

How to store 18650 batteries safely

What is the best way to store an 18650 battery?

In this blog post, rather than do my own testing - I will rely on the specification sheets provided by Panasonic, Samsung, and LG. We'll look at the storing section of these spec sheets, and break down the important factors and what they mean. Scroll to the end, the overview, to get to the conclusions of the post quickly.



A Panasonic NCR18650B 18650 cell

Storing the Panasonic 18650 B

From the 18650 B specification sheet

Storing Conditions	less than 1 month	-20 ~ +50°C	Percentage of recoverable capacity 80%*
	less than 3 months	-20 ~ +40°C	
	less than 1 year	-20 ~ +20°C	

$\ast = (\text{Discharging time after storage} / \text{Initial discharging time}) \ast 100$

The discharging time is measured by the discharge current of 0.65A until 2.5V of end voltage after the battery is fully charged at 25°C.

What does it mean?

There are three rows, each with different storage conditions. Note the second and third column are locked in place by the fourth. Each row represents recovering 80% of the battery's usable capacity. Since the rated capacity of the NCR18650B is 3200 mAh, this 80% represents 2560 mAh after storage.

1. If you are storing an 18650 battery for **less than a month**, you may store it in an environment as hot as 50°C and be able to recover 2560 mAh.
2. If you are storing an 18650 battery for **less than 3 months**, you may store it in an environment as hot as 40°C and be able to recover 2560 mAh.
3. If you are storing an 18650 battery for **less than 1 year**, you may store it in an environment as hot as 20°C and be able to recover 2560 mAh.

In the last case, storing for one year with a 20% drop in capacity translates to 1.6% loss of capacity *per month*, or 53 mAh.

In the first case (storing at high temperatures for less than one month) translates to a loss of 21 mAh *per day*.

Storage temperature and conditions

We can see from the above 3 items, it is **temperature** as the main factor determining the resulting capacity after storage, and ultimately how long you can store your battery for.

18650 batteries can be stored at very low temperatures, but high temperatures degrade them quickly. Rule of thumb: They must always be stored at less than 60°C.

Lithium-ion batteries, in most cases must maintain a voltage above 2.5V before they start to break down and decompose. Therefore, for long-term storage it is best to "top-up" your batteries when their voltage drops too low.

- *Note 1:* When receiving new cells, the manufacture will ship them at a 40% charge. However, it is very likely this will soon be set at 30% as airline safety regulations demand safer transport, and less charge is safer.
- *Note 2:* In these tests, Panasonic fully charged the batteries at 25°C, up to 4.2V. However, for long-term storage it is recommended not to store at a full charge, but to seek a lower voltage (more on that ahead).

Finally, the environment should be dry, or low humidity - without dust, or a corrosive gas atmosphere. Optimizing your cell's environment becomes more important the longer they are kept stored. Anything above 3 months may start to be considered long-term.



A close-up of the 25R top cap (positive terminal)

Storing the Samsung 25R

From the 25R specification sheet

Storing Conditions	less than 1 month	-30 ~ +60°C	Percentage of recoverable capacity 90%
	less than 3 months	-30 ~ +45°C	
	less than 1.5 year	-30 ~ +25°C	

Differences between the Samsung 25R and Panasonic 18650B

The Samsung 25R performs better during storage on all fronts. Across the board, the 25R can store at ten degrees lower than the 18650B. As well, the difference in higher temperatures, in favor of the 25R from 1 month, 3 months, to 1.5 years, is +10°C, +5°C, +5°C.

Most importantly, this 18650 battery can be stored a full six months longer and retain 90% capacity (10% more than the NCR18650B).

The optimal storing voltage

The 25R spec sheet notes that for long-term storage, the voltage should, rather than be fully charged, set at a lower, more optimal voltage. This is to prevent the degrading of performance characteristics. In the case of the 25R, the recommended voltage is $50 \pm 5\%$ of its standard (4.2V) charged state.

- This works out to be a range between 3.64V and 3.71V

Other batteries have different ranges, but most are close to ~50% voltage which is usually around ~3.7V.

Storing 18650 batteries overview

From the LG 18650 HE2 specification sheet

Storing Conditions	less than 1 month	-20 ~ +60°C	Percentage of recoverable capacity 90%
	less than 3 months	-20 ~ +45°C	
	less than 1 year	-20 ~ +25°C	

Overview

It is good to reference at least three batteries, and off the blog I have checked more. All 18650 batteries researched need a storage range of between -20 ~ +50°C (-4°F ~ +122°F) or they will degrade, so this is a good rule of thumb to use.

Also keep in mind the maximum temperature for storage should never exceed +60°C (140°F). It is better to store in a cold environment, than a hot one.

Optimally, a good storage temperature should be closer to 25°C (77°F) or a somewhat lower. The closer you are to an optimal temperature, the longer you will be able to store your batteries without "topping up" and recharging them.

For the most part, the maximum time for 18650 storage before recharge is about one year.

If you are intending long term 18650 storage, a storage charge closer to 50% of usable capacity (~3.7V) rather than 100% (4.2V) will prevent faster battery degradation.

Frequently asked questions and notes

What happens if I don't store my 18650 batteries correctly?

It will cause a loss of performance and your cells may leak and/or rust, and ultimately become unusable. Cells becoming unstable enough and exploding in storage is a possibility. In the worst case - explosion - it is not clear why this sometimes happens but it could be due to static, pressure, temperature, or packing incorrectly (allowing metal objects or batteries to touch).

Notes

- For very short-term storage, don't store the battery in a pocket or a bag together with metallic objects such as keys, necklaces, hairpins, coins, or screws when you are travelling.
- Remove the battery from its application before storing it. For example, from your e-cigarette, flashlight, or electric bike. You should optimally store the batteries in a fire-proof container, with optimal environmental conditions.
- Do not store 18650 batteries in or near objects that will produce a static electric charge.
- Quick pressure changes can also cause 18650 batteries to malfunction