The Dead Stick Flyer

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Tech Corner

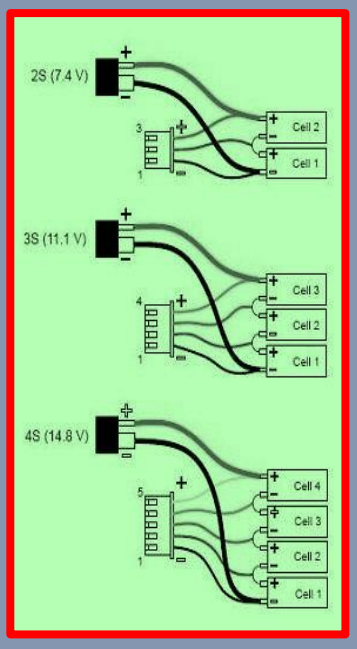
Lithium Battery "Balance Charging" Part 2 – "What does it mean" by Ron Lazzeri

Most RC users today know how to properly charge their batteries and do not need any specific advice or information. However, these articles are written for the new RC flyer or veteran flyer that needs more information on how to charge and care for their expensive batteries. See the "Part 1" article from last month's issue below for a general introduction.

- *Which batteries get direct "Balance Charged"?*
  - *In general, the batteries that are designed to be direct balance charged are as follows and are constructed with a "Balance Port" lead and a "Power" lead:*
    - *LiPo (Lithium Polymer batteries)*
    - *A123/Life batteries*
    - *Li-Ion (Lithium Ion batteries)*
      - *Note: Some Lithium Ion batteries do not have a "Balance Port" lead.*

- *What does it mean to "Balance Charge" a Battery?*
  - *Battery packs that can be "Balance Charged" are constructed of multiple individual battery cells wired together in "series" to arrive at their total voltage and amperage. In order to maintain and keep the battery pack at its peak performance and healthy state, it is important to charge and maintain the same voltage on each individual cell, within small tolerances. There are ways to check and maintain this using a Battery Checker Meter, but a current "state of the art" battery charger designed to "Balance Charge" batteries is the best way.*

- ***How are battery packs wired?***



  - ***To explain "Balance Charging" further it is good to look at how batteries are internally wired. This diagram shows how a 2S, 3S, and 4S battery is wired between the power lead and balance lead.***
  - ***The power lead has a (+) positive and (-) negative connector. This lead is connected to your RC device and should be matched to meet its rated voltage power requirements.***
  - ***The balance lead is comprised of multiple wires depending on how many cells are in the battery pack. Usually, the (-) negative wire is black and is in the same position on all packs. The other wires in the balance lead are connected to the remaining battery tabs. This lead is designed so the balance charger can read the voltage for each individual cell in the battery pack and adjust their individual voltages as needed, thus balancing the battery pack cells.***

- ***Use the appropriate RC Battery Charger:***
  - ***As mentioned previously, it is very important to use a current "state of the art" battery charger for charging today's high voltage and high amperage batteries. The charger's settings automatically select the correct charging voltage for each battery chemistry. Over charging a battery can result in a damaged battery or worse, an exploding battery and fire. Ouch!***

- ***How to "Balance Charge" a battery pack:***

  - ***Here is a simple explanation of how to "Balance Charge" a LiPo battery pack. The diagram shows how a balance charger is connected to a LiPo battery pack. Please read your charger's user manual for specific instructions on how to use and configure your charger.***
  - ***The power lead is connected to the (+) and (-) ports on the charger and the balance lead is connected to the appropriate balance port on the charger.***
  - ***If your charger only has 1 large balance port you may need to use a JST XH Adapter as shown or equivalent adapter. The battery pack's balance lead is connected to the appropriate adapter port and the adapter's lead is connected to the large balance port on the charger.***

- ***Next, you must configure your charger for the appropriate battery chemistry. In this example, choose the LiPo battery setting and the "Balance" charge method. Next, the charger will give you the option of changing the charge amperage rate and battery voltage. <u>These steps are vital to accurately charging the battery correctly</u>. You must select the correct amperage rate, like 1C or 0.5mah–0.8mah and select the correct voltage, like 11.1v for a 3S LiPo pack. If not, the charger may or may not catch the mismatch and could possibly over or under charge the battery causing an eventual problem.***

- ***To look at the individual battery cells while the balance charge is in process, press the "INC" button to change screens to the individual cell voltage screen. This will show you the charger's readout of each cell's voltage. The display will read as follows: Cell 1: 4.19 Cell2: 4.18 Cell 3: 4.19***
  Cell 4: 0.00 Cell 5: 0.00 Cell 6: 0.00

- ***<u>Some Useful "Balance Charging" Tips</u>:***
  - ***If you have the time, it is beneficial to charge the battery at a rate of 1C or lower, like 0.5mah–0.8mah. This lower charging rate is much gentler on the battery pack keeping it cooler and allows the battery chemistry more time to absorb the charge. It will also allow the "Balance Charging" process more time get all cells in balance, if needed. Depending on where the overall battery pack voltage is, like 95% charged, the balance charge process may not have enough time to balance the voltage between all cells.***
  - ***If you determine by looking at the individual cell voltages that some cells are out of balance when the charge is complete, it may require you to discharge the battery pack down to a safe level then balance charge the pack back up to a full charge. This may take several cycles to equalize the battery pack cells. If it does not help, keep an eye on the battery pack as it may be a sign of a future battery pack failure. <u>Your flight may not end well if the pack fails in flight</u>!***

Lithium Battery Charging & Maintenance – Part 1: ***by Ron Lazzeri***

With all of the different Lithium battery chemistry types and charging equipment on the market today, I thought it would be good to write an article describing some general guidelines for the safe handling, charging, and storage maintenance of the various batteries.

This can be a very complicated topic to discuss with a lot technical details to observe and follow, but I will make this article easy to read and easy to follow for 3 of the most used RC batteries today. It will, however, take some thought and preparation on the user's part to be successful.

Note: Going forward "V" stands for Voltage

- ***Battery chemistry types:***
  - ***LiPo (Lithium Polymer)***
  - ***A123 & LIFE***
  - ***LiIo (Lithium Ion)***

- ***Standard battery voltage parameters per cell:***

	LiPo	***A123/LiFe***	***LiIo***
Nominal Rated Voltage	***3.7v***	***3.3v***	***3.6v***
Maximum Charging Voltage	***4.2v***	***3.6v***	***4.1v***
Storage Voltage	***3.8v***	***3.3v***	***3.7v***
Minimum Discharging Voltages	***3 - 3.3v***	***2.6 – 2.9v***	***2.9 – 3.2v***

- ***Battery Pack Amperages (MAH) and Voltages (DC):***

  - ***Battery Cells:*** ***all of the battery types listed above can be purchased in various amperage and voltage configurations. The batteries can be found in single or multiple cell configurations from 1 to 6 cells commonly known and packaged as:***
    - ***1S: single cell,*** ***2S: two cells,*** ***3S: three cell***
    - ***4S: four cells,*** ***5S: five cells,*** ***6S: six cells***

  - ***Battery Voltages:*** ***each of the configurations above determine the nominal voltage of a battery pack. With each cell addition to the pack, the voltage increases by the nominal voltage of the individual cell.***

- ***Example:***
  - ***1S LiPo = 3.7v (1 x 3.7v)***
  - ***2S LiPo = 7.4v (2 x 3.7v)***
  - ***3S LiPo = 11.1v (3 x 3.7v)***
  - ***4S LiPo = 14.8v (4 x 3.7v)***
  - ***5S LiPo = 18.5v (5 x 3.7v)***
  - ***6S LiPo = 22.2v (6 x 3.7v)***

- ***<u>Battery Pack Amperages</u>: battery packs will be configured with a certain amperage capacity rating like 1400mah, 2200mah, or 3800mah, etc. The packs will also be given a certain charge and discharge rating known as the "C" rating. The "C" stands for the capacity rating or the overall ability of a battery to accept or discharge a certain amount of amperage per the batteries voltage rating.***

  - ***Battery charging MAH/AMP rating:***
    - ***A battery will be given a charging rating which is the charging amperage rate you should configure in your charger to safely charge the battery. Could be 0.5mah, 1.0amp, or higher.***
    - ***A battery's charging rating is calculated as follows:***
      - ***Battery capacity / 1000 = 1C Rating***
        - ***Example 2200mah / 1000 = 2.2C (1C rating)***
        - ***To calculate a higher C rating like a 2C rating you would multiply the 1C rating x 2 = 4.4C. Higher C calculations would be calculated the same way for 3C, 4C, 5C, etc.***
      - ***The battery manufacturer should provide on the battery the safe charging C rating but if they don't, 1C is a good rule to follow.***

  - ***Battery Discharging MAH/AMP Rating:***
    - ***The manufacturer should provide on the battery pack the discharge rating or capacity of the battery like 35-90C. This will enable you to properly match the battery discharge power capabilities to the power requirements of your plane, quad copter or car.***
    - ***The first number, 35C, is the normal sustained power discharge capabilities for the battery during its overall use.***
    - ***The second number, 90C, is the burst power discharge capabilities of the battery but only for a short duration. If you need to climb and consume a lot of power in a short period of time, this rating will indicate how this battery should perform under these circumstances.***

- ***Charging/Discharging Batteries:***
    - ***The process of Charging Lithium batteries is not that complicated. Here are some important tips for the proper charging of the battery types.***
        - ***The most important tip is make sure your charger has the capability of charging the battery type or chemistry you need to charge. This is very important because selecting the correct battery type means you are selecting the correct charging and cut-off voltage for the battery and will ensure the charger does not over-charge the battery, causing damage and/or an explosive fire.***
            - ***For example, your charger should have the capability of charging LiPo, A123/LiFe, and LiIo batteries and have the following charging functions like charge, balance charge, fast charge, storage charge and discharge. Additionally, the charger will have the ability to charge NiCD/NiMH batteries as well.***
        - ***Before charging your batteries, you must be sure to select the appropriate battery type before connecting your battery to your charger. Next, while in the charger's battery configuration mode, you will need to verify or change the amperage rate, voltage, capacity, and whether you want to charge, balance charge, fast charge, storage charge, or discharge the battery. This will tell the charger exactly what you want to do. If you accurately select the correct battery type and have a current charger with the current battery chemistry configurations built in, it will handle all the voltage parameters for you.***
            - ***<u>Charge Function</u>: this mode is a straight charging of the battery at the maximum charge voltage to arrive at the correct nominal battery voltage. This function does not determine if each cell is being charged correctly and could end up with one or more cells being over/under charged. The charger is only connected to the battery power lead.***
            - ***<u>Balance Charge</u>: this mode is a charge function that monitors each cell by using the balance lead on the battery. The power lead and the balance lead of the battery is connected to the charger. The charger will monitor and work to keep all cells at the same voltage by discharging any cell that is out of line with the others until they***

are all at the same voltage levels before the full charge process ends. <u>This is by far the best way to charge Lithium batteries for safety, long term health of the battery and maximum performance with all cells at their peak voltage</u>.

- ***<u>Fast Charge</u>: this mode is similar to the charge function except that it is done at a much higher amperage rate. This function is usually used when you are pressed for time and need the battery up to full amperage/voltage ASAP. This should be the exception charge rule and not your everyday rule. It will eventually wear your battery down if not handled correctly.***

- ***<u>Storage Charge</u>: this mode is an automatic function to be used whenever you will not be using your batteries for 2 months or more. This function will get the battery to 70% charge level so the battery can be safely and optimally stored for a period of time. Generally, Lithium Polymer batteries do not hold up well long term by being stored at full charge. Both power and balance leads are connected to the charger.***

- ***<u>Discharge</u>: this mode will discharge the battery down to each cells lowest permissible voltage level so you can then charge it back up and check on the health of the battery. It will tell you how much MAH capacity it took to discharge and charge it back up providing you an indication of the remaining battery capacity. Both power and balance leads are connected to the charger.***

- ***Physical Storage of LiPo Batteries:***

It is a good practice to store LiPo batteries in a fire proof container like a metal ammo case, an approved LiPo charging bag or box. LiPo batteries are the most vulnerable of all the Lithium batteries you will use so it is wise to safeguard your home, your car/trailer, or anywhere you store these batteries.