KONGSBERG

Instruction manual

MRU

Motion reference unit

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Document history

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Copyright

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. You must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

KONGSBERG disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Disclaimer

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Support information

If you require maintenance or repair, contact Kongsberg Discovery's support organisation. You can contact us using the following address: support.seatex@kd.kongsberg.com. If you need information about our other products, visit http://www.kongsberg.com/discovery.

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About this manual

Purpose of manual

The purpose of this publication is to provide the descriptions and procedures required to install and configure the MRU system.

Target audience

The publication is intended for technical personnel such as skilled shipyard and factory workers, electricians, qualified engineers, and naval architects.

License information

An export license is required for the export of some MRU models.

Registered trademarks

Windows® is a registered trademark of Microsoft Corporation in the United States and other countries.

Maintenance purposes

This publication is also intended as reference material for the maintenance personnel. Keep this publication for later use.

MRU

Topics

Product description

This product description is for the 5th generation MRU (Motion Reference Unit). These products are both mechanically and electrically compatible with the previous MRU generations. The 5th generation products are identified by serial numbers above 20000, a titanium coloured housing an Ethernet communication.

The MRU products are inertial attitude reference systems with dynamic linear motion measurement capability included. They are primarily intended for medium accuracy measurements of motion in marine applications where long lifetime and no regular maintenance are important. The MRU products are not equivalent to high performance gyro platform or laser gyro based devices but can compete with medium range “strap-down” rate gyro based Attitude and Heading Reference Systems (AHRS).

Performance

The MRU products are supplied in a range of models from MRU D to MRU 5+, which is the top performance model.

The table shows the performance of the various models.

Model	Roll/pitch (static accuracy)	Heave (real-time)	Heave period [s]	Acceleration [m/s²]
MRU 5+	0.008°	5 cm	25	0.0003
MRU 5	0.02°	5 cm	25	0.002
MRU E	0.03°	5 cm	25	0.002
MRU H	0.03°	5 cm	25	0.002
MRU 3	0.08°	5 cm	18	0.005
MRU S	0.2°	15 cm	18	0.01
MRU 2	0.03°			0.002
MRU D	0.2°			0.01

Capabilities

The different MRU products vary in performance to meet the various requirements for operation. The table shows the performance for the various models.

Overview of the capabilities of the MRU models								
Capability	**MRU 5+**	**MRU 5**	**MRU E**	**MRU H**	**MRU 3**	**MRU S**	**MRU 2**	**MRU D**
Primary sensors:								
Accelerometers	3	3	3	3	3	3	2	2
Angular rate sensors	3	3	3	3	3	3	2	2
Functions:								
Full "strap down" function	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Free mounting orientation	Yes	Yes	Yes	Yes	No	No	No	No
Lever arm corrections	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensor temperature comp. & linearisation & orthogonalisation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Built-in self testing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Outputs:								
Roll and pitch angles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Overview of the capabilities of the MRU models								
Yaw angle, dynamic only	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Heave measurements	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Surge and sway measurements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inputs:								
External speed	Yes	Yes	Yes	Yes	Yes	Yes	No	No
External heading	Yes	Yes	Yes	Yes	Yes	Yes	No	No
1PPS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interfaces:								
Ethernet communication	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Digital RS-232/422 compatible	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analog output from junction box	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

MRU models description

The MRU comes in various models, depending on its use.

MRU 5+

The MRU 5+ is the highest capability MRU model. It outputs roll, pitch, yaw and relative (dynamic) heave, surge and sway motion. Acceleration and velocity of the linear motions, as well as angular acceleration and velocity, are also output from the unit. This MRU provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the unit.

The MRU 5+ includes high-end Kongsberg Discovery AS developed MEMS (Micro Electro Machanical Structure) based gyro design. This gyro is called MRG (MRU Rate Gyro). It combines very low noise, excellent bias stability and outstanding gain accuracy.

The product is developed specially for hydrographic surveys and other high precision applications. The MRU 5+ is suitable as an IMU in integrated GNSS/inertial systems, as a backup sensor for position and heading determinations during dropout of GNSS signals.

MRU 5

The MRU 5 is constructed in the same way as the MRU 5+ but includes less accurate accelerometers.

It outputs roll, pitch and yaw angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs relative (dynamic) heave, surge, sway positions, velocities and accelerations in adjustable frames. This MRU provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the unit.

Typical applications are roll, pitch and heave compensation of multi-beam echo sounders on ROVs and ships for seabed mapping, heave compensation of offshore cranes, hydroacoustic positioning systems and dynamic motion monitoring of roll, pitch angles and linear accelerations on offshore structures.

MRU E

The MRU E is constructed in the same way as the MRU 5 but includes less accurate MEMS rate gyros.

This MRU provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the MRU E.

The MRU E is designed to operate at ambient temperatures from -25 to +70° C and to be installed on open decks, inside cabinets or on bulkheads. Typical applications for the MRU E is direct mounting of the unit under the helideck center to measure 3-axes linear accelerations together with roll, pitch and heave. The MRU E is typically used in a Helideck Monitoring System where the helideck is located separately from the accommodation and the hull.

The MRU E outputs roll, pitch and heave together with linear acceleration in 3-axes.

MRU H

The MRU H is constructed in the same way as the MRU 5 but includes less accurate MEMS rate gyros.

This MRU provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the MRU H.

The MRU H is specially designed for motion measurements in marine applications requiring highly accurate heave measurements in environments with extreme horizontal accelerations. The MRU H is an ideal sensor for roll, pitch and heave compensation of offshore cranes and echo sounders. The unit can also be used on typical ship motions monitoring applications such as helideck motion monitoring, hydroacoustic positioning systems, as well as hull stress monitoring.

The MRU H outputs roll, pitch and yaw angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs relative (dynamic) heave position, velocity and acceleration in adjustable frames.

MRU 3

The MRU 3 is constructed in the same way as the MRU H but includes less accurate accelerometers. The limitation compared to an MRU H is that the MRU 3 can only be mounted in one fixed direction relative to the vessel and that is with the connector pointing up or down.

The cost-effective MRU 3 model is specially designed for use in marine applications such as real-time motion compensation of single and multi beam echo sounders and offshore cranes. The unit incorporates 3-axis MEMS sensors for both linear acceleration and angular rate. The unit provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the MRU 3.

The MRU 3 outputs roll, pitch and yaw angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs relative (dynamic) heave position, velocity and acceleration in adjustable frames.

MRU S

The MRU S is constructed in the same way as the MRU 3 but includes less accurate angular rate gyros and accelerometers. The limitation in mounting direction is the same as for the MRU 3. Both sensors can only be mounted in one fixed direction relative to the vessel and that is with the connector pointing up or down.

The cost-effective MRU S model is specially designed for use in marine applications such as real-time roll, pitch and heave compensation of fishery sonars and echo sounders. The unit incorporates 3-axis MEMS sensors for both linear acceleration and angular rate. The unit provides no absolute north information and the measurement drifts slowly in yaw, except when external heading is input to the unit.

The MRU S outputs roll, pitch and yaw angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs relative (dynamic) heave position, velocity and acceleration in adjustable frames.

MRU 2

The MRU 2 is specially designed for use in marine applications that require both static and dynamic roll and pitch measurements. The unit incorporates 2-axis sensors for linear acceleration and angular rate. The limitation compared to an MRU H, which has 3-axis angular rate and acceleration measurements, is the fact that the MRU 2 is not capable of measuring heave and can only be mounted in one fixed direction relative to the vessel.

The MRU 2 achieves high reliability by using sensors with no rotational or mechanical wear-out parts.

Typical applications for an MRU 2 are roll and pitch measurements in offshore riser monitoring systems, dynamic positioning systems, telecommunication antenna compensation systems and motion damping systems on high speed crafts.

The MRU 2 outputs roll and pitch angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs surge and sway accelerations.

MRU D

The MRU D is constructed in the same way as the MRU 2 but includes less accurate angular rate gyros and accelerometers.

This cost-effective MRU model is specially designed for use in marine applications and is the ideal sensor for roll and pitch measurements on board ships. The unit incorporates 2-axis MEMS sensors for both linear acceleration and angular rate.

This unit has to be mounted in a fixed direction relative to the ship and that is with the connector pointing up or down. The MRU D is best suited for applications with limited range in roll and pitch. If unlimited mounting orientation and/or unlimited mounting range is required, we recommend one of the MRU models with sensors in all three axis.

Typical applications for this MRU D model are roll and pitch measurements in dynamic positioning systems, GNSS antenna compensation and motion damping systems on high speed crafts.

The MRU D outputs roll and pitch angles and corresponding angular rate vectors fixed to the vehicle frame. The unit outputs surge and sway accelerations.

Scope of supply

Basic items

Observe the basic items provided with a standard MRU delivery.

- 1 ea MRU sensor

  MRU 5+, MRU 5, MRU E, MRU H, MRU 3, MRU S, MRU 2, MRU D.

- 1 ea Wall mounting bracket

  For mounting the MRU to a wall

- 1 ea Ethernet cable

  Two-metre Ethernet configuration cable for connection to a computer

- 1 ea MRU JB3 junction box with three-metre CS8 cable

- 1 ea USB flash drive

  Including MRU configuration software, MRC+, end user documentation, configuration and calibration file.

- 1 ea MRU transportation box

  MRU-M-SC1

Additional required items

Additional items are required for operation. Additional required items can be purchased from Kongsberg Discovery AS or from a third party supplier.

- Computer for configuration purposes
- Data output cable for NMEA messages
- Data input cable for NMEA messages
- Display

Additional optional items

The following additional optional items can be used together with the MRU. Additional optional items can be purchased from Kongsberg Discovery AS.

- Subsea bottles with different depth rating
- Floor mounting bracket

  For mounting the MRU to the floor or deck
- Protected mounting bracket

  For mounting the MRU inside it to protect it from the environment

Product restrictions

Topics

Restrictions in export

Export of these MRU models requires an export license:

- MRU 5+, MRU 5, MRU E, MRU H and MRU 2

Important:

Notice to customer/importer/end user.

The inertial sensor specified here is shipped from Norway in accordance with the Norwegian Agency for Export Control and Sanctions (DEKSA) and U.S. Export Administration Regulations (EAR).

The inertial sensor will be subject to restrictions from your national export control authorities if resold, transferred or otherwise disposed from your country.

Resale, transfer or otherwise disposal of the inertial sensor to countries, persons or entities under UN, US, EU or Norwegian embargo/sanctions, is prohibited.

Any valid and approved export license granted to Kongsberg Discovery AS from the Norwegian Agency for Export Control and Sanctions (DEKSA) or the U.S. Government, is not an authorization for you to resell, transfer or other disposal of the inertial sensor.

Limited warranty

Changes or modifications to the product not explicitly approved by Kongsberg Discovery AS will void the warranty.

The liability of Kongsberg Discovery AS is limited to repair of this product only under the given terms and conditions stated in the sales documents. Consequential damages such as customer's loss of profit or damage to other systems traceable back to this product's malfunctions, are excluded.

The warranty does not cover malfunctions of the product resulting from the following conditions.

- The MRU is not shipped in the original transportation box.
- The MRU has been exposed to extreme shock and vibrations.
- The MRU housing has been opened by the customer in an attept to do repair work.
- Incorrect power connection.

Restrictions in use

The system requires certain conditions in order to operate.

MRU 5+

The MRU function is based on inertial sensors to operate. It is designed for use on-board marine surface operated vehicles with a linear acceleration less than ±45 m/s^2 (±4.5 g). And an angular rate range less than ±75°/s.

Only relative dynamic heave position is calculated.

The MRU 5+ product shall be used in maritime survey and navigation applications only. No military and nuclear end-users or uses.

MRU 5

The MRU function is based on inertial sensors to operate. It is designed for use on-board marine surface operated vehicles with a linear acceleration less than ±45 m/s^2 (±4.5 g). And an angular rate range less than ±75°/s.

Only relative dynamic heave position is calculated.

MRU E, MRU H, MRU 2

The MRU function is based on inertial sensors to operate. It is designed for use on-board marine surface operated vehicles with a linear acceleration less than ±45 m/s^2 (±4.5 g) and an angular rate range less than ±150°/s.

For MRU E and MRU H only relative dynamic heave position is calculated.

MRU 3

The MRU function is based on inertial sensors to operate. It is designed for use on-board marine surface operated vehicles with a linear acceleration less than ±40 m/s^2 (±4 g) and an angular rate range less than ±150°/s.

Only relative dynamic heave position is calculated.

MRU D, MRU S

The MRU function is based on inertial sensors to operate. It is designed for use on-board marine surface operated vehicles with a linear acceleration less than ±160 m/s^2 (±16 g) and an angular rate range less than ±75°/s.

For MRU S only relative dynamic heave position is calculated.

Definitions

Alignment

Alignment is the process of adjusting the current internal navigation frame in the instrument to the true external frame.

Attitude

Attitude is the orientation relative to the vertical axis of a floating structure. Heading is not included. If heading is included, the word "orientation" is used for the vehicle.

b-frame

b-frame is body frame. An orthogonal frame fixed to the MRU (Motion Reference Unit) housing or to the vehicle where the MRU is fixed.

g-frame

g-frame is geographic frame. An orthogonal frame having axes pointing North, East, and Down at the current location of the floating structure.

Heave

Heave is the vertical dynamic motion of a floating structure and defined positive down. Heave position and velocity are dynamic motion variables calculated for a selected average heave period.

IMU

An IMU is an Inertial Measurement Unit that outputs raw angular rate and linear acceleration data in three axis.

Origin

Origin is the zero point in the coordinate system. You can determine the origin location. Typical origin locations are the Commion Reference Point (CRP) in a survey report, the Centre of Gravity (GC), the Motion Reference Unit (MRU) or the intersection between Aft Perpendicular (AP), Base line (BL) and Centre line (CL).

P-axis

The P-axis is fixed in the vehicle and points in the starboard direction horizontally when the roll angle is zero. Positive rotation about this axis is bow of the vehicle up.

Pitch

A rotation about the pitch axis is positive when the bow moves up. Normally, pitch means the dynamic pitch angle motions.

R-axis

The R-axis is fixed in the vehicle and points in the forward direction horizontally when the pitch angle is zero. Positive rotation about this axis is starboard side of the vehicle down.

Roll

A rotation about the roll axis is positive when starboard side of the floating structure moves down. Normally, roll means the dynamic roll angle motion.

Starboard

When looking in the bow direction of a floating structure, this is the right hand side of the vehicle.

Y-axis

Yaw axis. The Y-axis is fixed in the vehicle (b-frame), and points in the downward direction when the vehicle is aligned horizontally. Positive rotation about this axis is turning the bow of the vehicle to starboard.

Yaw

A rotation about the vertical axis is positive when turning Eastward (clockwise) when the floating structure cruises in North direction. Normally, yaw means the dynamic yaw motion.

Support information

If you need technical support for your product you must contact a KONGSBERG office. A list of all our offices is available on our website.

- **Company name**: Kongsberg Discovery AS
- **Address**: Havnegata 9, N-7010 Trondheim, Norway
- **Telephone**: +47 33 03 41 00
- **Telephone, global 24h support**: +47 33 03 40 00
- **E-mail address**: support.seatex@kd.kongsberg.com
- **Website**: http://www.kongsberg.com

Kongsberg Support App

KONGSBERG support is also available in the Kongsberg Support App. Our support application is available for free in the App Store and Google Play.

Operation

Topics

Operating the unit

Normally, the MRU outputs signals on the serial line and/or Ethernet without any involvement from the operator.

When using the MRU for real-time heave measurements, it is important to tune the heave period to the vessel size and motion characteristics for the actual weather conditions. Since the configuration parameter for **Heave filter** only enters the default value of the heave period according to the selected mode, this value has to be tuned for the actual vessel and weather conditions in order to achieve optimum heave performance. Therefore, before a survey and/or during operation, check the heave performance of the MRU and tune the heave parameter until the best heave performance is achieved. An alternative is to select **Automatic** and let the unit estimate the heave filter parameters during operation.

Related topics

Turning on the MRU, page 80
Selecting heave filter options, page 104

Turning off the MRU

The unit is normally left running after it has been started. Should the unit be defective and in need of maintenance, it must be turned off.

Context

If the power to the unit is interrupted, the unit will stop automatically in a controlled way. The configuration for the unit will be stored while un-powered.

Procedure

To turn off the unit, disconnect the power to the unit.

Related topics

Turning on the MRU, page 80

Preparing the installation

Topics

Drawings

Outline dimension drawings are included in this manual.

Unless otherwise specified, all measurements are in millimetres. The drawings are not to scale.

General arrangement drawings of the vessel should be acquired to simplify determination of offsets between the MRU and the different monitoring points. Locations for the various parts of the system must be decided.

Necessary tools and equipment

We assume that you have a standard set of tools available. This tool set must comprise the normal tools for electronic and electromechanical tasks. This includes different

screwdriver types, pliers, spanners, a cable stripper, a soldering iron, etc.Each tool must be provided in different sizes. We recommend that all tools are demagnetized to protect your equipment.

Unless otherwise stated, all mounting hardware (such as bolts, nuts, washers, screws etc.) referred to in this document is to be supplied by the customer or the shipyard.

Additional equipment to the Motion Reference Unit (MRU):

- The heavy duty screened MRU cable (MRU-E-CS8) with the connector at one end and marked conductors at the other.
- The floor-mounting bracket (MRU-M-MB5) or the wall mounting bracket (MRU-M-MB4) complete with four M4.0 screws and three M6.0 screws.
- The MRU-E-JB3 junction box for connecting the MRU output signals to the host system and to supply the unit with 24 VDC power.
- A ship cable for connecting the MRU junction box with the host system. This cable can be delivered by Kongsberg Discovery AS, although normally it is delivered by the host system supplier, the shipyard or others.
- An external computer with the MRC+ configuration software installed.

Personnel requirements

This product is intended for installation by qualified professionals only. Improper installation or handling by untrained individuals may result in equipment damage, safety hazards, or non-compliance with regulations.

You can only do electrical installations if you are a certified electrician.

Sensor Unit transportation box

The unit is shipped in a specially designed transportation box. Keep the unit stored within the box until everything is ready for installation of the unit.

Note:

After the unit has been installed, please keep the transportation box. The unit must be shipped in this box for maintenance or repair in order to maintain the warranty.

MRU location

Correct location of the unit is important for the system performance.

Consider these factors when installing the unit.

- The unit is designed for installation in an indoor environment and for operation within the temperature range.

  Note:

  The MRU E can be installed in an outdoor environment inside an enclosure.

- Mount the unit close to the user equipment for which it is supposed to measure the motion.

  This location will avoid errors in alignment with the user equipment and it will eliminate errors due to ship-hull torsion.

- Mount the unit as close to the centre of gravity (GC) of the vessel as possible.

  This location will give the best roll, pitch and sway measurements, unless lever arm from the MRU location to the CG location is entered in the MRC+ configuration software.

- Alternatively, mount the unit along the R-axis of the vessel, low in the vessel and amidships.

  Roll is usually the most dominant angular motion. Avoid mounting the unit high up or out to the side of the vessel.

- Mount the unit away from areas with high frequency vibrations. Such as hydraulic pumps, thrusters and valves.
- Mount the unit onto a rigid and stable structure. Mount the unit directly onto the hull structure, if possible.
- Mount the unit away from the heat of machinery, heaters and air conditioning systems.
- Mount the unit in a location where it is not subject to sea water.
- Mount the unit with the X arrow on the unit pointing in the bow direction and parallel to the centre line of the vessel.

CAUTION:

Be aware of vibrations

The unit has some sensitivity to vibrations. Avoid mounting the unit on thin walls that may resonate with vibrations driven by machinery, propellers, pumps or motors.

The unit's function may be disturbed if strong vibrations around 14 kHz are present. The unit has some sensitivity to vibrations around sequences of 100 Hz (100, 200, 300 Hz and so on). Such vibrations should not exceed 0.5 m/s^2 in any direction.

Be aware of temperature changes

The unit is sensitive to frequent temperature changes. The safest location for the unit is where the temperature is low and the changes in temperature are slow.

Be aware of corrosion

The unit must not be subject to an environment which can cause corrosion. For example exposure to sea water.

Related topics

Motion Reference Unit (MRU) dimensions, page 157
MRU floor mounting bracket dimensions, page 159
MRU wall mounting bracket dimensions, page 161
MRU protected mounting bracket dimensions, page 163
Installing the MRU with floor mounting bracket, page 30
Installing the MRU with wall mounting bracket, page 33
Installing the MRU with protected mounting bracket, page 35

Junction box location

Consider these factors when installing the junction box.

- Place the junction box close to the MRU.
- Place the box within the distance of the MRU cable. The default length of the cable is 3 metres.
- Place the junction box in a location where it is easily accessible.

Related topics

MRU junction box dimensions, page 164
Installing the MRU junction box, page 37

MRU power requirements

The unit must be powered by a clean 10 to 36 VDC source. The recommended power source is 24 VDC, which is also the design power source. The unit's power lines are galvanically isolated from the signal circuits inside the unit. The maximum isolation voltage inside the unit is 200 VDC.

The unit should be protected by en external slow fuse rated at 2 A. There is a fuse in the MRU Junction Box.

CAUTION:

Permanent damage to the unit may occur if power is applied to the Ethernet or digital conductors. Therefore, it is very important to measure the power voltage at the connector before the unit is connected. Any damage resulting from incorrect connection or power, is not covered by the Kongsberg Discovery AS warranty.

Related topics

Cabling for the MRU system, page 58

Cable lengths

If the ship cable between the MRU junction box and the host system is longer than 30 metres, the DC resistance in the cable must be considered.

At 24 VDC the maximum DC resistance which is allowed in the cable is RDC < 10 Ω. This means maximum 200 metres cable at 0.75 mm^2.

The DC resistance is the sum of the forward and back resistance.

Related topics

Installing the MRU junction box, page 37
Cabling for the MRU system, page 58

System communication ports description

The MRU sensor has five communication lines. The digital communication lines COM1_OUT, COM1_IN, COM2_OUT, COM3_IN, COM4_IN, XIN, XOUT and EXT0 share a common ground (CGND). They are isolated from the unit's power system.

The Ethernet connection pins RJ_1, 2, 3 and 6 are isolated from the unit's power system.

COM1

COM1 is an RS-422 input and output line. Transmit is on OUT and receive on IN.

COM2

COM2 is an RS-232 input and output line. Transmit is on OUT and receive on IN. In the MRU-E-JB3 junction box this signal is also available as RS-422.

COM3

COM3 is an RS-422 or RS-232 input line.

COM4

COM4 is an RS-422 or RS-232 input line.

XIN and XOUT lines

These lines are general purpose I/O lines.

- **XIN**: Used for input of 1PPS signal only.
- **XOUT**: Internal use only.

EXT0 line

The EXT0 line if for internal use only. It is used for output of analog signals from the MRU junction box and to activate the relay when analog data are valid.

Ethernet ports

Five Ethernet output ports are available in the MRC+ configuration software for I/O setup. All input data and commands are sent to the static port which has the default port number 7550.

Related topics

Communication interface configuration, page 115

RS-422 A and B signal definition

Signal state definition according to the IEC 61162-1 standard from the International Electrotechnical Committee.

The idle, marking, logical 1, OFF or stop bit states are defined by a negative voltage on line A with respect to line B. The active, spacing, logical 0, ON or start bit states are defined by a positive voltage on line A with respect to line B. It should be noted that the above A with respect to B levels are inverted from the voltage input/output requirements of standard UARTs and that many line drivers and receivers provide a logic inversion.

Installation

Topics

Installing the MRU with floor mounting bracket

A correct installation of the Motion Reference Unit (MRU) is important in order to obtain high-quality and accurate measurements.

Prerequisites

You have found a rigid and stable mounting surface for the unit. This is important in order to avoid vibration and resonance.

Make sure that the surface between the MRU and the bracket is clean before you start to mount the unit. Connecting surfaces between the MRU and the bracket must in no way be damaged before mounting.

Context

The unit can be mounted on-board by use of the floor mounting bracket. MRU-M-MB5.

Note:

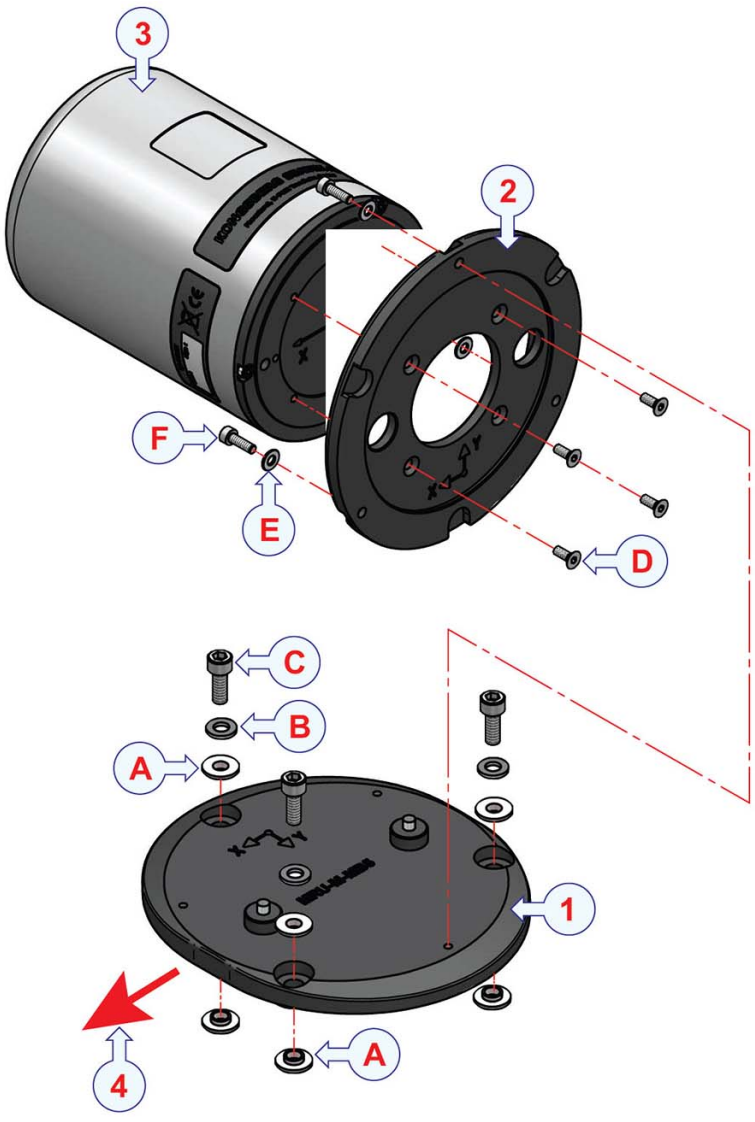
The MRU mounting angles have to be modified by use of the MRU configuration to correspond with the actual mounting orientation of the unit in the bracket. A precise mounting orientation is important to ensure that high-quality and accurate measurements are available to the host system.

Note:

After the unit has been installed, please keep the transportation box. The unit must be shipped in this box for maintenance or repair in order to maintain the warranty.

Note:

When removing the unit from the bracket for maintenance purposes, only unscrew the four screws which hold the unit. Do not remove the bracket from its position.



Objects

1. *Base plate*
2. *Adapter plate*
3. *MRU*
4. *Vessel bow direction*

Screws and washers

A. *Insulation sleeve*

B. *Washer M6 screw*

C. *M6 screw*

D. *M4 screw*

E. *Washer M4 screw*

F. *M4 screw*

Procedure

1. Identify the best mounting location for the unit.

   The best location is on the floor or on a steel table.

Base plate

2. Place the base plate on the mounting surface in the preferred orientation.

   If the orientation of the bracket can be freely selected, mount the base plate with the x arrow pointing in the bow direction.

3. Mark an drill three M6 holes in the mounting surface for the base plate screws.

4. Place an insulation sleeve between the mounting surface and the base plate for each of the three holes.

   Important:

   This is important for electrical and mechanical insulation of the unit from the mounting surface due to earthing. It is also important in order to prevent corrosion.

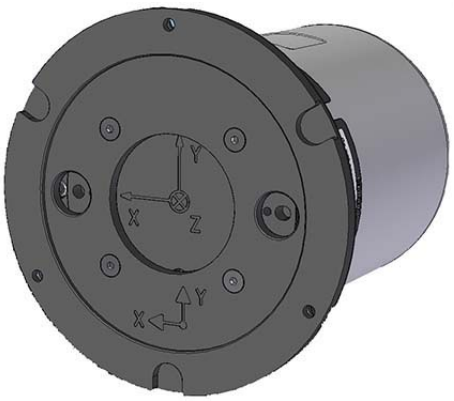
5. For each base plate hole, enter an insulation sleeve, then a washer and finally the M6 screw. A, B and C in the illustration.

6. In the other end of the mounting surface, enter a nut for each screw. Secure the nut with a washer or by using a self-locking nut.

Adapter plate

7. Attach the adapter plate to the MRU.

   Make sure that the x and y arrow directions are the same on the adapter plate and on the MRU.



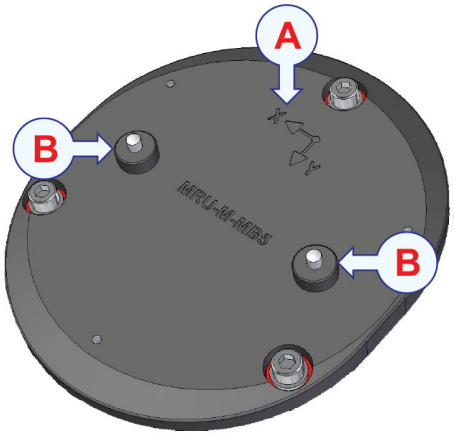
8. Enter the four M4 screws and fasten the adapter plate to the MRU.

   It is recommended to apply Loctite 242 glue or equivalent on the four MRU screws.

9. Place the MRU with the adapter plate on top of the base plate.

   Make sure that the MRU enters the steering pins on the base plate properly and that the orientation of the MRU is the same as indicated (x and y arrows) on the base plate.

   The base plate has steering pins and x and y arrow indication.



A. *x and y arrow indication*

B. *Steering pins*

10. Enter the three M4 screws with washers from the adapter plate to the base plate.

    It is recommended to apply Loctite 242 glue or equivalent on these three screws.

Related topics

MRU location, page 25
MRU floor mounting bracket dimensions, page 159
Cabling for the MRU system, page 58

Installing the MRU with wall mounting bracket

A correct installation of the Motion Reference Unit (MRU) is important in order to obtain high-quality and accurate measurements.

Prerequisites

Make sure that the surface between the MRU and the bracket is clean before you start to mount the unit. Connecting surfaces between the MRU and the bracket must in no way be damaged before mounting.

Make sure that there is enough space below the bracket for the MRU and the cable.

Context

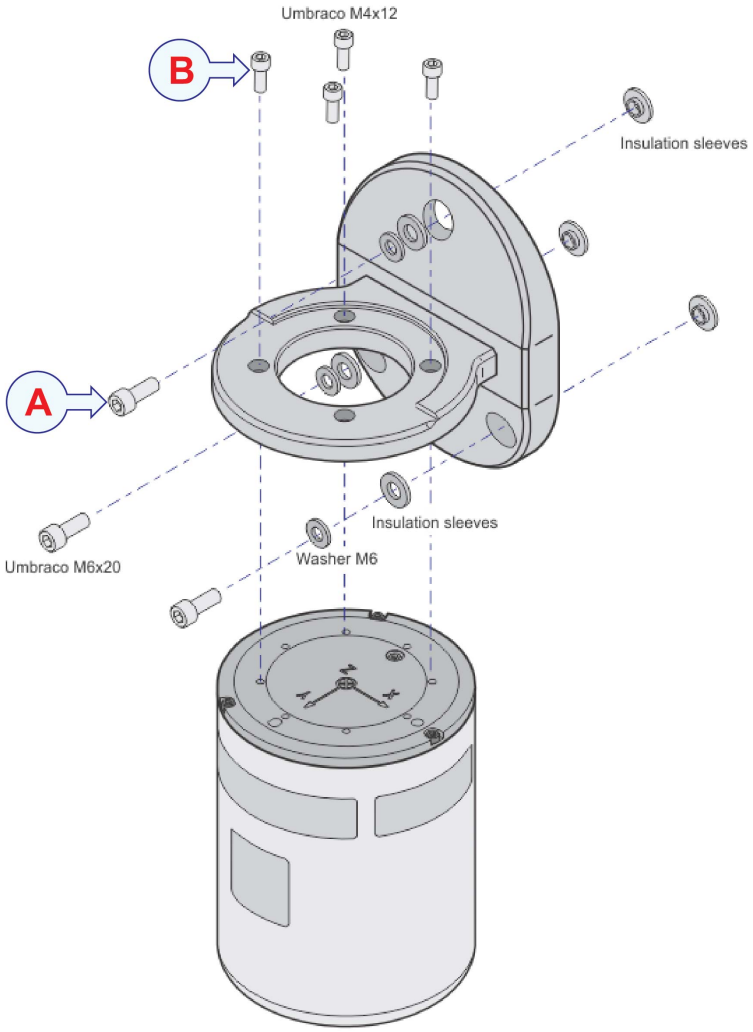
The unit can be mounted on-board by use of the wall mounting bracket. MRU-M-MB4.

Note:

After the unit has been installed, please keep the transportation box. The unit must be shipped in this box for maintenance or repair in order to maintain the warranty.

Note:

When removing the unit from the bracket for maintenance purposes, only unscrew the four screws which hold the unit. See B in the illustration. Do not remove the bracket from its position.



Procedure

1. Find a suitable location for the unit.

   Preferably mount the bracket on longitudinal or transversal bulkheads of the hull structure. This will assist in alignment of the unit and prevent vibration.

2. Clean the mounting surface if necessary.
3. Preferably mount the unit with the opening pointing downwards. As illustrated.
4. Mount the bracket to the wall with three screws. **A** in the illustration.
5. Mount the unit to the bracket with four screws. **B** in the illustration.

Related topics

MRU location, page 25
MRU wall mounting bracket dimensions, page 161
Cabling for the MRU system, page 58

Installing the MRU with protected mounting bracket

A correct installation of the Motion Reference Unit (MRU) is important in order to obtain high-quality and accurate measurements.

Prerequisites

Make sure that there is enough space below the bracket for the MRU and the cable.

Context

The unit can be mounted on-board by use of the protected mounting bracket. MRU-M-MB6.

Note:

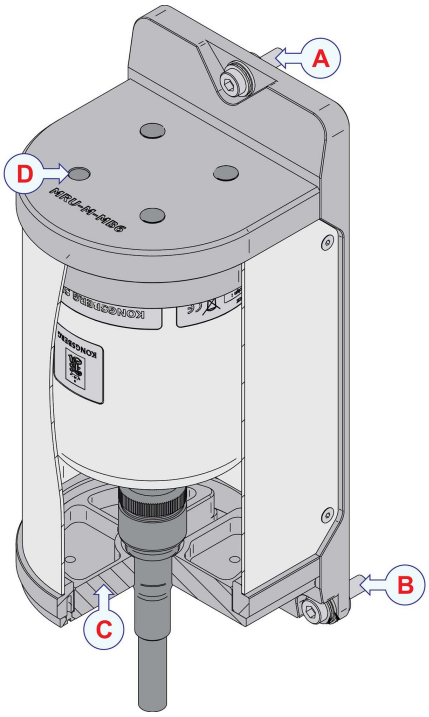
The MRU mounting angles have to be modified by use of the MRU configuration to correspond with the actual mounting orientation of the unit in the bracket. A precise mounting orientation is important to ensure that high-quality and accurate measurements are available to the host system.

Note:

When removing the unit from the bracket for maintenance purposes, only unscrew the four screws which hold the unit. Do not remove the bracket from its position.

Note:

After the unit has been installed, please keep the transportation box. The unit must be shipped in this box for maintenance or repair in order to maintain the warranty.



A. *Bracket top screw*

B. *Bracket bottom screws*

C. *Bottom cover*

D. *MRU fastening holes with cover caps*

Procedure

1. Find a suitable location for the unit.

   Preferably mount the bracket on longitudinal or transversal bulkheads of the hull structure. This will assist in alignment of the unit and prevent vibration.

2. Preferably mount the unit with the opening pointing downwards. As illustrated.

3. Mark and drill an M8 hole for the top screw. **A** in the illustration.

4. Enter the screw, insulation sleeve and washer without tightening the screw completely.

5. Align the bracket vertically using its own weight or by aligning it in relation to the wall.
6. Drill two holes for the bottom screws. **B** in the illustration.
7. Insert the two bottom screws with insulation sleeves and washers and tighten all three screws.
8. Unscrew and remove the cover at the bottom of the bracket. **C** in the illustration.
9. Fasten the cable (MRU-M-CS8) to the connector at the top of the unit.
10. Insert the unit into the bracket.
11. Fasten the unit to the bracket with four screws with lock washers. **D** in the illustration.
12. Place the cover caps over the screws holes and push down. This will make sure that no water enters the holes.

Related topics

MRU location, page 25
MRU protected mounting bracket dimensions, page 163
Cabling for the MRU system, page 58

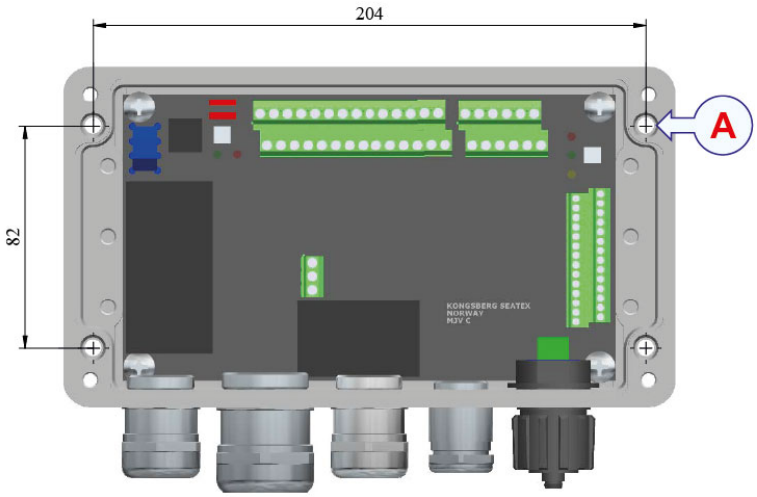
Installing the MRU junction box

The MRU junction box is an interface from the MRU cable to the screw terminals inside the box for termination of communication cables and power.

Prerequisites

- The junction box can be placed on the floor or on a wall.
- Make sure that the location is within the length of the 3-metre cable.
- Make sure that you have at least 100 mm space below the connectors when using the MRU-E-CS8 cable.

Context



A. *Mounting holes, Ø6 x 4*

Procedure

1. Unscrew and remove the lid.
2. Place the box onto its mounting position.
3. Mark four M6 holes for the box on the mounting surface.
4. Remove the box.
5. Drill four M6 holes in the marked positions.
6. Make sure that no metal shavings have entered the box while drilling. If so, remove the shavings.
7. Replace the box.
8. Fasten the box with washers and self-locking nuts.
9. Replace the lid and tighten the screws.

Related topics

Junction box location, page 26
Cable lengths, page 27
MRU junction box dimensions, page 164
Cabling for the MRU system, page 58
Replacing the MRU junction box, page 143

Calibrating the MRU axis

After the mechanical installation is completed, the MRU x, y and z axes must be aligned to the corresponding vessel axes or the axes of the system which is to be compensated.

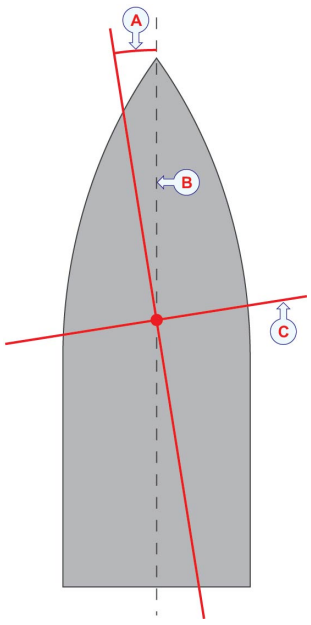
To achieve the MRU's specified roll and pitch accuracy, any misalignment of the MRU axes with the vessel axes must be precisely calculated and accounted for.

The MRU axes, and particularly the yaw axis, must be aligned with the vessel axes with an accuracy better than 0.1 degrees to make sure that the MRU functions are according to the specifications.

WARNING:

If the MRU is not calibrated and corrected for misalignment in yaw, the performance of the product will be degraded.

The illustrations shows the alignment of the MRU yaw axis to the vessel's longitudinal axis.



A. *Vessel axis*

B. *Yaw misalignment angle*

C. *MRU axis*

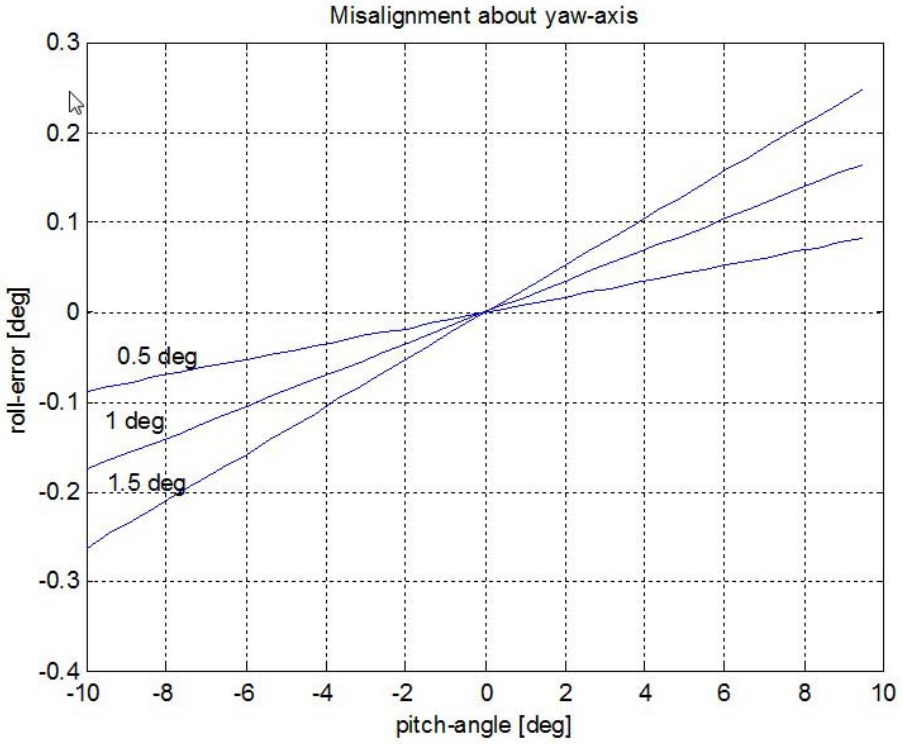
A typical alignment process consists of aligning the MRU axes to an external reference. The type of reference must be determined according to the required accuracy.

The reference for roll and pitch alignment must be carefully selected depending on the intended application. It may be the hull, a sensor such as a multibeam echo sounder or a USBL acoustic system. Some sensors have internal alignment routines, and accurate alignment of the MRU is not required.

An accurate alignment of the MRU x arrow towards the vessel's longitudinal axis (yaw orientation) is of special importance. If not properly aligned, the performance of the roll and pitch measurements from the MRU will be degraded.

The plot illustrates that a misalignment of 1 degree of the MRU in yaw will result in a roll error of ±0.09 degrees if the vessel is pitching ±5 degrees. To determine the misalignment of the MRU axis to an accuracy of 0.5 degrees or better is not easy and requires use of an accurate external reference.

The plot shows the value of the roll error as a function of the vessel's pitch angle, displayed at 0.5 degrees, 1 degree and 1.5 degrees MRU yaw misalignment.



Related topics

Determining the MRU mounting orientation, page 72

Installing the MRC+ configuration software

The MRC+ configuration software is used to set the configuration parameters for the MRU.

Prerequisites

You have received a USB flash drive with the MRC+ configuration software together with the MRU sensor. The flash drive is included in the MRU transportation box. If the

flash drive is not included in the delivery you must upload it from a customer support server.

Context

The MRC+ configuration software is a part of the standard delivery. The software has the following main functions:

- Setup of the MRU for specific applications
- Check the internal status of the MRU (status log file)
- Load new software to the MRU
- Plot data to the display and log data on file

The MRC+ communicates with the MRU through Ethernet. It runs under Windows 11 or later versions.

You must install the MRC+ configuration software on a local computer (standard Windows procedure). After installation, the MRC+ icon will appear on your desktop.

Procedure

1. Insert the USB flash drive with the software into a local computer.
2. Open the Windows File Explorer.
3. Locate the Removable disk drive to which the flash drive is connected.
4. Open the `MRC+ setup.exe` file located in the **SW/MRC** folder.
5. Follow the instructions on the screen in order to complete the installation of the MRC+.

6. Select **Run MRC+ now**.
7. Select **Finish**.
8. Close the Windows File Explorer and remove the USB flash drive.

Related topics

Connecting and starting the MRC+ configuration software, page 42

Connecting and starting the MRC+ configuration software

The MRC+ configuration software is used to set the configuration parameters for the MRU.

Prerequisites

You have installed the MRC+ configuration software on a local computer.

Context

The MRU sensor is set up with the default Ethernet address 192.168.1.20. The computer with the MRC+ configuration software has to be set up with the address in the range 192.168.1.xx, except for the same address as the unit. For example, if the unit has the Ethernet address 192.168.1.20 (default), then the address on the computer could be set to 192.168.1.10. The network mask is 255.255.255.0.

There are two options for connection between the MRU and the MRC+. The default setup is with a configuration cable kit and the other is via the JB3 MRU junction box.

The configuration cable kit consists of:

- Configuration cable (MRU-E-CE1) with connection box (MRU-T-015)
- Power supply (MRU-E-P24)

Default MRC+ connection setup

MRC+ connection setup with junction box

Procedure

1. **Default connection**:

   a. Connect a cable from a free Ethernet connector or switch on the local computer to the Ethernet connector on the MRU-T-015 box.

   b. Connect the configuration cable on the box to the MRU.

   Normally, the MRU-T-015 box and the MRU-E-CE1 are delivered with the unit for this purpose.

   c. Inser the power connector on the delivered power supply (MRU-E-P24) to the power inlet on the MRU-T-015 box.

   Power supply to the MRU is 24 VDC.

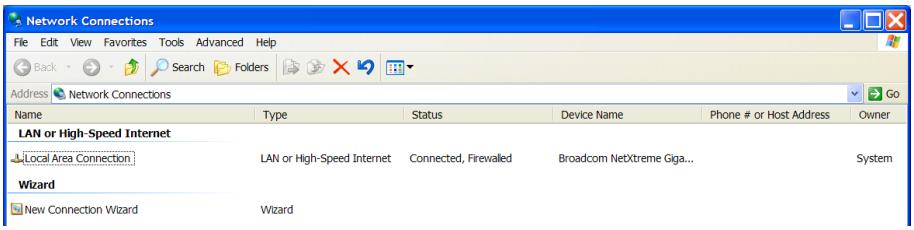
2. **Connection with junction box**:

   a. Connect the MRU cable between the junction box and the MRU.

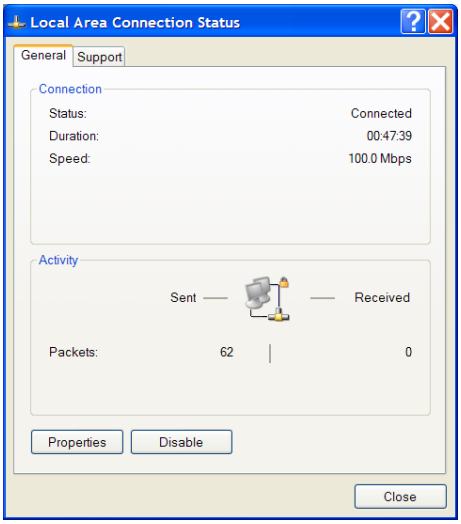
   b. Connect an Ethernet cable between the junction box and the local computer.

3. Observe that the LED on the MRU starts to flash green and blue, indicating that the unit receives power an that the software is running.

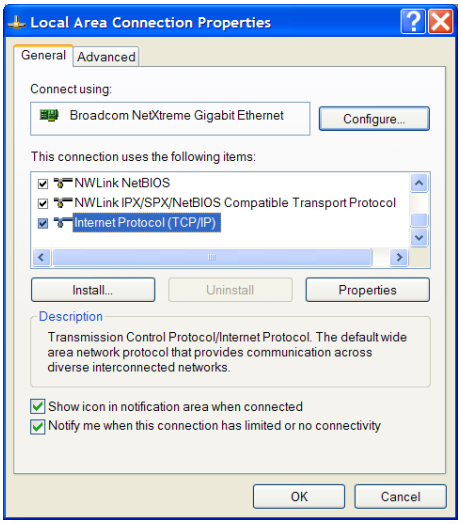
4. Set up the computer to use the local area connection by selecting **Settings** > **Network Connections** > **Local Area Connection**.



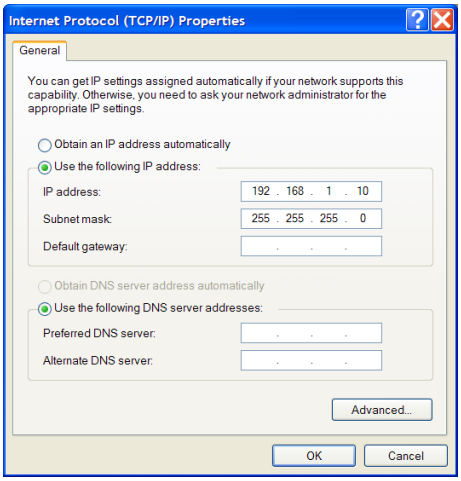
5. In the **Local Area Connection Status** dialog box, Select **General** > **Properties**.



6. In the **Local Area Connection Properties** dialog box, select **Internet Protocol (TCP/IP)** > **Properties**.



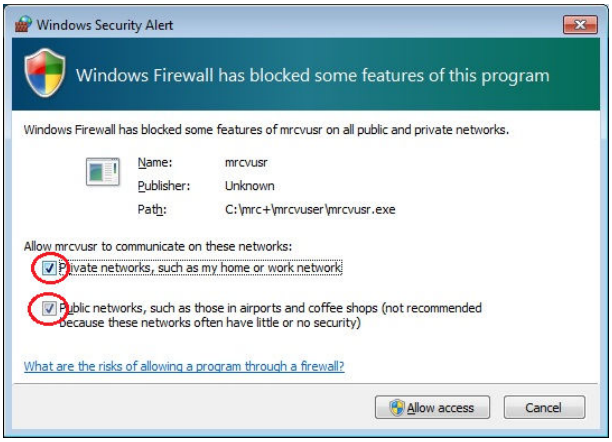
7. In the **Internet Protocol (TCP/IP) Properties** dialog box, select **Use the following IP address** and **Use the following DNS server addresses**.



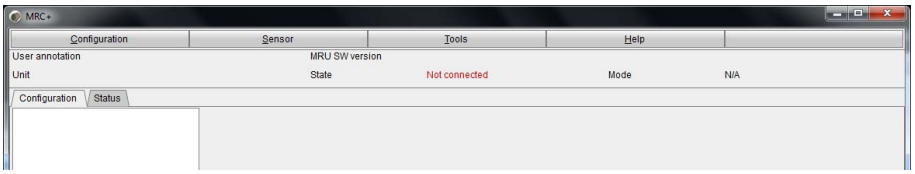
8. Select **OK**. Close the dialog boxes.

9. When the LED on the MRU flashes green, start up the MRC+ configuration software by double-clicking the MRC+ icon.

10. The first time you start up the MRC+ configuration software the **Windows Security Alert** dialogue box appears. Select both **Private networks** and **Public networks**.



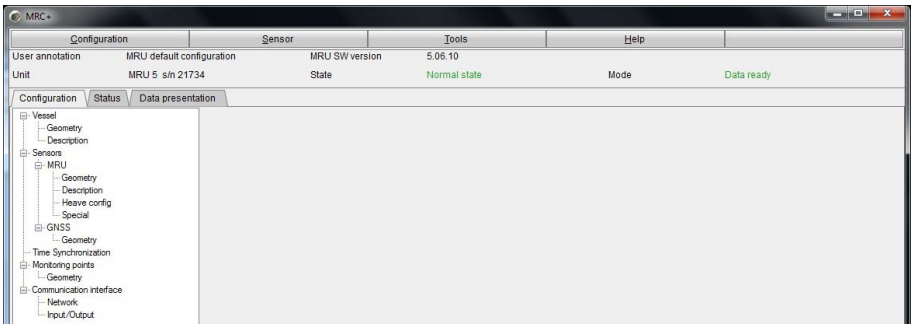
11. Select **Allow access**. The MRC+ configuration software will start.



12. Select **Sensor** > **Connect** > **IP address** > **Factory IP address**.

    The **Factory IP address** selection includes the default MRU IP address (192.168.1.20).

13. When a **Configuration** tab appears, you are connected to the MRU and can continue with the unit's setup.



Further requirements

If no connection is established with the MRU, make sure that the IP address and port number are correct.

To return to the default IP and port number for the MRU, press the small connector pin in the connection box on the configuration cable. Hold it in until the blue light turns yellow. A yellow flash will then appear on the LED indicating that default IP is used. Repeat the connection from step 13 above.

Related topics

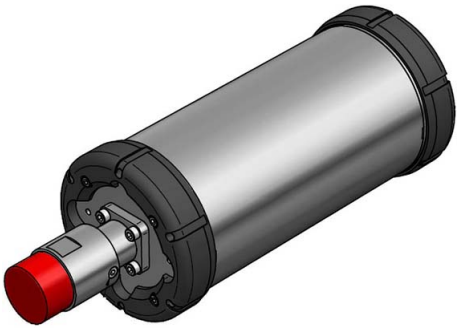
Installing the MRC+ configuration software, page 40
Transferring MRU configuration file to spare unit, page 142

Subsea installation

MRU subsea bottle - 4000 metres

This subsea bottle, MRU-M-SB14, is API 16D certified for being part of the BOP control system.

This subsea bottle, MRU-M-SB14, is made in titanium. It is designed for use down to 4000 metres.



The bottle includes a cavity seal screw for testing of whether there are humidity inside the subsea bottle or not. The 6–pin Seacon connector on the bottle includes a test port for testing the connector o-ring sealing.

Inside the bottle the MRU is mounted within an inner cylinder with steering plate.

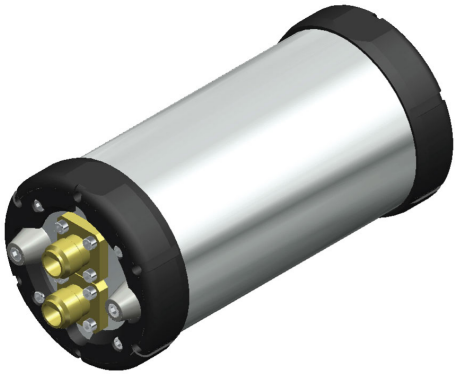
Correct installation and orientation of the MRU within the bottle is ensured by the design of this inner cylinder. The mounting orientation of the MRU within the bottle is indicated on the bottom cover plate.

On the outside there are four mounting holes (M6) on the bottom cover plate. You must design your own mounting arrangement for the bottle based on these four mounting holes (M6). In addition, there is a protection cap on each cover plate to protect the bottle from damage and for help during alignment.

The bottle is delivered with one 6-pin Seacon connector of type MSSK/MINK (SP)-6#16AWG FCR for Ethernet communication.

MRU subsea bottle - 4000 metres

This subsea bottle, MRU-M-SB9, is made in titanium.



It is designed for use down to 4000 metres. Inside the bottle the MRU is mounted within an inner cylinder with steering plate.

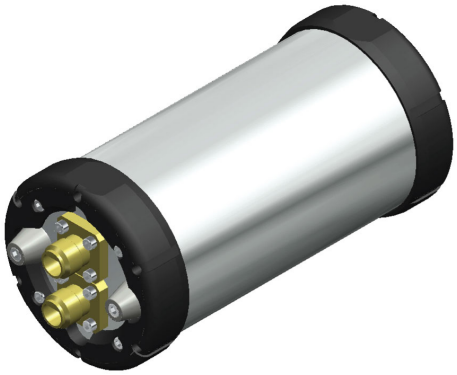
Correct installation and orientation of the MRU within the bottle is ensured by the design of this inner cylinder. The mounting orientation of the MRU within the bottle is indicated on the bottom cover plate.

On the outside there are four mounting holes (M6) on the bottom cover plate. You must design your own mounting arrangement for the bottle based on these four mounting holes (M6). In addition, there is a protection cap on each cover plate to protect the bottle from damage and for help during alignment.

The bottle is delivered with two 8-pin Seacon connectors. One for serial and one for Ethernet communication.

MRU subsea bottle - 1000 metres

This subsea bottle, MRU-M-SB10, is made in anodised aluminium.



It is designed for use down to 1000 metres. Inside the bottle the MRU is mounted within an inner cylinder with steering plate.

Correct installation and orientation of the MRU within the bottle is ensured by the design of this inner cylinder. The mounting orientation of the MRU within the bottle is indicated on the bottom cover plate.

On the outside there are four mounting holes (M6) on the bottom cover plate. You must design your own mounting arrangement for the bottle based on these four mounting holes (M6). In addition, there is a protection cap on each cover plate to protect the bottle from damage and for help during alignment.

The bottle is delivered with two 8-pin Seacon connectors. One for serial and one for Ethernet communication.

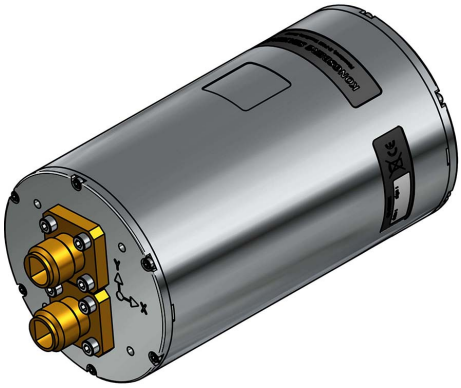
MRU subsea bottle - 500 metres

This subsea bottle, MRU-M-SB11, is made in stainless steel.

It is designed for use down to 500 metres. Inside the bottle the MRU is mounted on a steering plate.

On the outside there are four mounting holes (M6) on both cover plates. The mounting direction of the MRU within the bottle is indicated on the bottom cover plate.

The bottle is delivered with two 8-pin Seacon connectors. One for serial and one for Ethernet communication.



MRU subsea bottle - 10 metres

This light weight subsea bottle, MRU-M-SB12, is made in combined material with the cylinder in aluminum and the cover plates in POM (plastic).

It is designed for use down to 10 metres. Inside the bottle the MRU is mounted on a steering plate.

On the outside there are four mounting holes (M6) on both cover plates. The mounting direction of the MRU within the bottle is indicated on the bottom cover plate.

The bottle is delivered with two 8-pin Seacon connectors. One for serial and one for Ethernet communication.

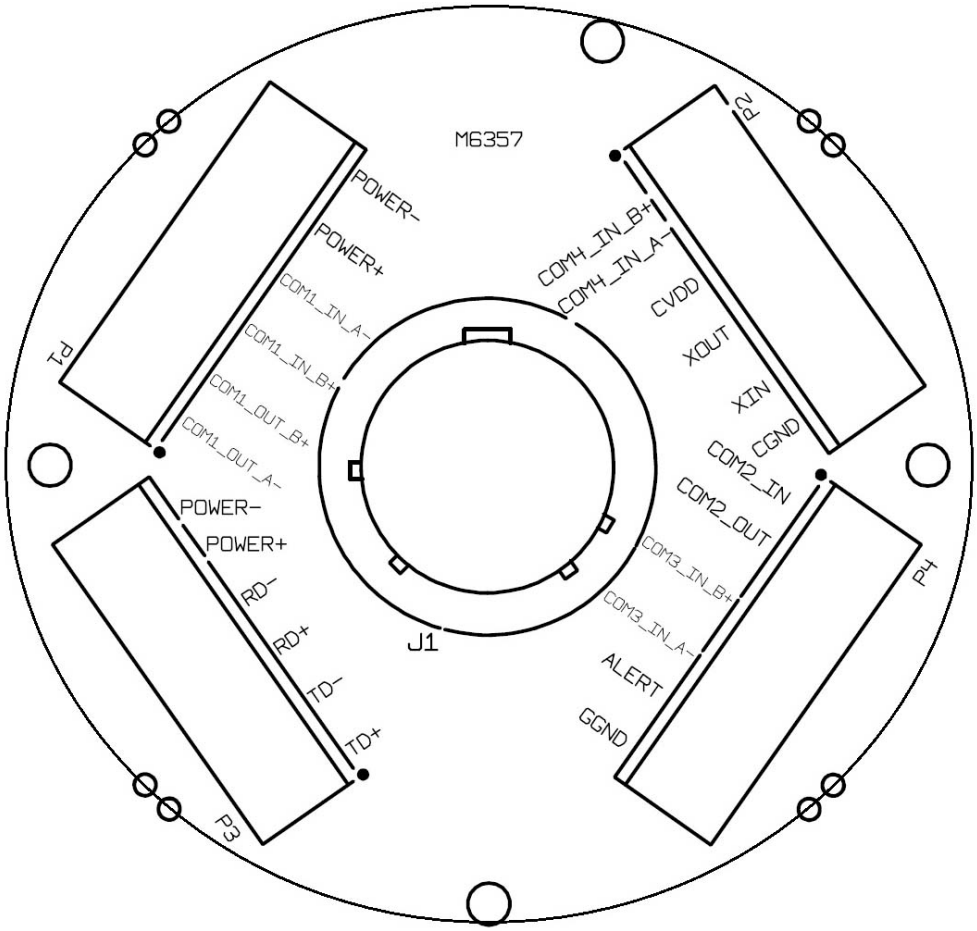
Seacon 6-pin connector and pin configuration

The MRU-M-SB14 subsea bottle is delivered with one 6-pin Seacon connector.

The connector is of type MSSK/MINK (SP)-6#16AWG FCR for Ethernet communication. A Seacon pigtail for the customer's own application can be delivered as an option (part no MRU-E-PT6).

Inside the bottle is a connector board where the wires from the Seacon connectors are terminated to the MRU connector pins. The connector board is mounted on the connector plate of the subsea bottle.

The illustration shows the layout of the connector board with the different terminals.



The pin layout is illustrated in the table.

Pin	Signal (Ethernet communication)
1	POWER - (0 V)
2	POWER + (24 V)
3	RD- (RJ_6)
4	RD+ (RJ_3)
5	TD- (RJ_2)
6	TD+ (RJ_1)

8-pin Seacon connector and pin configuration

The subsea bottles MRU-M-SB9, 10, 11 and 12 include two 8-pin Seacon connectors.

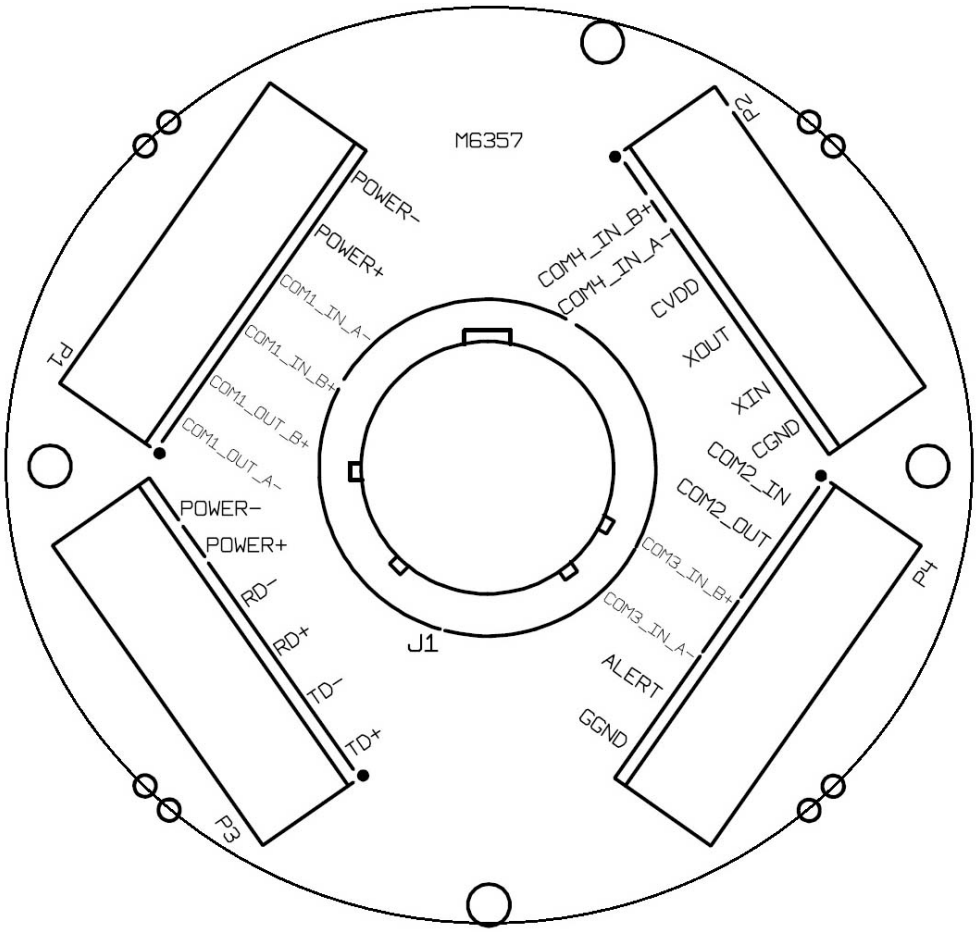
The part number for the Seacon connector is 5506-1508 (male). A Seacon pigtail for the customer's own application can be delivered as an option (part no MRU-E-PT8).

Inside the bottle is a connector board where the wires from the Seacon connectors are terminated to the MRU connector pins. You can modify which signals are input/output on the Seacon connector by reconnecting the wires from the Seacon connector. To mitigate the risk of damage, it is recommended that you modify the default wiring so that the power supply voltage can never be applied to the wrong connection in the event that the identical A and B connectors are mixed up. The connector board is mounted on the connector plate of the subsea bottle.

Note:

The COM2 output from the MRU is RS-232 and also from the subsea bottle (no RS-422 converting as on earlier revision of the connector board).

The illustration shows the layout of the connector board with the different terminals.



Connector A - default pin configuration

This default pin configuration is compatible with Seapath 130 and the Seapath 300 series.

Connector A: Default pin configuration - Seapath compatible	
Pin	**Signal (Seapath compatible)**
1	POWER -
2	POWER +
3	COM1_IN_A-
4	COM1_IN_B+
5	COM1_OUT_B+
6	COM1_OUT_A-
7	CGND (Ground ref. for XIN)
8	XIN (Seapath 1PPS)

Connector A - general serial communication

You can reconfigure the pin configuration to suit your application. An alternative pin configuration for serial communication with serial output on COM1 and input of speed or heading on COM3 or COM4 is illustrated in the table.

Connector A: General serial communication	
Pin	**Signal (General serial communication)**
1	POWER -
2	POWER +
3	COM3_IN_A-
4	COM3_IN_B+
5	COM1_OUT_B+
6	COM1_OUT_A-
7	COM4_IN_A-
8	COM4_IN_B+

Connector A - Geoswath serial communication

For interfacing Geoswath multibeams the pin configuration should be according to the table.

Connector A: Geoswath serial communication	
Pin	**Signal (Geoswath serial communication)**
1	POWER -
2	POWER +
3	COM3_IN_A- (RS-232 input)
4	COM4_IN_A- (RS-232 input)
5	COM2_OUT (RS-232 input)
6	Not connected
7	CGND (common ground for COM2, 3, 4 and XIN)
8	XIN (1PPS)

Connector B - default pin configuration, Ethernet communication

The default pin configuration for Ethernet communication is illustrated in the table.

Connector B: Default pin configuration, Ethernet communication	
Pin	**Signal (Ethernet communication)**
1	POWER -
2	POWER +
3	RD- (RJ_6)
4	RD+ (RJ_3)
5	TD- (RJ_2)
6	TD+ (RJ_1)
7	GGND
8	ALERT

Installing MRU in empty subsea bottle - SB9, SB10 and SB14

As an option the MRU can be delivered with a subsea bottle.

Prerequisites

You will need these items:

- Screw driver
- Silicone grease
- Nitrogen to flush MRU

Context

This prodecure applies to the subsea bottles MRU-M-SB9, MRU-M-SB10 and MRU-M-SB14.

Procedure

1. Remove the polycarbonate protection cap at the connector end of the bottle by unscrewing the four M5 screws holding the cap.
2. Unscrew the six M3 screws which hold the connector lid on to the main cylinder.
3. Carefully, push up the connector lid by inserting a couple of screw drivers into the traces at the top of the cylinder and bend gently and evenly.

   This may be easier if the bottle is placed horizontally so that the weight of the interior is not preventing the opening.

4. Remove the connector lid, including the inner support cylinder and steering plate, from the rest of the bottle.
5. Place the connector lid upside down on a table.
6. Remove the inner cylinder by unscrewing the four M3 screws along the edge, facing down towards the connector lid.
7. Attach the MRU to the connector board in the connector lid by gently turning it on the connector until it slides down into position. The connector slides into position when the coding pins align.
8. Make sure that the adapter with the o-ring is between the MRU and the connector board.
9. Reassemble the inner cylinder with steering plate and make sure that the direction is correct by looking into the inspection holes in the steering plate.

   Here you shoulde see the same markings on the MRU as indicated in the steering plate.
10. Fasten the MRU to the inner cylinder steering plate with the four M4 screws supplied with the cylinder.
11. Press the inner cylinder down and fasten the four M3 screws to the connector lid.
12. Inspect and apply silicon grease to the o-ring part of the main cylinder and the o-rings on the connector lid.

    Make sure that the PTFE support ring is ok and in position.
13. Flush the MRU with nitrogen, or at least make sure that the air inside is dry, before you insert the MRU into the main cylinder.

    The humidity should be < 30 % and with no water inside.
14. Slide the whole arrangement with the connector lid and the MRU back into the main cylinder and rotate it until the steering pin engages with bottom lid.
15. Press down and refasten the six M3 screws holding the connector lid.
16. Replace the protection cap.
17. For the 1000–metre bottle, MRU-M-SB10, place a zinc anode on it before installation on site.
18. Pressure test the subsea bottle before subsea installation.

    Remember always to place a dummy connector on connectors not used during the pressure test and subsea operation.

Related topics

MRU subsea bottle SB9 dimensions, page 166
MRU subsea bottle SB10 dimensions, page 167
MRU subsea bottle SB14 dimensions, page 170
Corrosion protection for 1000-metre subsea bottle, page 57

Installing MRU in empty subsea bottle - SB11 and SB12

As an option the MRU can be delivered with a subsea bottle.

Prerequisites

You will need these items:

- Screw driver
- Silicone grease
- Nitrogen to flush MRU

Context

This prodecure applies to the subsea bottles MRU-M-SB11 or MRU-M-SB12.

Procedure

1. Unscrew the six M3 screws which hold the connector lid on to the main cylinder.
2. Carefully, push up the connector lid by inserting a couple of screw drivers into the traces at the top of the cylinder and bend gently and evenly.

   This may be easier if the bottle is placed horizontally so that the weight of the interior is not preventing the opening.
3. Remove the connector lid from the rest of the bottle.
4. Attach the MRU to the connector board in the connector lid by gently turning it on the connector until it slides down in position (the coding of the connector fits).
5. Make sure that the adapter with the o-ring is between the MRU and the connector board.
6. Flush the MRU with nitrogen, or at least make sure that the air inside is dry, before you insert the MRU into the main cylinder.

   The humidity should be < 30 % and with no water inside.
7. Slide the whole arrangement with the connector lid and the MRU back into the main cylinder and rotate it until the steering pin engages with bottom lid.

8. Press down and refasten the six M3 screws holding the connector lid.
9. Pressure test the subsea bottle before subsea installation.

   Remember always to place a dummy connector on connectors not used during the pressure test and subsea operation.

Related topics

MRU subsea bottle SB11 dimensions, page 168
MRU subsea bottle SB12 dimensions, page 169

Corrosion protection for 1000-metre subsea bottle

The subsea bottle, MRU-M-SB10, requires some extra corrosion protection after installation on site.

The following should be taken into consideration to protect the subsea bottle from corrosion during installation on site.

- Coat all the cover screw holes with silicone grease to avoid pitting corrosion.
- Do not connect the bottle housing galvanically to any steel structures or other conducting materials.
- For long term submerged operations, connect a zinc anode cover to the bottle.
- If you do not use the screws provided in the kit, make sure that the replacement screws are made of stainless steel.

Related topics

Installing MRU in empty subsea bottle - SB9, SB10 and SB14, page 54

Cable layout and interconnections

Topics

Cabling for the MRU system

The MRU system relies on communication between each system unit and between the MRU system and external devices.

Prerequisites

Make sure that you have the cable types recommended for the installation.

Context

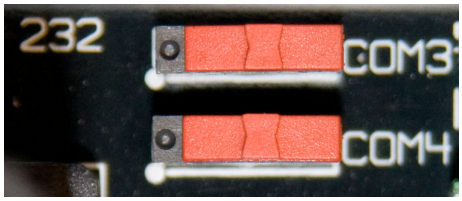
Important:

- *Cable with shield has to be used in order to fulfil the MRU's power and EMC requirements. The cable shield must be connected to ground in both ends.*
- *Make sure that the cable shield is in contact with the gland for grounding before the cable is fastened to the box. Use the required number of clips to fasten the cable to the wall.*
- *Fill the cable glands which are not used with self-bounding tape. Press the self-bounding tape together as a ball and fill it into the gland. Tighten the gland properly afterwards to ensure that it is watertight. This is in order to fulfil the enclosure protection specification.*
- *The junction box housing is grounded to earth through the screws used for mounting the box to the wall or floor. If the surface on which the junction box is mounted is NOT connected to earth, one of the junction box mounting screws must be connected to earth by connecting a wire from the screw to an object which is connected to earth.*

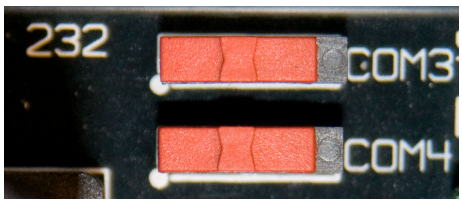
DIP switches

The DIP switch position for RS-422 communication is the default position. Then the swith is positioned to the right and a termination resistand of 120 Ohm will be connected.

Correct position of these DIP switches are only important with RS-422 communication when using long cables.



For RS-232 communication the DIP swith is positioned to the left.

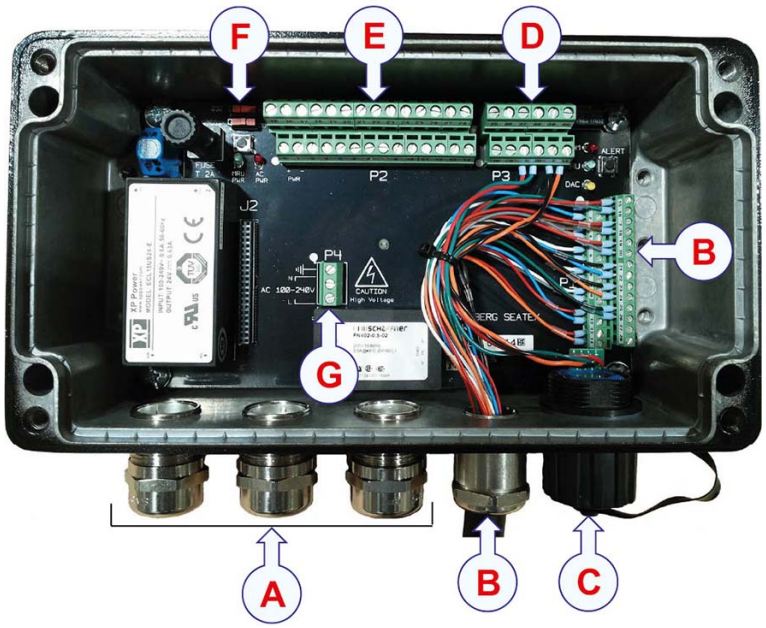


P4 terminal wires

The maximum nominal cross section for the cable wire to fit into the P4 terminal is 1.5 mm^2.

Junction box LED indicators after successful power-on

- The MRU PWR light diode in the junction box should be green indicating that the MRU receives power.
- The AC PWR light diode will be red if AC power is connected to the AC 100 - 240 V terminal; else AC PWR light diode is off.
- The COM light diode will be red and flashing if digital data are sent from the MRU on COM1.
- The MRU light diode will be green if the sensor unit is running, else off.
- The DAC diode will be yellow if analog output is used, else off.



A. *User configurable external interfaces*

B. *Cable to MRU (default pre-installed), P1 (MRU sensor side)*

C. *Ethernet cable*

D. *Relay and earth shield, P3*

E. *Termination of user external interfaces, P2 (User side)*

F. *DIP switches*

G. *Power cable*

Procedure

1. Insert the connector on the MRU cable, MRU-E-CS8, to the MRU sensor.
2. Remove the junction box lid.

3. Insert the open-end of the MRU cable to the P1 terminal in the junction box.

   The MRU cable is often delivered pre-terminated in the junction box.

4. If not pre-terminated, insert each of the cable wires in the MRU cable to the correct terminals on the **P1** side in the junction box.

MRU P1

Pin	Signal	Pair	Wire colour
1	PWR+	1	White
2	PWR-	1	Blue
3	Com1_Out_B	2	White
4	Com1_Out_A	2	Orange
5	Com1_In_B	3	White
6	Com1_In_A	3	Green
7	RJ_1	4	White
8	RJ_2	4	Brown
9	ALERT	5	White
10	GGND	5	Grey
11	RJ_3	6	Red
12	RJ_6	6	Blue
13	Com2_In	7	Red
14	Com2_Out	7	Orange

Pin	Signal	Pair	Wire colour
15	Com3_In_A	8	Red
16	Com3_In_B	8	Green
17	Com4_In_A	9	Red
18	Com4_In_B	9	Brown
19	CGND	10	Red
20	XIN	10	Grey
21	XOUT	11	Black
22	EXT0	11	Blue
23	Internal	12	Black
24	Internal	12	Orange
25	Internal	13	Black
26	5V	13	Green
27	Not used	14	Black
28	Not used	14	Brown

5. Insert the ship cable and/or the power cable through one of the free glands on the junction box.

6. Insert each of the cable wires into the correct terminals on the **P2** side in the junction box.

User P2

Pin	Signal	Description	Pin	Signal	Description
1	PWR+	Power+	15	Com3_In_A	RS-232/422
2	PWR-	Power gnd	16	Com3_In_B	RS-232/422
3	Com1_Out_B	RS-422	17	Com4_In_A	RS-232/422
4	Com1_Out_A	RS-422	18	Com4_In_B	RS-232/422
5	Com1_In_B	RS-422	19	Com2_In_A	RS-422
6	Com1_In_A	RS-422	20	Com2_In_B	RS-422
7	AN0+	Analog ch0	21	Com2_Out_A	RS-422
8	AN0-	Analog ch0	22	Com2_Out_B	RS-422
9	AN1+	Analog ch1	23	XIN	To MRU
10	AN1-	Analog ch1	24	CGND	
11	AN2+	Analog ch2	25	XOUT	From MRU
12	AN2-	Analog ch2	26	EXT0	From MRU
13	AN3+	Analog ch3	27	CGND	
14	AN3-	Analog ch3	28	L5V	5V out

7. Make sure that the DIP switches in the upper left corner of the junction box are in the correct position according to the communication on COM3 and COM4.

8. If a ready signal for the analog output signals is required, insert the ship cable wires for this signal into the correct terminals on the **P3** side in the junction box.

   This is done by feeding +24 V DC into RL_C pin and running a wire back into the host system from RL_NO pin. This will give the host system a +24 V DC signal from RL_NO pin when analog output signals are ready.

Note:

For RS-232 input or output on COM2, use pin 29 as communication ground (CGND).

User P3

Pin	Signal	Description	Pin	Signal	Description
29	CGND	RS-232	35	Com2_In	RS-232
30	Not in use		36	Com2_Out	RS-232
31	RJ_1	TD+	37	RL_NO	
32	RJ_2	TD-	38	RL_C	
33	RJ_3	RD+	39	RL_NC	
34	RJ_6	RD-	40	CHASSIS	⊥

9. Optional, insert the power cable with 100 to 240 VAC into the terminal on the **P4** side in the junction box if 24 VDC is not available.

Note:

*It is possible to input both 24 VDC on the user **P2** side and 100 to 240 VAC on the user **P4** side simultaneously.*

User P4

Pin	Signal	Wire colour
1	Ground	Yellow
2	N	Blue
3	L	Brown

10. Apply power to the junction box when all cable wires are connected. The MRU sensor will start up.

    Observe the LED indictors in the junction box.

    If the lights in the LEDs are according to your connections, the installation is now finished, unless the standard configuration delivered with the MRU needs to be modified for the specific installation.

11. Replace the junction box lid.

Related topics

MRU power requirements, page 27
Cable lengths, page 27
Installing the MRU with floor mounting bracket, page 30
Installing the MRU with wall mounting bracket, page 33
Installing the MRU with protected mounting bracket, page 35
Installing the MRU junction box, page 37

Wiring for MRU cable, page 64
Wiring for DP cable, page 65
Replacing the MRU junction box, page 143
Examining why MRU LEDs are not lit, page 138

Wiring for MRU cable

The MRU cable, MRU-E-CS8, has the Souriau connector in one end and open wires in the other end.

The table shows the wiring schematics for the MRU-E-CS8 cable.

Souriau 26-pin		**Signal description**	**Conductor**	
Signal conn.			**Pair**	**Colour**
PWR+	R	Power supply (+24 V)	1a	White
PWR−	B	Power supply (0 V)	1b	Blue
COM1_OUT_B	C	RS-422B+ output data from MRU	2a	White
COM1_OUT_A	T	RS-422A− output data from MRU	2b	Orange
COM1_IN_B	S	RS-422B+ input data to MRU	3a	White
COM1_IN_A	P	RS-422A− input data to MRU	3b	Green
RJ_1	G	TD+, Ethernet	4a	White
RJ_2	H	TD−, Ethernet	4b	Brown
ALERT	X	MRU alert	5a	White
GGND	A	MRU ground	5b	Grey
RJ_3	J	RD+, Ethernet	6a	Red
RJ_6	K	RD−, Ethernet	6b	Blue
COM2_IN	c	RS-232 data to MRU	7a	Red
COM2_OUT	M	RS-232 data from MRU	7b	Orange
COM3_IN_A	E	RS-422A- or RS-232 input signal to MRU	8a	Red
COM3_IN_B	Y	RS-422B+ or RS-232 return signal to MRU	8b	Green
COM4_IN_A	V	RS-422A- or RS-232 input signal to MRU	9a	Red
COM4_IN_B	L	RS-422B+ or RS-232 return signal to MRU	9b	Brown
CGND	a	Communication ground	10a	Red
XIN	U	Signal to MRU, 5 Volt or RS-232 level	10b	Grey
XOUT	b	Signal from MRU, 5 Volt level	11a	Black

Souriau 26-pin		Signal description	Conductor	
EXT0	F	Signal from MRU, 5 Volt level	11b	Blue
	Z	Internal control, do not connect	12a	Black
	W	Internal control, do not connect	12b	Orange
	D	Internal control, do not connect	13a	Black
5V	N	5 Volt out, max. 20 mA	13b	Green
		Not connected	14a	Black
		Not connected	14b	Brown

Related topics

Cabling for the MRU system, page 58

Wiring for DP cable

When Motion Reference Units are delivered for dynamic positioning (DP) installations a specific cable is used.

The table shows the wiring schematics for the MRU-E-DP2 cable.

Souriau 26-pin		Signal description	Conductor	
Signal conn.			**Pair**	**Colour**
SHIELD	A	Cable screen, connected to MRU housing		Screen
PWR+	R	Power supply (+24 V)	1	Blue
PWR−	B	Power supply (0 V)	1	Black
COM1_OUT_B	C	RS-422B+ output data from MRU	2	Orange
COM1_OUT_A	T	RS-422A− output data from MRU	2	Black
COM1_IN_B	S	RS-422B+ input data to MRU	3	Green
COM1_IN_A	P	RS-422A− input data to MRU	3	Black
RJ_1	G	TD+, Ethernet	4	Brown
RJ_2	H	TD−, Ethernet	4	White
ALERT	X	MRU alert	5	Grey
GGND	A	MRU ground	5	White
RJ_3	J	RD+, Ethernet	6	Orange
RJ_6	K	RD−, Ethernet	6	Red
XOUT	b	Signal from MRU, 5 Volt level	7	Brown

Souriau 26-pin		Signal description	Conductor	
CGND	a	Communication ground	7	Red

Related topics

Cabling for the MRU system, page 58

Surveying sensors on vessels

Topics

About sensor survey

In order to achieve the specified accuracy of the MRU, the installation must be surveyed.

The reference systems in use for this system are:

- The vessel coordinate system
- The MRU sensor point and axes system

A survey has to be performed to determine the offsets in angle and position from the vessel coordinate system to the MRU.

Vessel coordinate system

The *vessel coordinate system* is established to define the relative physical location of system units and sensors. It is a Cartesian coordinate system using three axes: X, Y and Z. X is positive forward, Y is positive towards starboard, and Z is positive downwards.

The coordinate system must be well defined. It is usually established by surveying and documenting coordinates of several points on the vessel. The X axis is in the longitudinal direction of the vessel. The Y axis is in the transverse direction of the vessel. The Z axis is perpendicular to the X and Y axes.

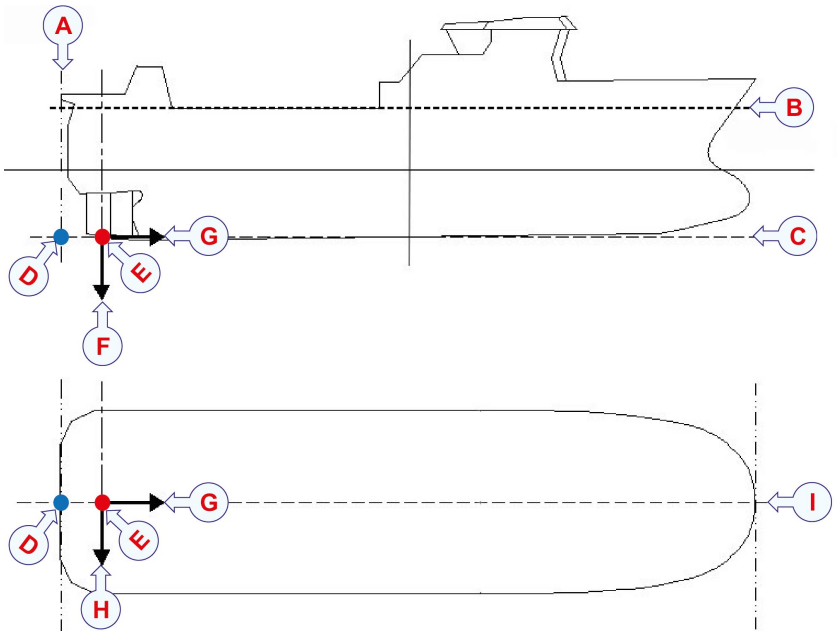
The X and Y axes constitute the reference plane on the vessel. This can be a best-fit plane on the main deck or a best-fit plane through the draught marks on the hull.

When establishing the vessel coordinate system, the origin can be freely chosen. Typical choices for origin are frame 0 at keel level, the vessel's centre of gravity (CG) or the location of the Inertial Measurement Unit. But any convenient point can be used.

In addition to the coordinate system it is useful to have an approximate X, Y and Z offset from the common reference point (CRP) to origin. The common reference point (CRP) is defined to be the intersection between stern, centre line and keel.

The chosen conventions must be made clear to all parties involved. Both to the survey personnel performing the survey and to the users of the survey results. Any deviation from the defined coordinate system should be well described in both text and drawings to avoid common misunderstandings.

The illustration shows the definition of origin on the vessel and positive X, Y and Z axes directions.



A. *Stern*

B. *Main deck*

C. *Keel*

D. *CRP (common reference point)*

E. *Origin*

F. *+Z axis*

G. *+X axis*

H. *+Y axis*

I. *CL (centre line)*

Surveying the MRU

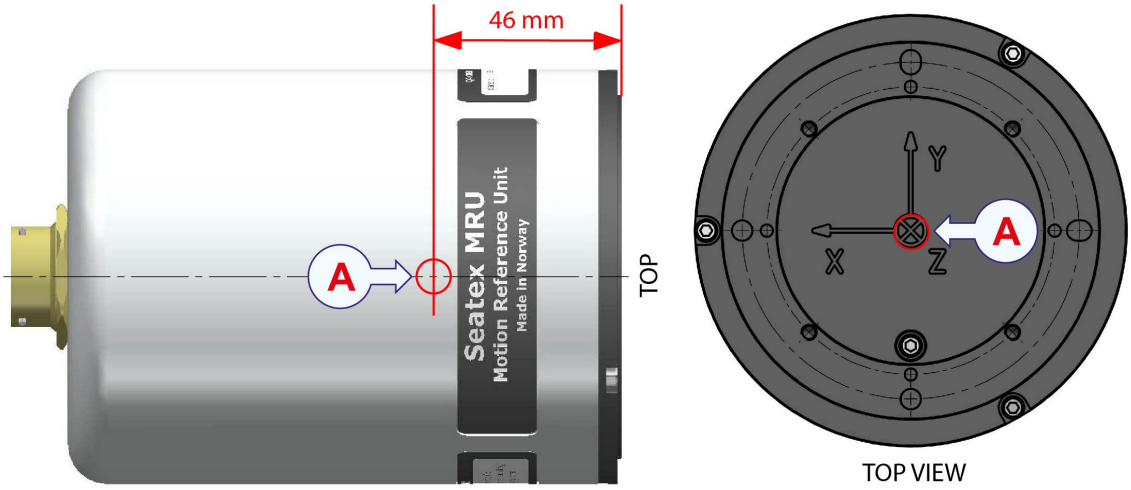
For the MRU (Motion Reference Unit) the following should be surveyed.

- The position (X, Y, Z) of the sensor point on the MRU.
- The mounting angles in roll, pitch and yaw (heading).

Note:

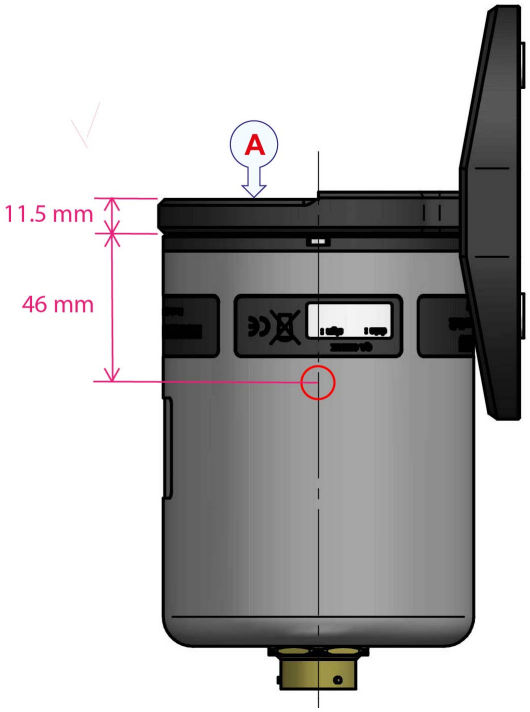
The MRU mounting bracket allows for an easy exchange with another MRU without affecting the orientation calibration. This is due to the precision of the dowel pins within the bracket. Therefore, when an MRU in a system is replaced with another unit, there is no need for re-surveying of the positions or angles if the mounting bracket is in the same location.

Sensor point and position for the MRU



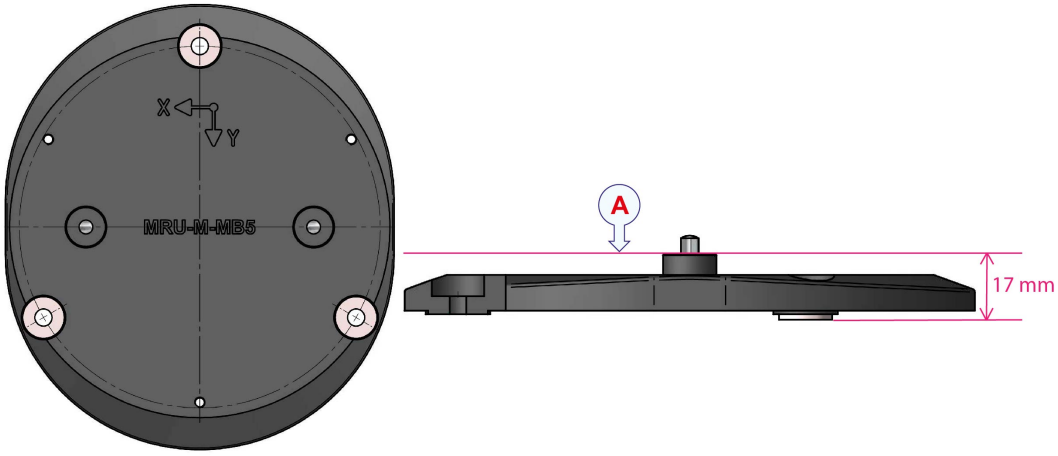
A. *Sensor point and position (0, 0, 0) for all MRU units*

Thickness of MRU wall mounting bracket from alignment surface



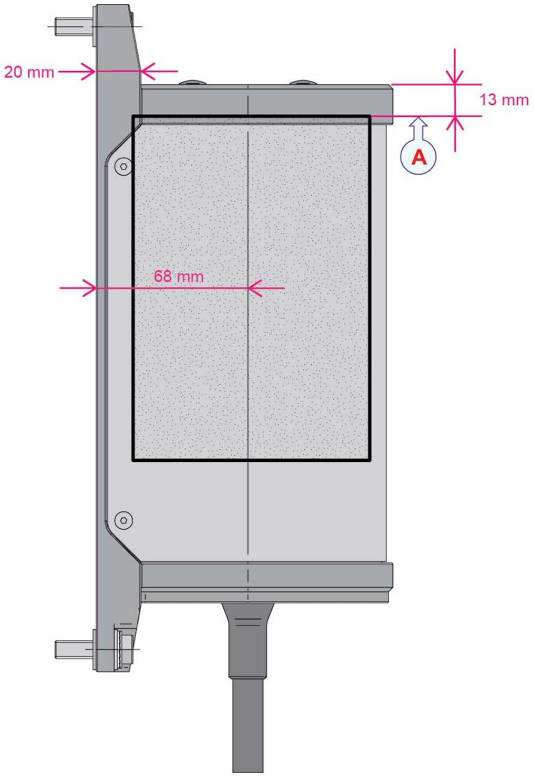
A. *Sensor plane on the wall mounting bracket*

Thickness of floor mounting bracket from alignment surface



A. *Sensor plane on the floor mounting bracket over the deck*

Thickness of MRU protected mounting bracket from alignment surface



A. *Sensor plane on the protected mounting bracket*

Related topics

Survey accuracy values, page 71

Survey accuracy values

The system must be surveyed according to the given accuracy level. If not, the performance of the system will be degraded.

- The distance vector from the origin to the MRU sensor point (X, Y, Z): < 0.1 metre
- The distance vector from the origin to the user defined monitoring points (X, Y, Z): < 0.1 metre
- The distance vector from the origin to the centre of gravity (CG) location (X, Y, Z): < 1 metre
- The yaw misalignment angles with the vessel axes: < 0.1°
- The misalignment angles (roll, pitch) with the vessel axes: < 0.05°

Related topics

Surveying the MRU, page 69

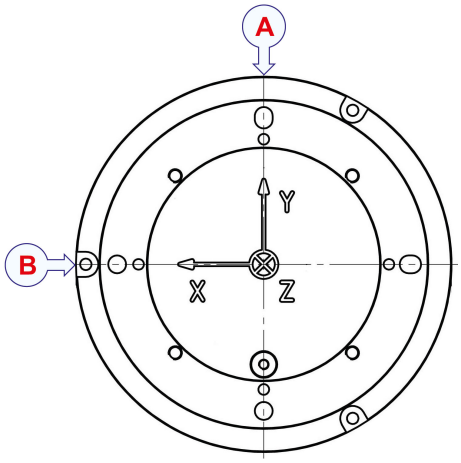
Determining the MRU mounting orientation

The default mounting position is defined with the MRU (Motion Reference Unit) connector facing downward, the x-axis pointing forward and the y-axis pointing to starboard. The directions marked on the MRU housing (x, y, z) should be aligned with the vessel axes in the following way:

- The x-axis (x arrow) points in the bow (forward) direction of the vessel
- The y-axis (y arrow) points horizontally and starboard
- The z-axis points in the downward direction

Top view of MRU with x, y and z direction

The illustration shows the mounting orientation of the x, y and z indexes at the top of the MRU according to the axes of the vessel.

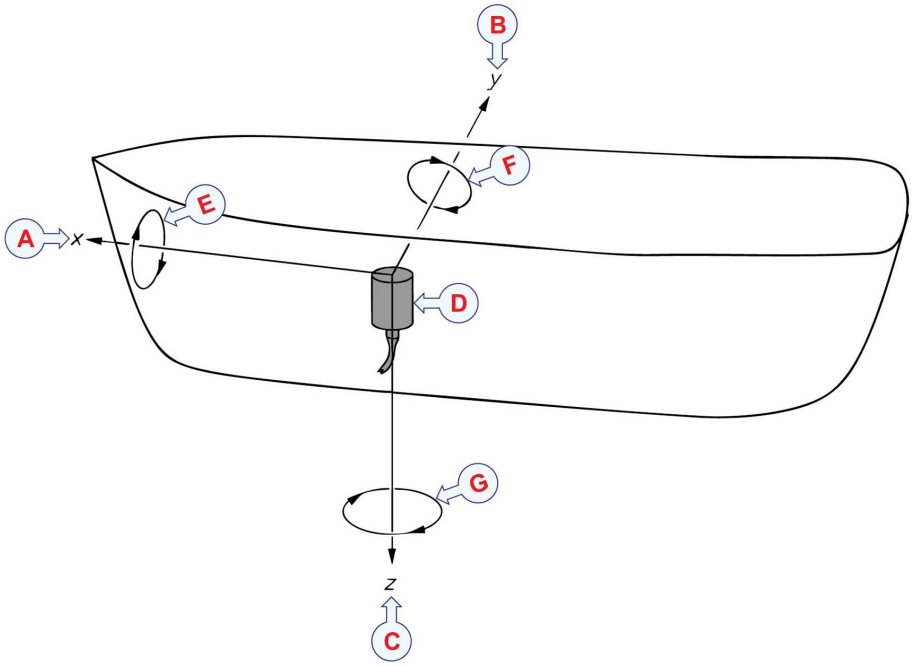


A. *To starboard*

B. *Bow direction*

Default MRU mounting position

The illustration shows the default mounting position of the MRU.



A. *x-axis*

x = Bow (forward) direction

B. *y-axis*

y = Starboard

C. *z-axis*

Ships down (not vertical)

D. *MRU location - normal mounting with connector downward*

E. *Positive roll means starboard side down*

F. *Positive pitch means bow up*

G. *Positive yaw (heading) turn starboard*

Positive (+) output signals from the MRU include:

- Positive pitch means bow up, or a clockwise rotation about the y-axis.
- Positive roll means starboard (right) side facing downward, or a clockwise rotation about the x-axis.
- Positive yaw (heading, azimuth) means a turn to starboard (right), or a clockwise rotation about the z-axis.

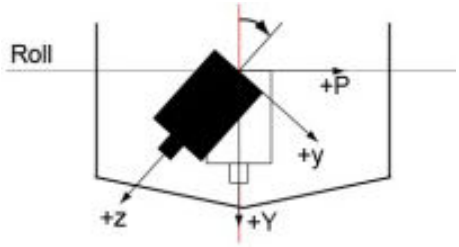
The MRU is best mounted with the logical axes in the direction described above to avoid confusion and problems with the definition of the roll, pitch and yaw output angles. However, the MRU can be mounted in any orientation relative to the above mentioned logical axes. In this case, the offset angles between the MRU axes (x, y, z) and the ship's axes (R, P, Y) are simply entered in the MRU configuration software, MRC+.

The MRU Mounting Wizard is available to assist in determining the MRU mounting angles. This mounting wizard starts with applying the main rotation which means to change the mounting angles in steps of 90-degrees for each axis. After applying the main rotation of the MRU, the subsea bottle offset angles are defined as the remaining offset angles of the MRU axes (x, y, z) relative to the ship's axes (R, P, Y). The roll and pitch bracket offset angles can be interpreted as the bottle's tilt angles relative to the ship's deck plane (horizontal plane). Be aware that these angles are not exactly the same as the MRU roll and pitch mounting angles. The MRU mounting angle wizard will convert the measured offset bottle angles into the corresponding roll, pitch and yaw mounting angles (Euler angles) which are used in the MRU.

The bottle offset angles are defined as:

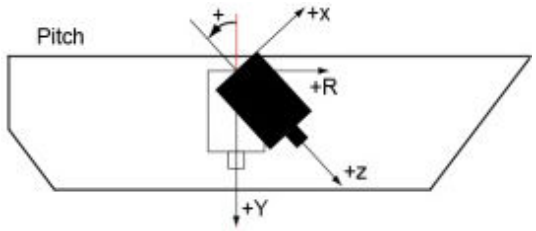
Roll offset angle

The angle between the ship's Y-axis and the projection of the MRU z- axis in the ship's PY-plane.



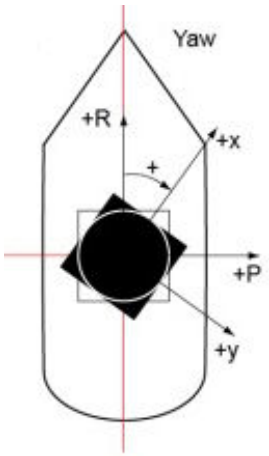
Pitch offset angle

The angle between the ship's Y-axis and the projection of the MRU z-axis in the ship's RY-plane.



Yaw offset angle

The angle between the ship's R-axis and the projection of the MRU x-axis in the ship's RP-plane.



The illustrations show the positive roll offset angle if the bottle tilts to starboard. The positive pitch offset angle if the bottle tilts to stern and the positive yaw offset angle if bottle is rotated clockwise.

Note:

Mounting of the MRU with the x-axis (x arrow) pointing up (0, 90, 0) or down (0, -90, 0) should be avoided due to the fact that there is a singularity in the Euler angle representation for a 90-degree pitch angle. Therefore, the MRU mounting wizard does not support these orientations.

Note:

If the offset angles exceed 45 degrees, another main rotation should be selected.

In Calibrating the MRU axis it is described to which accuracy the mounting angles have to be calibrated to make sure that the MRU functions are according to specifications. The MRU software automatically corrects the mounting angles back to the default orientation when these angles are set in the MRC+ configuration software.

See the *MRU Technical description* for details on the different frames which are used. Such as the MRU/sensor frame (x, y, z), ship/body frame (R, P, Y), heading frame (F, S, D) and geographical frame (N, E, D).

Related topics

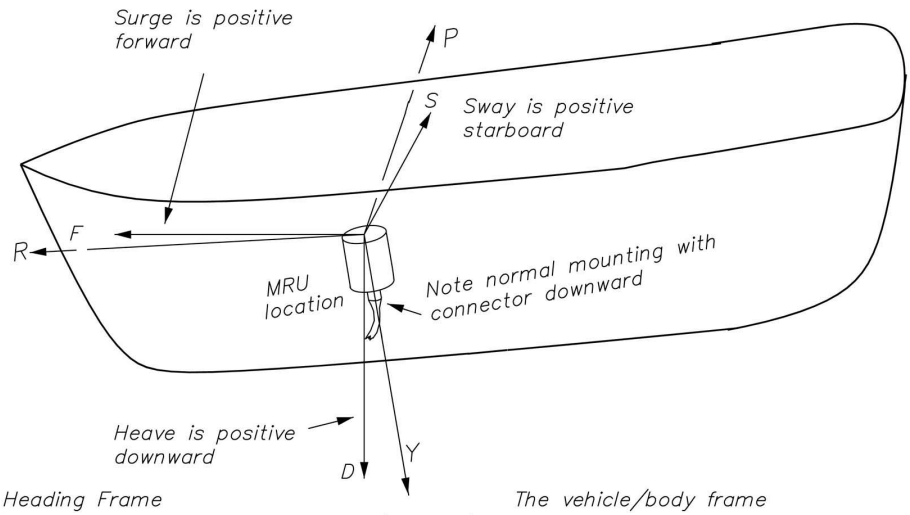
Calibrating the MRU axis, page 39
Setting MRU location and mounting angles, page 98

Axis direction for surge, sway and heave measurements

These are the definitions of the default axis directions for the linear motion.

- **Surge** is defined positive in a horizontal axis direction pointing forward (F-axis).
- **Sway** is defined positive in a horizontal axis direction pointing starboard (S-axis).
- **Heave** is defined positive pointing downward (D-axis).

The illustration shows the axis directions for surge, sway and heave.



Heading Frame
F : In R–direction but horizontal (Forward)
S : In P–direction but horizontal (Starboard)
D : True vertical direction

The vehicle/body frame
R : Bow direction
P : Starboard
Y : Ships down (not vertical)

Use of lever arms

Setting up lever arms in the MRC+ configuration software simplifies the installation of some applications, such as heave compensation of cranes.

The MRU sensor can then be located some distance away from the location of the monitoring points.

The following lever arm vectors from the unit to the location of the monitoring points (MP) can be used without significantly degrading the unit's linear position and velocity output accuracy:

- 100 metres: MRU 5+ and 5
- 70 metres: MRU E and H

- 40 metres: MRU 3
- 7 metres: MRU S

Note:

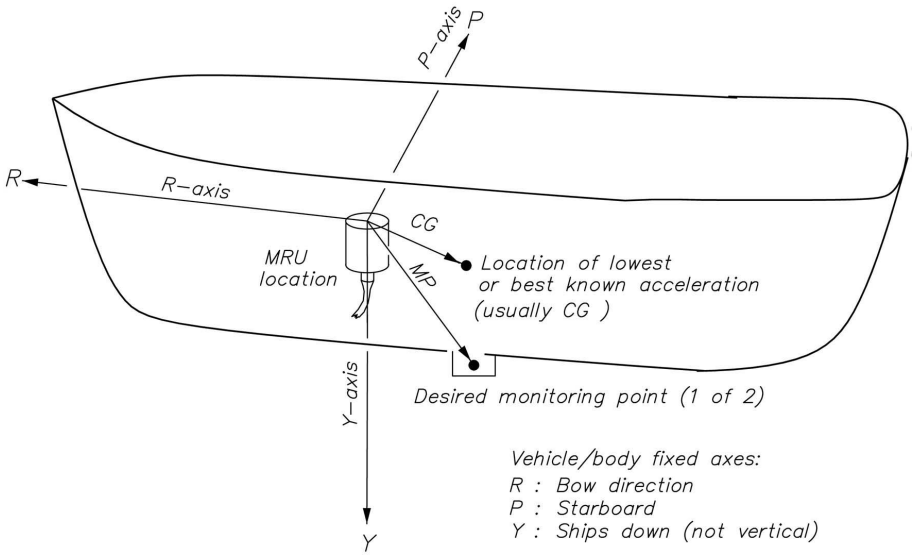
The unit's linear acceleration measurements can only be transferred a few metres else the accuracy of these measurements will be degraded.

The MRU achieves its best roll and pitch accuracy when the unit is mounted at the vessel's centre of gravity (CG). Although it is often not possible to mount the unit at precisely the CG, it is possible to compensate for this and achieve the same roll and pitch accuracy as if the unit was mounted at the vessel's CG by inputting the lever arm CG vector in the unit's configuration.

When lever arm corrections are used, the following lever arm co-ordinates must to be defined in the MRC+ configuration software:

- The centre of gravity lever arm
- The monitoring point lever arm

The illustration shows the location of the MRU, the centre of gravity (CG) and the monitoring points (MP) on the vessel.



Definition of the Centre of Gravity (CG) lever arm

This is the lever arm vector (the components along the R, P, Y axes) from the MRU to the vessel's centre of gravity (CG). The components must be measured in metres from the unit's location with an accuracy better than one metre.

Definition of the Monitoring Point (MP) lever arm

In the unit two individually configurable monitoring points are available. Typical vector (R, P, Y) from the unit to a desired MP is illustrated. The components must be measured in metres from the unit's location with an accuracy better than 0.1 metres. In systems where the MPs are not a fixed point relative to the unit's location (crane, for instance), the unit is designed to receive input co-ordinates for the lever arm MP from a computer through the digital interface. The command **Set Lever Arm Vector** is used to continuously update the unit with the correct MP values. See the *MRU Technical description* for more information on this command.

Note:

The unit's position is the origin of the co-ordinate system from which the CG and MP lever arms are to be measured. A component is positive when moving in the positive axis direction from the unit's position. Be aware that the vertical axis is positive down. Use the graphical view in MRC+ to make sure that the MPs are correctly positioned.

When using long lever arms, any vessel vibration sensed by the unit will increase the noise level of the measurements, because angular velocity and numerically derived angular acceleration are used in these computations.

CAUTION:

Use caution when selecting a location for the MRU. Incorrect use of lever arms will result in a degraded performance.

Related topics

Setting MRU location and mounting angles, page 98

Setting to work

Topics

Setting to work summary

When all hardware units have been installed, all the cables have been connected the MRU system can be turned on and set to work.

Prerequisites

- All system units have been installed.
- All system cables are connected.
- All cable connections are made.
- Correct operating power is available.

Procedure

1. Verify that all hardware and cable installation have been made correctly.
2. Apply power to the MRU by connecting the MRU cable (MRU-E-CS8) to the unit.

3. Apply power to the MRU JB3 junction box.

   The MRU is powered through the junction box.

4. Install the MRC+ application on a computer.
5. Configure the MRU system for operational use.
6. Verify that the MRU system is operational.

Related topics

Installation, page 30
Cable layout and interconnections, page 58
Installing the MRC+ configuration software, page 40
Connecting and starting the MRC+ configuration software, page 42
Turning on the MRU, page 80
MRU LED indicator, page 81
MRC+ configuration software overview, page 83

Turning on the MRU

When you have verified that all hardware units and cables have been properly installed, and that the supply power is correct, you can turn on the Motion Reference Unit (MRU) for the first time.

Context

The MRU will start automatically after power has been applied. It will remain in operation as long as it receives power.

It is recommended to leave the unit with power on after the start-up. Once the unit is installed, there is no need for manual intervention during operation.

Procedure

1. Make sure that the MRU cable is properly connected to the power source.
2. Observe that the LED on top of the unit is flashing.

   The unit needs some time before full accuracy is achieved. The maximum erection time is 15 minutes. During this period the unit runs an internal self check procedure for sensor and connection boards and performs an initial alignment.

3. When the unit has obtained full accuracy, the status message from the unit will change from **reduced accuracy** to **normal** on the communication lines.

Result

The system is now ready for configuration.

Related topics

Operating the unit, page 21
Turning off the MRU, page 22
MRU LED indicator, page 81

MRU LED indicator

The Motion Reference Unit (MRU) has one LED (Light Emitting Diode) indicator.

The LED indicator is located next to the connector on the unit. This LED indicates status of operation and configuration.

A. LED indicator

The LED function is described with a sequence of colours. Each second is divided into four slots.

- **Time sync**: The first slot in the sequence shows information about time synchronisation.
- **Blank**: The second slot in the sequence is always blank.
- **Aiding**: The third slot in the sequence shows status on external inputs.
- **Status**: The fourth slot in the sequence shows the unit's status.

The meaning of the colour in each slot is illustrated in the table.

Note:

One column in the table represents one second.

1-second flash per column			
Time sync	**Blank**	**Aiding**	**Status**
NO PPS		NO AID	OK
PPS OK		HEAD AID	
PPS & DATE OK		SPEED AID	
		HEAD & SPEED	

If default IP is selected, the LED is yellow every 4th second.

If there is something wrong with the unit, a flashing red light flashing at 4 Hz is observed.

Pressing the ALERT button changes the light to blue. By holding the ALERT button for more than 8 seconds, a yellow light indicates that the unit is reset to the default IP.

The ALERT/Reset button is located on the MRU-T-015 configuration box (the small connector pin) or within the MRU JB3 junction box (the small button close to the DIP switches).

If the sensor unit detects something wrong with an internal inertial component, a flashing magenta light flashing at 4 Hz is observed.

Related topics

Turning on the MRU, page 80

MRC+ configuration software

Topics

MRC+ configuration software overview

The MRC+ configuration software is used to set up the MRU. The software is installed on an external computer. You set up the system parameters from the **Configuration** tab in the software.

Configuration tab

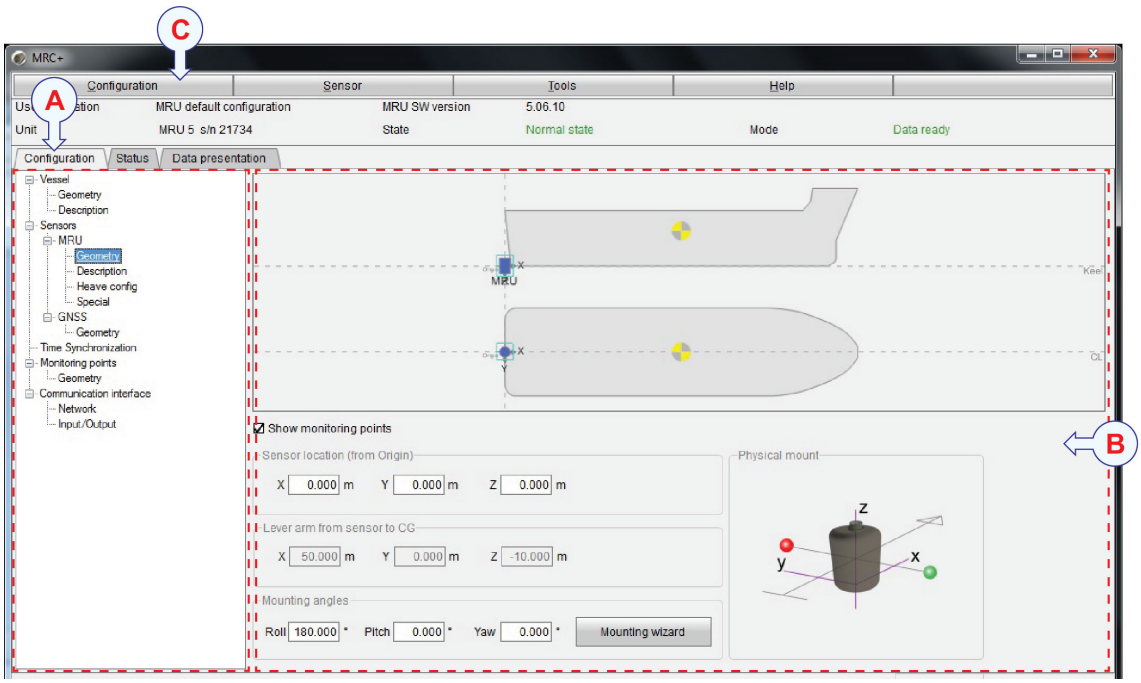
The **Configuration** tab contains the options for the configuration parameters available in the system.

Parameter settings section

When you select a configuration option, a parameter setting section appears. This is where you enter or change the various parameters for that option.

Configuration menu

For the parameter settings to take effect, you must send the configuration file to the MRU. This is done from the **Configuration** menu at the top of the display.



A. *Configuration tab with parameter options*

B. *Parameter settings section*

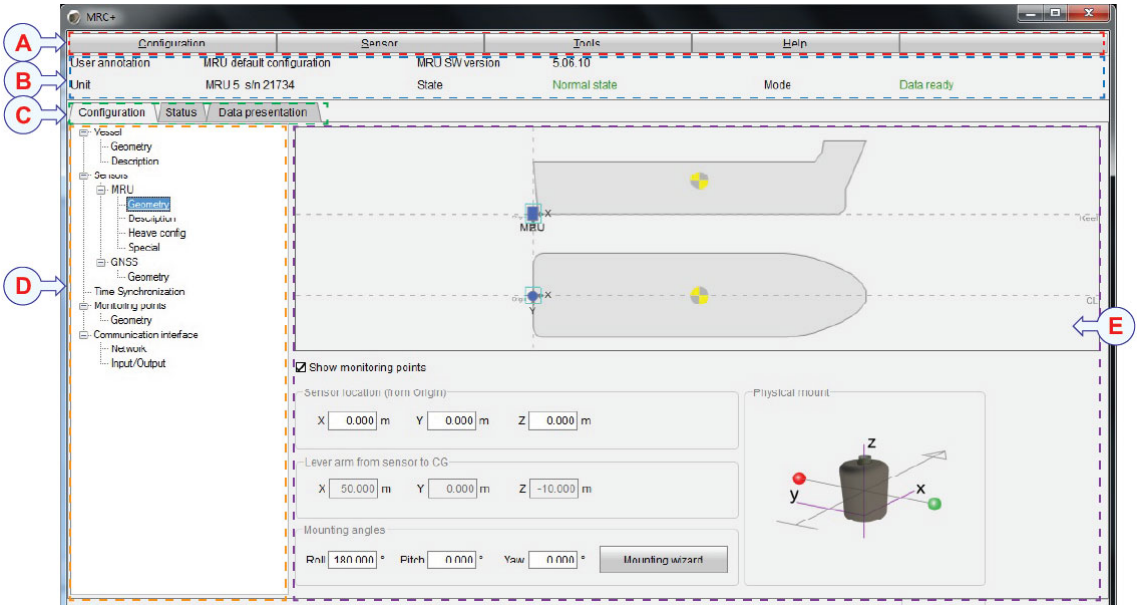
C. *Configuration menu*

Related topics

Configuration tab, page 87

Display organisation

The illustration shows the various parts of the display in the MRC+ configuration software.



A. *Top bar (with Application menu)*

B. *Information bar*

C. *Pages for configuration, status & events and presentation of system data*

D. *Configuration options (when Configuration tab is active)*

E. *Configuration parmeter settings*

Related topics

Menu system - Application menu, page 84
Information bar, page 86
Configuration tab, page 87

Menu system - Application menu

The Application menu in the top bar holds the menu system. The menus have sub-menus which offer various configuration options.

Configuration menu

The **Configuration** menu contains the setup options for the system.

Open

The **Open** option opens a configuration from file.

Save

The **Save** option saves the configuration to file.

Revert changes

The **Revert changes** option reverts all changes performed since the file was open.

Send to sensor unit

The **Send to sensor unit** option sends the edited configuration parameters in the MRC+ configuration software to the connected MRU sensor.

Exit

The **Exit** option exits the the MRC+ configuration software.

Sensor menu

The **Sensor** menu contains options on how to connect to the MRU, restart the MRU, send calibration file, synchronize clock and to upgrade the software.

Connect

The **Connect** option connects the MRC+ configuration software to the MRU sensor.

Restart sensor unit

The **Restart sensor unit** option restarts the MRU sensor.

Send calibration set

The **Send calibration set** option opens a calibration file and sends it to the connected MRU sensor.

Demo

The **Demo** option runs the MRC+ configuration software without an MRU sensor connected.

Synchronize clock

The **Synchronize clock** option synchronizes the clock within the MRU sensor to local time or UTC (Coordinated Universal Time).

Upgrade software

The **Upgrad software** option sends new software to the MRU sensor.

Tools menu

The **Tools** menu is not used.

Help menu

The **Help** menu contains help and system details.

MRC+ Help

The **MRC+ Help** option holds a PDF-file with description on how to configure the MRU sensor with MRC+.

Compatibility

The **Compatibility** option lists the MRU software versions which can be used together with the current MRC+ version.

Legacy Source IDs

The **Legacy Source IDs** option lists the variables which have been given new Source IDs in the 5th generation MRU.

About MRC+

The **About MRC+** option list the MRC+ software version, contact information and details on this software.

Related topics

Display organisation, page 84

Information bar

The Information bar on the top bar contains information about the connected MRU sensor.

User annotation

User annotation is a text which describes the specific configuration for a vessel or installation. This text will be displayed in the Information bar and on status information.

Unit

Unit is the type of MRU connected and the unit's serial number.

MRU SW version

SW version is the software version of the connected unit.

State

State is the status of the connected unit.

Mode

Mode is the unit's operation mode.

Related topics

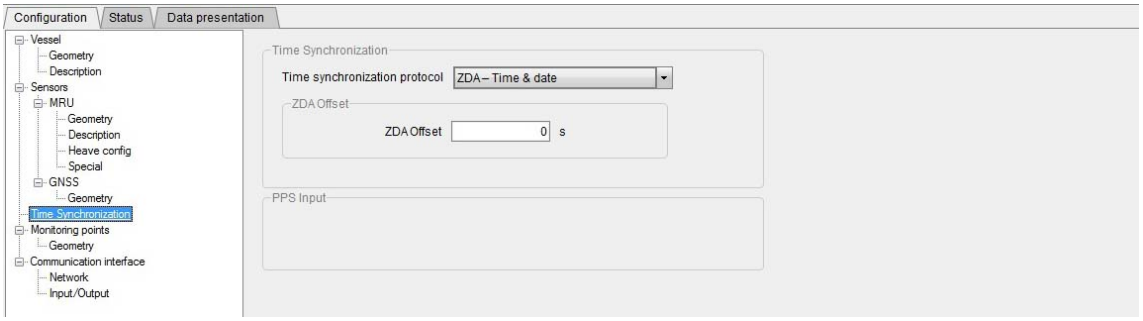
Entering user annotation information, page 103
Display organisation, page 84

Configuration tab

The **Configuration** tab in the MRC+ configuration software contains the system's setup parameters.

How to open

In the MRC+ configuration software, select the **Configuration** tab.



The parameters which can be set up are:

- Vessel geometry and description
- Sensor data, including:
  - MRU geometry, description, heave configuration and special
  - GNSS geometry
- Time synchronization
- Monitoring points geometry
- Communication interface, including:
  - Network
  - Input/output

Related topics

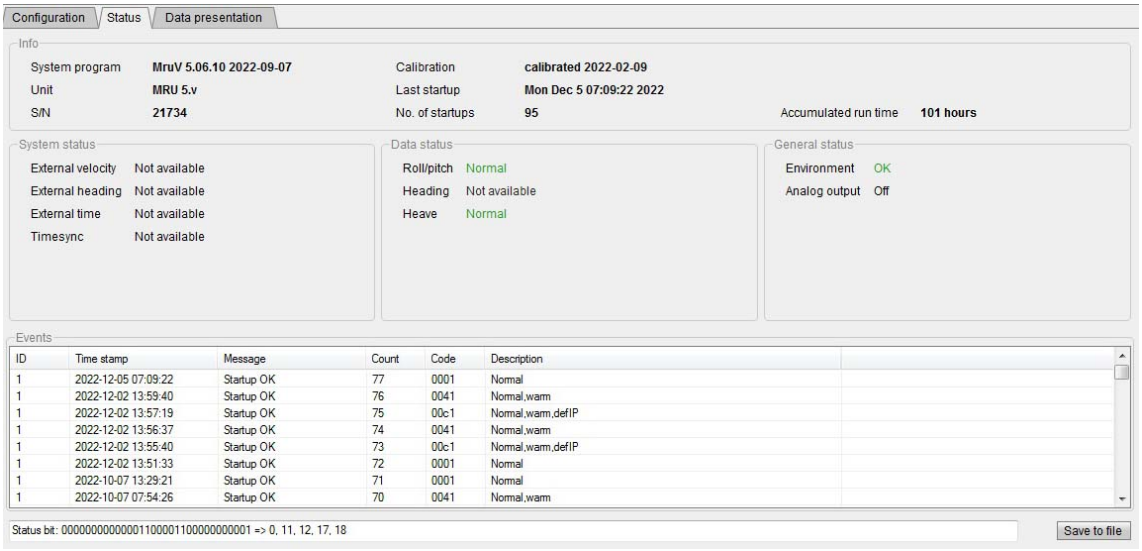
Vessel configuration, page 91
Sensors configuration, page 98
Time synchronization configuration, page 110
Monitoring points configuration, page 112
Communication interface configuration, page 115
Display organisation, page 84
Saving the MRU configuration, page 141

Status tab

In the **Status** tab you can see the current system status and events which have occurred.

How to open

In the MRC+ configuration softwarte, select the **Status** tab.



Info

System program

System program shows the current MRU software version on which the unit is operating.

Unit

Unit lists the current MRU model and its hardware revision. For example "v".

S/N

S/N shows the serial number of the connected unit.

Calibration

Calibration shows the serial number of the unit for which the calibration file is generated and the calibration date.

Last startup

Last startup shows the date and time for the last start-up of the unit.

No. of startups

No. of startups shows the number of start-ups the unit has had since it was manufactured.

Accumulated runtime

Accumulated runtime shows the number of hours the unit has been in operation since it was manufactured.

System status

External velocity

External velocity shows status and source for the external velocity input. The values are **Available** or **Not available**.

External heading

External heading shows status and source for the external heading input. The values are **Available** or **Not available**.

External time

External time shows status and source for the external time input. The values are **Available** or **Not available**.

Timesync

Timesync shows status and source for the external time synchronisation input. The values are **Available** or **Not available**.

Data status

Data status shows the status of the unit's data output for **Roll/pitch**, **Heading** and **Heave**. The values are **Not available**, **Reduced** or **Normal**.

General status

Environment

Environment shows status for the environment. For example temperature level. The values are **OK** or **Not OK**.

Analog output

Analog output shows the status for the analog output. The value is **On** if a junction box is connected and analog outputs are configured. If there is no junction box, the value is **Off**.

Events

Events shows the original event messages which have been generated.

Save to file

Select **Save to file** if you want to save the status information to a text file.

Related topics

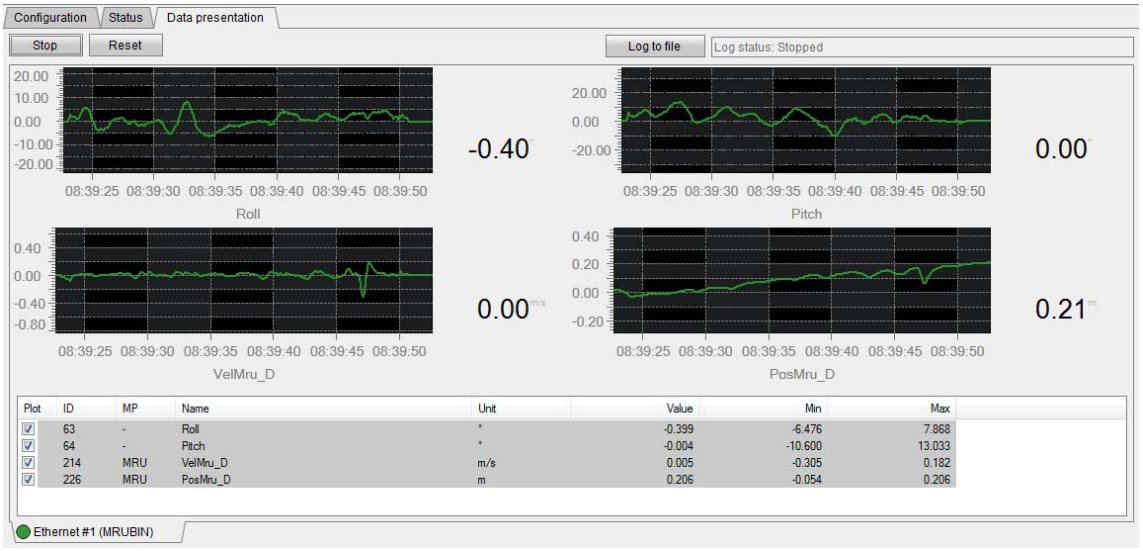
Status bit overview, page 204
Status bits description, page 205

Data presentation tab

The **Data presentation** tab presents the output variables configured on the Ethernet ports as graphs in the display. You can also log data to file.

How to open

In the MRC+ configuration software, select the **Data presentation** tab.



Description

Remember to set up the outputs on Ethernet port #1, #2, #3, #4 or #5 and to send the configuration to the MRU before you enter the **Data presentation** tab.

Maximum six variables can be plotted in the display simultaneously. The other output variables are displayed numerically. Select the check box in the **Plot** column to select the variables to be plotted. A green colour on the graphs indicates that the unit operates in normal mode. A yellow colour indicates that the unit outputs data with reduced accuracy.

Use the **Start/Stop** and **Reset** buttons to control the data presentation and the logging to file.

Select the **Log to file** button to log data to file. The data are saved in an ASCII file with the output variables stored as floats in columns. The file contains a header with the name of the variables, number of samples and the sample time. You can easily modify the file in a text editor to adjust to other, similar formats. The default file name is `*.tsa`.

Note:

*Outputs to Ethernet port #1, #2 or #5 have to be configured and sent to the MRU before the **Data presentation** tab is entered. If not, no data will be presented.*

*The outputs on COM1 and COM2 are not presented in this **Data presentation** tab. This is because the MRC+ only has connection to the unit through Ethernet and not through serial line.*

The illustration shows a green circle in front of the Ethernet port at the bottom of the page. If this circle is red, it may indicate problems with the MRC+ configuration software installed outside the firewall.

Related topics

Logging data to file, page 131
Changing the firewall settings, page 132
Output variables, page 195
Selecting graphical presentation of output variables, page 130

Vessel configuration

Topics

Setting vessel dimensions and reference points

You must define the dimensions and the reference points for the vessel which hosts the MRU system and the origin of the vessel coordinate system.

Prerequisites

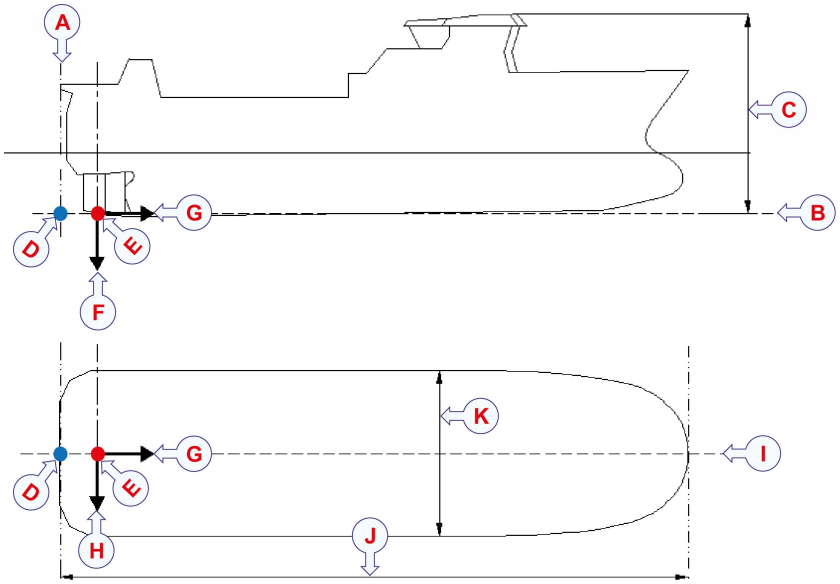
From the loading condition calculation of the vessel, find the location of the centre of gravity (CG) related to origin for a typical load condition.

Context

The pre-defined scalable vessel shape types rarely represent the actual outline of your vessel. In order to configure the accurate location of the various sensors, equipment and monitoring points on your vessel, you can load a separate vessel model from file. Select **Use vessel drawing** and browse for your specific vessel model file.

This is information you need in order to specify correct location of various sensors, equipment and monitoring points on a vessel. The information you enter here will help you later in the configuration process. The drawing is correctly scaled based on the vessel dimensions to make sure that the various points are correctly indicated. The measurement unit of the entered coordinates is metres.

The illustration shows different vessel dimensions and location of origin. If a survey report is available, the vessel origin should be located in the common reference point (CRP) used in the report.



A. *Stern*

B. *Keel*

C. *Overall height*

D. *CRP (common reference point)*

E. *Origin*

F. *+Z axis*

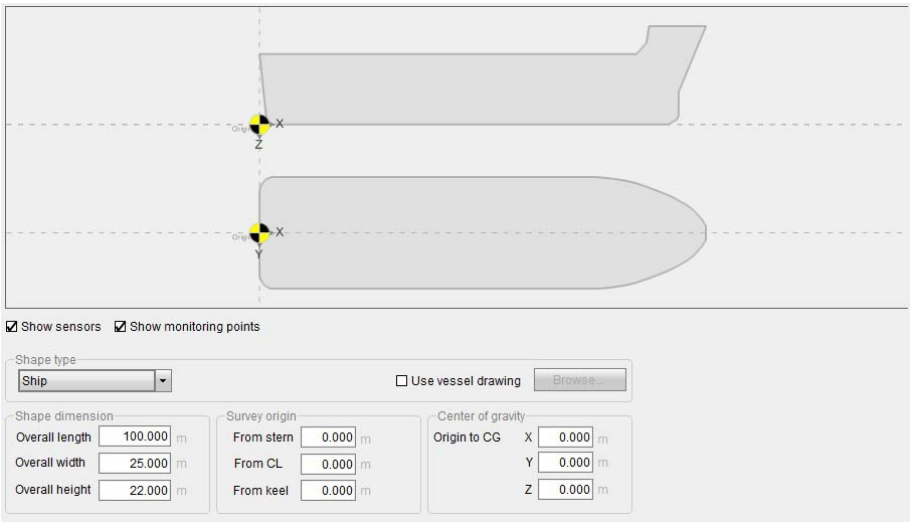
G. *+X axis*

H. *+Y axis*

I. *CL (centre line)*

J. *Overall length*

K. *Overall width*



Details

Show sensors, **Show monitoring points**

These items are displayed in the vessel illustration when you select the boxes.

Shape type

Shape type defines the shape of the vessel which hosts the system. You can select between Ship, Rig, Jackup (3 leg) and Jackup (4 leg). These are all scaled according to the dimensions given in the **Shape dimension** section.

Use vessel drawing

The general shape outline can be overridden by an actual shape defined in a drawing file. Supported file extensions are **Vessel models(*.svm)**, **Vessel vector images (*.svi)** and **Old vessel images (*.txt)**. This file can be created or edited in a text editor. When a valid drawing file has been loaded, the dimensions are defined by the loaded shape and the **Shape dimension** parameters are locked.

Shape dimensions

Shape dimensions holds parameters for the overall length of the vessel from stern to bow, the overall width of the vessel and the overall height, which is the distance from the highest point of the vessel to the keel.

Survey origin

All point locations in the configuration refer to the origin. The location of the origin is defined using the distance from stern, centre line (CL) and keel. The location of origin is often referred to as the common reference point (CRP) in survey reports. The distance from stern is the distance from the aft point of the ship to origin along the X axis. The distance from CL is the distance from the vessel's centre line, positive towards starboard. The distance from keel is the distance from the keel, positive downwards.

Centre of gravity (CG)

The **Origin to CG** X, Y and Z boxes define the location of CG related to origin. The CG is the centre of ratation in the vessel.

Procedure

1. Select the **Configuration** tab > **Vessel** > **Geometry**.
2. Select the shape of your vessel from the **Shape type** list or select **Use vessel drawing** if you have a specific vessel shape file you want to use. Select the **Browse** button to search for the wanted file.

   If you select **Use vessel drawing**, the **Shape dimension** parameters will be locked.
3. Enter the overall length, width and height dimensions of your vessel.
4. Enter the parameters for location of origin (survey origin).
5. Type the parameters for the centre of gravity (CG) location, X, Y and Z.

6. Select **Show sensors** and/or **Show monitoring points** if you want to display these objects in the vessel illustration.
7. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Importing vessel shape from file

You can load a vessel model from file in order to get accurate dimensions for your vessel.

Context

The pre-defined scalable vessel shapes represent the actual vessel outline only in rare cases. In order to configure the accurate location of various sensors, equipment and monitoring points, it is recommended to load a separate vessel model from file.

The system supports two types of two dimensional outlines: side view (towards starboard) and top view. Three file types are available: **Vessel models** (*.svm), **Vessel vector images** (*.svi) and **Old vessel images** (*.txt).

The vessel image file must meet the following requirements:

- The vessel data have to be in an ASCII file generated by Excel, Notepad or similar tools.
- The file head includes Overall length (LOA), Overall width, Overall height and Stern to Origin data in metres.
- Profile (side view) data in X and Z coordinates must be in metres, related to the origin. The coordinates are specified clockwise from a point aft of the origin, and the last coordinate has to equal the first coordinate to form a closed polygon.
- The top view data in X and Y coordinates must be in metres. The first coordinate has to be aft of the origin along the centre line. Successive coordinates are specified clockwise, and the last coordinate has to equal the first to form a closed polygon.

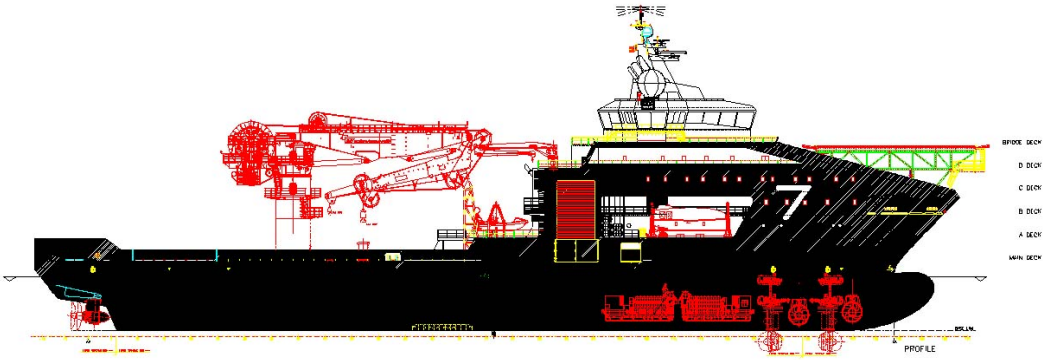
Vessel image files can be created by Kongsberg Discovery AS upon customer request. General arrangement (GA) drawings or similar are required to create vessel image files.

Procedure

1. Select the **Configuration** tab > **Vessel** > **Geometry**.
2. Select **Use vessel drawing**. The **Shape dimension** parameters will be locked.
3. Enter the parameters for the location of origin (survey origin).
4. Enter the navigation reference point location. X, Y, Z.
5. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Vessel shape from file

The illustration shows an example of a GA drawing of a multi-purpose vessel.



A user text file from Notepad may look like this.

mpv.svi - Notepad

File Edit Format View Help

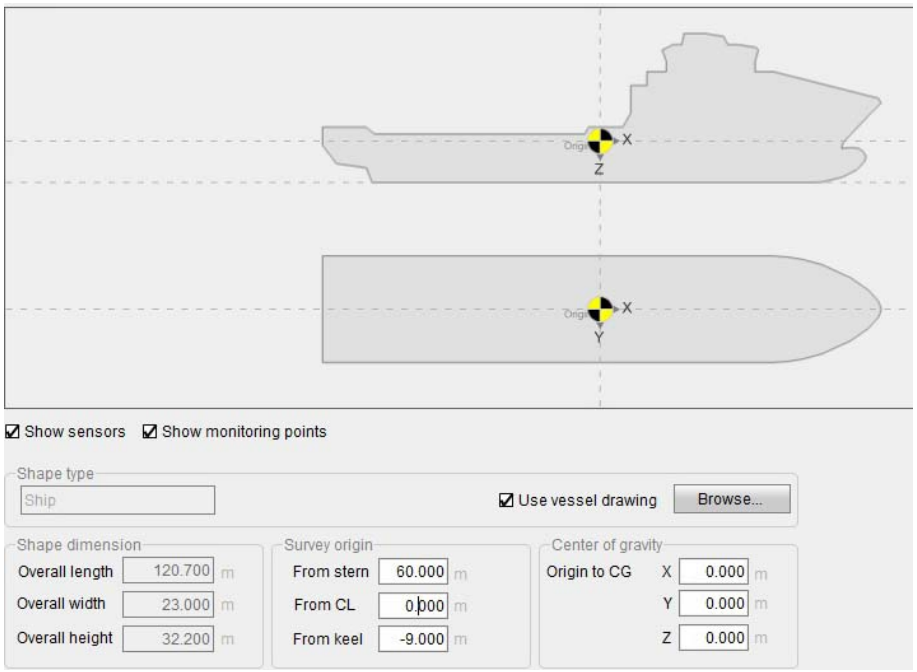
```
%Vessel Data [m]
%LOA = 120.70
%Width = 23.00
%Height = 32.20
%Aft to AP = 7.00

%Profile coordinates in (X,Z) [m]
0.00,-3.55
2.44,-3.19
3.69,0.00
98.60,0.00
101.00,-0.14
105.20,-1.12
108.36,-2.70
110.09,-4.51
110.35,-5.20
110.40,-5.43
110.40,-5.69
.
.
.
.
63.10,-24.00
63.10,-21.00
59.62,-21.00
59.62,-15.13
57.87,-12.99
49.65,-10.50
4.25,-10.50
2.31,-12.00
-7.00,-12.00
-7.00,-8.00
-4.00,-4.11
0.00,-3.55

%Profile cutout
-23.20,-36.48
-23.20,-10.24
23.20,-10.24
23.20,-36.48
-23.20,-36.48

%Top view coordinates in (X,Y) [m]
-7.00,0.00
-7.00,11.50
90.30,11.50
.
.
.
113.60,0.57
113.70,0.00
```

The vessel shape in the MRC+ Configuration looks like this.



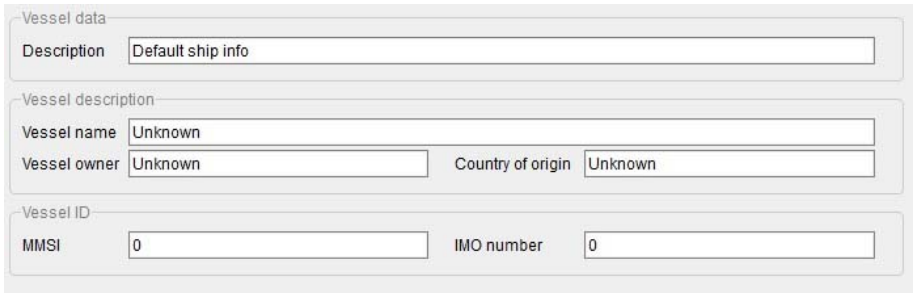
In the example, only the port side of the vessel top view is defined in the file. Symmetry is assumed, so this is sufficient to draw a symmetric vessel shape. If the vessel is not symmetric, use the section code **%Top view coordinates in (X,Y) [m] Complete** and give the coordinates along the complete shape, defined clockwise.

It is possible to define cutouts within the profile or top view polygons. For profile cutout, use **%Profile cutout n**, where **n** identifies the cutout.

Entering vessel identification parameters

The vessel **Description** parameters allow you to enter information about the vessel which is needed for identification purposes.

Context



Description

Description is a descriptive text for this configuration file. It will help you to identify this file the next time you upload it.

Vessel name

Vessel name is the name of the vessel. This box MUST be filled in. The default value is Unknown.

Vessel owner

Vessel owner is the owner of the vessel. This is optional information.

Country of origin

Country of origin is the country in which the vessel is registered. This is optional information.

MMSI

MMSI is the nine-digit Maritime Mobile Service Identity (MMSI) number which uniquely identifies your vessel. The default value is 0.

IMO number

IMO number is the International Maritime Organization (IMO) number which uniquely identifies your vessel. The default value is 0.

Procedure

1. Select the **Configuration** tab > **Vessel** > **Description**.
2. Enter a **description** of your vessel.
3. Enter the name of your vessel. This box cannot be empty. The default value is **Unknown**.
4. Enter the name of the **vessel owner**. This is optional information.
5. Enter the **country of origin** for the vessel. This is optional information.
6. Enter the MMSI number assigned to the vessel. The default value is 0.
7. Enter the IMO number assigned to the vessel. The default value is 0.
8. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Sensors configuration

Topics

Setting MRU location and mounting angles

The physical location of the MRU relative to the origin and its mounting angles is required for the MRU system to be able to calculate roll, pitch and heave.

Prerequisites

For accurate location of the MRU (Motion Reference Unit) a survey has to be carried out. If a survey report is available, the vessel Origin should be located in the CRP (Common Reference Point) used in the report.

Context

The MRU measures the roll, pitch, yaw and heave motions of the vessel. Under **MRU Geometry** you must define the physical location of the unit related to the origin location you created under **Vessel Geometry**.

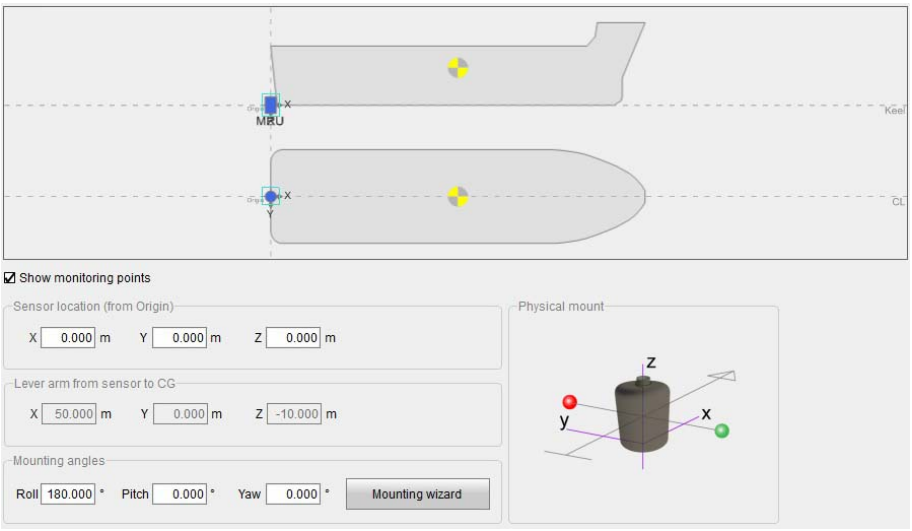
In the **MRU Geometry** page you enter the MRU location parameters, the X, Y and Z coordinates in meters, and the MRU mounting angles, the roll, pitch and yaw parameters in degrees. Look at the vessel illustration in the page to help you enter the correct signs for the coordinates. The illustration will show if the MRU appears at the expected location on the vessel.

If something looks out of place, check the signs and X, Y, Z coordinates you entered for the unit location and/or return to the **Vessel Geometry** page and check the vessel shape dimensions, the origin location and the centre of gravity (CG) location.

The MRU mounting angles can either be input manually or determined by use of the Mounting wizard. The **Mounting wizard** is located in the **Configuration** tab > **Sensors** > **MRU** > **Geometry**.

Note:

*The new MRU mounting angles are only valid in the MRU after you have entered the **Configuration** menu and selected **Send to sensor unit**.*



Details

Show monitoring points

These items are displayed in the vessel illustration when you select the boxes.

Sensor location (from origin)

This is the position of the MRU in X, Y, Z coordinates in metres from Origin. The MRU location has to be measured. The default position of the MRU is in the vessel Origin.

Lever arm from sensor to CG

The **Lever arm from sensor to CG** parameters are for information purposes only. They show the relative position between the MRU and the CG (Centre of Gravity). It is recommended that none of these coordinates exceed 150 metres. If they do, the MRU measurements can be unstable and start to oscillate.

Mounting angles

Mounting angles is the mounting angles of the MRU in degrees for roll, pitch and yaw. The Mounting Wizard is a helpful tool to obtain the correct roll and pitch compensation.

`Mounting wizard` button

Select this button and the Mounting wizard will assist you with the determination of the MRU mounting angles.

Procedure

1. Select the **Configuration** tab > **Sensors** > **MRU** > **Geometry**.
2. Enter the X, Y and Z coordinates in metres from Origin to the unit location.

   Make sure that the **Lever arm from sensor to CG** values do not exceed 150 metres. If they do, the MRU measurements can be unstable and start to oscillate.

3. Enter the unit's mounting angles in degrees for roll, pitch and yaw.

   If the mounting angle values are not known to you, use the Mounting Wizard to calculate these values.

4. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Related topics

Determining the MRU mounting orientation, page 72
Use of lever arms, page 76
Using Mounting Wizard to determine MRU mounting angles, page 100
Examining reduced roll and pitch performance, page 136

Using Mounting Wizard to determine MRU mounting angles

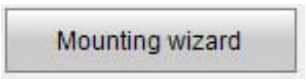
Use the Mounting Wizard to determine the roll, pitch and yaw mounting angles in degrees for the MRU.

Prerequisites

The MRU mounting bracket offset angles have to be available from a survey report or through other methods with similar accuracy.

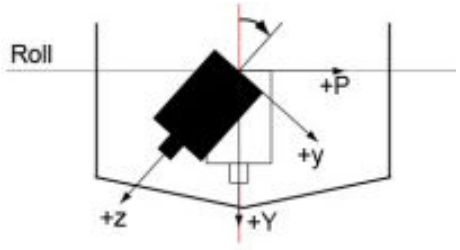
Context

You activate the wizard by selecting the `Mounting Wizard` button in the **Sensors MRU Geometry** page.

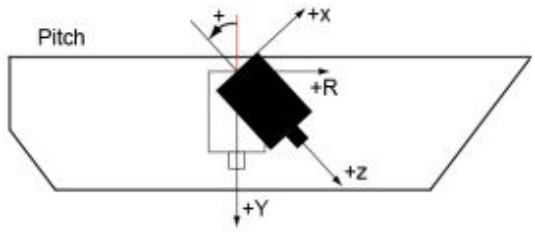


The mounting bracket offset angles which have to be entered are roll, pitch and yaw.

Roll offset angle
: The angle between the ship's Y-axis and the projection of the unit's z-axis in the ship’s PY-plane. Positive roll offset angle if the bracket tilts to starboard.

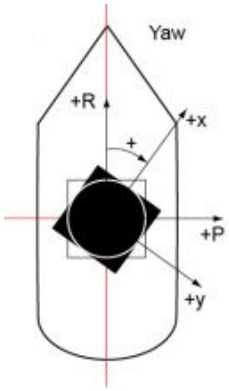


Pitch offset angle
: The angle between the ship’s Y-axis and the projection of the unit's z-axis in the ship’s RY-plane. Positive pitch offset angle if the bracket tilts to stern.



Yaw offset angle

The angle between the ship's R-axis and the projection of the unit's x-axis in the ship's RP-plane. Positive yaw offset angle if the bracket is rotated clockwise.



Note:

If the mounting bracket offset angles exceed 45 degrees, another main rotation should be selected.

Details

Connector direction

Connector direction is the direction in which the connector on the sensor unit points. The selections are Down, Up, Aft, Port, Bow or Starboard.

+x arrow direction

+x arrow direction is the direction in which the +x arrow on the sensor unit points. The selections are Bow, Starboard, Aft, Port, Up or Down.

Main rotation/Main rotation angles

This is the designated installation orientation of the MRU in the vessel, as indicated by **Connector direction** and **+ arrow direction**. These angles are multiples of 90 degrees.

Sensor bracket offset angles

Sensor bracket offset angles is the surveyed offset angles from the designated installation orientation.

Computed mounting angles

Computed mounting angles is the actual installation orientation of the MRU in the vessel, computed from the main rotation and sensor bracket offset angles.

Procedure

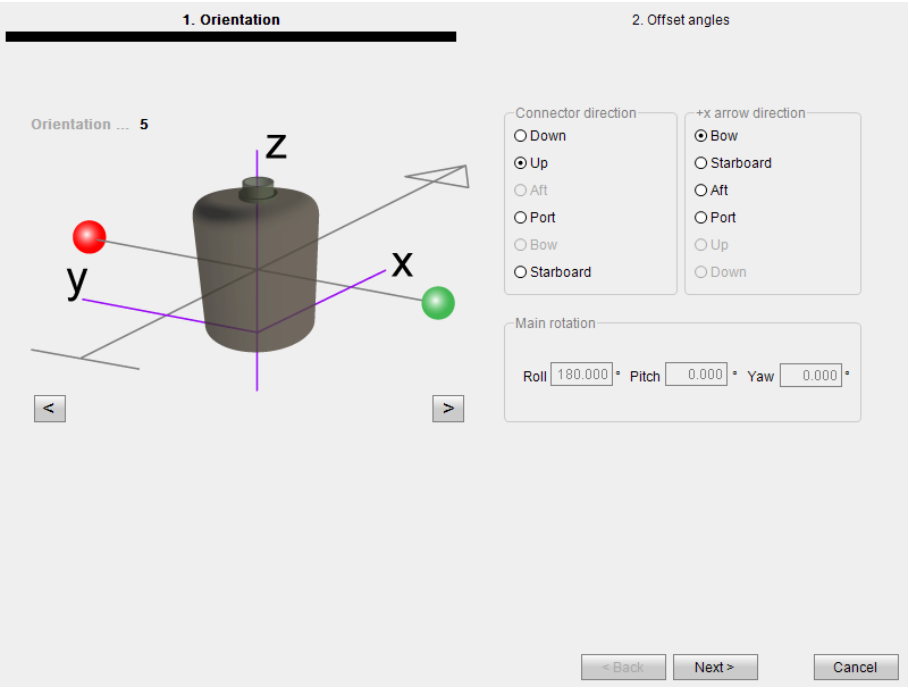
1. Select the **Configuration** tab > **Sensors** > **MRU** > **Geometry**.
2. Select the `Mounting Wizard` button and use the wizard to calculate the roll, pitch and yaw mounting angles.

   The red circle indicates Port. The green circle indicates Starboard. The arrow points in the bow direction.
3. In step 1, **Orientation**, you shall determine the orientation of the unit. There are two ways to determine the orientation.

   a. Select the < or > buttons to turn the unit around in 90-degree steps, axis by axis. Click until the correct mounting orientation of the unit has been found.

   Observe that the parameters for roll, pitch and yaw under **Main rotation** are automatically updated with the actual main rotation of the unit.

   b. Select the **Connector direction** options or the **+x arrow direction** options to select the unit orientation.



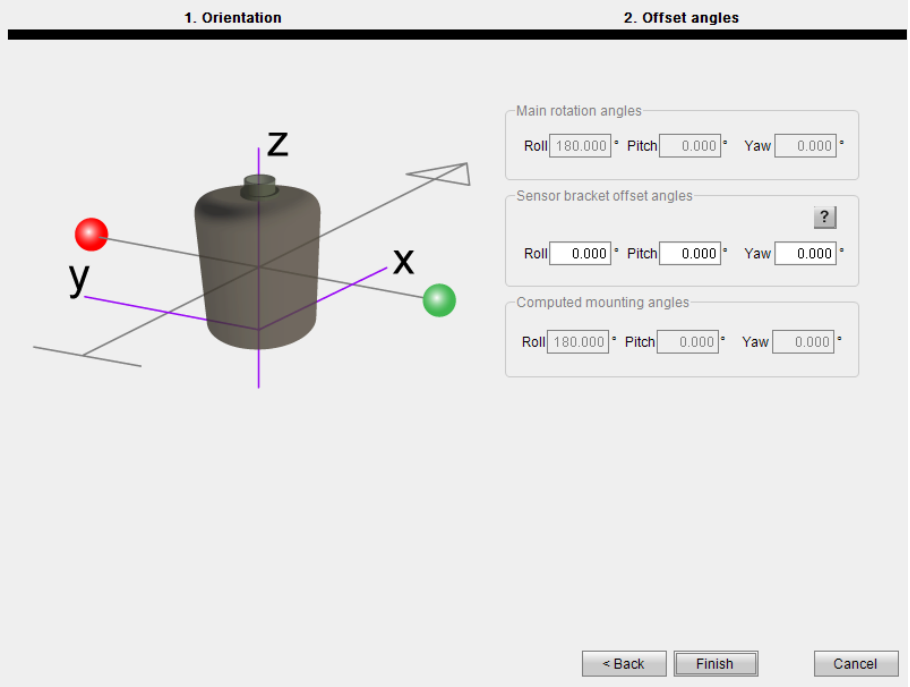
4. Select `Next` to continue to step 2, **Offset angles**.

   Observe that the roll, pitch and yaw mounting angles are now indicated under **Main rotation angles**.

5. Enter the surveyed unit bracket offset angles in degrees for roll, pitch and yaw.

   Select the Question mark button to get more help on the sign of the offset angles.

   The system calculates the mounting angles automatically and the values appear under **Computed mounting angles**.



6. Select `Finish` when you are ready to complete the offset angle setting.

   This will exit the wizard and take you back to the initial **MRU Geometry** page.

7. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Related topics

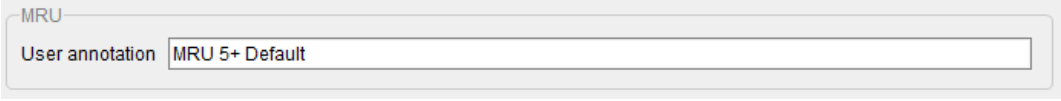
Setting MRU location and mounting angles, page 98

Entering user annotation information

The **Description** page holds the user annotation information.

Context

This information is helpful to identify the correct configuration file at a later stage.



Details

User annotation

The **User annotation** should be a text describing the specific configuration for a vessel or installation. This text will be displayed in the top bar and on status information.

Procedure

1. Select the **Configuration** tab > **Sensors** > **MRU** > **Description**.
2. In the **User annotation** box, enter the informative text.
3. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Related topics

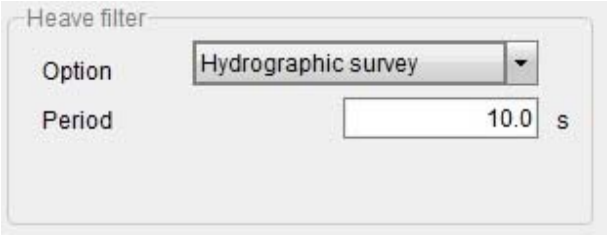
Information bar, page 86

Selecting heave filter options

The **Heave config** parameters allow you to tune the heave parameters to the vessel motion characteristics for the actual weather conditions. This is important when using real-time heave measurements in order to achieve optimum heave performance.

Context

The default settings for heave period and damping have to be tuned for the actual vessel and wether conditions in order to achieve optimum heave performance. Before a survey and/or during operation check the heave performance and tune the heave parameters until the best heave performance is achieved. An alternative is to select **Automatic** and let the system automatically choose the best settings.



You can select the heave filter options from the **Options** list. In the list you can select between three different heave filter modes: *General purpose*, *Hydrographic survey* and *Automatic*.

It you select other options than Automatic, you must enter an expected heave period.

Details

General purpose

Select **General purpose** when the heave phase is of no importance. This mode is typically selected when the system is to be used for measuring the heave height and period on oceanographic buoys.

Hydrographic survey

Select **Hydrographic survey** when the heave phase and amplitude have to be output correctly in real time. This mode is typically selected when the heave output signal from the system is to be used for heave compensation of echo sounders and offshore crane systems.

Automatic

Select **Automatic** when the vessel is operating in various sea states or when the average heave period is unknown. The *Automatic* filter mode estimates the average heave period and automatically sets the filter period in real time during operation. The Automatic filter mode uses the Hydrographic survey filter structure.

Period

An expected average heave **Period** has to be set to the heave filter unless the Automatic mode is selected. An alternative is to output the variable 129 **HeavePeriod** and use the value measured by the MRU as the averge heave period. The settling time for the heave measurements from the MRU is turned on or after a turn will be about 10 times the selected period, T_0.

Procedure

1. Select the **Configuration** tab > **Sensors** > **MRU** > **Heave config**.
2. Select the **heave filter** mode you want to use from the **Options** list.
3. If you select **Hydrographic survey** or **General purpose**, enter the wanted filter **period**.

   Values are between 1 and 25 seconds.

   Or you can select **Automatic** for the system to estimate the heave filter parameters.
4. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

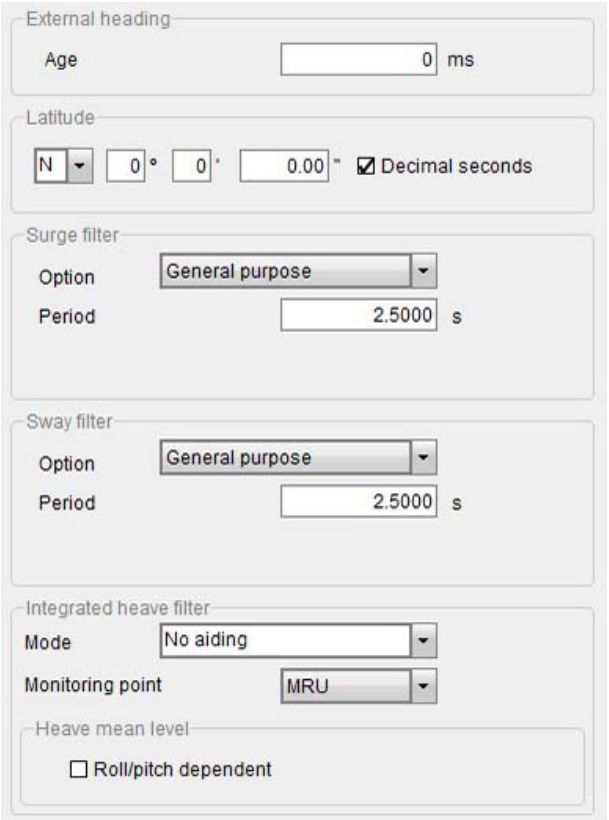
Related topics

Operating the unit, page 21
Examining reduced heave performance or depth error in echo sounder, page 137

Selecting additional configuration parameters

In the **Special** page you can change the settings for the less used setup parameters.

Context



Details

External heading

Age is a parameter for correction of delay in the external heading signal input to the MRU. This parameter should be set to 0 [ms] unless a more precise value is available.

Latitude

The approximate latitude for operation of the MRU is positive north, zero at equator and negative south. This parameter influences the built-in gravity estimation model of the unit. A correct setting will slightly improve the performance on roll and pitch of an MRU. An accuracy in the latitude parameter of approximately 5 degrees is sufficient.

Through the **Decimal seconds** box you can select between entering the latidude in degrees, minutes and seconds or degrees and minutes.

Surge filter and **Sway filter**

For these filters the options are **General purpose**, **Hydrographic survey** and **Automatic**. You can set the **Period** in the range 1 to 25 seconds for **General purpose**

and in the range 1 to 8 seconds for **Hydrographic survey**. The recommended period for surge and sway motion is in the range 2 to 4 seconds. The default value is 2.5 seconds.

Note:

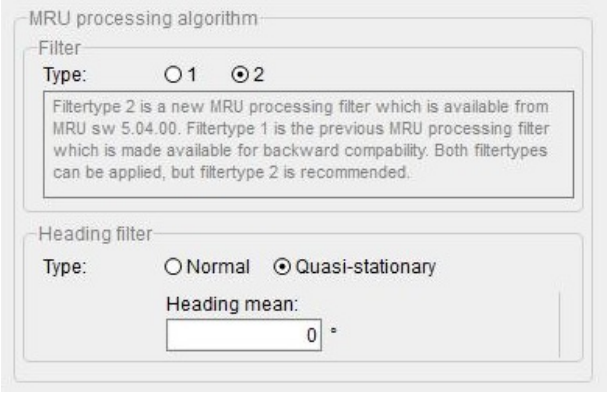
Surge and sway dynamic filtering (zero mean value) will work best for vessel motion that oscillates about a fixed mean value. A vessel that drifts around with a time varying mean value will give considerable noise to the filter output.

Integrated heave filter

For this filter you can select between *No aiding* or *Height aiding* mode. In addition, you have to select in which **Monitoring point** the heave shall be output. In *Height aiding* mode the height is input from the GNSS receiver. You can also select whether the heave should be output with zero mean value or with heave offset depending on static roll/pitch angle by selecting or deselecting the **Roll/ pitch dependent** box.

Note:

The integrated filter comes in addition to the standard heave filter and can be used in parallel with the regular heave filter implementation.



MRU processing algorithm

Two filter types are available for selection of MRU processing algorithm. Filter type 2 is a new MRU processing filter which is available from MRU software version 5.04.00. Filter type 1 is the previous MRU processing filter which is made available for backward compatibility. Both filter types can be applied, but filter type 2 is recommended. Type 2 is specially optimized for better robustness to vessel accelerations. Acceleration “noise” occurs at sea due to imperfect compensation of the vessel accelerations due to vessel turns and changes in the vessel speed.

Heading filter

If filter type 2 is selected, a new **Heading filter** can be selected. This is only valid for the models MRU 5 and MRU 5+. The options are then **Normal** or **Quasi-stationary**. The mode **Quasi-stationary** is intended only for applications where the MRU has a stationary heading, only with heading variations due to ocean waves, for example when anchored. Then the **Heading mean** value can be entered, forcing the MRU heading to oscillate about this mean value.

Note:

*The **Quasi-stationary** filter should not be used for an MRU where the heading mean value will vary with time.*

Procedure

1. Select the **Configuration** tab > **Sensors** > **MRU** > **Special**.
2. If external heading signal is input, select the correct age on the signal in milliseconds.
3. Enter the latitude the unit is operating at.
4. If surge and sway measurements are output from the units, select the preferred filter option and period for the motion to be measured.
5. If the integrated heave variables 90 and 91 are output for the unit, select the correct aiding mode and monitoring point.
6. Select the preferred MRU processing algorithm type.
7. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Entering antenna location parameters

The antenna position is used for lever arm compensation of the speed in the antenna to the MRU location. This is important when speed from the GNSS antenna is input to the unit.

Prerequisites

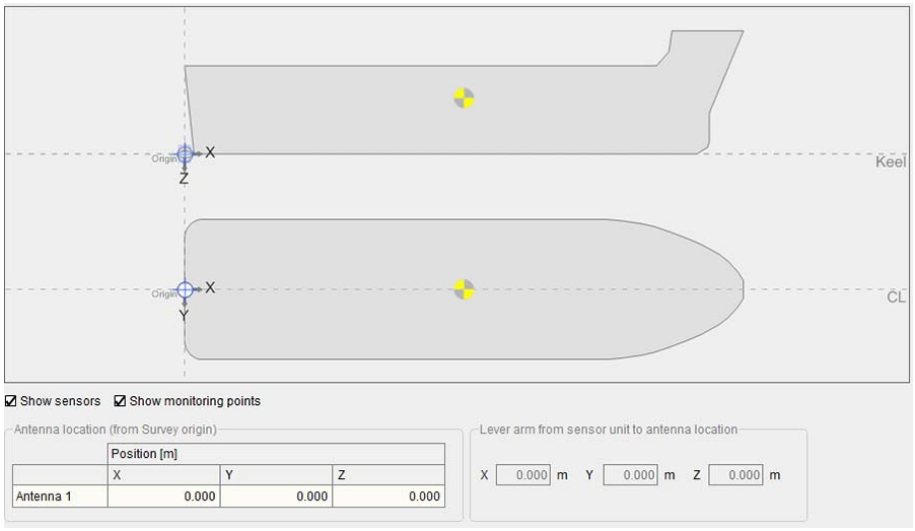
The distance vector from the origin to the GNSS antenna has to be measured before you can enter the parameters into the configuration.

Context

You can either drag and place the antenna symbol in the vessel illustration or you can enter the parameters directly into the table.

Important:

If you move the antenna after the system has been installed and configured, you must update the distance vector measurements and re-configure the antenna location.



Details

Show sensors, Show monitoring points

These items are displayed in the vessel illustration when you select the boxes.

Antenna location (from Survey origin)

Position: X, Y, Z. This is the surveyed antenna co-ordinates.

Lever arm from sensor unit to antenna location

The **Lever arm from sensor to antenna location** parameters are for information purposes only. They show the relative position between the MRU and the antenna. It is recommended that none of these coordinates exceed 50 metres. If they do, the MRU measurements can be degraded in accurracy.

Procedure

1. Select the **Configuration** tab > **Sensors** > **GNSS** > **Geometry**.
2. Select **Show sensors** and/or **Show monitoring points** if you want to display these objects in the vessel illustration.
3. Enter the surveyed antenna coordinates, X, Y, Z.
4. Make sure that the antenna has been located in the expected spot in the vessel illustration.

   If the antenna symbol does not appear where you expect it to in the vessel illustration, observe the GNSS antenna co-ordinates, the vessel dimensions and the entered location of origin.

5. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Time synchronization configuration

Topics

Setting the time synchronization, page 110

Setting the time synchronization

In order to time stamp the MRU output to an external time source, the unit should be time synchronized to an external clock.

Context

The unit can be set up to be synchronized by use of the following protocols:

- **ZDA - Time and data**: This is the default protocol.
- **NTP - Network Time Protocol**: For this protocol the NTP server's IP address must be input.
- **TSC - Time Sync Command**: The unit can be synchronized by use of this command.

A floating time offset (positive or negative) to the ZDA time can be input when the ZDA time protocol is chosen in order to synchronize the ZDA time to the 1PPS (ZDA comes before or after the 1PPS). For normal cases, the ZDA offset should be set to 0.

For the PPS input the following can be selected:

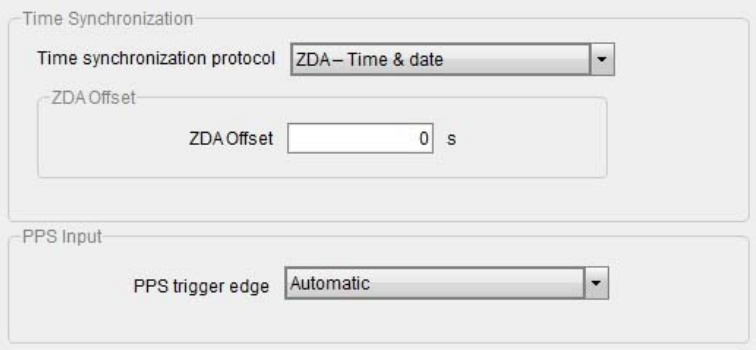
- **PPS source**: The source to be input to XIN.
- **PPS trigger edge**: Falling or rising trigger edge can be selected. The default selection is falling edge.

Note:

For the PPS configuration the selection of trigging on the rising edge will only be available for those units that have a harware upgrade. Hence, this selection will only appear in the MRC+ configuration software for those units that have this upgrade, which only will be new units. The unit's LED will flash white if PPS input is present. If the PPS polarity is wrong, the unit will show this with an additional blue flash.

Note:

If there is a problem with the synchronization with ZDA and PPS, this can be detected by looking at MRU variable numeber 148 ***Position input age****. This requires additional 1Hz GGA/GLL input. This variable will show the age of the position messages relative to the MRU clock. This age should normally be somewhere between 0 and 0.5 seconds if the ZDA time is synchronized correctly relative to the PPS pulse.*



Details

Time synchronization protocol

Here you can select the preferred **Time synchronization protocol**.

ZDA Offset

A floating time offset (positive or negative) to the ZDA time can be input when the ZDA time protocol is selected in order to synchronize the ZDA time to the 1PPS (ZDA comes before or after the 1PPS). For normal cases, the **ZDA Offset** should be set to 0.

PPS trigger edge

Here you can select the preferred **PPS trigger edge**. The values are **Automatic**, **Rising edge** and **Falling edge**.

Procedure

1. Select the **Configuration** tab > **Time Synchronization**.
2. Select the preferred time synchronization method.
3. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Monitoring points configuration

Topics

Setting monitoring points, page 112

Setting monitoring points

You must define the locations on the vessel for which you want the system to calculate the position.

Prerequisites

To get exact coordinates from origin to each monitoring point, each monitoring point has to be measured or calculated based upon drawings or previously measured points.

Context

You must define points (monitoring points) on the vessel where you want the position measurements to be output. The monitoring points are given relative to origin (positive forward, towards starboard and down). The position of a monitoring point relative to the origin is indicated in the vessel illustration when the cursor is over the monitoring point. As soon as a monitoring point has been defined, its location is indicated in the vessel illustration.

If a monitoring point appears incorrect, check the signs and the coordinates input for each monitoring point and the vessel dimensions and the entered location of origin in the **Vessel Geometry** page.

Note:

The system supports two user definable monitoring points.

Deleting a monitoring point

The toolbar at the top contains two icons. One for adding a monitoring point,  , and one for deleting a monitoring point,  .

You can delete a monitoring point by selecting the wanted point in the table and clicking the `Delete` button,  .

Show sensors

		Position [m]		
ID	Name	X	Y	Z
1	MP1	100.000	0.000	-22.000
2	MP1	0.000	0.000	-16.000

Details

Show sensors

These items are displayed in the vessel illustration when you select the boxes.

ID

This is the ID number for the given monitoring point.

Name

This is the name you give the monitoring point.

Position: X, Y, Z

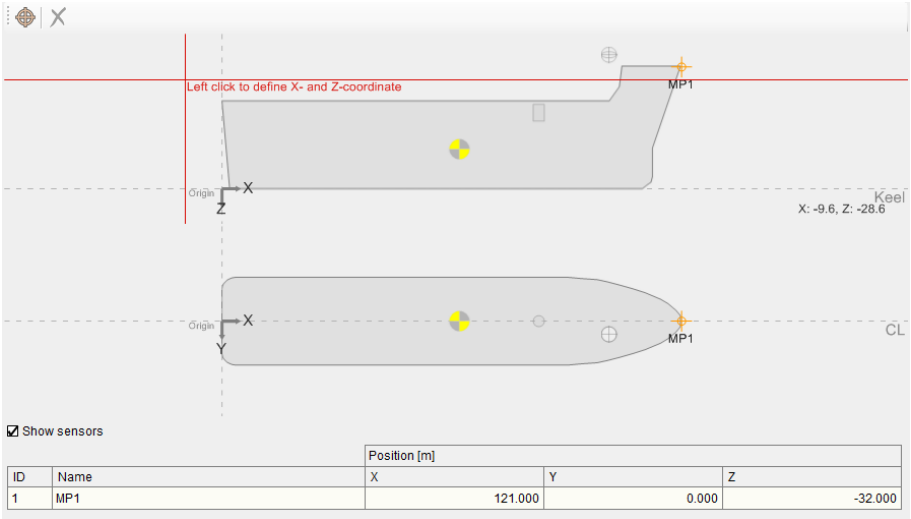
These are the surveyed co-ordinates in metres for the various monitoring points.

Procedure

1. Select the **Configuration** tab > **Monitoring points** > **Geometry**.
2. Select the Add button  at the top of the page to add a monitoring point.

   Observe that the cursor changes to two red lines which will help you to place the new monitoring point in the vessel illustration.

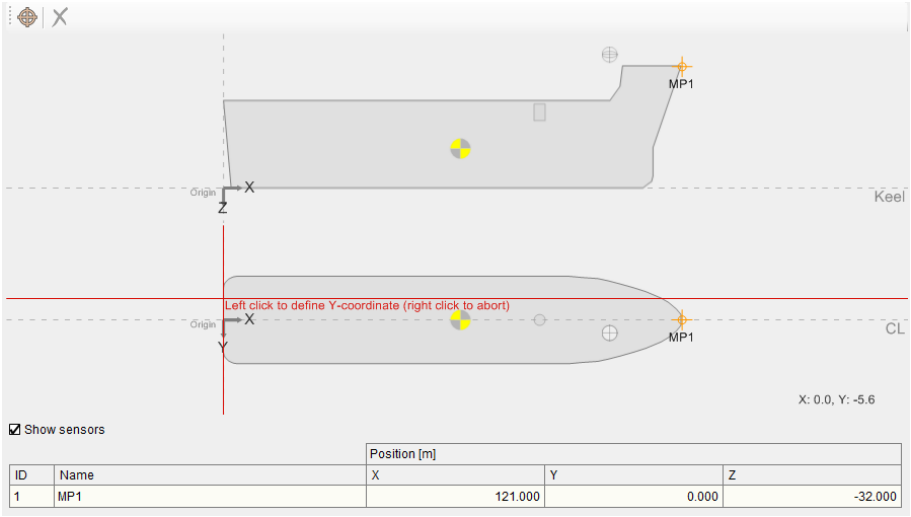
3. Drag the cursor to the location on the upper vessel illustration where you want to add the X and Z coordinates for your monitoring point and left-click the mouse button.



		Position [m]		
ID	Name	X	Y	Z
1	MP1	121.000	0.000	-32.000

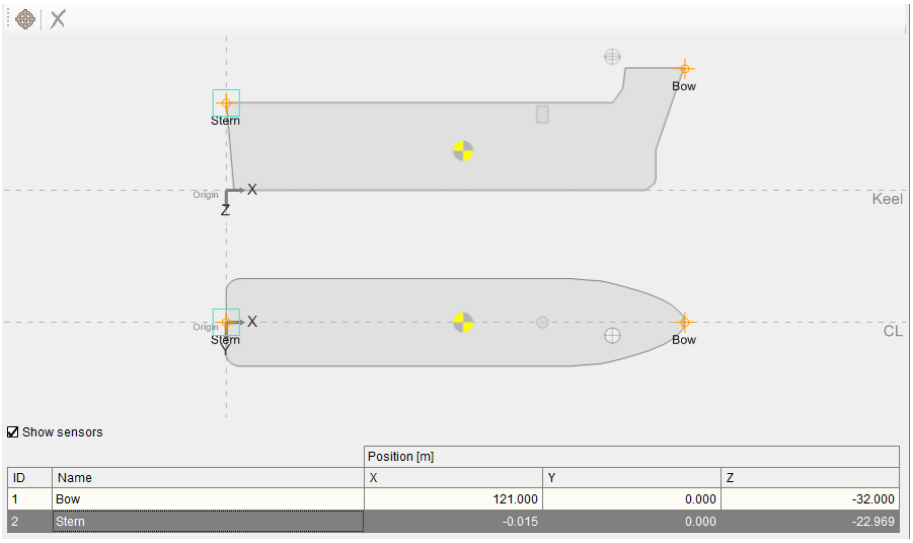
4. Continue and drag the cursor to the location in the lower vessel illustration where you want to add the **Y** coordinate for your monitoring point and left-click the mouse button.

   Observe that the coordinates for the new monitoring point appear in the monitoring points table. The table will also help you to get the wanted location for your monitoring point.



		Position [m]		
ID	Name	X	Y	Z
1	MP1	121.000	0.000	-32.000

5. Select the **Name** column in the table and type an identifying name for your monitoring point. Press `Enter` to confirm.



		Position [m]		
ID	Name	X	Y	Z
1	Bow	121.000	0.000	-32.000
2	Stern	-0.015	0.000	-22.969

6. Select the **X**, **Y** and **Z** columns and adjust the coordinates by typing the exact location of the monitoring point. If necessary. Press `Enter` to confirm.
7. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Communication interface configuration

Topics

Changing the MRU IP address

You must enter the Internet Protocol (IP) address for the MRU so it can communicate on the local area network (LAN).

Context

Under **Communication interface** > **Network** you can modify the IP address of the physical interface selected in the **Input/Output** list.

The MRU communicates with the operator software using UDP.

The default IP address for the MRU is: 192.168.1.20.

The default subnet mask for the MRU is: 255.255.255.0.

The default gateway for the MRU is: 192.168.1.1.

The computer which runs the operating software needs to be on the same subnet. Unless the IP address of the unit is changed, the valid IP address for the computer would be 192.168.1.0-255, excluding the address of the unit itself.

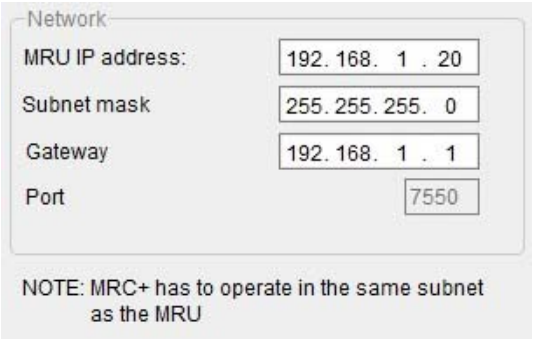
The listening port

The listening port is fixed to 7550. It is not configurable in the MRC+ configuration software. This port is used when talking to the MRU. All messages from the unit are output on the fixed port 7550. The unit will answer on the same IP and port as the message is received from.

Contact the network administrator for advice on IP address and mask assignments.

Note:

*Changes in the **IP Address, Subnet mask** and **Gateway** will only take effect after a restart of the unit.*



MRU IP address

This is the MRU internet protocol (IP) address for the interface. The default value is 192.168.1.20.

Subnet mask

This is the internet protocol (IP) sub-network mask for the interface. The default value is 255.255.255.0.

Gateway

This is the gateway address for the unit. The default value is 192.168.1.1.

Port

This is the listening port. This port is fixed to 7550. All messages from the unit are output on this port. The unit will answer on the same IP and port as the message is received from.

Procedure

1. Select the **Configuration** tab > **Communication interface** > **Network**.
2. Enter the MRU IP address for the interface.
3. Enter the subnet mask address for this interface.
4. Enter the IP address for the default gateway.
5. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.
6. Restart the unit for these changes to take effect and the new settings to be used.

Further requirements

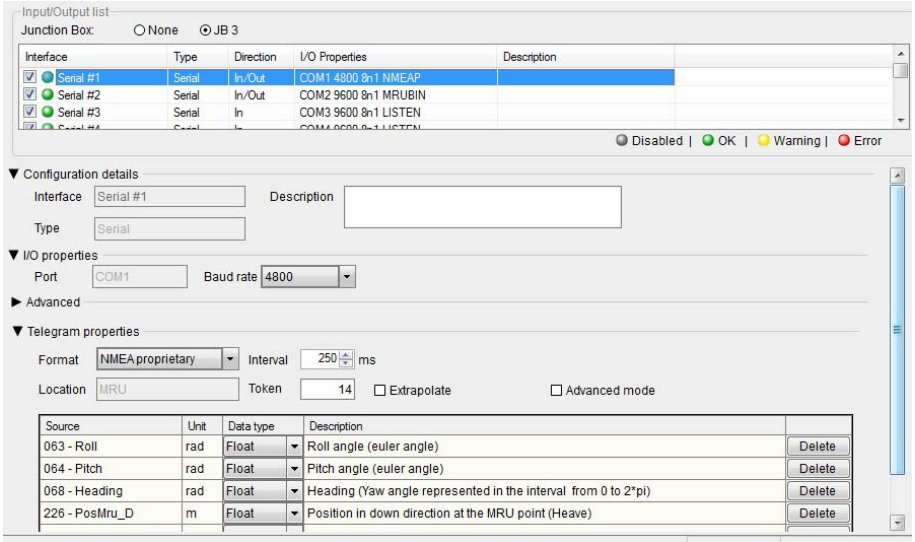
To restart the unit, select **Sensor** > **Restart sensor unit** in the MRC+ configuration software.

Setting up the serial interface

The Serial interface allows you to decide how the MRU shall communicate with and interface to other equipment.

Context

You can select a Serial interface for your communication in the **Input/Output list**. You can select between fixed or configurable telegram formats.



Configuration details

Interface

Interface is the communication interface you have selected from the **Input/Output list**.

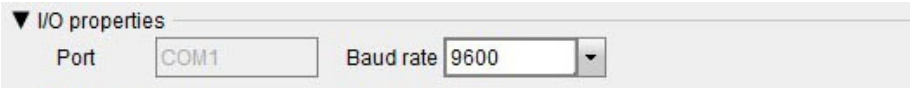
Description

In the **Description** box you can type an informative text about the interface you have selected. For example which equipment this communication line is connected to.

Type

Type shows the serial interface which you selected.

I/O properties



Port

Port is the port you want to use for the serial communication. COM1 to COM4.

Baud rate

Baud rate is the baud rate you want to use for the serial communication. The baud rate can be set from 1200 to 115200.

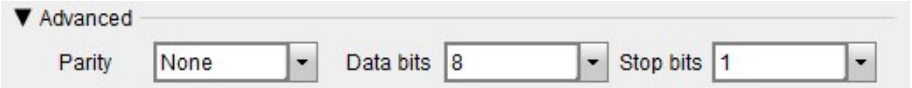
The baud rate required depends on the required number of digital output channels, the sample rate and the format selected. For the MRU Normal format each digital output channel requires approximately 40 bits, including transmission overhead. For a complete message, an overhead of approximately 40 bits is necessary, independent of the message length.

Example: Calculation of minimum baud rate with the MRU Normal format

- 4 channels out at a sample rate of 20 Hz (50 ms): (4ch * 40 + 40) * 20 Hz = 4000 Baud (minimum)

In real time applications, take into account that data are not available before the end of the message. Do not select a higher baud rate than needed. A high baud rate will load down the computer with interrupts, resulting in possible transmission errors if using long lines.

Advanced



Under **Advanced** you are able to modify the parity, stop bits and data bits. Normally, these parameters should be left unchanged. If these parameters are to be modified, they should only be modified by skilled personnel.

Parity

Select **Parity** on the selected serial line. Available values are **None**, **Even** or **Odd**.

Data bits

Select the number of **Data bits** on the selected serial line.

Stop bits

Select the number of **Stop bits** on the selected serial line.

Telegram properties

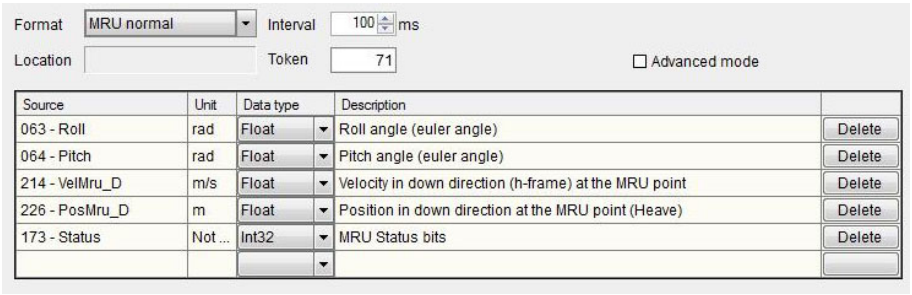
In the **Telegram properties** section you can enable and set up data messages which are transmitted to or received from external equipment.

The options in the **Telegram properties** section depend on the **Format** you have selected. You can select between fixed formats and configurable formats.

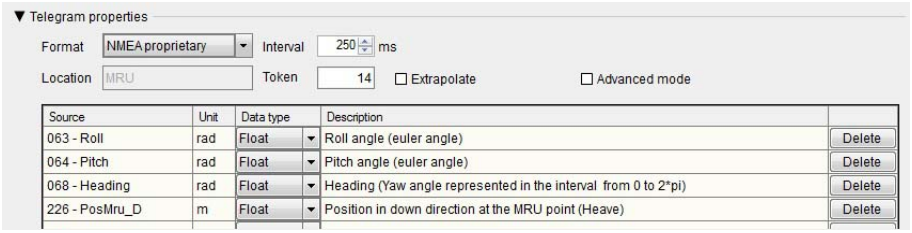
Format

The **Format** parameter selects the data output format. When selecting the **MRU Normal** and **NMEA proprietary** formats, you can select the number of variables, the variable number (**Source**) and the data type (**Float**, **Double**, **Word** and **Int32**) which is to be a part of this format.

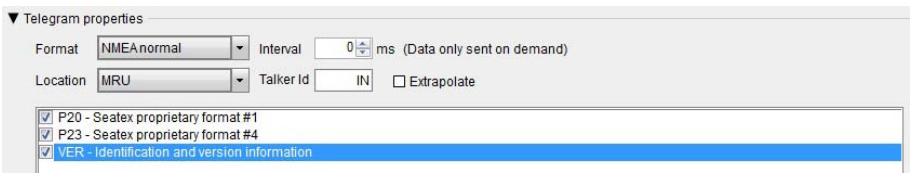
MRU normal format



NMEA proprietary format



NMEA normal format



NMEA selection

The **NMEA selection** option is activated if the **Format** is selected as **NMEA normal** Select between a number of NMEA telegrams.

Interval

The **Interval** is the time interval for cyclic auto transmit of data. The interval must be selected in steps of 5 milliseconds. Be aware of possible data overruns if the interval is too short. 0 ms == Auto Transmit OFF. The interval is set in milliseconds.

Location

This **Location** is the the location for output of the linear measurements (MRU, CG, MP1 or MP2). This selection is only available for other output formats than **MRU normal** and **NMEA proprietary**.

Talker ID

This is the **Talker ID** of NMEA messages sent from this output. The default value is IN.

Token

User selected numbers are associated with the selected format. This is a unique message marking byte with a value in the range 10 to 100.

Extrapolate

By selecting **Extrapolate** the output data will be output in real time. 0 ms internal processing delay.

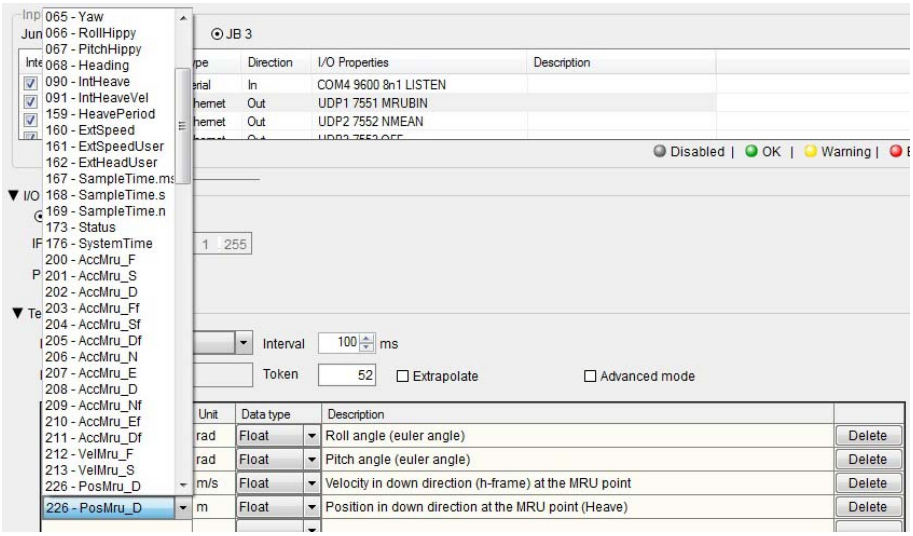
Advanced mode

You can enable or disble **Advanced mode**. If enabled, the more advanced source IDs will be listed.

Source

The **Source** column contains number of output variables. The number of output variables for each communication channel is limited to a maximum of 24. The actual output variables for each communication channel can be selected freely between a number of sources. Formats other than **MRU Normal** may limit the maximum number for output variables and/or the chosen time interval. The number of channels and the variables are defined in the format.

Many output variables are available from the unit. By activating the drop-down menu, a list of the most frequently used output variables is shown. To list the more advanced variables **Advanced mode** has to be selected before the drop-down menu has been activated.



Procedure

1. Select the **Configuration** tab > **Communication interface**.
2. Select the Serial interface, **Serial #x**, you want to set up in the **Input/Output list**.
3. Enter an informative text about the interface in the **Description** box. This is optional.
4. Select which baud rate you want to use from the **Baud rate** list.

   Maximum baud rate is 115200 bits/second.
5. Under **Telegram properties** select the wanted **Format**.
6. If you select **MRU normal** or **NMEA proprietary** format:
   a. Select the **Source** for the output variable and **Data type**.
   b. Select **Extrapolate** if you want data to be output in real time. This is optional.
   c. Select **Advanced** if you want to extend the **Source** list.
7. If you select **NMEA normal** format:
   a. Select **Interval**.
   b. Select **Location**.
   c. Select **Talker ID**.
   d. Select **Extrapolate** if you want data to be output in real time. This is optional.
   e. Select the wanted output format.
8. If you select a fixed format:
   a. Select **Interval**.

b. Select **Location**.

c. For **Token**, select the wanted number associated with the selected format. In the range 10 - 100.

d. Select **Extrapolate** if you want data to be output in real time. This is optional.

9. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

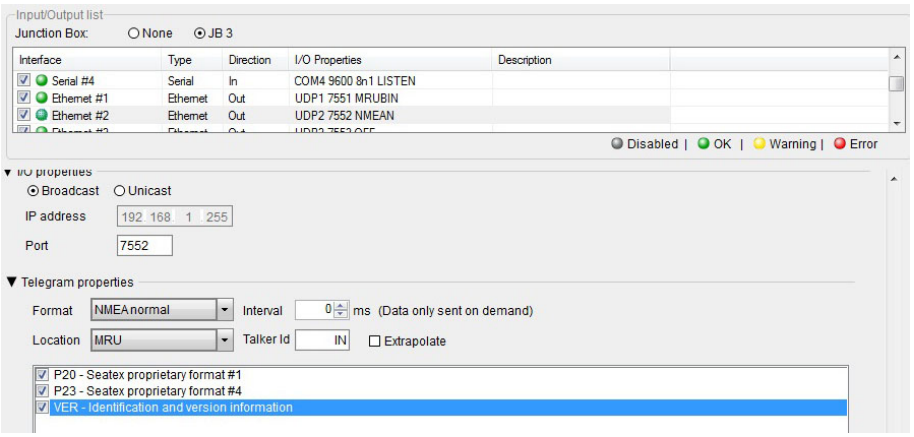
Setting up the Ethernet interface

The Ethernet interface allows you to decide how the MRU shall communicate via the internet protocol (IP) network.

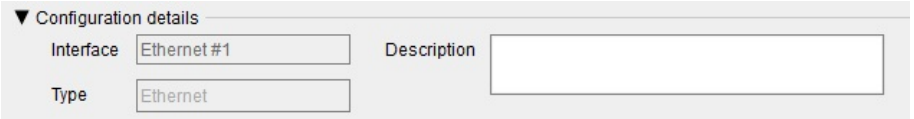
Context

Broadcasting is a method of transferring a message to all recipients simultaneously. Unicast transmission is the sending of messages to a single network destination identified by a unique address.

You can select an Ethernet interface for your communication in the **Input/Output list**.



Configuration details



Interface

Interface is the communication interface you have selected from the **Input/Output list**.

Description

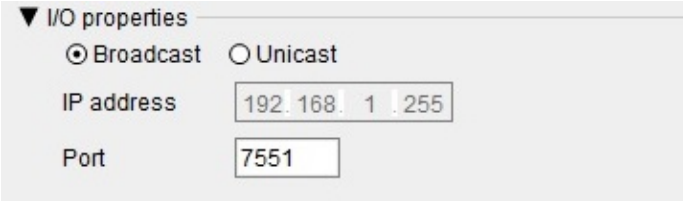
In the **Description** box you can type an informative text about the interface you have selected. For example which equipment this communication line is connected to.

Type

Type shows the Ethernet interface which you selected.

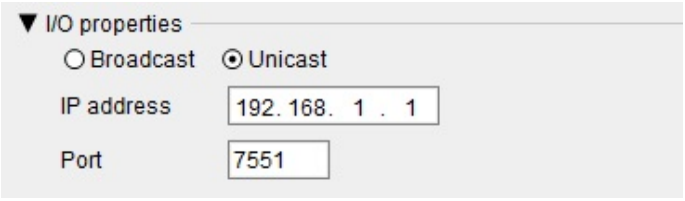
I/O properties - Broadcast

Broadcasting is a method of transferring a message to all recipients simultaneously.



I/O properties - Unicast

Unicast transmission is the sending of messages to a single network destination identified by a unique address.



IP address

This **IP addrress** is the target IP address, to which the unit is sending.

Port

Port is the number of the port to which the client listens.

Telegram properties

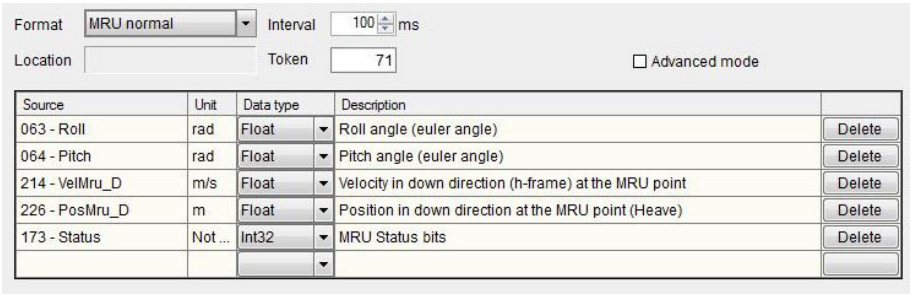
In the **Telegram properties** section you can enable and set up data messages which are transmitted to or received from external equipment.

The options in the **Telegram properties** section depend on the **Format** you have selected. You can select between fixed formats and configurable formats.

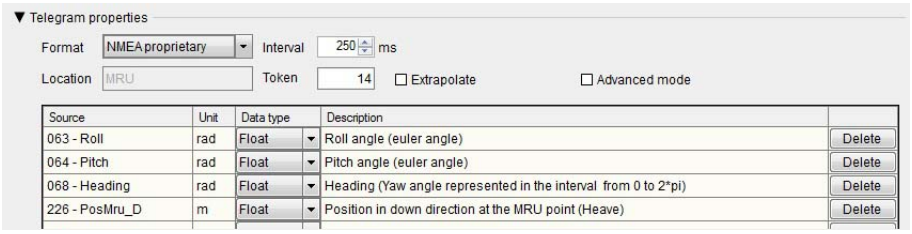
Format

The **Format** parameter selects the data output format. When selecting the **MRU Normal** and **NMEA proprietary** formats, you can select the number of variables, the variable number (**Source**) and the data type (**Float**, **Double**, **Word** and **Int32**) which is to be a part of this format.

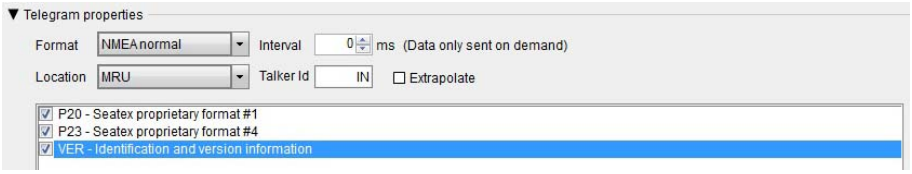
MRU normal format



NMEA proprietary format



NMEA normal format



NMEA selection

The **NMEA selection** option is activated if the **Format** is selected as **NMEA normal** Select between a number of NMEA telegrams.

Interval

The **Interval** is the time interval for cyclic auto transmit of data. The interval must be selected in steps of 5 milliseconds. Be aware of possible data overruns if the interval is too short. 0 ms == Auto Transmit OFF. The interval is set in milliseconds.

Location

This **Location** is the the location for output of the linear measurements (MRU, CG, MP1 or MP2). This selection is only available for other output formats than **MRU normal** and **NMEA proprietary**.

Talker ID

This is the **Talker ID** of NMEA messages sent from this output. The default value is IN.

Token

User selected numbers are associated with the selected format. This is a unique message marking byte with a value in the range 10 to 100.

Extrapolate

By selecting **Extrapolate** the output data will be output in real time. 0 ms internal processing delay.

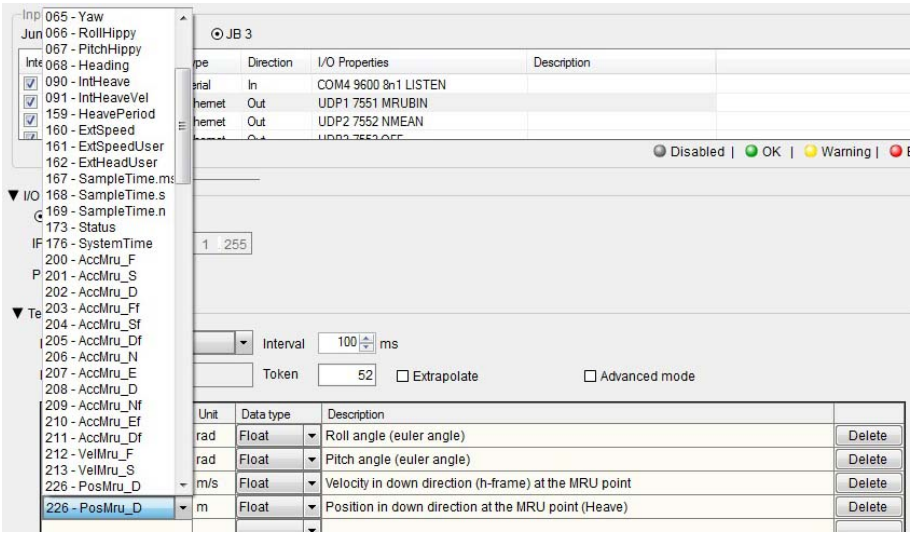
Advanced mode

You can enable or disble **Advanced mode**. If enabled, the more advanced source IDs will be listed.

Source

The **Source** column contains number of output variables. The number of output variables for each communication channel is limited to a maximum of 24. The actual output variables for each communication channel can be selected freely between a number of sources. Formats other than **MRU Normal** may limit the maximum number for output variables and/or the chosen time interval. The number of channels and the variables are defined in the format.

Many output variables are available from the unit. By activating the drop-down menu, a list of the most frequently used output variables is shown. To list the more advanced variables **Advanced mode** has to be selected before the drop-down menu has been activated.



Procedure

1. Select the **Configuration** tab > **Communication interface**.
2. Select the Ethernet interface, **Ethernet #x**, you want to set up in the **Input/Output list**.
3. Select the **Broadcast** or **Unicast** communication.
4. If you select **Broadcast**:
   a. Select the wanted **Port** number.
5. If you select **Unicast**:

a. Select the wanted **IP address** for the host computer.

b. Select the wanted **Port** number.

6. Under **Telegram properties** select the wanted **Format**.
7. If you select **MRU normal** or **NMEA proprietary** format:

   a. Select **Interval**.

   b. Select **Token**.

   c. Select the **Source** for the output variable and **Data type**.

   d. Select **Extrapolate** if you want data to be output in real time. This is optional.

   e. Select **Advanced** if you want to extend the **Source** list.

8. If you select **NMEA normal** format:

   a. Select **Interval**.

   b. Select **Location**.

   c. Select **Talker ID**.

   d. Select **Extrapolate** if you want data to be output in real time. This is optional.

   e. Select the wanted output format.

9. If you select a fixed format:

   a. Select **Interval**.

   b. For **Token**, select the wanted number associated with the selected format. In the range 10 - 100.

   c. Select **Location**.

   d. Select **Extrapolate** if you want data to be output in real time. This is optional.

10. Select the **Configuration** menu > **Send to <sensor unit>** to download the changes to the unit.

Setting up analog channels

You can set up analog channels if the MRU is connected to the JB3 junction box.

Context

The same output variable list is valid for the analog channels as for the digital communication. For each of the analog channels, you must specify the gain and offset. The limit on the output signal is fixed to ±10 Volt.

Gain is set according to the formula:

- [Voltage out in Volts] = Gain * [Selected Variable] + Offset

The gain therefore has scaling volts per physical unit. For example volts/metre.

Note:

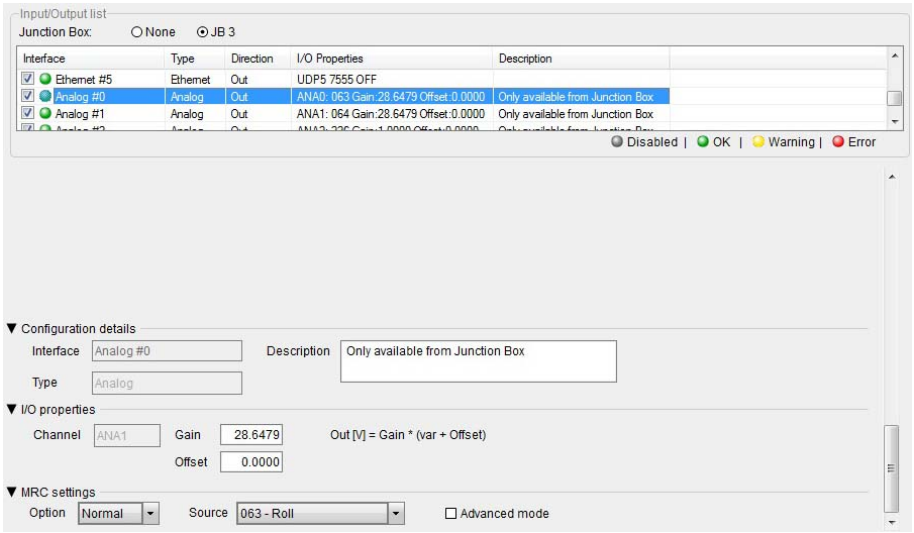
The variables in the MRU are given in standard SI units.

Example: Gain calculation

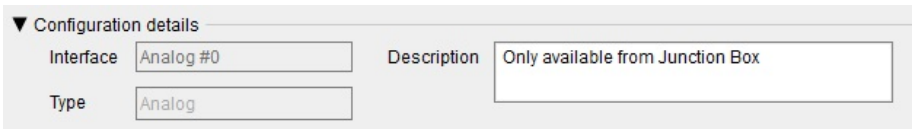
Requirement: ±10 V shall give ±0.5236 radians (±30 degrees). The gain factor must then be; Gain = volts/radians = 10/0.5236 = 19.0986 v/rad.

The available selection for **Option** in **MRC settings** are:

- **Off**: No analog signal is sent.
- **Fade-in**: It takes up to five minutes before the analog signal reaches full voltage value.
- **Normal**: The analog signal is sent with full voltage value from start-up.



Configuration details



Interface

Interface is the communication interface you have selected from the **Input/Output list**.

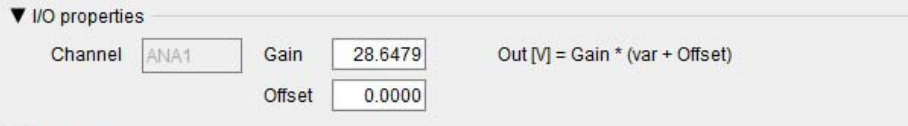
Description

In the **Description** box you can type an informative text about the interface you have selected. For example which equipment this communication line is connected to.

Type

Type shows the Analog interface which you selected. Analog output channels are available if the junction box is conneted.

I/O properties



Channel

Channel is the analog channel which you have selected.

Gain

Gain is the calculated gain value.

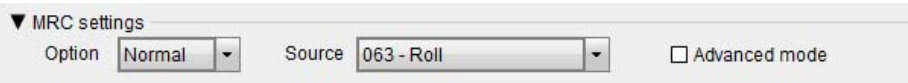
Offset

The output **Offset** is given in units of the physical variable.

Note:

This variable should not be used to offset the physical variable, but to adjust for fixed offsets in the operator's analog data acquisition system.

MRC settings



Option

The **Option** parameter holds options for the analog output.

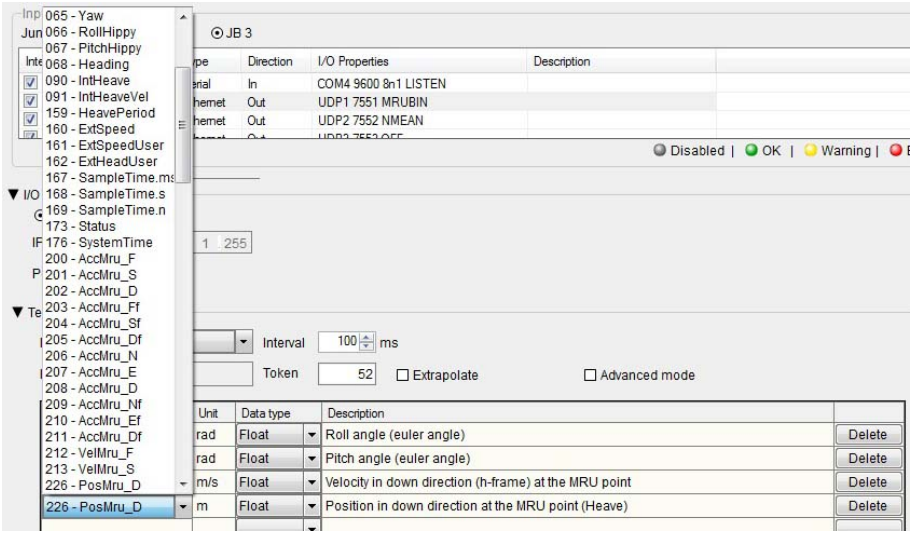
- **Off**: No analog output.
- **Normal**: Analog output. Signals with full value immediately.
- **Fade-in**: Analog output with a 5-minute fade-in. Signals with full value after 5 minutes.

Source

The **Source** column contains number of output variables.

Many output variables are available from the unit. By activating the drop-down menu, a list of the most frequently used output variables is shown. To list

the more advanced variables **Advanced mode** has to be selected before the drop-down menu has been activated.



Advanced mode

You can enable or disble **Advanced mode**. If enabled, the more advanced source IDs will be listed.

Procedure

1. Select the **Configuration** tab > **Communication interface**.
2. Select the Junction box **JB3** option in the **Input/Output list**.
3. Select the Analog interface, **Analog #x**, you want to set up in the **Input/Output list**.
4. Enter an informative text about the interface in the **Description** box. This is optional.
5. Enter **Gain** and **Offset** values.
6. Select wanted **Option**. Values are **Off**, **Fade-in** and **Normal**.
7. Select wanted data output **Source**.
8. Select **Advanced mode** if you want to extend the **Source** list.
9. Select the **Configuration** menu > **Send to sensor unit**.

Selecting graphical presentation of output variables

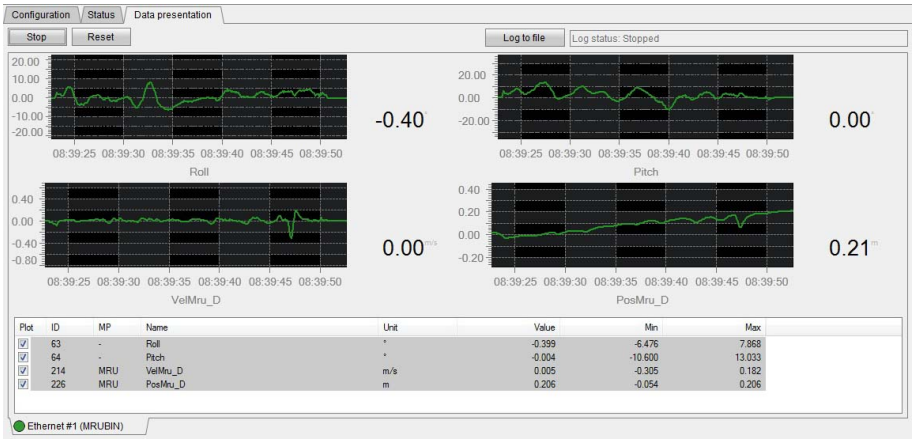
In the **Data presentation** tab you can make a graphical presentation of selected output variables.

Prerequisites

You must set up outputs on the Ethernet ports and send the configuration to the MRU before you enter the **Data presentation** tab.

Context

A maximum of six variables can be plotted simultaneously. The other output variables are presented numerically.



Procedure

1. Select the **Data presentation** tab.
2. Select the **Ethernet** tab for the wanted output port.
3. Select the **Plot** column for the wanted variables.
4. Select **Start**.

Related topics

Data presentation tab, page 90

Logging data to file

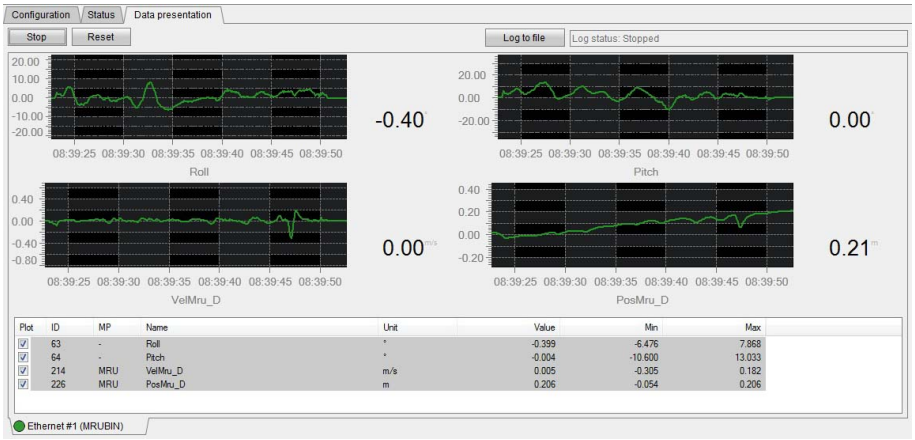
The **Data presentation** tab allows you to log system data to file.

Prerequisites

You must set up outputs on the Ethernet ports and send the configuration to the MRU before you enter the **Data presentation** tab.

Context

The log data are saved in an ASCII file with the output variables stored as floats in columns. The file contains a header with the name of the variables, the number of samples and the sample time. You can easily modify the file in a text editor to adjust to other, similar formats. The default file name is `*.tsa`.



Procedure

1. Select the **Data presentation** tab.
2. Select the **Ethernet** tab for the wanted output port to log data from.
3. Select the wanted variables in the **Plot** column.
4. Select **Start**.
5. Select **Log to file**.

   The data are saved in an ASCII file.
6. Select **Stop log to file** to end logging to file.

   The file can then be analyzed in a preferred tool.

Related topics

Data presentation tab, page 90

Changing the firewall settings

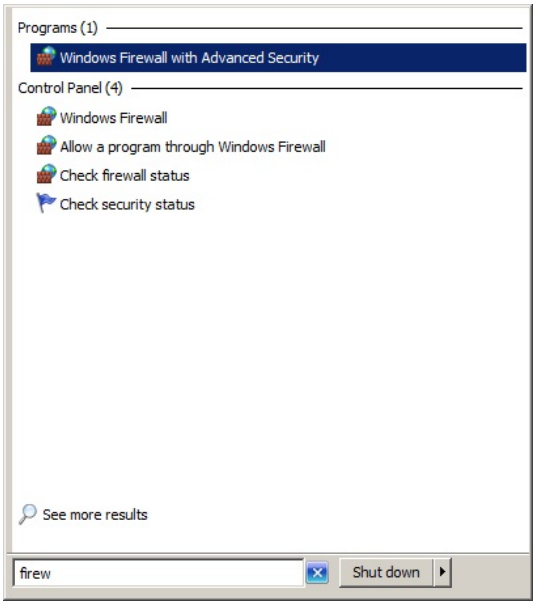
If you experience problems with the Ethernet connection, your firewall settings may be incorrect.

Context

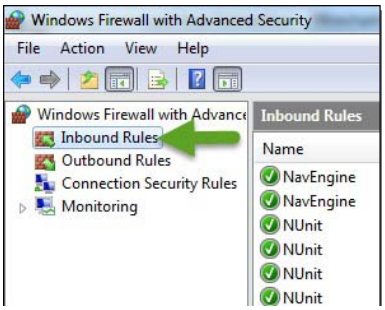
If the circle in front of the Ethernet port at the bottom of the **Data presentation** tab is red, you may have problems with the MRC+ installed outside the firewall. Then you must correct the firewall settings.

Procedure

1. Select the Windows Start button.
2. Enter **firewall** in the search box.
3. Select **Windows Firewall and Advanced Security**.

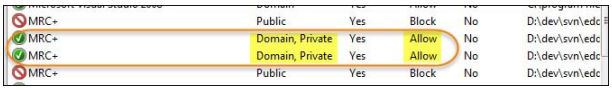


4. Select **Inbound Rules**.

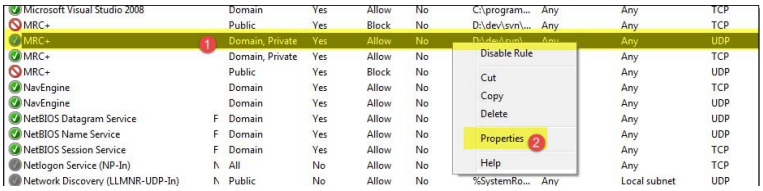


5. Scroll down the list tor MRC+ and see what is selected.

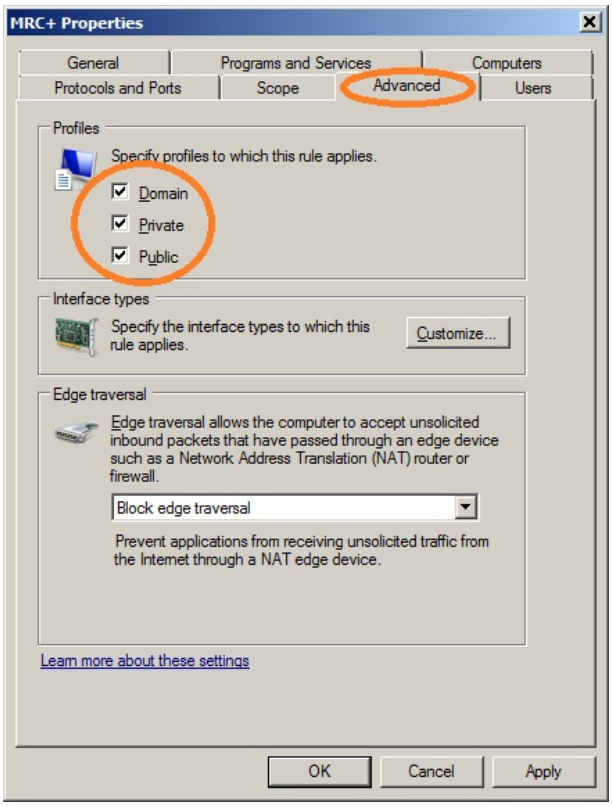
   If the MRC+ is in **Domain**, **Private**, this has to be corrected.



6. Select the line with UDP. Right-click and select **Properties**.



7. Under **Avanced**, select the profiles for **Domain**, **Private** and **Public**.



8. Select **Apply** and **OK**.

Related topics

Data presentation tab, page 90

Maintenance

Topics

About maintenance

Maintenance

The MRU system consists of both software and hardware. The software part can be updated to the latest version in the field by loading a software package into the MRU.

Service of the MRU hardware in the field can consist of:

- Replacing damaged cables and/or connectors
- Replacing the MRU
- Replacing the junction box
- Replacing other MRU additional equipment
- Checking the fuse:
  - In the junction box (if installed)

The MRU is not designed for service in the field. Opening the unit housing will result in damage or degradation of the unit and void the warranty. Damaged units have to be shipped back to Kongsberg Discovery AS for repair.

Note:

Original shipping boxes must be used for all transport.

When returning the MRU for service, only the MRU itself has to be returned. The mounting bracket shall not be returned but stay onboard.

During the time a damaged unit is in for repair, you can rent a spare unit from Kongsberg Discovery AS if needed.

Troubleshooting

The best tool for troubleshooting the MRU is the MRC+ configuration software. If trouble occurs, always connect an external comptuer to the unit or junction box by the test cable and power up the unit.

Returning equipment to manufacturer

Malfunctioning equipment should be returned to the manufacturer for repair.

Context

When you contact the customer support department, you will receive an RMA number (Return Material Authorisation) which will identify your service request. Use this number for all correspondence regarding your service request.

Procedure

1. Contact the manufacturer's customer support department
   - by phone: +47–33032407
   - by e-mail: support.seatex@kd.kongsberg.com
2. Provide information about the equipment to the customer support department
   - what type of equipment you want to return
   - the serial number for this equipment
   - why you want to return the equipment
   - your company name and address
3. In return you will receive an RMA number (Return Material Authorization) for reference purposes.
4. Include this RMA number as a reference with the equipment when you send it back to the manufacturer.

Troubleshooting

Topics

Examining Abnormal MRU status during startup

If the MRC+ configuration software responds with the MRU status **Abnormal** in red characters in the MRC+ top bar, no data will be transmitted from the unit.

Context

When this status appears on the screen, this is most like due to a hardware problem during startup.

Procedure

1. If **Abnormal** appears in the MRC+ software after startup, try to restart the unit.

   Unless there are some serious problems with the unit, it will now enter **Normal** mode after the restart.

2. If the unit still does not function properly, please contact your nearest KONGSBERG office.

Examining reduced roll and pitch performance

During operation situations may occur when the system to which the MRU is connected experiences reduced performance in roll and pitch.

Prerequisites

You need an external computer with the MRC+ configuration software and an Ethernet cable to connect the external computer with the MRU JB3 Ethernet plug. Alternatively, use the MRU Ethernet configuration cable (MRU-T-015) to connect the MRU to the external computer.

Context

This situation may occur if the unit's x-arrow is not properly aligned with the vessel's longitudinal axis. A misalignment of only one degree will reduce the performance when exposed to heavy motions due to cross-coupled roll and pitch measurements.

Procedure

1. Make sure that the unit's yaw offset according to the vessel's longitudinal axis is accurately measured and entered into the configuration software.

   In the MRC+ configuration software select the **Configuration** tab > **Sensors** > **MRU** > **Geometry**.

2. Make sure that the unit is correctly calibrated.

   Find out when the unit was last calibrated. If it has been several years since the last calibration, contact Kongsberg Discovery AS customer support to check whether the unit needs recalibration.

Related topics

Setting MRU location and mounting angles, page 98

Examining reduced heave performance or depth error in echo sounder

Sometimes the system to which the MRU is connected may experience reduced performance in heave or depth errors in the centre beam of an echo sounder.

Context

Procedure

1. There are oscillations in heave or in the depth of the centre beams.

   In the MRC+ configuration software, select the **Configuration** tab **Sensors** > **MRU/MGC** > **Heave config**.

   Make sure that the correct **Heave filter** mode and **Period** are selected.

2. Make sure that the unit is in the expected location according to the entered monitoring point (MP).

   The vertical vector component from the unit to the monitoring point is defined positive down. If the location of the transducer head is below the location of the unit, the vertical component will be positive and vice versa.

   In the MRC+ configuration software, select the **Configuration** tab > **Vessel**> **Geometry**. Use the 2D "vessel window" to see the location of the unit.

Related topics

Selecting heave filter options, page 104

Examining echo sounder depth error

Sometimes the system may experience depth errors in the outer beams on a multi-beam echo sounder.

Procedure

1. Make sure that the mounting angle around the z-axis (yaw) is correct.

   The oscillations in the depth of the outer beams are correlated with the pitch angle of the vessel. The unit's x-axis has to be parallel with the vessel's longitudinal axis as long as the echo sounder transducer head is aligned with the vessel axes.

2. Make sure that the distance vector from the unit to the vessels's centre of gravity (CG) is correct.

   The distance vector is the components along the x, y and z axis. Espcially make sure that the vertical component, z, is correct.

   The oscillations in the depth of the outer beams are correlated with the roll angle of the vessel. Please note that it is the co-ordinates from the unit to the CG which should be entered and that positive vertical direction is downwards. If the location of the CG is below the location of the unit, the vertical component (z) must be positive. Use the 2D "vessel window" to check that the unit is on the expected location according to the vessel's centre of gravity.

3. Make sure that the measurements from the two data sources are handled correctly and that a timing error has not occurred.

   There is incorrect synchronisation of the unit and the multi-beam data (timing error). A 1PPS input to the unit should be considered used. Post-processing of the unit and the multi-beam data can be used to analyse whether incorrect synchronisation is the reason for the depth errors.

Examining why MRU LEDs are not lit

The MRU can be connected to external equipment via the junction box.

Context

The MRU junction box is an interface from the MRU cable to the screw terminals inside the box for termination of communication cables and power.

Procedure

1. Make sure that the fuse in the junction box is not blown. Replace it if it is.

   The fuse is of type T2A 240 V with size 5 x 20 mm.

2. Make sure that the cable wires are properly connected to the terminals in the box.

3. Make sure that the cable wires are correctly terminated.
4. Make sure that the MRU receives power.

   The MRU PWR light diode should shine green when the unit receives power.
5. If the LED diodes indicate that the junction box is still not working, contact your nearest KONGSBERG office.

Related topics

Cabling for the MRU system, page 58

Periodic maintenance

Topics

Updating the MRU software

We recommend that you keep your product updated with the latest software version.

Kongsberg Discovery AS will offer regular software updates for the MRU with improvements and new functionalities. It is up to you to decide whether you will update your unit with the new software.

The new software is installed on the unit by following the setup procedure described in the Release Note for the actual software. These updates can be done without opening the MRU housing by connecting an external computer to the unit or junction box and installing the new software by use of the MRC+ configuration software.

Recalibrating the MRU

A recalibration of the MRU is required in order to achieve the specified performance of the unit.

Prerequisites

You must obtain the serial number of MRU.

Context

After years in operation a recalibration of the MRU is recommended for applications that depend on high static accuracy in roll and pitch.

The need for recalibration depends on the MRU model an the application in which the MRU is used.

The table can be used to evaluate when a recalibration is necessary due to the static roll and pitch accuracy required for your application.

	2 years	3 years	4 years	6 years
MRU 5+	0.008°	0.016°	0.022°	0.034°
MRU 5	0.02°	0.04°	0.055°	0.085°
MRU E	0.03°	0.05°	0.065°	0.095°
MRU H	0.03°	0.05°	0.065°	0.095°
MRU 3	0.08°	0.16°	0.24°	0.40°
MRU S	0.2°	0.28°	0.34°	0.46°
MRU 2	0.03°	0.05°	0.065°	0.095°
MRU D	0.2°	0.28°	0.34°	0.46°

The dynamic roll, pitch and heave accuracy is not significantly changed over the years. For applications that only require dynamic accuracy, no recalibration is needed.

Thes are applications such as:

- Fishery sonars.
- Heave compensation of offshore cranes.
- GNSS antenna motion compensation in Dynamic Positioning systems.
- Seabed mapping with multi-beam echosounder where patch tests are carried out regularly.
- MRU units part of Seapath with Automatic Online Calibration.

Procedure

1. Contact KONGSBERG customer support and ask for an RMA (Return Material Authorization).
2. Fill out the RMA with the MRU serial number (s/n) and return the RMA for customer support.
3. You will receive an RMA number. Attach this number to the shipment.
4. Remove the MRU from its location.

   Note:

   You only need to remove the MRU itself and not the mounting bracket.

5. Return the MRU in its specially designed transportation box.

Repairs and parts replacement

Topics

Replacing the MRU

If the unit fails, it can be replaced by a spare unit. Local repair is not possible.

Context

The replacement unit is delivered with the latest version of the software unless anything else is communicated.

Procedure

1. Disconnect the MRU cable from the power source.
2. Unscrew the screws which hold the unit to the mounting bracket.
3. Remove the unit from the mounting bracket.
4. Place the spare unit in the mounting bracket.
5. Refasten the screws which hold the unit to the mounting bracket.
6. Reconnect the MRU cable.

Related topics

Saving the MRU configuration, page 141
Transferring MRU configuration file to spare unit, page 142

Saving the MRU configuration

If you rent a spare unit, you must save the configuration on the original unit so you can transfer it to the spare unit.

Prerequisites

An external computer with the MRC+ configuration software and Ethernet cable for connection to the MRU JB3 junction box

Context

It is good practice to always make a copy of the configuration each time a change has been made. Then you have a copy should the unit malfunction.

If it is not possible to establish contact with the MRU or a backup copy of the used MRU configuration is not available, the spare unit has to be configured from start according to the configuration instructions in this publication.

When you have a valid copy of the configuration, you can transfer it to the spare unit.

Procedure

1. Connect an external computer to the unit which is to be repaired.
2. Start the MRC+ configuration software. Select the **Connect** button on the **Sensor** menu.
3. When contact is established, select the **Configuration** menu > **Save** to save the configuration to file.

   The configuration in the unit will then be saved on a file on the external computer.
4. Exit the MRC+ configuration software.

Related topics

Replacing the MRU, page 141
Transferring MRU configuration file to spare unit, page 142
Configuration tab, page 87

Transferring MRU configuration file to spare unit

When you have saved a copy of the MRU configuration file you must transfer the copy to the spare unit.

Prerequisites

An external computer with the MRC+ configuration software with the copied MRU configuration file.

Context

Note:

The MRU mounting bracket allows easy exchange with another MRU without affecting the orientation calibration. This is due to the precision of the dowel pins within the bracket. Therefore, when an MRU is replaced in a system with another unit it is no need for recalibration or offsets being measured again if the mounting bracket is in the same location.

Procedure

1. Connect an external computer to the unit.

2. Start the MRC+ configuration software. Select the **Connect** button on the **Sensor** menu.
3. When contact is established, select the **Configuration** menu > **Open** to read the saved configuration from a file on the computer.
4. Select the **Configuration** menu > **Send to sensor unit** to send the copied configuration file to the spare unit.
5. Exit the MRC+ configuration software.
6. Disconnect the spare unit from the configuration cable.
7. Place the spare unit into the mounting bracket.

Note:

Make sure that the unit is placed in the correct orientation.

Related topics

Connecting and starting the MRC+ configuration software, page 42
Replacing the MRU, page 141
Saving the MRU configuration, page 141

Replacing the MRU junction box

If an unexpected failure should occur with the junction box, you can replace the box.

Procedure

1. Remove the lid and disconnect the cables and wires.
2. Unscrew the mounting screws and remove the box.
3. Replace the old box with a new one.
4. Fasten the box with washers and self-locking nuts.
5. Reconnect the cables and wires as they were on the old box.
6. Replace the lid and tighten the screws.

Related topics

Installing the MRU junction box, page 37
Cabling for the MRU system, page 58

Technical specifications

Topics

Performance specifications

Orientation output

This is the orientation output for the various MRU models.

	5+	5	E	H	3	S	2	D
Angular orientation range	±180°, un-limited	±180°, un-limited	±180°, un-limited	±180°, un-limited	±45°	±45°	±25°	±25°
Resolution in all axes	0.0001°	0.0001°	0.0001°	0.0001°	0.0001°	0.0001°	0.0001°	0.0001°
Static accuracy roll, pitch (RMS)[2)]	0.008°	0.02°	0.03°	0.03°	0.08°	0.2°	0.03°	0.2°
Dynamic accuracy roll pitch (for ±5° amplitude) [1)]	0.002° 1-sigma	0.005° 1-sigma	0.010° 1-sigma	0.010° 1-sigma	0.010° 1-sigma	0.10° 1-sigma	0.015° 1-sigma	0.15° 1-sigma

Angular rate sensors

These are the angular rate sensor specifications for the various MRU models.

	5+	5	E	H	3	S	2	D
Number of sensors	3	3	3	3	3	3	2	2
Angular rate range	±75 °/s	±75 °/s	±150 °/s	±150 °/s	±150 °/s	±75 °/s	±150 °/s	±75 °/s
Angular rate noise roll, pitch, yaw (RMS) (bandwidth 0 - 10 Hz)	0.010°/s	0.010°/s	0.015°/s	0.015°/s	0.015°/s	0.03°/s	0.015°/s	0.03°/s
Scale factor error (RMS)	0.02 %	0.02 %	0.08 %	0.08 %	0.08 %	0.3 %	0.08 %	0.3 %

Acceleration sensors

These are the acceleration sensor specifications for the various MRU models.

	5+	5	E	H	3	S	2	D
Number of sensors	3	3	3	3	3	3	2	2
Acceleration range all axes	±45 m/s^2	±45 m/s^2	±45 m/s^2	±45 m/s^2	±40 m/s^2	±160 m/s^2	±45 m/s^2	±160 m/s^2
Acceleration noise (RMS)[1)]	0.0003 m/s^2	0.002 m/s^2	0.002 m/s^2	0.002 m/s^2	0.005 m/s^2	0.01 m/s^2	0.002 m/s^2	0.01 m/s^2
Scale factor error (RMS)	0.008 %	0.02 %	0.02 %	0.02 %	0.05 %	0.05 %	0.02 %	0.05 %

1) When the MRU is stationary over a 30-minute period.

Internal processing

These are the internal processing specifications for the various MRU models.

	5+	5	E	H	3	S	2	D
Main processing cycle frequency	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz
Orientation erection time (from power on)	Max 5 minutes	Max 5 minutes	Max 5 minutes	Max 5 minutes	Max 5 minutes	Max 5 minutes	Max 5 minutes	Max 5 minutes
Settling time in heave (from power on)	Max 15 minutes	Max 15 minutes	Max 15 minutes	Max 15 minutes	Max 15 minutes	Max 15 minutes		

Heave motion output

This is the heave motion output for the various MRU models.

	5+	5	E	H	3	S
Output range	±50 m	±50 m	±50 m	±50 m	±50 m	±50 m
Heave accuracy for 0 - 25 s motion periods (real-time) (RMS)	5 cm or 5 % whichever is highest	5 cm or 5 % whichever is highest	5 cm or 5 % whichever is highest	5 cm or 5 % whichever is highest		
Heave accuracy for 0 - 18 s motion periods (real-time) (RMS)					5 cm or 5 % whichever is highest	15 cm or 15 % whichever is highest
Heave accuracy for 10 s motion period (real-time) (RMS)	1 cm or 3 % whichever is highest	1 cm or 3 % whichever is highest	1 cm or 3 % whichever is highest	1 cm or 3 % whichever is highest	3 cm or 5 % whichever is highest	10 cm or 10 % whichever is highest
Heave accuracy for 0 - 50 s motion periods (delayed) (RMS)	1 cm or 1 % whichever is highest	1 cm or 1 % whichever is highest	1 cm or 1 % whichever is highest	1 cm or 1 % whichever is highest	2 cm or 2 % whichever is highest	N/A
Heave velocity accuracy (real-time) (RMS)	0.01 m/s	0.01 m/s	0.01 m/s	0.01 m/s	0.01 m/s	0.02 m/s

Surge and sway output

This is the surge and sway motion output for the various MRU models.

	5+	5	E	H	3
Output range	±50 m	±50 m	±50 m	±50 m	±50 m
Periods (delayed)	0 - 15 s	0 - 15 s	0 - 15 s	0 - 15 s	0 - 15 s
Accuracy surge, sway (delayed)	2 cm or 5 % whichever is highest	2 cm or 5 % whichever is highest	2 cm or 5 % whichever is highest	2 cm or 5 % whichever is highest	4 cm or 10 % whichever is highest

Weights and outline dimensions

MRU sensor

- **Type**: MRU 5th generation
- **Outline dimensions**:
  - **Height**: 140 mm
  - **Diameter**: 105 mm
- **Weight**:
  - **MRU 5+, 5, E, H**: 2.2 kg
  - **MRU 3, S, 2**: 2.0 kg
  - **MRU D**: 1.9 kg
- **Connector type**: Souriau 851–36RG 16–26S50 (MIL spec.)

MRU floor mounting bracket

- **Type**: MRU-M-MB5
- **Outline dimensions**:
  - **Length**: 160 mm
  - **Width**: 140mm
  - **Height**: 26.7 mm
- **Weight**: 0.8 kg

MRU wall mounting bracket

- **Type**: MRU-M-MB4
- **Outline dimensions**:
  - **Length**: 123.5 mm
  - **Width**: 110 mm
  - **Height**: 140 mm
- **Weight**: 0.8 kg

MRU protected mounting bracket

- **Type**: MRU-M-MB6
- **Outline dimensions**:
  - **Length**: 134.5 mm

- **Width**: 130 mm
- **Height**: 300 mm

- **Weight**: 2.4 kg

MRU junction box

- **Type**: MRU-E-JB3
- **Outline dimensions**:
  - **Length**: 226 mm
  - **Width**: 126 mm
  - **Height**: 90 mm
- **Weight**: 2 kg
- **Cable glands - clamping range**: 9 - 21 mm

Subsea bottle API 16D certified

- **Type**: MRU-M-SB14
- **Outline dimensions**:
  - **Height**:
    - **Incl. protection cap**: 305 mm
    - **Incl. connectors**: 368.5 mm
  - **Diameter**:
    - 129 mm
    - **Incl. protection cap**: 139.2 mm
- **Weight**:
  - **Dry weight**: 11.3 kg, incl. MRU
  - **Weight in water**: 7.5 kg, incl. MRU
- **Depth**: 4000 m
- **Connector type**: 1.6-pin Seacon MSSK/MINK (SP)-6#16AWG FCR

Subsea bottle 4000-metre

- **Type**: MRU-M-SB9
- **Outline dimensions**:
  - **Height**:
    - **Incl. protection cap**: 275 mm

    - **Incl. connectors**: 297.5 mm
  - **Diameter**:
    - 129 mm
    - **Incl. protection cap**: 139.2 mm
- **Weight**:
  - **Dry weight**: 10.3 kg, incl. MRU
  - **Weight in water**: 6.9 kg, incl. MRU
- **Depth**: 4000 m
- **Connector type**: 2, 8-pin Seacon

Subsea bottle 1000-metre

- **Type**: MRU-M-SB10
- **Outline dimensions**:
  - **Height**:
    - **Incl. protection cap**: 275 mm
    - **Incl. connectors**: 297.5 mm
  - **Diameter**:
    - 129 mm
    - **Incl. protection cap**: 139.2 mm
- **Weight**:
  - **Dry weight**: 7.6 kg, incl. MRU
  - **Weight in water**: 4.2 kg, incl. MRU
- **Depth**: 1000 m
- **Connector type**: 2, 8-pin Seacon

Subsea bottle 500-metre

- **Type**: MRU-M-SB11
- **Outline dimensions**:
  - **Height**:
    - 209 mm
    - **Incl. connectors**: 240.5 mm
  - **Diameter**: 120 mm

- **Weight**:
  - **Dry weight**: 7.8 kg, incl. MRU
  - **Weight in water**: 5.4 kg, incl. MRU
- **Depth**: 500 m
- **Connector type**: 2, 8-pin Seacon

Light weight subsea bottle

- **Type**: MRU-M-SB12
- **Outline dimensions**:
  - **Height**:
    - 209 mm
    - **Incl. connectors**: 240.5 mm
  - **Diameter**: 120 mm
- **Weight**:
  - **Dry weight**: 3.7 kg, incl. MRU
  - **Weight in water**: 1.3 kg, incl. MRU
- **Depth**: 10 m
- **Connector type**: 2, 8-pin Seacon

Power specifications

MRU sensor

- **Input voltage**: 10 - 36 VDC
- **Voltage - recommended**: 24 VDC
- **Power consumption**: 8 W max (typical 7.2 W)
- **Power rise speed**: Not critical
- **Batteries**: None. Connection to UPS recommended.

MRU junction box

- **Type**: MRU-E-JB3
- **Input voltage**: 24 VDC nominal (18 - 32 VDC) or 85 - 264 VAC
- **Output voltage**: 15 W, 24 VDC mains power

Environmental specifications

MRU sensor

- **Operating temperature**:
  - **MRU E**: −25 °C - +75 °C
  - **All other MRU models**: −5 °C - +55 °C
- **Storage temperature**: −25 °C - +70 °C
- **Operating humidity**: Sealed, no limit
- **Storage humidity**: Sealed, no limit
- **Enclosure material**: Anodised aluminium
- **Ingress protection (IP) code**: IP66
- **Max shock non-operational**: 1000 m/s^2 (10 ms peak)
- **MTBF (hours)**: 50000 h (computed)
- **MTBF (hours)**: 100000 h (service history based)
- **Electromagnetic compatibility**: IEC 60945/EN 60945
- **Vibration**: IEC 60945/EN 60945

MRU junction box

- **Type**: MGC-E-JB3
- **Operating temperature**: −25 °C - +55 °C
- **Storage temperature**: −25 °C - +70 °C
- **Ingress protection (IP) code**: IP65
- **Enclosure material**: Aluminium

Related topics

Storage, page 214

Interface specifications

- **Serial ports**:
  - **COM 1**: Bidirectional RS-422
  - **COM 2**: Bidirectional RS-232. From junction box user configurable RS-232/RS-422.

  - **COM 3 & 4**: Input only. User configurable RS-232/RS-422.
- **Baud rate**: 115200 baud, max.
- **Ethernet**: 1 x 10/100 Mbps
- **UDP/IP ports**: 5 outputs (user configurable), 1 input (static)
- **Data output variables**: 24, max. (serial line or Ethernet port)
- **Data output rate**: 200 Hz, max.
- **Analog output channels (from junction box only)**: 4 user configurable channels, ±10 V with 14 bits resolution
- **Timing accuracy**: 1 ms
- **Data delay**: Typical 3.5 ms plus transmission delay
- **Data output**: Cyclic output of data or by request from host computer

Data output specifications

- **Output protocols**:
  - MRU Normal. The MRU proprietary format.
  - NMEA proprietary
  - NMEA normal. Available formats VER, PSX20 and PSXN23.
  - Sounder
  - Simrad EM 3000
  - Atlas Fansweep
  - TSS1
  - Seapath binary 23
  - Seapath binary 25 (Raw IMU)
  - Seapath binary 26
  - PFreeHeave®
  - RDI ADCP
  - SMCC
  - PTVG
  - MDL

- HMS/VMM
- KM binary
- NAV binary
- OCTANS TAH

Data input specifications

- **Input protocols:**
  - MRU commands
  - NMEA format GGA, HDM, HDT, TSH, VBW, VHW, VTG, ZDA

Cable specifications

MRU cable

- **Type**: MRU-E-CS8, Heady duty screened, 14 x 2 x 0.25 mm^2
- **Length**: 3 m
- **Diameter**: 13.5 mm
- **Weight**: 0.27 kg/m
- **Flame retardation**: IEC 60332-1
- **Insulation**: PP (conductors), PUR (outer cover)
- **Screen**: Cu-braid
- **Bending radius**: 100 mm

Dynamic positioning (DP) cable

- **Type**: MRU-E-DP2, Heady duty screened, 7 x 2 x 0.25 mm^2
- **Length**: 15 m
- **Diameter**: 11 mm
- **Weight**: 0.19 kg/m
- **Flame retardation**: IEC 60332-1
- **Insulation**: ETFE
- **Screen**: Cu-braid

- **Bending radius**: 100 mm

Umbilical cable, serial and Ethernet communication

- **Type**: MRU-E-CS9, Umbilical cable, Cat 6, 4-pair, 23 AWG with screen
- **Length**: 15 or 30 m
- **Diameter**: 12.6 mm
- **Weight**:
  - **Weight in air**: 241 kg/km
  - **Weight in sea water**: 112 kg/km
- **Screen**: Alum/braid
- **Bending radius - static/dynamic**: 150 mm, minimum

Manufacturer's conformity declaration

This product is in compliance with relevant directives and product standards.

KONGSBERG

EU DECLARATION OF CONFORMITY

Manufacturer's name:	**Kongsberg Discovery AS**
Manufacturer's address:	**Havnegata 9, N-7010 Trondheim, Norway**

declares that the product:

Product name:	**MRU, Motion Reference Unit**
Model number:	**5th generation MRU: 2, 3, 5, 5+, D, E, H and S**
Product options:	**Junction Box MRU-E-JB3**

is in conformity with the **EMC directive 2014/30/EU**, using relevant sections of the following harmonised standards:

EMC:	**EN IEC 60945:2002**

Test references
Report no: REP070255B (EMC), issued by Nemko Scandinavia AS.

RoHS
To the best of our knowledge, with reference to standard **EN IEC 63000:2018,** the product is compliant with Directive **2011/65/EU** as amended by Commission Delegated Directive **EU 2015/863**.

Test reference
Report (RoHS): KSX-2017-RoHS2, issued by Kongsberg Seatex AS.

Supplementary information
The MRU and the Junction boxes operate from the vessel's 24 VDC supply. The MRU is compliant with applicable safety aspects found in IEC 61010-1.

Reference: Report *MRU_Safety_002*, issued by Kongsberg Seatex AS.

The product items are environmentally compliant to EN IEC 60945:2002, IACS E10 Rev.10:2024 and DNV-CG-0339:2021.

Date and signature
2026-05-26

Ane Dalsnes Storsæter, Vice President
Inertial Solutions

Doc item: 387621/D

Drawings

Topics

About the drawings

These drawings are for information and planning purposes only.

Unless otherwise specified, all measurements are in millimetres. The drawings are not to scale.

Information may be omitted. Observe the source drawings for additional details.

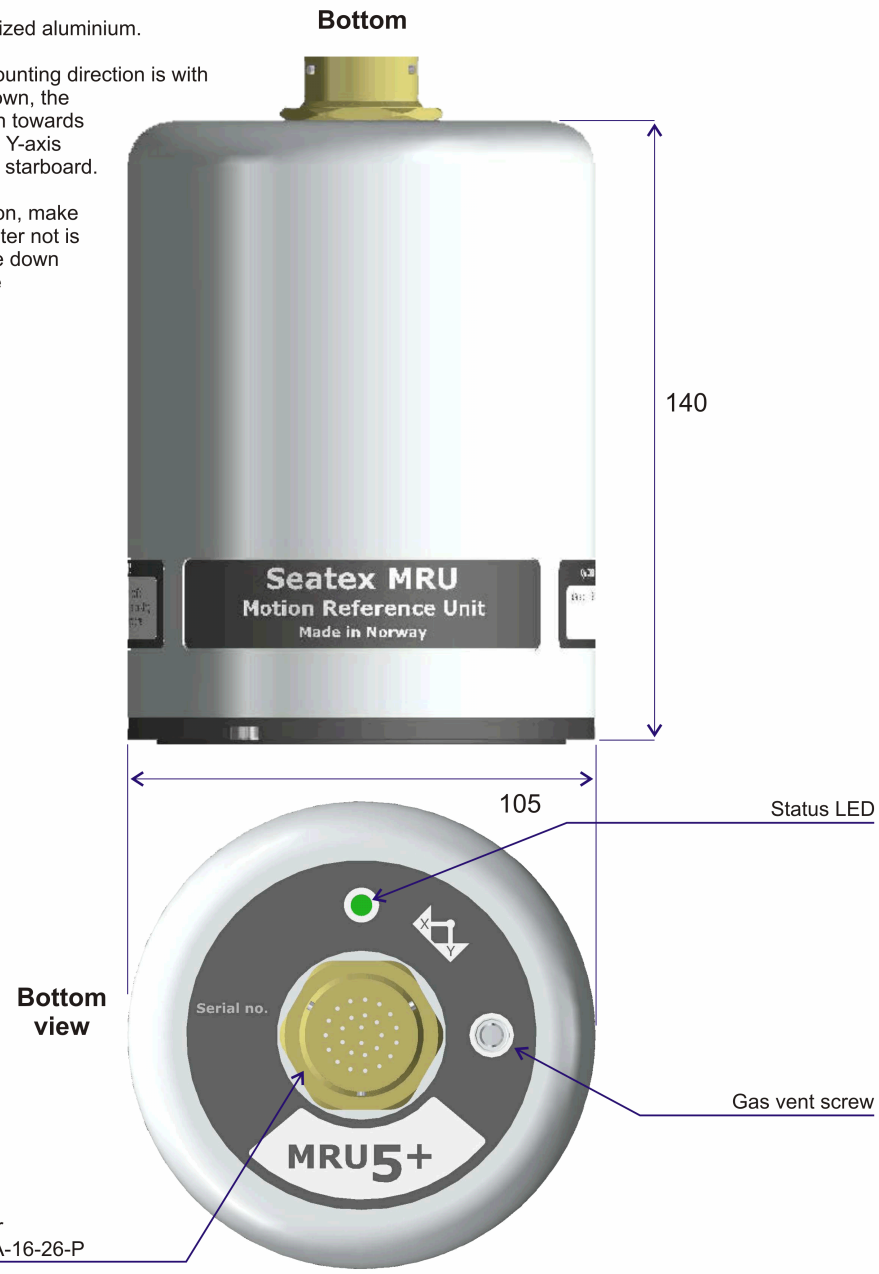
Motion Reference Unit (MRU) dimensions

Notes :

Housing in anodized aluminium.

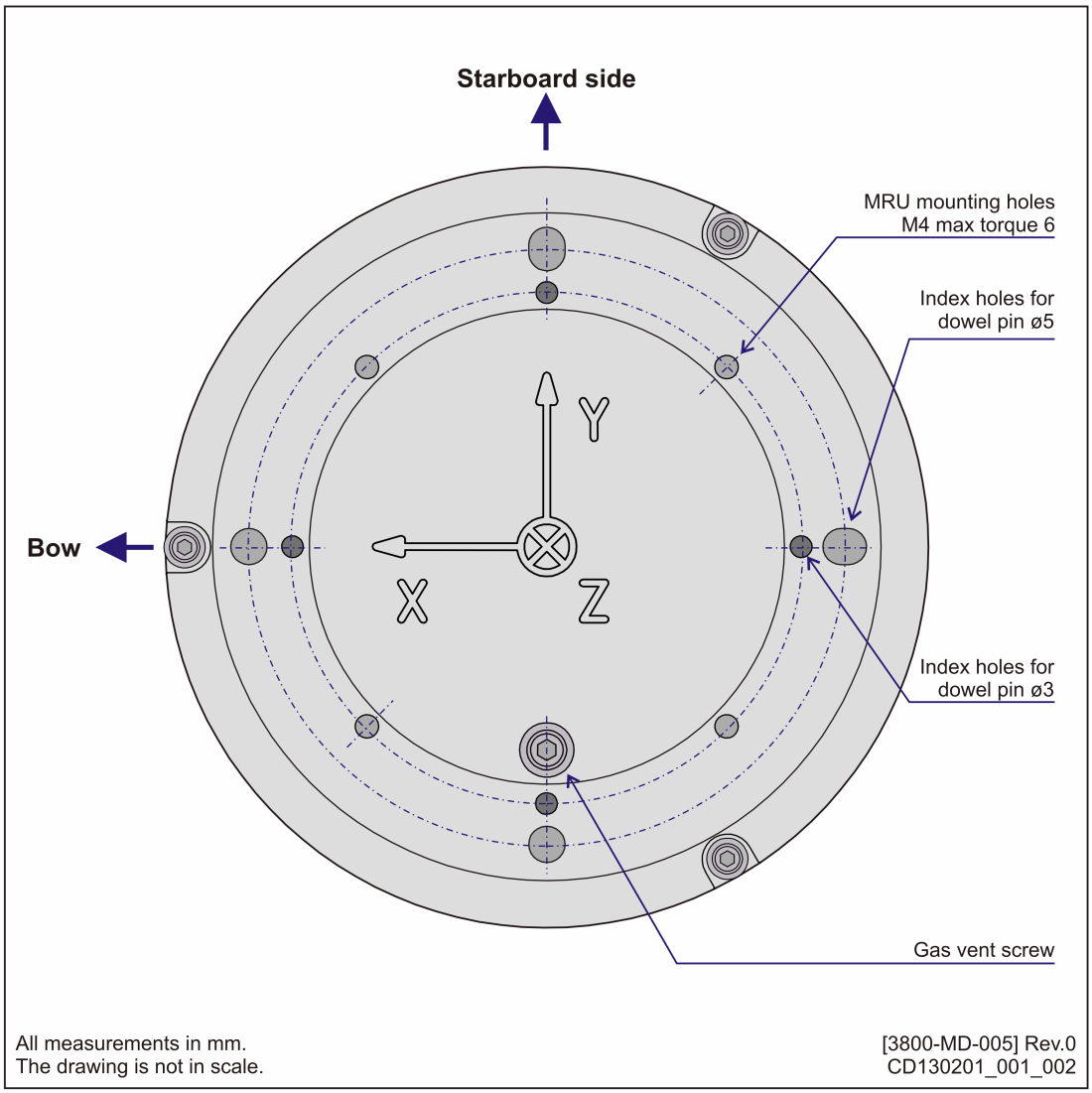
The standard mounting direction is with the connector down, the X-axis pointing in towards the bow, and the Y-axis pointing towards starboard.

To avoid corrosion, make sure that sea water not is able to penetrate down into the top plate index holes.

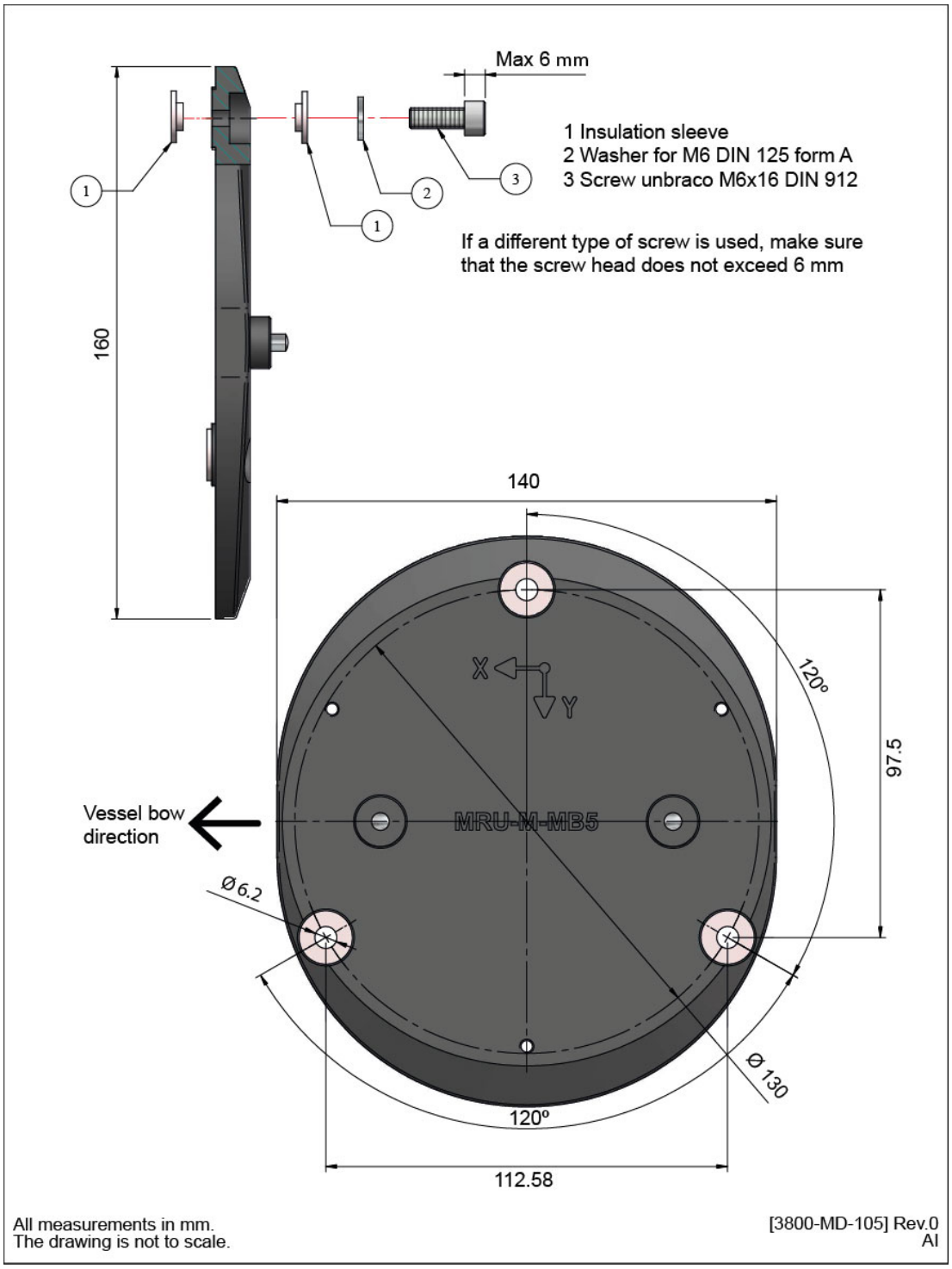


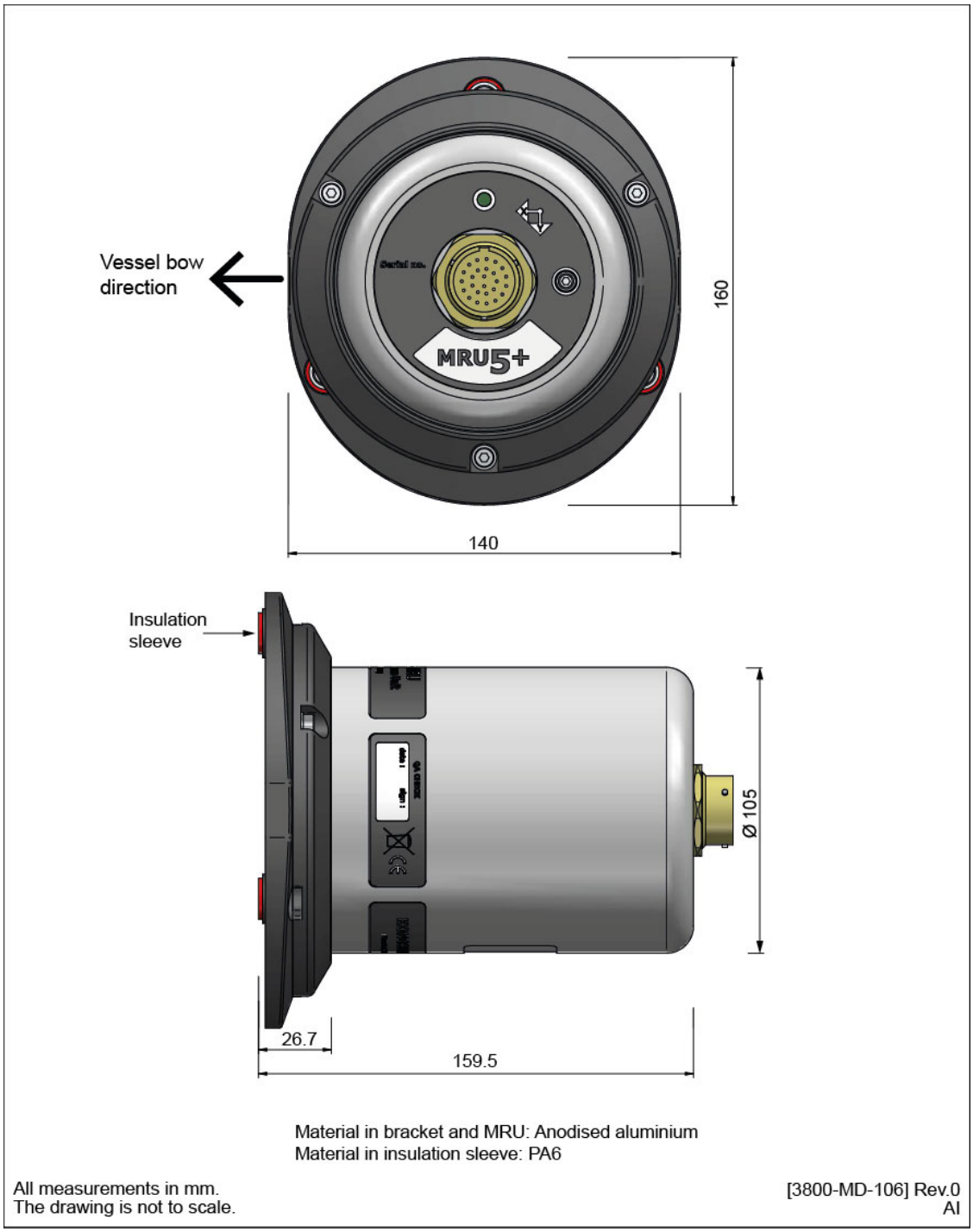
All measurements in mm.
The drawing is not in scale.

[3800-MD-005] Rev.0
CD130201_001_001


Starboard side
Bow
Y
X
Z
MRU mounting holes
M4 max torque 6
Index holes for
dowel pin ø5
Index holes for
dowel pin ø3
Gas vent screw
All measurements in mm.
The drawing is not in scale.
[3800-MD-005] Rev.0
CD130201_001_002

MRU floor mounting bracket dimensions



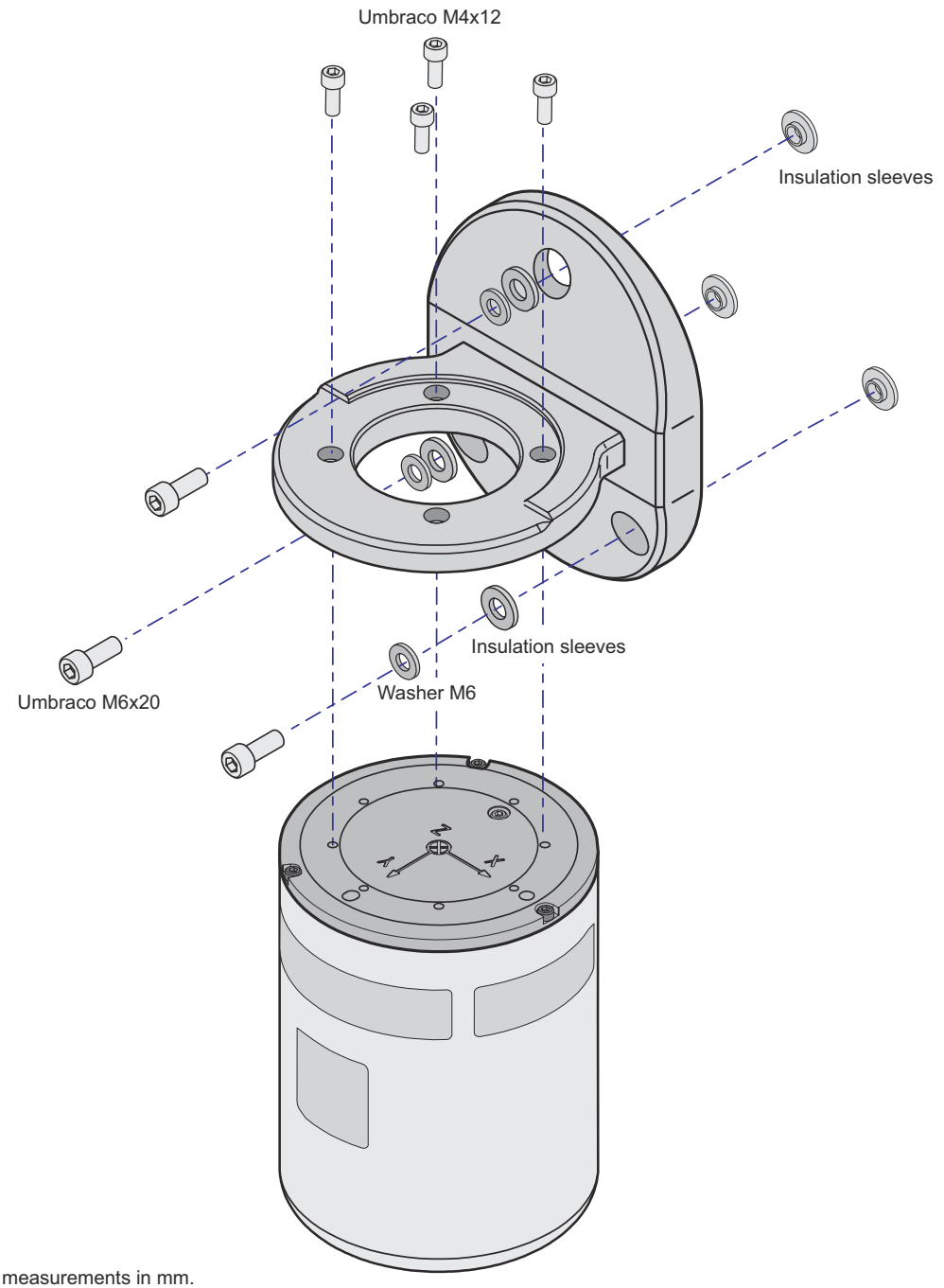


Material in bracket and MRU: Anodised aluminium
Material in insulation sleeve: PA6

All measurements in mm.
The drawing is not to scale.

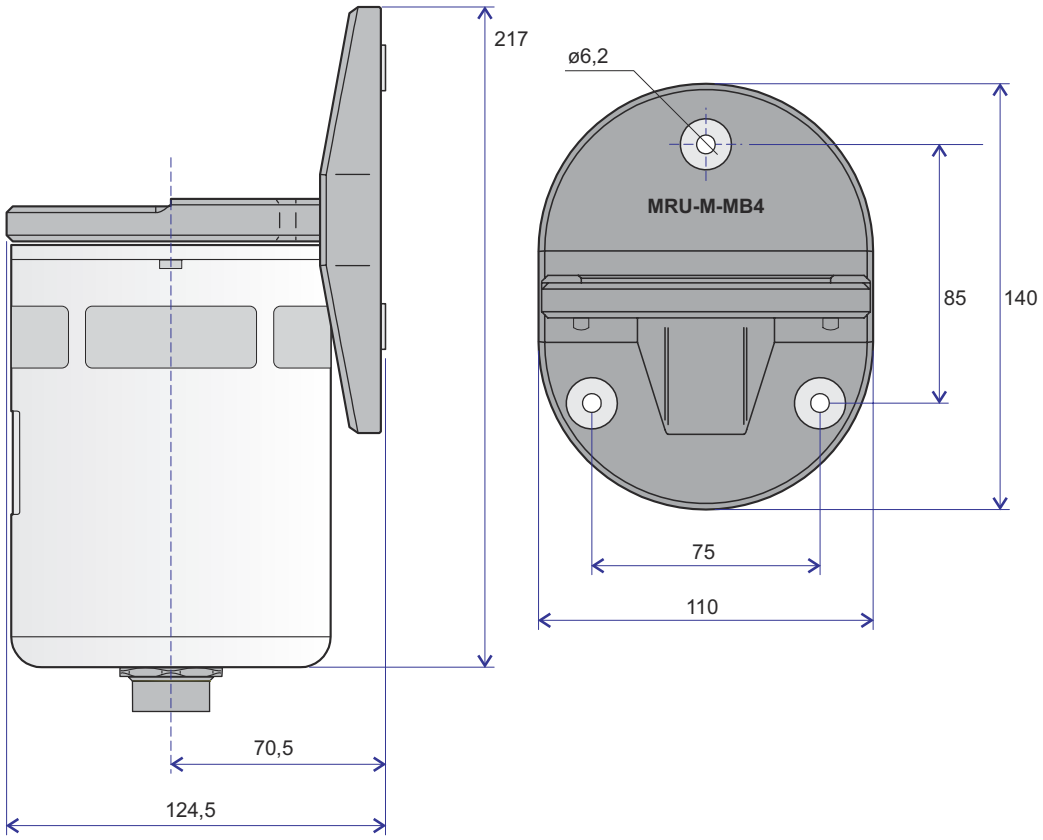
[3800-MD-106] Rev.0
AI

MRU wall mounting bracket dimensions



All measurements in mm.
The drawing is not in scale.
Information may be omitted. Observe the source drawing for additional details.

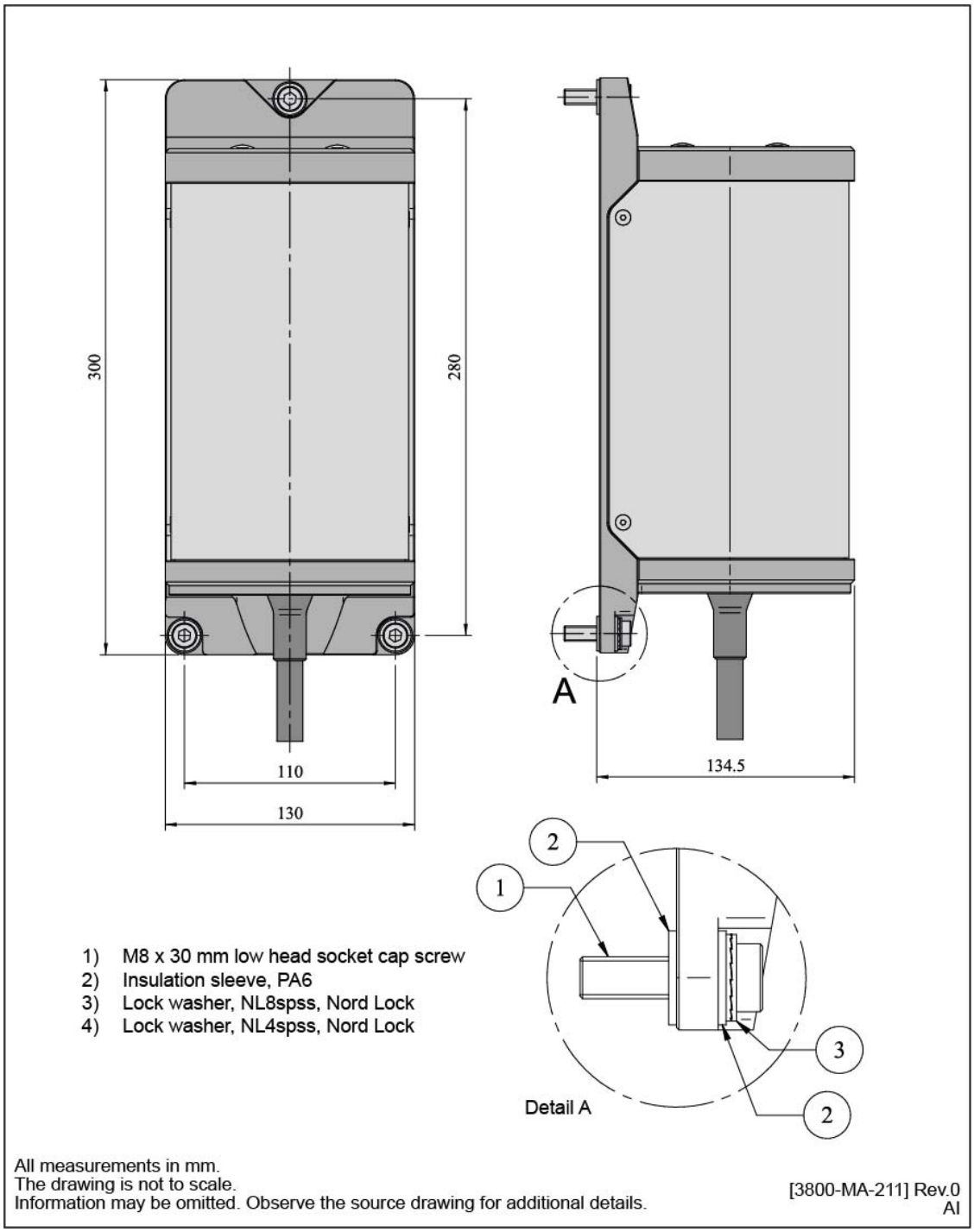
[3800-MD-009] Rev.4
CD12_3800_MD_009_001



All measurements in mm.
The drawing is not in scale.
Information may be omitted. Observe the source drawing for additional details.

[3800-MD-009] Rev.4
CD12_3800_MD_009_002

MRU protected mounting bracket dimensions

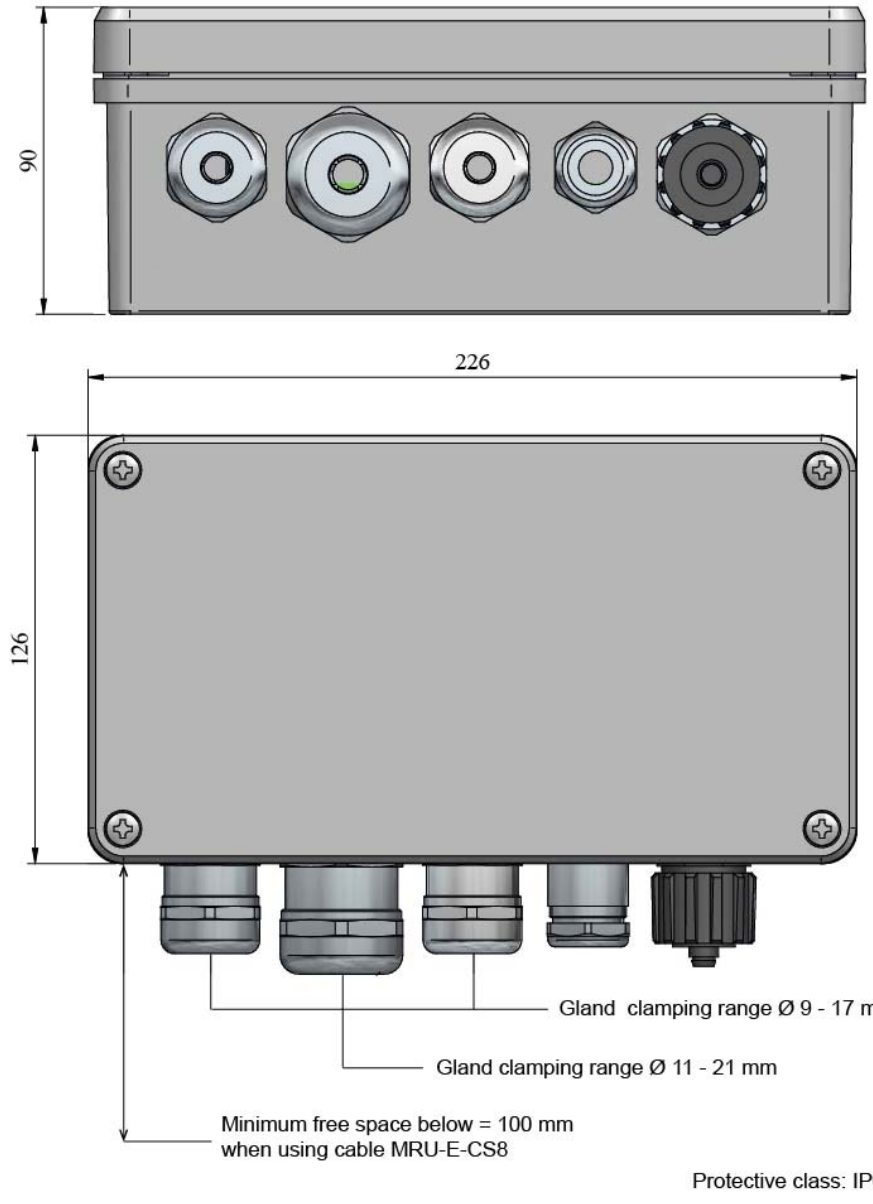


1) M8 x 30 mm low head socket cap screw
2) Insulation sleeve, PA6
3) Lock washer, NL8spss, Nord Lock
4) Lock washer, NL4spss, Nord Lock

All measurements in mm.
The drawing is not to scale.
Information may be omitted. Observe the source drawing for additional details.

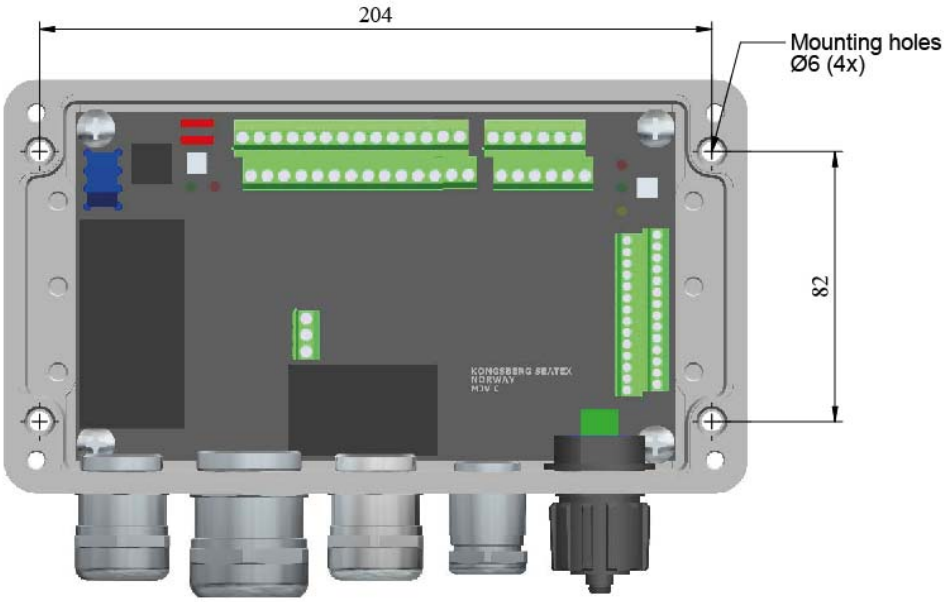
[3800-MA-211] Rev.0
AI

MRU junction box dimensions



All measurements in mm.
The drawing is not to scale.
Information may be omitted. Observe the source drawing for additional details.

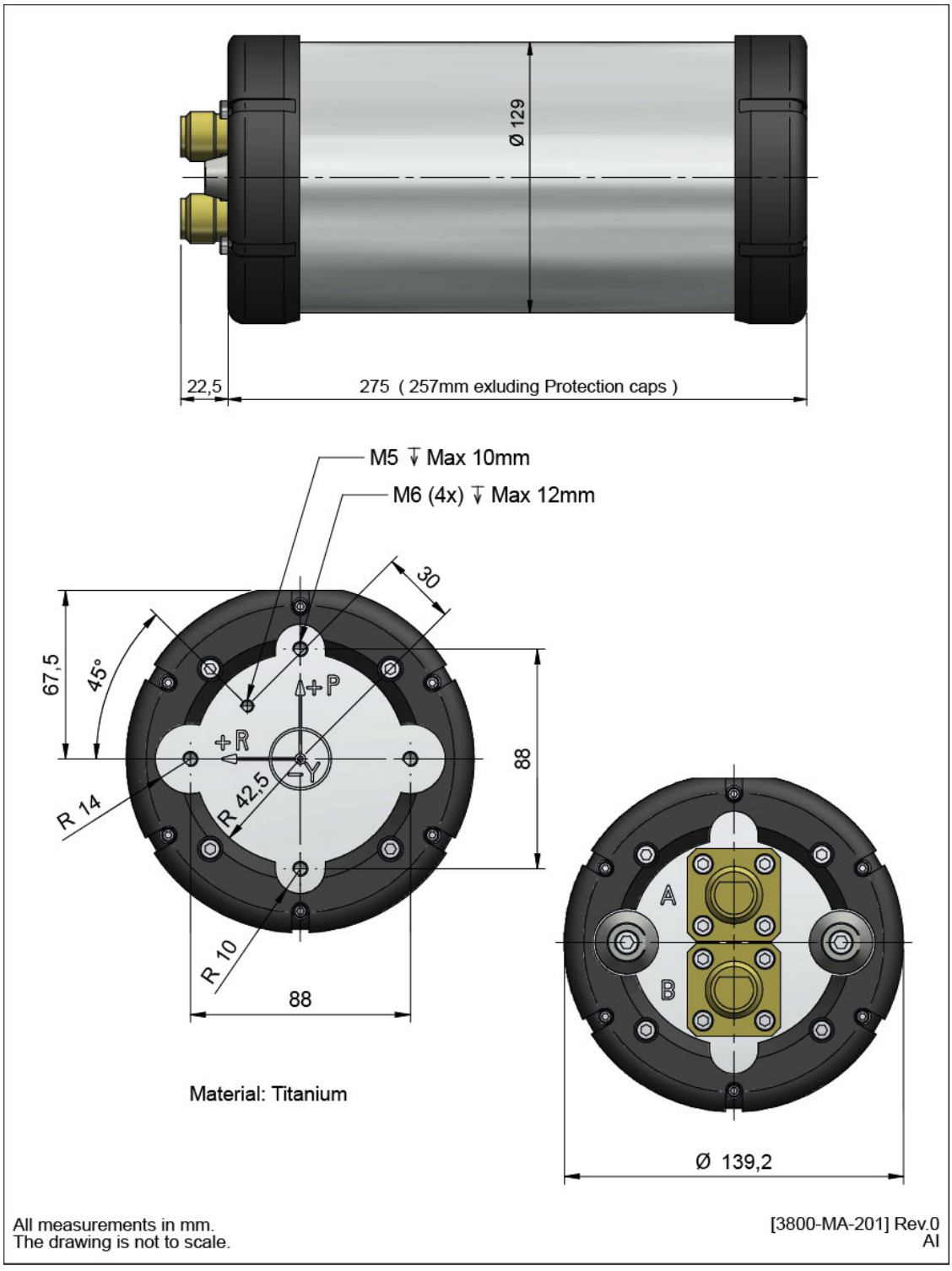
[3800-MD-401] Rev.5
AI



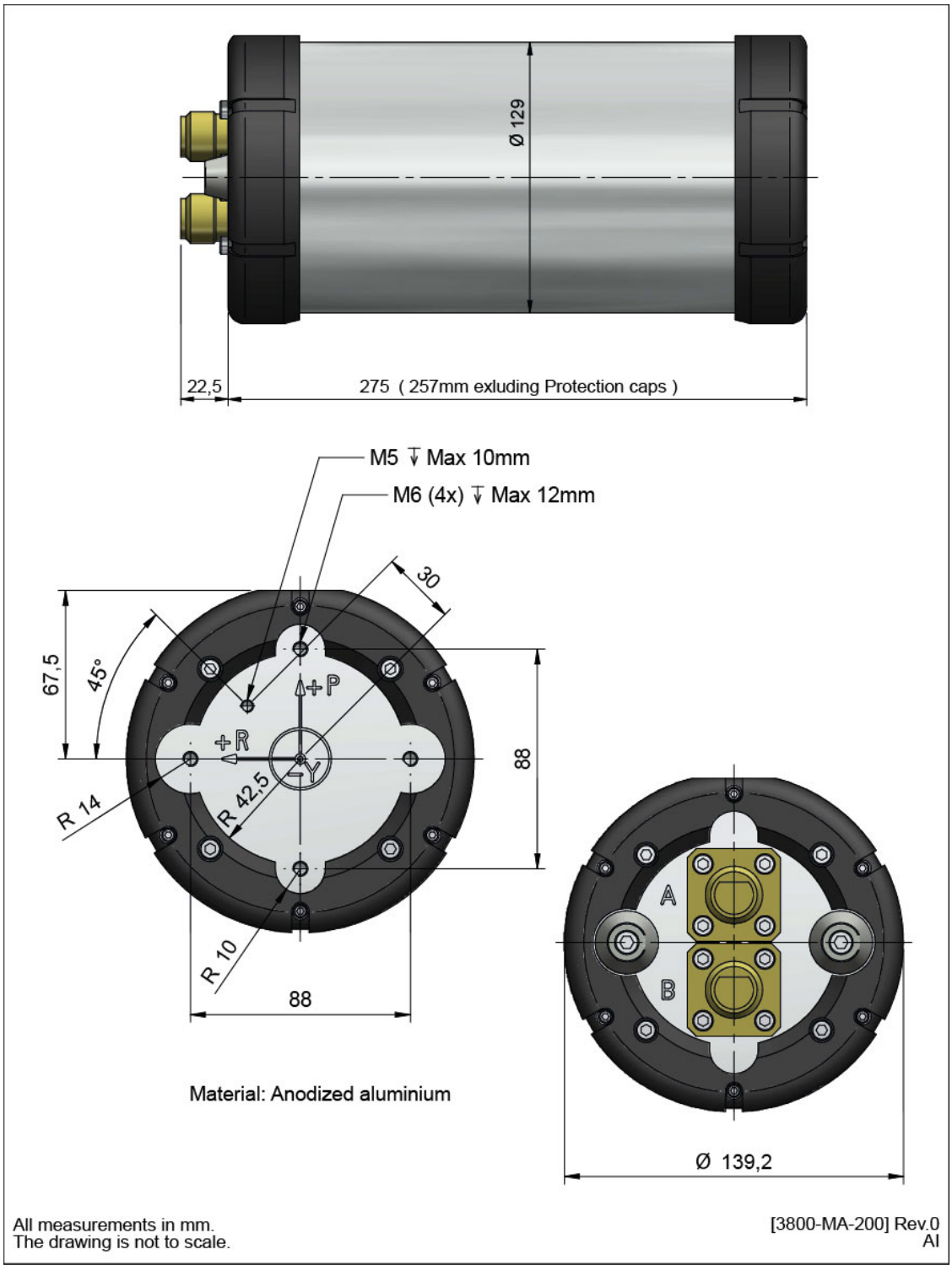
All measurements in mm.
The drawing is not to scale.
Information may be omitted. Observe the source drawing for additional details.

[3800-MA-401] Rev.5
AI

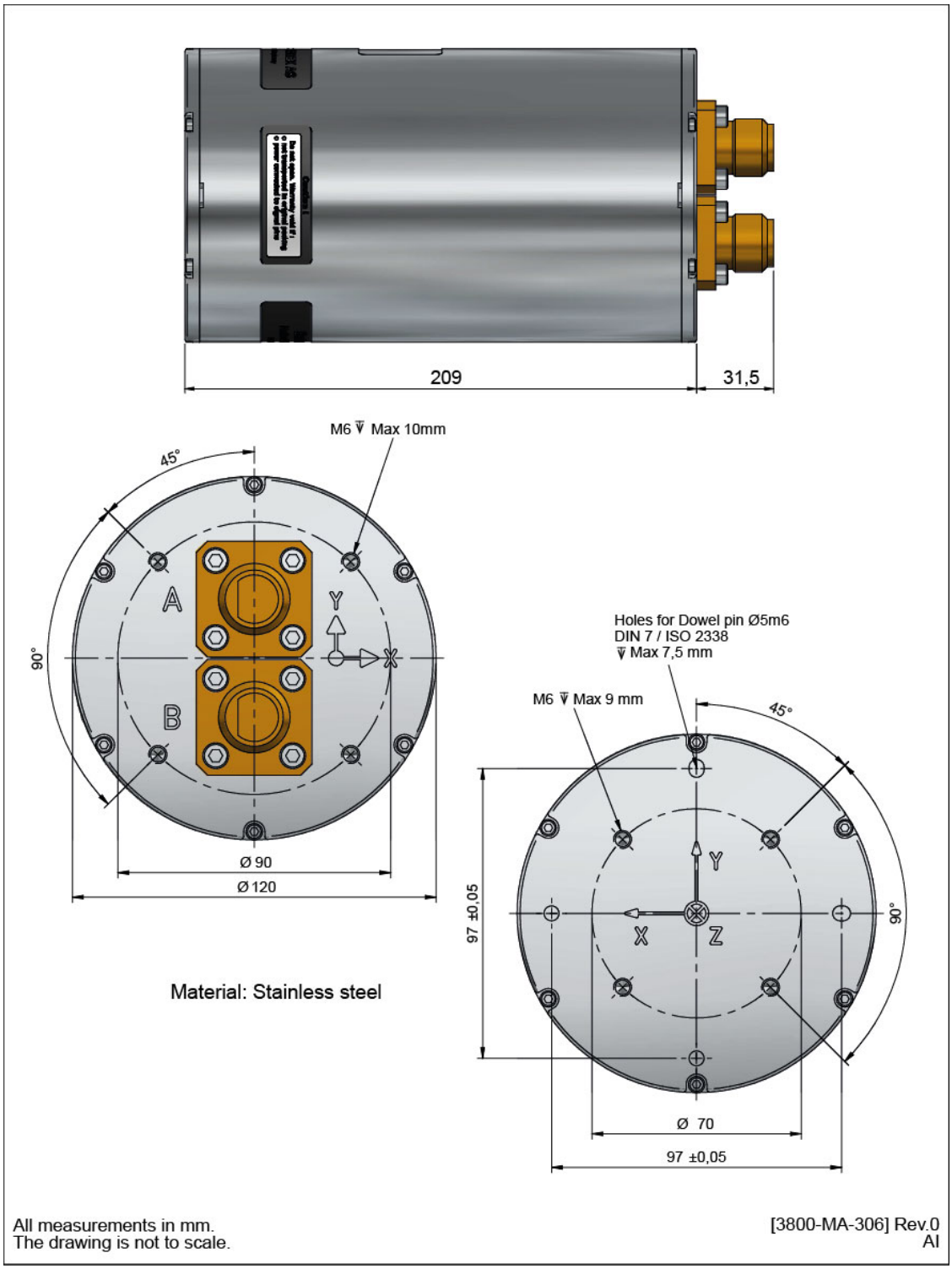
MRU subsea bottle SB9 dimensions



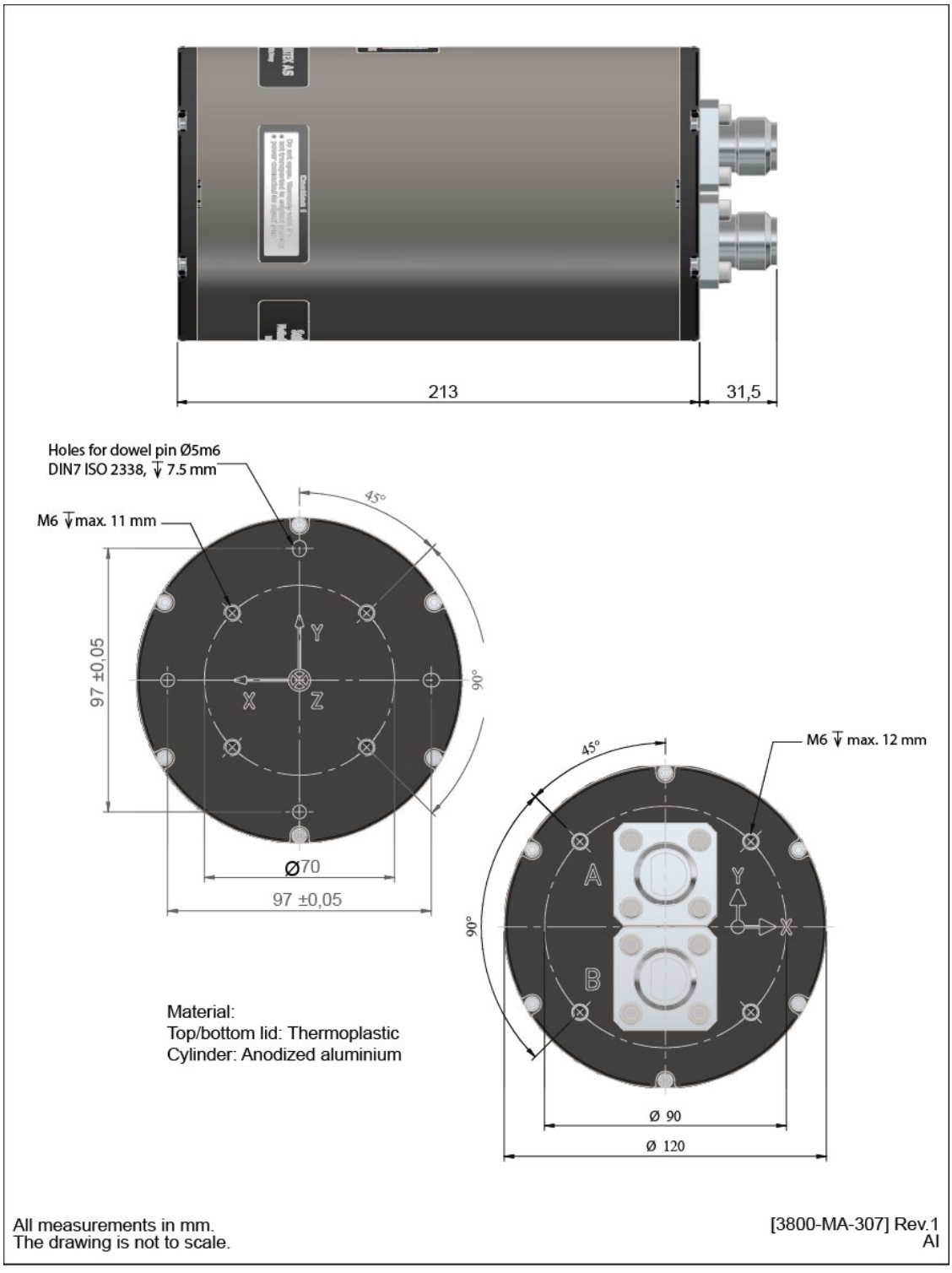
MRU subsea bottle SB10 dimensions



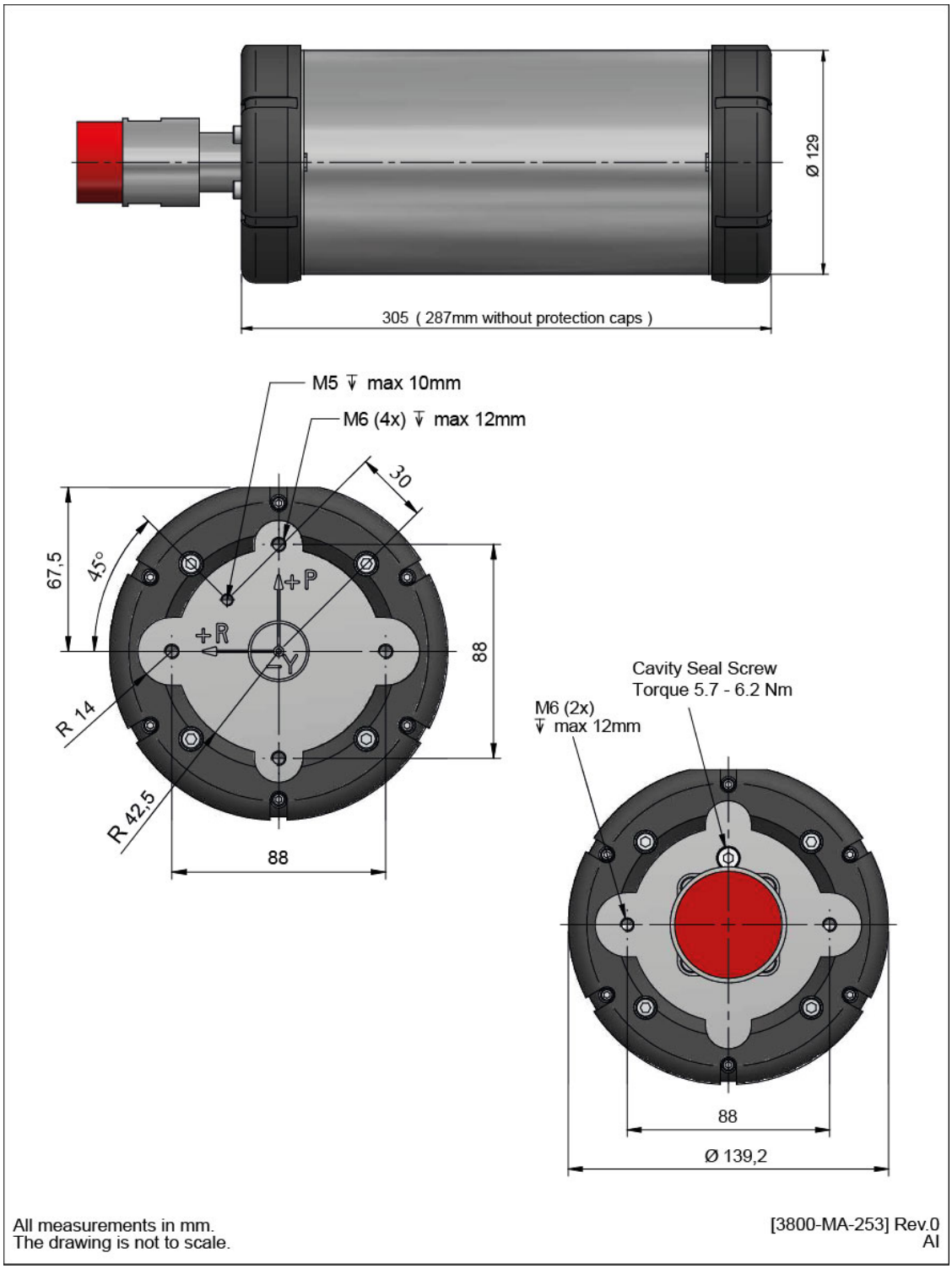
MRU subsea bottle SB11 dimensions

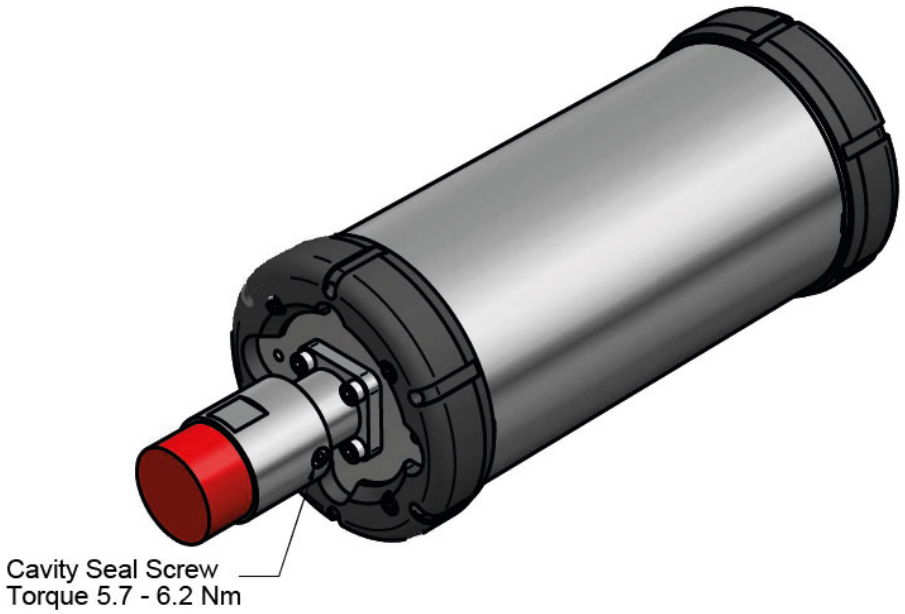


MRU subsea bottle SB12 dimensions



MRU subsea bottle SB14 dimensions





All measurements in mm.
The drawing is not to scale.

[3800-MA-253] Rev.0
AI

Telegram specifications

Topics

NMEA proprietary

The NMEA proprietary format is a configurable format where the number of variables and the variable number (**Source**) can be selected.

The NMEA Proprietary format follows the NMEA 0183, version 2.00, specifications with the exception that the baud rate may be set to other than 4800. The string is designed

to output up to six variables from the MRU variable list, together with a user selected token (10..100) accompanying the selections. If less than six variables are selected, empty fields are put in the NMEA string. It is possible to output more than six variables (maximum 16 variables) with this string, but then the length of the string will be longer than the standard 80 characters which is the NMEA standard.

Float data are written as floats (C print format %9.4e) and integers as integers (C print format %d). Only the MRU data out message is changed when using the NMEA format, all other messages remain as MRU Normal format messages. As the NMEA format is ASCII based, as opposed to the MRU Normal format, more than twice as many bytes are used to transfer a six-variable sentence by NMEA than MRU Normal. This feature will reduce the number of messages per second for a given baud rate (i.e., for a six-variable NMEA sentence, up to 12 messages per second at 9600 baud can be achieved). The MRU Normal format can transmit 35 messages per second under the same conditions.

Format

```
$PSXN,10,xx,x.xx,x.xx,x.xx,x.xx,x.xx,x.xx*hh<CR><LF>
```

Description

1. **$PSXN**: Kongsberg Discovery AS (former Kongsberg Seatex AS, Norway)
2. **10**: MRU message identifier (11 if data unstable)
3. **xx**: User defined token (10..100)
4. **x.xx**: Data field 1
5. **x.xx**: Data field 2
6. **x.xx**: Data field 3
7. **x.xx**: Data field 4
8. **x.xx**: Data field 5
9. **x.xx**: Data field 6
10. ***hh**: Checksum

The manufacturer mnemonic code SXN is NOT an NMEA approved mnemonic.

The message number is 10 for normal MRU data and 11 if data are unstable (at power-on and other restarts). The token value is a user adjustable number associated with the current format configuration.

Float data fields are written with "scientific notation" formats (i.e., 1.234e3 or -3.456e-12) and integers as decimal numbers (i.e. -12345 or 859). The asterisk "*" denotes a checksum feature, and "hh" is the hexadecimal checksum according to the NMEA standard.

Example: Typical NMEA proprietary string

4 variables ROLL = 0.051 rad, PITCH = -0.051 rad, HEAVE = 1.234 metres, DATE in seconds since 1 January 1970 00:00:00; token is 19, data stable.

```
$PSXN,10,019,5.100e-2,-5.100e-2,1.234e+0,771598427,,*61
```

1. **$PSXN**:
2. **10**: Message number, data stable
3. **019**: Token
4. **5.100e-2**: Roll
5. **-5.100e-2**: Pitch
6. **1.234e+0**: Heave
7. **771598427**: TueJun14 1994 12:53:47
8. **,,**: Empty fields
9. **x.xx**: Data field 6
10. ***61**: Checksum

PSXN20

The proprietary PSXN20 NMEA sentence contains quality indicators for roll, pitch, heading and position.

The sentence destination is positioning reference systems.

The sentence is based on NMEA sentence format.

Format

```
$PSXN,20,x,x,x,x*hh<CR><LF>
```

Description

1. **$**: Start character.
2. **PSXN**: Seatex ID (now Kongsberg Discovery AS)
3. **Message number**: 20.
4. **x**: horiz-qual - Horizontal position and velocity quality.

   0 = Normal

   1 = Reduced performance

2 = Invalid data

5. **x**: hgt-qual - Height and vertical velocity quality.

   0 = Normal

   1 = Reduced performance

   2 = Invalid data

6. **x**: head-qual - Heading quality.

   0 = Normal

   1 = Reduced performance

   2 = Invalid data

7. **x**: rp-qual - Roll and pitch quality.

   0 = Normal

   1 = Reduced performance

   2 = Invalid data

8. ***hh**: Checksum.
9. **<CR><LF>**: End of sentence.

PSXN23

The proprietary PSXN23 NMEA sentence contains attitude and heave data calculated in the MRU system.

The sentence destination is PRS monitoring systems.

The sentence is based on NMEA sentence format.

Format

```
$PSXN,23,x.x,x.x,x.x,x.x*hh<CR><LF>
```

Description

1. **$**: Start character.
2. **PSXN**: Seatex ID (now Kongsberg Discovery AS)
3. **Message number**: 23
4. **x.x**: Roll in degrees. Positive with port side up.

5. **x.x**: Pitch in degrees. Positive with bow up.
6. **x.x**: Heading, degrees true.
7. **x.x**: Heave [m]. Positive down.
8. ***hh**: Checksum (delimiter and field).
9. **<CR><LF>**: End of sentence.

Sounder

The Sounder format is a proprietary ASCII text format used when connecting to Simrad EA500 and other echo sounders.

By selecting this format the number of MRU variables is fixed and there is no token associated with it. However, the baud rate and output interval may be changed as required.

The format is ASCII based, with fixed length and terminated with CR and LF.

Format

```
:aabbbbshhhhxsrrrrspppp<CR><LF>
```

Description

1. **aa**: 2-character hex number with SWAY acceleration, in 0.03835 m/ss units
2. **bbbb**: 4 characters hex number with HEAVE acceleration, in 0.000625 m/ss units
3. **hhhh**: 4-character decimal number with HEAVE position in centimetres, positive up
4. **s**: 1 character of sign: <SPACE> if positive, "-" if negative
5. **x**: Warning character: <SPACE> if OK, "?" if data unstable
6. **rrrr**: 4-character decimal number with ROLL angle in hundreds of a degree
7. **s**: 1 character of sign: <SPACE> if positive, "-" if negative
8. **pppp**: 4-character decimal number with PITCH angle in hundreds of a degree
9. **s**: 1 character of sign: <SPACE> if positive, "-" if negative

The definition of the attitude angles in this format is different from the Euler angles definition used elsewhere. The difference appears in the roll angle, where:

$roll_{echo\text{-}sounder}$ = arcsin[sin($roll_{Euler}$) cos($pitch_{Euler}$)]

Example: Typical Sounder string

If the SWAY acceleration is 1.0 m/ss = 26 * 0.03835 = 0x1a * 0.03835, the HEAVE acceleration is 8.750 m/ss = 14000 * 0.000625 = 0x36b0 * 0.000625, the HEAVE is -2.54 metres, the ROLL is -0.87 degrees and the PITCH is 3.78 degrees.

Data is OK. The message is then:

```
:1a36b0 -0254 -0087 0378<CR><LF>
```

(total 27 characters)

Simrad EM 3000

The Simrad EM 3000 is a proprietary datagram format created by Simrad for use with digital motion sensors. It holds roll, pitch, heave and heading information. The datagram contains a 10-byte message.

Format

Data description	Example	Format	Valid range
Sync byte 1 / Sensor status **[1]**	90h to Afh = sensor status	1U	00h, 90h to Afh
Sync byte 2	Always 90h	1U	144
Roll LSB **[2]**		1U	
Roll MSB **[2]**		1U	
Pitch LSB **[2]**		1U	
Pitch MSB **[2]**		1U	
Heave LSB **[2]**		1U	
Heave MSB **[2]**		1U	
Heading LSB **[2]**		1U	
Heading MSB **[2]**		1U	

Description

LSB = least significant byte

MSB = most significant byte.

1. **Sync byte 1 / Sensor status**
   - **00h**: This value is sync byte 1.
   - **90h**: This value indicates valid measurements with full accuracy.

- Any value from **91h** to **99h** indicates valid data with reduced accuracy (decreasing accuracy with increasing number).
- Any value from **9Ah** to **9Fh** indicates non-valid data but normal operation (for example configuration or calibration mode).
- Any value from **A0h** to **AFh** indicates a sensor error status.

2. **All data are in 2's complement binary.**

   Resolution is 0.01 degrees for roll, pitch and heading, and 1 cm for heave.

   - Roll is positive with port side up with valid range ±179.99 degrees.
   - Pitch is positive with bow up with valid range ±179.99 degrees.
   - Heave is positive up with valid range ±9.99 m.
   - Heading is positive clockwise with valid range 0 to 359.99 degrees.

   If a value is outside the valid range, it is assumed to be non-valid, and rejected.

   Note:

   Heave is logged as positive downwards (the sign is changed) including roll and pitch induced lever arm translation to the transmit transducer.

You can define how roll is assumed to be measured, either with respect to the horizontal plane (the *Hippy 120* or *TSS* convention), or to the plane tilted by the given pitch angle (i.e. as a rotation angle around the pitch tilted forward pointing x-axis).

The latter convention (called *Tate-Bryant* in the POS/MVdocumentation) is used inside the system in all data displays and in the logged data. A transformation is applied if the roll is given with respect to the horizontal.

Note:

This format was originally designed for use with the early multibeam echo sounders manufactured by KONGSBERG. In the original version of the format (Simrad EM 1000), the first synchronisation byte was always assumed to be zero. The sensor manufacturers were then requested to include sensor status in the format using the first synchronisation byte for this purpose.

ATLAS

This is the default digital output format from a motion sensor that is to be interfaced with an Atlas Fansweep echo sounder. Each field in the output packet is a 16-bit 2's complement number expressed as two binary-coded digits.

Format

```
DLE RrPpHhQ DLE
```

Description

1. **DLE**: Start character, ASCII 10 Hex
2. **R**: Roll – MSB. Unit: Horn scaling 2π = 2**16
3. **r**: Roll – LSB
4. **P**: Pitch – MSB. Unit: Horn scaling 2π = 2**16
5. **p**: Pitch – LSB
6. **H**: Heave – MSB. Unit: 1 mm per increment
7. **h**: Heave – LSB
8. **Q**: Status code 0 to 7 inclusive. Below is a description of the various codes
9. **DLE**: Stop character, ASCII 10 Hex.

The various status codes have the following meaning:

- **0**: Unaided mode and stable data. The MRU is operating without external input data.
- **1**: Unaided mode but unstable data. The MRU is without external input data, but the data from the unit are unstable most likely due to alignment after power on or restart. The alignment period from power on or restart is normally 5 minutes.
- **2**: Speed aided mode and stable data. The MRU is operating with external input of speed data.
- **3**: Speed aided mode but unstable data. The MRU is operating with external input of speed data, but the data from the unit are unstable most likely due to alignment after power on, restart or input of speed data
- **4**: Heading aided mode and stable data. The MRU is operating with external input of heading data.
- **5**: Heading aided mode but unstable data. The MRU is operating with external input of heading data, but the data from the unit are unstable most likely due to alignment after power on, restart or input of heading data.
- **6**: Full aided mode and stable data. The MRU is operating with external input of both speed and heading data.

- **7**: Full aided mode but unstable data. The MRU is operating with external input of both speed and heading data, but the data from the unit are unstable most likely due to alignment after power on, restart or input of external data.

Teledyne TSS1 datagram format

Teledyne TSS1 is a proprietary datagram format created by Teledyne TSS Navigation Systems for heave, roll and pitch compensation. When you select this protocol, the number of sensor variables is fixed, and there is no token associated with it. The system decodes this format when you install the MotionASCII sensor.

Format

```
:aabbbb shhhhx srrrr spppp<CR><LF>
```

Description

The format is based on ASCII characters, the datagram has a fixed length, and it is terminated with a carriage return and line feed. Baud rate and output rate may be adjusted to fit your needs. The definition of the attitude angles in this format is different from the *Euler* angles definition used elsewhere. The difference appears in the roll angle, where:

$$Roll_{echo\ sounder} = \arcsin\left[\sin(Roll_{Euler}) \times \cos(Pitch_{Euler})\right]$$

1. **aa**: Sway acceleration

   This is a dual-character hex number. The value is provided as 0.03835 m/ss units.

2. **bbbb**:Heave acceleration

   This is a four-character hex number. The value is provided as 0.000625 m/ss units.

3. **s**: This is a single character.

   If the value is positive, a "space" character is provided.

   If the value is negative, a "–" character is provided.

4. **hhhh**: Heave position

   This is a four-character decimal number. The value is given in centimetres. Positive value is Up.

5. **x**: Status

   - **U**: Unaided mode/Stable data

     The sensor operates without external input data.

- **u**: Unaided mode/Unstable data

  The sensor operates without external input data. However, the data from the sensor is unstable. A probable cause for this is the lack of alignment after the sensor has been switched on or restarted. The alignment period from a power recycle is normally approximately five minutes.

- **G**: Speed aided mode/Stable data

  The sensor operates with external input of speed data.

- **g**: Speed aided mode/Unstable data

  The sensor operates with external input of speed data. However, the data from the sensor is unstable. A probable cause for this is the lack of alignment after the sensor has been switched on or restarted. It can also be a failure in the data input.

- **H**: Heading aided mode/Stable data

  The sensor operates with external input of heading data.

- **h**: Heading aided mode/Unstable data

  The sensor operates with external input of heading data. However, the data from the sensor is unstable. A probable cause for this is the lack of alignment after the sensor has been switched on or restarted. It can also be a failure in the data input.

- **F**: Full aided mode/Stable data

  The sensor operates with external input of both speed and heading data.

- **f**: Full aided mode/Unstable data

  The sensor operates with external input of both speed and heading data. However, the data from the sensor is unstable. A probable cause for this is the lack of alignment after the sensor has been switched on or restarted. It can also be a failure in the data input.

6. **s**: This is a single character.

   If the value is positive, a "space" character is provided.

   If the value is negative, a "–" character is provided.

7. **rrrr**: Roll angle

   This is a four-character decimal number. The value is given in hundredths of a degree.

8. **s**: This is a single character.

   If the value is positive, a "space" character is provided.

If the value is negative, a "–" character is provided.

9. **pppp**: Pitch angle

   This is a four-character decimal number. The value is given in hundredths of a degree.

Description

Positive roll	Port side up
Positive pitch	Bow up

RDI ADCP

The RDI format is used when connecting RDI ADCP equipment. The format is a proprietary ASCII text format.

Format

```
$PRDID,sddd.dd,sddd.dd,ddd,dd,<CR><LF>
```

Description

- **sddd.dd**: pitch - Pitch, degrees. s is the sign character, "+" or "-". ddd.dd is a decimal number with leading zeroes where appropriate. Positive with the bow up.
- **sddd.dd**: roll - Roll, degrees. s is the sign character, "+" or "-". ddd.dd is a decimal number with leading zeroes where appropriate. Positive with the port side up.
- **ddd.dd**: head - Heading, degrees true, with leading zeroes where appropriate.
- **<CR><LF>**: term - End of sentence (2 bytes, values 13 and 10).

Seapath Binary 23 datagram

The Seapath Binary 23 is a proprietary datagram format created by Kongsberg Maritime (https://www.kongsberg.com/maritime/), former Kongsberg Seatex, to provide position, motion and heading data from a Seapath sensor system.

Format

The binary format consists of a fixed-length message using 1-, 2- and 4-byte signed and unsigned integers. The signed integers are represented as two-complement numbers.

For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 44.

The data will be logged in the Network Attitude Velocity 110 datagram.

Element	Example	Format	Bytes	Valid range	Comment
Header					
	Always AAh	Unsigned	1		
	Always 51h	Unsigned	1		
Data					
Time, seconds		Integer	4		2A
Time, fraction of second	0.0001 seconds	2U	2	0 to 9999	2A
Latitude	2^{30} = 90 degrees	Integer	4	-2^{30} to 2^{30}	2B
Longitude	2^{30} = 90 degrees	Integer	4	-2^{31} to 2^{31}	2B
Height	Centimetres	Integer	4		2C
Heave	Centimetres	Integer	2		2D
North velocity	Centimetres/ second	Integer	2		
East velocity	Centimetres/ second	Integer	2		
Down velocity	Centimetres/ second	Integer	2		
Roll	2^{14} = 90 degrees	Integer	2	-2^{15} to 2^{15}	2E
Pitch	2^{14} = 90 degrees	Integer	2	-2^{15} to 2^{15}	2F
Heading	2^{14} = 90 degrees	Unsigned	2	0 to 2^{16}	
Roll rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} to 2^{15}	
Pitch rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} to 2^{15}	
Yaw rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} to 2^{15}	
Tail					

Element	Example	Format	Bytes	Valid range	Comment
Status Word		Bit-fields	2		1
Checksum		Unsigned	2		2

Comments

1. The status word consists of 16 single bit flags numbered from 0 to 15, where 0 is the least significant bit. Value 1 (true) means:
   - **Bit 0**: Reduced horizontal position and velocity performance
   - **Bit 1**: Invalid horizontal position and velocity data
   - **Bit 2**: Reduced heave and vertical velocity performance
   - **Bit 3**: Invalid heave and vertical velocity data
   - **Bit 4**: Reduced roll and pitch performance
   - **Bit 5**: Invalid roll and pitch data
   - **Bit 6**: Reduced heading performance
   - **Bit 7**: Invalid heading data
2. Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds. Latitude is positive north of the Equator. Longitude is positive east of Greenwich. Height is above the ellipsoid. Heave is positive down. Roll is positive with port side up. Pitch is positive with bow up.

   Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section.

   A. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds.

   B. Latitude is positive north of the Equator. Longitude is positive east of Greenwich.

   C. Height is above the ellipsoid.

   D. Heave is positive down.

   E. Roll is positive with port side up.

   F. Pitch is positive with bow up.

Seapath Binary 26

This binary format consists of a fixed-length message using 1, 2 and 4–byte signal and unsigned integers. The signed integers are represented as two-complement numbers. For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 52.

Format

Element	Scaling	Format	Bytes	Value
Header		Unsigned	1	AA Hex
Header		Unsigned	1	53 Hex
Time, seconds	seconds	Integer	4	
Time, fraction of second	0.0001 second	Unsigned	2	0 - 9999
Latitude	2^{30} = 90 degrees	Integer	4	-2^{30} - 2^{30}
Longitude	2^{30} = 90 degrees	Integer	4	-2^{31} - 2^{31}
Height	centimetres	Integer	4	
Heave real-time	centimetres	Integer	2	
North velocity	centimetres/ second	Integer	2	
East velocity	centimetres/ second	Integer	2	
Down velocity	centimetres/ second	Integer	2	
Roll	2^{14} = 90 degrees	Integer	2	-2^{15} - 2^{15}
Pitch	2^{14} = 90 degrees	Integer	2	-2^{15} - 2^{15}
Heading	2^{14} = 90 degrees	Unsigned	2	0 - 2^{16}
Roll rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} - 2^{15}
Pitch rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} - 2^{15}
Yaw rate	2^{14} = 90 degrees/ second	Integer	2	-2^{15} - 2^{15}
Delayed heave time, seconds	seconds	Integer	4	
Delayed heave time, fraction of second	0.0001 second	Unsigned	2	0 - 9999

Element	Scaling	Format	Bytes	Value
Heave, delayed	centimetres	Integer	2	
Status word		Bit-fields	2	
Checksum		Unsigned	2	

Description

Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds.

Latitude is positive north of the Equator. Longitude is positive east of Greenwich. Height is above the ellipsoid. Heave is positive down. Roll is positive with port side up. Pitch is positive with bow up.

The status word consists of 16 single bit flags numbered from 0 to 15, where 0 is the least significant bit.

A 1 value (true) means:

- **Bit 0**: Reduced horizontal position and velocity performance
- **Bit 1**: Invalid horizontal position and velocity data
- **Bit 2**: Reduced heave and vertical velocity performance
- **Bit 3**: Invalid heave and vertical velocity data
- **Bit 4**: Reduced roll and pitch performance
- **Bit 5**: Invalid roll and pitch data
- **Bit 6**: Reduced heading performance
- **Bit 7**: Invalid heading data
- **Bit 8**: Invalid delayed heave data

The remaining bits in the status word are reserved for future expansion.

PFreeHeave

The PfreeHeave® format is used to improve the accuracy on the real-time heave.

Format

Element	Scaling	Format	Bytes	Value
Header		Unsigned	1	AA Hex
Header		Unsigned	1	52 Hex
Time, seconds	Seconds	Integer	4	
Time, fraction of second	0.0001 second		2	0 - 9999
Heave	Centimetres	Integer	2	
Status word		Bit-fields	1	
Checksum		Unsigned	2	

Description

The PFreeHeave® format consists of a fixed-length message using 1-, 2- and 4-byte signed and unsigned integers. The signed integers are represented as two-complement numbers. For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 13.

The PFreeHeave output is delayed by a few minutes due to processing. The time fields contain time of validity for the data.

Checksum is calculated as a 16-bit Block Cyclic Redundancy Check (CRC) of all bytes between, but not including the Header and Checksum fields. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds.

Heave is positive down. The status field is zero if heave is valid, non-zero if heave is invalid.

Related topics

Cyclic redundancy check (CRC) algorithm, page 187

Cyclic redundancy check (CRC) algorithm

The 16-bit Block Cyclic Redundancy Check (CRC) algorithm is used to calculate the checksum in some formats. The algorithm is described in C and Fortran source code.

C code

```
#define POLY 0x8408
unsigned short blkcrc(
   unsigned char *bufptr,       /* message buffer */
   unsigned long len            /* number of bytes */
   )
{
   unsigned char i;
   unsigned short data;
   unsigned short crc = 0xffff;

   if (len == 0L) {
      return ~crc;
   }

 do {
      for (i=0, data = (unsigned short) (0xff & *bufptr++);
           i < 8;
           i++, data >>= 1) {
         if ((crc & 0x0001) ^ (data & 0x0001)) {
            crc = (crc >> 1) ^ POLY;
         } else {
            crc >>= 1;
         }
      }
   } while (--len);

   crc = ~crc;
   data = crc;
   crc = (crc << 8) | ((data >> 8) & 0xff);

   return crc;
}
```

Fortran code

```
SUBROUTINE blkcrc(inbuffer, len, crc)

INTEGER*2 len, i , bit
INTEGER*4 crc, data, poly
CHARACTER inbuffer*(*)

poly = 16#8408
crc  = 16#FFFF
data = 0

IF (len.EQ.0) THEN
    crc = 0
    RETURN
END IF

DO i = 1, len
    data = ICHAR(inbuffer(i:i))
    DO bit = 1, 8
        data = IAND(data,16#FF)
        IF (IAND(crc,16#01).EQ.(IAND(data,16#01))) THEN
            crc = ISHL(crc,-1)
        ELSE
            crc = ISHL(crc,-1)
            crc = IEOR(crc, poly)
        END IF
        data = ISHL(data,-1)
    END DO
END DO

data = IEOR(crc,16#FFFF)
crc = IOR(ISHL(data,8),IAND(ISHL(data,-8),16#FF))

END
```

Related topics

PFreeHeave, page 186

SMCC

The SMCC protocol is an NMEA 0183 based compatible string used when connecting to helideck monitoring systems and other systems.

The format is ASCII based with fixed length and terminated with checksum, CR and LF. It contains roll, pitch, yaw, surge, sway, heave, surge velocity, sway velocity, heave velocity, acceleration X, acceleration Y and acceleration Z.

For a detailed description of the SMCC format, see the *SMC IMU User Guide* from Ship Motion Control.

PTVG

This format sends roll, pitch and heading. Tokimek PVTG is a proprietary NMEA 0183 compatible protocol.

Format

```
$PTVG,abbbbP,accccR,ddd.dT*hh<CR><LF>
```

Description

1. **PTVG**: Telegram identifier
2. **abbbbP**: Pitch. bb(deg).bb(min). a [-] bow up / [space] bow down
3. **accccR**: Roll in degrees. cc(deg).cc(min). a [-] port up / [space] port down
4. **ddd.dT**: Heading in degrees
5. ***hh**: Checksum

MDL Trim Cube

This format contains heading, pitch and roll.

The MDL Trim Cube protocol is a proprietary fixed-length ASCII text format. It is terminated with CR and LF.

Format

```
HxxxxP±yyyyR±zzzz<CR><LF>
```

Description

1. **H**: 'H' character for heading.
2. **xxxx**: Heading angle in degrees multiplied by 10(no sign character). Four digits, range [0000, 3599].
3. **P**: 'P' character for pitch.
4. **±yyyy**: Pitch angle in degrees multiplied by 100 with its sign character "+" (pluss) or "-" (minus). Four digits after the sign character, range [-8999, +8999].
5. **R**: 'R' character for roll.
6. **±zzzz**: Roll angle in degrees multiplied by 100with its sign character "+" (pluss) or "-" (minus). Four digits after the sign character, range [-8999, +8999].

Note:

Roll is positive port down and pitch is positive bow down.

KM Binary datagram format

KM Binary is a proprietary datagram format created by KONGSBERG for general use. The system decodes this format when you install the KM Binary sensor.

Format

Data description	Unit of measurement	Format	No. of bytes
Start ID	#KMB	char	4U
Datagram length		uint16	2U
Datagram version (=1)		uint16	2U
UTC seconds	s	uint32	4U
UTC nanoseconds	ns	uint32	4U
Status		uint32	4U
Latitude	deg	double	8F
Longitude	deg	double	8F
Ellipsoid height	m	float	4F
Roll	deg	float	4F
Pitch	deg	float	4F
Heading	deg	float	4F

Data description	Unit of measurement	Format	No. of bytes
Heave	m	float	4F
Roll rate	deg/s	float	4F
Pitch rate	deg/s	float	4F
Yaw rate	deg/s	float	4F
North velocity	m/s	float	4F
East velocity	m/s	float	4F
Down velocity	m/s	float	4F
Latitude error	m	float	4F
Longitude error	m	float	4F
Height error	m	float	4F
Roll error	deg	float	4F
Pitch error	deg	float	4F
Heading error	deg	float	4F
Heave error	m	float	4F
North acceleration	m/s^2	float	4F
East acceleration	m/s^2	float	4F
Down acceleration	m/s^2	float	4F
Delayed heave:			
UTC seconds	s	uint32	4U
UTC nanosecond	ns	uint32	4U
Delayed heave	m	float	4F

Description

Data format	Little endian (the least significant byte is transmitted first). Float is according to IEEE - 754.
Datagram length	The total number of bytes in the datagram
Datagram version	The version is incremented if the datagram format is changed.
Timestamp format	Epoch 1970-01-01 UTC time
Position and height	At user-defined sensor reference point. Position in decimal degrees. • Latitude: Negative on Southern hemisphere • Longitude: Negative on Western hemisphere • Height: Positive above ellipsoid
Positive roll	Port side up

Positive pitch	Bow up
Positive heave	Downwards, at user-defined sensor reference point
	True north
Error fields	Sensor data quality: RMS-1= not implemented

Status

One bit per status info, 1= active

Bit	
	Invalid data:
0	Horizontal position and velocity
1	Roll and pitch
2	
3	Heave and vertical velocity
4	Acceleration
5	Delayed heave
Reduced performance:	
16	Horizontal position and velocity
17	Roll and pitch
18	
19	Heave and vertical velocity
20	Acceleration
21	Delayed heave

NAV binary

The NAV binary protocol contains Time, Latitude, Longitude, Altitude, Heave, North velocity, East velocity, Down velocity, Roll, Pitch, Heading, Roll rate, Pitch rate, Yaw rate, Status and checksum.

The NAV binary protocol is a proprietary binary format output from Exail (former iXblue). The format has 42 bytes length.

For a detailed description of the NAV binary format, see the *INS - Interface Library* document from iXblue.

OCTANS TAH

The OCTANS TAH protocol contains Time, Heading latency, Heading, Heading status, Roll, Roll status, Pitch, Pitch status, Heave in sensor location, Heave status, Heave in MP1, Surge in sensor location, Sway in sensor location, Heave velocity, Surge velocity, Sway velocity, Heading rate of turn and checksum.

The OCTANS TAH prototcol is a NMEA 0183 based compatible string output from iXBlue products. The format is ASCII based and maximum output rate is 20 Hz at baudrate 115200.

For a detailed description of the OCTANS TAH format, see the *INS - Interface Library* document from iXblue.

Output variables

Output variables

This is a list of the output variables from the system. These variables are presented in the **Data presentation** tab in the MRC+ configuration software.

No.	Variable name	Unit	Description
1	AngRate_R	[rad/s]	Angular rate in roll axis (b-frame)
2	AngRate_P	[rad/s]	Angular rate in pitch axis (b-frame)
3	AngRate_Y	[rad/s]	Angular rate in yaw axis (b-frame)
7	AngRate_F	[rad/s]	Angular rate in the forward axis (h-frame)
8	AngRate_S	[rad/s]	Angular rate in the starboard axis (h-frame)
9	AngRate_D	[rad/s]	Angular rate in the down axis (h-frame)
10	RateOfTurn	[rad/s]	Rate of turn
11	AccM_Rf	[m/s^2]	Low pass filtered measured acceleration in the roll axis in the MRU point (gravity not subtracted)
12	AccM_Pf	[m/s^2]	Low pass filtered measured acceleration in the pitch axis in the MRU point (gravity not subtracted)
13	AccM_Yf	[m/s^2]	Low pass filtered measured acceleration in the yaw axis in the MRU point (gravity not subtracted)
14	RateOfTurnFilt	[rad/s]	Filtered rate of turn
31	T.sensor house	[DegC]	Sensor house temperature
60	AngAcc_R	[rad/s^2]	Angular acceleration in roll axis (b-frame)
61	AngAcc_P	[rad/s^2]	Angular acceleration in pitch axis (b-frame)
62	AngAcc_Y	[rad/s^2]	Angular acceleration in yaw axis (b-frame)
63	Roll	[rad]	Roll angle (euler angle)

No.	Variable name	Unit	Description
64	Pitch	[rad]	Pitch angle (euler angle)
65	Yaw	[rad]	Yaw angle (euler angle)
66	RollHippy	[-1 1]	Sine of roll angle relative horizontal plane, Datawell Hippy compatible
67	PitchHippy	[-1 1]	Negative pitch angle sine, Datawell Hippy compatible
68	Heading	[rad]	Heading (Yaw angle represented in the interval from 0 to 2*pi)
69	TiltCosine	[-1 1]	Tilt angle cosine
70	MsgIndex	[ ]	Incrementing message index
72	SyncInfo	[int]	Time Sync info: number of syncs, date or PPS, valid, milliseconds change
90	IntHeave	[m]	Heave in configured measurement point. Integrated heave solution
91	IntHeaveVel	[m/s]	Heave velocity in configured measurepoint. Integrated heave solution
92	HeaveUnrel	[ ]	Heave transient indicator for integrated heave solution
93	IntHeight	[m]	Height in configured monitoring point. Integrated heave solution.
129	AutomaticPeriod	[s]	Heave period used in the automatic heave filter
148	ExtPosDelay	[s]	External position input time delay relative to internal clock
159	HeavePeriod	[s]	Estimated heave period. Output range 4 to 25 seconds.
160	ExtSpeed	[m/s]	Speed estimated from external speed input
161	ExtSpeedUser	[m/s]	External speed input from user
162	ExtHeadUser	[degrees]	External heading input from user
167	SampleTime.ms	[ms]	Seconds since 1970, millisecond fraction
168	SampleTime.s	[s]	Seconds since 1970.01.01 00:00.00 UTC
169	SampleTime.n	[nano]	Seconds since 1970, nanosecond fraction
173	Status	[ ]	MRU status bit that indicates its internal status
176	SampleTime	[ms]	Sample time in milliseconds since power on
177	CpuLoad	[ ]	Cpu load
178	UnitID	[ ]	Serial number or user supplied Unit ID
185	ExtCourseUser	[rad]	External (user) course over ground input

Linear motion variables in the MRU location

Variable 200 to 250.

No	Variable name	Unit	Description
200	AccMru_F	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in forward direction (h-frame)
201	AccMru_S	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in starboard direction (h-frame)
202	AccMru_D	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in down direction (h-frame)
203	AccMru_Ff	[m/s^2]	Low pass filtered acceleration at MRU point in forward direction (h-frame)
204	AccMru_Sf	[m/s^2]	Low pass filtered acceleration at MRU point in starboard direction (h-frame)
205	AccMru_Df	[m/s^2]	Low pass filtered acceleration at MRU point in down direction (h-frame)
206	AccMru_N	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in north direction (g-frame)
207	AccMru_E	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in east direction (g-frame)
208	AccMru_D	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in down direction (g-frame)
209	AccMru_Nf	[m/s^2]	Low pass filtered acceleration in north (g-frame) direction at the MRU point
210	AccMru_Ef	[m/s^2]	Low pass filtered acceleration in east (g-frame) direction at the MRU point
211	AccMru_Df	[m/s^2]	Low pass filtered acceleration in down direction (g-frame) at the MRU point
212	VelMru_F	[m/s^2]	Linear velocity at MRU point in forward direction (h-frame)
213	VelMru_S	[m/s^2]	Linear velocity at MRU point in starboard direction (h-frame)
214	VelMru_D	[m/s^2]	Linear velocity at MRU point in down direction (h-frame)
218	VelMru_N	[m/s^2]	Velocity in north direction (g-frame) at the MRU point
219	VelMru_E	[m/s^2]	Velocity in east direction (g-frame) at the MRU point
220	VelMru_D	[m/s^2]	Velocity in down direction (g-frame) at the MRU point
224	PosMru_F	[m]	Linear position at MRU point in forward direction (h-frame)
225	PosMru_S	[m]	Linear position at MRU point in starboard direction (h-frame)

No	Variable name	Unit	Description
226	PosMru_D	[m]	Linear position at MRU point in down direction (h-frame)
234	dSurgeMru	[m]	Delayed surge output at MRU point in north direction (h-frame). Output delayed 33 seconds from real-time
235	dSwayMru	[m]	Delayed sway output at MRU point in east direction (h-frame). Output delayed 33 seconds from real-time
236	dHeaveMru	[m]	Delayed heave output at MRU point in down direction (h-frame). Output delayed 132 seconds from real-time
238	AccMru_R	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in R-direction (b-frame)
239	AccMru_P	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in P-direction (b-frame)
240	AccMru_Y	[m/s^2]	Linear acceleration (raw/unfiltered) at MRU point in Y-direction (b-frame)
241	AccMru_Rf	[m/s^2]	Low pass filtered acceleration at MRU point in R-direction (b-frame)
242	AccMru_Pf	[m/s^2]	Low pass filtered acceleration at MRU point in P-direction (b-frame)
243	AccMru_Yf	[m/s^2]	Low pass filtered acceleration at MRU point in Y-direction (b-frame)
244	VelMru_R	[m/s^2]	Linear velocity at MRU point in R-direction (b-frame)
245	VelMru_P	[m/s^2]	Linear velocity at MRU point in P-direction (b-frame)
246	VelMru_Y	[m/s^2]	Linear velocity at MRU point in Y-direction (b-frame)
247	PosMru_R	[m]	Linear position at MRU point in R-direction (b-frame)
248	PosMru_P	[m]	Linear position at MRU point in P-direction (b-frame)
249	PosMru_Y	[m]	Linear position at MRU point in Y-direction (b-frame)

Linear motion variables in CG (Centre of Gravity)

Variables 250 to 300.

No	Variable name	Unit	Description
250	AccCg_F	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in forward direction (h-frame)
251	AccCg_S	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in starboard direction (h-frame)

No	Variable name	Unit	Description
252	AccCg_D	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in down direction (h-frame)
253	AccCg_Ff	[m/s^2]	Low pass filtered acceleration at CG in forward direction (h-frame)
254	AccCg_Sf	[m/s^2]	Low pass filtered acceleration at CG in starboard direction (h-frame)
255	AccCg_Df	[m/s^2]	Low pass filtered acceleration at CG in down direction (h-frame)
256	AccCg_N	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in north direction (g-frame)
257	AccCg_E	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in east direction (g-frame)
258	AccCg_D	[m/s^2]	Linear acceleration (raw/unfiltered) at CG in down direction (g-frame)
259	AccCg_Nf	[m/s^2]	Low pass filtered acceleration in north (g-frame) direction at CG
260	AccCg_Ef	[m/s^2]	Low pass filtered acceleration in east (g-frame) direction at CG
261	AccCg_Df	[m/s^2]	Low pass filtered acceleration in down direction (g-frame) at CG
262	VelCg_F	[ms]	Linear velocity at CG in forward direction (h-frame)
263	VelCg_S	[ms]	Linear velocity at CG in starboard direction (h-frame)
264	VelCg_D	[ms]	Linear velocity at CG in down direction (h-frame)
268	VelCg_N	[ms]	Velocity in north direction (g-frame) at CG
269	VelCg_E	[ms]	Velocity in east direction (g-frame) at CG
270	VelCg_D	[ms]	Velocity in down direction (g-frame) at CG
274	PosCg_F	[m]	Linear position at CG in forward direction (h-frame)
275	PosCg_S	[m]	Linear position at CG in starboard direction (h-frame)
276	PosCg_D	[m]	Linear position at CG in down direction (h-frame)
286	dHeaveCg	[m]	Delayed heave output at Cg in down direction (g-frame)

Linear motion variables in monitoring point 1, MP1

Variables 300 to 350.

No	Variable name	Unit	Description
300	AccMp1_F	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in forward direction (h-frame)
301	AccMp1_S	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in starboard direction (h-frame)
302	AccMp1_D	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in down direction (h-frame)
303	AccMp1_Ff	[m/s^2]	Low pass filtered acceleration at the first monitoring point in forward direction (h-frame)
304	AccMp1_Sf	[m/s^2]	Low pass filtered acceleration at the first monitoring point in starboard direction (h-frame)
305	AccMp1_Df	[m/s^2]	Low pass filtered acceleration at the first monitoring point in down direction (h-frame)
306	AccMp1_N	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in north direction (g-frame)
307	AccMp1_E	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in east direction (g-frame)
308	AccMp1_D	[m/s^2]	Linear acceleration (raw/unfiltered) at the first monitoring point in down direction (g-frame)
309	AccMp1_Nf	[m/s^2]	Low pass filtered acceleration in north direction (g-frame) at the first monitoring point
310	AccMp1_Ef	[m/s^2]	Low pass filtered acceleration in east direction (g-frame) at the first monitoring point
311	AccMp1_Df	[m/s^2]	Low pass filtered acceleration in down direction (g-frame) at the first monitoring point
312	VelMp1_F	[m/s]	Linear velocity at the first monitoring point in forward direction (h-frame)
313	VelMp1_S	[m/s]	Linear velocity at the first monitoring point in starboard direction (h-frame)
314	VelMp1_D	[m/s]	Linear velocity at the first monitoring point in down direction (h-frame)
318	VelMp1_N	[m/s]	Velocity in north direction (g-frame) at the first monitoring point
319	VelMp1_E	[m/s]	Velocity in east direction (g-frame) at the first monitoring point

No	Variable name	Unit	Description
320	VelMp1_D	[m/s]	Velocity in down direction at the first monitoring point
323	LA_VelMp1_D	[m/s]	Velocity in down direction (g-frame) at MP1, lever arm compensated from CG. The mean velocity depends on vessel tilt
324	PosMp1_F	[m]	Linear position at the first monitoring point in forward direction (h-frame)
325	PosMp1_S	[m]	Linear position at the first monitoring point in starboard direction (h-frame)
326	PosMp1_D	[m]	Linear position at the first monitoring point in down direction (h-frame)
335	LA_PosMp1_D	[m]	Lever arm compensated linear position relative to Cg in the first monitoring point in down direction (g-frame). The mean position depends on vessel tilt
336	dHeave Mp1	[m]	Delayed heave output at the first monitoring point in down direction (g-frame)

Linear motion variables in monitoring point 2, MP2

Variables 350 to 400.

No	Variable name	Unit	Description
350	AccMp2_F	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in forward direction (h-frame)
351	AccMp2_S	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in starboard direction (h-frame)
352	AccMp2_D	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in down direction (h-frame)
353	AccMp2_Ff	[m/s^2]	Low pass filtered acceleration at the second monitoring point in forward direction (h-frame)
354	AccMp2_Sf	[m/s^2]	Low pass filtered acceleration at the second monitoring point in starboard direction (h-frame)
355	AccMp2_Df	[m/s^2]	Low pass filtered acceleration at the second monitoring point in down direction (h-frame)
356	AccMp2_N	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in north direction (g-frame)
357	AccMp2_E	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in east direction (g-frame)

No	Variable name	Unit	Description
358	AccMp2_D	[m/s^2]	Linear acceleration (raw/unfiltered) at the second monitoring point in down direction (g-frame)
359	AccMp2_Nf	[m/s^2]	Low pass filtered acceleration in north direction (g-frame) at the second monitoring point
360	AccMp2_Ef	[m/s^2]	Low pass filtered acceleration in east direction (g-frame) at the second monitoring point
361	AccMp2_Df	[m/s^2]	Low pass filtered acceleration in down direction (g-frame) at the second monitoring point
362	VelMp2_F	[m/s]	Linear velocity at the second monitoring point in forward direction (h-frame)
363	VelMp2_S	[m/s]	Linear velocity at the second monitoring point in starboard direction (h-frame)
364	VelMp2_D	[m/s]	Linear velocity at the second monitoring point in down direction (h-frame)
368	VelMp2_N	[m/s]	Velocity in north direction (g-frame) at the second monitoring point
369	VelMp2_E	[m/s]	Velocity in east direction (g-frame) at the second monitoring point
370	VelMp2_D	[m/s]	Velocity in down direction (g-frame) at the second monitoring point
373	LA_VelMp2_D	[m/s]	Lever arm compensated linear velocity relative to Cg in the second monitoring point in down direction (g-frame). The mean velocity depends on vessel tilt
374	PosMp2_F	[m]	Linear position at the second monitoring point in forward direction (h-frame)
375	PosMp2_S	[m]	Linear position at the second monitoring point in starboard direction (h-frame)
376	PosMp2_D	[m]	Linear position at the second monitoring point in down direction (h-frame)
385	LA_PosMp2_D	[m]	Lever arm compensated linear position relative to Cg in the second monitoring point in down direction (g-frame). The mean position depends on vessel tilt
386	dHeaveMp2	[m]	Delayed heave output at the second monitoring point in down direction (g-frame)

Related topics

Data presentation tab, page 90
Status bits description, page 205

Status bit specifications

Topics

Status bit overview

The MRU sends out status bits which represent various system states. The status bits are presented in the **Status** tab in the MRC+ application.

The MRU sensor maintains a 32–bit status word, where each bit denotes different system states. Bit 0 is the least significant bit. Each bit will be set (1), or cleared (0). The whole status word is selectable as a variable for data formats which support user selectable variables. It should be selected as an INTEGER, not FLOAT.

Bit	Message	Description
0	SYS_NORM	Normal mode
1	SYS_ABNORM	Abnormal mode
4	SYS_TIMESYNC	Time synchronized
5	SYS_CLOCKSYNC	Clock synchronized
6	SYS_ANA_ON	Analog outputs ON
7	SYS_SENSERR	Sensor error
8	SYS_KALMAN_INIT	Initialization
9	SYS_HEAD_INIT	Heading alignment
10	SYS_MODEL_UNREL	Model unreliable
11	SYS_HORIZ_UNREL	Horizontal position unreliable
12	SYS_HORIZ_REDUCED	Horizontal position reduced accuracy
13	SYS_HEAVE_UNREL	Heave unreliable

Bit	Message	Description
14	SYS_HEAVE_REDUCED	Heave reduced accuracy
15	SYS_ROLLP_UNREL	Roll/pitch unreliable
16	SYS_ROLLP_REDUCED	Roll/pitch reduced accuracy
17	SYS_HEAD_UNREL	Heading unreliable
18	SYS_HEAD_REDUCED	Heading reduced accuracy
19	SYS_SPEED_AIDED	Speed aided
20	SYS_HEAD_AIDED	Heading aided
21	SYS_EXTPOS	External position input
22	SYS_EXTVEL	External velocity input
23	SYS_EXTYAW	External yaw input
24	SYS_POS_AIDED	Position aided
25	SYS_HEIGHT_AIDED	Height aided
26	SYS_SS_AIDED	Surge/sway aided
27	SYS_BAD_ENV	Bad environment
28	SYS_HIGH_LOAD	High CPU load
29	SYS_LAT_UNREL	Latitude unreliable
31	SYS_GST_AIDED	GST (position accuracy) aided

Related topics

Status tab, page 88

Status bits description

The various status bits are explained in more detail.

Mode

BIT 0: SYS_NORM - Normal mode

Normal mode indicates that no serious system error is detected, and that the overall MRU health seem to be OK.

Note:

This bit does not say anything about data integrity. For data integrity, check the data status and the SYS_MODEL_UNREL bit.

BIT 1: SYS_ABNORM - Abnormal mode

If the MRU abnormal bit is high, a serious system error has been detected. In *Abnormal* mode the MRU senor will flash with (only) red light on the LED. If the MRU is in *Abnormal* mode: connect the unit to the MRC+ configuration program to get more information about the error. If the error cannot be fixed by downloading a new configuration file, then contact customer support. Errors that would lead to an MRU in *Abnormal* mode are for example a malicious configuration file or a hardware error.

Time synchronization

BIT 4: SYS_TIMESYNC - Time synchronized

The MRU can be time synchronized to an external system by PPS pulse and/or ZDA, NTP or TSC messages. The SYS_TIMESYNC bit is set when the unit is synchronized by a PPS pulse. The PPS input synchronizes the “fraction of a second” part of the unit’s clock.

BIT 5: SYS_CLOCKSYNC - Clock synchronized

The SYS_CLOCKSYNC bit is set when the MRU date is synchronized to an external time source, for example ZDA input. If both PPS and ZDA are input to the unit, PPS will be used for synchronizing the fraction of the second and the ZDA to synchronize the seconds part of the clock. The unit clock is available as the Time variables in the output variable list.

Analog output

BIT 6: SYS_ANA_ON - Analog output On

The SYS_ANA_ON bit is set when the MRU outputs analog data through the junction box. This is only possible with a junction box with analog outputs.

Filter initialization

BIT 8: SYS_KALMAN_INIT - Kalman filter initialization

The Kalman initialization bit is set when the attitude filter (Roll/Pitch) is initializing. This initialization is only at startup of the MRU.

BIT 9: SYS_HEAD_INIT - Heading alignment

If the Heading initialization bit is set, the gyrocompass is in Heading initialization or Heading alignment mode.

Note:

This bit is only used for the gyrocompass (MGC), not for a regular MRU.

Data integrity

BIT 10: SYS_MODEL_UNREL - Model unreliable

This bit is set if at least one of the following bits are set: SYS_ROLLP_UNREL, SYS_KALMAN_INIT, SYS_ROLLP_UNREL, SYS_SENSERR, SYS_HEAVE_UNREL. This bit selects between q and Q in the MRU normal (binary) format.

Data status

BIT 11: SYS_HORIZ_UNREL - Horizontal position unreliable

BIT 12: SYS_HORIZ_REDUCED - Horizontal position reduced accuracy

BIT 13: SYS_HEAVE_UNREL - Heave unreliable

BIT 14: SYS_HEAVE_REDUCED - Heave reduced accuracy

BIT 15: SYS_ROLLP_UNREL - Roll and pitch unreliable

BIT 16: SYS_ROLLP_REDUCED - Roll and pitch reduced accuracy

BIT 17: SYS_HEAD_UNREL - Heading unreliable

BIT 18: SYS_HEAD_REDUCED - Heading reduced accuracy

Data status is reported for four different sets: Horizontal position, Heave, Roll/Pitch and Heading. There are 2 bits for each set, x_UNREL and x_REDUCED. A combination of these bits gives the following states for each set:

- **OK**: Both x_UNREL and x_ REDUCED bit are cleared
- **UNRELIABLE**: x_UNREL is set and x_REDUCED bit is cleared
- **REDUCED**: x_UNREL is cleared and x_REDUCED bit is set.
- **NOT AVAILABLE**: Both x_UNREL and x_ REDUCED bit are set

Horizontal position

Horizontal position status is only used for an MGC in Inertial navigation mode.

Note:

*The MGC only outputs absolute position when it is configured as an inertial navigation system (INS). For an MRU the horizontal position status is always set to **Not available**.*

Heading - MRU

The heading status for an MRU is set to **Not available** if no heading input is present. If a valid heading input is sent to the MRU, the MRU heading output will first have a transient period in order to align the internal heading to the input heading. In this alignment phase, the heading status will be set to **Unreliable**. When the difference between the input heading

and the internal MRU heading is less than 6 degrees, the MRU heading status will be changed to **Reduced**. If the difference between the input heading and the MRU heading is less than 0.5 degrees, the heading status will be set to **OK**. Hence, if the MRU reports reduced heading it means that the MRU yaw gyro measurement does not follow the heading input with high accuracy. This can for example be the case if there is a delay in the heading input or if the heading input is noisy.

Note:

*A delay in the heading input can be adjusted by modifying the **External heading age** parameter in the MRC+ configuration program.*

Heading - MGC

For the MGC gyrocompass the heading will be unreliable a couple of minutes after power on due to filter initialization. When the MGC has made a first estimate of the heading it will enter the alignment phase where the heading status will change to **Reduced**. This alignment phase of the MGC is indicated by the SYS_HEAD_INIT bit being high. When the alignment phase is finished, the MGC will output **OK** heading status if all integrity checks are passed. If the MGC reports **Unreliable** or **Reduced** heading after the alignment phase, there is a problem with either integrity or missing external inputs. Check the **Status** tab in the MRC+ configuration program to see if all needed external inputs are present.

Roll/ pitch

The roll and pitch status will be **Unreliable** during the initialization phase of the attitude filter or if internal integrity checks fail. The roll/pitch status is set to **Reduced** if estimated gyro biases are not as stable as expected.

Note:

A reduced status could occur due to several environmental factors, such as high temperature gradients, noisy or missing external input or a bad location of the MRU.

Heave

Heave status will be set to **Unreliable** during the heave initialization phase and if the heave signal reaches the configured maximum limits for heave position and heave velocity (heave clamping). The heave status will be set to **Reduced** if the internal integrity algorithms detect a heave transient or an acceleration bias out of range.

Note:

Heave transients can occur due to uncompensated centripetal acceleration in turn or due to changes of the mean height position of the MRU, for example due to vessel loading or unloading at harbour.

External input

Three different bits indicate that the MRU receives external input.

BIT 21: SYS_EXTPOS - External position

Set if external position input is received.

BIT 22: SYS_EXTVEL - External velocity

Set if external velocity input is received.

BIT 23: SYS_EXTYAW - External yaw

Set if external heading input is received

If an external input passes internal integrity checks and is accepted for use, the MRU will report that it is aided by the given external source.

BIT 19: SYS_SPEED_AIDED - Speed aided

The SYS_SPEED_AIDED bit is set when speed input is accepted.

BIT 20: SYS_HEAD_AIDED - Heading aided

The SYS_HEAD_AIDED bit is only used for an MRU and will be set when the heading status is **OK** or **Reduced**. Used for MRU only.

BIT 24: SYS_POS_AIDED - Position aided

The SYS_POS_AIDED bit is mainly used for an MGC and is set if the position input has been accepted.

BIT 25: SYS_HEIGHT_AIDED - Height aided

The SYS_HEIGHT_AIDED bit is set if the integrated heave filter is configured to Height aided mode and external height input is accepted.

BIT 26: SYS_SS_AIDED - Surge/sway aided

The SYS_SS_AIDED bit is set if the surge/sway filter is configured to Integrated mode and external surge/sway measurements are accepted.

BIT 31: SYS_GST_AIDED - GST aided

The SYS_GST_AIDED bit is set if an MGC is configured to Inertial navigation mode and GST input is accepted. Used for MGC inertial mode only.

Environment and sensor health

BIT 27: SYS_BAD_ENV - Bad environment

The bad environment bit SYS_BAD_ENV indicates a too high or too low system temperature.

BIT 28: SYS_HIGH_LOAD - High CPU load

The SYS_HIGH_LOAD bit indicates a too high processor load. This can be due to outputting too many variables at a high output rate in an ASCII based format on many channels at the same time. This problem can be fixed by reducing the number of output variables or reducing the output rate or using a binary output format.

Note:

*The CPU load can be monitored by outputting the **cpu_load** variable.*

BIT 29: SYS_LAT_UNREL - Latitude unreliable

The SYS_LAT_UNREL bit indicates that latitude is rejected. This can be due to incorrect latitude input from GNSS (Global Navigation Satellite System) receiver or that the latitude is set incorrectly on the configuration file (default value is 0) at startup of the MRU. Heavy accelerations during initialization (3 – 4 minutes from power-on) should be avoided. If this bit is set after the unit has been in operation for a while, the restart the unit with a correct latitude from power-on. Either from the GNSS receiver or by manual input.

BIT 7: SYS_SENSERR - Sensor error

The SYS_SENSERR bit is set if an internal integrity check detects a sensor abnormality. Abnormalities which are checked for are:

- **Communication with internal sensors**: A temporary loss of internal sensor communication.
- **Clipping (overrange) of sensor readings**: This could happen if the unit is exposed to an abrupt motion.
- **Out-of-limit temperatures in sensors**: If the unit is operated in a too high ambient temperature for a long time.
- **Out-of-limit system temperature**: If the unit is operated in a too high ambient temperature for a long time.
- **Internal voltage errors**: Make sure that internal voltages are within limits.
- **Accelerometer vector length**: Make sure that the accelerometer vector length is 1 g ± 0.8 g within 500 ms, and 1 g ± 0.2 g within 60 seconds.

If any of these abnormalities are detected, the SYS_SENSERR bit is set. The MRU sensor LED will flash magenta at 2 Hz to alert the operator. The

SYS_MODEL_UNREL bit will also be set. This situation will last for 60 seconds after the abnormalities eventually disappears. Thereafter the unit will continue as normal. An event will be logged for each abnormality detected.

Related topics

Status tab, page 88
Output variables, page 195

Event numbers

Event and warning numbers overview

This is a list of the event numbers which may have occurred in the system. These numbers are presented in the **Status** tab in the MRC+ configuration software.

No.	Message	Description
1	EV_STARTUP_OK	Date and time at last startup (power on)
2	EV_STARTUP_ERR	Error during startup
6	EV_PARSE_ERR	Parsing error
7	EV_MESSAGE_ERR	Message error
8	EV_SETCLOCK	Set MRU sensor clock
10	EV_INFO	Information on program or configuration change
11	EV_MSTATE	Change of model state (reliable or unreliable)
12	EV_BAD_TEMP	Too high internal temperature
19	EV_IMPROP_PWRDOWN	Improper power down or unexpected restart
22	EV_EXT_VAL_BAD	Bad validation of external input data
23	EV_INTERNAL_SYS	Internal system information
24	EV_SENSOR_INTEGRITY	Sensor integrity (lack of agreement between gyro and accelerometers)

Equipment handling

Topics

Taking delivery

When the equipment arrives at its destination:

- Perform an inspection immediately to register any damage that may have occurred in transit.
- If you find any damage, both the insurance company and the shipping agent must be informed immediately.

Unpacking and handling

Care should be taken when unpacking and handling the equipment. A visual inspection should be made to check that the equipment has not been damaged during shipment and that all components and parts are present according to the packing list.

The equipment contains delicate electronic components – handle with care and avoid shocks.

The equipment can be lifted by hand.

Storage

After the equipment in the boxes has been inspected and it has been verified that no damage has occurred, the equipment must be stored in its original packaging until the time of installation. The storage premises must be dry and well protected.

Verify that the location meets the environmental requirements defined for the equipment.

Sensor Unit transportation box

The unit is shipped in a specially designed transportation box. Keep the unit stored within the box until everything is ready for installation of the unit.

Note:

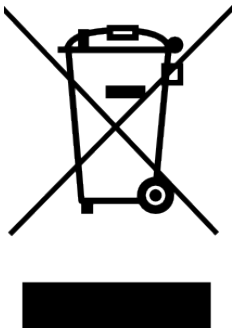
After the unit has been installed, please keep the transportation box. The unit must be shipped in this box for maintenance or repair in order to maintain the warranty.

Related topics

Environmental specifications, page 151

Disposal

At the end of the product lifetime, all parts and products must be disposed of in an environmentally-friendly way.



All electrical and electronic parts and components must 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. This 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.

All disposal of mechanical, electromechanical, electronic and chemical waste - including all types of batteries - must take place according to national and international rules and regulations. Observe the relevant Waste Electrical and Electronic Equipment (WEEE) regulations.

The equipment can be returned to Kongsberg Discovery AS if there is no local WEEE collection. The equipment is marked with this waste pictogram.

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