

Building Lithium-Iron-Phosphate Batteries

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Lithium-Iron-Phosphate Battery Overview

- 90+% Usable Energy (vs 50% with Lead Acid)
- Lighter & Smaller (1/6 the weight & ¼ the size of Lead)
- Longer Life Span (thousands of cycles vs hundreds)
- Near Flat Output Voltage Curve
- Temperature Range Limitations
 - DO NOT CHARGE BELOW FREEZING!
- Higher Cost Compared to Lead Acid?

Voltage	Capacity
14.4V	100%
13.6V	100%
13.4V	99%
13.3V	90%
13.2V	70%
13.1V	40%
13.0V	30%
12.9V	20%
12.8V	17%
12.5V	14%
12.0V	9%
10.0V	0%

Buy vs Build

- Buy

- Professional Products – Battleborn, Renogy, etc.
- Drop in Replacement for Lead Acid Batteries
- Features limited to what is offered
- Expensive - \$800+ for 100Ah

- Build

- Quality depends on materials & construction ability
- Features only limited by scope of build
- Save Money - \$200+ for 100Ah

Obtaining Materials

- Batteries

- Domestic Sources

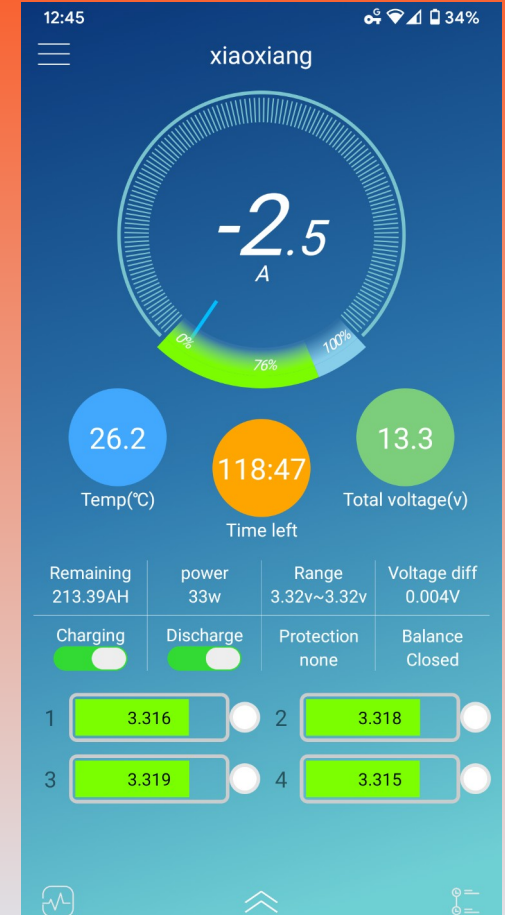
- More consistent product – some sources match, balance, and charge cells prior to shipping
 - Faster Shipping
 - Support Available
 - More Expensive - \$500 for four 100Ah cells

- Overseas Sources (China)

- Variable Quality – Grade A, Grade B, Used Cells, etc.
 - Slow Shipping (2 months)
 - Minimal Support
 - Save Money - \$170 for four 100Ah cells

Obtaining Materials

- Battery Management Systems (BMS)
 - Basic
 - Good Enough
 - No Low Temperature Cutoff
 - Inexpensive - \$30+
 - Full Featured
 - Custom Settings
 - Low Temperature Cutoff
 - Bluetooth Smartphone App
 - More Expensive - \$120+



Test Equipment

- Multimeter
 - Check Cell Voltages
 - Current Clamp Useful but Not Required
- Variable Regulated Power Supply
 - Required for Top Balancing Cells
 - Can also be used to Charge Battery
- LFP Battery Charger - Quick Charge Completed Battery

Battery Safety

- Respect the amount of energy on hand
 - Arc Flash is Real & Dangerous
 - Batteries are capable of discharging massive amounts of current in an instant
 - Use insulated tools, or cover terminals to avoid short circuits
 - Triple check battery polarities before wiring devices

Battery Construction

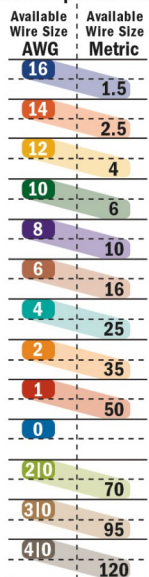
- Pack Assembly
 - Depends on Cell Type – Prismatic Easiest & Most Common
 - Threaded Rod, Tape, Double Sided Adhesive, Compression Straps, etc.
- Top Balancing
 - Assemble Pack in Parallel
 - Apply 3.65V to entire pack
 - Wait until current drops to ZERO
 - Required too assure that cells rise and fall together as pack charges & discharges

Battery Construction

- Final Assembly
 - Assemble Pack in Series – Use Proper Busbars!
 - Connect Balance Leads & Main Power Connections to BMS
 - Triple Check Balance Lead Wiring
 - Pay Attention to Wire Sizing & Match to BMS!
 - Small Wire = FIRE!
- Accessories
 - Power Distribution (Bus Bars and Cabling)
 - Circuit Protection (Circuit Breakers & Fuses)

Battery Construction

Standard and Metric Wire Comparison Table



KEY
AWG WIRE SIZE
CLOSEST EQUIVALENT IN METRIC

CIRCUIT LENGTH	CIRCUIT TYPE				CURRENT FLOW IN AMPS															
	10% VOLTAGE DROP Non Critical		3% VOLTAGE DROP Critical																	
	0 to 20 ft.	0 to 6.1 M	0 to 6 ft.	0 to 1.8 M	5A	10A	15A	20A	25A	30A	40A	50A	60A	70A	80A	90A	100A	120A	150A	200A
30 ft.	9.1 M	10 ft.	3.0 M	16 AWG	16 AWG	14 AWG	14 AWG	12 AWG	12 AWG	10 AWG	8 AWG	6 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	1 AWG	2/0 AWG
50 ft.	15.2 M	15 ft.	4.6 M	12 AWG	12 AWG	10 AWG	10 AWG	8 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	2 AWG	0 AWG	2/0 AWG
65 ft.	19.8 M	20 ft.	6.1 M	10 AWG	10 AWG	8 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	1 AWG	0 AWG	2/0 AWG
80 ft.	24.4 M	25 ft.	7.6 M	8 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	1 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
100 ft.	30.5 M	30 ft.	9.1 M	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	1 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
130 ft.	39.6 M	40 ft.	12.2 M	4 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	1 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
165 ft.	50.3 M	50 ft.	15.2 M	2 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	1 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
200 ft.	61.0 M	60 ft.	18.3 M	1 AWG	1 AWG	1 AWG	1 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		70 ft.	21.3 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		80 ft.	24.4 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		90 ft.	27.4 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		100 ft.	30.5 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		110 ft.	33.5 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		120 ft.	36.6 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG
		130 ft.	39.6 M	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	0 AWG	2/0 AWG

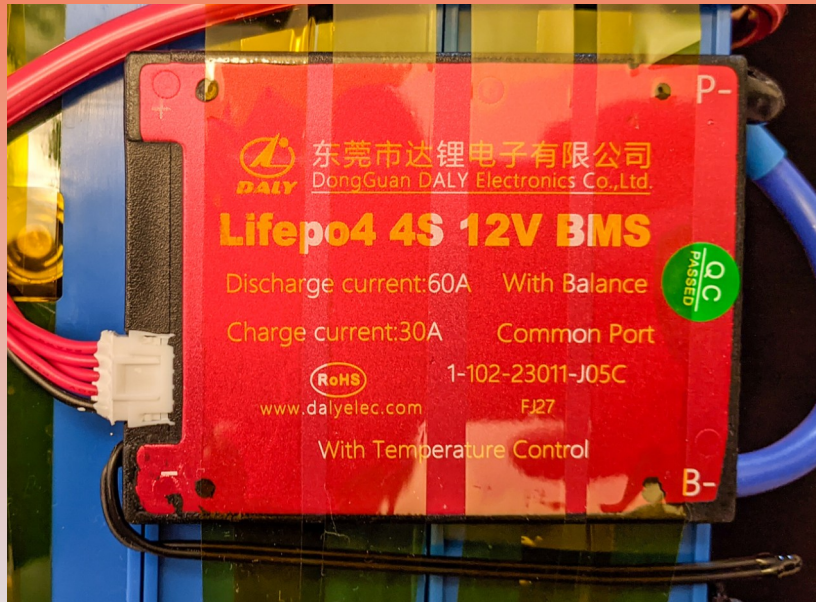
Although this process uses information from ABYC E-11 to recommend wire size and circuit protection, it may not cover all of the unique characteristics that may exist on a boat. If you have specific questions about your installation please consult an ABYC certified installer.

Testing

- Cell Balance
 - Individual Cells May Require Additional Charging
 - Cell Balance May Change as Pack Settles at 100% Charge Rest Voltage (13.6V)
- Capacity Test
 - Verify Cells have Rated Capacity
 - Easiest with Inverter & Heat Gun or Space Heater

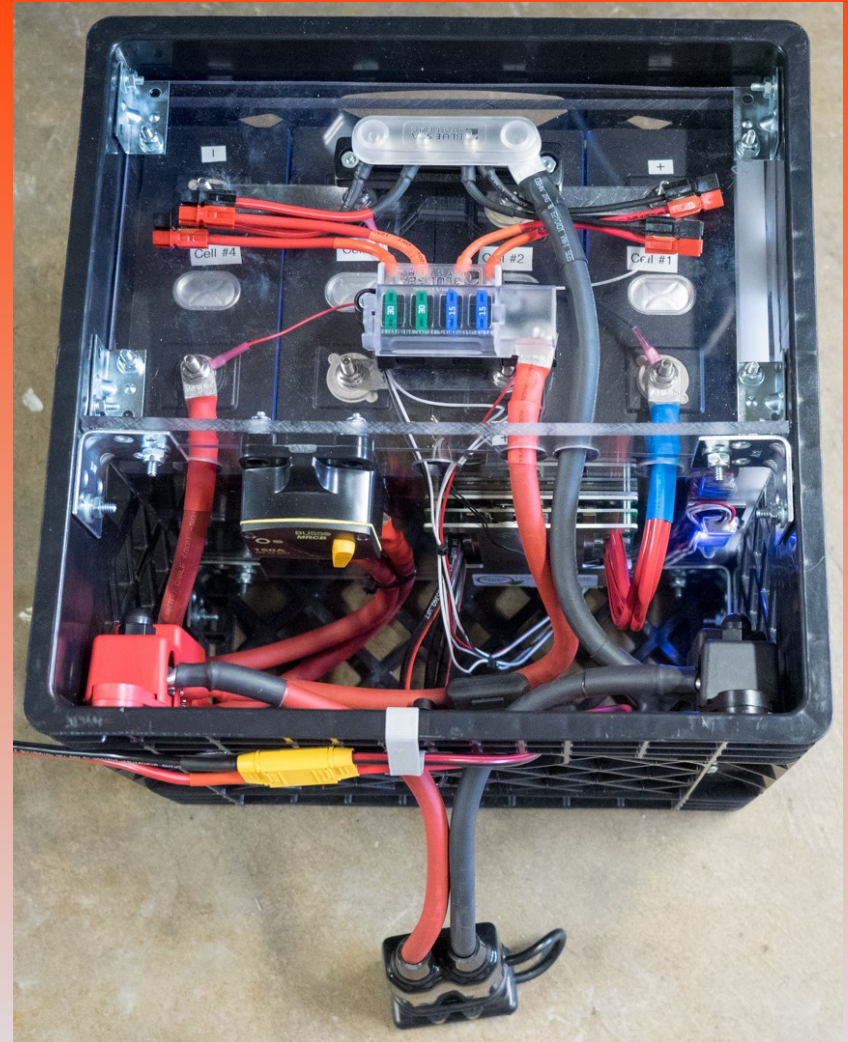
Examples

- 60Ah
 - Domestically Sourced Cells (Electric Car Parts)
 - Basic BMS (60 Amps)
 - \$450

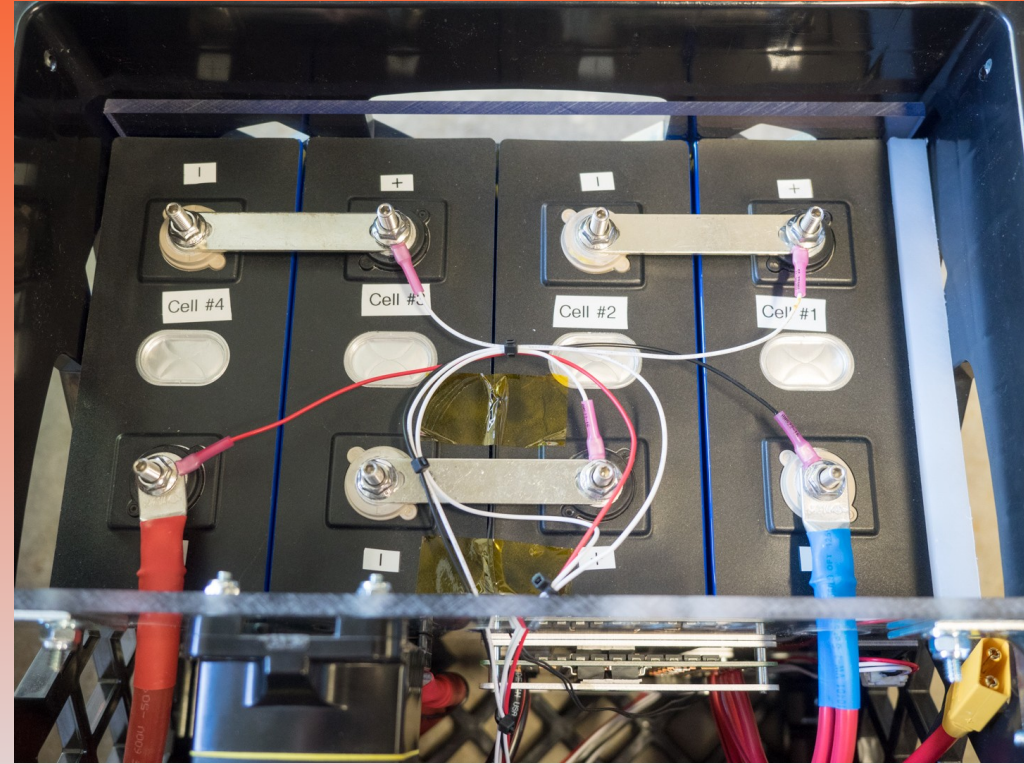


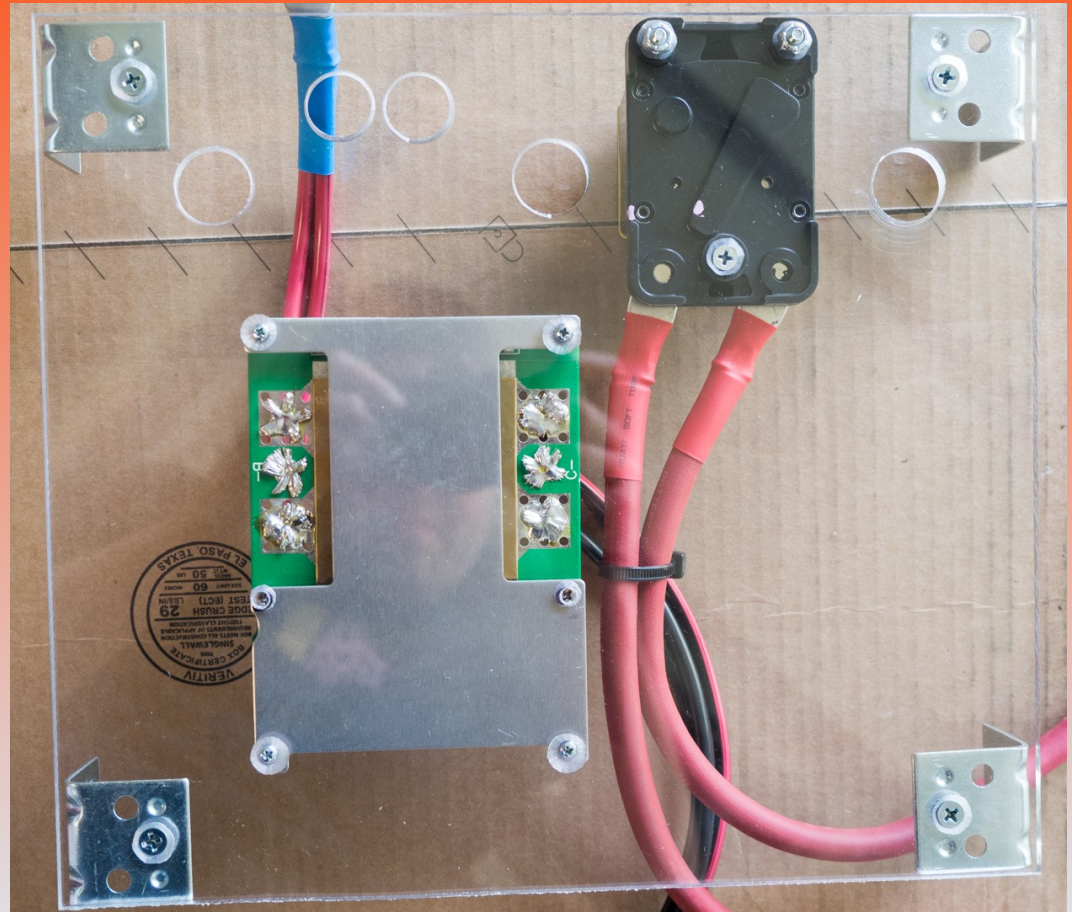
Example

- 280Ah – Milk Crate Battery
 - Chinese Sourced Cells (Aliexpress)
 - Full Featured BMS w-Bluetooth (120 Amps)
 - Power Distribution System
 - Main Circuit Breaker Disconnect
 - Power Busbars
 - Fused Charging Connection
 - Fuseblock for Small Loads (Radios, etc.)
 - PowerPole Connection for 1500W Inverter
 - Battery Pack Held In Place w-Plastic Sheets
 - \$1000 (Battery & BMS only - \$650)

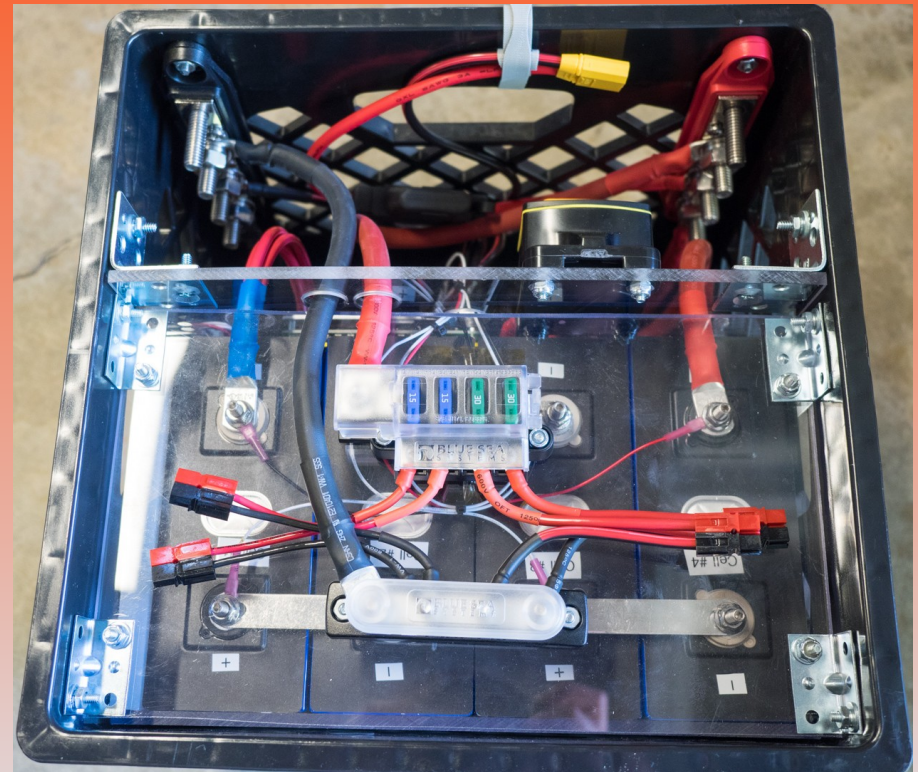
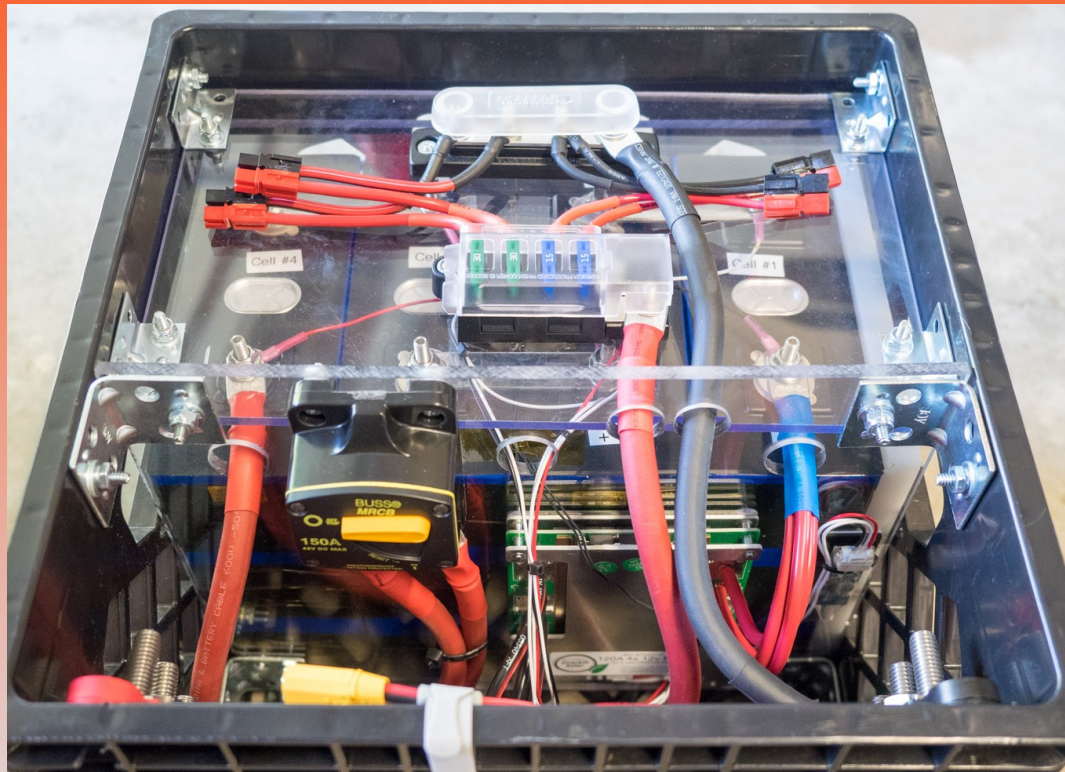


Example – 280Ah – Battery Pack Assembly





Example – 280Ah – Final Assembly



Resources

- YouTube
 - DIY Solar Power with Will Prowse - <https://www.youtube.com/user/erolprowse>
 - 280Ah Cell Test - https://www.youtube.com/watch?v=3U4ZfQ_IToI
 - Overkill Solar BMS Test - https://www.youtube.com/watch?v=uCC_3LoLYuw
 - Top Balancing - <https://www.youtube.com/watch?v=x5ABvbbics8>
 - Website - <https://www.mobile-solarpower.com/>
 - Lithium Solar - <https://www.youtube.com/c/LithiumSolar>
 - LifePO4 Basics - <https://www.youtube.com/watch?v=RZk9417Xow8>
- Blue Sea Systems Wire Sizing Guide
- Overkill Solar Manuals & Wiring Diagrams