IEC 61162-1

INTERNATIONAL STANDARD

colour inside

**Maritime navigation and radiocommunication equipment and systems – Digital interfaces –
Part 1: Single talker and multiple listeners**

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Maritime navigation and radiocommunication equipment and systems – Digital interfaces –
Part 1: Single talker and multiple listeners

INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 1: Single talker and multiple listeners

FOREWORD

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International Standard IEC 61162-1 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This fifth edition cancels and replaces the fourth edition published in 2010, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

• new identifiers have been added to Table 4;

• the sentences CBR and MEB have been removed as they are now solely used by AIS shore based equipment:

• new sentences ACN, ALC, ALF, ARC, EPV, HCR, HRM, MOB, NSR, RLM, RRT, SM1, SM2, SM3, SM4, SMB, SPW and TRL have been added;

- revisions have been made to ABK, ABM, GNS, NAK, NRM, RMC, ROR and TTD;

- the methods of testing in Annex B have been revised.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/799/FDIS	80/806/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

A list of all parts in the IEC 61162 series, published under the general title *Maritime navigation and radiocommunication equipment and systems – Digital interface*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,

- withdrawn,

- replaced by a revised edition, or

- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC 61162 Maritime navigation and radiocommunication equipment and systems – Digital interfaces consists of 5 parts which specify digital interfaces for application in marine navigation, radiocommunication and system integration, as follows:

Part 1:   *Single talker and multiple listeners;*

Part 2:   *Single talker and multiple listeners, high speed transmission;*

Part 3:   *Multiple talkers and multiple listeners – Serial data instrument network;*

Part 450: *Multiple talkers and multiple listeners – Ethernet interconnection;*

Part 460: *Multiple talkers and multiple listeners – Ethernet interconnection – Safety and security*

IEC technical committee 80 interface standards are developed with input from manufacturers, private and government organisations and equipment operators. The information is intended to meet the needs of users at the time of publication, but users should recognise that as applications and technology change, interface standards should change as well. Users of this standard are advised to immediately inform the IEC of any perceived inadequacies therein.

The first edition of IEC 61162-1 was published in 1995. The second edition published in 2000 removed some sentences which were no longer in use, added some new sentences and included details of the ship equipment defined in IMO resolutions together with appropriate sentences for communication between them. This information was subsequently removed from the third edition when it became the practice to specify the sentence formatters in the individual standards for equipment.

The third edition published in 2007 introduced a re-arrangement of the text and new sentences particularly to support the Automatic Identification System and the Voyage Data Recorder. The third edition also introduced a further type of start of sentence delimiter. The conventional delimiter "$" was retained for the conventional sentences which are now called parametric sentences. The new delimiter "!" identifies sentences that conform to special purpose encapsulation.

The fourth edition removed some sentences which were not in use, added some new sentences for new applications and made some corrections and additions. In particular the sentences of relevance to satellite navigation receivers were expanded to facilitate the description of new satellite systems.

This fifth edition also removes some sentences which are no longer in use, adds some new sentences for new applications and makes some corrections and additions.

Liaison has been maintained with NMEA and this edition has been aligned where appropriate with NMEA 0183 version 4.10.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 1: Single talker and multiple listeners

1 Scope

This part of IEC 61162 contains the requirements for data communication between maritime electronic instruments, navigation and radiocommunication equipment when interconnected via an appropriate system.

This part of IEC 61162 is intended to support one-way serial data transmission from a single talker to one or more listeners. These data are in printable ASCII form and may include information such as position, speed, depth, frequency allocation, etc. Typical messages may be from about 11 to a maximum of 79 characters in length and generally require transmission no more rapidly than one message per second.

The electrical definitions in this standard are not intended to accommodate high-bandwidth applications such as radar or video imagery, or intensive database or file transfer applications. Since there is no provision for guaranteed delivery of messages and only limited error checking capability, this standard should be used with caution in all safety applications.

For applications where a faster transmission rate is necessary, reference should be made to IEC 61162-2.

For applications to shore based equipment of the automatic identification system (AIS) reference should be made to the IEC 62320 series.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60945:2002, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61097-6, *Global maritime distress and safety system (GMDSS) – Part 6: Narrowband direct-printing telegraph equipment for the reception of navigational and meteorological warnings and urgent information to ships (NAVTEX)*

IEC 61108 (all parts), *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS)*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interface*

IEC 61162-2:1998, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission*

IEC 61174, *Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements, methods of testing and required test results*

IEC 61924-2:2012, *Maritime navigation and radiocommunication equipment and systems – Integrated navigation systems – Part 2: Modular structure for INS – Operational and performance requirements, methods of testing and required test results*

IEC 61996 (all parts), *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR)*

ISO/IEC 8859 (all parts), *Information technology – 8-bit single-byte coded graphic character sets*

ISO/IEC 8859-1:1998, *Information technology – 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No.1*

ISO/IEC 10646, *Information technology – Universal Coded Character Set (UCS)*

ITU-R Recommendation M.493, *Digital selective-calling system for use in the maritime mobile service*

ITU-R M.625, *Direct printing telegraph equipment employing automatic identification in the maritime mobile service*

ITU-R Recommendation M.821, *Optional expansion of the digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.1084, *Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service*

ITU-R Recommendation M.1371, *Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile band*

ITU-T Recommendation X.27/V.11:1996, *Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s*

IMO GMDSS.1/Circ.18, *Master plan of shore-based facilities for the global maritime distress and safety system (GMDSS master plan)*

IMO, *International Convention on Load Lines*

IMO, *International SafetyNET Manual*

IMO MSC.252(83)*, Performance standards for integrated navigation systems (INS)*

IMO MSC.302(87), *Performance standards for Bridge Alert Management (BAM)*

IMO Publication 951E, *NAVTEX Manual*

3   Terms and definitions

3.1   General

Common terms are defined in the glossary of Annex A. Where there is a conflict, terms are interpreted, wherever possible, in accordance with the references in Clause 2.

3.2   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.2.1
talker
any device which sends data to other devices

Note 1 to entry: The type of talker is identified by a 2-character mnemonic as listed in 8.2 (see Table 4).

3.2.2
listener
any device which receives data from another device

4   Manufacturer's documentation

Operator manuals or other appropriate literature provided for equipment that is intended to meet the requirements of this standard shall contain the following information:

a) identification of the A and B signal lines;

b) the output drive capability as a talker;

c) a list of approved sentences, noting unused fields, proprietary sentences transmitted as a talker and transmission interval for each sentence;

d) the load requirements as a listener;

e) a list of sentences and associated data fields that are required as a listener;

f) the current software and hardware revision if this is relevant to the interface;

g) an electrical description or schematic of the listener/talker input/output circuits citing actual components and devices used, including connector type and part number;

h) the version number and date of update of the standard for which compliance is sought.

5   Hardware specification

5.1   General

NOTE   Guidelines on methods of testing are given in Annex B.

One talker and multiple listeners may be connected in parallel over an interconnecting wire. The number of listeners depends on the output capability and input drive requirements of individual devices.

5.2   Interconnecting wire

Interconnection between devices may be by means of a two-conductor, shielded, twisted-pair wire.

5.3   Conductor definitions

The conductors referred to in this standard are the signal lines A and B, and shield.

5.4   Electrical connections/shield requirements

All signal line A connections are connected in parallel with all device A connections and all signal line B connections are connected in parallel with all device B connections. The shields of all listener cables should be connected to the talker chassis only and should not be connected at each listener.

5.5   Connector

No standard connector is specified. Wherever possible readily available commercial connectors shall be used. Manufacturers shall provide means for user identification of the connections used.

5.6   Electrical signal characteristics

5.6.1   General

This subclause describes the electrical characteristics of transmitters and receivers.

5.6.2   Signal state definitions

The idle, marking, logical 1, OFF or stop bit states are defined by a negative voltage on line A with respect to line B.

The active, spacing, logical 0, ON or start bit states are defined by a positive voltage on line A with respect to line B.

It should be noted that the above A with respect to B levels are inverted from the voltage input/output requirements of standard UARTs and that many line drivers and receivers provide a logic inversion.

5.6.3   Talker drive circuits

No provision is made for more than a single talker to be connected to the bus. The drive circuit used to provide the signal A and the return B shall meet, as a minimum, the requirements of ITU-T Recommendation X.27/V.11.

5.6.4   Listener receive circuits

Multiple listeners may be connected to a single talker. The listener receive circuit shall consist of an opto-isolator and shall have protective circuits to limit current, reverse bias and power dissipation at the opto-diode as shown in Figure 1. Reference to example circuits is made in 9.2.

The receive circuit shall be designed for operation with a minimum change of input voltage of 2,0 V and shall not take more than 2,0 mA from the line at that voltage.

NOTE   For reasons of compatibility with equipment designed to comply with earlier versions of NMEA 0183, it is noted that the idle, marking, logical "1", OFF or stop bit state had previously been defined to be in the range −15,0 V to +0,5 V. The active, spacing, logical "0", ON or start bit state was defined to be in the range +4,0 V to +15,0 V while sourcing was not less than 15 mA.
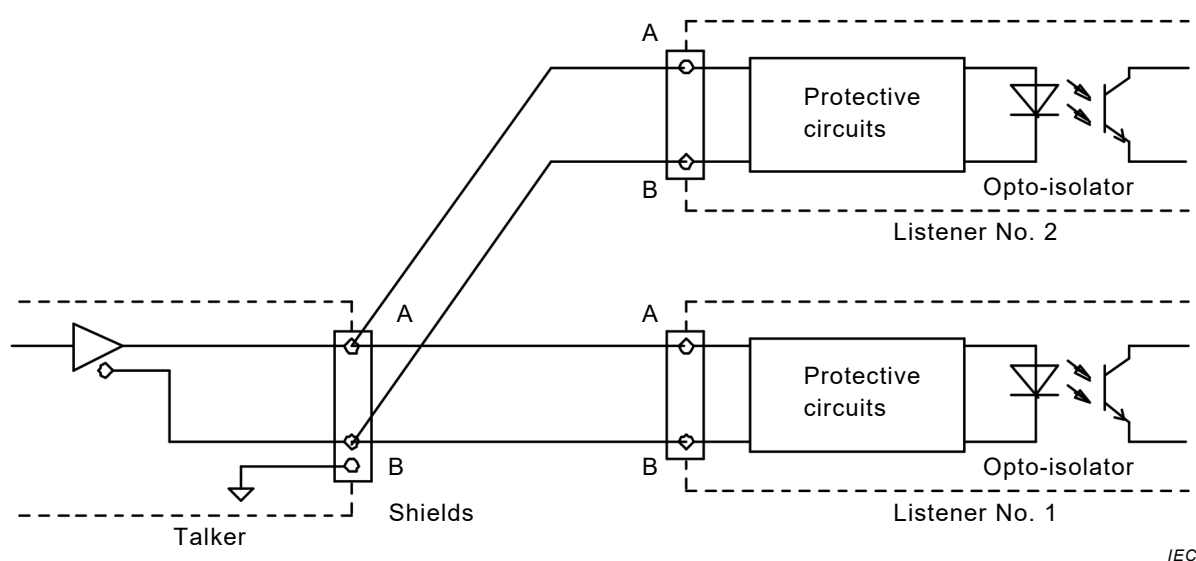
Figure 1 – Listener receive circuit

5.6.5 Electrical isolation

Within a listener, there shall be no direct electrical connection between the signal line A, return line B, or shield and ship's ground or power. Isolation from ship's ground is required.

5.6.6 Maximum voltage on bus

The maximum applied voltage between signal lines A and B and between either line and ground shall be in accordance with ITU-T Recommendation X.27/V.11.

For protection against mis-wiring and for use with earlier talker designs, all receive circuit devices shall be capable of withstanding 15 V between signal lines A and B and between either line and ground for an indefinite period.

6 Data transmission

Data is transmitted in serial asynchronous form in accordance with the standards referenced in Clause 2. The first bit is a start bit and is followed by data bits, least-significant-bit first, as illustrated by Figure 2.

The following parameters are used:

- baud rate 4 800;
- data bits 8 (D7 = 0), parity none;
- stop bits 1.
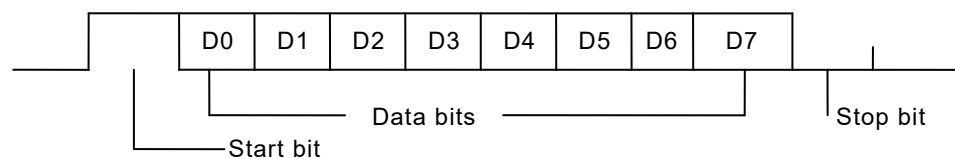
Figure 2 – Data transmission format

7 Data format protocol

7.1 Characters

7.1.1 General

All transmitted data shall be interpreted as ASCII characters. The most significant bit of the eight-bit character shall always be transmitted as zero (D7 = 0).

7.1.2 Reserved characters

The reserved character set consists of those ASCII characters shown in 8.1 (Table 1). These characters are used for specific formatting purposes, such as sentence and field delimiting, and except for code delimiting, shall not be used in data fields.

7.1.3 Valid characters

The valid character set consists of all printable ASCII characters (HEX 20 to HEX 7E) except those defined as reserved characters. The list of the valid character set is given in 8.1 (Table 2).

7.1.4 Undefined characters

ASCII values not specified as either "reserved characters" or "valid characters" are excluded and shall not be transmitted at any time.

When it is necessary to communicate an 8-bit character defined by ISO/IEC 8859-1 that is a reserved character (Table 1) or not listed in Table 2 as a valid character (e.g. in a proprietary sentence or text sentence), three characters shall be used.

The reserved character "^" (HEX 5E) is followed by two ASCII characters (0-9, A-F) representing the HEX value of the character to be communicated. For example:

- to send heading as "127.5°", transmit "127.5 ^F8";

- to send the reserved characters <CR><LF>, transmit "^0D^0A";

- to send the reserved character "^", transmit "^5E".

IEC 60945 states that, as a minimum requirement, English language shall be used for controls and displays. Other languages/characters are only supported by the TUT sentence.

7.1.5 Character symbols

When individual characters are used in this standard to define units of measurement, to indicate the type of data field, type of sentence, etc. they shall be interpreted according to the character symbol in 8.1 (Table 3).

7.2 Fields

7.2.1 String

A field consists of a string of valid characters, or no characters (null field), located between two appropriate delimiter characters.

7.2.2 Address field

7.2.2.1 General

An address field is the first field in a sentence and follows the "$" or "!" delimiter. It serves to define the sentence. The "$" delimiter identifies sentences that conform to the conventional

parametric and delimited field composition rules as described in 7.3.3. The "!" delimiter identifies sentences that conform to the special-purpose encapsulation and non-delimited field composition rules as described in 7.3.3. Characters within the address field are limited to digits and upper case letters. The address field shall not be a null field. Only sentences with the following three types of address fields shall be transmitted.

7.2.2.2   Approved address field

Approved address fields consist of five digits and upper case letter characters defined by this standard. The first two characters are the talker identifier, listed in 8.2 (Table 4). The talker identifier serves to define the nature of the data being transmitted.

Devices that have the capability to transmit data from multiple sources shall transmit the appropriate talker identifier (for example a device with both a GPS receiver and a LORAN-C receiver shall transmit GP when the position is GPS-based, LC when the position is LORAN-C-based, and IN for integrated navigation shall be used if lines of position from LORAN-C and GPS are combined into a position fix).

Devices capable of re-transmitting data from other sources shall use the appropriate identifier (for example GPS receivers transmitting heading data shall not transmit $GPHCD unless the compass heading is actually derived from the GPS signals).

The next three characters form the sentence formatter used to define the format and the type of data. A list of sentence formatters is given in 8.3.

7.2.2.3   Query address field

The query address field consists of five characters and is used for the purpose of requesting transmission of a specific sentence on a separate bus from an identified talker.

The first two characters are the talker identifier of the device requesting data, the next two characters are the talker identifier of the device being addressed and the final character is the query character "Q".

7.2.2.4   Proprietary address field

The proprietary address field consists of the proprietary character "P" followed by a three-character manufacturer's mnemonic code, used to identify the talker issuing a proprietary sentence, and any additional characters as required.

NOTE   A list of valid manufacturer's mnemonic codes may be obtained from NMEA (see 7.3.6).

7.2.3   Data fields

7.2.3.1   General

Data fields in approved sentences follow a "," delimiter and contain valid characters (and code delimiters "^") in accordance with the formats illustrated in 8.2 (Table 5). Data fields in proprietary sentences contain only valid characters and the delimiter characters "," and "^", but are not defined by this standard.

Because of the presence of variable data fields and null fields, specific data fields shall only be located within a sentence by observing the field delimiters ",". Therefore, it is essential for the listener to locate fields by counting delimiters rather than counting the total number of characters received from the start of the sentence.

7.2.3.2 Variable length fields

Although some data fields are defined to have fixed length, many are of variable length in order to allow devices to convey information and to provide data with more or less precision, according to the capability or requirements of a particular device.

Variable length fields may be alphanumeric or numeric fields. Variable numeric fields may contain a decimal point and may contain leading or trailing zeros.

7.2.3.3 Data field types

Data fields may be alpha, numeric, alphanumeric, variable length, fixed length or fixed/variable (with a portion fixed in length while the remainder varies). Some fields are constant, with their value dictated by a specific sentence definition. The allowable field types are summarized in 8.2 (Table 5).

7.2.3.4 Null fields

A null field is a field of length zero, i.e. no characters are transmitted in the field. Null fields shall be used when the value is unreliable or not available.

For example, if heading information were not available, sending data of "000" is misleading because a user cannot distinguish between "000" meaning no data and a legitimate heading of "000". However, a null field, with no characters at all, clearly indicates that no data is being transmitted.

Null fields with their delimiters can have the following appearance depending on where they are located in the sentence:

<div align="center">",,"   ",*"</div>

The ASCII NULL character (HEX 00) shall not be used as the null field.

7.2.4 Checksum field

A checksum field shall be transmitted in all sentences. The checksum field is the last field in a sentence and follows the checksum delimiter character "*". The checksum is the eight-bit exclusive OR (no start or stop bits) of all characters in the sentence, including "," and "^" delimiters, between but not including the "$" or "!" and the "*" delimiters.

The hexadecimal value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first.

Examples of the checksum field are:

$GPGLL,5057.970,N,00146.110,E,142451,A*27 and

$GPVTG,089.0,T,,,15.2,N,,,*53.

7.2.5 Sequential message identifier field

This is a field that is critical to identifying groups of 2 or more sentences that make up a multi-sentence message. This field applies only to a single sentence formatter, and is not used to associate different sentence formatters. This field is incremented each time a new multi-sentence message is generated with the same sentence formatter. This field's value is reset to zero when it is incremented beyond the defined maximum value. This field's maximum value, size, and format of this field is determined by the applicable sentence

definition in Clause 8. This is one of three key fields supporting the multi-sentence message capability (see 7.3.9).

7.3 Sentences

7.3.1 General structure

This subclause describes the general structure of sentences. Details of specific sentence formats are found in 8.3. Some sentences may specify restrictions beyond the general limitations given in this standard. Such restrictions may include defining some fields as fixed length, numeric or text only, required to be non-null, transmitted with a certain frequency, etc.

The maximum number of characters in a sentence shall be 82, consisting of a maximum of 79 characters between the starting delimiter "$" or "!" and the terminating delimiter <CR><LF>.

The minimum number of fields in a sentence is one (1). The first field shall be an address field containing the identity of the talker and the sentence formatter which specifies the number of data fields in the sentence, the type of data they contain and the order in which the data fields are transmitted. The remaining portion of the sentence may contain zero or multiple data fields.

The maximum number of fields allowed in a single sentence is limited only by the maximum sentence length of 82 characters. Null fields may be present in the sentence and shall always be used if data for that field is unavailable.

All sentences begin with the sentence-starting delimiter character "$" or "!" and end with the sentence-terminating delimiter <CR><LF>.

7.3.2 Description of approved sentences

Approved sentences are those designed for general use and detailed in this standard. Approved sentences are listed in 8.3 and shall be used wherever possible. When a deprecated sentence has been replaced by an approved sentence, this is indicated in 8.3 by a note.

Other sentences, not recommended for new designs, may be found in practice.

NOTE Such sentences are listed in NMEA 0183. Information on such sentences may be obtained from the National Marine Electronics Association (NMEA) (see 7.3.6).

An approved sentence contains, in the order shown, the following elements:

ASCII	HEX	Description
"$" or "!"	24 or 21	– start of sentence
<address field>		– talker identifier and sentence formatter
["," <data field>]		– zero or more data fields
["," <data field>]		
"*" <checksum field>		– checksum field
<CR><LF>	0D 0A	– end of sentence

7.3.3   Parametric sentences

7.3.3.1   Description

These sentences start with the "$" delimiter, and represent the majority of sentences defined by this standard. This sentence structure, with delimited and defined data fields, is the preferred method for conveying information.

The basic rules for parametric sentence structures are:

- the sentence begins with the "$" delimiter;

- only approved sentence formatters are allowed. Formatters used by special-purpose encapsulation sentences cannot be reused. See 8.2;

- only valid characters are allowed. See 8.1 (Table 1 and Table 2);

- only approved field types are allowed. See 8.2 (Table 5);

- data fields (parameters) are individually delimited, and their content is identified and often described in detail by this standard;

- encapsulated non-delimited data fields are NOT ALLOWED.

7.3.3.2   Structure

The following provides a summary explanation of the approved parametric sentence structure:

$aaccc, c---c*hh<CR><LF>

ASCII	HEX	Description
"$"	24	Start of sentence: starting delimiter.
aaccc		Address field: alphanumeric characters identifying type of talker, and sentence formatter. The first two characters identify the talker. The last three are the sentence formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate readouts by users.
","	2C	Field delimiter: starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.
c---c		Data sentence block: follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by the third and subsequent characters of the address field (the sentence formatter). Data fields may be of variable length and are preceded by delimiters ",".
"*"	2A	checksum delimiter: follows last data field of the sentence. It indicates that the following two alpha-numeric characters show the HEX value of the checksum.
hh		Checksum field: the absolute value calculated by exclusive- OR'ing the eight data bits (no start bits or stop bits) of each character in the sentence between, but excluding, "$" and "*". The hexadecimal value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first. The checksum field is required in all cases.

<CR><LF> 0D 0A   End of sentence: sentence terminating delimiter.

7.3.4   Encapsulation sentences

7.3.4.1   Description

These sentences start with the "!" delimiter. The function of this special-purpose sentence structure is to provide a means to convey information, when the specific data content is unknown or greater information bandwidth is needed. This is similar to a modem that transfers information without knowing how the information is to be decoded or interpreted.

The basic rules for encapsulation sentence structures are:

- the sentence begins with the "!" delimiter;
- only approved sentence formatters are allowed. Formatters used by conventional parametric sentences cannot be reused. See 8.2;
- only valid characters are allowed. See 8.1 (Table 1 and Table 2);
- only approved field types are allowed. See 8.2 (Table 5);
- only six-bit coding may be used to create encapsulated data fields. See 8.2 (Table 5);
- encapsulated data fields may consist of any number of parameters, and their content is not identified or described by this standard;
- the sentence shall be defined with one encapsulated data field and any number of parametric data fields separated by the "," data field delimiter. The encapsulated data field shall always be the second to last data field in the sentence, not counting the checksum field. See 7.2.3;
- the sentence contains a "total number of sentences" field. See 7.3.4.2;
- the sentence contains a "sentence number" field. See 7.3.4.2,
- the sentence contains a "sequential message identifier" field. See 7.3.4.2;
- the sentence contains a "fill-bits" field immediately following the encapsulated data field. The fill-bits field shall always be the last data field in the sentence, not counting the checksum field. See 7.3.4.2.

This method to convey information is to be used only when absolutely necessary, and will only be considered when one or both of two conditions are true, and when there is no alternative.

Condition 1: The data parameters are unknown by devices having to convey the information. For example, the ABM and BBM sentences meet this condition, because the content is not known to the Automatic Identification System (AIS).

Condition 2: When information requires a significantly higher data rate than can be achieved by the IEC 61162-1 (4 800 Bd) and IEC 61162-2 (38 400 Bd) standards, utilizing parametric sentences.

By encapsulating a large amount of information, the number of overhead characters, such as "," field delimiters can be reduced, resulting in higher data transfer rates. It is very unusual for this second condition to be fulfilled. As an example, an AIS has a data rate capability of 4 500 messages per minute, and satisfies this condition, resulting in the VDM and VDO sentences.

7.3.4.2   Structure

The following provides a summary explanation of the approved encapsulation sentence structure:

!aaccc,x1,x2,x3,c--c,x4*hh<CR><LF>

ASCII	HEX	description
"!"	21	start of sentence: starting delimiter.
aaccc		address field: alphanumeric characters identifying type of talker, and sentence formatter. The first two characters identify the talker. The last three are the sentence formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate readouts by users.
","	2C	field delimiter: starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.
x1		total number of sentences field: encapsulated information often requires more than one sentence. This field represents the total number of encapsulated sentences needed. This may be a fixed or variable length, and is defined by the sentence definitions in 8.3.
x2		sentence number field: encapsulated information often requires more than one sentence. This field identifies which sentence of the total number of sentences this is. This may be fixed or variable length, and is defined by the sentence definitions in 8.3.
x3		sequential message identifier field: this field distinguishes one encapsulated message consisting of one or more sentences, from another encapsulated message using the same sentence formatter. This field is incremented each time an encapsulated message is generated with the same formatter as a previously encapsulated message. The value is reset to zero when it is incremented beyond the defined maximum value. The maximum value and size of this field are determined by the applicable sentence definitions in Clause 8.
c--c		data sentence block: follows sequential message identifier field and is a series of data fields consisting of one or more parametric data fields and one encapsulated data field. The data field sequence is fixed and identified by third and subsequent characters of the address field (the "sentence formatter"). Individual data fields may be of variable length and are preceded by delimiters ",". The encapsulated data field shall always be the second to the last data field in the sentence.
x4		fill-bits field: this field represents the number of fill-bits added to complete the last six-bit coded character. This field is required and shall immediately follow the encapsulated data field. To encapsulate, the number of binary bits shall be a multiple of six. If it is not, one to five fill-bits are added. This field shall be set to zero when no fill-bits have been added. The fill-bits field shall always be the last data field in the sentence. This shall not be a null field.
"*"	2A	checksum delimiter: follows the last data field of the sentence. It indicates that the following two alphanumeric characters show the HEX value of the checksum.
hh		checksum Field: the absolute value calculated by exclusive-OR'ing the 8 data bits (no start bits or stop bits) of each character in the sentence, between, but excluding "!" and "*". The hexadecimal

value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first. The checksum field is required in all transmitted sentences.

<CR><LF> 0D 0A   end of sentence: sentence terminating delimiter.

7.3.5   Query sentences

7.3.5.1   Description

Query sentences are intended to request approved sentences to be transmitted in a form of two-way communication. The use of query sentences implies that the listener shall have the capability of being a talker with its own bus. Query sentences shall always be constructed with the "$" start of sentence delimiter.

The approved query sentence contains, in the order shown, the following elements:

ASCII	HEX	description
"$"	24	start of sentence
<aa>		talker identifier of requester
<aa>		talker identifier for device from which data is being requested
"Q"		query character, identifies query address
","		data field delimiter
<ccc>		approved sentence formatter of data being requested
"*" <checksum field>		checksum field
<CR><LF>	0D 0A	end of sentence

7.3.5.2   Reply to query sentence

The reply to a query sentence is the approved sentence that was requested. The use of query sentences requires cooperation between the devices that are interconnected. A reply to a query sentence is not mandatory and there is no specified time delay between the receipt of a query and the reply.

7.3.6   Proprietary sentences

These are sentences not included within this standard; these provide a means for manufacturers to use the sentence structure definitions of this standard to transfer data which does not fall within the scope of approved sentences. This will generally be for one of the following reasons:

a) data is intended for another device from the same manufacturer, is device specific, and not in a form or of a type of interest to the general user;

b) data is being used for test purposes prior to the adoption of approved sentences;

c) data is not of a type and general usefulness which merits the creation of an approved sentence.

NOTE   The manufacturer's reference list of mnemonic codes is a component of the equivalent specification NMEA 0183. [1]

_____

[1] The NMEA Secretariat maintains the master reference list which comprises codes registered and formally adopted by NMEA.

The address for the registration of manufacturer's codes is:

NMEA 0183 Technical Standards Committee   Phone: +1 410 975 9450

A proprietary sentence contains, in the order shown, the following elements:

ASCII	HEX	description
"$"	24	start of sentence
"P"	50	proprietary sentence ID
<aaa>		manufacturer's mnemonic code (The NMEA secretariat maintains the master reference list which comprises codes registered and formally adopted by NMEA)
[<valid characters,"^" and "," >]		manufacturer's data
"*"<checksum field>		checksum field
<CR><LF>	0D 0A	end of sentence

Proprietary sentences shall include checksums and conform to requirements limiting overall sentence length. Manufacturer's data fields shall contain only valid characters but may include "^" and "," for delimiting or as manufacturer's data. Details of proprietary data fields are not included in this standard and need not be submitted for approval. However, it is required that such sentences be published in the manufacturer's manuals for reference.

7.3.7 Command sentences

Command sentences are those that provide an ability to alter or change the configuration or operation of a device. Examples of legacy command sentences are the "HTC – Heading/Track control command" and the "ACA – AIS channel assignment" sentences. When a command sentence is generated in response to a Query sentence, a means to identify that the sentence has only a status report of current settings is required.

Some command sentences cannot be queried and provide a different sentence formatter for status information, so they should not be misinterpreted. This is the case with the HTC sentence. The HTD sentence is provided to determine the status of a heading control system's settings. There is a high possibility of misinterpretation if a device receives a query sentence for a HTC sentence, and erroneously provides the HTC sentence.

The ACA sentence is an example of a command sentence that can also be queried to determine the status of the current settings. The ACA sentence definition provides a field that, when set to any valid value, identifies the sentence as a status of current settings and not a command to change settings. There is a high probability of misinterpreting this sentence because the field is used for two distinct purposes at the same time.

To avoid any possibility of misinterpretation and to satisfy the requirements of the voyage data recorder required to be carried on ships under the SOLAS Convention, a clear and unambiguous means to identify that a command sentence is to be interpreted as a command or that it contains status information only and is not a command shall be provided.

Any sentence that contains one or more command fields shall be identified as a "command sentence". Command sentences shall contain the "Sentence status flag" field.

Field formatter	Description
a	Sentence status flag. This field is a required field for any sentence designated as a command sentence. The field distinguishes the contents of command sentence as being commands intended to change settings or as being status information only.
	This field shall not be null.

This field shall contain an "R" when the sentence is a status report of current settings. This may occur when the sentence is provided in response to a query or is autonomously generated.

This field shall contain a "C" when the sentence is a configuration command to change settings. A sentence without a "C" in this field is not a command. If a designated command sentence cannot be queried, as stated in the sentence's definition, this field shall always be set to "C".

Where data fields are NULL in a command sentence (sentence status flag = C), there is no change in their setting. When a configuration data field is NULL in a status report sentence (sentence status flag = R), this data field is not configured.

7.3.8   Valid sentences

Approved sentences, query sentences and proprietary sentences are the only valid sentences. Sentences of any other form are non-valid and shall not be transmitted on the bus.

7.3.9   Multi-sentence messages

Multi-sentence messages may be transmitted where a data message exceeds the available character space in a single sentence formatter. All the sentences in a multi-sentence message use the same sentence formatter. The key fields supporting the multi-sentence message capability shall always be included, without exception. These required fields are: total number of sentences, sentence number, and sequential message identifier fields. Only sentence definitions containing these fields may be used to form messages. The TUT and VDM sentences are good examples of how a sentence is defined to provide these capabilities.

The listener should be aware that a multi-sentence message may be interrupted by a higher priority message such as an alarm sentence, and thus the original message should be discarded as incomplete and has to await a re-transmission. The listener has to check that multi-sentences are contiguous.

Should an error occur in any sentence of a multi-sentence message, the listener shall discard the whole message and be prepared to receive the message again upon the next transmission.

7.3.10   Sentence transmission timing

Frequency of sentence transmission when specified shall be in accordance with the approved sentence definitions (see 8.3). When not specified, the rate shall be consistent with the basic measurement or calculation cycle but generally not more frequently than once per second.

It is desirable that sentences be transmitted with minimum inter-character spacing, preferably as a near continuous burst, but under no circumstance shall the time to complete the transmission of a sentence be greater than 1 s.

7.3.11   Additions to approved sentences

In order to allow for improvements or additions, future revisions of this standard may modify existing sentences by adding new data fields after the last data field but before the checksum delimiter character "*" and checksum field. Listeners shall determine the end of the sentence by recognition of "<CR><LF>" and "*" rather than by counting field delimiters. The checksum value shall be computed on all received characters between, but not including, "$" or "!" and "*" whether or not the listener recognizes all fields.

7.4 Error detection and handling

Listening devices shall detect errors in data transmission including:

a) checksum error (see 7.2.4);

b) invalid characters (see 7.1.3);

c) incorrect length of address field (see 7.2.2), and data fields as specified within sentence definitions;

d) time out of sentence transfer (see 7.3.10).

Listening devices shall use only correct sentences, consistent with the version of IEC 61162-1 supported by the talker devices.

7.5 Handling of deprecated sentences

Deprecated sentences are no longer recommended for sole use in new or revised designs. These sentences are valid sentences, but due to changing circumstances it is desirable to delete or replace these sentences.

Generally, in each of the deprecated sentences a reference is made to a replacement sentence in the current edition of the standard. Manufacturers are urged to use the currently recommended sentence in new or revised designs. It is desirable that manufacturers provide both new and old sentences whenever possible for a period of time that will serve as a phase-in period for new sentences.

8 Data content

8.1 Character definitions

Table 1, Table 2 and Table 3 indicate character definitions.

Table 1 – Reserved characters

ASCII	HEX	DEC	Description
<CR>	0D	13	Carriage return
<LF>	0A	10	Line feed – End of sentence delimiter
$	24	36	Start of sentence delimiter
*	2A	42	Checksum field delimiter
,	2C	44	Field delimiter
!	21	33	Start of encapsulation sentence delimiter
\	5C	92	TAG block delimiter
^	5E	94	Code delimiter for HEX representation of ISO/IEC 8859-1 (ASCII) characters
~	7E	126	Reserved for future use
<del>	7F	127	Reserved for future use

Table 2 – Valid characters

ASCII	HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC
Space	20	32	@	40	64	`	60	96
Reserved	21	33	A	41	65	a	61	97
"	22	34	B	42	66	b	62	98

ASCII	HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC
#	23	35	C	43	67	c	63	99
Reserved	24	36	D	44	68	d	64	100
%	25	37	E	45	69	e	65	101
&	26	38	F	46	70	f	66	102
'	27	39	G	47	71	g	67	103
(	28	40	H	48	72	h	68	104
)	29	41	I	49	73	i	69	105
Reserved	2A	42	J	4A	74	j	6A	106
+	2B	43	K	4B	75	k	6B	107
Reserved	2C	44	L	4C	76	l	6C	108
–	2D	45	M	4D	77	m	6D	109
.	2E	46	N	4E	78	n	6E	110
/	2F	47	O	4F	79	o	6F	111
0	30	48	P	50	80	p	70	112
1	31	49	Q	51	81	q	71	113
2	32	50	R	52	82	r	72	114
3	33	51	S	53	83	s	73	115
4	34	52	T	54	84	t	74	116
5	35	53	U	55	85	u	75	117
6	36	54	V	56	86	v	76	118
7	37	55	W	57	87	w	77	119
8	38	56	X	58	88	x	78	120
9	39	57	Y	59	89	y	79	121
:	3A	58	Z	5A	90	z	7A	122
;	3B	59	[	5B	91	{	7B	123
<	3C	60	Reserved	5C	92			7C	124
=	3D	61	]	5D	93	}	7D	125
>	3E	62	Reserved	5E	94	Reserved	7E	126
?	3F	63	_	5F	95	Reserved	7F	127

Table 3 – Character symbol

Symbol	Definition
A	Status symbol; Yes; Data valid; Warning flag clear; Auto; Ampere, ASCII
a	Alphabet character variable A through Z or a through z
B	Bar (pressure, 1 000 mb = 100 kPa (Pascal(Pa))), Bottom
C	Celsius (Degrees); Course-up
c	Valid character; Calculating
d	Destination-identification
D	Degrees (of arc)
E	Error; East; Engine
F	Fathoms (1 fathom equals 1,828 766 m)
f	Feet (1 foot equals 0,304 79 m)
G	Great circle; Green

Symbol	Definition
g	Good
H	Compass heading; Head-up; Hertz; Humidity
h	Hours; HEX number
I	Inches (1 inch equals 0,025 4 m)
J	Input operation completed
K	Kilometres; km/h; kg/m^3
k	Kilograms
L	Left; Local; Lost target
l	Latitude; Litres; l/s
M	Metres; m/s; Magnetic; Manual; Cubic metres
m	Minutes; message
N	Nautical miles; Knots; North; North-up; Newtons
n	Numeral; address
P	Purple; Proprietary (only when following "$" or "!"); Position sensor; Per cent; Pascal (pressure)
Q	Query; Target-being-acquired
R	Right; Rhumb line; Red; Relative; Reference; Radar tracking; revolutions/min (RPM)
S	South; Statute miles (1 609,31 m); Statute miles/h; Shaft Salinity parts/thousand; Simulator mode
s	Seconds; Six-bit number, Source-identification
T	Time difference; True; Track; Tracked target
t	Test
U	Dead reckoning estimate
u	Sign, if minus "-" (HEX 2D)
V	Data invalid; No; Warning flag set; Manual; Volt
W	West; Water; Wheelover
x	Numeric character variable
y	Longitude
Z	Time

8.2 Field definitions

Field definitions are indicated in Table 4 and Table 5.

Table 4 – Talker identifier mnemonics

Talker device		Identifier
Heading/track controller (autopilot)	general	AG
	magnetic	AP
Automatic identification system		AI
Bilge system		BI
Bridge navigational watch alarm system		BN
BAM central alert management function		CA
Communications:	digital selective calling (DSC)	CD
	data receiver	CR
	satellite	CS
	radio-telephone (MF/HF)	CT

Talker device		Identifier
	radio-telephone (VHF)	CV
	scanning receiver	CX
Direction finder		DF
Duplex repeater station		DU
Electronic chart system (ECS)		EC
Electronic chart display and information system (ECDIS)		EI
Emergency locator		EL
Emergency position indicating radio beacon (EPIRB)		EP
Engine room monitoring system		ER
Fire door controller/monitoring system		FD
Fire extinguisher system		FE
Fire detection system		FR
Fire sprinkler system		FS
Galileo positioning system		GA
BeiDou positioning system		GB
IRNSS positioning system		GI
GLONASS positioning system		GL
Global positioning system (GPS)		GP
QZSS positioning system		GQ
Global navigation satellite system (GNSS)		GN
Heading sensors:	compass, magnetic	HC
	gyro, north seeking	HE
	fluxgate	HF
	gyro, non-north seeking	HN
Hull door controller/monitoring system		HD
Hull stress monitoring		HS
Integrated communication system		IC
Integrated instrumentation		II
Integrated navigation		IN
LORAN: LORAN-C		LC
Network device		ND
Navigation light controller		NL
Proprietary code		P
Radar and/or radar plotting		RA
Propulsion machinery including remote control		RC
Sounder, depth		SD
Steering gear/steering engine		SG
Serial to network gateway function (SNGF)		SI
Electronic positioning system, other/general		SN
Sounder, scanning		SS
Turn rate indicator		TI
Microprocessor controller		UP
(0<=#<=9) User configured talker identifier[a]		U#
Velocity sensors:	Doppler, other/general	VD

Talker device		Identifier
	speed log, water, magnetic	VM
	speed log, water, mechanical	VW
Voyage data recorder		VR
Watertight door controller/monitoring system		WD
Water level detection system		WL
Transducer		YX
Timekeeper, time/date:	atomic clock	ZA
	chronometer	ZC
	quartz	ZQ
	radio update	ZV
Weather instrument		WI
a The U# talker identifier does not convey the nature of the device transmitting the sentence, and should not be "fixed" into a unit at manufacture. This is intended for special purpose applications. The U# talker identifier indicates that the devices talker identifier has been changed through external control.		

Table 5 – Field type summary

Field type	Symbol	Definition
Special format fields		
Status	A	Single character field: A = Yes, data valid, warning flag clear V = No, data invalid, warning flag set
Latitude	llll.ll	Fixed/variable length field: degrees/minutes and decimal – two fixed digits of degrees, two fixed digits of minutes and a variable number of digits for a decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/variable length field: degrees/minutes and decimal – three fixed digits of degrees, two fixed digits of minutes and a variable number of digits for a decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/variable length field: hours/minutes/seconds and decimal – two fixed digits of hours, two fixed digits of minutes, two fixed digits of seconds and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes and seconds to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy".
Numeric value fields		
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73). The specific use of this formatter and restrictions (for example integer, range) is defined in the sentence definition.
Fixed HEX field	hh-	Fixed length HEX numbers only, MSB on the left.
Variable HEX field	h--h	Variable length HEX numbers only, MSB on the left.
Fixed six-bit field	ss___	Fixed length six-bit coded characters only. See Annex C for field conversions.
Variable six-bit field	s--s	Variable length six-bit coded characters only. See Annex C for field conversions.
Information fields		
Variable text	c--c	Variable length valid character field.
Fixed alpha field	aa-	Fixed length field of upper-case or lower-case alpha characters.
Fixed number field	xx-	Fixed length field of numeric characters.
Fixed text field	cc-	Fixed length field of valid characters.

The following considerations have to be taken into account:

- Spaces should only be used in variable text fields.

- A negative sign "–" (HEX 2D) is the first character in a field if the value is negative. When used, this increases the specified size of fixed length fields by one. The sign is omitted if the value is positive.

- Units of measure fields are appropriate characters from the symbol table (Table 3) unless a specific unit of measure is indicated.

- Fixed length field definitions show the actual number of characters. For example, a field defined to have a fixed length of 5 HEX characters is represented as hhhhh between delimiters in a sentence definition.

8.3 Approved sentences

8.3.1 General format

General format of printed sentence information:

{mnemonic} – {name}

      {definition paragraph}

$--{sentence}

      └──{field descriptions}

    └──start of sentence and talker ID

8.3.2 AAM – Waypoint arrival alarm

Status of arrival (entering the arrival circle, or passing the perpendicular of the course line) at waypoint c--c.

$--AAM, A, A,x.x, N, c--c*hh<CR><LF>

                           └── Waypoint ID

                    └── Units of radius, nautical miles

              └── Arrival circle radius

          └── Status: A = perpendicular passed at waypoint; V = not passed

      └── Status: A = arrival circle entered; V = not entered

8.3.3 ABK – AIS addressed and binary broadcast acknowledgement

The ABK-sentence is generated when a transaction, initiated by reception of an ABM, AIR, or BBM sentence, is completed or terminated. This sentence provides information about the success or failure of a requested ABM broadcast of either ITU-R M.1371 Messages 6 or 12. The ABK process utilises the information received in ITU-R M.1371 Messages 7 and 13. Upon reception of either a VHF Data-link Message 7 or 13, or the failure of Messages 6 or 12, the AIS unit delivers the ABK sentence to the external application. This sentence is also used to report to the external application the AIS unit's handling of the AIR (ITU-R M.1371 Message 15) and BBM (ITU-R M.1371 Messages 8, 14, 25 and 26) sentences. The external application initiates an interrogation through the use of the AIR-sentence, or a broadcast through the use of the BBM sentence. The AIS unit generates an ABK sentence to report the outcome of the ABM, AIR, or BBM broadcast process.

```
$--ABK,xxxxxxxxx,x,x.x,x,x*hh<CR><LF>
```

— Type of acknowledgement [5]
— Message sequence number [4]
— ITU-R M.1371 Message ID [3]
— AIS channel of reception [2]
— MMSI of the addressed AIS unit [1]
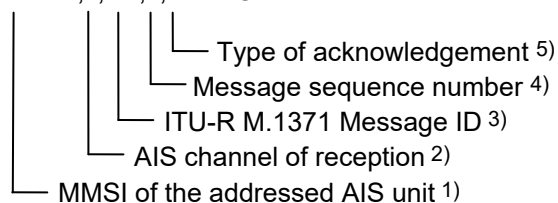
Comments:

1) Identifies the distant addressed AIS unit involved with the acknowledgement. If more than one MMSI is being addressed (ITU-R M.1371 Messages 15 and 16), the MMSI of the first distant AIS unit, identified in the message, is the MMSI reported here. This is a null field when the ITU-R M.1371 Message type is 8 or 14.

2) Indication of the VHF data link channel upon which a Message type 7 or 13 acknowledgement was received. An "A" indicates reception on channel A. A "B" indicates reception on channel B.

3) This indicates to the external application the type of ITU-R M.1371 message that this ABK sentence is addressing. Also see the message IDs listed in Comment 4.

4) The message sequence number, together with the Message ID and MMSI of the addressed AIS unit, uniquely identifies a previously received ABM, AIR, or BBM sentence. Generation of an ABK sentence makes a sequence message identifier available for re-use. The message ID determines the source of the message sequence number. The following lists the source by message ID:

ITU-R M.1371 Message ID   Message sequence number source

   6   sequential message identifier from ABM sentence

   7   addressed AIS unit's Message 7 sequence number

   8   sequential message identifier from BBM sentence

  12   sequential message identifier from ABM sentence

  13   addressed AIS unit's Message 13 sequence number

  14   sequential message identifier from BBM sentence

  15   no source, the message sequence number should be null

  25   sequential message identifier from ABM or BBM sentence (structured binary data),

  26   sequential message identifier from ABM or BBM sentence (structured binary data),

  70   sequential message identifier from ABM or BBM sentence (unstructured binary data),

  71   sequential message identifier from ABM or BBM sentence (unstructured binary data),

5) Acknowledgements provided are:

   0 = Message (6 or 12) successfully received by the addressed AIS unit,

   1 = Message (6 or 12) was broadcast, but no acknowledgement by the addressed AIS unit,

   2 = message could not be broadcast (i.e. quantity of encapsulated data exceeds five slots),

   3 = requested broadcast of Message (8, 14, 15, 25 or 26) has been successfully completed,

   4 = late reception of a Message 7 or 13 acknowledgement that was addressed to this AIS unit (own ship) and referenced as a valid transaction.

8.3.4   ABM – AIS addressed binary and safety related message

This sentence supports ITU-R M.1371 Messages 6, 12, 25 and 26 and provides an external application with a means to exchange data via an AIS transponder. Data is defined by the application only, not the AIS unit. This sentence offers great flexibility for implementing system functions that use the transponder like a communications device. After receiving this sentence via the IEC 61162-2 interface, the transponder initiates a VDL broadcast of Message 6, 12, 25, or 26. The AIS unit will make up to four broadcasts of Messages 6 and 12. The actual number will depend on the reception of an acknowledgement from the addressed "destination" AIS unit. The success or failure of reception of this transmission by the addressed AIS unit for Messages 6 and 12 is confirmed through the use of the "Addressed binary and safety related message acknowledgement" ABK sentence formatter, and the processes that supports the generation of an ABK sentence. The AIS transponder

determines the appropriate communications state for transmission of Message 26 over the VHF data Link.

```
!--ABM,x,x,x,xxxxxxxxx,x,xx,s--s,x*hh<CR><LF>
```
                              └── Number of fill-bits, 0 to 5 [7]
                           └── Encapsulated data [6]
                        └── ITU-R M.1371 Message ID [5]
                     └── AIS channel for broadcast of the radio message [4]
                  └── The MMSI of the destination AIS unit for the ITU-R M.1371 Message [3]
              └── Sequential message identifier, 0 to 3 [2]
           └── Sentence number, 1 to 9 [1]
        └── Total number of sentences needed to transfer the message,1 to 9 [1]
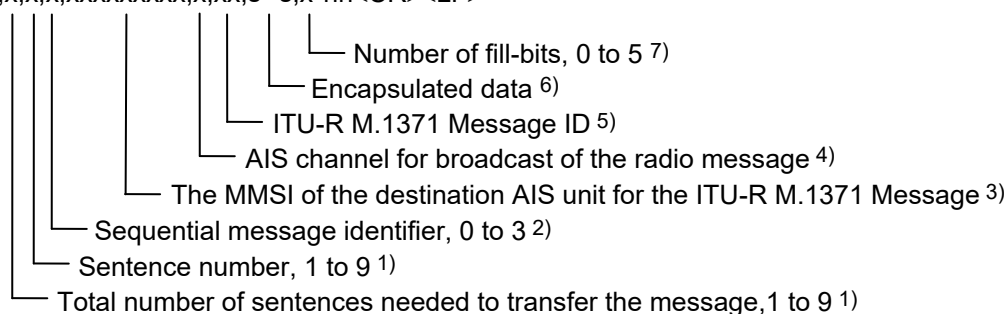
Comments:

1) The total number of sentences required to transfer the binary message data to the AIS unit.

    The first field specifies the total number of sentences used for a message, minimum value 1.

    The second field identifies the order of this sentence in the message, minimum value 1.

    All sentences contain the same number of fields. Successive sentences may use null fields for fields that have not changed, such as fields 4, 5, and 6.

2) This sequential message identifier serves two purposes. It meets the requirements as stated in the IEC 61162-1 "Sequential message identifier field" description, and it is the sequence number utilized by ITU-R M.1371 in Message types 6 and 12. The range of this field is restricted by ITU-R M1371 to 0 – 3. The sequential message identifier value may be reused after the AIS unit provides the "ABK" acknowledgement for this number.

3) The MMSI of the AIS unit that is the destination of the message.

4) The AIS channel that shall be used for the broadcast:

    0   =   no broadcast channel preference,

    1   =   Broadcast on AIS channel A,

    2   =   Broadcast on AIS channel B,

    3   =   Broadcast message on both AIS channels, A and B.

5) The ITU-R M.1371 message Id for the following addressed Messages:

     6 =   Binary addressed message,

    12 =   Addressed safety related message,

    25 =   Single slot binary message 25 (binary data coded using the 16-bit Application identifier),

    70 =   Single slot binary message 25 (unstructured binary data),

    26 =   Multiple slot binary message 26 with Communications State (binary data coded using the 16-bit Application identifier),

    71 =   Multiple slot binary message 26 with Communications State (unstructured binary data).

6) This is the content of the "binary data" parameter for ITU-R M.1371 Message 6, or the "Safety related Text" parameter for Message 12, or the "binary data" parameter for Message 25, or the "binary data" parameter for Message 26. The first sentence may contain up to 48 valid Six Bit codes (288 bit). Following sentences may contain up to 60 valid Six Bit codes (360 bit), if fields 4, 5, and 6 are unchanged from the first sentence and set to null. The actual number of valid characters shall be such that the total number of characters in a sentence does not exceed the "82-character" limit.

7) This cannot be a null field. See "x4 " in 7.3.4.

8.3.5   ACA – AIS channel assignment message

An AIS device can receive regional channel management information in four ways: ITU-R M.1371 Message 22, DSC telecommand received on channel 70, manual operator input, and an ACA sentence. The AIS unit may store channel management information for future use. Channel management information is applied based upon the actual location of the AIS device. An AIS unit is "using" channel management information when the information is

being used to manage the operation of the VHF receiver and/or transmitter inside the AIS unit.

This sentence is used both to enter and obtain channel management information. When sent to an AIS unit, the ACA sentence provides regional information that the unit stores and uses to manage the internal VHF radio. When sent from an AIS unit, the ACA sentence provides the current channel management information retained by the AIS unit. The information contained in this sentence is similar to the information contained in an ITU-R M.1371 Message 22. The information contained in this sentence directly relates to the initialisation phase and dual channel operation and channel management functions of the AIS unit as described in ITU-R M.1371.

$--ACA,x,llll.ll,a,yyyyy.yy,a,llll.ll,a,yyyyy.yy,a,x,xxxx,x,xxxx,x,x,x,a,x,hhmmss.ss*hh<CR><LF>
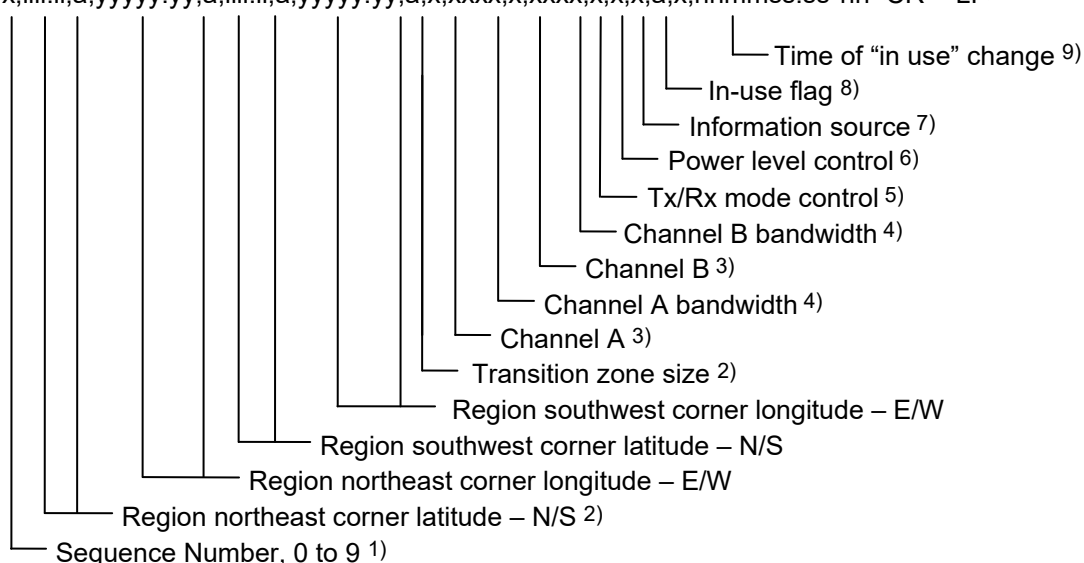
```
                                                        └─ Time of "in use" change 9)
                                                      └── In-use flag 8)
                                                    └──── Information source 7)
                                                  └────── Power level control 6)
                                                └──────── Tx/Rx mode control 5)
                                              └────────── Channel B bandwidth 4)
                                            └──────────── Channel B 3)
                                          └────────────── Channel A bandwidth 4)
                                        └──────────────── Channel A 3)
                                      └────────────────── Transition zone size 2)
                                    └──────────────────── Region southwest corner longitude – E/W
                                  └────────────────────── Region southwest corner latitude – N/S
                                └──────────────────────── Region northeast corner longitude – E/W
                              └──────────────────────────── Region northeast corner latitude – N/S 2)
                            └──────────────────────────────── Sequence Number, 0 to 9 1)
```

Comments:

1) This is used to bind the contents of the ACA and ACS sentences together. The ACS sentence, when provided by the AIS unit, should immediately follow the related ACA sentence, containing the same sequence number. The AIS unit generating the ACA and ACS sentences, should increment the sequence number each time an ACA/ACS pair is created. After 9 is used the process should begin again from 0. Information contained in the ACS sentence is not related to the information in the ACA sentence if the sequence numbers are different. When an AIS unit is queried for an ACA sentence, the AIS unit should respond with the ACA/ACS sentence pair. When an external device is sending an ACA sentence to the AIS unit, the sequence number may be null if no ACS sentence is being sent.

2) The resolution of the longitude and latitude fields is 1/10 minute. The range of the transition zone size is 1 to 8 nautical miles.

3) VHF channel number, see ITU-R M.1084, Annex 4

4) Value of 0, bandwidth is specified by channel number, see ITU-R M.1084, Annex 4
   Value of 1, bandwidth is 12,5 kHz.

5) Value of 0, transmit on channels A and B, receive on channels A and B,
   Value of 1, transmit on channel A, receive on channels A and B,
   Value of 2, transmit on channel B, receive on channels A and B,
   Value of 3, do not transmit, receive on channels A and B,
   Value of 4, do not transmit, receive on channel A,
   Value of 5, do not transmit, receive on channel B.

6) Value of 0, high power

   Value of 1, low power

7) Source identifiers:

   A = ITU-R M.1371 Message 22: Channel Management addressed message,

   B = ITU-R M.1371 Message 22: Channel Management broadcast geographical area message,

   C = IEC 61162-1 AIS Channel Assignment sentence,

   D = DSC Channel 70 telecommand,

M = operator manual input.
This field should be null when the sentence is sent to an AIS device.

8) This value is set to indicate that the other parameters in the sentence are "in-use" by an AIS unit at the time that the AIS unit sends this sentence. A value of "0" indicates that the parameters are not "in-use", and a value of "1" indicates that the parameters are "in-use". This field should be null when the sentence is sent to an AIS mobile unit. A value of "1" sent to a base station indicates that the parameters are "in-use"; a value of "0" indicates not "in-use".

9) This is the UTC time that the "In-use flag" field changed to the indicated state. This field should be null when the sentence is sent to an AIS unit.

8.3.6   ACK – Acknowledge alarm

Acknowledge device alarm. This sentence is used to acknowledge an alarm condition reported by a device.

$--ACK,xxx*hh<CR><LF>
         └─ Unique alarm number (identifier) at alarm source

8.3.7   ACN – Alert command

Sentences ACN, ALC, ALF and ARC are used for alert handling. Alert related communications are described in IEC 61924-2.

This sentence is used for acknowledge, silence, responsibility transfer and to request repeat of alert details in case the reception process has detected, based on ALC, that ALF has been missed.

Responsibility transferred is used for a special conditional state of an alert. In this state the source of an alert indicates the alert visually as an acknowledged alert (i.e. no flashing indication nor audible signal). In this state the source of an alert re-raises an unacknowledged alert, if the source of the alert is unable to receive heartbeat (HBT) sentences from the sender of the sentence.

This sentence cannot be queried.

$--ACN,hhmmss.ss,aaa,x.x,x.x,c,a*hh <CR><LF>
         │   │   │   │   │ └─ Sentence status flag [6]
         │   │   │   │   └─ Alert command, A, Q, O or S [5]
         │   │   │   └─ Alert Instance, 1 to 999999 [4]
         │   │   └─ Alert Identifier [3]
         │   └─ Manufacturer mnemonic code [2]
         └─ Time [1]

Comments:

1) Release time of the alert command. (e.g. for VDR purposes), optional can be a null field. Sender is allowed to use all alternatives defined in Table 5 Field type summary. Receiver is allowed to ignore content of this field. If receiver does not ignore this field it should support all alternatives defined in Table 5 Field type summary.

2) Used for proprietary alerts defined by the manufacturer. For standardized alerts this should be a null field.

3) The alert identifier is unique within a single alert source. The alert identifier is a variable length integer field of maximum 7-digit integer. It identifies the type of the alert, e.g. a "lost target" alert. Standardized alerts use unique alert identifiers described in equipment standards. Number range 10000-9999999 is reserved for proprietary alerts and number '0' is reserved for a command request to all alerts (e.g. alert command Q requests transmission of all alert states). Alert Identifier examples:

"001", "2456789", "245"

4) The alert instance identifies the current instance of an alert to distinguish alerts of the same type (Alert identifier) and from the same source (e.g. dangerous target). Alert instance is maximum a 6-digit integer from 1 to 999999, the number '0' indicates that the command is intended for all alert instances. Except for number '0', the number of alert instance can be freely defined by the manufacturer as long as it is unique for one type of alert (alert identifier). It is not permitted to modify the alert instance within a life cycle of a distributed alert

(from 'active and unacknowledged' state until 'normal' state is reached). It can be also a null field, when there is only one alert of that type.

5) This should not be a null field

acknowledge: A

request / repeat information: Q

responsibility transfer: O

silence: S

6) This field should be "C" and should not be a null field. This field indicates a command. A sentence without "C" is not a command.

8.3.8   ACS – AIS channel management information source

This sentence is used in conjunction with the ACA sentence. This sentence identifies the originator of the information contained in the ACA sentence and the date and time the AIS unit received that information.

$--ACS,x,xxxxxxxxx,hhmmss.ss,xx,xx,xxxx*hh<CR><LF>
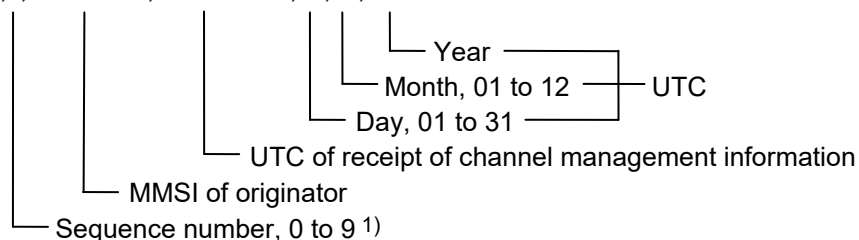
Comments:

1) This is used to bind the contents of the ACA and ACS sentences together. The ACS sentence, when provided by the AIS unit, should immediately follow the related ACA sentence, containing the same sequence number. The AIS unit generating the ACA and ACS sentences, should increment the sequence number each time an ACA/ACS pair is created. After 9 is used the process should begin again from 0. Information contained in the ACS sentence is not related to the information of the ACA sentence if the sequence numbers are different. When an external device is sending an ACA sentence to the AIS unit, the sequence number may be null if no ACS sentence is being sent.

8.3.9   AIR – AIS interrogation request

This sentence supports ITU-R M.1371 Message 10 and 15. It provides an external application with the means to initiate requests for specific ITU-R M.1371 messages, from distant mobile or base station, AIS units. A single sentence can be used to request up to two messages from one AIS unit and one message from a second AIS unit, or up to three messages from one AIS unit. The message types that can be requested are limited. The complete list of messages that may be requested can be found within the Message 15 description in ITU-R M.1371. Improper requests may be ignored. With Message 10 always Message 11 is requested.

The external application initiates the interrogation. The external application is responsible for assessing the success or failure of the interrogation. After receiving this sentence, the AIS unit initiates a radio broadcast (on the VHF Data Link) of a Message 10 or 15 – interrogation. The success or failure of the interrogation broadcast is determined by the application using the combined reception of the ABK-sentence and VDM sentences provided by the AIS unit. After receiving this AIR-sentence, the AIS unit shall take no more than four seconds to broadcast the Message 10 or 15, and the addressed distant unit(s) shall take no more than another four seconds to respond, a total of eight seconds.

If the requested message type is 11 then a Message 10 is transmitted to only one station. The fields of station 2 should be a null fields in this case.

```
$--AIR,xxxxxxxxx,x.x,x,x.x,x,xxxxxxxxx,x.x,x,a,x.x,x.x,x.x*hh<CR><LF>
```

```
                                               └──Message ID2.1, station-2 reply slot 6)
                                                └── Message ID1.2, station-1 reply slot 6)
                                               └── Message ID1.1, station-1 reply slot 6)
                                              └── Channel of interrogation 5)
                                             └── Message sub-section 3)
                                            └──Message Number requested from station-2 2)
                                           └── MMSI of interrogated station-2 4)
                                          └── Message sub-section 3)
                                         └──Second message number requested from station-1 2)
                                        └── Message sub-section 3)
                                       └── First message number requested from station-1 2)
                                      └── MMSI of interrogated station-1 1)
```

Comments:

1) Identifies the first distant AIS unit being interrogated. A single AIR sentence can be used to request two message numbers from the first AIS unit.

2) The following are examples of messages that may be requested from a distant mobile AIS unit. See ITU-R M.1371 Message 15 and Message 10 description for the actual message numbers.

   Message 3,   Position report,

   Message 5,   Ship static and voyage related data, see additional information in comment 3,

   Message 9,   Standard SAR aircraft position report,

   Message 18,   Standard Class B equipment position report,

   Message 19,   Extended Class B equipment position report,

   Message 21,   Aids-to-navigation report,

   Message 24,   Static-data report,

   Message 11,   UTC and date response. In this case message 10 is transmitted.

   Examples of messages that may be requested from a distant AIS base station include:

   Message 4,   Base station report,

   Message 24,   Static-data report.

3) This field is used to request a message that has been further sub-divided into alternative data structures. When requesting a message with alternative data structures, this message sub-section field should be provided, so that the correct sub-division of the message data is provided. If the message structure is not sub-divided into different structures, this field should be null.

4) This identifies the second distant AIS unit being interrogated. Only one message may be requested from the second AIS unit. The MMSI of the second AIS unit may be the same MMSI as the first AIS unit.

5) A = Channel A

   B = Channel B

   Null = no specific channel is being assigned. AIS mobile stations should ignore this data field.

6) Start slot number of interrogation reply, 0 to 2 249. Null if interrogation reply slot is not being assigned.

   AIS mobile stations should ignore this data field.

8.3.10   AKD – Acknowledge detail alarm condition

This sentence provides for acknowledgement of a detailed alarm condition reported through ALA.

As IEC 61162-1 does not guarantee reliable transport, the designer should be very careful about how this sentence is used. Problems can occur either when the initial alarm message was lost or when the acknowledgement message was lost. A possible solution is to retransmit the alarm message until acknowledgement has been received. When acknowledgement has been received, an alarm acknowledged should be sent. This acknowledgement should be sent on all subsequent acknowledgements. Acknowledgements should be sent on each

received alarm message after acknowledgement and further on until the alarm acknowledgement message has been received.

$--AKD,hhmmss.ss,aa,aa,xx,xxx,aa,aa,xx *hh<CR><LF>

```
                                    └── Instance of equipment/unit/item sending the
                                        knowledgement 5)
                                  └── Sub system indicator of system sending the
                                      acknowledgement 4)
                               └── System indicator of system sending the
                                   acknowledgement 3)
                            └── Type of alarm 2)
                         └── Instance number of equipment/unit/item 2)
                      └── Sub system equipment indicator of original alarm source 2)
                   └── System indicator of original alarm source 2)
              └── Time of acknowledgement 1)
```

Comments:

1) This defines the time of acknowledgement. This may be a null field.

2) These fields should contain the identical information of the corresponding fields from the ALA sentence being acknowledged.

3) Indicator characters identifying the system sending the acknowledgement. This field is two fixed characters, see Annex D. This may be a null field.

4) Indicator characters identifying the sub system sending the acknowledgement. This field is two fixed characters, see Annex D. This may be a null field.

5) Instance number identifying the equipment, unit or item sending the acknowledgement. This field is two fixed numeric characters. This may be a null field.

8.3.11 ALA – Report detailed alarm condition

This sentence permits the alarm and alarm acknowledge condition of systems to be reported. Unlike ALR this sentence supports reporting multiple system and sub-system alarm conditions.

Dedicated sentences (for example FIR, DOR, HSS, WAT) are intended for reporting from a dedicated alarm detection system.

As IEC 61162-1 does not guarantee reliable transport, the designer should be very careful about how this sentence is used. Problems can occur either when the initial alarm message was lost or when the acknowledgement message was lost. One possible solution (in some cases) is to retransmit the alarm message until acknowledgement has been received. When acknowledgement has been received, an alarm acknowledged should be sent. This acknowledgement should be sent on all subsequent acknowledgements. Acknowledgements should be sent on each received alarm message after acknowledgement and further on until the alarm acknowledgement message has been received.

$--ALA,hhmmss.ss,aa,aa,xx,xxx,a,a,c--c *hh<CR><LF>

```
                               └── Alarm's description text 8)
                             └── Alarm's acknowledged state 7)
                           └── Alarm condition 6)
                        └── Type of alarm (see 5)
                     └── Instance number of equipment/unit/item 4)
                  └── Sub-system equipment indicator of original alarm source 3)
               └── System indicator of original alarm source 2)
          └── Event time 1)
```
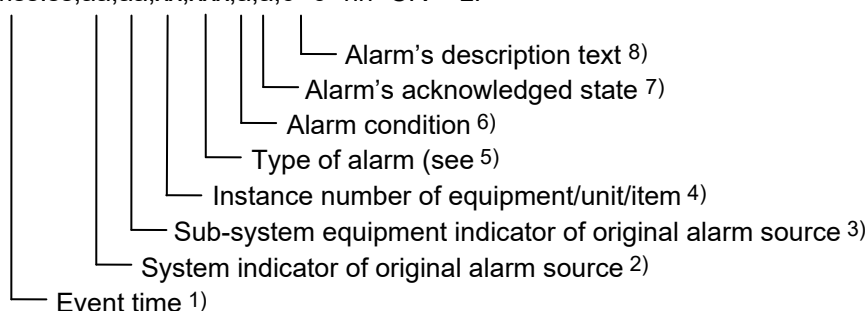
Comments:

1) Event time of alarm condition change including acknowledgement state change. If this is not available, this should be a null field.

2) Indicator characters as system of alarm source. This field is two fixed characters, see Annex D.

3) Indicator characters as sub-system of alarm source. This field is two fixed characters, see Annex D. For group alarms or if no sub-system can be identified, this should be a null field.

4) Instance number identifying the equipment, unit or item. This field is two fixed numeric characters.

5) Type of alarm. This field is three fixed numeric characters as defined in Annex D, Table D.1 . Codes 900 to 999 are user definable.

6) This field is a single character specified by the following:

   N = normal state;
   H = alarm state (threshold exceeded);
   J = alarm state (extreme threshold exceeded);
   L = alarm state (low threshold exceeded, i.e. not reached);
   K = alarm state (extreme low threshold exceeded, i.e. not reached);
   X = other.

7) This field is a single character specified by the following:

   A = acknowledged;
   V = not acknowledged;
   B = broadcast (acknowledgement not applicable);
   H = harbour mode;
   O = override.

8) Additional and optional descriptive text/alarm detail condition tag. Maximum number of characters will be limited by maximum sentence length and length of other fields.

8.3.12 ALC – Cyclic alert list

Sentences ACN, ALC, ALF and ARC are used for alert handling. Alert related communications are described in IEC 61924-2.

The purpose of this sentence is to satisfy the needs for a safe and consistent data distribution with a minimum of data traffic. Each change on an alert's data leads to an incremented Revision counter. So an alert processing device only needs to check the alert entries in the ALC messages to ensure that no ALF message has been lost. In the case where an ALF message has been lost, the missing message can be requested by sending a request alert command (see ACN – Alert command).

The ALC sentence provides condensed ALF sentence information. It contains the identifying data for each present alert of one certain source/device so that the receiver can understand which ALF has been missed (and retransmission of ALF can be requested by using ACN sentence). It shall be published cyclically at least every 30 s by each alert generating device.

The cyclic alert list transmission shall never stop. When all alerts are in normal state the cyclic alert list is empty, i.e. the number of alert entries is 0.

The length of this sentence is varying with the number of alerts (number of list entries) currently generated by related instance. In cases where the needed number of entries exceeds the permitted sentence length the number of sentences is increased.

$--ALC,xx,xx,xx,x.x,aaa,x.x,x.x,x.x,........,aaa,x.x,x.x,x.x*hh <CR><LF>
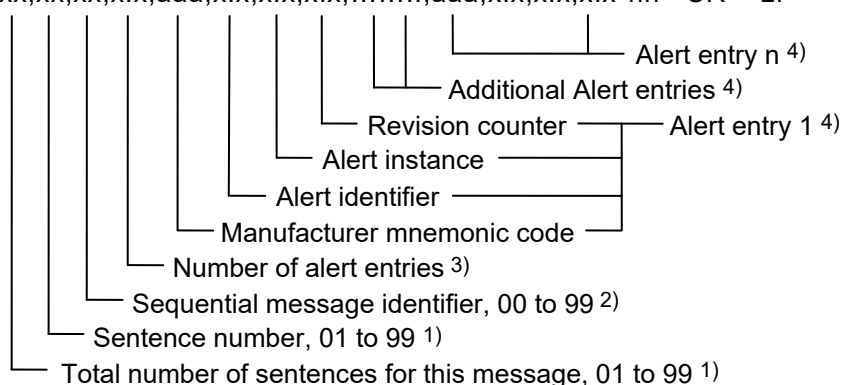
- Alert entry n [4]
- Additional Alert entries [4]
- Revision counter —— Alert entry 1 [4]
- Alert instance
- Alert identifier
- Manufacturer mnemonic code
- Number of alert entries [3]
- Sequential message identifier, 00 to 99 [2]
- Sentence number, 01 to 99 [1]
- Total number of sentences for this message, 01 to 99 [1]

Comments:

1) The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields.

2) The sequential message identifier relates all sentences that belong to a group of multiple sentences (i.e. message). Multiple sentences (see Comment 1) with the same sequential message identifier, make up one message.

3) Contains the number of alert entries transported within this sentence.

4) Alert entry 0 – *n*: Each alert entry consists of four fields:

   - Manufacturer Identifier (see ALF Manufacturer Identifier)

   - Alert Identifier (see ALF Alert Identifier)

   - Alert instance (see ALF Alert instance)

   - Revision Counter (see ALF Revision Counter)

Each entry identifies a certain alert with a certain state. It is not allowed that an alert entry is split between two ALC sentences.

8.3.13 ALF – Alert sentence

Sentences ACN, ALC, ALF and ARC are used for alert handling. Alert related communications are described in IEC 61924-2.

This sentence is used to report an alert condition and the alert state of a device. An ALF message shall be published for an alert each time the alert information in this sentence changes and on alert request (see ALC – Cyclic alert list).

To transmit additional alert description text (see Comment 12), optionally a second ALF sentence may be transmitted.

$--ALF,x,x,x,hhmmss.ss,a,a,a,aaa,x.x,x.x,x.x,x,c---c*hh <CR><LF>
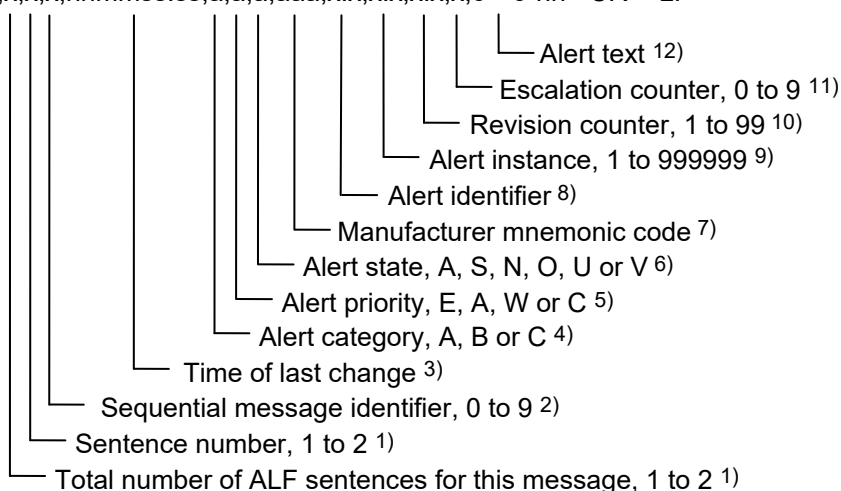
- Alert text [12]
- Escalation counter, 0 to 9 [11]
- Revision counter, 1 to 99 [10]
- Alert instance, 1 to 999999 [9]
- Alert identifier [8]
- Manufacturer mnemonic code [7]
- Alert state, A, S, N, O, U or V [6]
- Alert priority, E, A, W or C [5]
- Alert category, A, B or C [4]
- Time of last change [3]
- Sequential message identifier, 0 to 9 [2]
- Sentence number, 1 to 2 [1]
- Total number of ALF sentences for this message, 1 to 2 [1]

Comments:

1) The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields. When the sentence number is 2, the following Alert category, Alert priority and Alert state can be null fields.

2) The sequential message identifier relates all sentences that belong to a group of multiple sentences (i.e. message). Multiple sentences (see Comment 1) with the same sequential message identifier, make up one message.

3) Time should represent the last time the data within the alert message has changed. For example changing the alert text by in-/decrementing a contained counter or count down should cause a revision of alert message and a new time. Time is an optional field. The time-field is additional information about when this happened and not used for decision making. There is no mandatory requirement for time synchronization between the equipment. It should by either a null field (if not used) or UTC (if used). Sender is allowed to use all alternatives defined in Table 5 Field type summary. Receiver is allowed to ignore content of this field. If the receiver does not ignore this field it should support all alternatives defined in Table 5 Field type summary.

4) The alert category is in compliance with the category definition as described in INS Performance Standard (IMO MSC.252(83)) and Bridge Alert Management Performance Standard (IMO MSC.302(87)):

   A, Category A: Alerts where information at operator unit directly assigned to the function generating the alert is necessary, as decision support for the evaluation of the alert-related condition, e.g. graphical information of danger of collision or graphical information of danger of grounding.

   B, Category B: Alerts where no additional information for decision support is necessary besides the information which can be presented using alert source and alert description text.

   C, Category C: Alerts that cannot be acknowledged on the bridge but for which information is required about the status and treatment of the alerts, e.g., certain alerts from the engine.

5) Alert priority: Emergency Alarm: E, for use with Bridge alert management

   Alarm: A

   Warning: W

   Caution: C

6) The alert state transition is defined in IEC 61924-2:2012, Annex J

   active – unacknowledged: V

   active – silenced: S

   active – acknowledged or active: A

   active – responsibility transferred: O

   rectified – unacknowledged: U

   normal: N

7) Used for proprietary alerts defined by the manufacturer. For standardized alerts this should be a null field.

8) The alert identifier is unique within a single alert source. The alert identifier is a variable length integer field of maximum a 7-digit integer. It identifies the type of the alert, e.g. a "lost target" alert. Standardized alerts use unique alert identifiers described in equipment standards. Number range 10000-9999999 is reserved for proprietary alerts. Alert Identifier examples:

   "001", "2456789", "245"

9) The alert instance identifies the current instance of an alert to distinguish alerts of the same type (Alert identifier) and from the same source (e.g. dangerous target). Alert instance is maximum a 6-digit integer from 1 to 999999, the number '0' indicates that this sentence is intended for all alert instances. Except for number '0', the number of alert instance can be freely defined by the manufacturer as long as it is unique for one type of alert (alert identifier). It is not permitted to modify the alert instance within a life cycle of a distributed alert (from 'active and unacknowledged' state until 'normal' state is reached). It can be also a null field, when there is only one alert of that type.

10) The revision counter is the main method to follow up-to-date status. Revision counter is also unique for each instance of alert. Revision counter starts with 1 and the step for increment is 1. The count resets to 1 after 99 is used. Revision counter increments on each change of content of any field of the alert.

11) The escalation counter is presenting the number of alert escalations after time expiration during the state active-unacknowledged. The escalation counter starts with 0 and the step for increment is 1. The count resets to 1 after 9 is used. The alert escalation can be the escalation from warning into warning (activation of audible signal only), the escalation from warning to alarm or the escalation from alarm to alarm with activation of back-up navigator alarm.

12) This field is used for Alert title which is mandatory and for additional alert description which is optional.

   • The first ALF sentence transmits the Alert title. Alert title is maximum 16 characters short form of the alert text.

- The optional second ALF sentence transmits the additional alert description. Additional alert description is the long description of the alert. The additional alert description contains more information for decision making (i.e. alert description text).

- The second ALF sentence uses null fields for Time of last change, Alert category, Alert priority, and Alert state to allow longer text. The actual number of valid characters should be such that the total number of characters in a sentence does not exceed the "82"-character limit.

- Some equipment standards specify alert text longer than 16 characters (for example the AIS standard has defined some alerts to be coded with ALR sentence and with text longer than 16 characters). In such cases the first ALF sentence is used for the first 16 characters of the alert text as alert title and the second ALF sentence to carry the full alert text.

Examples:

$IIALF,1,1,0,124304.50,A,W,A,,192,1,1,0,LOST TARGET*14<CR><LF>

$IIALF,2,1,1,081950.10,B,A,S,XYZ,0512,1,2,0,HEADING LOST*2D<CR><LF>

$IIALF,2,2,1,,,,,XYZ,0512,1,2,0,NO SYSTEM HEADING AVAILABLE*0D<CR><LF>

8.3.14 ALR – Set alarm state

Local alarm condition and status. This sentence is used to report an alarm condition on a device and its current state of acknowledgement.

$--ALR,hhmmss.ss,xxx,A, A,c--c*hh<CR><LF>

                                      Alarm's description text

                            Alarm's acknowledge state, A = acknowledged
                                              V = unacknowledged

                      Alarm condition (A = threshold exceeded, V = not exceeded)

                Unique alarm number (identifier) at alarm source

        Time of alarm condition change, UTC
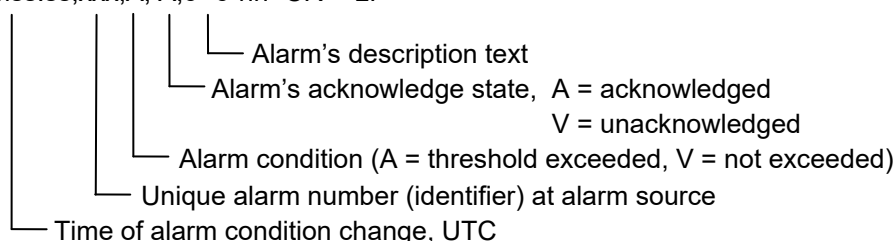
8.3.15 APB – Heading/track controller (autopilot) sentence B

Commonly used by autopilots, this sentence contains navigation receiver warning flag status, cross-track-error, waypoint arrival status, initial bearing from origin waypoint to the destination, continuous bearing from present position to destination and recommended heading to steer to destination waypoint for the active navigation leg of the journey.
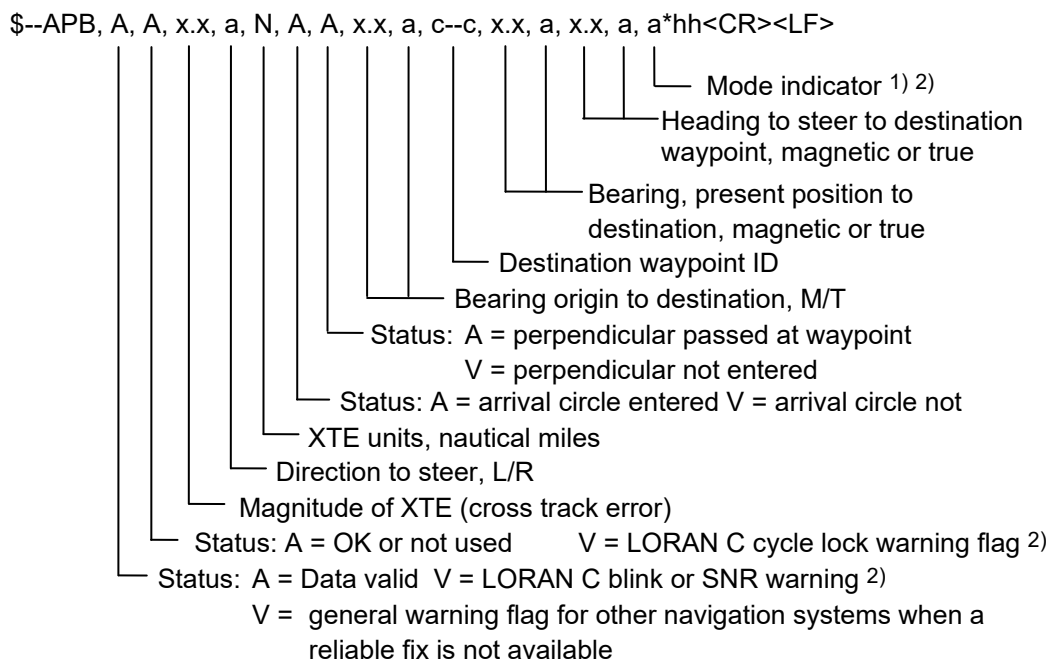
$--APB, A, A, x.x, a, N, A, A, x.x, a, c--c, x.x, a, x.x, a, a*hh<CR><LF>

```
                                                              └── Mode indicator 1) 2)
                                                        ─ Heading to steer to destination
                                                          waypoint, magnetic or true
                                               ─ Bearing, present position to
                                                 destination, magnetic or true
                                        ─ Destination waypoint ID
                                ─ Bearing origin to destination, M/T
                        ─ Status: A = perpendicular passed at waypoint
                          V = perpendicular not entered
                 ─ Status: A = arrival circle entered V = arrival circle not
             ─ XTE units, nautical miles
          ─ Direction to steer, L/R
      ─ Magnitude of XTE (cross track error)
   ─ Status: A = OK or not used      V = LORAN C cycle lock warning flag 2)
─ Status: A = Data valid  V = LORAN C blink or SNR warning 2)
      V =  general warning flag for other navigation systems when a
          reliable fix is not available
```

Comments:

1) Positioning system mode indicator:

    A = Autonomous mode;

    D = Differential mode;

    E = Estimated (dead reckoning) mode;

    M = Manual input mode;

    S = Simulator mode;

    N = Data not valid.

2) The positioning system mode indicator field supplements the positioning system status fields (fields 1 and 2), the status fields should be set to V = invalid for all values of mode indicator except for A = Autonomous and D = Differential. The positioning system mode indicator should not be null fields.

8.3.16   ARC – Alert command refused

Sentences ACN, ALC, ALF and ARC are used for alert handling. Alert related communications are described in IEC 61924-2.

This sentence is used for:

- Category A or C alerts (see IMO MSC.302(87)), for which it is illegal to accept acknowledge or responsibility transfer, e.g. not enough information for decision support available or the source of acknowledgement is not acceptable,

    In a system working properly such attempts should not happen.

- Category B (see IMO MSC.302(87)), if the source of acknowledge is not acceptable.

$--ARC,hhmmss.ss,aaa,x.x,x.x,c*hh <CR><LF>

```
                              └── Refused alert command, A, Q, O or S 5)
                         ─ Alert instance, 1 to 999999 4)
                    ─ Alert identifier 3)
               ─ Manufacturer mnemonic code 2)
      ─ Time 1)
```
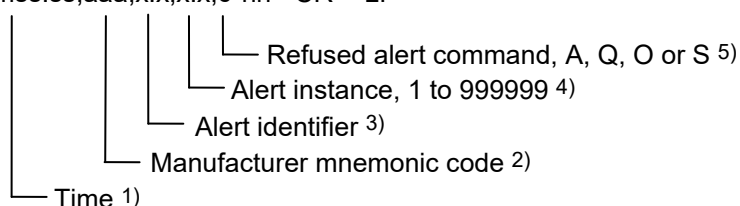
Comments:

1) Release time of the Alert Command Refused. (e.g. for VDR purposes), optional, can be a null field. Sender is allowed to use all alternatives defined in Table 5 Field type summary. Receiver is allowed to ignore content of this field. If receiver does not ignore this field it should support all alternatives defined in Table 5 Field type summary.

2) Used for proprietary alerts defined by the manufacturer. For standardized alerts this should be a null field.

3) The alert identifier is unique within a single alert source. The alert identifier is a variable length integer field of maximum a 7-digit integer. It identifies the type of the alert, e.g. a "lost target" alert. Standardized alerts use unique alert identifiers described in equipment standards. Number range 10000-9999999 is reserved for proprietary alerts. Alert Identifier examples:

   "001", "2456789", "245"

4) The alert instance identifies the current instance of an alert to distinguish alerts of the same type (Alert identifier) and from the same source (e.g. dangerous target). Alert instance is maximum a 6-digit integer from 1 to 999999. The number of alert instance can be freely defined by the manufacturer as long as it is unique for one type of alert (alert identifier). It is not permitted to modify the alert instance within a life cycle of a distributed alert (from 'active and unacknowledged' state until 'normal' state is reached). It can be also a null field, when there is only one alert of that type.

5) Refused Alert Command: Indicates refused "Alert command" of corresponding ACN sentence. This should not be a null field.

acknowledge:	A
request / repeat information:	Q
responsibility transfer:	O
silence:	S

8.3.17   BBM – AIS broadcast binary message

This sentence supports generation of ITU-R M.1371 binary Messages 8, 14, 25, and 26. This provides the application with a means to broadcast data, as defined by the application only. Data is defined by the application only – not the AIS. This sentence offers great flexibility for implementing system functions that use the transponder like a digital broadcast device. After receiving this sentence via the IEC 61162-2 interface, the AIS unit initiates a VHF broadcast of Message 8, 14, 25, or 26 within 4 s. See the ABK sentence for acknowledgement of the BBM with Messages 8 and 14. The AIS transponder determines the appropriate communications state for transmission of Message 26 over the VHF data link.

!--BBM,x,x,x,x,xx,s--s,x*hh<CR><LF>

```
        Number of fill-bits, 0 to 5 6)
        Encapsulated data 5)
        ITU-R M.1371 Message ID 4)
        AIS channel for broadcast of the radio message 3)
        Sequential Message identifier, 0 to 9 2)
        Sentence number, 1 to 9 1)
        Total number of sentences needed to transfer the message, 1 to 9 1)
```
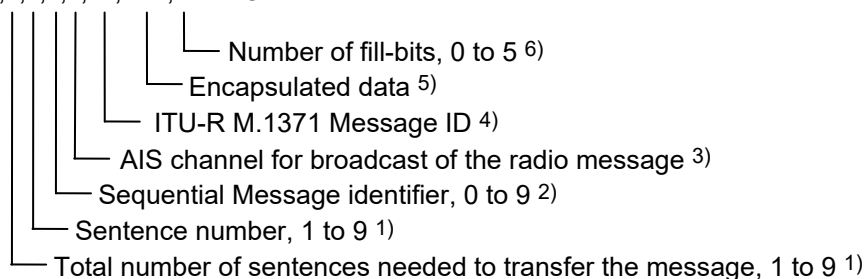
Comments:

1) The total number of IEC 61162-1 sentences required to transfer the contents of the binary message to the AIS unit. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. All sentences contain the same number of fields. Successive sentences may use null fields for fields that have not changed, such as fields 4 and 5.

2) The Sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This value is used by the ABK sentence to acknowledge a specific BBM sentence.

3) The AIS channel that shall be used for the broadcast:

   0   =   no broadcast channel preference,

    1 = Broadcast on AIS channel A,

    2 = Broadcast on AIS channel B,

    3 = Broadcast the message on both AIS channels A and B.

4)   The ITU-R M.1371 Message ID for the following broadcast messages:

    8 = Binary broadcast message,

    14 = Safety related broadcast message,

    25 = Single slot binary message 25 (binary data coded using the 16-bit Application identifier),

    70 = Single slot binary message 25 (unstructured binary data),

    26 = Multiple slot binary message 26 with Communications State (binary data coded using the 16-bit Application identifier),

    71 = Multiple slot binary message 26 with Communications State (unstructured binary data).

5)   This is the content of the "binary data" parameter for ITU-R M.1371 Messages 8, 25 or 26, or the "Safety related Text" parameter for Message 14. The first sentence may contain up to 58 valid Six Bit codes (348 bit). The following sentences may contain up to 60 valid Six Bit codes (360 bit), if fields 4 and 5 are unchanged from the first sentence and set to null. The actual number of characters shall be such that the total number of characters in a sentence does not exceed the "82-character" limit.

6)   This cannot be a null field. See "x4" in 7.3.4.

8.3.18   BEC – Bearing and distance to waypoint – Dead reckoning

Time (UTC) and distance and bearing to, and location of, a specified waypoint from the dead-reckoned present position.

$–BEC, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c*hh<CR><LF>
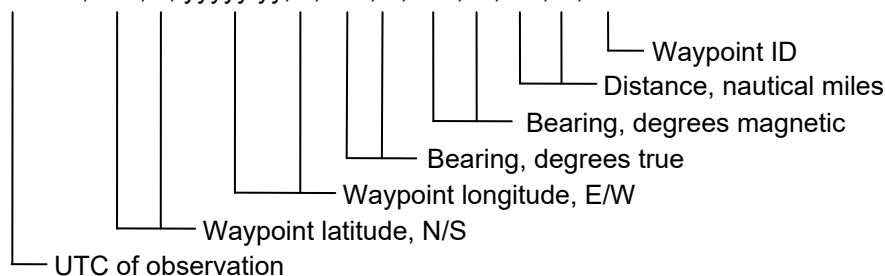
8.3.19   BOD – Bearing origin to destination

Bearing angle of the line, calculated at the origin waypoint, extending to the destination waypoint from the origin waypoint for the active navigation leg of the journey.

$--BOD, x.x, T, x.x, M, c--c, c--c*hh<CR><LF>
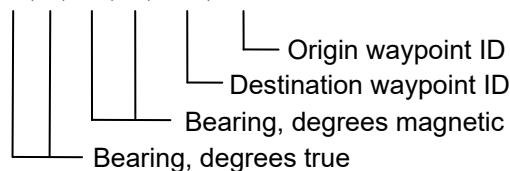
8.3.20   BWC – Bearing and distance to waypoint – Great circle

Time (UTC) and distance and bearing to, and location of, a specified waypoint from present position. $--BWC data is calculated along the great circle path from present position rather than along the rhumb line.

8.3.21   BWR – Bearing and distance to waypoint – Rhumb line

Time (UTC) and distance and bearing to, and location of, a specified waypoint from present position. $--BWR data is calculated along the rhumb line from present position rather than along the great circle path.

$--BWC, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c, a*hh<CR><LF>
$--BWR, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x.x, T, x.x, M, x.x, N, c--c, a*hh<CR><LF>
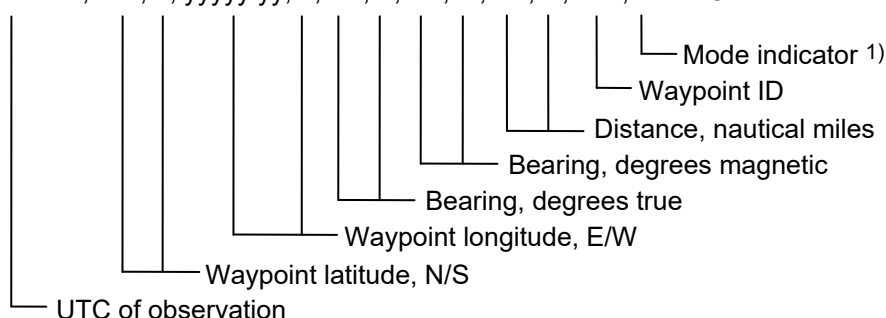
Mode indicator [1]
Waypoint ID
Distance, nautical miles
Bearing, degrees magnetic
Bearing, degrees true
Waypoint longitude, E/W
Waypoint latitude, N/S
UTC of observation

Comments:

1) Positioning system mode indicator:

A = Autonomous mode;

D = Differential mode;

E = Estimated (dead reckoning) mode;

M = Manual input mode;

S = Simulator mode;

N = Data not valid.

The mode indicator field should not be a null field.

8.3.22 BWW – Bearing waypoint to waypoint

Bearing angle of the line, between the TO and the FROM waypoints, calculated at the FROM waypoint for any two arbitrary waypoints.

$--BWW, x.x, T, x.x, M, c--c, c--c*hh<CR><LF>

FROM waypoint ID
TO waypoint ID
Bearing, degrees magnetic
Bearing, degrees true
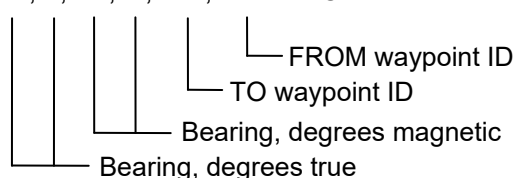
8.3.23 CUR – Water current layer – Multi-layer water current data

$--CUR,A,x,x.x,x.x,x.x,a,x.x,x.x,x.x,a,a*hh<CR LF>

Speed reference [4]
B: Bottom track
W: Water track
P: Positioning system
Heading reference in use, True/Magnetic T/M
Heading
Reference layer depth in metres [3]
Current speed in knots
Direction reference in use, True/Relative T/R
Current direction in degrees
Current depth in metres
Layer number [2]
Data set number, 0 to 9 [1]
Validity of the data, A = Valid, V = not valid
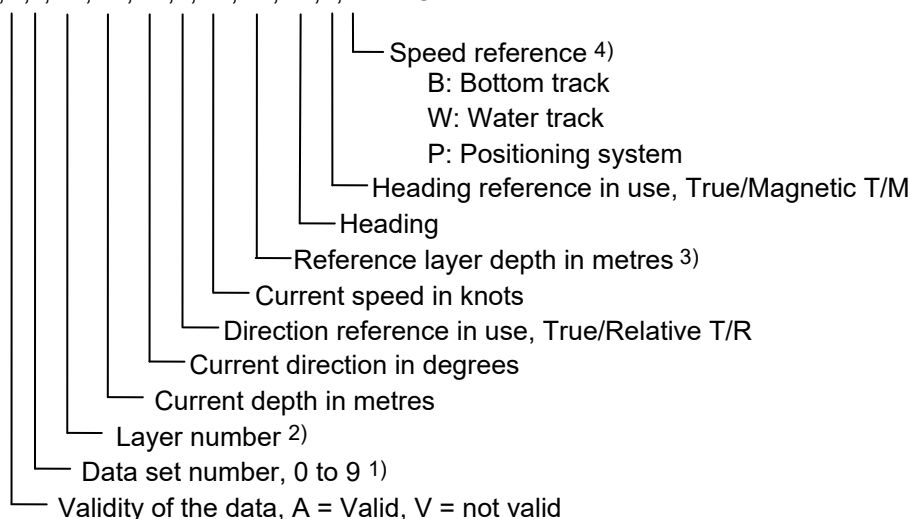
Comments:

1) The data set number is used to identify multiple sets of current data produced in one measurement instance. Each measurement instance may result in more than one sentence containing current data measurements at different layers, all with the same data set number. This is used to avoid the data measured in another instance to be accepted as one set of data.

2) The layer number identifies which layer the current data measurements were made from. The number of layers that can be measured varies by device. The typical number is between 3 and 32, though many more are possible.

3) The current of each layer is measured according to this reference layer, when the speed reference field is set to "water track", or the depth is too deep for bottom track.

4) "Speed reference" identifies the method of ship speed used for measuring the current speed.

8.3.24   DBT – Depth below transducer

Water depth referenced to the transducer.

$--DBT, x.x, f, x.x, M, x.x, F*hh<CR><LF>

```
             Water depth, fathoms
          Water depth, m
       Water depth, feet
```
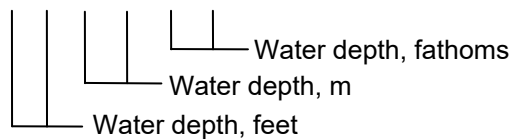
8.3.25   DDC – Display dimming control

The DDC sentence provides controls for equipment display dimming presets and a display brightness percentage.

$--DDC,a,xx,a,a*hh<CR><LF>

```
             Sentence Status Flag 4)
          Colour palette 3)
       Brightness percentage 00 to 99 2)
    Display dimming preset 1)
```
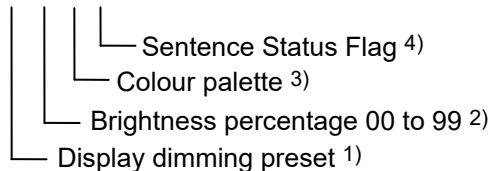
Comments:

1) The display dimming preset field contains an indicator that may be associated with a preset dimmed level on an electronic device.

   D = Day time setting

   K = Dusk setting

   N = Night time setting

   O = Backlighting off setting

   Actual display brightness levels for the display dimming preset indicators above are dependant upon the capabilities provided by the manufacturer of the equipment. Proper use of this field would be as follows. A device provides the operator or user with the ability to set a brightness level to be associated with day, dusk night, etc. Upon receipt of the DDC sentence, the device would switch its display brightness to the preset value the operator had determined for the corresponding indicator value. If the equipment had no brightness or dimming preset capability this field would be ignored.

2) The brightness percentage field contains a value from zero to ninety nine. The value zero, provided as 00, indicates that the display's brightness should be set to its most dimmed level, as determined by the capabilities of the equipment. The value ninety nine, provided as 99, indicates that the display brightness should be set to the brightest level, as determined by the capabilities of the equipment. Values between 0 and 99 correspond to some percentage of brightness, as determined by the equipment receiving this sentence.

3) The colour palette preset field contains an indicator that may be associated with a preset dimmed level on an electronic device.

   D = Day time setting

   K = Dusk setting

   N = Night time setting

   O = Backlighting off setting

4) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

R = Sentence is a status report of current settings (use for a reply to a query).

C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.26 DOR – Door status detection

This sentence indicates the status of watertight doors, fire doors or other hull openings / doors.

$--DOR,a,hhmmss.ss,aa,cc,xxx,xxx,a,a,c--c *hh<CR><LF>

```
                                    └─── Message description text 9)
                                  └── Water tight door switch setting 8)
                              └─ Door status 7)
                          └─ Door number or door open count 6)
                      └─ Second division indicator 5)
                  └─ First division indicator 4)
              └─ Type of door monitoring system 3)
          └─ Event time 2)
      └─ Message Type 1)
```
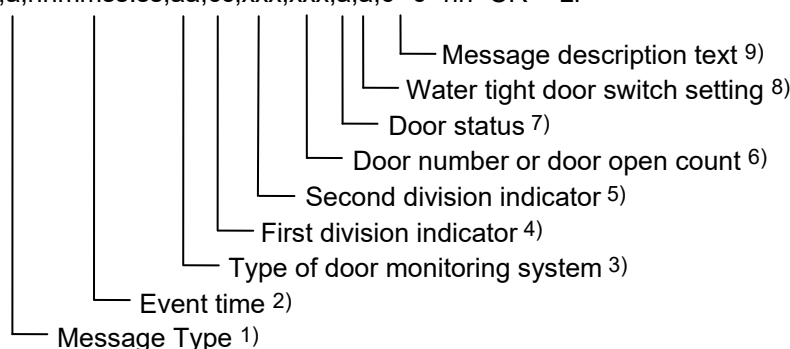
Comments:

1) S: Status for section: the number of faulty and/or open doors reported in the division specified in fields 4 and 5. The section may be a whole section (one or both of the division indicator fields are null) or a sub-section. The status S is normally transmitted at regular intervals. Examples of use are given in Annex E.

   E: Status for single door. (E may be used to indicate an event).

   F: Fault in system: Division indicator fields defines the section when provided.

2) Time when this status/message was valid. This may be a null field.

3) The field is two fixed characters, see table below.

4) First division indicator where door is located. This field is two characters, see table below.

5) Second division indicator where the door is located. This field is three numeric characters, see table below.

6) This field is three fixed numeric characters. When the message type field is E this field identifies the door. When message type field is S this field contains the number of doors that are open or faulty. When the message type field is F this field is null.

7) When the message type field is S or F this field should be a null field. When the message type field is E, this field is specified by the following:

   O = Open,

   C = Closed,

   S = Secured,

   F = Free status (for watertight door),

   X = Fault (door status unknown).

8) This field includes a single character specified by the following:

   O = Harbour mode (allowed open),

   C = Sea mode (ordered closed).

This may be a null field.

9) Descriptive text/door tag. If a door allocation identifier is string type, it is possible to use this field instead of the above door allocation fields. The maximum number of characters will be limited by the maximum sentence length and the length of other fields.

Type of door monitoring system		First division indicator	Second division indicator
ID	**System category**		
WT	Watertight door	Number of watertight bulkhead / frame number	Deck number
WS	Semi-watertight door (splash-tight)		
FD	Fire door	Number / letter of zone. This can also be identifier for control and monitoring main system.	Deck number or control system loop number or other control system division indicator as is appropriate for system
HD	Hull (shell) door	Door indication number / frame number	Deck number
OT	Other	As above	As above

8.3.27 DPT – Depth

Water depth relative to the transducer and offset of the measuring transducer. Positive offset numbers provide the distance from the transducer to the waterline. Negative offset numbers provide the distance from the transducer to the part of the keel of interest.

$--DPT,x.x,x.x,x.x*hh<CR><LF>

    Maximum range scale in use
    Offset from transducer, in metres [1] [2]
    Water depth relative to the transducer, in metres
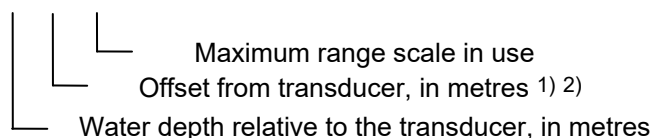
Comments:

1) "positive" = distance from transducer to water line; "-" = distance from transducer to keel.

2) For IEC applications, the offset should always be applied so as to provide depth relative to the keel.

8.3.28 DSC – Digital selective calling information

This sentence is used to receive a call from or provide data to a radiotelephone using digital selective calling in accordance with ITU-R M.493.

$ --DSC,xx,xxxxxxxxxx,xx,xx,xx,x.x, x.x,xxxxxxxxxx,xx, a,a*hh<CR><LF>

    Expansion indicator [1]
    Acknowledgement [2]
    Nature of distress [3] [4]
    MMSI of ship in distress [3] [5]
    Time [6] or Tel. No. [7]
    Position [8] or Channel/frequency [9]
    Type of communication [4] [11] or second telecommand [4]
    Nature of distress [4] [10] or first telecommand [4]
    Category [4]
    Address [5]
    Format specifier [4]
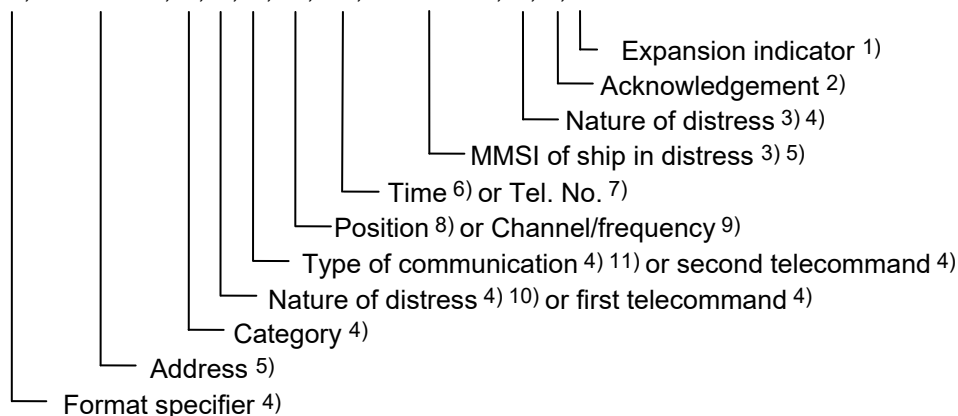
Comments:

1) Expansion indicator = "E", null otherwise. When set to "E" this sentence is followed by the DSC expansion sentence $--DSE, without intervening sentences, as the next transmitted or received sentence.

2) Acknowledgement type:

    R = Acknowledge request

    B = Acknowledgement

S = Neither (end of sequence)

3) For distress acknowledgement, distress relay and distress relay acknowledgement calls only, null otherwise.

4) Use two least-significant digits of symbol codes in ITU-R M.493.

5) Maritime Mobile Service Identifier (MMSI) for the station to be called or the MMSI of the calling station in a received call. For a nine-digit MMSI "0" should be added as the tenth digit. For calls to a geographic area the area is coded in accordance with ITU-R M.493.

System configuration (wiring) and the Talker ID are used to confirm if the sentence is transmitted or received. The MMSI of the calling station for transmitted calls is inserted automatically in the ITU-R M.493 transmission at the radiotelephone.

6) Time (UTC) of position, four digits, hhmm (hours and minutes).

7) Telephone number, 16 digits maximum, odd/even information to be inserted by the DSC equipment.

8) Latitude/longitude, degrees and minutes, 10 digits, coded in accordance with ITU-R M.493.

9) Frequency or channel, six or twelve digits, coded in accordance with ITU-R M.493.

10) Distress calls only.

11) Distress, distress acknowledgement, distress relay and distress relay acknowledgement calls only.

8.3.29   DSE – Expanded digital selective calling

This sentence immediately follows, without intervening sentences or characters, $--DSC when the DSC expansion field in this sentences is set to "E". It is used to provide data to or receive DSC expansion data from a radiotelephone using digital selective calling in accordance with ITU-R M.821.

```
$--DSE,x, x, a,xxxxxxxxxx, xx,c--c,..........,xx,c--c*hh<CR><LF>
                                         |  |   └────── Data set 'n'  1) 2)
                                         |  └───────── Additional data sets  1) 2)
                                         └──────────── Data set '1' 1) 2)
             └──── Vessel MMSI 3)
          └────── Query/reply flag 4)
        └──────── Sentence number 5)
     └─────────── Total number of sentences 5)
```
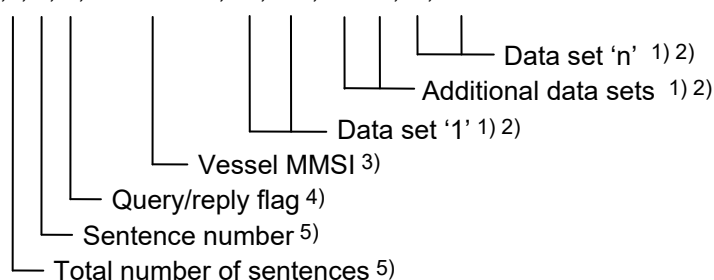
Comments:

1) Data sets consist of two fields. The first field is the code field: the two least significant digits of symbol codes in ITU-R M.821-1, Table 1. The second field is the data field: the additional information required by ITU-R M.821-1, null otherwise. The digits appearing in these fields are the data or commands as specified by ITU-R M.821-1 except for commands, the two least significant digits of Table 3 of ITU-R M.821-1 are preceded by ASCII "C" (HEX 43). A variable number of data sets are allowed, null fields are not required for unused data sets.

2) ASCII characters are used to describe text (station name and port of call), not symbols of ITU-R M.821-1, Table 2. When <,> (Comma, HEX 2C – a reserved character) is needed, <'> (Apostrophe, HEX 27) is substituted.

3) Identical to the address field in the associated $--DSC, $--DSI or $--DSR sentence.

4) "Q" = Query. A device is requesting expanded data. Code fields filled as desired, all data fields null.

"R" = Reply. A device is responding with selected expanded data, in response to a query.

"A" = Automatic. A device is transmitting data automatically, not in response to a query request.

5) The number of data sets may require the transmission of multiple sentences all containing identical field formats. The first field specifies the number of sentences, minimum value = 1. The second field identifies the order of this sentence (sentence number), minimum value = 1. For efficiency, it is permitted that null fields be used in the additional sentences when the data is unchanged from the first sentence (note that this practice can lead to the incorrect assembly of messages if there is a high risk of loss of sentence).

8.3.30   DTM – Datum reference

Local geodetic datum and datum offsets from a reference datum. This sentence is used to define the datum to which a position location, and geographic locations in subsequent

sentences, are referenced. Latitude, longitude and altitude offsets from the reference datum, and the selection of the reference datum, are also provided.

Cautionary notes: the datum sentence should be transmitted immediately prior to every positional sentence (e.g. GLL, BWC, WPL) which is referenced to a datum other than WGS84, the datum recommended by IMO.

For all datums the DTM sentence should be transmitted prior to any datum change and periodically at intervals of not greater than 30 s.

$--DTM,ccc,a,x.x,a,x.x,a, x.x,ccc*hh<CR><LF>

```
                    └── Reference datum 5)
                  └── Altitude offset, m 3)
                └── Lon offset, min, E/W 3)
              └── Lat offset, min, N/S 3)
            └── Local datum subdivision code 2)
          └── Local datum: 1) ──┬─ WGS84 = W84
                                 │  WGS72 = W72
                                 │  SGS85 = S85
                                 │  PE90 = P90
                                 │  User defined = 999
                                 └  IHO datum code 4)
```
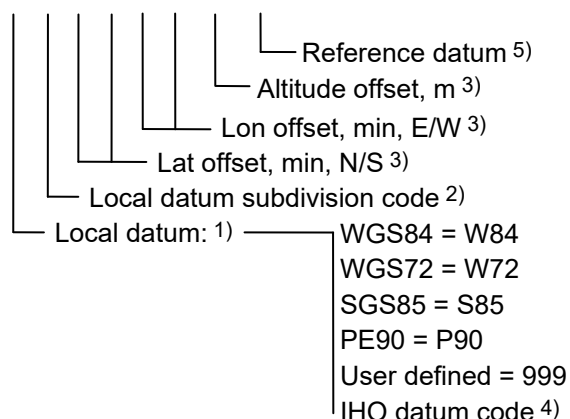
Comments:

1) Three character alpha code for local datum. If not one of the listed earth-centred datums, or 999 for user defined datums, use IHO datum code from International Hydrographic Organisation Publication S-60, Appendices B and C. Null field if unknown. This field should be set to 999 when manual offsets are entered and in use by the position fixing device.

2) One character subdivision datum code when available or user defined reference character for user defined datums, null field otherwise. Subdivision character from IHO Publication S60, Appendices B and C.

3) Latitude and longitude offsets are positive numbers, the altitude offset may be negative. Offsets change with position: position in the local datum is offset from the position in the reference datum in the directions indicated:

$$P_{local\ datum} = P_{ref\ datum} + offset$$

When field 1 contains a value of 999, these fields may not be null, and should contain the manually entered or user defined offsets.

4) Users should be aware that chart transformations based on IHO S60 parameters may result in significant positional errors when applied to chart data.

5) WGS84 = W84, WGS72 = W72, SGS85 = S85, PE90 = P90.

8.3.31   EPV – Command or report equipment property value

The EPV sentence provides a method to command and report specific equipment settings. This sentence is a command sentence.

This sentence may be queried resulting in the generation of one or more EPV sentences as necessary to report all configurable equipment properties and their current values.

When this sentence is sent as a command and not accepted, the receiving equipment shall generate a NAK sentence response providing an appropriate "reason code".

$--EPV,a,c--c,c--c,x.x,c--c*hh<CR><LF>
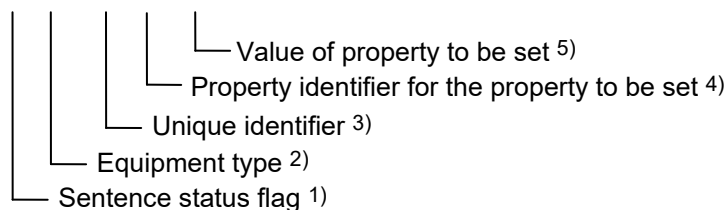
```
                    └── Value of property to be set 5)
                └── Property identifier for the property to be set 4)
            └── Unique identifier 3)
        └── Equipment type 2)
    └── Sentence status flag 1)
```

Comments:

1) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field shall not be null.

   R = Sentence is a status report of current settings (use for a reply to a query).

   C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

2) The equipment field contains the two character talker ID of the destination equipment when this sentence is sent as a command as designated by the "Sentence status flag" field, and identifies the device type for which the sentence is targeted. When this sentence is a report (e.g. in response to a query) as designated by the "Sentence status flag" field, the equipment type field contains the talker ID of the equipment generating the sentence.

3) The unique identifier identifies the same equipment irrespective of command versus response: For commands it identifies the equipment intended to receive the command. For responses it identifies the equipment that actually received the command. Under normal conditions the response will be received from the equipment for which the command was intended. Equipment should only send one or more response sentences in response to command sentences received and should not use response sentences for general reporting. The unique identifier may be null.

4) The property identifier is a variable length integer field that identifies a parameter that can be set as defined in an applicable equipment standard and is intended for commissioning settings.

5) The "Value of property to be set" is a variable length character string representing the intended configuration parameter value when the sentence is a command and the current value when the sentence is a report.

Examples of EPV sentence command and response:

Example 1:

   The example shows an ECDIS (with a Talker ID of "EI") setting the baud rate for the Port 1 of an AIS transponder (with a Talker ID of "AI"). In this example, the MMSI of the AIS is 503123450. The ECDIS would send the following command:

   $EIEPV,C,AI,503123450,101,38400*hh

   The AIS would send the following response:

   $AIEPV,R,AI,503123450,101,38400*hh

Example 2:

   The example shows an ECDIS (with a Talker ID of "EI") setting the baud rate for Port 1 of an AIS transponder (with a Talker ID of "AI"). In this example, the MMSI of the AIS is 503123450, but the wrong MMSI was used with two digits transposed from "45" to "54".

   The ECDIS would send the following sentence:

   $EIEPV,C,AI,503123540,101,38400*hh

   The AIS would send the following response indicating that it "Cannot fulfil request or command because of a problem with the data field in the sentence" due to the incorrect MMSI:

   $AINAK,EI,EPV,,11,*hh

Example 3:

   The example shows a protected EPV Sentence command and response using a SPW sentence for authentication. The example is for a Radar (Talker ID of "RA") setting the MMSI and IMO number of an AIS transponder (Talker ID "AI") and using a password. It is assumed that the MMSI is not yet set and therefore the value is 0. The Radar would send the following sentences:

   This sets the MMSI number:

   $RASPW,EPV,000000000,1,SESAME*hh

   $RAEPV,C,AI,000000000,106,503123450*hh

   This sets the IMO number:

   $RASPW,EPV,503123450,1,SESAME*hh

$RAEPV,C,AI,503123450,107,9241061*hh

The AIS would send the following response sentences:

$AIEPV,R,AI,503123450,106,503123450*hh

8.3.32 ETL – Engine telegraph operation status

This sentence indicates engine telegraph position including operating location and sub-telegraph indicator.

$--ETL,hhmmss.ss,a,xx,xx,a,x*hh<CR><LF>

```
                    │ │ │ │  │ │
                    │ │ │ │  │ └── Number of engine or propeller shaft 6)
                    │ │ │ │  └──── Operating location indicator 5)
                    │ │ │ └─────── Position indication of sub-telegraph 4)
                    │ │ └───────── Position indicator of engine telegraph 3)
                    │ └─────────── Message type 2)
                    └───────────── Event time 1)
```
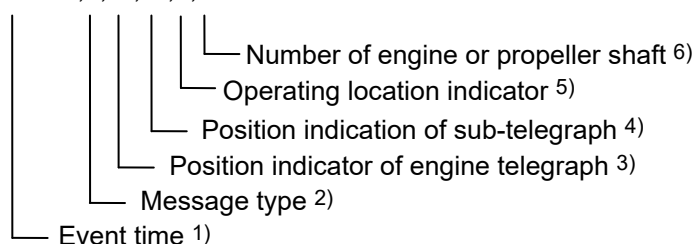
Comments:

1) Event time of condition change. This may be a null field.

2) Indicator character to identify message type. This should not be a null field.

   O = Order

   A = Answer-back

3) Numeric characters showing telegraph position. This field is two characters:

   00 = STOP ENGINE

   01 = [AH] DEAD SLOW

   02 = [AH] SLOW

   03 = [AH] HALF

   04 = [AH] FULL

   05 = [AH] NAV. FULL

   11 = [AS] DEAD SLOW

   12 = [AS] SLOW

   13 = [AS] HALF

   14 = [AS] FULL

   15 = [AS] CRASH ASTERN

4) Numeric characters showing sub-telegraph position. This field is two numeric characters:

   20 = S/B (Stand-by engine)

   30 = F/A (Full away – Navigation full)

   40 = F/E (Finish with engine)

5) Indication to identify location. This field is single character.

   B = Bridge

   P = Port wing

   S = Starboard wing

   C = Engine control room

   E = Engine side / local

   W = Wing (port or starboard not specified)

   If not known, this should be a null field.

6) Numeric character to identify engine or propeller shaft controlled by the system. This is numbered from centre-line. This field is single character:

0 = single or on centre-line

Odd = starboard

Even = port

8.3.33 EVE – General event message

This sentence is used to transmit events (e.g. actions by the crew on the bridge) with a time stamp.

$--EVE,hhmmss.ss,c--c,c--c*hh<CR><LF>

```
                 │       │        └── Event description
                 │       └── Tag code used for identification of source of event 1)
                 └── Event time 1)
```
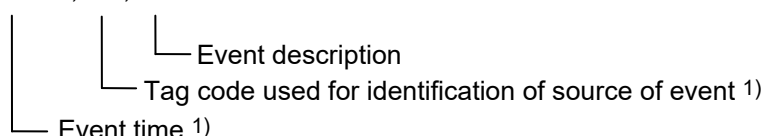
Comments:

1) This may be a null field.

8.3.34 FIR – Fire detection

This sentence indicates fire detection status with data on the specific location.

$--FIR,a,hhmmss.ss,aa,cc,xxx,xxx,a,a,c--c *hh<CR><LF>
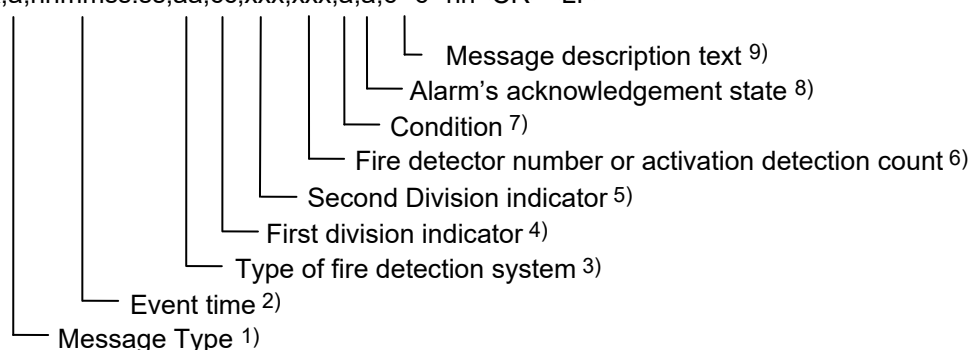
```
         │     │       │   │   │   │   │  │  └── Message description text 9)
         │     │       │   │   │   │   │  └── Alarm's acknowledgement state 8)
         │     │       │   │   │   │   └── Condition 7)
         │     │       │   │   │   └── Fire detector number or activation detection count 6)
         │     │       │   │   └── Second Division indicator 5)
         │     │       │   └── First division indicator 4)
         │     │       └── Type of fire detection system 3)
         │     └── Event time 2)
         └── Message Type 1)
```

Comments:

1) S: Status for section: Number of faulty and activated condition reported as number in field 6. The section may be a whole section (one or both of the division indicator fields are null) or a sub-section. The status S is normally transmitted at regular intervals. Examples of use are given in Annex E.

   E: Status for each fire detector. (E may be used to indicate an event.)

   F: Fault in system: Division indicator fields define the section when provided.

   D: Disabled: Detector is manually or automatically disabled from giving fire alarms.

2) Time of condition change or acknowledgement. This may be a null field.

3) The field is two fixed alpha characters, see table below.

4) First division indicator where detector is located. This field is two characters, see table below.

5) Second division indicator where detector is located. This field is three numeric characters, see table below.

6) This field is three fixed numeric characters. When the message type field is E this field identifies the detector. When the message type field is S this field contains the number of fire detectors activated. When the message type field is F or D this field is a null field.

7) When the message type field is S this field should be a null field. When the message type field is E, F or D this field includes a single character specified by the following:

   A = Activation

   V = Non-activation

   X = Fault (state unknown)

8) When the message field type is E or F this field includes a single character specified by the following:

A = acknowledged

V = not acknowledged

When the message field type is S or D this should be a null field.

9) Descriptive text/sensor location tag. If a sensor location identifier is string type, it is possible to use this field instead of above sensor allocation fields. The maximum number of characters will be limited by maximum sentence length and length of other fields.

Type of fire detection system		First division indicator	Second division indicator
ID	System category		
FD	Generic fire detector, can be any of the ones below.	Number / letter of zone. This can also be a control and monitoring system main unit identifier, for example fire central number/letter.	Loop number. This can also be another control and monitoring sub-system identifier, for example sub-central number.
FH	Heat type detector		
FS	Smoke type detector		
FD	Smoke and heat detector		
FM	Manual call point		
GD	Any gas detector	As above	As above
GO	Oxygen gas detector		
GS	Hydrogen sulphide gas detector		
GH	Hydro-carbon gas detector		
SF	Sprinkler flow switch	As above	As above
SV	Sprinkler manual valve release		
CO	CO_2 manual release	As above	As above
OT	Other	As above	As above
For units controlled from the fire alarm system (typically all FD, FH, FS, FD and FM), the normal division indicators should be fire zone and loop number.			

8.3.35 FSI – Frequency set information

This sentence is used to set frequency, mode of operation and transmitter power level of a radiotelephone; to read out frequencies, mode and power and to acknowledge setting commands. This is a command sentence.

$--FSI,xxxxxx,xxxxxx,c,x,a*hh<CR><LF>
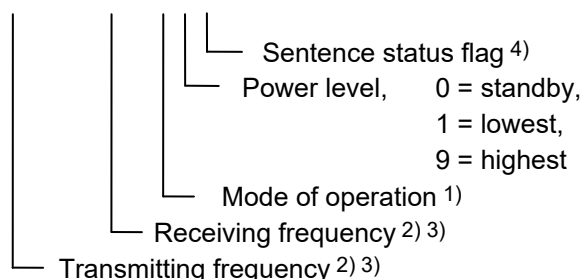
```
                    |    | | |   |
                    |    | | |   Sentence status flag 4)
                    |    | | Power level,   0 = standby,
                    |    | |                1 = lowest,
                    |    | |                9 = highest
                    |    | Mode of operation 1)
                    |    Receiving frequency 2) 3)
                    Transmitting frequency 2) 3)
```

Comments:

1) Mode of operation:

   d = F3E/G3E, simplex, telephone

   e = F3E/G3E, duplex, telephone

   m = J3E, telephone

   o = H3E, telephone

   q = F1B/J2B FEC NBDP, telex/teleprinter

  s = F1B/J2B ARQ NBDP, telex/teleprinter

  t = F1B/J2B, receive only, teleprinter/DSC

  w = F1B/J2B, teleprinter/DSC

  x = A1A Morse, tape recorder

  { = A1A Morse, Morse key/head set

  | = F1C/F2C/F3C, facsimile machine

  null for no information.

2) Frequencies to be in 100 Hz increments.

  MF/HF telephone channels to have first digit 3, followed by ITU channel numbers with leading zeros as required. MF/HF teletype channels to have first digit 4. The second and third digit give the frequency bands, and the fourth to sixth digits ITU channel numbers, each with leading zeros as required. VHF channels to have the first digit 9 followed by zero. The next number is "1" indicating the ship station's transmit frequency is being used as a simplex channel frequency, or "2" indicating the coast station's transmit frequency is being used as a simplex channel frequency, "0" otherwise. The remaining three numbers are the VHF channel numbers with leading zeros as required.

3) For paired frequencies, only the transmitting frequency needs to be included; null for receiving frequency field. For receive frequencies only, the transmitting frequency field should be null.

4) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

  R = Sentence is a status report of current settings (use for a reply to a query).

  C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.36 GBS – GNSS satellite fault detection

This sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM). Given that a GNSS receiver is tracking enough satellites to perform an integrity check of the position solution a sentence is needed to report the output of this process to other systems to advise the system user. With the RAIM in the GNSS receiver, the receiver can isolate faults to individual satellites and not use them in its position and velocity calculations. Also, the GNSS receiver can still track the satellite and easily judge when it is back within tolerance. This sentence shall be used for reporting this RAIM information. To perform this integrity function, the GNSS receiver should have at least two observables in addition to the minimum required for navigation. Normally, these observables take the form of additional redundant satellites.

If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the errors pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution the talker ID is GN and the errors pertain to the combined solution.

$--GBS, hhmmss.ss, x.x, x.x, x.x, xx, x.x, x.x, x.x, h, h*hh <CR><LF>

```
$--GBS, hhmmss.ss, x.x, x.x, x.x, xx, x.x, x.x, x.x, h, h*hh <CR><LF>
              │    │    │    │   │   │    │    │   │  │
              │    │    │    │   │   │    │    │   │  └── GNSS Signal ID 4)
              │    │    │    │   │   │    │    │   └───── GNSS System ID 3)
              │    │    │    │   │   │    │    └──────── Standard deviation of bias estimate
              │    │    │    │   │   │    └───────────── Estimate of bias on most likely failed satellite
              │    │    │    │   │   │                    (in metres)
              │    │    │    │   │   └────────────────── Probability of missed detection for most likely
              │    │    │    │   │                        failed satellite
              │    │    │    │   └────────────────────── ID number of most likely failed satellite 2)
              │    │    │    └────────────────────────── Expected error in altitude 1)
              │    │    └─────────────────────────────── Expected error in longitude 1)
              │    └──────────────────────────────────── Expected error in latitude 1)
              └───────────────────────────────────────── UTC time of the GGA or GNS fix associated with this sentence
```

Comments:

1) Expected error in metres due to bias, with noise = 0.

2) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted (these legacy systems remain in effect for new systems see Comment 3):

   a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.

   b) The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.

   c) The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+ satellite slot number. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites. This gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

3) System ID identifies the GNSS System ID according to the Table below. Note that a legacy numbering system as above should remain in effect.

4) GNSS Signal ID identifies the GNSS Signal ID according to the Table below.

System	System ID	Satellite ID	Signal ID	Signal/Channel
GPS	1 (GP)	1 – 99 1 – 32 is reserved for GPS 33 – 64 is reserved for SBAS 65 – 99 is undefined	0 1 2 3 4 5 6 7 8 9 – F	All signals L1 C/A L1 P(Y) L1 M L2 P(Y) L2C-M L2C-L L5-I L5-Q Reserved
GLONASS	2 (GL)	1 – 99 1 – 32 is undefined 33 – 64 is reserved for SBAS 65 – 99 is reserved for GLONASS	0 1 2 3 4 5 – F	All signals G1 C/A G1 P G2 C/A GLONASS (M) G2 P Reserved
GALILEO	3 (GA)	1 – 99 1 – 36 is reserved for Galileo SVs 37 – 64 is reserved for Galileo SBAS 65 – 99 is undefined	0 1 2 3 4 5 6 7 8 – F	All signals E5a E5b E5 a+b E6-A E6-BC L1-A L1-BC Reserved
RESERVED	4 to F			

8.3.37   GEN – Generic binary information

This sentence provides a means of transmitting generic binary information (e.g. lamp display status). The sentence is designed for efficient use of the bandwidth.

In general, the proper decoding and interpretation of binary data will require access to information developed and maintained outside of this standard. This standard contains information that describes how the data should be coded, decoded, and structured. The specific meaning of the binary data is obtained outwith this standard.

The packed generic binary data is "assumed to be" a linear array of 2^{16} (65 536) 16 bit entities. The GEN sentence specify new content for up to eight consecutive 16-bit entities indexed into the array by the first field.

$--GEN,hhhh,hhmmss.ss,hhhh,......,hhhh*hh<CR><LF>

Packed binary field "n" [3] [5]

Variable number of packed binary field [4] [5]

Packed binary field [3] [5]

Time stamp [2]

Index of first packed binary field in sentence [1] [5]
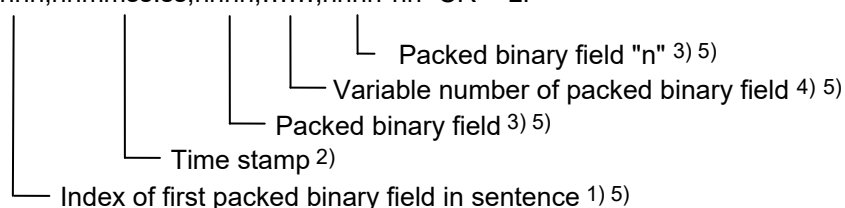
Comments:

1) Index of first group in GEN sentence. Address is represented in hexadecimal format in HEX range 0000 through FFFF. The 16-bit address is formatted as fixed 4-character HEX field.

2) This may be a null field.

3) The packed binary field is represented as a 16-bit value. The 16-bit value is formatted as fixed 4-character HEX field. This may be a null field.

4) Optional repeated packed binary field. Each repeat increases the index by one. Up to seven repetitions yielding a total of 128 bit per sentence is possible.

5)

   a) The 4-character HEX field values used in this sentence are interpreted as follows:

   hhhh = (highest bit) [15][14][13][12]…[3][2][1][0] (lowest bit)

   Least significant hexadecimal digit

   Most significant hexadecimal digit
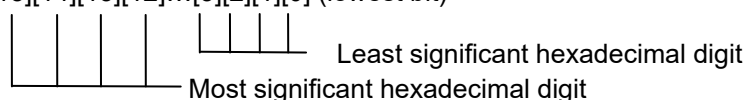
   b) The example below shows 10 groups of status information. The 4-character HEX field value of 0123 for the first packed generic status group at HEX address 0000 is interpreted as a 16-bit value with bits 0, 1, 5 and 8 being set. The status from the source is sent in two sentences:

   $VRGEN,0000,011200.00,0123,4567,89AB,CDEF,0123,4567,89AB,CDEF*64

   $VRGEN,0008,011200.00,0123,4567*6C

8.3.38   GFA – GNSS fix accuracy and integrity

This sentence is used to report the results of the data quality and integrity check associated with a position solution to other systems and to advise the system user. If only a single constellation (GPS, GLONASS, GALILEO, etc.) is used for the reported position solution, the talker ID is GP, GL, GA, etc. and the data pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution, the talker ID is GN and the parameters pertain to the combined solution. This sentence provides the quality data of the position fix and should be associated with the GNS sentence.

```
$--GFA,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x,c--c*hh<CR><LF>
```

Integrity status [3]
Selected accuracy level (m) [2]
Standard deviation of altitude (m)
Orientation of semi-major axis of error ellipse (deg) [1]
Standard deviation of semi-minor axis of error ellipse (m)
Standard deviation of semi-major axis of error ellipse (m)
Vertical protection level (m)
Horizontal protection level (m)
UTC time of GNS fix associated with this sentence
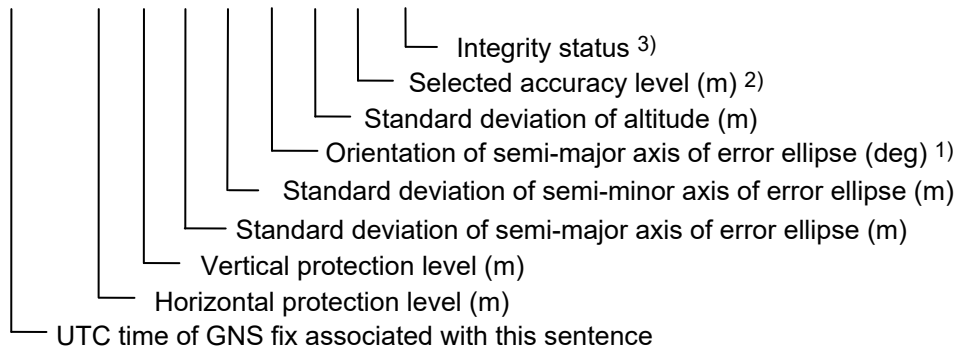
Comments:

1) Degrees from true north.

2) The selected accuracy level and the associated integrity requirements (alert limit, integrity risk limit, continuity, time-to-alarm) should be in accordance with Appendix 2 of IMO Res. A. 915(22).

3) The integrity status field is a variable length character field which indicates the status of the various integrity sources, with three currently defined; RAIM (first character), SBAS (second character) and Galileo integrity (GIC). This field should not be a NULL field and the characters should take one of the following values:

V = Not in use

S = Safe (when integrity is available and HPL<HAL)

C = Caution (when integrity is not available)

U = Unsafe (when integrity is available and HPL>HAL)

8.3.39   GGA – Global positioning system (GPS) fix data

Time, position and fix-related data for a GPS receiver.

Differential reference station ID, 0000-1023
Age of differential GPS data [2]
Units of geoidal separation, m
Geoidal separation [3]
Units of antenna altitude, m
Antenna altitude
above/below
Horizontal dilution of precision

```
$--GGA, hhmmss.ss, llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>
```

Number of satellites in use, 00 12, may be different from the number in view
GPS quality indicator [1]
Longitude E/W
Latitude N/S
UTC of position

Comments:

1) All GPS quality indicators in headings 1 through 8 are considered "valid". The heading "0" is the only "invalid" indicator. The GPS quality indicator field should not be a null field.

0 = fix not available or invalid

1 = GPS SPS mode

2 = differential GPS, SPS mode

3 = GPS PPS mode

4 = Real Time Kinematic. Satellite system used in RTK mode with fixed integers

5 = Float RTK. Satellite system used in RTK mode with floating solution

6 = Estimated (dead reckoning) mode

7 = Manual input mode

8 = Simulator mode

2) Time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used.

3) Geoidal separation: the difference between the WGS-84 earth ellipsoid surface and mean sea level (geoid) surface, " – " = mean sea level surface below the WGS-84 ellipsoid surface.

8.3.40   GLL – Geographic position – Latitude/longitude

Latitude and longitude of vessel position, time of position fix and status.

$--GLL,llll.ll,a,yyyyy.yy,a,hhmmss.ss,A,a*hh<CR><LF>

Mode indicator [1] [2]

Status [2]   A=data valid V=data invalid

UTC of position

Longitude, E/W

Latitude, N/S
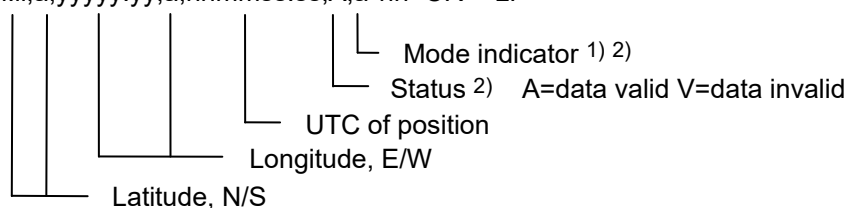
Comments:

1) Positioning system mode indicator:

   A = Autonomous

   D = Differential

   E = Estimated (dead reckoning)

   M = Manual input

   S = Simulator

   N = Data not valid

2) The mode indicator field supplements the status field (field 6). The status field should be set to V = invalid for all values of operating mode except for A = Autonomous and D = Differential. The positioning system mode indicator and status fields should not be null fields.

8.3.41   GNS – GNSS fix data

Fix data for single or combined satellite navigation systems (GNSS). This sentence provides fix data for GPS, GLONASS, possible future satellite systems and systems combining these. This sentence could be used with the talker identification of GP for GPS, GL for GLONASS, GA for Galileo, GN for GNSS combined systems, as well as future identifiers. Some fields may be null fields for certain applications, as described below.

If a GNSS receiver is capable simultaneously of producing a position using combined satellite systems, as well as a position using only one of the satellite systems, then separate $GPGNS, $GLGNS, etc. sentences may be used to report the data calculated from the individual systems.

If a GNSS receiver is set up to use more than one satellite system, but for some reason one or more of the systems are not available, then it may continue to report the positions using $GNGNS, and use the mode indicator to show which satellite systems are being used.

```
                            Navigational status indicator 5)  ─┐
                     Differential reference station ID 2)  ─┐  │
                            Age of differential data 2)  ─┐ │  │
                            Geoidal separation, m 4)  ─┐  │ │  │
                            Antenna altitude, m,  ─┐   │  │ │  │
                            re: mean-sea-level (geoid)  │  │  │ │  │
$-- GNS, hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,xx,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>
         │         │       │ │        │ │    │  └─ HDOP 3)
         │         │       │ │        │ │    └─ Total number of satellites in use, 00-99
         │         │       │ │        │ └─ Mode indicator 1)
         │         │       │ │        └─ Longitude, E/W
         │         │       └─┴─ Latitude, N/S
         └─ UTC of position
```
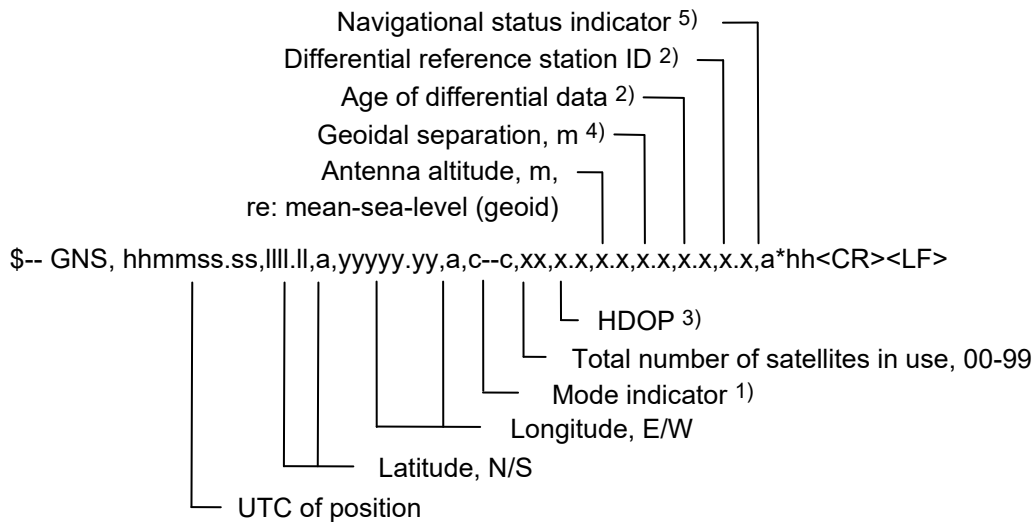
Comments:

1) Mode indicator. A variable length valid character field type with the first three characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites and the third indicate the use of Galileo satellites. If another satellite system is added to the standard, the mode indicator will be extended to four characters, new satellite systems should always be added on the right, so the order of characters in the mode indicator is: GPS, GLONASS, Galileo, other satellite systems in the future. The characters should take one of the following values:

A = Autonomous. Satellite system used in non-differential mode in position fix

D = Differential. Satellite system used in differential mode in position fix

E = Estimated (dead reckoning) mode

F = Float RTK. Satellite system used in real time kinematic mode with floating integers

M = Manual input mode

N = No fix. Satellite system not used in position fix, or fix not valid

P = Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as selective availability) and higher resolution code (P-code) is used to compute position fix. P is also used for satellite system used in multi-frequency, SBAS or Precise Point Positioning (PPP) mode

R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers

S = Simulator mode

The mode indicator should not be a null field.

Examples:

Using GPS receiver:
$**GP**GNS,122310.2,3722.425671,N,12258.856215,W,**A**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>
Also possible:
$**GP**GNS,122310.2,3722.425671,N,12258.856215,W,**AN**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>
$**GP**GNS,122310.2,3722.425671,N,12258.856215,W,**ANN**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>

Using GLONASS receiver:
$**GL**GNS,122310.2,3722.425671,N,12258.856215,W,**NA**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>
Also possible:
$**GL**GNS,122310.2,3722.425671,N,12258.856215,W,**NAN**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>

Using Galileo receiver:
$**GA**GNS,122310.2,3722.425671,N,12258.856215,W,**NNA**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF

Using combined system with GPS and differential GLONASS:
$**GN**GNS,122310.2,3722.425671,N,12258.856215,W,**AD**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>
Also possible:

$GNGNS,122310.2,3722.425671,N,12258.856215,W,**ADN**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>

Using combined system with differential GPS, GLONASS and Galileo:

$GNGNS,122310.2,3722.425671,N,12258.856215,W,**DAA**,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>

2) Age of differential data and Differential Reference Station ID:

a) When the talker is GN and more than one of the satellite systems are used in differential mode, then the "Age of differential data" and "Differential reference station ID" fields should be null. In this case, the "Age of differential data" and "Differential reference station ID" fields should be provided in following GNS sentences with talker IDs of GP, GL, etc. These following GNS messages should have the latitude, N/S, longitude, E/W, altitude, geoidal separation, mode, and HDOP fields null. This indicates to the listener that the field is supporting a previous $GNGNS sentence with the same time tag. The "Number of satellites" field may be used in these following sentences to denote the number of satellites used from that satellite system.

Example: A combined GPS/GLONASS receiver using only GPS differential corrections has the following GNS sentence sent.

$GNGNS,122310.2,3722.425671,N,12258.856215,W,DA,14,0.9,1005.543,6.5,5.2,23,S*hh<CR><LF>

Example: A combined GPS/GLONASS receiver using both GPS differential corrections and GLONASS differential corrections may have the following three GNS sentences sent in a group.

$GNGNS,122310.2,3722.425671,N,12258.856215,W,DD,14,0.9,1005.543,6.5,,,S*hh<CR><LF>

$GPGNS,122310.2, , , , , , ,7, , , ,5.2,23,S*hh<CR><LF>

$GLGNS,122310.2, , , , , , ,7, , , ,3.0,23,S*hh<CR><LF>

The Differential Reference station ID may be the same or different for the different satellite systems.

b) Age of Differential Data

For GPS Differential Data:

This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 1 corrections are used, the age is that of the most recent Type 1 correction. When RTCM SC104 Type 9 corrections are used solely, or in combination with Type 1 corrections, the age is the average of the most recent corrections for the satellites used. Null field when Differential GPS is not used.

For GLONASS Differential Data:

This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 31 corrections are used, the age is that of the most recent Type 31 correction. When RTCM SC104 Type 34 corrections are used solely, or in combination with Type 31 corrections, the age is the average of the most recent corrections for the satellites used. Null field when differential GLONASS is not used.

For Galileo Differential Data:

This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 41 corrections are used, the age is that of the most recent Type 41 correction. When RTCM SC104 Type 42 corrections are used solely, or in combination with Type 41 corrections, the age is the average of the most recent corrections for the satellites used. Null field when differential Galileo is not used.

3) HDOP calculated using all the satellites (GPS, GLONASS, Galileo and any future satellites) used in computing the solution reported in each GNS sentence.

4) Geoidal Separation: the difference between the earth ellipsoid surface and mean-sea-level (geoid) surface defined by the reference datum used in the position solution, "-" = mean-sea-level surface below ellipsoid. The reference datum may be specified in the DTM sentence.

5) The navigational status indicator is according to IEC 61108 requirements on 'Navigational (or Failure) warnings and status indications'. This field should not be a NULL field and the character should take one of the following values:

S =   Safe   when the estimated positioning accuracy (95 % confidence) is within the selected accuracy level corresponding to the actual navigation mode, and integrity is available and within the requirements for the actual navigation mode, and a new valid position has been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft
C =   Caution   when integrity is not available
U =   Unsafe   when the estimated positioning accuracy (95 % confidence) is less than the selected accuracy level corresponding to the actual navigation mode, and/or integrity is available but exceeds the requirements for the actual navigation mode, and/or a new valid position has not been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft
V =   Navigational status not valid, equipment is not providing navigational status indication.

8.3.42 GRS – GNSS range residuals

This sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM). Range residuals can be computed in two ways for this process. The basic measurement integration cycle of most navigation filters generates a set of residuals and uses these to update the position state of the receiver. These residuals can be reported with GRS, but because of the fact that these were used to generate the navigation solution they should be recomputed using the new solution in order to reflect the residuals for the position solution in the GGA or GNS sentence. The MODE field should indicate which computation method was used. An integrity process that uses these range residuals would also require GGA or GNS, the GSA, and the GSV sentences to be sent.

If only GPS, GLONASS, Galileo etc. is used for the reported position solution the talker ID is GP, GL, GA, etc. and the range residuals pertain to the individual system. If GPS, GLONASS, Galileo, etc. are combined to obtain the position solution multiple GRS sentences are produced, one with the GPS satellites, another with the GLONASS satellites, another with Galileo satellites, etc. Each of these GRS sentences shall have talker ID "GN", to indicate that the satellites are used in a combined solution. It is important to distinguish the residuals from those that would be produced by a GPS-only, GLONASS-only, Galileo-only, etc. position solution. In general the residuals for a combined solution will be different from the residual for a GPS-only, GLONASS-only, Galileo-only, etc. solution.

```
                                        Signal ID 4) ─┐
                              GNSS System ID 5) ─┐    │
                                                 │    │
$--GRS, hhmmss.ss,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,h,h*hh<CR><LF>
          │        │ └──────────────────────────────────┘
          │        │
          │        └─ Range residuals for satellites used in the navigation solution 1) 2)
          │           Order should match order of satellite ID 3) numbers in GSA. When
          │           GRS is used, GSA and GSV are generally required. Null for unused
          │           fields
          └──────── Mode:  0 =  residuals were used to calculate the position given
          │                     in the matching GGA or GNS sentence
          │                1 =  residuals were re computed after the GGA or GNS
          │                     position was computed
          └──────── UTC time of the GGA or GNS fix associated with this sentence
```

Comments:

1) If the range residual exceeds ±99,9 m, then the decimal part is dropped, resulting in an integer (−103,7 becomes −103). The maximum value for this field is ±999.

2) The sense or sign of the range residual is determined by the order of parameters used in the calculation. The expected order is as follows: range residual = calculated range – measured range.

3) When multiple GRS sentences are being sent then their order of transmission should match the order of corresponding GSA sentences. Listeners should keep track of pairs of GSA and GRS sentences and discard data if pairs are incomplete.

4) Signal ID identifies the actual ranging signal according to the Table below.

5) System ID, see Table below.

System	System ID	Satellite ID	Signal ID	Signal/Channel
GPS	1 (GP)	1 – 99	0	All signals
		1 – 32 is reserved for GPS	1	L1 C/A
		33 – 64 is reserved for SBAS	2	L1 P(Y)
		65 – 99 is undefined	3	L1 M
			4	L2 P(Y)
			5	L2C-M
			6	L2C-L
			7	L5-I
			8	L5-Q
			9 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GLONASS	2 (GL)	1 – 99	0	All signals
		1 – 32 is undefined	1	G1 C/A
		33 – 64 is reserved for SBAS	2	G1 P
		65 – 99 is reserved for	3	G2 C/A
		GLONASS	4	GLONASS (M) G2 P
			5 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GALILEO	3 (GA)	1 – 99	0	All signals
		1 – 36 is reserved for	1	E5a
		Galileo SVs	2	E5b
		37 – 64 is reserved for	3	E5 a+b
		Galileo SBAS	4	E6-A
		65 – 99 is undefined	5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
RESERVED	4 to F			

8.3.43   GSA – GNSS DOP and active satellites

GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentences, and DOP values. If only GPS, GLONASS, Galileo etc. are used for the reported position solution, the talker ID is GP, GL, GA etc. and the DOP values pertain to the individual system. If GPS, GLONASS, Galileo, etc. are combined to obtain the reported position solution, multiple GSA sentences are produced, one with the GPS satellites, another with the GLONASS satellites another with Galileo, etc. each of these GSA sentences shall have talker ID GN, to indicate that the satellites are used in a combined solution and each shall have the PDOP, HDOP and VDOP for the combined satellites used in the position.

GNSS System ID [2]

$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,h*hh<CR><LF>

```
                                             VDOP
                                          HDOP
                                       PDOP
               ID numbers of satellites used in solution [1]
          Mode: 1 = fix not available, 2 = 2D, 3 = 3D
        Mode:  M = manual, forced to operate in 2D or 3D mode
               A = automatic, allowed to automatically switch 2D/3D
```
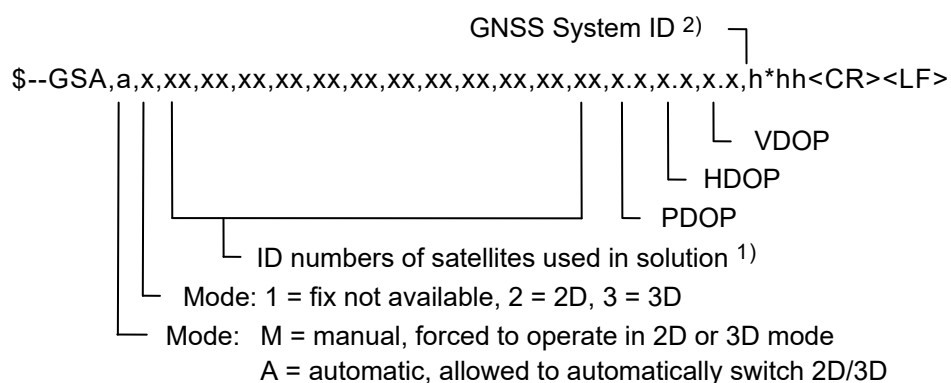
Comments:

1) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted.

   a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.

   b) The numbers 33 to 64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120 to 138. The offset from WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.

   c) The numbers 65 to 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+ satellite slot numbers. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, thus giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

2) GNSS System ID identifies the GNSS System ID according to the Table below.

System	System ID	Satellite ID	Signal ID	Signal/Channel
GPS	1 (GP)	1 – 99	0	All signals
		1 – 32 is reserved for GPS	1	L1 C/A
		33 – 64 is reserved for SBAS	2	L1 P(Y)
		65 – 99 is undefined	3	L1 M
			4	L2 P(Y)
			5	L2C-M
			6	L2C-L
			7	L5-I
			8	L5-Q
			9 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GLONASS	2 (GL)	1 – 99	0	All signals
		1 – 32 is undefined	1	G1 C/A
		33 – 64 is reserved for SBAS	2	G1 P
		65 – 99 is reserved for	3	G2 C/A
		GLONASS	4	GLONASS (M) G2 P
			5 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GALILEO	3 (GA)	1 – 99	0	All signals
		1 – 36 is reserved for	1	E5a
		Galileo SVs	2	E5b
		37 – 64 is reserved for	3	E5 a+b
		Galileo SBAS	4	E6-A
		65 – 99 is undefined	5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
RESERVED	4 to F			

8.3.44   GST – GNSS pseudorange noise statistics

This sentence is used to support receiver autonomous integrity monitoring (RAIM). Pseudorange measurement noise statistics can be translated in the position domain in order to give statistical measures of the quality of the position solution. If only GPS, GLONASS, Galileo, etc. is used for the reported position solution, the talker ID is GP,GL, GA, etc. and the error data pertain to the individual system. If satellites from multiple systems are used to obtain the position solution, the talker ID is GN and the errors pertain to the combined solution.

$--GST, hhmmss.ss, x.x, x.x, x.x, x.x, x.x, x.x, x.x*hh<CR><LF>

```
                                        └─ Standard deviation of altitude error (m)
                                      └── Standard deviation of longitude error (m)
                                    └──── Standard deviation of latitude error (m)
                                  └────── Orientation of semi major axis of error ellipse
                                          (degrees from true north)
                                └──────── Standard deviation of semi minor axis of error ellipse (m)
                              └────────── Standard deviation of semi major axis of error ellipse (m)
                           └───────────── RMS value of the standard deviation of the range inputs to the
                                          navigation process. Range inputs include pseudoranges and DGPS
                                          corrections
                  └──────────────────── UTC time of the GGA or GNS fix associated with this sentence
```

8.3.45 GSV – GNSS satellites in view

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission. Total number of sentences being transmitted and the number of the sentence being transmitted are indicated in the first two fields.

If multiple GPS, GLONASS, Galileo etc. satellites are in view, use separate GSV sentences with talker ID GP to show the GPS satellites in view, talker GL to show the GLONASS satellites in view and talker ID GA to show the Galileo satellites in view, etc. When more than one ranging signal is used per satellite, also use separate GSV sentences with a signal ID corresponding to the ranging signal.

The GN identifier shall not be used with this sentence.

```
                                      Signal ID 4) ─┐
$--GSV,x,x,xx,xx,xx,xxx,xx..............,xx,xx,xxx,xx,h*hh<CR><LF>
       │ │ │  │  │   │                   └───────┴─ Fourth SV 2)
       │ │ │  │  │   │                 └────────── Second and third SVs 2)
       │ │ │  │  │   └──────────────────────────── SNR (C/No) 00 to 99 dB-Hz, null when not tracking
       │ │ │  │  └──────────────────────────────── Azimuth, degrees true, 000 to 359
       │ │ │  └─────────────────────────────────── Elevation, degrees, 90° maximum
       │ │ └────────────────────────────────────── Satellite ID number 3)
       │ └──────────────────────────────────────── Total number of satellites in view
       │ └──────────────────────────────────────── Message number 1), 1 to 9
       └────────────────────────────────────────── Total number of messages 1), 1 to 9
```

Comments:

1) Satellite information may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The first field specifies the total number of sentences, minimum value 1. The second field identifies the order of this sentence (sentence number), minimum value 1. For efficiency it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per sentence. Null fields are required for unused sets when less than four sets are transmitted.

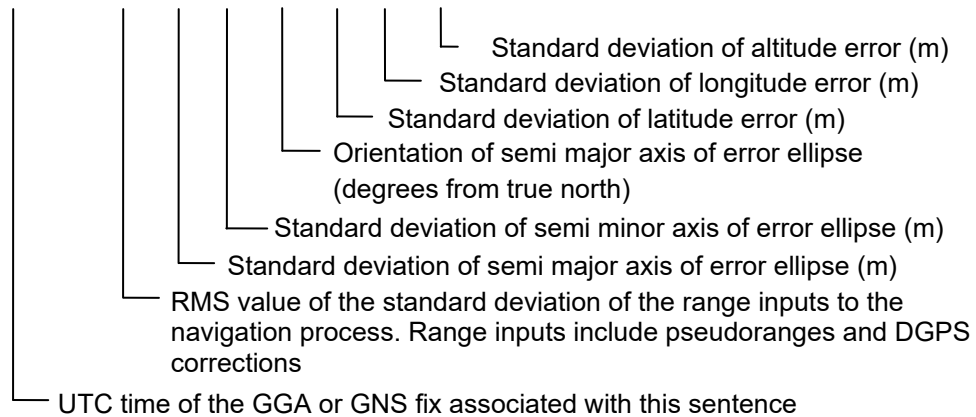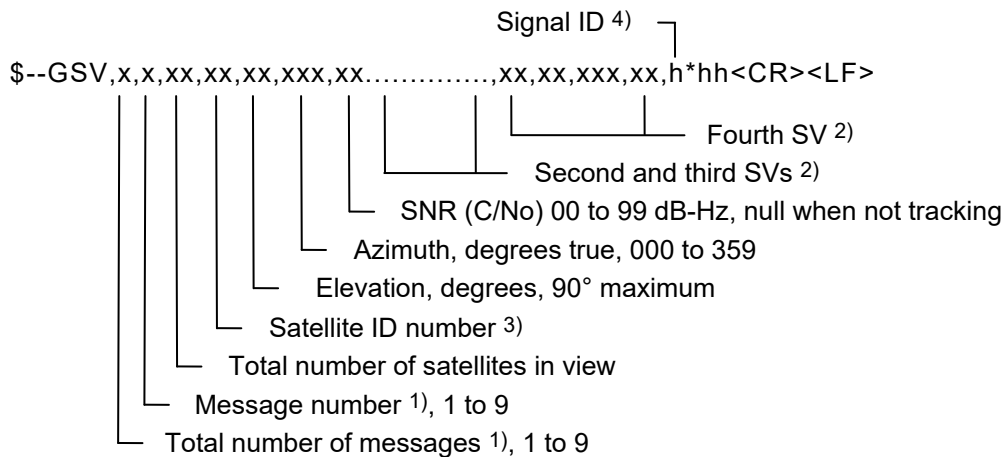3) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

   a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.

   b) The numbers 33 to 64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120 to 138. The offset from WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.

c) The numbers 65 to 96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+satellite slot number. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

4) Signal ID see Table below.

System	System ID	Satellite ID	Signal ID	Signal/Channel
GPS	1 (GP)	1 – 99	0	All signals
		1 – 32 is reserved for GPS	1	L1 C/A
		33 – 64 is reserved for SBAS	2	L1 P(Y)
		65 – 99 is undefined	3	L1 M
			4	L2 P(Y)
			5	L2C-M
			6	L2C-L
			7	L5-I
			8	L5-Q
			9 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GLONASS	2 (GL)	1 – 99	0	All signals
		1 – 32 is undefined	1	G1 C/A
		33 – 64 is reserved for SBAS	2	G1 P
		65 – 99 is reserved for	3	G2 C/A
		GLONASS	4	GLONASS (M) G2 P
			5 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
GALILEO	3 (GA)	1 – 99	0	All signals
		1 – 36 is reserved for	1	E5a
		Galileo SVs	2	E5b
		37 – 64 is reserved for	3	E5 a+b
		Galileo SBAS	4	E6-A
		65 – 99 is undefined	5	E6-BC
			6	L1-A
			7	L1-BC
			8 – F	Reserved

System	System ID	Satellite ID	Signal ID	Signal/Channel
RESERVED	4 to F			

8.3.46　HBT – Heartbeat supervision sentence

This sentence is intended to be used to indicate that equipment is operating normally, or for supervision of a connection between two units.

The sentence is transmitted at regular intervals specified in the corresponding equipment standard. The repeat interval may be used by the receiving unit to set the time-out value for the connection supervision.

$--HBT,x.x,A,x*hh<CR><LF>

       └── Sequential sentence identifier [3]

     └── Equipment status [2]

   └── Configured repeat interval [1]
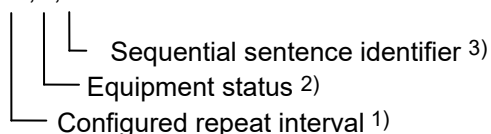
Comments:

1) Configured autonomous repeat interval in seconds. This field should be set to NULL in response to a query (see 7.3.5) if the query response feature is supported.

2) Equipment in normal operation   A = yes, V = no

   This field can be used to indicate the current equipment status. This could be the result of an built-in integrity testing function.

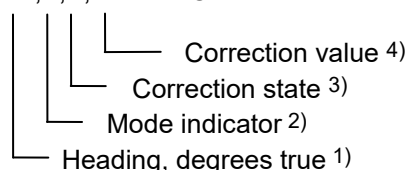3) The sequential sentence identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new sentence. The count resets to 0 after 9 is used.

8.3.47   HCR – Heading correction report

This sentence is used to inform the state and value of a heading correction included in the heading reported by the THS sentence when the heading source can apply a correction.

This sentence requires tight synchronization with THS sentence. This sentence should be sent immediately prior to every THS sentence for which the correction state field has changed compared to the previous THS sentence. For all "correction states" the HCR sentence should be transmitted periodically at intervals of not greater than 1,0 s.

$--HCR,x.x,a,a,x.x*hh<CR><LF>

       └── Correction value [4]

     └── Correction state [3]

    └── Mode indicator [2]

   └── Heading, degrees true [1]

Comments:

1) Value of heading for which this HCR is referenced. This value is not replacing heading value from the THS sentence. This value is used for synchronization between high data rate of THS sentence and low data rate of HCR sentence.

2) Mode indicator. This field should not be null.

   A = Autonomous

   E = Estimated (dead reckoning)

   M = Manual input

   S = Simulator mode

   V = Data not valid (including standby)

3) Correction state. This field should not be null.

   A = Both Speed/latitude and dynamic correction included in heading

   D = Dynamic correction included in heading

   S = Speed/latitude correction included in heading

   N = No correction included in heading

   V = Not available, reporting device does not know about correction state

4) Value of correction included in heading. Degrees +/- 180,0° with one decimal. Null field indicates correction state N (no correction included) or V (not available).

8.3.48   HDG – Heading, deviation and variation

Heading (magnetic sensor reading), which, if corrected for deviation, will produce magnetic heading, which, if offset by variation, will provide true heading.

$--HDG, x.x, x.x, a, x.x, a*hh<CR><LF>

          └─── Magnetic variation, degrees E/W [2] [3]

      └─── Magnetic deviation, degrees E/W [1] [3]

   └─── Magnetic sensor heading, degrees
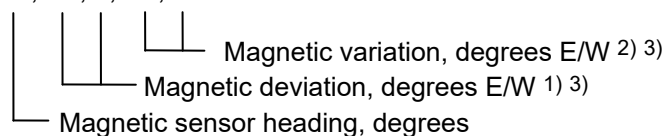
Comments:

1) To obtain magnetic heading: add easterly deviation (E) to magnetic sensor reading;

                               subtract westerly deviation (W) from magnetic sensor reading.

2) To obtain true heading: add easterly variation (E) to magnetic heading;

                               subtract westerly variation (W) from magnetic heading.

3) Variation and deviation fields will be null fields if unknown.

8.3.49 HDT – Heading true

Actual vessel heading in degrees true produced by any device or system producing true heading.

NOTE This is a deprecated sentence which has been replaced by THS.

$--HDT, x.x, T*hh<CR><LF>

      └─── Heading, degrees true

8.3.50 HMR – Heading monitor receive

Heading monitor receive: this sentence delivers data from the sensors selected by HMS from a central data collecting unit and delivers them to the heading monitor.

$--HMR,c--c,c--c,x.x,x.x,A,x.x,A,a,x.x,a,x.x,A,a,x.x,a,x.x,a*hh<CR><LF>

          └─── Variation,degrees E/W [1] [3]

        └─── Deviation sensor 2, degrees E/W [1] [2]

      └─── Sensor 2 Type T = True

                         M = Magnetic [1]

     └─── Status heading sensor 2: A = Data valid

                                     V = Data invalid

    └─── Actual heading reading sensor 2, degrees

   └─── Deviation sensor 1, degrees E/W [1] [2]

  └─── Sensor 1 Type T = True

                      M = Magnetic

 └─── Status heading sensor 1: A = Data valid

                               V = Data invalid

└─── Actual heading reading sensor 1, degrees

└─── Warning flag: A = difference within set limit

                    V = difference exceeds set limit

└─── Actual heading sensor difference, degrees

└─── Set difference by HMS, degrees

└─── Heading sensor 2, ID

└─── Heading sensor 1, ID

Comments:

1) For magnetic sensors used, the deviation for the sensors and the variation of the area should be obtained; otherwise, or if unknown, null fields.
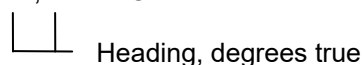
2) To obtain magnetic heading: add Easterly deviation (E) to magnetic sensor reading;

                               subtract Westerly deviation (W) from magnetic sensor reading.

3) To obtain true heading: add Easterly variation (E) to magnetic heading;

subtract Westerly variation (W) from magnetic heading.

8.3.51 HMS – Heading monitor set

Set heading monitor: two heading sources may be selected and the permitted maximum difference may then be set.

```
$--HMS,c--c,c--c,x.x*hh<CR> <LF>
```

Maximum difference, degrees [1]
Heading sensor 2, ID
Heading sensor 1, ID

Comments:

1) Maximum difference between both sensors which is accepted.

8.3.52 HRM – heel angle, roll period and roll amplitude measurement device

This sentence is used to provide the actual heel angle, roll period and roll amplitude of an electronic inclinometer to VDRs and other systems. Update rate for this message should be at least 5 Hz.
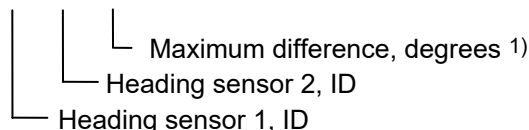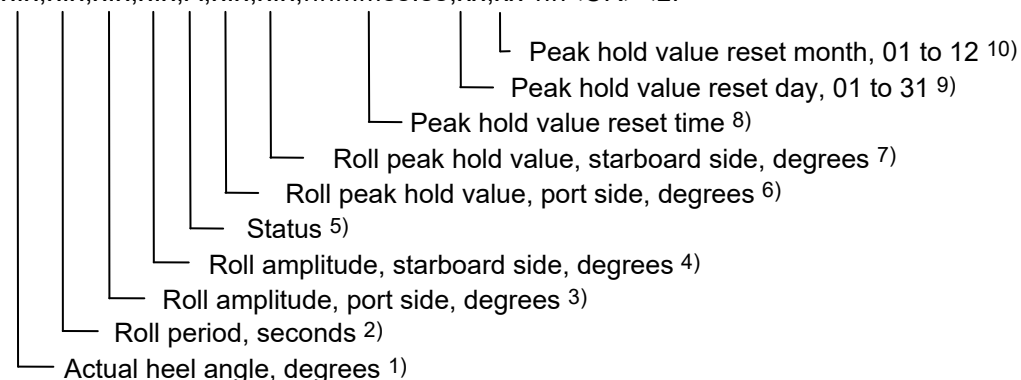
This sentence optionally provides roll peak hold values and their reset time as well. Roll peak hold value is the value indicated by friction pointers of conventional pendulum inclinometers.

In addition to the requirements of the IMO performance standard of electronic inclinometers, roll peak hold values may also be indicated on the displays of an electronic inclinometer. Roll peak hold value is the maximum absolute value of roll amplitude of port side and starboard side from the last reset time of peak hold value. The roll peak hold values are indicated as the value of the friction pointers of pendulum inclinometers and used for decision making in case of sailing under a severe weather condition. The optional values are provided for indicating information on roll peak hold values on dedicated displays or the other displays of integrated bridge systems.

```
$--HRM,x.x,x.x,x.x,x.x,A,x.x,x.x,hhmmss.ss,xx,xx*hh<CR><LF >
```

Peak hold value reset month, 01 to 12 [10]
Peak hold value reset day, 01 to 31 [9]
Peak hold value reset time [8]
Roll peak hold value, starboard side, degrees [7]
Roll peak hold value, port side, degrees [6]
Status [5]
Roll amplitude, starboard side, degrees [4]
Roll amplitude, port side, degrees [3]
Roll period, seconds [2]
Actual heel angle, degrees [1]

Comments:

1) Actual heel angle, momentary angle of roll referenced to a levelled ship to port or starboard side, (positive value starboard, negative value port).

2) Roll period, time between successive maximum values of heel angle to port over starboard and back to port (or the other way round).

3) Roll amplitude of port side as positive value, maximum value of heel angle to port side of the latest motion.

4) Roll amplitude of starboard side, maximum value of heel angle to starboard side of the latest motion.

5) Status, A=data valid, V=data invalid

6) Roll peak hold value of port side, maximum value of heel angle to port side of the motions measured from the last reset with a minimum resolution of 1 degree. This shall be a null field when data is not available.
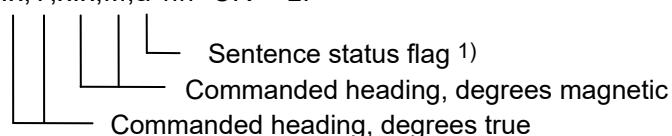
7) Roll peak hold value of starboard side, maximum value of heel angle to starboard side of the motions measured from the last reset with a minimum resolution of 1 degree. This shall be a null field when data is not available.

8) Peak hold value reset time, time when the peak hold values are reset, UTC hour, minute and second. Decimal point and fractions of the seconds shall not be used. This shall be a null field when data is not available.

9) Peak hold value reset day, day when the peak hold values are reset, UTC day. This shall be a null field when data is not available.

10) Peak hold value reset month, month when the peak hold values are reset, UTC month. This shall be a null field when data is not available.

8.3.53   HSC – Heading steering command

Commanded heading to steer vessel. This is a command sentence and may be used to provide input to a heading controller or to report the heading that has been commanded.

The HTC and HTD sentences are preferred for new applications, rather than the HSC sentence.

$--HSC,x.x,T,x.x,M,a*hh<CR><LF>

```
          |  |    |  |  |
          |  |    |  |  └──── Sentence status flag 1)
          |  |    |  └────── Commanded heading, degrees magnetic
          |  └────────────── Commanded heading, degrees true
```

Comments:

1) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

  R = Sentence is a status report of current settings (use for a reply to a query).

  C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.54   HSS – Hull stress surveillance systems

This sentence indicates the hull stress surveillance system measurement data.

$--HSS,c--c,x.x,A*hh<CR><LF>

```
        |    |  |
        |    |  └──── Data status (A = data valid, V = data invalid) 1)
        |    └────── Measurement value
        └────────── Measurement point ID
```

Comments:

1) This field should not be a null field.

8.3.55   HTC – Heading/track control command; HTD – Heading /track control data

HTC is a command sentence. Provides input to (HTC) a heading controller to set values, modes and references; or provides output from (HTD) a heading controller with information about values, modes and references in use.

```
                                              ┌─ Sentence status 7)
$--HTC,A,x.x,a,a,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,a*hh<CR><LF>
$--HTD,A,x.x,a,a,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,A, A, A,x.x*hh<CR><LF>
```

- Vessel heading, degrees
- Off-track status 5)   ┌─ A = within limits
- Off-heading status
- Rudder status ──────── └─ V = limit reached or exceeded
- Heading reference in use, T/M
- Commanded track 4) 6) degrees
- Commanded off-track limit 5) n.miles (unsigned)
- Commanded heading-to-steer 6), degrees
- Commanded rate of turn for heading changes, °/min
- Commanded radius of turn for heading changes, n.miles
- Commanded off-heading limit, degrees (unsigned)
- Commanded rudder limit, degrees (unsigned)
- Turn mode 3)   R = radius controlled
  - T = turn rate controlled
  - N = turn is not controlled
- Selected steering mode 2)
- Commanded rudder direction, L/R = port/starboard
- Commanded rudder angle, degrees
- Override 1),   A = in use, V = not in use

Comments:

1) Override provides direct control of the steering gear. In the context of this sentence, override means a temporary interruption of the selected steering mode. In this period, steering is performed by special devices. As long as field "override" is set to "A", both fields "selected steering mode" and " turn mode" should be ignored by the heading/track controller and its computing parts should operate as if manual steering was selected.

2) All steering modes represent steering as selected by a steering selector switch or by a preceding HTC sentence. Priority levels of these inputs and usage/acceptance of related fields are to be defined and documented by the manufacturer.

   Selected steering modes may be the following.

   M = Manual steering. The main steering system is in use.

   S = Stand-alone (heading control). The system works as a stand-alone heading controller. Field "commanded heading to steer" is not accepted as an input.

   H = Heading control. Input of commanded heading to steer is from an external device and the system works as a remotely controlled heading controller. Field "commanded heading to steer" is accepted as an input.

   T = Track control. The system works as a track controller by correcting a course received in field "commanded track". Corrections are made based on additionally received track errors (e.g. from sentence XTE, APB, etc.).

   R = Rudder control. Input of commanded rudder angle and direction from an external device. The system accepts values given in fields "commanded rudder angle" and "commanded rudder direction" and controls the steering by the same electronic means as used in modes S, H or T.

3) Turn mode defines how the ship changes heading when in steering modes S, H or T according to the selected turn mode values given in fields "commanded radius of turn" or "commanded rate of turn". With turn mode set to "N", turns are not controlled but depend upon the ship's manoeuverability and applied rudder angles only.

4) Commanded track represents the course line (leg) between two waypoints. It may be altered dynamically in a track-controlled turn along a pre-planned radius.

5) Off-track status can be generated if the selected steering mode is "T".

6) Data in these fields should be related to the heading reference in use.

7) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.
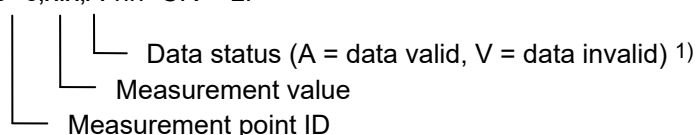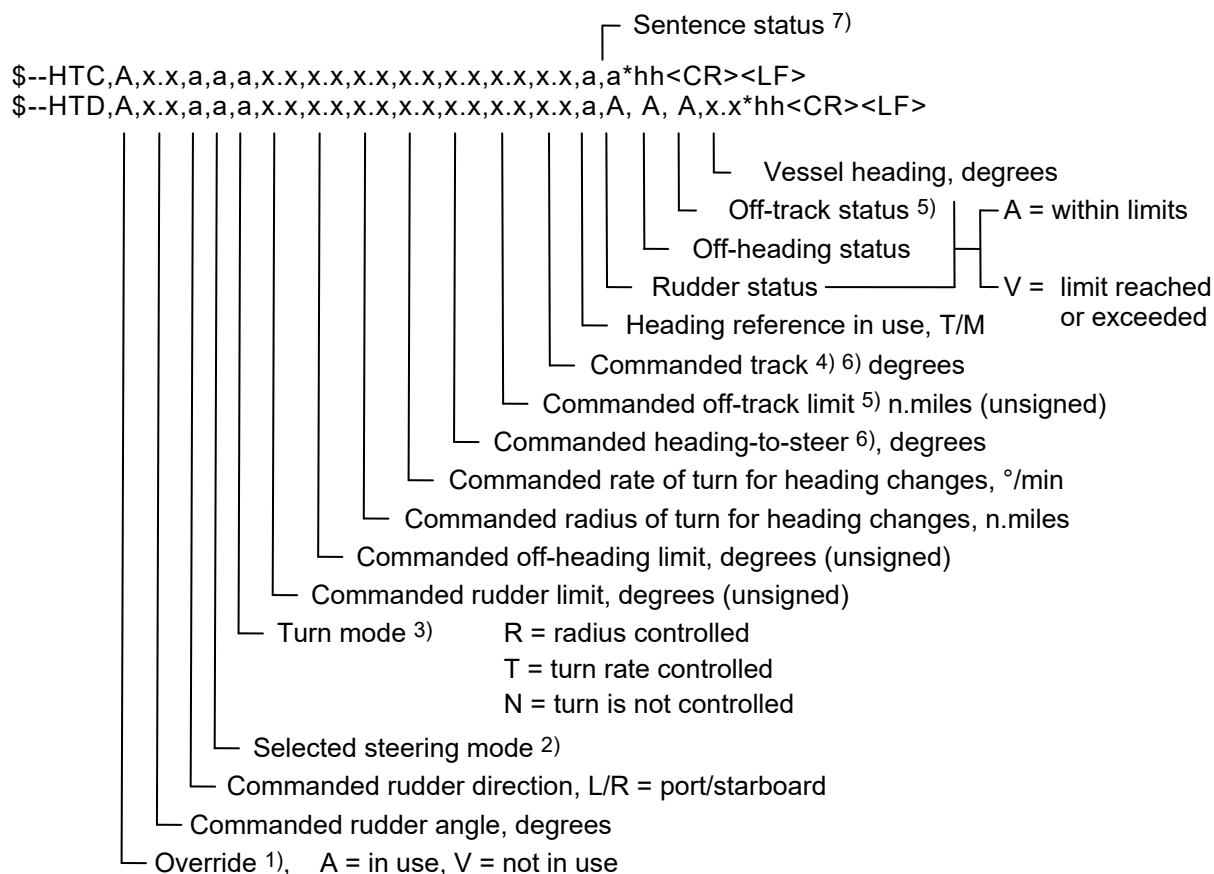
R = Sentence is a status report of current settings (use for a reply to a query).

C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.56 LR1 – AIS long-range reply sentence 1

The LR1 sentence identifies the destination for the reply and contains the information items requested by the "A" function identification character (see the LRF sentence).

$--LR1,x,xxxxxxxxx,xxxxxxxxx,c--c,c--c,xxxxxxxxx*hh<CR><LF>

- IMO number, 9-digit number [3]
- Call sign, 1 to 7 characters [3]
- Ship's name, 1 to 20 characters [3]
- MMSI of requestor (reply destination) [1]
- MMSI of responder [1]
- Sequence number [1] [2]

Comments:

1) The three fields, sequence number, MMSI of responder and MMSI of requestor are always provided.

2) The sequence number should be the same number as the sequence number of the LRI and LRF sentences that initiated this reply.

3) The characters that can be used are listed in the ITU-R M.1371, 6-bit ASCII. Some of the acceptable characters in this 6-bit ASCII table are the reserved characters within this standard IEC 61162-1, Table 1. These characters should be represented using the "^" method (see 7.1.4). The individual information items should be a null field if any of the following three conditions exist:

   – the information item was not requested;

   – the information item was requested but is not available;

   – the information item was requested but is not being provided.

8.3.57 LR2 – AIS long-range reply sentence 2

The LR2-sentence contains the information items requested by the "B, C, E and F" function identification characters (see the LRF sentence).

- Speed over ground, knots [3]
- Course over ground, degrees, true [3]
- Longitude, E/W [3]

$--LR2,x,xxxxxxxxx,xxxxxxxx,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x.x,T,x.x,N*hh<CR><LF>

- Latitude – N/S [3]
- UTC time of position [3]
- Date: ddmmyyyy, 8 digits
- MMSI of responder [1]
- Sequence number [1] [2]

Comments:

1) The two fields, sequence number and MMSI of responder, are always provided.

2) The sequence number should be the same as the sequence number of the LRI and LRF sentences that initiated this reply.

3) This field should be null if any of the following three conditions exist:

   – the information item was not requested;

   – the information item was requested but is not available;

   – the information item was requested but is not being provided.

8.3.58 LR3 – AIS long-range reply sentence 3

The LR3 sentence contains the information items requested by the "I, O, P, U and W" function identification character (see the LRF sentence).

```
                                              Persons, 0 to 8191 3) 4) ┐
                                                  Ship type 3) 6) ┐
                                           Ship breadth 3) ┐
                                          Ship length 3) ┐
$--LR3,x,xxxxxxxxx,c--c,xxxxxx,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
                                              └  Ship/cargo 3) 6)
                                          └  Draught 3)
                                      └  ETA time 3)
                              └  ETA date: ddmmyy 3)
                      └  Voyage destination, 1 to 20 chars 3) 5)
              └  MMSI of responder 1)
      └  Sequence number 1) 2)
```
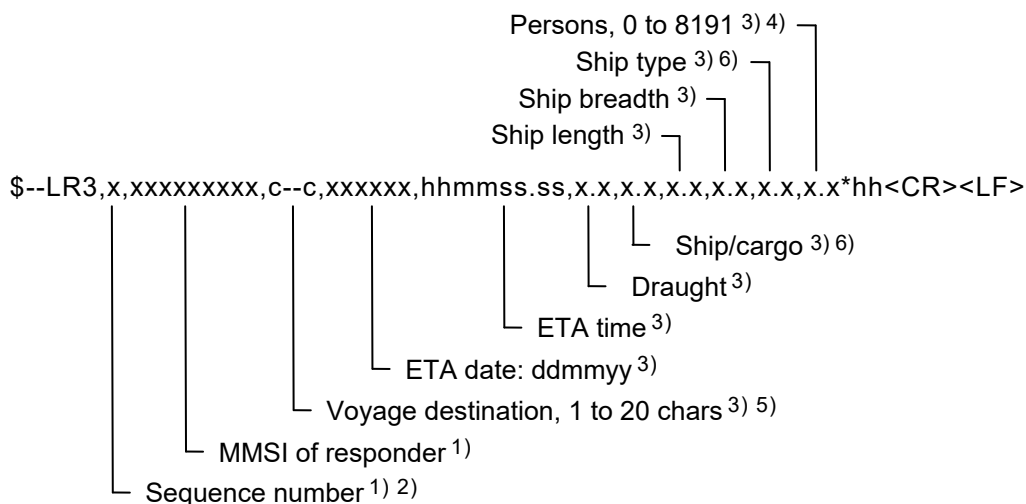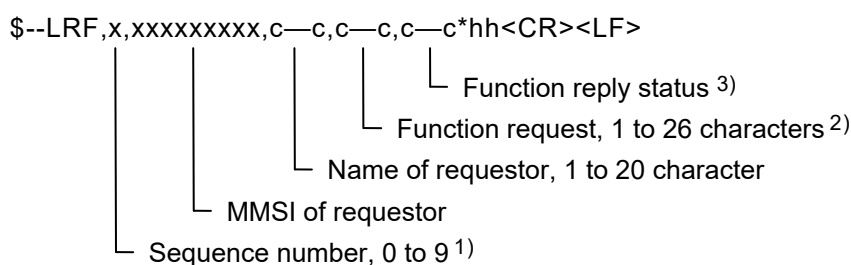
Comments:

1) The two fields, sequence number and MMSI of responder are always provided.

2) The sequence number should be the same as the sequence number of the LRI and LRF sentences that initiated this reply.

3) This field should be null if any of the following three conditions exist:

   – the information item was not requested;

   – the information item was requested but is not available;

   – the information item was requested but is not being provided.

4) Current number of persons on-board, including crew members: 0 to 8 191,

   0 = default (not available), 8 191 = 8 191 or more people.

5) The characters that can be used are listed in the ITU-R M.1371, 6-bit ASCII. Some of the acceptable characters in this 6-bit ASCII table are the reserved characters within this standard, Table 1. These characters should be represented using the "^" method (see 7.1.4).

6) See ITU-R M.1371, parameter "type of ship and cargo type" for the range of valid values for this field.

8.3.59 LRF – AIS long-range function

This sentence is used in both long-range interrogation requests and long-range interrogation replies. The LRF-sentence is the second sentence of the long-range interrogation request pair, LRI and LRF (see the LRI-sentence).

The LRF-sentence is also the first sentence of the long-range interrogation reply. The minimum reply consists of a LRF-sentence followed by a LR1-sentence. The LR2-sentence and/or the LR3-sentence follow the LR1-sentence if information provided in these sentences was requested by the interrogation. When the AIS unit creates the LRF-sentence for the long-range interrogation reply, fields 1, 2, 3 and 4 should remain as received in the long-range interrogation request; and field 5 (function reply status) and the new checksum are added to the LRF reply sentence.
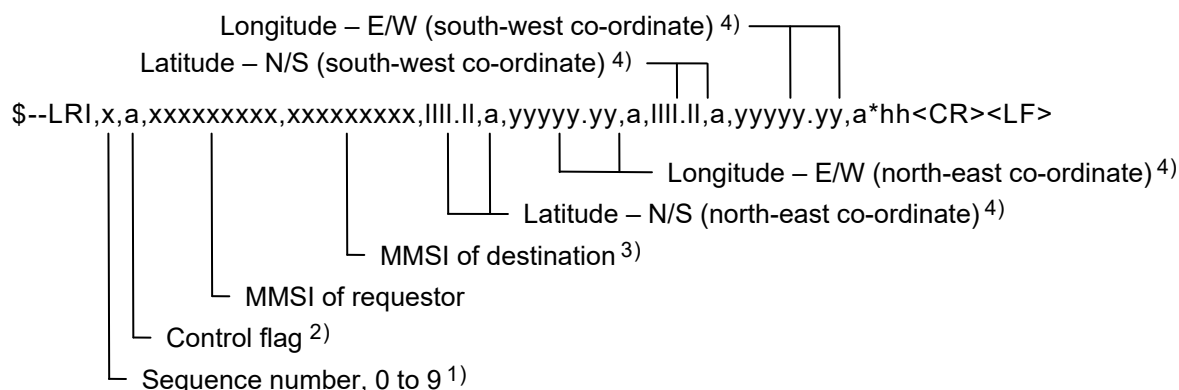
```
$--LRF,x,xxxxxxxxx,c—c,c—c,c—c*hh<CR><LF>
```

- Function reply status [3]
- Function request, 1 to 26 characters [2]
- Name of requestor, 1 to 20 character
- MMSI of requestor
- Sequence number, 0 to 9 [1]

Comments:

1) This is used to bind the contents of the LRI and LRF sentences together. The LRF sentence should immediately follow the LRI sentence and use the same sequence number. The requestor process should increment the sequence number each time a LRI/LRF pair is created. After 9 is used the process should begin again from 0. The long-range interrogation is not valid if the LRI and LRF sequence numbers are different.

2) The function request field uses alphabetic characters, based upon IMO Resolution A.851(20), to request specific information items. Specific information items are requested by including their function identification character in this string of characters. The order in which the characters appear in the string is not important. All characters are upper-case. Information items will not be provided if they are not specifically requested – even if available to the AIS unit. The IMO Resolution defines the use of all characters from A to Z, but not all defined information is available to the AIS unit. The following is a list of the function identification characters, with the information they request:

   A = Ship's: name, call sign, and IMO number;

   B = Date and time of message composition;

   C = Position;

   E = Course over ground;

   F = Speed over ground;

   I = Destination and Estimated Time of Arrival (ETA);

   O = Draught;

   P = Ship/cargo;

   U = Ship's: length, breadth, type;

   W = Persons on board.

3) The function reply status field provides the status characters for the "function request" information. When the long-range interrogation request is originated, the "function reply status" field should be null. The "function reply status" characters are organised in the same order as the corresponding function identification characters in the "function request" field. The following is a list of the "function reply status" characters with the status they represent:

   2 = information available and provided in the following LR1, LR2 or LR3 sentence,

   3 = information not available from AIS unit,

   4 = information is available but not provided (i.e. restricted access determined by the ship's master).

8.3.60 LRI – AIS long-range interrogation

The long-range interrogation of the AIS unit is accomplished through the use of two sentences. The pair of interrogation sentence formatters, a LRI sentence followed by a LRF sentence, provides the information needed by a universal AIS unit to determine if it should construct and provide the reply sentences (LRF, LR1, LR2, and LR3). The LRI sentence contains the information that the AIS unit needs in order to determine if the reply sentences need to be constructed. The LRF sentence identifies the information that needs to be in those reply sentences.

Longitude – E/W (south-west co-ordinate) [4]

Latitude – N/S (south-west co-ordinate) [4]

$--LRI,x,a,xxxxxxxxx,xxxxxxxxx,llll.ll,a,yyyyy.yy,a,llll.ll,a,yyyyy.yy,a*hh<CR><LF>

Longitude – E/W (north-east co-ordinate) [4]

Latitude – N/S (north-east co-ordinate) [4]

MMSI of destination [3]

MMSI of requestor
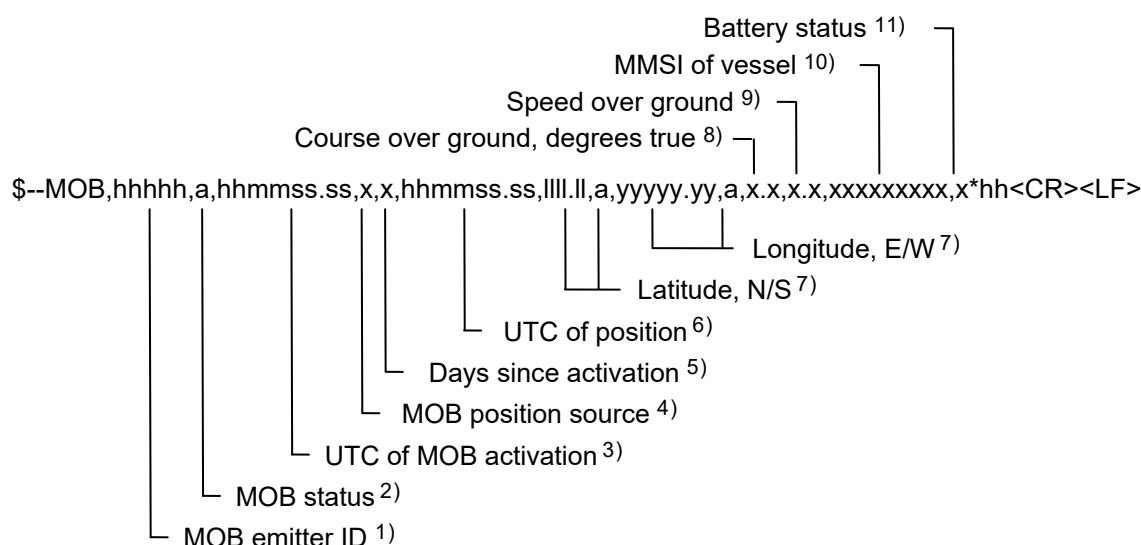
Control flag [2]

Sequence number, 0 to 9 [1]

Comments:

1) This is used to bind the contents of the LRI and LRF sentences together. The LRF sentence should immediately follow the LRI sentence and use the same sequence number. The requestor process should increment the sequence number each time a LRI/LRF pair is created. The sequencing process should continuously increment. After 9 is used the process should begin again from 0. The long-range interrogation is not valid if the LRI and LRF sequence numbers are different.

2) The control flag is a single character that qualifies the request for information. The control flag affects AIS unit's reply logic. The control flag cannot be a null field. When the control flag is "0", the logic is normal. Under "normal" operation, the AIS unit responds if either:

   – the AIS unit is within the geographic rectangle provided, and

   – the AIS unit has not responded to the requesting MMSI in the last 24 hours, and

   – the MMSI "destination" field is null.

   or

   – The AIS unit's MMSI appears in the MMSI "destination" field in the LRI sentence.

   When the control flag is "1", the AIS unit responds if:

   – the AIS unit is within the geographic rectangle provided.

3) This is the nine digit number that uniquely identifies the specific AIS unit that should respond. This field should be null when the interrogation is for a geographic region. When addressing a specific AIS unit, it is not necessary to provide the geographic co-ordinates of the region.

4) The geographic region being interrogated is a rectangle defined by the latitude and longitude of the north-east and south-west corners. These should be null fields when interrogating a specific AIS unit (see Comment 2).

8.3.61 MOB – Man over board notification

This sentence provides notification from a MOB monitoring system.

The "MMSI of vessel" field is an optional field that may be preconfigured within the MOB device to indicate the ship of origin. The included position information may be that of the vessel or the MOB device itself as identified in field 4, "MOB position source". Additional information may include the current state of the MOB device, time of activation, and MOB device battery status. This sentence may be used to set a MOB waypoint, or to initiate an alert process.

This sentence may be queried. If query support is provided, devices that generate this sentence shall respond with a MOB sentence for each known MOB emitter ID, such that a single query may result in multiple MOB sentence responses.
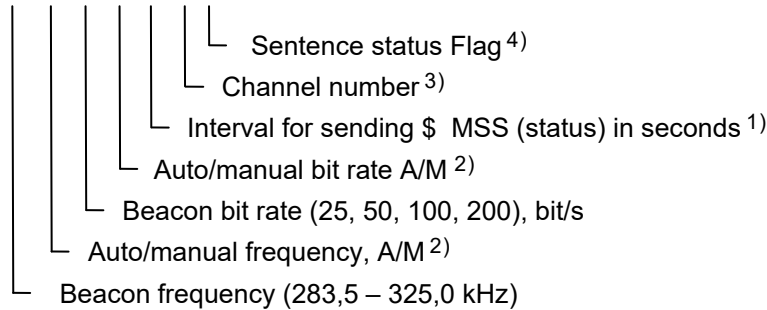
```
                                                            Battery status 11)  ⌐
                                              MMSI of vessel 10)  ⌐
                                  Speed over ground 9)  ⌐
                 Course over ground, degrees true 8)  ⌐
$--MOB,hhhhh,a,hhmmss.ss,x,x,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxxxxxxx,x*hh<CR><LF>
        |     | |        | | |        |        |         |   Longitude, E/W 7)
        |     | |        | | |        |        └─ Latitude, N/S 7)
        |     | |        | | |        └─ UTC of position 6)
        |     | |        | | └─ Days since activation 5)
        |     | |        | └─ MOB position source 4)
        |     | |        └─ UTC of MOB activation 3)
        |     | └─ MOB status 2)
        |     └─ MOB emitter ID 1)
```

Comments:

1) The MOB emitter ID is a 5-digit fixed length field of hexadecimal characters. This provides a unique identifier for each MOB emitter. Values that do not require five hexadecimal numbers should be preceded by "0" zeros, i.e. "FF" should be represented as "000FF". If the emitter ID is not known this field can be null.

2) The MOB status field provides information which can be used to evaluate the current state of the MOB.

   A =   MOB Activated

   T =   Test mode

   M =   Manual Button

   V =   MOB Not in Use

   E =   Error

3) The UTC of MOB activation provides the time (hhmmss) of the initial MOB device activation. The decimal point and associated decimal-fraction of seconds shall not be used.

4) MOB Position Source identifies the source of the position information reported by this sentence.

   0 = MOB position estimated by the vessel

   1 = MOB position reported by MOB emitter

   2-5 = Reserved

   6 = Error

5) The relative number of days since the activation of the MOB system.

6) The UTC time of position provides the time (hhmmss) of the position information. The decimal point and associated decimal-fraction of seconds shall not be used.

7) The latitude and longitude position fields are limited to a maximum of 3 decimal digits of minutes. This provides a position resolution of approximately 2 metres.

8) The Course over ground field is an integer field with no decimal point or decimal digits in units of degrees.

9) The Speed over ground field is an integer field with no decimal point or decimal digits in units of knots.

10) The MMSI number of the ship of origin may be set to null if unknown.

11) The Battery status field indicates the status of the MOB's internal power source. This field may be null if the MOB is unable to report the battery status. The valid states area:

   0 = Good

   1 = Low

   2–5 = Reserved

   6 = Error

8.3.62 MSK – MSK receiver interface

This is a command sentence. This sentence is used to set the controls of a radiobeacon MSK receiver (beacon receiver) or to report the status of an MSK receiver's controls in response to a query sentence.

```
$--MSK,x.x,a,x.x,a,x.x,x,a*hh<CR><LF>
                      └── Sentence status Flag 4)
                    └── Channel number 3)
                └── Interval for sending $ MSS (status) in seconds 1)
            └── Auto/manual bit rate A/M 2)
        └── Beacon bit rate (25, 50, 100, 200), bit/s
      └── Auto/manual frequency, A/M 2)
   └── Beacon frequency (283,5 – 325,0 kHz)
```

Comments:

1) When status data is not to be transmitted this field should be null.

2) If auto is specified, the previous field is ignored.

3) Set equal to "1" or null for single channel receivers.

4) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.
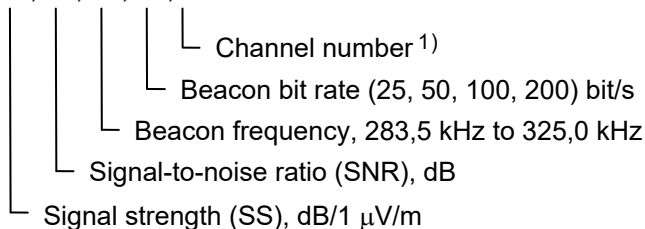
 R = Sentence is a status report of current settings (use for a reply to a query).

 C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.63 MSS – MSK receiver signal status

Signal-to-noise ratio, signal strength, frequency and bit rate from a MSK beacon receiver.

```
$--MSS,x.x,x.x,x.x,x.x,x*hh<CR><LF>
                    └── Channel number 1)
                └── Beacon bit rate (25, 50, 100, 200) bit/s
            └── Beacon frequency, 283,5 kHz to 325,0 kHz
        └── Signal-to-noise ratio (SNR), dB
   └── Signal strength (SS), dB/1 μV/m
```

Comments:

1) Set equal to "1" or null for single channel receivers.

In addition the beacon receiver shall respond to queries using the standard query request (Q). See 9.1.7 for examples.

8.3.64 MTW – Water temperature

```
$--MTW, x.x, C*hh<CR><LF>
           └── Temperature, degrees C
```
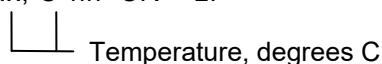
8.3.65 MWD – Wind direction and speed

The direction from which the wind blows across the earth's surface, with respect to north, and the speed of the wind.

$--MWD, x.x,T,x.x,M,x.x,N,x.x,M*hh<CR><LF>

```
                            └─ Wind speed, m/s
                        └─ Wind speed, knots
                └─ Wind direction, 0° to 359° magnetic
        └─ Wind direction, 0° to 359° true
```

8.3.66 MWV – Wind speed and angle

When the reference field is set to R (Relative), data is provided giving the wind angle in relation to the vessel's bow/centreline and the wind speed, both relative to the (moving) vessel. Also called apparent wind, this is the wind speed as felt when standing on the (moving) ship.

When the reference field is set to T (theoretical/calculated wind), data is provided giving the wind angle in relation to the vessel's bow/centreline and the wind speed as if the vessel was stationary. On a moving ship, these data can be calculated by combining the measured relative wind with the vessel's own speed.

Example 1: If the vessel is heading west at 7 knots and the wind is from the east at 10 knots the relative wind is 3 knots at 180°. In this same example the theoretical wind is 10 knots at 180° (if the boat suddenly stops the wind will be at the full 10 knots and come from the stern of the vessel 180° from the bow).

Example 2: If the vessel is heading west at 5 knots and the wind is from the southeast at 7,07 knots the relative wind is 5 knots at 270°. In this same example the theoretical wind is 7,07 knots at 225° (if the boat suddenly stops the wind will be at the full 7,07 knots and come from the port-quarter of the vessel 225° from the bow).

$--MWV, x.x, a, x.x, a, A *hh<CR><LF>

```
                    └─ Status, A = data valid  V= data invalid
                └─ Wind speed units,  K = km/h
                                      M = m/s
                                      N = knots
            └─ Wind speed
        └─ Reference, R = relative, T = theoretical
    └─ Wind angle, 0° to 359°
```

8.3.67 NAK – Negative acknowledgement

In general, the NAK sentence is used when a reply to a query sentence cannot be provided, or when a command sentence is not accepted. The NAK sentence reply should be generated within 1 s.

Use of NAK should be specified by the equipment standard.

This sentence cannot be queried.

$--NAK,cc,ccc,c--c,x.x,c--c*hh<CR><LF>

```
                    └─ Negative acknowledgement's descriptive text 5)
                └─ Reason code for negative acknowledgement 4)
            └─ Unique Identifier 3)
        └─ Affected sentence formatter 2)
    └─ Talker Identifier 1)
```

Comments:

1) Talker identifier from the sentence formatter that caused the NAK generation. This field should not be null.

2) Affected sentence formatter is either:

   – the "approved sentence formatter of data" being requested in a query that cannot be processed or accepted, or

   – the sentence formatter of the control or configuration sentence that cannot be processed or accepted.

   This field should not be null.

3) The Unique Identifier is used for system level identification of a device, 15 characters maximum. This is the Unique Identifier for the device producing the NAK sentence, when available.

4) Reason codes:

   0 =   Query functionality not supported

   1 =   Sentence formatter not supported

   2 =   Sentence formatter supported, but not enabled

   3 =   Sentence formatter supported and enabled, but temporarily unavailable (e.g. data field problem, unit in initialize state, or in diagnostic state, etc.)

   4 =   Sentence formatter supported, but query for this sentence formatter is not supported.

   5 =   Access denied, for sentence formatter requested

   6 =   Sentence not accepted due to bad checksum

   7 =   Sentence not accepted due to listener processing issue

   8 to 9:   reserved for future use

   10 =   Cannot perform the requested operation.

   11 =   Cannot fulfil request or command because of a problem with a data field in the sentence.

   12 to 48:   reserved for future use

   49 =   other reason as described in data field 5.

   Values greater than 50 may be defined by equipment standards.

   This field should not be null.

5) The length of this field is constrained by the maximum sentence length. This field may be null.

8.3.68   NRM – NAVTEX receiver mask

This command is used to manipulate the configuration masks that control which messages are stored, printed and sent to the INS port of the NAVTEX receiver. This a command sentence.

$--NRM,x,x,hhhhhhhh,hhhhhhhh,a*hh<CR><LF>

Comments:

1) The function code is used to further identify the purpose of the sentence. The meaning of the function code is as follows:

   0 – request messages for the given mask;

   1 – set/report the storage mask;

   2 – set/report the printer mask;

   3 – set/report the INS mask;

   4 to 9 – reserved for future use.

2) The frequency indicator identifies the frequency that the NAVTEX message was received on:

   1 = 490 kHz;

   2 = 518 kHz;

3 = 4 209,5 kHz;

4 through 9 are reserved for future use.

3) The transmitter coverage area mask is defined as a 32 bit hex field where the least significant bit represents transmitter coverage area 'A', the next bit is 'B' and so on up to bit 25 which is 'Z'. Bits 31 through 26 are reserved for future use and should be set to zero. To select a transmitter coverage area its corresponding bit should be set to one. To deselect a transmitter coverage area its corresponding bit should be set to zero.

4) The message type mask is defined as a 32 bit hex field where the least significant bit represents message type 'A', the next bit is 'B' and so on up to bit 25 which is 'Z'. Bits 31 through 26 are reserved for future use and should be set to zero. To select a message type its corresponding bit should be set to one. To deselect a message type its corresponding bit should be set to zero.

5) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

R = Sentence is a status report of current settings (use for a reply to a query).

C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

When another device (for example an INS) wishes to set one or more of the bit masks it sends one or more NRM sentences to the NAVTEX receiver. When another device wishes to determine the current values of the bit masks it sends a query sentence to the NAVTEX receiver as follows:

$--CRQ,NRM*hh<CR><LF>

On receiving this query, the NAVTEX receiver will respond with one NRM sentence for each mask type and frequency combination that it supports. For example, a NAVTEX receiver which supports separate storage, printer and INS masks for each of three receiver frequencies will return a total of nine NRM sentences in response to the above query.

Example usage:

$INNRM,2,1,00001E1F,00000023,C*38

This example specifies that message identifiers 'A', 'B' and 'F', received from transmitter areas 'A' to 'E' and 'J' to 'M' on 490 kHz should be sent to the printer port when they are received. Note that this command sets the printer mask for future use; there is no immediate output generated as a result of receiving this command.

Example usage:

$INNRM,0,2,00001E1F,0FFFFFFF,R*5F

This example requests that all currently stored messages of all message types, received from transmitter areas 'A' to 'E' and 'J' to 'M' on 518 kHz should be immediately returned to the requesting device as a series of NRX sentences. Note that this command does not update any of the stored masks.

8.3.69 NRX – NAVTEX received message

The NRX sentence is used to transfer the contents of a received NAVTEX message from the NAVTEX receiver to another device. As the length of a single NAVTEX message may exceed the number of characters permitted in a single sentence, many NRX sentences may be required to transfer a single NAVTEX message.

```
$--NRX,xxx,xxx,xx,aaxx,x,hhmmss.ss,xx,xx,xxxx,x.x,x.x,A,c--c*hh<CR><LF>
```

Message body [7]
Status indication [6]
Total number of bad characters
Total number of characters in this series of NRX sentences [5]
Year
Month 1-12
Day 1-31
UTC of receipt of message
Frequency table index 0-9 [4]
NAVTEX message code [3]
Sequential message id 00-99 [2]
Sentence number 001-999
Number of sentences 001-999 [1]
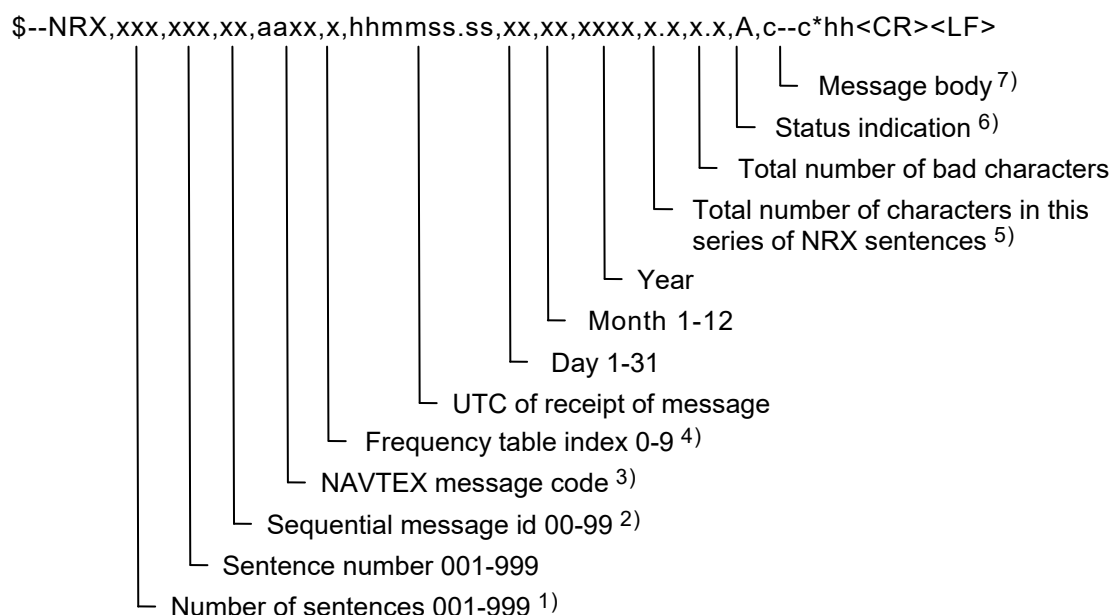
Comments:

1) The total number of sentences required to transfer the NAVTEX message from the NAVTEX radio receiver. The first field specifies the total number of sentences used for a message, minimum value 1. The sentence number field identifies the order of this sentence in the message, minimum value 1. All sentences contain the same number of fields. For efficiency, it is recommended that null fields be used in the additional sentences where the data is unchanged from the first sentence (this applies to fields 4 through 12).

2) The sequential message identifier provides a unique identifier for each NAVTEX message represented by a group of sentences. Though the message code (field 4) contains a NAVTEX message serial number, there are special cases when the message serial number is set to 00 and has a different meaning or when the same message code can occur more than once. When these conditions occur, the sequential message identifier can be relied upon to uniquely identify this NAVTEX message from other NAVTEX messages with the same message code.

3) The NAVTEX message code contains three related entities. The first character identifies the transmitter coverage area and the second character identifies the type of message. Both these characters are as defined in Table I of Recommendation ITU-R M.625-4, combination numbers 1 to 26. Transmitter identification characters are allocated by the IMO NAVTEX Co-ordinating Panel; these characters and the meanings of the message type characters are described in the NAVTEX manual (IMO publication 951E). The remaining two characters are restricted to numerals with a range of 00 to 99 and represent a serial number for each type of message. The value of 00 is a special case and not considered a serial number. See IEC 61097-6 for interpretation of special case value of 00.

4) The frequency indicator identifies the frequency that the NAVTEX message was received on:

   0 = not received over air (for example test messages);

   1 = 490 kHz;

   2 = 518 kHz

   3 = 4 209,5 kHz;

   4 through 9 are reserved for future use.

5) The total number of characters indicates the expected size of the message body sent in this sequence of NRX sentences. It does not include the additional overhead for reserved characters found in Table 1.

6) Status 'A' is used for syntactically correct message reception. Status 'V' is used for syntactically incorrect message reception, for example end characters NNNN missing.

7) The message body may contain both valid characters, see Table 2, and reserved characters, see Table 1. Reserved characters should be represented using the "^" method (see 7.1.4).

The example below shows a typical message received by the NAVTEX receiver distributed with the NRX sentence:

<start of example>

ZCZC IE69================================

ISSUED ON SATURDAY 06 JANUARY 2001.

INSHORE WATERS FORECAST TO 12 MILES

OFFSHORE FROM 1700 UT* TO 0500 UTC.
NORTH FORELAND TO SE**EY BILL.
12 HOURS FORECAST:

SHOWERY WINDS, STRONGEST IN NORTH.

NNNN

<end of example>

Inspecting the corresponding NRX sentences would typically show:
```
$CRNRX,007,001,00,IE69,1,135600,27,06,2001,241,3,A,=========================*09
$CRNRX,007,002,00,,,,,,,,,,========^0D^0AISSUED ON SATURDAY 06 JANUARY 2001.*29
$CRNRX,007,003,00,,,,,,,,,,,^0D^0AINSHORE WATERS FORECAST TO 12 MILES^0D^0AOFF*0D
$CRNRX,007,004,00,,,,,,,,,,,SHORE FROM 1700 UT^2A TO 0500 UTC.^0D^0A^0D^0ANORT*70
$CRNRX,007,005,00,,,,,,,,,,,H FORELAND TO SE^2A^2AEY BILL.^0D^0A12 HOURS FOREC*16
$CRNRX,007,006,00,,,,,,,,,,,AST:^0D^0A^0ASHOWERY WINDS^2C STRONGEST IN NORTH. *3C
$CRNRX,007,007,00,,,,,,,,,,, ^0D ^0A^0D ^0A*79
```

Decoding the message body should give the following result:


```
<start of decoding>
==================================
ISSUED ON SATURDAY 06 JANUARY 2001.

INSHORE WATERS FORECAST TO 12 MILES
OFFSHORE FROM 1700 UT* TO 0500 UTC.

NORTH FORELAND TO SE**EY BILL.
12 HOURS FORECAST:

SHOWERY WINDS, STRONGEST IN NORTH.

<end of decoding>
```

8.3.70   NSR – Navigation status report

This sentence is used to handle details of a consistent common reference system (CCRS) associated with an Integrated Navigation System (INS) which are not available in the value carrying sentences GLL, THS, VBW and VTG. Such details include integrity and plausibility of data and mode of STW.

Null fields are not allowed for this sentence.

The NSR sentence shall be sent periodically at intervals of not greater than 30 s. For all state changes the NSR sentence is transmitted prior to relevant sentence (e.g. GLL, THS etc.).

For the INS the talker id is "IN".

```
$--NSR, a, A, a, A, a, A, a, A, a, A, a, a, A *hh<CR><LF>
```

- Plausibility of time [2]
- Integrity of time [1]
- Mode of STW [3]
- Plausibility of depth [2]
- Integrity of depth [1]
- Plausibility of SOG and COG [2]
- Integrity of SOG and COG [1]
- Plausibility of STW [2]
- Integrity of STW [1]
- Plausibility of position [2]
- Integrity of position [1]
- Plausibility of heading [2]
- Integrity of heading [1]

Comments:

1) Integrity status:

   P = Passed, integrity verification passed

   F = Failed, integrity verification not passed

   D = Doubtful, integrity verification not possible

   N = Not available, reporting device does not support integrity check

2) Plausibility status:

   A = Yes (Plausible)

   V = No (Not plausible)

   N = Not available, reporting device does not support plausibility check

3) Mode of STW

   W = measured water reference

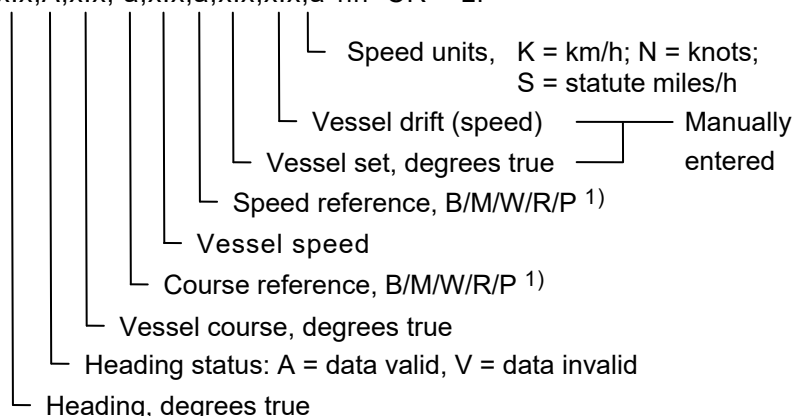   E = Estimated/calculated from non-water referenced sources

   M = Manual input

   N = Not available

8.3.71 OSD – Own ship data

Heading, course, speed, set and drift summary. Useful for, but not limited to radar/ARPA applications. OSD gives the movement vector of the ship based on the sensors and parameters in use.

```
$--OSD, x.x,A,x.x, a,x.x,a,x.x,x.x,a*hh<CR><LF>
```

Speed units,   K = km/h; N = knots;
S = statute miles/h

Vessel drift (speed) ——— Manually

Vessel set, degrees true ——— entered

Speed reference, B/M/W/R/P [1]

Vessel speed

Course reference, B/M/W/R/P [1]

Vessel course, degrees true

Heading status: A = data valid, V = data invalid

Heading, degrees true

Comments:

1) Reference systems on which the calculation of vessel course and speed is based. The values of course and speed are derived directly from the referenced system and do not additionally include the effects of data in the set and drift fields.

   B = bottom tracking log

   M = manually entered

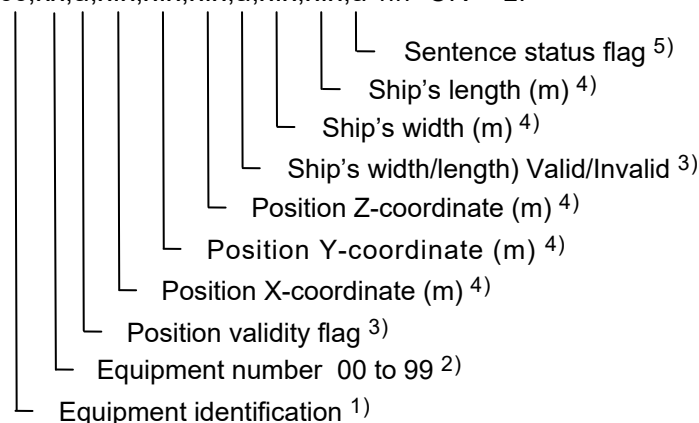   W = water referenced

   R = radar tracking (of fixed target)

   P = positioning system ground reference.

8.3.72   POS – Device position and ship dimensions report or configuration command

This sentence is used to report the device position (X, Y, and Z) of the equipment such as GNSS and radar antenna installed on board a ship and the ship dimensions. The consistent common reference position (CCRP) data may also be provided. This sentence can be used to configure or report the status and can be queried. This is a command sentence.

Usage is defined in equipment standards. Possible application may be to transmit this sentence at power up and repeatedly at 3 s interval.

```
$ – POS,cc,xx,a,x.x,x.x,x.x,a,x.x,x.x,a*hh<CR><LF>
```

Sentence status flag [5]

Ship's length (m) [4]

Ship's width (m) [4]

Ship's width/length) Valid/Invalid [3]

Position Z-coordinate (m) [4]

Position Y-coordinate (m) [4]

Position X-coordinate (m) [4]

Position validity flag [3]

Equipment number 00 to 99 [2]

Equipment identification [1]

Comments:

1) Equipment Identification is the talker ID given in Table 4.

2) Equipment number starts from one to maximum same equipment number. (e.g. 1 = Radar 1, 2 = Radar 2) Equipment number "0" is used for CCRP position (see IMO MSC.252(83)).

3) A (Valid) is used for configured device. V (Invalid) is for testing or unconfigured device. This field should not be NULL.

4) X , Y and Z coordination system.

 a) Origin (0,0) is located at the centre of the ship's aft most point.

 b) X-component: positive value (starboard), negative value (port) or zero (centre).

 c) Y-component: positive value or zero (forward distance from the ship's stern).

 d) Z-component: positive value (height from IMO summer load line, see IMO International Convention on Load Lines).

 e) The ship's length corresponds to maximum overall length.
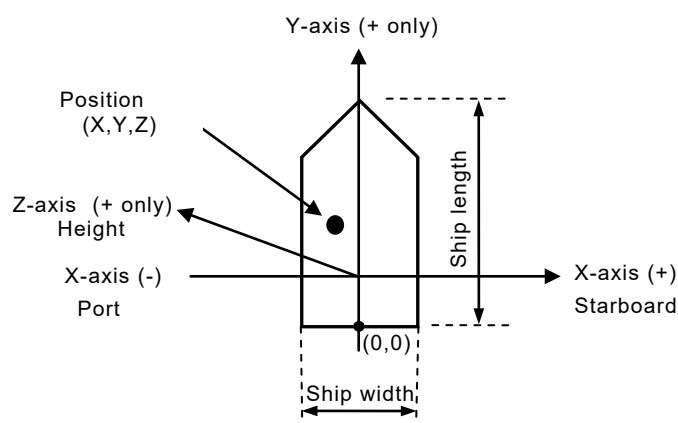
IEC

5) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.
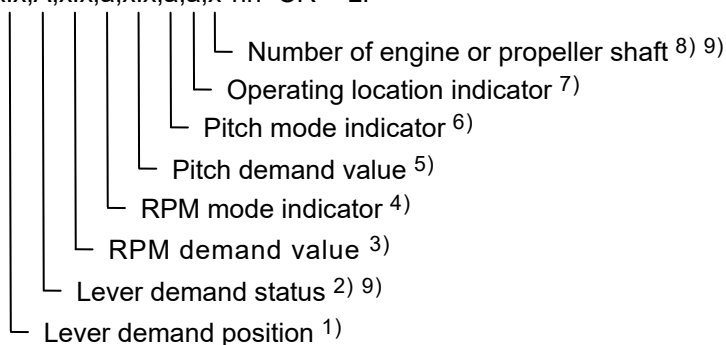
 R = Sentence is a status report of current settings (use for a reply to a query).

 C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.73 PRC – Propulsion remote control status

This sentence indicates the engine control status (engine order) on a remote control system. This provides the detailed data not available from the engine telegraph sentence ETL. The sentence shall be transmitted at regular intervals.

$--PRC,x.x,A,x.x,a,x.x,a,a,x*hh<CR><LF>

 Number of engine or propeller shaft [8] [9]
 Operating location indicator [7]
 Pitch mode indicator [6]
 Pitch demand value [5]
 RPM mode indicator [4]
 RPM demand value [3]
 Lever demand status [2] [9]
 Lever demand position [1]

Comments:

1) Lever position of engine telegraph demand. −100 to 0 to 100 % from "full astern" (crash astern) to "full ahead" (navigation full) " stop engine"

2) A = data valid

 V = data invalid

3) RPM demand value "-" Astern

4) P = Per cent (%): 0 to 100 % from zero to maximum rpm

 R = Revolutions per minute (rpm): "-" Astern

 V = data invalid

5) Pitch demand value

6) P = Per cent (%): −100 to 0 to 100 % from "full astern" (crash astern) to "full ahead" (navigation full) through "stop engine"

   D = degrees: "-": Astern

   V = data invalid

7) Indication to identify location. This field is single character.

   B = Bridge

   P = Port wing

   S = Starboard wing

   C = Engine control room

   E = Engine side / local

   W = Wing (port or starboard not specified)

   This may be a null field.

8) Numeric character to identify engine or propeller shaft controlled by the system. This is numbered from centre-line. This field is a single character.

   0 = single or on centre-line

   Odd = starboard

   Even = port

9) This should not be a null field.

8.3.74 RLM – Return link message

The RLM sentence is used to transfer a return link message received by a Return Link Service (RLS) compatible GNSS receiver from a Cospas-Sarsat recognized Return Link Service Provider (RLSP) to an RLS compliant Cospas-Sarsat 406 MHz Beacon.

The RLM sentence supports communications to an emitting beacon once a distress alert has been detected, located and confirmed. The communications may include acknowledgement of the alert to the emitting beacon as well as optional text messages, and may also include remote beacon configuration and testing.

The European GNSS (Galileo) Open Service Signal In Space Interface Control Document Issue 1.2 (Galileo OS SIS ICD) defines the content and structure of Fields 1, 3, and 4.

This sentence cannot be queried. All fields in the RLM sentence cannot be null.

```
$--RLM,hhhhhhhhhhhhhhh,hhmmss.ss,h,h--h*hh<CR><LF>
                │            │     │ └── Message body 4)
                │            │     └──── Message code 3)
                │            └────────── Time of reception 2)
                └─────────────────────── Beacon ID 1)
```

Comments:

1) The beacon ID field identifies the beacon intended to receive this message. This is a fixed length 15 hexadecimal character data field.

2) The time of reception field indicates the RLM timestamp (i.e. the time of reception of the last 20 bit packet of the RLM) in UTC. The field does not support decimal seconds. Any decimal point or decimal seconds should be ignored.

3) The Message code field identifies the type of RLM message service.

   0 = Reserved for future RLM services

   1 = Acknowledgement service RLM
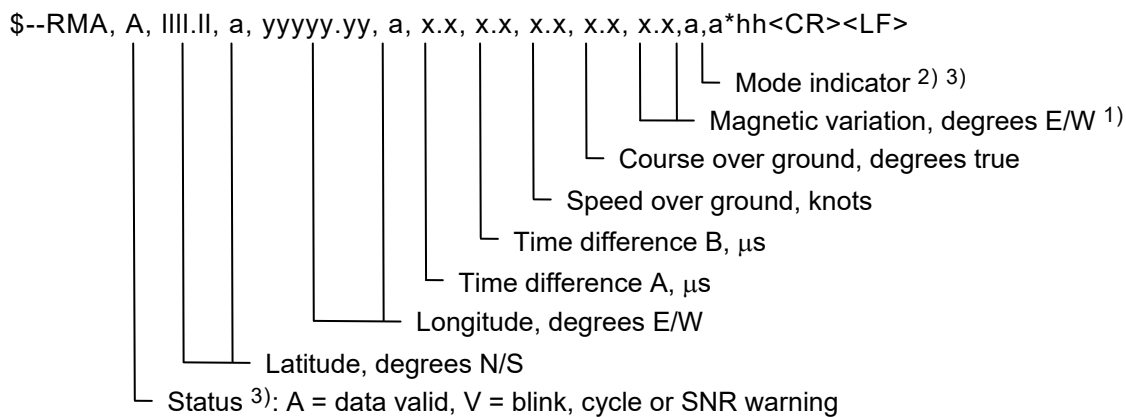
   2 = Command service RLM

3 = Message service RLM

4 – E = Reserved for future RLM services

F = Test service RLM (currently used only by the Galileo Program)

4) The message body is a variable length field encapsulating the data parameters provided by the RLSP into hexadecimal format. Galileo OS SIS ICD defines a short message containing 16 bit (4 hex characters) and a long message containing 96 bit (24 hex characters). Other GNSS, such as GLONASS may define a different length message.

8.3.75   RMA – Recommended minimum specific LORAN-C data

Position, course and speed data provided by a LORAN-C receiver. Time differences A and B are those used in computing latitude/longitude. This sentence is transmitted at intervals not exceeding 2 s and is always accompanied by RMB when a destination waypoint is active. RMA and RMB are the recommended minimum data to be provided by a LORAN-C receiver. All data fields should be provided, null fields are used only when data is temporarily unavailable.

$--RMA, A, llll.ll, a, yyyyy.yy, a, x.x, x.x, x.x, x.x, x.x,a,a*hh<CR><LF>

Mode indicator [2] [3]

Magnetic variation, degrees E/W [1]

Course over ground, degrees true

Speed over ground, knots

Time difference B, μs

Time difference A, μs

Longitude, degrees E/W

Latitude, degrees N/S

Status [3]: A = data valid, V = blink, cycle or SNR warning

Comments:

1) Easterly variation (E) subtracts from true course. Westerly variation (W) adds to true course.

2) Positioning system mode indicator:

   A = Autonomous mode;

   D = Differential mode;

   E = Estimated (dead reckoning) mode;

   M = Manual input mode;

   S = Simulator mode;

   N = Data not valid.

3) The positioning system mode indicator field supplements the status field (field No. 1), which should be set to V = invalid for all values of Mode indicator except for A = Autonomous and D = Differential. The positioning system mode indicator and status fields should not be null fields.

8.3.76   RMB – Recommended minimum navigation information

Navigation data from present position to a destination waypoint provided by a LORAN-C, GNSS, navigation computer or other integrated navigation system. This sentence always accompanies RMA or RMC sentences when a destination is active when provided by a LORAN-C, or GNSS receiver, other systems may transmit $--RMB without $--RMA or $--RMC.

Mode indicator [3] [4]

Arrival status A = arrival circle, entered or perpendicular passed
                 V = not entered or passed

$--RMB, A, x.x, a, c--c, c--c, llll.ll, a, yyyyy.yy,a,x.x, x.x, x.x, A, a *hh<CR><LF>

```
                                                    └─ Destination closing velocity, knots
                                                └─ Bearing to destination, degrees true
                                            └─ Range to destination, nautical miles [1]
                                        └─ Destination waypoint longitude, E/W
                                    └─ Destination waypoint latitude, N/S
                                └─ Destination waypoint ID
                            └─ Origin waypoint ID
                        └─ Direction to steer L/R
                    └─ Cross track error [2], nautical miles
                └─ Status [4]:    A = data valid
                                  V = navigation receiver warning
```

Comments:

1) If range to destination exceeds 999,9 nautical miles, display 999,9.

2) If cross track error exceeds 9,99 nautical miles, display 9,99.

3) Positioning system mode indicator:

   A = Autonomous mode;

   D = Differential mode;

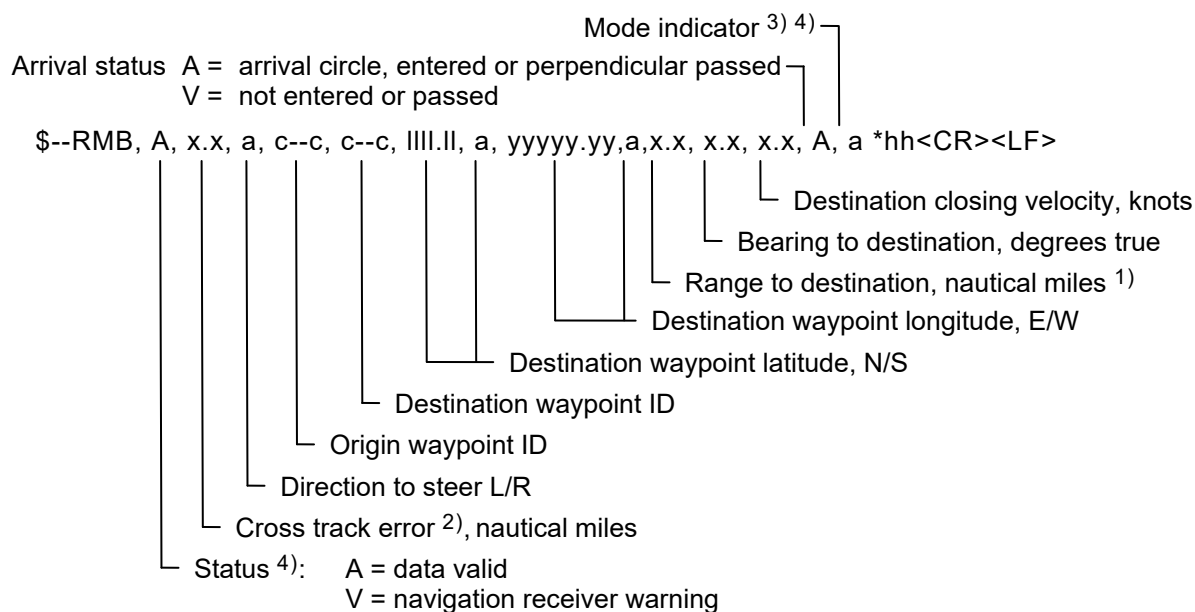   E = Estimated (dead reckoning) mode;

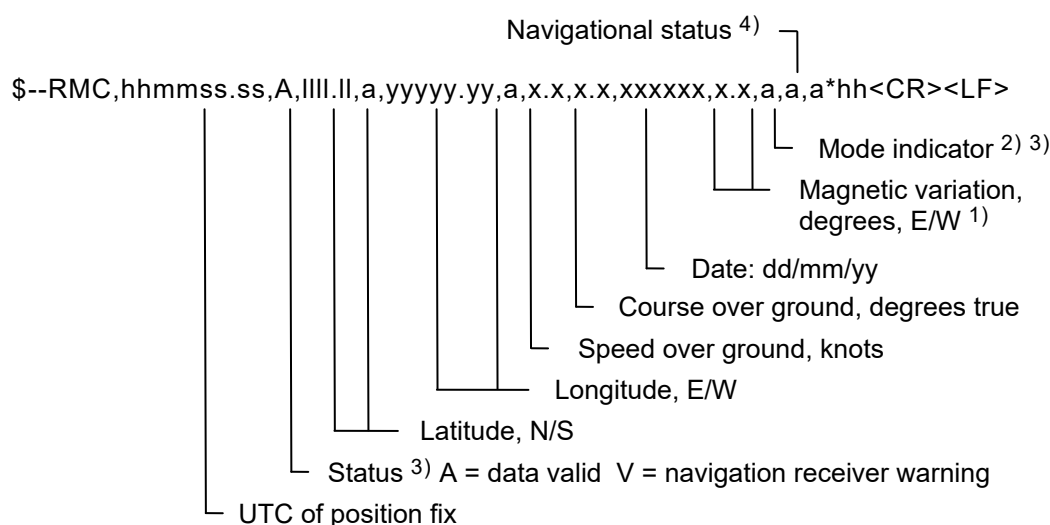   M = Manual input mode;

   S = Simulator mode;

   N = Data not valid.

4) The positioning system mode indicator field supplements the status field (field No. 1) which should be set to V = invalid for all values of Mode indicator except for A = Autonomous and D = Differential. The positioning system mode indicator and status fields should not be null fields.

8.3.77   RMC – Recommended minimum specific GNSS data

Time, date, position, course and speed data provided by a GNSS navigation receiver. This sentence is transmitted at intervals not exceeding 2 s and is always accompanied by RMB when a destination waypoint is active.

RMC and RMB are the recommended minimum data to be provided by a GNSS receiver. All data fields should be provided, null fields used only when data is temporarily unavailable.

Navigational status [4)]

$--RMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxxxx,x.x,a,a,a*hh<CR><LF>

Mode indicator [2) 3)]

Magnetic variation,
degrees, E/W [1)]

Date: dd/mm/yy

Course over ground, degrees true

Speed over ground, knots

Longitude, E/W

Latitude, N/S

Status [3)] A = data valid V = navigation receiver warning

UTC of position fix

Comments:

1) E = Easterly variation subtracts from True course

W = Westerly variation adds to True course

2) Positioning system mode Indicator:

A = Autonomous. Satellite system used in non-differential mode in position fix;

D = Differential. Satellite system used in differential mode in position fix;

E = Estimated (dead reckoning) mode;

F = Float RTK. Satellite system used in real time kinematic mode with floating integers;

M = Manual input mode;

N = No fix. Satellite system not used in position fix, or fix not valid;

P = Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as selective availability) and higher resolution code (P-code) is used to compute position fix. P is also used for satellite system used in multi-frequency, SBAS or Precise Point Positioning (PPP) mode;

R = Real time kinematic. Satellite system used in RTK mode with fixed integers;

S = Simulator mode.

3) The positioning system mode indicator field supplements the positioning system status field. The status field should be set to V = Invalid for all values of the mode indicator except for A= Autonomous, D = Differential, F = Float RTK, P = Precise and R = Real time kinematic. The positioning system mode indicator and status fields should not be null fields.

4) The navigational status indicator is according to IEC 61108 requirements on 'Navigational (or Failure) warnings and status indications'. This field should not be a NULL field and the character should take one of the following values:

S = Safe   when the estimated positioning accuracy (95 % confidence) is within the selected accuracy level corresponding to the actual navigation mode, and/or integrity is available and within the requirements for the actual navigation mode, and/or a new valid position has been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft.
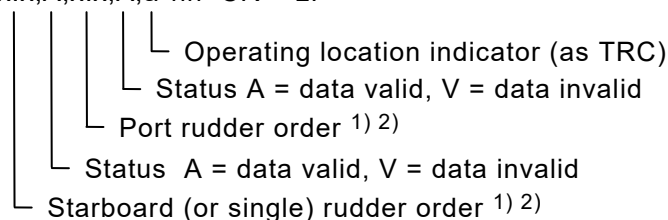
C = Caution   when integrity is not available.

U = Unsafe   when the estimated positioning accuracy (95 % confidence) is less than the selected accuracy level corresponding to the actual navigation mode, and/or integrity is available but exceeds the requirements for the actual navigation mode, and/or a new valid position has not been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft.

V =   Navigational status not valid, equipment is not providing navigational status indication.

8.3.78 ROR – Rudder order status

Angle ordered for the rudder.

```
$--ROR,x.x,A,x.x,A,a*hh<CR><LF>
            │ │ │ │ │ └─ Operating location indicator (as TRC)
            │ │ │ │ └─ Status A = data valid, V = data invalid
            │ │ │ └─ Port rudder order 1) 2)
            │ │ └─ Status  A = data valid, V = data invalid
            │ └─ Starboard (or single) rudder order 1) 2)
```
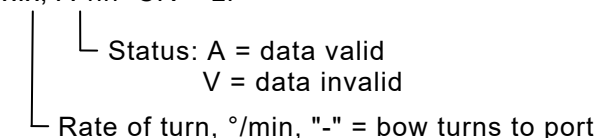
Comments:

1) Relative measurement of rudder order angle without units, "-" = bow turns to port.

2) The status field should not be a null field.

8.3.79   ROT – Rate of turn

Rate of turn and direction of turn.

```
$--ROT, x.x, A*hh<CR><LF>
         │   └─ Status: A = data valid
         │            V = data invalid
         └─ Rate of turn, °/min, "-" = bow turns to port
```
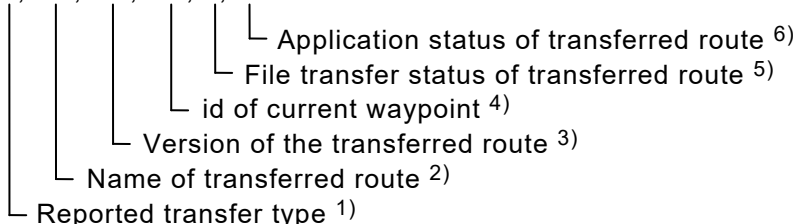
8.3.80   RRT – Report route transfer

This sentence is used to notify a device about a route transmission and to report the status of a received route transmission as described in IEC 61174.

When the sentence is used to inform or notify a device that a monitored route has been sent to that device, data fields 5 and 6 shall be null. When the sentence is used to inform or notify a device that an alternate route has been sent to that device, data fields 4, 5, and 6 shall be null. When the sentence is used to report the status of receiving and processing a monitored route by the receiving device all data fields are required. When the sentence is used to report the status of receiving and processing an alternate route by the receiving device all data fields expect data field 4 are required. In this case data field 4 shall be null.

The sentence may also be used to request route information for the case of an ECDIS that was not powered when a route was sent over the network and thus will not have the latest information.

After power on, an ECDIS shall send one or more RRT sentences with a 'Q' to ask for a retransmission. A receiver on receiving a sentence with a 'Q' shall resend any monitored and alternate route. If no route is being monitored, the receiver shall respond with an empty 'M' sentence ($--RRT,M,,,,,*hh<CR><LF>). If no alternate route is active, then an empty 'A' sentence shall be sent.

```
$--RRT, a, c-c, c-c, c-c, a, a *hh<CR><LF>
         │   │    │    │   │  └─ Application status of transferred route 6)
         │   │    │    │   └─ File transfer status of transferred route 5)
         │   │    │    └─ id of current waypoint 4)
         │   │    └─ Version of the transferred route 3)
         │   └─ Name of transferred route 2)
         └─ Reported transfer type 1)
```

Comments:

1) Reported type of transferred route. This field should not be null.
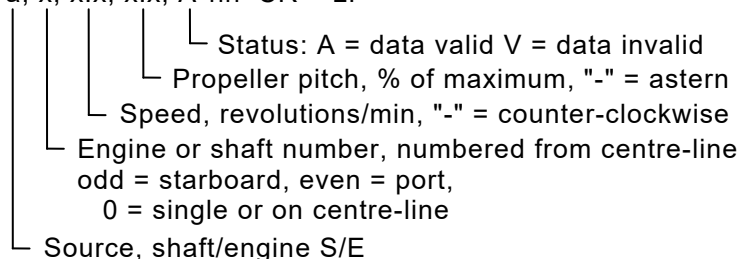
    M = Monitored route

A = Alternate route for editing

Q = Query for transmitting any monitored or alternative route for editing

2) Name of transferred route. Max 30 characters. This field should not be null except for a query or to indicate that no route is monitored in response to a query.

3) Version of transferred route. Max 20 characters. This field should not be null except for a query or to indicate that no route is monitored in response to a query.

4) Id of current waypoint for monitored route. Max 10 characters. This field is null for alternate routes for editing.

5) File transfer status of transferred route. This field shall be null when informing the transfer of a route. The following values are used for reporting the reception status:

A = successful reception of the route file transfer

E = error in reception of the route file transfer

6) Status of the intended application of the transferred route. This field shall be null when informing the transfer of a route. The following values are used for reporting the reception status:

A = content of the received route accepted and valid

V = content of received route rejected

P = pending, application level has not yet evaluated the received route

N = not applicable. This is used when reporting the reception status and when the file transfer status of the transferred route indicated an error in the reception of the route file transfer.

8.3.81   RPM – Revolutions
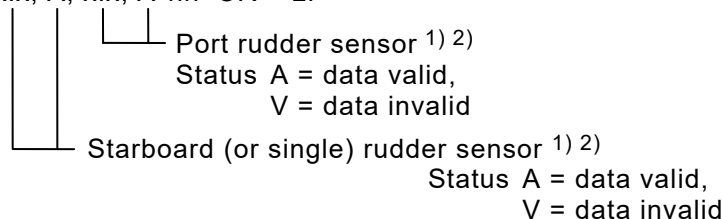
Shaft or engine revolution rate and propeller pitch

$--RPM, a, x, x.x, x.x, A*hh<CR><LF>

```
                       └ Status: A = data valid V = data invalid
                     └ Propeller pitch, % of maximum, "-" = astern
                 └ Speed, revolutions/min, "-" = counter-clockwise
             └ Engine or shaft number, numbered from centre-line
                odd = starboard, even = port,
                  0 = single or on centre-line
           └ Source, shaft/engine S/E
```

8.3.82   RSA – Rudder sensor angle

Relative rudder angle,from rudder angle sensor.

$--RSA, x.x, A, x.x, A*hh<CR><LF>

```
                    └┘ Port rudder sensor [1] [2]
                 Status A = data valid,
                       V = data invalid

           └ Starboard (or single) rudder sensor [1] [2]
                       Status A = data valid,
                             V = data invalid
```
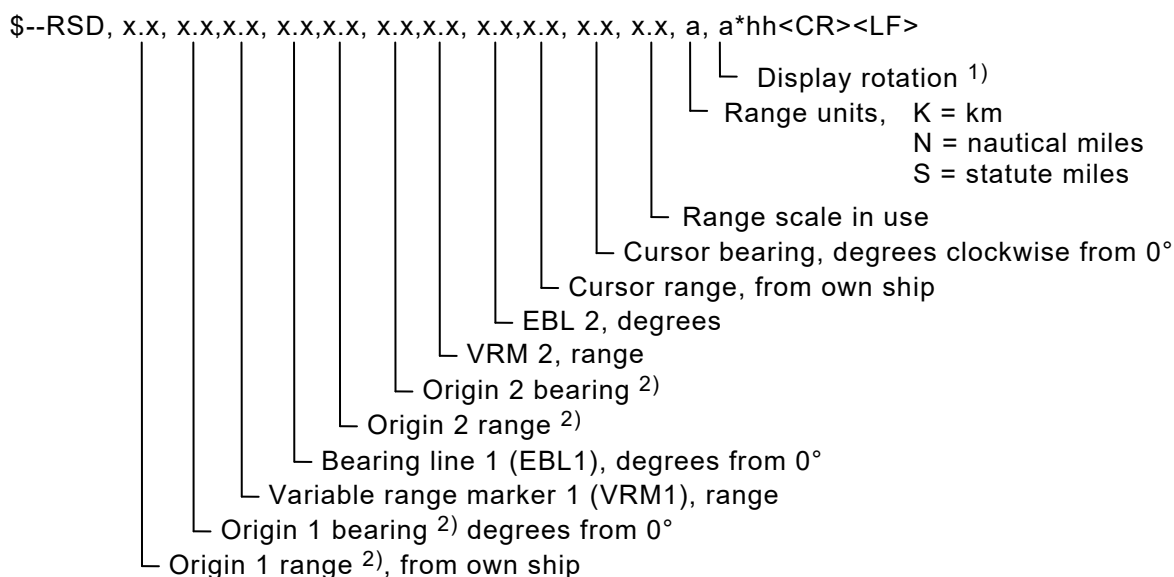
Comments:

1) Relative measurement of rudder angle without units, "-" = bow turns to port. Sensor output is proportional to rudder angle but not necessarily 1:1.

2) The status field should not be a null field.

8.3.83   RSD – Radar system data

Radar display setting data.

```
$--RSD, x.x, x.x,x.x, x.x,x.x, x.x,x.x, x.x, x.x, a, a*hh<CR><LF>
```

Display rotation [1]

Range units,   K = km
N = nautical miles
S = statute miles

Range scale in use

Cursor bearing, degrees clockwise from 0°

Cursor range, from own ship

EBL 2, degrees

VRM 2, range

Origin 2 bearing [2]

Origin 2 range [2]

Bearing line 1 (EBL1), degrees from 0°

Variable range marker 1 (VRM1), range

Origin 1 bearing [2] degrees from 0°

Origin 1 range [2], from own ship

Comments:

1) Display rotation:

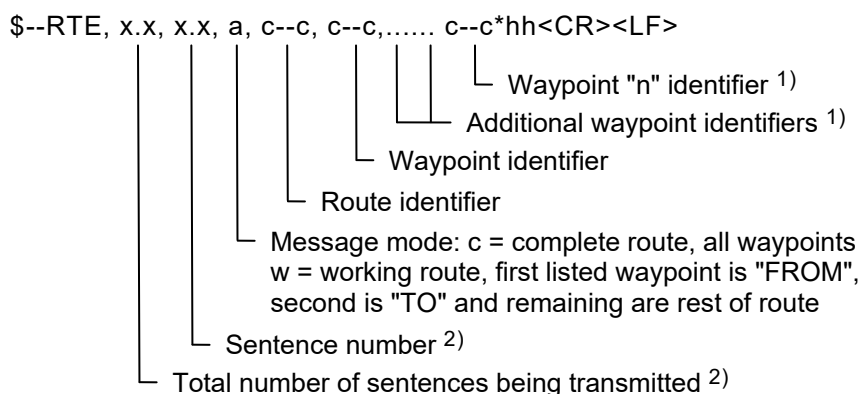C =   course-up, course-over-ground up, degrees true;

H =   head-up, ship's heading (centre-line) 0° up;

N =   north-up, true north is 0° up.

2) Origin 1 and origin 2 are located at the stated range and bearing from own ship and provide for two independent sets of variable range markers (VRM) and electronic bearing lines (EBL) originating away from own ship position.

8.3.84   RTE – Routes

Waypoint identifiers, listed in order with starting waypoint first, for the identified route. Two modes of transmission are provided: "c" indicates that the complete list of waypoints in the route is being transmitted; "w" indicates a working route where the first listed waypoint is always the last waypoint that had been reached (FROM), while the second listed waypoint is always the waypoint that the vessel is currently heading for (TO) and the remaining list of waypoints represents the remainder of the route.

```
$--RTE, x.x, x.x, a, c--c, c--c,...... c--c*hh<CR><LF>
```

Waypoint "n" identifier [1]

Additional waypoint identifiers [1]

Waypoint identifier

Route identifier

Message mode: c = complete route, all waypoints
w = working route, first listed waypoint is "FROM",
second is "TO" and remaining are rest of route

Sentence number [2]

Total number of sentences being transmitted [2]

Comments:

1) A variable number of waypoint identifiers, up to "n", may be included within the limits of allowed sentence length. As there is no specified number of waypoints, null fields are not required for waypoint identifier fields.

2) A single route may require the transmission of multiple sentences, all containing identical field formats when sending a complex message. The first field specifies the number of sentences, minimum value = 1. The second field identifies the order of this sentence (sentence number), minimum value = 1. For efficiency, it is permitted that null fields be used in the additional sentences when the data is unchanged from the first sentence. (Note that this practice can lead to the incorrect assembly of sentences if there is a high risk of loss of sentence.)

8.3.85   SFI – Scanning frequency information

This sentence is used to set frequencies and mode of operation for scanning purposes and to acknowledge setting commands. Scanning frequencies are listed in order of scanning. For DSC distress and safety watchkeeping only six channels shall be scanned in the same scanning sequence. To indicate a frequency set at the scanning receiver, use FSI sentence.

```
$--SFI, x.x, x.x, xxxxxx, c,........,xxxxxx, c*hh<CR><LF>
                │    │      │      │       │  │
                │    │      │      │       │  └─── Sixth frequency, mode 3)
                │    │      │      │       └────── Second to fifth frequency, mode 3)
                │    │      │      └───────────── Mode of operation 1)
                │    │      └──────────────────── First frequency or ITU channel 2)
                │    └─────────────────────────── Sentence number 4)
                └──────────────────────────────── Total number of sentences being transmitted 4)
```

Comments:

1) Mode of operation:

   d =   F3E/G3E simplex, telephone;

   e =   F3E/G3E duplex, telephone;

   m =   J3E, telephone;

   o =   H3E, telephone

   q =   F1B/J2B FEC NBDP, Telex/teleprinter;

   s =   F1B/J2B ARQ NBDP, Telex/teleprinter;

   t =   F1B/J2B receive only, teleprinter/DSC;

   w =   F1B/J2B, teleprinter/DSC;

   x =   A1A, Morse, tape recorder

   { =   A1A Morse, morse key/head set;

   | =   F1C/F2C/F3C, facsimile machine;

   null for no information.

2) Frequencies to be in 100 Hz increments.

   MF/HF telephone channels to have first digit 3 followed by ITU channel numbers with leading zeros as required.

   MF/HF teletype channels to have first digit 4; the second and third digit frequency bands; and the fourth to sixth digits ITU channel numbers; each with leading zeros as required.

   VHF channels to have first digit 9 followed by zero.

   The next number is "1" indicating the ship station's transmit frequency is being used as a simplex channel frequency, or "2" indicating the coast station's transmit frequency is being used as a simplex channel frequency. The remaining three numbers are the VHF channel numbers with leading zeros as required.

3) A variable number of frequency-mode pair fields is allowed up to a maximum of six pairs. Null fields are not required for unused pairs when less than six pairs are transmitted.

4) Scanning frequency information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

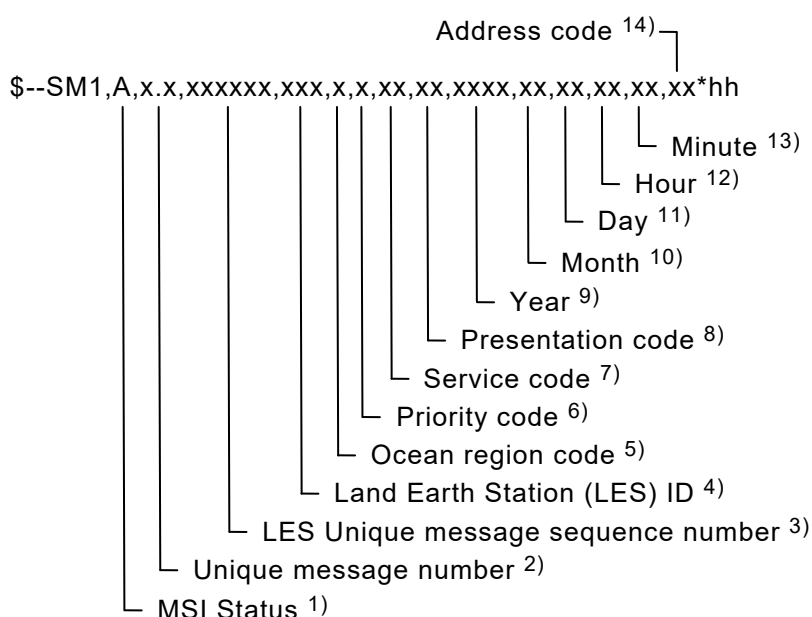### 8.3.86   SMI – SafetyNET Message, All Ships/NavArea

The SM1, SM2, SM3, SM4 and SMB sentences support Enhanced Group Call (EGC) Inmarsat-C and mini-C terminals as part of the international SafetyNET Service, an integral component of the Global Maritime Distress and Safety System (GMDSS).

The combination of the SM1, or SM2, or SM3, or SM4 and SMB sentences are used to report Maritime Safety Information (MSI) consisting of navigational and meteorological warnings,

meteorological forecasts, Search and Rescue (SAR) information and other urgent safety-related messages to other shipboard equipment.

The SM1 sentence is used to report MSI messages addressed to all ships as a general call or to provide an area designation as described in comment 14 below, based upon the MSI Service Code value of zero (00) or thirty one (31).

This SM1 sentence contains qualifying information related to the MSI message body in the corresponding SMB sentence(s). This includes the identification of the source of the MSI message, purpose and scope of the MSI message, and date/time of receipt. One or more SMB sentences shall always follow this sentence. This sentence and related SMB sentences are linked by the Unique Message number generated by the receiving EGC Terminal data field included in both sentences.

```
                                        Address code 14)
                                                       ┐
$--SM1,A,x.x,xxxxxx,xxx,x,x,xx,xx,xxxx,xx,xx,xx,xx,xx*hh
                                                  └ Minute 13)
                                               └ Hour 12)
                                            └ Day 11)
                                         └ Month 10)
                                      └ Year 9)
                                  └ Presentation code 8)
                              └ Service code 7)
                           └ Priority code 6)
                        └ Ocean region code 5)
                     └ Land Earth Station (LES) ID 4)
                 └ LES Unique message sequence number 3)
             └ Unique message number 2)
          └ MSI Status 1)
```

Comments:

1) The MSI Status field confirms if the entire Marine Safety Information Message has been or has not been correctly and completely received by the EGC Terminal.

   A = MSI Message complete: all data fields in this sentence and associated SMB sentences are complete and valid.

   V = MSI Message not complete: some data fields in this sentence may be null or set to an unknown state, or some characters within the MSI message body within the associated SMB sentences may be represented by the underscore "_" character.

2) This data field contains the Unique Message Number generated by the receiving EGC Terminal, sometimes referred to as a Mobile Earth Station (MES) or Ship Earth Station (SES). This is a variable length integer value with no decimal place or decimal digits. The maximum size of this field is 6 digits. This same data field is contained in the SMB sentence. This field shall not be null.

3) The Unique Message Sequence Number is assigned by the Land Earth Station (LES) originating this MSI message. This field is always 6 fixed digits, requiring zero fill if the value received from the LES contains less than 6 digits. For example, if the LES broadcast a 5 digit number "10345", it would be represented in this data field as "010345", both having the same numeric value. If any portion of the Unique Message Sequence Number is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

4) This field contains the 3-digit numeric ID of the LES that originated this MSI message. This field is always 3 fixed digits, requiring zero fill if the value received from the LES contains less than 3 digits. If any portion of the LES ID is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

5) Ocean Region code. This field shall not be null.

   0 = Atlantic Ocean Region – West

   1 = Atlantic Ocean Region – East

2 = Pacific Ocean Region

3 = Indian Ocean Region

4 – 7 = Reserved

8 = Unknown

9 = All ocean regions

6) Priority code of the MSI message. This field shall not be null.

1 = Safety

2 = Urgency

3 = Distress

4 -8 = Reserved

9 = Unknown

7) The fixed two-digit Service code identifies the type of this MSI message and corresponds to one specific address area (see comment 14). This field is set to null for all other Service Code values.

Service Code	Type of Service
00	All ships (general call)
31	NAVAREA/METAREA warning, MET Forecast, or Piracy warning to NAVAREA/METAREA

8) The Presentation code is a fixed two-digit numeric value that defines the language to be used for presentation of this MSI message. Current definitions are provided below.

Presentation Code Value	Language
00	International Alphabet Number 5

9) Year of message reception UTC (4 fixed digits).

10) Month of message reception UTC (2 fixed digits, 01 to 12).

11) Day of message reception UTC (2 fixed digits, 01 to 31).

12) Hour of message reception UTC (2 fixed digits, 00 to 23).

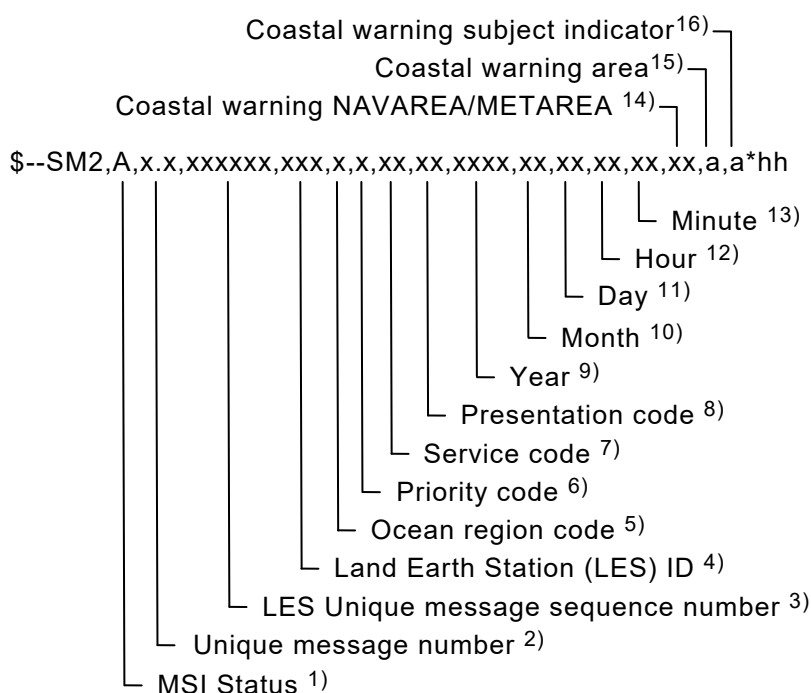13) Minute of message reception UTC (2 fixed digits, 00 to 59).

14) This field contains a fixed two-digit Address code/NAVAREA/METAREA and is dependent upon the Service code value provided in data field 7 as follows:

Service Code Value (data field 7)	Address Code value and meaning (data field 14)
00	00 – All Ships
31	01 to 21 – NAVAREA/METAREA number. 22 to 99 – Reserved for future address code assignments.
All other values or null	This data field is set to null.

8.3.87   SM2 – SafetyNET Message, Coastal Warning Area

The SM2 sentence is used to report MSI messages containing navigational, meteorological, or piracy coastal warnings as described in comments 14, 15, and 16 below, based upon the MSI Service Code value of thirteen (13).

This SM2 sentence contains qualifying information related to the MSI message body in the corresponding SMB sentence(s). This includes the identification of the source of the MSI message, purpose and scope of the MSI message, and date/time of receipt. One or more SMB sentences shall always follow this sentence. This sentence and related SMB sentences are linked by the Unique Message number generated by the receiving EGC Terminal data field included in both sentences.

```
                      Coastal warning subject indicator¹⁶⁾ ─┐
                              Coastal warning area¹⁵⁾ ─┐ │
           Coastal warning NAVAREA/METAREA ¹⁴⁾ ─┐ │ │
  $--SM2,A,x.x,xxxxxx,xxx,x,x,xx,xx,xxxx,xx,xx,xx,xx,xx,a,a*hh
                   │  │  │    │   │ │  │  │   │    │  │  │   └ Minute ¹³⁾
                   │  │  │    │   │ │  │  │   │    │  │  └ Hour ¹²⁾
                   │  │  │    │   │ │  │  │   │    │  └ Day ¹¹⁾
                   │  │  │    │   │ │  │  │   │    └ Month ¹⁰⁾
                   │  │  │    │   │ │  │  │   └ Year ⁹⁾
                   │  │  │    │   │ │  │  └ Presentation code ⁸⁾
                   │  │  │    │   │ │  └ Service code ⁷⁾
                   │  │  │    │   │ └ Priority code ⁶⁾
                   │  │  │    │   └ Ocean region code ⁵⁾
                   │  │  │    └ Land Earth Station (LES) ID ⁴⁾
                   │  │  └ LES Unique message sequence number ³⁾
                   │  └ Unique message number ²⁾
                   └ MSI Status ¹⁾
```

Comments:

1) The MSI Status field confirms if the entire Marine Safety Information Message has been or has not been correctly and completely received by the EGC Terminal.

   A = MSI Message complete: all data fields in this sentence and associated SMB sentences are complete and valid.

   V = MSI Message not complete: some data fields in this sentence may be null or set to an unknown state, or some characters within the MSI message body within the associated SMB sentences may be represented by the underscore "_" character.

2) This data field contains the Unique Message Number generated by the receiving EGC Terminal, sometimes referred to as a Mobile Earth Station (MES) or Ship Earth Station (SES). This is a variable length integer value with no decimal place or decimal digits. The maximum size of this field is 6 digits. This same data field is contained in the SMB sentence. This field shall not be null.

3) The Unique Message Sequence Number is assigned by the Land Earth Station (LES) originating this MSI message. This field is always 6 fixed digits, requiring zero fill if the value received from the LES contains less than 6 digits. For example, if the LES broadcast a 5 digit number "10345", it would be represented in this data field as "010345", both having the same numeric value. If any portion of the Unique Message Sequence Number is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

4) This field contains the 3-digit numeric ID of the LES that originated this MSI message. This field is always 3 fixed digits, requiring zero fill if the value received from the LES contains less than 3 digits. If any portion of the LES ID is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

5) Ocean Region code. This field shall not be null.

   0 = Atlantic Ocean Region – West

   1 = Atlantic Ocean Region – East

   2 = Pacific Ocean Region

   3 = Indian Ocean Region

   4 – 7 = Reserved

   8 = Unknown

   9 = All ocean regions

6) Priority code of the MSI message. This field shall not be null.

   1 = Safety

   2 = Urgency

   3 = Distress

   4 -8 = Reserved

9 = Unknown

7) The fixed two-digit Service code identifies the type of this MSI message and corresponds to the coastal warning area (see comments 14, 15, and 16). This field is set to null for all other Service Code values.

Service Code	Type of Service
13	Navigational, Meteorological, or Piracy Coastal warning

8) The Presentation code is a fixed two-digit numeric value that defines the language to be used for presentation of this MSI message. Current definitions are provided below.

Presentation Code Value	Language
00	International Alphabet Number 5

9) Year of message reception UTC (4 fixed digits).

10) Month of message reception UTC (2 fixed digits, 01 to 12).

11) Day of message reception UTC (2 fixed digits, 01 to 31).

12) Hour of message reception UTC (2 fixed digits, 00 to 23).

13) Minute of message reception UTC (2 fixed digits, 00 to 59).

14) The Coastal warning address consists of three fields, where this field identifies the NAVAREA/METAREA with a range from 01 to 21. This field is a two-digit numerical field containing the first two digits (X1X2) from the transmitted message's "4 alphanumeric coastal warning area address X1X2B1B2" that identify the NAVAREA/METAREA. (See IMO, International SafetyNET Manual). This field shall be null if there is an error in the received NAVAREA due to satellite radio link interference or if the Service Code field is not 13.

15) The Coastal warning area is a single alpha character field and has a range from A to Z. This is the second field (third character) from the transmitted message's "4 alphanumeric coastal warning area address X1X2B1B2". This field shall be null if there is an error in the received Coastal warning area due to satellite radio link interference or if the Service Code field is not 13. The coastal warning area associated with this character field is defined in the "MASTER PLAN OF SHORE-BASED FACILITIES FOR THE GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS MASTER PLAN)", (IMO GMDSS.1/Circ.18).

16) The Coastal warning subject indicator is a single alpha character field and has a range from A to Z. This is the third field (fourth character) from the transmitted message's "4 alphanumeric coastal warning area address X1X2B1B2". This field shall be null if there is an error in the received subject indicator due to satellite radio link interference or if the Service Code field is not 13.

A = Navigational warnings

B = Meteorological warnings

C = Ice reports

D = Search and rescue information, and acts of piracy warnings

E = Meteorological forecasts

F = Pilot service messages

G = AIS

H = LORAN messages

I = not used

J = SATNAV messages

K = Other electronic navaid messages

L = Other Navigational warnings – additional to subject indicator code (c_2) of A
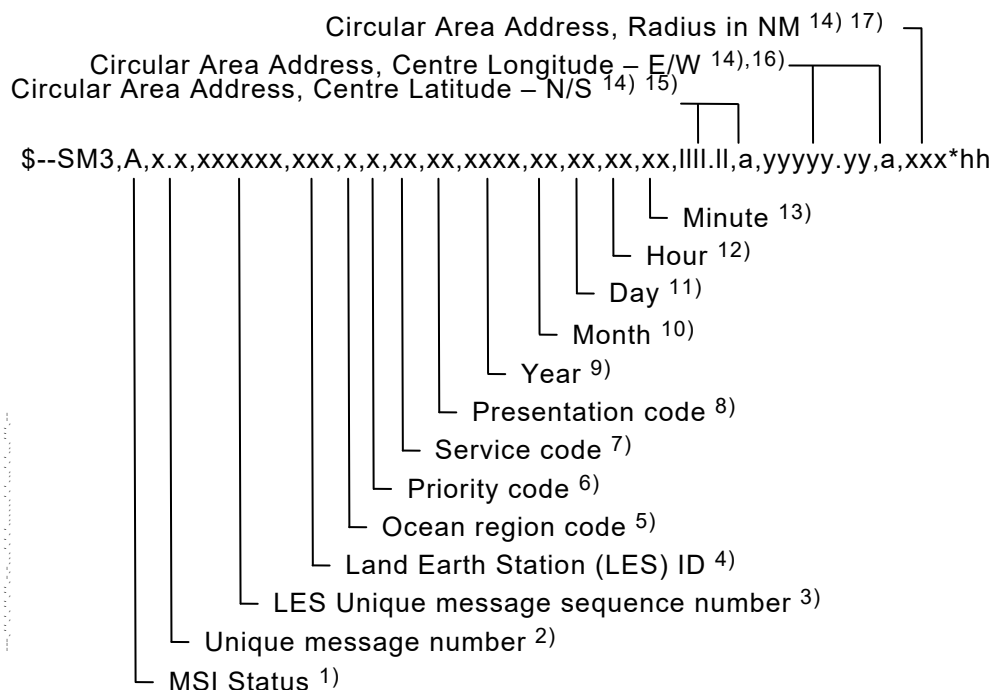
V, W, X, Y = Special services allocation by the International SafetyNET Panel

Z = No messages on hand

8.3.88 SM3 – SafetyNET Message, Circular Area address

The SM3 sentence is used to report MSI messages containing a shore-to-ship distress alert, or navigational, meteorological, or piracy warning, or SAR coordination to a circular area as described in comments 14, 15, 16, and 17 below, based upon the MSI Service Code values of either fourteen (14), twenty-four (24) or forty-four (44).

This SM3 sentence contains qualifying information related to the MSI message body in the corresponding SMB sentence(s). This includes the identification of the source of the MSI message, purpose and scope of the MSI message, and date/time of receipt. One or more SMB sentences shall always follow this sentence. This sentence and related SMB sentences are linked by the Unique Message number generated by the receiving EGC Terminal data field included in both sentences.

```
                                    Circular Area Address, Radius in NM 14) 17) ┐
                    Circular Area Address, Centre Longitude – E/W 14),16) ───────┐│
        Circular Area Address, Centre Latitude – N/S 14) 15) ──────────┐      │  │
                                                                       │      │  │
  $--SM3,A,x.x,xxxxxx,xxx,x,x,xx,xx,xxxx,xx,xx,xx,xx,llll.ll,a,yyyyy.yy,a,xxx*hh
                                                     └ Minute 13)
                                                 └ Hour 12)
                                             └ Day 11)
                                         └ Month 10)
                                     └ Year 9)
                                 └ Presentation code 8)
                             └ Service code 7)
                         └ Priority code 6)
                     └ Ocean region code 5)
                 └ Land Earth Station (LES) ID 4)
             └ LES Unique message sequence number 3)
         └ Unique message number 2)
     └ MSI Status 1)
```

Comments:

1) The MSI Status field confirms if the entire Marine Safety Information Message has been or has not been correctly and completely received by the EGC Terminal.

    A = MSI Message complete: all data fields in this sentence and associated SMB sentences are complete and valid.

    V = MSI Message not complete: some data fields in this sentence may be null or set to an unknown state, or some characters within the MSI message body within the associated SMB sentences may be represented by the underscore "_" character.

2) This data field contains the Unique Message Number generated by the receiving EGC Terminal, sometimes referred to as a Mobile Earth Station (MES) or Ship Earth Station (SES). This is a variable length integer value with no decimal place or decimal digits. The maximum size of this field is 6 digits. This same data field is contained in the SMB sentence. This field shall not be null.

3) The Unique Message Sequence Number is assigned by the Land Earth Station (LES) originating this MSI message. This field is always 6 fixed digits, requiring zero fill if the value received from the LES contains less than 6 digits. For example, if the LES broadcast a 5 digit number "10345", it would be represented in this data field as "010345", both having the same numeric value. If any portion of the Unique Message Sequence Number is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

4) This field contains the 3-digit numeric ID of the LES that originated this MSI message. This field is always 3 fixed digits, requiring zero fill if the value received from the LES contains less than 3 digits. If any portion of the LES ID is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

5) Ocean Region code. This field shall not be null.

    0 = Atlantic Ocean Region – West

    1 = Atlantic Ocean Region – East

    2 = Pacific Ocean Region

    3 = Indian Ocean Region

    4 – 7 = Reserved

    8 = Unknown

9 = All ocean regions

6) Priority code of the MSI message. This field shall not be null.

1 = Safety

2 = Urgency

3 = Distress

4 -8 = Reserved

9 = Unknown

7) The fixed two-digit Service code identifies the type of this MSI message and corresponds to a circular area address (see comments 14), 15), 16), and 17)). This field is set to null for all other Service Code values.

Service Code	Type of Service
14	Shore-to-Ship Distress Alert to a circular area
24	Navigational, Meteorological, or Piracy warning to a circular area
44	SAR Coordination to a circular area

8) The Presentation code is a fixed two-digit numeric value that defines the language to be used for presentation of this MSI message. Current definitions are provided below.

Presentation Code Value	Language
00	International Alphabet Number 5

9) Year of message reception UTC (4 fixed digits).

10) Month of message reception UTC (2 fixed digits, 01 to 12).

11) Day of message reception UTC (2 fixed digits, 01 to 31).

12) Hour of message reception UTC (2 fixed digits, 00 to 23).

13) Minute of message reception UTC (2 fixed digits, 00 to 59).

14) The Circular Area Address within an Inmarsat-C transmitted MSI message is a fixed ten-digit field consisting of eight-numeric digits and two-alpha digits. Example: A circle centered at latitude of 56°N and longitude of 34°W with a radius of 35 nautical miles is represented as "56N034W035" from the form "$D_1D_2LaD_3D_4D_5LoR_1R_2R_3$" (See IMO International SafetyNET Manual). Comments 15 – 17 describe how this information is apportioned to standard IEC 61162 data fields.

15) The Centre Latitude and latitude direction (N/S) is from the first three characters of the transmitted Circular Area Address, "$D_1D_2LaD_3D_4D_5LoR_1R_2R_3$". This is a fixed length field containing two digits of latitude in units of degrees, with the two digit minutes portion set to zeros and no decimal place or decimal minutes. A value of 56° N would be represented as "5600,N" in the sentence. Leading zeros are required when the latitude value is between 0 and 9 degrees. This field shall be null if there is an error in the received Centre Latitude due to satellite radio link interference or if the Service Code field is not 14, 24, or 44.
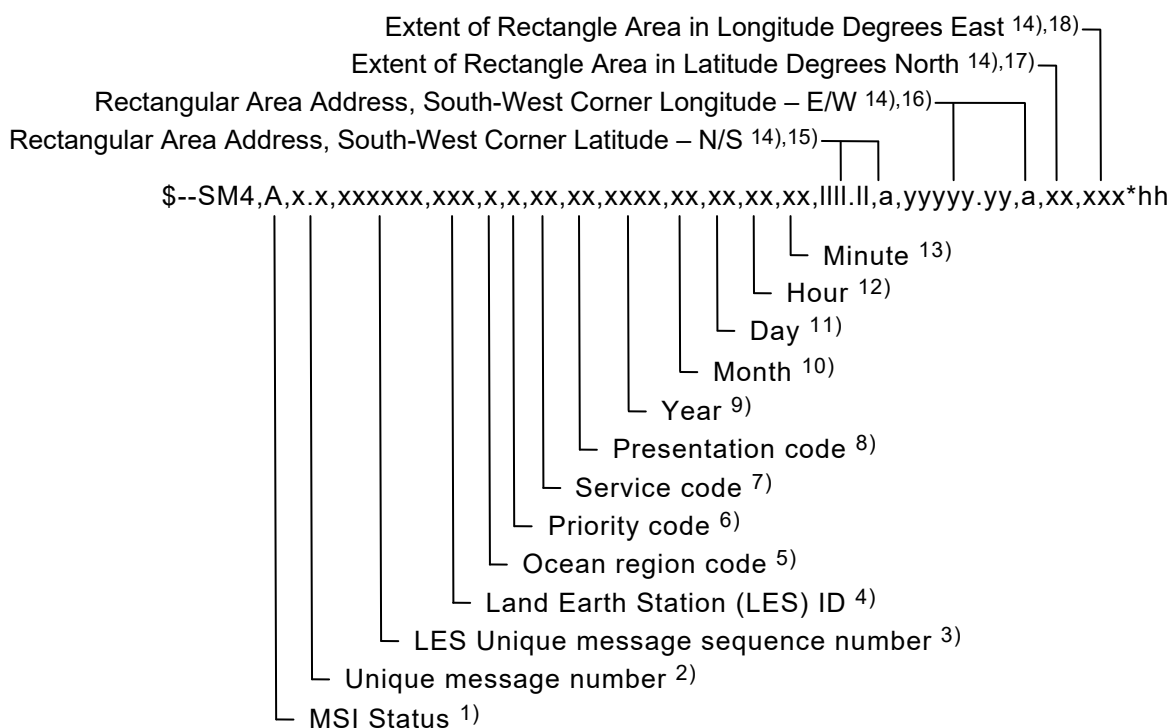
16) The Centre Longitude and longitude direction (W/E) is from the fourth through seventh characters of the transmitted Circular Area Address, "$D_1D_2LaD_3D_4D_5LoR_1R_2R_3$". This is a fixed length field containing three digits of longitude in units of degrees, with the two digit minutes portion set to zeros and no decimal place or decimal minutes. A value of 34° W would be represented as "03400,W" in the sentence. Leading zero(s) are required when the longitude value is between 0 and 99 degrees. This field shall be null if there is an error in the received Centre Longitude due to satellite radio link interference or if the Service Code field is not 14, 24, or 44.

17) The Radius is from the last three characters of the transmitted Circular Area Address, "$D_1D_2LaD_3D_4D_5LoR_1R_2R_3$". This is a three digit fixed length numeric field containing the radius in units of nautical miles. A value of 035 would be represented as "035" in the sentence. Leading zero(s) are required when the radius value is between 0 and 99 degrees. The maximum value for this field is 999 miles. This field shall be null if there is an error in the received Radius due to satellite radio link interference or if the Service Code field is not 14, 24, or 44.

8.3.89 SM4 – SafetyNET Message, Rectangular Area Address

The SM4 sentence is used to report MSI messages containing navigational, meteorological, or piracy warning, or SAR coordination to a rectangular area as described in comments 14), 15), 16), 17), and 18) below, based upon the MSI Service Code values of either four (4), or thirty-four (34).

This SM4 sentence contains qualifying information related to the MSI message body in the corresponding SMB sentence(s). This includes the identification of the source of the MSI message, purpose and scope of the MSI message, and date/time of receipt. One or more SMB sentences shall always follow this sentence. This sentence and related SMB sentences are linked by the Unique Message number generated by the receiving EGC Terminal data field included in both sentences.

```
                                    Extent of Rectangle Area in Longitude Degrees East 14),18)
                                    Extent of Rectangle Area in Latitude Degrees North 14),17)
              Rectangular Area Address, South-West Corner Longitude – E/W 14),16)
        Rectangular Area Address, South-West Corner Latitude – N/S 14),15)

        $--SM4,A,x.x,xxxxxx,xxx,x,x,xx,xx,xxxx,xx,xx,xx,xx,llll.ll,a,yyyyy.yy,a,xx,xxx*hh
                                                              Minute 13)
                                                              Hour 12)
                                                              Day 11)
                                                              Month 10)
                                                              Year 9)
                                                              Presentation code 8)
                                                              Service code 7)
                                                              Priority code 6)
                                                              Ocean region code 5)
                                                              Land Earth Station (LES) ID 4)
                                                              LES Unique message sequence number 3)
                                                              Unique message number 2)
                                                              MSI Status 1)
```

Comments:

1) The MSI Status field confirms if the entire Marine Safety Information Message has been or has not been correctly and completely received by the EGC Terminal.

   A = MSI Message complete: all data fields in this sentence and associated SMB sentences are complete and valid.

   V = MSI Message not complete: some data fields in this sentence may be null or set to an unknown state, or some characters within the MSI message body within the associated SMB sentences may be represented by the underscore "_" character.

2) This data field contains the Unique Message Number generated by the receiving EGC Terminal, sometimes referred to as a Mobile Earth Station (MES) or Ship Earth Station (SES). This is a variable length integer value with no decimal place or decimal digits. The maximum size of this field is 6 digits. This same data field is contained in the SMB sentence. This field shall not be null.

3) The Unique Message Sequence Number is assigned by the Land Earth Station (LES) originating this MSI message. This field is always 6 fixed digits, requiring zero fill if the value received from the LES contains less than 6 digits. For example, if the LES broadcast a 5 digit number "10345", it would be represented in this data field as "010345", both having the same numeric value. If any portion of the Unique Message Sequence Number is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

4) This field contains the 3-digit numeric ID of the LES that originated this MSI message. This field is always 3 fixed digits, requiring zero fill if the value received from the LES contains less than 3 digits. If any portion of the LES ID is received in error (i.e. due to satellite radio link interference) or unknown by the EGC Terminal, then this field shall be null.

5) Ocean Region code. This field shall not be null.

   0 = Atlantic Ocean Region – West

   1 = Atlantic Ocean Region – East

   2 = Pacific Ocean Region

   3 = Indian Ocean Region

   4 – 7 = Reserved

8 = Unknown

9 = All ocean regions

6) Priority code of the MSI message. This field shall not be null.

1 = Safety

2 = Urgency

3 = Distress

4 -8 = Reserved

9 = Unknown

7) The fixed two-digit Service code identifies the type of this MSI message and corresponds to a rectangular area address (see comments 14, 15, 16, 17, and 18). This field is set to null for all other Service Code values.

Service Code	Type of Service
04	Navigational, Meteorological, or Piracy warning to a rectangular area
34	SAR Coordination to a rectangular area

8) The Presentation code is a fixed two-digit numeric value that defines the language to be used for presentation of this MSI message. Current definitions are provided below.

Presentation Code Value	Language
00	International Alphabet Number 5

9) Year of message reception UTC (4 fixed digits).

10) Month of message reception UTC (2 fixed digits, 01 to 12).

11) Day of message reception UTC (2 fixed digits, 01 to 31).

12) Hour of message reception UTC (2 fixed digits, 00 to 23).

13) Minute of message reception UTC (2 fixed digits, 00 to 59).

14) The Rectangular Area Address within an Inmarsat-C transmitted MSI message is a fixed twelve-digit field consisting of ten-numeric digits and two-alpha digits. Example: a rectangle whose south-west corner is 60º N and 010º W, extending 30º north and 25º east, is coded as: 60N010W30025 from the form "D1D2LaD3D4D5LoD6D7D8D9D10" (see IMO, International SafetyNET Manual). Comments 15 – 18 describe how this information is apportioned to standard IEC 61162 data fields.

15) The South-West Corner Latitude and latitude direction (N/S) is from the first three characters of the transmitted Rectangular Area Address, "D1D2LaD3D4D5LoD6D7D8D9D10". This is a fixed length field containing two digits of latitude in units of degrees, with the two digit minutes portion set to zeros and no decimal place or decimal minutes. A value of 60º N would be represented as "6000,N" in the sentence. Leading zero(s) are required when the latitude value is between 0 and 9 degrees. This field shall be null if there is an error in the received South-West Corner Latitude due to satellite radio link interference or if the Service Code field is not 04 or 34.

16) The South-West Corner Longitude and longitude direction (W/E) is from the fourth through seventh characters of the transmitted Rectangular Area Address, "D1D2LaD3D4D5LoD6D7D8D9D10". This is a fixed length field containing three digits of latitude in units of degrees, with the two digit minutes portion set to zeros and no decimal place or decimal minutes. A value of 10º W would be represented as "01000,W" in the sentence. Leading zero(s) are required when the longitude value is between 0 and 99 degrees. This field shall be null if there is an error in the received South-West Corner Longitude due to satellite radio link interference or if the Service Code field is not 04 or 34.
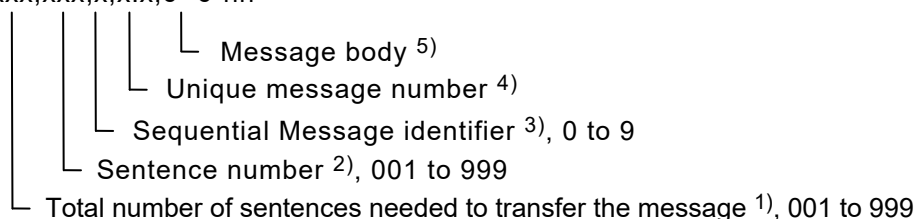
17) The Extent of Rectangle Area in Latitude Degrees is from the eighth and ninth characters of the transmitted Rectangular Area Address, "D1D2LaD3D4D5LoD6D7D8D9D10". This is a fixed length field containing two digits of latitude in units of degrees North. A value of 30º would be represented as "30" in the sentence. Leading zero(s) are required when the latitude value is between 0 and 9 degrees. This field shall be null if there is an error in the received Extent of Rectangle Area in Latitude Degrees due to satellite radio link interference or if the Service Code field is not 04 or 34.

18) The Extent of Rectangle Area in Longitude Degrees is from the last three characters of the transmitted Rectangular Area Address, "D1D2LaD3D4D5LoD6D7D8D9D10". This is a fixed length field containing three digits of longitude in units of degrees East. A value of 25º would be represented as "025" in the sentence. Leading zero(s) are required when the longitude value is between 0 and 99 degrees. This field shall be null if there is an error in the received Extent of Rectangle Area in Longitude Degrees due to satellite radio link interference or if the Service Code field is not 04 or 34.

8.3.90 SMB – IMO SafetyNET Message Body

The SMB sentence(s) contains the MSI message body related to the qualifying information in the preceding SM1, or SM2, or SM3, or SM4 sentence. This includes the identification of the source of the MSI message, purpose and scope of the MSI message, and date/time of receipt. One or more SMB sentences shall always follow a SM1, or SM2, or SM3, or SM4 sentence. The SM1, or SM2, or SM3, or SM4 sentence and related SMB sentence(s) are linked by the Unique Message number generated by the receiving EGC Terminal data field included in both sentences.

```
$--SMB,xxx,xxx,x,x.x,c--c*hh
           │   │   │ │  │  └ Message body 5)
           │   │   │ │  └ Unique message number 4)
           │   │   │ └ Sequential Message identifier 3), 0 to 9
           │   │   └ Sentence number 2), 001 to 999
           │   └ Total number of sentences needed to transfer the message 1), 001 to 999
```

Comments:

1) The total number of sentences field contains the number of sentences used for a MSI message, minimum value "001". This field cannot be null.

2) The sentence number field identifies which sentence number this specific SMB sentence is within the group of sentences that make up the MSI message, minimum value "001". This field may be null only when the "total number of sentences" field is "001" and no additional sentences are needed to convey this MSI message.

3) The sequential message identifier field is critical to identifying groups of 2 or more sentences that make up this multi-sentence message. This field is incremented each time a new multi-sentence message is generated with the same sentence formatter. This field's value is reset to zero when it is incremented beyond the maximum value of nine (range 0..9). This field may be null only when the "total number of sentences" field is "001" and no additional sentences are needed to convey this MSI message.

4) This data field contains the Unique Message Number generated by the receiving EGC Terminal, sometimes referred to as a Mobile Earth Station (MES) or Ship Earth Station (SES). This is a variable length integer value with no decimal place or decimal digits. This field cannot be null.

5) The Message body contains ASCII characters, and code delimiters if needed, up to the maximum permitted sentence length. Field four, the "Unique Message Number", is a variable length field usually containing six digits. When field four contains six digits, the message body may contain up to 53 characters including any code delimiters. Characters of the MSI message text shall be represented as underscore "_" if they are unknown or received in error by the EGC terminal (i.e. due to satellite radio link interference). The table below provides the allowable number of characters in this field based upon the number of digits in the Unique Message Number.

Unique Message Number Field Size (digits)	Message Body Field Size (characters)
1	58
2	57
3	56
4	55
5	54
6	53
7, 8, 9	52, 51, 50

Example of use.

The example shows a typical MSI message received by an EGC Terminal at 1430 on April 5th, 2012, and distributed by the SMB sentence.

LES 798 – MSG 5213 – **Distress Alert** to Area: 34N 76W 300
FROM: Maritime Rescue Coordination Centre xxx
TO: ALL SHIPS IN xxxxxxx
SAR SITREP NO: 02
FISHING BOAT 'xxx' WITH THREE PERSONS ON BOARD DEPARTED FROM xxx ISLAND ON
xxx AT NOONTIME AND SINCE THEN NO INFORMATION ABOUT HER. PARTICULARS ...
SHIPS SAILING IN VICINITY ARE KINDLY REQUESTED TO KEEP A SHARP LOOK OUT
INFORMING MRCC
REGARDS
        DUTY OFFICER

<end of example>

Inspecting the corresponding SM3 and SMB sentences would typically show:

```
$CSSM3,123456,005213,798,0,3,14,00,2012,04,05,14,30,3400,N,076,W,300*hh
$CSSMB,008,001,0,123456,FROM:Maritime Rescue Coordination Centre xxx^0D^0ATO:*hh
$CSSMB,008,002,0,123456, ALL SHIPS IN xxxxxxx^0D^0ASAR SITREP NO: 02^0D^0AFIS*hh
$CSSMB,008,003,0,123456,HING BOAT 'xxx' WITH THREE PERSONS ON BOARD DEPARRTED*hh
$CSSMB,008,004,0,123456, FROM xxx ISLAND ON^0D^0Axxx AT NOONTIME AND SINCE TH*hh
$CSSMB,008,005,0,123456,EN NO INFORMATION ABOUT HER. PARTICULARS ...^0D^0ASHI*hh
$CSSMB,008,006,0,123456,PS SAILING IN VICINITY ARE KINDLY REQUESTED TO KEEP A*hh
$CSSMB,008,007,0,123456, SHARP LOOK OUT^0D^0AINFORMING MRCC^0D^0AREGARDS^0D*hh
$CSSMB,008,008,0,123456,^0A    DUTY OFFICER*hh
```

8.3.91   SPW – Security password sentence

This sentence can be used for authentication. For this purpose the sentence has to be applied before the protected sentence (for example EPV, SSD).

NOTE   This sentence transmits the password in plain text which is a cyber security concern for networks.

Other sentences shall not be interleaved between the password sentence and protected sentence and the time between the SPW and the protected sentence should be limited. The password protected sentence pair should be sent without unnecessary delay between sentences. The recommendation is 1 s maximum timeout. Note that any of the signals may be lost and timed out.

If the SPW is not accepted (for example because the password is incorrect) the receiving device shall generate a NAK sentence with the reason code set to 11 and the associated sentence shall not be processed.

```
$--SPW,ccc,c--c,x,c--c*hh<CR><LF>
         │    │    │   └   Password [4]
         │    │    └   Password level [3]
         │    └   Unique identifier [2]
         └   Password protected sentence [1]
```

Comments:

1) The following sentence formatter that should be protected (for example EPV).

2) For AIS the unique identifier is the MMSI.

3) An integer number as defined below:

   1   = User level password;

   2   = Administrator level password;

   3-9 = Reserved.

4) Password as text up to 32 characters.

Example:

The password could be changed with a SPW+EPV sentence pair. In this example the Talker ID of "II" is used for Integrated Instrumentation and the AIS Talker ID of "AI" is used. The MMSI of the AIS Station is 211000001, and the administrator password is initially set to "SESAME" and will be changed to "HEUREKA143":

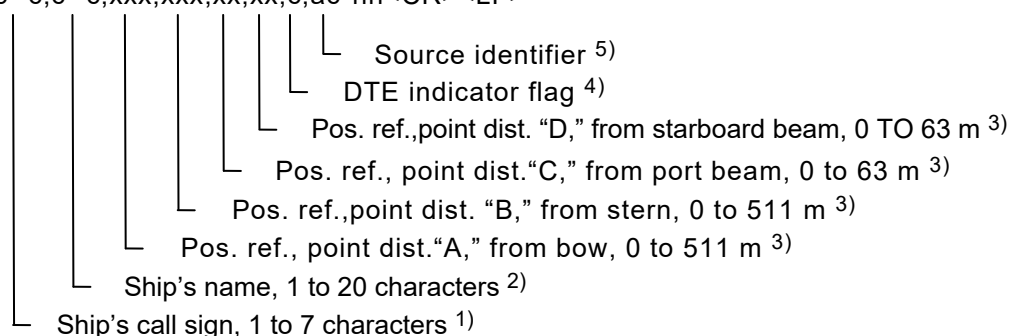$IISPW,EPV,211000001,2,SESAME*hh

$IIEPV,C,AI,211000001,111,HEUREKA143*hh

with response:

$AIEPV,R,AI,211000001,111,HEUREKA143*hh

8.3.92 SSD – AIS ship static data

This sentence is used to enter static parameters into a shipboard AIS unit. The parameters in this sentence support a number of the ITU-R M.1371 Messages.

```
$--SSD,c--c,c--c,xxx,xxx,xx,xx,c,ac*hh<CR><LF>
                              └ Source identifier [5]
                            └ DTE indicator flag [4]
                         └ Pos. ref.,point dist. "D," from starboard beam, 0 TO 63 m [3]
                      └ Pos. ref., point dist. "C," from port beam, 0 to 63 m [3]
                   └ Pos. ref.,point dist. "B," from stern, 0 to 511 m [3]
                └ Pos. ref., point dist. "A," from bow, 0 to 511 m [3]
             └ Ship's name, 1 to 20 characters [2]
         └ Ship's call sign, 1 to 7 characters [1]
```

Comments:

1) Ship's call sign. A null field indicates that the previously entered call sign is unchanged. The string of characters "@@@@@@@" is used to indicate that the call sign is not available.

2) The characters that can be used in the name are listed in the ITU-R M.1371, 6-bit ASCII. Some of the acceptable characters in this 6-bit ASCII table are the reserved characters within this standard (IEC 61162-1), Table 1. These characters should be represented using the "^" method (see 7.1.4). A null field indicates that the previously entered name is unchanged. The string of characters "@@@@@@@@@@@@@@@@@@@@" is used to indicate that the ship's name is not available.

3) These are the four dimensions from the bow, stern, port beam, and starboard beam to the horizontal reference point on the ship for which the current "position reports" are valid. The sum of A + B is the length of the ship in metres, and the sum of C + D is the width of the ship in metres. Refer to the ITU-R M.1371, Message 5, "reference point for reported position and dimensions of ship". If the reference point of "reported position" is not available, but the dimensions of the ship are available: A = C = 0 and B > 0 and D > 0. If neither the reference point for the reported position nor the dimensions of the ship are available: A = B = C = D = 0 (default). Use of a null field for A, B, C, and/or D indicates that the previously entered dimension for that parameter is unchanged. In many cases, the ship's reference point for "reported position" will be the location of the positioning antenna.

4) The DTE indicator is an abbreviation for data terminal equipment indicator. The purpose of the DTE indicator is to inform distant receiving applications that, if set to "available," the transmitting station conforms, at least, to the minimum keyboard and display requirements. The DTE indicator is only used as information provided to the application layer – indicating that the transmitting station is available for communications. On the transmitting side, the DTE indicator may be set by an external application using this sentence. DTE indicator flag values are:

0 = Keyboard and display are a standard configuration, and communication is supported;

1 = Keyboard and display are either unknown or unable to support communication.

5) The source identifier contains the talker ID of the position source at the location on the ship defined by data fields 3, 4, 5 and 6. The source identifier of "AI" should be used for the AIS units internal position source. This data field helps the AIS to distinguish the position information source for the purpose of changing the information broadcast in VDL message 5 for the location of position sensor antenna on the vessel.

8.3.93 STN – Multiple data ID

This sentence is transmitted before each individual sentence where there is a need for the listener to determine the exact source of data in a system. Examples might include

dual-frequency depth sounding equipment or equipment that integrates data from a number of sources and produces a single output.

$--STN, xx*hh<CR><LF>
        └─ Talker ID number, 00 to 99

8.3.94   THS – True heading and status

NOTE   This sentence replaces the deprecated sentence HDT.

Actual vessel heading in degrees true produced by any device or system producing true heading. This sentence includes a "mode indicator" field providing critical safety related information about the heading data, and replaces the deprecated HDT sentence.

$--THS,x.x,a*hh<CR><LF>
          │ └─ Mode indicator [1]
          └─ Heading, degrees true

Comments:

1) Mode indicator. This field should not be null.

    A = Autonomous

    E = Estimated (dead reckoning)

    M = Manual input

    S = Simulator mode

    V = Data not valid (including standby)

8.3.95   TLB – Target label

Common target labels for tracked targets. This sentence is used to specify labels for tracked targets to a device that provides tracked target data (e.g. via the TTM – Tracked target message). This will allow all devices displaying tracked target data to use a common set of labels (e.g. targets reported by two radars and displayed on an ECDIS).

$--TLB,x.x,c--c,x.x,c--c,...x.x,c--c*hh<CR><LF>
        │ │   └──┐   └──┐
        │ │   └───────┴─ Additional label pairs [1]
        │ └─ Label assigned to target 'n' [2]
        └─ Target number 'n' reported by the device.

Comments:

1) This sentence allows several target number/label pairs to be sent in a single message, the maximum sentence length limits the number of labels allowed in a message.

2) Null fields indicate that no common label is specified, not that a null label should be used. The intent is to use a null field as a place holder. A device that provides tracked target data should use its "local" label (usually the target number) unless it has received a TLB sentence specifying a common label.

8.3.96   TLL – Target latitude and longitude

Target number, name, position and time tag for use in systems tracking targets.

$--TLL,xx,llll.ll,a,yyyyy.yy,a,c--c,hhmmss.ss,a,a*hh<CR><LF>

```
                                              └ Reference target 2)
                                                = R, null otherwise
                                          └ Target status 1)
                                    └ UTC of data
                              └ Target name
                        └ Target longitude, E/W
              └ Target latitude, N/S
        └ Target number 00 – 99
```

Comments:

1) Target status:

   L = Lost, tracked target has been lost;

   Q = Query, target in the process of acquisition;

   T = tracking.

2) Reference target: set to "R" if target is a reference used to determine own ship's position or velocity, null otherwise.

8.3.97   TRC – Thruster control data

This sentence provides the status of control data for thruster devices. This sentence may also be used as a command sentence (see Comment 9). When providing status data the sentence shall be transmitted at regular intervals.

$--TRC,x,x.x,a,x.x,a,x.x,a,a*hh<CR><LF>

```
                           └ Sentence status flag 9)
                       └ Operating location indicator 7) 8)
                   └ Azimuth demand 6)
               └ Pitch mode indicator 5) 8)
           └ Pitch demand value 4)
        └ RPM mode indicator 3) 8)
     └ RPM demand value 2)
  └ Number of thruster, bow or stern 1)
```

Comments:

1) Numeric character to identify a thruster in the system. This is numbered from centre-line. This field is single digit:

   Odd = Bow thruster

   Even = Stern thrusters

2) "-" = port

3) P = Per cent (%): 0 % – 100 % from zero to maximum rpm

   R = Revolutions per minute (RPM)

   V = data invalid

4) "-" = port

5) P = Per cent (%)

   D = Degrees (°)

   V = data invalid

6) Direction of thrust in degrees (0^0 – 360^0). This may be a null field.

7) Indication to identify location. This field is single character.

   B = Bridge

P = Port wing

S = Starboard wing

C = Engine control room

E = Engine side / local

W = Wing (port or starboard not specified)

8) This should not be a null field.

9) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

R = Sentence is a status report of current settings (used for a reply to a query).

C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

8.3.98   TRL – AIS transmitter-non-functioning log

This sentence is specific to AIS class A stations. It is intended to support the retrieval of the AIS non-functioning log information.

AIS class A stations log the last 10 times of more than 15 min when the unit was not transmitting position reports. This includes times when the unit was switched off and times when the transmitter was inactivated by any means.

This sentence is used to output the logged non-functioning times. On a query for this sentence up to 10 sentences will be output, one sentence for each logged non-functioning time.

This sentence is always generated by class A stations as a response to a query even when no log entries exist.

```
$--TRL,x.x,x.x,x,xxxxxxxx,hhmmss.ss,xxxxxxxx,hhmmss.ss,x*hh<CR><LF>
```

Reason code [8]

Switch on UTC time [7]

Switch on date [6]

Switch off UTC time [5]

Switch off date [4]

Sequential message identifier [3]

Log entry number [2]

Total number of log entries [1]

Comments:

1) Total number of log entries (1...10). When a query is received for this sentence and no log entries exist, this field should be set to "0" and all other fields should be set to NULL. When a query is received for this sentence and one or more log entries exist, this field should report the total number of log entries.

2) The Log entry number identifies a specific log entry and the order of a single TRL sentence as part of a multi-sentence message with a range of 1 to the total number of log entries.

3) The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message.

4) Switch off date, in the format "ddmmyyyy".

5) Switch off UTC time. Required resolution is in minutes. The seconds may be set to 0 and the fractional part may be omitted.

6) Switch on date, in the format "ddmmyyyy".

7) Switch on UTC time. Required resolution is in minutes. The seconds may be set to 0 and the fractional part may be omitted.

8) Reason for transmitter non-functioning:

   1 = power off;

   2 = silent mode;

   3 = transmission switched off by channel management command;

   4 = equipment malfunction;

   5 = invalid configuration;

   6 to 9 = reserved for future use.

8.3.99 TRD – Thruster response data

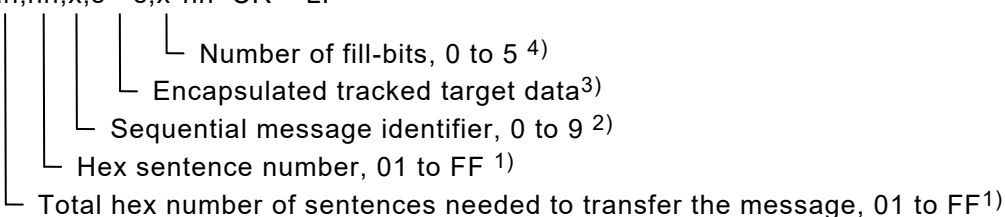This sentence provides the response data for thruster devices.

$---TRD,x,x.x,a,x.x,a,x.x*hh<CR><LF>

```
         │ │ │  │ │  └ Azimuth response 6)
         │ │ │  │ └ Pitch mode indicator 5) 7)
         │ │ │  └ Pitch response value 4)
         │ │ └ RPM mode indicator 3) 7)
         │ └ RPM response 2)
         └ Number of thruster, bow or stern 1)
```
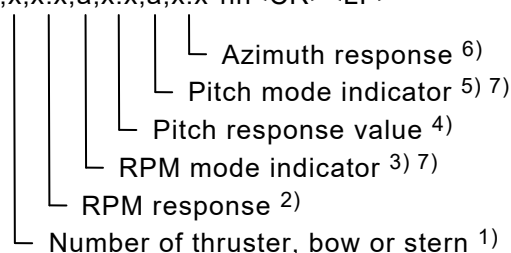
Comments:

1) Numeric character to identify a thruster in the system. This is numbered from the centre-line. This field is single digit:

   Odd =   Bow thruster

   Even = Stern thrusters

2) "-" = port

3) P =   Per cent (%): 0 – 100 % from zero to maximum rpm

   R =   Revolutions per minute (RPM)

   V =   data invalid

4) "-" port

5) P =   Per cent (%):

   D =   Degrees

   V =   data invalid

6) Direction of thrust in degrees ($0^0 – 360^0$). This may be a null field.

7) This should not be a null field.

8.3.100 TTD – Tracked target data

This sentence is used to transmit tracked radar targets in a compressed format. This enables the transfer of many targets with minimum overhead. New target labels are defined by the TLB sentence to reduce bandwidth use. Transmission of up to four targets in the same sentence is possible.

!--TTD,hh,hh,x,s—s,x*hh<CR><LF>

```
        │  │  │ │   └ Number of fill-bits, 0 to 5 4)
        │  │  │ └ Encapsulated tracked target data3)
        │  │  └ Sequential message identifier, 0 to 9 2)
        │  └ Hex sentence number, 01 to FF 1)
        └ Total hex number of sentences needed to transfer the message, 01 to FF1)
```

Comments:

1) The transfer of all tracked targets may require the transmission of multiple sentences. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields.

2) The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This should be a null field for messages that fit into one sentence.

3) The tracked target data structure is described in the tables below. Data is stored most significant bit first. Every message character is converted into six bits. One sentence may contain from one up to four structures of 15 characters in the same sentence. This field supports a maximum of 60 valid characters for messages transferred using multiple sentences.

4) This cannot be a null field. See "x4" in description of encapsulation sentences in 7.3.4.2.

Protocol version zero					
Parameter	**Number of bits**	**Range and resolution**	**Description**		
Protocol version	2	0 to 3	The protocol version shall always be set to zero for the structure defined below.		
Target number	10	0 to 1 023	The target number associated with the label with corresponding number. Target number zero is reserved for no tracking target.		
True bearing	12	to 359,9° Step 0,1°	North-up coordinate system 409,5 deg = Invalid or N/A data		
Speed	12	to 409,4 kn Step 0,1 kn	See speed mode and stabilisation mode 0 – 409,3 kn = valid speed 409,4 kn = valid speed of 409,4 or greater 409,5 kn = invalid speed or speed not available		
Course	12	to 359,9° Step 0,1°	See speed mode and stabilisation mode 409,5 deg = Invalid or N/A data		
Heading (AIS target only)	12	to 359,9° Step 0,1°	Reported heading from AIS, north-up coordinate system 409,4 deg = Invalid or N/A data 409,5 deg = No data, radar tracking target		
Tracked / AIS target status	3		Value	Radar	AIS
			000	Non-tracking	No target to report
			001	Acquiring target (not established)	Sleeping target
			010	Lost target	Lost target
			011	Reserved	Reserved
			100	Established tracking, no alarm	Activated target, no alarm
			101	Reserved	Reserved
			110	Established tracking, CPA/TCPA alarm	Activated target, CPA/TCPA alarm
			111	Established tracking, acknowledged CPA/TCPA alarm	Activated target, acknowledged CPA/TCPA alarm
Operation mode	1		0 = Autonomous (normal) 1 = Test target		
Distance	14	to 163,83 NM Step 0,01 NM	Distance to target 0 – 163,81 NM = valid distance 163,82 NM = valid distance of 163,82 NM or greater 163,83 NM = invalid distance or distance not available		
Speed mode	1		0 = True speed and course 1 = Relative speed and course		

Protocol version zero			
Parameter	**Number of bits**	**Range and resolution**	**Description**
Stabilisation mode	1		0 = Over the ground 1 = Through the water
Parameter = Reserved	2		Reserved for future use Always set to zero
Correlation / Association number	8	0 to 255	Number zero is reserved for no correlation / association Correlated / associated targets are assigned a common number
TOTAL	**90**		**90/6 = 15 characters**
Theoretical maximum throughput for IEC 61162-2 connections is calculated with the formula: targets/second = baud rate / bit per sentence * targets per sentence 38 400 /[22+90/6*4)*10] = 46 sentences / second (4 targets per sentence) = 187 targets / second HSC: 60/40 = 1,5 s / revolution: 280 targets / revolution (9 bit address space enough) Normal: 60/20 = 3 s / revolution: 561 targets / revolution (10 bit address space enough) Overhead for TLB – target label and other sentences are not included in this calculation.			
N/A:　　Not available			

Protocol version one			
Parameter	**Number of bits**	**Range and resolution**	**Description**
Protocol version	2	0 to 3	The protocol version shall always be set to one (1) for the structure defined below. Other values (2 and 3) are reserved for future modification of this structure.
Target number	10	0 to 1 023	The target number associated with the label with corresponding number. Target number zero is reserved for no tracking target.
CPA	14	to 163,83 NM Step 0,01 NM	CPA of target 163,84 NM = invalid or N/A data
TCPA	14	From – 81,91 min to + 81.91 min Step 0,01 min	Time to CPA of target, "-" increasing + 81,92 min = invalid or N/A data
Parameter = Reserved	2		Reserved for future use Always set to zero
TOTAL	42		42/6 = 7 characters
N/A:　　Not available			

8.3.101　TTM – Tracked target message

Data associated with a tracked target relative to own ship's position.
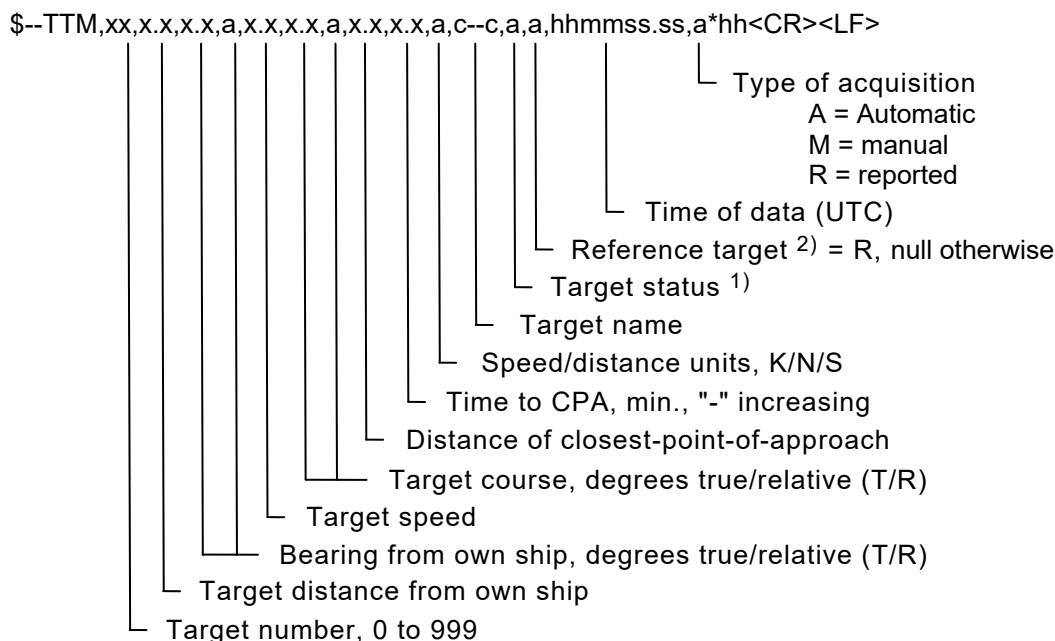
```
$--TTM,xx,x.x,x.x,a,x.x,x.x,a,x.x,x.x,a,c--c,a,a,hhmmss.ss,a*hh<CR><LF>
```

Type of acquisition
A = Automatic
M = manual
R = reported

Time of data (UTC)

Reference target [2] = R, null otherwise

Target status [1]

Target name

Speed/distance units, K/N/S

Time to CPA, min., "-" increasing

Distance of closest-point-of-approach

Target course, degrees true/relative (T/R)

Target speed

Bearing from own ship, degrees true/relative (T/R)

Target distance from own ship

Target number, 0 to 999

Comments:

1) Target status:

   L = Lost, tracked target has been lost;

   Q = Query, target in the process of acquisition;

   T = Tracking.

2) Reference target: set to "R" if target is a reference used to determine own ship's position or velocity, null otherwise.

8.3.102 TUT – Transmission of multi-language text

A sentence to support multi-language text using a variable length Hex field in the sentence definition.

The sentence structure is similar to the TXT sentence, however, it has two additional fields. There is a "source identifier" field used to identify the origin of the sentence and a "translation code" field that is used to define the coding system for the text body. This enables the use of multi-language codes, such as, unicode or other codes. A proprietary look-up table method is incorporated to allow pre-defined messages to be sent in short sentences.

```
$--TUT,aa,hh,hh,x,c--c,h--h*hh<CR><LF>
```

Text body [5]

Translation code for text body [4]

Sequential message identifier, 0 to 9 [3]

Sentence number, 00 to FF [2]

Total number of sentences in the messages, 01 to FF [2]

Source identifier [1]
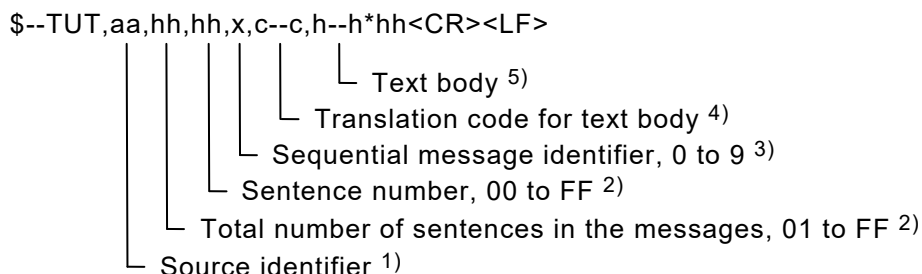
Comments:

1) The source identifier contains the talker ID indicating the type of equipment that originated this message. The source identifier is used to identify the manufactured purpose of the device.

2) Unicode text may require the transmission of multiple sentences all containing identical field formats. The second field specifies the total number of sentences in the message, minimum value 01^{hex}. The third field identifies the sequence of this sentence (sentence number), minimum value 01^{hex}. For efficiency, it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

3) The sequence message identifier number relates all sentences that belong to a group of multiple sentences. Multiple sentences (see Comment 2) with the same sequence identifier number, make up one text message.

4) The translation code identifies the Hex character coding method used in the text body field and determines the maximum number of Hex character positions available in the "text body" field.

U =   Unicode (ISO/IEC 10646), 56 Hex character positions in the text body.

A =   Subset of ISO/IEC 8859, 56 Hex character positions in the text body.

1-16 =   Part number of ISO/IEC 8859

P<aaa> =   Proprietary (user defined), 53 Hex character positions in the text body. This field consists of the letter "P" directly followed by the three letter manufacturer's mnemonic code. An example might be "PXYZ", if the XYZ company's equipment produced a TUT message with a proprietary translation code.

5) The text body consists either 56 or 53 Hex character positions, depending on the "translation code field". The number and type of characters and code delimiters if needed, up to the maximum permitted sentence length, are as follows.

U =>   Up to fourteen 16-bit unicode characters including code delimiters. Each unicode character is represented by 4 Hex character codes. The letter "A" would be represented by 0041 hex, while the "Katakana letter A" would be represented by 30A2 hex.

A or 1-16 =>   Up to twenty-eight 8-bit ASCII characters including code delimiters. Each ASCII character is represented by 2 Hex character codes. The letter "A" would be represented by 41 hex, while the Latin capital letter thorn "Þ" would be represented by DE hex. The "Katakana letter A" cannot be represented by 2 Hex character codes.

P<aaa> =>   Up to fifty-three 4-bit user-defined characters including code delimiters. These are intended to be used as an index or entry into a user defined (proprietary) look-up table. Each character is represented by 1 or more Hex character codes.

Example scenario containing the proprietary and unicode translation codes:

A depth sounder sends a warning of "Shallow Water!" to an integrated navigation system using a proprietary translation code. The integrated navigation system sends a unicode text message to a remote display in the local language of Kanji.

$SDTUT,SD,01,01,1,PXYZ,02*6D<CR><LF>

The integrated navigation system, upon receiving this sentence would look within in its own table for the unicode text contents referenced by the value 02. The text being reported in this TUT example is "Shallow Water!". Note that there is no constraint on how many hex characters are used to represent the look-up value. It could be represented in the field as 2 or 02 or 002 or 0002, as long as the sender and receiver of this know how to interpret this proprietary text body.

The integrated navigation system could then generate and send the following sentence using the unicode translation code to a remote display device in the local language desired; Kanji in this example. The Kanji equivalent of "Shallow Water!" is "浅瀬危険", and is represented according to unicode as the hex codes of 6D45 702C 5371 967A.

$INTUT,SD,01,01,1,U,6D45702C5371967A*5D<CR><LF>

The same text "Shallow Water!" could have been generated by the integrated navigation system using the ASCII translation code as shown below.

$INTUT,SD,01,01,1,A,5368616C6C6F7720576174657221*4B<CR><LF>

8.3.103 TXT – Text transmission

For the transmission of short text messages. Longer text messages may be transmitted by using multiple sentences.

```
$--TXT,xx,xx,xx,c--c*hh<CR><LF>
         │  │  │  └ Text message 3)
         │  │  └ Text identifier 2)
         │  └ Sentence number 1), 01 to 99
         └ Total number of sentences 1), 01 to 99
```

Comments:

1) Text messages may require the transmission of multiple sentences, all containing identical field formats when sending a complex message. The first field specifies the number of sentences, minimum value = 1. The second field identifies the order of this sentence (sentence number), minimum value = 1. For efficiency, it is permitted that null fields be used in the additional sentences when the data is unchanged from the first sentence. (Note that this practice can lead to the incorrect assembly of messages if there is a high risk of loss of sentence.)

2) The text identifier is a number, 01 to 99, used to identify different text messages.

3) ASCII characters, and code delimiters if needed, up to the maximum permitted sentence length (i.e. up to 61 characters including any code delimiters).

Example: A GPS receiver sends a text alarm message (message ID 25, DR MODE – ANTENNA FAULT!) upon reverting to dead-reckoning mode due to an antenna fault (note the use of "^ 21" to indicate "!", see 7.1.4).

$GPTXT,01,01,25,DR MODE-ANTENNA FAULT^21*38<CR><LF>

8.3.104 UID – User identification code transmission

This sentence allows a user to send an identification message to a system.

```
$--UID,c--c,c--c*hh<CR><LF>
         │    └ User identification code 2 (optional) 2)
         └ User identification code 1 1)
```

Comments:

1) User identification code UIC may consist of up to 20 alpha-numerical characters (A-Z, a-z, and 0-9). UIC will be used by the receiving system to identify the user and check the validity of the request. UIC might be recorded for accounting purposes. Field equipment needs to have means to input both UICs (e.g. input dialog).

2) User identification code 2 is optional and allows further identification of the user or his project.

Example: A GPS receiver sends a user identification message (uic1 HEPSLGN02376 and uic2 dB Los 23).

$GPUID,HEPSLGN02376,DB Los 23*hh<CR><LF>

8.3.105 VBW – Dual ground/water speed

Water-referenced and ground-referenced speed data.

$--VBW, x.x, x.x, A, x.x, x.x, A, x.x, A, x.x, A*hh<CR><LF>

Status [2]: stern ground speed,
A = data valid, V = data invalid

Stern transverse ground speed [1], knots

Status [2]: stern water speed,
A = data valid, V = data invalid

Stern transverse water speed [1], knots

Status [2]: ground speed,
A = data valid, V = data invalid

Transverse ground speed [1], knots

Longitudinal ground speed [1], knots

Status [2]: water speed, A = data valid, V = data invalid

Transverse water speed [1], knots

Longitudinal water speed [1], knots

Comments:

1) Transverse speed: "-" = port,

Longitudinal speed: "-" = astern.

2) The status field should not be a null field.

8.3.106 VDM – AIS VHF data-link message

This sentence is used to transfer the entire content of a received AIS message packet, as defined in ITU-R M.1371 and as received on the VHF Data Link (VDL), using the "six-bit" field type. The structure provides for the transfer of long binary messages by using multiple sentences.

Data messages should be transmitted in as few sentences as possible. When a data message can be accommodated in a single sentence, then it shall not be split.

!--VDM,x,x,x,a,s—s,x*hh<CR><LF>

Number of fill-bits, 0 to 5 [5]

Encapsulated ITU-R M.1371 radio message [4]

AIS channel [3]

Sequential message identifier, 0 to 9 [2]

Sentence number, 1 to 9 [1]

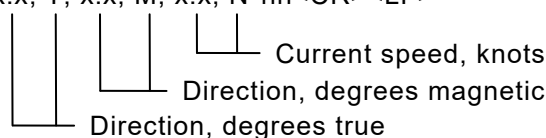Total number of sentences needed to transfer the message, 1 to 9 [1]

Comments:

1) The length of an ITU-R M.1371 message may require the transmission of multiple sentences. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields.

2) The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This may be a null field for messages that fit into one sentence.

3) The AIS channel is indicated as either "A" or "B". This channel indication is relative to the operating conditions of the AIS unit when the packet is received. This should be a null field when the channel identification is not provided. The VHF channel numbers for channels "A" and "B" are obtained by using a "query" (see 7.3.5) of the AIS unit for an ACA sentence.

4) This field supports up to 60 valid characters. Under certain conditions, this field may support up to a maximum of 62 valid characters:

a) When the message can be transmitted using a single sentence, the sequential message identifier field is set to null allowing an additional valid character in this encapsulated field.

b) When the AIS channel field is set to null an additional valid character is allowed in this encapsulated field.

c) The maximum number of 62 valid characters is only possible when the conditions allow both the sequential message identifier and AIS channel fields is set to null.

5) This cannot be a null field. See "x4" in 7.3.4.

8.3.107 VDO – AIS VHF data-link own-vessel report

This sentence is used to transfer the entire content of an AIS unit's broadcast message packet, as defined in ITU-R M.1371 and as sent out by the AIS unit over the VHF data link (VDL) using the "six-bit" field type. The sentence uses the same structure as the VDM sentence formatter.

```
!--VDO,x,x,x,a,s—s,x*hh<CR><LF>
              └   Number of fill-bits, 0 to 5 5)
            └ Encapsulated ITU-R M.1371 radio message 4)
         └ AIS channel 3)
       └ Sequential message identifier, 0 to 9 2)
     └ Sentence number, 1 to 9 1)
   └ Total number of sentences needed to transfer the message, 1 to 9 1)
```

Comments:

1) The length of an ITU-R M.1371 message may require the transmission of multiple sentences. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields.

2) The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This may be a null field for messages that fit into one sentence.

3) The AIS channel is indicated as either "A" or "B", "C" or "D", where "C" and "D" is used for the long range channels 75 and 76 respectively. This channel indication is relative to the operating conditions of the AIS unit when the packet is received. This should be a null field when the channel identification is not provided. The VHF channel numbers for channel codes "A" and "B" are obtained by using a "query" (see 7.3.5) of the AIS unit for an ACA sentence.

4) This field supports up to 60 valid characters. Under certain conditions, this field may support up to a maximum of 62 valid characters:

a) When the message can be transmitted using a single sentence, the sequential message identifier field is set to null allowing an additional valid character in this encapsulated field.

b) When the AIS channel field is set to null an additional valid character is allowed in this encapsulated field.

c) The maximum number of 62 valid characters is only possible when the conditions allow both the sequential message identifier and AIS channel fields is set to null.

5) This cannot be a null field. See "x4" in 7.3.4.

8.3.108 VDR – Set and drift

The direction towards which a current flows (set) and speed (drift) of a current.

```
$ VDR, x.x, T, x.x, M, x.x, N*hh<CR><LF>
              └ Current speed, knots
         └ Direction, degrees magnetic
   └ Direction, degrees true
```

8.3.109 VER – Version

This sentence is used to provide identification and version information about a device. This sentence is produced as a reply to a query sentence.

In order to meet the 79-character requirement, a "multi-sentence message" may be needed to convey all the data fields.

For example, an equipment may output the VER sentence autonomously upon power-up.

$--VER,x,x,aa,c--c,c--c,c--c,c--c,c--c,c--c,x*hh<CR><LF>

```
                                               └ Sequential message identifier 7)
                                             └ Hardware revision 5)
                                       └ Software revision 5)
                                 └ Model code (product code) 5)
                           └ Manufacturer serial number 5) 6)
                     └ Unique identifier 4)
                 └ Vendor ID 3)
            └ Device type 2)
        └ Sentence number, 1 to 9 1)
     └ Total number of sentences needed, 1 to 9 1)
```

Comments:

1) Depending on the number of characters in each data field, it may be necessary to use a "multi-sentence message" to convey a "VER reply." The first data field specifies the total number of sentences needed, minimum value 1. This is the total number of sentences required to transmit the information. The second data field identifies the sentence number, minimum value 1. Sentence number refers to the sequence number of the sentence within the total number of sentences. The tenth data field provides the sequential message identifier (see Comment 7).

2) The device type is used to identify the manufactured purpose of the device. Choice of the device type identifier is based upon the designed purpose of the device. It is set into the equipment based upon the primary design of the device and remains constant even if the user defined talker identifier feature is used.

3) Vendor identification (Example: either the NMEA 0183, 3-character "Manufacturer's Mnemonic Code" or NMEA 2000, 5-digit "Numeric Manufacturer's Code", 5 characters maximum).

4) The unique identifier is used for system level identification of a station, 15 characters maximum.

   When used with AIS stations, on output, this data field is the AIS station's unique identifier. When an MMSI is used as the unique identifier, it should be the MMSI of the station (for example, the "Real MMSI" of an AtoN station.

5) The data field length may be 32 characters maximum. When large character lengths are used and the 80 character sentence limit would be exceeded for a single sentence, a series of successive VER sentences should be used to avoid the problem (using data fields 1, 2, and 10 to ensure the multiple VER sentences are properly associated by the listener). Though null fields can be used for data fields contained in other sentences of the series, the unique identifier field should always contain the same value in every sentence of the series.

6) The manufacturer's serial number for the unit. Note, this "internal" manufacturer's serial number may or may not match the physical serial number of the device.

7) The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This data field may be a null field for messages that fit into one sentence.

8.3.110 VHW – Water speed and heading

The compass heading to which the vessel points and the speed of the vessel relative to the water.

$--VHW, x.x, T, x.x, M, x.x, N, x.x, K*hh<CR><LF>

- Speed, km/h
- Speed, knots
- Heading, degrees magnetic
- Heading, degrees true

8.3.111 VLW – Dual ground/water distance

The distance travelled, relative to the water and over the ground.

NOTE   Two additional fields have been added to the previous VLW sentence, and the description and title have been reworded to provide for distance relative to ground. This brings the sentence in line with the structure and information provided by the VBW sentence.

$--VLW,x.x,N,x.x,N,x.x,N,x.x,N*hh<CR><LF>

- Ground distance since reset, nautical miles
- Total cumulative ground distance, nautical miles
- Water distance since reset, nautical miles
- Total cumulative water distance, nautical miles

8.3.112 VPW – Speed measured parallel to wind

The component of the vessel's velocity vector parallel to the direction of the true wind direction. Sometimes called "speed made good to windward" or "velocity made good to windward".

$--VPW,x.x,N,x.x,M*hh<CR><LF>

- Speed, m/s, "-" = downwind
- Speed, knots, "-" = downwind

8.3.113 VSD – AIS voyage static data

This sentence is used to enter information about a ship's transit that remains relatively static during the voyage. However, the information often changes from voyage to voyage. The parameters in this sentence support a number of the ITU-R M.1371 messages.

$--VSD,x.x,x.x,x.x,c—c,hhmmss.ss,xx,xx,x.x,x.x*hh<CR><LF>

- Regional application flags, 0 to 15 [8]
- Regional application flags, 0 to 15 [8]
- Estimated month of arrival at destination, 00 to 12 (UTC) [6]
- Estimated day of arrival at destination, 00 to 31 (UTC) [6]
- Estimated UTC of arrival at destination [5]
- Destination, 1-20 characters [4]
- Persons on-board, 0 to 8 191 [3]
- Maximum present static draught, 0 to 25,5 m [2]
- Type of ship and cargo category, 0 to 255 [1]

Comments:

1) Type of ship and cargo category are defined under Message 5 of ITU-R M.1371. The descriptions of ship and cargo are indicated by a number. The values are defined in ITU-R M. 1371, Message 5. A null field indicates that this is unchanged.

2) The draught is reported in units of metres. Valid range is 0 to 25,5. The value 0 = not available and the value 25,5 indicates that the draught is 25,5 m or more. A null field indicates that this is unchanged.

3) Current number of persons on-board including crew. Valid range is 0 to 8 191. The value 0 = not available and the value 8 191 = 8 191 or more people. A null field indicates that this is unchanged.

4) The characters that can be used in the destination are listed in the ITU-R M.1371, 6-bit ASCII. Some of these characters are reserved characters in Table 1. These characters should be represented using the "^" method (see 7.1.4). A null field indicates that the previously entered destination is unchanged. The string of characters "@@@@@@@@@@@@@@@@@@@@" are used to indicate that the ship's destination is not available.

5) If the hour of arrival is not available, "hh" should be set to 24. If the minute of arrival is not available, "mm" should be set to 60. The seconds option "ss.ss" of the field may be set to "00" as the AIS unit only broadcasts hours and minutes. A null field indicates that this is unchanged.

6) The day and month of arrival are in UTC. The field is a fixed two-digit number requiring leading zeros. If the day of arrival is not available, "00" should be the number for the day. If the month of arrival is not available, "00" should be the number for the month. A null field indicates that this is unchanged.

7) The navigational status is indicated using the following values, a null field indicates the status is unchanged (reference ITU-R M.1371, Message 1, navigational status parameter):

0 = under way using engine	4 = constrained by draught	9 = reserved for High Speed Craft (HSC)
1 = at anchor	5 = moored	10 = reserved for Wing In Ground (WIG)
2 = not under command	6 = aground	11 to 14 = reserved for future use
3 = restricted manoeuvrability	7 = engaged in fishing	15 = default
	8 = under way sailing	

8) Definition of values 1 to 15 provided by a competent regional authority. Value should be set to zero (0), if not used for any regional application. Regional applications should not use zero. A null field indicates that this is unchanged (reference ITU-R M.1371, Message 1, reserved for the regional applications parameter).

8.3.114 VTG – Course over ground and ground speed

The actual course and speed relative to the ground.

$--VTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>

    Mode indicator [2]
    Speed over ground, km/h [1]
    Speed over ground, knots [1]
    Course over ground, degrees magnetic
    Course over ground, degrees true

Comments:

1) The speed over the ground should always be non-negative.

2) The mode indicator provides status information about the operation of the source device (such as positioning systems, velocity sensors, etc.) generating the sentence, and the validity of data being provided. The possible indications are as follows:

A = Autonomous mode;

D = Differential mode;

E = Estimated (dead reckoning) mode;

M = Manual input mode;

P = Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as selective availability) and higher resolution code (P-code) is used to compute position fix. P is also used for satellite system used in multi-frequency, SBAS or Precise Point Positioning (PPP) mode;

S = Simulator mode;

N = Data not valid.

The mode indicator field should not be a null field.

8.3.115 WAT – Water level detection

This sentence provides detection status of water leakage and bilge water level, with monitoring location data.
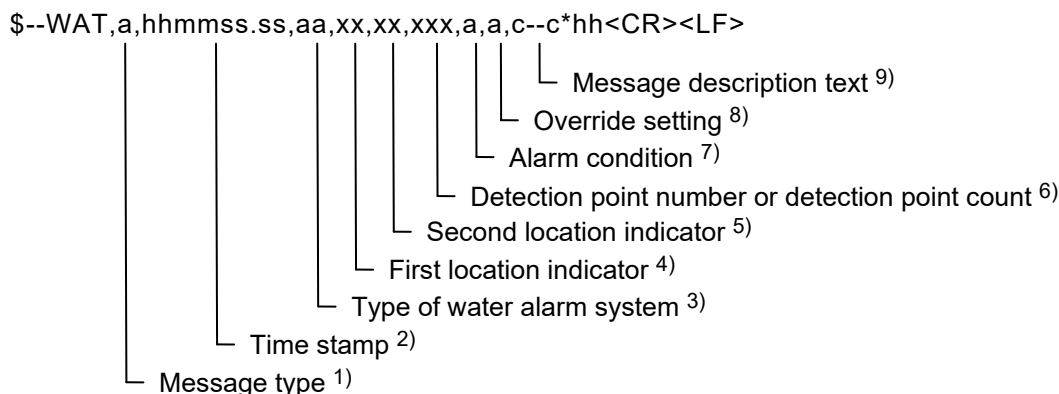
```
$--WAT,a,hhmmss.ss,aa,xx,xx,xxx,a,a,c--c*hh<CR><LF>
```

                                                    └─ Message description text [9]
                                              └─ Override setting [8]
                                         └─ Alarm condition [7]
                                    └─ Detection point number or detection point count [6]
                              └─ Second location indicator [5]
                        └─ First location indicator [4]
                  └─ Type of water alarm system [3]
            └─ Time stamp [2]
      └─ Message type [1]

Comments:

1) S: Status for section: Number of faulty and activated condition reported as number in fields 4 and 5. The section may be a whole section (one or both of the location indicator fields are null) or a sub-section. The status S is normally transmitted at regular intervals. Examples of use are given in Annex E.

   E: Status for each water level detector. (E may be used to indicate an event.)

   F: Fault in system: location indicator fields define the sections when provided.

2) Time when this status/message was valid. This may be a null field.

3) Indicator characters showing system detecting water level. The field is two fixed characters.

   WL =   Water level detection system;

   BI =   High water level by bilge system;

   HD =   Water leakage at hull (shell) door;

   OT =   others.

4) First location indicator characters showing detection location. This field is two characters. The content of this field is not defined by this standard, but the two location fields should uniquely define the source for the alarm.

5) Second location indicator character showing detection location. This field is two characters. The content of this field is not defined by this standard, but the two location fields should uniquely define the source for the alarm.

6) This field is three fixed numeric characters. When the message type field is E this field identifies the high-water-level detection point. When the message type field is S this field contains the number of the water leakage detection points. When the message type field is F this field is a null field.

7) When the message type field is S or F this field should be a null field. When the message type field is E this field is a single character specified by the following:

   N =   normal state;

   H =   alarm state (threshold exceeded);

   J =   alarm state (extreme threshold exceeded);

   L =   alarm state (low threshold exceeded, i.e. not reached);

   K =   alarm state (extreme low threshold exceeded, i.e. not reached);

   X =   fault (state unknown).

8) This field includes a single character specified by the following:

   O =   Override mode (water allowed in space);

   N =   Normal mode (water not allowed in space);
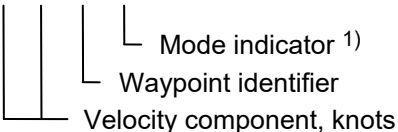
   If there is no override setting, this should be a null field.

9) Descriptive text/level detector tag. If a level detector identifier is string type, it is possible to use this field instead of above level detector location fields. Maximum number of characters will be limited by maximum sentence length and length of other fields.

8.3.116 WCV – Waypoint closure velocity

The component of the velocity vector in the direction of the waypoint, from present position. Sometimes called "speed made good" or "velocity made good".

```
$--WCV,x.x,N,c--c,a*hh<CR><LF>
            │ │ │ └─ Mode indicator 1)
            │ │ └─ Waypoint identifier
            └─┴─ Velocity component, knots
```

Comments:

1) Positioning system mode indicator:

    A = Autonomous mode;

    D = Differential mode;

    E = Estimated (dead reckoning) mode;

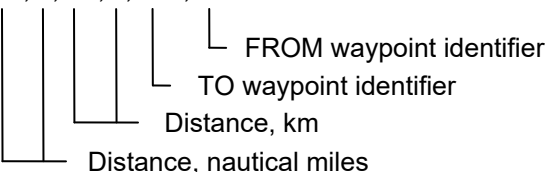   M = Manual mode;

    S = Simulator mode;

    N = Data not valid.

The positioning system mode indicator field should not be a null field.

8.3.117 WNC – Distance waypoint to waypoint

Distance between two specified waypoints.

```
$--WNC,x.x,N,x.x,K,c--c,c--c*hh<CR><LF>
          │ │ │ │ │   └─ FROM waypoint identifier
          │ │ │ │ └─ TO waypoint identifier
          │ │ └─┴─ Distance, km
          └─┴─ Distance, nautical miles
```
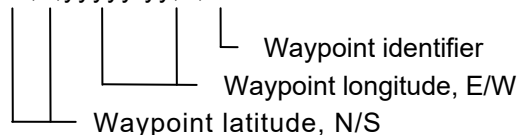
8.3.118 WPL – Waypoint location

Latitude and longitude of specified waypoint.

```
$--WPL,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
          │ │ │         │ └─ Waypoint identifier
          │ │ └─────────┴─ Waypoint longitude, E/W
          └─┴─ Waypoint latitude, N/S
```
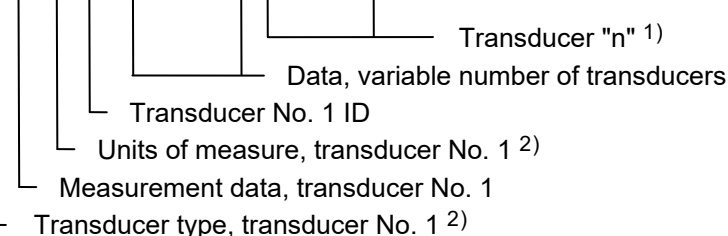
8.3.119 XDR – Transducer measurements

Measurement data from transducers that measure physical quantities such as temperature, force, pressure, frequency, angular or linear displacement, etc. Data from a variable number of transducers measuring the same or different quantities can be mixed in the same sentence. This sentence is designed for use by integrated systems as well as transducers that may be connected in a "chain" where each transducer receives the sentence as an input and adds on its own data fields before retransmitting the sentence.

```
$--XDR,a,x.x,a,c--c,...............a,x.x,a,c--c*hh<CR><LF>
       │ │ │ │              └───────┴─ Transducer "n" 1)
       │ │ │ │        └─ Data, variable number of transducers
       │ │ │ └─ Transducer No. 1 ID
       │ │ └─ Units of measure, transducer No. 1 2)
       │ └─ Measurement data, transducer No. 1
       └─ Transducer type, transducer No. 1 2)
```

Comments:

1) Sets of the four fields "type-data-units-ID" are allowed for an undefined number of transducers. Up to "n" transducers may be included within the limits of allowed sentence length; null fields are not required except where portions of the "type-data-units-ID" combination are not available.

2) Allowed transducer types and their units of measure are:

Transducer	Type field	Units	Comments
Temperature	C	C = degrees Celsius	
Angular displacement	A	D = degrees	"-" = anticlockwise
Absolute humidity	B	K = kg/m^3	Kilograms per cubic metre
Linear displacement	D	M = metres	"-" = compression
Frequency	F	H = Hertz	
Salinity	L	S = ppt	ppt = parts per thousand
Force	N	N = newtons	"-" = compression
Pressure	P	P = pascals	"-" = vacuum
Flow rate	R	I = litres/s	
Tachometer	T	R = revolutions/min	
Humidity	H	P = per cent	
Volume	V	M = cubic metres	
Voltage	U	V = volts	
Current	I	A = amperes	
Switch or valve	S	None (null)	1 = ON, CLOSED; 0 = OFF, OPEN
Generic	G	None (null)	x.x = variable data

8.3.120 XTE – Cross-track error, measured

Magnitude of the position error perpendicular to the intended track line and the direction to steer to return to track.

```
$--XTE,A,A,x.x,a,N,a*hh<CR><LF>
```
            └ Mode indicator [1] [2]
           └ Units, nautical miles
          └ Direction to steer, L/R
         └ Magnitude of cross-track error
        └ Status: A = data valid V = Loran-C cycle lock warning flag
       └ Status [2]   A = data valid, V = LORAN – C blink or SNR warning
                        V = general warning flag for other navigation systems
                        when a reliable fix is not available
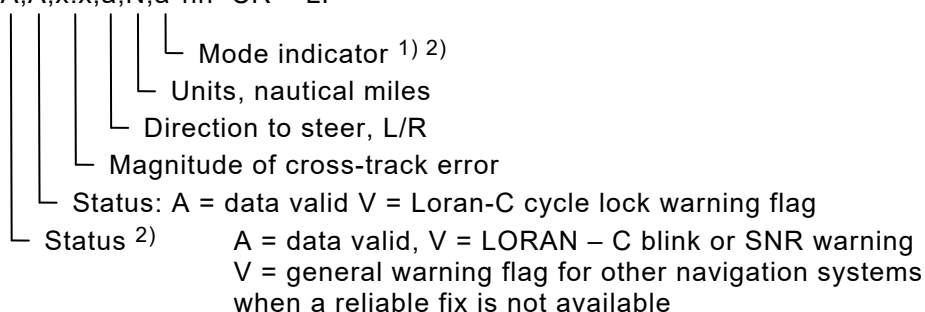
Comments:

1) Positioning system mode indicator:

    A =   Autonomous mode;

    D =   Differential mode;

    E =   Estimated (dead reckoning) mode;

    M =   Manual input mode;

    S =   Simulator mode;

    N =   Data not valid.

2) The positioning system mode indicator field supplements the positioning system status fields (fields 1 and 2); the status fields should be set to V = invalid for all values of indicator mode except for A = Autonomous and D = Differential. The positioning system mode indicator and status fields should not be null fields.

8.3.121 XTR – Cross-track error, dead reckoning

Magnitude of the dead reckoned position error perpendicular to the intended track line and the direction to steer to return to track.

```
$--XTR, x.x, a, N*hh<CR><LF>
          │   │   └ Units, nautical miles
          │   └ Direction to steer, L/R
          └ Magnitude of cross-track error
```
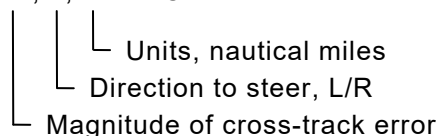
8.3.122 ZDA – Time and date

UTC, day, month, year and local time zone.

```
$--ZDA, hhmmss.ss, xx, xx, xxxx, xx, xx*hh<CR><LF>
                                      └ Local zone minutes 1), 00 to +59
                                    └ Local zone hours 1), 00 h to ±13 h
                              └ Year (UTC)
                        └ Month, 01 to 12 (UTC)
                  └ Day, 01 to 31 (UTC)
        └ UTC
```
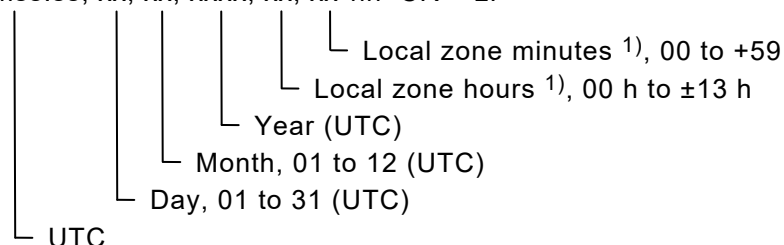
Comments:

1) Local time zone is the magnitude of hours plus the magnitude of minutes added, with the sign of local zone hours, to local time to obtain UTC. Local zone is generally negative for East longitudes with local exceptions near the international date line.

   Example: At Chatham Is. (New Zealand) at 1230 (noon) local time on June 10, 1995:

   $GPZDA,234500,09,06,1995,-12,45*6C<CR><LF>

   In the Cook Islands at 1500 local time on June 10, 1995:

   $GPZDA,013000,11,06,1995,10,30*4A<CR><LF>

8.3.123 ZDL – Time and distance to variable point

Time and distance to a point that might not be fixed. The point is generally not a specific geographic point but may vary continuously, and is most often determined by calculation (the recommended turning point for sailboats for optimum sailing to a destination, the wheel-over point for vessels making turns, a predicted collision point, etc.).

```
$--ZDL, hhmmss.ss, x.x, a*hh<CR><LF>
                          └ Type of point: ┬ C = collision
                                           │ T = turning point
                                           │ R = reference (general)
                                           └ W = wheel-over
                        └ Distance to point, nautical miles
        └ Time to point, 00 h to 99 h
```
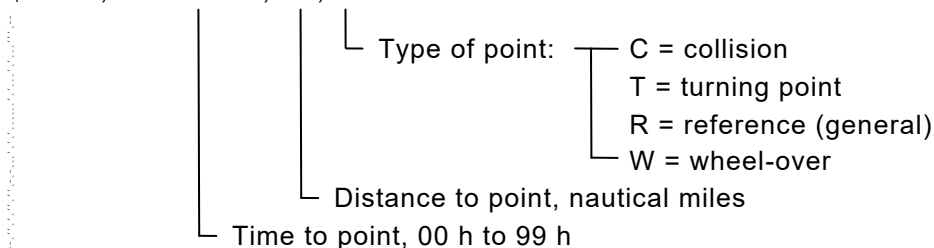
8.3.124 ZFO – UTC and time from origin waypoint

UTC and elapsed time from origin waypoint.

$--ZFO, hhmmss.ss, hhmmss.ss, c--c*hh<CR><LF>

```
              │              └── Origin waypoint ID
              └── Elapsed time, hh = 00 to 99
       └── UTC of observation
```

8.3.125 ZTG – UTC and time to destination waypoint

UTC and predicted time-to-go to destination waypoint.

$--ZTG, hhmmss.ss, hhmmss.ss, c--c*hh<CR><LF>

```
              │              └── Destination waypoint ID
              └── Time-to-go, hh = 00 to 99
       └── UTC of observation
```

9 Applications

9.1 Example parametric sentences

9.1.1 General

These examples are intended as samples of correctly constructed parametric sentences. They are representative samples only and show part of the wide range of acceptable variations possible with sentences. They shall not necessarily be used as templates for sentences.

9.1.2 Example 1 – LORAN-C latitude/longitude

This example gives present position in latitude/longitude, as determined by LORAN-C. The three character mnemonic in the address, GLL, indicates that the data is present position in latitude/longitude. The time (UTC) of the position fix is 09 h, 13 min and 42 s. Decimal seconds are not available and the decimal point is optionally omitted. There are no warning flags set in the navigation receiver as indicated by status A.

$LCGLL, 4728.31, N, 12254.25, W, 091342, A,A*4C<CR><LF>

```
                                                    └── Sentence terminator
                                                └── Checksum 4C HEX
                                            └── Mode indicator: A = autonomous mode
                                        └── Receiver status: no warnings
                                    └── Time of position fix
                                └── Units designator (west)
                            └── Longitude: 122°, 54,25′
                        └── Units designator (north)
                    └── Latitude 47°, 28,31′
                └── Address: LC = LORAN-C, GLL = present position
            └── Start of sentence
```

9.1.3 Example 2 – LORAN-C arrival alarm

This example illustrates arrival alarm data. The mnemonic code for arrival alarm is AAM. In this case, the address field is "LCAAM" for LORAN-C arrival alarm. The first data field shows "V" indicating the radius of the arrival circle HAS NOT been entered, the second data field is "A" showing that the perpendicular to the course line, at the destination, HAS been crossed. The third and fourth fields show the radius and units of the destination waypoint arrival circle ".15, N" for 0,15 nautical miles. Data field 5 is the waypoint identifier field of valid characters.

$LCAAM,V, A,.15, N, CHAT-N6*56<CR><LF>

- Sentence terminator
- Checksum 56 HEX
- Identifier for waypoint "CHAT-N6"
- Units of arrival circle, nautical miles
- Radius of arrival circle, 0,15
- Status: perpendicular has been crossed
- Status: arrival circle has not been entered
- Address: LC = LORAN-C, AAM = Arrival alarm
- Start of sentence
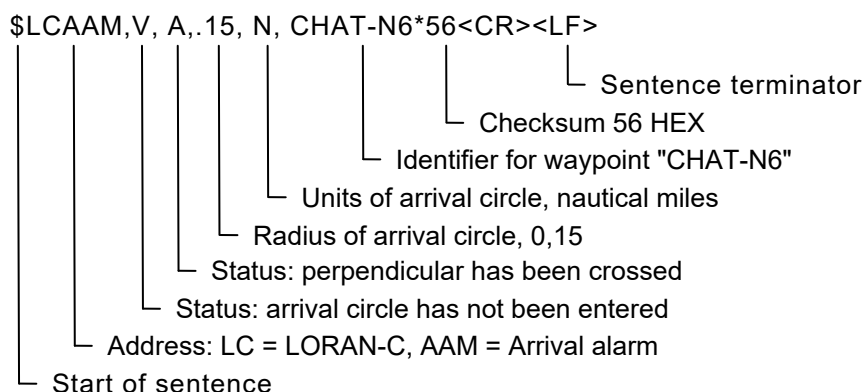
9.1.4 Example 3 – Proprietary sentence

A proprietary sentence has the following general format:

79 character sentence or less

$Paaa-- *hh <CR><LF>

- End of sentence
- Checksum
- Data, 72 character
- Three characters from manufacturer's mnemonic code
- Proprietary sentence identifier
- Start of sentence
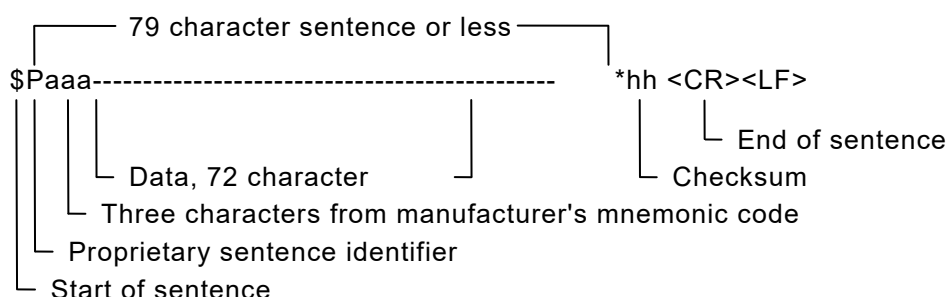
A specific example will have little meaning to someone other than the particular manufacturer that designed the sentence:

$PSRDA003[470738][1224523]???RST47, 3809, A004 *47<CR><LF>

- End of sentence
- Checksum 47 HEX
- Any series of value (non-reserved)
- Characters of manufacturer's choice
- Manufacturer's unique assigned code
- Proprietary sentence identifier
- Start of sentence
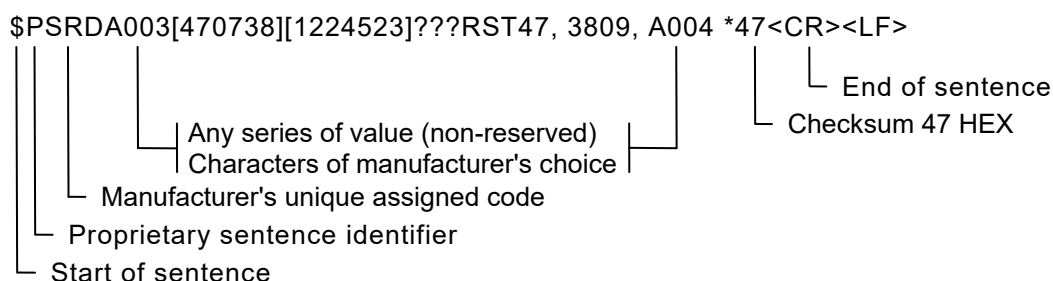
9.1.5 Example 4 – RMA examples

The following group of sentences show a typical progression of output data as a LORAN-C receiver acquires stations:

a) $LCRMA, V,,,,,14162.8,,,,,,N *6F<CR><LF>

Data invalid, only one TD acquired. Fields where data is not yet available are null fields;

b) $LCRMA, V,,,,,14172.3, 26026.7,,,,,N *4C<CR><LF>

Two TDs acquired but not settled, data invalid;

c) $LCRMA, A,,,,,14182.3, 26026.7,,,,,A *5B<CR><LF>

Data valid, two TDs cycled but latitude/longitude not yet calculated;

d) $LCRMA, A,4226.26,N,07125.89,W,14182.3,26026.7,8.5,275.,14.0,W,A*05<CR><LF>

Normal operation;

e) $LCRMA,V,4226.26,N,07125.89,W,14182.3,26026.7,8.5,275.,14.0, W,N*1D<CR><LF>

Data invalid, potential LORAN-C problem;

f) $LCRMA,A,4226.265,N,07125.890,W,14172.33,26026.71,8.53,275.,14.0,W,D*3B<CR>

LORAN-C operating in high resolution mode.

9.1.6   Example 5 – FSI examples

The following sentences show typical applications for remote control of radiotelephones:

a) $CTFSI, 020230, 026140, m, 0*14<CR><LF

Set transmitter 2 023 kHz, receiver 2 614 kHz, mode J3E, telephone, standby;

b) $CTFSI, 020230, 026140, m, 5*11<CR><LF>

MF/HF radiotelephone set transmit 2 023 kHz, receive 2 614 kHz, mode J3E, telephone, medium power;

c) $CTFSI,, 021820, o, *2D<CR><LF>

Set receiver 2 182 kHz, mode H3E, telephone;

d) $CDFSI, 900016,, d, 9*0811CR><LF>

Set VHF transmit and receive channel 16, F3E/G3E, simplex, telephone, high power;

e) $CTFSI, 300821,, m, 9*17<CR><LF>

Set MF/HF radiotelephone to telephone channel 821, for example transmit 8 255 kHz, receive 8 779 kHz, mode J3E, telephone, high power;

f) $CTFSI, 404001,, w, 5*08<CR><LF>

Set MF/HF radiotelephone to teletype channel 1 in 4 MHz band, for example transmit 4 172,5 kHz, receive 4 210,5 kHz, mode F1B/J2B, teleprinter, medium power;

g) $CTFSI, 416193,, s, 0*00<CR><LF>

MF/HF radiotelephone set to teletype channel 193 in 16 MHz band, for example transmitter 16 784,5 kHz, receiver 16 902,5 kHz, mode F1B/J2E ARQ, telex/teleprinter, standby;

h) $CTFSI, 041620, 043020, |, 9*0A<CR><LF>

Set MF/HF radiotelephone transmit 4 162 kHz, receive 4 302 kHz, mode F1C/F2C/F3C, facsimile machine, high power;

i) $CXFSI,, 021875, t, *3A<CR><LF>

Scanning receiver set to 2 187,5 kHz, mode F1B/J2B, receive only, teleprinter/DSC.

9.1.7   Example 6 – MSK/MSS examples

The following sentences show applications of query to a beacon receiver: GPS receiver (GP) query sentences to a data receiver (CR).

a) request for configuration information:

$GPCRQ,MSK*2E<CR><LF>

reply could be

$CRMSK,293.0,M,100,A,10,1*6F<CR><LF>

b) request for signal strength, S/N ratio:

$GPCRQ,MSS*36<CR><LF>

reply could be

$CRMSS,50,17,293.0,100,1*55<CR><LF>

9.1.8   Example 7 – DSC and DSE sentences

The following sentences might be output from a DSC capable VHF radio upon reception of a distress message (from another ship) with enhanced position resolution.

$CVDSC,12,3601234560,12,05,00,1474712519,0817,,,S,E,*51

$CVDSE,1,1,A,3601234560,00,12345678*0C

The fields of the first sentence indicate:

a) distress call;

b) from MMSI 360123456;

c) category distress (implicit in a distress call);

d) sinking (code 105);

e) respond by radiotelephony (G3E/F3E code 100);

f) position 47 47N 125 19W;

g) time of position 08:1;

h) null;

i) null;

j) end of sequence (no acknowledgement request);

k) expansion sentence to follow;

l) sentence checksum

$xxDSE,1,1,A,3601234560,00,12345678*0C

The fields of the second sentence indicate:

1) expansion sentence;

2) of which this is the first (and in this case only);

3) message sent automatically (not requested). This field probably not too useful in this case;

4) from MMSI 360123456;

5) with data containing enhanced position resolution;

6) 1234 minutes latitude and.5678 longitude (i.e. position 47 47.1234N 125 19.5678W);

7) sentence checksum.

The following are all DSC sentences received by an MF/HF radio.

All ships' distress relay from 011234567 for ship 999121212 at 47 47N 122 19W at time 12:34 on fire.

$CTDSC,16,0112345670,12,12,09,1474712219,1234,9991212120,00,S*19

All ships safety call from 011234567 to work J3E on 4125 kHz RX only.

$CTDSC,16,0112345670,08,09,26,041250,,,,S*11

9.1.9   Example 8 – FIR, DOR and WAT sentences

An example is given in Annex E.

9.2   Example encapsulation sentences

An example is given in Annex F.

9.3 Examples of receiver diagrams

The illustrative diagrams in Figure 3 and Figure 4 show the example structure of two opto-isolator based listener circuits that offer overvoltage, reverse voltage and power dissipation protection for the opto-isolator and serve to limit the current drawn from the line.
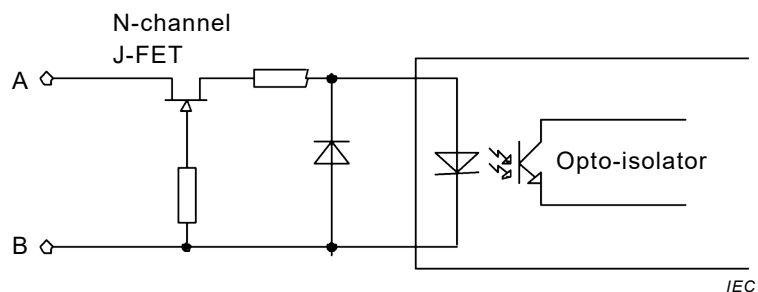
Figure 3 – Example 1, J-FET, N channel, opto-isolator based listener circuit
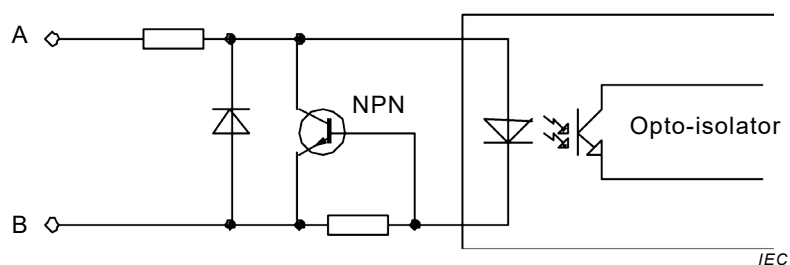
Figure 4 – Example 2, NPN opto-isolator based listener circuit

Annex A
(informative)

Glossary

The definitions which follow are included for additional understanding of this standard, but may not command universal acceptance.

accuracy: in navigation, measure of the error between the point desired and the point achieved, or between the position indicated by measurement and the true position (compare with **precision**).

address field: for sentences in this standard, fixed length field following the beginning sentence delimiter "$" (HEX 24); for approved sentences, composed of a two-character talker identifier and a three-character sentence formatter; for proprietary sentences, composed of the character "P" (HEX 50) followed by a three-character manufacturer identification code.

additional secondary factor: in LORAN-C, a correction in addition to the secondary phase factor correction for the additional time (or phase delay) for transmission of a low-frequency signal over a composite land-sea path when the signal transit time is based on the free-space velocity.

AIS: automatic identification system.

alarm: denotes a condition that has to be recognised, or acted upon immediately, for example depth minimum limit exceeded, anchor deep.

apparent wind: see **relative wind**.

approved sentence: sentence which is listed in this standard and annexes.

arrival alarm: alarm signal issued by a voyage tracking unit which indicates arrival at, or at a pre-determined distance from, a waypoint (see **arrival circle**).

arrival circle: artificial boundary placed around the destination waypoint of the present navigation leg, the entering of which will signal an arrival alarm.

arrival perpendicular: crossing of the line which is perpendicular to the course line and which passes through the destination waypoint.

azimuth: horizontal direction of a celestial point from a terrestrial point, expressed as the angular distance from a reference direction, usually measured from 000° at the reference direction clockwise through 359°.

ASCII: American standard code for information interchange. A seven-bit wide serial code describing numbers, upper and lower case alphabetical characters, special and non-printing characters. See American National Standards Institute (ANSI) ANSI X 3.15, ANSI X 3.16 and ANSI X 3.4.

atomic time: time obtained by counting the cycles of a signal in resonance with certain kinds of atoms.

autopilot: see **heading control system**.

bearing: horizontal direction of one terrestrial point from another, expressed as the angular distance from a reference direction, usually measured from 000° at the reference direction clockwise through 359°.

beaufort wind scale: numerical scale for indicating wind speed. Beaufort numbers (or forces) range from force 0 (calm) to force 12 (hurricane).

blink: in LORAN-C, signal used to indicate that a station is malfunctioning. Intended to prevent use of that signal for navigation.

checksum: for this standard, a mandatory validity check performed on the data contained in the sentences, calculated by the talker, appended to the message, then re-calculated by the listener for comparison to determine if the message was received correctly.

communication protocol: method established for message transfer between a talker and a listener which includes the message format and the sequence in which the messages are to be transferred. Also includes the signalling requirements such as baud rate, stop bits, parity, and bits per character.

course: horizontal direction in which a vessel is steered or intended to be steered, expressed as angular distance from north, usually from 000° at north, clockwise through 359°. Strictly, the term applies to direction through the water, not the direction intended to be made good over the ground (see **track**). Differs from **heading**.

course over ground (COG): term used to refer to the direction of the path over ground actually followed by a vessel (a misnomer, in that courses are directions steered or intended to be steered through the water with respect to a reference meridian).

cross track error (XTE): distance from the vessel's present position to the closest point on a line between the origin and destination waypoints of the navigation leg being travelled.

cycle lock: in LORAN-C, comparison, in time difference, between corresponding carrier cycles contained in the rise times of a master and slave station pulse is called cycle match. This value when refined to a determination of the phase difference between these two cycles results in cycle lock (see also **envelope-to-cycle distortion**).

data field: in a sentence, field which contains a data value.

diagnostic: usually denotes a failure, or warning of deterioration in a system, for example engine failure malfunction.

dead reckoning: process of determining the position of a vessel at any instant by applying to the last well-determined position (point of departure or subsequent fix) the run that has since been made, usually based on the recent history of speed and heading measurements.

delimiter: in this standard, character or characters used to separate fields or sentences. The following delimiters are used in this standard:

Field delimiters:

- ASCII "$" (HEX 24) for address field
- ASCII "," (HEX 2C) for data fields
- ASCII "*" (HEX 2A) for checksum field

Sentence delimiters

- carriage return <CR> and line feed <LF> (HEX 0D0A)

NOTE 1   <CR><LF> is not required to precede the first sentence transmitted.

deprecated sentence: sentence not to be used for new designs (see 7.5).

depth sounder: instrument which determines the depth of water by measuring the time interval between the emissions of a sound and the return of its echo from the bottom.

destination: immediate geographic point of interest to which a vessel is navigating. It may be the next waypoint along a route of waypoints or the final destination of a voyage.

deviation: angle between the magnetic meridian and the axis of a compass card, expressed in degrees east or west to indicate direction in which the northern end of the compass card is offset from magnetic north.

DGNSS: Differential GNSS, the use of GNSS measurements, some or all of which are differentially corrected.

DGPS: Differential GPS, the use of GPS measurements which are differentially corrected.

Doppler speed log: instrument which measures the relative motion between a vessel and the reflective sea bottom (for bottom return mode) or suspended particulate matter in the seawater itself (for water return mode) by measuring the frequency shifts between a transmitted and subsequently echoed acoustic or electromagnetic signal.

drift: speed of a current.

echo sounder: see **depth sounder**.

envelope-to-cycle distortion (ECD): time relationship between the phase of the LORAN-C carrier and the time origin of the envelope waveform.

event: is used to log a condition that has occurred and/or track the operation of some condition. Events are normally defined, for example transfer of control to the bridge.

fault: is a technical problem in one of the system components that will reduce the availability, or future availability, of some or all functions.

field: in this standard, character or string of characters immediately preceded by a field delimiter (see **delimiter**).

fixed field: in this standard, field in which the number of characters is fixed. For data fields, such fields are shown in the sentence definitions with no decimal point. Other fields which fall into this category are the address field and the checksum field (if present).

Galileo: a European Union project for a satellite navigation system.

geoid: surface along which the gravity potential is equal everywhere (equipotential surface) and to which the direction of gravity is always perpendicular.

geometric dilution of precision (GDOP): value representing all geometric factors that degrade the accuracy of a position fix which has been derived from a navigation system.

global navigation satellite system (GNSS): any single or combined satellite navigation system. Currently the options are: GPS, GLONASS and combined GPS/GLONASS.

GLONASS: an all-weather, continuous satellite navigation system, maintained by the Russian Space Forces. Normally composed of 24 satellites in 3 orbital planes with 8 satellites in each plane. The spacing of satellites in orbit is arranged so that a minimum of 4 satellites will be in view to users worldwide to provide position dilution of position (PDOP) of 6 or less.

global positioning system (GPS): all-weather, continuous satellite navigation system. The fully deployed operational system is intended to provide highly accurate position and velocity information in three dimensions and precise time and time interval on a global basis, to an unlimited number of authorized users.

great circle: intersection of the surface of a sphere and a plane through its centre.

great circle chart: chart on which a great circle appears as a straight line or approximately so.

great circle direction: horizontal direction of a great circle, expressed as angular distance from a reference direction.

group repetition interval (GRI): (of a particular LORAN-C chain) specified time interval for all stations of the chain to transmit their pulse groups. For each chain a minimum group repetition interval is selected of sufficient duration to provide time for each station to transmit its pulse group and additional time between each pulse group so that signals from two or more stations cannot overlap in time anywhere within the coverage area.

gyrocompass: compass having one or more gyroscopes as the directive element, and which is north-seeking. Its operation depends upon four natural phenomena: gyroscopic inertia, gyroscopic precession, the earth's rotation and gravity.

gyropilot: automatic device for steering a vessel by means of control signals received from a gyrocompass (see heading control system).

gyroscope: rapidly rotating mass free to move about one or both axes perpendicular to the axis of rotation and to each other.

heading: horizontal direction in which a ship actually points or heads at any instant, expressed in angular units from a reference direction, usually from 000° at the reference direction clockwise through 359°. (See **true heading** and **magnetic heading**).

heading control system: automatic device for steering a vessel so as to maintain heading in an intended direction. Mechanical means are used to steer the rudder. A radio navigation system is often connected to correct for track errors, or to select new destinations.

heading to steer: difference between the bearing to destination (from present position) and track made good, applied to the bearing to the destination to produce a heading that will guide the vessel to the destination.

horizontal alert limit (HAL): See IEC 61108-3.

horizontal dilution of precision (HDOP): similar to GDOP, except elevation factors are ignored.

horizontal protection level (HPL): the radius of a circle in the horizontal plane, with its centre being at the true position, which describes the region which is assured to contain the indicated horizontal position.

keel: longitudinal timber or plate extending along the centre of the bottom of a ship and often projecting from the bottom.

line of position (LOP): in LORAN or DECCA navigation systems, vector obtained by measurement of the time difference between the receipt of the master and slave signals which is then used to select a corresponding LOP from a chart or table. Two or more intersecting LOPs are required to obtain a position fix.

listener: in this standard, recipient of messages across an interconnecting link.

log: instrument for measuring the speed or distance or both travelled by a vessel.

LORAN: general designation of one group of radionavigation systems by which a hyperbolic line of position is determined through measuring the difference in the times of reception of synchronized pulse signals from two fixed transmitters.

magnetic bearing: bearing relative to magnetic north; compass bearing corrected for deviation.

magnetic heading: heading relative to magnetic north.

manufacturer identification code: in this standard, three character manufacturer identifier, usually an acronym derived from the company name, for use by a manufacturer as part of the address field in formulation of proprietary sentences.

Mercator map projection: conformal cylindrical map projection in which the surface of a sphere or spheroid, such as earth, is conceived as developed on a cylinder tangent along the equator. Meridians appear as equally spaced vertical lines and parallels as horizontal lines drawn farther apart as the latitude increases, such that the correct relationship between latitude and longitude scales at any point is maintained. Also known as Mercator map projection.

message: two or more sentences with the same sentence formatter. Messages are used when two or more sentences are needed to convey related data that exceeds the maximum sentence length. This only applies to those sentence formatters that are defined with key fields supporting multi-sentence messages.

navigation leg: portion of a voyage upon which the vessel currently travels. Each leg consists of two waypoints, an origin, a destination, and a line between them, upon which the vessel travels.

null field: indicates that data is not available for the field. Indicated by two ASCII commas, i.e. ",," (HEX 2C2C), or, for the last data field in a sentence, one comma followed by the checksum delimiter "*" (HEX 2A).

NOTE 2   The ASCII null character (HEX 00) is not to be used for null fields.

one-way communication protocol: protocol established between a talker and a listener in which only the talker may send messages (compare to **two-way** communication protocol).

origin waypoint: starting point of the present navigation leg.

precision: measure of how close the outcome of a series of observations or measurements cluster about some estimated value of a desired quantity, such as the average value of a series of observations of a quantity. Precision implies repeatability of the observations within some specified limit and depends upon the random errors encountered due to the quality of

the observing equipment, the skill of the observer and randomly fluctuating conditions such as temperature, pressure, refraction, etc. (compare with **accuracy**).

proprietary sentence: sentence to be sent across the interconnecting link which is not included in the list of approved sentences of this standard. All proprietary sentences sent over the interconnecting link contain a unique talker identifier which begins with a "P" (HEX 50) followed by a three-character manufacturer identification code.

relative bearing: bearing relative to heading or to the vessel.

relative wind: the speed and relative direction from which the wind appears to blow with reference to a moving point (also called **apparent wind**).

rhumb line: line on the surface of the earth making the same oblique angle with all meridians. A rhumb line is a straight line on a rhumb (or Mercator) projection.

rhumb direction: the horizontal direction of a rhumb line, expressed as angular distance from a reference direction. Also known as Mercator direction (see **Mercator** map projection).

RM- sentence: recommended minimum acceptable (RM-) sentence, a composite sentence recommended by this standard to ensure interoperability between talkers and listeners and to ensure that all data considered necessary for navigation is sent by a particular navigation unit.

route: planned course of travel, usually composed of more than one navigation leg.

route system: any system of one or more routes and/or routing measures aimed at reducing the risk of casualties during a voyage which may include such items as traffic separation schemes, recommended tracks, restricted areas, inshore traffic zones, etc.

semi-fixed field: data fields having a base other than 10, but using base 10 to express precision of the final term (such as minutes expressed as units with a decimal trailer instead of seconds in a base 60 field, or seconds expressed with a decimal trailer).

selected waypoint: waypoint currently selected to be the point towards which the vessel is travelling. Also called **"TO" waypoint, destination or destination waypoint**.

sentence formatter: in this standard, three-character sentence identifier which follows the talker identifier and is included as part of the address field. The sentence formatters are an integral part of the sentence definitions provided by this standard and annexes.

set: direction towards which a current flows.

signal-to-noise ratio (SNR): ratio of the magnitude of a signal to that of the noise (interference), often expressed in decibels.

speed log: instrument for measuring a vessel's speed through water and/or speed over ground. A single axis speed log normally measures speed along the longitudinal (fore/aft) axis of the vessel, while a dual axis speed log measures speed along the transverse (port/starboard) axis as well (see also **Doppler speed log**).

speed made good: adjusted speed which takes into account factors such as drift and wind speed. Can be estimated or computed by a navigation receiver.

speed over ground (SOG): speed of a vessel along the actual path of travel over ground.

talker: originator of messages across a link.

talker identifier: first two characters following the "$" (HEX 24) in a sentence (address characters 1 and 2); selected from Table 4.

time difference (TD): in LORAN-C, time difference measured from the time of reception of the master station signal to the time of reception of the slave station signal.

track: intended or desired horizontal direction of travel with respect to the earth. The track expressed in degrees of the compass may differ from the course due to allowances made in the course for such factors as sea and weather conditions in order to resume the desired track (see **track made good**).

track made good: single resultant direction from a point of departure to a point of arrival at any given time.

transducer: device that converts one type of energy to another, such as a loudspeaker that changes electrical energy into acoustical energy.

true bearing: bearing relative to true north; compass bearing corrected for compass error.

true heading: heading relative to true north.

two-way communication protocol: protocol established between a talker and a listener in which the listener may also issue requests to the talker when required (compare to **one-way** communication protocol).

UAIS: universal automatic identification system.

UART: universal asynchronous receiver/transmitter which produces an electrical signal and timing for transmission of data over a communications path, and circuitry for detection and capture of such data transmitted from another UART.

universal time coordinated (UTC): time scale based on the rotation of the earth which is disseminated by most broadcast time services (compare with **atomic time**).

variable field: data field which may or may not contain a decimal point and which may vary in precision following the decimal point depending on the requirements and the accuracy of the measuring device (talker).

variation: angle between the magnetic and geographic meridians at any place, expressed in degrees and minutes east or west to indicate the direction of magnetic north from true north.

voyage data recorder (VDR): device for automatically logging key operating parameters of a vessel and maintaining a secure record for subsequent analysis in the event of a collision, sinking or other incident.

warning: is similar to **alarm** but need not be acted upon immediately.

waypoint: reference point on a track.

wide area augmentation system (WAAS): an augmentation to GNSS which uses geostationary satellites to broadcast GNSS integrity and correction data and additional ranging signals.

Annex B
(normative)

Guidelines for methods of testing and required test results

B.1   General

The EUT (equipment under test), including all necessary test equipment shall be set up and checked to ensure that it is operational before testing commences. The manufacturer shall provide sufficient technical documentation of the EUT.

The manufacturer shall provide, unless otherwise agreed, all necessary test reports for type approval (including customers documents).

Where appropriate, tests against different clauses of this annex may be carried out simultaneously.

B.2   Definition of environmental conditions for the tests

The tests shall be carried out at normal environmental conditions as defined in IEC 60945 except for the test of B.4.5 which shall be performed at the environmental conditions as defined in IEC 60945 for the class of the EUT.

B.3   Examination of the manufacturer's documentation

Check for completeness according to this standard (IEC 61162-1).

Check the availability of the defined minimum sentences on the EUT (receiving and transmitting).

Check the documentation of approved and proprietary sentences:

- approved sentences for conformity with the standard;
- proprietary sentences for conformity with the standard and the documentation of the manufacturer;
- fields that are required or acceptable to a listener;
- noted unused fields to a talker;
- transmission interval for each sentence;
- interface port selection

Check the used talker – IDs.

Check the hardware requirements:

- output drive capability of talker;
- load requirement as listener;
- current software and hardware revision;
- interface pin configuration;
- electrical isolation of the input circuits for compliance with IEC 60945;

- description, schematic and PCB of listener receive and talker driver circuits, citing actual components and devices used, including connector type and part number.

B.4 Test of hardware

B.4.1 Interface units

(see 5.6.3)

For compatibility of the hardware, standard tests shall be used as defined in ITU-T X.27/V.11 for all transmitter interface units where compliance with ITU-T X.27/ V.11 is not documented.

B.4.2 Input circuit test

(see 5.6.4)

The receiver unit shall be connected to a data-source with a differential voltage of 2,0 V. Confirm by measurement that the current does not exceed 2,0 mA. The data source shall transmit appropriate sentences for this EUT. All sentences shall be received and detected without any errors or degradation.

B.4.3 Check of electrical isolation

(see 5.6.5)

Check in the manufacturer's documentation that the isolation of the receiver between signal line "A", return line "B", or shield and ships ground or power fulfil the requirements of IEC 60945.

B.4.4 Maximum input voltage test

(see 5.6.6)

Between the connectors 'A' and 'B' of the interface a voltage of 15 V shall be applied for at least 1 min. This test shall be carried out with both polarities of applied test voltage. After all tests the function of the interface shall be checked for any malfunction or damage.

B.4.5 Test arrangement for performance tests according to IEC 60945

The following test shall be carried out for testing capability of interconnection during the temperature tests defined in IEC 60945. Where the equipment manufacturer specifies a temperature range outside that specified in IEC 60945, the manufacturer's specification shall be employed.

To test the transmitting interface of the EUT, connect it to a reference-receiving interface that complies with Clause 5. To test the receiving interface of the EUT, connect it to a reference transmitting interface that complies with Clause 5. The reference equipment shall be outside the climatic chamber. The transmitting interface shall transmit a sequence of appropriate sentences and the receiving interface shall receive and detect these sentences without any errors or degradation. The check of the result can be carried out directly or indirectly at the receiving unit.

B.4.6 Test under maximum interface workload

After activating all ports of the EUT with the maximum number of approved sentences to be transmitted and/or received (channel workload 80 % to 90 %), the performance of the EUT shall not be degraded in any way. At least one of these sentences shall be usable for the EUT. The EUT may give an alert for a minor function not supported by the selected sentence, but the main function of the EUT shall be operational without any degradation. The test shall be carried out for 30 min.

B.4.7   Test for correct parsing of sentences

B.4.7.1   Test for correct use of special characters starting a sentence

There are 2 special characters which can occur on a line. The $ starts a parametric sentence, ! starts an encapsulated sentence. It is not mandatory for the EUT to implement the use of all 2 cases, but it is mandatory that if the EUT does not implement one of them that the EUT does not experience any malfunction when receiving any of 2 cases. This issue should be tested by sending simulated dataflow of mixed examples of all 2 to EUT and by observing correct behavior of EUT.

Refer to Table B.1 as an example.

Table B.1 – Example – Special characters

Special characters	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Transmission data flow of 3 special characters $ parametric sentence	$HEHDT,359.94,T*hh !AIVDM,1,1,,1,1000h>BCQp0eU@dN`o7Pj89n0000,0*hh	EUT does not experience any malfunction when receiving any of the 2 cases.		

B.4.7.2   Test for correct parsing of received sentences

Any characters between the <CR><LF> and the start of the next sentence should be ignored. This issue should be tested by sending simulated dataflow of mixed examples of interleaved valid and invalid characters between sentences to EUT and by observing correct behavior of the EUT.

Refer to Table B.2 as an example.

Table B.2 – Example – Parsing

Parsing	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Ignore any characters between the <CR><LF> and the start of the next sentence	Place *1234567890abcdefgehijklmopqsrtuvwxyz<>üöä;'#@€* in front of a valid sentence	Observing correct behaviour of the EUT.		

B.4.7.3   Test for future extension of received sentences

The provision for extending parametric sentences is to add comma separated fields between the last parameter field and the checksum delimiter character (asterisk). This capability should be tested by sending simulated dataflow of mixed examples with extended sentences with appropriately adjusted checksum to the EUT and by observing correct behavior of the EUT.

Refer to Table B.3 as an example.

Table B.3 – Example – Future extensions

Future extension	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Add comma separated fields between the last parameter field and the checksum delimiter character (asterisk)	Add ,,,, to a valid sentence	Observing correct behaviour of EUT.		

B.4.8 Test under long term conditions

For testing the capability of the EUT working constantly.

The EUT shall be connected to transmitting sources as defined by the manufacturer for normal operation. This test shall be carried out for 30 min, and all data transmitted by the EUT shall be recorded and analysed for corruption against this standard.

B.4.9 Protocol test of the interface of the EUT

(see Clause 7)

B.4.9.1 Data strings transmitted by the EUT

By altering the parameters of the EUT, appropriate data strings shall be transmitted.

These data strings are received by test equipment which is able to display the sentences.

a) Test of conformity with the manufacturer's documentation and this standard (IEC 61162-1).

b) Test of status accuracy for all status and operation mode indications.

c) Test of data accuracy corresponding with the status information and the selected operation mode.

Refer to Table B.4 as an example.

d) Test of checksum accuracy. The checksum of the sentences shall be checked with static and dynamic sentences.

Refer to Table B.5 as an example.

e) Test of transmitting intervals (if necessary)

**Table B.4 – Example – Data string GGA sent
by the EUT to the test receiver (listener)**

$--GGA, hhmmss.ss$^{(1)}$, llll.ll$^{(2)}$, a$^{(3)}$, yyyyy.yy$^{(4)}$, a$^{(5)}$, x$^{(6)}$, xx$^{(7)}$, x.x$^{(8)}$, x.x$^{(9)}$, M$^{(10)}$, x.x$^{(11)}$, M$^{(12)}$, x.x$^{(13)}$, xxxx$^{(14)}$*hh<CR><LF>

Field	Field label (and operational state)	Value sent from EUT in the data sentence	Received value at the test receiver
1	UTC of position	Value at the EUT	
2 + 3	Latitude, N/S	Value at the EUT	
4 + 5	Longitude, E/W	Value at the EUT	
6	GPS quality indicator – Fix not available or invalid (has to be set at EUT)	0	
	GPS quality indicator – GPS SPS mode, fix valid (has to be set at EUT)	1	
	GPS quality indicator – Differential GPS, SPS mode, fix valid (has to be set at EUT)	2	
	GPS quality indicator – GPS PPS mode, fix valid	3	
	Real time kinematic, satellite system used in RTK mode with fixed integers	4	
	Float RTK, satellite system used in RTK mode with floating integers	5	
	Estimated (dead reckoning) data	6	
	Manual input mode	7	
	Simulator mode	8	
7	Number of satellites in use, 00-12, may be different from the number in view	Value at the EUT	
8	Horizontal dilution of precision (HDOP)	Value at the EUT	
9	Antenna altitude above/below mean-sea-level (geoid)	Value at the EUT (always in metres, also when the displayed value is not in this unit)	
10	Units of antenna altitude, m	"M", also when value at the EUT not shown in metres	
11	Geoidal separation	Value at the EUT (always in metres, also when the displayed value is not in this unit)	
12	Units of geoidal separation, m	"M", also when value at the EUT not shown in metres	
13	Age of differential GPS data	Value at the EUT if differential mode, otherwise null field	
14	Differential reference station ID, 0000 – 1023	Value at the EUT if differential mode, otherwise null field (for GPS)	

Table B.5 – Example – Checksum data sent

Set condition	Actual condition
Each sentence shall send the correct checksum	

B.4.9.2   Data strings received by the EUT

Artificially generated data strings with various content and formatting shall be sent to the EUT. These are generated by the above-mentioned means and in accordance with the manufacturer's documentation.

a) Test of correct evaluation of the data.

   Refer to Table B.6 as an example.

b) Test of correct evaluation of all status indications and the selected operation mode.

   Refer to Table B.6 as an example.

c) Test of adequate reaction in case of incorrectness corresponding with the status information and the selected operation mode.

   Refer to Table B.6 as an example.

d) Test of correct evaluation of the checksum.

   Refer to Table B.7 as an example.

e) Test of break of data line.

   Refer to Table B.8 as an example.

f) Test of the required receiving intervals (if necessary).

   Refer to Table B.9 as an example.

g) Test of talker ID (if necessary).

   Refer to Table B.10 as an example.

Where the transmitted or received data corresponds to that shown on the display of the EUT, this data shall be compared directly with that sent by the test equipment.

Otherwise, if the data is altered or combined with other data so that direct access and comparison is not possible, parts of the test shall be adapted appropriately so that indirect comparison is possible.

Table B.6 – Example – Data string GNS received by the EUT

$xxGNS, hhmmss$^{(1)}$,llll.ll,$^{(2)}$,a$^{(3)}$,yyyyy.yy$^{(4)}$,a$^{(5)}$,c--c$^{(6)}$,xx$^{(7)}$,x.x$^{(8)}$,x.x$^{(9)}$,x.x$^{(10)}$,x.x$^{(11)}$,x.x$^{(12)}$,a$^{(13)}$*hh$^{(14)}$<CR><LF>

Field	Field label	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
				Remark	Result
1	UTC of position	123456.12	No value (Time = Time of fix based on UTC, not to be used as UTC)		
2+3	Latitude N/S	5432.1000,N	54°32.1000' N		
		Null field , N			
		5432.1000, null field	Invalid data shall be clearly marked		
4+5	Longitude E/W	01234.5600,E	012°34.5600' E		
		Null field , E			
		01234.5600, null field	Invalid data shall be clearly marked		
6	Mode indicator	ANN	Indication of position system GPS or GNSS (dependent on talker) and position quality A = Autonomous D = Differential E = Estimated F = Float RTK M = Manual input mode N = No fix P = Precise R = Real time kinematic S = Simulator mode NOTE *If Mode indicator is A, D, F, P or R then data are valid.*		
		DNN			
		FNN			
		PNN			
		RNN			
		NAN			
		NDN			
		NFN			
		NPN			
		NRN			
		NNA			
		NND			
		NNF			
		NNP			
		NNR			
		ENN	Other modes E = Estimated (dead reckoning) mode M = Manual input mode N = No fix S = Simulator mode NOTE *If Mode indicator is E, M, S or N then data are invalid* Invalid data shall be clearly marked		
		MNN			
		SNN			
		NEN			
		NMN			
		NSN			
		NNE			
		NNM			
		NNS			

$xxGNS, hhmmss$^{(1)}$,llll.ll,$^{(2)}$,a$^{(3)}$,yyyyy.yy$^{(4)}$,a$^{(5)}$,c--c$^{(6)}$,xx$^{(7)}$,x.x$^{(8)}$,x.x$^{(9)}$,x.x$^{(10)}$,x.x$^{(11)}$,x.x$^{(12)}$,a$^{(13)}$*hh$^{(14)}$<CR><LF>

Field	Field label	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
				Remark	Result
		Null field	Data marked as invalid		
		Any other characters			
7	Numbers of satellites in use	04	4		
8	Horizontal dilution of precision (HDOP)	1.0	1,0		
9	Antenna altitude above/below mean sea level – Units of antenna altitude, m	43.5,M	43,5 m		
10	Geoidal separation - Units of geoidal separation, m	12.3,M	12,3 m		
11	Age of differential GPS data	5	5		
12	Differential reference station ID, 0000 – 1023	0130	0130		
13	Navigational status indicator	S	S = Safe		
		C	C = Caution		
		U	U = Unsafe		
		V	V = Navigational status not valid This field should not be a NULL field		

Table B.7 – Example – Checksum data received

Checksum	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Test Checksum	correct	Right values displayed		
	wrong	After timeout of max. 10 s: Data marked as invalid		
	without checksum at EUT			

Table B.8 – Example – Break of data line

Interruption	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Interrupt of transmission	Switch off transmission	After timeout of max. 30 s: Data marked as invalid		

Table B.9 – Example – Receiving interval

Receiving interval	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Min. required receiving interval in accordance with manufacturer's documentation	XX s. (Note the min required receiving interval)	No failure at the EUT until min. required receiving interval is received		

Table B.10 – Example – Talker ID

Talker	Send to equipment under test (EUT)	Expected value/effects on the EUT	Actual value/effects observed on the EUT	
			Remark	Result
Talker ID ($xxGNS)	with talker GA, GP, GL, GN	Position marked with the corresponding positioning system If a combined system is used, the talker is GN for GNSS and the mode indicator field has to be evaluated to check the sensor source		

Annex C
(normative)

Six-bit binary field conversion

Valid characters (see Table 2).

Binary field, Most significant bit on the left. The two MSBs of the valid characters are not used. Table C.1 specifies the six-bit binary field conversion.

Table C.1 – Six-bit binary field conversion table

Valid character	Binary field	Valid character	Binary field
0	000000	P	100000
1	000001	Q	100001
2	000010	R	100010
3	000011	S	100011
4	000100	T	100100
5	000101	U	100101
6	000110	V	100110
7	000111	W	100111
8	001000	`	101000
9	001001	a	101001
:	001010	b	101010
;	001011	c	101011
<	001100	d	101100
=	001101	e	101101
>	001110	f	101110
?	001111	g	101111
@	010000	h	110000
A	010001	i	110001
B	010010	j	110010
C	010011	k	110011
D	010100	l	110100
E	010101	m	110101
F	010110	n	110110
G	010111	o	110111
H	011000	p	111000
I	011001	q	111001
J	011010	r	111010
K	011011	s	111011
L	011100	t	111100
M	011101	u	111101
N	011110	v	111110
O	011111	w	111111

The six-bit binary field conversion can be done mathematically as well as with Table C.1.

The algorithm to convert a 6-bit binary field to the appropriate 8-bit valid IEC 61162-1 character field is shown in Figure C.1 (see below). Similarly, an algorithm can also be used to convert the valid IEC 61162-1 characters to the 6-bit binary values as shown in Figure C.2 (see below).
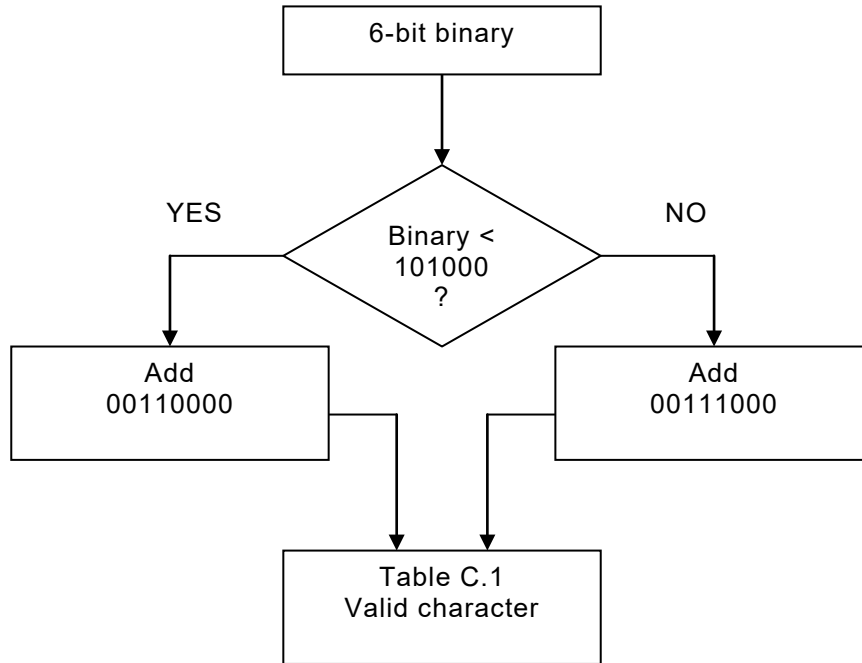
IEC

Figure C.1 – 6-bit binary code converted to valid IEC 61162-1 character

Consider the following examples:

000001 is less than 101000, therefore add 00110000

00110000
00110001 = 31_{hex} = 1 (see Table 2)

000010 is less than 101000, therefore add 00110000

00110000
00110010 = 32_{hex} = 2 (see Table 2)

111010 is not less than 101000, therefore add 00111000

00111000
01110010 = 72_{hex} = r (see Table 2)
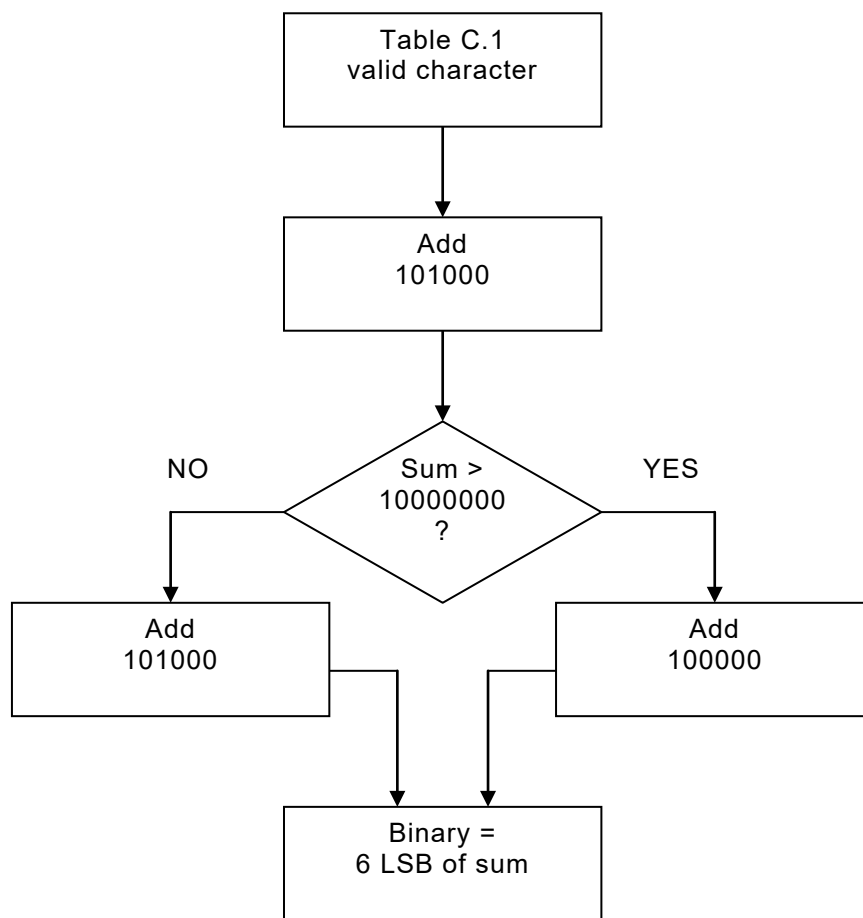
IEC

Figure C.2 – Valid IEC 61162-1 character converted to 6-bit binary code

Consider the previous examples:

The valid character "1" (00110001):

00110001 + 101000 = 01011001 which is not greater than 10000000.
Therefore, add 101000 to 01011001 = 10000001 and take the six right bits.
000001 are the six binary bits represented by a "1".

The valid character "2" (00110010):

00110010 + 101000 = 01011010 which is not greater than 10000000.
Therefore, add 101000 to 01011010 = 10000010 and take the six right bits.
000010 are the six binary bits represented by a "2".

The valid character "r" (01110010):

01110010 + 101000 = 10011010 which is greater than 10000000.
Therefore, add 100000 to 10011010 = 10111010 and take the six right bits.
111010 are the six binary bits represented by a "r".

Annex D
(normative)

Alarm system fields

Table D.1 specifies the alarm fields.

The mandatory alarms required by a VDR are indicated in the IEC 61996 series.

Table D.1 – System alarm fields

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	**System category**	**ID**	**Sub-system/equipment**	**No**	**Alarm contents**
SG	Steering gear	PU	Power unit	001	Stop
				002	Power fail
				003	Overload
				004	Phase fail
				005	Hydraulic fluid level low
				010	Run
		CL	Control system (actuator or drive unit for steering signal)	001	Power fail
PC	Propulsion control	PC	Propulsion control	001	Inhibition of starting of propulsion engine
				002	Automatic shutdown
				003	Automatic slowdown
				004	Safety system override
				005	Operating in barred speed range
				006	System power supply main and emergency feeders – failure
				007	CPP hydraulic oil pressure – low and high
				008	CPP hydraulic oil temperature – high and low
				009	Control, alarm or safety system, power supply failure
		RC	Remote control system	001	Power fail
				002	System abnormal
				003	Governor control abnormal
				004	Propeller pitch control abnormal
		MN	Monitoring system	001	Normal power source – fail
				002	Individual power supply to control, monitoring and safety systems – fail
				003	Integrated computerized system: data highway abnormal
				004	Integrated computerized system: duplicated data link – failure
		AL	Group alarm system	001	Power fail
				002	Personnel alarm

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				003	Dead man alarm
				004	Request backup OOW
		SP	System power source	001	Main feeder – fail
				002	Emergency feeder – fail
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
AM	Auxiliary machinery	EP	Electric power generator plant	001	Voltage – low and high
				002	Current – high
				003	Frequency – high and low
				004	Failure of online generator
				005	Bearing lub. oil inlet pressure – low
				006	Generator cooling inlet pump or fan motor – fail
				007	Generator cooling medium temperature – high
		RM	High voltage rotating machine	001	Stationary windings temperature – high
		FO	Fuel oil system	001	Settling and service tank level – high and low
				002	Overflow tank and drain tank level – high
		ST	Stern tube lub. Oil	001	Tank level – low
		BL	Boiler	001	Automatic shutdown
		MS	Propulsion machinery space	001	Bilge level – high
				002	Air condition system – fail
				003	Fire detected
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
DE	Diesel plant	FO	Fuel oil	001	Fuel oil tank heating control and temp. display and alarm – high
				002	Fuel oil engine inlet pressure – low
				003	Fuel oil before injunction pump temp. – high and low
				004	Leakage from high pressure pipe
		LO	Lubricating oil	001	Lub. oil to main bearing pressure – low
				002	Lub. oil to thrust bearing pressure – low
				003	Lub. oil to crosshead bearing pressure – low
				004	Lub. oil to camshaft pressure – low
				005	Lub. oil to camshaft temp – high
				006	Lub. oil inlet temp. – high

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				007	Thrust bearing pads temp temp – high
				008	Main, crank, crosshead bearing oil outlet temp. – high
				009	Cylinder lubricator, flow rate – low
				010	Lub. oil tanks, level – low
		TC	Turbo-charger	001	Lub. oil inlet, pressure – low
				002	Lub. oil outlet, temp. – high
		PS	Piston cooling	001	Coolant inlet, pressure – low
				002	Coolant outlet, temp. – high
				003	Coolant outlet, flow – low
				004	Coolant expansion tank, level – low
		SC	Seawater cooling	001	Seawater cooling pressure – low
		FW	Cylinder fresh water cooling	001	Water inlet pressure – low
				002	Water outlet from cylinder, temp. – high
				003	Oily contamination of engine cooling water system – fail
				004	Cooling water expansion tank, level – low
		CA	Compressed air	001	Starting air before main shut-off valve, pressure – low
				002	Control air, pressure – low
				003	Safety air, pressure – low
		SA	Scavenge air	001	Scavenge air box, temp. – high
				002	Scavenge air receiver water, level – high
		EH	Exhaust gas	001	Exhaust gas, temp. – high
				002	Exhaust gas deviation from average, temp. – high
				003	Exhaust gas before tarbo-charger, temp. – high
				004	Exhaust gas after tarbo-charger, temp. – high
		FV	Fuel valve coolant	001	Coolant, pressure low
				002	Coolant, temp. – high
				003	Coolant expansion tank, level – low
		EG	Engine	001	Rotation – wrong way
				002	Engine, overspeed
		OT	Others	001	Reduction gear lub. oil inlet, pressure – low
				900	Others (if necessary, it is possible to define by user.)
				999	

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
ST	Steam turbines plant	LO	Lubrication oil	001	Pressure at bearing inlet – high and low
				002	Temp. at bearing outlet – high
				003	Filter differential pressure – high
				004	Gravity tank level – low
		LC	Lubricating oil cooling system	001	Pressure – low
				002	Temp. at outlet – high
				003	Expansion tank level – low
		SW	Seawater	001	Pressure – low
		SM	Steam	001	Pressure at throttle – low
				002	Gland seal exhaust fan – failure
				003	Astern guardian valve – fail to open
		CD	Condensate	001	Condenser level – high and low
				002	Condensate pump pressure – low
				003	Condenser vacuum – low
				004	Salinity – high
		RT	Rotor	001	Vibration level – high
				002	Axial displacement – large
				003	Overspeed
				004	Shaft stopped – excess of set period
		PW	Power	001	Throttle control system power failure
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
GT	Gas turbine plant	FO	Fuel oil	001	Pressure – low
				002	Temp. – low and high
		LO	Lubricating oil	001	Inlet pressure – low
				002	Inlet temp. – high
				003	Main bearing oil outlet temp. – high
				004	Filter differential pressure – high
				005	Tank level – low
		CM	Cooling medium	001	Pressure – low
				002	Temp. – high
		SA	Starting	001	Stored starting energy level – low
				002	Automatic starting failure
		CB	Combustion	001	Flame failure
		EH	Exhaust gas	001	Temp. – high
		TB	Turbine	001	Vibration level – high

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				002	Rotor axial displacement – large
				003	Overspeed
				004	Vacuum at compressor inlet – high
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
EP	Electric propulsion plant	PG	Propulsion generator	001	Bearing lub. oil inlet pressure – low
				002	Voltage – off-limit
				003	Frequency – off-limit
				004	Stationary windings temperature – high
				005	Failure of online generator
				006	Transfer of standby generator
				007	Generator cooling medium temperature – high
				008	Generator cooling pump – failure
				009	Inter-pole windings temperature – high
		PA	Propulsion motor – AC	001	Bearing lub. oil inlet pressure – low
				002	Armature voltage – off-limit
				003	Frequency – off-limit
				004	Stationary windings temperature – high
				005	Failure of online generator
				006	Transfer of standby generator
				007	Motor cooling medium temperature – high
				008	Motor cooling pump – failure
		PD	Propulsion motor – DC	001	Bearing lub. oil inlet pressure – low
				002	Armature voltage – off-limit
				003	Motor overspeed
				004	Failure of online generator
				005	Transfer of standby generator
				006	Motor cooling medium temperature – high
				007	Motor cooling pump – failure
		PS	Propulsion SCR	001	Overload (high current)
				002	SCR cooling medium temperature – high
				003	SCR cooling pump – failure
		TF	Transformer	001	Transformer winding temp – high
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
PB	Propulsion boiler	FW	Feed water	001	Atmospheric drain tank level – high and low

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				002	Deaerator level – high and low
				003	Deaerator pressure – high and low
				004	Feed water pump pressure – low
				005	Feed water temp. – high
				006	Feed water outlet salinity – high
		BD	Boiler drum	001	Water level – high and low
				002	Water level – low-low
		SM	Steam	001	Pressure – high and low
				002	Superheater outlet temp. – high
		AR	Air	001	Forced draft fan – failure
				002	Rotating air heater motor – failure
				003	Fire in boiler casing
		FO	Fuel oil	001	Pump pressure at outlet – low
				002	Fuel oil temp – high and low
		BN	Burner	001	Atomizing medium pressure – off-limit
				002	Flame of burner – fail
				003	Flame sensor – fail
				004	Untake gas temp. – high
		PW	Power	001	Control system power failure
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
AB	Auxiliary boiler	FW	Feed water	001	Feed water outlet salinity – high
		BD	Boiler drum	001	Water level – high and low
		SM	Steam	001	Pressure – high and low
				002	Superheater outlet temp. – high
		AR	Air	001	Supply air pressure – fail
				002	Fire in boiler casing
		FO	Fuel oil	001	Pump pressure at outlet – low
				002	Fuel oil temp – high and low
		BN	Burner	001	Flame of burner – fail
				002	Flame sensor – fail
				003	Untake gas temp. – high
		PW	Power	001	Control system power failure
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
AD	Auxiliary diesel engine	FO	Fuel oil	001	Fuel oil leakage from injunction pipe
				002	Fuel oil temp. – high and low
				003	Service tank level – low
		LO	Lubricating oil	001	Bearing oil inlet pressure – low

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				002	Bearing oil inlet temp. – high
				003	Crankcase oil mist concentration – high
		CM	Cooling medium	001	Pressure – low
				002	Temp. – high
				003	Expansion tank, level – low
		ST	Starting medium	001	Energy level – low
		EH	Exhaust gas	001	Exhaust gas, temp. – high
		EG	Engine	001	Engine, overspeed
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
AT	Auxiliary turbine	LO	Lubrication oil	001	Pressure at bearing inlet – low
				002	Temp. at bearing inlet – high
				003	Temp. at bearing outlet – high
		LC	Lubricating oil cooling system	001	Pressure – low
				002	Temp. at outlet – high
				003	Expansion tank level – low
		SW	Seawater	001	Pressure – low
		ST	Steam	001	Pressure at inlet – low
		CO	Condensate	001	Condensate pump pressure – low
				002	Condenser vacuum – low
		RT	Rotor	001	Axial displacement – large
				002	Overspeed
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
AG	Auxiliary gas turbine	FO	Fuel oil	001	Pressure – low
				002	Temp. – high and low
		LO	Lubricating oil	001	Inlet pressure – low
				002	Inlet temp. – high
				003	Bearing oil outlet temp. – high
				004	Filter differential pressure – high
		CM	Cooling medium	001	Pressure – low
				002	Temp. – high
		SA	Starting	001	Stored starting energy level – low
				002	Ignition failure
		CN	Combustion	001	Flame failure
		EH	Exhaust gas	001	Temp. – high
		RT	Rotor	001	Vibration level – high
				002	Rotor axial displacement – large
				003	Overspeed

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	**System category**	**ID**	**Sub-system/equipment**	**No**	**Alarm contents**
				004	Vacuum at compressor inlet – high
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
CG	Cargo control plant	CH	Chemical cargo system	001	High and low temp. of cargo
				002	High temp. in tank
				003	Oxygen concentration in void space
				004	Malfunctioning of temp. controls of cooling system
				005	Failure of mechanical ventilation of cargo tank
				006	Low temp. in inerted cargo tanks
				900 | 999	Others (if necessary, it is possible to define by user.)
		LG	LPG/LNG cargo system	001	High and low temp in cargo tank
				002	Gas detection
				003	Hull or insulation temp. – high
				004	Cargo high pressure
				005	Chlorine concentration
				006	High pressure in chlorine cargo tank
				007	Liquid cargo in ventilation system – failure
				008	Vacuum protection of cargo tank – failure
				009	Inert gas pressure – high
				010	Gas detection equipment – failure
				011	Gas detection after bursting disk for chlorine – failure
				900 | 999	Others (if necessary, it is possible to define by user.)
		OL	Inert gas system	001	Low water pressure

System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	System category	ID	Sub-system/equipment	No	Alarm contents
				002	High water level in scrubber
				003	Gas temp. – high
				004	IG blower – failure
				005	Oxygen content volume – high
				006	Power supply of automatic control system – failure
				007	Low water level in water seal
				008	High and low pressure of gas
				009	Insufficient fuel oil supply
				010	Power supply – failure
				900 | 999	Others (if necessary, it is possible to define by user.)
WD	Watertight door controller	----	----	001	Hydraulic fluid reservoir level low
				002	Gas pressure low
				003	Electrical power loss
				900 | 999	Others (if necessary, it is possible to define by user.)
HD	Hull (shell) door controller	----	----	001	Door open or locking device not secured (representative)
				002	Power fail
				900 | 999	Others (if necessary, it is possible to define by user.)
FD	Fire door controller	----	----	001	System abnormal
				002	Power fail
				900 | 999	Others (if necessary, it is possible to define by user.)
FR	Fire detection system	HT	Heat detection type	001	System fail
				002	Power fail
		SM	Smoke detection type	001	System fail
				002	Power fail
		OT	Others	900 | 999	Others (if necessary, it is possible to define by user.)
OT	Other's system	----	----	900 | 999	Others (if necessary, it is possible to define by user.)

Annex E
(informative)

Example of use of FIR, DOR and WAT sentences

E.1 Example of the use of system status messages

Some sentences, currently FIR, DOR and WAT, are constructed to send complete system status as well as changes in status for relatively large systems. The sentences can accommodate systems with thousands of individual measurement points.

As this standard is a broadcast type protocol without any means for retransmissions or acknowledgements from the receiver, system status transfers will normally require period transmissions. This standard also has relatively low bandwidth so these sentences are constructed to send the complete system status as efficiently as possible. Efficiency relies on the premise that most measurement points have the same value, for instance, normal. Also, the sentences allow status to be sent for selectable sub-systems.

To enable the listener to detect problems in the talker or in the connection between them, the sentences should be used as an "alive" signal. Each talker sending data to a listener, for instance, a voyage data recorder, should continuously transmit sentences with the interval between transmissions not exceeding 5 min. The listener may assume there is a fault in the talker, or in the communication link, if no transmissions have been received in the last 10 min.

An appropriate sentence should be transmitted, without unnecessary delay, when there is a (condition) change of status.

Complete system status should be transmitted by the talker with a period not exceeding 2 h. This ensures that rarely occurring changes of state will be detected.

NOTE   This can be achieved by sending all individual status messages every 2 h or by sending summary status for each, for example, fire zone and then only individual status for those units that are not normal (e.g. doors that are not closed or fire detectors that are not normal). The method employed will depend upon the number of units and the baud-rate available.

The following contains examples of how these sentences can be used in different usage scenarios. The DOR sentence is used in the examples. Scenarios for the FIR and WAT sentences are similar.

E.2 Use of system division codes

These sentences allow the specification of where in the system a measurement point is located. The division may be done based on the ship's physical sub-division, for example into decks and fire zones or may be done based on the system's subdivision into, for example sub-central and data acquisition communication loop.

For the examples below, the system diagram of Figure E.1 will be used as reference.
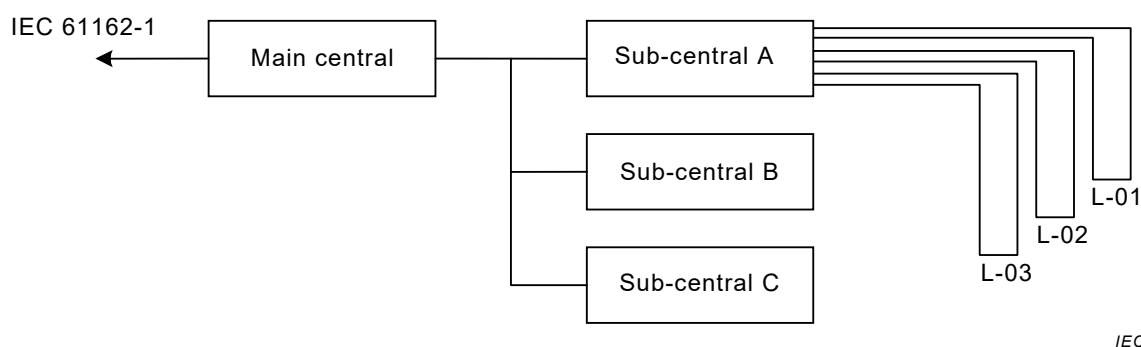
Figure E.1 – Example system diagram

The main central has the IEC 61162-1 link to external system status receivers. The system itself is divided into three sub-central units, each with a number of data acquisition loops or busses. In this case, it may be useful to use the sub-central identification codes "A", "B" and "C" as first division indicator and the loop number "01", "02", etc. as second division indicator.

NOTE   The first division indicator should be exactly two alphanumeric characters, for example coded as "CA" for sub-central A. The second division indicator should be numeric and exactly three digits long, for example coded as 001 for loop 01.

E.3   Send complete status

This example assumes that two units (unit 15 and 32) on loop 01 of central A and one unit (unit 26) on loop 02 on central B indicate "open fire door". One unit (unit 5) on loop 03 of central C is in fault. All other units indicate fire doors closed.

This can be reported from the main central by sending the following sentences:

```
$--DOR,S,,FD,,,004,,,*hh<CR><LF>
$--DOR,E,,FD,CA,001,015,O,,A01015 Cabin 23*hh<CR><LF>
$--DOR,E,,FD,CA,001,032,O,,A01032 Locker 10*hh<CR><LF>
$--DOR,E,,FD,CB,002,026,O,,B02026 Cabin 34*hh<CR><LF>
$--DOR,E,,FD,CC,003,005,X,,C03005 Cabin 45*hh<CR><LF>
```

It is also possible to report the summary status per sub-central and even per loop if so desired. If it is reported by central, the sentences may look like the following.

```
$--DOR,S,,FD,CA,,002,,,*hh<CR><LF>
$--DOR,E,,FD,CA,001,015,O,,A01015 Cabin 23*hh<CR><LF>
$--DOR,E,,FD,CA,001,032,O,,A01032 Locker 10*hh<CR><LF>
...
$--DOR,S,,FD,CB,,001,,,*hh<CR><LF>
$--DOR,E,,FD,CB,002,026,O,,B02026 Cabin 34*hh<CR><LF>
...
$--DOR,S,,FD,CC,,001,,,*hh<CR><LF>
$--DOR,E,,FD,CC,003,005,X,,C03005 Cabin 45*hh<CR><LF>
```

Reporting by central may be useful if many units are in abnormal states. Sending fewer event messages per summary message reduces the chance for inconsistencies between summary counts and individual event messages, due, for example to lost messages. Dividing transmissions also allows the central to put some time between blocks of data.

The following rules should be followed when sending and receiving system status:

a) the summary status sentence and the following detailed condition messages should be sent consecutively as a block with minimum time between the sentences and no other unrelated sentences inside the block;

b) when receiving a block, the receiver can consider the block finished when it receives an unrelated sentence, when all expected detailed conditions have been received or when no sentences have been received for 1 s. Any missing detailed conditions should in this case be considered as lost.

E.4 Change measurement point status

The sentences only allow for one status code per measurement point at any one time. This means that any new status sentence indicates a new status value. The following example shows unit 26 on loop 2 of Central B to go through states "open", "fault" and then back to normal.

```
$--DOR,E,,FD,CB,002,026,O,,B02026 Cabin 34*hh<CR><LF>
...
$--DOR,E,,FD,CB,002,026,X,,B02026 Cabin 34*hh<CR><LF>
...
$--DOR,E,,FD,CB,002,026,C,,B02026 Cabin 34*hh<CR><LF>
```

Note that a fault in one unit should be signalled as an E-flagged sentence with a status code of 'X'.

The following rules should be followed when sending and receiving system status:

a) only one status value can be assigned to a measurement point. It is not possible to signal that a point is both in fault and in a special state, for example open;

b) a change in the status values should be sent as a sentence as soon as possible after the change.

E.5 Point status change during a status update

If a point changes its status during a general status update, the status change sentence should be deferred to after the current status block has been fully transmitted.

NOTE   This is an argument for dividing long status blocks into shorter segments, to allow the interlacing of any status changes that may occur during status transmission.

As an example, the status block from the previous example should be combined with a change to fault in door 26 as shown in the sequence below.

```
$--DOR,S,,FD,,,004,,,*hh<CR><LF>
$--DOR,E,,FD,CA,001,015,O,,A01015 Cabin 23*hh<CR><LF>
$--DOR,E,,FD,CA,001,032,O,,A01032 Locker 10*hh<CR><LF>
$--DOR,E,,FD,CB,002,026,O,,B02026 Cabin 34*hh<CR><LF>
$--DOR,E,,FD,CC,003,005,X,,C03005 Cabin 45*hh<CR><LF>
...
$--DOR,E,,FD,CB,002,026,X,,B02026 Cabin 34*hh<CR><LF>
```

E.6 Failure in a sub-system

If a complete sub-system fails, for example Sub-central B, this should be signalled by a 'F' type sentence indicating the failure area.

```
$--DOR,F,,FD,CB,,,,,Sub-central B*hh<CR><LF>
```

NOTE   This may be followed by an ALR sentence to give more details of the problem.

In this case, the receiver should assume that all measurement units belonging to Sub-central B are undefined until the sub-system can be determined to be back to normal again.

E.7   Status updates when a sub-system is in fault

A status block cannot use total counts for the complete system when one sub-system is in fault. In this case, system status updates should be sent by sub-system. This means that the second option of the first example should be used as exemplified below.

```
$--DOR,S,,FD,CA,,002,,,*hh<CR><LF>
$--DOR,E,,FD,CA,001,015,O,,A01015 Cabin 23*hh<CR><LF>
$--DOR,E,,FD,CA,001,032,O,,A01032 Locker 10*hh<CR><LF>
...
$--DOR,F,,FD,CB,,,,,*hh<CR><LF>
...
$--DOR,S,,FD,CC,,001,,,*hh<CR><LF>
$--DOR,E,,FD,CC,003,005,X,,C03005 Cabin 45*hh<CR><LF>
```

The sub-system fault message should also be repeated in the status block.

E.8   Signal a correction of a sub-system fault

Any new message indicating a valid status for any unit in a sub-system or a status message for the sub-system itself should be interpreted as the sub-system being back to normal state. Any of the below sentences should be so interpreted.

```
$--DOR,E,,FD,CB,002,026,F,,B02026 Cabin 34*hh<CR><LF>
...
$--DOR,S,,FD,CB,,001,,,*hh<CR><LF>
$--DOR,E,,FD,CB,002,026,O,,B02026 Cabin 34*hh<CR><LF>
```

Until a complete system status has been received, the receiver should assume that all measurement points in the sub-system are in the normal state, for example, "closed" for fire doors. Thus, the sender should send a sub-system status block as the first immediately after the sub-system has been put back into normal operation.

Annex F
(informative)

Example encapsulation sentence

F.1   Example encapsulation sentence

This example is intended as a sample of correctly constructed encapsulation sentences. It is a representative sample only and shows part of the wide range of legal variations possible with sentences. It should not necessarily be used as a template for sentences.

F.2   AIS VHF data-link message VDM sentence encapsulation example

This standard supports the transport of encapsulated binary coded data. In general, the proper decoding and interpretation of encapsulated binary data will require access to information developed and maintained outwith this standard. This standard contains information that describes how the data should be coded, decoded, and structured. The specific meaning of the binary data is obtained from the referenced standards.

What follows is a practical example of how encapsulated binary coded data might be translated into meaningful information. The example is drawn from the operation of universal Automatic Identification System (AIS) equipment built to the ITU-R M.1371 recommendations. The sample sentence that will be used in this example is:

```
                          Number of "fill-bits"  (0 to 5) ┐
        Encapsulated ITU-R M.1371 ┐                       │
                  radio message │                         │

        !AIVDM,1,1,,A,1P000Oh1IT1svTP2r:43grwb05q4,0*01<CR><LF>
              │││└ AIS channel
              ││└ Sequential message identifier, (0 to 9)
              │└ Sentence number, (1 to 9)
              └ Total number of sentences needed to transfer the message, (1 to 9)
```

NOTE   See VDM sentence.

F.3   Background discussion – Encapsulation coding

Before considering the decoding process, it is necessary to understand the source of the binary bits encapsulated in this string. AIS is a series of radio broadcasts that use the marine VHF band. A number of messages may be broadcast by an AIS unit. The bit-by-bit descriptions of the contents of these messages are documented in tables contained in the ITU-R M.1371. Table F.1 is a sample from ITU-R M.1371-1. This table identifies all of the information needed to convert the encapsulated binary bits into information. The table identifies the bits, gives them parametric names, and units.

The bits listed in Table F.1 are the message data portion of a larger packet of binary bits that are created and broadcast by an AIS unit. The sample VDM-sentence shown above is an example of the output that would be created by every AIS unit that properly received a single AIS unit's broadcast. Figure F.1 shows the message data portions of the "radio packet" that is created and broadcast by an AIS unit. Only the message data bits (those described in the tables – such as Table F.1) are encapsulated in the string contained in the VDM-sentence.

Message Data (maximum of 168 bit for one-slot, maximum of 1 008 bit for five-slot)

Figure F.1 – Message data format

Assume, as an example, that the first 12 bit of the message data in Figure F.1 (bits 1 to 12) are: 000001100000. These would be the first 12 bit coded into the VDM encapsulate string. The VDM-sentence encapsulates data using the symbols of the "six-bit" field type. Each of the 64 possible combinations of ones and zeros that can make up a six bit binary string has been assigned a unique valid character. These assignments are listed in Table C.1.

For example, the first 12 bit would be divided into six bit strings, that is: 000001 and 100000. Using Table C.1, the binary string 000001 can be represented by a "1", and the binary string 100000 can be represented by a "P". The first two characters in the VDM-sentence encapsulated string would then be "1P". Note that observing upper and lower case letters is important when using Table C.1.

The maximum number of message data bits that can be contained in an AIS radio message is 1 008 bit. This number of bits requires 168 six-bit symbols. This quantity of characters is greater than can be accommodated by a single standard sentence. The encapsulation sentence structure has been designed to allow an encapsulation field to be broken into smaller strings that are transferred using multiple sentences. The important point to remember is that the encapsulation fields from a multiple sentence group, identified by the sequence number field and order by sentence number fields, be recombined into one continuous encapsulation string.

Although the string being used in this example can fit into one sentence, it could also be split and transferred using two sentences. In fact, it need not be split at any specific point. The two sentence pairs below are equivalent and are proper sentences for the transfer of the same encapsulation string.

> !AIVDM,2,1,7,A,1P000Oh1IT1svT,0*58<CR><LF>
> !AIVDM,2,2,7,A,P2r:43grwb05q4,0*0C<CR><LF>

> !AIVDM,2,1,9,A,1P000Oh1IT1svTP2r:43,0*7B<CR><LF>
> !AIVDM,2,2,9,A,grwb05q4,0*2F<CR><LF>

Note that the complete encapsulated message data string itself does not change in the two pairs, but that the "checksum" for the sentences changes. Using either a VDM encapsulation pair, the encapsulated string remains:

> 1P000Oh1IT1svTP2r:43grwb05q4.

Figure F.1 shows the message data as a horizontal table of bits. This can be shown in other ways. The left table in Figure F.2 shows how the message data bits can be redrawn in a table with 6 columns and as many rows as are needed to hold all the message data bits. The numbers in each of the table positions indicates the message data position of the bit in the AIS unit's broadcast. Organising the bits in this manner allows easy use of the conversion information shown in Table C.1 (see Annex C).

The following discussion will use "table lookup" methods to describe the decoding process. The reader should also be aware that this standard also contains binary mathematical methods that a computer would use to accomplish the same results.

F.4   Decoding the encapsulated string

The background discussion, above, described how the AIS unit codes the received binary message data bits into the characters of an encapsulation string. It explained that the AIS unit

- receives a broadcast message,

- organises the binary bits of the message data into 6-bit strings,

- converts the 6-bit strings into their representative valid characters – see Table C.1,

- assembles the valid characters into an encapsulation string, and

- transfers the encapsulation string using the VDM sentence formatter.

Again, the sample sentence that will be used in this decoding and interpretation example is:

!AIVDM,1,1,,A,1P000Oh1IT1svTP2r:43grwb05q4,0*01<CR><LF>

A calculation shows that the checksum, 71_{HEX}, is correct. This permits the interpretation of the sentence content to continue. Based upon the definition of a "VDM" sentence, this is a "single sentence encapsulation of an AIS VHF data link message". This message was produced by an AIS unit. The binary data, that has been encapsulated, was received on the AIS unit's "A" channel. Also, no bits were added to the binary string when it was encapsulated. The remainder of this example will focus on the proper interpretation of string: "**1P000Oh1IT1svTP2r:43grwb05q4**".

The process of decoding and interpreting the contents of the encapsulated string is a three step process:

a) the string symbols are converted back into the binary strings that they represent;

b) the binary strings are organised or parsed using the rules contained in the referenced document, in this case Table F.1;

c) the referenced document rules are used to convert the binary strings into the relevant information.

F.5   Conversion from symbols to binary bits

Figure F.2 is a visual aid that can be used to follow this process for the example string. The table on the left side of Figure F.2, **VDM bit positions**, is provided as a reference that can be used to identify the exact bit position of the corresponding binary bit in the table on the right side, **Bits represented by encapsulation symbol**, of Figure F.2. The use of this "reference grid" will become clearer as the example is discussed.

Down the centre of Figure F.2 is a column into which the example string has been entered from top to bottom. The arrows in Figure F.2 provide an idea about how the logic of the decoding process proceeds. Decoding of the VDM encapsulated string begins with the first symbol in the string. In this case, the symbol is "1" and the corresponding binary string from Table C.1 is "000001". The binary string is entered in the grid to the right of the "1", as indicated by the arrow. These six bit occupy bit positions 1 to 6. The left most "0" is in position 1 and the right most "1" is in position 6. Note how this corresponds with the reference diagram on the left of Figure F.2.

The second symbol in the string, "P", is processed next. The "P" represents the binary string "100000". This binary string is entered into the next row of the right grid – VDM bit positions 7 to 12. The same process is followed for each of the symbols of the encapsulated string down to the last one, which is a "4". The "4" represents the binary string "000100". This binary string is entered into the "last" row of the right grid – VDM bit positions 163 to 168.

The process of loading up the right grid with binary strings is a mechanical process that has nothing to do with the information content of the encapsulated binary data. It is simply the reverse process from what the AIS unit did to create the encapsulation string during the process of creating the VDM-sentence.

F.6   Organising the binary message data

The work sheet has been filled in to decode an "AIS Message 1". Notice that the two grids in Figure F.2 have a variety of shaded (grey) blocks. This is done to make it easier to locate the specific bits making up the Message 1 parameters in the decoded array of binary bits. The fact is, these blocks could not be filled in until the message type (message number) of AIS message was identified. Identification of the AIS message is done from the first six bit of the binary message data. The message number is simply the decimal equivalent of the binary number. In this case, 000001 = Message 1. After this is known the remaining blocks of the message can be shaded using information in Table F.1.

The parameters listed in Table F.1 are transmitted over the radio link as message data in the same order that they are listed in the table. The "number of bits" column of Table F.1 is used to establish the bits that apply to each of the parameters. Once established, this ordering of bits will be the same for every "Message 1". That is, until the reference table itself is changed.

This same ordering should be done for each of the referenced AIS message tables. For example if, after the decoding process was complete, and bits 1-6 were 000101, the VDM message identified would be Message 5 ($000101_2 = 5_{10}$). This references the "Ship static and voyage related data" message, see ITU-R M.1371.

The process of organising the decoded binary message data requires:

a) identification of the message number, and

b) organising or parsing the binary bits following the appropriate message table(s).

F.7   Interpreting the decoded binary strings

Final conversion of the organised bits into useful information involves the use of the

a) organised bits – right side of Figure F.2, and

b) the parameters descriptive information defined in Table F.1.

For example, the parameter "repeat indicator" is two bit – bits 7 and 8. Inspection of message data bits 7-8, Figure F.2, shows that the value is "10"$_2$. The descriptive information in Table F.1 for "repeat indicator" explains that "10" should be interpreted as "repeated twice". This conclusion is recorded in the space to the right of Figure F.2.

The next parameter in Table F.1, is the "user ID" (the MMSI number of the AIS unit that broadcast this message). This is a 30 bit binary integer. The conversion, $1111111_2 = 127_{10}$, discloses this unit's MMSI as 127.

This process continues down Table F.1. The results of each interpretation of the decoded binary message data are shown on the worksheet to the right of Figure F.2.

Table F.1 – Example message from ITU-R M.1371

Parameter	Number of bits	Description
Message ID	6	Identifier for this message 1, 2 or 3
Repeat indicator	2	Used by the repeater to indicate how many times a message has been repeated. Refer to ITU-R M.1371; 0 – 3; default = 0; 3 = do not repeat any more.
User ID	30	MMSI number
Navigational status	4	0 = under way using engine, 1 = at anchor, 2 = not under command, 3 = restricted manoeuvrability, 4 = constrained by her draught; 5 = moored; 6 = aground; 7 = engaged in fishing; 8 = under way sailing; 9 = reserved for future amendment of navigational status for HSC; 10 = reserved for future amendment of navigational status for WIG; 11 = power-driven vessel towing astern (regional use); 12 = power-driven vessel pushing ahead or towing alongside (regional use); 13 = reserved for future use; 14 = AIS-SART (active); 15 = not defined = default
Rate of turn ROT$_{[AIS]}$	8	0 to +126 = turning right at up to 708° per min or higher 0 to −126 = turning left at up to 708° per min or higher Values between 0 and 708° per min coded by $$ROT_{AIS} = 4.733\ SQRT(ROT_{sensor})\ \text{degrees per min}$$ where ROT$_{sensor}$ is the Rate of Turn as input by an external Rate of Turn Indicator (TI). ROT$_{AIS}$ is rounded to the nearest integer value. +127 = turning right at more than 5° per 30 s (No TI available) −127 = turning left at more than 5° per 30 s (No TI available) −128 (80 hex) indicates no turn information available (default). ROT data should not be derived from COG information.
SOG	10	Speed over ground in 1/10 knot steps (0-102.2 knots) 1 023 = not available, 1 022 = 102.2 knots or higher
Position accuracy	1	1 = high (<10 m; differential mode of e.g. DGNSS receiver) 0 = low (>10 m; autonomous mode of e.g. GNSS receiver or of other electronic position fixing device); default = 0
Longitude	28	Longitude in 1/10 000 min (±180 degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 min (±90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
COG	12	Course over ground in 1/10° (0-3599). 3600 (E10 hex)= not available = default; 3 601 – 4 095 should not be used
True heading	9	Degrees (0-359) (511 indicates not available = default).
Time stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which should also be the default value, or 62 if electronic position fixing system operates in estimated (dead reckoning) mode, or 61 if positioning system is in manual input mode or 63 if the positioning system is inoperative)
Special manoeuvre indicator	2	0 = not available = default; 1 = not engaged in a special manoeuvre; 2 = engaged in a special manoeuvre.
Spare	3	Not used. Should be set to zero
RAIM-Flag	1	RAIM (Receiver Autonomous Integrity Monitoring) flag of electronic position fixing device; 0 = RAIM not in use = default; 1 = RAIM in use)
Communication State	19	See ITU-R M.1371.
Total number of bits	168	

1P000Oh1IT1svTP2r:43grwb05q4

Encapsulation Symbol String

VDM bit positions (reference diagram)

Bits represented by encapsulation symbol

VDM bits						Symbol	Bits					
1	2	3	4	5	6	1	0	0	0	0	0	1
7	8	9	10	11	12	P	1	0	0	0	0	0
13	14	15	16	17	18	0	0	0	0	0	0	0
19	20	21	22	23	24	0	0	0	0	0	0	0
25	26	27	28	29	30	0	0	0	0	0	0	0
31	32	33	34	35	36	O	0	1	1	1	1	1
37	38	39	40	41	42	h	1	1	0	0	0	0
43	44	45	46	47	48	1	0	0	0	0	0	1
49	50	51	52	53	54	I	0	1	1	0	0	1
55	56	57	58	59	60	T	1	0	0	1	0	0
61	62	63	64	65	66	1	0	0	0	0	0	1
67	68	69	70	71	72	s	1	1	1	0	1	1
73	74	75	76	77	78	v	1	1	1	1	1	0
79	80	81	82	83	84	T	1	0	0	1	0	0
85	86	87	88	89	90	P	1	0	0	0	0	0
91	92	93	94	95	96	2	0	0	0	0	1	0
97	98	99	100	101	102	r	1	1	1	0	1	0
103	104	105	106	107	108	:	0	0	1	0	1	0
109	110	111	112	113	114	4	0	0	0	1	0	0
115	116	117	118	119	120	3	0	0	0	0	1	1
121	122	123	124	125	126	g	1	0	1	1	1	1
127	128	129	130	131	132	r	1	1	0	0	1	0
133	134	135	136	137	138	w	1	1	1	1	1	1
139	140	141	142	143	144	b	1	0	1	0	1	0
145	146	147	148	149	150	0	0	0	0	0	0	0
151	152	153	154	155	156	5	0	0	0	1	0	1
157	158	159	160	161	162	q	1	1	1	0	0	1
163	164	165	166	167	168	4	0	0	0	1	0	0

Binary conversion of symbol

Bits 1-6 = Identifier for this message

000001 = **message 1** (Reference Table F.1 to interpret following bits 7-168.)

Bit 7-8 = Repeat Indicator

2 = **message repeated twice**

Bits 9-38 = MMSI number of broadcasting unit

000000000000000000000001111111 = **127**

Bits 39-42 = Navigational status

0000 = **underway using engine**

Bits 43-50 = Rate of turn (equation used)

00000101 **= +1.1 degrees/minute**

Bits 51-60 = Speed over ground

1001100100 = **61.2 knots**

Bit 61 = Position accuracy

0 = **low (greater than 10 metres)**

Bits 62-89 = Longitude in 1/10000 minutes

0000111101111111010010010000 = **27 degrees 5 minutes East**

Bits 90-116 = Latitude in 1/10000 minutes

000001011101000101000010000 = **5 degrees 5 minutes North**

Bits 117-128 = Course over ground in 1/10 degrees

001110111111 = **95,9 degrees true**

Bits 129-137 = True heading

101011111 = **351 degrees true**

Bits 138-143 = UTC second when report generated

110101 = **53 seconds past the minute**

Bits 144-147 = Special manoeuvre

0000 = **not available and two spare**

Bits 148 = Spare

Bit 149 = RAIM Flag

0 = **RAIM not in use**

00 = **UTC Direct**
001 = **1 frames remaining until a new slot is selected, UTC hour and minute follow,**
01111001000100 = 01111:0010001 = **15: 17 UTC**
Bits 167-168 not used for UTC Sub-message

IEC

Figure F.2 – Work sheet for decoding and interpreting encapsulated string

Bibliography

IEC 61023, *Maritime navigation and radiocommunication equipment and systems – Marine speed and distance measuring equipment (SDME) – Performance requirements – Methods of testing and required test results*

IEC 61075, *Loran-C receivers for ships – Minimum performance standards – Methods of testing and required test results*

IEC 61097-1, *Global maritime distress and safety system (GMDSS) – Part 1: Radar transponder – Marine search and rescue (SART) – Operational and performance requirements, methods of testing and required test results*

IEC 61097-2, *Global maritime distress and safety system (GMDSS) – Part 2: COSPAS-SARSAT EPIRB – Satellite emergency position indicating radio beacon operating on 406 MHz – Operational and performance requirements, methods of testing and required test results*

IEC 61097-3, *Global maritime distress and safety system (GMDSS) – Part 3: Digital selective calling (DSC) equipment – Operational and performance requirements, methods of testing and required test results*

IEC 61097-4, *Global maritime distress and safety system (GMDSS) – Part 4: INMARSAT-C ship earth station and INMARSAT enhanced group call (EGC) equipment – Operational and performance requirements, methods of testing and required test results*

IEC 61097-7, *Global maritime distress and safety system (GMDSS) – Part 7: Shipborne VHF radiotelephone transmitter and receiver – Operational and performance requirements, methods of testing and required test results*

IEC 61097-8, *Global maritime distress and safety system (GMDSS) – Part 8: Shipborne watchkeeping receivers for the reception of digital selective calling (DSC) in the maritime MF, MF/HF and VHF bands – Operational and performance requirements, methods of testing and required test results*

IEC 61097-9, *Global maritime distress and safety system (GMDSS) – Part 9: Shipborne transmitters and receivers for use in the MF and MF/HF bands suitable for telephony, digital selective calling (DSC) and narrow band direct printing (NBDP) – Operational and performance requirements, methods of testing and required test results*

IEC 61097-13, *Global maritime distress and safety system (GMDSS) – Part 13: Inmarsat F77 ship earth station equipment – Operational and performance requirements, methods of testing and required test results*

IEC 61108-1, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61108-2, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 2: Global navigation satellite system (GLONASS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61108-3, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 3: Galileo receiver equipment – Performance requirements, methods of testing and required test results*

IEC 61108-4, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 4: Shipborne DGPS and DGLONASS maritime*

radio beacon receiver equipment – Performance requirements, methods of testing and required test results

IEC 61993-2, *Maritime navigation and radiocommunication equipment and systems – Automatic identification systems (AIS) – Part 2: Class A shipborne equipment of the universal automatic identification system (AIS) – Operational and performance requirements, methods of test and required test results*

IEC 61996-1, *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR) – Part 1: Voyage data recorder (VDR) – Performance requirements, methods of testing and required test results*

IEC 61996-2, *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR) – Part 2: Simplified voyage data recorder (S-VDR) – Performance requirements, methods of testing and required test results*

IEC 62065, *Maritime navigation and radiocommunication equipment and systems – Track control systems – Operational and performance requirements, methods of testing and required test results*

IEC 62252, *Maritime navigation and radiocommunication equipment and systems – Radar for craft not in compliance with IMO SOLAS Chapter V – Performance requirements, methods of test and required test results*

IEC 62287-1, *Maritime navigation and radiocommunication equipment and systems – Class B shipborne equipment of the automatic identification system (AIS) – Part 1: Carrier-sense time division multiple access (CSTDMA) techniques*

IEC 62287-2, *Maritime navigation and radiocommunication equipment and systems – Class B shipborne equipment of the automatic identification system (AIS) – Part 2: Self-organising time division multiple access (SOTDMA) techniques*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*

IEC 62320-1, *Maritime navigation and radiocommunication equipment and systems – Automatic Identification Systems (AIS) – Part 1: AIS Base Stations – Minimum operational and performance requirements, methods of testing and required test results*

IEC 62320-2, *Maritime navigation and radiocommunication equipment and systems – Automatic Identification Systems (AIS) – Part 2: AIS AtoN Stations – Operational and performance requirements, methods of testing and required test results*

IEC 62320-3, *Maritime navigation and radiocommunication equipment and systems – Automatic Identification Systems (AIS) – Part 3: Repeater stations – Minimum operational and performance requirements, methods of testing and required test results*

IEC 62388, *Maritime navigation and radiocommunication equipment and systems – Shipborne radar – Performance requirements, methods of testing and required test results*

ISO 8728, *Ships and marine technology – Marine gyro-compasses*

ISO 9875, *Ships and marine technology – Marine echo-sounding equipment*

ISO 10596, *Ships and marine technology – Marine wind vane and anemometers*

ISO 11606, *Ships and marine technology – Marine electromagnetic compasses*

ISO 11674, *Ships and marine technology – Heading control systems*

ISO 20672, *Ships and marine technology – Rate of turn indicators*

ISO 20673, *Ships and marine technology – Electric rudder angle indicators*

ISO 22090-1, *Ships and marine technology – Transmitting Heading Devices (THDs) – Part 1: Gyro-compasses*

ISO 22090-2, *Ships and marine technology – Transmitting Heading Devices (THDs) – Part 2: Geomagnetic principles*

ISO 22090-3, *Ships and marine technology – Transmitting Heading Devices (THDs) – Part 3: GNSS principles*

ISO 22554, *Ships and marine technology – Propeller shaft revolution indicators – Electric type and electronic type*

ISO 22555, *Ships and marine technology – Propeller pitch indicators*

ISO 25862, *Ships and marine technology – Marine magnetic compasses, binnacles and azimuth reading devices*

ITU-R M.489, *Technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz*

ITU-R M.493, *Digital selective-calling system for use in the maritime mobile service*

ITU-R M.540, *Operational and technical characteristics for an automated direct-printing telegraph system for promulgation of navigational and meteorological warnings and urgent information to ships*

ITU-R M.541, *Operational procedures for the use of digital selective-calling (DSC) equipment in the maritime mobile service*

ITU-R M.628, *Technical characteristics for search and rescue radar transponders*

ITU-R M.633, *Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) system operating through a satellite system in the 406 MHz band*

ITU-R M.688, *Technical characteristics for a high frequency direct-printing telegraph system for promulgation of high seas and NAVTEX-type maritime safety information*

ITU-R M.689, *International maritime VHF radiotelephone system with automatic facilities based on DSC signalling format*

ITU-T T.50:1992, *International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) – Information technology – 7-bit coded character set for information interchange*

ANSI X 3.15:1976, *American National Standards Institute – Character structure and character parity sense for serial-by-bit communication*

ANSI X 3.16:1976, *American National Standards Institute – Bit sequencing of the ANS code of information interchange in serial-by-bit data transmission*

ANSI X 3.4:1977, *American National Standards Institute – Code for information interchange*

COSPAS-SARSAT, *C/S T.001 Specification for COSPAS-SARSAT 406 MHz distress beacons*

Galileo ESA/GSA, *Open service (OS) signal in space (SIS) interface control document OS SIS ICD, European Space Agency*

GLONASS, *Interface control document, Russian Institute of Space Device Engineering*

GPS, *Global Positioning System, USA Department of Defence*

IHO, *Special publication No. 60, User's handbook on datum transformations involving WGS 84*

IMO A.424, *Performance standards for gyro-compasses*

IMO A.526, *Performance standards for rate-of-turn indicators*

IMO A.694, *General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO A.802, *Performance standards for survival craft radar transponders for use in search and rescue operations*

IMO A.803, *Performance standards for shipborne VHF radio installations capable of voice communication and digital selective calling*

IMO A.804, *Performance standards for shipborne MF radio installations capable of voice communication and digital selective calling*

IMO A.806, *Performance standards for shipborne MF/HF radio installations capable of voice communication, narrow-band direct printing and digital selective calling*

IMO A.807, *Performance standards for INMARSAT-C ship earth stations capable of transmitting and receiving direct-printing communications*

IMO A.808, *Performance standards for ship earth stations capable of two-way communications*

IMO A.809, *Performance standards for survival craft two-way VHF radiotelephone apparatus*

IMO A.810, *Performance standards for float-free satellite emergency position-indicating radio beacons (EPIRBs) operating on 406 MHz*

IMO A.818, *Performance standards for shipborne LORAN-C and CHAYKA receivers*

IMO A.824, *Performance standards for devices to indicate speed and distance*

IMO A.851(20):1997, *General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants*

IMO MSC 148(77), *Revised recommendation on performance standards for Narrow-Band Direct-Printing telegraph equipment for the reception of navigational and meteorological warnings and urgent information to ships (NAVTEX)*

IMO MSC 163(78), *Performance standards for shipborne simplified voyage data recorders (s-VDRs)*

IMO MSC.232(82), *Performance standards for electronic chart display and information systems (ECDIS)*

IMO MSC.252(83), *Adoption of the revised performance standards for Integrated Navigation Systems (INS)*

IMO *International Convention for the Safety of Life at Sea (SOLAS) 1974 (as amended)*

INMARSAT, *INMARSAT-C System definition manual (SDM), Volume 3: Ship earth station and an EGC receiver technical requirements*

NMEA 0183: *National Marine Electronics Association (USA) – Standard for interfacing marine electronic devices*

NMEA 0183 version 4.10

NOTE   The NMEA Secretariat maintains the master reference list which comprises codes registered and formally adopted by NMEA.

The address for the registration of manufacturer's codes is:

NMEA 0183 Technical Standards Committee	Phone: +1 410 975 9450
7 Riggs Ave	e-mail: info@nmea.org
Servana Pk, Maryland 21146, USA	web site http://www.nmea.org

RTCM:1998, *RTCM (Radio Technical Commission for Maritime Services) SC-104 Recommended standards for differential GNSS (Global Navigation Satellite Systems) service, version 2.2*

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