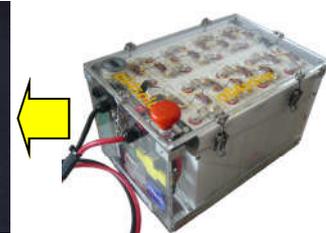


# High Quality Lithium Battery Packs For Boats

all4 solar <sup>TM</sup> Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)



## Just connect to the engine and go!

Lithium iron(ferite) batteries (LIFEPO04) only weigh 35-40% of lead acid batteries (depending on the size). Over 90% of the energy capacity can be used instantly compared to 60% from lead acid batteries. More than 2000 cycles life span and a high safety standard make these the perfect energy source for any electric marine propulsion system. Unlike other lithium batteries, these cells are very reliable and safe.

Now you can get these advanced batteries **ready to go**. Just connect to the engine. The acrylic or aluminium box includes the battery management system, main fuse, safety switch, main switch\* as well as an advanced battery monitoring system with integrated alarm function (f.e. when battery has X % of the capacity left). The system will automatically shut down the power connection to the engine as well as to the charger if discharged or fully charged. So any engine or charger can be used with this packs. No need to connect controll cables to engine or charger. The highest safety standards packed in one box Including BMS and monitor. Suitable for the installation on any boat (or vehicle).

**A battery charger (240 V AC) is included with each battery box as well as an electronic battery monitor\*.**

\*Monitor not included for battery packs below 2 KWH / 2000 WH (Opt.+ \$ 250.00)  
\*Main/safety switch & fuse external for battery packs upto 1 KWH—internal for battery packs over 1 KWH. Metal or plastic box instead of acrylic box for packs upto 1 KWH (=1000 WH).

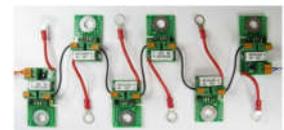


### Buidling your own lithium battery pack?

**We offer the most advanced battery management system on the market. The EMUS digital system monitors the voltage, temperature and balancing of each single cell with a free software to monitor and adjust the settings on you PC or even your mobile phone.**

**For details about this system download the brochure:**  
[www.all4solar.com.au/EMUS\\_BMS\\_A4S.pdf](http://www.all4solar.com.au/EMUS_BMS_A4S.pdf)

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# High Quality Lithium Battery Packs For Boats (Boxes)

**all4solar** (TM) Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

## Manual for LIFEP04 battey packs 48-96 V 100-200A systems v 1.5 2012

| Battery type | Nominal Capacity | Nominal Voltage | Charge Voltage max. | Low Voltage | Cont. discharge current | Max. discharge current |
|--------------|------------------|-----------------|---------------------|-------------|-------------------------|------------------------|
| AS48100      | 100 Ah           | 48 V / 51.2 V   | 59 V (25 A)         | 38 V        | 200 A (10240 Watt)      | 300 A (15360 Watt)     |
| AS96200      | 200 Ah           | 96 V / 102.4 V  | 118 V (50 A)        | 76 V        | 400 A (20480 Watt)      | 600 A (30720 Watt)     |

### PREPARARATION FIRST USE

Disconnect anything connected to the main plug. Switch the battery on by pulling out the safety switch. Then switch on the BMS (battery monitor system) via the toggle switch. You should hear the main contactor switching on and the green light illuminated on the BMS board. The battery monitor should start working and after a few seconds show the battery voltage. (How to program the battery monitor, reset the data etc.—read the separate manual). The battery voltage has to be at least 50/100 volts or higher. If the battery voltage is below 53 / 106 volts, we recommend to fully charge the battery first before use. If the battery voltage is below 40 volts, the main relay will switch off again. You have to immediately charge the battery by connecting the charger to the main plug and switching the BMS on / off. The voltage will increase and the contactor will should stay on. At 54 / 108 volts the battery is usually fully charged.

### CHARGING / STORAGE

Connect the charger to the main plug. The BMS has to be switched on at all times when a charger and / or a load are connected to the main plug. The BMS can be switched off, if the battery is not used for a longer period. The battery has to be fully charged, if not used for an extended period. It will lose approximately 4 Amp hours per month (BMS off = charge every 12 months) and 9 Amp hours per month (BMS on = charge every 6 months). These batteries do not have any memory effect, but we still recommend to always fully charge them to increase the life time and avoid damage.



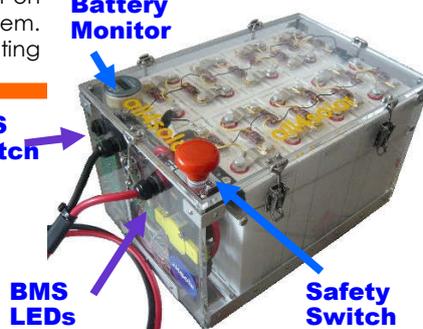
Make sure to not mix positive and negative connections!!

### USE THE BATTERY

Before connecting a load, switch the battery off by pushing the safety switch. Then connect the load to the main plug and pull the safety switch. Wait a few seconds, this allows the capacitors in the motor controller to charge which will avoid sparking in the main contactor of the battery. The BMS and the battery monitor have to be on: Check if the green light of the BMS is illuminated. If a red light is on, the battery should not be used. Check the voltage and recharge the battery first. If the red light stays on, check the led light on each cell (16 cells) and contact all4solar. Do not manipulate the system. If you do so, this will void the warranty as well as any use not respecting



Battery Monitor



- ◆ Do not expose the battery pack directly to water or fire
  - ◆ Do not solder directly to any component of the battery pack
  - ◆ Do not mix positive (red) and negative (black) connections
  - ◆ Do not short circuit the battery pack or any components
  - ◆ Do not mix with other battery types
  - ◆ Always fully charge the battery before use
  - ◆ Charge with 48 V/16 cell lithium battery charger or 48 V solar charge controller only. Or 96 V / 32 cell lithium battery charger / 96 V solar.
  - ◆ Store in dry | cool place | covered if installed on a boat
  - ◆ Switch the BMS on / off when safety switch is on only!
  - ◆ Do not expose to full sunlight | Do not operate over 40 C or below 0 C
  - ◆ Do not dismantle the battery pack and do not operate without the box | Do not change components
  - ◆ Do not disconnect a solar system and the grid charger at the same time | Use double switch in this case
  - ◆ Keep your battery clean and free from corrosion and dirt
  - ◆ Never connect load or charger to the battery with the BMS off or the red LED illuminated!
  - ◆ All cells should have the same voltage at all times—if not, the single cells have to be manually balanced!
- The improper use or the modification of the battery box will void the warranty. All4solar is not responsible for any damage caused by the use of this battery or damages to any applications connected to this battery. The user has to take necessary precautions to secure a safe use of this battery and the applications connected.

### ERRORS / CAUTION

**The battery is safe to operate when** THE GREEN LED ON THE BMS IS ON | THE RED LIGHT ON THE BMS IS NOT ON | THE GREEN LED ON EACH BATTERY CELL IS ON | THE BATTERY MONITOR IS ON | THE VOLTAGE IS OVER 48 / 96 VOLTS.

**The battery is not to be used when** THE GREEN LED ON THE BMS IS NOT ON | THE RED LIGHT ON THE BMS IS ON | THE GREEN LED ON EACH BATTERY CELL IS OFF OR RED | THE BATTERY MONITOR IS OFF | THE VOLTAGE IS UNDER 44 / 88 VOLTS (Recharge allowed, if all other indicators are ok) **MEASURE CELL VOLTAGES FIRST—if imbalanced see separate instructions**

# High Quality Lithium Battery Packs For Boats (Kit)

**all4solar** (TM) Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

## Manual for LIFEP04 battey packs 48-96 V 100-200A systems v 1.7 2013

| Battery type | Nominal Capacity | Nominal Voltage | Charge Voltage max. | Low Voltage | Cont. discharge current | Max. discharge current |
|--------------|------------------|-----------------|---------------------|-------------|-------------------------|------------------------|
| AS48100      | 100 Ah           | 48 V / 51.2 V   | 59 V (25 A)         | 38 V        | 200 A (10240 Watt)      | 300 A (15360 Watt)     |
| AS96200      | 200 Ah           | 96 V / 102.4 V  | 118 V (50 A)        | 76 V        | 400 A (20480 Watt)      | 600 A (30720 Watt)     |

### PREPARATION OF KIT

If you have ordered a kit—not a ready to go battery box, the system is prewired and all the connections are either marked or described hereafter in detail. You just need to connect the system. Please read carefully!

### INSTALLATION OF BATTERY CELLS

The battery cells are arranged in blocks of 4 or 8 and need to be fixed with a stable frame which can carry a force of at least 3 G (3 times the battery weight). See next page for possible arrangements. Make sure you do not touch the positive or negative terminals with any tools, metall or body parts!!



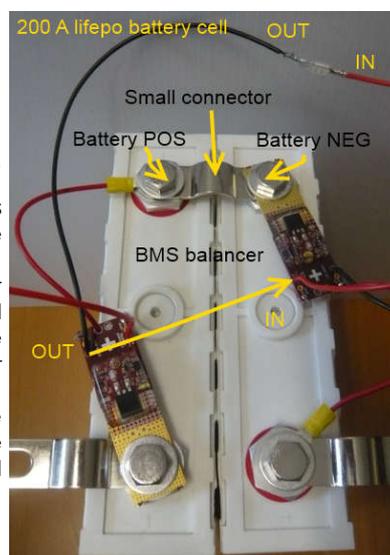
### CONNECTION OF THE CELLS

Before connecting the cells, please check the alignment and make sure, the cells are fixed and can not move. The terminal connectors are not suitable to hold the cells together!

The cell connectors are connected to the battery cell terminal—use anti oxydant fluid for long lasting connections. Next connect the cell balancer. The main board is connected to the NEGATIVE terminal and the red cable with the lug to the POSITIVE terminal. When connected a green LED lights up. If not, you have either conected incorrectly or the balancer is defect.

The cells need to be conected from a POSITIVE to a NEGATIVE terminal and the balancer controll cables (Red and Black) from the OUT connection on the balancer board from cell 1 to the IN connection on the balancer board from cell 2 etc.

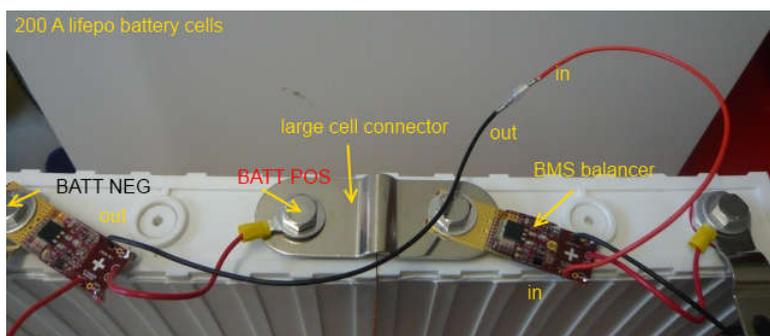
Connect 16 cells in series for 48 volt, 32 cells in series for 96 volt.



If all cells are connected there must be a POSITIVE terminal free at one end of the string and a NEGATIVE terminal at the other end. You have to measure 48—54 volts for a 16 cell system and 96-108 volt for a 96 volt system.

### CONNECTION OF BMS / POWER

The BMS system is mounted on a board fully wired with the DCDC converter (12 volts), the main fuse and the contactor. The safety switch is either mounted on the board or supplied separately with cables. Connect the safety switch to the POSITIVE battery terminal. Switch if off (pull out) and then connect to the contactor terminal. Use anti oxydant for all connections. Connect the positive cable from the main fuse to the main switch. Connect the cable from the main switch to the positive terminal on the engine controller.



Connect the NEGATIVE battery terminal with the supplied cable to the battery side of the shunt. Connect the engine side of the shunt to the negative terminal on the engine controller. **SEE ALSO „Problems with LiFePo4 cells“**

Follow the instructions for the battery box and the operator's manual of the engine to check & startup the system.

**ALL CELLS HAVE TO BE CHARGED TO THE EXACT SAME VOLTAGE. Check the documentation for the BMS system supplied and the battery instructions before connecting or changing settings.**

### ERRORS / CAUTION

**LED on balancers = green ok red&green = balancing red = not ok**

**The battery is safe to operate when** THE GREEN LED ON THE BMS IS ON | THE RED LIGHT ON THE BMS IS NOT ON | THE GREEN LED ON EACH BATTERY CELL IS ON | THE BATTERY MONITOR IS ON | THE VOLTAGE IS OVER 48 / 96 VOLTS.

**The battery is not to be used when** THE GREEN LED ON THE BMS IS NOT ON | THE RED LIGHT ON THE BMS IS ON | THE GREEN LED ON EACH BATTERY CELL IS OFF OR RED | THE BATTERY MONITOR IS OFF | THE VOLTAGE IS UNDER 44 / 88 VOLTS (Recharge allowed, if all other indicators are ok) **MEASURE CELL VOLTAGES FIRST—if inbalanced see separate instructions**

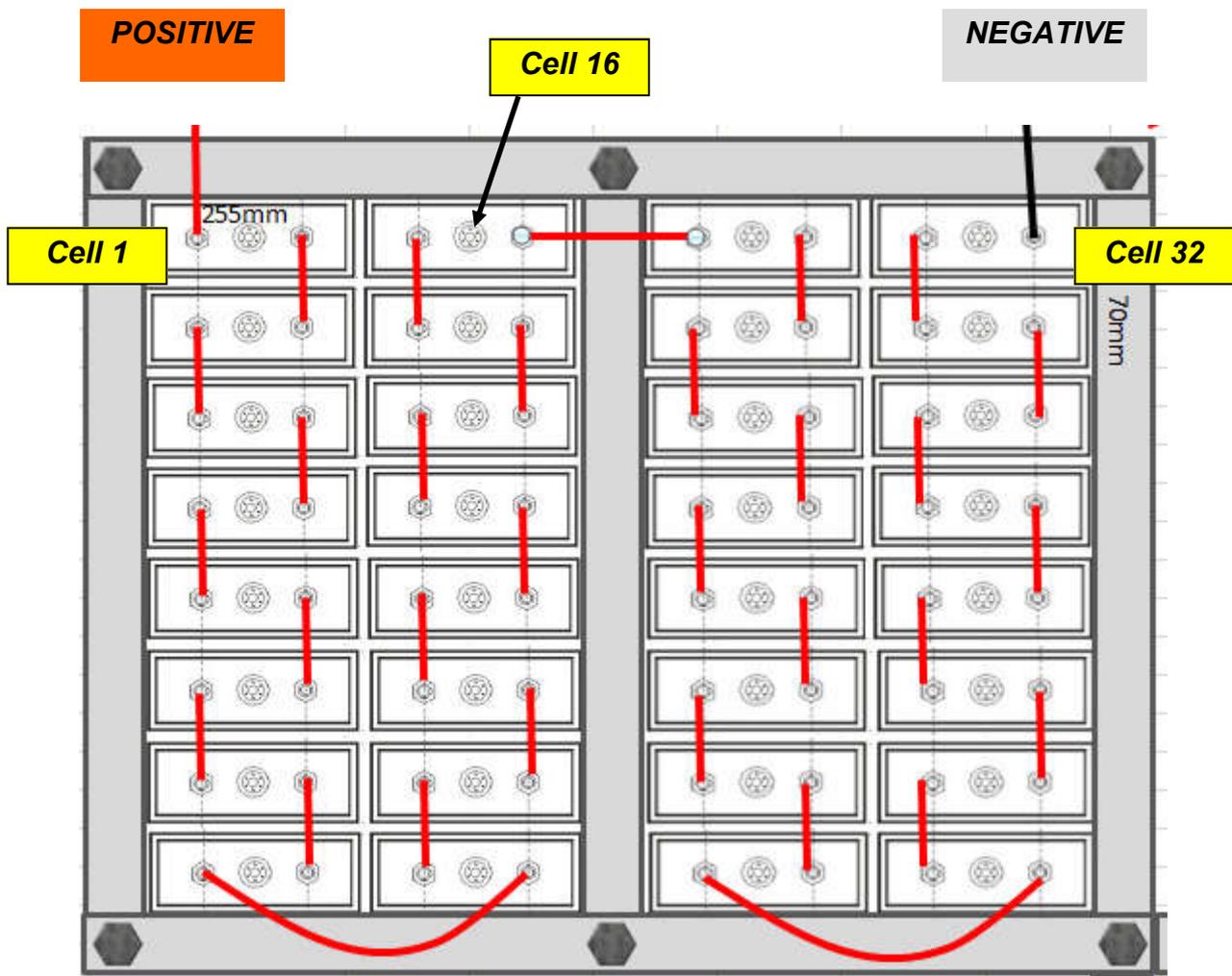
# High Quality Lithium Battery Packs For Boats (Kit)

**all4solar** (TM) Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
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[www.all4solar.com.au](http://www.all4solar.com.au)

Manual for LiFePO4 battery packs 48-96 V 100-200A systems V 1.5 2012

## CELL ARRANGEMENT (for kit application)

*LiFePO4 cells can expand when overdischarged, overcharged or when charged/discharged at high current. To avoid this, the frame has to be very tight and stable. The cells should be fixed by a full frame at the bottom, the centre and the top.*



**48 volt system = cell 1 to 16**  
**96 volt system = cell 1 to 32**

### CAUTION

Make sure, the battery terminals, / connectors / shunts / cables are not in contact with any metal parts of the frame. The battery frame / box needs to be fully enclosed. If used at 0.5 C average power consumption no ventilation is required. For permanent high currents ventilation is recommended. Cells should not be exposed to water / any sharp objects.

# High Quality Lithium Battery Packs For Boats (24 volt)

all4 solar Aquawatt Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

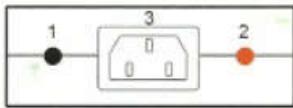
## Manual for LIFEPO4 battey packs

## 24 V 20A / 40 A system

v 1.2 2012

| Battery type | Nominal Capacity | Nominal Voltage | Charge Voltage | Low Voltage | Cont. discharge current | Max. discharge current |
|--------------|------------------|-----------------|----------------|-------------|-------------------------|------------------------|
| AS2440       | 40 Ah            | 24 V / 25.6 V   | 30.4 V (6 A)   | 17.6 V      | 30 A (770 Watt)         | 60 A (1540 Watt)       |
| AS2420       | 20 Ah            | 24 V / 25.6 V   | 30.4 V (6 A)   | 17.6 V      | 20 A (512 Watt)         | 30 A (768 Watt)        |

Connect the battery with the positive connection to the main switch (suitable for the voltage and the max. discharge current) and the negative connection to a main fuse (suitable for the voltage and the max. discharge current). Check the voltage at the output leads which connect to the motor and the solar system, if applicable. If all4solar supplies the main switch board, the lead to the battery is marked with „B“. The other leads connect to the solar system and the motor (any plug can be used). The battery charger can be connected to one of those plugs or directly to the battery. Some batteries have a separate plug for the charger. Do not try to connect the solar charger or the motor to this plug. The motor can be directly connected to the battery, however we recommend to always use a main switch and fuse.



1 = negative  
2 = positive  
3 = plug to charger  
(if applicable)

Main plug to motor and battery and optional to solar system and / or charger



- ◆ Do not expose the battery pack to water or fire
- ◆ Do not solder directly to any component of the battery pack
- ◆ Do not mix positive (red) and negative (black) connections
- ◆ Do not short circuit the battery pack
- ◆ Do not mix with other battery types
- ◆ Always fully charge the battery before use
- ◆ Charge with 24 V / 8 cell lithium battery charger or 24 V solar charge controller only
- ◆ If the battery has a 3-pin charger plug, charge via this plug | otherwise use the main plug
- ◆ Store in dry / cool place
- ◆ Do not expose to full sunlight
- ◆ Do not dismantle the battery pack and do not operate without the box
- ◆ Do not connect the solar system and the charger at the same time
- ◆ Keep your battery clean and free from corrosion and dirt

The improper use or the modification of the battery box will void the warranty. All4solar is not responsible for any damage caused by the use of this battery or damages to any applications connected to this battery. The user has to take necessary precautions to secure a safe use of this battery and the applications connected.

### What is supplied with your lithium battery:

Battery box (upto 1000 WH = metal / over 1000 WH acrylic) with BMS (Battery management syst.)  
Lead with DC plug (50 A)  
Main fuse (if ordered) | Main switch (if ordered)  
Digital battery monitor system (if ordered)  
Cable and DC plug to connect engine (if ordered)  
Documentation

# High Quality Lithium Battery Packs For Boats (12 Volt)

all4 solar Aquawatt Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

Small 12 V batteries for electric trolling motors or house batteries



## 12 VOLT BOAT BATTERIES

LIFEPO (Lithium)

Fully sealed and safe batteries for boat engines. Batteries can be added to the system any time by connecting parallel. BMS (Battery management system) included. Prices 2012 / subject to change w/o notice.

| Lithium 12 volt (12.8)                            |               |               |               |                |
|---|---------------|---------------|---------------|----------------|
| Capacity  | 20 Ah         | 40 Ah         | 60 Ah         | 80 Ah          |
| Discharge   | 30 A          | 50 A          | 80 A          | 100 A          |
| Charge  | 20 A          | 40 A          | 60 A          | 80 A           |
| BMS (protect)                                     | included      | included      | included      | included       |
| Monitor   | not incl.     | not incl.     | not incl.     | not. Incl      |
| Weight battery                                    | 3 kg          | 6 kg          | 9 kg          | 12 kg          |
| Sales Price incl. GST                             | 310.00        | 590.00        | 790.00        | 990.00         |
| 12 volt battery charger<br>5 -6A                  | 49.00         | 49.00         | 49.00         | 49.00          |
| Shipping AUS                                      | 5 kg          | 9 kg          | 13 kg         | 17 kg          |
| TNT Road transport                                | 40.00         | 60.00         | 60.00         | 70.00          |
| <b>TOTAL COST incl. GST</b>                       | <b>399.00</b> | <b>699.00</b> | <b>899.00</b> | <b>1109.00</b> |
| Approx runtime for 500<br>watt boat engine at 50% | 45 min.       | 90 min.       | 135 min.      | 3 h            |

## Large LIFEPO4 battery cells for assembling simple 12 volt applications (no box, no BMS, use for 12 volt only!)



4 LifePo4 high quality cells = 12.8 volts | 3 connectors | 8 bolts | 100 or 400 A fuse |  
100 A low voltage battery isolator | 2 lugs with 1 meter cable (32.5 mm2)  
Price incl. GST and delivery in Australia | 1 year warranty

**Use electronic charger  
to avoid charging over  
3.7 volts per cell (14.8 V)**

100 AH = \$ 990.00 | 200 AH = \$ 1650.00 | 400 AH = \$ 2950.00

# High Quality Lithium Battery Packs For Boats CELLS

all4 solar Aquawatt Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

## Problems with LiFePo4 cells V 1.3 2012

The most important rule with LiFePo4 cells is to keep all cells in a battery pack at the same charge level. You can measure each cell and there should be no difference in voltage of more than 0.02 volts. Usually the balancers or the BMS balance small differences. Cells have a different resistance, which can cause larger discrepancies over time. Balancers only work during charging. So the balancer shunts the charging current when voltage is over 3.3-3.5 V. But at high charge currents and if battery is never fully discharged, there could occur a higher imbalance. The charger used, should automatically reduce the current over 54 V (to C 0.1) and stop charging at 58 V. Only active BMS systems charge each cell individually, but are very expensive and have the disadvantage of limited charging current and a more complicated setup.

If a battery cell has a higher or lower voltage than the other cells it has to be disconnected and dis- or recharged with an electronic LiFePo4 single cell charger. Only charge one cell at the time! Ideally the battery pack is fully charged and then discharged to 3 volts per cell.

The imbalanced cell then is disconnected and charged / discharged to the same voltage. Repeat this process, to verify the result.



The electronic chargers usually show the charging voltage, not the voltage of the cell. Therefore you have to measure the cell voltage with a separate volt meter. After the charging process, you have to disconnect the cell for a few hours and recharge if the voltage drops.

Then the voltage should not drop faster than the voltage of the other cells. Otherwise the cell is damaged and has to be replaced.

If a LiFePo4 cell is over discharged or over charged, it can expand. To avoid this, the cells have to be stored

in a stable frame. Often used steel band is not sufficient! If a cell is expanded, it has to be secured to avoid the shell to be damaged. A lithium battery with a damaged shell cannot be used anymore!

Please note—no warranty applies, if cells are over discharged or overcharged. If a BMS shuts down the battery pack or indicates an error or a balancer indicates an error — first measure ALL cells. Do not use the battery unless the problem is solved and ALL cells have the same voltage and all cells are over 3.2 volts. Do not use cheap BMS systems.



The following information / procedure should only be carried out by specialists in a secure environment. All4solar is not reliable for any damage this can cause.

Over discharged cells below 2 volts or expanded cells can be re-used but need to be pressed into a frame and then charged to 3.2-3.3 volts. Then discharged to 2.5 volts and charged again.

ATTENTION: Do not dismantle cells or drill holes etc.

Only if the cells keep the voltage over a few days and the expansion is completely reduced, the cell can be reused. NEVER use cells which get hot when charged / discharged at a 1 C rate or which are physically damaged.

IMPORTANT: LiFePo4 cells from different manufacturers have different voltage limits. We recommend to use a BMS with a adjustable voltages.

# High Quality Lithium Battery Packs For Boats PERFORMANCE

all4 solar Aquawatt Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

## Performance with LiFePo4 cells V 1.2 2013

LiFePo4 cells unlike lead acid batteries can deliver upto 90% of their capacity. If they are new for the first 400-700 cycles even a little more than that.

So if you install a 10 KW (10000 watts) battery pack (Voltage \* Amps = Watts) it delivers upto 9 KW to your engine within one hour.

Now, what performance can you expect. This mainly comes down to the efficiency of your boat hull, the water conditions (wind, waves etc.) and the speed. Please note, that planning hulls are not really suitable for electric drives.

### Example

10 x 4.5 meter catamaran | 3 tons | high efficient displacement hull

High quality induction electric motor, inboard

No wind, no stream waves upto 0.8 meter

| KM / H | KNOTS | POWER FROM BATTERY | POWER OUTPUT ON SHAFT |
|--------|-------|--------------------|-----------------------|
| 7.4    | 4     | 2.3 KW             | 2 KW                  |
| 11.1   | 6     | 3.5 KW             | 3 KW                  |
| 14.8   | 8     | 7 KW               | 6 KW                  |
| 22.2   | 12    | 16.5 KW            | 14 KW                 |
| 29.6   | 16    | 34.5 KW            | 29 KW                 |
| 33.3   | 18    | 46.5 KW            | 40 KW                 |

Add at least 10% in power output requirement for safety reasons

Compare energy consumption petrol outboards to electric outboards

An average indicator for petrol engines is 0.20 litres per HP / hour

A 20 HP petrol engine at full throttle will use 4 litres / hour

A 40 HP petrol engine at full throttle will use 8 litres / hour

If you run a 20 HP engine which uses in average 2 litres per hour, you are operating at around 50% of the engines capacity, but the output will only be at around 40% due to the lower efficiency. The 20 HP equivalent would be a 13 KW electric outboard engine which requires a maximum of 15 KW input power. At 40% this are 6 KW. As the electric induction motor has an almost linear torque and efficiency curve, unlike DC motors or petrol engines, the 40% output are almost linear to the 40% input.

# High Quality Lithium Battery Packs Battery Types

all4 solar Aquawatt Australia  
123 Harbour Drive  
Trinity Park QLD 4879  
ABN 61832274764  
[www.all4solar.com.au](http://www.all4solar.com.au)

## Battery Types V 1.3 2013 Dominic de Vries

We recommend to use LiFePo4 battery cells or lead acid deep cycle batteries, which are both the most reliable and suitable battery types for boat propulsion.

### Deep Cycle Batteries

These are lead acid batteries similar to a car battery, but optimized for a use without maintenance and less sensitive to low discharge compared to conventional lead acid batteries. But all lead acid batteries offer only around 36-38 Watthours per kg weight when fully charged. Lead acid batteries can be discharged to 90-95% of their capacity, but only within 10-20 hours. So, if you need all the power in 1-2 hours, only 65% of the capacity is available and the voltage drops slowly with discharging. Also the lead acid batteries offer a life span of 500-800 cycles only but are the cheapest option.

### Lithium Batteries (There are different types!)

#### Li-ion Batteries

These are all battery types where lithium ions move between the positive and negative electrodes. There are types with high energy density like the Lithium Cobalt Oxide batteries which offer over 200 Watt hours per kg, but can be instable and dangerous for larger applications.

**IMPORTANT:** Some systems like chargers or BMS units only indicate „Li-Ion Batteries“. There is an important difference in the cell voltage of such batteries which can range from nominal 3.2 to 3.7 volts per cell. So a LiPo setup can damage a LiFePo4 battery!

#### LiFePo4 Batteries

Lithium Ferrite Phosphate batteries offer the safest and most economical option for boat batteries. The initial price is still 2-3 times higher than lead acid, but as those batteries last for over 2000 cycles at 1/3 of the weight (100 Wh / kg) the costs over a life cycle are less. Also these batteries can be discharged to over 90%, so less capacity is required.

#### LiPo / Lithium Polymer Batteries

Developed from high density Li-ion batteries these batteries keep the electrolyte in a polymer composite instead of an organic solvent. This makes them safer and cheaper to manufacture.

Those batteries offer a high energy density and are mainly used in consumer electronics (laptops, mobile phones etc.), but also in some electric vehicles. The batteries offer a life span of 400-800 cycles, but are quite sensitive to mechanical damage, temperature, under- or overcharge which reduces their life cycle. The energy density ranges from 120 to 200 Watthours per kg weight. We do not recommend these batteries for the use on boats, as they are not as reliable and safe as the LiFePo4 batteries and more expensive.

#### Future

There are promising projects, like the thin film lithium battery which is announced to offer over 10000 cycles or special high density capacitors. But this will not happen over night!