Operator Manual

Kongsberg Simrad EM 12
Multibeam echo sounder

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Note

Kongsberg Simrad AS makes every effort to ensure that the information contained within this document is correct. However, our equipment is continuously being improved and updated, so we cannot assume liability for any errors which may occur.

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

Kongsberg Simrad AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

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Main overview

This book is the Operator manual manual for the Kongsberg Simrad EM 12 multibeam echo sounder. It describes how to operate the EM 12 system safely and efficiently, and how to perform simple tests and basic maintenance.

Remarks

References

Further information about the EM 12 system may be found in the following manuals:

- EM 12 Installation manual
- EM 12 Maintenance manual

The reader

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

Document revisions

Rev	Date	Written by	Checked by	Approved by
A		RB	EHa	EHa
B	18.11.92	OM	EHa	EHa
C	02.06.93	OM	EHa	EHa
D	21.08.98	KR	EHa	EHa
E				
F				
G				

(The original signatures are recorded in the company's logistic database)

To assist us in making improvements to the product and to this manual, we would welcome comments and constructive criticism. Please send all such – in writing or by Email – to:

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References

(The information on this page is intended for internal use)

Documents

Sect	Title	Loc.	File	P.no/Rev
–	Complete book		130058	/D

Document history

Rev.A Original issue

Rev.B New software versions. All sections re–written. Refer to Endr. meld. D 005. Sections 2. Operational Procedures and 8. Bottom Detector Unit not included.

Rev.C Section 12 Appendices added to list of contents. New documents included in sections 2 and 8. Document revisions table updated.

Rev.D Major change to the manual. All document modules removed to create a complete book. Software descriptions changed to cover version OPU 4.x / BDU 1.9x. Refer to EM 130058D.

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1 OPERATIONAL PRINCIPLES

1.1 Introduction

The Kongsberg Simrad EM 12 is a high resolution 13 kHz multibeam echo sounding system, designed to operate in waters from less than 50 m to full ocean depth (11000 m). The beamwidth is 1.8° by 3.5° with a swath width of up to 3.5 times water depth and 81 beams. A dual version, the EM 12D, extends the maximum coverage to 7.5 times water depth with 162 beams. The system is roll– and pitch–stabilized and the advanced signal processing allows the depth to be calculated with an accuracy in the order of 50 to 60 cm or 0.25% of the depth.

The EM 12 design is based on the experience obtained with the Kongsberg Simrad multibeam echo sounder EM 100. This refers especially to the use of interferometric signal processing for determining the transducer–to–sea floor distance for each beam, to the principles used to compensate for vessel motion and ray bending effects caused by sound speed variations through the water column, and to the operator control and data storage systems.

The EM 12 is a complete surveying system when supplemented by the Kongsberg Simrad Merlin logging and data presentation system, and position, vessel motion and sound speed profile sensor. The built–in software translates raw detected ranges to sounding depths and positions on the seabed in real time, presents the data to the operator for quality control, and makes them available on Ethernet for logging and further inspection and use.

The transducer components and electronic circuit boards have been shown to be very reliable, which is as expected as they are either used in other Kongsberg Simrad sonar products, or developed using the same principles as employed in other Kongsberg Simrad equipment.

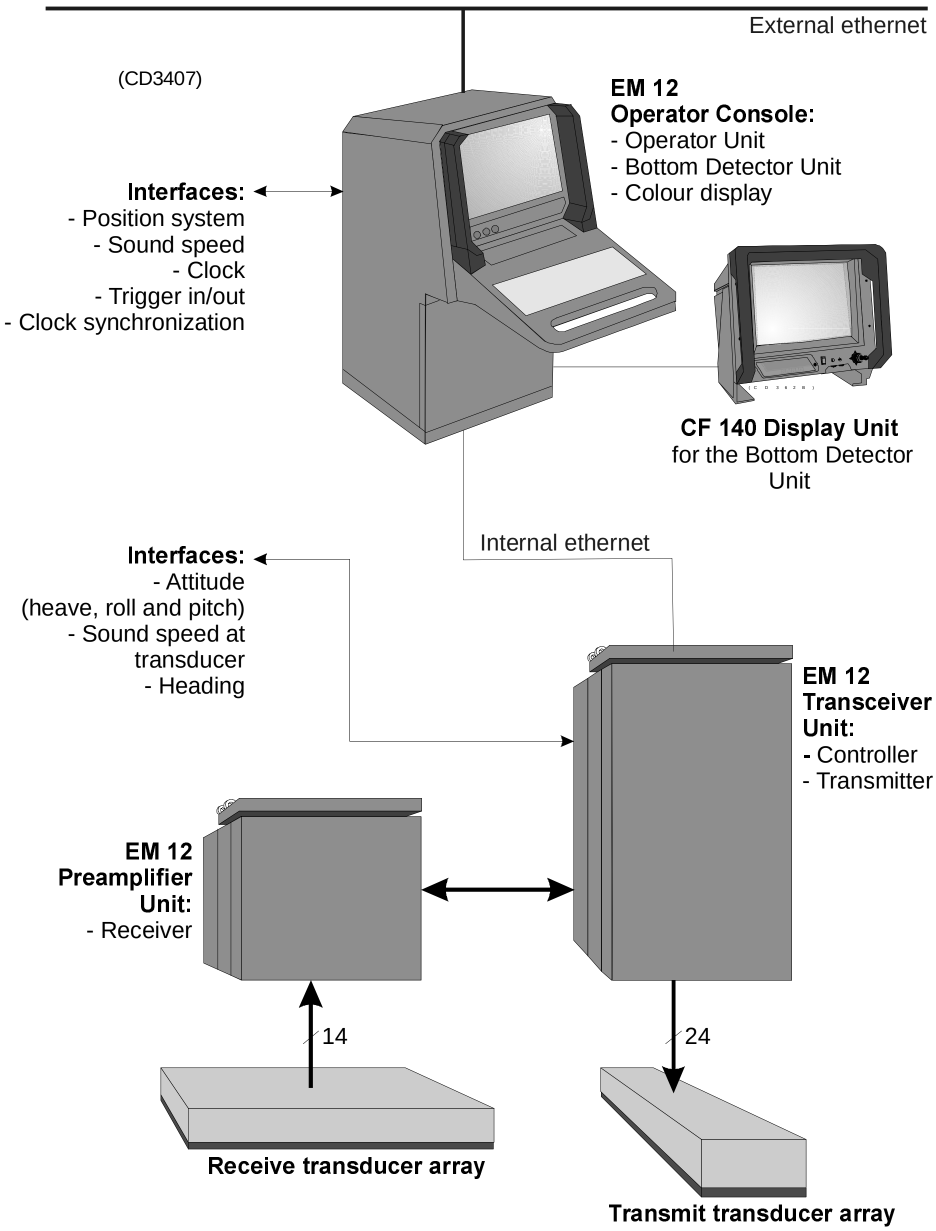


Figure 1 Typical EM 12 system configuration

1.2 EM 12 system description

System composition

The EM 12 is composed of

- transmit and receive transducer arrays
- transmitter sub–system
- receiver sub–system including:
  - beamformer
  - special digital signal processors
- Bottom Detector Unit
- Operator Unit with:
  - external interfaces for data input and output on serial line and Ethernet

The transmitter and receiver sub–systems are physically contained in a Preamplifier Unit and a Transceiver Unit. The Operator Unit is contained in an Operator Console. The EM 12D is basically two single systems except for the Operator Unit which is common.

Also included with existing systems may be units such as:

- Quality Assurance Unit
- Sonar Imaging Unit
- track plotter
- recorder/printers
- data storage device(s)

The EM 12 may also be delivered including the following workstation based software:

- data logging system (Mermaid)
- realtime display system (Merlin)
- post–processing system (Neptune)

Transducer arrays

Arrays

The EM 12 uses separate transducer arrays for reception and transmission. These are mounted in frames bolted to the hull in "T" or "L" configurations (Mill's Cross). The arrays are constructed from individual transducer modules. While the individual ceramic elements are identical, the receive and transmit modules are different due to different scan angle requirements. Each module has one 13.5 m length of cable with individual connections to each element in the module. If additional protection is required, each array may have an acoustic Titanium window mounted in front of it.

In the EM 12 one set of transducer arrays is used, and the arrays are mounted horizontally. In the EM 12D a dual set of transducer arrays is used, and the arrays are tilted to each side of the ship (40° is the optimum tilt angle, but other angles which may ease installation according to hull shape, may be used).

The short receive array is beneficial with regards to installation, and despite its broad beamwidth athwartships, accuracy is maintained due to the phase detection. The narrow fore–and–aft beamwidth of the transmit array is very important to achieve high accuracy and resolution, but the array length this requires usually does not cause installation problems.

Transmit module

- A transmit module contains 16 elements in a 4x4 configuration.
- 24 modules containing a total of 384 elements make up the transmitter array, which has a total length of 4.8 m.
- The transmit array must be mounted parallel to the keel of the vessel.
- The beamwidth is 1.8° in the fore–and–aft direction

Refer to the *Technical specifications* chapter on page 139 for further information.

Receive module

- A receive module contains 15 elements in a 3x5 configuration.
- 14 such modules containing a total of 210 elements make up the reception array, which has a total length of 2.4 m.
- The receive array must be mounted at 90° to the vessel's keel
- The beamwidth is 3.5° athwartships and 18° in the fore–and–aft direction.

Refer to the *Technical specifications* chapter on page 139 for further information.

Sound speed sensor

All the beams in the EM 12 are steered, and to do this correctly requires the sound speed at the transducer to be known. This is especially important for the EM 12D. A sound speed sensor is therefore used to continuously measure the sound speed in the water at the transducer. Its output is monitored and is used in the beamforming calculations. Such a sensor requires regular cleaning, and a good installation method is to mount the unit in a tank above the water line where it is easily accessible. Sea water can then be pumped through the tank from an inlet near the transducers.

Receiver sub–system

Overview

The receiver sub–system consists of:

- analogue preamplifiers
- A/D converters
- a digital beamformer
- digital signal processors

The analogue parts are contained in a separate Preamplifier Unit, while the digital parts are contained in the Transceiver Unit.

Preamplifier Unit

The 210 transducer signals – one for each element – are fed to stave transformers in the Preamplifier Unit. This unit first produces one stave signal for every line of five elements. The 42 stave signals are then fed to individual thick–film preamplifiers.

Each channel has a switchable attenuator network, and a steerable gain.

- The gain (TVG) is controlled by the digital signal processors in the Transceiver Unit in realtime.
- The dynamic TVG range for each channel is 60 dB.
- The TVG run is based on the sonar equation as given below.

The expected backscattering strengths of the normal incidence and the outermost beams are estimated from previous pings as is the depth. A linear interpolation is done between the normal incidence and outermost region, before the analogue output signals from the preamplifiers are coherently sampled and converted from analogue to digital format.

Finally, the data are transferred to the Transceiver Unit.

Transceiver Unit

The Transceiver Unit contains three sub–racks, one each for:

- reception (the digital part)
- transmission
- the unit's main power supplies

The computers used in the Transceiver Unit are special digital signal processors of Kongsberg Simrad design and include interfaces for:

- motion sensor
- heading sensor
- transducer depth sound speed sensor

The interface type delivered is in accordance with installation requirements; analogue, synchro and serial interfaces are all possible.

The reception processing stages consist of:

- beamforming with roll compensation
- digital filtering
- calculation of beam amplitude and phase for 81 beams
- transmission of data through two Ethernet coaxial cables to the Bottom Detector Unit:
  - raw data
  - vertical reference unit data
  - gyrocompass data

Each transmit transducer element is under the direct control of a transmitter signal processor through individual thick–film power amplifiers. The beam is shaped by this processor by setting the relative phases between the amplifier signals and by amplitude shading using pulse width modulation. The sounder frequency is also governed by the same processor. The control signals for the 384 transmitter power amplifiers are calculated by the signal processor. Mode, roll, pitch and sound speed are used as input parameters.

Bottom Detector and Operator Units

Overview

In the Bottom Detector and Operator Units, 80486 microcomputers on an industry standard bus (ISA) are used. The computers run an Intel realtime operating system (iRMX) which takes full advantage of the 80486 microprocessor and is able to handle the high data rates generated by the EM 12. Most of the software is written in a high level language, either C or PL/M, making it easy to interface with other equipment or modify as more powerful processors become available. The two units are interconnected with Ethernet.

Bottom Detector Unit

The Bottom Detector Unit uses the raw data from the Transceiver Unit to derive the ranges to the bottom in each beam. It has a 14 inch colour display and a menu system operated via a joystick on the display.

Power–on and operator entry

During normal conditions, operator entry is usually only required at power–on. However, if the system is equipped with an "ice window" to protect the transducer arrays, this should be entered. Also, the two Bottom Detector Units of the EM 12D must be set up for port and starboard and for synchronization[1]. After the power–on the Bottom Detector Unit is usually remotely controlled from the Operator Unit.

Display

On the colour display of the Bottom Detector Unit, the following data is shown ping–by–ping:

- reception transducer stave amplitudes versus time
- beam amplitude and phase versus time
- beam detection parameters
- bottom backscattering strength for all beams
- a measure of beam incidence angles acrosstrack

The stave amplitudes are very useful in assessing possible aeration, and the beam amplitude and phase display clearly show the effects of interference from other acoustic sources. The other displays are normally only used for test purposes.

The Built–in Test Equipment (BITE) system is run from the Bottom Detector Unit and is mainly used for test of the Transceiver Unit.

Operator Unit

The Operator Unit makes final data conversion from beam ranges to position and depths on the seabed, and interfaces to other systems in the ship. The Operator Unit has:

- a menu system to control all settings and operations of the sounder
- displays:
  - acrosstrack depth profile of the last ping
  - alongtrack depth profile of any selected beam
  - attitude, heading, and position data

Echo data from one selected beam may be chosen to give an echogram representation in that beam, or beam amplitude and phase data may be shown as a function of time, ping by ping.

1. *Except for the synchronization of the transmit pulses, operating mode, and internal clocks, the two sides of the EM 12D operate independently, and if synchronization is turned off, they are completely independent.*

Time tagging

The Operator Unit will usually receive position data from an external system, time–tag this data accurately, and transmit the position, depth and seabed image data on an external Ethernet to a logging system.

Clock resolution for time–tagging is 1/100 second. It is possible to connect the Operator Unit to a master survey clock on board to synchronize its clock with the survey clock of other systems.

Sound speed profile

The standard sound speed profile probe (the Applied Microsystems Ltd. SVP–16) may be read directly into the Operator Unit after a measurement. Alternatively, a profile may be prepared on an external computer and transferred to the Operator Unit, either over the Ethernet or on serial line. Sound speeds may also be entered, edited, and displayed directly on the Operator Unit. In the sound speed ray bending calculations, sound speeds for up to 100 different user–defined depths are used.

Track plotter / printer

The Operator Unit may drive an optional track plotter which gives a coverage plot in geographical coordinates. The track plotter shows the area that has been surveyed on up to A0 size paper (depending on plotter type). It will reveal any gaps in the coverage, and is thus a very useful survey tool. The plotter will first draw a coordinate grid according to your specification, and will then draw in one line per ping. Each line represents the line on the sea floor covered by that ping, so that as the ship moves, a corridor or "swath" is marked.

An echogram of any beam may also be displayed and printed on an HP PaintJet. The PaintJet may also be used for hardcopy of the Operator Unit screen.

1.3 EM 12 implementation

Operating modes

The transmit fan is roll– and pitch–stabilized, and in deep mode it is split in five (10 on the EM 12D) separate sectors to maximize source level and hence coverage. The receive beams are roll–stabilized and the receive beamforming is done through a combination of time delays and phase interpolation. Either equidistant and equiangle beam spacing may be chosen by the operator.

Two depth modes with different pulse lengths are implemented as described in Table 1 below:

Mode	Depth	Pulse length
Shallow	50–700 m (EM 12D) 500–1200 m (EM 12)	2 ms
Deep	500–11000 m	10 ms

Table 1 EM 12 Depth modes

The coverage achieved will depend on the version, and in accordance with the range capabilities given by the sonar equation. Typical coverage is as described in Table 2 below.

System	Depth	Coverage
EM 12D	Shallow waters	7.4 x water depth
	>2000 m	at about 15 km
EM 12	To approx. 4000 m	3.5 x water depth
	Deep waters	up to 20 km

Table 2 EM 12 Coverage

The EM 12 has three sectors with equidistant beam spacing available in its deep mode, all with 81 beams:

- 120°
- 105°
- 90°

The horizontal beam spacing and depth capability of these sectors are shown in Table 3 below.

Note that the coverage and depth capability of the 120° sector may be reduced if the vessel's roll is excessive, and the depth capability may vary according to the bottom conditions.

Angular sector	Maximum coverage	Usable depth range	Horizontal beam spacing
120°	3.5 x depth	50–5500 m	0.043 x depth

105°	2.6 x depth	5000–8000 m	0.033 x depth
90°	2 x depth	7500–11000 m	0.025 x depth

Table 3 EM 12 equidistant beam spacing

The EM 12D has five different sectors with equidistant beam spacing available in its deep mode, all with 162 beams:

- 150°
- 140°
- 128°
- 114°
- 98°

The horizontal beam spacing and depth capability of these sectors are shown in Table 4 below.

Note that the coverage will not be roll dependent as for the EM 12, but depth capability may vary with different bottom conditions.

Angular sector	**Maximum coverage**	**Usable depth range**	**Horizontal beam spacing**
150°	7.4 x depth	50–3000 m	0.047 x depth
140°	5.5 x depth	2500–4200 m	0.035 x depth
128°	4.1 x depth	3500–6000 m	0.026 x depth
114°	2.9 x depth	5000–8000 m	0.019 x depth
98°	2.3 x depth	7000–11000 m	0.015 x depth

Table 4 EM 12D equidistant beam spacing

The EM 12 has been designed with ease of operation in mind. Usually, the system operates without operator intervention, tracking the bottom and changing modes as required. Upon startup or in case the bottom is lost, which may happen for example if air is trapped beneath the transducer, the system recovers the bottom automatically.

The operating frequency of the EM 12 is 13 kHz. At this frequency, the absorption coefficient is in the range of 0.6–1.8 dB/km, varying with depth and temperature. Typical mean values through the water column are:

- 1.1 dB/km .... very deep waters
- 1.2–1.4 dB/km .... to 4000 m in equatorial waters

Due to the low frequency, which is required for a good coverage in deep waters, it is possible that under some special bottom conditions, the sound pulse will penetrate into the top layer without appreciable attenuation, causing the measured depth to be too large. The attenuation of the bottom can usually be given as *kf* where:

f is frequency in kHz

k is a bottom–dependent constant (usually ≈ 1 dB/m)

For fine silt with very high porosity, i.e. large water content (>60%), $k \approx 0.1$ dB/m or even less, giving a two–way absorption of 2.5 dB/m or less, causing penetration. This effect is most prominent with amplitude detection at a non–zero incidence angle. Phase detection is not very much affected, so in the EM 12, this effect will usually only be seen in shallow waters.

Raybending

The raybending is calculated through table look–up. The sound speed at the transducers, either measured or entered manually, is used for the determination of beam angles and may also be used to determine an initial raybending.

1.4 System theory and error sources

Conventional techniques

A single beam echo sounder obtains depth by measuring the time a sound pulse takes to propagate to the bottom and multiplying this time value by the mean speed of sound in the water column. Good accuracy depends on:

- small beamwidths in the echo sounder transducer
- a good estimate of sound speed
- a well–designed pulse receiver and detector

A single beam echo sounder normally only measures the depth vertically. To measure to the side, one could imagine using a mechanically tiltable transducer or multiple transducers, but electronic beamforming, i.e. the forming of multiple beams from a single transducer array, achieves the same results in a more cost–effective way. For good measurement density, the beamforming on the receiver side must be fast enough to allow simultaneous detections in all beams. The transmit transducer in a multibeam echo sounder must ensonify the area to be measured within the coverage of the receive transducer, which in principle does not require the use of multiple transmit beams.

The accuracy of a multibeam echo sounder depends on the same factors as those of the ordinary echo sounder. In addition, it is not enough merely to know the mean sound speed in the water column, but a detailed knowledge of how the sound speed varies with depth is also required. This is because the sound path is usually not straight when it is not vertical, and the resulting so–called "ray bending" must be calculated by the use of the actual sound speed profile to find the correct depth and location of soundings taken to the side.

Both single beam and simpler multibeam echo sounders use only amplitude detection to determine the travel time of the sound pulse. When the sound has a zero angle of incidence to the seabed, a good detection principle is to estimate the time of arrival of the leading edge of the returned echo. As the angle of incidence increases with beams measured to the side or when the seabed directly below the vessel is not horizontal, the returned echo loses its sharp leading edge. When the angle of incidence becomes sufficiently large, the echo will be so smeared out in time that an accurate simple amplitude detection is no longer possible. One is then required to use more sophisticated methods, for example using the variation in echo strength over the beam.

Sidescan sonars provide a "photographic" image of the seabed, and this may give an indication of the bathymetry. In some sidescan systems, an approximate measurement of depth has been achieved by using phase detection through an interferometric principle. By comparing the phase of the returned echo on two or more physically separated transducers, the angle of arrival may be estimated in addition to the range. However, this only works when the angle of incidence is large or the seabed is relatively flat, as the phase information may be destroyed when simultaneous echoes are received from different parts of the seabed. Note that a similar phase detection principle is used with success in short or ultra–short baseline acoustic positioning systems, in radars (usually called monopulse) and in optics (usually called splitbeam, a term which is also used in connection with ultra–short baseline positioning systems).

Advanced techniques

Phase detection method

The problem of multiple echoes with the phase detecting sidescan sonars can to a large extent be overcome by combining phase detection with the multi–beam principle. For each beam, two additional so–called halfbeams are formed from different sub–arrays of the receive transducer, with all three beams having the same pointing direction. The phase difference between the halfbeams, which is a measure of the angle of arrival of the returned echo, is calculated from the complex conjugate product of the two received signals, usually after some averaging of the product is done. The degree of averaging needed is determined by a combination of pulse duration, range and incidence angle, and is in practice derived from extensive simulations and experimental verifications. The averaging stabilizes the phase determination, reducing the effect of glint or random variation in signal strength due to destructive interference from different parts within the area producing the echo at any given time.

The distance between the acoustical centre of the two sub–arrays used to form the halfbeams determines the relationship between electrical phase and angle of arrival. When the phase is zero, the returned echo from the bottom comes in the centre of the beam. The phase as a function of time will theoretically be a second order function for a flat bottom, modulated by local changes in bottom curvature and by noise. A curve fit made to this time series of phase, from which the zero phase crossing can be determined, will therefore allow a very accurate determination of the range to the bottom in the centre of the beam, with a much higher accuracy than any method based only on amplitude information can provide.

Amplitude detection method

To achieve a valid curve fit to the angle of arrival time series, a minimum number of samples is required, so that the incidence angle or depth cannot be too small. Thus an amplitude–based method is required as a backup to the phase detection method. As noted earlier, at normal incidence the leading edge of the echo may be used, while at larger angles of incidence, the amplitude series across the beam is required.

If the bottom is flat or has a constant slope with uniform seabed composition, the amplitude time series will have a variation which is determined only by the beam pattern. Then, the maximum amplitude or, somewhat better, the mean of for example the –3 dB points, may be used to determine the range at the centre of the beam. However, with local slopes or variation of backscattering strength within the beam footprint, these simple detection principles do not give consistent results. Presently the best amplitude detection method seems to be the determination of the centre of gravity of the echo within the beam, but even this method is affected by local variations in seabed composition. Its use should thus be restricted to reasonably short echoes, which fortunately makes it a good alternative for the cases where the phase detection method fails.

Bottom detection

In the EM 12, the bottom detection is done as follows:

1 A search in range in each beam is first performed on sample amplitudes to determine where the bottom echo is.
The search is:

- limited to be within a range window whose extent has been established from where the bottom has been found in previous pings
- based on a sliding mean of the sample amplitudes to limit effects of noise. A minimum amplitude is required based upon the bottom backscattering strength found in previous pings.

2 Phase detection is then done, provided that there are more than 10 range samples within the –3 dB part of the beam pattern.

- If the curve fit has a sufficiently low variance, the resulting detection is accepted (both a second and a first order curve fit are tried, the latter over 3/4 of the samples, and the result of the one with the lowest variance is retained).
- If phase detection is not accepted an amplitude detection is done, provided that the number of samples within the –10 dB points is not too large.

The first round of detections is performed independently in all beams. A filtering of the detections is then done to eliminate spurious detections due to sidelobe echos, echos from fish, noise, etc. The severity of this filtering is determined by menu input from you.

3 A second round of detections is then performed on the beams with missing or rejected detections, but within limited range intervals as determined from where the bottom is (calculated from the ranges determined in neighbouring beams with accepted detections).

As in the first round phase detection is tried first and amplitude detection only if phase detection fails. Relaxed acceptance criteria are used in this second round, and a final filtering is done afterwards. With this procedure, the choice of detection method is not dependent upon the past history, but may adapt instantly to changing bottom topography.

After bottom detection the raw ranges and beam angles are converted to depths and positions relative to the water level and the vessel positioning system location respectively. Full account is taken of:

- the installation angles and location of the transducer
- any lever arm corrections needed to calculate additional heave due to pitch and roll not being measured at the transducer location
- the vessel draft and the location of the positioning system

Error sources

General

A multibeam echo sounder has, as any other measuring instrument, an inherent limit in its achievable accuracy. The total measurement accuracy, i.e. the uncertainty in the depth and location of the soundings, will in addition depend upon the inherent errors of additional instruments, i.e. vessel motion and heading sensors and positioning system, and the sensor(s) used to measure the speed of sound at the transducer and through the water column. In this section these error sources are quantified and discussed as far as possible, thus allowing the user of the multibeam system to judge the possible accuracy achievable under the specific conditions in which the system is operating.

All errors given below may be assumed to be RMS errors provided the sensor errors used are also RMS errors or RMS uncertainties. With this simplification the total system error can be calculated by the root mean squared addition of the individual contributions. Note that because of this, no effort has been made with respect to the signs of the individual error terms, and as given below the signs may thus not always be correct.

The coordinate system used assumes the x–axis to point forwards (alongtrack), the y–axis to point starboard (acrosstrack), and the z–axis to point vertically downward. A normal installation is assumed with all beam–steering in the y–z plane

Errors in range (ΔR in m) and angle ($\Delta\phi$ in radians) will translate into vertical errors (Δz) by simple geometry with ϕ as the angle from the vertical considered:

$$\Delta z = \Delta R \cos\phi$$

$$\Delta z = \Delta\phi R \sin\phi = \Delta\phi D \tan\phi$$

The position error (Δx or Δy) is also determined by range and angular errors:

$$\Delta x \; or \; \Delta y = \Delta R \sin\phi$$

$$\Delta x \; or \; \Delta y = \Delta\phi R \cos\phi = \Delta\phi D$$

Echo sounder errors

The error of a multibeam echo sounder is theoretically dependent upon a signal–to–noise ratio. However, provided that the signal–to–noise ratio is above 10 dB, the following equations have been found to model the depth and acrosstrack position errors of the Kongsberg Simrad multibeam echo sounders very well:

$$\Delta_{Z_A} = \sqrt{\left[\left(\frac{\Delta R_s}{2}\right)^2 + \left(\frac{c\tau}{4}\right)^2\right]\cos^2\phi + \frac{\Psi_y^2 D^2 \tan^2\phi}{144}}$$

$$\Delta_{Z_P} = \sqrt{\left[\left(\frac{\Delta R_s}{2}\right)^2 + \left(\frac{c\tau}{4}\right)^2\right]\cos^2\phi + 0.04\Delta R_s \Psi_y D \sin\phi}$$

$$\Delta_{Y_A} = \sqrt{\left[\left(\frac{\Delta R_s}{2}\right)^2 + \left(\frac{c\tau}{4}\right)^2\right]\sin^2\phi + \frac{\Psi_y^2 D^2}{144}}$$

$$\Delta_{Y_P} = \sqrt{\left[\left(\frac{\Delta R_s}{2}\right)^2 + \left(\frac{c\tau}{4}\right)^2\right]\sin^2\phi + \frac{0.04\Delta R_s \Psi_y D \cos\phi}{\tan\phi}}$$

Here, ΔR_s is the range sampling distance, Ψ_y is the acrosstrack beamwidth, and the indexes A and P refer to amplitude and phase detections respectively. The first term in the above equations is due to range error and the second to angular error. The system will usually use phase detection for long echoes (oblique beams) and amplitude detection for short echoes (near–nadir beams).

The alongtrack position error (Δx)

$$\Delta x = \frac{\psi_x R}{\sqrt{12}} \approx \frac{0.3\psi_x D}{\cos\phi}$$

Here, ψ_x is the alongtrack beamwidth.

Seabed topography will in principle contribute to vertical error by the effect it has on echo level and hence signal–to–noise ratio. Local variations of depth within the beam footprint will cause vertical errors, with amplitude detection being most affected. Seabed slope will in principle not cause vertical errors, but repeatability will be affected. As it will not be possible in post–processing to discern between the two; it is prudent to convert the total position error to a vertical error by multiplying the total position error by the slope gradient.

Any errors in system installation measurements larger than recommended in the *Installation Manual* and any errors in vessel draft, tide and datum heights will contribute directly to the total position system error.

Attitude sensors

In addition to the inherent errors of the multibeam echo sounder, the errors in motion sensor and gyrocompass measurements of heave, roll, pitch and heading errors contribute to total measurement accuracy.

Heave

Errors in heave will contribute directly to the total vertical error.

Roll errors

Errors in roll will contribute to depth and acrosstrack position errors:

$$\Delta z = D \Delta r \tan \phi$$

$$\Delta y = D \Delta r$$

Note that with older motion sensors there may be dynamic errors additional to the manufacturer's stated inaccuracy due to vessel horizontal accelerations, for example resulting from vessel turns.

Pitch errors

Errors in pitch will cause depth and alongtrack errors given by:

$$\Delta z = \frac{D \Delta p^2}{2}$$

$$\Delta x = D \Delta p$$

Heading errors

Errors in heading will cause alongtrack errors (Δx) and acrosstrack errors (Δy) given by:

$$\Delta x = D \Delta h \tan \phi$$

$$\Delta y = \frac{D \Delta h^2 \tan \phi}{2}$$

Note that the heading error of a gyrocompass is latitude-dependent and also usually influenced by horizontal accelerations.

In practice only roll error will be significant with regard to depth error and heading error in a gyrocompass with regard to alongtrack position error, while other motion and heading sensor angular error effects can usually be ignored. However the pitch error may be significant if the fore-and-aft distance between the motion sensor and the transducers is very large. Note also that while the dynamic pitch and roll accuracy of high performance motion sensors are in the order of 0.05°, there may be much larger static offset errors due to incorrect alignment of the motion sensor which may be significant. If the heading is from a system where two GPS receivers are used to derive heading, the heading accuracy may approach 0.05°, making the heading error contribution to total system accuracy insignificant.

Sound speed errors

Errors in sound speed will cause different errors depending on their nature and on the transducer configuration of the multibeam echo sounder. Sound speed errors may be due to sensor errors which can be modelled as an offset or bias plus noise. Especially the offset may be temperature- and depth-dependent. Sound speed errors may also be due to unmeasured changes in the water column with time and position. Sound speed errors are difficult to quantify in practice and the problems with temporal and positional variations may sometimes be so large that the only practical solution is to limit angular coverage.

Sensor-related errors

Noise in the measurement of the sound speed profile will not lead to any significant depth or position errors if it has a zero mean through the water column.

A fixed offset in the sound speed sensor will always give a range error and, if beam steering is used (in which case the beam pointing angle will be in error), also an angular error:

$$\Delta R = \frac{R\Delta c}{c}$$

$$\Delta\phi = \frac{\Delta c \tan(\phi - \beta - r)}{c}$$ only with electronic beam steering

Here, β is the installation tilt angle of the transducer array and the roll angle.

Depth and position errors

- Without electronic beam steering, the resulting depth and acrosstrack position errors are:

$$\Delta z = \frac{\Delta c D}{c}$$

$$\Delta y = \frac{\Delta c D \tan\phi}{c}$$

- With electronic beam steering, the resulting depth and acrosstrack position errors are:

$$\Delta z = \frac{\Delta c D}{c}\left[1 - \tan\phi \tan(\phi - \beta - r)\right]$$

$$\Delta y = \frac{\Delta c D}{c}\left[\tan\phi + \tan(\phi - \beta - r)\right]$$

To keep the sound speed sensor-related error to a nearly negligible magnitude, the sensor offset should be less than 1.5 m/s for a non-steered transducer, and less than 0.25 m/s for a horizontally mounted linear array with 140° coverage.

If the change in sound speed at the transducer depth extends deeper, there will be an additional range error, but the angular error remains unchanged. This range error is usually too small to be significant however, unless the change in sound speed is very large or is effective over a large depth range.

Sea surface related errors

Temporal and position–dependent sound speed variations may be modelled as for sensor errors, except when the sound speed variation is at the surface, or more correctly, at the transducer depth. The resulting error then depends upon transducer configuration, or on how much electronic beam steering is applied. For a curved or semi–circular transducer array, no or only a limited amount of steering is required, depending on the angular extent of the transducer with respect to angular coverage capability. For a linear or flat array, electronic beam steering is always applied except for the beam normal to the array, but the amount of steering applied for a particular beam pointing angle with respect to the vertical will depend upon the installation tilt angle of the array and also on the amount of roll.

The following equations assume that the sound speed error at the surface is modelled as a change in value from that actually used in the calculation of beam pointing angles and raybending. It is assumed that the change takes place at the transducer depth only, in which case there is no range error, but an angular error regardless of whether electronic beam steering is applied or not.

$\Delta\phi = \frac{\Delta c}{c}\tan\phi$ without electronic beam steering

$\Delta\phi = \frac{\Delta c}{c}[\tan\phi - \tan(\phi - \beta - r)]$ with electronic beam steering

Without electronic beam steering, the resulting depth and acrosstrack position errors are:

$$\Delta z = \frac{\Delta c}{c} D \tan^2\phi$$

$$\Delta y = \frac{\Delta c}{c} D \tan\phi$$

With electronic beam steering, the resulting depth and acrosstrack position errors are:

$$\Delta z = \frac{\Delta c}{c} D \tan\phi[\tan\phi - \tan(\phi - \beta - r)]$$

$$\Delta y = \frac{\Delta c}{c} D[\tan\phi - \tan(\phi - \beta - r)]$$

If the change in sound speed at the transducer depth extends deeper, there will be an additional range error, but the angular error remains unchanged. This range error is usually too small to be significant, however, unless the change in sound speed is very large or is effective over a large depth range, in which case the sound speed profile should be re–measured.

Implications

Note that with a horizontally mounted linear (and thus electronically steered) transducer the total error due to varying sound speed at the transducer depth is zero except for a small roll–dependent term. This is because there are two errors involved:

1) the beam pointing angle error

2) the error in the first step of the ray bending calculations

Each of these errors has the same magnitude but opposite signs, thus cancelling each other when roll is zero. In marked contrast, no such error cancellation takes place with a curved non–steered array and very little with a linear array which is tilted much from the horizontal.

As sound speed variations at the surface are often much larger than sound speed sensor errors, it can be concluded that the cylindrical non–steered array is significantly more sensitive to sound speed errors than the horizontally mounted steered linear array. That this somewhat surprising conclusion is the opposite of that drawn for sonars, is due to the fact that sonars are usually used looking horizontally while a multibeam echo sounder looks vertically.

For both a curved transducer and a flat transducer tilted say 40°, the sound speed at the transducer should be known to within 0.1 m/s if the resulting depth error is to be negligible within a 150° angular measurement sector. For a horizontally mounted flat transducer an uncertainty of up to 2 m/s is not significant assuming 130° coverage and 5° of roll. With more roll and larger coverage the sound speed uncertainty must be less for its effect to be insignificant, for example within 0.5 m/s with 140° coverage and 10° roll. In areas where one can expect larger surface sound speed changes than this, it is advisable to include a real–time sound speed sensor at the transducer depth with the system, otherwise a reduction in usable coverage or a reduced depth accuracy must be accepted. Note that in addition to correcting for surfaced–induced sound speed errors, the measured transducer depth sound speed can also be used as an indicator for when a new sound speed profile should be measured.

Bottom–related errors

It may sometimes not be practical to measure the sound speed profile all the way to the bottom and there will usually be an error in the necessary extension of the profile.

Another type of bottom–related sound speed problem that can be significant in not too deep waters occurs when a layer near the bottom with significantly different sound speed than the layer above moves upwards or downwards with changing depth due to current, and the change is not taken into account. The resulting vertical errors and acrosstrack position errors may in both cases be modelled as an error due a constant sound speed error from a particular depth (D_E) and all the way to the bottom:

$$\Delta z = \frac{\Delta c}{c}(D - D_E)(1 - \tan^2\phi)$$

$$\Delta y = \frac{2\Delta c}{c}(D - D_E)\tan\phi$$

This is a "worst–case" model, and a more realistic assumption could be to assume an error in sound speed linearly increasing from zero at a particular depth (D_E) to Δc at the bottom, in which case the depth and position errors are half of those assuming a constant sound speed error.

Other sound speed related errors

There are areas in the world where the sound speed changes very much over a short depth interval, and where the depth at which this change takes place shifts with time and position. Such an unaccounted shift gives a range error but no angular errors, resulting in the following vertical and acrosstrack position errors:

$$\Delta z = \frac{\Delta c \Delta D}{c}$$

$$\Delta y = \frac{2 \Delta c \Delta D \tan \phi}{c}$$

Finally, it should be noted that how ray bending calculations are performed (with regard to transducer depth in relation to the depths in the measured sound speed profile) may cause heave–induced errors if the sound speed changes much through the profile.

For example, if the calculations are done through a table look–up, this implies that the sound speed profile is anchored at the transducer, and may cause errors due to heave. This error is avoided if the calculations assume the transducer to move with heave relative to the sound speed profile. On the other hand, if there is a significant change in sound speed around the nominal transducer depth, there is in practice no way of knowing how the transducer moves relative to the sound speed profile with heave, although intuitively it would seem most correct to assume that the transducer moves with heave while the profile remains fixed.

It may also be noted that an inherent limitation in ray bending calculations is that one is usually forced to assume that the sound speed changes only with depth and that any change with position is negligible, at least for a particular beam.

Range capability

The fundamental equation for determining the range capability of an echo sounder is the sonar equation:

$$EL = SL - 2TL + BS$$

Here, EL is the received echo level, SL is the transmitter source level, $2TL$ is the two–way transmission loss, and BS is the backscattering strength of the target.

The two–way transmission loss is:

$$2TL = 2\alpha R + 40 \log R$$

Here, α is the absorption coefficient and R is the range. The absorption coefficient may be calculated from actual water temperature, salinity, depth and sounder frequency.

The backscattering strength will depend on seabed conditions and on the area (A) of the seabed seen by the echo sounder at each sample time:

$$BS = BS_B + 10\log A$$

$$A = \psi_T \psi_R R^2 \text{ around normal incidence } (\phi \approx 0)$$

$$A = \frac{c\tau\psi_T R}{2\sin\phi} \text{ elsewhere}$$

Here, c is the sound speed, τ is the pulse length, and ψ_T and ψ_R are the transmitter and receiver beamwidths respectively. The first equation for the area is valid until the bottom incidence angle is larger than the largest of the following two angles, given by:

$$\cos\phi_{L1} = \left(1 + \frac{c\tau}{2D}\right)^{-1}$$

$$\sin\phi_{L2} = -\frac{\Psi_R D}{c\tau} + \sqrt{\left(\frac{\Psi_R D}{c\tau}\right)^2 + 1}$$

The intrinsic backscattering strength of the seabed (BS_B) is usually very dependent upon the incidence angle, with the largest variation around normal incidence, and typically a Lambert's law dependence at larger incidence angles. It seems natural to define:

$BS_B = BS_N$ . . . . at normal incidence ($\phi = 0$)

$BS_B = BS_O \cos^2\phi$ . . . . for $\phi >$ about 10–25°

From 0° and to an incidence angle of about 10–25°, it can be judged from the literature that the backscattering strength to a good approximation varies linearly with angle. The angle at which the cross–over between the two regions takes place, in effect defining the sharpness of the normal incidence peak, is very dependent upon seabed material type.

Typically, BS_N will be about –15 dB, BS_O (O for oblique) about –35 dB, but the values may change within ±10 dB or even more depending upon seabed material type and roughness.

Putting all the above into a single equation, the result is:

$$EL = SL - 2\alpha R - 20\log R + 10\log\psi_T\psi_R + BS_N \quad \ldots\ldots\ldots\ldots (\phi = 0^\circ)$$

$$EL = SL - 2\alpha R - 30\log R + 10\log\frac{c\tau\psi_T\cos\phi}{2\tan\phi} + BS_o \quad \ldots (\phi > 10 - 25^\circ)$$

The echo level has to be above the noise level (NL) by a certain amount, typically 10 dB when using phase detection and 20 dB with amplitude detection, if the detections are to be reliable. At high sonar frequencies, the noise level is usually determined by the electronic self–noise of the preamplifiers, while at low frequencies, the sea noise level will usually dominate if the vessel is quiet. Vessel noise will vary with speed and often propeller revolution rate, and may be the dominant noise source even at high sonar frequencies if the vessel is small and is travelling at a high speed. The noise level is given by:

$$NL = NSL + 10\log BW - DI_R$$

Here, NSL is the noise spectral level, DI_R is the receive transducer directivity index and BW is the receiver bandwidth.

$DI_R = 46.2 - 10 \log \Psi_x \Psi_y$ with the beamwidth given in degrees.

2 OPERATIONAL PROCEDURES

2.1 Power on/off

Switch locations

The EM 12 system consists of several sub–systems and peripherals which all have their individual power on/off switches.

Master switch

Usually, the system will be installed with a separate master power on/off switch, and for most systems it will be located on the Operator Console above the keyboard. For this switch to be operative, all other switches must be left permanently **on** and the junction box switch must be set to *Normal* (see page 24). Power is switched off by using the master power on/off switch at any convenient time.

Display console

The Operator console has a console power on/off switch located in the bottom of the console. In addition, the computers within the consoles and the display monitors have individual power on/off switches.

Note that in case of a computer hang–up, power off/on may be used to reset the computer, or if the computer has a reset button, this may be used, or, if a keyboard is connected, simultaneous engagement of the Ctrl, Alt and Del keys may cause a reset.

Junction box

Most systems derive power from a junction box which internally contains a switch with two positions labelled *Normal* and *Service*. If set to *Service*, the master on/off switch will not switch power on/off to the display units. Thus, a remote reset of the Transceiver Unit can be accomplished by using the master on/off switch, provided that the junction box switch is in the *Service* position.

Separate systems

Note that any workstation–based systems for data logging or post–processing delivered with the EM 12 system will have their own power on/off procedure, and will not be connected to the master power on/off switch.

Software

The Operator Unit and the Bottom Detector Unit (as well as any Quality Assurance Unit and/or Sonar Imaging Unit that may be included) are supplied with software on 1.2 Mbyte 5.25″ floppy disks. When you switch power on or press the reset button, the computers of these units will boot and load the software from these disks.

Note ! *Otherwise the disks are not accessed, but they should still be left in the computers at all times to protect the heads of the drives.*

If the system disk is located in the disk drive when power is initiated, it will take approximately 90 seconds to boot and load. When this sequence is terminated, the main menu will appear.

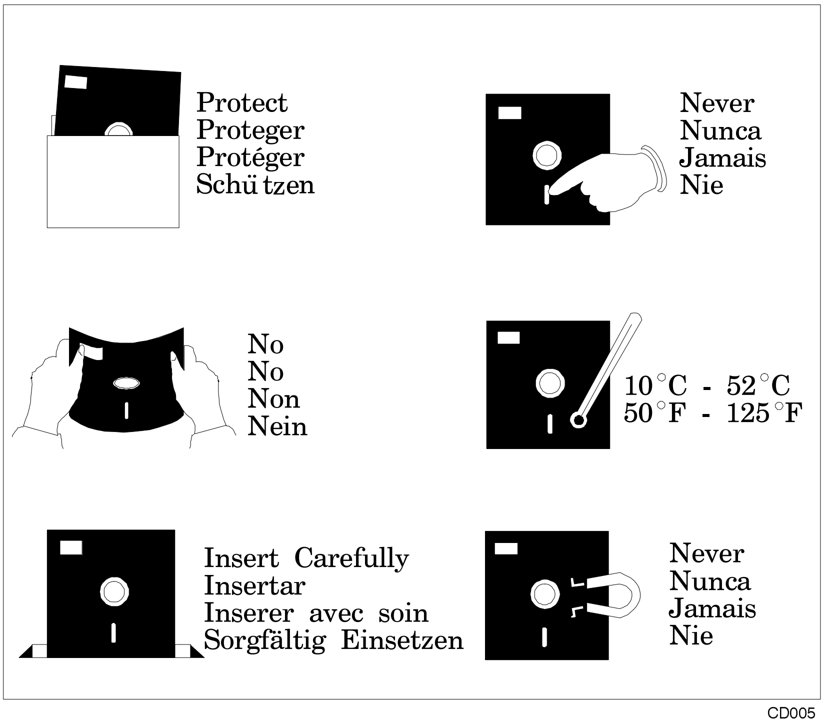


Figure 2 Floppy disk handling

If power is switched on while the system disk is **not** in its drive, the display will give the following message:

Insert system disk in drive and press any key to continue.

After loading and pressing a key, it will take approximately 30 seconds to boot and load. Press the reset button if no keyboard is connected. Each EM 12 system floppy disk is labelled with the following information:

- Unit
- Version number
- Date of release

A spare disk is always supplied with a new software release. The disk format is not MS–DOS, as the operating system is iRMX, an Intel real–time operating system. Thus, copies of the disks cannot be made as usual on a PC, but additional spare disks may be obtained from Kongsberg Simrad.

Note ! *The floppy disks must be handled with care, as instructed in Figure 2!*

2.2 System initialization

Booting up

After power has been switched on, all system screens should within two minutes come up with normal displays. Note that the Operator Unit computer reads the **Installation and Configuration Parameters** and **Sound Speed Profile** used during previous operation from memory with battery back–up. However, to ensure that no errors have occurred, the values in the Operator Unit Installation Menu and the Sound Speed Profile should be checked. Note that these parameters must always be entered at system installation (usually done during the Harbour Acceptance Test), and whenever the circuit board with the battery backed–up memory is replaced.

Note !

In case of failure in the battery backed–up memory:

1 *Run the RAMCLEAR program*

*If this program is on the Operator Unit floppy disk, press **Ctrl/C** to stop the OPU program, then enter **RAMCLEAR** on the keyboard followed by Enter.*

If this program is on its own floppy disk, insert the disk in the Operator Unit, reset the computer and follow the instructions which appear on the screen.

2 *Reboot*

3 *Reenter the proper values.*

After a RAMCLEAR or replacement of the battery backed–up memory board, the configuration parameters will revert to their default values. The default configuration values may cause problems for some users, and cannot readily be changed as the configuration is password protected. However, in case a user encounters this problem, the password can be obtained by calling Kongsberg Simrad. *See the section "Where to call for help" on page 30 for the correct telephone number.*

Basic parameters

Transducer position

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

The transducer horizontal position is given with respect to the positioning system reference centre. If the reference centre is moved, for example when changing to a different positioning system, the transducer position must also be changed. The soundings' positions on the seabed are given with respect to the positioning reference centre as defined by the transducer position.

Note that the depth of the transducer should initially be measured with the vessel being horizontal. If the loading of the vessel changes, the resulting draft change should be measured where the vertical reference unit is. The reason for this is that if the transducer and VRU are displaced horizontally (defined in a parameter **EPROM** in the Transceiver Unit), the EM 12 system uses the pitch and roll angles together with the heave sensor output to calculate an equivalent heave at the transducer, and heave sensors usually only measure dynamic heave.

Sensor offsets

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

Roll, pitch and heading sensors usually have an offset or zero bias which may change with time. The optional Quality Assurance Unit or Kongsberg Simrad MERLIN system may be used to determine these offsets, or alternatively they may be determined in post-processing (the Kongsberg Simrad NEPTUNE system allows offset errors to be found and compensated for in the logged data).

Roll offset

Roll offset is determined by comparing acrosstrack profiles from a line run in opposite directions, which is handled well by the optional Quality Assurance Unit or Kongsberg Simrad MERLIN system. It is important that the roll offset entered is reasonably correct, otherwise significant errors will occur in the real-time ray bending calculations.

Pitch offset

Pitch offset is determined by comparing alongtrack profiles from a line run at minimum ship speed in opposite directions up and down a not too steep slope with a significant depth change. This may be difficult with the limited line lengths allowed by the optional Quality Assurance Unit or Kongsberg Simrad MERLIN system. However, small pitch errors do not cause significant errors in ray bending calculations and may thus be found and compensated for in post-processing.

Heading offset

Heading offset can in principle be determined by comparing the position of a distinct seabed feature seen from two sides far out in the echo sounder swath. Note, however, that any heading offset is best measured with the vessel being tied up along a quay, using standard land surveying techniques to determine actual vessel heading.

Positioning system

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

The type of datagrams sent by the positioning system must be entered, and the time delay of the positions, i.e. the age of the positions when they arrive at the Operator Unit, must be found. Note that this time delay may be found either with the optional Quality Assurance Unit or Kongsberg Simrad MERLIN system or in post–processing. It is determined by re–running the lines used for determination of pitch offset at a significantly higher speed, and comparing alongtrack profiles.

External clock

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

The type of clock used (if any) must be defined.

Interfaces

The serial interface parameters must be defined (line 3 for positioning system, line 5 for sound speed profile, line 6 for external clock, and line 7 for track plotter).

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

Ethernet and IP addresses and UDP port number must be set for both Operator Unit and logging system if logging takes place over the Ethernet.

Data output

Note !

This parameter must be correctly set in the Operator Unit for the system to operate correctly and give correct measurement data.

It is recommended always to log **start/stop**, **parameters**, and **sound speed datagrams** in addition to **depth datagrams**, thus ensuring that all data relevant to the survey and possibly useful in analyzing survey results, are stored.

Usually, **position datagrams** should also be logged, unless they are logged separately as some users prefer.

Sonar Imaging data should also normally be logged, as these data may become valuable at a later time, even though the survey doesn't require these data.

Starting the echo sounder

After the installation parameters have been checked, some additional parameter entry is usually required on the Bottom Detector Unit, before the sounding may start.

EM 12S

On the Bottom Detector Unit, it is required to enter the type of ice window installed, if there is one. The type of beam spacing is then chosen, either equal spacing in angle or horizontal distance, by setting the **Operation menu–>Mounting** to **CENTR 1dgBS** or **CENTR EDBS** (described on page NO TAG). Soundings may then be started directly from the Operator Unit with no further settings on the Bottom Detector Unit, or soundings may be started from the Bottom Detector Unit itself if so desired (set EM 12 **menu–> Transmit Mode** to **Auto** or a specific mode – see page 62). Note that:

- the Operator Unit **Transmit Mode** must _not_ be set to **Off** in order to allow data to come through
- if the Operator Unit **Transmit Mode** is set to **Local,** the Bottom Detector's **Operation menu–>Data Out** parameter must be set to **On** (described on page 119).

EM 12D

On the Bottom Detector Units, it is required to enter the type of ice window installed, if there is one. The type of beam spacing is then chosen, either equal spacing in angle or horizontal distance, by setting the **Operation menu–>Mounting** to **PORT 1dgBS** or **PORT EDBS** for the port side system, and **STARB 1dgBS** or **STARB EDBS** for the starboard system (described on page NO TAG). The Bottom Detector Unit **Operation menu–>Dual Sync** command must be set to **On** (described on page NO TAG). Soundings may then be started directly from the Operator Unit with no further settings on the Bottom Detector Units, or started from the Bottom Detector Units themselves if so desired (set EM 12 **menu–>Transmit Mode** to **Auto** or a specific mode – see page 62). Note that:

- the Operator Unit **Transmit Mode** must _not_ be set to **Off** in order to allow data to come through
- if the Operator Unit **Transmit Mode** is set to **Local,** the Bottom Detector's **Operation menu–>Data Out** parameter must be set to **On** (described on page 119).

Initialization problems

If the echo sounder does not work properly after startup, i.e. with a stable bottom on the Operator Unit's acrosstrack display, this may either be due to a hardware fault, or to very difficult bottom conditions.

The EM 12 system has built–in automatic bottom finding and recovery algorithms, which have been found to be very reliable, but very difficult weather or seabed topography may cause them to fail. If this is the case, it may be necessary to lock the transmit mode to a deeper one than what is usually chosen automatically (i.e. do *not* use **Auto**) and/or force the echo sounder to correct depth by entering **Expected Depth** on the Operator Unit menu (EM 12, EM 950 and EM 1000).

On the EM 12, it is in addition possible to adjust the **Ext. Conditions** parameter on the Bottom Detector Unit to cater for difficult conditions which usually may be judged on the stave display.

If no soundings are received on the Operator Unit, it is advisable to check that power has been switched on to the Transceiver Unit and Bottom Detector Unit.

Also note that a minimum of 50 m of water depth is needed below the transducer(s).

If no obvious reason is found for the echo sounder not working properly, try resetting the system (power off/on), and if this does not help, try running the **BITE** tests to possibly locate a hardware error.

Where to call for help

Assistance is obtained by telephone at the Kongsberg Simrad Hydrographic Department. Please call:

- during Kongsberg Simrad's office hours (08:00–16:30 local time) . . (+47)–330 34000/(+47)–330 34257
- outside Kongsberg Simrad's office hours . . (+47)–916 31446

Running problems

Bugs

The EM 12 system will usually run continuously, giving excellent data quality, and we have observed that on many vessels the system will run with very little supervision from an operator. However, some caution is advised; for example one cannot guarantee 100% that a bug causing unintentional crashes does not remain, especially in a major new software release. It is therefore recommended that an external logging system is set up with an audible alarm to warn the operator if the EM 12 system stops sending data.

Weather/bottom problems

Problems may occur due to weather or difficult bottom. Note that a maximum and minimum depth may be entered on the Operator Unit which may be used to help the system in tracking the bottom and avoid false detections during difficult conditions. Acoustical interference may occur, both to and from an EM 12 system. Possibilities for external synchronization have been built into the systems, and will solve interference problems, although at the cost of reduced ping rates.

The blanking signal output from the EM 12 system may be tried, but it has been found that using the blanking input to the EM 12 usually makes the interference problem worse. If the interfering system can be tuned in frequency, this will usually be very helpful.

The transmitter power amplifiers have been found to be the most vulnerable component in the EM 12, mostly because there are so many of them, and because they are run with high voltages and are therefore under more stress than other components. The echo sounder will still give excellent data with more than 10% of these amplifiers out of order.

It is recommended to run the Transmitter Amplifier BITE test whenever convenient to verify a healthy status. Likewise it is recommended to run the BITE test on the preamplifiers when convenient.

2.3 Survey planning

Points for consideration

A survey should always be planned taking into account echo sounder characteristics, seabed topography and weather conditions. The need for calibration of the heading, roll and pitch sensors should be considered, and how and where to gather sound speed profiles should be considered.

Echo sounder characteristics

The important echo sounder characteristics are coverage versus depth and range sampling resolution. If the survey is to be run in a depth range which corresponds to that where the echo sounder usually changes coverage sector and/or pulse length and possibly range sampling rate, one should consider the possibility of running in fixed mode instead of in auto.

Coverage capability determines line spacing, and as it varies with bottom reflectivity, this must be estimated. Usually 10% overlap between lines is sufficient, but if large variations in reflectivity is expected, or reflectivity is unknown, it may be necessary to increase overlap.

Note that on the EM 12 it is possible to limit coverage on the Bottom Detector Unit. As a reduction in coverage may increase ping rate, this should be considered, especially if line spacing is determined by other equipment or large variations in depth along survey lines will anyway lead to large variations in coverage.

Seabed topography

If there are steep slopes on the bottom, it is strongly advised to run along these slopes, not up or down them. This will be beneficial in keeping coverage reasonably constant along survey lines, thus making survey planning easier. However the main reason for this advice is that the echo sounder performance will always be poorer when running up or down a slope rather than along. This is because much less acoustic energy is reflected back towards the transducer from steep slopes, causing less detections and the possibility of false detections in sidelobes (note however that sidelobe detections are very rare in the EM echo sounders due to the advanced signal processing implemented). Note that if circumstances require that survey lines are run up or down a slope, reduction of vessel speed will usually be required to allow the echo sounder to track the bottom continuously.

Weather conditions

Coverage capability is also affected by weather conditions and possibly also by vessel speed. Heavy seas and possibly vessel speed lead to increased noise level, and may also cause aeration on the transducers. Aeration is a function of sea state, but also of the heading with respect to the wave direction and the vessel speed. It is strongly advised that one builds a record of coverage versus sea state, heading with respect to wave direction, and vessel speed. This record could be very helpful in ensuring that surveys can be performed efficiently with a minimum of line rejections and corresponding reruns and fill–ins.

Sensor calibration

The drift rates of roll, pitch and heading offsets should also be recorded to enable efficient planning of calibration intervals. If calibration is required before a survey, a suitable calibration area should be determined before reaching the survey area.

Note that some vertical reference units such as the Hippy 120 are sensitive to horizontal accelerations. This implies that care should be taken in keeping the heading constant on a survey line, and that wide and slow turns are taken between the survey lines.

Sound speed profile gathering

A sound speed profile should always be taken in the surveying area and loaded into the Operator Unit before the survey is started. In some areas the profile will vary, mostly due to fresh water in flows from rivers or from currents from areas with different salinity such as outside the Strait of Gibraltar. If variations can be expected, where and when sound speed profiles are to be taken should be planned beforehand, and the survey line schedule should be adjusted to take this into account. Note that the measured sound speed value at the transducer depth should be compared with that measured by an installed velocimeter, or entered into the Operator Unit if only a temperature probe or no sensor is installed.

In some cases, the coverage capability of the echo sounder cannot be fully utilized, because errors in roll and sound speed profile measurements, which are critical in maintaining the accuracy of the outer beams, become too large in relation to the accuracy requirements of the survey. When equidistant beam spacing is available, coverage may be restricted by choosing the desired coverage sector. Note that the chosen sector should have a pulse length and resolution according to the depth range encountered, otherwise accuracy may be reduced.

2.4 System maintenance

Preventive maintenance

Introduction

The preventive maintenance of the EM 12 system described here does not include the Hull Unit, which is described in a separate *Hull Unit manual*.

As the EM 12 system is designed with only a few moving parts, the preventive maintenance is limited. Generally, no tools are required. Exceptions are stated in the maintenance procedure.

Preventive maintenance schedule

PERIOD	ACTION	REFERENCE
When required	Clean the cabinet exterior.	"Cabinet cleaning" page 34
Every 2 months	Clean or replace the fan filters in the Operator Unit, Quality Assurance Unit and Transceiver Unit.	"Filter cleaning and replacement" page 34

Cabinet cleaning

Clean the cabinet exterior with warm water, a mild liquid detergent and a soft, lint–free cloth.

Filter cleaning and replacement

The Operator Unit, Quality Assurance Unit and Transceiver Unit have a filter unit in the lower part of their cabinets. These filters should be checked regularly for excessive amount of dust particles.

On the operator cabinets, the filter units are located in small drawers underneath the cabinets. Pull straight out. The filter in the Transceiver Unit is easily removed once the cabinet door is opened.

Rinse the filter in water or use compressed air to clean it. Replace the filter if required.

Corrective maintenance

All corrective maintenance on the EM 12 system should be carried out by trained and experienced personnel. Corrective action is described in the applicable *Maintenance Manual*.

WARNING ! **The voltages used on the EM 12 system are lethal. Make sure that the first aid instructions for electrical shock are known by the personnel, and that a first aid kit is available.**

Whenever maintenance is carried out on the electrical system and the power is set to ON, two persons should always be present.

Do not perform corrective maintenance on the electronic cabinets while in rough seas. Do not attempt to open the cabinets, as these may suddenly swing out and cause damage and/or injury.

3 EM 12 MENU SYSTEM

3.1 Introduction

The Kongsberg Simrad EM Series is controlled through an interactive menu system using the cursor keys on a keyboard or with a joystick on the monitor or on the display console. The cursor keys (→ ← ↑ ↓) or equivalent joystick operations are used to navigate through the menu, to select options and to change numerical parameters. In exceptional cases, the keyboard is also used for direct entry of commands.

The EM 12 Bottom Detector Unit is controlled using a joystick. Where the following general instructions describe cursor key operations, corresponding joystick operations are applicable where appropriate (→ cursor key = right joystick movement, etc.)

The menus are always displayed on the upper right–hand part of the screen, with the current position in the menu highlighted in inverse video. The menu system is hierarchical typically with three levels. An entry in the menu might either be for choice of a sub–menu or for change of a parameter value. In the latter case the current value is displayed on the right–hand side of the menu.

3.2 Keyboard/joystick, cursor and menu

Pushing the keyboard arrows or moving the joystick enables the operator to navigate in the menu hierarchy. Each push on one of the ↑ or ↓ keys will move the cursor one line up or down in the current menu. The keyboard arrow pointing to the right (→) is used for moving into different levels in the menu and for entering values. Moving the joystick in the same direction indicated by the arrows has the same effect.

Keyboard button	**Joystick movement**	**Action**
↑	Up	Cursor up
↓	Down	Cursor down
→	Right	Enter
←	Left	Quit

Note that each menu has a heading showing the name of the menu.

The table below shows what normally happens each time the joystick or the → and ← keys are pushed.

Key/joystick sequence	Action
Initial location (→)	Normal operation
First push (→)	Jump from main command menu to chosen submenu. Parameter(s) are changed with the ″arrow″ keys.
Second push (→)	Bringing forth the choices of parameter values. Select value by using the ↑ or ↓ keys.
Third push (→)	Enter the new parameter value
Fourth push (←)	Return to normal operation

If you do *not* want to enter the changed value after all, push the ← key, and the parameter will not be changed. The text *Last command not entered* will appear in the operator message field.

Note !

Moving to the previous step with the left arrow key will not always cancel changes made to the command selection. Check that after you use the left arrow key, your preferred selection is (still) chosen.

3.3 Operation example

In normal operation the following text is displayed in the text section of the display:

```
MAIN MENU

SURVEY MENU
EM  12 MENU
TRACK PLOTTER MENU
SOUND VELOCITY MENU
GRAPHIC MENU
INSTALLATION MENU
CONFIGURATION MENU
TEST MENU
```

The main menu consists a list of the sub–menus available in the system. The inverse video field, hereafter called the cursor, will be on the last sub–menu command used.

1 Push joystick (up or down) or push the ↑ or ↓ keys until the cursor reaches the desired sub–menu, for example **SOUND VELOCITY** (shown in the screen example above as **bold** characters).

2 Push the joystick right (→) or push the → key and the sound speed menu will appear:

```
SOUND VELOCITY MENU

Load profile      Nav-1.0m
Probe range            0 m
Edit manual pro
```

3 Then push the joystick (up or down) or push the ↑ or ↓ keys until the cursor reaches the parameter to be changed, for example **Probe range**.

4 Push the joystick right (→) or push the → key.

The cursor moves to the current value for the parameter. A list of alternatives or parameter range limits appears at the bottom of the text section, where a cursor will be on the current value. Move the cursor up/down in the list of alternatives or to change the value.

```
SOUND VELOCITY MENU

Load profile      Nav-1.0m
Probe range            0 m
Edit manual pro

↑  = incr, max=1000
100 m
↓  = decr, min=0
```

5 To enter the chosen value into the system, push the → key/ move the joystick right (→). The parameter list of alternatives or range limits disappears and the new value chosen is displayed in the sub-menu.

```
SOUND VELOCITY MENU

Load profile      Nav-1.0m
Probe range          100 m
Edit manual pro
```

6 In order to return to the top menu level, push the ← key/joystick left (←).

4 DISPLAY PRESENTATIONS AND INTERFACES

4.1 System overview

Functional description

The Operator Unit is the main display unit for the EM 12 echo sounder. It is used for all major operator control and runs all external interfaces (excepting sensors which are connected to the Transceiver Unit). The results of your settings are transferred to the Bottom Detector Unit(s) and further to the Transceiver Unit to control the echo sounder operation.

The Operator Unit receives raw beam range data, ship attitude data and other miscellaneous data from the Bottom Detector Unit(s). Using these data and the raybending calculated from the sound speed profile, the beam ranges are transformed to depth and seabed position relative to the ship. The Depth datagram is the final data from the echo sounder.

On serial lines, the Operator Unit may receive ship position data from various positioning systems, external clock synchronization and sound speed profile data. A sound speed profile may also be transferred over the Ethernet from another computer.

If the echo sounder includes a Quality Assurance Unit, Depth and Position datagrams will also be transferred to this unit and to the optional Sonar Imaging Unit. Datagrams may be logged on an internal laser–disk in the Operator Unit and/or transferred to an external computer for example with Merlin or Mermaid, via Ethernet. Clock synchronization is also transferred to the Bottom Detector Unit(s).

The Operator Unit, if operated with a keyboard, may optionally drive a pen plotter to create track plots, and a graphics printer to generate an echogram type recording for one beam.

Display and menu

Main windows

The EM 12 Operator Unit display is divided into three main windows. Two graphic windows are situated on the left side of the screen, and a text window is placed on the right side.

- The text window is used to present the interactive menus, error messages and survey data.
- The upper graphic window is used to present the acrosstrack depth profile.
- The lower graphic window may be used to present a user selectable display.

Text window

The menu

The EM 12 Operator Unit menu is displayed on the right hand side of the screen. A list of available sub–menus or commands is displayed, and you may choose any of these by moving the cursor (inverse video) to the command, and pushing the **right arrow** (→) on the keyboard. Move the cursor with the **up** (↑) and **down** (↓) **arrow** keys on the keyboard. Move the cursor with the **left arrow** (←) to go back to the previous step.

Note ! *Moving to the previous step with the left arrow key will not always cancel changes made to the command selection. Check that after you use the left arrow key, your preferred selection is (still) chosen.*

The top of the menu window displays the following information:

- Product identification (Op. Unit)
- Date and time
- Current selected menu or sub–menu

Survey data presentation

The following information is shown in the lower half of the text window.

Ping information

Depth

The current depth reading of the most vertical beam.

Width

The total swath width of the latest ping.

Heave

The heave of the transducer at the time of the ping. A positive value is shown when the transducer is lower than the normal horizontal level.

Roll

The roll of the transducer at the time of the ping. Positive angles are shown when the port side of the vessel is raised above the horizontal plane.

Pitch

The pitch of the transducer at the time of the ping. Positive angles are shown when the bow of the vessel is raised above the horizontal plane.

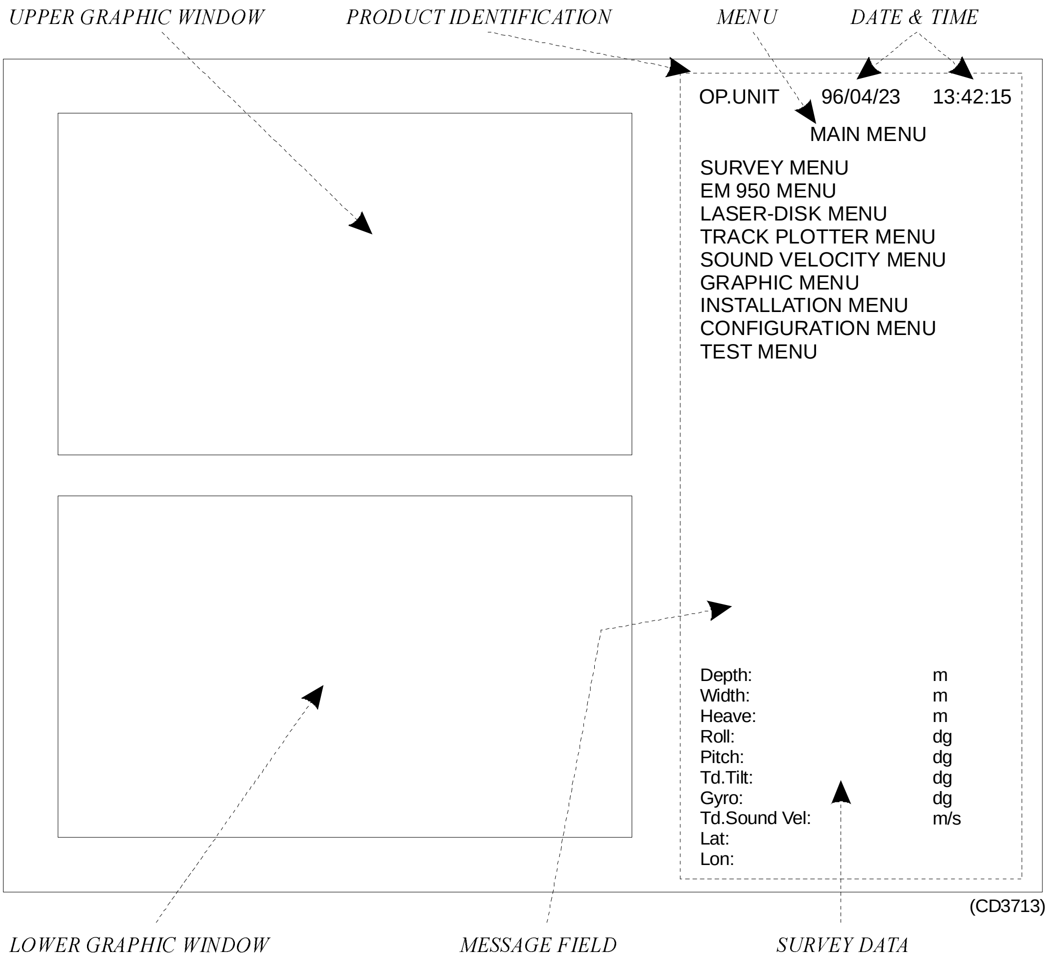


Figure 3 The EM 12 Operator Unit; display layout and menu

Td.Tilt

For EM 1000 and EM 950 only. Not applicable for EM 12.

Gyro

The heading of the transducer at the time of the ping.

TD.Sound vel

The current sea surface sound speed used in the beamforming.

Note ! *If bottom tracking is lost, ping related data may not be updated.*

Position information

Lat./ UTM N

The vessel's current latitude or UTM Northing position.

Lon./UTM E

The vessel's current longitude or UTM Easting position.

4.2 Graphic windows

Introduction

The left part of the display is comprised of two graphic windows. The upper graphic window always displays the **Acrosstrack depth profile**.

The lower graphic window displays either of the following graphic information:

- Alongtrack profile
- Sound speed profile
- Echogram
- Scope, i.e. ping amplitudes and phase

The graphic options may be selected from the **Graphic menu**, described on page 76.

Acrosstrack profile display

The acrosstrack profile display graphic shows the last measured depth of all beams as spots, thus making a curve across the window. Refer to Figure 4.

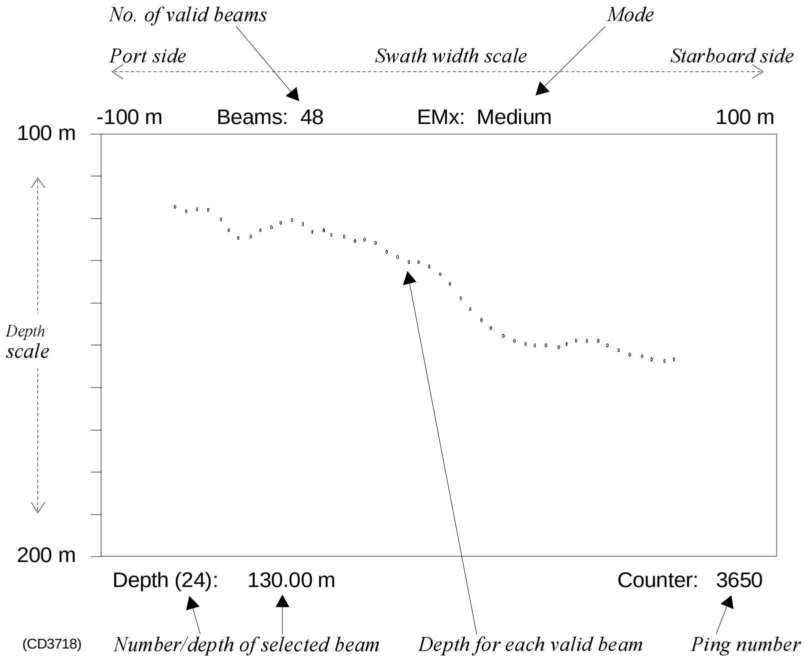


Figure 4 Acrosstrack profile

The width and depth range of the window are either automatically set according to the data by the system, or manually set by you. The profile is displayed in colours for additional information with a choice between positional information and bottom detection information.

The colours have the following significance:

Positional information

Red spots .... Port side beam

Green spots .... Starboard side beam

White spot .... Selected beam

Bottom detection information

Red spots ...... Beams with bottom detection based on phase

Blue spots . Beams with bottom detection based on amplitude

White spot .... Selected beam

Each beam's amplitude may be indicated by expanding the spots of the acrosstrack profile into bars, with the height corresponding to the signal strength.

You control the visual presentation of the acrosstrack profile display from the **Athwart profile** (i.e. acrosstrack) command of the **Graphic menu**, described on page 78.

Alongtrack profile display

The alongtrack profile display graphic shows the depth history of the selected beam as spots, thus making a curve across the window. The profile is displayed in colours for additional information with a choice between positional information and bottom detection information. The colours have the following significance:

Positional information

Red spots . . . . Port side beam

Green spots . . . . Starboard side beam

Bottom detection information

Red spots . . . . . . Beams with bottom detection based on phase

Blue spots . Beams with bottom detection based on amplitude

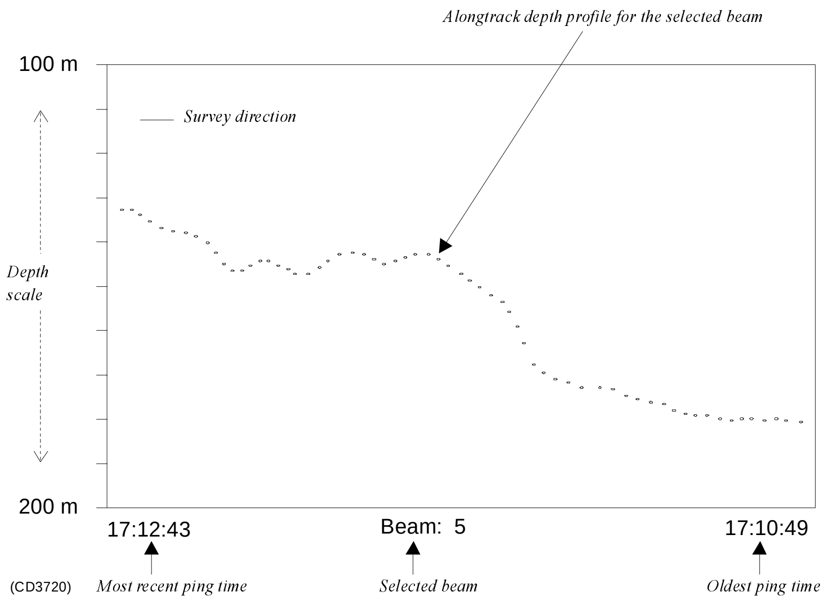


Figure 5 Alongtrack profile

The time scale depends on the ping rate and the selected interval between displayed pings. Note that the interval between two spots is the interval in use when the pings were received. The ping times of the oldest ping and the most recent ping are shown below the profile. The depth range is either automatically set by the system, or manually set by you.

Each beam's amplitude may be indicated by expanding the spots of the alongtrack profile into bars, with the height corresponding to the signal strength.

You may summon the alongtrack profile to be shown in the lower graphic window by selecting **Display–>Along tr.** from the **Graphic menu**, as described on page 76. You control the visual presentation of the alongtrack profile display via the commands of the **Alongtrack profile menu**, described on page 79.

Sound speed profile display

The sound speed profile display shows the actual sound speed profile used for the ray–bending calculations. The profile is displayed in colours for additional information.

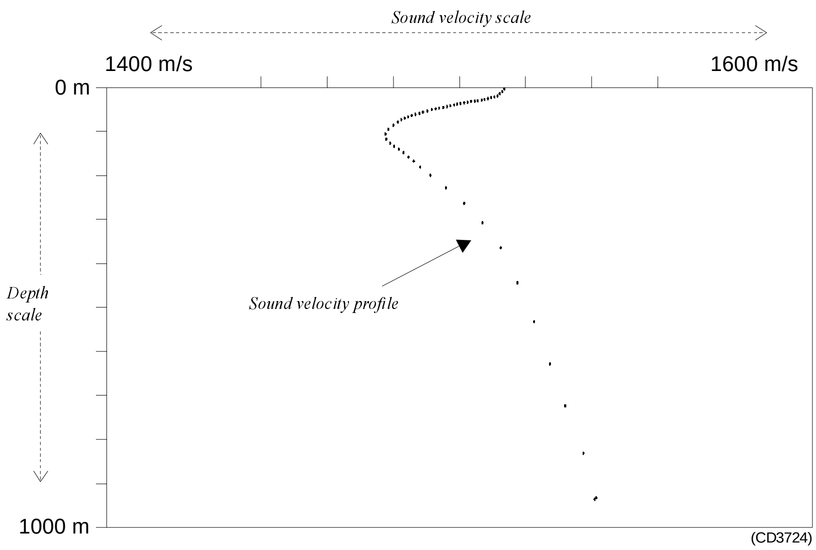


Figure 6 Sound speed profile

The colours have the following significance:

White . . . Non–edited value (e.g. loaded from external source)

Green . . . . The value you enter

You may summon the sound speed profile to be shown in the lower graphic window by selecting **Display–> Sound ve.** from the **Graphic menu**, as described on page 77. You control the visual presentation of the sound speed profile display via the commands of the **Sound velocity menu**, described on page 80.

The sound ray path shows a subset of the calculated ray paths as determined from the sound speed profile currently in use.

You may summon the sound ray path to be shown in the lower graphic window by selecting **Display–> Sound ve.** from the **Graphic menu**, as described on page 77 and specifying **Graphic–>Path** in the **Sound velocity menu**, described on page 81.

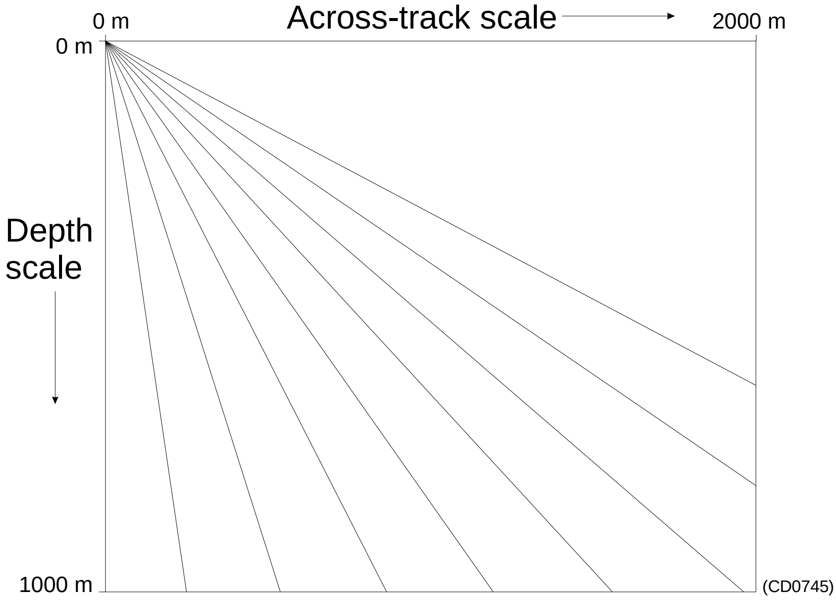


Figure 7 Sound ray path

Echogram display

The echogram display graphic shows a standard echogram based on data from one of the echo sounder beams. The beam to be displayed is selectable .

The colours represent the echo strength according to the colour scale displayed below the window.

You may set the depth scale and the start to fixed values, or the system may be set to have the bottom sample in the middle of the window (provided that there are bottom detections in the chosen beam).

The depth scales are nominal, assuming a constant sound speed of 1500 m/s, with no compensation for transducer depth or heave.

The echogram may be recorded on an optional graphics printer with some annotation added.

You may summon the echogram display to be shown in the lower graphic window by selecting **Display–>Echogram** from the **Graphic menu**, as described on page 77. You control the visual presentation of the echogram display via the commands of the **Echogram menu**, described on page 81.

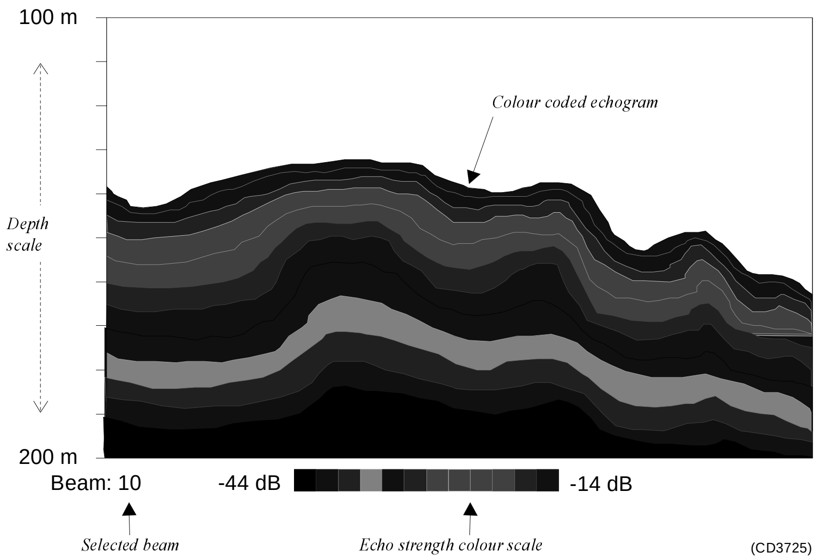


Figure 8 Echogram

Scope display

The **Scope** (Oscilloscope) display graphic is primarily used for test purposes. Amplitude and phase samples versus depth for one selected beam are shown on the display. The data is collected in a window centred at the detected slant range for the beam from the last ping, or in a depth window set by you.

- Amplitude data (blue) is the echo strength sampled every 60 cm (shallow) or 240 cm (deep).

  Normal amplitude (backscattering strength) for a sample from a bottom echo is –40 to –20 dB.

- Phase data (red) is the split beam electrical phase difference between two receiver halfbeams. Sample distance is 60 cm (shallow) or 240 cm (deep).

  When the phase crosses 0°, the bottom is in the centre of the beam. The electrical phase change is approximately ±60° within the main lobe where it approximates a straight line, but with a curvature which increases with beam angle.

- A vertical line is placed at the detection point. It is blue for amplitude detection and red for phase detection.

You may summon the scope display to be shown in the lower graphic window by selecting **Display–>Scope** from the **Graphic menu**, as described on page 77. You control the visual presentation of the scope display via the commands of the **Echogram menu**, described on page 81.

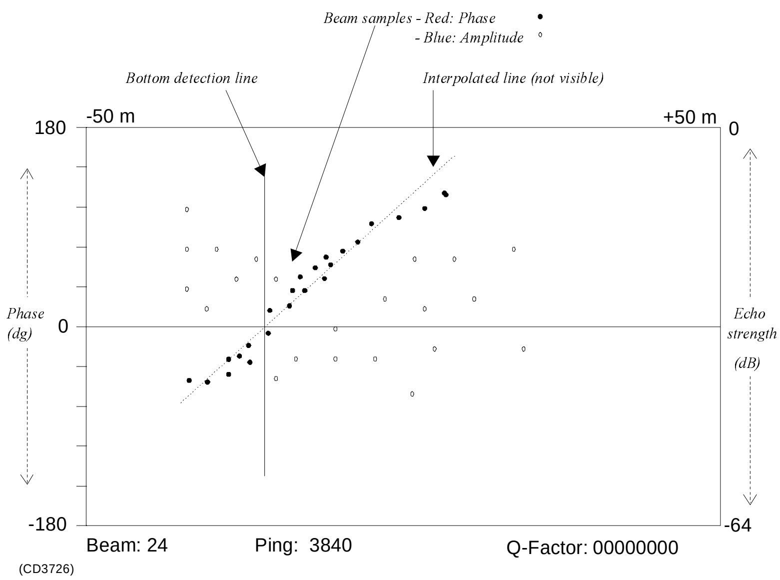


Figure 9 Scope display

4.3 Interfaces and peripherals

Introduction

The EM 12 Operator Unit has several communication interfaces for connection of the following external equipment:

- Ethernet interface
- Multiport serial interface
- Graphics printer interface

Ethernet interfaces

A local Ethernet interface is provided for Operator Unit communication with the Bottom Detector Unit(s), optional Quality Assurance Unit and optional Sonar Imaging Unit.

For communication with an external computer, a second Ethernet interface is included for data transfer out of the echo sounder and for receiving sound speed profiles.

Both Ethernets use the 10Base–2 standard (RG–58 type coaxial cable).

For information on external Ethernet address setup and protocol menu commands, see *Ethernet protocol menu* on page 92.

Multiport serial interface

All serial line connections are interfaced to the Operator Unit through a multiport serial interface. This unit has a special interface board (multiple serial line controller) mounted in the computer and a Connector Box with eight serial line (RS–232) connectors.

The ports on the Connector Box are connected as follows:

J1	Communication between the box and the Operator Unit's interface board
P1	Data output
P2	Clock sync to BDU
P3	Input from positioning system
P4	Not used for EM 12
P5	Sound speed profile input
P6	External clock synchronization
P7	Communication between the Operator Unit and the Track Plotter
P8	Not used

Graphics printer (option)

An HP PaintJet may be connected to the Operator Unit computer's parallel port. It is used for either hardcopy of the screen or continuous echogram type recording.

5 MENU OVERVIEW

5.1 Menu descriptions

Main menu

In the **Main menu**, the following submenus may be selected:

```
MAIN MENU

Survey menu
EM  12 menu
Track plotter menu
Sound velocity menu
Graphic menu
Installation menu
Configuration menu
Test menu
```

A brief command listing is shown on page 54. The default values are not described in that listing. These values are not applicable for users with a battery back–up memory board, as this memory will, when the system is booted, recall the latest values set by the operator including sound speed profile. Reset to default values may be done by executing the RAMCLEAR program on the program disk. Users without this memory board will always retrieve the default parameters when booting the program.

Survey

The **Survey menu** commands may control the logging device (external interfaces, the optical disk, and the track plotter) as well as the contents of Line Number, Planned Line Number, Responsible Operator and Annotation in the **Start**, **Stop** and **Parameter datagrams**. Refer to page 58 for further details.

EM 12

The EM 12 **menu** commands control vital parameters of the system functions in the multibeam echo sounder. Refer to page 60 for further details.

The **EM 12 menu** on the Operator Unit controls the EM 12 transmit/receive sub–systems through the Bottom Detector Unit(s).

Refer to chapter *EM 12 menu* on page 60 for further details.

Laser–disk

The **Laser–disk menu** commands control the optional optical disk unit used for data logging. Note that this menu will not appear if the system does not use such a disk unit. As this disk is obsolete, and not used by anyone to our knowledge, its use is thus not further described in this manual. Refer to the previous version of this manual if you still want to use it (this manual version can still be obtained from Kongsberg Simrad).

Track plotter

The **Track plotter menu** controls optional hard copy plotter, which will produce real–time documentation of the surveyed area. This is done by drawing acrosstrack lines from the utmost beam on the port side to the utmost beam on the starboard side and/or the track of the vessel. A geographical grid (FRAME) may be pre–plotted. Refer to chapter *Track plotter menu* on page 67 for further details.

Sound velocity

The EM 12 echo sounder computes bottom depth by using a sound speed profile rather than an average speed for all depths. This is required due to ray bending in the non–vertical beams. The **Sound velocity menu** is used, and you can enter the sound speed data in one of the following ways:

- manually from the keyboard
- automatically from a sound speed probe or external computer
- as a combination of the methods above

Refer to chapter *Sound velocity menu* on page 71 for further details.

Graphic

The **Graphic menu** commands control the visual presentation on the display screen and the printer. Refer to paragraph *Graphic menu* on page 76 for further details.

Installation

The **Installation menu** sets standard parameters given by the physical installation of the system and the interface and logging requirements. Refer to chapter *Installation menu* on page 84 for further details.

Configuration

The **Configuration menu** is for Kongsberg Simrad use only. A password is required. Refer to chapter *Configuration menu* on page 94 for further details.

Test

For the **Test menu**, refer to chapter *Test menu* on page 95 for further details.

5.2 Short–form menu listing

SURVEY MENU

Log

- On / Off

Starts and stops logging (page 58)

Line number

- 0 to 999

Defines current survey line number (page 58)

Planned line no

- 0 to 999

Planned survey line identity (page 59)

Operator

- <free text>

Identity of responsible operator (page 59)

Annotation

- <free text>

Comments on the survey (page 59)

EM 12 MENU

Transmit mode

- Off / Local / Auto / Shallow / Deep

By mode selection, the coverage and pulse length may be set manually or automatically

(page 60)

Power

- Off / 0 db / –10 dB / –20 dB

Controls output level of the EM 12. (page 61)

Expected depth

- 0 to 1200 m

Expected depth during the survey

(page 62)

Absorption coeff

- 0 to 99 dB/km

Mean absorption coefficient of water column used in gain setting in receiver

(page 62)

Sound–ve. sensor

- Off/On

Disables/enables input from sound speed sensor.

(page 64)

Sound velocity

- 1400 to 1600 m/s

Manual selection of sound speed to be used in beamforming (if sensor is out of order)

(page 65)

Ping count reset

- No/Yes

Resets ping counter

(page 65)

Active beams

- All / Even / Odd / None

Deactivates selected beams (page 65)

Simulator

- Off / Port / STB / Centre / Dual

Creates simulated datagrams and system may be run with Bottom Detector Unit (and Transceiver Unit) disconnected

(page 65)

TRACK PLOTTER MENU

Mode

- Off / On / On/Log / Frame

Controls the output to the plotter (page 69)

Scale

- <scale setting>

Use this command to define the scale of the plot (page 69)

North coordinates

- <UTM/latitude setting>

Define the plot's north/south coordinate (page 69)

East coordinates

- <UTM/longitude setting>

Define the plot's east/west coordinate (page 69)

Paper size

- A3 / A2 / A1 / A0

Defines plot paper's physical size (page 70)

Orientation

- North up / East up

Define paper's printout orientation (page 70)

Pen(s)

- 1 to 8

Select which plotter pen to use (page 70)

Pattern

- Swath / Posline / Combined

Select the printout mode (page 70)

Interval

- <time setting>

Slows down the dataflow to the plotter to avoid overflow (page 70)

SOUND VELOCITY MENU

Change profile

- Default / Set all / Edit

Sets sound speed values (page 72)

Load profile

- Nav. 1.0 m / Nav. 2.0 m / Simrad–A / Simrad–B / AMLSVP16 / AML–CALC

Loads sound speed profile from external device (page 73)

Layer compensation

- On / Off

Compensates for extra ray bending caused by a varying sound speed in a surface layer differing from values in sound speed profile (page 75)

GRAPHIC MENU

Beeper

- On / Off

Enables or disables the internal loudspeaker and its audible warnings (page 76)

Display

- Off / Alongtr. / Sound ve. / Echogram Scope / Stave

Controls the information presented in the lower graphic window (page 76)

Printer

- Off / Hardcopy / Echogram

Controls the information sent to the echogram printer (page 77)

Beam number

- 1 to 81 for EM 12S
- 1 to S1 (via 81 and 81S) for EM 12D

Select the beam used in the presentations in the lower graphic window (page 78)

Athwart profile

- Upper depth / Lower depth / Width Ping interval / Color code / Amplitude

Defines the visual presentation of the Acrosstrack profile presented in the upper graphic window (page 78)

Along tr. profile

- Upper depth / Lower depth / Ping interval / Color code / Amplitude

Defines the visual presentation of the Alongtrack profile presented in the upper graphic window (page 79)

Sound velocity

- Upper depth / Lower depth / Velocity start / Velocity stop / Graph / Plot

Defines the visual presentation of the Sound Speed profile in the lower graphic window (page 80)

Echogram

- Range / Upper depth / Ping interval

Defines the visual presentation of the Echogram in the lower graphic window (page 81)

INSTALLATION MENU

EM 12 Transducer

- Depth / Alongship offset / Athwart. offset / Rx mount (dual)

Defines the positional offset of the transducer array (page 84)

Motion sensor

- Heave / Roll / Pitch / Gyro / Roll offset / Pitch offset / Gyro offset / Roll Delay

Defines the parameters of the motion sensor (page 85)

Position system

- Input system / Time delay / Time tag

Selects which positioning system is to be used (page 86)

Datagram output

- Serial line RS–232 / Ethernet

Selects how the survey datagrams are distributed (page 87)

Date & time

- Date / Time / Ext.clock

Sets the system time (page 89)

Serial protocol

- Baudrate / Bits per char. / Stop bits / Parity

Defines the parameters for the serial lines (page 91)

Ethernet protocol

- <ethernet and IP addresses>

Sets up the ethernet interfaces (page 92)

CONFIGURATION MENU

Not available – Password protected (page 94)

TEST MENU

Version

Displays software version number of EM 12 Operator Unit (page 95)

CPU

Displays CPU counter (page 95)

Serial port

Choose port and parameters for each port (page 95)

LAN

Displays status for selected option (page 96)

Simrad

- <Kongsberg Simrad use only>

Primarily intended for maintenance personnel (page 96)

6 COMMAND REFERENCES

6.1 Introduction

This chapter presents detailed explanations to all the commands in the Kongsberg Simrad EM 12 Operator Unit menu structure.

Note ! *This EM 12 Operator Manual is based on Operator Unit software version 4.0x. Changes made to the software may require amendments to this manual. Minor changes in software are identified by the third digit in the version number.*

6.2 Main menu

The main command menu is the top level of the menu system, and consists of a list of the sub–menus available in the system.

The following sub–menus are available:

- Survey menu
- EM 12 menu (echo sounder)
- Track plotter menu
- Sound velocity menu
- Graphic menu
- Installation menu
- Configuration menu
- Test menu

Each sub–menu is fully described in the following paragraphs. Note that a system with two echo sounders installed will have two echo sounder sub–menus.

6.3 Survey menu

Purpose

The **Survey** commands control the logging device(s), the current survey line numbering, and the annotations in the Start, Stop and Parameter datagrams.

The following commands are available:

- Log
- Line number
- Planned line no.
- Operator
- Annotation

Commands

Log

The purpose of this command is to enable or disable the data logging.

The **On / Off** toggle provided starts and stops the data flow to the laser–disk and controls logging with the Simrad Mermaid or Merlin system on an external computer. The serial and Ethernet lines dataflow are not affected. However, when changing the toggle, **Start** and **Stop** datagrams are generated.

On the Kongsberg Simrad logging systems, the Start and Stop datagrams are used to close and open new logging files, suspending logging in between. Depending on selected mode, the toggle may also stop plotting on the track plotter.

The datagrams from the Operator Unit may be transmitted to the following devices:

- External computer connected via Ethernet

See the description of the *Datagram output menu* on page 87 for more information on these output devices.

A **Sound speed profile** datagram is generated with the Start datagram. For further information on this datagram, refer to the *Datagram formats* chapter on page 157.

Line number

The purpose of this command is to define the current survey line number (0–999), included in all the **Start**, **Stop** and **Parameter** datagrams generated. A change in this parameter takes effect from the next datagram the system generates.

Note ! *The line numbers are not incremented automatically.*

Planned line no.

The purpose of this command is to establish a planned survey line identity (0–999). The planned survey line identifies a line run in several pieces, or run more than once. This information is included in all **Start**, **Stop** and **Parameter** datagrams generated. A change in this parameter takes effect from the next datagram the system generates.

Note ! *The line numbers are not incremented automatically.*

Operator

Use this command to identity yourself as the responsible operator of the EM 12 system. You can enter free text.

Annotation

Use this command to enter a free text comment of maximum 80 characters. The comment may be given to be included in all **Start**, **Stop** and **Parameter** datagrams. A change in the text takes effect from the next datagram the system generates.

Note that only the first characters of the text are shown in the parameter field after the text has been entered. However, all information is included in the datagrams. The annotation may be used to enter date, survey location, etc. We recommend that a standard annotation is established.

6.4 EM 12 Menu

Purpose

The **EM 12 menu** on the Operator Unit controls the EM 12 Transceiver through the Bottom Detector Unit(s). The following parameters are available:

- Transmit mode
- Power
- Expected depth
- Absorption coeff.
- Sound ve. sensor
- Sound velocity
- Ping count reset
- Active beams
- Simulator

Transmit mode

Purpose

The **Transmit mode** parameter controls the actual pulse length and resolution of the echo sounder. Commands available are:

- Off
- Local
- Auto
- Shallow
- Deep

Off

The transceiver is set to standby mode and no transmitting takes place. No bottom detection is performed.

Local

The transmit mode is defined at the Bottom Detector Unit.

Auto

The system switches automatically between **Shallow** and **Deep** mode. It is advised to use this mode during operation.

Shallow

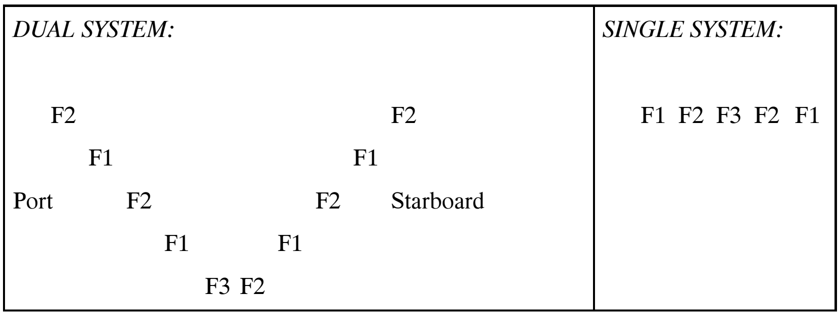
The **Shallow** transmit mode may be used to prevent frequent switches between **Shallow** and **Deep** mode or to increase the resolution at depths below the switch–over point (outer beams may then be lost).

In **Shallow** mode, the pulse is transmitted in one beam per transceiver, with a pulse length of 2 ms and a frequency of 12.7 kHz for the single system. For the dual system, the frequency is 12.7 kHz for the port system and 13.3 kHz for the starboard system. The range sampling rate is 60 cm.

Deep

The **Deep** transmit mode is used. This choice may be used to prevent frequent switches between **Shallow** and **Deep** mode when the average depth is near the automatic switch–over point.

In **Deep** mode, the pulse is transmitted in five beams per transceiver sequentially. The pulse length is 10 ms in each beam, i.e. 50 ms to cover the whole sector. The frequencies vary from 12.7 kHz to 13.3 kHz to minimize interference between the different beams as shown in the following figure. The range sampling rate is 240 cm.



where: F1=12.67 kHz, F2=13 kHz, F3=13.33 kHz

Note that if a specific coverage sector is required with equidistant beam spacing, the desired sector(s) should be set on the Bottom Detector Unit(s) and its Bottom Track parameter set to **Fixed mode** (further discussed in the chapter covering the Bottom Detector Unit, **Operation menu\Bottom track** section on page 115). Choice of **Deep** on the Operator Unit will then not cause the sectors to be switched automatically.

The choice of **Deep** and **Shallow** mode is made either by the system or by you. The system switches between the two modes depending on the depth below the keel and the sea bed conditions, normally at approximately 700 m for a dual system and approximately 1200 m for a single system.

Power

The **Power** command controls the output level of the EM 12. You may choose from the following parameters to reduce power output by 10 or 20 dB with respect to full power (0 dB) or turn it completely off:

- Off
- 0 dB
- –10 dB
- –20 dB

It is suggested to always use full power unless the EM 12 creates interference to other hydroacoustic equipment or possibly to itself in very shallow waters. If power output is reduced, it may be necessary to lock the transmit mode in **Deep**.

Expected depth

This depth is the minimum slant range to the seabed, usually the depth straight down. Entry of this parameter will force the echo sounder to assume this water depth. As bottom tracking and bottom recovery are usually fully automatic, entry of this parameter may only be required under very difficult conditions or to speed up bottom recovery on startup.

Absorption coeff.

This is the mean absorption coefficient of the water column used in gain setting in the receiver. The typical value is 1.1 dB/km in deep waters. For shallow waters it is higher, say 1.4 dB/km, but it is then of less importance for the operation of the echo sounder because of the shorter range. However, the absorption coefficient is important in determining the correct backscattering strength of the seabed used in the sonar imaging. Setting a correct value is therefore always recommended if the sonar image data are to be used, especially if the results are to be compared with those from other areas.

The absorption coefficient is given by the following formulae:

$$\alpha = \frac{A_1 f_1 f^2}{f^2 + f_1^2} + \frac{A_2 P_2 f_2 f^2}{f^2 + f_2^2} + A_3 P_3 f^2$$

$$A_1 = \frac{8.86 \cdot 10^{(0.78\, pH - 5)}}{c}$$

$$A_2 = \frac{21.44\, S(1 + 0.025T)}{c}$$

$$A_3 = 4.937 \cdot 10^{-4} - T(2.59 \cdot 10^{-5} - T(9.11 \cdot 10^{-7} - 1.5 \cdot 10^{-8} \cdot T)), T \leq 20^\circ C$$

$$A_3 = 3.964 \cdot 10^{-4} - T(1.146 \cdot 10^{-5} - T(1.45 \cdot 10^{-7} - 6.5 \cdot 10^{-10} \cdot T)), T \geq 20^\circ C$$

$$P_2 = 1 - Z(0.137 - 0.0062\, Z)$$

$$P_3 = 1 - Z(0.0383 - 4.9 \cdot 10^{-4}\, Z)$$

$$f_1 = 2.8 \sqrt{\frac{S}{35}} \cdot 10^{\left[4 - \frac{1245}{273 + T}\right]}$$

$$f_2 = \frac{8.17 \cdot 10^{\left[8 - \frac{1990}{273 + T}\right]}}{1 + 0.0018(S - 35)}$$

Here, α is given in dB/km, the sound speed ***c*** in m/s, the temperature ***T*** in °C, the depth ***Z*** in km, the salinity ***S*** in ppt, and the frequency ***f*** in kHz. The ***pH*** of the ocean is in the order of 7.6–8.2.

Note that 0.15 dB/km is a good approximation for the first term of the absorption coefficient formula for the EM 12 frequency, and that the last term may be set to zero. Figure 10 shows calculated absorption coefficient versus depth for summer or equatorial conditions (surface temperature of 30 °C) and winter or arctic conditions (surface temperature of 4 °C) for typical mid ocean conditions.

The mean values are the mean absorption coefficient from the surface to the depth indicated, and is the value to be entered in the EM 12 menu.

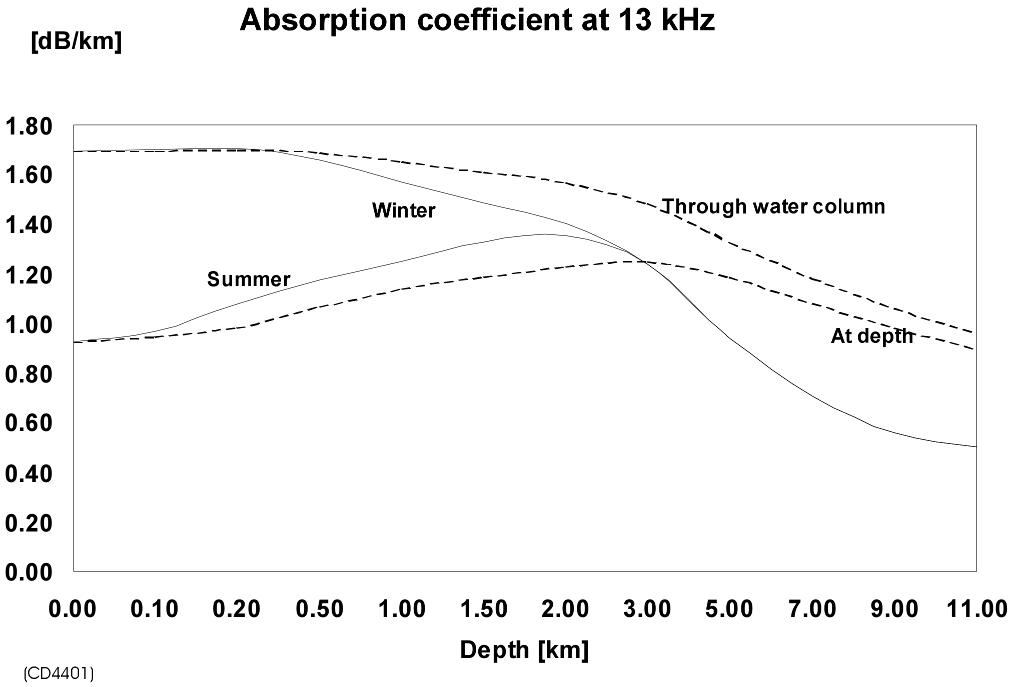


Figure 10 Calculated absorption coefficient

Sound–ve. sensor

The input from an external sound speed sensor located by the transducer array is disabled or enabled by this command. Normally, this input should be enabled to read the data from the sensor. If switched **Off**, the sound speed must be entered manually, and this may lead to a reduction in accuracy in the outer beams on each side when **Transmit mode** is set to **Shallow** (see page 60).

When set to **On**, a value sub–option appears:

±9.9 ms

which is the sound speed sensor offset.

The proper offset should be entered if it is observed that there is a small error in the sensor, for example when compared to the measurements from the sound speed profile sensor. Note that if layer compensation is to be used, the offset must be entered to make the measurement by the sensor equal to that of the profile sensor when the profile is taken.

Sound velocity

If a sound speed > 0 is selected, the chosen value is used in the beamforming instead of the value measured at the transducer by the sound speed sensor. Thus, 0 should always be used except when the sensor is out of order.

A formula for calculating sound speed is given in the chapter on *Loading profile directly from probe* on page 74.

Ping count reset

The ping counter is set to zero when **Yes** is chosen. The ping counter is incremented for every ping and is included in most datagrams from the echo sounder.

Active beams

If either the odd or even beams are not working properly they may be deactivated by setting these **Active beams** parameters accordingly:

- All
- Even
- Odd
- None

If all beams are disabled, then EM 12 will just ping very quickly, but with no processing of returns.

Simulator

A simulator is built into the Operator Unit. Upon activation, you can select from among five parameters:

- Off — The simulator is switched off
- Port — Port system simulation
- STB — Starboard system simulation
- Centre — Centre (single) system simulation
- Dual — Dual (Port & Starboard) system simulation

After selecting any of the simulator options, you will be asked to enter a number between 0 and 65535. This number sets the initial slant range and the depth steps to follow. The Operator Unit will then provide simulated datagrams, and the system may be run with the Bottom Detector Unit (and Transceiver Unit) disconnected.

Note !

*A Bottom Simulator circuit board may be installed in the Transceiver Unit. This board generates data for a flat seafloor at 100 m depth. The Operator Unit simulator is not to be used for control if this board is working, but the Transmit Mode may be set to **Local** for display purposes.*

Remove the four DAQ circuit boards and install the Bottom Simulator board in the position normally occupied by the DAQ4 board. Remember to re–install the DAQ boards after the test with the Bottom Simulator board is completed.

6.5 Track plotter menu

Purpose

Note ! *The Track Plotter is an optional device. If it is not installed, this menu option will not appear.*

Use the **Track plotter** to produce real–time documentation of the surveyed area. It plots acrosstrack lines from the utmost beam on the port side to the utmost beam on the starboard side and / or the vessel track. This option is useful, as the line spacing between survey lines and possible gaps in the survey may be checked immediately.

Figure 11 on page 68 shows an example of a track plot.

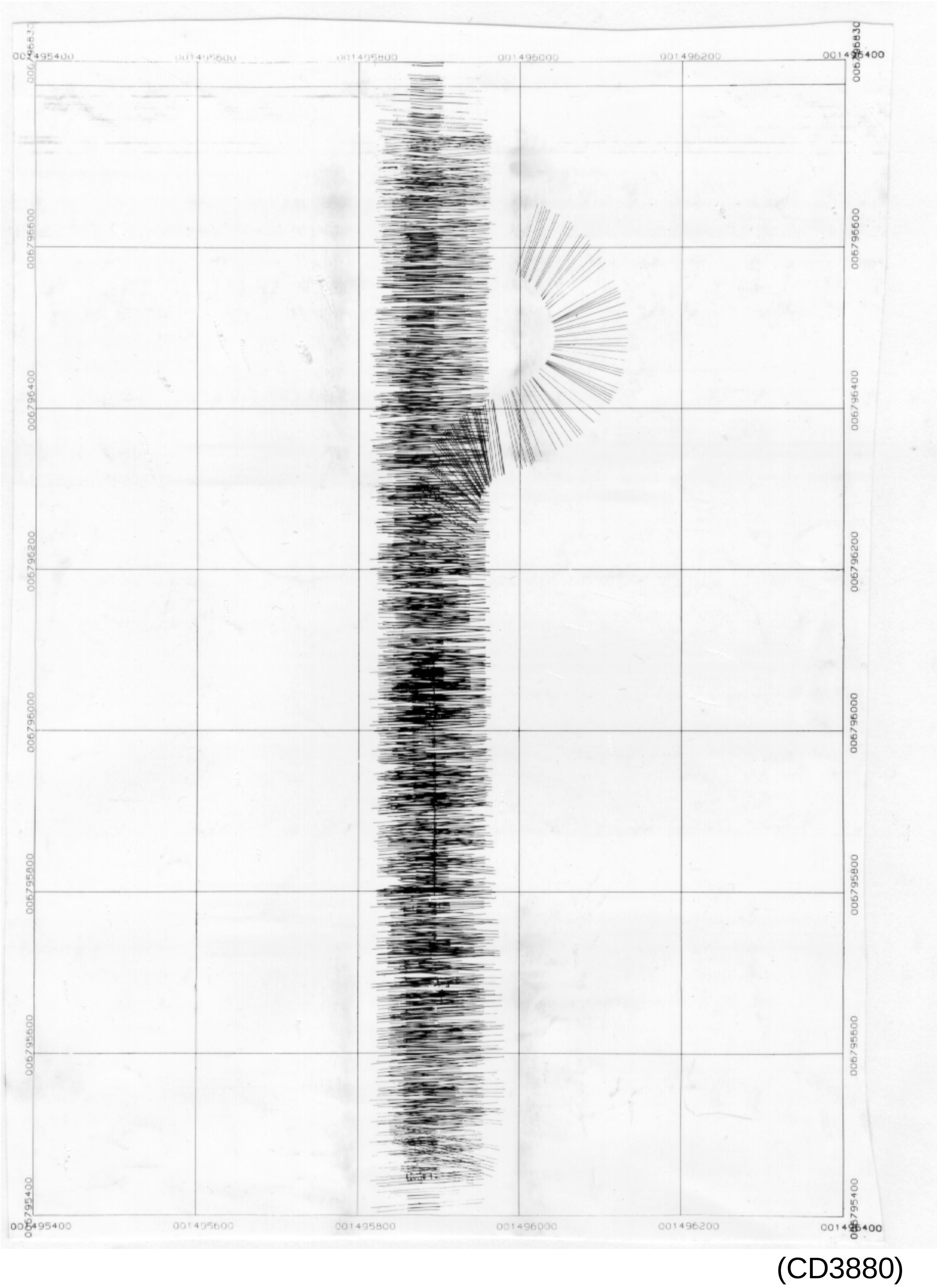
Note ! *Before plotting is started, the plotter must be prepared to accept data. Switch the plotter on and load paper and one or more pens (see paragraphs describing **Paper size** on page 70 and **Pen(s)** on page 70).*

A geographical grid (**Frame**) may be pre–plotted (see parameters of the **Mode** command on page 69).

The following commands are available:

- Mode
- Scale
- North coordinate
- East coordinate
- Paper size
- Orientation
- Pen(s)
- Pattern
- Interval

Note ! *For operation of the plotter, refer to the manufacturer's manual. Take care when specifying the scale and the coordinates of the lower left corner of the plot to ensure that the actual survey area is placed inside the plot frame.*



(CD3880)

Figure 11 Track plot example

Commands

Mode

Mode is the main control command for the plotter.

The parameter options are:

Off The plotting stops

On The plotter is initialized to plot coverage and/or position lines.

On / Log The same as **On**, except that the pen is always up when **Log** is set to **Off** in the Survey menu (refer to *Log* on page 58).

Frame The plotter produces a geographical grid. This grid should be made before the survey starts.

Note ! *If the **Frame** plot fails (no paper, plotter off, etc.), enter **Off** and then **Frame** again after the fault has been corrected. Enter **On** to commence coverage line plotting.*

Plotting may not start before the plotter parameters have been given appropriate values.

Scale

Use the **Scale** command to enter the scaling constant for the plot.

North coordinates

Type the North/South coordinate in either UTM or latitude format. See coordinate format specifications in Table 5.

East coordinates

Type the East/West coordinate in either UTM or longitude format.

The North and East coordinates define the lower left corner of the track plot. The coordinates must comply with following formats:

Coordinate	Format	Description
North UTM	nnnnnnnn	**n** is a digit (metre)
East UTM	nnnnnnn	**n** is a digit (metre)
latitude	ADD$mm.m	**A** is N or S **DD** is degrees 0–90 **mm** is minutes 0–59
longitude	BDDD$mm *or* BDD$mm.m	**B** is E or W **DDD** is degrees 0–180 **mm** minutes 0–59

Table 5 Coordinate format specifications

Note ! *Ensure that the position coordinate format corresponds with the positioning system input format (either UTM or latitude/longitude).*

Paper size

Four different standard paper sizes may be used on the track plotter. The size is chosen with this command.

- A3 corresponds to ANSI B
- A2 corresponds to ANSI C
- A1 corresponds to ANSI D
- A0 corresponds to ANSI E

Orientation

Use the **Orientation** command to select a **North up** or **East up** plot.

On the Calcomp 1076 plotter, the longest dimension of the plot is up/down, the shortest is left/right.

Pen(s)

The track plotter may be equipped with up to eight pens in different colours or widths. You can alter the pen choice any time, also while a coverage plot is being made. The pen is chosen by selecting a number between 1 and 8, corresponding to the pen numbering on the plotter.

Note ! *Take care with plotter pens. Replace the cap on ink pens, and remove pens from the plotter when not in use.*

Pattern

Use the **Pattern** command to define the printout mode on the plotter. Pattern options include:

- Swath
- Posline
- Combined

A **Swath** presentation is a line with a width equal to the ping coverage. Every time a Position datagram is received by the system, the width corresponding to the coverage of the last ping is drawn on the track plotter.

A **Posline** presentation will only draw the actual position of the ship upon receipt of the Position datagram. This location is presented as a dot on the paper. Note that positions will only be plotted if the system is acquiring depth data.

A **Combined** presentation combines the swath and posline presentation.

Interval

The echo sounder system may work faster than the plotter, and this may cause data overflow to the plotter. In order to avoid this, the dataflow to the plotter may be slowed down. The **Interval** command allows you to enter the number of seconds between each coverage line to be drawn.

6.6 Sound velocity menu

Purpose

The EM 12 echo sounder computes bottom depth, taking full account of the raybending caused by the variation of sound speed in the water column. The **Sound speed profile** is entered manually from the keyboard/joystick, automatically from a sound speed profile probe, from an external computer, or by a combination of these methods.

Note that it is assumed that the profile is anchored at the transducer, which will degrade accuracy in the outer beams when heave and sound speed variations are large.

Options available from the Sound velocity menu are:

- Change profile
- Load profile
- Layer compensation

Default depth values

The Sound speed profile consists of up to 100 pairs of depth and corresponding speed values. A maximum of 100 values is adequate for use in both deep and shallow waters, and assures sufficient accuracy in the ray–bending calculations.

As the sound speed changes most rapidly with depth in shallow waters, the default table depth intervals are very small in the beginning (shallow waters) and large at the end (deep waters), as shown in the table.

Default depth intervals in sound speed profile:

Depth interval	Depth range
1 m	1 – 50 m
10 m	50 – 100 m
25 m	100 – 200 m
50 m	200 – 300 m
100 m	300 – 2000 m
200 m	2000 – 3000 m
500 m	3000 – 12000 m

Changing depth values

The depth values may be changed, but as the allowable change is limited by the neighbouring depths, it may be cumbersome and should be carefully planned. If many deep settings are to be made shallower, it is advisable to start with changing the shallowest. Conversely, if many shallow settings are to be made deeper, it is advisable to start with changing the deepest.

Note ! *Alterations in the sound speed profile may require computing over several pings. During this time, erroneous depths may be generated. Data logging or pinging should therefore be disabled while the sound speed profile is being updated. A "working" message is displayed while updating is in progress.*

Changing the profile is possible in three different ways:

1 interactively via the **Change profile** command of the Sound speed profile menu

2 loading a complete profile from an external computer via Ethernet or Serial RS–232 using the **Load profile** command of the Sound speed profile menu

3 loading sound speed data **directly from a probe** (Navitronic SVP–1/SVM–1 or Applied Microsystems Ltd. SVP–16)

Commands and procedures

Change profile

Choose the **Change profile** command from the Sound speed profile menu to set the sound speed values.

Note ! *Before changing the Sound speed profile, it is useful to select **Display–>Sound speed** from the **Graphic menu** (see page 77) in order to set the lower graphic window to **Sound speed** mode for monitoring the change of setting. If necessary, change display scale for depth and/or sound speed to match profile (described on page 80).*

- Use **Default** to set all depths and corresponding sound speed values to the following Kongsberg Simrad default values:

Depth	Sound speed
0 – 2500 m	c = 1500 m/s
2500 – 5000 m	with S = 35 & T = 2.5 – {(Z–2000}/2000}
5000 – 12000 m	with S = 35 & T = 1.0

Default depth intervals in the sound speed profile are described on page 71.

- Use **Set All** to set all sound speed values in the profile to a fixed value from a specified depth which you will be asked for.
- Use **Edit** when you wish to alter the current sound speed profile.
  - Select the **Pair number** of the sound speed value appearing in the menu at the bottom of the text section.
  - Select/change the **Depth**
  - Select/change the **Sound speed**
  - Confirm new values by pressing the → key on the keyboard or leave values unchanged by pressing ←.

The sound speed is now set for a certain depth and a pair of data is generated. If a change of a sound speed value is wanted at other depths, repeat the procedure described above. The cursor will toggle between the depth setting and the sound speed setting until the new sound speed profile is entered (by pressing left ←).

The raybending calculations assume that the sound speed has a linear variation between the tabulated values in the profile.

Load profile

Choose the **Load profile** command from the Sound speed profile menu to load a sound speed profile from an external device. The following options are available:

- **NAV. 1.0 m**: This is for entering a profile on the RS–232 interface from a Navitronic sound speed meter with 1.0 m depth resolution.
- **NAV. 0.2 m**: Same as NAV. 1.0 M, except that the sound speed probe has a depth resolution of 0.2 m.
- **SIMRAD–A**: Loading Kongsberg Simrad ASCII sound speed profile datagram (RS–232).
- **SIMRAD–B**: Loading Kongsberg Simrad Binary sound speed profile datagram (RS–232 or Ethernet).
- **AMLSVP16**: Loading data directly from an Applied Microsystems Ltd. SVP–16 probe (RS–232).
- **AML–CALC**: Loading Applied Microsystems Ltd. CALC file from a PC (RS–232).

After a successful transmission, the following message will be displayed:

Load finished, data ok

Otherwise the following text will be displayed:

Load aborted, bad data

For further information, refer to the *Datagram formats* section of this manual on page 157.

Loading profile directly from probe

Using the Navitronic 0.2 m/1.0 m probe implies that only those sound speed values that match the currently defined depth values in the profile, will be used. The Navitronic profile should thus be inspected on the SVM–1 monitor display to judge the suitability of the current depth values. Note that the SVM–1 may upload a profile repeatedly in case changes have to be made or errors occur.

Note ! *User experience has shown that the Navitronic probe does not give correct measurements when the sound speed is higher than approximately 1500 m/s. This probe should therefore not be used in warm oceanic waters.*

Data from the Applied Microsystems Ltd. (AML) SVP–16 probe should normally be loaded into and inspected on a personal computer (PC). Because the Operator Unit does not accept more than 100 pairs of depth and sound speed, it may be necessary to reduce the amount of data in the file before loading the data into the Operator Unit. In case a PC is not used, it is possible to load uncalibrated data directly from the SVP–16 probe into the Operator Unit. Note that decreasing depth values will not be accepted by the Operator Unit.

If measured sound speed values are not available, they may be derived from tables, or, if the temperature and salinity profiles are known or estimated, calculated from a formula. While many formulae exist, the one from UNESCO Technical Paper in Marine Science, No. 44, is usually regarded as being authoritative. However, it is cumbersome and recent experiments showed that it has errors in the 1000–4000 m depth range. Therefore, a simpler formula with adequate accuracy is as follows (from Coppens, JASA March 1981, with a modified very deep water correction which follows the recent experimental data).

- For the surface:

$$c(0,T,S) = 1449.05 + T(4.57 - T(0.0521 - 0.00023T)) + (1.333 - T(0.0126 - 0.00009T)(S - 35)$$

where: **T** is temperature in °C
S is salinity in ppt

- For depths to 200 m in fresh water and 1000 m in the ocean:

$$c(Z,T,S) = c(0,T,S) + 16.5Z$$

where: **T** is temperature in °C
S is salinity in ppt
Z is depth in km

- For depths to 2000 m in fresh water and to 11000 m in the ocean (assuming that the water is very cold at great depths):

  $$c(Z,T,S) = c(0,T,S) + Z(16.3 + Z(0.22 - 0.003Z\sqrt{T+2}))$$

  where: **T** is temperature in °C
  S is salinity in ppt
  Z is depth in km

- For depths greater than 5000 m, a latitude correction should be applied:

  $$c(Z,T,S) = c(0,T,S) + Z'(16.3 + Z(0.22 - 0.003Z\sqrt{T+2}))$$

  where: **Z′** = Z(1 – 0.0026 cos2ϕ)
  ϕ is latitude in degrees
  T is temperature in °C
  S is salinity in ppt
  Z is depth in km

Layer compensation

If the sound speed at the transducer is measured continuously using a sensor, the measured values should also be used to compensate for the extra ray bending caused by a varying sound speed in a surface layer differing from the values in the sound speed profile. The initial ray bending at the transducer depth is calculated from the ratio of the measured value to that in the sound speed profile.

Note that this compensation should be used with caution in shallow waters. If the layer is thicker than half the depth, setting the compensation to **On** may only serve to increase the error, not decrease it. If a large difference between measured sound speed and that in the profile is observed, a completely new sound speed profile is required.

6.7 Graphic menu

Purpose

Use the **Graphic** menu to control the visual presentation on the display screen and the optional printer. The following commands are available:

- Beeper
- Display
- Printer
- Beam number
- Athwart profile
- Along tr. profile
- Sound velocity
- Echogram

Commands

Beeper

The computer is equipped with a small loudspeaker, which will give a beep every time an error message appears on the display. Use the **On**/**Off** parameters of the **Beeper** command to enable or disable this audible warning.

Display

Purpose

Use the **Display** command to control which information is to be displayed in the lower graphic window. The following options are available:

- Off
- Along tr.
- Sound ve.
- Echogram
- Scope
- Stave

Off

The lower graphic window disappears when this option is selected.

Along Tr.

The **Along–track** display shows the depth history of the selected beam. For description of the parameters adjusting the display, refer to **Along–track profile** menu on page 79.

A display example is shown in Figure 5 on page 45.

Sound Ve.

The **Sound velocity** display shows the sound speed profile currently in use. For description of the parameters adjusting the display, refer to **Sound speed profile** menu on page 80.

A display example is shown in Figure 6 on page 46.

Echogram

The **Echogram** display shows a traditional echogram created from the selected beam. For description of the parameters adjusting the display, refer to **Echogram** menu on page 81.

A display example is shown in Figure 8 on page 48.

Scope

The **Scope** display shows the amplitude and phase samples for the selected beam. The parameters for the Scope display are chosen in the **Echogram** menu (see page 81).

A display example is shown in Figure 9 on page 49.

Printer

The **Printer** command controls the use of the echogram printer. The following parameters are available:

- **Off** . . . . there will be no output to the printer
- **Hardcopy** . . . . copy of the display is printed
- **Echogram** . . . . . . continuous print of chosen beam echogram

Beam number

The **Beam number** command selects the current beam number for the lower display window. Note that the Along–track profile may be looked through by changing the beam number without entering it (i.e. cancel changes by using the left ←arrow key).

Range:

1 – 81 for EM 12S

(even if EM 100, EM 950 or EM 1000 is also installed)

1 – S1 (via 81 and 81S) for EM 12D

(even if EM 100, EM 950 or EM 1000 is also installed)

Athwart profile

Purpose

Use the **Athwart profile** command to control the visual presentation of the Acrosstrack profile displayed in the upper graphic window. The following options are available:

- Upper depth
- Lower depth
- Width
- Ping interval
- Color code
- Amplitude

A display example is shown in Figure 4 on page 44.

Upper depth

Selects the depth of the upper display border.

In **Manual** mode the depth may be set to a fixed value from 0 to 12000 m in steps of 1 m.

In **Auto** mode the upper depth is given a suitable value by the system, depending on the measured depths.

Lower depth

Selects the depth of the lower display border.

The **Manual** mode sets the depth to a fixed value from 0 to 12000 m in steps of 1 m.

In **Auto** mode the lower depth is given a suitable value by the system, depending on the measured depths.

Width

Selects the width of the displayed window.

The **Manual** mode sets the width to a fixed value from 0 to 30000 m in steps of 1 m.

In **Auto** mode the width is given a suitable value by the system, depending on the measured coverage.

Ping interval

Select the number of pings between each update of the acrosstrack profile display. The following options are available:

- 1:1
- 1:2
- 1:3
- 1:5
- 1:10
- 1:20

Color code

Selects whether position or bottom detection should be used for the colour coding in the Acrosstrack profile display.

PORT/STB: represents the beams on port and starboard sides of vessel

AMPL/PHA: represents the amplitude and phase of the beams

Amplitude

Selects whether or not to show the backscattering strength or amplitude value in the acrosstrack display. The amplitude is displayed as a bar on the beam depth value with the value indicated by the length of each bar.

Alongtrack profile

Purpose

Controls the visual presentation of the Alongtrack profile. The available parameter options are:

- Upper depth
- Lower depth
- Ping interval
- Color code
- Amplitude

Upper Depth

Selects the depth of the upper display border.

The **Manual** mode sets the depth to a fixed value of 0 to 12000 m in steps of 1 m.

In **Auto** mode, the upper depth is given a suitable value by the system, depending on the measured depths.

Lower depth

Selects the depth of the lower display border.

The **Manual** mode sets the depth to a fixed value from 0 to 12000 m in steps of 1 m.

In **Auto** mode, the lower depth is given a suitable value by the system, depending on the measured depths.

Ping interval

Selects the number of pings between each update of the alongtrack profile display. The following options are available:

- 1:1
- 1:2
- 1:3
- 1:5
- 1:10
- 1:20

Color code

Selects whether position or bottom detection should be used for the colour coding in the alongtrack profile display.

PORT/STB: represents the beams on port and starboard sides of vessel

AMPL/PHA: represents the amplitude and phase of the beams

Amplitude

Selects whether or not to show the backscattering strength or amplitude value in the alongtrack profile display. The amplitude is displayed as a bar on the beam depth value with the value indicated by the length of each bar.

Sound velocity

Purpose

Controls the visual presentation of the Sound Speed Profile. The following parameters are available:

- Upper depth
- Lower depth
- Velocity start
- Velocity stop
- Graph
- Plot

Upper depth

Selects the depth of the upper display border to a value from 0 to 12000 m in steps of 1 m.

Lower depth

Selects the depth of the lower display border to a value from 0 to 12000 m in steps of 1 m.

Velocity start

Selects the start of the display sound speed scale to a value from 1400 to 1700 m/s in steps of 1 m/s.

Velocity stop

Selects the stop of the display sound speed scale to a value from 1400 to 1700 m/s in steps of 1 m/s.

Graph

Selects the type of graph displayed to be **Profile** or **Path**.

If **Profile** is selected, the current sound speed profile is displayed (sound speed as a function of depth).

If **Path** is selected, then the sound ray paths for a fixed number of beam angles are displayed.

Plot

Selects the type of lines used on graph as **Points** (single points) or **Lines** (straight lines between consecutive points).

Echogram

Purpose

Controls the visual presentation of the echogram.

The **Echogram** parameters control both the **Echogram** and the **Scope** displays in the lower graphic window. The following parameters are available:

- Range
- Upper depth
- Ping interval

Range

Selects the depth range of the display to a value from 0 to 12000 m in steps of 1 m.

Selecting 0 m gives a constant number of samples in range with a resolution equal to the sampling interval (determined by echo sounder type and mode).

Upper depth

A start depth for the range may be set to a value from 0 to 12000 m in steps of 1 m.

Selecting 0 m implies automatic bottom tracking, i.e. a valid beam detection point is always in the middle of the display window.

Ping interval

Selects number of pings between each update of the Echogram/Scope display. The following options are available:

- 1:1
- 1:2
- 1:3
- 1:5
- 1:10
- 1:20

6.8 Installation menu

Purpose

All of the parameters in the **Installation** menu must be set correctly at installation time. Most remain fixed thereafter, but some may have to be changed from time to time, taking into account sensor drifts and varying survey requirements.

The following sub–menus are available:

- EM 12 Transducer menu
- Transducer menu
- Motion–sensor menu
- Position system menu
- Datagram output menu
- Date & time menu
- Serial protocol menu
- Ethernet protocol menu

Commands

Transducer menu

Purpose

The **Transducer menu** parameters set the positional offset of the transducer with respect to a chosen reference point.

The location of the transducer must be defined. There is one transducer menu implemented for each EM 12 system installed and the top of the menu includes the system designation "EM 12 Transd."

The parameters in the EM 12 Transducer menu are as follows:

- Depth
- Alongship offset
- Athwart. offset
- Rx mount (dual)

Depth

This parameter sets the depth of the transducer face referred to actual water level. This value is added to the computed bottom depth. It may have to be changed according to changes in vessel draft.

Alongship offset

The **Alongship offset** parameter sets the fore–and–aft position of the transducer. Values should be positive when the transducer is forward of the reference point. This value is the exact position of the transducer array in relation to the ship's reference point.

Athwart. offset

The **Athwart offset** parameter sets the athwartship position of the transducer. Values should be positive when the transducer is on the starboard side of the reference point. This value is the exact position of the transducer array in relation to the ship's reference point.

Note ! *The reference point should be the same used by the vessel's positioning system. The transducer location is used to calculate the sounding (x,y,z) coordinates with respect to this reference point.*

Rx mount (dual)

The **Athwart offset** parameter sets the transducer installation angles (usually 40 degrees) referred to the horizontal on a double–transducer system on the EM 12D.

Motion–sensor menu

Purpose

Motion–sensor parameters affect the data from the motion sensor(s) (Vertical Reference Unit and the heading sensor). The parameters available are:

- Heave
- Roll
- Pitch
- Gyro
- Roll offset
- Pitch offset
- Gyro offset
- Roll Delay

Heave

Disables/enables input from the heave sensor.

Roll

Disables/enables input from the roll sensor.

Pitch

Disables/enables input from the pitch sensor.

Gyro

Disables/enables input from the course gyro.

Roll offset

Correction factor of the roll sensor offset (zero static bias) set to value from 0 to ± 9.99° in steps of 0.01°.

The offset values are the static offset values of the attitude sensors and are subtracted from the actual measured values before these are used by the echo sounder. The values may be found by executing the **Calibration** procedure described in the *Quality Assurance Unit operator manual* or the *Merlin manual*.

Pitch offset

Correction factor of the pitch sensor offset (zero static bias) set to value from 0 to ± 9.99° in steps of 0.01°.

The offset values are the static offset values of the attitude sensors and are subtracted from the actual measured values before these are used by the echo sounder. The values may be found by executing the **Calibration** procedure described in the *Quality Assurance Unit operator manual* or the *Merlin manual*.

Gyro offset

Correction factor of the gyrocompass offset (zero static bias) set to value of 0 to ± 9.99° in steps of 0.01°.

The offset values are the static offset values of the attitude sensors and are subtracted from the actual measured values before these are used by the echo sounder.

Roll delay

Correction for time delay in roll sensor data set to value of 0 to 100 ms in steps of 1 ms.

Note ! *It is vital for good accuracy that the sensors are enabled and that the offsets and roll time delay values are set correctly.*

Position system menu

Purpose

Controls the positioning input. The parameters available are:

- Input system
- Time delay
- Time tag

Input system

The **Input system** command selects the accepted format of the positioning datagrams to the EM 12 system. Refer to the chapter describing *Datagram formats* on page 155 describing the different formats.

Commands available are:

- OFF
- SIMRAD 86
- MOTOROLA
- MICROFIX
- SIMRAD 90
- NMEA–183
- TRIMBLE
- DOLPHIN

- RWSLOD
- SIM. UTMN
- SIM. UTMS
- SIM. LALO

SIM. UTMN, SIM. UTMS and **SIM. LALO** simulate UTM or latitude/longitude position. When **Off** is selected, positioning input is ignored.

Time delay

The entered value is subtracted from the time the position data reaches the echo sounder as measured by its internal clock or the time stamp in the position datagram. This compensates for any time delay between the actual time of the position measurement and when the data reaches the echo sounder. The time delay value may be found by executing the **Calibration** procedure described in the *Quality Assurance Unit operator manual* or the *Merlin manual*.

Time tag

If **External** time tagging is selected, the time and date in the position input datagram will also be used in the position output datagram.

Internal time tagging implies that the time and date of the Operator Unit, when the position input datagram arrived, will be used in the position output datagram.

Note that if **External** is selected, correct time synchronization is achieved only if the Operator Unit and positioning system are synchronized to the same clock, and the position input datagram time stamp gives the time when the position was valid.

If **Internal** option is selected, correct time synchronization between echo sounder and position data is achieved only if the positioning data always arrive with a known fixed time delay.

Datagram output menu

Purpose

Parameters of the **Datagram output menu** control the datagram output. Parameter options are:

- Serial line RS–232
- Ethernet

The setup should be defined according to survey requirements, and the distribution of the data should be checked according to a check–list prior to each survey.

Serial line RS–232

The following commands select the output datagram(s) (more than one can be chosen) to be transmitted on the serial port:

- Depth
- Position
- Sound velocity
- Parameter
- Start–stop
- EM 100 Amplitude
- NMEA Depth

Note ! *Except for NMEA Depth, output on serial line is not recommended for EM 12 as the data rate will be too high.*

Each datagram may be switched **On** or **Off**. See description of each datagram below.

Ethernet

The following commands select the output datagram(s) to be transmitted on the external Ethernet:

- Depth
- Depth NMEA
- Position
- Sound velocity
- Parameter
- Start–stop
- EM 12 SIU ampl. & phase
- EM 100 amplitude
- Delayed heave (not applicable)

Each datagram may be switched **On** or **Off**. See description of each datagram below.

Depth

Setting this option to **On** enables the output of **Depth** datagrams.

Depth NMEA

This option is for output of depth straight down in the NMEA DPT format on serial line only.

Position

Setting this option to **On** enables output of **Position** datagrams.

Sound velocity

Setting this option to **On** enables output of **Sound speed** datagrams. A datagram is generated each time the sound speed profile is changed, and each time logging is started (in the **Survey** menu).

Parameter

Setting this option to **On** enables output of **Parameter** datagrams. A datagram is generated each time a parameter included in the datagram is changed.

Start–stop

Setting this option to **On** enables output of **Start–Stop** datagrams. A **Start** datagram is generated when logging is turned on in the **Survey** menu, and a **Stop** datagram when logging is turned **Off**.

SIU amplitude

Setting this option to **On** enables output of **Sonar image amplitude** datagrams.

EM 12 SIU amplitude & phase

Setting this option to **On** enables output of **Sonar image amplitude** and **phase** datagrams.

EM 100 amplitude

This option is inactive for the EM 12.

Delayed heave

This option is inactive for the EM 12.

Refer to *Datagram formats* on page 155 in this manual.

Date & time menu

Purpose

The system has an internal clock with battery backup. Use the **Date & time** commands only if the date or time has to be changed, the battery is replaced, or if synchronization with an external reference clock is to be established. The commands available are:

- Date
- Time
- Ext. clock

Date

Type the current date in the prompt field or use the joystick to enter the current date in the prompt field. Valid formats are:

- YY.MM.DD
- YY:MM:DD
- YY/MM/DD

End with the RETURN (ENTER) key or the → key (or press the joystick to the right →). Your selection will change the date at the top of the text window.

Time

Type the current time in the prompt field or use the joystick to enter the current time in the prompt field. Valid formats are:

- HH.MM.SS
- HH:MM:SS
- HH/MM/SS

End with the RETURN (ENTER) key or the → key (or press the joystick to the right →). Your selection will change the time at the top of the text window.

Ext. clock

If an external clock is connected and selected, the echo sounder internal clock will be synchronized to it. Command selections available are:

- OFF
- NAV. SDC4
- WEMPE/LT (Local time)
- WEMPE/GT (Global time)
- NMEA–183
- IFREMER
- TRIMBLE
- NERC

For information on accepted formats refer to *Datagram formats* on page 155 in this manual.

When initiated, the EM 12 system will accept the first datagram to update its internal clock. It will later accept a new datagram once every minute if its time differs less than ± 5 seconds from the internal clock. If the internal and external clocks differ by more than ± 5 seconds, set **Ext. clock** to **Off** and select the proper **Ext. clock** again.

Serial protocol menu

Purpose

The **Serial protocol menu** allows setup of the protocol parameters for each of the RS–232 serial communication ports.

The parameters of the **Serial protocol menu** are Serial–1 to Serial–7 which correspond to P1 to P7 on the multiport connector box.

The parameters of each Serial protocol are as follows:

- Baudrate
- Bits per char.
- Stop bits
- Parity

Baudrate

Sets the baud rate in bits per second. Options are:

- 300
- 600
- 1200
- 2400
- 4800
- 9600
- 19200

Bits per char.

Sets the number of bits used for each character as 7 or 8.

Stop bits

Sets the number of stop bits used as 1 or 2.

Parity

Sets the type of parity used. Commands available are:

- None
- Odd
- Even

Ethernet protocol menu

Purpose

This menu controls the external Ethernet interface (described in **Ethernet interfaces** on page 50).

Address setup

Setup of the addresses is required for correct transfer of data on the external Ethernet.

The EM 12 system incorporates a LAN (Local Area Network) interface of the Ethernet type. This interface provides efficient and high functionality interfacing to standard computers (DEC, SUN, HP, IBM PC etc.) used for data logging and post–processing. Communication via the LAN port is based on the UDP (User Datagram Protocol, a member of the TCP/IP protocol family).

The protocol requires that the following address fields are correctly defined:

- Destination ETHERNET address (6 bytes)
- Destination IP address (4 bytes)
- Destination UDP port number (2 bytes)
- Source ETHERNET address (6 bytes)
- Source IP address (4 bytes)
- Source UDP port number (2 bytes)

Both destination and source addresses are included in each transmission, and a complete address is comprised of Ethernet address, IP address and UDP port number. Each device on the network must have a unique address. There are three Ethernet address types:

- Individual (least significant bit of first byte is zero)
- Multicast (least significant bit of first byte is one)
- Broadcast (all ones).

Note that corresponding addresses on both the external computer (remote) and those of the echo sounder (local) must be set correctly if communication is to be successful. The EM 12 Operator Unit uses the source (its own) IP address and UDP port number to discriminate against extraneous Ethernet traffic.

Menu commands

Commands in the menu are:

- Local UDP port
- Remote UDP port
- Local ETH addr.
- Local IP addr.
- Remote ETH addr.
- Remote IP addr.

Local UDP port

User Datagram Protocol (UDP) port number on the Operator Unit.

Remote UDP port

UDP port number on the external computer.

Local ETH address

Ethernet address of the Operator Unit, entered as a sequence of 6 bytes (hexadecimal value). Address options range from 00:00:00:00:00:00 to FF:FF:FF:FF:FF:FF.

Example: 10:11:11:11:11:11

Local IP address

Internet Protocol address (IP) of the Operator Unit, entered as a sequence of 4 bytes. Address options range from 000.000.000.000 to 255.255.255.255.

Example: 192.009.200.255

Remote ETH address

Ethernet address of the external computer, entered as a sequence of 6 bytes (hexadecimal value). Address options range from 00:00:00:00:00:00 to FF:FF:FF:FF:FF:FF.

Example: 02:60:8C:4A:C7:34

Remote IP address

IP address of the external computer, entered as a sequence of 4 bytes. Address options range from 000.000.000.000 to 255.255.255.255

Example: 192.009.200.254

6.9 Configuration menu

This is for Kongsberg Simrad use only. A password is needed to enter this facility.

Use your **left arrow** (←) **key** or use the joystick (press **left**) to return to the Main menu.

If you accidentally enter a password, the following error message will appear: "Invalid Password!". This error message will disappear after some seconds and return you to the **Main menu**.

6.10 Test menu

Purpose

A Built–in Test Equipment (BITE) system is implemented on the System Operator Unit. Tests may be run from two sub–menus of the **Main menu**:

- **Test menu** for OPU status and interface tests described here.

The **Test menu** contains the following commands:

- Version
- CPU
- Serial port
- LAN
- Simrad

Commands

Version

Displays software version number of the EM 12 Operator Unit.

CPU

Displays CPU counter (higher number equals more spare CPU capacity).

Serial port

You may choose **Ports 1 – 7**. The following parameters for the selected port are displayed:

- Serial line
- Bytes input
- Last inbyte
- Bytes output
- Last outbyte
- Error count

LAN

Status for the selected option is displayed. Options available are:

- SW Stat1 (Software status LAN–1)
- SW Stat2 (Software status LAN–2)
- HW Stat1 (Hardware status LAN–1)
- HW Stat2 (Hardware status LAN–2)
- S. Reset 1 (Soft reset LAN–1)
- S. Reset 2 (Soft reset LAN–2)
- H. Reset 1 (Hard reset LAN–1)
- H. Reset 2 (Hard reset LAN–2)

LAN–1 = Internal network

LAN–2 = External network.

Note ! *LAN hardware reset will cause approximately 10 second loss of data (receive and transmit). Hardware status counters are reset after viewing.*

SIMRAD

Kongsberg Simrad use only (password required).

Use your **left arrow** (←) **key** or use the joystick (press **left**) to return to the Test menu.

If you accidentally enter a password, the following error message will appear: "Invalid Password!". This error message will disappear after some seconds and return you to the Test menu.

6.11 Error and status messages

General

The Operator Unit has a built–in system for error and status reporting. Errors may be either system or operator errors. An error message is shown for about five seconds. If the error is still present, the message is repeated until the error is corrected.

If more than one error occurs simultaneously, the messages will be shown in sequence until the errors are corrected.

LAN messages

The Operator Unit may include up to two Ethernet interfaces:

- **LAN–1** Local EM Ethernet (between Operator Unit, Bottom Detector Unit(s), Quality Assurance Unit and Sonar Imaging Unit)
- **LAN–2** External Ethernet (to external computers)

Error messages may occur for both LANs. Possible error messages are as follows (LAN–x represents either LAN–1 or LAN–2):

- LAN–x initialize error
- LAN–x address error
- LAN–x receive error
- LAN–x receive timeout
- LAN–x Rx data–size error
- LAN–x Rx datagram unknown
- LAN–x Rx datagram ignored
- LAN–2 Rx protocol unknown
- LAN–x transmit error
- LAN–x tx data–size error
- LAN–2 Rx ICMP type x

LAN–x initialize error

Ethernet board hardware failure.

LAN–x address error

Illegal Ethernet or Internet address.

LAN–x receive error

Error while receiving datagram. If error persists although a Hard reset is automatically done, there may be a hardware or cabling error.

LAN–x receive timeout

Expected datagram not received, i.e. usually no data is being sent to Operator Unit from Bottom Detector Unit(s) (although the echo sounder is not set to **Off** in the Operator Unit menu) for example due to loss of bottom tracking.

LAN–x Rx data–size error

Received datagram too long or too short.

LAN–x Rx datagram unknown

Unable to recognize received datagram type.

LAN–x Rx datagram ignored

A datagram is received, but ignored. A known datagram type may for example be sent by the Bottom Detector Unit(s) although the echo sounder has been set to **Off** by the Operator Unit, for example due to backlog of pings.

LAN–2 Rx protocol unknown

Data received on LAN–2 with unknown Ethernet protocol. Indicates incorrect setup of Ethernet parameters.

LAN–x transmit error

Transmission of datagram failed. As for Rx error may indicate hardware or cabling error if error persist.

LAN–x tx data–size error

Datagram too long or too short to be transmitted.

LAN–2 Rx ICMP type x

LAN–2 Internet control message protocol (ICMP) type X datagram received. This message may be issued by a workstation after having received a datagram with no process connected to the actual port (socket).

Miscellaneous messages

Other messages which may appear are as follows:

- Dataout serial–line error
- Dataout serial buff. full
- Printer error
- Track–plotter off–line
- Invalid position datagram
- Invalid external clock
- External clock timeout
- Invalid sound speed
- Display overload
- Internal error x
- Other

Dataout serial–line error

The serial port to external computer fails.

Dataout serial buff. full

Too much data is transmitted to the serial port (data is lost).

Printer error

Printer not responding.

Track–plotter off–line

Track plotter not responding within expected time.

Invalid position datagram

The format or content of the received position datagram is not valid.

Invalid external clock

The format or content of the received external clock datagram is not valid.

External clock timeout

Expected clock datagram has not been received within expected time.

Invalid sound speed

An invalid sound speed value has been found. Check all values in sound speed profile.

Display overload

Computer load is so high that some information on the display is lost. Display ping update interval should be reduced or lower window display changed or turned off.

Internal error x

Internal software error encountered. Consult Kongsberg Simrad AS.

Other

Consult Kongsberg Simrad AS.

7 BOTTOM DETECTOR UNIT

Note ! *This EM 12 Operator Manual is based on Bottom Detector Unit software version 1.9x. Changes made to the software may require amendments to this manual. Minor changes in software are identified by the third digit in the version number.*

7.1 Functional description

Overview

The Bottom Detector Unit controls the EM 12 Transceiver Unit based on commands from the Operator Unit and, in automatic mode, sets all parameters such as operation mode, coverage sector, depth range, etc.

The Bottom Detector Unit includes a colour screen with display of raw receiver amplitude, beam amplitude and phase data, and various detection parameters.

Data to and from the Transceiver Unit is passed through two coaxial cables (Ethernet). The Transceiver Unit communicates with the Operator Unit and the optional Quality Assurance Unit and Sonar Imaging Unit on the EM 12 internal Ethernet.

A joystick on the display unit is used to access the menu. The Bottom Detector Unit is usually mounted in a standard 19"instrument rack or in the Operator Console Unit.

The Bottom Detector is synchronized to the Operator Unit over Ethernet or preferably over serial line.

In a dual system (EM 12D), there are two Bottom Detector Units. They are synchronized to each other so that the two sides ping simultaneously, and the port system passes mode, ping number and time start to the starboard side.

The Bottom Detector Unit is used for initial system configuration and quality control. It is often also used for initial system startup (start of pinging).

Display and menu

Purpose

The display is divided into two parts. The left side of the screen is used to display a graphic window, and the right side is used for a text window.

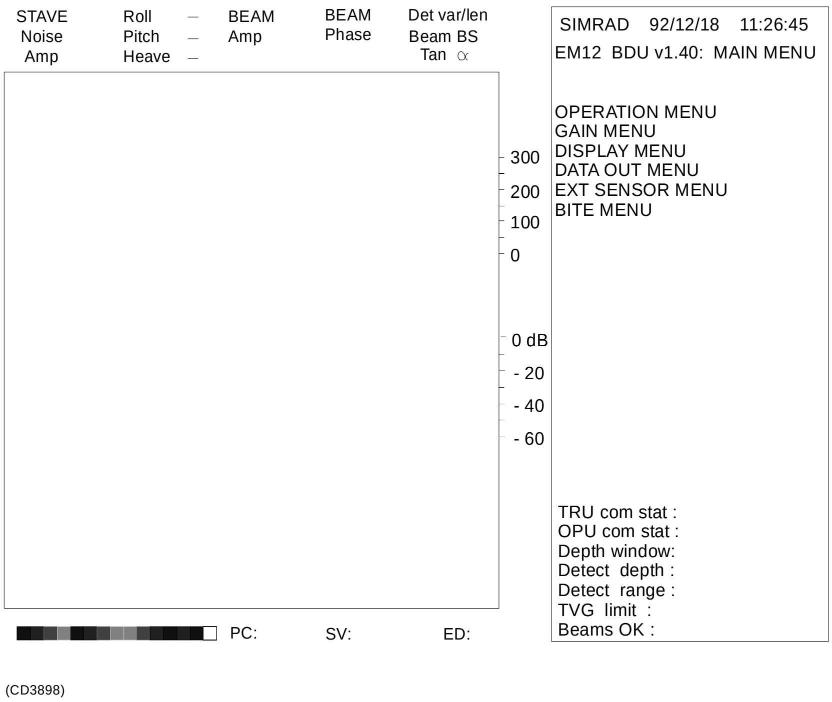
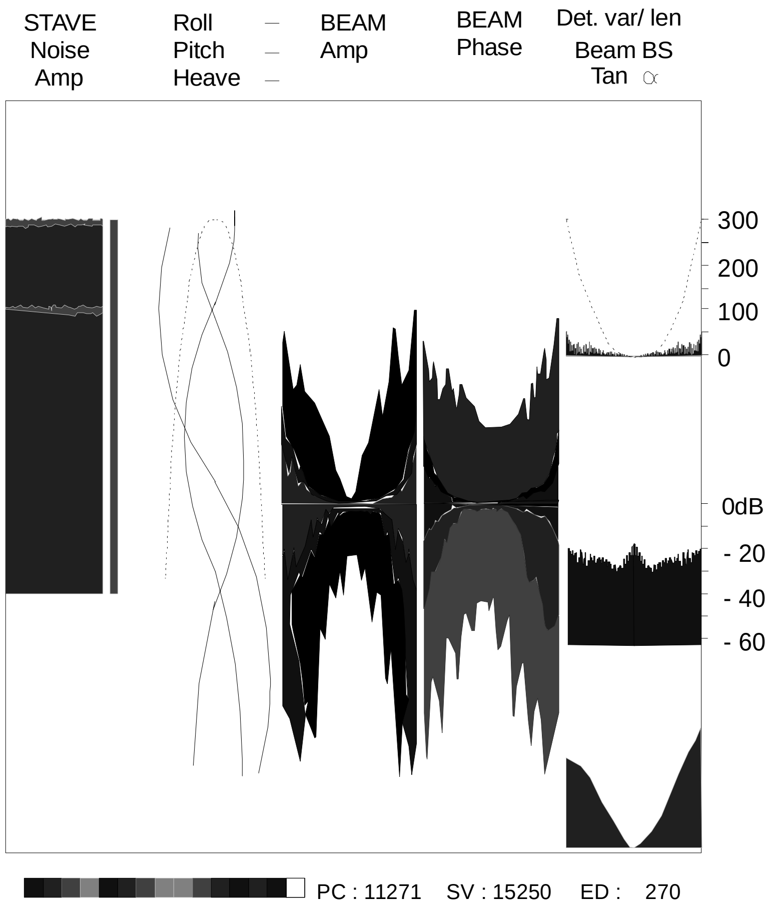


Figure 12 The Bottom Detector Unit; display layout

Graphic window

The graphic window is used to present:

- received stave amplitude versus time
- beam detections in the same timescale as the stave amplitude
- beam amplitude around the detection point
- beam phase around the detection point
- roll, pitch and heave versus time
- quality measure and detection window size for all beams
- reflectivity in all beams
- mean acrosstrack bottom slope
- roll, pitch and heave



(CD4400)

Figure 13 The Bottom Detector Unit;graphic window

Text window

The text window is used to present the interactive menus, messages and operational status data.

The menu

The Bottom Detector Unit menu is displayed on the right top side of the screen. A list of possible commands are displayed, and the operator may choose any of these by moving the cursor (inverse video) to the command by the use of the joystick.

The Bottom Detector Unit is operated by up and down movements of the joystick to move in a menu, left and right to move in the menu hierarchy. Parameters are changed with up and down movements of the joystick, and commands entered with right movements of the joystick. A white bar (reverse video) indicates the present position in the menu.

The top of the menu window will always display the following information:

- Date and time
- Current selected menu or sub–menu

Product information (BDU) and software version is displayed when **Main menu** is selected.

Operational status presentation

The following information is given in the bottom of the text window.

```
TRU com stat:
OPU com stat:
Depth window:
Detect depth:
Detect range:
TVG limit:
Beams OK:
```

TRU com stat / OPU com stat

The **TRU** and **OPU com stat** fields show the status of the three Ethernet interfaces. Occasional failures may occur, and will be corrected automatically, but a persistent failure state would indicate a hardware error. Communication failure with the Transceiver Unit may result in a failed ping. The graphic window will then show the error message **"Ping Failure"** in a red rectangle.

Depth window

The **Depth window** field shows in which depth range the echo sounder is trying to locate the bottom, while the **Detect depth** field shows the largest and smallest depths actually accepted in the last ping. Note that there should be some safety margin in the depth window.

The **Detect range** field shows the largest and smallest ranges actually accepted in the last ping. Note that there should be some safety margin in the depth window. The **Detect range** field should be compared to the **TVG limit** field, i.e. if the 60 dB dynamic range of the TVG is enough. If not, a change in gain will usually occur with priority to the shortest range.

TVG limit

The TVG has a limited dynamic range, and the range may not be sufficient in all circumstances. If this is the case, the ranges where this occurs are shown in these fields. Corrections are applied to the backscatter values if this occurs.

Beams OK

The **Beams OK** field shows the number of beams with accepted detections. If this is less than 33, the ping is not accepted if **Data Out** is set to **On** (see page 115). The graphic window will then show the error message **"Ping Rejected"** in a yellow rectangle. If this situation persists, a restart will occur.

7.2 The graphic windows

Overview

The data display is divided vertically into five parts, and these are from left to right:

- Stave data display
- VRU display
- Beam amplitude display
- Beam phase display
- Miscellaneous displays

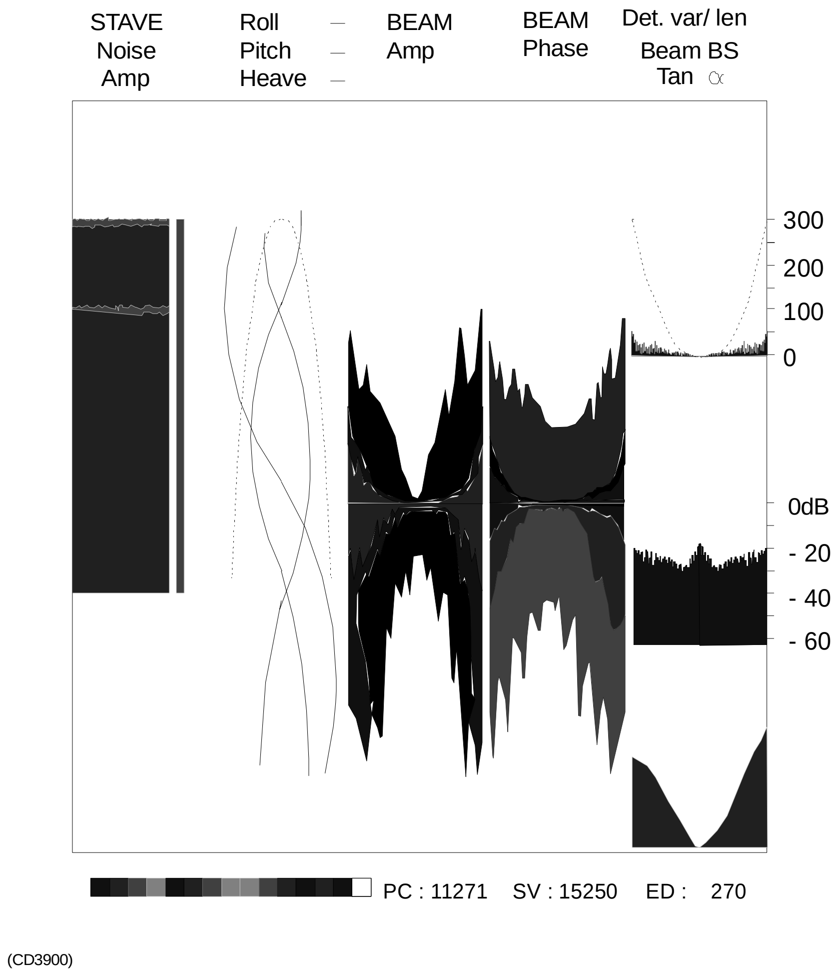


Figure 14 The graphic window

A colour scale is used by all display parts and consists of 15 colours – four shades of blue, four shades of green, four shades of yellow, two shades of red and white. The interval and the values of the colours vary according to menu settings. Dark blue represents the weakest signal, white the strongest as indicated in the colour scale on the bottom of the screen.

Ping counter (PC), transducer sound speed (SV), and the estimated depth straight down used for the displayed ping (ED) is shown beside the colour scale.

Stave display

The stave data display shows the signal level at each receiver stave with one pixel for each of the 42 staves horizontally with respect to time vertically (starting at the top with one line per 2.4 msec for shallow mode and one line per 9.6 msec for deep mode). The display usually starts just before the first bottom return.

The stave display is used for three main purposes:

- to see that the echo sounder is tracking the bottom well
- to see that there is not too much aeration on the transducer
- to see possible interference from other acoustic equipment

If the tracking is good, the top centimetre or so should show low signal level (blue or green colour at default scale setting), the rest high signal level (usually yellow). If the bottom is deeper than the tracking algorithm assumes, the low level band will be stretched or there will be a gradual change in colour from low to high signal level. If the bottom is shallower, the low signal part will not appear and there may also be a lot of variation in the strong signal part.

If there is aeration, the stave amplitudes will partly or completely show very low values (green or blue) where strong amplitudes are usually encountered. If not too severe, the system will still be able to detect the bottom, although detections may be noisy. The whole ping may also be rejected completely if the aeration is sufficiently severe. Note that in difficult bottom conditions with steep slopes, too much aeration and continuously lost pings may cause the echo sounder to lose bottom track.

If there is interference from other acoustic equipment, red lines indicating a very strong amplitude will occur with time intervals according to the ping period of the other equipment.

Note that the colour scale of the stave amplitude signal part may be changed in the display menu.

A white vertical band to the right of the stave amplitudes also gives an indication of the tracking performance of the echo sounder. The band shows the beam alarms from the Transceiver Unit as a function of time with the same time scaling as for the stave amplitudes. For correct operation, a solid band should start approximately where the stave amplitudes increase sharply. If a solid band starts a significant time later, the bottom is shallower than the tracking algorithm assumes, while an earlier start or a too short continuous band would indicate that the bottom is deeper.

Note that the start point in time and the colour scale of the stave amplitude signal part may be changed in the display menu. This may be useful in measuring combined sea and vessel noise level by setting the system **Bottom Track** to **Manual**, **Expected Depth** to 4000 m, **Transmit Mode** to **Shallow**, **TX power** to **Off**, and **Fixed Gain** to **max**. The level then obtained in stave amplitude is approximately 2 dB higher than the combined sea and vessel noise level.

The noise level before any bottom echo is returned will be displayed at the top of the stave data display, if **Amp/Phase Res** is set to **Samples** (i.e. highest resolution) in the display menu. The top 16 lines then show a stave amplitude some time before the bottom echo is received. As there are no echoes in this period, the display thus indicates stave noise level. The next band shows the mean of the 16 samples for each stave. The next two bands show the mean noise level in each beam for the same samples (odd beams in upper band, even in lower band). Note that the scaling of these display parts are always 2 dB per colour, with blue corresponding to lowest detectable level.

VRU and beam ranges display

The VRU display shows the roll (red), pitch (green) and heave (blue) signals graphically during the reception period. The time scale is as for the stave display and the VRU is sampled at 9.6 ms intervals. Display scaling is set in the menu.

Within the VRU display, the beam detections are also shown in the same time scale. This may be useful in judging detection performance as the points should form a reasonable continuous curve.

Beam amplitude and phase displays

The Beam Amplitude and Beam Phase display parts show the beam signals with detected bottom at the centre of the display. In case no valid bottom detection has been found for a particular beam, a range to the bottom is interpolated from the nearest neighbouring beams with valid detections. If the system is working as it should, strong amplitude colours should be in the centre, and the transition between the middle green colours (at default scale setting) should be at the centre of the phase display in most beams. If not so, the bottom conditions are very difficult, or there is a lot of aeration, or some of the settings are wrong, or there may be a fault in the transceiver. Beams with valid detections are marked in white or black (black in the amplitude display indicates amplitude detection and white in the phase display indicates phase detection).

Note that the generation of these displays is time consuming, and they should therefore be turned off or set to low resolution, especially in shallow waters.

Miscellaneous displays

There are three parameters shown on this display – detection parameters on top, beam reflectivity or backscattering strength in the middle, and angle of incidence in the lower part of the display.

The detection parameters indicate with red bars second order phase detection, with yellow bars first order phase detection and with blue bars amplitude detection. The height of the bars is according to the normalized variance in the curve fit for phase detection, length of echo for amplitude detection. In addition, for phase detection a blue dot indicates the length of the detection window.

The reflectivity values or backscattering coefficients per beam are shown with 1 dB/pixel with –64 dB as the lowest value possible. If slope corrected values are sent to the Sonar Imaging Unit display (as chosen in the **Data out** menu), red dots indicate the corrected values.

The angle of incidence is shown as the absolute angle of the tangent, with a scaling dependent on coverage sector used. Several minimums show a very rugged bottom with several normal incidents, while large tangents indicate a bottom sloping very strongly away from the ship.

7.3 Menu overview

This chapter contains a short–form review of all commands with the following information for each command:

- Command name
- Options
- Short description

Each command is described in detail in the *Command references* chapter on page 113.

The **Main menu** lists the selectable submenus as shown below:

```
MAIN MENU

Operation menu
Gain menu
Display menu
Data out menu
Ext. sensor menu
BITE menu
```

Operation menu

Command	Options	Description
Ping mode	Single Continuous Startup	Selects the BDU transmit state
Bottom track * see note	Manual Auto Fixed plen Fixed mode	Selects the operation mode for range and gain settings updating Fixed mode if equidistant beam spacing
Expected depth	50–11000 m	The expected bottom depth
Transmit mode * see note	Shal. start (S,D) Shallow Deep (1) Deep 120dg (S) Deep 105dg (S) Deep 90dg (S) Deep 150dg(D) Deep 140dg(D) Deep 128dg(D) Deep 114dg (D) Deep 98dg (D) Deep start	Controls pulse length and coverage sector Note! Options with notations in parenthesis are available as follows: 1 = 1–degree beam spacing S =EM 12S & equidistant beam spacing D=EM 12D & equidistant beam spacing no notation = always available
Data out	Off / On	Data to other display units
Mounting * see note	Starb 1dgBS Port 1dgBS Centr 1dgBS Starb EDBS Port EDBS Centr EDBS	Transducer mounting and beam spacing type
Dual sync.	Off / On	Synchronization of dual system
Ice window	None 6 mm Ti 10 mm Ti	Type of acoustic window mounted in front of transducers
External sync.	Off / On	Synchronization of echo sounder pinging
Ext. conditions	Excellent Good Poor Awful	Adapts algorithms according to weather and bottom conditions
Max. coverage	500–25000 m	Limits horizontal coverage
Max. angle	40–75 dg	Limits maximum beamangle

Note ! *The **Transmit mode** and **Bottom track** options will depend on the beam spacing chosen for the **Mounting** parameter.*

Gain menu

Command	Options	Description
Loss coeff.	1–99 dB/km	The assumed mean absorption coefficient of the water column
Fixed gain	6 dB 12 dB 18 dB 24 dB 30 dB	Analog gain between TVG amplifier and A/D converter
Tx power	Max –10 dB –20 dB Off	Output power level
ADC headroom	0–30 dB	Difference between saturation and mean signal level at the A/D converter input
Gain correction	–20 to +20 dB	BS correction value
Oblique BS	–50 to –10 dB	Estimated BS to the side
Normal BS	–40 to 0 dB	Estimated BS straight down

Display menu

Command	Options	Description
Amp/phase res	Samples Averaged Staves	Amount of data shown in the graphic display
Amp scale	1–5 dB	Scaling of the graphic display in the amplitude window
Amp start	–64 to 0 dB	Start level of the graphic display in the amplitude window
Phase scale	1–30 dg	Scaling of the graphic display in the phase window
Phase start	–180 to 150 dg	Start level of the graphic display in the phase window
Time start	0–1200	Start point of the graphic display in the stave window
Stave scale	1–5 dB	Scaling of the graphic display in the stave window
Stave start	0–64 dB	Start level of the graphic display in the stave window
Roll span	0.8–40 dg	Scaling for roll
Roll center	–15 to +15 dg	Scaling for roll
Pitch span	0.8–40 dg	Scaling for pitch
Pitch center	–15 to +15 dg	Scaling for pitch
Heave span	0.8–8 m	Scaling for heave
Heave center	–4 to +4 m	Scaling for heave

Data out menu

Command	Options	Description
Sonar image log	Off Amplitude Amp+phase	Sets data type to logging system
SIU display	Off "Real" TVG Flat TVG	Data type to Sonar Imaging Unit
Send echogram	0–81 beam	Beam number for scope data sent to the Operator Unit
Echogram data	Amp/phase Amp/QA Phase/QP QA/QP	Type of beam data to the Operator Unit Scope display
Disk storage	Off On	Store data on hard disk (for Kongsberg Simrad use only)

Ext. sensor menu

Command	Options	Description
Sound velocity	1400.0–1600.0 m/s	Manual sound speed at transducer
Velocimeter	In use Not used	Enable manual sound speed
VRU roll bias	0 – ±9.95 dg	Correction of roll data from the Vertical Reference Unit
VRU pitch bias	0 – ±9.95 dg	Correction of pitch data from the Vertical Reference Unit
VRU delay	0–100 ms	Delay in motion sensor
Max Tx pitch	±20 dg	Maximum pitch angle (bow raised) to emit a ping
Min Tx pitch	±20 dg	Minimum pitch angle (bow depressed) to emit a ping
Max Tx heave	±9.9 m	Maximum heave (ship raised) to emit a ping
VRU roll	In use Not used	Enables input from the roll sensor
VRU pitch	In use Not used	Enables input from the pitch sensor
VRU heave	In use Not used	Enables input from the heave sensor
Svel offset	±20 m/s	Offset of sound speed sensor

BITE menu

Command	Options	Description
Ping once	(no options)	Initiates transmission of one single ping
Run BITE test	SPB1 SPB2 SPB3 TRIF1 DASA–BEAM Rec w/TD SPBTX Rec n/TD Tx Amps MOSP SPB4 SPB5 SPB6 TRIF2 Odd ENET Even ENET Ext ENET	Select test of the Transceiver
Reset ENET	Odd TRU Even TRU OPU (ext) All	BDU Ethernet adapter commands
Data source	Transceivr Simulator Memory Disk beams	Defines the input source for data to be processed
Active beams	Even & odd Odd only Even only None	Defines active beams
Sector freq.	Test (13) 12.7 kHz 13.0 kHz 13.3 kHz	Transmit frequency
Auto restart	Enabled Disabled	Automatic search for bottom after loss of bottom tracking
Bottom filter	0–8	Spike filter strength

7.4 Command references

Main menu

The main command menu is the top level of the menu system, and consists of a list of the following sub–menus available in the system:

```
MAIN MENU

Operation menu
Gain menu
Display menu
Data out menu
Ext. sensor menu
Filter menu
BITE menu
```

Note that if **Bottom track** in the **Operation menu** is *not* set to **Manual** (see page 114), it will not be possible to change a number of parameters as they are updated according to bottom conditions. Furthermore, if the Operator Unit is in control (remote), i.e. **Transmit mode** is *not* set to **Off** or **Local**, you can change only the **Display Menu** parameters via manual input on the Bottom Detector Unit. When a menu parameter is not under your control, its value can still be observed by entering the menu, but any concurrent change will not be seen while it is displayed.

Operation menu

Overview

The **Operation menu** provides parameter settings relevant to different operation modes. The commands are used for initial setup of the echo sounder before starting operation. In local control, it is also used to prepare the echo sounder for **BITE tests**.

The following commands are available from the menu:

```
Ping mode
Bottom track
Expected depth
Transmit mode
Data out
Mounting
Dual sync.
Ice window
External sync.
Max. coverage
Max. angle
```

Ping mode

The **Ping mode** menu presents you with the following choices:

- Single
- Continuous
- Startup

Single

In **Single** mode, the system will transmit nothing unless activated by the **Ping once** command in the **BITE menu** (see page 125).

Continuous

In **Continuous** mode, the ping rate will be determined by the water depth or by processing time in shallow water.

During Operator Unit control, **Ping mode** is set to **Continuous** and cannot be changed on the BDU.

Startup

If set to **Startup**, the system will try to find the bottom with a long pulse with restricted angular coverage and, if successful, it will switch to **Ping mode** to **Continuous** and set **Bottom track** range and gain to **Auto** (see page 114). A startup ping will be indicated by the message "**Startup**" in a white rectangle in the display's graphic window.

Bottom track

The **Bottom track** menu presents you with the following choices:

- Manual
- Auto
- Fixed plen
- Fixed mode (if equidistant beam spacing)

Manual

If **Bottom track** is set to **Manual**, it is possible to change a number of other parameters manually. Otherwise, they are updated automatically according to bottom conditions.

Auto

The EM 12 Bottom Detector Unit is usually set to **Auto**. The system will then automatically set other parameters to suit depth and bottom conditions.

This is the main switch for range and gain commands. The Operator Unit will usually set **Bottom track** to **Auto** or possibly to **Fixed plen** automatically, except at startup, and the system will then set many other parameters to suit depth and bottom conditions.

If **Fixed mode** is chosen manually, it will not be overridden by the Operator Unit if the EM 12 **Transmit mode** is set to **Deep** on the Operator Unit (further discussed in chapter describing *Command references*, EM 12 **menu\Transmit mode** section on page 61).

Fixed plen / Fixed mode

If set to **Fixed plen** (pulse length) or **Fixed mode**, the system will perform as in **Auto**, except that it will not switch between long and short pulse lengths or coverage sectors, but stay in the mode chosen by the operator.

Expected depth

The **Expected depth** value sets the minimum slant range to the seabed, usually the depth straight down. The setting of this parameter is critical to system operation, and should usually be left to the system to update in **Non–manual** mode, except possibly at startup or if the system looses bottom tracking.

With manual startup, it should be set at the depth shown by a single–beam echo sounder or read from a chart. If enough detections are not achieved at this setting, adjust it up and down until tracking is possible, then switch **Bottom track** from **Manual** to **Auto, Fixed plen** or **Fixed mode**.

Transmit mode

The **Transmit mode** command selects the transmit pulse length and coverage sector with equidistant beam spacing.

Options for 1–degree beam spacing:

- Shallow
- Deep
- Deep start

Options for EM 12S and equidistant beam spacing:

- Shal. start
- Shallow
- Deep 120 dg
- Deep 105 dg
- Deep 90 dg
- Deep start

Options for EM 12D and equidistant beam spacing:

- Shal. Start
- Shallow
- Deep 150 dg
- Deep 140 dg
- Deep 128 dg
- Deep 114 dg
- Deep 98 dg
- Deep start

There are two pulse lengths available, 2 msec for shallow water and 10 msec for deep waters. A brief discussion of the two modes are given below .

In shallow mode a single transmit beam is used for the whole coverage sector, with a pulse length of 2 msec and a frequency of 12.7 kHz for the single system. For the dual system, the frequency is 12.7 kHz for the port system and 13.3 kHz for the starboard system.

In deep mode each ping covers the complete swath in five successive beams. The five beams are transmitted sequentially with a pulse length of 10 msec, i.e. 50 msec to cover the whole swath. The frequencies varies from 12.7 kHz to 13.3 kHz to minimize interference between the different beams as indicated in the figure below :

Dual System:	Single System:
F2 F2 F1 F1 Port F2 F2 Starboard F1 F1 F3 F2	F1 F2 F3 F2 F1
where: F1 = 12.67 kHz, F2 = 13 kHz, F3 = 13.33 kHz	

Use of deep or shallow mode is decided either by the system or manually by you. The system switches between the two modes depending on the depth below the keel and the bottom conditions. The switch between the modes is done at approximately 700–1000 m for a dual system and approximately 1500–2000 m for a single system.

Shallow : The **Shallow** transmission mode is used within 150° or 120° according to system. This choice may be used to prevent frequent switching between **Shallow** and **Deep** mode or to increase the range resolution.

Deep : The **Deep** transmission mode is used within 150° or 120° according to system. This choice may be used to prevent frequent switching between **Shallow** and **Deep** mode.

Shal. start : A 2 msec pulse is transmitted to find the bottom.

Deep start : A 10 msec pulse is transmitted in the centre to find the bottom.

Deep xxx dg : **Deep** mode with coverage sector as indicated. Only used for equidistant beam spacing.

Data out

If **Off** is selected, no data will be sent to other units (OPU, QAU, SIU). It is set to **On** when the Operator Unit is in control.

Mounting

- Starb 1dgBS
- Port 1dgBS
- Centr 1dgBS
- Starb EDBS
- Port EDBS
- Centr EDBS

This parameter must be set in accordance with the mounting of the transducers the Bottom Detector is using. Center for single system, port or starboard for dual system. This is also where the beam spacing is set to 1dgBS for equiangle, EDBS for equidistant.

Dual sync.

Must be **On** to synchronize the two transmitters in a dual system. Note that if **On**, time stamp, ping counter and transmit pulse length are determined by port side.

Ice window

- None
- 6 mm Ti
- 10 mm Ti

If this parameter is not set according to the window actually mounted, the backscattering values will not be correct.

External sync.

If **On**, the echo sounder will not ping unless the sync input signal to the Bottom Detector Unit is enabled.

Ext. conditions

- Excellent
- Good
- Poor
- Awful

Set according to weather (aeration) and bottom conditions. Detection and data collection parameters will be adjusted according to this parameter setting. Note that the least averaging will be used in **Excellent** and that automatic restart is disabled in **Awful**.

Max. coverage

Limits the horizontal swath width (to each side for a dual system). Note that a low value may increase the ping rate.

Max. angle

Limits the maximum beam positioning angle used. Note that a low value may increase the ping rate.

Gain menu

The **Gain** commands give the possibility for transceiver and bottom detector gain adjustment. During normal operation, most of these parameters are automatically adjusted according to depth and bottom conditions.

- Loss coeff.
- Fixed gain
- Tx power
- ADC headroom
- Gain correction
- Oblique BS
- Normal BS

Loss coefficient

This is the mean absorption coefficient of the water column which is typically 1.1 dB/km in very deep waters.

See discussion of absorption coefficient variation with temperature, salinity and depth in the **EM 12 menu** description, refer to page 60.

Fixed gain

This is the analog gain between TVG amplifier and A/D converter. It is automatically adjusted by the system in auto mode and no setting is thus required by the operator.

Tx power

- Max
- –10 dB
- –20 dB
- Off

The output level of the EM 12 may be reduced by 10 or 20 dB with respect to full power or turned completely off by setting this parameter. It is suggested always to use full power unless there is interference from the EM 12 to other equipment which a lower EM 12 power output could avoid. If power is reduced, it will usually be necessary to lock the transmit mode to one normally used for deeper waters than actually encountered.

ADC headroom

This is the difference between saturation level at the analog–to–digital converter input and the mean signal level at this point. The **ADC Headroom** may be decreased if the weather is bad, but should usually be left at the 20 dB default value.

Gain correction

The system uses the gain correction to increase the quality of readings from weak bottoms. Manual setting of this parameter has no effect.

Oblique BS

This is the estimated backscattering coefficient of the seabed when the incident angle is not at normal angle. It is automatically adjusted by the system in auto mode.

Normal BS

This is the estimated backscattering coefficient of the seabed at normal incident angle. It is adjusted automatically by the system in auto mode.

Display menu

The **Display** commands are used to change the graphic windows display scaling. Note that the display calculations are time consuming and may reduce ping frequency appreciably, especially in shallow waters.

- Amp/phase res.
- Amp scale
- Amp start
- Phase scale
- Phase start
- Time start
- Stave scale
- Stave start
- Roll span
- Roll center
- Pitch span
- Pitch center
- Heave span
- Heave center

Amp / Phase res

- Samples
- Averaged
- Staves

Samples: Beam Amplitude and Phase displays have highest range resolution, i.e. a pixel every 0.6 m (shallow) or every 2.4 m (deep) in range. In addition, noise levels before bottom are shown in stave display.

Averaged: Averaged amplitude and phase samples are shown in Beam Amplitude and Phase displays with a pixel for every fourth range sample.

Stave: The Beam Amplitude and Phase displays are turned off. This is the recommended option in normal operation.

Amp scale

The amplitude scale sets the amplitude range within an individual colour in the Beam Amplitude display.

Amp start

Selects the amplitude signal's lower limit in the Beam Amplitude display, i.e. the lowest value used by the darkest blue colour in the display.

Phase scale

The phase scale sets the phase range within an individual colour in the Beam Phase display.

Phase start

Selects the phase signal's lower limit in the Beam Phase display, i.e. the lowest value used by the darkest blue colour in the display.

Time start

The stave start determines on which transceiver datagram the Stave display starts. Used to offset stave display start with respect to bottom.

Stave scale

The stave amplitude scale sets the amplitude range within an individual colour in the Stave display.

Stave start

Selects the amplitude signal's lower limit in the Stave display, i.e. the lowest value used by the darkest blue colour in the display.

Roll span

The span of the displayable roll values shown in the VRU display.

Roll center

The roll value in the centre of the VRU display.

Pitch span

The span of the displayable pitch values shown in the VRU display.

Pitch center

The pitch value in the centre of the VRU display.

Heave span

The span of the displayable heave values shown in the VRU display.

Heave center

The heave value in the centre of the VRU display.

Data out menu

The **Data out menu** commands determine the type of data sent from the Bottom Detector Unit to the Operator Unit and the Sonar Imaging Unit as well as local data storage on the Bottom Detector Unit. Except for data storage, the Operator Unit determines data out when in control.

Note ! *__Data out__ must be set to __On__ if Sonar image and/or Echogram data are to be sent from the Bottom Detector Unit.*

- SIU display
- Send echogram
- Echogram data
- Disk storage

Sonar image log

- Off
- Amplitudes
- Amps + phase

Controls sending of Sonar Image data to the Operator Unit for logging.

SIU display

- Off
- ”Real” TVG
- Flat TVG

Controls sending of Sonar Image data to the Sonar Imaging Unit. The Sonar Image data are corrected for average acrosstrack bottom slope if ”REAL” TVG is chosen. Note that the data sent to the Operator Unit are always uncorrected, i.e. the flat bottom assumption is used for logged data.

Send echogram

Controls sending echogram/scope data of the selected beam (1–81) to the Operator Unit when not set to 0 (zero). The Echogram data are the datagrams for the Scope or Echogram display on the Operator Unit.

Echogram data

- Amp + phase
- Amp + QA
- Phase/QP
- QA/QP

Selects the contents of the echogram. The data in these datagrams may be chosen to be either beam amplitude and phase (**Amp/phase**), beam amplitude and averaged beam amplitude (**Amp/QA**), or phase and averaged phase (**Phase/QP**), or averaged beam amplitude and phase (**QA/QP**).

Disk storage

- Off
- On

Controls storage of beam data on hard disk. Hard disk installation is for Kongsberg Simrad use only.

Ext. sensor menu

The **Ext. Sensor menu** commands control the use of Vertical Reference Unit (VRU) and Velocimeter used to measure the sound speed at the transducers. All settings are determined by the Operator Unit when in control.

- Sound velocity
- Velocimeter
- VRU Roll Bias
- VRU Pitch Bias
- VRU Delay
- Max Tx pitch
- Min Tx pitch
- Max Tx heave
- VRU Roll
- VRU Pitch
- VRU Heave

Sound velocity

This is a sound speed setting which may be used instead of that measured at the transducer face by the sound speed probe.

Velocimeter

Choose **In use** to disable the sound speed probe and instead use the manually set sound speed. Note that if the probe is not working, this parameter must be set to **Not used** and the correct sound speed at the depth of the transducer must be entered in **Ext. sensor menu–>Sound speed**.

VRU roll bias

Use this command for correction of roll data from the vertical reference unit.

VRU pitch bias

Use this command for correction of pitch data from the vertical reference unit.

VRU delay

The value entered here is the time delay of data output from the vertical reference unit roll measurement. The entered value together with the internal delay of the EM 12 Transceiver Unit is used by the Operator Unit to correct the beam pointing angle error due to this delay.

Max Tx pitch

The value entered here sets the maximum pitch the ship can have (i.e. bow raised) for the EM 12 to emit a ping. The main use of this parameter is to avoid pinging when there is aerated water on the transducer face.

Comment: Note that this setting should be used with caution as a too low setting may cause a lower ping rate or lost pings.

Min Tx pitch

The value entered here determines the minimum pitch (i.e. bow depressed) the ship can have for the EM 12 to emit a ping. The main use of this parameter is to avoid a too large curvature of the footprint when pitching is excessive. Again, caution should be used. See above comment.

Max Tx heave

The value entered here determines the maximum heave (i.e. ship raised) the ship can have for the EM 12 to emit a ping. The main use of this parameter is to avoid aerated water when pinging. Again, caution should be used. See above comment.

Note that depending on VRU position, the measured heave may not be a good measure of the transducer depth with relation to sea surface.

VRU roll

This command enables (choose **In use**) or disables (choose **Not used**) input from the roll sensor.

VRU pitch

This command enables (choose **In use**) or disables (choose **Not used**) input from the pitch sensor.

VRU heave

This command enables (choose **In use**) or disables (choose **Not used**) input from the heave sensor.

Svel offset

This command is used to apply a correction to the sound speed sensor.

BITE menu

A Built–In Test Equipment (BITE) system is implemented on the Bottom Detector Unit for testing of Transceiver Unit and resetting of BDU Ethernet adapters.

The BITE commands described here are regarded as Off–line BITE, as you must initiate the tests with the echo sounder ping mode set to **Single** (i.e. off).

The EM 12 also supports an On–line BITE system (described in section **BITE test programs** on page 128) which reports failures and errors by displaying a message below the Bottom Detector Unit menu. A listing of these messages is found at **Error / status message listing** on page 135.

- Ping once
- Run BITE test
- Reset ENET
- Data source
- Active beams
- Sector freq.
- Auto restart
- Bottom filter

Note ! *Prior to starting the BITE program, the **Ping mode–>Single** (i.e. off) must be selected in the **Operation menu** (see **Ping mode** on page 114).*

Ping once

Activating this command will give a single ping when the ping mode is in **single**. It is used for test purposes only.

Run BITE test

- SPB1
- SPB2
- SPB3
- TRIF1
- DASA–BEAM
- Rec w/TD
- SPBTX
- Rec n/TD
- Tx AMPS
- MOSP
- SPB4
- SPB5
- SPB6
- TRIF2
- Odd ENET
- Even ENET
- Ext ENET

This selection determines which transceiver electronics are to be tested. When the test is run, a message will be given indicating whether the test is passed or failed, and the display will show the test data received from the Transceiver Unit.

For further information, please refer to chapter **BITE test programs** on page 128.

SPB1 – 3: Testing the Signal Processor Boards 1–3. Each test is run once. Refer to paragraph **SBP tests** on page 129.

TRIF1: Testing the Transceiver Interface board 1. Each test is run once. Refer to paragraph **TRIF tests** on page NO TAG.

DASA–BEAM: Testing the Data Sampling board (**DASA**) and the Beamformer board (**BEAM**). Each test is run once. Refer to paragraph **DASA–BEAM** test on page 131.

Rec w/TD: Preamplifier and Data Acquisition modules are tested by this selection, and the test is run once. The gain set assumes the transducers to be connected during the test, and any noise under the ship's hull may therefore influence the received data. Refer to paragraph **Rec w/TD and Rec n/TD tests** on page NO TAG.

SPBTX: Testing the Signal Processor Board TX. The test is run once. Refer to paragraph **SBP tests** on page 129.

Rec n/TD: Preamplifier and Data Acquisition modules are tested by this selection, and the test is run once. The gain set assumes that the transducers are not connected during the test. Refer to paragraph **Rec w/TD and Rec n/TD tests** on page NO TAG.

Tx Amps: This test checks the addressing and output from the 384 transmitter amplifiers. The test runs until a new command is selected, and the front–mounted LEDs on the Transducer Interface (TDINT) modules in the Transceiver Unit will be lit sequentially. Refer to paragraph **Tx Amps test** on page 132.

MOSP: The Motion Processor test is run once. Refer to paragraph **MOSP test** on page 132.

SPB4 – 6: Testing the Signal Processor Boards 4–6. Each test is run once. Refer to paragraph **SBP tests** on page 129.

TRIF2: Testing the Transceiver Interface board 2. Each test is run once. Refer to paragraph **TRIF tests** on page NO TAG.

Odd ENET: This option will initiate a test on the Odd Ethernet board between the Transceiver Interface 1 (TRIF1) module in the Transceiver Unit and the Odd Ethernet module in the Bottom Detector Unit.

Even ENET: This option will initiate a test on the Even Ethernet board between the Transceiver Interface 2 (TRIF2) module in the Transceiver Unit and the Even Ethernet module in the Bottom Detector Unit.

Ext ENET: The external Ethernet board in the Bottom Detector Unit is tested.

Reset ENET

- Odd TRU
- Even TRU
- OPU (ext.)
- All

Resets the chosen Ethernet board(s) in the Bottom Detector Unit.

Data source

- Transceivr
- Simulator
- Memory
- Disk beams

This mode is used for test, either on stored data from the hard disk or memory for seeing the effects of changing processing parameters.

This parameter must be in **Transceivr** mode in normal operation. When the BOTSIM board is inserted in the Transceiver Unit, the choice of **Simulator** will set all affected parameters correctly for use of this board.

Active beams

- Even & odd
- Odd only
- Even only
- None

If either the odd or even beams are not working properly, they may be deactivated by setting this parameter accordingly. If all beams are disabled (**None**), then EM 12 will just ping very quickly, but with no processing of returns.

Sector freq.

- Test (13)
- 12.7 kHz
- 13.0 kHz
- 13.3 kHz

The sector transmit frequency is set to **12.7 kHz** for EM 12S and port system of EM 12D in shallow mode, **13.3 kHz** for starboard system of EM 12D in shallow mode and **13.0 kHz** in deep mode. In **Test (13)** mode the frequency will be 13 kHz, but without any receiver digital filtering.

Auto restart

If the bottom tracking is lost, a bottom reacquisition will start if **Auto restart** is set to **Enabled**. If set to **Disabled**, the echo sounder will continue pinging without changing depth acquisition range.

Bottom filter

The Bottom Detector Unit runs a spike filter to avoid obviously wrong detections. In shallow waters, this may cause the loss of very sharp features such as the top of large wrecks. Increasing this parameter will reduce the amount of filtering.

7.5 Built–in test equipment (BITE)

BITE test programs

When initiating a BITE test, a command datagram is sent from the Bottom Detector Unit to the Transceiver Unit. The software in the Transceiver Unit will respond to the command, and initiate the various BITE test programs included in the software on the various circuit boards. This software will run hardware tests on the circuitry.

The BITE results are returned to the Bottom Detector Unit as a reply datagram. These datagrams include information on what has been tested, and what kinds of errors, if any, were found. These messages are interpreted by the software in the Bottom Detector Unit, and reports and error messages are issued.

Transceiver BITE tests – Reply datagram format

The BITE results from the Transceiver Unit are returned as datagrams with the following format:

WORD NUMBER	DATA	COMMENT
0	0006	Header
1		Test number
2		BITE status
2 – 99		BITE data

The BITE status word contains the status code for the applicable test. The status word may contain the following data:

CONTENT	INTERPRETATION
0	Ok
1	Error specified in BITE data
2	Data not tested
3	Test running, no data returned
4	Illegal command received at SPB3/6
5	Illegal test number received at SPB3/6
13	Illegal command received at SPB1/4
14	Illegal command received at SPB2/5
15	Illegal command received at SPBTX
81	No reply from SPB1/4
82	No reply from SPB2/5
83	No reply from SPBTX

The BITE data word contains the error code for the applicable test. The data word may contain the following data:

CONTENT	INTERPRETATION
0	Ok
1	Error
FFFF	Not applicable

SPB tests

The BITE data for the seven SPB tests (SPB1–6 and SPBTX) is as follows:

WORD NUMBER	PART TESTED
2	RAM next SPB
3	RALU, SEQ
4	MAC
5	Division
6	Main memory
7	Dual port RAM
8	EPROM
9	Table RAM
10	yy,mm μ–Program
11	dd,vv μ–Program
12	yy,mm EPROMS
13	dd,vv EPROMS
14 – 99	Spare

Words 10 through 13 contain the Year (yy), Month (mm), Date (dd) and Version (vv) of the μ–program and the EPROM software.

TRIF tests

The BITE data for the **Transceiver Interface (TRIF) tests** (**TRIF1** and **TRIF2**) are as follows:

WORD NUMBER	PART TESTED
2	Main RAM
3	Ethernet RAM
4	MOSP I/F RAM
5 – 99	Spare

In order to test these RAM functions, most of the circuitry on the Transceiver Interface (TRIF) board is utilized. However, the BITE test will not test all functions, such as the TVG generation and the serial input and output lines.

DASA–BEAM test

The BITE data for the Data Sampling and Beamformer boards test (**DASA–BEAM**) is as follows:

WORD NUMBER	PART TESTED
2	Test 1 (55AA)
3	Test 2 (AA55)
4 – 99	Spare

The DASA–BEAM test uses a known data word as input to the Data Sampling (DASA) board as reference. Two different words are used; 55AAh in the first test and AA55h in the second. This means that the test is run twice. The processing of the known data is checked by the signal processors, and the BITE results are returned to the Bottom Detector Unit in the telegram format shown above.

Rec w/TD and Rec n/TD tests

The BITE data for the Preamplifier and Data Acquisition boards tests (Rec w/TD and Rec n/TD) are as follows:

WORD NUMBER	PART TESTED
2	Stave 1 Phase
3	Stave 1 Amplitude
4	Stave 2 Phase
5	Stave 2 Amplitude
....	....
....	....
84	Stave 42 Phase
85	Stave 42 Amplitude
86 – 99	Spare

The **Rec test** uses a 13 kHz test signal with known amplitude to check the VCA32 preamplifier boards and the Data Acquisition (DAQ) boards.

The test signal is issued by the Data Sampling (DASA) board in the Transceiver Unit, and is input to all the preamplifier channels in the Preamplifier Unit. The test signal is processed by the four DAQ boards, and the resulting data is interpreted by the signal processors. The BITE result returned to the Bottom Detector Unit is as shown above. As the transducer will load the preamplifier when connected, the test **w/TD** and **n/TD** should be chosen according to whether or not the transducer is connected. Note that a defective transducer will to some degree affect the result of the test.

When the **Rec test** is run, the data column from the above table is presented in the graphic window as four vertical rows (Rows 1–4, with row 1 to the left) with 21 lines in each. Row 1 represents the phase values from the odd staves (1, 3 ,5 7, etc.), while Row 2 represents the amplitude values from the same staves.

Row 3 represents the phase values from the even staves (2, 4, 6, 8, etc.), while Row 4 represents the amplitude values from the same staves.

The mean phase is displayed at the bottom of Row 1.

The software in the Bottom Detector Unit will check the data returned from the Transceiver Unit, and see if the phase and amplitude for each stave are within the preset limits. When an error is found, the applicable value is displayed in red on the screen.

The 42 staves are processed as follows:

- **Preamplifier channels**
  - Staves 1 through 28 VCA32 preamplifier board No.1
  - Staves 29 through 42 VCA32 preamplifier board No.2
- **Data acquisition channels**
  - Staves 1 through 12 DAQ1
  - Staves 13 through 24 DAQ2
  - Staves 25 through 36 DAQ3
  - Staves 37 through 42 DAQ4

Tx Amps test

The **Tx Amps test** will not generate BITE data from the Transceiver Unit, but only a message to say that the test is running. The test is a sequential pinging one–by–one of the 384 transmitter amplifiers, and may be observed on the LEDs in the Transceiver Unit.

MOSP test

The BITE data for the **Motion Processor (MOSP) test** are as follows:

WORD NUMBER	PART TESTED
2	MOSP RAM
3	TRIF1 RAM
4	TRIF2 RAM
5	yy, mm MOSP sw
6	dd, vv MOSP sw
7 – 99	Spare

The MOSP RAM tests the memory on the MOSP circuit board.

The TRIF1/2 RAM tests the memory on the TRIF boards and thus also the communication between the MOSP and TRIF circuit boards.

Words number 5–6 contain the software versions as indicated above.

Ext. ENET test

The Ethernet tests run by the Bottom Detector Unit on its Ethernet interface boards will only result in error messages and no further error data if a fault is detected.

Error / status message listing

The following error messages may be displayed if a fault is detected. Each error code may be followed by an error number. When reporting an error to Kongsberg Simrad, please report this number.

Note ! *Run–time errors will result in a rejected ping. If an Ethernet error persists for several pings, a hard reset of the interface board is automatically initiated by the system.*

Off–line TRU test error messages

- SPB1 (odd beams) OK
- SPB2 (odd beams) OK
- SPB3 (odd beams) OK
- TRIF1 (odd beams) OK
- DASA/BEAM (odd bms) OK
- Preamps/DAQ (odd) OK
- SPBTX OK
- Tx table RAMS OK
- Tx amp test running
- MOSP OK
- SPB4 (even beams) OK
- SPB5 (even beams) OK
- SPB6 (even beams) OK
- TRIF2 (even beams) OK
- DASA/BEAM (even bms) OK
- Preamps/DAQ (even) OK
- SPB1 Failed
- SPB2 Failed
- SPB3 Failed
- SPB4 Failed
- SPB5 Failed
- SPB6 Failed
- DASA/BEAM Failed
- Preamps/DAQ Failed
- SPBTX Failed
- Tx table RAMS Failed
- MOSP Failed
- TRIF1 Failed
- TRIF2 Failed
- Unknown TRU return

Off–line Ethernet test error messages

- Odd beams ENET OK

- Even beams ENET OK
- Opcom ENET OK
- Odd ENET failed
- Even ENET failed
- Opcom ENET failed

On–line BITE error messages

- SPB1/2 error
- SPB4/5 error
- SPBTX error
- TX1 Fuse error
- TX2 Fuse error
- TX3 Fuse error
- TX4 Fuse error
- TX5 Fuse error
- TX6 Fuse error
- TX Voltage HI
- TX Voltage LO
- Odd ENET failed
- Even ENET failed
- Opcom ENET failed
- ENET Reset (TRU odd)
- ENET Reset (TRU even)
- ENET Reset (OPU)
- OPU LAN RX error
- OPU LAN TX error
- Unknown error no.
- OPU clock error
- Port BDU clock error
- BDU clock reset
- Local clock
- OPU clock
- Starboard clock set

8 TECHNICAL SPECIFICATIONS

8.1 Introduction

This chapter presents the main technical specifications for the EM 12 multibeam echo sounder.

Note that the specifications may be altered without prior warning.

8.2 Power supply specifications

Operational voltage and frequency:

Mains voltage .... 230 Vac ±15% 1–phase (47 to 63 Hz)

A 16A single phase supply is required for the Transceiver Unit, while a 10A single phase supply is required for the Preamplifier Unit. One 16A single phase supply is required for the operator consoles. All fuses must be slow–blow.

For dual EM 12 systems, the single phase supply lines for the Transceiver and Preamplifier Units must be duplicated.

Acceptable transients:

Short time (max 2 sec) .... ±25%, 42 – 69 Hz

Spikes (max 50μs) .... < 1000 V

Power interrupts:

Backup memory is implemented in the Operator Unit. Menu settings and sound velocity profile are stored in backup memory so operation can continue after power interruption. However, the system must be manually restarted.

Overall power requirements (maximum):

Single display operator consoles .... 230 Vac 300 VA

Dual display operator consoles .... 230 Vac 400 VA

EM 12 Transceiver Unit .... 230 Vac 460 VA

EM 12 Preamplifier Unit .... 230 Vac 200 VA

8.3 Environmental specifications

Standards:

EMC Noise emission: .... EN55022 (Class A)

EMC Noise immunity, voltage spikes: EN55101

Environment:

Operating temperature, sonar room: .... 0 to 55° C

Operating temperature, operating room: .... 0 to 40° C

Storage temperature: .... –30 to +70° C

Sonar room humidity: .... Up to 96% (non–condensing)

Operating room humidity: ..... Up to 95% (non–condensing)

Humidity requirements will depend on customer requirements. Normal specification is up to 80% non–condensing.

Vibration:

4 – 15 Hz: .... ± 0.76 mm

16 – 25 Hz: .... ± 0.51 mm

26 – 33 Hz: .... ± 0.25 mm

34 – 40 Hz: .... ± 0.13 mm

41 – 50 Hz: .... ± 0.076 mm

Shock:

Cabinets w/shock absorbers: .... 15g half period sine

Duration: .... 6 ms

Note ! *To extend the lifetime of the equipment, the sonar room should be equipped with sufficient ventilation and the temperature should not be too high (i.e. not > 30°C) for long periods of time.*

8.4 Physical dimensions

Introduction

The following pages contain the major physical dimensions of the units.

Note ! *All dimensions are given excluding mounting arrangements such as shock absorbers, etc. Normal arrangements for these, including dimensions, are shown in the drawings enclosed. Note also that when fitting the units, due space must be provided for the cables. Dimensions may vary slightly with degree of environmental protection offered.*

Single display operator console

Physical size . . . . H 1170 x W 540 x D 1075 mm

Weight . . . . 150 kg

Material . . . . Aluminum

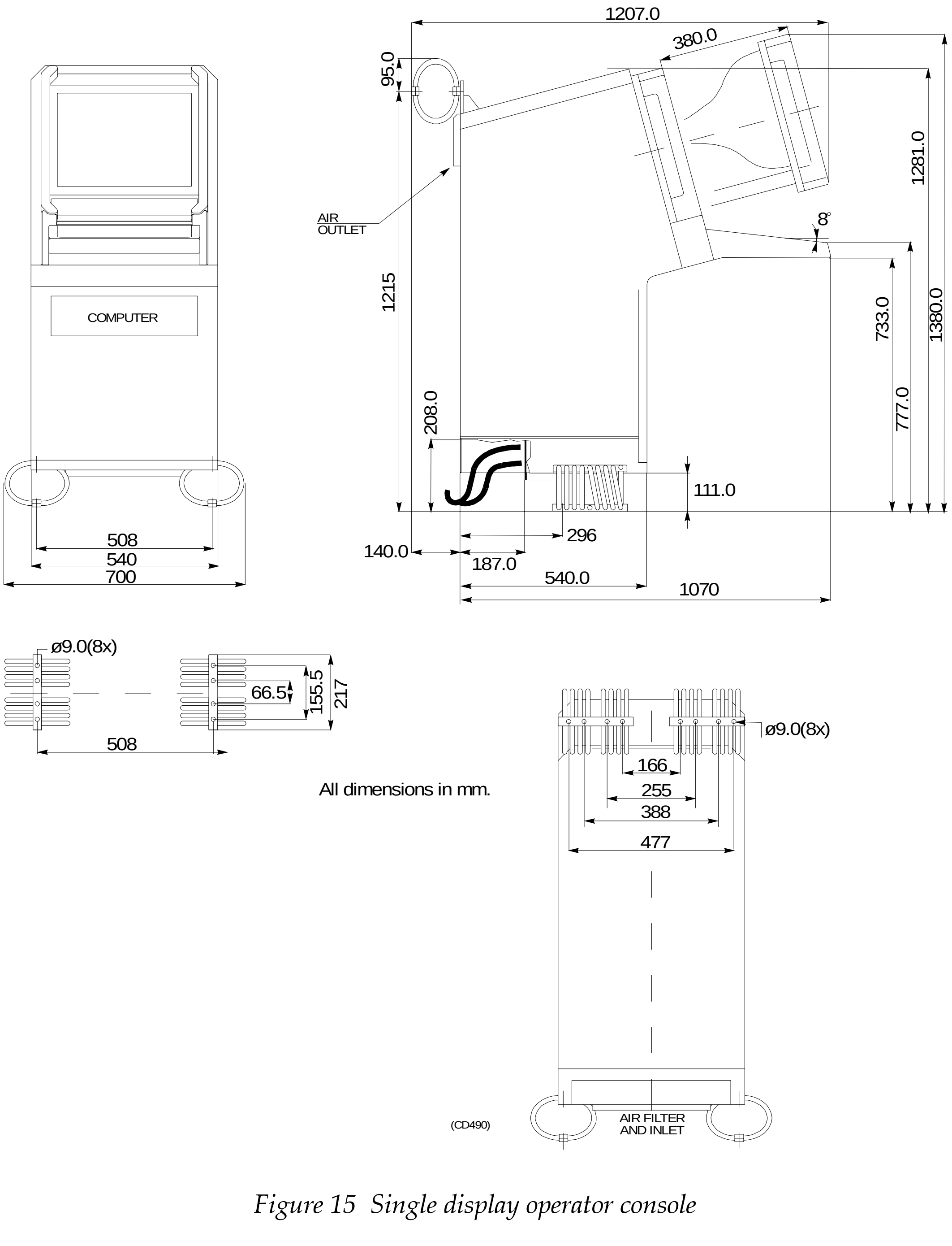


Figure 15 Single display operator console

Dual display operator console

Physical size . . . . H 1770 x W 540 x D 1075 mm

Weight . . . . 212 kg

Material . . . . Aluminum

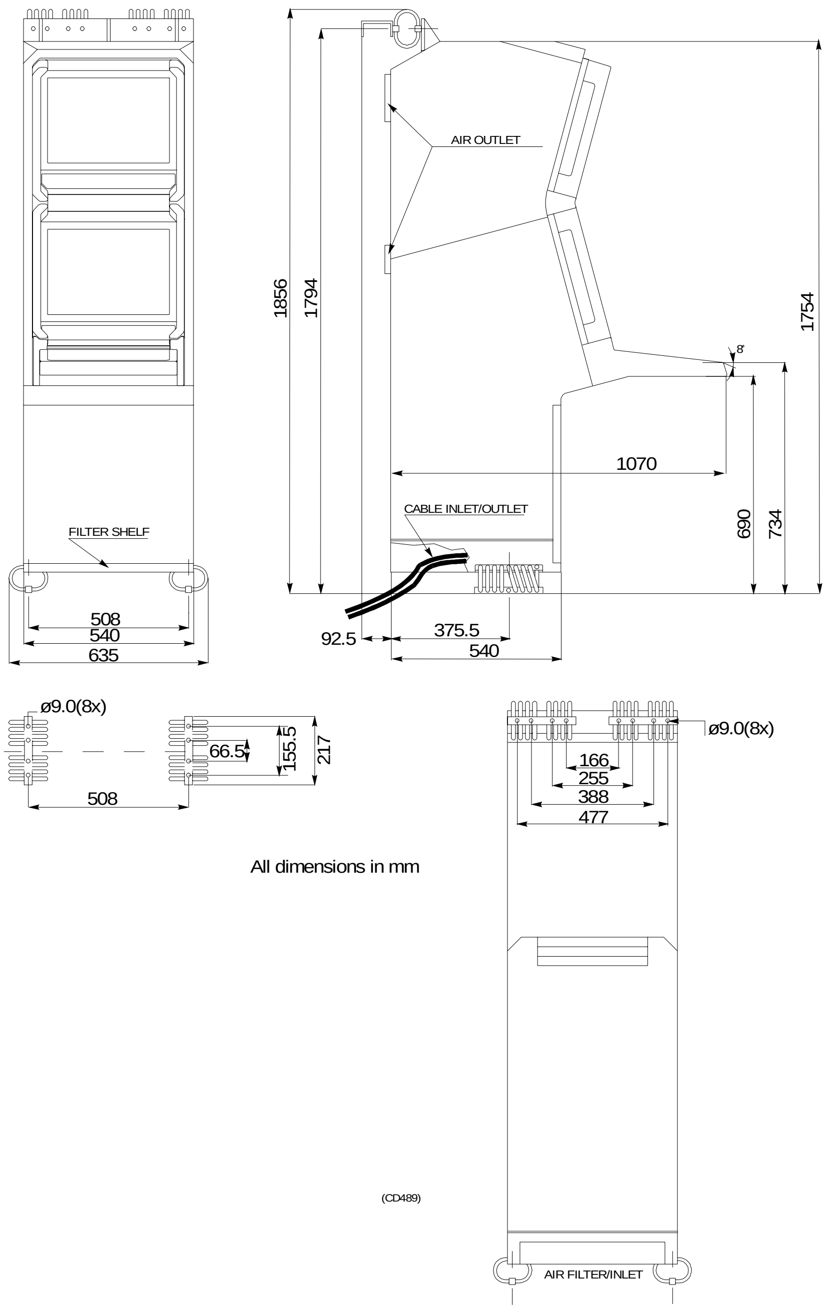


Figure 16 Dual display operator console

EM 12 Transceiver Unit

Height	1310 mm + 45 mm (lifting bolts)
Width	575 mm
Depth	520 mm
Weight	200 kg
Material	Steel

EM 12 Preamplifier Unit

Height . . . . 695 mm
Width . . . . 630 mm
Depth . . . . 465 mm
Weight . . . . 40 kg
Material . . . . Aluminum

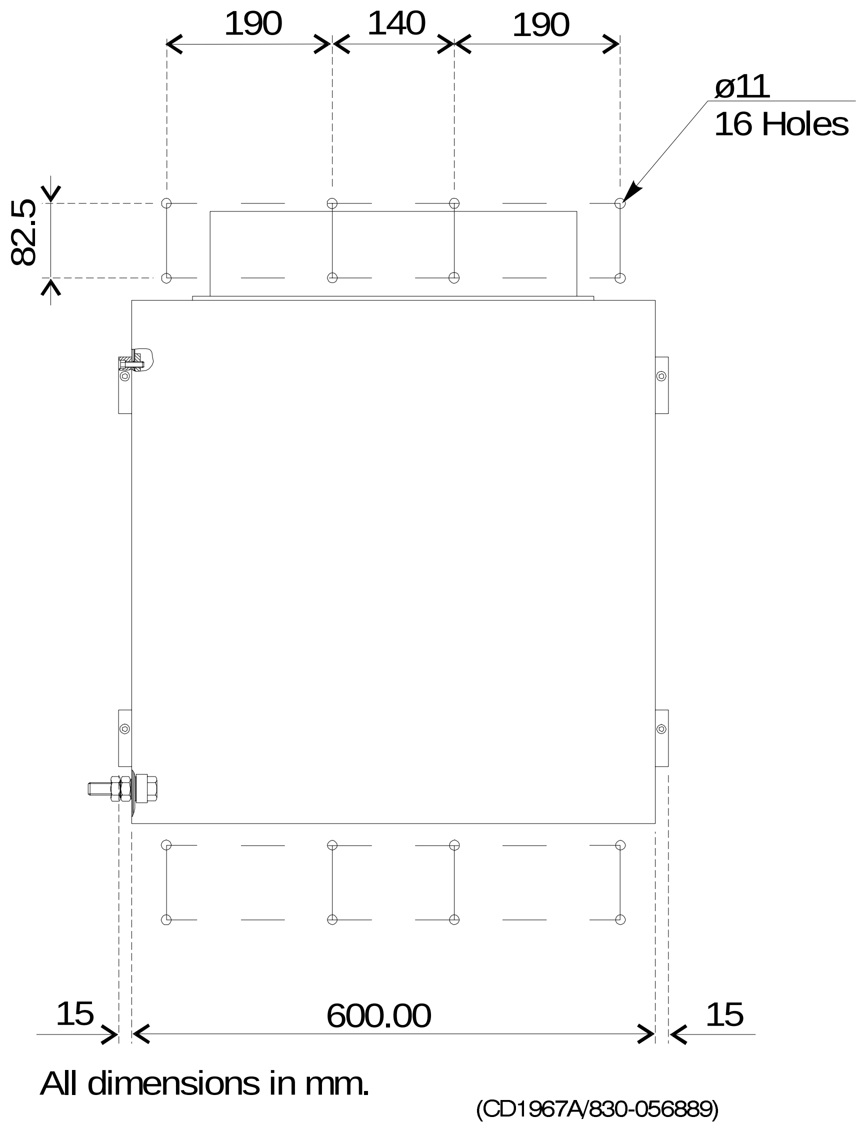


Figure 17 EM 12 Preamplifier Unit

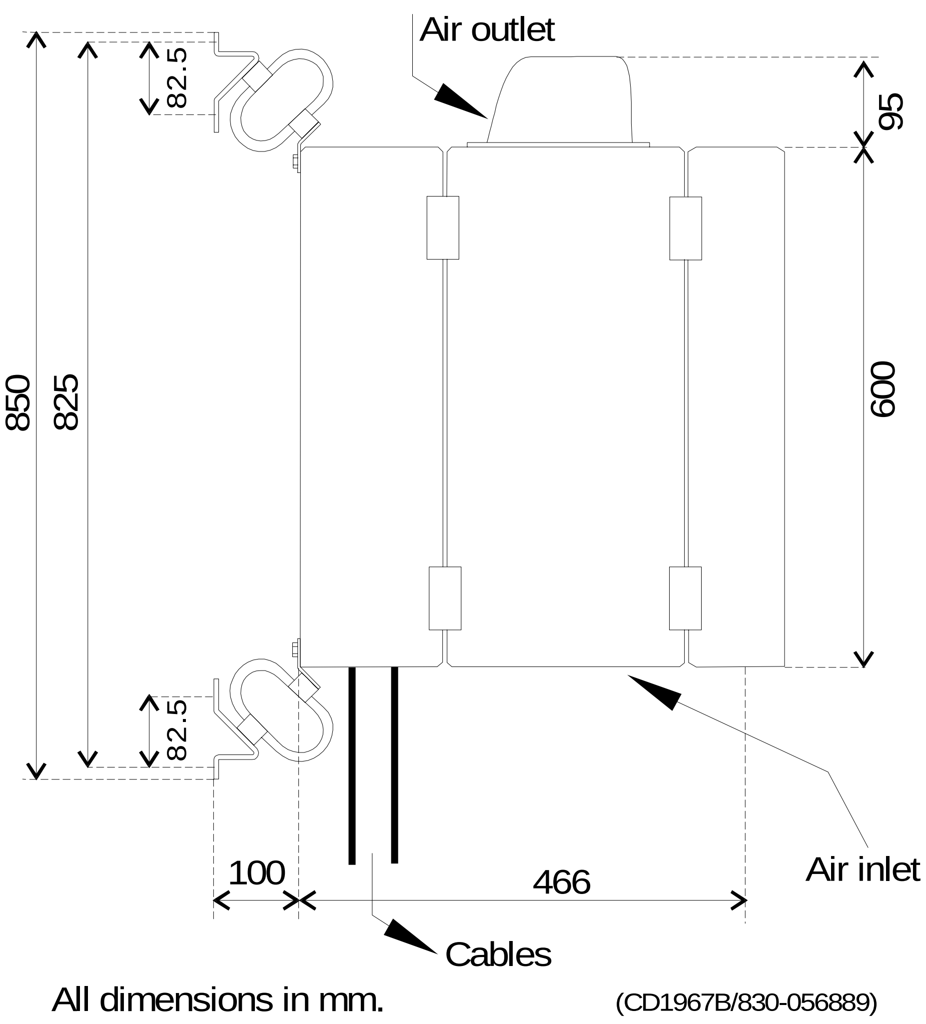


Figure 18 EM 12 Preamplifier Unit

8.5 Transducer array

Transmitter transducer array

The specifications are valid for both mounting frame and transducer modules.

Height . . . . 262 mm

Width . . . . 555 mm

Length . . . . 4800 mm

Weight:

- Mounting frame . . . . 600 kg
- Array modules . . . . 720 kg
- Total . . . . 1320 kg

Receiver transducer array

The specifications are valid for both mounting frame and transducer modules.

Height . . . . 262 mm

Width . . . . 555 mm

Length . . . . 2400 mm

Weight:

- Mounting frame . . . . 300 kg
- Array modules . . . . 400 kg
- Total 700

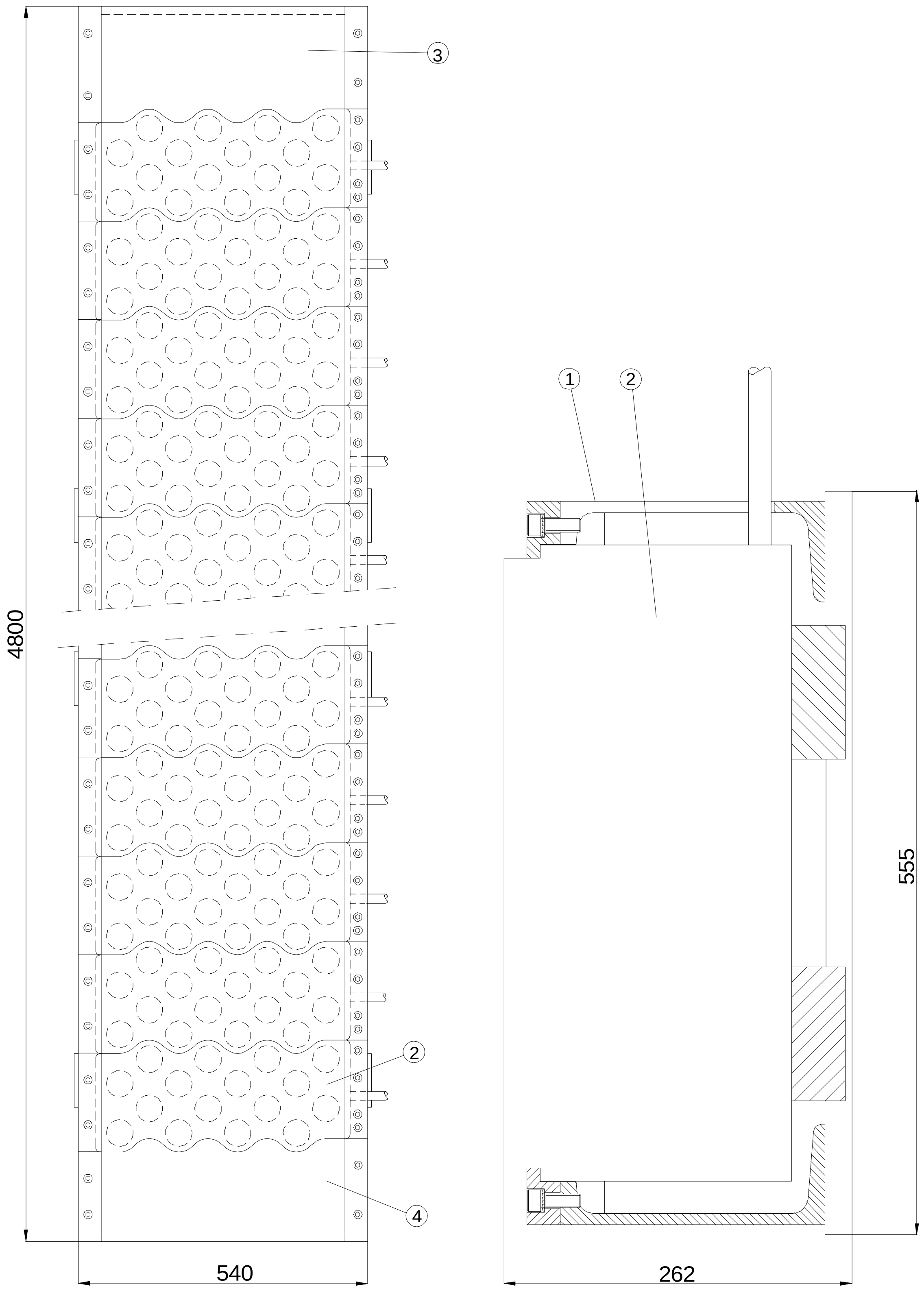


Figure 19 Transmitter transducer

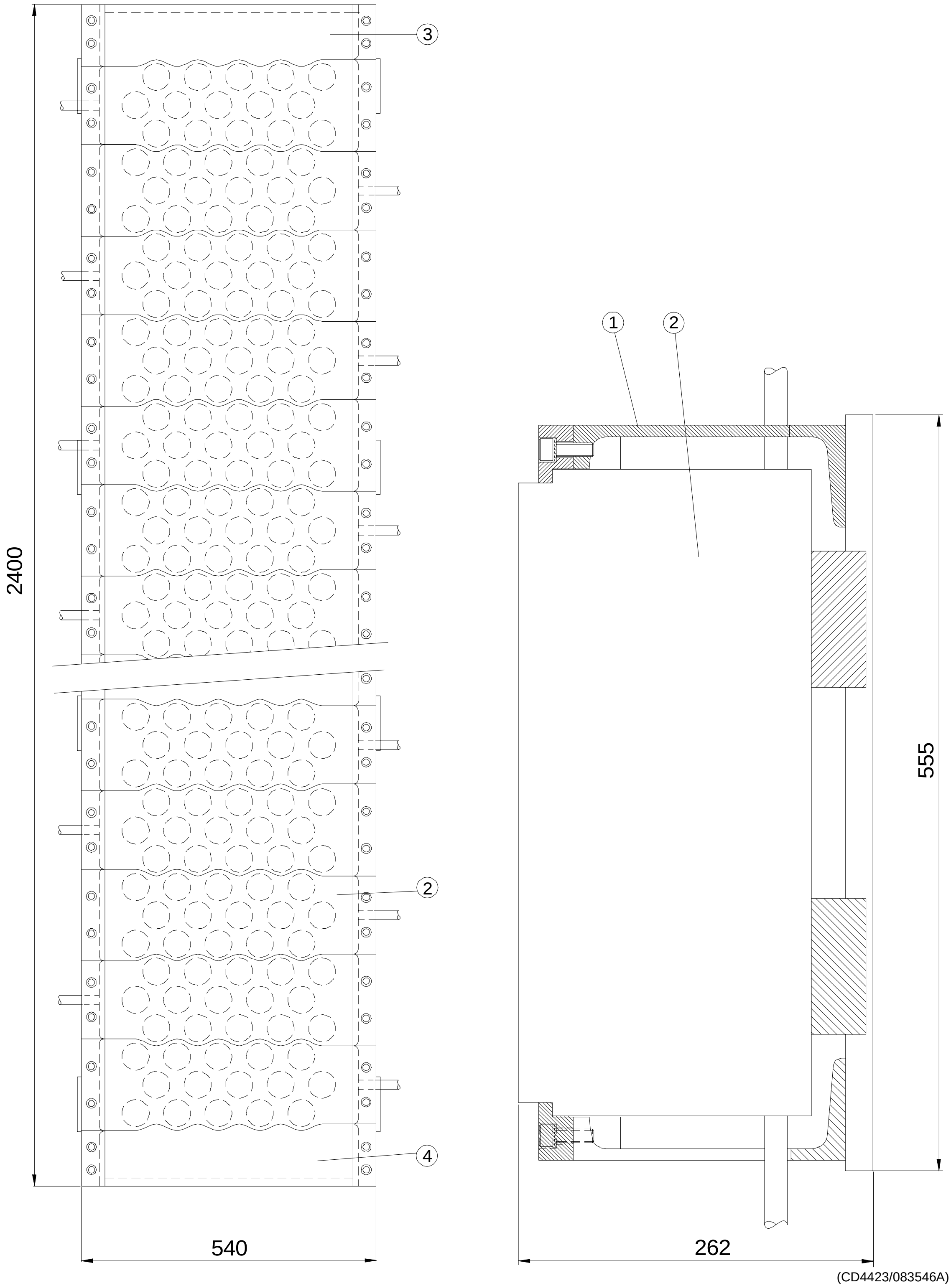


Figure 20 Receiver transducer

8.6 Commercial items

See manufacturer's manuals for data on delivered peripherals such as printers and plotters.

8.7 Computers and external interfaces

Operator Unit

Technology

Processor .... Intel 80486
Software storage .... 5.25 inch floppy disk
Display type .... 20″ inch VGA

Available interfaces

Data out Ethernet/RS–232
Positioning system RS–232
Sound velocity profile probe RS–232
External clock RS–232
Track plotter RS–232

Bottom Detector Unit

Technology

Processor .... Intel 80486
Software storage .... 5.25 inch floppy disk
Display type .... VGA

Available interfaces

Transmit Enable input .... Serial line CTS
Transmit Ready output .... Serial line RTS

8.8 Performance specifications

Receive transducer

Number of modules . . . . 14 (each with 15 elements)

Number of cables . . . 14 (16 coaxial cables in each – 15 are used)

Type of elements . . . . Circular Ceramic

Element sensitivity . . . . –184 dB/V rel. 1μPa

Impedance . . . . 60 ohm resistive

Frequency . . . . 13 kHz

Bandwidth . . . . 2 kHz

Transmit transducer

Number of modules . . . . 24 (each with 16 elements)

Number of cables . . . . 24 (16 coaxial cables in each)

Type of elements . . . . Circular Ceramic

Impedance . . . . 60 ohm resistive

Frequency . . . . 13 kHz

Bandwidth . . . . 2 kHz

Transmitter

Number of channels 384

Maximum power output per channel . . . . 50 W

Frequency . . . . 13 kHz

Total power output (electrical) . . . . 12 kW

Reduced power . . . . –10 dB or –20 dB

Source level:

– Shallow . . . . 230 dB

– Deep . . . . 237 dB

Pulse length:

– Shallow . . . . 2 ms

– Deep . . . . 10 ms

Electronic stabilization:

– Roll . . . . ± 15°

– Pitch . . . . ± 10°

Beamwidth:

– Fore–and–aft . . . . 1.8°

Athwartship:

- EM 12S . . . . 74–120°
- EM 12D . . . . 98–150°

Side lobes . . . . <–20 dB

Receiver

Number of channels 42

Bandwidth (analogue) . . . . 1.5 kHz

Gain control:

- Programmable Time Varied Gain (TVG) . . . . 60 dB
- Fixed gain reduction . . . . 0 to 30 dB in 6 dB steps
- Maximum total gain . . . . 120 dB

Range sample rate:

- Shallow . . . . 60 cm
- Deep . . . . 240 cm

Number of beams per ping

- EM 12S 81
- EM 12D 162

Beamwidth:

- Fore–and–aft . . . . 18°
- Athwartships . . . . 3.5°

Side lobes . . . . <–20 dB

Electronic roll stabilization . . . . ± 15°

9 DATAGRAM FORMATS

9.1 Introduction

The communication between the EM multibeam echo sounder and external devices is performed through an interchange of *datagrams*. These datagrams are described in this document.

The following datagram types are included:

- Output datagrams
  Datagrams generated by the echo sounder.
- Position input
  Data received from external positioning systems.
- External clock input
  Data received from external timing generators.
- Sound speed input
  Measured data uploaded from a sound speed profile probe or sound speed profiles prepared on an external computer.
- Remote request input

9.2 Description of the datagrams

The message part of the datagram is divided into several data fields, each consisting of one or more data bytes. The message part is described according to this form:

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note

Message contents and definitions

- **Description** – Short–form description of a data field.
- **Res** – Resolution
- **Units**

  Defines how to interpret the contents of a data field. The contents are described either by function or by units of measurement. A field may contain one or more units.
- **Format**

  Defines the coding of each unit. Two coding methods are used: *ASCII* and *Binary*.

Note !

This document uses a number and a lower case h to describe a hexadecimal value.
Example: 02h is equal to 2 in hexadecimal representation.

– **ASCII** (American Standard Code for Information Interchange)

√ **Byte ordering**

ASCII values are transmitted with the most significant byte first, for example.:

Transmitted value 1234 = 31h32h33h34h

Byte 1: 31h
Byte 2: 32h
Byte 3: 33h
Byte 4: 34h

√ **Signed / unsigned values**

ASCII numeric values may be signed or unsigned. A signed value has a + (positive) or a – (negative) in its first byte. The value is signed if the table field *valid range* includes both positive and negative values.

√ **Decimals**

ASCII numeric values may be with or without decimals. The decimal point may be included or a decimal point may be implied by the format description.

– **Binary**

√ **Byte ordering**

Binary values are transmitted with the least significant byte first, for example:

Transmitted value: 1234 = 04D2h

Byte 1: D2h
Byte 2: 04h

√ **Signed / unsigned values**

Binary values may be signed or unsigned. A signed negative value is given in two's complement representation. Unsigned values may use all bits for positive representation of a number. The value is signed if the field *valid range* includes both positive and negative values.

• **Bytes**

The bytes field gives the number of bytes for one unit in the column marked #, and the total number of bytes for a field in the column marked Σ.

• **Valid range**

The valid range field defines a unit's valid range in the format defined by the *format* field. Text enclosed by <> is used for describing the contents and not the actual value (i.e. <TEXT> is a text string consisting of any character in the current format). ⊔ is used as notation for a space.

- **Note**

  Corresponds to notes applicable to the table, which you will find listed directly below the table.

9.3 Output datagrams

Introduction

The data generated by the EM multibeam echo sounders are transmitted in a stream of individual *datagrams* to a logging system. Each datagram is described in this document.

The datagrams may be logged on internal or external logging systems.

The different datagrams are:

- Start datagram
- Stop datagram
- Parameter datagram
- Position datagrams
- Sound speed profile datagram
- Depth datagrams
- Sonar Image amplitude datagram
- Sonar Image amplitude and phase datagram
- Amplitude datagram
- Heave datagram

All EM multibeam output datagrams have the following structure:

Byte 1:	STX	02h
Byte 2:	Message type	xxh
Byte 3 to (n+2):	Message	n*xxh
Byte (n+3):	ETX	03h
Byte (n+4):	LSB of checksum	xxh
Byte (n+5):	MSB of checksum	xxh

The various datagrams are identified by the datagram type. The amount of data in a datagram and its meaning is defined by this type. The *checksum* is the arithmetic sum of all "n" data bytes (from and including byte 3 to and including byte (n+2)).

Datagrams are time tagged with the echo sounder clock unless otherwise noted.

The coordinate system used is shown in Figure 21 on page 158. The horizontal origo is at the positioning system's reference point and vertically it is at the water line. The coordinate system is right–handed with respect to angular rotation direction except regarding the EM 100.

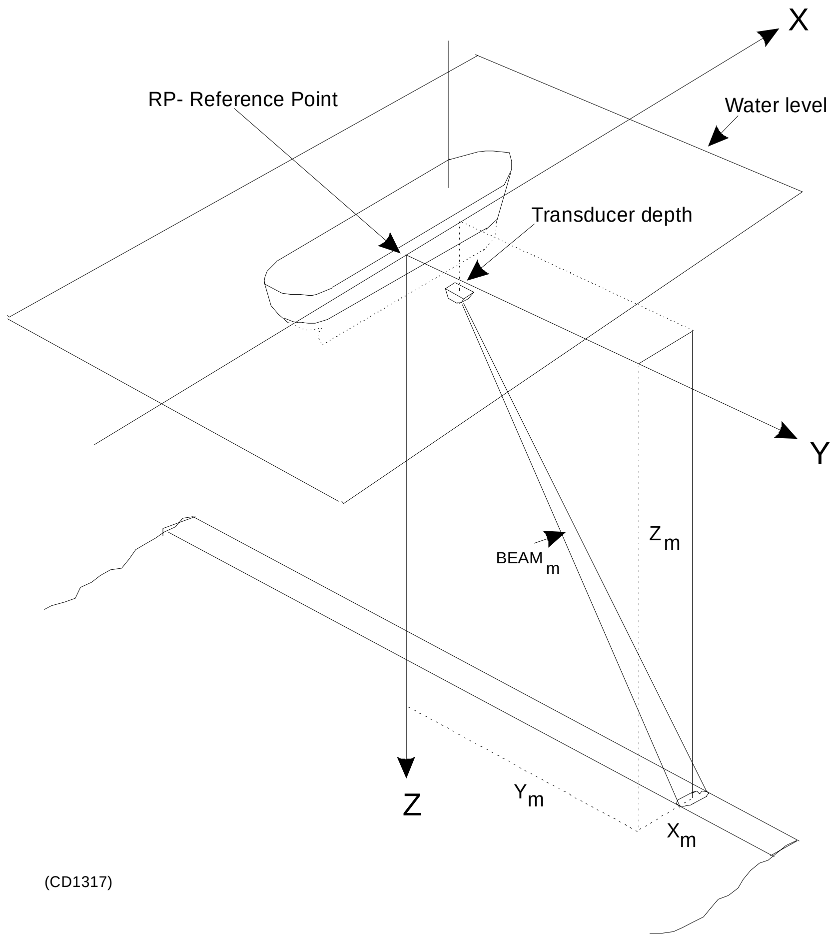


Figure 21 Coordinate system

Start, Stop and Parameter output

Note ! *The contents of the start, stop and parameter datagrams are identical; only the message type distinguishes the different datagrams.*

- Message type:
  - 85h (Start)
  - 86h (Stop)
  - 87h (Parameter)
- Number of data bytes: 421

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1 –	DD–days MM–months YY–years field separator	ASCII ASCII ASCII ASCII	2 2 2 1	7	1 – 31 1 – 12 0 – 99 ,	
Time	1 1 1 0.01 –	HH–hours MM–minutes SS–seconds hh–seconds field separator	ASCII ASCII ASCII ASCII ASCII	2 2 2 2 1	9	0 – 23 0 – 59 0 – 59 0 – 99 ,	
Positioning system type	– 1 –	header system code field separator	ASCII ASCII ASCII	4 1 1	6	PIS= 0 – 9 ,	
Positioning system time delay	– 0.1 –	header seconds field separator	ASCII ASCII ASCII	4 5 1	10	PTD= ± 59.9 ,	
Motion sensor roll offset	– 0.01 –	header degrees field separator	ASCII ASCII ASCII	4 5 1	10	MSR= ± 9.99 ,	
Motion sensor pitch offset	– 0.01 –	header degrees field separator	ASCII ASCII ASCII	4 5 1	10	MSP= ± 9.99 ,	
Motion sensor heading offset	– 0.01 –	header degrees field separator	ASCII ASCII ASCII	4 5 1	10	MSG= ± 9.99 ,	
EM 100 transducer depth	– 0.1 –	header metres field separator	ASCII ASCII ASCII	8 5 1	14	EM100TD= ± 99.9 ,	
EM 100 transducer fore–and–aft offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	8 5 1	14	EM100TX= ± 99.9 ,	
EM 100 transducer athwartships offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	8 5 1	14	EM100TY= ± 99.9 ,	
EM 12 transducer depth	– 0.1 –	header metres field separator	ASCII ASCII ASCII	7 5 1	13	EM12TD= ± 99.9 ,	
EM 12 transducer fore–and–aft offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	7 5 1	13	EM12TX= ± 99.9 ,	
EM 12 transducer athwartships offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	7 5 1	13	EM12TY= ± 99.9 ,	

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
EM 1000/950 transducer depth	– 0.1 –	header metres field separator	ASCII ASCII ASCII	9 5 1	15	EM1000TD= ± 99.9 ,	
EM 1000/950 transducer fore–and–aft offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	9 5 1	15	EM1000TX= ± 99.9 ,	
EM 1000/950 transducer athwartships offset	– 0.1 –	header metres field separator	ASCII ASCII ASCII	9 5 1	15	EM1000TY= ± 99.9 ,	
Spare	–	–	ASCII	80	80	spaces	
BDU software version	– – –	header annotation field separator	ASCII ASCII ASCII	4 4 1	9	BDU= 1.00 – 9.99 ,	
OPU software version	– – –	header annotation field separator	ASCII ASCII ASCII	4 4 1	9	OPU= 1.00 – 9.99 ,	
Responsible Operator	– – –	header annotation field separator	ASCII ASCII ASCII	3 8 1	12	RO= ,	
Planned line	– 1 –	header line number field separator	ASCII ASCII ASCII	13 4 1	18	PLANNED–LINE= 0–9999 ,	
Survey line	– 1 –	line header line number field separator	ASCII ASCII ASCII	12 4 1	17	SURVEY–LINE= 0 – 9999 ,	
Comment	– –	header annotation	ASCII ASCII	8 80	88	COMMENT: “Keyboard characters”	

Simrad 86 position output

Note !

This datagram must not be confused with the Simrad 86 position input datagram (described on page 178) from positioning systems. This output format will only be used if the input format is Simrad 86, Microfix or Motorola.

- Message type: 83h
- Number of data bytes: . . 28

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
Ship's position UTM Northing UTM Easting	 0.1 0.1	 metres metres	 ASCII ASCII	 8 8	16	 0 – 99999999 0 – 99999999	1
Spare	–	–	binary		4	0	

Notes

1 The UTM position given by the positioning system. The data has leading zeros.

Simrad 90 position output

Note !

This datagram must not be confused with the Simrad 90 position input datagram (described on page 174) from positioning systems. This output format will be used if the input format is not Simrad 86, Microfix or Motorola.

- Message type: 93h
- Number of data bytes: . . 90

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1 –	DD–days MM–months YY–years field separator	ASCII ASCII ASCII ASCII	2 2 2 1	7	1 – 31 1 – 12 0 – 99 ,	1
Time	1 1 1 0.01 –	HH–hours MM–minutes SS–seconds hh–seconds field separator	ASCII ASCII ASCII ASCII ASCII	2 2 2 2 1	9	0 – 23 0 – 59 0 – 59 0 – 99 ,	1
Latitude	1 0.0001 – –	degrees minutes North/South field separator	ASCII ASCII ASCII ASCII	2 7 1 1	11	0 – 89 0 – 59.9999 N or S ,	2
Longitude	1 0.0001 – –	degrees minutes East/West field separator	ASCII ASCII ASCII ASCII	3 7 1 1	12	0 – 179 0 – 59.9999 E or W ,	2
UTM Northing	0.1 –	metres field separator	ASCII ASCII	1 1 1	12	0 – 999999999.9 ,	2

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
UTM Easting	0.1 –	metres field separator	ASCII ASCII	9 1	10	0 – 9999999.9 ,	2
UTM zone no	1 –	zone number field separator	ASCII ASCII	2 1	3	1 – 60 ,	
UTM zone longitude	1 0.0001 – –	degrees minutes East/West field separator	ASCII ASCII ASCII ASCII	3 7 1 1	12	0 – 179 0 – 59.9999 E or W ,	2
System	1 –	– field separator	ASCII ASCII	1 1	2	0 – 2 ,	3
Q factor	1 –	– field separator	ASCII ASCII	1 1	2	0 – 9 ,	4
Speed	0.1 –	m/s field separator	ASCII ASCII	4 1	5	0 – 99.9 ,	5
Line heading	0.1	degrees	ASCII	5	5	0 – 359.9	6

Notes

1 Time of position measurement. It is the time from the echo sounder clock when the position arrives minus the positioning system time delay if time tagging has been set to internal. If set to external, the time is that provided in the position input datagram minus the time delay.

2 Position given by the positioning system. The UTM data have leading zeros. The UTM zone longitude field is valid only if East/West is set to E or W.

3 Determines the coordinate system which is valid.

0 = latitude/longitude
1 = UTM Northern hemisphere
2 = UTM Southern hemisphere

4 The Q factor may or may not be meaningful, dependent upon survey practice. If meaningful, it is related to positioning standard deviation as follows:

9 = <1 m
8 = <3 m
7 = <10 m
6 = <30 m
5 = <100 m
4 = <300 m
3 = <1000 m
2 = <3000 m
1 = <10000 m
0 = not valid position

5 The speed is usually a well filtered value giving the ship speed relative to the seabed.

6 The line heading is usually the expected heading of the survey line or it may be a filtered actual course made good.

Sound speed profile output

Note !

This datagram is used by the Operator Unit with software version 3.5x and later versions. For older sound sound profile datagrams no longer supported, see previous versions of this manual, or contact Kongsberg Simrad if a description is required.

- Message type: 9Ah
- Number of data bytes: . . 416

				Bytes			
Description	**Res**	**Units**	**Format**	#	Σ	**Valid range**	**Note**
Date	1 1 1	DD–days MM–months YY–years	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
No. of valid values	1	–	binary	2	2	1 – 100	1
100 occurrences of: depth sound speed	 1 0.1	 metres m/s	 binary binary	 2 2	400	 0 – 12000 14000 – 17000	

The sound speed profile datagram is issued every time the sound speed profile is changed.

Notes

1 The sound speed profile datagram consists of 100 pairs of depth and corresponding sound speed values. The ”No. of valid values” determines the number of depth and sound speed values in this table which are valid (always starting with the first pair).

EM 100 depth output

- Message type: 84h
- Number of data bytes: . . 145

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Time	1 1 1 1	HH–hours MM–minutes SS–seconds hh–hundredths	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
32 occurrences of : depth transverse position	 0.075 0.1	 metres metres	 binary binary	 2 2	128	 0 – 65535 −32768 – 32767	
Heading	0.1	degrees	binary	2	2	0 – 3599	1
Roll angle	0.2	degrees	binary	1	1	−128 – 127	1
Pitch angle	0.1	degrees	binary	1	1	−128 – 127	1
Heave	0.1	metres	binary	1	1	−128 – 127	1
Transducer relative position	0.1	metres	binary	2	2	−32768 – 32767	6
Transducer pitch	0.1	degrees	binary	1	1	−128 – 127	4
Version	0.1	–	binary	1	1	10 – 255	7

Notes

1 Time of measurement, when the sound was transmitted into the water.

2 Alongtrack sounding position must be calculated using sounding depth, transducer pitch and transducer relative position.

3 Positive roll angles when the starboard side is above the horizontal plane.

4 Positive pitch angles when the bow is below the horizontal plane (unique definition for the EM 100). The transducer pitch is used to calculate alongtrack displacement relative to the transducer position. With a hull unit the transducer pitch is different from the vessel pitch.

5 Positive heave value when the transducer is lower than the normal horizontal level.

6 The position of the transducer fore–and–aft & relative to the reference point. Positive values when the transducer is forward of the reference point.

7 Operator Unit software version.

EM 1000 and EM 950 depth output

- Message type: 97h
- Number of data bytes: . . 692

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1	DD–day MM–month YY–year	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
Ping number	1	–	binary	2	2	0 – 65535	11
Operational mode	1	–	binary	1	1	1 – 13	1
Ping quality factor	1	–	binary	1	1	–60 – 60	2
Depth below keel	0.02	metres	binary	2	2	0 – 65535	3
Heading	0.1	degrees	binary	2	2	0 – 3599	4
Roll angle	0.01	degrees	binary	2	2	− 2100 – 2100	4
Pitch angle	0.01	degrees	binary	2	2	− 2100 – 2100	4
Transducer pitch angle	0.01	degrees	binary	2	2	− 2100 – 2100	5
Heave	0.01	metres	binary	2	2	− 1000 – 1000	4
Sound speed	0.1	m/s	binary	2	2	14000 – 17000	6
60 occurrences of : depth acrosstrack distance alongtrack distance range reflectivity quality factor heave	 0.02 0.1 0.1 0.00005 0.5 – 0.1	 metres metres metres seconds dB – metres	 binary binary binary binary binary binary binary	 2 2 2 2 1 1 1	660	 0 – 65535 − 32768 – 32767 − 32768 – 32767 − 32768 – 32767 − 128 – 0 0 – 255 –100 – 100	 7 8 9 10

Notes

1

2 The ping quality factor shows the number of beams which have a sufficient echo strength to be accepted for bottom tracking and/or detection.

3 The measured depth in the most vertical beam.

4 The heading, roll, pitch, and heave are the sensor values at the ping transmit time, plus any offset values entered into the echo sounder. The heading is the reference (x–axis) for the right handed coordinate system in which alongtrack (x) and acrosstrack (y) distances and depths (z) are given. Thus:

- Roll angle is positive when the port side is above the horizontal plane.
- Pitch angle is positive when the bow is above the horizontal plane.
- Heave value is positive when the transducer is lower than its normal draft.

5 This is the transducer pitch relative to the ship coordinate system (the sum of the given ship and transducer pitch is the transducer pitch relative to the vertical).

6 The sound speed at the transducer depth, either measured or set by the operator.

7 The range is the two–way pulse travel time measured from the transducer.

8 The reflectivity is the maximum of filtered backscattering strength through each beam (corrected for sounder parameters).

9 The upper bit in the beam quality factor indicates whether amplitude (0) or phase (1) detection has been used.

- **Amplitude** – lower 6 bits indicate the number of amplitude samples used to calculate the detection point (0 – 63).
- **Phase**
  - √ the lower 6 bits are:

$$64 \; \frac{\textit{variance of the curve fit with phase versus time}}{\textit{maximum limit allowed}}$$

The maximum limit depends on the slope of the phase curve.

  - √ the next upper bit indicates whether a first (0) or second (1) order curve fit has been used.

10 Measured at reception time in each beam.

11 Ping number is odd when interlaced beams are shifted towards port.

EM 12 depth output

- Message type:
  - 94h . . . . . . Starboard
  - 95h . . . . . . Port
  - 96h . . . . . . Centre system
- Number of data bytes: 923

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1	DD–day MM–month YY–year	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Ping number	1	–	binary	2	2	0 – 65535	
Resolution	1	–	binary	1	1	1 – 2	1
Ping quality factor	1	–	binary	1	1	21 – 81	2
Depth below keel	0.1/0.2	metres	binary	2	2	0 – 65535	3
Heading	0.1	degrees	binary	2	2	0 – 3599	4
Roll angle	0.01	degrees	binary	2	2	−2100 – 2100	4
Pitch angle	0.01	degrees	binary	2	2	−2100 – 2100	4
Heave	0.01	metres	binary	2	2	−1000 – 1000	4
Sound speed	0.1	m/s	binary	2	2	14000 – 17000	5
Mode	1	–	binary	1	1	1 – 8	6
Spare	–	–	binary	1	1		
81 occurrences of :					891		
depth	0.1/0.2	metres	binary	2		0 – 65535	
acrosstrack distance	0.2/0.5	metres	binary	2		–32768 – 32767	
alongtrack distance	0.2/0.5	metres	binary	2		–32768 – 32767	
range	0.2/0.8	msec	binary	2		–32768 – 32767	7
reflectivity	0.5	dB	binary	1		–128 – 0	8
quality factor	–	–	binary	1		0 – 255	9
heave	0.1	metres	binary	1		–100 – 100	10

Notes

1 Where two resolution values are given (e.g. 0.1/0.2), this factor determines which is valid, i.e. 1 for high resolution, 2 for low.

2 The ping quality factor shows the number of beams which have accepted bottom detections.

3 The measured depth in the most vertical beam.

4 The heading, roll, pitch, and heave are the sensor values at the ping transmit time, plus any offset values entered into the echo sounder. The heading is the reference (x–axis) for the right handed coordinate system in which alongtrack (x) and acrosstrack (y) distances and depths (z) are given. Thus:

- Roll angle is positive when the port side is above the horizontal plane.
- Pitch angle is positive when the bow is above the horizontal plane.
- Heave value is positive when the transducer is lower than its normal draft.

5 The sound speed at the transducer depth, either measured or set by operator.

6

7 The range is the two way pulse travel time measured from the transducer.

8 The reflectivity is the maximum of the filtered backscattering strength through each beam (corrected for echo sounder parameters).

9 The upper bit in the beam quality factor indicates whether amplitude (0) or phase (1) detection has been used.

- **Amplitude** – lower 6 bits indicate the number of amplitude samples used to calculate the detection point (0 – 63).
- **Phase**
  - √ the lower 6 bits are:

    $$64 \frac{variance\ \ of\ \ the\ \ curve\ \ fit\ \ with\ \ phase\ \ versus\ \ time}{maximum\ \ limit\ \ allowed}$$

    The maximum limit depends on the slope of the phase curve.
  - √ the next upper bit indicates whether a first (0) or second (1) order curve fit has been used.

10 Measured at reception time in each beam.

Sonar image amplitude output

- Message type:
  - C8h . . . . . . Port side of EM 12D
  - C9h . . . . . . Starboard side of EM 12D
  - CAh . . . . . EM 12S, EM 1000 and EM 950
- Number of data bytes: 551

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1	DD–day MM–month YY–year	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
Ping number	1	–	binary	2	2	0 – 65535	
Range to normal incidence	1	ms	binary	2	2	0–32767	1
BS difference used in TVG	0.5	dB	binary	1	1	–128 – 127	11
Number of datagrams	1	–	binary	1	1	1 – 81	2
Datagram number	1	–	binary	1	1	1 – 81	3
Number of beams	1	–	binary	1	1	1 – 75	4
Number of beams occurrences of : beam number frequency samples in beam beam centre sample	 1 1 1 1	 – – – –	 binary binary binary binary	 1 1 2 2	6–450	 1 – 81 0 – 3 1 – 523 1 – 523	 5 6 7 8
Number of beams occurrences of : Number of samples in beam occurrences of : amplitude	0.5	dB	binary	1	1–523	–128 – 0	9
Possible occurrences of : spare	–	–	binary	1	0–522	0	10

Notes

1 The two–way travel time to normal incidence used in the echo sounder to calculate incidence angle dependence of backscattering amplitudes. Resolution is mode– and echo sounder–dependant, but is ¼ of that used in the depth datagrams for detected beam ranges:

EM 12, shallow . . . . 0.8 ms

EM 12, deep . . . . 3.2 ms

EM 1000 and EM 950 . . . . 0.2 ms

2 The amount of Sonar Image data for one ping may be larger than the maximum allowed in one datagram. The number of datagrams (typically 5–10) defines how many are provided with this particular ping.

3 Defines the datagram position in the datagram sequence for one ping.

4 The number of beams represented in the current datagram.

5 Defines the current beam.

6 Frequency for the current beam:

0 = 12.67 kHz
1 = 13.00 kHz
2 = 13.33 kHz
3 = 95 kHz

7 The number of samples in the current beam.

8 The sample number of the centre beam sample in the current beam, i.e. the x,y,z given in the depth datagram for this beam, is the position of this sample.

9 This table contains the amplitude data for one or more beams, as defined by the number of beams. Each beam contains a varying number of data samples, as defined by the number of samples in a beam.

10 To obtain a fixed length, the surplus of the datagram is filled with zeros.

11 The difference between the assumed backscatter coefficient at normal incidence and at oblique incidence used to "flatten" the amplitudes near normal incidence. In the second datagram of the sequence for one ping, the assumed backscatter coefficient at normal incidence is given.

Sonar image amplitude & phase output

- Message type:
  - CBh . . . . . Port side of EM 12D
  - CCh . . . . . Starboard side of EM 12D
  - CDh . . . . . EM 12S, EM 1000 and EM 950
- Number of data bytes: 1465

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1	DD–day MM–month YY–year	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
Ping number	1	–	binary	2	2	0 – 65535	
Range to normal incidence	1	ms	binary	2	2	0–32767	1
BS difference used in TVG	0.5	dB	binary	1	1	–128 – 127	11
Number of datagrams	1	–	binary	1	1	1 – 81	2
Datagram number	1	–	binary	1	1	1 – 81	3
Number of beams	1	–	binary	1	1	1 – 81	4
Number of beams occurrences of : beam number frequency samples in beam beam centre sample	 1 1 1 1	 – – – –	 binary binary binary binary	 1 1 2 2	6–486	 1 – 81 0 – 2 1 – 479 1 – 479	 5 6 7 8
Number of beams occurrences of : Number of samples in beam occurrences of : amplitude phase	 0.5 0.05	 dB degrees	 binary binary	 1 2	3–1437	 –128 – 0 – 3600 – 3600	 9
Possible occurrences of : spare	 –	 –	 binary	 1	0–1434		10

Notes

1 The two–way travel time to normal incidence used in the echo sounder to calculate incidence angle dependence of backscattering amplitudes. Resolution is mode– and echo sounder–dependant, but is ¼ of that used in the depth datagrams for detected beam ranges:

EM 12, shallow . . . . 0.8 ms

EM 12, deep . . . . 3.2 ms

EM 1000 and EM 950 . . . . 0.2 ms

2 The amount of Sonar Image data for one ping may be larger than the maximum of one datagram. The number of datagrams (typically 5–10) defines the number of datagrams representing one ping.

3 Defines the datagram position in the datagram sequence for one ping.

4 The number of beams represented in the current datagram.

5 Defines the current beam.

6 Frequency for the current beam:

0 = 12.67 kHz
1 = 13.00 kHz
2 = 13.33 kHz
3 = 95 kHz

7 The number of samples in the current beam.

8 The sample number of the centre beam sample in the current beam, i.e. the x,y,z given in the depth datagram for this beam, is the position of this sample.

9 This table contains the amplitude and electrical phase data for one or more beams, as defined by the number of beams. Each beam contains a varying number of data samples, as defined by the number of samples in a beam.

The electrical phase (Θ) may be converted to angle of arrival relative to beam centre (Φ) and thus the position on the seabed:

$$\Phi = 0.255 \cdot \lambda / \cos \Phi_b$$

where c is the transducer sound speed, f is the beam frequency and Φ_b the beam angle relative to the perpendicular on the receiver transducer array. Thus this datagram contains all the data needed for assessment of the local acrosstrack slopes on the seabed.

The above information is valid for the EM 12. Contact Kongsberg Simrad if you require the formula valid for another EM multibeam echo sounder.

10 To obtain a fixed length, the surplus of the datagram is filled with zeros.

11 The difference between the assumed backscatter coefficient at normal incidence and at oblique incidence used to "flatten" the amplitudes near normal incidence. In the second datagram of the sequence for one ping, the assumed backscatter coefficient at normal incidence is given.

EM 100 amplitude output

Note ! *This datagram is supported by Operator Unit software version 3.5x and higher.*

- Message type: 89h
- Number of data bytes: . . 48

Notes

1 Refer to EM multibeam echo sounder technical system description (results of bottom detection processing chapter).

Filtered heave output

Note ! *This datagram is only applicable for the EM 1000 and EM 950 multibeam echo sounders used with the Hippy 120C VRU.*

- Message type: 92h
- Number of data bytes: . . 1024

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 1 1	DD–day MM–month YY–year	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	1
Time	1 1 1 0.01	HH–hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	1
Spare	–	–	binary	8	8	–	
500 occurrences of : heave difference	0.01	metres	binary	2	1000	− 2000 – 2000	2

The delay between the measurement of the heave (unfiltered heave output) and the filtered heave output is 77.2 seconds with a Hippy 120C.

Notes

1 Time–tags the oldest sample (sample #1) of the 500 heave difference samples.

2 Equals the digitally filtered heave output minus the unfiltered heave output. The data are sampled every 0.1 second (10 Hz).

9.4 Position input

General

The EM multibeam echo sounder supports input from a range of positioning systems. This document describes the datagram formats accepted by the EM multibeam echo sounder.

Positioning datagrams are accepted on the RS–232 serial line *port P3* on the multiport connection box supplied with the Operator Unit.

Recommended serial port set–up is (except where noted):

- 1200 baud
- 8 data bits
- 1 stop bit
- no parity

This baud rate is high enough for the accuracy required and the necessary throughput, and it is low enough to avoid errors which might occur due to computer workload.

Simrad 90 position input

This input format is supported on systems with Operator Unit software version 3.1 and higher. It is the recommended format with the EM multibeam echo sounder.

Note ! *This datagram must not be confused with the Simrad 90 position output datagram (described in section on page 161).*

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of Sentence	ASCII	1	1	⊔	
Address	– –	address field separator	ASCII ASCII	5 1	6	0–9 and A–Z ,	
Date	1 1 1 –	DD–days MM–months YY–years field separator	ASCII ASCII ASCII ASCII	2 2 2 1	7	1 – 31 1 – 12 0 – 99 ,	
Time	1 1 1 0.01 –	HH–hours MM–minutes SS–seconds hh–seconds field separator	ASCII ASCII ASCII ASCII ASCII	2 2 2 2 1	9	0 – 23 0 – 59 0 – 59 0 – 99 ,	
Latitude	1 0.001 – –	degrees minutes North/South field separator	ASCII ASCII ASCII ASCII	2 7 1 1	11	0 – 90 0 – 59.9999 N or S ,	
Longitude	1 0.001 – –	degrees minutes East/West field separator	ASCII ASCII ASCII ASCII	3 7 1 1	12	0 – 180 0 – 59.9999 E or W ,	
UTM Northing	0.1 –	metres field separator	ASCII ASCII	11 1	12	0 – xxxxxxxxx.x ,	
UTM Easting	0.1 –	metres field separator	ASCII ASCII	9 1	10	0 – xxxxxxx.x ,	
UTM zone no	1 –	time zone field separator	ASCII ASCII	2 1	3	1 – 60 ,	
UTM zone longitude	1 0.001 – –	degrees minutes East/West field separator	ASCII ASCII ASCII ASCII	3 7 1 1	12	0 – 180 0 – 59.9999 E or W ,	1
System	1 –	 field separator	ASCII ASCII	1 1	2	0 – 2 ,	2
Q factor	1 –	– field separator	ASCII ASCII	1 1	2	0 – 9 ,	3
Speed	0.1 –	m/s field separator	ASCII ASCII	4 1	5	0 – 99.9 ,	4
Line heading	0.1 –	degrees field separator	ASCII ASCII	5 1	6	0 – 360.0 ,	5
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	0Dh 0Ah	

Notes

1 The UTM zone longitude field is only valid if East/West is set to E or W.

2 Determines which coordinate system is valid:

0 = lat./long.
1 = UTM Northern hemisphere
2 = UTM Southern hemisphere

3 The Q factor should be related to positioning standard deviation as follows:

9 = <1m
8 = <3m
7 = <10m
6 = <30m
5 = <100m
4 = <300m
3 = <1000m
2 = <3000m
1 = <10000m,
0 = not valid position

4 This speed may be used in the Quality Assurance Unit and the Sonar Imaging Unit. It should be a filtered ship speed relative to the seabed.

5 This line heading may be used in the Sonar Imaging Unit. It should be the expected survey line heading or a filtered actual course made good.

NMEA 0183 position input

The GLL datagram without time is supported on systems with Operator Unit software version 3.3 and higher. The GGA datagram is supported on systems with Operator Unit software version 3.6 and higher.

GLL format

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of Sentence	ASCII	1	1	⊔	
Address	– – –	talker identifier sentence formatter field separator	ASCII ASCII ASCII	2 3 1	6	0–9 and A–Z GLL ,	
Latitude	1 variable –	degrees minutes field separator	ASCII ASCII ASCII	2 3–n 1	6–n	0 – 90 0 – 59.99 ,	1
Hemisphere	– –	North/South field separator	ASCII ASCII	1 1	2	N or S ,	
Longitude	1 variable –	degrees minutes field separator	ASCII ASCII ASCII	3 3–n 1	7–n	0 – 180 0 – 59.99 ,	1
Hemisphere	–	East/West	ASCII	1	1	E or W	
Checksum	– –	delimiter –	ASCII ASCII	1 2	3	*	2
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	0Dh 0Ah	

GGA format

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of Sentence	ASCII	1	1	⊔	
Address	– – –	talker identifier sentence formatter field separator	ASCII ASCII ASCII	2 3 1	6	0–9 and A–Z GGA ,	
Time	1 1 1 – 1 –	HH–hours MM–minutes SS–seconds separator hh–hundredths field separator	ASCII ASCII ASCII ASCII ASCII ASCII	2 2 2 0–1 0–2 1	6–10	0–23 0–59 0–59 . 0–99 ,	1
Latitude	1 variable –	degrees minutes field separator	ASCII ASCII ASCII	2 3–n 1	6–n	0 – 90 0 – 59.99 ,	1
Hemisphere	– –	North/South field separator	ASCII ASCII	1 1	2	N or S ,	
Longitude	1 variable –	degrees minutes field separator	ASCII ASCII ASCII	3 3–n 1	7–n	0 – 180 0 – 59.99 ,	1

Description	Res	Units	Format	Bytes #	Σ	Valid range	Note
Hemisphere	–	East/West	ASCII	1	1	E or W	
Quality indicator	1 –	– field separator	ASCII ASCII	1 1	2	0–2 ,	2
Used satellites	1 –	– field separator	ASCII ASCII	2 1	3	not limited ,	2
HDOP	variable –	– field separator	ASCII ASCII	n 1	n+1	not limited ,	2
Antenna altitude	variable – – –	metres field separator metres field separator	ASCII ASCII ASCII ASCII	n 1 1 1	n+3	not limited , M ,	2
Geoidal separation	variable – – –	metres field separator metres field separator	ASCII ASCII ASCII ASCII	n 1 1 1	n+3	not limited , M ,	2
Age of DGPS data	variable –	seconds field separator	ASCII ASCII	n 1	n+1	not limited ,	2
DGPS station ID	1	–	ASCII	4 1	5	0–1023 ,	2
Checksum	– –	delimiter –	ASCII ASCII	1 2	3	*	2
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	0Dh 0Ah	

Notes

1 The length depends on the precision available.

2 Optional; the fields are not used by the multibeam echo sounder. See NMEA 0183 manual for description.

Simrad 86 position input

Note !

This datagram must not be confused with the Simrad 86 position output datagram (described on page 161).

Description	Res	Units	Format	Bytes #	Σ	Valid range	Note
Start character	–	Start of TeXt	ASCII	1	1	02h	
Message type	–	–	ASCII	1	1	41h	
Time Delay	0.01	seconds	ASCII	4	4	0 – 9999	1
Ship's position UTM Northing UTM Easting	 0.1 0.1	 metres metres	 ASCII ASCII	 8 8	16	 0 – 99999999 0 – 99999999	2

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Spare	–	–	ASCII	8	8	⊔ or 0	
Stop character	–	End of TeXt	ASCII	1	1	03h	
Checksum	– –	LSB MSB	binary binary	1 1	2	0 – 65356 0 – 65356	

Notes

1 Time delay of position measurement from actual measurement until transmitted to the EM multibeam echo sounder. Leading zeros (ASCII – 30h) should be added. It is applied to the time tag of the Simrad 86 output datagram.

2 UTM positions (in dm) at the antenna or at the reference point of the positioning system. Leading zeros (ASCII – 30h) must be added.

Motorola position input

The format is in accordance with the remote x and y format from Motorola Falcon 484.

Only the position data in the datagram are used by the EM multibeam echo sounder. The 19 field separators (commas) before the position data are in accordance with the Motorola format. The remainder of the datagram has no significance except for the stop character.

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of TeXt	ASCII	1	1	02h	
19 occurrences of : data field separator	 – –	 – separator	 ASCII ASCII	 ≥ 0 1	≥ 19	 not limited ,	
Position	0.1 – 0.1	X–Coordinate separator Y–Coordinate	ASCII ASCII ASCII	3–9 1 3–9	7–19	± 9999999.9 , ± 9999999.9	1
Other data	–	–	ASCII		≥ 0	not used	
Stop character	–	End of TeXt	ASCII	1	1	03h	

Notes

1 Position coordinates are right justified and leading zeros are suppressed. Negative values are indicated with a minus.

Microfix position input

The format is according to Racal Microfix documentation.

Recommended serial port set–up:

- 9600 baud
- 7 data bits
- 2 stop bits
- even parity

The output consists of up to three lines.

The first line contains a four–digit event number, the time and the X–Y coordinates in either lat/long or UTM format.

The second and third lines contain range information, but are ignored by the EM multibeam echo sounder.

Example:

```
EVENT:1234  TIME:12–34–56  X= 1234567.8  Y= 12345678.9

12 123456.7  23 222222.4 06 123423.7  30 45333.0

08   3453.0  03  67890.5 09 45 3661.1 21   598.9
```

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Event	– 1 –	header event number field separator	ASCII ASCII ASCII	6 4 2	12	EVENT: 0 – 9999 ⊔⊔	
Time	– 1 – 1 – 1 –	header hours separator minutes separator seconds field separator	ASCII ASCII ASCII ASCII ASCII ASCII ASCII	5 2 1 2 1 2 2	15	TIME: 0 – 23 – 0 – 59 – 0 – 59 ⊔⊔	
Position	– 0.1 – – 0.1	header X–Coordinate separator header Y–Coordinate	ASCII ASCII ASCII ASCII ASCII	3 10 2 3 11	29	X=⊔ 0–99999999.9 ⊔⊔ Y=⊔ 0–999999999.9 ⊔⊔	1)
End of line	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	
Range information	–	–	ASCII		≥0	not used	

Notes

1 The output format of the coordinates depends on the ″Coords″ option selected on the ″CMU Set–Up″ page. This option should be set to **TM GRID OUTPUT**.

Position coordinates are right justified and leading zeros are suppressed. Negative values are indicated with a minus, positive values with a space.

Thus a typical output would be:

X=␣␣␣␣22334.4

Y=␣␣␣1234567.8

Trimble position input

This format is only included for Kongsberg Simrad test purposes.

RWSLOD

This special format is used by Rijkswaterstaat of Holland only.

9.5 External clock input

Introduction

An external master clock may be interfaced to synchronize the internal clock of the echo sounder with external equipment. Clock synchronization is accepted on the RS–232 serial line *port P6* on the multiport connection box supplied with the Operator Unit.

Navitronic SDC–4 external clock input

This input format is supported on systems with Operator Unit software version 2.0 and higher.

Recommended serial port set–up:

- 600 baud
- 7 data bits
- 1 stop bit
- even parity

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Time	1 1 1 1	Julian day hours minutes seconds	ASCII ASCII ASCII ASCII	3 2 2 2	9	0 – 999 0 – 23 0 – 59 0 – 59	
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	

WEMPE 20018 external clock input

This input format is supported on systems with Operator Unit software version 2.0 and higher.

Recommended serial port set–up:

- 600 baud
- 7 data bits
- 2 stop bits
- even parity

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of TeXt	ASCII	1	1	02h	
GMT time	– 1 1 1	header hours minutes seconds	ASCII ASCII ASCII ASCII	1 2 2 2	7	U 0 – 23 0 – 59 0 – 59	
GMT date	– 1 1 1	header days months years	ASCII ASCII ASCII ASCII	1 2 2 2	7	D 1 – 31 1 – 12 0 – 99	
Local time	– 1 1 1	header hours minutes seconds	ASCII ASCII ASCII ASCII	1 2 2 2	7	L 0 – 23 0 – 59 0 – 59	
Local date	– 1 1 1	header days months years	ASCII ASCII ASCII ASCII	1 2 2 2	7	D 1 – 31 1 – 12 0 – 99	
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	
Stop character	–	End of TeXt	ASCII	1	1	03h	

NMEA 0183 ZDA external clock input

This input format is supported on systems with Operator Unit software version 3.1 and higher.

Recommended serial port set–up:

- 4800 baud
- 8 data bits
- 1 stop bit
- no parity

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of Sentence	ASCII	1	1	$	
Address	– – –	talker identifier sentence formatter field separator	ASCII ASCII ASCII	2 3 1	6	0–9 and A–Z ZDA ,	
Time	1 1 1 – 0.01 –	hours minutes seconds separator seconds field separator	ASCII ASCII ASCII ASCII ASCII ASCII	2 2 2 0–1 0–2 1	7–10	0 – 23 0 – 59 0 – 59 , 0–99 ,	

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Date	1 – 1 – 1 –	days separator months separator years field separator	ASCII ASCII ASCII ASCII ASCII ASCII	2 1 2 1 4 1	11	1 – 31 , 1 – 12 , 0 – 9999 ,	
Time zone	– 1	East/West time zone	ASCII ASCII	1 2	3	⊔ or – 0 – 12	1
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	

Notes

1 ⊔ = West
– = East

IFREMER external clock input

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of Sentence	ASCII	1	1	$	
Address	– –	address field separator	ASCII ASCII	5 1	6	0–9 and A–Z ,	
Date	1 – 1 – 1 –	day separator month separator year field separator	ASCII ASCII ASCII ASCII ASCII ASCII	2 1 2 1 2 1	9	1 – 31 / 1 – 12 / 0 – 99 ,	
Time	1 – 1 – 1 – 0.1	hours separator minutes separator seconds separator seconds	ASCII ASCII ASCII ASCII ASCII ASCII ASCII	2 1 2 1 2 1 1	10	0 – 23 : 0 – 59 : 0 – 59 , 0–9	
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	

Trimble external clock input

This format is for Kongsberg Simrad test purposes only.

NERC external clock input

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of sentence	ASCII	1	1	0Dh	
Date	1 – 1 –	YY–year separator DDD – Julian day separator	ASCII ASCII ASCII ASCII	2 1 3 1	7	0–99 : 1–366 :	
Time	1 – 1 – 1	HH – hour separator mm – minutes separator ss – seconds	ASCII ASCII ASCII ASCII ASCII	2 1 2 1 2	8	0–23 : 0–59 : 0–59	

9.6 Sound speed input

Introduction

A sound speed profile is required if the echo sounder is to give correct measurements. The sound speed profile is usually derived from a measurement through the water column, possibly supplemented by tabulated values.

The sound speed profile may be entered into the echo sounder...

- manually,
- from a sound speed profile datagram sent from an external computer,
- uploaded directly from the measuring instrument.

All the sound speed datagrams are accepted as input on the RS–232 serial line *port P5* on the multiport connection box supplied with the Operator Unit. The Simrad Binary Sound Speed Profile datagram is also accepted via Ethernet.

Simrad binary sound speed profile input

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	–	Start of TeXt	ASCII	1	1	02h	
Message type	–	–	binary	1	1	9Ah	
Date	1 1 1	DD–days MM–months YY–years	ASCII ASCII ASCII	2 2 2	6	1 – 31 1 – 12 0 – 99	
Time	1 1 1 0.01	HH-hours MM–minutes SS–seconds hh–seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 – 23 0 – 59 0 – 59 0 – 99	
No. of valid values	1	–	binary	2	2	1 – 100	1
100 occurrences of: depth sound speed	 1 0.1	 m m/s	 binary binary	 2 2	400	 0 – 12000 14000 – 17000	
End character	–	End of TeXt	ASCII	1	1	03h	
Checksum	– –	LSB MSB	binary binary	1 1	2	0 – 255 0 – 255	2

Notes

1 The sound speed profile datagram consists of 100 pairs of depth and corresponding sound speed values. The "No. of valid values" determines the number of depth and sound speed values which are valid in the table, starting from the first pair.

2 The checksum is calculated as for the output datagrams (described in *Introduction* on page 157).

Simrad ASCII sound speed profile input

This datagram has the same format as that used by the Simrad EA 500 Echo Sounder.

Description	Res.	Units	Format	Bytes		Valid range	Note
				#	Σ		
Header	– –	– separator	ASCII ASCII	2 1	3	SV ,	
Time	1 1 1 1 –	HH–hours MM–minutes SS–seconds hh–hundredths separator	ASCII ASCII ASCII ASCII ASCII	2 2 2 2 1	9	00–23 00–59 00–59 00–99 ,	
No. of values (n)	1 –	– separator	ASCII ASCII	3 1	4	⊔⊔1–100 ,	1, 2
n occurrences of: depth sound speed	 1 – 0.1 –	 metres separator m/s separator	 ASCII ASCII ASCII ASCII	 5 1 6 1	n*13	 ⊔⊔⊔⊔1–12000 , 1400.0–1600.0 ,	2
Termination	–	Carriage Return	ASCII	1	1	0Dh	

Notes

1 The sound speed profile datagram consists of up to 100 pairs of depth and corresponding sound speed values. The ”No. of valid values” determines the number of depth values and sound speed values which the datagram contains .

2 Leading spaces must be used.

Navitronic SVM–1 sound speed profile input

Recommended serial port set–up:

- 9600 baud
- 8 data bits
- 1 stop bit
- no parity

Description	Res	Units	Format	Bytes		Valid range	Note
				#	Σ		
Synchronization	–	–	ASCII	5	5	######	
Start character	–	–	ASCII	1	1	%	
Sound speed	1	average value	ASCII	5	5	0 – 99999	1
n occurrences of: sound speed	 1	 measured value	 ASCII	 5	n*5	 0 – 99999	1
Termination	– –	Carriage Return Line Feed	ASCII ASCII	1 1	2	Dh Ah	

Notes

1 The given value must be used in the formula below to give the sound speed value in m/s.

$SV = A - (value \cdot B)$ where A = 2904.12088255
B = 0.032383946756
SV= Sound speed [m/s]

A and B are constants used internally by the NAVITRONIC SVM–1.

Example:	Byte 12:	34h
	Byte 13:	33h
	Byte 14:	36h
	Byte 15:	36h
	Byte 16:	37h
	Value:	43667

Sound speed: $SV = A - (43667 * B) = 1490\, m/s$

Applied Microsystems Ltd. SVP–16

The Applied Microsystems Ltd. SVP–16 sound speed profile probe is supported in two ways:

- uploading the profile directly from the probe, or by
- uploading the profile from the PC–based Total System Software (delivered by Applied Microsystems Ltd. with the probe) in the so–called CALC format

Note that the Total System Software does not have the required upload capability, so for example a standard PC communication program must be used to perform the upload. This program must transfer the sound speed profile file (extension .REL) unchanged and without adding anything.

Note ! *If the file contains more than 100 pairs of depths and sound velocities, the extra points must be removed with a standard PC editor.*

Note that the probe must be armed from the PC software before deployment. Calibration data for a specific probe are used by the PC software. Thus, it is recommended to upload the probe data via the PC to achieve the highest accuracy, and only upload the probe data directly to the Operator Unit in an emergency.

The CALC format is an ASCII format with a five line header plus a variable number of lines with data as follows:

Line 1: CALC, sn, date, depthincrement, depthdisplay

Line 2: AML SOUND VELOCITY PROFILER S/N: xxxxx

Line 3: DATE:xxxxx TIME:xxxxx

Line 4: DEPTH OF SET (M): xxxx.x

Line 5: DEPTH(M) VELOCITY (M/S) TEMPERATURE (°C)

In the first line, sn is the sensor serial number , date is current date taken from computer, depthincrement is logging depth increment, and depthdisplay is depth units (meters or decibars). Line 3 gives the Julian date and time at start of sensor logging, and line 4 the pressure offset at sea level. The data in the header is not used by the EM system. Each data record contains three numbers: depth in metres, sound velocity in m/s and temperature in °C (not used by the EM system), separated by a space and terminated with a linefeed (LF). The numbers must all include a decimal point (xxx.x xxxx.x xx.xLF). The data are terminated by a line with three zeros separated by two spaces (0 0 0).

9.7 Remote request input

The Operator Unit may be requested to output a specific datagram (serial port or Ethernet). The datagrams which may be requested are the Sound Speed Profile datagram and the Start, Stop and Parameter datagram (refer to Output datagrams on page 157).

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character		Start of text	Binary	1	1	02h	
Request			Binary	1	1	3Fh	
Datagram type			Binary	1	1	85h, 86h, 87h, 9ah	
Stop character		End of text	Binary	1	1	03h	
Checksum		LSB MSB	Binary	1 1	2	0–FFh 0–FFh	1

Notes

1 The checksum is calculated as for the output datagrams.

Blank page

A

B

C

G

H

T

U

V

W

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