| FEATURE |

LITHIUM BATTERIES POWER REMOTE OCEANOGRAPHIC APPLICATIONS

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Low-power remote wireless sensors are bringing enhanced data intelligence to all types of oceanographic applications, including buoys (drifting, moored, ARGO), mayday and other emergency systems, GPS and ARGOS tracking devices, current meters, transponders, harbor lights, acoustic releases, and seismometers, to name a few.

These low-power applications typically utilize industrial grade lithium batteries that deliver high specific energy (energy per unit weight) and high energy density (energy per unit volume) to pack increased functionality into ever-shrinking packages. As the lightest non-gaseous metal, lithium offers higher electrical potential to deliver higher voltage (2.7-3.9 VDC). Lithium cells also feature a non-aqueous electrolyte that is less prone to freezing.

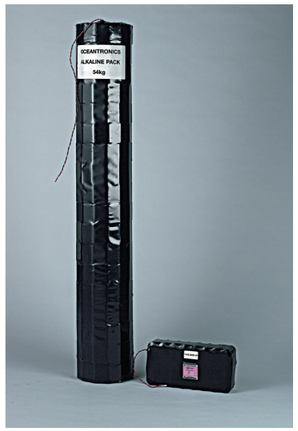
Numerous primary (non-rechargeable) lithium battery chemistries are available, with bobbin-type lithium thionyl chloride ($LiSOCl_2$) being widely preferred for ultra-long-life applications that draw average current measurable in microamps with pulses in the multi-Amp range.

Bobbin-type $LiSOCl_2$ cells are uniquely designed to harness the passivation effect, which reduces their annual self-discharge rate. However, due to their low-rate design, standard bobbin-type $LiSOCl_2$ cells cannot generate high pulses, requiring the use of a patented Hybrid Layer Capacitor (HLC). The standard bobbin-type cell delivers low-level background current during 'standby' mode while the HLC delivers high pulses to support wireless communication. The HLC also features an end-of-life voltage plateau that permits 'low battery' status alerts.

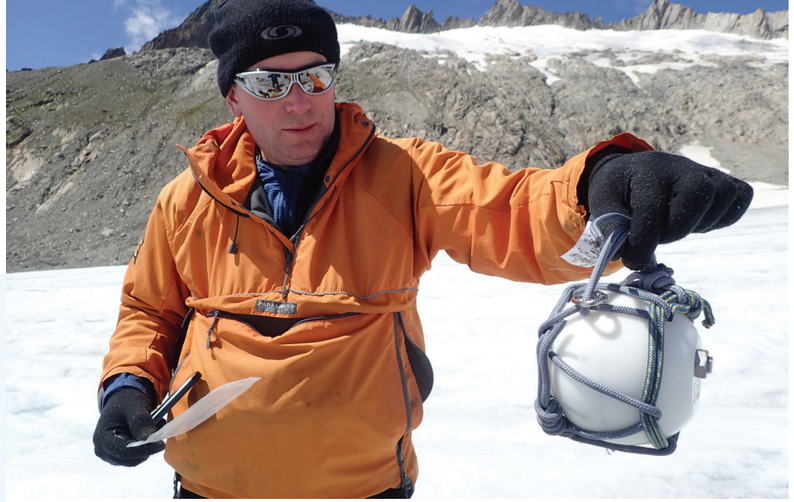
Here are some real-life examples involving these batteries:

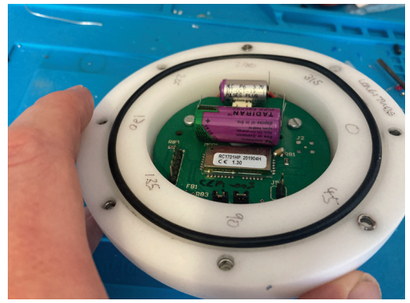
REDUCING THE SIZE OF A GPS/ICE BUOY PACK BY 90%

Oceantronics, a Hawaii-based producer of commercial radars, GPS systems and peripheral equipment, supplied GPS/ice buoys to NOAA/PMEL powered by bulky (54 kg) battery packs made with 380 alkaline D cells to provide one-year operating life for devices deployed at the North Pole Environmental Observatory.



» *Oceantronics redesigned the battery pack for its GPS/ice buoy to reduce weight and size of the device by 90% (54 kg down to 3.2 kg), making it easier to transport via helicopter. (Photo credit: Oceantronics/Sigrid Salo, NOAA/PMEL)*





» *Mike Prior-Jones prepares Cryoegg for deployment. (Photo credit: Mauro Werder) Bobbin-type $LiSOCl_2$ cells were chosen for their high capacity, high energy density, extended temperature range, and high pulse capabilities. (Photo credit: Cardiff University)*

To create a lighter and more miniaturized solution for monitoring Artic icebergs, a custom pack was created that combined 32 D-size bobbin-type LiSOCl2 cells and 4 HLCs to reduce size and weight by over 90% versus alkaline batteries. The redesigned pack increased operating life manyfold, survives 55°C, and meets UN standards for shipping hazardous goods.

In a similar application, scientists and engineers studying icebergs off Antarctica and their biological effects on the Southern Ocean used remotely piloted aircraft to drop asset-tracking tags on selected icebergs that transmitted their GPS coordinates via the Iridium satellite network. The battery had to weigh less than 500 g, survive a drop from more than 100 m, and operate reliably for up to one year at -30°C. The asset-tracking drop tags required 20 uA current in 'standby' mode with 1 A pulses when transmitting data and were powered by a 3.6 V, 2.4 Ah pack consisting of single AA-size LiSOCl2 bobbin-type cell and 2 HLCs. This solution weighed just 70 g and can operate at -55°C.

MONITORING DEEP SEA WATER CHANNELS

Researchers studying the impact of rising sea levels on deep water channels beneath glaciers in Greenland and Antarctica deployed a device developed by Cardiff University, the *Cryoegg*, to monitor changes in temperature, pressure, and electrical connectivity.

The *Cryoegg* utilizes the same 169 MHz Wireless M-Bus radio technology found in AMR/AMI utility meter transmitter units (MTUs) to transmit signals underwater, eliminating the need for bulky and expensive cables that can be easily damaged by glacial movement. The device is powered by hybrid bobbin-type $LiSOCl_2$ cells that deliver high capacity, high energy density, and high pulses, allowing data to be transmitted twice per day for up to two years.

REMOTE MONITORING OF FISH TELEMETRY DATA

VEMCO acoustic telemetry receivers and ultrasonic transmitters track the migratory activity of aquatic wildlife, warning beach goers if sharks or other predatory fish are near shore.

Fish are randomly tagged with 69 kHz and/or 180 kHz transmitters capable of operating at 500 m depths. A floating acoustic modem activates the transmitters then returns to a 'standby' state to minimize power consumption.

To transmit data through the OTN (Ocean Tracking Network) or AATAMS (Australian Acoustic Telemetry and Monitoring System) networks, these acoustic modems were powered by 24 D-sized bobbin-type LiSOCl2 cells in combination with 12 HLCs, delivering 1600 Wh of energy and 9.5 years of single channel listening (5.5 year life for dual channel listening), and other functionality such as omnidirectional listening and fast acoustic 'wake up'. Using alkaline batteries would have reduced operating life to one year.

MEASURING SUB-SEAFLOOR FLUID PRESSURES

Shifting subterranean tectonic plates cause deadly earthquakes and tsunamis. To gain greater insight into this generally inaccessible domain, scientists and geophysicists collaborated with the Ocean Drilling Program (ODP) to install Circulation Obviation Retrofit Kits (CORKs) that measure temperature and pressure on the seafloor and also within sub-seafloor boreholes.

CORK units incorporated a wellhead data logger accessible by deep submersibles. Some CORKs were outfitted with inflatable packers to record conditions at varying depths within the borehole. The wellhead data loggers were powered by hybrid $LiSOCl_2$ battery packs that draw 4 mW continuous current in 'standby' mode and 100 mW pulses while sampling data at a rate of one second per minute. The monitoring devices were powered by a battery pack consisting of 6 DD-size bobbin-type $LiSOCl_2$ cells capable of delivering 750 Wh capacity (7.2V, 105 Ah) for up to 7 years. These devices drew a relatively small amount of peak current, so no HLC was required.

(Courtesy of the Geological Survey of Canada, U.S. National Science Foundation, Integrated Ocean Drilling Program.)

MID-OCEAN-BOTTOM BROADBAND SEISMOMETER

The Monterey Bay Aquarium Research Institute (MBARI) deployed Monterey Ocean-Bottom Broadband (MOBB) seismometers to detect low-frequency seismic activity at 1000 m depths and more than 50 km from shore for four-month intervals between servicing. The MOBBs required 2.2 W of continuous power with pulses exceeding 7 W and were powered by a 10 kW/hr battery pack consisting of 96 D-size bobbin-type $LiSOCl_2$ cells and 12 HLCs. For more information, visit: *www.tadiranbatteries.de*.

TADIRAN BATTERIES