Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

WHITE PAPER

Model AA Series

INTRODUCTION

Technology advancements have succeeded in lowering the power consumption in electronic components, which has enabled battery suppliers to offer increasingly dense and larger storage capacity Lithium-ion (Li-ion) battery cells. This is good news for portable consumer electronics manufacturers developing more compact yet feature-rich devices. Users also benefit from extended battery life. Li-ion has become the battery of choice due to its small footprint and high energy density. Overtemperature and overcurrent protection must, therefore, keep pace with battery technology evolution by providing solutions that are also smaller, thinner and more robust. Consumers typically think of tablets and notebooks, but other electronics applications such as e-bikes, power tools and even consumer robots and energy grid storage can reap the benefits of a reduced battery pack cell count that ultimately cuts application costs.

The risks of overtemperature and overcurrent threats remain real, if not growing, concerns in larger Li-ion batteries. With higher capacity batteries comes higher stored energy, which has the potential to cause more damage. These next-generation battery designs require protection against high electrical currents and short circuits (internal, external or created by mechanical damage), and are especially vulnerable to various charging conditions that also create heat which can result in Li-ion damage. Depending on the battery design, the heat created by these high currents may exceed the battery's cooling efficiency or produce a localized hot spot. Even though the temperature of high capacity batteries during charge and discharge is similar to lower capacity batteries, the temperature does increase toward the end of discharging.

Developers also must address mandated safety standards for Lithium-ion batteries such as International Electrotechnical Commission (IEC) 62133 defined for portable sealed secondary cells, and for batteries made from them used in mobile applications. Furthermore, testing like the Underwriters Laboratory UL2054 Limited Power Source (LPS) Test ensures that the power output of a battery can be limited to decrease the possibility of a device malfunction. These standards and tests make finding reliable higher capacity overtemperature protection for all Li-ion designs a necessity.

Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

Model AA Series

LI-ION MARKET GROWTH

The global market for Li-ion batteries is expected to reach $33.1 billion by 2019, with the industry enjoying a compound annual growth rate (CAGR) of 14.4 percent over a seven-year span, according to Research and Markets, an international market research firm. Conservative estimates for expanded usage of new higher current capacity batteries predict that this part of the market will grow to $10 billion by 2020. Expansion is assumed as new high power and high capacity cells will be increasingly designed into more and more applications. But even niche battery segments are expected to thrive. For example, an IHS Technology report predicts the global market for batteries used in wearable electronics will reach $77 million by 2018, which is a tenfold increase from the $6 million total in 2014.

The next growth area predicted for Li-ion batteries is grid-scale battery installations needed for energy storage. Global sales of energy storage systems that typically require lithium-ion batteries are expected to triple from less than $2 billion in 2015 to roughly $6 billion by 2020. Lithium-ion batteries are deemed critical to the development of energy storage.

MEETING PROTECTION REQUIREMENTS

Li-ion batteries are regularly exposed to several potentially damaging overtemperature conditions. Short circuits or deep discharges can increase temperatures in the battery cell to levels high enough to cause damage not only to the battery cell itself, but to other components in the device. A battery exposed to overcurrent or overvoltage conditions that exceed specified limits can experience a considerable increase in cell temperature.

A well-established solution that meets overtemperature and overcurrent protection requirements is a miniature resettable Thermal Cutoff device (TCO) or mini-breaker. A miniature TCO is a resettable device that is attached to the battery cell and PCB using Ni-tabs. Miniature resettable TCOs operate using a combination of the temperature and electric current: at low temperature, higher currents can flow, and at high temperatures, the current derates and allowable current is reduced.

Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

Model AA Series

MEETING PROTECTION REQUIREMENTS *(Continued)*

The miniature resettable TCO is attached to the cell and PCB using Ni-tabs as shown below.

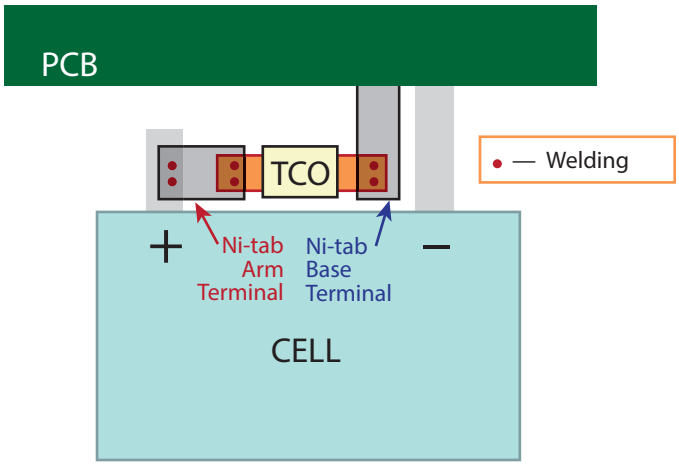

Figure 1. | *Example of the Miniature Resettable TCO Assembled in a Li-ion Battery*

How it works: When the environmental temperature rises and/or an excessive current flows through the arm or the bi-metal disc heats, the heat reverses/flips the position of the bi-metal disc lifting the arm to the open position. At this point, the current shunts to the PTC and heats it up to keep the bi-metal disc open and in a latched position until the fault is removed. This operation occurs virtually instantaneously with stable impedance, and restores the path for current between the terminals.

With the trend to produce higher cell capacities on larger cell surface areas, there is greater demand for lower thermal cutoff temperatures below 75 °C and miniature resettable TCOs that can help ensure an enhanced margin of safety. Also required for new Li-ion designs is protection that features higher resistance values and operating currents along with improved temperature sensing.

Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

Model AA Series

BREAKTHROUGH MINIATURE RESETTABLE TCO TECHNOLOGY

Bourns has introduced a new miniature resettable TCO device series, designated the Model AA Series. Implementing breakthrough thermal cutoff technology, the Model AA Series was developed in response to requests from multiple battery customers. Bourns was asked to provide a smaller solution that could also efficiently satisfy the growing protection requirements of higher capacity Li-ion batteries. The Model AA Series effectively delivers higher current overtemperature protection to make newer battery designs more reliable by controlling specified abnormal, excessive current virtually instantaneously.

For example, the Model AA85 is capable of carrying 14 A at 60 ˚C – offering as much as 37 % more current capacity compared to previously available miniature resettable TCOs from Bourns. The Model AA Series also delivers very low impedance/resistance (2 mΩ max.) – a full 60 % lower than earlier generation Bourns® miniature resettable TCOs which means additional protection assurance. The new miniature resettable TCO devices also meet IEC standards and UL requirements.

Table 1. | *There are four Bourns® Model AA Series, Model AA72AB0, AA77AB0, AA82AB0, and AA85AB0, offering varying temperature range options from 72 °C to 85 °C to meet an extensive array of battery application requirements.*

Model	AA72AB0	AA77AB0	AA82AB0	AA85AB0
Trip Temperature	72 ˚C ± 5 ˚C	77 ˚C ± 5 ˚C	82 ˚C ± 5 ˚C	85 ˚C ± 5 ˚C
Resistance	2 milliohms max.			

Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

Model AA Series

BATTERY DESIGN BENEFITS

The Model AA Series is a more effective protection solution in handling overcurrent and overtemperature risks due to its design, helping make batteries safer and more reliable. It is capable of managing higher current than existing Bourns® miniature resettable TCO devices due to the Model AA Series' lower resistance.

Another important cost and space-saving benefit for developers is that what previously required two TCOs to provide ample protection, now with Bourns' innovative design and high precision metal press process, a single Model AA Series device can meet protection requirements of many of the latest dense and higher current capacity batteries. The low resistance and compact package make the Model AA Series an optimal protection solution for virtually any space-constrained Li-ion application – all in a single package solution.

Bourns has developed its miniature resettable TCO products for stability, enhanced allowable voltage and improved leakage characteristics. Bourns is committed to continual product line expansion with the goal of maintaining the highest safety and reliability based on quality ISO 9001, ISO 14001, and ISO 27001 certifications. With Bourns, customers are assured of miniature resettable TCO products that are supported by decades of proven circuit protection technology expertise, superior customer service, and a global distribution sales channel.

Implementing Overtemperature and Overcurrent Protection Matching Today's Higher Current Capacity Lithium-Ion Batteries

Model AA Series

MAXIMIZING BATTERY RELIABILITY

A key value of the Bourns® Model AA Series solution is that it allows battery developers to maximize their available battery current capacity. Offering the highest current capacity of any miniature resettable TCO as of this writing, the Model AA Series minimizes the resistance by less than half of previous generations of miniature resettable TCO solutions from Bourns. Providing additional confidence, Bourns is known for delivering the smallest package sizes with a wide range temperature options matching specific application needs.

As a pioneer in overtemperature and overcurrent protection solutions, Komatsulite, now Bourns (acquired in 2015), engineered the first commercial miniature resettable thermal cutoff device in 2000, quickly ramping up to a total shipment volume of 2 billion devices in 2015 making it the market share leader for these devices. Under Bourns' leadership, the miniature resettable TCO products will continue to benefit from precision metal press processes, miniaturization and high current capacity engineering. Battery customers can depend upon a well-defined and established roadmap that includes further innovation.

ADDITIONAL RESOURCES

Please contact your local Bourns Application Engineer or Bourns Sales Representative for additional information.
Visit Bourns online at:

www.bourns.com

BOURNS®
11/16 • e/KLM1621

Americas: *Tel* +1-951 781-5500
Email americus@bourns.com

EMEA: *Tel* +36 88 520 390
Email eurocus@bourns.com

Asia-Pacific: *Tel* +886-2 256 241 17
Email asiacus@bourns.com