

LiFePo4 battery performance test

This document details the discharge testing of several LiFePo batteries purchased over the past four years. These batteries were purchased through Amazon from three different manufacturers; Ingosolly, BTRPower, and Miady. Miady was purchased in March 2022, BTRPower was purchased in December 2022, and Ingosolly was purchased in March 2024.

Miady – 12.8VDC, 20Ah

BTRPower – 12.8VDC, 50Ah

Ingosolly 12.8V, 200Ah

The Ingosolly LiFePo battery was used to power two CPAP machines with usage only during spring through summer camping. Total number of discharge/charge cycles is estimated at 40 and discharge voltage was never allowed below 12.5V except during this test procedure.

The BTRPower LiFePo battery was used to power Amateur Radio gear and used at varying temperatures throughout the year. Total number of discharge/charge cycles is estimated at 100 and discharge voltage was allowed to drop between 11.5 to 12.0 volts occasionally.

The Miady LiFePo battery was used to power Amateur Radio gear and used at varying temperatures throughout the year. The battery was tested four years ago and never delivered 20Ah of power and several tests measured 17Ah. Total number of discharge/charge cycles is estimated at 150 and discharge voltage was allowed to drop between 11.5 to 12.0 volts occasionally.

Initially all three batteries were initially tested to verify proper operation. The BTRPower battery did have issues which the manufacturer corrected and sent me a only delivered about 30Ah of power. Shipping costs were too high to return the battery so the manufacturer allowed me to keep the failed battery which I continue to use as a spare battery.

Discharge testing was accomplished using DC-AC inverters, a 60 Watt light bulb and two 17.5 Watt heating pads as loads, and a logging voltmeter load.

LiFePo4 battery performance test

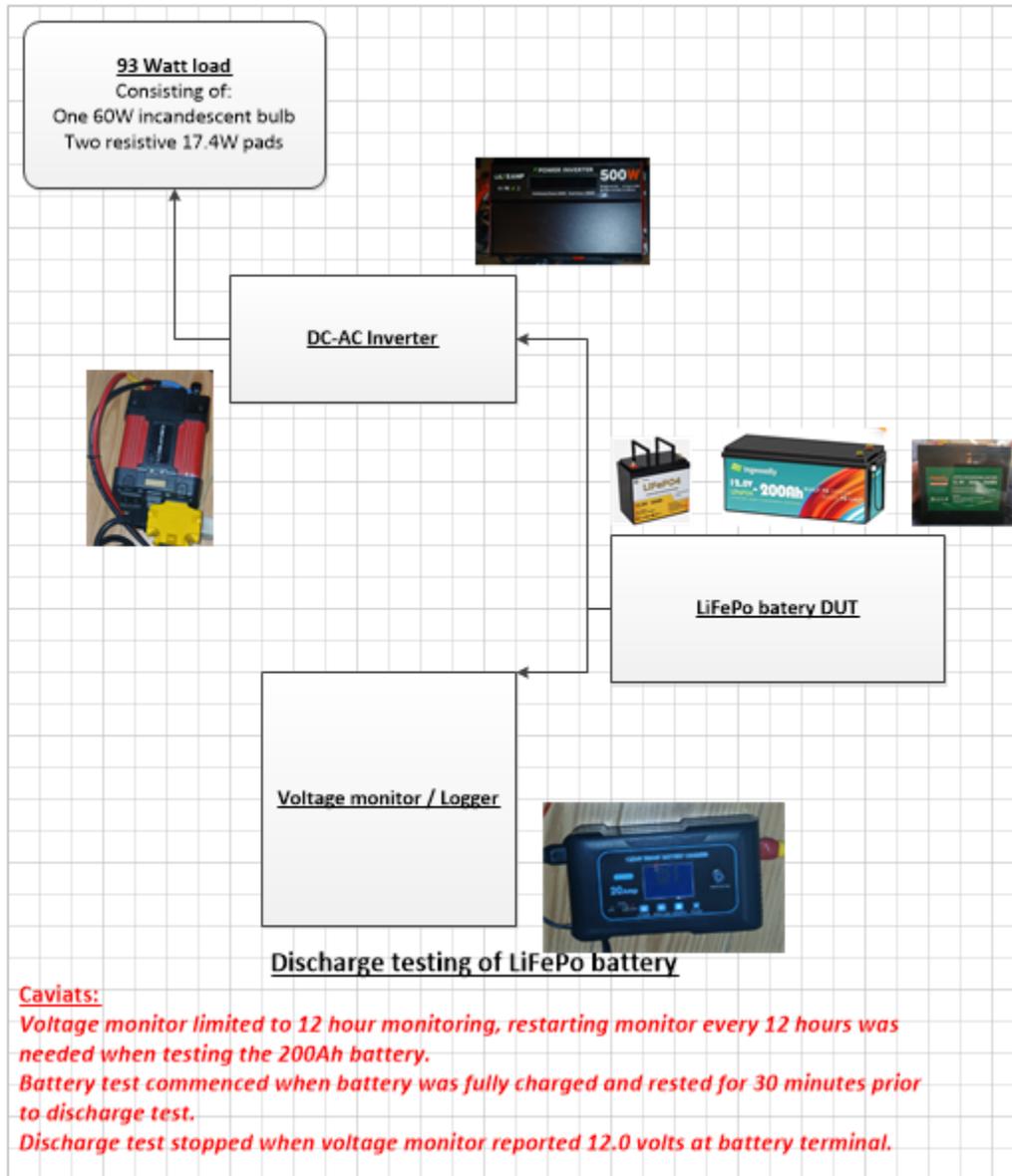


Figure One: Schematic representation of LiFePo discharge test set.

LiFePo4 battery performance test

After two plus years use I decided to check the performance of these batteries. Ingosolly warranted their battery for 5 years with a minimum of 4000 cycles (assuming heavy discharging) while BTRPower and Miady have a limited one-year warranty. For the most part all batteries were exposed to light discharges, stored at room temperatures (60F to 80F) and no mechanical shocks, I assumed all the batteries would perform well. Below is a typical manufacturer curve for a LiFePo battery discharge looks similar to this:

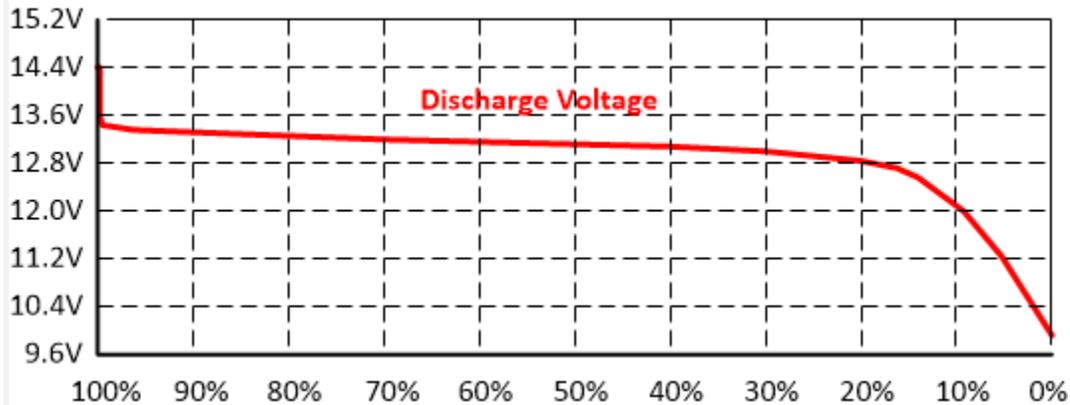


Figure Two: Typical discharge curve of LiFePo battery showing terminal voltage versus state of charge (SOC)

Using the test set as described and depicted on page one, I began the test. I first charged the battery until my Haisito Smart Battery Charger and waited until the charger indicated the battery was fully charged. I then waited 30 minutes and topped the battery off one additional time, again waiting for the “full” indicator to appear on the charger. I then allowed the battery to rest for 30 minutes prior to beginning the discharge cycle. The load was presented to the battery was resistive 93 watt load with a Olteanp 500 watt or Centec 400 watt power inverter converting the battery voltage to 120VAC for the load. Assuming the power inverter is 80% efficient (the manufacturer boasts up to 90% efficient). So we can add the inefficiency of the inverter and add 1.2 watts ($12V * 0.1A$) for the battery monitor equipment.

$[93 \text{ watts} * 120\%] + 1.2 \text{ watts} = 112.8 \text{ watts}$ (roughly 113 watts).

The manufacturer of the battery (Ingosolly) rates the battery at 2560 watts, so in theory the battery should be able to deliver power through the inverter for hours.

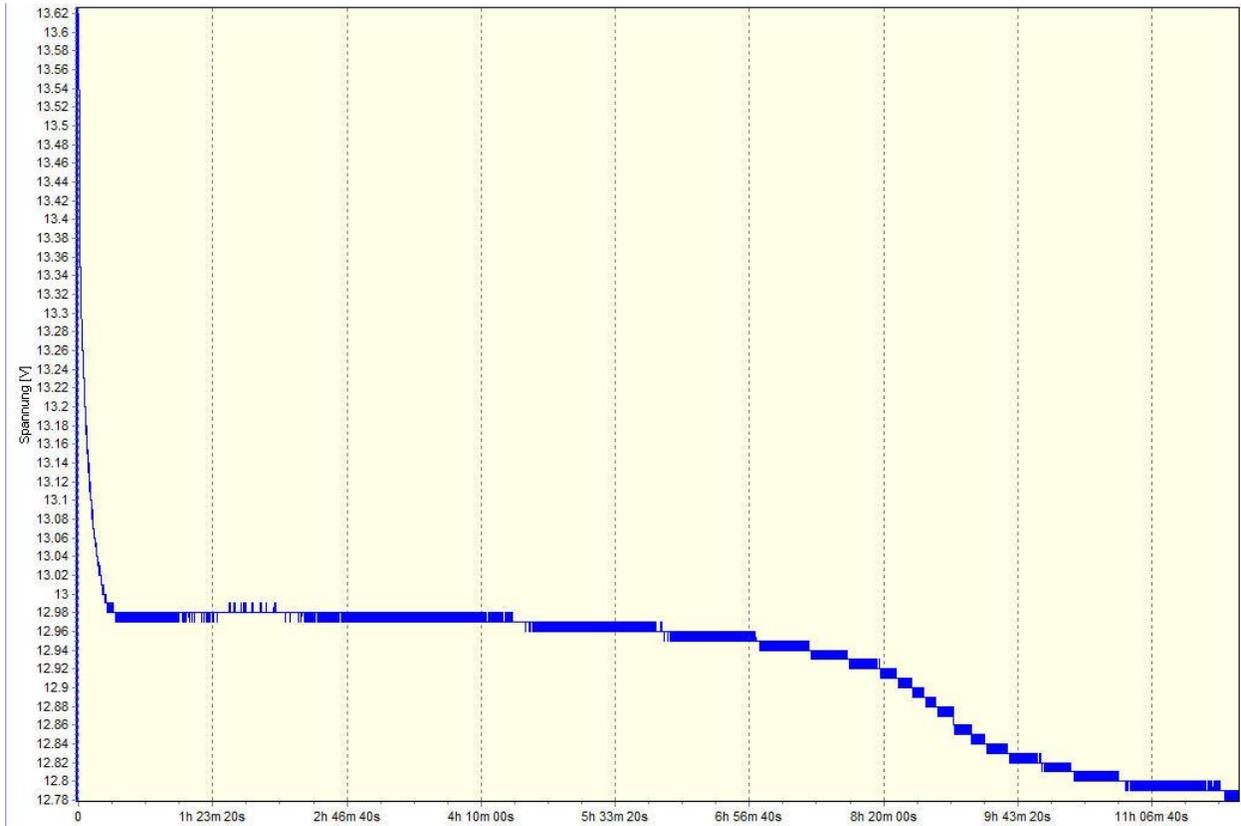
- Ingosolly estimated run time with discharge load - $[2560 \text{ watts} / 113 \text{ watts}] = \underline{\underline{22.6 \text{ hours}}}$.
- BTRPower estimated run time with discharge load - $[640 \text{ watts} / 113 \text{ watts}] = \underline{\underline{5.6 \text{ hours}}}$.
- Miady estimated run time with discharge load - $[256 \text{ watts} / 113 \text{ watts}] = \underline{\underline{2.26 \text{ hours}}}$.
 - Miady battery really only delivered 17Ah of power when new
 - $17Ah * 12.8V = 217 \text{ Watts}$: $217.6 \text{ watts} / 113 \text{ watts} = \underline{\underline{1.92 \text{ hours}}}$.

LiFePo4 battery performance test

Test results

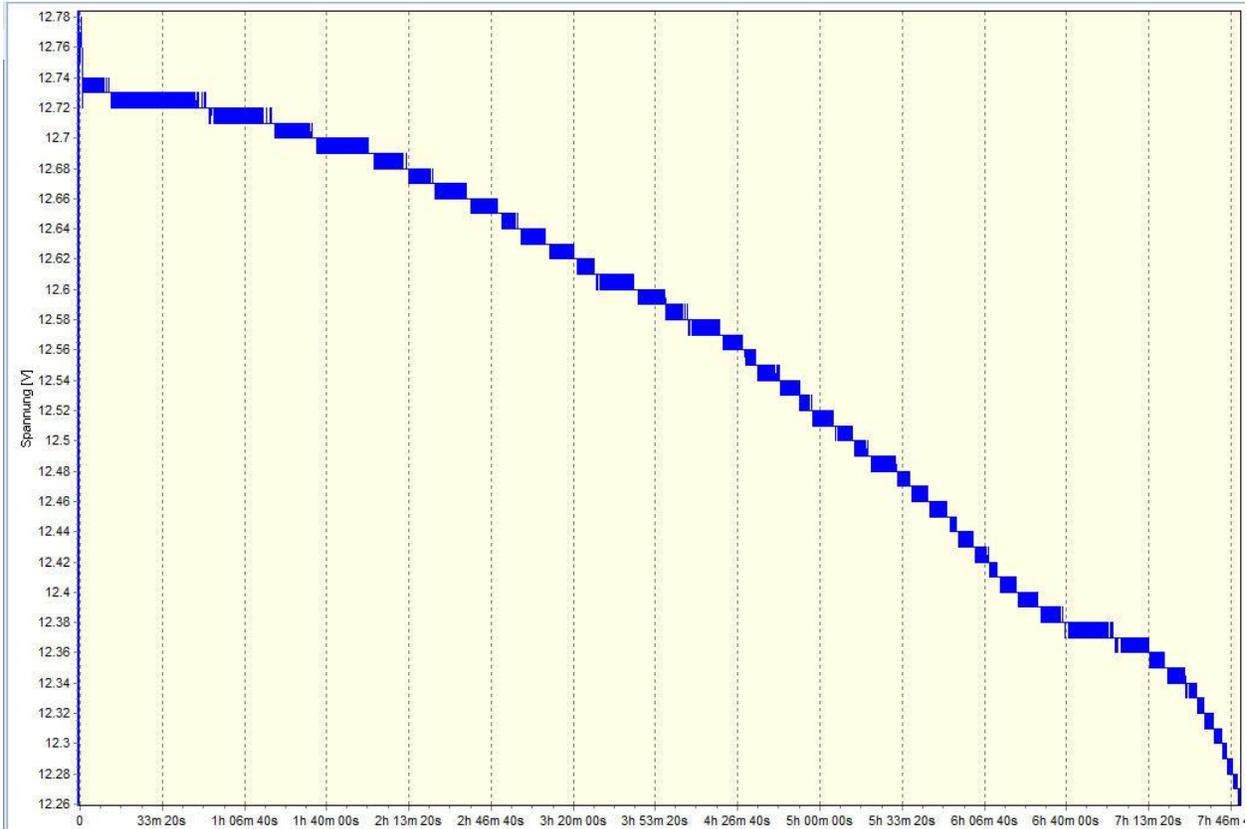
Ingosolly

Below are two charts depicting measured voltage over time for the Ingosolly LiFePo battery.



Graph One: Depicts the discharge characteristics for the first 12 hours of discharge test. Battery terminal voltage was 13.62 volts at the start of the test. After 12 hours the battery voltage had fallen to 12.78 volts.

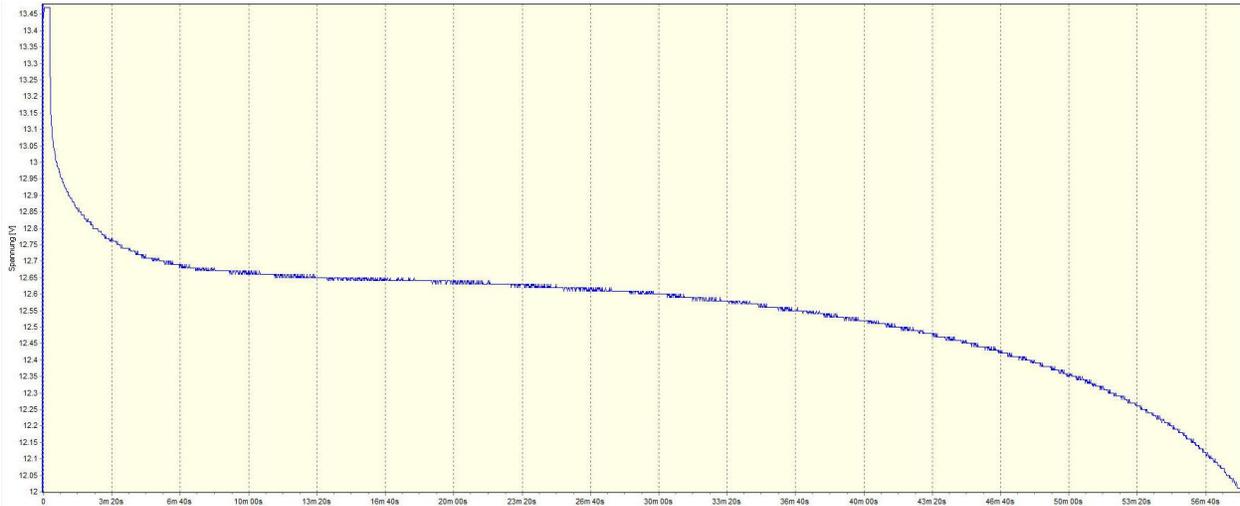
LiFePo4 battery performance test



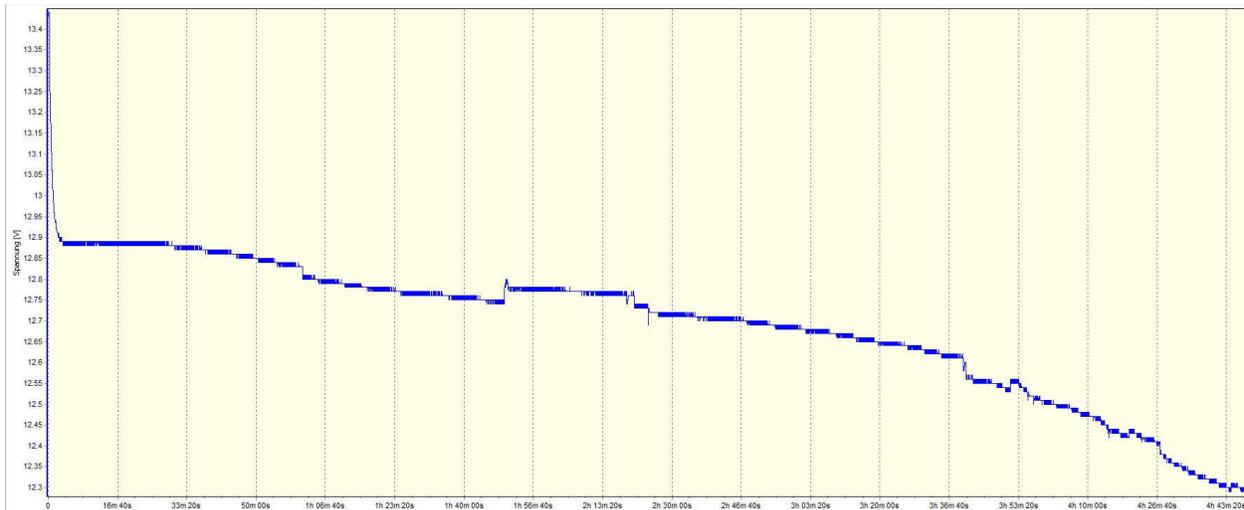
Graph Two: This chart depicts the last 8 hours of the discharge test. Ending voltage was 12.26 volts which most likely is between 10% to 15% SOC for the battery (see Table One). The test was halted to avert any long term damage to the battery caused by excessive discharge however Ingosolly states the built in BMS will prevent damage to the battery but shutting down discharge when battery terminal voltage reaches a certain threshold (while not stated, it is assumed to be 10.8 volts).

LiFePo4 battery performance test

BTRPower



Graph three: The above graph is the 'failed' BTRPower battery plot of voltage over time, time being 1-hour. Initially, 4 years ago, this battery displayed about 30Ah of service (approximately 380 watts). The above chart displays the battery service now has significantly reduced to approximately a 9Ah rating.



Graph four: The above graph shows the 'good' BTRPower battery of voltage over time with the 113 watt load. The testing was aborted when a cable inadvertently disconnected the voltage monitor but this data is still useful. Shown is the battery is cable of delivering 565+ watts of energy (113 watts * 5 hours).

LiFePo4 battery performance test

Miady



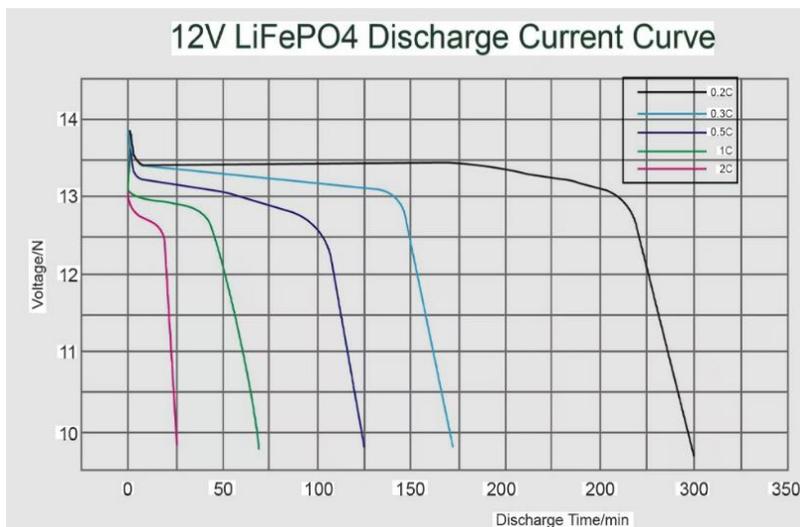
Graph Five: The Miady battery was able to deliver power for 1.93 hours. Based on the revised testing initially done four years ago, this battery has not degraded since put in service four years ago.

LiFePo4 battery performance test

Conclusion:

The batteries seem to have met the design parameters even after several years of use. The ability to accurately measure the internal resistance of the battery proved challenging and therefore only an estimated voltage drop across the internal BMS when under load could be done. The graphs vertical scales can be estimated to be 0.05 to 0.1 volts higher than recorded due to the BMS voltage drop. Most test stopped above the 12.0V threshold where the voltage data logger would stop recording voltages

LiFePo manufacturers produce discharge curves based on a percentage of capacity of discharge. Graph six shows a typical discharge curve based on a percentage of battery design capacity.



Graph Six: The above graph details discharge times factored by current draw from the battery. LiFePo batteries provide a very linear power delivery design capacity regardless of load presented to the battery.

LiFePo4 battery performance test

SOC	Voltage
100%	13.60
95%	13.50
90%	13.40
85%	13.35
80%	13.30
75%	13.25
70%	13.20
65%	13.15
60%	13.10
55%	13.05
50%	13.00
45%	13.00
40%	13.00
35%	12.95
30%	12.90
25%	12.85
20%	12.80
15%	12.40
10%	12.00
5%	11.00
0%	10.00

Table One: SOC vs Voltage of a typical LiFePo battery. SOC below 20% is non-linear with SOC between 80% to 20% is nearly a flat line. Most manufacturers recommend keeping the SOC between 20% to 80% with long-term storage at 50% and charging to full every 3-months.

A flatter discharge curve with a very sharp voltage drop toward the last few hours of the test was anticipated but that is not what the test showed. A very flat discharge occurred for some of the discharge but then a steady decline of battery voltage showed the battery has more a linear discharge curve at the tail end of its SOC with the final stages of the test showing a cliff dive drop in voltage.

These batteries is a better performer than an AGM chemistry battery with little or no degradation due to age and use.

Recharging:

Once the discharge test was completed, charging the battery back to full SOC was done. Generally higher capacity batteries can be charged at a higher current level but have found battery chargers incorrectly indicate a battery being fully charged if charged at a high current rate. Typically I charge 20Ah and 50Ah batteries at 5 Ah and 200Ah batteries at 10Ah.