APPLICATION NOTE

Reliable Overcurrent Protection for Internet of Things (IoT) Wearable Devices

MF-ASML/X

INTRODUCTION

Polymer Positive Temperature Coefficient (PPTC) thermistors or resettable fuses are common overcurrent protection devices used in consumer applications such as personal computers, game consoles, smartphones, tablets and now, wearables. The list of new and unique wearable applications and products continues to expand as consumers look to possess the next "must have" device. This has resulted in increased demand for PPTC thermistors in the consumer wearables market due to their ultra-low impedance "on" resistance values, extremely small form factor, and enhanced reliability.

WEARABLE BATTERY ISSUES

There are many wearable electronics applications today: smartwatches, fitness bands, GPS trackers, earbuds, health monitors, and virtual reality headsets, to name a few. Most of these applications today rely on lithium-ion or lithium polymer batteries for power, and consumers continue to demand longer battery life to maximize time between charges. Because of its higher energy density and superior battery charge capabilities, lithium-ion technology is the most commonly used battery technology in the wearables market today. Furthermore, due to the inherent space constraints in the ever-shrinking size of wearable devices, design engineers are especially sensitive and reliant on these newer and higher energy density batteries.

With lithium battery technology, events such as a short circuit, unspecified charging conditions (overcurrent) and overheating can result in a condition that can cause a thermal runaway during the energy transfer process. In a wearable device, it is unacceptable to experience a thermal event at any level because it can cause discomfort to the person wearing the device. Since lower voltage and longer operating times can be achieved only if the parasitic resistances or impedances can be kept to a minimum, Bourns developed a small form factor 0402-size resettable PPTC fusing device shown in Figure 1 on the next page. The new Bourns® Multifuse® Model MF-ASML/X series acts as a secondary overcurrent and overtemperature protection device to prevent such a thermal event from occurring within the device's specifications.

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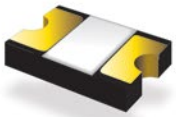

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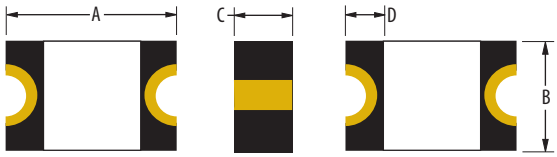
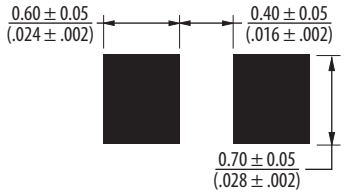
WEARABLE BATTERY ISSUES *(Continued)*

Physical Dimension
Lead-Free Terminals: Nickel/Gold Plating



Recommended Pad Layout



Dimension Unit	A		B		C		D
	Min.	Max.	Min.	Max.	Min.	Max.	Min.
mm	0.85	1.15	0.35	0.65	0.20	0.60	0.10
inch	(0.033)	(0.045)	(0.014)	(0.026)	(0.008)	(0.024)	(0.004)

Figure 1. | *Diagram of Bourns® Multifuse® Model MF-ASML/X PPTC Resettable Fuse in an 0402-Size Very Small Form Factor*

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DESIGNING FOR MAXIMUM PROTECTION

For consumer wearable applications, it is possible to implement the small form factor (0402-size) Multifuse® MF-ASML/X series into both the connector head of the USB charging cable and the PCB in the wearable device itself. This dual approach will protect the wearable device battery unit during a charging cycle and also will protect the circuitry during discharging, and powering of the device during usage in the event a short circuit or other overcurrent or overtemperature condition occurs, as shown in Figure 2.

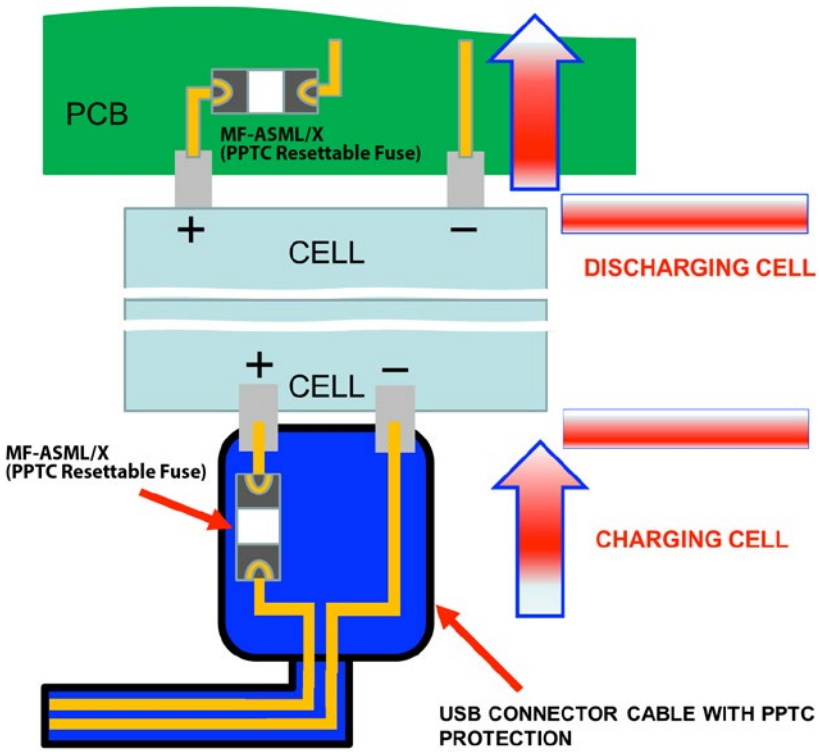

Figure 2. | *Using a Bourns® Multifuse® MF-ASML/X SMT PPTC on PCB and in Cable Connector Head Provides Effective Overcurrent and Overtemperature Protection in Wearable Applications*

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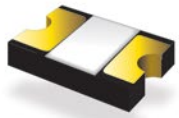

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IMPORTANCE OF CIRCUIT PROTECTION AT THE DESIGN STAGE

Circuit protection is often overlooked during the design stage in many applications. In the past, design engineers typically evaluated the trade-offs of additional cost, increased parasitic loading affecting data rates, and signal integrity in the I/O interfaces when deciding whether to add protection. However, with today's ever-shrinking sub-micron semiconductor technologies, the effects of electrostatic discharge (ESD) transients, faulty charging units that can cause potential fire hazards, and basic safety concerns in the growing wearable device market, including circuit protection in these designs has become the preferred practice.

Designers are now realizing that specifying circuit protection such as the Bourns® Model MF-ASML/X PPTC in a small 0402 size gives them increased resettable fuse performance from higher hold currents (Ihold), higher voltages (Vmax) and post trip resistance values for enhanced resistance stability. These features enable longer battery life and faster charging in today's smaller lithium-ion battery-based devices, making it an ideal resettable protection solution for a wide range of space-constrained wearable applications. Also, the capabilities of the Model MF-ASML/X allow designers to eliminate the damaging effects of an unspecified charging event, transient, or overtemperature condition of the battery within the device's specifications, thereby resulting in a safer end product for the consumer.

Table 1. | *Electrical Specifications and Device Performance*

Model	Max. Operating Voltage (V_{DC})	Max. Operating Current (A)	Working Temp.	Typical Current Trip Limit (A)		Initial Resistance Values (Ohms)		Max. Time To Trip		Tripped Power Dissipation
				@ 23 °C		@ 23 °C		@ 23 °C	@ 23 °C	Watts at 23 °C
				I_{Hold}	I_{Trip}	$R_{Min.}$	$R_{1Max.}$	(A)	(S)	Typical
MF-ASML035/6	6	50	-40 °C - 85 °C	0.35	0.70	0.05	0.85	8.0	0.10	0.5
MF-ASML050/6	6	50	-40 °C - 85 °C	0.50	1.00	0.04	0.50	8.0	0.10	0.5

Note: *Additional Multifuse® models with I_{hold} values of 100 mA and 200 mA will be available soon.*

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SIMPLE, COST-EFFECTIVE CURRENT MEASUREMENT

The need for small, reliable protection and the value it brings to consumer wearable products is increasingly more evident. Companies that produce wearable devices have learned that a field failure may not only signal possible safety-related design issues and large numbers of returns, but also trigger negative social media and viral news that can severely hurt the reputation of the manufacturer's brand and image, and affect future product sales. Ultimately, the return on investment (ROI) and risk-mitigation benefits that come from the addition of a small form factor protection device such as the Bourns® MF-ASML/X series PPTC resettable fuse can deliver significant total cost of ownership savings combined with the benefit of offering a more reliable, high-quality end product that is designed to meet a customer's operational expectations and improve their total experience.

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