Primary Lithium Coin

Handbook and Application Manual

ENERGIZER®

Technical Information

Introduction

Lithium coin cells were originally developed in the 1970's as a 3 volt miniature power source for low drain and battery backup applications. Their high energy density and long shelf life made them well suited for these applications. Lithium coin cells are available in a wide range of sizes and capacities.

As electronics have evolved over the decades, device designers have found lithium coin cells to be a useful power source for their size and capacity. Many of these newer applications have low background drains and utilize very fast high rate pulses (for example sensors). When design engineers select a battery power source, it is important that all of the battery characteristics be considered including battery internal resistance, capacity, voltage, size, etc.

Typical Characteristics

Electrochemical System	Nominal Voltage	Negative Electrode	Positive Electrode	Chemistry Electrolyte	Primary vs Secondary	Reaction Equation
Lithium Manganese Dioxide (Li/MnO_2)	3V	Lithium Metal	Manganese Dioxide	Lithium Salt in organic solvent	Primary (Non-Rechargeable)	$Li + Mn^{iv}O_2 \rightarrow Mn^{III}O_2(Li+)$

Common applications

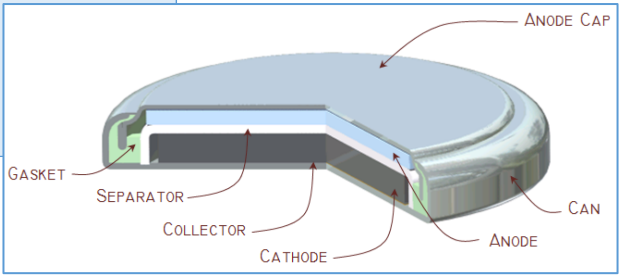
Application	Benefit of Lithium Coin Batteries
Childrens Toys 	Consistent voltage output keeps interactive features responsive and reliable. Lightweight design supports compact, portable toys.
Key Fobs 	High energy density and excellent pulse performance help enable reliable wireless communication. Their compact form factor fits easily into fob designs.
IoT Sensors 	Supports low-drain, pulse-demand applications like IoT sensors. Wide operating temperature supports outdoor and industrial environments.
Smart Tags 	Extended operational life and environmental stability support long term operation without frequent service.
Medical Devices 	Stable voltage output allows for accurate sensor readings. The small size of Lithium coin cells supports portable device designs.

Why use Lithium Coin?

Lithium coin batteries have seen a steady rise in popularity as consumer electronics demand slimmer, more efficient power sources. Their compact, low-profile design makes them ideal for devices where space is at a premium, such as key fobs, medical sensors, and remote controls. Over time, adoption has expanded beyond traditional uses into wearables and IoT devices, where reliability and long life are critical. These cells deliver high energy density and stable voltage, ensuring consistent performance even in very demanding environments.

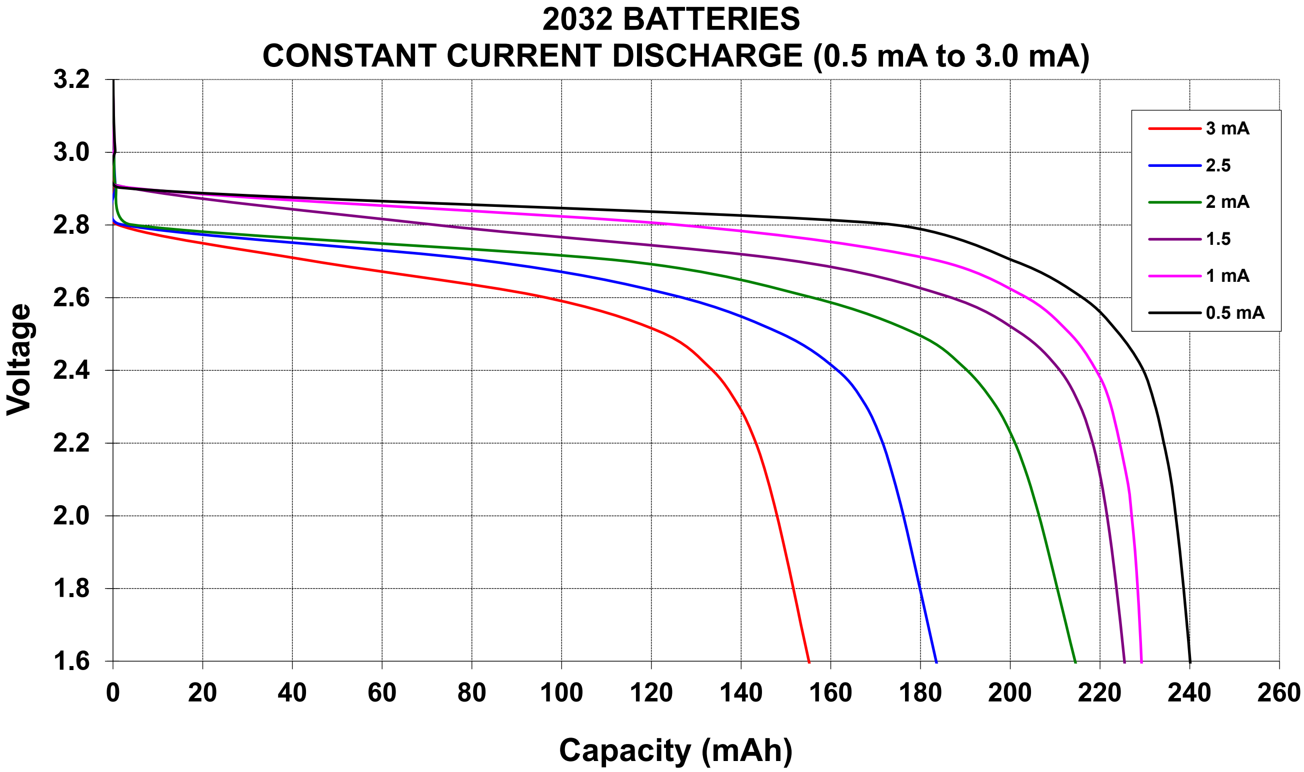
Battery Components

Anode – Supplies lithium ions during discharge.
Cathode – Accepts lithium ions and drives the electrochemical reaction.
Separator – Separates the anode and cathode while allowing ion flow.
Electrolyte – Enables ion transport between electrodes.
Gasket – Maintains seal and prevents leakage.
Can – Provides structural integrity and serves as the positive electrode.
Cap – Provides structural integrity and serves as the negative electrode.



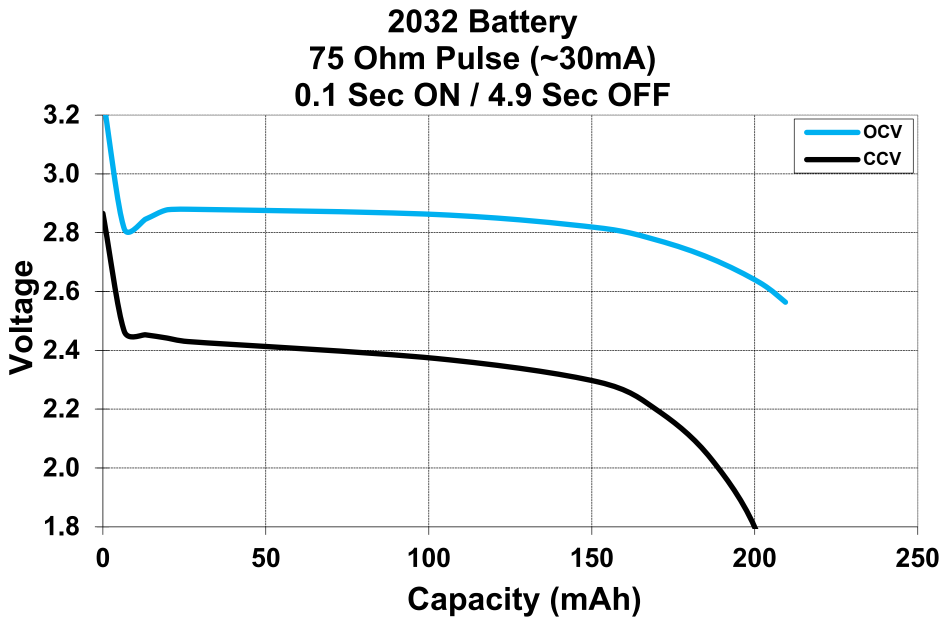
Capacity

Lithium coin cell capacity is influenced by several factors, including drain rate, cutoff voltage, and operating temperature. In general, these cells deliver their best efficiency at lower drain rates, making them ideal for devices with intermittent or low-power demands. Applications with high continuous current draw can reduce usable capacity and shorten battery life. Device circuitry also plays a critical role since products with a high cutoff voltage (greater than 2.0 V) may leave significant capacity unused when the device stops functioning. Temperature extremes further impact performance, with colder environments reducing discharge efficiency and warmer conditions accelerating self-discharge.



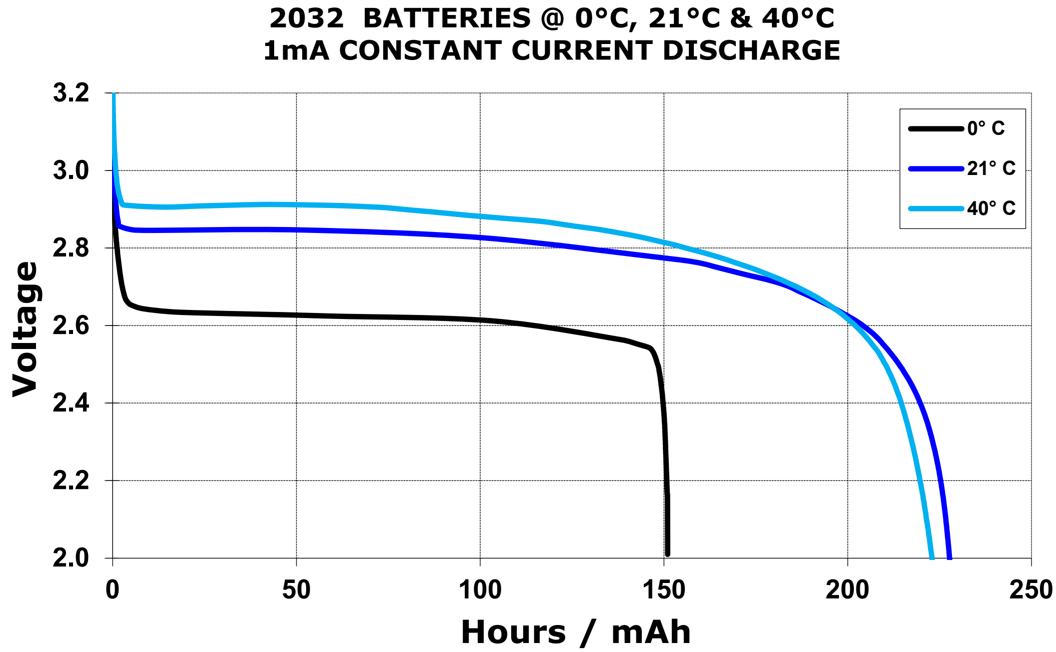
Pulse Effects

Batteries that are in low pulse drain applications will typically have a capacity near to the device average drain. However, for high pulse applications, the voltage drop of the battery during the pulse (CCV) needs to be accounted for. For example, the CCV pulse shown would meet a 2 volt cutoff much sooner than the average drain CCV due to the voltage drop during the pulse.



Temperature Effects

Cold temperatures cause the electrochemical reactions that take place within the battery to slow down and will reduce ion mobility in the electrolyte. In general, cold temperatures will negatively impact battery performance in devices and will reduce battery voltage and runtime. For example, a wireless garage door sensor could stop functioning in the cold of winter due to an excessive voltage drop. Below is an example of the impact of 0° C & 40° C temperatures on a 2032 battery under a 1mA continuous discharge.



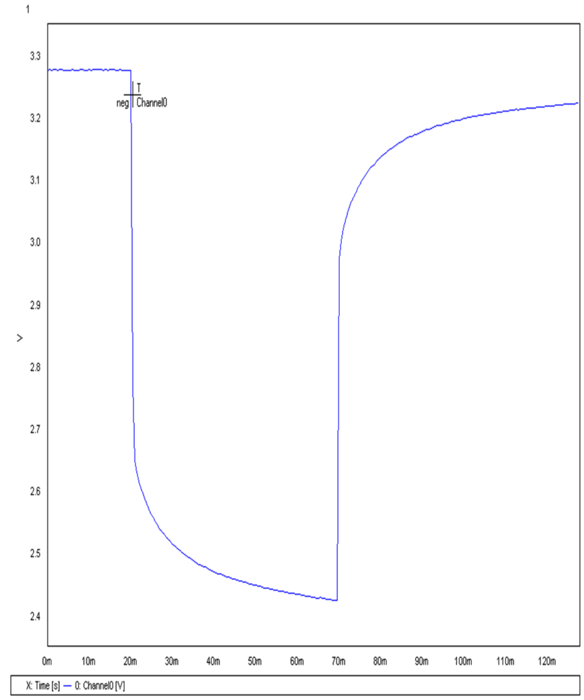
Temperature Side Note

A drop in performance at low temperatures does not mean the battery is depleted. Lithium coin cells temporarily lose capacity in extreme cold due to increased internal resistance, but this effect is reversible. Once the battery warms back to normal operating conditions, voltage and capacity recover, and the battery resumes service.

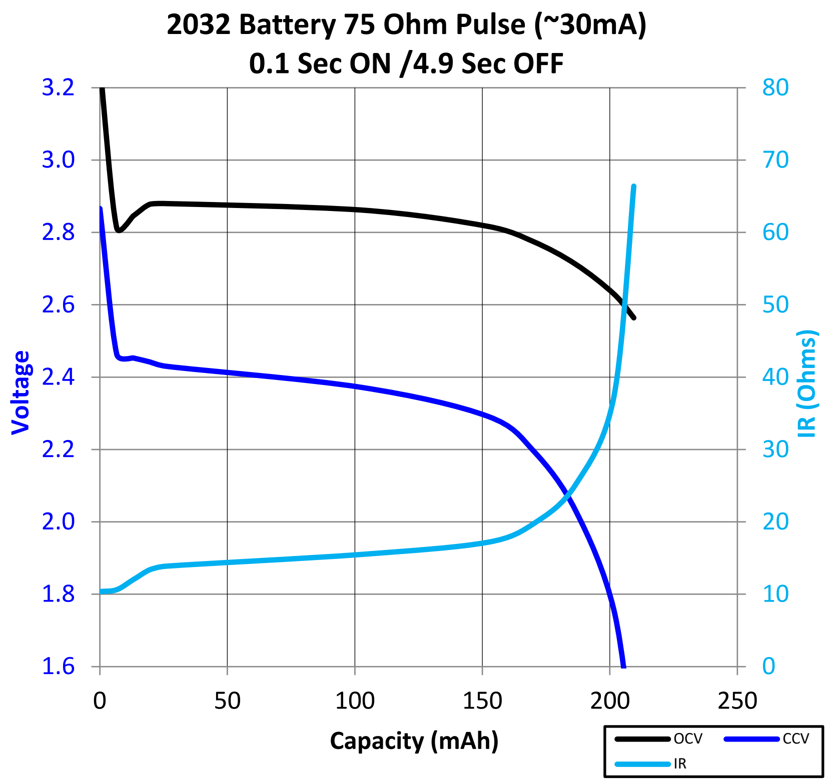
Internal Resistance

The internal resistance (IR) of a battery is defined as the opposition to the flow of current within the battery. The impact of battery IR can be seen in the magnitude of the voltage drop when a load is placed on the battery. In general, the IR of lithium coin cells is significantly higher than what is found in other common battery chemistry systems. For example, the starting IR of a 2032 battery is near 10 ohms. the starting IR of AA alkaline batteries is near 0.25 ohms. This difference in IR is caused by different constructions and active materials used in each battery.

The battery IR can be calculated using a dual pulse method. The scope trace to the right is of a fresh 2032 battery with a 1000K ohm background drain. A 50mSec 25 ohm pulse was applied. The IR can be calculated using the following equation. IR Ω = change in voltage divided by the change in current. The current readings are determined using ohms law. For this example, the IR calculation would be (3.279V - 2.429V) ÷ (.097A - .000003A) = 9Ω. The drain rate and pulse duration can impact the IR calculation.

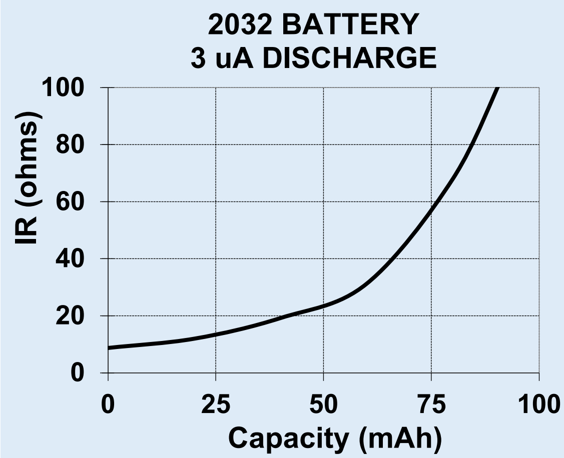


In low drain continuous applications, the battery IR may not be a critical factor. However, in high pulse applications, the battery IR can significantly impact runtime due to voltage drop. The battery IR will typically increase during discharge due to the impact of the reaction by-products on the battery chemistry.



Not all drains are the same

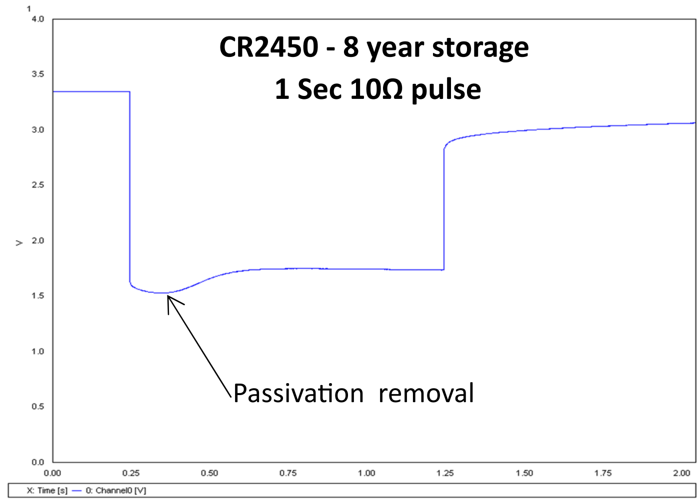
The drain rate and duty cycle can impact the battery IR during discharge. The IR increase during discharge is not constant for all drain rates. For example, very low uA drain rates can cause a significant rise in the battery IR early in the discharge.



Passivation

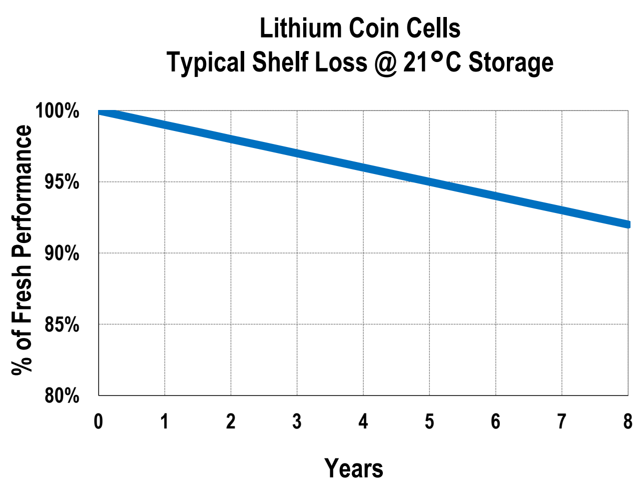
After years of storage, lithium coin cells can develop a perceptible poor conducting passivation layer. Passivation is the formation of a thin resistive layer on the lithium anode as a result of the chemical reaction between the anode and the electrolyte. This layer reduces the rate of self-discharge of the battery by slowing the reaction between the lithium metal and the electrolyte.

The passivation layer due to long term storage can contribute to a slightly higher initial internal resistance and subsequently an increased voltage drop when the battery is first put into use. Once a load is placed on the battery, the passivation layer will become thinner, and internal resistance typically returns to normal.



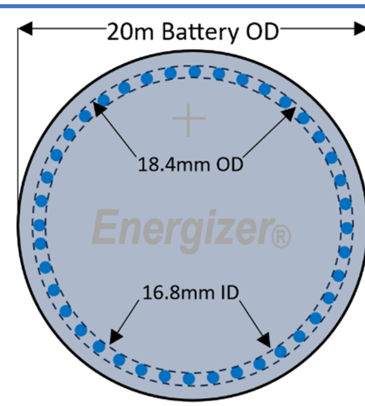
Shelf Life

The shelf life of lithium coin cells stored at normal room temperature and relative humidity is 10 to 12 years. When stored at normal room temperature and humidity, Lithium coin cells will lose approximately 1% of their capacity per year due to ingress and egress of vapors through the seal. When lithium coin cells have been stored for years in a sealed package, the smell of DME (1, 2-Dimethoxy Ethane) is sometimes noticeable when the packaging is first opened due to egress through the seal. The DME vapor has an ether like odor but there is not a safety concern.



Design Considerations

- Lithium coin cells maintain a relatively flat discharge curve until near end of life. Device manufacturers should account for this quick drop in voltage at end of life to avoid abrupt shutdowns.
- Ensure the initial inrush current from the device is accounted for when selecting a suitable battery. These currents can often times be several times higher than the general in-use loads and can lead to higher than expected voltage drop.
- *Energizer®* and *Rayovac®* branded Lithium coin cells have blue color alert dye on the positive side as part of a set of safety features to help prevent accidental ingestion. For best performance, avoid device contacts making contact in the designated area shown to the right.



Location of blue color alert dots found on Energizer® lithium coin cells.

Safety

There can be a serious safety hazard if a lithium coin cell is swallowed. In general, any device (not just toys) that a child may encounter should have a secure battery case that prohibits removal of the lithium coin cell without a tool or simultaneous movements (like a pill bottle). It is also important that when batteries are disposed of children do not have access to them. All *Energizer®, Rayovac®* and *Eveready®* products are designed to meet or exceed the safety and performance requirements of the various national and international industry battery standards. *Energizer®, Rayovac®* and *Eveready®* products are routinely sampled and tested against applicable standards both internally and independently. In addition, Energizer representatives routinely participate in the development of global battery standards.