

Battery Power for Remote Wireless Sensors

Hybrid lithium batteries are a reliable way to power sensors that require high current pulses to transmit their data.



Sol Jacobs, Tadiran Batteries

With the proliferation of sensors installed in remote or hard-to-access sites, providing the devices with operating and communication power has raised new challenges. These sensors, which require high current pulses, are at work in automatic meter reading, system control and data acquisition (SCADA), data loggers, measurement while drilling, resistance temperature units, and other remote monitoring applications.

High current pulse power, combined with low background currents, are typically required when the sensor has three (or more) operating modes:

- Sleep or standby, where battery power consumption ranges from nil to a low background current in the microamp range
- Measurement or interrogation, where the unit may require power in the range of a few hundred milliamps
- Transmission, where the unit may require a few amps for up to a few minutes before power-down and return to an energy-saving sleep or standby status

Battery or Photocell?

Many devices that are broadly defined as wireless because of their method of data transmission are not truly wireless in that they may require hardwiring to an AC power source. In remote sensor installations, however, it is often impossible or expensive to connect to the power grid. In situations where a self-contained power supply is required, design engineers have traditionally relied on two options: primary lithium battery power or photovoltaic systems with rechargeable batteries. Photovoltaic systems are naturally suited to sunny, temperate climates, but they tend to be large, comparatively expensive, and susceptible to breakage, and they require ongoing maintenance. Their use in inaccessible areas is therefore problematical.

Lithium batteries (see Figure 1, page 43) are the preferred choice for most remote sensing applications because they have the highest specific energy (energy per unit weight) and energy density (energy per unit volume) of all battery types. Lithium cells, all of which use a nonaqueous electrolyte, have nominal open-current voltages of 1.8–3.9 V. They also feature operating temperature ranges of -55°C to 85°C , and some can work at up to 150°C .

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Adapting Lithium Technology to High Current Pulse Applications

Lithium chemistry for primary power can be provided by lithium carbon monofluoride (LiCF_x), lithium manganese dioxide (LiMnO_2), or lithium thionyl chloride (LiSOCl_2). Of these, lithium thionyl chloride cells are best suited to high current pulse applications because they have the highest energy density (700 W-h/kg), the highest voltage (3.6 V), and the longest service life (up to 20 years). LiSOCl_2 batteries are available in both spiral wound and bobbin type. The bobbin-type configuration is particularly suited to wireless applications thanks to its extended temperature range of -55°C to 150°C , low self-discharge, and inherent safety. On the downside, high current pulse requirements present certain technical challenges to bobbin-type lithium cells, which have low current capability due to their low-rate design.

To overcome this problem, engineers at Tadiran developed PulsesPlus (see sidebar, page 46), a unique hybrid lithium battery that combines bobbin-type construction with a patented high-rate, low-impedance hybrid layer capacitor (HLC). The HLC can store up to 700 W-h/kg of energy, with a storage rate of 280 A-s for smaller capacitors and up to 1120 A-s with larger HLCs. Moreover, these batteries can be connected in series or in parallel to achieve higher pulses and higher voltages by combining multiple-cell/HLCs into battery packs.

Sample Applications

AMCi SatAlarm Monitoring Devices. AMCi (Golden, CO; 303-279-2002, amc-wireless.com) manufactures SatAlarm-Sentry sensors (see Figure 2, page 44) that monitor engines, compressors, tank levels, and similar SCADA devices. For example, if a natural gas pipeline compressor shuts down and causes an interruption in gas flow (a problem



Figure 1. For most remote sensing applications, lithium batteries are the power source of choice. Bobbin-type lithium thionyl chloride batteries have extremely low self-discharge, enabling them to last up to 20 years in extreme environmental conditions.





Figure 2. The SatAlarm-Sentry, shown here monitoring a gas pipeline compressor unit, provides early warnings of out-of-bounds conditions in remote installations. Powered by a hybrid lithium battery pack, SatAlarm devices offer up to 20 years of service between battery replacements.

SatAlarm's main communications pack is powered by four D-sized LiSOCl_2 cells and four HLCs. The use of hybrid lithium battery technology enables SatAlarm devices to be small, lightweight, and easily portable. The cells deliver high energy density and high current pulses without any passivation or voltage delay problems. With a temperature range of -40°C to 85°C , the SatAlarm can operate reliably, even under the extreme temperature excursions experienced at many remote locations.

AXTracker Mobile Asset Tracking Devices. The AX-Tracker made by Axonn (New Orleans, LA; 504-282-8119, www.axonn.net) is a true ready-to-go, self-contained telemetry device (see Figure 5, page 47) that attaches to the outside of

that may otherwise go undetected for hours), the SatAlarm sends a warning signal via satellite as soon as the compressor stops vibrating. This not only speeds repairs, but also provides the precise location of the problem.

cargo containers, railcars, or trailers and transmits real-time GPS location and other data via one-way simplex communications through the Globalstar Satellite Network. The units typically require high current pulses for periods up to 1.5 s.



Figure 3. Sensus Metering Systems' MXU 505C meter transceiver, shown here in an in-ground installation, works with handheld or vehicle-based RadioRead units to measure water consumption patterns and transmits them to a main computer terminal via DSSS technology. The use of hybrid lithium batteries enables Sensus Metering Systems to offer the industry's only published 20-year warranty.

The PulsesPlus

PulsesPlus batteries (see Figure 4) were developed specifically for applications such as automatic meter reading that require extremely long life at low average currents combined with periodic high current pulses. Marrying the inherent benefits of a standard bobbin-type lithium thionyl chloride cell with a hermetically sealed hybrid layer capacitor (HLC), they can be used to deliver pulses up to 3 A in amplitude and 380 A-s duration in a package no larger than two AA cells. By connecting these modules in series or parallel, a wide variety of voltages and capacities can be accommodated. The HLC is currently available in two sizes, all 15 mm in dia. with lengths varying from 20 to 50 mm.

Additional benefits include:

- Operating voltage of 3.6/3.9 V
- Instant response/no passivation
- Operating temperature range of -40°C to 85°C
- Hermetically sealed (glass-to-metal seal, laser welded)
- 20-year operating life
- Self-discharge $<1.5\%$ /year
- UL listed
- Compliant with current shipping regulations



Figure 4. PulsesPlus batteries from Tadiran use hybrid layer capacitors to deliver high current pulses. The batteries are available in a variety of standard cylindrical configurations as well as custom battery packs.



Figure 5. AXTracker mobile asset trackers are self-contained, battery-powered telemetry devices that can be attached to the outside of railcars, cargo containers, or trailers. The units send multiple daily transmissions of GPS location as well as other data via the Globalstar Satellite Network.

To accommodate AXTracker's extremely compact and low-profile design (9.2 by 6.45 by 1 in.), a custom battery pack was designed consisting of six lithium AA-cells and one HLC. The battery's low discharge rate, combined with its high capacity and high energy density, allow the units to offer three to seven years of uninterrupted service between battery replacements, depending on the configuration and number of daily transmissions.

Sensus MXU 505C Meter Transceiver Units. Sensus Metering Systems (Union-

town, PA; 800-638-3748, www.sensus.com) manufactures the RadioRead (see Figure 3), a completely automatic meter reading package for the water utility market. The system incorporates an MXU 505C meter transceiver unit.

Attached to water meters located underground, in cellars, or on the outside walls of buildings, the MXU 505C communicates with handheld or vehicle-based RadioRead interrogators, transmitting information using direct-sequencing spread-spectrum technology. After the MXU transmits the

meter's encoder identification and meter reading to the interrogation unit, that unit signals to the MXU that valid reading parameters have been met and instructs the MXU to power down to an energy-saving standby mode.

The MXU's transceiver is powered by one bobbin-type LiSOCl₂ C-cell in combination with an HLC. This hybrid battery pack delivers the high current pulses required to maximize data streams and increase transmission frequency. Furthermore, it offers a 20-year warranty made possible by the battery pack's low self-discharge rate, about 1%/year. The -40°C to 85°C temperature range allows meter readers to gather accurate, reliable, and timely data regardless of weather conditions.

By eliminating the need for battery changeouts over a 20-year period, the MXU 505C meter transceiver unit helps water utilities reduce maintenance and operating costs, resulting in a higher return on investment and the most efficient use of resources.

Summary

With new applications seemingly cropping up on a daily basis, and sensing devices becoming increasingly feature rich and power hungry, design engineers are sending a wakeup call to battery manufacturers for innovative solutions such as hybrid lithium battery technologies. ■

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