Thruster Manual

COPENHAGEN SUBSEA

Copenhagen Subsea A/S – Troljevej 2 – 2900 Hellerup – Denmark – Tel: +45 70221162
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Approvals

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Change History

Version no.	Changes
1.0	Initialization of document
1.1	Grammatical corrections
1.2	Connector interface and motor controller added
1.3	Maintenance section added
1.4	Graphical updates in Maintenance section
1.5	Grammatical corrections
1.6	Grammatical corrections
1.7	Record of conformity section added
1.8	Changes in Maintenance section and record of conformity section
1.9	Changes in: Assembly/disassembly, temperature conditions, sealing …
2.0	Changes in: Use loctite 577 on bolt and screws and insert bearing ring
2.1	Changes in: Mounting the Thruster - text added
2.2	Pt1000 noise removal using capacitor – explanation added Warning added regarding the thruster – It has to be fully submerged during operation
2.3	Changes in: Electrical connection Operation header added - insert blue sealing plug when operating
2.4	Changes in: Warnings, Precautions against overheating and Storage
2.5	Section deleted: Zink anode Section added: Electrical Isolation of the Thruster when Mounting Changes in: Mounting the Thruster & CRE Marine Replace Loctite 577 with AquaShield Grease

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Warnings

The design and configuration of your Copenhagen Subsea thruster might differ from the thruster pictured in this manual.

Disconnect the thruster from power when handling it.

Operate the thruster under water only. The warranty will not cover damages resulting from running the thruster without water to lubricate its bearings.

Connect the aluminum housing of the thruster to a sacrificial zinc anode to prevent corrosion.

If the thruster is exposed to liquids other than seawater or freshwater with a PH value between 6 and 9, the warranty will not cover any direct damages or any following damages.

Make sure the motor temperature is always below 70 degrees Celsius.

Use only Copenhagen Subsea A/S specially designed transport boxes for transportation.

Under no circumstance disassemble the rotor from the stator without using the appropriate tools as described in this manual as this may cause personal injury due to the strong magnetic forces that hold the rotor in place.

Be aware of the thruster is delivered with no propeller safeguarding to prevent access to the rotating propeller to protect against human injuries. Therefore, consider mounting a propeller guard when installing the thruster into your application or take other safety precautions.

During operation the thruster needs to be fully submerged in water.

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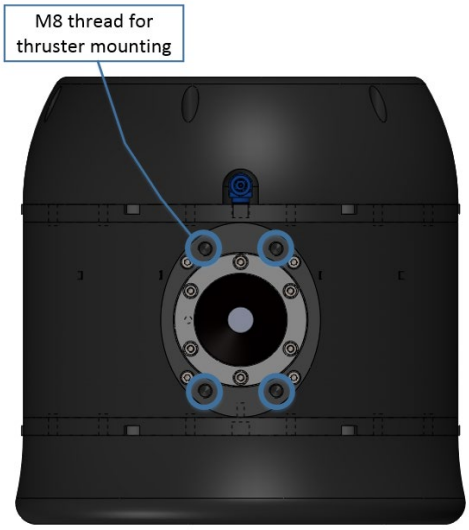
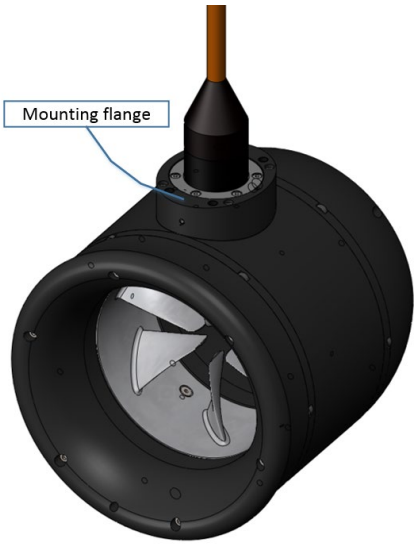
Mounting the Thruster

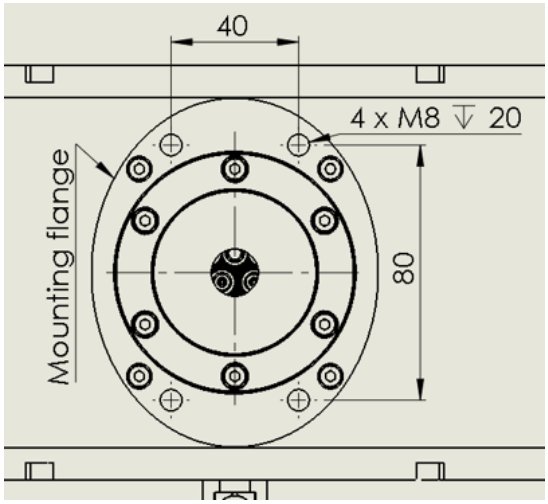


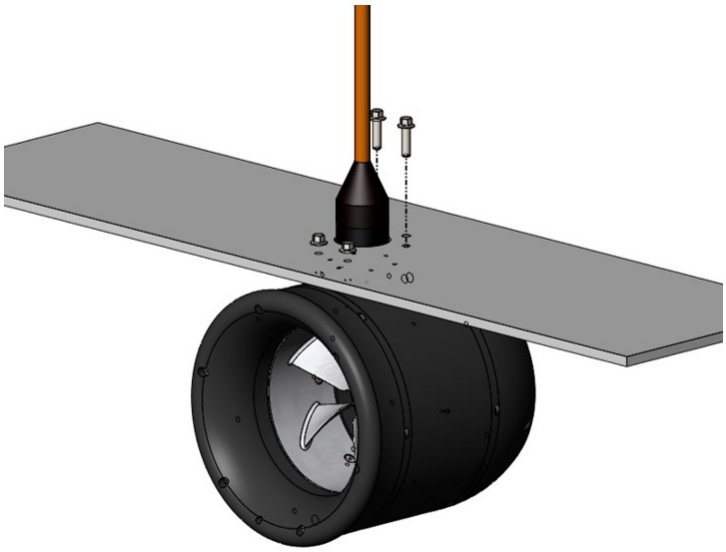


- Use the four holes pattern on the mounting flange when mounting the thruster.
- Make sure the mounting bracket on your application is robust and stable.
- See drawing below for mounting holes pattern
- Use a bit of AquaShield grease on the thread of the M8 mounting bolts when mounting the thruster.
- The material of the bolts has to be A4 and with the help of a torque wrench (18 Nm) screw in the bolts in a criss-cross tightening sequence.
- The bolt must be mounted so that it has at least 12mm of its thread inside the mounting flange.
- It is essential to occasional retighten the mounting bolts with help of a torque wrench (18 Nm)

Mounting holes pattern for:

VS, VM, VL and VXL thrusters





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Electrical Isolation of the Thruster when Mounting

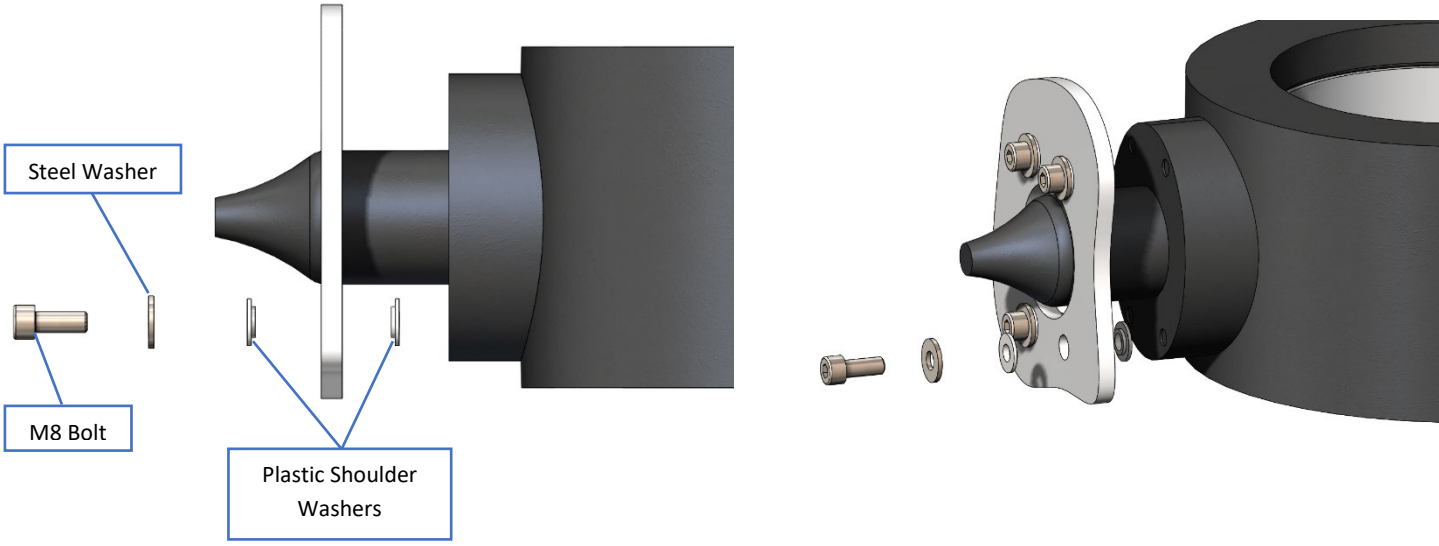
It is important to electrocally isolate the thruster when mounting the thruster onto the application. The reason for this is to avoid corrosion and cathodic debonding. When ordering a propulsion solution from Copenhagen Subsea, the necessary equipment to electrically isolate the thruster is included. For each thruster unit following set of washers follows:

- 2x plastic shoulder washers
- 1x flat plastic washer

Depending on the thickness of the mounting bracket, different set of washers shall be used.

- If the mounting bracket is thick enough to use a shoulder washer on both sides of the mounting bracket – the following set of washers are needed: (2x plastic shoulder washers)

  Insert the plastic shoulder washer on both side of the mounting bracket and add a steel washer between the mounting bolt and the plastic shoulder washer.



- If the mounting bracket is too thin to insert a shoulder washer in both sides on the mounting bracket – the following set of washers are needed: (1x plastic shoulder washer & 1x flat plastic washer)

  Insert the shoulder washer between the thruster and mounting bracket. Hereafter, add the flat plastic washer and a steel washer between the mounting bolt and the mounting bracket.

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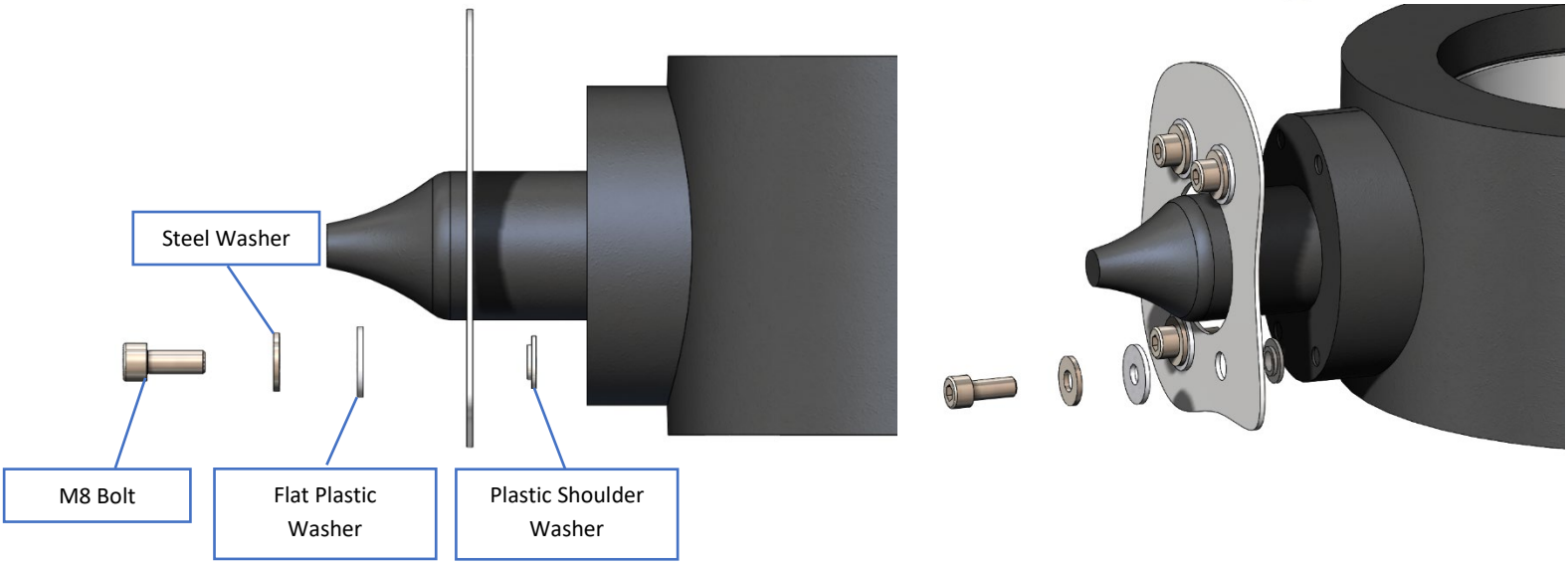
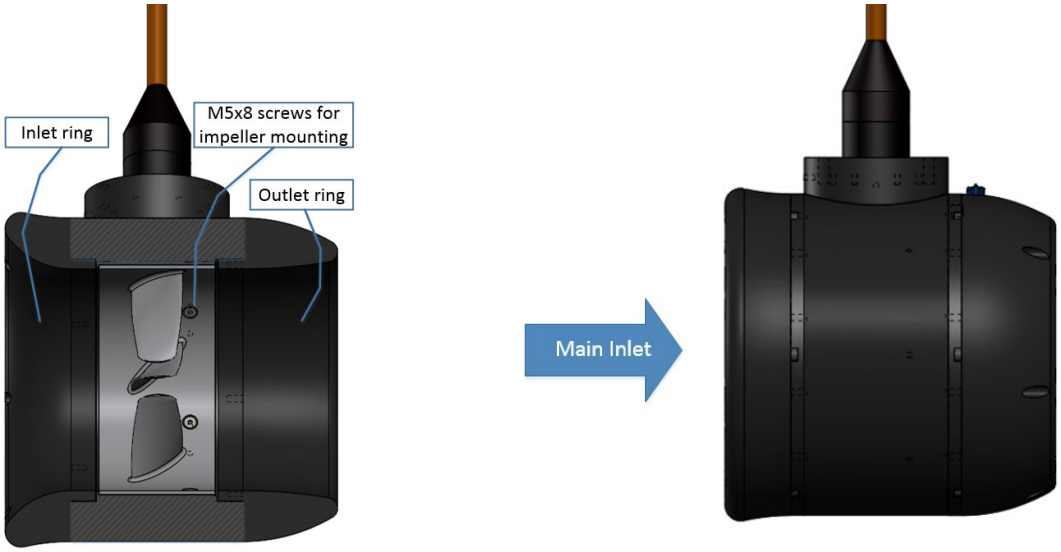


Main Water Inlet



To detect the main water inlet side of the thruster, look for the screws on the inside of the propeller. The main water inlet is on the opposite side of the propeller blades from these screws.

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Electrical Connection

When order thruster(s) from Copenhagen Subsea the thruster can be supplied with different connectors. Copenhagen Subsea determine suitable connectors together with the customer for each indiviaual case.

When receiving the thruster the connector supplied for the thruster is either:

- CRE underwater connectivity - http://www.cre-marine.com/index.html
- Macartney - Subconn - https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/

Subconn

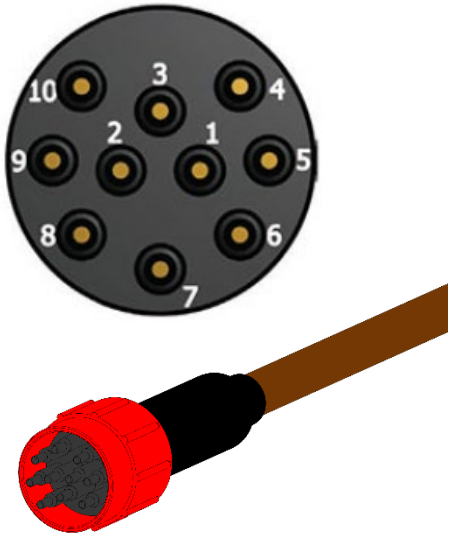
If the thruster is provided with a SubConn connector, please find the correct connector and read the information below.

SubConn10 pins

In order to supply the motor with sufficient power from the motor controller, each of the 3 phases of the thruster has been divided over two seperate pins on the connector:

Connector type: SubConn Circular 10 pins (OM10M)

Pin Connection	
Phase 1	1 and 2
Phase 2	3 and 4
Phase 3	5 and 6
PE (Protected Earth)	7 and 8
Temperature Sensor	9 and 10



For handling instructions, please see SubConn book on the following link:
https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-book/

For connector details, please click on the following link https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-circular-series/subconn-circular-6-8-and-10-contacts/

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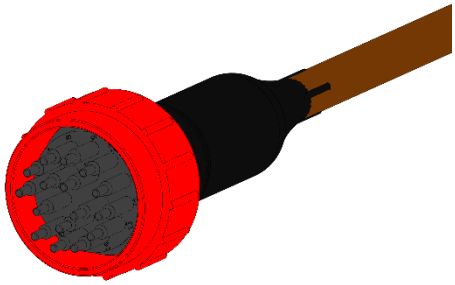
SubConn16 Pins

In order to supply the motor with sufficient power from the motor controller, each of the 3 phases of the thruster has been divided over four seperate pins on the connector:

Connector type: SUBCONN circular 16 pins (OM16M)

Pin Connection	
Phase 1	1, 2, 3 and 4
Phase 2	5, 6, 7 and 8
Phase 3	9, 10, 11, and 12
PE (Protected Earth)	13 and 14
Temperature Sensor	15 and 16



For handling instructions, please see SubConn book on the following link:
https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-book/

For connector details, please click on the following link: http://www.macartney.com/what-we-offer/systems-and-products/connectivity/subconn/subconn-circular-series/subconn-circular-12-16-and-25-contacts/

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CRE Marine

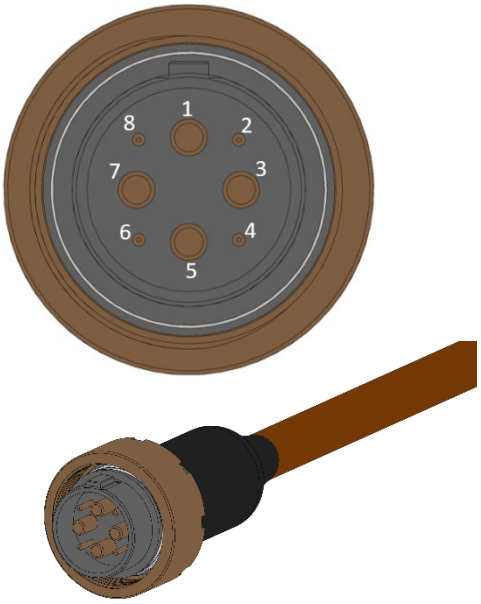
If the thruster is provided with a CRE Marine connector, please find the correct connector and read the information below.

C-Class 8 way

In order to supply the motor with sufficient power from the motor controller, each of the 3 phases of the thruster has their individual pin on the connector:

Connector type: CRE C-Class 8 ways (PLCO8M)

Pin Connection	
Phase 1	3
Phase 2	5
Phase 3	7
PE (Protected Earth)	1
Temperature Sensor	8 and 2
N/A	6
N/A	4



For handling instructions, please see on the following link: http://www.cre-marine.com/support.html

For connector details, please click on the following link: http://www.cre-marine.com/electrical_connectors.html

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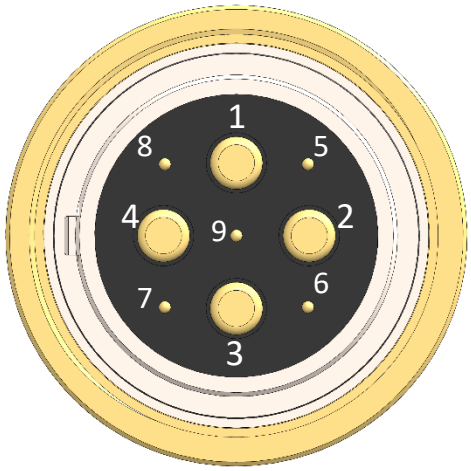
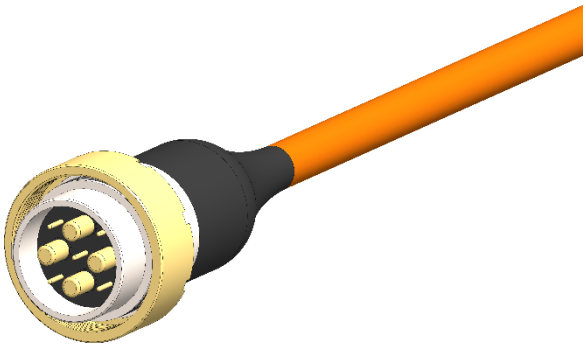
J-Class 9 way

In order to supply the motor with sufficient power from the motor controller, each of the 3 phases of the thruster has their individual pin on the connector:

Connector type: CRE C-Class 8 ways (PLJ09M)

Pin Connection	
Phase 1	2
Phase 2	3
Phase 3	4
PE (Protected Earth)	1
Temperature Sensor	8 and 5
N/A	6
N/A	7
N/A	9





For handling instructions, please see on the following link: http://www.cre-marine.com/support.html

For connector details, please click on the following link: http://www.cre-marine.com/electrical_connectors.html

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Motor controller interface

For electrical connection and communication to the motor controller, please see the user documentation of the motor controller supplied with the thruster.

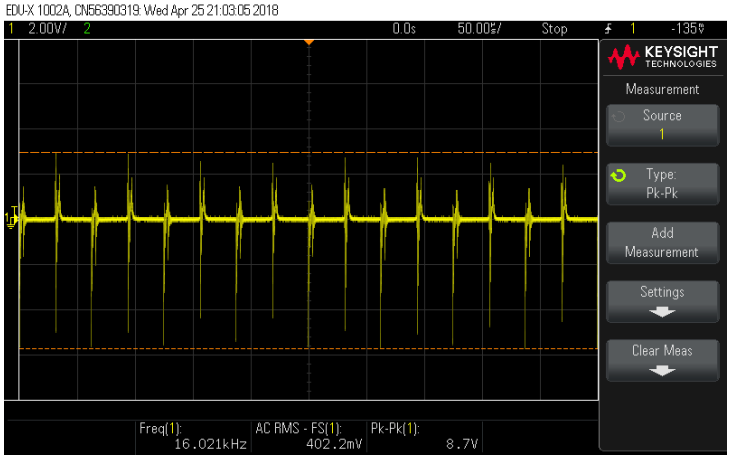
Precaution against overheating

Make sure the motor temperature is always under 70 degrees Celsius. Set this limit as the maximal motor temperature in the motor controller.

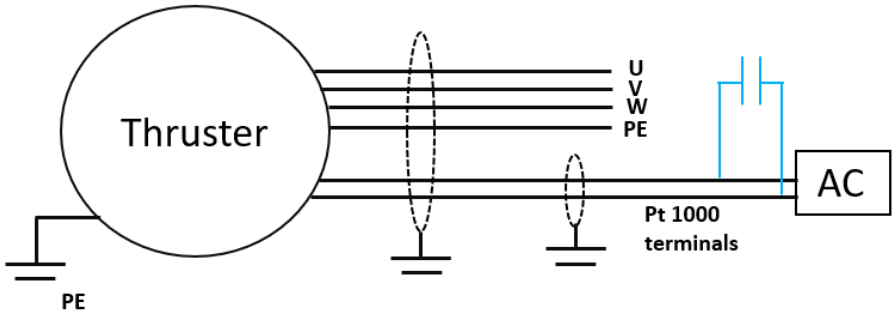
Pt 1000 temperature sensor – noise removal

Motor temperature is monitored via a Pt1000 resistor placed as close as possible to the motor windings. Linear relationship between resistance/temperature together with an analog converter gives a very accurate temperature measurement. However, being the sensor close to the winding makes it behave like an antenna, meaning that pulses will be induced at the switching frequency.

This can be seen in the next Figure, where pulses at 16 kHz (switching frequency supplied to the motor) appear to have a peak to peak value of 8.7 V.



Most analog converters have a low pass filter good enough to make the signal from the Pt1000 sensor stable and usable to read temperature. If this is not the case and the noise is too high, it is then recommended to consider the use of a small capacitor in parallel with the analog converter input. See Figure below.



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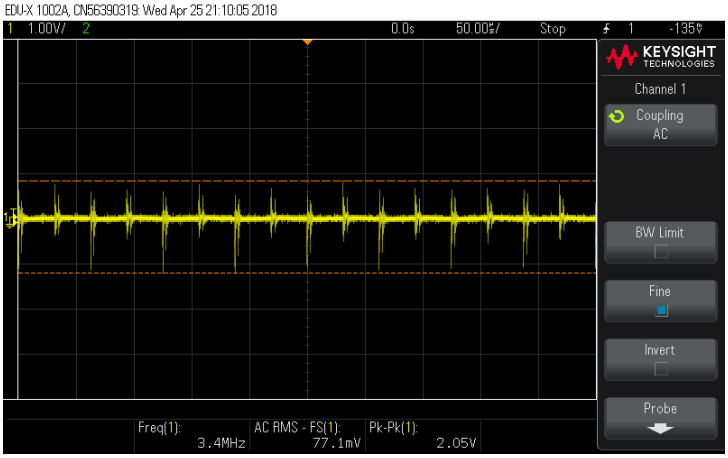
In the following Figure, the results of using 1 capacitor (rated 1 µF / 63 V) can be seen. Peak to peak value is reduced from 8.7 V to 2.05 V and RMS is reduced from 402.2 mV to 77.1 mV.



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Maintenance

The thrusters from Copenhagen Subsea A/S, are due to their construction, extremely robust and durable - but is nevertheless important to take good care of your thruster. Proper care will ensure a long life time of the thruster, and provide reliable operation for many years to come.

Besides flushing the thruster with fresh water after use, visual maintenance inspection of the inside of the thruster is required to ensure that the inside space is clean. Dirt must be cleaned-off with a piece of water soaked cloth – do not use any chemicals.

The first visual maintenance inspection has to be done after **50 hours** of operation. Hereafter the visual maintenance is only be required after each **200 hours** of operations for the rest of the thruster's lifetime.

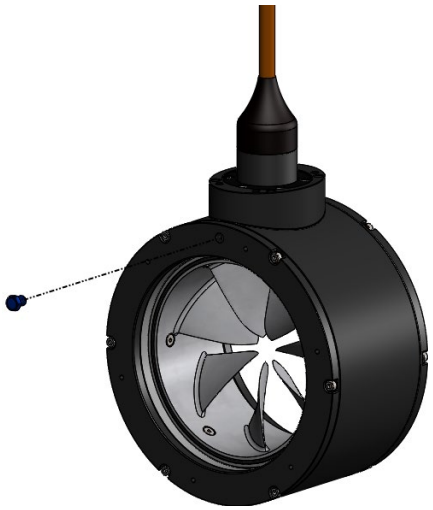
To perform the visual maintenance inspection on the rotor and stator, it is necessary to partly disassemble the motor. This is done by removing the bearing ring and pulling out the rotor as described in the procedure below. Maintenance video can also be seen in https://www.copenhagensubsea.com/maintenance

The rotor may be pulled out from both sides, depending on which side is most accessible. However, the preferred side is the outlet side.

Operation

Before launching the thruster into the water, insert the blue sealing plug in the flushing holes on the flange ring. The sealing plugs are included in the order, when ordering a propulsion solution from Copenhagen Subsea A/S.

- If the thruster is the compact configuration, insert the blue sealing plug on both sides of the thruster.
- If the thruster is the symmetric configuration, insert the blue sealing plug on both sides of the thruster.
- If the thruster is the asymmetric configuration, insert only the blue sealing plug in the side of the outlet.



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Storage Temperature

Operating temperature (water temperature surrounding the thruster) is between -5 ºC to 40 ºC. Storage temperature for thruster is from -45 ºC to 60 ºC.

Always make sure that the thruster temperature during operation (sensed temperature inside the thruster) does not exceed 70 ºC. All thrusters are equipped with a Pt1000 sensor that allows easy and stable temperature readings.

If the thruster is to be operated or stored in air temperatures below 0 ºC, below procedures must be followed to prevent the rotor from being locked by ice:

After recovery: When recovering the thruster from water to air temperatures below 0 ºC:

- Power-off the thruster.
- Blow out any remaining water from the thruster by applying a light air pressure through the flushing hole.
- Flush the thruster with an antifreeze fluid with a mixture ratio of 4/5 (antifreeze/water)
- Turn the rotor by hand to distribute the anitifreeze fluid.

Before launch into water: When a thruster with a material temperature below 0 ºC is submerged, the water can crystalized on its surface, and if the thruster is started instantly the ice can prevent the thruster from rotating freely, with subsequent overheating. To avoid this, it is important to heat up the thruster before launching into water.

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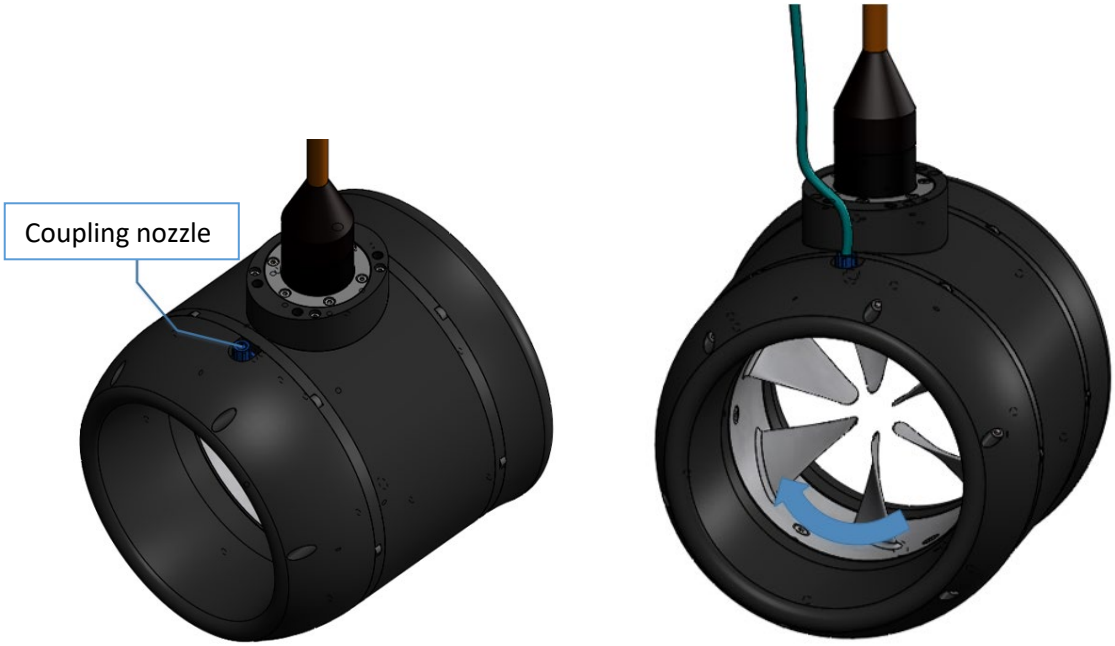
Flushing the thruster after use

To extend lifetime of the thruster, it should be flushed with fresh water after use.

⚠ When flushing the thruster, the power must be disconnected.



- The thruster has the blue sealing plug placed in the flushing hole - remove this blue sealing plug and insert the blue coupling nozzle instead.
- A Ø6x1 hose fits the coupling nozzle.
- Mount a hose to the coupling nozzle and flush with a lot of fresh water through the hose. Max 3-4 bar
- Turn the propeller round by hand during flushing.

Important note: The coupling nozzle has to be sealed during operation so that no small particles (sand, sediments, etc) can flow through and cause possible erosion on the inner surfaces of the thruster.

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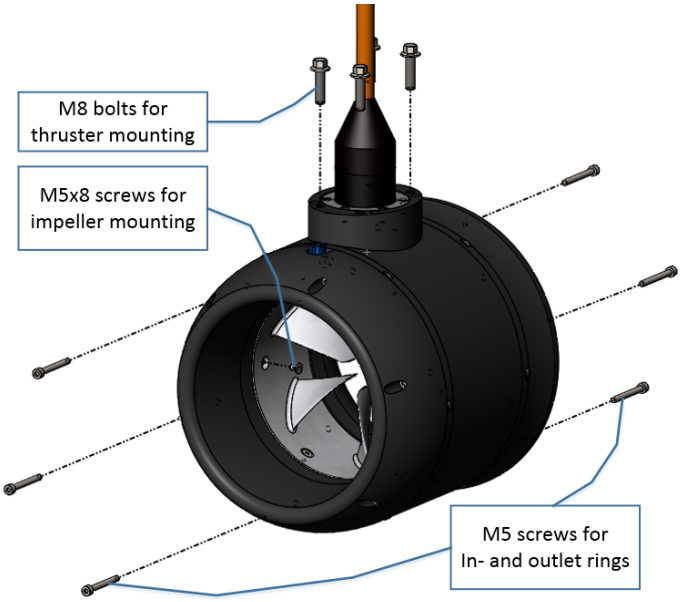
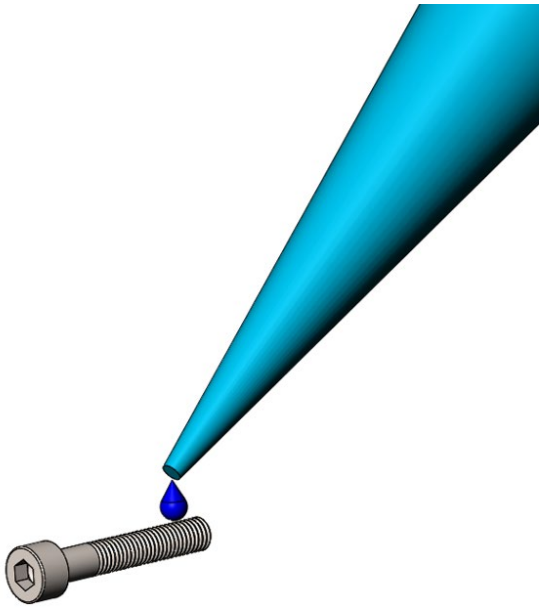
Use AquaShield grease on bolts and screws

All bolts and screws have been fixed with AquaShield grease from the manufacturer. Contact the manufacturer to find the nearst dealer of AquaShield grease.
https://www.houghtonintl.com/en/products/aquashield%E2%84%A2#:~:text=AQUASHIELD%E2%84%A2%20%E2%80%93%20Houghton%20International





If a thruster bolt or a screw has to be changed, swapped or re-fixed, always add a bit of AquaShield grease on the thread. Use a torque wrench to make sure the screws are properly tighten according to the following values:

- For inlet and outlet rings: 2 Nm
- For bearings : 4.6 Nm
- For propeller: 3.6 Nm

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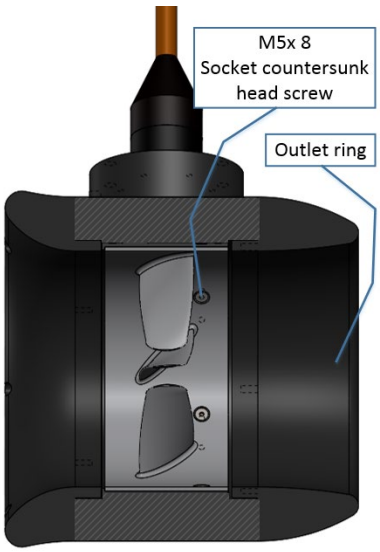
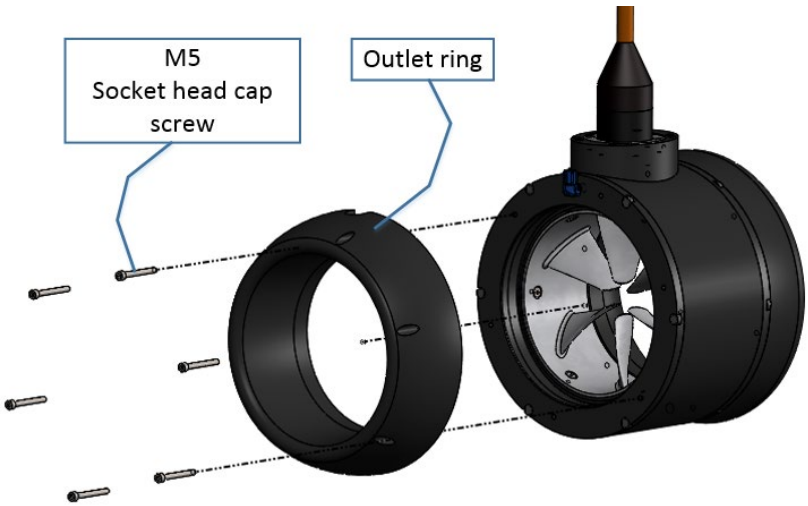
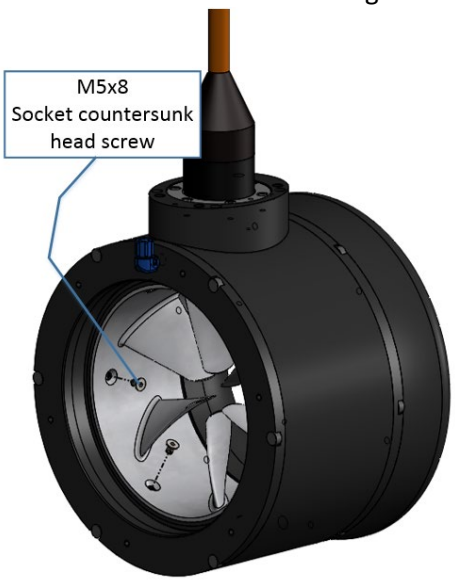
Remove Propeller

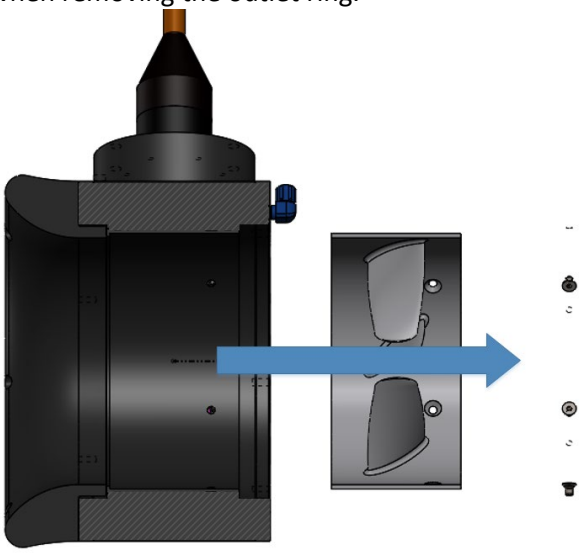
⚠ The power must be disconnected from the thruster when replacing the propeller.





- The outlet ring closest to the propeller screws must be removed.
- Remove the outlet ring by loosening and removing the M5 Socket head cap screws from the thruster.
- Be careful not to damage the coupling nozzle when removing the outlet ring.





- Loosen and remove all six M5x8 Socket countersunk head screws from the inside of the propeller.
- Gently drag the propeller out of the thruster.

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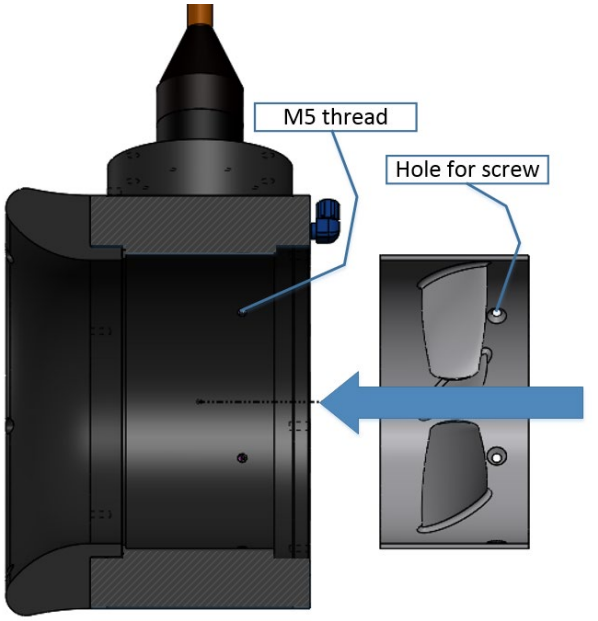
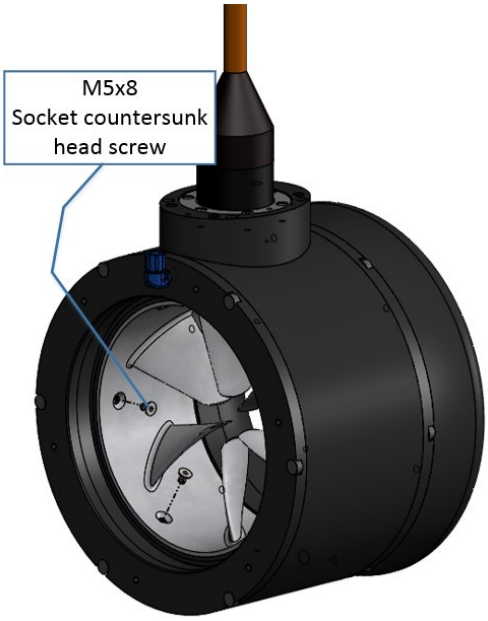
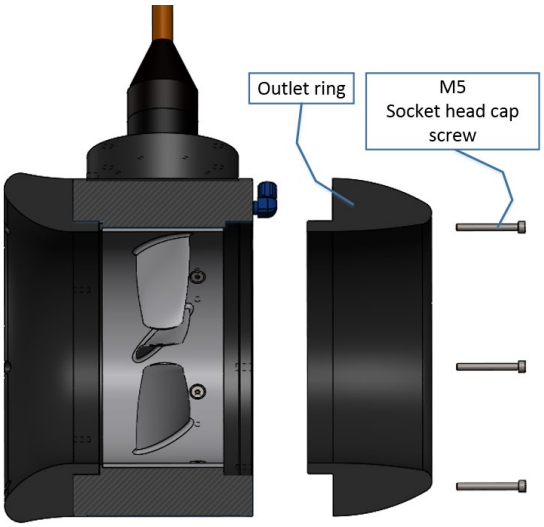
Insert Propeller





- Gently press the propeller into the thruster.
- Be aware of aligning the M5 threads and the holes for screws when inserting the propeller.
- Add a bit of AquaShield grease on the thread of all six M5x8 socket countersunk head screws.
- Mount the M5x8 socket countersunk head screws on the inside of the propeller and tighten them.



- Be careful not to damage the coupling nozzle when adding the outlet ring to the thruster.
- Add a bit of AquaShield grease on the thread of all the M5 socket head cap screws.
- Mount all the M5 socket head cap screws into the outlet ring and thruster and tighten them.

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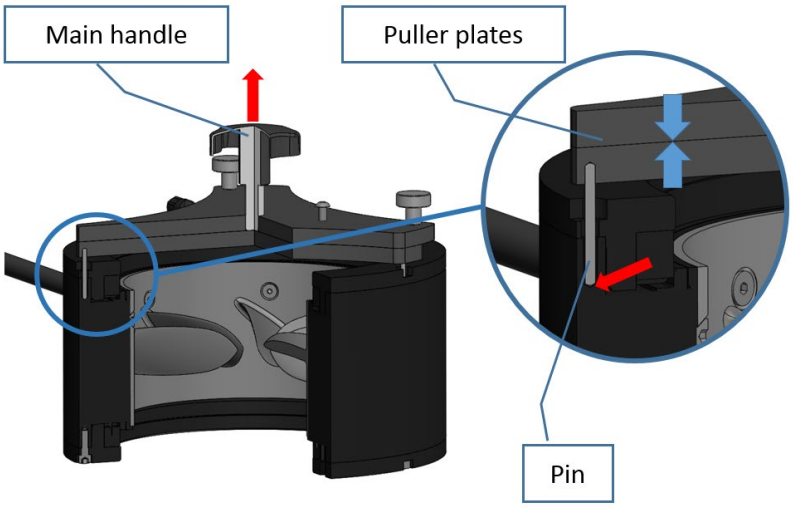
Remove bearing ring

- Remove the thruster outlet ring in the same order as described in the “remove propeller” section.
- Remove the 6 screws from the bearing ring
- Make sure the holes are clean: remove previously applied AquaShield grease
- Place the bearing puller parallel with the bearing ring and align the 3 pins with 3 of the 6 holes going through the bearing ring. Make sure the 3 pins stand firmly on the bottom of the screw holes
- Be careful not to damage the coupling nozzle when placing the bearing puller.



- Make sure that the main handle is fully retracted, that the puller plates are close together, and that the 3 pins stand firmly on the bottom of the screw holes.

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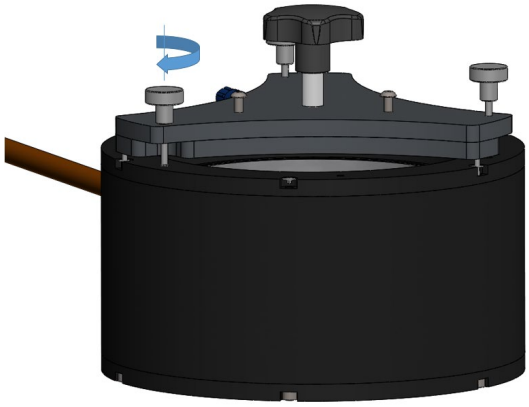

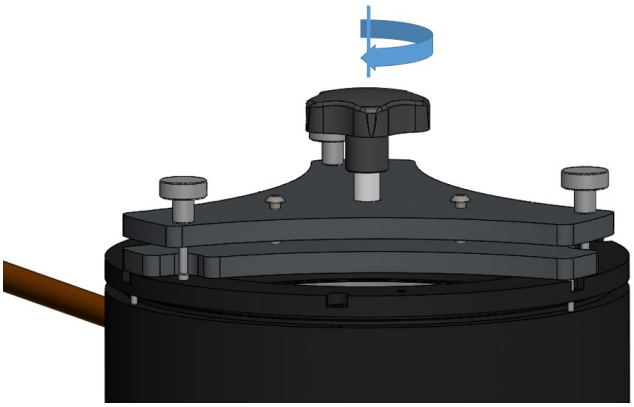

- Tighten the 3 finger screws. (Be careful not to damage the threads in the bearing ring when attaching the bearing ring puller)
- Turn the main handle until the bearing ring releases. Give it another couple of turns to make sure the lid is completely free of the stator ring.

- Remove the bearing ring puller together with the bearing ring.
- Remove the bearing ring.
- Be careful not to damage the ceramic bearings.

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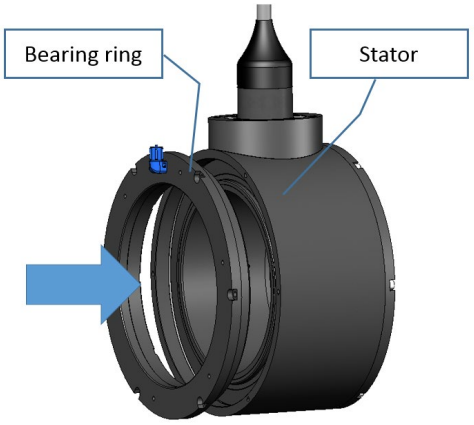
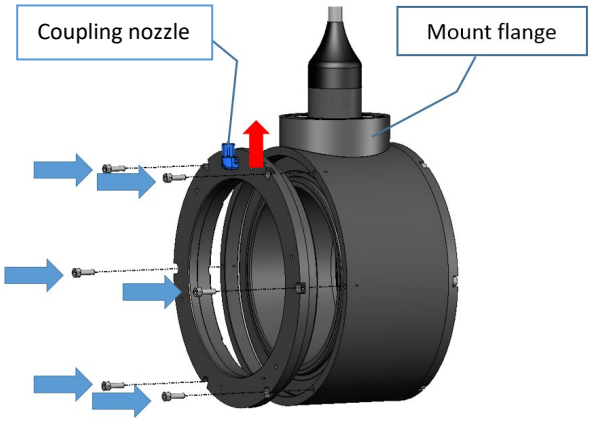
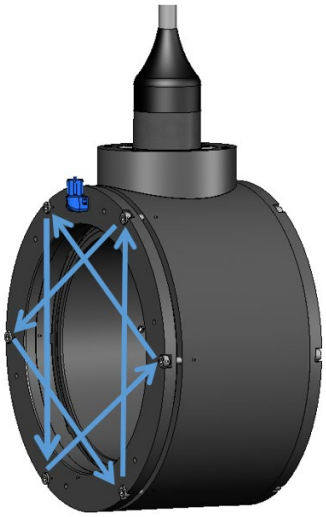
Insert bearing ring





- Place bearing ring on stator side.
- If there is a coupling nozzle, make sure that it is pointing towards the mount flange.
- Make sure the holes are clean: remove previously applied AquaShield grease
- Apply AquaShield grease in the holes and insert the 6 screws.
- With the help of a torque wrench (4.6 Nm) screw in the screws.
- When inserting the bearings, make sure to use plastic washers for the screws.



- Use the screws to pull the bearing ring into place.
- Turn the rotor by hand to make sure that it is inserted correctly and does not squeeze the bearings.
- Tighten the screws evenly in a star pattern to avoid damaging the ceramic bearings and to get an even force distribution on the bearing ring. Tightening force 5Nm dry or 4,6Nm lubricated.

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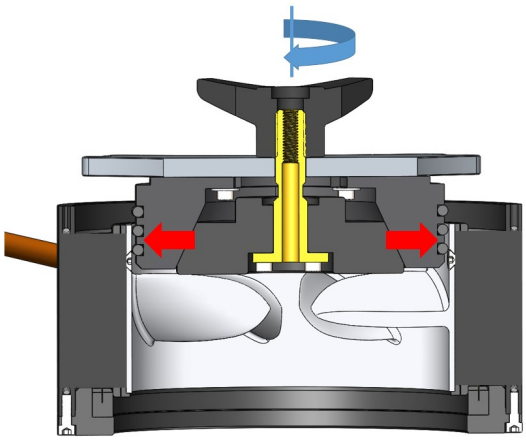
Remove Rotor

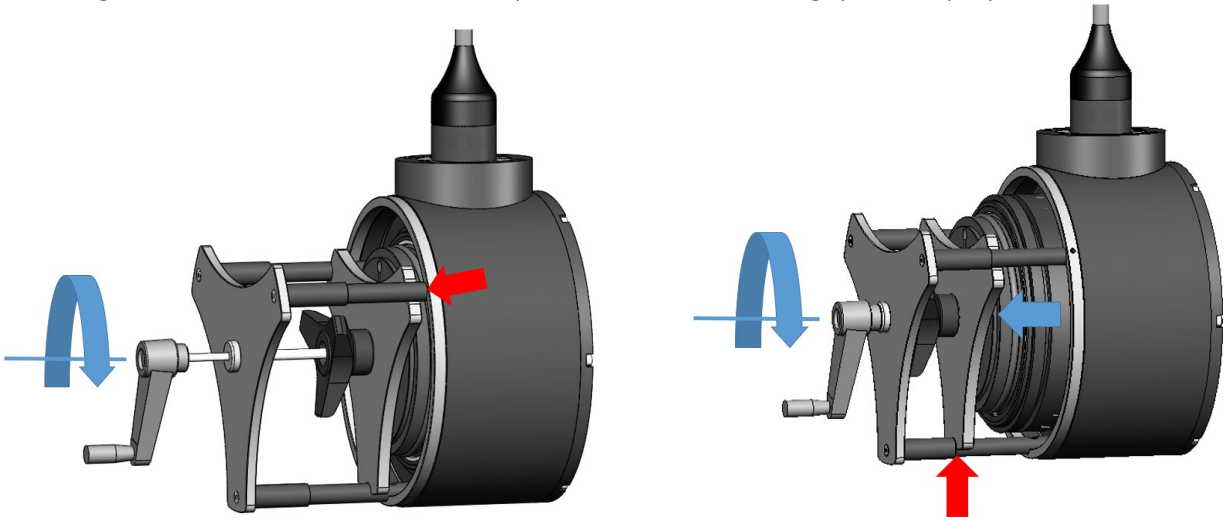
The rotor may be removed with or without the propeller. Be aware to remove both bearings before removing the rotor. Further, there are 3 ways of removing the rotor which is covered in this section.

With propeller:

The rotor may be removed with the propeller attached.



- Remove the bearing ring as described in the section “Remove bearing ring”
- Attach bottom part of the Rotor puller by placing it on top of the propeller blades in the outlet side of the propeller.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.



- Place the rotor puller top part so that it aligns with the stator body.
- Make sure the 3 legs align with the cutouts in the rotor puller bottom plate.
- Turn the handle to join top and bottom part of the rotor puller tool.
- Continue to turn the handle until the bottom plate hits the stop on the leg.

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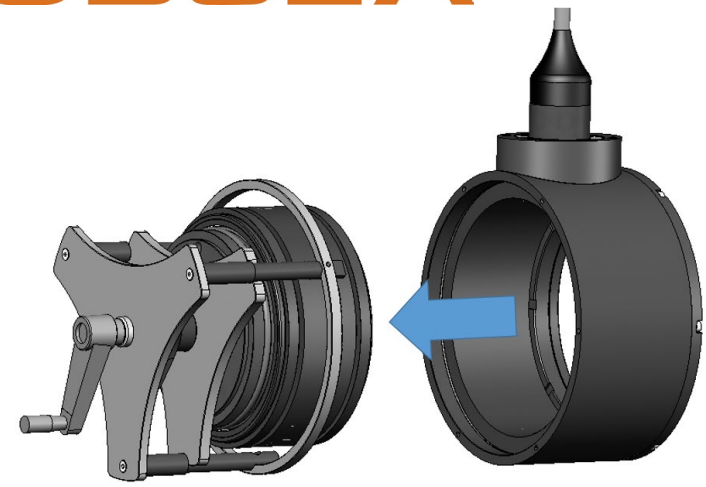
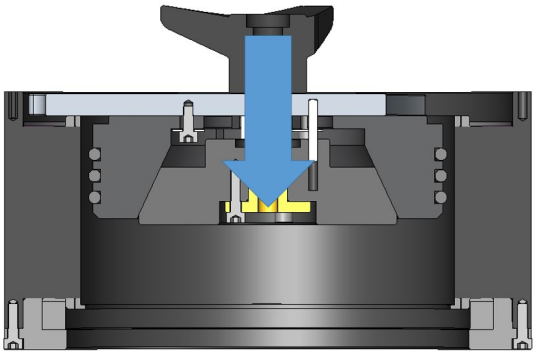
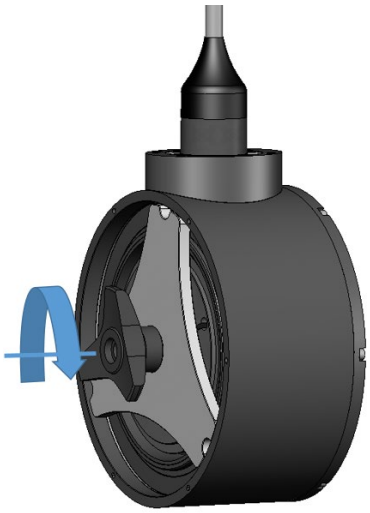


- Gently pull out the rotor and rotor puller tool.
- Be careful not to damage the ceramic bearings.

Without propeller:

If the propeller has already been removed, the rotor puller tool may still be used.
The procedure is the same as when the propeller is still attached.





- Attach bottom part of rotor puller by placing it in the outlet side of the rotor.
- The expansion block is inserted in full depth and the bottom plate rests on the rotor side.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.
- Follow the steps in the “Remove rotor with Propeller” section.

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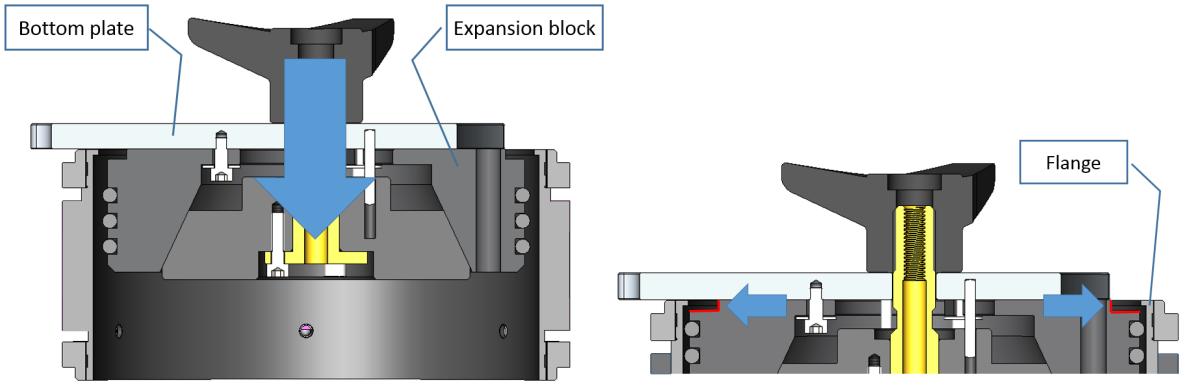
From inlet side:

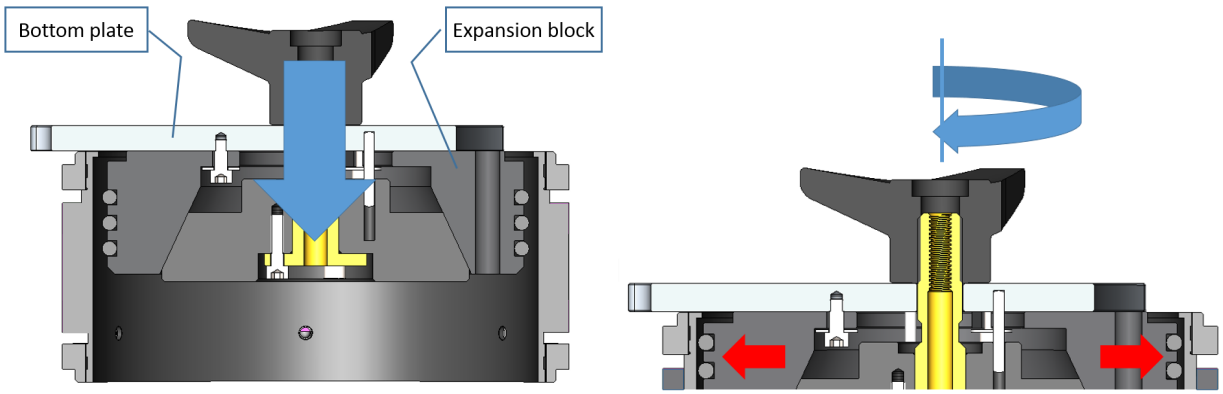
Removing the rotor from the inlet side follows the same procedure as “Remove Rotor with Propeller”



- When the propeller is removed, it is important to make sure that the expansion block is inserted in full depth and the bottom plate rests on the rotor side.
- The flange on the rotor inside wall should fit into the space between the bottom plate and the expansion block.
- The rest of the procedure follows the “Remove Rotor” section.

Insert rotor

When inserting the rotor make sure both bearings removed before inserting the rotor.



- Attach bottom part of Rotor puller by placing it in the center hole of the rotor.
- Make sure that the rotor is oriented correctly in relation to the stator inlet and outlet.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.

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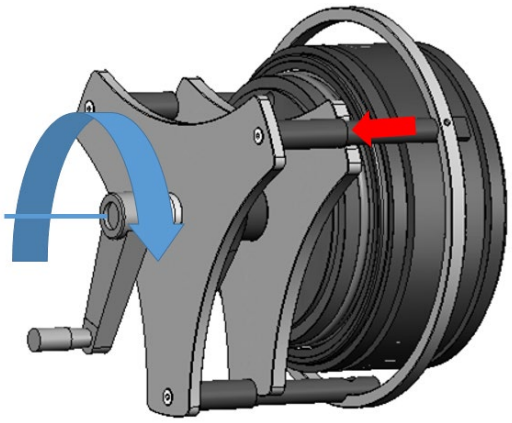
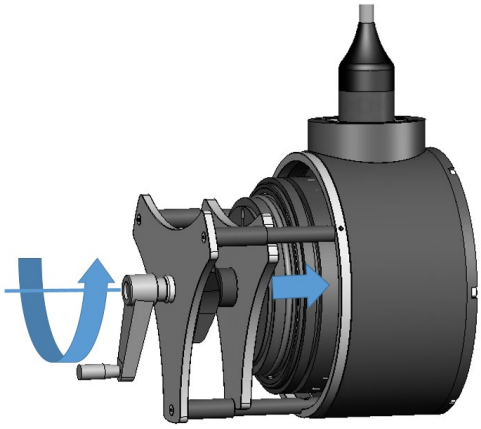


- Align the rotor puller top with the rotor bottom cutouts.
- Turn the handle until the rotor puller bottom is fully retracted.



- Push the rotor into the stator and hold the rotor puller tool against the stator to avoid misalignment.
- Be careful not to damage the ceramic bearings while inserting the rotor into the stator.
- Turn the handle to insert the rotor.
- Be careful not to damage the stator overmold while inserting the rotor.

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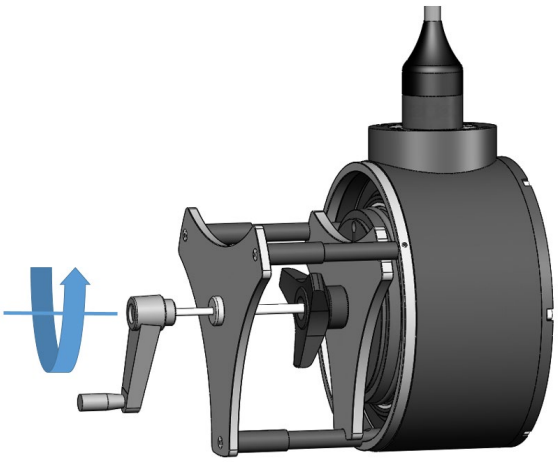

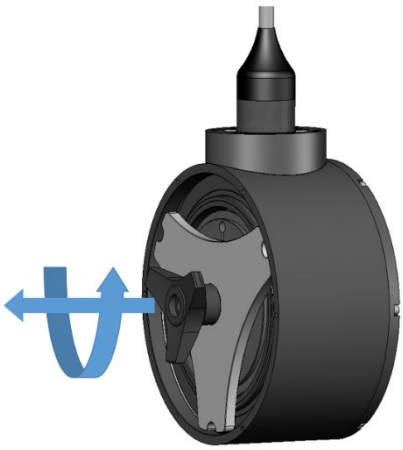

- Turn the handle in the opposite direction to screw the spindle back out.
- Release the center screw and pull out the rotor puller tool.
- Turn the rotor by hand to make sure that it is inserted correctly.
- These steps apply both with and without the propeller attached.
- (For instructions on how to mount the bearing ring, read the “Insert Bearing Ring” section).

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Disposal of the thruster

When the thruster is worn out or for other reasons cannot or will not be used anymore it is important to recycle the materials of the thruster - Mainly aluminum and cobber parts. This is done by returning the thruster to an authorized recycling company. Another option is to return the thruster to:

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2900 Hellerup
Denmark

Record of Conformity

All thruster from Copenhagen Subsea A/S is in conformity with the requirements and provisions of the following European Union directives and their respective standards.

Partly Completed Machinery Directive	2006/42/EC
EMC Directive	EMC 2014/30/EU
RoHS Directive	RoHS 2077/65/EU
REACH Directive	(EC) No. 1907/2006
Harmonised Standards	EN 60945
	EN 60204-1
	EN 60335-1
DNV • GL – Rules for Classification	Underwater technology, Edition December 2015 Part 3 Pressure hull and structures Chapter 2 Design loads

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