Installation manual

KONGSBERG

EM 710

Multibeam echo sounder

Base version

851-164851

EM 710
Multibeam echo sounder

Installation manual

About this document

Rev	Date	Written by	Checked by	Approved by
A	29.06.05	EB	BHL	KEN
	Original issue.			
B	11.08.06	ASM	BHL	KEN
	HWS 11 is available. 19” LCD monitor may be delivered to all EM systems. Emphasized default connection of TX transducer cables. Positioning system: Correction of the location system accuracy. Minor corrections			

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Chapters

This book is the installation manual for the EM 710. It describes how to install the various units used by the EM 710 system.

1 Purpose and description

This chapter of the manual presents the general scope of work and a brief description of the system. Refer to page 1.

2 Technical specifications

This chapter of the manual presents the technical specifications. Refer to page 14.

3 Transducer arrays

This chapter explains how to install the EM 710 Transducer arrays. Refer to page 17.

4 Installation examples

Several installation methods are available. This chapter briefly outlines some of them. Refer to page 37.

5 System cabinets

This chapter explains how to install various electronic cabinets, such as the Operator Station, the Transceiver Unit and the Remote Control. Refer to page 42.

6 Cable layout and interconnections

This chapter describes the cabling and interconnections that needs to be made between the units making up the EM 710. Refer to page 50.

7 Alignment

This chapter explains how to align the EM 710 system before it is put to operational use. Refer to page 89.

8 Installation checks

This chapter explains how to test the EM 710 system before it is put to operational use. Refer to page 99.

9 Equipment handling

This chapter describes equipment handling procedures. Refer to page 105.

10 Drawing file

This chapter holds referenced drawings. Refer to page 116.

Remarks

References

Further information about the EM 710 system supplied, may be found in the following manuals:

- SIS (Seafloor Information System) Operator Manual
- EM 710 Maintenance Manual

The reader

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

High voltage safety warning

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

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

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

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

NEVER WORK ALONE ON HIGH-VOLTAGE EQUIPMENT!

FIRST AID IN THE EVENT OF ELECTRIC SHOCK

Normally, even a high voltage electric shock will not kill instantly. The victim can still be revived even when his breathing and heart-beat have ceased.

Could **YOU** save someone's life? In the event of electric shock, the correct actions, performed quickly may well save the victim's life. **Make sure you know what to do!**

Immediate action

While shouting for help, remove the source of power from the victim. Switch off the supply if possible, or using a dry, non-conductive material (rubber gloves, broom handle etc.) to insulate yourself, separate the victim from the source. If the voltage exceeds 1000 volts, switch off the supply and be ready to catch the victim. Take care- do not become a victim yourself.

Commence first aid on the spot. Continue to shout for assistance till someone arrives.

1 Lay the victim flat on his back and loosen any tight clothing (collar, tie, belt etc.).

2 Open his mouth and check for and remove any false teeth, chewing gum etc.

3 Check if the victim is breathing. If not, check if his heart is beating. The pulse is normally easily found in the main arteries of the neck, either side of the throat, up under the chin.

If his heart is beating but he is not breathing, commence **ARTIFICIAL RESPIRATION**. If the victim's heart is not beating, commence **EXTERNAL CARDIAC MASSAGE (ECM).** Continue to shout for assistance till someone arrives.

EXTERNAL CARDIAC MASSAGE

1 Kneel beside the victim. Place the heel of one hand in the centre of his chest, at a position half way between the notch between the collar-bones at the top of his chest, and the dip in the breast-bone at the base of his rib cage. Place the other hand on top of the first.

2 Keeping the arms straight and using your entire weight, press down rapidly so that the breast bone is depressed four- five cm, then release the pressure. Repeat rhythmically at a rate of one cycle per second. This will be hard work, but keep going. His life depends on YOU. Do not worry about breaking his ribs - these will heal if he survives.

ARTIFICIAL RESPIRATION

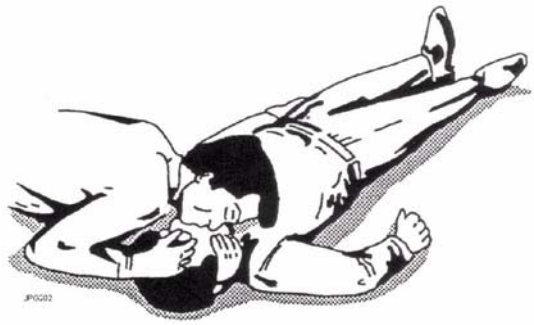
1 Kneel besides the victim's head. Place one hand under his neck and lift, allowing his head to fall back. This will lift his tongue and open the air passage in his throat.

2 Place the palm of the hand on his forehead to maintain the "chin-up" position.

3 Using the index finger and thumb of the same hand, pinch the victim's nostrils closed. Open his mouth.

4 Take a deep breath and cover his mouth with yours. Blow steadily into his lungs to expand his chest. Remove your mouth from his to allow the air to escape from his chest. You should be able to see his chest deflate.

5 Repeat the "inflation-deflation" cycle at a rate of about 12 cycles per minute till the victim begins to breath normally again.



COMBINING ECM AND ARTIFICIAL RESPIRATION

If you are alone, perform **ONE** cycle of artificial respiration for every **FIVE** cycles of ECM. This will be hard work, but keep going. His life depends on **YOU**!

If there are other people available to help, one should perform the ECM while one performs the artificial respiration for every five cycles of ECM. It will be much more efficient with two people.

Once the victim's heart is beating and he is breathing, roll him onto his side and support him in that position. As consciousness returns he may vomit, and this will allow any liquid to drain out of his mouth.

Remove the victim to a hospital as soon as possible, but do not interrupt the artificial respiration and EMC cycles till his heart beat and breathing returns.

If started quickly and performed correctly, the resuscitation methods described will keep a sufficient volume of oxygenated blood flowing trough the victims body to allow full recovery.

Proficiency in the resuscitation methods can only be achieved trough training. All personnel concerned should attend courses on a regular basis. Remember, someone's life could depend on you.

DO YOU KNOW WHAT TO DO?

1 PURPOSE AND DESCRIPTION

1.1 General

The purpose of this installation manual is to present the descriptions and drawings required to install the EM 710 multibeam echo sounder system.

The system described in this manual includes the complete system with associated cabinets.

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.

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

Note

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

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 installation procedure.

1.2 System overview

Key facts

The EM 710 multibeam echo sounder is a high to very high resolution seabed mapping system capable of meeting all relevant survey standards. The system configuration can be tailored to the user requirements, allowing for choice of beamwidths as well as transmission modes. The minimum acquisition depth is from less than 3 m below its transducers, and the maximum acquisition depth is up to 2000 m.

Acrosstrack coverage (swath width) is up to 5.5 times water depth to a maximum of more than 2000 m. The sounding density is very high, allowing even the very demanding LINZ special order survey specification for object detection to be met in full.

There are three basic versions of the EM 710:

- **EM 710 -** Full performance version.
- **EM 710S -** Continuous wave (CW) pulse forms only.
- **EM 710RD** - Short CW pulse only.

The reduced performance versions EM 710S (shallow) and EM 710RD (reduced depth) are upgradable to full performance.

Innovative acoustic principles

The EM 710 operates at sonar frequencies in the 70 to 100 kHz range. The transmit fan is divided into three sectors to maximize range capability but also to suppress interference from multiples of strong bottom echos. The sectors are transmitted sequentially within each ping, and uses distinct frequencies or waveforms.

Both CW pulses of different lengths and even longer, compressible waveforms (chirps) are utilized. The alongtrack beamwidth depends upon the chosen transducer configuration with 0.5, 1 and 2 degrees available as standard. Focusing is applied individually to each transmit sector to retain the angular resolution inside the near field. A ping rate of more than 25 per second is possible. The transmit fan is electronically stabilized for roll, pitch and yaw. The yaw stabilisation is accomplished by applying individual tilt control.

The EM 710 has a receive beamwidth of either 1 or 2 degrees, according to the size of the chosen receiver transducer. The number of beams are 256 or 128 respectively, with dynamic focusing employed in the near field. The distribution pattern may be set to be either equiangular or equidistant. All receive beams are electronically roll stabilized.

The swath coverage may be limited by the operator either in angle or in swath width without reducing the number of beams. A combination of phase and amplitude bottom detection algorithm is used, in order to provide soundings with the best possible accuracy.

High density beam processing mode provides up to 400 or 200 soundings per swath by using a limited range window for the detections, which in practice is equivalent to synthetically sharpening the beamwidth. In the high density mode more than one sounding may be created for each beam. In this mode, the size of each acoustic footprint is reduced to fit the higher sounding density. At the swath edges, the effective accuracy footprint is equivalent to a 0.2 degree beam.

With a 1 degree receive transducer the system is able to generate two separate alongtrack swaths per ping, thus doubling the alongtrack sounding density. The system produces up to 800 soundings per ping in this mode.

The coverage may be limited by the operator either in angle or in swath width without reducing the number of beams. This can be used to increase the sounding density if a particularly high resolution survey is to be done.

A combination of phase and amplitude bottom detection algorithm is used, in order to provide soundings with the best possible accuracy.

Acoustical seabed imaging

Integrated seabed acoustical imaging capability is included as standard. Software to use this data for automatic seabed classification is available.

Water column backscatter

A real time display window for water column backscatter is available. Logging of water column data and of raw stave data (before beamforming) is a system option.

Choice of operator softwares

The EM 710 is delivered as a complete stand-alone seabed mapping system. The Operator Station, a high-performance PC workstation, includes the necessary operator controls for setting up and running the system, data logging and system testing. The **Seafloor Information System** (SIS) by Kongsberg Maritime also includes an extensive set of graphical displays for data quality control, as well as system calibration and other tools which are required. SIS supports on-line real-time data cleaning to improve the overall survey efficiency.

Post-processing software for the EM 710 is available from both Kongsberg Maritime and third-party suppliers.

System drawing

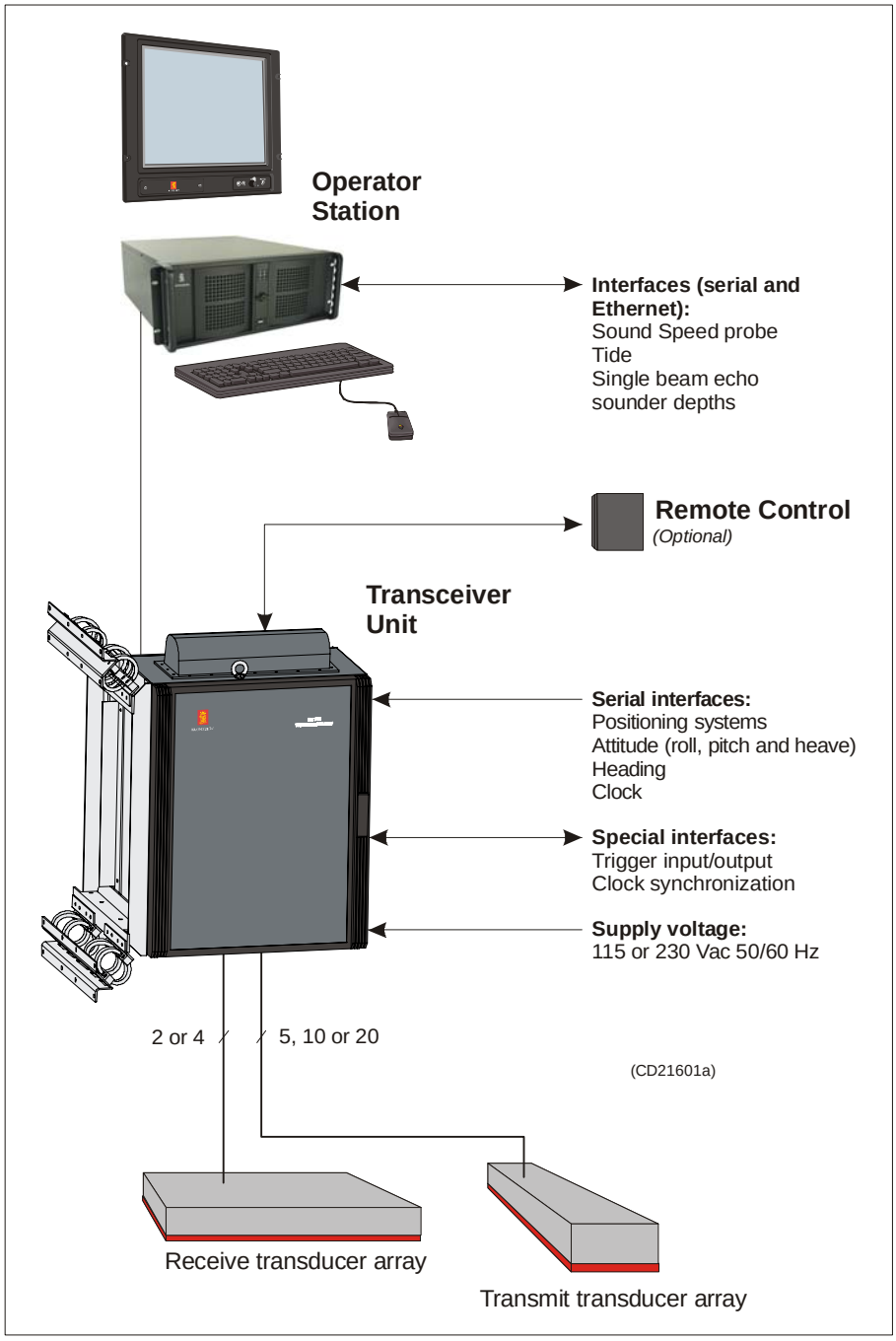


Figure 1 EM 710 system units and interfaces

System characteristics

Main units

The basic EM 710 multibeam echo sounder consists four units:

- Transmit Transducer
- Receive Transducer
- Transceiver Unit
- Operator Station

A complete mapping system will in addition include a vessel motion sensor, heading sensor, sound velocity sensor(s) and a positioning system.

Transducers

The EM 710 transducers are fully water tight units intended for many years of trouble-free operation in rough seas. The transmit and receive transducers both have a width of 224 mm and a height of 118 mm. Their length depends upon the chosen beamwidth, either 970 mm for a 1 degree unit or 490 mm for a 2 degrees unit. The weights are respectively 35 and 18 kg (excluding cables). The transducers have a maximum depth rating of 250 m.

A transmit beamwidth of 0.5 degree is achieved by mounting two 970 mm transmit transducers together alongship. Such a beamwidth reduction is not possible with the receive transducer.

The transducers are supplied as standard with 15 m long underwater cables terminated with a surface connector directly pluggable into the Transceiver Unit. On special order underwater connectors or longer cables may be supplied. Five or ten cables are used on the transmit transducer, two or four on the receive transducer, in accordance with the transducer length.

Transceiver Unit

The EM 710 Transceiver Unit contains all transmit and receive electronics, and the Processing Unit which performs the beamforming, bottom detection, and motion and sound speed corrections. It contains all interfaces for time-critical external sensors such as vessel attitude (roll, pitch, heading and heave), vessel position and external clock. More than one sensor of each type may be connected simultaneously, with one in use but all logged.

The Transceiver Unit comprises two 19” sub-racks contained in a cabinet designed for bulkhead or deck mounting. The number of circuit boards will depend upon the chosen transducer configuration. Twisted pair Ethernet is used for data communication with the Operator Station.

Operator Station

The Operator Station of the EM 710 is the Hydrographic Work Station (HWS) high performance dual-processor PC workstation. The operator software is the Seafloor Information System (SIS). The HWS is dual bootable to either Linux® or Windows XP®.

SIS, as a minimum, allows setting the EM 710 installation and runtime parameters, data logging and running self-test on the system without restrictions.

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

Alternatively, third-party software solutions can be used for the operator interface and real-time processing.

The HWS is normally supplied with a 19” industrialized LCD monitor with a resolution of 1280x1024 pixels. Support for a second monitor is included. 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.

1.3 Scope of supply and options

Standard system

A basic EM 710 multibeam echo sounder delivery includes:

1 Operator Station HWS with 19” LCD monitor

2 Transceiver Unit configured according to chosen model

3 Transducers in accordance to chosen model

- Transmit transducer (includes mounting frame for 0.5 degree version)
- Receive transducer
- Necessary transducer cables (15 m length)

4 Signal and control cables

- Ethernet cable between Transceiver Unit and Operator Station (4.5 m length)

5 All system software

6 Technical manuals covering system installation, operation and maintenance

Options

System options available include:

- Mounting arrangement for over-the-side mounting of 2 by 2 degrees model transducers which may include integrated motion sensor, heading sensor and positioning sensor
- Remote control unit for Transceiver Unit
- Non-standard cable lengths or connectors
- Helmsman Display and/or additional monitors
- Various software options
- Removable disks
- IP65 integrated keyboard and pointing device
- Spare parts

System integration

The EM 710 system as presented in this product description is prepared for integration with other sensors to form a complete seabed mapping and inspection system. Kongsberg Maritime can supply the EM 710 either as a sub-system for integration by the user or other parties, or we can offer complete system solutions tailored to the user’s need.

Dual frequency system solutions can be formed by combining the EM 710 with a lower frequency multibeam echo sounder such as the EM 120.

Additionally Kongsberg Maritime may deliver the EM 710 as part of a complete survey system. This may include integration with single beam echo sounders and/or other multibeam echo sounders for seamless coverage of any depth range.

1.4 General safety rules

The system operates on 115 and/or 230 Vac, 50/60 Hz without any need for wiring changes.

Warning ***This voltage can be 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 should always be present.
- 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 are heavy. Make sure that the appropriate tools and certified lifting equipment are available, and that the personnel are trained in installation and maintenance work.

1.5 Supply conditions

Equipment responsibility

Upon receipt of the EM 710 system units the installation shipyard automatically becomes fully responsible for the equipment. This responsibility covers the storage period before installation, the actual installation, and the period between the completion of the installation and the acceptance of the equipment by the end user or owner.

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.

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.

Assistance from Kongsberg Maritime

Kongsberg Maritime AS may assist during the installation if specified in the contract or requested by the installation shipyard or customer. Kongsberg Maritime AS may also assist with installation drawings. All such assistance is charged to the customer at the current rates.

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.

Terms and conditions

Kongsberg Maritime' Conditions of Sale shall apply, unless otherwise specifically stated in the quotation and in the below terms and conditions.

The warranty period, for hydrograhic echo sounders and sonars as well as software for these intstruments, is 24 months from date when the equipment is sent from the factory. For all other equipment and systems which are delivered, the respective manufacturers warranty terms are applied.

Kongsberg Maritime offers **maintenance contracts** that may extend the warranty period for a period as defined in the contract.

Kongsberg Maritime will take full system responsibility for the system as delivered by Kongsberg Maritime.

1.6 Installation requirements

Supply power

The supply voltage to the equipment is to be kept within ±10% of the installation's nominal voltage. Maximum transient voltage variations on the main switchboard's bus-bars are not to exceed -15% to +20% of the nominal voltage (except under fault conditions).

Environmental requirements

Temperature and humidity

All equipment, unless otherwise specified, must be protected from temperature extremes and excessive humidity.

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 underwater 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.

Dry docking

Make sure that ample clearance under the sonar trunk and/or protection blister is provided when dry docking the vessel. Avoid locating supporting blocks or structures in the vicinity of this equipment.

Note

The location of the sonar trunk and/or protection blister must be noted on the vessel's docking plan for future reference.

Wiring

The cables between the bridge, the various operation rooms and equipment rooms must be supported and protected along their entire lengths 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 interferences.

2 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 baud rate, parity, data length and stop bit length for:
  - Motion sensor (roll, pitch, heave and optionally heading) in format supported by sensors from Applanix, iXSEA, Kongsberg Seatex and VT TSS
  - Heading (gyrocompass) in either NMEA 0183 HDT, SKR82/LR60 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
  - Sea level height (tide)
  - Single beam echo sounder depths
  - Output of depth straight down in NMEA 0183 DPT format
- Interface for a 1PPS (pulse per second) clock synchronisation signal
- Firewire interface for external data storage device (tape or disk)
- USB 2.0 interfaces for data storage, printing or plotting
- Parallel interface for PostScript colour graphics printer/plotter
- Ethernet interface for input of sound speed profile, tide and echo sounder depths, and output of all data normally logged to disk

Physical specifications

Transducer, 2 degrees version

Length: 490 mm

Width: 224 mm

Height: 118 mm

Weight: 18 kg (nominal without cables)

Transducer, 1 degree version

Length: 970 mm

Width: 224 mm

Height: 118 mm

Weight: 35 kg (nominal without cables)

Transducer, 0.5 degree version (two 1 degree modules)

Length: 1940 mm

Width: 224 mm

Height: 118 mm

Weight: 70 kg (nominal without cables and mounting frame)

Transceiver Unit (version for bulkhead mounting)

Height: 841 mm

Width: 540 mm

Depth: 750 mm (nominal including shock absorbers)

Weight: 106 kg (2 by 2 degrees), 111 kg (1 by 2 degrees), 116 kg (1 by 1 degree) or 127 kg (0.5 by 1 degree)

Power: 115 Vac (60 Hz) and 230 Vac (50 Hz), < 900 W

Note

A smaller Transceiver Unit may be available for the 2 by 2 degrees model.

Operator Station

Height: 127 mm

Width: 427 mm (excluding rack fixing brackets)

Depth: 480 mm (excluding handles and connectors)

Weight: Approximately 20 kg

Power: 115 Vac (60 Hz) and 230 Vac (50 Hz), < 250 W

19 inch LCD monitor

Height: 444 mm (excluding mounting bracket)

Width: 483 mm (excluding mounting bracket)

Depth: 68 mm (excluding mounting bracket)

Weight: 12 kg (approx w/bracket)

Power: 115 Vac (60 Hz) and 230 Vac (50 Hz), 100 W (max)

Environmental and EMC specifications

The system meets all requirements of the IACS E10 specification.

The Transceiver Unit meet the additional stronger requirementes of the IEC 60945 specification.

The Operator Station and the LCD monitor are both IP22 rated. The Transceiver Unit is IP54 rated.

System performance data

- **Maximum ping rate:** More than 25 Hz
- **Number of beams and soundings for each ping:**
  - 1 by 2 and 2 by 2 degrees models: 128 beams with 200 soundings in High Density mode
  - 1 by 1 degree model: 256 beams with 400 soundings in High Density mode
  - 0.5 by 1 degree model: 512 beams with 800 soundings in High Density mode when using two swaths per ping
- **Beamwidths:** 0.5x1, 1x1, 1x2 or 2x2 degrees
- **Beam spacing:** Equidistant, Equiangle, High Density
- **Coverage sector:** Up to 140 degrees
- **Transmit beam steering:** Stabilized for roll, pitch and yaw
- **Receive beam steering:** Stabilized for roll
- **Depth range from transducers:** 3 to approximately 2,000 metres
- **Depth resolution:** 1 cm
- **Pulse lengths:** 0.15, 0.5 and 2 ms CW plus compressible (chirp) up to 200 ms
- **Range sampling rate:** 15 kHz (5 cm) at data output

Restrictions for use - limitations

Currently there may be a limitation in the use of combined long FM sweep and multiping / dual swath mode, due to a limited maximum transmit pulslength.

3 TRANSDUCER ARRAYS

3.1 Introduction

This chapter describes the installation of the EM 710 Transmit (TX) and Receive (RX) Transducer Arrays.

Drawings showing the installation principles and the physical dimensions are included in the text. Other drawings are included in the *Drawing File*.

→ *The Drawing File is located on page 116.*

3.2 Installation principles

Basic description

The EM 710 uses separate transducer arrays for transmitting and receiving sound pulses. The transducers may be fixed to the hull with bolts from the front, either directly on or recessed into the hull, or within sea chests.

There are no stringent requirements with regard to physical alignment, neither with respect to the vessel nor between transmit and receive transducers. However, the transmit and receive transducers should not have a large separation.

Note that the transmitter and receiver modules are of different types.

- The transmit transducers are designed as one or two separate module(s), building an array which is mounted in parallel with the keel.
- The receiver transducers are also designed as one individual module. The array is mounted athwartships.

The number of individual TX and RX modules in the two arrays depends on the chosen EM 710 configuration.

System configuration	TX modules	RX modules
0.5 x 1 degree	2 x TX1	1 x RX1
1 x 1 degree	1 x TX1	1 x RX1
1 x 2 degrees	1 x TX1	1 x RX2
2 x 2 degrees	1 x TX2	1 x RX2

The two transducer arrays are normally mounted as “T” or “L”-configurations under the vessel’s hull (Mills Cross configuration).

The cables connecting the transducers to the Transceiver Unit have a standard length of 15 m, and are terminated with connectors which plug directly into the cabinet.

Installation philosophy

The EM 710 system is supplied as a basic echo sounder with two relatively large transducers. While the electronic units are installed using normal tools, 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 (hull shape, potential aeration problems, ease of cable installation and so on).

The basic installation methods are:

- Gondola
- Blister
- Flush-mounted integrated into the hull
- Externally mounted with fairing(s)
- In a box keel
- Any combination of the above

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 should 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.

3.3 Installation steps

The following steps must be taken to install the EM 710 transducer arrays:

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

→ *How to determine the location of transducer arrays is discussed from page 24 onwards.*

Note

It is important to minimize the alongship gap between the RX and the TX arrays to improve the performance at very shallow water (to get overlap between RX and TX footprints).

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2 Design the transducer installation method.

- Several methods may be used: blister, flush mounting, external mounting with fairing(s), or any combination of these. The method must be chosen according to the vessel's hull design.
- On a new vessel, the transducer arrays may be incorporated into the hull for flush mounting. On older vessels, a transducer blister is usually designed to be mounted under the hull. A gondola can also be designed.

→ *Examples of transducer array installation methods are provided from page 37 onwards.*

→ *A typical blister is shown in figure 6 on page 28.*

→ *A typical gondola is shown in figure 7 on page 29.*

3 Prepare the transducer array installation arrangement.

- The installation arrangement must be capable of accepting the two transducer frames.

4 Install the steel conduits.

→ *The installation procedure is given on page 30.*

5 Install the mounting frames. Note that these are normally only required for the 0.5 degree transmit transducer.

→ *The installation procedure is given on page 32.*

6 Install the transducer modules.

→ *The installation procedure is given on page 34.*

7 Lay the transducer cables from the transducer modules to the steel conduits. Each cable is marked in both ends with the module's serial no. and the cable no.

8 Note the orientation of the transducer cable outlet from the transducer modules. Fill in the tables below.

Module type (TX1/TX2)	
Serial no.	
Cable orientation (notes 1, 2) (Port/starboard)	

Module type (TX1/TX2)	
Serial no.	
Cable orientation (notes 1, 2) (Port/starboard)	

Module type (RX1 or RX2)	
Serial no.	
Cable orientation (note 3) (Bow/astern)	

Note

It is possible to mount the TX array(s) with the cables pointing to the port or to the starboard side. The default orientation is starboard side. (This should be used if possible, but cabling may make it difficult.)

If mounting is in accordance with the default orientation, the installation heading is 0 degrees. If the TX array(s) is mounted with cables pointing to port side, 180 degrees must be added to the measured heading coming from the alignment. In this case the sign of the measured TX array installation roll and pitch angles must be inverted in the SIS installation menu.

Observe that the figures may have to be corrected after alignment measurements.

→ *Refer to the Alignment chapter on page 89.*

Note

For a 0.5 x 1 degree system, cables from both TX arrays must drawn in the same way (for example to the starboard side).

Note

It is possible to mount the RX array with the cables pointing towards bow or towards stern. The default orientation is astern. (This should be used if possible, but cabling may make it difficult.)

If mounting is in accordance with the default orientation, the installation heading is the measured value coming from the alignment. If the array is mounted with cables pointing towards bow, 180 degrees must be added to the measured heading. In this case the sign of the RX array installation roll and pitch angles must be inverted in the SIS installation menu..

Observe that the figures may have to be corrected after alignment measurements.

→ *Refer to the Alignment chapter on page 89.*

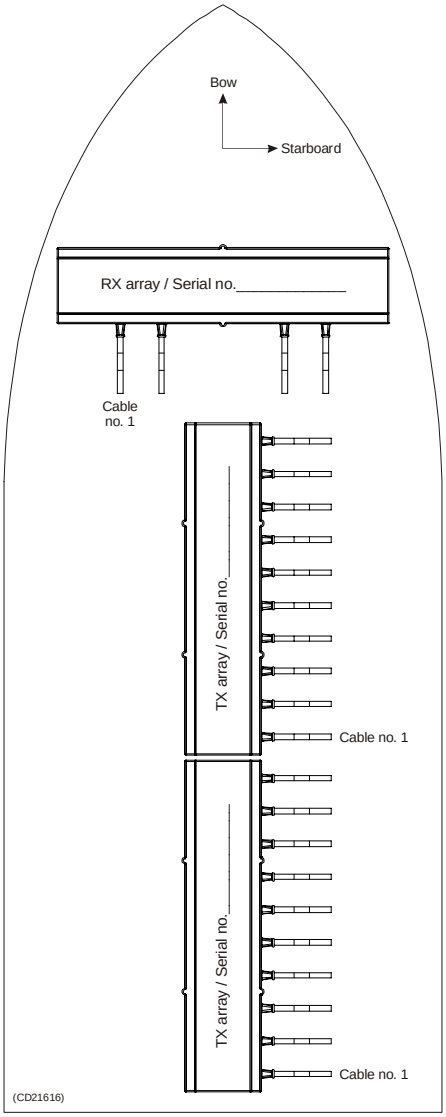
9 Pull the cables up through the steel conduits.

10 Seal the steel conduits.

11 Connect the cables to the Transceiver Unit.

→ *Refer to the Cable layout chapter on page 50.*

Figure 2 Default orientation of transducer modules and cables, top view, principle drawing



3.4 Locating the transducer array

General

Correct location of the system's tranducer 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.

→ *Figure 3 shows in principle the boundary layer of a vessel moving through the water.*

Furthermore, air bubbles in the sea water are pushed down below the hull and mixed into the boundary layer. The boundary layer is thin underneath the forward part of the vessel, and increases in thickness as it moves 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.

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 710, despite its high sonar frequency.

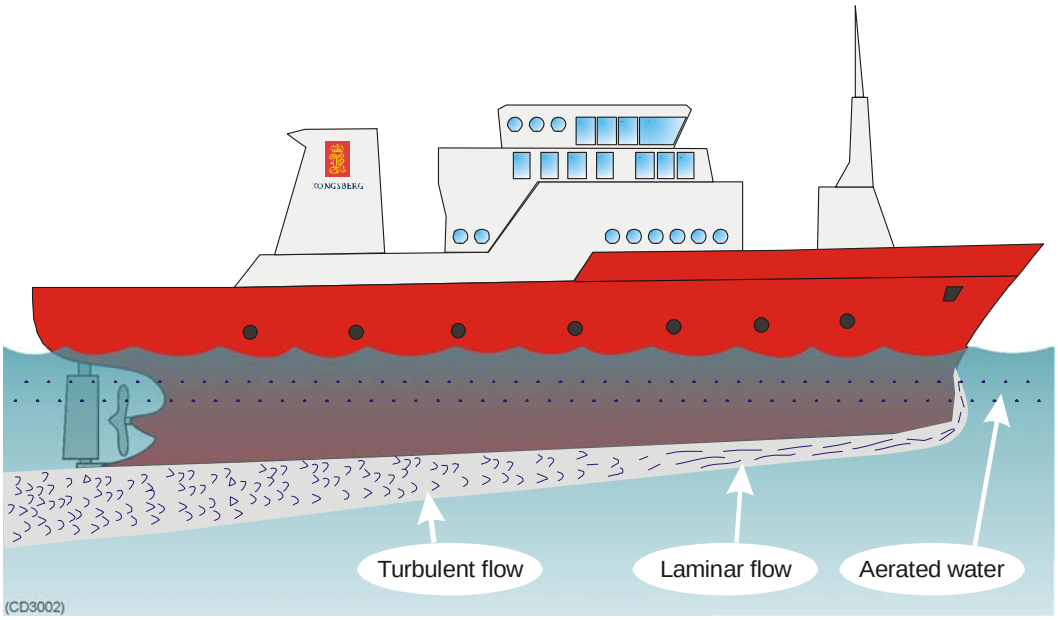


Figure 3 Sketch of boundary layer underneath the vessel

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

When a bow thruster operates, the noise and cavitation bubbles from its propellors may make an echo sounder useless, almost no matter where its transducer is installed. And even when it is not in operation, its tunnel creates turbulence, and if the vessel pitches much, the tunnel may be filled with air or aerated water in the upper position which is then released in the lower position.

Therefore, the transducer array should be placed well away 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.

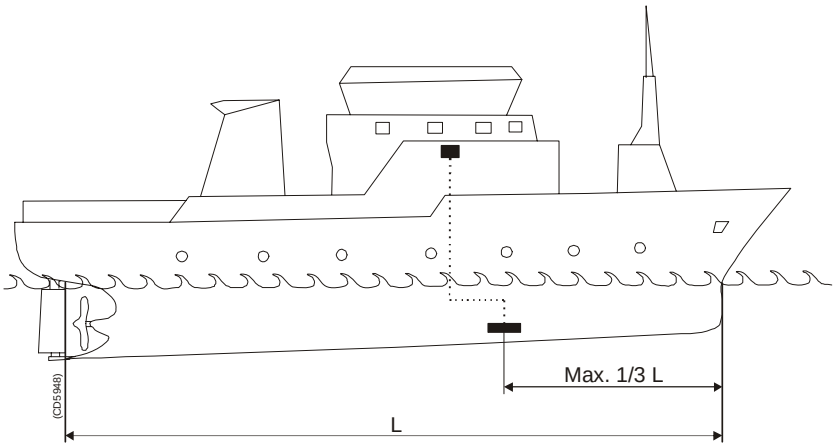


Figure 4 Recommended location of the transducer array on the hull

Generally the possibility of getting air bubbles in front of the transducer array is the most important factor, and thus the recommended transducer array location is in the fore part of the hull, with a maximum distance from the bow equal to one third of the total water line length of the hull, see the figure.

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.

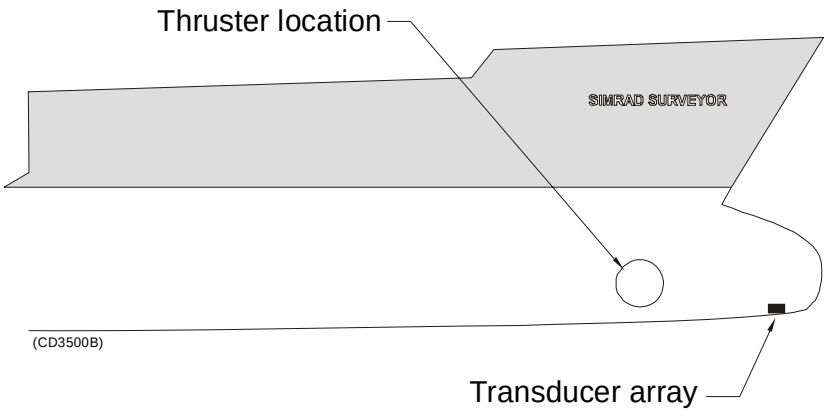


Figure 5 Transducer array located on a bulbous bow

This applies to the vessel in normal trim and speed.

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°. Under no circumstances should the array be tilted backwards when the vessel is moving at an appreciable speed.

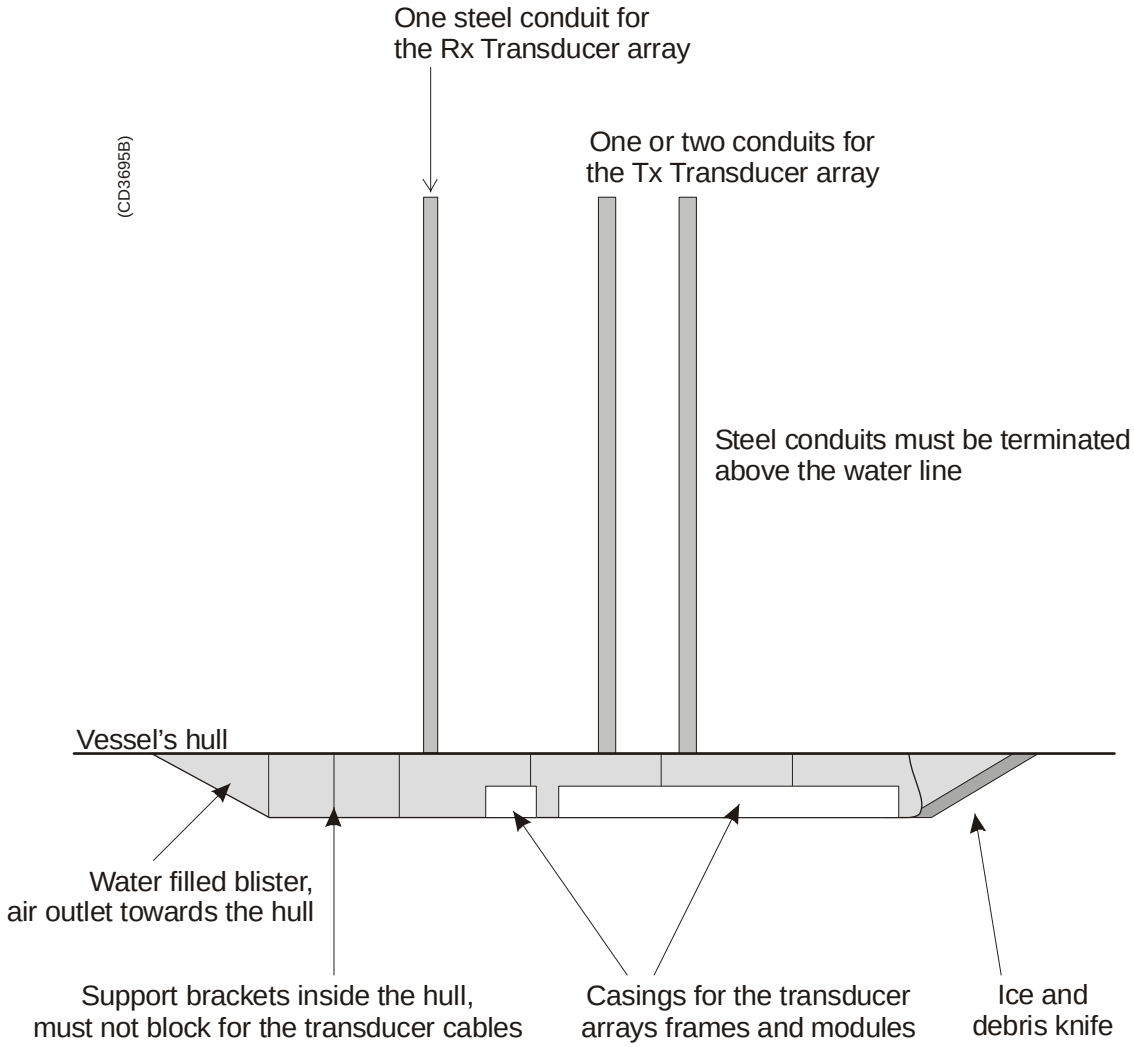


Figure 6 EM 710 blister and steel pipe arrangements (example)

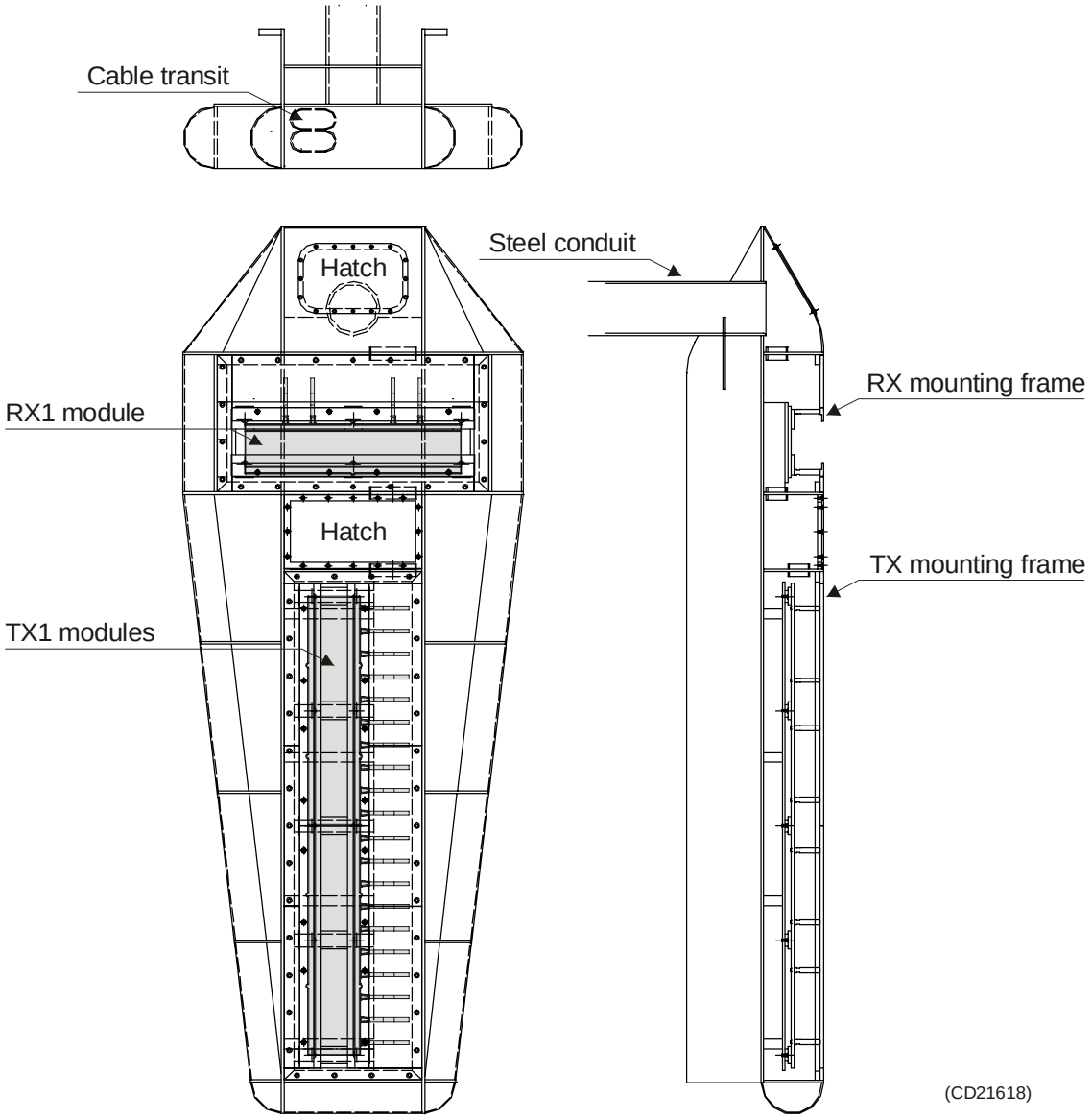


Figure 7 EM 710 gondola (0.5 x 1 degree system, example)

3.5 Installing the steel conduits

Introduction

The transducer cables connect through the vessel's hull using steel conduits. The steel conduits are welded to the vessel's hull. The top of each conduit must be closed and sealed to preserve the watertightness. This can be done with a "Brattberger" or a similar sort of sealing device.

The installation of the steel conduits must be properly planned, and all plans and drawings must be approved by the vessel's classification authority.

→ *Refer to figure 6 on page 28 for the principles.*

The steel conduits must be designed to fit each individual vessel. They are not included with the system delivery. The steel conduits must therefore be both provided (or manufactured) and installed by the installation shipyard.

The number of steel conduits depends on the chosen system configuration and the internal diameter of the conduits.

Thus:

- a 0.5 x 1 degree system (2 TX1 modules and 1 RX1 module) requires two TX conduits and one RX conduit.
- a 1 x 1 degree system (1 TX1 module and 1 RX1 module) requires one TX conduits and one RX conduit.
- a 1 x 2 degrees system (1 TX1 module and 1 RX2 module) requires one TX conduit and one RX conduit.
- a 2 x 2 degrees system (1 TX2 module and 1 RX2 module) requires one common TX and RX conduit.

Logistics and references

Safety - Refer to the general safety procedures.

Qualifications - Mechanical workers

Ship location - Dry dock

Special tools - None

Drawings - Refer to the *Drawing File*.

Procedure

1 Design the steel conduits with appropriate length and diameter to fit the echo sounder.

2 Mount the steel conduits from the vessel hull and up towards the sonar room and the EM 710 Transceiver Unit.

- The steel conduits should have an outer diameter of approximately 219 mm and an inner diameter of approximately 197 mm.

- The steel conduits are laid as required by the vessel structure and the location of the blister and sonar room. The conduits may be bent if required, but not more than 30 degrees. Note however that one or two sharp bends on the conduits may require a larger diameter.
- The upper opening of the steel conduits should be above the vessel's water line. If the openings are under the water line they must be secured according to the relevant classification rules. Use "Brattberger" sealings or similar sealing devices.

3 Close the top of the steel conduits with a seal.

- This is described on page 81.

3.6 Installing the mounting frames

Introduction

Mounting frames are designed to house the individual transducer modules. A mounting frame is normally required for the 0.5 degree transmit transducer as it consists of two separate modules. This should not be necessary for the other transducer models. These are self-contained units and due to their internal (very strong) carbon-fibre structures, they may be bolted directly to a flat mounting plate (for example).

While the transducer modules are mounted into the frames, the frames require casings. The casings must be individually designed for each vessel, and it is not a part of the system delivery. The casings must therefore both be provided (or manufactured) and installed by the installation shipyard.

The installation must be carried out according to arrangement drawings designed for the specific vessel. Refer to the drawings included in the *Drawing File*, and the applicable drawings prepared by the installation shipyard.

Logistics and references

Safety - Refer to the general safety procedures. Note that the units are heavy!

Personnel - Trained mechanical workers

Ship location - Dry dock

Special tools - None

Drawings - Refer to the following drawings in the *Drawing File*:

→ *TX mounting frame assembly, outline, 0.5 degree, pages 117, 118.*

→ *RX mounting frame assembly, outline, 1 degree, pages 119, 120.*

→ *TX/RX mounting frame assembly, outline, 2 degrees, pages 121, 122.*

Procedure

Note

The mounting frames must be handled with care. Please observe normal safety precautions for dockyard work and welding.

1 Manufacture the casings according to the attached production drawing.

2 Alter the drawings and the design as required to fit the vessel and the chosen installation method.

3 Mount the casings in the blister or integrated into the hull.

4 The mounting frames must be bolted onto the flat bars inside the casing.

- The number of flat bars depends on the length of the array.

Note *The mounting frames must be installed with correct orientation!*

---

5 The mounting frames must be bolted properly to the bars.

- The frames are fastened by M12 hex cap screws. Use a torque of approximately 74 Nm.

6 Check that the frames are mounted completely flat.

- No point on the frames may deviate from the horizontal plane with more than ± 0.5 mm.
- Refer to the *Alignment* chapter for a proposed measuring method.

→ *This chapter starts on page 89.*

7 Repeat the previous step until the alignment procedure has been performed successfully.

3.7 Installing the transducer modules

Introduction

For ease of installation, the transducers are built with standard modules:

- TX modules (type TX1 or TX2)
- RX modules (type RX1 or RX2)

The transducer module types are identified by their unique registration numbers, which are moulded into the rear of the element.

The transducer modules may be assembled in mounting frames especially designed for this purpose. The modules are secured with steel brackets, while the cables are pulled out on the side of each array.

Logistics and references

Safety - Refer to the general safety procedures. Note that the individual units are heavy !

Personnel - Trained mechanical workers and installation engineers from Kongsberg Maritime

Ship location - Dry dock

Special tools - None

References - Refer to the following drawings in the *Drawing File*:

→ *Outline dimensions, TX1 module, pages 125, 126.*

→ *Outline dimensions, TX2 module, pages 127, 128.*

→ *Outline dimensions, RX1 module, pages 129, 130.*

→ *Outline dimensions, RX2 module, pages 131, 132.*

Note — *Note that engineers from Kongsberg Maritime must be present to install the transducer modules.*

Procedure

Observe normal safety precautions for dockyard work.

Caution — *The transducer modules and the cables must be handled with care! The modules are heavy!*

Caution — *DO NOT LIFT THE MODULES BY THE CABLE!*

TX transducer modules

Note

When installing the TX transducer module(s), fill in the form on page 21.

1 If using mounting frames, hold the first transducer module up in the frame, else mount the module directly to the hull.

2 Pull out the transducer cables, and guide them out through the side of the mounting frame (if applicable).

3 Either (when using mounting frames):

Place the transducer modules into the frames and fasten them by the stay rods and clamping lists. The clamping lists are fastened to the mounting frames by M10 bolts with selflock threads. Use a maximum torque of 42 Nm and lubricate with Loctite 242.

Or (when mounting directly to the hull):
Secure the transducer module in place with the brackets, one on each side. Use torque approximately 70 Nm.

4 Mount the next transducer module next to the previous (only applicable for a 0.5 x 1 degree system).

- The gap between the individual modules is determined by the appurtenant mounting frame.
- If not using a mounting frame, mount the modules so that this gap equals 1 mm exactly.

5 Check that the transducer cables pass through the casing in such a way that they are not exposed to wear and tear. Secure as required.

6 Check that all bolts are properly fastened.

7 After installation measure the location of the transducer modules and their angular orientation in the vessel coordinate system accurately.

RX transducer modules

Note

When installing the RX transducer module, fill in the form on page 21.

1 Perform the same procedure as described above.

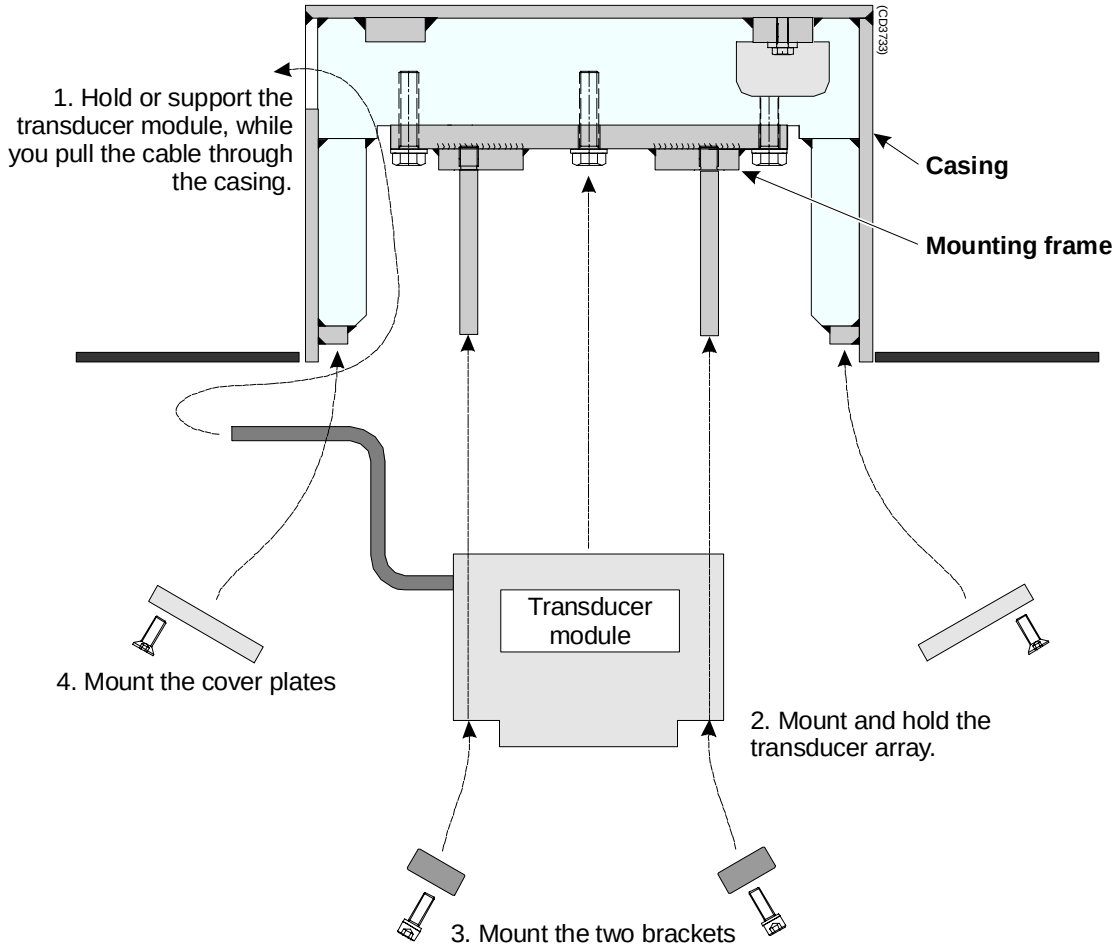


Figure 8 Transducer module installation principles (using mounting frames)

4 INSTALLATION EXAMPLES

This chapter provides a number of examples for transducer array installation. Installation procedures are also defined.

4.1 Transducer blister

Introduction

The transducer arrays must be mounted under the vessel's hull. To achieve this, you can design and manufacture a streamlined transducer blister, and mount it under the vessel's hull. This is the most convenient way when refitting a vessel with an EM 710 system.

→ *Refer to figure 9 on page 39 for the principles.*

Note

The inside surface of the blister must be protected with appropriate protective paint and an adequate amount of zinc.

Logistics and references

Safety - Refer to the general safety procedures.

Personnel - Trained mechanical workers

Ship location - Dry dock

Special tools - Torque wrench

Protection - Protective paint, zinc anodes

Drawings - None

Procedure

1 Design and manufacture the transducer blister.
- The blister must hold the two casings; one for the TX and one for the RX transducer arrays. The appropriate drawings describing these casings are included in the *Drawing File*.
- The blister will be water filled. To let the air escape, make a suitable hole in the rear end close to the vessel's hull.
- If necessary, place an "ice knife" in the forward end of the blister.

2 Prepare the inside surface protection of the blister. Paint with protective paint, and mount zinc anodes.

3 Mount the transducer blister under the vessel's hull.

4 Check the inside surface protection of the blister.
- Add paint or zinc as required.

5 Protect the outer surface of the blister.
- It must have similar protective treatment as the rest of the vessel's hull.

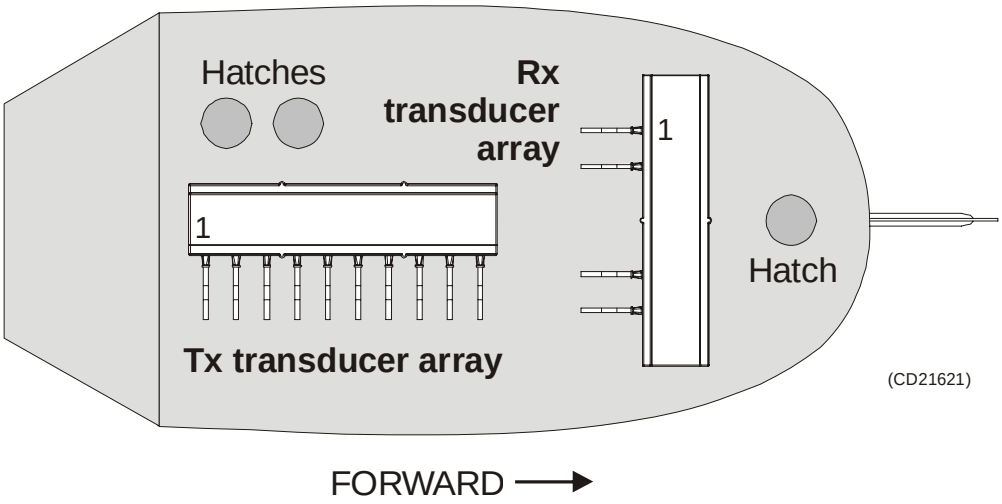


Figure 9 Transducer blister (1 x 1 degree default system).

4.2 Flush mount

The transducer arrays may be mounted flush with the vessel's hull. In order to do this, the shipyard must design a framework inside the hull to support the casings. The arrays must then be mounted so that their faces are flush with the outer hull.

Note

This installation method may prove unsuccessfull due to the turbulent and laminar flow under the hull. Thorough research on the vessel's hull design and the acoustic conditions must be made before attempting this installation method.

4.3 Fairings

The transducer arrays may be mounted directly under the vessel's hull and then "streamlined" with fairings. This installation method has proven successful in former multibeam echo sounder installations. The required installation drawings must be made by the installation shipyard or by third-party ship designers.

4.4 In a steel box

The transducer arrays may be mounted in steel boxes. The steel boxes must be surface treated as the vessel's hull.

Vessels with a box keel may use this for transducer installation. The box keel is already the deepest part of the vessel. If the box keel is too narrow to accommodate the transducer, it can be widened, either symmetrically or to one side only. In the last case the installation could also be described as a blister merged into the keel. Figure 10 illustrates a box keel installation.

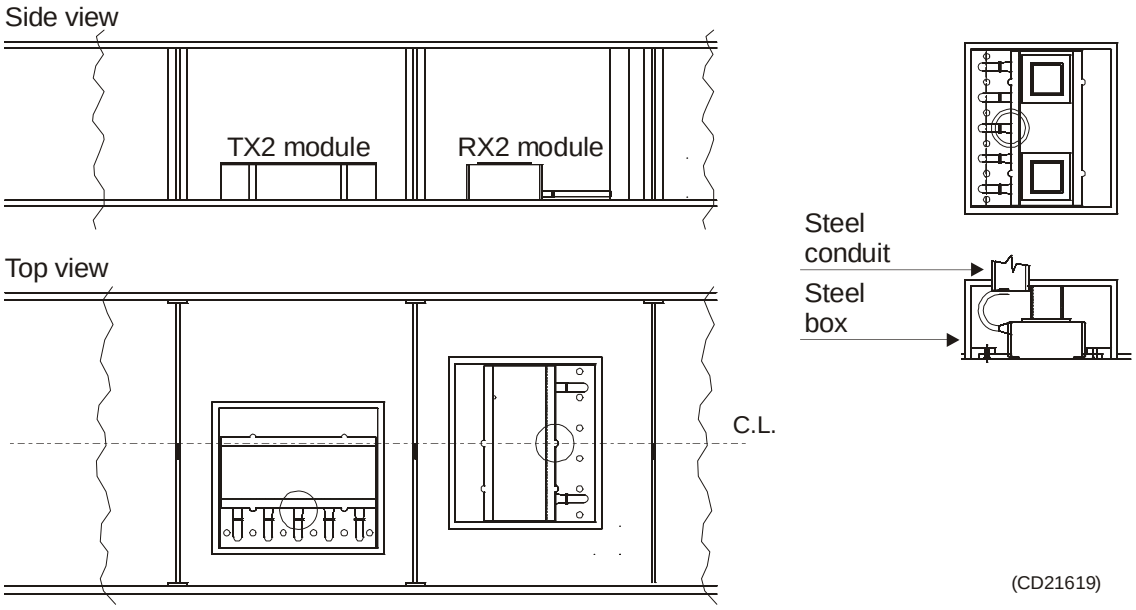


Figure 10 Box keel
(2 x 2 degrees system, example)

5 SYSTEM CABINETS

5.1 Introduction

This chapter describes the installation of the EM 710 **Transceiver Unit** in the equipment or operation room, and the **Operator Station** in the operation room.

The **Remote Control Junction Box** installation is also described.

Drawings showing the system and the physical dimensions are included in the Drawing file.

Note

Kongsberg Maritime strongly recommends that an Uninterruptible Power Supply (UPS) is used to power the Operator Station.

5.2 Operator Station

Description

The HWS 10/11 Hydrographic Work Station is the Operator Station normally used by the EM 710. This is a ruggedized PC work station, prepared for mounting in a standard 19” rack (requires 4 rack height units). It is supplied with a rackable 17.4” industrial LCD monitor, a keyboard and an optical mouse. A bracket for the monitor is included for table top, bulkhead and roof mounting. All components making up the HWS 10 are standard PC parts.

Location

It is recommended to place the Operator Station in a room with environmental conditions similar to those required for extended human occupation.

The Operator Station is usually mounted on a desk in the operation room, and suitably tied down or mounted in a rack.

Installation

No specific installation procedures exist for the Operator Station. However, you must install the units so that they are properly physically supported and protected for shock and vibration due to sea conditions.

5.3 Transceiver Unit

Description

This chapter presents the general installation procedures for the EM 710 Transceiver Unit.

The Transceiver Unit contains all transmit and receive electronics. It comprises two 19” sub-racks contained in a cabinet designed for bulkhead or deck mounting.

Note

The guidelines for installation presented here must be regarded as a base for detailed vessel specific plans prepared by the installation shipyard. These plans should include drawings, instructions and procedures specific to the ship in which the equipment is to be installed. If necessary, these drawings must be approved by the relevant maritime classification society.

Location

The EM 710 Transceiver Unit is normally installed in the vessel’s “sonar room” close to the transducer arrays. This room must be dry and free from excessive dust and vibration. Maximum humidity of 80% is recommended. Good ventilation for the equipment cooling must be provided.

Kongsberg Maritime recommends that this room is chosen close enough to the transducer arrays so that you do not need to extend the transducer cables. These have a standard length of 15 m.

The cabinet must be mounted on the bulkhead. Ensure that sufficient space is provided around the unit to allow the unit’s doors to open fully. Space must be provided to allow the power and interface cables to be installed, and to allow the cabinet to move on its shock absorbers.

Where space is restricted, it is possible to install the two 7H high sub-racks without using the supplied cabinet. However, it is then the responsibility of the customer to ensure adequate environmental protection (heat, humidity, vibration, EMC etc.) of the sub-racks, and to provide adequate fastening of all cables.

General information

The Transceiver Unit cabinet is fitted with a hinged front door and a rear protection cover. This gives you access to the circuit boards from both sides.

The unit is mounted on a support frame at the factory. This frame is mounted on the bulkhead with two shock absorbers; one mounted on top of the frame and one at the bottom.

Note that the space requirements for the Transceiver Unit must be adhered to.

→ *Refer to the principle drawing on page 135.*

Logistics

Safety - Refer to the general safety procedures. Note that the unit is heavy!

Personnel - Minimum two trained mechanical/electrical workers.

Ship location - In dry dock or at quay. The watertight integrity of the ship will not be affected.

Special tools - Lifting equipment.

References - None.

Drawings - Refer to the *Drawing File*.

Caution

The cabinet is heavy. Ensure that correct lifting equipment is available.

Procedures

Cabinet

1 Mark the location of the holes for the upper and lower shock absorbers on the bulkhead.

→ *Figure 11 shows the fixing hole pattern for the shock absorbers.*

→ *Figure 12 shows the distance from the lower holes on the lower shock absorber to the lower holes on the upper shock absorber.*

→ *Figure 12 also shows the minimum distance above the floor.*

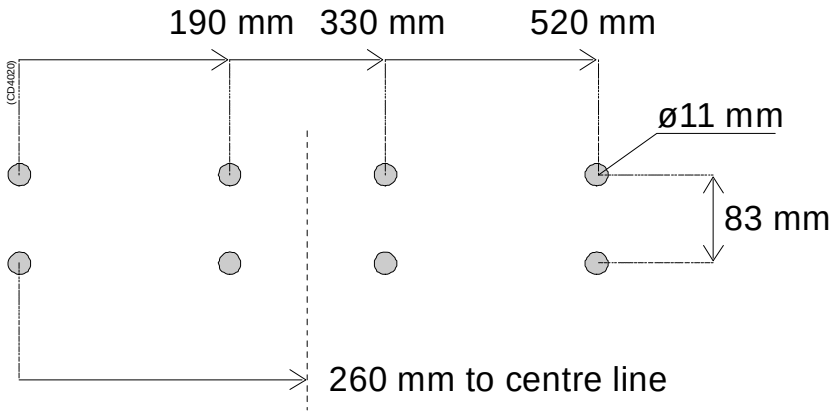


Figure 11 Fixing holes for one shock absorber

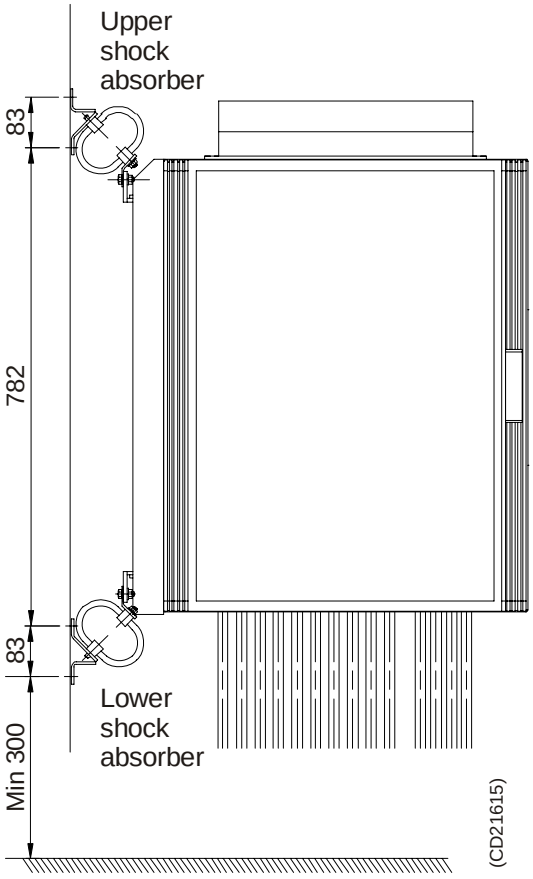


Figure 12 Distance between shock absorbers, distance to floor

2 Drill 11 mm holes, eight (8) for each shock absorber.

Caution *Always check on the other side of the bulkhead before drilling holes !*

---

3 The Transceiver Unit is delivered as a complete unit with shock absorbers. Mount the unit to the bulkhead with M10 bolts. These bolts must be supplied by the shipyard.

- As the Transceiver Unit is heavy, a lifting arrangement (articulated jack or similar) must be used.
- The foundation onto which the Transceiver Unit is mounted will determine the correct torque to be applied to the bolts.

4 Alternatively, the shock absorbers can be mounted to a pair of specially designed support brackets.

→ *An example of a suitable bracket is shown in the* Drawing file *on page 136.*

Transducer array cables and interfaces

All external cables (power cables, interface cables, transducer cables) enter the Transceiver Unit at the rear. The cables must be fastened to the cable clamp.

1 Prepare the cable clamp to receive the system cables.

2 Mount the cables according to the cable plan.

- Make sure that the transducer cable tables are filled in correctly.

→ *Refer to the* Cable layout *chapter on page 50.*

3 Thread the cables through the dedicated apertures in the cable clamp.

→ *The cable clamp arrangement is shown on page 138.*

Note *It is recommended to start threading the innermost cables.*

---

4 Tighten the M10 bolts with spring washers and nuts to close and secure the cable clamp.

Surface preservation

All exposed metal surfaces which are likely to corrode should be painted according to the appropriate preservation scheme. This includes welds, base frames and support brackets. Care must be exercised to ensure the cabinet is not splashed with paint.

5.4 Remote Control Junction Box

Introduction

This chapter presents the general installation procedures for the Remote Control Junction Box.

The Junction Box is a steel cabinet. The front door opens towards left, while the cables enter through the bottom of the cabinet.

Location

The Remote Control Junction Box will normally be located in the vincinity of the Operator Station. It holds the interconnections between the various units in the EM 710 system, and may also contain the master on/off switch for the entire system.

General information

The Remote Control Junction Box cabinet's total height is 300 mm.

→ *Refer to page 137 for outline dimensions and bolt hole positions.*

Logistics

Safety - Refer to the general safety procedures.

Personnel - Trained mechanical/electrical worker.

Ship location - No recommendations. The watertight integrity of the ship will not be affected.

Special tools - None.

References - None

Drawings - Refer to the *Drawing File*.

Cabinet installation

Caution *Always ascertain what is on the other side of bulkheads and decks before drilling or welding.*

---

1 Drill the required holes in the selected bulkhead, each hole capable of taking an M8 bolt. The bolts are included with the cabinet.

2 When the preparations for the bolts have been completed, position the cabinet and mount and tighten the securing bolts.

3 Use shake-proof washers, and tighten the bolts to a torque of approximately 50 Nm.

Cabling

Refer to the cable layout and interconnection documentation for sockets and connections.

Note

All power must be switched off prior to the cable installation. All cables must be available properly installed in cable ducting. Note should be taken not to excess the physical limitation of the cables. When securing the cable installation, make sure that enough cable slack is provided to allow the cabinet to move on its shock absorbers.

---

1 Introduce the cables into the appropriate cable glands on the cabinet, and connect them to the relevant terminals, ensuring enough slack is left to permit alterations, maintenance etc.

2 Ensure the cable glands are reassembled correctly, and that the cable screens are fitted securely into the glands.

3 Check all wiring, especially the power supplies, before switching power onto the unit.

6 CABLE LAYOUT AND INTERCONNECTIONS

6.1 Introduction

The standard cables used between the EM 710 system units and between the units and their external devices are shown here. For larger installations where the EM 710 is a subsystem, the cables will also be shown in the cable layout plan and interconnection diagram specific for the vessel into which the system is installed.

Note

All cable connections may have to be made in accordance with the guidelines laid down by the vessel's 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» be used as a guide.

Contact information:

DNV
Corporate Headquarters
Veritasveien 1
1322 Høvik
Norway
http://www.dnv.com

6.2 System cabling

Cable layout

The interconnection cables are identified on the cable plan drawings. The following pages give a brief description of each cable. In the *Drawing file*, each cable is identified with the appropriate terminations and required specifications.

Shipyard and system cables

General

Each individual cable is identified on the cable plan. The cables fall into two categories:

- Cables provided by the installation shipyard or owner
- System cables supplied with the delivery

Shipyard cables

The cables that must be provided by the shipyard or owner are identified as such in the descriptions. Note that the cable specifications given are the *minimum* specifications.

For each cable, the following information is provided:

- Connection to be made on each end of the cable (including system unit, terminal board identification and plug/socket to be used)
- Number of cores
- Recommended cable type
- Minimum cable specifications

The appropriate considerations must be taken to suit special requirements. Kongsberg Maritime accepts no responsibility for damage to the system or reduced operational performance if this is caused by improper cabling.

System cables

Several cables will be supplied with the system. Such cables normally comprise power cables for peripheral equipment, and interconnection cables for computers and/or workstations. These cables will normally be delivered with the hardware.

EM 710 Operator Station cables

The illustration and the list below specifies each cable used on the EM 710 Operator Station. References are made to detailed cable drawings.

Note that this information includes several cables that may not be in use on all installations.

→ *Refer to page 67 for a typical EM 710 cable configuration.*

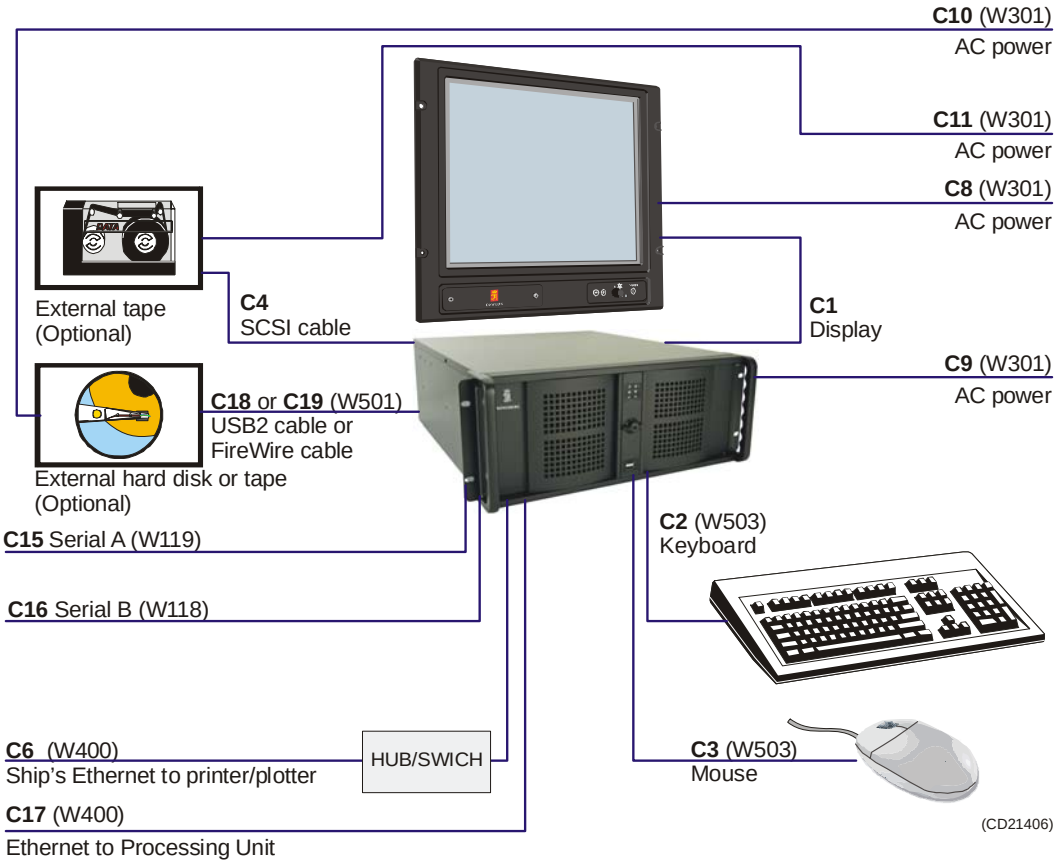


Figure 13 EM 710 Operator Station - Cable plan

C1 - Display

This is a standard DVI cable. It is normally supplied with the display unit.

→ *Cable details on page 152.*

Specific installations may include multiple display configurations with video splitters and/or switches.

C2 - Keyboard

This is a standard keyboard cable.

→ *Cable details on page 149.*

C3 - Mouse or pointing device

This is a standard mouse cable.

→ *Cable details on page 150.*

C4 - SCSI cable

This cable is used only if the Operator Station is used with external SCSI storage devices.

When applicable, the cable is provided by the user.

C6 - Printer or plotter

The Operator Station only provides one parallel interface to a printer or plotter. In most cases, printers and plotters are connected directly to the ship's Ethernet network.

→ *Cable details on page 151.*

When applicable, the cable is provided by the manufacturer.

C7 / C17 - Ship's Ethernet

The Operator Station is equipped with two Ethernet ports interface boards, one is used to communicate with the ship's Ethernet (C7) while the other (C17) is used to communicate with the Transceiver Unit.

→ *Cable details on page 147.*

The Ethernet cables must be provided by the installation shipyard.

C8 / C9 / C10 / C11 - AC power

These are AC mains cables. Note that C10 and C11 are only required if external SCSI storage devices are implemented.

→ *Cable details on page 146.*

All AC mains cables are normally supplied by the manufacturer.

C15 - Serial A

This serial line is intended for a sound speed probe, which is normally interfaced by means of a small junction box and a power supply.

If a sound speed probe is not used, the serial line may be used for other purposes.

→ *Sound speed probe cable details on page 141.*

→ *Standard 9-pin RS-232 serial line details on page 139.*

The cables must be provided by the installation shipyard.

C16 - Serial B

This serial line is intended for a tide sensor. If such a sensor is not used, the serial line may be used for other purposes.

→ *Standard 9-pin RS-232 serial line details on page 139.*

The cable must be provided by the installation shipyard.

C18 - USB cable

This is a standard USB2 cable for connecting external storage devices.

There are four USB ports in the back of the Operator Station and two USB ports in front. The two USB in front are normally blanked to allow for IP22.

One USB port is used for a software protection dongle.

→ *Cable details on page 148.*

The cable(s) must be provided by the user.

C19 - FireWire cable

This is a standard FireWire cable for connecting an external storage device.

There is one FireWire port in the back of the Operator Station.

The cable must be provided by the user.

Transceiver Unit cables

The illustrations and the cable lists below specify each cable used on the EM 710 Transceiver Unit. References are made to detailed cable drawings.

Note that this information includes several cables that may not be in use on all installations.

Also note that several cables interconnect the upper and lower sub-racks. Such cables will have a different denomination in each end.

→ *Refer to page 67 for a typical EM 710 cable configuration.*

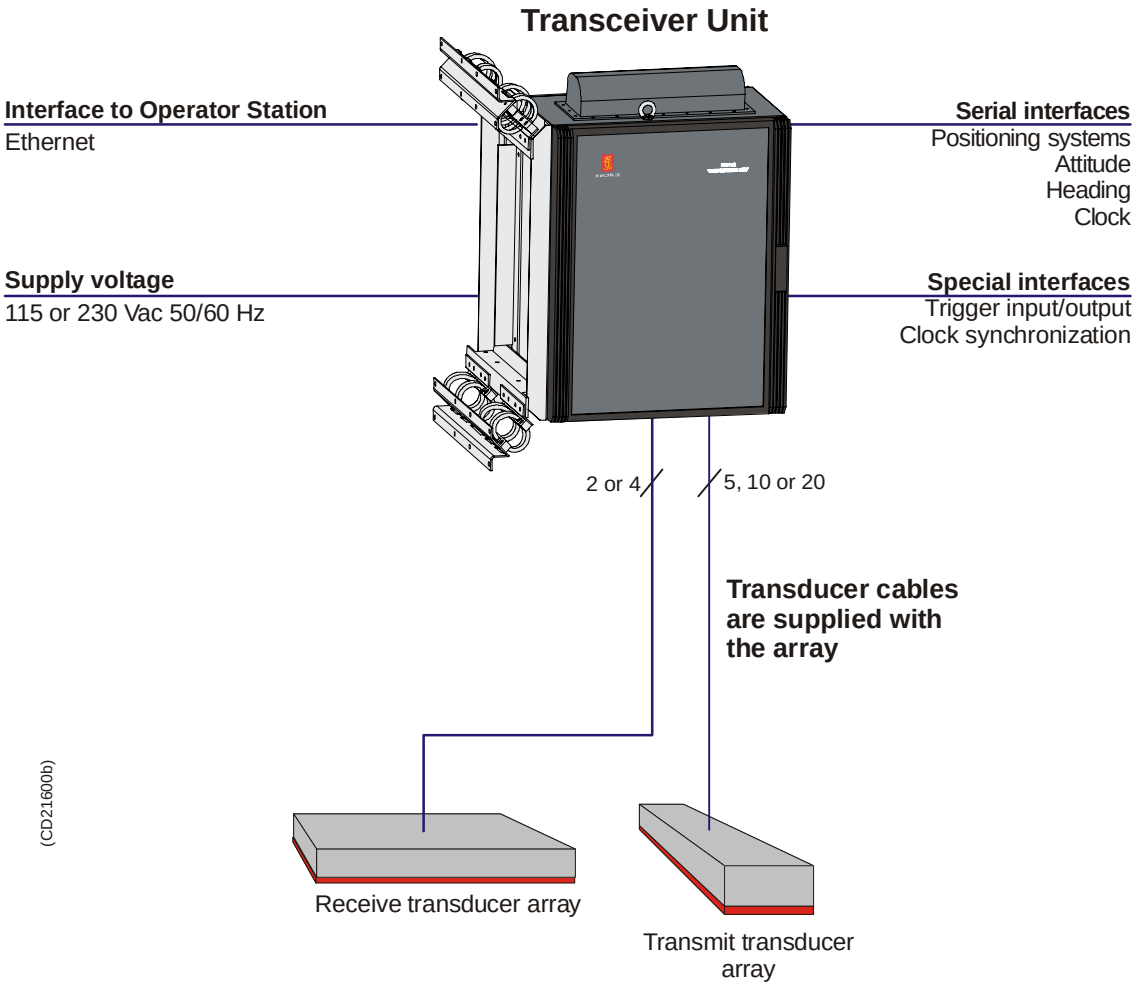


Figure 14 EM 710 Transceiver Unit, overview of interfaces

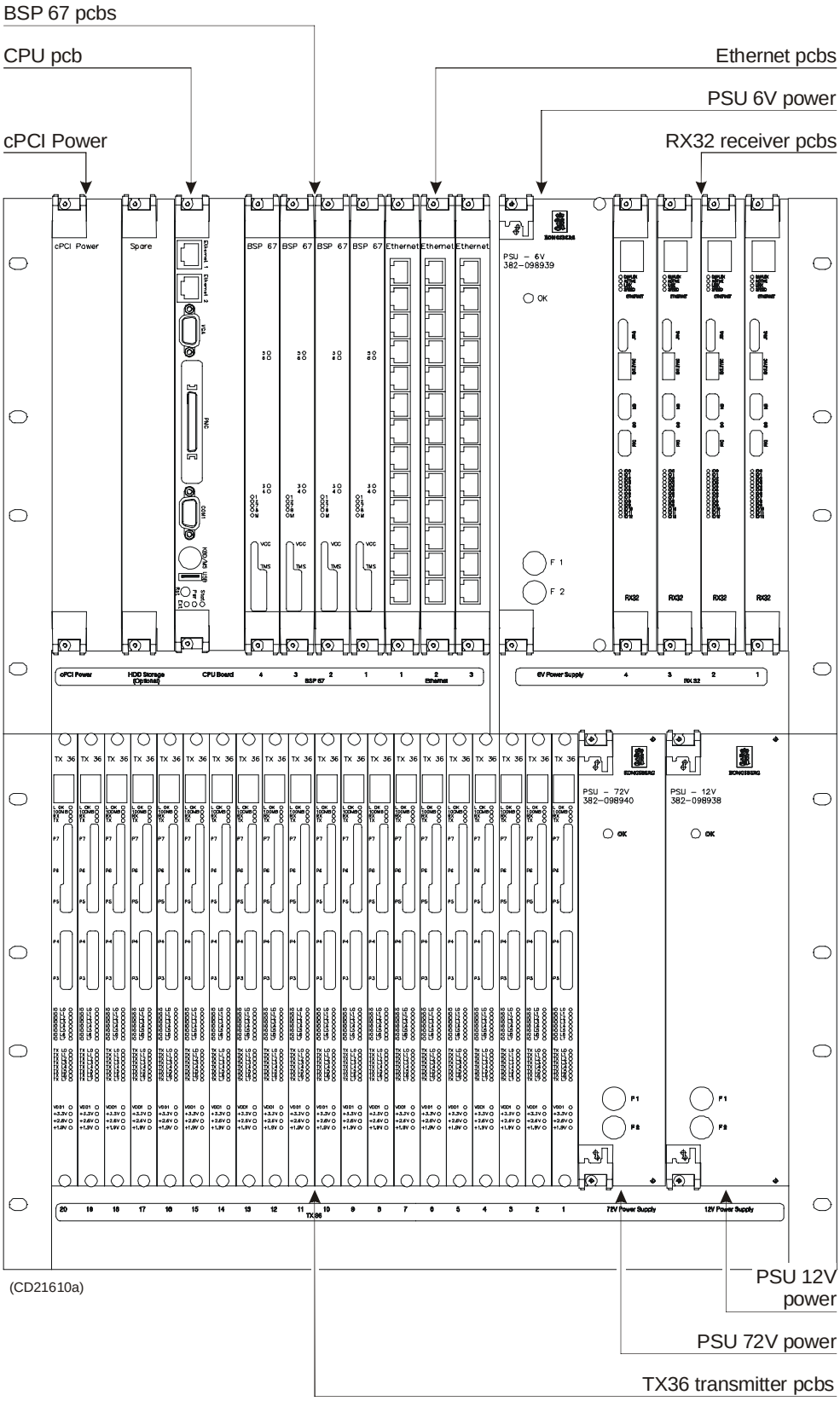


Figure 15 EM 710 Transceiver Unit sub-racks, front view, 0.5 x 1 degree model

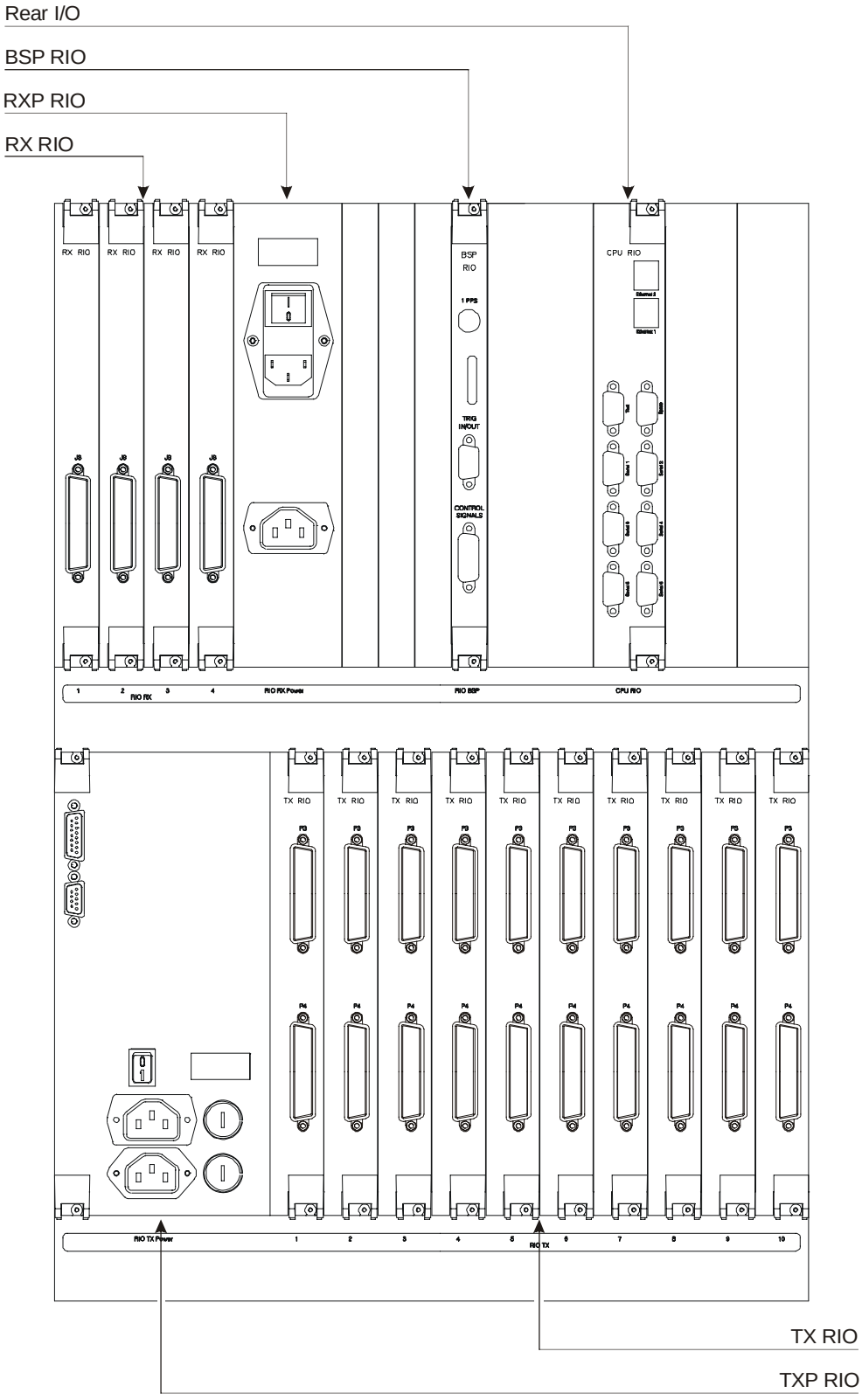
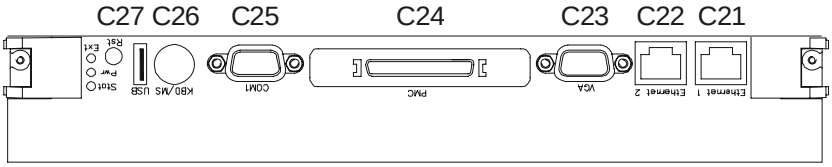


Figure 16 EM 710 Transceiver Unit sub-racks, rear view, 0.5 x 1 degree model

CPU Board cables



(CD21610b)

C21 / C22 - Ethernet

The Ethernet cables are equipped with standard RJ-45 connectors. The CPU board has two Ethernet ports (ETH1 and ETH2). C21 connects to ETH1 for communication with one of the Ethernet Switch Boards. C22 is not used.

The cable C21 is provided by the manufacturer.

→ *Cable details on page 147.*

C24 - PMC I/O Interface (PMC1)

The PMC cable is equipped with a 64-pin connector.

The PMC I/O signals of the PMC1 slot are available at a 64-pin double line header.

This cable is normally not used.

C25 - Serial line (COM1)

This is a serial line terminated in a 9-pin D-sub connector. COM1 is software selectable for RS-232 or RS-422/485 operation.

This cable is normally not used.

→ *Standard 9-pin RS-232/422/485 serial line details on page 142.*

C26 - Keyboard or mouse

This cable is used for adaptation of a keyboard to a standard 6-pin Minidin connector or to connect a PS/2 mouse, either directly or via an external cable splitter.

This cable is normally not used.

→ *Cable details on page 153.*

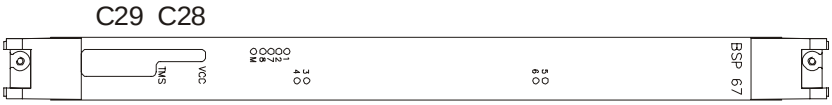
C27 - USB

The USB cable is equipped with a standard USB2 connector. One USB channel is available at the front panel of the CPU board.

This cable is normally not used.

→ *Cable details on page 148.*

BSP67 Board cables



(CD21610c)

C28 - VCC

This cable is connected to the VCC slot to provide a JTAG interface to the FGPA modules on the BSP 67 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.

C29 - TMS

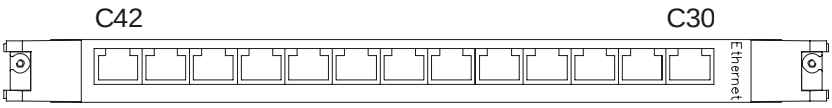
This cable is connected to the TMS Emulator slot for programming and development purposes.

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.

Ethernet Switch Board cables



(CD21610d)

C30 to C41 - Ethernet

The Ethernet cables are equipped with standard RJ-45 connectors. The Ethernet board has 12 Ethernet ports (0 to 11).

The Ethernet interface of each RX32 receiver and TX36 transmitter board must be connected to an Ethernet board.

Also, one Ethernet port must be used to communicate with the CPU board, either directly or through one of the other Ethernet boards.

These cables are provided by the manufacturer. Each cable is cut to a suitable length for connection to dedicated ports. The cable ends are labelled accordingly.

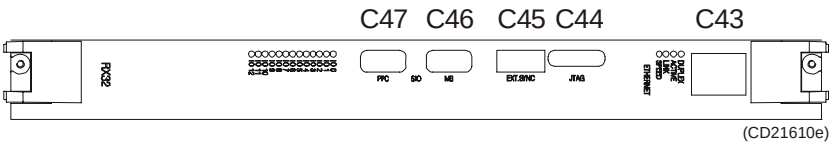
→ *Cable details on page 147.*

C42 - Parallel

The parallel port has a standard Ethernet RJ-45 interface.

This interface is not used.

RX32 Receiver Board cables



(CD21610e)

C43 - Ethernet

The Ethernet cable is equipped with a standard RJ-45 connector.

The Ethernet interface of the RX32 receiver board must be connected to an Ethernet board. This interface is used for all command input and sample data output.

This is normally the only cable connected to the RX32 receiver board. It is provided by the manufacturer.

→ *Cable details on page 147.*

C44 - JTAG

This cable is connected to the JTAG slot to provide a JTAG interface to the FGPA modules on the RX32 receiver board.

The signals of the JTAG slot are available at a 6-pin single line header.

Note

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

C45 - External synchronization (EXT SYNC)

This cable is connected to the EXT SYNC slot for accurate transmit synchronization with external equipment.

The signals of the EXT SYNC slot are available at a 10-pin double line header.

Note

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

C46 - MicroBlaze (MB)

This cable is connected to the MB slot for debugging the MicroBlaze (FPGA soft-core processor) program software.

The signals of the MB slot are available at a 10-pin double line header.

Note

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

C47 - PowerPC (PPC)

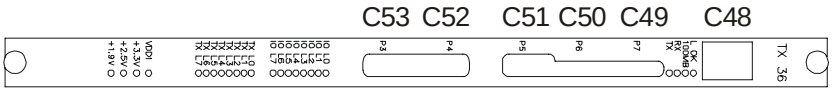
This cable is connected to the PPC slot for debugging the PowerPC (FPGA hard-core processor) program software.

The signals of the PPC slot are available at a 10-pin double line header.

Note

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

TX36 Transmitter Board cables



(CD21610f)

C48 - Ethernet

The Ethernet cable is equipped with a standard RJ-45 connector.

The Ethernet interface of the TX36 transmitter board must be connected to an Ethernet board. This interface is used for all command input and sample data output.

This is normally the only cable connected to the TX36 transmitter board. It is provided by the manufacturer.

→ *Cable details on page 147.*

C49 - IO JTAG

This cable is connected to the IO JTAG slot to provide a JTAG interface to the FGPA modules on the TX36 transmitter board.

The signals of the IO JTAG slot are available at a 6-pin single line header.

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

C50 - TX JTAG

This cable is connected to the TX JTAG slot to provide a JTAG interface to the FGPA modules on the TX36 transmitter board.

The signals of the TX JTAG slot are available at a 6-pin single line header.

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

C51 - External synchronization

This cable is connected to the EXT SYNC slot for accurate transmit synchronization with external equipment.

The signals of the EXT SYNC slot are available at a 10-pin double line header.

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

C52 - MicroBlaze (MB)

This cable is connected to the MB slot for debugging the MicroBlaze (FPGA soft-core processor) program software.

The signals of the MB slot are available at a 10-pin double line header.

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

C53 - PowerPC (PPC)

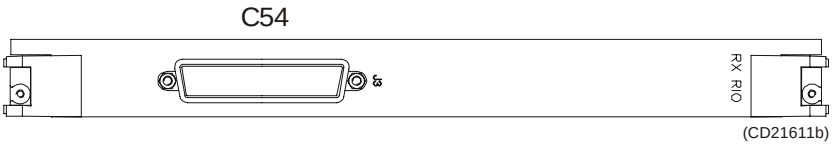
This cable is connected to the PPC slot for debugging the PowerPC (FPGA hard-core processor) program software.

The signals of the PPC slot are available at a 10-pin double line header.

Note

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

RX RIO cables



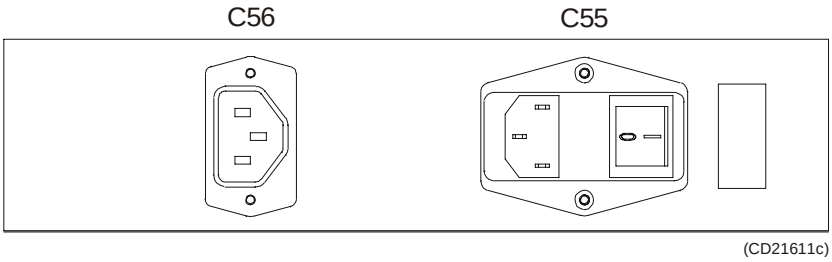
C54 - RX transducer

This is a RX transducer cable terminated in a 78-pin D-sub connector.

Each RX RIO board connects to one RX transducer cable.

→ *Cable details on page 154.*

RXP RIO cables



C55 / C56 - AC power

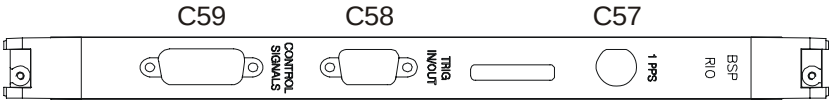
These are 115/230 Vac AC mains cables. Cable C55 must be equipped with a 3-pin IEC female socket and C56 in a male equivalent.

C55 connects to the TXP RIO board. C56 is normally not used.

The cable C55 is provided by the manufacturer.

→ *Cable details on page 146.*

BSP RIO cables



(CD21611d)

C57 - 1PPS

This is a standard coaxial cable. It is used to provide a 1PPS timing signal.

→ *Cable details on page 140.*

C58 - Trigger in/out

This is cable is equipped with a standard 9-pin D-sub connector.

The interface is used to synchronize the echo sounder's transmissions with other acoustic instruments.

This interface is normally not used (see cable C71).

→ *Cable details on page 143.*

C59 - Control signals

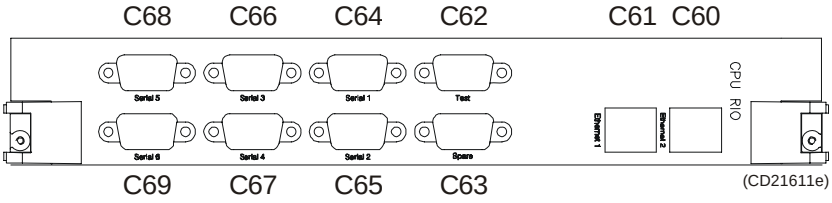
This cable is equipped with a standard 15-pin D-sub connector and is connected to the TXP RIO board.

The interface is used to transmit synchronization signals and TX enable signals (time stamp of TX pulses).

This cable is provided by the manufacturer.

→ *Cable details on page 144.*

Rear I/O cables



(CD21611e)

C60 / C61 - Ethernet

The Ethernet cables are equipped with standard RJ-45 connectors. The Rear I/O board has two Ethernet ports (Ethernet 1 and Ethernet 2). C61 connects to Ethernet 1 for communication with the Operator Station. C60 is not used.

The cable C61 is provided by the manufacturer.

→ *Cable details on page 147.*

C62 - Test

This cable is equipped with a standard 9-pin D-sub connector.

It is connected to the Rear I/O board for test purposes.

Note

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

C63 - Spare

This cable is equipped with a standard 9-pin D-sub connector.

This interface is not used.

C64 to C67 - Serial lines

These cables are equipped with standard 9-pin D-sub connectors. (C68 and C69 not used.)

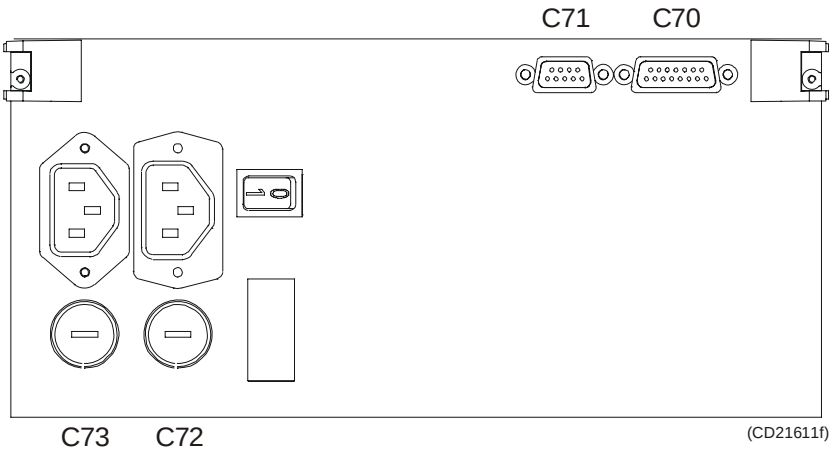
These interfaces are used for connection to external sensors (position, attitude etc.).

- C64 (serial port 1), normally position and clock input.
- C65 (serial port 2), normally attitude input.
- C66 and C67 (serial port 3 and 4) optional input.

For more details refer to the SIS operator manual.

→ *Cable details on page 139.*

TXP RIO cables



C70 - Control signals

This cable is equipped with a standard 15-pin D-sub connector and is connected to the BSP RIO board.

The interface is used to transmit synchronization signals and TX enable signals (time stamp of TX pulses).

This cable is provided by the manufacturer.

→ *Cable details on page 144.*

C71 - Remote On/Off control and synchronization

This cable is equipped with a standard 9-pin D-sub connector.

The interface is used to connect to a remote On/Off power switch. It is also used for external trigger output and synchronization.

→ *Cable details on page NO TAG.*

C72 / C73 - AC power

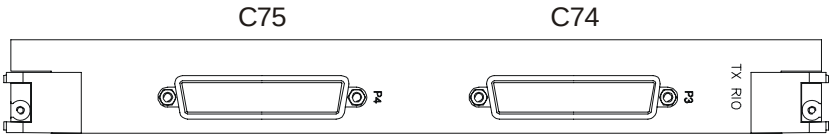
These are 115/230 Vac AC mains cables. Cable C72 must be equipped with a 3-pin IEC male socket and C73 in a female equivalent.

C72 connects to the RXP RIO board. C73 is connected to the ship's mains power.

The cable C72 is provided by the manufacturer.

→ *Cable details on page 146.*

TX RIO cables



(CD21611g)

C74 / C75 - TX transducer

These are TX transducer cables terminated in 78-pin D-sub connectors.

Each TX RIO board connects to two TX transducer cables.

→ *Cable details on page 154.*

Typical cable configuration

This chapter presents a standard cable configuration for a complete EM 710 echo sounder system. The following illustrations describe a 2 x 2 degrees model, but note that the actual cable layout will be different for every system, depending on the EM 710 model, the number of external sensors and other interfacing systems.

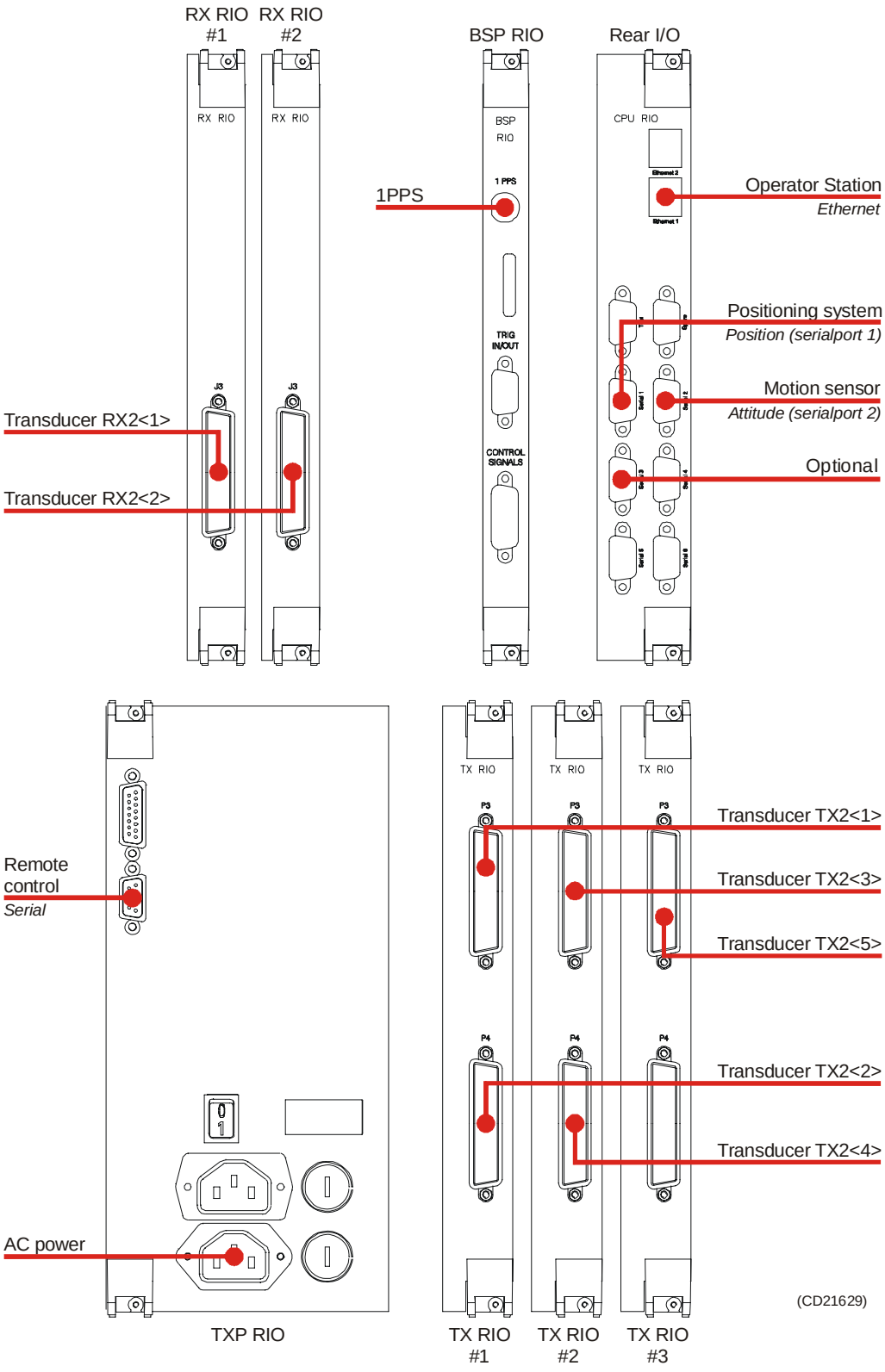


Figure 17 Cabling between the Transceiver Unit, other system units and external systems

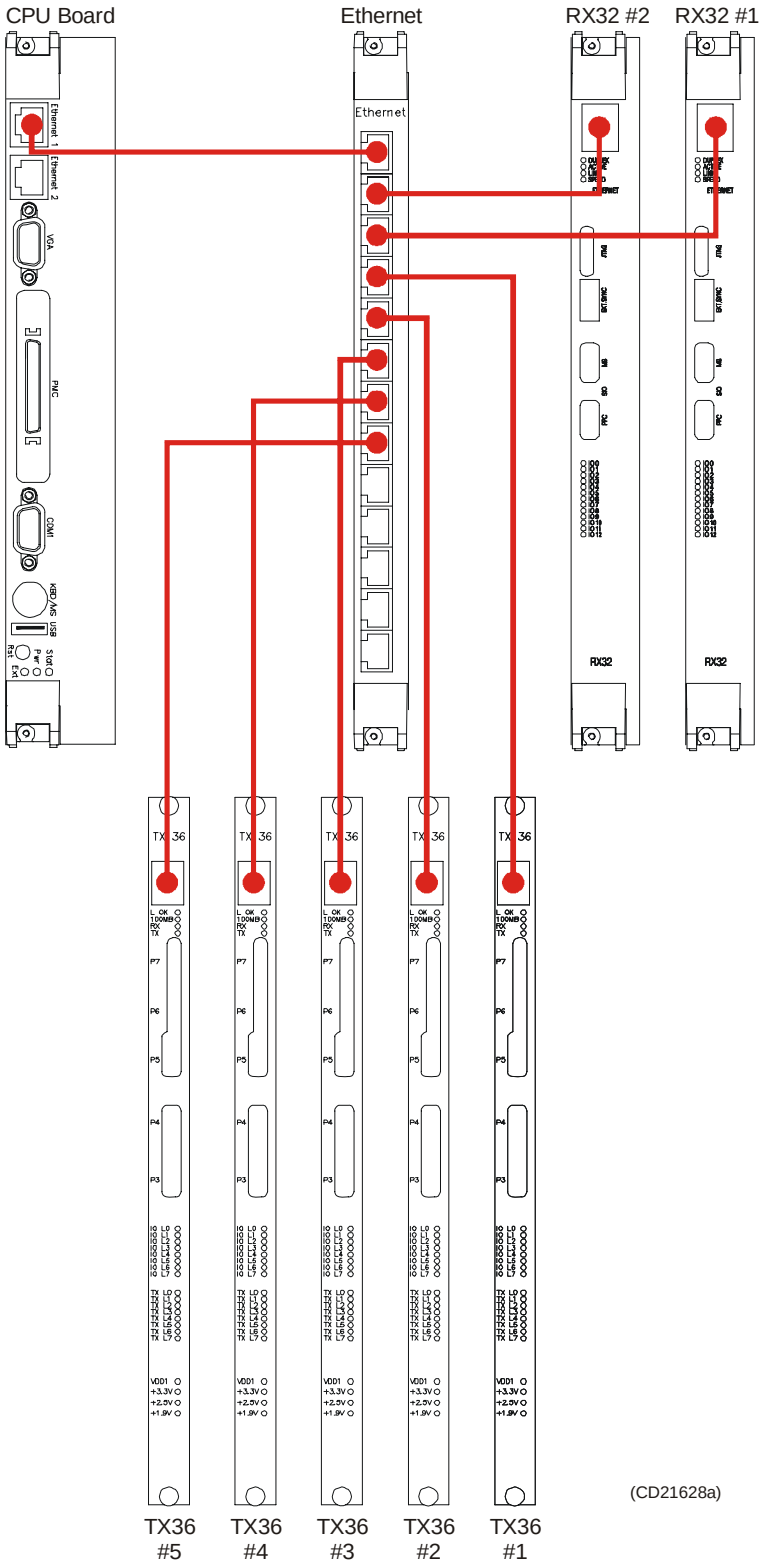


Figure 18 Internal cabling in the Transceiver Unit (Ethernet cables)

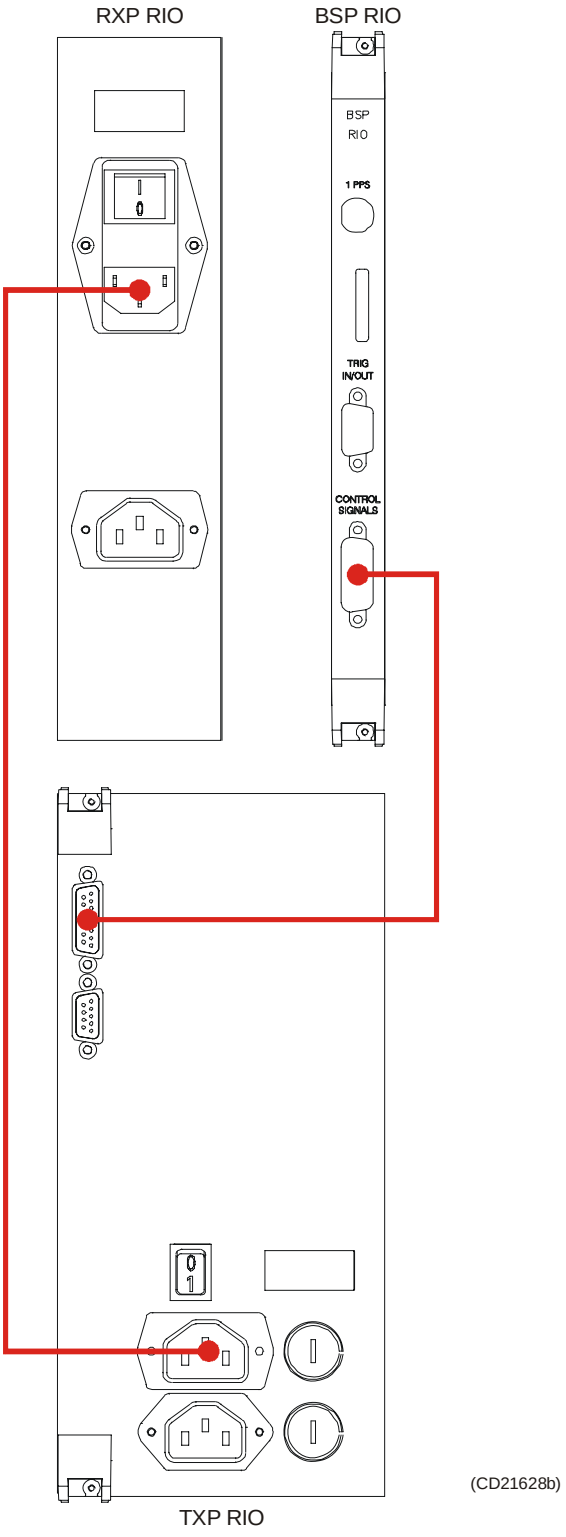


Figure 19 Internal cabling in the Transceiver Unit (power and control cables)

6.3 Transducer cables

Introduction

The transducer cables between the transducer arrays and the Transceiver Unit are all supplied by Kongsberg Maritime with the EM 710 system.

The physical number of cables depends on the chosen system beamwidth as shown the following tables.

System beamwidth (TX x RX)	*Number and type of TX transducer modules*	*Number and type of RX transducer modules*
	Number of cables from TX transducer array to Transceiver Unit	*Number of cables from RX transducer array to Transceiver Unit*
0.5 x 1 degree	2 x TX1	1 x RX1
	20	4
1 x 1 degree	1 x TX1	1 x RX1
	10	4
1 x 2 degrees	1 x TX1	1 x RX2
	10	2
2 x 2 degrees	1 x TX2	1 x RX2
	5	2

The following cable information is available both in the EM 710 installation and maintenance manuals. The cable markings are normally recorded in the installation manual first, and it is recommended to copy these records to the maintenance manual later.

Note that performance data about each element and it’s serial number are recorded in the Factory Acceptance Test documentation provided with each system.

Transmit array cable markings

The TX transducer module(s) and its cable is identified as follows:

TX1<m>/<n> (or TX2<m>/<n>

where <m> is the cable number (a number between 1 and 10) and <nnn> is the module's serial number (a numerical value).

The transducer cables are molded to the TX array, but connect in the other end to the Transceiver Unit (TRU) with 76-pin D-sub connectors.

Note — *During the installation of the TX array, you must fill in the cable identification table(s) below.*

Note — *For a 0.5 x 1 degree system, you will need all cables listed in the tables. With a 1 x 1 or 1 x 2 degrees system, you only need the first 10, while the 2 x 2 degrees system only requires the first 5 cables.*

Note — *The 0.5 x 1 degree system consists of two TX modules. It is essential to connect all 20 TX cables successively to the TX RIO boards in the Transceiver Unit. Where to start is determined by the physical orientation of the transducer cable outlet (port or starboard). Both options are shown in the figure below.*

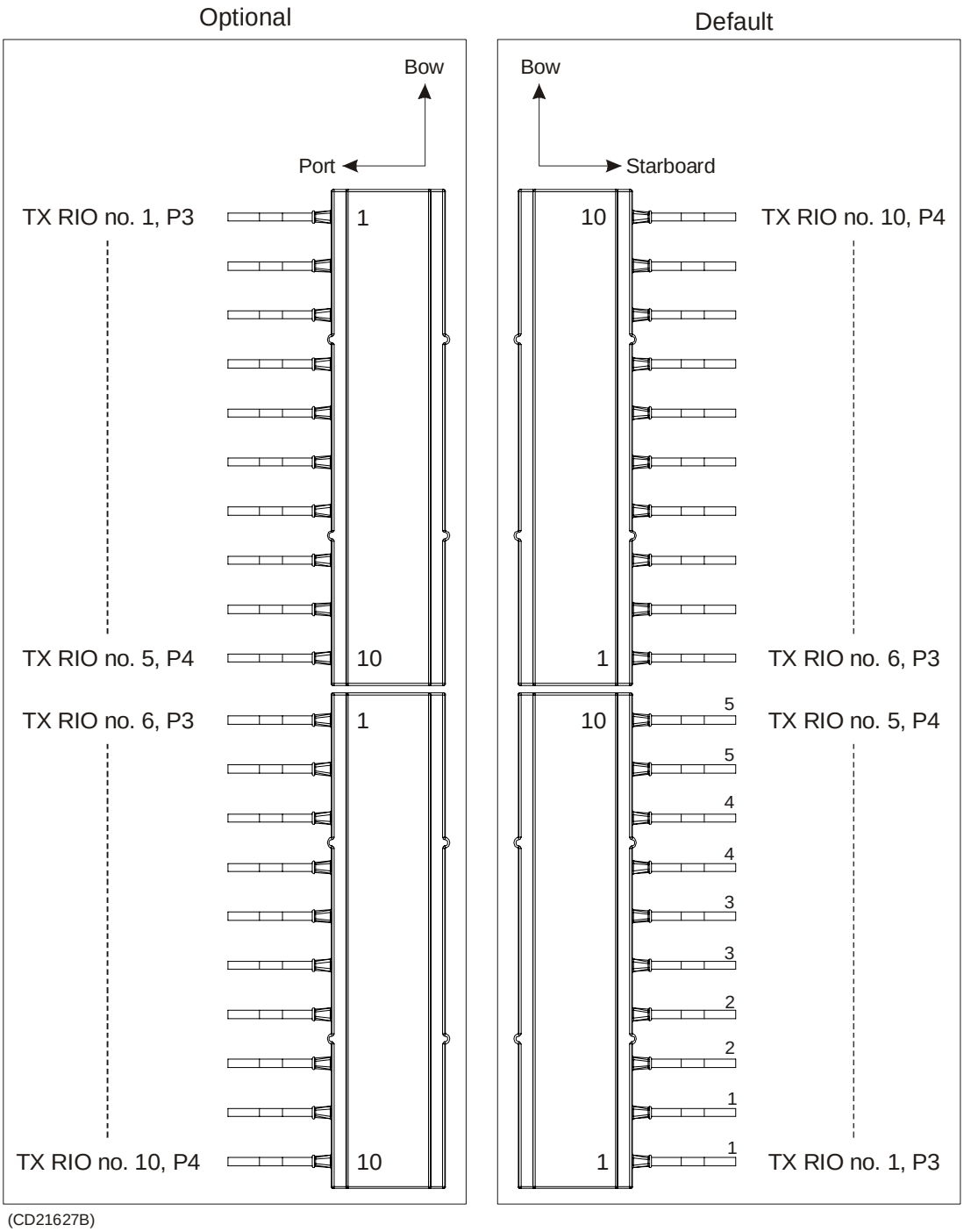


Figure 20 Connection of TX transducer cables, 0.5 x 1 degree system, top view

TX array identification		*TRU identification*	
Cable no.	***Serial no.***	***TX RIO no.***	***Socket no.***
1		1	P3
2		1	P4
3		2	P3
4		2	P4
5		3	P3
6		3	P4
7		4	P3
8		4	P4
9		5	P3
10		5	P4

TX array identification (second 0.5 degree array)		***TRU identification***	
Cable no.	***Serial no.***	***TX RIO no.***	***Socket no.***
1		6	P3
2		6	P4
3		7	P3
4		7	P4
5		8	P3
6		8	P4
7		9	P3
8		9	P4
9		10	P3
10		10	P4

Receive array cable markings

The RX transducer module(s) and its cable is identified as follows:

RX1<m>/<n> (or RX2<m>/<n>

where <m> is the cable number (a number between 1 and 4) and <nnn> is the module's serial number (a numerical value).

The transducer cables are molded to the RX array, but connect in the other end to the Transceiver Unit (TRU) with 76-pin D-sub connectors.

Note *During the installation of the RX array, you must fill in the cable identification table below.*

Note *In a 0.5 x 1 or 1 x 1 degree system, you will need all cables listed in the table. With a 1 x 2 or 2 x 2 degrees system, you only need the first 2 cables.*

RX array identification		***TRU identification***
Cable no.	***Serial no.***	***RX RIO no.***
1		1
2		2
3		3
4		4

6.4 Cable specifications

Introduction

The *Drawing file* chapter provides detailed information about the cables used in the system. Note that several cables may share identical specifications.

The technical parameters provided for the cables are the minimum specifications. Also, in most cases, it may be useful to install extra pairs in selected cables for future expansions.

Note

The cables specified may not meet the standards provided by the vessel's classifiaction society. Consult the applicable guidelines.

Kongsberg Maritime as takes no responsibility for performance degradation or damage caused to system, vessel or personnel if the cables used during installation do not meet these specifications.

6.5 Basic cabling requirements

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 (max. 0.5 metre) 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.

6.6 Cable gland assembly procedure

Purpose

Cable glands are used whenever a cable passes through a water-tight bulkhead or into a cabinet, to seal the opening through which the cable passes and to protect the cable from abrasion on the edges of the hole. Follow the guidelines detailed here when installing cables through cable glands.

Note

There are many different types of cable gland on the market. This procedure describes the types used (now and previously) as standard in the units manufactured by Kongsberg Maritime. The cable glands are not supplied with the system.

Even though the cabinets from Kongsberg Maritime may be prepared for specific types, the installation shipyard will be responsible for selecting cable gland types and installing them.

Note

The screen in transducer cables must never be connected to ship's ground in the cable glands!

General procedure

1 Ensure all the cables to be connected are completely isolated from any power sources.

- I.e. switch off and remove the supply fuses from any units or systems into which the cables are already connected.

2 Select the cable to be connected into the cabinet, and select the cable gland through which the cable is to pass.

Note

*A **minimum** of 5 to 10 cm of slack cable must be allowed (depending on the cable diameter and arrangement), both inside and outside the cabinet, when installing cables. This is to allow for vibration damping, maintenance and measurement errors. Always double-check your measurements before taking any irreversible actions.*

---

3 Depending on whether the cable has already been installed in conduits, either.

a (installed) measure the maximum length of cable required to reach from the final cable clip outside the cabinet to the terminal blocks inside the cabinet, add 20 cm, then remove the excess cable,

or:

b (loose cable) measure the maximum length of wire required to reach from the cable gland to the terminal blocks inside the cabinet, add 20 cm. and mark the cable.

Note

*The cable's outer insulation will extend into the cable gland to a point approximately 5 mm **outside** the outer surface of the cabinet wall into which the cable gland is secured.*

---

4 Taking care not to damage the screening, carefully remove the outer insulation from the required cable length.

5 Leaving an appropriate length of the screen exposed from the insulation, cut off the remainder.

Securing and terminating the cables

1 Referring to the wiring diagram and ensuring that there is 5 to 10 cm slack cable inside the cabinet, prepare and connect the cable cores to the appropriate terminals within the cabinet.

2 Secure the cable within the cabinet using cable clips.

3 Check the terminal connections against the wiring diagram to ensure they are correct.

Follow the same procedure for all the cables and cable glands. Once all the cables have been fitted:

4 Check the cabinet to ensure all tools and rubbish are removed, then close the cabinet door.

Once all the system cables are connected and checked:

5 Take the appropriate safety measures, then replace the fuses and apply power to the system.

6 Perform a system test to ensure the installation has been conducted successfully.

Multi-diameter modules

Multi-diameter cable glands are now available from several sources, and these types are becoming increasingly popular due to ease of use. Only a brief description of the system will be presented here, further information with technical specifications and installation descriptions must be obtained from the manufacturer(s).

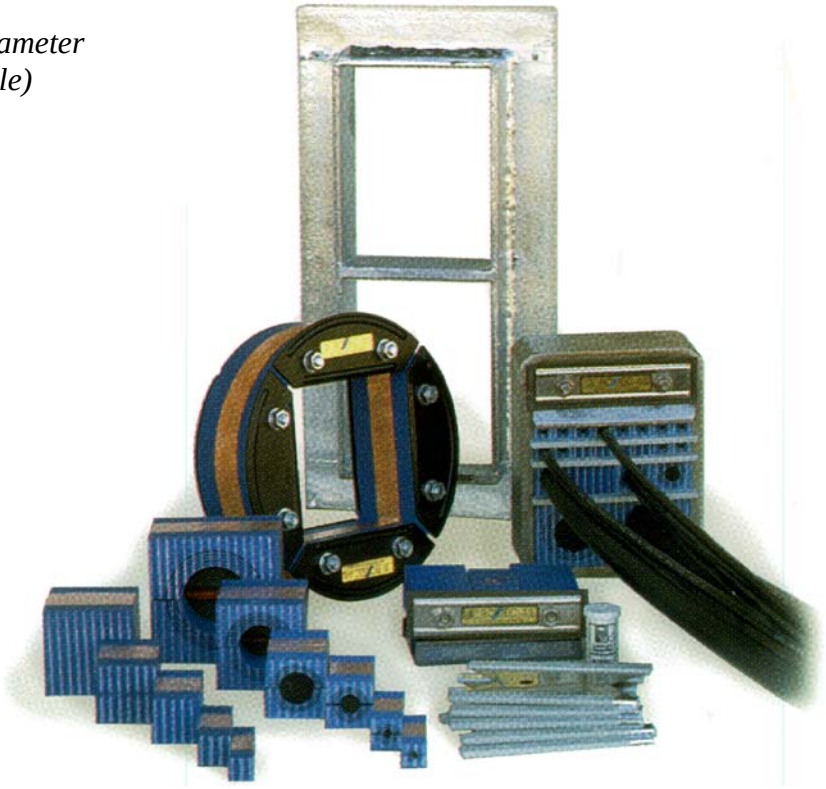


Figure 21 Multi-diameter modules (example)

The illustrations and examples here are from the following manufacturer:

```
Roxtec AB
Bx 540
S-371 23 Karlskrona, SWEDEN
http://www.roxtec.se
```

To use this sealing system, you first need to cut an opening in the wall (bulkhead, cabinet etc) you wish to penetrate, and this hole must be sized to fit one of the standard rectangular or circular frames provided by the manufacturer.

After the frame has been mounted, the cables can be pulled through, and in most cases the opening will be large enough even to accept the plugs on the cables.

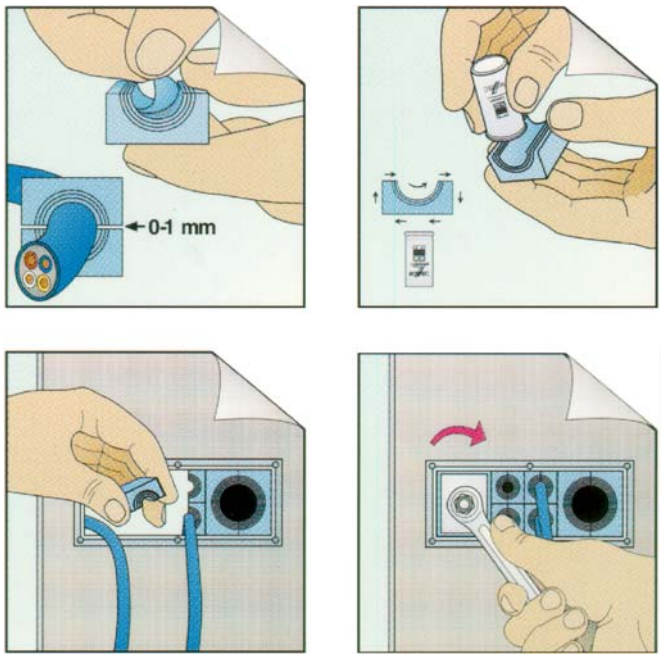


Figure 22 Multi-diameter system - general procedure

Once the cables are through, each cable is secured with a square module, which is adjusted to fit the cable’s outer diameter.

When the required number of modules are installed, the assembly is tightened with a compression unit.

This system is available with a large number of various modules and compression units, and it will also comply with screening and EMC requirements.

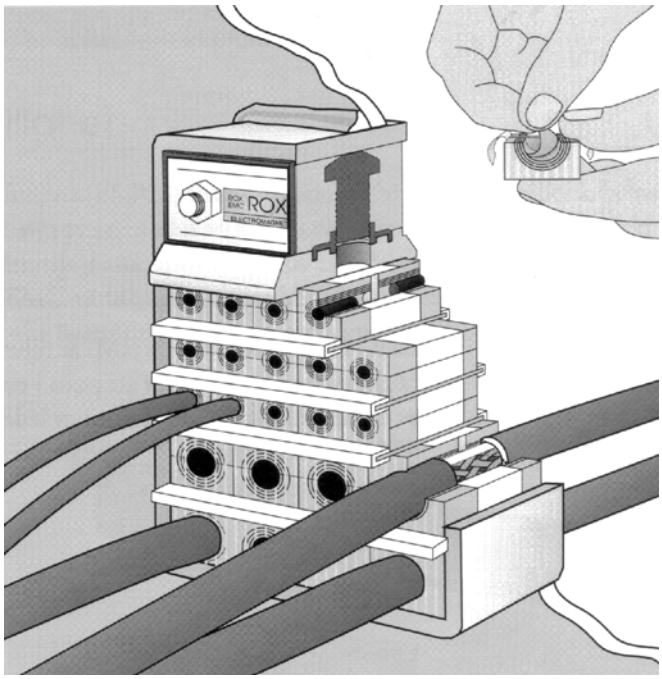


Figure 23 Multi-diameter system - The finishied assembly

Standard type

1 Ensure that all the cables to be connected are completely isolated from any power sources.

- Switch off and remove the supply fuses from any units or systems into which the cables are already connected. Verify that no safety interlocks have been bypassed. Tag out the system properly.

2 Select the cable to be connected into the cabinet, and select the cable gland through which the cable is to pass.

3 Slacken and remove the compression nut from the cable gland, and extract the compression seal and the screen collar from the body of the gland.

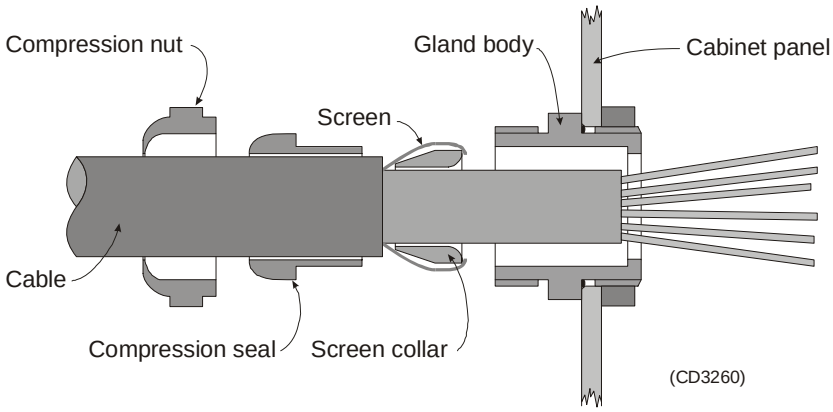


Figure 24 Standard cable gland assembly

Note

*A **minimum** of 5 to 10 cm of slack cable must be allowed (depending on the cable diameter and arrangement), both inside and outside the cabinet, when installing cables. This is to allow for vibration damping, maintenance and measurement errors. Always double-check your measurements before taking any irreversible actions.*

4 Depending on whether the cable has already been installed in conduits, either:

c (installed) measure the maximum length of cable required to reach from the final cable clip outside the cabinet to the terminal blocks inside the cabinet, add 20 cm, then remove the excess cable,

or:

d (loose cable) measure the maximum length of wire required to reach from the cable gland to the terminal blocks inside the cabinet, add 20 cm. and mark the cable.

Note

*The cable's outer insulation will extend into the cable gland to a point approximately 5 mm **outside** the outer surface of the cabinet wall into which the cable gland is secured.*

5 Taking care not to damage the screening, carefully remove the outer insulation from the required cable length.

6 Leaving 12 mm of the screen exposed from the insulation, cut off the remainder.

7 Taking care not to damage the screening, slide the compression nut (smallest diameter first) over the cable and onto the intact insulation.

8 Taking care not to damage the screening, slide the compression seal (rounded end first) over the cable and onto the intact insulation.

9 Slide the screen collar (narrow end first) onto the cable and fit it underneath the screen. Slide it as close to the intact outer insulation as possible.

10 If the screen extends beyond the "flat" end of the screen collar, fold any excess length over the end of the collar such that the screen will be gripped between the collar and the gland body when the parts are assembled.

11 Carefully thread the cable through the gland body till the screen collar is tight into the gland body.

12 Slide the compression seal into the gland body till the shoulder is hard up against the gland body.

13 Slide the compression nut over the compression seal and engage the threads.

14 While holding the gland body to prevent it turning, and pressing the cable into the gland, tighten the compression nut onto the gland body.

15 Referring to the wiring diagram and ensuring that there is 5 to 10 cm. slack cable inside the cabinet, prepare and connect the cable cores to the appropriate terminals within the cabinet.

16 Secure the cable within the cabinet using cable clips.

17 Check the terminal connections against the wiring diagram to ensure they are correct.

Follow the same procedure for all the cables and cable glands. Once all the cables have been fitted:

18 Check the cabinet to ensure all tools and rubbish are removed, then close the cabinet door.

Once all the system cables are connected and checked:

19 Take the appropriate safety measures, then replace the fuses and apply power to the system.

20 Perform a system test to ensure the installation has been conducted successfully.

Additional type 1 (842-093878)

1 Mount the cable gland body, and tighten it with the nuts on each side of the cabinet wall.

2 Slide the metal washers, the rubber gasket and the compression nut onto the cable in the order indicated in the figure.

→ *Refer to figure 25.*

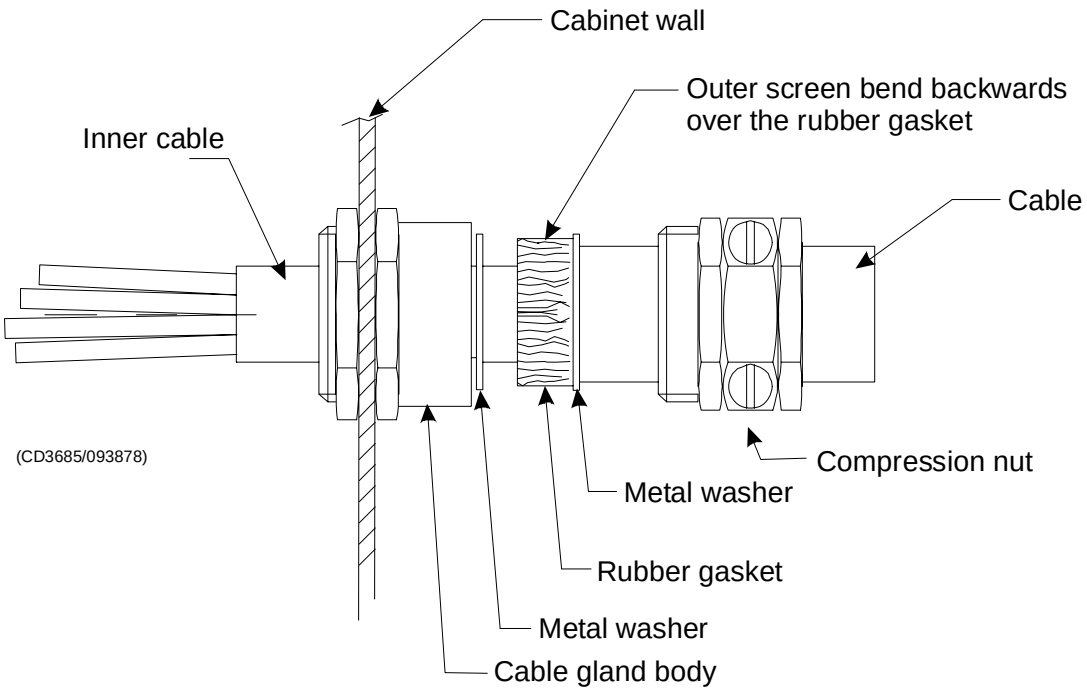


Figure 25 Cable gland, type 1 (842-093878)

3 Bend the screen over the rubber gasket.

4 Push the rubber gasket and the two metal washers carefully into the cable gland body.

5 While holding the gland body to prevent it turning, and pressing the cable into the gland, tighten the compression nut onto the gland body.

Additional type 2 (541-093642)

1 Mount the cable gland body, and tighten it with the nuts on each side of the cabinet wall.

2 Slide the metal washers, the rubber gasket and the compression nut onto the cable in the order indicated in the figure.

→ *Refer to figure 26.*

3 Bend the screen over the compression cone.

4 Push the compression conne, the washers and the rubber sealing washer into the cable gland body.

5 Close the mounting nut.

6 Close and tighten the compression nut on the other side of the cabinet wall.

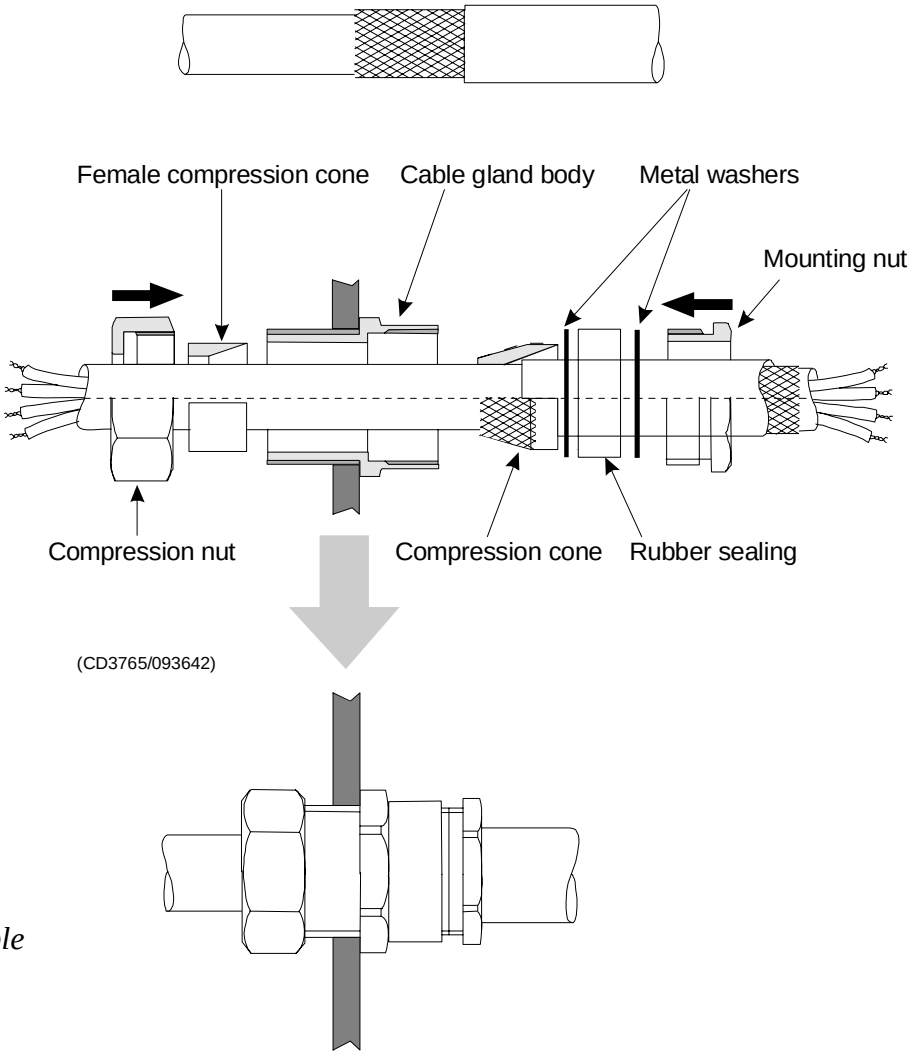


Figure 26 Cable gland, type 2 (541-093642)

7 ALIGNMENT

7.1 Introduction

The EM 710 is a precision instrument for bathymetric swath mapping. To be able to produce data that are both detailed and correct, it is necessary to calibrate the survey vessel more accurately than what may have been standard practice earlier. The required calibration consists of:

- measurement of where sensors are located
- measurement of how sensors are oriented
- measurement of the waterline vertical location
- alignment of angular measurement sensors
- determination of any offsets in sensor data
- determination of any time delays in sensor data

The results, with all measurements taken in a common vessel coordinate system, are to be entered in the EM 710 Operator Station.

Calibration must be taken seriously. It is recommended that this task and the continued control of the soundings' consistency is assigned to one motivated and qualified person in the organization. To achieve the best results, the calibration must be planned carefully, and monitored throughout the installation and the first sea trials. It is also recommended to repeat the calibration procedures with regular checks throughout the operation of the vessel.

7.2 Measurements

Objectives

The measurements to be made after installation are:

- the horizontal and vertical positions of the transducer arrays
- the angular orientation of the transducer arrays
- the horizontal and vertical positions of the motion sensor
- the angular orientation of the motion sensor
- the horizontal and vertical positions of the positioning system (radio or GPS antenna).

The measurements on the transducer arrays must be made with the vessel in dry dock, the others may be done with the vessel berthed.

It is however recommended that all measurements/offsets are established in dry dock. This gives the best alignment accuracy.

During the sea trials (SAT), calibration surveys are required as described in the EM 710 Operator Manual. Based on the calibration parameters determined from these surveys, proper values are entered into the EM 710 Installation menu found in the operator software.

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.

Alignment of motion and heading sensors

The alignment of the motion sensor and the heading sensor must be adjusted so that they provide zero values for pitch, roll and heading with the vessel lying still with normal trim and a true North heading. It is recommended that this takes place in the dry dock. Alternatively, the offsets from zero must be determined. This is easiest to do with the vessel berthed. Follow the procedures in the applicable sensor manuals.

Water line

Finally, the vertical position of the water line must be measured with the vessel in normal trim. This should preferably be done at normal survey speed, and must of course be repeated as the loading and hence the draft of the vessel changes.

Vessel coordinate system

A Cartesian coordinate system must be defined for the vessel. The following definition must be adhered to:

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

There is no restriction on 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 water line should therefore be marked on the hull with the vessel in normal trim before any dry docking.

Reference points must be established on the vessel at selected positions. These are needed during measurements of the sensor positions. Visual markings at these positions should be prepared and noted on the vessel drawings with XYZ coordinates in the vessel coordinate system.

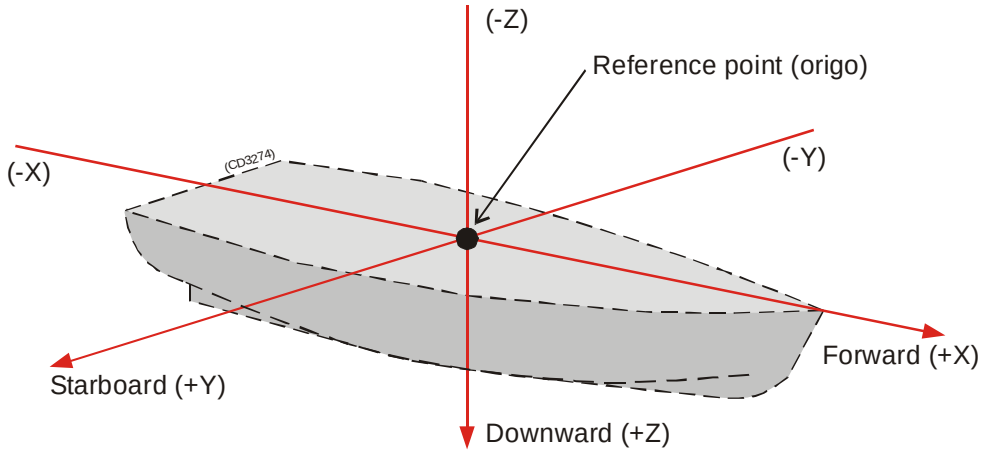


Figure 27 Reference points

Sensor location

Overview

The EM 710 transducers should be located according to the guide-lines given elsewhere in the installation manual. With regard to the location of other sensors the following guide-lines should be followed, but otherwise should be chosen according to the manufacturer's documentation.

The transmit transducer array should be approximately aligned along the vessel's keel, while the receive transducer array should be aligned 90° on the keel. Both transducers should be horizontal, approximately on a plane on the keel. There is no need for the arrays to have the exact same heading, roll and pitch.

Motion sensor

The system motion sensor should normally be mounted on the centerline of the vessel, either close to the EM 710 transducers or close to the vessel's CG (Center of Gravity).

The latter point is recommended if the sensor is used for other purposes than just with the EM 710, or if its accuracy is sensitive to horizontal accelerations.

If there is any point in the fore-aft direction which does not change height with respect to the waterline with changes in vessel speed, then this is the ideal location for the motion sensor. This will eliminate any errors from squat induced height changes which is not measured by current motion sensors.

Note *If the alongship distance between the transducer array and the motion sensor is larger than 50 m, the system accuracy may be degraded.*

Note *The motion sensor must be aligned with the vessel centerline.*

Heading sensor

The accuracy of the heading sensor may be sensitive to accelerations and should therefore be mounted close to the Center of Gravity (CG).

Note *The heading sensor must be aligned with the vessel centerline.*

Measurement accuracy

Overview

The required measurement accuracies given below have been determined from considerations on how they contribute to total system accuracy, i.e that any errors in these measurements shall not significantly contribute to depth or position errors in the soundings.

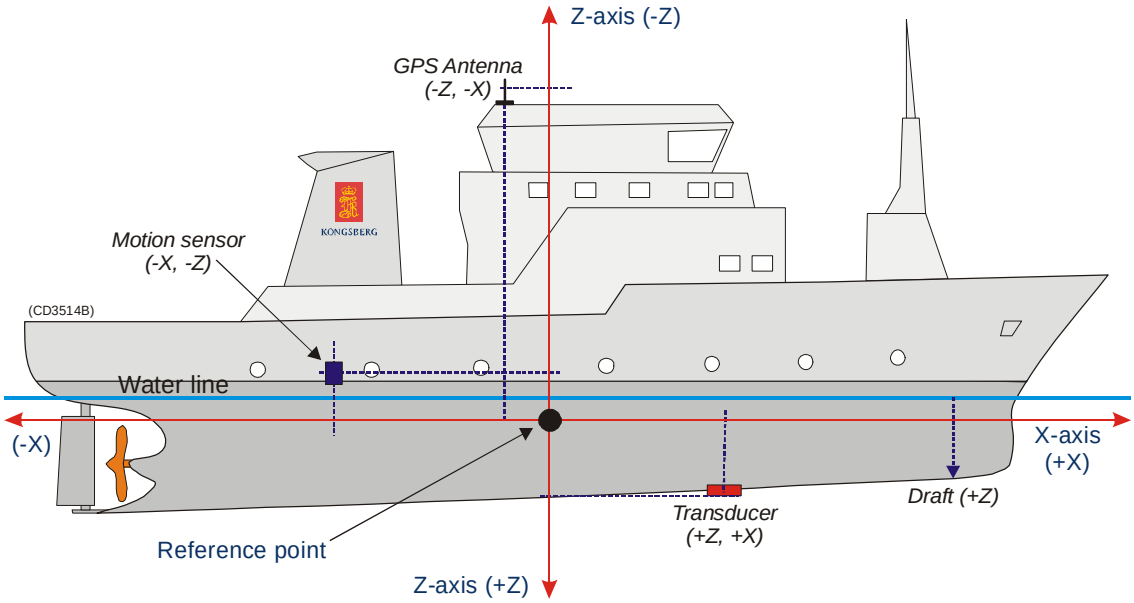


Figure 28 Reference points and CG

Transducer arrays

1 The vertical location of the transducer centers must be measured to an accuracy of ±2 cm.

2 Their horizontal location must be measured to an accuracy of ±5 cm.

These measurements must be made from the center of the transducer faces.

3 The heading of the transducers must be measured to an accuracy of ±0.1°

Note

The resulting relative heading error between the receive and transmit transducers must be less than ± 0.05°.

---

4 Measure the pitch of the transmit transducer to an accuracy of ±0.05°. For the receive transducer an accuracy of ±0.2° is sufficient.

5 Measure the roll to an accuracy of ±0.025° for the receive transducer. For the transmit transducer ±0.2° is sufficient accuracy.

Motion sensor

1 The vertical location of the motion sensor must be measured to an accuracy of ±10 cm.

2 Its horizontal location must be measured to an accuracy of ±5 cm.

Note *If the Motion Sensor performs lever arm correction to give heave data valid for another location than where it is actually mounted, it is this location which must be measured. (Of course the motion sensor needs to know both the location of this point and its own.)*

---

3 The forward axis on the motion sensor must be aligned with the X-axis of the vessel's coordinate system to an accuracy of ±0.1°.

The sensor must be aligned such that the indicated roll and pitch angles from the motion sensor when the vessel has a normal trim, i.e. the coordinate system's horizontal plane is horizontal, should be less than ±0.025° for roll and ±0.05° for pitch.

→ *Please refer to the manufacturers installation manual for more details.*

Heading sensor

The heading sensor must be aligned with the X-axis of the vessel's coordinate system to an accuracy of ±0.1°.

Positioning system

1 The vertical location of the positioning system antenna must be measured to an accuracy of ±2 cm.

- This is only required if the positioning system measures position in the vertical axis. This will be usually only be the case for real-time kinematic GPS systems and some optical positioning systems.

2 The positioning system antenna's horizontal location must be measured to an accuracy of ±5 cm.

Note *The given accuracies are maximum values, and if easily achievable, better accuracies should be obtained. The relative accuracy between Rx and Tx must be within ±0.10 ° in the heading alignment.*

Water line

1 The vertical distance to the waterline should be measured with an accuracy of ±2 cm.

Note

With the vessel in normal trim, i.e with an indicated pitch angle of zero from the motion sensor, the distance to the waterline may be measured anywhere on the vessel, but 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.

7.3 Measurement of the transducer orientation

The heading of the transducers is measured as the average heading of the two fore-and-aft oriented sides of each transducer in the horizontal plane of the vessel coordinate system. Thus, the heading of the transmit transducer is the heading of the long sides, while the heading of the receiver array is the heading of the short sides. For the receive transducer it may be better to measure the heading of the long sides, and then subtract 90° to achieve the correct value.

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. for roll the angle that the transducer's y-axis have with respect to the horizontal and for pitch the angle that the transducers x-axis ha 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.

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

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

Note that it may be most practical to perform these measurements on the transducer mounting frames before installation of the transducer module. A final verification after module installation is then required.

7.4 Mounting frames and structures

No actual measurements of the orientation or location of the transducer mounting structures are in principle required. However, the mounting structures must not deviate from a flat surface by more than ±0.5 mm This can be checked by measuring the relative vertical positions of the module mounting bars on the frames. If the deviations are too large, this has to be corrected before the modules are put in place.

Alternatively the flatness of the transducer mounting frame may be checked by using a sufficiently long and flat ruler, or with a sufficiently accurate inclinometer. This will make it difficult to see if there is any twist in the transducer array.

Note *Any twist in the transducer array will affect the soundings.*

7.5 Heading sensor calibration

It may not be possible to calibrate the heading sensor accurately enough through sea trials, so the calibration is normally done with the vessel berthed.

On the quay the geographical coordinates of two points must be known or measured so that the heading of a line on the quay can be established to an accuracy of better than ±0.1°. The distance from two points on the centerline of the vessel (fore and aft) are then measured so that the vessel's heading can be calculated. The heading sensor is then aligned to this heading or its measured offset determined.

The vessel must be turned 180° as many times as necessary with the alignment or offset checked until the **mean error** is within the specifications of the heading sensor.

7.6 Summary

The table below give a summary of the requirements to the accuracy of the measurements.

TX array	Measurement accuracy
Position (x, y) [m]	± 0.05
Position (z) [m]	± 0.02
Pitch [deg]	± 0.05
Roll [deg]	± 0.20
Heading [deg]	± 0.10

RX array	Measurement accuracy
Position (x, y) [m]	± 0.05
Position (z) [m]	± 0.02
Pitch [deg]	± 0.20
Roll [deg]	± 0.025
Heading [deg]	± 0.10

Motion sensor	Measurement accuracy
Position (x, y) [m]	± 0.05
Position (z) [m]	± 0.10
Pitch [deg]	± 0.05
Roll [deg]	± 0.025
Heading [deg]	± 0.10

Heading sensor	Measurement accuracy
Heading [deg]	± 0.10

Positioning system (antenna)	Measurement accuracy
Position (x, y) [m]	± 0.05
Position (z) [m]	± 0.02

Water line	Measurement accuracy
Position (z) [m]	± 0.02

8 INSTALLATION CHECKS

8.1 Scope

After the installation has been performed and before the EM 710 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 company which performed the installation to have the work rectified and brought up to the required quality standards.

Which specific tests that are conducetd are normally specified in the contract. In most cases, the following tests are performed:

- Installation tests
  - These tests are performed by the installation shipyard 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 test 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.

8.2 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 710 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 Station

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): _____

Transceiver Unit

Perform a close visual inspection of the EM 710 Transceiver Unit cabinet.

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

8 Check that the proper mounting bolts have been used, and that proper torque has been applied.

9 Check that the unit is not damaged.

10 Make sure that you have access to the internal part of the cabinet, and that appropriate slack has been applied to the cables.

11 Check that the air vents are not blocked.

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

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

14 Check that the door and the forward part of the cabinet can open completely.

15 Checked (date/sign): _____

8.3 Electrical checks

Scope

This section of the manual contains the test procedures for the EM 710 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.

8.4 Final installation checks

After installation - but before leaving the dry dock - a number of tests 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 710 and that the values are reasonable before leaving for sea trials.

6 Check that the echo sounder is acquiring reasonable sounding values.

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.

9 EQUIPMENT HANDLING

9.1 Overview

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

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

9.2 Transportation

General specifications

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

Note

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

Local transportation

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

The carton or case will normally be marked with text or symbols indicating which way up 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.

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

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

- The applicable weight certificate for the crane.
- The security of the lifting lugs.

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

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

9.3 Initial preservation

Introduction

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.

Specific specifications are presented below.

→ *For further information about storage, refer to page 111.*

→ *For further information about re-packing, refer to page 113.*

→ *For further information about temperature protection, refer to page 115.*

Original packing crate

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 repack 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.

→ *Refer to information on page 113.*

Ambient temperature and humidity

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

2 The storage area's mean temperature must not be lower than -30° C, and not warmer than +70° C.

- If other limitations apply, the crates will be marked accordingly.

Note

Transducers must not be stored in temperatures below -20° C, or higher than +60° C.

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

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

Shock and vibration

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

ESD precautions

→ *Refer to the information on page 114.*

Batteries

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

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

9.4 Inspection and unpacking

Inspection

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

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

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.

- Check the carton before opening it to ensure it shows no signs of dropping, immersion in water or other mishandling.
  - If the carton shows signs of such damage, refer to the paragraph covering Inspection on receipt.
- Place the carton on a stable work bench or on the floor with the top of the carton uppermost.
- In the absence of other instructions, always open the top of the carton first. 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.

Caution

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

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

Electronic and electro-mechanical units

Caution — *Beware of the dangers of Electro-Static Discharge (ESD) both to yourself and to the equipment, when handling electronic units and components. Refer to the precautions starting on page 114.*

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

Inspect the unit for damage before opening the plastic bag.

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

Note — *Do not break the seal to open a circuit board package before the board is to be used. If the board package is returned to the manufacturers with the seal broken, the 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.

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.

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.

Note — *Once the units are unpacked, great care must be taken to ensure that transducers and cabling are not exposed to any mechanical stress.*

Re-packing

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

→ *Refer to the information on page 113.*

9.5 Storage

Pre-installation storage

The equipment should 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.

Caution

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

After use storage

Introduction

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

Cleaning cabinets

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

- Wipe the cabinet externally using a damp cloth and a little detergent. Do not use excessive amounts of water as the unit may not be water tight. On completion, dry the unit thoroughly.
- All surfaces must be inspected for signs of corrosion, eg. 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.
- 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 have been exposed to a salt atmosphere while it was in use, it must be thoroughly cleaned both internally and externally to prevent corrosion.

- If the construction materials and type of unit permits, wash the unit using a high-pressure hose and copious amounts of fresh water.

  Examples:

  - The lower parts of hull units (outside the hull)
  - Subsea units
- 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.

- 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:

  - The upper parts of hull units (inside the hull)
  - Hydraulic systems

- 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.
- All surfaces must be inspected for signs of corrosion, eg. 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-packing

The unit should 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.

9.6 ESD precautions

Electrostatic Discharge (ESD)

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

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

ESD Protection during transport and storage

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

Unpacking and servicing ESD sensitive equipment

If it is necessary to open and touch the electronics inside the boxes/cabinets, then the following precautions MUST be taken:

- The working area must be covered by an approved conductive service mat that has a resistance of between 50kΩ and 2 MΩ, and is connected directly to a reliable earth point via its earthing cord.
- The service personnel involved must wear a wrist-band in direct contact with the skin, connected to the service mat.
- Printed circuit boards and other components should be placed on the conductive service mat during installation, maintenance etc.

Caution

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

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

9.7 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:

Note

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

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

Transducers must not be stored in temperatures below -20°C and above +60°C.

10 DRAWING FILE

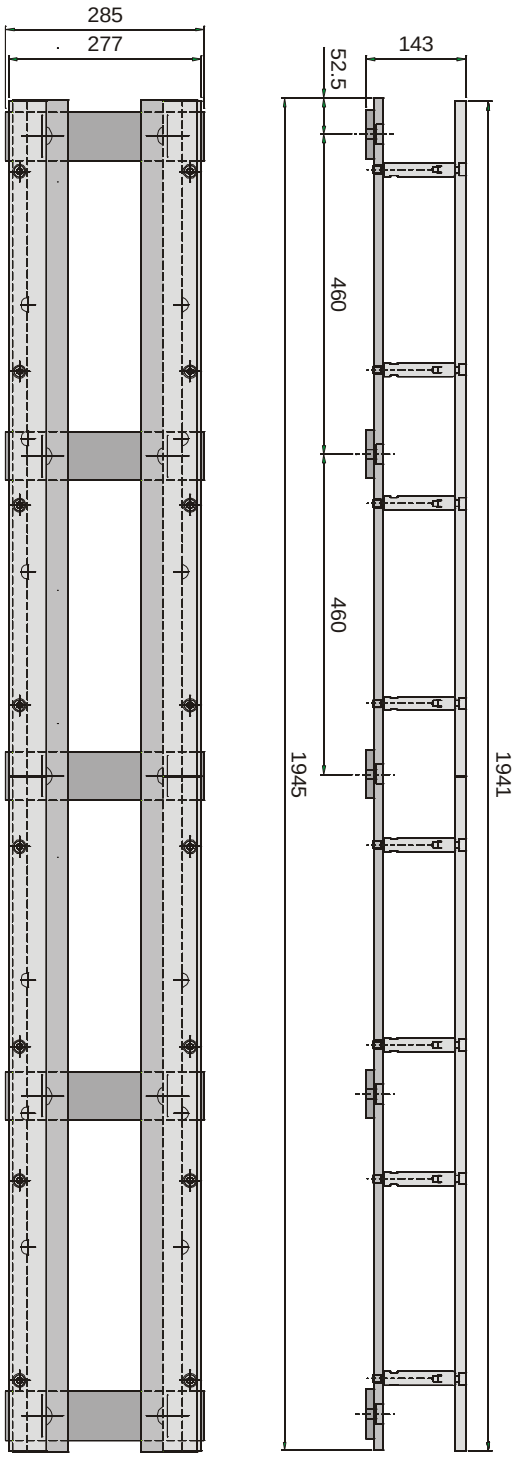
10.1 Overview

This chapter contains installation drawings and cable details.

Installation drawings

If required, certain drawings may be supplied on AutoCad or PDF format. To order, contact Kongsberg Maritime and refer to the drawing number in the bottom right corner of the frame.

Cable details



Note:
All measurements are in mm.
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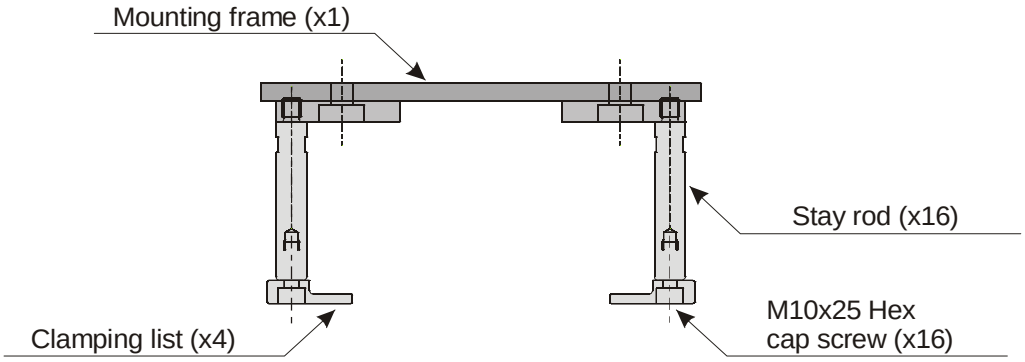
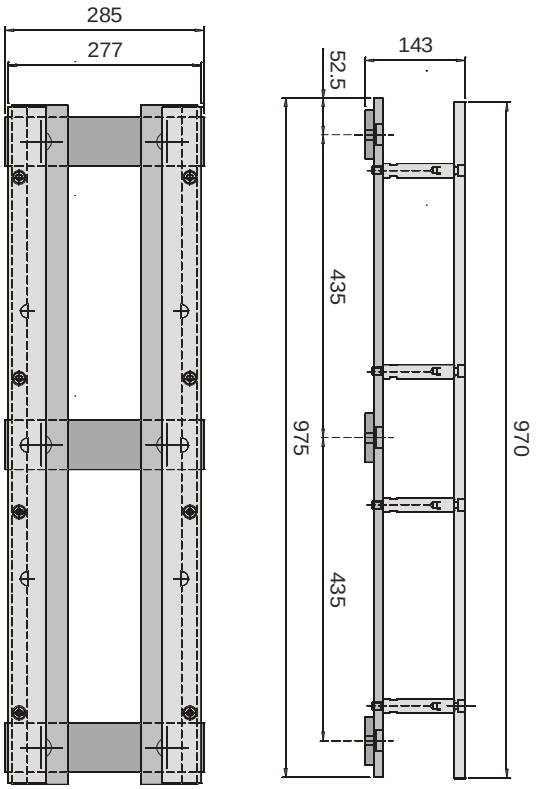
Page 1 of 2 (CD21607)	EM 710 0.5° mounting frame assembly TX module	**499-223137** Rev. A



Page 2 of 2 (CD21607)	EM 710 0.5° mounting frame assembly TX module	**499-223137** Rev. A



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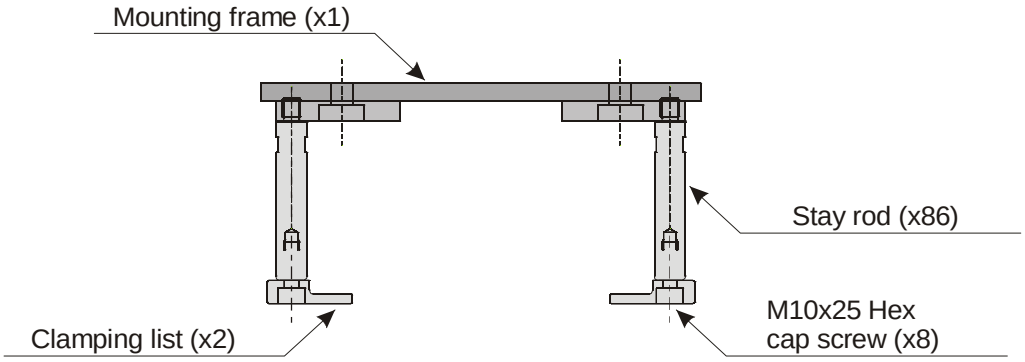
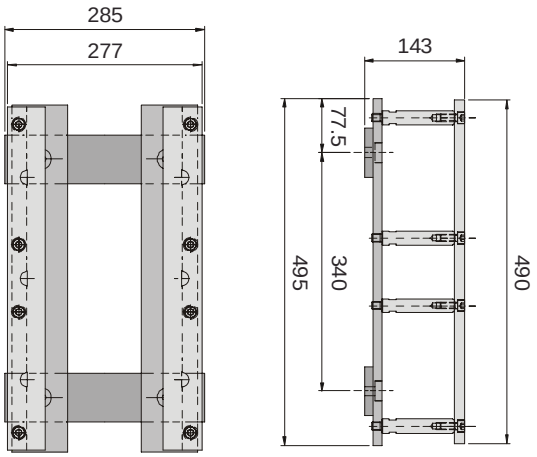
Page 1 of 2 (CD21608)	EM 710 1° mounting frame assembly RX module	**499-223139** Rev. A



Page 2 of 2 (CD21608)	EM 710 1° mounting frame assembly RX module	**499-223139** Rev. A



Note:
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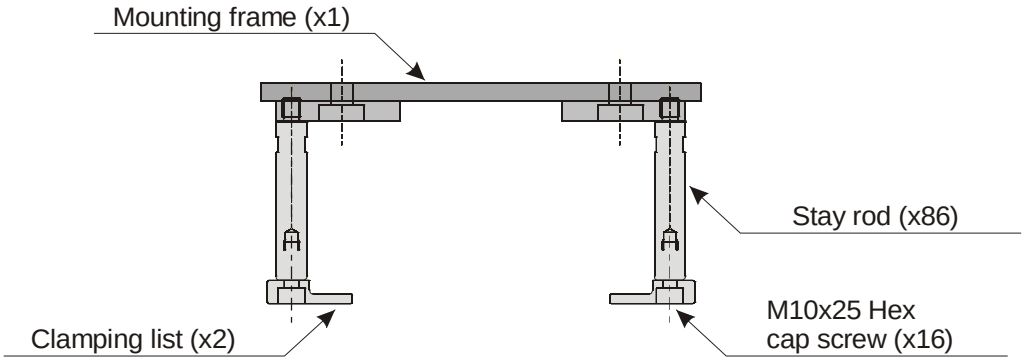
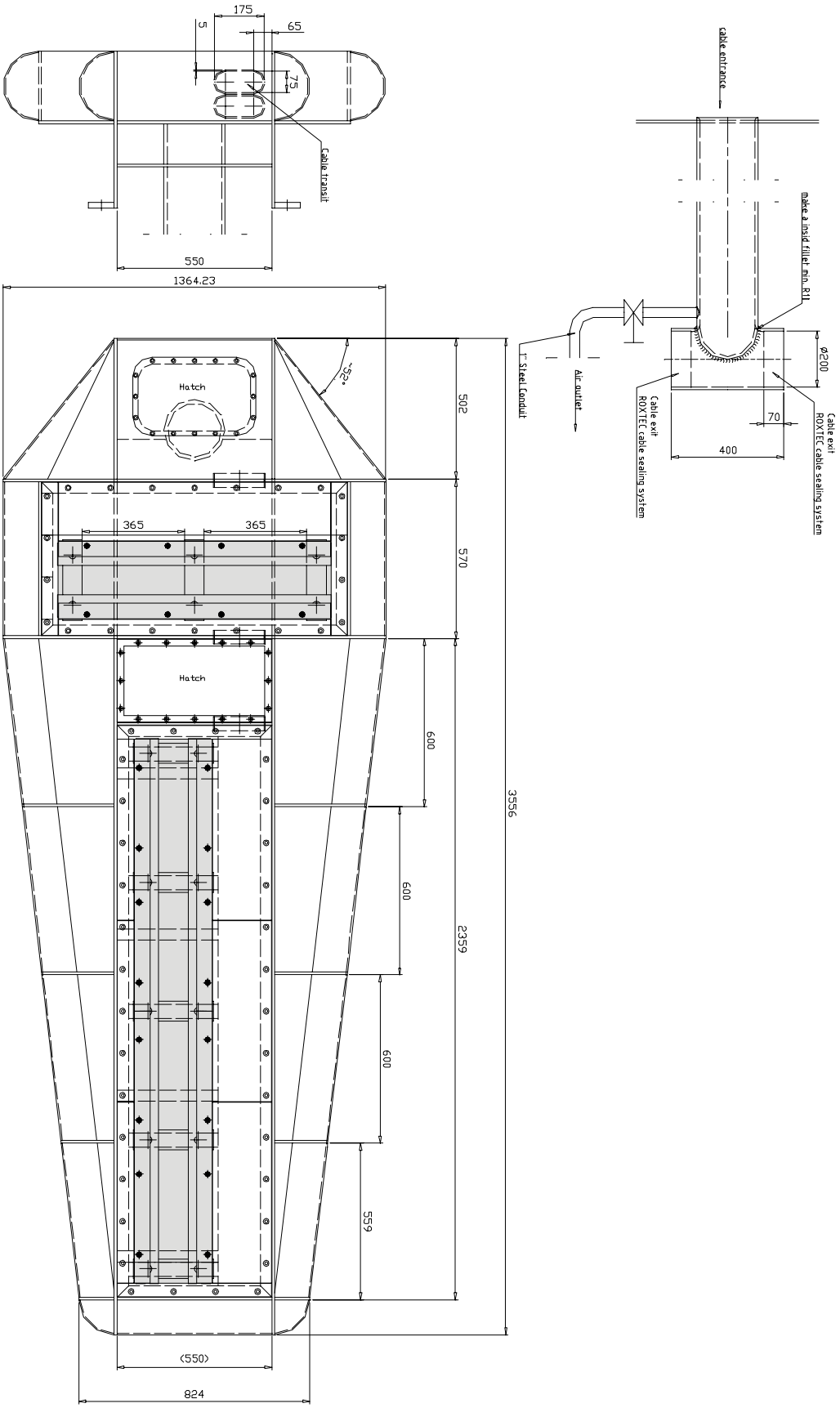
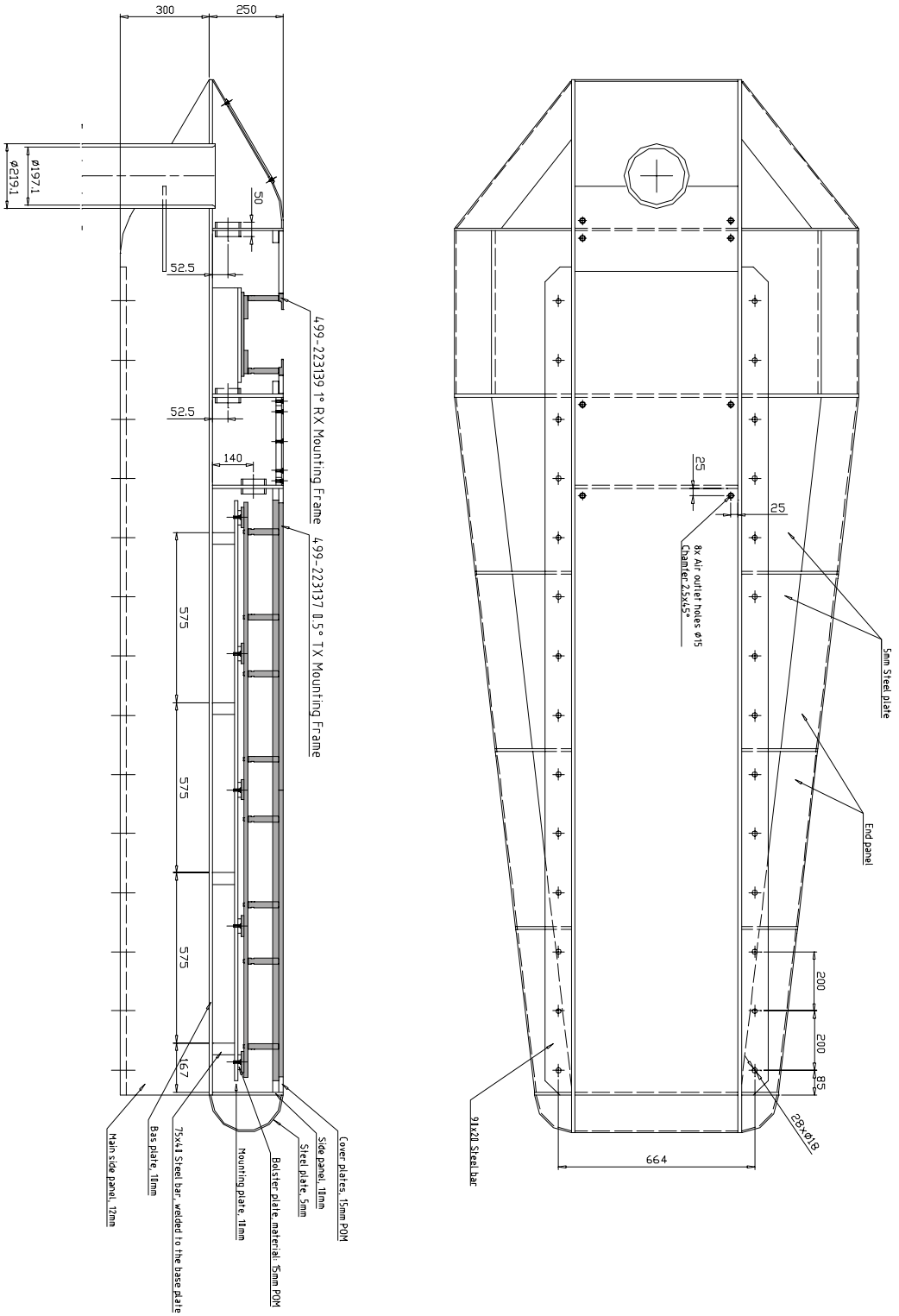
Page 1 of 2 (CD21612)	EM 710 2° mounting frame assembly TX/RX module	**499-223273** Rev. P1



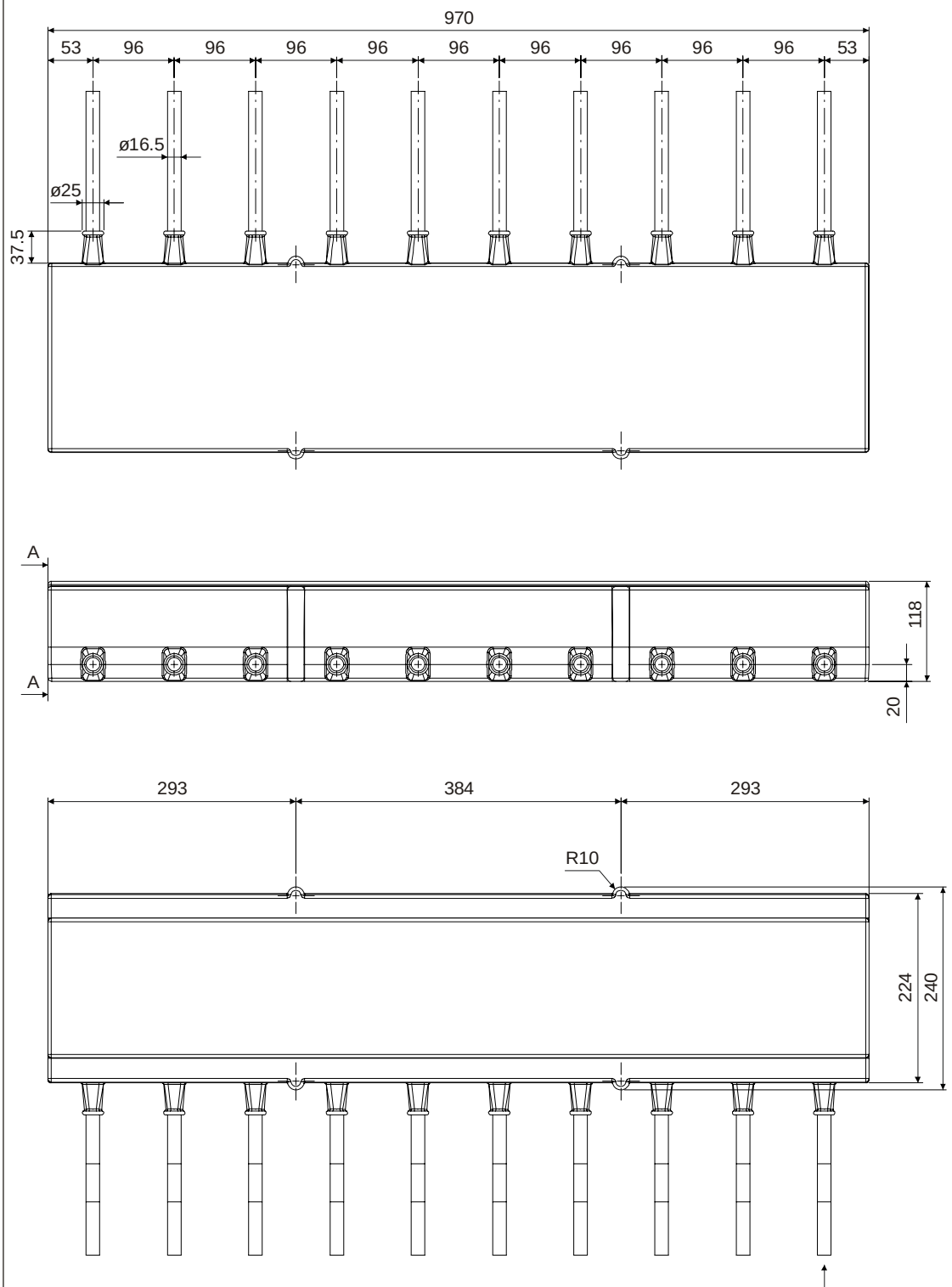
Page 2 of 2 (CD21612)	EM 710 2° mounting frame assembly TX/RX module	**499-223273** Rev. P1



Page 1 of 2 (CD21617)	EM 710 0.5 x 1° gondola Arrangement drawing	**828-223232** Rev. A



Page 2 of 2 (CD21617)	EM 710 0.5 x 1° gondola Arrangement drawing	**828-223232** Rev. A



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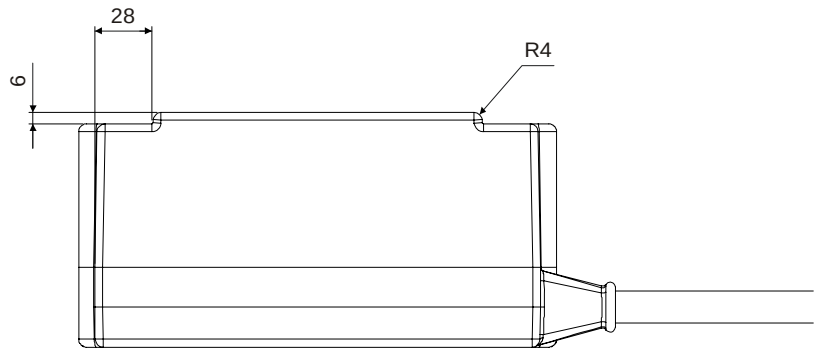
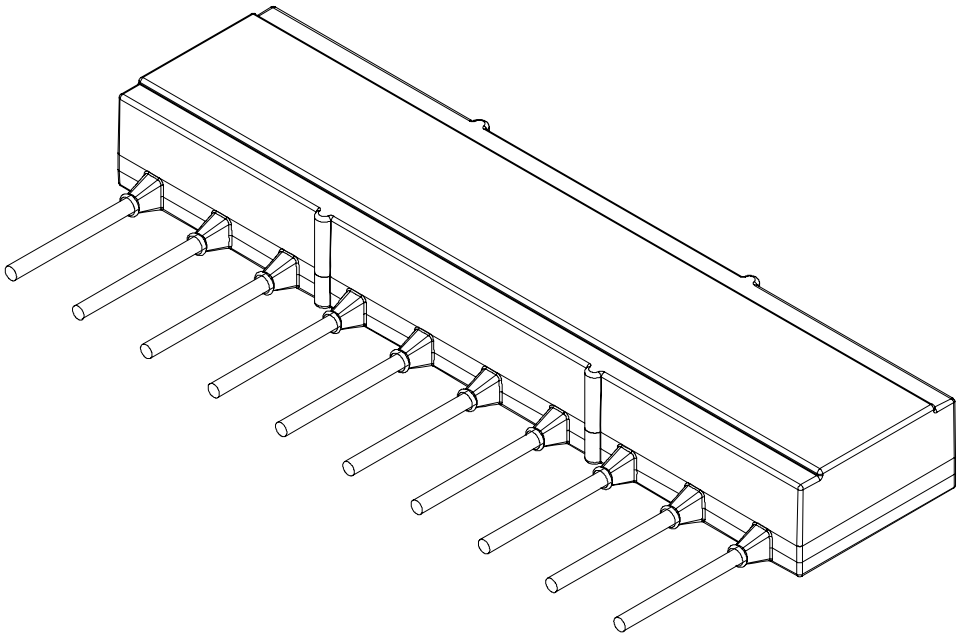
Page 1 of 2 (CD21603)	EM 710 Transducer TX1 Outline dimensions	**860-216148** Rev. A



Section A-A



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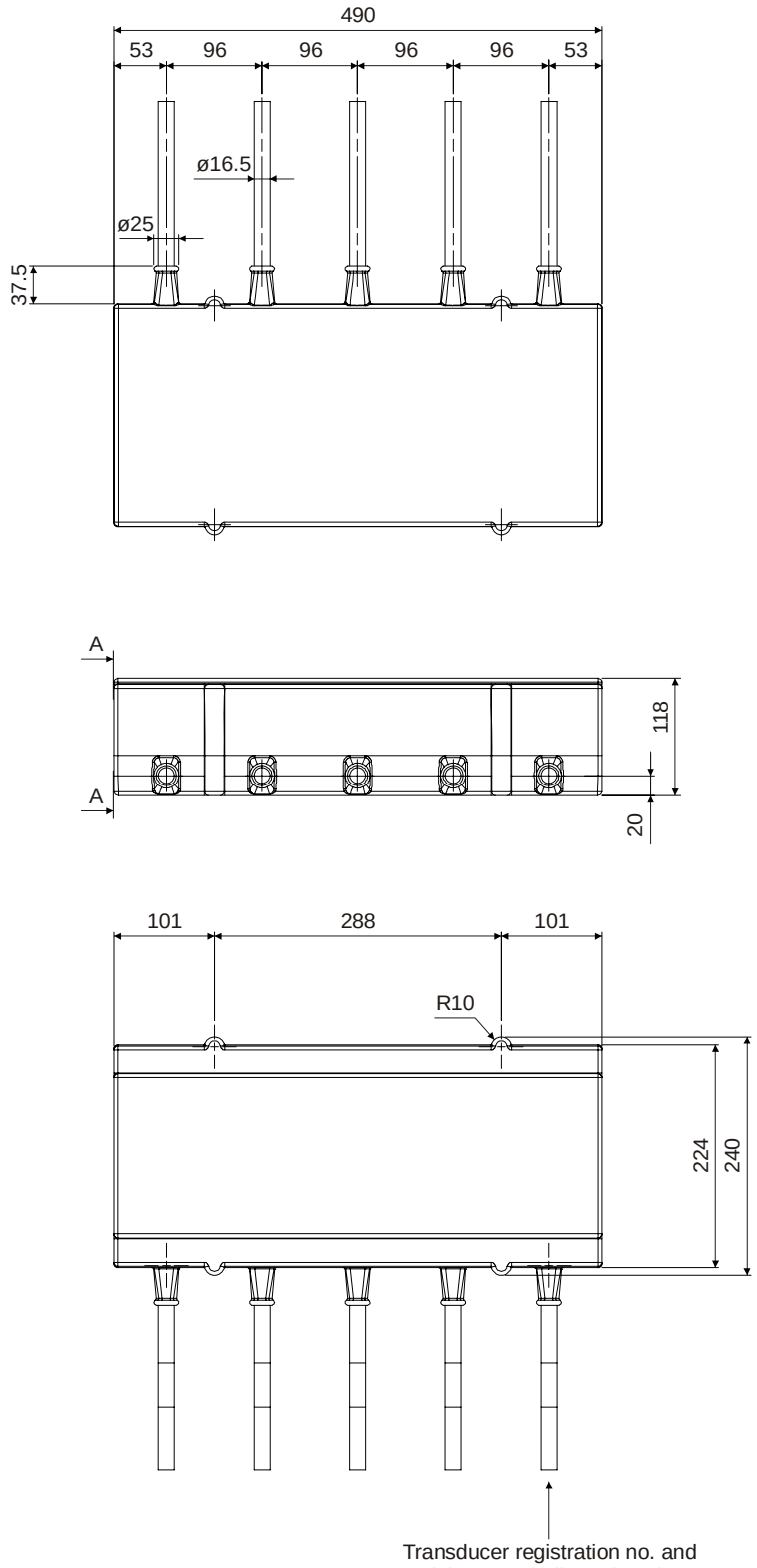
Page 2 of 2 (CD21603)	EM 710 Transducer TX1 Outline dimensions	**860-216148** Rev. A



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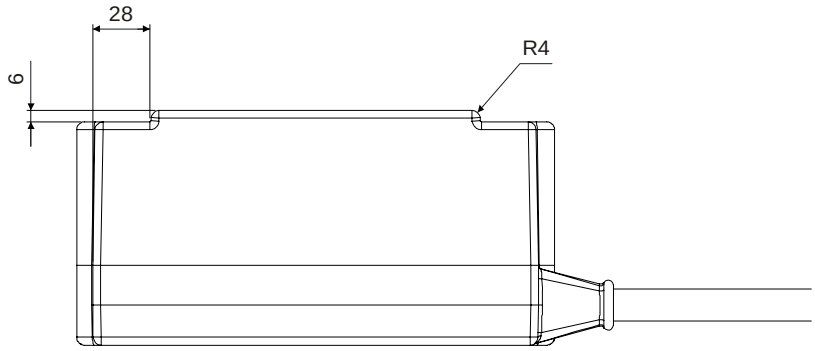
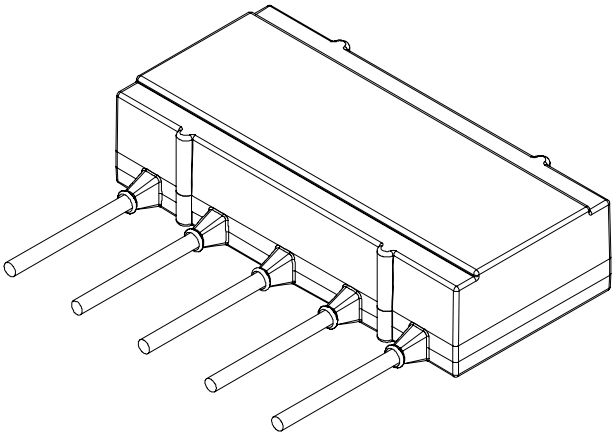
Page 1 of 2 (CD21604)	EM 710 Transducer TX2 Outline dimensions	**312-221048** Rev. A



Section A-A



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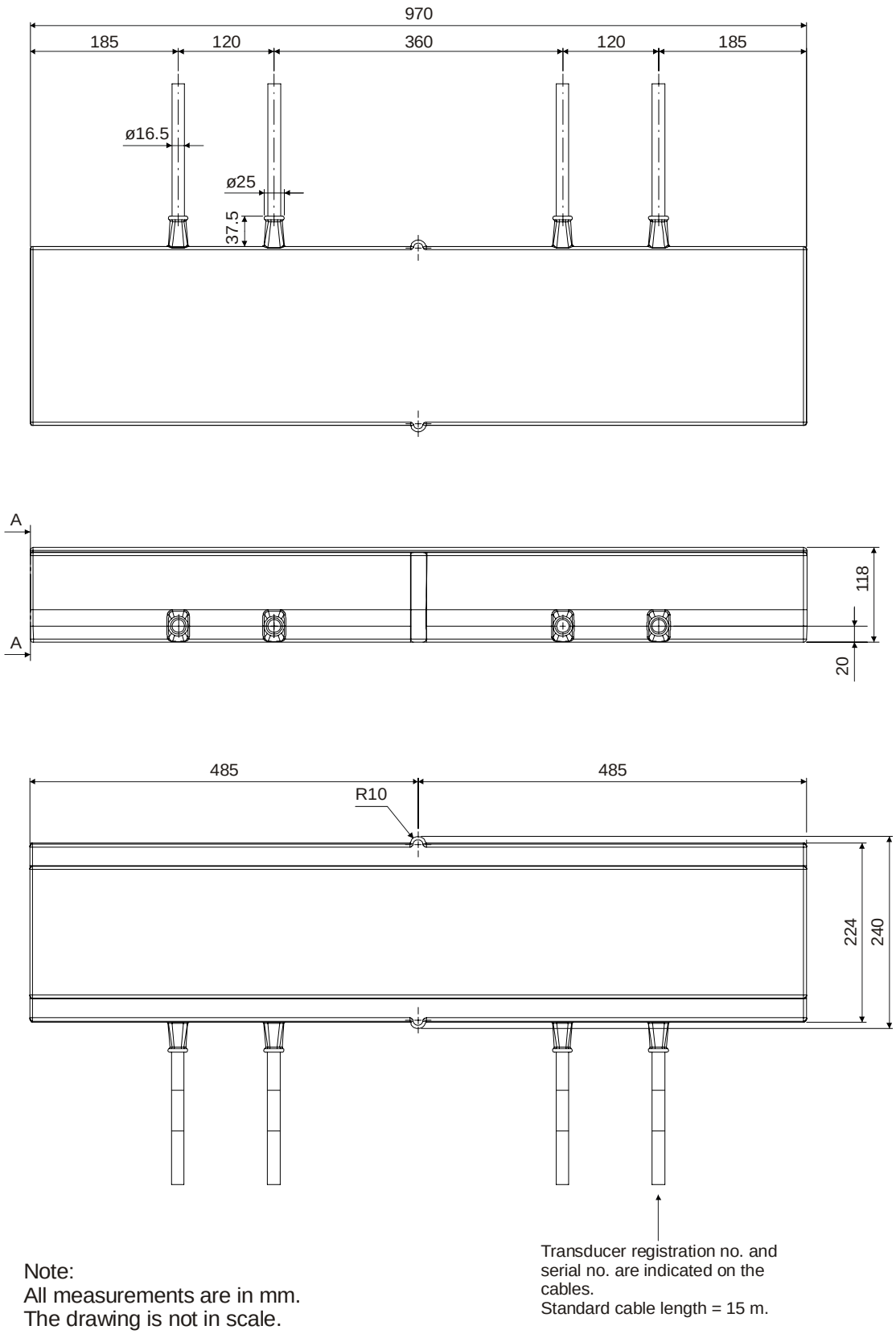
Page 2 of 2 (CD21604)	EM 710 Transducer TX2 Outline dimensions	**312-221048** Rev. A



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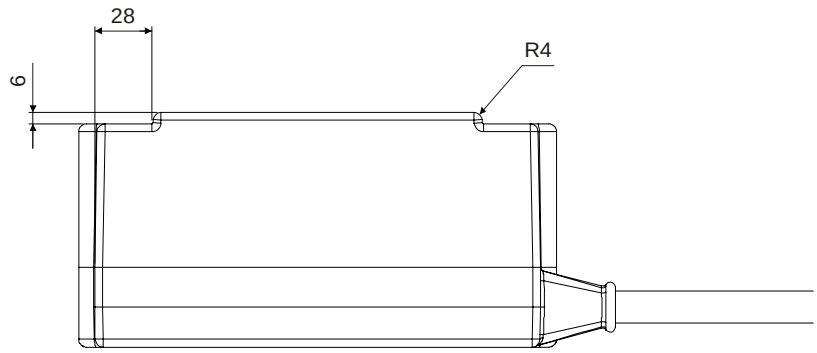
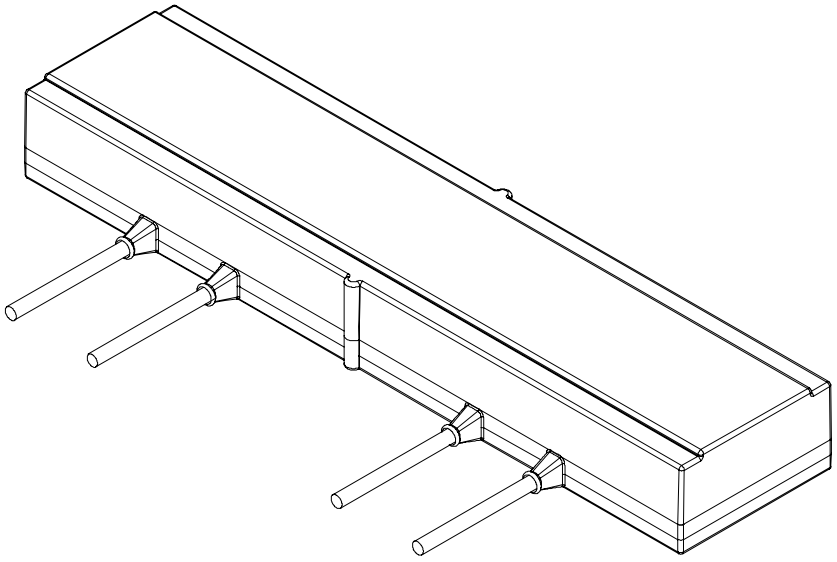
Page 1 of 2 (CD21605)	EM 710 Transducer RX1 Outline dimensions	**860-219621** Rev. A



Section A-A



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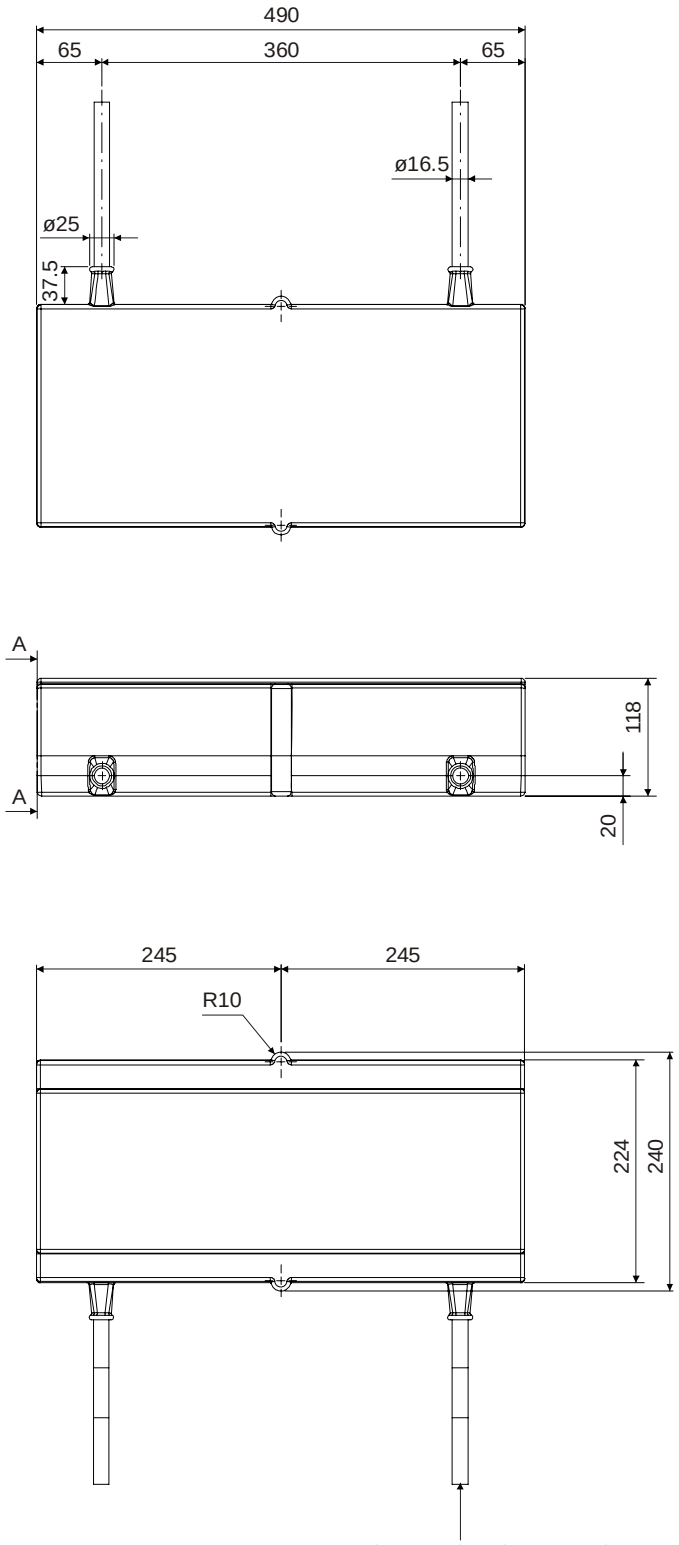
Page 2 of 2 (CD21605)	EM 710 Transducer RX1 Outline dimensions	**860-219621** Rev. A



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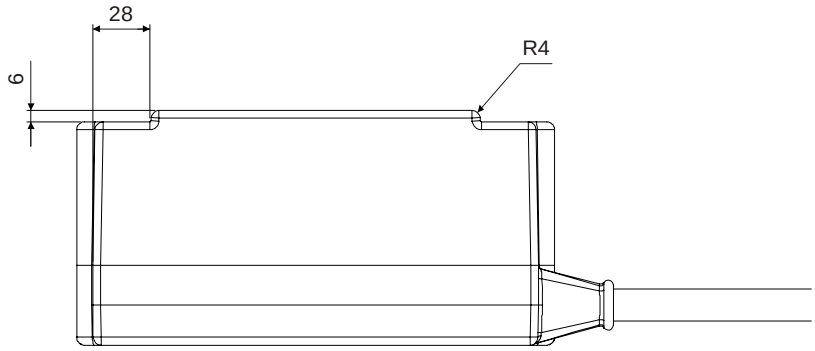
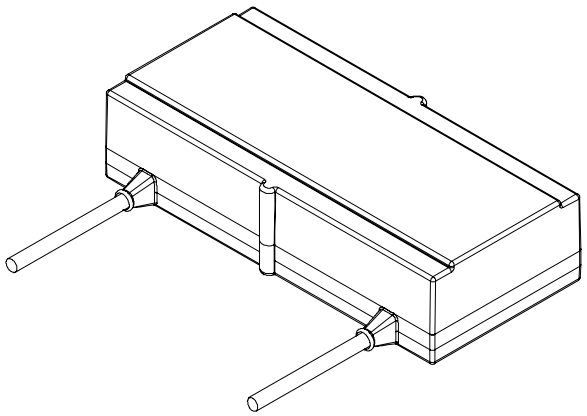
Page 1 of 2 (CD21606)	EM 710 Transducer RX2 Outline dimensions	**860-216146** Rev. A



Section A-A



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

Page 2 of 2 (CD21606)	EM 710 Transducer RX2 Outline dimensions	**860-216146** Rev. A

Note:
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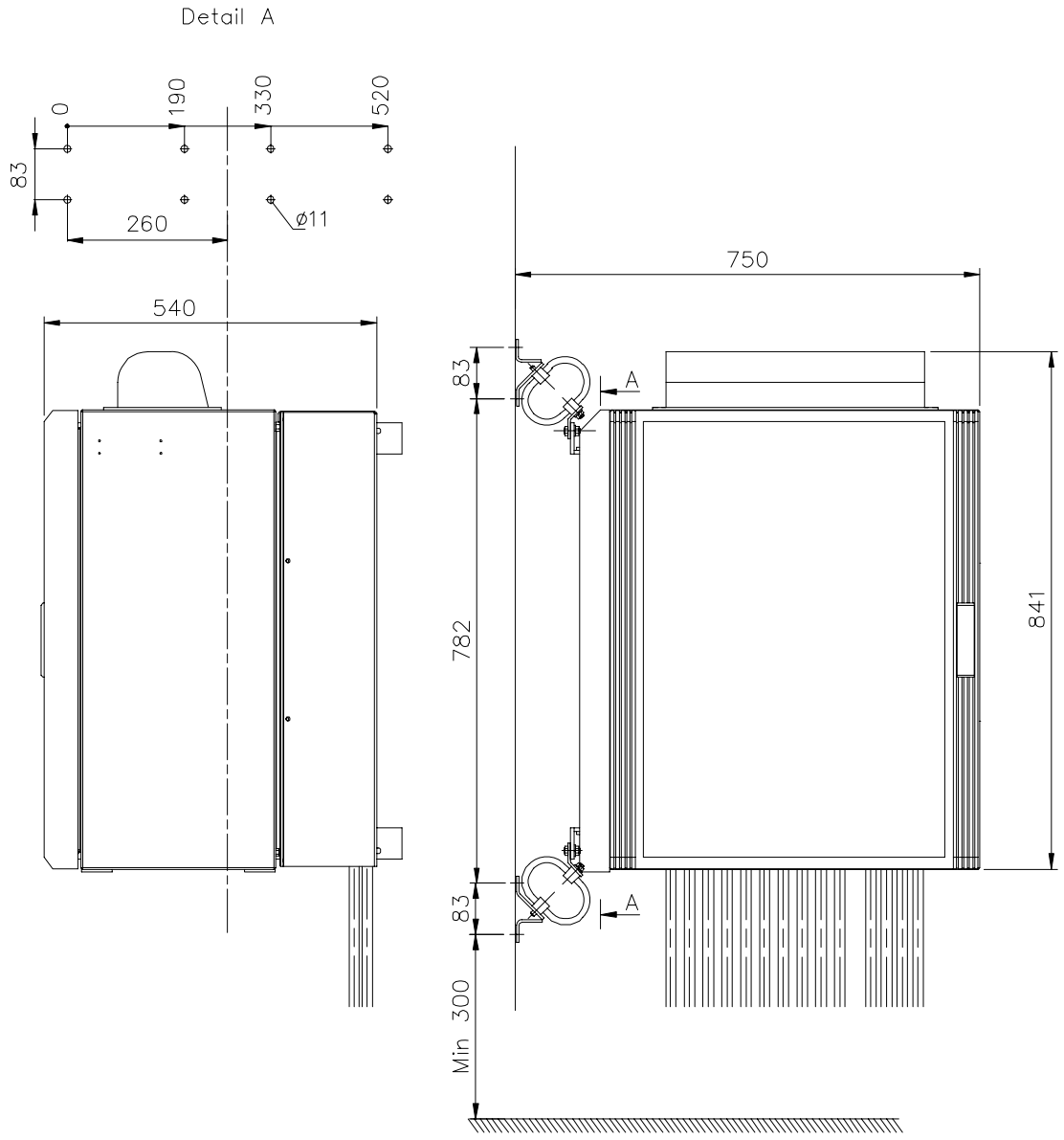
Page 1 of 1 (CD25000)	HWS 10 Operator Station Outline dimensions	- Rev.A



Note:
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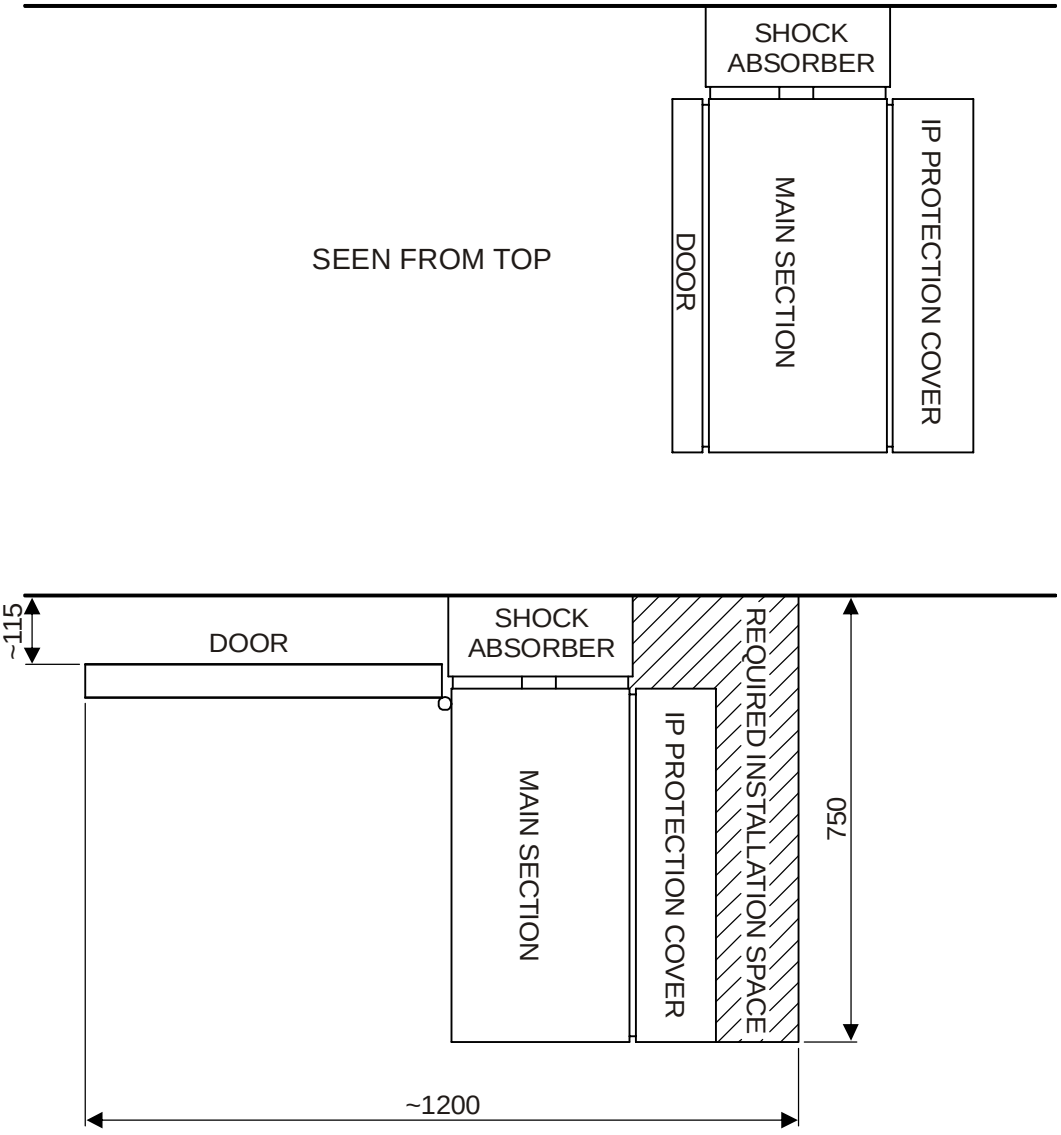
Page 1 of 2 (CD21602)	EM 710 Transceiver Unit Outline dimensions	**834-223122** Rev. Preliminary



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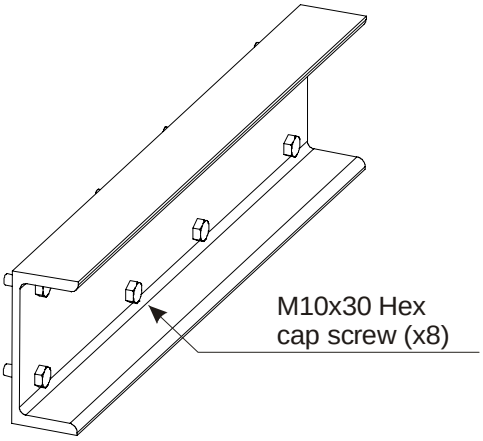
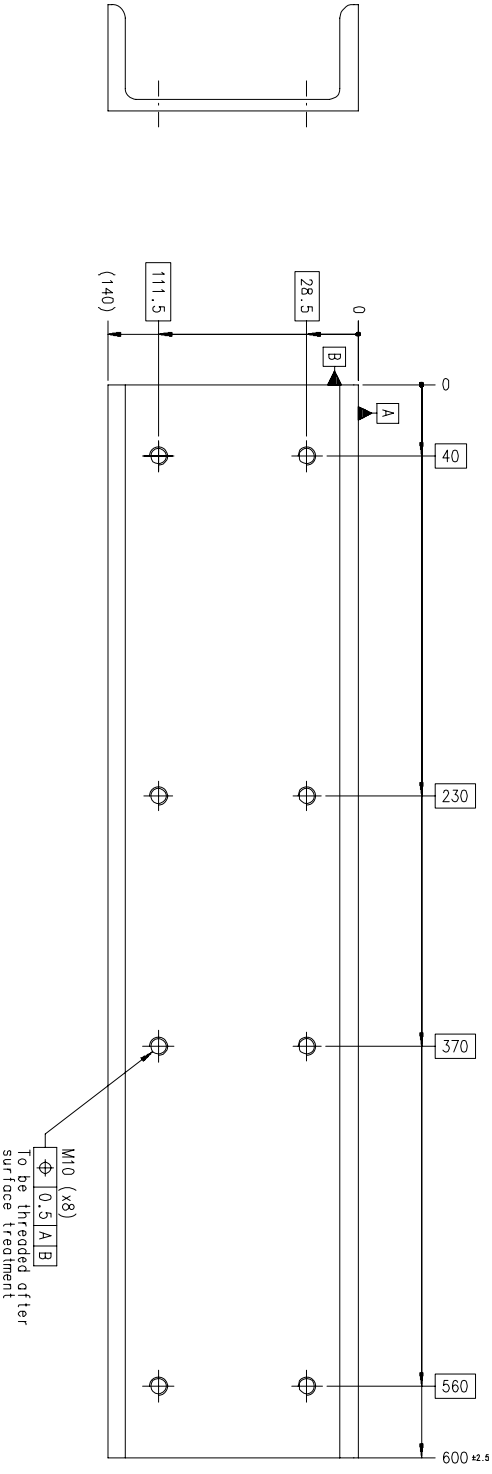
Page 2 of 2 (CD21602)	EM 710 Transceiver Unit Space requirements	**834-223122** Rev. Preliminary





Note:
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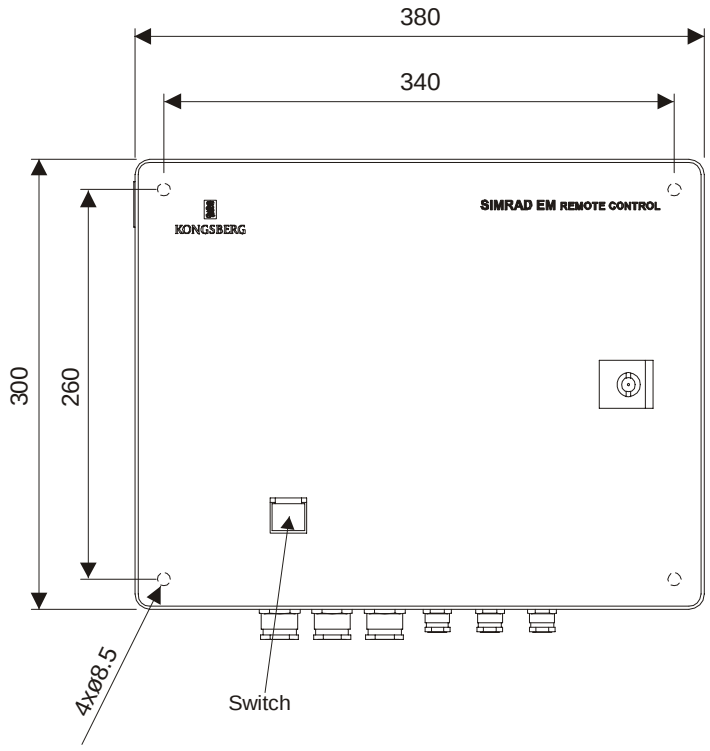
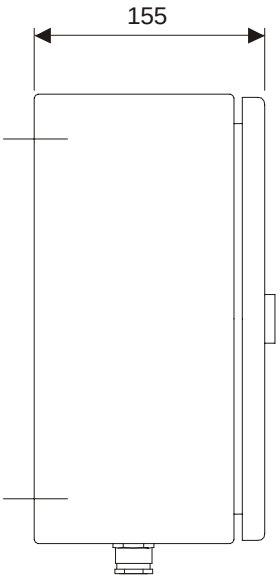
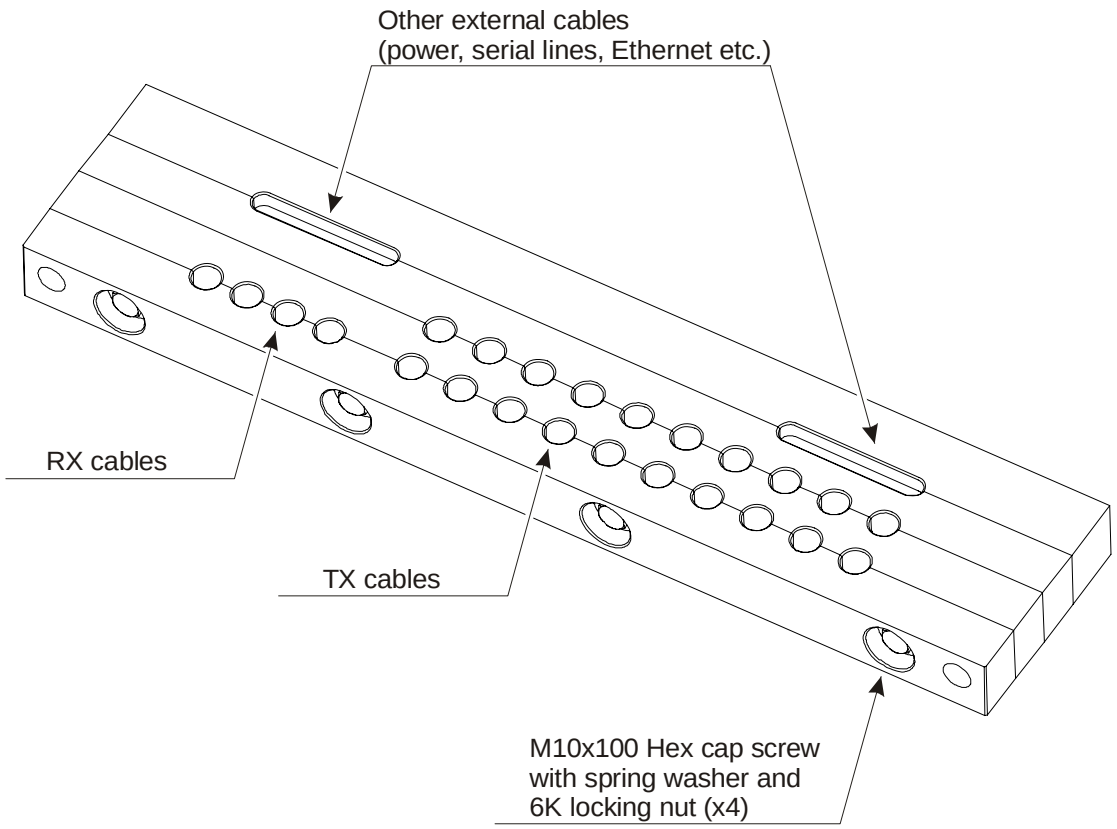
Page 1 of 1 (CD21613)	EM 710 Transceiver Unit Mounting bracket	**871-212984** Rev. A





Junction Box EM1-212595 (108-212591)

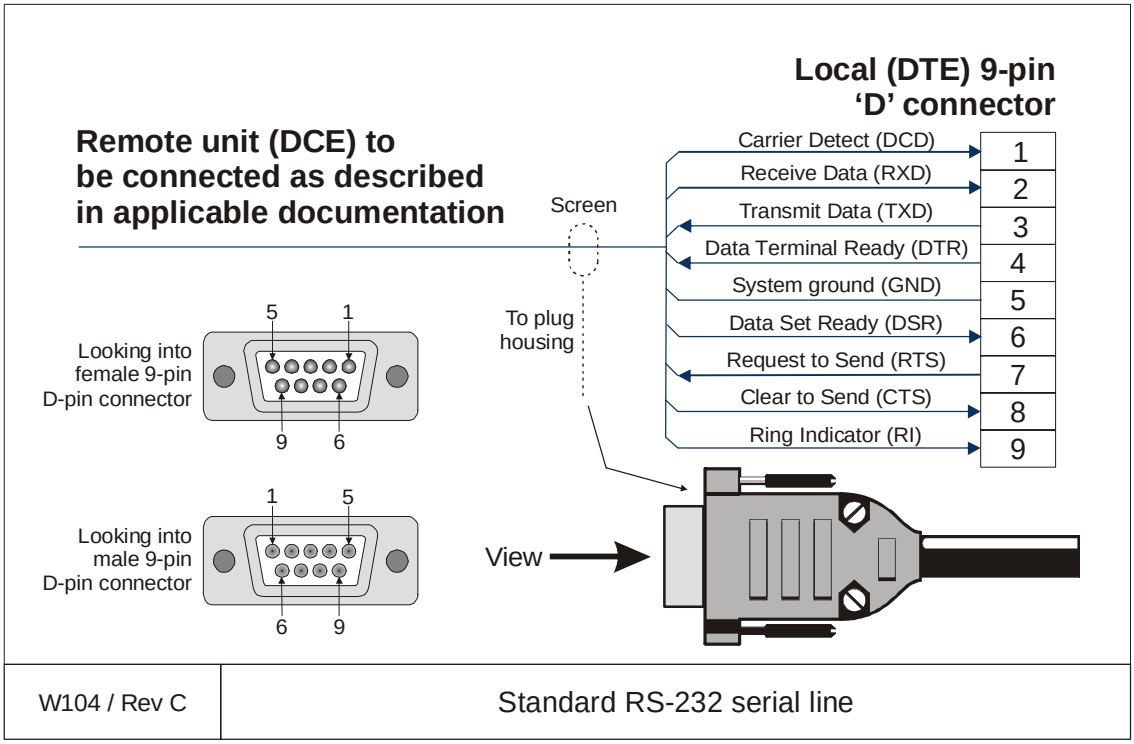
Page 1 of 1 CD4887	Junction Box, outline dimensions	**834-212593** Rev.B



Page 1 of 1 (CD21614)	EM 710 Transceiver Unit Cable clamp	**599-223163** Rev. P2

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.

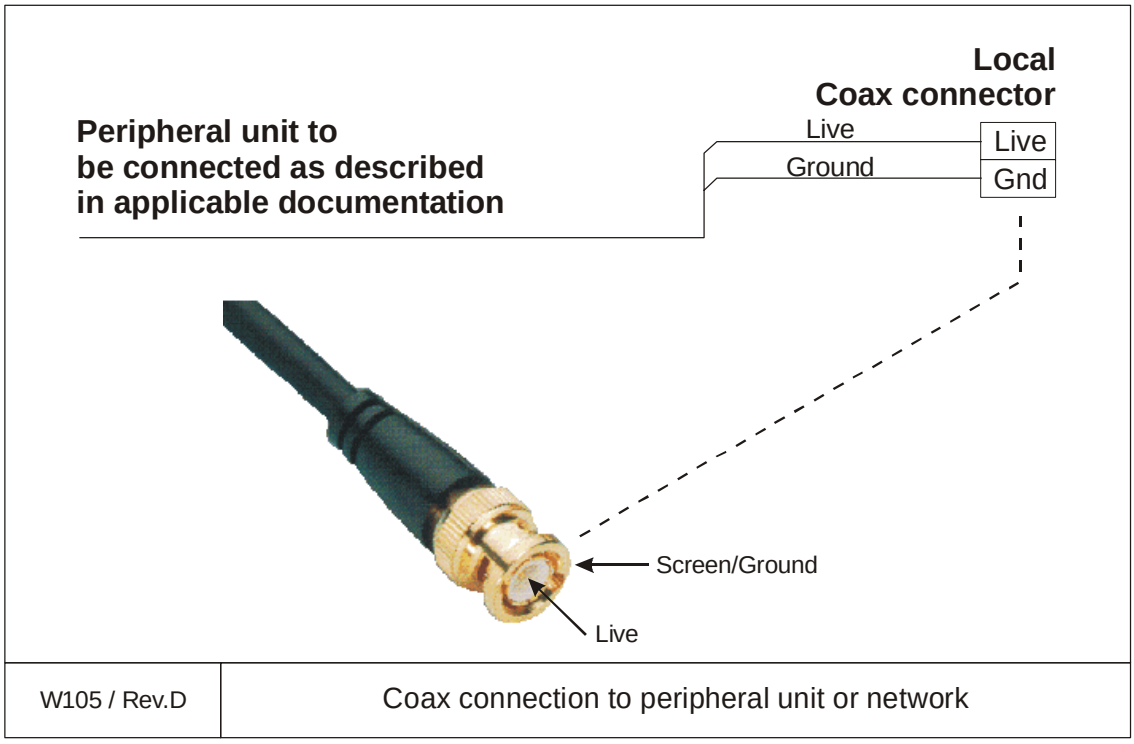


W104 / Rev C	Standard RS-232 serial line

Conductors	9 x 2 x 0.5 mm2
Screen	Screened twisted pairs and overall braided
Voltage	60V
Max.diameter	Set by the plugs

Generic coax cable

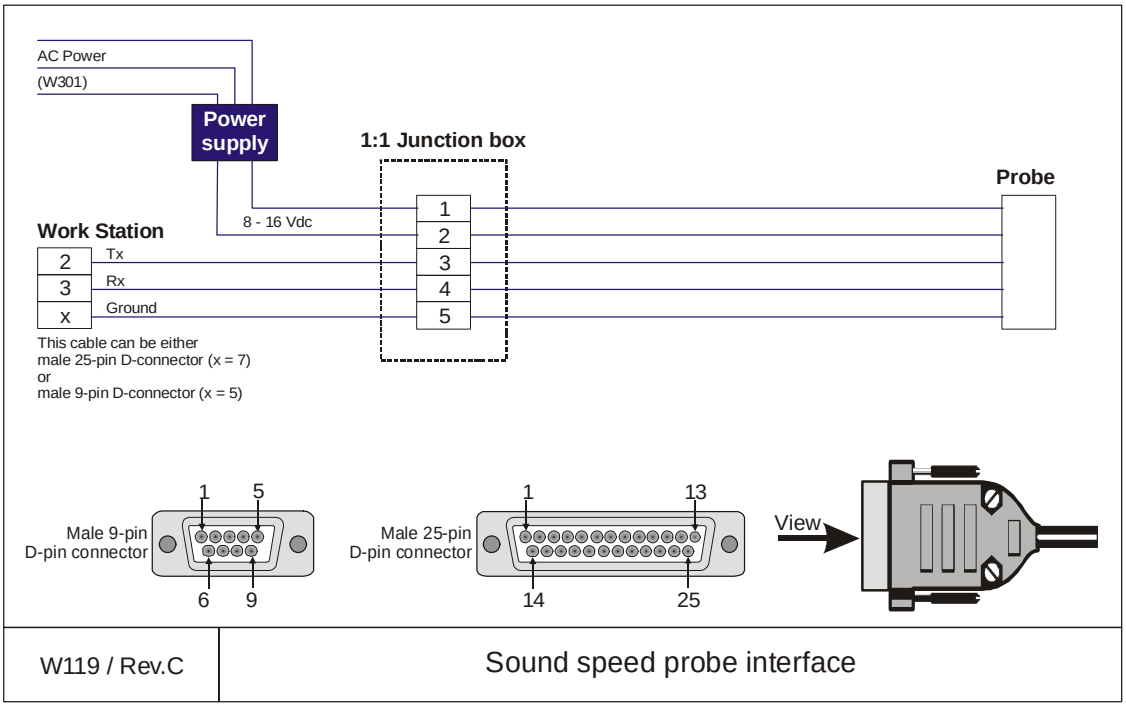
This cable is used for connections to peripheral units or networks.



W105 / Rev.D	Coax connection to peripheral unit or network

Sound speed probe interface

This cable provides the interconnection between the Processor Unit work station and the sound speed probe. This connection is normally made through a small junction box and with a power supply as indicated in the drawing.



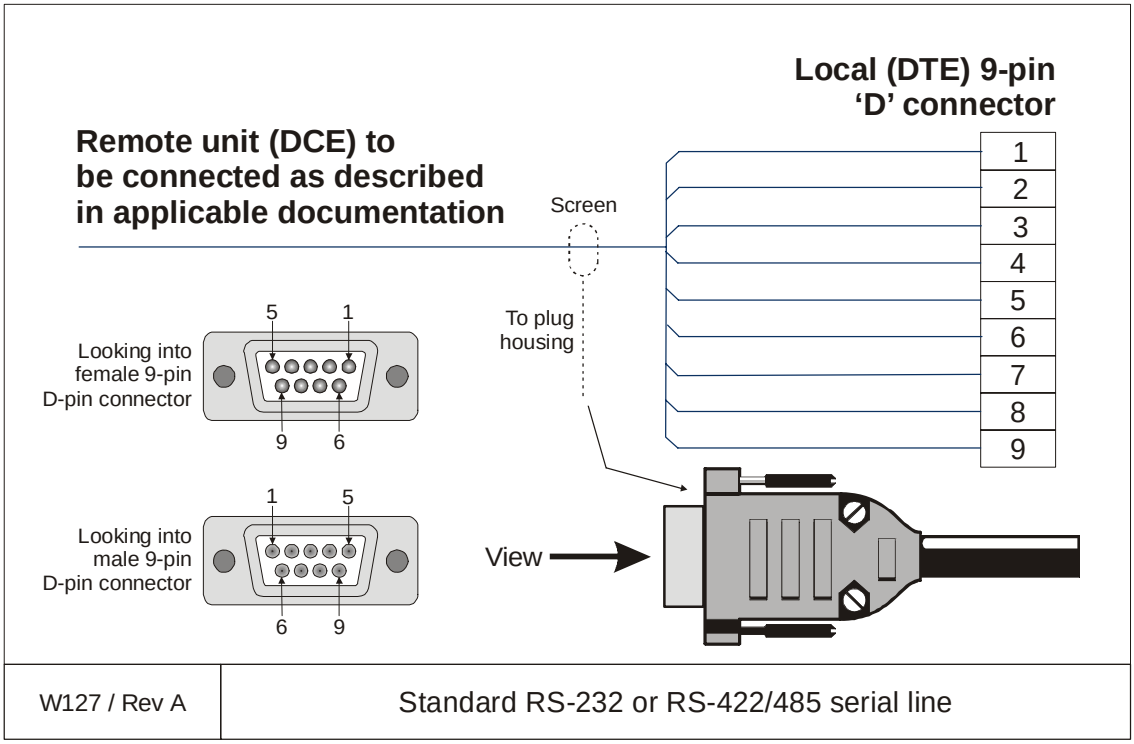
W119 / Rev.C	Sound speed probe interface

The cable between the junction box and the probe is supplied by the probe manufacturer.

Conductors	2 x 2 x 0.5 mm2
Screen	Overall braided
Voltage	60V
Max.diameter	Set by the plugs

Generic RS-232 or RS-422/485 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.



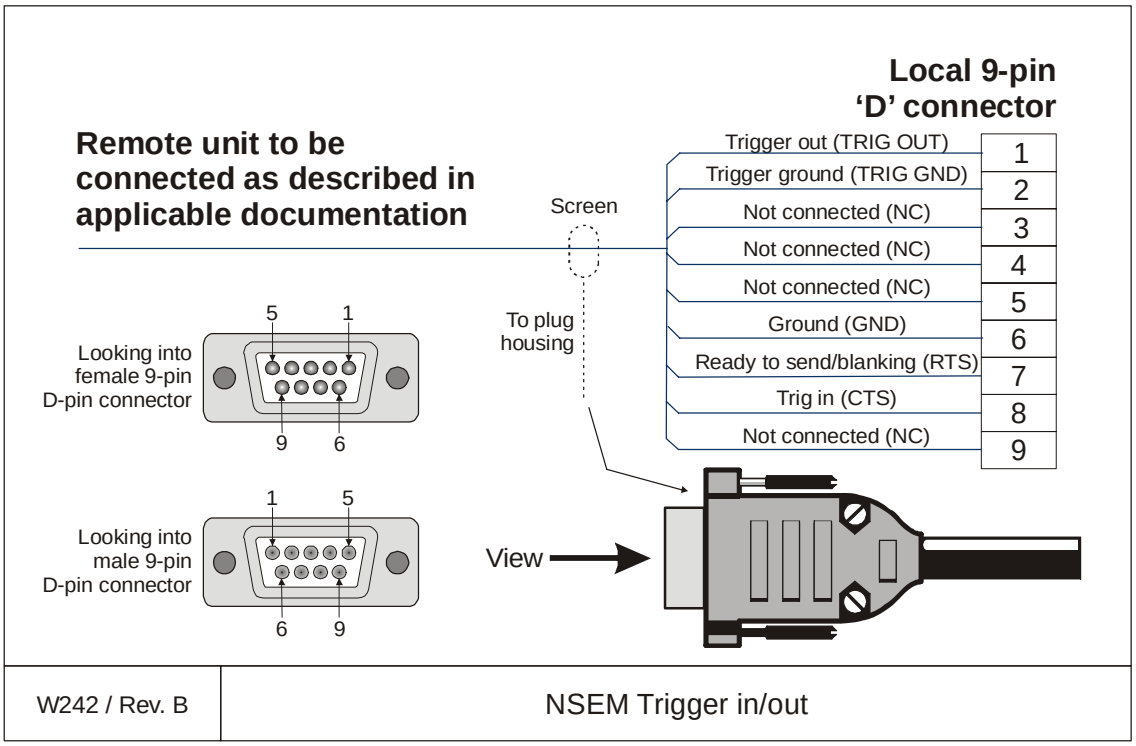
W127 / Rev A	Standard RS-232 or RS-422/485 serial line

Pin no.	Signal RS–232	Signal RS–422/485	Pin no.	Signal RS–232	Signal RS–422/485
1	DCD	TXD–	2	RXD	RTS–
3	TXD	CTS+	4	DTR	RXD+
5	GND	GND	6	DSR	TXD+
7	RTS	RTS+	8	CTS	CTS–
9	RI	RXD–			

Conductors	6 x 2 x 0.5 mm2
Screen	Screened twisted pairs and overall braided
Voltage	60V
Max.diameter	Set by the plugs

Trigger in/out

This cable is used to synchronize the echo sounder's transmissions with other acoustic instruments. It is terminated in a standard 9-pin D-sub connector at the EM 710 Transceiver Unit end.

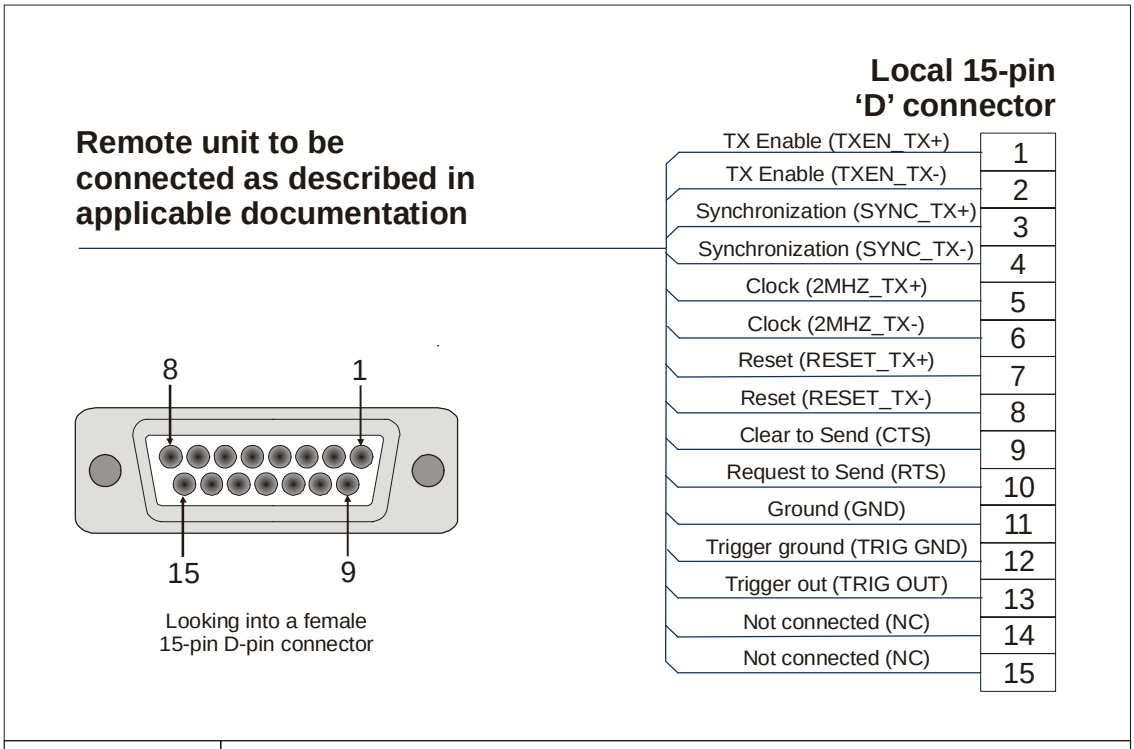


W242 / Rev. B	NSEM Trigger in/out

Conductors	9 x 2 x 0.5 mm2
Screen	Screened twisted pairs and overall braided
Voltage	60V
Max.diameter	Set by the plugs

Control signals

This cable is used to transmit synchronization signals and TX enable signals. It is terminated in a standard 15-pin D-sub connector at the EM 710 Transceiver Unit end.



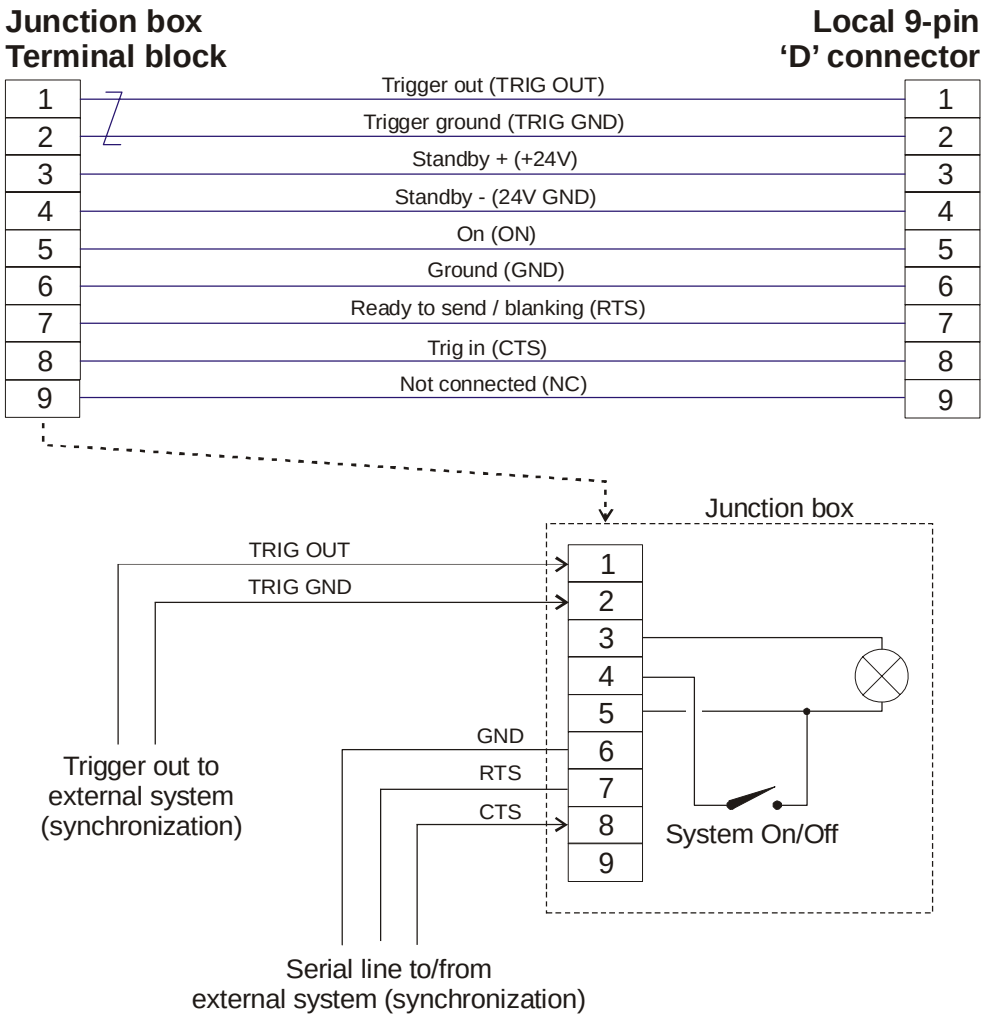
W243 / Rev. A	EM Control signals

Conductors	15 x 2 x 0.5 mm2
Screen	Screened twisted pairs and overall braided
Voltage	60V
Max.diameter	Set by the plugs

Remote On/Off control and synchronization

This cable connects the EM 710 Transceiver Unit to a remote On/Off switch, normally located in a Remote Control junction box.

The same connection allows trigger output and remote control (synchronization) with a serial line.

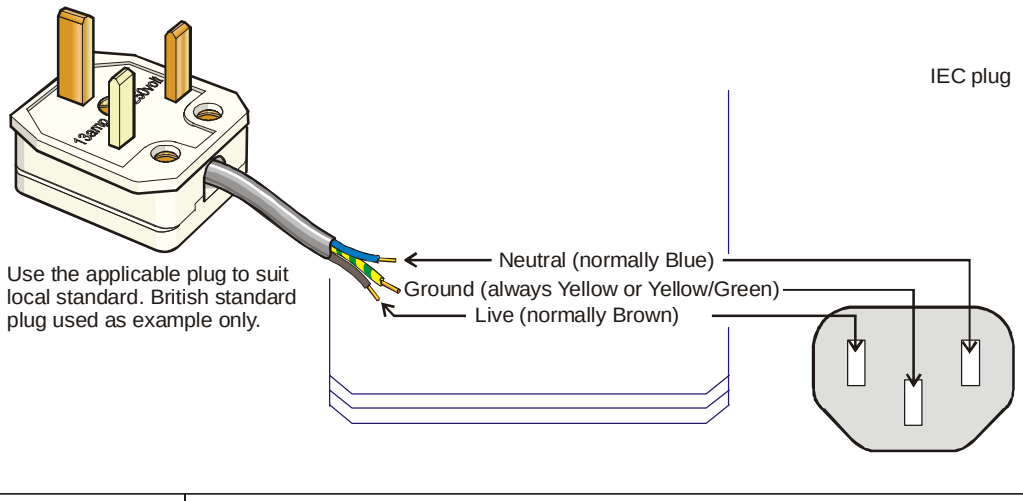


W245 / Rev. A	NSEM Remote On/Off control and synchronization

Conductors	5 x 2 x 0.5 mm2
Screen	Overall braided
Voltage	60V
Max.diameter	Set by the plugs

Standard AC power cable

This cable is a standard three-wire power cable. It is commercially available in standard lengths, or may be produced locally to suit the specific installation needs. The instrument end is terminated in a standard IEC female socket, while the other end is terminated in a plug suitable for the local standard.



W301 / Rev B	Standard power cable for 115/230 Vac 2-phase

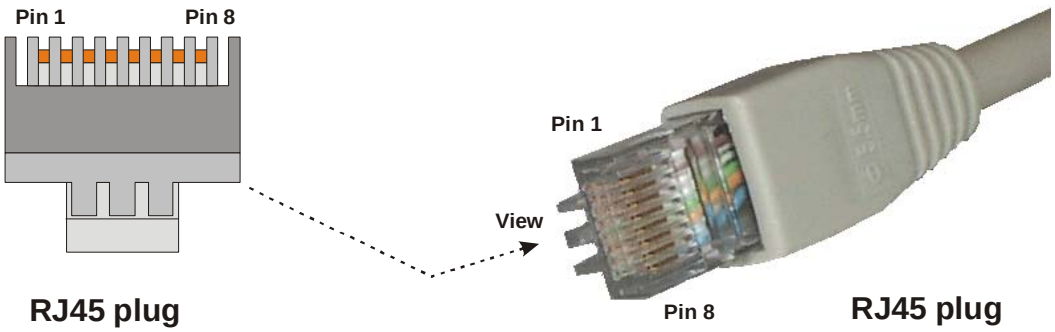
Note

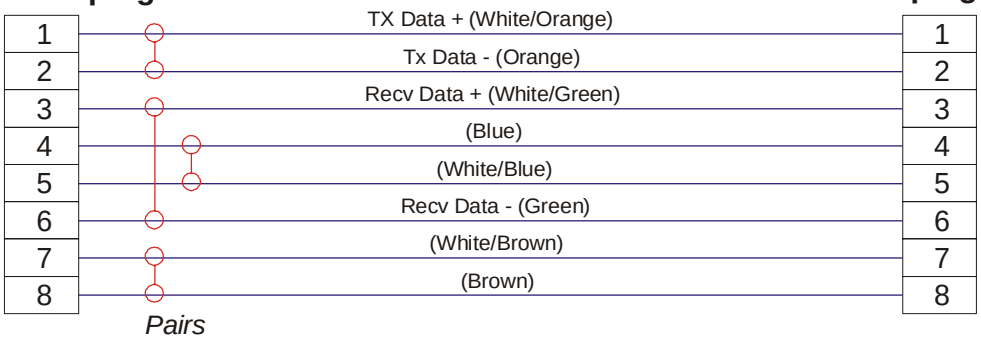
Different cable colours may be used for the “live” and “neutral” wires. Ground is however always on green/yellow.

Conductors	2 x 1.5 mm^2 + GND
Screen	None
Voltage	750 V
Max. diameter	Set by the plugs

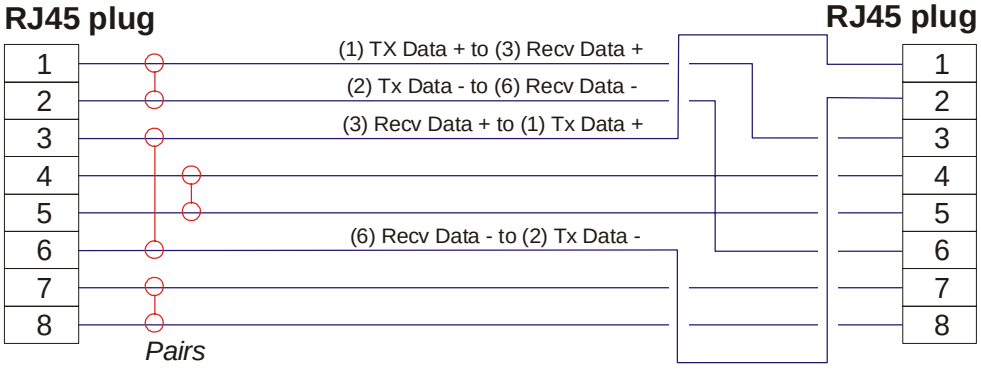
Ethernet with RJ45 plugs (screened)

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"

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

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

W400 / Rev G	Ethernet 10Base-T with RJ45 plugs

Standard USB cable

This is a standard commercial USB cable terminated with **A** and **B** plugs in either ends. The cable can be used for a variety of external devices. The order number provided is for a 4.5 m cable.

Universal Serial Bus (USB) cable
terminated with an **A-plug** in one end
and a **B-plug** in the other.

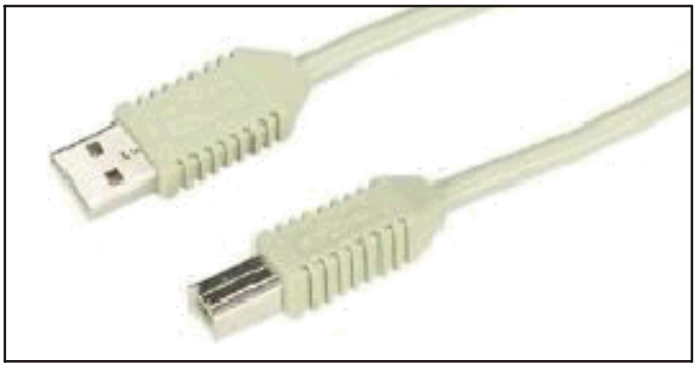
Internal cables:

Pair 1:
28 AWG twisted pair
(data, green, white)

Pair 2:
20 AWG twisted pair
(Power, red, black)

Shield:
Foil and braid

Length: 4.5 m
Order no: 719-078524

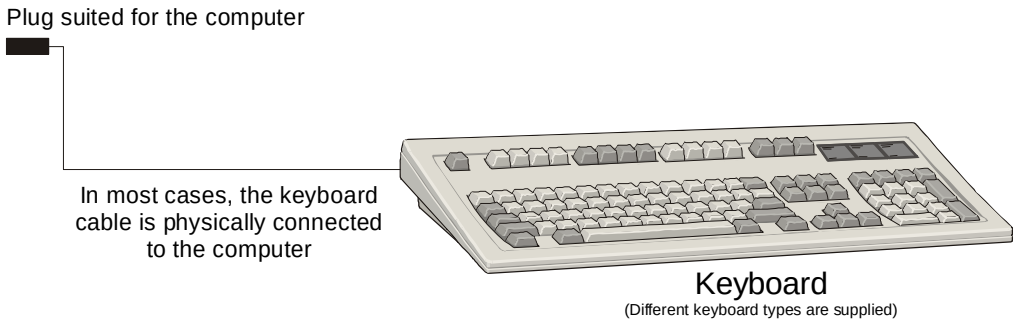


W501 / Rev.A	Commercial USB cable

Keyboard cable

This is a standard keyboard cable. In most cases, the cable is physically connected to the keyboard. It is terminated in a plug suited to fit the computer.

Several keyboard types are available for different languages and hardware platforms. Both the keyboard and the attached cable are commercial items.



W503 / Rev C	Keyboard

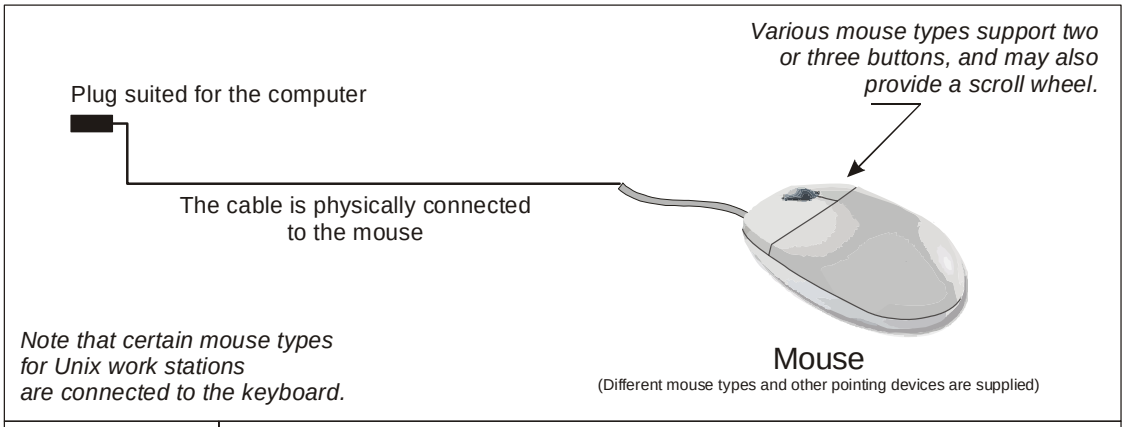
Mouse or pointing device cable

This is a standard mouse cable. It is physically connected to the mouse. It is terminated in a plug suited to fit the computer.

Note

On Unix work stations, the mouse is normally connected to the keyboard.

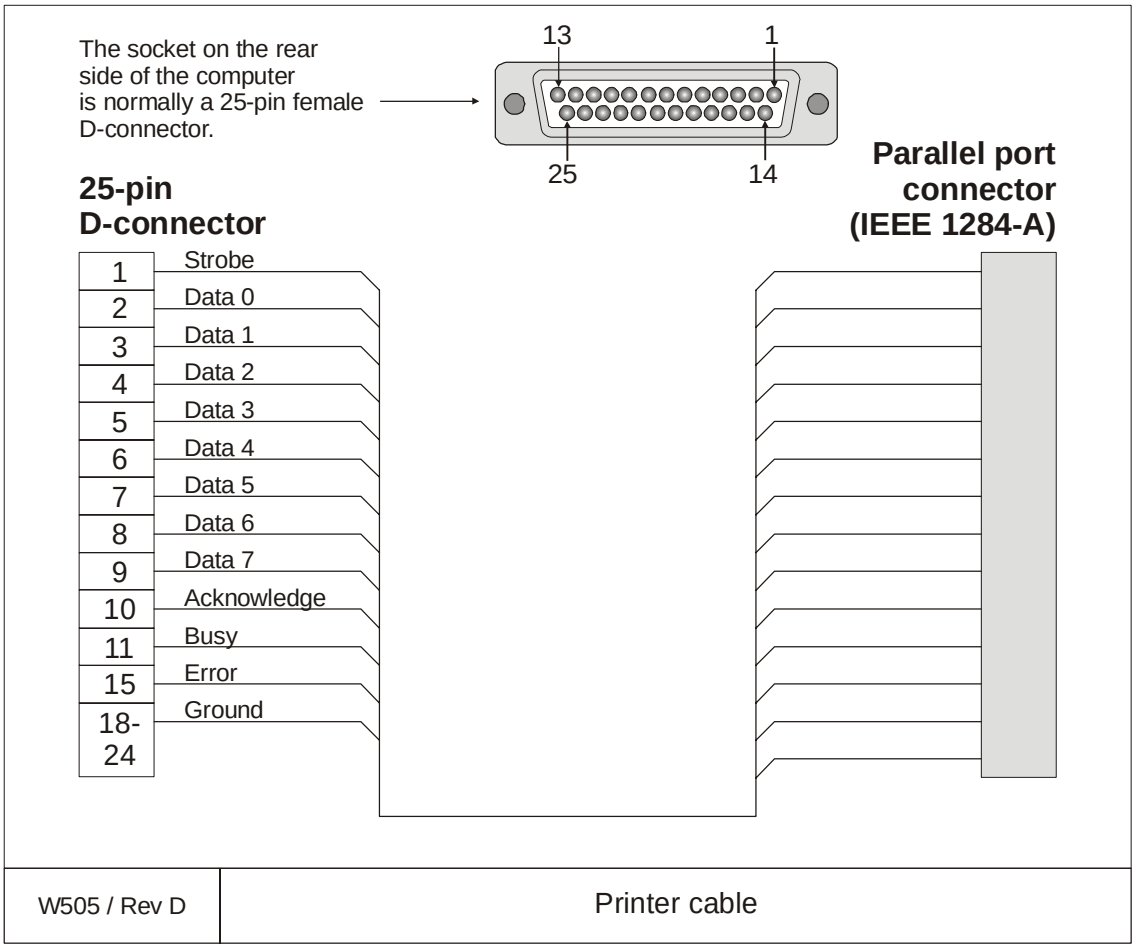
Several mouse and pointing device types are available with two or three buttons, and with or without a scroll wheel. Both the mouse and the attached cable are commercial items.



W504 / Rev C	Mouse / Pointing device

Printer cable

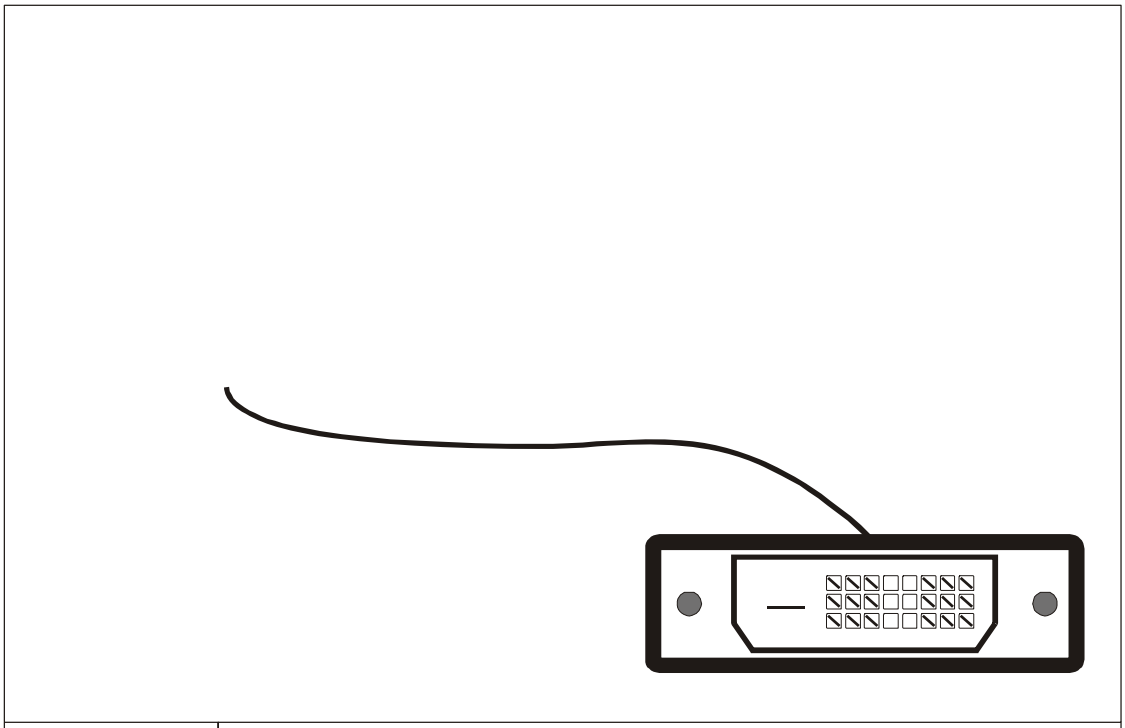
This is a standard printer cable. It is terminated in the computer's parallel port.



W505 / Rev D	Printer cable

Digital Video Interface (DVI) display cable

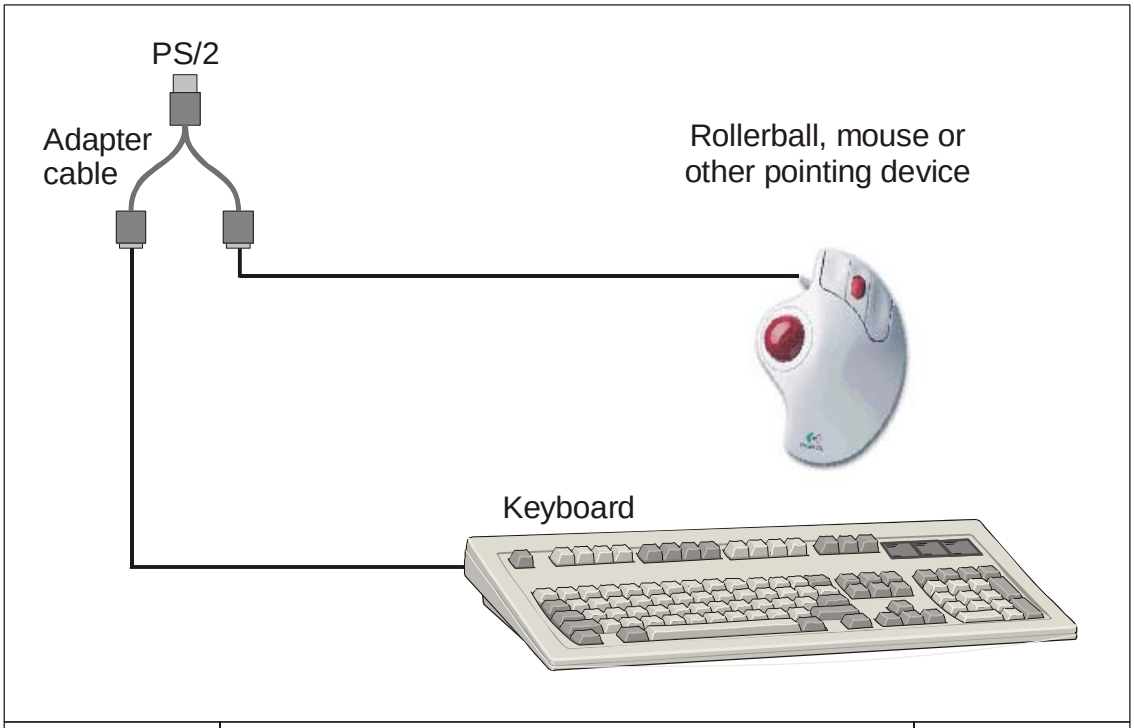
This cable is a standard DVI-I cable. It is connected to the LCD display.



W508 / Rev.A	DVI cable

Keyboard and rollerball

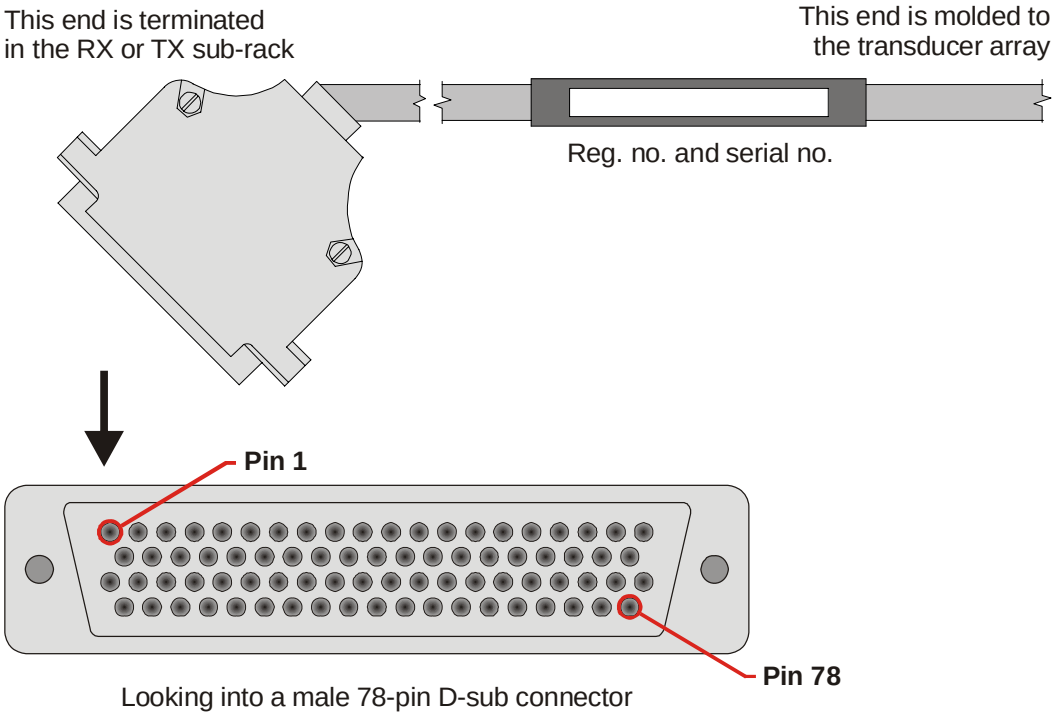
The mouse and the display are both equipped with standard PS/2 connectors. An adapter is used to fit both simultanously into one socket. The adapter must be used at all times, even when the keyboard is disconnected.



Revision: A	Keyboard and rollerball	**W511**

W815 - RX/TX transducer cables

These are the cables from the EM 710 Transceiver Unit to the RX/TX transducer arrays. Each cable is terminated at the cabinet's rear through a 78-pin D-sub connector. At the transducer end, the cables are molded to their respective arrays. The cables are supplied by the manufacturer.



W815 / Rev.B	RX/TX transducer cable termination

The following table displays the pin assignment in the transducer cable from the RX RIO board in the Transceiver Unit to the RX transducer.

Module no.	*Element no.*	*Pin no.*		*Wire colour code*	
1	1	1	21	White	Brown
1	2	40	60	Green	Yellow
1	3	2	22	Grey	Pink
1	4	41	61	Blue	Red
1	5	3	23	Black	Violet
1	6	42	62	Grey/pink	Red/blue
1	7	4	24	White/green	Brown/green

Module no.	*Element no.*	*Pin no.*		*Wire colour code*	
1	8	43	63	White/yellow	Yellow/brown
1	9	5	25	White/grey	Grey/brown
1	10	44	64	White/pink	Pink/brown
1	11	6	26	White/blue	Brown/blue
1	12	45	65	White/red	Brown/red
1	13	7	27	White/black	Brown/black
1	14	46	66	Grey/green	Yellow/grey
1	15	8	28	Pink/green	Yellow/pink
1	16	47	67	Green/blue	Yellow/blue
2	1	9	29	Grey/blue	Pink/blue
2	2	48	68	Grey/red	Pink/red
2	3	10	30	Grey/black	Pink/black
2	4	49	69	Blue/black	Red/black
2	5	11	31	White	Brown
2	6	50	70	Green	Yellow
2	7	12	32	Grey	Pink
2	8	51	71	Blue	Red
2	9	13	33	Black	Violet
2	10	52	72	Grey/pink	Red/blue
2	11	14	34	White/green	Brown/green
2	12	53	73	White/yellow	Yellow/brown
2	13	15	35	White/grey	Grey/brown
2	14	54	74	White/pink	Pink/brown
2	15	16	36	White/blue	Brown/blue
2	16	55	75	White/red	Brown/red

The following table displays the pin assignment in the transducer cable from the TX RIO board in the Transceiver Unit to the TX transducer.

Element no.	*Pin no.*		*Wire colour code*	
1	1	21	White	Brown
2	2	22	Green	Yellow
3	3	23	Grey	Pink
4	4	24	Blue	Red
5	5	25	Black	Violet

Element no.	*Pin no.*		*Wire colour code*	
6	6	26	Grey/pink	Red/blue
7	7	27	White/green	Brown/green
8	8	28	White/yellow	Yellow/brown
9	9	29	White/grey	Grey/brown
10	10	30	White/pink	Pink/brown
11	11	31	White/blue	Brown/blue
12	12	32	White/red	Brown/red
13	13	33	White/black	Brown/black
14	14	34	Grey/green	Yellow/grey
15	15	35	Pink/green	Yellow/pink
16	16	36	Green/blue	Yellow/blue
17	17	37	Green/red	Yellow/red
18	18	38	Green/black	Yellow/black
19	40	60	Grey/blue	Pink/blue
20	41	61	Grey/red	Pink/red
21	42	62	Grey/black	Pink/black
22	43	63	Blue/black	Red/black
23	44	64	White	Brown
24	45	65	Green	Yellow
25	46	66	Grey	Pink
26	47	67	Blue	Red
27	48	68	Black	Violet
28	49	69	Grey/pink	Red/blue
29	50	70	White/green	Brown/green
30	51	71	White/yellow	Yellow/brown
31	52	72	White/grey	Grey/brown
32	53	73	White/pink	Pink/brown
33	54	74	White/blue	Brown/blue
34	55	75	White/red	Brown/red
35	56	76	White/black	Brown/black
36	57	77	Grey/green	Yellow/grey

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