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## Battery fuel gauge and I/O port protection

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Mobile and wearables



Consumer electronics



Appliances

*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).*

# Battery fuel gauge ICs are used in many applications



# Faster charging enabled by USB Type-C: power delivery of up to 100 W possible with voltages up to 20 V

## Market trends and drivers

Consumer electronics and mobile devices are using increasingly faster charging methods, requiring higher voltages than ever before.

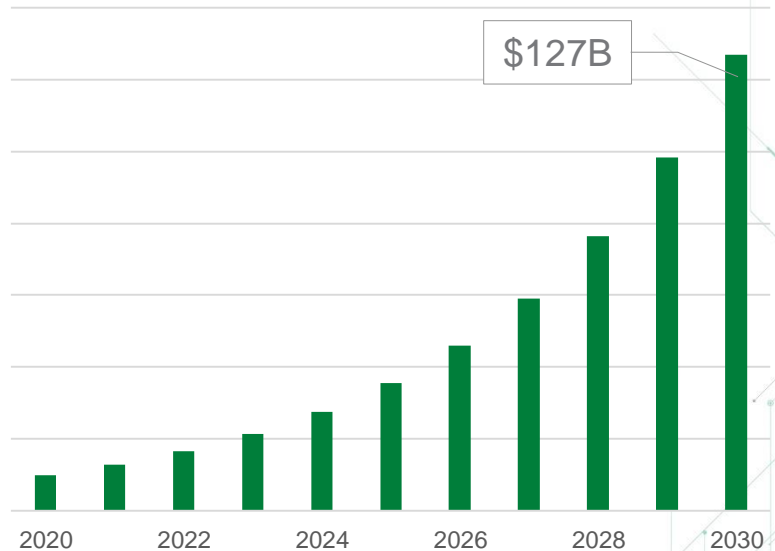
Now, 15 and 20 volts are very commonly used for charging in applications that previously used only 5 or 10 volts.

Higher-voltage charging increases the risk that locations within a device which previously had sufficient protection are no longer adequately protected.

Increasing use of USB Type-C is helping to enable higher-power charging in many applications.

## USB Type-C growth strong at ~29% CAGR

### USB Type-C Market



Source: [Future market insights](#)

# Components for battery management in mobile devices

## Temperature monitoring

- NTC



## Overcurrent & overtemperature protection

- PPTC
- Battery mini-breaker



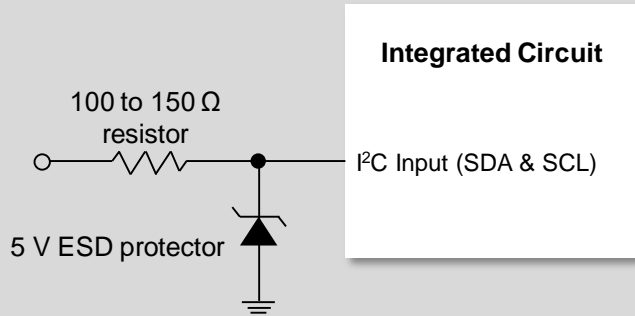
## ESD protection

- TVS diode array

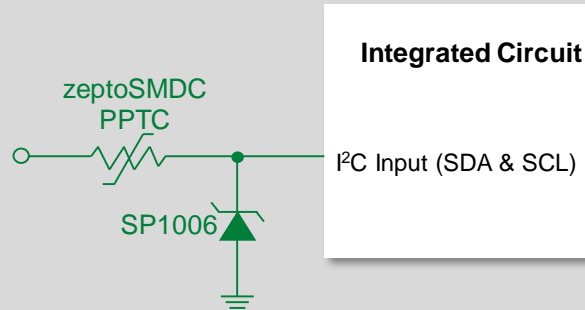


# zeptoSMDC and SP1006 devices provide enhanced protection of I/O ports—such as I<sup>2</sup>C on fuel gauge ICs

## Typical battery fuel gauge IC protection



## Littelfuse solution



- IC reference designs\* suggest using the resistor and ESD protector pair for I<sup>2</sup>C protection.
- Sustained overvoltage can cause the ESD protector to fail in a short-circuit condition, which may lead to further damage of the device and possibly to damage of items near the device.
- The zeptoSMDC prevents the ESD protector from failing during sustained overvoltage greater than 5 volts.

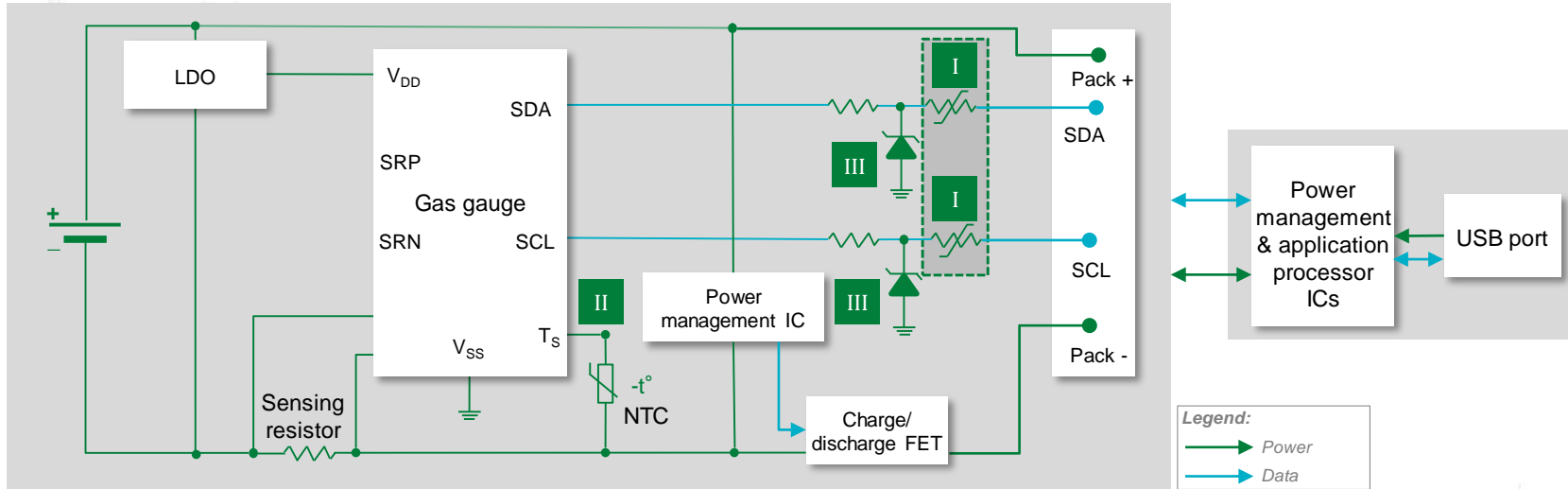
\* *Reference design examples:*

1. [TI fuel gauge](#)
2. [MAXIM fuel gauge](#)



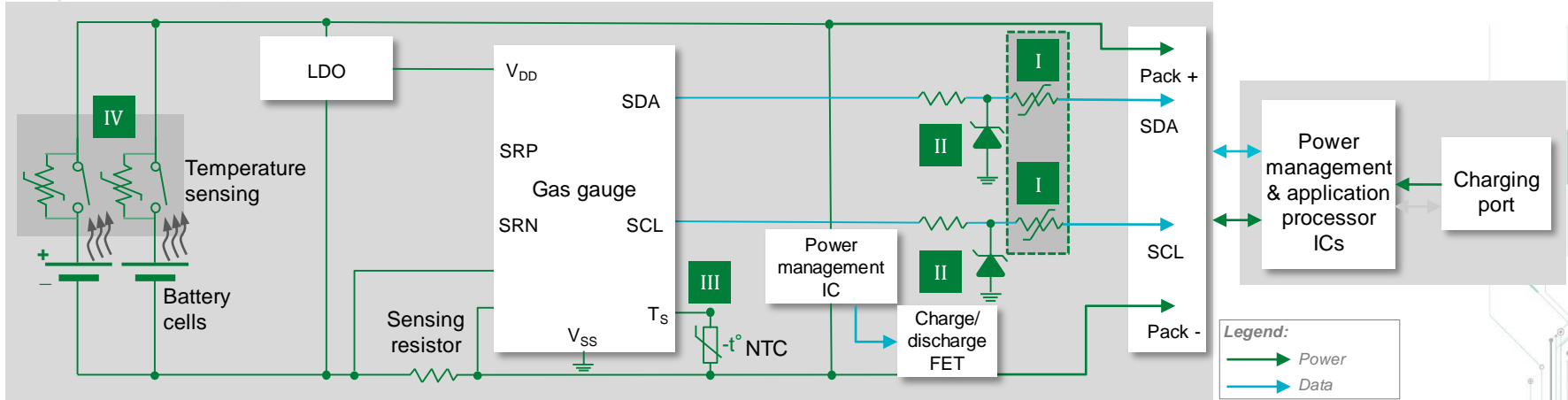
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# Typical single-cell battery protection reference system



	Technology	Function in Application	Series	Benefits	Features
I	PPTC	Overcurrent & overtemperature protection for battery management ICs & fuel gauges	<a href="#">zeptoSMDC</a>	Resets to normal operation after fault is cleared; saves space due to small footprint	Maximum electrical rating: 13 VDC; short circuit current: 82–200 mA; small footprint 0201 size
II	NTC	Ambient temperature measurement and temperature compensation for safe charge–discharge battery cycle	<a href="#">RA, RB, KR</a>	Provides safe operation of battery; smaller footprint saves space	Surface mountable; small form-factor
III	TVS diode array	ESD protection of I <sup>2</sup> C input	<a href="#">SP1006</a>	Small, space-saving design; low capacitance to prevent signal disruption	µDFN-2 (0201) footprint ±30 kV ESD withstand voltage

# Typical multicell battery protection reference system



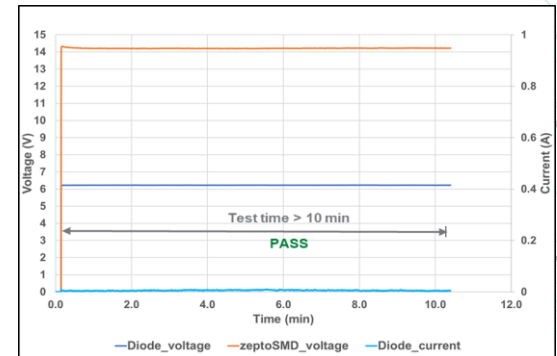
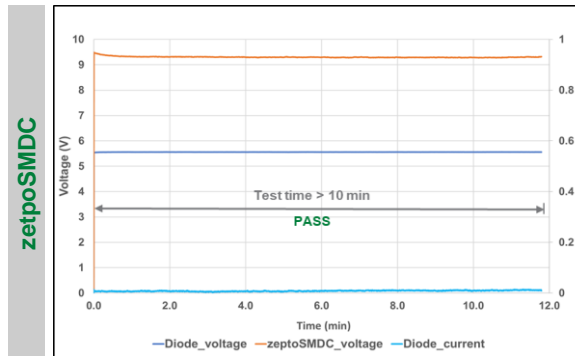
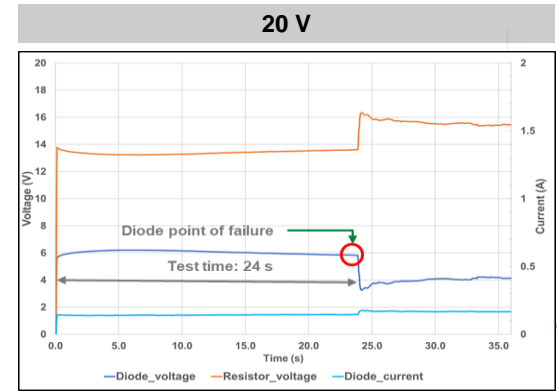
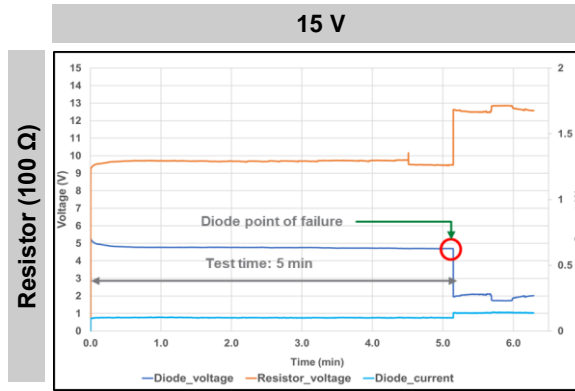
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III	NTC	Ambient temperature measurement and temperature compensation for safe charge–discharge battery cycle	<a href="#">RA, RB, KR</a>	Provides safe operation of battery; smaller footprint saves space	Surface mountable; small form-factor
IV	Battery Mini-breaker	Secondary overtemperature and overcurrent protection	<a href="#">MHP-TAC</a>	Longer battery life; sensitive thermal protection	I <sub>hold</sub> up to 15 A, milliohm resistance, 72 to 90° C cutoff temperature



# zeptoSMDC device protects IC and (5 V) Zener diode from sustained overvoltage conditions up to 20 V

Test Results ( $I_{ESD}$ )		
Part Number	15 V	20 V
Resistor (100 $\Omega$ )	Fail; <5 min (157 mA)	Fail; <24 sec (260 mA)
zeptoSMDC	Pass (11 mA)	Pass (7.8 mA)

- Without zeptoSMDC, ESD protector (5 V) Zener diode **failed** when  $I_{ESD} > 50$  mA
- zeptoSMDC limits current  $I_{ESD}$ , Zener diode remains **operational**
- Voltages 15 V and 20 V are present in USB-C power delivery (PD) interfaces





# Compliance and standards for mobile and wearable devices

Standard	Title	General Scope	Region
USB-IF	Universal Serial Bus specification	Supports advancement and adoption of Universal Serial Bus technology	Global
IEC 60950-1	Information technology equipment – Safety	Applicable to mains-powered or battery-powered information technology equipment, with a rated voltage not exceeding 600 V	Global
IEC 62368-1	Audio/video, information and communication technology equipment – Part 1: Safety requirements	Safety of equipment within the field of audio, video, information, and communication technology (rated voltage not exceeding 600 V)	Global
IEC 61000-4-2	Testing – Electrostatic discharge (ESD)	Established to check the ability of the equipment to survive repetitive electrical fast transients and bursts	Global
IEC 61000-4-4	Electrical fast transient/burst immunity test	Evaluating the immunity of equipment when subjected to electrical fast transient/bursts on supply, signal, control, and earth ports	Global
IEC 62133-2 & UL 62133-2	Safety requirements for portable sealed secondary lithium cells	Evaluating protection during various battery-fault scenarios	Global
UL 1642	Lithium batteries	Safety standards that deal with cells and small portable batteries; UL1642 applies to individual cells, whereas UL2054 is for small rechargeable battery packs	North America
UL 2054	Household and commercial batteries		North America

# Additional information can be found on [Littelfuse.com](http://Littelfuse.com)

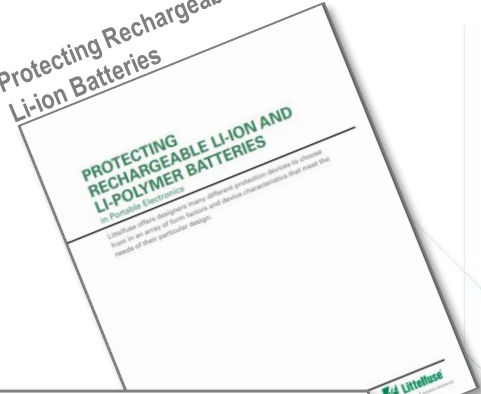
## Circuit Protection Selection Guide



## Circuit Protection Solutions Lithium-Ion Cells



## Protecting Rechargeable Li-ion Batteries



Click on each image to open the catalog

zeptoSMDC PPTC Datasheet

**PolySwitch® Resettable PPTCs before Mount > zeptoSMDC**

**zeptoSMDC Series**

**Applications**

- Consumer and battery
- Industrial IC
- Aerospace
- Portable medical equipment
- Vehicle gear groups
- All types of ICs
- Absorbent
- Circuit breakers
- Access systems
- Vehicle gear groups

**Benefits**

- High 10 VDC
- 200 mA current
- 100% reliability
- Small footprint
- High current
- 100% reliability
- 100% reliability

**Technical Characteristics**

Part Number	Maximum Voltage (VDC)	Rated Current (mA)	IC	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD	ESD
zeptoSMDC100	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

zeptoSMDC NPI Presentation

### PolySwitch® Resettable zeptoSMDC PPTC Series

**Problem/Solution**

The PolySwitch zeptoSMDC PPTC Series was developed to protect the lithium ion battery packs used in most mobile devices from overcurrent and overtemperature conditions. It works as 'fail-safe' to protect both the battery management ICs and battery fuel gauges. Available in the smallest form factor currently available, it is ideal for portable, mobile, and wearable consumer electronics applications.

**Benefits**

- Saves PCB space due to smallest available footprint.
- Helps protect battery monitor IC from electrical over-stress.
- Resets to normal operation after fault is cleared.

**Features**

- Surface mount, small 0201 size
- Maximum electrical rating: 13 VDC
- Short circuit current: 82-200 mA
- RoHS compliant and ISO/TS 16949 certified

**Technical resources:**

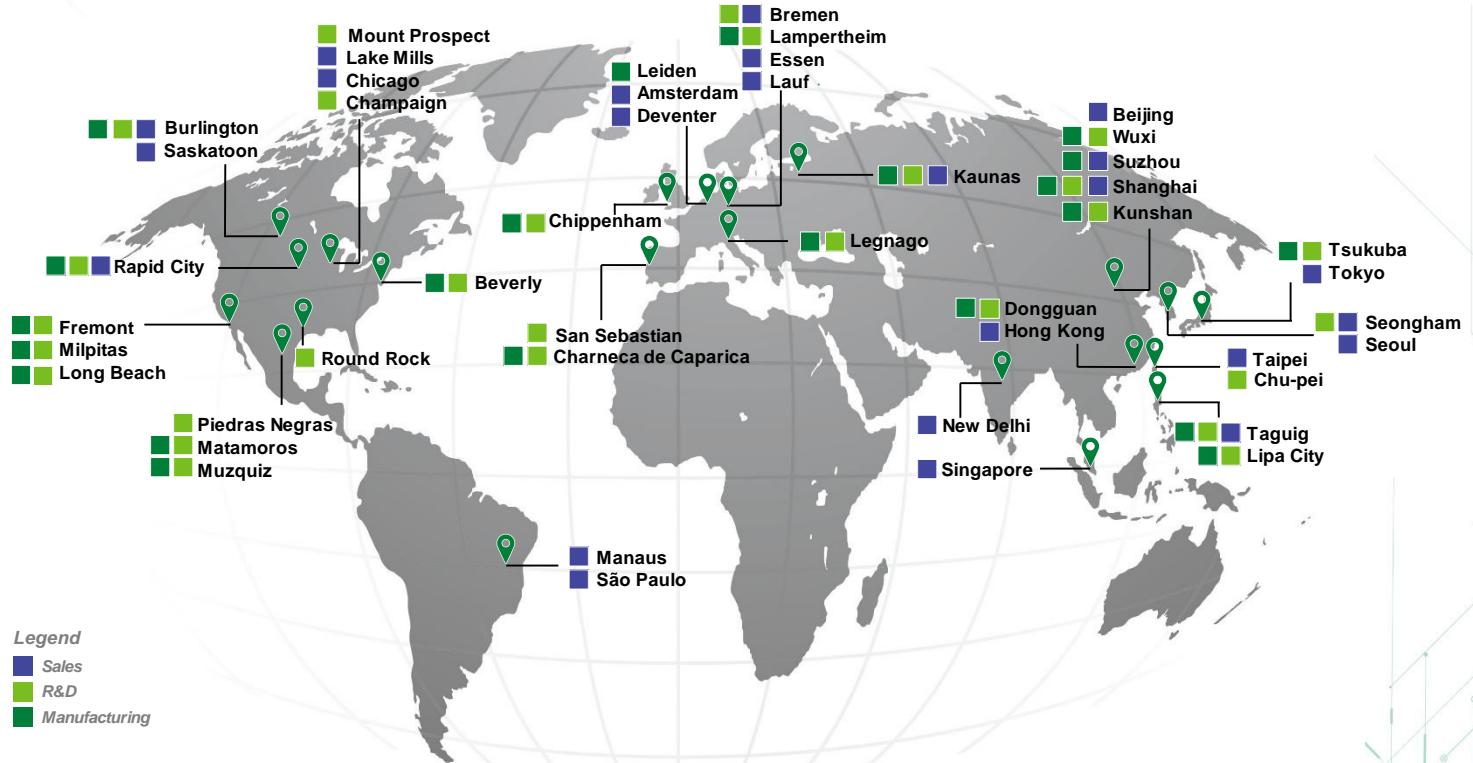
Series Page | Datasheet

**Markets/Applications**

- Smartphones and Tablets
- Notebook PC
- e-Readers
- Portable medical equipment
- Mobile point of sale
- Wearables
- Smartwatches
- Wireless speakers
- Portable game players

**zeptoSMDC NPI Presentation**

# Local resources supporting our global customers



*Legend*

- Sales
- R&D
- Manufacturing

# Partner for tomorrow's electronic systems

## Broad product portfolio

A global leader with a broad product portfolio, covering every aspect of protection, sensing, and control

## Application expertise

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

## Global customer service

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

## Compliance & regulatory expertise

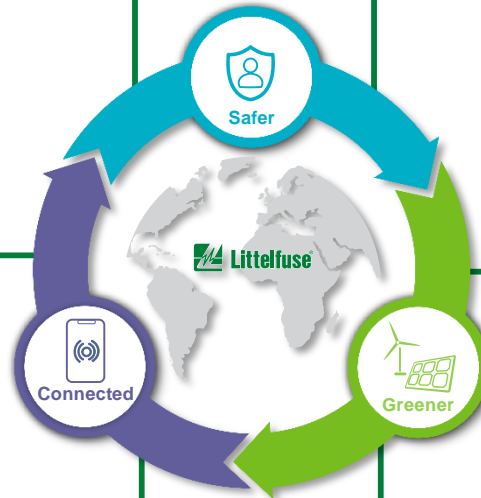
We help customers in the design process to account for requirements set by global regulatory authorities

## Testing capabilities

To help customers get products to the market faster, we offer certification testing to global regulatory standards

## Global manufacturing

High-volume manufacturing that is committed to the highest quality standards



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