

5 BATTERY CHARGING

In this chapter, you will learn how to:

- Check, and charge batteries
- How to properly store battery and drones after and before transportation

Example of Balance Charger: Turnigy Reaktor 250W 10A 1-6S Balance Charger

Details:

Input voltage: 10 – 18V DC

Charge current: 0.05 – 10A

Discharge current: 0.05 – 7A

Max charge: 250W

Max discharge: 20W

Weight: 360g

Size: 140 x 80 x 30mm

Features include:

IR measurement

Automatic cell count detection

Temperature based fan control

Configurable max voltage per lipo cell, up to 4.3v



Battery charging rules

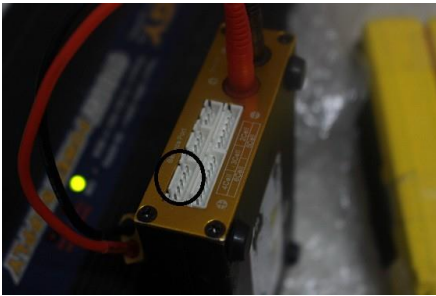
Its important to take note of these rules when charging your lipo battery

- Never charge your battery unattended - from time to time check to see if your battery is getting warm to the touch or starts to swell, if so stop charging immediately and contact an expert immediately (like someone on dronetrest) before using the battery again.
- Never charge a damaged battery - dont charge if it is swollen (puffy) or has any other visible signs of damage
- Always charge your battery at 1C or less - many chargers allow you to set a charging rate, although most batteries can support up to 5C charge rates (which makes charging your battery much faster). Its always best to charge at 1C or less as this means the chemicals inside your battery will gain energy slower which keeps them more stable and ultimately means your battery will have a much longer life in terms of charge/discharge cycles.
- Try to charge your batteries in a fireproof location, or in a lipo safe bag. - this just adds an extra layer of protection
- Ensure the number of cells and battery type are set correctly on your charger to match the cell count in your battery. - this is only applicable for more advanced chargers.

Note: You can simultaneously use different power supply ports for charging 2 or more batteries. Refer to page 6 for photos.

5.1 THE PROCESS OF CHARGING A BATTERY

1. Plug in the charge and balance leads between your charger and battery.



2. Select the appropriate LiPo balance charge mode on your charger. (ie LiPo Charge, LiPo Storage).
 - Press Enter to Switch between Parameters (ie Charge Mode, Current). Selected item is blinking.
 - Press + or - to increase or decrease values. Press Enter to Enter Value



3. Confirm that display shows the right parameters: Cell Count, Nominal Voltage, and Ampere Rating. The Charger will automatically display Cell count, and Nominal Voltage values once the battery is connected via balance and charge leads.
 - Hold Enter to Start Charging

In terms of the technical details of charging most chargers follow a two set process.

- The first process (constant current) is when a constant current is applied (at the rate you specified) and keeps that current flowing into the battery until a certain voltage is reached.
- After this threshold the charger will switch to constant voltage mode where the charger will vary the current to make sure all of the cells have the same voltage (the balancing step). As the cells get close to the maximum charge of 4.2V the current will drop slower until eventually stopping at 4.2V per cell

5.2 BATTERY CHECKING

Simply connect the balance plug of your pack in to the pins on the Cell Key and it will display individual cell voltage for up to 6 Lipoly cells then the total voltage of the battery pack.



Proper Storage of LiPo Batteries



5.3 STORAGE OF BATTERIES

1. Batteries must be placed orderly in a clean box/casing. see photo above
2. Dispatch usage when a battery shows signs of **bloating**; or if they cannot be balanced charged.
3. Avoid overcharging nor empty the battery as these may cause abrupt or gradual deterioration of cells.
4. Do not store them in high heat or in extremely cold areas.
5. Do not drop. Handle with care.

Battery Storage

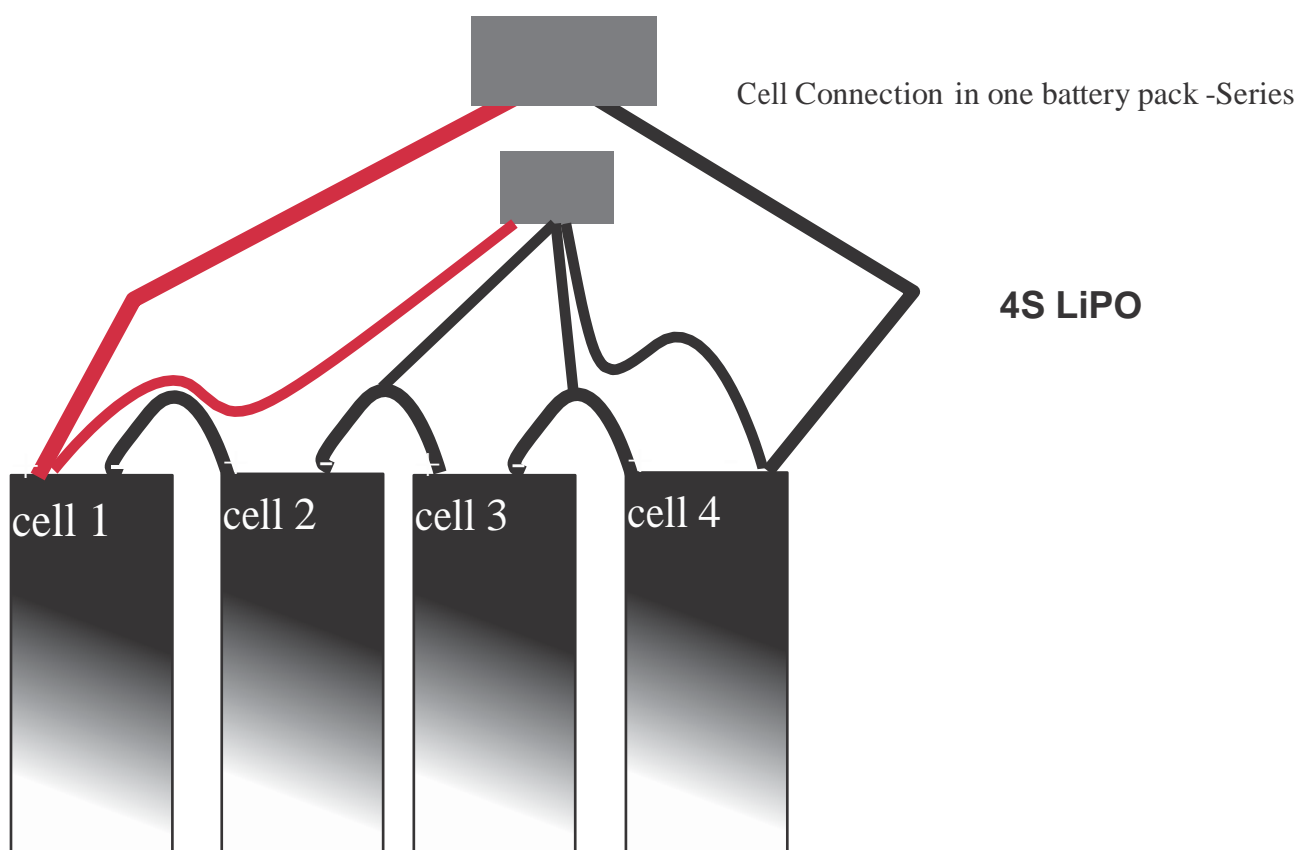
Another useful feature that some chargers have is the Lipo storage mode. From your Lipo battery guide, its best to store the battery at about 40% to 50% charge. So the storage mode on the charger will automatically charge/discharge the lipo to this range in each cell so you can safely store your battery when you are not going to flying for a while.

The batteries will only be fully charged again before heading out to go flying.

LiPO
5.0A

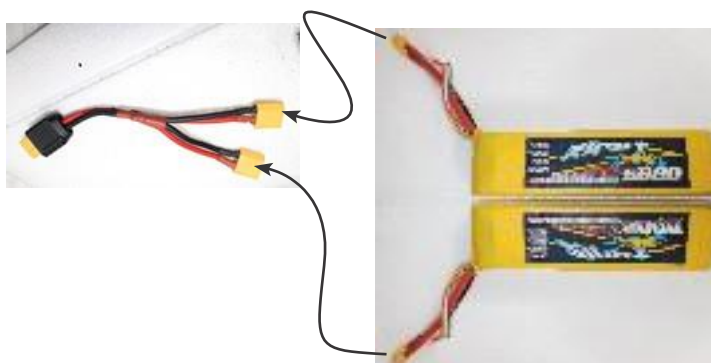
STORAGE
14.8v(4S)

5.4 LiPo



For the diagram above, the total pack is rated
 $3.7V \times 4 = 14.8V$ nominal (Each cell is rated 3.7v at 5000mAh and 10C)

BATTERY PACK WIRING CONFIGURATION - PARALLEL



Parallel Connection = Increased Capacity = Longer Run-Time

The illustration shows two 5000mAh Power Cell 14.8volt Lipo batteries connected in parallel. Note that both positive battery leads (in red) attach to the positive terminal on the connector that leads to the speed control, and both negative battery leads (in black) attach to the connector's negative terminal. When assembled in parallel, the combined packs will still have an output of 14.8 volts, but their total capacity will be 10000mAh (5000mAh X 2 = 10000mAh). Your vehicle will not be any faster, but its run-time will nearly double

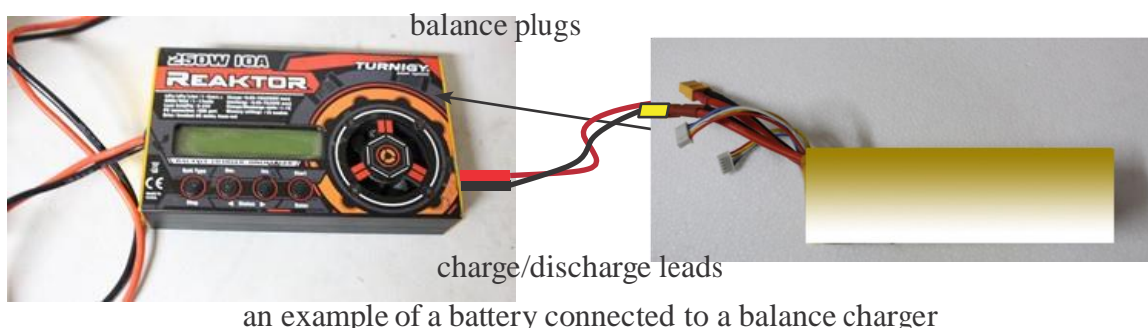
What makes a good or bad charger?

Investing on a good LiPo charger is important. We cannot use just any regular charger with lithium polymer batteries as they are not LiPo battery compatible. Using them might cause an explosion. This is due to the fact that these batteries have several cells that have a very specific voltage range.

There are a few important specifications you should look at before buying a lipo battery charger.

1. Balance Charging

99% of Lipo chargers have the ability to perform balance charging. This process will check the voltages of each individual cell in your battery and ensure they all have the same voltage. This is a critical factory to monitor as if one of the cells voltage increases or drops below the required voltage range the battery could get damaged, or worse, catch fire!. Fortunately, as I mentioned basically all chargers have this ability.



an example of a battery connected to a balance charger

- If you need to plug in the balance leads from your battery to your charger, it's a good indication that your charger has the balance function.
- If you just connect the main connector to your charger, then your charger does not have the balance function.
- When using the main lead, your charger is only able to read the overall voltage of your battery and not the individual cells so it's critical that you check these with a volt meter, or battery monitor to avoid any potential issues with your battery. You can also purchase separate battery balancers to ensure the voltages of each cell are correct, but these are very uncommon nowadays.

2. Cell compatibility

When buying a charger you should consider what LiPo batteries it can support. Some very cheap lipo chargers will only support 2S or 3S lipos, where the fancier ones will be able to support the full range from 1S to 6S. Other higher end chargers are also able to balance charge more than one LiPo at the same time.

3. Charging current

Most batteries specify a maximum charge rate as 1C, 2C etc.. however most chargers you specify the charge rate in Amps, so sometimes there is confusion between these two values. To convert your battery C charge rate to Amps you simply need to multiply the battery capacity by the C rating. So let's say we have a 2200mAh battery with a charge rate of 2C. So the maximum current we can charge this battery at is $2.2\text{Ah} \times 2 = 4.4\text{A}$. Similarly let's say we want to charge a 5100mAh battery at 1C, the max current we will need to set on our charger is $5.1\text{Ah} \times 1 = 5.1\text{A}$. The maximum current you can set for your charger depends on the power output it is capable of as described in the next section.

4. Power Output

All batteries have a certain power output level, defined in Watts, typically around 50W. This number represents how much power the charger can provide to your battery, ultimately the larger this is, the faster it can charge your battery. Watts are the product of current and voltage, so if you keep current constant (say at the recommended 1C value) you will use more power with higher voltage (bigger cell count) batteries. So having more power available is better. Let's look at an example, if we want to charge a 3S 2200mAh battery at 1C we will need to use $12.6\text{V} \times 2.2\text{A} = 27.72\text{W}$. If we want to charge a 3S 5100mAh battery at 1C we will use $12.6\text{V} \times 5.1\text{A} = 64.26\text{W}$ which is actually a little over the standard power rating for chargers. So we can only charge our 5100mAh battery at $50\text{W}/12.6\text{V} = 3.97\text{A}$ assuming we have a 50W charger.

5. Power Supply

Some batteries include a built-in power supply so you don't need to worry about this. But if your battery does not include a power supply you will need to make sure that the one you buy will match your charger in terms of specifications and also the connector is the same.

However the most important thing is to ensure that the power supply has the correct power (Watts). So if using a 50W charger, you will need to make sure your power supply will be able to provide at least 50W of power to the charger, however getting something a little over is best such as a 60W power supply.



- This serves as the power supply for the Balance Charger (Reaktor). Simply connect the two jacks of the Charger to the back panel of Turnigy Power Supply.
- Power Supply is connected to the main Power Line.

5.5 STORAGE OF BATTERIES

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Battery Storage

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LiPO	STORAGE
1.0A	14.8v(4S)

5.6 Rechargeable AA Batteries

Definitions of Terms

A cell is an electro-chemical device capable of supplying the energy that results from an internal chemical reaction to an external electric circuit.

The “c” rate is a current that is numerically equal to the A-hr rating of the cell. Charge and discharge currents are typically expressed in fractions or multiples of the c rate
ESR (Equivalent Series Resistance) is the internal resistance present in any cell that limits the amount of peak current it can deliver.

The Amp-hour capacity of a battery (or cell) is its most important figure of merit: it is defined as the amount of current that a battery can deliver for 1 hour before the battery voltage reaches the end-of-life point.

A battery is composed of one or more cells, either parallel or series connected to obtain a required current/voltage capability (batteries comprised of series connected cells are by far the most common).

A constant-voltage charger is a circuit that recharges a battery by sourcing only enough current to force the battery voltage to a fixed value.

Eneloop Batteries

- Alkaline Battery
 - Use immediately
 - Long storage life
 - High performance
- Rechargeable Battery
 - Reusable
 - Recyclable
 - High capacity



Charger

Panasonic eneloop can be recharged up to 2,100 times—they're ready to work longer than standard alkaline cells. They hold 70 %*2 of a full charge after 10 years*3 in storage. Reliable during emergency

*1 Battery life based on testing method established by IEC 61951-2 (7.5.1.3). Varies according to conditions of use.

*2 Capacity retention based on testing method established by IEC 61951-2 (7.3.2) when stored at 20 °C (based on Panasonic's estimation) and compared with minimum capacity. Varies according to conditions of use.

*3 70 % after 5 years for products in some regions.

Charger Used

The XTAR VC4 charger (photo above) is a combination of our XP4C and VC2 charger! This intelligent charger can recognize, charge, and display charging current, battery voltage, and charge capacity of both Ni-MH and Li-ion batteries at the same time! This is a USB powered charger so it can be plugged into any of...

Features:

1. Innovative LCD screen displays charging current, battery voltage, and charging capacity. It can also intelligently recognize and charge Ni-MH and Li-ion batteries and clearly display this information.
2. Intelligently identify a battery's input power and automatically adjust suitable charging method and charging current from 0.1A to 1.0A and up to 0.5A*4 / 1.0A*2 max.
3. Three charging stages (TC-CC-CV) can prolong your batterie's life.
4. Soft start will prevent any sudden current spikes which is used to prolong battery lifespan.
5. The charger can tell you the real capacity of your batteries.

Worry-free Charging:

1. Automatically stops charging when battery is fully charged and will automatically start charging again if the battery falls below 3.9V. This allows you to keep the batteries inside the charger overnight.
2. Intelligently identifies bad batteries by showing "null" and "Err" if reverse polarity has been detected.
3. ABS durable fireproof shell with perfect heat dissipation and high temperature resistance.

Functionality:

1. Four independent slots making each port operate like 4 separate chargers.
2. 0V activation function which rescues your overly discharged batteries when in most cases the batteries must be discarded. With our chargers you can bring them back to life.
3. Compatible with any USB power adapter or wall adaptor.
4. 2-minute non-activity backlight feature; inserting batteries will activate full LCD screen brightness, pressing the mode button for 1.5s can turn off the backlight at your will.

How to test your batteries mAh capacity:

Step 1: Insert your discharged battery (at a discharge cut-off voltage generally below 3.0V)

Step 2: Let the battery charge and notice the 0000mAh displayed on the screen. Do not remove the battery until the charge is complete.

Step 3: When the battery is fully charged, the screen will show "FULL" and the entire screen will flash 3 times every 10 seconds.

Step 4: The mAh on the screen should now give you the batteries actual capacity.

5.7 THE MAIN PARAMETERS FOR CHOOSING BEST DRONE BATTERY

Source: <http://diydrones.com/profiles/blogs/the-main-parameters-for-choosing-best-drone-battery>



Here are some tips to help you consider the main parameters for choosing a lipo battery for your drone.

1. *Main parameters*

1. Capacity

Normally, more capacity is mean more power and more energy. In fact As the battery gets larger, the increase in flight time becomes ineffective, because of the weight of battery. You should have to think about the weight when consider the capcity, Should not be absorbed in choosing bigger capacity battery simply.

2. Discharge Rate

Discharge Rate is yet another crucial aspect that need to be checked before you decide to settle for any battery for your drone. You need to get a battery whose C rating is convenient for your drone. you have to compare

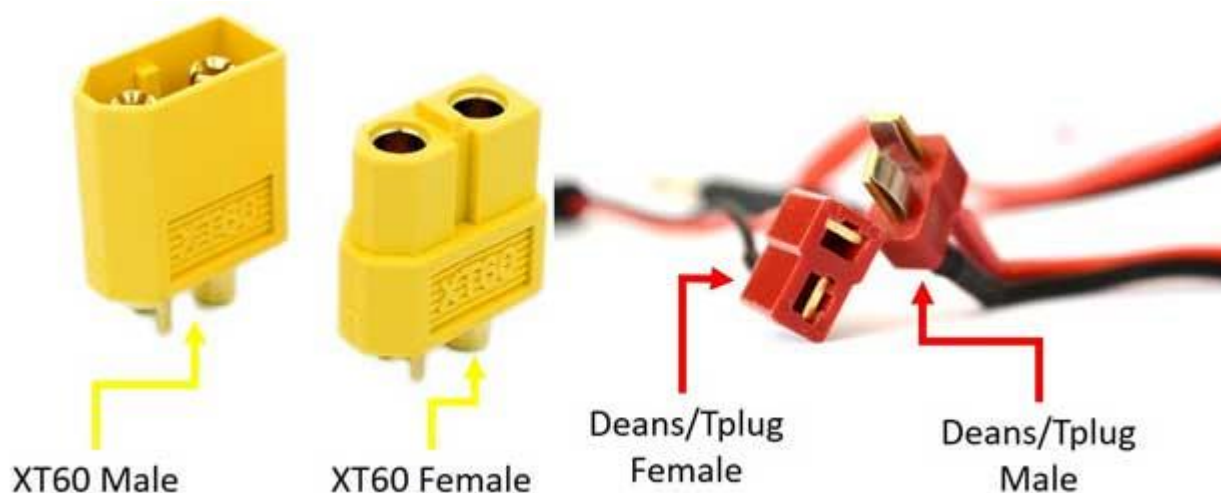
target c-rating and battery c-rating. In short, my principle is that battery c-rating is greater than target c-rating but not too higher.

3. Voltage

With a higher cell count, performance is maintained above par. However, higher cell counts translate to an increase in weight which, in some cases, affects performance. Choosing the right voltage of battery, you should reference in the datasheet of motor and esc.

4. Connectors

There are many common connectors include Deans, XT60, EC3 and JST etc. What is the performance impact of these connectors?



ST connector – up to 5A

XT60 connectors- up to 60 Amps

Deans – up to 60 Amps

EC3 connector – up to 60 Amps

EC5 connector- up to 120 Amps

5. Brand

Tattu , Bonka, Multistar, Turnigy , Zippy , Graphene , SMC, Dronelabs, Ready MadeRC, ThunderPower, Floureon, Venom, Pulse , E-flite etc. Which one is the best one? All of them are good enough, I highly recommend Tattu battery.

6. Conclusion

Choosing the right drone battery is no doubt important, and looking after your lipo battery is also important. If you have any question of any thing about the main parameters for choosing your drone battery and have more experiences, please leave your message on here, Thank you.

TLDR:

C-rating selection

Lipo Battery constant C-rating/Discharge rate should be greater than or equal to 2 times (best 4 times) the total Amp draw from full throttle drone

<https://ecalc.ch/>

SkyEye Analytics Inc. | www.skyeyeproject.com | info@skyeyeproject.com

Author/s: Josephine Medina, Nico Lasaca, Matthew Cua

10
Rev. No. 0.1 Updated 20/6/2017

https://ecalc.ch/toolbox/LiPo_TRUE_C.xls
<https://www.youtube.com/watch?v=mpNLZK955bA>

Connector Selection

Connector constant Current Rating should NEVER EVER be less than actual total current draw of the drone in full throttle or it will melt. Peak or Max current draw is BS and will cause heating of the connector with possible insulation melting or desoldering. You have been warned.\

