Extreme Environments Demand Extreme Lithium Power

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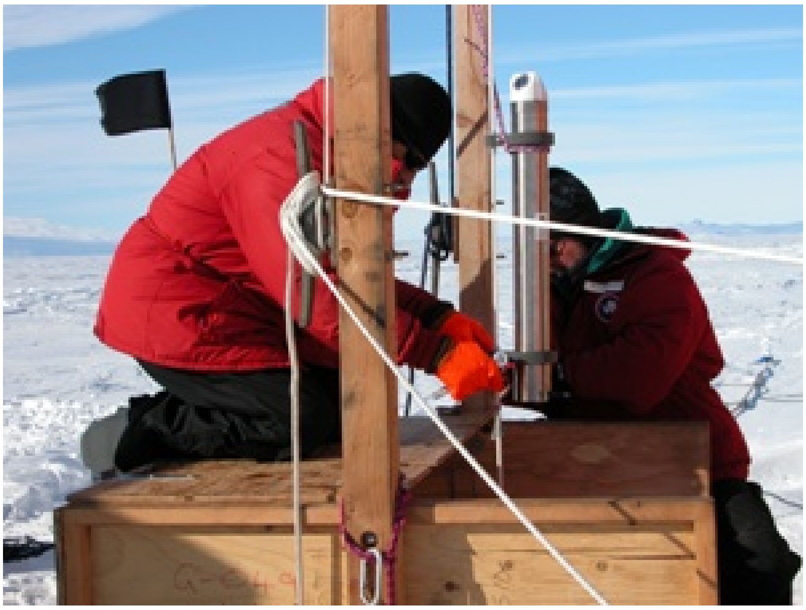
Harsh environmental conditions demand long-life lithium batteries capable of powering remote wireless sensors reliably for 25+ years

The more challenging the environment, the more critical the choice of power management solution. This maxim is especially true if the hostile environment is also located in an inaccessible location, making battery replacement difficult or impossible.



Remote sensors are increasingly finding their way into exotic locations, from seismic monitoring stations in Antarctica, to GPS tracking of ice bergs in the North Atlantic, to sensors that must withstand the extreme temperatures of oil and gas drilling equipment, to oceanographic sensors that must survive the frigid cold and high pressure of ocean depths.

Extreme environmental conditions can also found in everyday life. For example, millions of motorists flash their E-ZPass at toll booths each day, unaware that this RFID device is powered by a lithium thionyl chloride (LiSOCL2) battery capable of withstanding the extreme heat, vibration and rapid temperature cycling to which automotive windshields are subjected. LiSOCL2 chemistry is also utilized to power tens of millions of wireless automated meter reading (AMR) units worldwide, demanding reliable performance in all types of conditions, from artic cold to desert heat. These batteries are also being utilized in medical RFID tags that must withstand the prolonged heat of autoclave sterilization cycles, and data loggers that must work continuously in the cold chain.

Lithium thionyl chloride (LiSOCL2) chemistry is ideal for long-term deployment in challenging environmental conditions because it offers the highest specific energy (energy per unit weight) and energy density (energy per unit volume) of all existing battery chemistries. One reason for the high energy density is lithium's large electric potential, which exceeds that of other metals, and which produces the high voltages typical of lithium batteries (2.7-3.9 VDC). Lithium cells use a non-aqueous electrolyte, which enables certain LiSOCL2 batteries to operate in extreme temperatures (-55°C to 125°C), with certain models adaptable to the cold chain (-80°C). Recently, Tadiran LiSOCL2 cells were placed in a chyro chamber and subjected to progressively lower temperatures down to -100°C and continued to operate as needed.

Bobbin vs spiral wound construction

Lithium primary LiSOCl2 cells are constructed two ways: bobbin-type and spiral-wound. Bobbin cells combine the highest energy density, the highest voltage, a wide temperature range, and very low annual self-discharge (less than 1 percent per year). Bobbin cells consist of an outer cylinder made of lithium metal and an inner electrode that is reminiscent of a bobbin of thread. Spiral-wound cells use flat sheets of metal wound around a core, providing a large surface area that can create high currents. The greater number of layers within the spiral-wound cell reduces the volume of electrolyte these batteries can hold, whereas bobbin cells can hold more electrolyte, enabling them to deliver about 30% more energy than spiral-wound cells of equivalent size.

Bobbin-type LiSOCl2 cells have a proven track record in remote wireless applications. In 1984, this battery technology was chosen by Aclara (formerly Hexagram) to power their first generation of wireless AMR meters. Today, millions of these units remain in operation, the earliest of which are still operating on their original LiSOCl2 battery after 28+ years in the field.

A choice of batteries for high current pulse applications

Wireless sensors are becoming increasingly complex and feature-rich, with a growing demand for “On Demand” 2-way RF communications that require high current pulses for data gathering and transmission. To address the unique power requirements of high current pulse applications, Tadiran developed the PulsesPlus™ battery, which combines a standard bobbin-type LiSOCL2 battery with a patented Hybrid Layer Capacitor. This combination allows remote wireless devices to operate continuously with low background current, periodically drawing high current pulses for data capture and transmission, then returning to a low current “sleep” or “standby” state. The PulsesPlus battery also features a unique voltage curve that allows devices to be programmed to generate low battery status alerts. PulsesPlus batteries are available in a 3.6V system that indicates when approximately 95 percent of the battery’s capacity has been exhausted, and a 3.9V system that indicates when approximately 90 percent of available capacity has been used up.

Tadiran recently introduced a second alternative, Tadiran Rapid Response TRR© Series batteries, which do not require the use of an HLC but still deliver high capacity and high energy density without voltage or power delay.When a standard LiSOCl2 battery is first subjected to load, voltage can drop temporarily, and then return to its nominal value. TRR Series batteries virtually eliminate this voltage drop as well as voltage drop under pulse (or transient minimum voltage level).The final result is zero delay during the voltage response. These unique attributes enable TRR Series batteries to utilize available capacity more efficiently, thus extending the operating life of the battery by up to 15 percent under certain conditions, especially in extremely hot or cold temperatures.

Lithium battery technology is evolving rapidly to address the needs of high current pulse applications in extreme environments, providing design engineers with greater flexibility to craft optimized solutions that result in decades of maintenance-free battery performance.

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