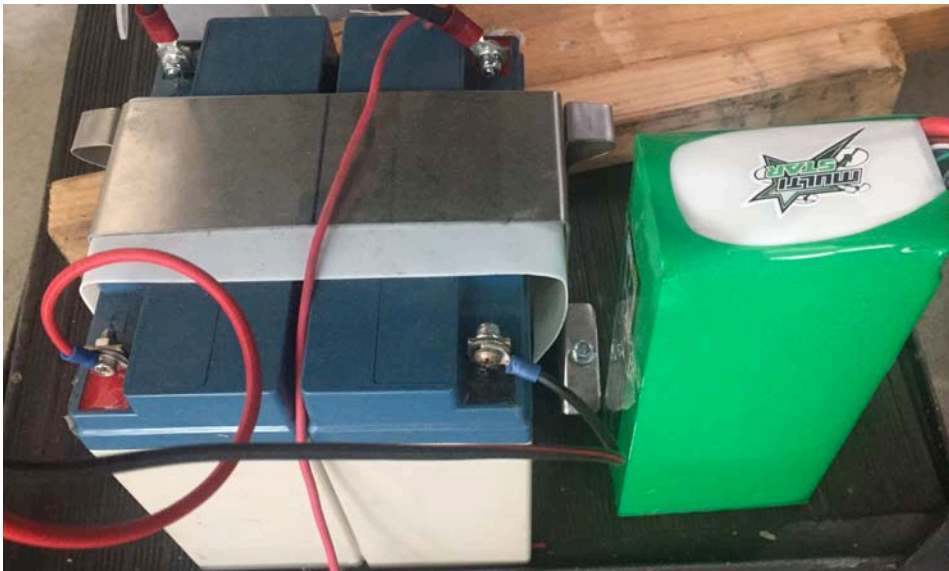


The proper care and feeding of Lithium Ion batteries

1. Lithium Ion compared with Lead
2. Understanding V - Ah and performance
3. The charging of Li-Ion
4. Types of Li-Ion Chargers
5. The rescue of a under-voltage battery
6. The incorporated charger solution (by Mitch)

| Lithium | Sealed Led |
|----------------------------|------------------------|
| Light and small | Heavy and big |
| Complex charge-discharge | Easy to charge |
| Hazard of fire – explosion | Stable, reliable |
| 500 charging cycles | About 1000 Cycles |
| Limited burst Amperage | High cranking Amperage |
| About 50% more expensive | Affordable. |

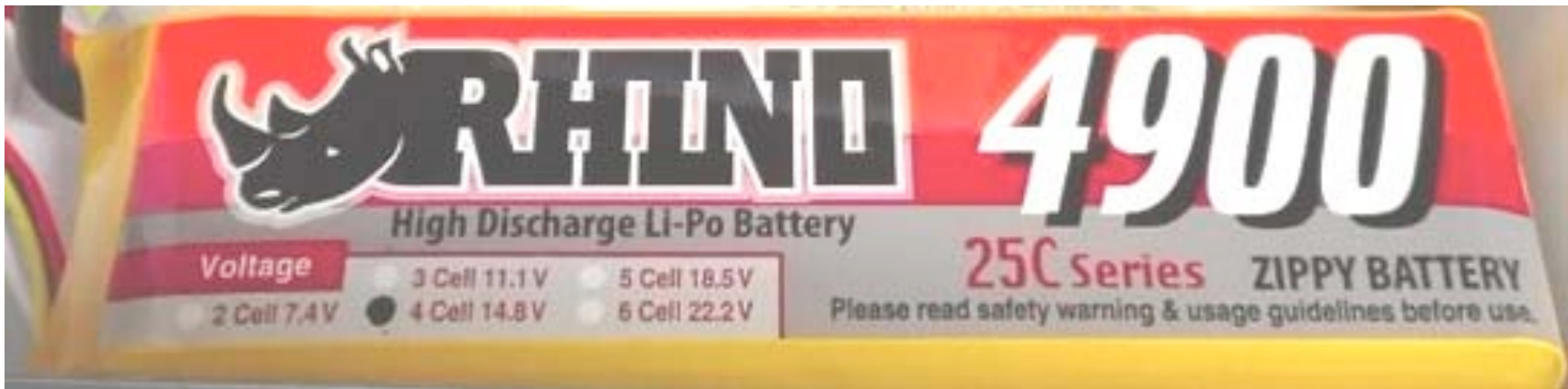


Compared:

- LIPO 22.2V at 20AH.
- Sealed Led. 24V at 20AH.
- Led is 7 times heavier.

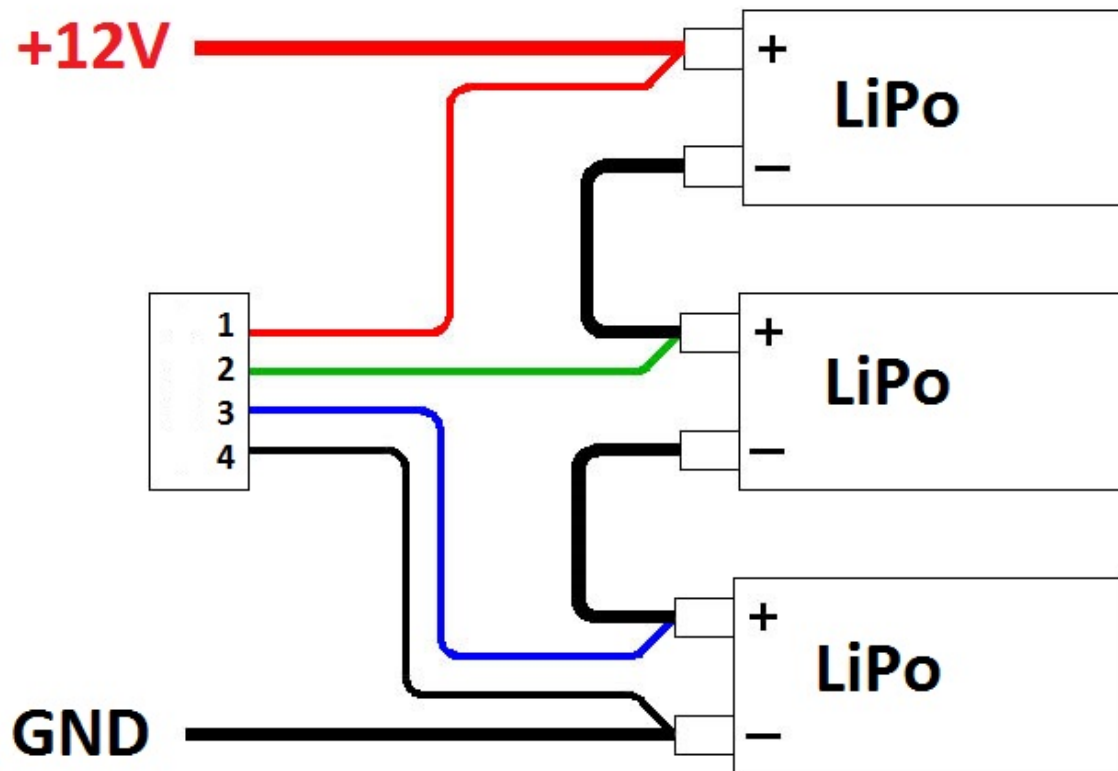
Volts – Amps - Performance

- The healthy voltage range is 3.0-4.2V. Median Voltage is: 3.7 V. The nominal voltage of a battery pack is the 3.7V multiplied by number of cells. For example a “3S” (3 Cell) battery is rated as a 11.1Volt battery.
- Amps-Hours are having the same meaning, however there is a “C” factor involved. A “25C” battery can be discharged to a maximum of 25 x AH capacity.
 $4.9\text{Ah} \times 25 = 122\text{A}$ max discharge
- High “C” factor are expensive.



The Charging of Lithium Ion

- Lipo batteries **can not** handle current shocks. They must be started on a gentle slope by a microprocessor assisted charger.
- Lipo batteries have various internal impedance resulting in in various voltage drops per each cell. This must be compensated by a “balancer”.



Types of Chargers

A “balanced battery” pack has all cells inside in a similar state of charge.

For example, a 3 cell pack could contain:

-Cell 1 - 3.7V

-Cell 2 -3.8V

-Cell 3 -3.6V

The charging process will not start if a battery is not balanced.

- Balance port only charger. Simple, self setting, but slow, only for small batts
- Single cell charger. Simple, but only for one batt cell.
- Self-setting multiple cell charger. Simple, but low current.
- Settable intelligent charger. Sophisticated, high current, fast charging time.
Capable to balance a battery, to discharge a battery, to measure Watt-hour.

A “troubled” battery wont be charged. The reasons could be:

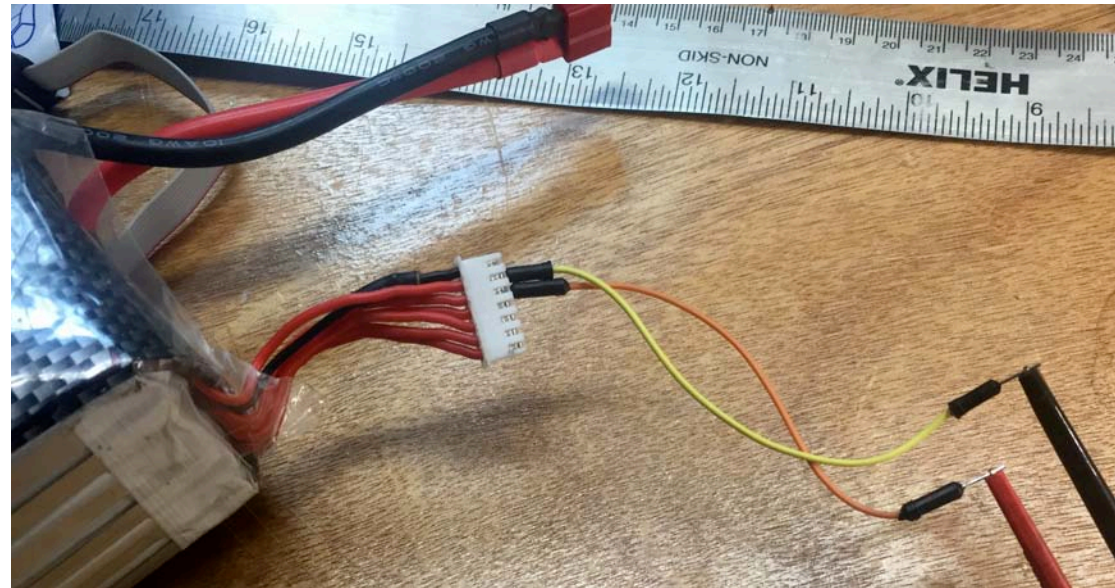
- A battery where all cells are within the “legal” limits (3-4.2V) but out of balance.
- A battery where one or more cells are under 3V or over 4.2V. (illegal)
- A battery fully discharged.

The rescue of a “troubled” battery

- If the total voltage of the LIPO is not in the range, the charger won't start.
- Most likely, one or more cells are too low (less than 3.7V) or too high (more than 4.2V).



- We must identify the trouble cells, and charge (or discharge) the non compliant ones manually



A lab power supply is a must. Apply a Diode on one terminal so the Voltage of the battery does not go in the power supply.

Start with a small voltage, increase voltage till you get about 2 A.



In time you'll need to increase voltage till you bring the cell or cells to the desired range.



Once all the cells are within parameters, take the battery for charging at the balanced charger.

Beware- the charger wont deal well with wide gaps between cells. For example if Cell One is at 4.05 V and Cell Four is at 3.7V, they are both “legal” but the gap is too wide. The charger will start but stop soon. (at 4.2V and 4.0V most likely).

The charger can only balance in small increments, can deal with a 200mV difference, but not more.

What to do? Discharge the high voltage Cell with a light bulb or a resistor.

Alternative: Use the “Balance” function of the charger or the meter. This takes hours or days, since they discharge a very small current.

If this procedure wont bring the cells in the “legal” territory, your battery is dead. RIP.

Can you take working cells from 2 different battery packs and make a new “good” one?

Yes, but the new pack will fail soon. Cells are “Paired” at the factory for similar impedance.

The incorporated charger

The Challenge: to have a simple one plug charging solution outside a robot, to avoid having to open case and disconnect – reconnect battery.

The Solution: wiring permanently a self setting charger with a relay disconnect circuit.

If the charger is left connected permanently, a 5mA current will drain the battery.

