Kongsberg EM Series Multibeam echo sounder

EM datagram formats

850-160692/R

Document history

Document number: 850-160692		
Rev. K	June 2009	A new output datagram, Network Attitude Velocity datagram 110, is added. The 3 D velocity input is used for Doppler compensation in FM mode. The range corrections applied is documented in the Raw range and angle 78 datagram. Installation, Runtime and status datagrams are updated with extra information. Changes in PTNL, GGK datagram
Rev. L	November 2009	Updated Runtime and Installation parameters. Updated PU information and status datagram to allow for EM 2040 datagrams. ExtraParameters added in Multibeam parameters section
Rev. M	January 2010	Added SIS generated datagrams. Added and modified comments.
Rev. N	September 2010	Typing error in KSSIS 80 format corrected. RFN parameter re-introduced in Installation datagram (see Multibeam Parameters section).
Rev. O	March 2012	General update including updates for SIS 3.9
Rev. P	June 2012	Updated Quality factor datagram 79, added appendix B "Handling of .all files"
Rev. Q	February 2013	General update including updates for EM 2040C and SIS 4.0
Rev. R	October 2013	Raw range and beam angle 78 datagram: Quality factor corrected to QF = 2500*sd/dr (Was QF = 250*sd/dr). Multibeam installation parameters updated for EM 2040 Dual TX.

Disclaimer

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

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. All users must be familiar with the contents of the appropriate manuals before attempting to install, operate, maintain or in any other way work on the equipment. Kongsberg Maritime AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Support information

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

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EM datagram formats

The data input and output formats to and from the EM Series multibeam echo sounders are described in this document. The information applies to the Kongsberg Maritime multibeam echo sounders introduced after 1995.

Note

The information herein applies to the EM 3002, EM 3000, EM 2040, EM 2000, EM 1002, EM 710, EM 302, EM 122, ME70BO, EM 300 and EM 120 multibeam echo sounders. Some of the information may not be relevant for your specific system. Please disregard this.

Information for EM 2040 is valid for all models of EM 2040, unless otherwise specified.

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

Note

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

Presentation format

The format description is according to the **NMEA 0183 standard, Approved Parametric Sentence Structure**, with the ASCII character(s) given as follows

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

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

Support information

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

You can also contact our main support office in Norway.

- **Address**: Strandpromenaden 50, 3190 Horten, Norway
- **Telephone**: +47 33 02 38 00
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- **E-mail address**: km.hydrographic.support@kongsberg.com
- **Website**: http://www.km.kongsberg.com

Input datagrams

Topics

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

Note

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

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

Position

Topics

- *Tide Input* on page 20
- *Depth, pressure or height input* on page 20

Overview

The EM Series accepts position data in the following formats

- NMEA 0183 GGA
- GGK
- PTNL, GGK
- SIMRAD 90
- Transponder position
- With the GGA and GGK datagrams, information contained in NMEA 0183 GST and VTG datagrams will also be accepted and used.

  Note

  The GST datagram is not used by the following multibeam echo sounders: EM 122, EM 302, EM 710, EM 2040, EM 2040C, EM 3002 and ME70BO.

- A datagram format for Sonar Head depth is provided for the EM 3002, EM 3000, EM 2040, EM 2000 and EM 710. Note that the format is the same as that used by the Paroscientific Digiquartz pressure sensor. This format may also be used for input of for example varying datum heights or other special height information on all models.
- A datagram format for input of tidal height is provided.

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

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

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

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

  or

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

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

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

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

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

SIS supports logging of all data from a Javad GPS receiver directly attached to the serial port on the HWS PC.

The Javad GPS receiver outputs binary data in addition to the NMEA datagrams. The binary can be used by third party software (like Terratec) to compute more accurate positions using post processing tools. The Javad data files are stored in a separate folder and kept separate from the other raw data to ease the post processing of the data. The operator chooses this directory in the runtime parameters in SIS.

A Trimble GPS receiver can also be attached to the serial line of the HWS PC. This is used for special purposes like land surveying.

GGA Datagram

Table 1 GGA Datagram

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

Notes

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

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

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

The GPS manufacturers may have different GPS quality indicators.

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

PTNL, GGK Local coordinate position datagram

Trimble GGK Datagram

Table 2 GGK Datagram

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

Notes

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

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

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

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

The GPS manufacturers may have different GPS quality indicators.

VTG Datagram

Table 3 VTG Datagram

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

Notes

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

Transponder position

Table 4 SSB - SSBL Position Datagram

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

Notes

1 Not used by multibeam echo sounders.

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

3 Only this transponder type is accepted by the multibeam.

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

Simrad 90 Position

Table 5 Simrad 90 datagram

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

Notes

1 The value of system descriptor defines the content of the datagram as follows.

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

Note

The EM 12, EM 950 and EM 1000 multibeam echo sounders will only accept values less than 3.

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

Table 6

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
0.01	0.02	0.05	0.1	.02.	0.5	1	2	5	10	20	50	100	200	500	1000

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

Tide Input

Table 7 Tide input datagrams

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

Notes

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

Depth, pressure or height input

This third party telegram definition provides a universal format to hold either depth, pressure or height information.

Table 8 Depth pressure or height input datagrams

Data Description	Format	Valid range	Note
Start identifier = *	Always 24h	—	—
Sentence identifier	ii	00 to 09	1
Talker identifier	ii	00 to 09	—
Depth or height in meters and decimal meters	x.x	—	2
End of sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

Notes

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

2 If input is depth, it will be used in the depth output datagram to offset the transmit transducer depth.

If input is height, which will usually imply a time or position variable datum height, its use will depend on the sentence identifier and will be implemented as required by a specific customer.

Depth is positive downwards. Depths may be scaled and offset adjusted using constants:

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

Attitude

Topics

Overview

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

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

  or

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

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

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

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

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

Roll, pitch and heading in the Sperry Marine MK-39 MOD2 Attitude and Heading Reference System format is also accepted. A second motion sensor must then be used to supply heave.

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

EM 122, EM 302, EM 710, EM 2040 and EM 2040C use frequency modulated (FM) pulses to extend the detection range while maintaining the high resolution. To properly take into account the Doppler-effect when using FM mode, real time 3D velocity input is needed from the motion sensor. The data, on proprietary format, is available via Ethernet from some of the manufacturers. Currently three manufacturers are supported.

See also *Network attitude velocity input format* on page 24.

EM Attitude input format

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

- Byte 1: Sync byte 1 = 00h, or Sensor status = 90h-AFh
- Byte 2: Sync byte 2 = 90h
- Byte 3: Roll LSB
- Byte 4: Roll MSB
- Byte 5: Pitch LSB
- Byte 6: Pitch MSB
- Byte 7: Heave LSB
- Byte 8: Heave MSB
- Byte 9: Heading LSB
- Byte 10: Heading MSB

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

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

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

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

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

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

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

- 90h in the first byte indicates a valid measurements with full accuracy
- any value from 91h to 99h indicates valid data with reduced accuracy (decreasing accuracy with increasing number)
- any value from 9Ah to 9Fh indicates non-valid data but normal operation (for example configuration or calibration mode)
- and any value from A0h to AFh indicates a sensor error status

Network attitude velocity input format

EM 122, EM 302, EM 710, EM 2040 and EM 2040C use frequency modulated (FM) pulses to extend the detection range and still maintaining the high resolution. To properly take into account the Doppler-effect when using FM mode, real time 3D velocity input is needed from the motion sensor. The data, on proprietary format, is available via Ethernet from some of the manufacturers. Currently the following formats are supported:

- Seatex Binary format 11
- Seatex Binary format 23
- POS-MV GRP 102/103
- Coda Octopus MCOM

For details about the formats, please refer to manufacturer documentation.

The datagram will be logged in the Network Attitude Velocity 110 datagram, and the range corrections applied is documented in the raw range and angle 78 datagram.

Sperry MK-39 Attitude input format

The format is 18 bytes long, and it is organised as 9 words. The most signigicant byte of a word is transmitted first.

- Word 1 AA55h.
- Word 2 Status and time.
- Word 3 Heading.
- Word 4 Roll.
- Word 5 Pitch.
- Word 6 Heading rate.
- Word 7 Roll rate.
- Word 8 Pitch rate.
- Word 9 Checksum (MSB) and 1's complement of checksum (LSB).

All data are in 2's complement binary. Heading is given within ±180°, roll and pich within ±90°. (Note however that the values ±180° and ±90° are not permitted, as these are one bit too high.)

Heading is measured with reference to true North, and positive when the bow points eastwards. Roll is per definition a rotation angle (Tate-Bryant) and positive when the starboard side goes up. Pitch is positive when the bow goes down.

HDT format

Table 9 HDT Format

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

SKR80 format

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

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

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

Clock datagrams

Topics

Clock

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

ZDA format

Table 10 ZDA format

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

Notes

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

Note

Trimble UTC format is also supported.

Sound speed datagrams

Topics

Overview

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

The new format is completely in ASCII and allows 9998 entries without limitations in resolution. But the echosounder have other limitations, check note 9. In addition to depth and sound speed, it allows input of absorption coefficient, pressure, temperature and salinity or conductivity. The latter parameters may be used to calculate depth, sound speed and absorption coefficient. Use of a depth dependent absorption coefficient allows a more accurate determination of bottom backscatter strength.

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

Kongsberg Maritime SSP format

Table 11 SSP format

Data Description	Format	Length	Valid range	Note
Start identifier = $	Always 24h	1	—	—
Talker identifier	aa	2	Capital letters	—
Datagram identifier	Always Sxx,	4	S00 to S53	1,2
Data set identifier	xxxxx,	6	00000 to 65535	—
Number of measurements = N	xxxx,	5	0001 to 9999	9
UTC time of data acquisition	hhmmss,	7	000000 to 235959	3
Day of data acquisition	xx,	3	00 to 31	3
Month of data acquisition	xx,	3	00 to 12	3
Year of data acquisition	xxxx,	5	0000 to 9999	3
N entries of the next 5 fields – See note 4				
– Depth in m from water level or Pressure in MPa	x.x,	2 –	0 to 12000.00 0 to 1.0000	4
– Sound velocity in m/s	x.x,	1 –	1400 to 1700.00	—
– Temperature in °C	x.x,	1 –	-5 to 45.00	—
– Salinity in parts per thousand or Conductivity in S/m	x.x,	1 –	0 to 45.00 or 0 to 7.000	—
Absorption coefficient in dB/km	x.x	0 –	0 to 200.00	5
Data set delimiter	CRLF	2	0Dh 0Ah	—
End of repeat cycle				
Latitude in degrees and minutes, plus optional decimal minutes	llll.ll,	Variable 5 –	0000 to 9000.0...	6
Latitude – N/S	a,	2	N or S	6
Longitude in degrees and minutes, plus optional decimal minutes	yyyyy.yy,	Variable 6 –	00000 to 18000.0...	6
Longitude – E/W	a,	2	E or W	6
Atmospheric pressure in MPa	x.x,	1 –	0 to 1.0000	6
Frequency in Hz	xxxxxx,	Variable	—	7
User given comments	c—c	Variable	—	6
Optional checksum	*hh	—	—	8
End of datagram delimiter = \CRLF	5Ch 0Dh 0Ah	3	—	—

Notes

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

Table 12 SSP format

Identifier	Input data	Data to be used	Comment
S00	D,c	D,c	Same as S10, but used immediately.
S01	D,c,T,S	D,c,α(D,T,S,L)	Same as S12, but used immediately.
S02	D,T,S	D,c(D,T,S,L),α(D,T,S,L)	Same as S22, but used immediately.
S03	D,T,C	D,c(D,T,C,L),α(D,T,S,L)	Same as S32, but used immediately.
S04	P,T,S	D(P,T,S,L),c(P,T,S,L),α(P,T,S,L)	Same as S42, but used immediately.
S05	P,T,C	D(P,T,C,L),c(P,T,C,L),α(P,T,C,L)	Same as S52, but used immediately.
S06	D,c,α	D,c,α	Same as S11, but used immediately.
S10	D,c	D,c	—
S11	D,c,α	D,c,α	—
S12	D,c,T,S	D,c,α(D,T,S,L)	—
S13	D,c,α,f	D,c,α	Frequency dependent
S20	D,T,S	D,c(D,T,S,L)	—
S21	D,T,S,α	D,c(D,T,S,L),α	—
S22	D,T,S	D,c(D,T,S,L),α(D,T,S,L)	—
S23	D,T,S,α,f	D,c(D,T,S,L),α	Frequency dependent
S30	D,T,C	D,c(D,T,S,L)	
S31	D,T,C,α	D,c(D,T,S,L),α	
S32	D,T,C	D,c(D,T,S,L),α(D,T,S,L)	
S33	D,T,C,α,f	D,c(D,T,S,L),α	Frequency dependent
S40	P,T,S	D(P,T,S,L),c(P,T,S,L)	
S41	P,T,S,α	D(P,T,S,L),c(P,T,S,L),α	
S42	P,T,S	D(P,T,S,L),c(P,T,S,L),α(P,T,S,L)	
S43	P,T,S,α,f	D(P,T,S,L),c(P,T,S,L),α	Frequency dependent
S50	P,T,C	D(P,T,C,L),c(P,T,C,L)	
S51	P,T,C,α	D(P,T,C,L),c(P,T,C,L),α	
S52	P,T,C	D(P,T,C,L),c(P,T,C,L),α(P,T,C,L)	
S53	P,T,C,α,f	D(P,T,C,L),c(P,T,C,L),α	Frequency dependent

2 S00 – S06 is a special case because the sound speed profile will be taken into use immediately without further operator intervention. The checksum is then mandatory and must be correct.

Furthermore an entry for zero depth must be present and the profile must be extended to 12000m.

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

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

5 Same date and time for all frequencies.

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

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

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

9 There is a limitation on the size of the sound velocity profile. The file used by the PU must be maximum 30 kB and limited to a maximum number of depth points. Maximum 1000 points for EM 2040, EM 710, EM 302 and EM 122. Maximum 570 points for older sounders. The profile can be edited and decimated in the SIS SVP editor.

SIS will give a warning and reject the input profile if to many measurements.

AML Smart Sensor and AML Micro Sensor format

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

For the AML Micro Sensors, the fields have been swapped so the sound speed is always the first field.

The supported AML Smart Sensor message formats are:

- SV = Sound Velocity
- SV&P = Sound Velocity and Pressure
- SV&T = Sound Velocity and Temperature

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

The accepted message formats are as follows:

Table 13 SV Format

±	x	x	x	x	.	x		CR	LF

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

Table 14 SV&P Format

±	x	x	x	.	x	x		±	x	x	x	x	.	x		CR	LF

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

Table 15 SV&T Format

±	x	x	.	x	x	x		±	x	x	x	x	.	x		CR	LF

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

Note

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

Note

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

Depth input datagrams from single beam echo sounder

Topics

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

- NMEA 0183 DBS
- NMEA 0183 DPT
- Binary datagrams from the Kongsberg Maritime EA echo sounder series, referred to as the Simrad format.

DBS Format

Table 16 DBS Format

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

Notes

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

DPT Format

Table 17 DPT Format

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	aa	Capital letters	—
Sentence formatter	Always DPT,	—	—
Depth in meters from the transducer	x.x,	0.1 –	—
Offset of transducer from waterline in meters	x.x,	0 –	1

Table 17 DPT Format (cont'd.)

Data Description	Format	Valid range	Note
Maximum range scale in use	x.x,	—	—
Checksum	*hh	—	—
End of sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

Notes

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

Simrad format

Table 18 Simrad format

Data Description	Format	Valid range	Note
Start identifier = D	Always 34h	—	—
Channel identifier	x,	1 to 311	1
Time as HHMMSShh	xxxxxxxx,	00000000 to 23595999	1
Depth in meters from the transducer	32 bit IEEE 754 floating point	0.1 –	1
Bottom backscattering strength in dB	32 bit IEEE 754 floating point	—	—
Transducer number	32 bit integer	—	—
Athwartship slope in degrees	32 bit IEEE 754 floating point	—	—

Notes

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

Note

The datagram must be sent on Ethernet to Processing Unit UDP2. For UDP port address, see PU information and status on page 99

Remote control datagrams

A Remote Control datagram has been implemented to allow

- the multibeam echo sounder to start logging on remote command.
- the multibeam echo sounder to send out parameter and sound speed profile datagrams, "IUR", consisting of Installation parameters (I), sound speed profile datagram (U) and Runtime datagram (R), as a response to the remote command.
- the survey line numbers to be set from a remote location.

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

In addition to the primary application of the Remote Control datagrams as described above, they are also used to report the SIS pinging and logging status to external recipients. For more information on this, see "notification of SIS pinging and logging activity" in the SIS Operator Manual (doc.no: 850-164709).

Table 19 Remote Control datagrams

Data Description	Format	Valid range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	aa	Capital letters	—
Datagram identifier	Rxx,	R00 to R20	1
EM model number	EMX=dddd,	—	—
Responsible operator	ROP=a—a,	—	2
Survey identifier	SID=a—a,	—	2
Survey line number	PLN=d..d,	—	2
Survey line identifier (planned line no)	PLL=d—d,	—	2
Comment	COM=a—a	—	3
Optional checksum	*hh	—	—
End of datagram delimiter = \CRLF	5Ch 0Dh 0Ah	—	—

Notes

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

- R00 - System to stop pinging (and logging if on)
- R10 - System to stop all logging (but continue or start pinging).
- R11 - System to start logging locally and send a start sequence "IUR" consisting of an installation parameter datagram (I), sound speed profile datagram (U) and a runtime datagram (R).
- R12 - System to start logging locally. "IUR" will be sent.
- R13 - System to start logging on new line to local storage only.

- R20 - System to send “IUR”.
- The current version of SIS does not support R11 and R13. On SIS, the effect of R00, R10 and R12 datagrams is exactly the same as if the operator has used the pinging and logging buttons.

2 The current version of SIS has no support for ROP, SID and PLN. PLL is used for R12 to indicate line number to be logged.

3 Only used for “External notification of SIS pinging and logging activity”, see SIS Operator Manual.

Sound speed at transducer

In addition to receiving sound speed at transducer from sound velocity probe/sensor attached to the SIS HWS through a serial line, it is also possible to send this information through the Ethernet.

Note

The datagram format and port address etc. is also explained in the “External sensors” chapter in the SIS Reference Manual.

KSSIS 80 Datagram

Sound velocity and temperature sent over LAN (UDP) to SIS HWS

Table 20 KSSIS 80 input datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Always KS	—	—
Sentence formatter	Always SIS,	—	—
Datagram ID	Always 80,	—	—
Sound speed (m/s)	x.x,	1400.0 – 1700.0	—
Temperature (Celsius)	x.x	—	—
End if sentence delimiter = CRLF	Always 0Dh 0Ah	—	—
End if sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

Output datagrams

Topics

Introduction

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

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

Note

Please be aware that the following echo sounders: EM 3002, EM 710, EM 302, EM 122, EM 2040, EM 2040C and ME70BO use little endian byte order.

Note

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

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

- All datagrams (except the NMEA DPT datagram) start with STX, datagram type and time tag, and end with ETX and checksum (sum of bytes between STX and ETX). In addition the total length of the datagram (not including the length field) will precede the STX byte, given as a four byte binary number.
- The length field is only included when logging to tape and/or disk, but not for datagrams logged to a remote location. The length can then be derived from the network software. Systems logging data remotely should add this length at the start of each datagram. This length is required if the data are to be used with Kongsberg Maritime post-processing systems.
- The time stamp resolution is 1 millisecond and includes the century. The time stamp is binary. The date is given as 10000*year(4 digits) + 100*month + day, for example 19950226 for February 26, 1995. All date fields in the output datagrams use this format. A time is usually given (in milliseconds) from midnight.
- The datagrams identify the multibeam echo sounder model and its serial number. The system model number is 120 for the EM 120, 300 for the EM 300, etc. For the EM 3000D (the dual head system) the model number was originally given as 3002 and the serial number is that of Sonar Head number 1. However in the depth datagram model numbers 3003-3008 are now used to also identify the actual transmit and sampling frequencies of the two heads. If only one head is activate on the EM 3000D, it is coded as a single head system. For EM 3002 the model number is 3020. The EM 3002 has separate datagrams (depth, range, seabed image, water column) for the two sonar heads.
- Due care has been taken to include all parameters needed in postprocessing in the relevant datagrams, with a minimum of data duplication. Where resolution of a data field is variable, a resolution descriptor is included.
- Invalid data are always identified by the highest positive number allowed in a field unless otherwise noted.
- A real-time parameter datagram has been added to enable logging of parameters not used in postprocessing, but which may be important in checking the quality of the logged data, or to allow tracing of reasons for possible malfunctions.
- Attitude data as time continuous records and raw ranges and beam pointing angles are logged to allow eventual postprocessing corrections. The logged attitudes are valid at the transmit transducer, and are corrected for any sensor offsets.

Systems with dual swaths (fans of receiver beams with different tilt) will have separate datagrams for each swath.

In the datagrams for EM 122, EM 302, EM 710, ME70 BO, EM 2040 and EM 2040C, both valid and invalid beams are included (The beam index then became redundant information and is therefore removed). This is done to be able to store seabed image data also for beams missing a valid detection.

Multibeam data

Topics

Depth datagram

Note

This datagram is used for EM 2000, EM 3000, EM 3002, EM 1002, EM 300 and EM 120. The XYZ 88 on page 43 is used for EM 122, EM 302, EM 710, ME70 BO, EM 2040 and EM 2040C.

Table 21 Depth datagram

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = D(epth data) (Always 44h)	1U	—	—
EM model number (Example: EM 3000 = 3000)	2U	—	—
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Heading of vessel in 0.01°	2U	0 to 35999	—
Sound speed at transducer in dm/s	2U	14000 to 16000	—
Transmit transducer depth re water level at time of ping in cm	2U	0 to 65536	1
Maximum number of beams possible	1U	48 –	—
Number of valid beams = N	1U	1 to 254	—
z resolution in cm	1U	1 to 254	—
x and y resolution in cm	1U	1 to 254	—

Table 21 Depth datagram (cont'd.)

Data Description	Format	Valid range	Note
Sampling rate (f) in Hz **or** Depth difference between sonar heads in the EM 3000D	2U 2S	300 to 30000 -32768 to 32766	3 4
Repeat cycle — N entries of :	16*N	—	—
Depth (z) from transmit transducer (unsigned for EM 120 and EM 300)	2S or 2U	-32768 to +32766 or 1 to 65534	2
Acrosstrack distance (y)	2S	-32768 to 32766	2
Alongtrack distance (x)	2S	-32768 to 32766	2
Beam depression angle in 0.01°	2S	-11000 to 11000	3
Beam azimuth angle in 0.01°	2U	0 to 56999	3
Range (one - way travel time)	2U	0 to 65534	3
Quality factor	1U	0 to 254	5
Length of detection window (samples/4)	1U	1 to 254	—
Reflectivity (BS) in 0.5 dB resolution) (Example: -20 dB = 216)	1S	-128 to +126	—
Beam number	1U	1 to 254	6
End of repeat cycle			
Transducer depth offset multiplier	1S	-1 to +17	1
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

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

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

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

One way travel time = range / sampling rate / 4

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

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

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

Table 22 EM 3000D

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

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

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

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

XYZ 88

Note

This datagram is used for the models EM 2040, EM 2040C, EM 710, EM 122, EM 302 and ME70BO. All receiver beams are included, check detection info and real time cleaning for beam status (note 4 and 5).

Table 23 XYZ 88

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = X (58h, 88d)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (Example: Sep 26, 2005 = 20050926)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Heading of vessel (at TX time) in 0.01°	2U	0 to 35999	—
Sound speed at transducer in dm/s	2U	14000 to 16000	—
Transmit transducer depth in m re water level at time of ping	4F	—	1
Number of beams in datagram = N	2U	1 – 1024	—
Number of valid detections	2U	1 – 1024	—
Sampling frequency in Hz	4F	—	—
Scanning info.	1U	—	7
Spare	3U	—	—
Repeat cycle - N entries of :	20*N	—	—
Depth (z) from transmit transducer in m	4F	—	2
Acrosstrack distance (y) in m	4F	—	2
Alongtrack distance (x) in m	4F	—	2
Detection window length in samples	2U	—	—
Quality factor	1U	0 – 254	3
Beam incidence angle adjustment (IBA) in 0.1 deg	1S	-128 to 126	6
Detection information	1U	—	4
Real time cleaning information	1S	—	5
Reflectivity (BS) in 0.1 dB resolution (Example: –20.1 dB = FF37h= 65335)	2S	—	4
End of repeat cycle			
Spare (always 0)	1U	0	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

1 The transmit transducer depth should be added to the beam depths to derive the depths re the water line. Note that the transducer depth will be negative if the actual heave is large enough to bring the transmit transducer above the water line. This may represent a valid situation, but may also be due to an erroneously set installation depth of either the transducer or the water line.

2 The beam data are given re the transmit transducer or sonar head depth and the horizontal location (x,y) of the active positioning system's reference point. Heave, roll, pitch, sound speed at the transducer depth and ray bending through the water column have been applied.

3 Scaled standard deviation (sd) of the range detection divided by the detected range (dr):

Quality factor = 250*sd/dr.

4 This datagram may contain data for beams with and without a valid detection:

A) If the most significant bit (bit7) is zero, this beam has a valid detection. Bit 0–3 is used to specify how the range for this beam is calculated.

0= Amplitude detect (0xxx 0000)

1= Phase detect (0xxx 0001)

2-15= Future use

B) If the most significant bit (bit7) is 1, this beam has an invalid detection. Bit 0–3 is used to specify how the range (and x,y,z parameters) for this beam is calculated

0= Normal detection (1xxx 0000)

1= Interpolated or extrapolated from neighbour detections (1xxx 0001)

2= Estimated (1xxx 0010)

3= Rejected candidate (1xxx 0011)

4= No detection data is available for this beam (all parameters are set to zero) (1xxx 0100)

5-15= Future use

The invalid range has been used to fill in amplitude samples in the seabed image datagram.

Bit 4 Reflectivity (used in Beam intensity display) correction for Lamberts law and for normal incidence:

0= not compensated (xxx0 xxxx) (to show beam incidence angle dependency)

1= compensated (xxx1 xxxx) (uses same correction as for seabed image data)

5 A real time data cleaning module may flag out beams.

Negative values indicates that this beam is flagged out, and is not to be used.

6 Due to raybending, the beam incidence angle at the bottom hit will usually differ from the beam launch angle at the transducer and also from the angle given by a straight line between the transducer and the bottom hit. The difference from the latter is given by the beam incidence angle adjustment (IBA). The beam incidence angle re the horizontal, corrected for the ray bending, can be calculated as follows:

BAC = atan(z / abs(y)) + IBA.

BAC is positive downwards and IBA will be positive when the beam is bending towards the bottom. This parameter can be helpful for correcting seabed imagery data and in seabed classification.

7 Only used by EM 2040. See appendix *EM 2040 Scanning mode* on page 116 for details.

Central beams echogram

Note

This datagram is only available for EM 120 and EM 300.

Table 24 Central beams echogram

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = K (Always 4Bh)	1U	—	—
EM model number (Example: EM 3000 = 3000)	2U	—	—
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Mean absorption coefficient in 0.01 dB/km	2U	1 to 20000	1
Pulse length in μs	2U	50 –	1
Range to normal incidence used in TVG	2U	1 to 16384	1
Start range sample of TVG ramp if not enough dynamic range (0 else)	2U	0 to 16384	—
Stop range sample of TVG ramp if not enough dynamic range (0 else)	2U	0 to 16384	—
Normal incidence BS in dB (BSN) (Example: -20 dB = 236)	1S	-50 to +10	1
Oblique BS in dB (BSO) (Example: -1 dB = 255)	1S	-60 to 0	1
Tx beamwidth in 0.1°	2U	1 to 300	1
TVG law crossover angle in 0.1°	1U	20 to 300	1
Number of included beams (N)	1U	1 –	—
Repeat cycle — N entries of :	6*N	—	
beam index number	1U	0 to 253	2
spare byte to get even length (Always 0)	1U	—	—
number of samples per beam = Ns	2U	1 –	—
start range in samples	2U	1 –	3
End of repeat cycle			
Repeat cycle – ΣNs entries of:	ΣNs	—	
Sample amplitudes in 0.5 dB (Example: -30 dB = 196)	1S	-128 to +126	—
End identifier = ETX (Always 03h)	1U	—	—
End of repeat cycle			
Spare byte if required to get even length (Always 0 if used)	0–1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

1 The sample amplitudes are not corrected in accordance with the detection parameters derived for the ping, as is done for the seabed image data.

2 The beam index number is the beam number - 1.

3 The range for which the first sample amplitude is valid for this beam given as a two-way range. The detection range is given in the raw range and beam angle datagram. Note that data are provided regardless of whether a beam has a valid detection or not.

Raw range and beam angle (F)

Note

Only used for EM 3000

Table 25 Raw range and beam angle datagrams

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = F (Always 46h)	1U	—	—
EM model number (Example: EM 3000 = 3000)	2U	—	—
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Maximum number of beams possible	1U	48 –	—
Number of valid receive beams = N	1U	1 to 254	—
Sound speed at transducer in dm/s	2U	14000 to 16000	—
Repeat cycle – N entries of :	8*N	—	—
– Beam pointing angle in 0.01°	2S	-11000 to 11000	1
– Transmit tilt angle in 0.01°	2U	-2999 to 2999	1
– Range (two-way travel time)	2U	0 to 65534	1
– Reflectivity (BS) in 0.5 dB resolution	1S	-128 to 126	—
– Beam number	1U	1 to 254	—
End of repeat cycle			
Spare (Always 0)	1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	21U	—	—

Notes

1 The beam pointing angle is positive to port and the transmit tilt angle is positive forwards for a normally mounted system looking downwards. The range resolution in time is the inverse of the range sampling rate given in the depth datagrams.

Raw range and beam angle (f)

Note

Used for EM 120, EM 300, EM 1002, EM 2000, EM 3000 and EM 3002

Table 26 Raw range and beam angle datagrams

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

Table 26 Raw range and beam angle datagrams (cont'd.)

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

Notes

1 0 = cw, 1 = FM

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

3 The beam number normally starts at 0.

Raw range and angle 78

Note

Used for EM 122, EM 302, EM 710, ME70 BO, EM 2040 and EM 2040C. All receiver beams are included, check detection info and real time cleaning for beam status (see note 3 and 4).

Table 27 Raw range and beam angle 78 datagram

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = N (4eh, 78d)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (Example: Sep 26, 2005 = 20050926)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Sound speed at transducer in 0.1 m/s	2U	14000 to 16000	—
Number of transmit sectors = Ntx	2U	1 –	—
Number of receiver beams in datagram = Nrx	2U	1 –	—
Number of valid detections	2U	1 –	—
Sampling frequency in Hz	4F	—	—
Dscale	4U	—	5
Repeat cycle 1 - Ntx entries of:	24*Ntx	—	—
Tilt angle re TX array in 0.01°	2S	-2900 to 2900	6
Focus range in 0.1 m (0 = No focusing applied)	2U	0 to 65534	—
Signal length in s	4F	—	—
Sector transmit delay re first TX pulse, in s	4F	—	—
Centre frequency in Hz	4F	—	—
Mean absorption coeff. in 0.01 dB/km	2U	—	—
Signal waveform identifier	1U	0 to 99	1
Transmit sector number / TX array index	1U	—	7
Signal bandwidth in Hz	4F	—	—
End of Repeat cycle 1			
Repeat cycle 2 - Nrx entries of:	16*Nrx	—	—
Beam pointing anlge re RX array in 0.01°	2S	-11000 to 11000	6
Transmit sector number	1U	—	8
Detection info	1U	—	3
Detection window length in samples	2U	—	—
Quality factor	1U	0 to 254	2

Table 27 Raw range and beam angle 78 datagram (cont'd.)

Data Description	Format	Valid range	Note
D corr	1S	—	5
Two way travel time in s	4F	—	5
Reflectivity (BS) in 0.1 dB resolution	2S	—	3
Real time cleaning info	1S	—	4
Spare	1U	—	—
End of Repeat cycle 2			
Spare (Always 0)	1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

1 0 = cw, 1 = FM up sweep, 2= FM down sweep.

2 Scaled standard deviation (sd) of the range detection divided by the detected range (dr):

Quality factor = 2500*sd/dr.

3 This datagram may contain data for beams with and without a valid detection:

A) If the most significant bit (bit7) is zero, this beam has a valid detection. Bit 0–3 is used to specify how the range for this beam is calculated.

0= Amplitude detect (0xxx 0000)

1= Phase detect (0xxx 0001)

2-15= Future use

B) If the most significant bit (bit7) is 1, this beam has an invalid detection. Bit 0–3 is used to specify how the range (and x,y,z parameters) for this beam is calculated

0= Normal detection (1xxx 0000)

1= Interpolated or extrapolated from neighbour detections (1xxx 0001)

2= Estimated (1xxx 0010)

3= Rejected candidate (1xxx 0011)

4= No detection data is available for this beam (all parameters are set to zero) (1xxx 0100)

5-15= Future use

The invalid range has been used to fill in amplitude samples in the seabed image datagram.

Bit 4 Reflectivity (used in Beam intensity display) correction for Lamberts law and for normal incidence:

0= not compensated (xxx0 xxxx) (to show beam incidence angle dependency)

1= compensated (xxx1 xxxx) (uses same correction as for seabed image data)

4 For future use. A real time data cleaning module may flag out beams. Bit 7 will be set to 1 if the beam is flagged out. Bit 0-6 will contain a code telling why the beam is flagged out.

5 The Doppler correction applied in FM mode is documented here to allow the uncorrected slant ranges to be recreated if desired. The correction is scaled by a common scaling constant for all beams and then included in the datagram using a signed 8 bit value for each beam. The uncorrected range (two-way travel time) can be reconstructed by subtracting the correction from the range in the datagram:

T(uncorrected) = T(datagram) - D(corr)/D(scale)

6 The angles are relative to the transducer array, except for ME70BO, where the angles are relative to the horizontal plane

7 Transmit sector number / TX array index parameter in the TX loop.

For EM 2040, this parameter is used to specify which of the three separate TX arrays is used for the actual sector. See appendix *EM 2040 transducer installation offsets* on page 110 for details. For other echo sounders, the parameter is a loop index (0-(Ntx-1)).

8 Transmit sector number parameter in the RX loop

This parameter is an index to the TX loop, see note 7. For use in EM 2040, see appendix *EM 2040 transducer installation offsets* on page 110 for details.

Seabed image datagram

Note

This datagram is used for EM 2000, EM 3000, EM 3002, EM 1002, EM 300 and EM 120.

Table 28 Seabed image datagram

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

Notes

1 These fields have earlier had other definitions.

2 The beam index number is the beam number -1.

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

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

Seabed image data 89

Note

Used for EM 122, EM 302, EM 710, ME70 BO, EM 2040 and EM 2040C.

Table 29 Seabed image data 89 datagram

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = Y (59h, 89d)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (Example: Sep 26, 2005 = 20050926)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Sampling frequency in Hz	4F	—	—
Range to normal incidence used to correct sample amplitudes in no. of samples	2U	1 to 16384	—
Normal incidence BS in 0.1 dB (BSN)	2S	—	—
Oblique BS in 0.1 dB (BSO)	2S	—	—
Tx beamwidth along in 0.1°	2U	1 to 300	—
TVG law crossover angle in 0.1°	2U	20 to 300	—
Number of valid beams (N)	2U	1 –	—
Repeat cycle – N entries of :	6*N	—	
Sorting direction	1S	-1 or 1	1
Detection info	1U	—	2
Number of samples per beam = Ns	2U	1 –	—
Centre sample number	2U	1 –	3
End of repeat cycle			
Repeat cycle – ΣNs entries of:	ΣNs	—	—
Sample amplitudes in 0.1 dB (Example: -30.2 dB = FED2h = 65234d)	2S	—	—
End of repeat cycle			
Spare (Always 0)	1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

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

2 This datagram may contain data for beams with and without a valid detection:

A) If the most significant bit (bit7) is zero, this beam has a valid detection. Bit 0–3 is used to specify how the range for this beam is calculated.

0= Amplitude detect (0xxx 0000)

1= Phase detect (0xxx 0001)

2-15= Future use

B) If the most significant bit (bit7) is 1, this beam has an invalid detection. Bit 0–3 is used to specify how the range (and x,y,z parameters) for this beam is calculated

0= Normal detection (1xxx 0000)

1= Interpolated or extrapolated from neighbour detections (1xxx 0001)

2= Estimated (1xxx 0010)

3= Rejected candidate (1xxx 0011)

4= No detection data is available for this beam (all parameters are set to zero) (1xxx 0100)

5-15= Future use

The invalid range has been used to fill in amplitude samples in the seabed image datagram.

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

Water column datagram

Note

Used for EM 122, EM 302, EM 710, EM 2040, EM 3002 and ME70BO.

The receiver beams are roll stabilized.

Table 30 Water column datagram

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	48 to 65535	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = k (Always 6Bh)	1U	—	—
EM model number (Example: EM 3000 = 3000)	2U	—	—
Date = year*10000 + month*100 + day (Example: Feb 26, 1995 = 19950226)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Number of datagrams	2U	1 to Nd	2
Datagram numbers	2U	1 to Nd	2
Number of transmit sectors = Ntx	2U	1 to 20	—
Total no. of receive beams	2U	1 to Nd	—
Number of beams in this datagram = Nrx	2U	1 to Nd	—
Sound speed in 0.1 m/s (SS)	2U	14000 to 16000	—
Sampling frequency in 0.01 Hz resolution (SF)	4U	1000 to 4000000	1
TX time heave (at transducer) in cm	2S	–1000 to 1000	—
TVG function applied (X)	1U	20 to 40	4
TVG offset in dB (C)	1S	—	4
Scanning info.	1U	—	7
Spare	3U	—	—
Ntx entries of :		—	
Tilt angle re TX array in 0.01°	2S	-1100 to 1100	—
Center frequency in 10 Hz	2U	1000 to 50000	—
Transmit sector number	1U	0 to 19	—
Spare	1U	—	—
Nrx entries of :			
Beam pointing angle ref vertical in 0.01°	2S	-11000 to 11000	—
Start Range sample number	2U	0 to 65534	—
Number of samples (Ns)	2U	0 to 65534	6
Detected range in samples (DR)	2U	0 to 65534	3
Transmit sector number	1U	0 to 19	—
Beam number	1U	0 to 254	5

Table 30 Water column datagram (cont'd.)

Data Description	Format	Valid range	Note
Ns entries of: Sample amplitude in 0.5 dB resolution	1S	-128 to126	—
Spare byte if required to get even length (always 0 if used)	0 – 1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

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

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

For EM 3002 the maximum number of datagrams Nd is 16 and the maximum number of beams Nb is 254. For EM 122, EM 302, EM 710, ME70BO, EM 2040 and EM 2040C this is increased to allow for up to 32 datagrams and 512 beams.

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

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

5 The 1U beam number (valid range 0-254) is redundant information and is limited to a maximum of 255 beams. For systems with more than 255 beams this parameter will be set to 255 (invalid).

6 From 01.01.2008, this number will always be an even number, due to alignments

7 Only used by EM 2040. See appendix *EM 2040 Scanning mode* on page 116 for details.

Quality factor datagram 79

Note

Used for EM 122, EM 302, EM 710, EM 2040, EM 2040C, EM 3002 and ME70BO.

Table 31 Quality factor datagram 79

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	–	
Start identifier = STX (Always 02h)	1U	–	
Type of datagram = O (4fh, 79d)	1U	–	
EM model number (Example: EM 710 = 710)	2U	–	
Date = year*10000 + month*100 + day (Example: Jan 23, 2012 = 20120123)	4U	–	
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	
Ping counter (sequential counter)	2U	0 to 65535	
System serial number	2U	100 –	
Number of receive beams = Nrx	2U	1 –	
Number of parameters per beam = Npar	1U	1 –	2
Spare	1U	–	
Repeate cycle. Nrx entries of:	4*Nrx*Npar		2
IFREMER quality factor	4F	>=0	1
(More parameters may be added in the future)			
End of repeate cycle.			
Spare (Always 0)	1U	–	
End identifier = ETX (Always 03h)	1U	–	
Check sum of data between STX and ETX	2U	–	

Notes

1 The Quality Factor is an estimate of the standard deviation of the detected depth.

$$QF = -\log\left(\frac{\mathrm{Est}\,(\partial z)}{z}\right)$$

Examples:

QF = 3.0 means an estimated standard deviation of 0.1% of the detected depth.

QF = 2.0 means an estimated standard deviation of 1.0% of the detected depth.

QF = 0 means that the Quality Factor could not be computed.

The Quality Factor is calculated by the echo sounder according to formulas provided by IFREMER.

References:

a Lurton X., Augustin J.M., "A Measurement Quality Factor for Swath Bathymetry Sounders", IEEE Journal Of Oceanic Engineering, 35 (4), pp.852-862 (2010)

b Lurton X., Ladroit Y., Augustin J.M., "A Quality Estimator of Acoustic Sounding Detection" The International Hydrographic Review, Nov.2010, vol.4, pp 35-45 (2010)

2 Currently, only one parameter is defined, i.e. Npar = 1. In the future, the datagram format may be expanded with additional parameters. Software decoding the datagram should take into account Npar when decoding the datagram. If Npar is larger than expected, additional parameters should be ignored. If Npar is smaller than expected, some parameters are not available. Note there may be data collected with preliminary echosounder software with Npar set to zero, even though there is one parameter per beam (i.e. Npar = 0 and Npar = 1 both means 1 parameter per repeat cycle). Each parameter is assumed to be 4 bytes long.

External sensors

Topics

Attitude datagram

Table 32 Attitude datagram

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

Notes

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

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

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

Network attitude velocity datagram 110

Table 33 Network attitude velocity datagram 110

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = n(etwork data) (Always 6Eh, 110d)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (Example: Feb 08, 2007 = 20070208)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Network Attitude counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	
Number of entries = N	2U	1 –	—
Sensor system descriptor	1S	—	1
Spare	1U	—	—
Repeat cycle – N entries of:	—	—	
– Time in milliseconds since record start	2U	0 to 65535	—
– Roll in 0.01°	2S	-18000 to 18000	—
– Pitch in 0.01°	2S	-18000 to 18000	—
– Heave in cm	2S	-1000 to 10000	—
– Heading in 0.01°	2U	0 to 35999	—
– Number of bytes in input datagram (Nx)	1U	1 to 254	—
– Network attitude input datagram as received	Nx x 1U	—	2
End of repeat cycle	—	—	—
Spare byte if required to get even length (always 0 if used)	0 – 1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

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

- 0x10 xxxx – attitude velocity sensor 1 (UDP5)
- 0x11 xxxx – attitude velocity sensor 2 (UDP6)
- 01xx xxxx – velocity from the sensor is active
- 0xxx xxx1 – heading from the sensor is active
- 0xxx xx0x – roll from the sensor is active
- 0xxx x0xx – pitch from the sensor is active
- 0xxx 0xxx – heave from the sensor is active
- 1111 1111 – (-1) function is not used

2 Complete input datagram. Header is kept for identification:

POS M/V:	$GRP102 or $GRP103 (ASCII)
CodaOctopus MCOM:	E8h
Seapath binary 11:	q (ASCII)
Seapath binary 23:	AAh 51h

An extra byte is added at the end of the input datagram if needed for alignment.

Clock

Table 34 Clock datagrams

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

Notes

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

Depth (pressure) or height datagram

Table 35 Depth (pressure) or height datagram

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

Notes

1 **0**: The height is derived from the GGK or GGA datagram and is the height of the water level at the vertical datum (possibly motion corrected).

Height is derived from the active position system only.

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

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

200: Input from depth sensor.

Heading

Table 36 Heading datagrams

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

Position

Table 37 Position datagrams

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

Notes

1 These data will be valid only if available as input.

The calculation is done according to the selected position input format.

See *Position* on page 9.

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

- xxxx xx01 - position system no 1
- xxxx xx10 – position system no 2
- xxxx xx11 – position system no 3
- 10xx xxxx – the position system is active, system time has been used
- 11xx xxxx - the position system is active, input datagram time has been used

- xxxx 1xxx – the position may have to be derived from the input datagram which is then in SIMRAD 90 format.

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

Single beam echo sounder depth

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

Table 38 Single beam echo sounder depth datagram

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

Notes

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

Tide datagram

Table 39 Tide datagram

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

Sound speed

Topics

Surface sound speed

Table 40 Surface sound speed datagram

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

Sound speed profile datagram

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

Table 41 Sound speed profile datagram

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

Kongsberg Maritime SSP output datagram

This datagram will contain the profile actually used in the real time raybending calculations to convert range and angle to xyz data.

Table 42 Kongsberg Maritime SSP output datagram

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

Multibeam parameters

Topics

Installation parameters

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

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

Table 43 Installation parameters

Data Description	Example	Format	Valid range	Note
Number of bytes in datagram	—	4U	—	—
Start identifier = STX	Always 02h	1U	—	—
Type of datagram = I or i(installation parameters) or r(emote information)	Start = 049h Stop = 069h Remote info = 70h	1U	—	—
EM model number	EM 3000 = 3000	2U	—	—
Date = year*10000 + month*100 + day	Feb 26, 2009 = 20090226	4U	—	—
Time since midnight in milliseconds	08:12:51.234 = 29570234	4U	0 to 86399999	—
Survey line number	—	2U	0 to 65534	—
System serial number	—	2U	100 –	24
Secondary system serial number	—	2U	100 –	24
Water line vertical location in m	WLZ=x.x,	ASCII	—	—
System main head serial number	SMH=x.x,	ASCII	100 –	1
Hull Unit	HUN=x,	ASCII	0 or 1	—
Hull Unit tilt offset	HUT=x.x,	ASCII	—	—
TX serial number	TXS=x-x,	ASCII	100 –	25
TX no. 2 serial number	T2X=x-x,	ASCII	100 –	25
RX no. 1, serial number	R1S=x-x,	ASCII	100 –	—

Table 43 Installation parameters (cont'd.)

Data Description	Example	Format	Valid range	Note
RX no. 2, serial number	R2S=x-x,	ASCII	100 –	—
System transducer configuration	STC=x,	ASCII	0– 4	26
Transducer 0 vertical location in m	S0Z=x.x,	ASCII		19
Transducer 0 along location in m	S0X=x.x,	ASCII		19
Transducer 0 athwart location in m	S0Y=x.x,	ASCII		19
Transducer 0 heading in degrees	S0H=x.x,	ASCII		19
Transducer 0 roll in degrees re horizontal	S0R=x.x,	ASCII		19
Transducer 0 pitch in degrees	S0P=x.x,	ASCII		19
Transducer 1 vertical location in m	S1Z=x.x,	ASCII	—	19
Transducer 1 along location in m	S1X=x.x,	ASCII	—	19
Transducer 1 athwart location in m	S1Y=x.x,	ASCII	—	19
Transducer 1 heading in degrees	S1H=x.x,	ASCII	—	19
Transducer 1 roll in degrees re horizontal	S1R=x.x,	ASCII	—	19
Transducer 1 pitch in degrees	S1P=x.x,	ASCII	—	19
Transducer 1 no of modules	S1N=x — x,	ASCII	—	19
Transducer 2 vertical location in m	S2Z=x.x,	ASCII	—	19
Transducer 2 along location in m	S2X=x.x,	ASCII	—	19
Transducer 2 athwart location in m	S2Y=x.x,	ASCII	—	19
Transducer 2 heading in degrees	S2H=x.x,	ASCII	—	19
Transducer 2 roll in degrees re horizontal	S2R=x.x,	ASCII	—	19
Transducer 2 pitch in degrees	S2P=x.x,	ASCII	—	19
Transducer 2 no of modules	S2N=x—x,	ASCII	—	19
Transducer 3 vertical location in m	S3Z=x.x,	ASCII	—	19
Transducer 3 along location in m	S3X=x.x,	ASCII	—	19
Transducer 3 athwart location in m	S3Y=x.x,	ASCII	—	19
Transducer 3 heading in degrees	S3H=x.x,	ASCII	—	19
Transducer 3 roll in degrees re horizontal	S3R=x.x,	ASCII	—	19
Transducer 3 pitch in degrees	S3P=x.x,	ASCII	—	19
TX array size (0=0.5º, 1=1º, 2=2º)	S1S=x,	ASCII	—	—
RX array size (1=1º, 2=2º)	S2S=x,	ASCII	—	—
System (sonar head 1) gain offset	GO1=x.x,	ASCII	—	—
Sonar head 2 gain offset	GO2=x.x,	ASCII	—	—
Outer beam offset	OBO=x.x,	ASCII	—	—
High/Low Frequency Gain Difference	FGD=x.x,	ASCII	—	—
Transmitter (sonar head no1) software version	TSV=c—c,	ASCII	—	2
Receiver (sonar head 2) software version	RSV=c—c,	ASCII	—	2
BSP software version	BSV=c—c,	ASCII	—	2
Processing unit software version	PSV=c—c,	ASCII	—	2
DDS software version	DDS=c—c,	ASCII	—	2

Table 43 Installation parameters (cont'd.)

Data Description	Example	Format	Valid range	Note
Operator station software version	OSV=c—c,	ASCII	—	2
Datagram format version	DSV=c—c,	ASCII	—	2
Depth (pressure) sensor along location in m	DSX=x.x,	ASCII	—	—
Depth (pressure) sensor athwart location in m	DSY=x.x,	ASCII	—	—
Depth (pressure) sensor vertical location in m	DSZ=x.x,	ASCII	—	—
Depth (pressure) sensor time delay in millisec	DSD=x—x,	ASCII	—	—
Depth (pressure) sensor offset	DSO=x.x,	ASCII	—	—
Depth (pressure) sensor scale factor	DSF=x.x,	ASCII	—	—
Depth (pressure) sensor heave	DSH=aa,	ASCII	IN or NI	3
Active position system number	APS=x,	ASCII	0 to 2	7
Position system 1, quality check of position, 0=off, 1=on	P1Q=x,	ASCII	0 or 1	27
Position system 1 motion compensation	P1M=x,	ASCII	0 or 1	4
Position system 1 time stamp used	P1T=x,	ASCII	0 or 1	5
Position system 1 vertical location in m	P1Z=x.x,	ASCII	—	—
Position system 1 along location in m	P1X=x.x,	ASCII	—	—
Position system 1 athwart location in m	P1Y=x.x,	ASCII	—	—
Position system 1 time delay in seconds	P1D=x.x,	ASCII	—	—
Position system 1 geodetic datum	P1G=c—c,	ASCII	—	—
Position system 2, quality check of position, 0=off, 1=on	P2Q=x,	ASCII	0 or 1	27
Position system 2 motion compensation	P2M=x,	ASCII	0 or 1	4
Position system 2 time stamp use	P2T=x,	ASCII	0 or 1	5
Position system 2 vertical location in m	P2Z=x.x,	ASCII	—	—
Position system 2 along location in m	P2X=x.x,	ASCII	—	—
Position system 2 athwart location in m	P2Y=x.x,	ASCII	—	—
Position system 2 time delay in seconds	P2D=x.x,	ASCII	—	—
Position system 2 geodetic datum	P2G=c—c,	ASCII	—	—
Position system 3, quality check of position, 0=off, 1=on	P3Q=x,	ASCII	0 or 1	27
Position system 3 motion compensation	P3M=x,	ASCII	0 or 1	4
Position system 3 time stamp use	P3T=x,	ASCII	0 or 1	5
Position system 3 vertical location in m	P3Z=x.x,	ASCII	—	
Position system 3 along location in m	P3X=x.x,	ASCII	—	
Position system 3 athwart location in m	P3Y=x.x,	ASCII	—	
Position system 3 time delay in seconds	P3D=x.x,	ASCII	—	
Position system 3 geodetic datum	P3G=c—c,	ASCII	—	
Position system 3 on serial line or Ethernet	P3S= x,	ASCII	0 for Ethernet	
Motion sensor 1 vertical location in m	MSZ=x.x,	ASCII	—	

Table 43 Installation parameters (cont'd.)

Data Description	Example	Format	Valid range	Note
Motion sensor 1 along location in m	MSX=x.x,	ASCII	—	
Motion sensor 1 athwart location in m	MSY=x.x,	ASCII	—	
Motion sensor 1 roll reference plane	MRP=aa,	ASCII	HO or RP	
Motion sensor 1 time delay in milliseconds	MSD=x—x,	ASCII	—	
Motion sensor 1 roll offset in degrees	MSR=x.x,	ASCII	—	
Motion sensor 1 pitch offset in degrees	MSP=x.x,	ASCII	—	
Motion sensor 1 heading offset in degrees	MSG=x.x,	ASCII	—	
Motion sensor 2 vertical location in m	NSZ=x.x,	ASCII	—	6
Motion sensor 2 along location in m	NSX=x.x,	ASCII	—	6
Motion sensor 2 athwart location in m	NSY=x.x,	ASCII	—	6
Motion sensor 2 roll reference plane	NRP=aa,	ASCII	HO or RP	6
Motion sensor 2 time delay in milliseconds	NSD=x—x,	ASCII	—	6
Motion sensor 2 roll offset in degrees	NSR=x.x,	ASCII	—	6
Motion sensor 2 pitch offset in degrees	NSP=x.x,	ASCII	—	6
Motion sensor 2 heading offset in degrees	NSG=x.x,	ASCII	—	6
Gyrocompass heading offset in degrees	GCG=x.x,	ASCII	—	—
Roll scaling factor	MAS=x.x,	ASCII	—	—
Transducer depth sound speed source	SHC=x,	ASCII	0 or 1	8
1PPS clock synchronization	PPS=x,	ASCII	0 to 2	20
Clock source	CLS=x,	ASCII	(0), 1 to 3	9
Clock offset in seconds	CLO=x,	ASCII		
Active attitude velocity sensor	VSN =x,	ASCII	0 – 2	10
Attitude velocity sensor 1 UDP port address (UDP5)	VSU =x–x,	ASCII	1024 – 65535	11
Attitude velocity sensor 1 Ethernet port	VSE =x,	ASCII	0 to 2	12
Attitude velocity sensor 2 UDP port address (UDP6)	VTU =x–x,	ASCII	1024 – 65535	11
Attitude velocity sensor 2 Ethernet port	VTE =x,	ASCII	0 to 2	12
Active roll/pitch sensor	ARO =x,	ASCII	2, 3, 8, or 9	22
Active heave sensor	AHE =x,	ASCII	2, 3, 8, or 9	22
Active heading sensor	AHS =x,	ASCII	0 to 9	23
Ethernet 2 address	VSI= xxx.xxx.xxx.xxx,	ASCII	—	13
Ethernet 2 IP network mask	VSM= xxx.xxx.xxx.xxx,	ASCII	—	13
Multicast sensor IP multicast address (Ethernet 2)	MCAn= xxx.xxx.xxx.xxx,	ASCII	—	15
Multicast sensor UDP port number	MCUn=x—x,	ASCII	1024 – 65535	15
Multicast sensor identifier	MCIn=aaaah,	ASCII	See PU Setup command	15
Multicast position system number	MCPn=x,	ASCII	0 – 3	16
Ships noise level	SNL =x,	ASCII	0 to 2	21
Cartographic projection	CPR=aaa,	ASCII	—	—

Table 43 Installation parameters (cont'd.)

Data Description	Example	Format	Valid range	Note
Responsible operator	ROP=c–c,	ASCII	—	—
Survey identifier	SID=c–c,	ASCII	—	—
Raw File Name	RFN=c–c	ASCII	—	17
Survey line identifier (planned line no)	PLL=x—x,	ASCII	—	Not used
Comment	COM=c–c,	ASCII	—	18
Spare byte if required to get even length	Always 0 if used	0–1U	—	—
End identifier = ETX	Always 03h	1U	—	—
Check sum of data between STX and ETX	—	2U	—	—

Notes

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

EM 3000: Serial number of the head.

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

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

4 1 = the positions are motion compensated

0 = the positions are not motion compensated

5 0 = the system has used its own time stamp for the valid time of the positions

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

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

7 Position system number -1.

8 0 = Transducer depth sound speed is used as the initial entry the sound speed profile used in the raytracing calculations.

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

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

9 (0 - not set)
1 – ZDA
2 – Active POS
3 – Operator station

10 0 – Attitude velocity sensor not used.

1 – Attitude velocity sensor 1 active.

2 – Attitude velocity sensor 2 active.

(If VSN = 0, the other VSx parameters are not relevant and need not to be sent.)

It is assumed that attitude velocity sensor 1 and motion sensor 1 is the same physical unit and share the installation parameters MSx. It is also assumed that attitude velocity sensor 2 and motion sensor 2 is the same physical unit and share the installation parameters NSx.

11 Value depends on sensor type.

12 0 – Not in use

1 – Use the existing Ethernet port used for communication to topside (SIS).

2 – Use Ethernet 2 (if available). Network address and mask are set up by VSI and VSM.

13 Ethernet 2 on the transceiver unit is configured with IP address and network mask according to VSI and VSM.

14 Not used.

15 Sensor input datagrams to be provided on given formats.

Note

Available from SIS version 3.7.

xxxx xxxx xxxx xxxx xxxx xx1x	—	NMEA GGA
xxxx xxxx xxxx xxxx xxx1 xxxx	—	NMEA ZDA
xxxx xxxx 1xxx xxxx xxxx xxxx	—	NMEA GLL
xxxx xxx1 xxxx xxxx xxxx xxxx	—	Own Ship's Data, position
xxxx xx1x xxxx xxxx xxxx xxxx	—	ROV Depth and Sound speed from Own Ship's Data
xxxx x1xx xxxx xxxx xxxx xxxx	—	Sound Velocity (SOUNDVELOCTYPROFILE_DATA)
xxxx 1xxx xxxx xxxx xxxx xxxx	—	Attitude Sagem format

16 This number indicates which position system that will arrive via this multicast.
0 – no position will be received from Multi cast, default value.
1 – position system 1
2 – position system 2
3 – position system 3

17 The RFN parameter has been reintroduced specifically for customers converting from Merlin to SIS. This parameter contains the name of the raw data file used for normal logging and for watercolumn logging (i.e. the .all and .wcd files). The RFN parameter is included in the Installation Parameters (’I’) datagram found at the start of the logged filed and in the Stop datagram (’i’) datagram found at the end of the logged file. This RFN parameter is also included in the distributed ’I’ and ’i’ datagrams.

Note

The RFN parameter contains the file name with the extension (.all or.wcd), but not the storage path.

Raw File Name convention:

`LineNo_YYYYMMDD_HHMMSS(UTC)_ShipName.all`

18 The comment field may contain any ASCII characters.

19 Transducer 1–3 (S0–S3) will have different function depending on type of echo sounder used:

Echo sounder	S0–Transducer 0	S1–Transducer 1	S2–Transducer 2	S3–Transducer 3
EM 122, EM 302, EM 710	Not used	TX transducer	RX transducer	Not used
EM 2040	Not used	TX transducer	RX transducer	Not used
EM 2040 dual RX	Not used	TX transducer	RX transducer port	RX transducer starboard
EM 2040 dual TX	TX transducer port	TX transducer starboard	RX transducer port	RX transducer starboard
EM 3002/EM 2040C	Not used	Sonar head 1	Sonar head 2	Not used
ME70BO	Transducer	Not used	Not used	Not used

The installation parameters refer to the centre of the transducer faces. For EM 2040, the physical transducer arrays are offset relative to the centre of the transducer faces. Please refer to appendix *EM 2040 transducer installation offsets* on page 110 for details.

For EM 2040C, the physical transducer arrays are offset relative to the centre of the sonar head face. Please refer to appendix *EM 2040C installation offsets* on page 118.

20 1PPS setup:

0 – not in use
1 – falling edge detect
2 – rising edge detect

21 Ships noise level to be entered under System Parameter in the Installation menu.

0 – Normal
1 – High
2 – Very high

22 Specifies input port for active sensor.

2 – COM2 (motion sensor1)
3 – COM3 (motion sensor2)
8 – UDP5 (attitude velocity sensor 1)
9 – UDP6 (attitude velocity sensor 2)

23 Specifies input port for active heading sensor.

0 – UDP2 (position system 3)
1 – COM1 (position system 1)
2 – COM2 (motion sensor 1)
3 – COM3 (motion sensor 2 or position system 2)
4 – COM4 (position system 3)
5 – Multicast 1
6 – Multicast 2
7 – Multicast 3
8 – UDP5 (attitude velocity sensor 1)
9 – UDP6 (attitude velocity sensor 2)

24 For EM 3002 Dual Head, EM 2040 Dual RX and EM 2040C Dual Head: Multibeam datagrams related to Head 1 / RX 1 (port) is labelled with "System serial number". Multibeam datagrams related to Head 2 / RX 2 (starboard) is labelled with "Secondary system serial number".

25 For an EM 2040 dual TX configuration, “TX serial number” is used for serial number for TX1 (port), while “TX no. 2 serial number” is is used for TX2 (starboard).

26 System transducer configuration parameter (STC) in the Installation datagram contains system info:

STC	Transducer configuration	Example systems
0	Single TX + single RX	EM 122, EM 302, EM 710, EM 2040 Single
1	Single Head	EM 3002 Single, EM 2040C Single, EM 2040P
2	Dual Head	EM 3002 Dual, EM 2040C Dual
3	Single TX + Dual RX	EM 2040 Dual RX
4	Dual TX + Dual RX	EM 2040 Dual TX

If present, the STC parameter can be used in decoding of the transducer installation parameters.

	S0X/Y/Z/R/P/H	S1X/Y/Z/R/P/H	S2X/Y/Z/R/P/H	S3X/Y/Z/R/P/H
STC=0	–	TX	RX	–
STC=1	–	Head	–	–
STC=2	–	Head 1	Head 2	–
STC=3	–	TX	RX 1	RX 2
STC=4	TX 1	TX 2	RX 1	RX 2

27 0 – The quality check is performed by the operator station. If there is height info in the data, height datagram will be created.
1 – The quality check is performed in the TRU/PU

Runtime parameters

Table 44 Runtime parameters

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = R(untime parameter) (Always 052h)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (at start of data record) (Example: june 26, 2009 = 20090626)	4U	—	—
Time since midnight in milliseconds (at start of data record) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter	2U	0 to 65535	—
System serial number	2U	100 –	—
Operator Station status	1U	—	1
Processing Unit status (CPU)	1U	—	1
BSP status	1U	—	1
Sonar Head or Transceiver status	1U	—	1
Mode	1U	0 –	2
Filter identifier	1U	0 to 255	3
Minimum depth in m	2U	0 to 10000	—
Maximum depth in m	2U	1 to 12000	—
Absorption coefficient in 0.01 dB/km	2U	1 to 20000	4
Transmit pulse length in μs	2U	1 to 50000	13
Transmit beamwidth in 0.1 degrees	2U	1 to 300	—
Transmit power re maximum in dB	1S	0 to – 50	—
Receive beamwidth in 0.1 degrees	1U	5 to 80	—
Receive bandwidth in 50 Hz resolution	1U	1 to 255	10
Mode 2 or Receiver fixed gain setting in dB	1U	— 0 to 50	12
TVG law crossover angle in degrees	1U	2 to 30	—
Source of sound speed at transducer	1U	0 to 3	5
Maximum port swath width in m	2U	10 to 30000	8
Beam spacing	1U	0 to 3	6
Maximum port coverage in degrees	1U	10 to 110	8
Yaw and pitch stabilization mode	1U	—	7
Maximum starboard coverage in degrees	1U	10 to 110	8
Maximum starboard swath width in m	2U	10 to 30000	8

Table 44 Runtime parameters (cont'd.)

Data Description	Format	Valid range	Note
Transmit along tilt in 0.1 deg. or Durotong speed in dm/s	2S 2U	-300 to 300 20000 to 25000	9
Filter identifier 2 or HiLo frequency absorption coefficient ratio	1U	0 to 255 0 to 120	11
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

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

Table 45 Multi beam system status

Operator Station status		
Bit number	**Function**	**Model**
xxxx xxxx	For future use	–
Processing Unit status (CPU)		
Bit number	**Function**	**Model**
xxxx xxx1	Communication error with BSP (or CBMF)	All models except ME70BO
xxxx xx1x	Communication error with Sonar Head or Transceiver	All models except EM 2040 and ME70BO
	Communication error with slave PU	EM 2040/EM 2040C
	Problem with communication with ME70	ME70BO
xxxx x1xx	Attitude not valid for this ping	All models
xxxx 1xxx	Heading not valid for this ping	All models
xxx1 xxxx	System clock has not been set since power up	All models
xx1x xxxx	External trigger signal not detected	All models except ME70BO
x1xx xxxx	CPU temperature warning	All models except EM 1002
	Hull Unit not responding	EM 1002
1xxx xxxx	Attitude velocity data not valid for this ping	EM 122, EM 302, EM 710, EM 2040, EM 2040C
BSP status EM 2000, EM 3000 and EM 3002		
Bit number	**Function**	**Model**
xxxx xxx1	Error on RX data received by BSP 1 (May be a bad high speed link)	EM 2000, EM 3000, EM 3000D, EM 3002, EM 3002D
xxxx xx1x	Too much seabed image data on BSP1	EM 3000, EM 3000D
xxxx x1xx	Invalid command received by BSP1	EM 3000, EM 3000D
xxxx 1xxx	Errors on BSP1	EM 3002, EM 3002D

Table 45 Multi beam system status (cont'd.)

xxx1 xxxx	Error on RX data received by BSP 2 (May be a bad high speed link)	EM 3000D, EM 3002D
xx1x xxxx	Too much seabed image data on BSP2	EM 3000D
x1xx xxxx	Invalid command received by BSP2	EM 3000D
1xxx xxxx	Errors on BSP2	EM 3002, EM 3002D
BSP status EM 1002		
Bit number	**Function**	**Model**
xxxx xxx1	Sample number error in RX data received from SPRX	—
BSP status EM 120 and EM 300		
xxxx xxx1	Sample number error in RX data received from SPRX	—
xxxx xx1x	Missing RX header data from SPRX	—
xxxx x1xx	Missing sample data from SPTX	—
xxxx 1xxx	Missing second RX header data from SPTX	—
xxx1 xxxx	Bad sync TRU – PU – BSP	—
xx1x xxxx	Bad parameters received from PU	—
x1xx xxxx	Internal sync problem in BSP	—
1xxx xxxx	Checksum error in header from SPTX	—
BSP status EM 122, EM 302 and EM 710		
Bit number	**Function**	**Model**
xxxx xxx1	Error on RX data received by BSP 1	—
xxxx xx1x	Error on RX data received by BSP 3	—
xxxx x1xx	Errors on BSP 3	—
xxxx 1xxx	Errors on BSP 1	—
xxx1 xxxx	Error on RX data received by BSP 2	—
xx1x xxxx	Error on RX data received by BSP 4	—
x1xx xxxx	Errors on BSP 4	—
1xxx xxxx	Errors on BSP2	—
BSP status EM 2040/EM 2040C		
Bit number	**Function**	**Model**
xxxx xxx1	Error on data from BSP 1 – master PU	—
xxxx xx1x	Error on data from BSP 2 – master PU	—
xxxx x1xx	Error on data from BSP 3 – master PU	—
xxxx 1xxx	Error on data from BSP 4 – master PU	—
xxx1 xxxx	Error on data from BSP 1 – slave PU	—
xx1x xxxx	Error on data from BSP 2 – slave PU	—
x1xx xxxx	Error on data from BSP 3 – slave PU	—
1xxx xxxx	Error on data from BSP 4 – slave PU	—
CBMF status EM 2040/EM 2040C		
xxxx xxx1	Error on data from CBMF 1 – master PU	
xxxx xx1x	Error on data from CBMF 2 – master PU	
xxxx x1xx	Error on data from CBMF 3 – slave PU	

Table 45 Multi beam system status (cont'd.)

xxxx 1xxx	Error on data from CBMF 4 – slave PU	
Sonar Head status EM 2000, EM 3000 and EM 3002		
Bit number	**Function**	**Model**
xxxx xxx1	Temperature to high on Sonar Head 1	EM 2000, EM 3000, EM 3000D, EM 3002, EM 3002D
xxxx xx1x	Data link failure on Sonar Head 1	EM 2000, EM 3000, EM 3000D, EM 3002, EM 3002D
xxxx x1xx	DC Supply Voltages in Sonar Head 1 is out of range	EM 2000, EM 3000, EM 3000D, EM 3002, EM 3002D
xxxx 1xxx	Spare	—
xxx1 xxxx	Temperature to high on Sonar Head 2	EM 3000D, EM 3002D
xx1x xxxx	Data link failure on Sonar Head 2	EM 3000D, EM 3002D
x1xx xxxx	DC Supply Voltages in Sonar Head 2 is out of range	EM 3000D, EM 3002D
1xxx xxxx	Spare	—
Transceiver status EM 120 and EM 300		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit voltage (HV) out of range	—
xxxx xx1x	Low voltage power out of range	—
xxxx x1xx	Timeout error (SPRX waits for SPTX)	—
xxxx 1xxx	Receive channel DC offset(s) out of range	—
xxx1 xxxx	Illegal parameter received from PU	—
xx1x xxxx	Internal communication error (SPTX – SPRX sync)	—
x1xx xxxx	Timeout error (SPTX waits for SPRX)	—
1xxx xxxx	Defective fuse(s) in transmitter	—
Transceiver status EM 122, EM 302 and EM 710		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit voltage (HV) out of range	—
xxxx xx1x	Low voltage power out of range	—
xxxx x1xx	Error on Transmitter	—
xxxx 1xxx	Error on Receiver	—
xxx1 xxxx	Not implemented	—
xx1x xxxx	Not implemented	—
x1xx xxxx	Not implemented	—
1xxx xxxx	Not implemented	—
Transceiver status EM 1002		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit voltage (HV) out of range	—
xxxx xx1x	Low voltage power out of range	—

Table 45 Multi beam system status (cont'd.)

xxxx x1xx	Transmit voltage (HV) to high	—
xxxx 1xxx	Error in command from PU (Illegal parameter)	—
xxx1 xxxx	Error in command from PU (Bad checksum)	—
xx1x xxxx	Error in command from PU (Bad datagram length)	—
Transceiver status EM 2040		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit power (HV) out of range	—
xxxx xx1x	Communication error with TX	—
xxxx x1xx	Communication error with RX 1 (port)	—
xxxx 1xxx	Communication error with RX 2 (starboard)	—
xxx1 xxxx	Communication error with IO2040 – master PU	—
xx1x xxxx	Communication error with IO2040 – slave PU	—
x1xx xxxx	Spare	—
1xxx xxxx	Spare	—
Sonar Head status EM 2040C		
Bit number	**Function**	**Model**
xxxx xxx1	Transmit power (HV) out of range SH1	—
xxxx xx1x	Communication error with TX SH1	—
xxxx x1xx	Communication error with RX SH1	—
xxxx 1xxx	Temperature to high SH1	—
xxx1 xxxx	Transmit power (HV) out of range SH2	—
xx1x xxxx	Communication error with TX SH2	—
x1xx xxxx	Communication error with RX SH2	—
1xxx xxxx	Temperature to high SH2	—

2 *Mode*

Ping mode (EM 3000)

- xxxx 0000 - Nearfield (4º)
- xxxx 0001 - Normal (1.5º)
- xxxx 0010 - Target detect

Ping mode (EM 3002)

- xxxx 0000 - Wide Tx beamwidth (4°)
- xxxx 0001 - Normal Tx beamwidth (1.5°)

Ping mode (EM 2000, EM 710, EM 1002, EM 300, EM 302, EM 120 and EM 122)

- xxxx 0000 - Very Shallow
- xxxx 0001 - Shallow
- xxxx 0010 - Medium
- xxxx 0011 - Deep
- xxxx 0100 - Very deep

- xxxx 0101 - Extra deep

Ping mode (EM 2040)

- xxxx 0000 - 200 kHz
- xxxx 0001 - 300 kHz
- xxxx 0010 - 400 kHz

TX pulse form (EM 2040, EM 710, EM 302 and EM 122)

- xx00 xxxx - CW
- xx01 xxxx - Mixed
- xx10 xxxx - FM

Frequency (EM 2040C)

Frequency = 180 kHz + 10 kHz * parameter

Examples:

- xxx0 0000 - 180 kHz
- xxx0 0001- 190 kHz
- xxx1 0110 - 400 kHz

TX pulse form (EM 2040C)

- xx0x xxxx - CW
- xx1x xxxx - FM

Dual Swath mode (EM 2040, EM 710, EM 302 and EM 122)

- 00xx xxxx - Dual swath = Off
- 01xx xxxx - Dual swath = Fixed
- 10xx xxxx - Dual swath = Dynamic

3 *The filter identifier byte is used as follows:*

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

4 The used absorption coefficient should be derived from raw range and angle 78 datagram or, for older systems, from the seabed image or central beams echogram datagram if it is automatically updated with changing depth or frequency.

This absorption coefficient in this datagram is valid at the following frequency

- EM 120/EM 122: 12 kHz
- EM 300/EM 302: 31.5 kHz
- EM 710: 85 kHz
- ME70BO: 85 kHz
- EM 1002: 95 kHz
- EM 2000: 200 kHz
- EM 3000/EM 3002: 300 kHz
- EM 2040/EM 2040C: 300 kHz

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

- 0000 0000 - From real time sensor
- 0000 0001 - Manually entered by operator
- 0000 0010 - Interpolated from currently used sound speed profile
- 0000 0011 - Calculated by ME70BO TRU
- xxx1 xxxx - Extra detections enabled
- xx1x xxxx - Sonar mode enabled
- x1xx xxxx - Passive mode enabled
- 1xxx xxxx – 3D scanning enabled

6 *The beamspacing identifier is used as follows:*

- 0000 0000 - Determined by beamwidth (FFT beamformer of EM 3000)
- 0000 0001 - Equidistant (Inbetween for EM 122 and EM 302)
- 0000 0010 - Equiangle
- 0000 0011 - High density equidistant (In between for EM 2000, EM 120, EM 300, EM 1002)

EM 3002:

	bit 7	bit 6 – 4; head 2	bit 3 – 0; head 1
Only one sonar head is connected. If two heads are connected, both have the same beam spacing.	0	0 = always (no head 2)	1 = equidistant 2 = equiangle 3 = high density
Two sonar heads are connected. Individual beam spacing is possible.	1	1 = equidistant 2 = equiangle 3 = high density	1 = equidistant 2 = equiangle 3 = high density

7 *The yaw and pitch stabilization identifier is set as follows:*

- xxxx xx00 - No yaw stabilization
- xxxx xx01 - Yaw stabilization to survey line heading (Not used)
- xxxx xx10 - Yaw stabilization to mean vessel heading

- xxxx xx11 - Yaw stabilization to manually entered heading
- xxxx 00xx - Heading filter, hard
- xxxx 01xx - Heading filter, medium
- xxxx 10xx - Heading filter, weak
- 1xxx xxxx - Pitch stabilization is on.

8 Port swath width and coverage was in earlier versions the sum of port and starboard

9 *EM 3002, EM 2040, EM 3000, EM 710, EM 302, and EM 122:*

Transmit along tilt value, used to offset the along-ship tilting of transmit fan (called “Along Direction” in SIS and can be set from the Runtime parameters – Sounder Main menu).

EM 1002:

Sound speed in Durotong (SSD) for the EM 1002 transducer. This value (set to zero if not available) depends on the water temperature. SSD can be used to calculate the water temperature in degree C:

- Temp = -0.013913*SSD+313.565

10 Receiver bandwidth values 1 to 254 for receiver bandwidth 50 Hz to 12.7 kHz. A value of 255 indicates bandwidth larger than 12.7 kHz.

11 *Filter identifier 2 or HiLo frequency absorption coeff:*

Penetration filter (EM 2040, EM 710, EM 302 and EM 122)

- xxxx xx00 - Penetration filter = Off
- xxxx xx01 - Penetration filter = Weak
- xxxx xx10 - Penetration filter = Medium
- xxxx xx11 - Penetration filter = Strong

Detect mode (EM 3002 and EM 2040)

- xxxx 00xx - Detect mode: Normal
- xxxx 01xx - Detect mode: Waterway
- xxxx 10xx - Detect mode: Tracking
- xxxx 11xx - Detected mode: Minimum depth

Phase ramp (EM 2040, EM 3002, EM 710, EM 302 and EM 122)

- xx00 xxxx - Short phase ramp
- xx01 xxxx - Normal phase ramp
- xx10 xxxx - Long phase ramp

Special TVG (EM 3002 and EM 2040)

- x0xx xxxx - Normal TVG
- x1xx xxxx - Special TVG

Special amp detect / soft sediments

- 0xxx xxxx - Normal amp detect
- 1xxx xxxx - Special amp detect or soft sediments (EM 3002)

HiLo frequency absorption coefficient ratio (EM 1002)

0 – 120

12 *Mode 2 or RX fixed gain*

RX array use (EM 2040)

- xxxx xx00 - Off (RX inactive)
- xxxx xx01 - RX 1 (port) active
- xxxx xx10 - RX 2 (starboard) active
- xxxx xx11 - Both RX units active

Sonar head use (EM 2040C)

- xxxx xx00 - Off (Both inactive)
- xxxx xx01 - SH 1 (port) active
- xxxx xx10 - SH 2 (starboard) active
- xxxx xx11 - Both active

Pulselength (EM 2040)

- xxxx 00xx - Short CW
- xxxx 01xx - Medium CW
- xxxx 10xx - Long CW
- xxxx 11xx - FM

Pulselength (EM 2040C)

- x000 xxxx - Very Short CW
- x001 xxxx - Short CW
- x010 xxxx - Medium CW
- x011 xxxx - Long CW
- x100 xxxx - Very Long CW
- x101 xxxx - Extra Long CW
- x110 xxxx - Short FM
- x111 xxxx - Long FM

Receiver fixed gain setting in dB (EM 2000, EM 1002, EM 3000, EM 3002, EM 300, EM 120)

13 *Transmit pulse length*

The transmit pulse length may not be the same for all TX sectors, and the pulsforms may vary. The pulselength given here is 1/(transmit bandwidth) for the centre sector. FM pulse: 1/sweep bandwidth. The total TX pulselength for each sector can be found in the range and angle datagram.

Mechanical transducer tilt

Table 46 Mechanical transducer tilt datagrams

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = J (Always 4Ah)	1U	—	—
EM model number (Example: EM 1002 = 1002)	2U	—	—
Date = year*10000 + month*100 + day (at start of data record) (Example: Feb 26, 1995 = 19950226)	4U	—	—
Time since midnight in milliseconds (at start of data record) (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Tilt counter (sequential counter)	2U	0 to 65535	—
System serial number	2U	100 –	—
Number of entries = N	2U	1 –	—
Repeat cycle – N entries of:	4*N	—	
– Time in milliseconds since record start	2U	0 to 65534	—
– Tilt in 0.01 degrees	2S	-1499 to +1499	1
End of repeat cycle			
Spare (Always zero)	1U	—	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

1 This tilt angle is the measured mechanical tilt of a hull unit such as that often supplied with the EM 1002. It is positive when the transducer is tilted forwards.

ExtraParameters datagram

This datagram is used to give supplementary information, and contains information as specified by the Content identifier.

Table 47 ExtraParameters 3

Data Description	Format	Valid range	Note
Number of bytes in datagram	4U	—	—
Start identifier = STX (Always 02h)	1U	—	—
Type of datagram = 3 (33h, 51d)	1U	—	—
EM model number (Example: EM 710 = 710)	2U	—	—
Date = year*10000 + month*100 + day (Example: Sep 26, 2005 = 20050926)	4U	—	—
Time since midnight in milliseconds (Example: 08:12:51.234 = 29570234)	4U	0 to 86399999	—
Ping counter (sequential counter)	2U	0 to 65535	—
System serial number	2U		—
Content identifier	2U		1
Array of variable length	variable		2
Spare byte if required to get even length (Always 0)	0 – 1U	—	
Spare (always 0)	1U	0	—
End identifier = ETX (Always 03h)	1U	—	—
Check sum of data between STX and ETX	2U	—	—

Notes

1 Content identifier.

Ident.	Information contents
1	Calib.txt file for angle offset
2	Log all heights
3	Sound velocity at transducer
4	Sound velocity profile
5	Multicast RX status
6	Bscorr.txt file for back scatter corrections.

2 Array of variable length. This array is described for each content identifier.

Content identifier = 1: The Calib.txt file

The ‘Array of variable length’ contains a text field of 100 characters, containing the file name “calib.txt”. Thereafter, the contents of the file follows.

File layout

The angular correction table is made with 1 degree step, from 100 degrees port to 100 degrees starboard (201 elements). The angular offset in this file has been added to the beam angles in the raw range and angle datagram.

File	Comment
EM 300	Name of echo sounder
Line1	For comments
Line2	— ″ —
Line3	— ″ —
Line4	— ″ —
Line5	— ″ —
100 0.0 x.x	Info BS offset Angle offset
......	
-100 0.0 x.x	

Content identifier = 2: Log all heights

This datagram configuration is used for logging parameter settings related to the definition of additional approved position quality factors. Each of the three positioning systems available in the PUs has a set of parameters.

The ‘Array of variable length’ is used as follows:

Data Description	Format	Valid range	Note
Active positioning system	4S	0 – 2	
Quality factor setting for pos. system 1, 2, 3.	3 *4S	1=PU decodes Q-factor. Default 0=External PU decode	1
Number of quality factors for pos. system 1, 2, 3	3 *4S	0 – n	2
Variable no of entries follows = total number of all quality factors:			**3**
Quality factor	4S	0 – m	4
Limit	4S	0 cm default = not used	5

Notes

1 Each positioning system has its own individual setting.
Value ‘1’ indicates that the PU should decode the quality factors in the traditional way. This is the default.
Value ‘0’ indicates that the PU should skip quality factor decoding as this is performed externally. The PU should always transmit the height datagram ‘h’.

2 Each positioning system have an independent set of additional quality factors. The number of quality factors for each system must be specified. Default value is 0.

3 Each quality factor is described by two entries, the quality factor itself and a limit, forming a pair. This results in a variable number of such pairs, depending on how many additional quality factors is set by the operator. If no quality factors are defined, no pairs are included. The sequence of pairs is important. First, all pairs for positioning system 1 is listed, if any. Next any pairs for positioning system 2 and at the end, any pairs for positioning system 3.

4 A quality factor is a positive number. Currently no upper limit is imposed.

5 Uncertainty in position fix in cm. This uncertainty is associated with the quality factor value. Currently not used.

Content identifier = 3: Sound velocity at transducer

The array of variable length will contain the received datagram containing the sound velocity at transducer.

Table 48 Current sound velocity

Data Description	Format	Valid range	Note
Spare	2U	0 if unused	
Sound velocity	4F	m/s	—

Content identifier = 4: Sound velocity profile

The array of variable length will contain the received datagram containing the sound velocity profile.

Table 49 SOUNDSPEEDPROFILE_DATA

Name	Type	Data Description
Spare	2U	0 if unused
header		
header, messageID	int32	unique message ID across the PSS-CSI2 interface
header, time, seconds	int32	Seconds since 1970-01-01 00:00:00 UTC
header, time, microSeconds	int32	Microseconds
header, size	int32	the size in bytes of the entire message (including header)
header, sourceID	int32	the ID of the component sending the message.
header, destinationID	int32	the ID of the component receiving the message.
sequenceNumber	int32	A number incremented for each transmission of this message.
The current sound speed including depth		
soundSpeedPoint, depth	real32	Depth in meters
soundSpeedPoint, speed	real32	Sound speed in m/s.
The current temperature including depth		
TemperaturePoint, depth	real32	Depth in meters
TemperaturePoint, temperature	real32	Temperature in degrees Celsius
The time the official SSP was recorded.		
time, seconds	int32	Seconds since 1970-01-01 00:00:00 UTC
time, microSeconds	int32	Microseconds
numberOfPointsInOfficialSSP	int32	The number of elements in the ‘officialSSP’ array.

Table 49 SOUNDSPEEDPROFILE_DATA (cont'd.)

Name	Type	Data Description
Repeat cycle - N entries of SSP:	**12*N**	**Array containing the official sound speed points sorted with ascending depth order.**
soundSpeedPoint, depth	real32	Depth in meters
soundSpeedPoint, speed	real32	Sound speed in m/s.
End of repeat cycle		
The time the official TP was recorded.		
time, seconds	int32	Seconds since 1970-01-01 00:00:00 UTC
time, microSeconds	int32	Microseconds
numberOfPointsInOfficialTP	int32	The number of elements in the 'officialTP' array.
Repeat cycle - N entries of TP:	**12*N**	**Array containing the official temperature points sorted with ascending depth order.**
TemperaturePoint, depth	real32	Depth in meters
TemperaturePoint, temperature	real32	Temperature in degrees Celsius
End of repeat cycle		

Table 50 Common data types

Basic data types	Size (bytes)	Description
int32	4	32-bit signed integer (two's complement)
real32	4	32-bit floating point (IEEE 754)

Content identifier = 5: Multicast input status

The array of variable length will contain the status of received data via multicast.

Table 51 Multicast input status

Name	Type	Data Description
Multicast 1 status	4U	1) used for position system 1
Multicast 2 status	4U	1) used for position system 1
Multicast 3 status	4U	1) used for position system 1
Multicast 4 status	4U	1) used for sound velocity profile
Multicast 5 status	4U	1)
Multicast 6 status	4U	1)
Multicast 7 status	4U	1)
Multicast 8 status	4U	1)
Multicast 9 status	4U	1)
Multicast 10 status	4U	1)

Notes

1 The sensor input status is coded in accordance with that given in the PU Setup datagram, but indicates which sensor datagram types are actually being received on the respective ports.

Content identifier = 6: Bscorr.txt file

In order to calibrate real-time back scatter levels, correction values may be incorporated in a file called bscorr.txt and downloaded to the TRU (or PU). The contents of this file will be stored in the *.all files using the Extra Parameters datagram.

The exact format of the file may vary from echo sounder to echo sounder. Please refer to the documentation for the specific echo sounder for further details.

In this case, "Array of variable length" has the following format:

Data description	Format	Valid range
Nc = Number of bytes in text string	2U	–
Text string containing contents of bscorr.txt file	1*Nc	–

PU information and status

Topics

PU ID output

The PU Id datagram is broadcasted every second after the PU is powered up, until a host processor takes command of the Processing Unit through a PU0 datagram. The PU0 datagram may however order the broadcast of this datagram to continue. The broadcast is sent to Ethernet adress 157:237:255:255 on Port 1999. The broadcast will resume if the host processor sends a P00 datagram which releases its control of the PU.

Table 52 PU Id output datagrams

Data Description	Example	Format	Valid range	Note
Start identifier = STX	Always 02h	1U	—	—
Type of datagram = 0	Always 30h	1U	—	—
EM model number	1002	2U	—	1)
Date = year*10000 + month*100 + day	Feb 26, 1995 = 19950226	4U	—	2)
Time since midnight in milliseconds	08:12:51.234 = 29570234	4U	0 to 86399999	2)
Byte order flag	Always 1	2U	—	3)
System serial number	—	2U	100 –	—
UDP port no 1	—	2U		4)
UDP port no 2	—	2U	—	4)
UDP port no 3	—	2U	—	4)
UDP port no 4	—	2U	—	4)
System descriptor	—	4U	—	5)
PU software version	—	16U	ASCII string	6)
BSP software version	—	16U	ASCII string	6)
Sonar Head/Transceiver software version	Sonar head 1 software version	16U	ASCII string	6)
Sonar Head/Transceiver software version	Sonar head 2 software version	16U	ASCII string	6)
Host IP address	—	4U	—	7)
TX Opening angle	0	1U	0, 1, 2 or 4	8)
RX Opening angle	1	1U	1, 2 or 4	9)
Spare	0 if not used	6U	—	
Spare	0 if not used	1U	—	
End identifier = ETX	Always 03h	1U	—	
Check sum of data between STX and ETX		2U	—	

Notes

1 “1002” must be replaced with the name of the system. 1002 is for EM 1002, 120 for EM 120, 300 for EM 300, 710 for EM 710, 2000 for EM 2000, 3000 for EM 3000, 3020 for EM 3002, 302 for EM 302, 122 for EM 122, 121 for EM 121A, 850 for ME70BO, 2040 for EM 2040, 2045 for EM 2040C.

The EM model number and checksum are required.

2 The system time and date will start at 0 on power up, i.e. the host processor must always set the clock in its first setup command.

3 The byte order of the whole datagram is indicated by this flag.

4 Datagrams are to be sent to the different PU UDP ports as follows (in addition to use of PU serial ports):

- Port 1: Command datagrams
- Port 2: Sensor datagrams except motion sensor
- Port 3: First motion sensor
- Port 4: Second motion sensor

5 System descriptor. (Information for internal use) :

00 xx xx xxh – Old CPU card

01 xx xx xxh – VIPer or CoolMonster

02 xx xx xxh – CT7

03 xx xx xxh – Kontron

04 xx xx xxh – Kontron and BSP67B for EM 710

05 xx xx xxh – Concurrent Technologies PP432

06 xx xx xxh – EM2000 AUV

07 xx xx xxh – Concurrent Technologies PP 833

For EM 122, EM 302, EM 710, EM 2040 and EM 2040C (One bit per function, 8 LSB shown):

xxxx xxx0b – Single RX / Single Head

xxxx xxx1b – Dual RX / Dual Head

xxxx xx0xb – Single swath

xxxx xx1xb – Dual swath

xxxx x0xxb – BSP 67B

xxxx x1xxb – CBMF

xxxx 1xxxb – PTP (IEEE 1588 clock sync) supported

xxx0 xxxxb – Deep water sonar head

xxx1 xxxxb – Shallow water sonar head

xx1x xxxxb – Extra detections supported

x1xx xxxxb – RS 422 serial lines supported

Two bits used to indicate EM 2040 model:

0 0xxx xxxxb EM 2040 Normal

0 1xxx xxxxb EM 2040 Dual TX (2*TX and 2*RX)

1 0xxx xxxxb spare

1 1xxx xxxxb EM 2040P

Old sounders (hex format):

xx xx xx 01h – EM 1002S

xx xx xx 02h – EM 952

xx xx xx 03h – EM 1002: with Hull Unit

xx xx xx 04h – EM 1002S: with Hull Unit

xx xx xx 05h – EM 952: with Hull Unit

xx xx xx 08h – EM 3001

xx xx xx 09h – EM 3002 long pulse available

xx xx x1 xxh – EM 3002 Rx gain not available

6 The first two elements, PU software version and BSP software version, are the same for all echo sounders. The last two will vary, depending on which echo sounder you have:

EM 120 / EM 300: SPRX software version and SPTX software version.

EM 710 / EM 302 / EM 122: RX32 software version and TX36 software version.

EM 1002: SPRX software version and Hull Unit software version.

EM 2000: Sonar Head software version on the third element and number four is empty.

EM 2040 / EM 2040C: RX and TX software version

EM 3000 / EM 3002: Sonar Head 1 software version and Sonar Head 2 software version.

7 This is the address derived from the source of the first PU0 datagram, it is 0.0.0.0 if the PU is not controlled by a host processor.

8 TX Opening angle:

0 = 0.5 degrees, valid for EM 122, EM 302 and EM 710.

1 = 1 degree, valid for EM 122, EM 302 and EM 710.

2 = 2 degrees, valid for EM 122, EM 302 and EM 710.

4 = 4 degrees, valid for EM 122 and EM 302.

9 RX Opening angle:

1 = 1 degree, valid for EM 122, EM 302 and EM 710.

2 = 2 degrees, valid for EM 122, EM 302 and EM 710.

4 = 4 degrees, valid for EM 122 and EM 302.

PU Status output

The PU Status datagram is sent out every second if requested by the host processor. It has two functions, to indicate that the system is alive and receiving sensor data, and to give sensor data regularly for a potential screen update.

Table 53 PU Status output

Data Description	Example	Format	Valid range	Note
Start identifier = STX	Always 02h	1U	—	—
Type of datagram = 1	Always 31h	1U	—	—
EM model number	1002	2U	—	1)
Date = year*10000 + month*100 + day	Feb 26, 1995 = 19950226	4U	—	—
Time since midnight in milliseconds	08:12:51.234 = 29570234	4U	0 – 86399999	—
Status datagram counter	—	2U	0 – 65535	—
System serial number	—	2U	100 –	—
Ping rate in centiHz	—	2U	0 – 3000	—
Ping counter of latest ping	—	2U	0 – 65535	—
Distance between swath in 10%	10	4U	0 – 255	2)
Sensor input status, UDP port 2	—	4U	—	3)
Sensor input status, serial port 1	—	4U	—	3)
Sensor input status, serial port 2	—	4U	—	3)
Sensor input status, serial port 3	—	4U	—	3)
Sensor input status, serial port 4	—	4U	—	3)
PPS status	—	1S	—	4)
Position status	—	1S	—	4)
Attitude status	—	1S	—	4)
Clock status	—	1S	—	4)
Heading status	—	1S	—	4)
PU status	—	1U	—	11)
Last received heading in 0.01°	—	2U	0 – 35999	5)
Last received roll in 0.01°	—	2S	-18000 – 18000	5)
Last received pitch in 0.01°	—	2S	-18000 – 18000	5)
Last received heave at sonar head in cm	—	2S	-999 – 999	5)
Sound speed at transducer dm/s	—	2U	14000 – 16000	6)
Last received depth in cm	—	4U	0 –	5)
Along-ship velocity in 0.01 m/s	—	2S	—	—
Attitude velocity sensor status	0x81	1U	—	12)
Mammal protection ramp	—	1U	—	13)
Backscatter at Oblique angle in dB	-30	1S	—	7)
Backscatter at normal incidence in dB	-20	1S	—	7)
Fixed gain in dB	18	1S	—	7)

Table 53 PU Status output (cont'd.)

Data Description	Example	Format	Valid range	Note
Depth to normal incidence in m	27	1U	—	7), 8)
Range to normal incidence in m	289	2U	—	7), 9)
Port Coverage in degrees	—	1U	—	7), 9)
Starboard Coverage in degrees	—	1U	—	7), 9)
Sound speed at transducer found from profile in dm/s	—	2U	14000 – 16000	9)
Yaw stabilization angle or tilt used at 3D scanning, in centideg.	—	2S	—	9)
Port Coverage in degrees or Across-ship velocity in 0.01 m/s	—	2S	—	10)
Starboard Coverage in degrees or Downward velocity in 0.01 m/s	—	2S	—	10)
EM2040 CPU temp in °C	0 if not used	1S	—	—
End identifier = ETX	Always 03h	1U	—	—
Check sum of data between STX and ETX	—	2U	—	—

Notes

1 "1002" must be replaced with the name of the system: 1002 is for EM 1002, 120 for EM 120, 300 for EM 300, 710 for EM 710, 2000 for EM 2000, 3000 for EM 3000, 3020 for EM 3002, 302 for EM 302, 122 for EM 122, 121 for EM 121A, 850 for ME70BO, 2040 for EM 2040, 2045 for EM 2040C.

The EM model number and checksum are required.

2 Achieved swath distance in percent of required swath distance. The value is shown in 10% steps, and the range is 0 – 255. 0 indicates that the function is not used. 10 indicates 100% (achieved swath distance equals required swath distance).

3 The sensor input status is coded in accordance with that given in the PU Setup datagram, but indicates which sensor datagram types are actually being received on the respective ports.

4 0 or a negative number indicates that the quality of the data received is not acceptable, positive OK.

5 These values are all from sensor input (active motion sensor or depth sensor).

6 Not implemented on release 5.1u25 or older.

7 Automatic tracking info used by the echo sounder.

8 Spare except for releases made before January 2004 (EM 3000, EM 2000).

9 Not included for releases made before January 2004 (EM 3000, EM 2000).

10 For EM 3002: From January 2005 used for port and starboard coverage.

EM 710, EM 302, EM 122: Across and downward velocity

Other sounders: Spare

11 0 = off

1 = active

2 = simulator

10 = ME70BO TRU – disconnected

11 = ME70BO TRU – mode change

12 The two most significant bit (MSB) indicates sensor status:

00xx xxxx = no data received

10xx xxxx = data received from attitude velocity system 1

01xx xxxx = data received from attitude velocity system 2

11xx xxxx = data received from both attitude velocity systems

The six least significant bits (LSB) are used to indicate sensor input datagram type:

xx00 0000 = velocity attitude sensor not connected

xx00 0001 = Seatex binary format 11 / binary format 23

xx00 0010 = Applanix Group 102/103

xx00 0011 = CodaOctopus MCOM

(List may be expanded in the future to include more sensor types.)

13 Mammal protection: High voltage power supply remaining ramp up time in %.

PU BIST result output

The PU BIST (built in self test) result datagram is sent out as a result of a BIST command. The test result is given as an ASCII string plus a status value. For a dual EM 3000 / EM 3002 and BIST # 99 (used for startup), two datagrams are used, one for each head.

Table 54 PU BIST result output

Data Description	Example	Format	Valid range	Note
Start identifier = STX	Always 02h	1U	—	—
Type of datagram = B	Always 42h	1U	—	—
EM model number	1002	2U	—	1)
Date = year*10000 + month*100 + day	Feb 26, 1995 = 19950226	4U	—	—
Time since midnight in milliseconds	08:12:51.234 = 29570234	4U	0 to 86399999	—
BIST result counter (sequential counter)	—	2U	0 – 65535	—
System serial number	—	2U	100 –	—
Test number	—	2U	—	—
Test result status	—	2S	—	2)
Test result description, terminated with “/0”, total length is variable (max = 5000)	—	NU	ASCII string	3)
Spare byte if required to get even length	Always 0 if used	0–1U	—	—
End identifier = ETX	Always 03h	1U	—	—
Check sum of data between STX and ETX	—	2U	—	—

Notes

1 “1002” must be replaced with the name of the system.

1002 is for EM 1002, 120 for EM 120, 300 for EM 300, 710 for EM 710, 2000 for EM 2000, 3000 for EM 3000, 3020 for EM 3002, 302 for EM 302, 122 for EM 122, 121 for EM 121A, 850 for ME70BO, 2040 for EM 2040 and 2045 for EM 2040C.

The EM model number and checksum are required.

2 A negative number or zero indicates an error, 1 that result is OK and test is finished, while 2 indicates that result so far is OK, but the test is not finished.

The test result status interpretation is special for EM 1002 in some cases:

When ’Test number’ is 15:

0 = error

1 = OK (no hull unit)

2 = OK (hull unit error)

3 = OK (hull unit OK)

When ’Test number’ is 99:

-2 = OK (hull unit error/missing)

0 = error

1 = OK

3 The text will always start with an identifying mnemonic.

SIS generated output

Topics

APB Datagram

APB Autopilot sentence according to NMEA 0183 version 2.3.

Table 55 APB output datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Always KM	—	—
Sentence formatter	Always APB,	—	—
Status	Always A,	—	—
Status	Always A,	—	—
Magnitude of XTE (cross track error)	x.x,	—	—
Direction to steer	a,	L or R	—
XTE units (nautical miles	Always N,	—	—
Status 1	a,	A or empty	—
Status 2	a,	A or empty	—
Bearing origin to waypoint	x.x,	0.0 to 359.9	—
Bearing type	a,	M or T	—
Destination waypoint ID	Always wid,	—	—
Bearing, present position to destination	x.x,	0.0 to 359.9	—
Bearing type	a,	M or T	—
Heading to steer to destination waypoint	x.x	0.0 to 359.9	—
Bearing type	a,	M or T	—
Mode indicator	Always A,	—	1
Checksum	*hh	—	—
End if sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

Notes

1 Field does not exist if the system is configured to use NMEA version prior to 2.30

DPT Datagram

DPT sentence according to NMEA 0183 version 2.3 contains depth relative to the transducer and offset from transducer.

Table 56 DPT output datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Ka	KA to KJ	1
Sentence formatter	Always DPT,	—	—
Water depth relative to transducer, meters	x.x,	0 to 12,000	—
Offset from transducer, meters	x.x,	—	—
Maximum range scale in use	Always 12000.0	—	—
Checksum	*hh	—	—
End if sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

RTE Datagram

The RTE routes datagram is part of the DynPos datagram set. Two datagrams are sent when DynPos output is enabled and a planned line is activated

Table 57 RTE output datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Always KM	—	—
Sentence formatter	Always RTE,	—	—

WPL Datagram

This datagram is part of the DynPos datagram set. Two datagrams are sent when DynPos output is enabled and a planned line is activated

The WPL datagram contains the coordinates of the activated line. One datagram is sent for each point on the line.

Table 58 WPL output datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Always KM	—	—
Sentence formatter	Always WPL,	—	—
Waypoint latitude	llll.ll,	—	—
Latitude — N/S	a,	N or S	—
Waypoint longitude	yyyyy.yy,	—	—
Longitude — E/W	a,	E or W	—
Waypoint ID	c—c		

KSSIS 31 Datagram

Datagram from SIS HWS sent to external applications containing a combined set of information per ping.

Table 59 KSSIS 31 output datagram

Data Description	Format	Valid Range	Note
Start identifier = $	Always 24h	—	—
Talker identifier	Always KS	—	—
Sentence formatter	Always SIS,	—	—
Datagram ID	Always 31,	—	—
Model number	x,	—	—
Serial number	x,	—	—
Beams sent	x,	—	—
Beams received	x,	—	—
Depth from surface to seafloor(cm)	x.x,	—	—
Depth from surface to transducer (cm)	x.x,	—	—
Across distance (cm)	x.x,	—	—
Across distance, port (cm)	x.x,	—	—
Across distance, starboard (cm)	x.x,	—	1
Last tide (m)	x.x,	—	—
Last geoid undulation (m)	x.x,	—	—
Last distance from the geoid to the vertical reference (m)	x.x,	—	—
Minimum depth in swath (cm)	x.x,	—	—
Maximum depth in swath (cm)	x.x,	—	—
End if sentence delimiter = CRLF	Always 0Dh 0Ah	—	—

Notes

1 0 if the total across is to the opposite side

Appendix A
EM 2040 details

EM 2040 transducer installation offsets

For most EM type echo sounders, all elements in the TX and RX transducer arrays are used for all beams, giving a common x,y,z location for each transducer. But for the EM 2040 this is different. The TX transducer has 3 separate arrays, used for port, centre and starboard sectors, and the RX array has an along-ship offset.

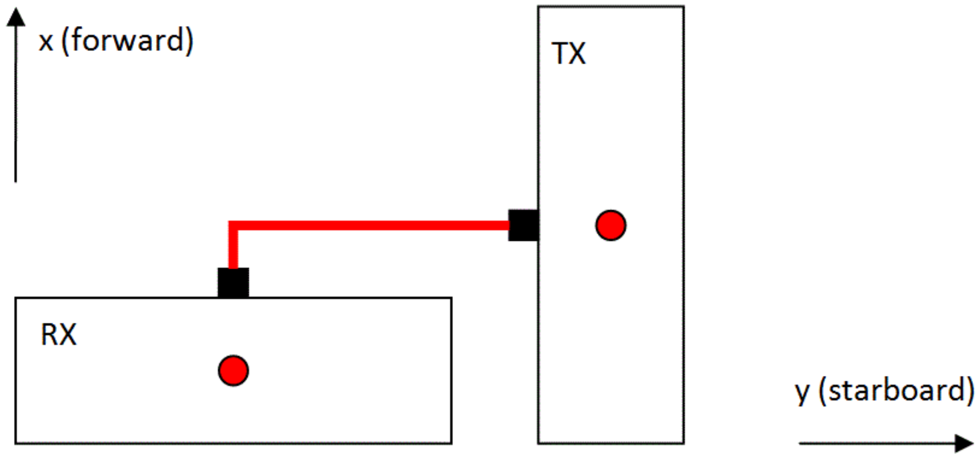
The transducer x,y,z offsets are taken into account by the PU when calculating the "XYZ 88" datagram. If it is needed to recalculate XYZ data in post-processing from the "Raw Range and angle 78" datagram, these offsets should also be taken into account.

For the EM 2040, the transducer installation coordinates refers to the center of the transducer faces. The installation coordinates are given in the "Installation parameters" datagram:

TX:	S1X, S1Y, S1Z	
RX1:	S2X, S2Y, S2Z	(single RX/port RX)
RX2:	S3X, S3Y, S3Z	(starboard RX)

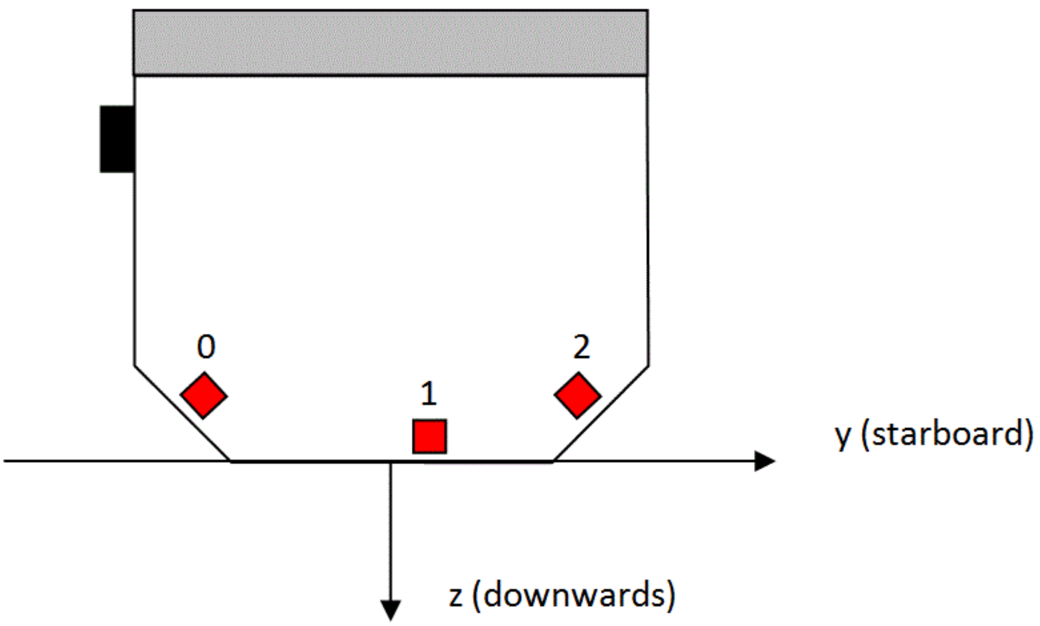
The coordinates are given in the Vessel Coordinate System, where x is forward, y is starboard and z is downward.

Figure 1 Typical EM 2040 transducer configuration viewed from above (single RX)



TX array offsets:

Figure 2 TX transducer seen from behind (default orientation):

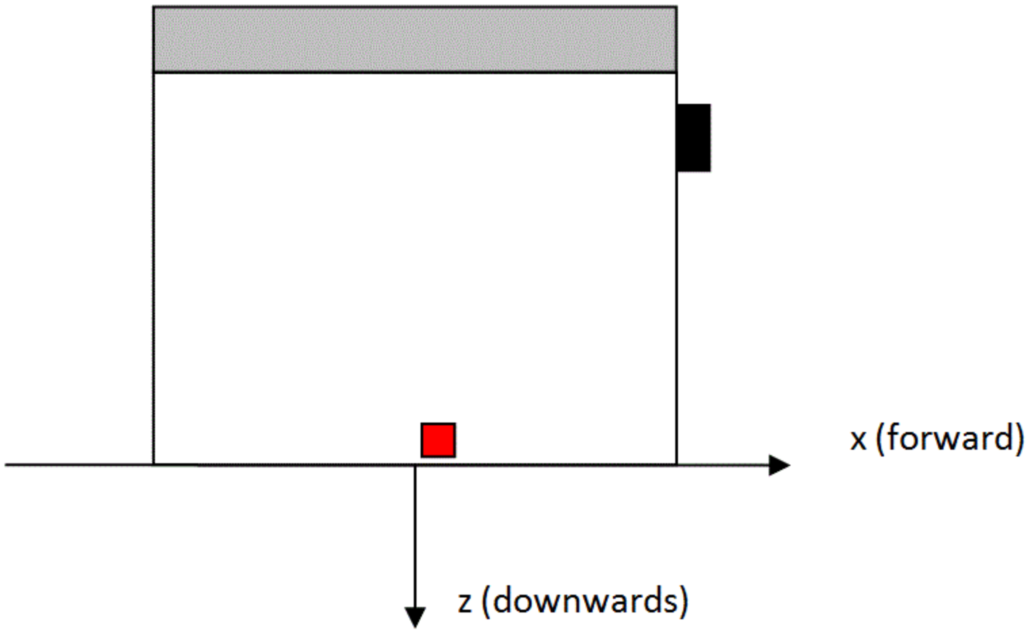


When the TX array is mounted at default orientation, i.e. plug on port side, element # 1 at aft, the x,y,z positions for the 3 TX line arrays relative to the centre of the array face are:

	Index	Forward (x)	Starboard (y)	Downwards (z)
Port array	0	0 mm	–55.4 mm	–12.0 mm
Centre array	1	0 mm	13.15 mm	–6.0 mm
Starboard array	2	0 mm	55.4 mm	–12.0 mm

RX array offsets:

Figure 3 RX transducer seen from starboard (default orientation):



When the RX array is mounted at default orientation, ie plug on front side, element # 1 at port side, the X,Y,Z positions of the line array re centre of the RX array face are:

Forward (x)	Starboard (y)	Downwards (z)
11.0 mm	0 mm	–6.0 mm

Use of TX array index in the “Raw range and angle 78” datagram

In order to take into account TX array offsets when processing data from the “Raw range and angle 78” datagram, the actual array being used is coded into the transmit sector section of the datagram (Repeat cycle 1), using the “Transmit sector number / TX array index” parameter. I.e. for the EM 2040, this parameter does not mean transmit sector, but array index. The transmit sector number can be derived implicitly by counting number of

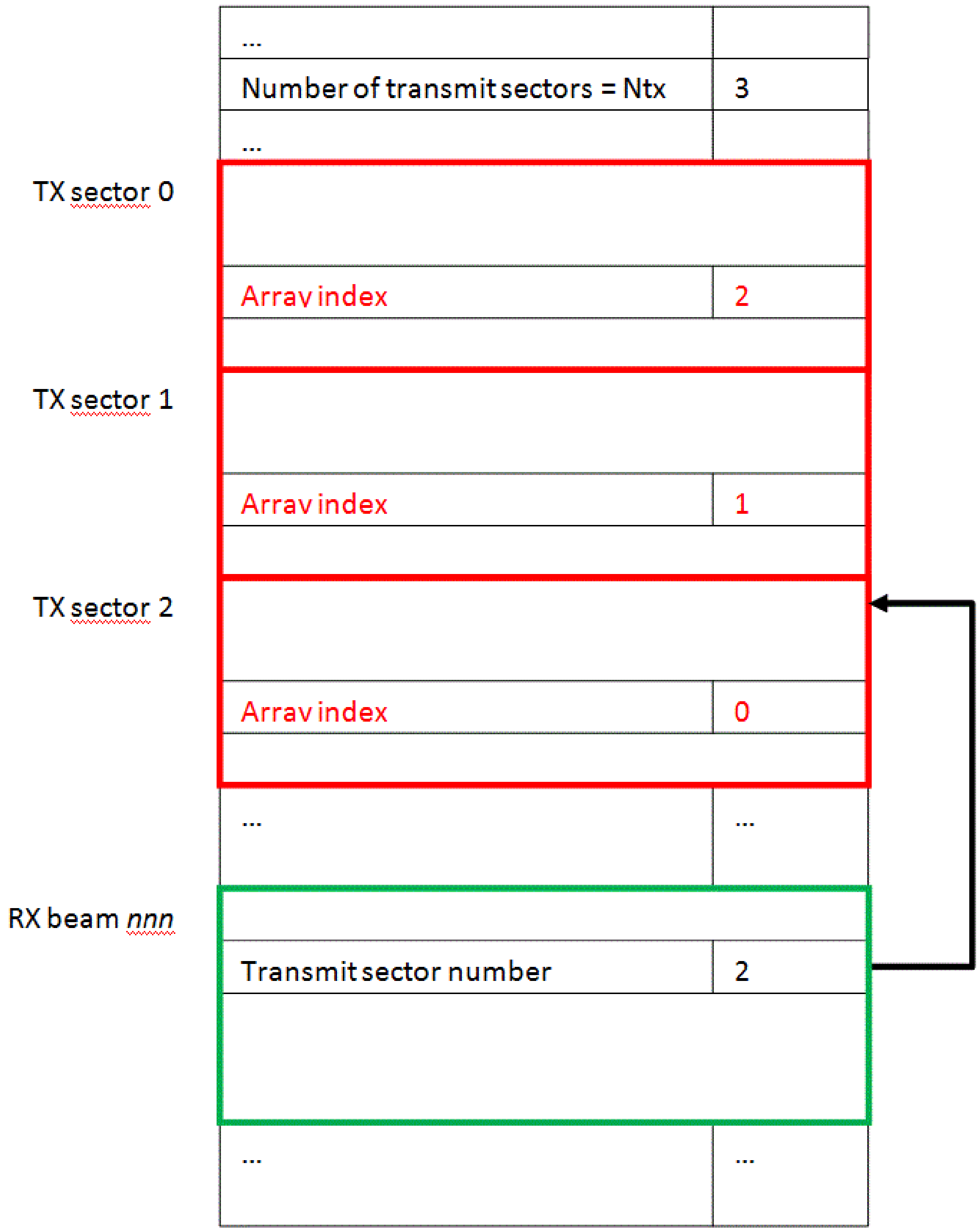
“Repeat cycle 1” entries – first cycle is transmit sector 0, second cycle is transmit sector 1 etc. Note that in the receive beam section of the datagram (Repeat cycle 2), “Transmit sector number” still means just that – transmit sector.

Example:

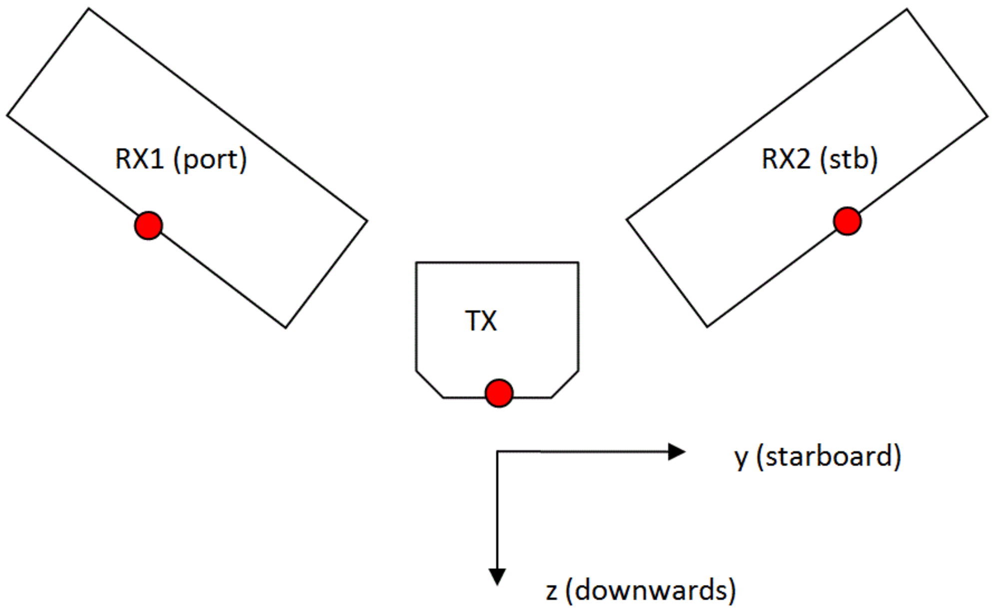
- Three sectors – sector 0, 1 and 2.
- Array indexes are 2, 1 and 0 respectively (which typically implies that the TX is installed with a 180°heading offset).
- One of the beams has the “Transmit sector number” parameter set to 2, i.e. it is pointing to the last TX block (Repeat cycle 1) in the datagram. For this TX sector, the array index is 0.

•

Figure 4 Excerpt of the "Raw range and angle 78" datagram:



EM 2040 Dual RX



For Dual RX, the installation coordinates (x, y, z) and angles (roll, pitch, heading) are given by the following parameters in the “Installation parameters” datagram:

TX:	S1X, S1Y, S1Z, S1R, S1P, S1H
RX1 (port):	S2X, S2Y, S2Z, S2R, S2P, S2H
RX2 (starboard):	S3X, S3Y, S3Z, S3R, S3P, S3H

Note that the installation coordinates refer to the center of the transducer faces. For information about the location of the physical transducer arrays inside the transducer units, see appendix *EM 2040 transducer installation offsets* on page 110.

For EM 2040 Dual RX, data from RX1 (port) and RX2 (starboard) are stored in separate datagrams. This relates to the following datagrams:

- *XYZ 88* on page 43
- *Raw range and angle 78* on page 51
- *Seabed image data 89* on page 56
- *Water column datagram* on page 58

The datagrams from the different RX units are differentiated by the parameter “System serial number”. The “System serial numbers” for the two RX units are found in the header of the “Installation parameters” datagram. The parameters called “System serial number” is valid for RX1 (port), while the parameter called “Secondary system serial number” is valid for RX2 (starboard).

Data description	Example	Format	Valid range	Note
Number of bytes in datagram	–	4U	–	1
Start identifier = STX	Always 02h	1U	–	
Type of datagram = I, I or r	49h, 69h, 70h	1U	–	
EM model number	EM 2040 = 2040	2U	–	
Date = year*10000 + month*100 + day		4U	–	
Time since midnight in milliseconds		4U	0 to 86399999	
Survey line number	—	2U	0 to 65534	
System serial number	123	2U	100 –	
Secondary system serial number	10123	2U	100 –	

Using the example above, multibeam datagrams (XYZ etc) for RX1 (port) will have the “System serial number” parameters set to 123, while multibeam datagrams for RX2 (starboard) will have the “System serial number” parameter set to 10123.

Note

Note that the “Installation parameters” datagram also contains information about transducer serial numbers in parameters TXS, R1S and R2S. These will generally be different from the “System serial number” parameter used in the datagram headers and are included for reference only.

EM 2040 Scanning mode

When running in Scanning mode, one of two or three sectors is transmitted per ping. This means that data from two or three pings need to be coupled together to form the complete swath. This can be done using the “Scanning info” parameter which is coded into the “XYZ 88” and “Water Column” datagrams. In the “Scanning info” parameter, the total number of scanning sectors is coded into the four least significant bits, while the actual scanning sector (counting from zero) is coded into the four most significant bits.

If the “Scanning info” parameter is set to 0, scanning is not used.

Example: Scanning with 3 sectors.

Ping counter	Scanning info	Swath number
1	03h	1
2	13h	
3	23h	
4	03h	2
5	13h	
6	23h	

Due to lack of spare bytes, the Scanning info is not directly coded into “Raw range and angle 78” and “Seabed image data 89” datagrams. In order to couple together data from these datagram types, the “Scanning info” parameter has to be extracted from the corresponding “XYZ 88” datagram using the “Ping counter” as a common reference.

Appendix B EM 2040C installation offsets

For the EM 2040C, the TX and RX arrays are integrated into a common sonar head. The transducer arrays are not placed at the centre of the sonar head. The EM 2040C can have one or two sonar heads. For most EM echo sounders separate x,y,z installation parameters are given for the RX and the TX arrays. For EM 2040C the installation parameters entered by the operator refers to the centre of the face of the sonar head(s). The transducer x,y,z offsets are taken into account by the Processing Unit when calculating the “XYZ 88” datagram. If it is needed to recalculate XYZ data in post-processing from the “Raw Range and angle 78” datagram, these offsets should also be taken into account.

The sonar head installation coordinates are given in the “Installation parameters” datagram:

- SH 1: S1X, S1Y, S1Z
- SH 2: S2X, S2Y, S2Z

The coordinates are given in the Vessel Coordinate System, where x is forward, y is starboard and z is downward. The x,y,z positions for the RX and TX transducer arrays relative to the centre of the sonar head face are:

	Forward (x)	**Starboard (y)**	**Downwards (z)**
TX	3.8 mm	40.0 mm	-6.0 mm
RX	-45.5 mm	0.0 mm	-6.0 mm

For EM 2040C with dual sonar heads, data from SH1 and SH2 are stored in separate datagrams, using different serial numbers. This relates to the following datagrams:

- XYZ 88
- Raw range and angle 78
- Seabed image data 89
- Water column
- Stave display

The “System serial numbers” for the two sonar heads are found in the header of the “Installation parameters” datagram. The parameters called “System serial number” is valid for SH1, while the parameter called “Secondary system serial number” is valid for SH2.

Data Description	Example	Format	Valid range	Note
Number of bytes in datagram	-	4U	-	1
Start identifier = STX	Always 02h	1U	-	-
Type of datagram = I, I or r	49h, 69h, 70h	1U	-	-
EM model number	EM 2040C= 2045	2U	-	-
Date = year*10000 + month*100 + day		4U	-	-
Time since midnight in milliseconds		4U	0 to 86399999	-
Survey line number	-	2U	0 to 65534	-
System serial number	0123	2U	100 -	-
Secondary system serial number	0125	2U	100 -	

Using the example above, multibeam datagrams (XYZ etc) for SH1 will have the “System serial number” parameters set to 0123, while multibeam datagrams for SH2 will have the “System serial number” parameter set to 0125.

Appendix C
Handling of .all–files

The Seafloor Information System, SIS, is responsible for logging all the data from the Kongsberg multibeam echosounder systems, MBES. In addition SIS will display real time digital terrain models made from these data.

SIS runs on a PC-architecture computer running Windows. Data from the MBES arrives at the PC via an Ethernet connection as UDP packets of variable length.

The data is stored in files with the extension .all. The prefix is normally nnnn_YYYYMMDD_HHMMSS, with the name of the ship appended if the operator has chosen to: nnnn_YYYYMMDD_HHMMSS_Shipname. The letters nnnn is the line number, while the time in the first datagram in the file is decoded and used to make the rest of the prefix. (Note that the clock in the PC is not used).

The storage locations of the .all-files are defined by the operator. First a general location is set, i.e. c:\sisdata\rawdata with the name of the survey appended to the path. The rest of the path can be defined by the operator in SIS to be a tree-structure or not. Typically the rest of the path is year/month/day so the complete path may be: c:\sisdata\rawdata\my_survey\2006\10\20\0001_20061020_123456_Shipname.all.

Because the tree-structure can be chosen freely, it is necessary to find all the files below the general location and the survey, c:\sisdata\rawdata\my_survey, and then sort all the files by their date and time, YYYYMMDD_HHMMSS, to find the chronological sequence of files.

The datagrams from the MBES arrives at the PC in one stream. The timestamp of the data may not be strictly sequential. For example motion sensor data is grouped together and sent from the MBES to SIS in one datagram containing 100 motion sensor measurements with individual timestamps, and then they may arrive one second behind the depth datagram. This makes it necessary to read several motion sensor datagrams to find the correct one to be used when applying motion to the depth data. The individual datagram types must be handled separately and the interpolation to other datagram types must be done based on the timestamps.

When one survey line is closed and a new survey line is opened, the stream of datagrams is cut exactly when the operator chooses to create a new line. The result is that the datagram needed to merge data at the end of the previous line may be found in the beginning of the next line. One typical situation is that one position datagram is followed by one depth datagram in the previous line, and the next position datagram is found in the beginning of the next line. To interpolate the correct position for the last depth datagram, the position datagram just before it must be used together with the position datagram in the following line.

The content of the datagrams is described in the datagram description. When the datagrams are written to file, the size of the datagram is written before the datagram in two bytes (one short integer). Thus to read the file, first read two bytes (one short), then read that number of bytes from the file which is then one datagram. The datagram is easily decoded by inspecting the header information in each datagram.

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