

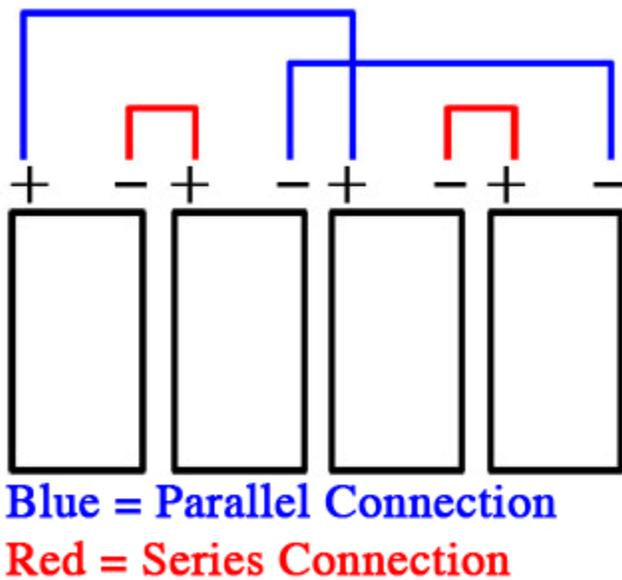
Li-Po batteries have been available to the RC market in various forms for years primarily geared for low amp draw aircraft use. Several manufacturers have brought Li-Po to the table for vehicles and there are plenty of myths and misunderstanding surrounding them. With safety features some are including such as hard cases, short prevention fuses and only using top quality cells Li-Po is becoming more unlikely to be a safety issue. User error is still its primary limitation but by consistently following the proper procedures an accident is very unlikely. These batteries are still struggling in most locations to gain acceptance in the race community. I cannot stress enough the importance that proper care and use, only running quality packs and educating yourself on the technology. It only takes one accident at a club to reinforce the stigma that some attach to these batteries.

C Rating

C rating is simply a measure of the battery's current draw capabilities. If it is rated 20C, a 3000 mAh battery it will handle a constant amp draw as high as 60A. Some batteries also list burst and peak C ratings along with a period of seconds. This simply means the battery can handle the respective amp draws for the amounts of time given.

Configuration

Li-Po batteries have a coding system that shows exactly what configuration it is in. You may see codes such as 2S2P, 3S2P, etc. The first part - a number followed by an "S" shows how many cells there are in series which tells you what voltage the pack has. A 1S pack has 3.7V nominal, 2S is 7.4V, 3S is 11.1V and so on in 3.7V increments. The second part - a number followed by "P" shows how many cells are in parallel. A 2P pack would have two additional cells running in series and attached parallel to increase total pack capacity. For example, the Team Orion Platinum battery is in a 2S2P configuration which is a total of 4 - 3.7V 2400mAh cells with 2 sets of cells in series to get the voltage to 7.4V and those two sets attached in parallel to increase the mAh of the pack to a total of 4800 mAh. $3.7V \times 2 \text{ cells} = 7.4V$ and $2400mAh \times 2 \text{ cell sets} = 4800 \text{ mAh}$. Cells in series only give an increase in total voltage while capacity stays the same as a single cell.



Charging/Discharging

The two most important things in Li-Po safety is charging and discharging. Other than physical damage, the most likely cause of fires with these batteries is simple carelessness in the charging and discharging process.

Charging

To charge Li-Po, a charger that is made to charge Li-Po using the CC-CV method is a requirement. Also be sure to set the charger properly according to the number of cells in series ignoring cells in parallel. A 2S2P pack is set for 2 cells since the cells in parallel don't effect voltage. A CC-CV charger charges using a constant amperage (CC- constant current) rate until the battery voltage rises to close to 8.4V or 8.4V exactly depending on the charger software when charging a 2S pack. At this point the battery is approximately 80% charged. The charger then switches to lowering the amp rate while maintaining the voltage at 8.4V (CV – constant voltage). While a charger that handles all types of batteries including NiMH and NiCd is convenient, extra care needs to be taken to insure that proper Li-Po settings are used every time. If buying a dedicated Li-Po charger, get one that has settings that are not easy to accidentally change during the charge. Most Li-pos should be charged at no more than a 1C rate which means charge at a rate that matches the battery capacity. Again using the Orion Platinum as an example, you would set the charger to charge at 4.8A (4800mAh = 4.8A). This will complete the charge in a little over one hour. Unlike NiMH, a Li-Po will perform nearly as well even if not fully charged so many people will charge until the charger switches to CV mode. This way the battery gets to full voltage - 8.4V but with sufficient capacity to finish a normal race. A charge stopping at this point takes roughly 40 min. Team Orion has recently claimed that both the Platinum (4800) and Carbon (3200) can be safely charged at a 2C rate with no safety issues and no effects on battery life. Some Li-Po chargers such as the Duratrax Ice set the charge rate based off the capacity of the battery that gets entered. To charge at a higher rate than 1C on chargers that operate this way, simply set the capacity to double it and set the max charge to 50%. This way in the event of a system glitch, it will not continue to charge significantly past a safe point. You will not save a significant amount of charging time if charging to full charge in this method however. A good amount of the time a battery is charging is in the CV stage which will reduce your charge rate rapidly at a 2C rate. The battery voltage is likely to reach 8.4V earlier in the process as well starting the CV mode when the battery has less capacity than if you were at a 1C rate.

Charging Safely

There are several techniques that can be used to prevent a disaster in the event a battery flames up:

1 - Never charge unattended.

2 – Never attempt to charge a damaged or puffed up battery. Dispose of in the method described later. It's better to lose a battery than your entire charging setup and/or house.

3 - Do not charge on or around flammable surfaces and objects. A concrete garage or basement floor is ideal.

4 – Charge in a oven safe dish such as pyrex or in a Li-Po sack/battery bunker or even an ammo case. Batteries can move when flaring.

5 – Batteries can flare up multiple times as each cell goes off. One cell will ignite the rest.

6 – If charging in a pyrex dish, place a ziplock bag of sand on top of the battery. If the battery flares the bag will melt, filling the dish with sand and covering the battery.

Discharging

Unlike NiCd/NiMH there is no real reason to discharge Li-Po before charging and may even reduce its usable lifetime. Never discharge below 3.0V per cell which in the case of most packs means 6.0V for a 2S pack. As a safety buffer, most cutoff devices respond when the battery gets down to approximately 6.25-6.30V. This is after the point the vehicle will start slowing noticeably so it's not going to reduce drive time by cutting off at that higher voltage. Never leave the battery plugged in after use as there may be a small current draw on it slowly reducing it to below the safe voltage level. There are a variety of cutoffs available including some speed controls with it built in. A couple that I've tried is the Apogee Loud Obnoxious Alarm which sounds a loud buzzer when the voltage cutoff is hit. It also sounds the alarm after 60 minutes of a battery being plugged in to remind you to disconnect. Another is the Novak Smart Stop which has throttle interruptions to indicate low voltage. It will cut the throttle several times as a warning eventually stopping it entirely. Cutoff devices do not stop current drain on the battery entirely; they are only indicators of the low voltage condition.

After discharging the battery there is no need to wait to start recharging. The battery will actually cool while charging. If done with runs for the day charge at least to 80% before storing. This will prevent the battery from self-discharging below the safe threshold.

Storage

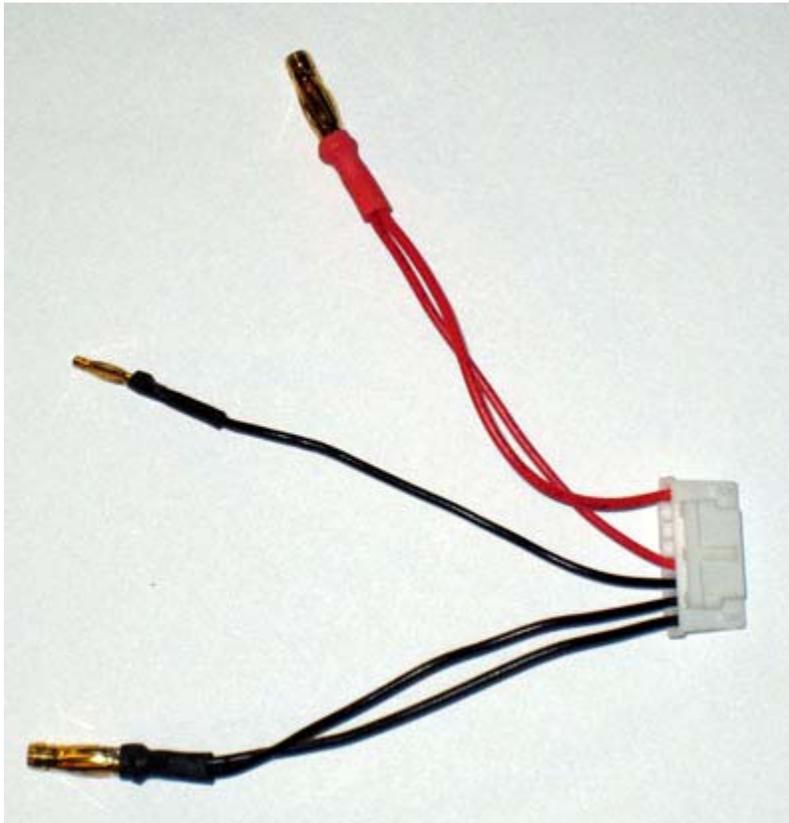
Batteries should be stored in a fire safe location. .50 Cal ammo boxes available in Army Surplus stores or on eBay are an excellent and cheap way of storing. In the event of fire, it won't do any damage outside of the box. Make sure to store on a non-flammable surface and away from flammable liquid containers, etc.

Li-Po batteries should be stored with some charge in them. 50 - 80% for idle periods of less than 2 - 3 months and full charge for longer periods. Even though the self-discharge rate is

significantly less than with NiMH and NiCd batteries, there is a possibility the pack could discharge below 3.0V per cell potentially damaging it.

Balancing

Balancing is occasionally required to get all cells in the pack to the same voltage. Since chargers limit the pack voltage to 4.2V per cell based off the total pack cell count. So with a 2S pack the charger will stop at 8.4V. However if one cell has a higher voltage than the other you may end up with one cell at 4.4V and the other at 4.0V. A balancer is either used during the charging process to stop charging to each cell as they reach 4.2V or in passive mode which discharges the higher voltage cells to match the lowest. Depending on the manufacturer, there are different ways to check and accomplish. Some makers include taps that match up to a specific type of balancer. In the case of Orion packs, a custom connector needs to be created for them. In the picture below an Orion Stability Balancing System 2S connector was modified using 2 – 4mm plugs and 1 – 2mm plug. This will allow balancing in either active charging or passive mode.



To check for balance in Orion packs, use a multimeter and measure the voltage of one cell with the positive lead in the positive port and the negative in the balance port. Then check the other

cell with the negative lead in the negative port and the positive in the balance port. Compare the voltage numbers. Orion considers their cells in balance if the voltage of the cells is within .02V of each other. Orion does not believe their cells require frequent balancing and from personal experience with mine they are right. I have over 30 runs on a few and no balancing is required yet.

Disposal

In the event of battery damage, battery puffing, smoke or any other indicators that the battery is not safe, DO NOT CHARGE. Dispose of in the following matter. Discharge the battery slowly to 2.5V per cell - 5.0V for a 7.4V pack. In a container large enough to fully submerge the battery in, mix water and as much salt as you can get to dissolve. Place the battery in the solution and leave in a fire safe area as a precaution. After 24 hours check the voltage. If at zero, dispose of in the trash. If not zero, continue for another 24 hours. Keep checking until fully drained.

If the battery is simply at the end of its life or its performance is lacking and not in a dangerous state, there may be resources in your community for safe disposal. Fire stations, hazardous waste disposal locations and even Radio Shacks may take used batteries for proper recycling.

This article will be added to as time allows and as information is discovered. There are other quality packs other than Orion's such as Maxamp's and A123's and other technical info to be added.