Maintenance Manual

KONGSBERG

EM 710

Multibeam echo sounder

Base version

852-164852

EM 710
Multibeam echo sounder

Maintenance manual

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KONGSBERG

Chapters

This book is the maintenance manual for the EM 710 multibeam echo sounder. It describes how to perform intermediate maintenance on the system.

1 Purpose and description

This section presents a general introduction to the echo sounder system, and defines the maintenance philosophy. Refer to page 1.

2 Technical specifications

This chapter of the manual presents the technical specifications. Refer to page 8.

3 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 11.

4 Operator Station

This chapter describes the design and operation of the HWS 10. Refer to page 38.

5 Transceiver Unit

This chapter describes the design and operation of the Transceiver Unit. Each circuit board is explained, as well as overall block diagrams and the theory of operation. Refer to page 40.

6 Troubleshooting and BIST

This chapter provides basic procedures for automatic and traditional troubleshooting. It also includes BIST self tests. Refer to page 78.

7 Replacement procedures

This chapter explains how to perform replacement of the line replaceable units (LRU). Refer to page 80.

8 Datagram formats

The formats for data input and output to and from the EM Series multibeam echo sounders are described here. Refer to page 86.

9 Spare parts

This chapter provides a listing of the line replaceable units with illustrations and order numbers. Refer to page 141.

10 Drawing file

This chapter holds referenced drawings. Refer to page 148.

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 Installation Manual

The reader

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

Table of contents

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

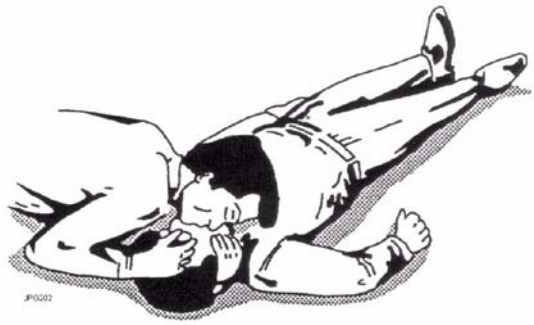
1 Kneel besides the victim's head. Place one hand under his neck and lift, allowing his head to fall back. This will lift his tongue and open the air passage in his throat.

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

This is the maintenance manual for the EM 710 multibeam echo sounder system.

The manual contains detailed descriptions of each of the units in the system. Each circuit board and mechanical assembly is described. The manual also describes the troubleshooting process based on the Built-In Self test (BIST) software, and it includes procedures for disassembly and reassembly of the replaceable items.

This manual does not describe the maintenance of the Operator Station and the peripheral devices (printers, plotters and sensors). For information about these items, refer to the applicable manufacturer's documentation.

The manual will also list the unique boards in the different system delivered.

1.2 Maintenance philosophy

Kongsberg Maritime AS defines three levels for maintenance manuals:

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

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

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

Note — *This maintenance manual is prepared for the intermediate level.*

1.3 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 -** CW pulse forms only.
- **EM 710RD** - Short CW pulse only.

The reduced performance versions EM 710S and EM 710RD 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 up to 25 per second is possible. The transmit fan is electronically stabilized for roll, pitch and yaw.

The EM 710 has a receive beamwidth of either 1 or 2 degrees depending on the chosen receive transducer. The number of beams is 256 or 128 respectively, with dynamic focusing employed in the near field.

A 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.

With a 0.5 degree transmit and 1 degree receive transducer the system will be able to generate two separate alongtrack swaths per ping. The system produces up to 800 soundings per ping in this mode.

The beamspacing may be set to be either equiangular or equidistant. The receive beams are electronically roll stabilized. This can be used to increase the resolution beyond what is achievable in normal operation. In high density mode, the size of each acoustic footprint is reduced to fit the higher sounding density. The 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.

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

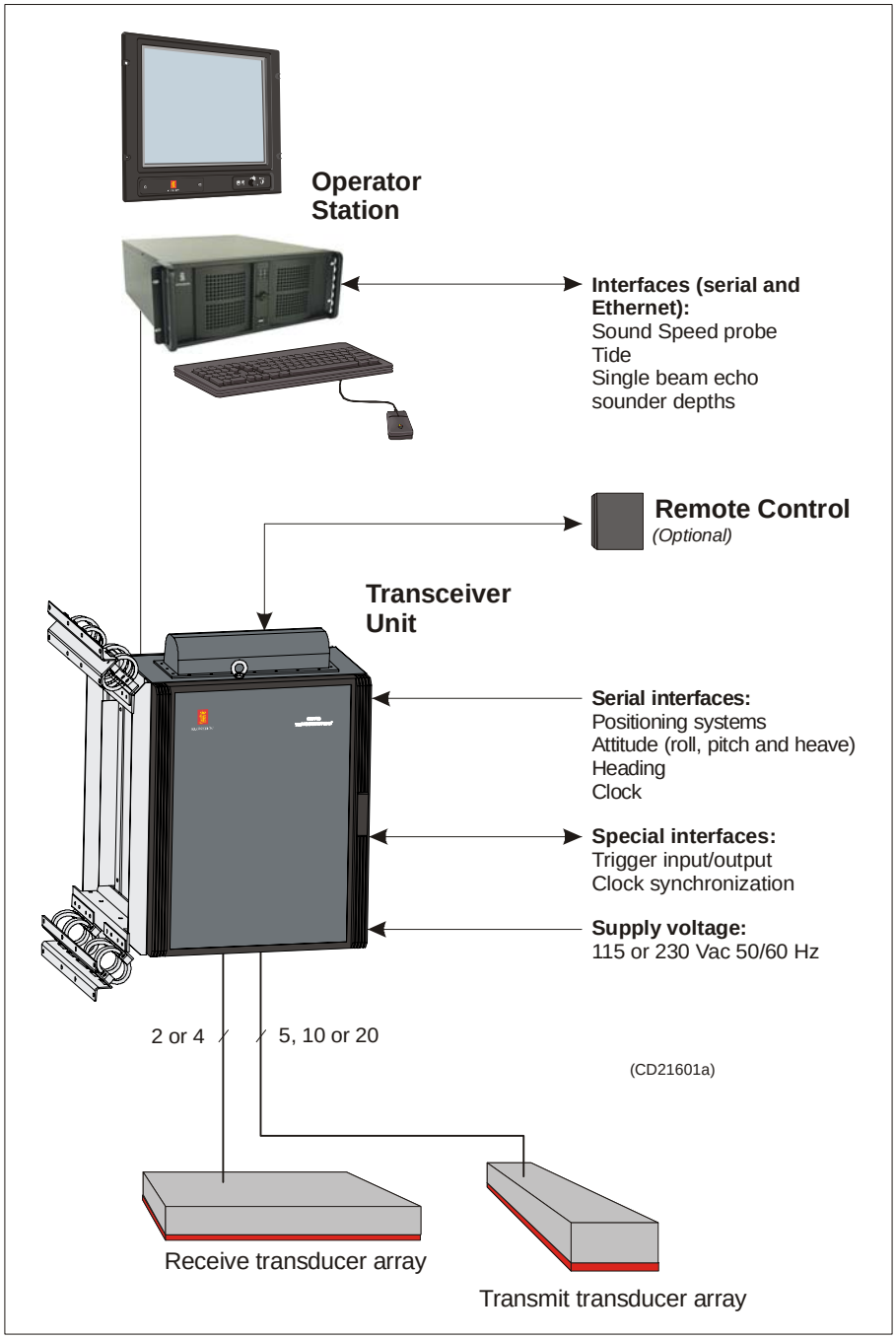


Figure 1 EM 710 system units and interfaces

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 HWS 10 high performance dual-processor PC workstation. The operator software is the Seafloor Information System (SIS). The HWS 10 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 10 is normally supplied with a 17.4” 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.

1.4 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.
- Read and understand the first aid instructions for electric shock.
- 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.

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
- SCSI interface intended for tape drive
- 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

LCD monitor

Height: 400 mm (excluding mounting bracket)

Width: 460 mm (excluding mounting bracket)

Depth: 71 mm (excluding mounting bracket)

Weight: 9.2 kg

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

Environmental and EMC specifications

The system meets all requirements of the IACS E10 specification. The Transceiver Unit meets the additional stronger requirements 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:** 30 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

3 CABLE LAYOUT AND INTERCONNECTIONS

3.1 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

3.2 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 28 for a typical EM 710 cable configuration.*

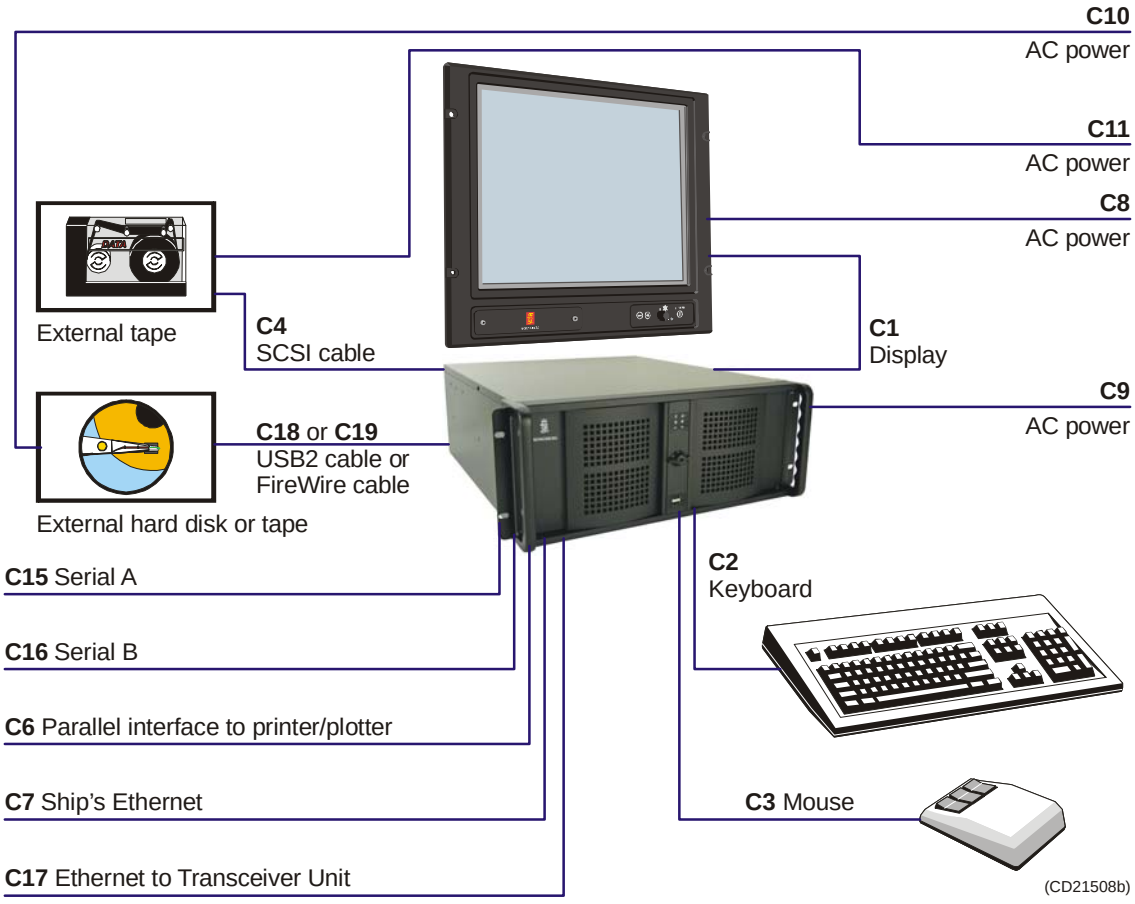


Figure 2 EM 710 Operator Station - Cable plan

C1 - Display

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

→ *Cable details on page 185.*

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 181.*

C3 - Mouse or pointing device

This is a standard mouse cable.

→ *Cable details on page 182.*

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 183.*

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 179.*

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 178.*

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 173.*

→ *Standard 9-pin RS-232 serial line details on page 171.*

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 171.*

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 180.*

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 28 for a typical EM 710 cable configuration.*

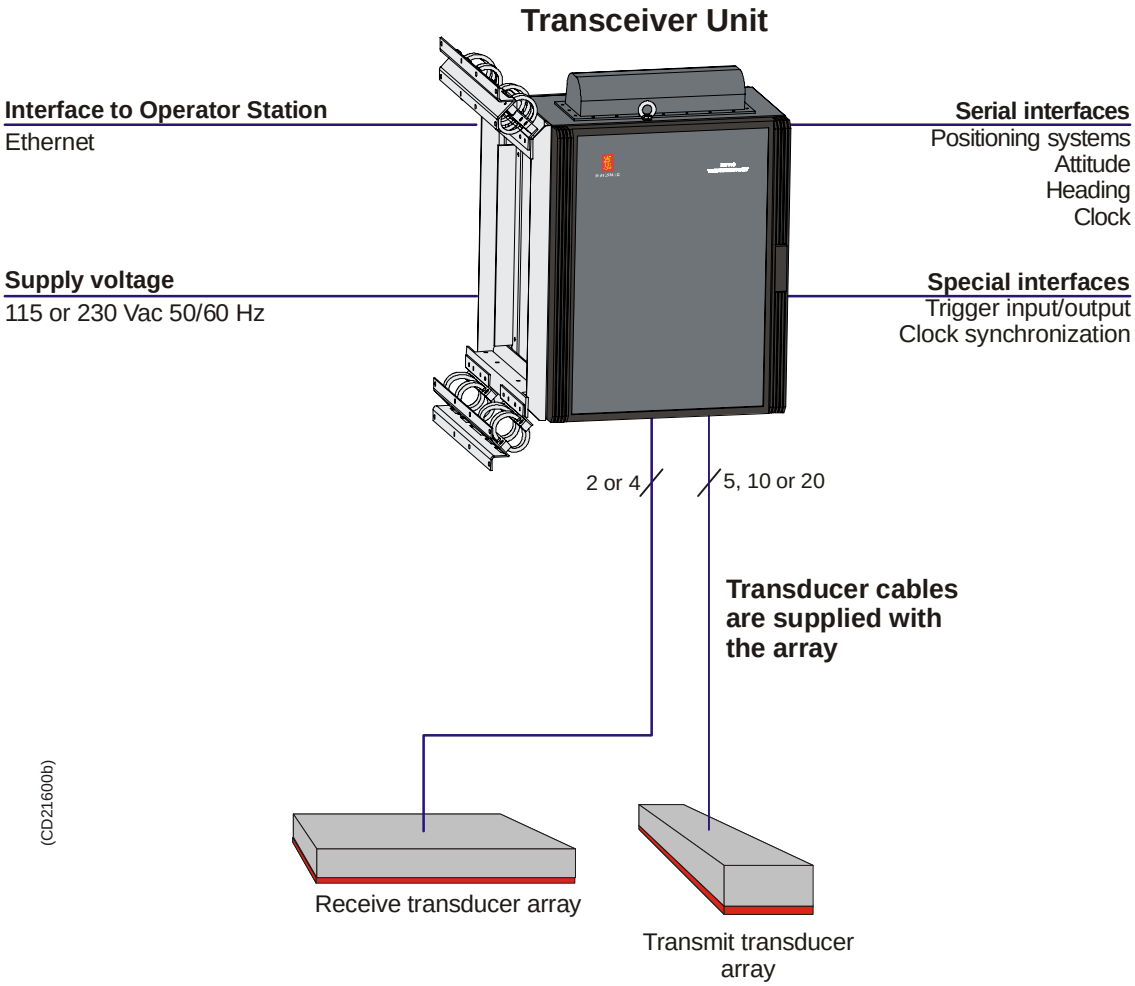


Figure 3 EM 710 Transceiver Unit, overview of interfaces

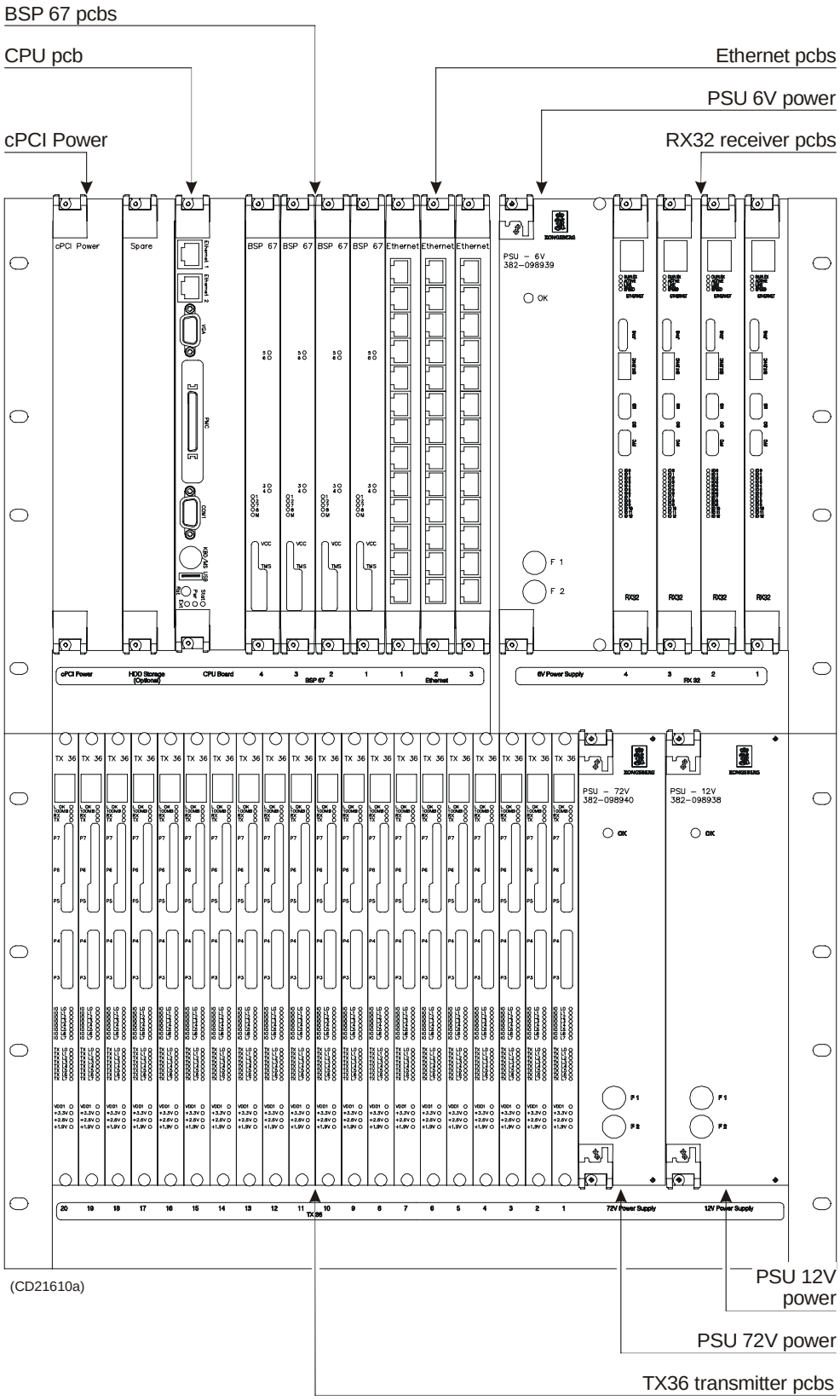


Figure 4 EM 710 Transceiver Unit sub-racks, front view, 0.5 x 1 degree model

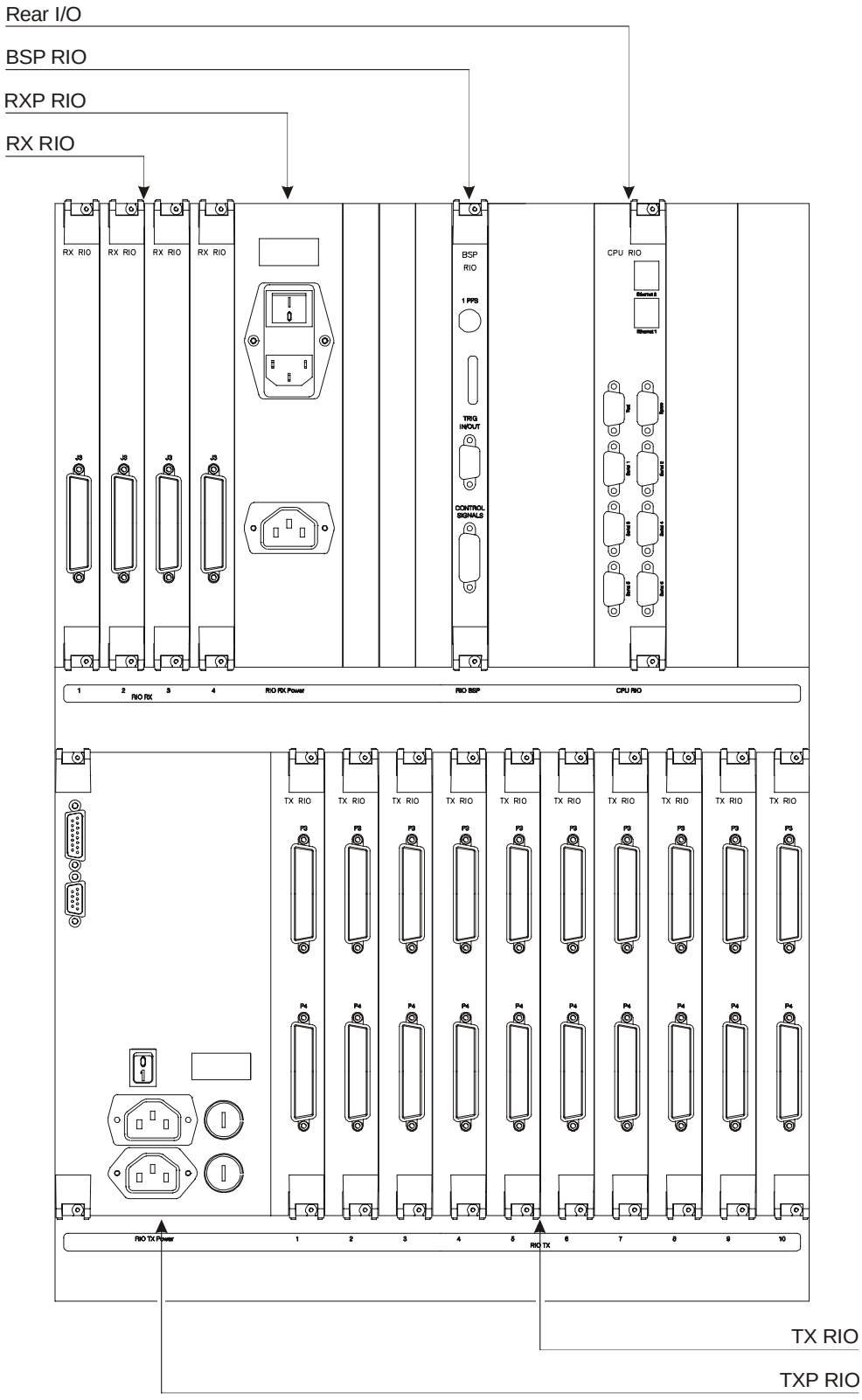
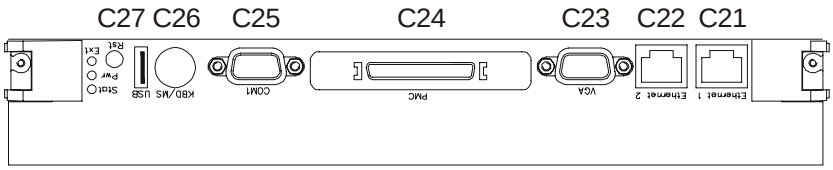


Figure 5 EM 710 Transceiver Unit sub-racks, rear view, 0.5 x 1 degree model

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 179.*

C23 - VGA Interface

The VGA Interface cable is equipped with a 15-pin D-Sub connector. The monitor signals are available at the front panel of the CPU Board.

This cable is normally not used.

→ *Cable details on page 184.*

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 connnector. 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 174.*

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 186.*

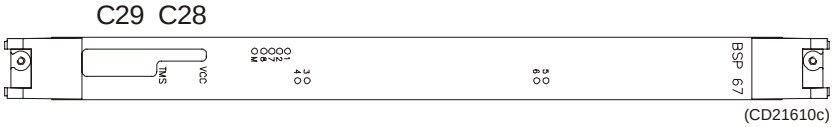
C27 - USB

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 180.*

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

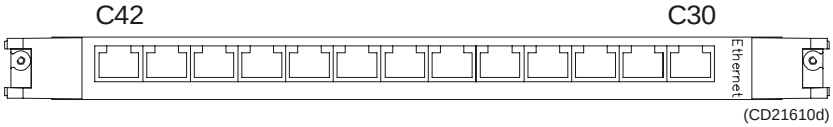
This cable is connected to the TMS Emulator slot for programming and development purposes.

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.

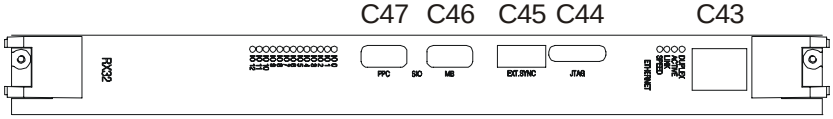
→ *Cable details on page 179.*

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 179.*

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)

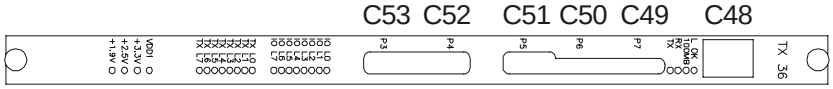
This cable is connected to the PPC slot for debugging the PowerPC (FPGA hard-core processor) program software.

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



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 179.*

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)

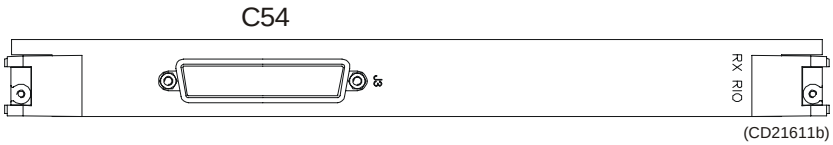
This cable is connected to the PPC slot for debugging the PowerPC (FPGA hard-core processor) program software.

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



(CD21611b)

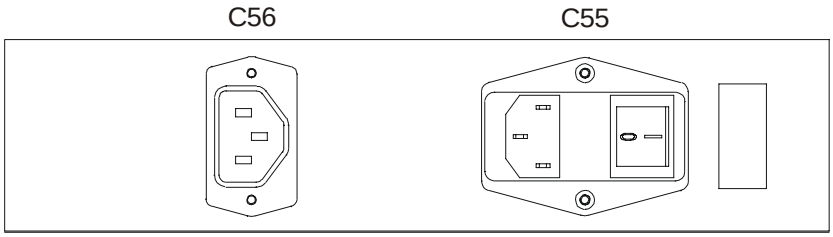
C54 - RX transducer

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

Each RX RIO board connects to one RX transducer cable.

→ *Cable details on page 187.*

RXP RIO cables



(CD21611c)

C55 / C56 - AC power

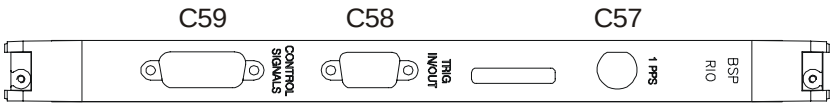
These are 115/230 Vac AC mains cables. Cable C55 must be equipped with a 3-pin IEC female socket and C56 in a male equivalent.

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

The cable C55 is provided by the manufacturer.

→ *Cable details on page 178.*

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 172.*

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 175.*

C59 - Control signals

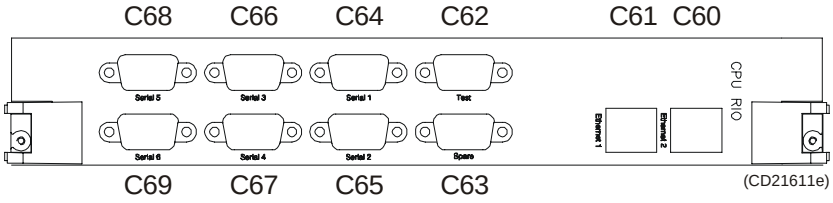
This cable is equipped with a standard 15-pin D-sub connector and is connected to the TXP RIO board.

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 176.*

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 179.*

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.

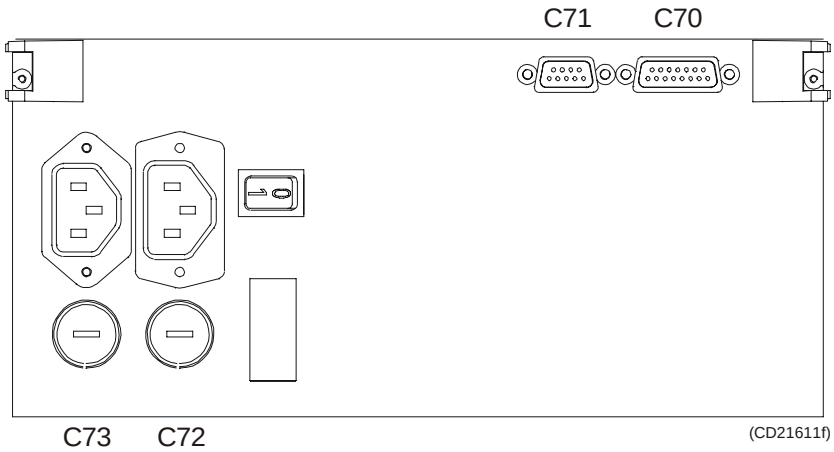
C64 to C69 - Serial lines

These cables are equipped with standard 9-pin D-sub connectors.

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

→ *Cable details on page 171.*

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 176.*

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 177.*

C72 / C73 - AC power

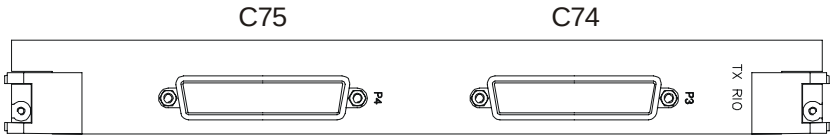
These are 115/230 Vac AC mains cables. Cable C72 must be equipped with a 3-pin IEC male socket and C73 in a female equivalent.

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 178.*

TX RIO cables



(CD21611g)

C74 / C75 - TX transducer

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

Each TX RIO board connects to two TX transducer cables.

→ *Cable details on page 187.*

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.

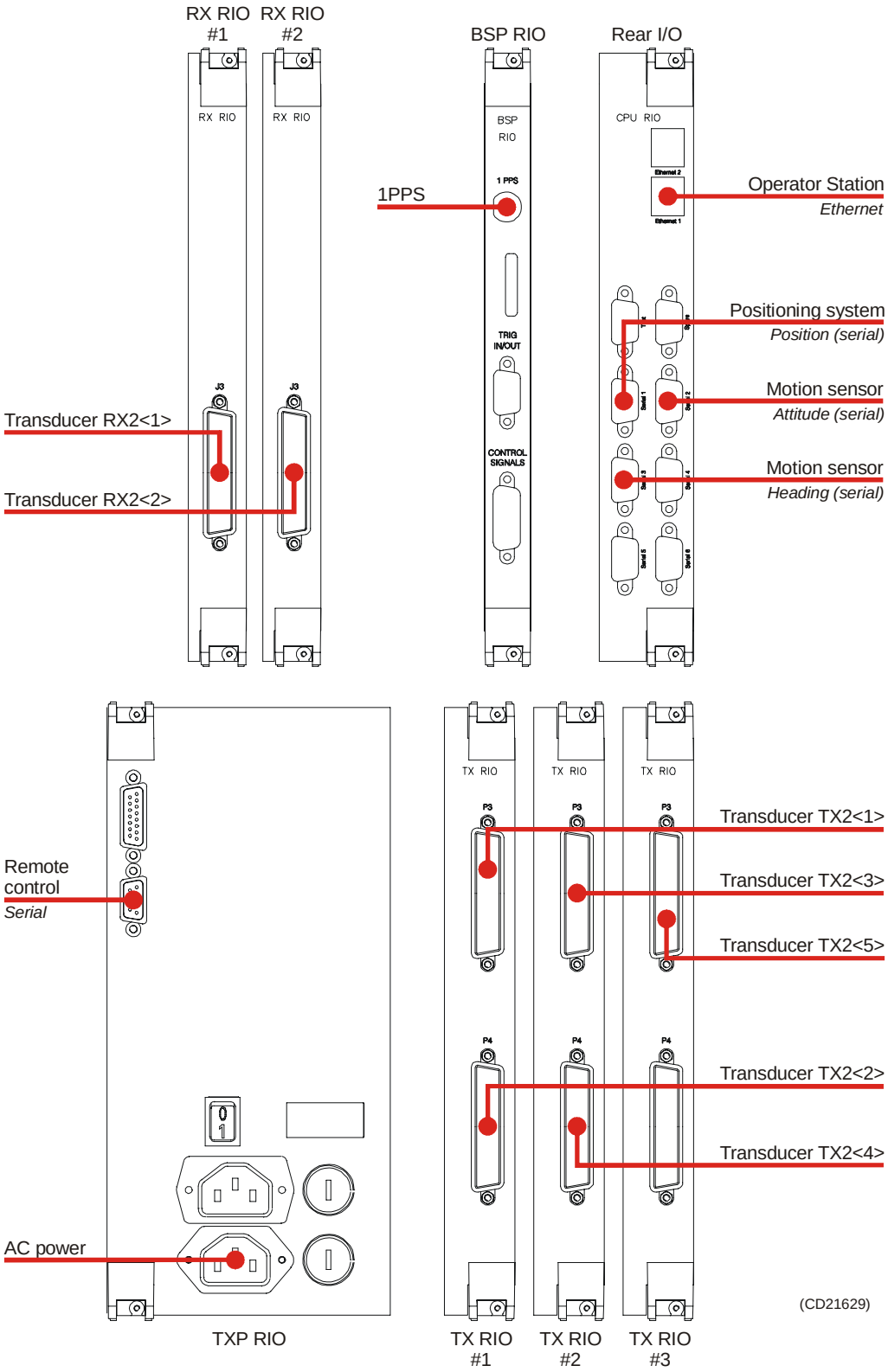


Figure 6 Cabling between the Transceiver Unit, other system units and external systems

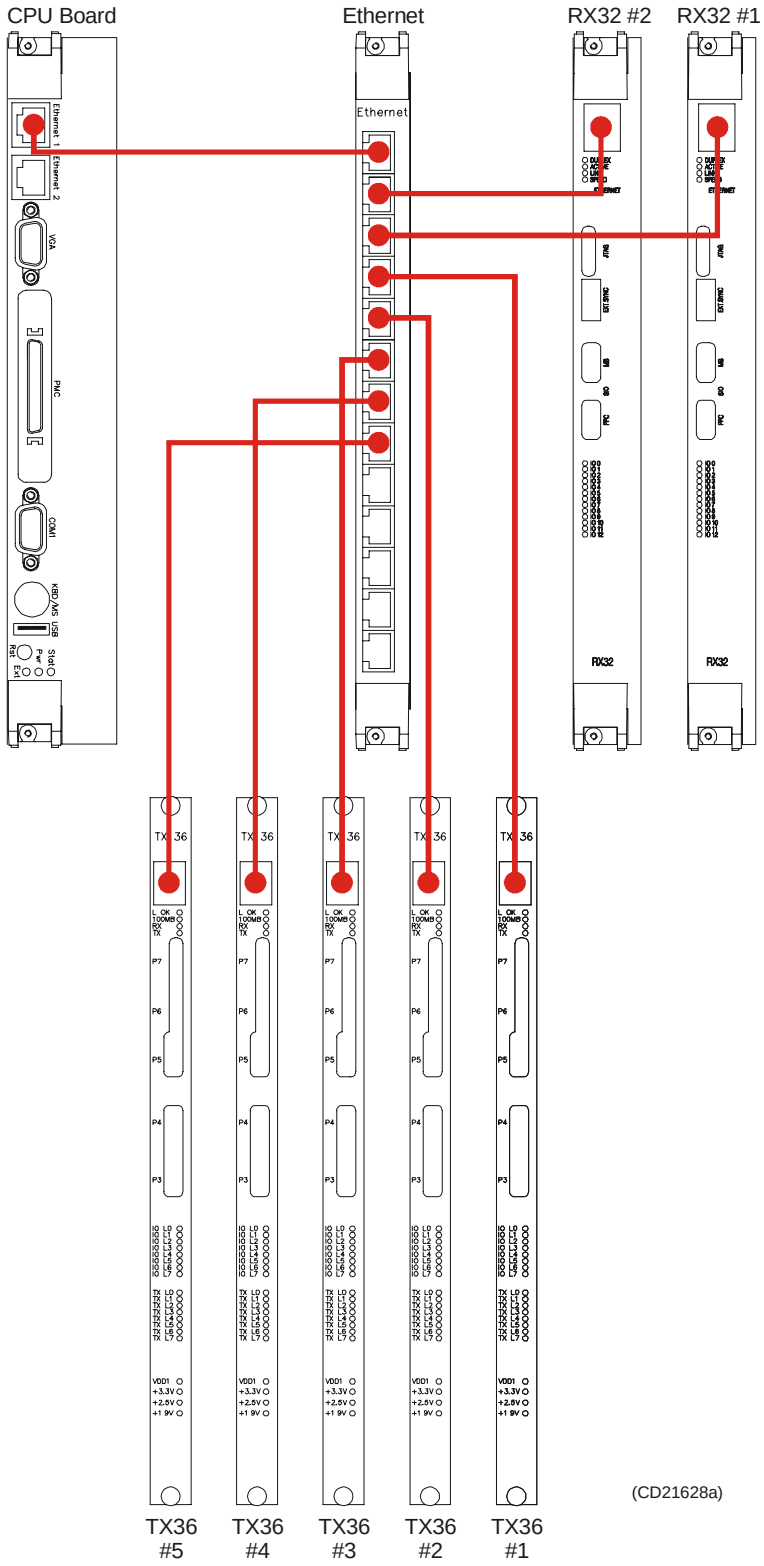


Figure 7 Internal cabling in the Transceiver Unit (Ethernet cables)

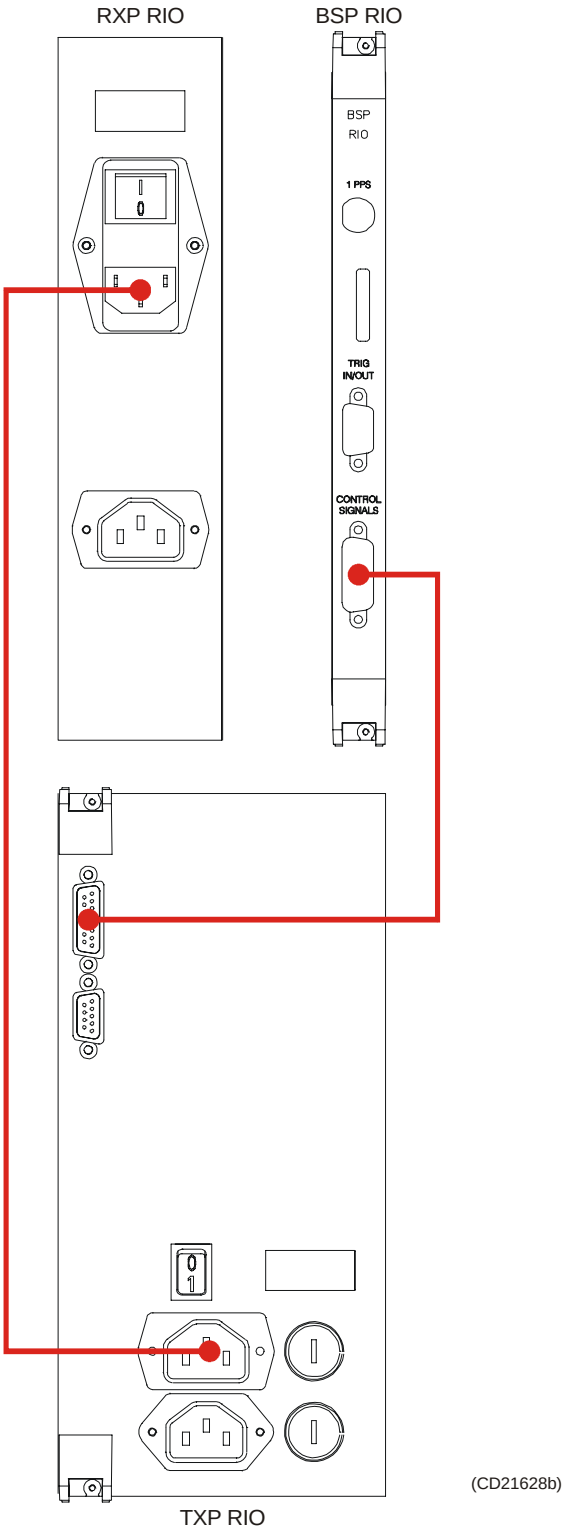


Figure 8 Internal cabling in the Transceiver Unit (power and control cables)

3.3 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.*

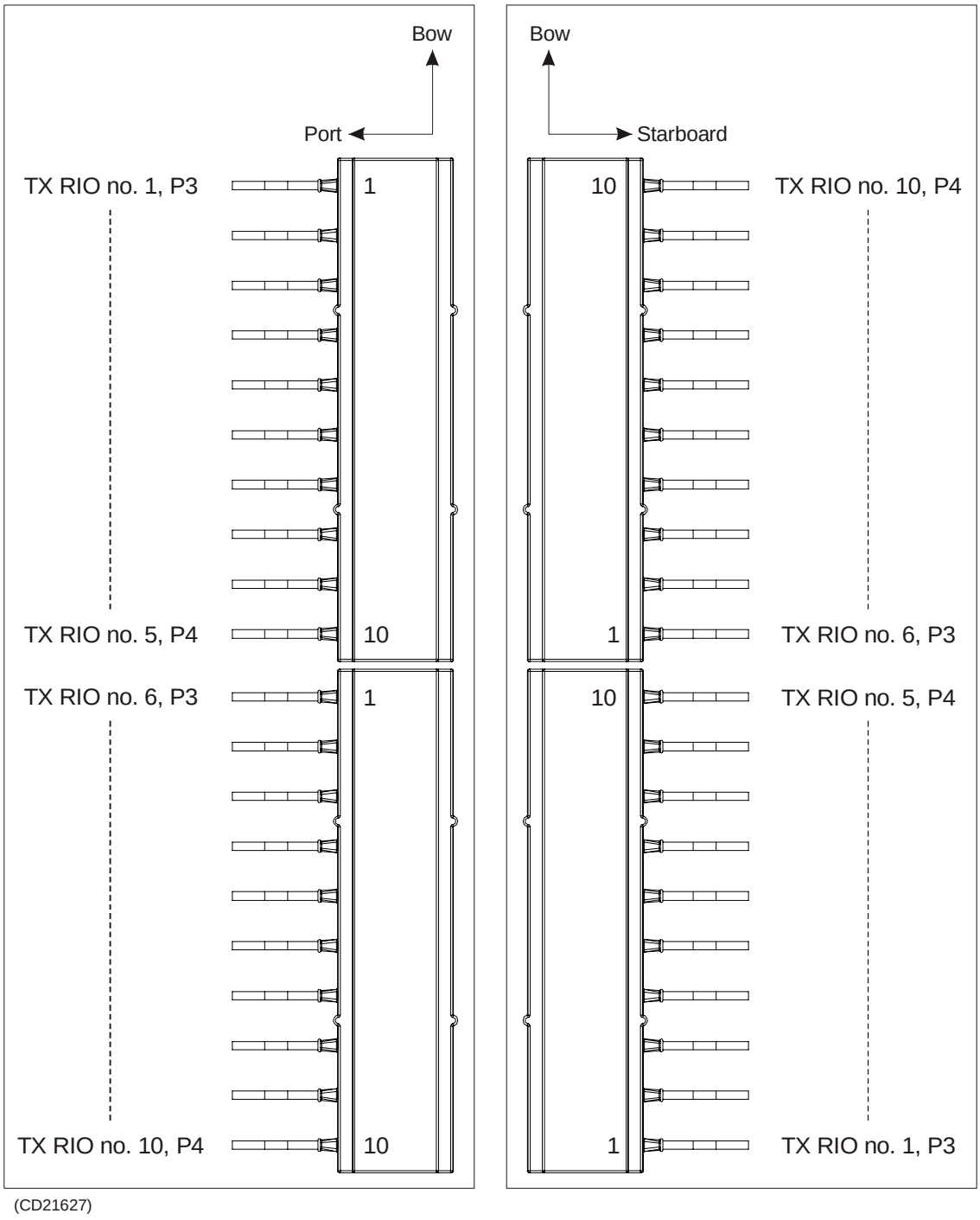


Figure 9 Connection of TX transducer cables, 0.5 x 1 degree system, top view

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

TX array identification (second 0.5 degree array)		***TRU identification***	
Cable no.	***Serial no.***	***TX RIO no.***	***Socket no.***
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

4 OPERATOR STATION

4.1 Description and main functions

Overview

The HWS 10 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.

This chapter provides the following information:

→ *Theory of operation, page 39.*

4.2 Theory of operation

Overview

The HWS 10 is equipped to handle the heavy processing requirements and high-speed, largevolume data storage demands of today's hydrographic systems. It has been specifically designed as the optimal platform for running the Seafloor Information System (SIS) real-time operating software used on the Kongsberg EM multibeam echo sounders. Special features of SIS include real-time:

- Gridding of sounding data.
- Filtering of sounding data.
- 3-D visualization of sounding data.
- Storage and visualization of high resolution backscatter data from the seabed and the water column.

Software

The partitioned system disk is dual bootable with Linux® and Microsoft Windows XP® respectively. SIS software is factory installed and tested on both operating systems.

Data storage

The primary task of the HWS 10 is to safeguard the collected data and to visualize it for quality control. All data is initially stored on a pair of high performance SerialATA disks. These disks are run in a RAID1 configuration, thus ensuring against loss of data even if one disk should fail. They are mounted in hot swappable enclosures, so that the collected data may be transported on the disk. A DVD recorder is the standard means for permanent archiving of the collected data. For users having preferences for other storage devices or media, the HWS 10 includes USB 2.0, Firewire (IEEE 1394) and SCSI interfaces. Gigabit Ethernet is available for transfer of the data to another network computer. For temporary storage data may also be backed up to the system drive.

5 TRANSCEIVER UNIT

5.1 Description and main functions

Overview

The EM 710 Transceiver Unit contains all transmit and receive electronics. It comprises two 19” sub-racks contained in a cabinet designed for bulkhead or deck mounting.

- The upper **Receiver rack** holds the receiver boards, circuit boards for processing, beam forming and commication and two power supplies.
- The lower **Transmitter rack** holds the transmitter boards and two power supplies.

Both sub-racks are equipped with high efficiency fans. The filtered air inlet is at the bottom of the Transceiver Unit, and the outlet is at the top.

The Transceiver Unit is mounted on shock and vibration dampers.

This chapter provides the following information:

→ *Description and main functions, this page.*

→ *Receiver rack, page 41.*

→ *Transmitter rack, page 44.*

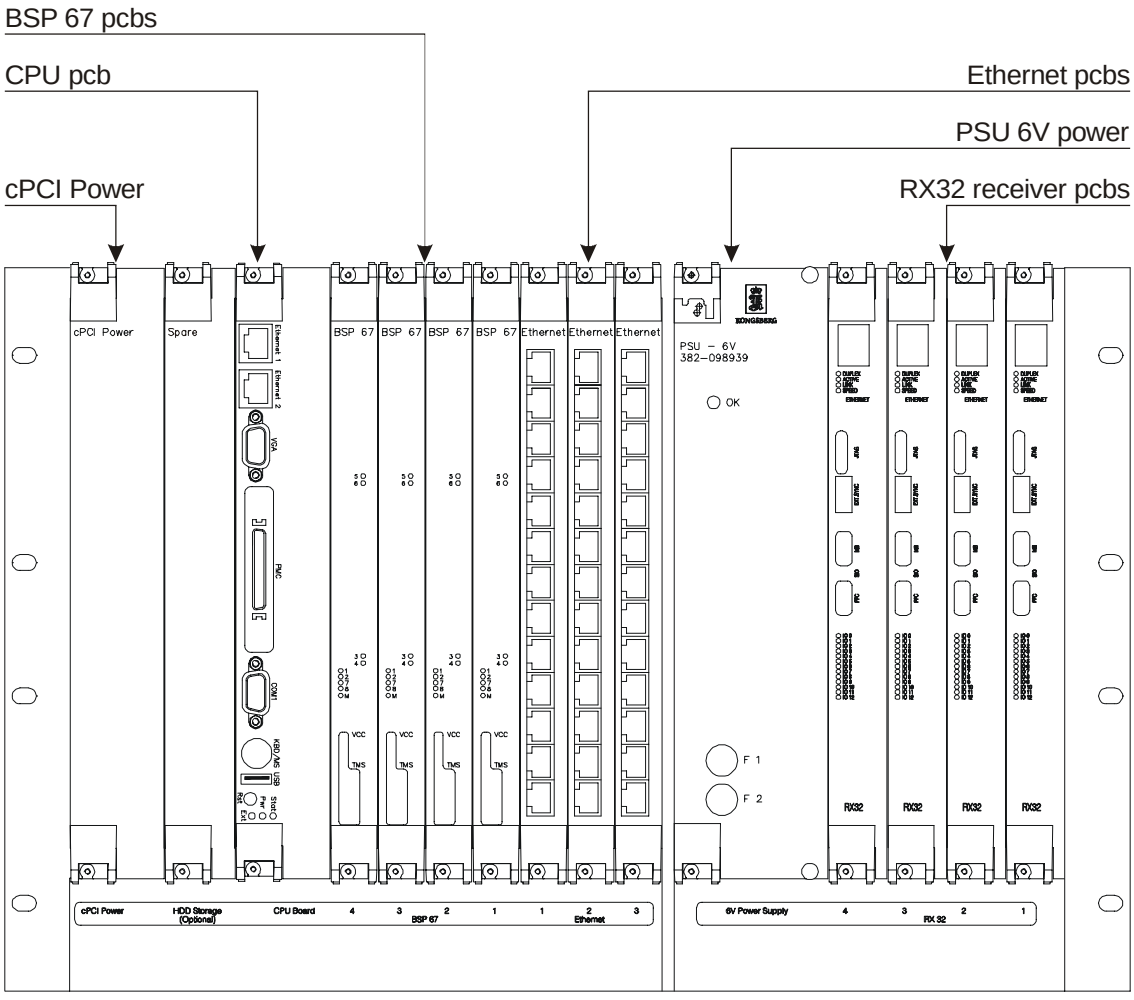
→ *Theory of operation, page 46.*

→ *Circuit board descriptions, page 48.*

Receiver rack

The Receiver rack is the upper sub-rack of the Transceiver Unit. It holds several circuit boards and power supplies. All the units are accessed either from the front or the rear of the rack.

The Receiver rack contains an 84 HP backplane allowing circuit boards and modules to be inserted from both sides. Two different sizes of 6U boards can be used (depths 160 and 220 mm). All circuit boards are supported by guide rails. The rack also contains two high efficiency fan units.



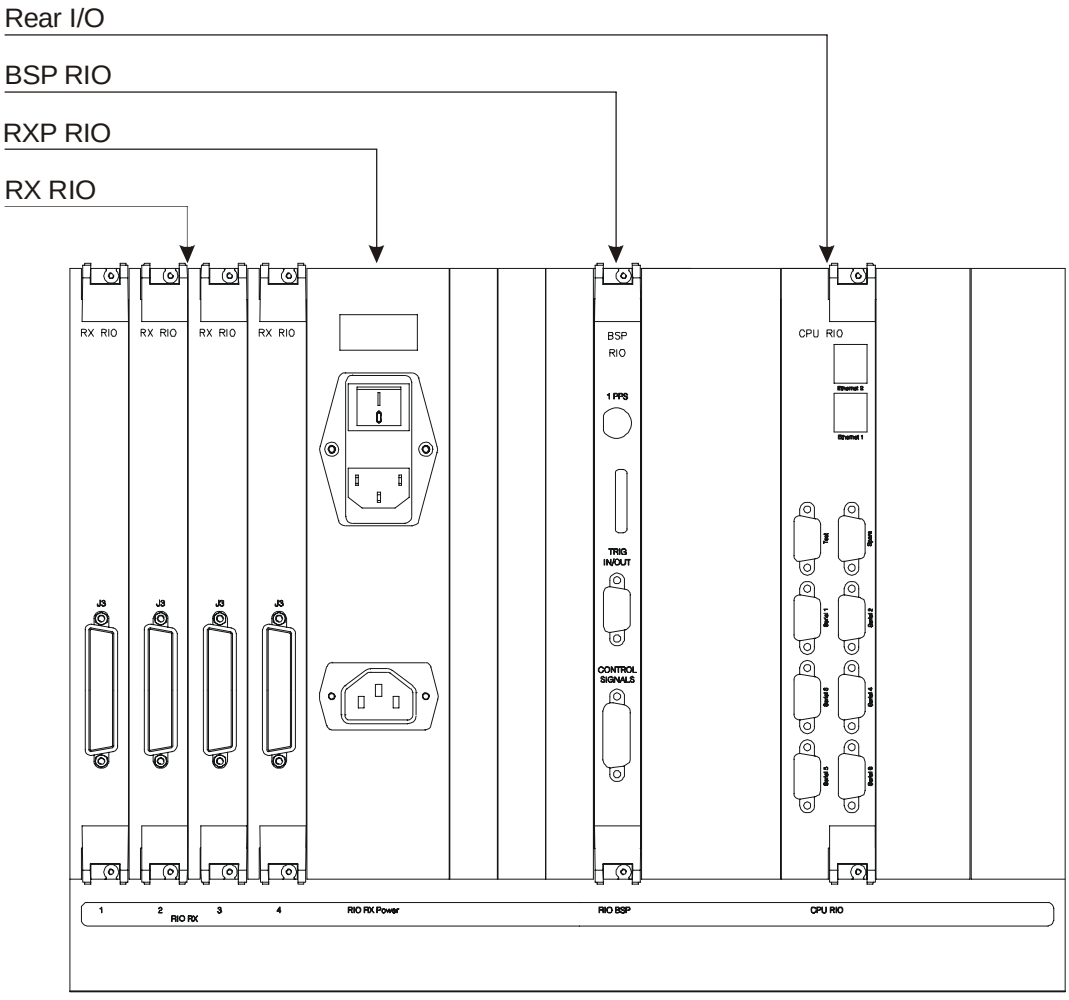
(CD21622a)

Figure 10 Receiver rack, front view, 0.5 x 1 degree model

The Receiver rack holds the following front mounted circuit boards and modules (from left):

- cPCI Power Supply
- CPU Board
- BSP 67 Board

- Ethernet Switch Board
- Power Supply PSU 6V
- RX32 Receiver Board



(CD21622b)

Figure 11 Receiver rack, rear view, 0.5 x 1 degree model

The following circuit boards and modules are rear mounted (from left):

- RX RIO Rear Interface Board
- RXP RIO Rear Interface Module
- BSP RIO Rear Interface Board
- Rear I/O Interface Board

The illustrations above display the typical circuit board configuration for a 0.5 x 1 degree system. The number of boards used in the Transceiver Unit is different for each EM 710 model. For the Receiver rack, this is indicated by the table below.

RX rack	*No. of items*			
Circuit boards	*0.5 x 1*	*1 x 1*	*1 x 2*	*2 x 2*
cPCI Power Supply	1	1	1	1
CPU Board	1	1	1	1
BSP 67 Board	4	4	2	2
Ethernet Switch Board	3	2	2	1
Power Supply PSU 6V	1	1	1	1
RX32 Receiver Board	4	4	2	2
RX RIO Rear Interface Board	4	4	2	2
RXP RIO Rear Interface Module	1	1	1	1
BSP RIO Rear Interface Board	1	1	1	1
Rear I/O Interface Board	1	1	1	1

Transmitter rack

The Transmitter rack is the lower sub-rack of the Transceiver Unit. It holds several circuit boards and power supplies. All the units are accessed either from the front or the rear of the rack.

The Transmitter rack contains an 84 HP backplane allowing circuit boards and modules to be inserted from both sides. The front mounted modules are all 6U deep (220 mm) and the rear modules have a standard depth of 80 mm. All circuit boards are supported by guide rails. The rack also contains a high performance fan unit.

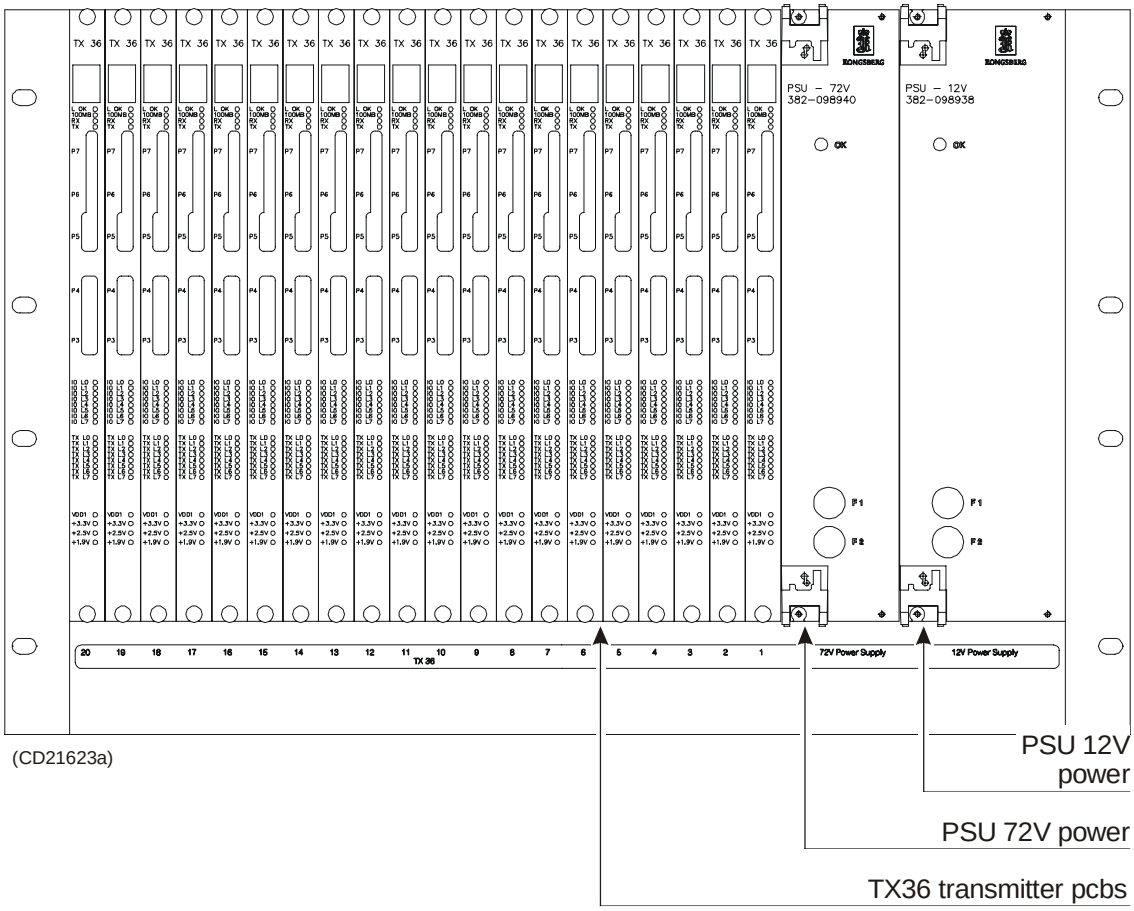


Figure 12 Transmitter rack, front view, 0.5 x 1 degree model

The Transmitter rack holds the following front mounted circuit boards and modules (from left):

- TX36 Transmitter Board
- Power Supply PSU 72V
- Power Supply PSU 12V

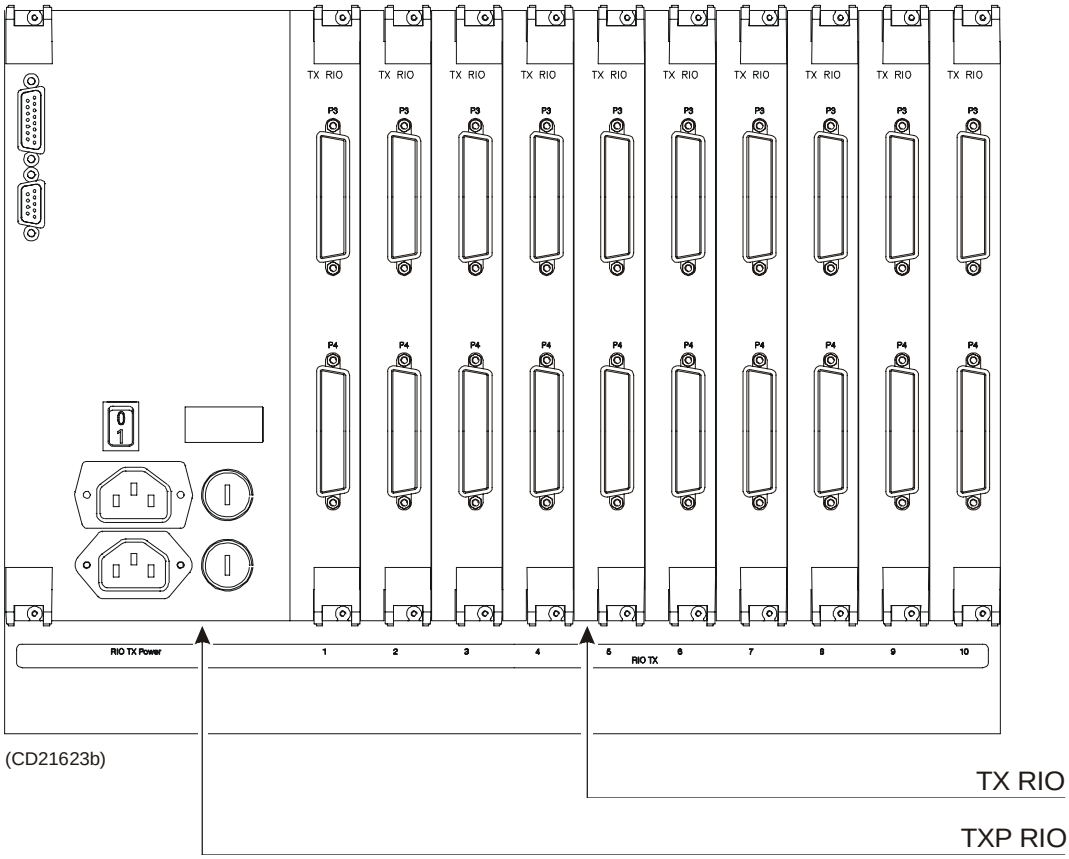


Figure 13 Transmitter rack, rear view
0.5 x 1 degree model

The following circuit boards and modules are rear mounted (from left):

- TXP RIO Rear Interface Board
- TX RIO Rear Interface Board

The illustrations above display the typical circuit board configuration for a 0.5 x 1 degree system. The number of boards used in the Transceiver Unit is different for each EM 710 model. For the Transmitter rack, this is indicated by the table below.

TX rack	*No. of items*			
Circuit boards	*0.5 x 1*	*1 x 1*	*1 x 2*	*2 x 2*
TX36 Transmitter Board	20	10	10	5
Power Supply PSU 72V	1	1	1	1
Power Supply PSU 12V	1	1	1	1
TXP RIO Rear Interface Board	1	1	1	1
TX RIO Rear Interface Board	10	5	5	3

5.2 Theory of operation

Overview

This chapter presents a functional description of the EM 710 Transceiver Unit.

Simplified block diagram

The simplified block diagram for the Transceiver Unit presents the following main functions:

- Transmission
- Reception
- Processing

The various parameter settings made on the Operator Station are sent to the Control Processor. The information (runtime and installation parameters, sound speed etc.) is interpreted, and passed on through an Ethernet interface to the RX32 and TX36 Boards.

After the transmission, the RX32 Board is instructed to receive the samples for all the receiver staves and pass them on to the BSP67 Boards.

The BSP67 Boards perform the band pass filtering and the beamforming of the receiver element data.The beam data are transferred to the CPU Board via the cPCI bus.

The CPU Board performs the bottom detection and produces the output datagrams. It also reads the sensor data (position, attitude etc) input from the RS-232 serial lines. These serial lines are connected via the Rear I/O Board and a serial line PMC module mounted on the CPU Board. The sound speed information is received from the Operator Station.

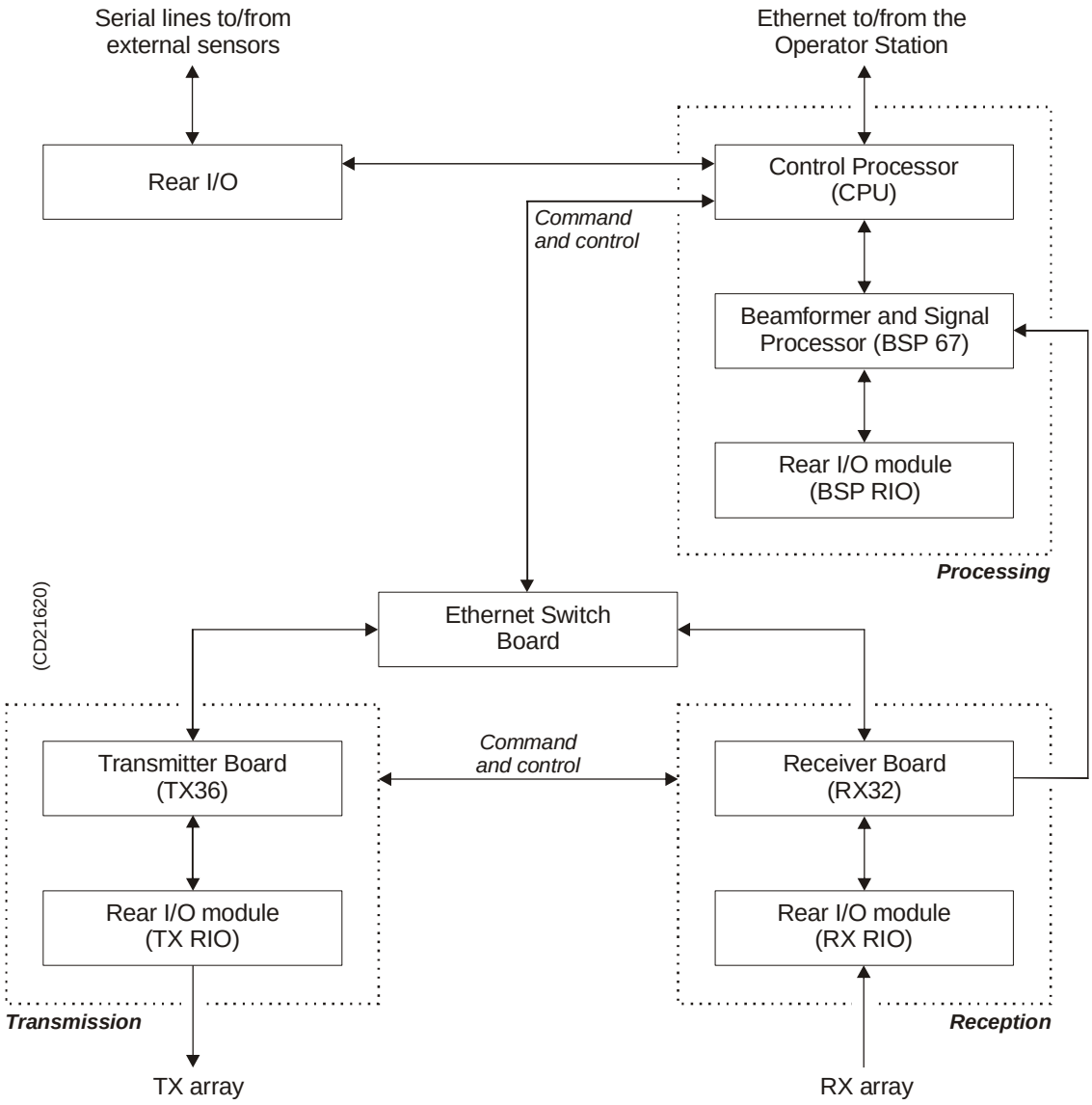


Figure 14 Transceiver Unit, simplified block diagram

5.3 Circuit board descriptions

Overview

In the following all the circuit boards and modules in the EM 710 Processing Unit are described. All facilities useful for maintenance personnel are provided.

→ *BSP67 Board, page 49.*
→ *cPCI Power Supply, page 50.*
→ *CPU Board, page 52.*
→ *Ethernet Switch Board, page 59.*
→ *Power Supply PSU 6V, page 60.*
→ *Power Supply PSU 12V, page 61.*
→ *Power Supply PSU 72V, page 62.*
→ *Rear Interface Board (BSP RIO), page 63.*
→ *Rear Interface Board (Rear I/O), page 64.*
→ *Rear Interface Board (RX RIO), page 65.*
→ *Rear Interface Board (RXP RIO), page 66.*
→ *Rear Interface Board (TX RIO), page 68.*
→ *Rear Interface Board (TXP RIO), page 68.*
→ *Receiver Board (RX32), page 70.*
→ *Transmitter Board (TX36), page 74.*

BSP67 Board

Purpose and description

The Beamforming & Signal Processing Board (BSP67) is a double cPCI board. The BSP67 Board is used by the Transceiver Unit for beamforming and signal processing purposes.

The processing power in the BSP67 Board is based on nine Texas C67 digital signal processors working in parallel while beamforming the data.

Specifications

Power consumption: 3 A at 3.3 Vdc / 5 Vdc

Facilities

LEDs

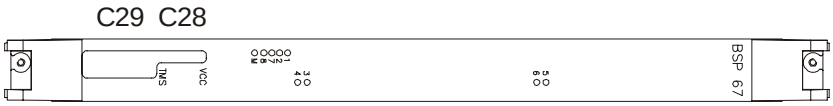
There is one LED for each of the signal processors (1-8, M). The LEDs are marked 1, 2, 3, 4, 5, 6, 7, 8 for the eight beamformers and M for the master.

When OK, the LEDs will flash with a frequency of 1 Hz.

External connections

The following cables can be connected to the circuit board:

- C28 - VCC (for test purposes only)
- C29 - TMS (for test purposes only)



(CD21610c)

cPCI Power Supply

Purpose and description

This is a standard 400 W cPCI Power Supply. Its main purpose is to supply DC output to the CPU, BSP 67 and Ethernet Switch circuit boards. The AC input version of the power supply is used by the Transceiver Unit.

Key features

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

Specifications

Input

Input voltage: 90 to 264 Vac, 47 to 63 Hz

Maximum input current: 4.8 A at 115 Vac, 2.4 A at 230 Vac

Inrush current: 30 A at 120 Vac, 60 A at 230 Vac

Power factor: 0.99

Leakage current: < 3mA

Output

Output voltage and current ratings:

Output voltage (Vdc)	Maximum output current (A)
3.3	50.0
5.0	50.0
12.0	12.0
–12.0	4.0

Line regulation: ± 2 %

Load regulation: ± 2 to 3 %

Ripple and noise: 1 % (peak-to-peak)

General

Efficiency: 70% minimum at 110 Vac

Isolation: Input to ground 1500 Vac, input to output 3000 Vac

Facilities

LEDs

There are two front panel LEDs:

Green: Power good

Amber: Power fail

External connections

None.

CPU Board with PMC Module

Purpose and description

The CT7 cPCI Single Board Computer is a fully IBM-AT compatible stand-alone PC. It is used by the Transceiver Unit as the Central Processing Unit (CPU).

The TPMC866 is a standard single-width 32 bit PMC module. It has eight channels of high performance RS-232 serial interface with front I/O and back I/O. It is mounted on the CPU Board.

Key features

- Intel® Pentium III processor, 850 MHz
- Easy updating, in-system programmable Flash BIOS
- FlashDrive, 32 MByte
- PCI Mezzanine Card (PMC) Interface

Specifications

Input

Supply voltages: +5 Vdc, +12 Vdc, -12 Vdc

Current (max): 10.6 A at 5 Vdc, 0.85 A at 12 Vdc, 0.45 A at -12 Vdc

Power consumption: 5.5 A at 5 Vdc

Capability

DRAM: 128 MB SDRAM with ECC. Running at 66/100 MHz

Chipset: Intel 82440GX with 82371EB (PIIX4e) ISA bridge

EEPROM: Serial EEPROM 512 Byte

CMOS RAM: 114 byte non-volatile RTC, MC146818 compatible RTC with on-board Lithium battery

Facilities

LEDs

There are three front panel LEDs:

Blue: Hot swap

Green: Power OK

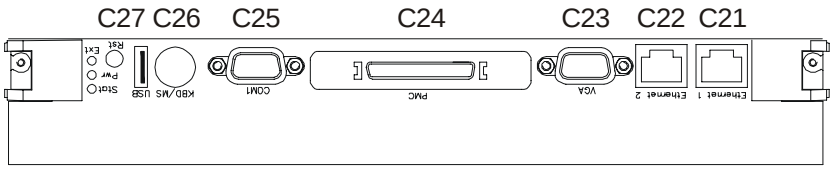
Red: Power fail

External connections

The following cables can be connected to the circuit board:

- C21 / C22 - Two high speed PCIbus Ethernet controller (Intel 82559ER) with 10BaseT and 100BaseTX interface and integrated FIFO buffer

- C23 - AGP VGA C&T 69000 (2MB) or 69030 (4MB) with 64-bit Windows accelerator and LCD flat panel interface
- C24 - 64Bit/33MHz PCI mezzanine connector for standard PMC
- C25 - Serial I/O, asynchronous 16550 compatible channel with 16 byte FIFO
- C26 - IBM PC/AT compatible keyboard controller with PS/2 style connector
- C27 - High-speed 12 Mbit/sec USB port



(CD21610b)

Setup for SBS CT-7 CPU Board

Standard CMOS Setup

Date

Time

FloppyDrive A: . . . . . Not Installed
FloppyDrive B: . . . . . Not Installed

Primary Master: . . . . . Not Installed
Primary Slave: . . . . . Not Installed
Secondary Master: . . . . . Auto On
Secondary Slave: . . . . . Not Installed
Boot Sector Virus Protection . . . . . Disabled

Advanced CMOS Setup

Quick Boot . . . . . Disabled
Pri Master ARMD Emulated as . . . . . Auto
Pri Slave ARMD Emulated as . . . . . Auto
Sec Master ARMD Emulated as . . . . . Auto
Sec Slave ARMD Emulated as . . . . . Auto
1st Boot Device . . . . . USB-CDROM
2nd Boot Device . . . . . 1st IDE-HDD
3rd Boot Device . . . . . Disabled
Try Other Boot Devices . . . . . No
Initialize 120 Device . . . . . No
Floppy Access Control . . . . . Read-Write
Hard Disk Access Control . . . . . Read-Write
S.M.A.R.T. for Hard Disk . . . . . Enabled
BootUp Num-Lock . . . . . On
PS/2 Mouse Support . . . . . Disabled
System Keyboard . . . . . Absent
Primary Display . . . . . Absent
Password Check . . . . . Setup
BOOT To OS/2 . . . . . No

Wait for ’F1’ if Error . . . . . Eanbled
Internal Cache . . . . . WriteBack
System Bios Cacheable . . . . . Enabled
Onboard VGA . . . . . Auto
Display Mode . . . . . CRT and DFP
Digital Flat Panel Type . . . . . VGA TFT 16
Stretch Text Mode . . . . . Yes
Stretch Graphics Modes . . . . . No
Symbios SCSI BIOS . . . . . Enabled

Advanced Chipset Setup

USB Funtion . . . . . Enabled
USB KB/Mouse Legacy Support . . . . . Auto
Port 64/60 Emulation . . . . . Disabled
SERR# . . . . . Enabled
PERR# . . . . . Enabled
USWC Write Port . . . . . Enabled
BX Master Latency Timer (Clkks) 64
DRAM Integrety Mode . . . . . ECC Hardware
Power Down SDRAM . . . . . Enabled
PIIX4 SERR# . . . . . Enabled
TypeF DMA Buffer 1 Channel . . . . . Disabled
TypeF DMA Buffer 2 Channel . . . . . Disabled
DMA-0 Type . . . . . Normal ISA
DMA-1 Type . . . . . Normal ISA
DMA-2 Type . . . . . Normal ISA
DMA-3 Type . . . . . Normal ISA
DMA-4 Type . . . . . Normal ISA
DMA-5 Type . . . . . Normal ISA
DMA-6 Type . . . . . Normal ISA
DMA-7 Type . . . . . Normal ISA
PCI Downstream Window 1 Type . . . . . Disabled
PCI Downstream Window 1 Size . . . . . N/A
PCI Downstream Window 2 Type . . . . . Disabled

PCI Downstream Window 2 Size . . . . . N/A
PCI Downstream Window 3 Type . . . . . Disabled
PCI Downstream Window 3 Size . . . . . N/A
PCI Upstream Window 0 Type . . . . . Disabled
PCI Upstream Window 0 Size . . . . . N/A
PCI Upstream Window 1 Type . . . . . Disabled
PCI Upstream Window 1 Size . . . . . N/A
PCI Upstream Window 2 Page Size . . . . . Disabled
VMWbus System Controller State . . . . . Auto
VMEbus Fast DTACK# Filtering . . . . . Disabled
VMEbus Access Window Size 512MB
Spread Spectrum Clock Modulation . . . . . Low

Power Management Setup

Power Managememnt/APM . . . . . Disabled

…

…

Processor Thermal Protection . . . . . Enabled
Thermal Duty Cycle . . . . . 87.5 %

PCI / Plug and Play Setup

Plug and Play Aware O/S . . . . . No
PCI Latency Timer (PCI Clocks) 64
PCI VGA Priority . . . . . Offboard
PCI VGA Palette Snoop . . . . . Disabled
PCI IDE BusMaster . . . . . Enabled
DMA Channel 0 . . . . . PnP
DMA Channel 1 . . . . . PnP
DMA Channel 3 . . . . . PnP
DMA Channel 5 . . . . . PnP
DMA Channel 6 . . . . . PnP
DMA Channel 7 . . . . . PnP
IRQ3 . . . . . PCI/PnP
IRQ4 . . . . . PCI/PnP
IRQ5 . . . . . PCI/PnP

IRQ7 . . . . . PCI/PnP
IRQ10 . . . . . PCI/PnP
IRQ11 . . . . . PCI/PnP
IRQ14 . . . . . PCI/PnP
IRQ15 . . . . . PCI/PnP

Peripheral Setup

OnBoard FDC . . . . . Auto
Drive and Port Interface . . . . . A:FDC, B:FDC
Swap Floppy Drives . . . . . No
Onboard Serial Port1 . . . . . 3F8h
Onboard Serial Port2 . . . . . 2F8h
Onboard Serial Port2 CIR . . . . . N/A
Serial Port2 Mode . . . . . Normal
Serial Port2 IR DMA Channel . . . . . N/A
Serial Port2 Duplex Mode . . . . . Full
Serial Port2 Receiver Polarity . . . . . Active High
Serial Port2 Xmitter Polarity . . . . . Active High
Serial Port2 IR Interface RX2/TX2
OnBoard ParallelPort 378h
Parallel Port Mode . . . . . Normal
EPP Version . . . . . N/A
Parallel Port IRQ 7
Parallel Port ECP DMA Channel . . . . . N/A
OnBoard IDE . . . . . Both
CompactPCI sideband INTP IRQ . . . . . Disabled
OnBoard IPMI controller . . . . . Auto
OnBoard High-Res Timer IRQ . . . . . Auto
OnBoard Ethernet #1 connector . . . . . Rear
OnBoard Ethernet #2 connector . . . . . Rear

Auto-Detect Hard Disk

N/A

Change User Password

N/A

Change Supervisor Password

N/A

Auto Configuration with Optimal Settings

N/A

Auto Configuration with Fail Safe Settings

N/A

Save Settings and Exit

Save current settings and exit (Y/N) ? Y

Exit without Saving

N/A

Ethernet Switch Board

Purpose and description

This is a 12 channel cPCI Ethernet Switch Board. It is used to interconnect the RX32 Receiver Boards and TX36 Transmitter Boards with the CPU Board.

Key features

- 12 ports of 10/100BaseTX, auto-negotiating, front panel
- Full wire speed layer 2 switching on all ports
- 1k MAC address table
- Auto address learning
- Auto address aging

Specifications

Power consumption: 1.2 A at 3.3 Vdc

Ports: 10/100 BaseTX: 12

Parallel port: 1

Port routing: RJ-45 10/100 BaseTX (at front)

Facilities

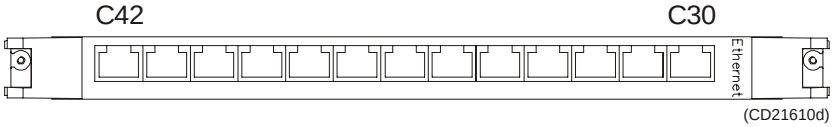
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C30 to C41 - Ethernet ports
- C42 - Parallel port



(CD21610d)

Power Supply PSU 6V

Purpose and description

This is a 6 V / 25 A power supply. It is used to supply DC power to the RX32 Receiver Boards.

Specifications

Input

Maximum operating range: 90 to 264 Vac

Nominal input voltage range: 110 to 240 Vac, 47 to 64 Hz

Inrush current: < 10 A in 10 ms

Power factor: > 90 %

Output

Output voltage: 6 Vdc ± 2 %

Switching frequency: 167.667 kHz

Output current limit: < 28 A

Minimum load: 1 A

Maximum load: 25 A continuously

Line regulation: < ± 0.2 %

Load regulation: < ± 1 %

Ripple and noise: < 60 mV (peak-to-peak)

Facilities

LEDs

Green: Power good

External connections

None.

Power Supply PSU 12V

Purpose and description

This is a 12 V / 24 A power supply. It is used to supply DC power to the TX36 Transmitter Boards. It can also deliver 72 A extra during transmit (with maximum 10 % TX duty cycle).

Specifications

Input

Maximum operating range: 90 to 264 Vac

Nominal input voltage range: 110 to 240 Vac, 47 to 64 Hz

Inrush current: < 10 A in 10 ms

Power factor: > 90 %

Output

Output voltage: 12 Vdc ± 2 %

Switching frequency: 167.667 kHz

Output current limit: < 27 A, approx. 500 ms delay

Minimum load: 1 A

Maximum load: 24 A continuously (dependent on number of TX36 boards)

Maximum load: 100 A, < 400 ms

Line regulation: < ± 0.2 %

Load regulation: < ± 1 %

Ripple and noise: < 100 mV (peak-to-peak)

Facilities

LEDs

Green: Power good

External connections

None.

Power Supply PSU 72V

Purpose and description

This is a 72 V / 5 A power supply. It is used to charge the capacitor battery located on the TX RIO boards.

Specifications

Input

Maximum operating range: 90 to 264 Vac

Nominal input voltage range: 110 to 240 Vac, 47 to 64 Hz

Inrush current: < 10 A in 10 ms

Power factor: > 90 %

Output

Output voltage: 72 Vdc ± 0.5 V

Switching frequency: 167.667 kHz

Output current limit: < 5.5 A

Maximim load: 3.5 A continuously

Maximum load: 5.0 A, < 400 ms

Line regulation: < ± 0.2 %

Load regulation: N/A

Ripple and noise: < 400 mV (peak-to-peak)

Facilities

LEDs

Green: Power good

External connections

None.

Rear Interface Board (BSP RIO)

Purpose and description

This is the rear I/O module for the master BSP. It holds control signals from the TX sub-rack (TX enable, 20 MHz, Reset, power sync), external trig interface (TX pulse output, RX ready output, trig input) and 1PPS input.

Facilities

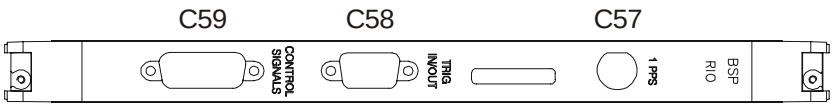
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C57 - 1PPS
- C58 - Trigger in/out
- C59 - Control signals



(CD21611d)

Rear Interface Board (Rear I/O)

Purpose and description

This is the rear I/O module for external sensors. For this purpose, it is equipped with six serial lines.

Facilities

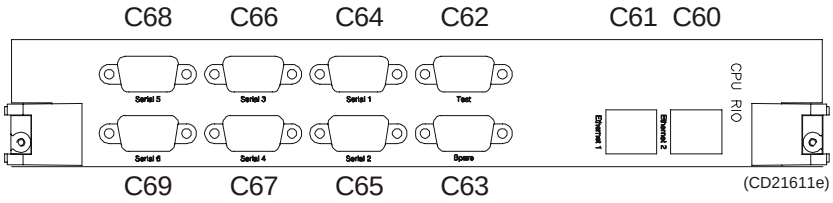
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C60 / C61 - Ethernet
- C62 - Test
- C63 - Spare
- C64 to C69 - Serial lines (RS-232)



Rear Interface Board (RX RIO)

Purpose and description

This is the rear I/O module for the RX32 Receiver Board. It holds transformers and band pass filters. It also connects the 32 receiver channels to the 78-pin connector. The signals are low level ac signals, < 5 V and < 0.1 A.

Facilities

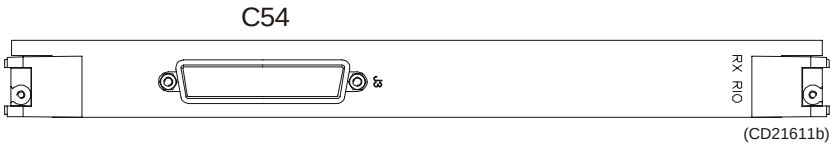
LEDs

None.

External connections

The following cable can be connected to the circuit board:

- C54 - RX transducer



(CD21611b)

Rear Interface Board (RXP RIO)

Purpose and description

This is a rear I/O module with AC input filter. It connects the 110/230 Vac input to the backplane. One AC output plug with filter is also available for the possibility to connect an extra fan module.

Facilities

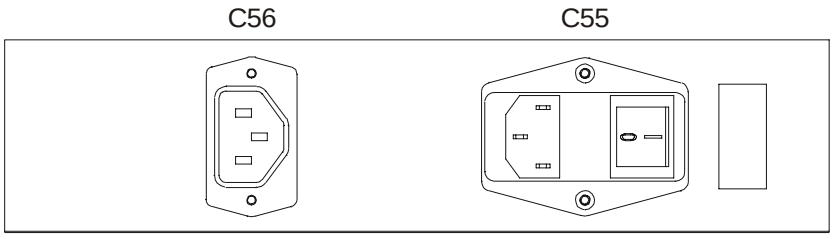
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C55 / C56 - AC power



(CD21611c)

Rear Interface Board (TX RIO)

Purpose and description

This is the rear I/O module for two TX36 Transmitter Boards. It contains a capacitor bank connected to the 72 V Power Supply. It also connects the 72 transmitter channels to two 78-pin connectors. The transmitters have common ground.

Facilities

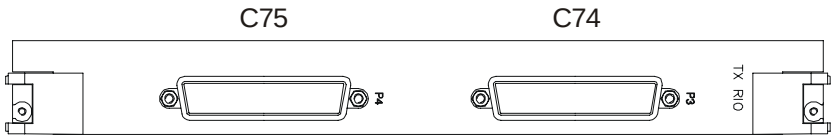
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C74 / C75 - TX transducer



(CD21611g)

Rear Interface Board (TXP RIO)

Purpose and description

This is a rear I/O module with the following features:

- AC input with filter and fuse
- Relay for remote control
- AC output for RX sub-rack
- A heater resistor (20 to 30 W)
- A bleeder resistor (47 ohm) for the 72 V Power Supply (max 175 Vdc, 3 A)
- Buffers for LVDS control signals
- 24 V stand-by power supply

Facilities

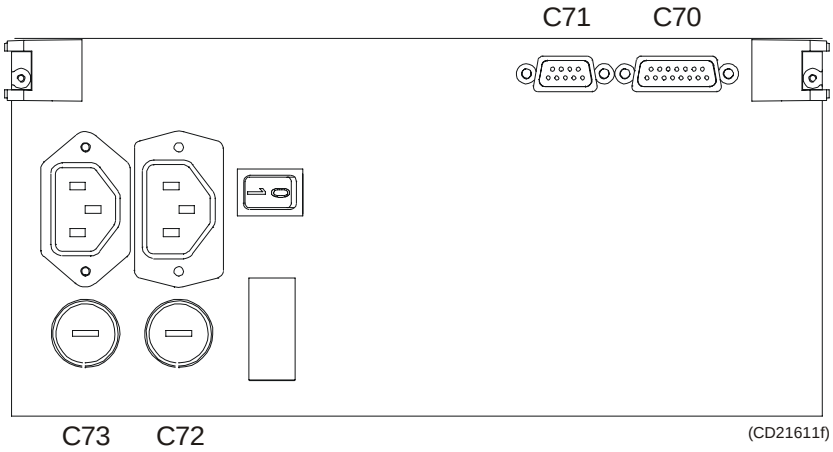
LEDs

None.

External connections

The following cables can be connected to the circuit board:

- C70 - Control signals
- C71 - Remote On/Off control and synchronization
- C72 / C73 - AC power


C71
C70
C73
C72
(CD21611f)

Receiver Board (RX32)

Purpose and description

The RX32 Receiver Board is designed for reception and processing of transducer data.

The board consists of the following main modules:

- Power supplies
- Network FPGA and surrounding components
- Receiver part, 32 identical FPA receiver channels
- Transmit/receive switches, 32 identical channels

The RX32 Receiver Board includes 32 independent FPA (Floating Point Amplifier) receivers. The operating frequency is programmable within the range 10 to 500 kHz. All command input and sample data output are communicated via a 100 Mbit/s Ethernet interface.

The receivers generate band pass filtered complex sample data at a programmable output rate. The sample values from all 32 receivers can be output via the Ethernet interface without further processing. Onboard power circuitry generates all internal voltages from a +12 Vdc and a +6 Vdc input.

The receiver is based upon the FPA ASIC (Application-Specific Integrated Circuit). The FPA ASIC is a complete one-channel frontend, including all the signal-processing from the transducer input to a digital serial interface to a signal processor. The RX data is collected by a FPGA (Field Programmable Gate Array).

A 4 bit nibble link in the backplane is used to transfer the sample values from the RX32 board to the BSP67 board(s).

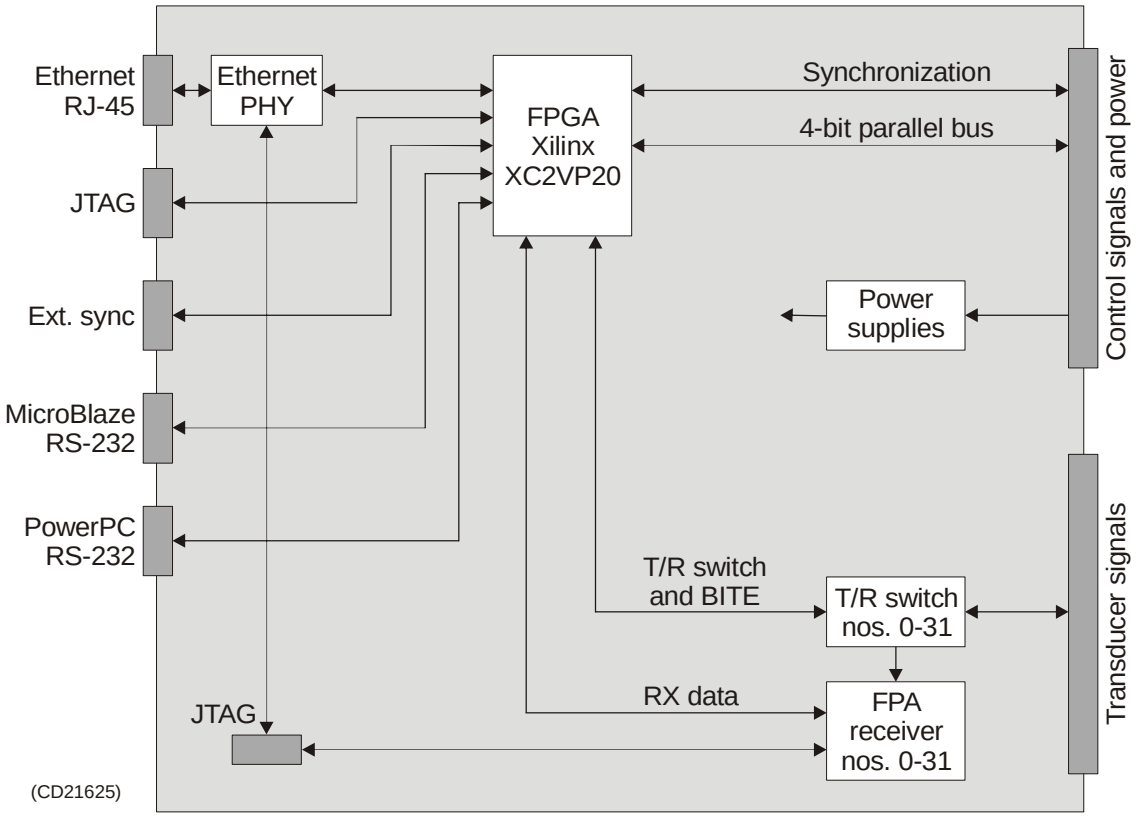


Figure 15 RX32 block diagram

Specifications

Power

Main supply voltages: +6 Vdc, +12 Vdc

Internal current consumption: 2.0 A (5 Vdc), 0.6 A (3.3 Vdc), 1.2 A (1.8 Vdc)

Tranducer interface

No. of channels: 32

Receiver input impedance: 75 or 1000 ohm, software selectable

Transducer connections: Differential

Transducer connector: 96-pin Euro connector

Interfaces

Ethernet: 10/100 Mb/s

Nibble bus: Special 4 bit interface

ID0 - 4: Active high Identification Bit 0-4 (maximum 32 board address)

CLK20MHZ: Master clock in system, 20 MHz

RESET~: Active low, synchronized to negative edge of CLK2MHZ

TXENABLE~: Active low, synchronized to negative edge of CLK2MHZ

MASTER~: Active low, enables master signal source

Receiver

Input termination: Fully differential input

Input impedance: Matched to transducer (75 ohms) or high impedance (1 kohm)

Frequency range: 10 to 500 kHz

Lowpass filter: LP filter (anti-aliasing) 62.5, 125, 250 and 500 kHz

Gain: 0 to 90 dB in 6 dB steps

Noise figure (impedance match): 5 dB

Noise figure (high impedance): 2 dB

AGS: Automatic Gain Selection for each channel - selection of optimum gain setting to make best use of A/D input range

Sampling: Simultaneous sampling of all channels, 2 MHz

A/D: 12 bit resolution

Dynamic range: > 140 dB

Signal processing : Digital demodulation, filtering and decimation (ratio 7 to 256)

Facilities

LEDs

Ethernet: Four LEDs display Ethernet operating mode and activity

- LINK: The connection to the external device is OK (green)
- SPEED: The detected bit rate is 100 Mbit/s (yellow)
- ACTIVITY: Flashing light indicates transmit and receive activity (green)
- DUPLEX: The interface operates in full duplex mode (yellow)

I/O: Eight yellow LEDs display processor activity and error conditions.

- IO 0: The PowerPC embedded program broadcasts a BOOTP/DHCP (Boot Strap Protocol / Dynamic Host Configuration Protocol) request via the Ethernet interface.

- IO 1: A BOOTP/DHCP reply message has been received from an external boot server.
- IO 2: The PowerPC sends a TFTP (Trivial File Transfer Protocol) request to the boot server asking for its application program.
- IO 3: The PowerPC embedded program is up and running. The PowerPC embedded program is included in the FPGA firmware as initialized block RAM.
- IO 4: This LED flashes when the receivers are running and generating sample data. The flash speed is proportional to the receiver decimation clock.
- IO 5: This LED is reserved for product maintenance tasks.
- IO 6: This LED flashes every time TXENABLE goes active.
- IO 7: The MicroBlaze embedded program is up and running. The MicroBlaze embedded program is included in the FPGA firmware as initialized block RAM.

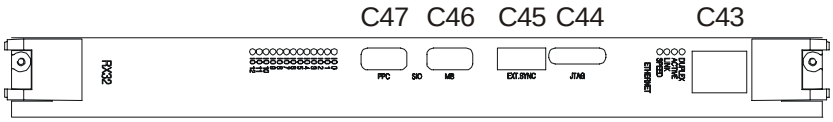
Power: Five green LEDs indicate that the internal supply voltages are OK.

- +5 V
- +2.5 V
- +3.3 V
- +6 V
- +12 V

External connections

The following cables can be connected to the circuit board:

- C43 - Ethernet
- C44 - JTAG
- C45 - External synchronization (EXT SYNC)
- C46 - MicroBlaze (MB)
- C47 - PowerPC (PPC)



(CD21610e)

Transmitter Board (TX36)

Purpose and description

The TX36 Transmitter Board is designed for processing and transmission of transducer data.

The board consists of the following main modules:

- Power supplies
- Network FPGA
- TX FPGA
- Transmitter part, 36 identical PWM transmitter channels

The TX36 Transmitter Board includes 36 independent PWM (Pulse Width Modulation) transmitters. The operating frequency is programmable within the range 10 to 500 kHz. All command input and sample data output are communicated via a 100 Mbit/s Ethernet interface.

The board includes software for synthesizing the transmit signal at runtime. A variety of different beam shapes and time signals can be generated by entering a few high level input parameters. Onboard power circuitry generates all internal voltages from a +12 Vdc input. A separate high voltage input is provided for feeding the output stage of the transmitters.

The transmitters are based on a PWM (Pulse Width Modulation) technique, with a switching frequency of 2 MHz. This makes it possible to generate arbitrary signals in the whole frequency band 10 to 500 kHz. Traditional CW pulses at any frequency or amplitude can be generated, as well as more complex waveforms, and several simultaneous signals. These signals are specified by the user and generated in the TX FPGA.

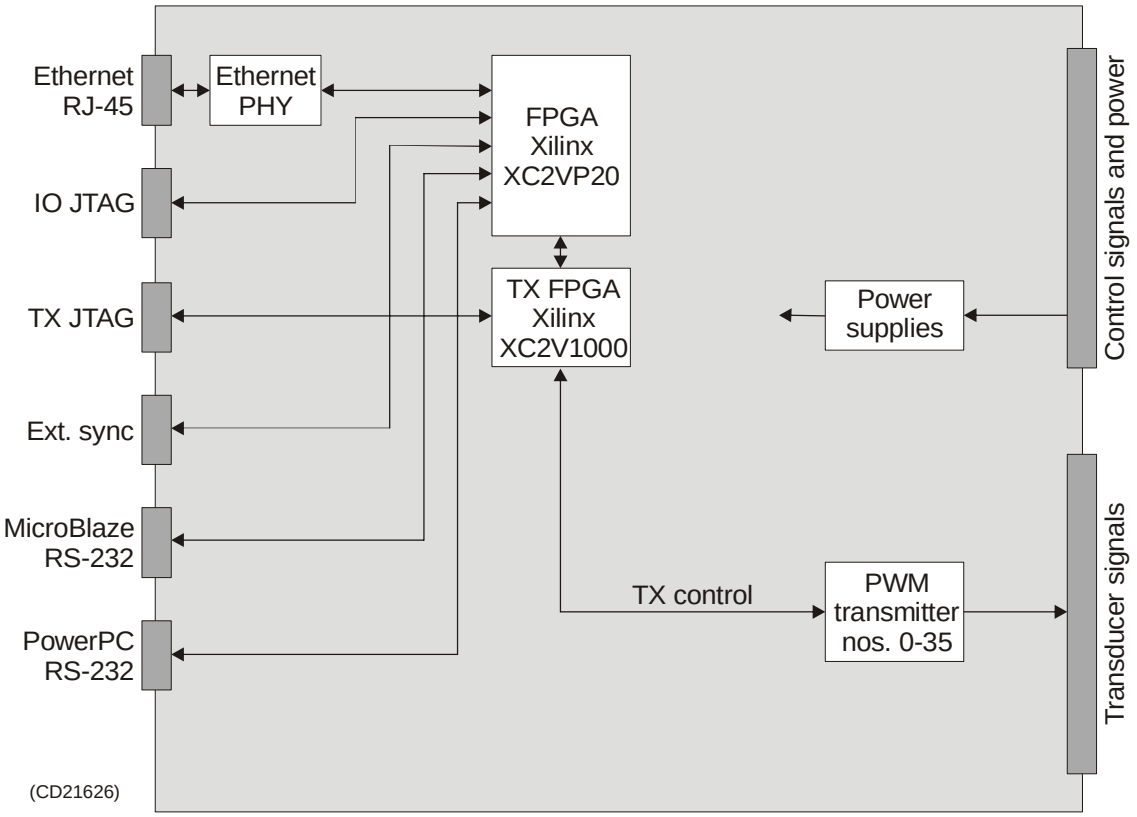


Figure 16 TX36 block diagram

Specifications

Power

Main supply voltages:· +12 Vdc (used for the TX driver circuits), + 72 Vdc (high voltage supply for the transmitter output stage)

Maximum mean current consumption: 1 A (typically)

Internal current consumption: 2.0 A (5 Vdc), 0.6 A (3.3 Vdc), 1.2 A (1.8 Vdc)

Tranducer interface

No. of channels: 36

Transducer impedance: 75 ohm

Transducer connections: Single-ended

Transducer connector: 96-pin Euro connector

Interfaces

Ethernet: 10/100 Mb/s

ID0 - 4: Active high Identification Bit 0-4 (maximum 32 board address)

CLK20MHZ: Master clock in system, 20 MHz

RESET~: Active low, synchronized to negative edge of CLK20MHZ

TXENABLE~: Active low, synchronized to negative edge of CLK20MHZ

MASTER~: Active low, enables master signal source

Transmitter

Output signal frequency range: 10 to 500 kHz

PWM switching frequency: 20 MHz

Output signal waveform: Arbitrary waveform, described by “Nyquist samples”

Max. output power: 40 to 50 W (output power is reduced at low frequencies). Less than 10 W is used by the EM 710.

Output signal reduction: -1.1 dB at 10 kHz, -0.8 dB at 12 kHz, -0.3 dB at 20 kHz and 0 dB at 100 kHz

Max. pulse length: 400 ms

Max. duty cycle: 10 % (frequency dependant)

High voltage supply: 0 to 175 Vdc. 72 Vdc is used by the EM 710.

Facilities

LEDs

Ethernet: Four LEDs display Ethernet operating mode and activity

- LINK: The connection to the external device is OK (green)
- SPEED: The detected bit rate is 100 Mbit/s (yellow)
- ACTIVITY: Flashing light indicates transmit and receive activity (green)
- DUPLEX: The interface operates in full duplex mode (yellow)

TX: Eight yellow LEDs display transmission activity.

I/O: Eight yellow LEDs display processor activity and error conditions.

- IO 0: The PowerPC embedded program broadcasts a BOOTP/DHCP (Boot Strap Protocol / Dynamic Host Configuration Protocol) request via the Ethernet interface.
- IO 1: A BOOTP/DHCP reply message has been received from an external boot server.

- IO 2: The PowerPC sends a TFTP (Trivial File Transfer Protocol) request to the boot server asking for its application program.
- IO 3: The PowerPC embedded program is up and running. The PowerPC embedded program is included in the FPGA firmware as initialized block RAM.
- IO 4: This LED flashes when the receivers are running and generating sample data. The flash speed is proportional to the receiver decimation clock.
- IO 5: This LED is reserved for product maintenance tasks.
- IO 6: This LED flashes every time TXENABLE goes active.
- IO 7: The MicroBlaze embedded program is up and running. The MicroBlaze embedded program is included in the FPGA firmware as initialized block RAM.

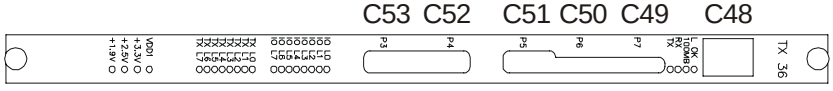
Power: Five green LEDs indicate that the internal supply voltages are OK.

- +5 V
- +2.5 V
- +3.3 V
- +6 V
- +12 V

External connections

The following cables can be connected to the circuit board:

- C48 - Ethernet
- C49 - IO JTAG
- C50 - TX JTAG
- C51 - External synchronization
- C52 - MicroBlaze (MB)
- C53 - PowerPC (PPC)



(CD21610f)

6 TROUBLESHOOTING

6.1 Messages

Introduction

The EM 710 provides numerous messages to inform you of major and minor hardware and software errors.

The messages, if they occur, will be displayed in SIS' **Message service** window and/or in the Status bar.

The different utilities operating on the EM 710 Operator Station each issue several messages. These messages can be sorted in three categories:

- Information
- Warnings
- Errors

The messages presented as **warnings** merely point out small inaccuracies, and must be regarded as guidelines to the normal operation of the system.

The operational **errors** reflect major and minor hardware and software errors, some of which must be acted upon to ensure the normal operational capability.

→ *Refer to the* Seafloor Information System (SIS) Operator manual *for further information.*

6.2 BIST tests

BSP

This test checks all Beamformer and Signal Processing circuit boards in the EM 710 Transceiver Unit.

TX36

This test checks all TX36 transmitter circuit boards in the EM 710 Transceiver Unit (voltage, current and temperature).

RX32

This test checks all RX32 receiver circuit boards in the EM 710 Transceiver Unit (voltage, current and temperature).

TRU Power

This test checks the 6 V, 12 V and 72 V power supplies in the EM 710 Transceiver Unit. All the output levels are tested.

RX 32 / BSP link

This test checks the nibble bus interface between the RX 32 receiver circuit boards and and the BSP circuit boards.

RX channels

This test checks all RX channels (including the transducers). The BIST resport lists phase and amplitude response of all RX channels, and also the impedance of the transducers.

TX channels

This test checks all TX channels (including the transducers). The BIST report lists channels outside the limits.

RX noise level (broadband)

This test measures the average isotropic spectral noise level for each receiver channel (in dB rel 1 μPa/Hz). Wide RX bandwidth (70 to 100 kHz) is used.

RX noise spectrum

This test measures the average isotropic spectral noise level for each board (in dB rel 1 μPa/Hz). It is displayed with 700 Hz steps from 70 to 100 kHz.

TRU software date / version

This test presents the software date and versions for the CPU, BSP, RX32 and TX36 circuit boards.

7 REPLACEMENT PROCEDURES

7.1 Introduction

Overview

This chapter presents the basic procedures for disassembly and reassembly of the replaceable parts in the EM 710 system.

Safety precautions

The system operates on 115 and/or 230 Vac, 50/60 Hz.

Warning ***This voltage can be lethal.***

System power must be switched off before any replacement is carried out. Failure to do so may lead to personal injury, and/or serious damage to the system.

→ *General safety rules (in detail), page 7.*

ESD precautions

The replacement procedures presented in this chapter allows you to replace circuit boards. These are delicate devices, and special attention must be made to the handling of these.

The following precautions are therefore very important:

- The working area must be covered by an approved conductive service mat that has a resistance of between 50 kΩ and 2 MΩ, and is connected directly to a reliable ground point via its grounding cord.
- The maintenance technician or engineer must use a grounding bracelet, firmly connected to an ESD grounding point.
  - The bracket in the upper left corner of the EMU serves as ESD grounding point when working in front of the cabinet.
  - The two profile beams mounted on each side wall of the cabinet serves as ESD grounding points when working at the back of the cabinet.
- All circuit boards must be stored in anti-static bags while not in use.

A standard tool set is required to perform the removal and replacement of the modules. This tool set should contain the following tools:

- Cabinet key
- Standard screwdrivers in different widths and lengths
- Standard cross-slot screwdrivers in different widths and lengths
- Allen keys in metric sizes
- Philips screwdrivers in different sizes
- Pozidrive screwdrivers in different sizes
- Flat nosed pliers
- Lap jointed pliers
- Wire cutters
- Soldering iron
- Open ended and ring spanners in metric sizes
- Adjustable spanners
- Socket set
- Solder
- Wire straps in different sizes

7.2 Procedures for Transceiver Unit

Overview

The Line Replaceable Units (LRUs) in the EM 710 Transceiver Unit are:

- Receiver rack:
  - cPCI Power Supply
  - CPU Board
  - BSP 67 Boards
  - Ethernet Switch Boards
  - Power Supply PSU 6V
  - RX32 Receiver Boards
  - RX RIO Rear Interface Boards
  - BSP RIO Rear Interface Board
  - Rear I/O Interface Board
- Transmitter rack:
  - TX36 Transmitter Boards
  - Power Supply PSU 72V
  - Power Supply PSU 12V
  - TXP RIO Rear Interface Board
  - TX RIO Rear Interface Boards
- Other devices:
  - Fuses
  - Fan drawers

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

Circuit boards

Introduction

The Transceiver Unit holds two wired racks. Both wired racks hold plug-in circuit boards.

All units are accessed either from the front or the rear of the wired rack. Access is gained to the wired racks by opening the front protective cover of the Transceiver Unit. Use the special key supplied to open it. Also open the Transceiver Unit's rear door using the four handles and two bolts.

→ *Location of circuit boards in the Receiver rack, page 41.*

→ *Location of circuit boards in the Transmitter rack, page 44.*

Warning ***The system must be switched off prior to disassembly.***

Disassembly procedure

1 Gain access to the wired rack.

2 Remove the front mounted cables from the applicable circuit boards.

3 Remove the upper and lower screw fastening the circuit board to the rack.

4 Release the circuit board using the hot swap ejectors.

5 Pull the board carefully out.

Reassembly procedure

1 Reverse the above procedure. Make sure that the unit connects properly to the backplane.

Fuses

Introduction

The Transceiver Unit holds several power supplies. The following are equipped with primary fuses:

- Power Supply PSU 6V
- Power Supply PSU 72V
- Power Supply PSU 12V

Disassembly procedure

The fuses on these power supplies are front mounted. No disassembly is required.

Reassembly procedure

Replace with the same type of fuse.

Fan drawers

Introduction

There are several fan drawers in the Transceiver Unit. Two fan drawers are located underneath the Receiver rack and one underneath the Transmitter rack.

Access is gained to the wired racks by opening the front protective cover of the Transceiver Unit.

Warning ***The system must be switched off prior to disassembly.***

Disassembly procedure

Each fan drawer is fastened to the wired rack by two thumb-screws.

1 Gain access to the wired rack.

2 Twist the right thumb-screw on the fan drawer anti-clockwise a few turns, then left thumb-screw clockwise a few turns.

3 Pull the fan drawer carefully out.

Reassembly procedure

1 Reverse the above procedure. Make sure that the unit connects properly to the rear socket.

8 EM DATAGRAM FORMATS

8.1 Introduction

Note — *The information herein is common for the EM 3002, EM 3000, EM 2000, EM 1002, EM 710, EM 300 and EM 120 multibeam echo sounders. Some of the information may not be relevant for your specific system. Please disregard this.*

Note — *The information in this document is not valid for the EM 12, EM 100, EM 950 and EM 1000 multibeam echo sounders.*

The formats for data input and output to and from the EM Series multibeam echo sounders are described here. The information given here is valid for the Kongsberg Maritime multibeam echo sounders introduced after 1995.

Note — *In order to meet special customer requirements, Kongsberg Maritime may have to change the datagram formats described here. The formats presented in this document may therefore be altered without prior notice, although backward compatibility will be maintained as far as possible. Before software is written in accordance with this document, it is strongly recommended to contact Kongsberg Maritime to ensure that the latest version is used, and that any planned changes are taken into account.*

8.2 Presentation format

The format description is according to the NMEA 0183 standard for ASCII fields, with the ASCII character(s) given as follows:

- “x.x” defines a variable length numerical field, with optionally included decimal point and sign.
- “c--c” defines a variable length field of printable characters.
- “x--x” defines a variable length field of numeric characters.
- “a_ _” defines a fixed length field of alphabetical characters (for example “aa”= two character long field.
- “x_ _” defines a fixed length field of numeric characters.

For binary fields, the length is given in number of bytes plus “U” for unsigned and “S” for signed data.

8.3 Input datagrams

Introduction

Only a limited number of input formats from external sensors are accepted. These are primarily in accordance with the NMEA 0183 specification, or based upon the principles of that specification.

Note

The majority of these formats have not been defined by Kongsberg Maritime. Thus, these formats are not controlled by Kongsberg Maritime.

Almost all input formats are ASCII. Serial line input on the multibeam echo sounder's Processing Unit is most common, but some datagrams - which are not time critical - are interfaced on serial line(s) or Ethernet to the Operator Station.

Position

Overview

The EM Series accepts position data in the following formats:

- NMEA 0183 GGA
- GGK
- SIMRAD 90
- With the GGA and GGK datagrams, information contained in NMEA 0183 VGST and VTG datagrams will also be accepted and used.
- A datagram format for Sonar Head depth is provided for the EM 3002, EM 3000 and the EM 2000. Note that the format is the same as that used by the Paroscientific Digiquartz pressure sensor. This format may also be used for input of for example varying datum heights or other special height information on all models.
- A datagram format for input of tidal height is provided.

The **GGA format** is given below according to the NMEA 0183 version 2.30 description.

The **GGK format** was originally defined by the US Army Corps of Engineers for their tests with kinematic GPS. Trimble's proprietary version of the format is supported. If any changes to the format are made if it becomes part of the NMEA standard, this will be implemented.

To preserve the inherent accuracy of the kinematic GPS data it is necessary to correct the data for vessel motion. This requires accurate timing synchronisation between the motion sensor and the GPS receiver. It is therefore imperative that:

- the position datagram has a constant and known time delay,

or

- the time stamp in the datagram is actually the time of the position fix, that synchronisation to the 1PPS signal of the GPS receiver is enabled, and that the system clock has been set correctly.

As neither of these conditions may not be possible to achieve with a sufficient accuracy, the application of motion correction is operator selectable. Motion compensation may be applied to any position input, not only kinematic GPS.

In addition to position data from the GGA or GGK datagrams, speed and course over ground from **NMEA VTG** datagrams may also be copied into the position output datagram. These values may be useful in filtering of the positioning during postprocessing. If a VTG datagram does not follow the GGA or GGK datagram the course and speed fields of the output datagrams will be set to their invalid values.

As an alternative to GGA, the **SIMRAD 90 format** position datagram may be used. The SIMRAD 90 format is intended to be the format of choice when the positioning system is not a stand-alone GPS receiver supplying GGA or GGK format datagrams. The SIMRAD 90 format can in addition to global longitude latitude coordinates also be used for Northing Easting type projection coordinates (e.g. UTM).

To cater for applications where the EM 2000 or EM 3000 Sonar Head is mounted on a subsea vehicle, the original SIMRAD 90 format has been expanded to allow inclusion of the depth of the vehicle in addition to its horizontal position in longitude latitude or Northing Easting coordinates.

GGA Datagram

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always GGA,	–	–
UTC of position	hhmmss.ss,	000000 to 235959.9...	–
Latitude in degrees and minutes, plus optional decimal minutes	llll.ll,	0000 to 9000.0...	–
Latitude – N/S	a,	N or S	–
Longitude in degrees and minutes, plus optional decimal minutes	yyyyy.yy,	00000 to 18000.0...	–
Longitude – E/W	a,	E or W	–
GPS quality indicator	x,	0 to 8	1
Number of satellites in use	xx,	00 to 12	–
HDOP	x.x,	0 to	1
Antenna altitude re mean sea level (geoid)	x.x,	–	2
Units of antenna altitude	M,	–	–
Geoidal separation (sea level re WGS–84)	x.x,	–	2
Units of geoidal separation	M,	–	–
Age of differential GPS data	x.x,	–	–
Differential reference station id	xxxx,	0000 to 1023	–
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

The HDOP (Horizontal Dilution Of Precision) value will be scaled and copied to the ”Measure of position fix quality” field in the position output datagram. The scale factor depends upon the GPS quality indicator’s value:

- 1 - (SPS or standard GPS) => 1000
- 2 - (differential GPS) => 100
- 3 - (PPS or precise GPS) => 200, but 10 if GGA is treated as RTK. (See Note 2)
- 4 - (kinematic GPS with fixed integers) => 10
- 5 - (kinematic GPS with floating integers) => 50
- 6 - (estimated or dead reckoning mode) => 1000
- 7 - (manual input mode) => 1000
- 8 - (test mode) => 1000, but 10 if GGA is treated as RTK. (See Note 2)
- The ”Measure of position fix quality” field will be set to 65534 (largest valid number) if the indicator is zero (non-valid position).

This scaling is used to give at least a relatively correct position fix quality change (in the order of cm) if there are dropouts in differential, precise or kinematic measurements, although HDOP is not a meter value.

Note 2

When the quality factor is 4 or 5 a height output datagram is automatically generated, and also if the quality factor is 3 or 8 and the operator has set the GGA position to be an RTK position. The height is the sum of these two fields which are assumed positive upwards (antenna above geoid).

GGK Datagram

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always GGK,	–	–
UTC time of position	hhmmss.ss,	000000 to 235959.99...	–
UTC date of position	MMDDYY,	010100 to 123199	–
Latitude in degrees and minutes, plus optional decimal minutes	llll.llllll,	0000 to 9000.0...	–
Latitude – N/S	a,	N or S	–
Longitude in degrees and minutes, plus optional decimal minutes	yyyyy.yyyyyy,	00000 to 18000.0...	–
Longitude – E/W	a,	E or W	–
GPS quality indicator	x,	0 to 3	1
Number of satellites in use	xx,	00 to 12	–
DOP	x.x,	0 –	1
Antenna ellipsoidal height	x.x,	–	–
Units of antenna ellipsoidal height	M,	–	–
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

The DOP (Dilution Of Precision) value will be scaled and copied to the ”Measure of position fix quality” field in the position output datagram. The scale factor depends upon the GPS quality indicator’s value:

- 1 (SPS or standard GPS) => 1000
- 2 (differential GPS) => 100
- 3 (kinematic GPS) => 10

The ”Measure of position fix quality” field will be set to 65534 (largest valid number) if the indicator is zero (non-valid position).

This scaling is used to give at least a relatively correct position fix quality change (in cm) if there are dropouts in differential, precise or kinematic measurements, although DOP is not a meter value.

VTG Datagram

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always VTG,	–	–
Course over ground, degrees true	x.x,T,	0 to 359.9...	1
Course over ground, degrees magnetic	x.x,M,	0 to 359.9..	1
Speed over ground, knots	x.x,N,	0 –	1
Speed over ground, km/h	x.x,K,	0 –	1
Mode indicator	a	A,D,E,M,S or N	–
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

Only true course and the first valid speed field will be used.

Transponder position Datagram

SSB - SSBL Position:

Data Description	Format	Valid range	Note
Start_character	$		
Address	PSIMSSB		
Time	,hhmmss.ss		2
TP code	,B01		3
Status	,A		4
Error code	,cc_		1
Coordinate system (always radians)	,R		
Orientation (always north oriented)	,N		
SW filter	,		1
X coordinate (Latitiude)	,x.x		
Y coordinate (Longitude)	,x.x		
Depth (Sonar depth in m)	,x.x		
Expected accuracy (Pos. quality in m)	,x.x		
Additional info	,		1
First add value	,		1
Second add value	,		1
Checksum	*hh		
Termination	CRLF		

Note 1

Not used by multibeam echo sounders.

Note 2

Decoded and used if Clock Synchronisation is set from position datagram.

Note 3

Only this transponder type is accepted by the multibeam.

Note 4

A = OK, V will give bad positions, but datagram will be accepted for logging.

Simrad 90 Datagram

Data Description	Format	Length	Valid range	Note
Start identifier = $	Always 24h	1	–	–
Talker identifier	aa	2	Capital letters	–
Sentence formatter	Always S90,	4	–	–
Date of position	DDMMYY,	7	010100 to 311299	–
UTC of position as hour, minute, second, hundredth of second	hhmmssss,	9	00000000 to 23595999	–
Latitude in degrees, minutes and decimal minutes	xxxx.xxxx	9	0000.0000 to 9999.9999	A
Hemisphere identifier	a,	2	N or S	A
Longitude in degrees, minutes and decimal minutes, or depth in meters	xxxxx.xxxx	10	00000.0000 to 18000.0000	A
Hemisphere or depth identifier	a,	2	E, W or D	A
Northing or range in meters	xxxxxxxxx.x,	12	000000000.0 to 999999999.9	B
Easting or depth in meters	xxxxxxx.x,	10	0000000.0 to 9999999.9	B
UTM zone number	xx,	3	01 to 60	–
User defined central meridian longitude or bearing	xxxxx.xxxx	10	00000.0000 to 35999.9999	C
Hemisphere or bearing identifier	a,	2	E, W, or B	C
System descriptor	x,	2	0 to 7	1
Position fix quality indicator	x,	2	0 to 9 and A to F	2
Speed over ground in m/s	xx.x,	5	00.0 to 99.9	3
Course over ground in degrees	xxx.x	5	000.0 to 359.9	3
End of sentence delimiter = ,CRLF	Always 2Ch 0Dh 0Ah	3	–	–

Note 1

Value of system descriptor defines content of datagram as follows. (Note that the Kongsberg Maritime EM 12, the EM 950 and the EM 1000 multibeam echo sounders will only accept values less than 3):

- **0 -** The position is longitude latitude in global coordinates given in the fields noted A.

- **1 -** The position is Northing Easting on the Northern hemisphere given in the fields noted B. If the projection is defined to be UTM the UTM zone number or a user definable central meridian longitude may be given in the field noted C.
- **2 -** As for system descriptor equal to 1, but the position is on the Southern Hemisphere.
- **3 -** As for system descriptor equal to 0, but in addition the depth is given in the Easting field noted B.
- **4 -** As for system descriptor equal to 1, but in addition the depth is given in the longitude field noted A.
- **5 -** As for system descriptor equal to 2, but in addition the depth is given in the longitude field noted A.

Note 2

The position fix quality given in the position output datagram will be derived from the quality indicator (this differs from the original definition of the format) as follows (in m):

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
0.01	0.02	0.05	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000

Note 3

If these fields have valid values they will be copied to equivalent fields in the position output datagram. They may be used in filtering of the positioning during postprocessing. (The original definition of the format had line heading in the course field and its use was to orient real-time displays).

Tide input

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	a	Capital letter	–
Sentence formatter	Always TIDE,	–	–
Date and time of prediction / measurement	YYYYMMDDhhmm,	199601010000 to 999912312359	–
Tide offset in meters and decimal meters	x.x	±327.66	1
Optional checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

A negative number will be assumed to indicate an increase in sea level.

Depth pressure or height input

Data Description	Format	Valid range	Note
Start identifier = *	Always 2Ah	–	–
Sentence identifier	ii	00 to 09	1
Talker identifier	ii	00 to 99	–
Depth or height in meters and decimal meters	x.x	–	2
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

A sentence identifier equal to 00 is used for underwater vehicle depth, all other identifiers are customer specific (usually a datum height).

Note 2

If input is depth, it will be used in the depth output datagram to offset the transmit transducer depth. If input is height, which will usually imply a time or position variable datum height, its use will depend on the sentence identifier and will be implemented as required by a specific customer. Depth is positive downwards. Depths may be scaled and offset by operator settable constants:

output_depth [m] = scale_factor * (input_depth - offset)

Attitude data

Overview

Attitude data is generally accepted on one or more serial input port(s) as:

- roll, pitch, heave and heading on one port,

or

- roll, pitch and heave on one port and heading separately on another port.

The data update rate should be commensurate with the expected dynamics of the vessel (typically up to 100 Hz).

The acceptable format for roll, pitch, heave and optionally also heading is a 10 byte long message originally defined in the EM 1000 for use with digital motion sensors. It is supported by the following sensors:

- Applied Analytics POS/MV
- Photokinetics Octans
- Seatex MRU
- Seatex Seapath
- TSS DMS-05

Heading will be accepted in the NMEA 0183 HDT format or in the format used by the Simrad Robertson SKR80(82) gyrocompass. A current loop to RS-232 converter may then be required. The Lemkuhl LR40(60) Scan Repeater format is also accepted, as it is the same as that of the SKR80 with the exception of an extra status byte. Note that if the attitude sensor is capable of reading the gyrocompass and transfer the heading to the attitude sensor datagram (if it does not measure heading itself), this is preferable to interfacing the gyrocompass directly to the system.

Attitude data may be supplied from more than one sensor. All data may be logged, but only one set as chosen by the operator will be used in real time.

EM Attitude input format

The EM attitude format is a 10-bytes long message defined as follows:

- Byte 1: Sync byte 1 = 00h, or Sensor status = 90h-AFh
- Byte 2: Sync byte 2 = 90h
- Byte 3: Roll LSB

- Byte 4: Roll MSB
- Byte 5: Pitch LSB
- Byte 6: Pitch MSB
- Byte 7: Heave LSB
- Byte 8: Heave MSB
- Byte 9: Heading LSB
- Byte 10: Heading MSB

where **LSB** = least significant byte, **MSB** = most significant byte.

All data are in 2's complement binary, with 0.01° resolution for roll, pitch and heading, and 1 cm resolution for heave.

- Roll is positive with port side up with ±179.99° valid range
- Pitch is positive with bow up with ±179.99° valid range
- Heave is positive up with ±9.99 m valid range
- Heading is positive clockwise with 0to 359.99° valid range.

Non-valid data are assumed when a value is outside the valid range.

How roll is assumed to be measured is operator selectable, either with respect to the horizontal plane (the Hippy 120 or TSS convention) or to the plane tilted by the given pitch angle (i.e. as a rotation angle around the pitch tilted forward pointing x-axis). The latter convention (called Tate-Bryant in the POS/MV documentation) is used inside the system in all data displays and in logged data (a transformation is applied if the roll is given with respect to the horizontal).

Note that heave is displayed and logged as positive downwards (the sign is changed) including roll and pitch induced lever arm translation to the system's transmit transducer.

This format has previously been used with the EM 950 and the EM 1000 with the first synchronisation byte always assumed to be zero. The sensor manufacturers have been requested to include sensor status in the format using the first synchronisation byte for this purpose. It is thus assumed that:

- 90h in the first byte indicates a valid measurements with full accuracy
- any value from **91h to 99h** indicates valid data with reduced accuracy (decreasing accuracy with increasing number)

- any value from **9Ah to 9Fh** indicates non-valid data but normal operation (for example configuration or calibration mode)
- and any value from **A0h to AFh** indicates a sensor error status

HDT format

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always HDT,	–	–
Heading, degrees true	x.x,T	0 to 359.9...	–
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

SKR80 format

The SKR80 sends out a stream of data with four bytes for each measurement. There is one byte for each digit:

- The first byte for the decimal degree (Example: xxx.X)
- The second for the degree (Example: xxX.x)
- The third for the 10’s degree (Example: xXx.x)
- The fourth for the 100’s degree (Example: Xxx.x)

The two uppermost bits of a byte are always zero, the next two bits give the digit, 00 for the decimal, 01 for the degree, 10 for the 10’s degree, and 11 for the 100’s degree. The lowest four bits give the digit value in 4-bit BCD format. As an example a heading of 234.5° will give the four bytes 05h 14h 23h 32h. The LR40 adds a fifth byte at the end for status with the two upper bits of the status byte set to 11 (11000000 for OK, 11001010 for alarm). This status byte is ignored.

Clock

The system clock is used to time stamp all data output. The clock may be set upon start of new survey or power-up on the Processing Unit (recommended source is a NMEA ZDA format datagram). The clock will drift, typically some seconds per day, unless it is synchronised to a 1 PPS (pulse per second) input signal (the clock millisecond counter will be set to zero whenever a pulse is received). A fully correct clock is only necessary if the output data are later to be combined with other time critical data logged or created by other systems, for example an accuracy of up to one minute would be necessary to apply tidal changes. If the timestamp supplied in the position input datagrams is to be used, it is imperative that the system clock is correctly set and that 1 PPS synchronisation is used.

ZDA format

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always ZDA,	–	–
UTC	hhmmss.ss,	000000 to 235959.9...	–
Day	xx,	01 to +31	–
Month	xx,	01 to +12	–
Year	xxxx,	0000 to 9999	–
Local zone hours	xx,	–13 to +13	1
Local zone minutes	xx	00 to +59	1
Optional checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

Local zone time is not used. An offset time may be entered by the operator to get the system clock to show a different time than UTC.

Note 2

Trimble UTC format is also supported.

Sound Speed

Overview

A sound speed profile may be loaded into the Operator Station either on a serial line or on Ethernet. Formats previously used with existing Kongsberg Maritime echo sounders (Kongsberg Maritime ASCII and Binary Sound Velocity Profile input datagrams) will be accepted, but since their resolution in depth is limited to 1 m and the number of entries to 100, a new format given below without these limitations is recommended. This format is also accepted by the Kongsberg Maritime HIPAP and HPR underwater positioning systems (but not necessarily vice-versa). Note that a complete profile may be pieced together from several datagrams and edited with the Operator Station's Sound Speed Editor.

The new format is completely in ASCII and allows 9998 entries without limitations in resolution. In addition to depth and sound speed, it allows input of absorption coefficient, pressure, temperature and salinity or conductivity. The latter parameters may be used to calculate depth, sound speed and absorption coefficient. Use of a depth dependent absorption coefficient allows a more accurate determination of bottom backscatter strength.

Note that this datagram may also be logged as output, retaining information not included in the standard sound speed profile output datagram, such as where and when the profile has been taken.

Kongsberg Maritime SSP format

Data Description	Format	Length	Valid range	Note
Start identifier = $	Always 24h	1	–	–
Talker identifier	aa	2	Capital letters	–
Datagram identifier	Always Sxx,	4	S00to S53	1,2
Data set identifier	xxxxx,	6	00000 to 65535	–
Number of measurements = N	xxxx,	5	0001 to 9999	–
UTC time of data acquisition	hhmmss,	7	000000 to 235959	3
Day of data acquisition	xx,	3	00 to 31	3
Month of data acquisition	xx,	3	00 to 12	3
Year of data acquisition	xxxx,	5	0000 to 9999	3
N entries of the next 5 fields – See note 4				
– Depth in m from water level or Pressure in MPa	x.x,	2 –	0 to 12000.00 0 to 1.0000	4
– Sound velocity in m/s	x.x,	1 –	1400 to 1700.00	–
– Temperature in °C	x.x,	1 –	–5 to 45.00	–

Data Description	Format	Length	Valid range	Note
– Salinity in parts per thousand or Conductivity in S/m	x.x,	1 –	0 to 45.00 0 to 7.000	–
Absorption coefficient in dB/km	x.x	0 –	0 to 200.00	5
Data set delimiter	CRLF	2	0Dh 0Ah	–
End of repeat cycle				
Latitude in degrees and minutes, plus optional decimal minutes	llll.ll,	Variable 5–	0000 to 9000.0...	6
Latitude – N/S	a,	2	N or S	6
Longitude in degrees and minutes, plus optional decimal minutes	yyyyy.yy,	Variable 6–	00000 to 18000.0...	6
Longitude – E/W	a,	2	E or W	6
Atmospheric pressure in MPa	x.x,	1 –	0 to 1.0000	6
Frequency in Hz	xxxxxx,	Variable	–	7
User given comments	c––c	Variable	–	6
Optional checksum	*hh	–	–	8
End of datagram delimiter = \CRLF	5Ch 0Dh 0Ah	3	–	–

Note 1

The datagram identifier identifies what type of data is included. This is shown in the following table where D is depth, P is pressure, S is salinity, C is conductivity, c is sound speed, α is absorption coefficients, and L is latitude. The notation c(T,S) indicates for example that the sound speed is to be calculated from the temperature and salinity input data. When pressure is used, the atmospheric pressure must be given if the pressure is absolute, otherwise the pressure must be given re the sea level and the atmospheric pressure must be zero.

→ *Refer to page 138 for EM 710 specific information.*

Identifier	Input data	Data to be used	Comment
S00	D,c	D,c	
S10	D,c	D,c	
S11	D,c,a	D,c,a	
S12	D,c,T,S	D,c,a(D,T,S,L)	
S13	D,c,a,f	D,c,a	Frequency dependent
S20	D,T,S	D,c(D,T,S,L)	
S21	D,T,S,a	D,c(D,T,S,L),a	
S22	D,T,S	D,c(D,T,S,L),a(D,T,S,L)	
S23	D,T,S,a,f	D,c(D,T,S,L),a	Frequency dependent

Identifier	Input data	Data to be used	Comment
S30	D,T,C	D,c(D,T,S,L)	
S31	D,T,C,a	D,c(D,T,S,L),a	
S32	D,T,C	D,c(D,T,S,L),a(D,T,S,L)	
S33	D,T,C,a,f	D,c(D,T,S,L),a	Frequency dependent
S40	P,T,S	D(P,T,S,L),c(P,T,S,L)	
S41	P,T,S,a	D(P,T,S,L),c(P,T,S,L),a	
S42	P,T,S	D(P,T,S,L),c(P,T,S,L),a(P,T,S,L)	
S43	P,T,S,a,f	D(P,T,S,L),c(P,T,S,L),a	Frequency dependent
S50	P,T,C	D(P,T,C,L),c(P,T,C,L)	
S51	P,T,C,a	D(P,T,C,L),c(P,T,C,L),a	
S52	P,T,C	D(P,T,C,L),c(P,T,C,L),a(P,T,C,L)	
S53	P,T,C,a,f	D(P,T,C,L),c(P,T,C,L),a	Frequency dependent

Note 2

S00 is a special case because then the sound speed profile will be taken into use immediately without further operator intervention. The checksum is then mandatory and must be correct. Furthermore entries for zero depth and a deeper depth than expected during the survey must be included.

Note 3

Note that these fields have fixed length and leading zeros must be used.

Note 4

The depth or pressure field is always required while the other fields are optional except for those required by the datagram identifier. The field-delimiting commas must always be included even if the fields are empty.

Note 5

Same date and time for all frequencies.

Note 6

The positions, atmospheric pressure and comment fields are optional. Note that the option field must not include a \. It is recommended to include sensor type in the comment field.

Note 7

The field is only present/valid for S13, S23, S33, S43, S53. These datagrams contain absorption coefficients directly and are only valid for the given frequency. If an echo sounder employs several frequencies (eg. EM 710 uses frequencies between 60 and 100 kHz) a datagram must be sent for each frequency used with a maximum of 10 seconds between each datagram.

Note 8

The checksum field is calculated between the $ and the * delimiters by exclusive OR'ing of all bytes. The checksum is required for datagram S00, but is optional for the others.

AML Smart Sensor format

An **AML Smart Sensor** may be used directly for sound speed profile input on a serial line to the Operator Station. The sensor may also be used to measure the sound speed at the transducer depth continuously during surveying.

The supported AML Smart Sensor message formats are:

SV = Sound Velocity

SV&P = Sound Velocity and Pressure

SV&T = Sound Velocity and Temperature

Each message from the sensor is transmitted as a sequence of ASCII characters terminated by a CRLF pair.

The accepted message formats are as follows:

SV Format:

±	X	X	X	X	.	X		CR	LF

where xxxx.x is the measured sound speed in m/s.

SV&P Format:

±	X	X	X	.	X	X		±	X	X	X	X	.	X		CR	LF

where the first field is the pressure in decibars relative to the surface and the second is sound speed in m/s.

SV&T format:

±	X	X	.	X	X	X		±	X	X	X	X	.	X		CR	LF

where the first field is the temperature in degrees Celsius and the second is sound speed in m/s.

Note *The message formats above are presented in table format to make it easier to see the location and number of spaces in each message.*

Note *Note The '±' character should be interpreted as follows. If the number in the field immediately following this charater is negative, then this character will be "-" (minus). However, if the number in the field immediately following this character is positive, then this character will be a " " (space).*

Depth input from single beam echo sounder

Overview

Depth datagrams from a single beam echo sounder are accepted for display and logging on the system. The following formats are supported:

- NMEA 0183 DBS
- NMEA 0183 DPT
- Binary datagrams from the Kongsberg Maritime EA 500 echo sounder series.

DBS format

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always DBS,	–	–
Depth in feet	x.x,f,	0.1 –	1
Depth in meters	x.x,M,	0.1 –	1
Depth in fathoms	x.x,F	0.1 –	1
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

The decoding priority will be meter field, feet field and fathom field with the depth value extracted from the first field with valid data.

DPT format

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Sentence formatter	Always DPT,	–	–
Depth in meters from the transducer	x.x,	0.1 –	–
Offset of transducer from waterline in meters	x.x,	0 –	1
Maximum range scale in use	x.x	–	–
Checksum	*hh	–	–
End of sentence delimiter = CRLF	Always 0Dh 0Ah	–	–

Note 1

A negative value implying that the offset is from the keel should not be used.

EA 500 format

Data Description	Format	Valid range	Note
Start identifier = D	Always 34h	–	–
Channel identifier	x,	1 to 3	1
Time as HHMMSShh	xxxxxxxx,	00000000 to 23595999	1
Depth in meters from the transducer	32 bit IEEE 754 floating point	0.1 –	1
Bottom backscattering strength in dB	32 bit IEEE 754 floating point	–	–
Transducer number	32 bit integer	–	–
Athwartship slope in degrees	32 bit IEEE 754 floating point	–	–

Note 1

Only the channel identifier, depth and time will be decoded by the system. The least significant byte is transmitted first (the Intel convention).

Note

The datagram must be sent on Ethernet to UDP port number 2200 on the Operator Station.

Remote control

Overview

A Remote Control datagram has been implemented to allow:

- the multibeam echo sounder to start logging on remote command.
- the multibeam echo sounder to send out parameter and sound speed profile datagrams as a response to the remote command.
- the survey line numbers to be set from a remote location.

Note that the parameter and sound speed profile datagrams are always sent out when logging is started or any changes are made to the parameters or sound speed. They may also be sent out regularly at operator specified intervals.

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	–	–
Talker identifier	aa	Capital letters	–
Datagram identifier	Rxx,	R00 to R20	1
EM model number	EMX=dddd,	–	–
Responsible operator	ROP=a--a,	–	–
Survey identifier	SID=a--a,	–	–
Survey line number	PLN=d..d,	–	–
Survey line identifier (planned line no)	PLL=d--d,	–	–
Comment	COM=a--a	–	–
Optional checksum	*hh	–	–
End of datagram delimiter = \CRLF	5Ch 0Dh 0Ah	–	–

Note 1

Rxx defines what action the system is to take with respect to pinging and logging of data in addition to changes in the parameters. Note that logging of survey data on local storage is not affected, this is determined by operator control from the menu only.

- R00 - System to stop pinging (and logging if on)
- R10 - System to stop all logging (but continue or start pinging).
- R11 - System to start logging on new line to both local and remote
- R12 - System to star logging on new line but only to local storage
- R13 - System to start logging on new line but only to remote
- R20 - System to send installation parameter datagram and sound speed profile datagrams to remote

8.4 Output datagrams

Introduction

Output datagrams are usually logged to disk on the EM Series Operator Station. The output datagrams may also be exported to user provided programs on the Operator Station or on an external Ethernet network using UDP protocol (remote logging). An NMEA DPT depth datagram may be exported on a serial line.

The output datagrams are mostly in binary format using signed or unsigned integer numbers with lengths of 1, 2 or 4 bytes.

The same endian (little or big) as used in the input datagrams will be used for the output datagrams. With a PC based operator station little endian is normally used.

Note

We recommend that software written to decode EM Series data includes a check for the byte ordering with a provision for byte swapping. Suitable data fields to check on are the length field at the start of the datagram, the EM Series model number field and possibly the date and time fields.

The basic output datagram structure established with the EM 100 echo sounder is retained.

- All datagrams (except the NMEA DPT datagram) start with STX, datagram type and time tag, and end with ETX and checksum (sum of bytes between STX and ETX). In addition the total length of the datagram *(not including the length field)* will precede the STX byte, given as a four byte binary number.
- The length field is only included when logging to tape and/or disk, but not for datagrams logged to a remote location. The length can then be derived from the network software. Systems logging data remotely should add this length at the start of each datagram. This length is required if the data are to be used with Kongsberg Maritime post-processing systems.
- The time stamp resolution is 1 millisecond and includes the century. The time stamp is binary. The date is given as 10000*year(4 digits) + 100*month + day, for example 19950226 for February 26, 1995. All date fields in the output datagrams use this format. A time is usually given (in milliseconds) from midnight.

- The datagrams identify the multibeam echo sounder model and its serial number. The system model number is 120 for the EM 120, 300 for the EM 300, etc. For the EM 3000D (the dual head system) the model number was originally given as 3002 and the serial number is that of Sonar Head number 1. However in the depth datagram model numbers 3003-3008 are now used to also identify the actual transmit and sampling frequencies of the two heads. If only one head is activate on the EM 3000D, it is coded as a single head system. For EM 3002 the model number is 3020.
- Due care has been taken to include all parameters needed in postprocessing in the relevant datagrams, with a minimum of data duplication. Where resolution of a data field is variable, a resolution descriptor is included.
- Invalid data are always identified by the highest positive number allowed in a field unless otherwise noted.
- A real-time parameter datagram has been added to enable logging of parameters not used in postprocessing, but which may be important in checking the quality of the logged data, or to allow tracing of reasons for possible malfunctions.
- Attitude data as time continuous records and raw ranges and beam pointing angles are logged to allow eventual postprocessing corrections. The logged attitudes are valid at the transmit transducer, and are corrected for any sensor offsets.
- A new *Range and beam angle datagram* (type f), is included, that contains more details. (From January 2004).

Depth

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = D(epth data) (Always 44h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	4
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Ping counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Heading of vessel in 0.01°	2U	0 to 35999	–
Sound speed at transducer in dm/s	2U	14000 to 16000	–
Transmit transducer depth re water level at time of ping in cm	2U	0 to 65536	1
Maximum number of beams possible	1U	48 –	–
Number of valid beams = N	1U	1 to 254	–
z resolution in cm	1U	1 to 254	–
x and y resolution in cm	1U	1 to 254	–
Sampling rate (f) in Hz **or** Depth difference between sonar heads in the EM 3000D	2U 2S	300 to 30000 –32768 to 32766	3 4
Repeat cycle – N entries of :	16*N	–	–
Depth (z) from transmit transducer (unsigned for EM 120 and EM 300)	2S or 2U	–32768 to +32766 or 1 to 65534	2
Acrosstrack distance (y)	2S	–32768 to 32766	2
Alongtrack distance (x)	2S	–32768 to 32766	2
Beam depression angle in 0.01°	2S	–11000 to 11000	3
Beam azimuth angle in 0.01°	2U	0 to 56999	3
Range (one–way travel time)	2U	0 to 65534	3
Quality factor	1U	0 to 254	5
Length of detection window (samples/4)	1U	1 to 254	–
Reflectivity (BS) in 0.5 dB resolution) (Example: –20 dB = 216)	1S	–128 to +126	–
Beam number	1U	1 to 254	6
End of repeat cycle			
Transducer depth offset multiplier	1S	–1 to +17	1
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

The transmit transducer depth plus the depth offset multiplier times 65536 cm should be added to the beam depths to derive the depths re the water line. The depth offset multiplier will usually be zero, except when the EM 2000/3000 Sonar Head is on an underwater vehicle at a depth larger than 655.36 m. Note that the offset multiplier will be negative (-1) if the actual heave is large enough to bring the transmit transducer above the water line. This may represent a valid situation, but may also be due to an erroneously set installation depth of either the transducer or the water line.

Note 2

The beam data are given re the transmit transducer or sonar head depth and the horizontal location of the active positioning system's antenna. Heave, roll, pitch, sound speed at the transducer depth and ray bending through the water column have been applied. On the EM 1002/2000/3000/3002 the beam depths must be regarded as signed values to take into account beams which may be going upwards. On the EM 120/300 the beam depths are always positive and the values are therefore unsigned.

Note 3

The range, beam depression angle (positive downwards and 90° for a vertical beam) and beam azimuth angle (re vessel centerline) are given relative to the transducer (sonar head) at the ping transmit time. Heave, roll, pitch and sound speed at the transducer depth have been applied, but not ray bending. These values may thus be directly used for a new ray bending calculation with a revised sound speed profile to generate new sounding depths and positions without any need for using attitude data.

One way travel time = range / sampling rate / 4

Note that if the data need to be reprocessed with a new sound speed at the transducer depth or new roll, pitch or heave values, full reprocessing starting with the raw range and beam angle data is required. Attitude data is also required in this reprocessing, and both these data types will in the future be logged as standard.

If the beam azimuth angle has a value larger than 35999, the beam pointing angle has replaced the beam depression angle, and the raw two-way travel time has replaced the one-way heave and beam angle corrected travel time. The transmit tilt angle plus 54000 is given in the beam azimuth angle field. The use of this data definition is available on remote output to a port named as “RawDepth...” for use by other systems which do their own attitude and sound speed processing.

Note 4

In an EM 3000D the transmit transducer depth is that of Sonar Head number 1, taking into account the depth offset multiplier as described in note 1. The range multiplier is replaced by the difference in depth between Sonar Head number 1 and 2, i.e. head 2 depth is equal to head 1 depth (possibly modified with depth offset multiplier) plus the depth difference. The range sampling rates in Hz of the two heads is given through the EM model number according to the following table:

EM model number	3003	3004	3005	3006	3007	3008
Sonar Head 1	13956	14293	13956	14621	14293	14621
Sonar Head 2	14621	14621	14293	14293	13956	13956

Previously the model number of the EM 3000D was given as 3002 with head sample rates of 13956 and 14621 Hz respectively. The head depths in this case should be assumed to be equal, and although the mathematical derivation of final beam depths would otherwise be the same as described above, the transmit transducer depth was not actually exactly that of the sonar heads.

Note 5

The quality number’s upper bit signifies whether amplitude (0) or phase (1) detection has been used. If amplitude the 7 lowest bits give the number of samples used in the centre of gravity calculation. If phase the second highest bit signifies whether a second (0) or first (1) order curve fit has been applied to determine the zero phase range, and the 6 lowest bits indicates the quality of the fit (actually the normalized variance of the fit re the maximum allowed, i.e. with a lower number the better the fit).

Note 6

Beam 128 is the first beam on the second sonar head in an EM 3000D dual head system.

Raw range and beam angle

New datagram, added January 2004. This datagram replaces the old F datagram.

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = f (Always 66h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Ping counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Number of transmit sectors = Ntx	2U	1 to 20	–
Number of valid receive beams = N	2U	1 to 1999	–
Sampling frequency in 0.01 Hz (F)	4U	100 to 100000 * 100	
ROV depth in 0.01 m	4S		
Sound speed at transducer in 0.1 m/s	2U	14000 to 16000	–
Maximum number of beams possible	2U	1 to 1999	
Spare 1	2U		
Spare 2	2U		
Ntx entries of :	20*Ntx	–	
Tilt angle in 0.01°	2S	–2900 to 2900	–
Focus range in 0.1 m (0 = No focus)	2U	0 to 65535	–
Signal length in μs	4U		–
Transmit time offset in μs	4U		–
Center frequency in Hz	4U		–
Bandwidth in 10 Hz	2U	1 to 65535	–
Signal waveform identifier	1U	0 to 99	1
Transmit sector number	1U	0 to 19	–
N entries of :	12*N		
Beam pointing angle ref array in 0.01°	2S	–11000 to 11000	–
Range in 0.25 samples (R)	2U	0 to 65535	2
Transmit sector number	1U	0 to 19	–
Reflectivity (BS) in 0.5 dB resolution	1S	–128 to 127	–
Quality factor	1U	0 to 254	–
Detection window length in samples (/4 if phase)	1U	1 to 254	
Beam number	2S	–1999 to 1999	3
Spare	2U		

Data Description	Format	Valid range	Note
Spare (Always 0)	1U	0	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

0 = cw, 1 = FM

Note 2

Two way travel time = R / (4 * F / 100)

Note 3

The beam number normally starts at 0.

Seabed image

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = S(eabed image data) (Always 53h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234	4U	0 to 86399999	–
Ping counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Mean absorption coefficient in 0.01 dB/km	2U	1 to 20000	1
Pulse length in μs	2U	50 –	1
Range to normal incidence used to correct sample amplitudes in no. of samples	2U	1 to 16384	–
Start range sample of TVG ramp if not enough dynamic range (0 else)	2U	0 to 16384	–
Stop range sample of TVG ramp if not enough dynamic range (0 else)	2U	0 to 16384	–
Normal incidence BS in dB (BSN) (Example: –20 dB = 236)	1S	–50 to 10	–
Oblique BS in dB (BSO) (Example: –1 dB = 255)	1S	–60 to 0	–
Tx beamwidth in 0.1°	2U	1 to 300	–
TVG law crossover angle in 0.1°	1U	20 to 300	–
Number of valid beams (N)	1U	1 to 254	–
Repeat cycle – N entries of :	6*N	–	
beam index number	1U	0 to 253	2
sorting direction	1S	–1 or 1	3
number of samples per beam = Ns	2U	1 –	–
centre sample number	2U	1 –	4
End of repeat cycle			
Repeat cycle – ΣNs entries of:	ΣNs	–	
Sample amplitudes in 0.5 dB (Example: –30 dB = 196)	1S	–128 to 126	–
End of repeat cycle			
Spare byte if required to get even length (Always 0 if used)	0–1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

These fields have earlier had other definitions.

Note 2

The beam index number is the beam number - 1.

Note 3

The first sample in a beam has lowest range if 1, highest if -1. Note that the range sampling rate is defined by the sampling rate in the depth output datagram and that the ranges in the seabed image datagram are all two-way from time of transmit to time of receive

Note 4

The centre sample number is the detection point of a beam.

Water column

The receiver beams are roll stabilized

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	48 to 65535	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = k (Always 6Bh)	1U	–	–
EM model number (Example: EM 3002 = 3020)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Ping counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Number of datagrams	2U	1 to 16	2
Datagram numbers	2U	1 to 16	2
Number of transmit sectors = Ntx	2U	1 to 20	–
Total no. of receive beams	2U	1 to 254	–
Number of beams in this datagram = Nrx	2U	1 to 254	–
Sound speed in 0.1 m/s (SS)	2U	14000 to 16000	–
Sampling frequency in 0.01 Hz resolution (SF)	4U	1000 to 4000000	1
TX time heave (at transducer) in cm	2S	–1000 to 1000	
TVG function applied (X)	1U	20 to 40	4
TVG offset in dB (C)	1S	–	4
Spare	4U	–	–
Ntx entries of :		–	
Tilt angle in 0.01°	2S	–1100 to 1100	–
Center frequency in 10 Hz	2U	1000 to 50000	–
Transmit sector number	1U	0 to 19	–
Spare	1U	–	–
Nrx entries of :			
Beam pointing angle in 0.01°	2S	–11000 to 11000	–
Start Range sample number	2U	0 to 65535	–
Number of samples (Ns)	2U	0 to 65535	–
Detected range in samples (DR)	2U	0 to 65536	3
Transmit sector number	1U	0 to 19	–
Beam number	1U	0 to 254	–
Ns entries of: Sample amplitude in 0.5 dB resolution	1S	–128 to127	–

Data Description	Format	Valid range	Note
Spare byte if required to get even length (always 0 if used)	0 – 1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

The sample rate is normally decimated to be approximately the same as the bandwidth of the transmitted pulse.

Note 2

Maximum 64 kB in one datagram. More than 1 datagram may be required to transfer the data. Example: 500 m range * 160 beams * 1 Byte / 0.1 m per sample gives 800 kB. This requires 13 datagrams. A number of complete beams will be transferred in each datagram.

Note 3

Total Range in meters = Sound speed * detected range / (sample rate * 2) = SS10 * DR / (FS100 * 2) = 5 * SS * DR / FS (FS100= FS/100, SS10= SS/10). The range is set to zero when the beam has no bottom detection.

Note 4

The TVG function applied to the data is X logR + 2 Alpha R + OFS + C. The parameters X and C is documented in this datagram. OFS is gain offset to compensate for TX Source Level, Receiver sensitivity etc.

Position

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = P(osition data) (Always 050h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Position counter (sequential counter)	2U	0 to 65535	–
System / serial number	2U	100 –	–
Latitude in decimal degrees*20000000 (negative if southern hemisphere) (Example: 32°34’ S = –651333333)	4S	–	–
Longitude in decimal degrees*10000000 (negative if western hemisphere) (Example: 110.25° E = 1102500000)	4S	–	–
Measure of position fix quality in cm	2U	–	1
Speed of vessel over ground in cm/s	2U	0 –	1
Course of vessel over ground in 0.01°	2U	0 to 35999	1
Heading of vessel in 0.01°	2U	0 to 35999	–
Position system descriptor	1U	1 to 254	2
Number of bytes in input datagram	1U	– 254	–
Position input datagram as received	Variable	–	3
Spare byte if required to get even length (Always 0 if used)	0–1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

These data will be valid only if available as input.

Note 2

The position system descriptor shows which source this data is from and its real-time use by bit coding:

- xxxx xx01 - position system no 1
- xxxx xx10 – position system no 2
- xxxx xx11 – position system no 3
- 10xx xxxx – the position system is active, system time has been used

- 11xx xxxx - the position system is active, input datagram time has been used
- xxxx 1xxx – the position may have to be derived from the input datagram which is then in SIMRAD 90 format.

Note 3

Complete input datagram except header and tail (such as NMEA 0183 $ and CRLF).

Depth (pressure) or height

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = h(eight data) (Always 068h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (EXample: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Height counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Height in cm	4S	–4294967296 to 4294967295	–
Heigth type	1U	0 to 100	1
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

0: The height is derived from the GGK or GGA datagram and is the height of the water level are the vertical datum (possibly motion corrected).

1 - 99: The height type is as given in the *Depth (pressure) or height input datagram*.

100: The input is depth taken from the *Depth (pressure) or height input datagram*.

Tide

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	-	-
Start identifier = STX (Always 02h)	1U	-	-
Type of datagram = T(ide data) (Always 054h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	-	-
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	-	-
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	-
Tide counter (sequential counter)	2U	0 to 65535	-
System serial number	2U	100 -	-
Date = year*10000 + month*100 + day (from input datagram) (Example: Feb 26, 1995 = 19950226)	4U	-	-
Time since midnight in milliseconds (from input datagram) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	-
Tidal offset in cm	2S	-32768 to 32766	-
Spare (Always 0)	1U	-	-
End identifier = ETX (Always 03h)	1U	-	-
Check sum of data between STX and ETX	2U	-	-

Attitude

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = A(ttitude data) (Always 041h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (at start of data record) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (at start of data record) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Attitude counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Number of entries = N	2U	1 –	–
Repeat cycle – N entries of:	12*N	–	
– Time in milliseconds since record start	2U	0 to 65534	–
– Sensor status	2U	–	1
– Roll in 0.01°	2S	–18000 to 18000	–
– Pitch in 0.01°	2S	–18000 to 18000	–
– Heave in cm	2S	–1000 to 10000	–
– Heading in 0.01°	2U	0 to 35999	–
End of repeat cycle			
Sensor system descriptor	1U	–	2
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

The sensor status will be copied from the input datagram's two sync bytes if the sensor uses the EM format. See the input format description for further details.

Note 2

The sensor system descriptor will show which sensor the data is derived from, and which of the sensor's data have been used in real time by bit coding:

- xx00 xxxx – motion sensor number 1
- xx01 xxxx – motion sensor number 2
- xxxx xxx1 – heading from the sensor is active
- xxxx xx0x – roll from the sensor is active
- xxxx x0xx – pitch from the sensor is active
- xxxx 0xxx – heave from the sensor is active

Heading

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = H(eading data) (Always 048h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (at start of data record) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (at start of data record) (System: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Heading counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Number of entries = N	2U	1 –	–
Repeat cycle – N entries of:	4*N	–	–
– Time in milliseconds since record start	2U	0 to 65534	–
– Heading in 0.01°	2U	0 to 35999	–
End of repeat cycle			
Heading indicator (active or not) (0 = inactive)	1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Clock

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = C(lock data) (Always 043h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (of EM clock) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (of EM clock) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Clock counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Date = year*10000 + month*100 + day (from external clock input) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (from external clock datagram) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
1 PPS use (active or not) (0 = inactive)	1U	–	1
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

Shows if the system clock is synchronised to an external 1 PPS signal or not.

Surface sound speed

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = G (Always 047h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (at start of data record) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (at start of data record) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Sound speed counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Number of entries = N	2U	1 –	–
Repeat cycle – N entries of:	4*N	–	
– Time in seconds since record start	2U	0 to 65534	–
– Sound speed in dm/s (including offset)	2U	14000 to 15999	–
End of repeat cycle			
Spare (Always 0)	1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Sound speed profile

This datagram will contain the profile actually used in the real time raybending calculations to convert range and angle to xyz data. It will usually be issued together with the installation parameter datagram.

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = U (Always 055h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (at start of use) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (at start of use) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Profile counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Date = year*10000 + month*100 + day (when profile was made) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (when profile was made) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Number of entries = N	2U	1 –	–
Depth resolution in cm	2U	1 to 254	–
Repeat cycle – N entries of:	8*N	–	–
- Depth	4U	0 to 1200000	–
– Sound speed in dm/s	4U	14000 to 17000	–
End of repeat cycle			
Spare byte to get even length (Always 0)	1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Kongsberg Maritime SSP output

This datagram will contain the profile as received as input, and is logged as is to enable use of its data in postprocessing. The real time use of its data is decided by the operator, the sound speed profile actually being used is given by the sound speed profile output datagram (see above).

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = W (Always 057h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
SSP counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Input datagram starting with Sentence formatter and ending with Comment	Variable	–	–
Spare byte if required to get even length (Always 0 if used)	0 – 1U	–	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Single beam echo sounder depth

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = E(cho sounder data) (Always 045h)	1U	–	–
EM model number (Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (of EM clock) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (of EM clock) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Echo sounder counter (sequential counter)	2U	0 to 65535	–
System serial number	2U	100 –	–
Date = year*10000 + month*100 + day (from input datagram if available) (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (from input datagram if available) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Echo sounder depth from waterline in cm	4U	0 to 1200000	–
Source identifier (S, T, 1, 2 or 3)	ASCII	–	1
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

Identifies the source datagram type, i.e. NMEA DBS, NMEA DPT or EA 500 series channel 1-3 respectively.

Runtime parameters

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	–
Start identifier = STX (Always 02h)	1U	–	–
Type of datagram = R(untime parameter) (Always 052h)	1U	–	–
EM model number /Example: EM 3000 = 3000)	2U	–	–
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	–	–
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	–
Ping counter	2U	0 to 65535	–
System serial number	2U	100 –	–
Operator Station status	1U	–	1
Processing Unit status	1U	–	1
BSP status	1U	–	1
Sonar Head or Transceiver status	1U	–	1
Mode	1U	0 –	2
Filter identifier	1U	0 to 254	3
Minimum depth in m	2U	0 to 10000	–
Maximum depth in m	2U	1 to 12000	–
Absorption coefficient in 0.01 dB/km	2U	1 to 20000	4
Transmit pulse length in μs	2U	1 to 50000	–
Transmit beamwidth in 0.1 degrees	2U	1 to 300	–
Transmit power re maximum in dB	1S	0 to –50	–
Receive beamwidth in 0.1 degrees	1U	5 to 80	–
Receive bandwidth in 50 Hz resolution	1U	1 to 254	–
Receiver fixed gain setting in dB	1U	0 to 50	–
TVG law crossover angle in degrees	1U	2 to 30	–
Source of sound speed at transducer	1U	0 to 3	5
Maximum port swath width in m	2U	10 to 20000	–
Beam spacing	1U	0 to 3	6
Maximum port coverage in degrees	1U	10 to 110	–
Yaw and pitch stabilization mode	1U	–	7
Maximum starboard coverage in degrees	1U	10 to 110	–
Maximum starboard swath width in m	2U	10 to 20000	–
Spare (Always 0)	2U	–	–
HiLo frequency absorption coefficient ratio	1U	00 to 120	–
End identifier = ETX (Always 03h)	1U	–	–
Check sum of data between STX and ETX	2U	–	–

Note 1

The table below shows the system error status coded by one bit for each detected error. The status bit is set to one if error is detected.

Operator Station status		
Bit number	**Function**	**Model**
xxxx xxxx	For future use	
Processing Unit status		
Bit number	**Function**	**Model**
xxxx xxx1	Communication error with BSP	All models
xxxx xx1x	Communication error with Sonar Head or Transceiver	All models
xxxx x1xx	Attitude not valid for this ping	All models
xxxx 1xxx	Heading not valid for this ping	All models
xxx1 xxxx	System clock has not been set since power up	All models
xx1x xxxx	External trigger signal not detected	All models
x1xx xxxx	Hull Unit not responding	EM 1002
1xxx xxxx	Spare	
BSP status (EM 710)		
Bit number	**Function**	**Model**
xxxx xxx1	Error on RX data received by BSP 1 (May be a bad high speed link)	
xxxx xx1x	Too much seabed image data on BSP1	
xxxx x1xx	Invalid command received by BSP1	
xxxx 1xxx	Errors on BSP1	
xxx1 xxxx	Not implemented	
xx1x xxxx	Not implemented	
x1xx xxxx	Not implemented	
1xxx xxxx	Not implemented	
Transceiver status (EM 710)		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit voltage (HV) out of range	
xxxx xx1x	Low voltage power out of range	
xxxx x1xx	Error on Transmitter	
xxxx 1xxx	Error on Receiver	
xxx1 xxxx	Not implemented	

xx1x xxxx	Not implemented	
x1xx xxxx	Not implemented	
1xxx xxxx	Not implemented	

Note 2

The mode identifier byte is used as follows:

- 0000 0000 - Nearfield (EM 3000) or Very Shallow
- 0000 0001 - Normal (EM 3000) or Shallow (default for EM 2000)
- 0000 0010 - Target detect (EM 3000) or Medium
- 0000 0011 - Deep
- 0000 0100 - Very deep
- 0000 0101 - Extra deep (EM 300)

Note 3

The filter identifier byte is used as follows:

- xxxx xx00 - Spike filter set to Off
- xxxx xx01 - Spike filter is set to Weak
- xxxx xx10 - Spike filter is set to Medium
- xxxx xx11 - Spike filter is set to Strong
- xxxx x1xx - Slope filter is on
- xxxx 1xxx - Sector tracking or Robust Bottom Detection (EM 3000) is on
- 0xx0 xxxx - Range gates have Normal size
- 0xx1 xxxx - Range gates are Large
- 1xx0 xxxx - Range gates are Small
- xx1x xxxx - Aeration filter is on (EM 120 and EM 300)
- x1xx xxxx - Interference filter is on (EM 120 and EM 300)

Note 4

The used absorption coefficient should be derived from the seabed image or central beams echogram datagram if it is automatically updated with changing depth.

Note 5

The sound speed (at the transducer depth) source identifier is used as follows :

- 0000 0000 - From real time sensor
- 0000 0001 - Manually entered by operator
- 0000 0010 - Interpolated from currently used sound speed profile

Note 6

The beamspacing identifier is used as follows:

- 0000 0000 - Determined by beamwidth (FFT beamformer of EM 3000)
- 0000 0001 - Equidistant
- 0000 0010 - Equiangle
- 0000 0011 - Equiangle around nadir, equidistant in between or high density (EM 710 and EM 3002)

Note 7

The yaw and pitch stabilization identifier is set as follows:

- xxxx xx00 - No yaw stabilization
- xxxx xx01 - Yaw stabilization to survey line heading (Not used)
- xxxx xx10 - Yaw stabilization to mean vessel heading
- xxxx xx11 - Yaw stabilization to manually entered heading
- 1xxx xxxx - Pitch stabilization is on.

Installation parameters

This datagram is an ASCII datagram except for the header which is formed as in all other output datagrams. The datagram is issued as a start datagram when logging is switched on and as a stop datagram when logging is turned off, i.e. at the start and end of a survey line. It may also be sent to a remote port as an information datagram. It is usually followed by a sound speed profile datagram.

In the datagram all ASCII fields start with a unique three character identifier followed by "=". This should be used when searching for a specific field as the position of a field within the datagram is not guaranteed. The number or character part following is in a variable format with a minus sign and decimal point if needed, and with "," as the field delimiter. The format may at any time later be expanded with the addition of new fields at any place in the datagram.

For the EM 3000 and EM 3002 the transducer 1 data are for the Sonar Head and the transducer 2 data are for the second Sonar Head of an EM 3000D or an EM 3002. For other new EM systems with separate transmit and receive transducers, transducer 1 refers to the transmit transducer, and transducer 2 refers to the receive transducer.

Data Description	Example	Format	Valid range	Note
Number of bytes in datagram	–	4U	–	1
Start identifier = STX	Always 02h	1U	–	–
Type of datagram = I or i(nstallation parameters) or r(emote information)	Start = 049h Stop = 069h Remote info = 70h	1U	–	–
EM model number	EM 3000 = 3000	2U	–	–
Date = year*10000 + month*100 + day	Feb 26, 1995 = 19950226	4U	–	–
Time since midnight in milliseconds	08:12:51.234 = 29570234	4U	0 to 86399999	–
Survey line number	–	2U	0 to 65534	–
System serial number	–	2U	100 –	–
Serial number of second sonar head	–	2U	100 –	–
Water line vertical location in m	WLZ=x.x,	ASCII	–	–
System main head serial number	SMH=x.x,	ASCII	100 –	1
Hull Unit	HUN=x	ASCII	0 or 1	–
Hull Unit tilt offset	HUT=x.x	ASCII	–	–
Transducer 1 vertical location in m	S1Z=x.x,	ASCII	–	–
Transducer 1 along location in m	S1X=x.x,	ASCII	–	–

Data Description	Example	Format	Valid range	Note
Transducer 1 athwart location in m	S1Y=x.x,	ASCII	–	–
Transducer 1 heading in degrees	S1H=x.x,	ASCII	–	–
Transducer 1 roll in degrees re horizontal	S1R=x.x,	ASCII	–	–
Transducer 1 pitch in degrees	S1P=x.x,	ASCII	–	–
Transducer 1 no of modules	S1N=x––x,	ASCII	–	–
Transducer 2 vertical location in m	S2Z=x.x,	ASCII	–	–
Transducer 2 along location in m	S2X=x.x,	ASCII	–	–
Transducer 2 athwart location in m	S2Y=x.x,	ASCII	–	–
Transducer 2 heading in degrees	S2H=x.x,	ASCII	–	–
Transducer 2 roll in degrees re horizontal	S2R=x.x,	ASCII	–	–
Transducer 2 pitch in degrees	S2P=x.x,	ASCII	–	–
Transducer 2 no of modules	S2N=x––x,	ASCII	–	–
System (sonar head 1) gain offset	GO1=x.x,	ASCII	–	–
Sonar head 2 gain offset	GO2=x.x,	ASCII	–	–
Outer beam offset	OBO=x.x	ASCII	–	–
High/Low Frequency Gain Difference	FGD=x.x	ASCII	–	–
Transmitter (sonar head no1) software version	TSV=c––c,	ASCII	–	2
Receiver (sonar head 2) software version	RSV=c––c,	ASCII	–	2
BSP software version	BSV=c––c,	ASCII	–	2
Processing unit software version	PSV=c––c,	ASCII	–	2
Operator station software version	OSV=c––c,	ASCII	–	2
Datagram format version	DSV=c––c,	ASCII	–	2
Depth (pressure) sensor along location in m	DSX=x.x,	ASCII	–	
Depth (pressure) sensor athwart location in m	DSY=x.x,	ASCII	–	
Depth (pressure) sensor vertical location in m	DSZ=x.x,	ASCII	–	
Depth (pressure) sensor time delay in millisec	DSD=x––x,	ASCII	–	–
Depth (pressure) sensor offset	DSO=x.x,	ASCII	–	–
Depth (pressure) sensor scale factor	DSF=x.x,	ASCII	–	–
Depth (pressure) sensor heave	DSH=aa,	ASCII	IN or NI	3
Active position system number	APS=x,	ASCII	0 to 2	7
Position system 1 motion compensation	P1M=x,	ASCII	0 or 1	4
Position system 1 time stamp used	P1T=x,	ASCII	0 or 1	5
Position system 1 vertical location in m	P1Z=x.x,	ASCII	–	–
Position system 1 along location in m	P1X=x.x,	ASCII	–	–
Position system 1 athwart location in m	P1Y=x.x,	ASCII	–	–
Position system 1 time delay in seconds	P1D=x.x,	ASCII	–	–
Position system 1 geodetic datum	P1G=c––c,	ASCII	–	–
Position system 2 motion compensation	P2M=x,	ASCII	0 or 1	4
Position system 2 time stamp use	P2T=x,	ASCII	0 or 1	5
Position system 2 vertical location in m	P2Z=x.x,	ASCII	–	–
Position system 2 along location in m	P2X=x.x,	ASCII	–	–

Data Description	Example	Format	Valid range	Note
Position system 2 athwart location in m	P2Y=x.x,	ASCII	–	–
Position system 2 time delay in seconds	P2D=x.x,	ASCII	–	–
Position system 2 geodetic datum	P2G=c––c,	ASCII	–	–
Position system 3 motion compensation	P3M=x,	ASCII	0 or 1	4
Position system 3 time stamp use	P3T=x,	ASCII	0 or 1	5
Position system 3 vertical location in m	P3Z=x.x,	ASCII	–	–
Position system 3 along location in m	P3X=x.x,	ASCII	–	–
Position system 3 athwart location in m	P3Y=x.x,	ASCII	–	–
Position system 3 time delay in seconds	P3D=x.x,	ASCII	–	–
Position system 3 geodetic datum	P3G=c––c,	ASCII	–	–
Position system 3 on serial line or Ethernet	P3S= x,	ASCII	0 for Ethernet	–
Motion sensor 1 vertical location in m	MSZ=x.x,	ASCII	–	–
Motion sensor 1 along location in m	MSX=x.x,	ASCII	–	–
Motion sensor 1 athwart location in m	MSY=x.x,	ASCII	–	–
Motion sensor 1 roll reference plane	MRP=aa,	ASCII	HO or RP	–
Motion sensor 1 time delay in milliseconds	MSD=x––x,	ASCII	–	–
Motion sensor 1 roll offset in degrees	MSR=x.x,	ASCII	–	–
Motion sensor 1 pitch offset in degrees	MSP=x.x,	ASCII	–	–
Motion sensor 1 heading offset in degrees	MSG=x.x,	ASCII	–	–
Motion sensor 2 vertical location in m	NSZ=x.x,	ASCII	–	6
Motion sensor 2 along location in m	NSX=x.x,	ASCII	–	6
Motion sensor 2 athwart location in m	NSY=x.x,	ASCII	–	6
Motion sensor 2 roll reference plane	NRP=aa,	ASCII	HO or RP	6
Motion sensor 2 time delay in milliseconds	NSD=x––x,	ASCII	–	6
Motion sensor 2 roll offset in degrees	NSR=x.x,	ASCII	–	6
Motion sensor 2 pitch offset in degrees	NSP=x.x,	ASCII	–	6
Motion sensor 2 heading offset in degrees	NSG=x.x,	ASCII	–	6
Gyrocompass heading offset in degrees	GCG=x.x,	ASCII	–	–
Roll scaling factor	MAS=x.x,	ASCII	–	–
Transducer depth sound speed source	SHC=x	ASCII	0 or 1	8
Active heading sensor	AHS=x,	ASCII	1 to 4	–
Active roll sensor	ARO=x,	ASCII	1 to 4	–
Active pitch sensor port no	API=x,	ASCII	1 to 4	–
Active heave sensor port no	AHE=x,	ASCII	1 to 4	–
Cartographic projection	CPR=aaa,	ASCII	–	–
Responsible operator	ROP=c––c,	ASCII	–	–
Survey identifier	SID=c––c,	ASCII	–	–
Survey line identifier (planned line no)	PLL=x––x,	ASCII	–	–
Comment	COM=c––c,	ASCII	–	–

Data Description	Example	Format	Valid range	Note
Spare byte if required to get even length	Always 0 if used	0–1U	–	–
End identifier = ETX	Always 03h	1U	–	–
Check sum of data between STX and ETX		2U	–	–

Note 1

Serial number of head no 2 if that head is the only one in use with the EM 3000D, otherwise the serial number of head no 1 in the EM 3000D or the only head in the EM 3000.

Note 2

A version number is given as 3 alphanumerical fields separated by decimal points, plus date as yymmdd (for example 3.02.11 991124).

Note 3

IN = the heave of an underwater vehicle is presumed to be measured by the vehicle's depth sensor and the heave sensor input is not used by system.

Note 4

1 = the positions are motion compensated

0 = the positions are not motion compensated

Note 5

0 = the system has used its own time stamp for the valid time of the positions

1 = the system has used the time stamp of the position input datagram (external time).

Note 6

If entries for a second motion sensor are not included although two sensors are being used, they are presumed to have the same parameters.

Note 7

Position system number -1.

Note 8

0 = Transducer depth sound speed is used as the initial entry the sound speed profile used in the raytracing calculations.

1 = Transducer depth sound speed is NOT used for raytracing calculations.

Note that the source of the sound speed at the transducer depth (and this sound speed is always used to calculate beam pointing angles if required) is logged in the runtime datagram.

8.5 Handling of SSP datagrams

Overview

The SSP datagram format is used for input of depth or pressure profiles containing:

- Sound speed (m/s)
- Temperature (°C)
- Salinity (parts per thousand)
- Absorption coefficient

SSP datagrams are sent to the Operator Station on port 4001.

The SSP format is a generic format and the actual type of information conveyed is defined by an identifier. Currently the following are defined:

Identifier	Input data	Data to be used	Comment
S00	D,c	D,c	
S10	D,c	D,c	
S11	D,c,a	D,c,a	
S12	D,c,T,S	D,c,a(D,T,S,L)	
S13	D,c,a,f	D,c,a	Frequency dependent
S20	D,T,S	D,c(D,T,S,L)	
S21	D,T,S,a	D,c(D,T,S,L),a	
S22	D,T,S	D,c(D,T,S,L),a(D,T,S,L)	
S23	D,T,S,a,f	D,c(D,T,S,L),a	Frequency dependent
S30	D,T,C	D,c(D,T,S,L)	
S31	D,T,C,a	D,c(D,T,S,L),a	
S32	D,T,C	D,c(D,T,S,L),a(D,T,S,L)	
S33	D,T,C,a,f	D,c(D,T,S,L),a	Frequency dependent
S40	P,T,S	D(P,T,S,L),c(P,T,S,L)	
S41	P,T,S,a	D(P,T,S,L),c(P,T,S,L),a	
S42	P,T,S	D(P,T,S,L),c(P,T,S,L),a(P,T,S,L)	
S43	P,T,S,a,f	D(P,T,S,L),c(P,T,S,L),a	Frequency dependent
S50	P,T,C	D(P,T,C,L),c(P,T,C,L)	
S51	P,T,C,a	D(P,T,C,L),c(P,T,C,L),a	
S52	P,T,C	D(P,T,C,L),c(P,T,C,L),a(P,T,C,L)	
S53	P,T,C,a,f	D(P,T,C,L),c(P,T,C,L),a	Frequency dependent

Legend:

a Absorption coefficient
c Sound speed
C Conductivity
D Depth
f frequency
P Pressure
L Latitude (always present)
S Salinity
T Temperature

The notation ’a(D,T,S,L)’ means that the absorption coefficient is calculated from depth, temperature, salinity and latitude.

Usage

Note that the use of absorption coefficients from SSP datagrams (calculated or directly) is currently only available for EM 710 multibeam echo sounder. Absorption coefficients for the echo sounders EM 120, EM 300, EM 1002, EM 2000, EM 3000 and EM 3002 must be set manually from the Runtime parameter’s Filter and Gains tab.

SIS will receive the SSP datagrams over the network on port 4001. Upon reception, SIS will always generate a sound velocity profile file (.asvp), either directly (e.g. if S00, S11 is received) or by performing the necessary calculations from the supplied data.

An absorption coefficient profile file (.abs), based on the supplied data, will also be generated for all frequencies used by the echo sounders. There is a special case for EM 710, see below.

When SSP datagrams are received by SIS, the SVP Editor will be informed of the new .asvp and .abs files. A warning will be given if the SVP Editor is not running.

Using the SVP editor the user may edit the .asvp and .abs files and store the edited files. The user can select to use these files by selecting the .asvp file, i.e. sound profile, from the Runtime parameter’s Sound Speed’ tab.

EM 710 specific

An extension of the SSP format is defined for use with the EM 710 multibeam echo sounder. This echo sounder will employ a set of frequencies between 60 kHz and 100 kHz. The modified SSP format is applicable when the absorption coefficient is contained directly in the datagram. The datagram must then contain an additional frequency parameter for which the contained absorption profile is valid. The extended format is used in the S13, S23, S33, S43 and in the S53 (see the table above). In this case there must be one datagram for each frequency and they must be received within 10 second of each other.

9 SPARE PARTS

9.1 Overview

This chapter contains an illustrated presentation of the spare parts available for the EM 710 multibeam echo sounder. All the parts are not listed her, only those defined as Line Replaceable Units (LRU) to be changed by the on-board maintenance personnel.

9.2 Spares data presentation

Spares table

The parts are presented in a table format ("**5008**") specified by the Royal Norwegian Navy.

An example is shown below.

10 SNo	11 Drawing ref	13 Prod.p.no	15 Article name	18 Price	21 Unit	22 Quantity
	12 Other ref.	14 TM part.no	16 Technical data	19 TM code	26 User-spares	27 Base spares
	24 Date	17 NATO No		23 Status	20 Comp	25 Ser.no.
1	Fig.1 - 05.03.97	290-085827 - -	Powec Power Supply PMP 4M.02	- - -	EA 0 C	1 0 N/A
2	Fig.1 05.03.97	299-049179 - -	Fan Drawer Assembly	- - -	EA 0 C	3 0 N/A

The parts information in this table also conforms to the civilian standard **NS 5820** specified by the Norwegian Standardisation Society (Norges Standardiserings Forbund).

Parts list codes

These are the code descriptions for the information in the table.

Key codes to the parts list		
No	**Caption**	**Description**
10	Serial no.	Row number in list.
11	Drawing no. & item no.	The number of the drawing, and the position on that drawing, of the part.
12	Other references	Any other applicable references are included here.
13	Producer's part no.	The part number to be used when ordering spares from Kongsberg Maritime AS.
14	True manufacturer's part no.	Part number designated by manufacturer of part. Will be same as (13) if part is manufactured or assembled by Kongsberg Maritime AS.
15	Article name	The name of the unit or part.
16	Technical data	Any additional technical information which may be relevant.
17	NATO catalogue no.	The NATO stock number will be added where appropriate.
18	Currency/unit price	Price of the part, and the applicable currency
19	True manufacturer's code	This is a code number to identify the suppliers of the parts to enableyou to order directly from the suppliers in an emergency.
20	Component	Component definition. **C** = a component which cannot be broken down into smaller units. **P** = a part which may contain separately replaceable components. **S** = a set of parts.
21	Unit	The SI units applicable to the component. E.G. m = metric units for bolts etc.
22	Quantity	The total number of that particular part included in the system.
23	Status	Code for use by the Navy. Will be completed by the Navy
24	Date	This is the date the row was last updated.
25	Serial number	The component serial number where applicable.
26	User spares	The suggested number of spares to be held by the user.
27	Spares at base	The suggested number of spares to be held at the user's home base.

9.3 Operator Station (HWS 10) spare parts

The line replaceable units in the HWS10 Operator Station are circuit boards, fans and power supply

Commercial items can be replaced by other manufactureres than the ones listed here. Ensure compability!

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	Fig.- - 01.04.04	719-099078 PC-DL DELUXE -	Motherboard - Commercial item (ASUS)	- - -	EA 0 C	1 0 N/A
2	Fig.- 01.04.04	719-099080 CT6472Z335 -	Memory PC2700, 512 MB DDR DIMM, Unbuffered, ECC Commercial item (Crucial)	- - -	EA 0 C	4 0 N/A
3	Fig.- 01.04.04	719-099079 BX80532KE2800B -	Processor Intel 2.8 GHz Xeon (PC533) (mounted on the motherboard)	- - -	EA 0 C	1 (or 2) 0 N/A
4	Fig.- 01.04.04	719-099081 V9560XT -	Graphics card Nvidia FX5600XT 128 MB Commercial item (ASUS)	- - -	EA 0 C	1 0 N/A
5	Fig.- 01.04.04	719-099093 WD1200JD -	Hard disk IDE, Caviar 120 GB, S-ATA Comm. item (Western Digital)	- - -	EA 0 C	1 0 N/A
6	Fig.- 01.04.04	719-099082 WD360GD -	Hard disk Raptor 36.7 GB S-ATA Comm. item (Western Digital)	- - -	EA 0 C	2 0 N/A
7	Fig.- 01.04.04	719-099085 SuperSwap 1100 -	Hot-Swap drive enclosure Disk enclosure for S-ATA disk Commercial item (Promise)	- - -	EA 0 C	2 0 N/A
8	Fig.- 01.04.04	719-099083 PX-708A/T3B -	DVD recorder 8 x DVD+R Commercial item (Plextor)	- - -	EA 0 C	1 0 N/A
9	Fig.- 01.04.04	719-099090 MPF-920-Z/121 -	3.5” floppy disk - Commercial item (Sony)	- - -	EA 0 C	1 0 N/A
10	Fig.- 01.04.04	719-099133 PILA8460BN -	Ethernet card 10/100 Mbs Commercial item (Intel)	- - -	EA 0 C	1 0 N/A
11	Fig.- 01.04.04	719-099084 DC-315U Ultra -	SCSI card Ultra narrow Commercial item (Tekram)	- - -	EA 0 C	1 0 N/A
12	Fig.- 01.04.04	719-099086 EG465AX-VE(W) FM 24P -	Power supply ATX 460W PFC Commercial item (Enermax)	- - -	EA 0 C	1 0 N/A
13	Fig.- 01.04.04	- FD121225HB -	Fan 80mm, 12Vdc Commercial item	- - -	EA 0 C	1 0 N/A
14	Fig.- 01.04.04	- KM128025HB -	Fan 120mm, 12Vdc Commercial item	- - -	EA 0 C	1 0 N/A

9.4 Transceiver Unit

Overview

The line replaceable units in the EM 710 Transceiver Unit are:

- Circuit boards
- Power supplies
- Fans
- Cables

Receiver rack

The spare parts in Receiver rack are accessible either from the front or the rear.

Front modules

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	– – –	382-098860 – –	cPCI Power Supply RTC400PM42	– – –	EA – C	1 – N/A
2	– – –	382-218820 – –	CPU Board with PMC module	– – –	EA – C	1 – N/A
3	– – –	382-223189 – –	BSP67 Board with mezzanine x 2	– – –	EA – C	4/2 * – N/A
4	– – –	719-098950 – –	Ethernet Switch Board CP945FP-12	– – –	EA – C	3/2/1 * – N/A
5	– – –	382-098939 – –	Power Supply PSU 6V 150W , PA10077	– – –	EA – C	1 – N/A
6	– – –	382-218720 – –	RX32 Receiver Board	– – –	EA – C	4/2 * – N/A
7	– – –	 – –	Fan Unit (right) **	– – –	EA – C	1 – N/A
8	– – –	 – –	Fan Unit (left) **	– – –	EA – C	1 – N/A

Rear modules

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	– – –	382-219486 – –	RX RIO Rear Interface Board	– – –	EA – C	4/2 * – N/A
2	– – –	 – –	RXP RIO Rear Interface Board	– – –	EA – C	1 – N/A
3	– – –	382-219683 – –	BSP RIO Rear Interface Board	– – –	EA – C	1 – N/A
4	– – –	382-219182 – –	Rear I/O Interface Board	– – –	EA – C	1 – N/A

Backplane

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	– – –	382-098823 – –	RX Backplane ***	– – –	EA – C	1 – N/A

Transmitter rack

The spare parts in Transmitter rack are accessible either from the front or the rear.

Front modules

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	– – –	382-206644 – –	TX36 Transmitter Board	– – –	EA – C	20/10/5* – N/A
2	– – –	382-098940 – –	Power Supply PSU 72V HV standard, PA10074	– – –	EA – C	1 – N/A
3	– – –	382-098938 – –	Power Supply PSU 12V PA10076	– – –	EA – C	1 – N/A
4	– – –	129-098825 – –	Fan Unit **	– – –	EA – C	1 – N/A

Rear modules

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	- - -	382-098822 - -	TXP RIO Rear Interface Board	- - -	EA - C	1 - N/A
2	- - -	382-219483 - -	TX RIO Rear Interface Board	- - -	EA - C	10/5/3 * - N/A

Backplane

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	- - -	382-098745 - -	TX Backplane ***	- - -	EA - C	1 - N/A

Note * - Quantity dependent on model.

Note ** - If only a single fan fails, it might be convenient not to replace the complete Fan Unit. The following 115 Vac fans are used:

- NMB 4715 119x119x38 mm
- PAPST TYP3600 92x92x38 mm

Please contact Kongsberg Maritime for further information.

Note *** - Replacing the backplane is a complex process. Exchange of the complete sub-rack should be considered. Please contact Kongsberg Maritime for further information.

Cables

Several Transceiver Unit cables are supplied with the system. These are connected either at the front or the rear.

SNo	Drawing ref	Prod.p.no	Article name	Price	Unit	Quantity
	Other ref.	TM part.no	Technical data	TM code	User-spares	Base spares
	Date	NATO No	Other information	Status	Comp	Ser.no.
1	– – –	380-075079 – –	Ethernet cable (Rear I/O to Operator Station)	– – –	EA – C	1 – N/A
2	– – –	380-223298 – –	Ethernet cable set (internal, 0.5 x 1 degree system)	– – –	EA – C	1 – N/A
3	– – –	380-223299 – –	Ethernet cable set (internal, 1 x 1 degree system)	– – –	EA – C	1 – N/A
4	– – –	380-223300 – –	Ethernet cable set (internal, 1 x 2 degrees system)	– – –	EA – C	1 – N/A
5	– – –	380-223301 – –	Ethernet cable set (internal, 2 x 2 degree system)	– – –	EA – C	1 – N/A
6	– – –	380-096286 – –	Power cable (TXP RIO to RXP RIO)	– – –	EA – C	1 – N/A
6	– – –	380-218672 – –	Control cable (TXP RIO to RXP RIO)	– – –	EA – C	1 – N/A

10 DRAWING FILE

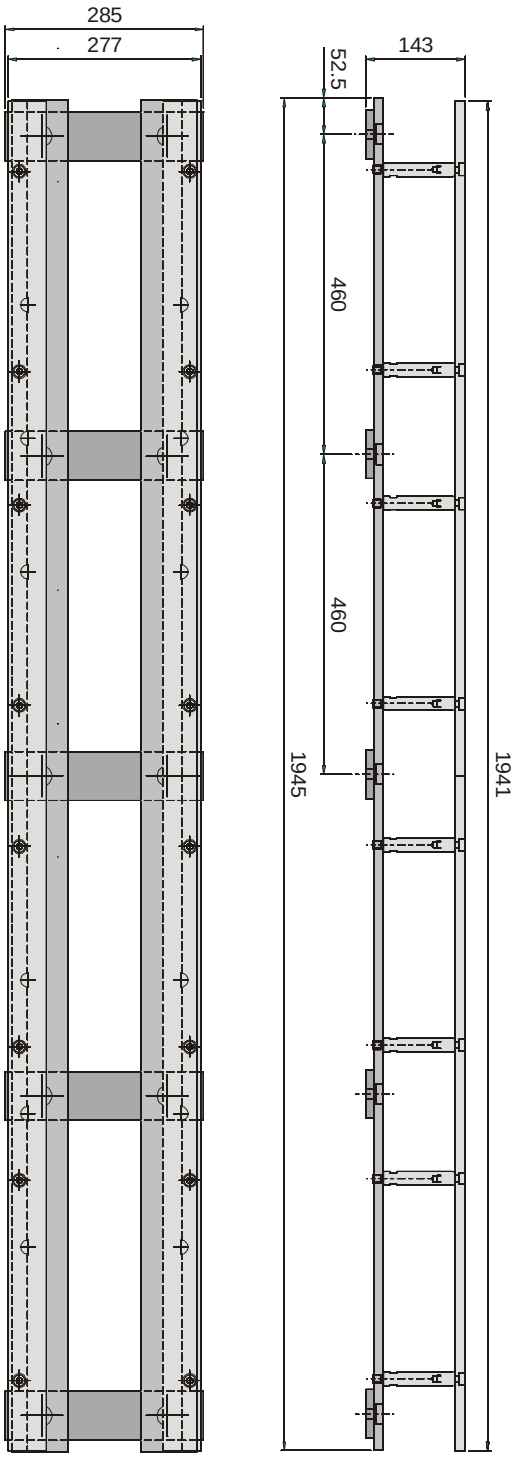
10.1 Overview

This chapter contains installation drawings and cable details.

Installation drawings

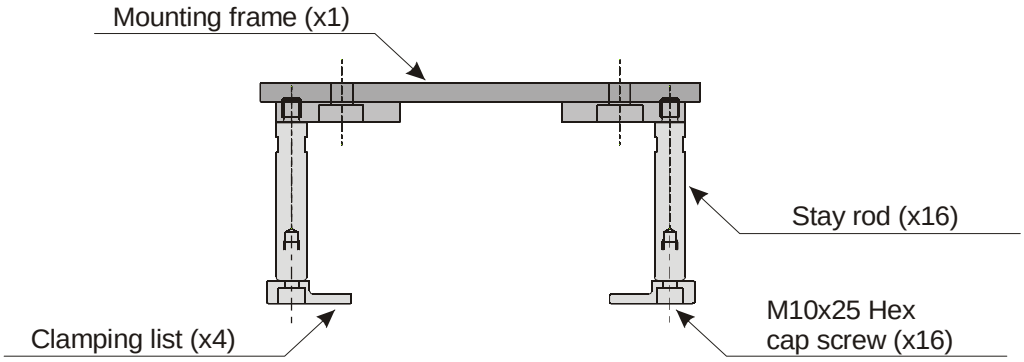
If required, certain drawings may be supplied on AutoCad or PDF format. To order, contact Kongsberg Maritime and refer to the drawing number in the bottom right corner of the frame.

Cable details

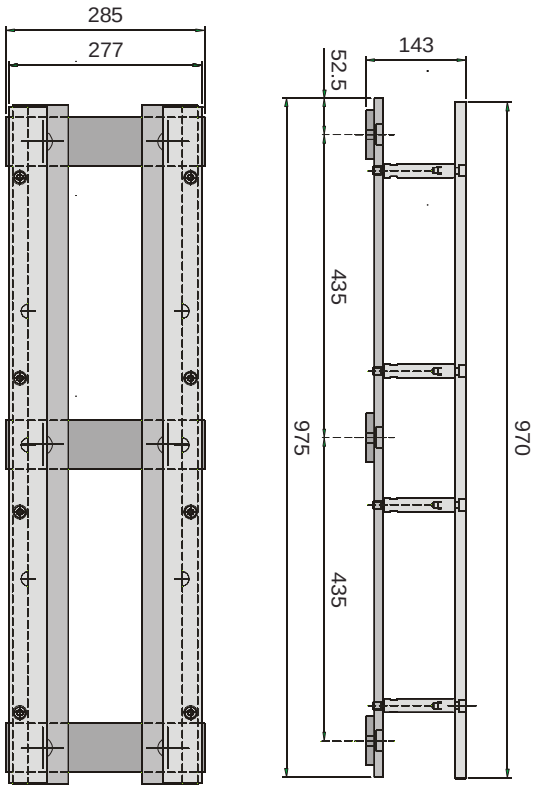


Note:
All measurements are in mm.
The drawing is not in scale.

Page 1 of 2 (CD21607)	EM 710 0.5° mounting frame assembly TX module	**499-223137** Rev. A

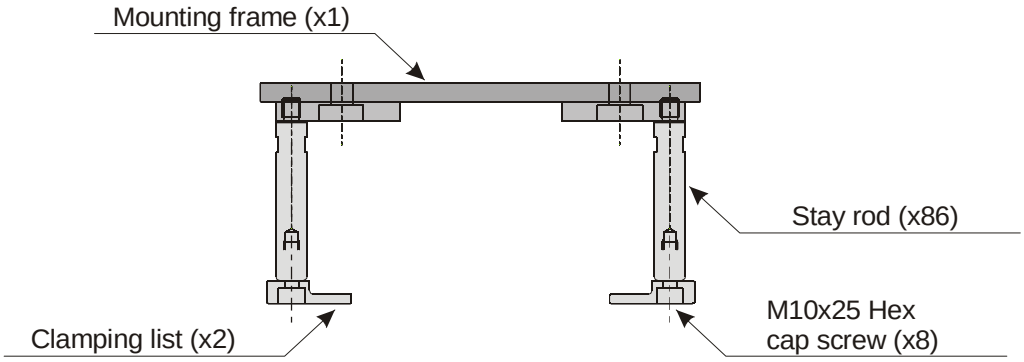


Page 2 of 2 (CD21607)	EM 710 0.5° mounting frame assembly TX module	**499-223137** Rev. A

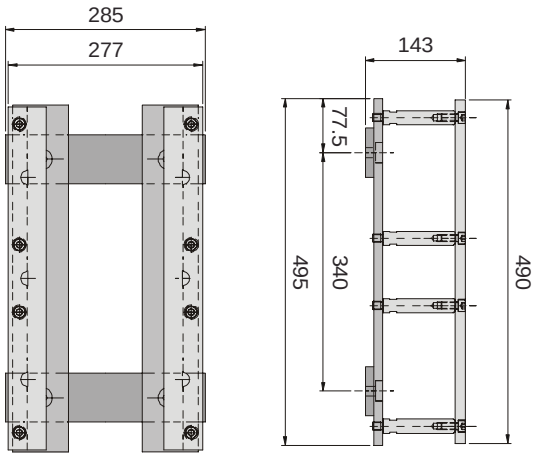


Note:
All measurements are in mm.
The drawing is not in scale.

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

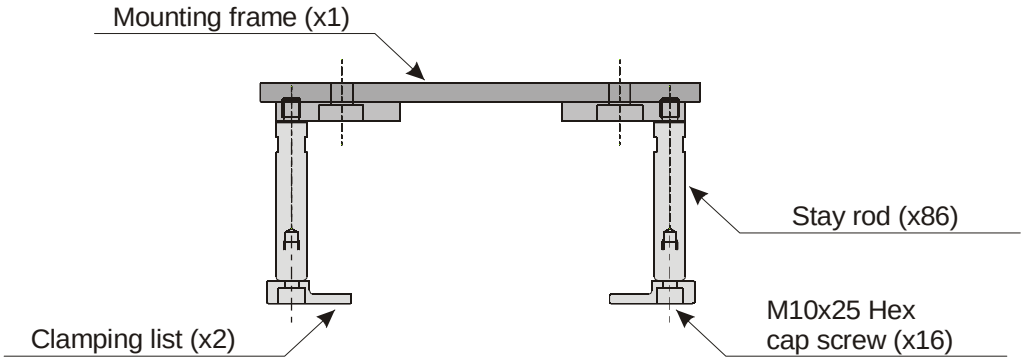


Page 2 of 2 (CD21608)	EM 710 1° mounting frame assembly RX module	**499-223139** Rev. A

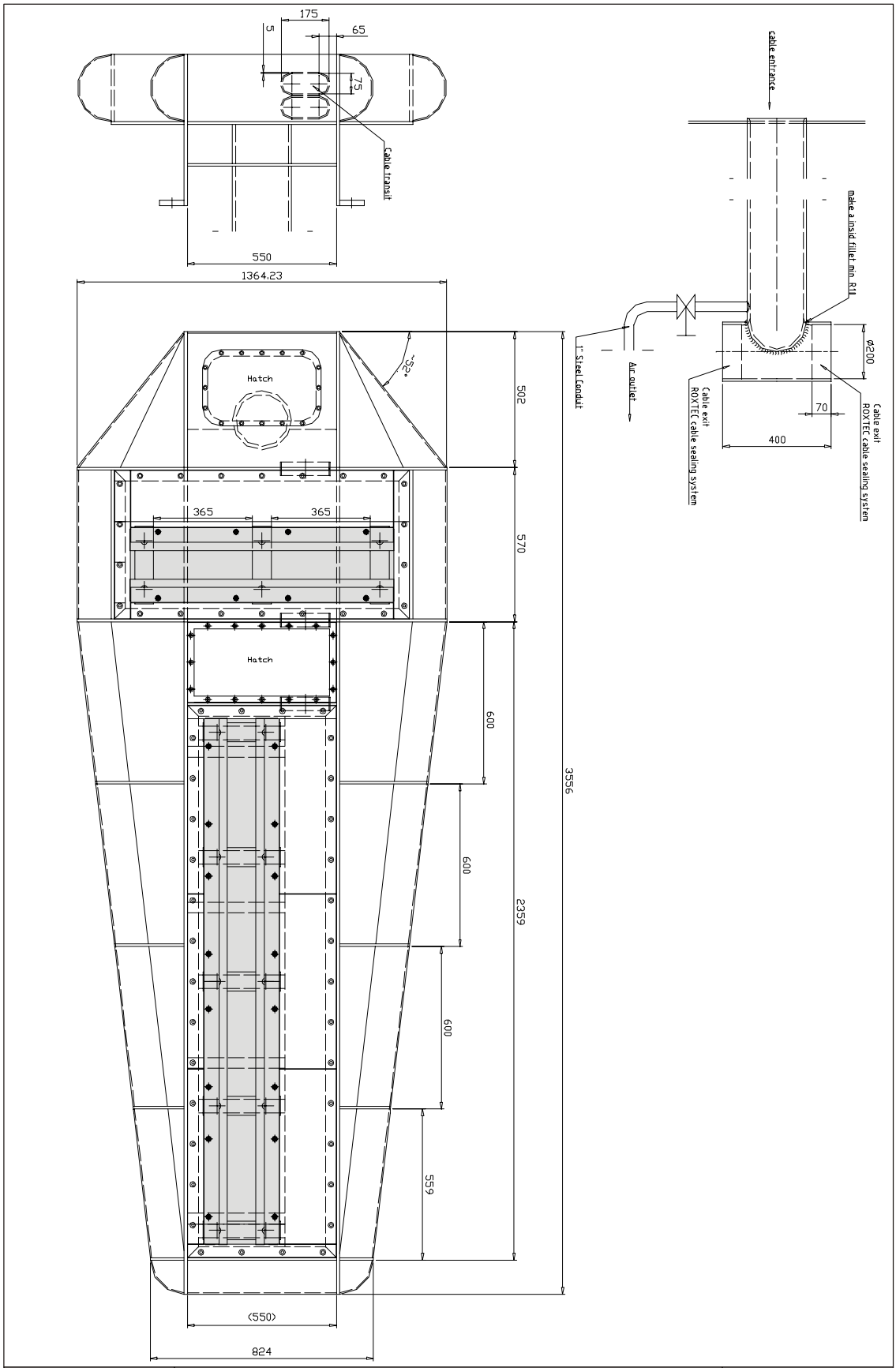


Note:
All measurements are in mm.
The drawing is not in scale.

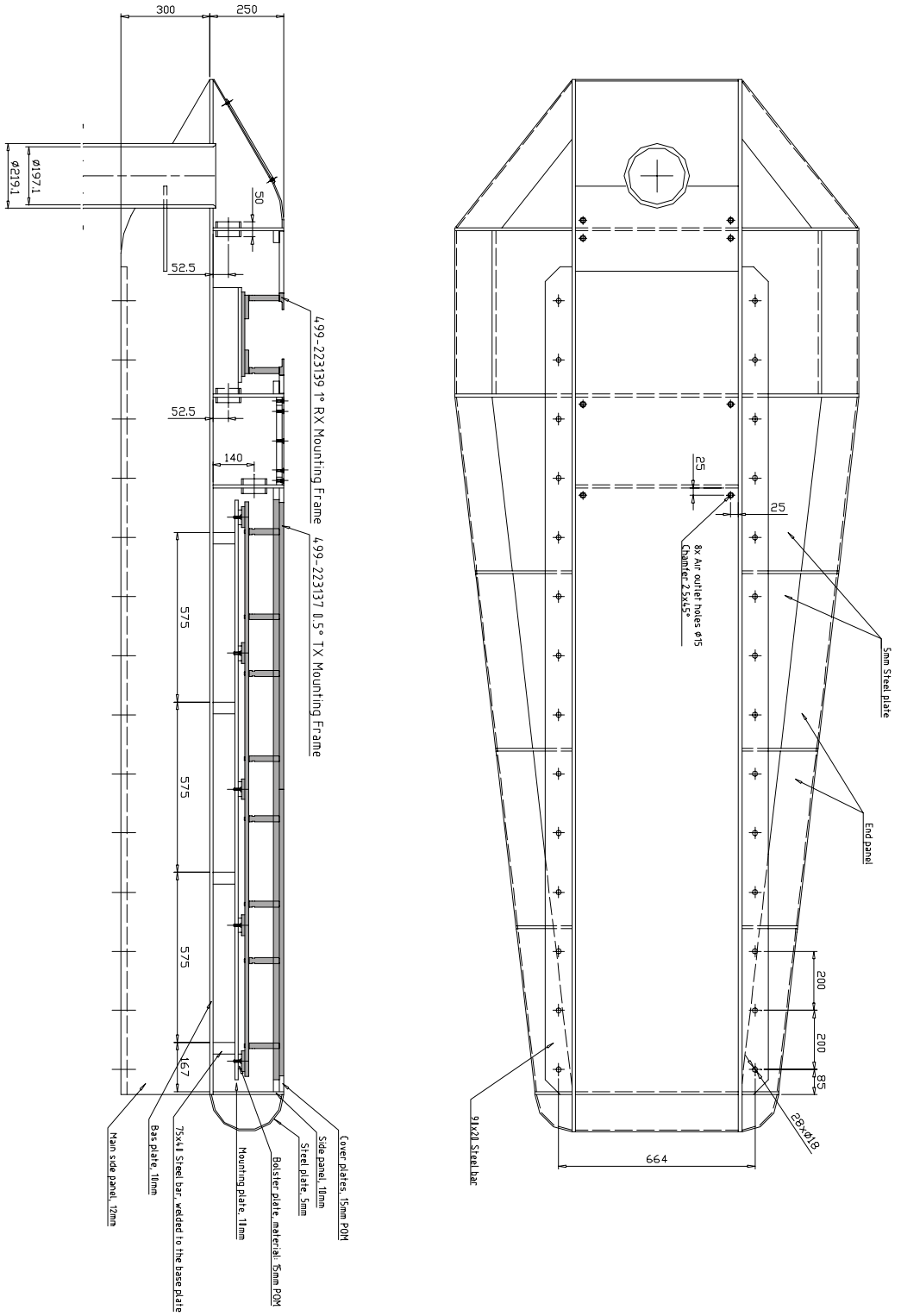
Page 1 of 2 (CD21612)	EM 710 2° mounting frame assembly TX/RX module	**499-223273** Rev. P1



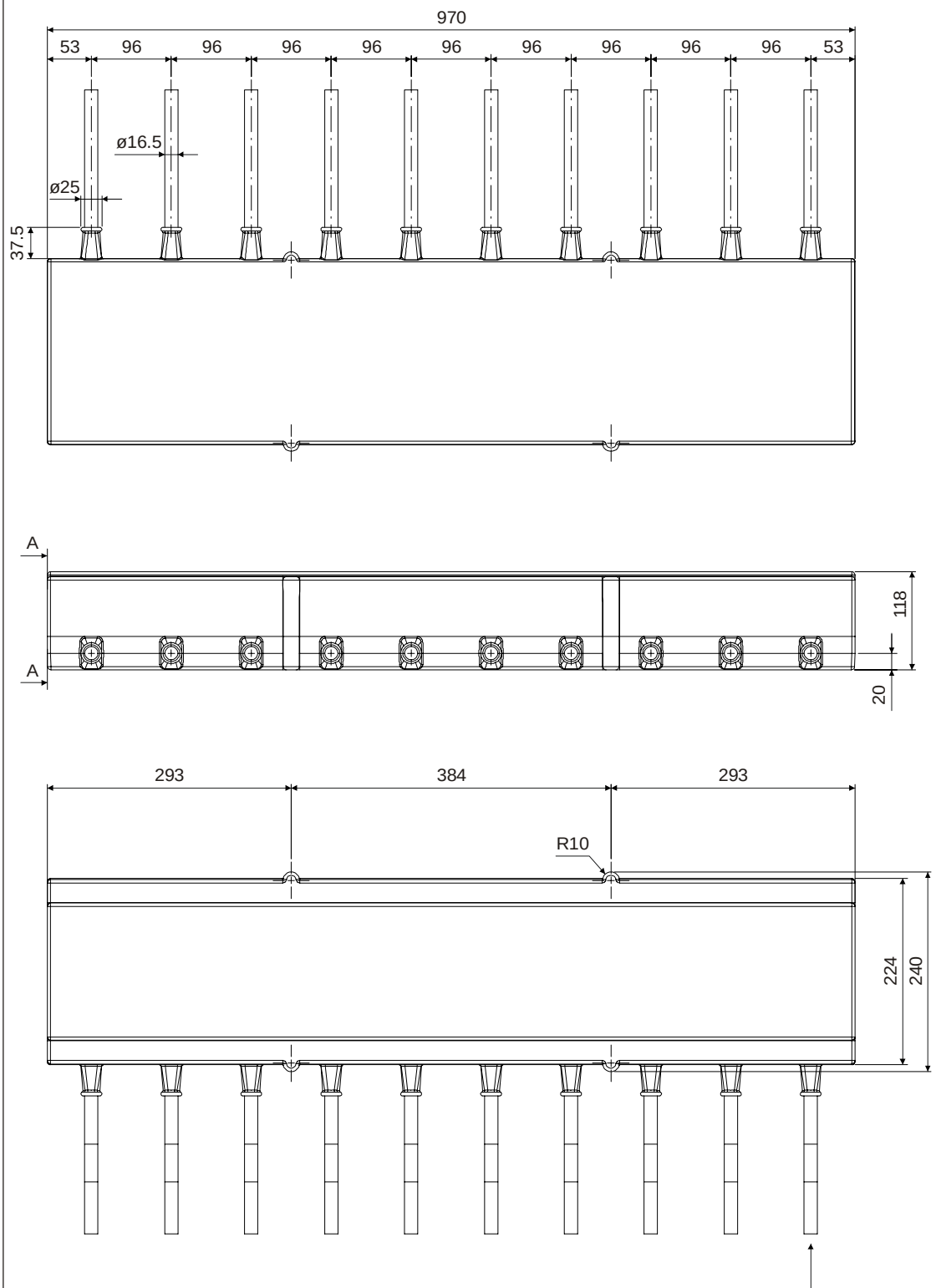
Page 2 of 2 (CD21612)	EM 710 2° mounting frame assembly TX/RX module	**499-223273** Rev. P1



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

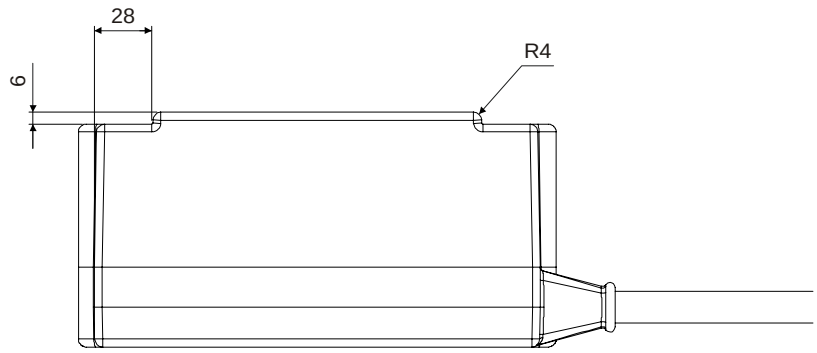


Page 2 of 2 (CD21617)	EM 710 0.5 x 1° gondola Arrangement drawing	**828-223232** Rev. A

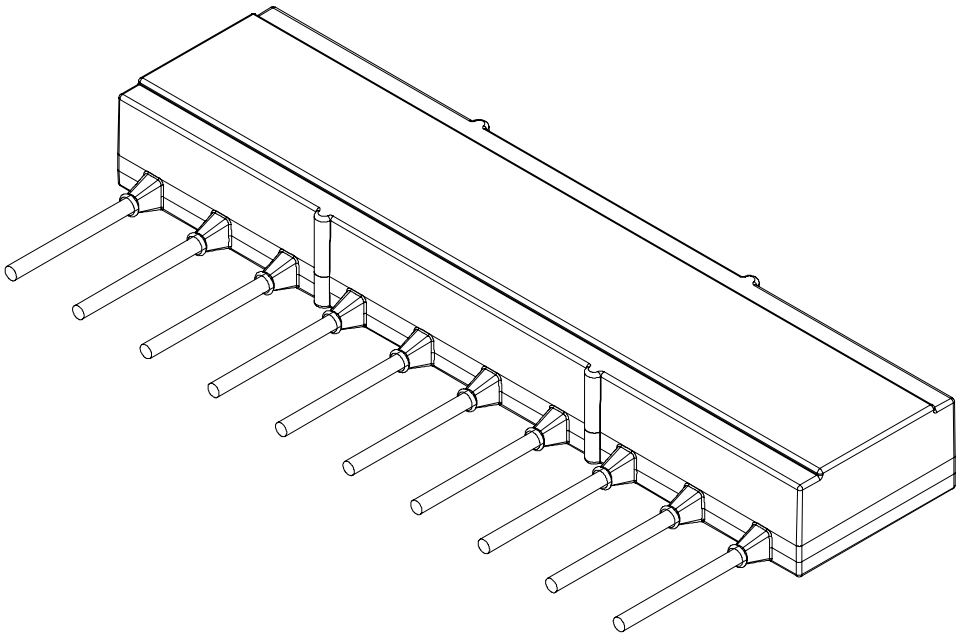


Note:
All measurements are in mm.
The drawing is not in scale.

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

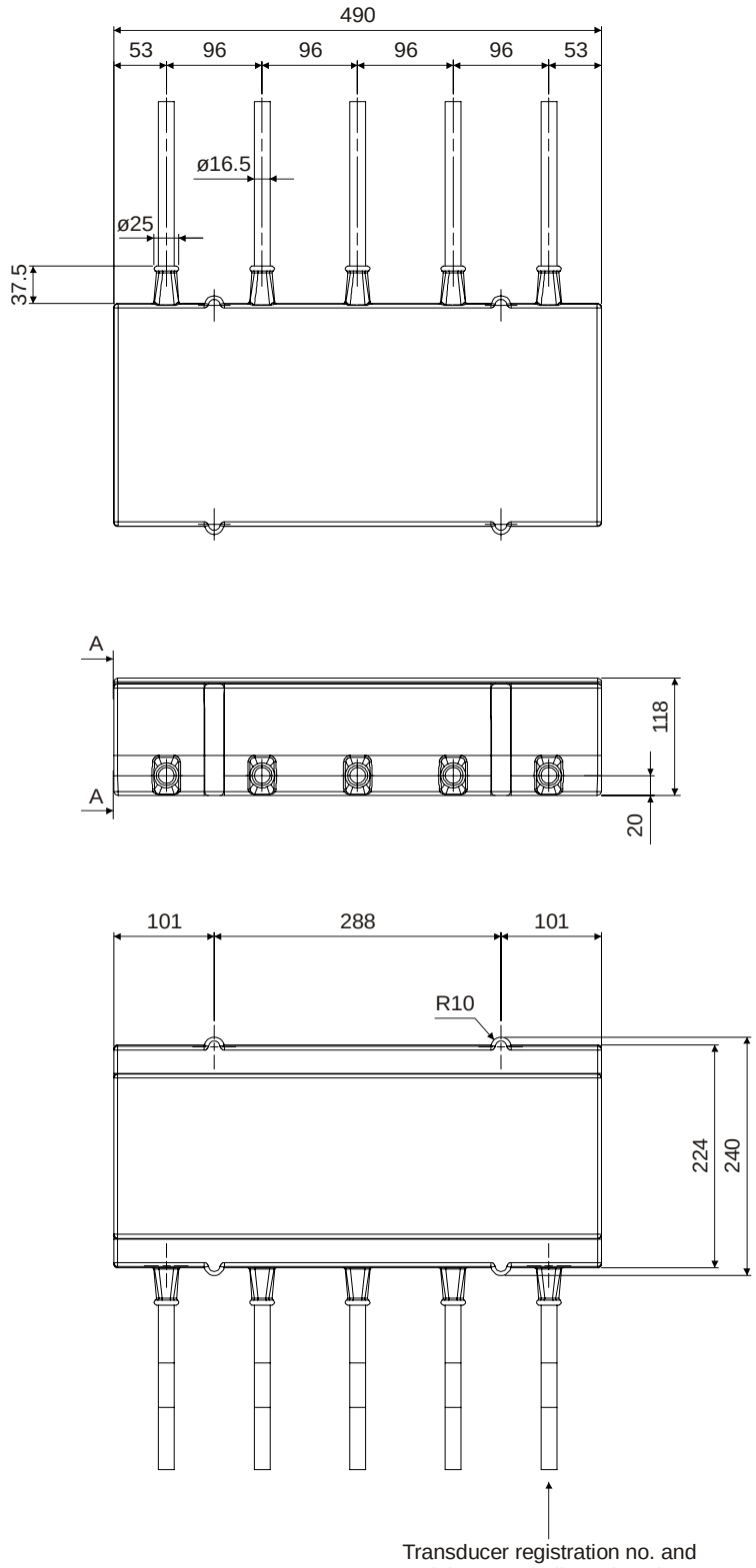


Section A-A



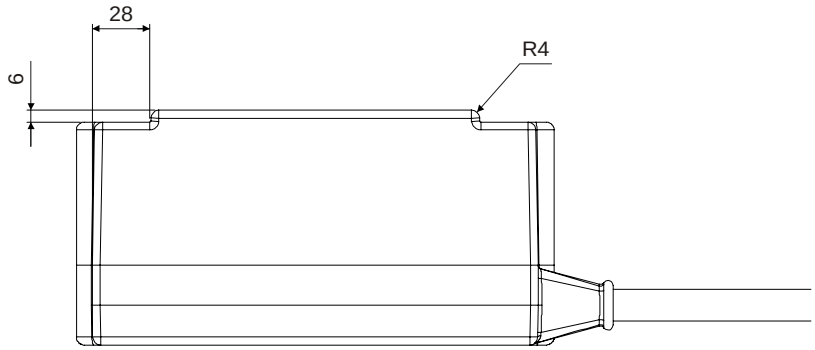
Note:
All measurements are in mm.
The drawing is not in scale.

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

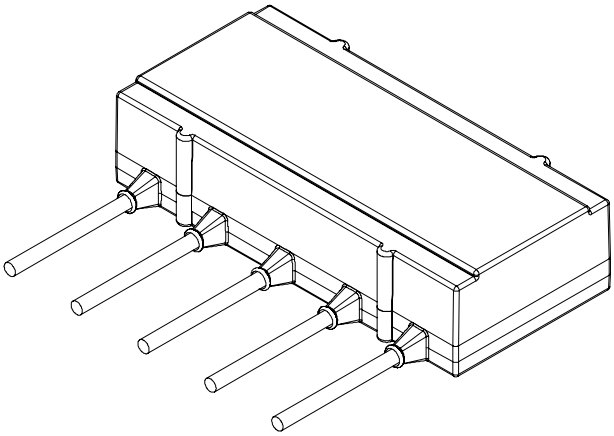


Note:
All measurements are in mm.
The drawing is not in scale.

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

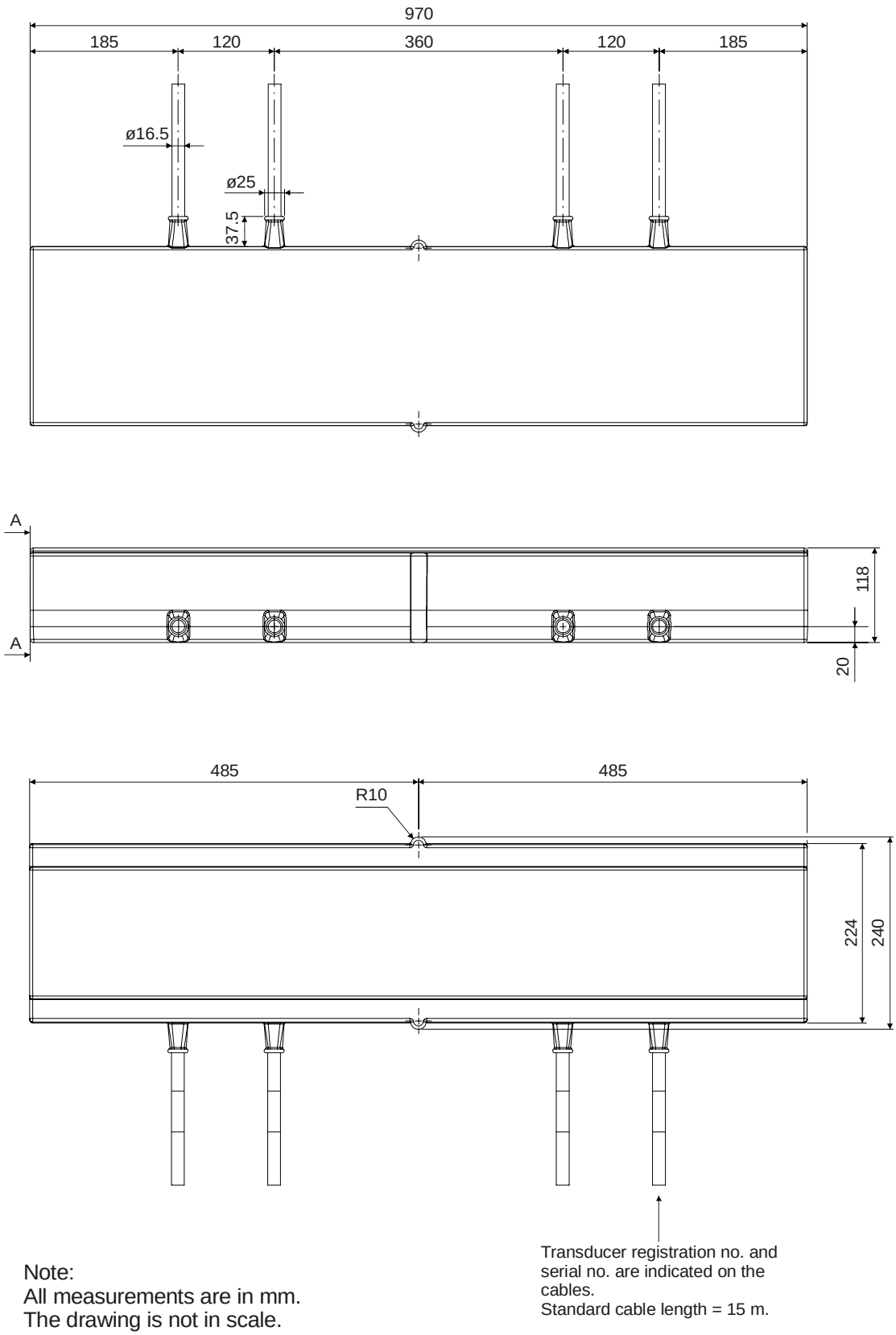


Section A-A



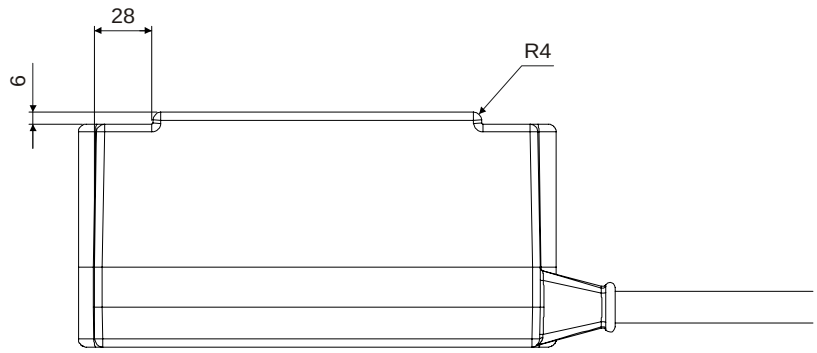
Note:
All measurements are in mm.
The drawing is not in scale.

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

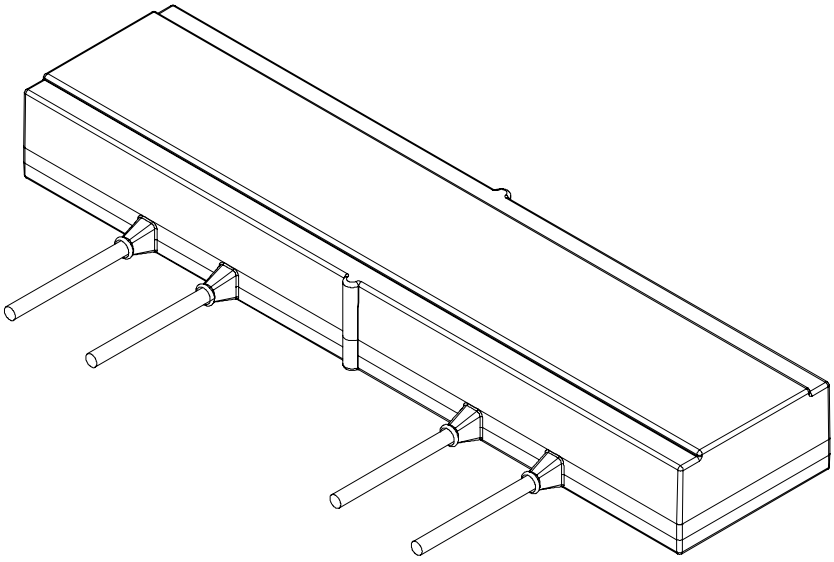


Note:
All measurements are in mm.
The drawing is not in scale.

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

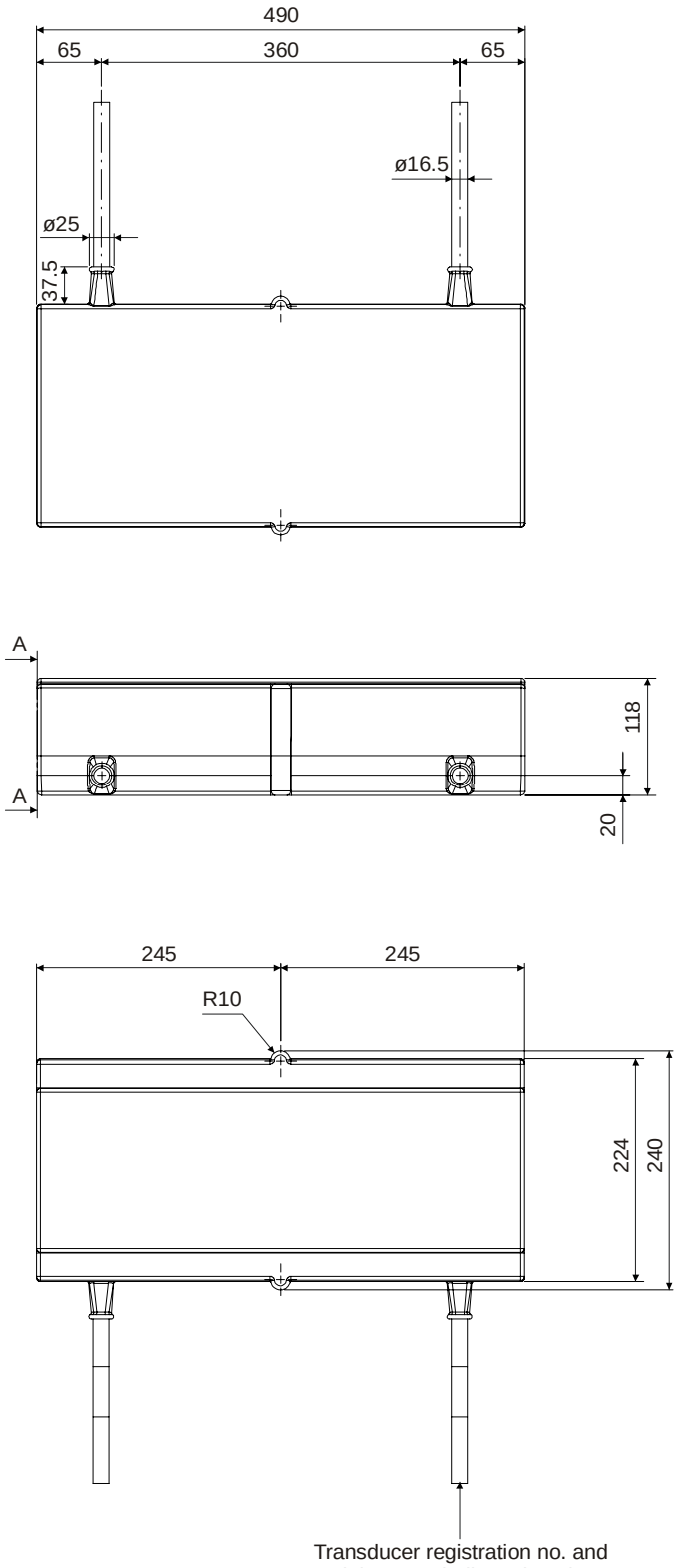


Section A-A



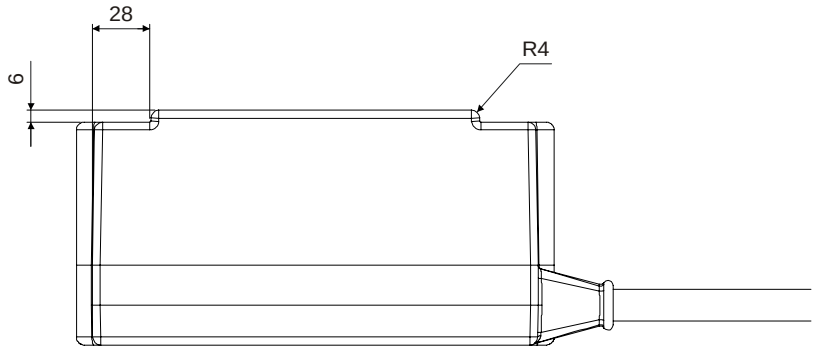
Note:
All measurements are in mm.
The drawing is not in scale.

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

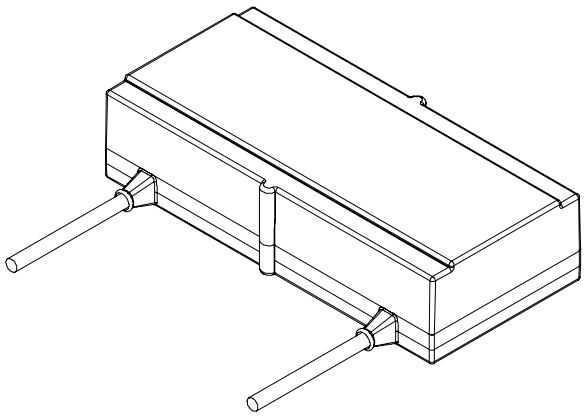


Note:
All measurements are in mm.
The drawing is not in scale.

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



Section A-A

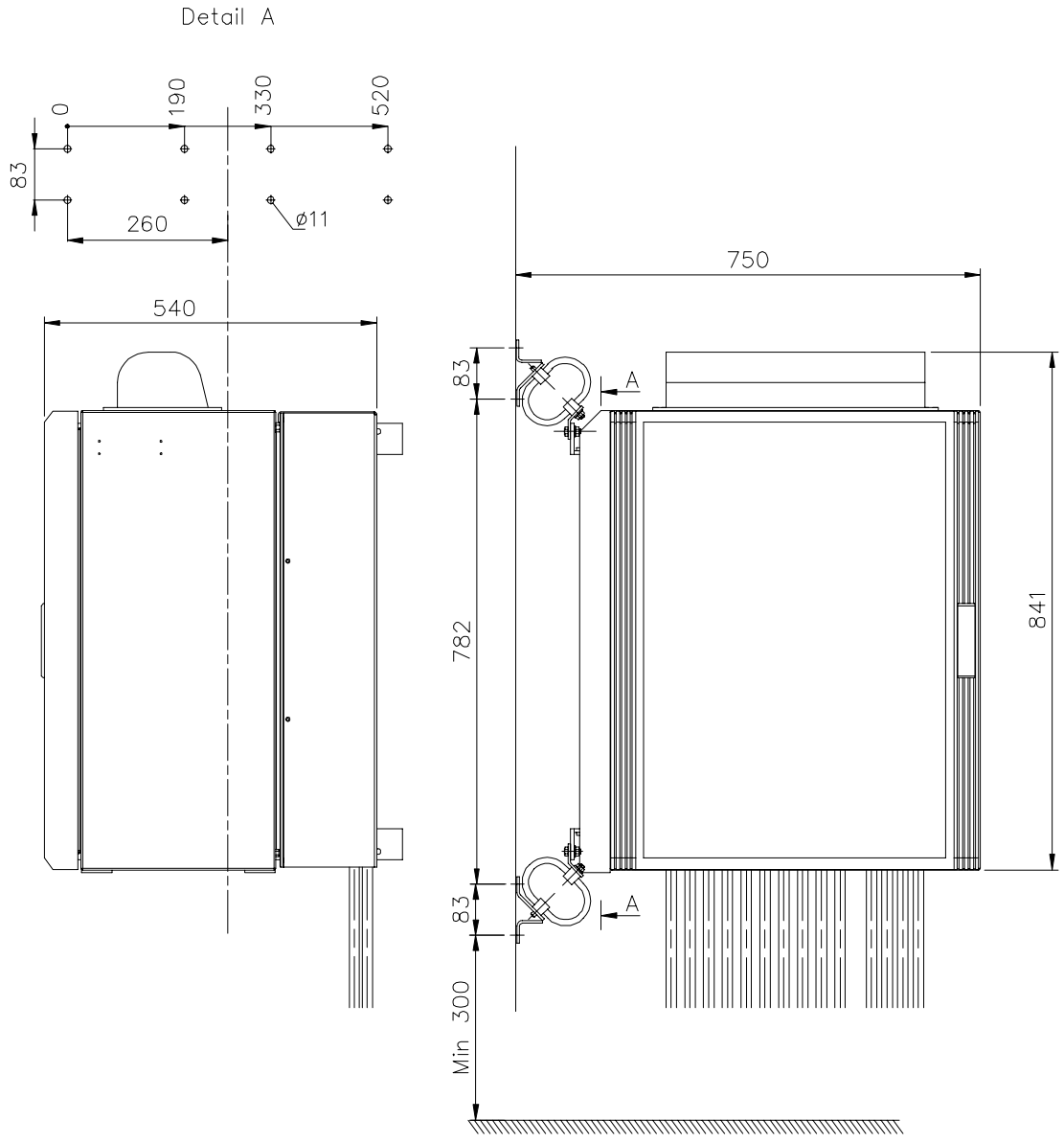


Note:
All measurements are in mm.
The drawing is not in scale.

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

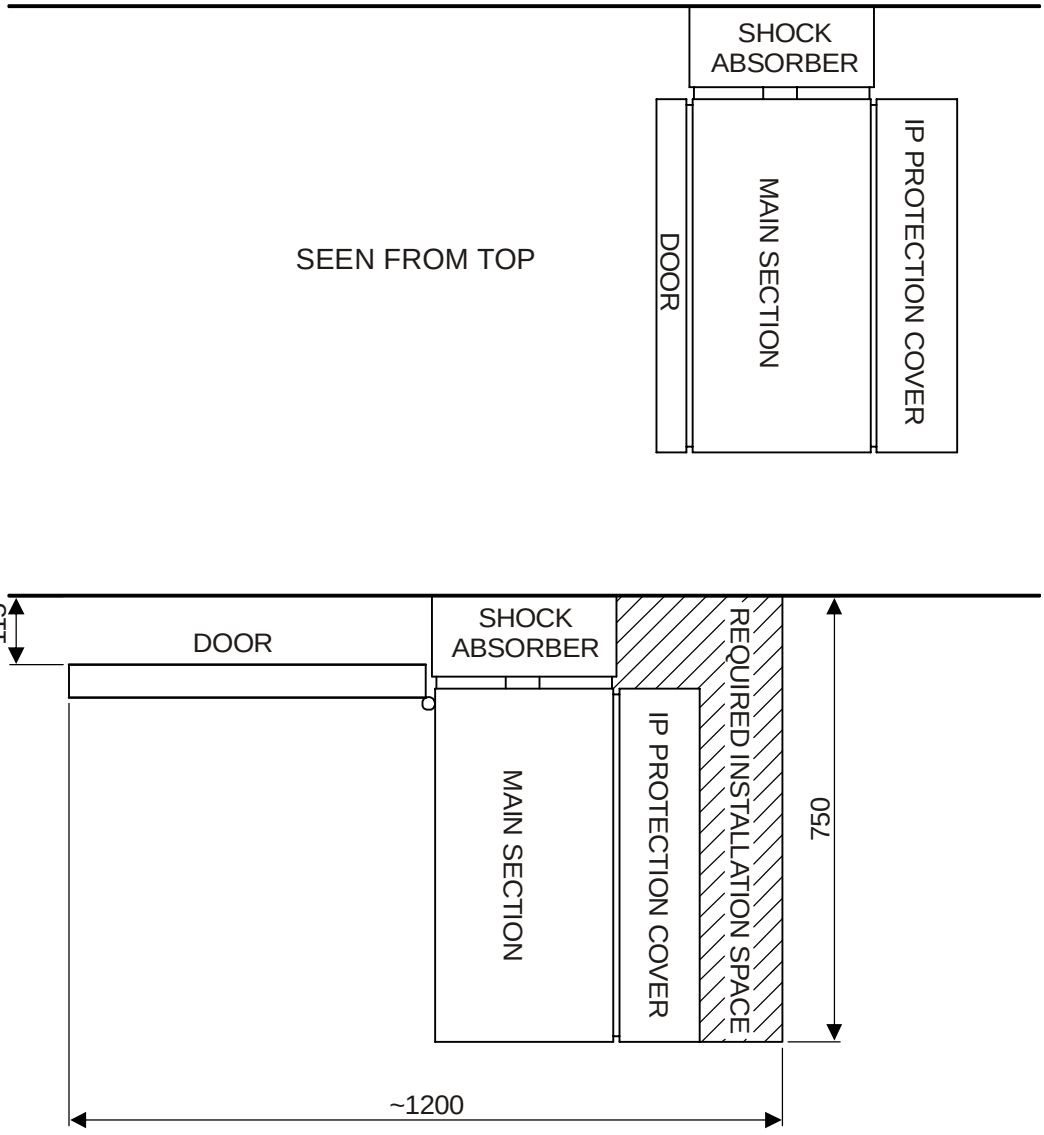
Note:
All measurements are in mm.
The drawing is not in scale.

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



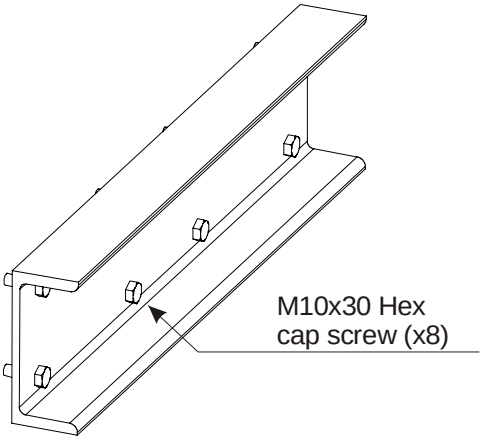
Note:
All measurements are in mm.
The drawing is not in scale.

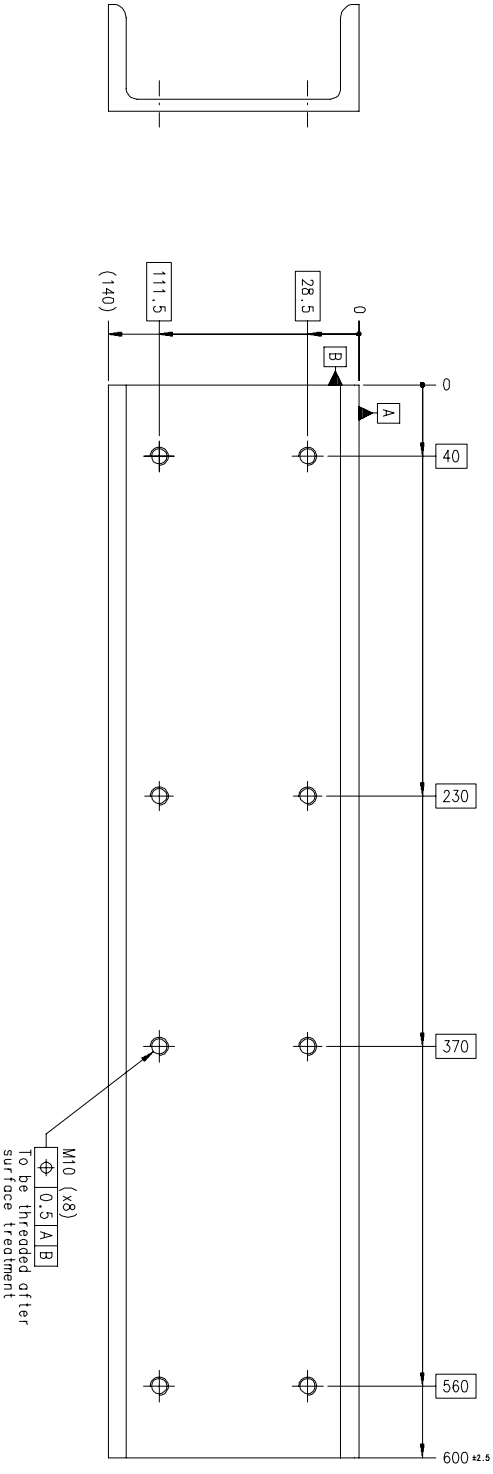
Page 1 of 2 (CD21602)	EM 710 Transceiver Unit Outline dimensions	**834-223122** Rev. Preliminary



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

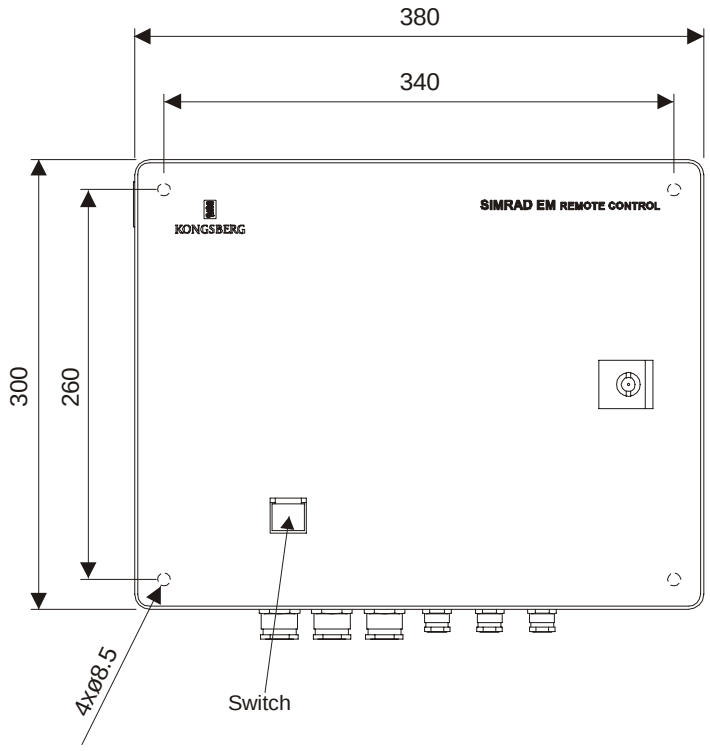
Page 2 of 2 (CD21602)	EM 710 Transceiver Unit Space requirements	**834-223122** Rev. Preliminary

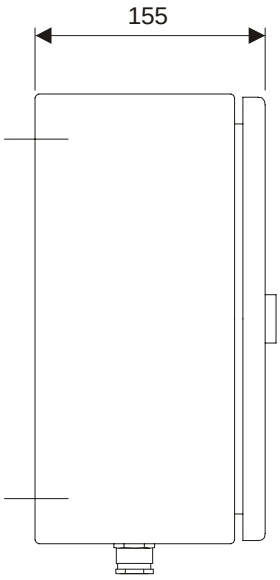




Note:
All measurements are in mm.
The drawing is not in scale.

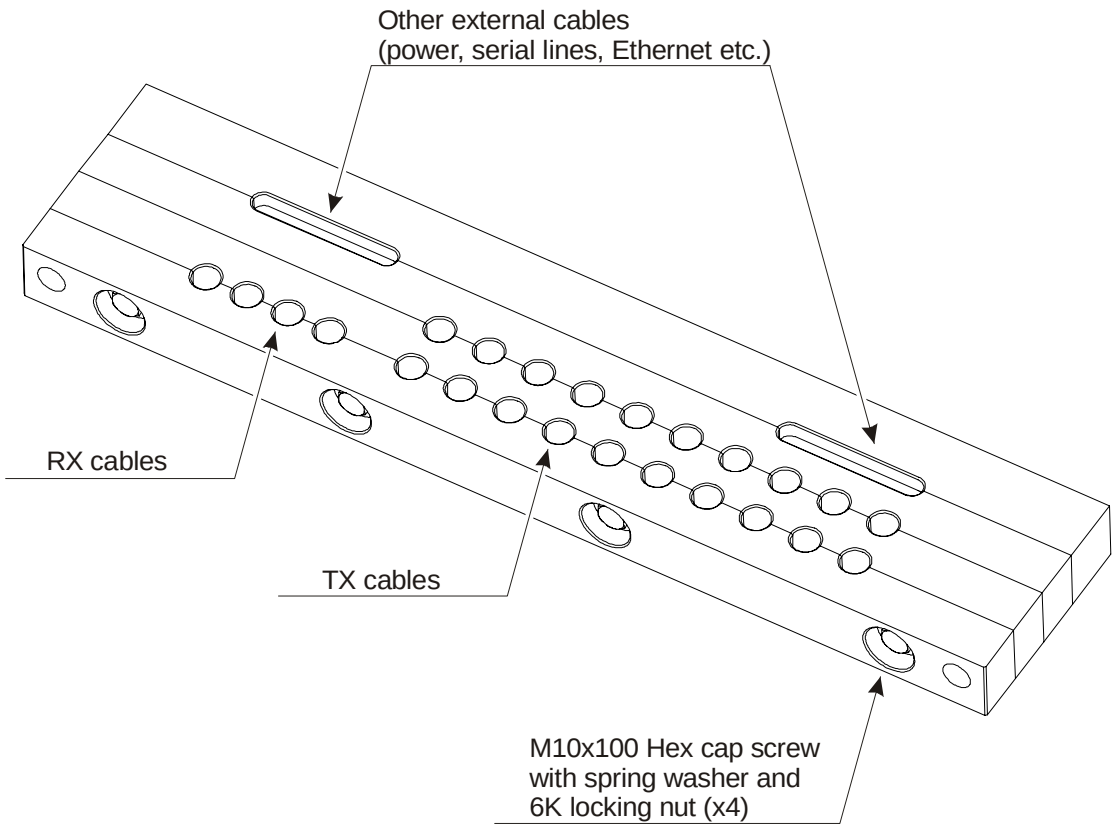
Page 1 of 1 (CD21613)	EM 710 Transceiver Unit Mounting bracket	**871-212984** Rev. A





Junction Box EM1-212595 (108-212591)

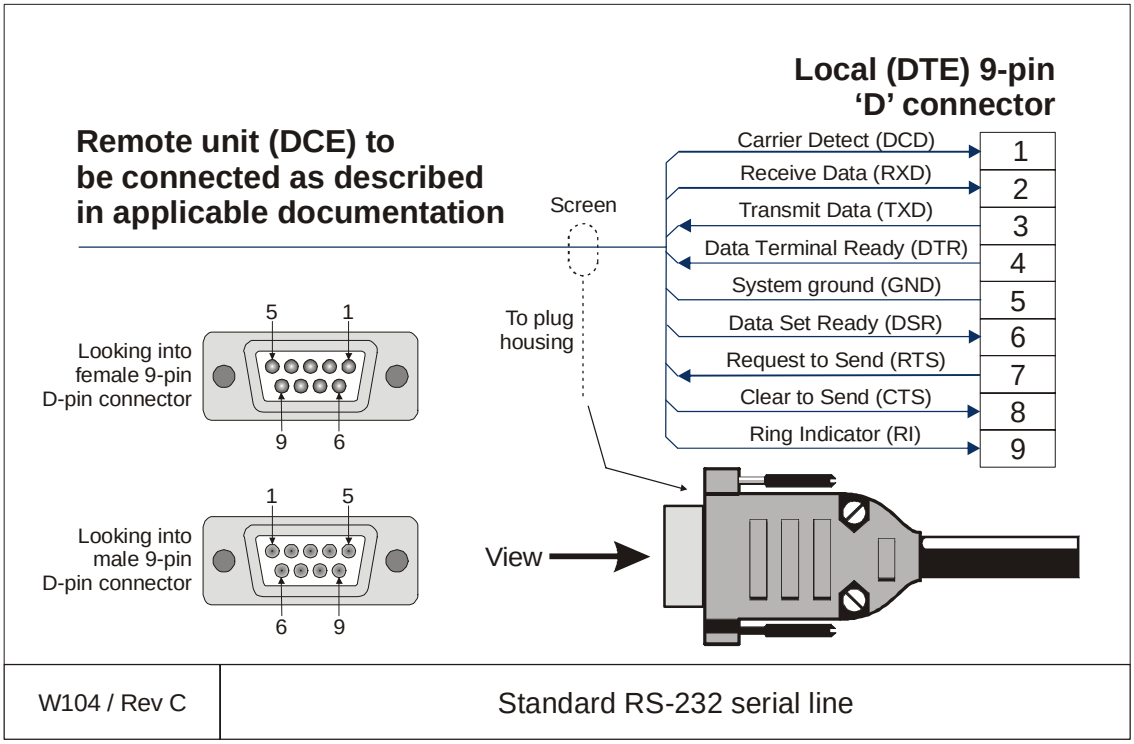
Page 1 of 1 CD4887	Junction Box, outline dimensions	**834-212593** Rev.B



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.

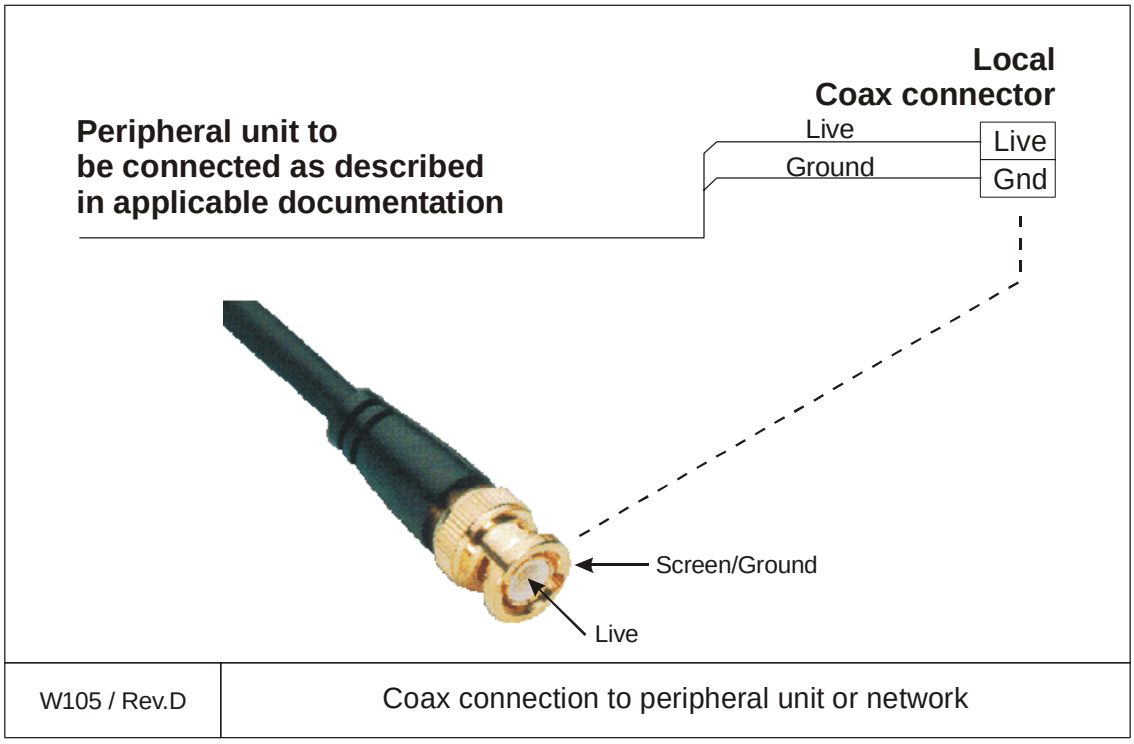


W104 / Rev C	Standard RS-232 serial line

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

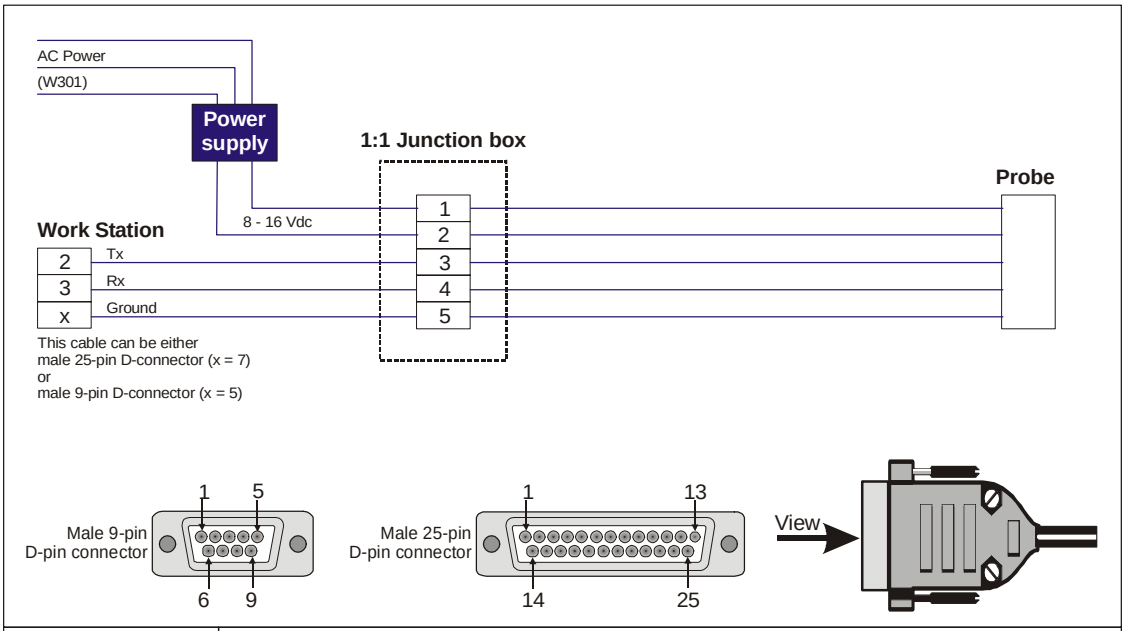
This cable is used for connections to peripheral units or networks.



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.



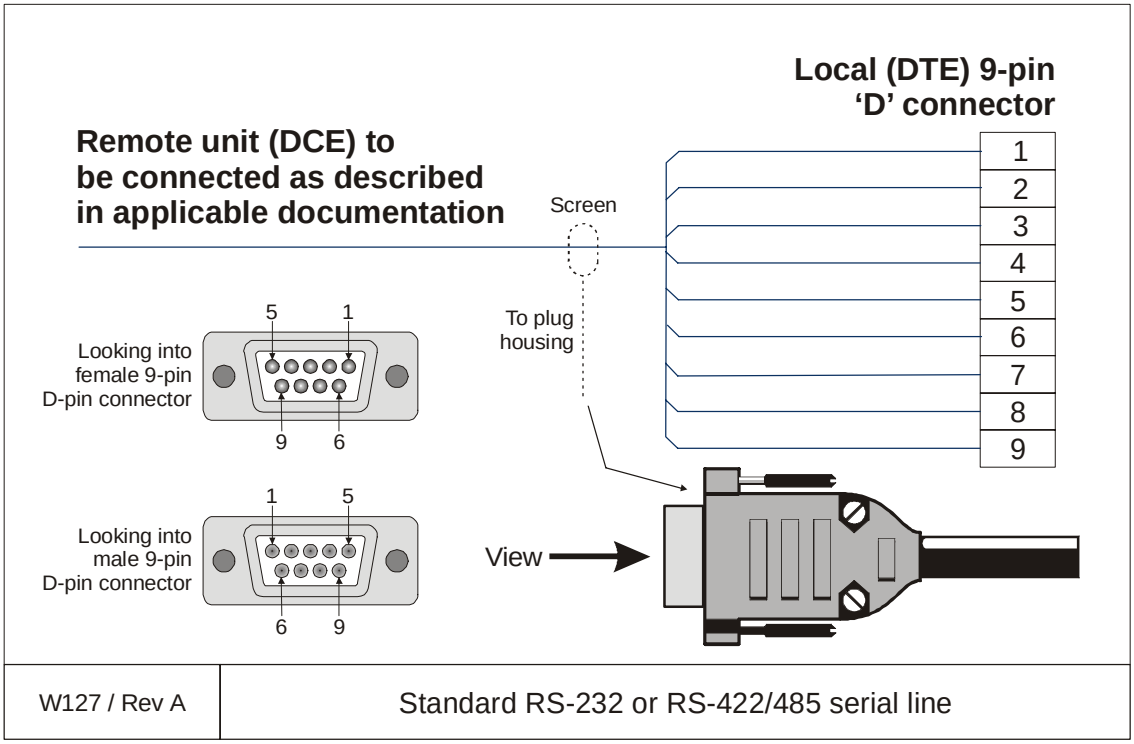
W119 / Rev.C	Sound speed probe interface

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.



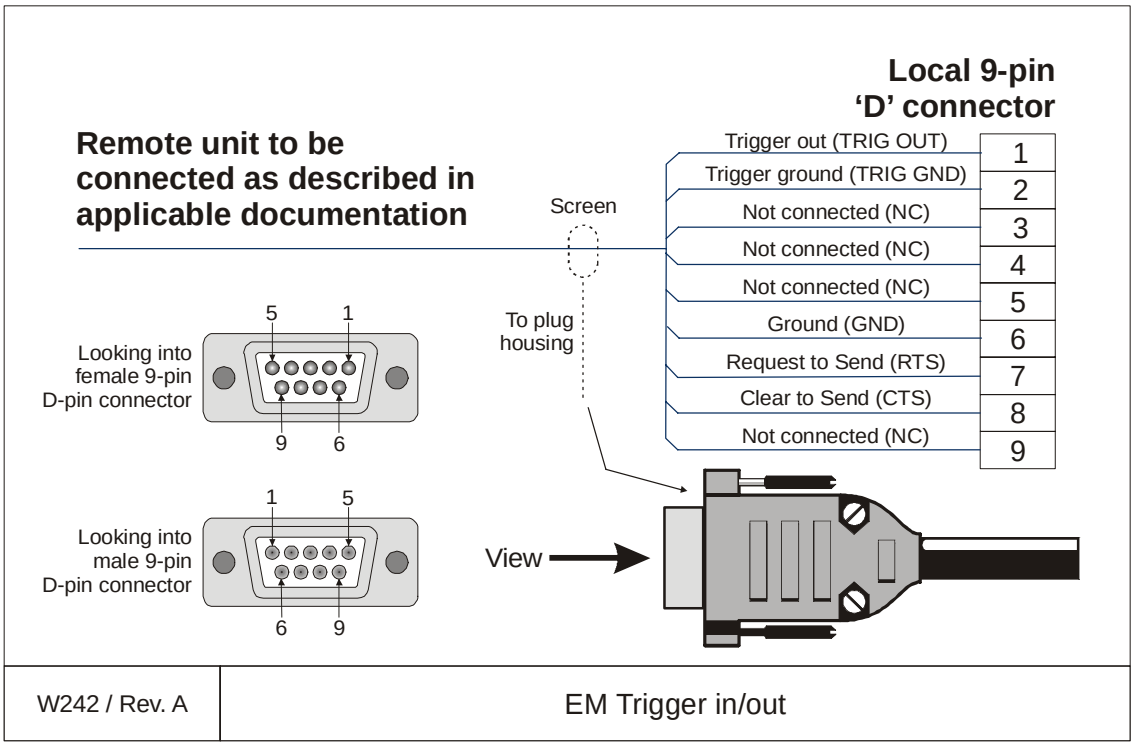
W127 / Rev A	Standard RS-232 or RS-422/485 serial line

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.

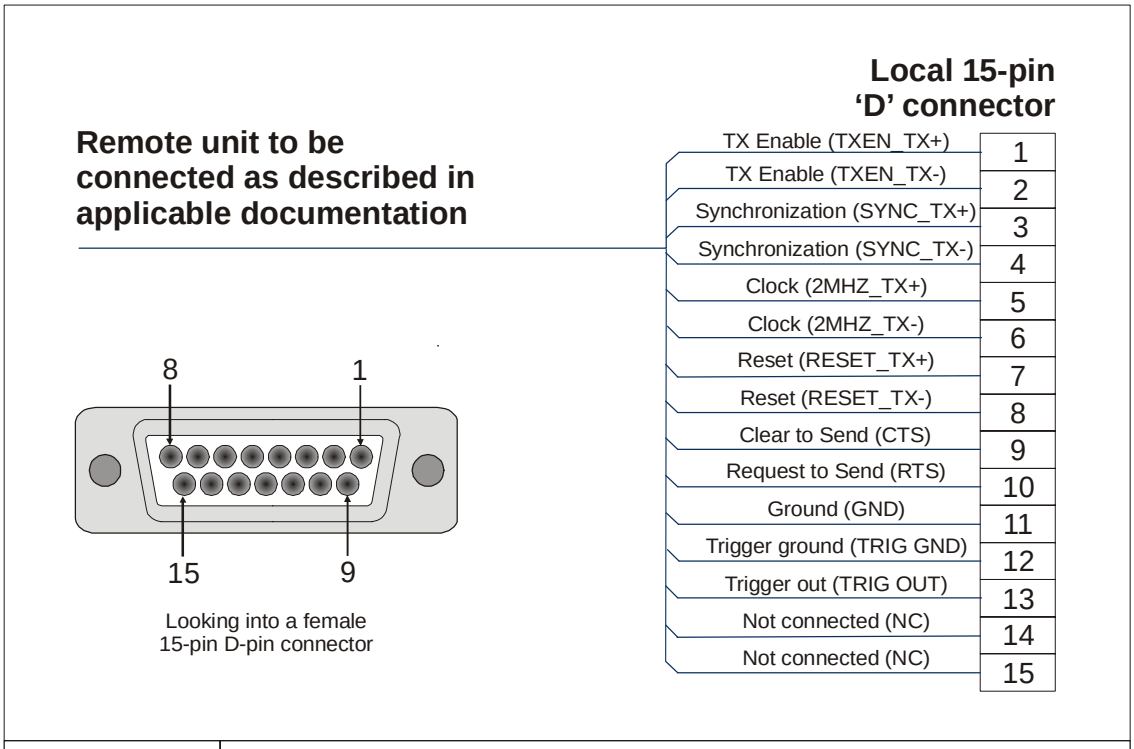


W242 / Rev. A	EM Trigger in/out

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.



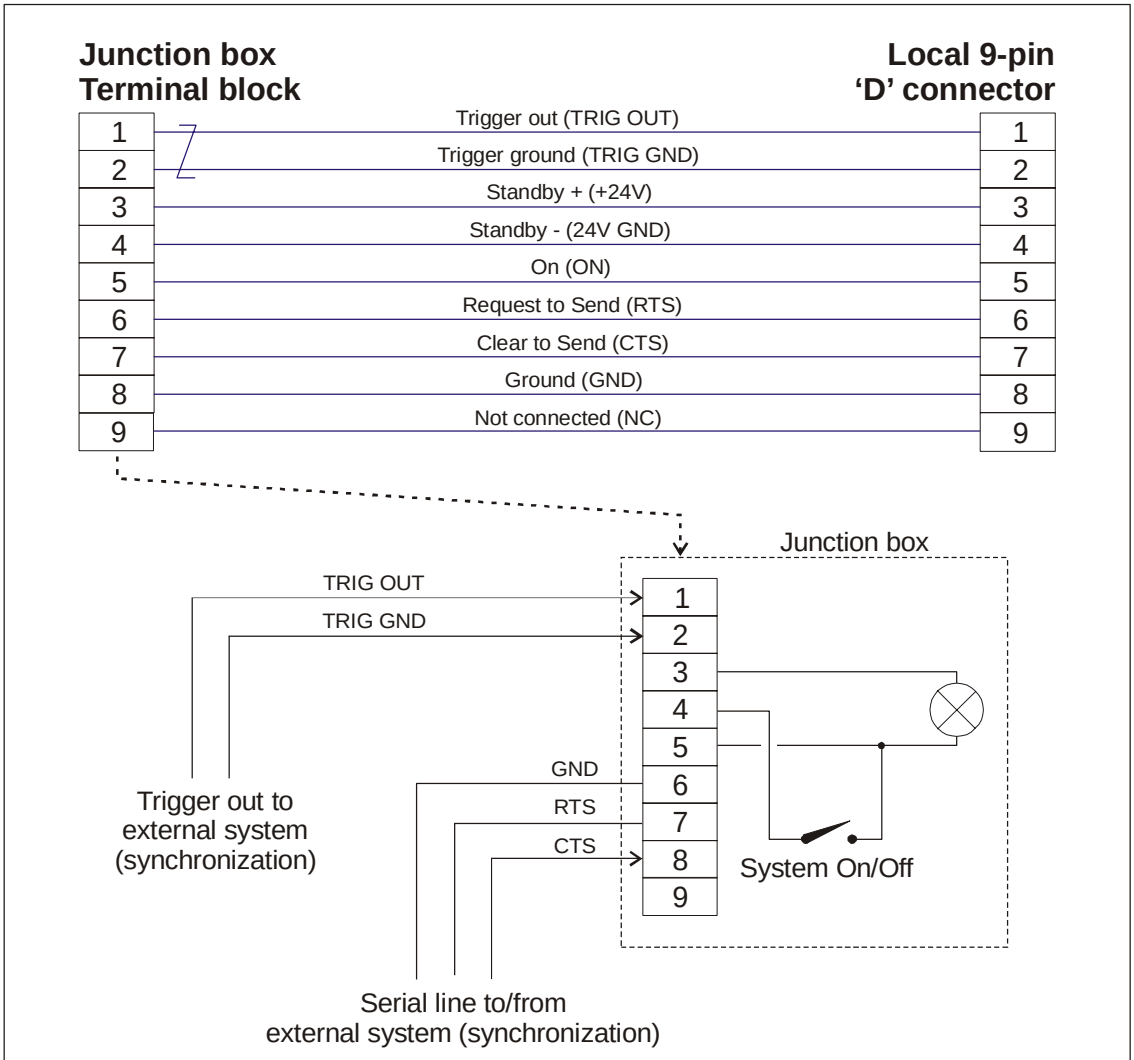
W243 / Rev. A	EM Control signals

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.

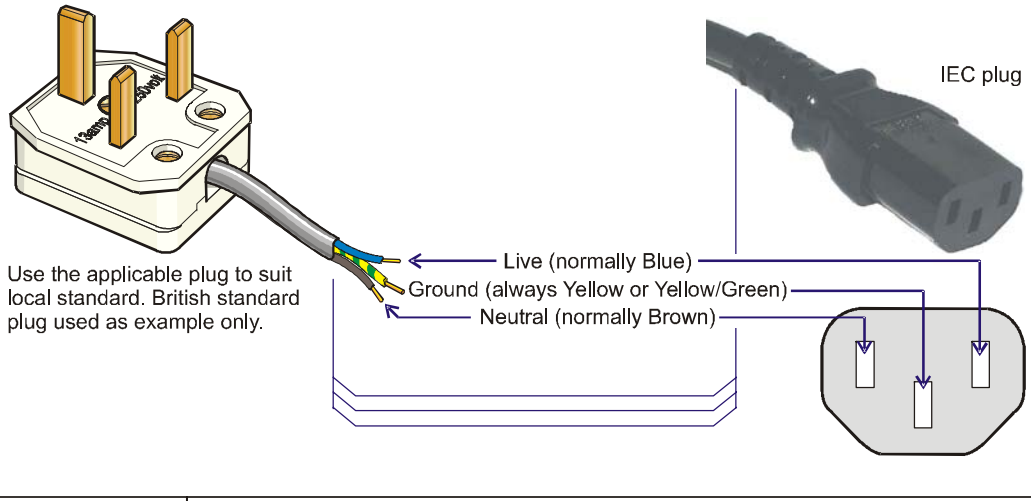


W244 / Rev. A	EM Remote On/Off control and synchronization

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

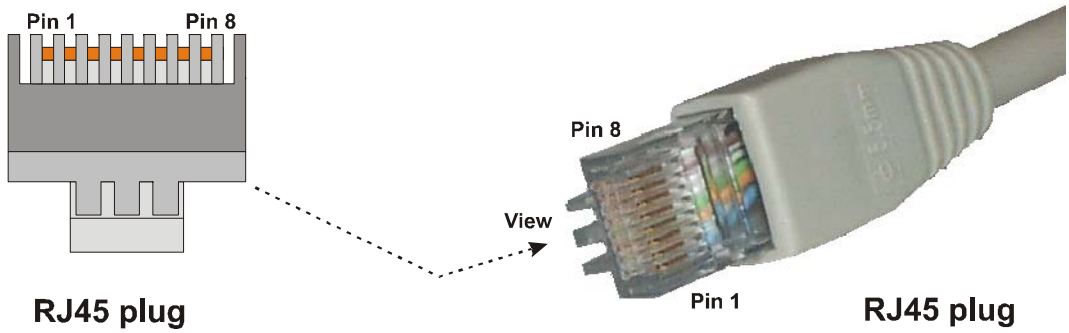
Note

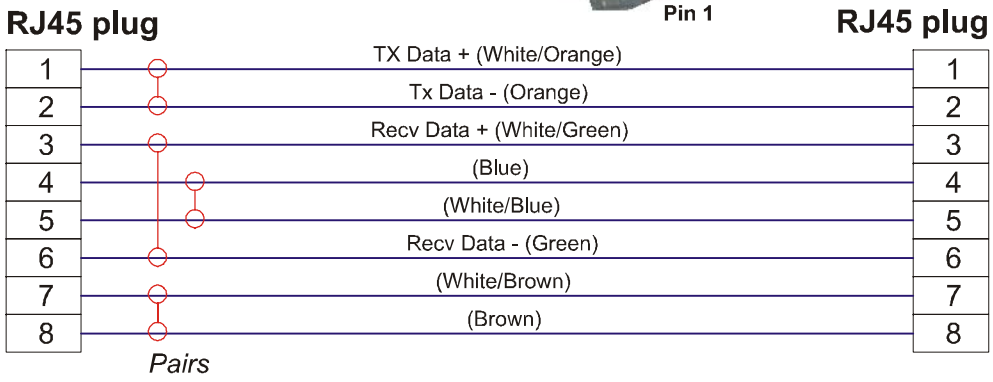
Different cable colours may be used for the "live" and "neutral" wires. Ground is however always on green/yellow.

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

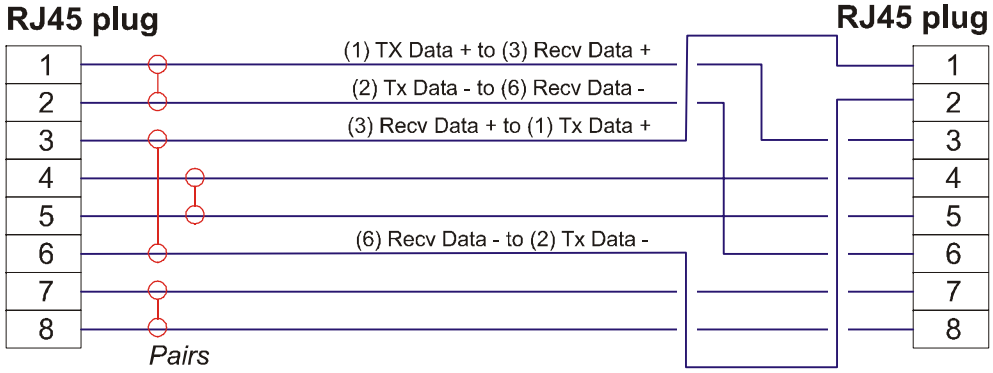
Ethernet with RJ45 plugs (screened)

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 E	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.

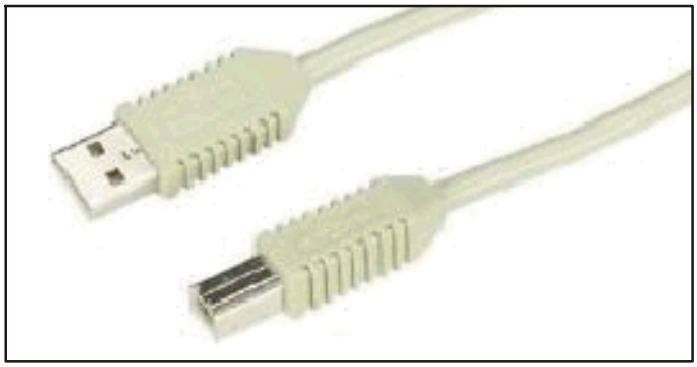
Internal cables:

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

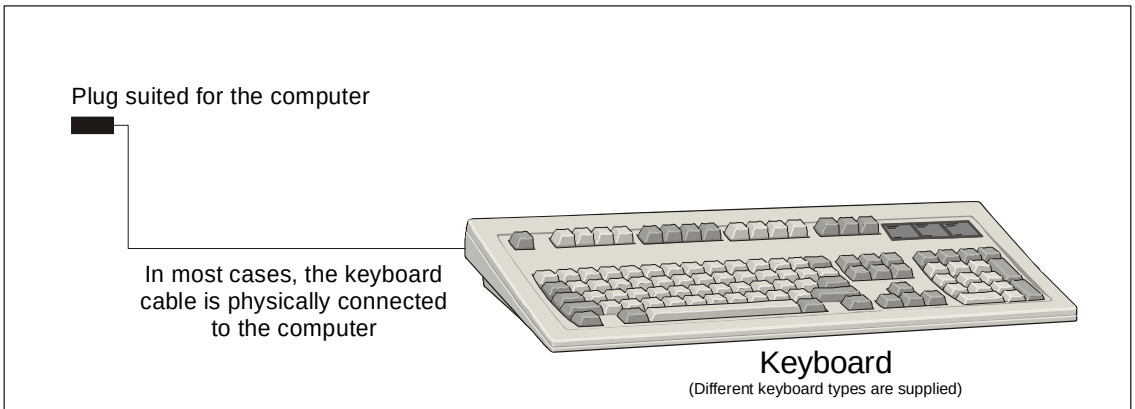


W501 / Rev.A	Commercial USB cable

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

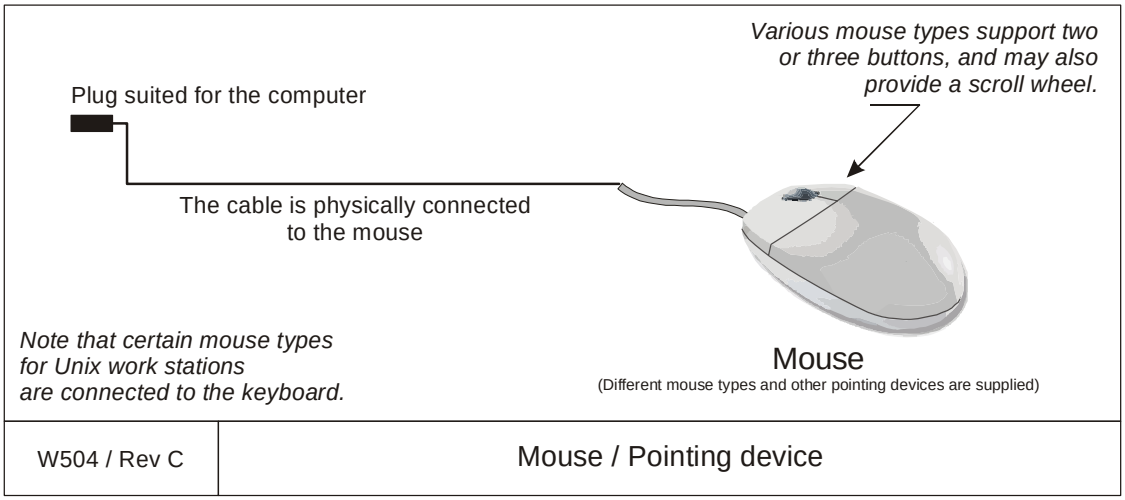
Mouse or pointing device cable

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.

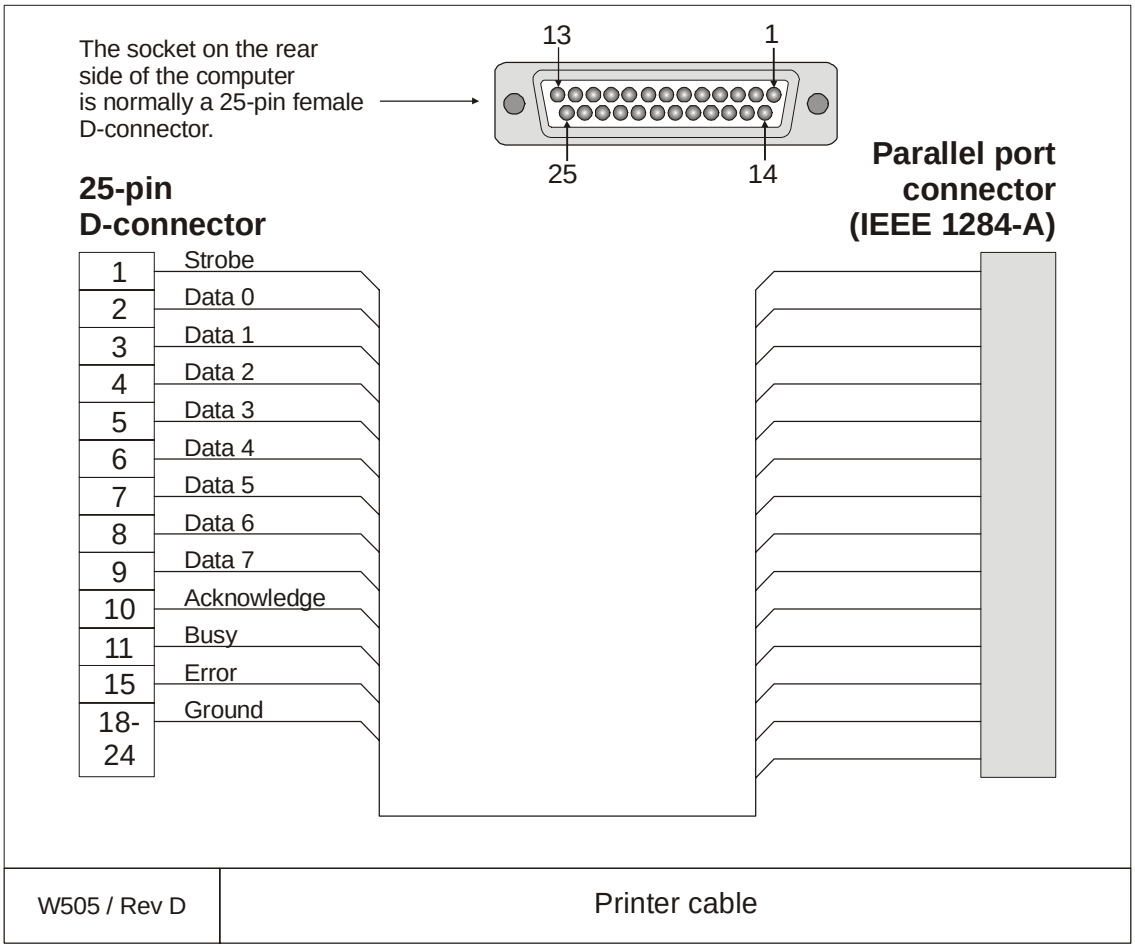
Several mouse and pointing device types are available with two or three buttons, and with or without a scroll wheel. Both the mouse and the attached cable are commercial items.



W504 / Rev C	Mouse / Pointing device

Printer cable

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

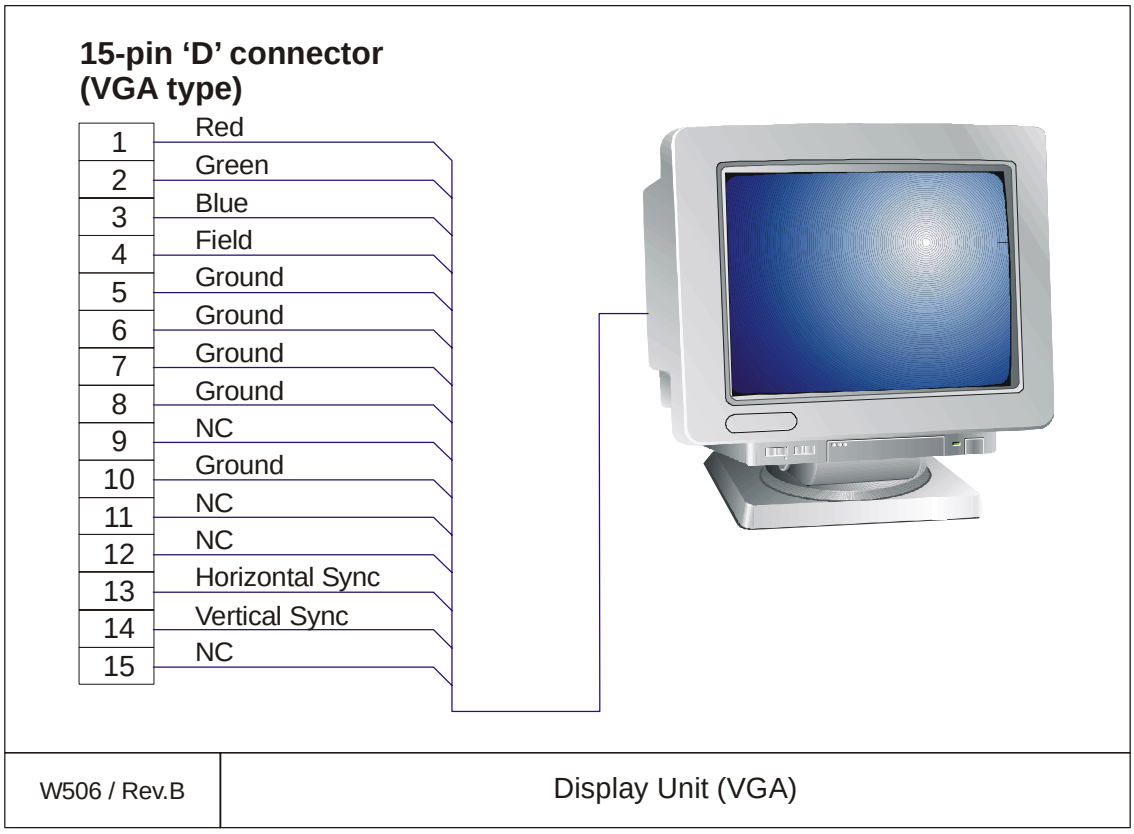


W505 / Rev D	Printer cable

VGA display cable

This is a standard VGA display cable.

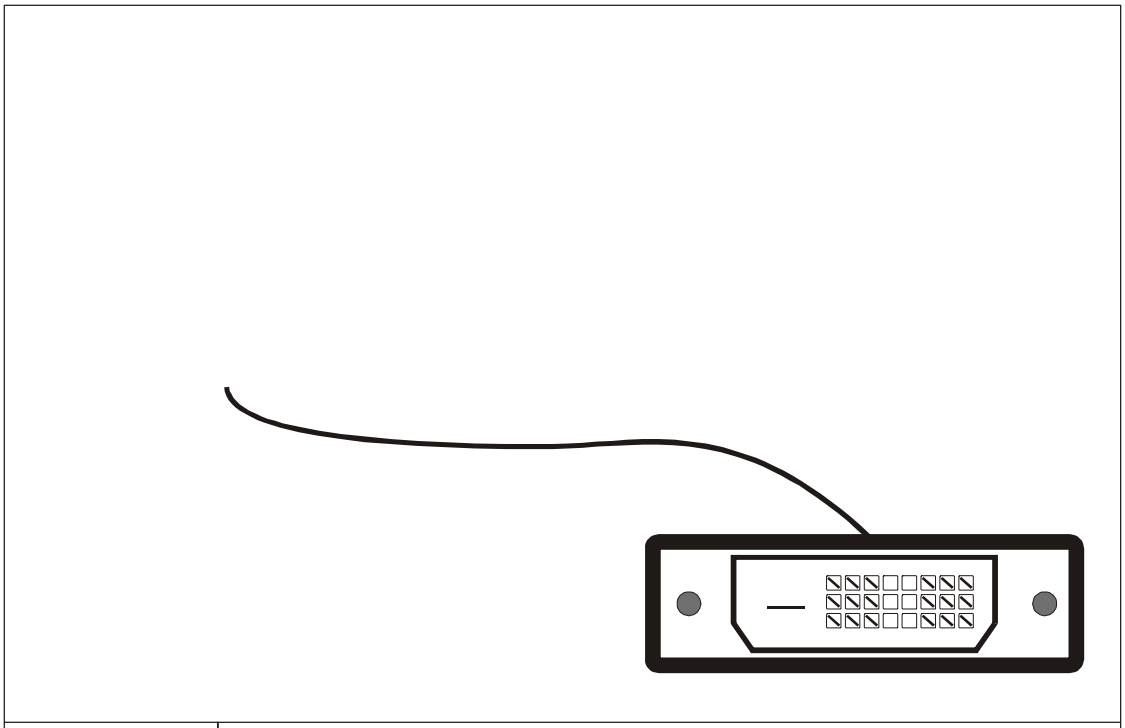
It is terminated in a standard commercial VGA plug. In most cases, the cable is physically attached to the rear side of the display.



W506 / Rev.B	Display Unit (VGA)

Digital Video Interface (DVI) display cable

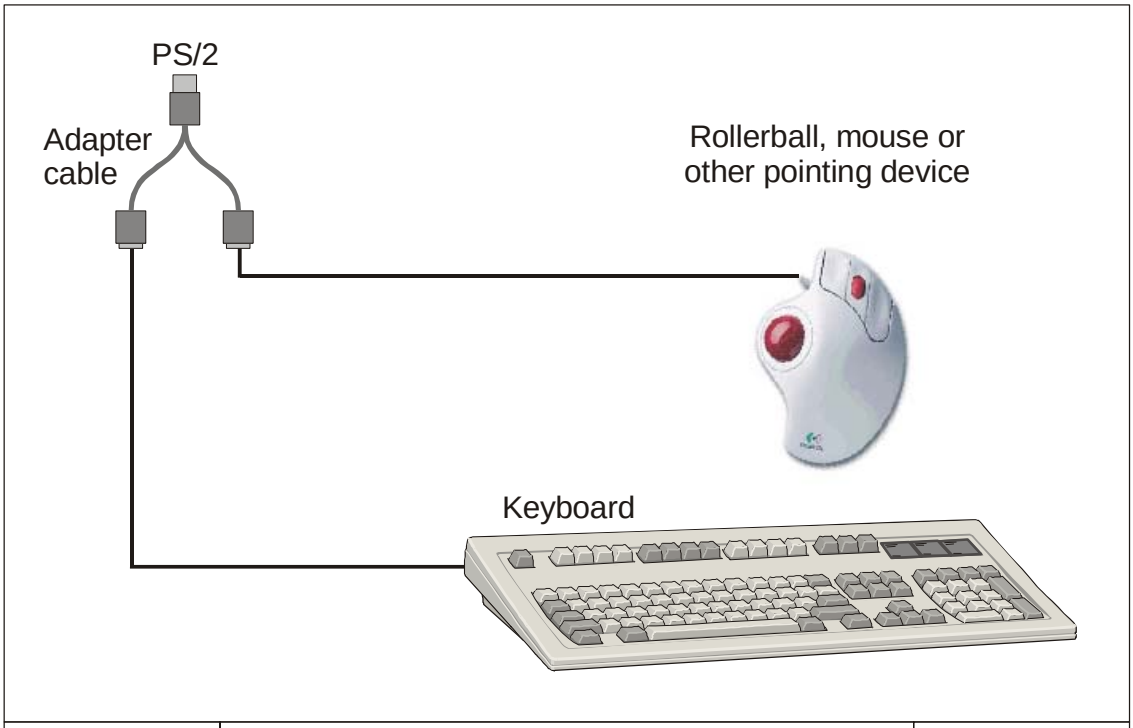
This cable is a standard DVI-I cable. It is connected to the LCD display.



W508 / Rev.A	DVI cable

Keyboard and rollerball

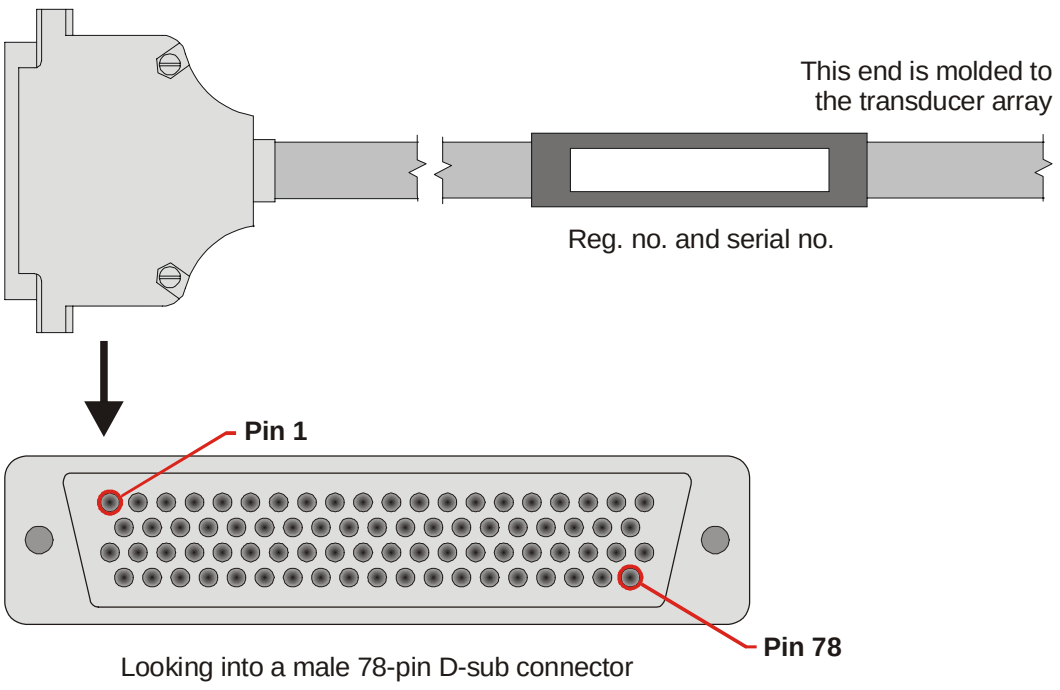
The mouse and the display are both equipped with standard PS/2 connectors. An adapter is used to fit both simultanously into one socket. The adapter must be used at all times, even when the keyboard is disconnected.



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.A	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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