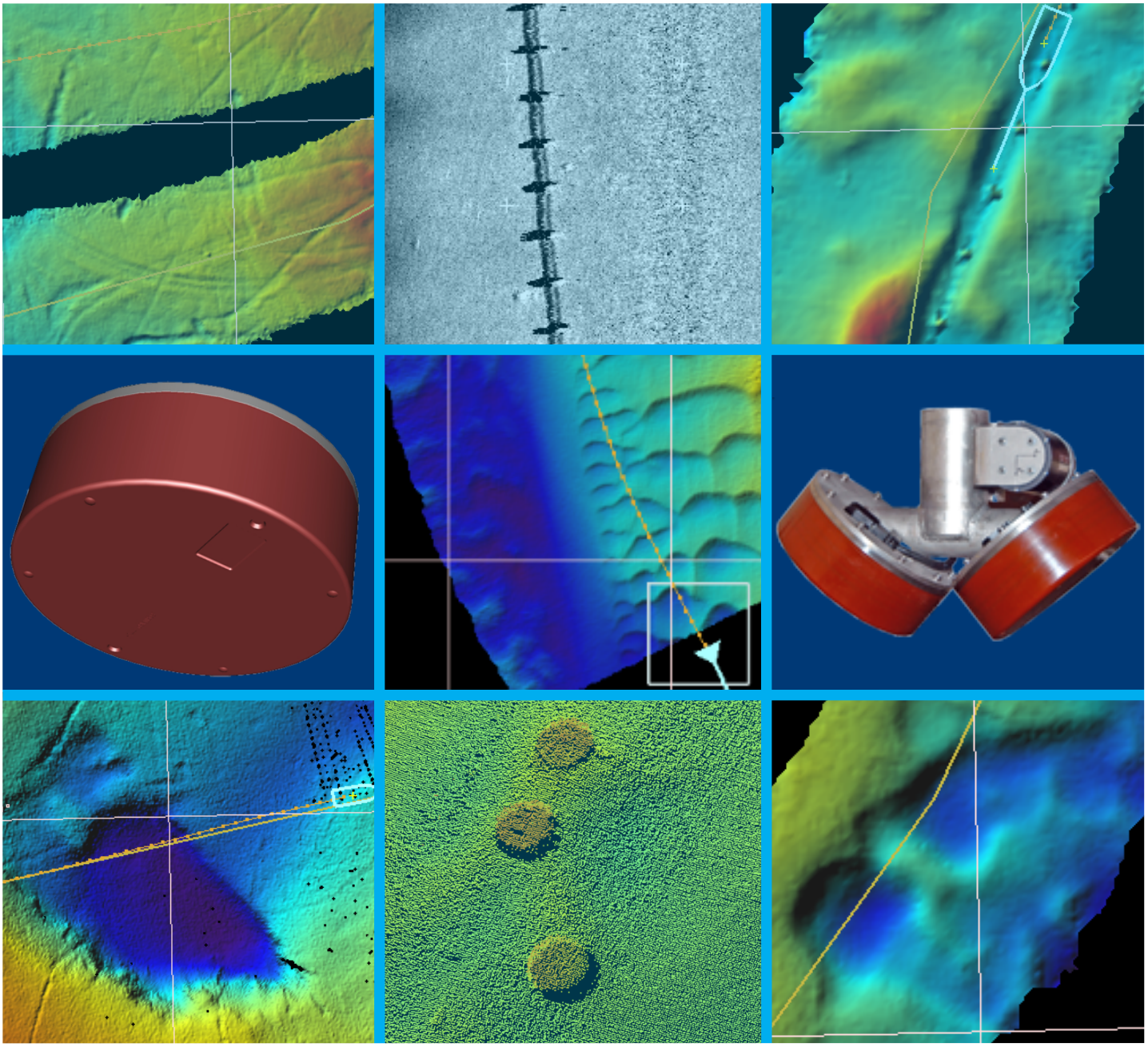
Installation manual

KONGSBERG

EM 2040C

Multibeam Echo Sounder



KONGSBERG

Kongsberg EM 2040C Multibeam Echo Sounder

Installation manual

378789/C
July 2015

Revision status

Document number: 378789 / Revision C		
Rev. A	January 2013	First revision.
Rev. B	December 2013	Processing Unit: Added information for Slim PU Sonar head: updated with low profile connector
Rev. C	July 2015	Added cable plans for dual swath and info. about Slim PU setup

Disclaimer

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

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. All users must be familiar with the contents of the appropriate manuals before attempting to install, operate, maintain or in any other way work on the equipment.
Kongsberg Maritime AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Support information

If you require maintenance or repair, contact one of our offices, distributors or dealers. You can also contact us using the following address: km.hydrographic.support@kongsberg.com. If you need information about our other products, visit http: //www.km.kongsberg.com.
See also *Support information* on page 15.

Table of contents

About this manual

Purpose

The purpose of this manual is to provide the information and basic drawings required for installation of the Kongsberg EM 2040C.

Target audience

The manual is intended for technical personnel; qualified maintenance engineers and technicians. It is assumed that the personnel is conversant with the general principles of maritime electronic equipment, in particular echo sounder and hydrographic systems. The personnel must also be familiar with computer hardware, signal processing, interface technology and traditional troubleshooting on electronic and mechanical products.

We assume that you are familiar with the Windows® 7 operating system, and conversant with network addressing and communication principles.

Installation instructions

The instructions provided in this manual must be followed carefully to ensure optimal performance. As a guide, installation procedures are presented in the order they are to be performed.

Note

The installation instructions given in this document must be adhered to. Failure to do so may render the guarantee void.

Kongsberg Maritime AS will accept no responsibility for any damage or injury to the system, vessel or personnel caused by equipment that has been incorrectly installed or maintained, or by drawings, instructions or procedures that have not been prepared by us.

Registered trademarks

Windows®, Windows XP®, and Windows® 7 are either registered trademarks, or trademarks of Microsoft Corporation in the United States and/or other countries.

EM® is a registered trademark of Kongsberg Maritime AS in Norway and other countries.

Kongsberg EM 2040C

Study this chapter to familiarize yourself with the Kongsberg EM 2040C.

Topics

Related topics

System description

- High resolution
- Wide frequency range
- Short pulse lengths, large bandwidth
- FM chirp
- Complete roll and pitch stabilization
- Nearfield focusing both on transmit and receive
- Water column
- Seabed image
- Swath coverage:
  - Single head: 130 degrees
  - Dual head: 200 degrees
- Depth rating:
  - EM 2040C: 50 m
  - EM 2040CX: 1500 m
- Easy to install
- Dual swath as option

The EM 2040C (C=Compact) is a shallow water multibeam echo sounder based on the EM 2040 technology, an ideal tool for any high resolution mapping and inspection application. The receiver and transmitter are integrated in a common sonar head, with the same dimensions as the EM 3002. The system fulfils the IHO-S44 special order and the more stringent LINZ specification.

The EM 2040C is available in an EM 2040CX version where the subsea part has a depth rating of 1500 m for operation on ROV or AUV

Yaw stabilization is available in dual head configuration. Each head uses one sector, and by independently steering each sector the system can stabilize for the yaw movement of the vessel.

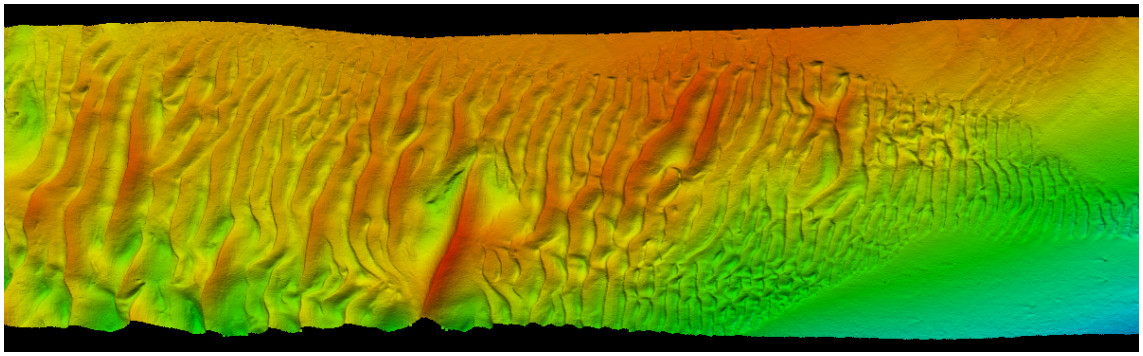
The operating frequency range is from 200 to 400 kHz with frequency selection in step of 10 kHz, enabling the user to choose on the fly the best operating frequency for the application. Due to the very large operating bandwidth available the system will have an output sample rate of more than 60 kHz. The system will thus effectively operate with very short pulse lengths, less than 25 microseconds, which gives a raw range resolution ($c\tau/2$) of 18 mm and an accuracy of less than 10mm ($c\tau/4$).

In dual head mode, both heads are operated independently creating one swath from each head simultaneously. This is due to a very flexible solution by using two different frequencies for each head.

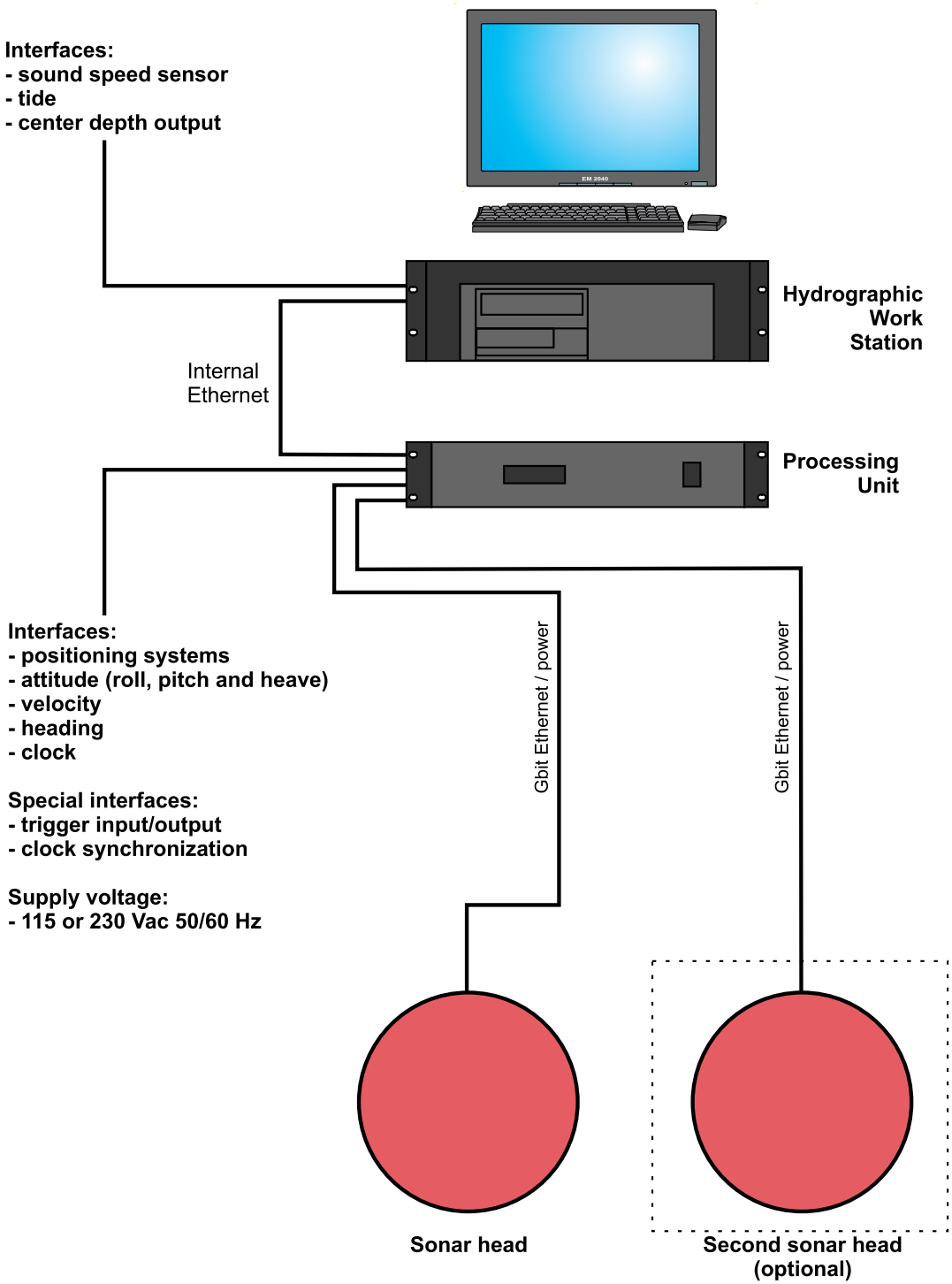
By utilizing both CW and FM chirp pulses, the system can achieve a much longer range capability with a higher resolution. The maximum depth range is 520 m at 200 kHz and a swath with up to 690 m with dual head.

The angular coverage for 200 to 300 kHz is up to 130º with one sonar head, allowing coverage of 4.3 times water depth. With two sonar heads, tilted 35-40 degrees to each side, 200 º can be covered. This allows surveying to the water surface or up to 10 times water depth on flat bottoms. For frequencies above 320 kHz the angular coverage per head is gradually decreasing to 70º at 400 kHz.

As an option the EM 2040C can be delivered with the dual swath capability, allowing a sufficient sounding density along track at a high vessel speed.



System diagram



(cd02104001)

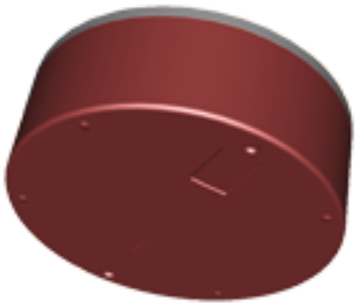
System units

The Kongsberg EM 2040C comprises the following main units.

Topics

Sonar head

The EM 2040C sonar head is a short cylindrical container with the transducers located on one end, and with cable connector and fastening holes on the other. The end with the transducers is the sonar head's "face".



A single cable with an underwater plug, connects the sonar head to the processing unit.

Processing unit

The EM 2040C Processing Unit is basically a standard computer using a commercially available processor board. It also provides signal processing boards. Receive data is filtered and beamformed using the signal processing boards, then transferred to the processor board. The processor board has serial interfaces for input of external time-critical sensors, and an Ethernet line for communication with the Hydrographic Work Station.

The EM 2040C Processing Unit receives information directly from the EM 2040C sonar head(s).

The processing unit also supplies 48 VDC power to the sonar head(s).

Ethernet switch

A high capacity Ethernet switch is sometimes required.

If you use more than one Processing Unit in your EM 2040C system, you must use an Ethernet switch to connect each Processing Unit to the Hydrographic Work Station.

A high capacity Ethernet switch (1000BASE-T) is included in the EM 2040C delivery in this case.

Operator Station

The main operator station of the EM 2040C system is the Hydrographic Work Station (HWS). This is a high performance PC workstation running on the Microsoft Windows 7 operating system. The operational software provided with the HWS is the *Seafloor Information System (SIS)*.

This software will, as a minimum, allow you to define the run-time parameters, and to log data.

The SIS also includes functionality for survey planning, two- and three dimensional geographical display of the survey results, seabed image and water column displays, plus real-time data cleaning algorithms. Third-party software solutions may also be used for the operator interface and real-time processing.

The Hydrographic Work Station communicates with the EM 2040C processing unit and the ship's network using Ethernet.

Network security

Equipment manufactured by Kongsberg Maritime are frequently connected to the ship's local area network. Connecting any computer to a network will always expose the data on that computer to all other computers connected to the network. Several threats may immediately occur:

- Remote computers can read the data.
- Remote computers can change the data.
- Remote computers can change the behavior of the computer, for example by installing unwanted software.

Usually, two parameters are used to define the threat level:

- The likelihood that any remote connection will do any of the above.
- The damage done if a remote connection succeeds doing this.

Because Kongsberg Maritime has no information regarding the complete system installation on any vessel, we cannot estimate the threat level and the need for network security. For this reason, we cannot accept responsibility for network security. Systems provided by Kongsberg Maritime are regarded as stand-alone systems, even though they may be connected to a network for sensor interfaces and/or data distribution.

Important

No safety applications are installed on any Kongsberg Maritime computers to protect these against viruses, malware or unintentional access from external users.

Securing the EM 2040C itself has no meaning unless there is a policy in place that secures all computers in the network, including physical access by trained and trusted users. This must always be a task for the customer to implement.

If you wish to connect the EM 2040C to the ship's network, you must implement the same security mechanisms on the EM 2040C computer(s) as for the rest of the network. In the tentative standard from Det Norske Veritas (DNV) - *Integrated Software Dependent System (DNV-OS-D203)* – this is described as a task for the network responsible person in charge of the overall behaviour of the network system. Some key elements here must be:

- The same anti-virus protection on all computers, including routines for updating this protection.
- The same settings for the firewall on all computers.
- Controlled physical access to computers on the network.
- Trusted operators.
- Log-in access mechanisms
- Same policy for attaching peripheral equipment to the computers (USB devices, hard drives etc)
- Installation of programs on any computer in the network, verification that each program is authentic.
- Definition of which programs are allowed to run on each computer.
- Logging mechanism of computer activity, and inspection of these logs.

How to define and implement these rules depends on each end user's network system configuration, which again must be a result of the policies and threat levels the end user has defined for the complete installation. For some products the network consists of only processor units or work stations, transceivers and a few sensors. On other vessels, larger computer systems can be installed to include numerous products and data systems. As the DNV-OS-D203 suggests, there must be one responsible person for the security of a system, large or small.

Support information

If you need technical support on the EM 2040C system you must contact a Kongsberg Maritime office. A list of all our support offices is provided on http://www.km.kongsberg.com.

You can also contact our main support office in Norway.

- **Address**: Strandpromenaden 50, 3190 Horten, Norway
- **Telephone**:
  - +47-330-34100
  - +47-99203801
- **Telephone, 24h**: +47-3303-2407
- **E-mail address**: km.hydrographic.support@kongsberg.com
- **Website**: http://www.km.kongsberg.com

Preparations

This chapter provides the information necessary to plan the installation of the Kongsberg EM 2040C according to Kongsberg Maritime's requirements.

Correct location of the sonar head(s) is vital for the operational performance.

Several variables must be taken into consideration, the most important of which is the vessel's construction. This guide can be used to select the best location for the sonar head and processing unit.

Topics

Locating the sonar head

A single answer to the question “where to install the sonar head(s)” cannot be given.

The physical location of the sonar head depends on the vessel's design and construction, how the hull is shaped, and how the water runs along the hull. There are however a number of important guidelines, and some of these are even conflicting.

Topics

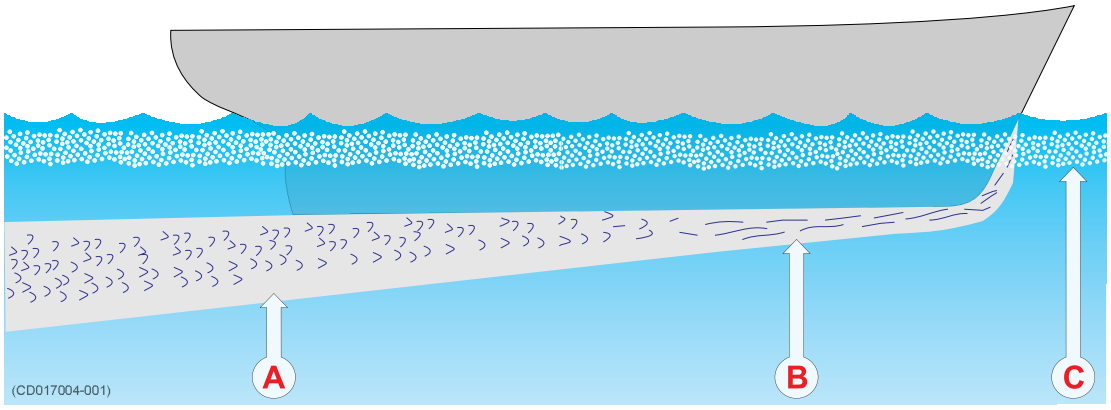
Go deep to escape the boundary water layer

The upper water layers of the sea contain a myriad of small air bubbles created by breaking waves. In heavy seas the uppermost 5-10 metres may be air-filled, with the highest concentrations near the surface. Air bubbles absorb and reflect sound waves, and may in the worst conditions block sound transmission totally.

When your vessel moves through the sea, the friction between the hull and the water creates a boundary layer. The thickness of the boundary layer depends upon the vessel speed and the roughness of its hull. Any objects protruding from the hull, and any dents in the hull, will disturb the flow and increase the thickness of the boundary layer.

The flow in this boundary layer may be laminar or turbulent. A laminar flow is a nicely ordered, parallel movement of the water. A turbulent flow has a disorderly pattern, full of eddies. The boundary layer increases in thickness when the flow goes from laminar to turbulent.

Boundary layers underneath a vessel



A *Turbulent flow*

B *Laminar flow*

C *Air bubbles in the water*

Furthermore, air bubbles in the sea water are pushed down below the hull and mixed into the boundary layer. The boundary layer is thin underneath the forward part of the vessel, and increases in thickness as it moves towards aft. If the sides of the hull are steep, some of the air bubbles in the boundary layer may escape to the sea surface along the vessel sides. It is our experience that a wide and flat bottom, with a rising angle less than about 13 degrees athwarthship, is prone to cause air problems for a transducer.

The conclusion is that the sonar head(s) should be mounted as deep as possible, and in the forward part of the hull.

However, this is not an invariable rule. Certain thruster designs combined with its physical location on the hull may still offer suitable locations near the thruster. If you are in doubt, consult a naval architect.

Stay away from the propellers

The propulsion propeller is the dominant noise source on most vessels. The noise is transmitted through the sea water, and may in extreme cases reduce the maximum range capability of the EM 2040C, despite its high operational frequency.

Cavitation

For this reason, the sonar head should be placed far away from the propeller, which means on the fore part of the hull. Positions outside the direct line of sight from the propeller are favourable.

On small vessels with short distances it is advised to mount the sonar head on that side of the keel where the propeller blades move upwards, because the propeller cavitation is strongest on the other side. The cavitation starts most easily when the water flows in the same direction as the propeller blade, and that is to some degree the case at that side of the keel where the propeller blades move downwards.

Choose a position far away from the bow thruster(s)

Bow thruster propellers are extremely noisy. When in operation, the noise and cavitation bubbles created by the thruster make the echo sounder or sonar useless, almost no matter where the transducer is installed. And when not in operation, the tunnel creates turbulence. If your vessel is pitching, the tunnel may be filled with air or aerated water in the upper position and release this in the lower position.

In general, the sonar head must therefore be placed well away from the bow thruster. In most cases, a location forward of the bow thruster is advantageous.

However, this is not an invariable rule. Certain thruster designs combined with its physical location on the hull may still offer suitable locations near the thruster. If you are in doubt, consult a naval architect.

Avoid protruding objects

Objects protruding from the hull, such as zinc anodes, sonar transducers or even the vessel's keel, generate turbulence and flow noise. Holes and pipe outlets are also important noise sources. They may act as resonant cavities amplifying the flow noise at certain frequencies.

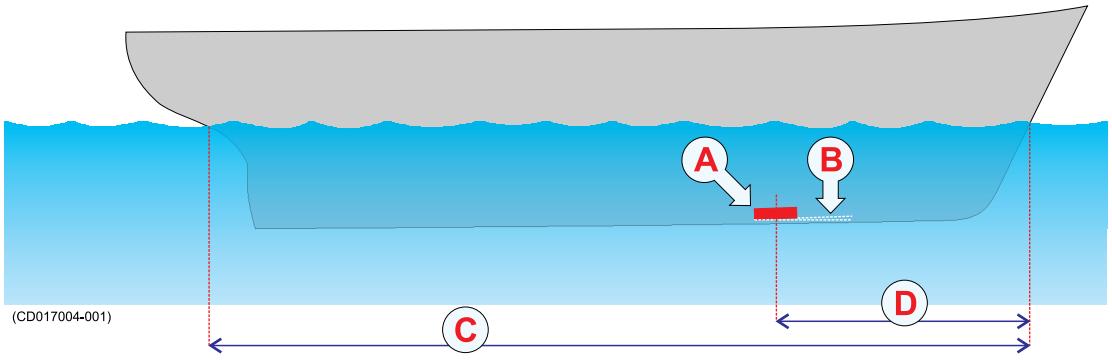
Do not place a sonar head in the vicinity of such objects, and especially not close behind them. For the same reason, it is very important that the hull area around the face of the sonar head is as smooth and level as possible. Even traces of sealing compound, sharp edges, protruding bolts or bolt holes without filling compound will create noise.

Summary and general recommendations

Some of the installation guidelines provided may be conflicting. Each vessel must be treated individually in order to find the best compromise.

In general, the most important factor is to avoid air bubbles in front of the sonar head(s). For this reason, the recommended sonar head location is normally in the fore part of the hull, well ahead of the noise created by the bow wave. The maximum distance from the bow is normally equal to one third of the total water line length of the hull.

Typical recommended location



A *Sonar head*

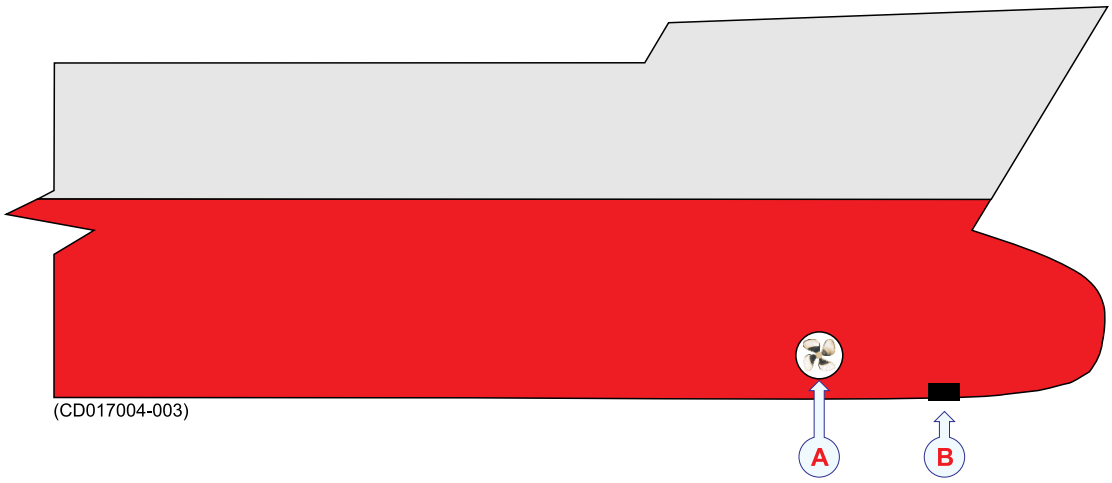
B *Inclination angle*

C *Hull length at water line*

D *Maximum 1/3 of the hull length at water line (C)*

If the vessel hull has a bulbous bow, this may well be a good sonar head location, but also in this case the flow pattern of the aerated water must be taken into consideration. Often the foremost part of the bulb is preferable.

Typical location on a bulbous bow



A *Thruster*

B *Location of the sonar head*

This applies to the vessel in normal trim and speed. Under no circumstances should the head(s) be tilted backwards when the vessel is moving at an appreciable speed. Mounting screws must never be extruding from the sonar head(s), and the space around the screws must be filled with a compound or a locking ring.

Installing the sonar head

This chapter describes the physical installation of the Kongsberg EM 2040C sonar head.

The installation shipyard must design and manufacture installation hardware to fit each individual vessel. Whenever required, the installation shipyard must also have the installation approved by the applicable maritime authorities.

Topics

Related topics

Sonar head description

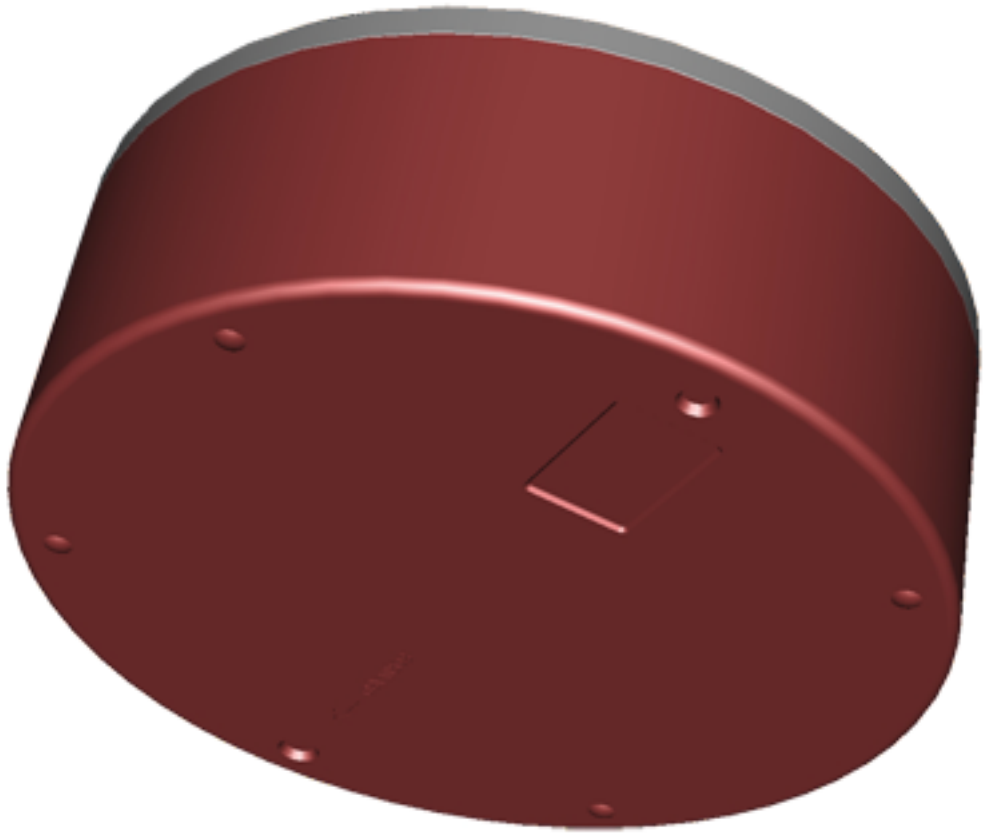
The EM 2040C multibeam echo sounder is normally used for seabed mapping. The sonar head should then be aligned with the vessel keel, and mounted fairly horizontally looking downwards (single head system).

The sonar head is a short cylindrical container with the transducers located on one end, and with cable connector and fastening holes on the other. The side with the transducers is the sonar head's "face". Both sides of the head have index holes to assist in measuring the sonar head angular orientation, and the face has a forward indicator.

Note

The current version of the Kongsberg EM 2040C is delivered with low profile connector similar to the EM 3002.

The previous version was delivered with circular connector (DIL 13).



Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Installation guidelines

Each sonar head must be mounted so that it has a clear view within its coverage sector, i.e. no obstructions are permitted within a sector of minimum ±75° acrosstrack and ±30° alongtrack with respect to the face of the sonar head. It is important that the sonar head is mounted so that the water in front of it is not aerated.

The sonar head is fastened with ten M8 bolts. If access to the rear of the head to fasten these bolts is not possible, a **mounting ring** must be used as part of the mounting structure to allow fastening of the bolts from the front. This mounting ring must have an opening to allow clearance for the connector and cable, for example a hole with a diameter of 250 mm.

Note

The risk of galvanic corrosion must be taken into account in the design of the mounting structure. Periodic inspection of the mounting screws and use of sacrificial anodes will be required in a permanent installation.

Mounting arrangements for both permanent and temporary installations are covered in this chapter. Temporary installations may include:

- over the side or bow on small vessels
- on subsea vehicles (such as an ROV)

The EM 2040C transmit sector coverage is maximum ± 65 degrees referred to the sonar head mounting angle.

To increase the across coverage, a dual head installation can be used. The two heads may be positioned on each side of the keel. The ideal roll installation angle is about 35°. To avoid gaps in the data at shallow depths, the two heads should be mounted with minimum across ship distance.

Installation angle	Total coverage	Angular overlap	Transmit frequency
±35°	±100°	±30°	200-320 kHz
±35°	±85°	±15°	350 kHz
±35°	±70°	±0°	400 kHz

With increased installation angles, the total coverage is increased, and the overlap between heads is reduced accordingly.

Other mounting angles are also possible, depending on the application.

A forward tilt of 0–2 degrees is recommended as described below, but the amount of forward tilt is not critical.

Note

Note that an accurate measurement of the final position and angular orientation of the sonar head is always required after installation.

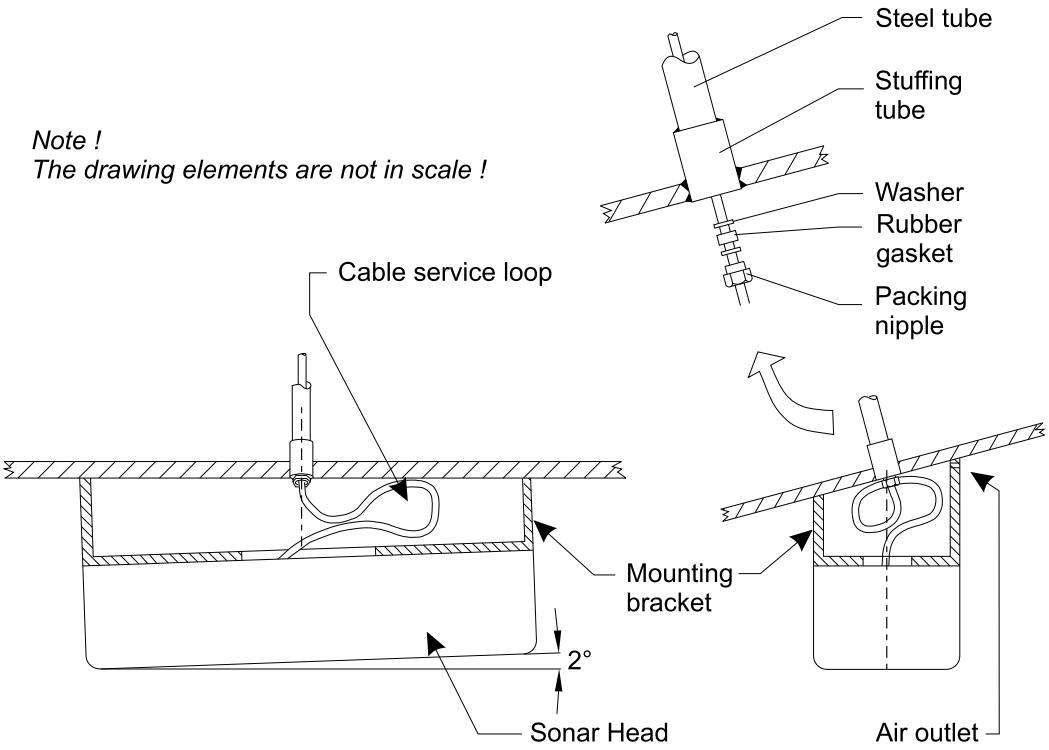
Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

External mounting

The sonar head can be installed outside the hull, provided that the maximum vessel speed is not too high. See figure *External mounting on vessel hulls (example)* on page 24.

Figure 1 External mounting on vessel hulls (example)



cd02104004

A mounting bracket, made by the shipyard, may be placed between the sonar head and the hull, to adapt for the deadrise angle of the hull, or to achieve the desired mounting angle of the head. The bracket should have the same outline dimensions as the sonar head. A location approximately 0.5 m aside from the keel may be adequate for the passage of water between the keel and the transducer.

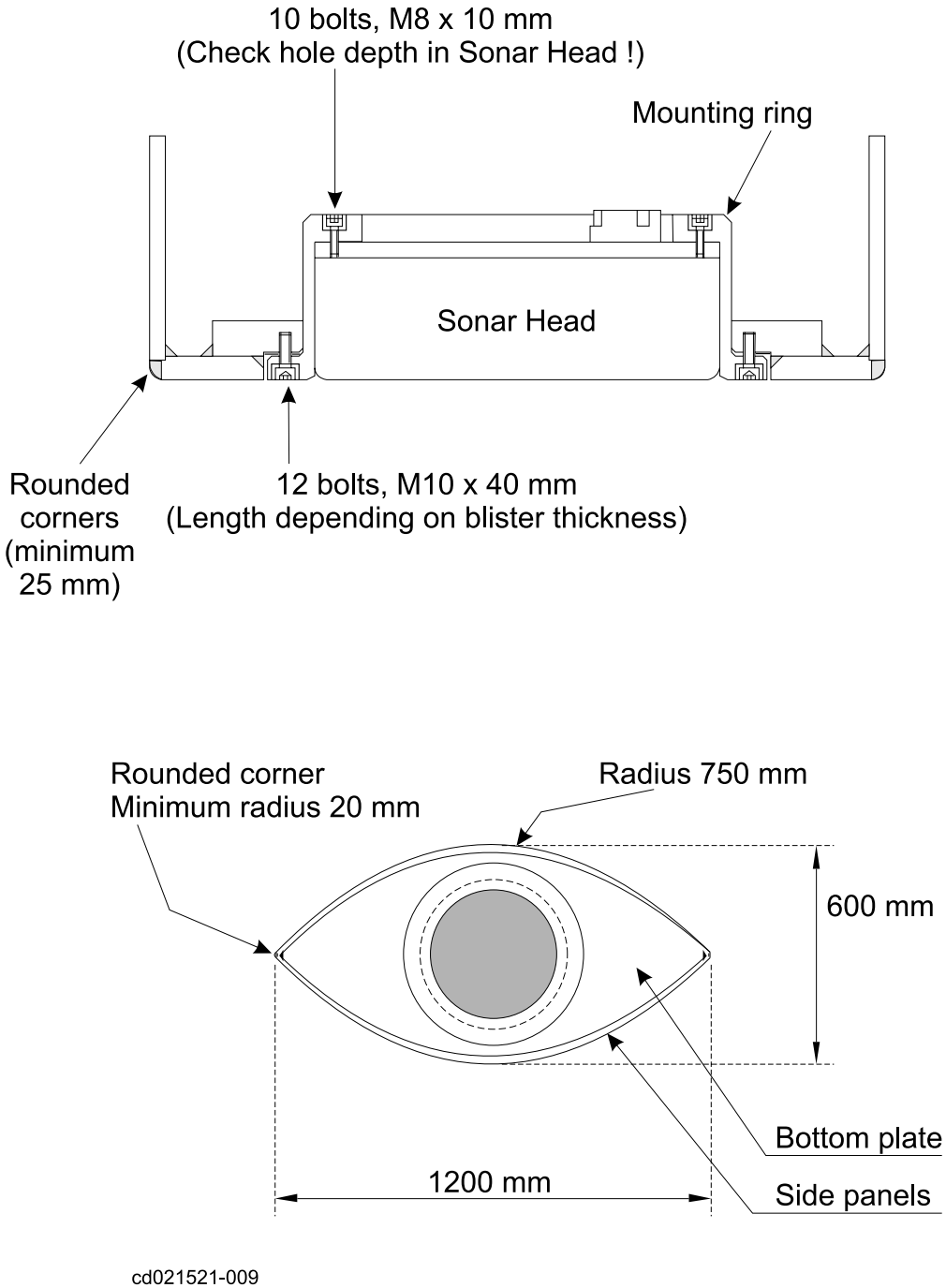
Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Blister mounting

For vessels travelling at high speeds, or to add protection against objects in the water hitting the sonar head, a blister installation is the recommended method. It may also bring the sonar head below the boundary layer. A blister is illustrated in figure *Sonar head blister for moderate speeds (example)* on page 26. A common blister may be used for the EM 2040C sonar head and transducers for other acoustic equipment if due care is taken with respect to acoustic interference between the different instruments.

Figure 2 Sonar head blister for moderate speeds (example)



The best performance is obtained with a blister height of 40 cm or more. A streamlined shape and rounded edges will reduce flow noise. A vertical leading edge or front will guide aerated water to the sides of the blister. The orientation of the blister should follow the water flow.

On a conventional hull shape, without a bulb, the front of the blister should have a few degrees toe-in towards the bow (see figure *Blister toe-in towards the keel* on page 28). The blister is placed to one side of the hull, and the distance from the keel is a trade off between a close distance giving a turbulent flow of water in a narrow passage, and a large distance bringing the sonar head higher up and blocking the view of the bottom. Normally a distance of approximately 1 m is a good compromise, see figure *Location of blister relative to the keel* on page 29 .

Figure 3 Blister alternative for speeds above 12 knots (example)

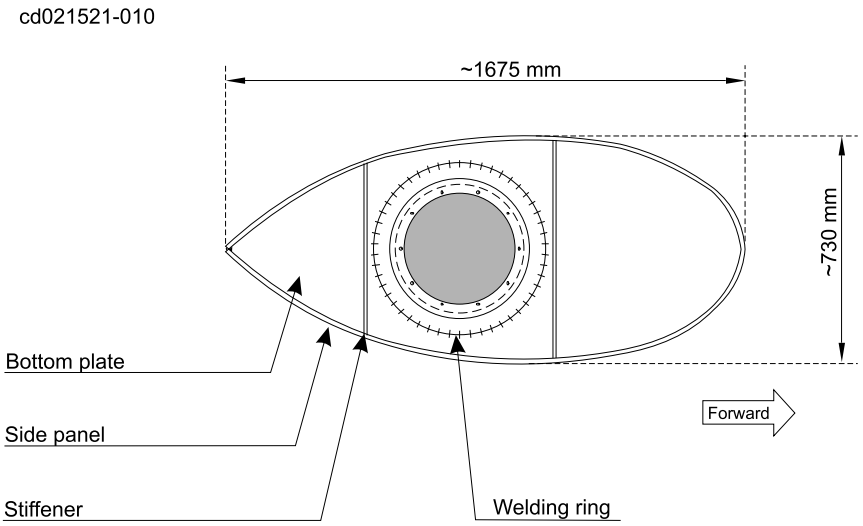


Figure 4 Blister arrangement - example for dual head

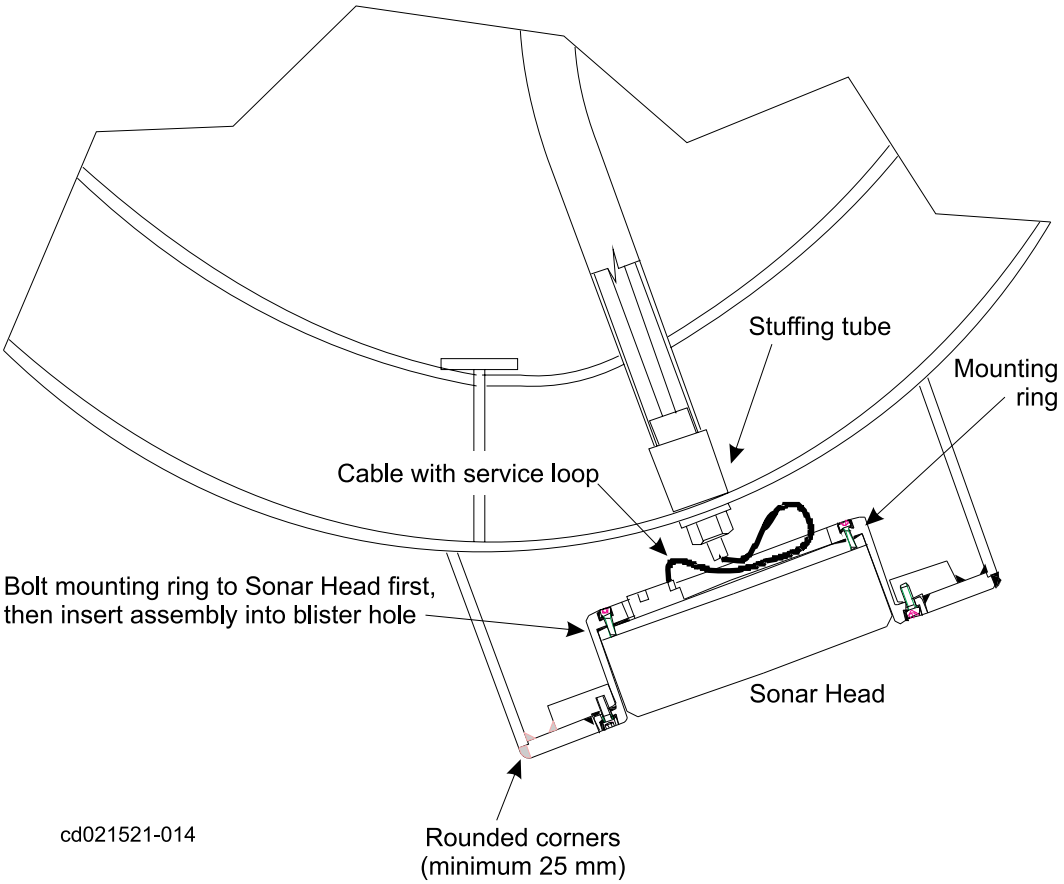


Figure 5 Blister toe-in towards the keel

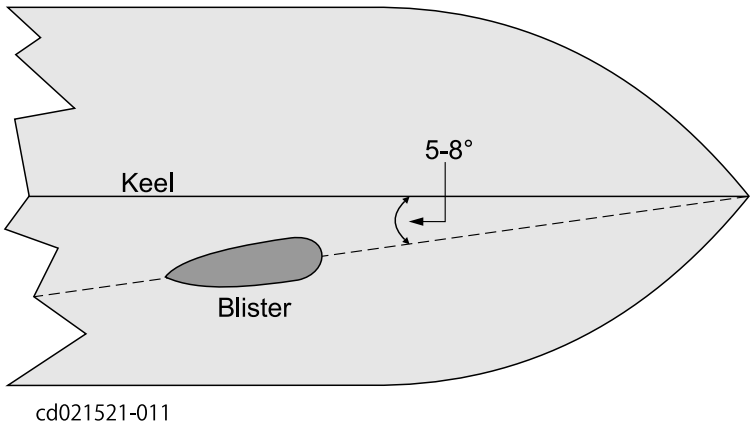
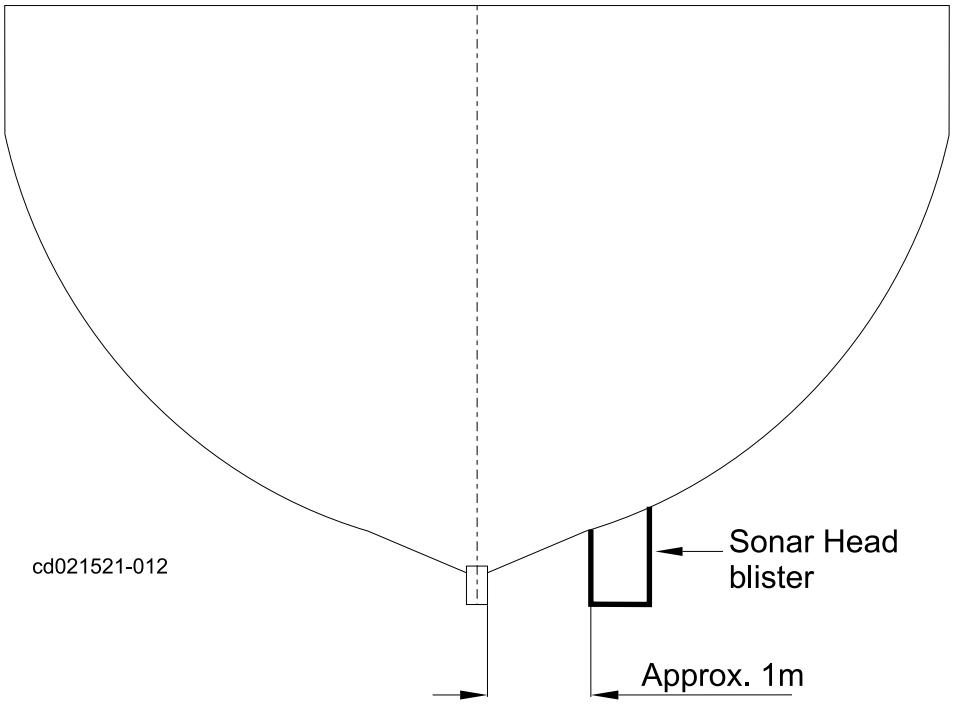


Figure 6 Location of blister relative to the keel



The interior of the blister should be filled with sea water by provision of a drainage hole in the bottom and an air outlet on the top. It is an important security precaution to have water pressure behind the head to counterbalance the outside pressure during vessel pitch in a rough sea.

The sonar head cable should penetrate the hull in a stuffing tube, see figures *External mounting on vessel hulls (example)* on page 24 and *Blister arrangement - example for dual head* on page 28. An adequate loop of the cable behind the sonar head must be provided for easy mounting or removal of the head.

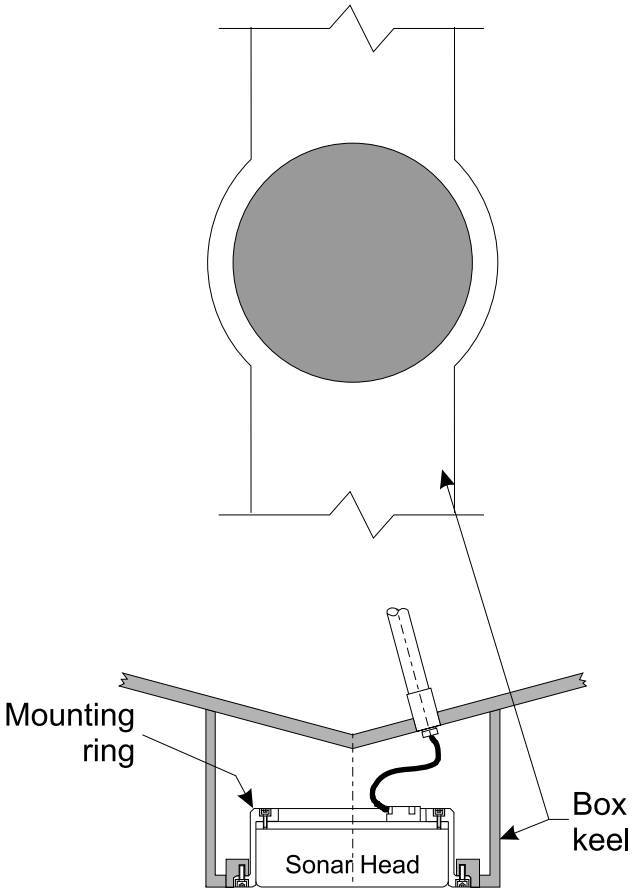
Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Keel mounting

Vessels having a box keel may use this for sonar head installation. The box keel is already the deepest part of the vessel. If the box keel is too narrow to accommodate the head, it can be widened, either symmetrically or to one side only. In the last case the installation could also be described as a blister merged into the keel. The figure *Symmetrical box keel installation (example)* on page 30 illustrates a symmetrical box keel installation.

Figure 7 Symmetrical box keel installation (example)



Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Retractable hull mounting

Retractable hull units are commonly used for horizontal looking sonars, but may also be utilized for the EM 2040C sonar head. The retractable hull unit is more expensive than a blister, but on vessels without a keel and with a wide, flat bottom, a retractable hull unit may be the only acceptable method for bringing the sonar head below the boundary layer. If a hull unit is already available on the vessel on which the sonar head is to be installed, it should definitely be considered.

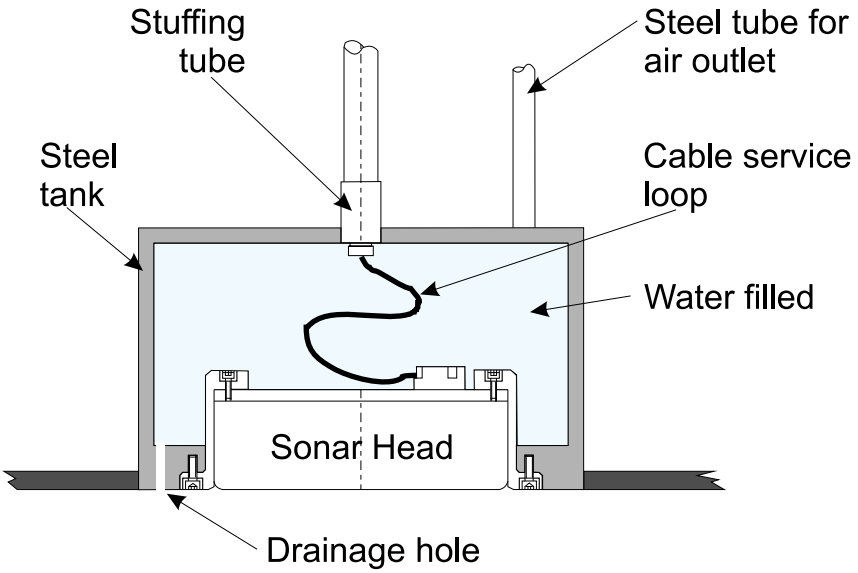
Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Flush mounting

Flush mounting may be used on very large vessels with a hull so deep that no air bubbles are found below the hull, and on vessels operating in shallow harbours or waters, where a protruding blister cannot be accepted. The figure *Flush mounting of sonar head in steel tank (example)* on page 31 illustrates EM 2040C sonar head flush mounting.

Figure 8 Flush mounting of sonar head in steel tank (example)



The standard procedure for flush mounting on a steel vessel is to weld a steel tank inside the hull, and mount the sonar head into this tank. As for a blister, it is recommended to ensure that the interior of the tank is water filled. This can be accomplished by air release through a steel tube, which is extended either to open air above the water line or to the water outside the hull at a point higher than the tank interior. If the tube is extended to open air, drainage must be provided via a separate hole in the tank bottom. Sonar head mounting in a steel tank is shown in figure *Flush mounting of sonar head in steel tank (example)* on page 31.

Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Non permanent mounting

The small size and weight of the EM 2040C system units makes the system truly portable. For temporary installations on a vessel the sonar head might be deployed through an existing gate valve on the vessel or on a pole fixed to the bow or on small vessels to the side.

The main consideration in such an installation is that the mounting structure is sufficiently rigid, i.e. dynamic displacements of the sonar head must be less than 2 cm and 0.05°, that the line of sight from the sonar head to the bottom is not blocked, and that aerated water is kept away from the sonar head face.

Figure 9 Bow mounting - example

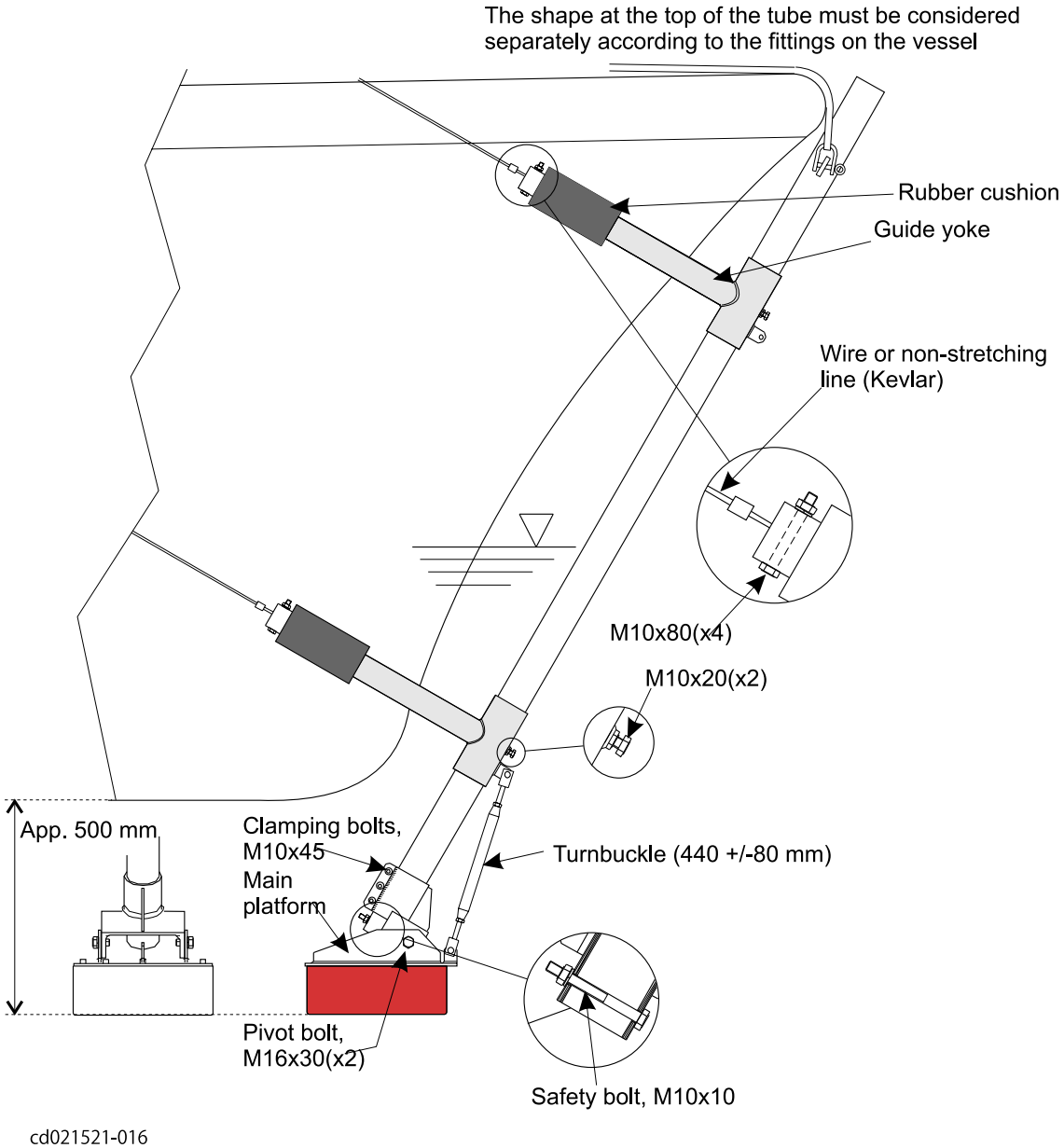
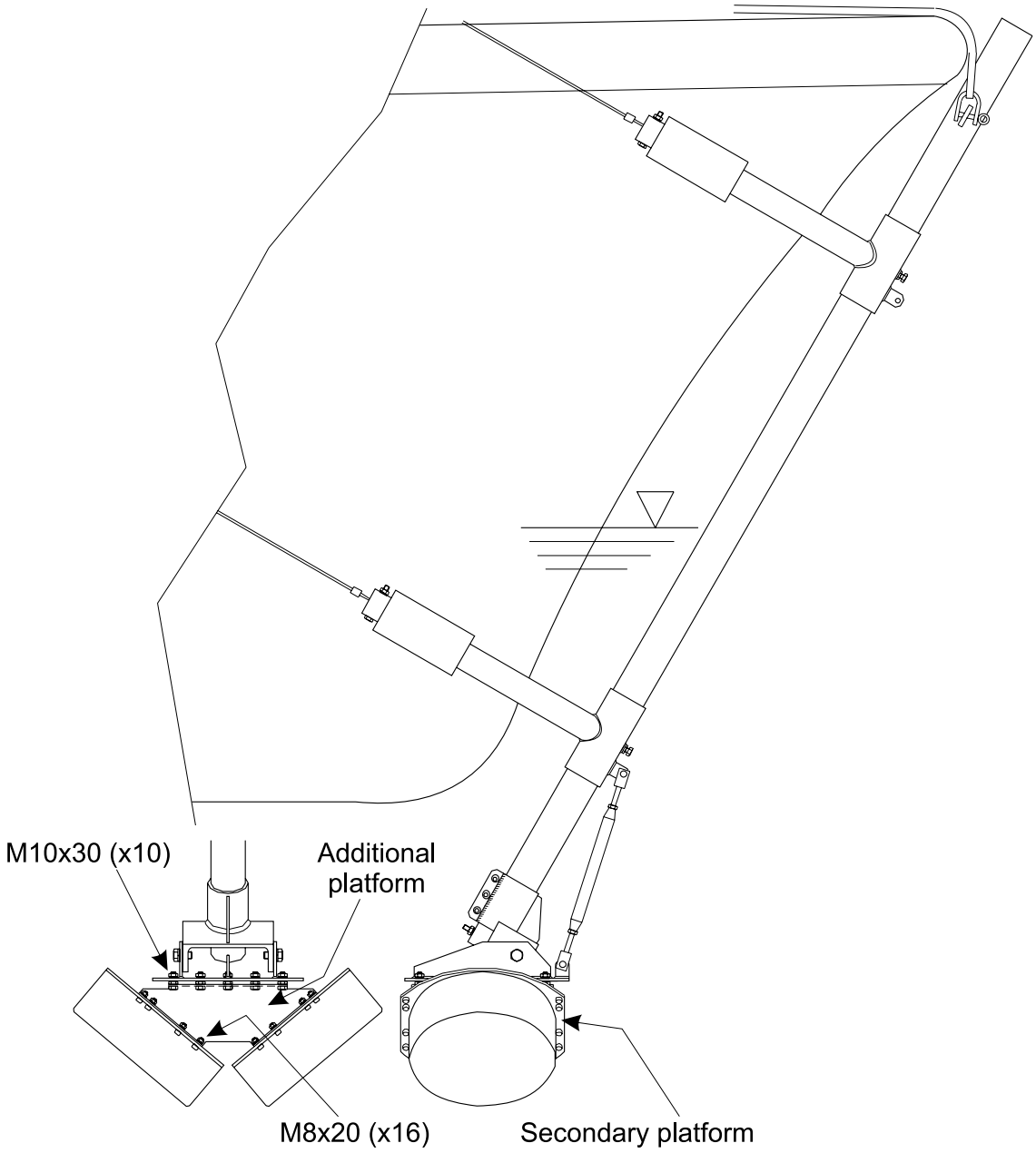


Figure 10 Bow mounting, dual system - example



cd021521-017

Note

When installing the system as shown on the previous illustrations, all nuts, bolts and washers must be manufactured of stainless steel (AISI 316). All bolts with lengths less than 30 mm must be fully threaded.

Related topics

- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Cabling

It is recommended to lay a tube, preferably made of steel, from the sonar head to above the water line, and draw the sonar head cable through this tube. This will avoid the need for a watertight feed-through for the cable, and reduces the risk of problems due to noise and interference with other electrical equipment, especially if the steel tube goes all the way to the EM 2040C Processing Unit. Tube dimensions should be minimum 35 mm inner diameter and minimum 6 mm wall thickness (4.5 mm if galvanized). If the standard cable length of 15 m is too short, you must order a longer cable with the system. A watertight feed-through is available from Kongsberg Maritime in case it is not possible to draw the cable through a tube above the water line.

Caution

Tube dimensions are recommendations from Kongsberg Maritime AS. Whenever required, the installation shipyard must also have the installation approved by the applicable maritime authorities.

Related topics

- *External mounting* on page 24
- *External mounting on vessel hulls (example)* on page 24
- *EM 2040C Transducer cable w/ low profile connector* on page 73
- *EM 2040C Transducer cable w/ circular connector* on page 75
- *Sonar head w/ low profile connector, outline dimensions* on page 78
- *Sonar head w/ circular connector, outline dimensions* on page 79

Alignment

This chapter describes the requirements for alignment of the Kongsberg EM 2040C sonar heads and associated sensors.

Topics

Related topics

Introduction

Caution

Alignment that does not meet the requirements set out in this chapter may lead to a malfunctioning echo sounder system. The final verification of correct alignment can only be carried out during calibration at sea. If poor alignment is found to be the reason for a malfunctioning system the vessel most likely will have to be dry docked to repeat the alignment procedures.

The multibeam echo sounder is a precision instrument for bathymetric swath mapping. To achieve the obtainable precision of the bathymetric data the **alignment** of all involved sensors must be determined to highest possible accuracy. The requirements are set out in this chapter.

Alignment of all sensors includes determining the following:

- The vessel coordinate system
- The location of the sonar heads and sensors in the vessel coordinate system
- The orientation of the sonar head in the vessel coordinate system

The results, with all sensor location and orientation referred to a common vessel coordinate system, are to be entered into the operator software.

Caution

Determining the alignment within the given tolerances requires professional land surveying carried out by qualified and trained surveyors using proven survey equipment and methods. Kongsberg Maritime recommends using third part companies with well proven experience within vessel dimensional control.

Sufficient time and satisfactory work conditions must be given to the land survey work.

The Kongsberg Maritime installation engineer is not equipped or trained to determine the alignment, and has no means of verifying the alignment results until calibration at sea has been carried out.

Accuracy requirements

Note

The following accuracy requirements are minimum requirements. Higher accuracy will provide better results and should therefore always be aimed at.

Sonar head	Alignment accuracy
Position (x, y)	± 0.02 m
Position (z)	± 0.005 m
Pitch	± 0.05 deg
Roll	± 0.02 deg
Heading	± 0.05 deg

Motion sensor	Alignment accuracy
Position (x, y)	± 0.05 m
Position (z)	± 0.05 m
Pitch	± 0.05 degrees
Roll	± 0.02 degrees
Heading	± 0.05 degrees

Heading sensor	Alignment accuracy
Heading	± 0.1 deg

Positioning system (antenna)	Alignment accuracy
Horizontal position (x, y)	± 0.05 m
Vertical position (z)	± 0.005 m

Water line	Alignment accuracy
Position (z)	± 0.005 m

Related topics

- *Alignment specifications* on page 90

Vessel coordinate system

A Cartesian coordinate system must be defined for the vessel.

Caution

The vessel coordinate system defined by the land survey contractor will not necessarily be the same as used by the Kongsberg Maritime systems. Take care to identify the differences between the results provided by the land survey contractor and the Kongsberg Maritime definition, and how to convert between them.

The common coordinate reference system which all installation angles and locations are referred to must be unambiguously defined. The following information is required:

- **Origin**, i.e. where X=0, Y=0 and Z=0. This may be a theoretical or a physical point. A description of the location of the origo is required.
- **X-axis**: A description of what points or lines the x-axis is defined by, and a definition of positive x-axis

- **Y-axis**: A description of what points or lines the y-axis is defined by, and a definition of positive y-axis
- **Z-axis**: A description of what points or lines the z-axis is defined by, and a definition of positive z-axis

Kongsberg Maritime uses the following definition of the vessel coordinate system, which for input to any Kongsberg Maritime system must be adhered to:

- X = forwards
- Y = to starboard
- Z = pointing downwards

There are no restrictions to where the coordinate system's origo is located.

Note

The sea surface with the vessel in normal trim defines the horizontal (X-Y) plane. The waterline should therefore be marked on the hull with the vessel in normal trim before dry docking for installation of sonar heads/transducers.

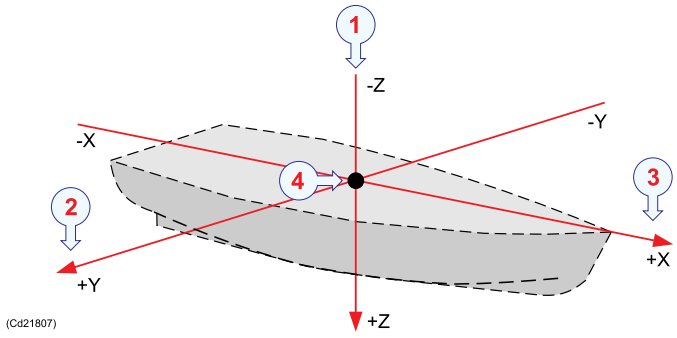
Figure 11 Kongsberg Maritime vessel coordinate system definition

1 *Downward (Z-axis)*

2 *Starboard (Y-azis)*

3 *Forward (X-axis)*

4 *Reference point (origo)*



Kongsberg Maritime definition of orientation

- Roll is positive when starboard side is low
- Pitch is positive when bow is high
- Yaw is positive clockwise
- Heave is positive up

The sensors

Motion sensor

This sensor can be based upon:

- Systems combining GPS with a Motion Unit, e.g. Seapath
- System based on only a Motion Unit, e.g. MRU

Note

The GPS based systems provides roll, pitch and heading observations as well as position and heave. Requirements applicable to all sensors must be assessed when using such a system.

The motion sensor provides the multibeam echo sounder with the angular orientation of the vessel coordinate system with respect to the gravity vector i.e. roll and pitch (usually the motion sensor also provides heave and sometimes heading). The motion sensor must therefore know its physical orientation, or installation angles, with respect to the vessel coordinate system. The accuracy of the roll and pitch measurements of your motion sensor must be as specified in *Interface specifications* on page 88 or better.

Installation of the motion sensor must be carried out according to the manufacturer's installation instructions.

Determining the sensor's installation angles must be performed within the given tolerance for roll and pitch. The motion sensor must also be aligned with the vessel centre line to the given accuracy to avoid that cross-coupling between roll and pitch measurements degrades the accuracy. The installation angles are either input to the motion system software or must be entered into the multibeam echo sounder software. Take care not to apply the correction twice.

The motion sensor performance must be verified after installation. This includes verification of the installation angles to the required accuracy as well as verification of the stated accuracy of the system.

The following calibration should be performed:

- Calibration from shore (in dock or alongside a quay)
- Calibration at sea where integrated system tests are carried out

Heading sensor

This sensor can be based upon:

- Systems combining GPS with a Motion Unit, e.g. Seapath
- Gyro compasses (incl. fibre optic gyro compasses)

Note

GPS based heading systems combines data from GPS antennas and a motion sensor. For such systems both the location of the GPS antennas and the location and alignment of the motion sensor applies.

Heading sensors should be mounted in accordance with the suppliers installation manual.

The heading sensor performance must be verified after installation. This includes verification of the installation angles to the required accuracy as well as verification of the stated accuracy of the system.

The following calibration should be performed:

- Calibration from shore (in dock or alongside a quay)
- Calibration at sea where integrated system tests are carried out

Positioning system

Most positioning systems are today based on Global Navigation Satellite System technology (GNSS) such as GPS, GLONASS and/or (later) GALILEO. The location of the positioning system antenna must be measured, including its height.

Note that some GNSS based systems use two (or more) antennas to provide vessel heading. Consult the positioning system's installation manual for how these antennae are to be aligned and how accurately the location of the antennae needs to be measured.

The GNSS antenna offset may in some cases be applied within the GNSS receiver so that the output position refers to the vessel reference point. Take care not to apply the correction twice.

The positioning sensor performance must be verified after installation. This includes verification of the installation location (antenna offsets) to the required accuracy as well as verification of the stated accuracy of the system.

The following calibration should be performed:

- Calibration from shore (in dock or alongside a quay)
- Calibration at sea where integrated system tests are carried out

Related topics

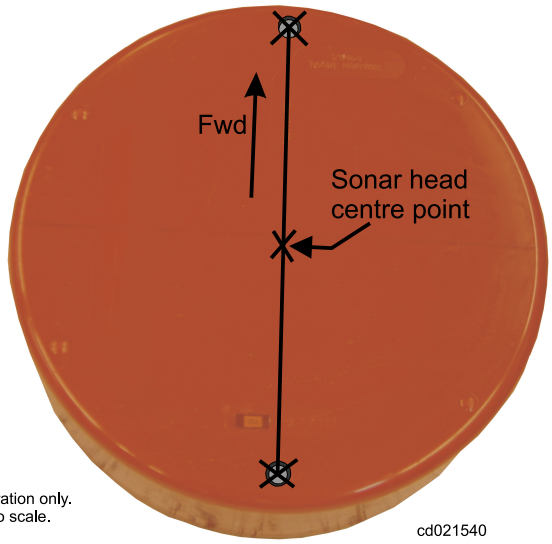
- *Calibration* on page 42
- *Interface specifications* on page 88

Waterline

With the vessel in normal trim, i.e with an indicated pitch angle of zero from the aligned motion sensor, the distance to the waterline can be measured anywhere on the vessel. Otherwise it must be measured at the alongship physical location of the motion sensor. The measurement should be taken on both sides of the vessel and averaged to remove any roll effects. Simultaneous measurements are required if the vessel is moving.

Sonar head measurements

The EM 2040C Sonar Head has two index marks on the face and on the lid to be used for measuring its centre point and orientation.



A ruler oriented with the face index marks can be used to give the heading and pitch of the Sonar Head. By making the ruler as a right-angle cross the roll may be measured.

The index marks on the lid may be used for the same purpose, but they are rotated 90 degrees.

Coordinate systems

The heading of the Sonar Head is measured as the heading of the projection of a line through the face index marks into the horizontal plane of the vessel coordinate system. If the Sonar Head is mounted in such a way that the X-axis is vertical, the heading angle must be measured as the heading of the Y-axis with 90 degrees subtracted. See the definition below.

The measurement of roll and pitch is done in a coordinate system which is the vessel coordinate system rotated about the Z-axis so that its X-axis is pointing in the transducer's heading direction.

- The pitch of the Sonar Head is measured as the angle in the vertical plane between the horizontal plane and the line through the face index marks.
- The roll of the Sonar Head is measured as the angle in the vertical plane between the horizontal plane and a line on the face at right angle to the line through the face index marks.

Pitch

The pitch installation angle is measured between the X axis and the horizontal plane. The angle is positive if the axis points upwards (bow up), and negative if it points down. The range is between -90 and +90 degrees.

Roll

The roll installation angle is measured between the Y axis and the horizontal plane. The angle is positive if the axis points downwards (port side up), and negative if it points up. The range is between -180 and +180 degrees.

To determine if the roll installation angle is larger than +90 or smaller than -90 degrees, consider how much roll was required to bring the Sonar Head into its final position. Use the standard definition for roll direction.

Making the measurements

The actual measurement of the installation angles may be done by two different methods.

- The most accurate method is to use land surveying techniques, establish a horizontal plane, and do distance measurements to and in this plane.
- The second method is to use an inclinometer to measure roll and pitch angles combined with distance measurements in the horizontal plane for heading. This method is easier, but it requires a sufficiently accurate inclinometer.

Which method is to be used must be determined by the facilities available. The use of land surveying techniques is the recommended method, and is especially appropriate on a new vessel where all sensor locations must be measured. The two other methods may be appropriate when installing an EM 2040C on a survey vessel where other sensor positions and orientations are already established. A prerequisite for using an inclinometer is of course that it is accurate enough.

Related topics

- *Accuracy requirements* on page 36

Calibration

It is advisable to perform a calibration survey at regular intervals or prior to any large survey to check the performance of the sensors. If any sensor has been replaced or another navigation antenna is installed etc, a new calibration is required.

Calibration from shore

Caution

Calibration of the sensors from shore requires professional land surveying carried out by qualified and trained surveyors using proven survey equipment and methods. Kongsberg Maritime recommends using third part companies with well proven experience within vessel dimensional control.

Sufficient time and satisfactory work conditions must be given to the land survey work.

The Kongsberg Maritime installation engineer is not equipped or trained to carry out the calibration from shore, and has no means of verifying the alignment results until calibration at sea has been carried out.

Verification of roll and pitch

With installation angles applied the motion unit's roll and pitch data output should in average be equal to the roll and pitch angles of the vessel. This can be checked by doing observations of the vessel's roll and pitch placement and compare these values to readings from the motion sensor.

The difference between the calculated (C) level of the vessel and the observed (O) values from the motion sensor (C-O) must in average be within the installation angle tolerance. The standard deviation of the C-O should be within the stated accuracy of the motion system.

Note

The motion sensor unit uses accelerometers. Due time to stabilize the readings after movements must be allowed for before data verification takes place.

Verification of heading

With installation angles applied the heading data output should in average be equal to the heading of the vessel. This can be checked by doing observations of the vessel's actual heading and compare these values to readings from the heading sensor.

The difference between the calculated (C) and the observed (O) heading (C-O) must in average be within the installation angle tolerance. The standard deviation of the C-O should be within the stated accuracy of your heading system.

Note

If the heading sensor unit uses accelerometers, due time to stabilize the readings after movements must be allowed for before data verification takes place.

Position verification

The GPS antenna must be position by land survey methods. At the same time readings from the GPS system must be recorded.

The difference between the calculated (C) and the observed (O) coordinates (C-O) must in average be within the installation angle tolerance. The standard deviation of the C-O should be within the stated accuracy of your heading system.

Calibration at sea

During the sea trials (SAT), calibration surveys are required as described in the SIS Operator Manual. Based on the calibration parameters determined from these surveys, together with the measurements done in the dry-dock, final values are entered into the EM 2040C.

Related topics

- *Accuracy requirements* on page 36

Requirements for survey report

Caution

The land survey contractor shall issue a written survey report before approval of the alignment. This is the only mean of verification of the alignment while the vessel is still in dock.

The survey report shall include, but not be limited to, information as follows:

- **Scope of work** that summarizes what work has been carried out
- **Personnel**
- **Survey equipment** used, including date of expiry of certification where applicable
- **Definition of vessel coordinate system**
- **Results** including illustrating sketches and/or photos

  A summary of the results, i.e. the X, Y and Z figures and installation angles, where applicable, for all relevant point that has been surveyed, is useful for quickly finding the values to apply. However, such values should always be accompanied by illustrating sketches and/or photos to eliminate any misunderstandings of location or signs.

  Illustrations to alignment results must be unambiguous with respect to sign. We recommend that the illustration indicates the following direction (where applicable):

  – Forward direction
  – The direction of the view, e.g. looking towards starboard
  – Bow up or down for pitch alignment
  – Starboard up or down for roll alignment
- **Accuracy of results** that has been achieved

Related topics

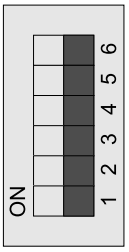
- *Accuracy requirements* on page 36

Installing the Slim Processing Unit

CBMF board dip switch setting

CBMF is the compact beamformer board used in the Slim Processing Unit.

All the dip switches on all the CBMF boards should be set to OFF. OFF is when they are pushed towards the edge of the circuit board.

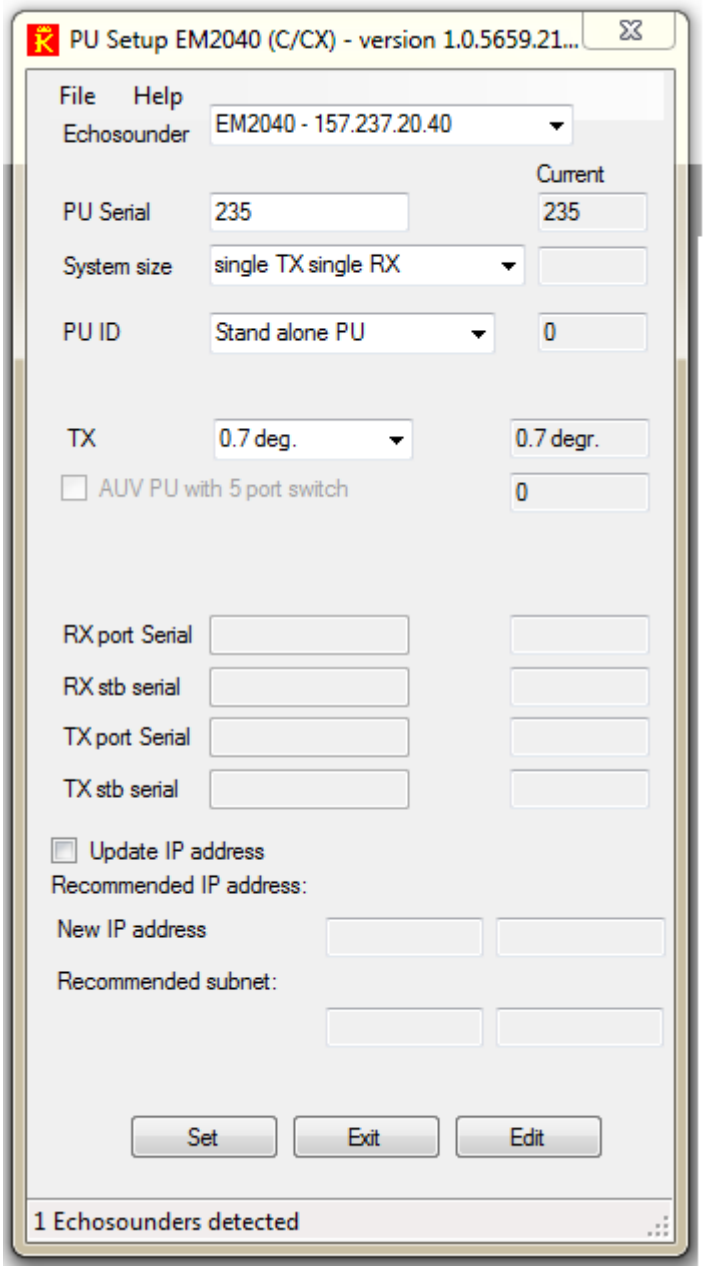


(CD090306_001_001)

Processing Unit Setup

The EM 2040C Processing Unit has to be set up with system size, PU ID and IP address. These settings are set from the factory, and you are normally not required to change them.

However, if the system is upgraded to a different system size, they have to be changed. The program `PUSetup2040` is used for this.



The `PUSetup2040.exe` is to be found here:

- On the Hydrographic Work Station: `C:\Program Files (x86)\Kongsberg Maritime\SIS\PU\EM2040\Update\Support\TRUSetup\PUSetup2040.exe`
- On the installation medium: `medium\PU\EM2040\Update\Support\TRUSetup\PUSetup2040.exe`

For details, please refer to *Short guide to PUSetup2040, document number 398602B*.

Upgrade to dual swath

If the the EM 2040C is to be upgraded to dual swath, the System Size has to be set accordingly.

Upgrade to two Processing Units

If the the EM 2040C has more than one Processing Unit, each PU has to be set up with different IP addresses and if it is the master or slave PU.

Cable layout and interconnections

This chapter provides the cable plan and cable installation requirements for the Kongsberg EM 2040C.

There are two versions of processing unit (PU) for the EM 2040C:

- EM 2040C-1. Two PUs are required if this version is used for a dual head application.
- EM 2040C-2 (Slim PU). One PU with two CBMF boards is required if this version is used for a dual head or dual swath application.

  Two PUs with two CBMF boards each is required for dual head and dual swath in combination.

This chapter provides separate cable plans for the two versions.

Note

All electronic installation and corresponding wiring must be in accordance with the vessel's national registry and corresponding maritime authority and/or classification society.

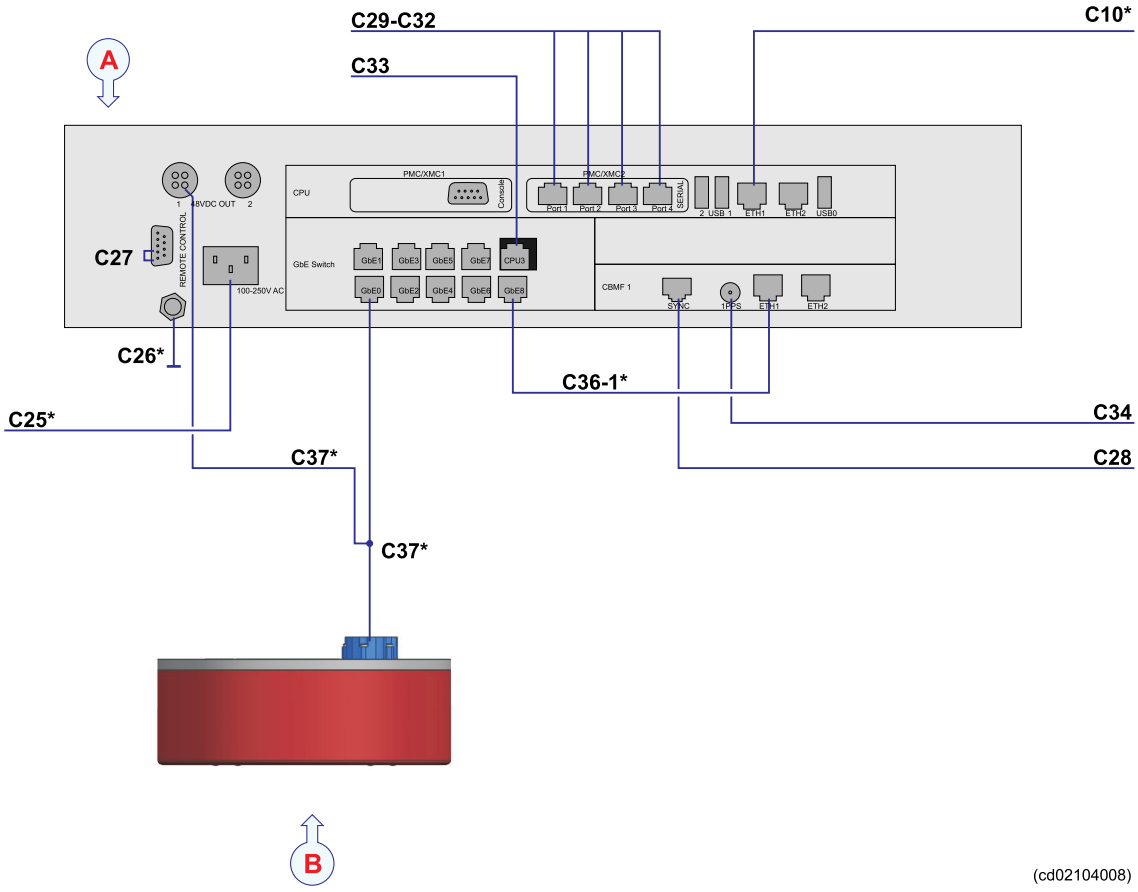
If no such guidelines exist, Kongsberg Maritime AS recommends that Det norske Veritas (DNV GL) Report No. 80-P008 «Guidelines for Installation and Proposal for Test of Equipment» should be used as a guide.

Topics

Related topics

Cable plan – single head – slim PU

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.

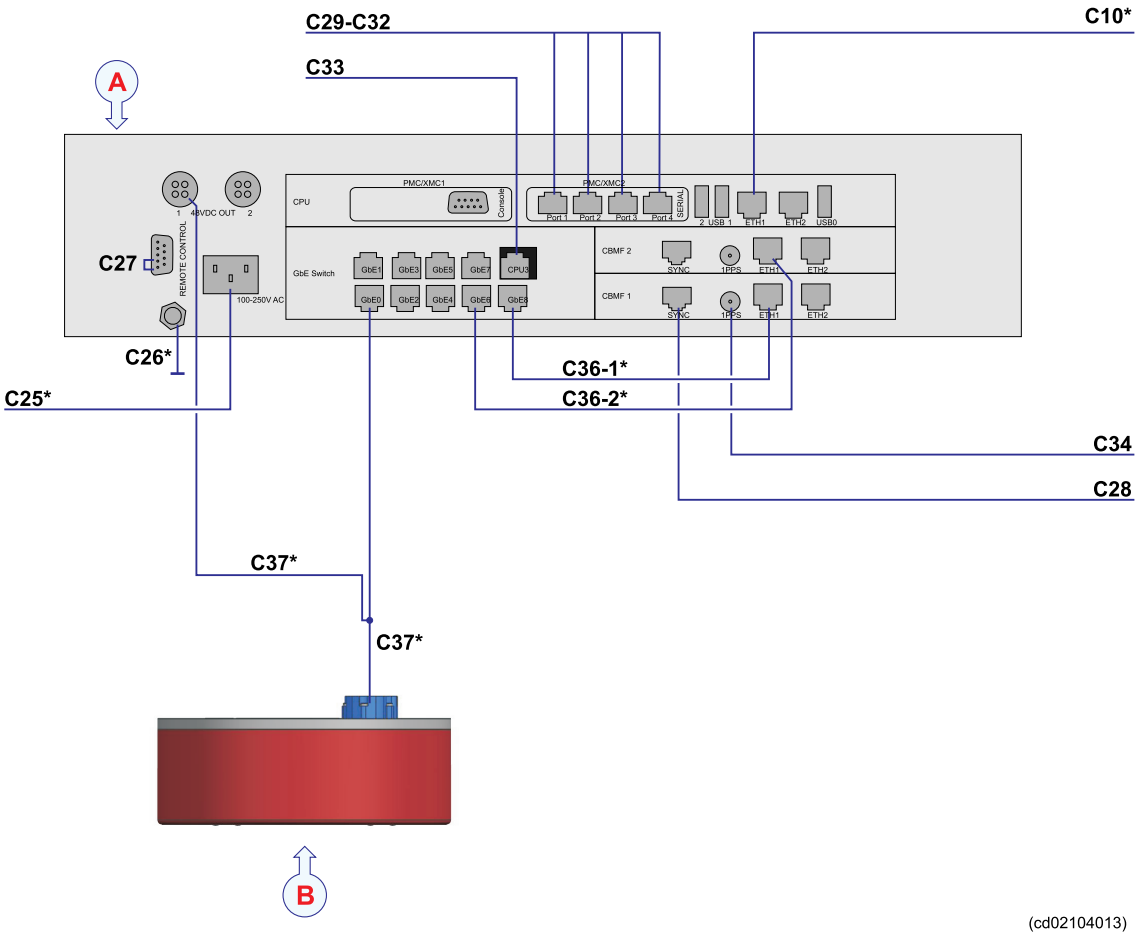


A Processing Unit

B Sonar head

Cable plan – single head – dual swath – slim PU

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.



A Processing Unit

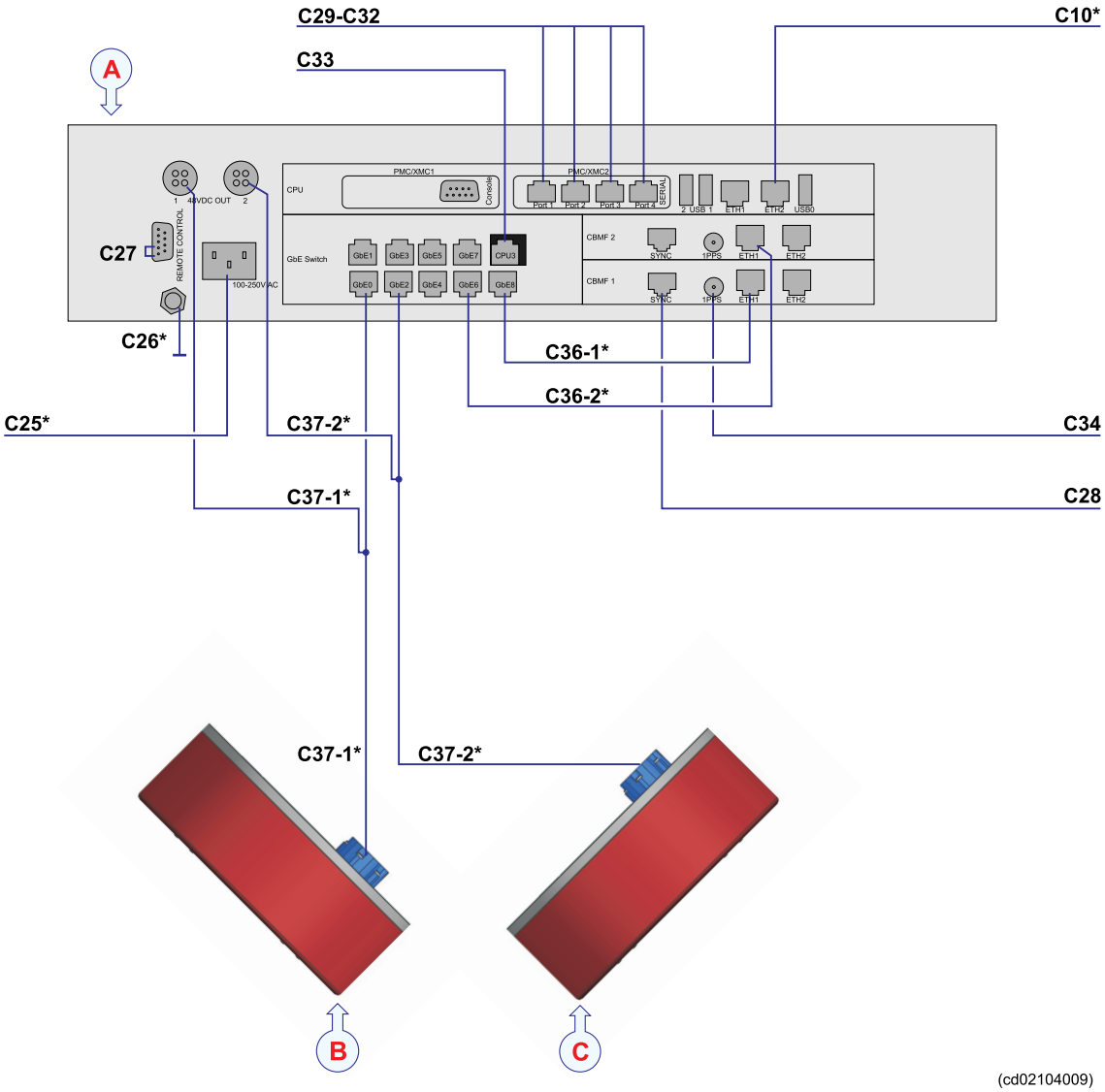
B Sonar head

Note

The dual swath option is only available with the Slim Processing Unit.

Cable plan – dual head – slim PU

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.



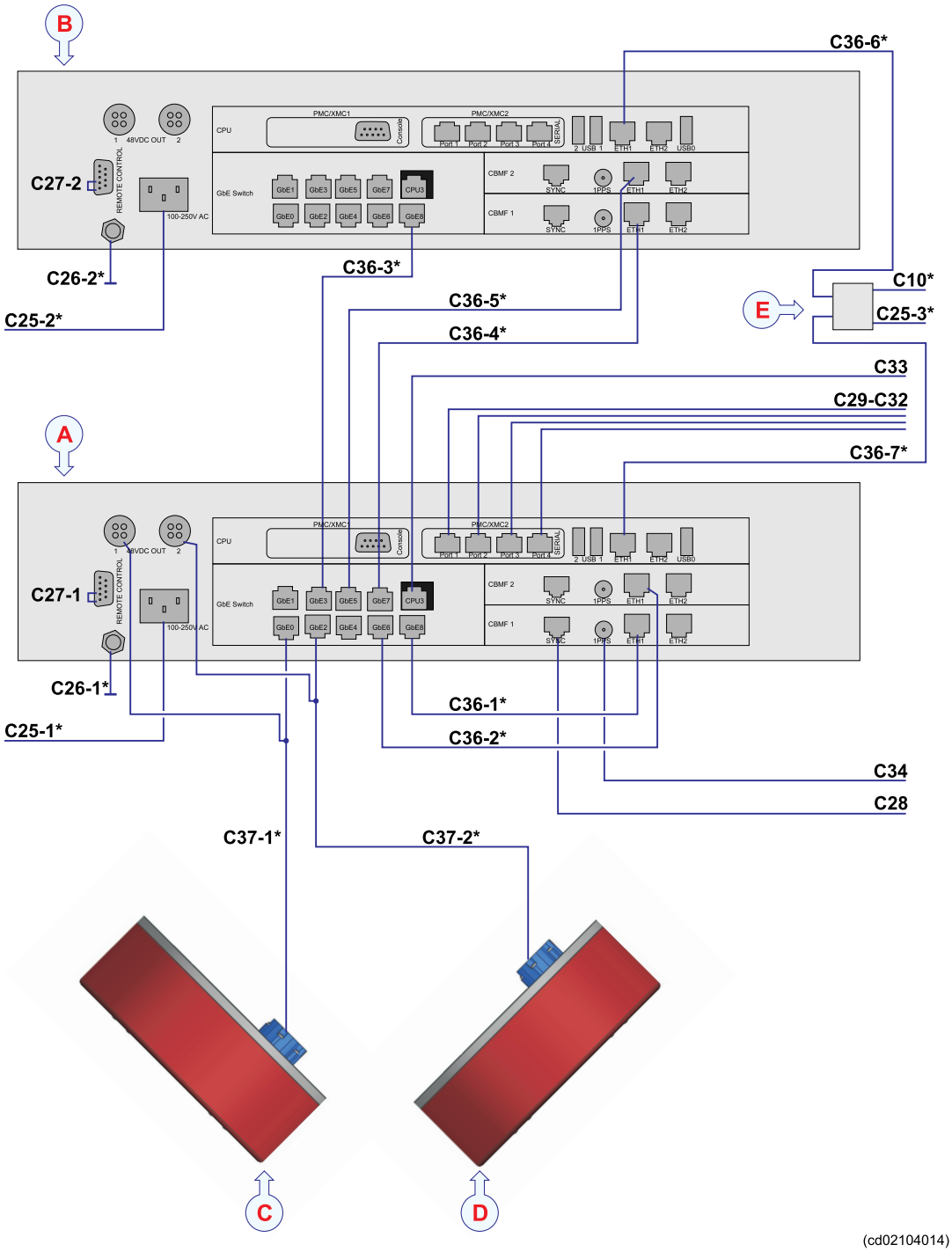
A Processing Unit

B Sonar head

C Sonar head

Cable plan – dual head – dual swath – slim PU

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.



A Processing Unit, master

B Processing Unit, slave

C Sonar head

D Sonar head

E Ethernet switch

Note

The dual head dual swath option is only available with the Slim Processing Unit. Two Processing Units are required.

Cable plan – single head – PU 1

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.

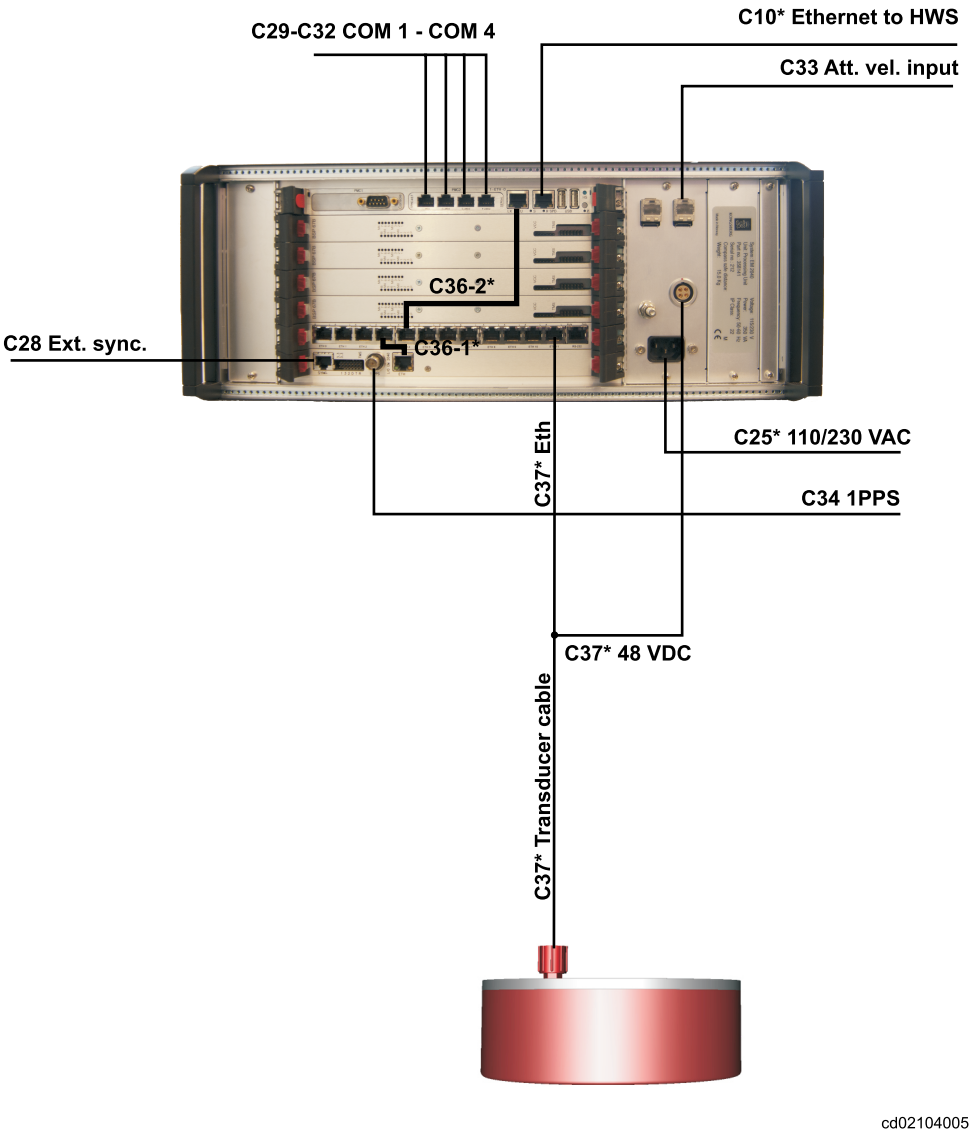
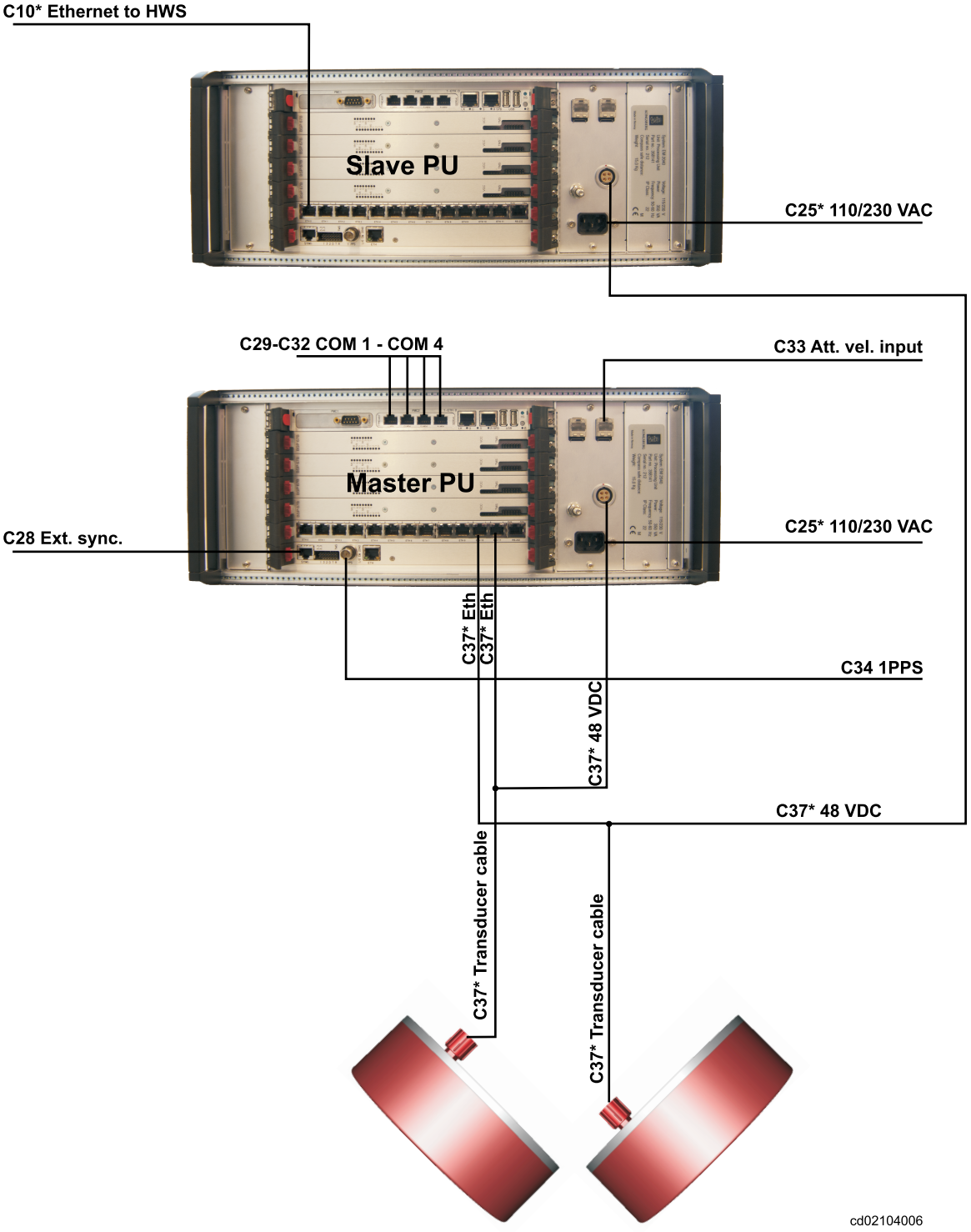


Table 1 C36 specifications – Internal Ethernet connections (single head)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	Transducer data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the IO2040 and to the transducers

Cable plan – dual head – PU 1

Observe the cable plan for the Kongsberg EM 2040C. Cables identified with an asterisk (*) are provided by Kongsberg.



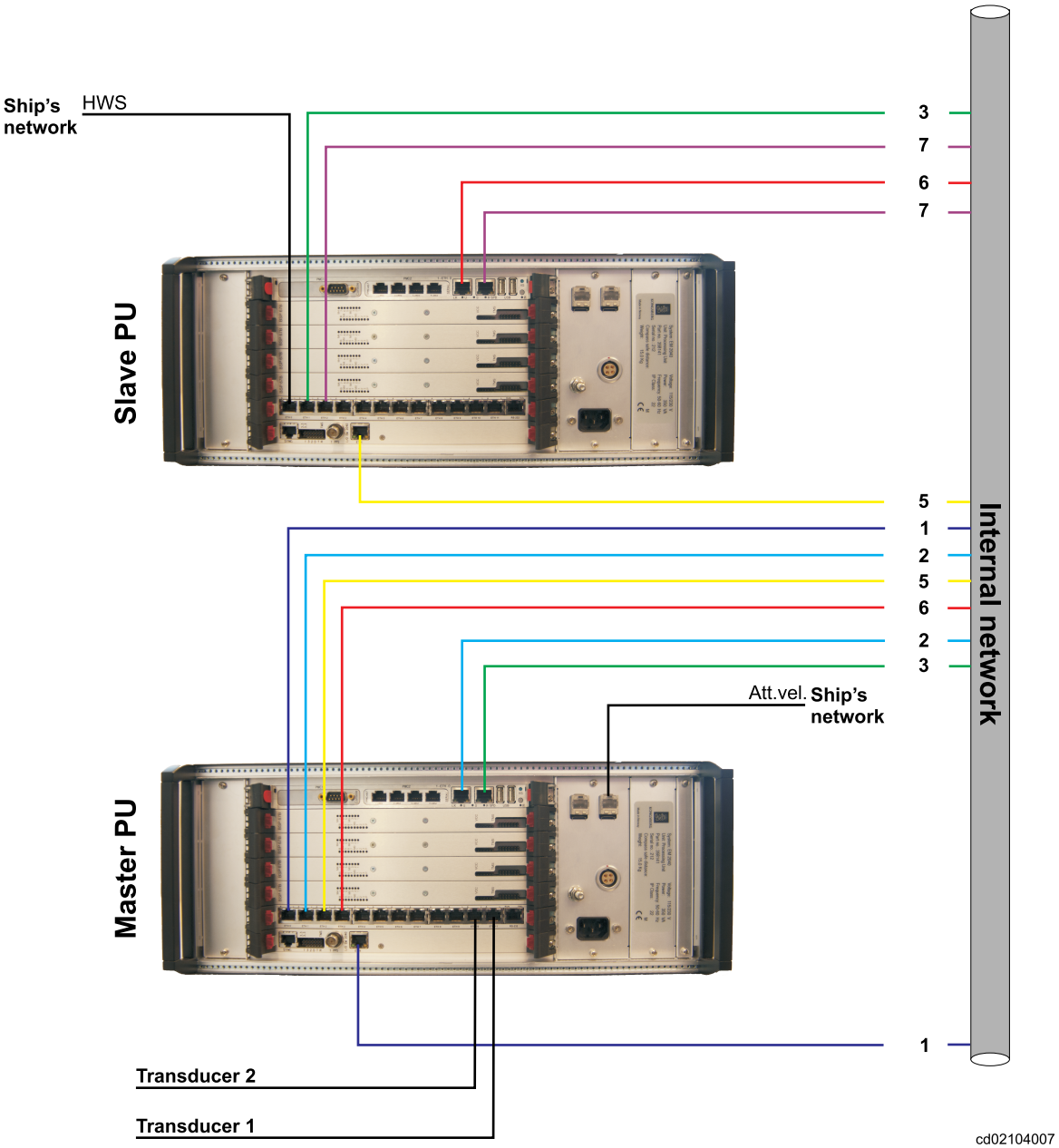


Table 2 C36 specifications – Internal Ethernet connections (dual head)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	Transducer data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the internal network (IO2040, transducers, slave CPU, slave IO2040)
3	Master CPU port 2	Slave Switch	Communication from the CPU with the external network (HWS, att.vel.) via the Slave switch
5	Master Switch	Slave IO2040	Transducer 2 data to IO2040 board on Slave PU for dual heads

Table 2 C36 specifications – Internal Ethernet connections (dual head) (cont'd.)

Connection no.	Connection point	Connection point	Used for
6	Master Switch	Slave CPU port 1	Communication from the Slave CPU to the Master CPU (sensor data, BITS, etc.)
7	Slave CPU port 2	Slave switch	Communication from the Slave CPU with the external network (HWS) via the Slave switch

List of cables

Observe the list of cables for the Kongsberg EM 2040C. The **Cx** numbers refer to the cable plan. References are made to the individual cable drawings specifying each cable with its connectors.

The spare numbers in the cable list are implemented to make the **Cx** numbers consistent for different EM models.

The following list of cables applies to all configurations of EM 2040C.

C1 Spare cable number

C2 Spare cable number

C3 Spare cable number

C4 Spare cable number

C5 Spare cable number

C6 Spare cable number

C7 Spare cable number

C8 Spare cable number

C9 Spare cable number

C10 **EM2040C/C10 Ethernet between HWS and processing unit**

- A 5 meter long Ethernet cable is provided with the Operator station (HWS). If a longer cable is required, this must be provided by the installation shipyard.
- The cable must be a Gigabit Ethernet cable.
- See *RJ45 Ethernet, screened (straight and crossover)* on page 72.

C11 Spare cable number

C12 Spare cable number

C13 Spare cable number

C14 Spare cable number

C15 Spare cable number

C16 Spare cable number

C17 Spare cable number

C18 Spare cable number

C19 Spare cable number

C20 Spare cable number

C21 Spare cable number

C22 Spare cable number

C23 Spare cable number

C24 Spare cable number

C25 EM2040C/C25 AC mains to processing unit (PU)

- This is a AC mains cable with a spring-loaded IEC lock system. The lock button must be release before it is disconnected.
- The cable is provided with the processing unit. If the AC mains connector on the cable does not fit, replace it with a suitable connector.
- Cable length is 3 meters. If this is too short, an extension cable or custom made cable is required.
- See *AC mains with IEC lock* on page 70 .

C26 Spare cable number

C27 EM2040C/C27 Remote control

- Applicable for Slim PU only.
- The PU can be turned on/off from an external junction box, normally located in the vicinity of the Operator Station. The cable from this box is connected to the Remote control plug on the PU.

  This cable must be provided by the installation shipyard.
- If Remote control is not used, a termination plug has to be inserted in the Remote control plug on the PU.

  This plug is a 9 pin D-SUB supplied with the PU.

C28 EM2040C/C28 External synchronization

- This connection is used for interface to an external synchronization system (e.g. K-Sync) used when multiple echo sounders are employed on the same vessel. The external synchronization connector is located on the IO2040 board of the processing unit.
- This is an optically isolated connection that requires ~10mA current. Input power and resistor value must be adjusted accordingly.
- The connector is RJ45 type.
- The cable must be provided by the installation shipyard.
- See *External synchronization interface* on page 69.

C29 EM2040C/C29 Serial line interface (COM1)

- The processing unit (PU) is equipped with four serial line connectors for input of position, attitude/motion, heading and time. The serial line connectors are 8 pin RJ45 modular jack connectors located on the CPU board.
- The serial lines are normally set up as follows:
  - COM1: Positioning system
  - COM2: Motion sensor
  - COM3: Auxiliary 1
  - COM4: Auxiliary 2
- The serial communication signal is RS232 or RS422 type. Selection between RS232 and RS422 is made in Seafloor Information Systen (SIS). The connectors are RJ45 with pinout compliant with the TIA/EIA-561 standard.
- The cables must be provided by the installation shipyard.
- See *RJ45 Serial interface RS232* on page 63 .

  See *RJ45 Serial interface RS422* on page 64 .
- For standard 9-pin D-SUB RS232 serial interface connectors, the cable specification is shown in *RJ45 to 9-pin D-SUB direct serial cable RS232* on page 66.

  For standard 9-pin D-SUB RS422 serial interface connectors, the cable specification is shown in *RJ45 to 9-pin D-SUB direct serial cable RS422* on page 67.
- RJ45-9pin D-SUB adapters are provided with the system, but to minimize signal loss it is recommended to avoid the use of adaptors, and instead prepare custom made cables for each serial input to the PU.
- See *Configurable RJ45 to D-SUB interface adapter* on page 65.

C30 EM2040C/C30 Serial line interface (COM2)

C31 EM2040C/C31 Serial line interface (COM3)

C32 EM2040C/C32 Serial line interface (COM4)

C33 EM2040C/C33 Ethernet from Attitude Velocity sensor

- The Ethernet cable must be provided by the shipyard.
- The cable must be a Gigabit Ethernet cable.
- See *RJ45 Ethernet, screened (straight and crossover)* on page 72 [w400].
- For PU-1 this this port is labeled **I**. The Ethernet port has to be configured via the **Installation parameters** menu in SIS. In the the SIS installation menu this port is referred to as **Ethernet 2**.
- For PU-2 (Slim PU) this is a port on the internal switch.

C34 EM2040C/C34 1PPS

- This is a timing signal terminated in a coax connector.
- The cable must be provided by the installation shipyard.
- This is an optically isolated connection that requires ~10mA current. Input power and resistor value must be adjusted accordingly.

C35 Spare cable number

C36 EM2040C/C36 Internal PU Ethernet connections

- The number of internal Ethernet connections depends on the chosen configuration, i.e. number of sonar heads and version of processing unit.
- The required cables are provided with the processing unit(s).

C37 EM2040C/C37 Transducer cable

- The transducer cable holds two connectors; Ethernet and 48 VDC.
- The Ethernet interface is 1 Gbit/s link to processing board in the sonar head.
- The standard length of the transducer cable is 15 meters. The cable is also available in 30 and 50 meters length.
- The minimum bend radius is 130 mm.
- The cable is provided with the echo sounder.
- See *EM 2040C Transducer cable w/ low profile connector* on page 73.
- See *EM 2040C Transducer cable w/ circular connector* on page 75.

Note

For a dual head system a second cable is required.

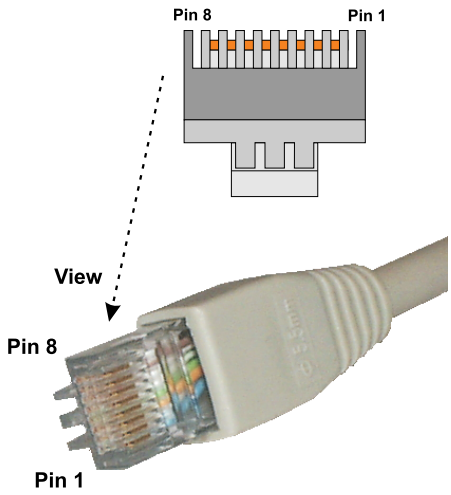
Cable drawings

The drawings provided specify in detail each cable used by the Kongsberg EM 2040C.

Topics

RJ45 Serial interface RS232

This cable comprises a multi purpose serial line. It provides interface with peripheral units. One end of the cable connects to the processing unit with a RJ45 connector, while the other connects to the peripheral with a 9 pin delta plug. Only the TxD, RxD and GND pins are used. Twisted pair cabling is sufficient.



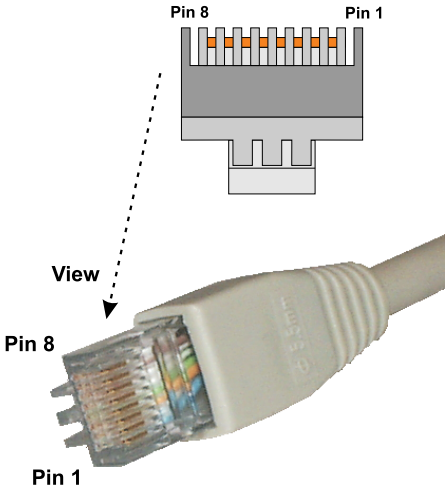
RJ45 plug

1	
2	
3	
4	GND
5	RxD
6	TxD
7	
8	

W146 Rev.C	RS232 pin assignment RJ45

RJ45 Serial interface RS422

This cable comprises a multi purpose RS422 serial line. It provides interface with peripheral units. One end of the cable connects to the processing unit with a RJ45 connector, while the other connects to the peripheral with a 9 pin delta plug. Only the TxD+, TxD-, RxD+, RxD- and GND pins are used. Twisted pair cabling is sufficient.



RJ45 plug

1	
2	
3	TxD+
4	GND
5	+5V Termination supply
6	TxD-
7	RxD+
8	RxD-

W152 Rev.B	RS422 pin assignment RJ45

Configurable RJ45 to D-SUB interface adapter

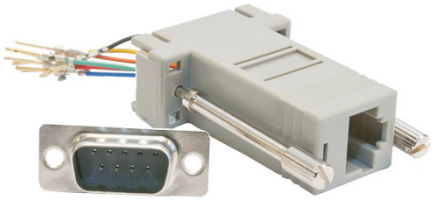
To connect peripheral equipment providing serial data on a 9-pin D-SUB plug a configurable adapter is provided. In order to allow for different D-SUB interfaces the pins of the adapter is not terminated. See figure below for termination for RS323 and RS422.

Note

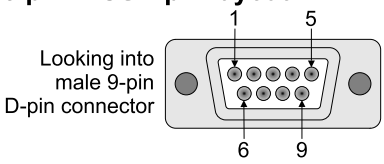
RS232: Only the TxD, RxD and GND pins are used. The pins not used can either be pinned according to the figure below or cut inside the converter.

RS422: Only the TxD+, TxD-, RxD+, RxD- and GND pins are used. The pins not used should be cut inside the converter. Make sure you isolate the green wire in the converter since this wire carries an unfused 5 V termination supply.

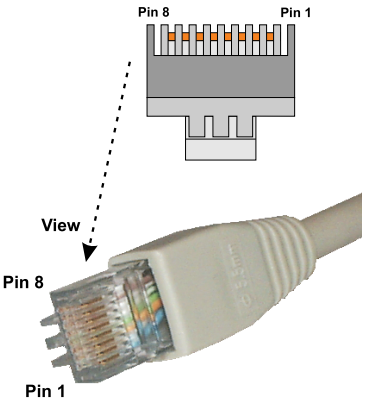
RJ45 to 9 pin D-SUB adapter



9 pin D-SUB pin layout



RJ45 plug pin layout



RJ45

Pin	Signal	Colour
1		Blue
2		Orange
3		Black
4	GND	Red
5	RxD	Green
6	TxD	Yellow
7		Brown
8		White

D-SUB RS232

Pin	Signal	Colour
1		Orange
2	RxD	Green
3	TxD	Yellow
4		Black
5	GND	Red
6		Blue
7		White
8		Brown
9		

RJ45

Pin	Signal	Colour
1		Blue
2		Orange
3	TxD+	Black
4	GND	Red
5	+5V	Green
6	TxD-	Yellow
7	RxD+	Brown
8	RxD-	White

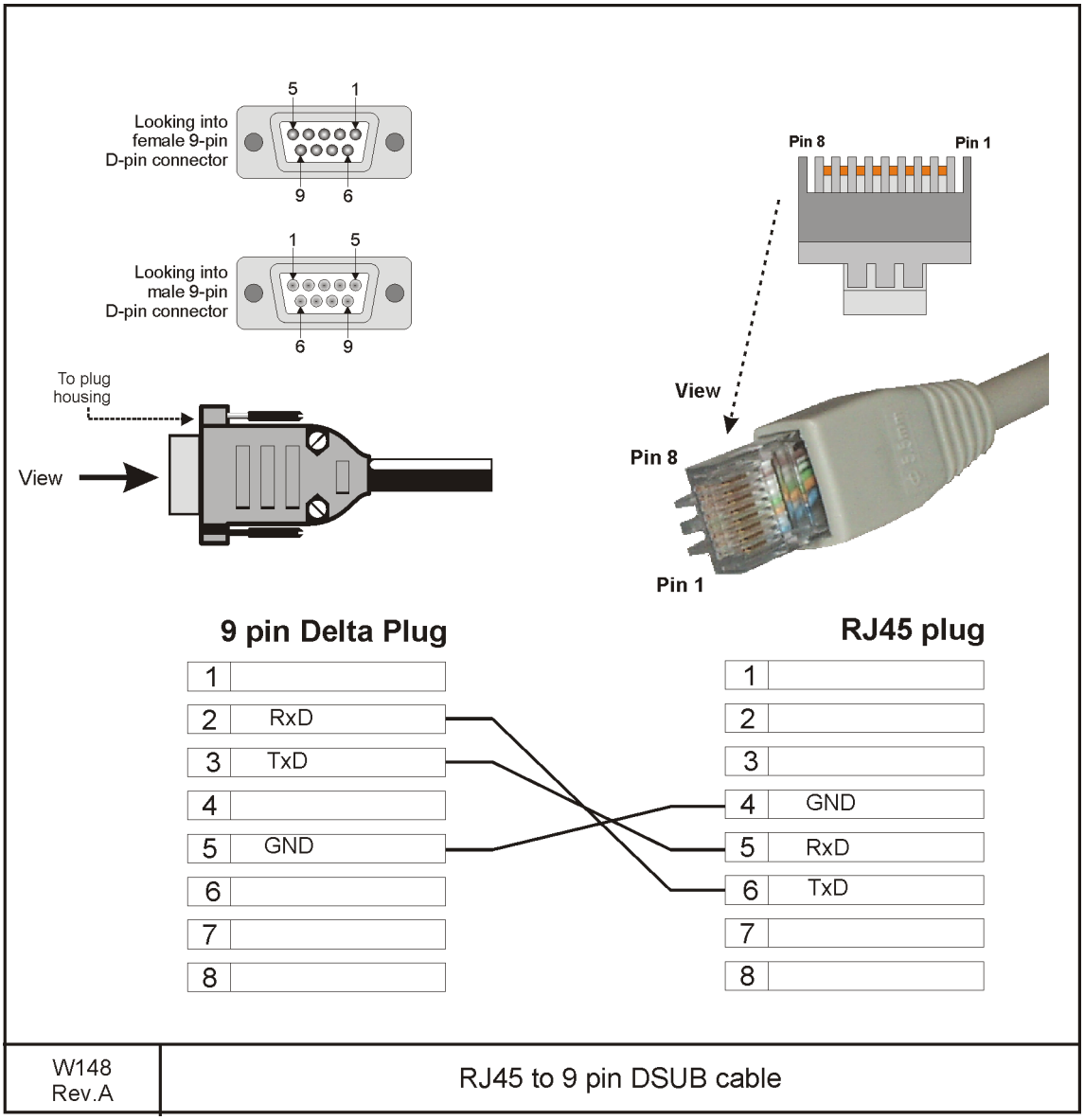
D-SUB RS422

Pin	Signal	Colour
1	TxD-	Yellow
2	TxD+	Black
3		
4		
5	GND	Red
6	RxD-	White
7	RxD+	Brown
8		
9		

W147 Rev.C	EM 2040/EM 2040C pin assignment RJ45 - 9 pin D-SUB adapter

RJ45 to 9-pin D-SUB direct serial cable RS232

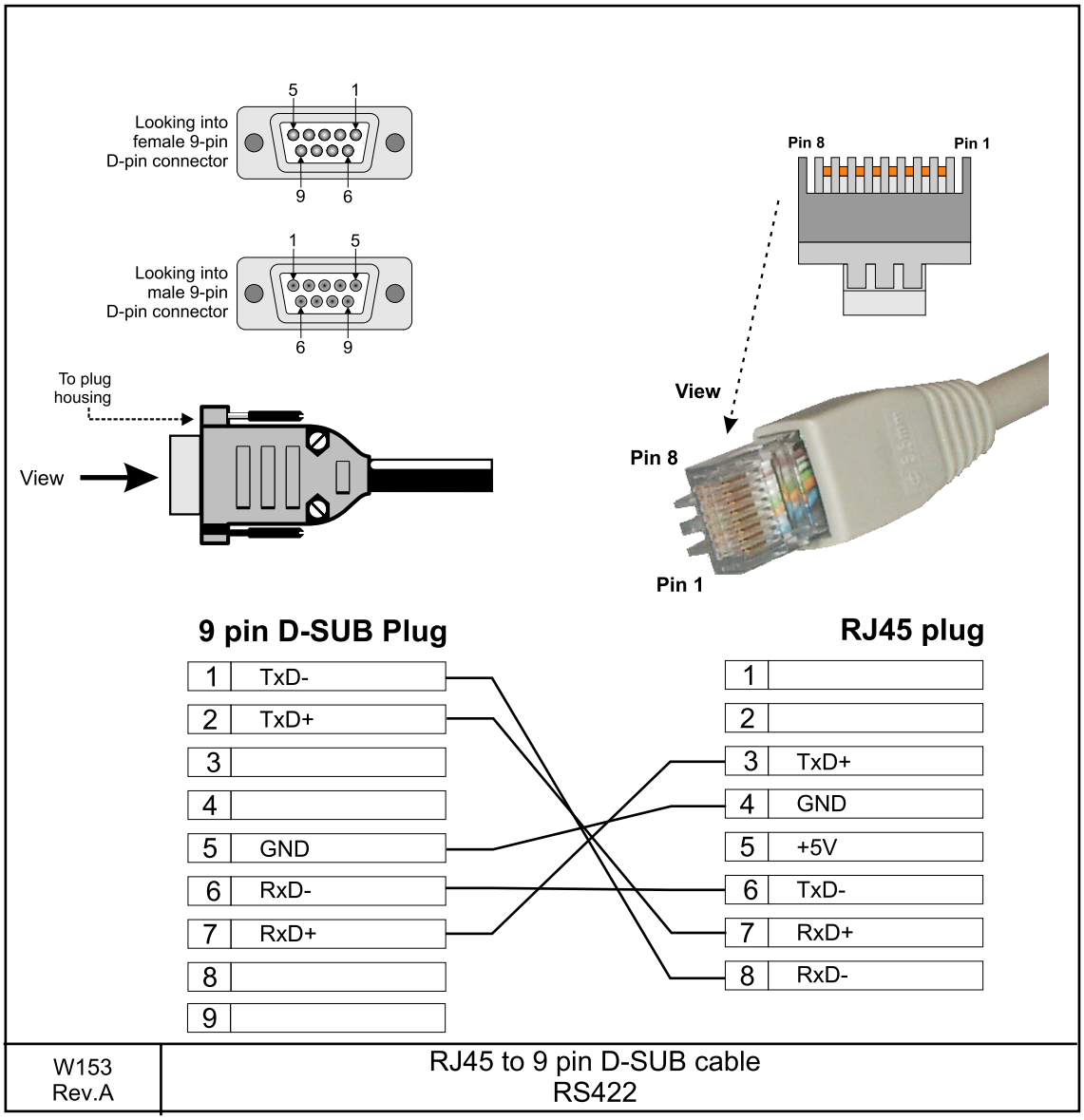
This cable can be used to connect peripheral units with serial data on 9-pin D-SUB interface to the RJ45 RS232 serial interface plug of the EM 2040C. One end of the cable connects to the processing unit with a RJ45 connector, while the other connects to the peripheral with a 9 pin D-SUB. Only the TxD, RxD and GND pins are used. Twisted pair cabling is sufficient.



W148 Rev.A	RJ45 to 9 pin DSUB cable

RJ45 to 9-pin D-SUB direct serial cable RS422

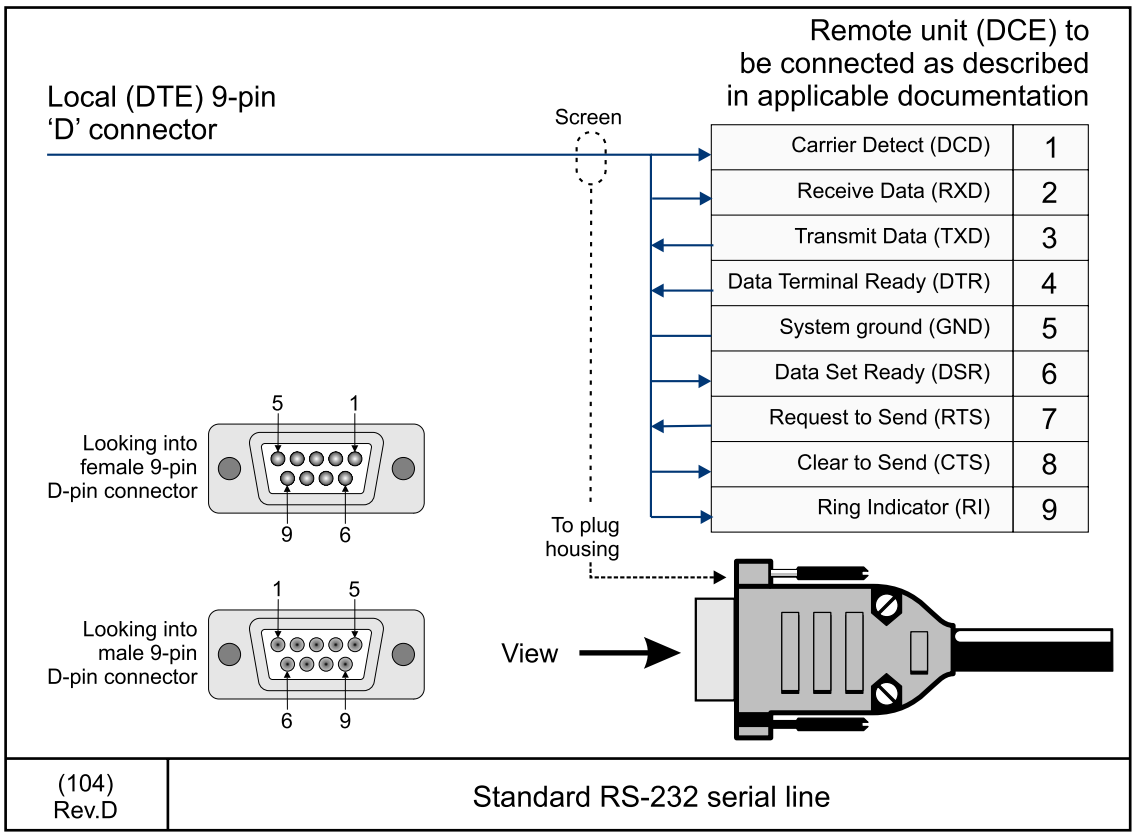
This cable can be used to connect peripheral units with serial data on 9-pin D-SUB interface to the RJ45 RS422 serial interface plug of the EM 2040C. One end of the cable connects to the processing unit with a RJ45 connector, while the other connects to the peripheral with a 9 pin D-SUB. Only the TxD+, TxD-, RxD+, RxD- and GND pins are used. Twisted pair cabling is sufficient.



Generic RS-232 Serial line

This cable comprises a multi purpose serial line. It provides interface with any peripheral unit. One end of the cable connects to the local unit **(DTE)** with a 9-pin D-sub connector, while the other connects to the peripheral **(DCE)** as described in the peripheral unit's documentation.

In many cases, only the **RxD**, **TxD** and **GND** pins are used. Twisted pairs are sufficient in the cable.



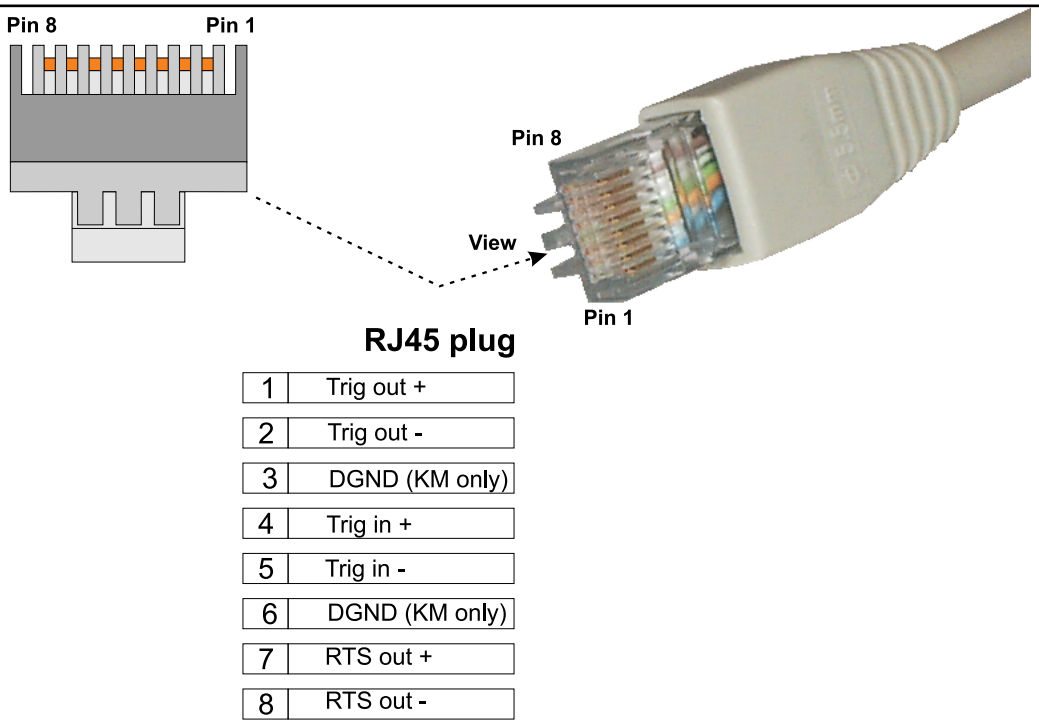
Cable specifications

- **Conductors**: 5 x 2 x 0.5 mm²
- **Screen**: Screened twisted pairs and overall braided
- **Voltage**: 60 V
- **Maximum diameter**: Limited by the plugs

External synchronization interface

This connection allows synchronisation of the Kongsberg EM 2040C Multibeam echo sounder systems.

The cable is not included with the delivery, and must be provided by the installation shipyard.



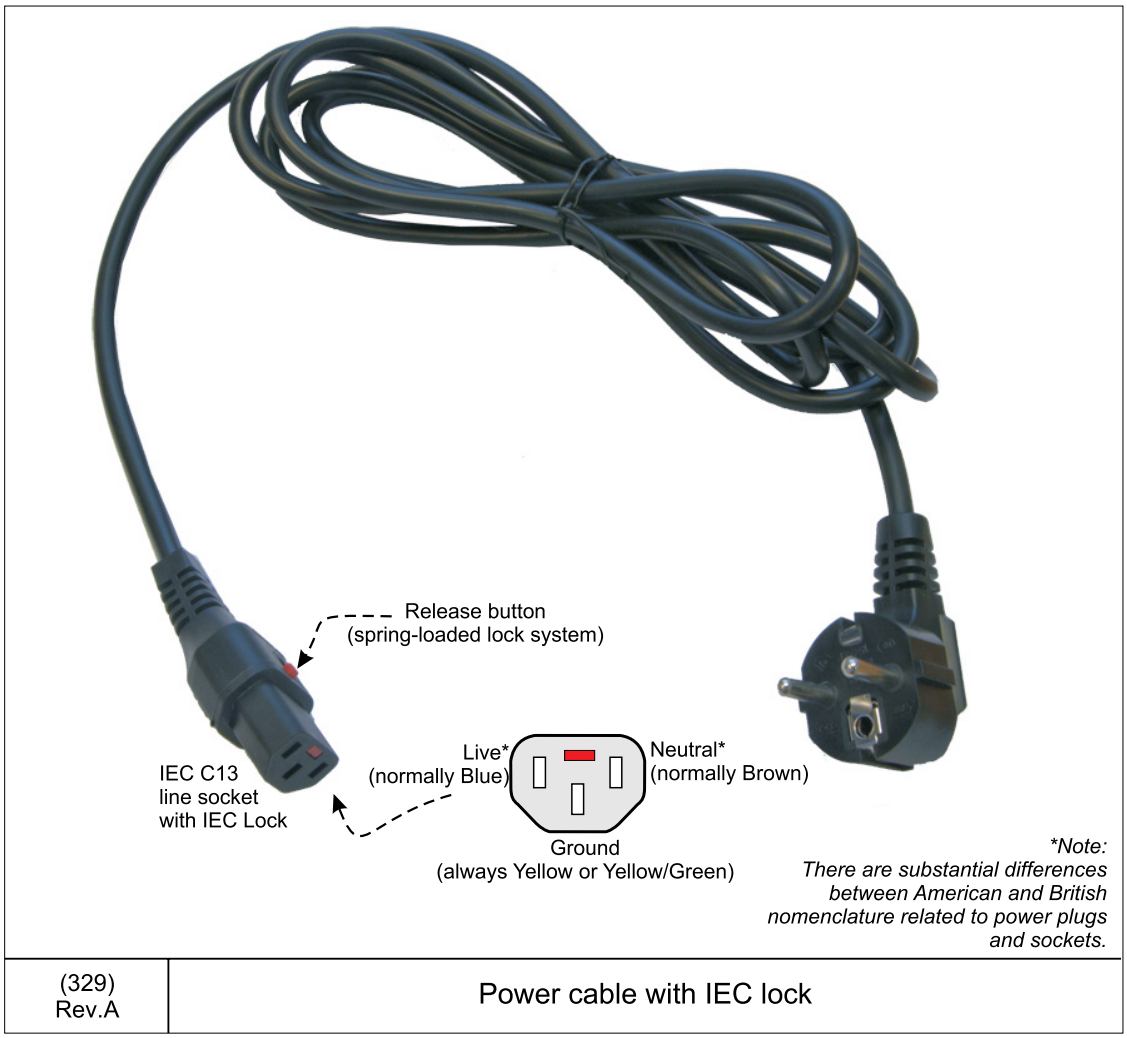
W253 Rev.A	External synchronization pin assignment RJ45

Cable specifications

- Conductors: 5 x 2 x 0.5 mm²
- Screen: Screened twisted pairs and overall braided
- Voltage: 60 V
- Maximum diameter: Limited by the plugs

AC mains with IEC lock

This is a 230 VAC power cable for mains power. One end is fitted with an IEC plug with a patented IEC lock system, the other with a standard European mains plug. The cable is 3 meters long.



(329) Rev.A	Power cable with IEC lock

Note

Remember to release the lock before removing the cable. The release button may be hidden on the underside.

Cable specifications

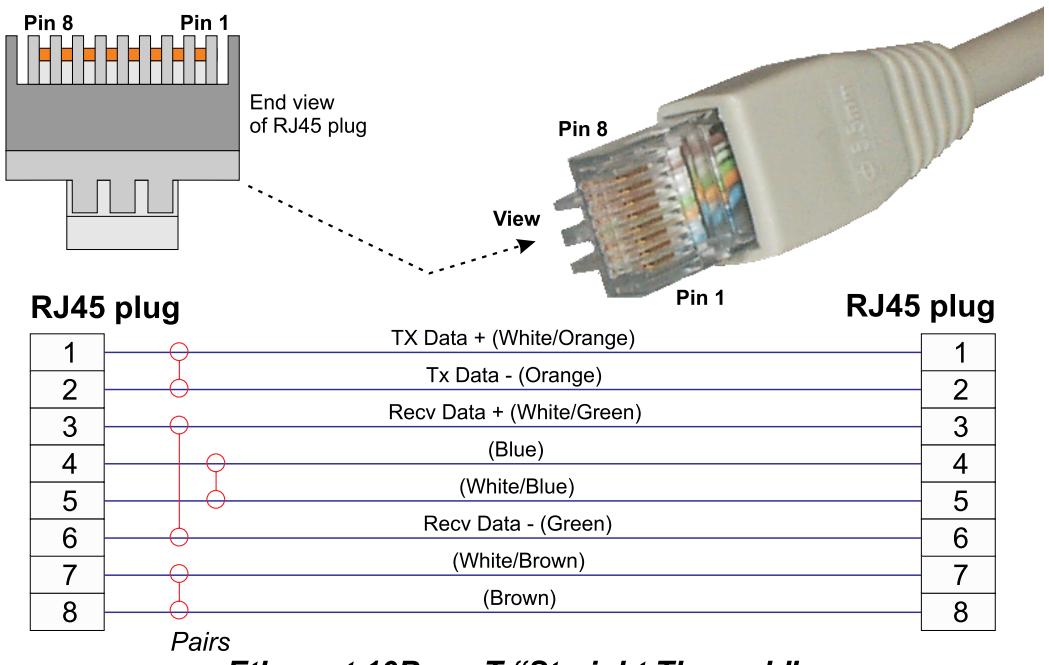
- **Conductors**: 2 x 1.5 mm² + GND
- **Screen**: None
- **Voltage**: 750 V
- **Maximum diameter**: Set by the plugs

More information

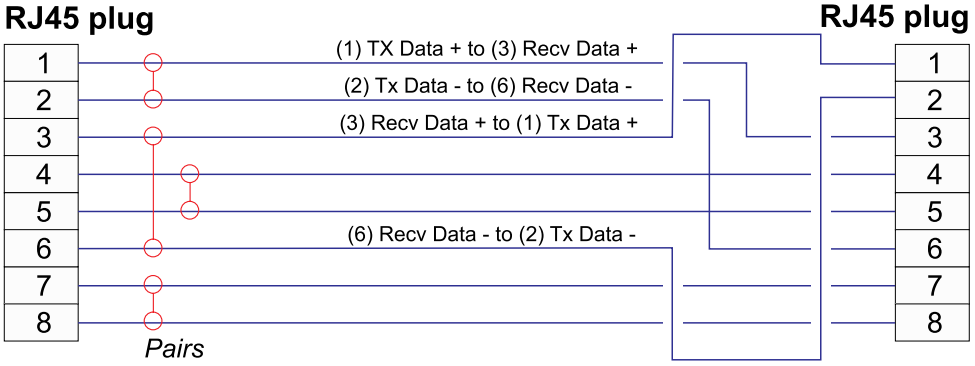
- http://www.ieclock.co.uk/step-by-step-plug.php

RJ45 Ethernet, screened (straight and crossover)

This cable contains the Ethernet connection. RJ45 plugs are used to terminate the cable. Note that these plugs must be screened to comply to EC rules.



Ethernet 10Base-T "Straight Through"



Ethernet 10Base-T "Crossover"

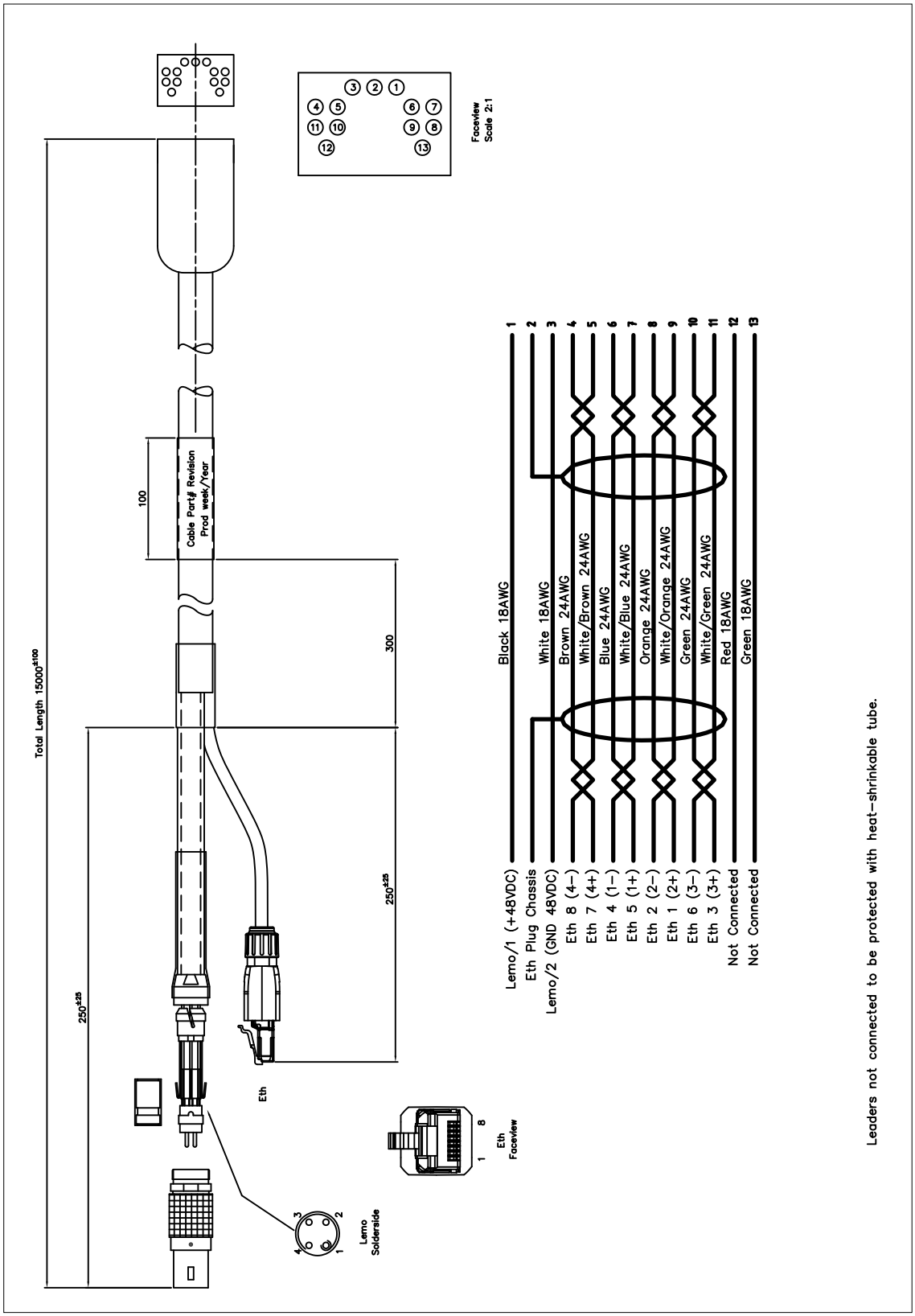
The "crossover" cable is used to cascade HUBs, or for connecting two ethernet stations or computers back-to-back without a HUB)

W400 Rev.F	Ethernet 10Base-T with RJ45 plugs

Note

In order to prevent noise and crosstalk, you are strongly adviced to use the cable pairs indicated above.

EM 2040C Transducer cable w/ low profile connector



W834 Rev.A dwg 380605	EM 2040C Transducer cable - 15 m Low profile connector

Cable specifications

- SubConn® Power/Ethernet Cable, Type *D/P-P4TP24#/4C18#*
- 13 pin with 4 Ethernet twisted pairs, 4 power conductors and 1 screen
- Cable length: 15, 30 and 50 meters
- Cable diameter: 13.97 mm nom.
- Weight in air: 246 kg/km nom.
- Weight in sea water: 90 kg/km nom.
- Min. bending radius: 130 mm
- Depth rating: 6000 metres
- Screen: Ethernet twisted pairs are screened
- Voltage:
  - Power conductor: 600V, max. 4 amp
  - Twisted pairs: 250V, max. 1 amp

Note

The current version of the Kongsberg EM 2040C is delivered with low profile connector similar to the EM 3002.

The previous version was delivered with circular connector (DIL 13).

Important

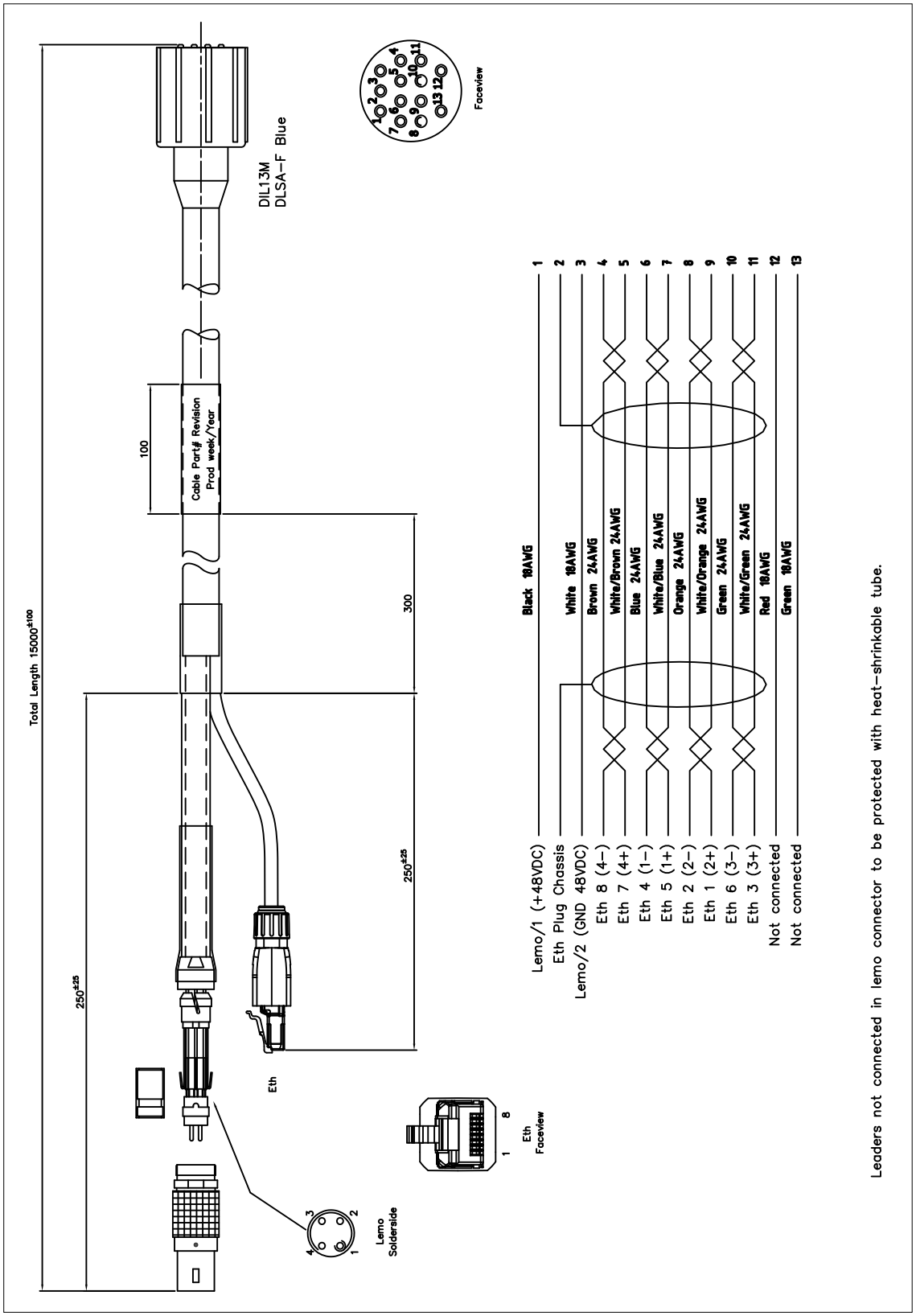
Precautions when using the SubConn® underwater connectors:

- The connector should not be exposed to extended periods of heat or sunshine.

  Should this occur and the connectors become very dry, they should be soaked in fresh water before use.
- Ensure the connectors are lubricated with Molykote® 44 Medium - but use very sparingly.
- Any accumulation of sand or mud in the female contact should be removed with fresh water.
- Disconnect by pulling straight not at an angle. Do not pull on the cable and avoid sharp bends at cable entry.

The recommendations from the manufacturer of the underwater connectors may be subject to change without prior notice. Please refer to the manufacturers website for updated information: http://www.macartney.com

EM 2040C Transducer cable w/ circular connector



W833 Rev.B dwg 376768	EM 2040C Transducer cable - 15 m DIL13 connector

Cable specifications

- SubConn® Power/Ethernet Cable, Type *D/P-P4TP24#/4C18#*
- 13 pin with 4 Ethernet twisted pairs, 4 power conductors and 1 screen
- Cable length: 15, 30 and 50 meters
- Cable diameter: 13.97 mm nom.
- Diameter DLSA locking sleeve: 36 mm
- Weight in air: 246 kg/km nom.
- Weight in sea water: 90 kg/km nom.
- Min. bending radius: 130 mm
- Depth rating: 6000 metres
- Screen: Ethernet twisted pairs are screened
- Voltage:
  - Power conductor: 600V, max. 4 amp
  - Twisted pairs: 250V, max. 1 amp

Note

The current version of the Kongsberg EM 2040C is delivered with low profile connector similar to the EM 3002.

The previous version was delivered with circular connector (DIL 13).

Important

Precautions when using the SubConn® underwater connectors:

- The connector should not be exposed to extended periods of heat or sunshine.

  Should this occur and the connectors become very dry, they should be soaked in fresh water before use.
- Ensure the connectors are lubricated with Molykote® 44 Medium - but use very sparingly.
- Any accumulation of sand or mud in the female contact should be removed with fresh water.
- Disconnect by pulling straight not at an angle. Do not pull on the cable and avoid sharp bends at cable entry.

The recommendations from the manufacturer of the underwater connectors may be subject to change without prior notice. Please refer to the manufacturers website for updated information: http://www.macartney.com

Drawing file

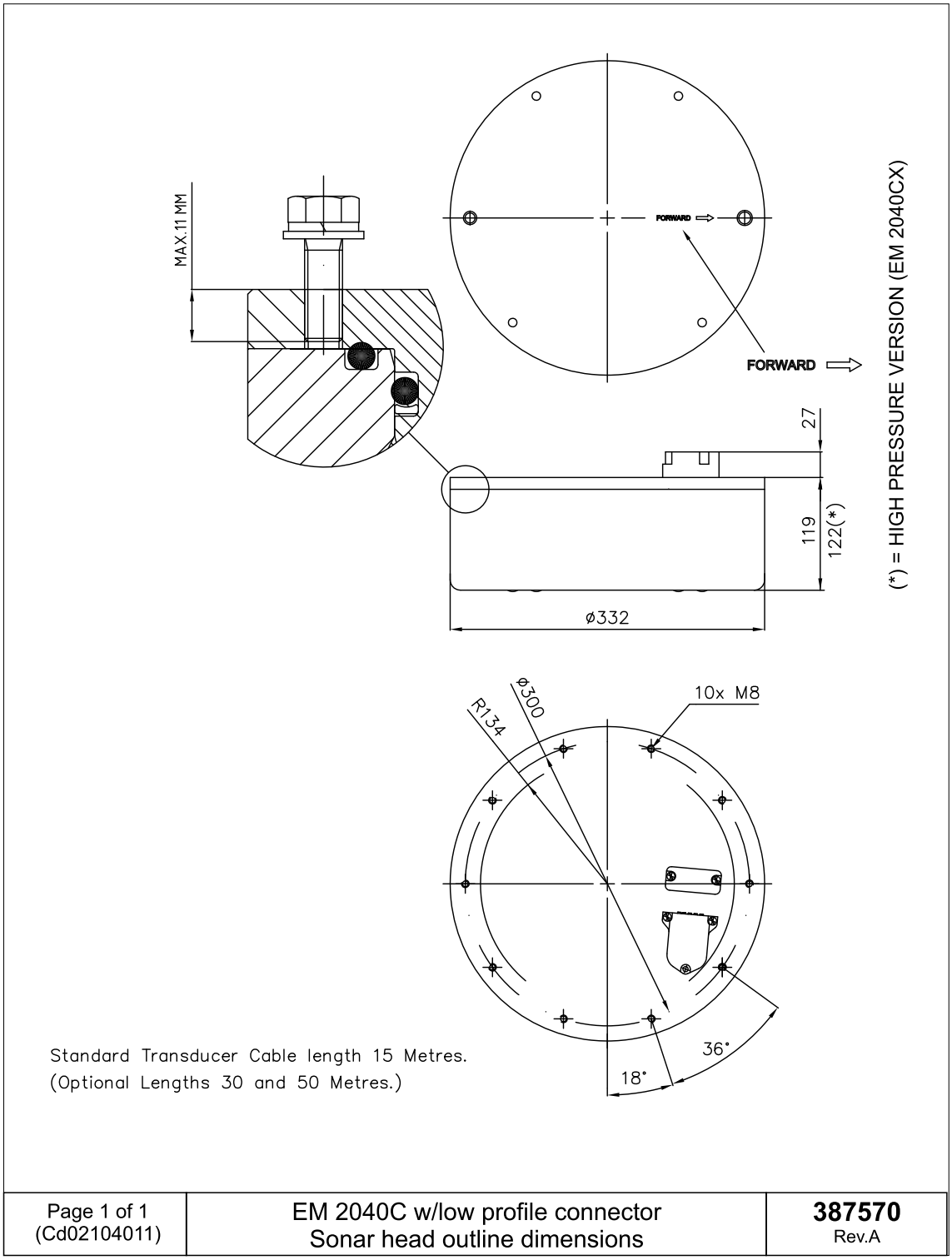
This chapter contains relevant drawings related to the installation and maintenance of the Kongsberg EM 2040C.

Note

The mechanical drawings are for information and guidance only. They are not in scale. All dimensions are in mm unless otherwise is noted. The original installation drawings are available on PDF format.

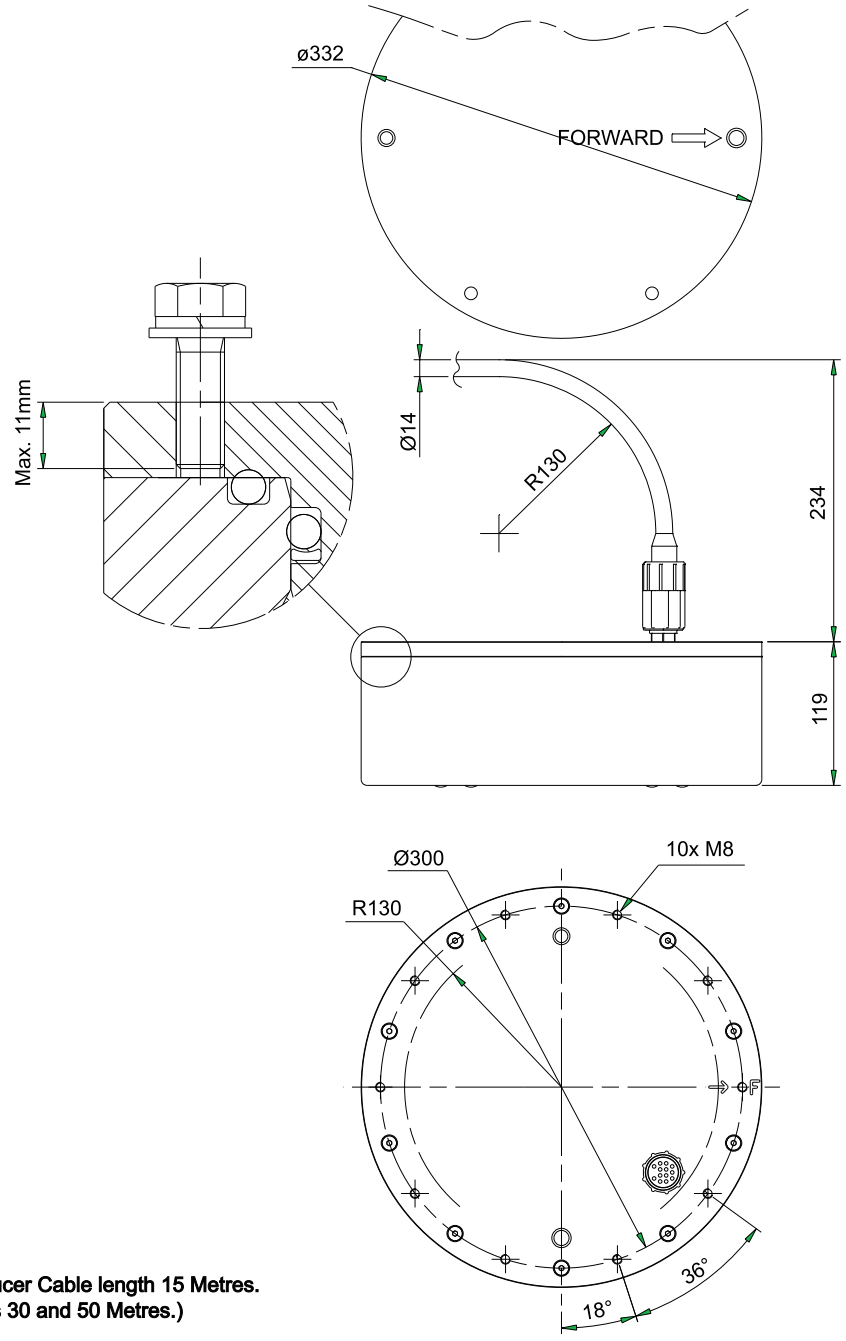
Topics

Sonar head w/ low profile connector, outline dimensions



Page 1 of 1 (Cd02104011)	EM 2040C w/low profile connector Sonar head outline dimensions	**387570** Rev.A

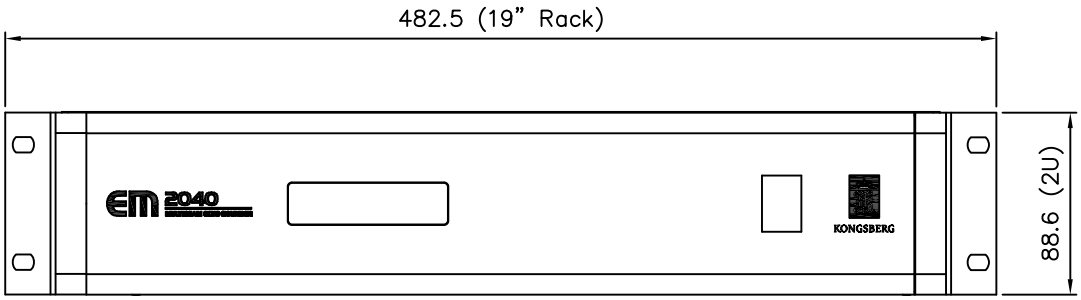
Sonar head w/ circular connector, outline dimensions



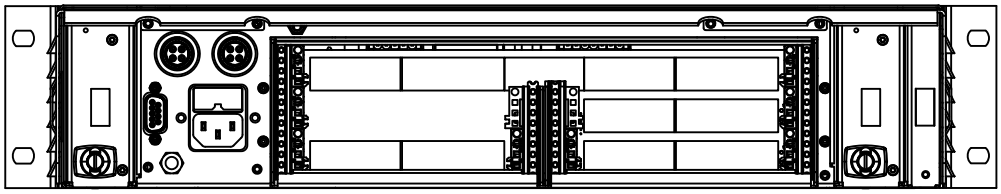
Standard Transducer Cable length 15 Metres.
(Optional Lengths 30 and 50 Metres.)

Page 1 of 1 (Cd02104002)	EM 2040C Sonar head outline dimensions	**377446** Rev.A

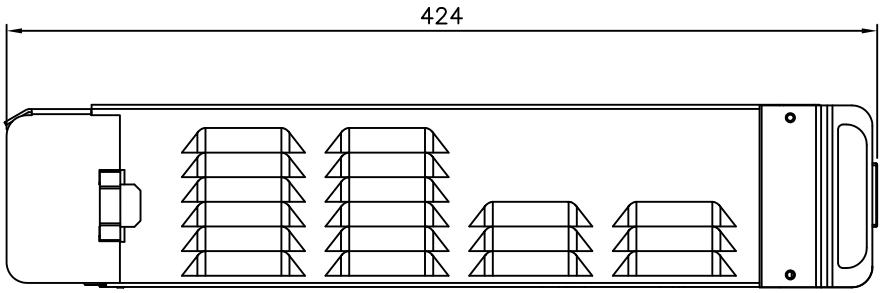
Slim processing unit (EM 2040C-2), outline dimensions



Front View



Rear View

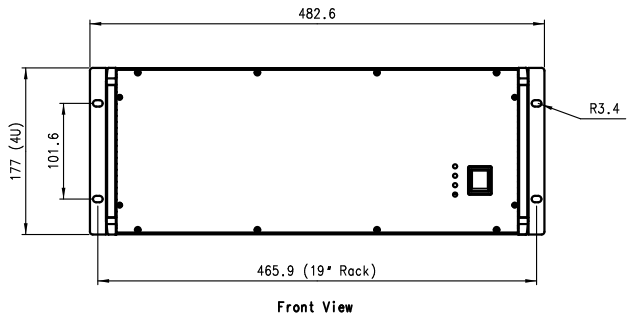


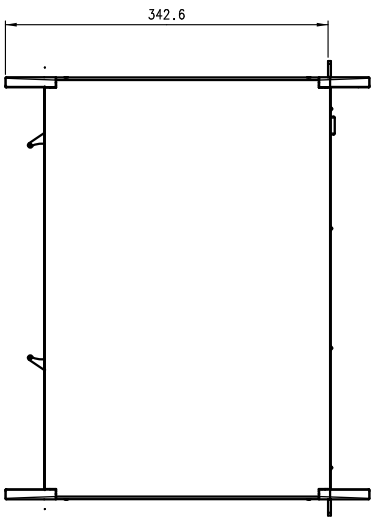
Side View

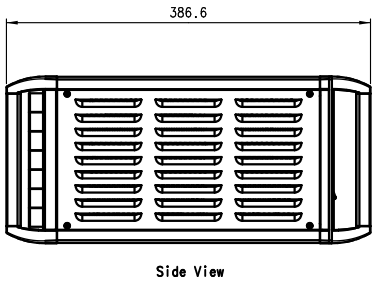
Weight: 10,5kg

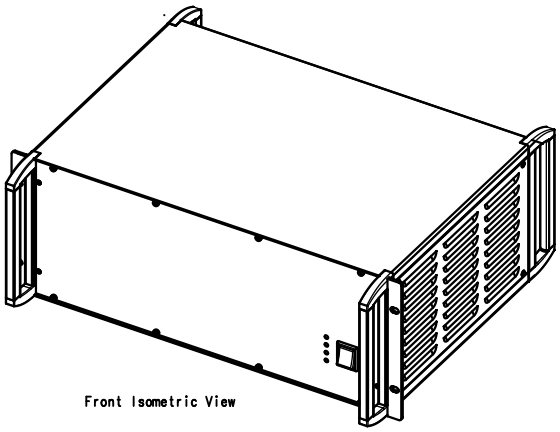
Page 1 of 1 (Cd02104012)	EM 2040/EM 2040C Slim Processing Unit Desktop/rack version outline dimensions	**385422** Pro01

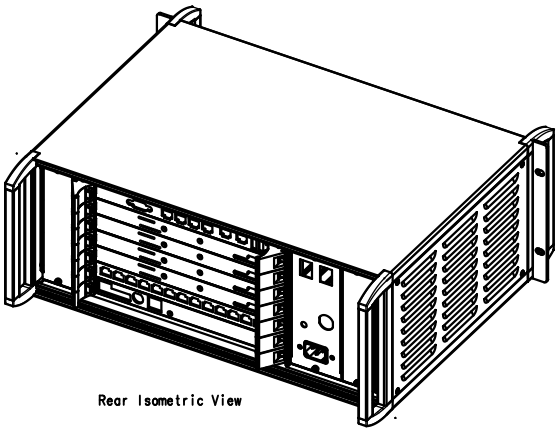
Processing unit (EM 2040C-1), outline dimensions

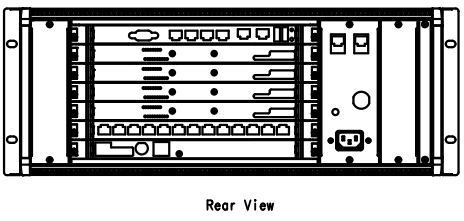












Page 1 of 1 (Cd02104003)	EM 2040/EM 2040C Processing unit Desktop/rack version outline dimensions	**357264** Rev. A

Technical specifications

This chapter provides the technical specifications and requirements related to the Kongsberg EM 2040C.

Topics

Performance specifications

This section provides the performance specifications for the Kongsberg EM 2040C.

- **Frequency range:** 200 – 400 kHz
- **Operator selectable frequencies:** 200 – 400 kHz in 10 kHz steps
- **Sonar head depth rating:**
  - EM 2040C: 50 m
  - EM 2040CX: 1500 m
- **Maximum detected depth:** Limited to 600 m (relative to the surface)
- **Minimum detected depth:** 0.5 m
- **Maximum ping rate:**50 Hz
- **Number of soundings per ping (single head):**Up to 800 (400 per swath)
- **Number of soundings per ping (dual head):**Up to 1600 (400 per swath)
- **Beamwidth (TX x RX) at 200 kHz:** 2 x 2 degrees
- **Beamwidth (TX x RX) at 300 kHz:** 1.3 x 1.3 degrees
- **Beamwidth (TX x RX) at 400 kHz:** 1 x 1degrees
- **TX source level at 300 kHz:** 204.5 dB re 1 µPa at 1 m
- **RX beam spacing:** Equidistant, equiangle and high density
- **Coverage sector (single head):** up to 130 degrees at 200 – 320 kHz
- **Coverage sector (single head):** 100 degrees at 350 kHz
- **Coverage sector (single head):** 70 degrees at 400 kHz
- **Coverage sector (dual head):** 200 degrees at 200 – 320 kHz,
- **Coverage sector (dual head):** 170 degrees at 350 kHz,
- **Coverage sector (dual head):** 140 degrees at 400 kHz
- **Transmit beam steering:** Stabilised for pitch (+/- 10 degrees)
- **Receive beam steering:** Stabilised for roll (+/- 15 degrees)
- **Yaw stabilized beams:** +/- 10 degrees, for dual head only
- **Range resolution (defined as cT/2):** 18.8 mm at 25 µs pulse
- **Pulse length (CW):** 25 – 600 µs (1700 µs with FM disable)
- **Pulse length (FM):** Up to 12 ms
- **Output sampling rate:**Up to 61 kHz (15 mm)

Table 3 Max depth and coverage, EM 2040C, cold ocean water

Operating frequency	Max depth	Max coverage across	
		Single head	Dual head
200 kHz	520 m	570 m	690 m
300 kHz	450 m	525 m	625 m
350 kHz	400 m	475 m	570 m
400 kHz	350 m	350 m	500 m

Note

The calculated coverage (in FM mode) is based on NL=45 dB. Backscatter strength used is BS=-10 dB.

Weights and outline dimensions

This section provides the technical specifications and requirements related to weight and outline dimensions.

For more detailed information about the physical dimensions, see the *Drawing file*.

Related topics

- *Drawing file* on page 77

Sonar head EM 2040C

- **Diameter:** 332 mm
- **Height:** 119 mm
- **Volume:** 10.3 liters
- **Weight:** 18.8 kg in air / 8.4 kg in water

Sonar head EM EM 2040CX

- **Diameter:** 332 mm
- **Height:** 122 mm
- **Volume:** 10.6 liters
- **Weight:** 26.1 kg in air / 17 kg in water

Processing unit PU-2 Slim PU (2U 19” rack mounted)

- **Width:** 482.5 mm (19” rack)
- **Height:** 88.6 mm (2U)
- **Depth:** 424 mm
- **Weight:** 10.5 kg

Processing unit PU-2 Slim PU for AUV use

- **Width:** 310.3 mm
- **Height:** 147.1 mm
- **Depth:** 233.4 mm
- **Weight:** 4.3 kg

Processing unit PU-1 (4U 19” rack mounted)

- **Width:** 447 mm (19” rack)
- **Height:** 178 mm (4U)
- **Depth:** 345 mm
- **Weight:** 15 kg

Note

More than one processing unit may be necessary, depending on number of sonar heads and dual swath capability.

Hydrographic Work Station (Operator station)

- **Make and model:** HP MP8300H
- **Width:** 338 mm
- **Height:** 100 mm
- **Depth:** 379 mm
- **Weight:** 7.6 kg

Colour display

- **Make:** ISIC A/S (http://isic-systems.com)
- **Model:** DuraMON WS 24 inch
- **Width:** 601 mm
- **Height:** 408 mm
- **Depth:** 68 mm
- **Weight:** 10 kg

Power specifications

This section provides the technical specifications and requirements related to the AC and/or DC mains supply.

Processing unit PU-2 Slim PU (2U 19” rack mounted)

- **Supply voltage:**100 to 250 Vac, 47 to 63 Hz
- **Power consumption:**
  - Maximum 115 W, without sonar head, including one CBMF board
  - Maximum 160 W, including one sonar head and pinging
  - Maximum 175 W, including one sonar head and pinging with long FM pulse

Processing unit PU-2 Slim PU for AUV use

- **Supply voltage:**48 Vdc ±10%
- **Power consumption:**
  - Maximum 2.6 A, without sonar head
  - Maximum 3.3 A, including one sonar head and pinging
  - Maximum 3.7 A, including one sonar head and pinging with long FM pulse

Processing unit PU-1 (4U 19” rack mounted)

- **Supply voltage:**
  - 115 Vac ±10%, 60 Hz ±5%
  - 230 Vac ±10%, 50 Hz ±5%

  Power consumption:
  - Maximum 115 W, without sonar head
  - Maximum 280 W, including one sonar head

Processing unit PU-1 for AUV use

- **Supply voltage:**48 Vdc ±10%
- **Power consumption:** Maximum 5 A

Sonar head

- **Supply voltage:** 48 VDC ±10%, normally supplied by the processing unit (PU)
- **Power consumption:** Maximum 1.3 A

Hydrographic Work Station (Operator station)

- **Make and model:** HP MP8300H
- **Supply voltage:** 115/230 Vac / 47 to 63 Hz / single phase, selectable (nominal)
- **Maximum voltage deviation:** 15%
- **Maximum transient:** 20% of nominal voltage, recovery time 3 s
- **Power consumption:** Maximum 250 W

Colour display

- **Make:** ISIC A/S (http://isic-systems.com)
- **Model:** DuraMON WS 24 inch
- **Supply voltage:**
  - **Standard:** 90 to 264 Vac / 50 to 60 Hz / single phase
  - **Optional:** 18 to 36 Vdc
- **Power consumption:** Maximum 40 W

This information is taken from the manufacturer's data sheet revision 15.05.2013.

Environmental specifications

This section provides the technical specifications and requirements related to the environmental conditions.

Reference standards

- IEC 60945
- EMC Noise emission: EN61000-6-4
- EMC Noise immunity: EN61000-6-2

Note

To extend the lifetime of the equipment, it is recommended to mount the units at locations having sufficient ventilation. The temperature should not be high, i.e. more than 30 °C, over long periods of time.

Sonar head

- **Operational temperature:** -5 to +40°C
- **Storage temperature:** -10 to +50°C (preliminary values)
- **Depth rating:**50 m
- **Vibration (IEC 60945):** 5 – 100 Hz, 0.7 g
- **Shock (KM additional specification):** Peak acceleration 15 g, half sine pulse, duration 11 ms

Processing unit PU-2 Slim PU (2U 19" rack mounted)

- **Operational temperature:** 0 to +50°C
- **Storage temperature:** -30 to +70°C
- **Humidity:** 93%, relative, non-condensing, at 40 ºC
- **IP rating:** IP 22
- **Vibration:** Designed to meet IEC 60945

Processing unit PU-1 (4U 19” rack mounted)

- **Operational temperature:** 0 to +50°C
- **Storage temperature:** -30 to +70°C
- **Humidity:** 93%, relative, non-condensing, at 40 ºC
- **IP rating:** IP 22
- **Vibration:** Tested according to 60945

Hydrographic work station (operator station)

- **Make and model:** HP MP8300H
- **Operational temperature:** 0 to +50°C
- **Storage temperature:** –20 to +70°C
- **Humidity:** 5 to 95% relative non-condensing
- **IP rating:** IP 22 if optional kit for rack mount is used
- **Vibration:** IEC 60945

Colour display

- **Make:** ISIC A/S (http://isic-systems.com)
- **Model:** DuraMON WS 24 inch
- **Operational temperature:** -15 to +55°C
- **Storage temperature:** -20 to +70°C
- **Humidity:** 8 to 90%, relative
- **IP rating:**
  - **Front:** IP66
  - **Rear:** IP20

Interface specifications

This section provides the technical specifications and requirements related to the interface signals.

Processing Unit

- Serial lines with operator adjustable communication parameters for:
  - Motion sensor (roll, pitch, heave and optionally heading) in format supported by sensors from the main suppliers like Kongsberg Seatex, Kongsberg Maritime HAIN, Applanix, iXSEA, Coda Octopus and Teledyne TSS
  - Heading in NMEA 0183 HDT
  - Position in NMEA 0183 GGA or GGK format
  - External clock in NMEA 0183 ZDA format
- Ethernet interface:

  - Velocity input (required for Doppler compensation in chirp mode) in format supported by sensors from the main suppliers like: Kongsberg Seatex, Applanix POS MV, CodaOctopus F180 and IXSEA Phins.
  - Position: Kongsberg Maritime HAIN
  - Precision Time Protocol (PTP) according to IEEE 1588-2008. P2P or E2E, slave only.
- Interface for 1PPS (1 pulse per second) signal
- External synchronization signals

HWS

- Sound speed at transducer
- Printer/plotter
- Interface for input of sound speed profile (Ethernet or serial line)
- Tide input (Ethernet or serial line)
- Single beam echo sounder depths (Ethernet)
- Output of all data normally logged to disk (to Ethernet)
- Output of depth below keel in NMEA 0183 DPT format (serial line)
- Output to autopilot in NMEA 0183 APB format (serial line)

Doppler shifts

All new generation of multibeam echo sounders from Kongsberg Maritime have an extended range performance by use of a frequency modulated transmitter pulse (FM), also called chirp pulse. In the FM mode, the Doppler shift made by the movements of the survey vessel relative to the bottom, cases a range error. This error must be corrected. The following motion sensors have specifications that fullfills our requirements for doppler shift corrections:

- Kongsberg Maritime – Seapath series
- Kongsberg Maritime – HAIN
- Applanix – Pos MV
- Coda Octopus – F180
- IXSEA – Phins

Velocitiy input requirements via ethernet

- Velocity: 0.03 m/s RMS
- Roll, pitch and yaw rate: 0.03 deg/s RMS
- Latency: Maximum 5 ms
- Update rate: 100 Hz

Sensor accuracy

The accuracy of the sensor data, as specified by the sensor manufacturer, must fulfill (preferably surpass) the following requirements:

- Roll 0.02 degrees RMS
- Pitch 0.05 degrees RMS
- Heading 0.1 degrees RMS
- Heave (real-time output) 5 cm or 5% whichever is highest

Alignment specifications

This section provides the requirements related to alignment accuracy.

Alignment accuracy

- **Position (x, y):** ± 0.02 m
- **Position (z):** ± 0.005 m
- **Pitch:** ± 0.05 deg
- **Roll:** ± 0.02 degrees
- **Heading:** ± 0.05 degrees

Appendix A
General safety rules

The EM 2040C operates on 230 VAC 50/60 Hz.

WARNING

This voltage is lethal!

The following safety precautions must be followed at all times during installation and maintenance work

- Always switch off all power before installation or maintenance. Use the main circuit breaker, and label the breaker with a warning sign that informs others that maintenance or installation work is being carried out on the system.
- For safety reasons during troubleshooting on the equipment with power ON, two persons must always be present.
- Read and understand the applicable first aid instructions for electric shock.
- Whenever maintenance is carried out, it is essential that a first aid kit is available, and that the maintenance personnel are familiar with the first aid instructions for electrical shock.
- The various parts of the system may be heavy. Make sure that the appropriate tools and certified lifting equipment are available, and that the personnel are trained in installation and maintenance work.

Appendix B Equipment handling

This section provides the basic rules for transportation, storage and handling of units. In this context, a unit may be any large or small part of the system. It can be supplied as part of the initial delivery, or as a spare part.

Topics

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. These units must be checked properly, and the regulations must be investigated by the packer/shipper before the unit is dispatched.

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 or case containing the unit 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 or case will normally be marked with text or symbols indicating which way it is to be placed. Follow any instructions given, and ensure the case is always placed with its “top” uppermost.

The carton or 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 or 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 you attempt to lift it.
- You must always use lifting apparatus that is approved and certified for the load.

Heavy units may be equipped with lifting lugs for transportation by crane within the workshop or installation area. Before you use a crane:

- 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 forklift 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 (eg. 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 re-pack the unit(s) according to the packing instructions.

7 If the crate has been opened, make sure that is it closed and sealed after the inspection. Use the original packing material as far as possible.

8 The storage room/area must be dry, with a non-condensing atmosphere. It must be free from corrosive agents.

9 The storage area's mean temperature must not be lower than -10° C, and not warmer than +50° C. If other limitations apply, the crates will be marked accordingly.

10 The crate must not be exposed to moisture from fluid leakages.

11 The crate must not be exposed to direct sunlight or excessive warmth from heaters.

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

13 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) have arrived at their destination.

1. Check all wooden or cardboard boxes, plastic bags and pallets for physical damage. Look for signs of dropping, immersion in water or other mishandling.
2. If damage is detected externally, you will have to open the packaging to check the contents. Request a representative of the carrier to be present while the carton is opened, so any transportation damage can be identified.
3. 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.
4. If the units are not damaged, check the humidity absorbing material. If required, dry or replace the bags, then re-pack the unit(s) according to the packing instructions.

Unpacking

General unpacking procedure

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 contents for damage and retrieve any accompanying documentation.

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

1. 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.
2. Place the carton on a stable work bench or on the floor with the top of the carton uppermost.
3. In the absence of other instructions, always open the top of the carton first. The contents 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. Do not use a knife to open cardboard cartons
4. 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 contents.
5. If a wooden crate has been closed using screws, always remove them using a screwdriver. Do not attempt to prise the lid off with a crowbar or similar.

6 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.

Unpacking electronic and electromechanical units

Electronic and electromechanical 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

Beware of the dangers of Electro-Static Discharge (ESD) both to yourself and to the equipment, when handling electronic units and components.

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

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 manufacturer with the seal broken, the contents 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.

Unpacking 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.

Unpacking transducers

Transducers may be supplied mounted to a hull unit (if any), or packed separately. Crates are normally identified by the order number and the serial number.

The transducer face must be protected by a rigid, padded cover (e.g. a wooden box lined with foam rubber) all the time it is exposed to the risk of physical damage.

Caution

Once transducer is unpacked, great care must be taken to ensure that transducer body and cabling is not exposed to any mechanical stress.

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 (eg. 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 contents 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.

Note

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.

Storage after use

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.

1 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.

2 All surfaces must be inspected for signs of corrosion, flaking/bubbling paint, stains 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.

3 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.

Mechanical units

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

1. If the construction materials and type of unit permits, wash the unit using a high-pressure hose and copious amounts of fresh water. Examples are the lower parts of hull units (outside the hull) or subsea units
2. Ensure that all traces of mud and marine growth are removed. Use a wooden or plastic scraper to remove persistent growth, barnacles etc. On completion, dry the unit thoroughly.

   Caution

   Do not use a high pressure hose in the vicinity of cables or transducers. Do not use sharp or metal tools on a transducer face.

3. If the materials or type of unit prevents the use of a high-pressure hose, wipe the unit using a cloth dampened with water containing a little detergent. Examples are the upper parts of hull units (inside the hull) and hydraulic systems
4. Do not use excessive amounts of water as some components on the unit may not be water tight. Wipe off the detergent with a damp cloth, then dry the unit thoroughly.
5. All surfaces must be inspected for signs of corrosion, flaking/bubbling paint, stains etc. Damaged or suspect areas must be cleaned, prepared and preserved using the correct preservation mediums. The mediums to be used will normally be defined in the unit's maintenance manual.

Cables

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

Internal batteries

If the unit contains batteries, these may discharge slowly during storage. If the unit is to be stored for an extended period, disconnect or remove all internal batteries.

A suitable piece of insulating material can be placed between the battery and the electrical contacts to prevent electrical discharge. The battery can then remain in the unit, reducing the risk of it being misplaced during the storage period.

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.

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. a light oil) before packing.

Re-packaging

Whenever possible, the unit must be stored and transported in its original packing material and/or crate. In the event that this material is not available, proceed as follows:

- Small units must be protected from damp by being placed within a plastic bag at least 0.15 mm thick. An appropriate quantity of desiccant material should be placed inside this bag, and the bag sealed. The sealed unit must then be placed in an appropriate carton or crate, and supported in the container by appropriate shock-absorbing insulation (polystyrene foam chips etc.).
- Large units must be placed in a suitable cardboard box or wooden crate. The unit must be protected against physical damage by means of shock-absorbing insulation mats. The box must be clearly marked with its contents, and must be stored in a dry and dust-free area.

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:

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

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

Note

Unless otherwise specified, transducers must not be stored in temperatures below -10° C and above +50° C.

Circuit board handling and packaging

Circuit boards are delicate items. They may work year after year in an advanced product, but then fail due to a small spark of static electricity. For this reason, it is very important that they are properly handled and protected during shipping.

Beware of ESD!

When you handle electronic circuit boards, you must beware of the dangers of electrostatic discharge (ESD), both to yourself and to the equipment. In order to ensure safe transport and storage, circuit boards and other electronic units will always be wrapped in a clear plastic protective bag, and the bag will be sealed. See also section *Electro-Static Discharge (ESD)* on page 101.

Unpacking and handling circuit boards

Observe the following steps to unpack a circuit board.

1. Wherever possible, prepare a suitable workbench. It must have an approved conductive service mat, and it must be connected directly to a reliable earth point via its earthing cord. You must wear a wristband in direct contact with the skin, and the wristband must be connected to the service mat.
2. Lift the circuit board, in its protective bag, out of the carton and place it in a stable position on the a floor/work bench.
3. Inspect the unit for damage before you open the plastic bag.
4. Do not break the seal to open a circuit board package before the board shall to be used. If the board package is returned with the seal broken, we will assume that the content has been used, and we will bill you accordingly.
5. Assuming all is well, open the bag and remove the unit.
6. Take out and keep the documentation. You will need it if the circuit board shall be returned to us. Also, remove any packing and desiccant material that may be inside.
7. Keep the protective plastic bag for future use.

Unpacking on board the vessel

When you are working on board a vessel, an “approved conductive service mat” is often far away. As you still need to unpack circuit boards, make sure that you do it in the instrument room, or at another location where you have a steel deck. Keep far away from the bridge or any other rooms with wall-to-wall carpets! If possible, bring a wristband and ground yourself.

Returning a circuit board

If you wish to return a circuit board to us, observe the following rules.

Note

Failure to follow these rules may result in unserviceable circuit boards.

1. Place the circuit board to be returned in the same protective plastic bag as you originally received it in - or a protective bag of similar ESD protection quality.

2 DO NOT use standard plastic bags, such as commercial bubble wrap.

3 Fill in all the necessary information on the applicable documentation and place it inside the bag.

4 Seal the bag.

5 Place the circuit board in a suitable carton, and secure it for shipping.

Electro-Static Discharge (ESD)

What is ESD?

Electro-Static Discharge (ESD) is the transfer of an electrostatic charge between two bodies at different electrostatic levels, 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

Sensitive electronic circuit boards must be transported and stored in protective packing bags. 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:

1 The working area must be covered by an approved conductive service mat that has a resistance of between 50 kΩ and 2 MΩ, and is connected directly to a reliable earth point via its earthing cord.

2 The service personnel involved must wear a wristband in direct contact with the skin, connected to the service mat.

3 Printed circuit boards must be placed on the conductive service mat during installation, maintenance etc.

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

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

Disposal

At the end of the product lifetime, all Kongsberg Maritime products must be disposed in an environmental friendly way.

Kongsberg Maritime offers a product recycling service and we recommend that this is used. The service is described on http://www.km.kongsberg.com →**Products** →**Services** →**Product recycling**.

All electrical and electronic 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 thus be disposed of according to national and international rules and regulations. Observe the relevant Waste Electrical and Electronic Equipment (WEEE) regulations.

Appendix C Basic cable requirements

This chapter provides general information related to the installation of system cables.

Topics

Cable trays

All permanently installed cables associated with the system must be supported and protected along their entire lengths using conduits and/or cable trays. The only exception to this rule is over the final short distance (maximum. 0,5 meters) as the cables run into the cabinets/units to which they are connected. These short service loops are to allow the cabinets to move on their shock mounts, and to allow maintenance and repair.

- Wherever possible, cable trays must be straight, accessible and placed so as to avoid possible contamination by condensation and dripping liquids (oil, etc.). They must be installed away from sources of heat, and must be protected against physical damage. Suitable shields must be provided where cables are installed in the vicinity of heat sources.
- Unless it is absolutely unavoidable, cables should not be installed across the vessel's expansion joints. If the situation is unavoidable, a loop of cable having a length proportional to the possible expansion of the joint must be provided. The minimum internal radius of the loop must be at least twelve times the external diameter of the cable.
- Where a service requires duplicate supply lines, the cables must follow separate paths through the vessel whenever possible.
- Signal cables must not be installed in the same cable tray or conduit as high-power cables.
- Cables containing insulation materials with different maximum-rated conductor temperatures should not be bunched together (that is, in a common clip, gland, conduit or duct). When this is impractical, the cables must be carefully arranged such that the maximum temperature expected in any cable in the group is within the specifications of the lowest-rated cable.
- Cables with protective coverings which may damage other cables should not be grouped with other cables.
- Cables having a copper sheath or braiding must be installed in such a way that galvanic corrosion by contact with other metals is prevented.
- To allow for future expansion of the system, all cables should be allocated spare conductor pairs. Also, space within the vessel should be set aside for the installation of extra cables.

Radio Frequency interference

All cables that are to be permanently installed within 9 m (30 ft) of any source of Radio Frequency (RF) interference such as a transmitter aerial system or radio transmitters, must, unless shielded by a metal deck or bulkhead, be adequately screened by sheathing, braiding or other suitable material. In such a situation flexible cables should be screened wherever possible.

It is important that cables, other than those supplying services to the equipment installed in a radio room, are not installed through a radio room, high power switch gear or other potential sources of interference. Cables which must pass through a radio room must be screened by a continuous metal conduit or trunking which must be bonded to the screening of the radio room at its points of entry and exit.

Physical protection

Cables exposed to the risk of physical damage must be enclosed in a steel conduit or protected by a metal casing unless the cable's covering (e.g. armour or sheath) is sufficient to protect it from the damage risk.

Cables exposed to an exceptional risk of mechanical damage (for example in holds, storage-spaces and cargo-spaces) must be protected by a suitable casing or conduit, even when armoured, if the cable covering does not guarantee sufficient protection for the cables.

Metallic materials used for the physical protection of cables must be suitably protected against corrosion.

Grounding

All metallic cable coverings (armour, metallic sheathing etc.) must be electrically connected to the vessel's hull at both ends except in the case of final sub-circuits where they should be connected at the supply end only.

Grounding connections should be made using a conductor which has a cross-sectional area appropriate for the current rating of the cable, or with a metal clamp which grips the metallic covering of the cable and is bonded to the hull of the vessel. These cable coverings may also be grounded by means of glands specially intended for this purpose and designed to ensure a good ground connection. The glands used must be firmly attached to, and in good electrical contact with, a metal structure grounded in accordance with these recommendations.

Electrical continuity must be ensured along the entire length of all cable coverings, particularly at joints and splices. In no case should the shielding of cables be used as the only means of grounding cables or units.

Metallic casings, pipes and conduits must be grounded, and when fitted with joints these must be mechanically and electrically grounded locally.

Cable connections

All cable connections are shown on the applicable cable plan and interconnection diagrams.

Where the cable plan shows cable connections outside an equipment box outline, the connections are to be made to a plug or socket which matches the plug or socket on that particular item of equipment.

Where two cables are connected in series via a junction box or terminal block, the screens of both cables must be connected together but not grounded.

Cable terminations

Care must be taken to ensure that the correct terminations are used for all cable conductors, especially those that are to be connected to terminal blocks. In this case, crimped sleeve-terminations must be fitted to prevent the conductor core from fraying and making a bad connection with the terminal block. It is also of the utmost importance that where crimped terminations are used, the correct size of crimp and crimping tool are used. In addition, each cable conductor must have a minimum of 15 cm slack (service loop) left before its termination is fitted.

Cable identification

Cable identification codes corresponding to the cable number shown in the cable plan must be attached to each of the external cables. These identification codes should be positioned on the cable in such a way that they are readily visible after all panels have been fitted. In addition, each cable conductor should be marked with the terminal board number or socket to which it is connected.

Index