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Lithium Batteries

for

Industrial IOT

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Tadiran Batteries Ltd.
44 Yitzhak Rabin Blvd., Kiryat Ekron 7695001, Israel
www.tadiran.com

Tadiran Batteries GmBH
Industriestr. 22, D-63654 Budingen, Germany
www.tadiranbatteries.de

REMOTE WIRELESS DEVICES IN THE IIOT

Billions of battery-powered devices are soon to be interconnected through the Cloud-based Industrial Internet of Things (IIoT), including transportation infrastructure, energy, environmental monitoring, smart manufacturing, healthcare, smart buildings, and industrial automation.

Use of primary and rechargeable lithium batteries eliminate the need for the impractical expense of hard-wiring to the electrical grid, which can cost up to $100 per foot to install. Generally, the more remote the application, the greater the need for an industrial grade lithium battery.

Ideal for applications drawing low daily current

Wireless devices that draw low average daily current are predominantly powered by primary bobbin-type lithium thionyl chloride ($LiSOCl_2$) chemistry, which offers unique advantages over all other lithium chemistries, including higher energy density, higher capacity, the widest temperature range, and a lower annual self-discharge rate.

The operating life of a bobbin-type $LiSOCl_2$ cell depends largely on its annual energy usage and its annual self-discharge rate. In many cases, more energy is lost through annual battery self-discharge than through actual battery usage. How a battery is manufactured affects its annual self-discharge rate.

Tadiran offers superior quality bobbin-type $LiSOCl_2$ cells that feature a self-discharge rate of 0.7% per year, retaining nearly 70% of their original capacity after 40 years. Lesser quality bobbin-type $LiSOCl_2$ cells can have a self-discharge rate of 3% per year, exhausting 30% of their capacity every 10 years.

Easily modified for high pulse applications

If the IIoT-related application requires high pulses, the recommended solution is a **PulsesPlus™** battery, which combines a standard $LiSOCl_2$ cell with a patented hybrid layer capacitor (HLC). The standard $LiSOCl_2$ cell delivers low background current to power the device is in its ‘standby’ mode, while the HLC delivers high pulses required for data interrogation and transmission.

PulsesPlus™ batteries are advantageous to supercapacitors that store high pulses in an electrostatic field rather than in a chemical state. Supercapacitors have drawbacks for industrial applications, including short duration power, linear discharge characteristics that do not allow for use of all the available energy, low capacity, low energy density, and very high self-discharge (up to 60% per year). Supercapacitors linked in series also require cell-balancing circuits.

Rechargeable batteries will power the IIoT

Certain applications may be well suited for energy harvesting in combination with rechargeable Lithium-Ion (Li-ion) batteries being used for energy storage.

Inexpensive consumer grade Li-ion cells have a life expectancy of less than 5 years and 500 recharge cycles and operate within a moderate temperature range of 0°C - 40°C. By contrast, industrial grade **TLI Series** Li-ion batteries can operate for up to 20 years and 5,000 full recharge cycles, and offer an expanded temperature range of -40°C to 85°C, along with the ability to deliver high pulses (5A for a AA-size cell). Industrial grade **TLI Series** rechargeable batteries are constructed with a hermetic seal instead of a crimped seal that may leak.

Bobbin-type $LiSOCl_2$ cells and industrial grade Li-ion rechargeable batteries offer intelligent solutions for battery-powered devices used throughout the IIoT.

For more information **contact us** today or complete our **application questionnaire**.

The differences between consumer and industrial batteries

Battery design is rapidly evolving for both consumer and industrial applications.

Edited by: **Leslie Langnau**, Managing Editor

Consumer devices are not designed to operate in industrial environments. Billions of batteries are manufactured globally each year, the vast majority of which are used in consumer devices such as flashlights, cameras, laptops and cell phones. These consumer applications require both rechargeable and primary (non-rechargeable) batteries.

Batteries that are used in handheld devices are usually easily recharged or easily replaced, and are designed to operate at moderate temperatures. Devices such as cell phones are usually replaced every two years as part of a contract upgrade, and laptop/tablet devices quickly become obsolete. As a result, most consumer grade rechargeable batteries are only required to operate for a few years with approximately 500 full recharge cycles.

Other consumer products such as flashlights, remote controllers and toys typically use inexpensive primary lithium batteries that are also designed to operate within a temperature range (-0 to 40° C) with an expected lifespan of 2-3 years.

Industrial applications require more ruggedized batteries. Unlike consumer applications, industrial devices are often used in remote, hard-to-reach locations where the device needs to be self-powered and battery replacement and recharging is difficult or impossible. Identifying the ideal power management option is important to these applications because battery failure usually results in failure for the device. As a result, industrial grade batteries must be able to deliver reliable power for as long as the device is able to operate. Some examples include automated utility meters that have to operate up to 25 years outdoors, remote wireless sensors, automotive toll tags, GPS tracking devices, oceanographic instruments, as well as process control and monitoring devices used in remote locations that are subjected to extreme environmental conditions.

Certain industrial grade applications must withstand extreme temperatures ranging from -55 to 85° C, with cold chain applications going down to -80° C, and high temperature applications reaching as high as 150° C.

Primary cells and their markets

Alkaline cells are inexpensive and easily available. But their low voltage (1.5 V), high annual self-discharge rate, limited temperature range, and crimped seals make them highly cost effective for certain portable handheld devices but ill suited for long life operation in extreme environments.

Primary lithium cells (1.5 V or 3 V) deliver the quick pulses required for applications such as camera flashes. However, these batteries have a relatively narrow temperature range of -20 to 60° C, and their crimped battery seals can leak and corrode over time. In addition, the annual self-discharge of these batteries is too high for long-life applications.

By contrast, industrial grade primary lithium batteries need to be mechanically designed to endure harsh environments, with very high energy density to support a small form factor, very low annual self-discharge for long operating life, and a more robust seal to prevent possible leaks and lost energy capacity. The preferred long-term power solution for a remote wireless device is a bobbin-type lithium thionyl chloride (LiSOCL2) battery, which features the highest capacity and highest energy density of any lithium chemistry, along with a very low annual self-discharge rate, the widest possible operating temperature range, and a hermetic glass-to-metal seal to help prevent battery leakage. Certain battery manufacturers design their bobbin-type LiSOCL2 batteries to deliver 10-year shelf life with a self-discharge rate of 2-3% per year. The XOL Series battery offers a low annual self-discharge rate of 0.7% per year, and can operate maintenance-free for up to 40 years.

A growing number of industrial applications require rechargeable lithium ion (Li-ion) cells that can work for up to 20 years while surviving thousands of recharge cycles, operating across a wide temperature range, and delivering high pulses while retaining a very small form factor.

» Unlike consumer applications, industrial devices are often used in remote, hard-to-reach locations where the device needs to be self-powered and battery replacement and recharging is difficult or impossible.

The earliest rechargeable batteries were made of Nickel Cadmium (NiCad). Originally developed back in the mid-nineteenth century, NiCad batteries are less in demand because they tend to be large and have low energy density. NiCad batteries also suffer from "memory effect," whereby the battery does not fully recharge if it is not fully depleted.

The next phase in the evolution of the rechargeable battery was the introduction of the Nickel-Metal Hydride (NiMH) battery. NiMH batteries have a high annual self-discharge rate, making them poorly suited for applications requiring extended storage life.

The most recent phase in the evolution of the rechargeable battery is the emergence of the Li-ion cell, which is increasingly popular since the battery efficiently uses lithium to provide high power output. Li-ion cells are now available in both consumer and industrial grades.

The most popular version of the consumer grade Li-ion battery is the ubiquitous 18650 cell, which was designed and manufactured by the makers of laptop computers for use in their own products. These consumer grade Li-ion cells deliver approximately 500 full recharge cycles with a temperature range of -20 to 60° C, as this is all that their intended application required. Meanwhile, design improvements that would have allowed consumer grade Li-ion batteries to deliver long-life operation at extended temperature ranges — including lower self-discharge, high cycle rate, and hermetic sealing—were never implemented for the simple reason that it would have made these batteries more expensive.

As consumer grade Li-ion cells age, they experience a gradual degradation of the cathode, making the battery less receptive to future recharging, which reduces battery operating life.

In cases where the consumer devices need to be sleek and ergonomically designed—such as a smart phone, camera or tablet—power is often supplied by a lithium polymer battery, also referred to as a laminate cell. The primary advantage of a lithium polymer battery is design flexibility, as a lithium polymer cell is packaged in a flexible material that can be rolled or stacked like a deck of cards, with the positive and negative terminals protruding from the cell as tabs. This flexible material enables the lithium polymer battery to be custom shaped to be very thin, or quite large, depending on its intended use. This material is also more susceptible to puncture than a battery encased in a steel or aluminum can. If a lithium polymer cell is punctured it can cause an internal short circuit or result in the battery self-discharging prematurely. A punctured cell can also swell in size if the anode reacts with moisture.

» A good long-term power solution for a remote wireless device is a bobbin-type lithium thionyl chloride (LiSOCL2) battery, which features the highest capacity and highest energy density of any lithium chemistry, along with a very low annual self-discharge rate, the widest possible operating temperature range, and a hermetic glass-to-metal seal to help prevent battery leakage.

Industrial grade rechargeable cells

In order to operate for extended periods in remote, harsh environments, a Li-ion cell must have extremely low annual self-discharge, be able to be charged and discharged thousands of times, operate at extreme temperatures (-40 to 85° C), be small in size, and not suffer from the same aging issues associated with consumer grade rechargeable Li-ion batteries.

The first industrial grade rechargeable Li-ion cell was recently introduced, the Tadiran TLI Series, which is capable of providing up to 20 years of service life with 5000 full recharge cycles, operates and recharges in temperatures ranging from -40 to 85° C, is capable of delivering up to 15 A pulses from an AA-sized cell, and features a glass-to-metal seal to withstand harsh environments. DW

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Components

Comparing Consumer And Industrial Batteries For Wireless Applications

by *Sol Jacobs* | Jul 14, 2017 12:00am

The world is now truly wireless, and self-powered devices are becoming integral to everything from mass consumer electronics to remote industrial applications, each with very unique power requirements.

Consumer electronic devices are generally powered by either alkaline batteries, consumer grade lithium primary (non-rechargeable) batteries, or consumer grade Lithium-ion (Li-ion) rechargeable batteries. There is also a growing list of industrial applications that require long-life power sources capable of supporting two-way wireless communications. These applications include utility meter reading (AMR/AMI), wireless mesh networks, M2M and system control and data acquisition (SCADA), data loggers, measurement while drilling, oceanographic measurements, and emergency/safety equipment, to name a few.

The growth in remote wireless communications is being propelled by technologies designed to extend battery life, including low power components, ICs and circuitry, along with low power communications protocols such as ZigBee, WirelessHART, Bluetooth, DASH7, INSTEON, and Z-Wave.

Start by understanding your overall performance requirements

Each application is unique in terms of its power requirements. The most common performance variables include:

- Energy consumed in 'stand-by' mode (the background current)
- Energy consumed during 'active' mode (including the size, duration, and frequency of pulses)
- Storage time (a battery will self-discharge during storage, diminishing its capacity)
- Thermal environments (including storage and in-field operation)
- Equipment cut-off voltage (as the battery's capacity is exhausted, the voltage can drop too low for the device to operate; an effect that is magnified in extreme temperatures)
- Battery self-discharge rate (which can be higher than the average daily current consumed)
- Battery replaceability or rechargeability
- Total cost of ownership (factoring in the battery's initial purchase price along with all future maintenance and battery replacement costs, where applicable)

Specifying a power supply invariably involves certain trade-offs, so you need to prioritize your list of desired attributes to ensure that the wireless device performs as required.

Don't be fooled by low initial expense

Consumer primary (non-rechargeable) batteries are mainly used to power flashlights, remote controls, and toys, while consumer grade rechargeable Li-ion batteries typically power smart phones, tablets and notebook computers, and similar devices. However, the low initial cost of a relatively short-lived consumer battery can be very misleading when applied to long-term industrial applications, including the risk of reduced productivity and/or the loss of sensitive data due to battery failure.

With long-term deployments, you need to determine the total cost of ownership, factoring in all costs associated with future battery maintenance or replacement, which can skyrocket if the wireless device is being deployed in a remote, difficult-to-access location. For example, accessing a wireless device that measures structural stress on a bridge abutment can involve the erection of scaffolding and safety harnesses. Other remote locations are simply inaccessible, such as seismic monitoring sensors deployed on the ocean floor.

Comparing Primary (non-rechargeable) Batteries

Primary Cell	$LiSOCL_2$ Bobbin-type with Hybrid Layer Capacitor	$LiSOCL_2$ Bobbin-type	Li Metal Oxide Modified for high capacity	Li Metal Oxide Modified for high power	Alkaline	$LiFeS_2$ Lithium Iron Disulfate	$LiMnO_2$ CR123A
Energy Density (Wh/1)	1,420	1,420	370	185	600	650	650
Power	Very High	Low	Very High	Very High	Low	High	Moderate
Voltage	3.6 to 3.9 V	3.6 V	4.1 V	4.1 V	1.5 V	1.5 V	3.0 V
Pulse Amplitude	Excellent	Small	High	Very High	Low	Moderate	Moderate
Passivation	None	High	Very Low	None	N/A	Fair	Moderate
Performance at Elevated Temp.	Excellent	Fair	Excellent	Excellent	Low	Moderate	Fair
Performance at Low Temp.	Excellent	Fair	Moderate	Excellent	Low	Moderate	Poor
Operating life	Excellent	Excellent	Excellent	Excellent	Moderate	Moderate	Fair
Self-Discharge Rate	Very Low	Very Low	Very Low	Very Low	Very High	Moderate	High
Operating Temp.	-55°C to 85°C, can be extended to 105°C for a short time	-80°C to 125°C	-45°C to 85°C	-45°C to 85°C	-0°C to 60°C	-20°C to 60°C	0°C to 60°C

Alkaline cells are readily available and extremely inexpensive, but have major drawbacks, including low voltage (1.5 V), a limited temperature range (-0°C to +60°C), a high annual self-discharge rate that reduces life expectancy to 2-3 years, and crimped seals that may leak.

Consumer primary lithium cells are also inexpensive, delivering 1.5 V or 3 V, along with high pulses to power a camera flash. These batteries have several limitations, including a narrow temperature range (-20°C to +60°C), a high annual self-discharge rate, and crimped seals that may leak.

Lithium thionyl chloride (LiSOCl2) cells are the preferred choice for wireless applications that require long-term power, especially in extreme environments. Bobbin-type LiSOCl2 batteries offer the highest capacity and highest energy density of any lithium chemistry, along with an extremely low annual self-discharge rate (less than 1% per year). This chemistry also features the widest temperature range (-80°C to +125°C), and a glass-to-metal hermetic seal that is less prone to leakage.

An assortment of lithium thionyl chloride (LiSOCl2) cells.

How a bobbin-type LiSOCl2 battery is manufactured, and the raw materials used, can greatly influence its operating life. An inferior quality LiSOCL2 battery may have an annual self-discharge rate of up to 3% per year, losing 30% of its available capacity every 10 years. Conversely, a superior grade bobbin-type LiSOCl2 battery can feature an annual self-discharge rate as low as 0.7% per year, thus permitting certain wireless devices to operate for up to 40 years on a single battery. Selecting a superior grade battery could lower your total cost of ownership substantially by eliminating future expenses associated with battery replacement, which far exceeds the cost of the battery itself.

To ensure long-term battery performance in extreme environments, state-of-the-art manufacturing techniques must be used to produce top quality batteries. This process begins by choosing the highest grade of raw materials, then employing total quality management tools such as six sigma methodologies and statistical process controls (SPC) during all phases of manufacturing to ensure greater lot-to-consistency. Not all batteries are manufactured to such high standards, so due diligence is required to verify that the batteries are UL-approved and offer a higher safety margin by being able to withstand extreme temperature, humidity, shock, vibration, and puncture.

With battery replacement costs estimated at many times the initial cost of the original battery, it is important to know the source of the raw materials, the manufacturing processes employed, and to verify the accuracy of all claims involving battery life expectancy based on typical annual self-discharge rate.

Long-term lab test results and data from the field have been assembled by Tadiran to create a huge database that accurately predicts battery performance for all types of remote wireless applications.

Industrial applications require more robust batteries

Consumer batteries do not perform well in extreme environments. A prime example is the cold chain, where wireless devices continually monitor the transport of frozen foods, pharmaceuticals, tissue samples, and transplant organs at controlled temperatures as low as -80°C. Bobbin-type $LiSOCl_2$ batteries are uniquely suited for the cold chain due to their high specific energy (energy per unit weight), high energy density (energy per unit volume), and their non-aqueous electrolyte, as the absence of water allows specially modified cells to operate in extreme temperatures ranging from -80°C to +125°C.

Wireless devices increasingly require high pulses of energy to support two-way wireless communications and other functionality. To offset the added power drain, these devices must be designed to conserve energy by operating mainly in a “stand-by” state and drawing nominal amounts of current, periodically querying the data, and only becoming “active” for brief intervals to manage data retrieval and wireless communications.

Standard bobbin-type $LiSOCl_2$ batteries are ideal for delivering low rate current. But when a high pulse is required, these batteries can experience a temporary drop in voltage, or transient minimum voltage (TMV). Consumer electronic devices use supercapacitors to minimize TMV. However, supercapacitors are ill suited for industrial applications due to their inherent drawbacks, including a high self-discharge rate - up to 60% per year - and a limited temperature range that prohibits their use in harsh environments. A supercapacitor made up of two 2.5V capacitors in series also requires a balancing circuit, which draws additional current.

For long-life industrial applications, the predominant solution is to combine a standard bobbin-type $LiSOCl_2$ cell in combination with a patented Hybrid Layer Capacitor (HLC). The battery and HLC work in parallel, with the standard cell supplying the background current while the single-unit HLC acts like a rechargeable battery to store and deliver high pulses. These hybrid batteries feature a unique end-of-life performance curve with a measurable voltage plateau that can be interpreted to issue low battery status alerts.

Certain wireless applications are ideal for energy harvesting

A growing number of wireless applications are proving to be well suited for energy harvesting devices that use rechargeable Li-ion batteries to store the harvested energy. Consumer grade Li-ion batteries have become extremely popular due to their high efficiency and high-power output.

The most popular type of Li-ion cell, the 18650, was developed by laptop computer manufacturers as an inexpensive solution that could last approximately five years and 500 full recharge cycles. However, consumer grade rechargeable Li-ion batteries are not well suited for long-term deployment in extreme environments, as these cells experience a gradual degradation of the cathode, making them less receptive to future recharging, which reduces their potential lifespan. Consumer grade Li-ion batteries have other drawbacks, including a high self-discharge rate and a narrow operating temperature range.

To overcome these limitations, industrial grade rechargeable Li-ion batteries were developed that can operate maintenance-free for up to 20 years and 5,000 full recharge cycles. These ruggedized batteries feature a very low annual self-discharge rate and can be recharged in extreme temperatures (-40°C to +85°C). Unlike consumer batteries, these cells can deliver the high pulses needed for two-way wireless communications (up to 15A pulses from an AA-sized cell), and also feature a glass-to-metal seal to withstand harsh environments.

Table 2 comparison of consumer versus industrial Li-ion rechargeable batteries.xlsx

		TLI-1550 (AA)	Li-Ion
		Industrial Grade	18650
Diameter (max)	[cm]	1.51	1.86
Length (max)	[cm]	5.30	6.52
Volume	[cc]	9.49	17.71
Nominal Voltage	[V]	3.7	3.7
Max Discharge Rate	[C]	15C	1.6C
Max Continuos Discharge Current	[A]	5	5
Capacity	[mAh]	330	3000
Energy Density	[Wh/l]	129	627
Power [RT]	[W/liter]	1950	1045
Power [-20C]	[W/liter]	> 630	< 170
Operating Temp	deg. C	-40 to +90	-20 to +60
Charging Temp	deg. C	-40 to +85	0 to +45
Self Discharge rate	[%/Year]	<5	<20
Cycle Life	[100% DOD]	~5000	~300
Cycle Life	[75% DOD]	~6250	~400
Cycle Life	[50% DOD]	~10000	~650
Operating Life	[Years]	>20	<5

For example, IPS solar-powered parking meters use industrial grade rechargeable Li-ion batteries to deliver true wireless connectivity to the IIoT. They save millions of dollars in initial installation costs by eliminating the need to hard-wire metropolitan sidewalks.

IPS solar-powered parking meters eliminate hard-wiring issues.

These wireless networked solar powered parking meters are state-of-the-art and include multiple payment system options, access to real-time data, integration to vehicle detection sensors, user guidance, and enforcement modules. All parking meters are wirelessly networked to a comprehensive web-based management system. Small photovoltaic panels gather solar energy, with industrial grade rechargeable Li-ion batteries used to store energy and to deliver the high pulses required for advanced, two-way wireless communications, thus ensuring 24/7/365 system reliability for up to 20 years.

Technological advancements are creating dynamic opportunities for bobbin-type $LiSOCl_2$ batteries and industrial grade Li-ion rechargeable batteries to deliver intelligent, long-term power sources for all sorts of remote wireless devices. Demand for industrial grade batteries will accelerate as billions of wireless devices become integrated into the burgeoning IIoT.

About the Author

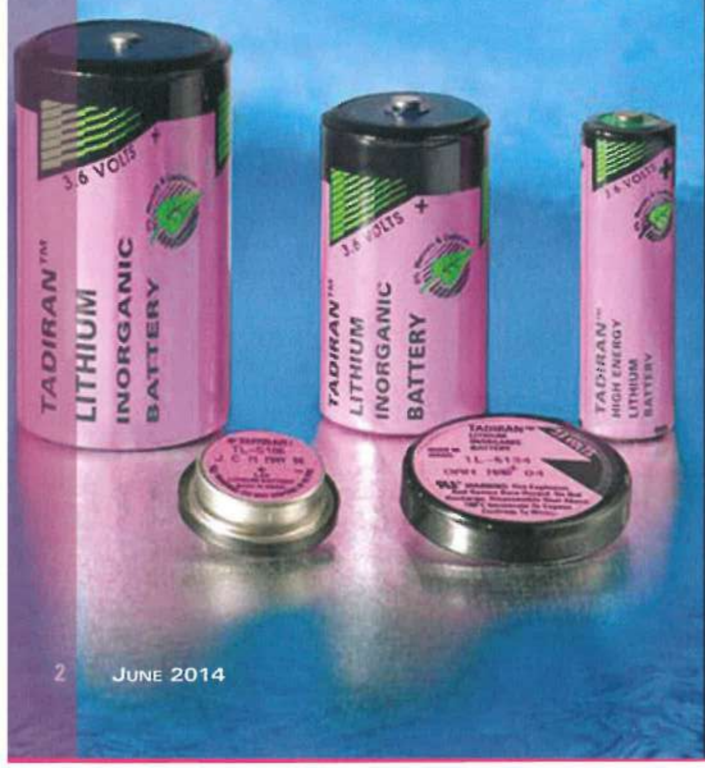
Sol Jacobs is the Vice President and General Manager of Tadiran Batteries Ltd.

Powering Remote Wireless Devices for 40 years

Bobbin-type thionyl chloride (LiSOCL2) batteries enable remote wireless devices to operate maintenance-free for up to four decades.

By Sol Jacobs, VP and General Manager, Tadiran Batteries

Selecting the ideal power management solution is a critical design consideration, especially for remote wireless devices intended for use in harsh environments. In many instances, these devices are off-the-grid, thus requiring self-contained power in hard-to-access locations where battery replacement or recharging are not options.

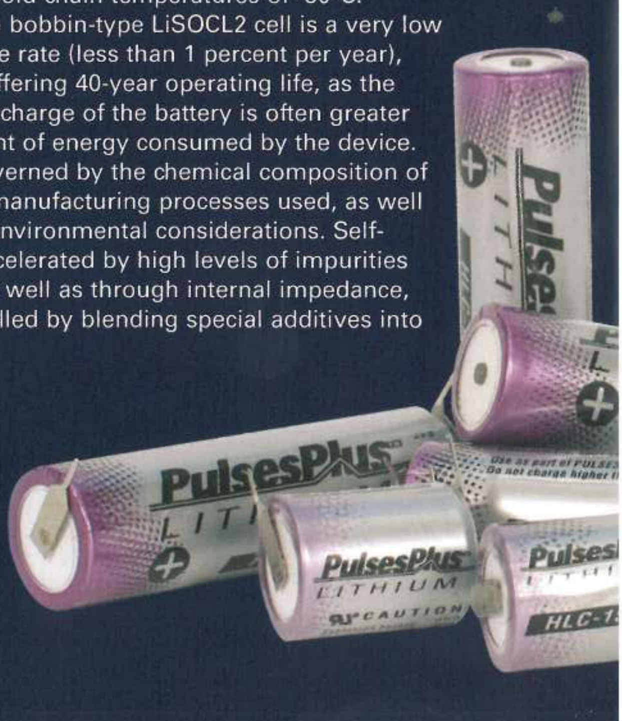


Lithium chemistry remains the preferred choice for remote wireless applications due to its intrinsic negative potential, which exceeds that of all other metals. The lightest non-gaseous metal, lithium offers the highest specific energy (energy per unit weight) and energy density (energy per unit volume) of all available battery chemistries. Lithium cells are all non-aqueous, and have normal OCVs of between 2.7 and 3.6 V. The absence of water allows lithium chemistries to operate in more extreme temperatures.

While numerous lithium chemistries are available, lithium thionyl chloride (LiSOCL2) chemistry stands apart due to unique performance attributes that make it ideal for applications such as electronic toll tags, RFID, environmental monitoring, SCADA, mil/aero, smart grids, automatic meter reading (AMR), wireless mesh networks, system control and data acquisition (SCADA), data loggers, measurement while drilling, oceanographic measurement, and emergency/safety equipment.

LiSOCL2 batteries are constructed two ways, using spirally wound or bobbin-type construction. Of the two alternatives, bobbin-type Li/SOCL2 cells deliver the higher energy density (1420 Wh/l) along with higher capacity, as well as the ability to withstand more extreme temperatures (-55°C to 150°C), with specialized models adaptable down to cold-chain temperatures of -80°C.

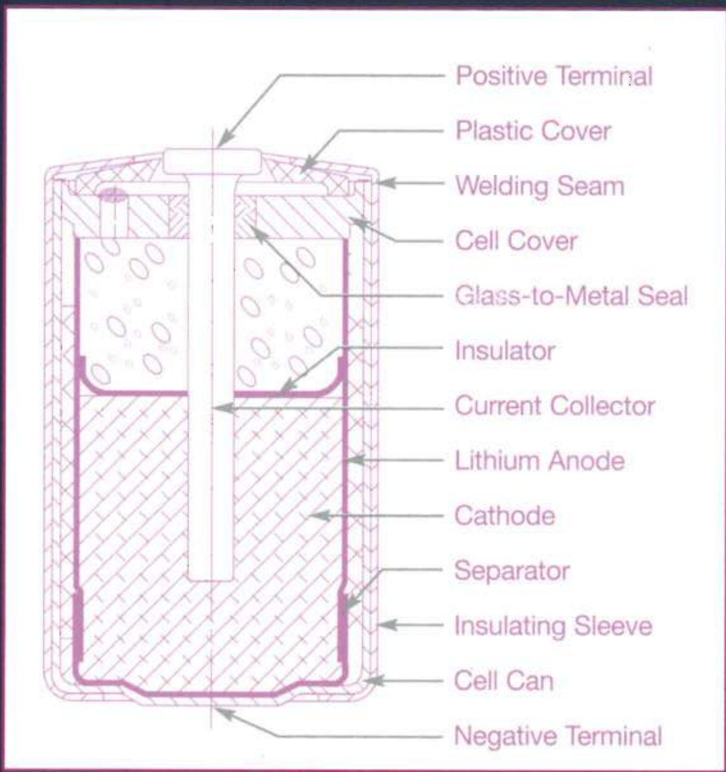
A key attribute of a bobbin-type LiSOCL2 cell is a very low annual self-discharge rate (less than 1 percent per year), which is crucial to offering 40-year operating life, as the total lifetime self-discharge of the battery is often greater than the total amount of energy consumed by the device. Self-discharge is governed by the chemical composition of the electrolyte, the manufacturing processes used, as well as mechanical and environmental considerations. Self-discharge can be accelerated by high levels of impurities in the electrolyte, as well as through internal impedance, which can be controlled by blending special additives into the electrolyte.



High Pulse Applications

Numerous parameters influence the battery selection process, including:

- Energy consumed in dormant mode (the base current).
- Energy consumed during active mode (including the size, duration, and frequency of pulses).
- Storage time (self-discharge during storage diminishes capacity).
- Thermal environments (including storage and in-field operation).
- Equipment cut-off voltage (as battery capacity is exhausted, or in extreme temperatures, voltage can drop to a point too low for the device to operate).
- Battery self-discharge rate (which can be higher than the current draw from actual use).



If the wireless application involves dormant periods at elevated temperatures, alternating with periodic high current pulses, then lower transient voltage readings can result during initial battery discharge. This phenomenon, known as transient minimum voltage (TMV), affects bobbin-type LiSOCl2 batteries due to their low-rate design.

One alternative is to use PulsesPlus lithium thionyl chloride batteries that combine a standard long-life bobbin-type LiSOCL2 cell with a patented hybrid layer capacitor (HLC). The battery and HLC work in parallel, with the battery supplying long-term low-current power while the HLC supplies pulses up to 15 A, thus eliminating the voltage drop that normally occurs when a pulsed load is initially drawn. The single-unit HLC works in the 3.6 to 3.9 V nominal range to deliver high pulses and a high safety margin, thus avoiding the balancing problems, current leakage, and bulkiness associated with supercapacitors.

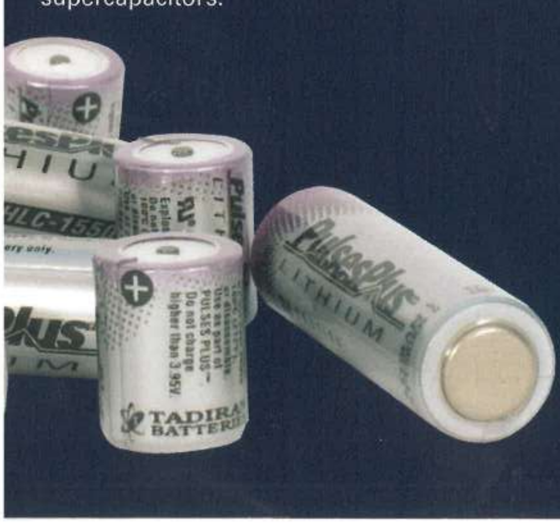
When low to moderate pulses are required, Tadiran Rapid Response TRR Series batteries could offer a solution. These batteries do not require the use of an HLC but deliver high capacity and high energy density while virtually eliminating TMV and power delay issues that affect standard LiSOCL2 batteries when they are first subjected to load. TRR Series batteries use available capacity efficiently to extend battery operating life up to 15 percent in certain instances, including extreme temperatures.

Evaluating Battery Suppliers

Bobbin-type LiSOCl2 batteries made with high-quality materials and advanced manufacturing techniques can reduce the potential for electrolyte leakage, short circuits, and batch-to-batch inconsistency that can shorten service life. The annual self-discharge rate can vary from less than 1 percent per year for a leading brand to as much as 2.5 percent to 3 percent per year for a lower quality product. As a result, design engineers need to be extremely wary of battery manufacturer claims regarding low annual self-discharge at ambient temperatures, which may not be valid depending upon the size of the battery, its method of construction, or environmental considerations, as the difference of just a few microamps in annual self-discharge rate can translate into years of battery life expectancy.

To authenticate product quality and traceability back to the raw materials, potential battery suppliers should be required to submit multiple customer references along with fully documented and verifiable test results for battery pulses, low-temperature pulses, discharge, and repeatability.

Careful due diligence during the vendor selection process will ensure reliable, long-term power. PDD



PROVEN **40** YEAR **OPERATING** LIFE*

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The battery of the future is here today. Tadiran bobbin-type lithium thionyl chloride ($LiSOCL_2$) batteries feature an annual self-discharge rate of just 0.7% per year: so energy efficient that they allow low power consuming wireless devices to operate for up to 40 years on a single battery. No one else even comes close. Tadiran lithium batteries also feature the highest capacity, highest energy density, and widest temperature range of any lithium cell, plus a glass-to-metal hermetic seal for added ruggedness and reliability in extreme environments.

For a battery that lasts as long as your device, run with Tadiran.

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Tadiran Batteries
2001 Marcus Ave.
Suite 125E
Lake Success,
NY 11042
1-800-537-1368
516-621-4980

www.tadiranbat.com

* Tadiran LiSOCL2 batteries feature the lowest annual self-discharge rate of any competitive battery, less than 1% per year, enabling these batteries to operate over 40 years depending on device operating usage. However, this is not an expressed or implied warranty, as each application differs in terms of annual energy consumption and/or operating environment.

IoTnews

A guide to how lithium batteries can bring remote wireless power to the IIoT

By Sol Jacobs
30 June 2016

Advanced primary lithium batteries will support the Industrial Internet of Things (IIoT) by enabling remote wireless devices to operate maintenance-free for up to 40 years.

Wireless connectivity is key to permitting greater convergence and interoperability between ‘smart’ devices that will soon be connected to the burgeoning IIoT.

Closely tied to the development of low-power communications protocols such as ZigBee, WirelessHART, and LoRa, remote wireless technology has grown exponentially, impacting everything from manufacturing and distribution to transportation infrastructure, energy production, environmental monitoring, healthcare, smart metering, process control, asset tracking, safety systems, machine-to-machine (M2M), and system control and data automation (SCADA) applications, to name a few.

Wireless technology is exploding in part because it eliminates the need for hard-wiring, which can cost $100 or more per linear foot, especially in remote, environmentally sensitive locations, where logistical, regulatory, and permitting hurdles make wireless connectivity a virtual necessity.

Choosing among primary batteries

Numerous factors need to be considered when selecting a primary (non-rechargeable) battery, including: energy consumed in active mode (including the size, duration, and frequency of pulses); energy consumed in dormant mode (the base current); storage time (as normal self-discharge during storage diminishes capacity); thermal environments (including storage and in-field operation); equipment cut-off voltage (as battery capacity is exhausted, or in extreme temperatures, voltage can drop to a point too low for the sensor to operate); battery self-discharge rate (which can be higher than the current draw from average sensor use); and lifetime cost considerations, taking into account future battery replacement costs, where applicable.

Inexpensive consumer-grade alkaline batteries can be ideal if the device is easy to access and operates within a moderate temperature range (i.e. indoor thermostats and wireless light switches). However, alkaline batteries do have some serious drawbacks, including low voltage (1.5 V or lower), a limited temperature range (0°C to 60°C), a high self-discharge rate that reduces life expectancy to as little as one to two years, and crimped seals that may leak. The low cost of an alkaline battery can also be highly misleading once you factor in the need for future battery replacements.

Comparing lithium chemistries

Lithium is preferred for long-life battery applications because its intrinsic negative potential exceeds that of all other metals. Lithium is also the lightest non-gaseous metal and offers the highest specific energy (energy per unit weight) and energy density (energy per unit volume) of all, which serves to reduce battery size and weight. Lithium cells also feature a normal operating current voltage (OCV) ranging between 2.7 and 3.6, and the electrolyte is non-aqueous, which extends the temperature range.

Numerous primary lithium battery chemistries are commercially available, including iron disulfate (LiFeS2), lithium manganese dioxide (LiMNO2), and lithium thionyl chloride (LiSOCl2) chemistry *(see table below):*

Primary Cell	$LiSOCL_2$ Bobbin-type with Hybrid Layer Capacitor	$LiSOCL_2$ Bobbin-type	Li Metal Oxide Modified for high capacity	Li Metal Oxide Modified for high power	Alkaline	$LiFeS_2$ Lithium Iron Disulfate	$LiMnO_2$ CR123A
Energy Density (Wh/1)	1,420	1,420	370	185	600	650	650
Power	Very High	Low	Very High	Very High	Low	High	Moderate
Voltage	3.6 to 3.9 V	3.6 V	4.1 V	4.1 V	1.5 V	1.5 V	3.0 V
Pulse Amplitude	Excellent	Small	High	Very High	Low	Moderate	Moderate
Passivation	None	High	Very Low	None	N/A	Fair	Moderate
Performance at Elevated Temp.	Excellent	Fair	Excellent	Excellent	Low	Moderate	Fair
Performance at Low Temp.	Excellent	Fair	Moderate	Excellent	Low	Moderate	Poor
Operating life	Excellent	Excellent	Excellent	Excellent	Moderate	Moderate	Fair
Self-Discharge Rate	Very Low	Very Low	Very Low	Very Low	Very High	Moderate	High
Operating Temp.	-55°C to 85°C, can be extended to 105°C for a short time	-80°C to 125°C	-45°C to 85°C	-45°C to 85°C	-0°C to 60°C	-20°C to 60°C	0°C to 60°C

Consumer grade lithium iron disulfate (LiFeS2) cells are inexpensive and can deliver high pulses, but feature a narrow temperature range (-20°C to 60°C), a high annual self-discharge rate, and crimped seals that may leak.

Lithium Manganese Dioxide (LiMNO2) cells, including the popular CR123A, offer a space-saving solution, as one 3V LiMNO2 cell can replace two 1.5V alkaline cells. LiMNO2 batteries deliver moderate pulses, but suffer from low initial voltage, a narrow temperature range, a high annual self-discharge rate, and crimped seals.

Bobbin-type lithium thionyl chloride (LiSOCl2) batteries are overwhelmingly preferred for long-life applications that draw low average daily current. Bobbin-type LiSOCl2 batteries feature the highest capacity and highest energy density of all lithium cells, along with the widest temperature range (-80°C to 125°C) and a glass-to-metal hermetic seal.

A superior quality bobbin-type LiSOCl2 cell can have a self-discharge rate as low as 0.7% per year, thus retaining nearly 70% of its original capacity after 40 years. By contrast, a lesser quality bobbin-type LiSOCl2 cell can have a self-discharge rate as high as 3% per year, thus losing nearly 30% of its available capacity every 10 years.

Batteries that deliver long life - even in extreme environments

Bobbin-type LiSOCl2 batteries power virtually all wireless meter transmitter units (MTUs) in AMI/AMR gas and water utility metering applications. The MTUs are typically buried in underground pits or mounted on building exteriors and exposed to extreme temperatures. It is critical for the batteries to deliver long operating life with high reliability so as to avoid the risk of large-scale system wide battery failures that can disrupt normal billing cycles and create customer service nightmares that drive up the total cost of ownership.

The fact that bobbin-type LiSOCl2 chemistry can endure extreme temperature cycling makes them ideal for use in automotive electronic toll tags, where heat soak on an automotive windshield can hit 113°C (according to SAE) when parked, cooling down rapidly to room temperature. Conversely, in extremely frigid weather, the battery must be able to handle cold soak and a rapid temperature rise.

Within the medical field, bobbin-type LiSOCl2 cells are being used to power RFID asset tracking devices that can withstand high temperature autoclave sterilization. Specially modified bobbin-type LiSOCl2 cells are also being deployed in the medical cold chain, where frozen pharmaceuticals, tissue samples and transplant organs must be kept at controlled temperatures as low as -80°C, with certain cells able to survive prolonged testing at -100°C.

Adapting lithium batteries to deliver high pulses

Due to its low rate design, a standard bobbin-type LiSOCl2 cell cannot deliver the high pulses required to power advanced, two-way communications. This challenge can be overcome by combining a standard bobbin-type LiSOCl2 cell with a patented hybrid layer capacitor (HLC). The standard cell delivers low background current while the HLC works like a rechargeable battery to deliver the high pulses required to initiate data interrogation and transmission.

Supercapacitors can also be used to store high pulses for certain consumer applications, but are generally not recommended for industrial applications due to inherent limitations, including an inability to provide long-term power, linear discharge qualities that do not allow for use of all the available energy, low capacity, low energy density, and high annual self-discharge rates (up to 60% per year). Supercapacitors linked in series also require the use of cell-balancing circuits that draw additional current.

Lithium batteries will continue to evolve to serve the emerging IIoT, bringing reliable low-cost power management solutions to remote locations and extreme environments.

https://www.iottechnews.com/news/2016/jun/30/guide-how-lithium-batteries-can-bring-remote-wireless-power-iiot/

IoTnews

Realising the full potential of energy harvesting and the IioT

By Sol Jacobs
30 June 2016

The market for industrial wireless devices is exploding, with wireless technology becoming central to a wide range of applications that will be essential to the Industrial Internet of Things (IIoT). These applications include AMR/AMI for utility metering, wireless mesh networks, structural sensors, machine to machine (M2M) and system control and data acquisition (SCADA), data loggers, measurement while drilling, oceanographic measurements, and emergency/safety equipment, to name a few.

Common to all these applications will be a growing need for technology convergence and interoperability throughout the IIoT: a growth curve that has been aided by the development of low-power communications protocols such as ZigBee, WirelessHART, LoRa, Bluetooth, DASH7, INSTEON, Z-WAVE and others. These protocols combine with low-power circuitry and intelligent software design to extend battery life with uncompromised product performance.

Identifying the ideal power supply

A remote wireless device is only as reliable as its power supply, which needs be optimised based on application-specific requirements. The vast majority of remote wireless devices continue to be powered by primary (non-rechargeable) lithium batteries. However, a rapidly growing number of applications are well suited for energy harvesting in combination with rechargeable Li-ion batteries or supercapacitors to store the harvested energy. Many types of renewable energy sources are available, including: solar, wind, thermal, vibration, kinetic, and RF/EM signals.

The decision of when to deploy an energy harvesting device should be based on numerous factors, including: the reliability of the device and its energy source; the required operating life of the device; average daily current draw; size and weight considerations; environmental requirements; and cost.

The typical energy harvesting device has five key components: a sensor, a transducer, an energy processor, a microcontroller, and an optional radio link. The sensor detects and measures environmental parameters such as motion, proximity, temperature, humidity, pressure, light, strain vibration, and pH. The transducer and energy processor work together to convert, collect, and store the electrical energy in either a rechargeable lithium battery or a supercapacitor. The microcontroller collects and processes the data, while the radio link communicates with a host receiver or data collection point.

While supercapacitors are often utilised in consumer grade devices, they have major drawbacks that limit their use in industrial grade applications. Supercapacitors suffer from high self-discharge rates that can cause premature battery failure, and their limited temperature range prohibits their use in extreme environments. Solutions involving multiple supercapacitors also require the use of balancing circuits that draw additional current and add to cost.

Industrial grade Li-ion batteries are now available

Rechargeable lithium battery technology continues to improve, with Lithium-ion (Li-ion) batteries remaining the most popular choice for both consumer and industrial applications. As a safety precaution, all Li-ion batteries require protection circuits to prevent over- or under-charging.

Consumer grade Li-ion cells are reasonably inexpensive and widely available, but have a limited life expectancy of roughly five years and 500 recharge cycles. These consumer cells are also designed to operate within a moderate temperature range (-10 to 60°C). In addition, they cannot deliver the high pulses required for advanced two-way communications and/or remote shut-off capabilities.

Industrial grade Li-ion batteries are highly recommended for long-term deployment in remote, inaccessible locations, offering extended operating life of up to 20 years and 5,000 full recharge cycles, an extended temperature range (-40°C to 85°C), and the ability to deliver high pulses (5 A for an AA-size cell). These ruggedly constructed batteries also feature a glass-to-metal hermetic seals, whereas consumer rechargeable batteries (table one, below) uses crimped seals that may leak.

		TLI-1550 (AA)	Li-Ion
		Industrial Grade	18650
Diameter (max)	[cm]	1.51	1.86
Length (max)	[cm]	5.30	6.52
Volume	[cc]	9.49	17.71
Nominal Voltage	[V]	3.7	3.7
Max Discharge Rate	[C]	15C	1.6C
Max Continuous Discharge Current	[A]	5	5
Capacity	[mAh]	330	3000
Energy Density	[Wh/l]	129	627
Power [RT]	[W/liter]	1950	1045
Power [-20C]	[W/liter]	> 630	< 170
Operating Temp	deg. C	-40 to +90	-20 to +60
Charging Temp	deg. C	-40 to +85	0 to +45
Self Discharge Rate	[%/Year]	<5	<20
Cycle Life	[100% DOD]	~5000	~300
Cycle Life	[75% DOD]	~6250	~400
Cycle Life	[50% DOD]	~10000	~650
Operating Life	[Years]	>20	<5

Due to high labour costs, replacing a battery can be far more expensive than the cost of the original battery. Therefore, for long-term deployments, you need to calculate the differential in total lifetime cost of using consumer grade Li-ion batteries that require replacement every 5 years and 500 recharge cycles versus choosing an industrial grade Li-ion battery that can operate maintenance-free for up to 20 years and 5,000 full recharge cycles.

Typical example of an urban energy harvesting application

The IIoT will eventually encompass virtually all conceivable external environments, creating distinctly unique power management challenges and opportunities for both urban and rural environments.

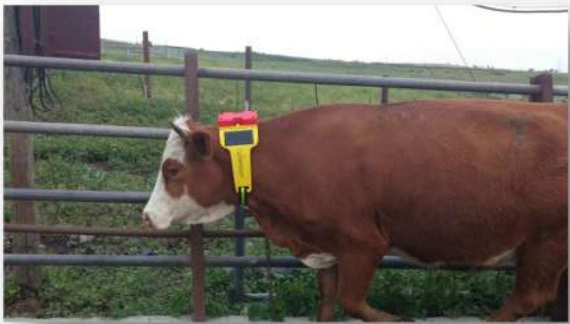
Within urban centers, extending the AC power grid to accommodate IIoT-enabled devices will be prohibitively expensive. For example, a solar-powered parking meter (main picture) was developed by the IPS Group that eliminates the need to bring power to every parking meter. Instead, energy harvesting devices and industrial grade rechargeable Li-ion batteries combine to provide a highly reliable, long-term, low-cost power management solution. These state-of-the-art wireless parking meters feature advanced functionality such as multiple payment system options, access to real-time data, integration to vehicle detection sensors, user guidance, and enforcement modules, and connectivity to a comprehensive web-based management system.

Miniaturised photovoltaic panels have been integrated into the parking meters, serving to gather solar energy that is then stored in industrial grade rechargeable Li-ion battery, providing sufficient available capacity to deliver 24/7/360 reliability along with high pulses to power advanced two-way wireless communications. Use of a 20-year battery also cuts long-term maintenance costs, and reduces the risk of lost revenue and reporting capabilities caused by recurring battery failures.

Long-life rechargeable Li-ion batteries are also essential for remote areas

The expanding IIoT is also create dynamic growth opportunities for wireless devices to serve highly remote locations, including extreme environments and locations far beyond the reach of the AC power grid.

A prime example where remote connectivity is required using energy harvesting as the power source is CattleWatch *(below)*, an innovative solution that deploys solar-powered ‘smart collars’ to turn a herd of cattle into a remote wireless mesh network.



CattleWatch utilises solar-powered ‘smart collars’ that allow a herd of cattle to form a wireless mesh network. Ranchers can remotely manage their herd through connectivity via Iridium satellites to the IIoT. Industrial grade rechargeable Li-ion batteries enable the ‘smart collars’ to be light, compact, and more comfortable for cows to wear.

All cows are equipped with RFID collars while a small number of cattle are outfitted with more sophisticated ‘hub collars’ that communicate to the internet cloud via Iridium satellites. Once formed, the wireless mesh network broadcasts continuously via satellite to provide the rancher with real-time data that monitors daily animal behavior, including herd location, walking time, grazing time, resting time, water consumption, in-heat condition and other health events. The rancher also receives instant notification if a potential threat is detected from predatory animals or poachers.

The hub collars are equipped with miniature PV panels that gather solar energy, while the industrial grade Li-ion batteries store sufficient energy to deliver the high pulses needed to initiate satellite communications. Industrial grade Li-ion batteries were chosen over bulkier supercapacitors because they enabled the ‘smart collars’ to be smaller, lighter, and more comfortable for the animals to wear.

These two examples illustrate the ‘tip of the iceberg’ in terms of the potential opportunities for IIoT-related applications to be powered by energy harvesting devices in combination with industrial grade Li-ion rechargeable batteries to provide maintenance-free operation for up to 20 years. Such a reliable long-term power supply solution could help reduce the total cost of ownership for a wide range of IIoT-related applications.

https://www.iottechnews.com/news/2016/aug/10/realising-full-potential-energy-harvesting-and-iiot/

Batteries for the Industrial Internet of Things

APRIL 26, 2016 BY

by **Sol Jacobs, Tadiran Batteries**

Not all battery chemistries are the same when it comes to powering devices designed for the IIoT. A few guidelines help field cells able to handle rugged surroundings for long periods.

The development of electricity in the late 1800s drove the first industrial revolution by providing abundant and inexpensive power to factories. This paradigm shift led to the development of innovative machines and processes that defined the modern workplace by boosting factory production.

Slightly more than a century later, a similar revolution is underway: the Industrial Internet of Things (IIoT). It is beginning to transform the modern workplace, bringing seamless connectivity to all types of industrial applications, including machine-to-machine (M2M) and system control and device automation (SCADA) technologies.

Some batteries are now formulated specifically to handle the high current pulses that characterize some IoT-communication modes. An example is the PulsesPlus battery, available in sizes from ½ AA to DD and multi-cell packs. PulsesPlus batteries feature bobbin type construction, plus a unique hermetically sealed hybrid layer capacitor.

Unlike the past, however, the IIoT will not be bound by the limitations of the old-fashioned factory floor. A new generation of wireless technology extends the IIoT to places not currently served by the national power grid.

The main limitations of traditional electric power are proximity and expense, as it costs $100/ft or more to extend hard-wired ac power to any industrial setting. This cost becomes even more problematic with the logistical, regulatory, and permitting hurdles required to extend ac power to remote, inaccessible locations that are often environmentally sensitive as well.

The emerging IIoT will not be held back by the power grid. It will thrive on battery-operated sensors that extend Big Data analytics to all types of industries, including but not limited to transportation infrastructure, energy production, environmental monitoring, manufacturing, distribution, healthcare, smart buildings and industrial automation.

Industrial applications will need power supplies that can perform reliably even in extreme environmental conditions. This is especially true for applications characterized by complex, multi-tiered interoperability to synchronize manufacturing, supply chain logistics and product marketing.

Generally speaking, the more remote the application, the more likely the need for an industrial-grade lithium battery. Inexpensive consumer-grade batteries could suffice in certain instances, especially for easily accessible devices that operate within a moderate temperature range. However, inexpensive consumer-grade batteries can also be highly misleading: The cost of labor to replace a consumer-grade battery typically far exceeds that of the battery itself. For example, consider what it takes to replace batteries in a seismic monitoring system sitting on the ocean floor or in a stress sensor attached to a bridge abutment.

To judge whether a short-lived consumer-grade battery is a worthy investment, you must calculate the lifetime cost of the power supply. To be accurate, the calculation has to properly account for the cost of all labor and materials associated with future battery replacements.

Primary $LiSOCl_2$ batteries predominate

Remote wireless sensors designed for long-term deployments are mainly powered by bobbin-type lithium thionyl chloride ($LiSOCl_2$) batteries. These cells offer special performance attributes that are particularly well suited for devices that draw low average daily current.

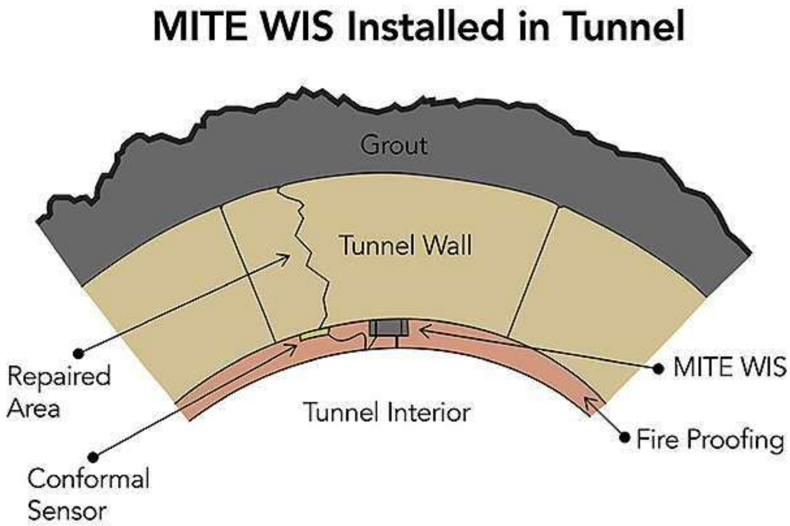
Bobbin-type $LiSOCl_2$ cells feature high energy density, high capacity and a wide temperature range. They also have a low annual self-discharge rate, with certain bobbin-type $LiSOCl_2$ cells able to operate for up to 40 years. These features have made bobbin-type $LiSOCl_2$ batteries the preferred power source for virtually all meter transmitter units (MTUs) in AMI/AMR metering for water and gas utilities.

MTUs are often buried in underground pits and see extreme temperatures that far exceed the limitations of consumer grade batteries. Extended battery life is essential to AMI/AMR applications because any large-scale system wide battery failure could create potential chaos by disrupting billing and customer service operations. To preempt this type of problem, utility companies specify bobbin-type $LiSOCl_2$ batteries that have been field proven to operate maintenance-free for decades.

Bobbin-type $LiSOCl_2$ batteries are also found in electronic toll tags, another early IIoT-related application. These batteries were chosen because they can handle the severe temperature cycles that characterize car interiors. Heat soak can hit 113° C (according to SAE) when parked, cooling down rapidly to room temperature. In cold weather, of course, the battery must handle cold soak and a rapid temperature rise.

The MITE WIS remote unit is a small, extremely low-power, wireless device for extended data acquisition and recording. The units can be configured for such sensors as strain gauges, resistive thermal devices (RTDs), pressure sensors, humidity sensors, accelerometers, and so forth. A unit transmits its data in realtime to the receiver or it can store its data in non-volatile memory. This data is later downloaded via RF to the receiver and application software for display and storage.

This same battery technology is now being adapted to other transportation applications, such as MITE-WIS wireless data acquisition systems embedded within concrete repair patches in tunnels. These self-powered units monitor concrete sections to help detect problems in repairs that have been covered by a layer of high-temperature fireproofing. Bobbin-type $LiSOCl_2$ batteries are also powering wireless sensors that monitor stress and vibration on critical bridge infrastructure. These battery-powered sensors often mount to the underside of bridge abutments, a location that cannot be accessed for routine maintenance without expensive scaffolding or safety harnesses. Batteries that can operate reliably for extended periods solve this problem.



MITE WIS units monitor repaired concrete sections of a tunnel and determine when a failure occurs by sensing strain variations across the boundaries of the concrete patches. During monthly scheduled maintenance closures, the units download data wirelessly. They are powered by bobbin-type $LiSOCl_2$ batteries.

The operating life of a bobbin-type $LiSOCl_2$ cell can vary significantly depending on its annual energy usage and annual self-discharge rate. Most remote wireless devices use a low-power communication protocol to help extend battery life. In addition, these devices operate mainly in a “sleep” mode that draws little or no current, periodically querying for the presence of data and awakening only if certain pre-set data thresholds are exceeded. It is not uncommon for more energy to be lost through annual battery self-discharge than through actual battery use.

The way a battery is manufactured and the quality of its raw materials can significantly impact its annual self-discharge rate. For example, the highest quality bobbin-type $LiSOCl_2$ cells feature a self-discharge rate as low as 0.7% annually. This means they retain nearly 70% of their original capacity after 40 years. By contrast, a lesser quality bobbin-type $LiSOCl_2$ cell can have a self-discharge rate of up to 3% per year. So nearly 30% of available capacity is lost every 10 years from annual self-discharge.

Resensys SenSpot wireless sensors contain bobbin-type $LiSOCl_2$ batteries that let them monitor stress and vibration on critical bridge infrastructure. These battery-powered sensors often mount to the underside of bridge abutments, a spot that cannot be accessed for routine maintenance without expensive scaffolding or safety harnesses.

High pulse requirements

Standard bobbin-type $LiSOCl_2$ cells are not designed to deliver high pulses. This challenge can be overcome by combining a standard bobbin-type $LiSOCl_2$ cell with a patented hybrid layer capacitor (HLC). The standard $LiSOCl_2$ cell delivers the low background current needed to power the device during sleep mode. The HLC works like a rechargeable battery to store and deliver the high pulses needed to initiate data interrogation and transmission.

Alternatively, supercapacitors can be used to store high pulse energy in an electrostatic field. While in wide use for consumer products, supercapacitors are generally not recommended for industrial applications because of inherent limitations, such as the ability to provide only short-duration power linear discharge qualities that do not allow for use of all the available energy, low capacity, low energy density, and high annual self-discharge rates (up to 60% per year). Supercapacitors linked in series also require the use of cell-balancing circuits.

Bobbin-type $LiSOCl_2$ batteries can handle the vast majority of long-life remote wireless applications. But there will be a growing number of IIoT-related applications that are well suited to be powered by energy harvesting devices, with Lithium-Ion (Li-Ion) rechargeable batteries used to store the harvested energy.

Several considerations go into the decision to deploy energy harvesting. Factors include the reliability of the device and its energy source; the expected operating life of the device; environmental parameters; size and weight restrictions; and the total cost of ownership.

Consumer-grade Li-Ion cells are candidates where the device is easily accessible and only operates for five years and 500 recharge cycles or less. They are also possibilities when the temperature range is a moderate 0 to 40° C. However, if the wireless device is slated for a remote site and could be exposed to extreme temperatures, the better choice is probably an industrial grade Li-Ion battery. These devices can operate up to 20 years and give 5,000 full recharge cycles, with an expanded temperature range of -40 to 85° C. They also can deliver high pulses (5 A for a AA-size cell). Industrial grade Li-Ion cells are ruggedly constructed with a hermetic seal, which is superior to the crimped seals found on consumer-grade rechargeable batteries, which may leak.

The Hexagram STAR system provides fully automatic meter reading via narrow band meter transmitters. The STAR MTU mounts near the utility meter and several times each day broadcasts the meter reading and account information by way of a brief radio transmission. They are powered by bobbin-type $LiSOCl_2$ batteries.

A prime example of industrial grade rechargeable Li-ion batteries in an IIoT-themed application is the IPS solar-powered parking meter. This networked meter offers multiple payment options (credit/debit card, contactless payment, and so forth), access to real-time data, and a web-based management system. It is also wireless, so it eliminates the overwhelming task of having to hard-wire millions of municipal parking meters.

Li-ion batteries in IPS smart parking meters deliver enough energy to handle the high pulses that arise during data communications. The batteries also work for up to 20 years.

IPS solar powered parking meters can connect with modules that read license plates and can notify authorities about outstanding parking violations. Built-in photovoltaic panels harvest and store the solar energy, charging industrial-grade rechargeable Li-Ion batteries. The batteries deliver enough energy to handle the high-current pulses that arise during data communications. The batteries also provide up to 20 years of 24/7/365 system reliability.

The next industrial revolution will be driven largely by electronic devices that are truly wireless, with bobbin-type $LiSOCl_2$ cells and industrial grade Li-Ion rechargeable batteries combining to support technology convergence and interoperability. These long-term power supply solutions will power IIoT-connected wireless devices reliably and maintenance-free for decades.

Lithium Battery Application Questionnaire

TADIRAN BATTERIES LTD

To enable Tadiran to provide the most appropriate solution to your battery requirement, kindly fill in this questionnaire with the maximum data you can provide. Your data will be treated with full confidence and be used only for optimizing our solution.

Company: Address:

Contact Person: Title:

Tel: Fax: E-mail:

Application Details:

Brief Description:

Battery is used for: ☐ Back up ☐ Main power source

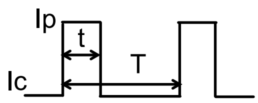
Electrical Requirements:

Operating Voltage: Maximum Nominal Minimum (cut-off) volts

Constant Current: Ic=

Pulse Current: Ip= ; Duration: t= ;Every: T=

Pulse Load Profile: Please enclose a drawing if needed
Qualification Tests: Please enclose specifications



Expected Operating Life: ; Storage of battery before use:

Environmental Requirements

Please specify percentage (%) of time per temperature

Storage Temperature (ºC): Max. % ; Average % ; Min. %

Operating Temperature (ºC): Max. % ; Average % ; Min. %

Special conditions of humidity, shock, vibration etc.': ☐
Please enclose specifications or list in the remarks below

Size and Dimensions of cell: (Please attach a drawing if a battery pack is required)

Preferred Cell Size ; Max. Space Available (mm): L= W= H=

Estimated Annual Requirement: 1st year 2nd year 3rd year

Qty for First delivery ; Expected during , 2015

Alternative Battery: Type Maker Model

Remarks:

Form filled by: Customer ☐ Tadiran REP. ☐ Name: Date:

www.tadiranbatteries.con


IOT Application
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TLM LITHIUM