COPENHAGEN SUBSEA

Copenhagen Subsea Thruster Manual

Version 4.1

Copenhagen Subsea A/S

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COPENHAGEN SUBSEA

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Introduction

This manual provides essential information for the safe installation, operation, and maintenance of the Copenhagen Subsea thruster. Following the instructions in this manual will help ensure reliable performance, long service life, and safe handling of the thruster.

This manual applies to all Copenhagen Subsea thruster models and voltage variants. Because each thruster is delivered with model-specific performance characteristics, electrical requirements, and operating limits, users must always refer to the motor data sheet supplied with the thruster at delivery. If the data sheet is missing or additional copies are required, it can be obtained by contacting Copenhagen Subsea. A 2D drawing of the specific thruster also follows the thruster when delivered. This drawing shows main dimensions and picture of the thruster nameplate. The thruster nameplate is placed on the outside of the thruster and contains important data like Type, Serie No, depth rating etc.

The instructions in this manual describe the general installation, operation, and maintenance procedures that apply to all thruster configurations.

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

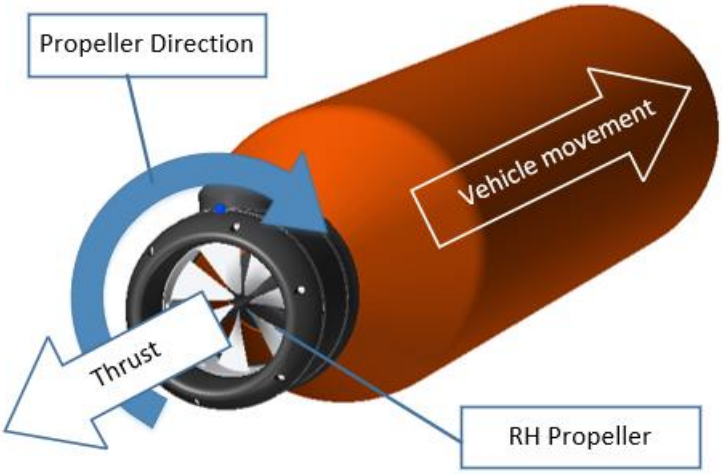
Functional Description

The thruster's purpose is to generate propulsion or maneuvering force for underwater vehicles by accelerating water through an integrated propeller unit. The thruster uses a shaftless, direct-drive motor design in which the rotor rotates inside the stator without traditional shaft seals. The propeller is supported by ceramic flange bearings that are lubricated and cooled by the surrounding water.

During operation, the thruster must always be fully submerged, as the water provides both cooling and lubrication. Running the thruster in air can cause overheating and damage to the bearings. The thruster is designed for use in fresh or salt water within the specified temperature and pH ranges.

Propeller design

Copenhagen Subsea offer different propellers designs. The Symmetric propellers are optimized to deliver the same amount of thrust in both directions. The Asymmetric propellers give more thrust in forward direction than in reverse direction. Both the Symmetric and the Asymmetric propellers come in Right Hand (RH) and in left Hand (LH) versions and in 4 sizes (VS, VM, VL, VXL). Propeller Part No, size and propeller type are printed on the outside of the propeller.



A Right-Hand (RH) propeller rotates clockwise when viewed from behind the propeller looking forward, and it produces forward thrust in that rotation direction.

A Left-Hand (LH) propeller rotates counterclockwise when viewed from behind the propeller looking forward, and it produces forward thrust in that rotation direction.

Configurations

Thruster configurations with standard straight penetrator

The cable on this type of thruster is routed through the center of the elliptical mounting flange. The cable runs perpendicular to the water flow.

To give even more thrust in- and outlet ring can be installed at the thruster. For the Asymmetric propeller the configuration of an Inlet ring and an outlet ring works very well. The Symmetric propeller works well with an Outlet-Outlet configuration.

Compact.

(No rings)

This thruster is ideal for compact vessel integration. By using a symmetric propeller, the thruster functions optimally as a tunnel thruster built into the hull of a subsea vehicle.

Asymmetric configuration

(with 1 Inlet ring and 1 Outlet ring)

The Asymmetric setup is optimized to deliver high and efficient thrust in a primary direction. This setup is often used as the main propulsion in vehicles that have a forward direction.

Symmetric configuration

(with 2 Outlet rings)

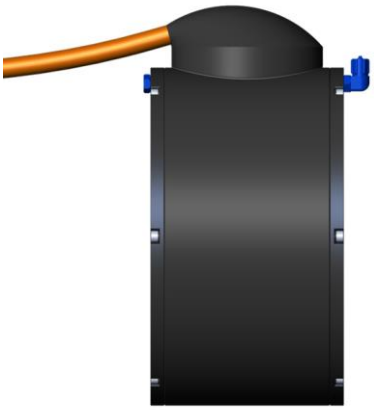
The Symmetric setup is optimized to deliver the same amount of thrust in both directions. This setup is often used in station keeping ROV's where it is important to position the ROV precisely despite of strong currents.

AUV thruster configurations with dome-shaped cable penetrator

The cable on the AUV thruster enters through a molded dome-shaped cable penetrator. The cable runs parallel to the water flow. The AUV thruster design gives less drag in water and with an *Inline Mounting Bracket* it is easy to install at the end of a classic AUV.

AUV Thruster

(No rings)

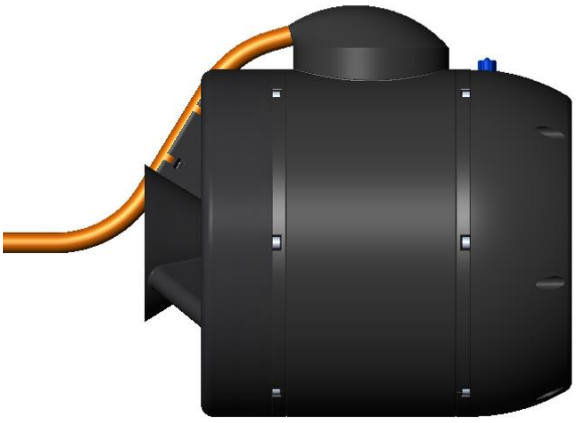


This configuration allows for a different cable routing compared to a thruster with a standard straight penetrator. However, it also requires a different mounting method.

This configuration works well both with a symmetric or an asymmetric propeller.

AUV – Inline mount

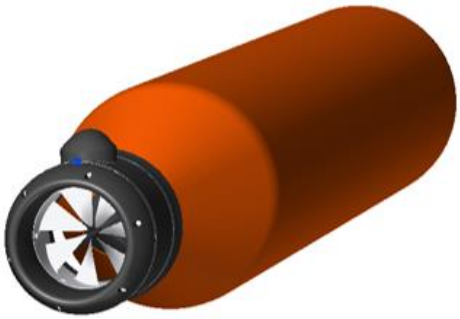
(With Inline Mounting Bracket)



This configuration is designed for use on a classic AUV. The Inline Mounting Bracket is used as both an inlet ring and to mount the thruster to the AUV. The cable runs smoothly from the penetrator to the center of the AUV along one of three hydrodynamically shaped arms on the bracket.

The outlet ring directs the water flow to improve thruster efficiency.

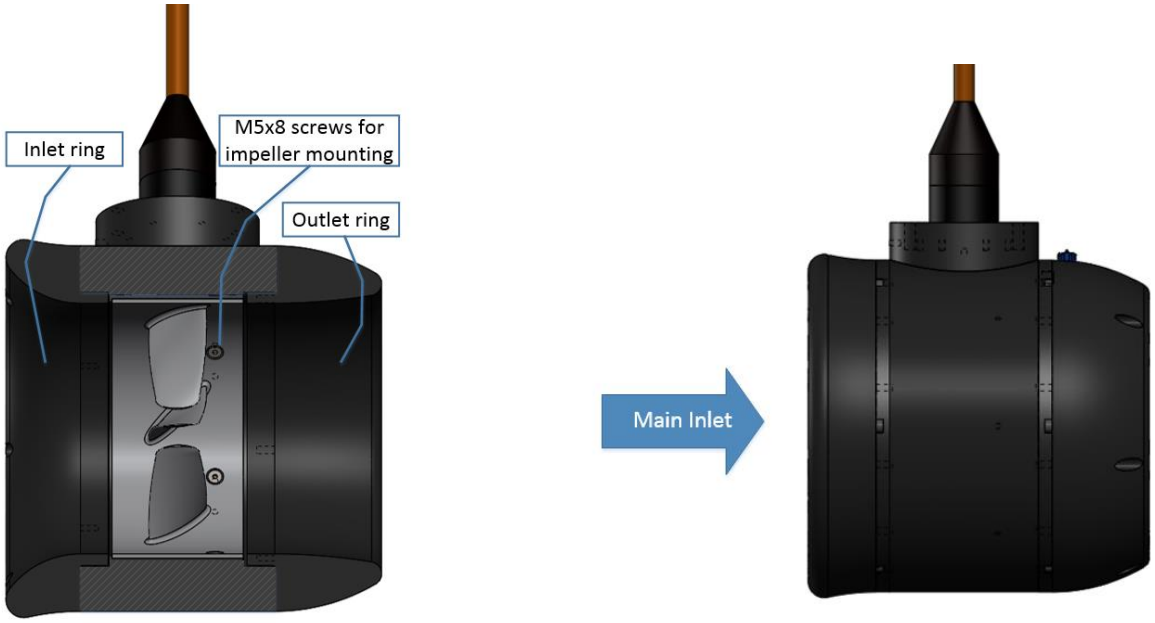
An asymmetric propeller is recommended for this configuration



AUV – Inline mount installed on a classic AUV

Detect Main Water Inlet

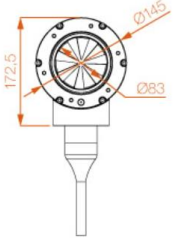
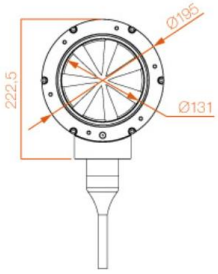
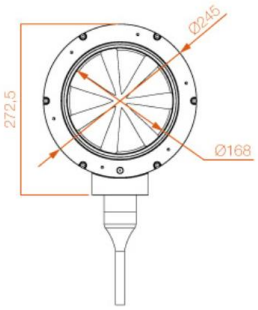
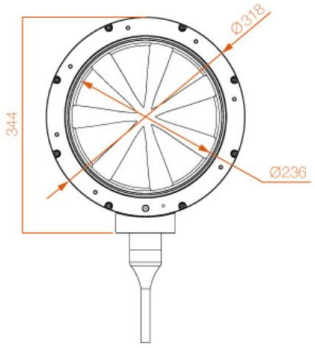
To detect the main water inlet please see the picture below.



Picture shows a configuration with an Inlet and an Outlet ring

Weight information

The weight of the thruster depends of the size, configuration, cable dimension etc. The table below shows an overview of the minimum weight (in air)

VS Version Small	VM Version Medium	VL Version Large	VXL Version Extra Large
			
VS:	VM	VL	VXL
from 4,5 kg	from 5,7 kg	from 9,1 kg	from 17,8 kg

Warnings

Hazard symbols

The following hazard symbols are used in this manual. Familiarize yourself with them before installing, operating or servicing the thruster.

Symbol	Meaning
	General warning. Read the manual carefully. Failure to observe warnings may cause injury or damage.
	Strong magnetic field. The rotor contains powerful permanent magnets. Keep away from pacemakers, magnetic media, ferromagnetic tools and other sensitive electronics.
	Electrical hazard. Disconnect power before handling, mounting or servicing the thruster.
	Hot surface / overheating. Motor temperature must stay below 70 °C. Surfaces may be hot after operation.
	Crushing / pinch hazard. Strong magnetic forces during rotor handling. Use only the dedicated tools described in this manual.
	Rotating parts. Keep hands and objects away from the propeller and rotor. Do not operate without proper guarding or underwater.

Warning list

	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 taking other safety precautions.
	Keep hands and other objects out of the propeller, when there is power on the thruster
	Disconnect the thruster from power when handling it.
	Operate the thruster under water only. The warranty will not cover damage resulting from running the thruster without water to lubricate its bearings.

	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 the max temp. Rated at the Thruster nameplate.
	Never bend the cable more than the allowed bending radius (see the limits at the 2D drawing of the specific thruster
	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 careful when handling the rotor. It has strong magnetic force. Avoid steel tools next to the rotor.
	During operation the thruster needs to be fully submerged in water.
	Be aware of sharp edges when handling the propeller
	Handling the thruster with care during installation and transportation
	Use Copenhagen Subsea A/S specially designed transport boxes for transportation
	Be careful not to damage the thruster outer surfaces
	Avoid damaging the cable and connector
	The thruster acts as a generator when the rotor is rotated by an external force (e.g. water flow or manual handling). This may result in unexpected voltage on the cable.

Technical Data

A Motor Datasheet and a 2D product drawing of the specific thruster follow the thruster when delivered. The two documents have key information for the specific thruster. See example below:

- Keep the motor data sheet and 2D drawing for future use.

Motor Datasheet

Example

Motor Datasheet

Motor Type	VM1 - 35 turns	Stator No.	A 3457	Date Created:	14-01-202

Parameters	Value	Unit	Description
P	5,7	kW	*Input power to motor*
n	2100	rpm	*Nominal speed*
T	21,97	Nm	*Nominal torque*
V_{peak}	535,38	$V_{ph-ph,peak}$	*Peak phase-to-phase motor nominal voltage*
V_{rms}	378,57	$V_{ph-ph,rms}$	*Effective phase-to-phase motor nominal voltage*
K_e	158,13	$\frac{E_{ph-ph,rms}}{Krpm}$	*Effective phase-to-phase voltage constant*
I_{peak}	12,75	A_{peak}	*Peak motor nominal current*
I_{rms}	9,02	A_{rms}	*Effective motor nominal current*
K_t	2,44	$\frac{Nm}{A_{rms}}$	*Torque constant*
N_{turns}	35	-	*Winding number of turns*
R_{ph-ph}	5954,86	$m\Omega$	*Phase-to-phase resistance*
L_{ph-ph}	5580,56	mH	*Phase-to-phase inductance*
pp	12	-	*Pole pairs*
f	420	Hz	*Maximum frequency*

See page 2 for important information regarding thruster use

Example

Electric Subsea Thrusters
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An internal part No. of the stator inside the Thruster
(Thruster S/N is shown at the nameplate)

P - Electrical input power to the motor. Actual mechanical output will be slightly lower due to drive and electrical losses

n - Thruster max RPM at nominal load

T - Nominal torque at rated load

V peak -the instantaneous peak voltage between phases. Used when sizing drive electronics, DC bus, and insulation.

V rms - Effective phase-to-phase voltage needed.

K e - Voltage the motor generates per 1000 rpm. Used for controller tuning

I peak - Peak current draw. Used for sizing fuses, cables, and the drive's peak current capability.

I rms - Continuous current rating. Determines steady-state heating and the required cable and drive capacity.

K t - Torque produced per amp.

N turns - Number of wire turns per coil in the stator.

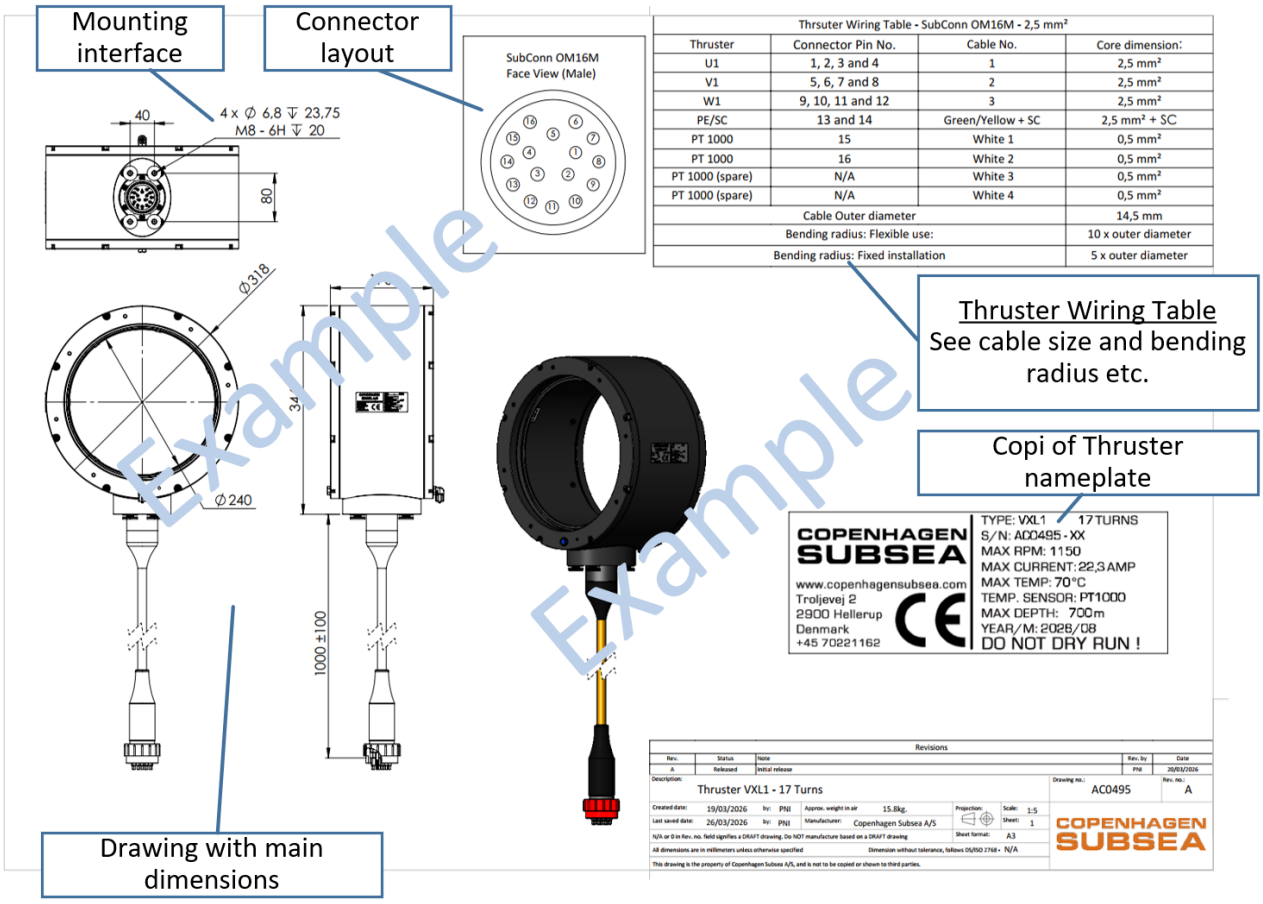
R ph-ph - Resistance between two phases

L ph-ph - Inductance between two phases

pp - Number of magnetic pole pairs in the rotor

f - Maximum electrical frequency at top RPM.

2D product drawing



Thrsuter Wiring Table - SubConn OM16M - 2,5 mm²			
Thruster	Connector Pin No.	Cable No.	Core dimension:
U1	1, 2, 3 and 4	1	2,5 mm²
V1	5, 6, 7 and 8	2	2,5 mm²
W1	9, 10, 11 and 12	3	2,5 mm²
PE/SC	13 and 14	Green/Yellow + SC	2,5 mm² + SC
PT 1000	15	White 1	0,5 mm²
PT 1000	16	White 2	0,5 mm²
PT 1000 (spare)	N/A	White 3	0,5 mm²
PT 1000 (spare)	N/A	White 4	0,5 mm²
Cable Outer diameter			14,5 mm
Bending radius: Flexible use:			10 x outer diameter
Bending radius: Fixed installation			5 x outer diameter

COPENHAGEN SUBSEA
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TYPE: VXL1 17 TURNS
S/N: AC0495 - XX
MAX RPM: 1150
MAX CURRENT: 22,3 AMP
MAX TEMP: 70°C
TEMP. SENSOR: PT1000
MAX DEPTH: 700m
YEAR/M: 2026/08
DO NOT DRY RUN !

Revisions				
Rev.	Status	Note	Rev. by	Date
A	Released	Initial release	PNI	20/03/2026

Description: Thruster VXL1 - 17 Turns
Drawing no.: AC0495
Rev. no.: A
Created date: 19/03/2026 by: PNI
Last saved date: 26/03/2026 by: PNI
Approx. weight in air: 15.8kg.
Manufacturer: Copenhagen Subsea A/S
Projection:
Scale: 1:5
Sheet: 1
Sheet format: A3
N/A or 0 in Rev. no. field signifies a DRAFT drawing. Do NOT manufacture based on a DRAFT drawing
All dimensions are in millimeters unless otherwise specified
Dimension without tolerance, follows DS/ISO 2768 - N/A
This drawing is the property of Copenhagen Subsea A/S, and is not to be copied or shown to third parties.
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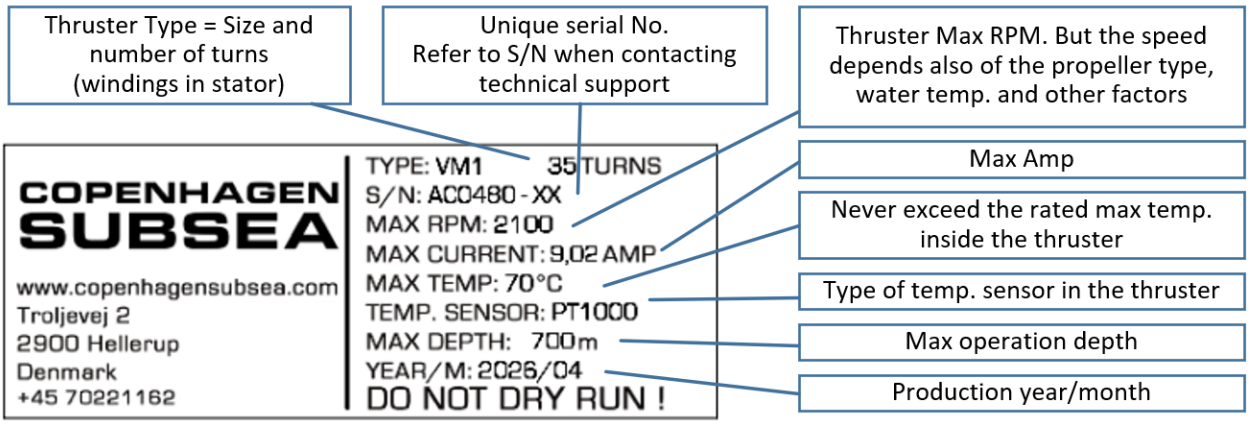
Thruster Nameplate

A Thruster Nameplate is attached on the outside of the thruster. It contains information for the specific thruster. The picture below shows an example:



Assembly Instructions (for Partly Completed Machinery)

(To be supplied with each Copenhagen Subsea Thruster)

These Assembly Instructions are intended for the machine builder who integrates a Copenhagen Subsea thruster into a complete machine. The thruster is a partly completed machinery and must not be put into service until the final machine has been assessed and CE-marked by the machine builder.

The information below describes the conditions for safe integration, the intended use, foreseeable misuse, operating limits, environmental limits, and the mechanical, electrical, and safety interfaces that must be respected.

1. Intended Use

The Copenhagen Subsea thruster is intended to provide propulsion or maneuvering force for underwater vehicles by accelerating water through an integrated propeller unit. The thruster is designed for continuous operation while fully submerged, where the surrounding water provides cooling and lubrication for the ceramic bearings.

The thruster is intended for use in freshwater or seawater with a pH between 6 and 9, and within the specified temperature and depth ratings shown on the thruster nameplate.

The thruster must be operated only with a suitable motor controller capable of limiting current, RPM, and temperature according to the thruster's specifications.

The thruster is not a standalone machine and must only be used as a component in a larger system that is CE-marked by the machine builder.

2. Foreseeable Misuse

The following foreseeable misuse scenarios must be prevented by the machine builder:

- Operating the thruster out of water, which can cause overheating and bearing damage.
- Operating in liquids outside the specified pH range or in chemically aggressive fluids.
- Operating without adequate propeller guarding, as the thruster is delivered without safeguarding.
- Operating with blocked or restricted water inlet/outlet flow.
- Using a motor controller that does not enforce current, RPM, or temperature limits.
- Bending the cable below its minimum bending radius, as stated at the 2D drawing of the thruster.
- Failing to electrically isolate the thruster from the mounting structure, which may cause galvanic corrosion.
- Allowing unintended start-up during installation or maintenance.
- Running the thruster with the flushing port open, allowing particles to enter the motor housing.

The machine builder must implement protective measures to eliminate or reduce these risks.

3. Operating Limits

The following operating limits must be respected:

Thermal limits:

- Maximum internal motor temperature: See Thruster Nameplate
- Water temperature during operation: –5 °C to +40 °C

Electrical limits

Maximum current and RPM: according to the thruster's motor datasheet and nameplate.

Connector current limits:

SubConn OM10M: max 20 A
SubConn OM16M: max 40 A
CRE B-Class: max 50 A
CRE C-Class: max 125 A
CRE J-Class: max 170 A

Mechanical limits

- Cable bending radius: as specified in the thruster's 2D drawing
- Depth rating: As stated on the thruster nameplate (e.g., 700 m, 3000m 6000m)
- Mounting bolts: 4 × M8, A4 stainless steel - Torque: 10 Nm - Minimum thread engagement: 12 mm (When using ellipse shaped mount flange)

The machine builder must ensure that none of these limits are exceeded in the final application.

4. Environmental Limits

The thruster may only be used under the following environmental conditions:

- Water type: Freshwater or seawater with pH range: 6–9
- Operating water temperature: –5 °C to +40 °C
- Storage temperature: –45 °C to +60 °C
- Particulate exposure: Flushing port must be sealed during operation to prevent erosion.
- Corrosion: Thruster must be electrically isolated from dissimilar metals to avoid galvanic corrosion.
- The installation location must ensure free water flow to both inlet and outlet.

5. Interface Conditions

5.1 Mechanical Interface

- The thruster must be mounted using the four M8 threaded holes in the mounting flange.
- Use A4 stainless steel bolts, tightened to 10 Nm in a crisscross pattern.
- The mounting structure must be rigid enough to withstand thrust loads and vibration.
- Electrical isolation washers supplied with the thruster must be installed to prevent galvanic corrosion.

5.2 Electrical Interface

- The thruster must be connected to a compatible motor controller capable of:
  - Limiting current
  - Limiting RPM
  - Monitoring Pt1000 temperature
  - Shut down before the thruster temperature exceeds the maximum value stated on the nameplate. Be aware of temperature overshoot.

- PE (Protective Earth) must be connected via the designated connector pins.
- EMC measures (shielding, grounding, filtering) must be implemented by the machine builder.

5.3 Cooling and Water Flow Interface

- The thruster must be fully submerged during operation.
- Water inlet and outlet must not be obstructed.
- No structural elements may be placed in the flow path.
- The flushing port must be sealed during operation.

5.4 Safety Interface

The machine builder must consider implementing:

- Propeller guarding to prevent access to rotating parts
- Emergency stop functionality for the complete machine
- Protection against unintended start-up
- Monitoring temperature, current, and RPM
- System-level risk reduction measures based on the machine builder's risk assessment

6. Residual Risks Transferred to the Integrator

The following residual risks cannot be eliminated by the design of the partly completed machinery alone and are transferred to the system integrator. The integrator shall address each item in the final machinery and document it in their own risk assessment in accordance with EN ISO 12100.

	Mechanical guarding: The thruster is delivered without a propeller guard. The integrator shall provide guarding or restrict personnel access to the propeller/rotor area in the final machinery.
	External motor controller: The integrator shall provide a motor controller (drive) with PWM frequency and voltage matched to the thruster motor datasheet. Keep the transients in mind when choosing the motor controller.
	Over-current protection: External over-current and over-voltage protection in the drive is required to prevent damage from stalling, faults or transients.
	Thermal protection: The integrator shall implement automatic shutdown based on the Pt1000 temperature signal. Motor temperature must not exceed the maximum value stated on the nameplate. Note that temperature may continue to rise after shutdown.
	Emergency stop: An emergency stop function shall be provided in the final machinery in accordance with EN ISO 13850 where applicable.
	EMC installation: Shielding, grounding and filtering shall be implemented to ensure EMC compliance of the final machinery. The thruster itself has been tested in accordance with EN 60945.
	Generator: The thruster acts as a generator when the rotor is rotated by an external force (e.g. water flow or manual handling). This may result in unexpected voltage on the cable.
	Rotation direction verification: Correct rotation direction shall be verified before taken in use.
	Lock-out / tag-out: The integrator shall provide a means to disconnect and isolate the thruster from power before service or maintenance.

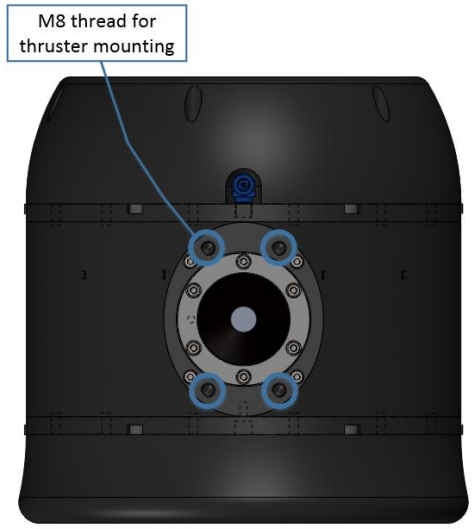
Handling: Consider the weight of the Thrusters before installation and removal. - See weight information at the 2D drawing.

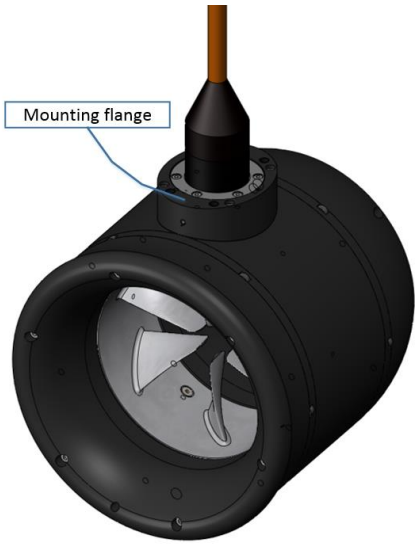
Magnetic field: The integrator shall keep magnetically sensitive equipment (compasses, sensors, magnetic media) at a sufficient distance from the thruster.

Mounting the Thruster

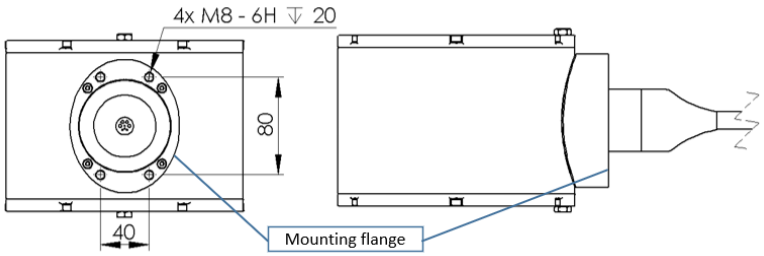
Mount Flange

If the thruster is equipped with an ellipse-shaped mounting flange and a cable penetrator as shown below, please follow the instructions in the guide below.

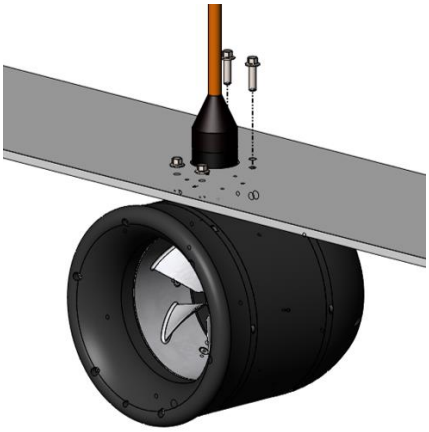




- Use the four-hole pattern on the mounting flange when mounting the thruster.
- Ensure the mounting bracket on your application is robust and stable.
- Refer to the drawing below for the mounting hole pattern.
- Use A4 stainless steel M8 screws. Apply **Loctite 243** to the threads.
- Tighten the screws with a torque wrench to **10 Nm**, using a criss-cross tightening sequence.
- Ensure each screw engages at least 12 mm of thread inside the mounting flange.
- Periodically check and retighten the screws to **10 Nm** with a torque wrench.



Mounting holes pattern for:
VS, VM, VL and VXL thrusters



Electrical Isolation of the Thruster

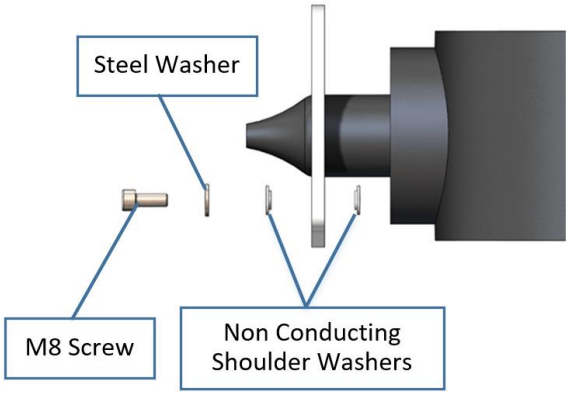
It is important to electrically isolate the thruster when mounting the thruster onto the application. The reason for this is to avoid corrosion and cathodic debonding. When ordering a propulsion solution from Copenhagen Subsea, the necessary equipment to electrically isolate the thruster is included.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

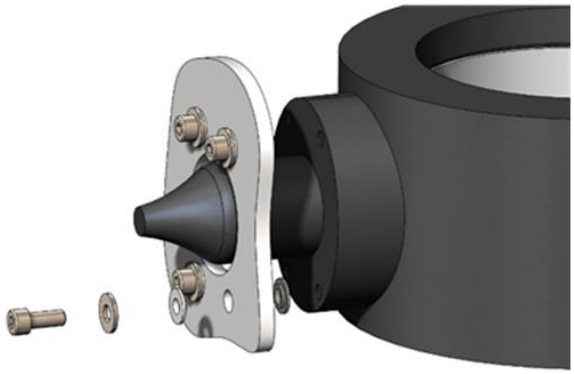
- 2x non conducting shoulder washers

Depending on the thickness of the mounting bracket, different sets 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 non conducting shoulder washers)

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



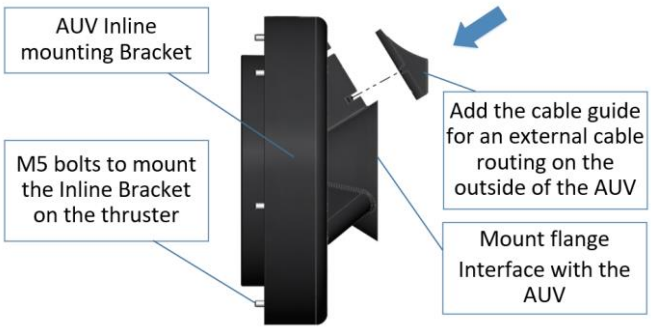


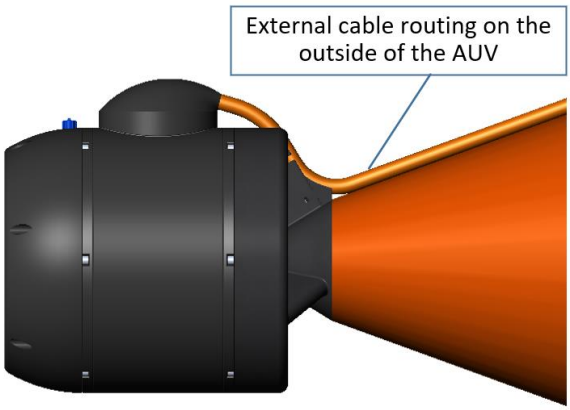
AUV Inline Mounting

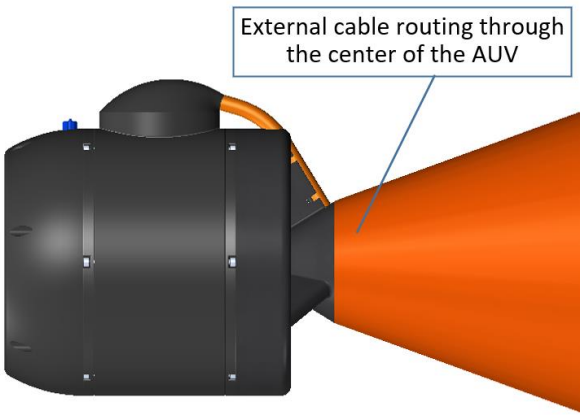
If the thruster is equipped with a molded dome-shaped cable penetrator as shown below, please follow the instructions in the guide below.

Cable routing

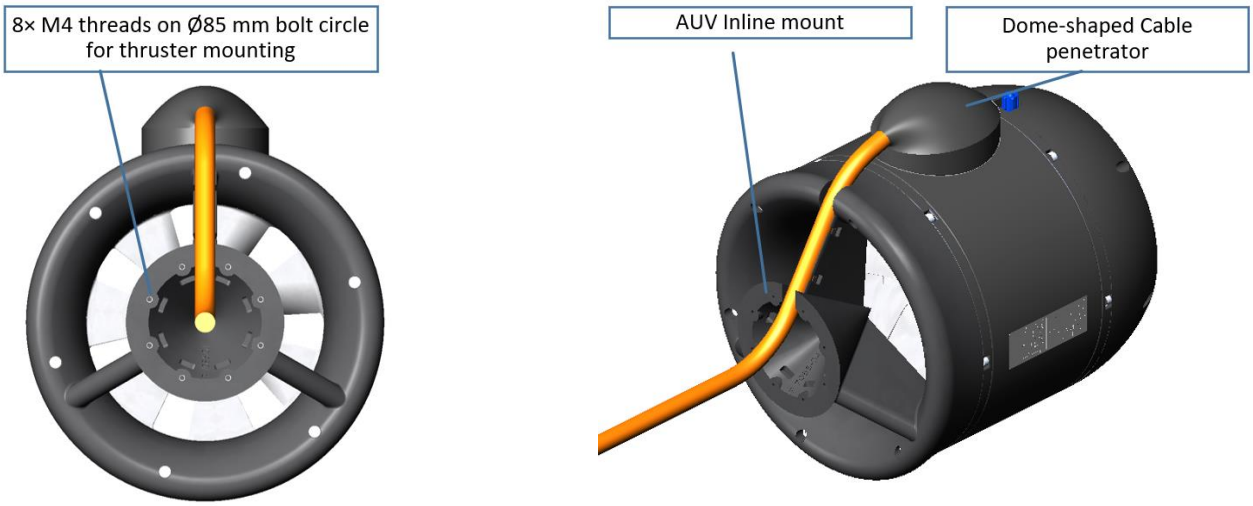
With the AUV Inline Mounting Bracket there are two options for cable routing. The cable runs smoothly from the penetrator along one of the bracket's three hydrodynamically shaped arms. From the arm, the cable can either be routed to the center of the AUV for internal cable routing, or guided externally by adding a cable guide.



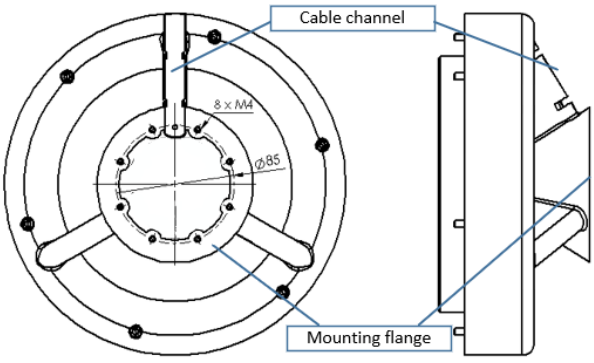




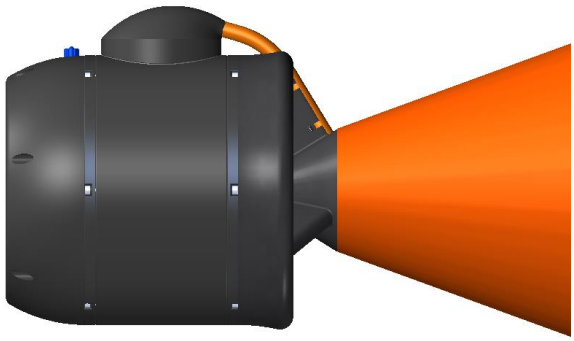
Mounting AUV thruster on the end of an AUV



- Use the 8-hole pattern on AUV Inline mounting bracket when mounting the thruster.
- Ensure the mounting bracket on your application is robust and stable.
- Refer to the drawing below for the mounting hole pattern.
- Use A4 stainless steel M4 screws. Apply **Loctite 243** to the threads.
- Tighten the screws with a torque wrench to **2,5 Nm**, using a criss-cross tightening sequence.
- Ensure each screw engages at least 12 mm of bracket.
- Periodically check and retighten the screws to **2,5 Nm** with a torque wrench.



Mounting holes pattern for:
VS, VM, VL and VXL thrusters



Subsea Electrical Connectors

Copenhagen Subsea thrusters are supplied with moulded power cables. The cable diameter and length vary depending on the thruster type, customer requirements, and power consumption.

Thruster cables are delivered either as open-ended (without a connector) or with a connector from SubConn or CRE-Marine. The available connector options are listed later in this section.

The drawing provided with the delivered thruster includes detailed information about the cable size and the connector type used.

SubConn

Copenhagen Subsea uses two different SubConn connectors on the thruster: the SubConn Circular 10-pin (OM10M) and the SubConn Circular 16-pin (OM16M).

Please identify the correct connector and refer to the information provided below.

General information about SubConn: https://www.macartney.com/connectivity/subconn/

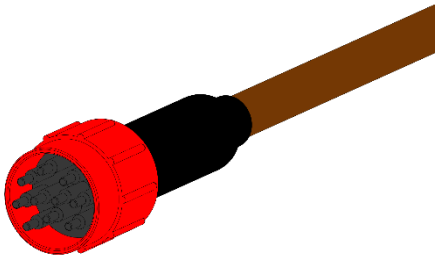
For handling instructions, please see SubConn book on the following link:
https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-book/

SubConn10 pins

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

Connector type: SubConn Circular 10 pins (OM10M)

Pin Connection	
Motor phase	1 and 2
Motor phase	3 and 4
Motor phase	5 and 6
PE (Protected Earth)	7 and 8
Temperature Sensor	9 and 10
NB: Max 20 Amp.	



Further connector details:
https://www.macartney.com/connectivity/subconn/subconn-circular-series/subconn-circular-6-8-and-10-contacts/

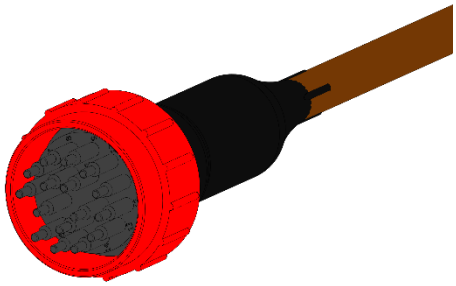
SubConn16 Pins

To ensure the motor receives sufficient power from the motor controller, each of the thruster's three phases is distributed across four separate pins on the connector:

Connector type: SubConn circular 16 pins (OM16M)

Pin Connection	
Motor phase	1, 2, 3 and 4
Motor phase	5, 6, 7 and 8
Motor phase	9, 10, 11, and 12
PE (Protected Earth)	13 and 14
Temperature Sensor	15 and 16
NB: Max 40 Amp.	

Further connector details:
https://www.macartney.com/connectivity/subconn/subconn-circular-series/subconn-circular-12-16-and-25-contacts/



CRE Marine

Copenhagen Subsea uses three different CRE-Marine connectors on the thruster: the B-Class 10-way (PLB10M), the C-Class 8-way (PLC08M), and the J-Class 9-way (PLJ09M).

Please identify the correct connector and refer to the information provided below.

General information about CRE Marine: https://www.cre-marine.com/

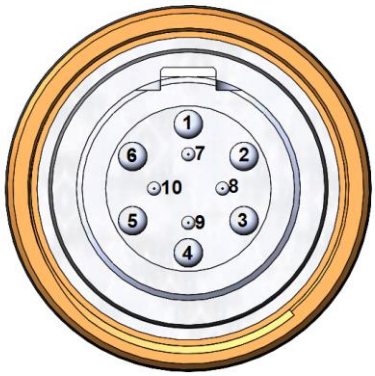
CRE electrical connectors, please see SubConn book on the following link: https://www.cre-marine.com/products/subsea-electrical-connectors

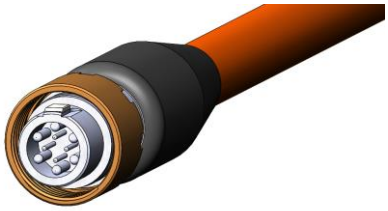
B-Class 10 ways

Connector type: CRE B-Class 10 ways (PLB10M)

Pin Connection	
Motor phase	2
Motor phase	4
Motor phase	6
PE (Protected Earth)	1
Temperature Sensor	7 and 8
Temperature Sensor*	9 and 10
N/A	3
N/A	5
NB: Max 50 Amp.	

*In some cases, an additional spare temperature sensor is included.





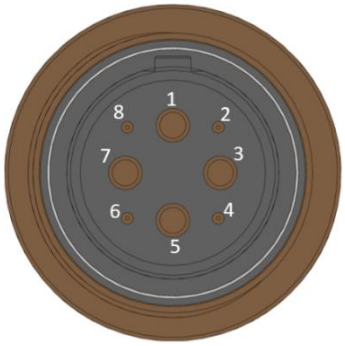
Further connector details:

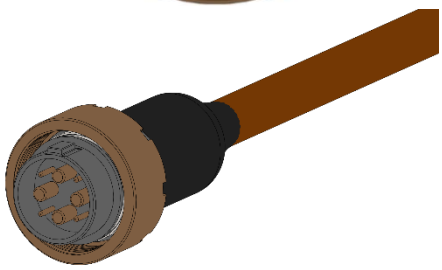
https://www.cre-marine.com/electrical_connectors2/Subsea-Electrical-Connectors-B-SIZE-DATABOOK-REVISION-2024-01.PDF

C-Class 8 ways

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

Pin Connection	
Motor phase	3
Motor phase	5
Motor phase	7
PE (Protected Earth)	1
Temperature Sensor	8 and 2
N/A	6
N/A	4
NB: Max 125 Amp.	





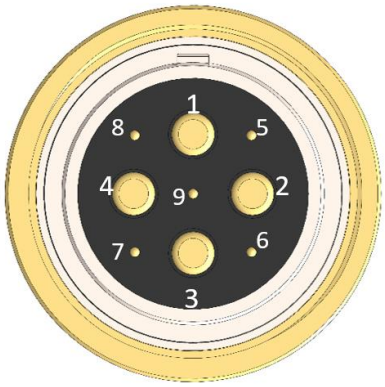
Further connector details:

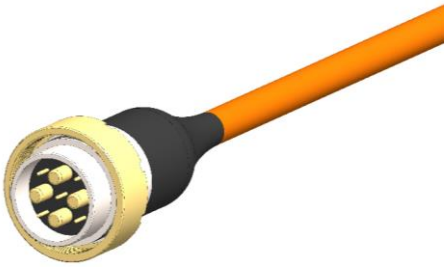
https://www.cre-marine.com/electrical_connectors2/Subsea-Electrical-Connectors-C-SIZE-DATABOOK-REVISION-2024-02.PDF

J-Class 9 way

Connector type: CRE J-Class 9 ways (PLJ09M)

Pin Connection	
Motor phase	2
Motor phase	3
Motor phase	4
PE (Protected Earth)	1
Temperature Sensor	8 and 5
N/A	6
N/A	7
N/A	9
NB: Max 170 Amp.	





Further connector details:

https://www.cre-marine.com/electrical_connectors2/Subsea-Electrical-Connectors-J-SIZE-DATABOOK-REVISION-2021-02_2023-08-08.pdf

Motor controller interface

Thruster speed is controlled by an external motor controller. Motor controllers are produced by many manufacturers across a wide range of voltages and sizes, supporting various communication protocols and interfaces. Copenhagen Subsea does not supply motor controllers. For assistance identifying a suitable option, contact support@copenhagensubsea.com; a whitelist of known and tested motor controllers is available on request.

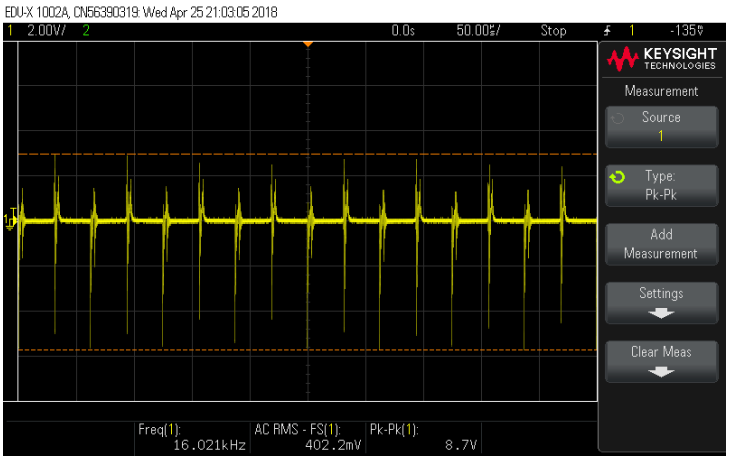
When selecting a motor controller, the basic requirements are that it matches the thruster's power rating in kW and amps and is compatible with the system voltage it will operate with. The thrusters are 3-phase AC Permanent Magnet Synchronous Motors (PMSM) operating in a sensorless configuration: no physical position or rotation sensors are fitted in the motor, and rotor position is determined by the controller from back-EMF. The motor controller must therefore be capable of operating with a sensorless PMSM motor.
The motor datasheet supplied with each thruster lists the electrical parameters required for controller configuration and tuning.

Precaution against overheating

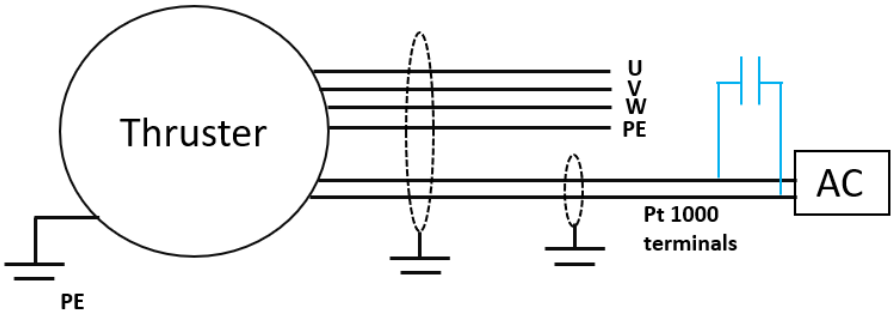
Make sure the motor temperature is always under maximum value stated on the nameplate. Note that temperature may continue to rise after shutdown. Set this limit as the maximal motor temperature in the motor controller.

Pt1000 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.

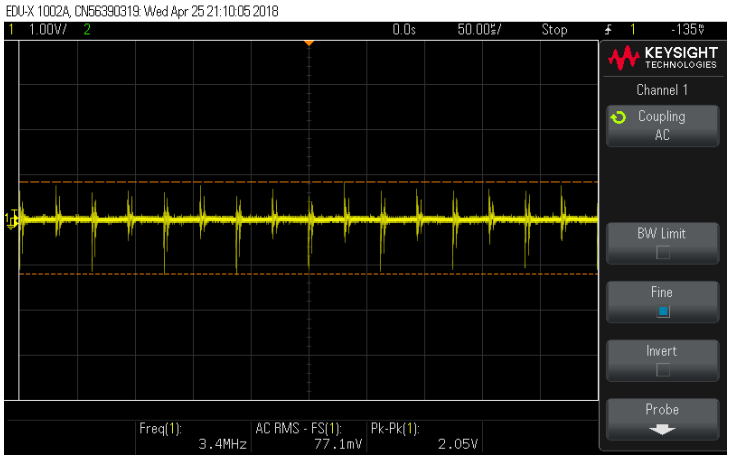


Most analog converters have a low pass filter good enough to make the signal from the Pt1000 sensor stable and usable to read temperature. If this is not the case and the noise is too high, it is then recommended to consider the use of a small capacitor in parallel with the analog converter input.
See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



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.



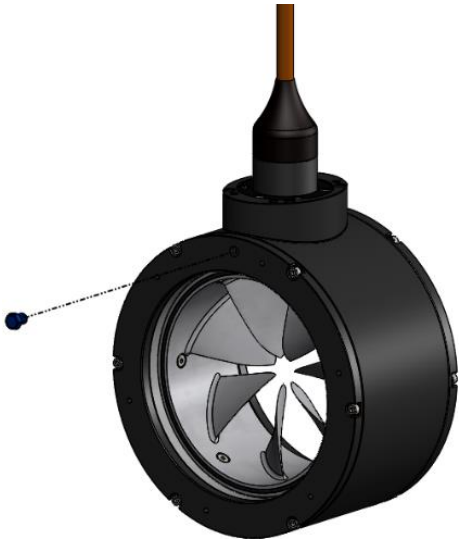
Operation

Blinded flushing holes

Before launching the thruster into the water, insert the blue sealing plug into 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.

1/8” BSPT blinding plug



Operation temperature

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

Always make sure that the thruster temperature during operation (sensed temperature inside the thruster) does not exceed maximum temperature value stated on the nameplate. Note that temperature may continue to rise after shutdown. 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, the procedures below 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 light air pressure through the flushing hole.
- Flush the thruster with an antifreeze fluid (Recommendation: Inhibited Propylene Glycol–Based Antifreeze)
- Turn the rotor by hand to distribute the antifreeze fluid.

Before launch into water: When a thruster with a material temperature below 0 ºC is submerged, the water can crystallize on its surface, and if the thruster is started instantly there is theoretical risk that the ice can prevent the thruster from rotating freely, with subsequent overheating. To avoid this, it is important to heat the thruster to above 5°C before submerging.

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.

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 lifetime 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 must be done after **50 hours** of operation. Hereafter visual maintenance is to be only required after each **200 hours** of operation 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 in this chapter. Maintenance video can also be seen in https://www.copenhagensubsea.com/maintenance

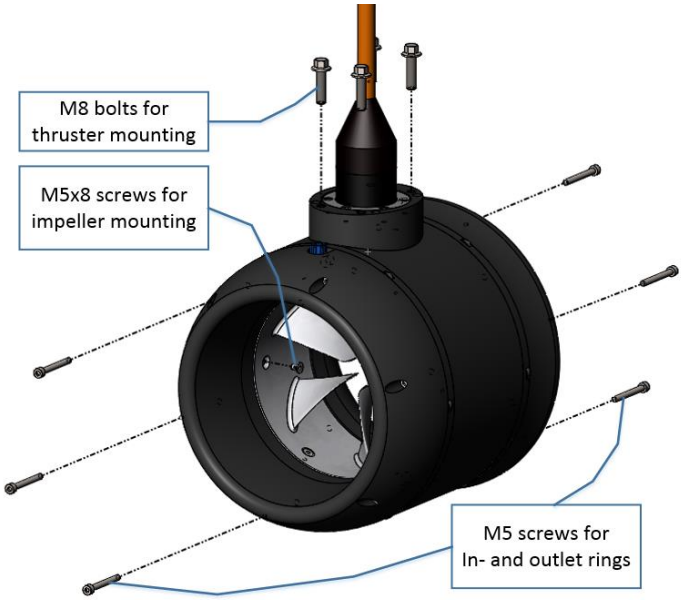
The rotor may be pulled out from both sides, depending on which side is most accessible. However, the preferred side is the outlet side.

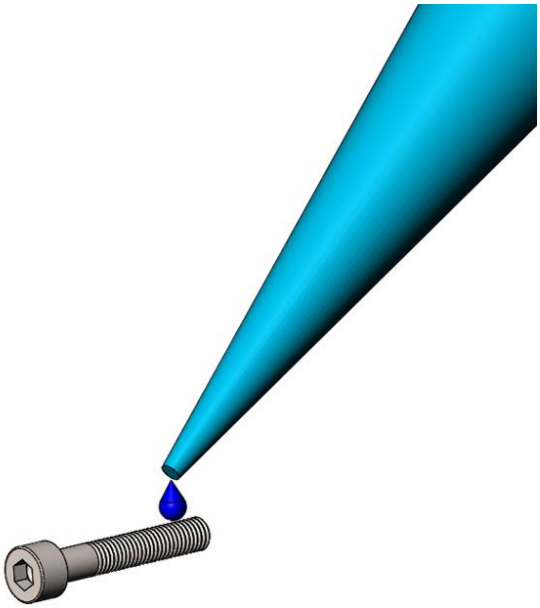
Maintenance schedule

Item	To do	Interval
Plugs at flushing holes	Make sure the flushing holes are blinded by 1/8" plugs (BSPP)	Before every use
Thruster	Flush the thruster with fresh water through the flushing holes	After every use
Cable	Check for cable damage	After every use
Propeller	Check for damage/wear	After every use
Thruster	Wipe off dirt/marine fouling (for better cooling)	When needed
Rotor and Stator	Remove Rotor and look for wear inside the thruster	1st after 50 hours, then after each 200 hours
Bearings	Remove Rotor and look for wear on the bearings	1st after 50 hours, then after each 200 hours
Thruster	Remove Rotor and wipe off water from the thruster inside	Before storage
Thruster	Add antifreeze fluid through the flushing holes	Before operating in colder conditions below 0 ºC

Use AquaShield grease on screws

All screws have been fixed with AquaShield grease from the manufacturer. Contact the manufacturer to find the nearest dealer of AquaShield grease.
Except do not use AquaShield on M8 screws for the thruster mounting, but here use Loctite 243. See earlier chapter on “Mounting the Thruster”.



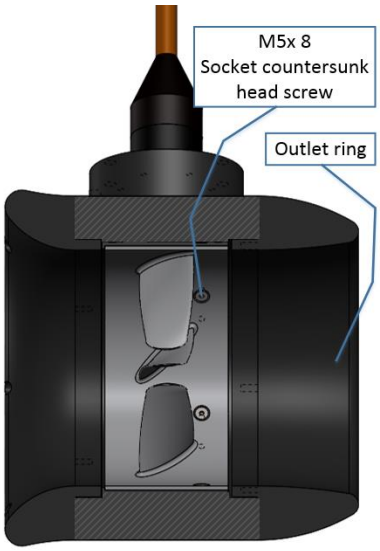


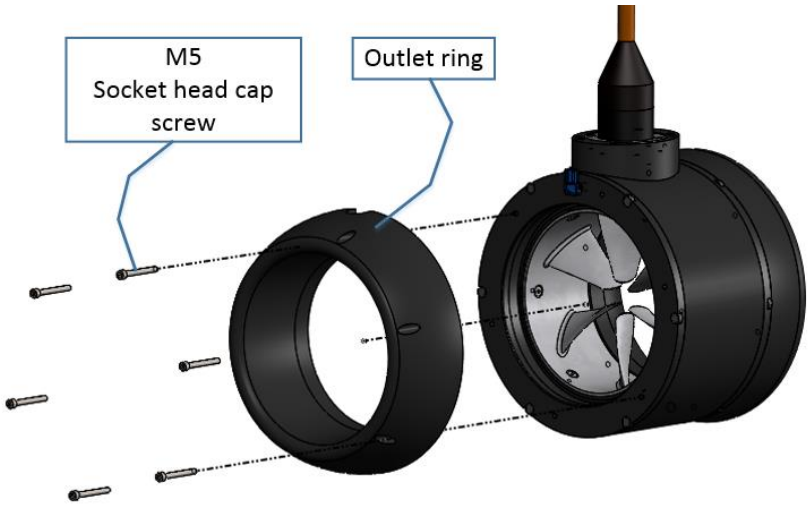
If a thruster bolt or a screw must be changed, swapped or re-fixed, always add a bit of AquaShield grease on the thread. Use a torque wrench to make sure the screws are properly tightened according to the following values:

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

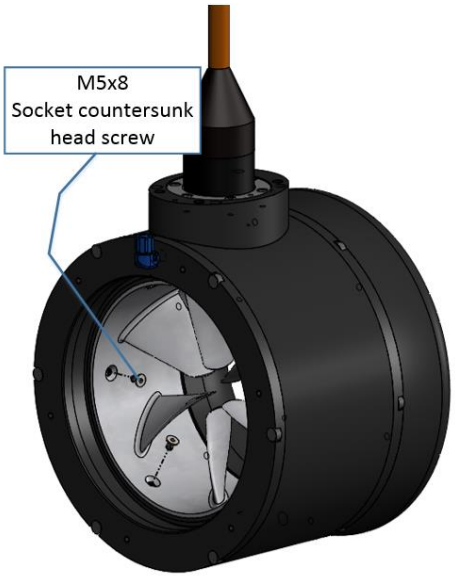
Remove Propeller

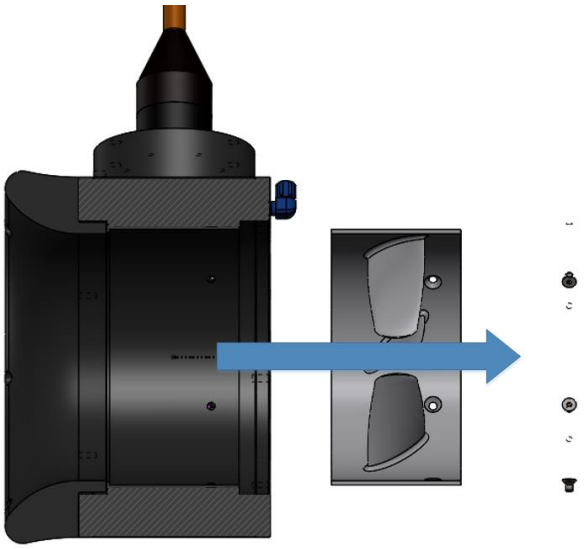
The power must be disconnected from the thruster when replacing the propeller.





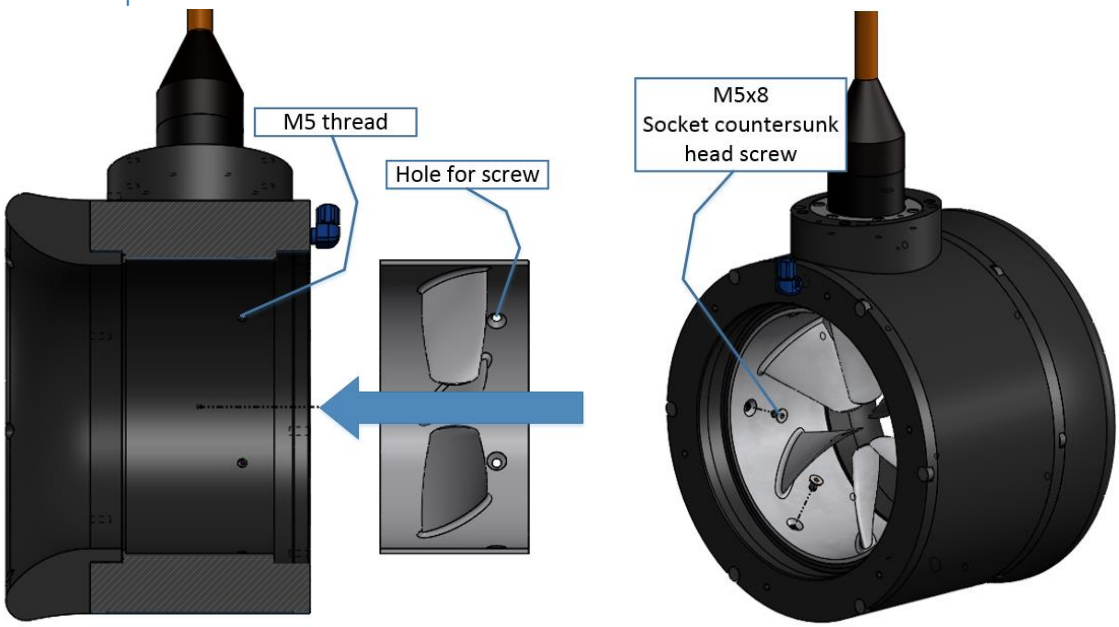
- The outlet ring closest to the propeller screws must be removed.
- Remove the outlet ring by loosening and removing the M5 Socket head cap screws from the thruster.
- Be careful not to damage the coupling nozzle when removing the outlet ring.



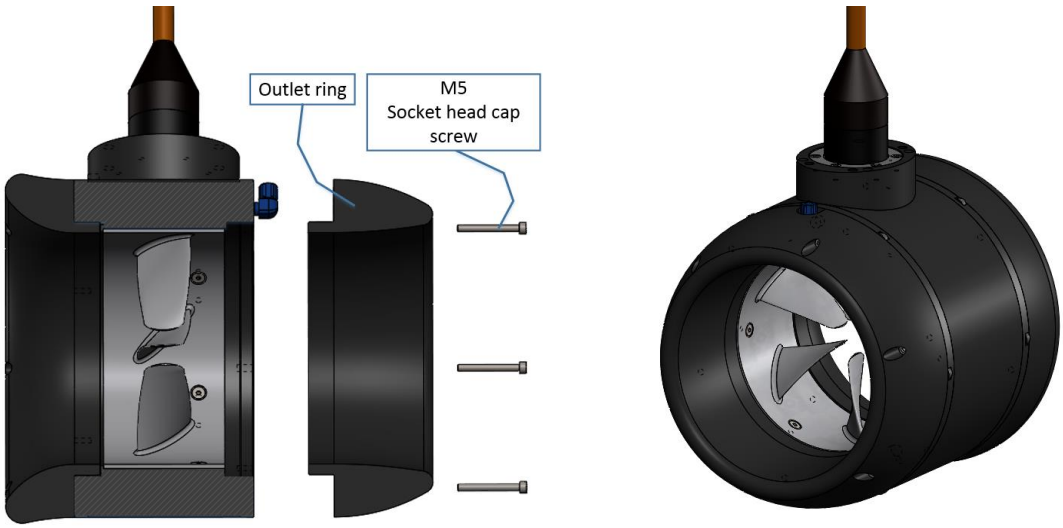


- Loosen and remove all six M5x8 Socket counter-sunk head screws from the inside of the propeller.
- Gently drag the propeller out of the thruster.

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.

Thruster Maintenance Tool

To remove the bearings ring and the rotor the two Thruster Maintenance Tools are required.

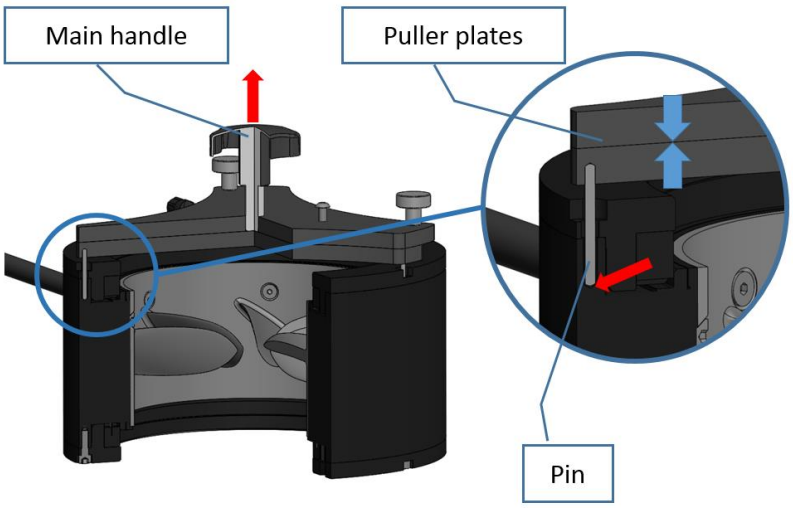
Bearing Ring Puller Tool

Rotor Puller Tool

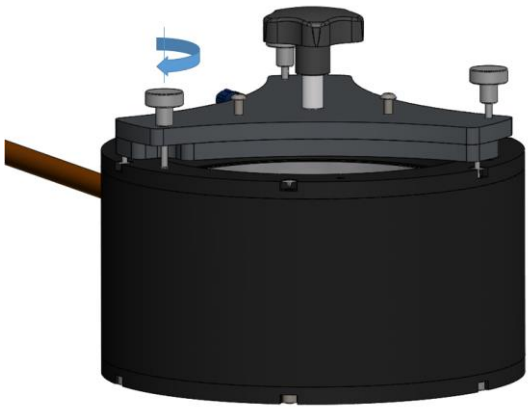
Follow the How-to descriptions or scan the QR-code to see a video guide

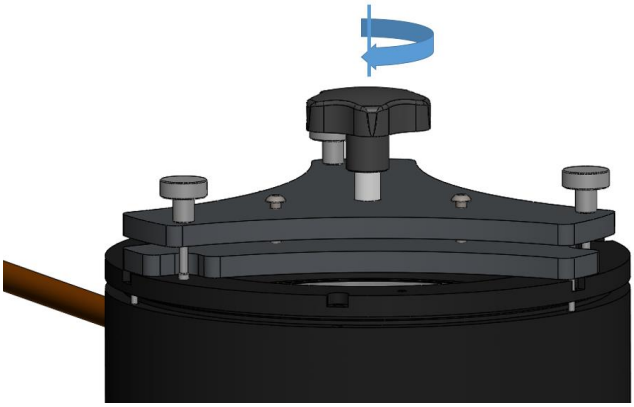
Remove bearing ring

- 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.

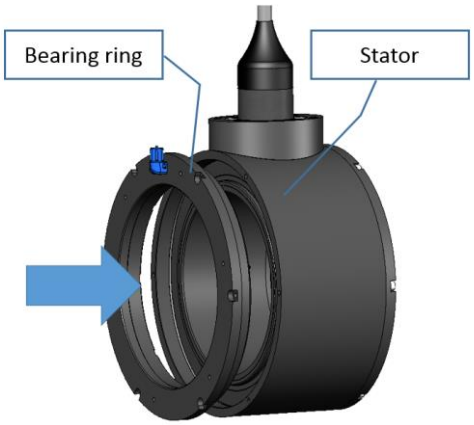


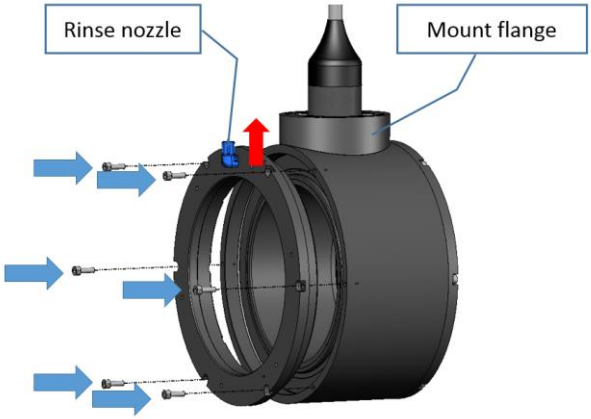


- Tighten the 3 finger screws. (Be careful not to damage the threads in the bearing ring when attaching the bearing ring puller)
- Turn the main handle until the bearing ring releases. Give it another couple of turns to make sure the lid is completely free of the stator ring.

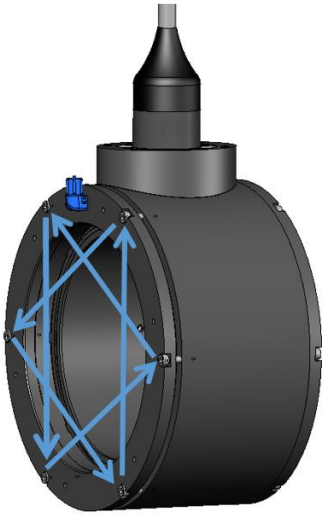
- Remove the bearing ring puller together with the bearing ring.
- Remove the bearing ring.
- Be careful not to damage the ceramic bearings.

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



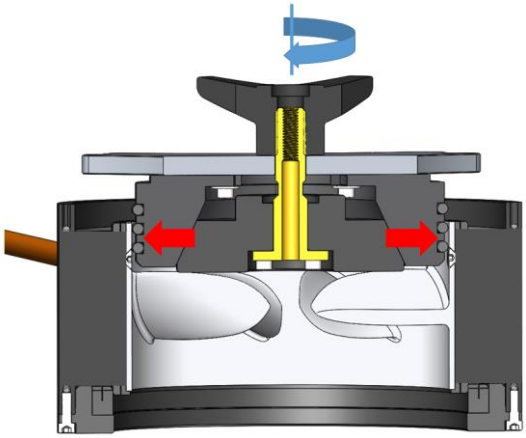
- Use the screws to pull the bearing ring into place.
- Turn the rotor by hand to make sure that it is inserted correctly and does not squeeze the bearings.
- Tighten the screws evenly in a star pattern to avoid damaging the ceramic bearings and to get an even force distribution on the bearing ring.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

Remove Rotor

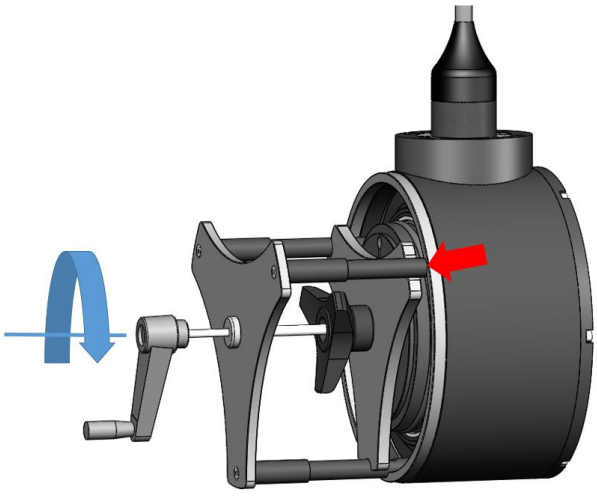
The rotor may be removed with or without the propeller. Be aware to remove both bearings before removing the rotor. Further, there are 3 ways of removing the rotor which is covered in this section.

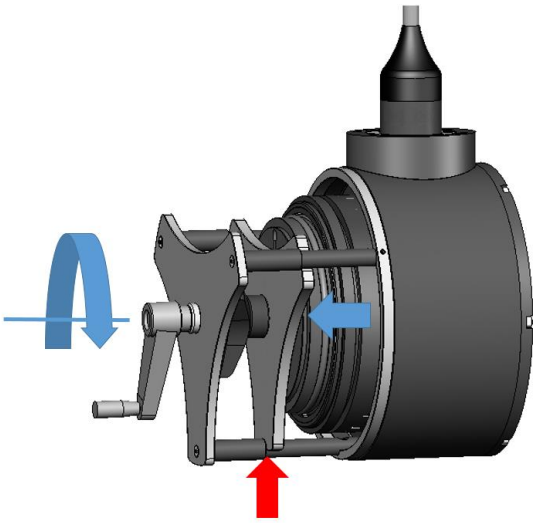
With propeller:

The rotor may be removed with the propeller installed.

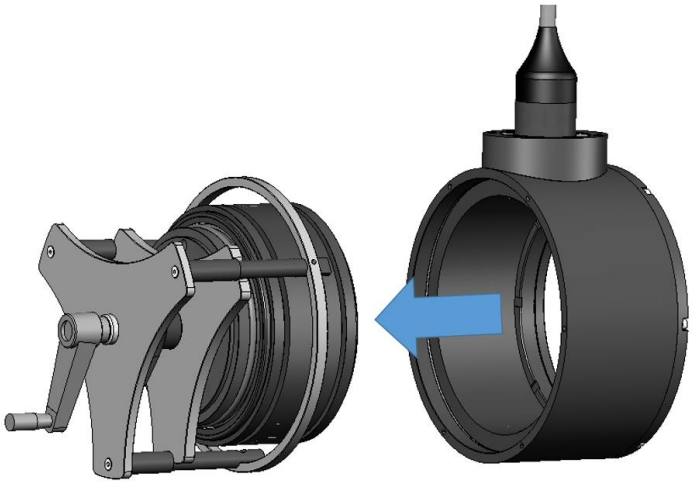


- Remove the bearing ring as described in the section “Remove bearing ring”
- Attach bottom part of the Rotor puller by placing it on top of the propeller blades in the outlet side of the propeller.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.





- 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.

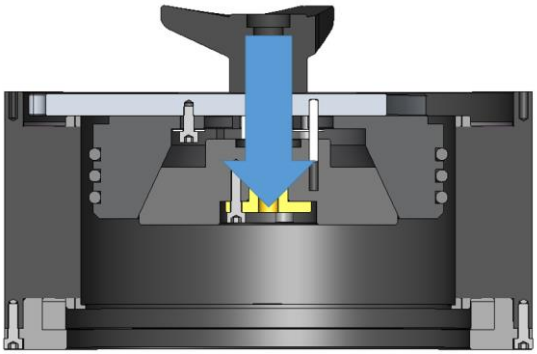


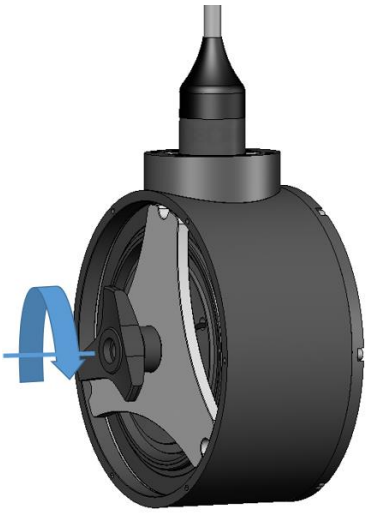
- Gently pull out the rotor and rotor puller tool.
- Be careful not to damage the ceramic bearings.

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.

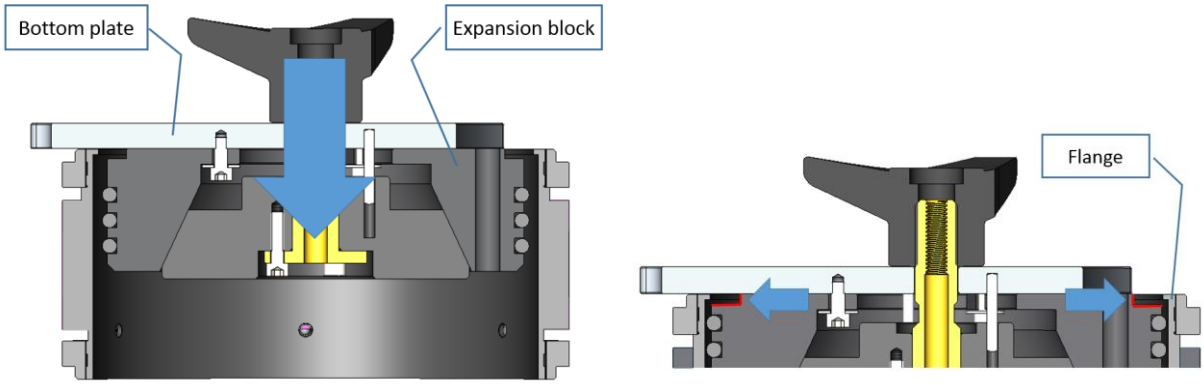




- Attach bottom part of rotor puller by placing it in the outlet side of the rotor.
- The expansion block is inserted in full depth and the bottom plate rests on the rotor side.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.
- Follow the steps in the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

From inlet side:

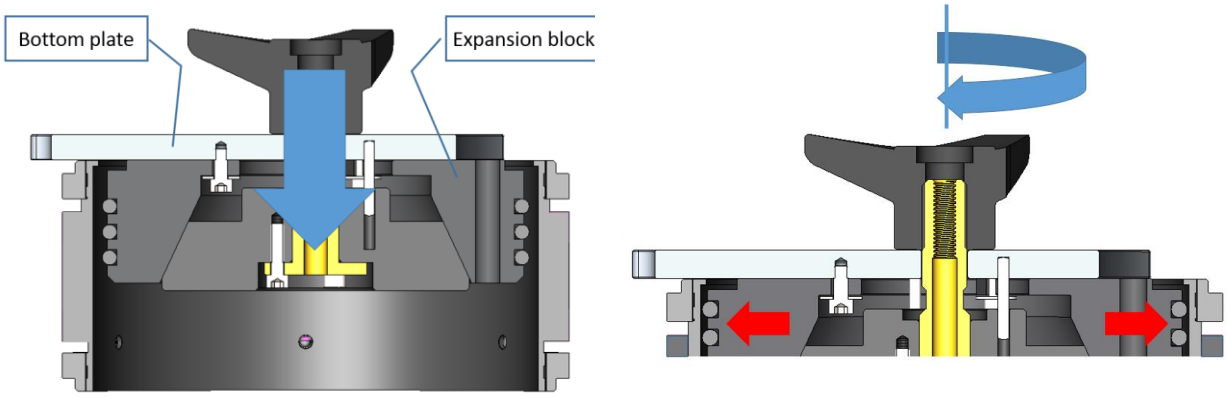
Removing the rotor from the inlet side follows the same procedure as “Remove Rotor with Propeller”



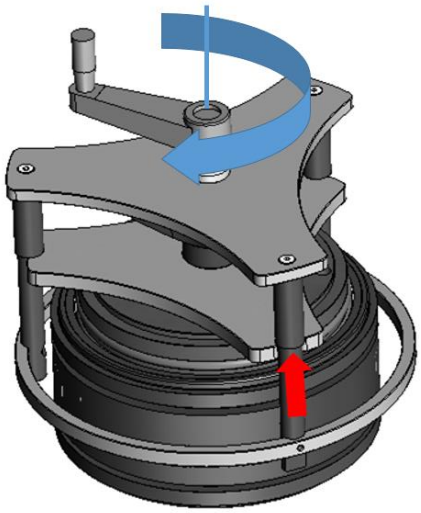
- When the propeller is removed, it is important to make sure that the expansion block is inserted in full depth and the bottom plate rests on the rotor side.
- The flange on the rotor inside wall should fit into the space between the bottom plate and the expansion block.
- The rest of the procedure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

Insert rotor

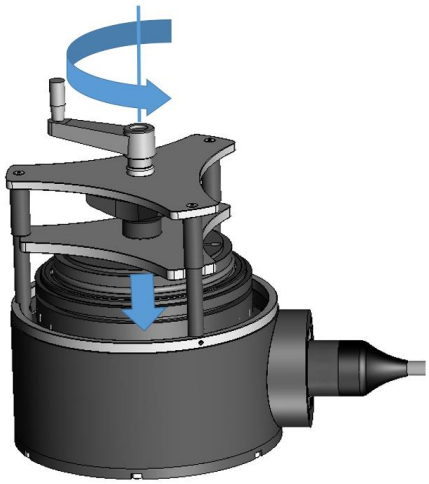
When inserting the rotor, make sure both bearings are removed before inserting the rotor.



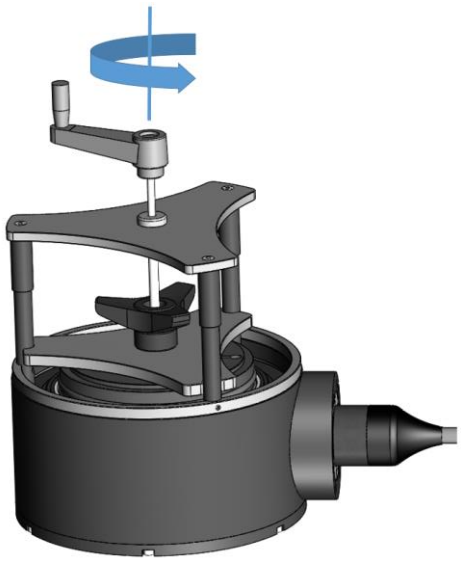
- Attach bottom part of Rotor puller by placing it in the center hole of the rotor.
- Make sure that the rotor is oriented correctly in relation to the stator inlet and outlet.
- Tighten the center screw until the expansion block has a firm grip on the propeller inside wall.

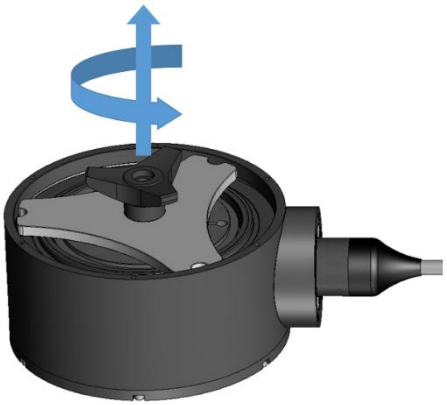


- Align the rotor puller top with the rotor bottom cutouts.
- Turn the handle until the rotor puller bottom is fully retracted.



- 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 inner surface while inserting the rotor.



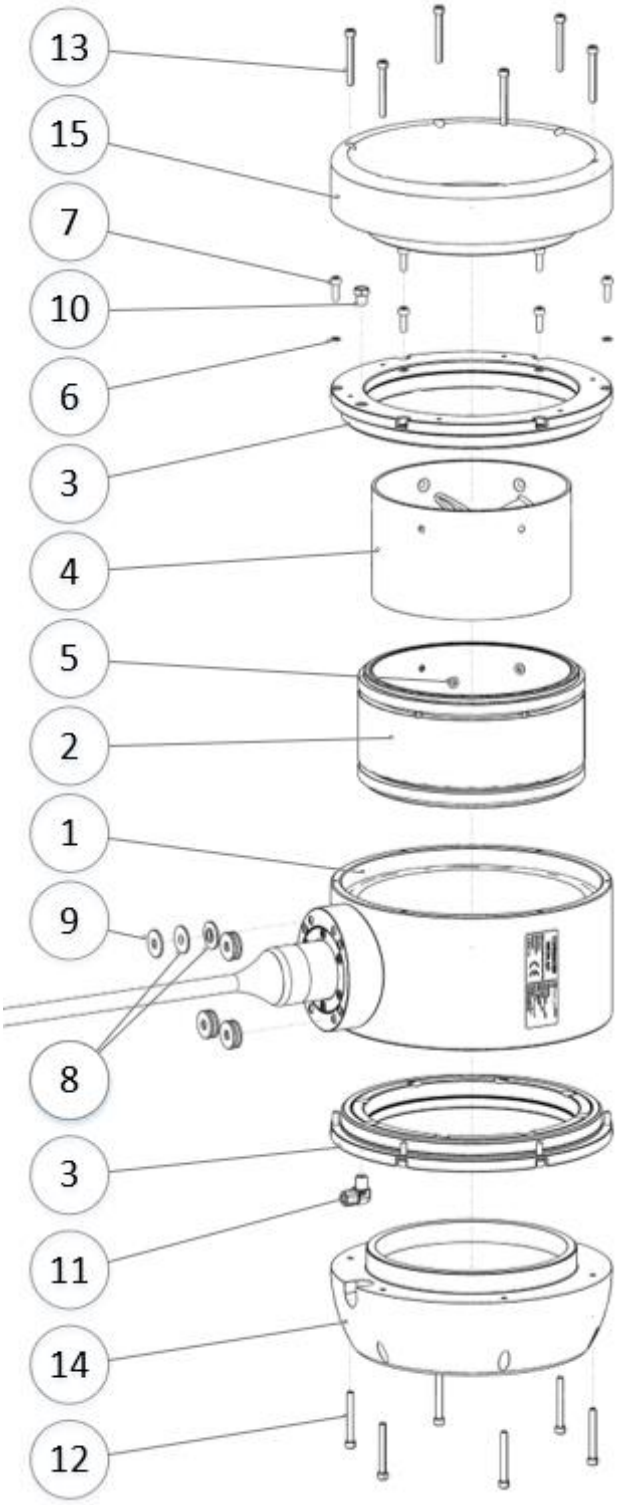


- Turn the handle in the opposite direction to screw the spindle back out.
- Release the center screw and pull out the rotor puller tool.
- Turn the rotor by hand to make sure that it is inserted correctly.
- These steps apply both with and without the propeller attached.
- (For instructions on how to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

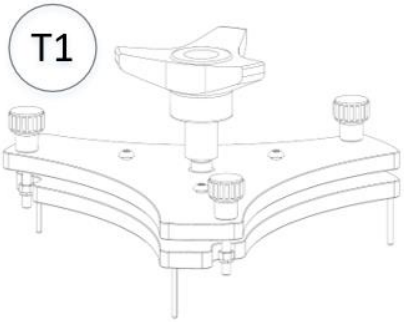
Spare parts and accessories

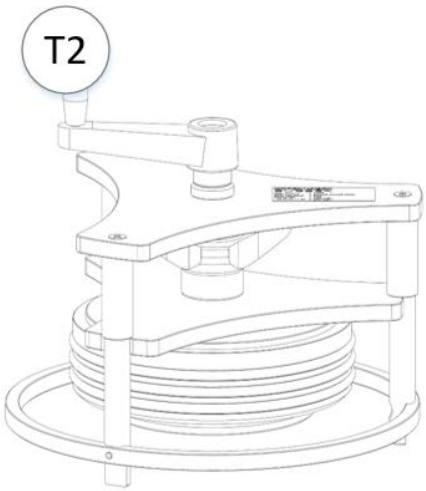
Spare parts and accessories for the thruster are available from Copenhagen Subsea. To place an order or enquire about availability, contact us at sales@copenhagensubsea.com quoting the relevant part number from the parts list below. If you are uncertain which parts are required, our team is ready to help.

The drawing to the right shows a thruster in an exploded view. The reference numbers in the drawing can be used to find the correct part number in the spare part list.



The drawings below show the Thruster Maintenance Tools. Find the right part No in the spare part list.





Reference No.	Description	VS Part No	VM Part No	VL Part No	VXL Part No
1	Stator	Find the S/N on the Thruster nameplate			
2	Rotor	Find the S/N on the Thruster nameplate or on the sticker inside to Rotor			
3	Bearing Ring	A 1489	A 1133	A 1129	A 1417
4	Propeller – SYM- RH	P 8269	P 8258	P 8273	P 8277
	Propeller – SYM- LH	P 8268	P 8257	P 8272	P 8276
	Propeller – ASYM- RH	P 8267	P 8260	P 8275	P 8279
	Propeller – ASYM- LH	P 8265	P 8259	P 8274	P 8278
5	Hexalobular countersunk screws M5 x 8 ISO 14581 A4	I 2283	I 2283	I 2283	-
5	Hexalobular countersunk screws M5 x 10 ISO 14581 A4	-	-	-	I 2284
6	Ø8,7 - ø5.2mm Epoxy Flat Washer - Black	PC0135	PC0135	PC0135	PC0135
7	M5 x 16 - ISO 4762 - A4	I 0296	I 0296	I 0296	-
	M5 x 20 - ISO 4762 - A4	-	-	-	I 2579
8	Insulation Sleeve Ø24/11,9/8,1mm - Epoxy black	PC0136	PC0136	PC0136	PC0136
9	M8 Flat washer ISO 7093	I 2685	I 2685	I 2685	I 2685
10	Hex Threaded Plug PA 1/8 BSPT	I 2175	I 2175	I 2175	I 2175
11	Flushing fittings 90 deg.	I 0676	I 0676	I 0676	I 0676
12	M5x30 Hex socket head cap ISO 4762 - A4	I 2843	-	-	-
	M5x40 Hex socket head cap ISO 4762 - A4	-	I 3176	-	-
	M5x45 Hex socket head cap ISO 4762 - A4	-	-	I 2551	I 2551
13	M5x30 Hex socket head cap ISO 4762 - A4	I 2843	-	-	-
	M5x40 Hex socket head cap ISO 4762 - A4	-	I 3176	-	-
	M5x45 Hex socket head cap ISO 4762 - A4	-	-	I 2551	I 2551
14	Thruster Inlet-Ring	P 3921	P 2888	P 2800	P 3511
15	Thruster Outlet-Ring	P 3534	P 2889	P 2801	P 4055
T1	Bearing Ring Puller Tool	A 2465	A 1884	A 1707	A 1887
T2	Rotor Puller Tool	A 2466	A 1874	A 1723	A 1875

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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 copper parts. This is done by returning the thruster to an authorized recycling company.

Another option is to return the thruster to:

Copenhagen Subsea A/S
Troljevej 2
2900 Hellerup
Denmark

Email: sales@copenhagensubsea.com

Record of Conformity

All thrusters from Copenhagen Subsea A/S are 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 2011/65/EU
REACH Directive	(EC) No. 1907/2006
Harmonized 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

Appendix – Declaration of Incorporation

COPENHAGEN SUBSEA

DECLARATION OF INCORPORATION

EU Declaration of Incorporation

for Partly Completed Machinery

Issued in accordance with Machinery Directive 2006/42/EC, Annex II Part B | Revision: 2026-05

MANUFACTURER

Copenhagen Subsea A/S
Troljevej 2, 2900 Hellerup, Denmark
Tel: +45 7022 1162
E-mail: sales@copenhagensubsea.com

1. IDENTIFICATION OF THE PARTLY COMPLETED MACHINERY

Product name	Copenhagen Subsea Thruster
Versions covered	VS, VM, VL, VXL — including AUV variants
Voltage range	12 - 700 VDC (model-specific; refer to nameplate and datasheet)
Serial number	Per order — refer to nameplate
Year of manufacture	Per order — refer to nameplate

2. DECLARATION

Copenhagen Subsea A/S hereby declares that the partly completed machinery described above:

- Meets the relevant Essential Health and Safety Requirements (EHSR) of Annex I of Machinery Directive 2006/42/EC applicable to partly completed machinery, as documented in the technical file.
- Has been designed and manufactured in accordance with the principles of EN ISO 12100.
- Has been manufactured taking into account the following standards: EN 60945, EN 60204-1, EN 60335-1.
- Is intended to be incorporated into a machine or assembly of machines, and must not be put into service until the final machinery has been declared in conformity with Directive 2006/42/EC, where applicable.

The manufacturer undertakes to transmit, in response to a reasoned request by national authorities, the relevant technical documentation specified in Annex VII Part B of Directive 2006/42/EC.

3. OTHER DIRECTIVES CONSIDERED DURING DESIGN

EMC Directive 2014/30/EU and RoHS Directive 2011/65/EU were considered during design. No conformity is declared here under these directives.

4. PERSON AUTHORISED TO COMPILE THE TECHNICAL FILE · SIGNATURE

Name	Henrik Neuschäfer Larsen	**Place**	Hellerup, Denmark
Title	Co-founder & Chief Technical Officer	**Date**	2026-06-17
Address	Troljevej 2, 2900 Hellerup, Denmark	**Signature**	