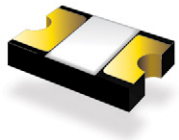
APPLICATION NOTE

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



MF-ASML/X Series

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 wearable devices, design engineers are especially sensitive and reliant on these newer and higher energy density batteries.

In lithium battery technology, however, 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 for even a non-combustible thermal event at any level to occur because it can cause discomfort to the user. Since lower voltage and longer operating times can only be achieved if the parasitic resistances or impedances can be kept to a minimum, Bourns developed a very 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 an event from occurring.

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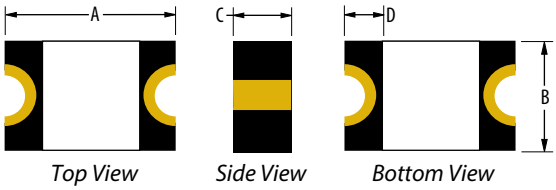
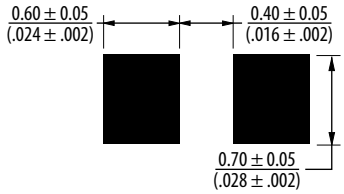
WEARABLE BATTERY ISSUES *(Continued)*

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 Multifuse® small form factor (0402-size) MF-ASML/X series into both the connector head of the USB charging cable and in the wearable device itself on the actual PCB. This protects the wearable device battery unit during a charging cycle and also protects 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.

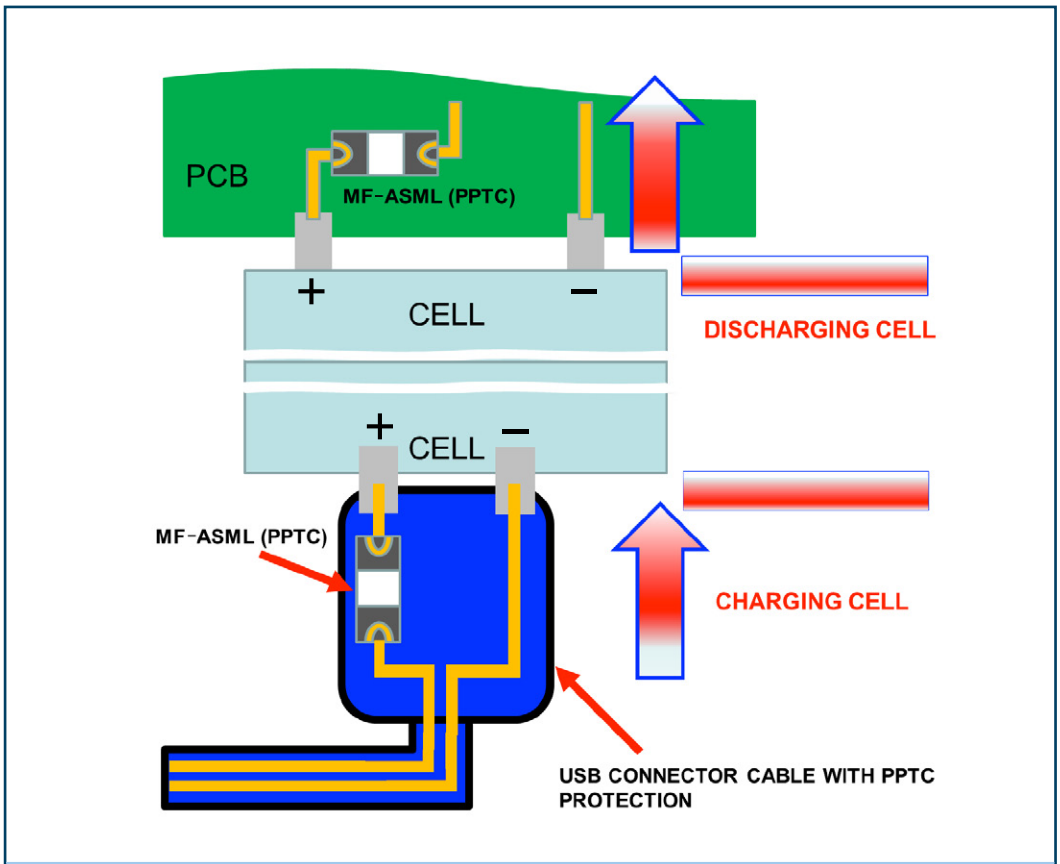

Figure 2. | *Using a Bourns® Multifuse® MF-ASML/X SMT PPTC on PCB and in Cable Connector Head Provides Effective Overcurrent and Overtemperature Protection in Wearable Applications*

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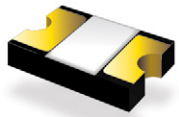

MF-ASML/X Series

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 between adding protection or not. 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, there has been a shift in the emphasis to include circuit protection in these designs.

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 (I_{hold}), higher voltages (V_{max}) 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 effectively eliminate the damaging effects of an unspecified charging event, transient, or overtemperature condition of the battery, 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-ASML010/6	6	50	-40 °C - 85 °C	0.10	0.3	0.15	3.0	0.5	1.0	0.5
MF-ASML020/6	6	50	-40 °C - 85 °C	0.20	0.5	0.10	1.6	1.0	1.0	0.5
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
MF-ASML075/6	6	50	-40 °C -85 °C	0.75	1.50	0.025	0.25	8.0	0.1	0.5

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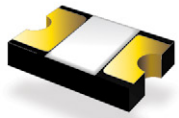

MF-ASML/X Series

SIMPLE, COST-EFFECTIVE CURRENT MEASUREMENT

The need for small, reliable protection and the value it brings to consumer wearable products is becoming increasingly more evident. Companies that produce wearable devices have learned that a field failure may not only signal possible warranty 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, 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 Bourns® MF-ASML/X series PPTC can deliver significant total cost of ownership savings combined with the benefit of offering a more reliable, high-quality end product that meets a customer's operational expectations and improves their total experience in the process.

ADDITIONAL RESOURCES

For more information about Bourns' complete product line, please visit: www.bourns.com

- Bourns® Multifuse® Polymer PTC Offering
- Bourns® Multifuse® Polymer PTC Technical Library
- Bourns® Multifuse® Polymer PTC Product Guide
- Bourns® Multifuse® Polymeric PTC & Ceramic PTC Brochure
- Bourns® Multifuse® Polymer PTC Application Table and Selection Guide
- Bourns® Multifuse® Polymer PTC Product Training Modules
- Bourns® Multifuse® Polymer PTC Design Kits

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