Build Your Own Battery Pack

Don KI5AIU

3/5/2020

Goals

- Understand battery choices
- Design and build a battery for field operations
- Save some $$

Battery Choices

Sealed Lead Acid (SLA)

Pros

- Readily available. You can find a lead-acid battery just about anywhere you find auto parts.
- Very affordable - a Group 31 size deep cycle lead-acid battery with 100ah of capacity will cost $150 - $300, depending on type and quality.
- Lead acids are reliable and durable - they're built to take a lot of abuse, especially in automotive applications where vibration can be a serious problem.

Cons

- They're (relatively) heavy. Compared to $LiFePO_4$ batteries, lead-acids have a low energy-to-weight ratio.
- Shorter lifespan and cycle life than $LiFePO_4$ batteries, especially when they're deeply discharged.
- Discharging deep-cycle lead-acid batteries below 20% (and sometimes 50%) permanently reduces the battery's capacity.
- There are some concerns about gas discharge and acid leakage, only this is relatively rare on newer maintenance free batteries.
- High current loads rapidly diminish rated capacity...most deep-cycle lead acid batteries are designed for slow, steady discharge over a 20+ hour period. if the time frame is reduced, the capacity rating drops.

Battery Choices

Lithium Iron Phosphate ($LiFePO_4$)

Pros

- Long life span (5-10 years) vs lead acid (1-3 years
- Longer cycle life, as $LiFePO_4$ batteries last 1,000 to 3,000 charge and discharge cycles, compared to similarly sized lead-acid batteries, which can range from 200 - 1000
- $LiFePO_4$ batteries are less susceptible to problems caused by depth of discharge...a $LiFePO_4$ battery can be dropped to 20% of charge without long-term damage. Most lead-acid batteries lose capacity or cycle life if they're discharged more than 50%.
- Lighter than lead-acid batteries.
- Very safe - the odds of a "thermal runaway" (aka battery fire) are very low. The same can not be said of other lithium ion chemistries.

Cons

- As mentioned, $LiFePO_4$ batteries are costly.
- Susceptible to damage via overcharging or over discharging (problem solved by using a Battery Management System -BMS).
- Needs a $LiFePO_4$ capable charger.

How Large of a Battery Pack?

Check you radio specs

	(with optional TCXO-9)
Supply Voltage:	Normal: 13.8 VDC ±15 %, Negative Ground
Current Consumption:	Squelched: 550 mA (Approx.)
	Receive: 1 A
	Transmit: 22 A
Case Size (W x H x D):	6.1" x 2.0" x 9.2" (155 x 52 x 233 mm)
Weight (Approx.):	4.6 lb. (2.1 kg)

Or monitor with a meter

How Large of a Battery Pack

- Determine amp draw on receive and transmit
- Note that you will draw less amps if you run at less output.
- Ballpark a 75% receive and 25% transmit, so for a rough estimate use your receive amp draw
- Divide into the total amp hours of the battery to get an approximate duration of the battery.

Ok, lets build....

First an easy one

- Using 12v 12 Ah $LiFePO_4$ battery ($83 from Amazon)
- Can be used as is (you may want to add case, charge and discharge ports.
- Maximum draw is 15A
- Battery Management System (BMS) is built in.
- Non expandable

The Easy One

Next, a more complicated one

What we will need:

- Cells (Headway 38120)
- Cell Holders
- Connection strips/plates
- Battery Management System (BMS)
- Case
- Wire and various connectors

The Cells

Headway 38120 cells. 3.2V each, 8 Ah, $LiFePO_4$ chemistry, screw terminals. These cells can sustain a 200A discharge rate!

The Cell Holders

The holders are modular and slide together to make whatever configuration you want. 4S1P configuration. xSyP where X = number of cells in series, and y is the number of cells in parallel. You could double the Ah by building a 4S2P battery.

The connection strips/plates

Headway cells have screw terminals. Much easier (and safer) than trying to tack weld connections. Also makes it easier to modify the battery pack. Plates have four holes and are used to interconnect series packs into parallel packs.

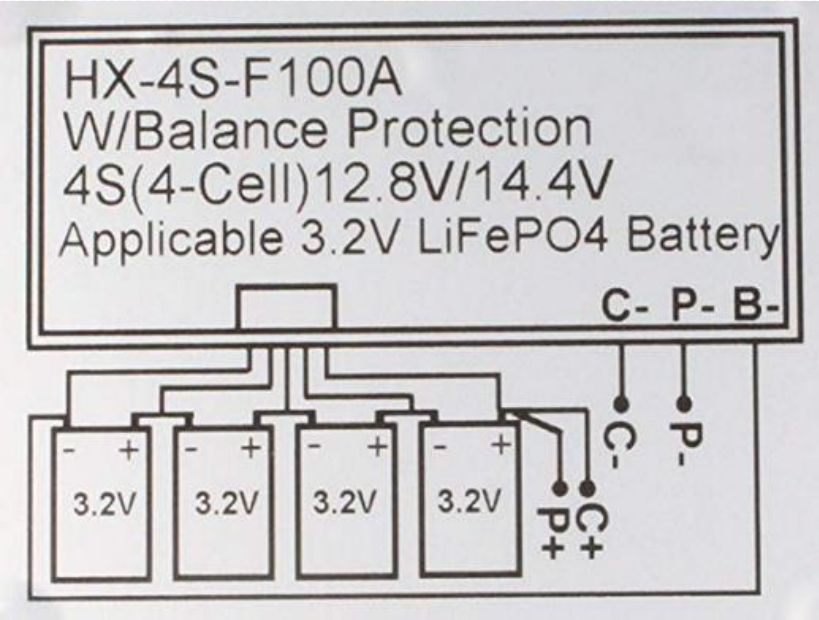
The Battery Management Systems (BMS)

FX-4S-F100A ($13 at Amazon)

- Protection circuit board is the heart of battery pack, must have to avoid explosion, fire and damage
- It will protect battery pack from overcharging, over-discharging, over-current and short circuit
- The equilibrium function will keep each cell in balance for good service life
- Used for 4 series 12V $LiFePO_4$ batteries
- Has separate charge and discharge circuits
- Can supply up to 100A

How the BMS is wired to the Pack

B- is Battery negative, B+ is Battery positive
C- is the Charge negative, C+ is Charge positive
P- is the Pack negative, P+ is the Pack positive (Pack terminals are where you discharge the pack from (ie connected to your load)



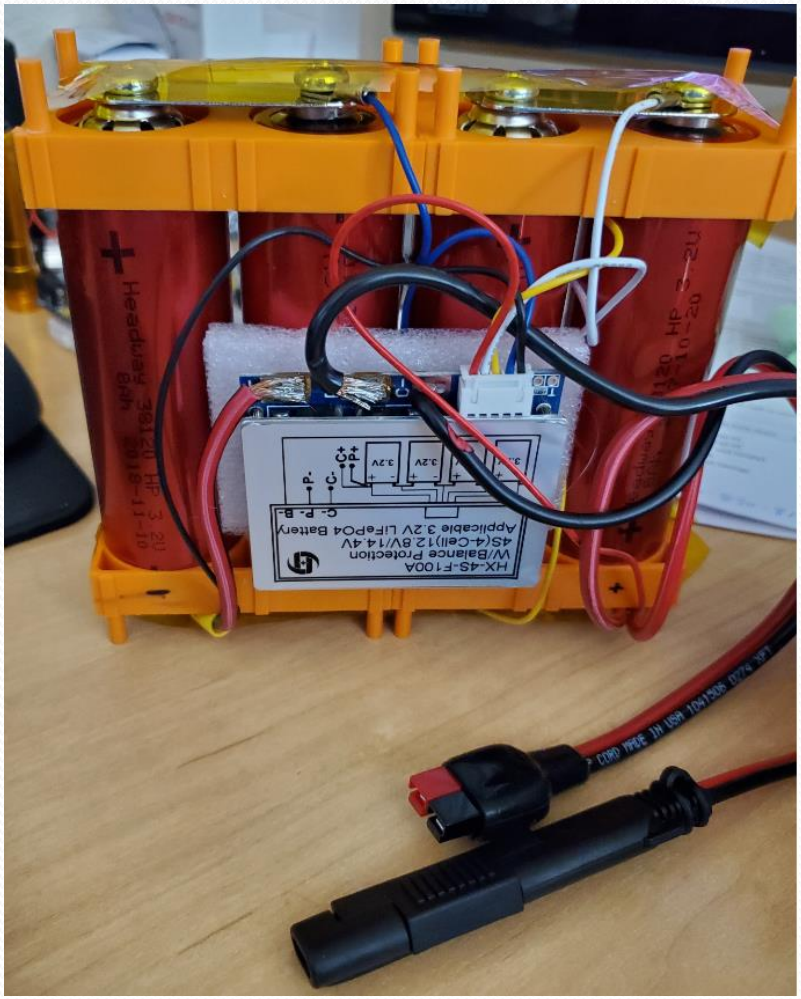
And the Etcetera

- Case – depends on what size battery pack you build.
- Wire – pick a wire size that supports your expected Amp draw.
- Discharge Connectors – or not. I use Power Pole connectors.
- Charge Connector – or not. You could use battery clips to charge the pack. I used an SAE power connector for charging.
- Meter – optional, but a good way to see what's happening with your pack.

The pack

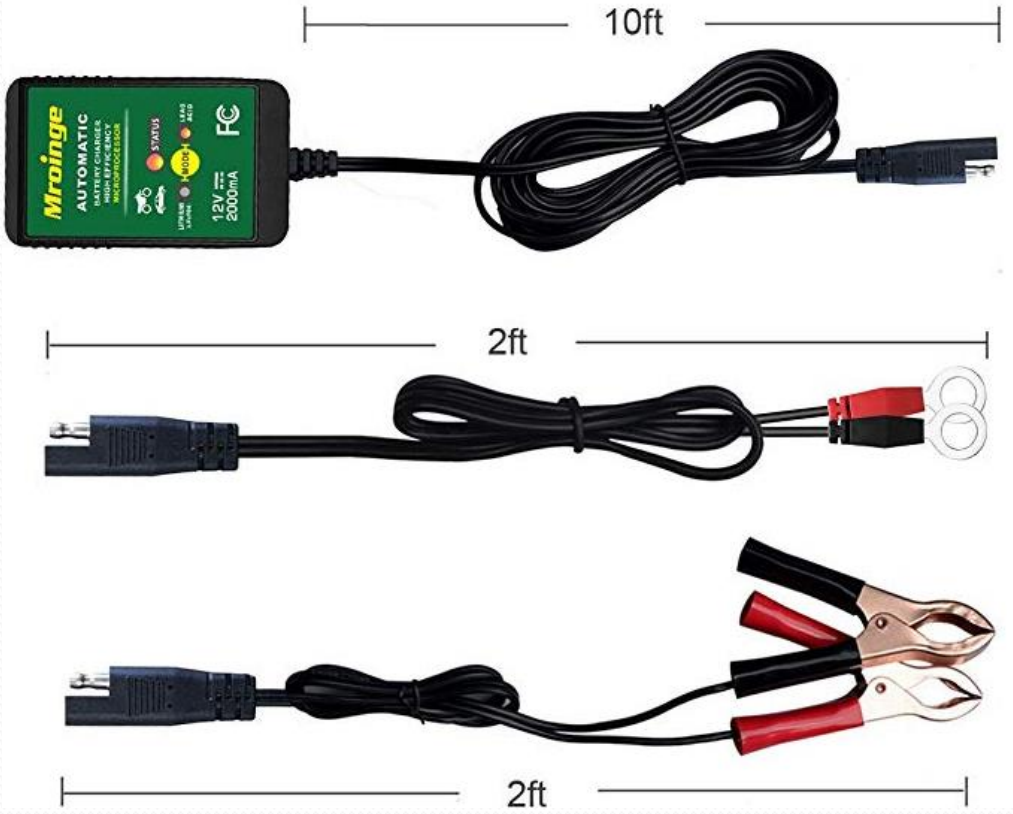
A Headway 4S1P pack with BMS and connectors for charge and discharge. Pack will support 100A draw (well not with those wires!), but I can run multiple radios off of the pack. Adding four more cells in parallel, turns it into a 16Ah pack.

Note Headway cells are either red or blue. The red are 8Ah; the blue are 10Ah.



Chargers

LiFePO4 batteries use a four stage charge cycle. The charger must accommodate that. This is the one I got from Amazon ($20). It will do Lead acid as well as LiFePO4. Comes with different leads if you don't want to add a charging port (just use the clips). Or use the ring terminals permanently attached.



How does it work?

- Ben and I generally wear out before the pack does.
- When testing configurations for POTA, we used a Yaesu FT-857D, vertical and end fed antennas. We ran FT8 (5W) and SSB (10W) for over an hour, and the pack voltage was still 13.2V when we finished.
- Still need to do some packaging on the Headway pack, but I'm pleased with it's operation.
- A big THANK YOU to Mark Seamans for pointing me to the Headways and for bouncing ideas off of. Mark builds to the max; I build to a budget.

Did I save any $$$

- On the Headway, I'm not sure; but I think I did.
- On the easy pack, I'm sure I did. A comparable Bioenno pack, the BLF 1212A, is $125 vs $83.

Bill of Material (Easy Pack)

Bill of Materials	Price
LiFePo4 rechargeable battery -	$ 83.99
SAE power cable (2/pk, need 1) -	$ 10.99
Charger -	$ 20.99
Ring Terminals - https://www.homedepot.com/p/Gardn	$ 2.65
Battery box (optional) - https://www.harborfreight.com/	$ 4.99
Assorted PowerPole connectors (optional)	

Bill of Material (Headway pack)

Bill of Materials	Price
SAE Polarity Reversal plugs -	$ 8.99
Watt meter & Power analyzer (optional) -	$ 16.99
SAE power cable (2/pk, need 1) -	$ 10.99
Kapton tape -	$ 8.99
Battery Management System -	$ 13.50
Charger -	$ 20.99
Headway 38120 (4) -	$ 44.00
Cell holder and straps - https://www.ebay.com/itm/heac	$ 20.00
Ring Terminals - https://www.homedepot.com/p/Gardn	$ 2.65
Battery box (optional) - https://www.harborfreight.com/	$ 4.99
Assorted PowerPole connectors (optional)	