waterworld

48-6500

LITHIUM IRON PHOSPHATE BATTERY

Version 1.2.2 - English

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Congratulations and thank you for purchasing the Waterworld 48-6500 Lithium Iron Phosphate battery. At Waterworld it is our goal to give our customers the best performing, most relieable and safest battery system possible. To achieve this we need your help during installation and operation. Please read these instructions carefully to maintain our high standards during installation and operation of the battery.

Also, reading the manual will teach you how you can get the best out of your system and increase its longetivity!

If you have any questions or remarks regarding this manual or the battery itself please feel free to contact us at:
service@ww-el.com or visit www.ww-el.com

We hope you enjoy your battery!

*Technical changes and errors in the manual are reserved. Always use the latest version of the manual available at ww-el.com

Contents

1. Introduction

1.1 General information on the instructions

The instructions in this document describe all functions and provides safety information on the WW 48-6500 Lithium Iron Phosphate Battery.

It is our goal to make the use of our batteries as easy as possible by providing all the information needed to understand, install and operate the battery. This instruction manual ensures you are able to operate the battery safely in compliance with its intended use. If by any chance you feel information is not clear or are not certain how to install or operate the battery, please contact our customer service for your safety and the safety of the battery.

Always use the most recent version of these instructions which can be downloaded on our website:
www.ww-el.com/downloads

By reading and following these instructions you will:
- Avoid dangers to yourself and your surroundings.
- Reduce outage times and repairs.
- Increase the lifetime of your battery and the reliability of your system.

1.2 Safety information

In this instruction manual safety information will be presented using symbols and hazard classes. The hazard classes are subdivided in categories based on severity of the consequences and the likelihood of occurrence. The hazard classes are depicted below:

Hazard classes

⚠ Danger!

Direct hazard with high risk.
Death or severe physical injuries may result if the risk is not avoided.

⚠ Warning!

Potential danger
Severe physical injuries may result if theinstructions are not followed properly.

⚠ Attention!

Danger with low risk
Physical injuries may resultwhen the instructions are not followed

⚠ Advice

Mandatroy instructions
Use these instructions for safety and correct installation of your battery.

2. Product delivery details

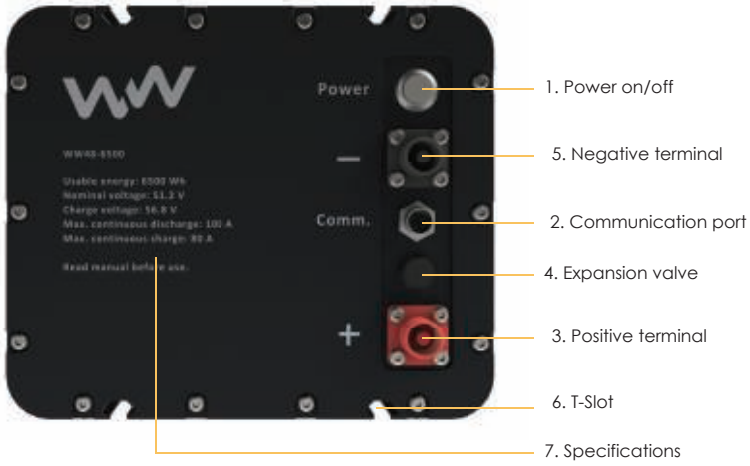
2.1 Overview of components

WW 48-6500 Lithium Iron Phosphate battery

The following components are included in the product package:
- 1x 48 Volt battery
- 1x User manual
- 1x Positive male cable plug*
- 1x Negative male cable plug*
- 4x M5 type 30 T-nut

Optional: Battery Link (needed in combination with a WaterWorld drivetrain)

The following components are included in the product package:
- 1x Battery Link module
- 1x User manual
- 1x RJ45 waterproof data cable



2.2 Overview and controls of WW 48-6500

1. Power Button
2. Communication socket
3. Negative terminal
4. Expansion valve
5. Positive terminal
6. T-slots
7. Specifications

Negative terminal connector

Positive terminal connector

***available separate at your WaterWorld dealer**

Power Button

Use the power button to remove voltage over the battery terminals. When the switch is pressed in the battery is turned on and it will have 51.2V (nominal) over its terminals. When the switch is pressed again and the button is level with the enclosure the battery is turned off and will not have voltage over the output terminals

Communication socket

The communication socket is only used in combination with a WaterWorld drivetrain. To enable the communiaction port a WaterWorld communication gateway is needed. This is further explained in chapter 5.5 of this user manual.

Negative terminal

The (female) black negative terminal (-) needs to be connected to the negative (-) terminal of your system. To do this use the black (male) negative terminal connector provided to you seperately. IMPORTANT! the female terminal is only waterproof when covered by the plastic cover that comes with delivery or when the male connector is plugged in. An open terminal is NOT waterproof.

Expansion valve

The expansion valve regulates air pressure between the inside of the battery and its outside environment. The valve is waterproof as long as it is not damaged. Make sure that during installation the expansion valve is safe from damage.

Positive terminal

The (female) red postitve terminal (+) needs to be connected to the positive (+) terminal of your system. To do this use the red (male) positive terminal connector provided to you seperately. IMPORTANT! the female terminal is only waterproof when covered by the plastic cover that comes with delivery or when the male connector is plugged in. An open terminal is NOT waterproof.

T-Slots

The type 30 T-Slots in the alumuninium battery enclosure enable attaching accesories to the enclosure. Four M5 nuts are provided in the T-slot to attach the handles or rubber supports.

Specifications

The most important specifications to consider are engraved on the enclosure. Make sure these are not damaged and can be read by the user.

Serial number

The serial number can be found on the back of the battery. An example of the serial number is: WWNL-22014865001

3. Technical specifications of 48-6500

General Features	
Capacity	6500 Wh
Nominal Voltage	51.2 V
Final discharging voltage	43.2 V
Maximum discharge rate	100 A
Maximum discharge rate at nominal voltage	5120 W
Weight	60 kg
Dimensions (LxBxH)	650 mm x 255 mm x 215 mm
Volume	35.6 L
Battery Chemistry	Lithium iron phosphate (LFP) LiFePO4

Battery management and safety	
On-off switch	Yes
Cell balancing	Yes
High current and short-circuit protection	Yes
Deep discharge protection	Yes, cut off at 41.6 V
individual cell string voltage monitoring	Yes
Safety vent for each cell	Yes
Cell temperature monitoring and protection	Yes
Temperature monitoring of battery electronics	Yes
Low temperature shut off	Yes
High temperature shut off	Yes

Lifetime data	
Cycle lifetime	>4000 cycles with 80% discharge depth at 25 °C to capacity loss of 20% at 0.2 C

Battery composition	
Capacity per cell	6 Ah
Nominal voltage per cell	3.2 V
Cell connection	16S22P

Information system	
Interface	CAN
Electronic battery identification	Yes
Error identification	Yes

Use information	
Ambient temperature, discharging	-10°C up to +45°C
Ambient temperature, charging	0°C up to +45°C
Ambient temperature, storage	-25°C up to +60°C
Typical storage time at 50% SOC	40 weeks without any load (turned off)
Max connections	Up to 1 Series 8 Parallel
Max quick charge	80 A
Protection class	IP65

4. Safety

4.1 General safety instructions

⚠ Advice!

Read the instructions in this user manual carefully before operating the battery system. Always comply with safety warnings stated in this user manual. Always stay alert while working with and installing of the battery and other electric components

4.2 Safety introduction

The battery and its components are designed with safety and user friendliness as a top priority and have been extensively tested. However, dangerous situations may occur when the battery is not handled properly or misused. This can result in physical harm to persons or property. Always follow the guidelines stated in this user manual as well as local safety and accident prevention regulations.

4.3 Intended use

The WW 48-6500 battery can be used as a stand alone battery or in combination with WaterWorld electric drive systems. Please be aware the data cable is only compatible with WaterWorld electric drive systems in combination with the WaterWorld communication gateway. The maximum power output of the battery is 5120 Watt. It is important to realise that when a bigger load is connected the battery will shut off to avoid damage. The battery must always operate in a system that respects its specifications. When a larger power is needed batteries can be installed in parallel up to 8P.

4.4 Unintended use

The manufacturer accepts no liability when the battery is used as anything that is not specifically defined as its “intended use” as defined in this user manual. All other use cases that are not described in this manual are defined as “unintended use”. The operator of the battery is solely responsible for any harm or danger arising from such unintended use.

Amongst others, the following are deemed unintended use:

- Permanent contact with water
- Use of third party battery chargers
- Use of cable sets that do not have a master switch or sufficient fuses

4.5 Before use

Before use check the condition and functioning of the battery. The battery may only be handled and operated by adults.

4.6 General safety information

Please read the following carefully

⚠ Danger!

Risk of fatal electric shock!
Contact with uninsulated or damaged parts may lead to electric shock resulting in death or severe physical injuries.

- Never do any repair work to any part of the system yourself. This leads to dangerous circumstances and voids the warranty.
- Never touch any uninsulated or broken wiring or any other damaged/defective parts.
- When you suspect a problem never touch any metal components and switch off the main system switch and after switch off the battery immediately.
- Prevent any electrical components from coming into contact with water.
- Always have the battery switched off during installation or during any form of handling the battery.

⚠ Danger!

Fire Hazard! Danger to life
Never charge the battery when it is damaged.

⚠ Danger!

Fire Hazard! Danger to life
Always use appropriate conductive electric cable with the right cross-section when connecting loads. If you are not sure what cross section is needed please contact your dealer or another professional or use IONBASE/WaterWorld branded cables.

⚠ Danger!

Fire Hazard! Danger to life
never use flammable gases, solvent or vapours on the system.

⚠ Danger!

Risk of death or severe physical injuries from electromagnetic radiation
Persons with a cardiac pacemaker must maintain a 50 cm distance from any IONBASE battery or charger.

⚠ Warning!

Danger injury by electric shock as result of short circuit

- Remove all metal jewelry before handling or installing the battery or any other electrical equipment.
- Never leave tools in contact with the battery but store them away at a safe distance.
- Always be aware of the polarity of the battery terminals. Make sure you connect the battery at the correct polarity.
- Make sure the battery terminals are clean and free of corrosion.

⚠ Caution!

Never open the battery

Opening the battery will void warranty and will lead to permanent damage to the battery. Maintenance and repairs may only be done by a certified professional.

⚠ Caution!

Fluids or gases leaking from a damaged battery can cause injuries and other harm

- Avoid contact with any fluids spilling from the battery.
- Avoid contact with skin and eyes.
- Never inhale gases from the battery.
- Contact your dealer or a professional in case of leakage from the battery.

⚠ Caution!

Damage to the battery from heat

- Make sure the battery is never near external heat sources.
- Never store flammable objects near the battery.
- Store the battery in a well ventilated area.
- Never place the battery in direct sunlight. Especially during summer or high ambient temperatures.

⚠ Advice!

Increase the lifetime of your battery by reducing its exposure to extreme temperatures, moisture and direct sunlight.

5. Installation of the battery

Important! Please charge your batteries before use.

⚠ Danger!

Danger to life from electric shock

- Avoid touching the battery terminals.
- Never undertake repair work on the battery yourself.
- Never touch any defective components
- Prevent any external forces from working on the battery and the cables.
- If you detect any defect, shut down your system and the battery immediately

⚠ Caution!

Damage to the battery and your system can result from incorrect installation. Please read the instructions carefully.

- Always make sure to turn the battery off during installation using the main switch.
- Make sure to always first connect the red positive cable to the red positive terminal then connect the black negative cable to the black negative terminal.
- When disconnecting the battery make sure to first disconnect the black negative terminal before disconnecting the red positive terminal.
- Never transpose the polarities!

5.1 Connecting multiple batteries in parallel

⚠ Danger!

Never connect the batteries in series! Fire and damage to the battery and your system may result.

- Make sure to never connect multiple batteries in series.
- Never series connect the battery with any other third party batteries.

⚠ Advice!

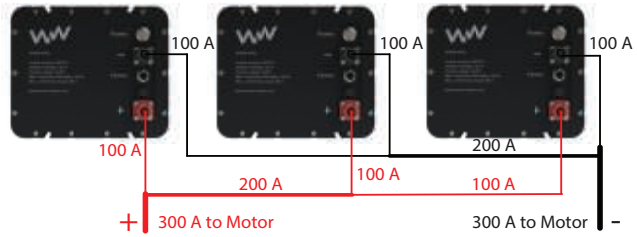
- Up to 8 batteries can be connected in parallel.
- For systems containing a WaterWorld drive train or controller a gateway is required to be able to use the data communication functions.

Important! it is very important the batteries are all at the same voltage before connecting them in parallel. Please check the voltage difference between the batteries is below 0.50 Volts. If not please charge or discharge the batteries to equal voltage.

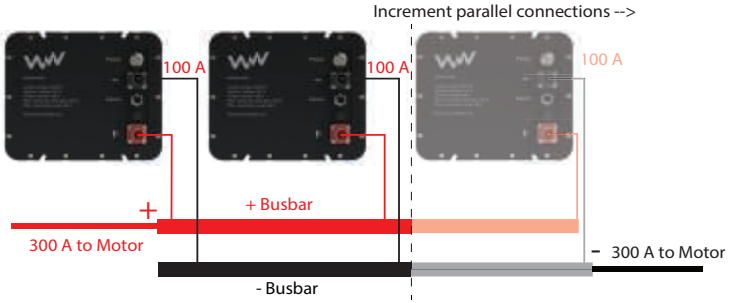
Important! Check your system for short circuit by measuring the resistance of the system before connecting your batteries. The resistance should be >100 Ohm.

Connecting multiple batteries in parallel can be done in the following ways of which method 2 is preferred:

Method 1: Note different cable thiknesses have to be used due to the difference in current. **IMPORTANT**: for each battery the total cable length of the negative side needs to be the same length as the positive side.



Method 2: Using a positive and a negative busbar to connect the batteries to makes it easier to handle the currents. IMPORTANT: make sure each battery has equal cable lengths between the busbar and hte battery for both the negative and the positive sides.



5.2 Installation

⚠ Caution!

Damage to the battery and your system can result from incorrect installation. Please read the instructions carefully.

- Install the battery in a dry location that cannot be flooded.
- Do not install the battery near any heat emitting components.
- Choose a well ventilated location for installation of the battery.
- Make sure to always tightly fasten the battery to a base to avoid any damage to the battery and its surroundings from vibrations or shaking of the battery.

Installation using the T-slots of the battery enclosure

1. Place the battery in your chosen location and make sure the location complies with the requirements mentioned above.
2. Use the T-slot to secure the battery to a solid base with bolts of your choosing. It is also possible to strap the battery into place using lashing straps.
3. Check if the battery is fastened securely.

⚠ Advice!

- Make sure the battery terminals and data port are easily accessible and are not in contact or close near any other objects that can damage the components.
- Make sure the equivalation valve on the battery is not obstructed from functioning properly.

5.3 Wiring

⚠ Warning!

Danger injury by electric shock as result of short circuit

- Remove all metal jewelry before handling or installing the battery or any other electrical equipment.
- Never leave tools in contact with the battery but store them away at a safe distance.
- Always be aware of the polarity of the battery terminals. Make sure you connect the battery at the correct polarity.
- Make sure the battery terminals are clean and free of corrosion.

Always use cables with approriate thickness to handle the currents associated with your system. Table 5.3.1 provides guidelines for choosing cable thicknesses at different electrical currents and different cable lengths.

Important: add a 200 A fuse in line with each battery .

Table 5.3.1

Cable thickness guideline				
	length 1m	length 3m	length 10m	length 15m
50 A	16 mm2	16 mm2	35 mm2	50 mm2
100 A	35 mm2	35 mm2	70 mm2	95 mm2
200 A	70 mm2	70 mm2	120 mm2	
300 A	95 mm2	95 mm2		
400 A	120 mm2	120 mm2		
500 A	120 mm2			

5.4 Ventilation

⚠ Caution!

Make sure the vent plug is free of obstacles and can operate without obstruction

To prevent the battery from overheating please make sure the battery is in a ventilated space. Positioning your battery in a well ventilated and cool space will increase battery health and product lifetime. The heat fins on the enclosure function as a heat sink. Allowing airflow over the enclosure will cool down the battery and increase performance an product lifetime.

5.5 Checking your system

Before turning on your batteries please check your system for any mistakes. Check your system for short circuit using your multimeter.

Make sure your system does not draw any small residual currents <1A or <50W per battery. Loads under 50 Watt will not be detected by the BMS and can over longer periods of time affect the SoC presentation. By charging the battery to 100% the SoC presentation is calibraterd. If there are any small loads in your system make sure to charge your batteries to 100% more frequently.

5.6 Switching the battery on and off

To turn on the battery push the main switch(es) on the battery(s) using the on/off switch on the front of the battery. The system needs some time to start up. Note the battery is turned on when the switch is clicked inwards. The battery is turned off when the switch is level with the surface.

5.7 Connecting the WaterWorld Battery Link

When combining Waterworld 48-6500 batteries with a WaterWorld electric drive a system can be created in which the battery and motor communicate with each other. To enable this communication a communication gateway is added between the WaterWorld system and the Waterworld battery. Figure 5.5.1 shows how the system is connected. Always connect the first battery in the most left communication port 1. When adding batteries use the first port available to the right e.g. port 2, port 3, and port 4.

On the side of the Battery Link 2 CAN ports are located. Connect the CAN communication cable to the gateway and to the other side to any CAN port on the WaterWorld system.

The Battery Link feautures a LED light for every communication port. This LED signals the status of the communication.

- **Green**: the battery has succesfully connected to the WaterWorld system.
- **Green blinking**: the system is trying to connect. Please wait a moment.
- **Orange**: The battery discharge is turned off. There is no voltage over the batteries terminals.
- **Red**: there is no connection detected between the battery and the Battery Link. Please reset the system by turning of all batteries and turning them back on after 30 seconds. If there is still no connection please contact our customer support.
- **LED off**: there is no data cable connected. Please make sure you properly connected the cable to the data socket on the battery

5.8 Functions of the WaterWorld Battery Link

The BatteryLink integrates your batteries with the other components of your WaterWorld drive. This results in an extremely reliable system. In addition, the functions of the BatteryLink ensure that your batteries are managed even better, so that they will last longer. The functions of the BatteryLink are described below.

Accurate battery charge percentage
Due to the built-in smart shunt in the battery management system in the battery, the current battery percentage of the battery is always accurately communicated to the WaterWorld display. The self-learning algorithm in the battery management system corrects for degradation of your battery over time, so that the battery percentage and sailing time remain accurate over the entire life of your system.

High temperature power protection
When the battery gets too hot (60C+) it will switch off. To prevent this, the BatteryLink will reduce the power of the motor before this temperature is reached. When this happens you will receive a notification in the WaterWorld display. Limiting the power gives the battery(s) the opportunity to cool down and ensures a reliable system that does not stop you unexpectedly.

Low temperature power protection
At low temperatures (below freezing) the BatteryLink protects the battery. The power of the motor is reduced which gives the battery the chance to warm up before the maximum power can be demanded. This will dramatically extend the battery lifetime.

Battery shut-off protection
In the case of a multi-battery system, it can happen unexpectedly that a battery fails due to low battery voltage, too high temperature or some other problem. This can result in a chain reaction where other batteries have to deliver too much power beyond the limit as described in the specifications. This results in shutting down all battery(s) and thus shutting down the system. To prevent this, in this event the BatteryLink will limit the power so that the remaining battery(s) always continue to work within their specifications. This ensures that your system does not shut down and you can continue sailing. You will receive a message in the WaterWorld display with the error message.

Getting home safely
When the battery(s) are almost empty, it is important not to use too much power from the engine as this can result in the batteries failing. This is the case with all types of batteries. To minimize this effect, with a low "state of charge" of the batteries, the maximum power of the motor is reduced somewhat and you will receive an error message. This ensures that you can always come home safely and that you do not come to a standstill unexpectedly.

Error messages
When the BatteryLink limits the system, you will always be provided with a message in the display. This means you are always aware of what is happening in the system.

6. Protection mode

The battery will go in protection mode when the battery is operating outside its specification limits. There are two types of protection. The first protection switches off the battery, when the conditions of the battery are back within its specification limits the battery turns back on and is functioning again. The second protection is irreversible and a dealer needs to be contacted for service.

7. Charging the battery

⚠ Danger!

Fire hazard!

- Never charge a damaged battery.
- Do not use the charger near flammable or explosive materials and provide ventilation.
- The output voltage of the battery charger must be the same as the specified charging voltage of the battery.
- Position the battery so that the fan can rotate properly and blow air freely through the heat fins.
- Place the charger in a dry location where it will not be in permanent contact with water.
- Do not open the charger to avoid electric shock

Always use a Waterworld certified charger to charge your battery. Third party chargers are not supported and may damage your battery.

When using a third-party battery charger, it should always be a CC/CV lithium charger with the correct charging voltage.

⚠ Warning!

- Always use Waterworld approved LFP battery chargers.
- Make sure the charger is connected with the correct polarity.
- Make sure the battery terminals are clean and free of corrosion.
- The battery charger needs to be compatible with the battery and output 56.8 Volt.

7.1 Overview of charging components

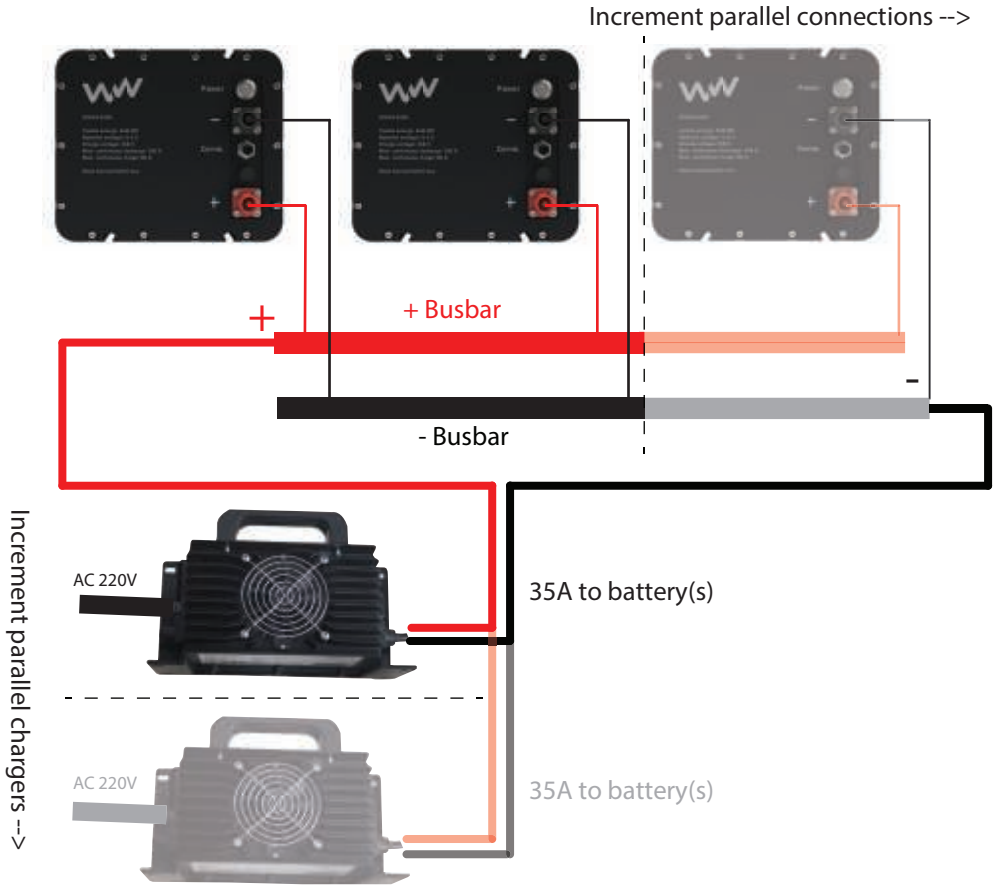
The following components are included as standard:

- 1x 48 Volt 35 A Battery charger, EU plug - Anderson connector
- 1x Anderson connector connection set

7.2 Connecting the charger to the battery

Always be aware of the polarity of the battery. Make sure the positive terminal of the battery is connected to the positive terminal of the charger and the negative terminal of the battery is connected to the negative terminal of the charger.

Never exceed the maximum charging current as stated in the battery specifications. Charge overcurrent will cause the battery to go into protection mode and charging will stop. When multiple batteries are connected in parallel the maxmimum charging current is the sum of the individual max charging currents of the batteries. In this case multiple chargers can be connected to the batteries in parallel to achieve higher charge rates.


Increment parallel connections -->
+
+ Busbar
-
- Busbar
AC 220V
35A to battery(s)
AC 220V
35A to battery(s)
Increment parallel chargers -->

7.2 Charging the battery

The battery is charged to a Voltage of 56.8 V. The battery starts charging with a constant current stated as the max charging current on the charger. When the battery reaches its max Voltage the charger will continue charging at constant Voltage. When the battery is fully charged the charger turns of. NOTE: there is no float charging stage! This is to increase the battery lifetime.

Constant current: charging at max current as stated on the charger.
Constant voltage: charging at max Voltage as stated on the charger.

Use information	
Battery chemistry	Lithium Iron Phosphate
Input voltage	220V AC +/- 20%
Input current	≤13A
Output voltage	56.8V
Output current	35A
IP rating	IP65

7.5 LED status indicator

1. Red flashing LED:
   Battery <80% charged
2. Yellow flashing LED:
   Battery >80% charged
3. Green flashing LED:
   Battery 100% charged
4. Green LED steady on:
   Battery charging is complete, the charger switches off automatically

7.6 Error identification

Red or red - green flashes every 3 seconds: problem from battery

Solution: 1. There is a short circuit in the system, measure your system. 2. The battery may be overheated. Place the battery in a well-ventilated area.

Yellow flashes every 3 seconds: mains problem

Solution: check if the input voltage is correct. A problem could be that the cables to the input side of the charger are too thin or too long.

Green flashes every 3 seconds: Trouble from battery charger

Solution: The battery charger has overheated. Place the battery charger in a well-ventilated area and make sure the fan can run properly. The air through the heat fins of the charger must be able to blow freely.

8. Storage and maintenance

⚠ Caution!

Never clean the battery using a high pressure cleaner.
Never use corrosive cleaning agents on the battery

8.1 Storage

Before long term storage (3 weeks +) always make sure to charge the battery to at least 50%. Switch off the battery before storing and disconnect the data cable.

Ideal storage temperatures range from 5-20 degrees Celsius.

8.2 Maintenance

Maintenance by user

The contacts can be treated with a suitable contact spray once every year.

Maintenance by WaterWorld

The battery has a very long lifetime during which minimal service is needed. However, it is recommended that every 8 years regardless of use intensity the battery is checked by your service dealer on the following points:

- Watertightness of the waterproof seal
- BMS error memory
- Battery cell status
- Overall safety of the system

9. Error problem solving

Error messages can only be read when the battery is used in combination with the WaterWorld BatteryLink. To read errors without a battery link, the battery will have to be taken to a service station.

Overtemperature

The battery temperature is higher than allowed according to the specifications. Let the battery cool down before using it again. When the battery has cooled down sufficiently, it will switch on again by itself.

Undertemperature

The battery temperature is lower than allowed according to the specifications. Allow the battery to warm up before using it again. When the battery has warmed up sufficiently, it will switch on again by itself.

Overcurrent

The battery has been exposed to an excessive discharge current and has entered protection mode. Unplug the load and wait 30 seconds. The battery will turn back on by itself. Note: The battery has been disabled for protection. Prevent this from happening again by checking that the system meets the specifications of the battery before reconnecting the battery to the system.

Undervoltage

The battery voltage has dropped below the minimum voltage. This means the battery is empty. Recharge the battery within 72 hours to avoid damage/degradation to the battery.

10. Transportation guidlines

Lithium batteries are classified as class 9 products. This means that the battery must be treated according to UN3480 standards. For that reason, the battery must be packed according to UN code. For transport by road, train and by ship, use the original packaging as it meets all standards. Please note that the original packaging does not meet the requirements set for air freight. For this, the battery must be repacked with suitable packaging. For air freight, the battery must be charged a maximum of 30%.

11. End of life and disposal

The battery is considered at the end of its life when the capacity is below 60% of its original capacity. When disposing the battery please send the battery back to Waterworld for disposal. Or dispose of the battery according to EU legislation 2002/96/CE to an official recycling facility. Most parts of the battery and its enclosure can be recycled.

12. Tips to increase battery lifetime

The battery is protected by the settings in the Waterworld battery management system and the settings of the Waterworld charger. This ensures a long battery life and safe operation. However, there are additional actions one can take to even further extend the lifetime of your battery. Since we want you to enjoy your battery for as long as possible and since a longer battery life reduces waste and strain on the environment. We put together a tips and tricks section to maximize battery life of your Waterworld battery. Note, the following are guidelines:

1. Try not to expose the battery to extreme temperatures. Especially high temperatures will shorten the lifetime of the battery. Installing your battery in a well ventilated place is highly recommended. The optimal temperature conditions for the battery are between 15-25 degrees Celsius.
2. Try not to push your battery to the charge limits. Ideally a battery is cycled between 20% and 80% state of charge. Although it is very well possible to fully discharge the battery, try to minimise discharging your battery below 20% to increase the lifetime of your battery.
3. Your battery will degrade faster when a lot of energy is drawn from or put in in a short amount of time. Try lowering the load on the battery by sailing slower or simply use more batteries in parallel. This will greatly improve your battery lifetime.
4. Minimise vibrations and shocks on the battery as much as possible.

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electric drive systems