18650 Battery Safety Guidance

1. What are 18650 batteries?

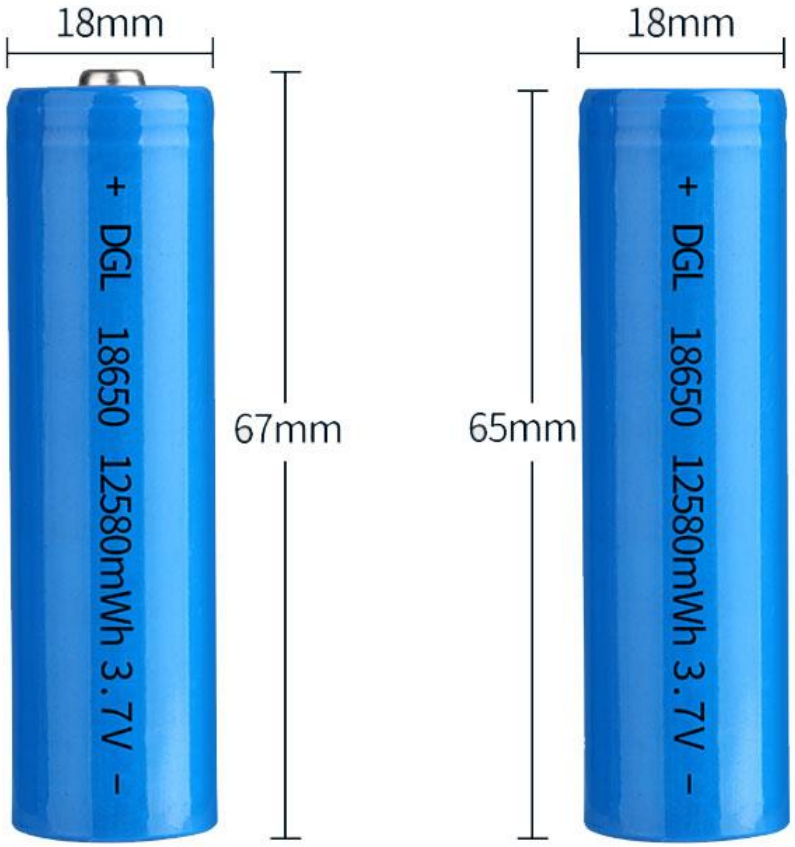
18650 batteries are standardized rechargeable Lithium-ion batteries.

They have the advantages of light weight, large capacity, no memory effect, no toxic substances, etc., which are widely used in daily life. Many digital devices like mobiles and cameras use lithium-ion batteries as power sources, despite their relatively high price.

Compared to other rechargeable battery technologies, Lithium-ion batteries have high energy densities and low self-discharge. The capacity of a lithium-ion battery is 1.5 to 2 times of a Ni-MH battery with the same weight.

2. Specification

The first 4 digits of the designation "18650" indicate the physical dimensions while the 5th digit indicates it is a cylinder cell. And there are two kinds of them on market: button top and flat top. As shown in the figure below:



Theoretically, a 18650 lithium-ion battery tends to have a life cycle of over 500 charge cycles, with a nominal voltage of 3.6V or 3.7V and a nominal capacity of around 2.5A/h per cell.

When fully charged, it gives 4.2V output, and after discharging, its voltage gradually drops to 3V and below.

It is generally considered that the battery runs out when its no-load voltage is below 3.0V. And for most lithium-ion batteries, the no-load voltage should not be discharged below 3.2V, otherwise, it will cause damage to the batteries.

3. Principle of Charging & Discharging

When charging the battery, lithium ions are generated at the positive electrode of the battery, and the generated lithium ions move through the electrolyte to the negative electrode.

The carbon as the negative electrode is in the form of a layer structure, which has many micro-pores, and the lithium ions that reach the negative electrode are embedded in the micro-pores of the carbon layer, and the more lithium ions are embedded, the higher the charging capacity.

By the same token, when the battery is discharged (i.e., the process we use the battery), the lithium ions embedded in the carbon layer of the negative electrode come out and move back to the positive electrode. The more lithium ions that return to the positive electrode, the higher the discharge capacity. What we usually call the battery capacity refers to the discharge capacity.

It is not difficult to see that during the charge and discharge of a lithium-ion battery, lithium ions move from the positive electrode → negative electrode → positive electrode.

If we compare the lithium-ion battery to a rocking chair, the two ends of the rocking chair are the two poles of the battery, and the lithium-ion is like a good sportsman, running back and forth on both ends of the rocking chair. Therefore, the experts gave the lithium-ion battery a cute name: rocking chair battery.

4. Safety Precautions

Since 18650 batteries usually come with large capacity, they need to be used properly to avoid abnormal heating, explosion, or even fire accident.

4.1 Storage Tips for 18650 Battery

- Store in a dry and cool environment
- Cannot be contacted with water or used in water. Water is a conductor of electricity, which will cause battery overheating and short-circuiting.
- Do not store in a high-temperature or high-humidity environment, which may intensify the reaction of the battery and result in reduced service life or lower capacity.
- Cannot be put together with metal and other conductive objects, which can easily cause a short circuit in the battery.
- The insulation tape of the battery can't be damaged, or it's easy to cause a short circuit.
- The 18650 battery should be removed from the device and stored in an insulated case if it's not been used for a long time. For a device that is hard to remove the battery from, power it off first to avoid short circuits resulting from improper placement.
- All batteries should be stored where kids can't reach them to avoid safety accidents.
- Kids under the age of 14 years old should use 18650 batteries with an adult's guidance and supervision.

4.2 Battery Polarity

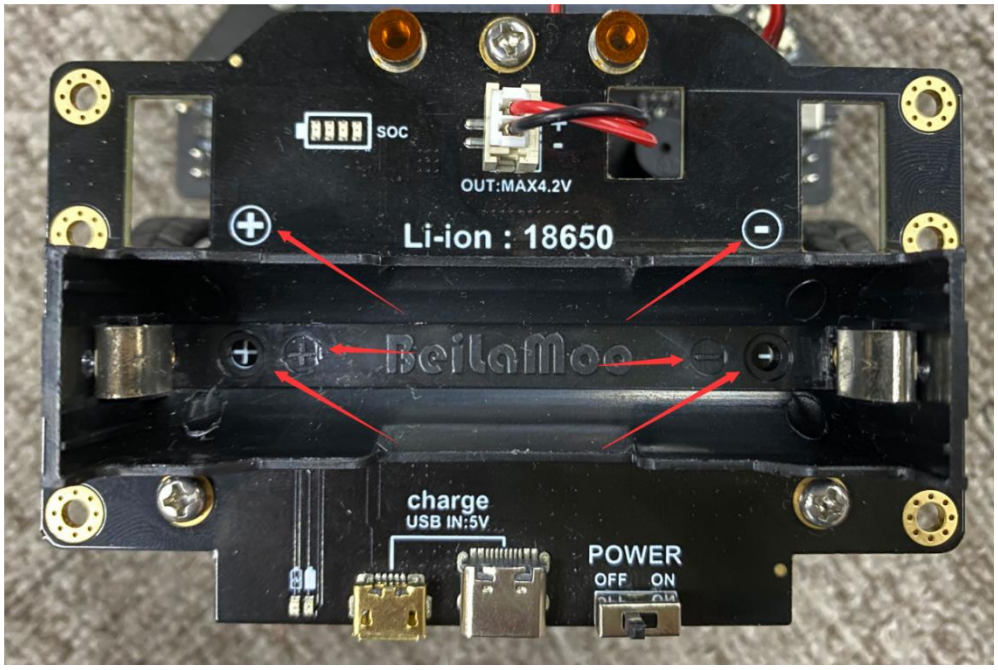
It is important to confirm the battery polarity before use since the wrong connection may damage the device, catch fire or even lead to an explosion.

The plus sign"+" indicates the positive battery terminal while the minus sign"-" indicates the negative battery terminal.

Safety Tips: The entire cylinder of the battery wrapped with insulation tape is majorly a negative terminal. Do not damage the insulation tape, since the negative metal surface is covered by the insulation tape to prevent it from coming into contact with other terminals, batteries or metal objects, which avoids short circuits. Meanwhile, don't attempt to short-circuit the negative and the positive with a screwdriver, tweezers, or other metal objects! Any short circuit of the battery will cause overheating, fire, or even explosion and other dangers!

4.3 Install & Remove Battery

The battery polarity has been marked at multiple places on the 18650 battery holder of Maqueen Plus. As shown in the figure below:



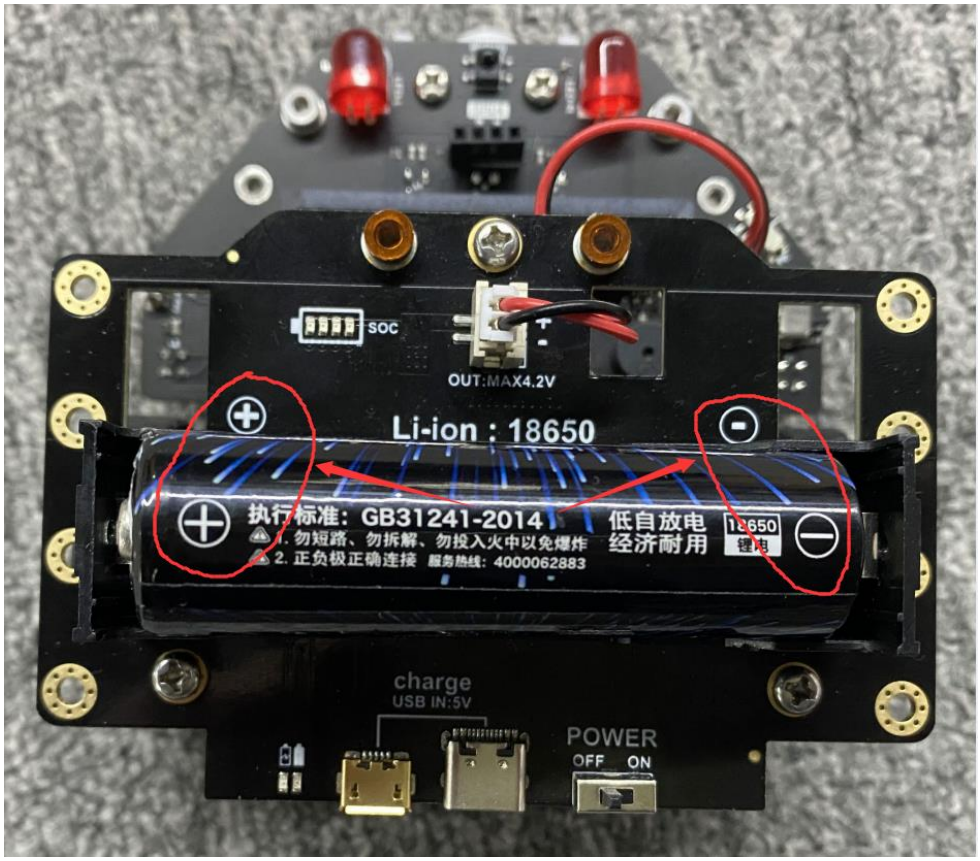
Before installation, please ensure that the “POWER” switch is turned to the “OFF” side.

Please note that the battery “+” goes to the “+” on the battery holder, and the “-” to “-”.

Installation process:

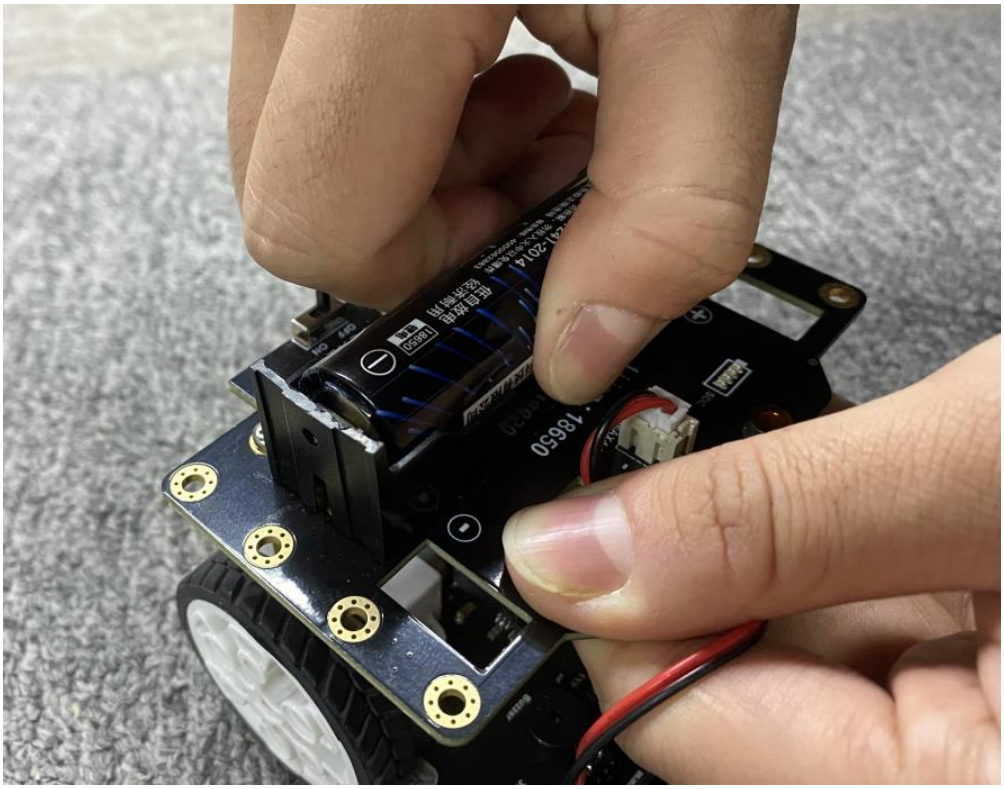
1. Find the positive and negative marks of the battery.
2. Place the negative end of the battery into the battery case first.
3. Then press the positive end and push it into the right place of the case.
4. Check again if the positive and negative terminals are correctly installed.
5. Turn on the power switch and check if the power indicator lights up correctly.

The 18650 battery should be installed on Maqueen Plus by teachers or under the guidance of teachers. Please don't let kids or students install 18650 batteries by themselves to avoid danger.



Please pay attention to the following points when you need to remove the 18650 battery from your Maqueen Plus:

- Don’t use your fingers to pull the battery out directly. For reliable battery connection, the 18650 battery case is designed to tightly hold the battery, so it can easily cause serious damage to your nail cover when you remove it with your fingers.
- Don't use any sharp tools such as screwdrivers to pry the battery, which may cause a short circuit and damage the insulation tape.
- Turn off the "POWER" before taking out the battery.
- Store the battery properly, refer to 4.1 for details.
- Hold the middle part of the battery with your hand, and turn it while pulling up to get it out of the battery holder. As shown in the figure below：



4.4 Notice

- Don't touch the circuit board and the battery with any conductive objects such as tweezers, pliers, screwdrivers, etc. when using Maqueen Plus, as this may cause a short circuit that damages the device or leads to other dangers.
- The "POWER" switch on the battery plate should be turned off timely when Maqueen Plus is not in use. Long-term powering on may cause device damage, battery over-discharge, or short circuits that may lead to a fire and other risks.

4.5 Battery Charging Instructions

There are 4 LED indicators on the battery plate of Maqueen for indicating 18650 battery level. Please recharge the battery in time when only one LED is on.

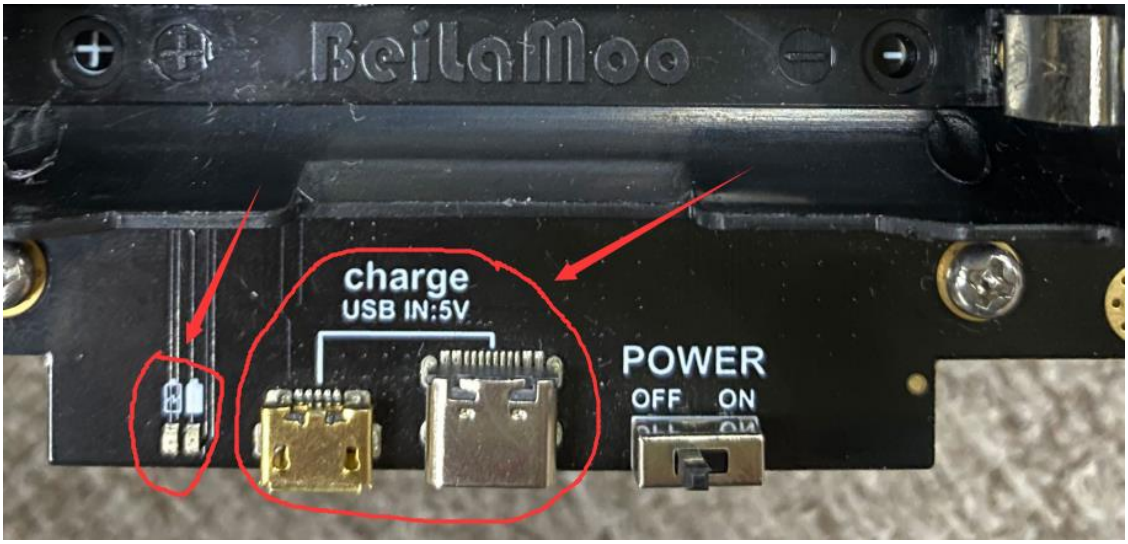
Please use qualified and safe chargers and cables, such as a mobile charger to charge the battery. Unqualified charging devices may cause slow charging, failure, or even damage to the battery and device.

There are two USB ports on the battery plate of Maqueen Plus: a Type-C and a MicroUSB. Both are used for battery charging. But they cannot be connected to cables and used at the same time. Please choose only one to use at a time.

Two charging indicators are placed on the left side of the MicroUSB port:

- In charging: The left red LED turns on
- Fully charged: The right green LED turns on

As shown in the figure below:



Please note the following during charging:

- It will take about 4 hours to fully charge a 18650 battery.
- Turn off "POWER" during charging.
- Don't charge at night or when there is no one around.
- Unplug the cable in time when the battery is fully charged.