

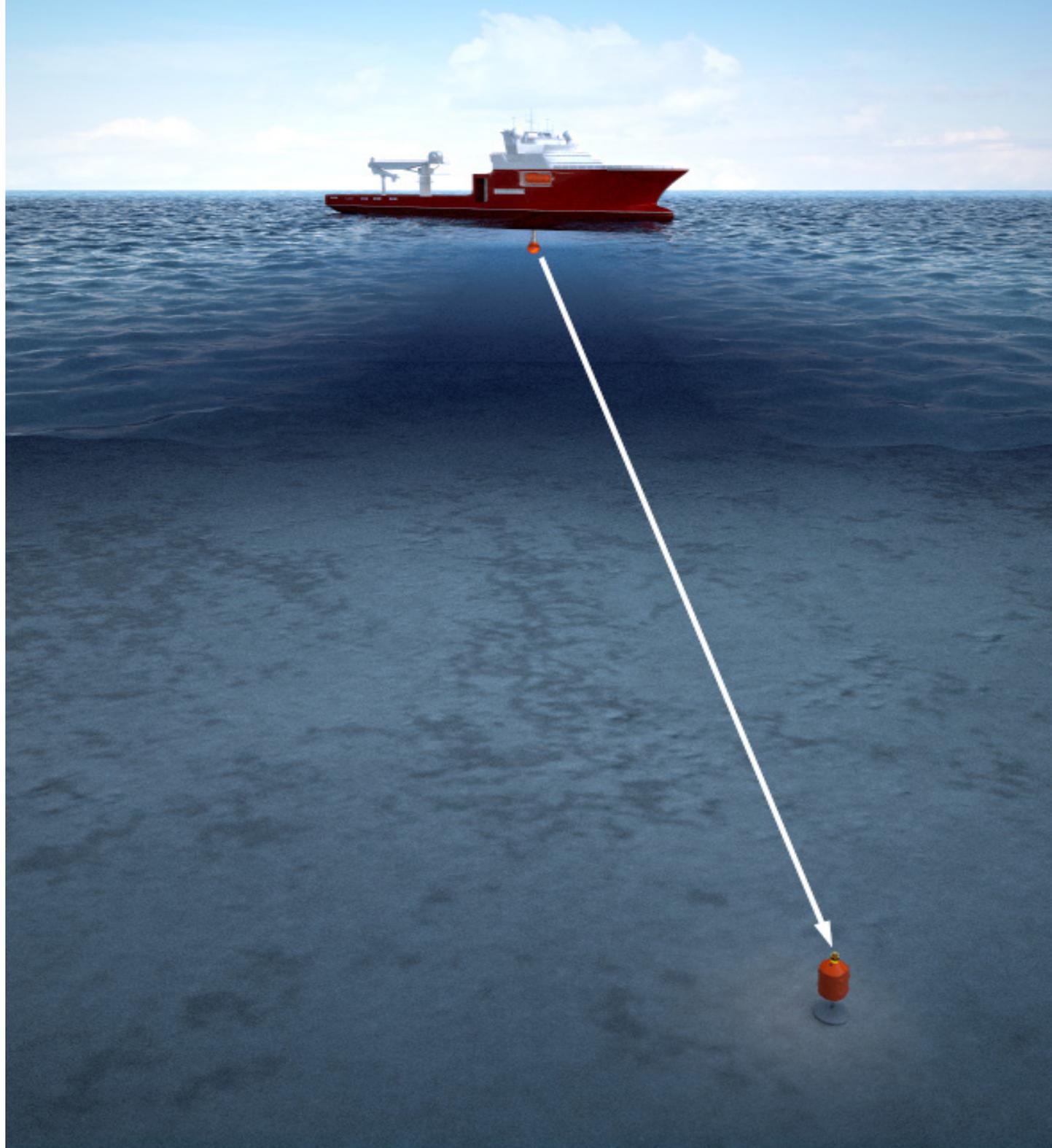
Instruction Manual



KONGSBERG

HAIN Reference

Hydroacoustic Aided Inertial Navigation





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Hydroacoustic Aided Inertial Navigation
Instruction Manual

Document history

Rev	Date	Written by	Checked by	Approved by
H	28 August 2015	IJG/ABW	TRE	ABW
	Updated maintenance and LRUs.			
I	17 August 2016	IJG/ABW	TRE	ABW
	Changed location and packaging. Removed sections on old IMUs.			

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Disclaimer

Kongsberg Maritime endeavours to ensure that all information in this document is correct and fairly stated, but does not accept liability for any errors or omission.

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. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment. Kongsberg Maritime disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

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Remarks

The reader

The installation information in this manual is intended for the design and installation engineers at the shipyard performing the installation. The information is supplied as the basis for the shipyard's own installation drawings applicable to the vessel. On completion of the installation, this manual must be kept on the vessel for reference purposes during system maintenance.

The operator information in this manual is intended to be used by the system operator. He/she should be experienced in the operation of positioning systems, or should have attended a Kongsberg Maritime training course.

The maintenance information in this manual is intended to be used by a trained maintenance technician or engineer, with experience of electronic and digital circuitry, computers and electromechanical design. The level of information is based on Kongsberg Maritime's maintenance philosophy: The onboard technical personnel shall, with the help of the documentation and the system's built-in test functions, be able to identify malfunctions, locate the fault, and replace major parts, modules and components on the "Line Replaceable Unit" (LRU) level. He/she will however not attempt to repair the LRUs.

HIGH VOLTAGE SAFETY WARNING

The voltages used to power this equipment are potentially lethal. Even 110 volts can kill.

Whenever possible, the following precautionary measures should be taken before any work is carried out inside the equipment:

- Switch off all high-voltage power supplies.
- Check the operation of any door interlocks and any other safety devices.
- Completely discharge all high-voltage capacitors.

It should be noted that interlocks and safety devices are normally located only at regular access points, and high voltages may be exposed during dismantling.

Caution

Never work alone on high-voltage equipment! Refer to general safety procedures.

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1 ABOUT THIS MANUAL

The manual contains descriptions, specifications, procedures and illustrations required to install, operate and maintain the system units.

The manual also defines the equipment responsibility, and provides general information about preservation, packing and storage of the units.

The system is described down to circuit board level, named as the Line Replaceable Units (LRUs). Block diagrams and drawings are used to simplify the descriptions.

References

- HiPAP 502/452/352/102 System Instruction Manual
- APOS Online help

Abbreviations

APOS	Acoustic Positioning Operator Station
DP	Dynamic Positioning
dGPS	differential Global Positioning System
GPS	Global Positioning System
HAIN	Hydroacoustic Aided Inertial Navigation
HiPAP	High Precision Acoustic Positioning
HPR	Hydroacoustic Position Reference
IMU	Inertial Measurement Unit
INS	Inertial Navigation System

2 SYSTEM DESCRIPTION

This chapter gives an overall description of the HAIN Reference system.

Topics

- *HAIN Computer on page 2*
- *Inertial Measurement Units on page 3*
- *Operator Station on page 3*

The HAIN units consist of a computer without a monitor and the IMU (Inertial measurement unit) installed on a bracket together with a power supply.

HAIN computer

The HAIN computer executes the navigation algorithm, which consists of Strap-down navigation equations and a Kalman filter. The unit is interfaced to an IMU (Inertial Measurement Unit) and to the APOS (Acoustic Positioning Operator Station).

The HAIN computer receives the aiding positions (latitude/longitude) from the APOS, and it limits the position-drift that is inherent in inertial navigation systems. Vessel position, attitude, speed and expected accuracy, are sent back to the APOS at 1 Hz update.



Figure 1 HAIN computer

Inertial Measurement Units

The IMU consists of three accelerometers and three gyros, measuring the vessel's accelerations and rotation in three axes very accurately (see Figure 2).



Figure 2 HAIN Reference Sensor unit

Operator station - APOS

The HAIN system is operated from APOS and has the following main functions:

- Controls the HAIN system.
- Displays position and sends position and status data.

The information received from the HAIN computer is displayed and sent to external computer(s). APOS can request status information in the HAIN computer to be displayed, which helps the operator to check the system in real-time.

System layout

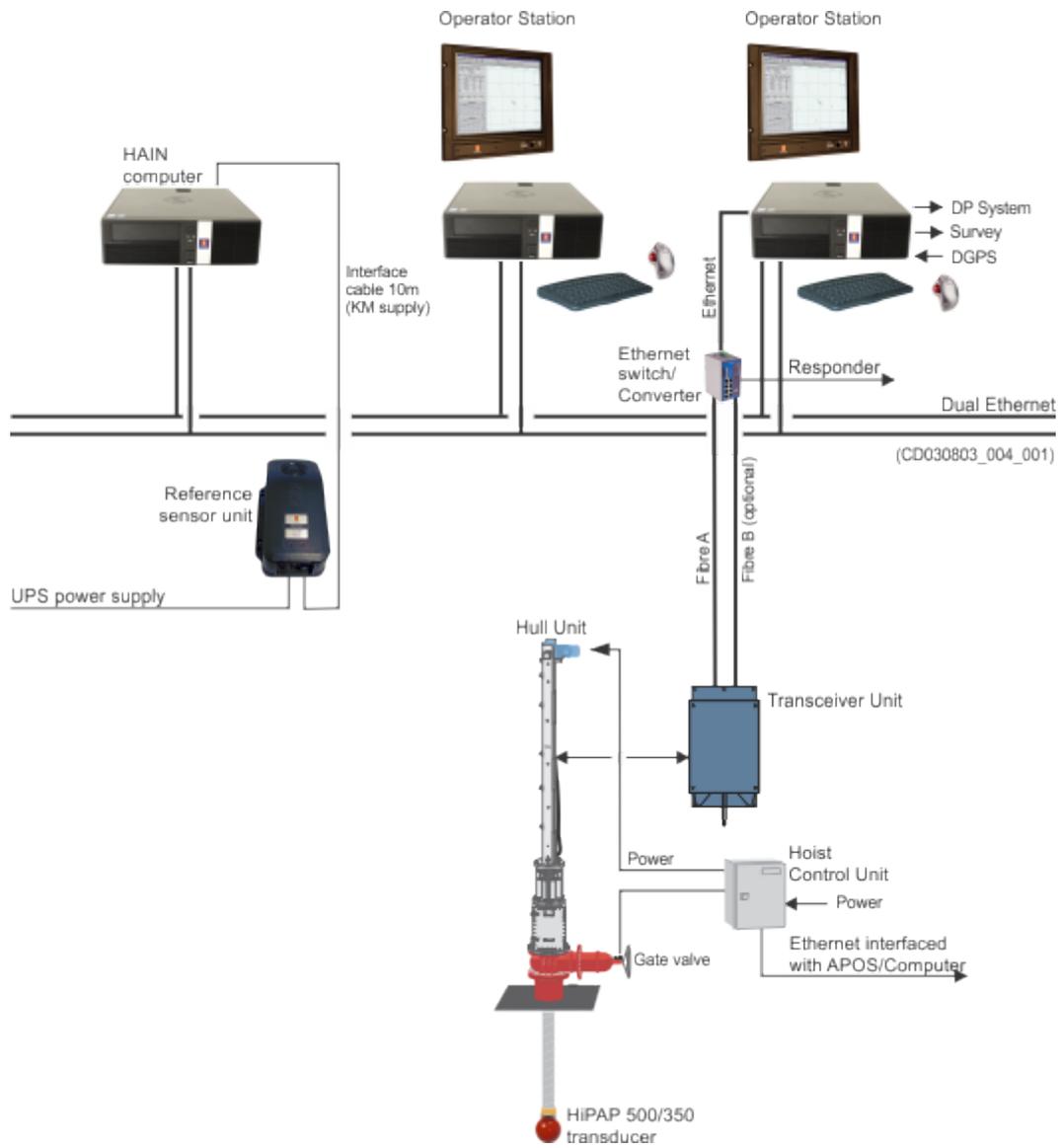


Figure 3 HAIN Reference system layout

3 INTRODUCTION TO HAIN

This chapter gives a general introduction to the HAIN system.

Topics

- *Introduction on page 5*
- *Advantages of HAIN on page 6*
- *Inertial navigation on page 6*
 - *Drift on page 6*
 - *Aiding on page 6*
 - *Gyrocompassing on page 7*

Introduction

The HAIN system is an extension to the High Precision Acoustic Positioning (HiPAP) or Hydroacoustic Position Reference (HPR) systems. HAIN uses acoustic position measurements and inertial navigation to get more precise, accurate, reliable, and frequent position measurements than achieved by the acoustic positioning systems alone. In addition HAIN will provide accurate measurements of the vehicle's velocity and orientation.

HAIN is operated from APOS.

The following two systems are available:

- **HAIN Reference**
 - Supplying accurate position, orientation and velocity of surface vessels. Typically for vessels running Dynamic Positioning (DP).
- **HAIN Subsea**
 - Supplying accurate position, orientation and velocity of tethered underwater vehicles. Typically used in survey applications.

Advantages of HAIN

- Increased accuracy.
- Increased robustness.
- Increased reliability.
- Increased update rate.
- Positioning during acoustic drop out.
- Optimal combination of several sensors' measurements.
- Log of vehicle's motion

Inertial navigation

The base of inertial navigation is the inertial measurement unit (IMU) which measures the acceleration and angular rate in all three dimensions. This is normally done by having three perpendicular gyroscopes and accelerometers.

Navigation on inertial measurement is based on knowing the initial values of position, orientation, and velocity, and integrating the measurements from the IMU from these initial values.

This means:

- Angular rates are integrated to give orientation.
- Accelerations are integrated to give velocities.
- The calculated velocities are integrated to give position.

Drift

The inertial sensors as any other sensor have errors. The integration effectively removes most of the rapid noise, but it also makes the effects of longer term errors increase with time. The errors in inertial navigation system will therefore grow with time. This is usually called drift, as the navigation system slowly drifts off from the correct values. After a while the drift will reach unacceptable levels.

Aiding

Note

To be sure the aiding system is “free” from systematic errors, it is very important that the HIPAP-system has valid offset-parameters based on a TD-alignment. To regard this as “Valid”...no attitude-sensors or offset-values are changed since the TD-alignment was performed. It is also important that the Gyro and VRS is maintained according to specification.

The solution to drift is aiding, meaning external sensors that provide input (corrections) to the navigation system. These can be measurements (one, two or three dimensions) of:

- position
- orientation
- velocity

The external measurements are compared to the estimates of the navigation system and the estimates are then updated accordingly. This will in general control the drift.

In HAIN a Kalman Filter is used to make the combination of external measurements and the estimates into an optimal updated estimate.

Acoustic and inertial positioning principles in combination are ideal, since they have complementary qualities. Acoustic positioning is characterised by relatively high and evenly distributed noise and no drift in the position, whilst inertial positioning has very low short-term noise and relatively large drift in the position over time.

Gyrocompassing

The inertial navigation system, will gyrocompass, provided that the orientation, latitude and velocity is fairly correct and that the angular rate measurements are of sufficient quality.

For many applications though, the initial orientation is not known and some method of determining the initial orientation. This can be achieved by gyrocompassing, which means using the inertial measurements in a slightly different manner together with some knowledge of velocity and latitude to obtain heading, roll, and pitch estimates. These estimates are then initial values for the navigation system to start on.

HAIN uses another orientation sensor, the IMU's internal gyrocompassing algorithm, or its own gyrocompassing algorithm for initialization.

4 TECHNICAL SPECIFICATIONS

This chapter lists the main technical specification for the HAIN units.

Topics

- *HAIN computer on page 8*
- *Inertial Measurement Units on page 8*
- *HAIN Connections on page 9*

HAIN computer

The HAIN computer is the same computer used for the HiPAP system.

Weight:	Approx. 7 kg
Dimensions (WxDxH):	338 x 379 x 100 mm

Power specifications

Voltage:	100/240 VAC 50/60 Hz autosensing 240 W 85+ autosensing power
Power consumption from power supply	240 W

Connections

Parallel port:	1 x HP Parallel Port Adapter
Serial port:	COM1 8 port Bluestorm card
USB:	8 x USB 2.0
VGA:	1 x VGA – implemented on motherboard
Display port:	1 x Display port – implemented on motherboard Display port adapter (HP Display port to DVI-D Adapter)
Audio:	1 x Audio in 1 x Audio out Integrated High Definition audio with AD1884 codec
Others:	2 x PS2 1 x Headphone/line-out 1 x Microphone in

Inertial Measurement Units

HAIN Reference Sensor Unit

General

Weight	9 kg
Width	239 mm
Length	395 mm
Height	171 mm
Operating temperature range	0 to – 60 °C

Power

Requirements	90 - 264 VAC
Consumption nominal	25 W
Input protection	Internal 3.15 A fuse on both lines

HAIN Connections

All connections to and from the computer are made on the rear of the unit.

- VHDC1-68 connector, PORT 1 to 8 for serial line cable (split cable; W-U010a,... W-U010h).
- Ethernet connectors for NET A and Net B
- Ethernet connector - connection to the transceiver unit
- USB ports
- HDMI connector to display
- VGA connector for display
- Trackball (mouse)
- Keyboard PS/2 style connector
- Power input

The computer rear panel may look like the following figure:



Figure 4 Computer rear panel

5 INSTALLATION

This chapter includes the basic information required to install the HAIN units.

Prerequisite

It is very important to read chapter 9 *Equipment handling* on page 29 before installing the HAIN units.

Topics

→ *Inertial Measurement Units* on page 11

→ *HAIN Computer* on page 16

Related topics

→ *Equipment handling* on page 29

→ *Drawings in the Drawing file chapter* from page 38

HAIN Computer

The HAIN computer is supplied without monitor and keyboard.

Unit location

The HAIN computer must be easily accessible during operation of the system.

If IMU Bracket is used; the HAIN computer and IMU Bracket must be installed within 10 m of each other due to length of connecting cable being 10 m and cannot be extended.

Logistics

Safety - Refer to the safety warning in the front of this manual.

Personnel - Minimum 2 trained mechanical/electrical fitters.

Special tools - None.

19" rack installation

The HAIN computer can be supplied with a rail kit for rack mounting.

Procedure

- 1 Mount the rails and brackets onto the unit. Use the bolts and washers provided.
- 2 Follow the procedure provided by the rack manufacturer and mount the unit into the rack.

- 3 Connect the cables.

Desktop installation

The HAIN computer must be placed on a suitable desk or shelf and secured in position using the mounting brackets provided.

- Ensure that the desk/shelf is strong enough to support the weight of the units.
- Check that you can operate the system comfortably before securing the units in position.

Note

Several of the cables are delivered with the units. Connectors and pin allocations for these cables are given in this document for reference only.

Cabling

Ensure that enough excess cable is provided to allow the units to be moved around during maintenance.

- 1 Connect the standard cables between the various units.
- 2 Connect the HAIN computer to the Dual Ethernet and the IMU.
- 3 Check the supply voltages and all cable connections before applying power to the system.

Note

Attaching monitor, mouse and keyboard may be required during installation and inspection. In normal operation the HAIN system is controlled through APOS and does not require any human interface devices (such as mouse, trackball, keyboard or monitor).

Grounding

The computer chassis must be grounded using the ground terminal screw on the computer rear panel. This terminal has to be connected to PE (Protection Earth).



Figure 5 Computer - ground terminal screw

Inertial Measurement Units (IMU)

Unit location

Caution

The IMU makes a high-pitch sound when running, so it is not recommended to install the unit in manned areas.

The HAIN system can be placed anywhere on the vessel. Both computer and sensor unit must be placed in a dry space. Unless there are other consideration the HAIN Reference Sensor unit should be placed close to the HiPAP transducer.

The cable between the HAIN Reference Sensor Unit and HAIN computer can be changed to a longer cable holding the same Cat-5e specifications. (Older HAIN IMUs using non-Ethernet connection to the HAIN computer may not extend the length of the cable.)

Cabling

- 1 Connect the Ethernet cable between the sensor units RJ45 and the HAIN computer's transceiver net.
- 2 The HAIN computer and the IMU are powered by the UPS. Connect the standard cables between the various units.
- 3 One Cat5e or better offshore-grade Ethernet cable has to be installed between the HAIN computer and each of the DP network distribution units (NDU) for Net-A and Net-B.
- 4 Check the supply voltages and all cable connections before applying power to the system.

IMU Location offset

The performance of the HAIN system is affected by how accurate the physical position of the IMU reference point relative to the DP reference point (datum) is entered in the HAIN configuration in APOS. The position must be measured forward/aft, starboard/port and up/down

Caution

The error of measured IMU location must be less than 0.2 meters to avoid possible performance degradation, and less than 0.02 meters to be irrelevant.

Logistics

Safety - Refer to the safety warning in the front of this manual.

Personnel - Minimum 2 trained mechanical/electrical fitters.

Special tools - None.

Drawings – Outline drawings in the Drawing file chapter from page 39

IMU Installation

Care must be taken so the internal cable/plug on the bracket is not damaged during installation or use.

Caution

The IMU sensor is very delicate. Take precaution during unpacking and installation. Do not drop or hit the unit.

The sensor bracket must be installed directly onto the vessel structure.

- Make sure the unit will not be affected by e.g. oscillations from flexible/moving bulkhead panels.
- It is recommended the unit is mounted with the reference x-direction pointing forward and levelled towards the vessel bow.

→ Refer to X-, Y- and Z-axis in Figure 6 and Figure 7.

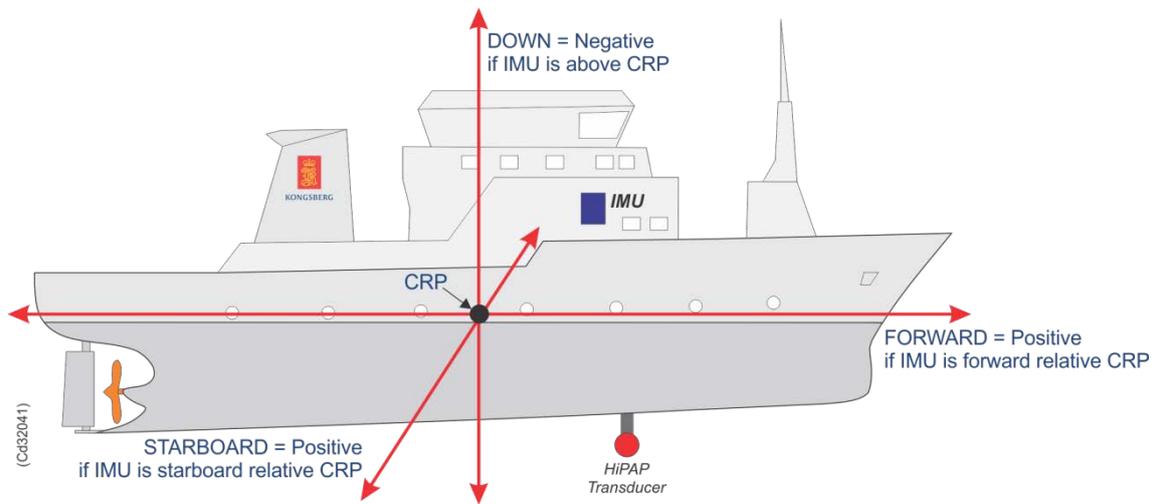


Figure 6 Reference points

Note Figure 6 shows the axis definition of the IMU location.

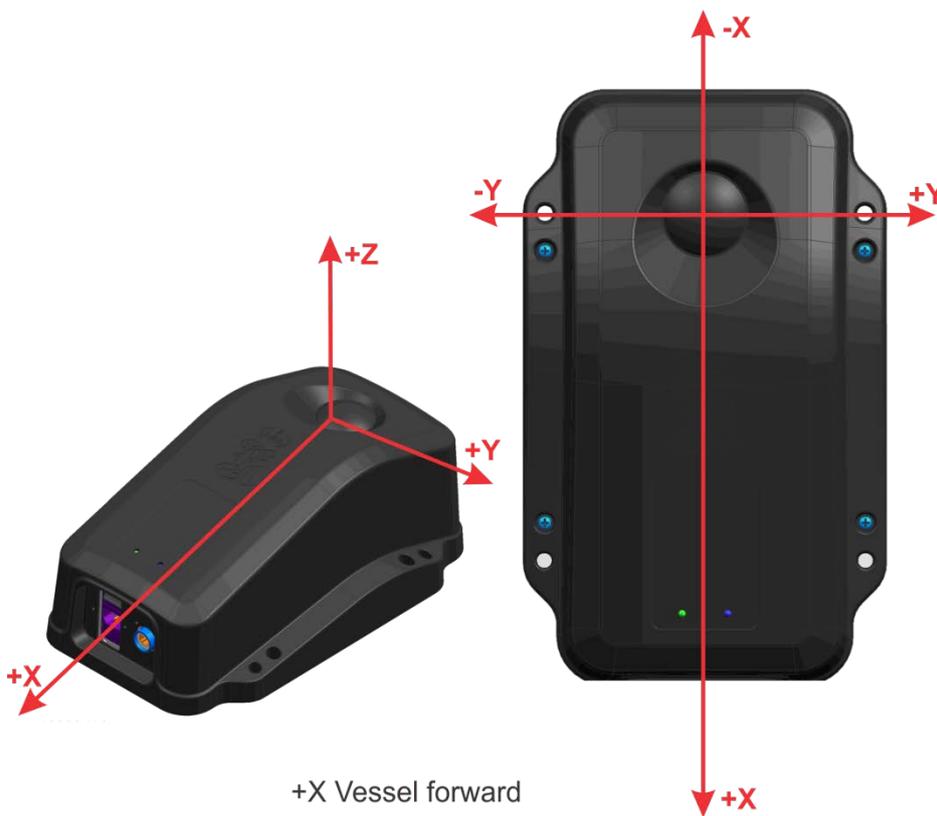


Figure 7 Reference direction of the HAIN Sensor unit

Note Figure 7 shows the axis definitions of the HAIN Sensor unit.

Commissioning

After the mechanical installations are complete the final software setup, configuration, and system calibration can be performed by a KONGSBERG engineer.

During commissioning it is recommended that the vessel is floating freely and has got good acoustic positioning running (either HiPAP or HPR) from at least one stationary geographically fixed transponder or array.

Without any unforeseen problems the commissioning could be completed in 4 hours. Under certain situations though, the KONGSBERG engineer may decide to do additional testing and calibration to ensure that the HAIN system perform as well as possible according to specification.

6 CABLES AND INTERCONNECTIONS

This chapter specifies the interconnection cables for the HAIN system.

Topics

- Cable specification in the table on page 17
- Cable plan on page *Error! Bookmark not defined.*
- Cable list using HAIN Reference Sensor Unit on page 19

Cable specifications in the table

Cable no:	The W-Uxx number (Wire –UNAVxx)
HIPAP cable no.:	001 - xxx: Top system (Ship/Rig) and Hull Unit connections Identical cables same number with a, b, c... Example: W-U00xa, W-U00xb, W-U00xc,...
KM cable ID	W-U001 - W-Uxxx
Core no W-U	The cable core number or colour
Cable no:	The W-Hxx number (Wire –HAINxx)
KM cable ID	W-H001 - W-Hxxx
Core no W-H	The cable core number or colour
Cable from/ Connection type	The name of the unit the cable comes from Plug/Table block etc
Term/Plug Pin no	Terminal (TB) or plug (P) number The connection pin
Cable to/ Connection type	The name of the unit the cable goes to Plug/Table block etc
Term/Plug Pin no	Terminal (TB) or plug (P) number The connection pin
Cable type/spec Signal	Cable type or specification for the cable The signal function Rx, Tx, Up, Down etc
Signal type	Signal type, serial, analogue, Ethernet etc
Ref. plug layout/ cable	Reference to connector illustration/cable overview

Cable plan

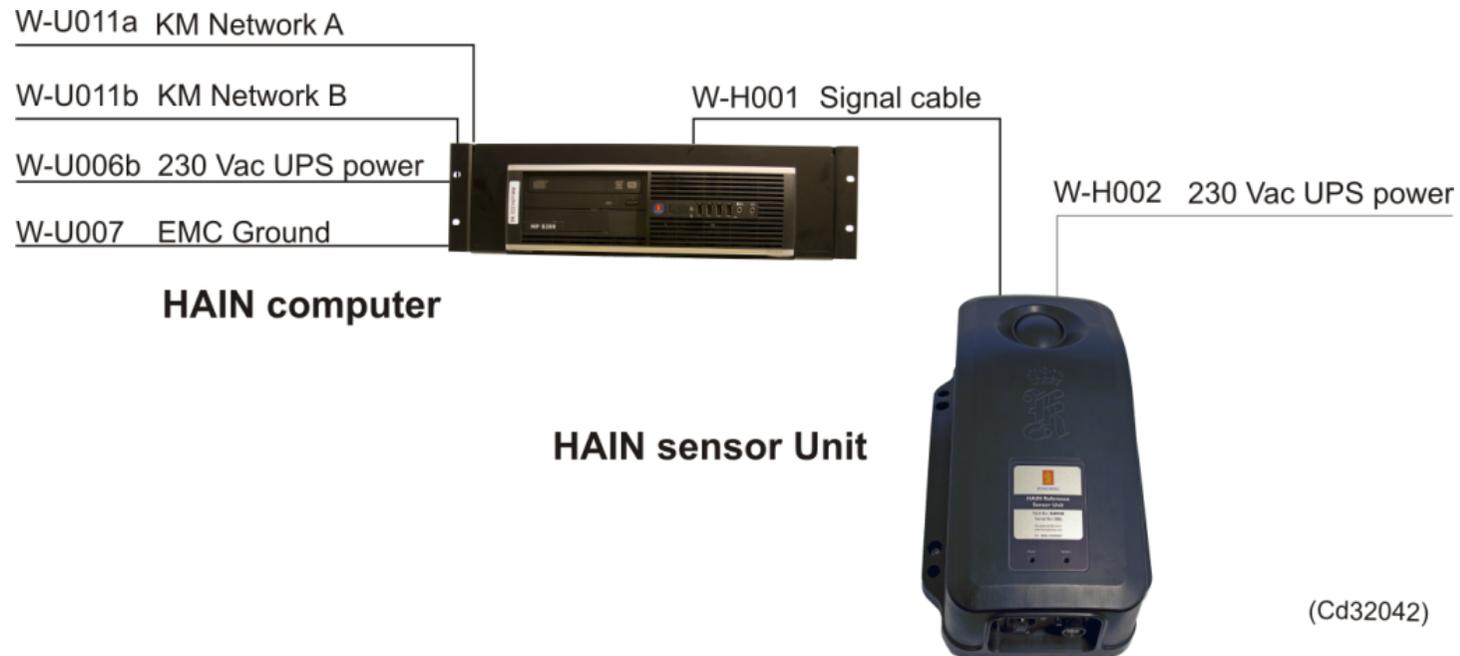


Figure 8 Cable connections for the HAIN computer

Cable list using HAIN Reference Sensor Unit

KM cable ID Core U/W-H	Cable from/ Connection type	Term/Plug Pin no.	Cable to/ Connection type	Term/Plug Pin no.	Cable type / Spec. signal	Signal type	Ref. Plug layout
MP8200 HAIN Computer							
W-U006b	Mains Socket	Vessel UPS: Fuse : F	HAIN Computer	IEC	Power	115 / 230 VAC	
W-U007	EMC ground	Screw terminal	HAIN Computer	Screw terminal	EMC optional cable	EMC Ground	
W-U011a	HAIN Computer	NET A	KM Network A	RJ45 - A - Port	Cat 5e 100/ 1000 BaseTX port	Ethernet	
W-U011b	HAIN Computer	NET B	KM Network B	RJ45 - B - Port	----- " -----	Ethernet	
W-H001	Sensor Unit	RJ45	HAIN Computer	RJ45 - Transceiver	----- " -----	Ethernet	
W-H002	Mains Socket	Vessel UPS: Fuse : F	Sensor Unit	IEC	Power	230 Vac	

7 OPERATION

Topics

- *General on page 20*
- *Use in DP on page 20*
- *Create the HAIN object on page 21*
- *Monitoring on page 21*
- *Logging and support on page 23*

Note

The dialog boxes and their details change when new SW releases are delivered. The APOS on-line help is always up-to-date.

General

APOS is the operator station for HAIN. The philosophy for operating the HAIN-icon and its submenus is the same as for the other navigation functions in the APOS.

APOS and detailed HAIN operation, is described in the integrated APOS on-line help.

To configure a new HAIN-object or change settings you are required to be logged in as service-user.

Configuration of HAIN can also be performed on the HAIN computer by the HainController application:

`\HAIN\Bin\HainController.exe.`

Use in DP

HAIN Reference is often used as a reference for the vessel's DP. The HAIN output to DP is sent by APOS on a protocol designed for HAIN data. You must check with your DP whether or not it can utilize HAIN data.

Note

HAIN and its aiding acoustic positioning are not independent, so you should never use HAIN and the aiding acoustic positioning as independent references in DP at the same time. One of them must be turned off or put in monitoring. Many DPs will not allow use of the same transponder or transceiver as is being used in aiding HAIN.

Should the aiding position source to HAIN fall out, you can switch HAIN to use another position source as aid instead. This can be done on the fly, during continuous HAIN operation. Beware then of the independence mentioned above.

Create the HAIN object

Prerequisites

You must create the HAIN positioning object in APOS, just as you create other APOS positioning objects.

You must be logged in as service and have enabled HAIN positioning in your APOS to do this.

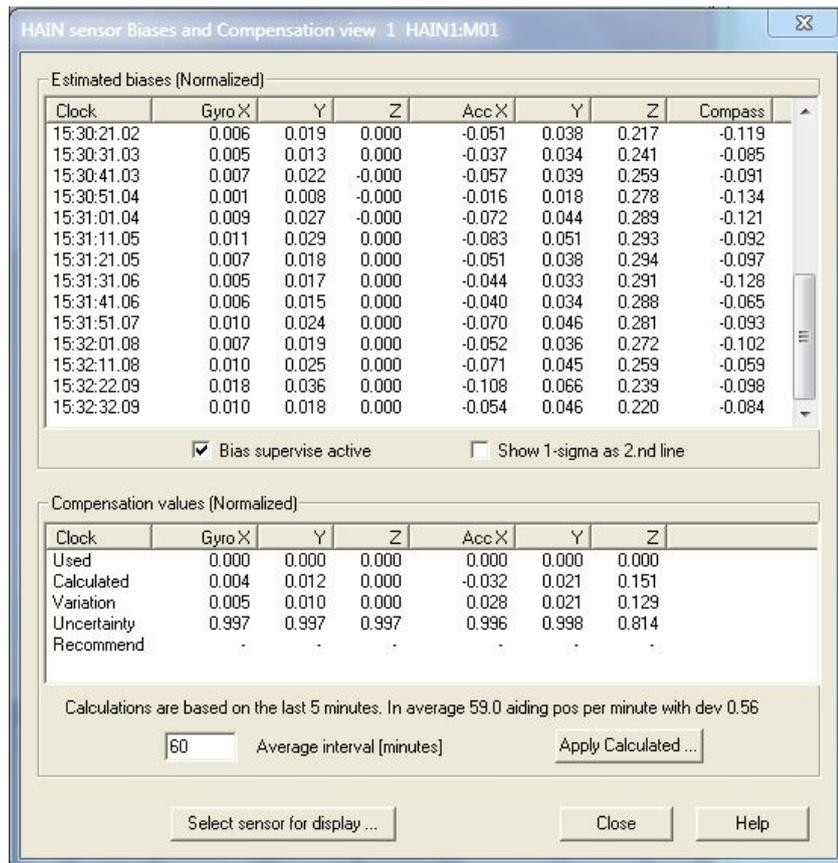
- 1 Select **Positioning** → **HAIN Positioning** in the main menu.
 - The dialog box is explained in the APOS Online help *Positioning* → *HAIN Positioning* → *HAIN Positioning*.
- 2 Right click on the HAIN icon in APOS to reach the context sensitive menu.

Monitoring

This topic is covered best in the APOS on-line help.

HAIN Sensor biases

Sensor biases... is a command in the context sensitive menu of the HAIN icon.



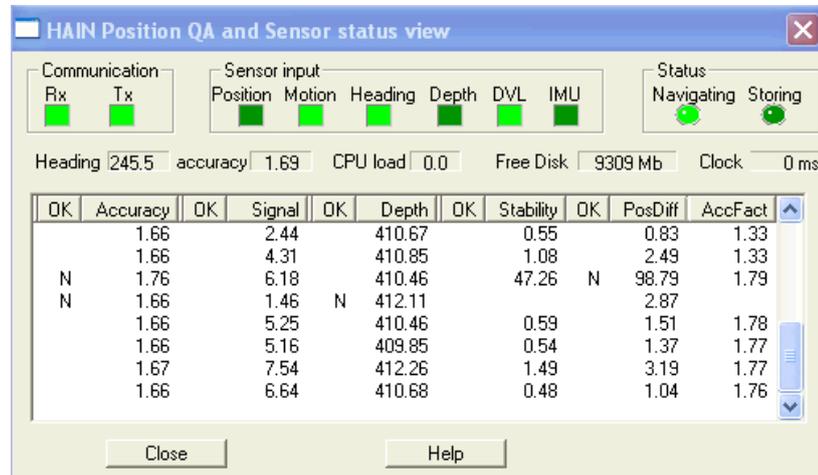
- The dialog box is explained in the APOS online help Positioning → HAIN Positioning → HAIN Sensor Biases.

The main purpose of the dialog box is to observe the bias estimates. The values are normalized with their QA parameters set up for the sensors in your system. So a value less than 1.0 means that the estimated bias is less than its 1-sigma QA parameter. If the biases are consistently greater than 1, it may be an indication of systematic errors, which may deteriorate HAIN performance. Please retrieve at least 1 hour of HAIN data (APOS right click HAIN icon choose Retrieve HAIN data) and e-mail this together with a short description of the issue to km.support.hpr@kongsberg.com for support. If the HAIN log files are too large for e-mailing they can be uploaded to <https://ftp.km.kongsberg.com>. If the Bias automatic supervise function is active, the HAIN will restart the positioning if one or more of the biases are consistently greater than 3.

If Sensor biases are consistently running at some level, it may stem from a fixed offset. You can then use the Apply Calculated button, to remove this fixed offset from the measurements directly.

HAIN Position Status view

HAIN Position Status vies... is a command in the context sensitive menu of the HAIN icon.



Note

It is recommended to keep the status view visible in APOS when running HAIN.

You should look for two things:

- If any of the lights become red, there is an indication of a problem with that sensor.
- If many position measurements have <N> on their OK status, this is an indication of problems with the position measurements.

Logging and support

HAIN stores all measurements on disk, and thus generates more than 1 GB of data every day. These data can be used to identify problems, evaluate performance or afterwards trace vehicle's motion. To avoid filling up the disk, HAIN will delete log files on its own disk if they are older than a specified time, or the disk has less than 50 MB of free storage. HAIN will only delete logged data on the drive where it is installed, regardless of what is the current selected logging drive.

The logged data are valuable tools for KONGSBERG support and operators are occasionally required to retrieve the data from the HAIN computer to send to KONGSBERG for analysis.

Retrieving HAIN data

As of APOS 4.20.0 you can retrieve the data by right-clicking the HAIN icon in APOS.

If you are running older versions of APOS, follow instructions below:

- 1** In APOS open “HAIN Properties” to see which drive and mission name are being logged to, and “Cancel” the dialog.
- 2** Set up screen, mouse and keyboard for the HAIN computer, or use Remote Desktop Connection if available, to open the HAIN computers desktop on your screen.
- 3** On the HAIN computer copy the files stored in <drive>\LogData\<mission> where <drive> and <mission> are respectively the drive and mission found in step 1. They are usually “D” and “unnamed”.
- 4** Copy the data to network server, CD, DVD, memory stick or other.
- 5** These data can then be uploaded to KONGSBERG’s FTP or sent by e-mail, memory stick, DVD or CD.

8 MAINTENANCE

This chapter describes the maintenance routines the various parts of the system.

- *See APOS Online Help for more information regarding the maintenance of the HAIN units.*
- The maintenance personnel are expected to replace faulty Line Replaceable Units (LRUs), and have access to standard electronic instruments, such as oscilloscopes and multimeters.

Warning

Kongsberg Maritime accepts no responsibility for any damage or injury to the system or personnel caused by drawings, instructions and procedures not prepared by Kongsberg Maritime.

Neither Kongsberg Maritime nor our dealers will accept responsibility for damage or injury to the system or personnel resulting from incorrect maintenance performed on the system.

Note

Static electricity will damage sensitive electronic components. Ensure the work bench has a conductive surface and is connected to the vessel/platform ground. Wear an grounding bracelet while working on electronic racks.

Topics

- *Safety on page 26*
- *Before you start on page 26*
- *Maintenance philosophy on page 26*
- *Maintenance schedule on page 28*
- *Preventive maintenance on page 28*

Related topics

- *Spare parts on page 38*
- *Drawings in the Drawing file chapter from page 39*

Safety

Refer to standard company/vessel safety procedures before commencing maintenance work.

→ See also *High voltage safety warning on page II in this manual.*

Note

After any maintenance work, the system must be checked to ensure it works correctly. Refer to the procedure in the Test and alignment procedures.

Before you start

Before you start performing any maintenance, the power must be switched off, and it must be kept off while the maintenance is being carried out.

Warning

The maintenance engineer MUST wear a grounding bracelet, which is securely connected to the vessel's ground, at all times when performing maintenance on the units.

- 1 Switch off all power to the HAIN system and other systems connected to the HAIN.
- 2 For the other systems, remove the fuses if possible and label the fuse panels with tags stating that maintenance is being carried out on the system.

Maintenance philosophy

The maintenance philosophy recommended by Kongsberg Maritime is:

- On-board maintenance should be carried out by a maintenance engineer, with the assistance of the operator. The maintenance should include the following:
 - Calibrations
 - Simulations
 - Functional tests
 - Traditional troubleshooting based on a good knowledge of the system.

- Replacement of faulty parts should be limited to the line replaceable units (LRUs) recommended in the spare parts list.

Note

To reduce the number of spare boards required, standard circuit boards without software may be provided. In the event of a replacement becoming necessary, the software on the faulty circuit board must then be transferred to the new board. Any links and switches on the new circuit board must also be set as on the old board.

Whenever a faulty unit has been replaced, the unserviceable unit should be sent to Kongsberg Maritime, or an appointed dealer, for repair.

Error detection

If a fault is detected, the operator should call the maintenance engineer at the earliest opportunity. The operator should be issued with a standard procedure detailing how he/she is to respond to system errors or faults. This procedure should contain the following (as a minimum):

Whenever an error message appears:

- Write down any Alarm message.
- Write down the parameters currently set in the system.
- Write down a brief description of the actions currently being carried out.
- Write down the commands being executed (if any) when the error appeared.
- Write down the controls carried out (if any) when the error message appeared.
- Write down any other information that might be valuable to the maintenance engineer during troubleshooting. This also includes events not directly connected to the system (for example bad weather, excessive temperature in operations room etc.).

Verification

The first action to be performed by the maintenance engineer on receipt of a fault message must be fault verification. If the system has been closed down, it should be powered up again (unless the fault has caused serious damage to the system), and an attempt made to make the fault reappear.

- Verify the fault during continued operation.

Maintenance schedule

Maintenance routines must be performed regularly and effectively to ensure that the equipment is kept in top condition.

The chart below states the **maximum** recommended intervals at which the various routines should be performed - the intervals should be decreased if the system is used excessively.

Maintenance chart

Unit	Weekly	1-3 Month	6 Months	Note
All units - exterior	Clean	-	Check	-
All cable connections	-	-	Check	-
Recalibration	-	-	-	Never

Preventive maintenance

The preventive maintenance consists of keeping the units clean.

Use:

- Soft lint-free cloth
- Mild liquid detergent

9 EQUIPMENT HANDLING

This chapter describes how to transport, pack and unpack, clean, preserve and store electronic, electro-mechanical and mechanical units supplied by Kongsberg Maritime.

The units may be supplied as spare parts, or as parts of a delivery.

Topics

- *Transportation on page 29*
- *Storage on page 34*
- *Re-packing on page 36*
- *ESD precautions on page 36*
- *Temperature protection on page 37*

Transportation

Unless otherwise stated in the accompanying documentation, electronic, electro-mechanical and mechanical units supplied by Kongsberg Maritime can be transported using all methods approved for delicate equipment; (by road, rail, air or sea). The units are to be transported in accordance with general or specific instructions for the appropriate unit(s), using pallets, transport cases, or carton boxes as appropriate.

Note

Special local restrictions concerning air transportation may be applied to units containing certain types of batteries. The units should be checked and the regulations investigated by the packer/shipper before the unit is dispatched.

Local transportation

All local transportation must be carried out according to the same specifications as for the initial delivery. In general, all units must be handled with care. The carton/case containing the equipment must be kept dry at all times, and must be sheltered from the weather. It must not be subjected to shocks, excessive vibration or other rough handling.

The carton /case will normally be marked with text or symbols, indicating which way it is to be placed. You must follow the instructions given, and ensure that the carton/case is always placed with its “top” uppermost.

The carton/case must not be used for any purpose for which it was not intended (step, table, etc.), and in the absence of other information, no other cartons/cases must be stacked on top of it.

Lifting

A heavy crate will normally be marked with its weight, and the weights of other cartons or crates will normally be entered on the packing list.

- You must always check the weight of a crate before attempting to lift it.
- You must always use lifting apparatus that is certified for the load.

Heavy units may be equipped with lifting lugs for transportation by crane within the workshop or installation area. Before a crane is used, check:

- You must check the applicable weight certificate for the crane.
- You must check the security of the lifting lugs.

Ensure that all available lifting lugs are used. Ensure the unit remains under control during the operation to avoid damage to the unit, equipment or personnel.

Heavy units may be transported using a fork-lift truck. Special attention must then be paid to the position of the unit's centre of gravity. The units must be properly secured to the truck.

Storage prior to installation or use

When a system, a unit or a spare part has been delivered to the customer, it may be subject to long-time storage prior to installation and use. During this storage period, certain specifications must be met. The equipment must be preserved and stored in such a way that it does not constitute any danger to health, environment or personal injury.

- 1** The equipment must be stored in its original transportation crate.
- 2** Ensure that the units are clearly separated in the shelves and that each unit is easily identifiable.
- 3** The crate must not be used for any purpose for which it was not intended (e.g. work platform etc.).
- 4** The crates must not be placed on top of each other, unless specific markings permit this.
- 5** The crates must not be placed directly on a dirt-floor.

- 6 Do not open the crate for inspection unless special circumstances permit so.
 - “Special circumstances” may be suspected damage to the crate and its content, or inspections by civil authorities.
 - If any units are damaged, prepare an inspection report stating the condition of the unit and actions taken. Describe the damage and collect photographic evidence if possible. Re-preserve the equipment.
 - If the units are not damaged, check the humidity absorbing material. If required, dry or replace the bags, then repack the unit(s) according to the packing instructions.
- 7 If the crate has been opened, make sure that it is closed and sealed after the inspection.
 - Use the original packing material as far as possible.

→ Refer to information on page 36.

Ambient temperature and humidity

- 1 The storage room/area must be dry, with a non-condensing atmosphere. It must be free from corrosive agents.
- 2 The storage area’s mean temperature must not be lower than -30°C, and not warmer than +70°C.
 - If other limitations apply, the crates will be marked accordingly.

Note

Transducers must not be stored in temperatures below -30° C, or higher than +55° C.

- 3 The crate must not be exposed to moisture from fluid leakages.
- 4 The crate must not be exposed to direct sunlight or excessive warmth from heaters.

Shock and vibration

Caution

The crate must not be subjected to excessive shock and vibration.

ESD precautions

→ Refer to the information on page 36.

Batteries

If the unit contains normal batteries, these may have been disconnected/isolated before the unit was packed. These must only be reconnected before the installation starts. Units containing batteries are marked.

Caution

Units containing lithium or alkaline batteries must be handled separately and with care. Such units are marked accordingly. Do not attempt to recharge such batteries, open them or dispose of them by incineration. Refer to the applicable product data sheets.

Inspection

An inspection must be carried out immediately after the unit(s) has arrived at their destination.

- Check all wooden or cardboard boxes, plastic bags and pallets for physical damage. Look for signs of dropping, immersion in water or other mishandling.
- If damage is detected externally, you will have to open the packaging to check the content.
 - Request a representative of the carrier to be present while the carton is opened, so any transportation damage can be identified.
- If any units are damaged, prepare an inspection report stating the condition of the unit and actions taken. Describe the damage and collect photographic evidence if possible. Send the inspection report to Kongsberg Maritime as soon as possible.
- If the units are not damaged, check the humidity absorbing material. If required, dry or replace the bags, then repack the unit(s) according to the packing instructions.

Unpacking

Caution

The IMU sensor is very delicate. Take precaution during unpacking and installation. Do not drop or hit the unit.

Normal precautions for the handling, transportation and storage of fragile electronic equipment must be undertaken.

Note

If the unit is not to be prepared for immediate use, you may consider storing it unopened in its original packing material.

However, it may be useful to open the case to check its content for damage and retrieve any accompanying documentation.

- Check the carton before opening it to ensure it shows no signs of dropping, immersion in water or other mishandling.
 - If the carton shows signs of such damage, refer to the paragraph covering Inspection on receipt.
 - Place the carton on a stable work bench or on the floor with the top of the carton uppermost.
 - In the absence of other instructions, always open the top of the carton first. Its content will normally have been lowered into the carton from above, so this will usually be the easiest route to follow.
 - Care must be used when opening the carton to ensure the contents are not damaged.
-

Caution

Do not use a knife to open cardboard cartons - the content may lie close to the surface, and may be damaged by the blade.

- If the carton has been closed using staples, remove the staples from the carton as you open it. This will reduce the possibilities of scratch injury to yourself and damage to the content.
- If a wooden crate has been closed using screws, always remove them using a screw-driver. Do not attempt to prise the lid off with a crow-bar or similar.
- Once the carton is open, carefully remove all loose packing and insulation material. Check for manuals and other documents that may have been added to the carton during packing, and put these to one side. Check also for special tools, door keys etc.

Electronic and electro-mechanical units

Caution

Beware of the dangers of Electro-Static Discharge (ESD) both to yourself and to the equipment, when handling electronic units and components. Refer to the ESD precautions starting on page 36.

Electronic and electro-mechanical units will normally be wrapped in a clear plastic bag. Lift the unit, in its bag, out of the carton and place it in a stable position on the floor/work bench.

Inspect the unit for damage before opening the plastic bag.

Note *Cables must **never** be used as carrying handles or lifting points.*

Note *Do not break the seal to open a circuit board package before the board is to be used. If the board package is returned to the manufacturers with the seal broken, the content will be assumed to have been used and the customer will be billed accordingly.*

Assuming all is well, open the bag and remove the unit.

Open the unit and check inside. Remove any packing and desiccant material that may be inside.

Mechanical units

Mechanical units may be heavy. Using a suitably certified lifting apparatus, lift the unit out of the crate and place it in a stable position on the floor/work bench.

Inspect the unit for damage and remove any packing material that may be inside the unit.

Re-packing

If the unit is not to be installed immediately, re-pack it in its original packing material to prevent damage in the intervening period.

→ *Refer to the information on page 36.*

Storage after unpacking

The unit must whenever possible be stored in its original transportation crate until ready for installation. The crate must not be used for any purpose for which it was not intended (e.g. work platform etc.).

Once unpacked, the equipment must be kept in a dry, non-condensing atmosphere, free from corrosive agents and isolated from sources of vibration.

Note *Do not break the seal to open a circuit board package before the board is to be used. If the board package is returned to the manufacturers with the seal broken, the content will be assumed to have been used and the customer will be billed accordingly.*

The unit must be installed in its intended operating position as soon as possible after unpacking.

If the unit contains normal batteries, these may have been disconnected/isolated before the unit was packed. These must then be reconnected during the installation procedure. Units containing batteries are marked.

Caution

Units containing lithium or alkaline batteries must be handled separately and with care. Such units are marked accordingly. Do not attempt to recharge such batteries, open them or dispose of them by incineration. Refer to the applicable product data sheets.

After use storage

If a unit is removed from its operating location and placed into storage, it must be properly cleaned and prepared before packing.

Cleaning cabinets

If a cabinet has been exposed to salt atmosphere while it was in use, it must be thoroughly cleaned both internally and externally to prevent corrosion.

- Wipe the cabinet externally using a damp cloth and a little detergent. Do not use excessive amounts of water as the unit may not be water tight. On completion, dry the unit thoroughly.
- All surfaces must be inspected for signs of corrosion, e.g. flaking/bubbling paint, stain etc. Damaged or suspect areas must be cleaned, prepared and preserved using the correct preservation mediums for the unit. The mediums to be used will usually be defined in the units' maintenance manual.
- All surfaces must be inspected for signs of corrosion, e.g. flaking/bubbling paint, stain etc. Damaged or suspect areas must be cleaned, prepared and preserved using the correct preservation mediums for the unit.
- Open the unit, and using a vacuum cleaner, remove all dust etc. from the unit. Great care must be taken to ensure the circuit boards and modules are not damaged in the process.

Cables

Wipe clean all exposed cables, and check for damage. If a cable shows signs of wear or ageing, contact Kongsberg Maritime for advice.

Dehumidifier

Place a suitably sized bag of desiccant material (silica gel or similar) into the unit to keep the electronic components as dry as possible.

Coatings

Spray the unit externally with a corrosion inhibitor (e.g. light oil) before packing.

Re-packing

The unit should be stored and transported in its original packing material and/or crate.

ESD precautions

What is ESD?

Electro-Static Discharge (ESD) is the transfer of an electrostatic charge between two bodies at different electrostatic potentials, caused either by direct contact or induction by an electrostatic field.

The passing of a charge through an electronic device can cause localised overheating, and it can also “puncture” insulating layers within the structure of the device. This may deposit a conductive residue of the vaporised metal on the device, and thus create a short circuit. This may result in a catastrophic failure, or degraded performance of the device.

ESD Protection during transport and storage

Sensitive electronic equipment must be transported and stored in protective packing bags, boxes and cabinets. The circuit boards must not be transported or stored close to strong electrostatic, electro-magnetic or radioactive fields.

If it is necessary to open and touch the circuit board inside the protective bag, then the following precautions must be taken:

- The working area must be covered by an approved conductive service mat that has a resistance of between 50 kW and 2 MW, and is connected directly to a reliable earth point via its earthing cord
- The service personnel involved must wear a wrist-band in direct contact with the skin, connected to the service mat.

- Printed circuit boards and other components should be placed on the conductive service mat during installation, maintenance etc.

Caution

If, for any reason, it is necessary to move the circuit board or components from the conductive service mat, they must be placed in an approved anti-static transportation container (e.g. static shielding bag) before transportation.

-
- During installation and servicing, all electrical equipment (soldering irons, test equipment etc.) must be grounded.

Temperature protection

If the unit must be protected against extremes of temperature, the carton/crate must be lined on all walls, base and lid with 5 cm thick polyurethane or polystyrene foam.

These units will be identified as delicate in the applicable documentation.

The package must then be clearly marked.

Caution

Must not be transported or stored in temperatures below -5 degrees Celsius.

Other units can normally be stored in temperatures between -30° C and +70° C, refer to the system's technical specifications for details.

10 SPARE PARTS

This chapter lists the parts and modules defined by Kongsberg Maritime as *Line Replaceable Units (LRUs)*. The required mounting components (such as nuts, bolts, washers etc.) are identified on the diagrams, but have not been allocated order numbers as we regard these items as standard commercial parts available from retail outlets around the world.

The part number in the list of spare parts is subject to change due to obsolescence.

Units

KM P/N	Units	Comments
Computer		
413092	Computer for sensor unit	
401652	Graphics card	
400819	Ethernet interface card	
381270	Serial interface card	
Sensor unit		
366948	HAIN reference sensor unit ITAR	ITAR
366966	HAIN reference sensor unit MGC	Non-ITAR

11 DRAWING FILE

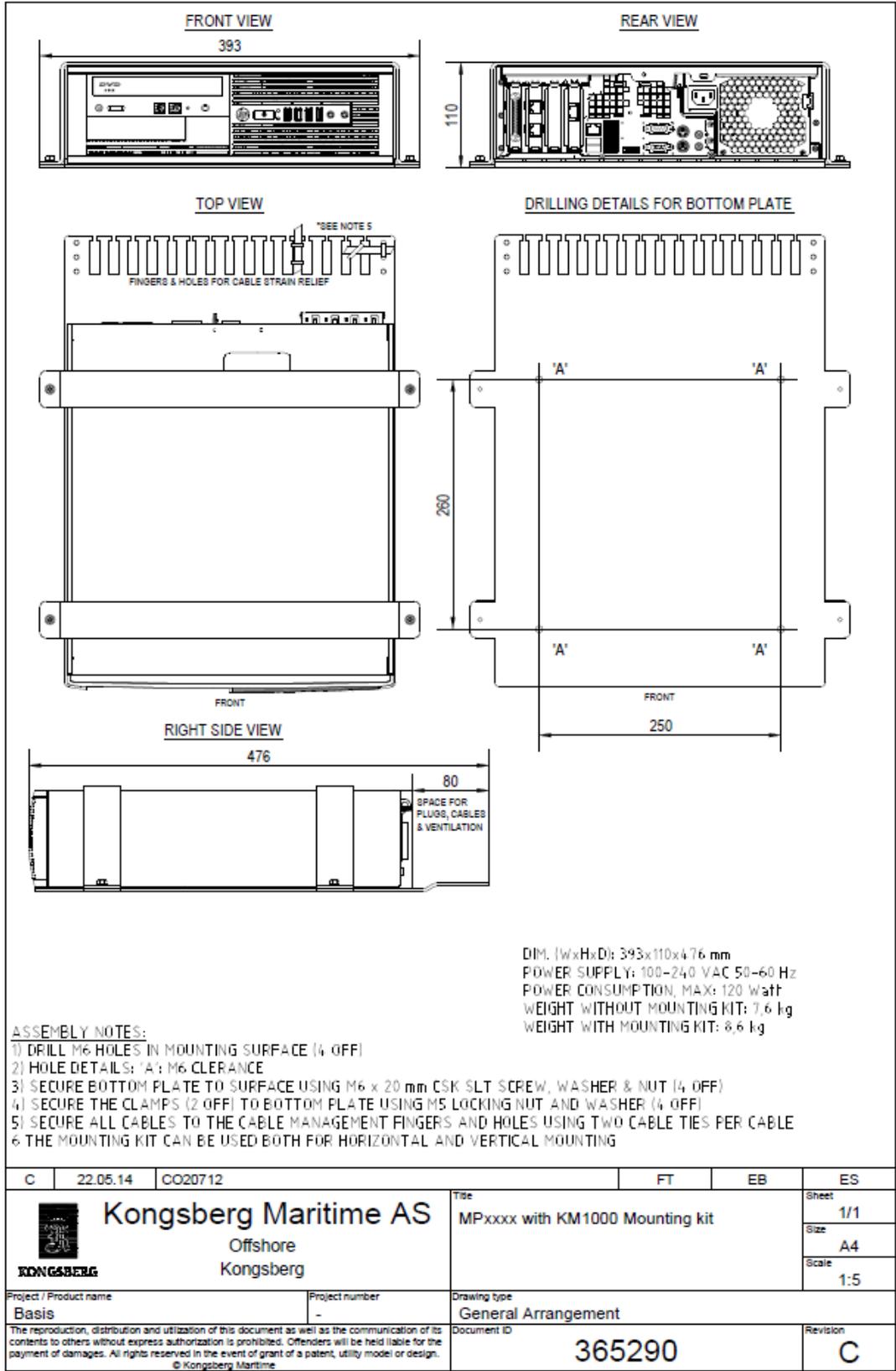
This chapter holds illustrations referred to in various sections in this manual. The illustrations are based on the original system drawings and wiring diagrams.

- The original drawings are available in electronic format on request.
- Unless otherwise noted, all measurements are in millimetres.
- The illustrations are not in scale.

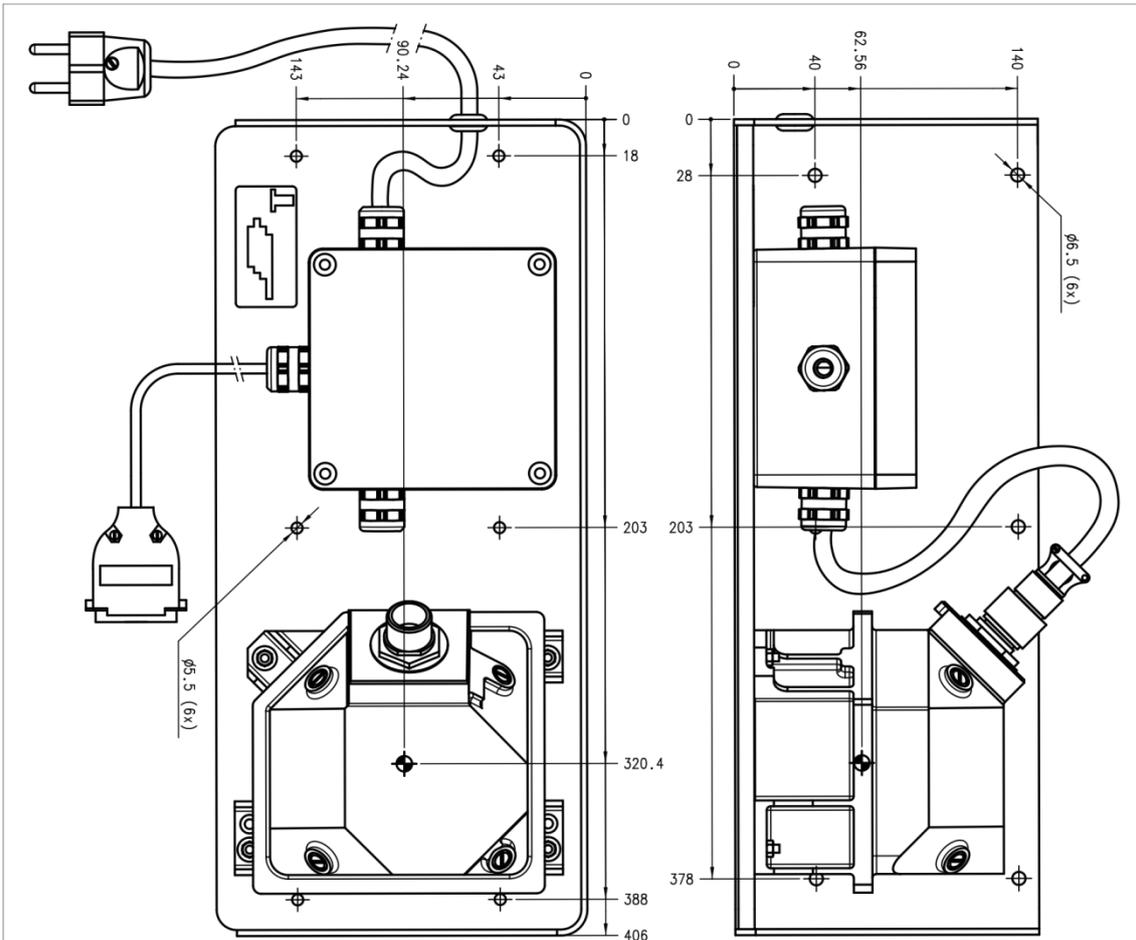
Drawings

Draw. No.	Rev.	Description	Ref.
Outline dimensions/mounting			
365290	C	Computer desktop	on page 39
371591	C	Computer rack	on page 41
318175	B	IMU bracket – Outline dimensions	on page 42
366948	C	HAIN Reference Sensor unit – outline dimensions	on page 43
394080	A	Wall bracket for IMU 90 and/or HG9900	on page 44
394258	A	Floor mounted pedestal for IMU 90 and/or HG9900	on page 45

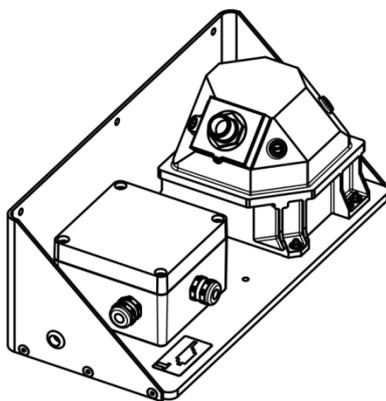
Computer – desktop mounting and outline dimensions



HG9900 with bracket – outline dimensions

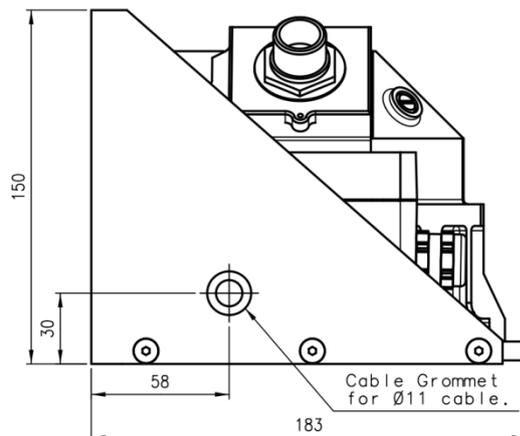


All dimensions are nominal, for information only.
Weight: 6.3Kg



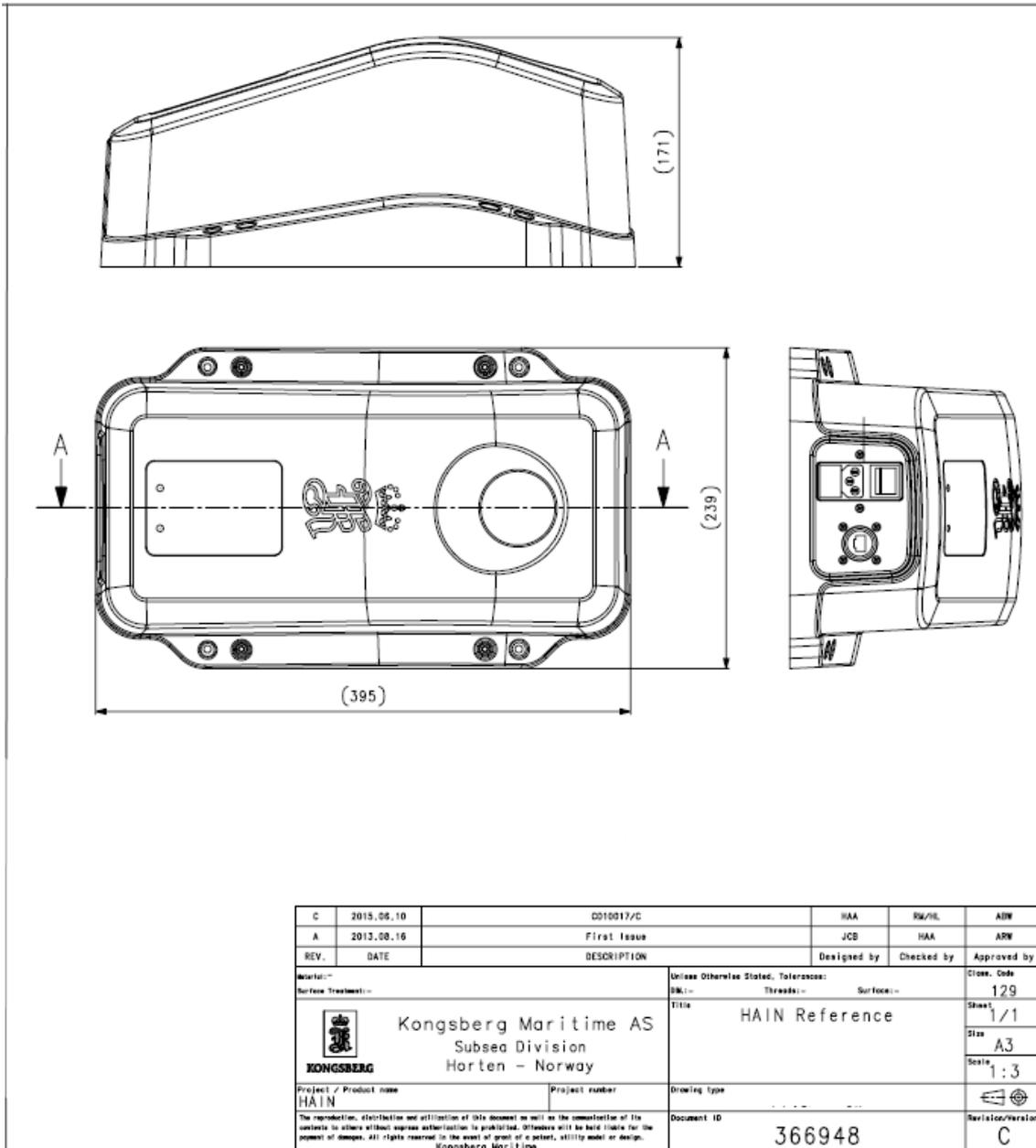
ISO 1:5

Note:
All measurements are in mm.
The drawing is not in scale.

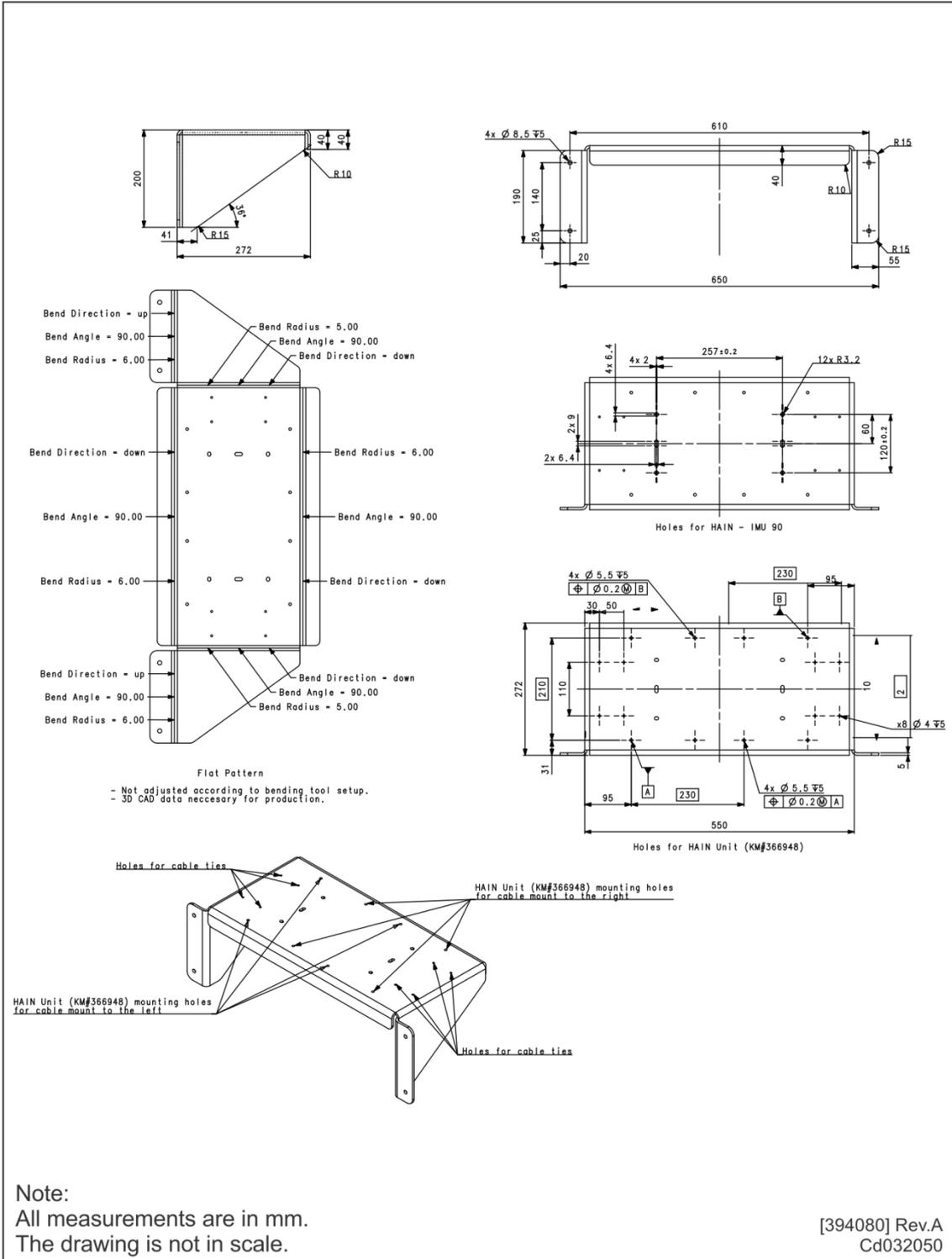


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318175 Rev. B

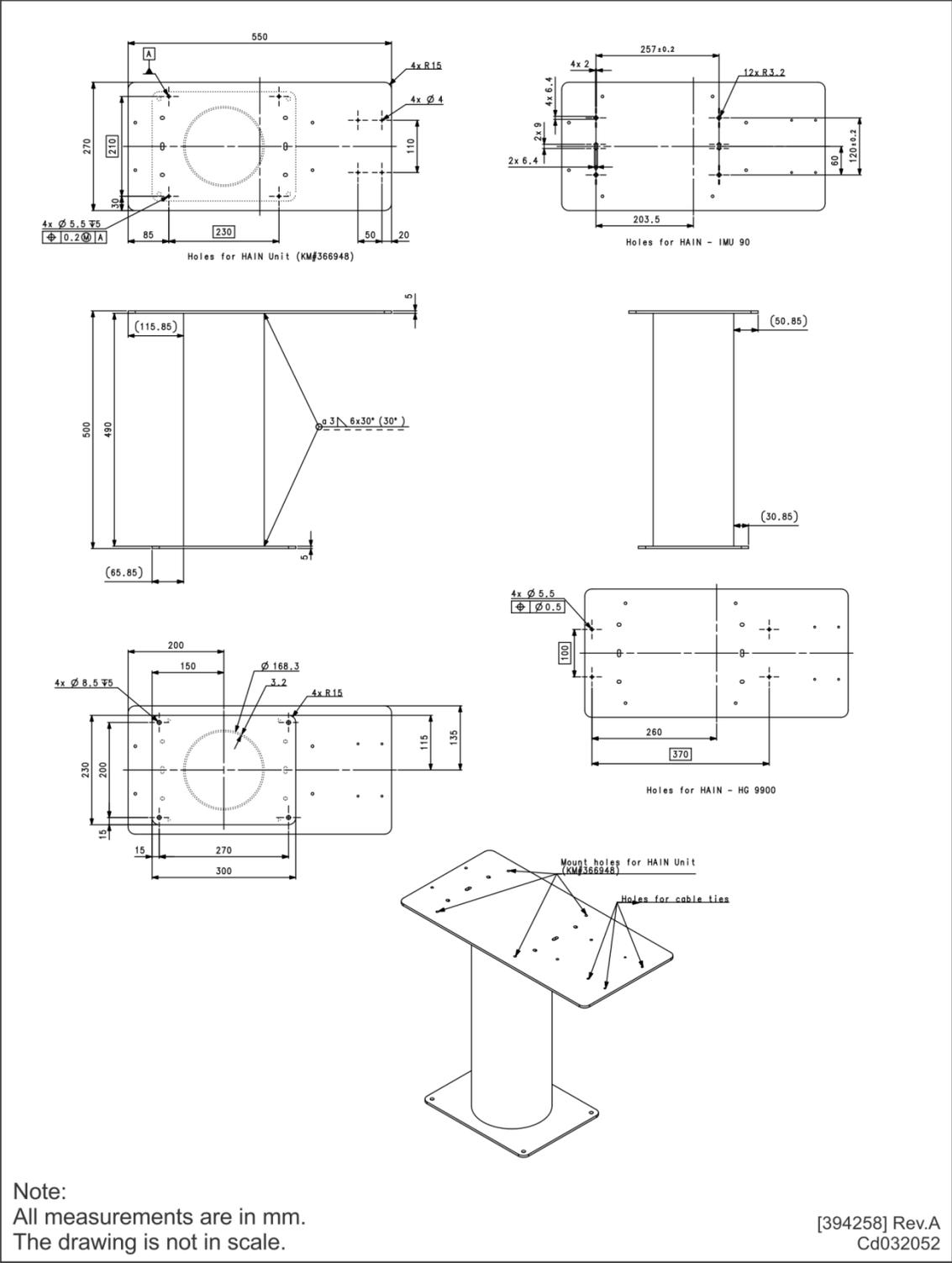
HAIN Reference Sensor unit – outline dimensions



Wall bracket for IMU 90 and/or HG9900



Floor mounted pedestal for IMU 90 and/or HG9900



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