin device; controlled fusible element Surface-mountable; compatible with lead-free solder processes as per IEC standards; PPTC only for single-cell applications
3	Current Sensing Resistor	Part of current measurement circuitry	L4CL	Cost-effective solution compared to competing technologies. Compact size. Late Temperature De-rating	Tolerance down to 0.5%; separate voltage-sensing terminals; SMD form factor
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	Low profile with a maximum height of 1 mm; low leakage of 1.0 µA
5	PPTC	Overcurrent protection for TVS or Zener diodes	zeptoSMDC	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 or other MCU/BMS ports	SP1006	Small, space-saving design prevents signal disruption with low capacitance	µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage



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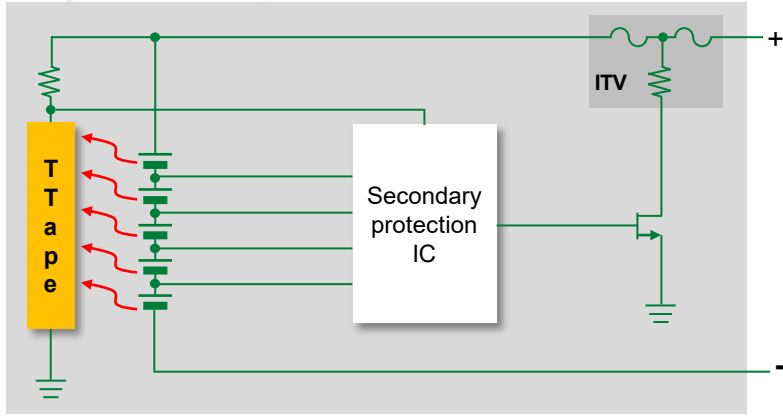
Digital temperature
monitoring for battery systems (TTape™)

TTape™ platform: overtemperature detection at each cell



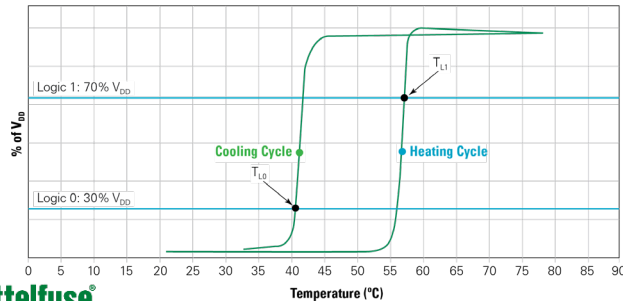
- **Detect** dangerous hotspot due to cell imbalance, ageing, external heat, high load or fast charging
- Extends serviceable **life** of battery packs and adds **safety**:
 - **Increase resolution** of temperature monitoring areas, TTape™ platform sensing points are on each cell
 - Monitors many cells/large areas using a **single** TTape device, thus saving processing power
 - **Ultra-fast responses for quicker alerts**
- Can **wake** BMS in-case of overtemperature
- **No calibration** + **simple** integration with BMS
- $\leq 500 \mu\text{m}$ thin \rightarrow **conformal installation**

TTape™ platform and ITV: monitoring for rechargeable Lithium batteries



* ITV – Three-terminal fuse. Third heater terminal activated by MOSFET.

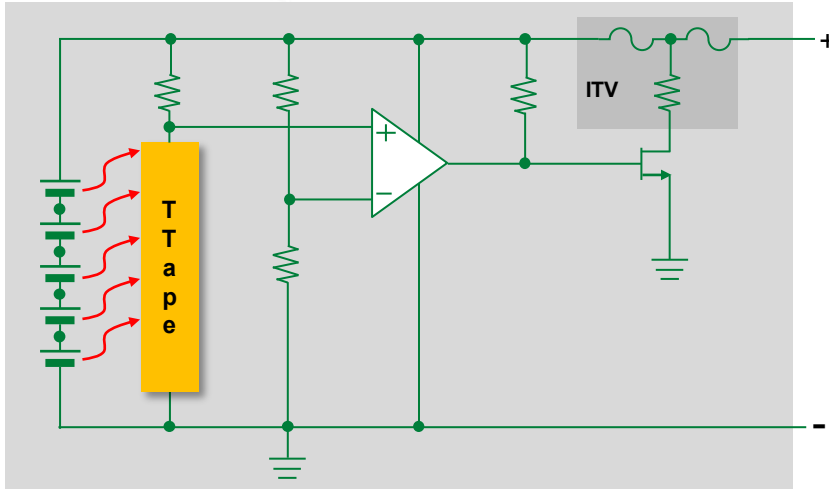
Temperature Indication Characteristics



*V_{DD}– Voltage supply to the drain

- TTape™ device detects the temperature of each battery cell and connects to battery protection IC.
- When a cell's temperature exceeds limits, TTape™ resistance change is recorded by MCU. MCU activate a cutoff mechanism (in this example MOSFET with ITV).
- The MCU could take other action based on the TTape™ alert, such as initiating cooling systems or alerting users to potential safety issues.

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



* ITV – Three-terminal fuse. Third heater terminal activated by MOSFET.

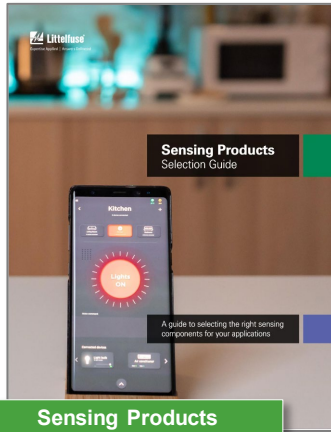
- TTape™ device detects the temperature of each battery cell and connects to comparator.
- The comparator evaluates this resistance change; if it indicates an overtemperature condition, device sends a signal to activate the MOSFET.
- The activated MOSFET then triggers the ITV (Three-terminal Fuse), which disconnect the power to the battery, preventing thermal runaway or potential battery damage.

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

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



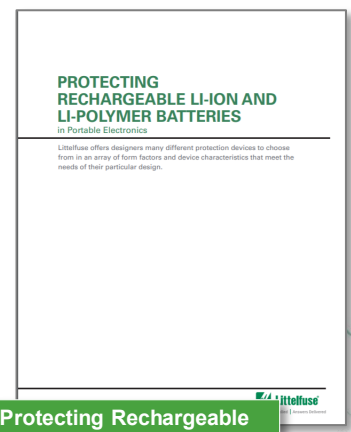
Circuit Protection Selection Guide



Sensing Products Selection Guide

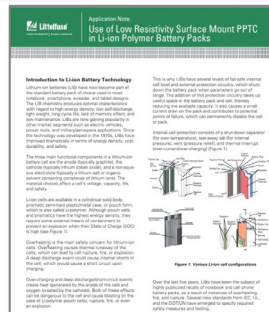


Circuit Protection Solutions Li-Ion Cell

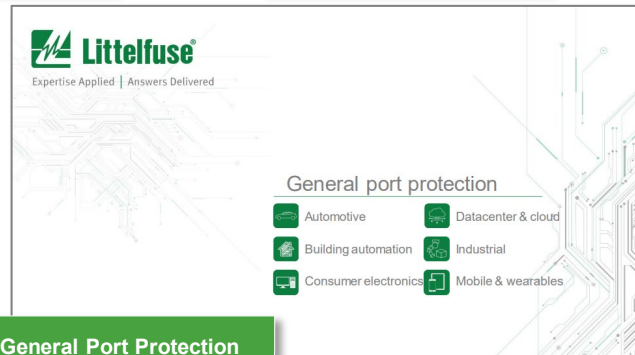


Protecting Rechargeable Li-ion Batteries

Click on the images for more information

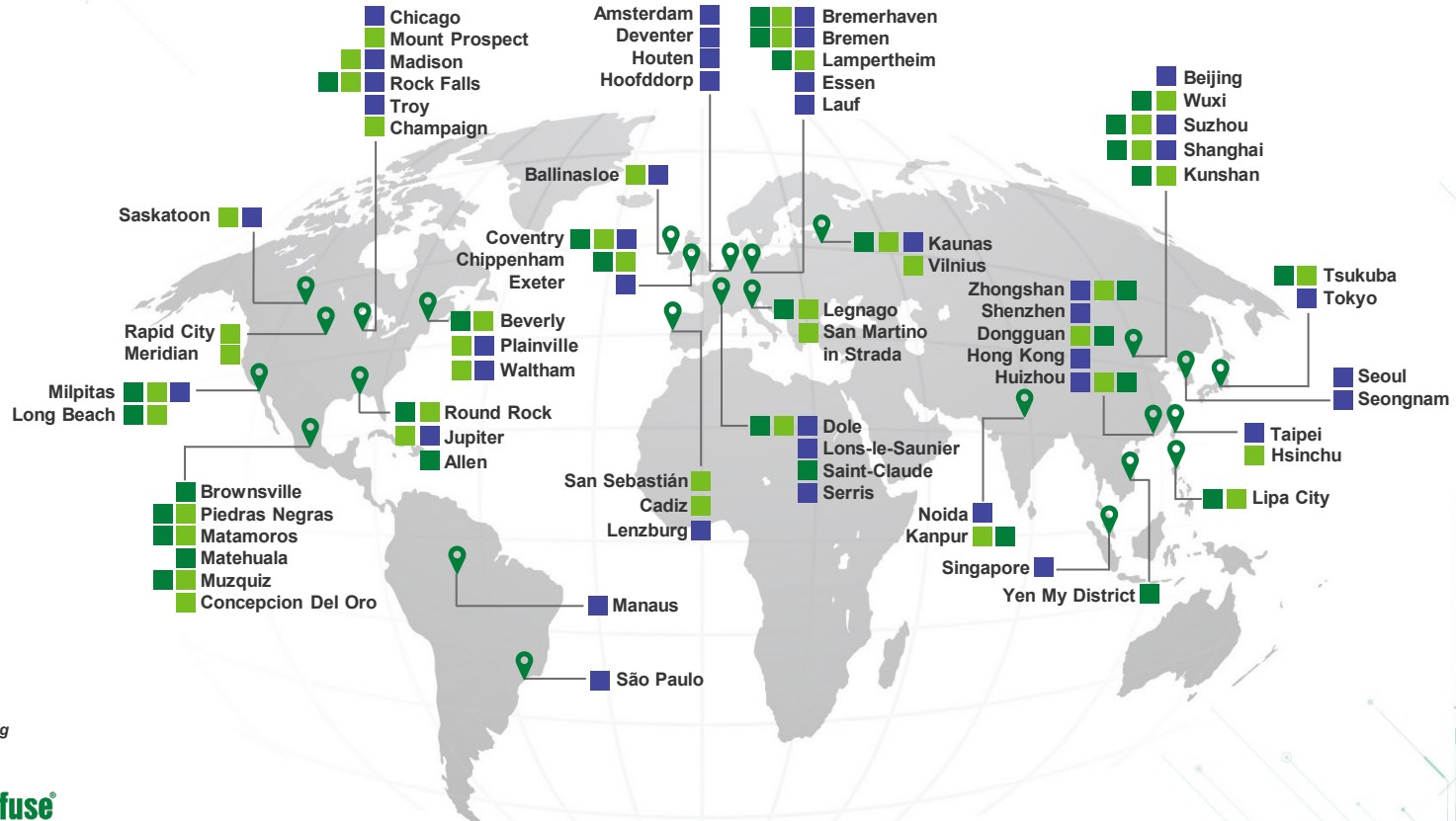


Lithium-Ion Battery Pack Protection with PPTC



General Port Protection

Local resources supporting our global customers



Legend
■ Sales
■ R&D
■ Manufacturing

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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