

N.B. The information below is my best shot based on my personal experience and research. This article may be corrected or updated at any time so if you find a mistake or a better way of doing any of this please let me know.

Charging LiPo batteries can be rather complicated and technical. I have tried to make this article as straightforward as I can but some maths cannot be avoided.

This article aims to set out roughly how LiPos behave in terms of charging and what we might want from a charger. I have left out much detail in an attempt to make it as accessible to as many pilots as possible. Some of these simplifications are addressed in another article “LiPo Batteries And Chargers - Technical!” which some pilots may find helpful.

Clones

Much electronic equipment is available as cheap copies of items developed by established manufacturers. Some “cloned” chargers work OK, but many do not. Some appear to work but do not charge batteries properly, some work with limitations and some are actually dangerous in that they do not meet electrical safety standards.

Batteries are expensive. Improper charging will reduce their service life and can cause deadstick landings or crashes. I think the risks associated with “clone” chargers are not worth the apparent cost savings.

There are many good chargers on the market. I believe the examples below are good. I cannot test every charger on the market and pilots will have their own preferences. My recommendation for UK pilots is to buy properly branded chargers from a UK supplier.

Cells and Batteries

Understanding the difference between a cell and a battery is crucial! When most people talk about an “AA battery” they actually mean an AA cell. A battery is two or more cells put together so that their voltages add to make a higher voltage.

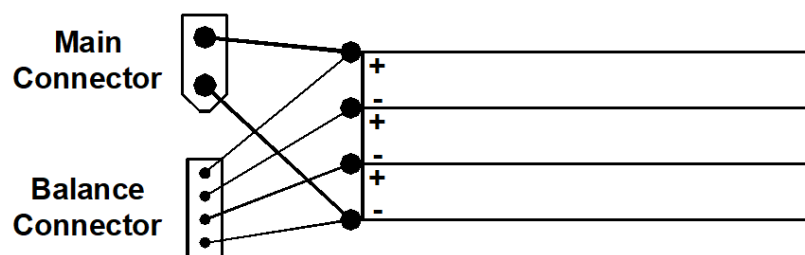
The single (1S) LiPo cell

We can check the amount of charge in a LiPo cell by measuring its voltage.

Charge	Voltage	
%	V	
100	4.2	Full
90	4.1	
80	4.0	
40	3.8	Storage
10	3.7	
0	3.3	Empty

These voltages are for cells which have no load on them. i.e. The battery is not driving the motor in our model or other significant load. Cells are normally charged to 4.2 volts (100% charge), and we would not normally want the voltage to fall below 3.7 volts (10%). We normally store them at about 3.8 volts (40%).

A battery consists of multiple cells. A three cell (3S) battery might look a bit like this:



Each cell will have a voltage of 4.2 volts when fully charged so the overall voltage of the battery will be $3 \times 4.2 = 12.6$ volts.

Batteries can be charged at a relatively low current through the balance connector. To charge at higher currents they are charged through the main connector and the balance connector is used to ensure each cell is charged to the same voltage.

Depending on who you ask, a battery is “balanced” when the “spread” of its cell voltages is less than about 20mV (0.02 volts). The “spread” is the difference between the lowest and highest cell voltages of a battery.

A spread of 30mV (0.03 volts) is the maximum I would consider reasonably safe to use, and I would be careful to land my model with plenty of charge to spare.

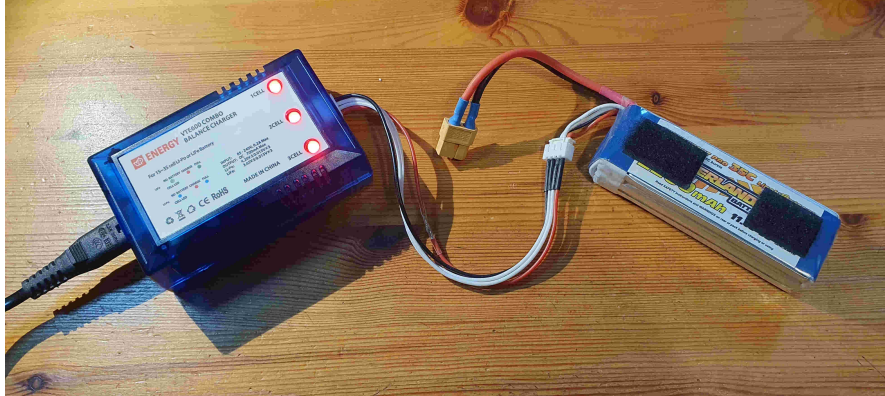
Key Point - Connections to the battery balance connector must be good for a charger to work properly. This includes the connector on the battery itself and any extension cable or “balance board”. These connectors can become slack with the repeated plugging and unplugging of normal use and so not connect properly.

Furthermore, some balance connectors are themselves “clones” of poor quality. If you find a battery is badly balanced after charging check all the balance connections.

The balance connector type is called JST-XH. Genuine ones (made by JST) are very cheap but a bit tricky to fit and require a proper crimping tool. However if a balance connector is dodgy it may damage our expensive battery or cause other problems through poor charging and should be replaced.

Simple Chargers

Chargers are available for 2S and 3S batteries which work through the balance connector alone.



The one in the picture works well and can be switched to charge LiFe batteries which require different voltages to LiPos. In this one the maximum charge current is fixed at 700mA (0.7A) so the 2200mAh LiPo shown will take 2 or 3 hours to charge.

On this type of charger lights indicate the state of charge of each individual cell.

“Computer Controlled” Chargers

To charge at higher currents we generally use a computer (microprocessor) controlled charger. This will apply the selected charging current to the main battery connector. To balance the battery the computer will monitor the voltage of each cell through the balance connector and “bleed off” some charge current from cells with the highest voltages.

Charging Power

The power of a charger is specified in watts (W). The maximum current we can charge a battery with can be calculated by dividing this power by the voltage of the battery we are charging.

If we have a 60 watt charger charging a 3S battery to 12.6 volts the maximum charge current will be $60 / 12.6 = 4.8$ amps.

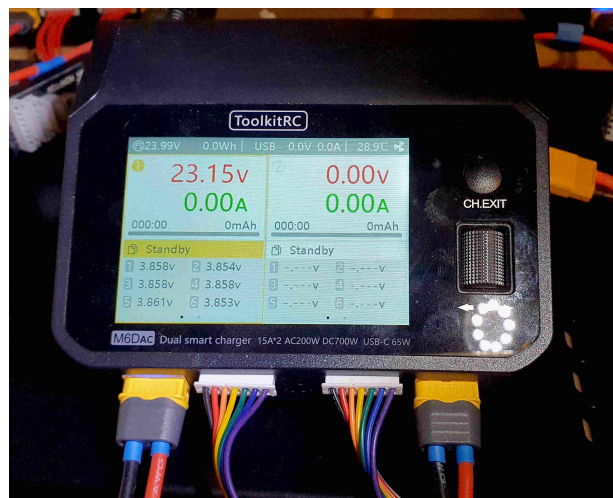
If the same charger is charging a 4S battery to 16.8 volts the maximum charge current will be $60 / 16.8 = 3.6$ amps.

If the current is set too high for the charger, most chargers will reduce the current to the safe limit automatically.



This is the Imax B6 V2 charger made by SkyRC. It charges a single battery at up to 60 watts. This one is supplied from between 11 and 18 volts DC, but a mains version is available. SkyRC generally makes reliable chargers and you will find these online.

You will also find very similar looking “clones” calling themselves “Imax B6” at about half the price. Although well built mechanically, the one I tested did not balance the battery properly and left one cell at a worryingly high voltage. I put it in the bin for electrical products at the recycling centre.



This is the M6DAC made by ToolKitRC. It has two charging channels each capable of charging at 350 watts. This is the mains version which can alternatively run on a supply between 7 and 28 volts DC and a very compact DC only version is also available. I find this easier to use than the SkyRC charger above (I make fewer mistakes setting it up!) because it has a section of screen for each channel showing most of the important information all the time. The selection of charge current etc. is simpler and less fiddly. It costs a bit more than double the SkyRC charger above but has two channels and is much more powerful and flexible.

Both these chargers can charge several battery types other than LiPos.

Balancing Current

The balancing current of a computer controlled charger is the current which bypasses a cell to reduce its charge current in order to balance the battery. A high balancing current has two advantages. One is that it can restore the balance of a poorly balanced battery more easily. The other is that in many circumstances a high balancing current will help to complete the charge more quickly. I suspect good balancing may also help to extend the life of aging batteries.

Balancing current is specified in milliamps. For the SkyRC charger above it is 300mA and for the ToolKitRC it is 1000mA (1A). The Imax B6 "clone" I tried was specified at 300mA but did not achieve an acceptable balance in my tests.

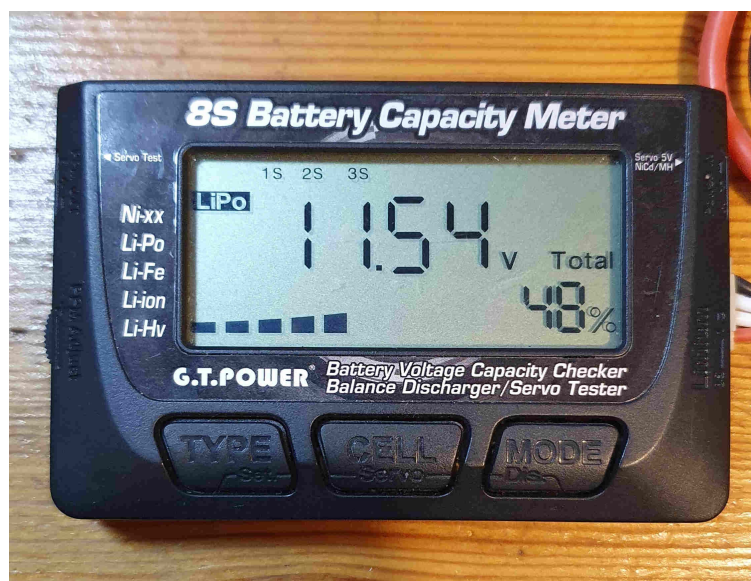
Main Points

- 1) Always use a balance charger for LiPos.
- 2) Although Lipo batteries can be charged faster, a charge rate of between 0.5C and 1C is recommended where C is the Ah or mAh capacity of the battery. I normally aim for about 0.8C.
- 3) Cell deterioration and gassing (puffing) occurs most at cell voltages above 4.0V (about 80% charge) or below 3.7V (about 10% charge). The longer the battery is kept fully charged the more it will deteriorate. Try not to charge batteries too far in advance of using them. I usually fly in the morning and charge my batteries the evening before. That compromise works for me but other pilots will find ones to suit their own flying habits.
- 4) Try not to keep batteries charged if you are not using them. At the end of a flying day I look at weather forecasts and assess my chances of flying in the following few days. If I expect to fly within 2 or 3 days I leave them charged, otherwise I discharge them to storage level.
- 5) Make sure your balance connections are in good condition as described earlier.
- 6) Optimum storage voltage is 3.8 to 3.85 volts on each cell. I normally check cell voltages after a flying session. If they are in the range 3.78 to 3.85 volts I leave them, otherwise I charge or discharge them to between 3.8 and 3.85 volts per cell.

This type of balancer/meter/discharger is very effective:



For batteries from 2S to 6S it will show individual cell voltages and it can discharge each cell individually to a selected voltage (3.8V for storage) at about 250 mA. It will immediately show if the voltage of one or more cells differ significantly from the rest.



This meter has a higher resolution and is more accurate. Individual cell voltages can be read by pressing a button to step through the cells one at a time. It shows the overall charge in the battery as a percentage which some pilots prefer to cell voltages.

7) Try to time your flights so the battery is at storage voltage after you land. If you have appropriate telemetry you can monitor the battery voltage in flight.

8) Cells should not be discharged below 3.3V. Most ESCs detect when overall battery voltages fall to somewhere around this level and shut themselves down.

9) Lipo batteries work best between about 10 and 30 degrees C. Do not let them get below 0 deg.C . If they have been stored below 10 deg.C make sure they are

warmed before charging them.

10) Some manufacturers recommend batteries are “broken in gently” for one or two cycles meaning something like:

a) Charge as normal.

b) Leave for about 30 minutes to settle.

c) Discharge (to storage voltage) at a low current (around 1 or 2C).

11) If you think a battery has become badly unbalanced, charge it at a low current, say 0.25C. Charging will take longer but the charger balancing system should work more effectively. Alternatively use a discharger/balancer to balance the battery before charging.
