Special Section

Batteries, Battery Management & Power Sources

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Making Wireless Sensors Truly Wireless

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Demand is growing for intelligent, low-cost wireless sensors. Approximately 80 million "wireless" monitoring devices are in use worldwide, serving applications such as SCADA, level monitoring, flow meters, AMR, data loggers, measurement while drilling, overflow alarms and RTUs.

However, many applications considered "wireless" are not truly wireless since devices that are not hard-wired for communications still require hard-wiring for power. Hard-wiring involves expensive cable and wiring (estimated at $18 to $40 per foot), and limits the choice of potential locations.

Designing Remote Wireless Sensors Using Lithium Battery Technology

Recently, Oak Ridge National Laboratory outlined 12 requirements for "The Ideal Wireless Sensor." Their number-one criteria was the need for "adequate battery life" followed by the need to "be self powered" and "suitably small."

Based on these and other performance criteria, lithium batteries represent a good choice for wireless sensors. Unlike household alkaline batteries that have low initial voltages and high self-discharge, lithium chemistries feature the highest specific energy (energy per unit weight) and energy density of all battery types. Higher energy density is due to lithium's high potential.

Lithium cells — all of which use a non-aqueous electrolyte — have nominal open circuit voltages (OCVs) of between 2.8V and 3.9V. Lithium cells also feature extended operating temperature ranges with some lithium-based cells able to operate in temperatures up to +150°C.

Lithium Batteries Are Not All Alike

Primary batteries can use a variety of lithium chemistries including Li/CFx (lithium poly carbon monofluoride), Li/MnO_2 (lithium manganese dioxide), Li/SO_2 (lithium sulfur dioxide) and Li/$SOCl_2$ (lithium thionyl chloride).

Li/CFx cells have an OCV of 2.8V and moderate energy density. Cylindrical types use a spiral cathode for higher rate capability and have crimped plastic seals. Though generally safe, under extreme high temperature and humidity conditions the elastomer seal can break, causing the cell to fail.

Li/MnO_2: These 3.0V cells are similar to Li/CFx cells both in terms of construction as well as issues related to high temperature and humidity. Their energy density and voltage is slightly better than Li/CFx cells, especially at cold temperatures.

Li/SO_2: These 2.8V cells deliver high current, especially at cold temperatures. Their main drawback is high self discharge and reduced capacity. The service life and energy density of Li/SO_2 cells are typically half that of lithium thionyl chloride cells.

Li/$SOCl_2$: Lithium thionyl chloride 3.6V cells feature the highest energy density and voltage of all lithium chemistries, with up to 15 to 20 years of service life. Bobbin-type lithium thionyl chloride cells offer extended temperature ranges (-55°C to +150°C). High capacity, small size and an ability to withstand broad fluctuations in pressure, temperature and shock make bobbin-type cells especially well-suited for remote locations.

Lithium thionyl chloride cells from Tadiran.

High Current Pulse Hybrids

Many types of wireless sensors require high current pulses, presenting technical challenges to bobbin-type cells. These applications often involve low continuous current (or background current) coupled with high current pulses of up to several Amperes.

Bobbin-type cells deliver powerful capacity and energy density, but have a low current capability due to their low rate design. To overcome this, Tadiran has developed PulsesPlus™, a hybrid battery that combines a bobbin-type cell with a patented high rate, low impedance HLC (hybrid layer capacitor).

This hybrid system delivers extremely high currents with an excellent safety margin. The HLC can store up to 700 Wh/Kg of energy, with the rate of energy storage varying from 280 A/sec. with smaller HLCs, to 1,120 A/sec. with larger size HLCs.

Examples of Truly Wireless Remote Sensors

Asset Tracking/Monitoring Devices. A manufacturer of mobile asset tracking and monitoring sensors for cargo vessels, truck fleets and vehicles, as well as sentry sensors for engines and tank levels, utilizes wireless sensors to communicate with headquarters via satellite communications. These sensors require a battery that combines high energy density, a wide temperature range and a long service life. Alkaline batteries are problematic due to the number of cells required (20 D-sized cells). Temperature range is also an issue since alkaline cell capacity drops by 60 percent at -10°C.

The solution involved a main communications pack powered by four D-sized lithium thionyl-chloride cells plus four hybrid layer capacitors (HLCs). Hybrid lithium battery technology enables these devices to be smaller and lighter, delivering high energy density and high current pulses without any passivation or voltage-delay problems. The hybrid lithium's extended temperature range of -40°C to +85°C enables tracking and monitoring devices to perform in severe climates, including heat-intensive drilling, pumping equipment and fleet vehicles.

AMR Meter Transmitter Units

A manufacturer of fixed network automatic meter reading systems designed for automatic gas, electric and water meter reading uses an MTU which contains a narrow band UHF transmitter.

To date, the company has installed over two million MTUs that use lithium thionyl chloride batteries. Most of these systems are still operating on the original batteries after 15 or more years in the field. The extended temperature range of the lithium thionyl chloride battery is essential, as these MTUs must operate in severe environmental conditions (-40°C to 85°C) for up to 20 years.

AMR Meter Interface Units. Another application involves meter interface units (MIUs) that transmit data from utility meters to walk-by or drive-by data collectors. Capable of multiple data transmissions per day, these MIUs require a long-life battery because battery replacements add to service costs. Hybrid lithium thionyl chloride batteries are preferred for this application, both for their high capacity and their expected service life of more than 15 years.

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