Main Feature

Military Batteries

High-Power Lithium Technology Proves Ripe for Mil Apps

Commercial battery technologies have evolved to meet the military's needs. Lithium solutions are cost-effective, offer long shelf life and instantaneous activation without requiring a squib, heater or heat shield.

Sol Jacobs, VP and General Manager
Tadiran Batteries

The U.S. DoD recently identified the need for a reliable high-power battery for single-use military applications as a "critical problem" demanding significant attention. Demand for high-voltage/high-rate batteries is growing for applications like guidance systems for rockets and missiles, smart ammunition, torpedoes, mines, sonobuoys, unattended ground sensors, UAVs, artillery fuses, active decoy systems, trajectory correction add-on kits, proximity fuses for bombs and sensors for dispersed munitions.

Figure 1

The TLM-1550HP high-power lithium battery from Tadiran Batteries.

These devices require batteries that deliver high voltage and high power rates for short periods of time, ranging from fractions of a second to several hours. Design engineers must consider extremely long shelf life, rapid activation, size/volume/weigh limitations, capacity and energy density requirements, and the ability to test the battery to ensure system readiness. Certain battery technologies also require squibs or gas generators to start the battery, thermal insulation to protect against internal heat and heating elements to ensure reliable operation at low temperatures.

Reserve Batteries

Traditionally, reserve batteries were preferred for single-use military applications because, in most cases, the electrolyte is either stored separately from the rest of the battery or pyrotechnic devices are used to activate the battery, allowing it to remain inert until use. This results in a tradeoff between long shelf life and the inability to test the battery for system readiness. Reserve batteries also require delayed activation until the chemical reaction occurs. Available reserve batteries include thermal, lead-acid, silver-zinc and lithium thionyl chloride.

Thermal batteries contain a metallic salt electrolyte, non-conducting when solid at ambient temperatures, but an excellent ionic conductor when molten. Activated by a squib (pyrotechnic charge), thermal batteries provide a high burst of power—a few watts to several kilowatts—for a short period of time. Advantages include ruggedness, safety, reliability and long shelf life. Thermal batteries have operating temperatures of 400° to 700°C and require insulation to conserve heat and protect surrounding components.

Silver-zinc batteries are complicated systems utilizing a gas generator, tubular electrolyte reservoir, manifold, battery block, vent and heater system. This technology is expensive and has a relatively low energy density. Design times and costs are high, due to the extra components required.

Spin-activated lead-acid batteries, commonly utilized for military fuses and marine applications, store the electrolyte (typically fluoroboric acid) in an ampoule or bladder, which is cut open when the shell is fired, and the electrolyte wets the cell stack via the centrifugal force of the spinning shell. Spin-activated lithium thionyl chloride batteries, often found in artillery-delivered minelets or communication jammers, are slowed by parachute and must continue to operate for some time after impact. Advantages include very high rates of discharge with no voltage delay. Spin-activated batteries tend to have low energy capacity and relatively long activation times.

A COTS Alternative: High-Power Primary Lithium

Recently, a high-power lithium battery, the TLM-1550HP (Figure 1), was developed by Tadiran Batteries employing the Hybrid Layer Capacitor (HLC) technology found in their PulsesPlus batteries, a widely accepted commercial technology in use worldwide. This AA-size cylindrical cell features an open circuit voltage of 4.0 volts, 2 watt-hours total energy and the capacity to handle 15A current pulses and 5A maximum continuous current at 3.2V. A smaller, 27 mm version delivers 1 watt-hour total energy, and a 20 mm version delivers 0.5 watt-hour.

High-power lithium primary batteries offer a wide temperature range (-40° to +80°C) and up to 20 years of storage life, with self-discharge of 1% per year at room temperature. They can be routinely tested to ensure system readiness, promoting fewer "duds" when utilized in missile systems and other munitions. By combining small cells into various shapes and sizes, battery packs can be made using off-the-shelf products, leading to faster design times and less expense.

High-power lithium batteries are extremely safe and can be shipped as non-hazardous goods, as the solvents are non-toxic and non-pressurized, with a glass-to-metal hermetical seal. These batteries have performed well in safety tests, including nail penetration, crush tests, high-temperature chambers, short circuit and charge tests.

This chemistry does not generate high internal temperatures, eliminating the need for thermal insulation. These batteries also operate at low temperatures, saving space and costs by negating the need for external heating elements. Other advantages include faster activation with instantaneous voltage and no waiting time—with no squibs or gas generators required to start the battery, even after extended storage time. These cells remain "on" for testing all of the time, with proven methods used to ensure that the battery power remains disconnected from the actual weapons systems before use.

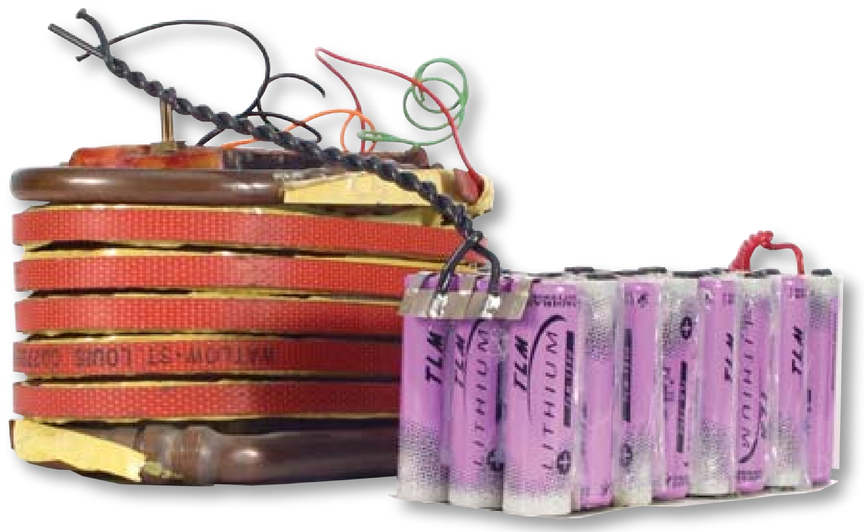

Figure 2

Twenty-four AA-size high-power lithium batteries are still smaller than the silver-zinc battery pack they will replace.

Typical Applications

Typical examples in which high-power commercial lithium batteries have been substituted for expensive custom reserve batteries include:

MOFA fuses for guided artillery shells: The best example of an attempt to standardize batteries for military applications is the Multi-Option Fuse for Artillery (MOFA) battery for 105 mm and 155 mm bursting artillery projectiles. Options considered were lead-acid, thermal and lithium oxyhalide, with lithium oxyhalide selected. By comparison, a high-power lithium primary commercial battery consisting of two 20 mm cells is smaller and lighter, provides up to double the operating time with instantaneous activation and more stable voltage.

Back-up power for UAVs: Previously, in the event of a power failure, UAVs utilized large D-sized cell primary lithium battery packs to operate the guidance system, enabling UAVs to glide to a safe landing. Replacing the larger battery pack with a smaller pack of AA-size high-power lithium primary batteries led to substantial size and weight reductions, extended shelf life and fewer battery replacements.

Primary power for a missile system: Guidance systems on an air-to-ground missile powered by a silver-zinc battery pack will be converted to a pack using 24 high-power primary lithium batteries, resulting in faster production, greater availability, reduced weight and volume, greater energy density and reduced cost. The TLM pack does not need the squib, gas generator and heater associated with the silver-zinc pack (Figure 2).

Powering a guided artillery shell: In guided munitions, a larger reserve battery that delivered medium power, high capacity and low current pulses was converted to a high-power lithium battery pack consisting of four to six 20 mm batteries. This commercial alternative reduced size, weight and cost.

High-power lithium commercial battery technology can successfully compete against traditional reserve batteries, delivering benefits such as greater design flexibility, size and weight reductions and significant cost savings. ▮

Tadiran Batteries
Port Washington, NY.
(516) 621-4980.
[www.tadiranbat.com].