



**Kräutler Advanced Electric Boat Engines**

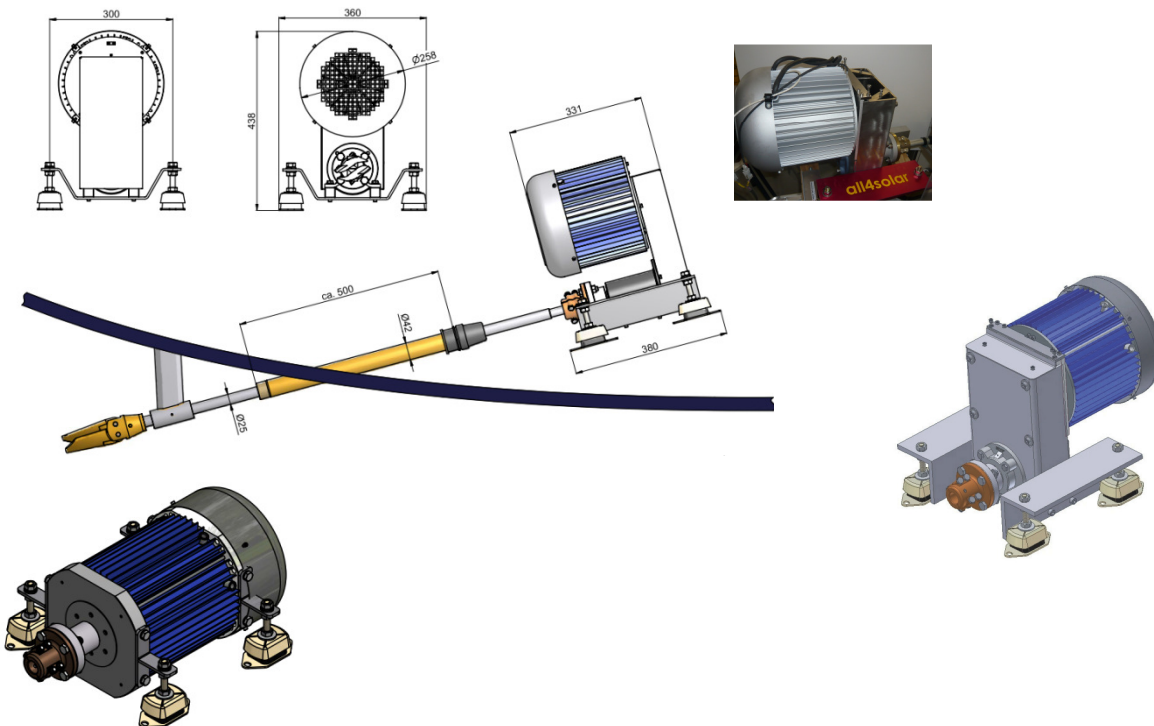
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**all4solar**  
electric boat engines & solar power

# Operator's Manual

## Advanced Electric AC Induction Inboard Boat Engine

### WA 2.5 – 10 KW | 48 V DC



Dear Customer

Congratulations! You purchased a high quality product with exceptional performance. To ensure this for many years, we kindly ask you to read this document carefully and familiarize yourself with the motor before using it.

This manual has been compiled to help you install and operate your inboard engine with safety and pleasure. It contains details for the motor, all equipment fitted or optionally supplied and information on its installation, operation and maintenance.

Please note, that incorrect installation and operation can cause severe damages or injuries and will void any warranty from the supplier.

We wish you a lot of pleasure with this unique „green power“- motor.

all4solar

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Please note the following information in this handbook and report these, as well as any change of ownership to the manufacturer | reseller ([service@all4solar.com.au](mailto:service@all4solar.com.au)) within 4 weeks of purchase to register for full warranty entitlement (see section 8).

- ◆ Owner: .....
- ◆ Phone/Email: .....
- ◆ Date of purchase: .....
- ◆ Dealer/point of sales: .....
- ◆ Serial number (see motor): ..... | ..... KW
- ◆ Type: ☐ direct ☐ with gear box
- ◆ Main use: ☐ saltwater ☐ freshwater

Check the actual status of any motor before purchase a used engine – send an email to [service@all4solar.com.au](mailto:service@all4solar.com.au) indicating the serial number.

## Contents

1) Hazard communication .....	5
1.1 Hazard signs.....	5
1.2 Unpacking .....	6
1.3 Eligibility of the boat .....	6
1.4 Motor & accessories .....	7
2) Installation on the boat.....	11
2.1 Installation engine.....	11
2.2 Installation water pump (water cooled engines only).....	11
2.3 Electric power supply .....	12
2.4 Initial system start.....	16
2.5 Safety stickers.....	17
2.6 Warranty information operation   installation.....	18
2.7) Digital battery monitor .....	19
2.8) Controller messages.....	19
3) Section not used for this engine.....	19
4) Operational area.....	20
5) Drive with the inboard motor .....	20
5.1) Turn-on procedure .....	21
5.2) Drive forward.....	21
5.3) Reverse .....	21
5.4) Safety Switch .....	21
5.6) Error messages on display .....	22
5.7) Low voltage alert (optional) .....	23
5.8) Power and output .....	23
5.9) Swimming & passengers .....	24
6) Maintenance & inspection .....	24
6.1) Service, spare parts and lubricants.....	24
6.2) Service chart .....	26
7) Boat transport & trailering.....	27
8) Warranty .....	27
9) Technical data.....	28
9.1) Technical data & drawings engines 2.5 – 6 KW .....	28

9.2) Technical data & drawings engines 8 - 10 KW .....	33
9.3) Power   torque .....	34
9.3) General technical facts.....	35
10) Spare parts .....	36
11) Installation diagram .....	37
12) Propeller information.....	37
13) High power batteries.....	38
14) Battery charging / solar power.....	39
14.1) Standard grid chargers .....	39
14.2) Charging with solar power.....	39
14.3) Generators.....	39
14.4) Solar panels.....	40
14.5) Wind generators.....	41
15) Conformity Declaration .....	42

## 1) Hazard communication

Before operating your motor you have to carefully read and understand this operator's manual.

As you read this manual, please note the hazard warnings which alert you to safety precautions related to unsafe conditions or operating procedures. We have included these warnings because we are concerned about your safety.

### 1.1 Hazard signs



#### **DANGER**

Calls attention to immediate hazards that **WILL** result in severe personal injury or death.



#### **WARNING**

Identifies hazards or unsafe practices that **COULD** result in severe personal injury or death.



#### **CAUTION**

Indicates hazards or unsafe practices that **COULD** result in minor personal injury or product or property damage.



#### **INFO**

Indicates important information for a safe and easy operation or highlights special circumstances.

For any third party equipment (batteries, switches, fuses, cables etc.) read the operations and instructions manual as well as the safety recommendations of those suppliers.

If at any point you do not understand this documentation or explanations seem unclear, do not proceed the installation or operation prior to contacting your engine dealer!

## 1.2 Unpacking



### **WARNING**

Do not leave any small parts unattended as small children and animals could swallow. Clean the engine, controller and all parts and check for any damages. Fix the motor to a stable frame that it cannot drop or move. The engine has always to be lifted by two people or with adequate lifting equipment.

If any part of the motor, the controller or the accessories are damaged, do not install or operate. Contact us immediately.

## 1.3 Eligibility of the boat



### **WARNING**

Only install your motor on boats which are suitable to carry the weight of the engine and the accessories as well as the battery. Please note, that AC induction motors produce more thrust than a diesel or petrol engine with the same KW output. The output power for the electric motors is measured at the propeller shaft. A 10 KW induction motor can be compared to a 20 HP diesel engine.

Do not connect your motor to the battery or any other power source before you have not read the entire manual.

This engine is suitable for a direct connection of a propeller shaft for boat propulsion. It is specially designed for this purpose. Do not use it for other applications like road vehicles.

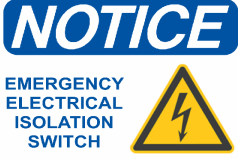



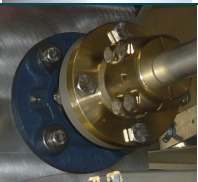



For information about dimensions, weight and power output as well as the recommended boat weights, check the engine documentation and section 9 of this manual.

## 1.4 Motor & accessories










If you purchase one of our advanced AC induction inboard engines, you receive the basic accessories which will support the easy installation on your boat. The installation of an electric inboard motor system is not “rocket science”, but should be planned and executed by a boat builder or a experienced person. Before ordering, please check what material you require. The list below gives you an overview over everything necessary excluding the battery and the shaft with a propeller.










### THE FOLLOWING PRODUCTS ARE INCLUDED WITH EVERY ENGINE

Electric AC induction motor with mounting rails  With or without gear box	With vent for air cooled version or waterpump for water cooled version	
Drive belt	For unit with drive belt reduction only	
Bearings	SKF FYC 306  SKF FYC 305	
AC controller / inverter  Type 1234   1236   1238 depending on the voltage and current rating of the engine  Water cooling aluminium plate (for water cooled engines only) mounted to controller  Use heat exchanger for salt water use!	Suitable for engine rated voltage and current / water cooled, if engine is water cooled.  Controller is installed on a aluminium plate and includes the electric ventilaton, the internal fuse and the main contactor	 
Harness wire / cables controller to lever and key switch including plugs	1.5 meter cable from controller to engine	
Single lever forward and reverse   0 – 5 V output to controller and forward – reverse switch	Other variations available as option. Comes with a 5 meter cable.	
Simple 400 Amp fuse block with fuse		

Safety sticker		
Key Switch	On / Off to controller	
<p>Water pump for cooling 12 V / for 13 mm hose. 10 L / min.</p> <p>Fresh water only.</p>	Requires 12 volts DC power supply. If not available a DC DC converter is required to connect to main battery (48-96 V).	
Documentation	<ul style="list-style-type: none"> <li>◆ Inboard Engine manual</li> <li>◆ Controller manual</li> <li>◆ Monitor / Display manual</li> <li>◆ DC DC converter manual</li> </ul>	
<p>Engine mounts (4 units)</p> <p>40 kg / mount</p> <p>For 8-10 mm bolts (2 for each mount – not supplied)</p>	Any similar type engine mount can be used	
Standard fix shaft coupling for 25 mm shaft	<p>Reggiani Nautica 51800500</p> <p>Or one half coupling Polyflex 424 or 434 (additional cost for flexible coupling disc)</p>	
Standard main switch 300 Amp		
Digital Battery monitor	High end digital battery monitor with alarm function and option to f.e. auto start a generator	
Main contactor	200-400 A / 12 v coil (1.2 A = 14.4 watts)	



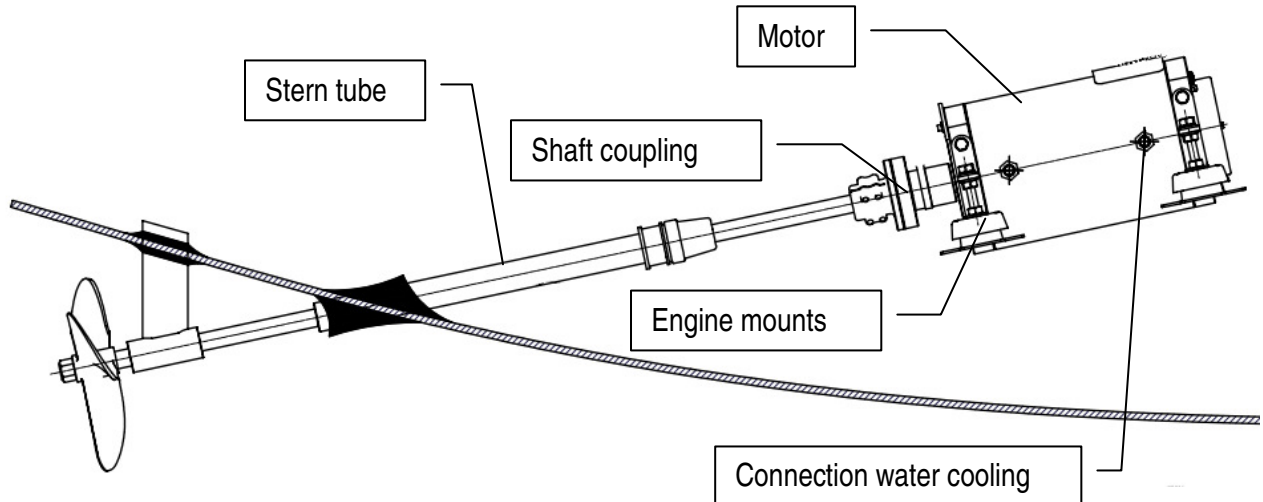
<b>THE FOLLOWING PRODUCTS NEED TO BE ORDERED SEPARATELY IF THEY ARE REQUIRED</b>		
Anderson type plug 350 A	ONLY IF SEPARATELY ORDERED	
Anderson type plug 175 A	ONLY IF SEPARATELY ORDERED	
Anderson type plug 50 A	ONLY IF SEPARATELY ORDERED	
DC DC converter from engine voltage (48/96 V) to 12 V for pump & appliances max. 200 watts  For water cooled engines only.  Including connection cables and plugs	ONLY IF SEPARATELY ORDERED	
13 mm hose for water cooling	ONLY IF SEPARATELY ORDERED	
High Power 350-400 Amp 160 V DC fuse block with fuse. Blue Sea T225	ONLY IF SEPARATELY ORDERED	
Main Switch – Blue Sea HD 600 Amp   100 V	ONLY IF SEPARATELY ORDERED	
Main Switch – Blue Sea Mini 350 Amp   50 V	ONLY IF SEPARATELY ORDERED	
Resistor 470 O   10 W	SUPPLIED WITH EVERY MAIN SWITCH to pre charge controller capacitors – NOT SUPPLIED, if precharge function ON in controller (Curtis controllers)	

Push button for resistor	<i>SUPPLIED WITH EVERY MAIN SWITCH</i>	
Emergency Switch – 250 A (for battery) incl. resistor	<i>ONLY IF SEPARATELY ORDERED</i>	
95 mm <sup>2</sup> flexible cable for 300 Amp / 48-96 volts  3 meter	<i>ONLY IF SEPARATELY ORDERED</i>	
50 mm <sup>2</sup> flexible cable for 200 Amp / 48-96 volts  3 meter	<i>ONLY IF SEPARATELY ORDERED</i>	
32.5 mm <sup>2</sup> flexible cable for 150 Amp / 48-96 volts  3 meter	<i>ONLY IF SEPARATELY ORDERED</i>	
Shaft coupling 25 – 30 mm To attach to a shaft.  Flexible couplings available upto 45 mm <sup>2</sup> shafts (TO ORDER SEPARATELY)		
Heat exchanger   needs to be able to absorb at least 10 KW heat	<i>We use a simple marine hot water system heat exchangers with double setup (4-5 L / min. each).</i>	
Water pump (for fresh and salt water) 20 L / minute	<i>12 Volts   ½ " male connection adapter to 13 mm hose required   SS316 grade</i>	
Curtis 840 Monitor	<i>Shows rpm, running hours, voltage and errors from the controller</i>	

More parts available like various shaft coupling discs and couplings to propeller shaft.

Material, size and colour may vary, without changes to the performance and functionality. The manufacturer reserves the right to change without prior notice.

## 2) Installation on the boat



Usually electric engines are mounted on existing frames which are 450 – 550 mm wide. As these engines use less space than a diesel engine there is usually more than enough space available.

The engine can be installed in any angle. Please note, that geared drives take more space than direct drives.

### 2.1 Installation engine

Take the dimensions of the engine frame with the engine mounts. Then adapt the holes in the engine frame to the requirements of the existing frame in the engine compartment of the boat. The aluminium frame can be easily adapted. If a wider frame is required, the aluminium profiles have to be of adequate size to cope with the forces of the engine. Drilling additional holes to the frame weakens the stability.

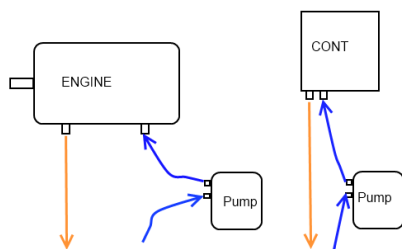
Do never install the engine without engine mounts, even electric engines do not produce the vibration experienced by combustion engines, the lack of flexibility can damage the rotor / shaft bearings.

The engine should have space to any part of the engines compartment of at least 40 mm. Allow more space for the air cooled versions, as well as adequate ventilation in the engine room.

For the connection to the propeller shaft or a gear box a suitable shaft coupling has to be used. Please check section 9 to comply with the maximum torque / force of the engine.

### 2.2 Installation water pump (water cooled engines only)

The water pump is either driven by a belt drive from the engine shaft or by a 12 volt power source. The water pump has to be able to pump at least 12 litres of water per minute. The engine and the controller have to be cooled with engine coolant or fresh water. If used in salt water a heat exchanger has to be used. If directly connected to fresh water, a suitable water filter is to be used.



**DANGER**

When running the engine, keep a distance of at least 1 meter or close the compartment.

## 2.3 Electric power supply

**CAUTION**

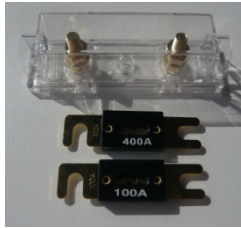
This guide helps you to setup your electric boat propulsion respecting the highest safety levels. Do not connect this engine directly to a battery without a main switch, a safety switch and a fuse! With the Kräutler inboard engines all the gear is supplied and included in the price!

The motor may only be connected to onboard power systems and accessories of 48 or 96 volts which comply with the CE / ISO standard. For the correct voltage of your system check the technical data in section 9.

Between the battery and the main switch a 150-350 Amp fuse (suitable for 50 to 100 volts DC ) has to be connected (depending on the maximum current for the engine). **All engines / controllers are supplied with a main fuse, but we still recommend to use another fuse to the battery connection.**

350 A | 100 V

100 – 400 A | 50 V



- All installations and insulations have to comply with low voltage (upto 100 volts) and marine electric installation regulations.
- The main switch has to be rated for 50 or 100 DC | 300 Amp continuous current.
- A safety switch should be connected between the main switch and the battery. The switch has to be accessible to the operator at all times! The controller safety switch does not replace the battery safety switch!



Or similar switch suitable for 300 A | 50 volts

- The cables should be as short as possible. B&S tinned cables are to be used with a sufficient square size of 32.5 mm<sup>2</sup> to 50 mm<sup>2</sup> (50 volts | 150 – 200 Amp). For permanent full power use of 300 Amps, upto 100 volts or cable lengths over 3 meter 70-95 mm<sup>2</sup> cables are recommended.

- ◆ The lugs and battery terminals need to be eligible for 300 Amp / 50 to 100 volts DC.
- ◆ The motor is supplied with SB 175 or SB 350 plugs. All connections have to be mounted at a dry place under deck / covered against rain and sea water. The switch board should be made of non conducting material (plastic or wooden board 10 – 15 mm).
- ◆ The maximum battery idle voltage may not be higher than 60 volts DC for 48 V engines or 110 volts for 96 volt engines.
- ◆ The maximum battery voltage under power is 54 volts for 48 volt engines and 103 volts for 96 volt engines. The minimum battery voltage is 40 volts DC for 48 volts engines and 87 volts for 96 volt engines. Variations of these voltages can cause severe damage to the controller and the electric motor.
- ◆ The onboard installation of the power supply should be supervised by an authorized specialist.

Operation is only allowed with a battery power supply. The direct supply from solar panels or generators can damage the controller if the voltage limits are controlled. If the battery is charged with a battery charger or solar panels, the motor should be disconnected by the main switch unless suitable charge controllers are used.

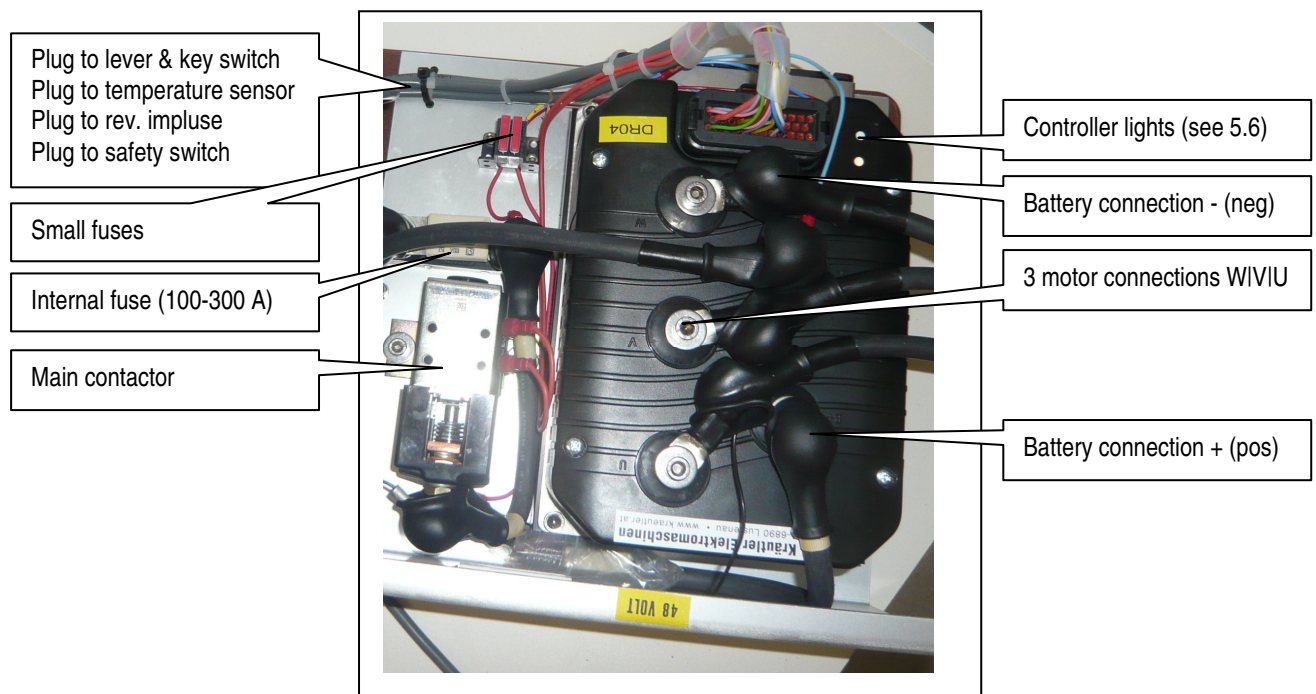
Only use battery chargers and cables, suitable for the use in the marine environment. The safe installation and operation of those is not part of this manual.

***Do not connect the engine to the propeller shaft until you have finished all of the electric installation and tested the engine to run in both directions!***

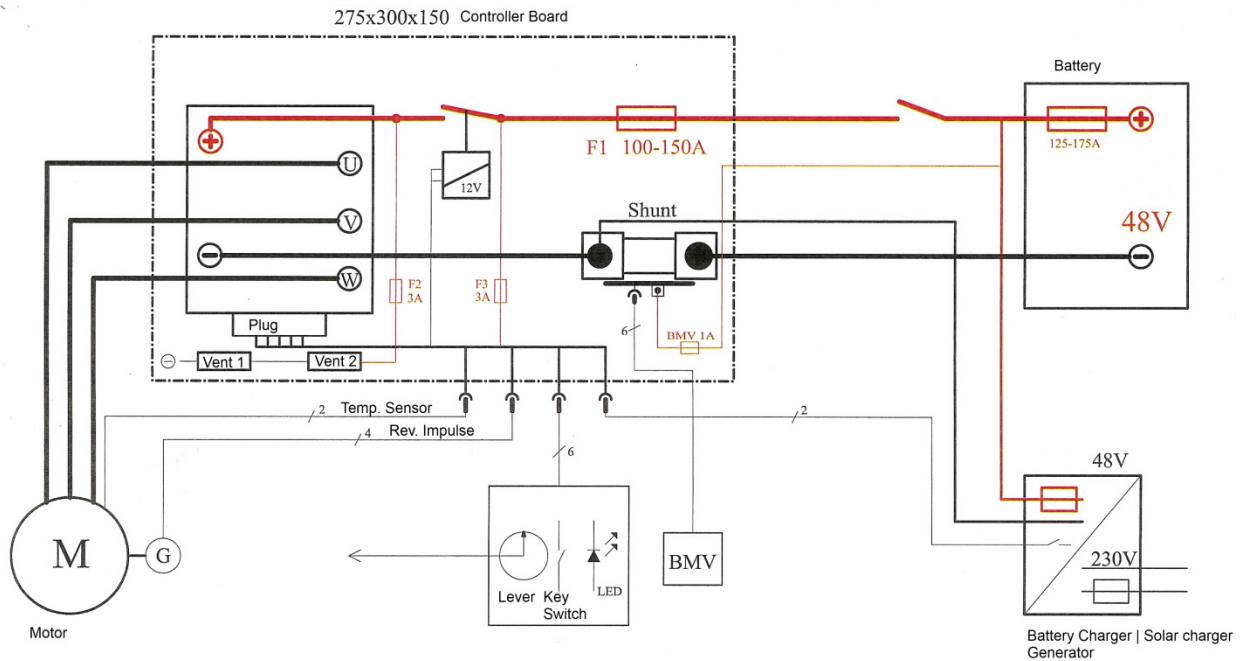


### CAUTION

The controller is supplied with a supporting aluminium frame, containing the internal fuse, the fuses for the main contactor and the internal power supply as well as the main contactor. All the connections are prewired with plugs.







- ◆ Connect the controller to the motor by first connecting the temperature and the rev. impulse plug
- ◆ Connect the three motor power connection (W|V|U) with the 6 mm lugs to the controller. Use an allen key to fix the bolts and use contact spray to prevent corrosion.
- ◆ Connect the lever which includes the key switch.
- ◆ As safety switch a standard toggle switch can be used or any other switch to comply with safety regulations. The safety switch will switch off the main contactor and stop the engine.
- ◆ Connect the shunt (included in the battery monitor package) to the negative main power string.
- ◆ The connection of the positive power string to the battery has to include the main switch and a battery fuse.

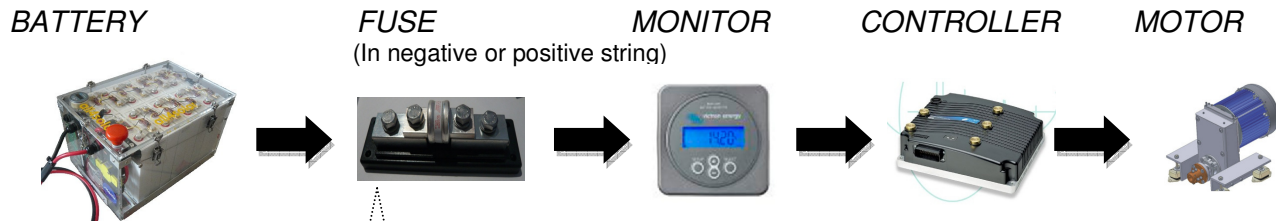
**MAKE SURE, THE TEMPERATUR SENSOR AND THE IMPULSE SENSOR CABLES ARE SECURELY INSTALLED AWAY FROM ANY POWER CABLE TO AVOID INTERFERENCE OF THE IMPULSE.**

The (fused) connection of a battery charger has to be done to the load side of the negative shunt connection and the positive battery connection. For details about batteries and chargers, we offer a separate documentation.

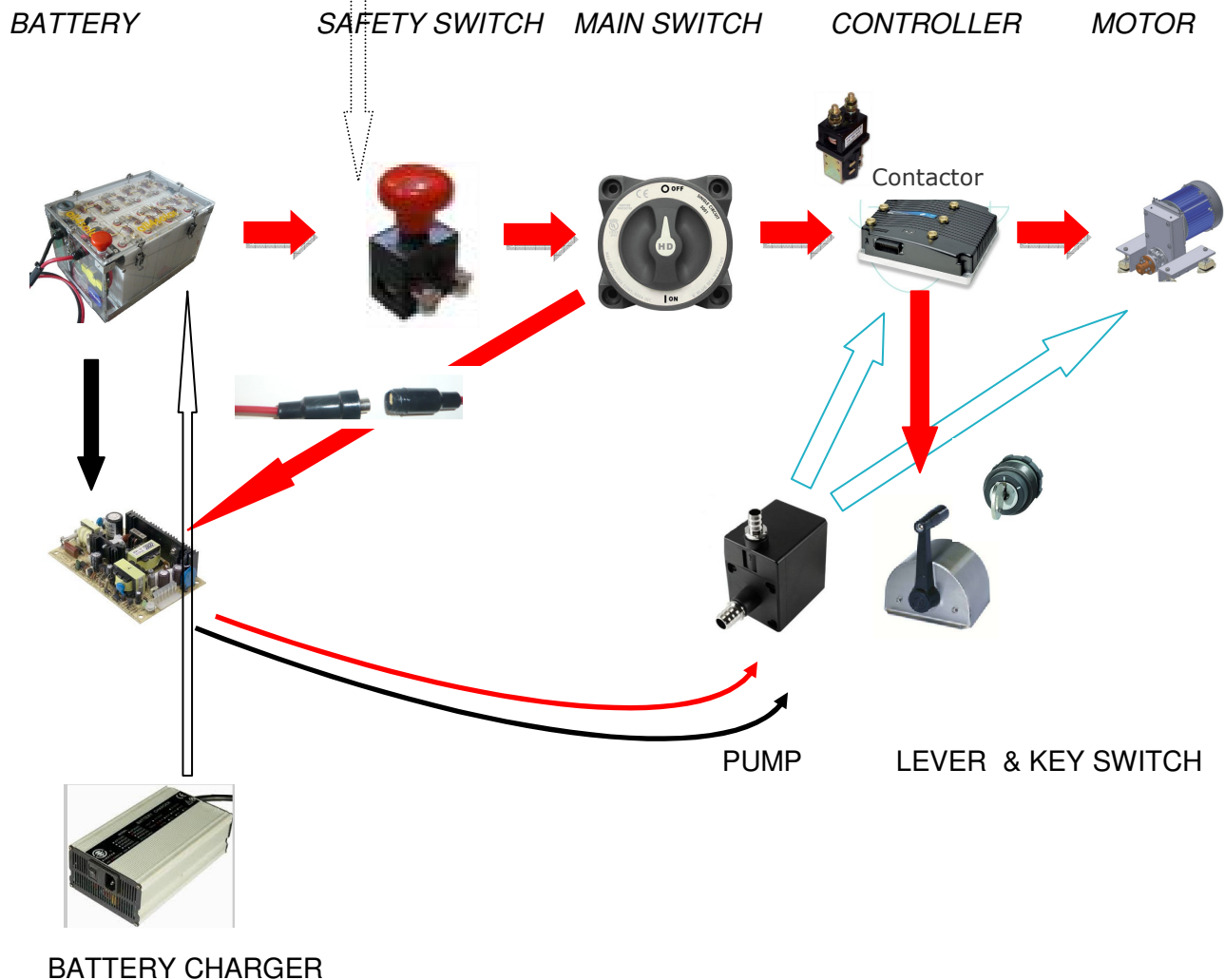
**WE CAN PREWIRE THE BATTERY CONNECTION AND THE SHUNT CONNECTION IF REQUESTED. BUT AS INSTALLATION IS DIFFERENT ON EACH BOAT WE RECOMMEND TO DO THIS AFTER ALLOCATING ALL EQUIPMENT IN THE ENGINE COMPARTMENT.**

## OVERVIEW ELECTRIC SETUP

### NEGATIVE (-) CONNECTION DC STRING



### POSITIVE (+) CONNECTION DC STRING



**CONNECT THE BATTERY LAST WITH ALL SWITCHES OFF!**

## 2.4 Initial system start

- Check all connections and make sure, the engine shaft can turn free.
- The water pump (s) have to be connected to the controller and the engine.

- 1 – Switch off main switch
- 2 – Switch off emergency switch
- 3 – Connect engine
- 4 – Move lever in neutral position
- 5 – Connect battery
- 6 – Switch on emergency switch
- 7 – Check if the engine shaft is not blocked
- 8 – Switch on main switch
  - ⇒ The battery monitor starts operating
  - ⇒ The led on the lever is lit
  - ⇒ The controller led is lit
  - ⇒ The water pump starts operating
- 9 – Switch on engine via the key switch
  - ⇒ The main contactor switches on
  - ⇒ The controller starts working
  - ⇒ The engine is ready to run

- Test the engine by shifting the lever forward and backward. When changing from forward to back always stop in the neutral position.
  - ⇒ Disconnect the water pump, if the boat is not in water
- The engine can be run without the water cooling system operating at idle power for a short time.
- Disconnect the battery (reverse the procedures above) and then connect the propeller shaft. Turn the propeller manually and make sure there is no blockage or resistance.
- Proceed with the above start procedure again.
- When the engine is connected, the procedure starts with point 7. See also Section 5.1.



### CAUTION

Also check the separate manual for the digital motor controller (Curtis) as well as the manual for the monitor (s).



## 2.5 Safety stickers

The following safety stickers are recommended to be fixed to the system. The operator is responsible for a safe installation, operation and proper indication of any dangerous parts.

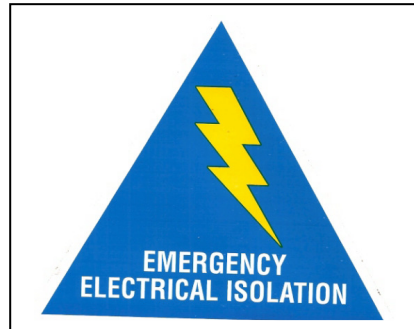
### High voltage sign (example only)

- In motor compartment
- On battery box
- On switch board

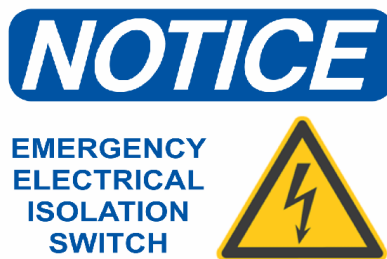


### Emergency switch (example only)

- On switch board | battery pack



All4solar supplies two vinyl stickers with each motor kit (approx 18 x 25 cm)



## 2.6 Warranty information operation | installation

Incorrect installation, use of unsuitable accessories or variations in voltage voids the warranty.

Electrolysis is the decomposition of metals exposed to an electric current. When your boat is connected to a shore power AC electrical system, it is also connected to an earth ground circuit. This can cause an electrolytic current which causes the decomposition of all submerge metal. The manufacturer's warranty does not cover any corrosion. Check and change anodes periodically.

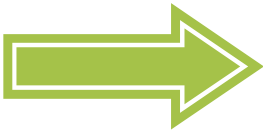
For details about the warranty conditions see section 8.



### **WARNING – CAUTION – MOTOR OPERATION**

Never operate the motor without water cooling under load. Only for test purposes. Secure the area around the propeller and the engine. No person is allowed closer than 1 meter if the engine is running. When turning the key switch, and the lever, the motor starts turning immediately.

Make sure the water intake (s) are free and the pump is pumping water through the system (only for water cooled engines).



**DO NOT OPERATE  
BEFORE YOU HAVE  
READ THE ENTIRE  
MANUAL**

## 2.7) Digital battery monitor

The manual for the battery monitor is included in the pack containing the monitor and the shunt.



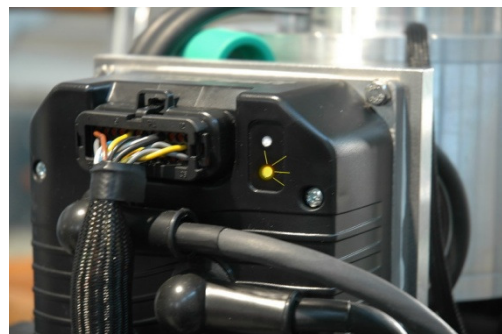
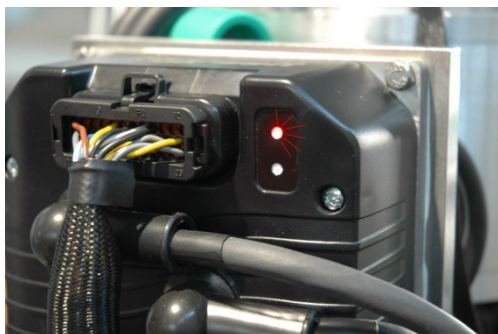
The shunt included with the meter has to be installed between the negative battery pole and the fuse / main switch. The battery charger has to be connected on the fuse side and not directly to the negative battery pole, as otherwise the meter cannot count the amp hours charged.

See separate manual for battery installation and operation instructions for the installation, programming and operation of the monitors.

Optionally a original Curtis monitor can be connected to the plug wired to the controller which shows the voltage, the battery state (only for lead acid batteries, based on voltage), the rotations per minute and error informations from the controller.

## 2.8) Controller messages

Two signalization lights are integrated in the controller cover. Flashing of the red and the yellow light indicates a fault.



If both lights are switched of, the motor is not connected or insufficient voltage is supplied to the system.

## 3) Section not used for this engine

XXX

## 4) Operational area

The electric inboard motor can be used in fresh water and if equipped with a suitable heat exchanger for the cooling system in salt water.

The engine room has to be equipped with a bilge pump. The engine, the controller and the accessories must not be exposed to water.

If the boat is moored, the system should be completely disconnected from the battery. Check the filters of the water pump.



### ATTENTION

The motor should only be used in water not colder than 5 degrees Celsius and not warmer than 30 degrees Celsius. Variations of these limits can result in damage of the motor and the cooling system.

## 5) Drive with the inboard motor



### DANGER

As boat operator you are fully responsible for the security of all passengers on board as well as to any other water craft, swimmers or animals within your area of operation.

You have to be aware of all rules & regulations for operating a water craft. The detailed knowledge of this operator's manual and the instructions for the boat and all equipment is a very important part of your responsibility.

A swimming person cannot avoid very quickly even if a boat runs at low speed. Therefore you have to switch off the motor if a person is close to your boat.

ANY CONTACT WITH A MOVING VESSEL, THE PROPELLER OR ANY OTHER PART OF THE MOTOR OR THE BOAT CAN LEAD TO SEVERE INJURY.

Always equip your boat with safety gear!

## 5.1) Turn-on procedure

***For first time start or reconnection of the engine to the battery see section 2.4***

**The following procedure applies to installed systems**

- 1 – Move lever in neutral position
- 2 – Switch on emergency switch (es)
- 3 – Switch on main switch
  - ⇒ The battery monitor starts operating
  - ⇒ The water pump starts operating
- 4 – Switch on main switch
  - ⇒ The battery monitor starts operating
  - ⇒ The led on the lever is lit
  - ⇒ The controller led is lit
  - ⇒ The water pump starts operating
- 5 – Switch on engine via the key switch
  - ⇒ The main contactor switches on
  - ⇒ The controller starts working
  - ⇒ The engine is ready to run

Make sure the water pump is running. The engine's temperature and the controller temperature are monitored by the system to avoid over heating. This can result in a sudden stop of the engine.

We recommend to have a spare pump and hose on board for longer trips.

## 5.2) Drive forward

Move the lever from the neutral position slowly forward. Unlike with combustion engines, the motor will react immediately. Please remember, that AC induction motors produce more thrust at low revs than petrol or diesel engines.

*We recommend to not operate the engine at full power (max. Amps on display) for more than 30 minutes. This would indicate, that the prop is not suitable for the setup as full torque is required to run the boat. At full throttle (= max. rpm of the engine) the boat should just use maximum power up to the nominal speed is reached and then reduce the power requirement to 70-80%.*

## 5.3) Reverse

The same procedure as driving forward, but move the lever backwards backwards. Do not drive backwards at high speeds! The engine can handle this, but this might be dangerous as the maneuverability of the boat is limited.

When changing from forward to the reverse stop at the neutral position for two seconds.



### CAUTION

Changing direction at high speeds can cause heavy damage or injury!

## 5.4) Safety Switch

The use of a safety switch is highly recommended. Please note, that the operation of the safety switch will stop the engine immediately.



## **CAUTION**

An accidental activation of the safety switch can cause loss of control and injury to the passengers!

### **5.6) Error messages on display**

See section 2.9.

## 5.7) Low voltage alert (optional)

If a battery is discharged under 42 volt (48 volt system) / 84 volt (96 volt system) this can damage the battery. If the voltage gets close to this value you will hear a warning sound. Slow down the motor to help the battery to regain voltage. We recommend using two battery blocks with two battery positions. So you can operate on one battery block and then switch to the second block as reserve.

Below 40 volts / 80 volts, the controller will stop to work!

We recommend to use the alarm function on the digital battery monitor.

## 5.8) Power and output

The motor controller automatically adapts the power output / torque to the boat you use. Unlike combustion engines, the lever controls the engine speed by changing the frequency of the three phases and not the power.

With slow and heavy boats the motor produces more thrust. If the boat floats easily, the motor speed is automatically increased.

***For technical details see section 9***

With lithium batteries, the power output is increased by 20% compared to lead acid.

Please note, that lead acid batteries only supply about 60% of their capacity in 1-2 hours of use. Lithium batteries can be discharged upto 95% in one hour.

See our battery – information document for more detailed information.

12 tonne cat – 2 x 10 KW inboard



2 tonne cruiser – 50 KW inboard



## 5.9) Swimming & passengers



### WARNING

Prior to swimming of the boat, always switch off the motor and pull the key. Do not leave children or untrained passengers in the boat without attendance.

While swimming close to the boat or while loading or unloading procedure any connection to a battery charger has to be disconnected.

All passengers should know the position and function of the emergency switch as well as the basic safety rules. Small children should always wear personal floating devices / life jackets.

## 6) Maintenance & inspection

The boat operator is fully responsible for the safety check and the maintenance of the motor, the boat and all equipment and accessories.

Make sure that all installations are in good condition prior to starting for a trip. Ensure the batteries have adequate charge for the distance planned to travel including reserve.

Periodical maintenance and inspection as well as treatment and operation according to this manual reduce problems and minimize of costs. This guarantees a long and reliable operation of your motor.

### 6.1) Service, spare parts and lubricants

The service should only be done by an authorized service centre with original or recommended spare parts and lubricants.

As owner of this inboard motor you should be aware of all recommended maintenance and repair instructions, even an AC induction motor needs hardly any maintenance.

If a boat propulsion system is not checked on a regular bases, a safe and trouble free operation cannot expected.

The prescribed services will ensure that any costly repair is unlikely to be needed.



### 6.1.1 Motor / Controller

The AC induction motor and the controller do not need any maintenance. Keep the engine and the controller clean.

Only clean with water and if required dish washer liquid. Make sure there is no corrosion and spray non corrosion contact spray to the contacts from time to time.

When idling without load, the motor should not use more than 5-10 Amps.

NEVER open the motor or the controller.

### 6.1.2 Cooling system (for water cooled engines only)

If a closed cooling system is used, the coolant has to be replaced from time to time. In this case a expansion tank should be installed to make sure, there is no air in the system.

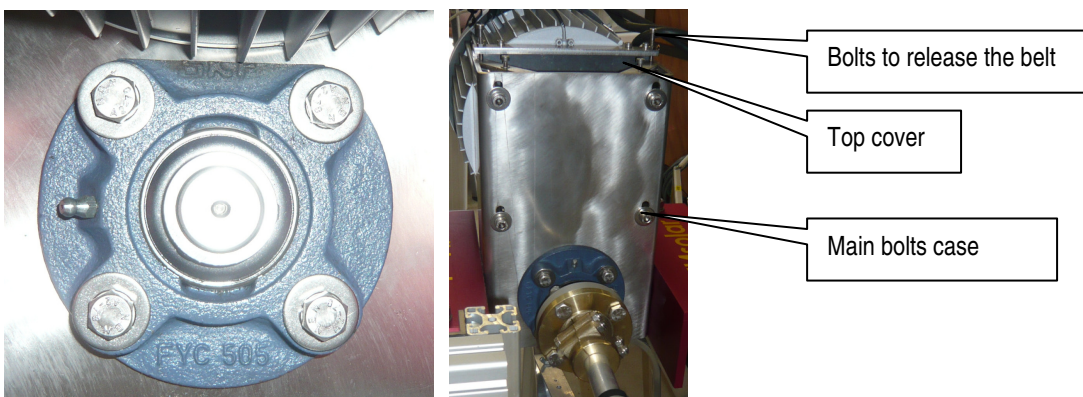
Check for any leaks in the system after each trip.

If the motor is stored for a longer period or over winter in places, where the temperature falls below 5 C, the water cooling system has to be completely emptied!

### 6.1.3 Belt Drive / Greasing & electric connections (for engines with reduction gear only)

Clean and then grease all joints and grease fittings every 2 months. All cable plugs, electric connections and main fuses to be checked for corrosion and to be treated with a protection and lubrication spray if necessary. Any damaged plugs, cables or connections to be replaced.

Engines with a gear belt require the bearings to be greased from time to time.



The belt has to be tight and without any damages. Otherwise it has to be replaced. To replace remove the top cover and then loose the main bolts of the casing. The smaller bolts on top of the casing allow to release the belt and tighten the belt.

## 6.2) Service chart

Relates to the electric motor, controller and supplied accessories only.

<b>Shedule</b>	<b>by Operator</b>	<b>by authorized dealer or specialized workshop</b>	<b>by manufacturer</b>
After each trip	Check the water cooling system & filters		
	Check the electric contacts and switches		
	Check gearbox / transmission (if applicable) Check transmission belt for damages	Replace belt if damaged (partnumber on belt) Replace oil of gear box every 100-150 hours	
Each 100 hours or at least once a year	Clean the engine and the controller Grease transmission bearings (if applicable)		
	Check the electric cables & switches for damage or corrosion	Replace plugs / connectors if corroded	Replace internal sensors, switches, cables
Every 5 years	Replace transmission belt (if applicable) and main electric switches. Those parts can last for over 10 years, if well maintained	Replace the main switch, the emergency switch, the water pump and the hoses Replace the belt	
	Check the shaft coupling	Replace the shaft coupling	
Mechanical repairs		Basic maintenance & replacements of mechanical parts	Repair after mechanical damage or overheat
Electrical repairs			Any repair on electric motor, controller, sensors, monitor, DCDC converter

In case other spare parts are needed or the motor has any damage, send an email with a digital photo to [info@all4solar.com.au](mailto:info@all4solar.com.au) indicating the motor number, name of the owner and the parts needed or damaged.

## 7) Boat transport & trailering



### ATTENTION

When transported on a road trailer we recommend to disconnect the shaft coupling and fix the motor additional to the engine mounts to avoid damages. Always disconnect from the battery system.

## 8) Warranty

Your inboard motor is backed by a 1 year warranty for workmanship and material. The warranty does not cover any damaged which result from faulty handling, operating or maintenance. The following points will void the warranty:

- 1) Operation or maintenance differing from the information and instructions in this manual or any other manufacturer's documentation.
- 2) Preparation and participation in competitions or races or any form of competition.
- 3) Water damages to the motor.
- 4) Damages caused by collision, accidents, contact with any solid materials.
- 5) Capsize of the boat or drowning the motor into the water.
- 6) Grow of any kind of marine organism on the motor surface.
- 7) Incorrect use of the motor or use on unsuitable boats.
- 8) Normal aging process.
- 9) If serviced by none authorized or specialized workshop.
- 10) Damage by corrosion.

The warranty does not include wear parts such as: Joints & gaskets, hoses and rubber parts. The warranty only covers the motor and the controller. It does not cover damaged to the boat or and accessories, the batteries, switches, fuses, battery charger, trailer or any kind of equipment not supplied by all4solar.

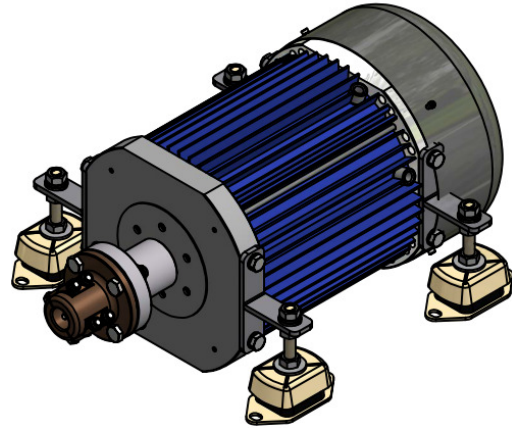
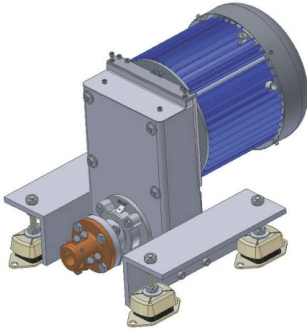
Transport to all4solar for damaged parts is to be paid by customer. The redelivery to the customer is paid by all4solar, if warranty applies.

If all4solar supplies any third party product (battery, chargers, cables etc.) the warranty conditions of these supplier applies.

all4solar cannot be held liable for any damage or injury caused by the use of this motor.

## 9) Technical data

### 9.1) Technical data & drawings engines 2.5 – 6 KW



#### 4.3 KW ENGINE

- Advanced electric AC induction motor for 48 V DC
- Shaft coupling (25 mm to 30 mm)
- Ready to install with engine mounts
- Cables with plug to battery/Main Switch/Contactor
- Single lever with switch lock prewired
- Digital motor controller & battery monitor
- 4.3 KW output / thrust similar to a 9-10 HP diesel \*
- 5 KW power consumption (104 Amp) - 1400 rpm
- Weight 44 kg (engine) 10 kg controller & gear
- For boats upto 4.0 t (one engine)
- Run time at an average 40% throttle 2 h 20 min.

\* performance thrust with lithium battery 5.1 KW h

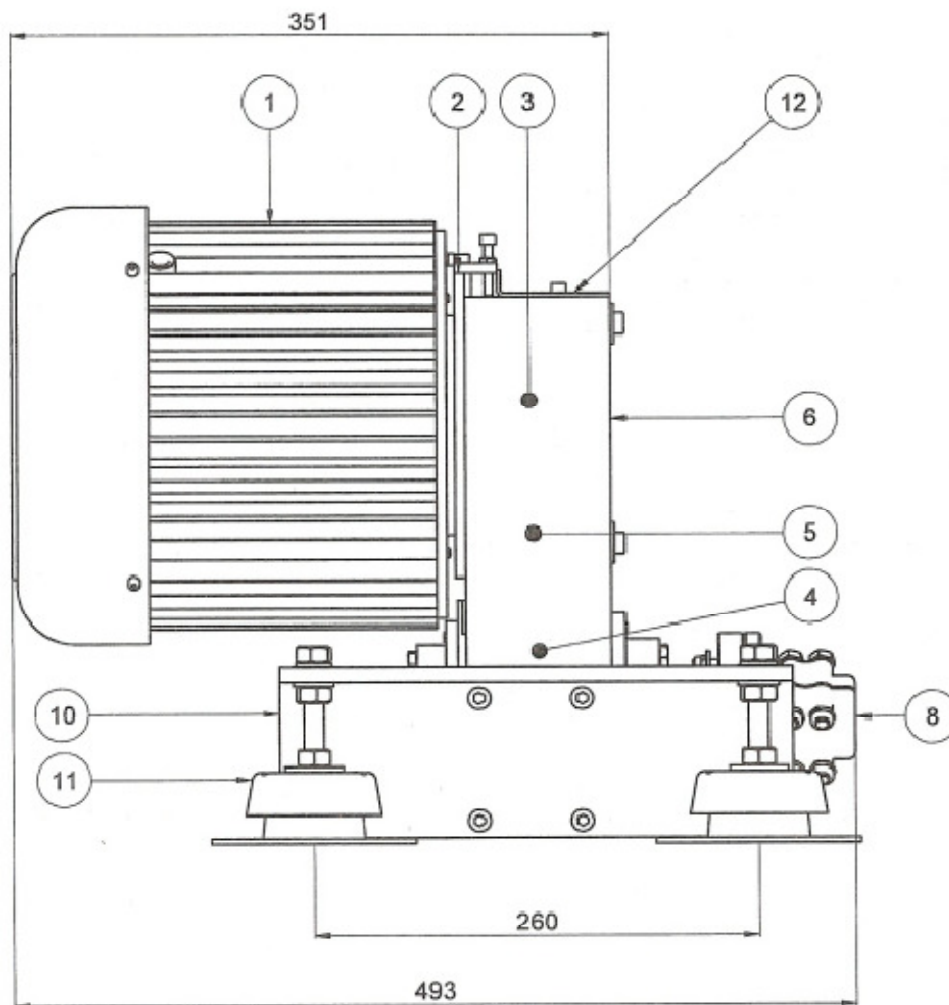
#### 6.0 KW ENGINE

- Advanced electric AC induction motor for 48 V DC
- Shaft coupling (25 mm to 30 mm)
- Ready to install with engine mounts
- Cables with plug to battery/Main Switch/Contactor
- Single lever with switch lock prewired
- Digital motor controller & battery monitor
- 6.0 KW output / thrust similar to a 9-10 HP diesel \*
- 7.1 KW power consumption (143 Amp) - 1400 rpm
- Weight 50 kg (engine) 10 kg controller & gear
- For boats upto 6 t (one engine)
- Run time at an average 40% throttle 1 h 40 min.

\* performance thrust with lithium battery 5.1 KW h

Torque on shaft: 50 / 70 NM nominal | Shaft couplings and shaft should be able to Handle at least double the nominal torque!

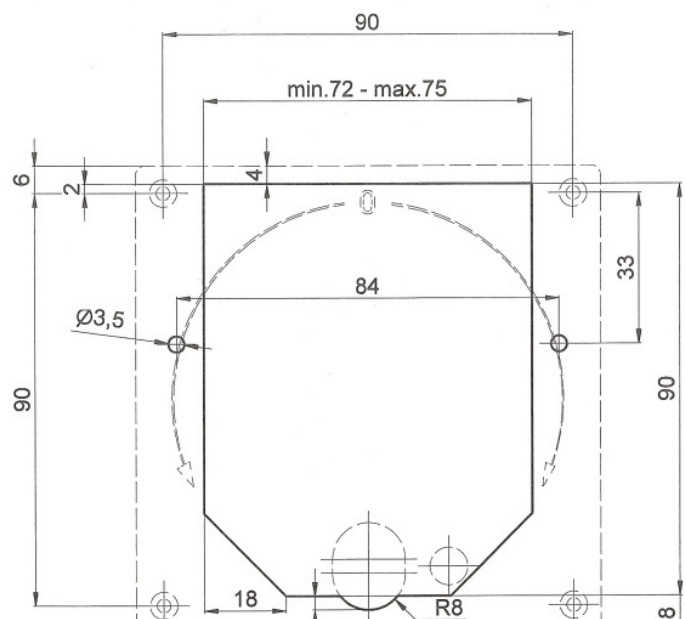
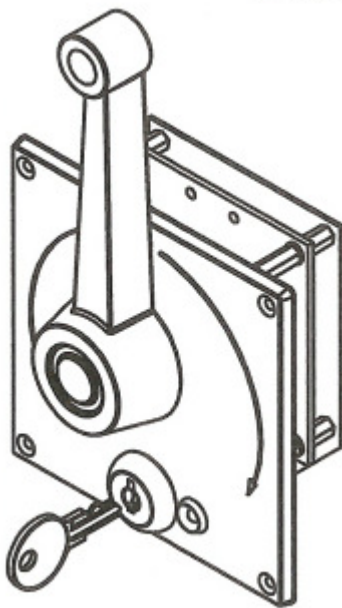
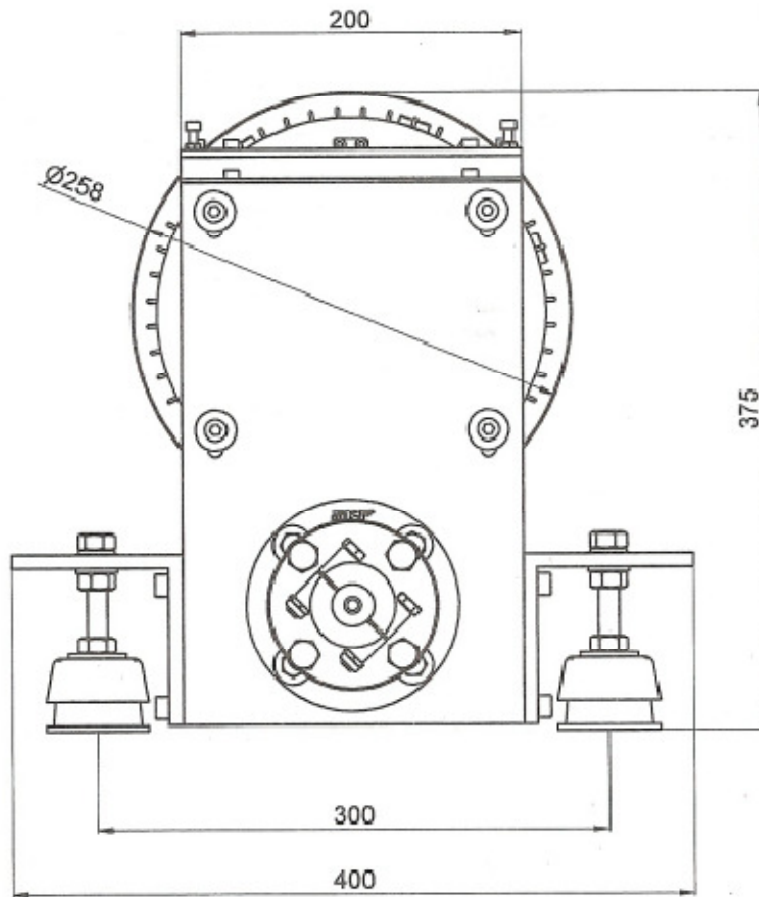
Engine type: 3 phase AC induction motor 132 M IP 54  
 4 poles | start connected (Y)  
 1400 rpm nominal | 50-60 NM torque (shaft)  
 Pole voltage 33-35.5 V DC (for 48 V nominal battery power)

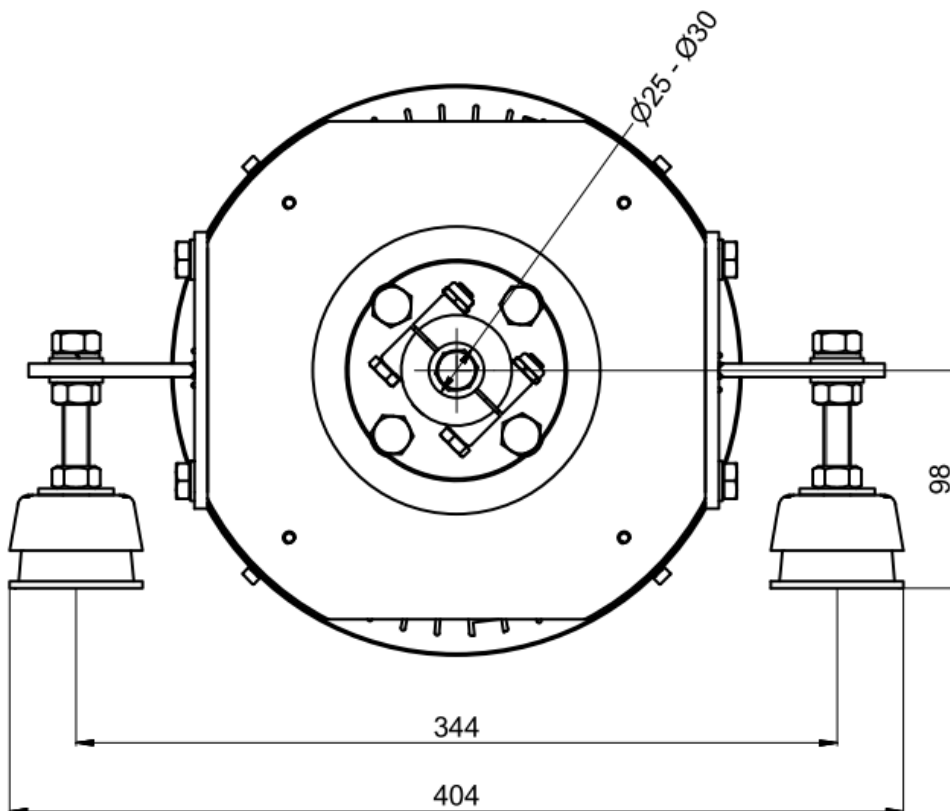
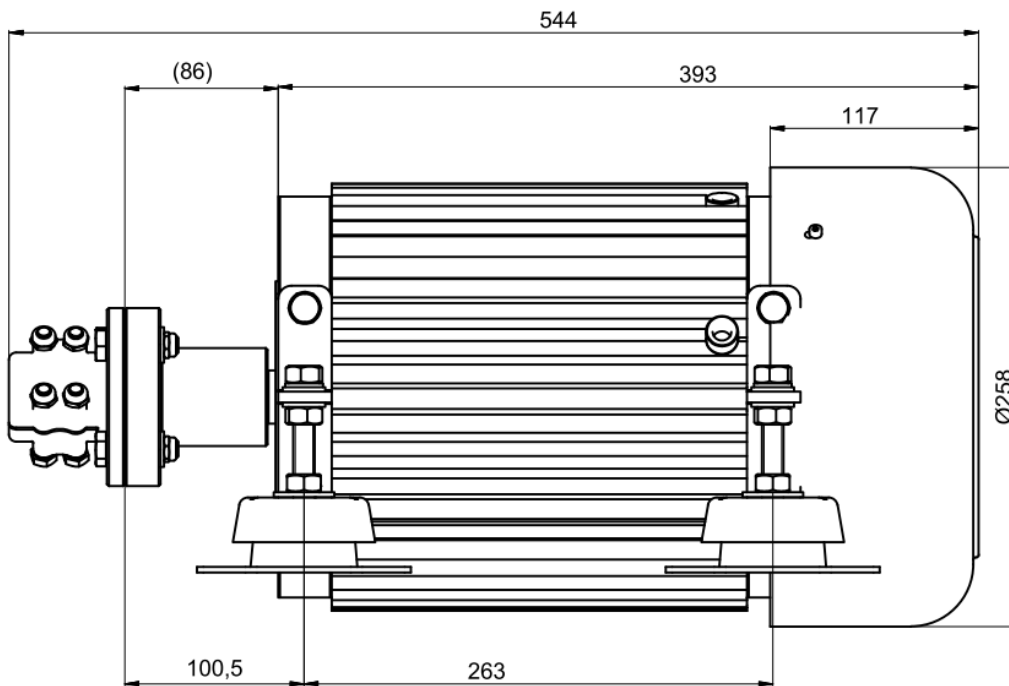


**DRAWING WITH GEAR BOX – IDENTICAL ENGINE AVAILABLE WITHOUT GEAR BOX  
SEE FOLLOWING PAGES FOR DETAIL DRAWINGS**

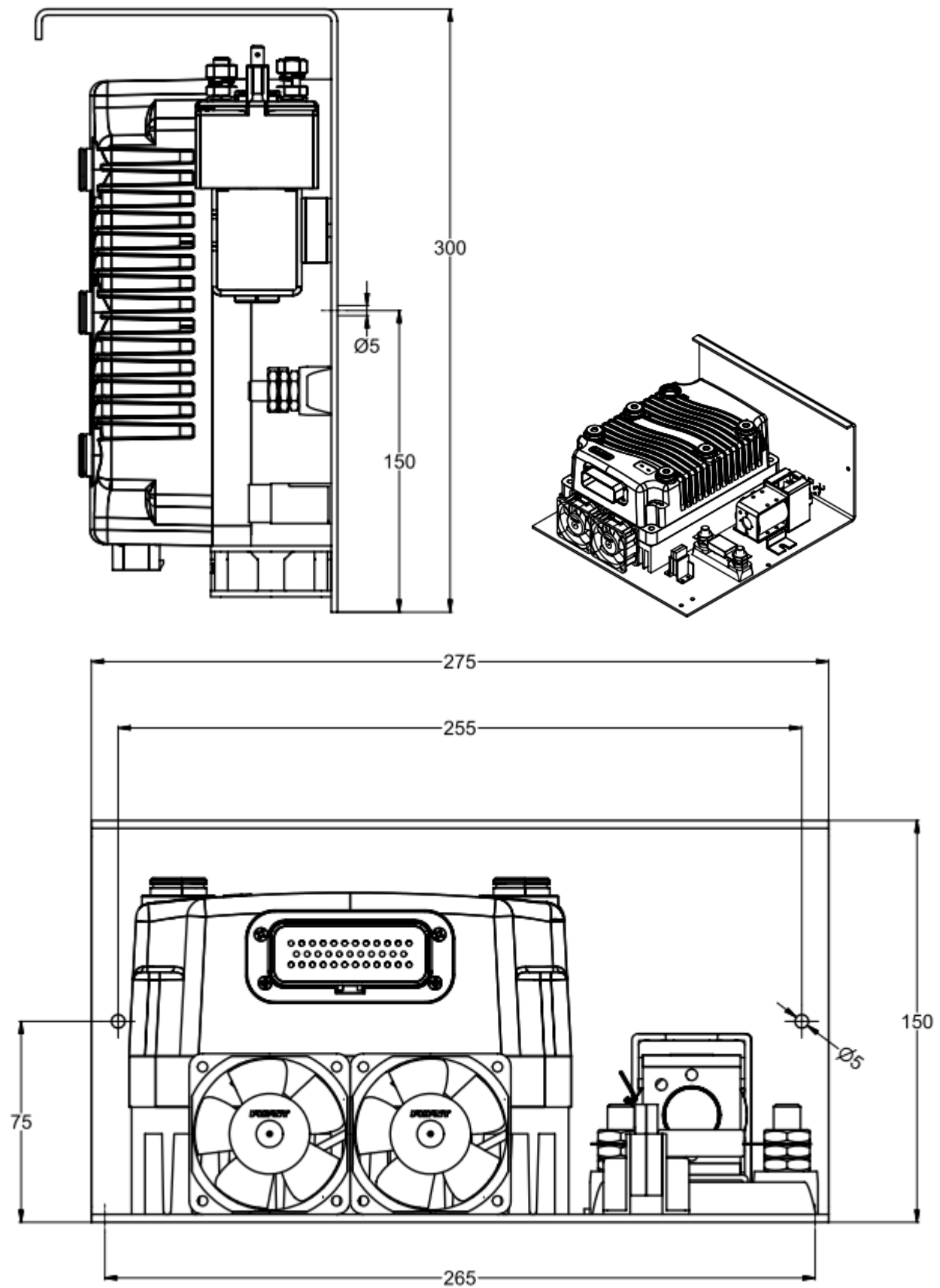
1 – ENGINE	Kräutler 132 S 4,3   6.0
2 – ENGINE SUPPORT PLATE	Aluminium
3 – BELT CASING (X)	Stainless Steel
4 – DRIVE PULLEY (X)	48
5 – BELT (X)	Power Grip HTD 640 8 M
6 – MOTOR PULLEY (X)	28
7 – SHAFT & BEARINGS (X)	SIGF FYC 306   305
8 – SHAFT COUPLING	Reggiani Nautica 51800500
10 – BASIC FRAME (X)	Aluminium
11 – ENGINE MOUNT	Steel   Rubber 12 mm   10 mm
12 – TOP BELT DRIVE COVER (X)	Aluminium

(X) – for engines with reduction gear only











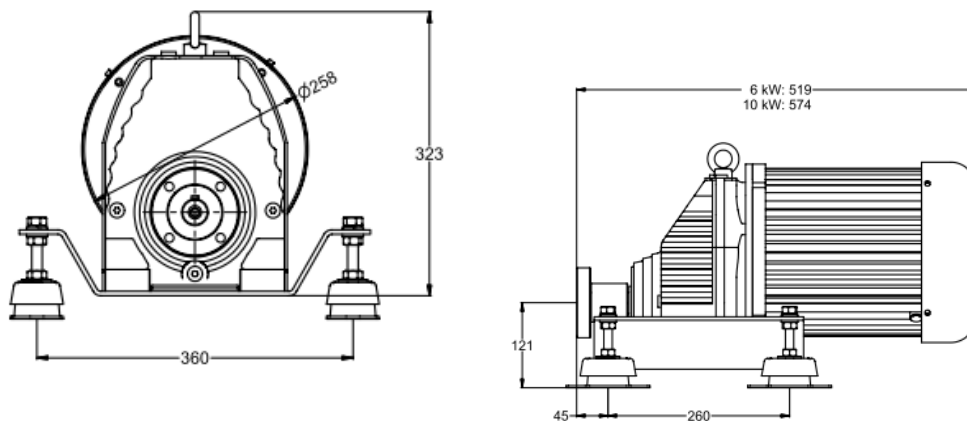
## 9.2) Technical data & drawings engines 8 - 10 KW

### 10.0 KW ENGINE

- Advanced electric AC induction motor for 96 V DC
  - Integrated gear box and shaft coupling (30 mm)
  - Ready to install with engine mounts
  - Cables with plug to battery/Main Switch/Contactor
  - Single lever with switch lock prewired
  - Digital motor controller & battery monitor
  - 10.0 KW output / thrust similar to a 20 HP diesel \*
  - 11.8 KW power consumption (123 Amp) - 1200 rpm
  - Weight 64 kg (engine) 10 kg controller & gear
  - For boats upto 10.0 t (one engine)
  - Run time at an average 40% throttle 2 h
- \* performance thrust with lithium battery 10.2 KW h

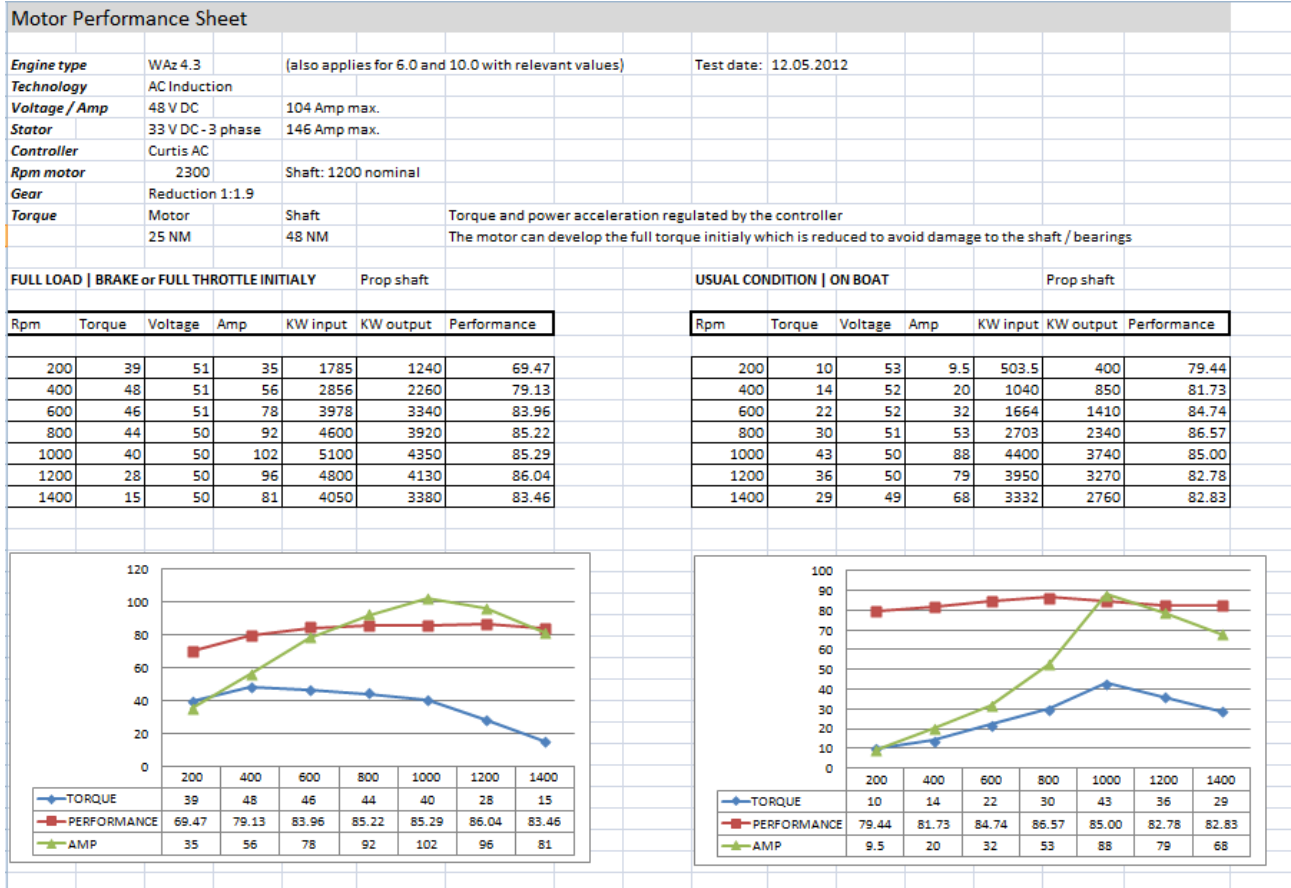
Torque on shaft: 100 NM nominal | Shaft couplings and shaft should be able to Handle at least double the nominal torque!

Engine type: 3 phase AC induction motor / Kräutler 132 S 10,0  
 4 poles | start connected (Y)  
 2500 rpm nominal | 50 NM torque  
 65 V DC (for 96 V nominal battery power)  
 Gear Box 1:2 ratio  
 Engine mounts steel / rubber | 10 / 12 mm



### 9.3) Power | torque

#### WAz 4.3 (4.3 KW)



### 9.3) General technical facts

#### Static thrust and torque

"The measured thrust produced by a propeller when movement is prevented"

1 Newton = weight power of 102 grams (standard force of gravity) = thrust

1000 lb ft (pound / feet) = 1356 Nm (Newton meter) = torque

1 Newton meter = power to lift 102 gram on an 1 meter moment arm

1 Lb-Ft = 1.35582 Nm

#### Power

Electric motors are moved by electric power. For boats we need to use a DC (direct current) power supply, as the electricity needs to be stored in batteries which can only provide DC power. As AC motors have some advantages, the motor controller can have an AC output to the motor (see AC / DC motors) which acts like an inverter (converting DC to AC power).

Watt = voltage X ampere or amps

1 kilo watt = 1000 watts = 1.341 hp (Use for el. outboards 1.5 hp for inboards 1.7-2 hp)

1 kw h = 1 kilo watt output per hour (f.e. battery capacity)

#### AC / DC motors

DC = direct current / positive and negative / electricity always flows in one direction (battery)

AC = alternating current / the electricity changes direction by alternating at a certain wave frequency (like the 240 V power supply)

DC motors are equipped with permanent magnets on a stator and electric magnets on a rotor (rotating) which are switched on and off in a sequence related to the rotation of the stator. The brushed DC motors (the cheapest option) have brushes to the rotor switching the electric coils (magnets) on and off to create a force with the permanent magnets. The controllers for these motors just need to limit the power input to change the power output of the motor. The brushless DC motors do have the electric coils in the stator and the permanent magnets fixed on the rotor which makes the construction simpler and more efficient. But the motor controller is more complex and needs to switch the electric power according to the information of the position of the rotor by sensors. The AC induction motor has electric coils on the stator and a rotor driven by the magnetic field (induction). The rotation is related to the frequency of the alternation. There are a lot of subtypes, synchronous, two or three phase or induction with usually 4 or 6 poles. But the following points are important: An DC motor is a cheaper option, but changes the torque with the rotation speed, where an AC motor can create a more stable torque over a wide range of rotation speed. The AC motor is maintenance free as the shaft bearings are the only moving parts. This makes this motor ideal for engines over 5 KW.

#### Efficiency

Efficiency is defined by the percentage of energy output compared to the energy input. An electric drive system has several components, so the overall efficiency is important to look at.

Batteries – efficiency input (charge) and output - Lead acid = 90% - Lithium = 99%

DC brushed motor including controller = 60 – 85 % - only efficient at specific rotation speeds

DC brushless motor including controller = 65 – 95% - only efficient at specific rotation speeds

AC motor including controller = 84-88% - efficient over a wide range of rotation speeds

The AC motor or for smaller applications the synchronous brushless motor in combination with a lithium battery are the most efficient systems for boat propulsion.

## 10) Spare parts

As mentioned before, these electric inboard engines only require a limited maintenance.

All spare parts, related to the engine and the controller need to be supplied and replaced by all4solar. All other parts can be replaced with any SIMILAR product which usually are available everywhere. Please refer to the list in section 9.

If ordering from all4solar refer to the latest product list in section 1.4. If something is unclear, send an email with a digital photo to [info@all4solar.com.au](mailto:info@all4solar.com.au). The use of unsuitable spareparts will void the warranty.

Only use original high quality spare parts.

## 11) Installation diagram

See section 2

## 12) Propeller information

The most important thing to know about props. There is no way to exactly calculate the performance of a propeller on a certain boat with a specific engine. Only testing will give you the accurate results.

Material:	Aluminium	Cheap and light
	Stainless Steel	5 times stronger than Aluminium / efficient
	Composite	Light & efficient

Blades:	2 – Small trolling motors   large folding props   Sail drives   efficient high speed   less drag
	3 – Fast outboard motors   larger props on inboard engines   Sail drives   more thrust
	4 – High Thrust applications or large props for displacement and semi displacement

Size:	Diameter of the prop
-------	----------------------

Pitch:	The pitch is the distance the boat could theoretically travel for each revolution of the propeller without the slip (loss).
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The increase of the pitch by one inch usually results in 150 – 250 higher rpm at full throttle for props from 9 to 12 inches at 2000-2400 rpm and less for larger props at less rpm.

Increasing the pitch will result in less thrust but higher maximum speed.

Regeneration:	This is a quite controverse issue. The main problem is, that a propeller builds up water pressure to speed up the water faster than the speed of the boat.
	When “braking” to achieve the power regeneration function the water pressure is build up on the “wrong” side of the prop where usually you have an under pressure.
	The slip is increased dramatically reducing the performance.
	The result is, that the regeneration produces drag, but this cannot be converted completely into rotations of the propeller. The hull speed has to be at least 7-9 knots to achieve a frequency over usually 10 Hz which will allow the motor to produce enough power output to charge the battery. The efficiency can be increased by using a completely turnable sail drive.

Prop sizes to be used:

1000-1400 rpm	10 HP	10 – 14 inch
	20 HP	11 – 15 inch

Propellers:	<a href="http://www.seahawk.com.au/">www.seahawk.com.au/</a>	<a href="http://www.flexofold.com/">www.flexofold.com/</a>
	<a href="http://www.australpropeller.com.au/">http://www.australpropeller.com.au/</a>	

## 13) High power batteries

Instead of lead acid batteries, lithium – based systems offer a much higher energy density and a stable power output as well as much higher efficiency.

A 100 Ah lead acid battery can only supply approximately 60 Ah in one hour with a voltage dropping continuously.

Lithium based batteries can deliver up to 95% of their capacity within a very short time and with a stable voltage. The disadvantage of this effect is the lack of reserve, if the battery is discharged.

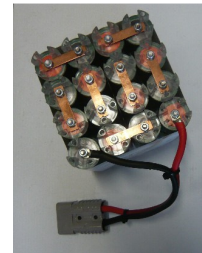
Some important information related to lithium based batteries:



LIPO batteries need a controller (BMS) which checks the single voltage of each unit and keeps the voltage leveled. These battery packs supply up to 180 watt-hours per kilo weight, but need attention. We actually do not recommend using these packs for marine installations.



LiFePo batteries do not essentially require a controller (even this is recommended) and are not as sensitive as LIPO batteries. They supply about 100 watt-hours per kilo weight and can last over 2000 cycles. We recommend to use this reliable technology for power supply for boats.



16 cells deliver 51.2 volts and 30 cells deliver 96 volts. Make sure, your battery pack allows discharging with the maximum Amps required for the engine.

If you use LIFEPO4 batteries, we recommend to carry a second battery as backup as well as a suitable battery monitor to measure the battery capacity.

## 14) Battery charging / solar power

### 14.1) Standard grid chargers

For charging the batteries you must use a suitable charger. Always make sure, the charger is fully protected from water and covers the battery voltage and type. If AGM lead acid batteries are installed, each battery can alternatively be charged individually with a 12 volt battery charger, but all batteries must be charged up to the same level to keep the full potential of the batteries and assure the maximum power output.

Always use automatic digital chargers with several charging modes (charge, float etc.) to extend the life of your batteries and get the complete charge at all times.

48 V chargers used for golf carts are powerful, reliable and economic. For Lithium batteries use suitable digital chargers (We supply those with our batteries).

Do not use cheap 12 V chargers for car batteries.

Maximum charge voltage for a 48 V battery:

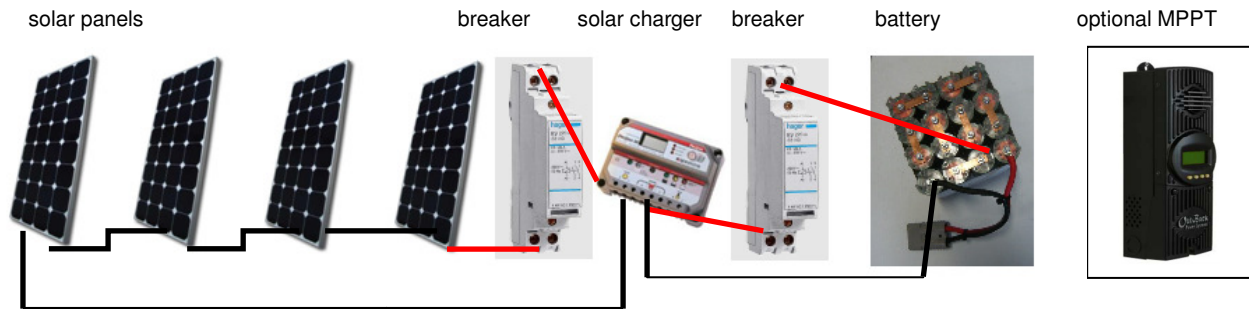
59 Volts max. charge voltage	Lithium 3.7 volts/cell
54 Volts floating	Lithium 3.4 volts/cell



### 14.2) Charging with solar power

Charging your batteries with solar power is the perfect solution for the all4solar concept of sustainable boat propulsion. Either you mount light weight panels on your boat or use a fix solar system on shore.

Any type of photovoltaic solar panels can be used, but we recommend a minimum power of 200 Watts (4 x 12 Volts nominal / 50 Watts in series). Please note, that at full sunshine a 48 V / 100 Ah battery pack needs 2-3 days for a 50% charge with a 200 watt (4 x 50 watt panels) solar system.



We recommend that you install an automatic circuit breaker between the battery and the solar charge controller and between the solar charge controller and the solar panel (Either DC breakers or 250 V AC automatic breakers).

Do not connect the solar panels directly to the batteries always use either a charge controller (48 V DC) or a Maximum Point Power Tracker System MPPT (to optimize the solar power output).

All4solar is not responsible for any installation of batteries or battery charge systems on your boat. Always contact a specialized or authorized (if applicable) installer prior to any installation or purchase.

### 14.3) Generators

The generator should be suitable to charge the DC voltage or to supply the 240 V battery charger. Remote control option with battery monitor available.





## 14.4) Solar panels

There are different types of photovoltaic solar panels on the market. The sunlight has a maximum power of 900 – 1100 Watts per m<sup>2</sup> when shining on a surface. If 10% can be converted to electricity, that means that about 90 – 110 Watts output can be produced per m<sup>2</sup> of solar panels.



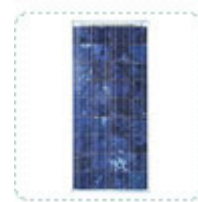
### Mono Crystalline

High efficiency – converts upto 20 % of solar light  
To use if only limited surface is available (f.e. on a boat)  
Best solution for a fix long term installation



### Poly Crystalline

Less efficiency – converts upto 16 % of solar light  
Somewhat cheaper than mono crystalline – needs more space  
Economic solution for fix long term installation



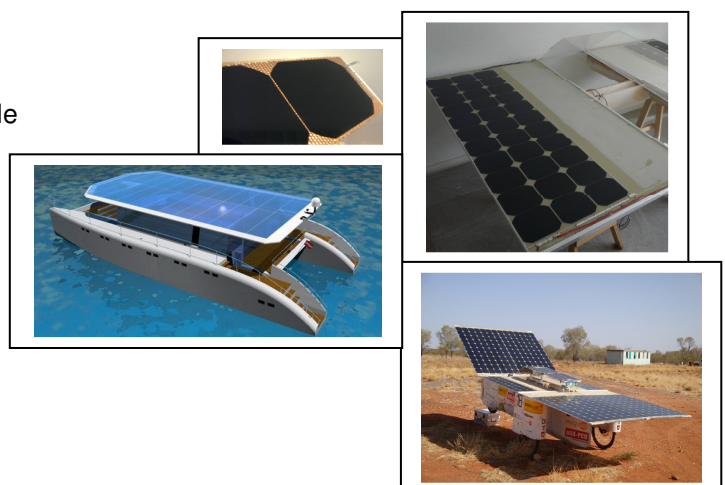
### Thin film

Converts between 5 – 10% of solar light  
Very light and flexible constructions possible  
Many different types available  
Best solution for transportable systems or mounting on vehicles



### Individual solar panels

Can convert upto 28% of the sunlight  
Very light and flexible constructions possible  
For integrated projects  
More expensive solution





## 14.5) Wind generators

Wind generators generate free power for 24 hours and are the ideal solution in combination with a solar pv system.

Silentwind offers high tech wind generators which are not only light and quiet, but also very efficient. The system includes the controller which can be directly attached to the all4solar battery- and electric propulsion systems.

[www.silentwind.com.au](http://www.silentwind.com.au)



Example power calculation:

600 watt / 48 volt DC system

10-14 knots wind output average 300 watts over 24 hours = **7.2 KW**

## 15) Conformity Declaration

### EG Konformitätserklärung / EC Declaration of Conformity

Der Hersteller / The manufacturer:

**Kräutler Elektromaschinen GmbH**  
**Hohenemser Str. 47**  
**A-6890 Lustenau**

erklärt hiermit, dass die Erzeugnisse / hereby declares that the products:

**Elektro-Bootsmotor**  
**electric powered boat engine**

**Type / type**

132S 2,0 8 / 132S 2,5 8 / 132S 3,0 8 / 132S 3,5 8  
132S 4,0 8 / 132S 4,3 8 / 132S 5,0 8 / 132S 6,0 8 / 132M 8,0 8  
AC[H][V][AV][R] 1,8 / AC[H][V][AV][R] 3,5 / AC[H][V][AV][R] 4,0 / AC[H][V][AV][R] 8,0

**Zubehör / accessories**

Wechselrichter Type DR 6-8; 24-48V Gleichstrom  
auf Grundplatte mit Hauptschütz und Einhebelschaltung

*inverter type DR 6-8; 24-48V direct current  
assembled on base plate with main contactor and single lever control*

den folgenden Bestimmungen entsprechen:  
*are in conformity with the following regulations:*

⇒ **Elektromagnetische Verträglichkeitsverordnung 89/336 EWG**  
**Electromagnetic Compatibility (EMC) Directive 89/336 EWG**

⇒ **Prüfgrundlage:**  
Europäische Norm: Kleine Wasserfahrzeuge – Elektrische Systeme-Kleinspannungs-Gleichstrom (DC) Anlagen (EN 10133:2000)  
Vorausgesetzt ist die Übereinstimmung mit deren Installationsordnungen und einer maximalen Kabellänge von 1,0 Meter zwischen Wechselrichter und Motor.

**Based on:**  
*European Standard: Small craft – Electrical systems – extra-low-voltage d.c. installations (EN 10133:2000)*  
*The accordance with their technical regulations is presupposed.*  
*The maximum cable length between inverter and motor may not exceed one meter.*

⇒ **Gutachten:**  
Elliot Nr. 55364 vom 23.04.2004  
**Expert report:**  
*Elliot no. 55364, dated 23<sup>rd</sup> of April 2004*

**Kräutler Elektromaschinen GmbH**

Kräutler Harald  
Geschäftsführer / chief executive officer CEO

Lustenau, am 21. Jänner 2010  
Lustenau, 21<sup>st</sup> of January 2010

