

# LiPo Battery Guide

## What's a LiPo battery?

LiPo battery, its full name is lithium polymer battery, people also called Li-Po battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly and others). LiPo is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid one. High conductivity semisolid polymers form this electrolyte. These LiPo batteries provide a higher specific energy than other lithium-battery types. It is a newer type of battery now used in many consumer electronics devices. They have been gaining in popularity in the radio control industry over the last few years, and are now the most popular choice for anyone looking for long run times and high power.

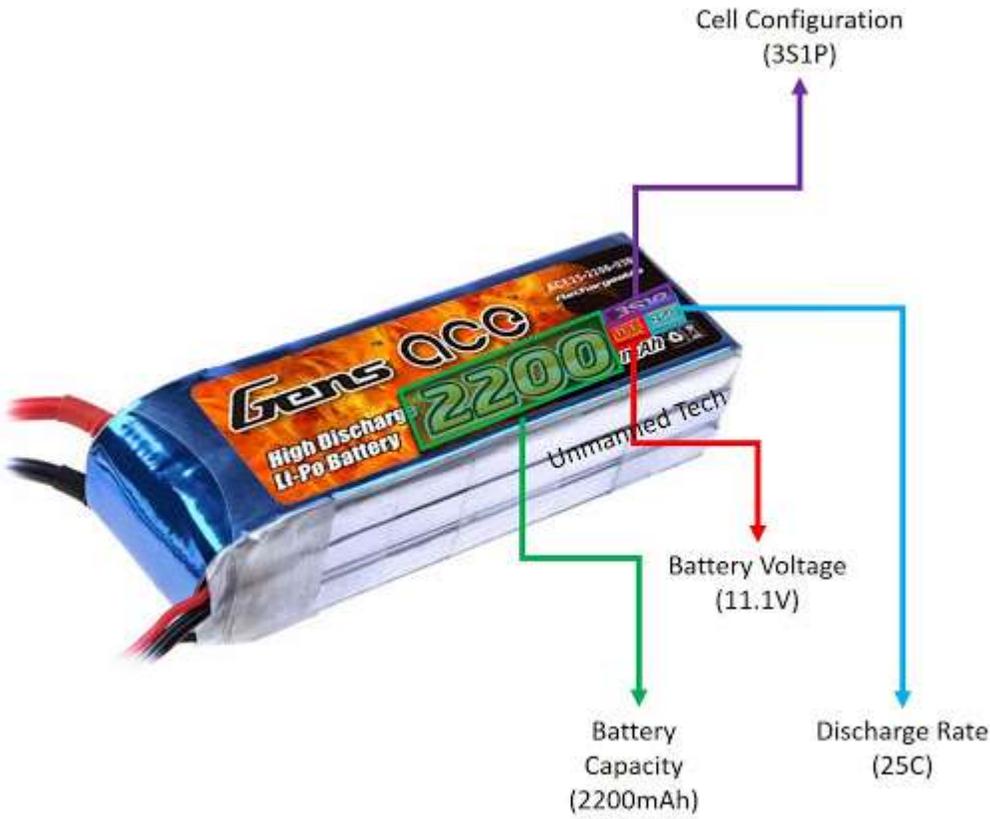
LiPo batteries offer a wide array of benefits. But each user must decide if the benefits outweigh the drawbacks. For more and more people, they do. In my personal opinion, there is nothing to fear from LiPo batteries, so long as you follow the rules and treat the batteries with the respect they deserve.

This guide is to introduce the basic LiPo battery knowledge about LiPo Battery Parameters, LiPo battery's choice, LiPo battery's maintenance, LiPo battery's safe and Gens Ace Tattu LiPo battery's Service.

- LiPo Battery Parameters Introduction
- How to choose a LiPo battery?
- How to maintain the LiPo battery
- LiPo Battery Safety

## LiPo Battery Parameters Introduction

We can see there are some Parameters on this LiPo battery, they are Battery Capacity, Battery Voltage, Cell Configuration and Discharge Rate, our guide will introduce what are these parameters stand for?



- Discharge Rating
- Cell Configuration
- Battery Voltage
- Battery Capacity

## Cell Configuration

A battery is constructed from rectangular cells which are connected together to form the battery. A cell which can be considered a battery in itself, holds a nominal voltage of 3.7V. By connecting more of these in series, the voltage can increase to 7.4V for a 2 cell battery, 14.8V for a 4 cell battery and so on. By connecting more batteries in parallel the capacity can be increased. Often you will see numbers like 3S2P, which mean the battery as 4 cells (4S) connected in series, and there are 2 cell sets connected in parallel (2P), giving a total number of 6 individual sells in the battery. So, the number of cells is what defines the voltage of the battery. Having a higher voltage means the battery can provide more power to drive bigger motors, however more power does not necessarily mean the battery will provide energy for longer, that is defined by the battery capacity.

## Battery Voltage

A LiPo cell has a nominal voltage of 3.7V, and a LiPo cell = 1 cell = 1S = 3.7V. For the 14.8V battery above, that means that there are four cells in series (which means the voltage gets added together). This is sometimes why you will hear people talk about a “4S” battery pack – it means that there are 4 cells in Series. So, a four-cell (4S) pack is 14.8V, a three-cell (3S) pack is 11.1V, and so on.

3.7V battery = 1 cell x 3.7V= 1S battery  
7.4V battery = 2 cells x 3.7V= 2S battery  
11.1V battery = 3 cells x 3.7V= 3S battery  
14.8V battery = 4 cells x 3.7V= 4S battery  
18.5V battery = 5 cells x 3.7V= 5S battery  
22.2 V battery = 6 cells x 3.7V= 6S battery  
29.6 V battery = 8 cells x 3.7V= 8S battery  
37.0V battery = 10 cells x 3.7V= 10S battery  
44.4V battery = 12 cells x 3.7V= 12S battery

The voltage of a LiPo battery pack is essentially going to determine how fast your vehicle is going to go. Voltage directly influences the RPM of the electric motor (brushless motors are rated by kV, which means ‘RPM per Volt’). If you have a brushless motor with a rating of 3,500kV, that motor will spin 3,500 RPM for every volt you apply to it. On a 2S LiPo battery, that motor will spin around 25,900 RPM. On a 3S, it will spin a whopping 38,850 RPM. The more voltage you have, the faster you’re going to go.

When you select LiPo battery, you need to know your motor of RC model, Voltage has an impact on motor, and motor influence the speed. The higher voltage is, the higher power (P) of the motor is, and here is the formula:

$$P=U*I$$

“P” is power, “U” is voltage, “I” is current. As you know, the voltage influences the power of the motor of battery, and the power has an impact on the RPM of the motor, that means speed. In some racing, pilots need the batteries are of high voltage to meet the needs of their RC model to get a high burst.

## Battery Capacity

The 1300mAh on the picture means the capacity of the LiPo battery. Capacity is used to measure how much power a battery can hold and the unit of capacity is milliamp hours (mAh), which means 1300mA can be put on the battery to discharge it in one hour. Milliamp also can be converted to amps(A), here is the conversion:

$$1300mAh=1.3 \text{ Amp Hour}(1Ah)$$

Generally, capacity can determine how long you can run before you have to recharge. A larger capacity pack may give you longer flight times but being heavier it will adversely

affect performance. But it's also influenced by the speed, the faster you fly your plane, the less your flight time is. Higher speeds consume more power, so your capacity is used much quicker.

## Discharge Rating

Discharge Rate ("C" Rating) is simply how fast a battery can be discharged safely. A battery with a discharging rating of 95C, that means you can safely draw it at the 95 times more than the capacity of the pack. A 10C pack = 10 times more, a 20C pack = 20C times more than 1300mA. Here is the calculation below:

$$95C = 95 \times \text{Capacity (in Amps)} = 95 \times 1300\text{mA} = 123500\text{mA} = 123.5\text{A}$$

From the theoretical stand point, if you discharge your battery 1300mAh battery at 2600mAh, the battery pack would be exhausted in half an hour. From the above calculation, drawing the battery at 123.5A would drain this battery in 0.63 minutes.

Some situations require a battery with a high discharging rate, i.e. in a race. The higher "C" rating means you can get a higher burst of power. This is why so many pilots attach such a great importance into the high discharge rate. But the disadvantage of the high "C" rating is it may get heavier and affect its performance. The battery discharge C rating needs to be matched to your vehicle. Using a discharge rate (C rating) that is too low, can result in your battery being damaged, and your drone or car under-performing since the battery can't release current fast enough to power your motors properly. Since higher C rating batteries are heavier, if the battery you are using has a C rating that is too high, you will just be carrying extra weight around that you don't need, ultimately reducing the running time.

## How to choose a LiPo battery

Our LiPo batteries are mainly used for RC hobbies, like RC cars, Drone/UAV, RC Airplane/Heli and FPV. In order to get the best flight (or run time) and performance it's important to know how to go about choosing the best LiPo battery.

Like most components on a drone or car, they are related to other components, and the battery is no exception. The correct battery mainly depends on the size of your drone or car, and the type and number of motors you use. In this guide we will discuss how to ensure your battery will work properly with your drone or car before you buy it.

## Knowing what size battery you need

To get the longest flight or running times you should use the largest battery (in terms of capacity) that you possibly can while still keeping the weight within reason for your vehicle. The other thing to take into account is the physical size of the battery.

# How to calculate the maximum continuous current output for your battery

In order to know what the total current draw of your drone system is, we can calculate it based on this simple formula:

Max continuous Amp draw (A) = Battery capacity (Ah) x Discharge rate (C)

For example, we have a 5100mAh 3 cell LiPo battery with a 10C rating. To find the maximum continuous amp draw, we first convert the 5100mAh to 5.1Ah, and multiply that number by 10C, to give a total continuous output of  $(5.1 \times 10) = 51A$

## How to find the optimum C rating

As choosing the battery is often the last step to building your vehicle, we will already know what motors and ESC we are using. Since the motors will draw the most amount of energy from your battery, we can base our calculation around this.

## The battery C rating depends on the capacity

There is no fixed C rating that you will need to use since the maximum current output of a battery depends on the capacity and C rating. Typically, the smaller the capacity of a battery, the higher the C rating needs to be. This is why for many high-capacity multi-rotor batteries you will find very low C ratings in the range of 10-15C.

## How much capacity do I need?

Now that you know the required current draw from your battery, the capacity and C rating can be found. In general, it's best to get the highest possible capacity battery that you can, while still keeping the total weight of your vehicle within reason.

Using a quadcopter example, we know that 50% thrust is around 500g per motor (or 2Kg thrust in total). Our frame, electronics and motors weight come to 1.2Kg. That leaves 800-1000g that we can use for the battery. You should try to find the highest capacity LiPo that you can find that weighs less than this.

## Battery Voltage

The battery voltage, or cell count is another important decision that you will need to make. Higher voltage batteries allow your motors to produce more power, however the higher voltage batteries are heavier since they contain more cells.

There is no golden rule to follow when it comes to battery voltage, but the way you can find the best voltage for your drone is to look through your motor thrust data tables and compare the efficiency. You will find that motors are generally more efficient and powerful when using higher cell count LiPo's (higher voltage), but some of the efficiency bonus is

negated by the increase in weight and cost of the battery. So depending on how many motors you are using you will need to choose what is best for your current setup.

One thing to bear in mind is to also make sure that your motors/ESC and other electronics are able to support the voltage of your battery. Some motors will only support a specific cell count LiPo, or a specific range of voltages which might make the decision easier.

## Battery Connectors

Soldering battery connectors can be a real pain, so it is a good idea to try find a battery connector that you like, and stick to it. That allows you to swap batteries easily, and if you decide to build another drone in the future you can use the same batteries. Common connectors include Deans (t-plug), XT60, EC3 and also EC5 connectors.

## Number of batteries

The number of batteries you decide to use on your drone does not ultimately make much difference as there are pros and cons of using more batteries. Firstly, using more batteries has an added layer of safety as if one battery should fail, you still have another that you can use to quickly land. Also, if you have the flexibility of replacing one battery if one of them gets older than the other. Charging time can be reduced if you have two chargers as each one can charge at the same time. However, using two batteries can be more complex to mount and wire and buying two batteries can sometimes be more expensive than buying one. So ultimately using one or more batteries comes down to the drone you are using and your own preference.

## How to maintain the LiPo battery?

### Before Charge

- Please read the charger instruction book before charging.
- Always check the voltage of batteries before each charge session in order to ensure they are at or above the minimum safe starting voltage. If starting voltage is below recommended levels then the batteries have been over discharged or have experienced a failure and should NOT be charged.
- Always check the battery before charging for any type of damage. Check the battery packaging, wires and connectors for defects, which may cause a short circuit and eventual battery failure.
- Make sure you are using charge leads which are compatible with the battery connectors.
- User should check the polarity of the battery cable and charger lead carefully before the connection to avoid any short circuit.
- Always verify the charger is in good condition. A poor-quality charger can be dangerous.

It is solely your responsibility to assure that the charger you use works properly. Always monitor the charging process to assure batteries are being charged properly. Failure to do so may result in a fire.

## Charging

- Only use charger designed for lithium polymer/Lion battery. Do not use a NIMH/ NICD/ LIFEPO4/ LEAD ACID charger. If the charger can support different battery types. Be absolutely sure to select the Lithium polymer (LiPo) mode on the charger. Failure to do so may cause a fire, which may result in personal injury and property damage.
- User should Always charge Batteries in an open area away from flammable materials, liquids and surfaces.
- Never charge Batteries inside of the model.
- Never charge batteries below freezing (0°C, 32°F)
- Never charge Batteries that are hot to the touch (above 100° F). DO NOT handle Batteries until they are cool.
- User should always set the charger to the proper cell count and/or voltage listed on batteries' labels.
- User should always set the charger to the amp charge rate as listed on batteries' labels.

The charger should never be set to charge batteries at a rate greater than 1C (One (1) times the capacity of Batteries in amp hours) unless another C rate is specified in the manufacturer's product documentation or the rate is preset as part of a specific battery and charger combination. DO NOT alter the charge rate once charging has begun.

- Never overcharge Batteries beyond the capacity listed on Batteries' labels.
- Never overcharge batteries over their rated maximal voltage (4.2V/cell for LiPo).
- Use suitable and good quality chargers, please don't use cheap or low quality chargers, use the professional Lithium polymer charger to charge the Gens ace & Tattu battery. When charging, please make sure the surroundings is clean, without sundries around. Don't charge without monitoring. Using a LiPo sack is suggested when charging to ensure the charging safety. Stop charging timely when the battery is fully charged. Do not connect the charger and the battery for a long time when the battery is fully charged. We will not be responsible for any personal injury and property lost or any kind accident that caused by improper charging.

## Discharging

- Never discharge batteries at amperage rates higher than specified on batteries' labels.
- Never allow the temperature of batteries to exceed 140°F during discharge. Adequate cooling for batteries is required, especially when discharging at or near maximum rates.
- Never discharge batteries to voltage below which they are rated by the manufacturer when measured under load (connected to the vehicle or a charger capable of discharge). Batteries discharged to a voltage lower than the lowest approved voltage may be damaged, resulting in loss of performance and potential fire when batteries are charged.

- Never discharge battery to a level below 3V per cell under load. For Tattu series batteries which are used for Unmanned Aircraft System, the recommended cut off voltage is 3.5V per cell.
- Never leave battery unattended during the discharging process. During the discharging process, user should monitor the process constantly and react to potential problem that may occur.
- In case of emergency, discontinue the process immediately, disconnect the battery, place it in a safe area, and observe it for approximately one hour. This may cause the battery to leak and the reaction with air may cause the chemicals to ignite, resulting in a fire. A safe area should be outside of any building or vehicle and away from any combustible materials. A battery can still ignite even after one hour.
- User need to check the conditions of the battery before use it or discharge it. Stop using it if user found the cells are not balanced or cells are puffing or weeping.

## LiPo Battery Storage:

- Do not directly connect the terminals with metal objects. This will short-circuit Batteries, resulting in heat and electrical discharge.
- Never store loose Batteries together, the Batteries' terminals may contact one another causing a short circuit.
- Never storage Batteries to extreme temperatures or direct sunlight. The battery should be stored within  $-10^{\circ}\text{C} \sim 45^{\circ}\text{C}$  range environmental condition. If the battery has to be stored for a long time (Over 3 months), the environmental condition should be:

Temperature:  $23 \pm 5^{\circ}\text{C}$

Humidity:  $65 \pm 20\% \text{RH}$

The voltage for long term storage should be 3.6V~3.9V range per cell

- Always disconnect batteries when not in use and store batteries in a non-conductive and fireproof container.
- Never alter, puncture or impact batteries or related components.

This information is courtesy of Gens Ace.