Building a Battery Pack for Your Go-Box

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Overview

- How to determine battery requirements
- Planning the Battery Pack
- Connector Options
- Charging Solutions
- How to build a 18650 battery pack

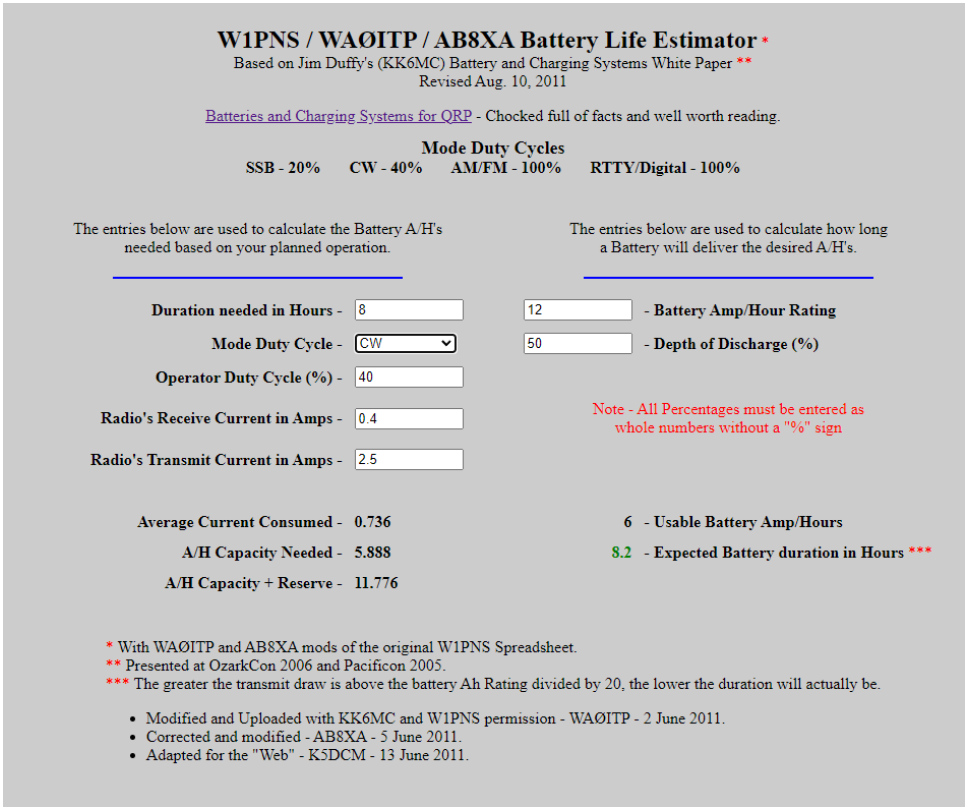
Determining Battery Requirements

- Decide on the modes you will be using
  - CW
  - SSB
  - Digital
  - AM
  - FM
- Decide on usage style
  - Contesting
  - Causal Use
- Decide on output wattage
  - QRP
  - QRO
  - Combination of both
- Decide how long you want to be operating before having to charge

Determining Battery Requirements

- Determine the power usage of your rig
  - Use a good power source like a standard 30A power supply
  - Connect an ammeter inline between the power source and your rig
  - Record the amperage usage while receiving
  - Record the amperage usage while transmitting at your intended power output
  - If you have tuners, lights, etc make sure they hooked up as well and turned on while recording your measurements
- Calculate battery requirements
  - W1PNS / WAØITP / AB8XA Battery Life Estimator - http://www.4sqrp.com/Battery_Capacity/index.php

Determining Battery Requirements



W1PNS / WAØITP / AB8XA Battery Life Estimator *

Based on Jim Duffy's (KK6MC) Battery and Charging Systems White Paper **
Revised Aug. 10, 2011

Batteries and Charging Systems for QRP - Chocked full of facts and well worth reading.

Mode Duty Cycles
SSB - 20% CW - 40% AM/FM - 100% RTTY/Digital - 100%

The entries below are used to calculate the Battery A/H's needed based on your planned operation.

The entries below are used to calculate how long a Battery will deliver the desired A/H's.

Duration needed in Hours - 8
Mode Duty Cycle - CW
Operator Duty Cycle (%) - 40
Radio's Receive Current in Amps - 0.4
Radio's Transmit Current in Amps - 2.5

12 **- Battery Amp/Hour Rating**
50 **- Depth of Discharge (%)**

Note - All Percentages must be entered as whole numbers without a "%" sign

Average Current Consumed - 0.736
A/H Capacity Needed - 5.888
A/H Capacity + Reserve - 11.776

6 - Usable Battery Amp/Hours
8.2 - Expected Battery duration in Hours ***

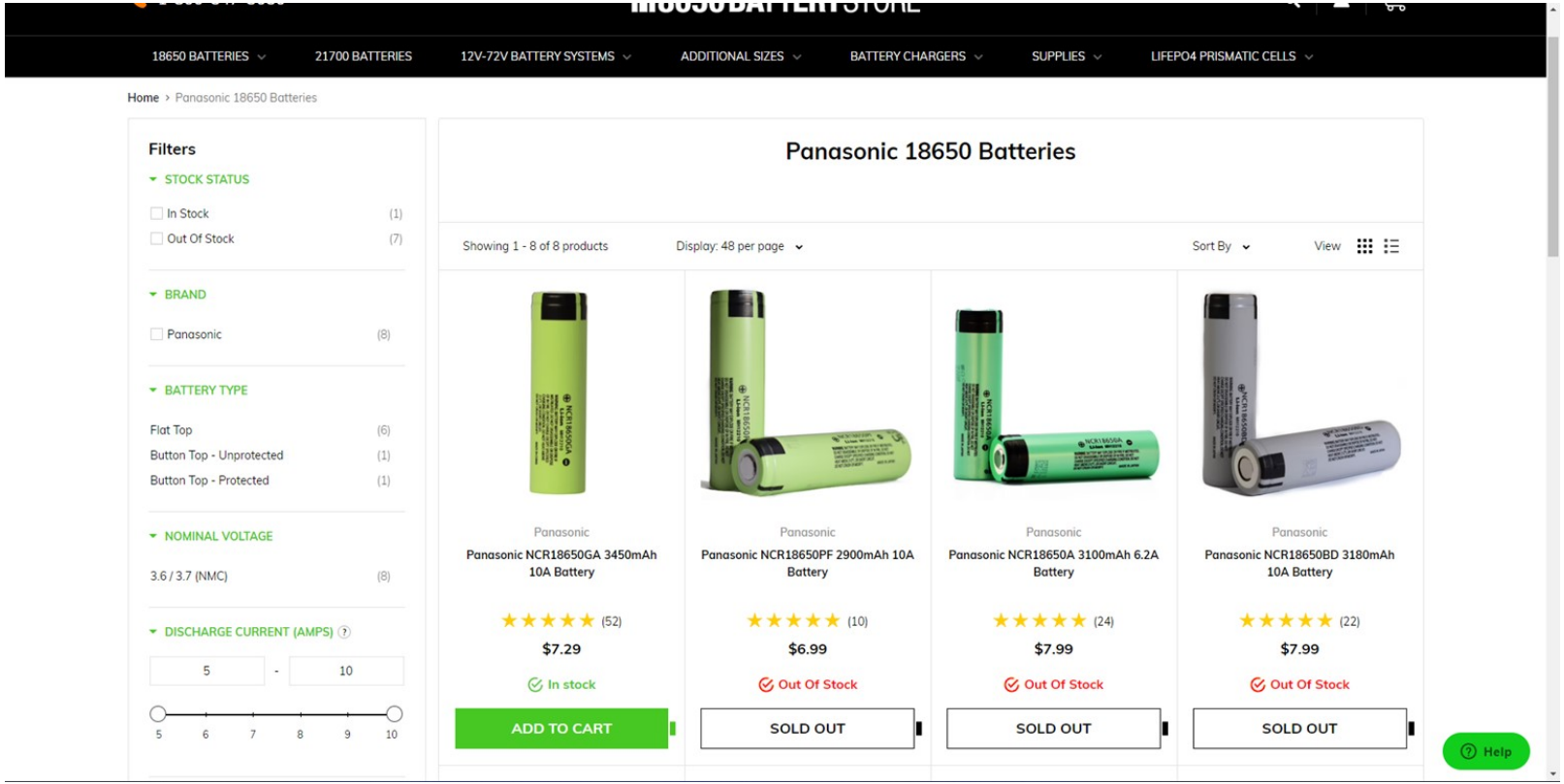
* With WAØITP and AB8XA mods of the original W1PNS Spreadsheet.
** Presented at OzarkCon 2006 and Pacificon 2005.
*** The greater the transmit draw is above the battery Ah Rating divided by 20, the lower the duration will actually be.

- Modified and Uploaded with KK6MC and W1PNS permission - WAØITP - 2 June 2011.
- Corrected and modified - AB8XA - 5 June 2011.
- Adapted for the "Web" - K5DCM - 13 June 2011.

Planning Your Battery Pack

- We can use several sites on-line to determine how many batteries and what configuration we need.
- Cell Saviors, https://cellsaviors.com/pack-planner, has a pack planner, where you pick a battery and then input what you need.
- There are several sites that sell new 18650 batteries, I use https://www.18650batterystore.com/
- Steps to use
  - Select the battery you want to use
  - Select the number of cells in series and in parallel you need based on your requirements
  - Best to use the A/H Capacity + Reserve value to ensure you have a big enough battery

Select a Battery



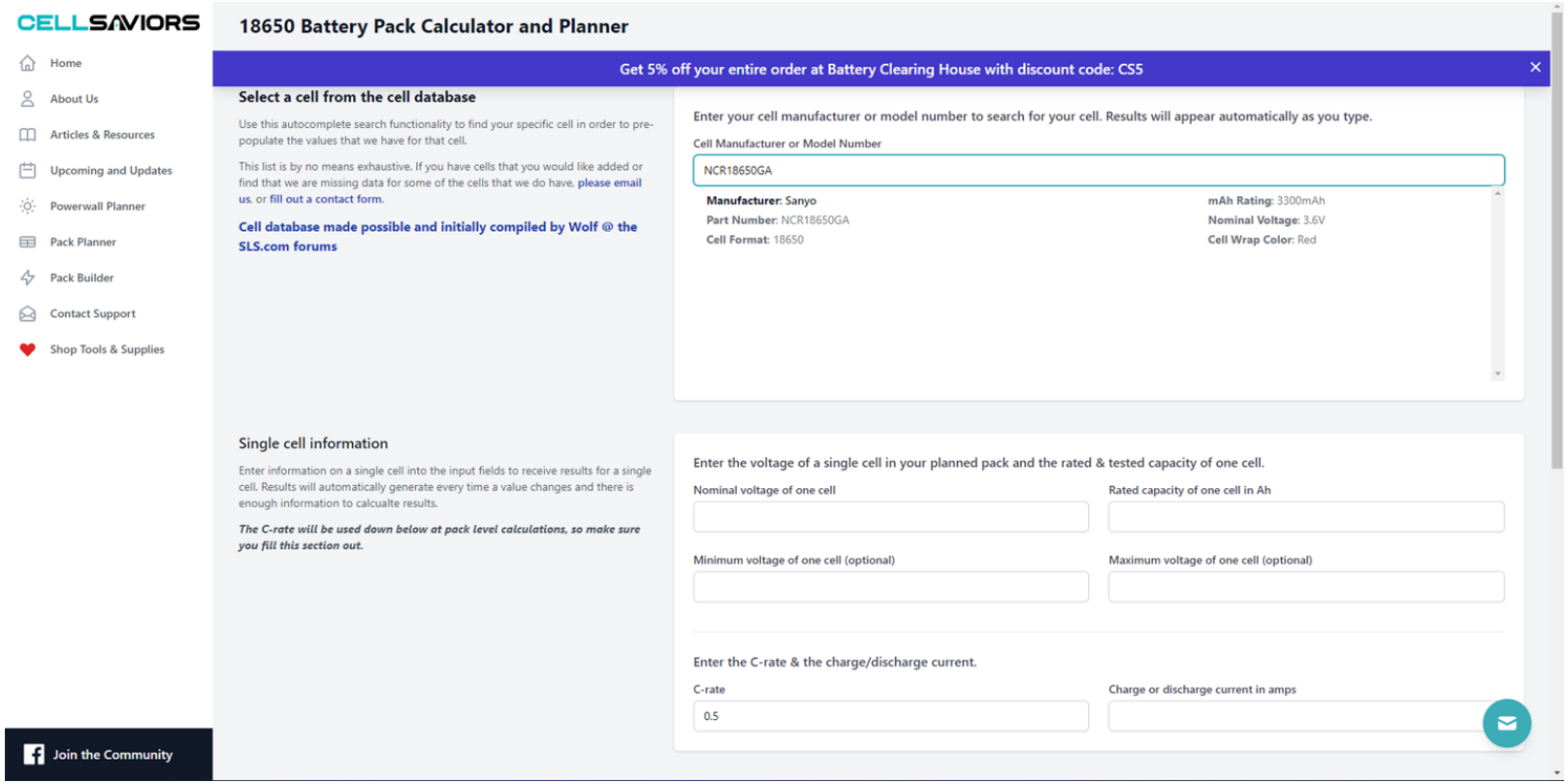
Record the Battery Characteristics

Panasonic NCR18650GA 3450mAh 10A Battery

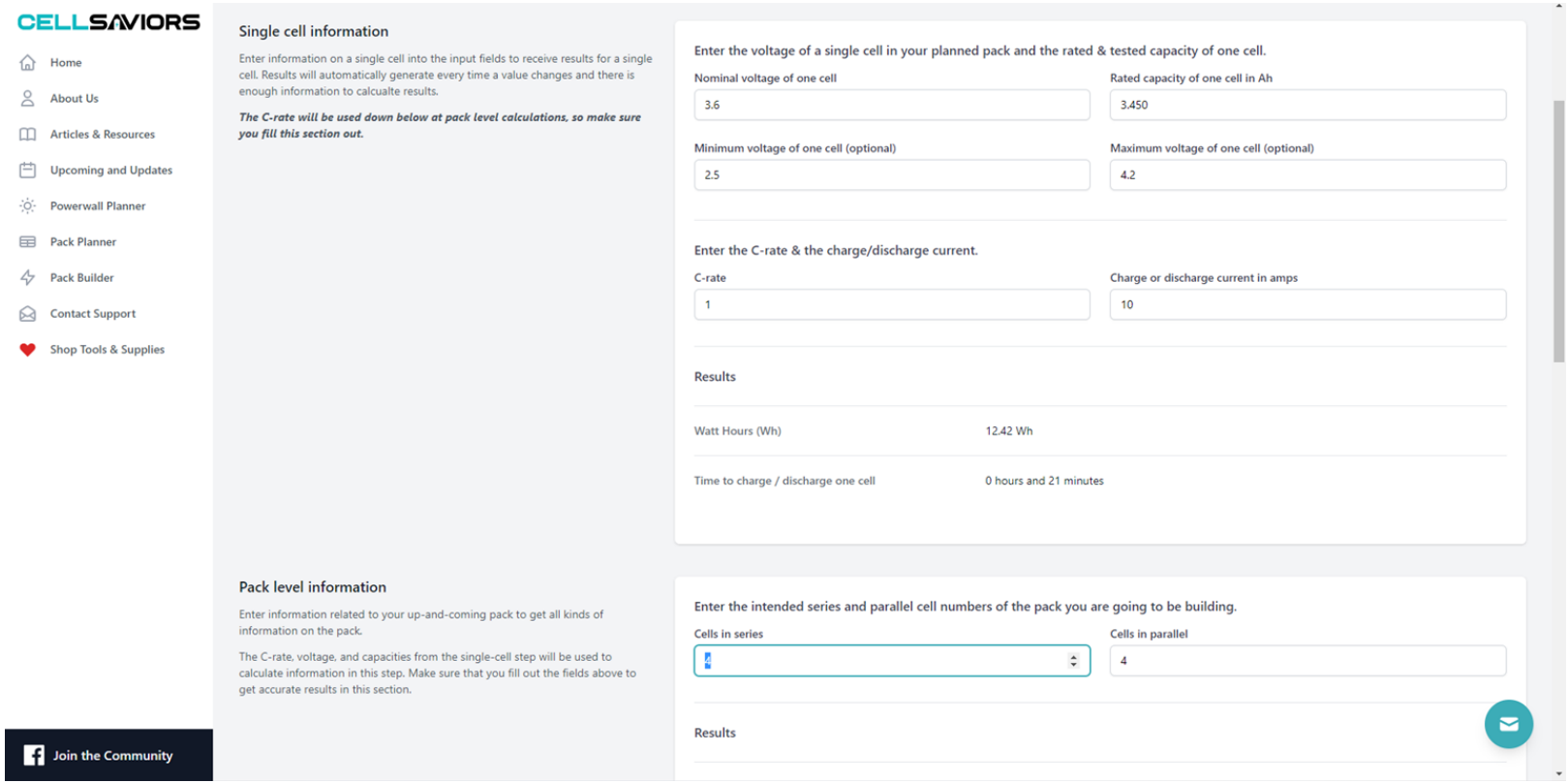
Specifications:

Manufacturer	Panasonic
Model	GA
Size	18650
Positive Terminal	Flat Top
Nominal Capacity	3450mAh
Continuous Discharge Rating (max)	10A
Nominal Voltage	3.6V
Maximum Voltage	4.2V
Discharge cut-off Voltage	2.5V
Protected	No
Rechargeable	Yes
Approx. Dimensions	18.33mm x 65.08mm
Approx. Weight	46.5g
Country of Origin	Japan
Associated Names	NCR18650GA, GA6
Data Specification Sheet	Panasonic NCR18650GA Datasheet

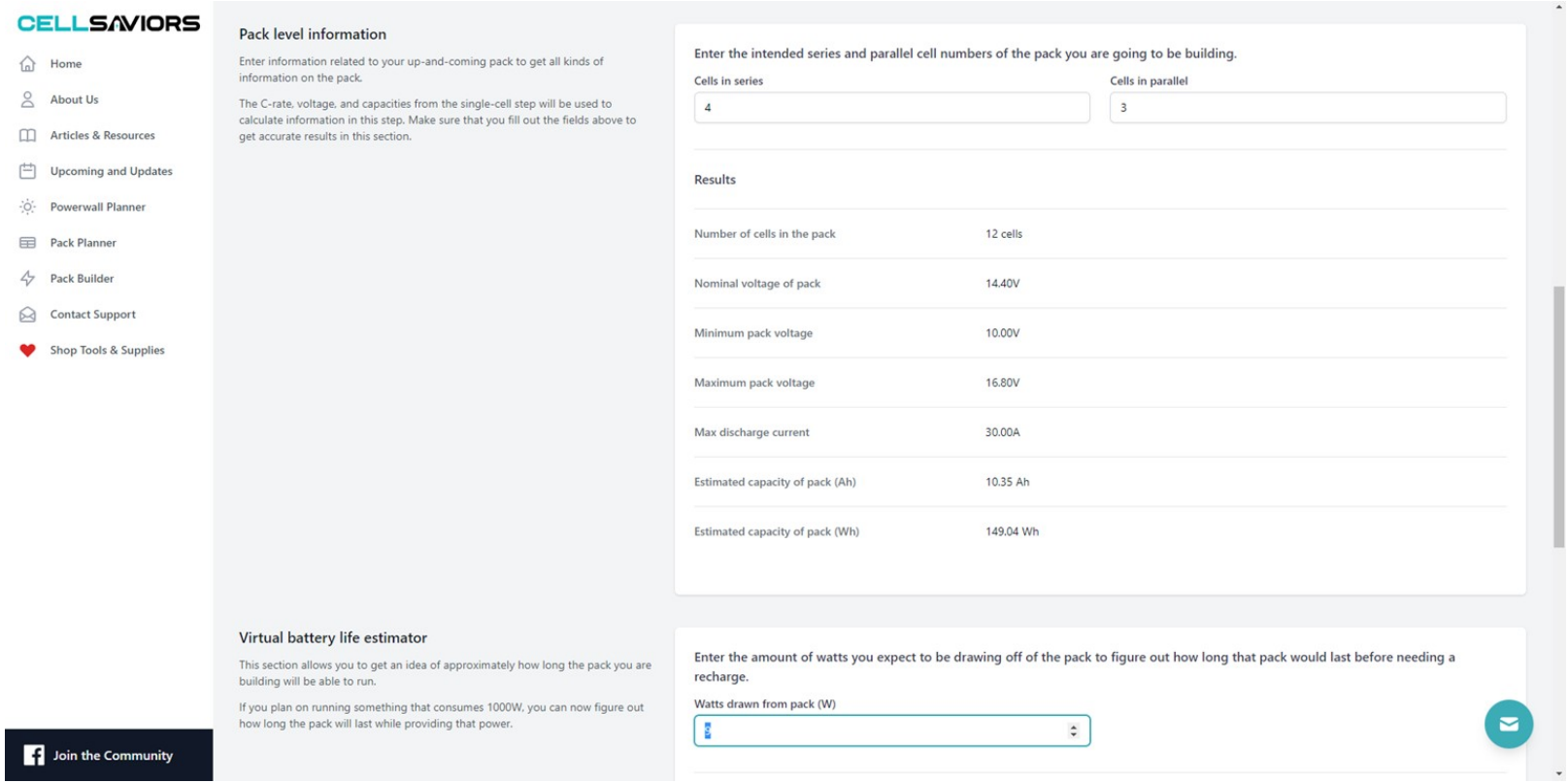
Pick the Battery in the Planner



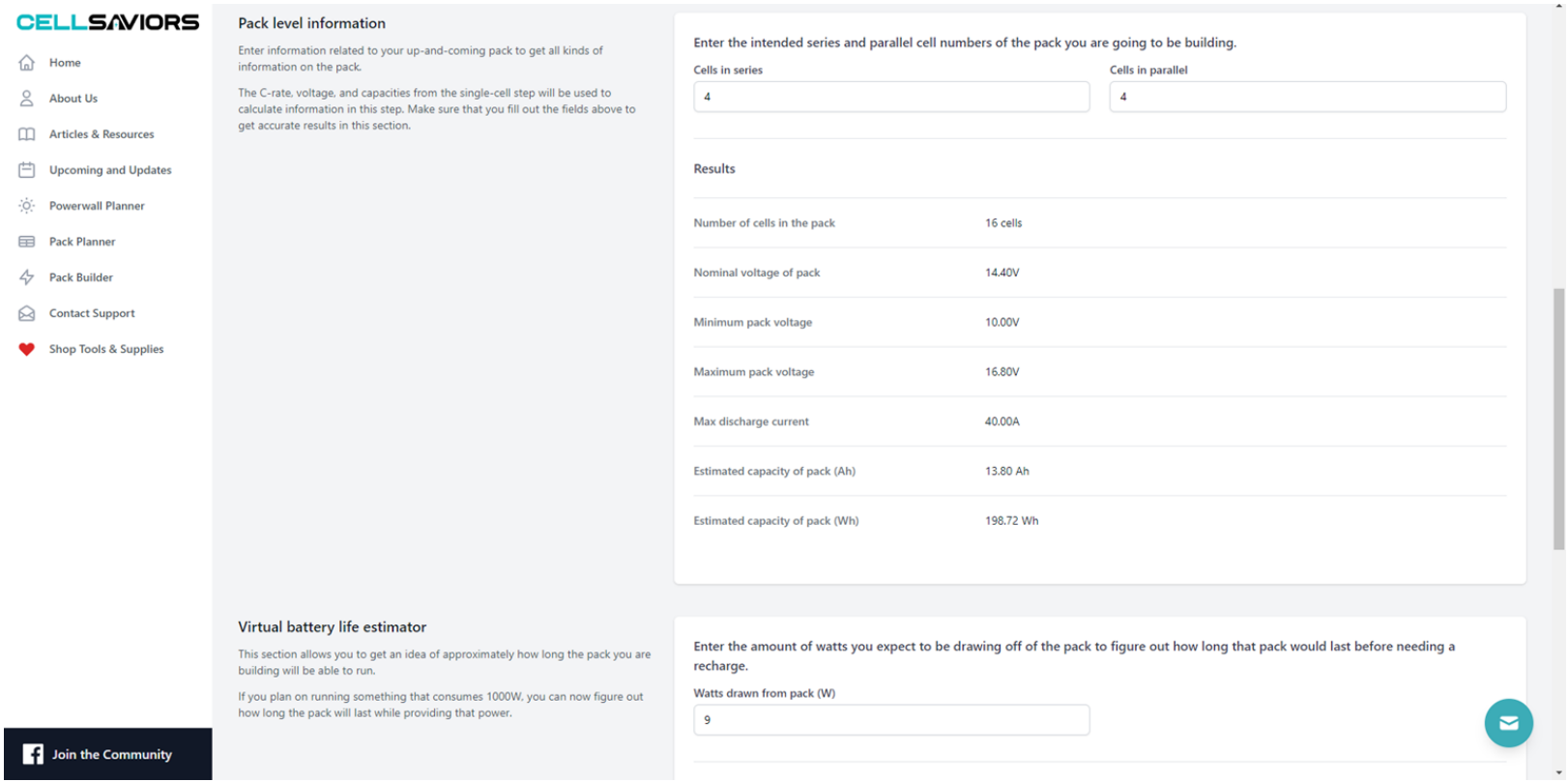
You Can Also Manually Enter Values



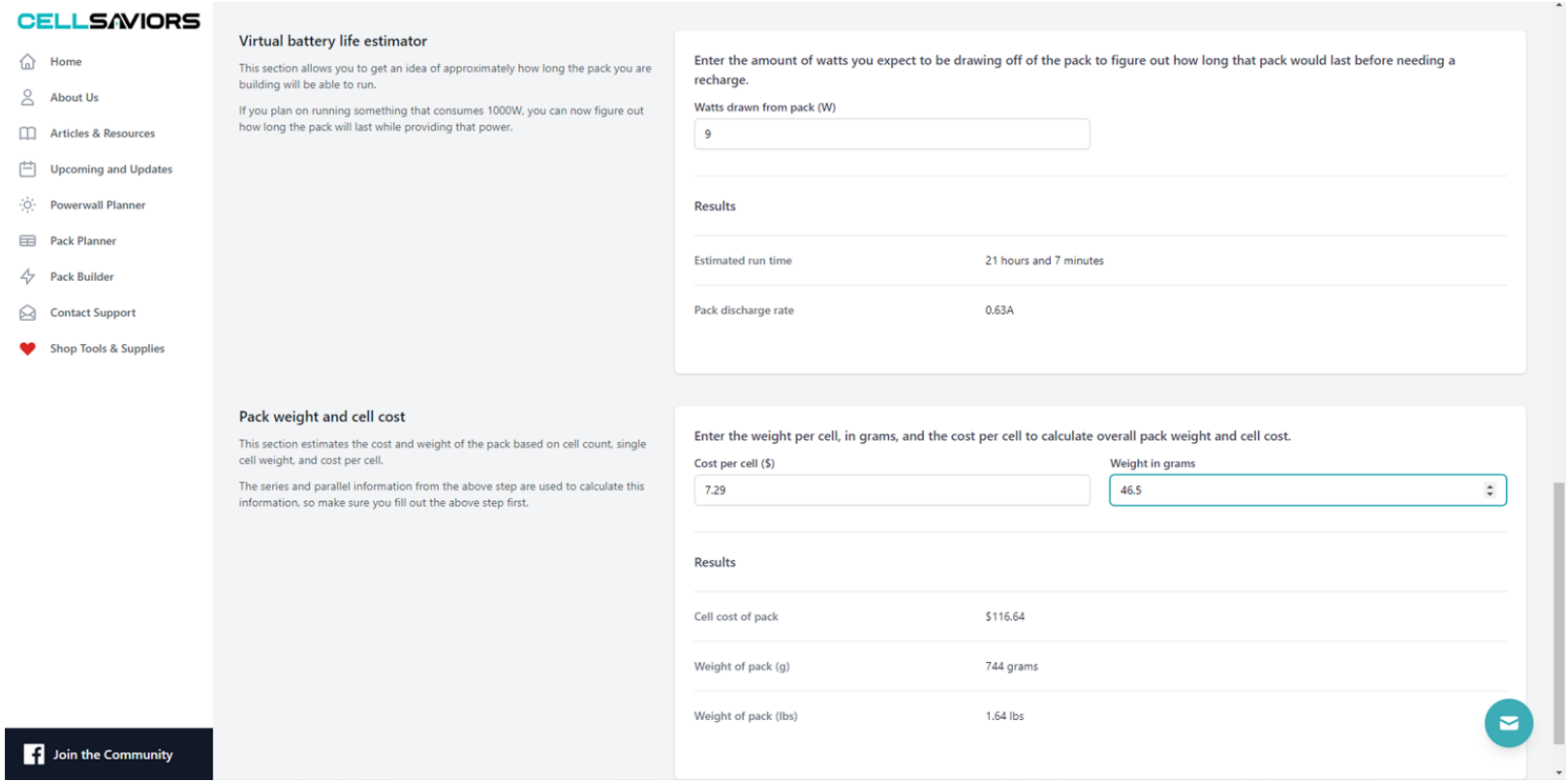
Select the Configuration - 4S (14.4V) 3P (10.35 Ah)



Select the Configuration - 4S (14.4V) 4P (13.80 Ah)



Calculate Life Time, Cost and Weight



Building out

1. Get parts
2. Test cells to get actual capacity per cell
3. Plan cell placement based on actual values
4. Assemble the pack

Parts and Links

Parts and Links will be provided in a separate hand out along with all resource links so you can build your own pack.

- 18650, 21700, or other Battery Cells
- BMS 4S rated at 2x Amperage you will be pulling
- Wire rated at 2x Amperage you will be pulling 14ga - 24A, 12ga - 34A https://www.engineeringtoolbox.com/wire-gauges-d_419.html
- Cell Holders
- Kapton Tape
- Felt Insulator Stickers

Test Cells for Actual Capacity

Use a battery tester like the Opus BT - C3100 to measure each cell’s current capacity via a discharge test

Annotate the capacity on each cell

Depending on the number of cells you will be using this could take a couple of days

Plan The Cell Placement

1. To plan on where each cell goes in your pack, use the Pack Builder web site at https://www.repackr.com/#/pack-builder
2. Enter in the capacity of each cell you will be using in Step 1
3. Enter the Pack Dimensions 4S or 3S and 1P, 2P, 3P, 4P, etc.
4. Generate the Pack assembly configuration

Enter Cell Capacities in Step 1

Pack Builder

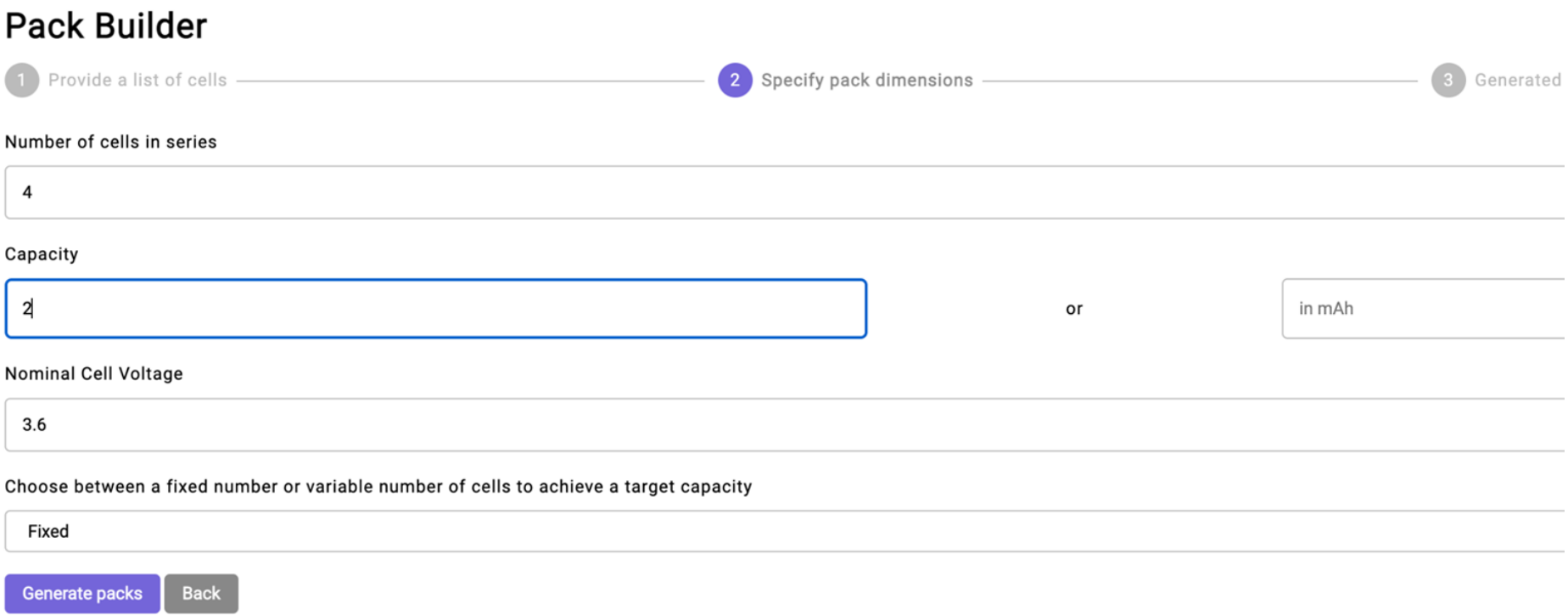
1 Provide a list of cells — 2 Specify pack dimensions

Comma separated list of cell capacities in mAH to be added to the packs

3410,3416,3343,3347,3344,33433471,3416

Add Cells

Specify Pack Dimensions in Step 2



Generate Pack Details

Pack Builder

1 Provide a list of cells — 2 Specify pack dimensions — 3 Generated pack

Start again | Export CSV | Copy to Clipboard | Compact

Summary

Each parallel pack once connected together will create a battery with these characteristics.

Voltage (3.6 nominal)	14.4V	Amp Hours	6.757 Ah	Watt Hours	97.3008 Wh

Clicking on a capacity will highlight it in green to help you check off cells you've found.

Parallel Pack 0

#	Capacity
0	3416
1	3344
Total Capacity	6760 mAh
Divergence (from the average pack capacity)	-13 mAh
Deviation (between the capacity of cells in the pack)	50 mAh

Parallel Pack 1

#	Capacity
0	3471
1	3343
Total Capacity	6814 mAh
Divergence (from the average pack capacity)	41 mAh
Deviation (between the capacity of cells in the pack)	90 mAh

Pack Details Continued

Parallel Pack 2

#	Capacity
0	3410
1	3347
Total Capacity	6757 mAh
Divergence (from the average pack capacity)	-16 mAh
Deviation (between the capacity of cells in the pack)	44 mAh

Parallel Pack 3

#	Capacity
0	3416
1	3343
Total Capacity	6759 mAh
Divergence (from the average pack capacity)	-14 mAh
Deviation (between the capacity of cells in the pack)	51 mAh

Arrange Batteries in Holder

Tape Battery Pack with Kapton Tape

Cut Nickel Strips To Size

Weld Strips To Cells

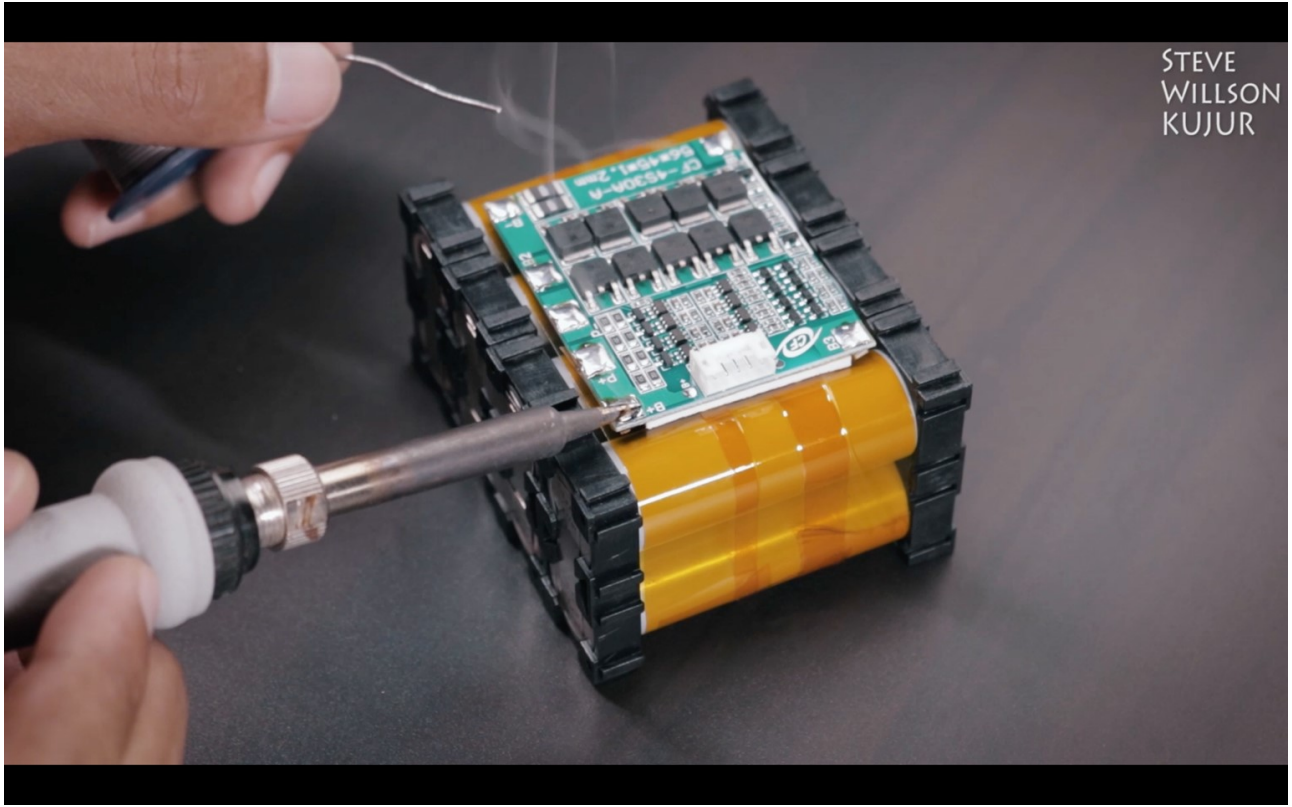
Weld Cells In Parallel

Weld Cells In Series

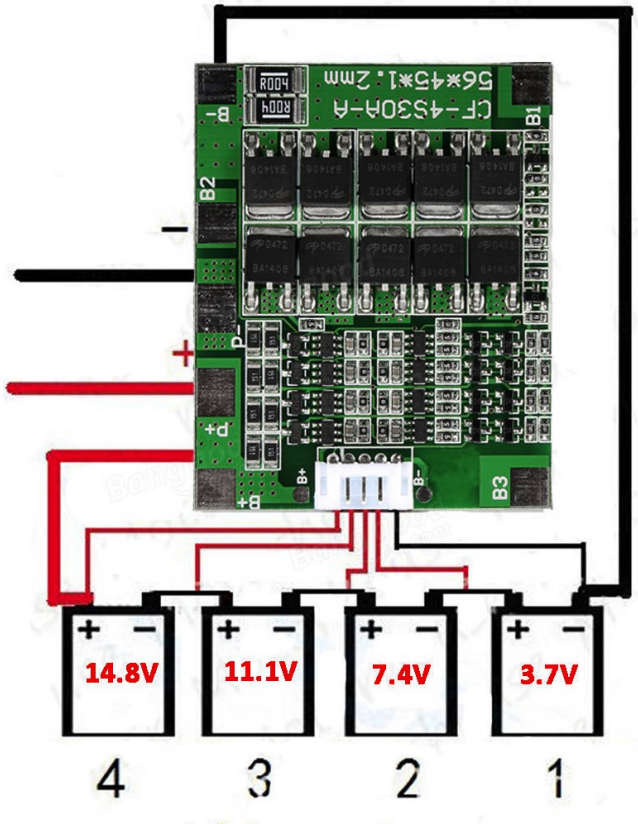
Weld Cells In Series Second Side

Attach BMS To Battery Pack

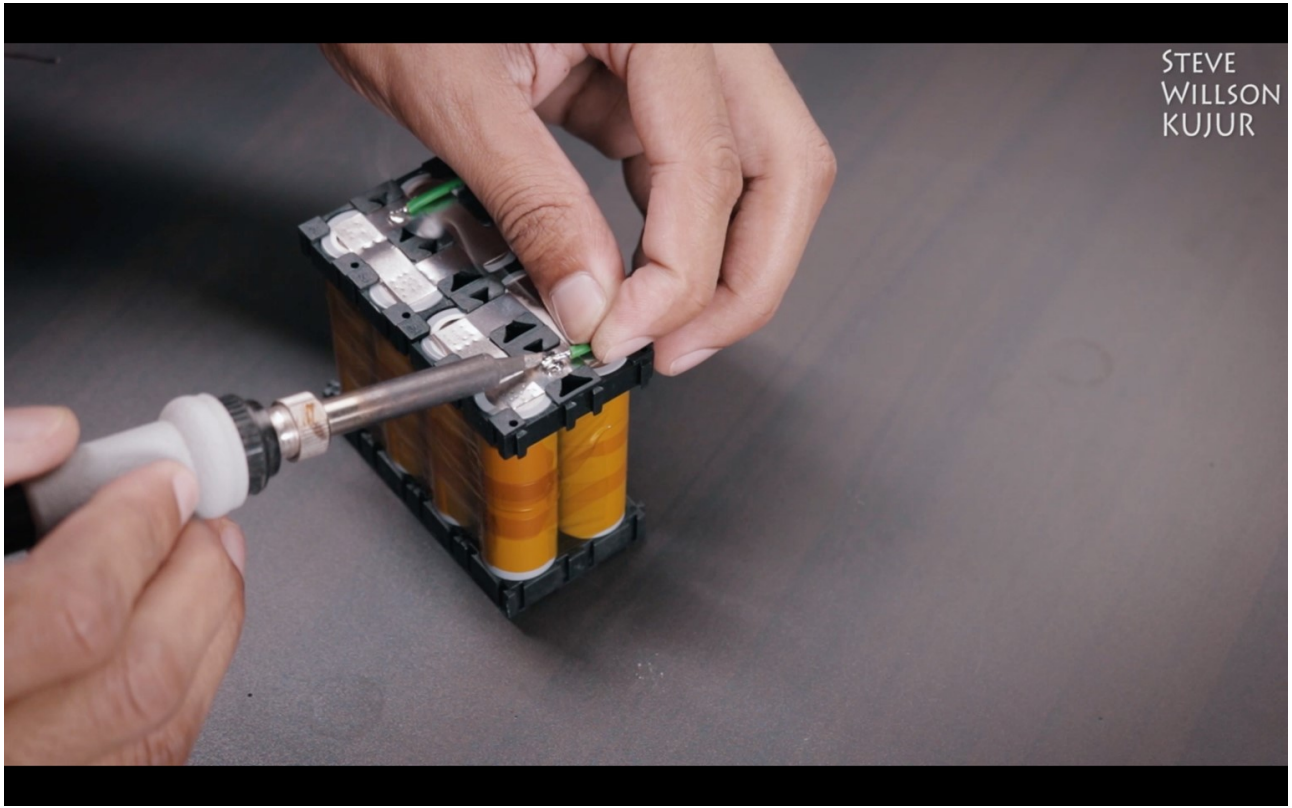
Pre-Tin Connections On BMS



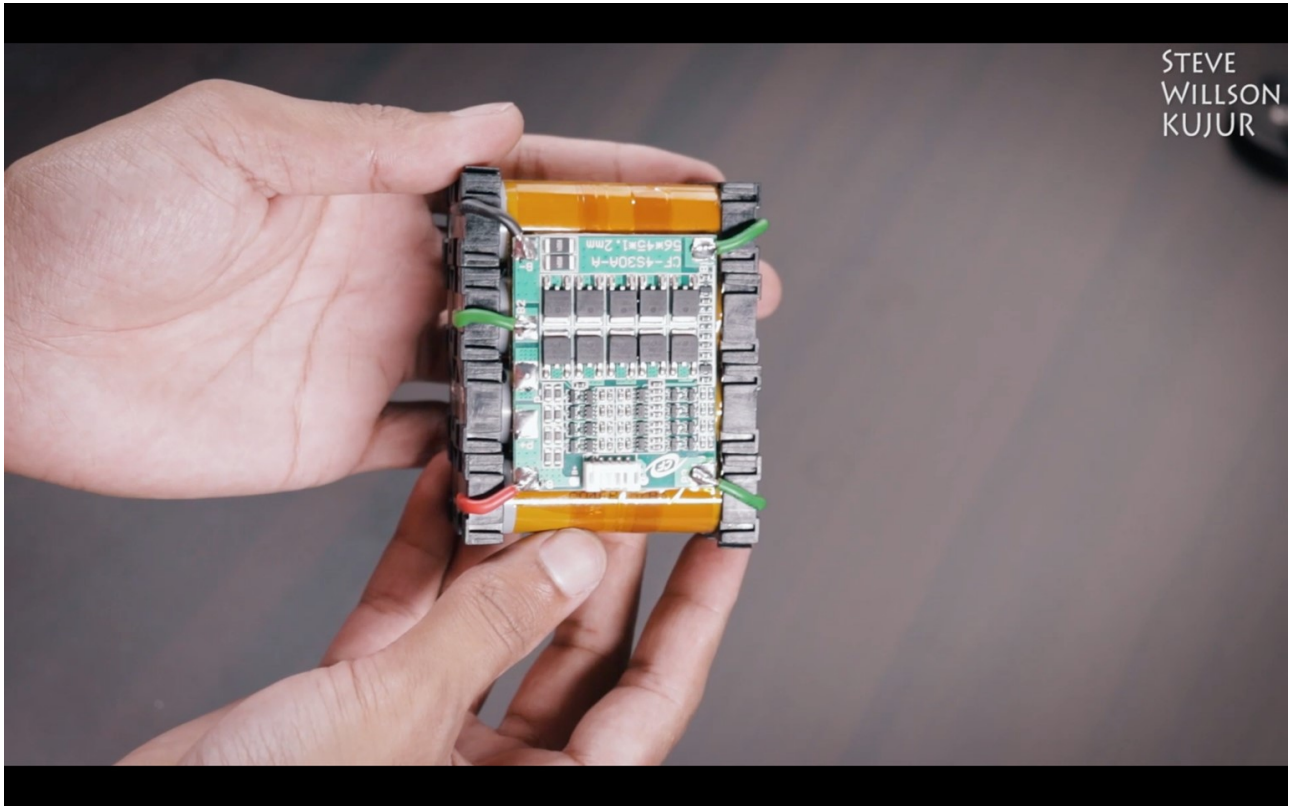
BMS Wiring Diagram



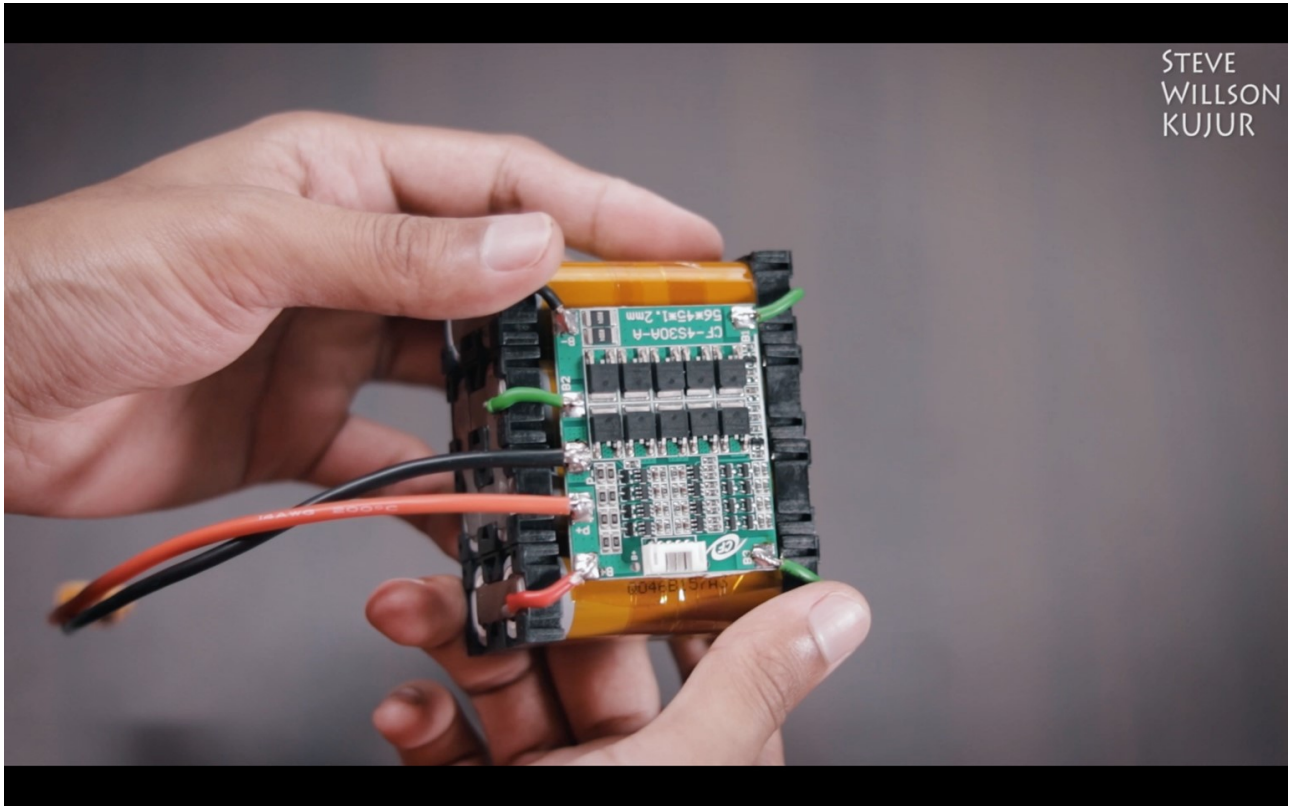
Solder BMS Connections to Cells



Final Wiring Example



Solder Charging/Discharging Connections To BMS



Resources

- Beginner’s guide to building 18650 battery packs - https://www.youtube.com/watch?v=tKg-jIrr_JE
- W1PNS / WAØITP / AB8XA Battery Life Estimator - http://www.4sqrp.com/Battery_Capacity/index.php
- Cell Savior Pack Planner - https://cellsaviors.com/pack-planner
- rePackr - 18650 pack builder - https://www.repackr.com/#/pack-builder

Links to Parts

Batteries -https://www.18650batterystore.com/ https://www.batteryspace.com/

https://batteryhookup.com/

Battery Tester - https://www.amazon.com/gp/product/B01852TBOU Out of Stock

Amazon - 4 slot charger/tester

Heat shrink covers - Amazon 110mm

Kapton Tape - eBay - 2 x 1” x 36yd rolls

Battery Management Circuits Amazon 3S 25A Amazon 4S 30A

Ready built packs - https://www.batteryspace.com/ https://bmsbattery.com/ebike-battery/652-16350-12v-10ah-38120s-lifepo4-battery-4-cells-ebike-battery-pack-battery.html#/212-discharge_current-20_40a