Lithium Coin
Handbook and Application Manual

Lithium/Manganese Dioxide - Coin (Li/MnO_2) Energizer Brands, LLC. 1-800-383-7323

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Introduction:

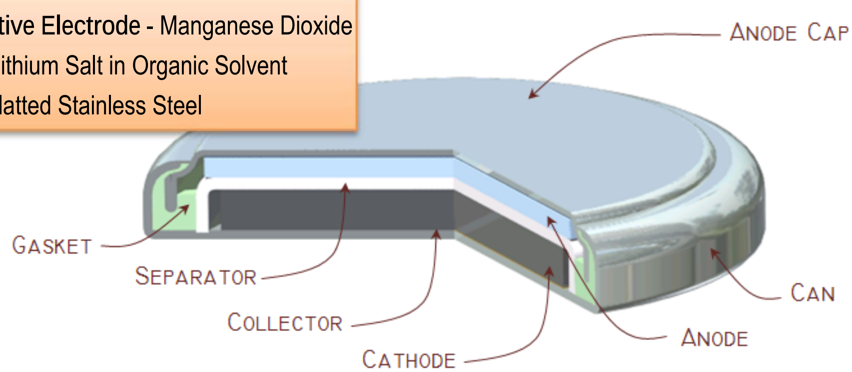
Lithium coin cells were originally developed in the 1970's as a 3 volt miniature power source for low drain and battery backup applications. Their high energy density and long shelf life made them well suited for these applications. Lithium coin cells are available in a wide range of sizes and capacities.

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.

- Lithium / Manganese Dioxide (Li/MnO_2)
- Li + $Mn^{iv}O_2 \longrightarrow Mn^{III}O_2(Li+)$
- 3V Nominal Voltage
- -30°C to 60°C Recommended Operating Temperature
- UN 38.3 Approved
- Not Rechargeable

Cross Section:

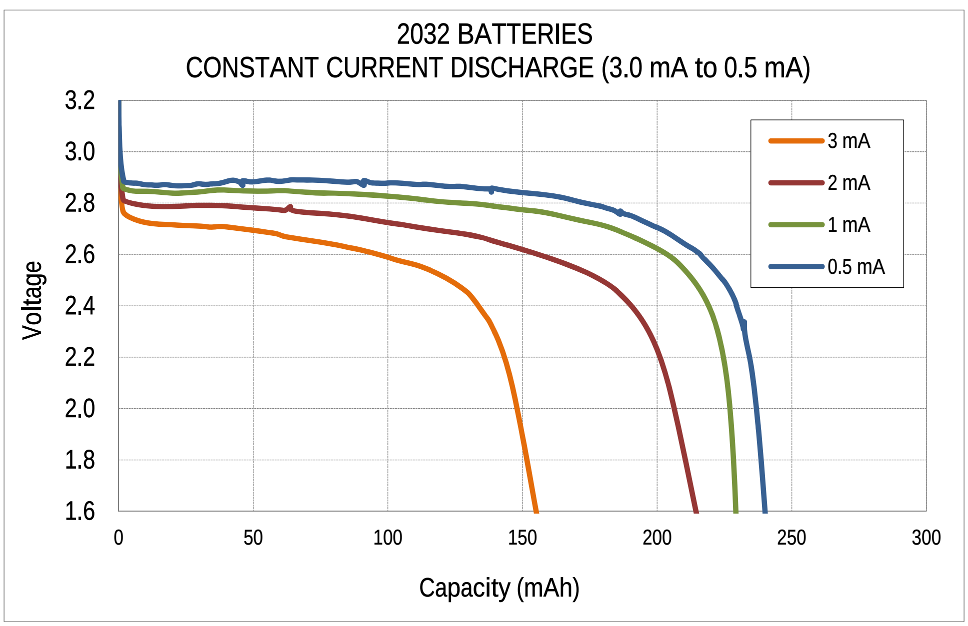
Anode Negative electrode - Lithium Metal
Cathode Positive Electrode - Manganese Dioxide
Electrolyte - Lithium Salt in Organic Solvent
Can - Nickel Platted Stainless Steel



Capacity Ratings:

Battery	Rating (mAh)	Rating drain to 2V	Datasheet
CR 1025	30	68KΩ (~43uA)	http://data.energizer.com/PDFs/cr1025.pdf
CR 1216	34	62KΩ (~46uA)	http://data.energizer.com/PDFs/cr1216.pdf
CR 1220	40	45KΩ (~64uA)	http://data.energizer.com/PDFs/cr1220.pdf
CR 1616	55	30KΩ (~97uA)	http://data.energizer.com/PDFs/cr1616.pdf
CR 1620	79	30KΩ (~97uA)	http://data.energizer.com/PDFs/cr1220.pdf
CR 1632	130	15KΩ (~190uA)	http://data.energizer.com/PDFs/cr1632.pdf
CR 2012	58	30KΩ (~97uA)	http://data.energizer.com/PDFs/cr2012.pdf
CR 2016	90	30KΩ (~97uA)	http://data.energizer.com/PDFs/cr2016.pdf
CR 2025	163	15KΩ (~193uA)	http://data.energizer.com/PDFs/cr2025.pdf
CR 2032	240	15KΩ (~190uA)	http://data.energizer.com/PDFs/cr2032.pdf
CR 2320	135	10KΩ (~290uA)	http://data.energizer.com/PDFs/cr2320.pdf
CR 2430	290	10KΩ (~290uA)	http://data.energizer.com/PDFs/cr2430.pdf
CR 2450	620	7.5KΩ (~390uA)	http://data.energizer.com/PDFs/cr2450.pdf

The capacity of a battery in an application will depend on the device drain rate and the cutoff voltage. In general, lithium coin cells are more efficient at lower drain rates. Device circuitry that has a high cutoff voltage (i.e. greater than 2 volts) will leave capacity unused in the battery when the device stops working.



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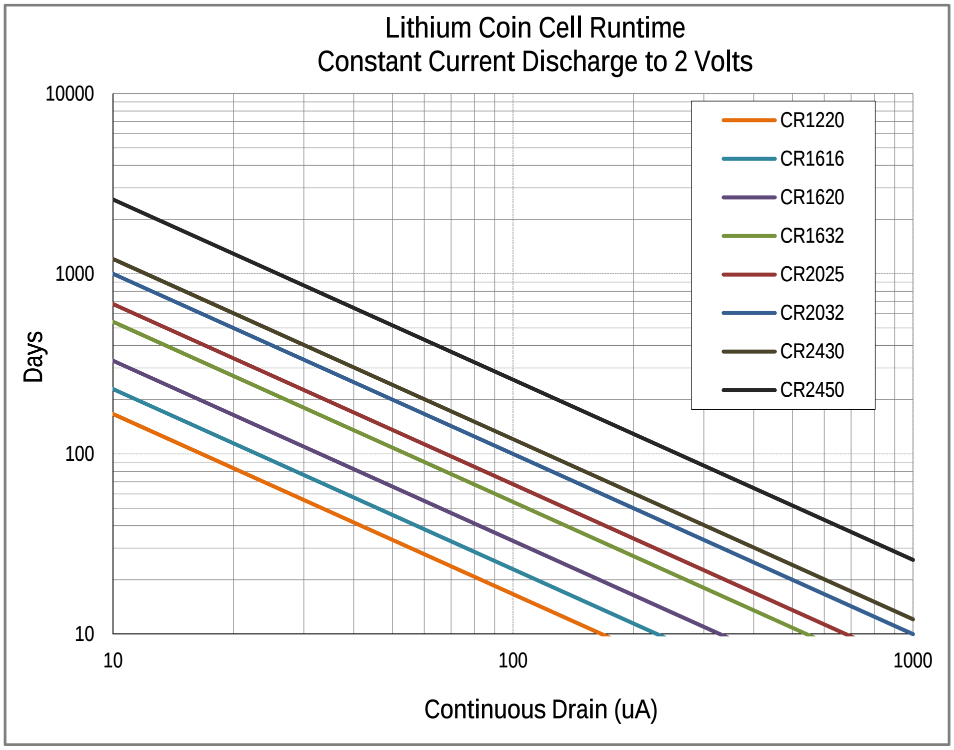
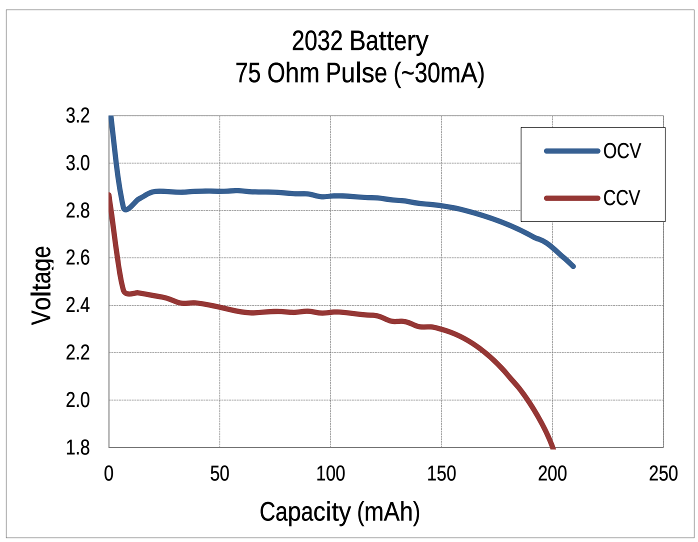
Estimated Continuous Runtimes to 2.0 Volts at 21°C:



Pulse Effects:

Batteries 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 below would meet a 2 volt cutoff much sooner than the average drain CCV due to the voltage drop during the pulse.



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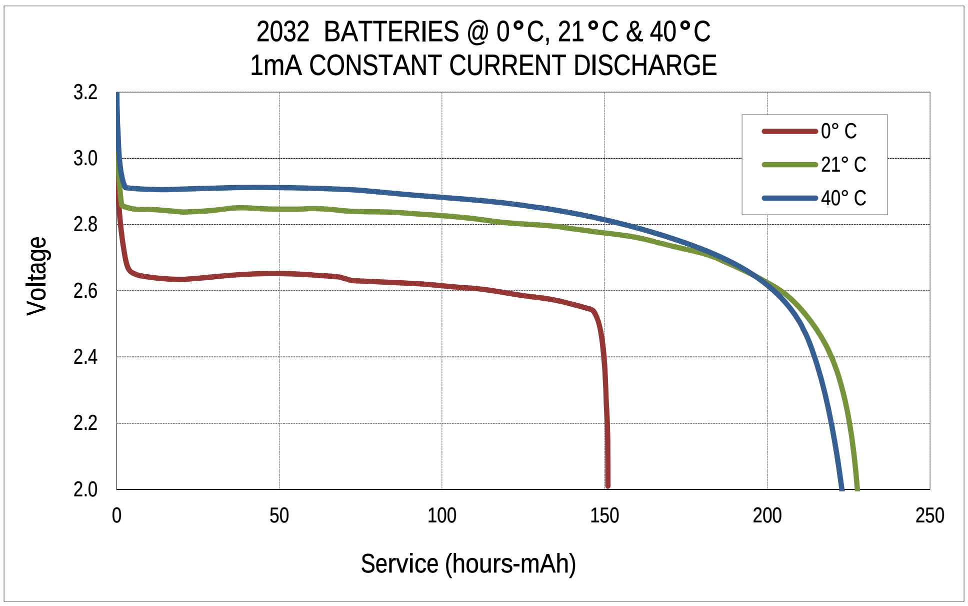
Temperature:

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.



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 an E92 AAA alkaline battery is near 0.3 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 below is of a fresh 2032 battery with a 1000K ohm background drain. A 50 mSec 25 ohm pulse

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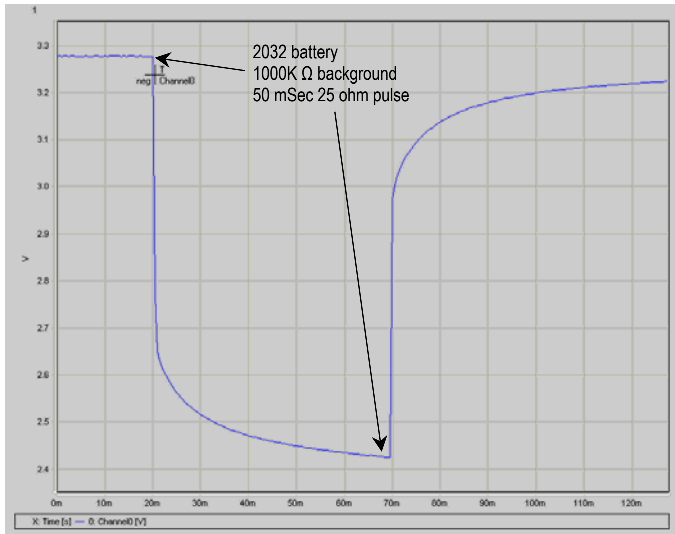
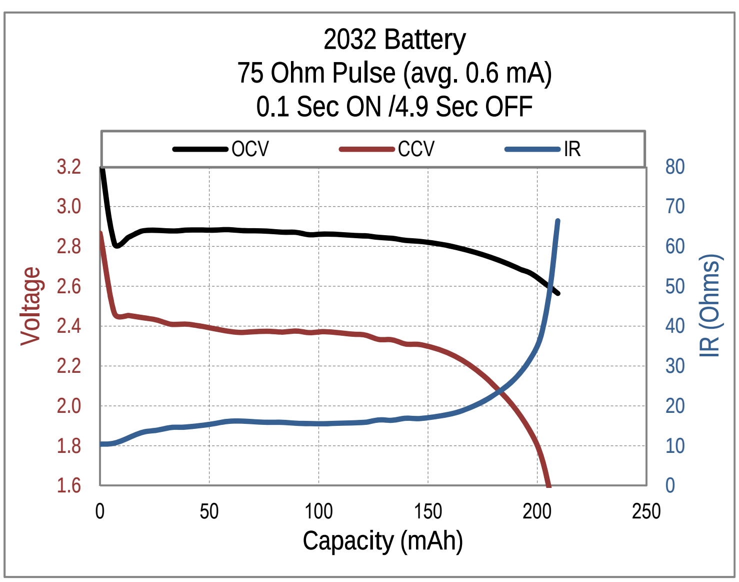
was applied. The IR can be calculated using the following equation. IR Ω = change in voltage divided by the change in current. The current readings are determined using ohms law. For the example below, the IR calculation would be (3.279V - 2.429V) ÷ (.097A - .000003A) = 9Ω. The drain rate and pulse duration can impact the IR calculation.

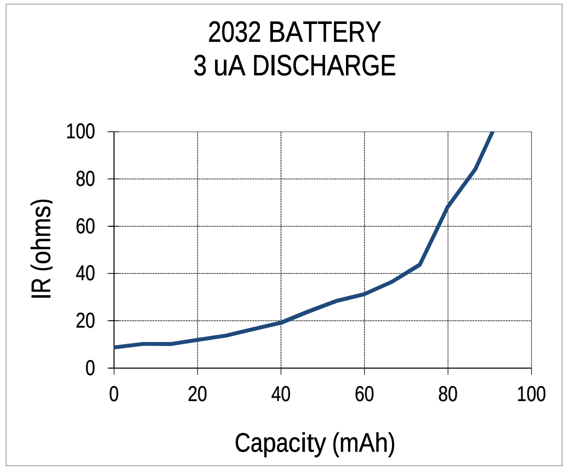


In low drain continuous applications (i.e. watch) the battery IR may not be a critical factor. However, in high pulse applications (i.e. wireless sensors), the battery IR can significantly impact runtime due to voltage drop. The battery IR will typically increase during discharge due to the impact of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

Below is an example of a discharge curve with IR calculations. The drain rate and duty cycle can impact the battery IR during discharge.

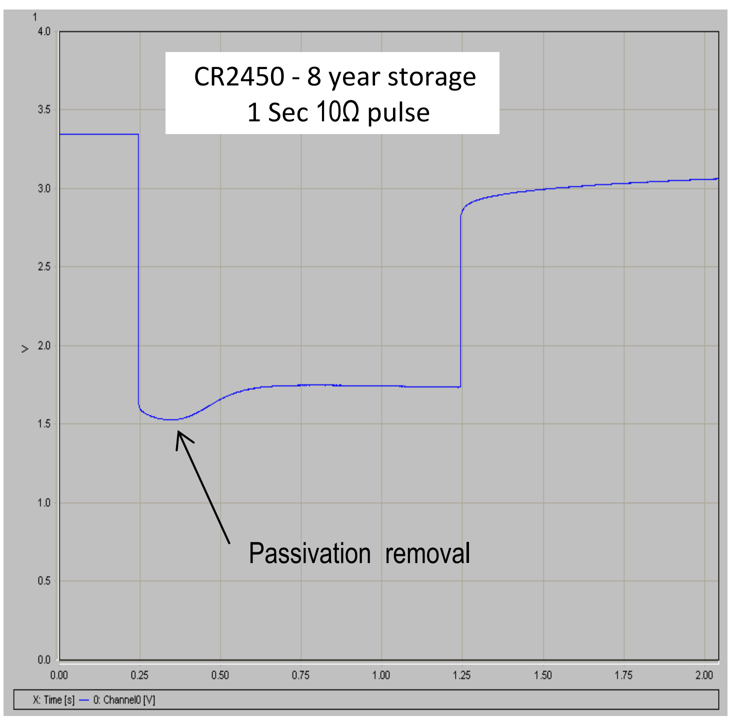


The IR increase during discharge is not constant for all drain rates. For example, very low uA drain rates can cause a significant rise in the battery IR early in the discharge.



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.

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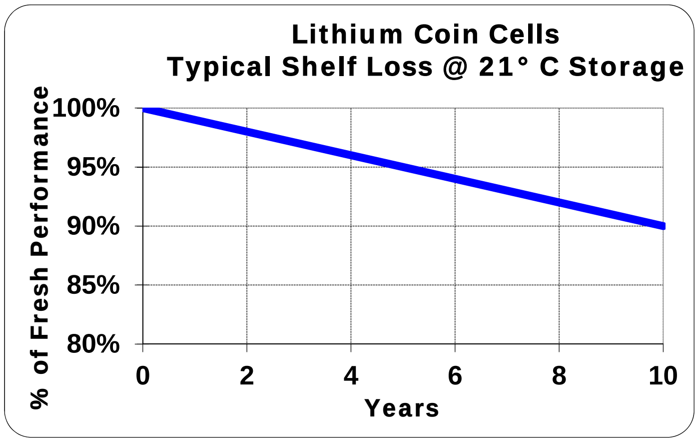
Shelf Life:

The shelf life of lithium coin cells stored at normal room temperature and relative humidity is 10 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 either like odor but there is not a safety concern.

Safety:

There is a serious safety hazard if a lithium coin cell is swallowed. Click link for details. *Energizer®* recommends that any device (not just toys) that a child may encounter 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®* and Eveready products are designed to meet or exceed the safety and performance requirements of the various national and international industry battery standards. *Energizer®* 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.