MOTION REFERENCE UNIT

MRU MARINE

Norwegian Subsea

MRU MARINE USER MANUAL

MRU

HIGH PERFORMANCE, AFFORDABLE & ROBUST

6DOF MOTION SENSOR

5 CM / 5 %

0.01 - 0.05 RMS°

IP68

MRU Marine User Manual Version 1.6.0

Document number: NORSUB-MMUM-1.6.0

Intro

The purpose of the user manual is to provide information about the Norwegian Subsea (NORSUB) Marine Motion Reference Units (MRU Marine 3000, MRU Marine 6000, and MRU Marine 9000 models).

Restrictions in Warranty

The Seller's liability for defects is stated in the Norwegian Subsea general terms and conditions of sale. For the warranty to be valid the MRU:

- must not be subjected to extreme shock, rough handling or extensive vibrations.
- must only be opened by Norwegian Subsea.
- must not be stored or used in temperatures outside the range -40 to +85 deg. C.
- must be handled with care.
- must only be used with the correct power supply (10 – 36 V DC power).

Any breach of the points above will void the warranty.

Disposal

All electrical and electronic components have to be disposed of separately from the municipal waste stream via designated collection facilities appointed by the government or local authorities. The correct disposal and separate collection of your old appliance will help prevent potential negative consequences for the environment and human health. It is a precondition for reuse and recycling of used electrical and electronic equipment. For more detailed information about disposal of your old appliance, please contact your local authorities or waste disposal service.
In support of the global requirements to dispose of electrical waste within environmentally acceptable specifications, Norwegian Subsea offers customers the take-back and recycle process to properly dispose of surplus and end-of-life products.
Equipment that is returned to Norwegian Subsea through this program is disposed of in an environmentally safe manner using processes that comply with the WEEE (EU Directive on Waste Electrical and Electronic Equipment) regulations. All Norwegian Subsea-branded products are accepted under the program.

Support Information

Please contact Norwegian Subsea for technical support at support@norwegian-subsea.no.
Technical support is available Monday - Friday between 09.00 – 17.00 CET.

Product Returns

In case of product returns, the buyer shall arrange for return shipment to Norwegian Subsea. Please note that a return merchandise authorization (RMA) from Norwegian Subsea is required in advance.

The return address is:

Norwegian Subsea
Hovfaret 8
0275 Oslo
Norway

Export Restrictions

The MRU must not be exported or re-exported to countries listed on the Norwegian Ministry of Foreign Affairs' prohibition list. Please contact Norwegian Subsea for further details.

	MRU MARINE USER MANUAL (NORSUB-MMUM-x.x.x) REVISION HISTORY		
	VERSION	CODE	NOTES
LEGACY	1.2.0	NORSUB-MMUM-1.2.0	First digital release.
	1.3.0	NORSUB-MMUM-1.3.0	First print release. The manual is completely redesigned to add all the important mechanical, electrical, and technical sensor information.
	1.3.1	NORSUB-MMUM-1.3.1	Minor correction of typos.
	1.3.5	NORSUB-MMUM-1.3.5	Modified section “Restrictions in warranty”. Added “Maintenance” section.
	1.4.0	NORSUB-MMUM-1.4.0	Minor updates.
CURRENT	1.6.0	NORSUB-MMUM-1.6.0	Updated protocols, male/female connector labels.

NOTE

Please read this user manual to ensure proper use of the MRU and the configuration software.

NORSUB MRU MARINE

HIGH-PERFORMANCE MOTION REFERENCE UNITS

NORSUB MRUs are high-performance, compact, and affordable 6 DOF motion sensors. They use state-of-the-art MEMS technology and advanced sensor fusion algorithms, resulting in accurate and reliable roll, pitch, yaw, surge, sway, heave position and velocity measurements. Performance is high also during horizontal accelerations and in irregular coupled motions.

TAILOR-MADE FOR MARINE USE

The MRU Marine is ideal for use in marine applications such as active heave compensation of offshore cranes & winches, motion compensated gangways, helideck motion monitoring, motion compensation of wave radars and sonars, motion monitoring of ships and floating offshore wind turbine structures. High performance in irregular motions makes it ideal for real sea conditions.

EASY INTERFACING

The MRU Marine comes with ethernet and serial ports for easy communication with your system. Industrial communication protocols (e.g. Modbus TCP, Ethernet/IP, Modbus RTU) can be used for PLC interfacing. The MRU comes with a wide range of standard and customized data protocols in ASCII or binary formats. Custom length cables, junction boxes, pigtail cables are available too.

NORSUB MRU MARINE

HIGH-PERFORMANCE MOTION REFERENCE UNITS

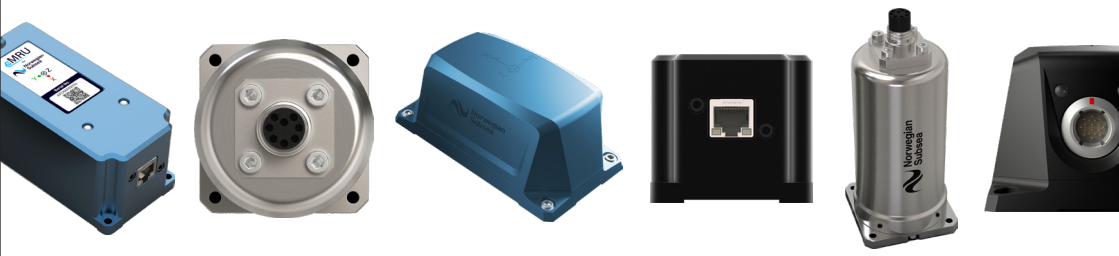
The NORSUB MRU Marine outputs roll, pitch, yaw, heave, surge and sway measurements at configurable output rates up to 100 Hz. The MRU Marine consists of a high-end MEMS 6 DOF IMU (3 x gyroscopes and 3 x accelerometers) and a processing unit where the motions states are calculated using an advanced sensor fusion algorithm. It is available in the basic version for dry use, or in the S (subsea) version for submerged use (up to 50 meters). The Marine MRU comes in two different versions, one with a 16 pin connector (Basic), and one with a 8 pin SubConn connector (S). The S version is recommended for applications where the MRU may be submerged. The two versions are seen in the figure below; Basic (left) and S (right).

AN MRU FOR YOUR NEEDS

A high-end magnetometer can be included in the MRU to provide accurate magnetic heading. The MRU Marine comes in three different versions: 3000, 6000 and 9000 models to accommodate for different accuracy requirements and budgets.

A SOLUTION FOR EVERY APPLICATION

Norwegian Subsea AS offers a portfolio of sensors, cables, connectors, and software tools which covers a variety of applications, environmental, and operational requirements. Visit the company website to choose the Norwegian Subsea MRU that fits your needs!



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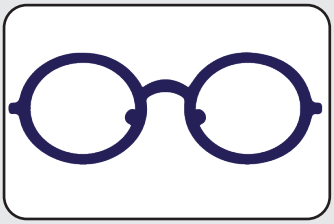
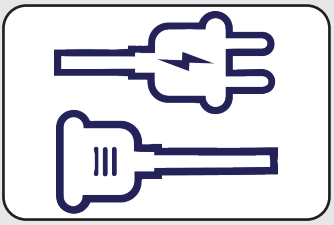


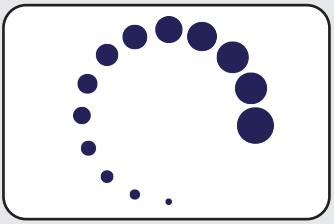
1. CHECK ITEMS

Verify that all the items are in the shipment (see MRU Marine User Manual for details).



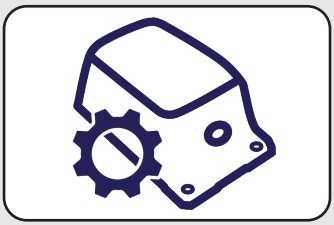
2. CONNECT THE MRU

Connect the MRU Marine to a PC through an Ethernet port with an Ethernet cable, or through an RS-232 or RS-485 serial port with an RS-232 or RS-485 serial cable (see MRU Marine User Manual for details).



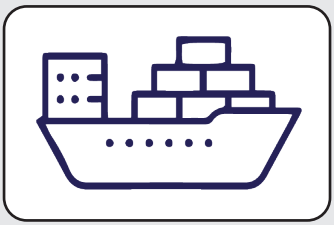
3. INSTALL THE SOFTWARE

Install the NORSUB MRU Configuration Software by double clicking on the installer file (`setup.exe`) on the USB memory stick (see MRU Configuration Software User Manual for details).



4. CONFIGURE THE MRU

Run the NORSUB MRU Configuration Software to configure the MRU Marine (see MRU Configuration Software User Manual for details).



5. INSTALL THE MRU

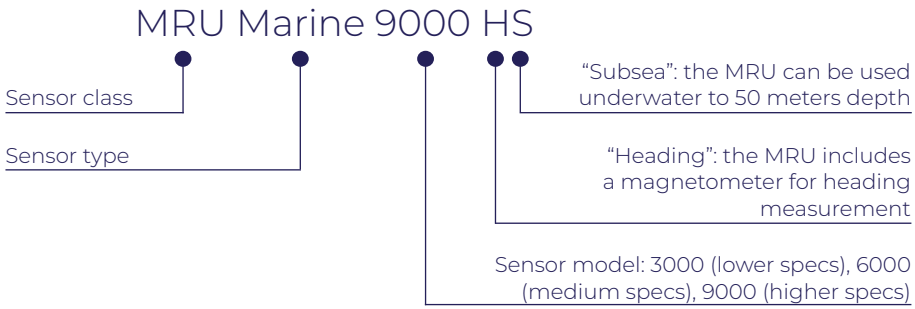
Install the configured MRU Marine at the desired location.

MRU Marine Models

The MRU Marine comes in 12 different models which cover a variety of performance and features. The MRU Marine models are:

BASIC	MRU 3000 MRU 6000 MRU 9000	MRU Marine 3000 MRU Marine 6000 MRU Marine 9000
H	MRU 3000 H MRU 6000 H MRU 9000 H	MRU Marine 3000 H MRU Marine 6000 H MRU Marine 9000 H
S	MRU 3000 S MRU 6000 S MRU 9000 S	MRU Marine 3000 S MRU Marine 6000 S MRU Marine 9000 S
HS	MRU 3000 HS MRU 6000 HS MRU 9000 HS	MRU Marine 3000 HS MRU Marine 6000 HS MRU Marine 9000 HS

The model name is explained here:



Variations between models will be explicitly described in this manual.
In the following the MRU Marine 3000/6000/9000 will be referred to as "Basic", the MRU Marine 3000/6000/9000 H will be referred to as "H", the MRU Marine 3000/6000/9000 S will be referred to as "S", and the MRU Marine 3000/6000/9000 HS will be referred to as "HS".

Product List

The MRU Marine models, marine cables, junction boxes and other MRU Marine accessories available for purchase at Norwegian Subsea are listed in the following:

NORWEGIAN SUBSEA MRU MARINE-RELATED PRODUCT LIST		
PRODUCT NAME	Product No.	
NORSUB MRU 9000 Marine	10001	MRU MARINE
NORSUB MRU 6000 Marine	10002	
NORSUB MRU 3000 Marine	10003	
NORSUB MRU 9000 Marine H	10004	
NORSUB MRU 6000 Marine H	10005	
NORSUB MRU 3000 Marine H	10006	
NORSUB MRU 9000 Marine S	10007	
NORSUB MRU 6000 Marine S	10008	
NORSUB MRU 3000 Marine S	10009	
NORSUB MRU 9000 Marine HS	10010	
NORSUB MRU 6000 Marine HS	10011	
NORSUB MRU 3000 Marine HS	10012	
NORSUB MRU 9000 Marine S (Ethernet & RS-232)	10201	
NORSUB MRU 6000 Marine S (Ethernet & RS-232)	10202	
NORSUB MRU 3000 Marine S (Ethernet & RS-232)	10203	
NORSUB MRU 9000 Marine HS (Ethernet & RS-232)	10204	
NORSUB MRU 6000 Marine HS (Ethernet & RS-232)	10205	
NORSUB MRU 3000 Marine HS (Ethernet & RS-232)	10206	

Table 1: Norwegian Subsea MRU Marine-related product list (part 1).

Product List

NORWEGIAN SUBSEA MRU MARINE-RELATED PRODUCT LIST		
PRODUCT NAME	Product No.	
NORSUB MRU 9000 Marine S (Ethernet & 2 wire RS-485)	10213	MRU MARINE
NORSUB MRU 6000 Marine S (Ethernet & 2 wire RS-485)	10214	
NORSUB MRU 3000 Marine S (Ethernet & 2 wire RS-485)	10215	
NORSUB MRU 9000 Marine HS (Ethernet & 2 wire RS-485)	10216	
NORSUB MRU 6000 Marine HS (Ethernet & 2 wire RS-485)	10217	
NORSUB MRU 3000 Marine HS (Ethernet & 2 wire RS-485)	10218	
Marine Junction Box 1.0	20001	JUN. BOX
Marine Junction Box 2.0	20002	
Marine Cable 2 m	30001	MARINE CABLES
Marine Cable 5 m	30002	
Marine Cable 10 m	30003	
Marine Cable 20 m	30004	
Marine Cable xx m	30005	
Marine Pigtail Cable 2 m	30006	MARINE PIGTAILS
Marine Pigtail Cable 5 m	30007	
Marine Pigtail Cable 10 m	30008	
Marine Pigtail Cable 20 m	30009	
Marine Pigtail Cable xx m	30010	
Transport Case M	40001	ACCESSORIES
Power Supply 24 V DC	40002	
Subsea Dummy Plug F	40003	
Subsea Dummy Plug M	40004	
USB stick with MRU configuration software	40005	

Table 2: Norwegian Subsea MRU Marine-related product list (part 2).

Items List (Basic, H)

A standard shipment of the MRU Marine 3000 / MRU Marine 3000 H, MRU Marine 6000 / MRU Marine 6000 H, and MRU Marine 9000 / MRU Marine 9000 H contains the following items (*):

1. 1 x NORSUB MRU Marine;
2. 1 x Marine cable;
3. 1 x Junction box;
4. 1 x Power supply;
5. 1 x USB flash drive with the NORSUB MRU Configuration Software;
6. 1 x Configuration Software user manual and 1 x MRU Marine user manual.

1. MRU

NORSUB MRU Marine

2. CABLE

Marine cable

3. JUNCTION BOX

Junction box to connect the MRU to a system

4. POWER SUPPLY

Standard 24V DC power supply

5. USB FLASH DRIVE

USB drive with the NORSUB MRU Configuration Software

6. USER MANUALS

Configuration Software user manual and MRU Marine user manual

(*) The shipment content (such as cable length and cable connectors) may vary from the above item list depending on items in your order (see “Product List” on page 4).

Items List (S, HS)

A standard shipment of the MRU Marine 3000 S / MRU Marine 3000 HS, MRU Marine 6000 S / MRU Marine 6000 HS, and MRU Marine 9000 S / MRU Marine 9000 HS contains the following items (*):

1. 1 x NORSUB MRU Marine;
2. 1 x Subsea shallow water cable;
3. 1 x USB flash drive with the NORSUB MRU Configuration Software;
4. 1 x Configuration Software user manual and 1 x MRU Marine user manual.

1. MRU

NORSUB MRU Marine

2. CABLE

Subsea shallow water cable

3. USB FLASH DRIVE

USB drive with the NORSUB MRU Configuration Software

4. USER MANUALS

Configuration Software user manual and MRU user manual

(*) The shipment content (such as cable length and cable connectors) may vary from the above item list depending on items in your order (see “Product List” on page 4).

System Set-Up (Basic, H)

- Connect the female connector of the MRU marine cable to the MRU and the male connector to the junction box.
- Connect the junction box through Ethernet or serial (RS-232 or RS-485) port to the host-PC.
- Connect the power supply to the power terminal block on the junction box. It is recommended to plug the power supply to the power socket last, because this operation will start-up the MRUMarine.

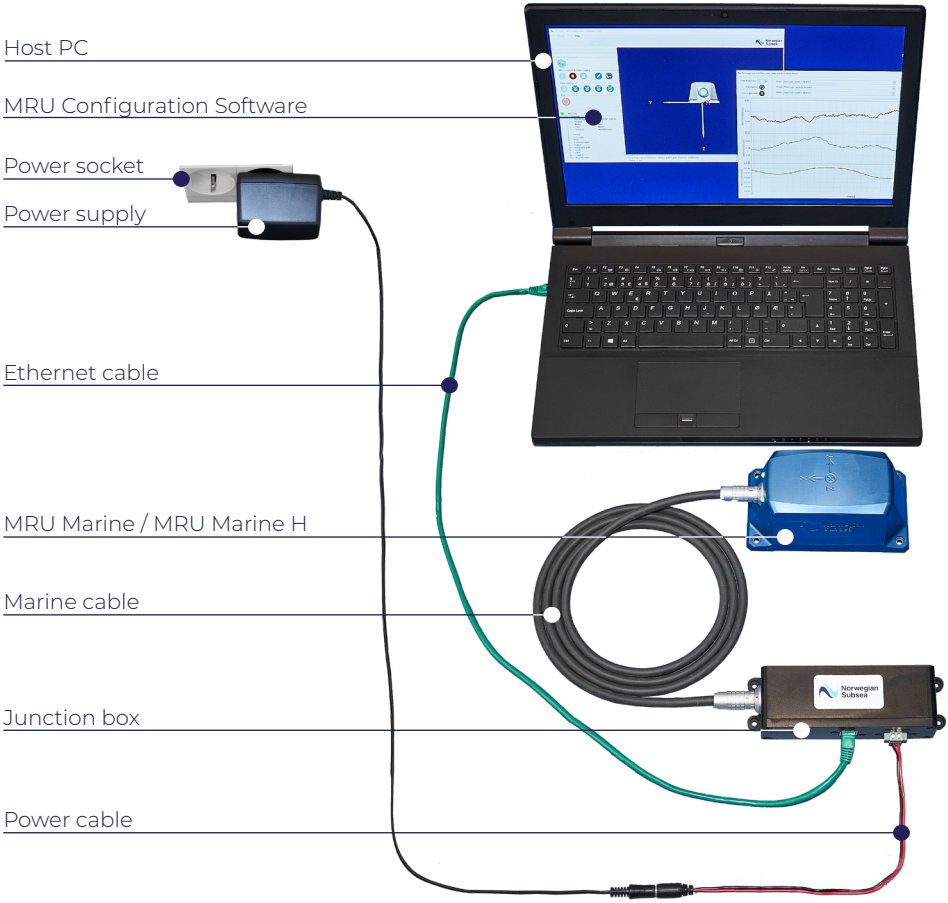


Figure 1: System set-up for the MRU Marine / MRU Marine H, Ethernet connection.

System Set-Up (S, HS)

- Connect the male connector of the shallow water cable to the MRU SubConn connector, and the other end to your system (*). In the following figure, a subsea shallow water cable with an RJ45 plug and a power barrel jack is shown.
- Connect the RJ45 plug (ethernet) or DB-9 connector (serial) to your system.
- Connect the power cable to the power supply. It is recommended to plug the power supply to the power socket last, because this operation will start-up the MRU Marine.

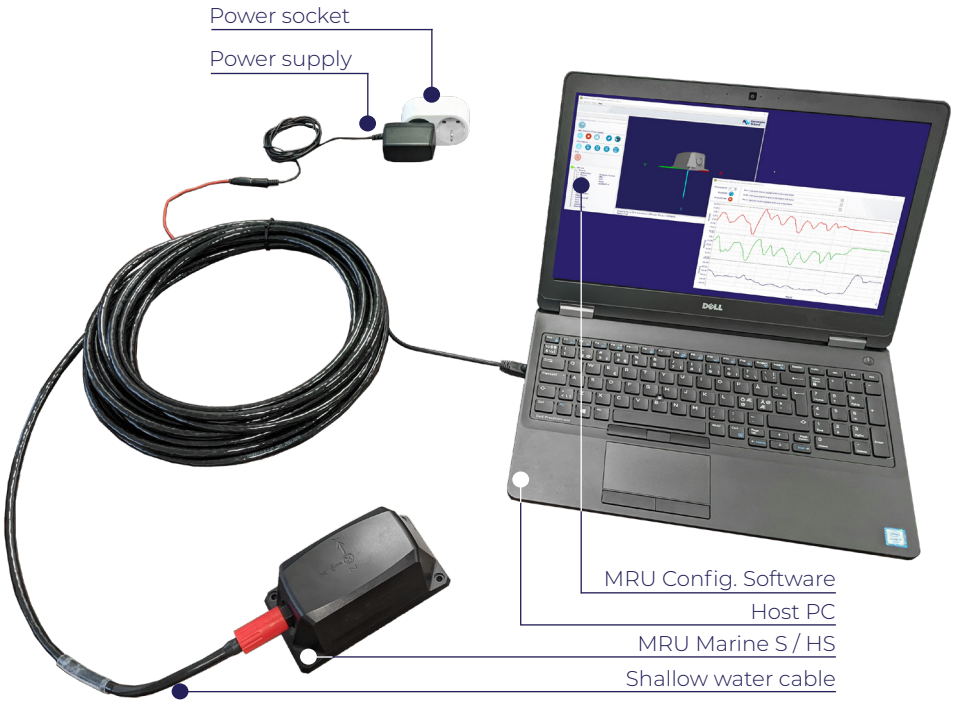


Figure 2: System set-up for the MRU Marine S / MRU Marine HS, Ethernet connection.

(*) The cable and connector may vary depending on your order specifications.

2. MECHANICAL INTERFACE

Design (Basic, H)

The dimensions of the MRU Marine / MRU Marine H are:

- Length: 154.0 mm;
- Breadth: 86.0 mm;
- Height: 66.6 mm.

The footprint of the MRU Marine and MRU Marine H is seen in Figure 4 and Figure 8, dimensions are in millimeters. The figures show the 4 mounting holes and the 2 alignment holes/slots on the center line. The MRU is mounted to a solid surface using 4 x M5 screws. 4 mm diameter alignment dowels are recommended for best alignment during installation.

The MRU Marine 3000/6000/9000 and MRU Marine 3000/6000/9000 H are identical when considering geometry, construction and materials.

Figure 3: MRU Marine / MRU Marine H: front and back views.

Design (Basic, H)

Figure 4: MRU Marine / MRU Marine H: side, top, and bottom views.

LED Indicators (Basic, H)

The MRU Marine and MRU Marine H models have two LED indicators that provide feedback on the MRU status and configuration.
The status LED 1 provides a general overview of the MRU status. Its color indicates if the MRU is working properly, requires a restart, or if a critical error must be investigated further (see Table 3).

Figure 5: MRU Marine / MRU Marine H: status LED indicators.

STATUS LED 1		
COLOR	BLINKING PATTERN	DESCRIPTION
Green	Constant light	MRU powered up, everything is OK
Yellow	Constant light	MRU powered up, requires restart
Red	Constant light	MRU powered up, critical error. Check status bits

Table 3: Color and blinking pattern for status LED 1.

The status LED 2 provides detailed information about the MRU status from its color and blinking pattern. The status LED 2 loops through 7 colors with fixed order (see Figure 6), and every color is associated to a status category.

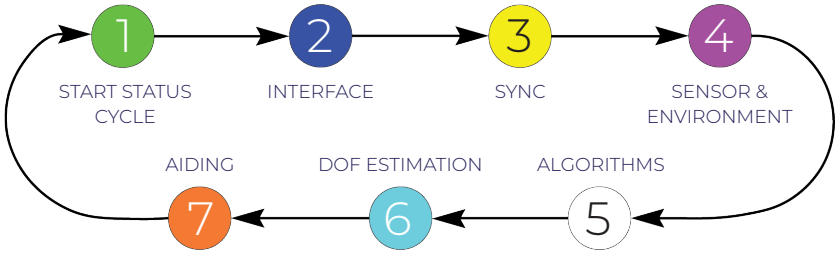


Figure 6: Status LED 2 colors cycle.

LED Indicators (Basic, H)

To check the status of a category, simply monitor the blinking pattern of the category color. The blinking patterns are described in Table 4. For example, 3 pulses of status LED 2 in turquoise indicates that the heading measurement is faulty. The orange light following the turquoise blinking pattern tells the status of the aiding. If it blinks only once, then position, velocity and heading aiding are OK.

Notice that if no errors are detected, the status led will keep blinking with a green light.

STATUS LED 2				
ORDER	COLOR	BLINKING PATTERN	DESCRIPTION	STATUS BIT
1	Green	1 long pulse	Sequence start	-
2	Blue	1 pulse	Only Ethernet configuration port available	-
		2 pulses	Ethernet and RS-232 port available	-
		3 pulses	Ethernet and RS-485 port available	-
3	Yellow	1 pulse	Time and clock synced	4, 5
		2 pulses	Time synced. Clock not synced	
		3 pulses	Time not synced. Clock synced	
		4 pulses	Time and clock not synced	
4	Magenta	1 pulse	Sensor and environment OK	9, 10, 11
		2 pulses	Sensor saturated, environment OK	
		3 pulses	Sensor OK, temp. or vibrations out of bounds	
5	White	1 pulse	Algorithms OK	13, 14, 15
		2 pulses	Unstable / initializing algorithms	
6	Turquoise	1 pulse	All DOFs OK	16, 18, 20, 22
		2 pulses	Roll/Pitch not OK	
		3 pulses	Heading not OK	
		4 pulses	Heave not OK	
		5 pulses	More than one DOF not OK	
7	Orange	1 pulse	Position, velocity and heading aiding	27, 28, 29
		2 pulses	Position and velocity aiding	
		3 pulses	Position and heading aiding	
		4 pulses	Heading and velocity aiding	
		5 pulses	No aiding	

Table 4: Color and blinking pattern for status LED 2.

Technical Drawings (Basic, H)

MRU Marine / MRU Marine H top, side and front technical drawings. All dimensions are in millimeters:

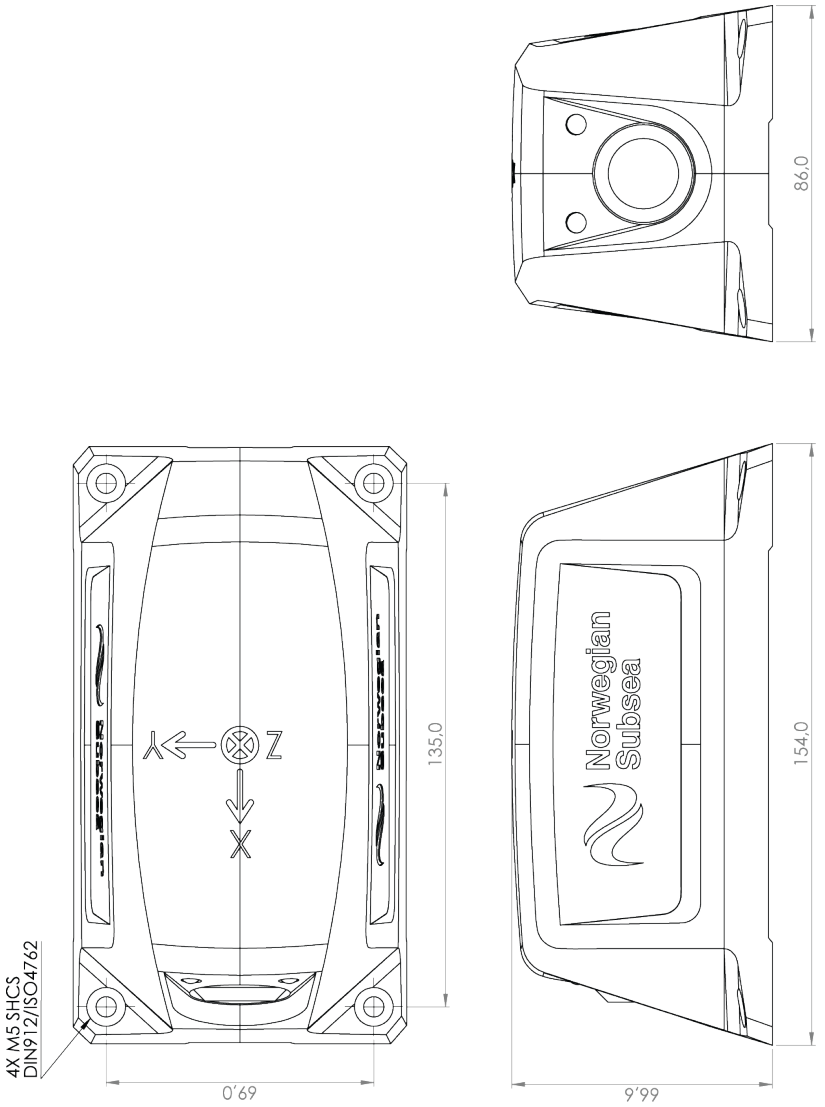


Figure 7: MRU Marine / MRU Marine H technical drawings: top, side, front views.

Technical Drawings (Basic, H)

MRU Marine / MRU Marine H bottom and section A-A technical drawings. All dimensions are in millimeters:

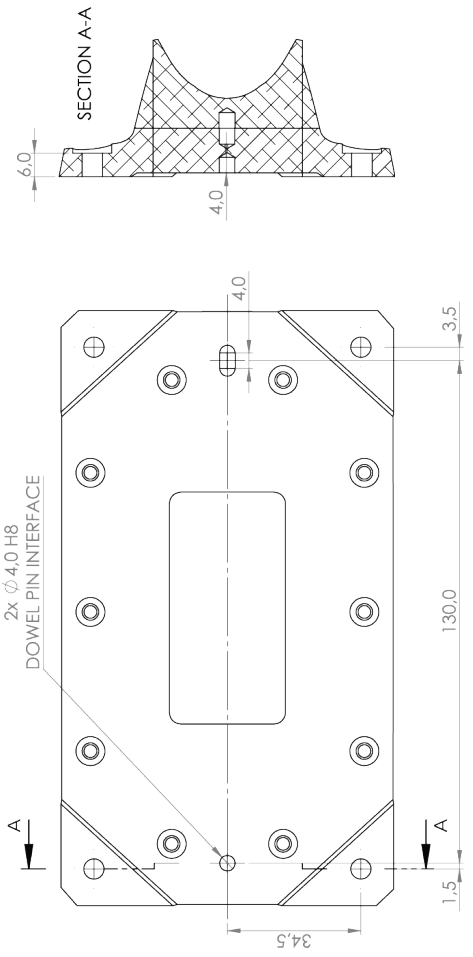


Figure 8: MRU Marine / MRU Marine H technical drawings: bottom view.

Junction Box Technical Drawings

The MRU Marine and MRU Marine H models can be delivered with a junction box. The dimensions of the junction box are:

- Length: 174.0 mm;
- Breadth: 63.2 mm;
- Height: 45.0 mm.

The footprint of the junction box is seen in the top view of Figure 11. The junction box can be mounted to a surface using 4 x M4 machine screws in the mounting holes.
All dimensions are in millimeters:

Figure 9: MRU Marine and MRU Marine H junction box.

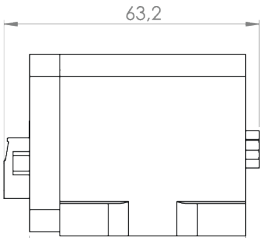


Figure 10: Junction box technical drawings: back side.

Junction Box Technical Drawings

The junction box top, left and right side technical drawings are showed in the following. All dimensions are in millimeters:

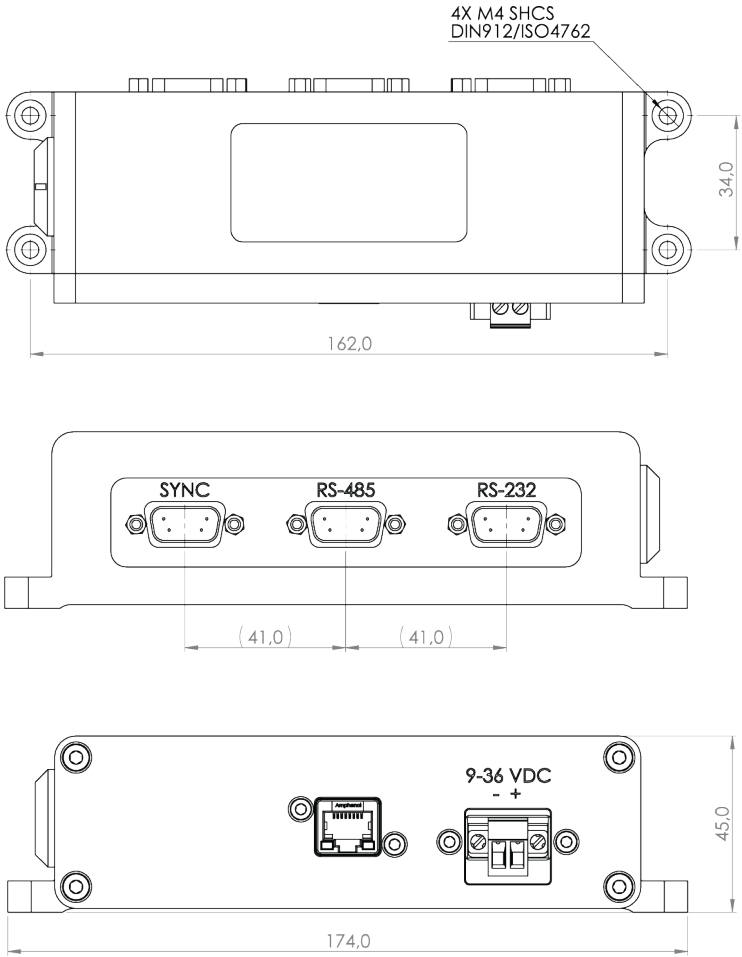


Figure 11: Junction box technical drawings: top, left, and right side.

Design (S, HS)

The dimensions of the MRU Marine S / MRU Marine HS are:

- Length: 154.0 mm;
- Breadth: 86.0 mm;
- Height: 66.6 mm.

The footprint of the MRU Marine S / MRU Marine HS is seen in Figure 13 and Figure 15, dimensions are in millimeters. This shows the 4 mounting holes and the 2 alignment holes/ slots on the center line. The MRU is mounted to a solid surface using 4 x M5 screws. 4 mm diameter alignment dowels are recommended for best alignment during installation.

The MRU Marine 3000/6000/9000 S and MRU Marine 3000/6000/9000 HS are identical when considering geometry, construction and materials.

Figure 12: MRU Marine S / MRU Marine HS: front and back views.

(*) The MRU Marine S / MRU Marine HS are shipped with a MALE 8-pins SubConn connector, even though a female connector is depicted in the figure.

NOTE

The MRU Marine S / MRU Marine HS are shipped with a MALE 8-pins SubConn connector.

Design (S, HS)

Figure 13: MRU Marine S / MRU Marine HS: side, top, and bottom views.

Technical Drawings (S, HS)

MRU Marine S / MRU Marine HS top, side and front technical drawings. All dimensions are in millimeters:

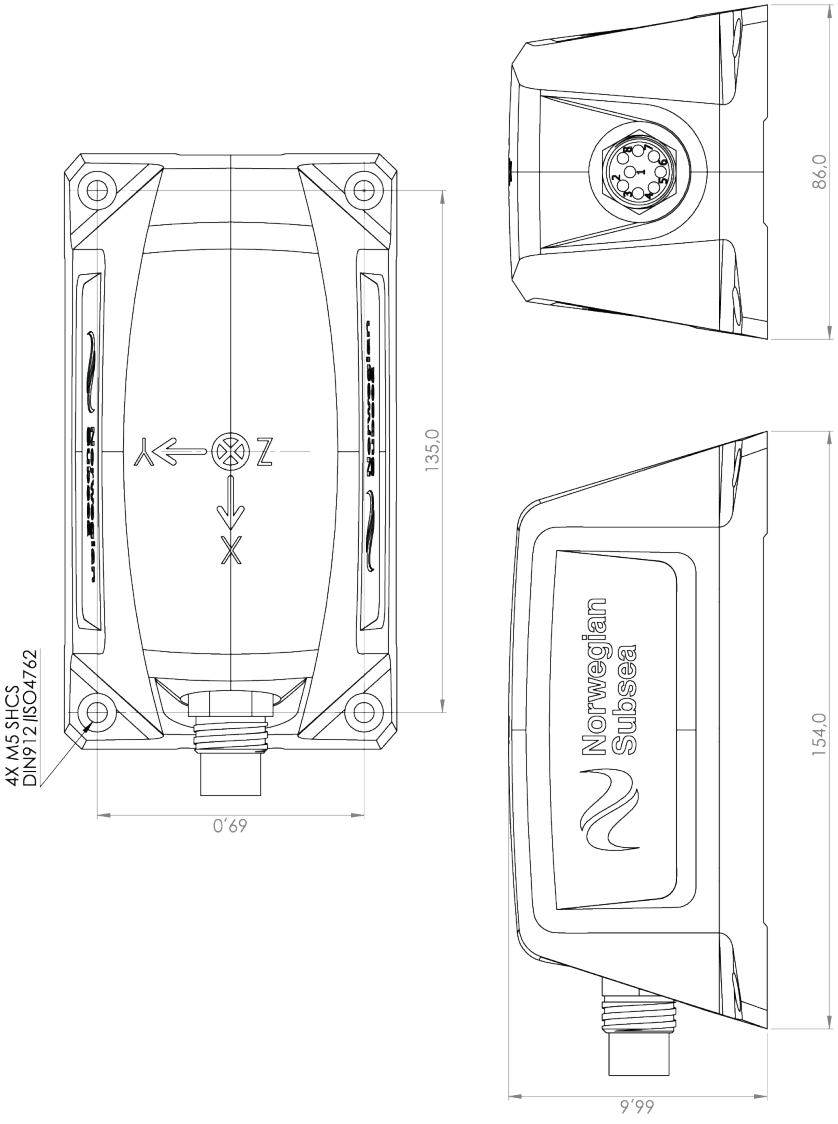


Figure 14: MRU Marine S / MRU Marine HS technical drawings: top, side, front views.

Technical Drawings (S, HS)

MRU Marine S / MRU Marine HS bottom and section A-A technical drawings. All dimensions are in millimeters:

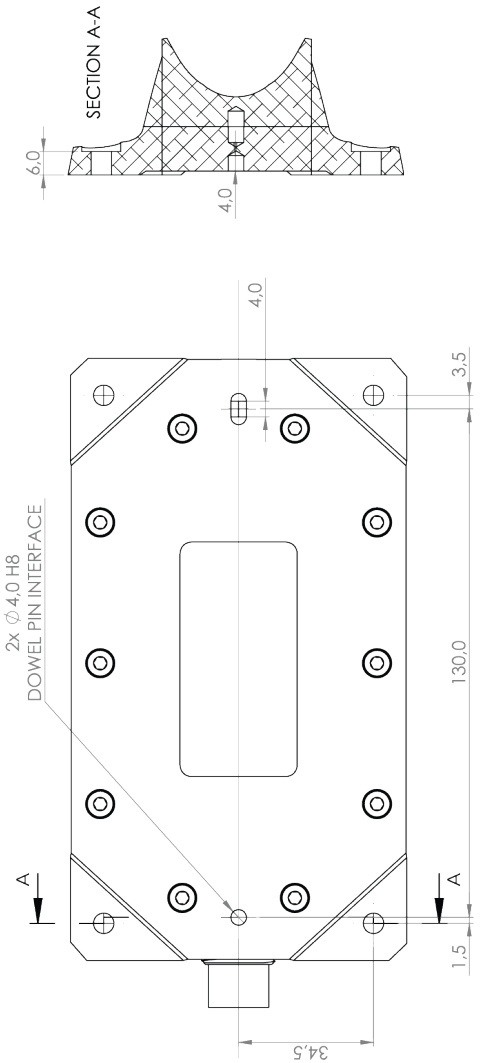


Figure 15: MRU Marine S / MRU Marine HS technical drawings: bottom view.

3. ELECTRICAL INTERFACE

Marine Cable / Connectors (Basic, H)

The MRU Marine and MRU Marine H models are connected to the junction box with a Norwegian Subsea marine cable plugged to a 16 pins marine connector.
The connector pinout and the cable wires color code are given in Figure 16 and Table 5.

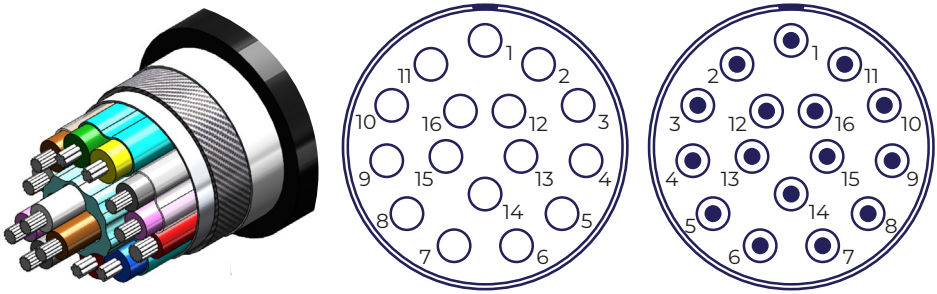


Figure 16: Marine cable cross section and marine connectors. Female connector on the center, male connector on the right.

STANDARD 16 PINS CONNECTOR			
WIRE COLOR	PIN No.	SIGNAL (from MRU, male connector)	
Red + black	1	24V	POW.
Brown + black	2	GND	
Green	3	Tx_D1+	ETHERNET
Yellow	4	Tx_D1-	
Blue	5	Rx_D2+	
Red	6	Rx_D2-	
Gray	7	Tx+ (RS-485)	RS-485
Pink	8	Tx- (RS-485)	
Black	9	Rx+ (RS-485)	
Violet	10	Rx- (RS-485)	
White	11	Tx (RS-232)	RS-232
Brown	12	Rx (RS-232)	
Pink + black	13	Sync1	SYNC
Gray + black	14	Sync2	
White + black	15	Shield	SHIELD
Not connected	16	shield	

Table 5: Marine cable wires color code, marine connector pinout and signals.

Marine Cable / Connectors (Basic, H)

Technical details on the marine cable are given in the following:

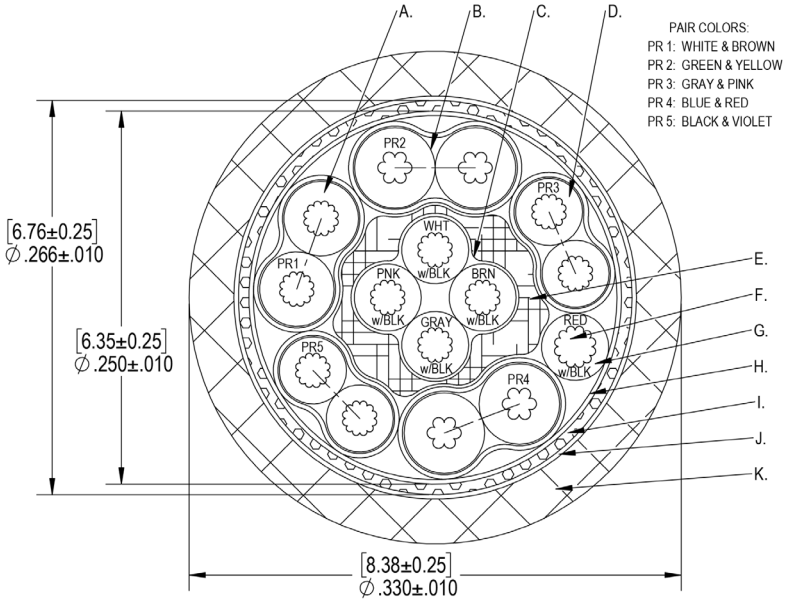


Figure 17: Marine cable cross section.

ITEM	SPECIFICATION
A	24/2 unshielded RS-232 data pair (1 each)
B	24/2 shielded Ethernet pair (2 each)
C	24/2 unshielded quad (1 each)
D	24/2 unshielded RS-485 data pair (2 each)
E	Flame retardant poly filler
F	22 AWG 19x .0058'' [19x0.15mm] TC OD: .028+/- .0005'' [0.71+/- 0.01mm]
G	9 MILS [0.23mm] XLPE INSULATION 7 MILS [0.18mm] MIN XLPE INSULATION OD: .050+/- .002'' [1.27+/- 0.05mm]
H	Aluminum/polyester foil shield (foil out)
I	38 AWG TC braided shield (75% min coverage)
J	Tissue paper separator
K	30 MILS [0.76mm] pressured polyurethane jacket 24 MILS [0.61mm] pressured polyurethane jacket (jacket color: black)

Table 6: Marine cable components description.

Junction Box (Basic, H)

A Norwegian Subsea junction box interfaces the MRU Marine and MRU Marine H to the Ethernet, RS-232 or RS-485 ports of a system. The main connector in the front of the junction box is mated with a marine cable from the MRU (see “Marine Cable / Connectors (Basic, H)” on page 26).

The nominal power input to the MRU Marine is 24 V DC. The MRU will work with input voltages from 10-36 V. The unit is protected against reverse polarity. If input voltage drops below 12 V, the unit will shut down safely. There is no over-voltage protection, too high input voltage may damage the MRU Marine permanently. Power consumption is ca. 6 W.

Figure 18: Junction box connectors.

WARNING

The MRU Marine does not have an over-voltage protection.
Too high voltage may damage the MRU Marine permanently.

Junction Box (Basic, H)

The signal diagram for the junction box is reported in Table 7:

MRU Marine JUNCTION BOX SIGNAL DIAGRAM		
CONNECTOR	PIN N.	SIGNAL
Power, terminal block	+	10-36 VDC
	-	GND
Ethernet, RJ45	1	Tx_D1+
	2	Tx_D1-
	3	Rx_D2+
	6	Rx_D2-
RS-485, DB-9 (male)	1	GND
	4	Rx+ (RS-485)
	5	Rx- (RS-485)
	8	Tx+ (RS-485)
	9	Tx- (RS-485)
RS-232, DB-9 (male)	2	Rx (RS-232)
	3	Tx (RS-232)
	5	GND
Sync, DB-9 (male)	6	GND
	7	sync1
	8	GND
	9	sync2

Table 7: Junction box signal diagram.

Shallow Water Cable / Connectors (S, HS)

The MRU Marine S and MRU Marine HS models are connected to a system with the shallow water cable plugged to a SubConn connector. The 8 pin SubConn connector has not enough pins for power, Ethernet, RS-232 and RS-485 ports. The 5 available power and communication configurations for the SubConn connector are given below. Note that all signals are w.r.t to the MRU connector.

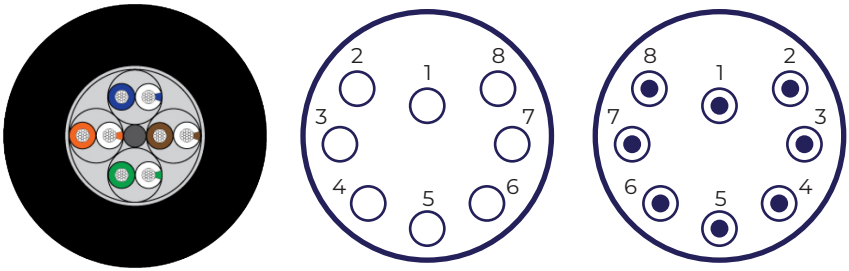


Figure 19: Shallow water cable section and 8-pins SubConn connector. Female connector on the center, male connector on the right.

SHALLOW WATER CABLE AND SubConn CONNECTOR CONFIGURATION 1			
WIRE COLOR	PIN N.	SIGNAL	
TP 4 (Brown)	1	GND	POWER
TP 4 (White /Brown)	2	24V	POWER
TP 1 (Blue)	3	GND	POWER
TP 1 (White/Blue)	4	24V	POWER
TP 2 (White/Orange)	5	Tx_D1+	ETHERNET
TP 2 (Orange)	6	Tx_D1-	ETHERNET
TP 3 (White/Green)	7	Rx_D2+	ETHERNET
TP 3 (Green)	8	Rx_D2-	ETHERNET

SHALLOW WATER CABLE AND SubConn CONNECTOR CONFIGURATION 2			
WIRE COLOR	PIN N.	SIGNAL	
TP 4 (Brown)	1	GND	POW.
TP 4 (White /Brown)	2	24V	POW.
TP 1 (Blue)	3	Tx	RS-232
TP 1 (White/Blue)	4	Rx	RS-232
TP 2 (White/Orange)	5	Tx_D1+	ETHERNET
TP 2 (Orange)	6	Tx_D1-	ETHERNET
TP 3 (White/Green)	7	Rx_D2+	ETHERNET
TP 3 (Green)	8	Rx_D2-	ETHERNET

Table 8: Shallow water cable and connector configurations 1 and 2.

Shallow Water Cable / Connectors (S, HS)

SHALLOW WATER CABLE AND SubConn CONNECTOR CONFIGURATION 3			
WIRE COLOR	PIN N.	SIGNAL	
TP 4 (Brown)	1	GND	POW.
TP 4 (White /Brown)	2	24V	POW.
TP 1 (Blue)	3	Tx	RS-232
TP 1 (White/Blue)	4	Rx	RS-232
TP 2 (White/Orange)	5	Tx+	RS-485
TP 2 (Orange)	6	Tx-	RS-485
TP 3 (White/Green)	7	Rx+	RS-485
TP 3 (Green)	8	Rx-	RS-485

SHALLOW WATER CABLE AND SubConn CONNECTOR CONFIGURATION 4			
WIRE COLOR	PIN N.	SIGNAL	
TP 4 (Brown)	1	GND	POWER
TP 4 (White /Brown)	2	24V	POWER
TP 1 (Blue)	3	GND	POWER
TP 1 (White/Blue)	4	24V	POWER
TP 2 (White/Orange)	5	Tx+	RS-485
TP 2 (Orange)	6	Tx-	RS-485
TP 3 (White/Green)	7	Rx+	RS-485
TP 3 (Green)	8	Rx-	RS-485

SHALLOW WATER CABLE AND SubConn CONNECTOR CONFIGURATION 5			
WIRE COLOR	PIN N.	SIGNAL	
TP 4 (Brown)	1	GND	POW.
TP 4 (White /Brown)	2	24V	POW.
TP 1 (Blue)	3	(B)+	RS-485
TP 1 (White/Blue)	4	(A)-	RS-485
TP 2 (White/Orange)	5	Tx_D1+	ETHERNET
TP 2 (Orange)	6	Tx_D1-	ETHERNET
TP 3 (White/Green)	7	Rx_D2+	ETHERNET
TP 3 (Green)	8	Rx_D2-	ETHERNET

Table 9: Shallow water cable and connector configurations 3,4, and 5.

Shallow Water Cable / Connectors (S, HS)

SHALLOW WATER CABLE COMPONENTS	
ITEM	DESCRIPTION
Twisted pair	0.25 mm² (#24AWG) stranded tinned copper wires 19/.005, twisted together, insulated with Polypropylene, approx. 0.35 mm wall thickness (4 off)
Filler	Rod filler for roundness
Blinder	An overall clear tape wrap
Outer jacket	Polyurethane jacket. 85A Shore Hardness. Color black. Nominal thickness approx. 1.27 mm
Color code	Twisted pair #1: Brown & White/Brown Twisted pair #2: Blue & White/Blue Twisted pair #3: Orange & White/Orange Twisted pair #4: Green & White/Green

Table 10: Shallow water cable components descriptions.

SHALLOW WATER CABLE TECHNICAL DETAILS	
PARAMETER	VALUE
Diameter	Nom. 9.65 mm
Weight in air	82 kg/km
Weight in seawater	6 kg/km
Minimum bending radius	102 mm
Depth rating	300 m
Operating voltage	300 V

Table 11: Shallow water cable technical details.

4. TECHNICAL SPECIFICATIONS

Output Protocols

The MRU outputs industry standard or custom NMEA/ASCII and binary protocols are:

NAME	TYPE	DATA
Custom NMEA	NMEA	All data from parameter list, see chapter 6
Custom Binary	Binary	All data from parameter list, see chapter 6
ATLAS	Binary	Roll, pitch, heave
GYROCOMPAS1	NMEA	Roll, pitch, heading, status
IFREMER VICTOR	Binary	Roll, pitch, heading, roll rate, pitch rate, yaw rate, acc x, acc y, acc z
MDL	ASCII	Roll, pitch, heading
NORSUB	NMEA	Roll, pitch, yaw, heave
NORSUB2	NMEA	Roll, pitch, yaw, heave, heave vel
NORSUB6	NMEA	Roll, pitch, yaw, surge, sway, heave, roll rate,pitch rate, yaw rate, surge vel, sway vel, heave vel, acc x, acc y, acc z
NORSUB6g	NMEA	Roll, pitch, yaw, surge, sway, heave, roll rate,pitch rate, yaw rate, surge vel, sway vel, heave vel, acc x, acc y, acc z (including gravity)
NORSUB7	NMEA	Roll, pitch, yaw, surge (body frame), sway (body frame), heave, roll rate,pitch rate, yaw rate, surge vel (body frame), sway vel (body frame), heave vel, acc x (body frame), acc y (body frame) acc z, period x, period y, period z, amplitude x, amplitude y, amplitude z, STATUS
NORSUB7b	NMEA	Roll, pitch, yaw, surge (body frame), sway (body frame), heave, roll rate,pitch rate, yaw rate, surge vel (body frame), sway vel (body frame), heave vel, acc x (body frame), acc y (body frame) acc z, period x, period y, period z, amplitude x, amplitude y, amplitude z, STATUS_A, STATUS_B
NORSUB8	NMEA	Roll, pitch, yaw, surge (NED frame), sway (NED frame), heave, roll rate,pitch rate, yaw rate, surge vel (NED frame), sway vel (NED frame), heave vel, acc x (NED frame), acc y (NED frame), acc z, period x, period y, period z, amplitude x, amplitude y, amplitude z, STATUS
NORSUB PRDID	NMEA	Pitch, roll
Tokimek PTVG	NMEA	Roll, pitch, yaw
RDI ADCP	NMEA	Roll, pitch, yaw

Table 12: List of output protocols (part 1).

Output Protocols

NAME	TYPE	DATA
SMCA	NMEA	Roll, pitch, surge,sway, heave
SMCC	NMEA	Roll, pitch, yaw, surge, sway, heave, surge vel, sway vel, heave vel, acc x, acc y, acc z
SMCCg	NMEA	Roll, pitch, yaw, surge, sway, heave, surge vel, sway vel, heave vel, acc x, acc y, acc z (including gravity)
Simrad EM 3000	Binary	Roll, pitch, yaw, heave
TSS1	ASCII	Roll, pitch, heave, status

Table 13: List of output protocols (part 2).

Custom NMEA: custom output protocol in NMEA format. See the MRU Configuration Software User Manual for the full list of available output variables.

Custom Binary: custom output protocol in binary format. See the MRU Configuration Software User Manual for the full list of available output variables.

Output Variables

The following table shows the available variables for every protocol.

NAME	TYPE	Roll	Pitch	Yaw	Heading	Roll rate	Pitch rate	Yaw rate	Surge	Sway	Heave	Surge velocity	Sway velocity	Heave velocity	Surge acc.	Sway acc.	Heave acc.	Heave acc. (incl.g)	Surge period	Sway period	Heave period	Surge amplitude	Sway amplitude	Heave amplitude	STATUS	STATUS_A	STATUS_B
Atlas	bin.	/	/								/																
Gyrocompasl	ASCII	/	/		/																						
Ifremer Victor	bin.	/	/		/	/	/	/							/	/	/										
MDL	ASCII	/	/		/																						
NORSUB	ASCII	/	/	/							/																
NORSUB2	ASCII	/	/	/							/			/													
NORSUB6	ASCII	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/										
NORSUB6g	ASCII	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/									
NORSUB7	ASCII	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/		
NORSUB7b	ASCII	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/		/	/

Table 14: Output protocol data (part 1).

Output Variables

NAME	TYPE	DATA																									
		Roll	Pitch	Yaw	Heading	Roll rate	Pitch rate	Yaw rate	Surge	Sway	Heave	Surge velocity	Sway velocity	Heave velocity	Surge acc.	Sway acc.	Heave acc.	Heave acc. (incl.g)	Surge period	Sway period	Heave period	Surge amplitude	Sway amplitude	Heave amplitde	STATUS	STATUS_A	STATUS_B
NORSUB8	ASCII	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/		
NORSUB PRDID	ASCII	/	/																								
Tokimek PTVG	ASCII	/	/	/																							
RDI ADCP	ASCII	/	/	/																							
SMCA	ASCII	/	/						/	/	/																
SMCC	ASCII	/	/	/					/	/	/	/	/	/	/	/	/										
SMCCg	ASCII	/	/	/					/	/	/	/	/	/	/	/	/	/									
Simrad EM 3000	bin.	/	/	/							/																
TSS1	bin.	/	/								/																

Table 15: Output protocol data (part 2).

Technical Specifications

MRU MARINE 3000/6000/9000 PHYSICAL CHARACTERISTICS		
PARAMETER	BASIC & H	S & HS
Weight	1200 g	1200 g
L x B x H	154 x 86 x 66.6 mm	154 x 86 x 66.6 mm
Depth rating	IP68	50 m

Table 16: MRU Marine physical characteristics.

MRU MARINE PERFORMANCE						
PARAMETER	3000 BASIC & S	3000 H & SH	6000 BASIC & S	6000 H & SH	9000 BASIC & S	9000 H & SH
Roll & pitch	+/- 0.05 degs	+/- 0.05 degs	+/- 0.02 degs	+/- 0.02 degs	+/- 0.01 degs	+/- 0.01 degs
Real-time heave	5.0 cm or 5.0 %	5.0 cm or 5.0 %	5.0 cm or 5.0 %	5.0 cm or 5.0 %	5.0 cm or 5.0 %	5.0 cm or 5.0 %
Heading	N/A	+/- 0.5 degs	N/A	+/- 0.5 degs	N/A	+/- 0.5 degs

Table 17: MRU Marine performance.

MRU MARINE RANGE						
PARAMETER	3000 BASIC & S	3000 H & SH	6000 BASIC & S	6000 H & SH	9000 BASIC & S	9000 H & SH
Acceleration range	+/- 3 g	+/- 3 g	+/- 4 g	+/- 4 g	+/- 10 g	+/- 10 g
Gyroscopes	+/- 150 degs/s	+/- 150 degs/s	+/- 450 degs/s	+/- 450 degs/s	+/- 450 degs/s	+/- 450 degs/s
Heave	+/- 50 m	+/- 50 m	+/- 50 m	+/- 50 m	+/- 50 m	+/- 50 m
Yaw	N/A	360 degs	N/A	360 degs	N/A	360 degs
Pitch	+/- 90 degs	+/- 90 degs	+/- 90 degs	+/- 90 degs	+/- 90 degs	+/- 90 degs
Roll	+/- 180 degs	+/- 180 degs	+/- 180 degs	+/- 180 degs	+/- 180 degs	+/- 180 degs
Output frequency	0 - 100 Hz	0 - 100 Hz	0 - 100 Hz	0 - 100 Hz	0 - 100 Hz	0 - 100 Hz

Table 18: MRU Marine range.

Technical Specifications

MRU MARINE 3000/6000/9000 POWER AND INTERFACES		
PARAMETER	BASIC & H	S & HS
Power consumption	6.0 W	6.0 W
Supply voltage	10-36 V DC (24 V nominal)	10-36 V DC (24 V nominal)
Internal storage	32 GB	32 GB
Communication	Ethernet, RS-232, RS-485 (422), 2 x sync.	One of the following: ◆ Ethernet ◆ Ethernet and RS-232 ◆ RS-232 and RS-485 ◆ RS-485 ◆ Ethernet and 2 wire RS-485
Protocols	See “Output Protocols” on page 36 for the complete list	See “Output Protocols” on page 36 for the complete list

Table 19: MRU Marine power and interfaces.

MRU MARINE 3000/6000/9000 ENVIRONMENTAL SPECIFICATIONS	
PARAMETER	BASIC, H, S, HS
Enclosure material	Anodized aluminum 6061-T6
Enclosure protection	IP-68 / 50 m
Operating temperature range	-40 to +85 degrees Celsius
Operating humidity (max)	No limit (sealed)
Storage temperature range	-40 to +85 degrees Celsius
Storage humidity	No limit (sealed)
Electromagnetic compatibility (immunity/emission)	IEC 60945/EN 60945
Vibration	IEC 60945/EN 60945
Max shock non-operational (10 ms peak)	2000 m/s² (half-sine 0.5 msec)
MTBF (computed)	100000 h

Table 20: MRU Marine environmental specifications.

5. MAINTENANCE

Maintenance General Information

The Norwegian Subsea MRUs are designed to be maintenance free, and no field maintenance is expected.

Repair or modification to the MRU must be done by Norwegian Subsea personnel. Attempts of opening the MRU will void the warranty.

No periodic maintenance is expected except for firmware upgrades. Any other maintenance shall be carried out by Norwegian Subsea.

Firmware Upgrades

Norwegian Subsea releases free firmware upgrades for the MRUs. The latest version of the firmware can be downloaded from the download pages of the company home page after registration of an MRU. Please contact Norwegian Subsea support for legacy versions of the MRU firmware.

Please see the MRU Configuration Software manual for how to save and apply configuration settings of the MRU.

Re-calibration and Validation

This note applies to the MRU Marine series and models no. 3000, 6000 and 9000.
The NORSUB MRU Marine calibration certificate is valid for 4 years, and full product specification is maintained in this period under normal operating conditions.

Notes:

1. The specified heave accuracy of 5 cm / 5% is maintained over the MRU's lifetime, also without re-calibration.
2. Re-calibration and validation of the MRU every 4th year is recommended if the customer requires
3. full product specification after expiration of a valid calibration certificate.
4. However, the specified accuracy in roll & pitch for a given model is usually met over the MRU's lifetime under normal operating conditions as Norwegian Subsea uses only validated sensors with exceptional stability.
5. The lifetime accuracy in roll & pitch, without re-calibration, will not exceed 0.1, 0.05 and 0.035 degrees for the 3000, 6000 and 9000 models, respectively, under normal operating conditions.
6. Thus, selecting a more accurate model than initially required may extend the calibration intervals or remove the need for re-calibration.
7. The computed MTBF (mean time between failure) for a NORSUB MRU Marine is 100 000 hours, but actual lifetime depends on use, vibrations, and temperature. An MRU lifetime of 10 years or more under normal continuous operation can be expected.

Re-calibration

PARAMETER	MARINE 3000	MARINE 6000	MARINE 9000
Spec: Roll & pitch	0.05 degs	0.02 degs	0.01 degs
Spec: Heave	0.05 cm / 5%	0.05 cm / 5%	0.05 cm / 5%
Re-calibration interval	4 years	4 years	4 years
No recalibration: Roll & pitch	0.1 degs	0.05 degs	0.035 degs
No re-calibration: Heave	0.05 cm / 5%	0.05 cm / 5%	0.05 cm / 5%

Table 21: MRU performance and re-calibration.

Repairs

All repairs except for cable replacement must be performed by Norwegian Subsea.

Please contact Norwegian Subsea support if an MRU is assumed faulty. If troubleshooting with Norwegian Subsea support does not solve the issue, an RMA must be issued by Norwegian Subsea before the MRU can be sent for repair.

Troubleshooting

Please see the MRU Configuration Software manual for how to troubleshoot the MRU.

Norwegian Subsea delivers high performance Motion Reference Units (MRU) and motion sensors for marine, subsea and land use. Our products combine MEMS sensor technology and sensor fusion algorithms to give accurate and reliable motion, velocity and acceleration measurements for control and monitoring applications.

Norwegian Subsea was founded in 2014. Today, we are a fast-growing supplier of motion sensors to customers worldwide. We deliver motion sensors to satisfied customers in industries as diverse as ship motion monitoring, hydrography, green energy, and subsea oil production.

Our mission is to create better and more affordable motion sensors for users in marine, land and subsea industries. We do this by combining advanced sensor fusion algorithms with high quality hardware and the latest MEMS sensors. Our sensors are thoroughly put to test in state-of-the-art labs as well as in the field.

Norwegian Subsea is headquartered in Oslo, Norway.

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