108368 / AA067

HPR 300 telegrams

This document describes the HPR 300 external equipment telegram formats.

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Document history

Rev. A	First issue.
Rev. B	Updated to new document standard.

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1 TRANSPONDER TELEGRAMS

1.1 Summary

Kongsberg Simrad’s Hydroacoustic Position Reference (HPR) system is often used by other equipment to determine the position of the vessel relative to an underwater structure on the seabed or a remotely operated vehicle (ROV).

Normally the HPR system and the external equipment exchange the necessary information using "telegrams". Each telegram consists of a number of bytes sent over a serial communications link (20 mA current loop or RS232C).

Normally, the HPR system sends a telegram to the external equipment with new position information as soon as new data is available. The telegrams contain the following information as standard:

- The position of a transponder.
- The transponders entered into the system by either external equipment or the operator.
- The transducer and beam width being used.
- Other control information.

209 systems delivered in 1981 or earlier, which do not have this telegram format, may be updated if convenient.

1.2 Introduction

The telegrams between the HPR system and external equipment are transmitted using asynchronous drivers and receivers.

Each byte has a 7-bit code, 1 parity bit (odd parity), 1 start bit and 2 stop bits. The format of the bytes is shown in *Figure 1*.

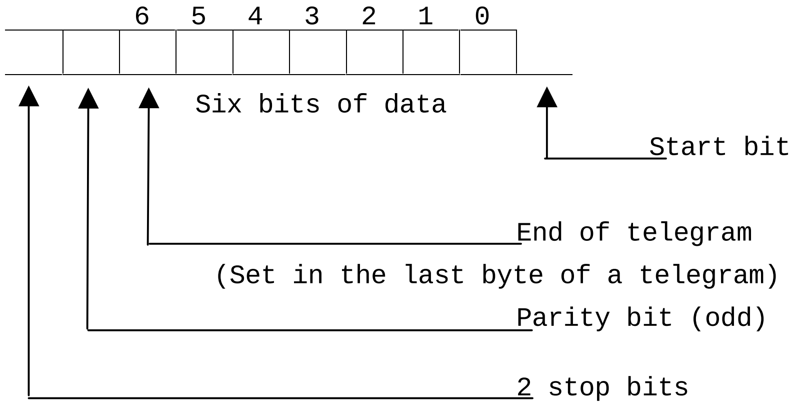


Figure 1 The format of the telegram bytes

1.3 Format of telegrams sent from the HPR system

1.3.1 Telegram contents

Telegrams sent from the HPR system consist of the following bytes:

Byte contents	No. of bytes	Byte index in telegram
HEAD	1 byte	0
ROLL (or X-angle)	2 bytes	1
PITCH (or Y-angle)	2 bytes	3
COURSE	2 bytes	5
TRANSPONDER INDEX	1 byte	7
X-POS OR RANGE	3 bytes	8
Y-POS OR BEARING	3 bytes	11
Z-POS OR DEPTH	3 bytes	14
STATUS	1 byte	17
TIMEOUT	1 byte	18
TP's IN SEQUENCE	3 bytes	19
TRACKING TD ANGLE	2 bytes	22
TEST	1 byte	24
TP TYPE	1 byte	25
TP SPECIFICATION	1 byte	26
TRANSDUCERS	1 byte	27
TD STATUS	1 byte	28
KALMAN FILTER WINDOW	1 byte	29
CHECKSUM	1 byte	30
END OF TELEGRAM	1 byte	31
	32 bytes	

The rest of this chapter contains a description of the bytes.

1.3.2 HEAD (1 byte)

The HEAD byte defines the mode in which the HPR system is running, and some parameters concerning the coordinates used in the telegrams.

Bit 0 is set when running in normal acoustic mode (run mode).

Bit 1 is set when running in test mode.

Bit 2 is set if the position is calculated in polar coordinates. It is zero if the position is calculated in cartesian coordinates.

Bit 3 is set if north is the Y direction in cartesian coordinates and the zero bearing direction in polar coordinates (north oriented coordinates). It is zero if the heading of the vessel is the Y-direction in cartesian coordinates and the zero-bearing direction in polar coordinates (vessel oriented coordinates).

Bit 4 is set if the coordinates contained in the telegrams are filtered by a Kalman filter. It is zero if the coordinates are unfiltered. This has to be agreed between the customer and Simrad.

Bit 5 is set if the position reference point is the spare (e.g. the bow) reference point of the vessel. It is zero if the reference point is the main (e.g. the moonpool) reference point of the vessel.

If the telegram does not contain any position information, bits 2, 3, 4 and 5 are invalid.

Bits 0, 1 and 5 may be changed by the operator using the control unit. The other bits may not be altered.

1.3.3 ROLL, or inclinometer TP X-angle (2 bytes)

These bytes normally contain the roll angle read from the Vertical Reference Unit.

When the telegram contains transponder/responder position information, the angle is read when the reply is received. Otherwise it will be read immediately before the telegram transmission.

The first byte contains the 6 MSBs of the angle, and the last byte contains the 6 LSBs. The angle is coded in 2’s complement.

The resolution (weight of the LSB) is .0878906 degrees (equal to 360 degrees divided by 2^{12}) and the angle is consequently in the range +180° to -180°. A positive roll angle means that the vessel’s starboard side is down.

If the telegram contains information about an inclinometer TP, these bytes contain the X-angle of the TP (marked 1 on the top of the TP). The format is the same as for the roll angle. A positive X-angle means that the TP is leaning towards starboard.

1.3.4 PITCH, or inclinometer TP Y-angle (2 bytes)

These bytes contain the pitch angle read from the vertical reference unit.

It is read just after the roll angle, and they have the same format.

A positive pitch angle means that the bow of the ship is up.

If the telegram contains information about an inclinometer TP, these bytes contain the Y-angle of the TP (marked 2 on the top of the TP). The format is the same as for the pitch angle. A positive Y-angle means that the TP is leaning forwards.

1.3.5 COURSE (2 bytes)

These bytes contain the angle read from the Gyro Compass.

It is read just after the roll angle, and they have the same format.

Normally, the course angle is the angle between the north vector and the Y-direction. Seen from above, clockwise is the positive angle direction.

1.3.6 TRANSPONDER INDEX (1 byte)

If the telegram contains transponder position information, this byte contains the number of that transponder (from 1 to 16).

Otherwise this byte is zero.

The transponders 1 to 9 have indices 1-9. The transponders □, ⊙, ∇, X,Y, emergency-A and emergency-B, have indices 10 to 16 (decimal).

1.3.7 X-POS RANGE (3 bytes), Y-POS OR BEARING (3 bytes), Z-POS DEPTH (3 bytes)

These bytes contain the position of the transponder/responder. The position is either in cartesian coordinates X, Y and Z or in polar coordinates; range, bearing and depth (indicated in bit 3, Head byte).

The Y direction is alongships forward when vessel-oriented, and north when north-oriented.

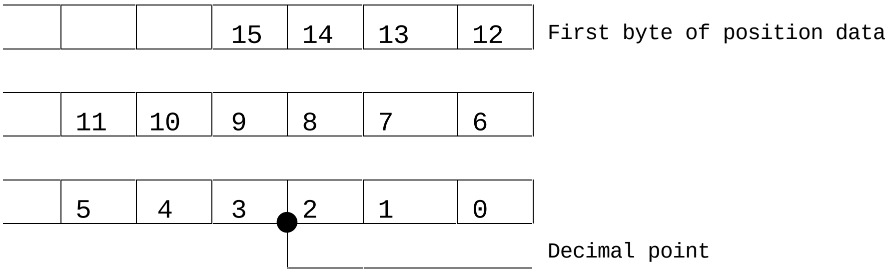
The X direction is atwartships starboard when vessel-oriented, and east when north-oriented.

The Z direction is downward, i.e. depth.

The range is the horizontal distance to the transponder / responder measured on the sea surface.

The bearing angle is the angle between the Y direction (along-ships forward or north) and the range vector. Positive angle is clockwise seen from above.

The format of the X, range, Y and Z bytes are shown in the figure below.



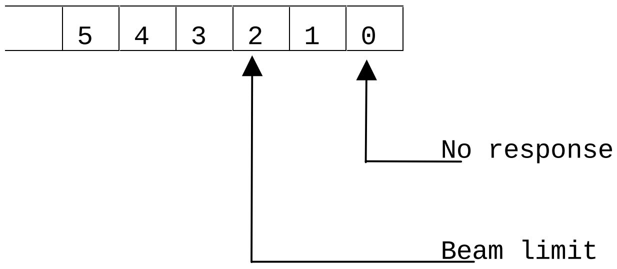
The position is coded in 2’s complement. The resolution (weight of the LSB) is 0.125 m, and the position is consequently in the range ± 4096 m.

The format of the bearing angle is the same as for the roll angle. When polar coordinates are used, there is a spare byte between the 2 bearing bytes and the depth bytes.

1.3.8 STATUS (1 byte)

This byte contains some the HPR system status information.

The format of the byte is shown below:



The "no response" bit is set when:

- No position reply within the timeout limit.
- The reply is rejected by the programs.
- There is an interrogator failure.

When "No Response" is received, the TRANSPONDER CODE byte tells the system which transponder/responder the HPR system failed to receive a correct reply from. The position bytes do not contain any position information.

The BEAM LIMIT bit is set when the reply is received in the outer part of the beam in operation. It is only valid for a fixed transducer without the tracking-medium or tracking-narrow facilities.

1.3.9 TIMEOUT (1 byte)

A TP may reply with one or more pulses.

Bit 0 in timeout is set if the first pulse is not received.

Bit 1 is set if the second pulse is not received.

Bit 2 is set if the third pulse is not received.

1.3.10 TRANSPONDERS IN SEQUENCE (3 bytes)

These 3 bytes define the total number of transponders operating in the system introduced by either the operator or the external equipment.

The format of the bytes is shown below. The bits associated with transponders activated in the system at the present, are set.

Byte 1

5	4	3	2	1	0
		B	A	Y	X

Byte 2

5	4	3	2	1	0
∇	⊙	□	9	8	7

Byte 3

5	4	3	2	1	0
6	5	4	3	2	1

The TP numbers and symbols are drawn inside their associated bits.

1.3.11 TRACKING TD-ANGLE (2 bytes)

These 2 bytes contain the angle of the tracking transducer when a reply from the transponder is received.

The first byte contains the 6 MSBs of the angle, and the last byte contains the 6 LSBs.

The format of the angle is as for the roll angle.

1.3.12 TEST (1 byte)

This byte contains information about the self diagnostics performed by the transceiver unit.

Bit 0 is set when a data memory (RAM) error is detected.

Bit 1 is set when a program memory (PROM) error is detected.

Bit 2 is set when an error in one of the other cards in the interrogator is detected. (FIC-TRAN, SDC-TRAN, TSB-TRAN, TRC-TRAN, RPC-TRAN, IOC-TRAN, FIL-TRAN, TRANSDUCER).

Bit 3 is set when an error in one of the serial lines connected to the transceiver is detected. (INTF-DP, INTF-DSPL, INTF-TRAN, INTF-STB, INTF-PORT, STB-MOTOR, PORT-MOTOR).

Bit 4 is set when the processor is restarted. (UMC-TRANC).

1.3.13 TRANSPONDER TYPE (1 byte)

This byte contains a binary number indicating what transponder type the telegram contains data from.

0 means standard TP

1 " responder

2 " depth TP

3 " beacon

4 " depth beacon

5 " inclinometer TP

1.3.14 TRANSPONDER SPECIFICATION (1 byte)

This byte contains some parameters of the transponders of the telegram.

Bit 0 is set if the TP is mobile (e.g. mounted on a ROV), and zero if it is fixed. This information is entered by the operator and may be used by the DP system to decide which TPs should be used as DP reference.

Bit 1 is set if the TP is a low interrogation rate TP. It is zero if it is a normal interrogation rate TP.

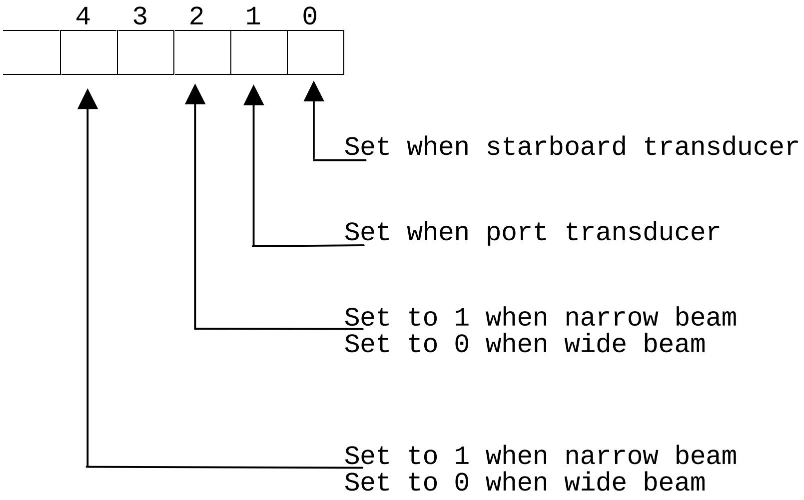
Bit 2 is set if the TP is a low priority TP. It is zero if it is a normal priority TP.

Bit 3 is set if the operator has specified a fixed depth for the TP. The fixed depth information is used by the programs to compensate for ray bending.

1.3.15 TRANSDUCER (1 byte)

This byte contains information about the transducer and the beam width.

The format is as shown below:



Bit 2 defines the beam selected by the operator for the TP.

Bit 4 identifies the beam used by the HPR system in the last interrogation. When the operator selects narrow beam, the HPR system has to use wide beam to establish TP position before switching to narrow beam. When the operator selects wide beam, the HPR system uses wide beam.

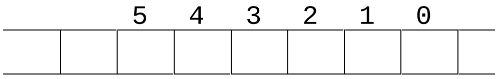
When the telegram contains position information of the Z transponder/responder, the byte defines the status when the reply was received. Otherwise they define the status when the telegram was built up.

The term "narrow beam" in this code is rather imprecise. It means the narrow beam of the actual TD, (i.e. not the wide beam).

The "narrow beam" may be either the medium beam (± 30 degrees) of the standard TD, the narrow beam (± 15 degrees) of the fixed TD or one of the narrow beams of the tracking TD.

1.3.16 TD STATUS (1 byte)

This byte defines the status of the transducers connected to the HPR system.



Bits 5, 4 and 3 are for the port transducer, while bits 2, 1 and 0 are for the starboard transducer.

For the 2 LSBs (0 & 1, and 3 & 4)

00 = auto track

01 = stopped

10 = train manual left

11 = train manual right

For the MSBs (2 and 5)

0 = fixed transducer

1 = tracking transducer

1.3.17 STANDARD DEVIATION SIGMA (1 byte)

Standard deviation is calculated within the software filter, based on 4 measurements. When "timeout" and "Ping accepted" Sigma will increase up to a value of 13,5% of predicted range.

1.3.18 CHECKSUM (1 byte)

This byte contains the exclusive-or of all bytes of the telegram, not including the checksum byte itself and the end of telegram byte.

1.3.19 END OF TELEGRAM (1 byte)

This byte contains 40H, and defines the end of the telegram.

It is the only byte of the telegram with bit 6 set.

1.4 Format of telegrams received by the HPR system

1.4.1 Telegram contents

The telegrams sent from external equipment to the HPR system consist of the following bytes:

Byte contents	**No. of bytes**	**Byte index in telegram**
HEAD	1 byte	0
TRANSPONDER INDEX	1 byte	1
TRANSPONDER TYPE	1 byte	2
TP SPECIFICATION	1 byte	3
TRANSDUCER	1 byte	4
COORDINATE ORIENTATION AND REFERENCE POINT	1 byte	5
SPARE	1 byte	6
SYMBOL 1	6 bytes	7
SYMBOL 2	6 bytes	13
VECTOR 1	4 bytes	19
SYMBOL MODE	1 byte	23
SPARE	1 byte	24
CHECKSUM	1 byte	25
END OF TELEGRAM	1 byte	26
	32 bytes	

1.4.2 HEAD (1 byte)

The HEAD byte specifies whether the HPR system must change the mode in which it is running, and if the rest of the telegram is valid or not.

Bit 0 set means that the whole telegram is valid. If this is zero, only the head byte will be handled by the HPR system.

Bit 2 set means change to test mode.

Bit 3 set means change to run mode.

1.4.3 TRANSPONDER INDEX (1 byte)

This byte specifies a transponder to be either inserted into or removed from the transponder sequence.

The format of the byte is the same as for the transponder index byte sent from the HPR system.

Examples:

- Transponder index byte equal to zero means no change in the transponder sequence.
- Transponder index byte equal to 05 means that transponder 5 shall be either inserted into or removed from the transponder sequence. If transponder 05 is already in the transponder sequence, it will be removed. Otherwise it will be inserted.

As may be seen from the examples, a transponder index other than 00 specifies a change in the transponder sequence.

1.4.4 TRANSPONDER TYPE (1 byte)

This byte defines the type of transponder being inserted into the transponder sequence by this telegram.

0 means standard TP

1 " responder

2 " depth TP

3 " beacon

4 " depth beacon

5 " inclinometer TP

1.4.5 TRANSPONDER SPECIFICATION (1 byte)

This byte defines some parameters of the transponder being inserted into the transponder sequence by this telegram.

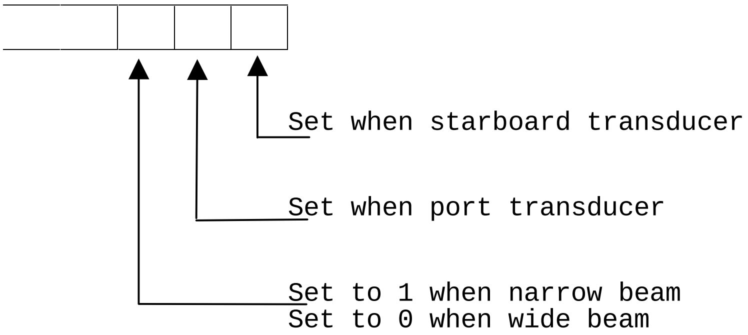
Bit 0 is set if the TP is mobile, and is zero if it is fixed.

Bit 1 is set if the TP is a low interrogation rate TP, and is zero if it is a normal interrogation rate TP.

Bit 2 is set if the TP is a low priority TP.

1.4.6 TRANSDUCER (1 byte)

This byte specifies the transducer and beam width to be used for the TP in the transponder index byte.



The HPR system will start to interrogate the TP on the selected transducer in wide beam.

If the HPR system receives valid replies from the TP in wide beam, and the external equipment has specified narrow beam, the HPR system will switch to narrow beam. It will then continue to interrogate in narrow beam. If the system receives too many timeouts or too great a variance in the measurement, it will switch back to wide beam.

It will use wide beam until the TP position is re-established, then it will switch to narrow beam. All this will be done automatically by the HPR system.

1.4.7 COORDINATE ORIENTATION AND REFERENCE POINT (1 byte)

This byte defines the orientation of the coordinates and their reference point used in telegrams sent from the HPR system.

Bit 0 set means that the information in bit 4 is valid.

Bit 1 set means that the information in bit 5 is valid.

Otherwise this information is as specified by the operator.

Bit 4 set means that the coordinate system will be north oriented. Otherwise it will be vessel oriented. The orientation selected by the operator will always be used on the HPR system display.

Bit 5 set means that the spare reference point is to be used as the reference point of the coordinates. Otherwise the main reference point of the vessel will be used. Bit 5 will effect both the data in the telegrams sent from the HPR system, and the data on the HPR system display.

1.4.8 SYMBOL 1 (6 bytes)

The external equipment may specify up to 2 custom defined symbols and 1 vector to be displayed at the HPR system display. The symbol mode byte, which will be explained later, defines which of these 3 symbols / vectors are to be displayed, and if they shall blink or not.

The form of the 2 symbols must be discussed with Kongsberg Simrad.

The first 3 bytes of symbol 1 define the X-coordinate of the first symbol. The last 3 bytes of symbol 1 define the Y-coordinate of the first symbol.

The format of the X and Y values are the same as for the X, Y and Z position data in the telegrams sent from the HPR system.

The X and Y values are vessel-oriented, with the vessel in the origin.

1.4.9 SYMBOL 2 (6 bytes)

These 6 bytes define the X and Y coordinates of the second custom symbol. The format is the same as for symbol 1.

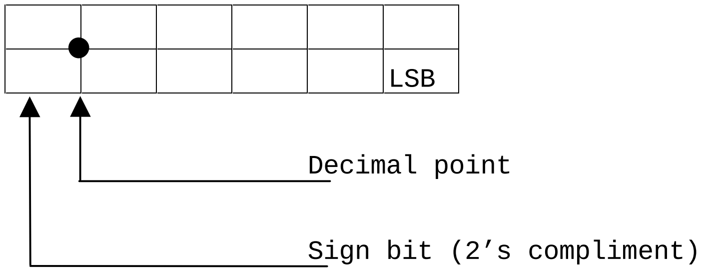
1.4.10 VECTOR 1 (4 bytes)

These 4 bytes define the direction of the custom specified vector.

The first 2 bytes contain the sine value of the angle between the Y direction and the vector, and the 2 last bytes contain the cosine value of the same angle.

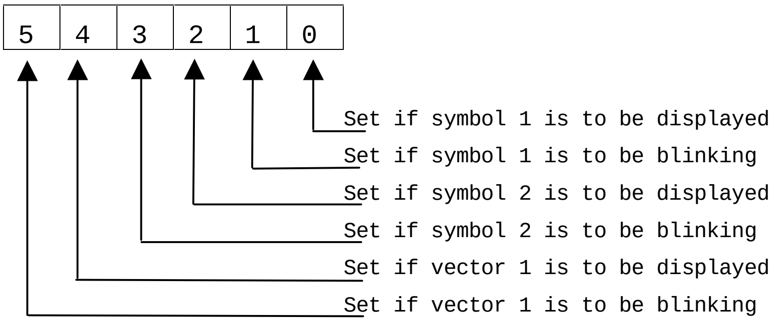
Seen from above, clockwise is the positive angle direction.

The format of the angle is described in the figure.



1.4.11 SYMBOL MODE (1 byte)

The format of this byte is explained in the figure below.



When the bits 0, 2 or 4 are zero, the corresponding symbol or vector (if it is displayed) will be removed from the display.

1.4.12 SPARE (1 byte)

Not used in the standard systems.

1.4.13 CHECKSUM (1 byte)

This byte only contains the exclusive-or of all the bytes of the telegram, not including the checksum byte itself and the end-of-telegram byte.

1.4.14 END OF TELEGRAM (1 byte)

This byte is equal to 40H, and defines the end of the telegram.

1.5 Time of telegram transmission

The external equipment or the operator determines the number of transponders to be in the system. The HPR system does however determine the sequence of transponder activations, and when to activate them.

The transponders are activated in the sequence ☐, ⊙, ∇, X, Y, 1, 2, 3, 4, 5, 6, 7, 8, 9, emergency A and emergency B. (Assuming they are active in the system at the time).

The interval between the activation of the same transponder is constant if possible under the physical circumstances. If that is not possible, they are activated with as little delay as possible.

The telegrams with position information are sent to the external equipment immediately after the position is calculated.

When no transponder is in the system, dummy telegrams are sent with fixed intervals (6.2 secs.). That is done to allow the external equipment to test that the HPR system is alive. These dummy telegrams do not contain any transponder codes, and consequently no position information. The rest of the dummy telegrams, however, are valid.

The interval between the end of one telegram and the start of the next is a minimum of 150 ms. This may be changed if required by the customer.

As explained in chapter 1, each byte consists of 7 data bits, 1 parity bit, 1 start bit and 2 stop bits, i.e. a total of 11 bits.

The transmission time of one byte is consequently 11/baud rate seconds.

Example:

The transmission time T of a telegram from the 209/200 and 309/300 transceiver with a baud-rate of 2400 baud, is:

$$T = 32 \text{ x } 11/2400 \text{ s} = 0{,}147 \text{ s} = 147 \text{ ms}$$

This may easily be seen on an oscilloscope.

The computing time of a TP reply in the HPR system transceiver is approximately 300 ms. The computing of a TP reply is done while the next TP in the sequence is being interrogated. When the travel time of the interrogation and the reply pulse in water is less than 300 ms (corresponds to slant range 225 m), the HPR system may interrogate 3 TPs each second. That matches with a 150 ms interval between stop and start of telegrams and a baud-rate of 2400 baud.

If a longer interval or a slower baud-rate is selected, the telegram transmission will become a bottleneck in the system. Then TP interrogations have to wait for telegram transmissions to be finished. Simrad therefore recommends 2400 baud and an interval between stop and start of telegrams of less than or equal to 150 ms.

2 2’S COMPLIMENT BINARY CODING

2.1 Introduction

This part is a guide to deciphering the 2’s complement coded information contained in the HPR system telegrams. It is designed for those programmers unfamiliar with binary number manipulation.

Three logic operators are used: AND, OR and EX-OR, which might be unfamiliar to some. No attempt is made to explain what these operators do in logic terms, the reader is simply instructed when to use them. In these examples, it is assumed at all times that each byte of data is contained in a 16 bit register. However, this might not necessarily be so. This will depend on the computing system in use.

2.2 Telegram reception

The initial problem in dealing with the HPR system telegrams is that of receiving one full telegram in the same order that it was transmitted. The usual method of accomplishing this is to use the "End of Telegram" byte as a reference to mark the end of a telegram. (This is the only byte which has bit 6 set, and this corresponds to 64 decimal or 40 in hexadecimal). Thus, a method of telegram reception could be as follows:

The receiving computer should store bytes until it receives 64 decimal, which corresponds to the end of a telegram. It may now process the bytes of the telegram just received.

- The first step in this processing should be to check that the number of bytes in the telegram are correct and that the EX-OR of all bytes in the telegram is 64 decimal.

The next byte that the computer receives (after 64 decimal) is the first byte of the next telegram. The interval between these two bytes can vary from 0.15 secs to 4 secs. There is no interval between bytes belonging to the same telegram.

Figure 2 illustrates the above.

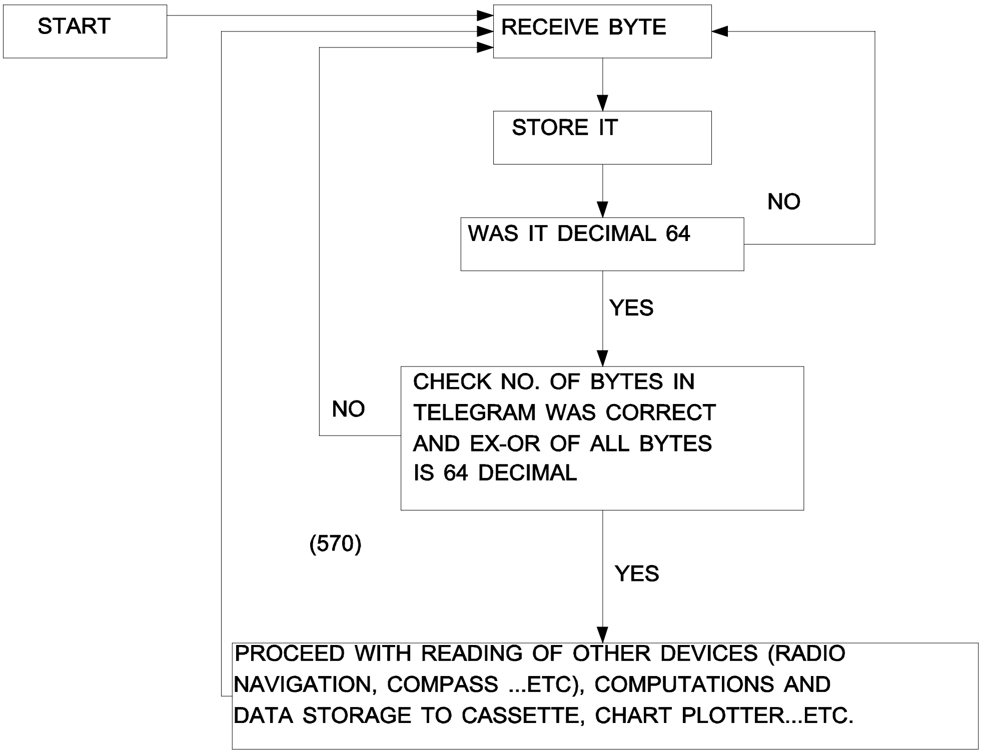


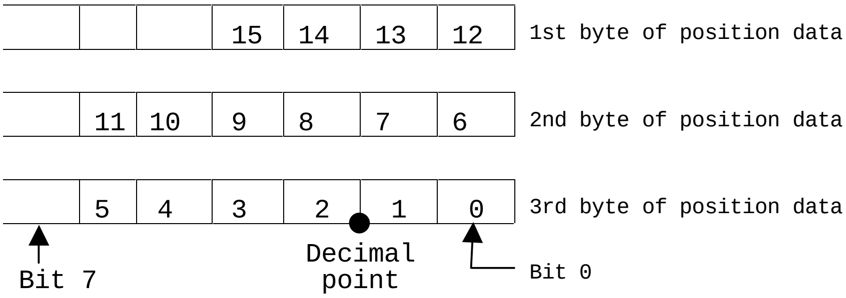
Figure 2 Telegram reception flow diagram

2.3 Position data in cartesian coordinates

2.3.1 General

The three coordinates, X, Y and Z, are each given as 3 bytes. These 3 bytes need to be assembled to make one 16-bit number, before decoding the 2’s complement. The following is a method for accomplishing this:

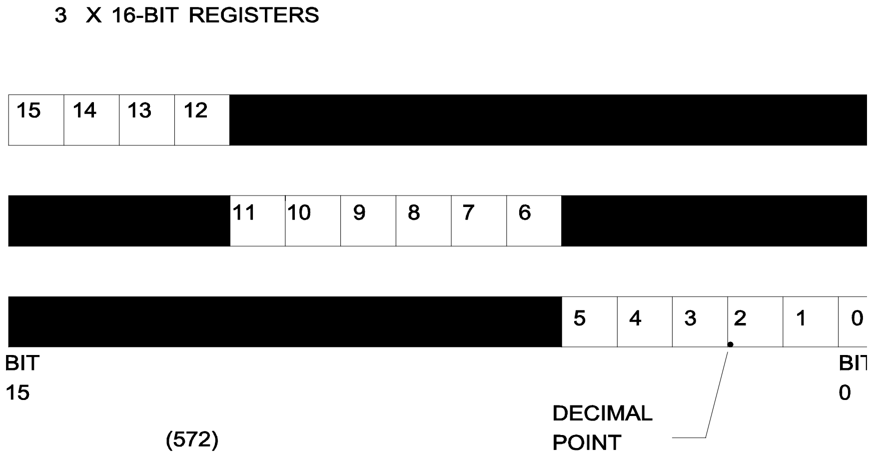
1. Of the three bytes, the first contains 4 bits and the second and third each contain 6 bits of relevant data.



			15	14	13	12	1st byte of position data
	11	10	9	8	7	6	2nd byte of position data
	5	4	3	2	1	0	3rd byte of position data

Note ! *Only the lower 8 bits of the 16-bit register are shown.*

Take the first byte and "AND" it with decimal 15 (00001111 binary). This clears bits 4 to 15. Shift the result twelve places to the left. Take the second byte, and "AND" it with 63 decimal (00111111 binary). This clears bits 6 to 15. Shift the result six places to the left. Take the third byte, and "AND" it with decimal 63 (00111111 binary). Leave this result as it is. The data is now in the following positions:



The shaded areas contain only zeros.

The first and second bytes should now be "OR’d", and the result "OR’d" with the third byte. The coordinate will now be a 16-bit binary number, held in 2’s complement form.

2. Check the most significant bit (MSB) (i.e. bit 15).

If bit 15 is zero, convert the binary to a decimal number and divide the result by 8 to place the decimal point in the correct position. This is a positive number.

If bit 15 is a one, complement the complete number and add 1 to it. Convert the binary number to a decimal, and divide it by eight to place the decimal point in the correct position. This number should then be multiplied by -1 to make it negative.

The above procedure should be used for all three coordinates (X, Y & Z).

Example 1:

The 3 bytes for the X coordinate are:

0 0 0 0 1 1 1 1 byte 1

0 0 1 1 0 0 1 1 byte 2

0 0 0 0 1 0 1 1 byte 3

Bits 0 to 3 of byte 1 contain relevant information. Bits 0 to 5 of bytes 2 and 3 also contain relevant information.

"AND-ing" byte 1 with decimal 15 masks out bits 4 to 15, and "AND-ing" bytes 2 and 3 with decimal 63 masks out bits 6 and 7 in each byte. After shifting byte 1 twelve places to the left and byte 2 six places to the left, the situation is as shown below:

1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 byte 1

0 0 0 0 1 1 0 0 1 1 0 0 0 0 0 0 byte 2

0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 byte 3

↑ ↑

bit 15 bit 0

"OR" the numbers to give:

1 1 1 1 1 1 0 0 1 1 0 0 1 0 1 1

↑ ↑

bit 15 bit 0

Refer to note on page 32 .

Bit 15 is a 1, therefore the number is negative. Take the complement of the number and add one. This gives:

0 0 0 0 0 0 1 1 0 0 1 1 0 1 0 1 = 821 decimal

Divide this by 8 to place the decimal point correctly, and multiply by -1 to make it negative.

$$X = \frac{821}{8} \text{ x}(-1) = - 102.63 \text{ metres}$$

Example 2:

The 3 bytes for the Y coordinate are:

0 0 0 0 0 0 0 0 byte 1

0 0 0 0 1 1 0 1 byte 2

0 0 1 0 1 1 1 0 byte 3

After the "AND" and "OR" operations, this gives:

```
0 0 0 0 0 0 1 1 0 1 1 0 1 1 1 0 = 878 decimal
↑                             ↑
bit 15                        bit 0
```

Refer to note on page 32 .

Bit 15 is zero, so the number is positive and no complementing is required. Divide by 8 to put the decimal point in the correct position.

$$Y = \frac{878}{8} = 109.75 \text{ metres}$$

2.4 Positioning data in polar coordinates

2.4.1 General

The range and depth are deciphered in the same manner as shown for the X, Y and Z coordinates.

The bearing is deciphered in a slightly different manner. Byte 3 of the 3 bearing bytes is a spare and can be ignored.

"AND" the first byte with decimal 63 and shift it six places to the left. "AND" the second byte with decimal 63 and "OR" it with the first byte. The result is a 12 bit number. To convert this to an angle between 0° and 360°, convert the binary number to decimal and multiply by 0.0878906. This gives an angle in the required range.

0.0878906 = 360° (in a circle)
4096 (max. decimal number with 12 bits)

That is: 0.0878906 is the weight of the LSB (least significant bit).

2.4.2 Course

The course can be decoded by the same method used to decode the bearing given with the position in polar coordinates.

2.4.3 Roll and Pitch

Convert the 2 bytes to a 12 bit number as shown for the bearing in polar coordinates.

x	x	x	x	11	10	9	8	7	6	5	4	3	2	1	0

↑ Bit 15 ↑ Bit 0

Positions marked with an X will be zero.

It is usual to convert roll and pitch to an angle between -180° and +180°.

This is achieved as follows:

If bit 11 is a zero, convert the binary number to a decimal and multiply it by 0.0878906.

If bit 11 is a one, complement all 12 bits and add one to the resulting number. Convert the binary number to decimal, and multiply by -0.0878906 to make the number negative and to place decimal point correctly.

A negative ROLL corresponds to Starboard side up.

A negative PITCH corresponds to Stern up.

Example 3:

For position data given in polar coordinates, the bearing bytes are as follows:

0 0 1 0 0 1 0 0 byte 1

0 0 0 1 1 0 1 0 byte 2

0 0 0 0 0 0 0 0 byte 3

Byte 3 will always be zero so this can be ignored. Bits 0 to 5 of bytes 1 and 2 contain the relevant information, so "AND" both bytes with decimal 63. Byte 1 must be shifted 6 places to the left. This gives:

0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 byte 1

0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 byte 2

"OR" the two numbers to give:

0 0 0 0 1 0 0 1 0 0 0 1 1 0 1 0 = 2330 decimal

Refer to note on page 32 .

As the bearing angle is required in the range 0° to 360°, there is no need to worry about the 2’s complement. Multiply the number by 0.0878906 to obtain the angle.

2330 x 0.0878906 = 205°

Example 4:

The two Roll bytes received are the same as given in Example 3 for bearing. After "AND-ing" and "OR-ing", this gives:

0 0 0 0 1 0 0 1 0 0 0 1 1 0 1 0

↑

Bit 11

As the pitch and roll angles are required in the range -180° to +180°, bit 11 must be checked and the 2’s complement taken into account. Bit 11 is set (negative angle) so complement the number and add 1. This gives:

0 0 0 0 0 1 1 0 1 1 1 0 0 1 1 0 = 1766 decimal

Multiply by -0.0878906 to make number negative and to place the decimal point correctly.

Roll = 1766 x -0.08789O6 = -155° (i.e. starboard side up)

Example 5:

The two pitch bytes received are:

0 0 0 1 0 1 0 0 byte 1

0 0 0 1 1 0 1 0 byte 2

After "AND-ing" and "OR-ing", this gives:

0 0 0 0 0 1 0 1 0 0 0 1 1 0 1 0 = 1306 decimal

↑ ↑

bit 11 bit 0

Bit 11 is zero so there is no need to complement. Multiply by 0.0878906 to obtain the pitch.

Pitch = 1306 x 0.0878906 = 114.8° (i.e. bow up)

Note !

OR, EX-OR or ADD may be used here. Although these are by no means the same operation, they will each give the same result when used in this case.

3 PRACTICAL POINTS

When using the HPR system in conjunction with a radio navigation system to accurately plot the position of an underwater object, it is important that both systems give data for a similar moment in time. Occasionally a reply might not be received from a transponder upon interrogation (as might happen during vessel manoeuvring). When this happens, the telegram transmitted for that interrogation will not contain "valid" position data, and this can be detected by examining bit 0 of the status byte of the telegram. Equally important is the fact that if the radio navigation system is read first and the computing system is waiting for a "valid" telegram from the HPR system (i.e. one which contains position data) a time delay occurs between the reading of the radio navigation and the HPR systems. Thus the following points should be kept in mind to help reduce errors due to software:

1. Check the status byte for validity of position data.

2. Check that no significant time delay can occur between the reading of the HPR system and any other system which requires to be time referenced with the HPR system.

4 HARDWARE INTERFACE CONNECTIONS

The telegrams described in this note are sent from the HPR system transceiver on two current loop interfaces and two RS232C interfaces.

The baud-rate of these four interfaces may be 110, 300, 600, 1200, 2400 or 4800 bauds. The four interfaces have the same baud-rate.

Telegrams to the HPR system transceiver from external equipment are sent to the HPR system using either a current loop interface or an RS232C interface.

For information regarding the interfaces refer to the *HPR 400 standard Installation manual*.