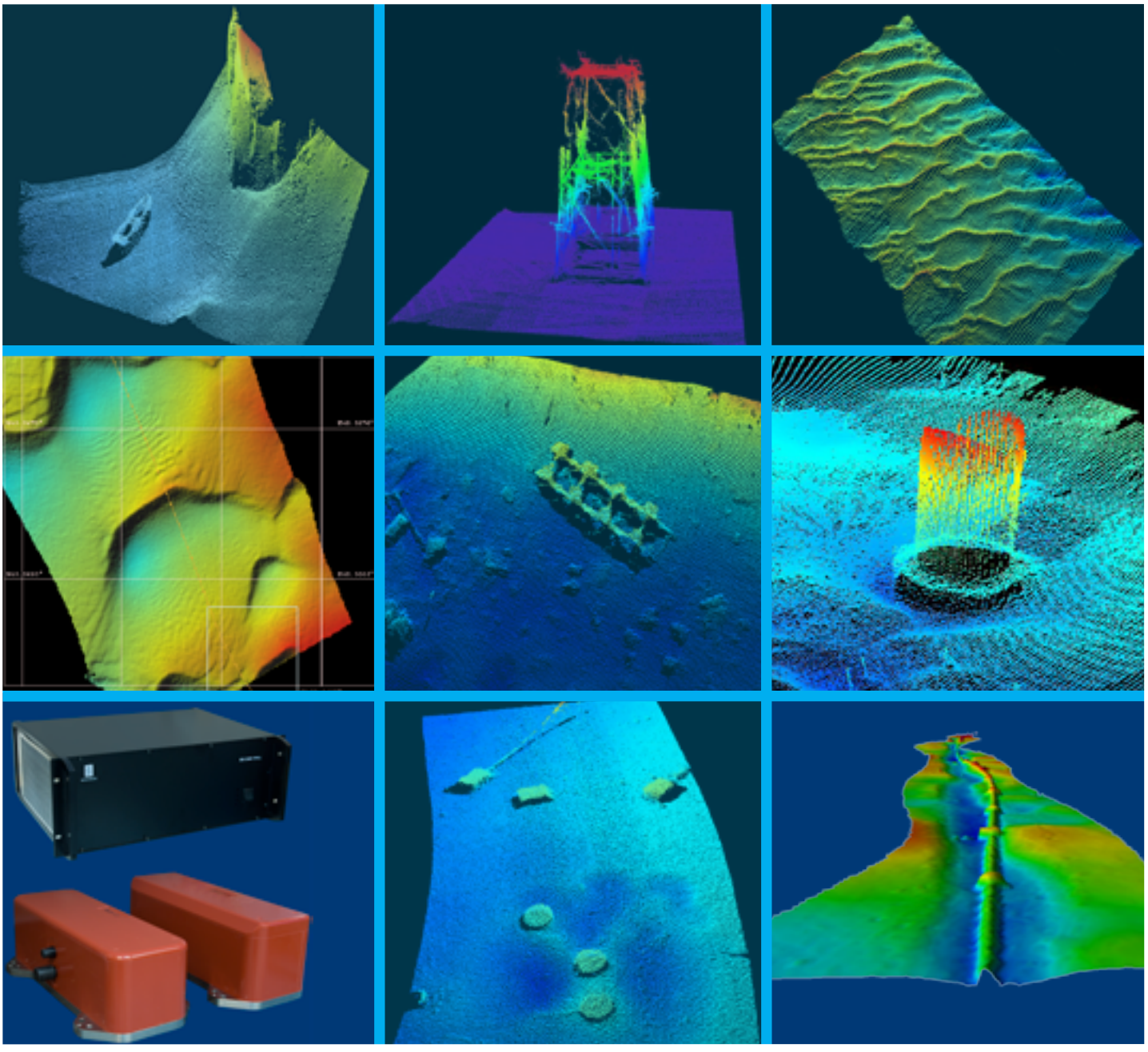
Instruction Manual

KONGSBERG

EM 2040

Multibeam Echo Sounder



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Instruction Manual

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July 2012

Document history

Document number: 346210		
Rev. A	November 2010	First version
Rev. B	March 2011	General updates.
Rev. C	July 2012	New PU version supported. It contains new power supply and Ethernet card. General updates.

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. The user must be familiar with the contents of the appropriate manuals before attempting to install, operate or 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

If you require maintenance on your equipment, contact Kongsberg Maritime AS using the following address:km.hydrographic.support@kongsberg.com. If you need other information about this product, or any other Kongsberg Maritime AS products, visit http://www.km.kongsberg.com.

Table of contents

Introduction

Topics

About this manual

This is the instruction manual for the EM 2040 multibeam echo sounder system. The purpose of the manual is to present the information needed to install and maintain the echo sounder.

Note

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

Note

Detailed vessel specific mechanical drawings for the installation must be provided by the customer, or any shipyard contracted to perform the installation. Kongsberg Maritime AS may, on special order, supply these drawings. Drawings must be approved by the appropriate vessel certification authority prior to installation of the system.

This manual defines the equipment responsibility, and provides instructions for unpacking and storage.

No special tools are generally required to perform installation, removal and replacement of modules and parts. When special tools are required, these are listed in the procedure.

The manual contains detailed descriptions of each of the units in the system. Each circuit board and mechanical assembly is described. The manual also includes procedures for disassembly and reassembly of the replaceable items.

Information about how to administrate the system and how to handle warnings and system errors are explained in the SIS Operator Manual.

This manual does not give a detailed description of the Operator Station and the peripheral devices (printers, plotters and sensors). For information about these items, refer to the HWS instruction manual and applicable manufacturer's documentation.

Maintenance philosophy

Kongsberg Maritime defines three levels for maintenance manuals:

Organizational - You will only perform limited preventive and corrective maintenance on the system. There is no need for technical education or training, and no need for any instruments. Typical tasks are exterior cleaning, or changing fuses.

Intermediate - You will perform overall preventive and corrective maintenance on the system. It is recommended that you are an educated engineer with experience from computerized design and mechanical systems. It is further expected that you can use standard electronic instruments, such as an oscilloscope. You should be trained by Kongsberg Maritime to perform maintenance on the system. Typical tasks may include troubleshooting, testing and circuit board replacement.

Depot - You will perform detailed maintenance on the system and on the circuit boards and modules. You must be an educated engineer with experience of computerized design and mechanical systems. It is further expected that you can use standard electronic instruments, such as an oscilloscope. You should be trained by Kongsberg Maritime to perform maintenance on the system.

Note

This maintenance manual is prepared for the intermediate level.

System overview

Topics

Key facts

- Frequency range from 200 to 400 kHz
- Dual swath capability, allowing sufficient sound density alongtrack at reasonable survey speed
- IEEE 1588 time synchronization system
- FM chirp allowing much longer range capability (depth and coverage) compared to CW pulses
- Complete roll, pitch and yaw stabilization
- Nearfield focusing on both transmit and receive
- Operates with very short pulse lengths – shortest pulse is 25 microseconds
- The depth rating of the subsea parts is 6000 metres
- Available with dual RX system, increasing the coverage to up to 200 degrees (±100 degrees)
- IHO-S44 special order compliant
- The EM 2040 has two TX array sizes:
  - EM 2040-04 (0.4 degrees at 400 kHz)
  - EM 2040-07 (0.7 degrees at 400 kHz)

The EM 2040 multibeam echo sounder is the first system to bring all the advanced features of deep water multibeams to the near bottom sounding environment.

The EM 2040 operating bandwidth is from 200 to 400 kHz, which is a full octave, and this is achieved using the standard transducers. Three standard modes are available. 300 kHz is used for normal operation, giving an optimum balance between high resolution, depth capability and tolerance of performance deteriorating factors such as water column sediments. 200 kHz is available for meeting requirements to operate at the standard hydrographic single beam frequency, but also to achieve the best depth capability. 400 kHz is provided for inspection work with the utmost resolution.

EM 2040 has the functionality of the lower frequency EM systems, and the small size and weight advantage of the high frequency systems, as well as beamwidth of 0.4 degrees.

FM pulses are used to increase the maximum range capability without sacrificing resolution. Example: 12 ms FM with 1.7 kHz sweep bandwidth compared to 600 us CW pulse (1.7 kHz bandwidth): The resolution is the same since the bandwidth is the same. The signal to noise ratio in FM mode is increased by 13 dB. This has the same effect as increasing the transmit power level by 13 dB. The range resolution (defined as cT/2) for 600 us CW pulse is 45 cm. A 4.5 ms CW pulse would give the same coverage as 12 ms FM. But this CW pulse would give a range resolution of 200 cm (= 4.5 * 45 cm).

The normally recommended survey frequency is 300 kHz. At this frequency the bandwidth used is more than 75 kHz with three angular sectors running at separate frequencies. With dual swath six frequencies are used (with shortest pulse the total bandwidt used is more than 100 kHz). The minimum pulse length is 70 microseconds in three sectors, and reduced to 35 microseconds using one sector. With 35 μs pulse the range resolution (defined as $c\tau/2$) is 26 mm. For deep waters FM chirp is employed with a bandwidth of 1.7 kHz. This allows a swath width in the order of 600 m and a depth capability of about 400 m in cold ocean waters.

The 200 kHz frequency mode is similar to the 300 kHz mode. It uses the same CW pulse lengths, while the FM chirp pulse length is increased. The range and depth resolution is the same. Normally two sectors are used per swath, but single sector can also be used. At this frequency the absorption in the water is lower than at 300 kHz, resulting in increased swath width and depth capability. In cold ocean waters with FM chirp a swath width of 700 m can be expected and approximately 500 m depth capability.

The 400 kHz frequency mode is intended for high resolution inspection work. Very short transmit pulses and wide receiver bandwidth is used. The operator may select between one and three transmit sectors. With a single RX transducer the coverage limit is 120 degrees (±60 degrees), and with dual RX the coverage is 180 degrees (±90 degrees). The shortest pulse used is 25 μs giving a range resolution less than 20 mm ($c\tau/2$). It is also possible to run dual swath, but not using the shortest pulse length.

The EM 2040 is modular, allowing the user to tailor the beamwidths to the operational requirements, 0.4 by 0.7 degrees or 0.7 by 0.7degrees. The transmit fan is divided into three sectors pinging simultaneously at separate frequencies. This ensures a very strong and beneficial dampening of multibounce interference which on simpler systems often is seen at beam angles from 60 degrees and outwards. The EM 2040 has dual swath capability, allowing a sufficient sounding density alongtrack at a reasonable vessel speed.

EM 2040 also has a scanning mode, i.e. one sector is transmitted at a time, giving the possibility to use the shortest pulse length while still keeping the full swath coverage.

The standard depth rating of the EM 2040 subsea parts is 6000 m. The system is ideal for use on subsea vehicles such as AUVs or ROVs. All analog electronics are contained in the transducers, and communication to the topside processing unit is on standard Ethernet. For subsea vehicle use the processing unit may be installed in a pressure rated tank with an inner diameter as small as 230 mm.

For more information about the use of EM 2040 on ROVs and AUVs please see the following application notes (document numbers in brackets):

- High Resolution Bathymetry from ROV Mounted EM 2040 [368428]
- High Resolution Bathymetry from ROV Mounted EM 2040 and HAIN Inertial Navigation [368429]

Dual RX system

The transmit transducer has an angular coverage of 200 degrees (±100 degrees) as standard, allowing for a coverage of 5.5 times the water depth when matched with a single receive transducer. Adding a second receive transducer allows surveying to the water surface or up to 10 times water depth on a flat bottom.

The two RX transducers are normally mounted in a V-shape with approximately 35 degrees inclination.

The pulse lengths and frequencies will be the same as for one RX transducer.

System characteristics

Main units

The EM 2040 consists of four main units:

- Transmit transducer
- Receive transducer(s)
- Processing unit (PU)
- Operator Station (HWS)

A complete system for seabed mapping will in addition include a transducer mounting plate, a motion sensor, a heading sensor, a sound velocity sensor and a positioning system.

Transducers

The EM 2040 transducers consist of separate linear arrays for transmit and receive in a Mills cross configuration. The transmit array is electronically steerable alongtrack while the receive array is steerable athwartship. Both arrays contain all analog electronics and digital control units with Ethernet interfaces to the processing unit.

The transducers are made from composite ceramics, designed and tested to operate to a depth of 6000 m. The transmitter array consists of three separate line arrays, one looking straight downwards and the two others pointing 55 degrees to each side.

The transducers have Ethernet data interfaces. The receiver uses Gbit Ethernet whilst the transmitter uses 100 Mbit Ethernet. The transmitter also has 48 VDC supply which is routed to the receiver. The interconnecting cable included also carries a synchronization signal.

The material in the transducer housing is Titanium.

The EM 2040 is delivered with a mounting plate with factory aligned guidances. It is recommended that the mounting plate is built into a steel casing and protected by a baffle for multipath reduction. Optionally, the transducers may be delivered mounted on a frame together with the motion sensor and a sound speed sensor, factory aligned for ease of mounting.

The EM 2040 is fully prepared for upgrading to cater for more demanding applications. Adding a second receive transducer increases the angular coverage to up to 200 degrees (±100 degrees).

Processing unit

The EM 2040 processing unit is basically a Compact PCI standard computer using a commercially available CPU board with an Intel dual core CPU, plus signal processing boards. Receive data from the Gbit link is match filtered by an FPGA board before transferred to the signal processing boards. The CPU board has serial interfaces for input of external time-critical sensors and Gigabit Ethernet for communication with the operator station. SATA interfaces are available for integrated data logging to a local hard disk (option intended for AUV use).

Currently the EM 2040 system requires one PU per RX transducer and one additional PU per RX transducer for dual swath capability.

The processing unit also supplies 48 VDC power to the transducers.

Operator station

The Operator Station of the EM 2040 is the standard HWS (Hydrographic Work Station) high performance PC work station. The operator software is SIS (Seafloor Information System).

As a minimum, the unlicensed version of SIS allows for setting the EM 2040 installation and runtime parameters, logging and displaying data, as well as running the built in self tests.

The licensed version of the SIS software also includes functionality for survey planning, real-time 2D and 3D geographical display of the survey data, seabed image and water column displays. There are also real-time data cleaning algorithms available.

Alternatively, third-party software solutions can be used for operator interface and real-time processing. Contact Kongsberg Maritime for information.

The HWS is normally supplied with a 19” industrialized LCD monitor with a resolution of 1280x1024 pixels. Support for up to four monitors is available. A spill proof US keyboard and a standard optical mouse is normally supplied, but optionally a small IP 65 rated keyboard with integrated track stick can be delivered.

Interfaces

For completeness, data input from an attitude sensor, a heading sensor and a positioning system is required, as is the sound speed profile of the water column between the transducers and the bottom. Sound speed at the transducer, clock and 1PPS are optional inputs.

The EM 2040 will be equipped to handle the IEEE 1588 time synchronization system, and to support the better time accuracy this provides. Multiple sensors supplying the same type of data may be logged. Data input is usually on serial line, but Ethernet input is also supported. The processing unit has full trigging capability and 1 PPS signal interface.

The formats currently supported by Kongsberg Maritime's range of multibeam echo sounders will be retained, likewise the time-tagging principles used. All data are time-tagged using the same clock reference as the multibeam.

Transmit signal characteristics

The signals employed are either CW pulses with effective pulse length from 25 to 600 μs or FM chirps with a pulse length up to 12 ms, the latter used to increase range capability. Increased coverage with more than 35% has been verified when switching from the longest CW pulse to FM pulse for the 300 kHz mode. The transmitted signals are shaded in time (tapered) to reduce out of band leakage, in practice the CW signal length is 50% larger than the effective pulse length. Power reduction of 10 and 20 dB is possible, selected by the operator.

Transmission beam

Three transmit sectors are normally used per swath. Shading is employed to reduce side lobes. Alongtrack steering of the sectors take into account both yaw and pitch to position the transmit footprints as closely as possible perpendicular to the survey line direction. The alongtrack beam is steerable within ±10º. The sectors will normally use different frequencies and they will transmit simultaneously.

To compensate for nearfield effects the transmission of the sectors are focused at the range determined from the previous ping. The focusing range will usually differ between the three transmit sectors.

Ping rate

The ping rate is normally only limited by the two-way travel time, with very little additional delay required. The maximum range required per ping is determined automatically, taking into account the need to sample the full width of the outermost beam as well as that the depth may increase on the next ping. Maximum ping rate is 50 Hz. This can be reduced by the operator or controlled by external sync.

Signal processing

To increase the transmit source level and to reduce the effect of multipaths, the EM 2040 uses several transmit sectors per swath. To avoid crosstalk between the sectors, high precision bandpass filters are implemented to match the transmitted signals. Also the transmit waveforms are formed to avoid out of band components. The receiver has a very high instantaneous dynamic range, removing the need for analogue gain control (TVG).

Beam characteristics

The beam forming uses split beam technology.

The beamforming uses real-time roll (i.e. the beams are fully roll stabilized) and dynamic focusing in the near-field region. Sound speed at the transducer depth is used as well; it may preferable be read from a real-time sensor, interpolated from the sound speed profile or from an operator entered value.

The beam spacing may be set to equidistant or equiangle. 256 actual beams are formed per swath for a 0.7 degree receiver, spaced over an angular sector which is configurable or derived from the actual coverage achieved.

When using high density processing more than one detection is derived from each beam. The spacing of the soundings is chosen so that equidistant sampling of the bottom is achieved. The high density mode is used to increase the number of soundings from the multibeam echo sounders with up to 400 soundings per swath.

While operating in the single sector mode the system may reduce the number of beams and number of soundings. The actual numbers depend on the pulse length.

Bottom detection

The phase difference between the halfbeams, which is a measure of the angle of arrival of the returned echo, is calculated. A curve fit is made to the resulting time series of phase, from which the zero phase crossing is found determining the range to the bottom in the centre of the beam.

When high density mode is enabled, the phase curve for a beam is used to derive more than one detection and not only at the centre of the beam. The detection window is shortened accordingly, and the spacing of the soundings is chosen so that equidistant sampling of the bottom is achieved. This mode is used to increase the number of soundings available from the multibeam echo sounders with up to 400 soundings per swath.

The footprint will typically be two times the across sampling distance.

Amplitude-based bottom detection is the alternative to phase detection when the number of samples is too small or the phase curve too noisy, typically at small incidence angles or depths.

Depth corrections

The bottom detection process determines the two-way travel time and angle to the bottom in a transducer fixed coordinate system. The sound speed at the transducer depth, the sound speed profile and the vessel attitude both at transmit and receive time are then employed to calculate the Cartesian coordinates of each sounding relative to the water surface and vessel heading. Attitude offsets, time delay and sensor locations including vessel travel are employed in this procedure. The refraction calculations are done using Snell's law assuming constant gradients within the layers defined by the sound speed profile, starting at the actual depth of the transmit transducer at the transmit time.

Seabed imagery

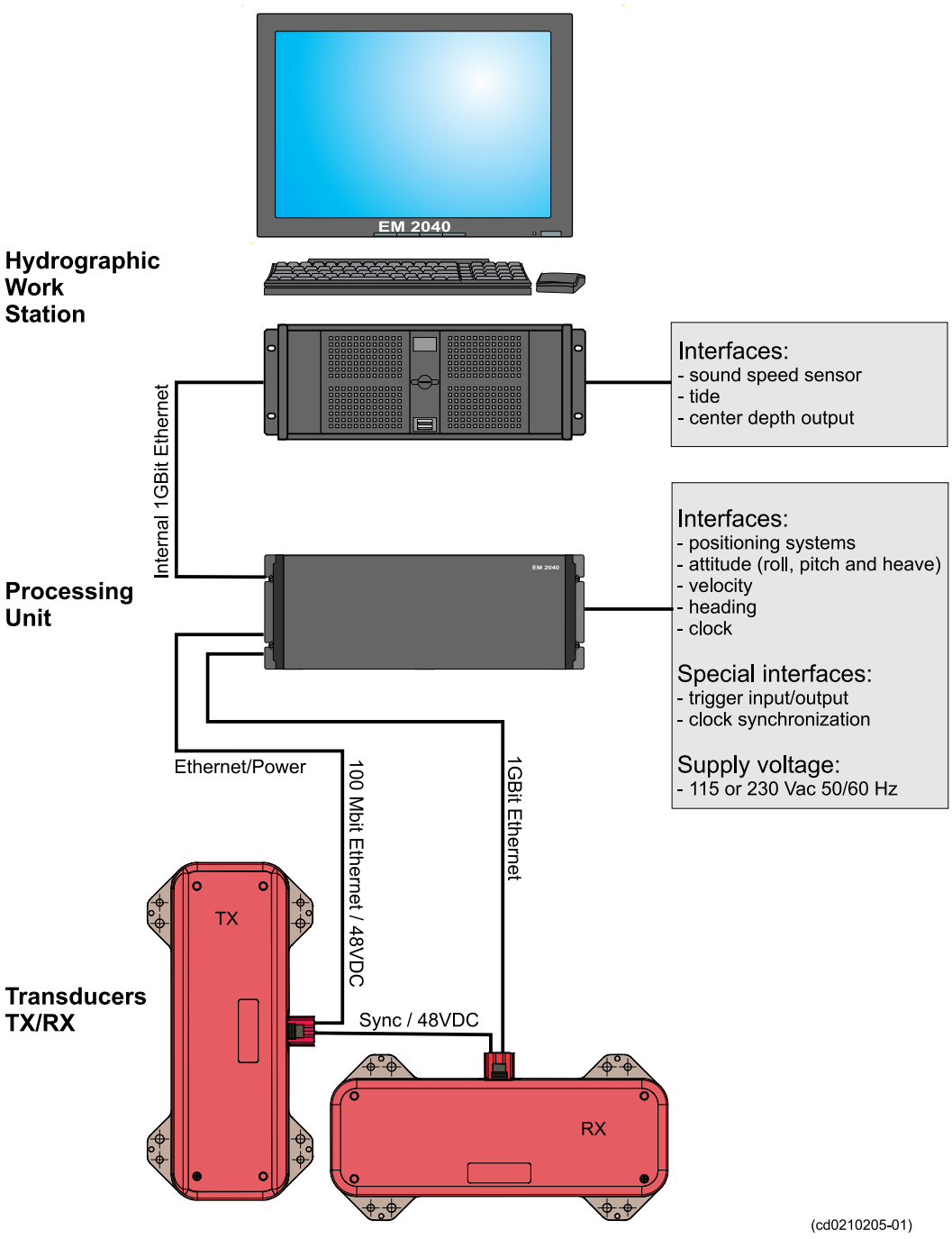
The principles used in the current Kongsberg Maritime multibeam echo sounders are retained in the EM 2040. This implies that each sounding will include a measure of the bottom's backscatter strength. Imagery data samples will be derived for every range sample giving a time continuous high resolution record across for each ping. The imagery record is extended over gaps due to missing beams and also beyond that of the outermost valid detection.

The backscattering calculation principles used in the current Kongsberg Maritime multibeam echo sounders are also retained. The fact that no TVG is applied in the receiver is compensated through the use of the same model as in the other Kongsberg multibeam echo sounders.

Water column data

The beam amplitudes from the water column can be displayed at the operator station. The data can optionally be logged to a separate file or logged together with the rest of the echo sounder datagrams.

System drawing



Scope of supply

Units

The EM 2040 Multibeam Echo Sounder delivery comprises the following items

- Operator Station
  - HWS work station with display, mouse, keyboard, hard disk and DVD recorder
- EM 2040 Processing unit
- EM 2040 TX and RX Transducer Arrays
- Cabling
  - Transducer cables
  - 5 m Ethernet cable for interconnection of the HWS and the processing unit
  - Power cables (115 and/or 230 VAC)
- Transducer mounting plate

Services

Kongsberg Maritime AS may assist with the required engineering services for installation. These services may include

- Recommending the best location of the transducer arrays
- Installation sketches to fit the specific vessel
- Assistance during the installation
- Testing
- Training

Assistance from Kongsberg Maritime AS must be ordered separately, and are charged according to the contract.

Supply conditions

Equipment responsibility

Upon receipt of the equipment the system owner or installation shipyard automatically becomes fully responsible for the equipment, unless otherwise stated in the contract. This responsibility covers the storage period before installation, the actual installation, commissioning, and the period between the completion of the commissioning and the acceptance of the equipment by the end user (normally the owner of the vessel or platform into which the equipment is to be installed).

Project management

Project manager

Kongsberg Maritime AS will normally appoint a dedicated project manager for the delivery project. The project manager will follow up the installation and delivery, and will be the installation shipyard's and end user's point of contact.

Installation performed by Kongsberg Maritime

Kongsberg Maritime AS will assist during the installation if specified in the contract or requested by the installation shipyard or customer. Before any installation work by Kongsberg Maritime AS can begin, all cables (at least those which are in any way connected with the system) must be run and connected to their respective terminations. These cables together with the transducer installation will then be checked by the Kongsberg Maritime AS engineers before they are used.

Depending upon the availability of electrical power either from the generators on board or from ashore, the equipment related to the system, and the various parts of the system will be tested during the Setting to Work (STW) period. This requires that interfaces to equipment delivered by other subcontractors are ready for integration testing.

Delays may occur if any of the equipment related to the system is not available for Kongsberg Maritime AS for testing. During sea trials, the vessel must be at Kongsberg Maritime's disposal when required, even though Kongsberg Maritime cannot be held responsible for expenses relating to the running costs of the vessel.

After completion of the commissioning, the equipment should be officially handed over to the end user and the appropriate documents signed in accordance with the contract. All defects or deviations from the contract must be specified in detail in these documents. It should be noted that if such defects or deviations are not specified, they cannot be used by any of the parties concerned as valid reason for not signing the documents.

Installation, supervision and commissioning

Electrical and mechanical installation

The installation shipyard is normally responsible for the installation of the entire system. In addition, the shipyard is responsible for providing and connecting all cables other than special cables supplied with the equipment. The actual installation and cable laying must comply with the vessel's classification rules and the recommendations given in this manual.

A prefabricated mounting plate is delivered to ensure accurate alignment of the transducers. In addition, we recommend that the mounting plate is built into a steel casing and further protected by a baffle. The steel casing and baffle must be manufactured in accordance with recommendations and drawings provided in this manual.

During the installation period, the equipment must be covered in such a way that it is protected from dust, paint spray/splashes and welding/cutting sparks. Precautions must be taken to ensure that no part of the equipment is used as a work platform, or for any other purpose for which it was not designed.

Note

Any damage incurred during the installation period, even with a Kongsberg Maritime AS representative present, is the installation shipyard's responsibility unless it can be proven that the damage was due to production or material defects in the equipment delivered by Kongsberg Maritime AS, or irresponsibility by Kongsberg Maritime AS personnel.

Pre-commissioning and acceptance tests

Pre-commissioning and acceptance tests are conducted by Kongsberg Maritime AS personnel.

Installation tests

The Kongsberg Maritime installation period (after shipyard installation) is normally divided into three consecutive phases;

- The initial start-up and dock-side testing period. This period is normally known as Setting-to-Work (STW).
- Dock-side commissioning under operational conditions. This commissioning period is normally ended with a Harbour Acceptance Test (HAT).
- Sea Acceptance Test (SAT) with final commissioning under operational conditions at sea.

The extent of the tests is normally defined in the contract.

If required during a contractual test period, the shipyard must provide assistance necessary for the rapid and efficient completion of the work even when the work is to be performed outside normal working hours. This requirement includes assistance from subcontractors when applicable. Excessive waiting time resulting from delays caused by the shipyard will be charged to the shipyard.

HAT and SAT are performed according to Kongsberg Maritime test procedures.

Installation requirements

Power supply

The supply voltage to the equipment is to be kept within the specifications given in *Power requirements* on page 25.

Kongsberg Maritime strongly recommends that the EM 2040 processing unit (PU) as well as the Operator Station (HWS) are powered through an Uninterruptedly Power Supply (UPS). The UPS must be large enough to allow minimum 10 minutes operation. The system can then be switched off in a controlled manner in case of power failures.

When using diesel generator for the ship's power, it is important to make sure that the power is clean. In order to make sure there are no unwarranted power spikes, appropriate filters may have to be installed.

Noise sources

The vessel's hull, rudder(s) and propeller(s) should be thoroughly inspected in dry dock prior to installation. Roughness below the water-line, deformities in the shell plating and protruding obstacles can create acoustical noise. These sources of turbulence must be smoothed or removed as best as possible. It is especially important that the propeller(s) is not pitted or damaged. It is also important to make sure painting is done properly with smooth surfaces. Any sanding before painting and clean-up must be done before installation procedure starts. The work area must be clean.

Wiring

All cables between the bridge, the various operation- and equipment rooms, must be supported and protected along their entire length using conduits or cable trays. Note that the cables must not be installed in the vicinity of high-power supplies and cables, antenna cables or other possible sources of interference. Kongsberg Maritime recommends that there are minimal bending of cables from transducers to operating room.

Warranty

The warranty on the scope of supply is 24 months from the date when the equipment is sent from the factory. Warranty does not cover damage or defects coming from improper storing of the equipment (i.e. cable damage by temperature oscillation, rusty components, physical damage caused be improper handling etc.)

Technical specifications

Note

Kongsberg Maritime is engaged in continuous development of its products and reserves the right to alter specifications without prior notice.

Interfaces

- 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, Applanix, iXSEA, Coda Octopus and VT TSS
  - Heading (gyro compass) in either NMEA 0183 HDT, SKR82/LR40 or Sperry Mk39 format
  - Position in either Simrad 90, NMEA 0183 GGA or GGK format
  - External clock in NMEA 0183 ZDA format
  - Sound speed at transducer
  - Output of depth straight down in NMEA 0183 DPT format
- Interface for 1PPS (1 pulse per second) signal
- Clock synchronization signal
- Firewire interface for external data storage, printing or plotting
- Parallel interface for post script colour graphics
- Printer/plotter
- Ethernet interface for velocity input required for Doppler compensation in chirp mode. Formats by the following sensors are supported:
  - Kongsberg Seatex Seapath
  - Applanix POS MV
  - CodaOctopus F180
  - IXSEA Phins
- Ethernet interface for input of sound speed profile
- Tide and echo sounder depths

- Output of all data normally logged to disk

Physical specifications

Transmit transducer, EM 2040-04

- **Length:** 727 mm
- **Width:** 142 mm
- **Height:** 150 mm
- **Volume:** 15 liters
- **Weight:** 45 kg in air / 30 kg in water

Transmit transducer, EM 2040–07

- **Length:** 407 mm
- **Width:** 142 mm
- **Height:** 150 mm
- **Volume:** 8.6 liters
- **Weight:** 24 kg in air / 16 kg in water

Receive transducer

- **Length:** 407 mm
- **Width:** 142 mm
- **Height:** 136 mm
- **Volume:** 7.8 liters
- **Weight:** 23 kg in air / 16 kg in water

Processing unit (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 receive arrays and dual swath capability.

Hydrographic Work Station (4U 19” rack mounted)

- **Width:** 427 mm
- **Height:** 178 mm
- **Depth:** 480 mm

- **Weight:** 20 kg

19” monitor

- **Width:** 483 mm
- **Height:** 444 mm
- **Depth:** 68 mm
- **Weight:** 12 kg

Transducer mounting plate, EM 2040–07

- **Length:** 614 mm
- **Width:** 407 mm
- **Height:** 139 mm, including support pillars
- **Weight:** 16 kg in air

Transducer mounting plate, EM 2040–04

- **Length:** 615 mm
- **Width:** 725 mm
- **Height:** 139 mm, including support pillars
- **Weight:** 23 kg in air

Power requirements

Power supply, hull mounted system

Voltage	Frequency
115 VAC ±10%	60 Hz ±5%
230 AC ±10%	50 Hz ±5%

Power supply, AUV use

Voltage
48 VDC ±10%

Power consumption, hull mounted system

Unit	Power
One processing unit, incl. 0.4 by 0.7 degrees transducers	< 300 W
One processing unit, including 0.7 by 0.7 degrees transducers	< 275 W
Operator station	< 250 W
Monitor	< 100 W

Power consumption, AUV use

Unit	Voltage	Current
Processing unit	48 VDC	< 5 A
0.7 degrees RX transducer	48 VDC	< 0.6 A
0.7 degrees TX transducer	48 VDC	< 0.25 A (CW mode) < 0.5 A (FM mode)
0.4 degrees TX transducer	48 VDC	< 0.5 A (CW mode) < 1.0 A (FM mode)

Environmental and EMC specification

Reference standards

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

Temperature (°C)

Unit	Storage	Operating
Operator station (HWS) and monitor	-30 to 70	5 to 50
Processing unit	-30 to 70	0 to 50
Transducers	-10 to 50 (Preliminary values)	-5 to 40

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.

Humidity

- 5 to 95% relative, non-condensing

Vibration

- 5–150 Hz
- 1 g

Shock

- Peak acceleration: 15 g
- Half sine pulse
- Duration 11 ms

IP grade

- Processing unit, Operator station (HWS) and monitor: IP 22

System performance data

- **Frequency range:** 200 – 400 kHz
- **Max ping rate:** 50 Hz
- **Swath coverage sector:** Up to 140 degrees, 5.5 times water depth (single RX) / 200 degrees, 10 times water depth (dual RX)
- **Sounding patterns:**
  - Equiangular
  - Equidistant
  - High density
- **Roll stabilized beams:** Yes, ±15 degrees
- **Pitch stabilized beams:** Yes, ±10 degrees
- **Yaw stabilized beams:** Yes, ±10 degrees
- **Output sample rate:** Up to 60 kHz (1.25 cm)

Table 1 Available beam widths

	200 kHz	300 kHz	400 kHz
TX (EM 2040-04)	0.75 degrees	0.5 degrees	0.4 degrees
TX (EM 2040-07)	1.5 degrees	1 degrees	0.75 degrees
RX	1.5 degrees	1 degrees	0.75 degrees

The transmit and receive fans may be electronically stabilized for pitch movements in order to always point vertically. The receive beams are electronically stabilized for roll. Roll, pitch, yaw, heave and the applied stabilization are fully taken into account when calculating sounding depths and positions. In the near field the receive beams are dynamically focused to maintain angular resolution even at very short ranges.

Table 2 Angular coverage across

Mode	Single RX	Dual RX
200 and 300 kHz	Up to 140 degrees (±70)	Up to 200 degrees (±100)
400 kHz	Up to 120 degrees (±60)	Up to 180 degrees(±90)

Transmitter

- 3 line arrays
- Array mounting roll angles: -55 degrees, 0 degrees and +55 degrees
- Beamwidth along: 0.4 or 0.7 degrees @ 400 kHz
- Source level:
  - EM 2040–04: Up to 218 dB re 1 µPa @ 1 m
  - EM 2040–07: Up to 212 dB re 1 µPa @ 1 m
- Electronic steering along: ±10 degrees
- Angular coverage across: 200 degrees (180 degrees in 400 kHz mode)

Figure 1 TX transmission sector

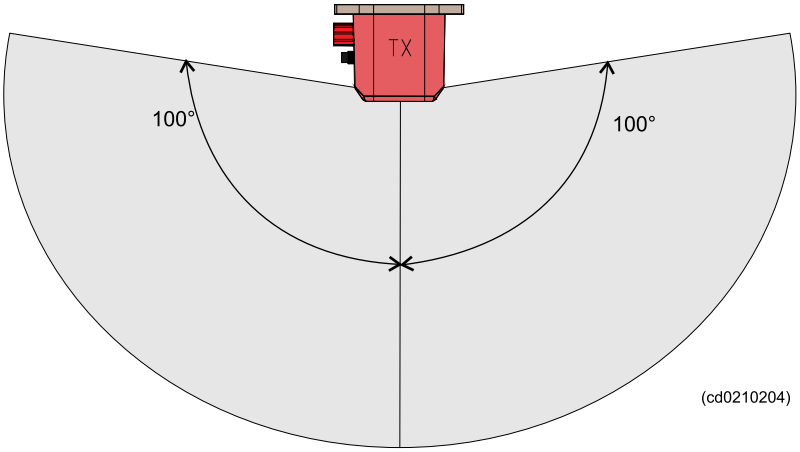


Table 3 Pulse lengths

	200 kHz		300 kHz		400 kHz	
	CW	FM	CW	FM	CW	FM
Normal mode	70/200/600 µs	3/12 ms	70/200/600 µs	2/6 ms	50/100/200 µs	N/A
Single sector mode	35/70/150 µs	1.5 ms	35/70/150 µs	1.5 ms	25/50/100 µs	N/A

Table 4 Max number of soundings per ping (dual swath)

	200 kHz	300 kHz	400 kHz
Single system	800	800	800
Dual system	1600	1600	1600

Note

Single sector mode and short pulse length may give reduced number of soundings.

Table 5 Max depth and coverage, EM 2040-04

	Cold ocean		Cold fresh water	
Operating frequency	**Max depth**	**Max coverage**	**Max depth**	**Max coverage**
200 kHz	635 m	890 m	1360 m	1900 m
300 kHz	480 m	740 m	740 m	1120 m
400 kHz	315 m	430 m	430 m	540 m

Table 6 Max depth and coverage, EM 2040-07

	Cold ocean		Cold fresh water	
Operating frequency	**Max depth**	**Max coverage**	**Max depth**	**Max coverage**
200 kHz	600 m	850 m	1300 m	1780 m
300 kHz	465 m	705 m	700 m	1060 m
400 kHz	300 m	410 m	375 m	510 m

Note

The calculated coverage is based on NL=44 dB for the 400 kHz mode, NL=46 dB for the 300 kHz mode and NL=50 dB for the 200 kHz mode. Backscatter strength used is BS=-10 dB.

Restriction for use – limitations

Do not ping in dry dock.

Cable layout and interconnections

Please find provided the installation procedures and requirements for the EM 2040 cables. These instructions must be used together with the cable plan.

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) Report No. 80-P008 «Guidelines for Installation and Proposal for Test of Equipment» should be used as a guide.

Topics

PU configurations

The EM 2040 system requires one PU per RX transducer and one additional PU per RX transducer for dual swath capability. The configuration options are as follows:

- **Single RX – Single Swath:**
  One PU required. See *Cable plan – single RX – single swath* on page 36.
- **Single RX – Dual swath:**
  Two PUs required. See *Cable plan – single RX – dual swath* on page 37.
- **Dual RX – Single swath:**
  Two PUs required. See *Cable plan – dual RX – single swath* on page 40.
- **Dual RX – Dual swath:**
  Four PUs required. See *Cable plan – dual RX – dual swath* on page 43.

List of cables

The following list of cables applies to all configurations.

C1 EM2040/C1 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 *Ethernet with RJ45 plugs (screened)* on page 166.

C2 EM2040/C2 Ethernet from Attitude Velocity sensor

- The Ethernet cable must be provided by the shipyard.
- The cable must be a Gigabit Ethernet cable.
- See *Ethernet with RJ45 plugs (screened)* on page 166.
- The upgraded version of the PU (V2) is equipped with a separate Ethernet port which can be used for this. 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**. In figure *Rack layout — upgraded version (V2)* on page 54 this port is labeled **I**.

  If only one PU of the original version (V1) is used (single RX, single swath) and attitude velocity input is being utilized, the attitude velocity input is interfaced on the HWS Ethernet cable (C1). An external Ethernet switch must in this case be used. The Ethernet switch must be provided by the shipyard.

C3 EM2040/C3 Serial line interface (COM1 through COM4)

- 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 bottom board on the right side of the PU seen from rear side.
- 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 type. 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* on page 158.
- For standard 9-pin DSUB RS232 serial interface connectors, the cable specification is shown in *RJ45 to 9-pin DSUB direct serial cable* on page 160.
- RJ45-9pin DSUB 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 DSUB serial interface adapter* on page 159.

C4 EM2040/C4 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 164.

C5 EM2040/C5 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.
- See description of the optical isolation in *1PPS input* on page 49.

C6 EM2040/C6 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.
- See description of the optical isolation in *External synchronization* on page 49.
- The connector is RJ45 type.
- The cable must be provided by the installation shipyard.
- See *EM 2040 external synchronization interface* on page 161.

C7 EM2040/C7 TX transducer cable

- The TX transducer cable holds three connectors; Eth1 to TX1, Eth2 to TX2 and 48 VDC.

  TX2 is used only for large (i.e. 0.4 degrees) systems.
- The TX1 and TX2 interfaces are 100 Mbit/s Ethernet links to processing board in the transmitter 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 100 mm.
- The cable is provided with the echo sounder.
- See *EM 2040 TX transducer cable* on page 167.

C8 EM2040/C8 RX transducer cable

- The RX transducer cable is a 1 Gbit/s Ethernet link between the RX transducer and the processing unit
- 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 100 mm.
- The cable is provided with the echo sounder.
- See *EM 2040 RX transducer cable* on page 169.

Note

For a dual RX system a second PU and cable is required.

C9 EM2040/C9 Sync/48 VDC

- This cable provides power to the RX transducer as well as synchronization between the TX and the RX transducer.
- The cable is provided with the echo sounder.
- The cable length is 0.5 or 1.5 meters for a single RX system.
- For a dual RX system the cable is extended by a split and 1 or 3 meters additional cable to each RX transducer, i.e. a total of 1.5 or 3.5 meters cable to each transducer.
- See *EM 2040 TX to RX transducer cable* on page 171 for single RX system.
- See *EM 2040 TX to dual RX transducer cable* on page 173 for dual RX system.

C10 EM2040/C10 Internal PU Ethernet connections

- The number of internal Ethernet connections depends on the chosen configuration, i.e. number of required PUs.
- The required cables are provided with the processing unit(s).
- The data sent over the different Intenal Ethernet connections are described for each configuration in the sections below:
  - **Single RX – Single Swath:**

    One PU required. See *Cable plan – single RX – single swath* on page 36.
  - **Single RX – Dual swath:**

    Two PUs required. See *Cable plan – single RX – dual swath* on page 37.
  - **Dual RX – Single swath:**

    Two PUs required. See *Cable plan – dual RX – single swath* on page 40.
  - **Dual RX – Dual swath:**

    Four PUs required. See *Cable plan – dual RX – dual swath* on page 43.

Cable layout

This section presents cable diagram for the individual configurations of the EM 2040.

The internal Ethernet connections are detailed in separate diagrams and tables.

Note

- Cables identified with an asterisk (*) are supplied with the echo sounder.
- The Ethernet switch connection ports can be freely chosen.
- For dual swath and/or dual RX the Ethernet switch of Slave 1 is chosen for communication with the ship's Ethernet, i.e. with the HWS and the attitude velocity sensor.
- Operator station cable layout are provided in the HWS documentation.

Figure 2 Network overview – single RX/dual swath or single swath/dual RX

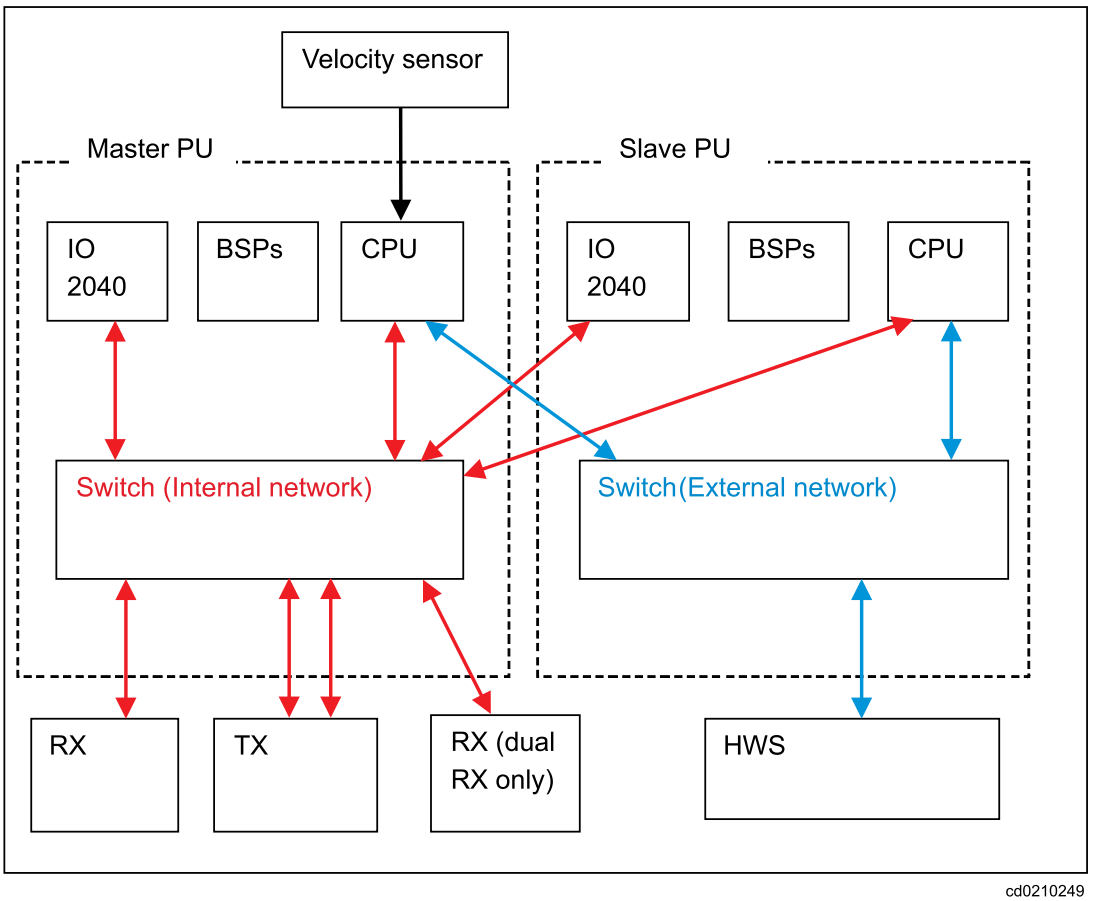
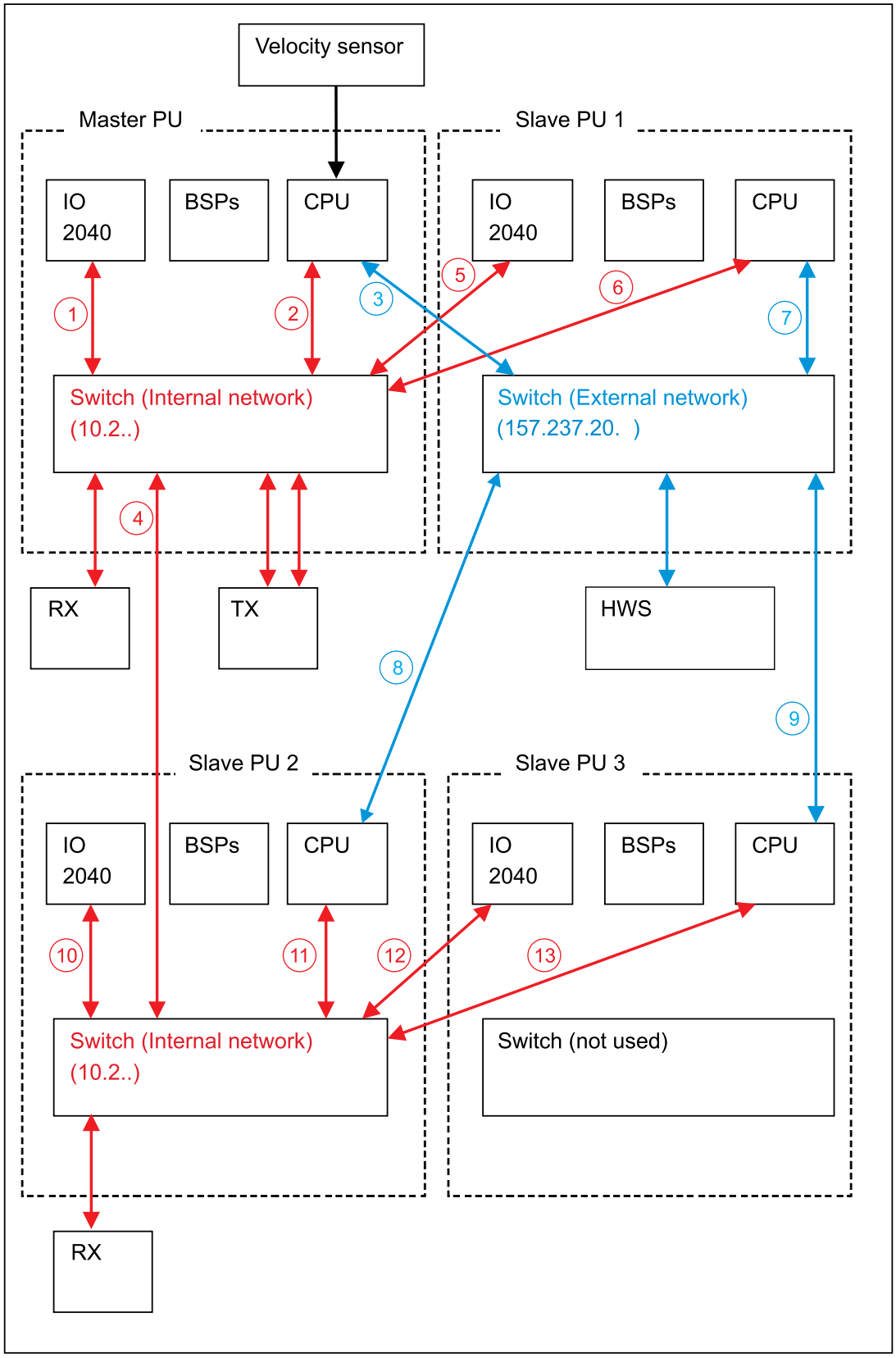


Figure 3 Network overview – dual RX/dual swath



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Cable plan – single RX – single swath

Figure 4 EM 2040 cables – single RX – single swath

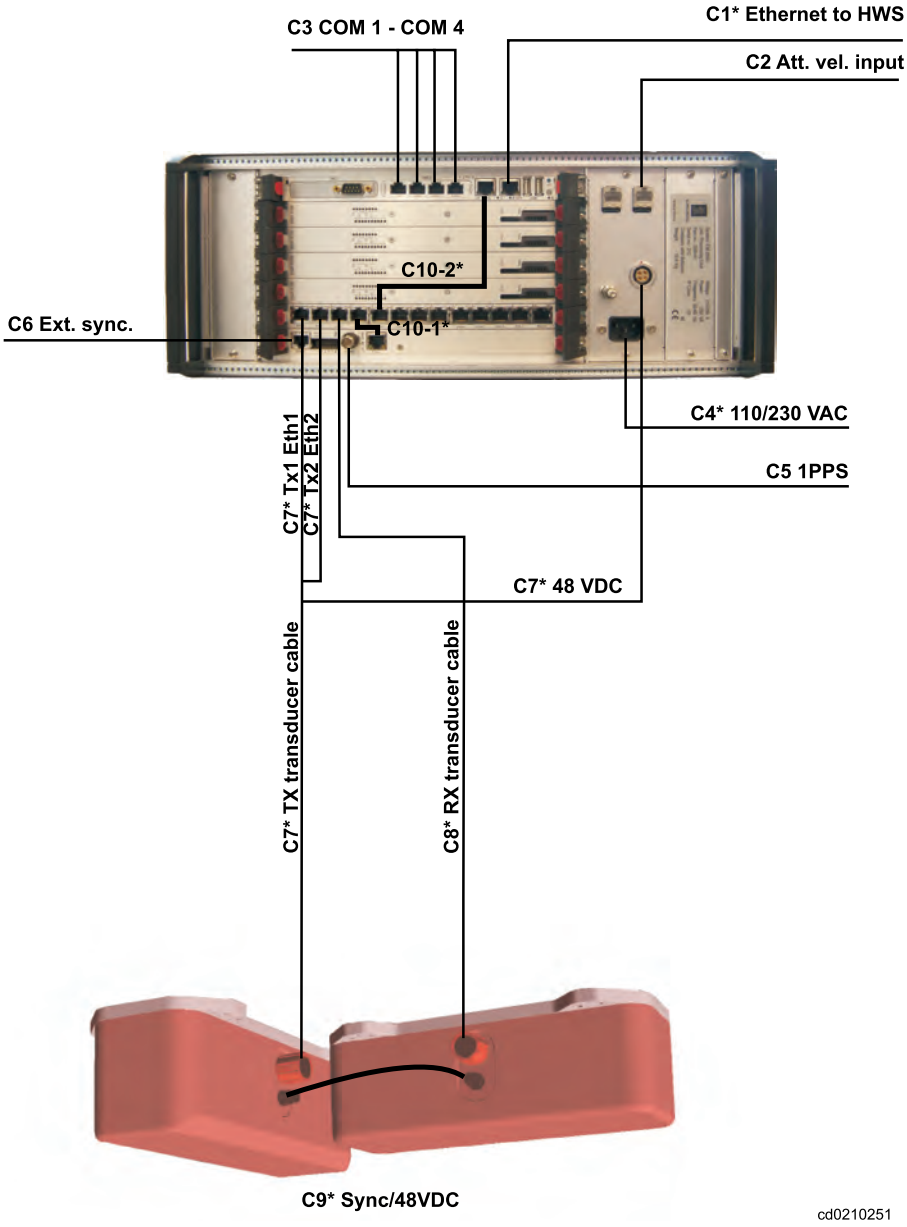


Table 7 C10 specifications – Internal Ethernet connections (single RX, single swath)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	RX1 data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the IO2040 and to the TX and RX transducers

Cable plan – single RX – dual swath

Figure 5 External PU and transducer cables (single RX, dual swath)

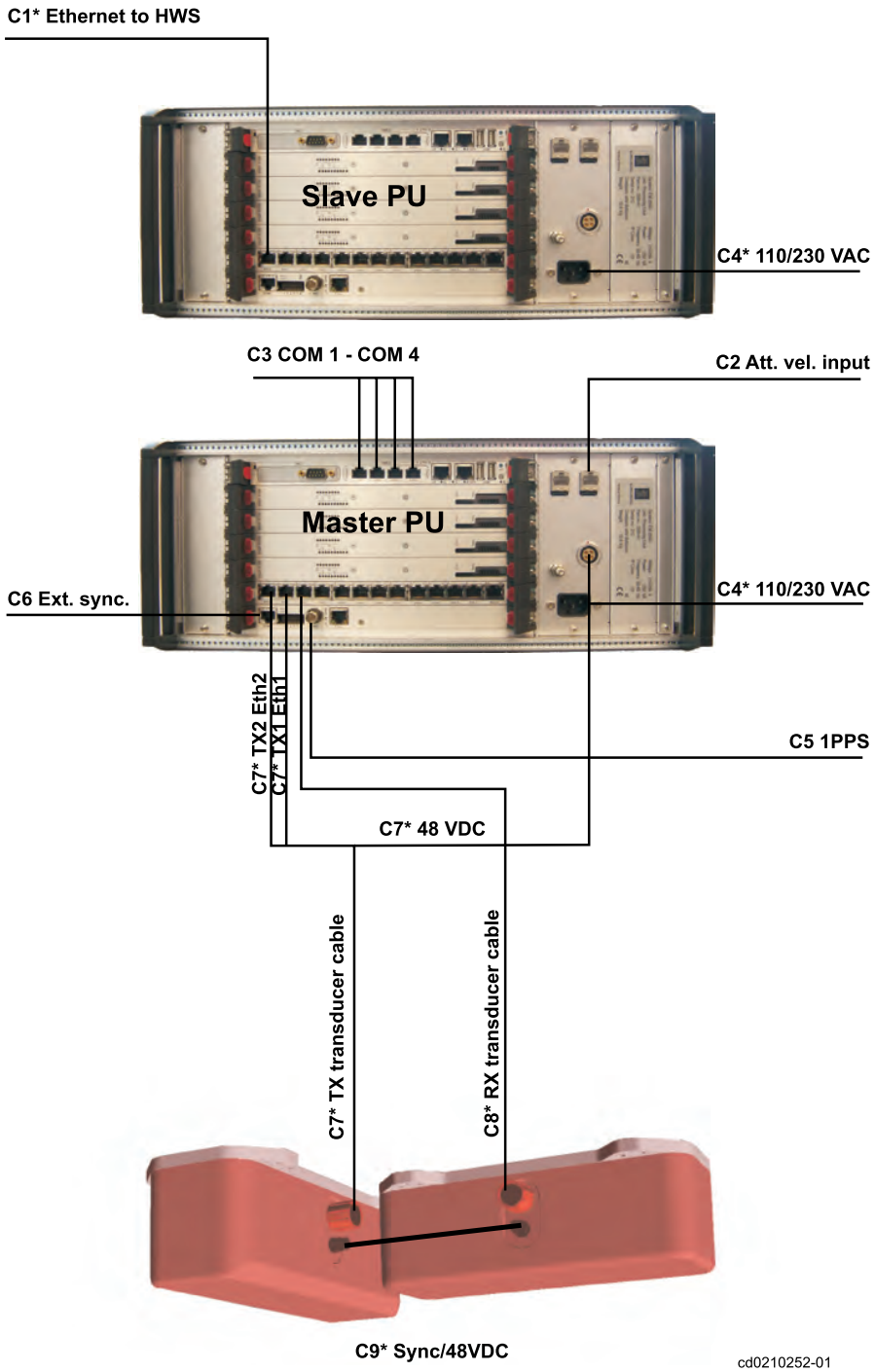


Figure 6 C10 layout – Internal Ethernet connections (single RX, dual swath)

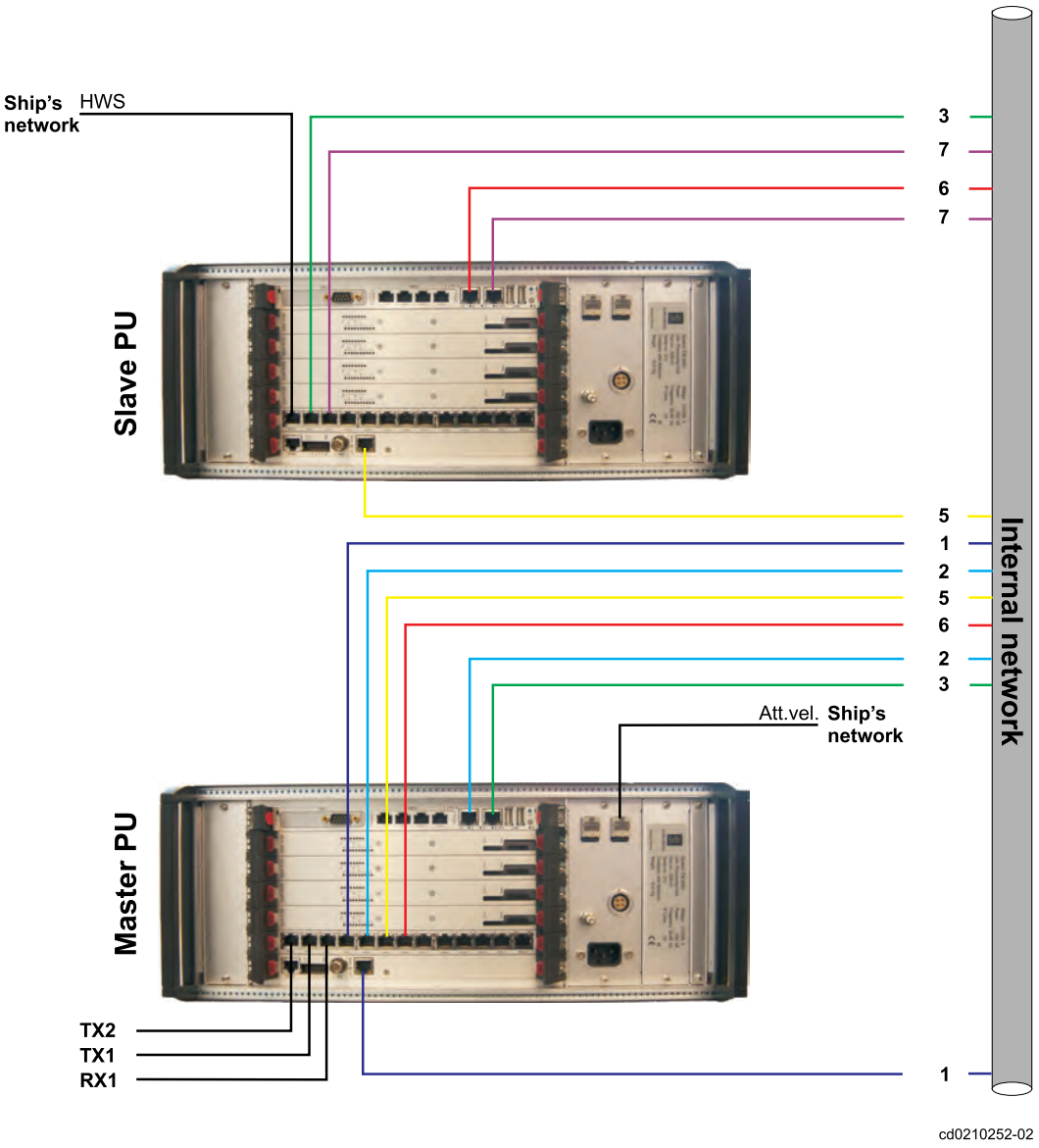


Table 8 C10 specifications – Internal Ethernet connections (single RX, dual swath)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	RX1 data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the internal network (IO2040, TX and RX transducers and slave CPU)
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	RX1 data to IO2040 board on Slave PU for dual swath

Table 8 C10 specifications – Internal Ethernet connections (single RX, dual swath) (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, BIST, etc.)
7	Slave CPU port 2	Slave switch	Communication from the Slave CPU with the external network (HWS) via the Slave switch

Cable plan – dual RX – single swath

Figure 7 External PU and transducer cables (dual RX, single swath)

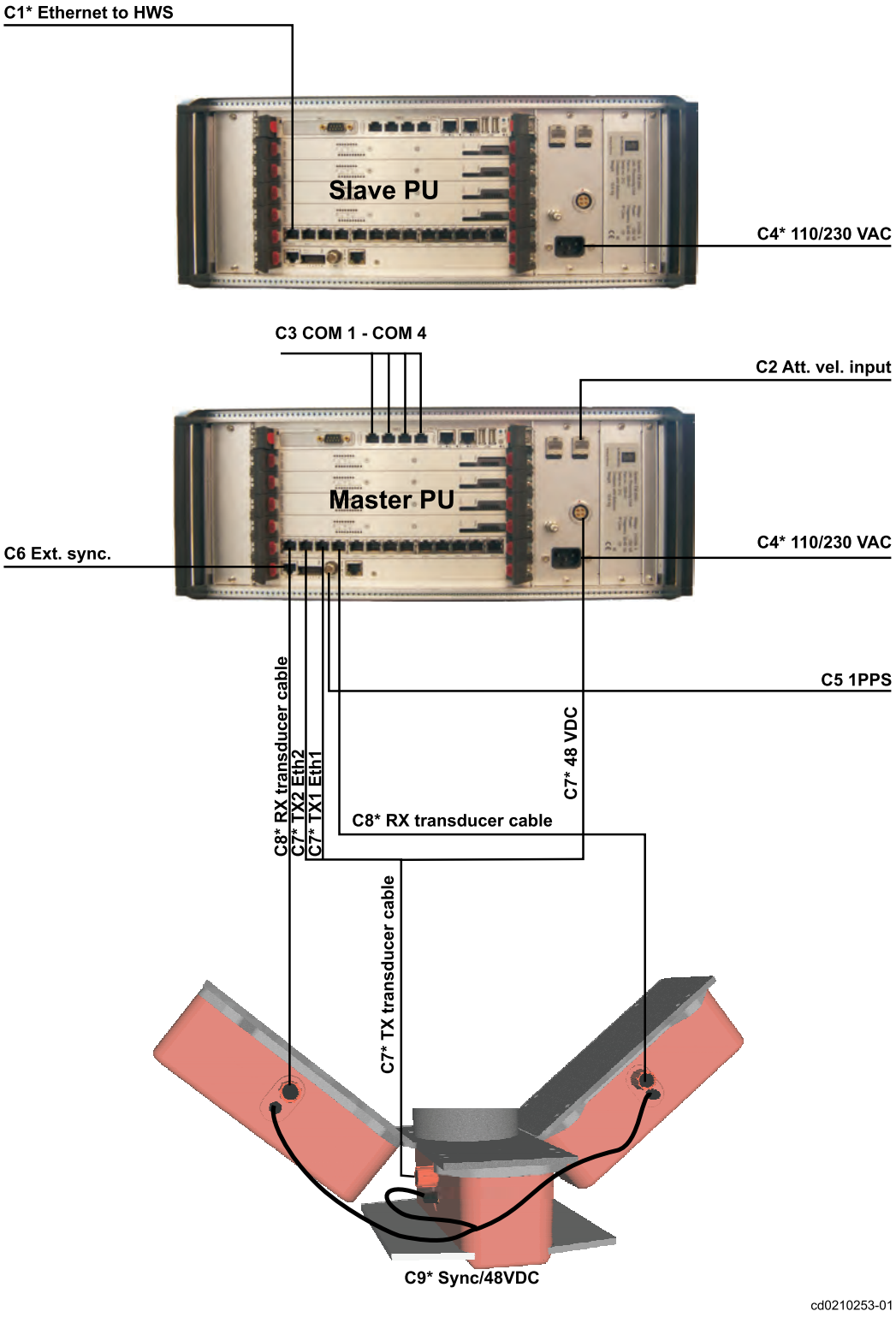


Figure 8 C10 layout – Internal Ethernet connections (dual RX, single swath)

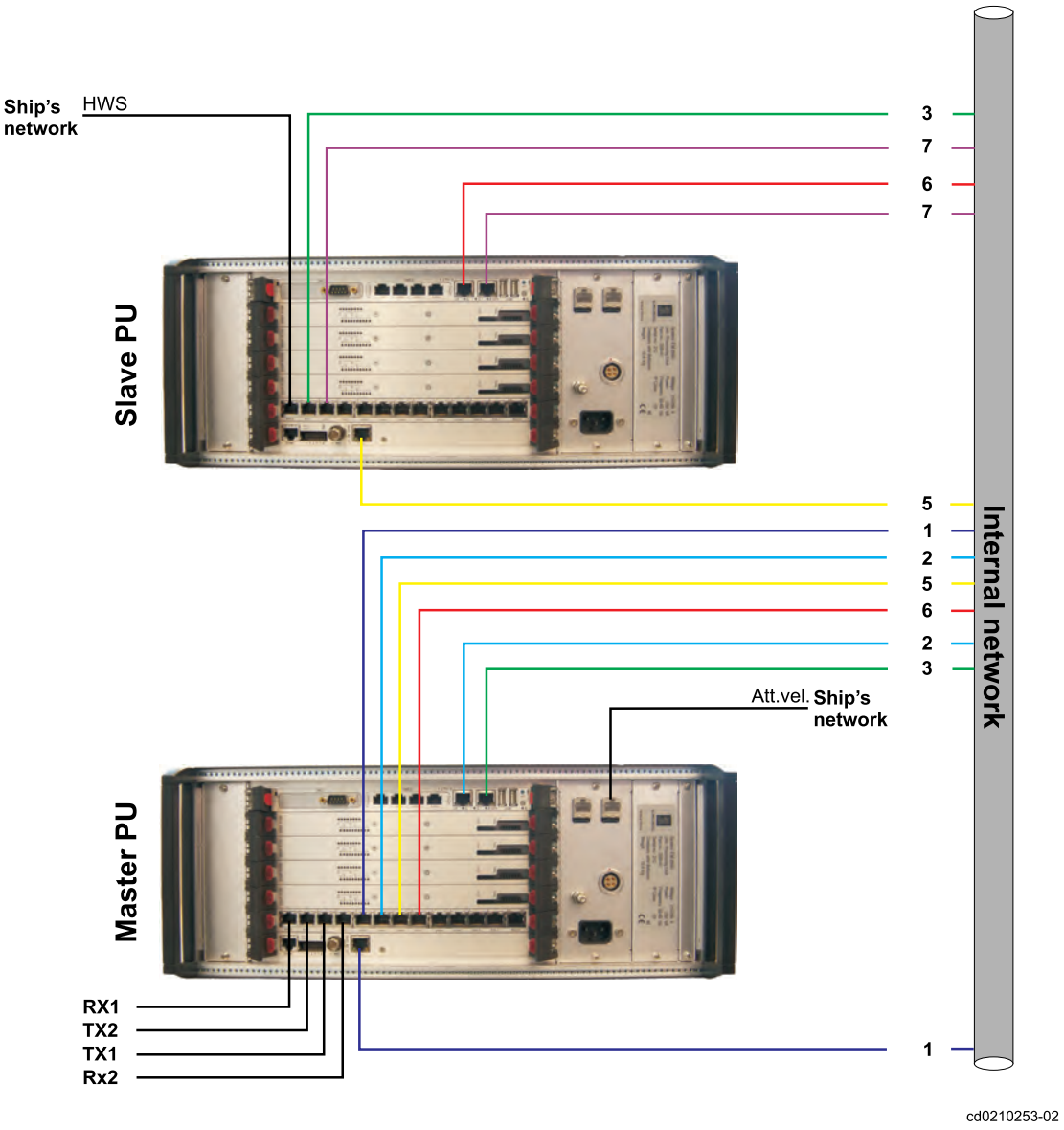


Table 9 C10 specifications – Internal Ethernet connections (dual RX, single swath)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	RX1 data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the internal network (IO2040, TX, RX, 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	RX2 data to IO2040 board on Slave PU for dual RX

Table 9 C10 specifications – Internal Ethernet connections (dual RX, single swath) (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

Cable plan – dual RX – dual swath

Figure 9 External PU and transducer cables (dual RX, dual swath)

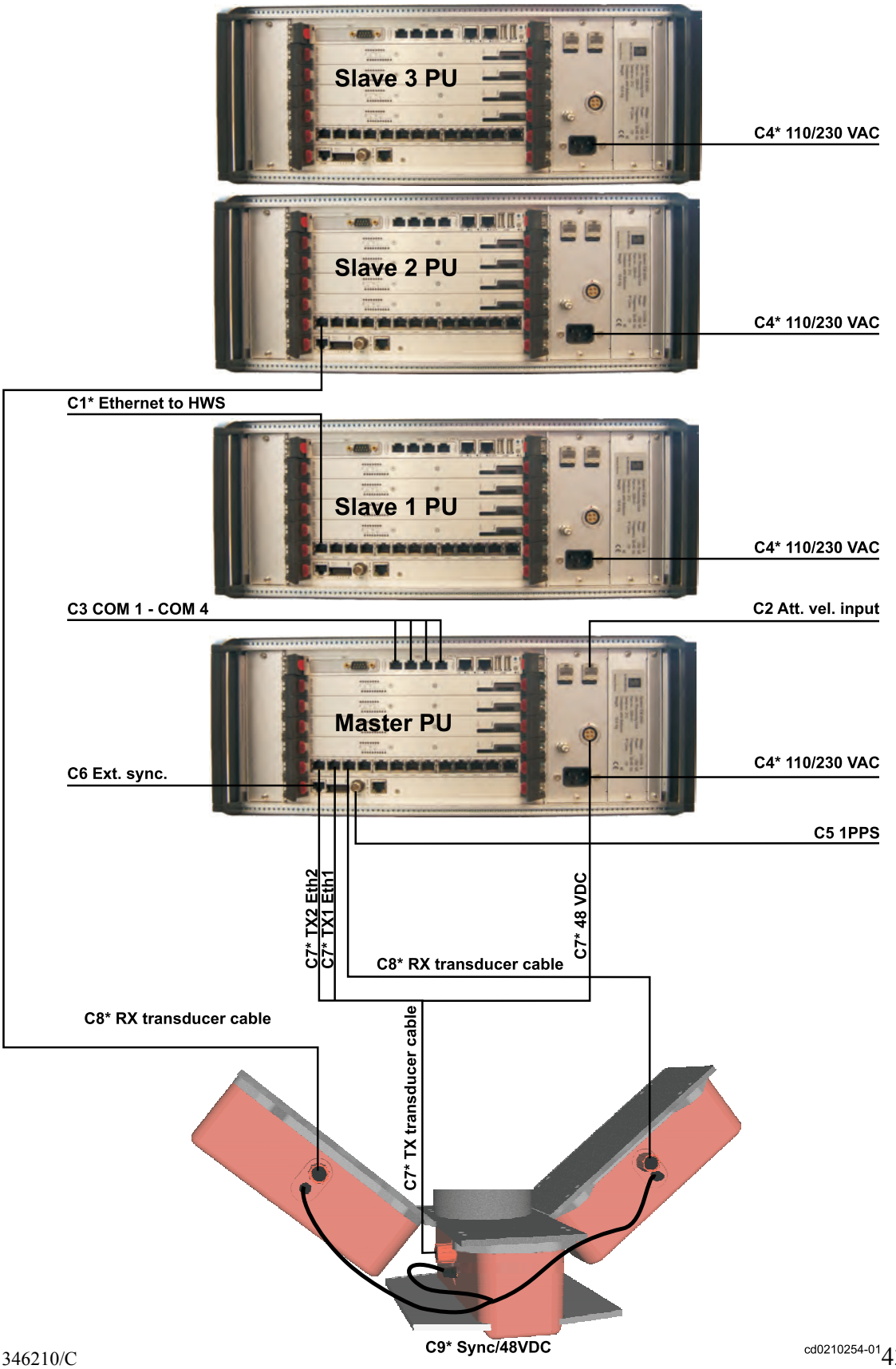


Figure 10 C10 layout – Internal Ethernet connections (dual RX, dual swath)

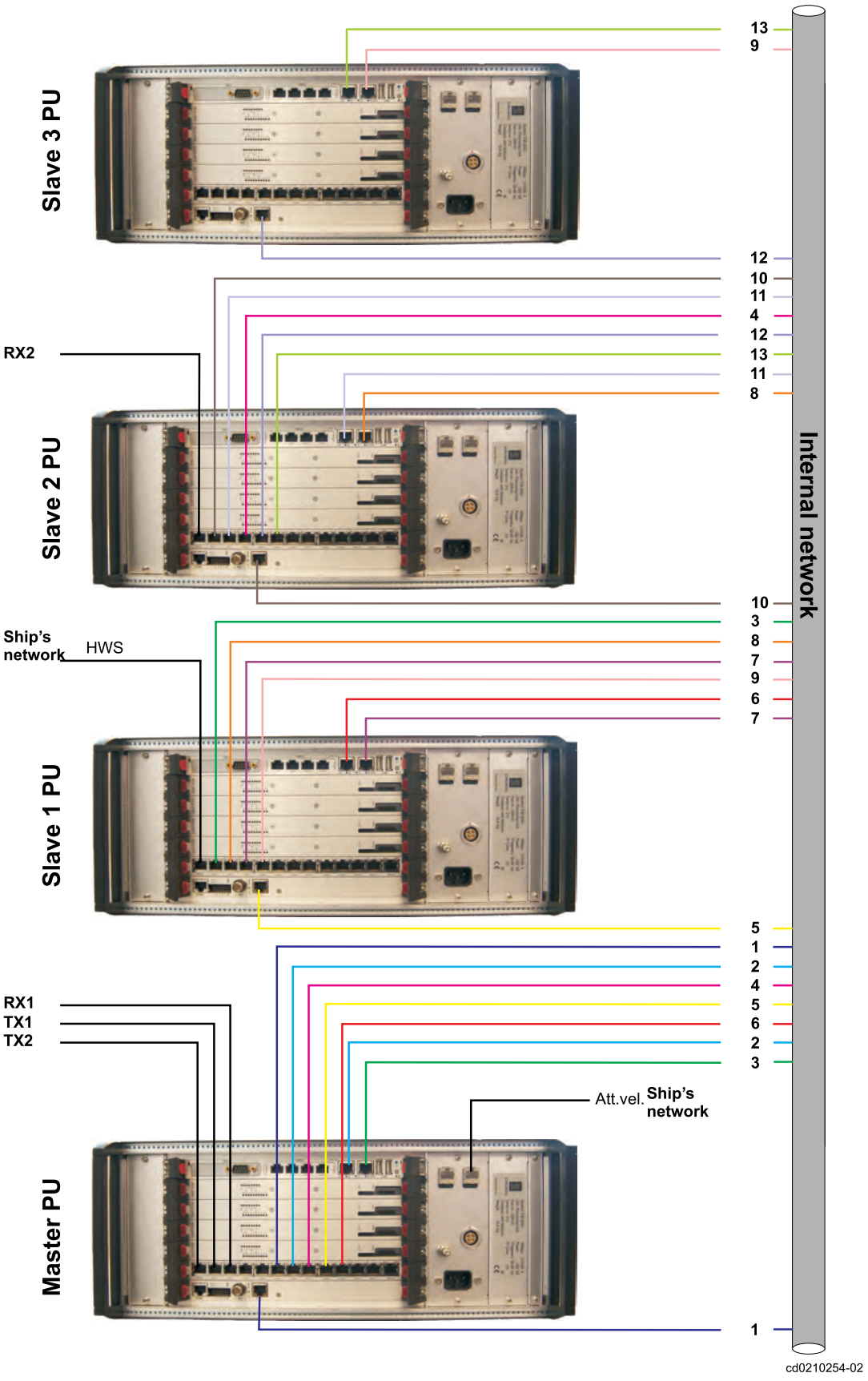


Table 10 C10 specifications – Internal Ethernet connections (dual RX, dual swath)

Connection no.	Connection point	Connection point	Used for
1	Master Switch	Master IO2040	RX1 data to IO2040 board
2	Master Switch	Master CPU port 1	Communication from the CPU board to the internal network
3	Master CPU port 2	Slave 1 Switch	Communication from the CPU with the external network (HWS) via the Slave 1 switch
4	Master Switch	Slave 2 Switch	Communication between switches
5	Master Switch	Slave 1 IO2040	RX1 data to IO2040 board on slave 1 PU for dual swath
6	Master Switch	Slave 1 CPU port 1	Communication from the slave 1 CPU board with Master CPU
7	Slave 1 CPU port 2	Slave 1 switch	Communication from the Slave 1 CPU with the external network (HWS) via the Slave 1 switch
8	Slave 2 CPU port 2	Slave 1 switch	Communication from the Slave 2 CPU with the external network (HWS) via the Slave 1 switch
9	Slave 3 CPU port 2	Slave 1 switch	Communication from the Slave 3 CPU with the external network (HWS) via the Slave 1 switch
10	Slave 2 Switch	Slave 2 IO2040	RX2 data to IO2040 board
11	Slave 2 Switch	Slave 2 CPU port 1	Communication from the CPU board to the internal network
12	Slave 2 Switch	Slave 3 IO2040	RX2 data to IO2040 board on Slave 3 PU for dual swath
13	Slave 2 Switch	Slave 3 CPU port1	Communication from the Slave 3 CPU board with internal network

SubConn® underwater connectors

The following procedures should be followed 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.

Processing unit

Topics

The EM 2040 processing unit is basically a Compact PCI standard computer using a commercially available CPU board with an Intel dual core CPU, plus signal processing boards. Receive data from the Gbit link is match filtered by an FPGA board before transferred to the signal processing boards. The CPU board has serial interfaces for input of external time-critical sensors and Gigabit Ethernet for communication with the operator station. SATA interfaces are available for integrated data logging to a local hard disk (option intended for AUV use).

Currently the EM 2040 system requires one PU per RX transducer and one additional PU per RX transducer for dual swath capability.

The processing unit also supplies 48 VDC power to the transducers.

Figure 11 EM 2040 Processing unit

Processing unit installation

Description

The processing unit consists of an instrument case with integrated rack mounting in a 19 inch rack. Ventilation is provided through slits located on the right and left side. These must not be blocked.

Location

One processing unit is required per 0.7 degrees RX transducer and one additional PU is required per 0.7 degrees RX transducer for dual swath capability.

The processing units (PUs) may be mounted in a standard 19” rack, requiring 4U (4 rack height units) per PU.

On large vessels the PUs may have to be mounted closer to the transducer arrays than the Operator Station due to restricted length of the cable connecting the two units (15 m standard length, optional 30 and 50 m).

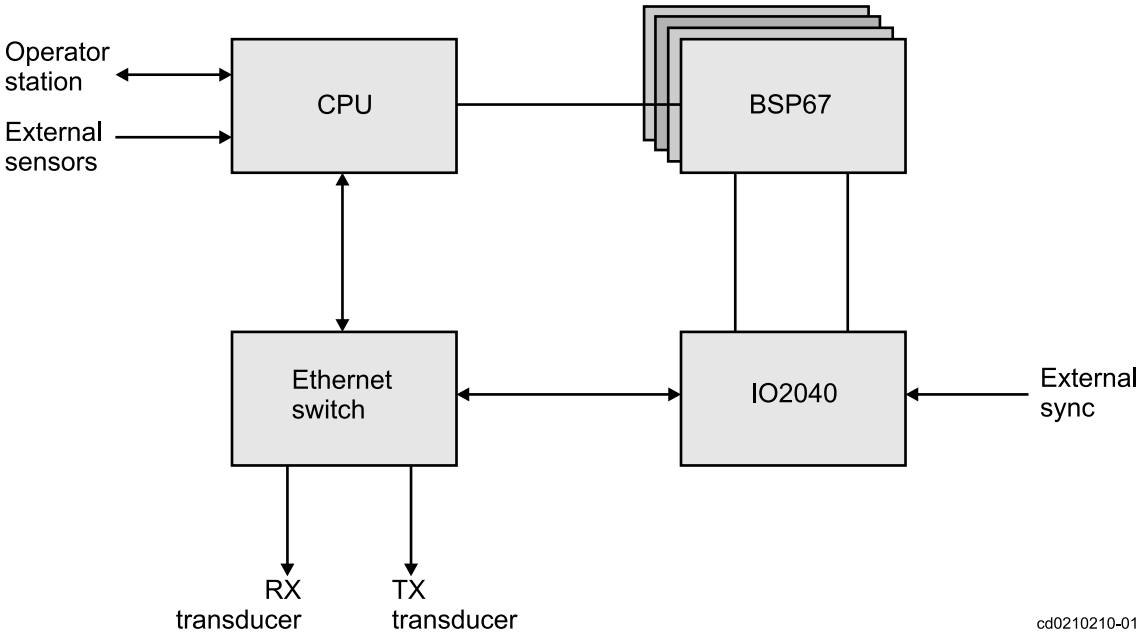
Solutions for mounting the processing units in an underwater vehicle is available.

Installation

There are no specific installation procedures for the processing unit. However, you must install the unit so that it is properly physically supported and protected against shock, vibration and rough movements due to sea conditions.

Theory of operation

Simplified block diagram



Control functions

The processing unit is switched on/off by a power button on the front side of the unit.

The IEC inlet on the rear side of the PU is fused (PC flange mount fused inlet – PF0001/PC). A 5 x 20 mm fuse is housed within the power connector. This fuse will prevent exterior damages caused by malfunctions within the PU.

Status LEDs

There are four Light-Emitting Diodes (LEDs) located next to the on/off switch on the front side of the processing unit. When the LEDs are numbered from 1 to 4 starting from the top they indicate the PU status as follows:

1 LED is turned on when booting is started.

2 LED is turned on when booting is in progress.

3 LED is turned on when booting is completed. The processing unit is ready to start pinging.

4 Ping indicator. The LED flashes when the processing unit is pinging.

1PPS input

The 1 PPS (one pulse per second) signal is connected to the coax connector on the IO2040 interface board. The IO2040 board is equipped with an optocoupler at this input. The input series resistor is tuned for a TTL signal (Low level<0.6 V, High level>3.2 V). It can be selected in SIS wether the the falling edge or the rising edge of the signal is used by the processing unit to synchronize the internal clock. The 1 PPS signal must be minimum 1 microsecond long.

Note

The input current must be ~10mA. To achieve this you may have to use additional resistors. This is the same principles that applies for the External synchronization inputs.

See Optical isolated input signals on page 50.

External synchronization

When multiple echo sounders are employed on a vessel it is essential to optimize the timing of the transmitting of each system. The Kongsberg Maritime **K-Sync** Synchronizing Unit provides highly configurable timing.

The EM 2040 provides the following synchronization signals:

- **RTS (Ready To Send):** This is an output signal from the EM 2040 to the synchronization system that goes active when the EM is ready to transmit. The signal is inactive when the echo sounder is transmitting, receiving or processing samples.
- **Trig out:**The EM 2040 issues a trig out signal. The trig out signal starts before the first transmit pulse and is terminated after the end of the last transmit pulse. For EM 2040 all pulses in one swath are transmitted simultaneously. With dual swath, two pulses are transmitted in sequence. The length of this trig signal is 0.7 ms plus the total TX signal length. For CW pulses the actual TX pulse is 1.5 times the nominal pulse length (because of amplitude tapering).

  Reference to the Raw range and angle 78 datagram:
  The transmit time for the TX pulse is referred to the centre of the pulse.
  The total length of the TX pulse is given in the datagram (Signal length)

  The time delay from the leading edge of the trig out pulse to the centre of the first TX pulse is:
  506 us + 0.5 * signal length

  Example of signal length (200 kHz, Normal sector):

Short CW:	101 us
Medium CW:	288 us
Long CW:	865 us
Short FM:	3 ms
Long FM:	12 ms

- **CTS (Clear To Send/Trig in):** The EM 2040 can be triggered by an external signal that will cause the echo sounder to ping. The IO2040 board is equipped with an optocoupler at this input. The input series resistor is tuned for a TTL signal (Low level<0.6 V, High level>3.2 V). There is a delay from the external trig signal is received to the start of the transmit pulse (Trig out). This is caused by signal processing in the TX transducer (pitch stabilization, focus range etc).

  If the acquisition range is less than 250 ms (approximately 190 m range), the delay is 1.5 ms.

  At larger ranges the delay depends on the number of transmit pulses per ping (to optimize pitch stabilization). This means that the delay depends on ping mode (frequency), sector mode and swath mode (single/dual). The delay is from 7 to 28 ms.

Table 11 EM 2040 Trig delay if acquisition range > 250 ms

Sector mode	Swath mode	Ping mode	No. of TX pulses	Trig delay
Normal	Single	200 kHz	2	11 ms
		300 kHz	3	15 ms
		400 kHz	3	15 ms
	Dual	200 kHz	4	20 ms
		300 kHz	6	28 ms
		400 kHz	6	28 ms
Single	Single	200 kHz	1	7 ms
		300 kHz	1	7 ms
		400 kHz	1	7 ms
	Dual	200 kHz	2	11 ms
		300 kHz	2	11 ms
		400 kHz	2	11 ms

Table 12 EM 2040 external synchronization signal characteristics

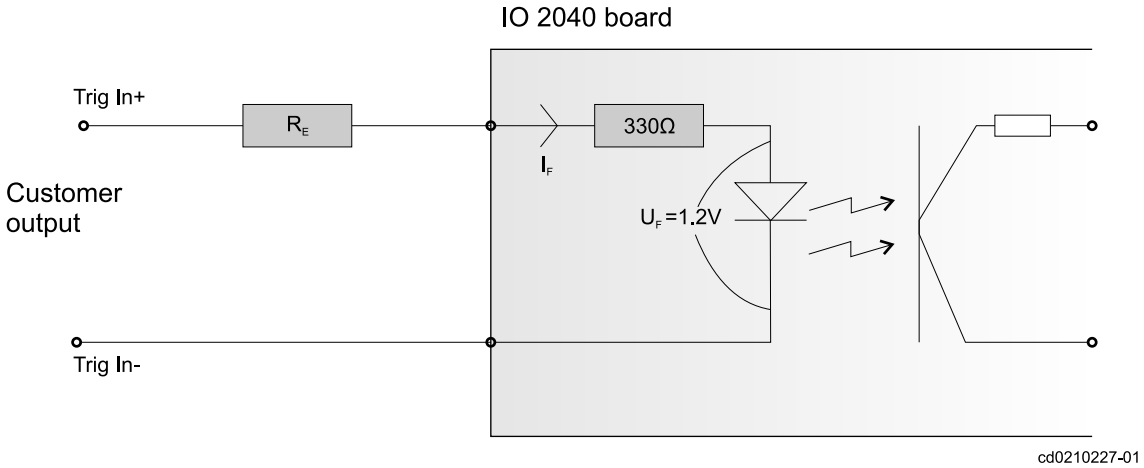
Signal	Type	Active
RTS (out)	Open collector output from isolation unit	High
Trig out	Open collector output from isolation unit	Low
CTS (in)	Input to isolation unit	High

Optical isolated input signals

Note

The following applies to the 1PPS input and the External synchronization Trig In signal.

Figure 12 Input signals (e.g. Trig In signal)



The input current must be approximately 10 mA. Depending on your input signal additional resistance must be applied to achieve the required input current. Two examples are shown below to clarify.

Equation 1 +4.5V input signal

$$I_F = \frac{4.5V - 1.2V\,(U_F)}{330\Omega} \approx 10mA$$

I.e. using +4.5V input signal the input current will be as required (~10mA). No additional resistance required.

Equation 2 +12V input signal

$$R_{TOT} = \frac{12V - 1.2V\,(U_F)}{10mA} = \frac{10.8}{0.010} = 1080\Omega$$

$$R_E = 1080 - 330 = 750\Omega$$

I.e. an added resistor of 750Ω and minimum 0.1 Watt must be used.

Note

The input signals must not be negative, i.e. no RS232 signals can be used for these inputs.

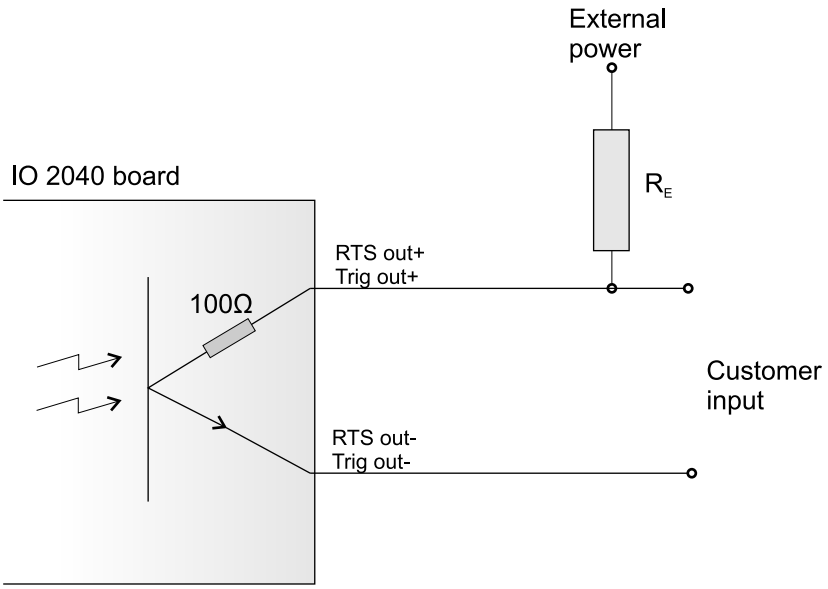
Optical isolated output signals

Note

The following applies to the Trig Out and the RTS Out output signals of the External synchronization.

The collector current must be approximately 10 mA. A resistor must be used to tune the collector current depending on your voltage.

Figure 13 External resistor requirements to IO2040 board



Power	Resistor value	Min. effect
5V	0.38 kOhm	0.1 W
12V	1.08 kOhm	0.15 W
24V	2.28 kOhm	0.25 W

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Note

To avoid ground loops and damage of the EM 2040 electronics caused by external connections, all connections are optically isolated.

The synchronization signals are interfaced to the EM 2040 through the RJ45 connector on the IO2040 interface board.

See

- *IO2040 board* on page 65
- *EM 2040 external synchronization interface* on page 161

Sensor input

The RS232 external interfaces to the EM 2040 processing unit is via the PMC (PCA Mezzanine Card) serial interface ports on the CPU board. Four external sensors can be connected using serial interface and RJ45 connectors.

In addition, the CPU board holds two Ethernet UDP ports available for sensor input.

The EM 2040 allows for the following sensor inputs:

- One, two or three positioning systems
- One or two motion/attitude sensors
- One heading system
- One clock input
- Velocity input (via Ethernet)

Circuit board descriptions

The EM 2040 processing unit holds several circuit boards, power supplies and connectors. All connections between the boards are made on a purpose made backplane.

For deliveries before June 2011 the original version of the EM 2040 processing unit was used, see *Rack layout — original version (V1)* on page 55.

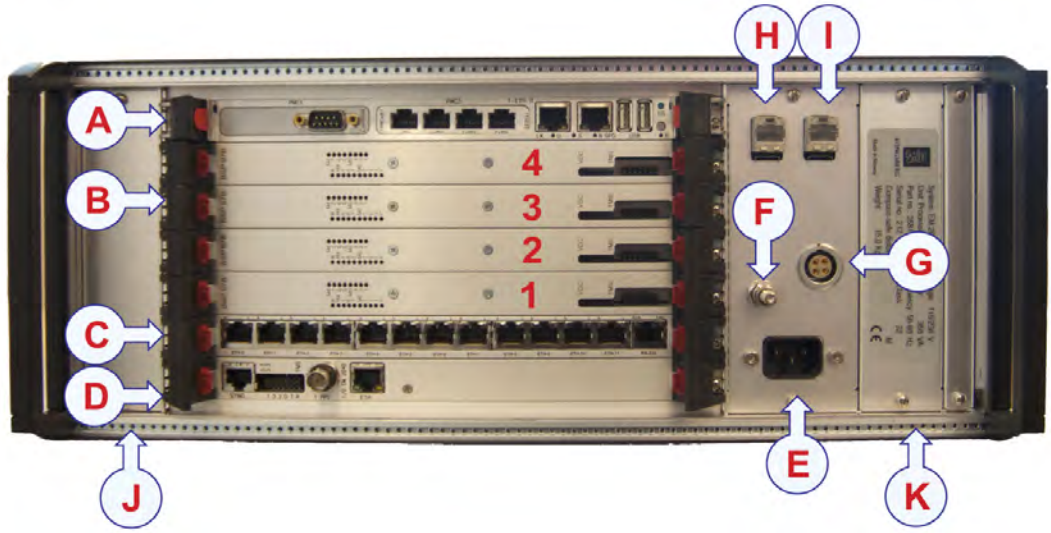
From June 2011 the upgraded version of the processing unit is delivered, see *Rack layout — upgraded version (V2)* on page 54.

Topics

Rack layout — upgraded version (V2)

For deliveries before June 2011 the original version of the EM 2040 processing unit was used, see *Rack layout — original version (V1)* on page 55.

Figure 14 Processing unit rear side — upgraded version (V2)



A Concurrent CPU board.

See *Control Processor Unit (CPU) board* on page 69.

B Four BSP 67B boards, numbered 1 to 4 from bottom to top.

See *Beamforming & Signal Processor (BSP) board* on page 71

C Ethernet switch board.

See *Ethernet Switch Board – Vadatech CP218* on page 57.

D IO2040 interface board.

See *IO2040 board* on page 65.

E 110/230 VAC power connector and fuse

F Ground connection point. When required the ESD wrist strap is also connected at this point.

G 48 VDC power supply to transducers.

See *Power Supply Exelsys* on page 61.

H Spare Ethernet port.

I Ethernet port for attitude velocity input. The 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**.

J Fan plug-in module.

K Fan plug-in module.

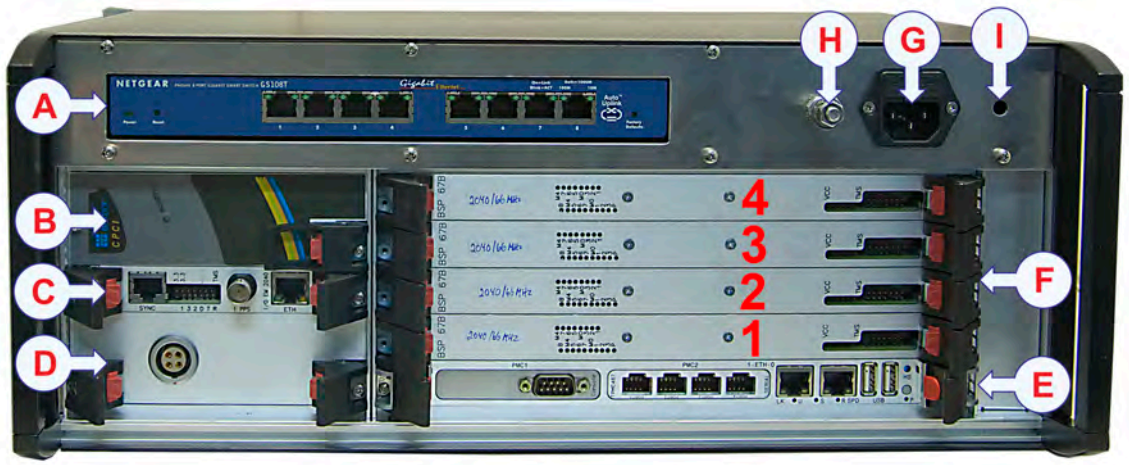
- The power supply is enclosed inside the processing unit and is not visible from the outside.

  See *Power Supply Exelsys* on page 61.

Rack layout — original version (V1)

From June 2011 the upgraded version of the processing unit is delivered, see *Rack layout — upgraded version (V2)* on page 54.

Figure 15 Processing unit rear side — original version (V1)



A Ethernet switch.

See *Ethernet switch* on page 59.

B PCI power supply.

See *Compact PCI Power Supply* on page 63.

C IO2040 interface board.

See *IO2040 board* on page 65.

D 48 VDC power supply to transducers.

See *48 VDC Power Supply* on page 67.

E Concurrent CPU board.
See *Control Processor Unit (CPU) board* on page 69.

F Four BSP 67B boards, numbered 1 to 4 from bottom to top.
See *Beamforming & Signal Processor (BSP) board* on page 71

G 110/230 VAC power connector and fuse

H Ground connection point

I ESD wrist strap connection point

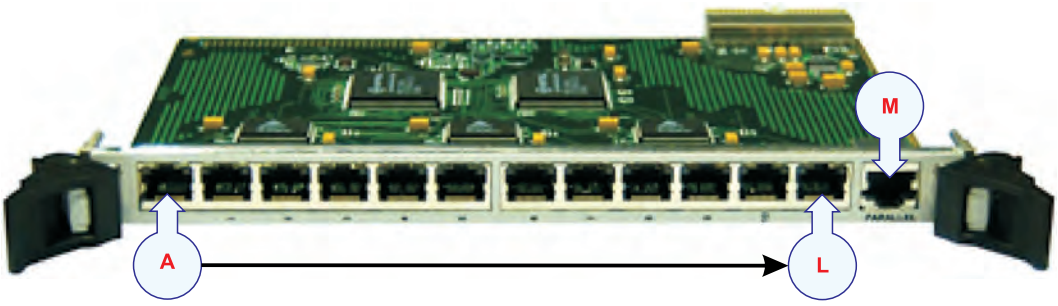
All boards are interconnected through a custom made backplane.

Ethernet Switch Board – Vadatech CP218

Purpose and description

The CP218 is a 12 channel compact PCI (cPCI) managed layer two Ethernet switch board. It is used to interconnect the TX and RX transducers with the IO2040 and CPU board.

Figure 16 Ethernet Switch Board Vadatech CP218



Key features

- Compact PCI (cPCI) compliant
- Managed layer 2 switch
- 12 ports of 10/100/1000 via RJ–45 (A-L on *Ethernet Switch Board Vadatech CP218* on page 57)
- Support up to 8k MAC address

Specifications

Power consumption: 6 W

Ports: 10/100/1000: 12 RJ-45 at front

Serial port: 1. the serial port has a standard RJ-45 interface. (M on *Ethernet Switch Board Vadatech CP218* on page 57)

Facilities

Each channel has two green light emitting diodes: one is labeled L and is lit when the link is active. One is labeled A and is flashing with the activity on the link.

External connections

The Ethernet switch holds the following connections:

- C8 – 1Gbit Ethernet connection to RX transducer
- C7 – 100 Mbit Ethernet connection to TX transducer (Eth 1 to TX1)
- C7 – for 0.4 degree systems only – 100 Mbit Ethernet connection to second TX transducer connector (Eth2 to TX2)
- C10 – Ethernet connection to IO2040 board

- C10 – Ethernet connection to the CPU

C7 to C10 refer to the cables in *List of cables* on page 31.

Ethernet switch

Purpose and description

This is an 8-port Gigabit switch used to interconnect the TX and RX transducers with the IO2040 and CPU board. This switch was used in the original version of the processing unit.

Figure 17 Ethernet switch Netgear GS108T

External connections

The Ethernet switch holds the following connections:

- C8 – 1Gbit Ethernet connection to RX transducer
- C7 – 100 Mbit Ethernet connection to TX transducer (Eth 1 to TX1)
- C7 – for 0.4 degree systems only – 100 Mbit Ethernet connection to second TX transducer connector (Eth2 to TX2)
- C10 – Ethernet connection to IO2040 board
- C10 – Ethernet connection to the CPU

C7 to C10 refer to the cables in *List of cables* on page 31.

Key features

- Eight 10/100/1000 Mbps auto sensing Gigabit Ethernet ports

Specifications

- Power consumption: 7.68W maximum
- LEDs:
  - Per port: Link/activity and speed
  - Per unit: Power
- Physical dimensions:
  - Width: 235 mm
  - Depth: 101 mm

  - Height: 26 mm
  - Weight: 0.69 kg
- Performance:
  - Forwarding modes: Store-and-forward
  - Bandwidth: 16 Gbps full duplex
  - Network latency: Less than 20 microseconds for 64-byte frames in store-and-forward mode for 100 Mbps to 100 Mbps transmission
  - Buffer memory: 128 KB embedded memory per unit
  - Address database size: 8,000 media access control (MAC) addresses per system
  - Addressing: 48-bit MAC address
  - Mean time between failure (MTBF): ~12 years
  - Acoustic noise: 0 dB

Power Supply Exelsys

Purpose and description

This power supply is used in the upgraded version (V2) of the EM 2040 PU.

It is a configurable power supply in the Xhite family from Exelsys, and it consists of a powerPac which can be populated with up to 6 powerMods with different voltage levels.

The configuration used is XHA222250P00A which means it is an XHA powerPack of 400W populated with four Xg2 and one Xg5 powerMods. Each powerMod has a multi-turn potentiometer that adjusts the output within the specified range. Clockwise rotation increases output voltage. Resolution is approximately 5% of nominal voltage per turn.

The purpose of the power supply is to supply 5 VDC and 3.3 VDC output to the circuit boards in the processing unit. It will also provide the required 48 VDC power to the transducers.

The power supply is enclosed inside the processing unit and is not visible from the outside.

Figure 18 Exelsys Xhite XHA Power Supply

Internal connections

A Connection for 5 VDC.

B Connection for 3.3 VDC.

C Connection for 48 VDC.

External connections

The 48 VDC power output to the transducers is made available using a power connector mounted in the PU cover.

See **G** in *Processing unit rear side — upgraded version (V2)* on page 54.

Key features

- Ideal for use in harsh environments
- Reduced system heat dissipation
- International safety approvals

Specifications

- **General:**
  - Isolation: Input to chassis 1500 VAC, input to output 3000 VAC
- **Input:**
  - Input voltage: 85 to 264 VAC, 47 to 63 Hz
  - Inrush current: 25A max at 230 VAC at 25 ºC
- **Output:**
  - Output voltage and current ratings per powerMod:

Model	Nominal output voltage (VDC)	Minimum output voltage (VDC)	Maximum output voltage (VDC)	Maximum output current (A)	Comment
Xg2	5.0	3.2	6.0	20	Used for 3.3 and 5 V
Xg5	48.0	28.0	58.0	3	

  - Line regulation: ± 0.1 % for ± 10 % change from nominal line
  - Load & cross regulation: ± 0.2% for 25 to 75 % load change
  - Ripple and noise: 1.0 % (peak-to-peak) for 20 MHz bandwith

Compact PCI Power Supply

Figure 19 cPCI Power Supply

Purpose and description

This power supply was used in the original version (V1) of the processing unit. For the upgraded version (V2) of the processing unit the power supply is replaced by *Power Supply Exelsys* on page 61.

This is a standard 300 W cPCI (3U) Telkoor Power Supply. Its main purpose is to supply DC output to the CPU, IO 2040, BSP 67B and to the Ethernet Switch circuit boards. The AC input version of the power supply is used by the processing unit.

A DC version of the power supply will be supplied for AUV use, i.e. supplied by 48VDC.

External connections

- None.

Key features

- PICMG 2.11 compliant
- AC or DC input versions
- Industry standard
- Power factor corrected
- Active current share
- International safety approvals

Specifications

- **General:**
  - Efficiency: 70% minimum at 110 VAC
  - Isolation: Input to ground 1500 VAC, input to output 3000 VAC
- **Input:**
  - Input voltage: 85 to 264 VAC, 47 to 63 Hz
  - Inrush current: 50A max @ 230 VAC
  - Power factor: >0.95

- **Output:**
  - Output voltage and current ratings:

Output voltage (VDC)	Maximum output current (A)
3.3	40.0
5.0	30.0
12.0	5.0
-12.0	1.0

  - Line regulation: ± 0.5 %
  - Load regulation: ± 1 to 5 %
  - Ripple and noise: 60-120 mV (peak-to-peak)
- **LEDs:**
  - Green: Power good
  - Amber: Power fail

IO2040 board

Purpose and description

The IO2040 card is designed and manufactured by Kongsberg Maritime. It can be fitted with different front covers (long or short) to fit in the different types of processing units used for the EM 2040. The figure *The IO2040 interface board* on page 65 shows an IO2040 card with short front cover.

The IO2040 controls the interfaces between the transducers and the BSP boards. It is used for filtering of data from the receiver elements. In addition, the external sync signal as well as the 1PPS input is found on this board.

Figure 20 The IO2040 interface board

Note

To avoid ground loops and damage of the EM 2040 electronics caused by external connections, all connections are optically isolated. Refer to description in External synchronization on page 49.

External connections

A C6 – Synchronization signal input/output

B Test purposes

C C7 – 1PPS input

D C5 – Ethernet connection to switch for communication with RX transducer

C5 to C7 refer to the cables in *List of cables* on page 31.

Key features

- External synchronization interface to optionally avoid interference between echo sounder systems.

  See *External synchronization* on page 49.
- 1PPS for precise timing interface.

  See *1PPS input* on page 49.
- Matched filter in FPGA of the RX signal for improved detection.
- 1Gbit input of RX signal via the Ethernet switch.
- Parallel output buses to the 4 BSP boards.

  See *Beamforming & Signal Processor (BSP) board* on page 71.

48 VDC Power Supply

Purpose and description

This power supply is used in the original version (V1) of the EM 2040 PU.

The 48 VDC power supply delivers the required 48 VDC power to the transducers.

The TX transducer cable houses the 48 VDC power cable in addition to the 100 Mbit Ethernet data cable.

Figure 21 48 VDC power supply

External connections

The 48 VDC power output to the transducers is made available using a power connector mounted in the PU cover.

See **D** in *Processing unit rear side — original version (V1)* on page 55.

Key features

This is a Telkoor power supply unit. It is an open frame single output AC/DC switcher 48 VDC power to the transducers. The unit is built in a 1U 3”x5” footprint and mounted on the PU base plate.

Specifications

The power supply input is 85–265 VAC.

- **Input:**
  - AC input voltage: 85–265 VAC

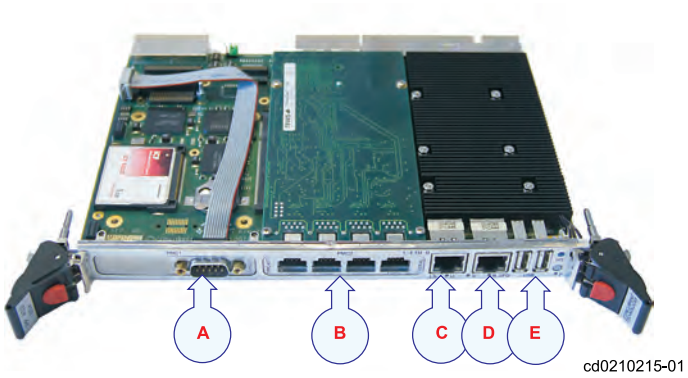
  - Input inrush current: 60A maximum, cold start at 25°C, 250 VAC
  - Active power factor correction:
    * 0.98 typical at 230 VAC, full load
    * 0.99 typical at 115 VAC, full load
  - Efficiency at 230 VAC full load: 80% typical at 230 VAC, full load
  - Efficiency at 115 VAC full load: 75% typical at 115 VAC, full load
  - Input line protection: Internal line fuse IEC type 5A 250 VAC normal BLO
  - Hold-up time: 16 msec minimum at any input voltage in range and full load
- **Output:**
  - V1/current: +48 VDC / 4.2 A
  - Total output power: 200 Watt
  - Line regulation: ± 0.2% for Vin (min) to Vin (Max)
  - Remote sense (open sense lines protected): Outputs are internally sensed at the output connector
  - Transient response: ± 5% max. deviation for load change of 25% to 75%, at slew rate of 1 A/µsec, recovery time less than 500 msec
  - Over-voltage protection: Outputs shut down at 130% of V1 nominal, AC input must be recycled to reset
  - Short circuit protection: Yes
  - Temperature protection: Shutdown due to excessive internal temperature 90 to 97°C (base plate) automatic recovery

Control Processor Unit (CPU) board

Purpose and description

The Concurrent PP 432/052 is a PC-compatible high performanc dual PMC Compact PCI (cPCI) board used by the EM 2040 processing unit as the Central processing unit (CPU).

Figure 22 The Concurrent CPU board with EM 2040 connectors



External connections

A For Kongsberg Maritime use only

B **C3 – COM1 to COM4**

RS-232 serial ports with RJ45 connectors.

See also *RJ45 Serial interface* on page 158.

C **C4 – Ehternet from CPU to Ethernet switch**

Required for communication with transducers and IO2040. The cable is provided with the system.

D **C1 – 1GBit Ethernet to HWS / C2 1GBit Ethernet from Attitude Velocity sensor**

Communication with Operator station (HWS). This is a commercial cable to be provided by the installation shipyard.

If attitude velocity input is being utilized and the original version (V1) of the PU is used, the attitude velocity input is interfaced on the same Ethernet port as the Ethernet communication with the HWS. An external Ethernet switch must in this case be used. The switch and the Ethernet cable are commercial items that must be provided by the installation shipyard.

See *Ethernet with RJ45 plugs (screened)* on page 166 for a description of the cable.

The upgraded version of the PU (V2) is equipped with a separate Ethernet port which can be used for connection to the attitude velocity sensor. 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**. In figure *Rack layout — upgraded version (V2)* on page 54 this port is labeled **I**.

E USB port – not in use

C1 to C4 refer to the cables in *List of cables* on page 31.

Key features

- 2.16 GHz Intel Core Duo processor
- 4 Gbytes of single channel DDR2-400 ECC SDRAM
- 2 x PMC module interface, with front and rear user I/O
- 4 x Serial ATA150 (SATA) channels
- 4 x 10/100/1000 Mbps Ethernet interfaces

Specifications

- Supply voltage: +3.3 VDC, +5VDC, +12 VDC, -12 VDC
- Current (max): 3.7A@+3.3VDC, 6.8A@+5VDC, 0.05A@±12 VDC
- +12 VDC and -12 VDC routed to PMC slots

Beamforming & Signal Processor (BSP) board

Purpose and description

The Beamforming & Signal Processing Board (BSP 67B) is a double cPCI board. The BSP67B Board is used by the processing unit for beamforming and signal processing purposes. The processing power in the BSP 67B Board is based on sixteen Texas C6713B digital signal processors (DSP) working in parallel.

Figure 23 BSP 67B Board

External connections

The following cables can be connected to the circuit board

- **A - VCC to TMS** For FPGA programming and test purpose

  This cable is connected to the VCC slot to provide a JTAG interface to the FPGA modules on the BSP 67B board. The signals of the VCC slot are available at a 36-pin single line header.

  Note

  This interface is only to be used by Kongsberg Maritime personnel.

- **B - TMS** For test purposes only

  This cable is connected to the TMS Emulator slot for programming and development purposes. The signals of the TMS slot are available at a 14-pin double line header.

  Note

  This interface is only to be used by Kongsberg Maritime personnel.

Key features

There is one LED for each of the sixteen DSPs. The LEDs are marked M4, 5, 6, 7, M0, 1, 2, 3 on both Base board and Mezzanine Board. The upper row is for Mezzanine Board. When BSP 67B is loaded, the LEDs will normally flash with a frequency at 1 Hz. LEDs marked B and P are for test purpose only.

Specifications

Power consumption: 40 W at 3.3 VDC / 5 VDC

Replacement procedures

Caution

Always use ESD equipment when opening the processing unit.

The replaceable units in the EM 2040 processing unit are:

- Ethernet switch
- cPCI power supply (used with the original version (V1) of the processing unit)
- 48 VDC power supply (used with the original version (V1) of the processing unit)
- Exelsys Power supply (used with the upgraded version (V2) of the processing unit)
- Interface board IO2040
- Control Processor board (CPU)
- Beamformer & Signal Processor (BSP1, BSP2, BSP3 and BSP4)

The replacement procedures for these parts are described in the following disassembly and reassembly procedures.

The modules that are accessible, are described in this chapter.

Circuit boards and modules

The processing unit hold plug-in circuit boards and modules. The replacement of these modules is described in this procedure.

The system must be switched off prior to disassembly. The circuit boards are accessed at the back of the processing unit.

Disassembly

1. Remove the mounted cables from the applicable circuit boards.
2. Unfasten the screws.
3. Press the clamps on both sides.
4. Pull the board/unit carefully out.

Reassembly

1. Check links and switches on the new board and compare to the old board.
2. Insert new circuit boards and modules in reverse order. Mount the removed cables and the front covers.
3. Check that the circuit boards and modules have been installed in their correct locations! (Refer to the applicable pictures and drawings).

Fan — upgraded version (V2)

The fans are easily accessible from the back of the processing unit, they are shown as item J and K in figure *Processing unit rear side — upgraded version (V2)* on page 54.

Disassembly

1. Switch off the circuit breaker.

2 Disconnect the AC input power cable.

3 Loosen the screws on the fan module and pull out the module.

4 Remove the fan from the module.

Reassembly

1 The new fan is placed by reversing the above procedure.

48 V Power Supply (used with the original version (V1) of the processing unit)

Disassembly

1 Switch off the circuit breaker.

2 Disconnect the AC input power cable

3 Unbolt the unit. It is mounted with four captive-bolts so they cannot fall out. The nuts and spring washers are accessible.

Reassembly

1 The new power supply is placed by reversing the above procedure.

Exelsys Power supply (used with the upgraded version (V2) of the processing unit)

Disassembly

1 Switch off the circuit breaker.

2 Disconnect the AC input power cable

3 Remove the front panel on the processing unit.

4 Loosen the six bolts that hold the bracket with the power supply in place.

5 Disconnect the wires on the power supply.

6 The bracket with the power supply can now be removed.

7 Loosen the power supply from the bracket, the four screws are accessible under the bracket.

8 Remove the power supply.

Reassembly

1 The new power supply is placed by reversing the above procedure.

Transducer arrays

Caution

The transducer arrays shall under no circumstances be opened or attempted repaired in field. Malfunctions reported by the Built-In self tests shall be reported to Kongsberg Maritime support for troubleshooting and/or replacement instructions.

Any attempts to open the transducer arrays may void the guarantee.

Topics

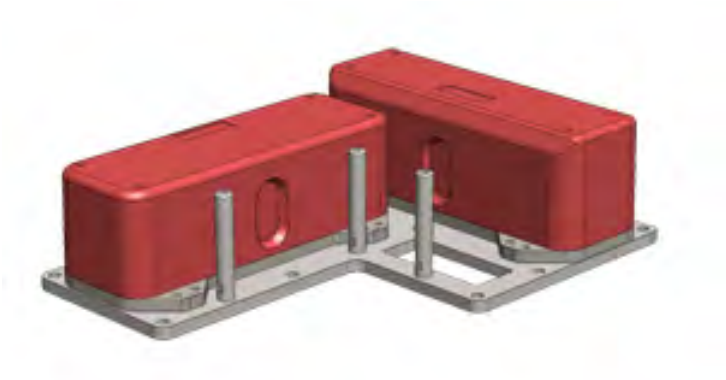
Transducer array installation

Correct location, orientation and alignment of the system's transducer is vital for the performance of the EM 2040. A transducer mounting plate is provided with the system to ensure accurate relative orientation of the transducers. Further, the transducer arrays must be mounted such that the water in front of the arrays is not aerated.

Kongsberg Maritime's recommendations for optimal installation of the EM 2040 system is described in this section.

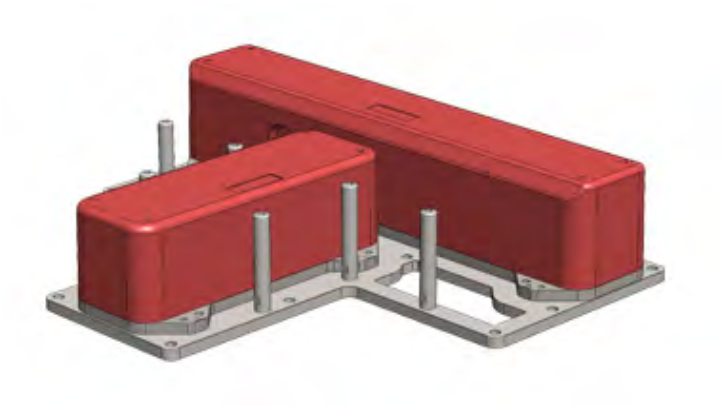
Transducer mounting plate

Figure 24 TX and RX transducer on prefabricated mounting plate, 0.7 by 0.7 degree system



To ease installation, as well as ensuring that the relative alignment between the transducers are determined within the required accuracy, a Kongsberg Maritime fabricated mounting plate is delivered with the EM 2040 transducer arrays. The mounting plate is fitted with a guidance system that ensures that the transducer arrays are aligned within the required accuracy.

Figure 25 TX and RX transducer on prefabricated mounting plate, 0.4 by 0.7 degree system



The requirement for knowing the relative heading between the EM 2040 RX and TX transducers are extremely strict, and can only be met using high precision land survey methods and equipment. Also the mechanical mounting of the arrays must be carried out with this requirement in mind. The slightest slack will degrade the system performance.

We strongly advise using the mounting plate that is provided. The mounting plate is delivered with wedge-locking washers, which should be used.

Flatness of the transducer mounting plate:

The mounting structure must not deviate from a flat surface more than ± 0.2 mm. If the mounting plate is not used, the same requirements applies to the surface where the transducer is mounted.

Applicable torque values:

- The mounting plate must be bolted to the structure with a torque of approximately 75 Nm.
- The RX and TX transducers must be bolted to the mounting plates with a torque of approximately 43 Nm.

Note

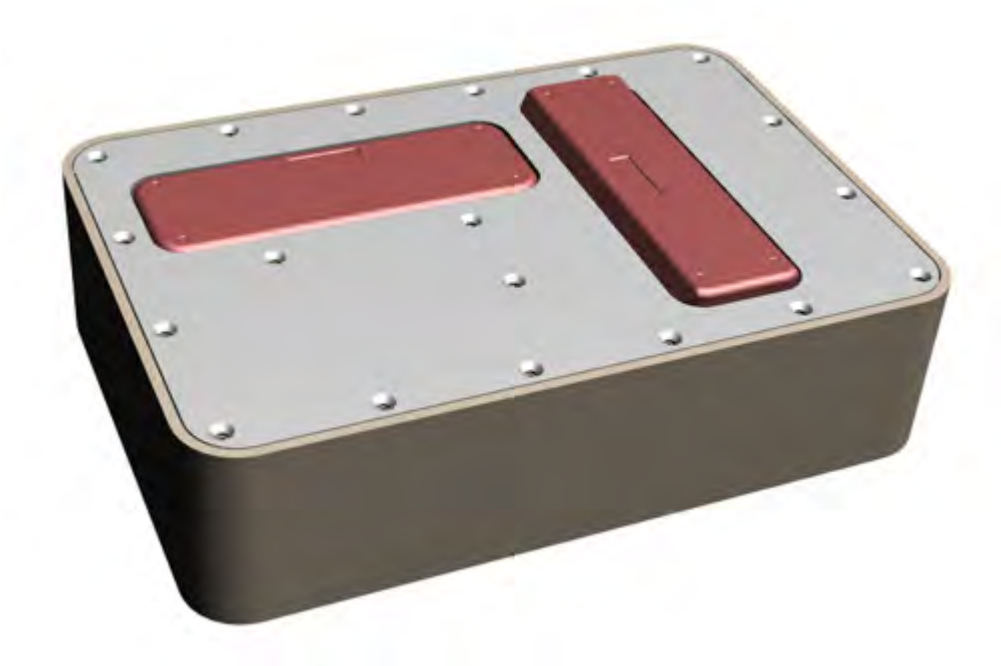
Torque guidelines applies for Nord-Lock stainless steel washers with stainless steel bolts, lubricated with Nord-Lock GTP600 or equivalent lubrication.

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.

We further recommend that the mounting plate is built into a steel casing and protected by a baffle for multipath reduction.

Figure 26 Example of casing and baffle



See *Baffle for multipath reduction* on page 85 for detailed description.

Transducer orientation

Default orientation of the TX and RX transducers are defined as follows:

- TX is mounted with cable connector on port side.
- RX is mounted with cable connector on forward side.

To ease the cabling, it is allowed to mount the transducers 180 degrees rotated (back to front). The relative heading between the RX and the TX shall however always be 90 degrees.

If the transducers are mounted back to front, the installation angles must be reverted, i.e.:

- 180 degrees must be added to TX/RX transducer heading
- The sign of TX/RX transducer roll and pitch installation must be inverted

Note

TX/RX installation angles are determined during the alignment process and entered into the operator software, e.g. SIS. The TX/RX installation angles are normally not changed during calibration at sea or during operation.

Figure 27 TX and RX transducers default mounting – Top view

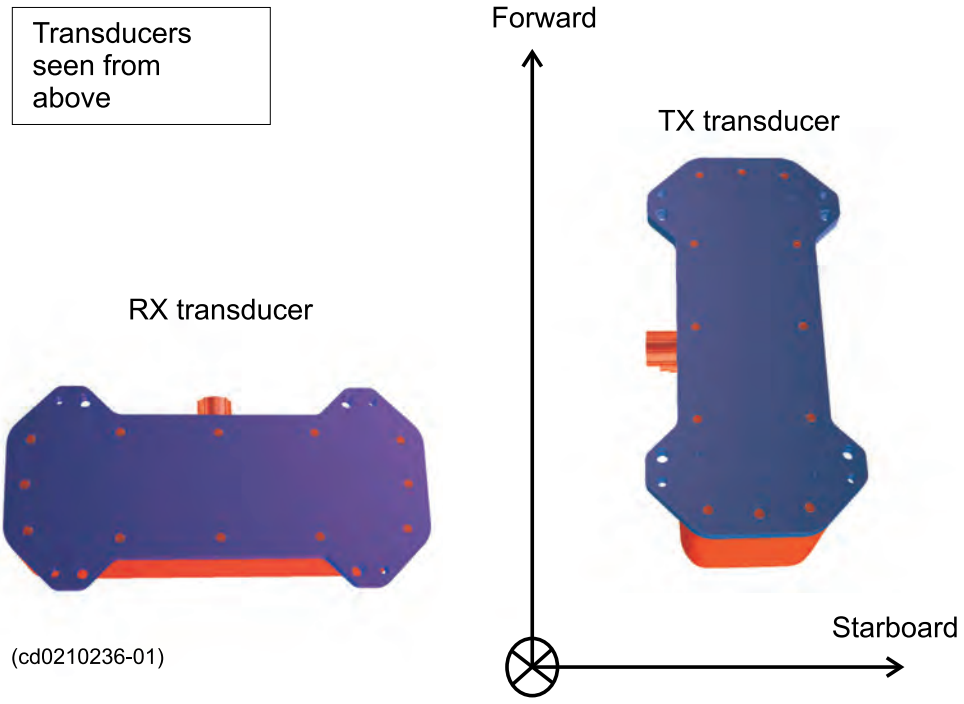
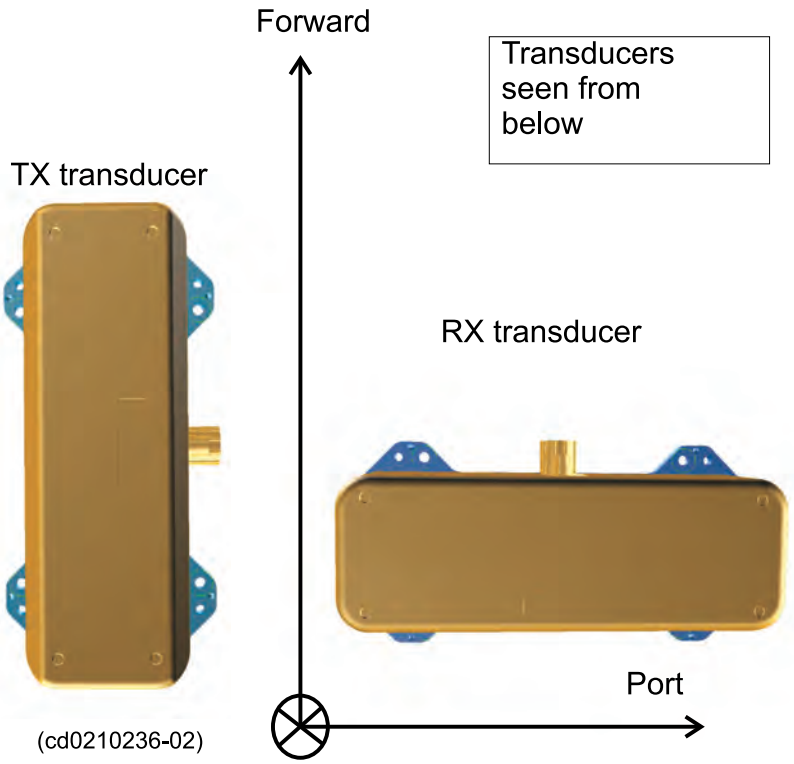


Figure 28 TX and RX transducer default mounting – Bottom view



TX mounted with cable connector on port side has element number 1 at the aft part, i.e. with increasing element numbers in forward direction. RX mounted with cable connector on forward side has element number 1 at port side, i.e. with increasing element numbers in starboard direction. An **x** is marked in the moulding at the transducer end that contains element number 1.

If mounting is in accordance with the default orientation, the installation heading as determined from the alignment process shall be applied directly. If the TX array is mounted with cables pointing to starboard side (back to front), 180 degrees must be added to the TX transducer heading determined during the alignment. Also, the sign of the TX transducer roll/pitch installation angles must be inverted.

If the RX array is mounted with cables pointing backwards (back to front), 180 degrees must be added to the RX transducer heading determined during the alignment. Also, the sign of the RX transducer roll/pitch installation angles must be inverted.

Note that the TX/RX installation angles normally not will be changed after completion of the alignment process. Any additional roll, pitch or heading offsets determined during calibration at sea will normally be applied to the sensor installation angles (attitude and heading sensors). Sensor installation angles shall not be corrected for back-to-fore installation of TX/RX transducers.

Free viewing sector

The EM 2040 Multibeam Echo Sounder is supplied with two relatively small transducers, alternatively three transducers for a dual RX system. The transducer arrays must be mounted so that they have a clear view of the bottom. For the TX and RX transducers the required free viewing sectors relative to the arrays are:

TX free viewing sector

- Along: θ > 20 deg
- Across: β > 130 deg

Figure 29 TX free viewing sector – across direction

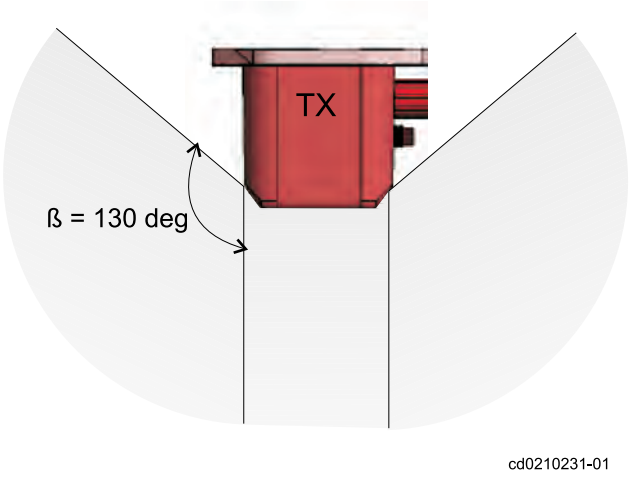
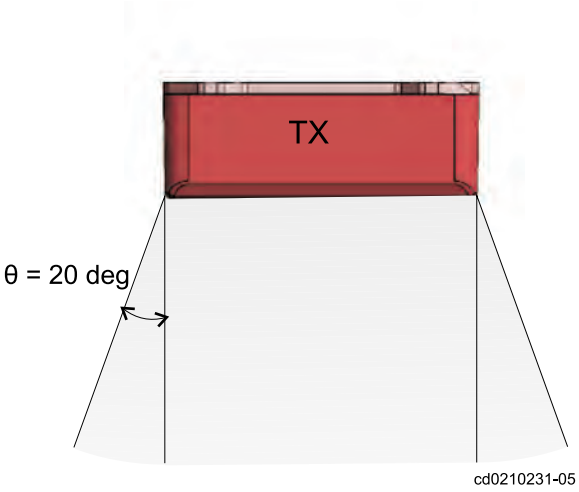


Figure 30 TX free viewing sector – along direction



Note

With recommended fairing/baffle the across viewing sector is 90 degrees for a single RX system. See section below; Single RX on page 85.

RX free viewing sector

- Along: θ > 35 deg
- Across: α > 80 deg

Figure 31 RX free viewing sector – across direction

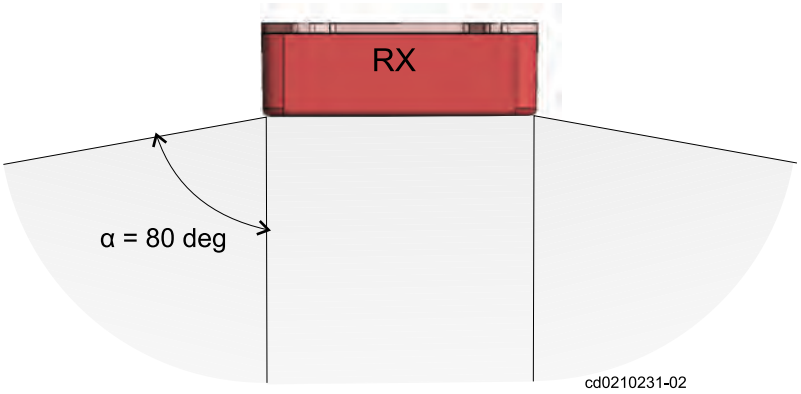
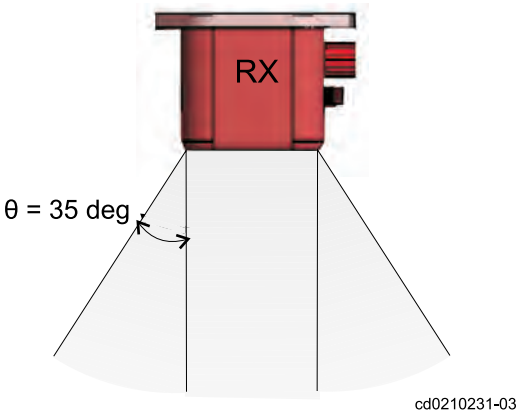


Figure 32 RX free viewing sector – along direction

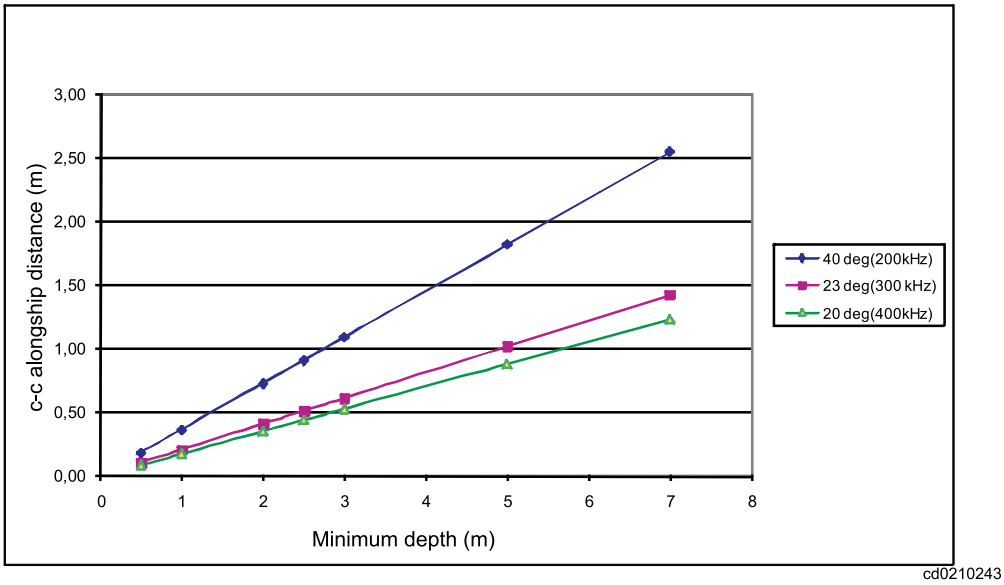


Transducer array location for minimum depth capability

The alongship and across distance between the centre of the RX and TX arrays (c-c) limits the minimum depth capability (the TX and RX beam pattern must overlap). The closer the centre RX and centre TX are to each other, the more overlap, and the closer to the transducers observations can be made.

The overlap decreases with frequency.

Figure 33 Minimum depth vs. alongship distance between TX and RX



Example of c-c alongship distance

Figure 34 0.7 by 0.7 degree "L" mounting example (bottom view)

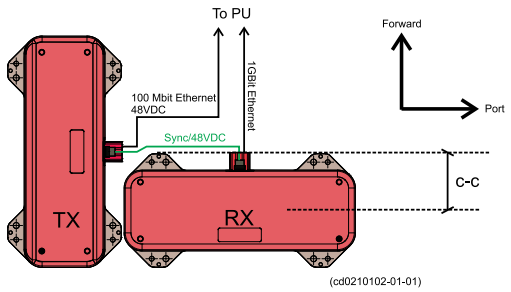
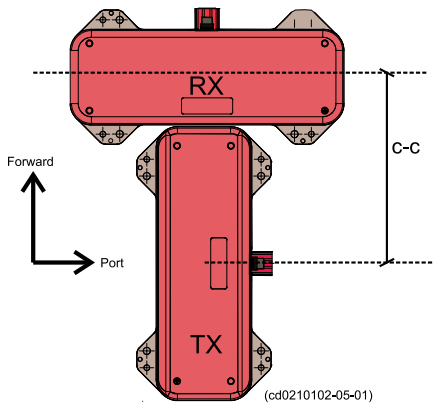


Figure 35 0.7 by 0.7 degree "T" mounting example (bottom view)

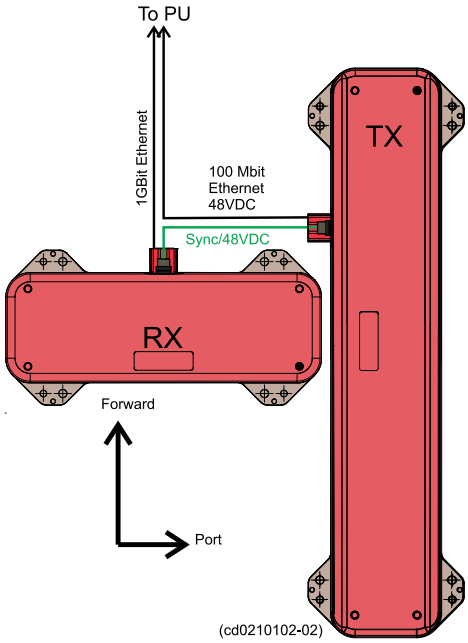


The illustrations above show 0.7 by 0.7 degrees systems mounted in an "L" and a in a "T" configuration.

The "L" configuration should be chosen for depths below transducers of less than 2 meters. In this example the shortest c-c distance is about 100 mm. This configuration will give overlap at less than 1 meters depth (relative to transducer depth).

For a 0.7 by 0.7 degrees system mounted in a "T" configuration, the minimum c-c distance is 300 mm, giving a minimum depth for overlap of approximately 2 meters (relative to transducer depth).

Figure 36 0.4 by 0.7 degree "L" mounting example (bottom view)

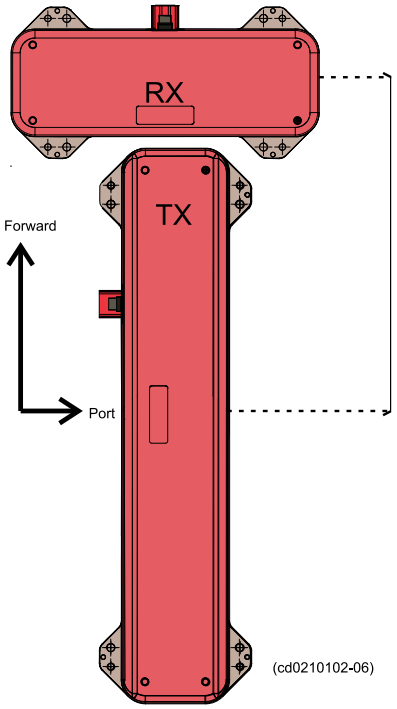


For a 0.4 by 0.7 degrees system, mounting in an "L" configuration gives the lowest possible overlap depth.

Note

In this example the TX is mounted 180 degrees rotated.

Figure 37 0.4 by 0.7 degree "T" mounting example (bottom view)



A 0.4 by 0.7 degrees system mounted in a "T" gives a minimum depth of around 3 meters.

Note

In this example the TX is mounted 180 degrees rotated.

Note

The use of the provided transducer mounting plate will ensure optimal relative location and orientation of the TX and RX transducer arrays.

Mounting of dual RX system

In a dual RX installation the two RX transducer arrays may be positioned on each side of the keel with a roll angle of 35 to 40 degrees. To be able to cover ± 100 degrees the roll installation angle should not be less than 35 degrees. To obtain overlap between the two RX arrays at shallow depths, the roll installation angle should not be more than 40 degrees, and the across distance between the two RX arrays should be as small as possible.

Example: With ± 40 degrees roll installation angle and across distance between the centre of the two RX transducers of 1 meter, the overlap between the two heads starts at about 1.4 metres depth below the RX transducers (with beams steered 60 degrees re array). With c-c of 2 meter the overlap starts at 2.8 metres.

Figure 38 Dual RX installation example

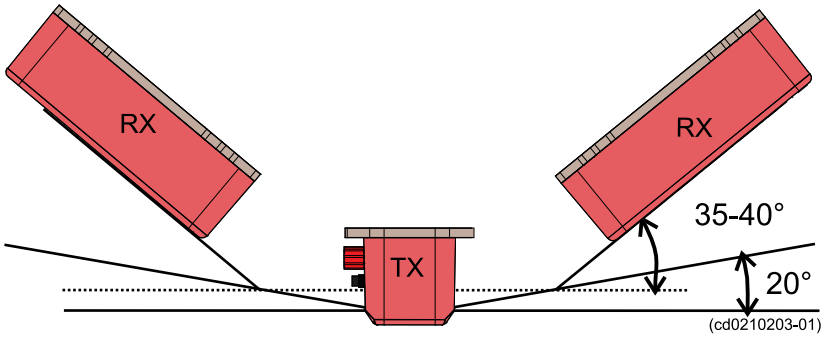


Figure 39 0.7 by 0.7 degree, dual RX mounting

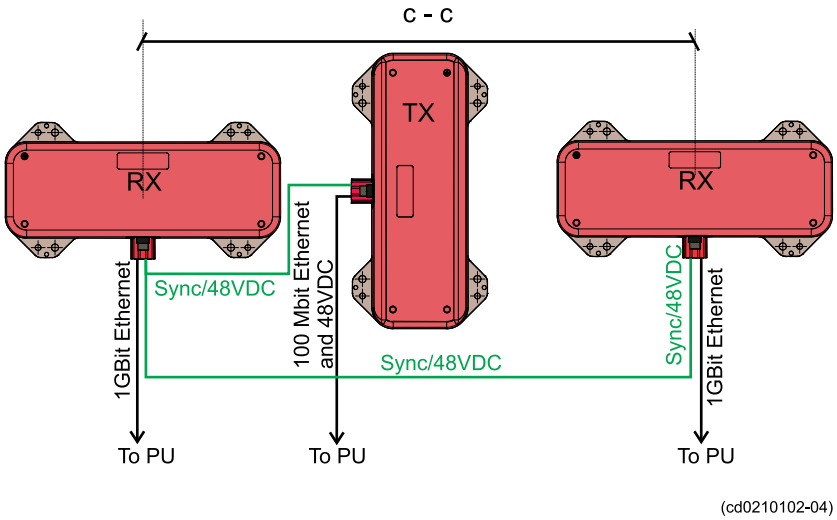
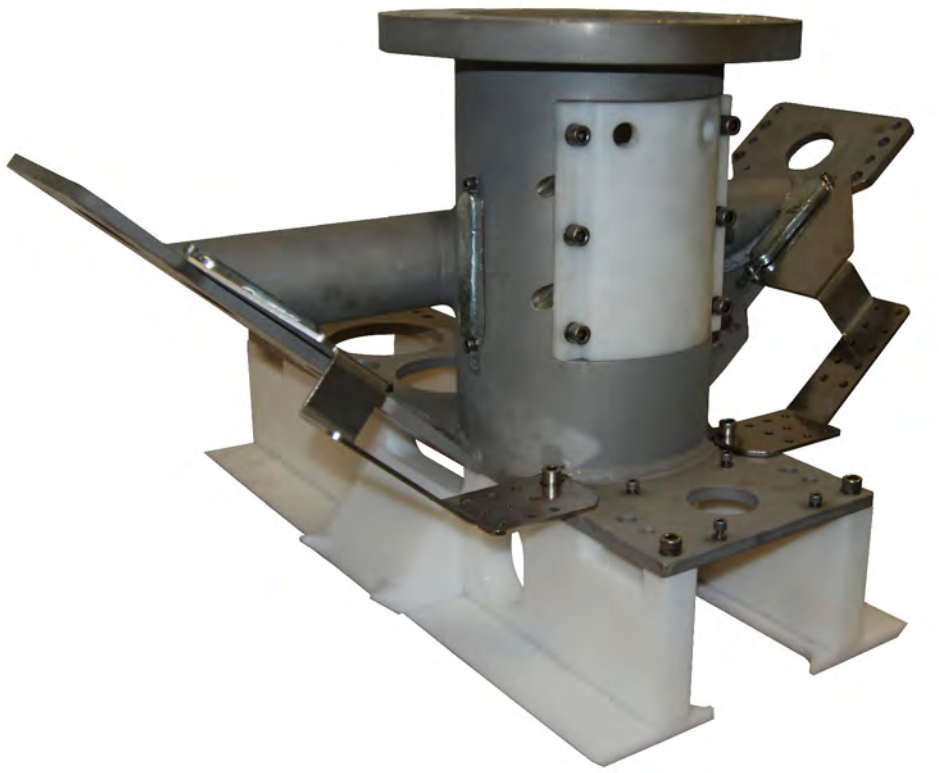


Figure 40 Example of mounting bracket for dual RX



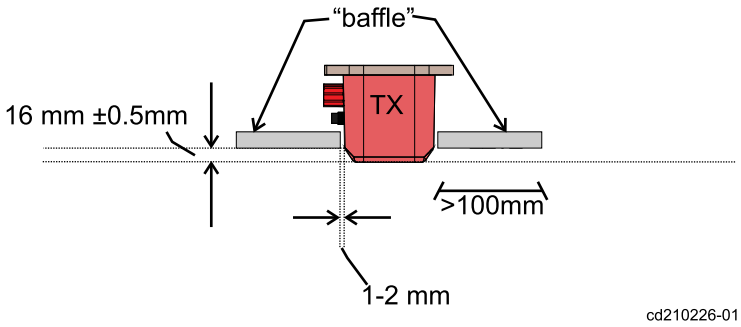
All cables must be supported and protected along their entire lengths using conduits and/or cable trays. The dual RX mounting bracket is equipped with cable brackets for support of the transducer cables.

Baffle for multipath reduction

Single RX

With a single receiver transducer, the transmit transducer beam pattern across is wider than the angular coverage of the receiver beams, especially for the lowest frequencies. To avoid multipath via surface or other objects, it is beneficial to mount a “baffle” on each side of the transmit transducer. This baffle should be mounted horizontally 16 mm above the TX transducer face. The width of the baffle should be minimum 100 mm. There should be a clearance of 1 – 2 mm between the transducer and the baffle. The baffle must be made of POM material.

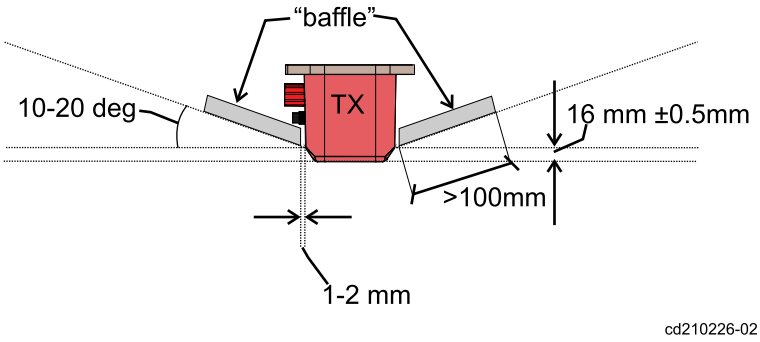
Figure 41 Illustration – baffle for multipath reduction – single RX



Dual RX

With a dual RX the across coverage is up to 200 degrees. To avoid multipath via surface or other objects, the same type of baffle as for single RX should be used. If 200 degrees coverage is required, it should be rotated 10–20 degrees to each side. If 160 degrees is sufficient, the baffle should be mounted horizontally. There should be a clearance of 1 – 2 mm between the transducer and the baffle. The baffle must be made of POM material.

Figure 42 Illustration – baffle for multipath reduction – dual RX



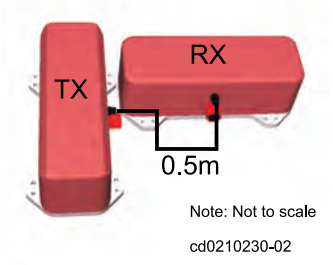
Transducer cables and space requirements

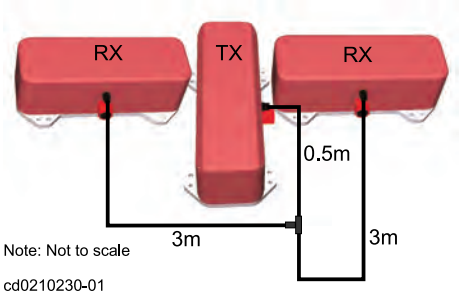
The EM 2040 transducer cables are Ethernet cables fit with underwater connectors at the transducer ends.

For procedure for cleaning and lubrication of underwater connectors, see *SubConn® underwater connectors* on page 45.

The transducer cables are available in the standard length of 15 meters or the optional lengths of 30 or 50 meters.

The TX/RX synchronization/power cable between the transmit transducer (TX) and the receive transducer(s) (RX) is provided in the standard length 0.5 or 1.5 meters for a single RX system and 3.5 or 1.5 meters for a dual system.

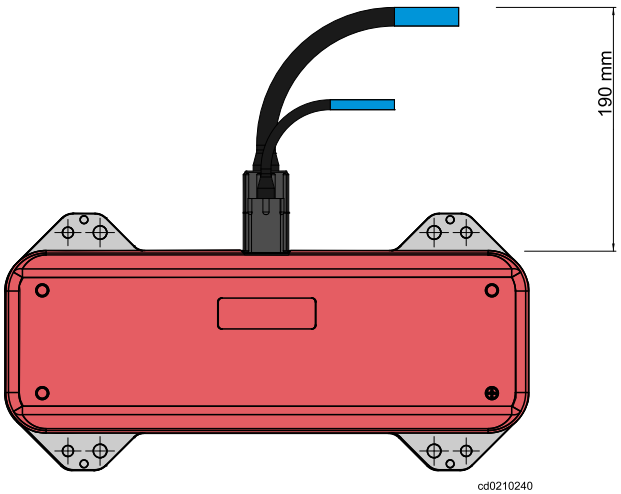




The bend radius, i.e. the minimum radius you can bend the transducer cable without damaging it, is 100 mm.

The connector and cable will with minimum bend radius build 190 mm, see figure below.

Figure 43 Cable space requirements



See *Cable layout and interconnections* on page 30 for cable details.

The transducer cables are passed through the hull via a steel conduit. The steel conduit is normally extended until it reached a minimum of 1000mm above the waterline. The top of the conduit has to be sealed off with a watertight cable gland from e.g. Roxtec or MCT Brattberg.

Locating the transducer array

Correct location of the system's transducer is vital for the operational performance.

A single answer to the question of where to locate the transducer arrays cannot be given. It depends very much on the vessel's construction. However, there are some important guidelines which are generally applicable.

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 a 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.

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 aftwards. 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.

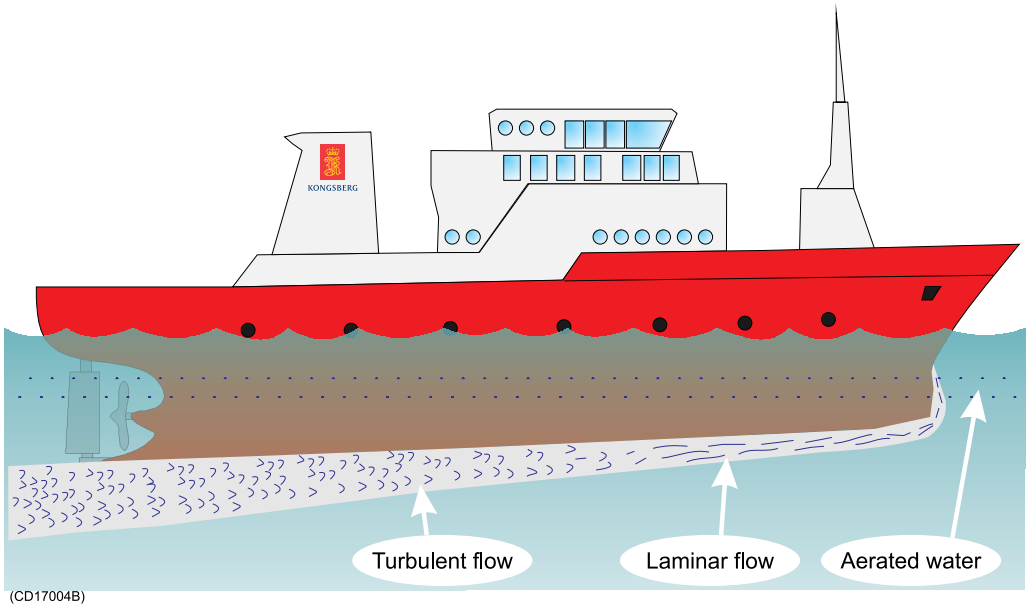
Sketch of boundary layer underneath the vessel on page 89 shows in principle the boundary layer of a vessel moving through the water.

The conclusion is that the transducer array should be mounted as deep as possible, and in the forward part of the hull.

Propeller noise

The propulsion propeller is the dominant noise source on most vessel types. The noise is transmitted through the sea water, and may in extreme cases reduce the maximum range capability of the EM 2040.

Figure 44 Sketch of boundary layer underneath the vessel



The transducer arrays should therefore be placed far away from the propeller, which means on the forward part of the hull. Positions outside the direct line of sight from the propeller are favourable.

When a bow thruster operates, the noise and cavitation bubbles from its propellers may make an echo sounder useless. Even when the bow thruster is not in operation, its tunnel creates turbulence.

The tunnel may also drag air under the water, which escapes and make noise.

The transducer array should be placed with large distance from the bow thruster.

Noise from protruding objects on the hull

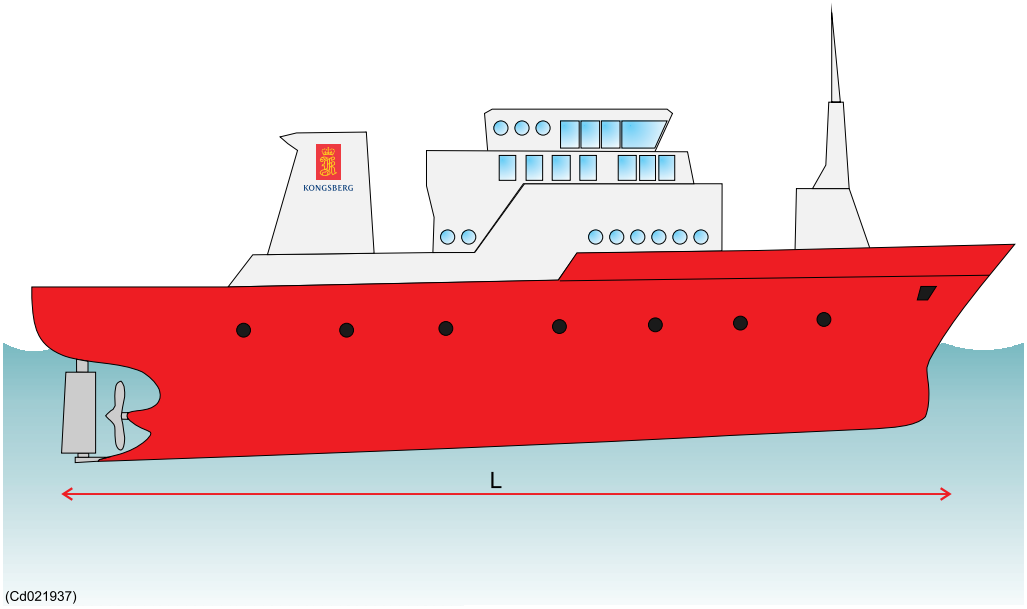
Objects protruding from the hull, such as zinc anodes, sonar transducers or even the vessel's keel, generate turbulence and flow noise. Also holes and pipe outlets are noise sources. They may act as resonant cavities amplifying the flow noise at certain frequencies.

Thus the transducer array should not be located in the vicinity of such objects, and especially not close behind them.

Summary

Some of the above guidelines may be conflicting, and each case has to be treated individually in order to find the best compromise.

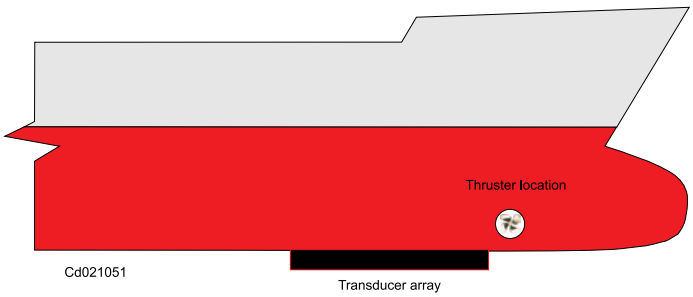
Figure 45 Recommended location of the transducer array on the hull



The possibility of getting air bubbles in front of the transducer array is the most important factor.

If the vessel hull has a bulbous bow, this may well be a good transducer array 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 as shown below.

Figure 46 Transducer array located on a bulbous bow



If a nominal horizontal mounting of the transducer array is desired, the transducers can be mounted parallel to the keel. Most ships have a positive design pitch of 0.5 to 2 degrees. Backward tilt is not recommended, it may limit the operational weather window.

The recommended transducer array location is in the fore part of the hull, and normally follow the keel line with respect to tilt.

Installation methods

The EM 2040 Multibeam Echo Sounder is supplied with two relatively small transducers, alternatively three transducers for a dual RX system. A transducer mounting plate is provided for ensuring relative orientation of the transducers within required accuracy.

The transducer arrays must be located and installed depending on the vessel's design. A number of different factors related to the vessel's design must be taken into consideration during the installation planning.

There are often customer requirements that will influence the chosen installation method. The basic installation methods are:

- Gondola
- Blister
- Flush mounted into the hull
- External non-permanent mounting

A fairing will usually be added around the transducers to ensure laminar water flow without any aeration problems. A blister or gondola installation may help in avoiding air bubble blockage of the sound path under the transducers by aerated water. Blisters and gondolas may also contain additional transducers for other systems.

Normally, in a permanent installation, the cables enter the hull through tubes which are fitted with standard ship type cable glands (Brattberg, Roxtec or equivalent) to provide water tightness. The cable glands must be of the type having a pressure rating of 4 bars or more. If the tubes end below the vessel's water-line, classification requirements may require a double set of glands.

The installation of the transducer arrays must thus be planned together with the installation shipyard and/or the client.

Once the installation method is defined, the installation shipyard must provide the necessary drawings. These drawings must be approved by the vessel's classification authority.

If required, Kongsberg Maritime AS can assist with the required engineering.

The gondola installation

Figure 47 Example – gondola (EM 710)

A gondola is like a pod hanging down from under the ship's keel. The transducers are installed inside this unit. There is a gap between the gondola and the ship's hull. Aerated water will pass through this gap, and thus not be pushed under the transducer face. This allows for optimal acoustic performance within a wider weather window. The gondola installation is generally a preferred method.

The blister installation

Figure 48 Example – blister

A blister is a mounting construction fully welded to the hull of the ship. It contains casings which form the main part of the unit housing the transducer frames. The aim of this design is to direct the aerated water to the sides of the installation thus ensuring good acoustic environments for the transducers.

The flush mounted installation

With the flush installation method the transducers are installed inside the ship's hull. The transducer faces are then levelled with the surface of the hull. This method exposes the transducers to passing air bubbles which will affect the system performance. If this

method is chosen great care must be taken during the planning process to ensure best possible transducer location. The benefit of a flush mounted installation is that nothing protrudes from the keel.

Note

The EM 2040 TX transducer consists of three separate line arrays, one looking straight downwards and the other two pointing 55 degrees to each side. The face of the EM 2040 transducer can thus NOT be installed completely in flush with the hull. The transducer must be installed placing the transducer face 16 mm below the hull's surface in order to allow for free viewing sector for the side pointing arrays.

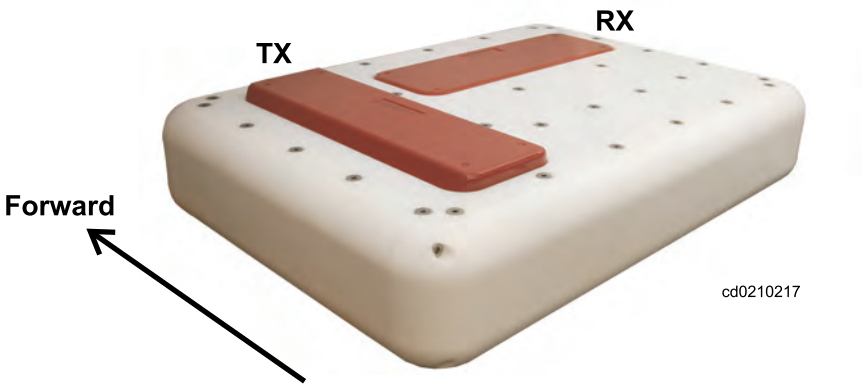
External non-permanent mounting

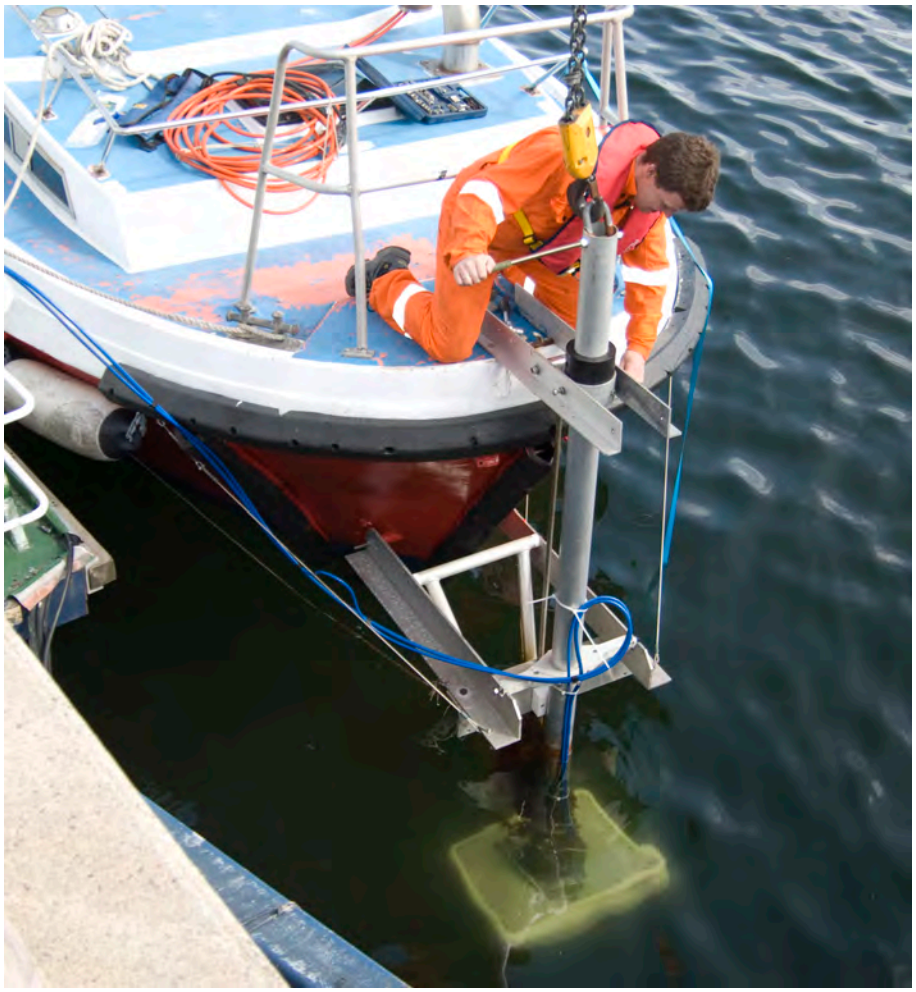
The small size and weight of the EM 2040 transducers makes the system truly portable. For temporary installations on a vessel the transducers may be deployed through an existing gate valve on the vessel or on a pole fixed to the bow or over the side.

The main considerations in such an installation is that the mounting structure is sufficient rigid and that the relative orientation between the transducers are within required accuracy. Dynamic displacement must be less than the installation accuracy requirements, the line of sight from the transducers to the bottom can not be blocked, and aerated water must be kept away from the transducer faces.

A prefabricated baffle, provided by Kongsberg Maritime, may be used to ensure a rigid, high accuracy installation and laminar water flow. An example of a Kongsberg Maritime fabricated baffle that has been mounted to a pole over the bow is shown below.

Figure 49 Example of 0.7 by 0.7 degree mounting in prefabricated baffle





Installation procedure

1 Assess the EM 2040 installation requirements to optimize the performance of your installation.

→ *Transducer array installation* on page 75

2 Determine the physical location of the transducer arrays under the vessel's hull.

→ *Locating the transducer array* on page 88.

3 Design the transducer installation method.

→ *Installation methods* on page 91.

4 Prepare the transducer array installation arrangement.

5 Install the transducers.

6 Run the transducer cables from the transducer arrays to the processing unit.

For procedure for cleaning and lubrication of underwater connectors, see *SubConn® underwater connectors* on page 45.

Note

Preventive actions should be taken to avoid corrosion. Kongsberg Maritime recommends to apply a lubricant like Nord-Lock GTP600 or Aqua Shield to the bolts.

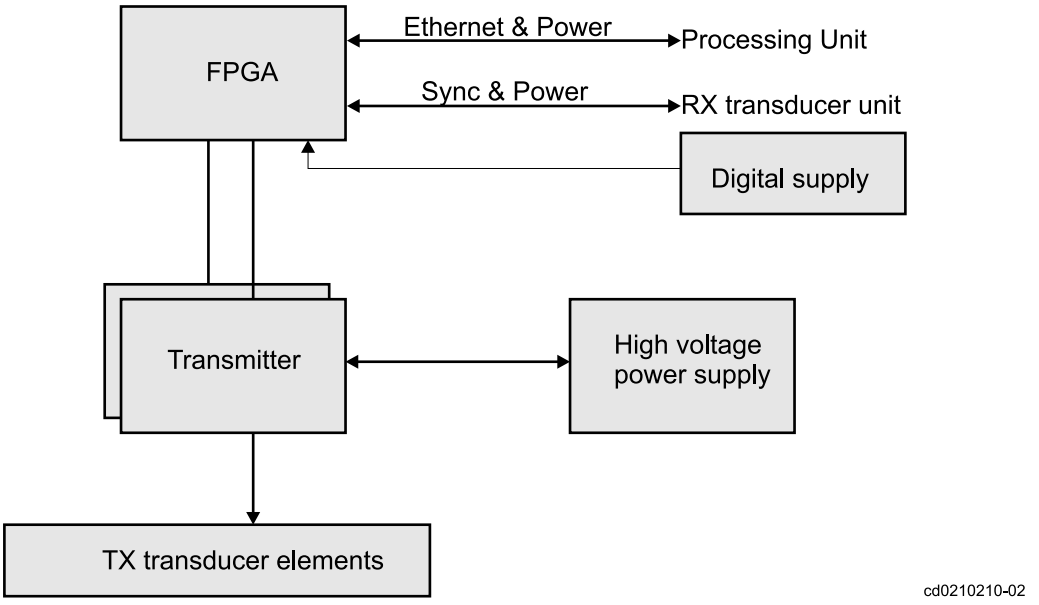
Note

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.

Theory of operation

TX transducer unit

Figure 50 EM 2040 TX transducer unit



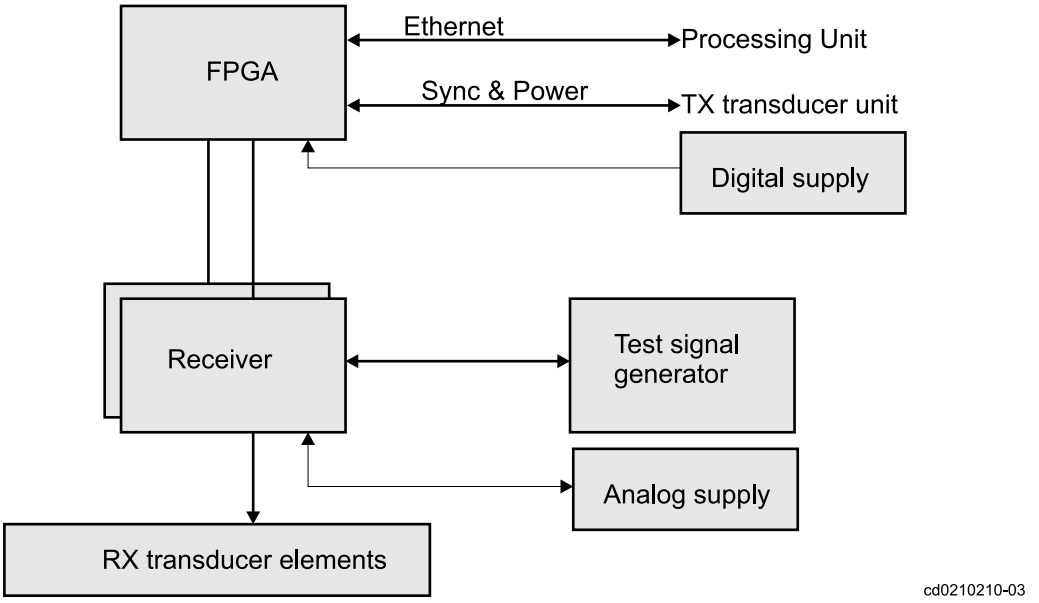
Input commands specifying the transmitted signal are downloaded via the Ethernet interface prior to transmission. The processing board (LPFPGA) computes the required output signal at each transducer element and sends the appropriate digital square wave signals to each transmitter board (LPTX16). The high voltage analog signal from each transmitter is routed to the correct transducer element via the backplane board (HBP144) and the two routing harness boards (HRHTX72). The backplane board and the routing harness boards contain no active components.

The transmitter head is powered from a single 48V input. The head contains two switching supplies, the transmitter high voltage supply and the digital supply. The processing board controls the switching frequency of the two supplies via control lines. The processing board can also digitally read the input/output voltage of each supply. The transmitter boards are powered via the backplane.

The synchronization lines are provided for accurate time synchronization between multiple processing boards.

RX transducer unit

Figure 51 EM 2040 RX transducer unit



The transducer signals are amplified by the four low noise preamplifier boards (HPA32), and the backplane board (HPAB128) routes the amplified signals to the correct receiver board (LPRX16). The processing board (LPFPGA) reads the digitized signals from the receiver boards and outputs high speed processed data via the Ethernet interface.

The receiver head is powered from a single 48V input. The head contains two switching supplies, the analog supply and the digital supply. The processing board controls the switching frequency of the two supplies via control lines. The processing board can also digitally read the input/output voltage of each supply. Please note that all analog circuitry (preamplifier boards, receiver boards, test signal board) is powered via the backplane.

The synchronization lines are provided for accurate time synchronization between multiple processing boards.

Replacement procedures

The transducer heads are only to be serviced by Kongsberg Maritime in controllable environments.

Caution

Do not make any attempt to open the transducer heads. Any attempts to open the transducer heads may void the guarantee.

Subsea vehicle installation

Caution

Installation of the EM 2040 on a subsea vehicle must be carried out according to relevant procedures and restrictions applicable for the subsea vehicle. The mounting and unmounting procedures set out in the following takes only the EM 2040 requirements into account.

Caution

Do only ping with the transducer arrays submerged.

Topics

The Kongsberg EM 2040 may just as well be used on a subsea vehicle (ROV or AUV) as on a surface vessel. In principle the only difference is that an additional sensor is required to measure the vehicle's depth. However, there are a number of practical issues related to the installation that must be resolved, and these may differ depending on the possibilities offered by the particular vehicle.

EM 2040 TX and RX data is provided from the transducer arrays to the processing unit on high speed Ethernet links. The challenge in installing the transducers on a subsea vehicle lies in bringing the data from the transducers to the processing unit. In this context, we separate between ROV and AUV as follows:

EM 2040 on AUV – Autonomous Underwater Vehicle

- The processing unit must be installed in a pressure rated tank.
- 48 VDC must be provided to the processing unit.
- EM 2040 control and data logging must be handled by the AUV control software.

EM 2040 on ROV – Remotely Operated Vehicle

- The processing unit can be installed on the mother vessel, provided EM 2040 data can be transferred over the ROV umbilical at sufficient data rate.
- A multiplexer system must be used to send signals between the ROV and the mother vessel, including the high speed EM 2040 data.
- The EM 2040 operator system will be the same as for a ship mounted system.

For more information about the use of EM 2040 on ROVs please see the following application notes (document numbers in brackets):

- High Resolution Bathymetry from ROV Mounted EM 2040 [368428]
- High Resolution Bathymetry from ROV Mounted EM 2040 and HAIN Inertial Navigation [368429]

Principles for EM 2040 on an AUV

The EM 2040 for AUV installations consists of the processing unit and two or three transducer arrays.

The processing unit, or the PU in short, is basically an instrument case with electronics for signal processing and functional controls of the multibeam echo sounder. For installations on AUV Kongsberg Maritime provides a compact assembly of the PU electronics that can be fitted into a pressure rated housing. The housing can be either spherical or cylindrical, and there are two versions of the PU that can be used to fit inside the housing. These versions of the PU is in the following referred to as the cylinder AUV PU and sphere AUV PU. The AUV PU assemblies can be delivered with or without the pressure housing designed by Kongsberg Maritime. The cylindrical housing is currently pressure rated down to 1000 metres and the spherical housing is pressure rated down to 3000 metres.

The components of the EM 2040 AUV PU versions are the same as of the standard versions of the processing unit. The components are thoroughly described in *Processing unit* on page 46.

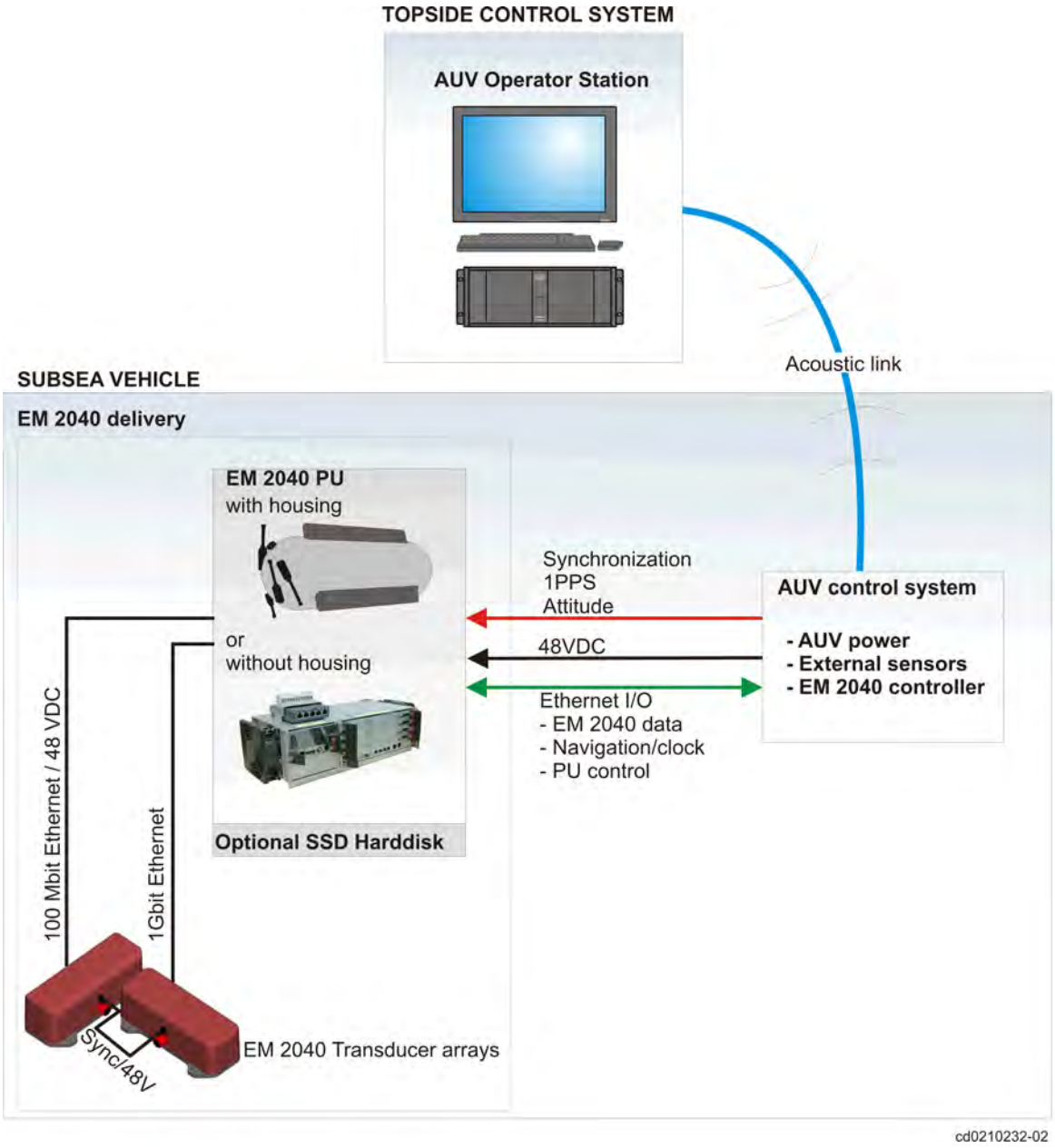
The EM 2040 interfaces are controlled by the vehicle's control system. All ancillary data from the vehicle sensors (position, motion, velocity, 1PPS and depth) must be integrated in real time with the bathymetry data.

The EM 2040 processing unit requires 48 VDC power. This must be provided by the subsea vehicle battery system.

The EM 2040 transducer arrays are pressure rated down to 6000 metres. The installation position and angular orientation of the transducer arrays must be measured as on a surface vessel installation.

Data logging can be performed locally within the processing unit using the optional SSD disk, or by the payload processor via the Ethernet connection. Toggling data logging on/off is controlled by the subsea vehicle operator system. Please refer to the subsea vehicle operator manual for instructions.

Figure 52 EM 2040 principle drawing for AUV installation



Processing unit for subsea vehicle – AUV PU

Description

The EM 2040 PU can be delivered with all system parts assembled into a container purpose made for AUV mounting. The EM 2040 AUV PU consists of the same components as the standard processing unit, only assembled into a compact solution that can be closed into a pressure rated housing. The cylindrical housing is currently pressure rated down to 1000 meters, and the spherical housing is pressure rated down to 3000 meters.

Note

The pressure housing is optional – the inner assembly of the AUV PU can also be provided.

Power relay, opto isolator and DC/DC converter are not provided with the inner assembly.

See A3 print of the complete interconnection diagram enclosed in Arrangement drawings on page 218 for details.

Figure 53 Cylinder AUV processing unit inner assembly

A Terminal block

The terminal block is used for input of the power supplied by the subsea vehicle system.

See *EM 2040 Power supply for AUV PU* on page 103.

B Ethernet switch

This is a 5-port version of the Gigabit switch used on the V1 version of the EM 2040 PU. Specifications and external connections are the same.

See *Ethernet switch* on page 59.

C PCI power supply

This is a standard 300 W cPCI (3U) Telkoor Power Supply. Its main purpose is to supply DC output to the CPU, IO 2040, BSP 67B and to the Ethernet Switch circuit boards. The DC input version of the power supply is used by the AUV processing unit.

This is the same board as used on the V1 version of the EM 2040 PU, except that this is the DC version, i.e. supplied by 48VDC.

See *Compact PCI Power Supply* on page 63.

D IO2040 interface board

The IO2040 controls the interfaces between the transducers and the BSP boards. It is used for filtering of data from the receiver elements. In addition, the external sync signal as well as the 1PPS input is found on this board.

This is the same board as used on the standard EM 2040 PU.

See *IO2040 board* on page 65.

E 4 BSP 67B boards

The Beamforming & Signal Processing Board (BSP 67B) is a double cPCI board. The BSP67B Board is used by the processing unit for beamforming and signal processing purposes. The processing power in the BSP 67B Board is based on sixteen Texas C6713B digital signal processors (DSP) working in parallel.

This is the same board as used on the standard EM 2040 PU, but it is fitted with low profile ejector handles. This is done to fit the PU into the AUV pressure rated bottle. If the board is to be replaced the low profile ejector handles has to be moved to the new board.

See *Beamforming & Signal Processor (BSP) board* on page 71

F Concurrent CPU board

The Concurrent PP 432/052 is a PC-compatible high performanc dual PMC Compact PCI (cPCI) board used by the EM 2040 processing unit as the Central processing unit (CPU).

The same board is used on all versions of the EM 2040 PU. However, for the EM 2040 AUV PU solution the CPU board may optionally be fitted with a Solid State Drive (SSD) storage device for data logging. It is also fitted with low profile ejector handles, this is done to fit the PU into the AUV pressure rated bottle.

See *Control Processor Unit (CPU) board* on page 69 for description of the standard CPU board..

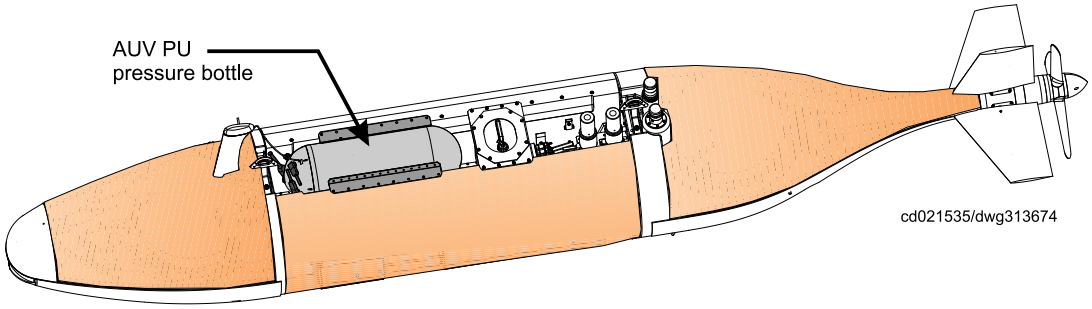
See *Data logging* on page 105 for description of the data logging options for the AUV PU.

Figure 54 AUV PU bottle

Location

The AUV PU bottle is pressure rated and may thus be freely mounted to the subsea vehicle provided cables for power and required interfaces can be made available. Mounting brackets are provided.

Figure 55 Installation example from a Kongsberg Maritime HUGIN AUV



For installation of the assembled PU components only, i.e. without the pressure bottle provided by Kongsberg Maritime, the PU components must be installed in other means of a pressure rated container that is fitted to the subsea vehicle.

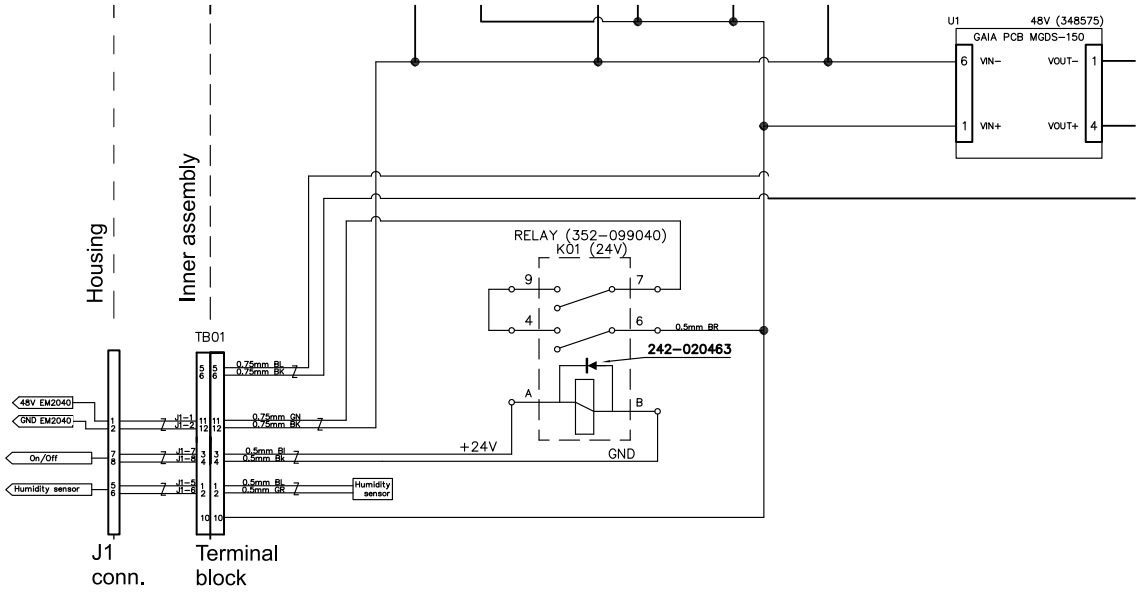
EM 2040 Power supply for AUV PU

The EM 2040 AUV PU requires 48 VDC. A 24 VDC on/off control is provided for enabling/disabling power to the system.

Note

The power relay and the DC/DC converter are provided with the AUV PU housing.

Figure 56 AUV PU power input



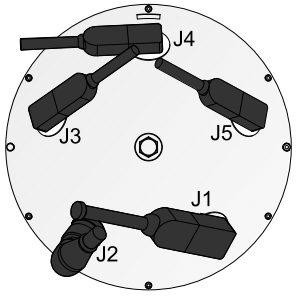
cd0210233/dwg 352518

Note

Above illustration is a cut from the AUV PU interconnection diagram. An A3 print of the complete interconnection diagram is enclosed in Arrangement drawings on page 218.

External connections

The EM 2040 container holds 5 connectors.



cd021536/dwg330877

Connector	Description
J1	Power and on/off control from AUV control system
J2	1 GBit Ethernet link for EM 2040 data, AUV control system
J3	TX transducer cable (power and data)
J4	Synchronization, 1PPS and attitude input
J5	RX transducer cable (1GBit Ethernet)

Note

J2 and J5 are the same connector type. Be careful to connect correctly.

For AUV PU cable layout, see *Cable layout for EM 2040 on an AUV* on page 107.

For complete interconnection diagram please refer to *Cable layout for EM 2040 on an AUV* on page 107.

Data logging

EM 2040 data can be logged via the Ethernet link between the AUV PU and the AUV control system provided the AUV control system includes data logging facilities for the EM 2040 data.

Alternatively, data logging can be performed locally within the processing unit using a Solid-State Drive (SSD) data storage device. The SSD disk is fitted to the CPU board. Data from the SSD disk must then be downloaded via the Ethernet link when the vehicle is recovered.

Installation

The EM 2040 AUV PU is provided with two mounting brackets. The mounting brackets must be attached to the PU housing and to the AUV.

Outline dimensions of the PU tube, as well as screw hole dimensions, are enclosed in the drawing files of this manual.

See *AUV PU cylinder– outline dimensions* on page 153.

1 Mount the AUV PU using provided mounting brackets to the subsea vehicle.

2 Connect the external connectors.

Maintenance

Caution

Make sure to adhere to the procedures applicable to the subsea vehicle before carrying out any maintenance work.

Caution

There are no preventive maintenance procedures for the EM 2040 processing unit.

Note

Opening a Kongsberg Maritime fabricated pressure container is considered depot level maintenance and must be conducted on shore in a maintenance area.

Caution

Do not stand in front of the opening of the container when you open it as the pressure may be high.

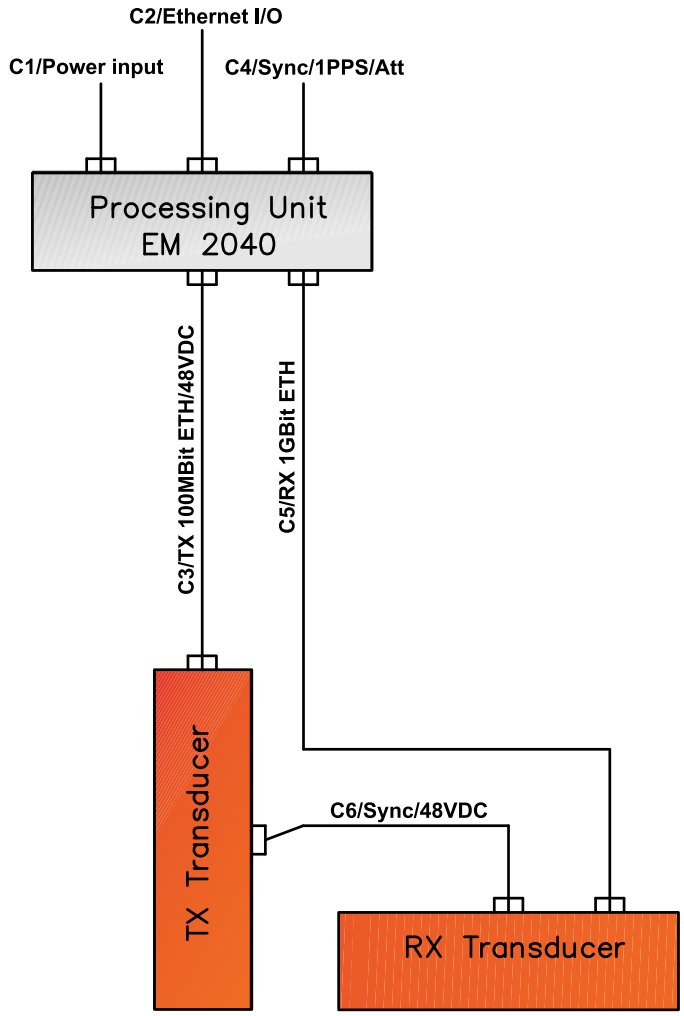
If the container can be opened the PU circuit boards may be accessed . The following procedure must then be followed:

1. Determine from the BIST tests which component of the system is failing.
2. If any of the circuit board of the PU is reported to be malfunctioning:
   - **a** Switch off all power to the system.
   - **b** Open the container in which the EM 2040 PU is mounted. Make sure to comply with the procedures applicable to the subsea vehicle.
   - **c** Disconnect all cables connected to the PU.
   - **d** Remove the PU from the container by unscrewing the mounting screws.
   - **e** Replace the relevant component.

     See *Replacement procedures* on page 73 for instructions.
   - **f** Install the PU into the container.
   - **g** Connect the interface cables to the PU.
   - **h** Secure the PU in the container according to relevant subsea vehicle procedures.

Cable layout for EM 2040 on an AUV

Figure 57 AUV PU Cable layout



The cables listed below must be present for integration between the subsea vehicle control system, the EM 2040 processing unit and the transducers.

C1 EM2040AUV/C1 Power input

- 48 VDC power must be delivered to the processing unit.
- A 24 VDC on/off control is provided for enabling/disabling power to the system.
- An open ended cable with PU sub-connector is provided with the AUV PU housing.
- PU sub-connector is detailed in *AUV PU power cable* on page 163
- If the AUV PU is delivered without the KM housing the cable must be provided by the customer.
- Refer to *A3 Interconnection diagram – AUV PU Housing* in *Arrangement drawings* on page 218

C2 EM2040AUV/C2 Ethernet I/O

- This is a Gigabit Ethernet connection for communication with the vehicles control system. The connection is used for
  - EM 2040 data output
  - PU control
- An open ended cable with a Gigabit sub-connector is provided with the AUV PU housing.
- PU sub-connector is detailed in *AUV PU Gigabit cable* on page 176.
- If the AUV PU is delivered without the KM housing the cable must be provided by the customer. The connection at the inner assembly is standard RJ-45.
- Refer to A3 *Interconnection diagram – AUV PU Housing* in *Arrangement drawings* on page 218

C3 EM2040AUV/C3 TX 100MBit Ethernet and 48VDC

- This is the TX transducer cable providing TX control and 48 VDC to the TX and RX transducers.
- The cable is provided with the system.
- A pressure rated sub-connector is provided with the AUV PU housing.
- PU sub-connector is detailed in *AUV PU TX transducer cable* on page 175
- If the AUV PU is delivered without the KM housing the sub-connector must be provided by the customer.
- Refer to A3 *Interconnection diagram – AUV PU Housing* in *Arrangement drawings* on page 218

C4 EM2040AUV/C4 Synchronization, 1PPS and attitude

- This is a signal cable used for communication with the vehicles control system. The connection is used for:
  - Synchronization of pinging activity
  - 1PPS input to PU
  - Attitude input
- An open ended cable with PU sub-connector is provided with the AUV PU housing.
- PU sub-connector is detailed in *AUV PU synchronization cable* on page 162
- If the AUV PU is delivered without the KM housing the cable must be provided by the customer.
- Refer to A3 *Interconnection diagram – AUV PU Housing* in *Arrangement drawings* on page 218

C5 EM2040AUV/C5 RX 1GBit Ethernet

- This is a 1GBit Ethernet RX transducer cable providing data from the RX transducer.
- The cable is provided with the system.
- A pressure rated sub-connector is provided with the AUV PU housing.
- PU sub-connector is detailed in *AUV PU Gigabit cable* on page 176.
- If the AUV PU is delivered without the KM housing the sub-connector must be provided by the customer. The connection at the inner assembly is standard RJ-45.
- Refer to A3 *Interconnection diagram – AUV PU Housing* in *Arrangement drawings* on page 218

C6 EM2040/C13 Sync/48 VDC

- This cable provides power to the RX transducer as well as synchronization between the TX and the RX transducer.
- The cable is provided with the echo sounder.
- The cable length is 0.5 meters for a single RX system.
- For a dual RX system the cable is extended by a split and 3 meters additional cable to each RX transducer, i.e. a total of 3.5 meters cable to each transducer.
- See *EM 2040 TX to RX transducer cable* on page 171 for single RX system.
- See *EM 2040 TX to dual RX transducer cable* on page 173 for dual RX system.

Transducer arrays on a subsea vehicle

The EM 2040 TX transducer array used for subsea vehicle installations is the same as used for surface vessel installations.

The same installation and maintenance procedures applies.

Location

The EM 2040 transducer arrays must be attached to the vehicle body having the same considerations in mind as for a ship installation, i.e.

- ensuring relative orientation within required accuracy, e.g. by using a prefabricated mounting plate
- avoiding aerated water in front of the transducers
- providing clear view of the bottom
- optimal distance between TX and RX
- using baffle for multipath reduction

See *Transducer array installation* on page 75 for details.

Installation procedure

1. Determine the physical location of the transducer arrays under the vehicles' hull.

   See *Locating the transducer array* on page 88.
2. Design the transducer installation method.

   See *Installation methods* on page 91.
3. Prepare the transducer array installation arrangement.
4. Install the transducers.
5. Run the transducer cables from the transducer arrays to the processing unit.
6. Lubricating oil must be applied to the bolts to avoid corrosion.

Alignment

The transducer's position and angular orientation on the vehicle must be determined in the same manner as on a surface vessel installation.

Please refer to *Alignment* on page 112 for applicable requirements and descriptions.

Alignment within the requirements is as important for subsea vehicles as it is for vessel installation. Alignment that does not meet the requirements may lead to a malfunctioning echo sounder system.

Maintenance

Caution

Do not make any attempts to open the transducer arrays, this will void the guarantee.

Malfunctions reported by the built-in self tests shall be reported to Kongsberg Maritime support for troubleshooting and/or replacement instructions.

Principles for EM 2040 on an ROV

Having the processing unit installed on the mother vessel and the transducer arrays mounted on an ROV, the required data links are:

- one 1Gbit Ethernet for RX data
- one or two 100Mbit Ethernet for TX data
- 48 VDC to the TX transducer

A multiplexer system is required for these data links.

For more information about the use of EM 2040 on ROVs and AUVs please see the following application notes (document numbers in brackets):

- High Resolution Bathymetry from ROV Mounted EM 2040 [368428]
- High Resolution Bathymetry from ROV Mounted EM 2040 and HAIN Inertial Navigation [368429]

The application notes can be found at the Kongsberg Maritime website http://www.km.kongsberg.com.

Alignment

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 transducer arrays and sensors in the vessel coordinate system
- The orientation of the transducer arrays 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.

Topics

Alignment requirements

Note

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

RX and TX alignment requirements

General requirements[1]	Alignment accuracy
Mounting angle between of RX and TX	90 ± 1 degrees
Relative heading between RX and TX	± 0.05 degrees

TX array	Alignment accuracy
Position (x, y)	± 0.02 m
Position (z)	± 0.005 m
Pitch	± 0.05 deg
Roll	± 0.20 deg
Heading[1]	± 0.05 deg

RX array	Alignment accuracy
Position (x, y)	± 0.02 m
Position (z)	± 0.005 m
Pitch	± 0.20 degrees
Roll	± 0.02 degrees
Heading[1]	± 0.05 degrees

Transducer array's maximum deviation from a plane

Transducer array flatness requirements	Max
Deviation from the ideal plane at any point	± 0.2 mm

Motion sensor alignment requirements

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

1. The RX and TX shall be mounted perpendicular to each other. The relative heading between the TX and the RX array shall deviate no more than ±1 degree from 90 degrees.

   The relative heading between RX and TX must after installation be determined to an accuracy of ± 0.05 degrees.

Heading sensor alignment requirements

Heading sensor	Alignment accuracy
Heading	± 0.1 deg

Position sensor alignment requirements

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

Waterline determination requirements

Water line	Alignment accuracy
Position (z)	± 0.005 m

External sensor's performance requirements

The motion reference unit, as well as the heading unit must be precision sensors with highest possible performance.

The accuracy of the sensor data, as specified by the sensor manufacturer, must adhere to the following requirements:

Sensor data	Sensor accuracy
Roll	0.02 degrees RMS
Pitch	0.05 degrees RMS
Heading	0.1 degrees RMS
Velocity vector	< 0.03 m/s RMS
Roll, pitch, yaw rate	< 0.03 degrees/s RMS
Time delay	< 5 ms latency
Velocity sensor update rate	≥100 Hz

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:

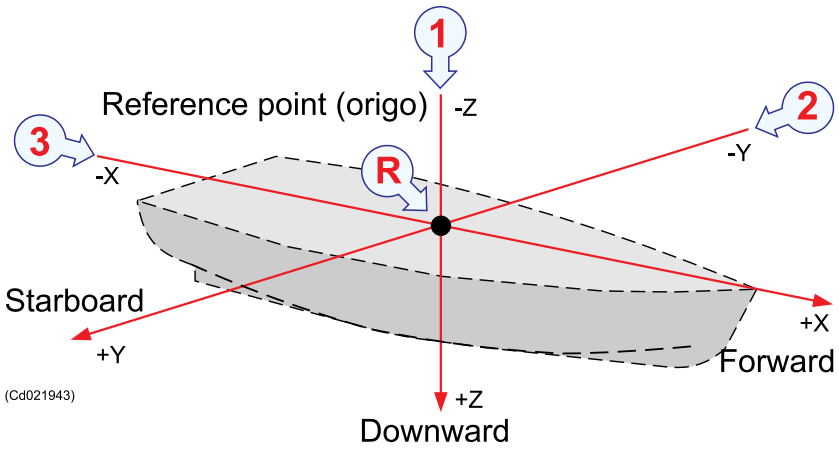
- X = forwards
- Y = to starboard
- Z = pointing downwards

There is no restriction as 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 transducers.

Figure 58 Kongsberg Maritime vessel coordinate system definition



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 *External sensor's performance requirements* on page 115 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.

Calibration

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

Please see *Calibration* on page 122 for description of the calibration requirements.

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. See Motion sensor on page 118.

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

Calibration

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

Please see *Calibration* on page 122 for description of the calibration requirements.

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.

Calibration

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

Please see *Calibration* on page 122 for description of the calibration requirements.

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.

Transducer measurements

After installation of the TX and RX arrays the following must be determined and verified:

- Relative heading between the transducer arrays

  See *Transducer heading* on page 121
- Roll, pitch and heading of the transducer arrays

  See *Transducer roll and pitch* on page 121
- Centre location of the transducer arrays

  See *Transducer position* on page 121

Related topics

- *Alignment requirements* on page 114

Transducer heading

The receiver transducer (RX) and the transmit transducer (TX) shall be mounted perpendicular to each other. The TX shall be mounted along the keel, and the RX shall be mounted across the keel. The relative heading between the TX and the RX array shall deviate no more than ±1 degree from 90 degrees.

The relative heading between RX and TX must after installation be determined to an accuracy of 0.05 degrees. Index marks along the arrays must be used during the alignment.

Transducer roll and pitch

Roll and pitch measurements are made according to standard conventions with positive pitch angle if the transmitter array's forward end is above the aft end (tilts up), and positive roll if the starboard side of the receiver array is lower than the port side.

Note that the roll and pitch angles to be measured are relative to the horizontal plane as defined by the vessel's coordinate system. I.e., roll is the angle that the transducer's y-axis have with respect to the horizontal and pitch is the angle that the transducers x-axis have with respect to the horizontal plane. The multibeam echo sounder converts the measured angles as entered into the installation menu to rotation angles before use i.e. do not do such a conversion before entering them into the system.

Transducer position

The location of the centre of each transducer array face must be measured in the vessel coordinate system. This centre must be measured relative to the system reference point. Measurements must be done in the X, Y and Z directions on all transducers.

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 2040.

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

Note

An alignment report template is enclosed in the Appendices. The template may be used to verify the alignment report provided by the land survey contractor. Alternatively, the report template may be completed and serve as the final alignment report.

System test

Topics

After the installation has been performed and before the EM 2040 system is brought into operation for the first time, a series of test procedures must be carried out to confirm a correct installation.

Some of the tests can be carried out on individual units once that particular unit has been installed. However, in the interests of safety and to avoid possible mistakes, it is recommended to set aside a period of time at the end of the installation phase specifically for the checks and tests. The entire set of tests can then be performed in sequence to ensure the entire system is comprehensively checked.

Note

If the test engineer is not satisfied with the quality of any part of the installation, he/she must contact the customer to have the work rectified and brought up to the required quality standards.

Which specific tests that are to be conducted are normally specified in the contract. In most cases, the following tests are performed

- Installation tests
  - These tests are performed during the installation work. The general procedures are given in this chapter. These tests take place before power is applied to the system.
- Setting To Work (STW)
  - This work is performed by the installation personnel from Kongsberg Maritime. All specific hardware and software units are checked, and the cabling is controlled.
- Harbour Acceptance Test (HAT)
  - This test is performed by the installation personnel from Kongsberg Maritime together with representatives from the customer and in some cases the installation shipyard.

- Sea Acceptance Test (SAT)
  - This test takes place with the vessel in open sea. It is performed by the installation personnel from Kongsberg Maritime together with representatives from the customer and in some cases the installation shipyard. The purpose of the test is to check the functional specifications of the system during normal working conditions.

Visual inspection of units

Scope

WARNING

These checks must be completed before any power is switched onto the system.

After the physical installation has been carried out, all the system units must be visually checked to ensure that the EM 2040 units have been installed correctly. You must ensure that the units have been mounted in the correct locations, correctly orientated (e.g. the right way up) and are correctly secured.

Operator Unit

Perform a close visual inspection of the unit according to the following procedure

1 Check that the unit is installed properly, secured, and that it is suitably orientated to enable easy operation.

2 Check that the unit is not damaged.

3 Make sure that appropriate slack has been applied to the cables.

4 Check that the air vents are not blocked.

5 Check the immediate environment around the unit. The operator should have easy access to a communication system, and it must be possible to dim and/or switch off the deckhead lights.

6 Checked (date/sign):_____

Processing unit

Perform a close visual inspection of the EM 2040 processing unit.

1 Check that the unit is installed in the correct location, and is suitably orientated to enable easy maintenance.

2 Check that the unit is not damaged.

3 Make sure that you have access to the unit from both sides, and that appropriate slack has been applied to the cables.

4 Check that the air vents are not blocked.

5 Check that the sonar room is equipped with proper light for maintenance work.

6 Check that the sonar room is equipped with the ventilation facilities required for continuous operation.

7 Checked (date/sign):_____

Electrical checks

This section of the manual contains the test procedures for the EM 2040 system's power and signal interface cables.

WARNING

These checks must be completed before any power is switched onto the system.

Cabling

Visual cable inspection

Refer to the cable plans and interconnection diagrams, and check all power and interconnection cables. Any locally fitted plugs and connectors should also be checked to ensure that the correct types have been used for the specific locations. (Sealed or spark-proof connectors in areas where flammable gasses may accumulate, etc.)

Ensure that all cable connections have been made according to the cable plan, and that all connections are tight and secure. Ensure that all cables are correctly laid in conduits, or are otherwise protected according to the regulations and recommendations laid down by the vessel's registering authority. Ensure all protective covers are fastened correctly.

Cable connections and continuity

After the cable connections have been completed and the visual inspection has been carried out, all the cable cores must be checked for correct connection and continuity. Refer to the cable plans and interconnection diagrams, and check all interconnection cables. Any locally fitted plugs and connectors must be checked for shorts or open circuits. Ensure all cable connections have been made according to the cable plan, and that all connections are tight and secure.

The check procedure will require two engineers equipped with two-way communication devices; one will require continuity test equipment, while the other will require a suitable shorting strap.

Follow the check procedure below for each cable core

1 Position yourselves one at each end of the cable to be checked. Good communications must be established between you and your assistant.

2 Ensure that the cable to be tested is not connected to any power source.

- If a cable terminates in a plug at the unit, the test will be more easily conducted if the plug is disconnected.

3 Select one pair of cable cores, and check that the cores are connected to the correct terminals in the unit.

4 Connect your continuity tester to the two terminals in question and check the continuity.

- If a low resistance exists between the two cores, this may indicate the cores are connected to circuits or units with low internal resistance. If this is the case, disconnect the cores from the terminal block and test again.
- The resistance should be nearing ∞ ohms.

5 Tell your assistant to short the two cores together. Repeat the previous test.

- The resistance should be 0 (zero) ohms.

6 Tell your assistant to remove the shorting strap.

- Check that the resistance reaches ∞ ohms again.

7 Check each core's resistance to ground, and each core's resistance to all the other cores in the cable.

- All results should be close to ∞ ohms.

8 Assuming the test results are correct, the cores must be reconnected to the terminal block (if they had been removed), and the terminals checked to ensure they are tight.

9 On completion, move on to the next pair of cores and repeat the tests until the entire cable has been checked.

Operational voltages

Check that the operational voltages on the equipment match the power available on the vessel.

Final installation checks

After installation - but before un-docking - a number of verification must be done to check that the mechanical end electrical installation has been performed correctly.

Procedure

1 Check that the measured positions of the transducers, motion sensor and positioning system antenna are reasonable by comparing them with those estimated from the vessel drawings.

2 Check that the measured installation angles of the transducers is reasonable by comparing them with measurements done with a simple inclinometer.

3 Check that the specified sacrificial anodes have been mounted, and that any specified anti-fouling paint has been applied correctly.

4 Check that all system units have been fastened properly and that all nuts and bolts have been tightened properly.

5 Check that the data from the motion sensor, the heading sensor and the positioning system are correctly read by the EM 2040 and that the values are reasonable before un-docing.

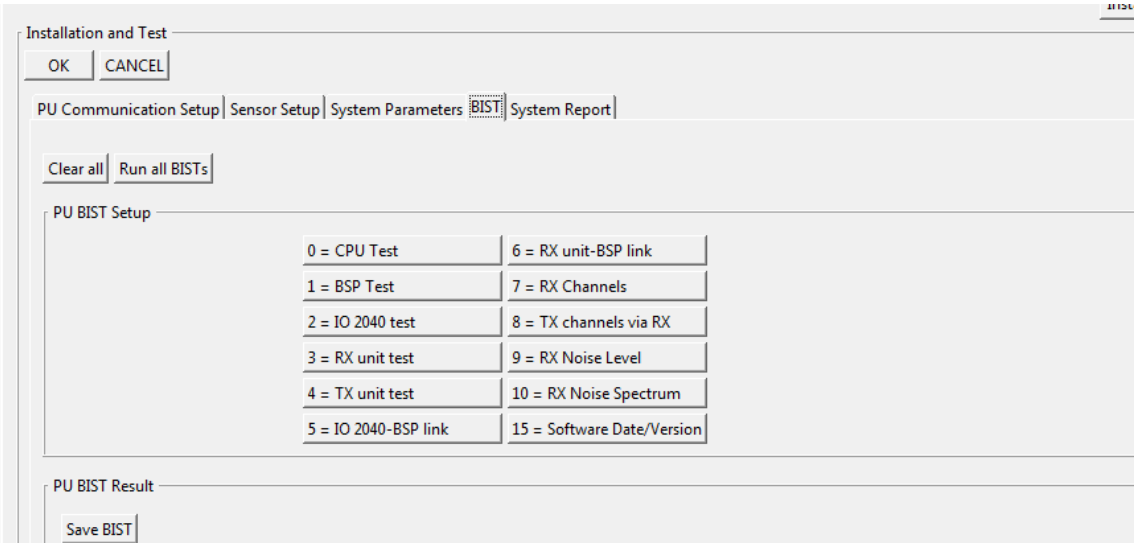
The steps in this procedure may be incorporated in the “Harbour Acceptance Test” carried out as a final check to test both the installation and the main functions of the system.

Built-in self test

Caution

Do not ping in dry dock. For the EM 2040 BIST tests, BIST no. 8 must not be run in dry dock.

The Built-In Self Test, BIST, provides a number of automatic tests that may be run to check the operation of the echo sounder. The BIST are run from the operator software SIS running on the Operator Station (HWS).



How to run the Built-In Self Test

1 Open the **Installation parameters** frame in SIS.

2 Select the **BIST** tab.

3 Press the test button for the test you want to run

or

Press **Run all BISTs** if you want all tests to be run sequentially.

Note

The test is executed when the button is pressed.

The results of the test will be shown in the **PU BIST Result** fields, containing:

- **Date:** Date when test was run
- **Time:** System time when test was run
- **Ser.no:** Serial number of the head where the test was run.
- **BIST:** The number of the BIST test that has been run.
- **Result:** The overall result of the test.
- **Description:** A description of the test returned from the PU (processing unit).

EM 2040 BIST	
0	CPU Test
1	BSP Test
2	IO 2040 Test
3	RX unit test
4	TX unit test
5	IO 2040-BSP link
6	RX unit-BSP link
7	RX Channels
8	TX channels via RX
9	RX Noise Level
10	RX Noise Spectrum
15	Software Date/Version
16	System info

BIST results

- **CPU test**

  This test presents the CPU type, the CPU clock frequency, the current and maximum temperatures for the CPU die and for the CPU board. In addition some key voltages are reported, and finally the network addresses for the board's interfaces.

- **BSP test**

  This test checks all Beamformer and Signal Processing circuit boards in the EM 2040 processing unit.

- **IO 2040 test**

  This test presents the IO 2040 board temperature, the internal power supply voltages (and the external 48 V supply (used for the RX and TX transducer units) voltage). In addition software and firmware versions are displayed.

- **RX unit test**

  This test presents the receiver FPGA board temperature, the internal power supply voltages and the 48 V supply input voltage. In addition software and firmware versions are displayed.

- **TX unit test**

  This test presents the transmitter FPGA board temperature, the internal power supply voltages and the 48 V supply input voltage. In addition software and firmware versions are displayed.

  This test takes a while because the HV power is discharged and charged to test the two power levels (Maximum and -20 dB).

- **IO 2040-BSP link**

  This test checks the parallel bus interface between the IO 2040 and the BSP 67B circuit boards. A large set of known data is transferred from IO 2040 to the CPU board via the BSP 67B boards. The data received is checked by the CPU card.

- **RX unit-BSP link**

  This test checks the GBit interface between the RX transducer unit and the IO 2040 board. A large set of known data is transferred from RX unit via IO 2040 and BSP 67B boards to the CPU board. The data received is checked by the CPU card.

- **RX channels**

  The receiver has a programmable signal generator board that is used to inject a test signal at the preamplifier inputs. This test checks all RX channels. The BIST report lists phase and amplitude response of all RX channels for 200, 300 and 400 kHz.

- **TX channels via RX**

  This test checks all TX channels (including the transducers). This is done by transmitting at one by one TX amplifier and checking the received level (through the water) by the receiver unit(s). This test may require that the water deth is not to large. A warning will be given if this is the case.

- **RX noise level (broadband)**

  This test measures the average isotropic spectral noise level for each receiver channel (in dB rel 1 μPa/Hz) at three bands:

  – 180 - 220 kHz

  – 280 - 320 kHz

  – 360 - 400 kHz

  –

  The receiver directivity index, the transducer sensitivity and the filter bandwidth is used to convert to isotropic spectral noise level. The noise level should normally be below 50 dB

- **RX noise spectrum**

  This test measures the isotropic spectral noise level for each receiver channel as done in the RX noise level test. The noise spectrum level is displayed for 5 kHz bands for groups of 32 channels. In addition the average level for all channels are displayed. This spectrum test can be used to search for external noise sources.

- **TRU software date / version**

  This test presents the software date and versions for the CPU, BSP 67B, IO 2040, RX and TX units.

- **System info**

  This test acquires information needed (serial numbers, software versions, BIST results etc) for a status report. This report can be sent to the factory to update the EM 2040 product database.

Maintenance program

The purpose of this document is to provide guidance to operators and maintenance workers on recommended maintenance procedures for multibeam echo sounders and ancillary equipment. The guidelines will assist in keeping the equipment fully operational and in detecting problems and malfunctions as early as possible.

Before every survey (alongside)

The following systems shall be maintained:

Remove old surveys

If possible, delete all surveys from the hard disks on the EM Operator stations. This will ensure that different surveys are not mixed together and that all data disks are empty at survey start.

Defragment all survey disks

At survey start, and during the survey (if time allows), defragment the data disk(s). This is performed to optimise the disk capacity.

Run all BISTs

The system has several BIST incorporated in the system software. Run all these to verify correct system operation or take corrective action if any alarms appears.

Verify operation of all external sensors

The various multibeam echo sounders are part of an integrated system with several external sensors. Verify operation of each ancillary system using the relevant technical and operational manuals. Perform corrective actions if necessary.

Before every survey (offshore)

Roll calibration check

Perform a Roll calibration as described in the operator manual and check if any roll offset values have changed. If different from the last calibration, update and verify.

Pitch calibration check

Perform a Pitch calibration as described in the operator manual and check if any pitch offset values have changed. If different from the last calibration, update and verify.

Cross line verification check

To check the sound speed corrections, run two lines perpendicular to each other and verify the swath versus the centre beam.

Every time used

Clean the SVP probe in fresh water.

Each time the SVP unit is used, it shall be cleaned in fresh water and stored in a dry and safe place. Verify that no physical damage is done to the unit and that the sacrificial anodes (if any) are all intact.

Every 6 months

Check all external cables

All interface cables are connected to the various electronic units by delta connectors or similar. Verify that all connectors are securely fastened and that all cables are free from physical damage.

Clean all air filters

Wherever there are air filters, they shall be cleaned at least every 6 months. If the units are installed in a dirty environment, then shorter intervals between cleaning may be required.

Every dry-docking

Docking

WARNING

For cleaning – do not use high pressure cleaner or similar.

All transducers should be checked when the ship is in dry-dock. Remove very carefully all marine growth with a **wooden** or **plastic** ice scraper. Then renew the anti fouling paint on the transducer faces. Great care must be taken when performing this.

How to do replace the anti fouling paint

- The transducer has to be rubbed softly with hand with a very fine sand paper.
- A thin layer of primer dependent of the frequency of the system
- Antifouling type SeaQuantum Ultra, Layer thickness 125 micron

Primer on 300 kHz and 200-400 kHz systems: Penguin primer, 75 micron layer thickness.

Primer on all other systems: Safeguard Universal ES, 125 micron layer thickness.

Note

The last primer is giving the best protection but contains micro sized aluminium grains and has yet not been tested for 200-400 kHz systems.

This is Kongsberg Maritime's list of approved antifouling paints on polyurethane transducer housing.

From Jotun Paints, Sandefjord Norway

- Antifouling Seamate HB 33
- Antifouling Seamate HB 66
- Antifouling Seamate HB 99
- Racing
- Non-stop

From International Paints

- Intersleek tie coat +425 FCS
  - BXA386/BXA390BXA391 grey
  - HKA563/HKA570/HKA571 Yellow

  Mix BXA386, BXA390 and BXA391 first, then apply. When dry, mix HKA563, HKA570 and HKA571, apply.

From Hempel IFA Coatings AS

- Hempel A/F Classic 76550

From Jotun-Henry Clark Ltd

- Anti-fouling Seaguardian

Note

Refer to the manufacturer's documentation and data sheets for a complete procedure.

Diver

With a diver available it is recommended that the transducer arrays are gently wiped using a **wooden** or **plastic** ice scraper.

Spare parts

This chapter contains a presentation of the spare parts available for the EM 2040 multibeam echo sounder. All parts are minimum of what we recommend onboard and at site.

Note that the spare parts list deviates slightly for the different versions of processing unit.

Table 13 Ship installation spare parts PU upgraded version (V2), KM Part. no. 358141

Pcs	KM part no.	Description	Reference
1	353494	Exelsys power supply (AC mains input)	*Power Supply Exelsys* on page 61
1	340372	Concurrent CPU board	*Control Processor Unit (CPU) board* on page 69
1	367895	IO2040 board	*IO2040 board* on page 65
1	342174	Beamforming & Signal Processor (BSP) board	*Beamforming & Signal Processor (BSP) board* on page 71
1	373388	12-port gigabit switch	*Ethernet Switch Board – Vadatech CP218* on page 57
1	360664	Fan, plug-in unit	

Table 14 Ship installation spare parts PU original version (V1), KM Part. no. 342164

Pcs	KM part no.	Description	Reference
1	326495	Compact PCI power supply (AC mains input)	*Compact PCI Power Supply* on page 63
1	326536	48 VDC power supply (internal power supply)	*48 VDC Power Supply* on page 67
1	340372	Concurrent CPU board	*Control Processor Unit (CPU) board* on page 69
1	367930	IO2040 board	*IO2040 board* on page 65
1	342174	Beamforming & Signal Processor (BSP) board	*Beamforming & Signal Processor (BSP) board* on page 71
1	343253	8-port gigabit switch	*Ethernet switch* on page 59

Table 15 Installation spare parts cylinder AUV PU, KM Part. no. 352389

Pcs	KM part no.	Description	Reference
1	326535	Compact PCI power supply (DC for AUV)	
1	340372	Concurrent CPU board	*Control Processor Unit (CPU) board* on page 69
1	367930	IO2040 board	*IO2040 board* on page 65
1	342174	Beamformer & Signal Processor (BSP) board	*Beamforming & Signal Processor (BSP) board* on page 71
1	307828	5-port gigabit switch (GS105GE ProSafe 5 port, GIGABIT. NETGEAR.)	

Table 16 Installation spare parts sphere AUV/compact PU, KM Part. no. 357997

Pcs	KM part no.	Description	Reference
1	326535	Compact PCI power supply (DC for AUV)	
1	340372	Concurrent CPU board	*Control Processor Unit (CPU) board* on page 69
1	367895	IO2040 board	*IO2040 board* on page 65
1	342174	Beamformer & Signal Processor (BSP) board	*Beamforming & Signal Processor (BSP) board* on page 71
1	373388	12-port gigabit switch	*Ethernet Switch Board – Vadatech CP218* on page 57

Drawings

In this chapter outline dimension drawings and cable details are presented.

Caution

The drawings are not to scale.

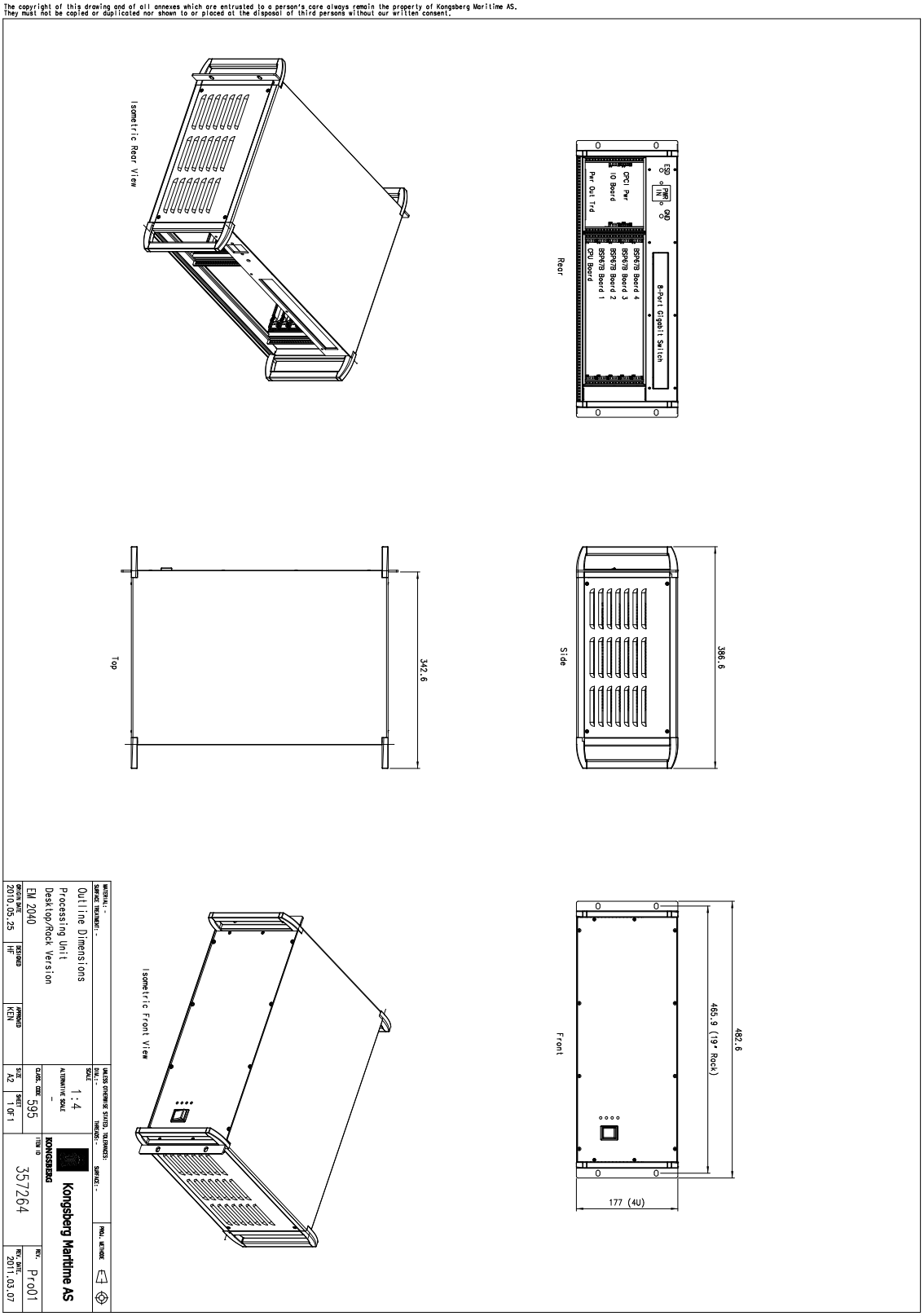
Outline dimension drawings

Cable drawings

Outline dimension

Rack/Desktop processing unit V1 – Outline dimensions

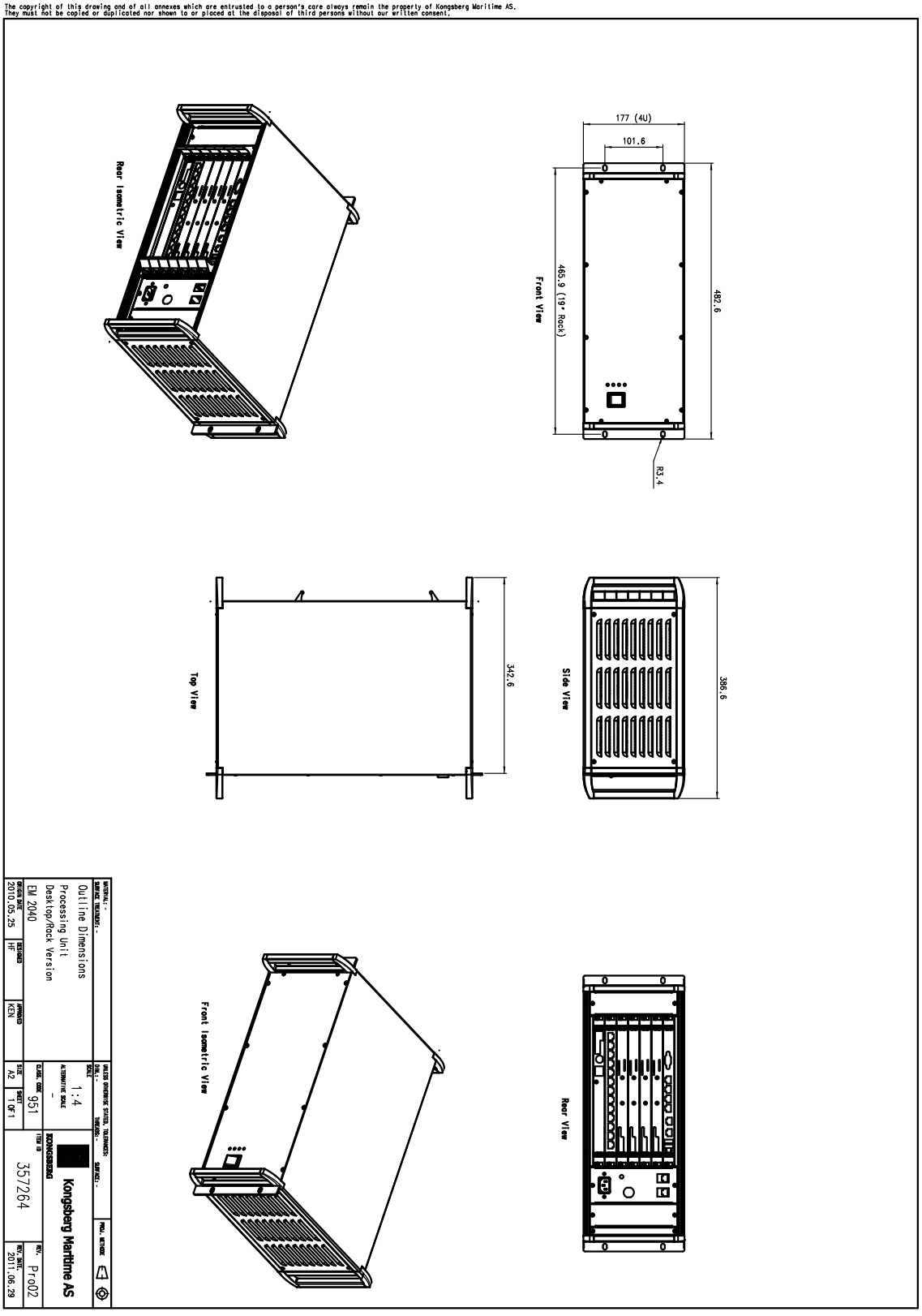
Figure 59 Processing unit Rack/Desktop version V1 – Outline dimensions



(cd0210207-02)

Rack/Desktop processing unit V2 – Outline dimensions

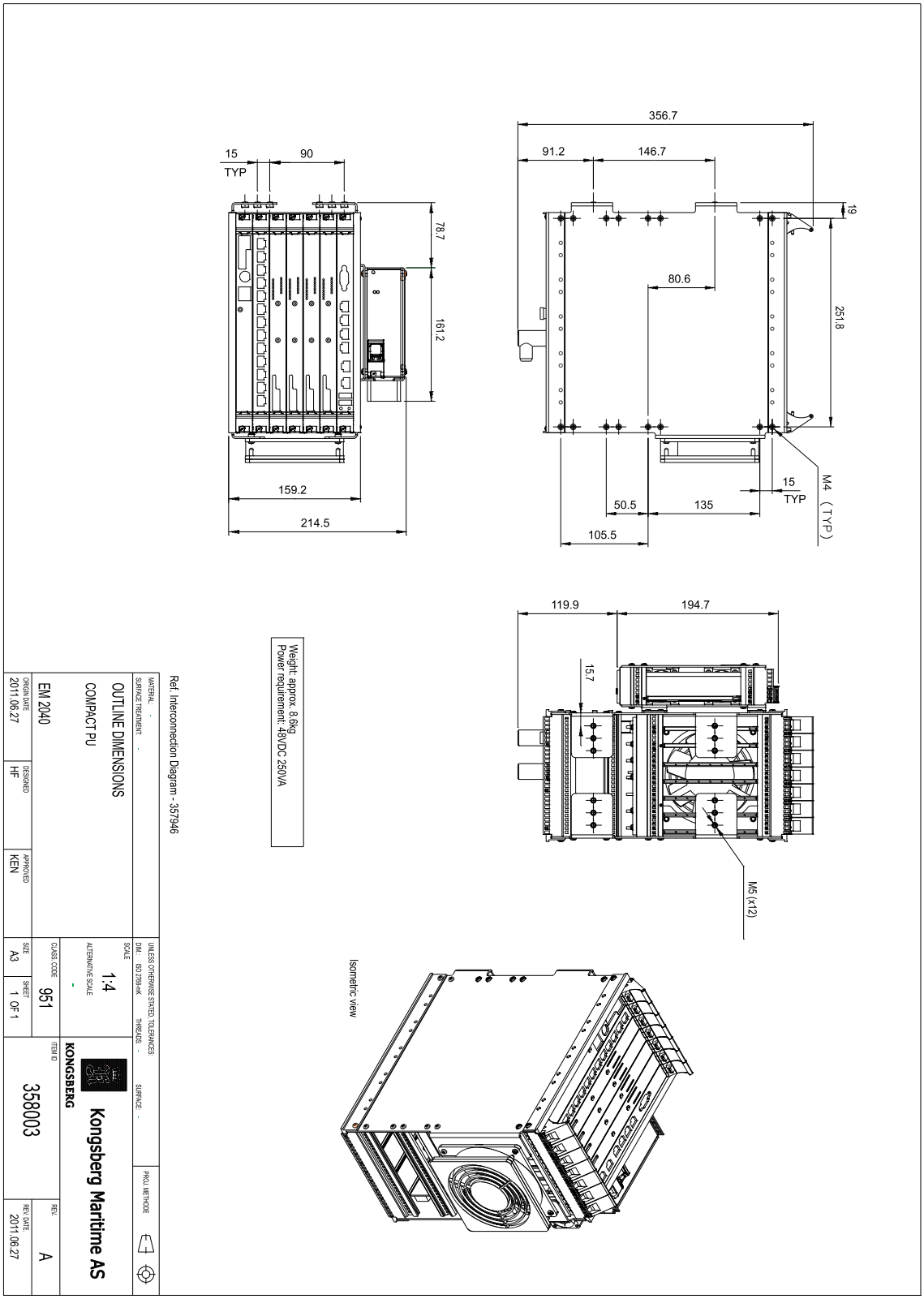
Figure 60 Processing unit Rack/Desktop version V2 – Outline dimensions



(cd0210207-02b)

Compact/AUV sphere processing unit– Outline dimensions

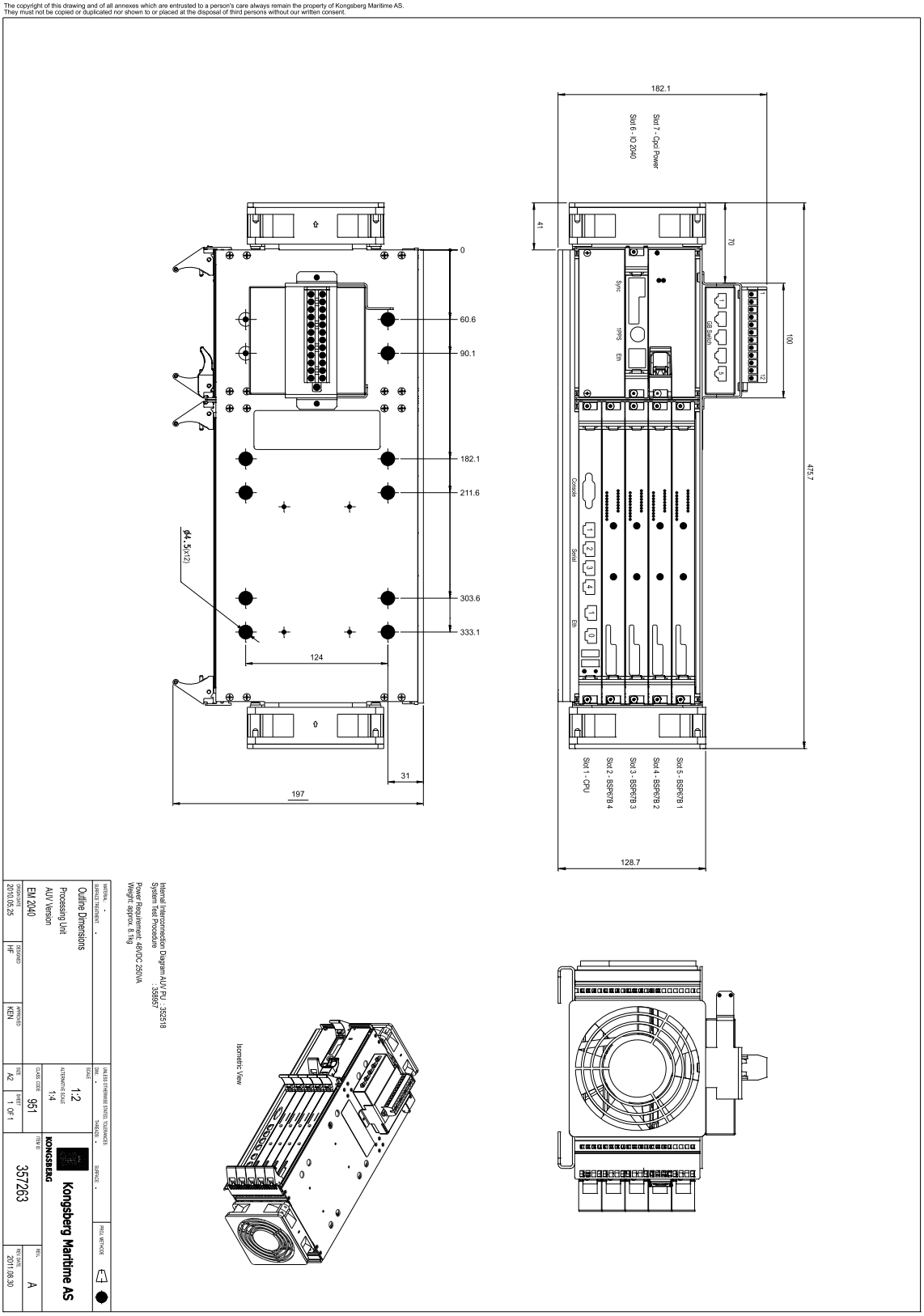
Figure 61 Processing unit compact/AUV sphere version – Outline dimensions



(cd0210256)

AUV cylinder processing unit – Outline dimensions

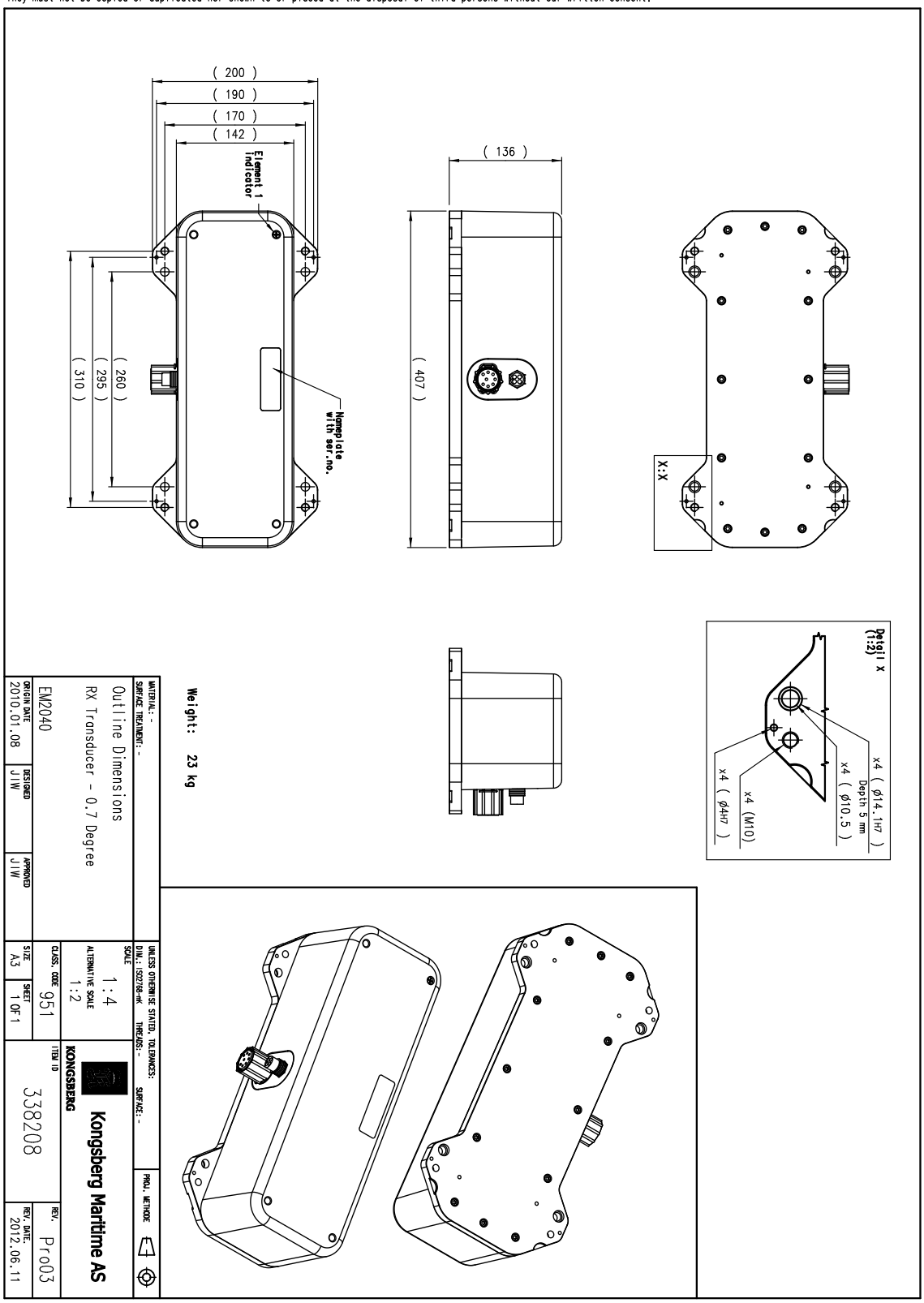
Figure 62 Processing unit AUV cylinder version – Outline dimensions



(cd0210235-01b)

0.7 degree RX transducer – Outline dimensions

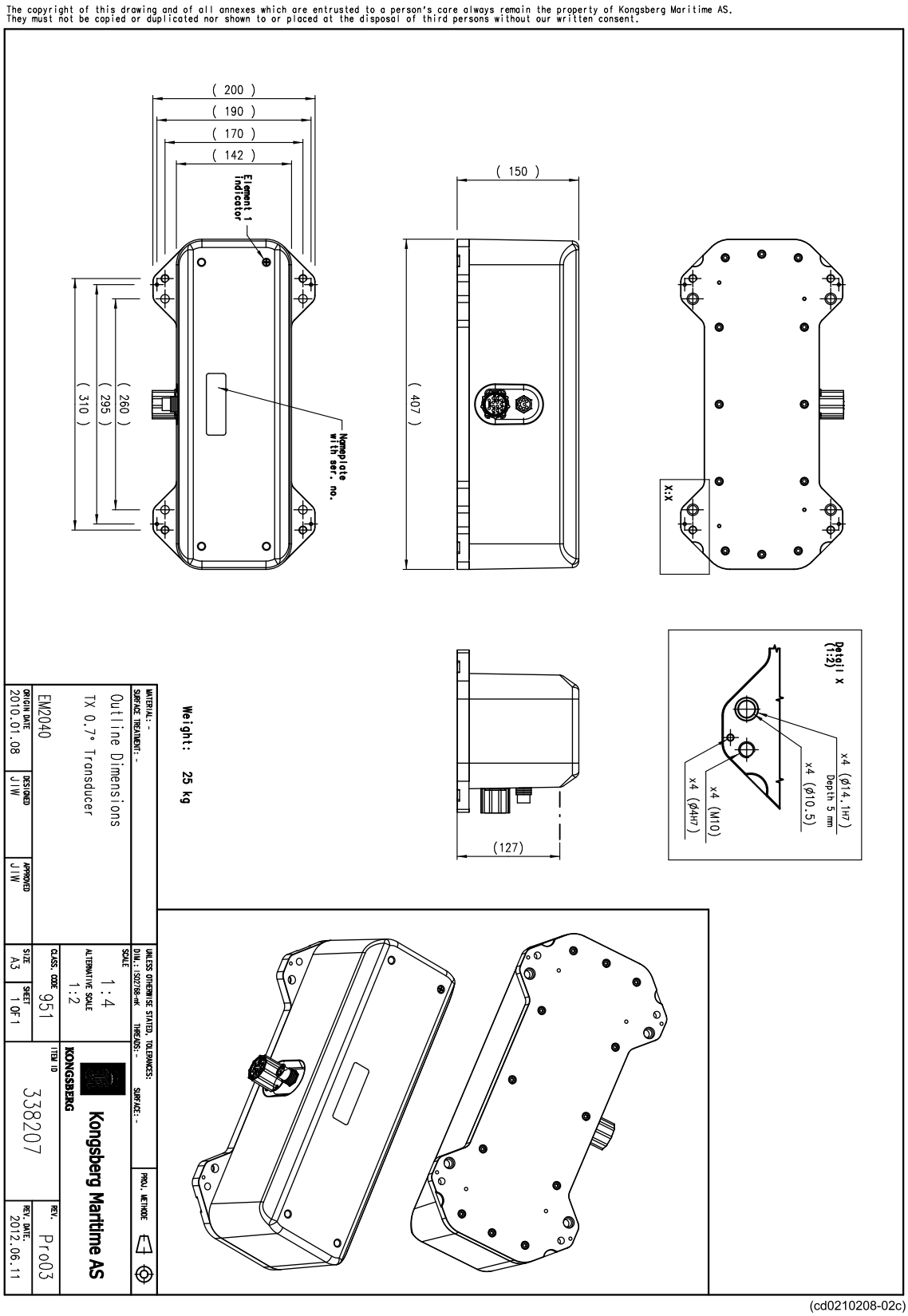
Figure 63 0.7degree RX transducer – outline dimensions (Not to scale)



(cd0210208c)

0.7 degree TX transducer – Outline dimensions

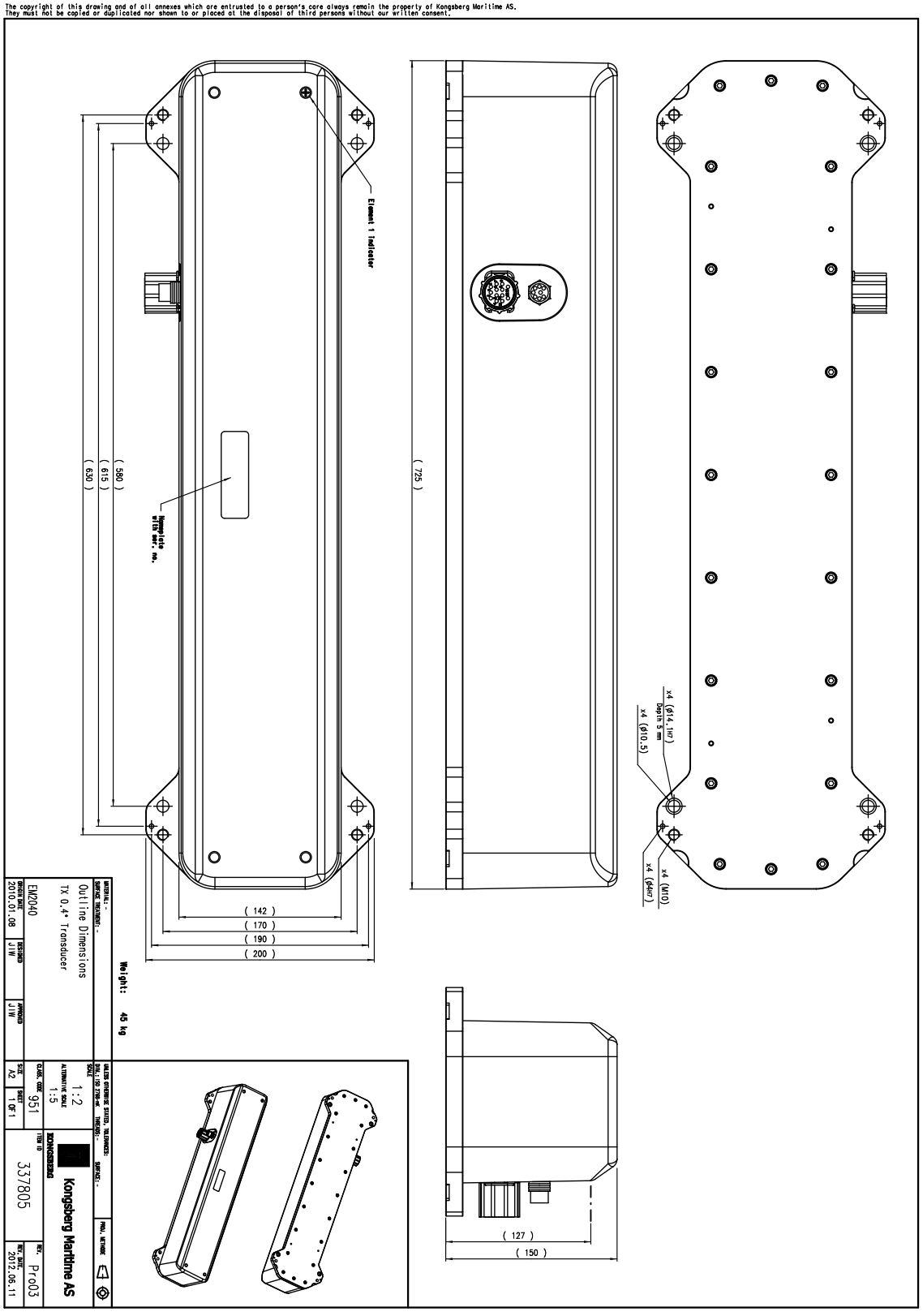
Figure 64 0.7 degree TX transducer – outline dimensions (Not to scale)



(cd0210208-02c)

0.4 degree TX transducer – Outline dimensions

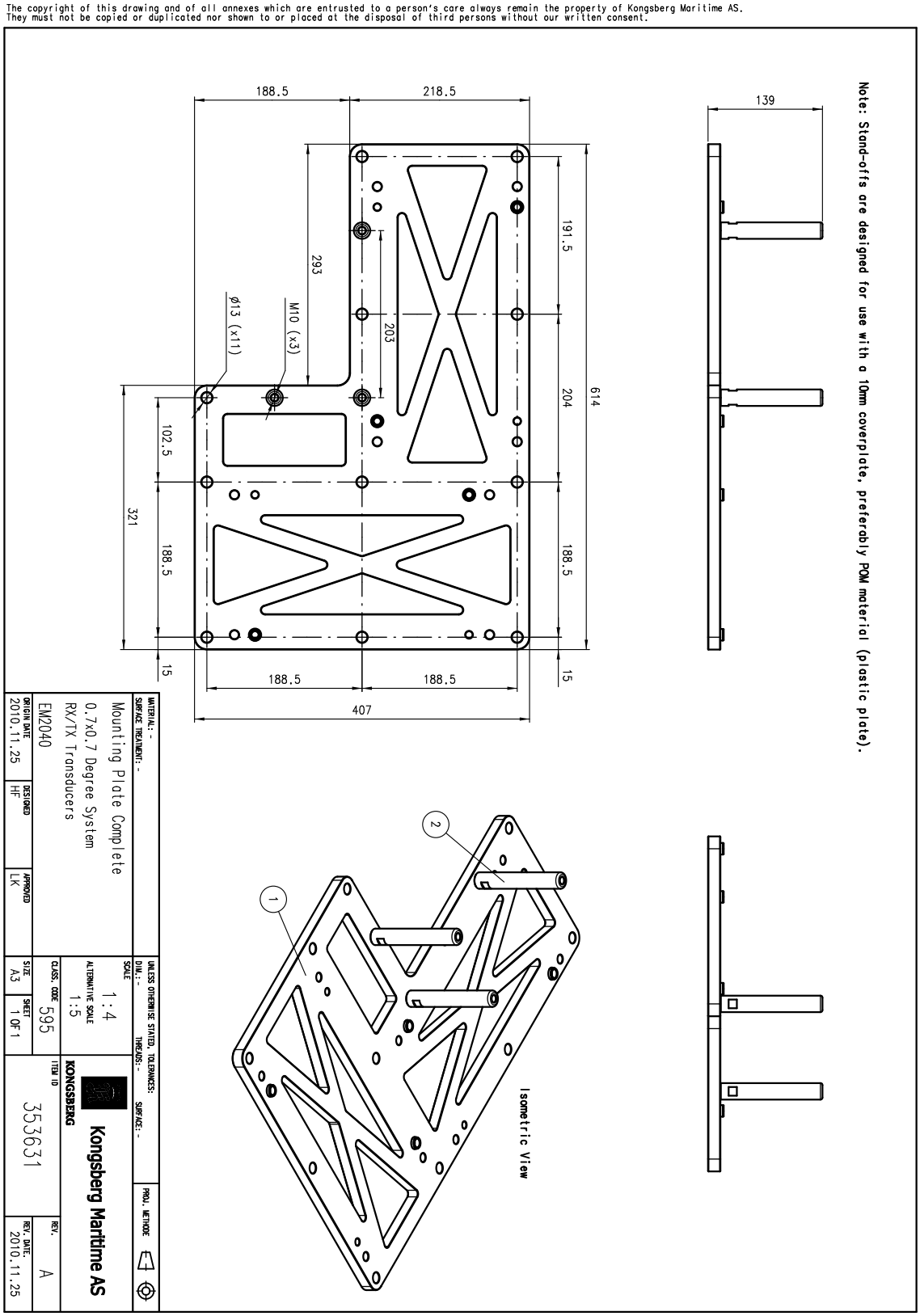
Figure 65 0.4 degree TX transducer – outline dimensions (Not to scale)



(cd0210208-01c)

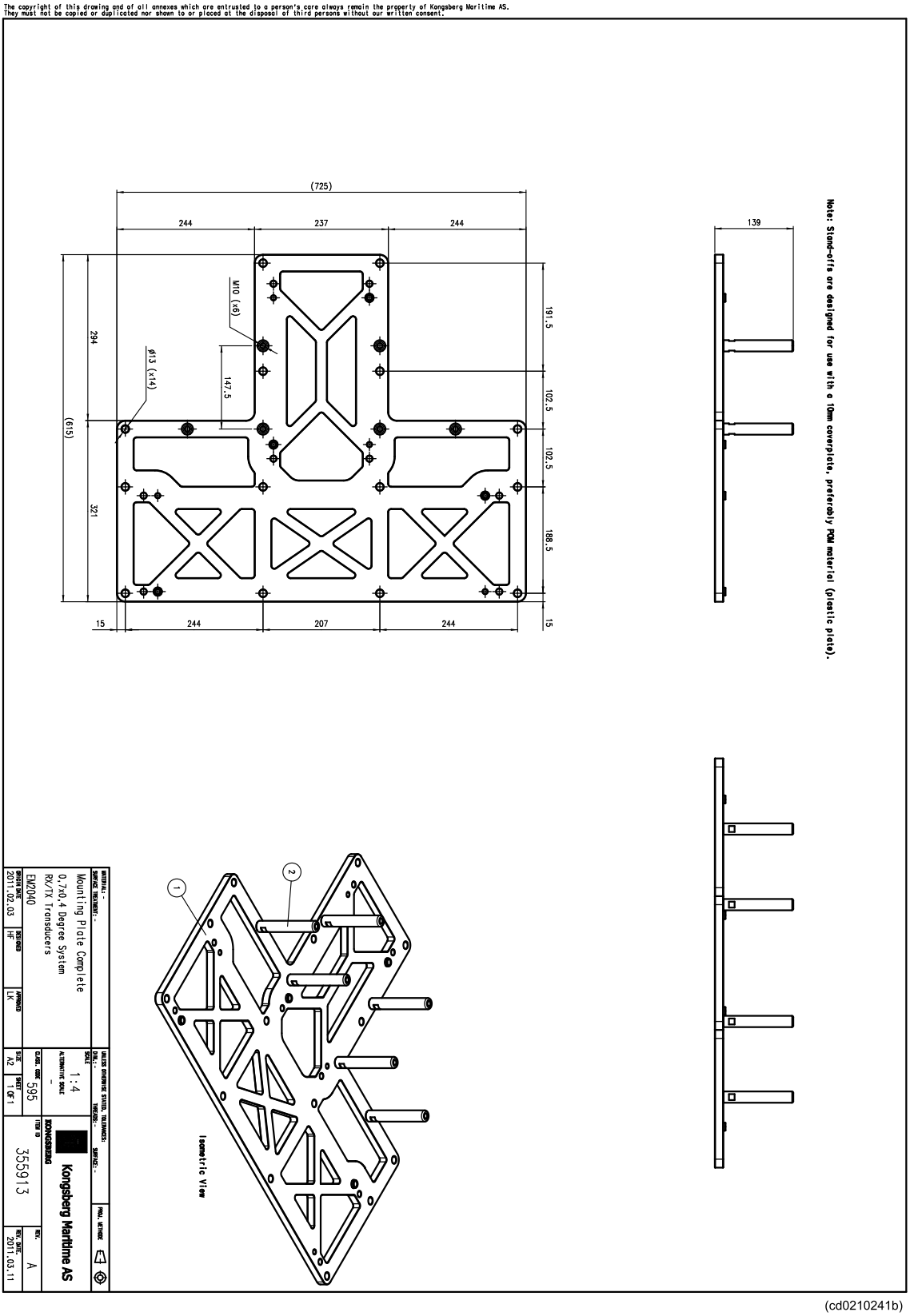
0.7 by 0.7 degree mounting plate – Outline dimensions

Figure 66 0.7 by 0.7 degree mounting plate – outline dimensions (Not to scale)



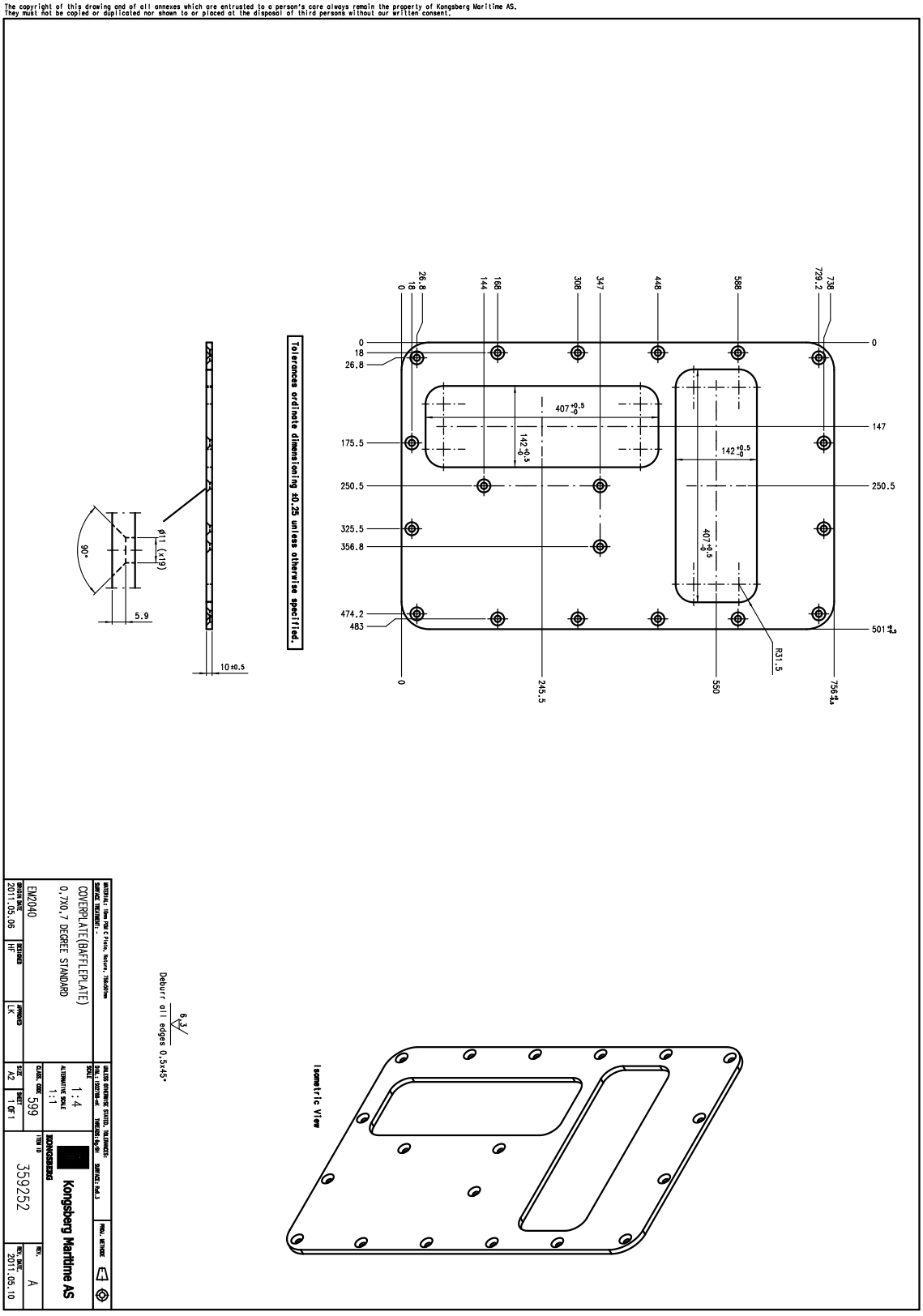
0.4 by 0.7 degree mounting plate – Outline dimensions

Figure 67 0.4 by 0.7 degree mounting plate – outline dimensions (Not to scale)



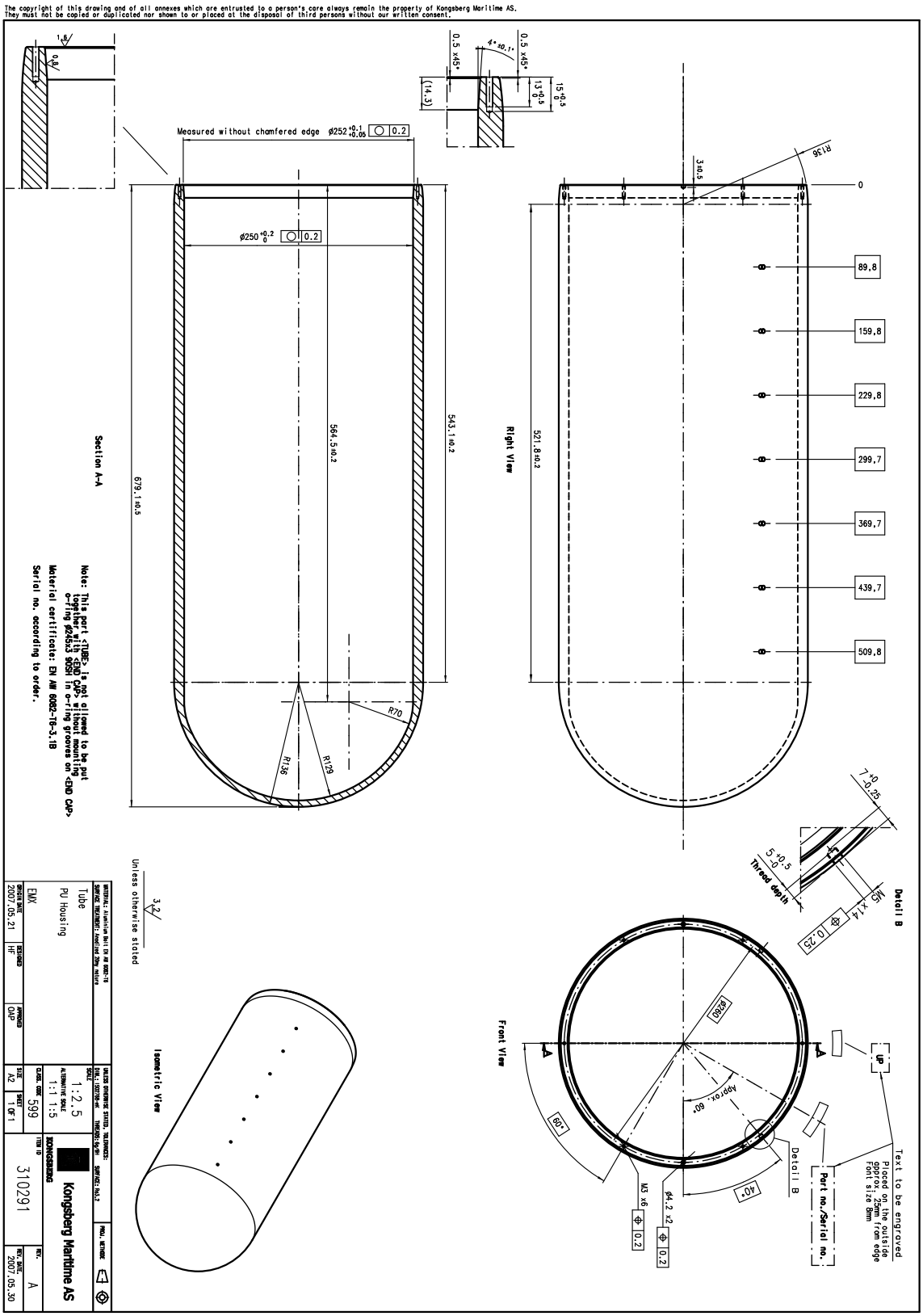
0.7 by 0.7 degree cover plate (baffle plate) – Outline dimensions

Figure 68 0.7 by 0.7 degree cover plate – outline dimensions (Not to scale)



AUV PU cylinder– Outline dimensions

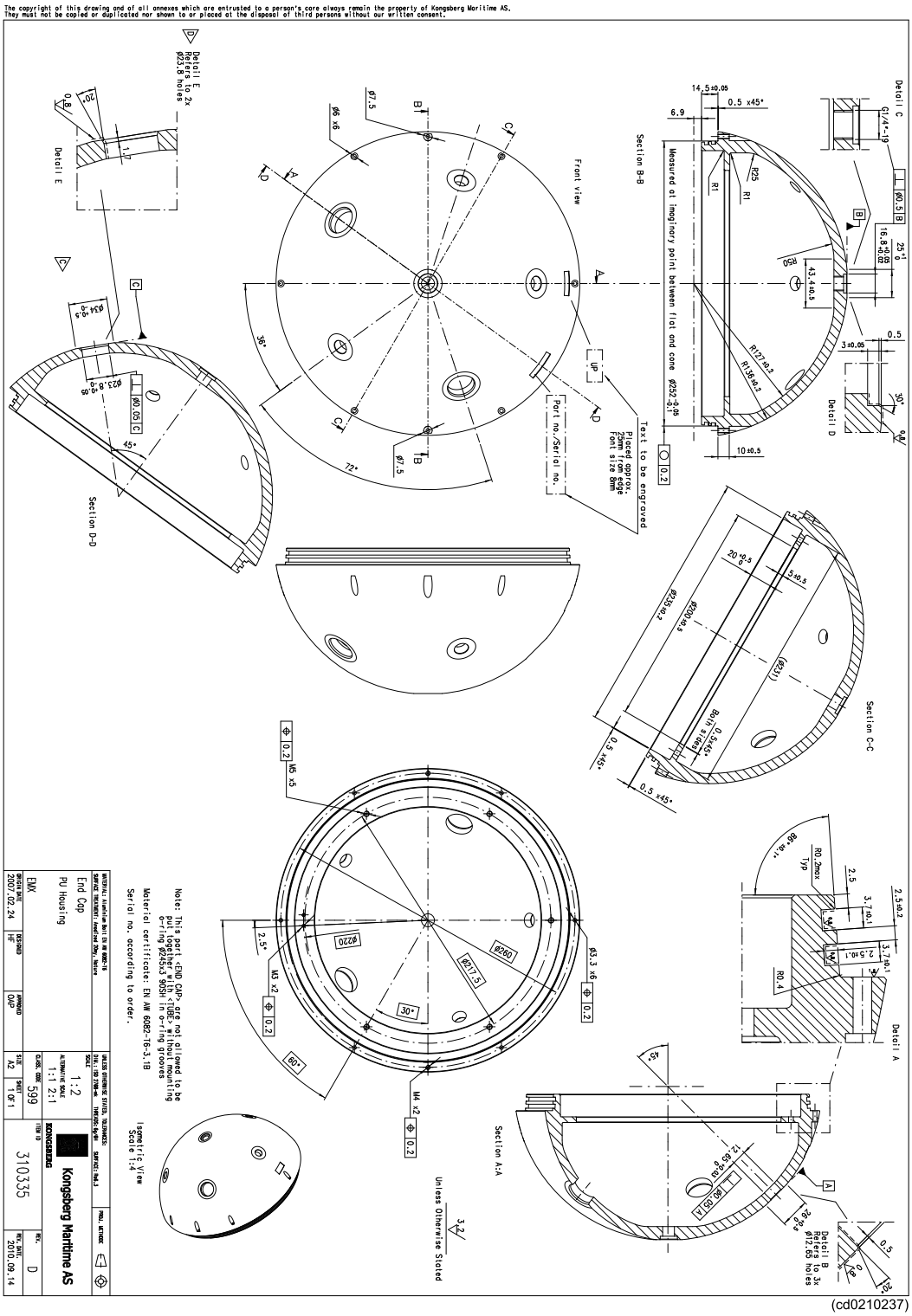
Figure 69 AUV PU cylinder– outline dimensions



(cd0210234b)

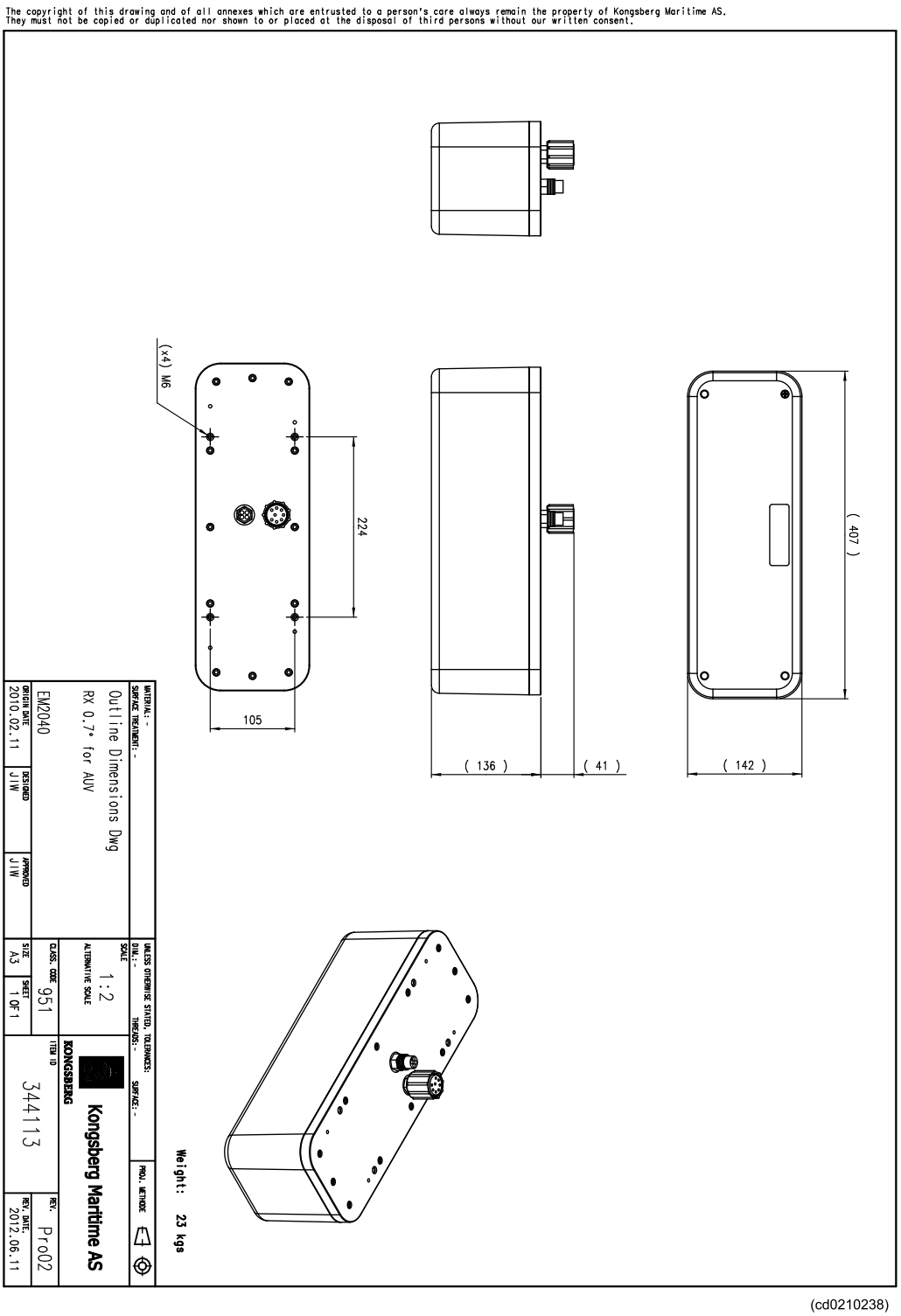
AUV PU cylinder end cap – Outline dimensions

Figure 70 AUV PU cylinder end cap – outline dimensions



Alternative 0.7 degree RX transducer for AUV – Outline dimensions

Figure 71 0.7 degree RX transducer for AUV – outline dimensions

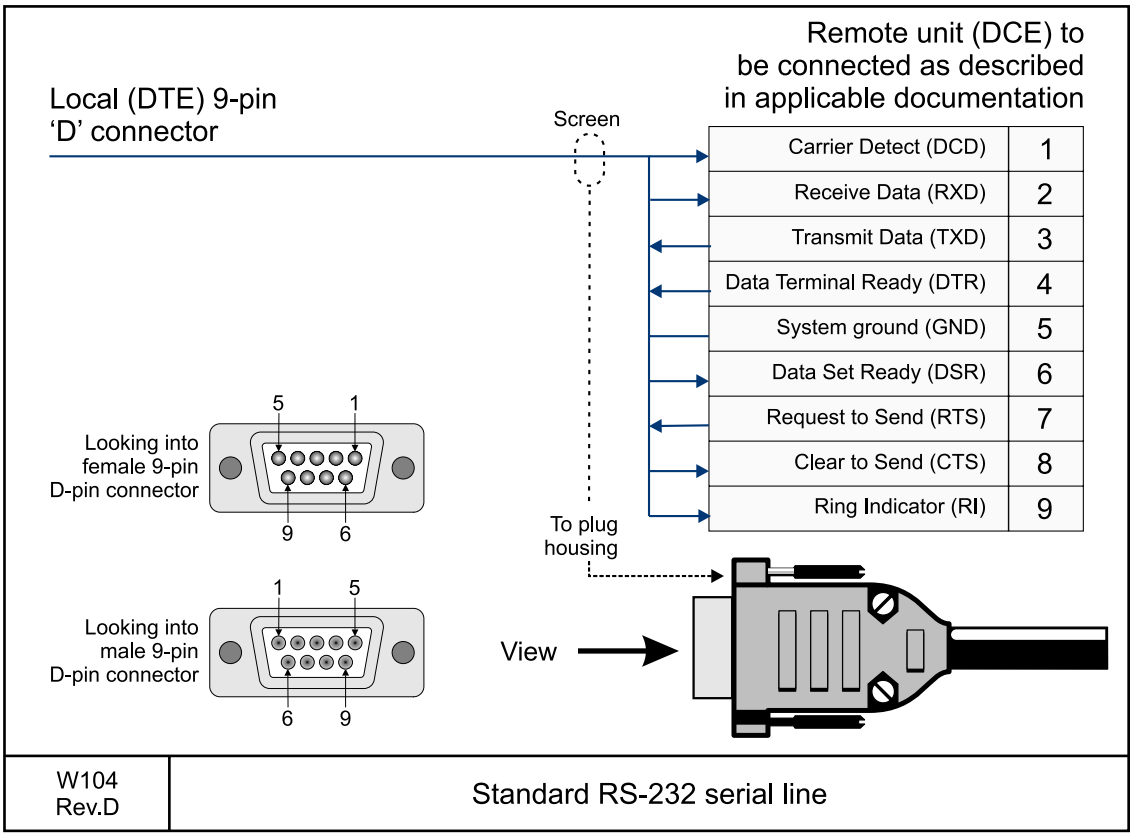


Cable drawings

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-connector, while the other connects to the peripheral **(DCE)** as described in the peripheral unit's documentation.

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

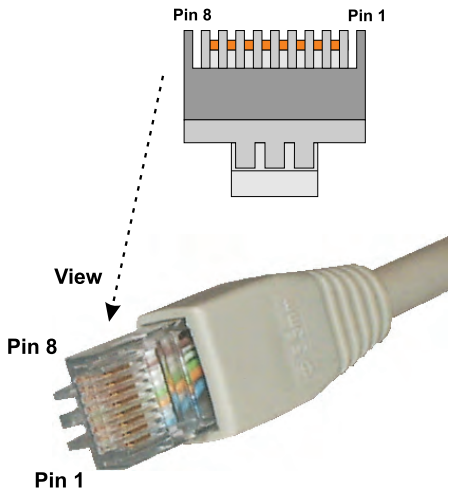


Cable specifications

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

RJ45 Serial interface

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.



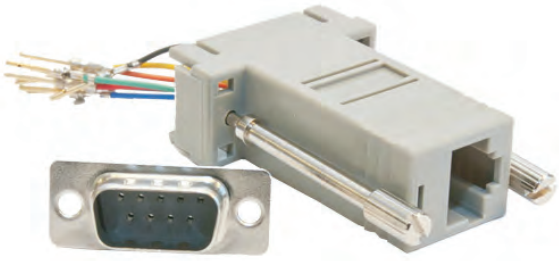
RJ45 plug

1	
2	
3	
4	GND
5	RxD
6	TxD
7	
8	

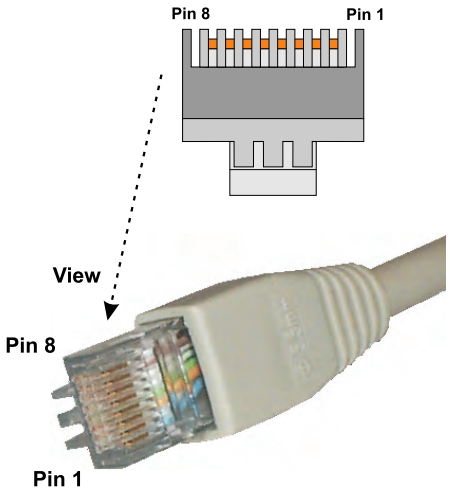
W146 Rev.C	RS232 pin assignment RJ45

Configurable RJ45 to DSUB serial interface adapter

To convert peripheral equipment providing serial data on a 9-pin delta plug a configurable adapter to convert to the RJ45 EM 2040 serial interface is provided. In order to allow for different DSUB interfaces the pins of the adapter is not terminated. Only the TxD, RxD and GND pins are used. Twisted pair cabling is sufficient.



RJ45 to 9 pin DSUB adapter



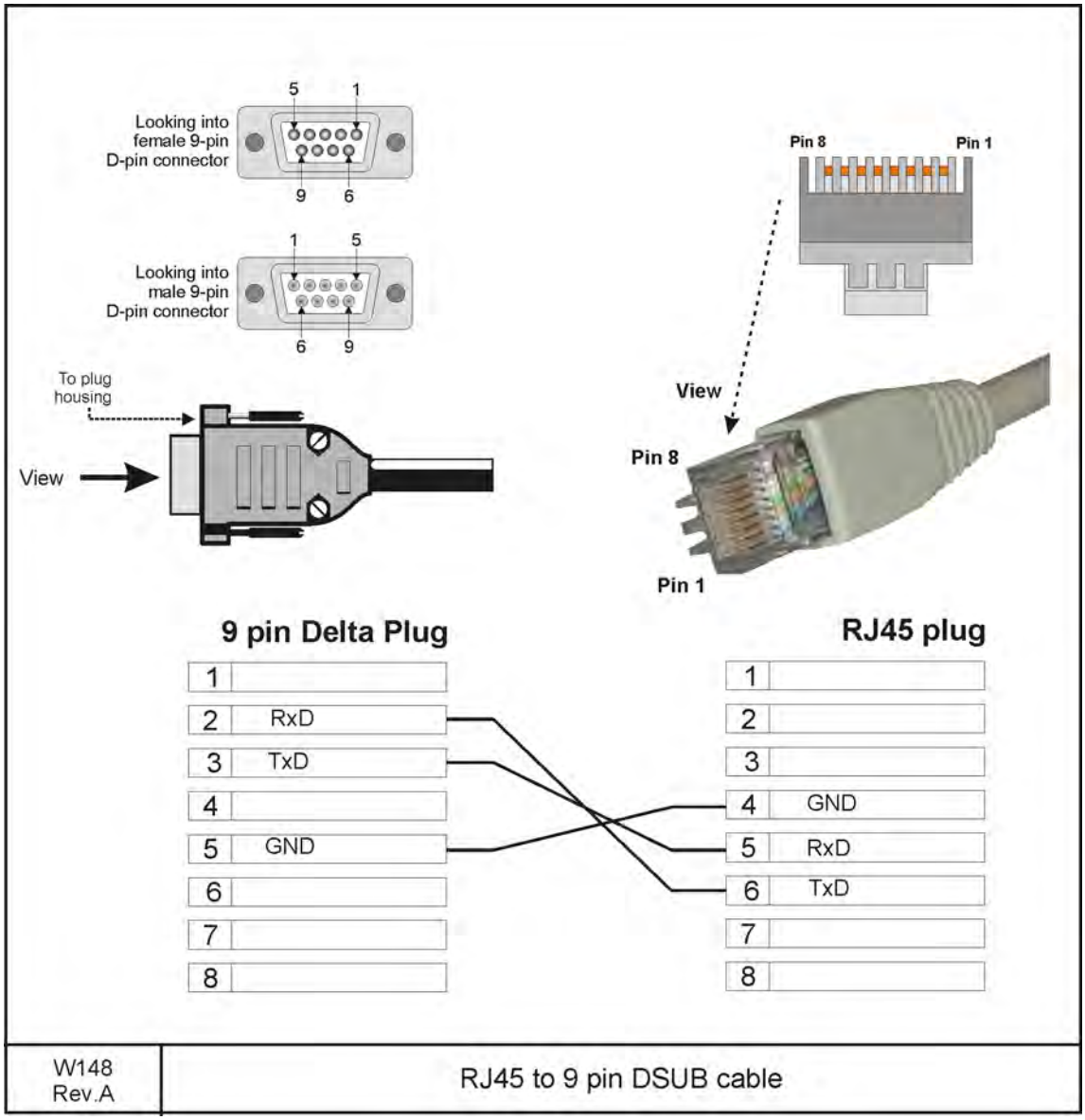
RJ45 serial plug

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

W147 Rev.A	EM 2040 RS232 pin assignment RJ45-9 pin DSUB adaptor

RJ45 to 9-pin DSUB direct serial cable

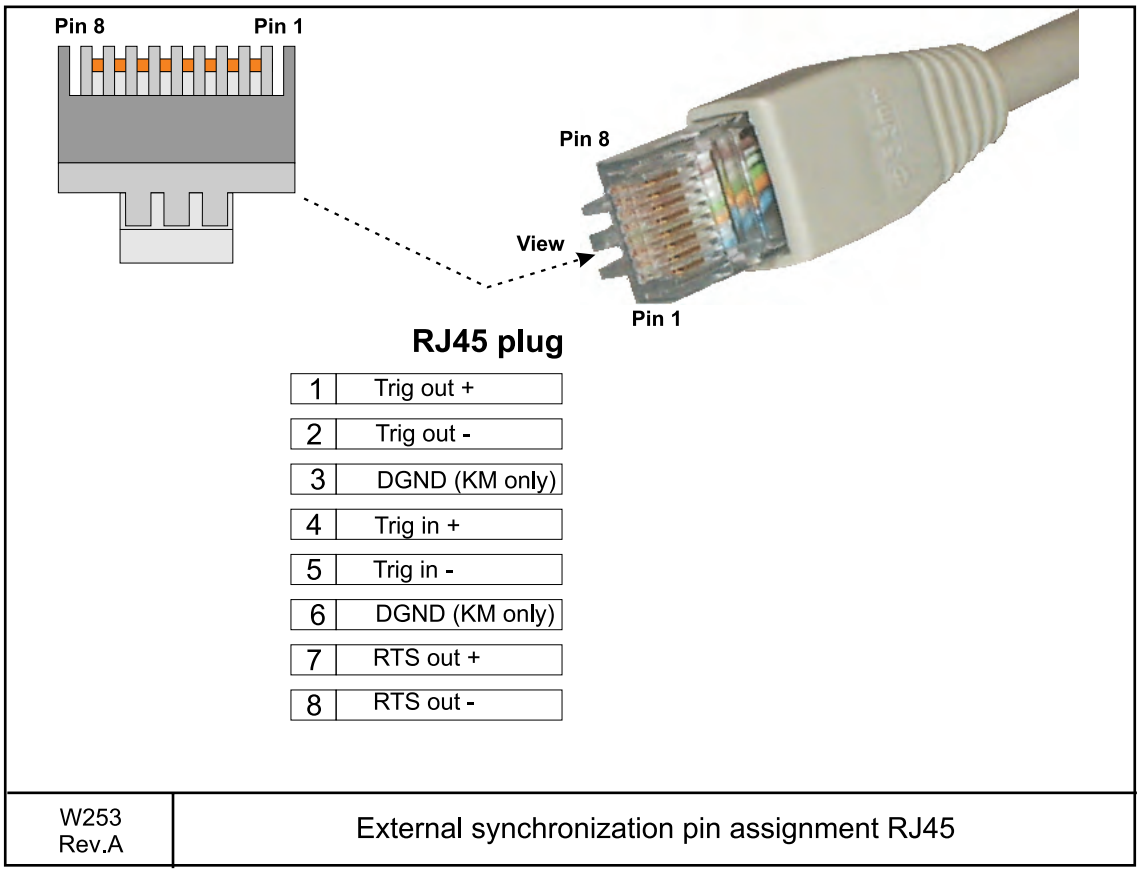
This cable can be used to connect peripheral units with serial data on 9-pin DSUB interface to the RJ45 serial interface plug of the EM 2040. One end of the cable connects to the processing unit with a RJ45 connector, while the other connects to the peripheral with a 9 pin delta plug. Only the TxD, RxD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



EM 2040 external synchronization interface

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

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

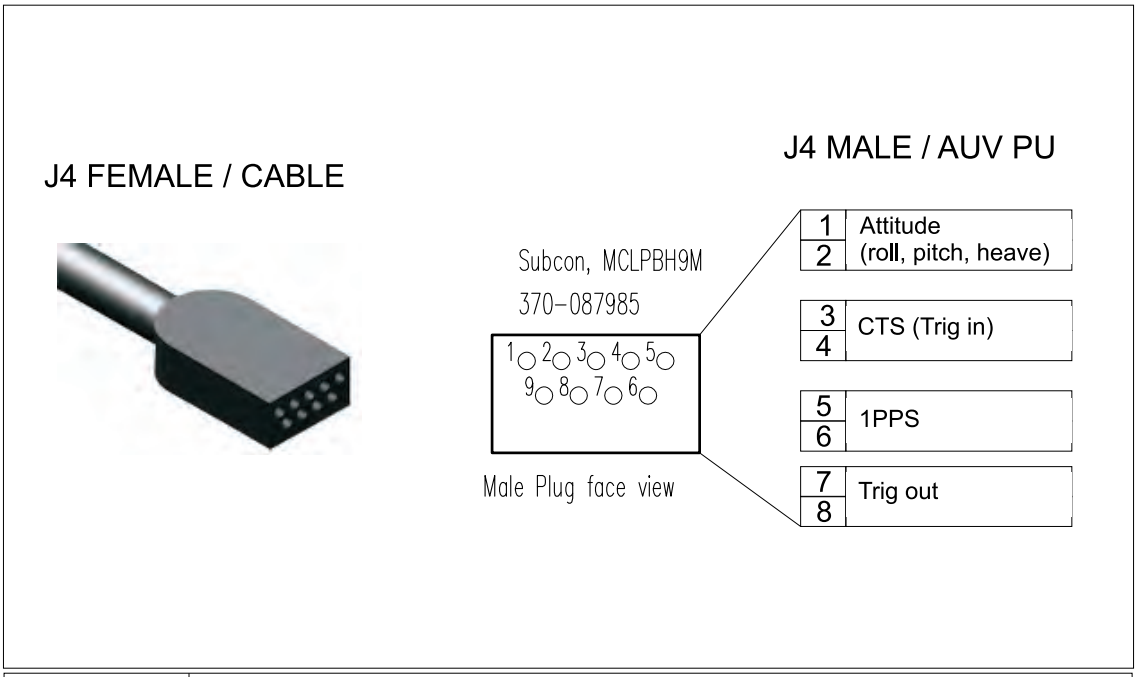


W253 Rev.A	External synchronization pin assignment RJ45

Cable specifications

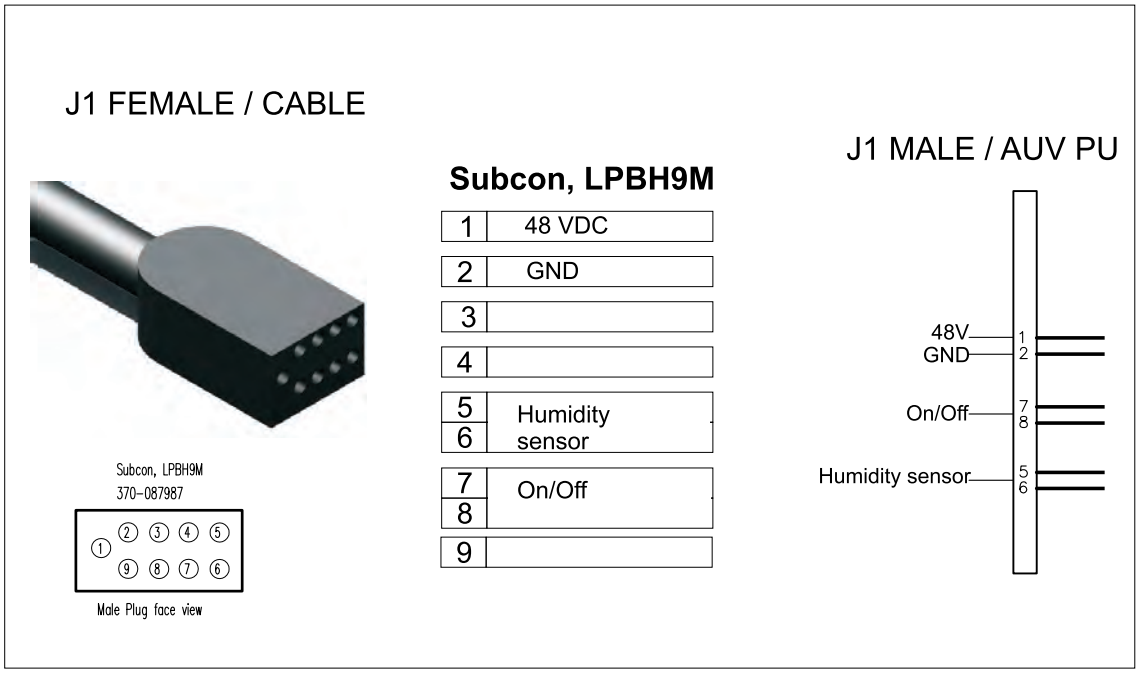
- Conductors: 5 x 2 x 0.5 mm²
- Screen: Screened twisted pairs and overall braided
- Voltage: 60 V
- Maximum diameter: Limited by the plugs

AUV PU synchronization cable



W254 dwg 352518 Rev.A	EM 2040 AUV PU external sensors, synchronization and 1PPS cable

AUV PU power cable



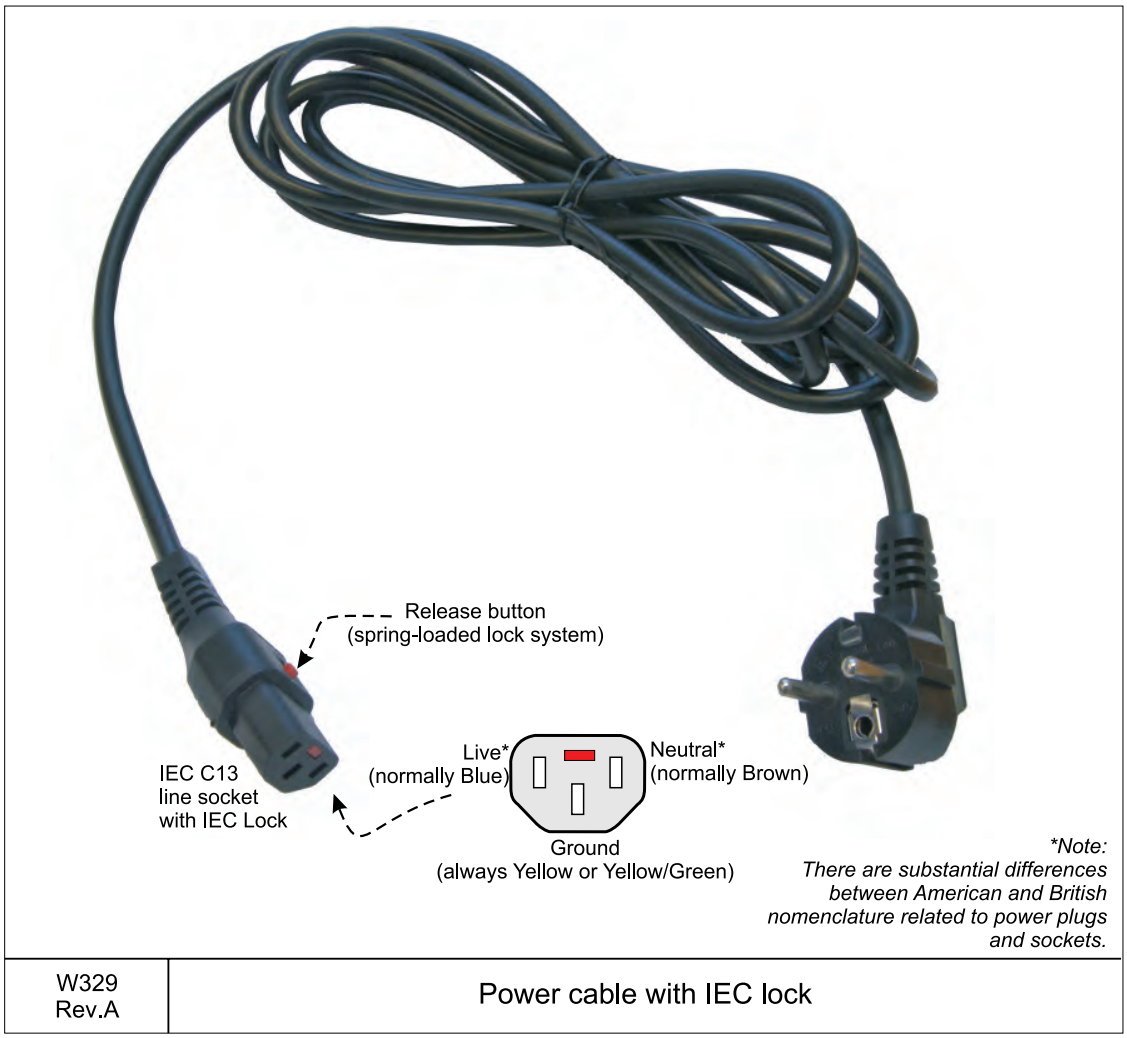
W328 dwg 352518 Rev.A	EM 2040 AUV PU power cable

Cable specifications

- **Number of pins**: 9

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.



W329 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

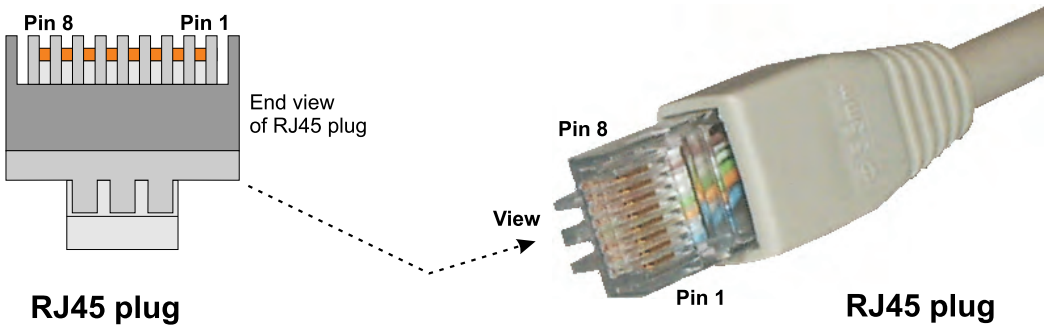
- **Conductors**: 2 x 1.5 mm² + GND
- **Screen**: None
- **Voltage**: 750 V
- **Maximum diameter**: Set by the plugs

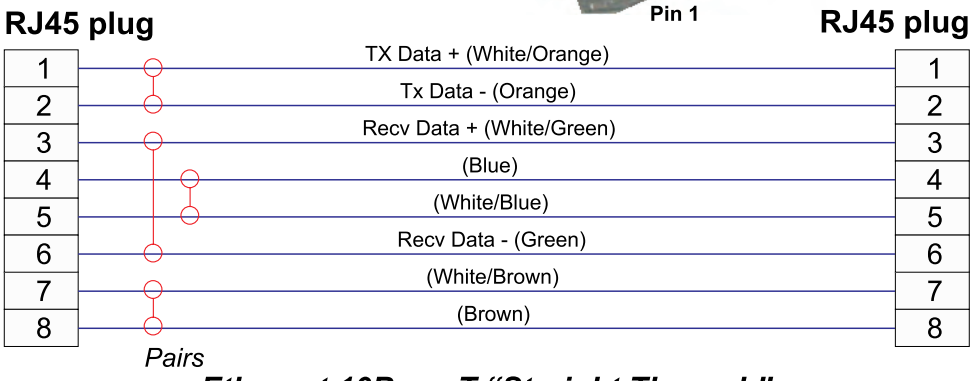
More information

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

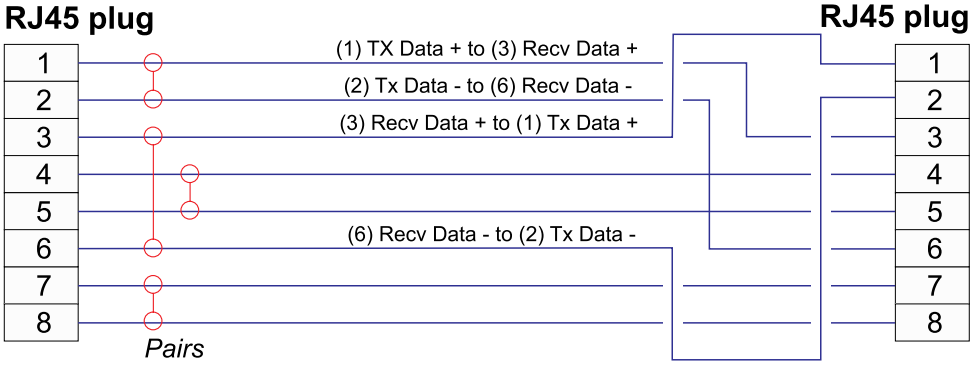
Ethernet with RJ45 plugs (screened)

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"

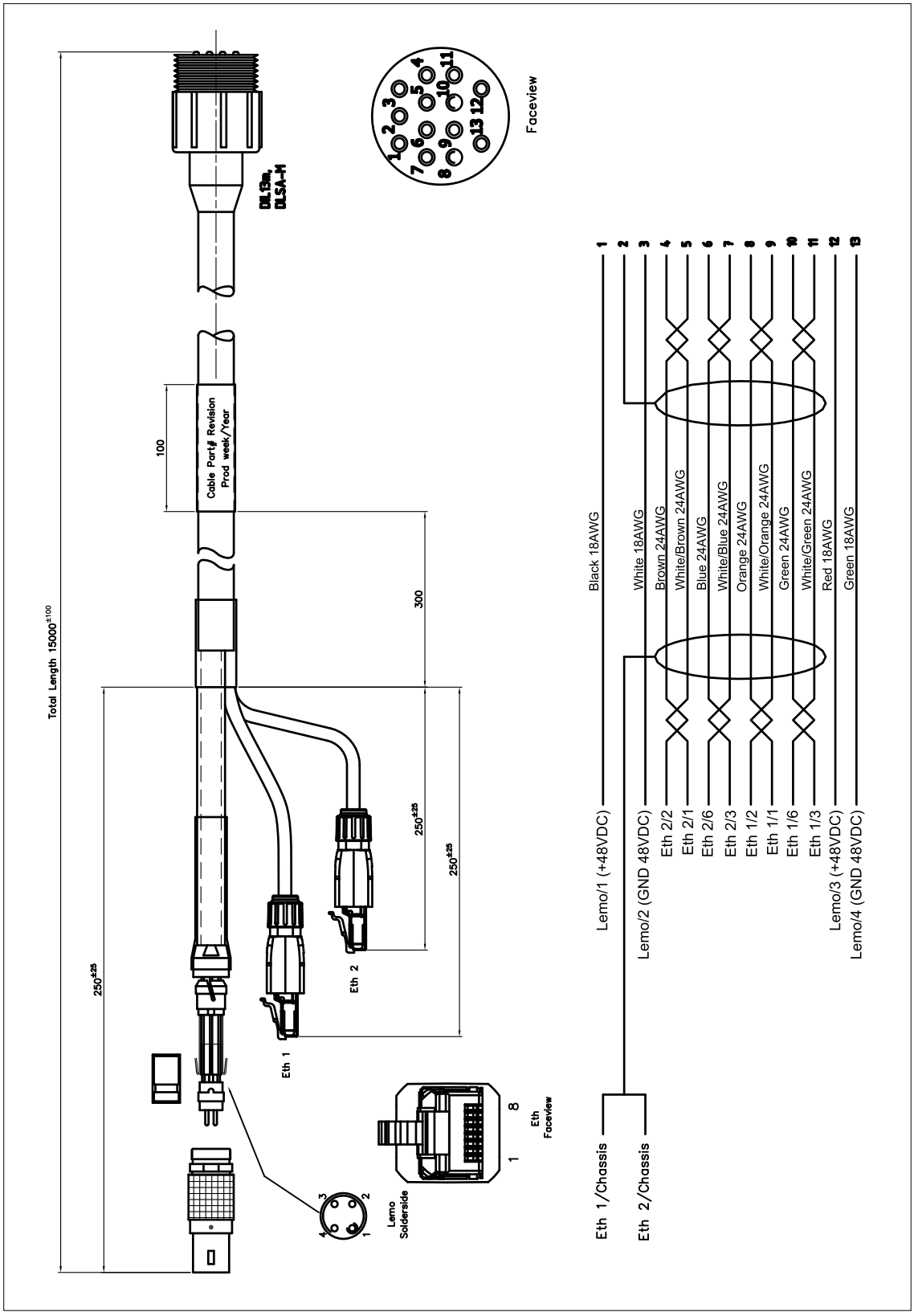
The "crossover" cable is used to cascade HUBs, or for connecting two ethernet stations or computers back-to-back without a HUB)

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 2040 TX transducer cable



W827 Rev.B dwg 348012	EM 2040 TX transducer cable - 15 m

Cable specifications

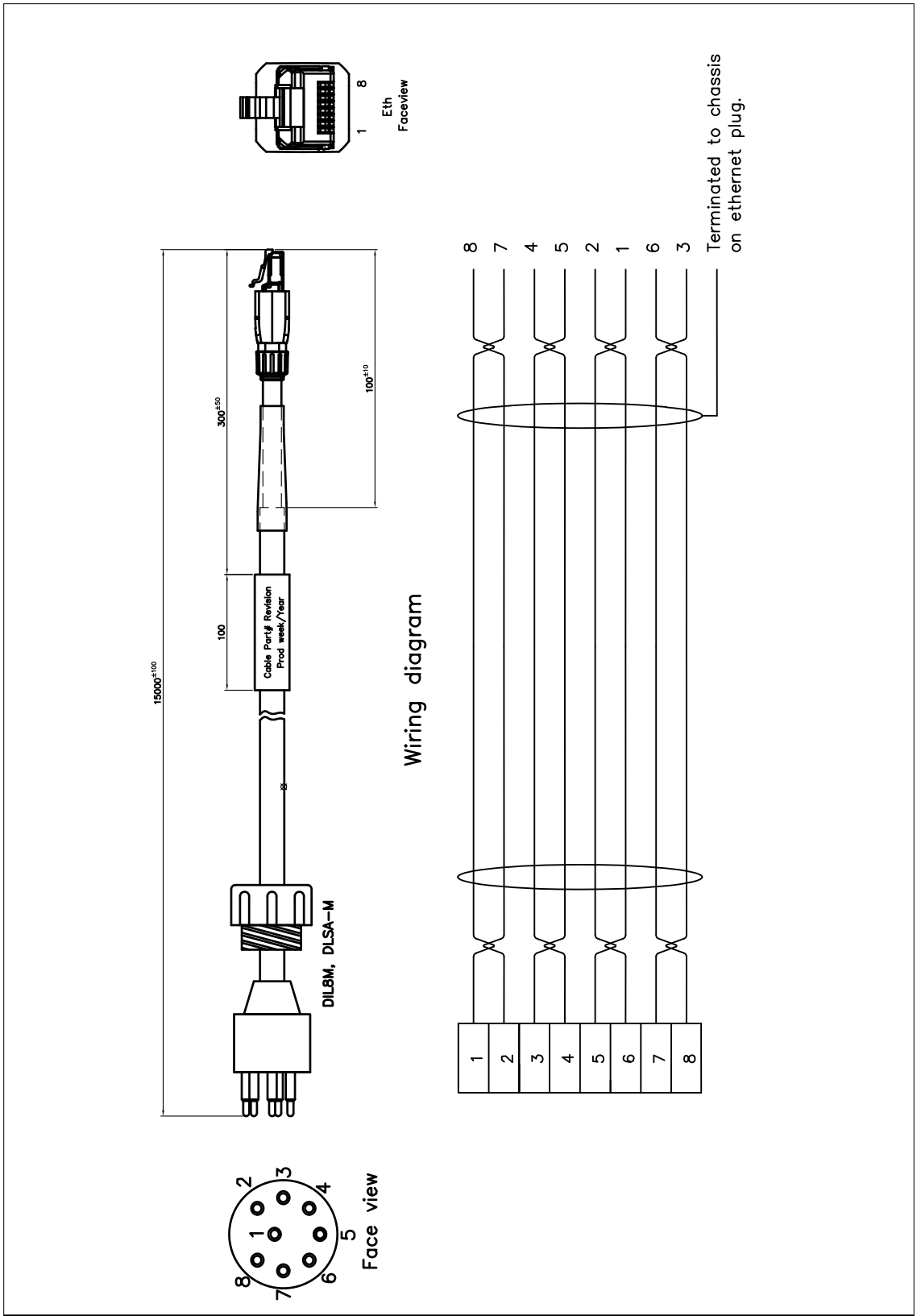
- SubConn® Power/Ethernet Cable, Type *D/P-P4TP24#/4C18#*
- 13 pin with 4 Ethernet TPs, 4 power conductors and 1 screen
- Cable length: 15, 30 and 50 meters
- Cable diameter: 13.97 mm nom.
- Diameter DSLA locking sleeve: 36 mm
- Weight in air: 75 kg/km nom.
- Weight in sea water: 27 kg/km nom.
- Min. bending radius: 100 mm
- Depth rating: 6000 metres
- Screen: Overall braided
- Voltage:
  - Power conductor: 600V, max. 4 amp
  - Twisted pairs: 250V, max. 1 amp

The following procedures should be followed 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.

EM 2040 RX transducer cable



W828 Rev.A dwg 348011	EM 2040 RX transducer cable - 15 m

Cable specifications

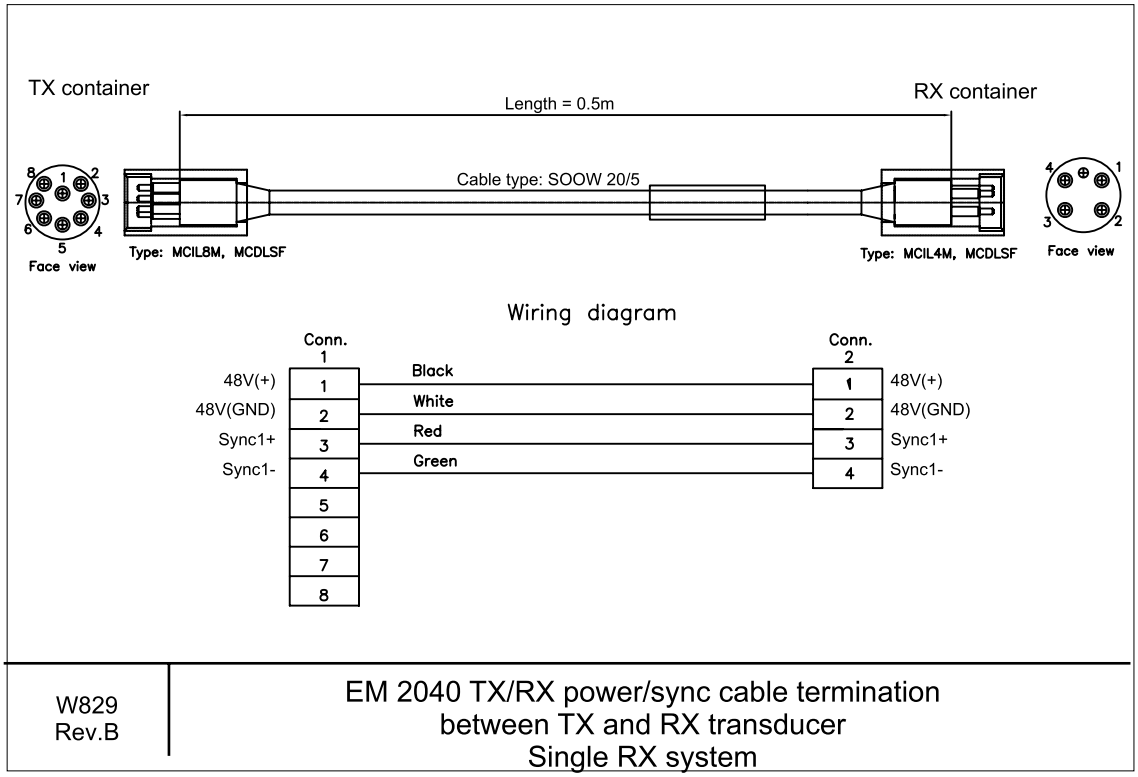
- SubConn® Ethernet Cable, Type *D-P4TP24#*
- 8 pin with 4 Ethernet TPs
- Cat6 Ethernet cable
- Cable length: 15, 30 and 50 meters
- Cable diameter: 10.4 mm nom.
- Diameter DSLA locking sleeve: 36 mm
- Weight in air: 140 kg/km nom.
- Weight in sea water: 53 kg/km nom.
- Min. bending radius: 100 mm
- Depth rating: 6000 metres
- Screen: Overall braided
- Voltage: 250V max. 1 amp

The following procedures should be followed 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.

EM 2040 TX to RX transducer cable



Cable specifications

- MCIL8M, MCDLSF connector in TX end
- MCIL4M, MCDLSF connector in RX end
- Power and synchronization cable
- TX end connector diameter:
- RX end connector diameter:
- Cable length: 0.5 or 1.5 meters
- Depth rating: 6000 metres
- Screen: Overall braided
- Voltage: 250V max. 1 amp

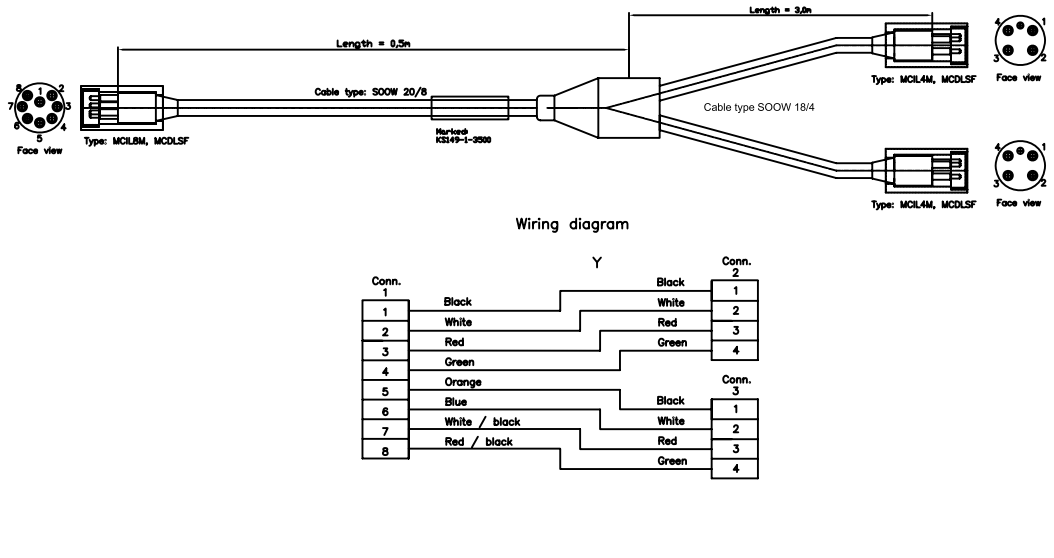
The following procedures should be followed when using the SubConn® underwater connectors:

- 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.

EM 2040 TX to dual RX transducer cable



W830 Rev.B	EM 2040 TX to RX transducer cable termination Dual RX system

Cable specifications

- Manufactured by MacArtney Underwater Technology
- MCIL8M, MCDLSF connector in TX end
- MCIL4M, MCDLSF connector in RX end
- Power and synchronization cable
- TX end connector diameter, with locking sleeve: 22 mm
- RX end connector diameter, with locking sleeve: 22 mm
- Cable length: 0.5 + 3.0 meters or 0.5 + 1.0 meters
- Depth rating: 6000 metres
- Screen: Overall braided
- Voltage: 250V max. 1 amp

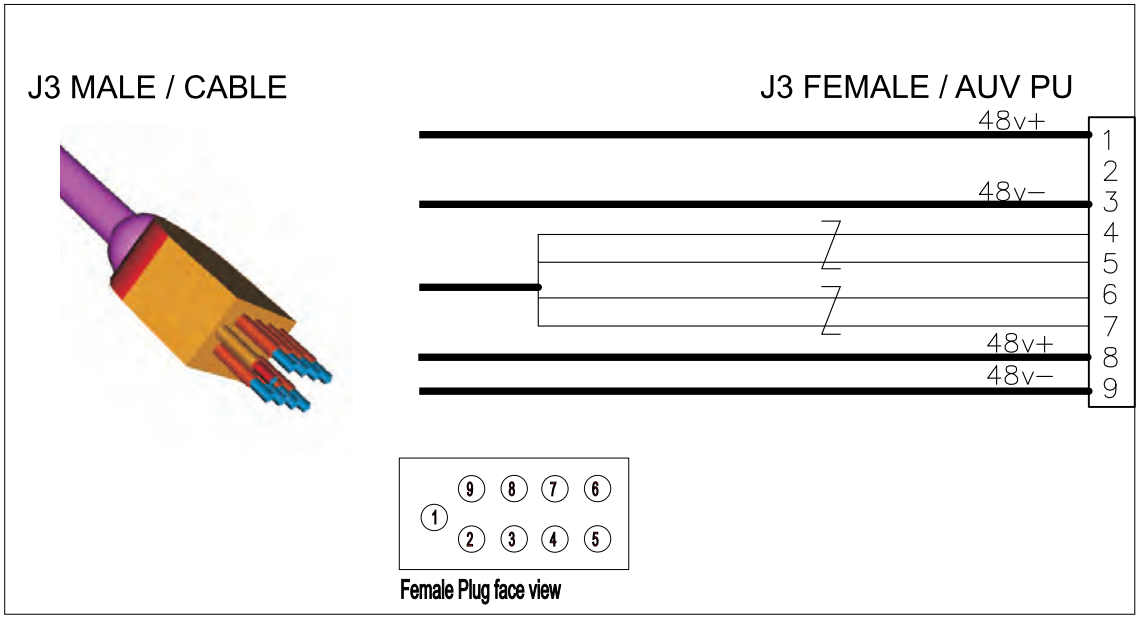
The following procedures should be followed when using the SubConn® underwater connectors:

- 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.

AUV PU TX transducer cable



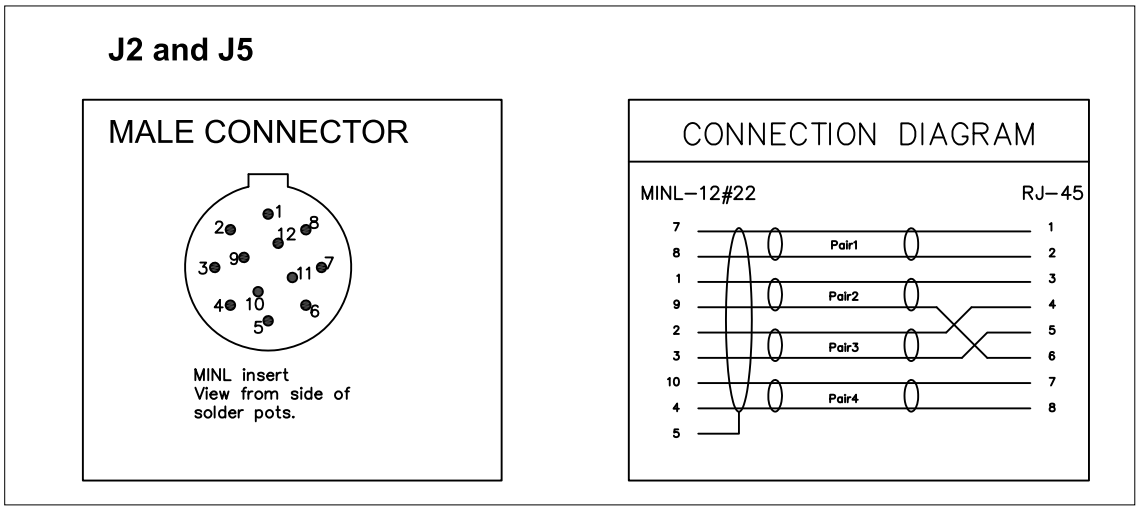
W831 dwg 352518 Rev.B	EM 2040 AUV PU TX Transducer cable

The following procedures should be followed 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.

AUV PU Gigabit cable



W832 dwg 330401 Rev.A	EM 2040 AUV PU Gigabit cable

Appendix A
General safety rules

The Kongsberg EM 2040 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 187.

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.

Appendix D Alignment report template

Topics

General information

Table 17 Scope of work

Sensor/system	Position	Heading	Roll	Pitch	Flatness

Table 18 Personnel

Name	Position and responsibilities

Table 19 Equipment

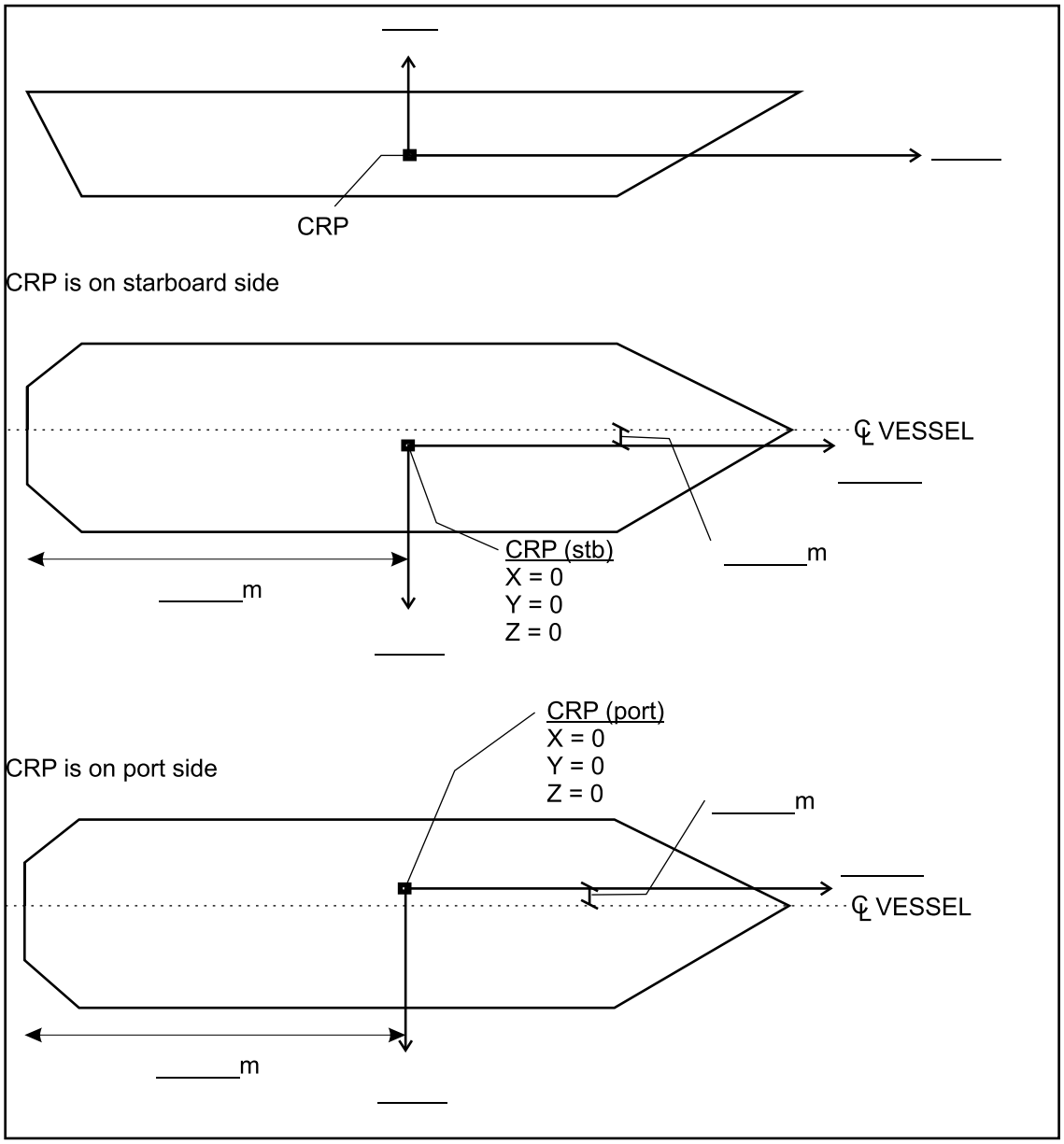
Make and model	Certificate expiry date

Vessel coordinate system

Table 20 Coordinate reference system definition

	Definition / description
Origin point	
X-axis	
X-axis is positive	
Y-axis	
Y-axis is positive	
Z-axis	
Z-axis is positive	
Vessel reference plane	
Additional description of vessel coordinate system	

Figure 72 Vessel reference system definition



Instructions

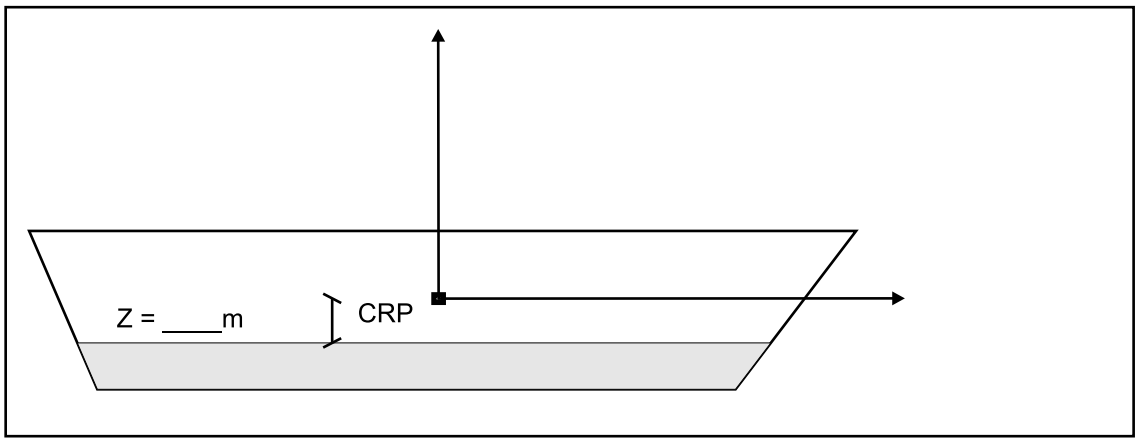
- Use only the sketch that applies to your CRP location, i.e. CRP on port or starboard side
- Enter definition of axes, i.e. which of the axes is X-axis, which is Y-axis and to what direction is the Z-axis pointing
- Enter distance to CRP from vessel centre line and from vessel stern, alternatively from other physical definable locations of the vessel

Waterline

Table 21 Waterline observations

Point no.	Z	Point description
Remarks		

Figure 73 Waterline



Instructions

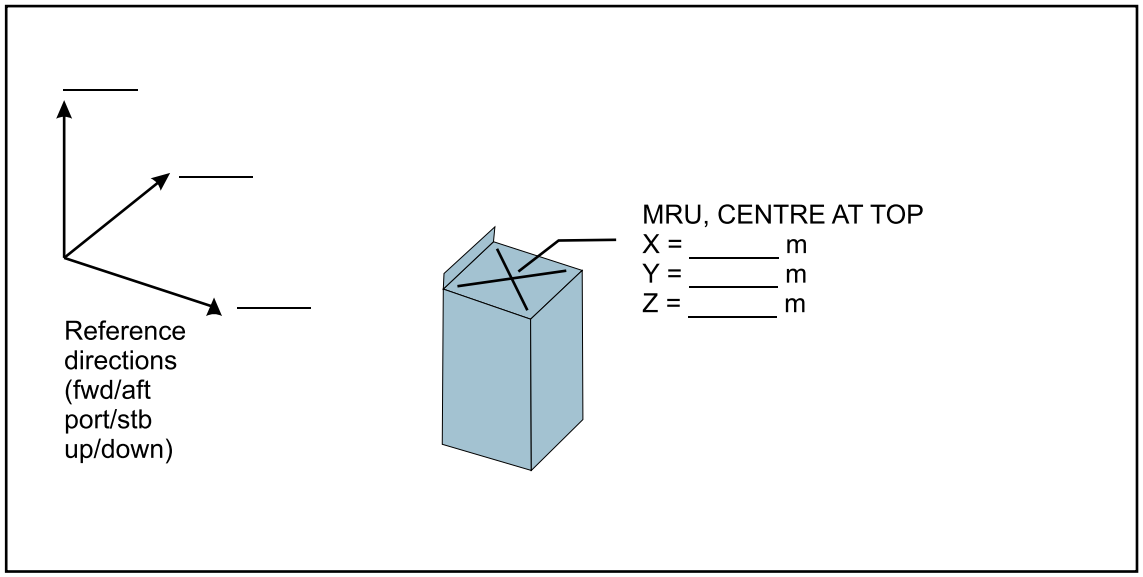
- Indicate all survey points used to define the waterline
- Enter Z value of waterline
- Enter definition of axes (forward and up)

Motion reference unit

Table 22 Motion sensor alignment

	MRU	Survey accuracy
x		
y		
z		
roll		
pitch		
yaw		
Remarks		

Figure 74 MRU position

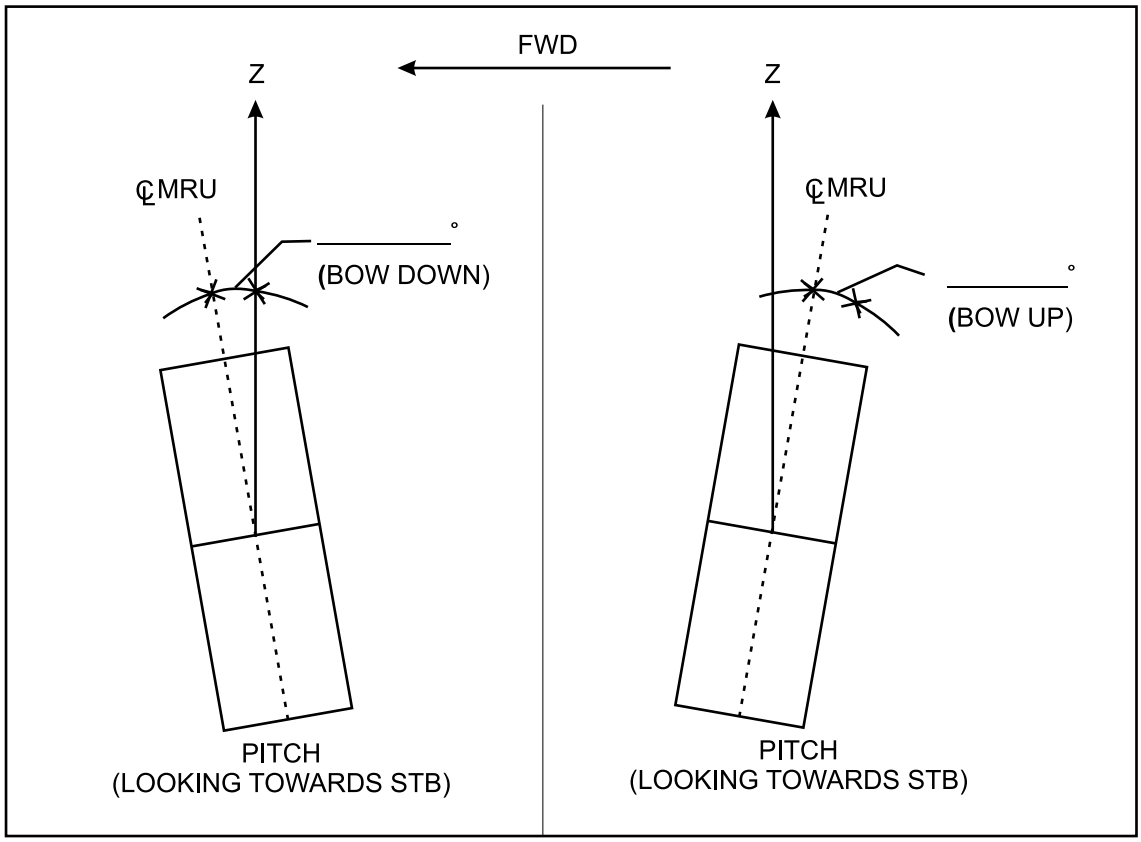


(cd029005)

Instructions

- Enter distances from CRP along the defined X-, Y- and Z-axes
- Indicate reference directions of the MRU installation that clarifies which way the unit is mounted

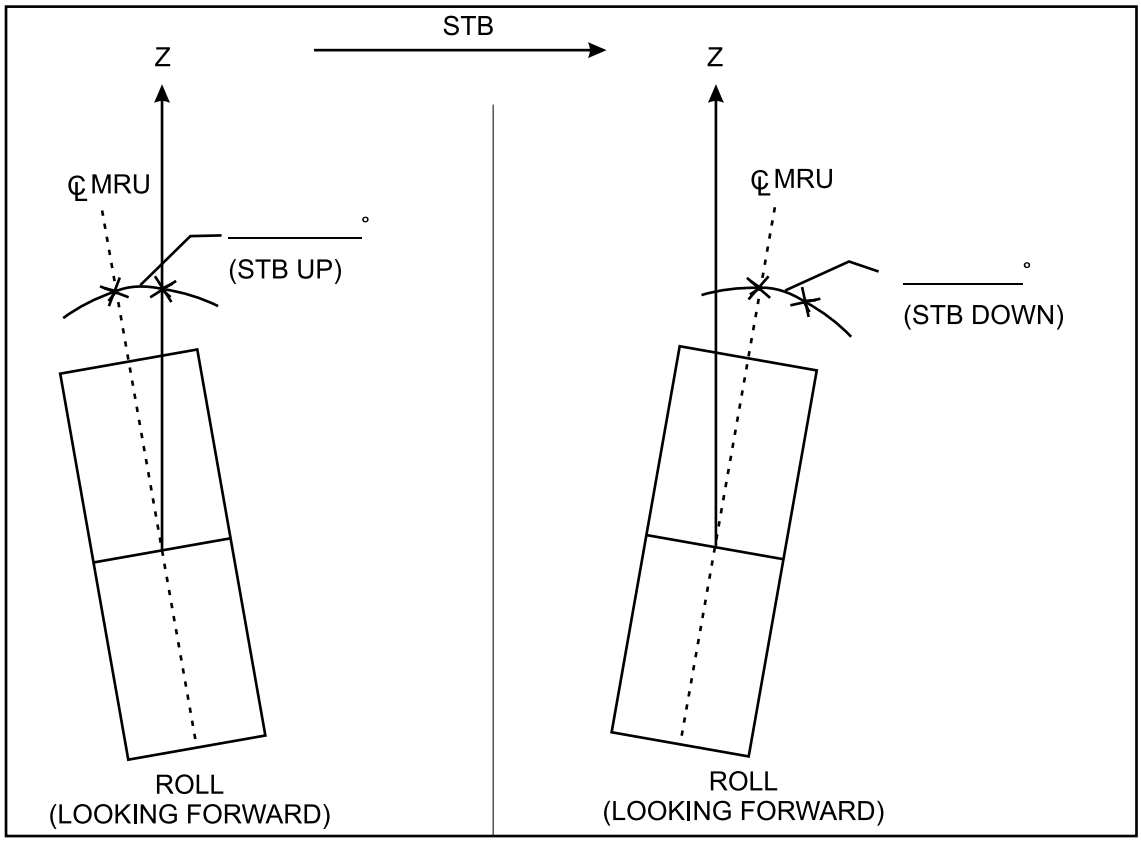
Figure 75 MRU pitch



Instructions

- Use only the sketch that applies to your MRU installation, i.e. pointing down in bow (fore) or aft direction
- Enter angle between MRU centre axis and vessel coordinate Z-axis along the fore-aft direction

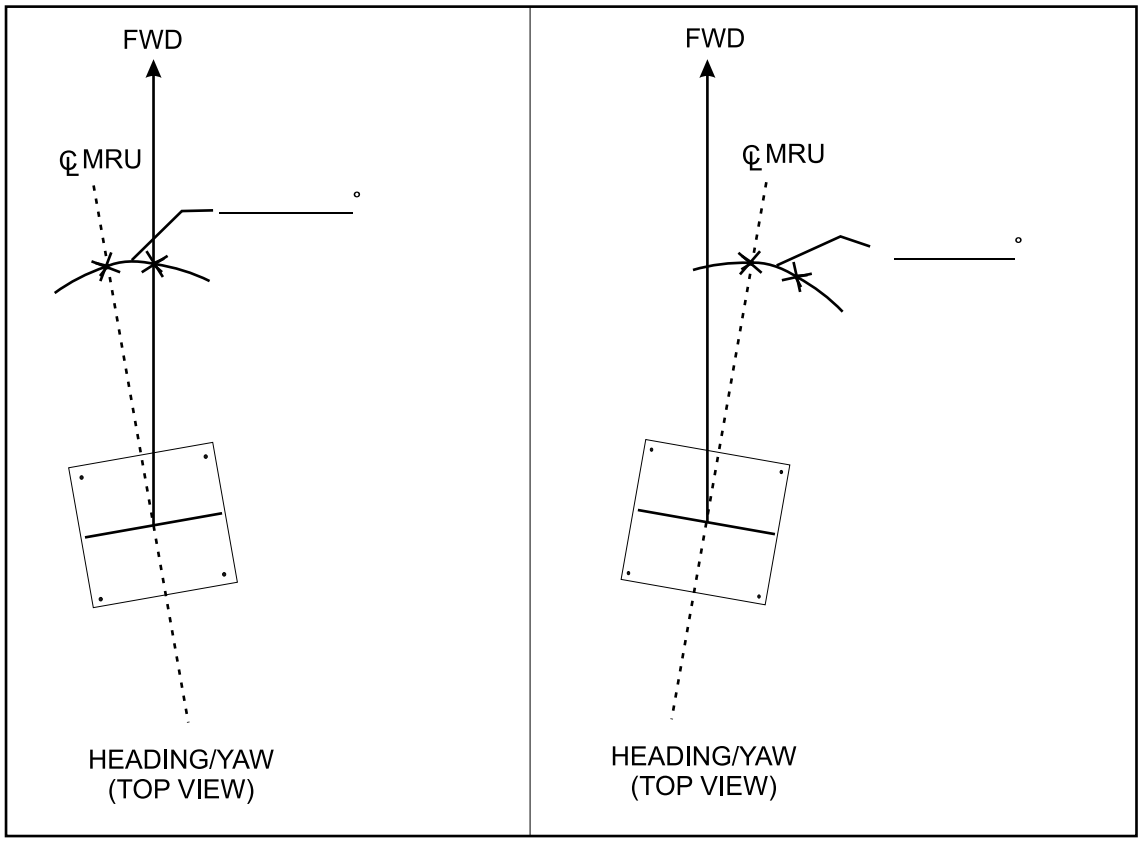
Figure 76 MRU roll



Instructions

- Use only the sketch that applies to your MRU installation, i.e. pointing down in port or starboard direction
- Enter angle between MRU centre axis and vessel coordinate Z-axis along the port-stb direction

Figure 77 MRU heading/yaw



Instructions

- Use only the sketch that applies to your MRU installation, i.e. pointing to port or starboard side of the vessel centre line
- Enter angle between MRU centre axis and vessel coordinate forward axis along as seen from above

GPS heading sensor

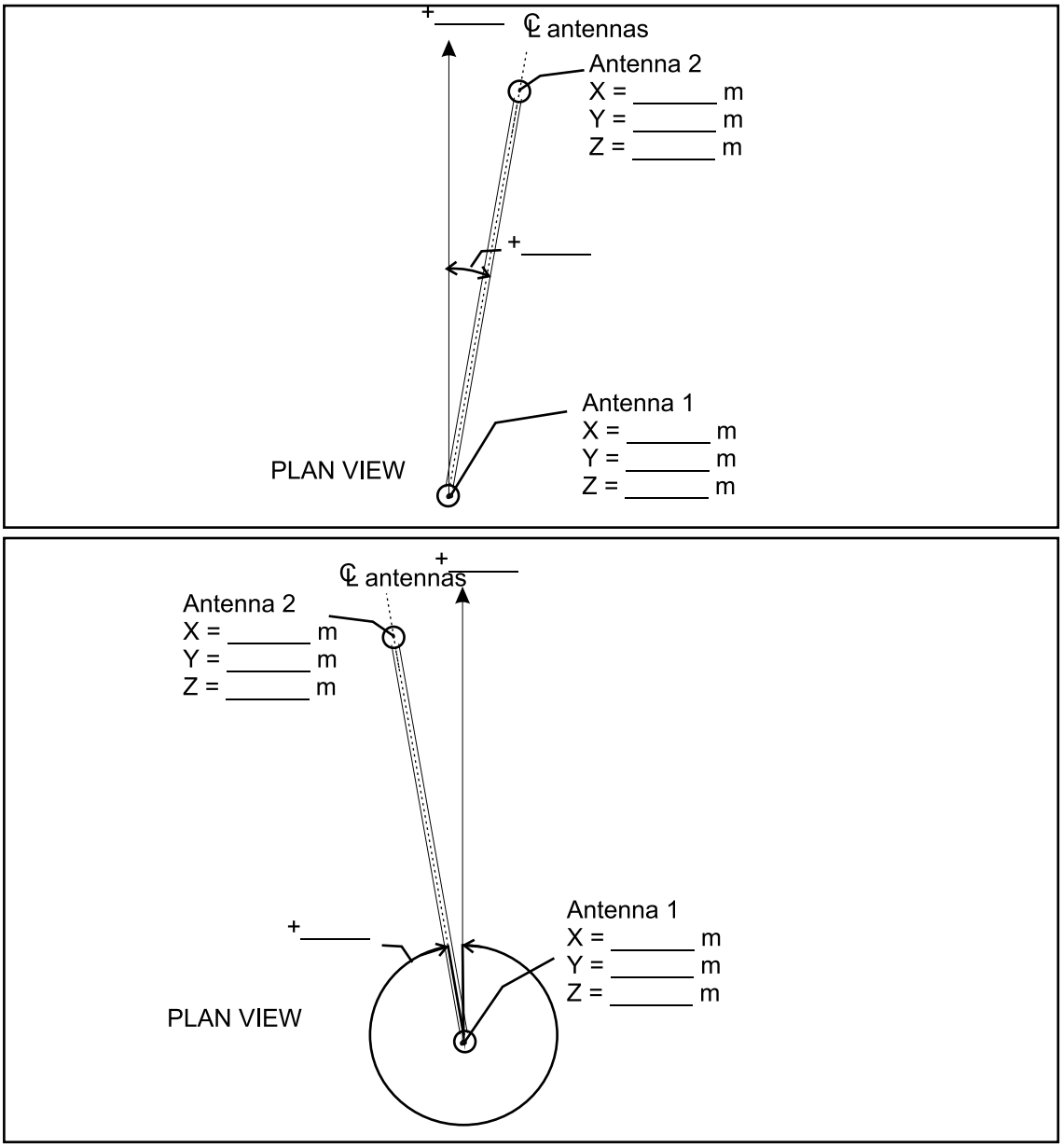
Note

Applies to any system that uses GPS/GNSS for heading determination, e.g. Seapath and POSMV.

Table 23 GPS heading alignment (Seapath, POSMV, etc.)

	Antenna 1	Survey accuracy
x		
y		
z		
	Antenna 2	Survey accuracy
x		
y		
z		
	Heading (1-2)	Survey accuracy
Heading rel. vessel ref. system		
Remarks		

Figure 78 GPS heading



Instructions

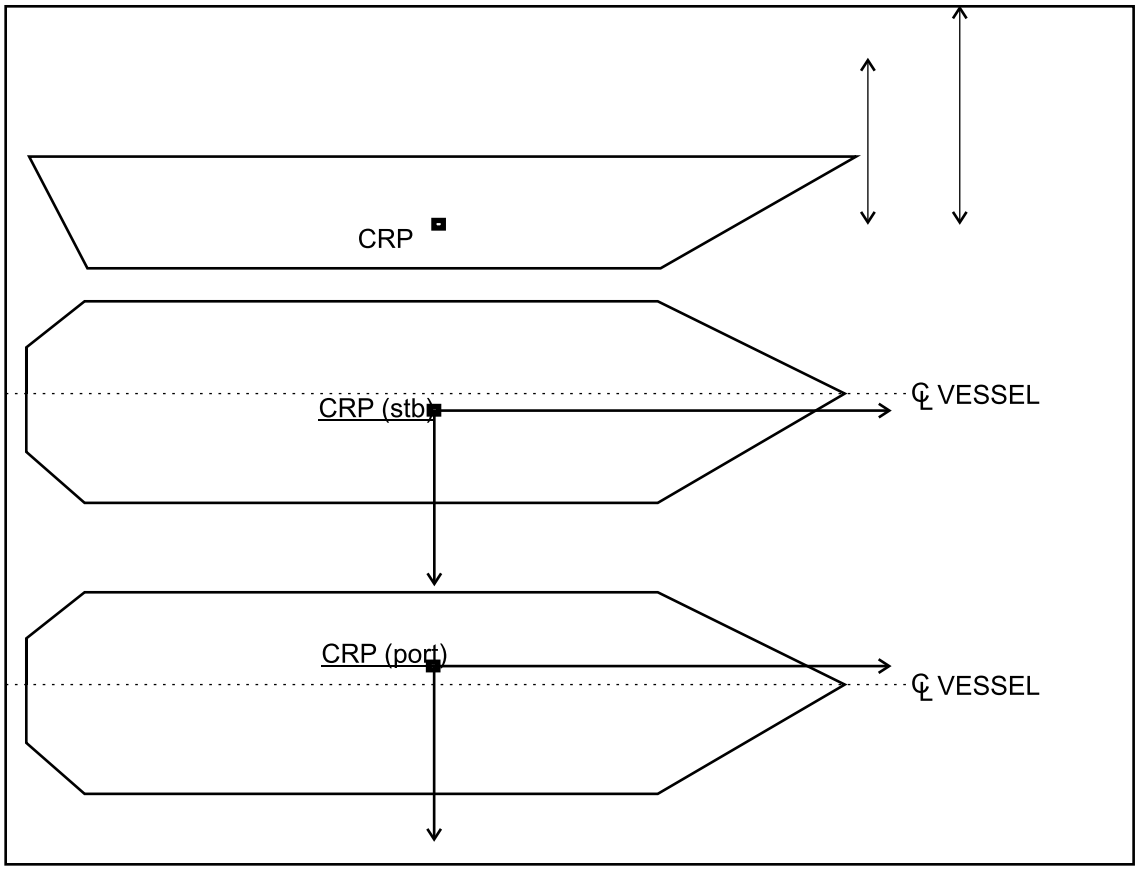
- Use only the sketch that applies to your installation, i.e. pointing port or starboard as seen from above
- Enter reference direction, i.e. whether antenna direction referred to X or Y direction (forward or sideways)
- Enter angle between antenna centre axis and reference axis
- Enter distances from CRP along the defined X-, Y- and Z-axes

Position sensor

Table 24 Position sensor alignment summary

	Antenna 1	Accuracy
x		
y		
z		
	Antenna 2	Accuracy
x		
y		
z		
	Antenna 3	Accuracy
x		
y		
z		
	Antenna 4	Accuracy
x		
y		
z		
	Antenna 5	Accuracy
x		
y		
z		

Figure 79 Position system



Instructions

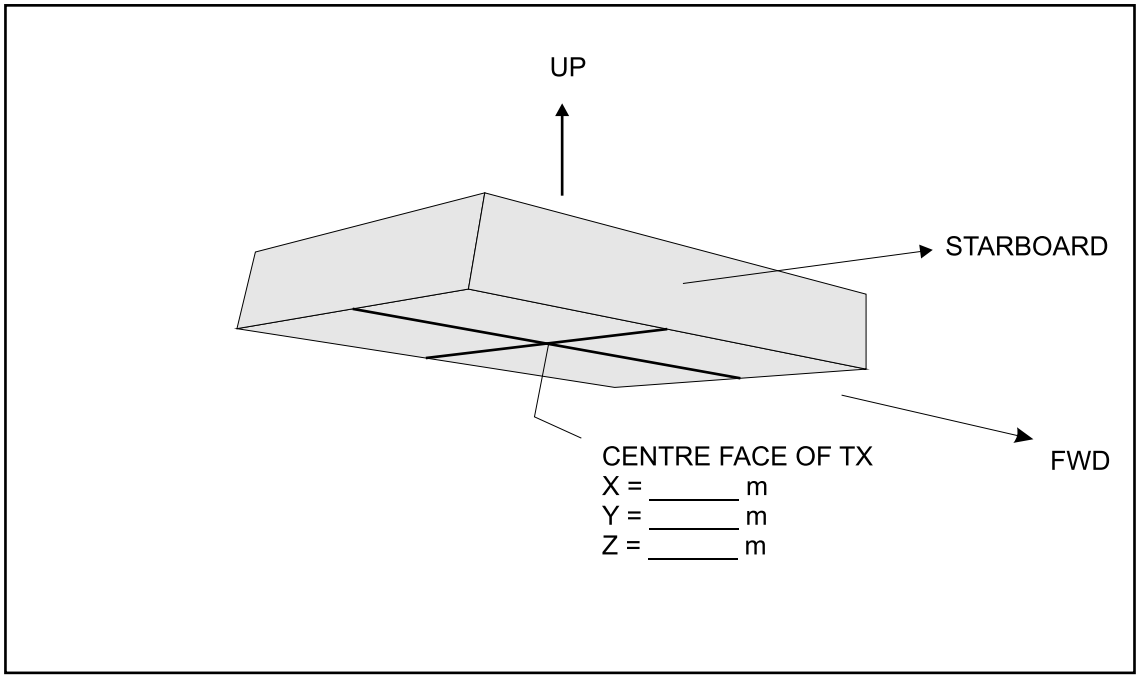
- Use only the sketch that applies to your installation, i.e. CRP on port or starboard side of vessel centre line
- Indicate all antenna locations on sketch, both height and as seen from above
- Enter definition of axes

TX transducer array

Table 25 TX transducer array

	TX	Survey accuracy
x		
y		
z		
roll		
pitch		
yaw		
Remarks		

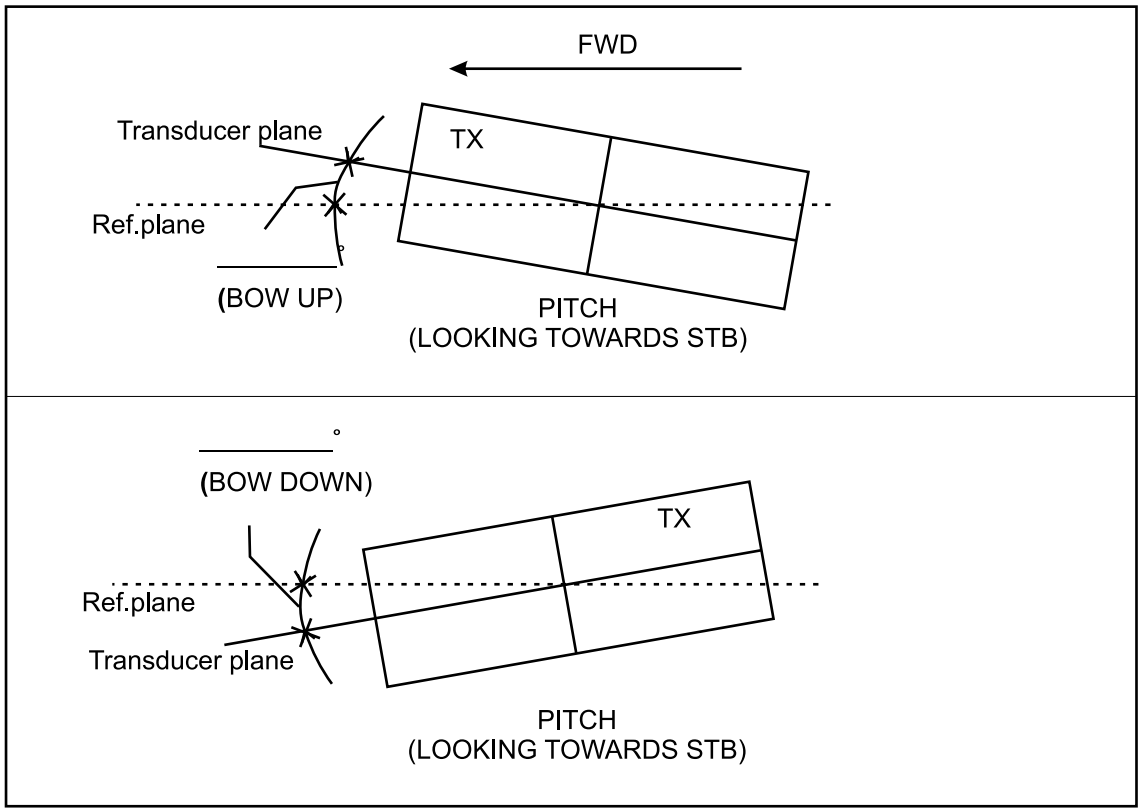
Figure 80 TX position



Instructions

- Enter distances from CRP along the defined X-, Y- and Z-axes

Figure 81 TX pitch

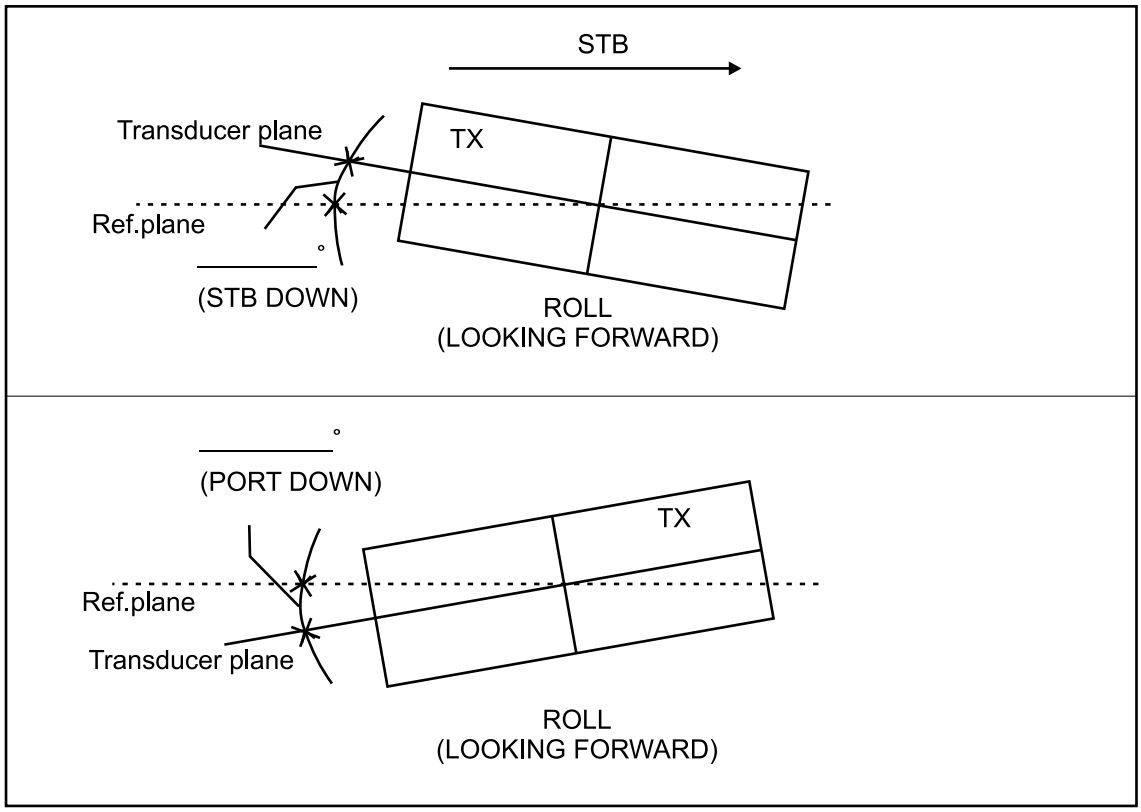


(cd029011-01)

Instructions

- Use only the sketch that applies to your TX array installation, i.e. pointing down in bow (fore) or aft direction
- Enter angle between transducer plane and vessel reference axis along the fore-aft direction
- Enter definition of fore-aft direction (X or Y)

Figure 82 TX roll

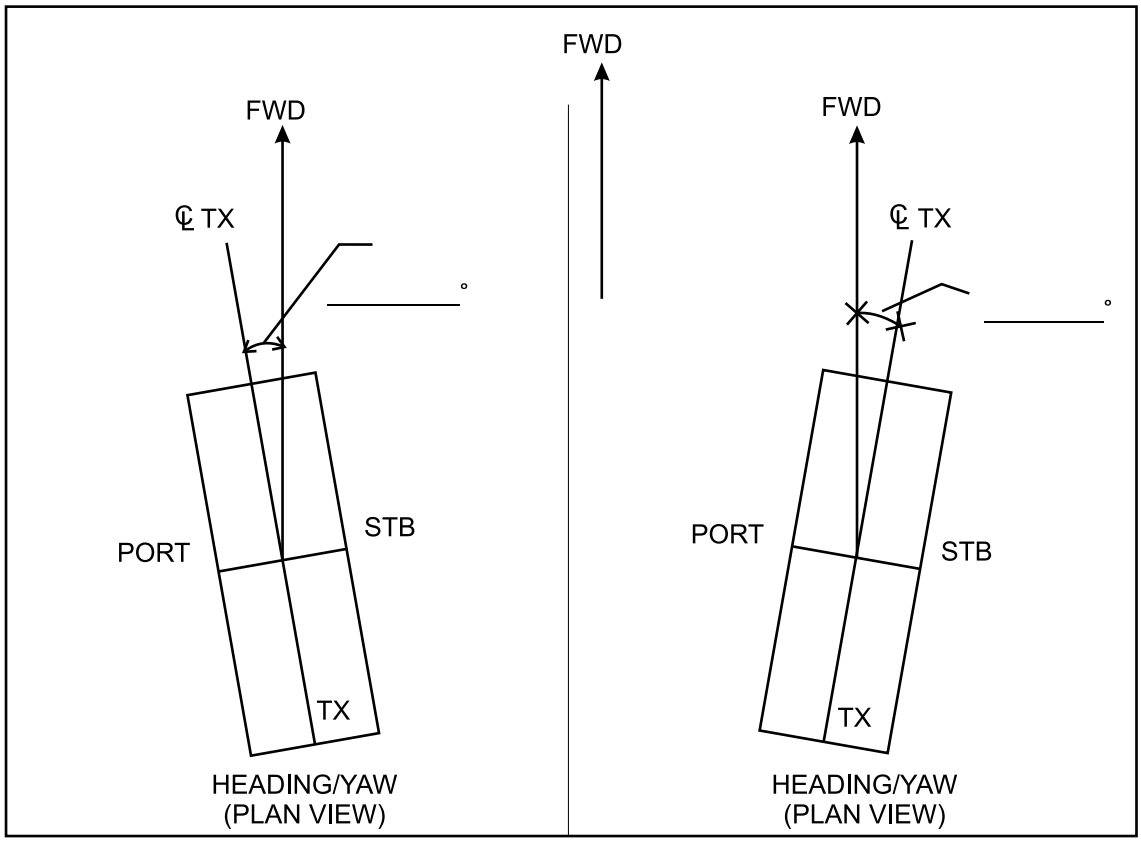


(cd029011-02)

Instructions

- Use only the sketch that applies to your TX array installation, i.e. pointing down on port or starboard side
- Enter angle between transducer plane and vessel reference axis along the port-stb direction
- Enter definition of port-stb direction (X or Y)

Figure 83 TX heading/yaw



Instructions

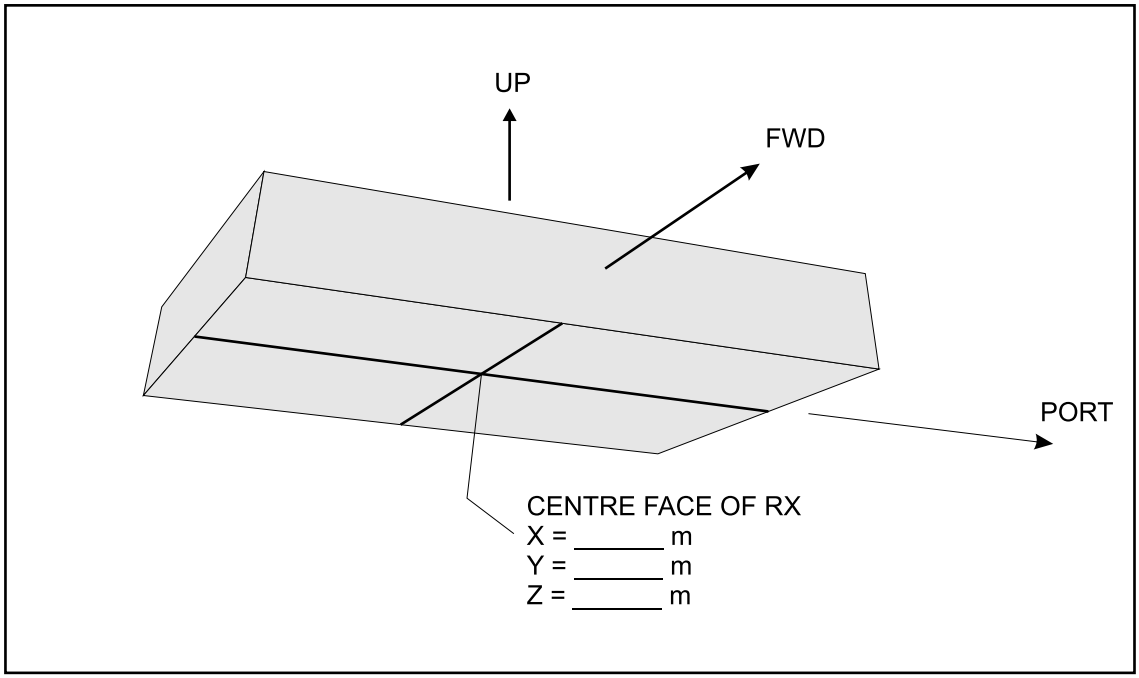
- Use only the sketch that applies to your TX array installation, i.e. heading to port or starboard side
- Enter angle between transducer centre line and vessel forward axis
- Enter definition of forward direction (X or Y)

RX transducer array

Table 26 RX transducer array

	RX	RX 2 (if applicable)	Survey accuracy
x			
y			
z			
roll			
pitch			
yaw			
Remarks			

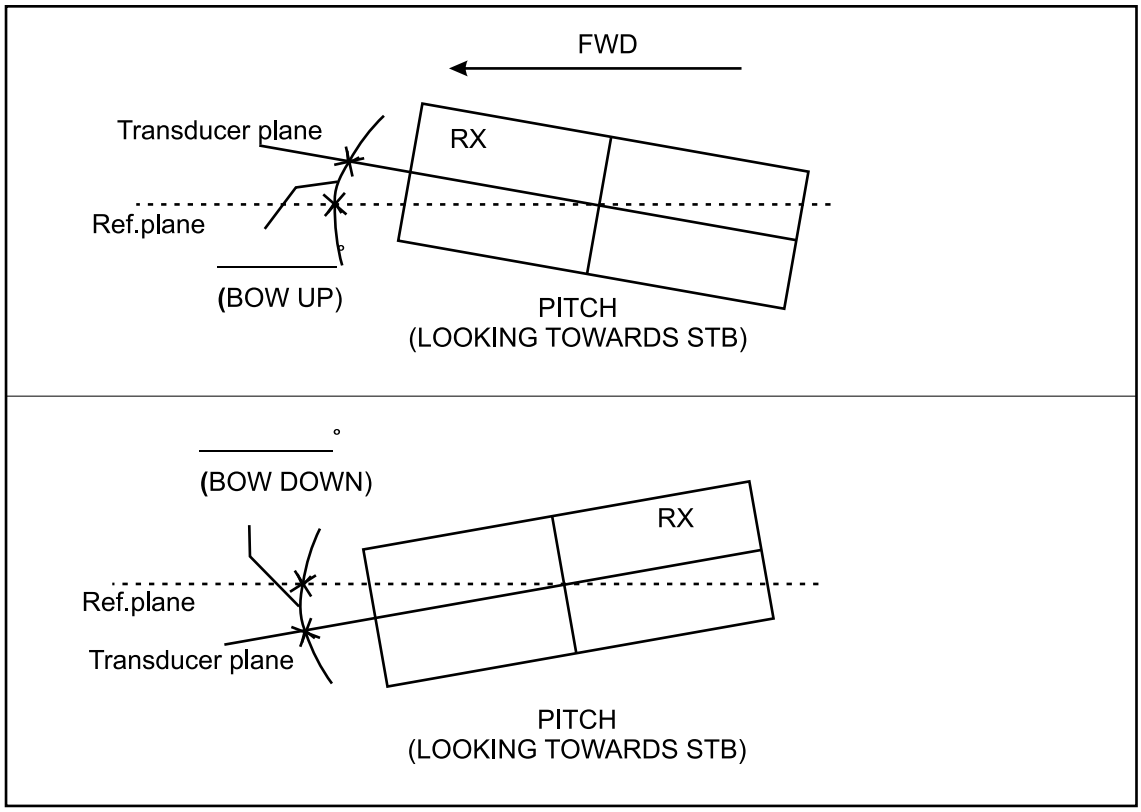
Figure 84 RX position



Instructions

- Enter distances from CRP along the defined X-, Y- and Z-axes

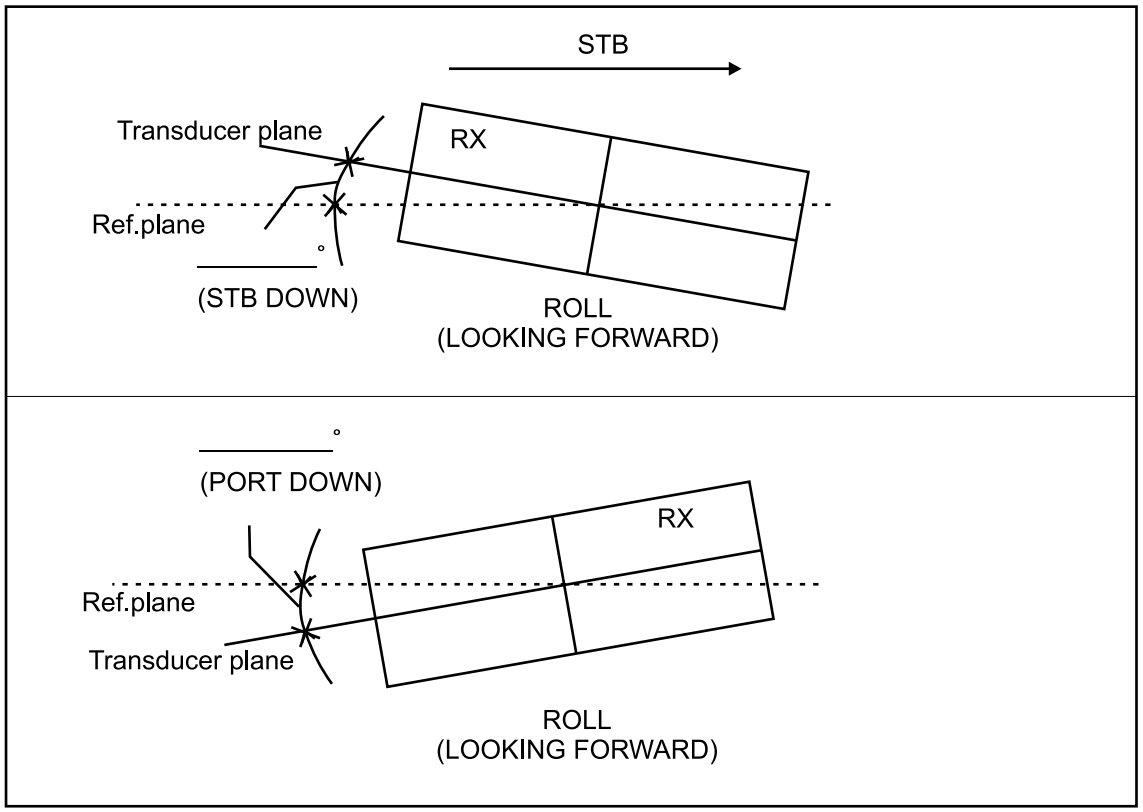
Figure 85 RX pitch



Instructions

- Use only the sketch that applies to your RX array installation, i.e. pointing down in bow (fore) or aft direction
- Enter angle between transducer plane and vessel reference axis along the fore-aft direction
- Enter definition of fore-aft direction (X or Y)

Figure 86 RX roll

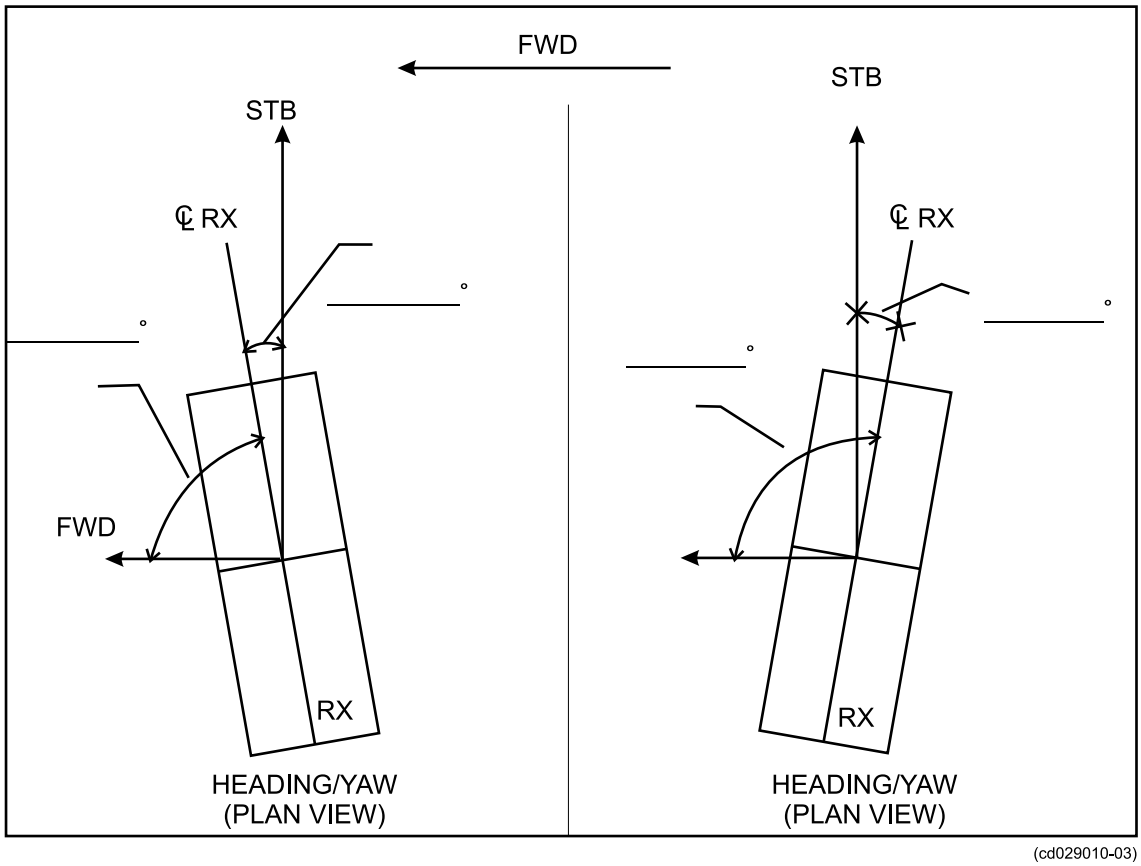


(cd029010-02)

Instructions

- Use only the sketch that applies to your RX array installation, i.e. pointing down on port or starboard side
- Enter angle between transducer plane and vessel reference axis along the port-stb direction
- Enter definition of port-stb direction (X or Y)

Figure 87 RX heading/yaw



Instructions

- Use only the sketch that applies to your RX array installation, i.e. heading towards fore or aft side
- Enter angle between transducer centre line and vessel starboard axis
- Enter definition of starboard direction (X or Y)

Appendix E
Arrangement drawings

Drawing reg.no.	Drawing title
352518	Interconnection diagram – AUV PU Housing

Appendix F
Index (interactive)

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