Discharging a Buddipole 4S2P A123 Battery Pack

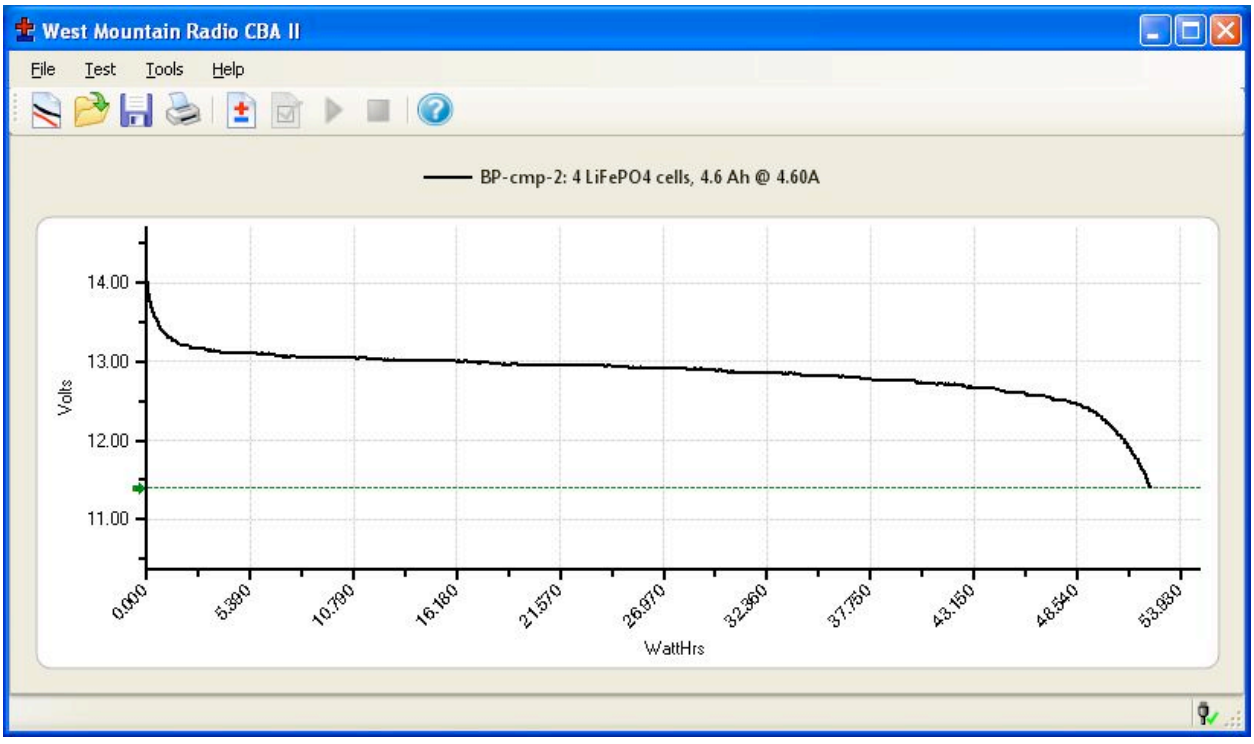
by Charles Preston KL7OA Version 1.2 3-20-10
http://www.charlespreston.net/batteryop/Discharging-a-Buddipole-4S2P-A123-Battery-Pack.pdf

Disclaimer - This is not intended as authoritative information about A123 Lithium Ion cells. I'm providing the guidelines I use to lower the risk that I will misuse expensive battery packs and shorten their useful service life.

Summary
I discharge the Buddipole 4S2P battery packs only down to 12.0 VDC, measured with a moderate load like 4.6 A.

These battery packs provide the lightest, smallest A123 package available for their energy capacity, which is a characteristic I really like. Smallest and lightest also means no over-discharge protection, and their discharge voltage should be monitored to prevent over-discharge.

Explanation
You can see from the screen snapshot in the URL below that most of the useful energy from a Buddipole 4S2P A123 battery pack was obtained by the time the voltage reached 11.4, when the discharge rate was 4.6 A. I think of the 4S2P as a 50 Wh battery pack, and it had provided 52.3 Wh by this point.



http://charlespreston.net/batteryop/Buddipole-4S2P-A123.JPG

I picked the 11.4 V discharge cutoff for the capacity test by using 2.8 V/cell (see 3. below) and adding 0.2 V as an additional margin.

While I'm not making a claim that a lower discharge limit will damage a battery pack, it's useful to keep in mind that the cells discharge and charge at different rates, and setting a discharge voltage limit too low could result in one cell over-discharging repeatedly, which may reduce the service life of the whole battery pack.

Three Yaesu radios vary at least 0.2 V in their reported voltage for the same battery pack. Once discharged to 11.4 V under load, this 4S2P measured 11.6 with no load on a digital voltmeter, and 11.3-11.5 with just receive current load on two FT-817ND radios and an FT-857D, measured one at a time. So there may be at least 0.2 V difference in measurement between radios.

Considering the possible difference in individual cell voltages, and the possible error in voltage readings from radios, I prefer to stop discharging these battery packs at 12.0 V under load, when I've already gotten 51 Wh from the battery pack. Also, once there is very little capacity left, it is easy to over-discharge the battery pack accidentally (see 5. below)

Corroborating information for a low voltage discharge limit for A123 cells
Here's what I'm using as corroborating information that there is a low voltage discharge limit that should be observed on A123 battery packs.

1. The discharge curve from A123 shown on the Buddipole site stops at 2.0 V.

2. "Overdischarging an A123 pack below 2.0V/cell will damage the cells (contrary to some reports)."
from FMA Direct Cellpro Multi4 Charger manual

3. "If all cells are 2.8 volts or more all LED's will turn on and remain lit for three seconds. . . . If one cell in your pack is low and has less than 2.8 volts, then it's LED will not turn on. This means that your battery pack has been discharged too far. DO NOT CHARGE FAST!!"
from Astro "Blinky" 123 Battery Balancer instruction sheet

4. The Multi4 charger showed 0% fuel, with the lowest cell voltage as 2.96 V. The charger designers apparently agree that the battery pack was fully discharged.

5. Another 4S2P pack, also discharged to 11.4 V under load, was left hooked up for a few minutes on receive, to the FT-857D. The FT-857D cut off, and the battery pack voltage was measured at 10.1, with the lowest cell voltage 2.15 according to the Multi4 charger. This illustrates the difference between individual cell voltages, since the other cell pairs were about 2.7 V. The Multi4 initially charged this battery pack at a very low rate, and would not charge at a normal rate until the lowest cell voltage measured 2.8 V.