CHAPTER 7

EM 121A DATAGRAM FORMATS

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7. DATAGRAM FORMATS

7.1 INTRODUCTION

The communication between the EM 121A sounders and external devices is performed through an interchange of datagrams. These datagrams are described in this document.

7.1.1 Description Of The Datagrams

The message part of the datagram is divided into several data fields, each consisting of one or more data bytes. The message part is described according to this form:

Description	Res	Units	Format	Bytes \#	 Σ	 Valid range

7.1.1.1 Message Contents and Definitions

Description

Short-form description of a data field

Res

Resolution of the data

Units

Defines how to interpret the contents of a data field. The contents are described either by function or by units of measurement. A field may contain one or more units.

Valid Range

The valid range field defines a unit's valid range in the format defined by the *format* field. Text enclosed by <> is used for describing the contents and not the actual value (i.e., <TEXT> is a text consisting of any character in the current format), is used as notation for a space.

Notes (superscript numbers)

Correspond to notes applicable to the table.

7.3 RECORD FORMATS

This document describes the data record formats for the EM 121A. The ports referred to relate to the Cable Plan (824-117545) included in the Installation Manual.

7.3.1 Depth Record

The Depth Record is transmitted twice each ping with one half of the beams per datagram.

Record Name: Depth Record

Message Type: 89h

Number of Data Bytes: 961

Port: C10

Table 7.1 - Depth Record (every ping)

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range
Date	1	DD-day	ASCII	2	6	1 - 31
	1	MM-month	ASCII	2		1 - 12
	1	YY-year	ASCII	2		0 - 99
Time	1	HH-hours	ASCII	2	8	0 - 23
	1	MM-minutes	ASCII	2		0 - 59
	1	SS-seconds	ASCII	2		0 - 59
	0.01	hh-seconds	ASCII	2		0 - 99
Ping number[12]	1	-	binary	2	2	0 - 65535
Mode[1]	1	-	binary	1	1	0 - 11
Ping quality factor[2]	1	-	binary	1	1	0 - 121
Number of beams in datagram[15]	-	-	binary	1	1	60 or 61
TX pulse length	1	ms	binary	1	1	1 - 20
Beam width	1	degree	binary	1	1	1, 2 or 4
TX power level[17]	1	-	binary	1	1	0 - 5
TX status[16]	-	-	binary	1	1	0 - 58
RX status[16]	-	-	binary	1	1	0 - 128
Depth below keel[3]	z resol.	meters	binary	2	2	0 - 65535

Notes:

1

1 = EM 12, shallow	0.6 m/sample	
2 = EM 12, deep	2.4 m/sample	
3 = EM 1000, deep	0.3 m/sample	
4 = EM 1000, medium	0.3 m/sample	
5 = EM 1000, shallow	0.15 m/sample	
6 = EM 121(A), shallow	0.3 m/sample	61 beams
7 = EM 121(A), intermediate	0.6 m/sample	121 beams
8 = EM 121(A), deep	2.4 m/sample	121 beams
9 = EM 121(A), very deep	4.8 m/sample	121 beams
10 = EM 121(A), deep 2°	2.4 m/sample	121 beams
11 = EM 121(A), very deep 2°	4.8 m/sample	121 beams

2 *The ping quality factor shows the number of beams that have accepted bottom detections.*

3 *The measured depth in the most vertical beam.*

4 *The heading, roll, pitch, and heave are the sensor values at the ping transmit time, plus any offset values entered into the echo sounder. The heading is the reference (x-axis) for the right handed coordinate system in which along-(x) and acrosstrack (y) distances and depths (z) are given. Thus, the roll angle is positive when the port side is above the horizontal plane, the pitch angle is positive when the bow is above the horizontal plane, and the heave value is positive when the transducer is lower than its normal draft.*

5 *The sound velocity at the transducer depth, either measured or set by operator.*

7 *The two way travel time in milliseconds equals the range value times the range multiplier.*

8 *The amplitude is the mean back scattering strength over each beam (corrected for beam patterns, echo sounder parameters, and Lambert's law, assuming a flat horizontal bottom).*

9 *The upper bit in the beam quality factor indicates whether amplitude (0) or phase (1) detection has been used. If amplitude detection is used, the lower 6 bits indicate the number of amplitude samples used to calculate the detection point (0 - 63). If phase detection is used, the lower 6 bits is 64 times the variance of the curve fit to phase versus time, divided by the maximum limit allowed (this limit depends on the slope of the phase curve), while the next upper bit indicates whether a first (0) or second (1) order curve fit has been used.*

10 *Measured at reception time in each beam.*

11 *Depth per sound velocity profile.*

12 *Reset each time mission parameters is set.*

13 *Pointing angle of beam at reception.*

15 *The number of beams represented in the current datagram. Beams 1 - 61 are in the first datagram, beams 62 - 121 are in the second datagrams. Beam 1 is the port-most beam.*

7.3.2 Parameter Record

The Parameter Record is transmitted each time a parameter is changed.

Record Name: Parameter Record

Message Type: ECh

Number of Data Bytes: 433

Port: C10

Table 7.2 - Parameter Record (each time any parameter changes)

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range
Date	1	DD-day	ASCII	2	7	1 - 31
	1	MM-month	ASCII	2		1 - 12
	1	YY-year	ASCII	2		0 - 99
	-	field separator	ASCII	1		,
Time	1	HH-hours	ASCII	2	9	0 - 23
	1	MM-minutes	ASCII	2		0 - 59
	1	SS-seconds	ASCII	2		0 - 59
	1	hh-seconds	ASCII	2		0 - 99
	-	field separator	ASCII	1		,
Positioning system type	-	header	ASCII	4	6	PIS=
	1	system code	ASCII	1		0 - 9
	-	field separator	ASCII	1		,
Positioning system time delay[1]	-	header	ASCII	4	10	PTD=
	0.1	seconds	ASCII	5		±59.9
	-	field separator	ASCII	1		,
Motion sensor type[5]	-	header	ASCII	4	6	MST=
	1	-	ASCII	1		0 - 1
	-	field separator	ASCII	1		,
Motion sensor roll offset[2]	-	header	ASCII	4	10	MSR=
	0.01	degrees	ASCII	5		±9.99
	-	field separator	ASCII	1		,

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range
Surface Sound Velocity source[6]	1	-	ASCII	1	2	0 - 1
	-	field separator	ASCII	1		,
Roll delay	1	ms	ASCII	3	4	0 -100
	-	field separator	ASCII	1		,
Condition flag[3]	1	-	ASCII	1	2	0 - 3
	-	field separator	ASCII	1		,
Spike filter strength[4]	1	-	ASCII	1	2	0 - 3
	-	field separator	ASCII	1		,
Ship ID	1	-	ASCII	5	6	0 - 9999
	-	field separator	ASCII	1		,
Mission number	1	-	ASCII	6	7	0 - 9999
	-	field separator	ASCII	1		,
Sonar Processor Computer software version	-	header	ASCII	4	9	SPC=
	-	annotation	ASCII	4		1.00 - 9.99
	-	field separator	ASCII	1		,
Data Processor Computer software version	-	header	ASCII	4	9	DPC=
	-	annotation	ASCII	4		1.00 - 9.99
	-	field separator	ASCII	1		,
Responsible operator	-	header	ASCII	3	12	RO=
	-	annotation	ASCII	8		
	-	field separator	ASCII	1		,
Planned line	-	header	ASCII	13	18	PLANNED -LINE=
	1	line number	ASCII	4		0 - 9999
	-	field separator	ASCII	1		,
Survey line	-	line header	ASCII	12	17	SURVEY-LINE=
	1	line number	ASCII	4		0 - 9999
	-	field separator	ASCII	1		

7.3.3 Sound Velocity Profile Record

This Sound Velocity Profile Record format defines the record structure for receiving SVP data from an external source and the format for outputing the SVP data from the sonar. The SVP record is transmitted each time the SVP is changed in the sonar.

Record Name: Sound Velocity Profile Record

Message Type: 9Ah

Number of Data Bytes: 416

Port: C10

Table 7.3 - Sound Velocity Profile Record

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range
Date	1	DD-day	ASCII	2	6	1 -31
	1	MM-month	ASCII	2		1 - 12
	1	YY-year	ASCII	2		0 - 99
Time	1	HH-hours	ASCII	2	8	0 - 23
	1	MM-minutes	ASCII	2		0 - 59
	1	SS-seconds	ASCII	2		0 - 59
	0.01	hh-seconds	ASCII	2		0 - 99
No. of valid values[1]	1	-	binary	2	2	1 - 100
100 occurrences of					400	
•depth	1	meters	binary	2		0 - 12000
•sound velocity	0.1	m/s	binary	2		14000 - 17000

Notes:

[1] *The sound velocity profile datagram consists of 100 pairs of depth and corresponding sound velocity values. The "No. of valid values" determines the number of valid depth and sound velocity values (always starting with the first pair that were received). For depths greater than the last data point, the value for the last data point is used.*

Description	Res	Units	Format	Bytes #	Bytes Σ	Valid range
UTM Northing	0.1	meters	ASCII	11	12	0 - xxxxxxxxx.x
	-	field separator	ASCII	1		,
UTM Easting	0.1	meters	ASCII	9	10	0 - xxxxxxx.x
	-	field separator	ASCII	1		,
UTM zone no.	1	zone	ASCII	2	3	1 - 60
	-	field separator	ASCII	1		,
UTM zone longitude[1]	1	degrees	ASCII	3	12	0 - 180
	0.001	minutes	ASCII	7		0 - 59.9999
	-	East/West	ASCII	1		E or W
	-	field separator	ASCII	1		,
System[2]	1	-	ASCII	1	2	0 - 2
	-	field separator	ASCII	1		,
Q factor[3]	1	-	ASCII	1	2	5
	-	field separator	ASCII	1		,
Speed[4]	0.1	m/s	ASCII	4	5	0 - 99.9
		field separator	ASCII	1		,
Line heading[5]	0.1	degrees	ASCII	5	6	0 - 360.0
	-	field separator	ASCII	1		,
Termination	-	Carriage return	ASCII	1	2	Dh
	-	Line feed	ASCII	1		Ah

7.3.5 Sidescan Amplitude Record

A variable number (depth related) of sidescan amplitude datagrams are transmitted for each ping.

Record Name: Sidescan Amplitude Record

Message Type: CAh

Number of Data Bytes: 551

Port: C11

Table 7.5 - Sidescan Amplitude Record

				Bytes		
Description	**Res**	**Units**	**Format**	**#**	**Σ**	**Valid range**
Date	1	DD-days	ASCII	2	6	1 - 31
	1	MM-months	ASCII	2		1 - 12
	1	YY-years	ASCII	2		0 - 99
Time	1	HH-hours	ASCII	2	8	0 - 23
	1	MM-minutes	ASCII	2		0 - 59
	1	SS-seconds	ASCII	2		0 - 59
	0.01	hh-seconds	ASCII	2		0 -99
Ping number	1	-	binary	2	2	0 - 65535
Sound velocity	0.1	m/s	binary	2	2	14,000 - 17,000
Mode[1]	1	-	binary	1	1	1 -11
Number of datagrams[2]	1	-	binary	1	1	1 - 121
Datagram number[3]	1	-	binary	1	1	1 - 121
Number of beams[4]	1	-	binary	1	1	1 - 75
Number of beams occurrence of:					6 - 450	
beam number[5]	1	-	binary	1		1 - 121
frequency[6]	1	-	binary	1		0 - 4
samples in beam[7]	1	-	binary	2		1 - 523
beam center sample[8]	1	-	binary	2		1 - 523

[9] This table contains the amplitude data for one or more beam, as defined by the number of beam, Each beam contains a varying number of data sample, as defined by the number of samples in a beam.

[10] To obtain a fixed length, the surplus of the datagram is filled with zeros.

7.3.6 Sonar Image, Amplitude, and Phase Record

This output can be selected instead of the Sidescan Amplitude Record (defined in Table 5). A variable number (depth related) of these datagrams are transmitted for each ping.

Record Name:	Sonar Image, Amplitude, and Phase Record
Message Type:	CDh
Number of Data Bytes:	1465
Port:	C11

Notes:

[1] 1 = EM 12, shallow	0.6 m/sample	
2 = EM 12, deep	2.4 m/sample	
3 = EM 1000, deep	0.3 m/sample	
4 = EM 1000, medium	0.3 m/sample	
5 = EM 1000, shallow	0.15 m/sample	
6 = EM 121(A), shallow	0.3 m/sample	61 beams
7 = EM 121A, intermediate	0.6 m/sample	121 beams
8 = EM 121(A), deep	2.4 m/sample	121 beams
9 = EM 121(A), very deep	4.8 m/sample	121 beams
10 = EM 121(A), deep 2	2.4 m/sample	121 beams
11 = EM 121(A), very deep 2	4.8 m/sample	121 beams

The given range sampling distances are nominal and assume a sound velocity of 1500 m/s.

[2] *The amount of Sonar Image Data for one ping may be larger than the maximum of one datagram. The number of datagrams (typically 5 - 10) defines the number of datagrams representing one ping.*

[3] *Defines the datagrams position in the datagram sequence for one ping.*

[4] *The number of beams represented in the current datagram.*

[5] *Defines the current beam.*

[6] *Frequency for the current beam:*

0 = 12. 67 kHz

1 = 13.00 kHz

2 = 13.33 kHz

3 = 95 kHz

4 = 12 kHz

[7] *The number of samples in the current beam.*

[8] *The sample number of the center beam sample in the current beam, i.e., the x, y, z given in the depth datagram for this beam, is the position of this sample.*

[9] *This table contains the amplitude and electrical phase data for one or more beams, as defined by the number of beams. Each beam contains a varying number of data samples, as defined by the number of samples in a beam.*

The amplitude is the mean back scattering strength over each beam (corrected for beam patterns, echo sounder parameters, Lambert's Law), assuming a flat horizontal bottom. The phase is the measured electrical phase (±180) from the split beams.

[10] *To obtain a fixed length, the surplus of the datagram is filled with zeros.*

7.3.8 Raw Data

These records are used for logging of raw data from the receiver, i.e., before beamforming. There are four records, a header datagram containing all data valid for a ping, a receiver datagram containing receiver data and attitude data, PAM datagram, and dummy datagram. These datagrams are output from the Receiver Rack.

7.3.8.1 Raw Data Header Record

Record Name:	Raw Data Header Record
Message Type:	E6
Number of Data Bytes:	71
Port:	R11

Table 7.7 - Raw Data Header Record

Description	Res.	Units	Format	Bytes #	Bytes Total	Valid Range
Date	1	DD-days	ASCII	2	7	1 - 31
	1	MM-months	ASCII	2		1 - 12
	1	YY-year	ASCII	2		0 - 99
	-	field separator	ASCII	1		,
Time	1	HH-hours	ASCII	2	9	0 - 23
	1	MM-minutes	ASCII	2		0 - 59
	1	SS-seconds	ASCII	2		0 - 59
	0.01	hh-hundredths	ASCII	2		0 - 99
	-	field separator	ASCII	1		,
Latitude	1	degrees	ASCII	2	11	0 - 89
	0.0001	minutes	ASCII	7		0 - 59.9999
	-	north/south	ASCII	1		N or S
	-	field separator	ASCII	1		,
Longitude	1	degrees	ASCII	3	12	0 - 179
	0.0001	minutes	ASCII	7		0 - 59.9999
	-	east/west	ASCII	1		E or W
	-	field separator	ASCII	1		,
Ping number	1	-	Binary	2	2	0 - 65535

Notes:

1 *Valid at ping time.*

2 *Number of datagrams for this ping including this datagram.*

3 *Sample numbers referred to the start of the TX pulse. The time delay of the bandpass filters and the digital pipelining delays are compensated for.*

4 *The acoustic intensity level at a stave input is calculated by:*

$$V = 20\log\left(k \bullet \frac{\sqrt{I^2 + Q^2}}{\sqrt{2} \bullet 2048}\right) - TVG - F - PG - M$$

V = the rms value of the acoustic intensity (dB re 1 μPa)

k = positive range of digitizer/(Volt)

F = Fixed gain in the receiver (dB)

PG = Programmable Gain in the receiver (dB)

M = hydrophone sensitivity/(dB)

I = digitized in-phase sample value (from the Raw Data Record)

Q = digitized quadrature sample value (from the Raw Data Record)

TVG = Time Varied Gain (from the Raw Data Record)

5 *TX power level: transmitter power level referred to maximum power level (0 dB)*

0 = OFF

1 = -18 dB

2 = -12 dB

3 = -6 dB

4 = 0 dB

5 = 0 dB (unshaded)

6 *In steps of 3 dB.*

Notes:

1 *Valid at this datagram. The roll signal is sampled by the EM 121A for every receive sample (400 or 800 uS) and is used to roll stabilize 8 or 16 beams per sample. Therefore, every stored sample is a new one.*

2 *Overload Detectors*

The 16 receiver boards have three overload detectors each. By software control, it is possible to select one among eight channels on the boards to be connected to the overload detectors. The detectors are read every sample and stored on the tape together with the stave data. The 3 least significant bits in a byte are used to indicate status (0 = OK, 1 = failure).

During 8 pings all 128 channels will be tested. The sequence is as follows:

0, 8, 16 ... 120
1, 9, 17 ... 121
2, 10, 18 ... 122
3, 11, 19 ... 123
4, 12, 20 ... 124
5, 13, 21, ... 125
6, 14, 22, ... 126
7, 15, 23, ... 127

The first number (0 - 7) on each line above will be the overload channel offset number stored in the datagram.

The lobe pattern of the staves are the same for all channels, and they point in the same direction on each half of the array, therefore, the same signal will be received on the staves, only shifted by a short time delay.

3 *The 12 least significant bits of the 2 byte word contain the I or Q amplitude value.*

Description	Res.	Units	Format	Bytes #	Bytes Total	Valid Range
Voltage	2	volt	binary	1		0 - 255
Current	0.1	amp	binary	1		0 - 100
Voltage phase $_V$	2	degree	binary	1		-90 - 90
Current phase $_I$	2	degree	binary	1		-90 - 90

Notes:

[1] *Total status, one bit per channel:*

0 = OK

1 = Error

[2] *128 is added if the phase of the signal is not measured during the current ping.*

[3] *Calculated power =* $V * I * \cos(\Phi_V - \Phi_I)$

[4] *Calculated from the measured level of the transmitter power supply at transmission time and the transmitter mode.*