

# Design Talk: Batteries

## Improving Battery Life in Portable Electronics

by Ron Demcko, AVX ([www.avx.com](http://www.avx.com) [1])



Portable electronics are evolving so quickly that one can barely keep up with the new devices available to end-users. Regardless of the system, consumers expect more functionality in a smaller device that operates for a longer period of time between charges.

Significant progress has been made to increase the efficiency of a portable devices power operation, specifically the optimization of RF circuit and digital ASIC / support logic power consumption. Designers are currently concentrating on power losses due to passive components that can negatively impact the systems overall power consumption.

Passive components are now being optimized to reduce power consumption as well as improve battery life and reliability. Most recently, much effort has been focused on providing low-leakage components for DC conversion and burst-power applications.

### Transient Voltage Suppressors

Multilayer varistors (MLVs) are essentially miniature bi-directional transient voltage suppressors (TVSs) that act as EMI filters in their 'off' state. In the 'off' state, MLVs also exhibit a leakage current. A typical system might have a large number of these devices typically protecting any connection to the outside world - battery terminals, charge ports, Vcc lines to critical and susceptible ICs such as charge controllers and ASICs are some of the most common applications. Since MLVs are used between signal and ground or power and ground - in shunt configuration, the leakage currents of the MLV add to the loading on the battery and can represent a significant drain on battery life.

Addressing the issue of leakage, devices have been developed such as MLVs with

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an 'off' state leakage of 1ua, an improvement of approximately 50x over standard MLVs. This positively impacts battery life, signal to noise ratio, and even the light intensity in LED light engines needing TVS protection. Such devices are available in case sizes as small as 0402 from AVX, with an 0201-sized version in development. Due to their package size, a component like this can take the place of a back-to-back zener diode and an EMC capacitor, providing up to 97% PCB area reduction.

Additionally, these low leakage MLVs offer a sub 1 FIT failure rate and a higher 'in rush' current capability than diodes, as well as a higher peak power capability with virtually no wear out phenomena. Generally speaking, MLVs are available in case sizes range from single element discrete devices in case sizes from 0402 to 1206. Dual-element devices are available in 0405 and 0508 case sizes and four-element arrays are available in the 0612 case size. These array devices are ideal for multiplexed bus and sensor protection.

### Double Barrier Layer Capacitors

A typical supercapacitor is available in values from 10 mF to 1 F at voltages up to 15 VDC. These devices exhibit low leakage characteristics from 5 ua to 40 ua depending on case size and the value of the capacitor. This low level of leakage allows them to be used in parallel with the portable systems battery to create a hybrid battery capable of powering pulsed power end systems efficiently. Their low leakage prevents them from drawing significant power during powered down states of the system. AVX's BestCap devices, for example, offer significantly low voltage drop for pulse power applications of durations of up to ~ 100msec. Additionally, the higher battery voltage supplied by the supercapacitor keeps the voltage pulse above the "cut off voltage" limit for a significantly longer time.

### Thin Printed Batteries Provide a Design Alternative

by Matt Ream, Blue Spark Technologies, ([www.bluesparktechnologies.com](http://www.bluesparktechnologies.com))

[2]



Product design engineers seeking new power source technologies to improve the design, performance, manufacturability and cost of electronic products and systems should consider an exciting new technology – thin, flexible, 1.5 Volt carbon-zinc printed batteries. Printed batteries are an example of

the emerging world of printed electronics in which functional circuits, displays and power sources are printed by traditional means onto various substrates. These technologies are enabling companies to bring innovative new products to market faster and more cost-effectively, and to improve the performance and cost basis of many existing products.

Thin printed batteries are manufactured using a roll-to-roll printing process which can scale quickly and economically to meet high-volume demand. The batteries are printed on a recyclable PET base material, using carbon, zinc and manganese dioxide. The anode material is a laminate of zinc foil, and the cathode material is a mix of manganese dioxide and carbon. After a separator paper is placed atop the printed design, a couple of drops of electrolyte solution are added, with a top layer of PET used to seal in the primary battery cell. Power generation results from a chemical reaction between the electrolyte liquid and the other printed materials. Printed batteries can be stored in cold storage to halt this chemical reaction until needed.

Unlike lithium, mercury and other battery chemistries, thin printed carbon-zinc batteries are eco-friendly and contain no toxic substances. As a result, they are safely disposable, recyclable and meet the European Union's RoHS Directive and other industry standards. In addition, printed electronics can help bring exciting products to market faster, at lower cost and with lower environmental impact.

Because printed carbon-zinc battery designs are easy to customize, design engineers can specify size and shape (rectilinear or non-rectilinear), and overall voltage, storage capacity and thickness can be adjusted according to the application's power requirements. Additional design considerations include ease of product integration, manufacturability and assembly.

With their high-volume availability, low cost, and ease of integration and assembly, thin printed batteries offer a high-value alternative to traditional button or coin batteries frequently used to extend the performance of Battery Assisted radio frequency identification (RFID) systems. Because of their compact form factor, flat profile and flexibility, printed batteries are dramatically simpler to integrate into powered and RFID cards, labels and tags than traditional batteries. Also, the batteries can frequently share the same substrate occupied by other printed electronic circuits. This results in more rapid integration, as well as reduced manufacturing and assembly time and costs.

**Considering Aftermarket Batteries**

by Jeffrey VanZwol, Micro Power Electronics, ([www.micro-power.com](http://www.micro-power.com)) [3]



As a portable device manufacturer, it is your responsibility to protect your company and customer base from the aftermarket packs, or at least manage the suppliers of aftermarket batteries for your device. There are many options available to design in protection against aftermarket batteries. The most obvious is the form of the packaging and connectors, but this approach can be circumvented by simple measurements, and once an aftermarket version is available, the original manufacturer would have to change the form factor, a non-trivial task.

Labeling, such as stickers, certification markings, & holograms are another possibility, but good quality, cheap, scanners and color copiers make these methods easy to reproduce. Web based registration is another idea, but it creates an inconvenience for the user. A device manufacturer's objective is to increase the pain level of an unauthorized manufacturer so that they choose not to manufacture a clone of the battery pack. An electronic challenge and response or electronic identification (ID) may be warranted for the protection of the OEM's product; the added cost of an ID based solution may be sufficient to achieve the goal of increasing the time and expense to create counterfeits.

However, a simple ID approach should not be considered secure because an oscilloscope measurement will give all the information needed to reproduce a static ID. If an unauthorized manufacturer is willing to add the cost to reproduce the ID, then this system fails to protect the end user or the OEM.

A changing challenge-and-response protocol between the battery and the device is a more secure approach. One could employ a cyclical redundancy check (CRC) method. In this system the challenger, which is the portable device, sends a command to read the ID from the responder, which is the battery. A more secure version of the challenge/response technique is to use a public domain algorithm, such as a SHA-1/HMAC. This authentication strategy is the method of choice in the battery industry; it can be implemented in the fuel gauge or in a separate IC. Fortunately, many of the latest fuel gauges have SHA-1 based authentication as one of their features, so simply planning for the implementation of this feature with appropriate design on the device side is all that is necessary to implement a secure ID solution.

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A webcast on this topic is available on the ECN Website at:

<http://www.ecnmag.com/batterypack> [4]

[See page two...](#) [5]

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