

# FAQ

- *Certification – Copenhagen Subsea is conform with the following standards and provisions, please see our ‘Certificate of Conformity’.*
  - *REACH Declaration - (EC) No 1907/2006*
    - Under the REACH declaration Copenhagen Subsea A/S has the role as Downstream user and only applies substances (chemical elements and its compounds) from within the EU, and has therefore no obligation to register these substances according to the REACH Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006.
  - *RoHS Declaration – 2011/65/EU*
  - *EMC – 2014/30/EU*
  - *Machine directive – 2006/42/EC*
  - *Pressure verification*
    - *DNV • GL – Rules for Classification  
Underwater technology, Edition December 2015  
Part 3, Pressure hull and structures  
Chapter 2 Design loads*
- *What type of motor controller do you use?*
- We utilize off-the-shelf motor controllers, which are tuned to match the electrical parameter of the thruster. By modifying the number of windings, we design thrusters which can adapt to a supply voltage level between 24-800 VDC. However, our standard thruster winding is for 560 VDC. The thrusters are operated in a sensorless configuration without the use of physical feedback sensors, this is to increase the reliability – the motor controller uses the back EMF from the thruster to determine the rotational velocity.
- At a first sight the industrial controllers are generally larger, but this is because they are built to perform reliably in offshore conditions with extended temperature range. These controllers also have more built in capacitance to handle overload currents during acceleration and generated current coming back from the motor during deceleration. And allows fast shifts of rotational direction. These elements are crucial to keep an ROV stable in challenging offshore conditions.
- For a robust and responsive system, we can recommend controllers with high capacitance from the following suppliers of motor controllers:
  - Piktronik - <http://www.piktronik.com/>
  - Bonfiglioli - <https://www.bonfiglioli.com/en/>
  - OMRON - <https://industrial.omron.eu/en/products/frequency-inverters>
- There are smaller motor controllers on the market, and the customer are free to experiment with these on their own risk but be aware that it will give a less responsive system. For smaller controllers for systems with low respond times we can recommend controllers from
  - ELMO – <https://www.elmomc.com/>

- *Can we use other motor controllers instead of the ones that you are using?*
  - We utilize motor controllers from the world's leading suppliers of industrial grade sensorless drives. If the customer wants to use another motor controller, they are free to experiment with this on their own risk we will in this case deliver a data sheet which can be handed over to the motor controller supplier as a help in the tuning process.
  
- *Is your rim drive propeller available with motor feedback sensors (hall effect or other)? They are needed with some type of drivers.*
  - To improve the reliability, we do not use physical feedback sensors in our thruster. Therefore, not all motor controllers can be used. In customized projects the Motor controller parameter must be adapted to our thrusters through a tuning process. This tuning process is also offered by us as part of the delivery and ensures that the system performs optimally.
  
- *Can your thruster be used as a turbine for electrical power generation.*
  - This is in theory possible, but we have no experience with this – It will require a four-quadrant drive. We do not have these types of drives in our portfolio and the customer have to make the tuning of the drive in sensorless mode themselves.
  
- *How do you manage the speed control?*
  - The speed control is managed by the motor controller. The input to the motor controller is a start/stop command, direction command (CW/CCW) and RPM value.
  
- *If the sensorless controller needs adaptation to the thruster, what happens if we have to replace a controller or thruster?*
  - We only have to do the tuning process once, after this the settings are saved in the controller and will fit all thrusters of the same type. If you must replace a motor controller you simply upload the parameter set to the new controller. The thrusters are always interchangeable.
  
- *Is the thruster limited automatically based on temperature, or is this something we have to control by reducing the speed through the drive?*
  - The internal motor temperature must never exceed 70°C. Therefore, all our thrusters are installed with a PT1000 temperature sensor which can tell you what the internal temperature of the thruster is. The motor controller does not provide overtemperature protection this must be done via a central computer which monitor the internal temperature of the thrusters during operation and turns down the RPM such the temperature does not exceed the 70°C.

- *Can you give a list of requirements from your side that you need in order to specify a thruster and motor controller solution?*
  - Please complete our specification document which contains all the information that we need in order to suggest a suitable solution. The specification document is to clarify all the technical details and can be downloaded from our webpage.
- *Do you have any application notes or minimum recommendations for customers to consider when integrating your thrusters into designs?*
  - All the required information for our customers, when integrating our thrusters, are contained in our thruster manual and technical application note which can be downloaded from our webpage.
- *Is the compact option only available with a symmetric propeller, or can the compact version be ordered as an asymmetric option?*
  - It is possible to get a compact version with an asymmetric propeller. You can configure the propeller and inlet & outlet rings exactly as you like.
- *How do you provide support?*
  - We assist with fault tracing worldwide via remote support via phone and computer, the faulty equipment must be de-installed by the customer and returned to us according to our standard conditions.
- *I am wanting to know if these types of thrusters can be scaled up to be primary propulsion?*
  - It is possible to use our thruster as main propulsion. To optimize the use of the thruster as main propulsion the propeller can be optimized for a specific speed. This will be quoted separately.
- *What is your maximum test pressure?*
  - We verify the pressure rating according to the DNV•GL – Rules for Classification. We can supply thrusters which are pressure rated to water depths of 700 meter and 3,000 meter.
- *What is the independent certified pressure verification?*
  - All our models have been through a pressure verification to ensure our thrusters are complied with the specified depth ratings according to the DNV•GL – Rules for Classification. However, the independent certified pressure verification is an additional certificate the customer can acquire to conduct a pressure verification of their individually ordered thruster. The pressure verification is conducted by an independent 3<sup>rd</sup> part and is complied with the DNV•GL Rules for Classification - Part 3: pressure hull and structures/ Chapter 2: design loads.
- *What is your delivery time for the thrusters?*
  - The delivery time for the complete setup is between 12-16 weeks – it is also depending on the tuning process of the motor controller. The lead time includes a conservative estimate for the tuning of the motor controller.
- *Are your products under export control - What is your ECCN? (Export Control Classification Number)*

- Our thrusters are not under export control.
- *Are counter-rotating propellers/thrusters available?*
  - We can provide our thrusters with either clockwise or counter-clockwise rotating propellers.
- *Are the thrusters capable of continuous saltwater immersion?*
  - Yes, as long as you ensure that the zinc anode is correctly installed according to the manual.
- *Do you have your thrusters on stock?*
  - All our thrusters are build-to-order, so we are capable of adapting to the specific customer requirement – If the customer orders a thruster we have built before the lead time is shorter.
- *Do you have any thrusters we can test with?*
  - We do not have thrusters we can offer for testing free of charge. However, we have a rental pool where you can rent one of our thrusters including a motor controller for 3x400 VAC supply voltage. We also offer product demonstrations at our facility.
- *Is it possible to order a thruster without the connector and you provide us with the specs for the cable and connector?*
  - Yes, it is possible. However, we run a qualified process for molding subsea connectors, where we ensure that there are no air bubbles in the casting, that it is mechanically stable, and that the molding material is compatible with the outer material of the cable. If you are comfortable with making the connector molding yourself, we can supply the thruster without the connector and provide the necessary specs.
- *How does sediment rich environment influence the average operational time, for example operations close to the ocean floor or in a harbor?*
  - We have done extensive testing of our thruster in many different conditions also in sediment rich water. These tests have not disclosed any decrease of the average operational time. It is important to make sure the flushing hole is closed during operation to prevent large sediments to enter the thruster. As described in the manual, it is also 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 inspection of the inside of the thruster is required to ensure that the inside space is clean. Dirt can be cleaned of 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 the visual maintenance is only required after each 200 hours of operations for the rest of the thruster's lifetime.
- *Can you give an estimation of the heat dissipation for the motor controller we have to generate within the vehicle?*
  - This information is most often provided by the manufacturer of the motor controller. Please look in the manual of the corresponding motor controller.
- *Concerning the heat dissipation of the thruster itself: does the thruster need to be circulated by water flow also at the outer diameter or is the water flow at the inner diameter sufficient for an adequate heat dissipation?*

- We have conducted tests, where the thruster is used as a tunnel thruster, that show that the main heat is dissipated in the center of the thruster. It needs to be fully submerged in water, but it does not require that the water is flowing freely past the outside of the thruster.
- *Do you have any design proposals or solution for how to integrate your thruster onto an AUV? (different connector, mechanical adaptation from thruster to AUV)?*
  - Yes, please contact our sales department for images of our proposed concept for an AUV integration. The mounting piece as proposed is 3D printed in nylon and glass, this is the same material as the propeller, and it is very durable and strong.
- *What is the thruster running on AC or DC?*
  - Our thrusters running at AC but the input to the motor controller is DC
- *What kind of material is the outer housing made of?*
  - The outer housing on the thruster is made of anodized aluminum.
- *It appears that your thrusters are generally less efficient than other, more traditional thrusters. Am I understanding this correctly?*
  - We have equal efficiency compared to traditional thrusters with the same propeller size. One of the great features of our thrusters is that we can put more power into the thruster due to the excellent cooling. This means the rim driven design inherently has more power per propeller area than conventional thruster technology. Giving the user extra overhead to compensate for strong sea currents, which will expand the weather window in which their vehicle can be operated.
- *I'm in doubt which size to choose – e.g. VS or VM? **General recommendation***
  - If you have room for a larger thruster will we always recommend acquiring the larger thruster, since the larger thruster is much more efficient compared to the smaller ones regarding the thrust/power ratio. Thereby, a larger thruster enables you to run the thruster at lower RPM and still achieve your required thrust force and thereby extend the lifespan of the thruster and have extra head room to counteract strong currents. Also - using a larger thruster will give you more endurance on a battery powered vehicle.
- *I note the sensitivity of power ratings to water temperature (falling as temperature rises) - why is this?*
  - The rim driven thruster has the advantage of excellent cooling due to the large stator surface which is in contact with the surrounding water through the aluminum housing. This means the rim driven design inherently can provide more thrust per propeller area than conventional thruster technology. But as for conventional thruster technology, the maximum delivered power of the thruster is depending on the temperature of the surrounding water - cooler water gives better cooling and more power can be dissipated in the thruster. However, even in the warmest water, our thruster is still able to deliver more power than conventional thruster technology.
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- *What is the lead time on your propellers?*
  - Our lead time on our propellers is 3 weeks from received the 50% of pre-payment.
  
- *Do your thrusters create cavitation at max. RPM?*
  - We have designed our thrusters such they do not create cavitation at max RPM.
  
- *Can you provide CAD models of your propellers or the propeller that we have purchased?*
  - Unfortunately, we cannot share our propeller design due to propriety rights.