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Electronics Association

National Marine Electronics Association

International Marine Electronics Association

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VPW – Speed – Measured Parallel to Wind 127

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WCV – Waypoint Closure Velocity 129
WNC – Distance – Waypoint to Waypoint 129
WPL – Waypoint Location 129
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COP – Configure the Operational Period, Command 69
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DCN – DECCA position 70
DCR – Device Capability Report 71
DDC – Display Dimming Control 71
DOR – Door Status Detection 72
DPT – Depth 74
DSC – Digital Selective Calling Information 74

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WPL – Waypoint Location 129
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XTE – Cross-Track Error, Measured 131
XTR – Cross-Track Error – Dead Reckoning 131
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Approved TAG Block Encapsulation Formatters

None defined in NMEA 0183 version 4.10.

Preface

The International Marine Electronics Association (IMEA) is a sister company of the National Marine Electronics Association. IMEA is a U.S. non-profit organization organized under the U.S. tax codes of a 501 (c) (3). This permits IMEA to pursue alternative sources of revenue and to establish a Non-Profit Foundation. The National Marine Electronics Association (NMEA) / International Marine Electronics Association Interface Standards are intended to serve the public interest by facilitating interconnection and interchangeability of equipment, minimizing misunderstanding and confusion between manufacturers, and assisting purchasers in selecting compatible equipment. For the purposes of this standard, NMEA will be used as the brand name for this standard with the understanding that NMEA and IMEA currently co-own this standard.

NMEA/IMEA are worldwide organizations promoting the standardization of digital interfaces. One of the objectives of NMEA /IMEA is to collaborate and cooperate with appropriate U.S. and International organizations to assure worldwide safety and harmonization on questions concerning standardization and equipment operation of the global marine electronics industry.

NMEA interface standards are developed with input from manufacturers, private and government organizations, and equipment operators worldwide. The information contained in this standard is intended to meet the needs of users at the time of publication, but users must recognize that as applications and technology change, interface standards must change as well. Users of this document are advised to immediately inform NMEA of any perceived inadequacies in this standard.

NMEA or IMEA accepts no liability on its directors, employees, volunteers or agents including individual experts and members of its standard technical committees, the NMEA 0183 Technical Standards Committee for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this NMEA Technical Standard Publication, NMEA 0183 Standard of Digital Interfaces, NMEA 0183 High Speed Standard for Digital Interfaces or any other NMEA Technical Standard Publications. NMEA also publishes NMEA 1083 HS (High Speed), the NMEA 2000 Standard as the industry networking digital interface standard for marine electronics and the NMEA Installation Standard for the proper of installation of marine electronics aboard vessels.

Standards are adopted by NMEA without regard to whether or not their adoption may involve patents on articles, materials or processes. By such action, NMEA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting these Standards.

This NMEA 0183 Interface Standard has been prepared by the NMEA 0183 Technical Standards Committee under the guidance of the NMEA Standards Programs with permission by the NMEA Standards Committee.

This Standard defines electrical signal requirements, data transmission protocol and timing, and specific sentence formats for a 4800-baud serial data bus. For operation at the higher rate of 38,400-baud refer to NMEA Standard 0183-HS. This version 4.10 cancels and replaces NMEA 4.00 published in November 2008, and constitutes a technical revision. It is in theory backward compatible to version NMEA 0183 2.0. Versions before 2.0 are not forward compatible.

Each bus shall have only a single TALKER but may have multiple LISTENERs.
Because of differences in baud rate and other transmission parameters, NMEA 0183 data is not directly compatible with NMEA 0180 or NMEA 0182 Standards.
Equipment that is specified by IMO to meet the SOLAS regulations is governed by the requirements of IEC 61162-1: Digital Interfaces, Maritime Navigation and Radio Communications Equipment and Systems. The IEC Standard 61162-1 is aligned closely with the NMEA 0183 Standard for single talker multiple listeners. The IEC 61162-2 is closely aligned with NMEA 0183 HS for single talker multiple listeners, high speed transmission (38,400 baud). The IEC 61162-3 references NMEA 2000 Standard for multiple talkers and multiple listeners on a Controller Area Network (CAN).

Availability and Updates of the Standard

This standard may be modified by action of the NMEA 0183 Technical Standards Committee as the need arises.

Updates to this Standard are published periodically in:
Marine Electronics Journal, Inc. - The Official Journal of the NMEA,
www.nmea.org
www.standards.nmea.org.

For subscription information to the Marine Electronics Journal contact the NMEA / IMEA International Office.

For information about this standard, contact:

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http://www.nmea.org

1. Introduction

1.1 Scope

This standard is developed to permit ready and satisfactory data communication between electronic marine instruments, navigation equipment and communications equipment when interconnected via an appropriate interface. This standard is intended to support one-way serial data transmission from a single talker to one or more listeners. This data is 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.

This version NMEA Version 4.10 includes shipboard, non shipboard and land base equipments and networks for maritime and other industry use and has been expanded to include the new Galileo Global Navigation Satellite System. Many of the existing GNSS sentences have been extended to accommodate Galileo and future GNSS. Continued advancements in AIS technologies have resulted in enhancements to a number of AIS sentences as well as some new AIS sentences. This version incorporates a number of corrections to TAG BLOCK methods that were previously published as NMEA ERRATA #0183 0910 01.

In the past, all NMEA 0183 sentences were listed alphabetically. To facilitate new technologies NMEA decided to separate NMEA 0183 sentences into separate sections for this version.

1.2 Intended Application and Limitations on Use

This standard is intended to support one-way serial data transmission from a single TALKER to one or more LISTENERs. This is data in printable ASCII form and may include information such as position, speed, depth, frequency allocation, etc. Typical messages might be 11 to a maximum of 79 characters in length and generally require transmission no more often than once 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 sentences and only limited error-checking capability, this standard should be used with caution in critical applications.

This standard, in theory, is backward compatible to version NMEA 0183 2.0.

Versions before 2.0 are not forward compatible.

There are multiple versions of the NMEA 0183 specification in use in the marine industry. Prior to NMEA 0183 version 2.0 (1992), including NMEA 0180 and NMEA 0182, the hardware employed a single ended interface implemented with one signal wire and a common ground, based on TIA-232. All implementations from 2.0 and later employ a differential interface with two signal wires, based on ANSI/TIA/EIA 422-B (RS 422). Most remaining differences between versions are related to the content of the data sentences sent between devices.

Due to the difference between the single ended and differential interfaces implemented in TIA-232 and ANSI/TIA/EIA 422-B (RS 422), older versions of NMEA 0183 prior to version 2.0 cannot be connected to equipment supporting NMEA 0183 version 2.0 or higher without proper interface circuitry. Do not connect one of the signal wires of the differential interface to the common ground of the single ended interface! See the NMEA 0400 Installation Standard for proper installation wiring.

1.3 Definitions

1.3.1 General

Common terms are defined in Appendix A, Glossary, of this Standard. Where there is a conflict terms shall be interpreted wherever possible in accordance with the references in Section 1.4.

1.3.2 TALKERs

A TALKER is any device that sends data to other devices within this standard. The type of TALKER is identified by a 2-character mnemonic as listed in Section 6.2.1 (Table 7).

1.3.3 LISTENERs

A LISTENER is any device that receives data from another device.

1.4 References

1.4.1 Informative References

American National Standards Institute:
ANSI X 3.4-1986 (R1997) Information Systems – Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

American Practical Navigator, Defense Mapping Agency Hydrographic/Topographic Center, Publication No. 9, DMA Stock No. NVPUB9V1, Volumes I and II

Electronic Industries Association Standards:
ANSI/TIA/EIA 422-B (RS 422)-94 May 1994 (R2000)

International Electrotechnical Commission:
3, rue de Varembe
P.O. Box 131
1211 Geneva 20
SWITZERLAND

IEC 61162-1: Digital Interfaces, Maritime Navigation and Radiocommunications Equipment and Systems

IEC 61162-2 Digital Interfaces, Maritime Navigation and Radiocommunications Equipment and Systems

Interface Control Document, Navstar GPS Space Segment/Navigation User Interface. Rockwell International Corporation Document No. ICD-GPS-200 Revision B (November 30, 1987)

GLONASS Interface Control Document, 1995

NMEA 0400 Installation Standard

RTCM SC-104, RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.2, January 1998

Special Publication No. 60, User's Handbook On Datum Transformations Involving WGS84, First Edition, June 1994. International Hydrographic Bureau, 7 Avenue President J.F. Kennedy, B.P. 445, MC 98011 Monaco Cedex

"The Unicode Standard, Version 2.0", ISBN 0-201-48345-9, Author: The Unicode Consortium, Publisher: Addison-Wesley. This is equivalent to the ISO/IEC 10646-1 standard as to Unicode values and tables in IEC 10464-1.

1.4.2 Normative References

IALA Recommendation A-126, *The Use of Automatic Identification System (AIS) in Marine Aids to Navigation*

IEC Standard 62320-1, Maritime navigation and radiocommunication equipment and systems – Automatic identification system (AIS) – Part 1: AIS Base Stations – Minimum operational and performance requirements, methods of testing and required test results

IEC Standard 62320-2, Maritime navigation and radiocommunications equipment and systems – Automatic identification system (AIS) – Part 2: AIS AtoN Stations – Minimum operational and performance requirements, methods of testing and required test results\

IEC 60945: Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results

IMO Recommendation on Performance Standards for a Universal Automatic Identification System (AIS) MSC.74 (69)

IMO SOLAS Convention, Chapter V (2002)

IMO A.830 (19) Code on Alarms and Indicators, 1995

IMO HSC Code, Chapter 13

IMO A.861 (20):1997, Performance standards for shipborne voyage data recorders (VDRs)

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

ISO/IEC 10646-1:1993, *Unicode standard.*

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

International Telecommunication Union (ITU) Recommendations:
A. ITU-R M.493-9, Digital Selective-Calling System For Use In The Maritime Mobile Service.

B. ITU-R M.821-1, Optional Expansion of the Digital Selective-Calling System For Use In The Maritime Mobile Service.

C. ITU-R M. 825-3, Characteristics of a Transponder System Using Digital Selective-Calling Techniques For Use With Vessel Traffic Services and Ship-To-Ship Identification.

D. ITU-R M.1371, Technical Characteristics for a Universal Shipborne Automatic Identification System using Time Division Multiple Access in the VHF Maritime Mobile Band.

NMEA 0183-HS – 38.4 K-baud Serial Data Standard For Interfacing Marine Electronic Devices, Version 1.00, July 1, 2000, National Marine Electronics Association, 7 Riggs Ave Severna Pk, MD 21146 USA

2. Manufacturer's Documentation

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

1. Identification of the A and B signal lines.
2. The output drive capability as a TALKER.
3. A list of approved sentences, noting unused fields, Proprietary sentences transmitted as a TALKER, and transmission interval for each sentence.
4. The load requirements as a LISTENER.
5. A list of sentences and associated data fields that are required as a LISTENER.
6. The current software and hardware revision if this is relevant to the interface.
7. An electrical description or schematic of the LISTENER/TALKER input/output circuits citing actual components and devices used, including connector type and part number.
8. The Version No. and date of update of the standard for which compliance is assured.
9. Previous version numbers of this standard that are supported by the equipment.
10. The degree to which these methods are incorporated in a device or process should be fully described in the equipment documentation describing the operation of the device or process. Testing should be done to confirm proper implementations for receipt and generation of TAG Blocks.

3. Hardware Specification

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.

3.1 Interconnecting Wire

Interconnection of devices shall be by means of a two-conductor, shielded, twisted-pair wire (See Figure 1). Ribbon, flat cables or coax and cable assemblies of this type are prohibited as they do not meet these requirements.

3.1.1 Wire Color Code Labels

This Standard establishes specific wiring color-codes labels for all NMEA 0183 interface signals. Table 1 below identifies signal color codes required to identify and differentiate between NMEA 0183 Talker and Listener connections.

All wiring provided by the manufacturer shall follow Table 1 below. This includes equipment pigtails and cable assemblies whether attached or not attached.

Table 1 - NMEA 0183 Signal Color Code Labels

Name	Color	Twisted Pair	Description
Talker A	White	Talker Pair	Data-H
Talker B	Brown		Data-L
Listener A	Yellow	Listener Pair	Data-H
Listener B	Green		Data-L
NMEA 0183-HS C	Black		Ground
Shield	Bare		See Section 3.3

When it is necessary to extend the NMEA 0183 wiring, the Talker Color Code Label should be used for cabling between connections. (Refer to the NMEA 0400 Installation Standard for proper installation wiring)

3.1.2 Cable Type

Interface cables, regardless of length, shall be composed of multi-conductor tinned shielded cable with a minimum 95 percent shielding. A twisted pair employing 22 AWG stranded wire shall be used for the NMEA 0183 data signals.

NMEA 0183-HS requires a third conductor, which is used to ensure that the common mode ground potential is the same at all drivers and receivers.

3.2 Conductor Definitions

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

3.3 Electrical Connections/Shield Requirements

All signal line "A" connections are connected in parallel with the device "A" connections and all signal line "B" connections are connected in parallel with all device "B" connections. The shields of all LISTENER cables shall be connected to the TALKER chassis only and shall not be connected at each LISTENER.

3.4 Connector

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

3.4.1 Device Connections

The manufacturer shall include both the male and female connector of NMEA 0183 devices whether attached or not attached directly to the device chassis. The connector shall meet the IP rating of the device.

3.4.1.1 Mating Connector

The mating connector cable assembly shall be a minimum of one meter in length and comply with Table 1 and Figure 1.

3.4.1.2 Chassis Connector

Cable mounted chassis connectors shall not exceed 30 centimeters from the device. Wires to the cable mounted conncetors shall follow Table 1 and Figure 1.

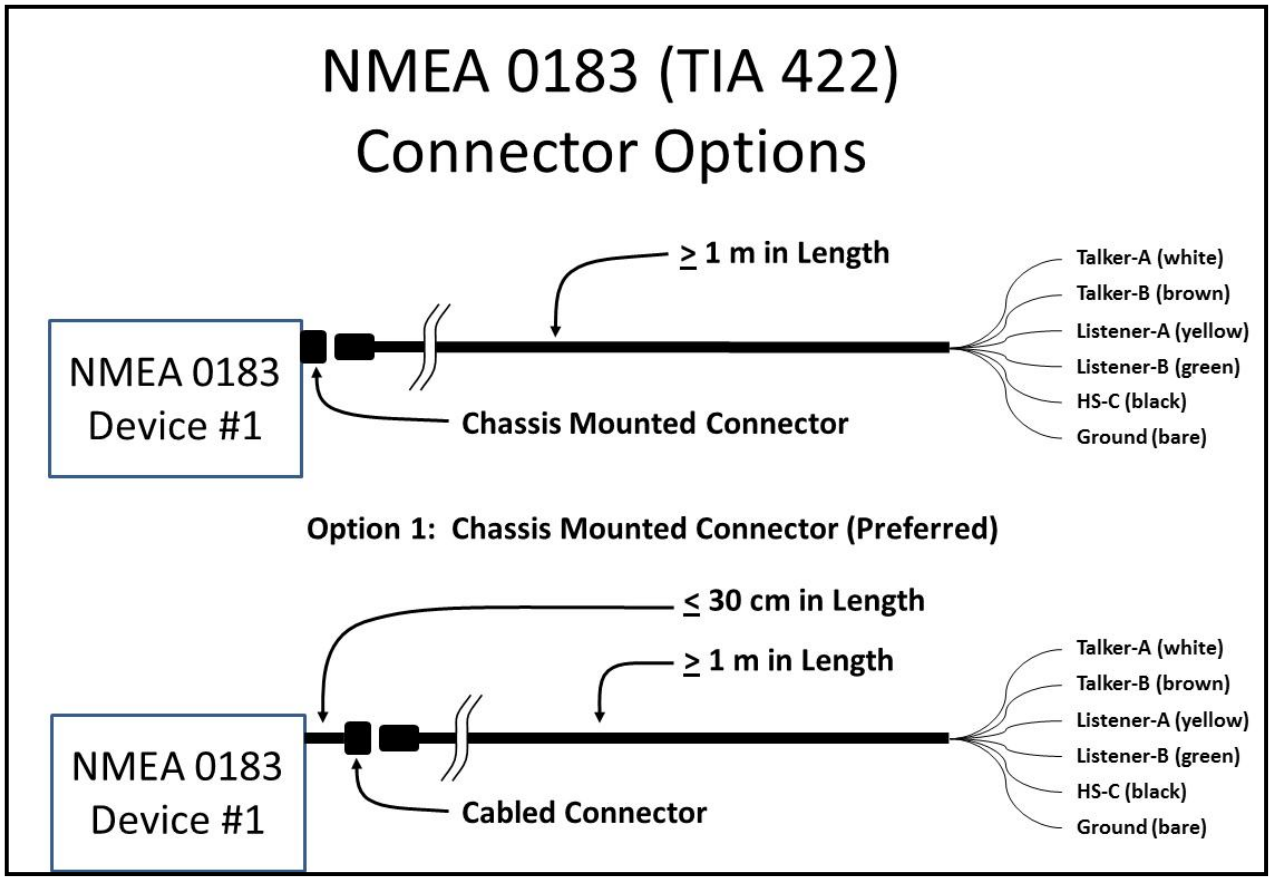


Figure 1 - NMEA 0183 Connector Options

3.5 Electrical Signal Characteristics

This section describes the electrical characteristics of transmitters and receivers.

3.5.1 Signal State Definitions

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

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

Note 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.

3.5.2 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, at a minimum, the

requirements of ANSI/TIA/EIA 422-B (RS 422) or ITU-T V.11.

TIA RS 232 shall not be used.

3.5.3 LISTENER Receive Circuits

Multiple LISTENERs may be connected to a single TALKER. The LISTENER receive circuit shall consist of an opto-isolator and should have protective circuits to limit current, reverse bias and power dissipation at the opto-diode as shown in Figure 2. Reference is made to example circuits in Appendix G of this Standard.

The receive circuit shall be designed for operation with a minimum differential input voltage of 2.0 Volts and shall not take more than 2.0 mA from the line at that voltage.

For reasons of compatibility with equipment designed to earlier versions of this standard, it is noted that the "idle, marking, logical "1", OFF or stop bit state" had previously been defined to be in the range -15 to + 0.5 Volts. The "active, spacing, logical "0", ON or start bit state" was defined to be in the range +4.0 to +15 Volts while sourcing not less than 15 mA.

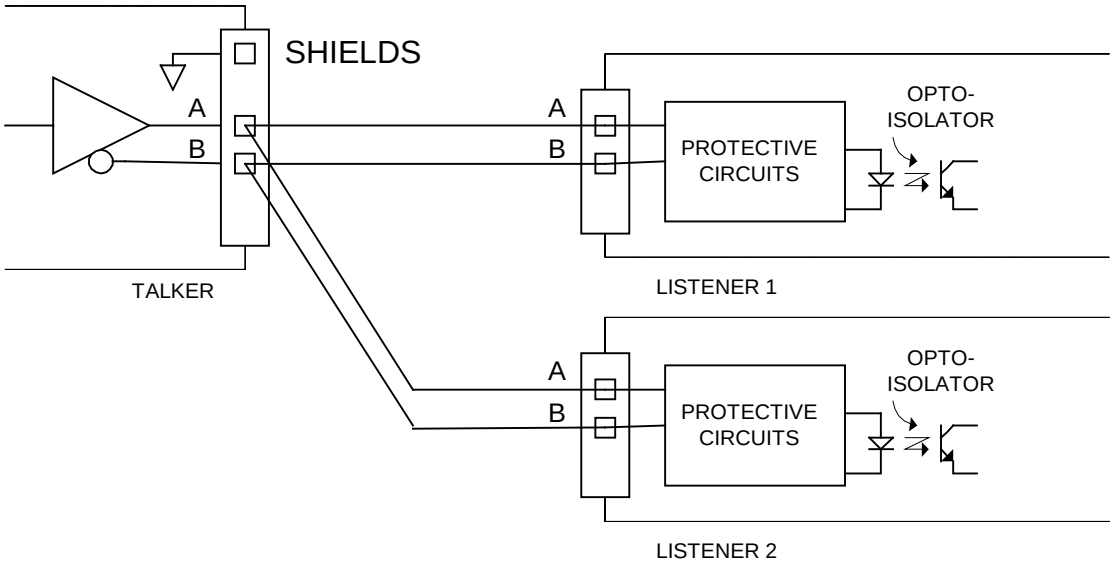


Figure 2 - Listener Receive Circuit

3.5.4 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.

3.5.5 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 the ANSI/TIA/EIA 422-B (RS 422) specification or ITU-T V.11.

For protection against miss wiring and for use with earlier TALKER designs, all receive circuit devices should be capable of withstanding 15 volts between signal lines "A" and "B" and between either line and ground for an indefinite period.

4. Data Transmission

Data is transmitted in serial asynchronous form in accordance with ANSI standards. The first bit is a start bit and is followed by data bits, least-significant-bit first as illustrated by Figure 3. The following parameters are used:

Baud rate	4800
Data bits	8 (d7 = 0)
Parity	None
Stop bits	One

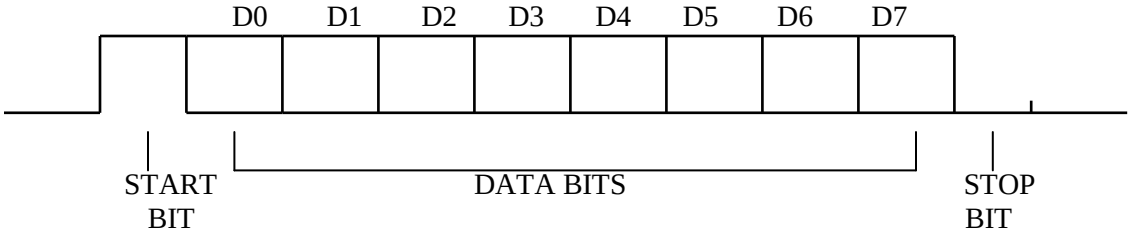


Figure 3 - Data Transmission Format

5. Data Format Protocol

5.1 Characters

All transmitted data shall be interpreted as ASCII characters. The most significant bit of the 8-bit character shall always be transmitted as zero (d7 = 0).

5.1.1 Reserved Characters

The reserved character set consists of those ASCII characters shown in Section 6.1 (Table 4). 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.

5.1.2 Valid Characters

The valid character set consists of all printable ASCII characters (HEX 20 to HEX 7E) except those defined as reserved characters. Section 6.1.2 (Table 5) lists the valid character set.

5.1.3 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 8859-1 that is a Reserved Character (Table 4) or not listed in Table 5 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 "127.5º" 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.

5.1.4 Character Symbols

When individual characters are used in this standard to define units of measure, indicate the type of data field, type of sentence, etc. they shall be interpreted according to the character symbol table in Section 6.1.3 (Table 6).

5.2 Fields

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

5.2.1 Address Field

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 found in Section 5.3.3. The "!" delimiter identifies sentences that conform to the special-purpose encapsulation and non-delimited field composition rules found in Section 5.3.4. 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:

5.2.1.1 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 Section 6.1.4 (Table 7).

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 Galileo receiver shall transmit GP when the position is GPS based, GA when the position is Galileo based, and GN for a combined navigation position from both Galileo and GPS. 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 compass heading is actually derived from GPS signals).

The next three characters form the Sentence Formatter used to define the format and the type of data. Sections 8.1, 8.2, 9.1, 9.2 10.1 list approved Sentence Formatters.

5.2.1.2 Query Address Field

The query address 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".

5.2.1.3 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.

A valid list of Manufacturer's Mnemonic Codes is contained in Appendix B. A current list can be found on the NMEA website, www.nmea.org or www.standards.nmea.org. NMEA provides the Manufacturer's Mnemonic Code at no charge. NMEA issues and maintains the Manufacturer's Mnemonic Codes for NMEA 0183 and IEC 61162-1. Manufacturers requesting a Mnemonic Code should contact NMEA at info@nmea.org.

5.2.2 Data Fields

Data Fields in approved sentences follow a "," delimiter and contain valid characters (and "^" code delimiters) in accordance with the formats illustrated in Section 6.2.1 (Table 8). 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 total number of characters received from the start of the sentence.

5.2.2.1 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".

5.2.2.2 Data Field Types

Data fields may be alpha, numeric, alphanumeric, variable length, fixed length, 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 Section 6.2.1 (Table 8), Field Type Summary.

5.2.2.3 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: ",," ",*"

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

5.2.3 Checksum Field

A checksum field is required and 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 8-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 4 bits of the result is converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first.

For example: (the use of checksum field)
$**GPGLL,5057.970,N,00146.110,E,142451,A***27<CR><LF> and
$**GPVTG,089.0,T,,,15.2,N,,,***7F<CR><LF>

5.2.4 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 are determined by the applicable sentence definition. This is one of three key fields supporting the multi-sentence message capability. See Section 5.3.8 - Multi-sentence Messages (using the same formatter)

5.3 Sentences

This section describes the general structure of sentences. Details of specific sentence formats are found in Sections 8, 9, 10. Some sentences may specify restrictions beyond the general limitations given in this part of the standard. Such restrictions may include defining some fields as fixed length, variable length, floating numeric field 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 <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 start delimiter character "$" or "!" and end with the sentence termination delimiter <CR><LF>.

5.3.1 Description of Approved Sentences

Approved sentences are those designed for general use and detailed in this Standard. Approved sentences are listed in Sections 8, 9, 10, and Appendix G. Sentences contained in Sections 8, 9, and 10 be shall used wherever possible.

Appendix G contains deprecated sentences that may be phased-out of use, are not recommended for new designs, but may be met in practice.

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

"$" or "!"	HEX 24 or HEX 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>	Hex 0D 0A - End of sentence

5.3.2 Valid Sentences

Approved sentences (Parametric & Encapsulation), Command 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.

5.3.3 Parametric Sentences

These sentences start with the "$" (HEX 24) delimiter, and represent the majority of approved sentences defined by this standard. This sentence structure, with delimited and defined data fields, shall be the preferred method for conveying information.

The basic rules for parametric sentence structures are:

1. The sentence begins with the "$" delimiter.
2. Only approved sentence formatters are allowed. Formatters used by special-purpose encapsulation sentences cannot be reused.
3. Only valid characters shall be allowed. See Section 6.1.2 (Table 4 and Table 5).
4. Only approved field types shall be allowed. See Section 6.2 (Table 8).
5. Data fields (parameters) are individually delimited, and their content is identified and often described in detail by this standard.
6. Encapsulated non-delimited data fields are NOT ALLOWED.

5.3.3.1 Approved Parametric Sentence Structure

The approved parametric sentence structure is shown below. A description of each character or character group is provided in Table 2.

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

Table 1 - Parametric Sentence Elements

ASCII	HEX	DESCRIPTION
"$"	24	Start of Sentence.
ccccc		Address Field. Alphanumeric characters identifying type of TALKER, and Sentence Formatter. The first two characters identify the TALKER. The last three are the Sentence Formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate readouts by users.
","	2C	Field delimiter. Starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.
c--c		Data Sentence block. Follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by 3rd and subsequent characters of the address field (the "Sentence Formatter"). Data fields may be of variable length and are preceded by delimiters ",".
"*"	2A	Checksum Delimiter. Follows last data field of the sentence. It indicates that the following two alphanumeric characters show the HEX value of the Checksum.
hh		Checksum Field. The absolute value calculated by exclusive-OR'ing the 8 data bits (no start bits or stop bits) of each character in the Sentence, between, but excluding "$" and "*". The hexadecimal value of the most significant and least significant 4 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	Terminates Sentence.

5.3.4 Encapsulation Sentences

These sentences start with the "!" (HEX 21) 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:

1. The sentence begins with the "!" delimiter.
2. Only approved sentence formatters shall be allowed. Formatters used by conventional parametric sentences cannot be reused. See Section 8.1
3. Only valid characters shall be allowed. See Section 6.1, 6.1.2 (Table 4 and Table 5).
4. Only approved field types shall allowed. See Section 6.2 (Table 8, Table 9, Table 10).
5. Only Six bit coding may be used to create encapsulated data fields. See Section 6.2.4 Encapsulated data fields may consist of any number of parameters, and their content is not identified or described by this standard
6. The sentence must 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 Section 5.2.2.
7. The sentence contains a "Total Number Of Sentences" field. See Section 5.3.3.1.
8. The sentence contains a "Sentence Number" field. See Section 5.3.4.1.
9. The sentence contains a "Sequential Message Identifier" field. See Section 5.3.4.1.

10. 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 Section 5.3.4.1.

Note:
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) transponder.

Condition 2: When information requires a significantly higher data rate than can be achieved by the NMEA 0183 (4,800 baud) and NMEA 0183-HS (38,400 baud) 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, a AIS transponder has a data rate capability of 4,500 messages per minute, and satisfies this condition, resulting in the VDM and VDO sentences.

5.3.4.1 Approved Encapsulation Sentence Structure

The approved encapsulation sentence structure is shown below. A description of each character or character group is provided in Table 3.

!ccccc,x^1,x^2,x^3,c--c,x^4*hh<CR><LF>

Table 2 - Encapsulation Sentence Elements

ASCII	HEX	DESCRIPTION
"!"	21	Start of Sentence.
ccccc		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.
x^1		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 fixed or variable length, and is defined by the sentence definitions in Section 8.2. and 9.2.
x^2		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 Section 8.2. and 9.2
x^3		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 is determined by the applicable sentence definitions in Section 8.2.. and 9.2.
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. Data field sequence is fixed and identified by 3rd 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 last data field in the sentence.
x^4		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 must 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 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 4 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	Terminates Sentence.

5.3.5 Query Sentences

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:

"$"	HEX 24 - Start of sentence
<cc>	TALKER Identifier of requester
<cc>	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>	HEX 0D 0A - End of sentence

5.3.5.1 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, unless specified in the sentence definition or other applicable equipment standard.

5.3.6 Proprietary Sentences

Proprietary sentences 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 but must follow the rules for sentence structure as outlined in this standard. This will generally be for one of the following reasons:

1. 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;

2. Data is being used for test purposes prior to the adoption of approved sentences;

3. Data is not of a type and general usefulness which merits the creation of an approved sentence.

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

"$" or "!"	Hex 24 or Hex 21- Start of sentence
"P"	Hex 50 - Proprietary sentence ID
<ccc>	Manufacturer's Mnemonic code
[<valid characters>, “^”, “,”]	Manufacturer's data
"*"<checksum field>	Checksum field
<CR><LF>	Hex 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-character 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.

5.3.7 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 Regional Channel Assignment Message" sentences. When a command sentence is generated in response to a Query sentence, a means to identify that sentence as 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 ship 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 as identified in Table 8.

5.3.8 Multi-sentence Messages (using the same formatter)

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
- 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.

Use of the multi-sentence message method applies in single sensor configurations and for a single sentence formatter. This method does not address all requirements where multiple talkers with the same nature (talker identifier) are providing information. Implementations should apply the TAG Block methods where different sentence formatters from equipment with the same nature need to be linked. The TAG Block method is the recommended NMEA 0183 means for linking sentences with different sentence formatters (See Section 7).

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.

5.3.9 Multi-sentence Messages (using any different sentence formatters)

Sentences with different sentence formatters can be associated or "linked" to each other. This is done using TAG Blocks that are added to each sentence – forming "lines". See Section 7 TAG Blocks and also Section 7.7 Sentence-Grouping (associated lines) - "line-linking".

5.3.10 Sentence Transmission Timing

Frequency of sentence transmission when specified shall be in accordance with the approved sentence definitions (Sections 6.3, 6.4). When not specified, the rate should 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 second.

5.4 Error Detection and Handling

Listening devices shall detect errors in data transmission including:

- Checksum error
- Invalid characters
- Incorrect length of TALKER identifier, sentence formatter, and data fields
- Time out of sentence transfer.

Listening devices shall use only correct sentences, consistent with the version of NMEA 0183 supported by the Talker devices. Versions of NMEA 0180 and NMEA 0183 previous to version 2.0 are not compatible with any other versions on NMEA 0183.

5.5 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 this 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. Deprecated sentences can be found in Appendix H of this standard. For any updated deprecated sentences, check the Marine Electronics Journal, www.nmea.org or standards.nmea.org

5.6 Future 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 should 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.

6. Data Content

6.1 Character Definitions

6.1.1 Reserved Characthers

Table 3 - Reserved Characters

	Hex	Dec	
<CR>	0D	13	Carriage return ┐ End of sentence delimiter
<LF>	0A	10	Line feed ┘
$	24	36	Start of Parametric 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 8859-1 characters
~	7E	126	Reserved for future use
<del>	7F	127	Reserved for future use

6.1.2 Valid Characters

Table 4 - Valid Characters

Character	Hex	Dec		Character	Hex	Dec		Character	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
#	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

6.1.3 Character Symbols

Table 5 - Character Symbols

A	Status symbol; Yes; Data Valid; Warning Flag Clear; Auto; Ampere; ASCII, Acknowledged, Activation, Autonomous
a	Alphabet character variable A through Z or a through z
B	Bars (pressure, 1000 Mb =1 Std. Atm. = 100kPa); Bottom, Broadcast, Bridge
C	Celsius (Degrees); Course-up, Caution, Engine Control Room
c	Valid character; Calculating, Unix time
D	Degrees (of Arc), Differential
d	Destination-identification (TAG Block)
E	Error; East; Engine, Estimated, Engine side/local
F	Fathoms (1 fathom equals 1,828,766 m), Float RTK
f	Feet (1 foot equals 0.30479 m)
G	Great Circle; Green
g	Good; Sentence-grouping (TAG BLOCK)
H	Compass Heading; Head-up; Hertz; Humidity Alarm State (Threshold Exceeded), Harbor Mode
h	Hours; HEX number
I	Inches (1 inch equals 0.0254 m)
J	Input operation completed, Alarm State (Extreme Threshold Exceeded)
K	Kilometers; km/hour, kg/m^3 Alarm State (Extreme Low Threshold Exceeded)
k	Kilograms
L	Left; Local; Lost Target Alarm State (Low Threshold Exceeded)
l	Latitude; Liters; Liters/second
M	Meters; Meters/second; Magnetic; Manual; Cubic Meters, Manual Input Mode
m	Minutes; message
N	Nautical miles; Knots; North; North-up; Newton Normal State, No fix
n	Numeral; address; line-count (TAG Block)
P	Purple; Proprietary (only when following “$” or “!”); Position sensor; Percent; Pascal (pressure), Precise, Port wing
Q	Query; Target-Being-Acquired, Override
R	Right; Rhumb line; Red; Relative; Reference; Radar Tracking; Rev/min (RPM), Real Time Kinematic
r	Relative time
S	South; Statute miles; Statute miles/hour (1609.31 m); Shaft; Salinity in parts per thousand Simulator Mode; Source-identification (TAG BLOCK), Status, Safe, Simulator Mode, Starboard Wing,
s	Seconds; Six bit number
T	Time difference; True; Track; Tracked-Target
t	Test; text-string (TAG Block)
U	Dead Reckoning Estimate , Unsafe
u	Sign, if minus "-" (HEX 2D)
V	Data invalid; No; Warning Flag Set; Manual; Volt, Not Acknowledged, Not in Use
W	West; Water; Wheelover, Wing
X	Numeric character variable
Y	Longitude
Z	Time

6.1.4 Talker Identifier Mnemonics

(Address Characters 1 and 2)

Table 6 - Talker Identifier Mnemonics

TALKER DEVICE	IDENTIFIER
Independent AIS Base Station	AB
Dependent AIS Base Station	AD
HEADING TRACK CONTROLLER (Autopilot): General Magnetic	AG AP
Mobile Class A or B AIS Station	AI
AIS Aids to Navigation Station	AN
AIS Receiving Station	AR
AIS Station (ITU_R M1371, ("Limited Base Station')	AS
AIS Transmitting Station	AT
AIS Simplex Repeater Station	AX
Bilge Systems	BI
Bridge Navigational Watch Alarm System	BN
COMMUNICATIONS: Digital Selective Calling (DSC) Data Receiver Satellite Radio-Telephone (MF/HF) Radio-Telephone (VHF) Scanning Receiver	CD CR CS CT CV CX
Direction Finder	DF
Duplex Repeater Station	DU
Electronic Chart System (ECS)	EC
Electronic Chart Display & Information System (ECDIS)	EI
Emergency Position Indicating Beacon (EPIRB)	EP
Engine Room Monitoring Systems	ER
Fire Door Controller/Monitoring Point	FD
Fire Extinguisher System	FE
Fire Detection Point	FR
Fire Sprinkler System	FS
Galileo Positioning System	GA
GLONASS Receiver	GL
Global Navigation Satellite System (GNSS)	GN
Global Positioning System (GPS)	GP
HEADING SENSORS: Compass, Magnetic Gyro, North Seeking Fluxgate Gyro, Non-North Seeking	HC HE HF HN
Hull Door Controller/Monitoring Panel	HD
Hull Stress Monitoring	HS
Integrated Instrumentation	II
Integrated Navigation	IN
Loran C	LC
Multiplexer	MX
Navigation Light Controller	NL
Proprietary Code	P

TALKER DEVICE		IDENTIFIER
Radar and/or Radar Plotting		RA
Propulsion Machinery Including Remote Control		RC
Physical Shore AIS Station		SA
Sounder, depth		SD
Steering Gear/Steering Engine		SG
Electronic Positioning System, other/general		SN
Sounder, scanning		SS
Turn Rate Indicator		TI
Microprocessor Controller		UP
($0 \leq \# \leq 9$) User configured talker identifier[1]		U# [1]
VELOCITY SENSORS:	Doppler, other/general	VD
	Speed Log, Water, Magnetic	VM
	Speed Log, Water Mechanical	VW
Voyage Data Recorder		VR
Watertight Door Controller/Monitoring Panel		WD
Weather Instruments		WI
Water Level Detection Systems		WL
Transducer		YX
TIMEKEEPERS, TIME/DATE:	Atomics Clock	ZA
	Chronometer	ZC
	Quartz	ZQ
	Radio Update	ZV

NOTES:

1

The "U#" talker identifier does not convey the nature of the device transmitting the sentence, and should not be "fixed" into a unit at manufacturing. This is intended for special purpose applications. The "U#" talker identifier indicates that the device's default talker identifier has been changed through external control (See BCG Sentence)

6.2 Field Definitions

6.2.1 Special Format Fields

Table 7 - Special Format Fields

Special Format Field	Symbol	Definition
Sentence Status Flag	a	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". When 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.
Status	A	A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set
Latitude	llll.ll	Fixed/Variable length field: degreesminutes.decimal - 2 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for 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: degreesminutes.decimal - 3 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for 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: hoursminutesseconds.decimal - 2 fixed digits of hours, 2 fixed digits of minutes, 2 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 that are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll,ll", "x", "yyyy.yy"

6.2.2 Numeric Value Fields

Table 8 - Numeric Value Fields

Field Type	Symbol	Definition
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeroes. The decimal point and associated decimal-fraction are optional if full resolution is not required. (for 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 number field	xx__	Fixed length field of numeric characters
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.

NOTES:

1. Spaces shall only be used in variable text fields.

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

3. Units of measure fields are appropriate characters from the Character Symbol Table (Section 6.1.3 Table 6) unless a specific unit of measure is indicated

4. 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.

6.2.3 Information Fields Table

Table 9 - Information Fields

Field Type	Symbol	Definition
Fixed alpha field	aa___	Fixed length field of upper-case or lower case alpha characters.
Variable text	c--c	Variable length valid character field.
Fixed text field	cc___	Fixed length field of valid characters
Fixed Six bit field	ss___	Fixed length Six bit coded characters only. See Table 11 and Figures 3 & 4 for field conversions.
Variable Six bit field	s--s	Variable length Six bit coded characters only. See Table 8 Table 11 and Figures 3 & 4 for field conversions.

NOTES:

1. Spaces shall only be used in variable text fields.
2. 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.
3. Units of measure fields are appropriate characters from the Character Symbol Table (Section 6.1.3 Table 6) unless a specific unit of measure is indicated.
4. 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.

6.2.4 Six-bit Binary Conversion Table

Valid Characters (See Section 6.1.2 Table 5)

Binary Field, **Most Significant Bit** on the left.

The two MSB's of the Valid Characters are not used.

Table 10 - Binary Field Conversion

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 11.

The algorithm to convert a 6-bit binary field to the appropriate 8-bit valid 0183 character field is shown in Figure 3

Similarly, an algorithm can also be used to convert the valid 0183 characters to the 6-bit binary values as shown in Figure 4

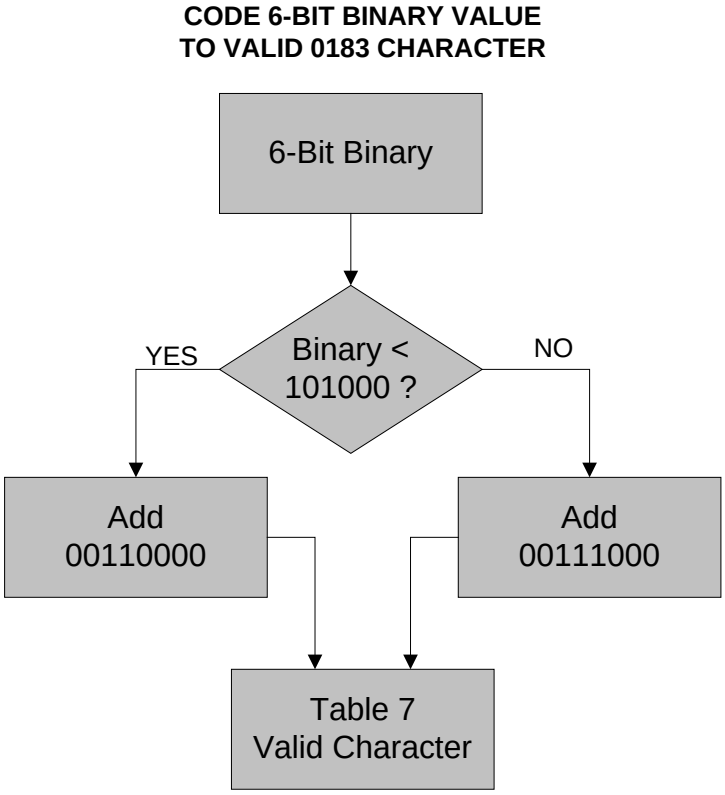


Figure 4 - NMEA 0183 Character Validation

Consider the following examples:

000001 is less than 101000, therefore add 00110000
00110000
00110001 = 31_{hex} = 1 (See Table 11)

000010 is less than 101000, therefore add 00110000
00110000
00110010 = 32_{hex} = 2 (See Table 11)

111010 is not less than 101000, therefore add 00111000
00111000
01110010 = 72_{hex} = r (See Table 11)

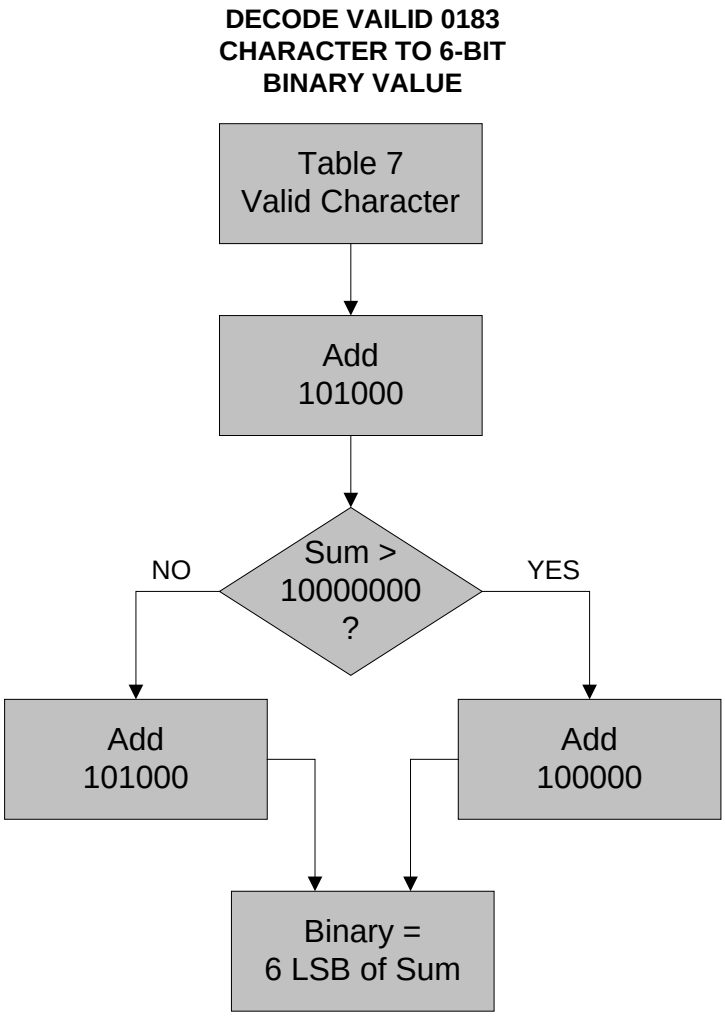


Figure 5 - NMEA 0183 Character Encoding

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".

7. TAG (Transport, Annotate, and Group) Block

7.1 Introduction

7.1.1 Overview

The content of this section describes data formats and rules that may be used to extend the NMEA / 0183 "sentence" structure for use in simple applications and complex networks, shipboard and land networks consisting of many devices and controllers. The networks' elements facilitate communications where a talker's output may be received by multiple listeners and where a listener may receive output by multiple talkers. The purpose of this section is to define methods that permit talkers and listeners to communicate over a common communications channel without affecting the operation of uninvolved listeners.

The development of these methods also considered the possibility that the communications connection may be unreliable or be subject to unknown time delays.

The methods described can be partially applied as needed. The degree to which these methods are incorporated into a device or process should be fully described in the documentation describing the operation of the device or process. Testing should be done to confirm proper implementations for receipt and generation of TAG Blocks.

In general, the data format and rules are presented from the perspective of an individual device or process. The operation of controllers that simultaneously communicate and manage many devices is not discussed in detail. However, the data format and rules have taken into consideration the needs of controllers.

7.1.2 Background

The structure of NMEA 0183 sentences is intended to support the transport of equipment data. The specific meaning of the data in each sentence is based upon the "Sentence Formatter" and the position and format description of each "Data Field" within a sentence.

The TAG Block structure and content is intended to clarify the relationship of sentences to each other and to the equipment between which sentences are communicated. The TAG Block structure introduces the addition of sentence-related information into the character stream containing NMEA 0183 defined sentences. Also, TAG Block methods can be used to link the data contained in sentences that have different formatters. This is accomplished using "parameter-codes" inside the TAG Block (See Section 7.4).

A TAG Block is not intended to transport equipment data – this remains the purpose of the "Sentence Formatter" / "Data Field" structure.

The following sections describe the TAG Block structure and definitions. The combination of the structure and definitions makes it possible to:

- Reliably link or associate "Data Fields" across different "Sentence Formatters,"
- Accurately identify the source of a sentence,
- Accept sentences only from recognized sources,
- Identify the timing relationship among sentences from different equipment,
- Accurately identify the intended destination for a sentence,
- Ignore sentences intended for other destinations,
- Permit annotation of sentences during their transport, and
- Detect the loss of sentences during communication between equipment.

The TAG Block can be used to adapt sentences to other systems (such as an AIS network) without changing an existing NMEA 0183 sentence definition or content. A TAG Block can be used to:

- Associate or "link" various combinations of TAG Blocks and sentences (See Section 7.11)
- Better manage sentences, and
- Support transport of NMEA 0183 sentences over any type of network – independent of the network's protocol.

7.2 Interoperability with 0183 devices not recognizing TAG Blocks

The TAG Block coding described below was chosen while taking into consideration the existing sentence decoding rules in NMEA 0183. Devices without the TAG Block feature should be unaffected by the presence of the TAG Block, if they have properly implemented the NMEA 0183 sentence decoding rules. Implementing TAG Block coding implies that the receiving device has followed the NMEA 0183 sentence decoding rules, that there are sufficient memory input buffers to handle the combined size of a TAG Block and NMEA 0183 sentence, and that there exists the ability to deal with lines containing valid or possibly invalid characters.

7.3 TAG Block Structure

The "\" character is designated as the "TAG Block delimiter."

- A TAG Block shall begin with a "\" character, and be closed with a "\" character.
- The closing character is always preceded by the checksum (*hh) of the TAG Block content.
- When combined with a standard sentence, the TAG Block shall appear ahead of the sentence.
- The beginning TAG Block "\" symbol shall follow the "<CR><LF>" symbols at the end of the preceding sentence.
- The TAG Block closing "\" appears before a symbol beginning a sentence (either a "$" or "!"), another beginning TAG Block "\", or the <CR><LF> symbols.
- A TAG Block may also be used without a following NMEA 0183 sentence; the closing "\" character of the last TAG Block in the "line" is followed by the <CR><LF> symbols. This can be useful when line length is a concern.

The maximum number of characters in a TAG Block shall be 80 characters including the beginning and closing "\" TAG Block delimiters.

Section 5.3 of NMEA 0183 states that the maximum number of characters in a sentence shall be 79 characters between the starting delimiter "$" or "!" and terminating delimiter <CR><LF>. The character content of a "TAG Block" plus the TAG Block delimiters is not included in the sentence character count.

The contents of the TAG Block (valid characters between the two "\" characters) may contain any valid character (See Table 5) and some of the reserved characters (Table 4).

The TAG Block should not contain either the TAG Block delimiter, or the start of sentence delimiters, "$" or "!", or characters reserved for future use, "~" or <del> characters. The remaining reserved characters (<CR>, <LF>, ",", "*", and "^", found in Table 3 shall be used as defined.

If the TAG Block content is in error, the TAG Block and the entire "line" or "group" shall not be used (See Section 7.5).

In order to allow for improvements or additions, future revisions of this standard may add parameter-codes. A TAG Block is not considered "in error" when it contains an unsupported "parameter-code." The unsupported parameter-code should be ignored.

7.4 TAG Block format

Each TAG Block may contain one or more parameters consisting of a "parameter-code" and "parameter value." Each parameter value may be either a numeric value or a character string. Each parameter value is preceded by a parameter-code that is used to identify the parameter. The parameter-code and parameter value are separated by a colon (:). For the definition of each parameter-code, see Section 7.9.

7.4.1 The general form of a TAG Block is:

\Parameter-code:parameter value or string,parameter-code:parameter value or string,…*hh\

A parameter-code is always immediately preceded by either the beginning "\" character or a comma (","). The associated parameter value or parameter string immediately follows the parameter-code. The delimiter at the end of the parameter value or parameter string is either a comma (,) when more parameter-codes follow, or the asterisk (*) that precedes the TAG Block checksum (hh) at the end of the TAG Block. Applying these rules results in four ways to delimit the parameter:

\x:value or **string*hh** (parameter delimited by "\" and "*" - single parameter TAG Block)

\x:value or **string,** (parameter delimited by "\" and "," - beginning of multi-parameter TAG Block)

,x:value or **string*hh** (parameter delimited by "," and "*" - end of multi-parameter TAG Block)

,x:value or **string,** (parameter delimited by "," and "," – amid TAG Block parameter in multi-parameter TAG Block)

Notes:

Where "x" is the parameter-code that identifies the parameter value or string.

The following is an example of a TAG Block with two parameters and a linked sentence:

\s:r003669961,c:1153612428*77\!AIVDM,1,1,,A,;3fIsl1uIsGmfJR6?4F8cl100000,0*79<CR><LF>

- In this example, the "s" inside the "\s:" identifies the value "r003669961" as the unique identifier for the AIS unit that is providing the linked VDM sentence.
- The "c" inside the ",c:" identifies the value 1153612428 as the UNIX time in seconds when the linked VDM sentence was constructed. The linking of a TAG Block with a single sentence is further described in Section 7.4.3.

7.4.2 TAG Block "hexadecimal checksum" (*hh)

In order to improve the integrity of the parameters in a TAG Block, the "Exclusive OR" hexadecimal checksum (*hh) that is calculated for every NMEA 0183 sentence shall also be used for the content of each TAG Block (see examples below). The checksum is the 8-bit Exclusive OR (no start or stop bits) of all characters in the TAG Block, including the "," and "^" delimiters, between but not including the beginning "\" character and the "*" checksum delimiter.

7.4.3 TAG Block "line"

A TAG Block "line" can be formed in three ways:

1. The TAG Block can appear alone to form a "line".
2. The TAG Block may precede a sentence to form a "line" with an associated NMEA 0183 sentence.
3. Multiple TAG Blocks may appear one after another to form a "line" or they may precede a sentence to form a "line" with an associated NMEA 0183 sentence.

A TAG Block "line" is only valid when either a <CR><LF> immediately follows the last TAG Block closing "\" symbol, or when a valid NMEA 0183 sentence immediately follows the last TAG Block closing "\" symbol. TAG Blocks are linked with a sentence when no <CR><LF> or any characters separate the last TAG Block and sentence.

The general form of a line is either:

\Parameter-code:value,…*hh\[\ Parameter-code:value,…*hh\ …]<CR><LF>

Or

\Parameter-code:value,…*hh\[\Parameter-code:value,…*hh\ …]*valid sentence*<CR><LF>

Note: The square brackets "[...]" above illustrate optional TAG Blocks in a "line".

Inclusion of any character (including <CR><LF>) between the closing "\" character and the "start of sentence" delimiter ($ or !) breaks the association between the TAG Block(s) and a sentence.

7.5 Error Detection

As described above, a line links character strings (TAG Block(s) and sentence) with independent checksums and different format rules. The combination forms a single package of related information. The information in the entire package is compromised if an error occurs in any part of the line.

If any of the following errors are detected, the entire line or grouped lines shall be considered to be in error and should not be used. If an error is detected in any grouped line, all lines of that group shall not be used.

- The listener calculated exclusive-or checksum of the TAG Block contents does not equal the talker-calculated checksum (*hh). This test applies to all TAG Blocks on a line.
- A start of sentence delimiter, "$" or "!", appears before the TAG Block is closed with a "*hh\".
- The character following the last TAG Block closing "\" symbol is not a valid start of sentence delimiter or <CR><LF> characters.
- The TAG Block parameter-codes are used incorrectly.
- Errors listed in Section 5.4 (Error Detection and Handling).

Note:

There is currently no mechanism to report errors found in the TAG Block portion of a "line". Errors found in sentences may be reported using the NAK sentence - as specified in the equipment's documentation.

7.6 TAG Block line - sentence model

The purpose of the TAG Block is to provide a mechanism to clarify the relationship of sentences to each other and to the equipment among which sentences are communicated. The TAG Block structure adds sentence-related information to the NMEA 0183 sentence format – producing the \TAG Block\Sentence "line."

Figure 6 below shows the processing relationship between the TAG Block Line Input and Line Output processes and the NMEA 0183 Sentence Process. The "NMEA 0183 Sentence Process" in Figure 6 represents all of the existing conventions, rules, and sentence definitions described in NMEA 0183. The "blocking" of input and "appending" of output is controlled through the use of the TBS and CPx command sentences and parameter-code values. The details and logic of these processes are discussed below (See Section 7.13).

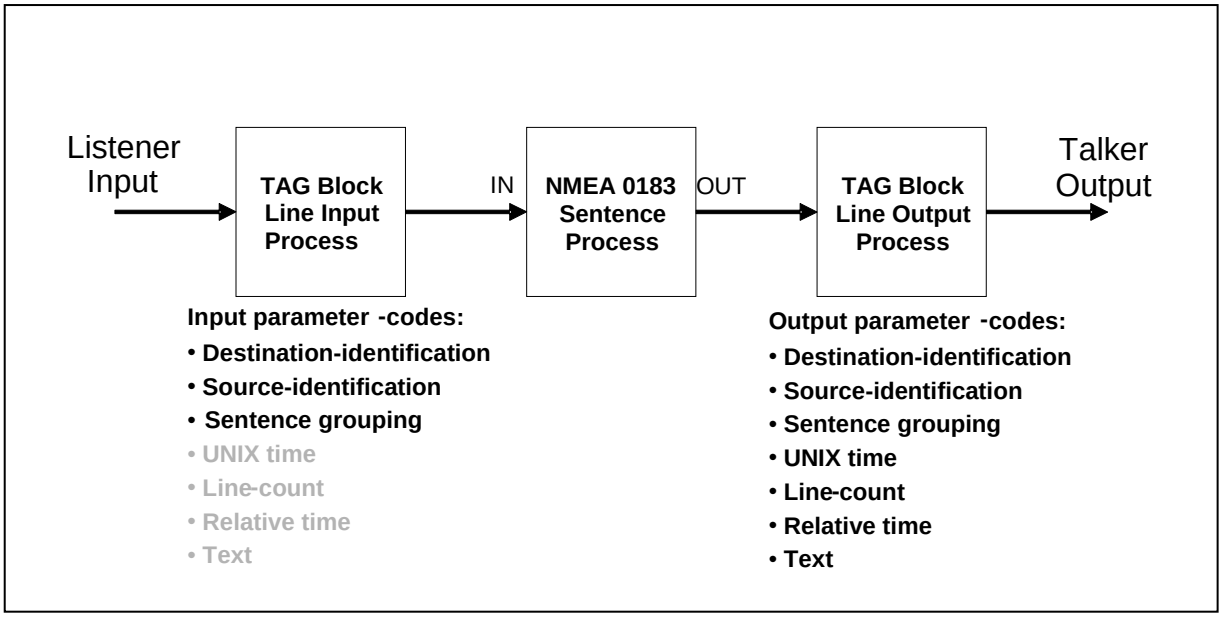


Figure 6 – TAG Block Sentence Model

Note: The four of the "Input parameter-codes" are listed in light grey.

Data fields supporting these parameter codes are provided in each "CPx" configuration sentence, but rules for the application of these parameter-codes to the TAG Block Line Input Process are not developed and do not appear in this document.

When at least one TAG Block "listener" parameter-code is enabled:

- The TAG Block Line Input Process will analyze input lines before the sentences they contain are passed to the NMEA 0183 sentence processes.
- It is possible that analysis of the line may result in the attached sentence(s) being blocked and not passed to the NMEA 0183 Sentence Process. Blocking may be due to the outcome of the

Listener's TAG Block Line Input Process logic (See Section 7.7) or detection of a data reception error (See Section 7.5).

When at least one TAG Block "talker" parameter-code is enabled:

- The TAG Block Line Output Process may add a TAG Block to a sentence to create a "line" after the sentence is output from the NMEA 0183 Sentence Process.

When all the TAG Block features of a device are disabled:

- The logical model of the device reverts to the NMEA 0183 Sentence Process alone.
- "Listener Input" goes directly to the "IN" of the NMEA 0183 Sentence Process.
- The NMEA 0183 Sentence Process should completely ignore the TAG Blocks and recognize only the sentence portions of the lines.
- "Talker Output" will be a complete sentence from the "OUT" side of the NMEA 0183 Sentence Process.

The presence of TAG Block information in the "Listener Input" to a device or process that has disabled TAG Block capabilities does not activate, or use, those capabilities while those capabilities remain disabled (See Section 7.13).

7.6.1 Input Sentence blocking using TAG Block "destination" and "source"

As introduced in Section 7.1.2, a device or process should be able to ignore sentences not intended for its application. This is particularly important concerning "command" sentences that are capable of changing the configuration of the device or process. The TAG Block provides two parameter-codes that may be applied for this purpose – destination-identification and source-identification. The details for both of these parameter-codes are provided below in the TAG Block parameter-code dictionary (See Section 7.9). Presented here are the rules concerning the use of these parameter-codes to properly ignore sentences not intended for a device's or process' application.

When the listener's destination-identification (See CPD Sentence) is enabled, the "TAG Block Line Input Process" in Figure 6 is responsible for reviewing each line received and blocking the sentences of those lines where the TAG Block destination-identification does not match the UI (Unique Identifier) of the device or process. Similarly, when the listener's source-identification (See CPS Sentence) is enabled, the "TAG Block Line Input Process" is responsible for reviewing each line received and blocking the sentences of those lines where the TAG Block source-identification does not match one of the source-identifications recognized by the device or process (See TBS Sentence).

Table 12 lists all the possible combinations of input lines, and settings for the listener destination-identification and listener source-identification data fields. Also provided is the correct result for each set of conditions.

7.6.1.1 Listener's TAG Block Line Input Process

Listener's TAG Block Line Input Process logic for sentence blocking using destination-identification and source-identification parameter-codes.

Table 11 - Listener's TAG Block Line Input Process

Input	Listener destination-identification (See CPD)	Listener source-identification (See CPS)	Pass line's sentence to NMEA 0183 Sentence Process?
Line with sentence but no TAG Block	**Disabled**	**Disabled**	Yes
	Disabled	Enabled	No
	Enabled	**Disabled**	No
	Enabled	Enabled	No
Line with TAG Block (containing both destination-identification of the listener and a recognized source-identification of the talker)	**Disabled**	**Disabled**	Yes
	Disabled	Enabled	Yes
	Enabled	**Disabled**	Yes
	Enabled	Enabled	Yes
Line with TAG Block (containing destination-identification of the listener, but no source-identification recognized by the listener)	**Disabled**	**Disabled**	Yes
	Disabled	Enabled	No
	Enabled	**Disabled**	Yes
	Enabled	Enabled	No
Line with TAG Block (containing no destination-identification matching the listener's, but containing a recognized source-identification of the talker)	**Disabled**	**Disabled**	Yes
	Disabled	Enabled	Yes
	Enabled	**Disabled**	No
	Enabled	Enabled	No
Line with TAG Block (containing neither a destination-identification matching the listener's, nor containing a recognized source-identification of the talker)	**Disabled**	**Disabled**	Yes
	Disabled	Enabled	No
	Enabled	**Disabled**	No
	Enabled	Enabled	No

7.6.2 Output TAG Blocks with “destination” and “source”

7.6.2.1 Source

If the talker source-identification is enabled, a TAG Block, containing at least the source-identification parameter-code and value, should be linked to every output sentence or grouped output sentences.

7.6.2.2 Destination

The talker destination-identification parameter-code is used on output only when the output is a necessary reply to an input sentence. Sentences that are autonomously output and are not a reply should not use the talker destination-identification parameter-code.

When the talker destination-identification is enabled, a TAG Block containing the destination-identification parameter-code value matching the source-identification parameter-code value of the input, should be linked to output sentences for the conditions described in Table 13.

Situations where this parameter-code may be necessary include a response to query sentence or response(s) to commands that request status information. The parameter-code may also be used with a NAK (when supported) reply as appropriate.

Table 13 lists all the possible combinations of output lines, and settings for the talker destination-identification and listener source-identification data fields. Also provided is the correct result for each set of conditions.

7.6.2.3 Talker’s TAG Block Line Output Process

Talker’s TAG Block Line Output Process logic for line construction using destination-identification and source-identification parameter-codes.

Table 12 - Talker's TAG Block Line Output Process

Input Case	Talker destination-identification (See CPD)	Line output with TAG Block including destination-identification (d:) set to input source-identification value
Line with sentence but no TAG Block	**Disabled**	No
	Disabled	No
	Enabled	No
	Enabled	No
Line with TAG Block (containing both destination-identification of the listener and a recognized source-identification of the talker)	**Disabled**	No
	Disabled	No
	Enabled	Yes
	Enabled	Yes
Line with TAG Block (containing destination-identification of the listener, but no source-identification recognized by the listener)	**Disabled**	No
	Disabled	No
	Enabled	Yes if s: provided in input
	Enabled	Yes if s: provided in input
Line with TAG Block (containing no destination-identification matching the listener's, but containing a recognized source-identification of the talker)	**Disabled**	No
	Disabled	No
	Enabled	Yes
	Enabled	Yes
Line with TAG Block (containing neither a destination-identification matching the listener's, nor containing a recognized source-identification of the talker)	**Disabled**	No
	Disabled	No
	Enabled	Yes if s: provided in input
	Enabled	Yes if s: provided in input

7.7 Sentence-Grouping (associated lines) - "line-linking"

Sentences with different sentence formatters can be associated or "linked" to each other. This is done using TAG Blocks that are added to each sentence – forming "lines" (See Section 7.4.3). The association of two or more lines forms a "group" (See Section 7.11). Each line of a group must contain a TAG Block. Each line may or may not include a sentence. Multi-sentence messages may be in a group. A single TAG Block linked to a sentence to form a single line is not a group (See Section 7.4.3). The Data Fields of sentences supporting the multi-sentence message method shall also be properly applied (See Section 5.3.8) even when linked with TAG Blocks.

The TAG Block does not replace the multi-sentence message method or requirements.

If an error is detected in any line of a group, all lines of that group should not be used. The "TAG Block Line Input Process" should not pass lines of a group to the "NMEA 0183 Sentence Process" until all lines of the group have been checked for errors (See Section 7.5).

The "Talker sentence-grouping" data field (See CPG Sentence.) enables the function of grouping sentences using TAG blocks on output. The specific details should be described in a device's (or process') documentation.

7.8 Rules for processes assisting in the transport of lines from talker to listener

Where networks connect talkers and listeners, there are events that can affect the transport of the “lines”.

Multiple TAG Blocks may exist in a single “line”. This is the result when a process adds information to a “line” containing one (or more) TAG Block(s). When multiple “lines” are grouped, additional TAG Blocks may be added to any one of the grouped “lines”. For such a case, the rules for adding TAG Block information are:

- Do not modify or add parameters to an existing TAG Block.
- Additional TAG Block parameters shall be added in a new TAG Block.
- New TAG Blocks are added to an existing “line(s)”.
- Insert an additional TAG Block immediately following the last TAG Block and prior to any sentence that may be part of the “line.”
- It is strongly recommended that the Source-identification Parameter Code “s” be included in the additional TAG Block to identify the process or equipment that added or inserted the new TAG Block. This enables the final recipient of the “line” to know from where the additional information originated.

Another process example is:

- If a command sentence is broadcast with a destination-identification and the path from talker to listener is “broken,” it may be helpful to the originating process if the originating process is informed that the command sentence cannot be relayed and has been deleted by a network process. This type of behavior would be application specific.

7.9 TAG Block Parameter-code Dictionary

Table 13 - TAG Block Parameter-code

Parameter-code	Parameter Name	Form
c	UNIX time	c:positive integer
d	Destination-identification	d:*alphanumeric string* (15 char. maximum)
g	Sentence-grouping	g:numeric string
n	Line-count	n:positive integer
r	Relative time	r:positive *integer*
s	Source-identification	s:*alphanumeric string* (15 char. maximum)
t	Text-string	t:valid character string

7.9.1 UNIX time parameter – "c"

Form: c:positive integer

c: *(lower case "C")* UNIX Time in seconds or milliseconds calculated from the UNIX epoch time 00:00:00 UTC on January 1, 1970. UNIX time (or POSIX time) is an encoding of UTC. Each day increases this number by exactly 86400 seconds per day. When enabled, this UNIX time tag is attached to every line. When set for milliseconds and millisecond resolution is not available, the value should contain zeros for the millisecond digits of the UNIX time.
This parameter is controlled using the CPC sentence.

7.9.2 Destination-identification Parameter – "d"

Form: d:alphanumeric string (unique identifier, 15 character maximum)

d: *(lower case "D")* destination-identification. This parameter is a unique "alphanumeric string" used to indicate the listener device or process for which the attached sentence or sentence group is intended. For a Base Station this is the SID sentence data field, "Unique Identifier", that represents the system level station identification.

Use of this parameter in the TAG Block does not remove the requirement to include the "Unique Identifier" field in the attached sentence – where the attached sentence contains a "Unique Identifier" field for a destination's unique identifier. The unique identifier value should appear both in the "d" parameter-code and, where appropriate, in the linked sentence's "Unique Identifier" data field. For sentences with "Unique Identifier" (UI) data fields, the NMEA 0183 Sentence Process" (See Section 7.6) must evaluate the UI value as required for the specific sentence formatter. This evaluation is separate from the "TAG Block Line Input Process" that evaluates the "s" or "d" parameter-codes of a TAG Block.

Each device (or process) in a network may have a unique identifier. When the destination-identification parameter appears in a TAG Block, it indicates the identifier for the device for which the linked sentence or group of sentences is intended. Each listener is responsible for testing the destination-identification value before accepting sentences (See Section 7.6.1). This is particularly important when the sentence is for configuration or control. In a group (g:) of lines, the destination-identification parameter need only appear in one of the TAG Blocks in the group. It is possible that a TAG Block, or a group with two or more TAG Blocks, may contain multiple destinations. Each listener is responsible for recognizing its own identifier, and each listener would treat the line or group of lines as addressed to that unit.

Under certain conditions, a device (or process) may link a destination-identification to a reply to an input sentence (See Section 7.6.2.2 for a complete description).

This parameter is controlled using the CPD sentence.

7.9.3 Sentence-grouping Parameter – "g"

Form: g:*numeric string* (form of string: "x-y-code")

Where x, y, and code (group-code) are positive integers

g: *(lower case "G")* sentence-grouping string. A series of sentence-grouping strings are used to link lines into a group. This method is used to associate or link sentences. The method applies rules similar to the rules used to extend a sentence formatter beyond the limitation of an 80-character sentence length (See Section 5.3.8). The three required parameters in each sentence-grouping string are: sentence number (x), total number of sentences (y), and a unique sequential identifier (group-code). A "-" (dash) character is used to separate the numbers.

Each combination of a TAG Block and NMEA 0183 sentence creates a "line". A line containing only a TAG Block without a linked sentence can also be part of a group. The value of the "x" (integer) indicates the line number within the group, and the "y" (integer) indicates the total number of lines in the group. The code parameter should be limited to a positive integer that is the same in each line in the group. The combined string, "x-y-code," is used to uniquely identify the lines of a group.

When the TAG Block feature is being used to group multiple lines, the sentence-grouping string shall appear first. The sentence-grouping parameter-code "g" immediately follows the beginning TAG Block "\" symbol.

When the TAG Block feature is enabled, it is not necessary to include the "g" parameter-code for single line sentences (That is, "g:1-1-*(group-code)*" is not required.).

Any device equipped with TAG Block capabilities shall support the sentence-grouping parameter as a "listener."

This parameter is controlled using the CPG sentence.

7.9.4 Line-count Parameter – "n"

Form: n:positive integer

n: *(lower case "N")* line-count. A positive integer always beginning at the "initial line count" value. The "initial line-count" value is incremented by the "count increment" for each occurrence of the parameter being attached to a line by a talker. This value is reset as configured using the CPN-sentence.

When the line-count parameter is active, a TAG Block should precede every sentence. Every TAG Block shall contain a line-count parameter. The line-count parameter is incremented after each time it is output.

This parameter is controlled using the CPN sentence.

7.9.5 Relative time Parameter – "r"

Form: r:*integer*

r: *(lower case "R")* Time in seconds or units defined by the equipment's manufacturer calculated from an initialized starting time or count. The value is calculated starting with the initialized time. The initial time from which relative time is calculated is not defined by this standard, but defined by the application or equipment performance standard specifying the use of this parameter code. The event that begins this count may be unique to the device that is generating the related sentences. When enabled, this time tag shall be attached to every line. The value of this parameter code may be negative.

This parameter is controlled using the CPR sentence.

7.9.6 Source-identification Parameter – "s"

Form: s:alphanumeric string (Unique Identifier, 15 character maximum)

s: *(lower case "S")* source-identification. This parameter is a unique "alphanumeric string" used to identify the talker device or process that originated the linked sentence or sentence group. For an AIS Base Station this is the SID sentence data field, "Unique Identifier", that represents the system level station identification. Only one source-identification may appear in a TAG Block.

Use of this parameter in the TAG Block does not remove the requirement to include the "Unique Identifier" field in the attached sentence – where the attached sentence contains a "Unique Identifier" field for the source's unique identifier. The unique identifier should appear both in the "s" parameter-code and, where appropriate, in the sentence's "Unique Identifier" data field.

When the talker source-identification parameter is active, a TAG Block should precede every sentence. Every TAG Block or TAG Block group shall contain a source-identification.

In TAG Blocks attached to a group of lines, it is necessary to include the source-identification parameter in at least one of the TAG Blocks in the group.

(Also see Section 7.6.1 and Section 7.6.2.1 for information on how the source-identification parameter-code value is applied).

When source-identification is enabled, it is possible that the "TAG Block Line Input Process" may block command and request sentences from the "NMEA 0183 Sentence Process" (See Section 7.6). To circumvent this condition, the source-identification "blocking" process should always recognize the unique identifier "DEFAULTSOURCE". Designers should take care to minimize the need to revert to the use of this unique identifier during normal system operation.

This parameter is controlled using the CPS sentence.

7.9.7 Text-string Parameter – "t"

Form: t:alphanumeric string

(lower case "T") text-string. This is a free-form character string using any valid character (See Table 5). Note that the colon (:) is permitted – refer to Section 7.4 for proper detection of a parameter-code. The character string should not contain a "reserved character" (See Table 4). The end of the

alphanumeric string is delimited by either a comma (,) or asterisk and hexadecimal checksum (*hh). If any other reserved character ends the alphanumeric string, the entire line should be considered to be in error and shall be discarded. The ten (10) NMEA 0183 reserved characters are:

$ * , ! \ ^ ~ <CR> <LF> <del>

Reserved characters are available through the application of the method described in section 7.1.3.

The “t” parameter-code may appear more than one time in one TAG Block.

This parameter is controlled using the CPT sentence.

Examples of lines:

\t:This base station command is for station,d:b003669920,t:from PSS,s:PC01234*hh\

7.10 Parameter-code Configuration, Control, and Status (Informative)

7.10.1 Minimum NMEA 0183 TAG Block requirements

When TAG Block is supported, as a minimum, the implementation of TAG Block functions requires that equipment recognize and properly respond to the TBR sentence. Further TAG Block supported functionality will depend on the purpose and requirements of the specific equipment. For example, a device that must support the linking of different sentence formatters would support:

- TBR sentence, and
- CPG sentence, and parameter-code “g”

7.10.2 Minimum requirements for AIS Base Stations using TAG Blocks

If independent AIS Base Stations are part of a network of Base Stations, the minimum TAG Block requirements include support for:

- TBR and TBS sentences,
- CPD sentence, and parameter-code “d” – talker and listener,
- CPG sentence, and parameter-code “g” – talker and listener, and
- CPS sentence, and parameter-code “s” – talker and listener.

7.11 Line linking (sentence linking and sentence grouping)

The combined use of the TAG Block methods and parameter-codes can be used to efficiently link different NMEA 0183 sentences and “multi-sentence messages” into a group. Line linking is not intended to replace the “multi-sentence message” method (See Section 5.3.8). Once linked, groups can be transported by a variety of communication mediums (serial port, USB, UDP, TCP/IP network connection, etc.). In general, these are data connections with multi-talker/multi-listener relationships; or a single-talker/multi-listener relationship where there can be timing issues among the talker’s internal processes (see the examples below).

When sentence-grouping is used, the sentence-grouping parameter-code, “g:”, shall appear as the first parameter-code in the TAG Block.

Note that if the TAG Block content is in error, the TAG Block and the entire sentence-group shall not be used (See Section 7.5).

7.11.1 Two Line Grouping Example:

\g:1-2-1234,s:r3669961,c:1120959341*hh\!ABVDM,1,1,1,B,100000?0?wJm4:`GMUrf40g604:4,0*hh

\g:2-2-1234*hh\$ABVSI,r3669961,1,013536.96326433,1386,-98,,*hh

\g:1-2-2346,s:r3669962,c:1120959342*hh\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*hh

\g:2-2-2346*hh\$ABVSI,r3669962,1,013538.05654921,1427,-101,,*hh

\g:1-2-1235,s:r3669961,c:1120959342*hh\!ABVDM,1,1,2,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*hh

\g:2-2-1235*hh\$ABVSI,r3669961,2,013538.05656223,1427,-88,,*hh

\g:1-2-1236,s:r3669961,c:1120959344*hh\!ABVDM,1,1,3,B,103OwmgP01Jn7WHGa4M6v?w<0D02,0*hh

\g:2-2-1236*hh\$ABVSI,r3669961,3,013539.44331849,1479,-51,,*hh

\g:1-2-2347,s:r3669962,c:1120959344*hh\!ABVDM,1,1,2,B,103OwmgP01Jn7WHGa4M6v?w<0D02,0*hh

\g:2-2-2347*hh\$ABVSI,r3669962,2,013539.44333151,1479,-51,,*hh

7.11.2 Three Line Grouping Example:

The previous example may also be presented as follows:

\g:1-3-1234,s:r3669961,c:1120959341*hh\

\g:2-3-1234*hh\!ABVDM,1,1,1,B,100000?0?wJm4:`GMUrf40g604:4,0*hh

\g:3-3-1234*hh\$ABVSI,r3669961,1,013536.96326433,1386,-98,,*hh

\g:1-3-2346,s:r3669962,c:1120959342*hh\

\g:2-3-2346*hh\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*hh

\g:3-3-2346*hh\$ABVSI,r3669962,1,013538.05654921,1427,-101,,*hh

\g:1-3-1235,s:r3669961,c:1120959342*hh\

\g:2-3-1235*hh\!ABVDM,1,1,2,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*hh

\g:3-3-1235*hh\$ABVSI,r3669961,2,013538.05656223,1427,-88,,*hh

\g:1-3-1236,s:r3669961,c:1120959344*hh\

\g:2-3-1236*hh\!ABVDM,1,1,3,B,103OwmgP01Jn7WHGa4M6v?w<0D02,0*hh

\g:3-3-1236*hh\$ABVSI,r3669961,3,013539.44331849,1479,-51,,*hh

\g:1-3-2347,s:r3669962,c:1120959344*hh\

\g:2-3-2347*hh\!ABVDM,1,1,2,B,103OwmgP01Jn7WHGa4M6v?w<0D02,0*hh

\g:3-3-2347*hh\$ABVSI,r3669962,2,013539.44333151,1479,-51,,*hh

7.12 TAG Block used with query sentences

A TAG Block may be linked to a query sentence (See Section 5.3.5.1) to help ensure the desired device responds to a query. When using TAG Blocks, the response to a query sentence will vary depending on the structure of the query sentence:

- When a listener receives a query sentence without a TAG Block, the listener should respond using the rules described in Section 5.3.5.1 and Table 15 below.
- When a listener receives a query sentence prefaced with a TAG Block, the listener should reply using the rules described in Table 15 below.

An AIS Base Station is required to respond or acknowledge a query sentence (See NAK Sentence) within one (1) second of receiving a query sentence.

7.12.1 Reply to a \TAG Block\query sentence combination

Queries and replies may or may not use the TAG Block source-identification "s:" or destination-identification "d:". The use of "s:" or "d:" is configured using the CPS or CPD sentences.

The following table presents the logical outcomes for various combinations of enabled CPS and CPD "listener" parameter-codes.

Table 14 - Rules Controlling Listener's Processing of Talker's Query

Query Sentence	Listener destination-identification (See CPD)	Listener source-identification (See CPS)	Listener's Action
Without TAG Block	**Disabled**	**Disabled**	Process query and reply
	Disabled	Enabled	Ignore query
	Enabled	**Disabled**	Ignore query
	Enabled	Enabled	Ignore query
With TAG Block containing both destination-identification of the listener and a recognized source-identification of the talker.	**Disabled**	**Disabled**	Process query and reply
	Disabled	Enabled	Process query and reply
	Enabled	**Disabled**	Process query and reply
	Enabled	Enabled	Process query and reply
With TAG Block containing destination-identification of the listener, but no source-identification recognized by the listener.	**Disabled**	**Disabled**	Process query and reply
	Disabled	Enabled	Ignore query
	Enabled	**Disabled**	Process query and reply
	Enabled	Enabled	Ignore query
With TAG Block containing no destination-identification matching the listener's, but containing a recognized source-identification of the talker.	**Disabled**	**Disabled**	Process query and reply
	Disabled	Enabled	Process query and reply
	Enabled	**Disabled**	Ignore query
	Enabled	Enabled	Ignore query
With TAG Block containing neither a destination-identification matching the listener's, nor containing a recognized source-identification of the talker.	**Disabled**	**Disabled**	Process query and reply
	Disabled	Enabled	Ignore query
	Enabled	**Disabled**	Ignore query
	Enabled	Enabled	Ignore query

7.12.2 Example of Query using the \TAG Block\Query Format

In the following example, the query source is a computer with a talker identifier "UP", and a unique identifier "ControlPC1". The Base Station is assigned the talker identifier "AB", with a unique identifier, "A003669955".

Query using a TAG Block:

\s:ControlPC1,d:A003669955,c:1149654649*58\$UPABQ,VER*3A

Note: The epoch time (UNIX time) of the query is included. This is important for managing a negative response.

Response to Query using a TAG Block:

\s:A003669955,d:ControlPC1*2C\$ABVER,1,1,,AB, XYZ,A003669955,XYZ0001,Beta,1,1*00

7.13 TAG Block parameter control and configuration

When a "talker" TAG Block parameter is enabled, TAG Blocks will be linked to the associated sentences as required to implement the parameter. When enabled, multiple TAG Block parameters associated with a sentence share a single TAG Block. Although TAG Block parameters may appear in any order, when the sentence-grouping parameter-code is used, the sentence-grouping string shall always appear as the first parameter-code in the TAG Block.

7.13.1 Control and configuration features

The TAG Block parameters are controlled and configured using the sentence formatters

– TBR and CPx.

Each TAG Block parameter can be independently controlled for "talker" or "listener" as needed for a particular device. When a TAG block parameter is enabled for a talker, the talker will include this parameter in the output TAG blocks as required. When a TAG block parameter is enabled for a listener, the listener's use of the TAG Block parameter is "enabled."

Some TAG Block parameters have configuration options, such as, the line-count parameter.

7.13.2 TAG Block Filters

TAG Block configuration sentences (CPx) also contain a "Unique Identifier" field and "Sentence status flag" field to serve as filters to prevent accidental control or configuration changes.

A listener device or process should examine both the "Unique Identifier" and "Sentence status flag" data fields before taking any action using the information in the TAG Block configuration sentence.

- If the "Unique Identifier" field is not equal to the unique identifier of the listener device or process, the sentence shall be ignored.

- If the "Unique Identifier" field matches the unique identifier of the listener device or process and the "Sentence status flag" field is a "C," the device or process should apply the information in the sentence.

- If the "Sentence status flag" field is "R," the device or process should not apply the information in the sentence.

8. Approved General Purpose Sentences

8.1 Approved General Purpose Parametric Sentences

General format of printed sentence information:

*{**mnemonic**} - {**name**}
{definition paragraph}

$--{sentence}
└ {field descriptions}
└ Start of sentence and Talker ID

8.1.1 Approved General Purpose Parametric Formatters

AAM – Waypoint Arrival Alarm 50
ACK – Acknowledge Alarm 50
ADS – Automatic Device Status 50
AKD – Acknowledge Detail Alarm Condition 51
ALA – Set Detail Alarm Condition 52
ALM – GPS Almanac Data 64
ALR – Set Alarm State 65
APB – Heading/Track Controller (Autopilot) Sentence "B" 65
BEC – Bearing & Distance to Waypoint – Dead Reckoning 66
BOD – Bearing - Origin to Destination 66
BWC – Bearing & Distance to Waypoint – Great Circle 66
BWR – Bearing & Distance to Waypoint – Rhumb Line 67
BWW – Bearing – Waypoint to Waypoint 67
CEK – Configure Encryption Key Command 68
COP – Configure the Operational Period, Command 69
CUR – Water Current Layer 70
DBT – Depth Below Transducer 70
DCN – DECCA position 70
DCR – Device Capability Report 71
DDC – Display Dimming Control 71
DOR – Door Status Detection 72
DPT – Depth 74
DSC – Digital Selective Calling Information 74
DSE – Expanded Digital Selective Calling 75
DSI – DSC Transponder Initialize 76
DSR – DSC Transponder Response 77
DTM – Datum Reference 78
ETL – Engine Telegraph Operation Status 79
EVE – General Event Message 80
FIR – Fire Detection 80
FSI – Frequency Set Status or Command 82
GBS – GNSS Satellite Fault Detection 83

GEN – Generic Binary Information 84
GFA – GNSS Fix Accuracy and Integrity 845
GGA – Global Positioning System Fix Data 86
GLC – Geographic Position – Loran-C 87
GLL – Geographic Position – Latitude/Longitude 87
GMP – GNSS Map Projection Fix Data 88
GRS – GNSS Range Residuals 92
GSA – GNSS DOP and Active Satellites 94
GST – GNSS Pseudorange Error Statistics 95
GSV – GNSS Satellites In View 96
HBT – Heartbeat Supervision Sentence 987
HDG – Heading, Deviation & Variation 98
HDT – Heading, True 98
HMR – Heading Monitor Receive 98
HMS – Heading Monitor Set 99
HSC – Heading Steering Command 99
HSS – Hull Stress Surveillance Systems 99
HTC – Heading/Track Control Command 100
HTD – Heading/Track Control Data 100
LCD – Loran-C Signal Data 101
MLA – GLONASS Almanac Data 102
MSK – MSK Receiver Interface Command 103
MSS – MSK Receiver Signal 103
MTW – Water Temperature 103
MWD – Wind Direction & Speed 104
MWV – Wind Speed & Angle 104
NAK – Negative Acknowledgement 104
NRM – NAVTEX Receiver Mask Command 106
NRX – NAVTEX Received Message 107
OSD – Own Ship Data 109
POS – Device Position and Ship Dimensions Report or Configuration Command 109
PRC – Propulsion Remote Control Status 110
RMA – Recommended Minimum Specific Loran-C Data 111
RMB – Recommended Minimum Navigation Information 112
RMC – Recommended Minimum Specific GNSS Data 113
ROR – Rudder Order Status 114
ROT – Rate Of Turn 114
RPM – Revolutions 115
RSA – Rudder Sensor Angle 115
RSD – Radar System Data 115
RST – Equipment Reset Command 116
RTE – Routes RTE – Routes 116
SFI – Scanning Frequency Information Status and Command 117
SID – Set an Equipment’s Identification and Command 118
STN – Multiple Data ID 118
THS – True Heading and Status 119
TLB – Target Label 119
TLL – Target Latitude and Longitude 120

TRC – Thruster Control Data 120
TRD – Thruster Response Data 121
TTM – Tracked Target Message 122
TUT – Transmission of Multi-language Text 122
TXT – Text Transmission 124
UID – User Identification Code Transmission 124
VBW – Dual Ground/Water Speed 125
VDR – Set & Drift 125
VER – Version 125
VHW – Water Speed and Heading 126
VLW – Dual Ground/Water Distance 127
VPW – Speed – Measured Parallel to Wind 127
VTG – Course Over Ground & Ground Speed 127
WAT – Water Level Detection 128
WCV – Waypoint Closure Velocity 129
WNC – Distance – Waypoint to Waypoint 129
WPL – Waypoint Location 129
XDR – Transducer Measurements 130
XTE – Cross-Track Error, Measured 131
XTR – Cross-Track Error – Dead Reckoning 131
ZDA – Time & Date 132
ZDL – Time & Distance to Variable Point 132
ZFO – UTC & Time from Origin Waypoint 132
ZTG – UTC & Time to Destination Waypoint 133

AAM – Waypoint Arrival Alarm

Status of arrival (entering the arrival circle, or pass 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 = perpendicular not passed
       └ Status: A = arrival circle entered
                 V = arrival circle not entered
```

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
```

ADS – Automatic Device Status

This sentence is used to output, autonomously and periodically, the device's current status of the time source and time synchronization method, position source, and the general alarm state of the device. The ADS sentence is output at the defined interval or when there is a change in status. The equipment standard or manufacturer's documentation should identify the status values supported.

The individual equipment standards are responsible for defining the alarm conditions under which the Alarm status is active or not active.

When this sentence is used with AIS Base stations, the interval for automatic output of this sentence is defined using the BCG sentence, and null data fields are not allowed.

```
$--ADS,c--c,hhmmss.ss,a,x,a,a*hh<CR><LF>
       |        |      | | | |
       |        |      | | | └ UTC timing source [5]
       |        |      | | └ Position source [4]
       |        |      | └ Time Sync. Method [3]
       |        |      └ Alarm status [2]
       |        └ Time (hour, minute, second) of status report
       └ Unique Identifier [1]
```

Notes:

1) 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 (See the SID sentence formatter). For devices other than AIS Base Stations this field may be null.

2) Alarm status:
   A = active
   V = not active

3) Method of time synchronization
   0 = UTC direct
   1 = UTC indirect (AIS equipment)
   2 = synchronized to an AIS Base Station

3 = semaphore (AIS equipment)
4 = no VDL synchronization reference (AIS equipment)
5 = manual
6 to 9 = reserved for future use

4) I = internal
E = external
S = surveyed
N = none

5) E = external
I = internal
N = none

AKD – Acknowledge Detail Alarm Condition

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

Note:

As NMEA 0183 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 shall be sent. This acknowledgement must be sent on all subsequent acknowledgements. Acknowledgements must 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>

- Time of acknowledgement [1]
- System indicator of original alarm source [2]
- Sub system equipment indicator of original alarm source [2]
- Instance number of equipment/unit/item [2]
- Type of alarm [2]
- System indicator of system sending the acknowledgement [3]
- Sub system indicator of system sending the acknowledgement [4]
- Instance of equipment/unit/item sending the acknowledgement [5]

Notes:

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 ALA Sentence Table 16. This may be a null field.

4) Indicator characters identifying the sub system sending the acknowledgement. This field is two fixed characters, see ALA Sentence Table 16. 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.

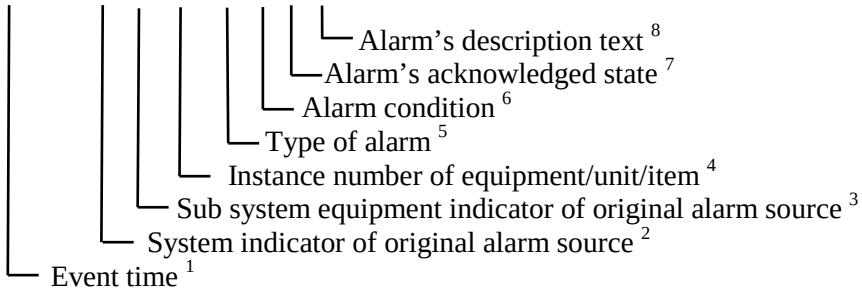
ALA – Set Detail Alarm Condition

This sentence permits the alarm condition of a system to be set. The data source is identified and the alarm category is defined and avoids any conflict between alarms and devices.

Note:

As NMEA 0183 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 shall be sent. This acknowledgement must be sent on all subsequent acknowledgements. Acknowledgements must 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>



Notes:

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 Table 16).

3) Indicator characters as sub system of alarm source. This field is two fixed characters, (See Table 16). 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 (See Table 16). Codes 900-999 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 = harbor 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.

NOTE The mandatory alarms required by a VDR are indicated in Annex B of IEC 61996.

Table 15 - 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
				003	Dead man alarm
				004	Request backup OOW

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**
		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

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	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
				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 turbo-charger, 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**
				004	Exhaust gas after turbo-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, overspend
		OT	Others	001	Reduction gear lub oil inlet, pressure – low
				900 | 999	Others (if necessary, it is possible to define by user.)
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	Over speed
				004	Shaft stopped – excess of set period

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**
		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
				002	Rotor axial displacement – large
				003	Over speed
				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

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**
				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 overspend
				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
				002	Dearator level – high and low
				003	Dearator 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

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	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	Intake 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	Intake 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

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	Fuel oil temp – high and low
				003	Service tank level – low
		LO	Lubricating oil	001	Bearing oil inlet pressure – low
				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, over speed
		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	Over speed
		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

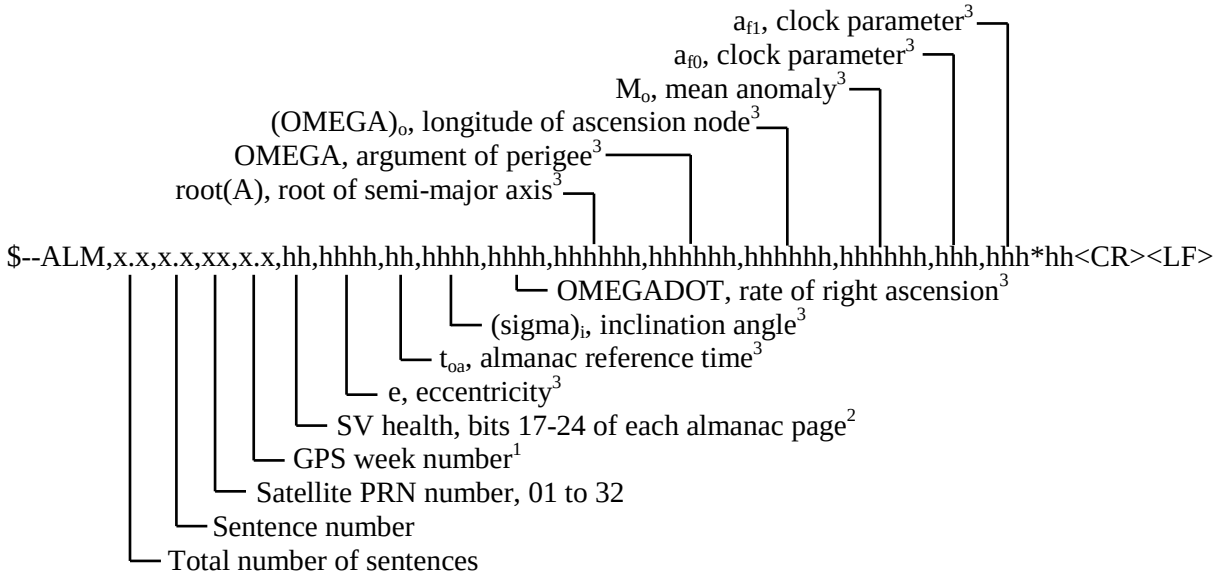
System indicator (field 2)		Sub-system/equipment indicator (field 3)		Type of alarm (field 5)	
ID	**System category**	**ID**	**Sub-system/ equipment**	**No**	**Alarm contents**
				002	Inlet temp – high
				003	Bearing oil outlet temp – high
				004	Filter differential pressure – high
		CM	Cooling medium	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	Over speed
				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

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	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
				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

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**
				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.)

ALM – GPS Almanac Data

Contains GPS week number, satellite health and the complete almanac data for one satellite. Multiple sentences may be transmitted, one for each satellite in the GPS constellation, up to a maximum of 32 sentences.



Notes: (Reference ICD-GPS-200, Rev. B)

1) Variable length integer, 4 digits maximum (0 to 9999). This is an extended GPS week number to which the almanac reference time parameter is referenced. Week zero refers to the week starting 06 January 1980. The value is the "Extended Week Number", which is the elapsed number of weeks since week zero. Extended week numbers shall not be reset to zero when the 10-bit GPS week number rolls back to zero every 19.6 years.

   This value must be determined by the GPS receiver at the time of the almanac data decoding. It is based on the 8-bit Almanac Reference week from Page 25, Sub frame 5, Word 3, bits 17 to 24; that 8-bit value must be expanded by the GPS receiver to give a full Extended Week Number. Furthermore, care must be taken to ensure that the Almanac Reference Time and the Extended Week Number are correctly linked as part of a single almanac data set, avoiding inconsistencies between different almanac data sets when new almanac uploads occur after reading Page 25 of Sub frame 5.

2) Reference paragraph 20.3.3.5.1.3, Table 20-VII and Table 20-VIII.
3) Reference Table 20-VI for scaling factors and units.

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 acknowledgment.

$--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

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, Mag 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
- Status: A = arrival circle entered
- XTE units, nautical miles
- Direction to steer, L/R
- Magnitude of XTE (cross-track-error)
- Status[2]: A = Data valid or not used, 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

Notes:

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

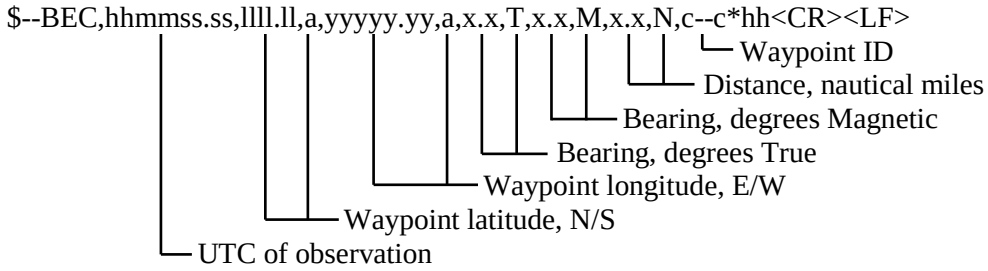
2) The positioning system Mode Indicator field supplements the positioning system Status fields, the Status fields shall be set to:

   - V = Invalid for all values of Indicator mode except for
   - A = Autonomous
   - D = Differential.

The positioning system Mode Indicator and Status fields shall not be null fields.

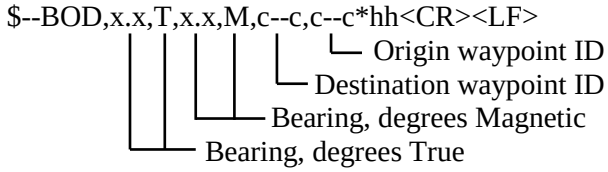
BEC – Bearing & Distance to Waypoint – Dead Reckoning

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



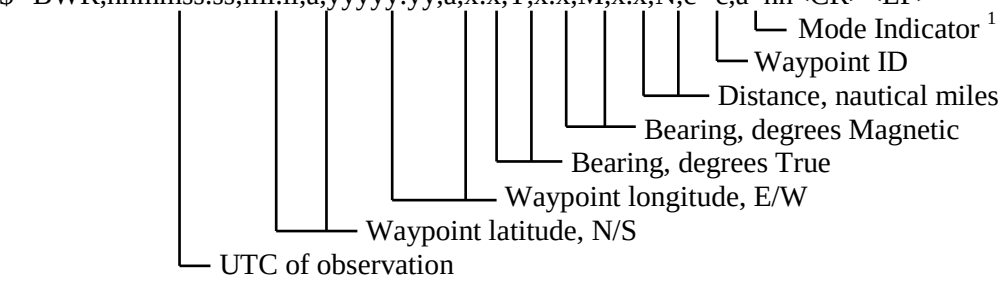
BOD – Bearing - Origin to Destination

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.



BWC – Bearing & 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.



Notes:

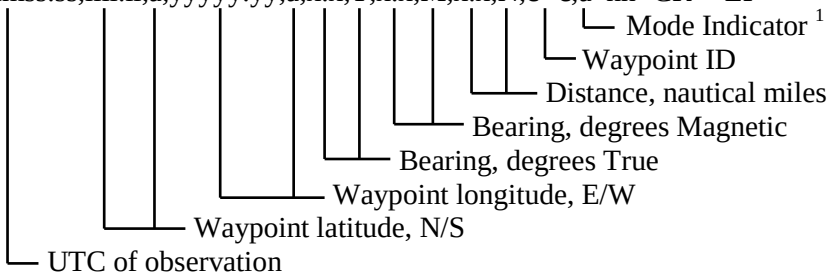
1) Positioning system Mode Indicator:
   - A = Autonomous mode
   - D = Differential mode
   - E = Estimated (dead reckoning) mode
   - M = Manual input mode
   - S = Simulator mode
   - N = Data not valid

   This field shall not be a null field.

BWR – Bearing & 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>



Notes:

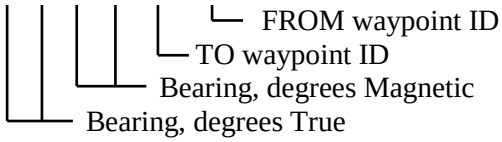
2) Positioning system Mode Indicator:
   - A = Autonomous mode
   - D = Differential mode
   - E = Estimated (dead reckoning) mode
   - M = Manual input mode
   - S = Simulator mode
   - N = Data not valid

   This field shall not be a null field.

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>



CEK – Configure Encryption Key Command

This sentence configures the key that will be used by a device to implement encryption.

This sentence provides a mechanism for the entry of a key, but it does not provide security for the key.

This sentence can be queried.

```
$--CEK,x,x,x,c--c,h--h,a*hh<CR><LF>
                        └─ Sentence status flag [5]
                     └─ New AES encryption key [4]
                  └─ Unique Identifier [3]
               └─ Sequential message identifier, 0-9 [2]
            └─ Sentence number, 1-9 [1]
         └─ Total number of sentences, 1-9 [1]
```

Notes:

1) An encryption key may exceed the size of a single sentence, resulting in the transmission of multiple sentences to convey the complete encryption key 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.

   The "Sentence Number" field may be null when there is only one sentences per message, as when the "Total number of sentences" field is set to a value of 1.

2) The sequential message identifier is a number, 0 to 9, used to identify different messages. This field may be null when there is only one sentence per message, as when the "Total number of sentences" is set to a value of 1.

3) The Unique Identifier is used for system level identification of a station, 15 characters maximum (see the AID sentence formatter). For AIS AtoN equipment, on input, this sentence should be accepted only if this data field matches the AtoN Station's Unique Identifier, while on output, this data field is the AtoN Station's Unique Identifier.

   For AIS AtoN Stations this is the Real MMSI of the AIS AtoN Station being addressed. This sentence should be accepted only if this field matches the Real MMSI of the AIS AtoN Station.

4) The AES encryption key is in hexadecimal format. The actual number of "hex" symbols in a sentence must be adjusted so that the total number of characters in a sentence does not exceed the "82-character" limit. If the sentence exceeds the "82-character" limit, the key will be split across multiple sentences.

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).

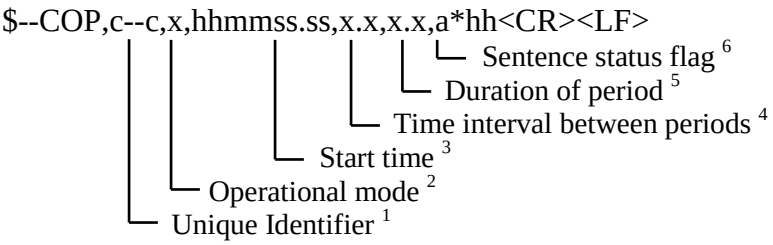
   C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

COP – Configure the Operational Period, Command

This sentence configures the operational schedule of a device. This includes directly enabling or disabling device operation, or having the device operation controlled by an internal process.

For example, this is used to coordinate operation of an AtoN chain as specified in IEC 62320-2. (See "Optional chaining of AIS AtoN Stations"). When chaining, the duration of AIS AtoN Station's receiver wake up time must be sufficient to allow correct operation of a chain.

This sentence can be queried.

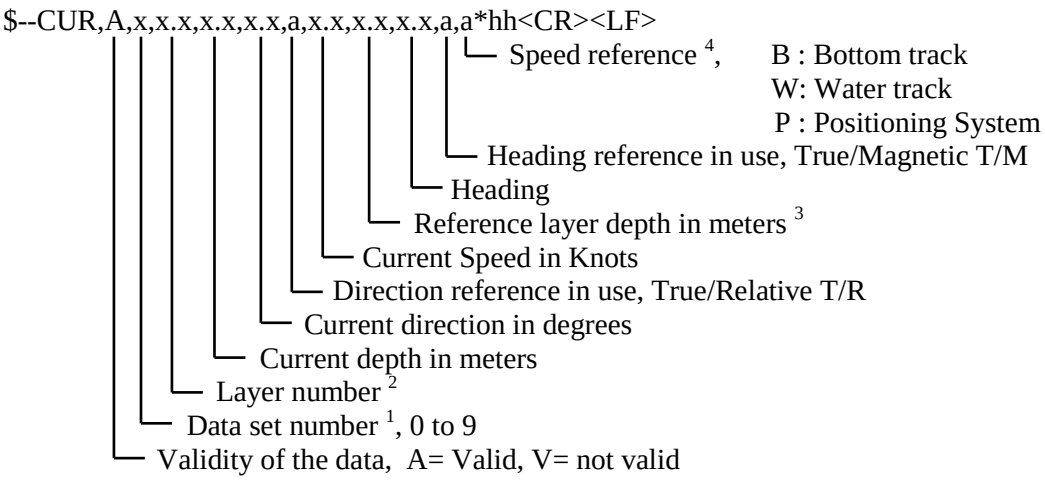


Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum (see the AID sentence formatter). On input, this sentence should be accepted only if this data field matches the AtoN Station's Unique Identifier. On output, this data field is the AtoN Station's Unique Identifier.
2) 0 = operation controlled by internal process using the defined operating schedule.
   1 = enable operation
   2 = disable operation
3) Start time used to calculate the operational schedule. This is also the beginning time of the first operational period.
4) Time Interval between the beginning times of the operational periods in units of seconds.
5) Duration of operational period in units of seconds. (86400 seconds equals 24 hours).
6) 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.

CUR –- Water Current Layer

Multi-layer water current data.

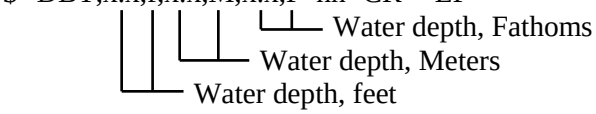


Notes:

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.

DBT – Depth Below Transducer

Water depth referenced to the transducer.



DCN – DECCA position

Status and lines-of-position for a specified DECCA chain. This Sentence has been deprecated and should not be used for new designs. See Appendix H for sentence structure.

DCR – Device Capability Report

This sentence is used to report the capabilities of a device. The identification of the device's capabilities is specified in the appropriate equipment standard. A capability is indicated using a binary-state (0 or 1).

The binary-states are coded using a mask represented as a hexadecimal field (hhhh…). Each bit position of a hexadecimal character is assigned to a specific capability. This provides four capabilities per each hexadecimal character. The assignment of bit positions to capabilities is not contained here. The association of a capability to a bit position should be specified in the equipment's standard.

Generally, as in the NRM sentence the association of capability to bit position begins with the least significant bit (LSB) of the hexadecimal field.

This sentence can be used to report an AIS AtoN Station's capabilities (See IEC 62320-2, Annex B, Table B.3, "Function identifier" column). There are thirty-four capabilities listed in this table beginning with "000000." The capability represented by Function identifier "000000 (dec 0)" is reported by the LSB of the hexadecimal field. The thirty-fourth capability would be reported by the second bit of the 9th hexadecimal character.

This sentence can be queried.

```
$--DCR,c--c,hhhhhhhhhhhhhhhhhhhhhhhhhhhhhhhh*hh<CR><LF>
          |                              └ Capabilities [2]
          └ Unique Identifier [1]
```

Notes:

1) The Unique Identifier is used for system level identification. When provided, this is the Unique Identifier of the device.
   - For an AIS AtoN Station, see the AID sentence formatter. The Unique Identifier for an AIS AtoN Station is the Real MMSI.
2) The Capabilities mask is defined as a 128 bit hex field where the least significant bit represents the first capability, the next bit represents the second capability and so on up to bit 128 (most significant bit) which is the 128th capability. This data field is fixed length containing 32 hexadecimal characters.
   0 = Capability not supported or not defined
   1 = Capability supported

DDC – Display Dimming Control

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

```
$--DDC,a,xx,a,a*hh<CR><LF>
       |  |  |  └ Sentence Status Flag [4]
       |  |  └ Color palette [3]
       |  └ Brightness percentage 00 to 99 [2]
       └ Display dimming preset [1]
```

Notes:

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 dependent 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 the ability to set a brightness level to be associated with Day, Night, Dusk, etc. Upon receipt of the DDC sentence, the device would switch it's 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 (0) to ninety-nine (99). 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 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 Color Palette Preset field contains an indicator that may be associated with a preset dimmed level on an electronic device.

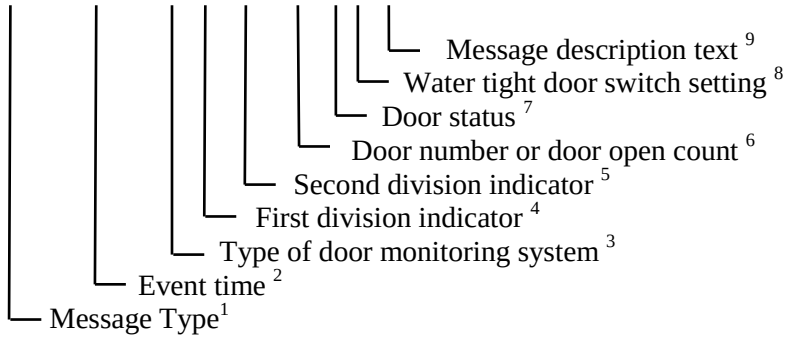
   D = Day time setting
   K = Dusk setting
   N – Night time setting
   O = Backlighting off setting

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 = Status Report
   C = Configuration or Command to change a setting
   This field shall not be null

DOR – Door Status Detection

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

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



Notes:

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 Appendix C.1.8.
   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 17)

4) First division indicator where door is located. This field is two characters, If a two character location indicator is not supported, the first division indicator location may be provided in the message description text field, see Note 9. (See Table 17)

5) Second division indicator where the door is located. This field is three numeric characters, If a three character location indicator is not supported, the second division indicator location may be provided in the message description text field, see Note 9. (See Table 17)

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 = Harbor mode (allowed open)
   C = Sea mode (ordered closed)
   This may be a null field.

9) Message Description Text. This field may also contain a textual detector location when the reporting system does not support first or second division indicator codes (Field 4 and Field 5). See Notes 4 and 5. Maximum number of characters will be limited by maximum sentence length and length of other fields.

Table 16 - Door Status Indicators

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 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

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[1,2], meters
- Water depth relative to the transducer, meters

Notes:

1) "positive" = distance from transducer to water-line, "-" = distance from transducer to keel
2) For IEC applications the offset shall always be applied so as to provide depth relative to the keel.

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 Recommendation ITU-R M.493 (formerly CCIR Recommendation 493).

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

- Expansion indicator [11]
- Acknowledgement [10]
- Nature of Distress [9, 1]
- MMSI of ship in distress [9, 2]
- Time [7] or Tel. No. [8]
- Position [5] or Channel/Frequency [6]
- Type of Communication [1,4] or Second Telecommand [1]
- Nature of Distress [1,3] or First Telecommand [1]
- Category[1]
- Address [2]
- Format Specifier [1]

Notes:

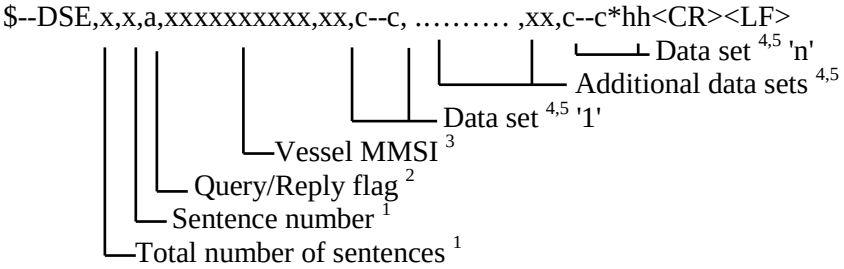
1. Use two least-significant digits of symbol codes in ITU-R M.493 Table 3.
2. Maritime Mobile Service Identifier (MMSI) for the station to be called or the MMSI of the calling station in a received call. For a nine-digit MMSI "0" shall be added as the tenth digit. For calls to a geographic area the area is coded in accordance with ITU-R M.493 paragraph 5.3 and Fig. 6. 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.
3. Distress calls only
4. Distress, Distress Acknowledgment, Distress Relay, and Distress Relay Acknowledgment calls only.
5. Latitude/longitude, degrees and minutes, 10 digits, coded in accordance with ITU-R M.493 paragraph 8.1.2
6. Frequency or channel, six or twelve digits, coded in accordance with ITU-R M.493 Table 13.
7. Time (UTC) of position, four digits, hhmm (hours and minutes)
8. Telephone number, 16 digits maximum, odd/even information to be inserted by the DSC equipment
9. For Distress Acknowledgement, Distress Relay and Distress Relay Acknowledgement calls only, null otherwise.

10. Acknowledgement type:
    R = Acknowledge Request
    B = Acknowledgement
    S = Neither (end of sequence)

11. 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.

DSE – Expanded Digital Selective Calling

This sentence immediately follows, without intervening sentences or characters, $--DSC, $--DSI or $--DSR when the DSC Expansion field in these 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 Recommendation ITU-R M.821 (formerly CCIR Recommendation 821).



Notes:

1) The number of Data Sets 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) "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.

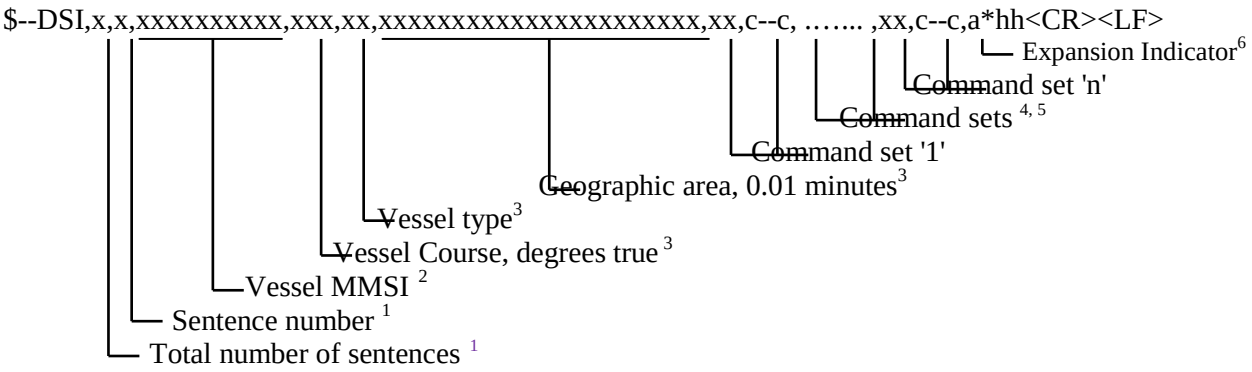
3) Identical to the address field in the associated $--DSC, $--DSI or $--DSR sentence.

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

5) ASCII characters are used to describe text (station name and port of call), not symbols of ITU-R M.821 Table 2. When "," (Comma, HEX 2C - a reserved character in NMEA 0183) is needed, <'> (Apostrophe, HEX 27) is substituted.

DSI – DSC Transponder Initialize

This sentence is used to provide data to a radiotelephone for use in making calls using Digital Selective Calling in accordance with Recommendation ITU-R M.825 (formerly CCIR Recommendation 825)



Notes:

1) The number of Command Sets 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) Maritime Mobile Service Identifier (MMSI) for the individual station to be called. For a nine-digit MMSI "0" shall be added as the tenth digit. This field is null when addressing ships by area.
Information relevant to the voyage of a ship may be provided by using the own ship MMSI together with the following command sets:
   00, followed by the second digit other ships in ITU-R M.825 Table 3 (status)
   05, followed by a null second field (entering a VTS)
   07, followed by a null second field (leaving a VTS)
   14, followed by a second field beginning “00” or “01” as described in paragraph 8.1.5 of ITU-R M.825 (destination)
   21, followed by a second field containing the next port of call
   23, followed by the draft as described in paragraph 8.1.10 of ITU-R M.825

3) All vessels in a geographic area, or vessels of a specific type or on a specific course in that area, may be addressed. Code in accordance with ITU-R M.825 paragraph 5. and Table 3. These fields shall be null when the MMSI of an individual station is used.

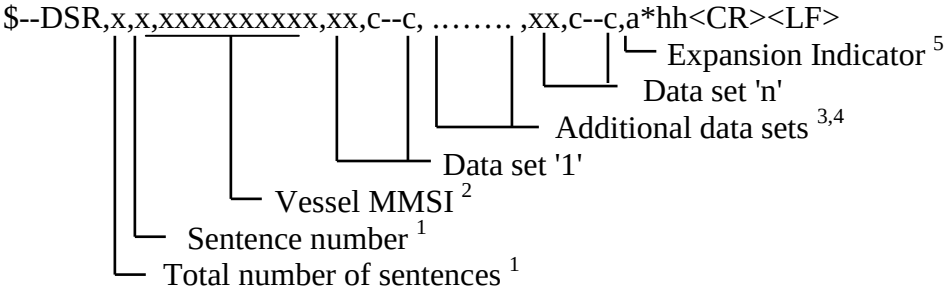
4) ASCII characters are used to describe station name and port of call, not symbols of ITU-R M.825 Table 1. When "," (Comma, HEX 2C - a reserved character in NMEA 0183) is needed, <‘> (Apostrophe, HEX 27) is substituted.

5) Command sets consist of two fields. The first field is the two least significant digits of symbol codes in ITU-R 825 Table 4, the second field is the additional information required by ITU-R M.825, null otherwise.
A variable number of command sets are allowed, null fields are not required for unused command sets.

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

DSR – DSC Transponder Response

This sentence is used to receive data from a radiotelephone using Digital Selective Calling in accordance with Recommendation ITU-R M.825 (formerly CCIR Recommendation 825)



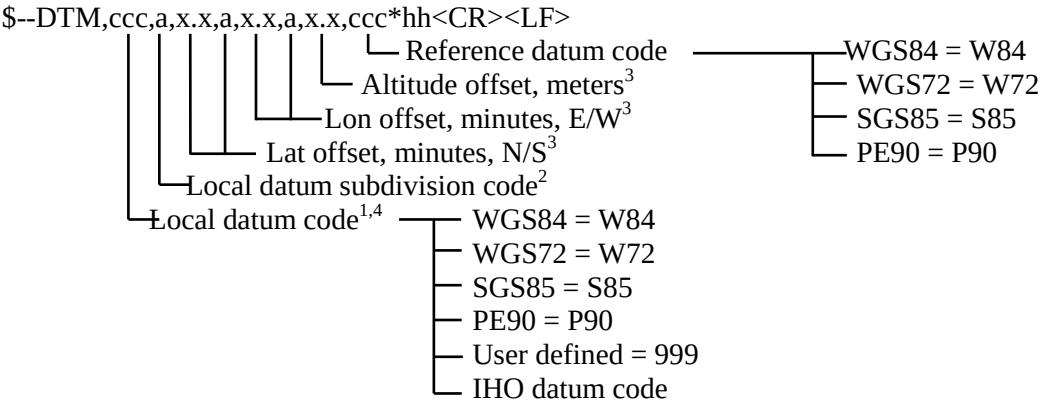
Notes:

1) The number of Data Sets 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) Maritime Mobile Service Identifier (MMSI) of the station responding. For a nine-digit MMSI "0" shall be added as the tenth digit.
3) Data sets consist of two fields. The first field is the two least significant digits of symbol codes in ITU-R 825 Table 4, the second field is the additional information required by ITU-R M.825, null otherwise. A variable number of data sets are allowed, null fields are not required for unused data sets.
4) ASCII characters are used to describe station name and port of call, not symbols of ITU-R M.825 Table 1. When "," (Comma, HEX 2C - a reserved character in NMEA 0183) is needed, <‘> (Apostrophe, HEX 27) is substituted.
5) Expansion indicator = "E", null otherwise. When set to "E" this sentence is followed by the DSC Expansion sentence $--DSE, without intervening sentences or characters, as the next received sentence.

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



Cautionary Note:

The datum sentence should be transmitted immediately prior to every positional sentence (e.g., GLL, BWC, WPL) that is referenced to a datum other than WGS84, which is 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 seconds.

Notes:

1) Three character alpha code for local datum. If not one of the listed earth-centered datums, or 999 for user defined datum, use IHO datum code from International Hydrographic Organization Publication S-60 Appendices B and C. Null field if unknown.
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 S-60 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:

$$\mathbf{P}_{\text{local datum}} = \mathbf{P}_{\text{ref datum}} + \mathbf{offset}$$

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

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]

Notes:

1) Event time of condition change, This may be a null field.
2) Indicator to identify message type. This shall not be a null field;
   O = Order Status
   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 a 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 shall be a null field.
6) Numeric character to identify engine or propeller shaft controlled by the system. This is numbered from center-line. This field is single character:
   0 = single or on center-line
   Odd = starboard
   Even = port

EVE – General Event Message

This sentence is used to transmit events (for example 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]

Note:

1) This may be a null field.

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]

Notes:

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 Appendix C.1.8.
   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 characters. (See Table 18)
4) First division indicator where detector is located. This field is two characters (See Table 18.) If a two character location indicator is not supported, the first division indicator location may be provided in the message description text field, see Note 9
5) Second division indicator where detector is located. This field is three numeric characters. (See Table 18) If a three character location indicator is not supported, the second division indicator location may be provided in the message description text field, see Note 9.
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 shall 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 shall be a null field.

9) Message Description Text. This field may also contain a textual detector location when the reporting system does not support first or second division indicator codes (Field 4 and Field 5). (See Notes 4 and 5). Maximum number of characters will be limited by maximum sentence length and length of other fields.

Table 17 - Fire Detection Indicators

Type of Fire Detection System		First Division Indicator	Second Division Indicator
ID	**System category**		
FD	Generic fire detector, can be any of the below.	Number of zone. This can also be control and monitoring system main unit identifier, e.g., fire central number.	Loop number. This can also be another control and monitoring sub-system identifier, e.g., 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	CO2 manual release	As above	As above
OT	Other	As above	As above

NOTE: For units controlled from the fire alarm system (typically all HT, SM, DM and MC), the normal division indicators should be fire zone and loop number.

FSI – Frequency Set Status or Command

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.

$--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]

Notes:

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, FAX-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.

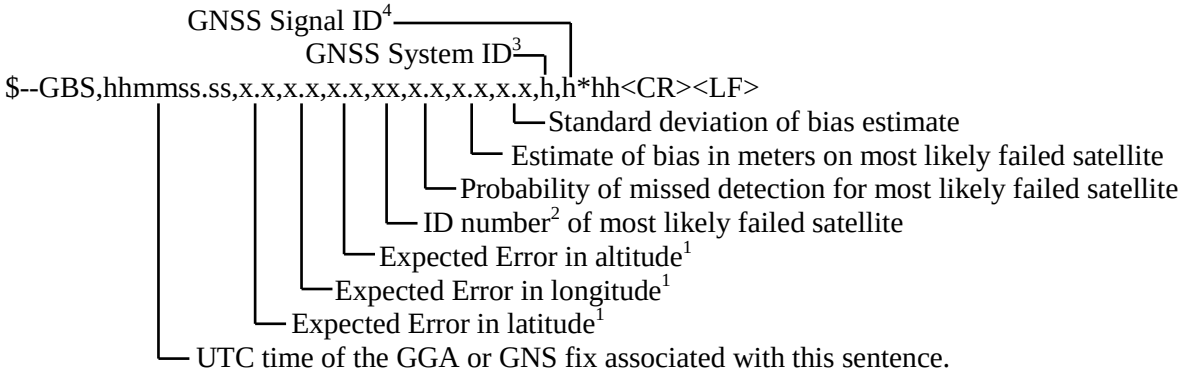
3) For paired frequencies the transmitting frequency only need to be included; null for receiving frequency field. For receive frequencies only, the transmitting frequency field shall be null.

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.

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 integrity checks of the positioning quality 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 must 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, Galileo etc. is used for the reported position solution the talker ID is GP, GL, GA,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.



Notes:

1) Expected error in meters 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:
   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 NMEA 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 19 below. Note that legacy numbering system as above should remain in effect.

4) GNSS Signal ID identifies the GNSS Signal ID according to the Table 19 below.

Table 18 - GNSS Identification Table - GBS

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 99	0	All Signals
		1 -32 are served 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
GLONASS	2 (GL)	1 - 99	0	All Signals
		33 - 64 is reserved for SBAS	1	G1 C/A
		65 - 99 is reserved for GLONASS	2	G1 P
			3	G2 C/A
			4	GLONASS (M) G2 P
			5 - F	Reserved
GALILEO	3 (GA)	1 - 36 is reserved for Galileo Sats	0	All Signals
		37 - 64 is reserved for Galileo SBAS	1	E5a
		65 - 99 is undefined	2	E5b
			3	E5 a+b
			4	E6-A
			5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved
RESERVED	4 to F			

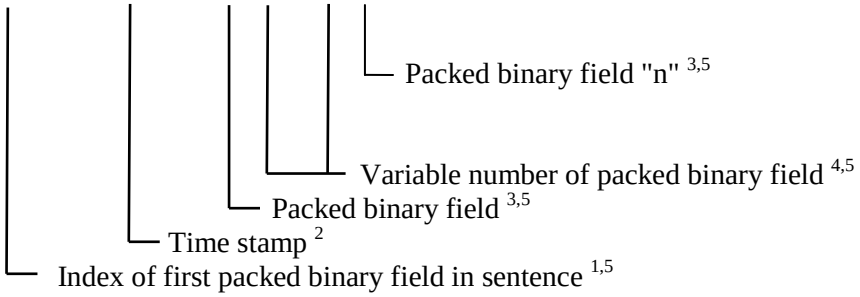
GEN – Generic Binary Information

This sentence provides a means of transmitting generic binary information (i.e. 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 not specified by this standard.

The packed generic binary data is "assumed to be" a linear array of 2^{16} (65536) 16 bit entities. The GEN sentence may contain up to eight consecutive 16-bit entities indexed into the array by the first field.

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



Notes:

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.

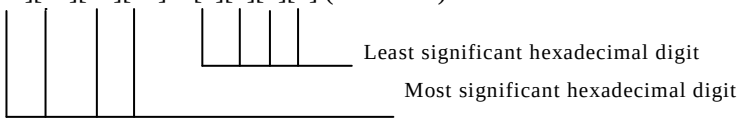
3) The packed binary field is represented as a 16-bit value. The 16-bit value is formatted as fixed 4-character HEX field. This may be a null field.

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



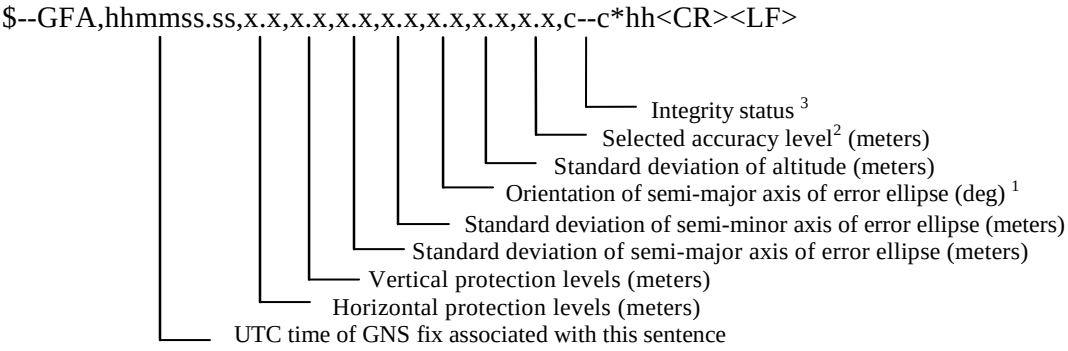
B. The example below shows 10 groups of status information. The 4-character HEX field value of 0123 for the first packed generic status group at HEX address 0000 is interpreted as a 16-bit value with bits 0, 1, 5 and 8 being set. The status from the source is sent in two sentences:

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

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

GFA - GNSS Fix Accuracy and Integrity

This sentence is used to report the results of the data quality 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 provides the quality data of the position fix and should be associated with the GNS sentence.



Notes:

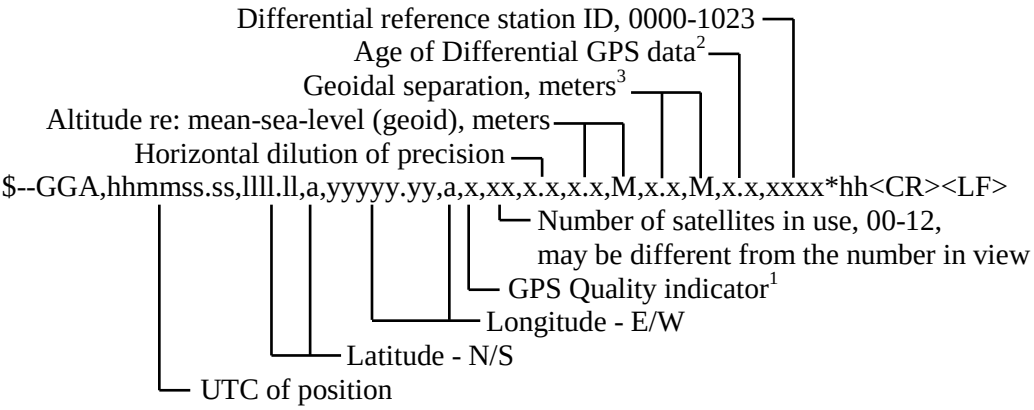
1) Degrees from true north

2) The selected accuracy level and 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 indicate the status of the various integrity sources, with three currently defined; RAIM (first character), SBAS (second character) and Galileo integrity (GIC). This field shall not be Null.
The characters shall take one of the following values:
V = Not in use
S = Safe (when integrity is available and Horizontal Protection Limit (HPL) < Horizontal Alert Level (HAL)
C = Caution (when integrity is not available)
U = Unsafe (when integrity is available and HPL>HAL)

GGA – Global Positioning System Fix Data

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



Notes:

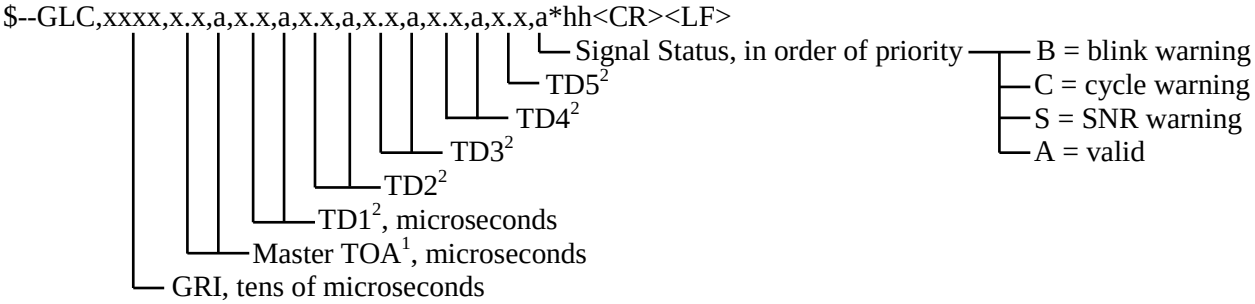
1) GPS Quality Indicator: All GPS quality indicators in heading 1-5 are considered valid. The GPS quality indicator filed shall not be a null field
   0 = Fix not available or invalid
   1 = GPS SPS Mode, fix valid
   2 = Differential GPS, SPS Mode, fix valid
   3 = GPS PPS Mode, fix valid
   4 = Real Time Kinematic. System used in RTK mode with fixed integers
   5 = Float RTK. Satellite system used in RTK mode, floating integers
   6 = Estimated (dead reckoning) Mode
   7 = Manual Input Mode
   8 = Simulator Mode
   The GPS Quality Indicator field shall not be a null field.

2) Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is not used 300

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

GLC – Geographic Position – Loran-C

Loran-C GRI, status and Time Difference (TD) lines of position for present vessel position.



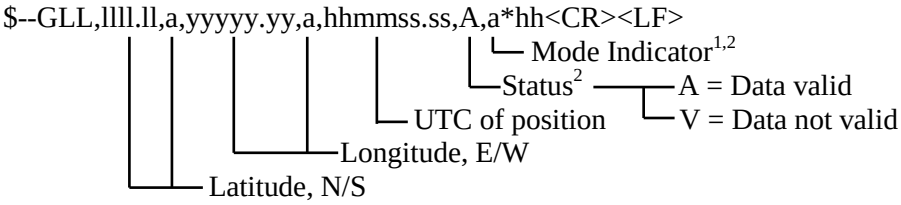
Notes:

1) Master TOA provides for direct ranging operation. It may be the actual range to the Master in microseconds or be offset and track the arrival of the Master signal.

2) Time difference numbers in microseconds are in the Loran-C Coding Delay order with null fields used when values are unavailable.

GLL – Geographic Position – Latitude/Longitude

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



Notes:

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 field, the Status field shall be set to:
   V = Invalid for all values of Indicator mode except for
   A= Autonomous
   D = Differential.
   The positioning system Mode Indicator and Status fields shall not be null fields.

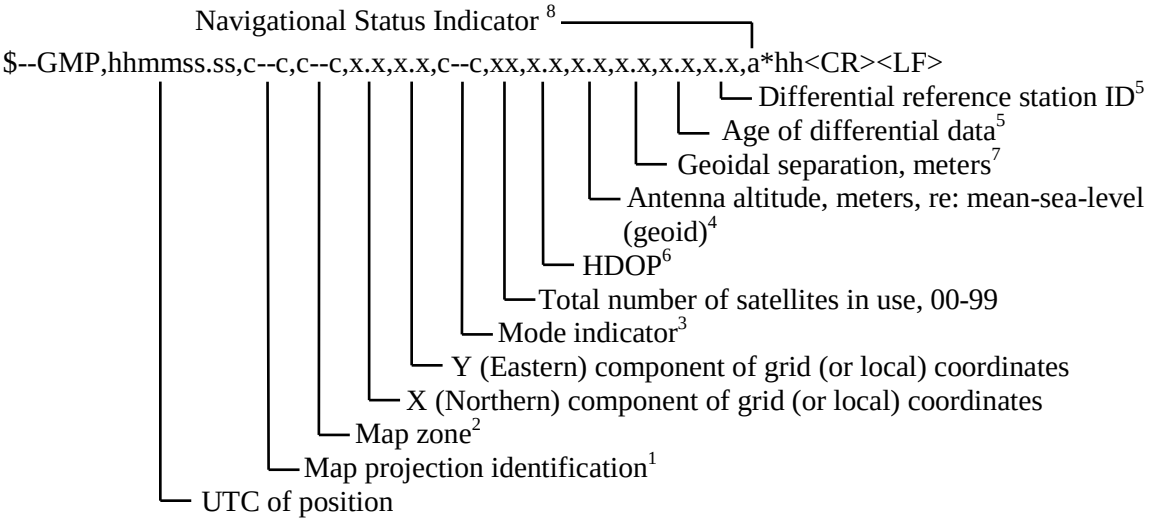
GMP – GNSS Map Projection Fix Data

This sentence supports land use and provides map projection co-ordinates of any GNSS system.

Fix data for single or combined satellite navigation systems (GNSS) in grid (or local) coordinates expressed in the given map projection. This sentence provides fix data for GPS, Galileo, 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 $GPGMP and $GLGMP 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 $GNGMP, and use the mode indicator to show which satellite systems are being used.



Notes:

1) Map Projection identification. A variable length valid character field type consisting of 3 characters as follows:
   UTM = Universal Transverse Mercator
   LOC = Local Coordinate System

2) Map Zone. A variable length valid character field type containing of the map projection zone. A typical Map Zone field might contain M20 for a Map Projection Identification of UTM.

3) 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 indicates 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 shall always be added on the right, so the order of characters in the Mode Indicator is: GPS, GLONASS, GA, other satellite systems in the future. The characters shall 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. Corrections from ground stations or Satellite Based Augmentation System (SBAS).
   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, or Precise Point Positioning (PPP) modeR = Real Time Kinematic. Satellite system used in RTK mode with fixed integers
S = Simulator Mode
The Mode Indicator shall not be a null field.

4) Antenna Altitude. This is referenced to mean-sea-level for UTM map projections or to local coordinates if LOC map projections are specified.

5) 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 shall be null. In this case, the "Age of differential data" and "Differential reference station ID" fields shall be provided in following GMP sentences with talker IDs of GP, GL, GA etc. These following GMP sentences shall have the map projection identification, map zone, X coordinate, Y coordinate, altitude, geoidal separation, mode, and HDOP fields null. This indicates to the listener that the field is supporting a previous $GNGMP 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.

   For Example:

   A Combined GPS/GLONASS/Galileo receiver using only GPS differential corrections has the following GNS sentence sent.

   $GNGMP,122310.2,UTM,M20,12345.56,65543.21,DA,14,0.9,1005.543,6.5,5.2,23*75<CR><LF>

   For Example:

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

   $GNGMP,122310.2,UTM,M20,12345.56,65543.21,DD,14,0.9,1005.543,6.5,,*58<CR><LF>

   $GPGMP,122310.2, , , , , ,7, , , ,5.2,23*4D<CR><LF>

   $GLGMP,122310.2, , , , , ,7, , , ,3.0,23*55<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.

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

7) 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.

8) Navigational Status Indicator: 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

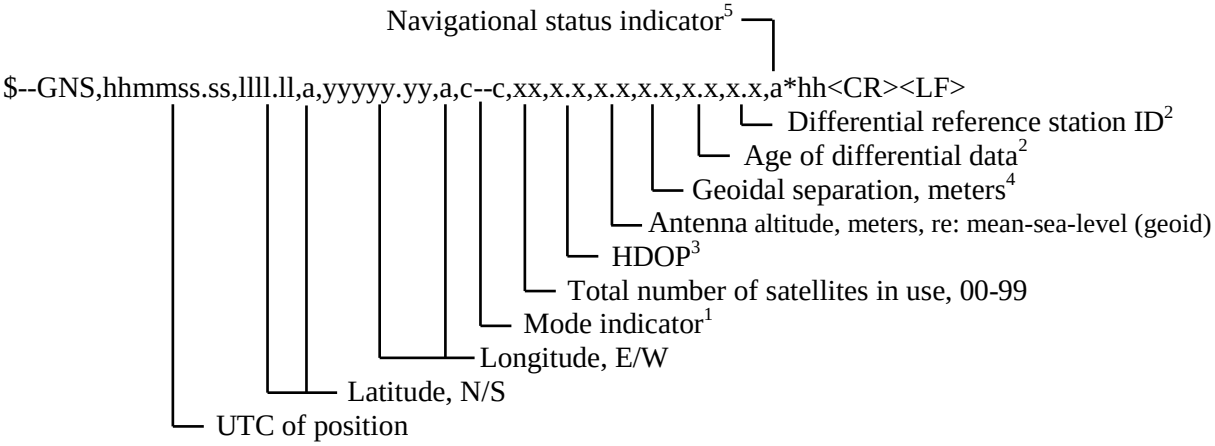
navigation mode, and/or a new valid position has not been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft
V = Navigational status not valid, equipment is not providing navigational status indication.

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 and $GLGNS 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.



Notes:

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 character indicates 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 shall 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 shall 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. Corrections from ground stations or Satellite Based Augmentation System (SBAS).

   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, 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 shall not be a null field.

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 shall be null. In this case, the "Age of differential data" and "Differential reference station ID" fields shall be provided in following GNS sentences with talker IDs of GP, GL, GA etc. These following GNS messages shall 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/Galileo 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*59<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,,*74<CR><LF>
   $GPGNS,122310.2, , , , , ,7, , , ,5.2,23*4D<CR><LF>
   $GLGNS,122310.2, , , , , ,7, , , ,3.0,23*55<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.

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.

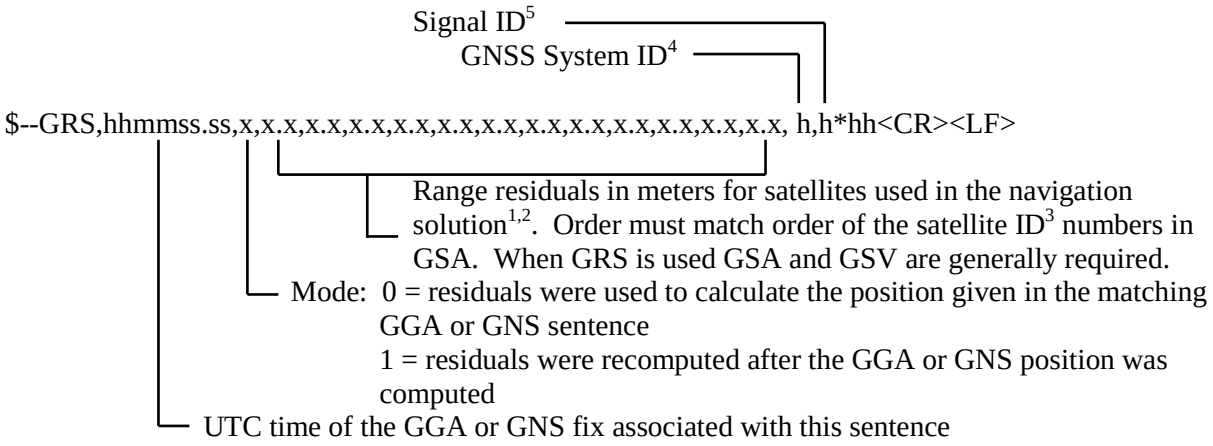
GRS – GNSS Range Residuals

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, GSA, and GSV sentences to be sent.

If only GPS, Galileo, GLONASS, 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, etc. are combined to obtain the position solution multiple GRS sentences are produced, one with the GPS satellites, another with the GLONASS 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, etc. position solution. In general the residuals for a combined solution will be different from the residual for a GPS-only, GLONASS-only, etc. solution.



Notes:

1) If the range residual exceeds ±99.9 meters, 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 must match the order of corresponding GSA sentences. Listeners shall keep track of pairs of GSA and GRS sentences and discard data if pairs are incomplete.

4) Signal ID indentifies the actual ranging signal according to the Table 20 below.

5) System ID according to Table 20 below.

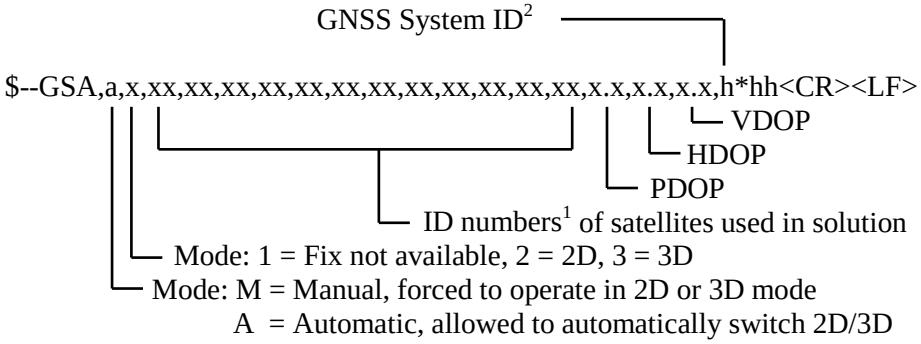
Table 19 - GNSS Identification Table - GRS

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 99	0	All Signals
		1 -32 are served 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
GLONASS	2 (GL)	1 - 99	0	All Signals
		33 - 64 is reserved for SBAS	1	G1 C/A
		65 - 99 is reserved for GLONASS	2	G1 P
			3	G2 C/A
			4	GLONASS (M) G2 P
			5 - F	Reserved
GALILEO	3 (GA)	1 - 36 is reserved for Galileo Sats	0	All Signals
		37 - 64 is reserved for Galileo SBAS	1	E5a
		65 - 99 is undefined	2	E5b
			3	E5 a+b
			4	E6-A
			5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved
RESERVED	4 to F			

GSA – GNSS DOP and Active Satellites

GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence, and DOP values.

If only GPS, GLONASS, Galileo etc. is used for the reported position solution the talker ID is GP, GL, 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 and another with Galileo satellites, 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.



Notes:

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 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA 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.

   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. GNSS System ID field was added to accommodate new GNSS system in the future without requiring a new sentence for each new system. Current use of the GSA for GPS and GLONASS continues and the GNSS System ID should be set accordingly for those systems.
   When the Talker ID is GN, the GNSS System ID provides the only method to determine the meaning of the SVIDs. GNSS System ID values of three or greater alter the meaning the SVID numbers as specified in Table 21 below. The GNSS System ID field shall not be null.

2) GNSS System ID identifies the GNSS System ID according to the Table 21 below.

Table 20 - GNSS Identification Table - GSA

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 99	0	All Signals
		1 -32 are served 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
GLONASS	2 (GL)	1 - 99	0	All Signals
		33 - 64 is reserved for SBAS	1	G1 C/A
		65 - 99 is reserved for GLONASS	2	G1 P
			3	G2 C/A
			4	GLONASS (M) G2 P
			5 - F	Reserved
GALILEO	3 (GA)	1 - 36 is reserved for Galileo Sats	0	All Signals
		37 - 64 is reserved for Galileo SBAS	1	E5a
		65 - 99 is undefined	2	E5b
			3	E5 a+b
			4	E6-A
			5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved
RESERVED	4 to F			

GST – GNSS Pseudorange Error Statistics

This sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM). Pseudorange measurement error 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 reported 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,x.x*hh<CR><LF>

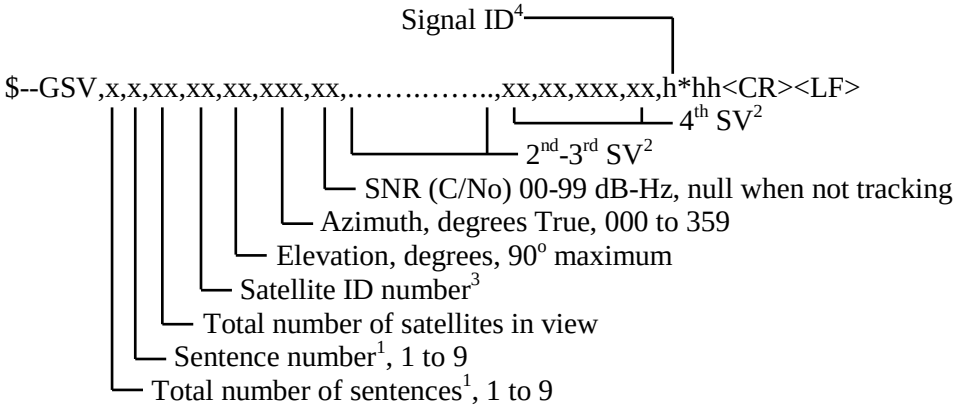
- Standard deviation of altitude error (meters)
- Standard deviation of longitude error (meters)
- Standard deviation of latitude error (meters)
- Orientation of semi-major axis of error ellipse (degrees from true north)
- Standard deviation of semi-minor axis of error ellipse (meters)
- Standard deviation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

GSV – GNSS Satellites In View

The GSV sentence provides the number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. The GSV sentence contains four satellites maximum per transmission. The total number of sentences being transmitted and the sentence number 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 and talker GL to show the GLONASS satellites in view and talker GA to show the Galileo satellites in view, etc. When more than 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.



Notes:

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 not 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 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA 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.

4) Signal ID according to Table 22 below. This field shall not be null.

Table 21 - GNSS Identification Table - GSV

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 99	0	All Signals
		1 -32 are served 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
GLONASS	2 (GL)	1 - 99	0	All Signals
		33 - 64 is reserved for SBAS	1	G1 C/A
		65 - 99 is reserved for GLONASS	2	G1 P
			3	G2 C/A
			4	GLONASS (M) G2 P
			5 - F	Reserved
GALILEO	3 (GA)	1 - 36 is reserved for Galileo Sats	0	All Signals
		37 - 64 is reserved for Galileo SBAS	1	E5a
		65 - 99 is undefined	2	E5b
			3	E5 a+b
			4	E6-A
			5	E6-BC
			6	L1-A
			7	L1-BC
			8-F	Reserved
RESERVED	4 to F			

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]

Notes:

1) Configured autonomous repeat interval in seconds. This field should be set to Null in response to a query if this feature is supported.

2) Equipment in normal operation
A = Yes

V = No

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

HDG – Heading, Deviation & 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

Notes:

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 shall be null fields if unknown.

HDT – Heading, True

This is a deprecated sentence and should not be used for new designs. This sentence has been replaced by THS. See Appendix H for sentence structure.

HMR – Heading Monitor Receive

Heading Monitor Receive: This sentence delivers data from the heading sensors selected by \$--HMS from a central data collecting unit and delivers them to a 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/M
- Status, Sensor 2, A = Data valid
- Heading reading, Sensor 2, degrees
- Deviation, Sensor 1, degrees E/ W[1,2]
- Sensor 1 type, T/M
- Status, Sensor 1, A = Data valid
- Heading reading, Sensor 1, degrees
- Warning flag, A = difference within set limit, V = difference exceeds set limit
- Actual heading sensor difference, degrees
- Difference limit setting, degrees
- Heading Sensor 2 ID
- Heading Sensor 1 ID

Notes:

1) For magnetic sensors: magnetic variation and deviation should be provided, null if unknown.
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

HMS – Heading Monitor Set

Set Heading Monitor: two heading sensors may be selected and the maximum permitted difference between headings set.

```
$--HMS,c--c,c--c,x.x*hh<CR><LF>
          |  |  |  └─ Maximum difference[1], degrees
          |  |  └──── Heading Sensor 2 ID
          |  └─────── Heading Sensor 1 ID
```

Notes:
1) Maximum allowed difference between sensors.

HSC – Heading Steering Command

Commanded heading to steer vessel. This sentence is the status of the command heading and not the heading command.

```
$--HSC,x.x,T,x.x,M,a*hh<CR><LF>
          |  |  |  |  └─ Sentence Status Flag [1]
          |  |  |  └──── Commanded heading, degrees Magnetic
          |  |  └─────── Commanded heading, degrees True
```

Note:
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 a "C" is not a command.

HSS – Hull Stress Surveillance Systems

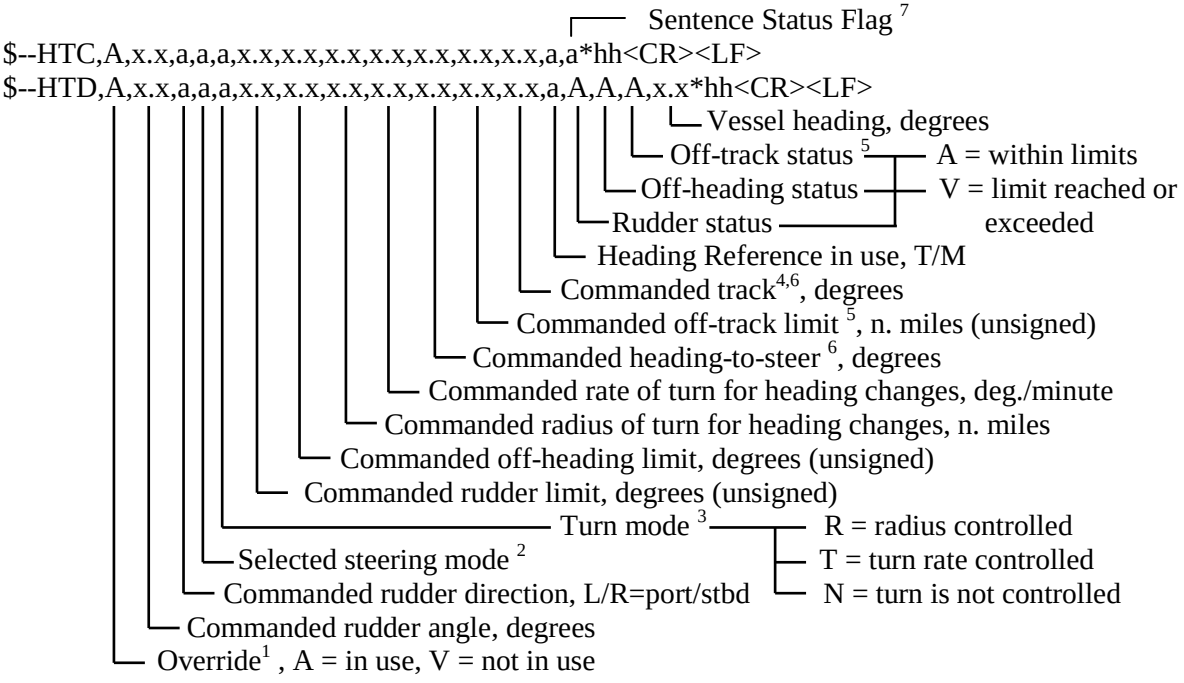
This sentence indicates the hull stress surveillance system (HSS) measurement data.

```
$--HSS,c—c,x.x,A*hh<CR><LF>
          |  |  |  └─ Data status [1]
          |  |  └──── Measurement value
          |  └─────── Measurement point ID
```

Note:
1) A = data valid
   V = data invalid
This field shall not be null.

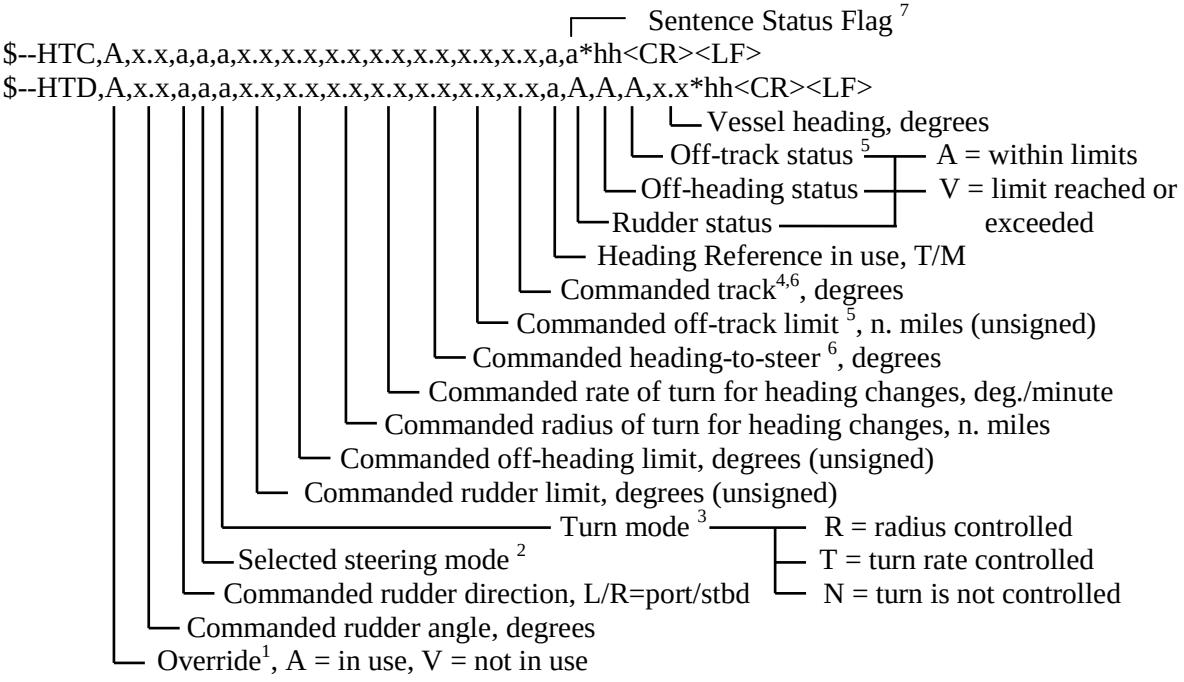
HTC – Heading/Track Control Command

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.



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.

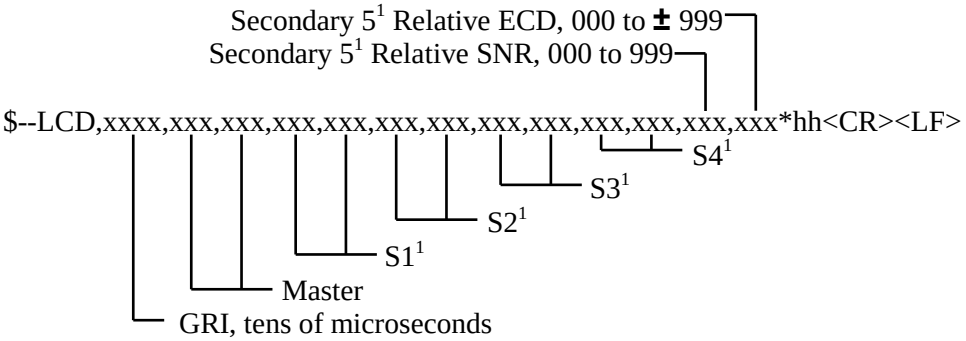


Notes:

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" shall be ignored by the heading/track controller and its computing parts shall 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:
   - M = Manual steering. The main steering system is in use
   - S = Standalone (heading control). The system works as a standalone 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, …)
   - 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 on the ship's maneuverability 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 shall 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.

LCD – Loran-C Signal Data

Signal-to-Noise ratio and pulse shape (ECD) data for Loran-C signals.

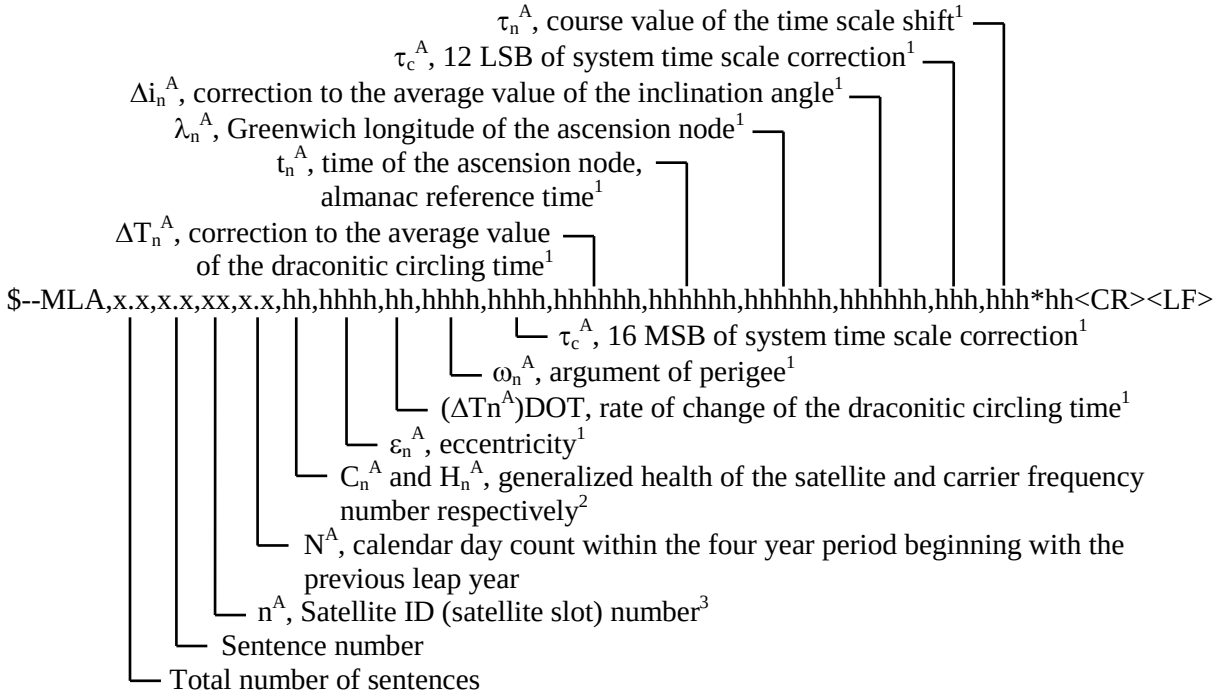


Notes:

1) Data is in the Loran-C Coding Delay order with null fields used when values are unavailable.

MLA – GLONASS Almanac Data

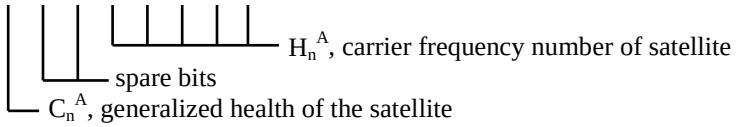
Contains complete almanac data for one GLONASS satellite. All data are transmitted in accordance with the GLONASS Interface Control Document. Multiple sentences may be transmitted, one for each satellite in the GLONASS constellation.



Notes: (Reference GLONASS Interface Control Document, 1995)

1) Section 4.5, Table 4.3. The least significant bits (LSB, low bits) of the HEX data field corresponds to the LSB of the word indicated in Table 4.3. If the number of available bits in the HEX field is greater than is necessary to represent the word in Table 4.3, then the most significant Bits (MSB, upper bits) of the HEX field are unused and filled with zero (0).

2) C_n^A and H_n^A from the GLONASS Interface Control Document are represented in this 2-character HEX field as follows: hh = [8][7][6][5][4][3][2][1] (LSB)



3) The numbers 65-96 are used to identify 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

MSK – MSK Receiver Interface Command

Command sentence to a radio beacon MSK receiver (beacon receiver) or reply from an MSK receiver 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), seconds [1]
- Auto/Manual bit rate, A/M [2]
- Beacon bit rate (25,50,100,200) bits per second
- Auto/Manual frequency, A/M [2]
- Beacon Frequency, 283.5-325.0 kHz

Notes:

1) When status data is not to be transmitted this field is "null"
2) If Auto is specified the previous field value is ignored
3) Set equal to “1” or null for single channel receiver.
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.

MSS – MSK Receiver Signal

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.x,x*hh<CR><LF>

- Channel number[1]
- Beacon bit rate (25,50,100,200) bits per second
- Beacon Frequency, 283.5-325.0 kHz
- Signal-to-Noise ratio (SNR), dB
- Signal Strength (SS), dB re: 1 uV/m

Notes:

1) Set equal to “1” or null for single channel receivers

   In addition the beacon receiver shall respond to Queries using the standard NMEA Query request.

MTW – Water Temperature

$--MTW,x.x,C*hh<CR><LF>

- Temperature, degrees C

MWD – Wind Direction & 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, meters/second
- Wind speed, knots
- Wind direction, 0 to 359 degrees Magnetic
- Wind direction, 0 to 359 degrees True

MWV – Wind Speed & Angle

When the reference field is set to R (Relative), data is provided giving the wind angle in relation to the vessel's bow/centerline 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 actual wind), data is provided giving the wind angle in relation to the vessel's bow/centerline 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.

For 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 degrees. In this same example the theoretical wind is 10 knots at 180 degrees (if the boat suddenly stops the wind will be at the full 10 knots and come from the stern of the vessel 180 degrees from the bow).
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 degrees. In this same example the theoretical wind is 7.07 knots at 225 degrees (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 degrees 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/M/N/S
- Wind speed
- Reference, R = Relative
  T = Theoretical
- Wind angle, 0 to 359 degrees

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 one (1) second.

A NAK can be used with or without a TAG Block. When the TAG Block feature is active, the NAK should use a TAG Block when appropriate (See Section 7.12.1). The NAK sentence is not used to report an "error" (See Section 7.5) in the TAG Block portion of a "line" (See Section 7.6).

Use of NAK should be specified by the equipment standard (Also see Section 7.6.2.2.).

This sentence cannot be queried.

$--NAK,cc,ccc,c--c,x.x,c--c*hh<CR><LF>

- Talker Identifier [1]
- Affected sentence formatter [2]
- Unique Identifier [3]
- Reason code for negative acknowledgement [4]
- Negative acknowledgement's descriptive text [5]

Notes:

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. (See the SID sentence).

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 fulfill 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.

NRM – NAVTEX Receiver Mask Command

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 is a command sentence.

$--NRM,x,x,hhhhhhhh,hhhhhhhh,a*hh<CR><LF>

- Sentence status flag [5]
- message type mask [4]
- transmitter coverage area mask [3]
- frequency table index [2], 1 to 9
- function code [1], 0 to 9

Notes:

- 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
- The frequency indicator identifies the frequency that the NAVTEX message was received on:
  - 1 = 490 kHz
  - 2 = 518 kHz
  - 3 = 4209.5 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 shall be set to zero. To select a transmitter coverage area its corresponding bit shall be set to one. To deselect a transmitter coverage area its corresponding bit shall 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 shall be set to zero. To select a message type its corresponding bit shall be set to one. To deselect a message type its corresponding bit shall be set to zero.

   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 sentences 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.

   For Example:

   $INNRM,2,1,00001E1F,00000023*57

   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.

   For Example:

   $INNRM,0,2,00001E1F,0FFFFFFF*21

   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.

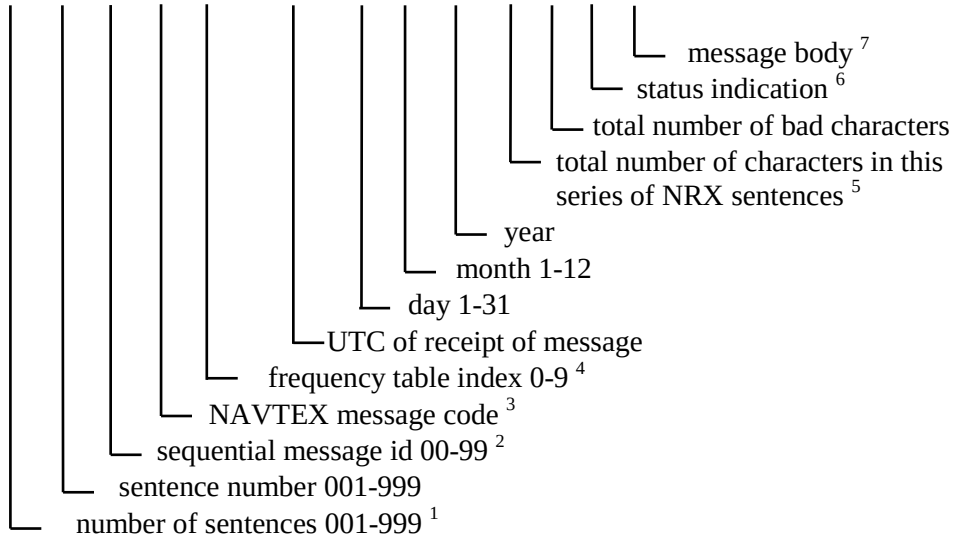
5) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

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.

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 NMEA 0183 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>



Notes:

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.625-3, combination numbers 1-26. Transmitter identification characters are allocated by the IMO NAVTEX Co-coordinating 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 4.3.5 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 (i.e. test messages)
   1 = 490 kHz
   2 = 518 kHz

3 = 4209.5 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 4.

6) Status ‘A’ is used for syntactically correct message reception. Status ‘V’ is used for syntactically incorrect message reception, e.g. end characters NNNN missing.

7) The message body may contain reserved characters as defined in NMEA 0183.

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,,,,,,,,,,^OD^0A^OD^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.

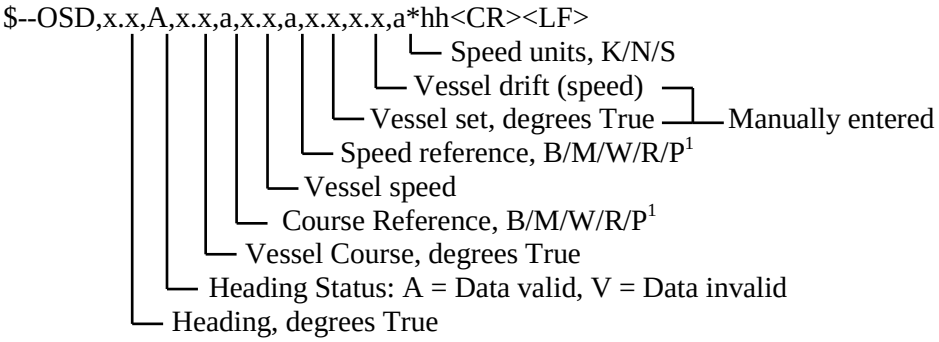
NORTH FORELAND TO SE**EY BILL.
12 HOURS FORECAST:

SHOWERY WINDS, STRONGEST IN NORTH.

<end of decoding>

OSD – Own Ship Data

Heading, course, speed, set and drift summary. Useful for, but not limited to radar and radar plotting applications. OSD gives the movement vector of the ship based on the sensors and parameters in use.



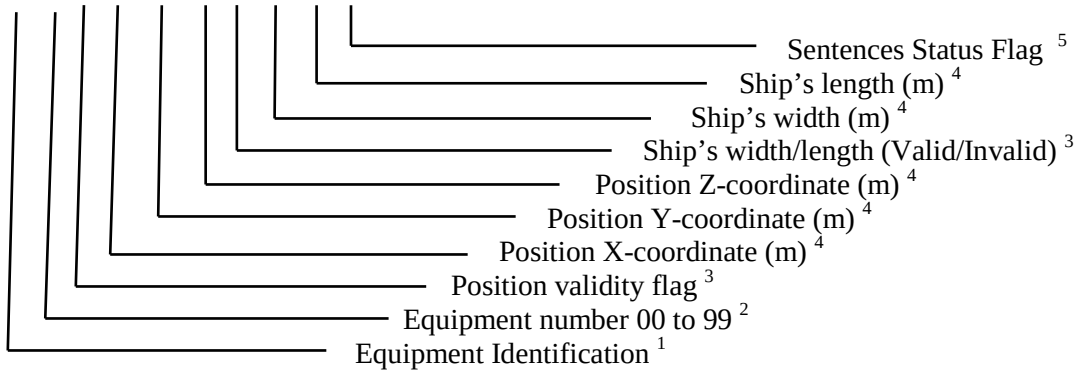
Notes:

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

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 ship dimensions. The consistent common reference position (CCRP) data may also be provided. This is can be used to configure or report the status can be queried. This is a command sentence.

Usage of this sentence is defined in the corresponding equipment standards. Possible application may be to transmit this sentence at power up and repeatedly at 30 second interval.



Notes:

1) Equipment identification is the talker ID (See Table 6)

2) Equipment number starts from one to maximum same equipment number. (i.e. 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 used for testing or non-configured device. This filed should not be Null.

4) X, Y, Z coordination system

   a) Origin (0,0) is located at the center of the ship's aft most point

   b) X-component:

   - Starboard = positive value
   - Port = negative value
   - Center = zero

   c) Y- component:

   - Positive value or zero (forward distance from the ship's stern)

   d) Z – component:

   - Positive value (height from IMO summer load (see IMO Convention on Load Lines)

   e) The ship's length corresponds to the maximum overall length

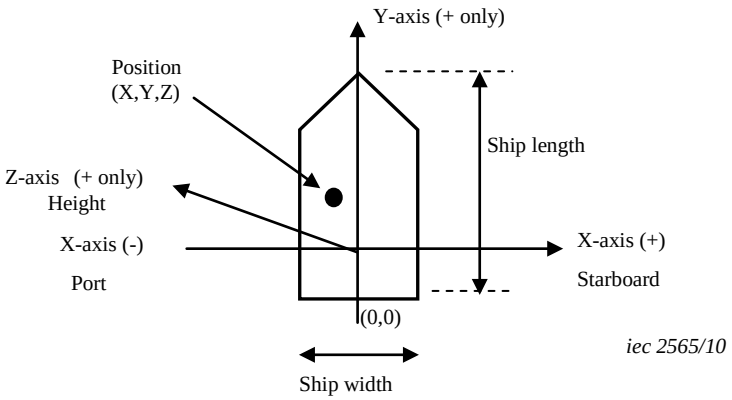


Figure 7 – Device Position and Ship Dimensions

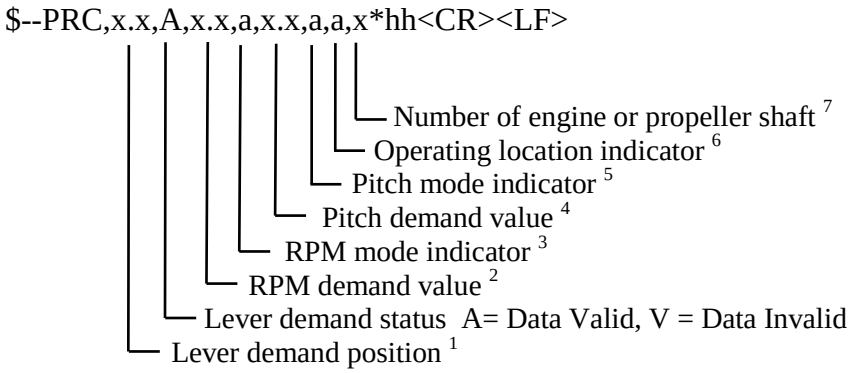
5) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

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.

PRC – Propulsion Remote Control Status

This sentence indicates the engine control status (engine order) on a M/E remote control system. This provides the detail data not available from the engine telegraph.



Notes:

1) Lever position of engine telegraph demand. -100 – 0 – 100% from “full astern” (crash astern) to “full ahead” (navigation full) “ stop engine”

2) This field shall not be null.3) RPM demand value “-“ Astern

4) P = Per cent (%):0 – 100% from zero to maximum rpm
R = Revolutions per minute (rpm) : “-“ Astern
V = data invalid

5) Pitch demand value

6) P = Per Cent (%) : -100 – 0 – 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.

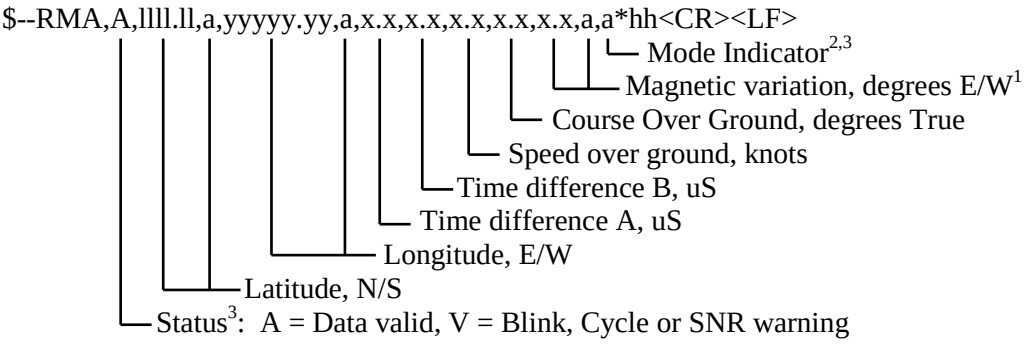
8) Numeric character to identify engine or propeller shaft controlled by the system. This is numbered from center-line. This field is a single character
0 = single or on center-line
Odd = starboard
Even = port
This field shall not be null.

9) This should not be a null field.

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-seconds 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 must be provided, null fields used only when data is temporarily unavailable.



Notes:

1) E = Easterly variation subtracts from True course
   W = Westerly variation adds to True course

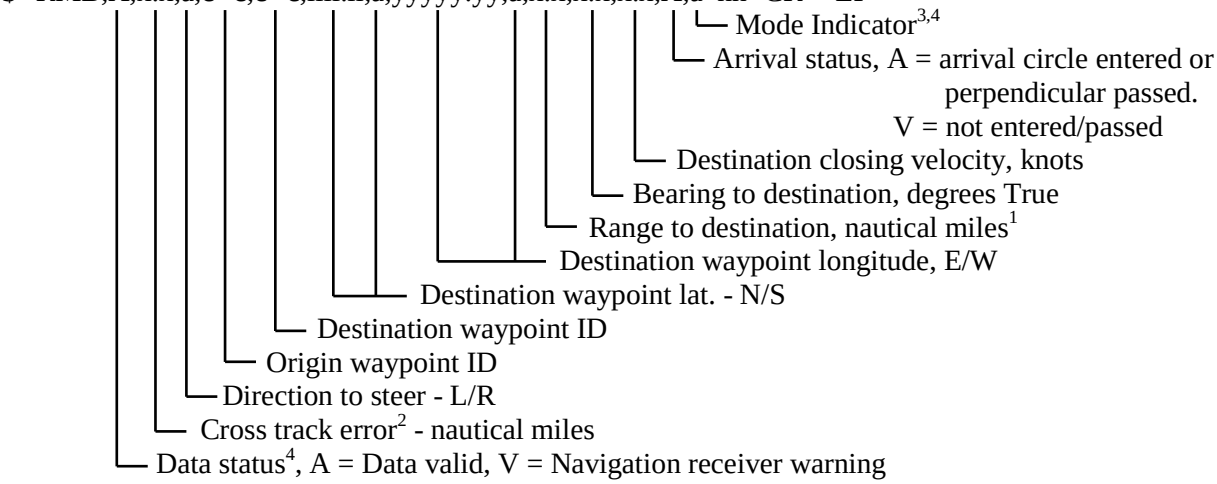
2) Positioning system Mode Indicator:
   A = Autonomous mode
   D = Differential mode
   E = Estimated (dead reckoning) mode
   M = Manual input mode
   S = Simulator mode
   N = Data not valid

3) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to:
   V = Invalid for all values of Indicator mode except for
   A= Autonomous
   D = Differential.
   This field shall not be null.

RMB – Recommended Minimum Navigation Information

Navigation data from present position to a destination waypoint provided by a Loran-C, GNSS, DECCA, 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.



Notes:

1) if range to destination exceeds 999.9 NM, display 999.9

2) if cross track error exceeds 9.99 NM, display 9.99

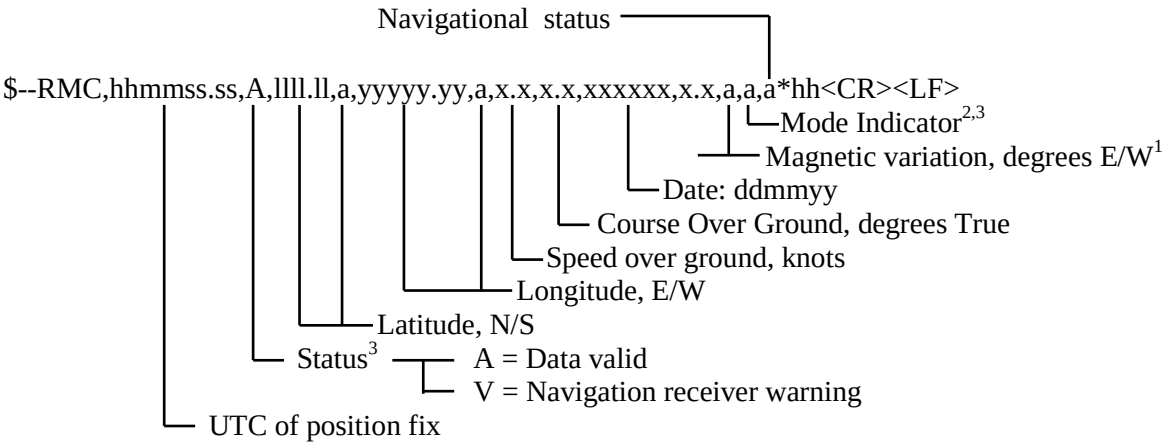
3) Positioning system Mode Indicator:
   A = Autonomous mode
   D = Differential mode
   E = Estimated (dead reckoning) mode
   M = Manual input mode
   S = Simulator mode
   N = Data not valid

4) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to:
   V = Invalid for all values of Indicator mode
   except for
   A= Autonomous
   D = Differential.
   This field shall not be null.

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-seconds 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 must be provided, null fields used only when data is temporarily unavailable.



Notes:

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. Corrections from ground stations or Satellite Based Augmentation System (SBAS).
   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, 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 shall not be a null field.

3) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to:
V = Invalid for all values of Indicator mode
except for
A= Autonomous
D = Differential
This field shall not be null.

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 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.

ROR – Rudder Order Status

Relative rudder angle which is ordered for the rudder angle system.

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

- Command source location (as TRC)
- Port rudder order [1,2]
- Status A = data valid, V = data invalid
- Starboard (or single) rudder order [1,2]
- Status:
  - A = valid,
  - V = data invalid

Notes:

1) Relative measurement of rudder order angle without units, "-" = bow turns to port.

2) The status field shall not be null.

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, degrees/minute, "-" = bow turns to port

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 max., "-" = astern
       |  |  +------- Speed, rev/min, "-" = counter-clockwise
       |  +---------- Engine or shaft number, numbered from centerline
       |                                      0 = single or on centerline
       |                                      odd = starboard
       |                                      even = port
       +------------- Source, shaft/engine S/E
```

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],
       |   |  |      Status  A = Data valid,
       |   |  |              V = Data Invalid
       |   |  +------ Starboard (or single) rudder sensor[1],
       |   |         Status  A = Data Valid,
       |   |                 V = Data Invalid
       |   +--------- Status  A = Data valid
       |                      V = Data Invalid
       +------------- Port rudder sensor[1],
```

Notes:

1) Relative measurement of rudder angle without units, "-" = "Bow Turns To Port". Sensor output is proportional to rudder angle but not necessarily 1:1.

RSD – Radar System Data

Radar display setting data.

```
                                                  Display rotation[1]
                                                  Range units, K/N/S
                                                  Range scale in use
$--RSD,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,a*hh<CR><LF>
       |   |   |   |   |   |   |   |   |   |   |   |   |
       |   |   |   |   |   |   |   |   |   |   |   +- Cursor bearing, degrees clockwise from 0°
       |   |   |   |   |   |   |   |   |   |   +----- Cursor range, from own ship
       |   |   |   |   |   |   |   |   |   +--------- EBL2, degrees
       |   |   |   |   |   |   |   |   +------------- VRM2, 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
       |   +----------------------------------------- Status  A = Data valid
       |                                                      V = Data Invalid
       +--------------------------------------------- Status  A = Data valid
                                                              V = Data Invalid
```

Notes:

1) Display rotation:
   C = Course-up, course-over-ground up, degrees True
   H = Head-up, ship's heading (centerline) 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.

RST – Equipment Reset Command

This sentence is used to restart or reset the equipment.

This sentence cannot be queried.

$--RST,c--c,x,x,a*hh<CR><LF>

- Sentence status flag [4]
- Equipment status [3]
- Equipment reset command [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. When the Unique Identifier is provided, this sentence should be accepted only if this data field matches the equipment's Unique Identifier.

2 This field restarts equipment operation or resets equipment settings. Null indicates no action taken.
1 = This commands the equipment to restart operation using the current values for all configurable settings.
2 = This commands the equipment to reset all configurable settings to the default factory values.

3) This field reports completion of the equipment restart or reset.
1 = equipment restart using the current values for all configurable settings.
2 = equipment reset all configurable settings to the default factory values.
3 = unexpected restart using the current values for all configurable settings (no RST command).
4 = unexpected reset all configurable settings to the default factory values (no RST command).
5 to 9 reserved for future use.

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

RTE – Routes 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 are 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), 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
- Sentence mode
  - c = complete route, all waypoints
  - w = working route, 1st listed waypoint is 'FROM', 2nd is 'TO', and remaining are rest of route
- Sentence number[2]
- Total number of sentences being transmitted[2]

Notes:

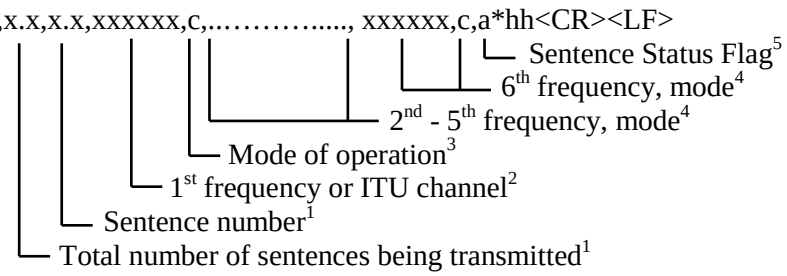
1) A variable number of waypoint identifiers, up to 'n', may be in included within the limits of allowed sentence length. As there is no specified number of waypoints, null fields are not required for Waypoint Identifier fields.

2) A single route may require the transmission of multiple sentences all containing identical field formats when sending a 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.

SFI – Scanning Frequency Information Status and Command

This sentence is used to set or command frequencies and mode of operation for scanning purposes and to acknowledge setting commands. Scanning frequencies are listed in order of scanning.

Note:
For DSC distress and safety watch keeping only 6 channels shall be scanned in the same scanning sequence.
To indicate a frequency set at the scanning receiver use FSI sentence.



Notes:

1) Scanning frequency information may require the transmission of multiple sentences 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.

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 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) 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, FAX-machine
null for no information

4) A variable number of frequency-mode pair fields are allowed up to a maximum of six pairs. Null fields shall be required for unused pairs when less than six pairs are transmitted.

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.

SID – Set an Equipment's Identification and Command

This sentence is used to configure an equipment's Unique Identifier and/or MMSI. The Unique Identifier is used for system level identification. The MMSI is used to identify the AIS station on the VHF Data Link.

The Current Unique Identifier is required to change the Base Station's Unique Identifier. The Current MMSI is not required to change the Unique Identifier.

The Current Unique Identifier and the Current MMSI are required to change the MMSI.
Proper installation of a Base Station's Unique Identifier and MMSI may be confirmed by using a query.

This sentence may be used for other equipment beside AIA Base Station.

$--SID,c--c,c--c,xxxxxxxxx,xxxxxxxxx,a*hh<CR><LF>
- Sentence status flag [5]
- New MMSI [4]
- Current MMSI [3]
- New Unique Identifier [2]
- Current Unique Identifier [1]

Notes:

1) The Current Unique Identifier is used for system level identification of a station, 15 characters maximum. On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

2) The New Unique Identifier data field is used to change the Unique Identifier of the Base Station. If the Unique Identifier is not intended to be changed, this field should be a null field. On output from a Base Station, this data field should be a null field.

3) The Current MMSI is a nine-digit number; leading zeros are required. On input, if the MMSI is not being changed, this field should be a null field. On output from the Base Station, this data field is the Base Station's MMSI.

4) The New MMSI data field is used to change the MMSI of the Base Station. If the MMSI is not intended to be changed, this field should be a null field. On output from a Base Station, this data field should be a null field.

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.

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

THS – True Heading and Status

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 HDT sentence.

This sentence replaces the HDT sentence.

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

- a — Mode indicator[1]
- x.x — Heading, degrees True

Notes:

1) Mode indicator :
   - A = Autonomous
   - E = Estimated (dead reckoning)
   - M = Manual input
   - S = Simulator
   - V = Data not valid (including standby)

   This field shall not be null.

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>

- x.x,c--c — Additional label pairs[2]
- c--c — Label assigned to target 'n'[1]
- x.x — Target number 'n' reported by the device

Notes:

1) 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 placeholder. 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.
2) This sentence allows several target number/labels pairs to be sent in a single sentence, the maximum sentence length limits the number of labels allowed in a sentence.

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>

- xx — Target number, 00 to 99
- llll.ll,a — Target latitude, N/S
- yyyyy.yy,a — Target longitude, E/W
- c--c — Target name
- hhmmss.ss — UTC of data
- a — Target status[1]
- a — R = Reference target[2], null otherwise

Notes:

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
3) a reference used to determined own-ship position or velocity, null otherwise.

TRC – Thruster Control Data

This sentence provides the status of control data for thruster devices. This sentence may be also be used as a Command Sentence. When providing status data the sentence shall be transmitted at regular intervals.

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

- x — Number of thruster, bow or stern[1]
- x.x,a — RPM demand value[2]
- a — RPM mode indicator[3]
- x.x,a — Pitch demand value[4]
- a — Pitch mode indicator[5]
- x.x,a — Azimuth demand[6]
- a — Operating location indicator[7]
- a — Sentence Status Flag[8]

Notes:

1) Numeric character to identify a thruster in the system. This is numbered from center-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
   This field shall not be null
4) "-" = port

5) P = Per cent (%)
   D = Degrees
   V = data invalid
   This field shall not be null

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)
   This field shall not be null.

8) 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.

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]
- Pitch response value[4]
- RPM mode indicator[3]
- RPM response[2]
- Number of thruster, bow or stern[1]

Notes:

1) Numeric character to identify a thruster in the system. This is numbered from center-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
   This field shall not be null.

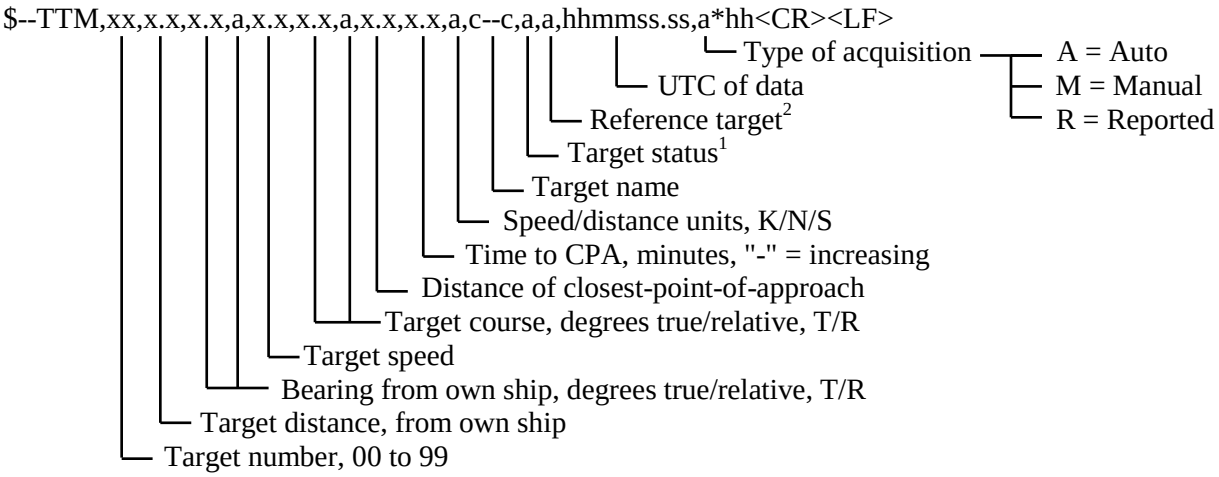
4) "-" port

5) P = Per cent (%):
   D = Degrees
   V = data invalid
   This field shall not be null.

6) Direction of thrust in degrees (0^0 – 360^0)
   This may be a null field.

TTM – Tracked Target Message

Data associated with a tracked target relative to own ship's position.



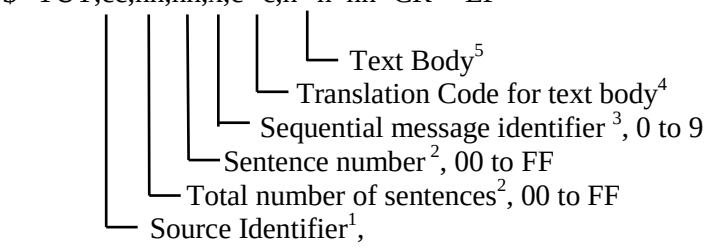
Notes:

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 determined own-ship position or velocity, null otherwise.

TUT – Transmission of Multi-language Text

This sentence is used for the transmission of multi-language text. 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.



Notes:

1) The Source Identifier contains the Talker ID indicating the type of equipment that originated this sentence. The Source Identifer is used to identify the manufactured purpose of the device. The Talker ID U# does not represent the manufactured purpose of the device, thus the U# Talker ID is not allowed in this field. This field shall always contain the Talker ID assigned to the equipment at the time of manufacture.

2) Unicode text may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The second field specifies the total number of sentences, minimum value 01^{hex}. The third field identifies the order 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 Sequential message identifier number relates all sentences that belong to a group of multiple sentences. Multiple sentences (see note 2) with the same sequential message identifier number, makeup 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 10646-1), 56 Hex character positions in the text body.
   - A = ASCII (Subset of ISO 8859-1), 56 Hex character positions in the text body.
   - 1-16 = The specific part number of the ISO 8859 standard, a value of 3 would refer to ISO 8859-3.
   - 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 sentence 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 it's 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>

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

Notes:

1) Text messages may consist of 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) 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).

   For 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 Section 5.1.3).

   $GPTXT,01,01,25,DR MODE - ANTENNA FAULT^21*38<CR><LF>

UID – User Identification Code Transmission

Messages 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]

Notes:

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.
   For Example: A GPS receiver sends a user identification message (uic1 HEPSLGN02376 and uic2 DB Los 23).

   $GPUID,HEPSLGN02376,DB Los 23*hh<CR><LF>

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, stern ground speed — A = Data valid; V = Invalid
- Stern transverse ground speed[1], knots
- Status, stern water speed, A = Data valid
- Stern transverse water speed[1], knots
- Status, Ground speed, A = Data valid
- Transverse ground speed[1], knots
- Longitudinal ground speed [1], knots
- Status: Water speed, A = Data valid
- Transverse water speed[1], knots
- Longitudinal water speed[1], knots

Notes:

1) Transverse speed: "-" = port, Longitudinal speed: "-" = astern

VDR – Set & 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

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 an AIS Base Station the VER sentence shall be output autonomously upon power-up. For other equipment the VER sentence may be output 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]

Notes:

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 Note 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 (See BCG Sentence). For AIS device types, (See Section 9).

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 device, 15 characters maximum.

   When used with AIS stations, on output, this data field is the AIS Station's Unique Identifier (See the SID sentence). 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)

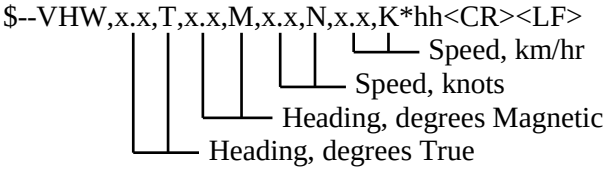
5) The data field length may be 32 characters maximum. The length of 32 characters was chosen in order to be consistent with similar data field lengths in the NMEA 0183 standard. When large character lengths are used and the 80 character sentence limit would be exceeded for a single sentence, a series 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. Maximum length 32 characters.

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.

VHW – Water Speed and Heading

The compass heading to which the vessel points and the speed of the vessel relative to the water.



VLW – Dual Ground/Water Distance

The distance traveled, relative to the water and over the ground.

$--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

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, meters/second, "-" = downwind
- Speed, knots, "-" = downwind

VTG – Course Over Ground & 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/hr[1]
- Speed over ground, knots[1]
- Course over ground, degrees Magnetic
- Course over ground, degrees True

Notes:

1) The speed over ground should always be a positive value

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 the data provided.

The possible indications are as follows:

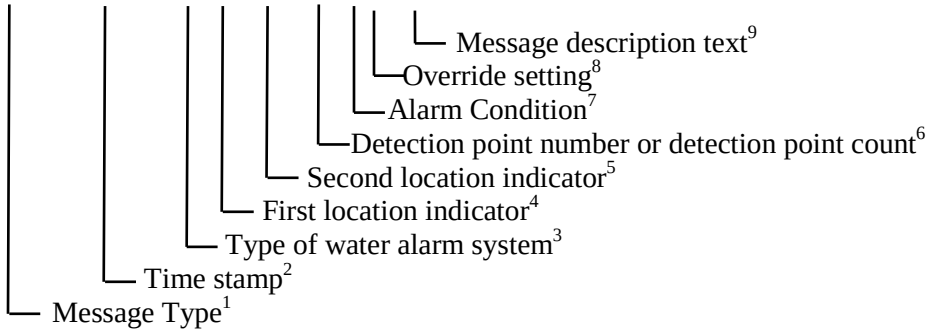
A = Autonomous mode
D = Differential mode Corrections from ground stations or Satellite Based Augmentation System (SBAS).
E = Estimated (dead reckoning) mode
M = Manual input mode
N = Data not valid
P = Precise. Satellite system used in precision mode. Precision mode is defined as no deliberate degradation (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, or Precise Point Positioning (PPP) mode
S = Simulator mode

This Mode Indicator field shall not be a null field.

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>



Notes:

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 Appendix C.1.8.
   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 shall uniquely define the source for the alarm. If a two character location indicator is not supported, the first location indicator may be provided in the message description text field, (see Note 9).

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 shall uniquely define the source for the alarm. If a two character location indicator is not supported, the second location indicator may be provided in the message description text field, (see Note 9).

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 shall be a null field.

7) This field is a single character field.
   - When the message type field is S or F this field shall 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)

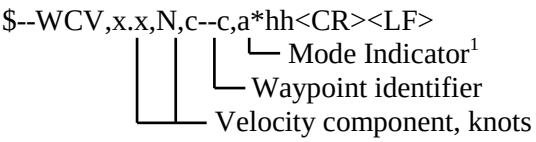
8) This field is a single character specified by the following:
   O = Override mode (water allowed in space)
   N = Normal mode (water not allowed in space)

If there is no override setting, this shall be a null field.

9) Message Description Text. This field may also contain a textual detector location when the reporting system does not support first or second division indicator codes (Field 4 and Field 5). See Notes 4 and 5. Maximum number of characters will be limited by maximum sentence length and length of other fields.

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".

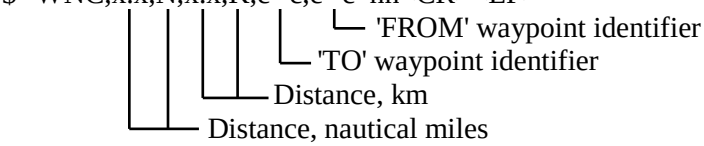


Notes:

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
   This field shall not be a null.

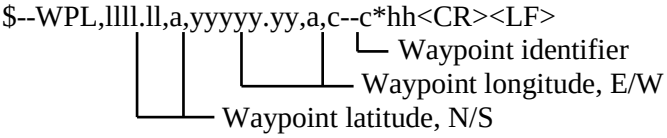
WNC – Distance – Waypoint to Waypoint

Distance between two specified waypoints.



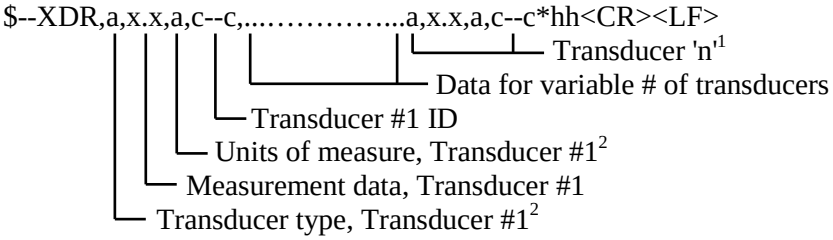
WPL – Waypoint Location

Latitude and longitude of specified waypoint.



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 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 its own data fields on before retransmitting the sentence.



Notes:

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.

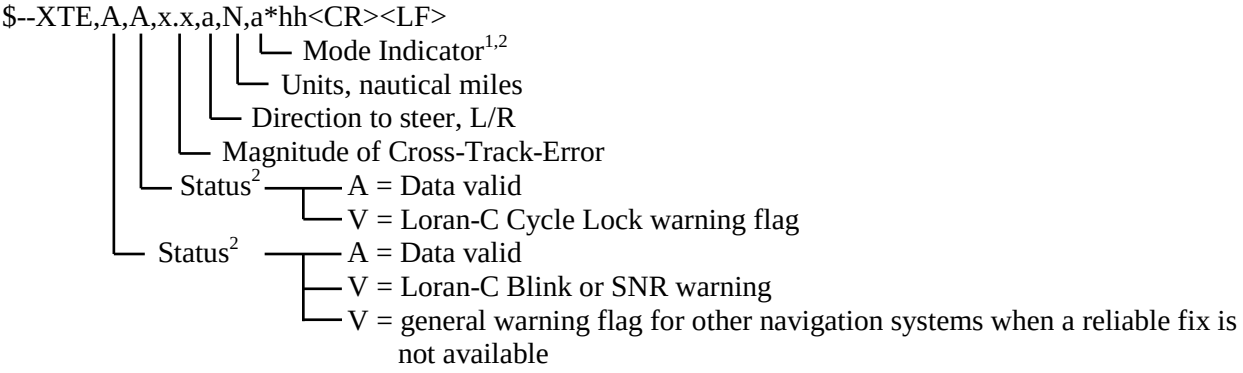
2) Allowed transducer types and their units of measure are according to Table 23.

Table 22 - XDR Transducer Types and Units of Measure

Transducer	Type Field	Units Field	Comments
temperature	C	C = degrees Celsius	
angular displacement	A	D = degrees	"-" = anti-clockwise
linear displacement	D	M = meters	"-" = compression
frequency	F	H = Hertz	
force	N	N = Newton	"-" = compression
pressure	P	B = Bars, P = Pascal	"-" = vacuum
flow rate	R	l = liters/second	
tachometer	T	R = RPM	
humidity	H	P = Percent	
volume	V	M = cubic meters	
generic	G	none (null)	x.x = variable data
current	I	A = Amperes	
voltage	U	V = Volts	
switch or valve	S	none (null)	1 = ON/ CLOSED, 0 = OFF/ OPEN
salinity	L	S = ppt	ppt = parts per thousand
absolute humidity	B	K equals kg/m^3	Kilograms per cubic meter

XTE – Cross-Track Error, Measured

Magnitude of the position error perpendicular to the intended track line and the direction to steer to return to the intended track.



Notes:

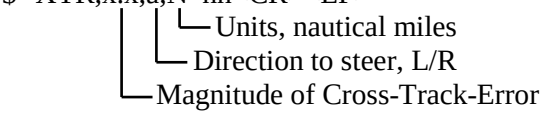
1) Positioning system Mode Indicator:
   - A = Autonomous mode
   - D = Differential mode
   - E = Estimated (dead reckoning) mode
   - M = Manual input mode
   - S = Simulator mode
   - N = Data not valid

2) The positioning system Mode Indicator field supplements the positioning system Status fields, the Status fields shall be set to:
   - V = Invalid for all values of Indicator mode except for
   - A = Autonomous
   - D = Differential

   These fields shall not be null.

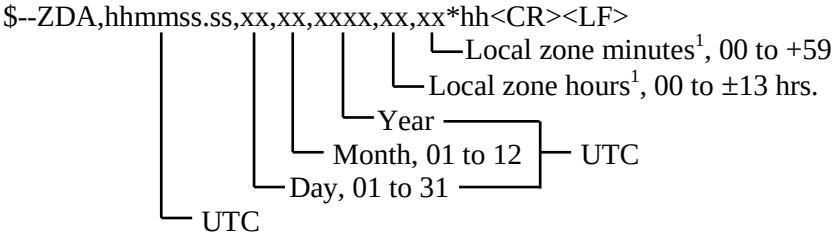
XTR – Cross-Track Error – Dead Reckoning

Magnitude of the dead reckoned position error perpendicular to the intended track line and the direction to steer to return to the intended track.



ZDA – Time & Date

UTC, day, month, year and local time zone.



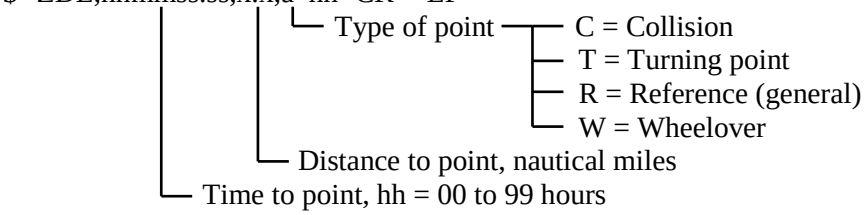
Notes:

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.

   For 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>

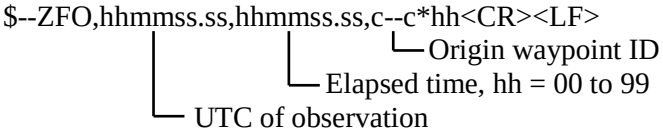
ZDL – Time & Distance to Variable Point

Time and distance to a point that might be non-fixed. The point is generally not a specific geographic point but may vary continuously and is most often determined by calculation (the recommended turning or tacking point for sailing vessels, the wheel-over point for vessels making turns, a predicted collision point, etc.)



ZFO – UTC & Time from Origin Waypoint

UTC and elapsed time from origin waypoint.



ZTG – UTC & 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
```

8.2. Approved General Purpose Encapsulation Sentences

General format of printed sentence information:

*{**mnemonic**} - {**name**}
{definition paragraph}

!--{sentence}
{field descriptions}
Start of sentence and Talker ID

8.2.1 Approved General Purpose Encapsulation Formatters

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 data [3]
       |  |  └─ 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 FF [1]
```

Notes:
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 below. 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 "x[4]" in description of encapsulation sentences.

8.2.1.1 Tracked Target Data Structure

Every target (tracked or AIS) is packed according to the structure below (See Table 24). Data is stored most significant bit first. Every message character is converted into six bits. The structure is encapsulated as 15 characters. The sentence may contain from one to four targets.

Table 23 - Target Data Structure

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. Other values 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
True bearing	12	to 359.9° Step 01°	North-up coordinate system 409,5° = invalid or N/A data
Speed	12	to 409.4 kn Step 0.1 kn	See speed mode and stabilization mode 409,5 kn = invalid or N/A data
Course	12	to 359.9° Step 0.1°	See speed mode and stabilization mode 409,5° = invalid or N/A data
Heading (AIS target only)	12	to 3599° Step 01°	Reported heading from AIS, north-up coordinate system 409,4° = invalid or N/A data 409,5° = 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 163,84 NM = invalid or N/A data

Parameter	Number of bits	Range and resolution	Description
Speed mode	1		0 = true speed and course 1 = relative speed and course
Stabilization 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
N/A: Not available			

Note

Theoretical maximum throughput for NMEA 0183 HS connections is calculated with the formula:
targets/second = baud rate/bits 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 bits address space enough)
Normal: 60/20=3 s/revolution: 561 targets/revolution (10 bits address space enough)
Overhead for TLB – target label and other sentences are not included in this calculation.

9. Approved AIS Sentences

Note: Please refer to Appendix D for data requirements for AIS Base Station, and refer to Appendix E for data requirements for AIS AtoN Stations.

9.1 Approved AIS Parametric Sentences

General format of printed sentence information: These sentences are AIS specific.

*{**mnemonic**} - {**name**}
{definition paragraph}

$--{sentence}
└ {field descriptions}
└ Start of sentence and Talker ID

9.1.1 Approved AIS Parametric Formatters

ABK – AIS Addressed and Binary Broadcast Acknowledgement 136
ACA – AIS Regional Channel Assignment Message 137
ACF – General AtoN Station Configuration Command..... 140
ACG – Extended General AtoN Station Configuration Command 141
ACM – AIS Base Station Addressed Channel Management Command 142
ACS – AIS Channel Management Information Source..... 143
AFB – AtoN Forced Broadcast Command..... 143
AGA – AIS Base Station Broadcast of a Group Assignment Command..... 144
AID – AtoN Identification Configuration Command..... 145

AIR – AIS Interrogation Request 146
ASN – AIS Base Station Broadcast of Assignment Command 147
BCG – Base Station Configuration, General Command 149
BCL – Base Station Configuration, Location Command 150
CBR – Configure Broadcast Rates for AIS AtoN Station Message Command. 151
DLM – Data Link Management Slot Allocations for Base Station Command 153
ECB – Configure Broadcast Schedules for Base Station Messages, Command 155
FSR – Frame Summary of AIS Reception 156
LRF – AIS Long-Range Function 157
LRI – AIS Long-Range Interrogation 158
LR1 – AIS Long-range Reply Sentence 1 159
LR2 – AIS Long-range Reply Sentence 2 159
LR3 – AIS Long-range Reply Sentence 3 160
SPO – Select AIS Device's Processing and Output, Command 161
SSD – AIS Ship Static Data 162
TFR – Transmit Feed-Back Report 163
TPC – Transmit Slot Prohibit, Command 164
TSA – Transmit Slot Assignment 165
TSP – Temporary Transmit Slot Prohibit 166
TSR – Transmit Slot Prohibit Status Report 167
VSD – AIS Voyage Static Data 167
VSI – VDL Signal Information 169

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 utilizes 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 (M.1371 message 15) and BBM (M.1371 messages 8, 14) 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 AIR or BBM broadcast process.

```
$--ABK,xxxxxxxxx,a,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]
```

Notes:

1. Identifies the distant addressed AIS unit involved with the acknowledgement. If more than one MMSI are being addressed (M.1371 message 15), 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 Note 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 sequential message identifier available for reuse. The Message ID determines the source of the Message sequence number. Table 25 lists the source by Message ID:

Table 25 - ITU-R M. 1371 Message Sequence Number Source

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, ITU-R M.1371
8	sequential message identifier from BBM-sentence
12	sequential message identifier from ABM-sentence
13	addressed AIS unit's message 13, sequence number, ITU-R M.1371
14	sequential message identifier from BBM-sentence
15	No source, the Message sequence number shall be a null field
25	Sequential message identifier from ABM or BBM sentence
26	Sequential message identifier from ABM or BBM sentence

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, or 15) 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 a valid transaction.

ACA – AIS Regional Channel Assignment Message

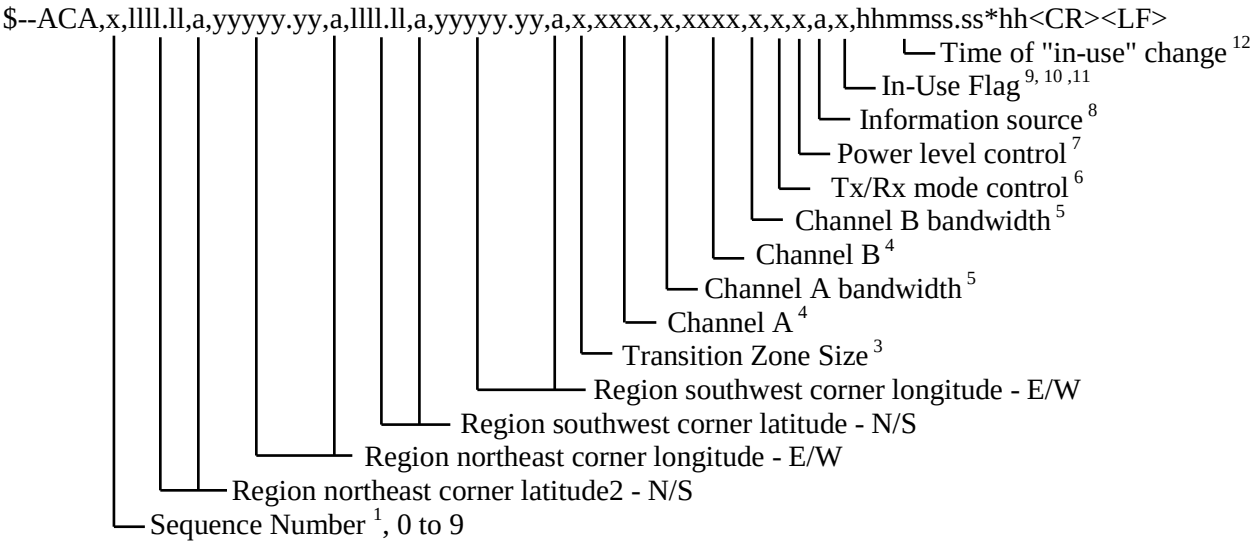
An AIS unit can receive regional channel management information four ways: ITU-R M.1371 message 22, DSC telecommand received on channel 70, manual operator input, and an ACA sentence. The AIS unit may store channel management information for future use. Channel management information is applied based upon the actual location of the AIS unit. An AIS unit is "using" channel management information when the stored information is being used to manage the operation of the VHF receivers and/or transmitter inside the AIS unit.

The ACA sentence is used to both enter and obtain channel management information. When sent to an AIS mobile 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 currently stored channel management information retained inside the AIS unit. The Data Fields contained in this sentence are similar to the “Parameters” contained inside an ITU-R M.1371 message 22. The Data Fields contained in this sentence directly relate to the Initialization Phase and Dual Channel Operation and Channel Management functions of the AIS unit, as described in ITU-R M.1371.

An AIS Base Station contains a list of regions. The list contains the content for one or more message 22 broadcasts. ACA sentences sent to an AIS base station for the purpose of loading AIS message 22 parameters for broadcast are sent to the AIS base station with a “1” in the “In-Use Flag” Data Field to indicate that the region is defined; a “0” in the “In-Use Flag” Data Field indicates that the region should be deleted. An ACA sentence sent to an AIS base station should not contain null values in any field; further when a region is deleted (via the “In-Use Flag” = “0”) the LAT/LON values in the ACA sentence must be an exact match of the values in the stored region.

This sentence may be queried. A query sent to an AIS unit for the ACA sentence shall cause the AIS unit to send an ACA sentence for each and every region defined and currently stored inside the AIS unit. If more than one region is currently stored inside the AIS unit, a single query will result in multiple ACA sentences being sent by the AIS unit. For an AIS base station, the response includes ACA sentences currently stored for message 22 broadcasts.

An AIS mobile unit shall autonomously send several ACA sentences when application of regional information causes the operational settings of the AIS unit to change (i.e. when entering or leaving a geographic region). The multiple ACA sentences contain the information for the discontinued operational settings of regional information no longer being used (In-Use Flag = 0) and the operation settings of the current regional information in use (In-Use Flag = 1).



Notes:

1) This is used to bind the contents of the ACA and ACS sentences together. The ACS sentence, when provided by the AIS unit, shall immediately follow the related ACA sentence, containing the same sequence number. The AIS unit generating the ACA and ACS sentences, shall increment the sequence number each time an ACA/ACS pair is created. After the sequence number "9" is used, the process shall 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 as 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 latitude and longitude fields shall be fixed at 1 decimal place of minutes (1/10 of a minute). If a higher resolution is provided to an AIS unit, the receiving AIS unit shall truncate to 1/10's of minute.

3) Range of 1 to 8 nautical miles.

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

5) When sent to an AIS unit:

   - A value of 0 corresponds to the bandwidth as specified by channel number, see ITU-R M.1084, Annex 4 For AIS equipment designed to ITU-R M.1371-1 and 1371-2, a value of 1, bandwidth is 12.5 kHz .
   - For AIS equipment designed to ITU-R M.1371-3 and 1371-4, this value is ignored.

   When sent from an AIS unit:

- A value of 0 indicates that bandwidth is specified by channel number, see ITU-R M.1084, Annex 4 For AIS equipment designed to ITU-R M.1371-1 and 1371-2, a value of 1, bandwidth is 12.5 kHz .
- For AIS equipment designed to ITU-R M.1371-3 and 1371-4, this value is always set to 0.

6) 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

7) Value of 0, high power
Value of 1, low power

8) 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 = NMEA 0183 AIS Channel Assignment sentence,
D = DSC Channel 70 telecommand, and
M = operator manual input.
This field should be null when the sentence is sent to an AIS unit.

9) 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. The above statement applies to application of regional operating characteristics currently stored inside an AIS unit.

When sent from an AIS Base Station, a value of 0 is not valid, and a value of “1” indicates that the parameters are stored and available for use by the broadcast scheduler for Message 22, as controlled by the ECB sentence. This does not mean that a message 22 broadcast is scheduled using these parameters, only that the parameters will be used if and when a message 22 is scheduled by the ECB sentence.

10) This field should be null when the sentence is sent (input) to a mobile AIS unit because the usage is controlled by the stations position. When an AIS unit physically enters or exits a region as defined by a pre-loaded ACA sentence, the event of entering or exiting a region, not the act of receiving an ACA sentence, causes the AIS unit to apply the pre-loaded regional information to its operational characteristics. Note that this is only true for AIS mobile stations. It does not apply to base stations and AtoNs

11) When loading regional channel management information into an AIS Base Station for future scheduling and broadcast of ITU Message 22, the following values shall apply:

A value of “1” sent to an AIS Base Station indicates that the parameters are available for use in a scheduled message 22 broadcast as controlled by the ECB sentence.

A value of “0” sent to an AIS Base Station indicates that the parameters are no longer available for use in a scheduled message 22 broadcast as controlled by the ECB sentence, and the region should be deleted from the list since a valid region setting requires that the ACA sentence requires no null values and the “In-Use Flag” set to 1

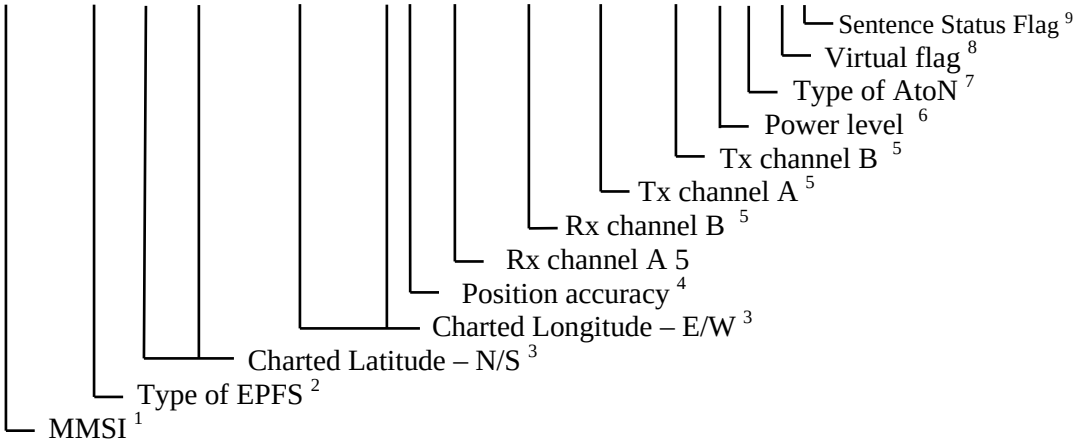
12) This is the UTC time that the "In-Use Flag" field changed to the indicated state. This field should be null when the sentence is sent to a mobile AIS unit..

ACF – General AtoN Station Configuration Command

This sentence and the ACG sentence are used to configure Message 21 content for Real, Synthetic, and Virtual AIS AtoN Stations.

Content of message 21 is determined by the AIS AtoN station as configured by the ACG and ACF sentences and other processes monitoring the status of the AtoN (See IEC 62320-2.).
This sentence can be queried.

\$--ACF,xxxxxxxxx,x,llll.llll,a,yyyyy.yyyy,a,x,xxxx,xxxx,xxxx,xxxx,x,xx,x,a*hh<CR><LF>



Notes:

1) This sentence should be accepted only if the MMSI matches a previously input MMSI (See AID sentence).

2) Identifies the source of the position, see ITU 1371 Message 21 parameter (Type of electronic position fixing device)

3) Charted position (See IALA A.126). If EPFS is "7 (surveyed)," this parameter is the broadcast position. Otherwise the EPFS position is broadcast.

4) 0 = low > 10m.
1 = high < 10m; differential mode of DGNSS.

5) VHF channel number, see ITU-R M.1084. Default values, Rx channel A = 2087 (simplex on AIS1), Tx channel A = 2087 (simplex on AIS1), Rx channel B = 2088 (simplex on AIS2), and Tx channel B = 2088 (simplex on AIS2)

6) 0 = default manufacturer power level (nominally 12,5 Watts)
1 to 9 as defined by the manufacturer

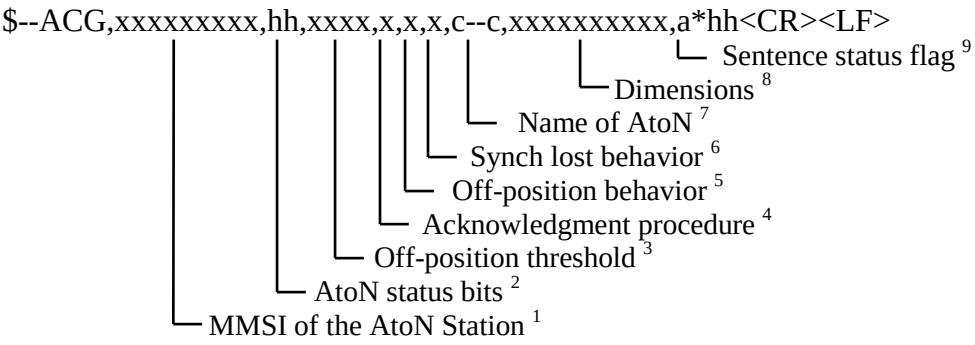
7) See ITU-R M.1371, Message 21, "Type of aids-to-navigation" parameter:
0 = Type of AtoN not specified (default)
1 to 31 = Type as defined in ITU-R M.1371, Message 21, Table 71 ("The nature and type of AtoN can be indicated with 32 different codes")

8) See ITU-R M.1371, Message 21, "Virtual AtoN flag" parameter and "Repeat indicator" parameter
0 = Set "Virtual AtoN flag" to "0" and "Repeat indicator" parameter to "0," for a real AtoN at the indicated position. This is the default value.
1 = Set Virtual AtoN flag to "1," for a Virtual AtoN at the indicated position.
2 = Set Virtual AtoN flag to "0" and Repeat indicator parameter to value other than "0," for a Synthetic AtoN at the indicated position.

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 (use for a reply to a query).
C = Sentence is a Configuration Command to change settings. A sentence without "C" is not a command.

ACG – Extended General AtoN Station Configuration Command

This sentence and the ACF sentence are used to configure the AtoN Station parameters when it is initially installed, and later in order to make changes to the way it operates. This sentence supports system administration of the AIS AtoN Station operation.
This sentence can be queried.



Notes:

1) This sentence should be accepted only if the MMSI matches a previously input MMSI (See AID sentence).

2) AtoN Status Bits, Indication of the AtoN Status, default “00 hex”: For a Virtual AtoN this field should be 00 hex . The three most significant bits represent the Page ID. (See IEC 62320-2, Annex C, Message 21 – AtoN status bits)

3) Off-position indicator is generated when this threshold is exceeded (distance in meters) – (See IEC 62320-2, Off-position monitoring)

4) Determines behavior of AtoN for message acknowledgement (replying using Message 7 and 13).
   0 = will provide acknowledgement as defined by manufacturer (If an acknowledgement procedure is implemented, it is enabled.).
   1 = will not provide acknowledgement (If an acknowledgement procedure is implemented, it is disabled.).

5) Off-position behavior:
   0 = Maintain current transmission schedule (use message ID Index 0)
   1 = Use transmission schedule configured by CBR using, affected MMSI, message ID 21, message ID index 1. When the transmission schedule for Index 1 has not been configured, the off-position maintains the message ID Index 0 schedule.

6) Synch lost behavior (UTC source lost):
   0 = Silent (no transmissions)
   1 = Continue operation

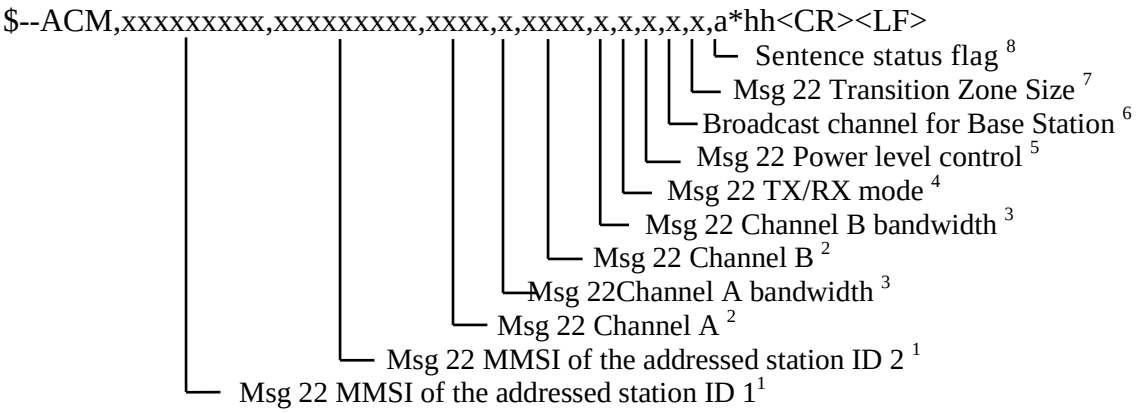
7) Name of the AtoN: maximum 34 characters

8) Reference point of reported position; Should be given as dimension (aaabbbccdd) of the buoy (see ITU-R M.1371, Message 21)

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 (use for a reply to a query).
   C = Sentence is a configuration command to change settings. A sentence without “C” is not a command.

ACM – AIS Base Station Addressed Channel Management Command

This sentence is used to provide an AIS Base Station with the information it uses to transmit an addressed VDL Message 22. This contains settings that are transmitted to one or two specified AIS station(s). Upon receiving this sentence, the Base Station should prepare and make the appropriate transmission (See ITU-R M.1371, Message 22.). This is a command sentence.
This sentence cannot be queried.



Notes:

1) Identifies the distant addressed AIS unit(s) intended to receive the ITU-R M.1371 Message 22. The first MMSI field (field 1) identifies the first AIS unit. The second MMSI field (field 2) identifies the second AIS unit, and may be set to null if only one AIS unit is being addressed.

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

3) See ITU-R M.1371 message 22
   0 = bandwidth is specified by channel number, see ITU-R M.1084, Annex 4
   1 = bandwidth is 12.5 kHz

4) See ITU-R M.1371 message 22
   0 = transmit on channels A and B, receive on channels A and B
   1 = transmit on channel A, receive on channels A and B
   2 = transmit on channel B, receive on channels A and B

5) See ITU-R M.1371 message 22
   0 = high power
   1 = low power

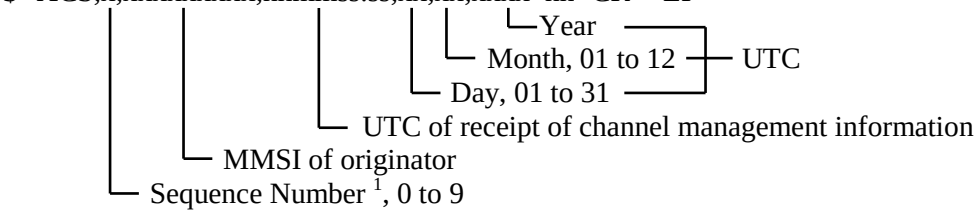
6) The field identifies the channel that the Base Station should use to broadcast the ITU-R M.1371 Message 22. This field should not be a “null” field.
   0 = No broadcast channel preference
   1 = broadcast on AIS channel A
   2 = broadcast on AIS channel B
   3 = broadcast on both AIS channel A and AIS channel B

7) Range of 1 to 8 nautical miles. This should take into consideration the transition zone size for the area in which the specified AIS station(s) are located.

8) 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.
   C = Sentence is a configuration command to change settings. A sentence without “C” is not a command

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.



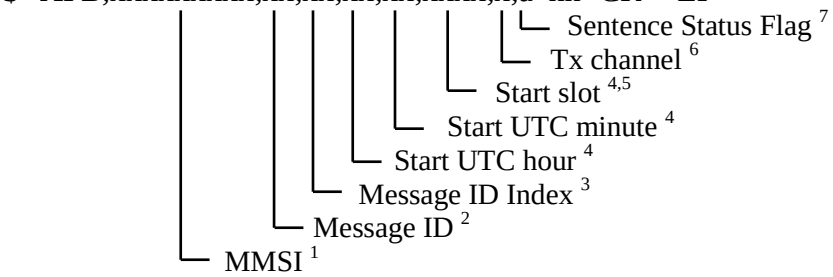
Notes:

1) This is used to bind the contents of the ACA and ACS sentences together. The ACS sentence, when provided by the AIS unit, shall immediately follow the related ACA sentence, containing the same sequence number. The AIS unit generating the ACA and ACS sentences, shall increment the sequence number each time an ACA/ACS pair is created. After 9 is used the process shall 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 as 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.

AFB – AtoN Forced Broadcast Command

This sentence is used to force transmission of the indicated VDL message previously input into the AIS AtoN Station using the ACG, ACF, or MEB sentences.

This sentence cannot be queried.



Notes:

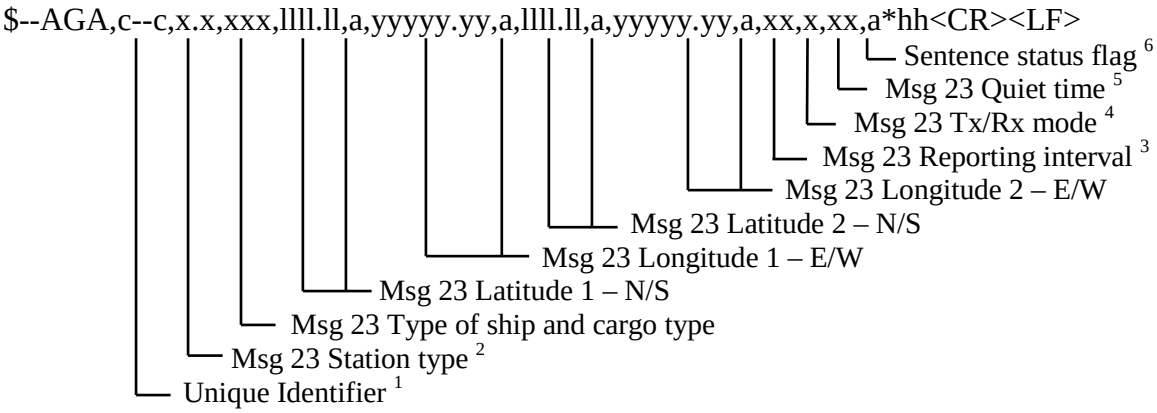
1) This sentence should be accepted only if the MMSI matches a previously input MMSI (See AID sentence).
2) Message ID is the number of the message being scheduled (See ITU-R M.1371).
3) Message ID Index is used to distinguish multiple occurrences of the same MMSI and Message ID combination. Valid range is 0 to 7.
4) Nominal start slot is determined by the combination of Start UTC hour, Start UTC minute, and Start slot.
5) Starting slot valid range is -1 to 2249. If start slot is null, the AtoN Station will use RATDMA for transmission.
6) (Also see ACF sentence Data Fields “Tx channel A” and “Tx channel B”)

   1 = Tx channel A as configured by ACF sentence
   2 = Tx channel B as configured by ACF sentence

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

AGA – AIS Base Station Broadcast of a Group Assignment Command

This sentence is used to provide an AIS Base Station with information it uses to broadcast a "group assignment Message 23". Upon receiving this sentence, the Base Station should prepare the content of a Message 23. Broadcast scheduling for Message 23 is defined using an ECB sentence. This is a command sentence.



Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See the SID Sentence). On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

2) The field identifies the group of mobile stations for the group assignment.
   0 = all types of mobiles (default)
   1 = Class A mobile station only
   2 = all types of Class B mobile stations
   3 = SAR airborne mobile station
   4 = Class B "SO" mobile stations only
   5 = Class B"CS" shipborne mobile station only
   6 = Inland waterways
   7-9 = for regional use
   10-15 = for future use

3) The field identifies the reporting interval as defined in Table 17 of IEC 62287.
   0 = as given by the autonomous mode
   1 = 10 min
   2 = 6 min
   3 = 3 min
   4 = 1 min
   5 = 30 s
   6 = 15 s
   7 = 10 s
   8 = 5 s
   9 = next shorter reporting interval
   10 = next longer reporting interval
   11 = 2 s (not applicable to class B CS)
   12-15 = reserved for future use

4) This is the parameter sent in a message 23. (See "TX/RX Mode" parameter, ITU-R M.1371 message 23)
   0 = transmit on channels A and B, receive on channels A and B (default)
   1 = transmit on channel A, receive on channels A and B
   2 = transmit on channel B, receive on channels A and B
   3 = reserved for future use

5) 0 = no quiet time (default)
   1-15 = quiet time 1min to 15 min

6) 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.

AID – AtoN Identification Configuration Command

This sentence is used to load, for an AtoN Station, its Real, Virtual or synthetic, and chained (parent or child) MMSI(s). The Real MMSI from the factory should be as defined by manufacturer. Each AtoN Station will maintain a table of its MMSI(s). (Reference IEC 62320-2)

For an AIS AtoN Station, this sentence must input a MMSI prior to configuring the parameters for the MMSI (See: CBR, ACG, ACF, AFB, DCR, CEK, COP, MCR, MEB, and TPC sentences).

This sentence can be queried. When queried, the query response will continue until all known AtoN MMSIs and types have been transferred.

```
$--AID,c--c,x,xxxxxxxxx,a,a*hh<CR><LF>
                          └─Sentence status flag [5]
                        └─ Virtual, Real, or chained [4]
                    └─ MMSI [3]
                └─ Create or delete MMSI [2]
            └─ Unique Identifier of AtoN Station [1]
```

Notes:

1) Unique Identifier of the AtoN Station. The Unique Identifier is used for system level identification of a station, 15 characters maximum. On input, this sentence should be accepted only if this data field matches the AtoN Station's Unique Identifier. On output, this data field is the AtoN Station's Unique Identifier. (To address an AtoN station, this should be the Real MMSI of the AIS AtoN Station being addressed. The initial factory setting of the Real MMSI should be defined by manufacturer, for example 990000000.

2) 0 = delete MMSI provided in field 3;
   1 = add MMSI provided in field 3
   If the Real MMSI is deleted, the AIS AtoN Station's Real MMSI should revert to the factory setting. When a MMSI is deleted, all associated messages and transmission schedules for that MMSI should be deleted.

3) MMSI to be added or deleted.

4) Real AtoN, chained, or Virtual AtoN: Real AtoN is own station (AIS AtoN Station may have one Real MMSI). Chained indicates an MMSI that this station is responsible for relaying messages to and from. Virtual AtoN indicates an MMSI that this station is responsible for generating at least a Message 21.
   R = Real AtoN
   V = Virtual or Synthetic AtoN
   P = Parent AtoN Station that is a member of a chain
   C = Child AtoN Station that is a member of a in the chain
   M = Maintenance

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.

AIR – AIS Interrogation Request

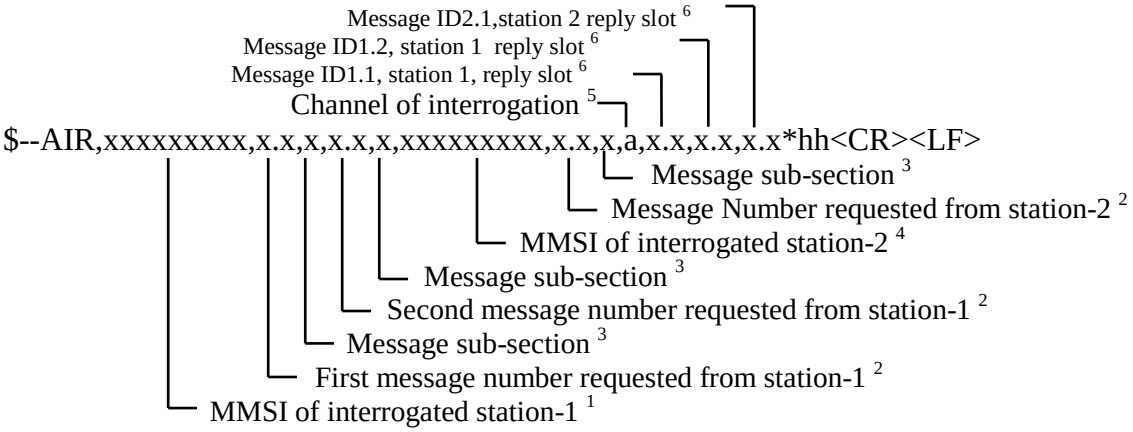
This sentence supports ITU-R M.1371 messages 10 and 15. It provides an external application with the means to initiate requests for specific ITU-R M.1371 messages, from distant mobile or base station, AIS units.

For a message 15, a single AIR 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.

For message 10, a single AIR sentence is used to request a message 11 from one distant AIS unit or a message 4 from one base station. See note 2 below to distinguish a request for message 4 using message 10 or message 15. Improper requests should be ignored.

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) typically respond within another four seconds.

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-UTC and date inquiry, or message 15 - Interrogation. For message 15, 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. For message 10, the success or failure of the interrogation broadcast is determined by the application using the reception of VDM sentence containing the requested message (11 or 4) from a distant AIS unit or AIS base station.



Notes:

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 Table 26).

Table 26 - Message Examples for a Mobile AIS Unit

Field Value	ITU-R M.1371 Message Number Request	Description	ITU-R M.1371 Message Transmitted
3	Message 3	Position Report	Message 15
5	Message 5	Ship static and voyage related data, see additional information in Note 3.	Message 15
9	Message 9	Standard SAR Aircraft Position Report	Message 15
11	Message 11	UTC and date response. A Message 10 is transmitted for this request. A Message 10 is transmitted to only one station. The fields of station 2 shall be null fields. When a base station receives a message 10, the response should be with message 4 instead of message 11, within 4 seconds of reception.	Message 10
18	Message 18	Standard Class B equipment position report	Message 15
21	Message 21	Aids-to-navigation report	Message 15
24	Message 24	Static-data report	Message 15

Table 27 - Examples of messages that may be requested from a distant AIS base station

Field Value	ITU-R M.1371 Message Number Request	Description	ITU-R M.1371 Message Transmitted
4	Message 4	Base Station Report. A Message 15 is transmitted requesting a Message 4 Base Station Report. Response time is dependent upon Base Station configuration, and may be subject to the next scheduled Message 4 transmission	Message 15
24	Message 24	Static-data report	Message 15

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 must 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 when specific channel not being assigned. AIS mobile stations shall ignore this data field.

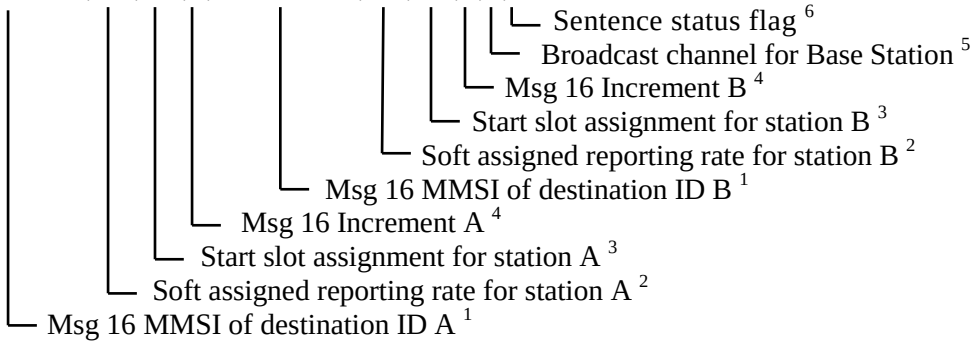
6) AIS mobile stations shall ignore this data field.

ASN –AIS Base Station Broadcast of Assignment Command

This sentence is used to provide an AIS Base Station with the information it uses to broadcast an "assignment VDL Message 16". This contains settings that are broadcast to the specified AIS station(s).

Upon receiving this information, the Base Station should prepare and make the appropriate broadcast (see ITU-R M.1371, Message 16). This is a command sentence.
This sentence cannot be queried.

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



1) Identifies the distant addressed AIS unit(s) for the VDL assignment. The first set of four fields apply to a single AIS unit, while the second set of four fields (fields 5 – 8) apply to a second AIS unit. When only one AIS unit's assignment schedule is being provided, the second set of four fields (fields 5 – 8) may be set to null.

2) This field corresponds to the ITU-R M.1371 Message 16 Offset field. The Base Station will only use this field if the "increment for AIS" field (fields 4 and 8 of this sentence) for the same AIS unit is set to zero. The range of values for this field consists of multiples of 20, between and including 20 to 600. Values that are less than 600 but are not multiples of 20 will be interpreted as the next higher multiple of 20. Values above 600 will be interpreted as 600. This field should be set to null when the "increment for AIS" field (fields 4 and 8 of this sentence) for the same AIS unit is set to a non-zero value.

3) When the increment field is non-zero, this field is the start slot for assigned reports. The Base Station should provide the proper Message 16 off-set at time of broadcast to accomplish this assignment. The Base Station calculates the Message 16 "off-set" as the difference of this start slot and the slot of the broadcast. The range of values for this field consists 0 to 2249 in units of slots. This field should be set to null when the "increment for AIS" field (fields 4 and 8 of this sentence) for the same AIS unit is set to a zero value.

4) This field identifies the increment parameter in units of slots for the associated values of this field. The range of values is from 0 to 6. Note that a value of zero does not provide an increment, see NOTE 2 above. This field should not be set to null, unless the entire four field set for this AIS unit is not provided, because the Base Station may invoke two distinctly different assignment methods based on a zero or non-zero value. The values and their meanings are:

   0 = Reporting rate is based upon the "soft assigned reporting rate for same AIS unit" (fields 2 and 6)/10 min
   1 = 1125 slots
   2 = 375 slots
   3 = 225 slots
   4 = 125 slots
   5 = 75 slots
   6 = 45 slots

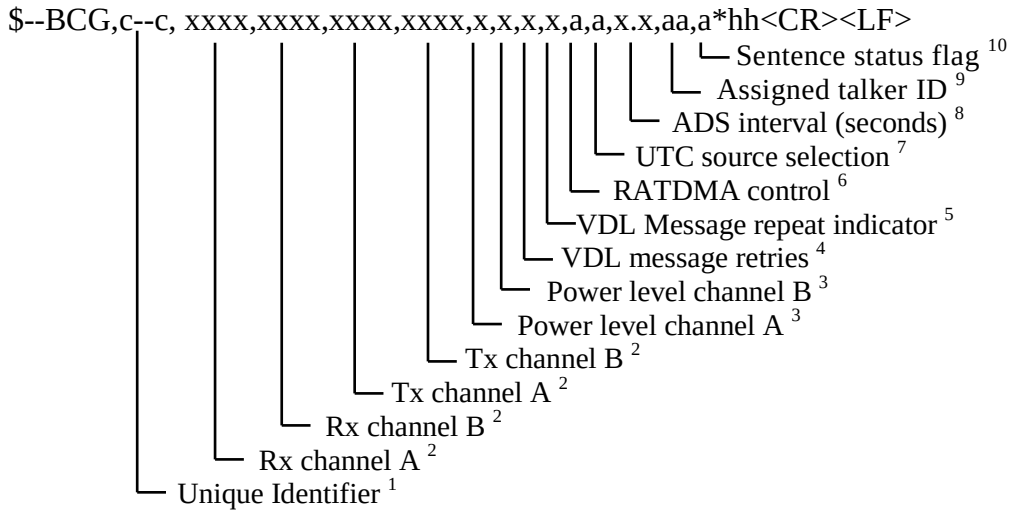
5) The field identifies the channel that the Base Station should use to broadcast the ITU-R M.1371 Message 16. A null value in this field indicates no change from previous received value when this sentence is sent to a Base Station and indicates unknown when this sentence is received from a Base Station. The values and their meanings for this are:
   0 = no broadcast channel preference
   1 = broadcast on AIS channel A
   2 = broadcast on AIS channel B

6) 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.
C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

BCG – Base Station Configuration, General Command

This sentence and the BCL sentence are used to configure the Base Station parameters when the Base Station is installed and during operation. This sentence is also used to select the UTC synchronization source to be used by the Base Station. (Also see ADS sentence).



Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

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

3) 0 = high power (Nominal 12,5 W)
   1 = low power (Nominal 2 W)
   2 to 8 reserved for future use
   9 = transmission disabled (zero W), this is the default power-up state.

4) This is the number of automatic retries for addressed messages. An AIS station may automatically re-broadcast up to three retries. An addressed message is automatically re-broadcast if an AIS station does not receive the required acknowledgement.
   0 = do not automatically re-broadcast addressed messages.
   1 = limit automatic re-broadcast to one retry
   2 = limit automatic re-broadcast to two retries
   3 = permitted to use the maximum number of three automatic re-broadcasts = default

5) This is the VDL Message parameter "Repeat indicator" (RI). This is used to indicate how many times a message has been repeated. See message content tables in ITU-R M.1371. This is the RI for messages generated by the base station. Separate rules apply for repeated messages or VDM input messages. See the applicable equipment standard.
   0 = default, broadcast messages may be repeated
   1 or 2 = based on overall system design, may reduce number of times VDL broadcasts are repeated
   3 = "do not repeat anymore"

6) Controls the Base Station's ability to use RATDMA access to the VDL:
   0 = off (Base Station cannot use RATDMA access to VDL)
   1 = on (Base Station may use RATDMA access to VDL)

7) Controls the UTC synchronization source used by the Base Station:

E = external UTC source
I = internal UTC source
X = external UTC source with fallback to internal UTC source
Y = internal UTC source with fallback to external UTC source, if available

8 The default interval is 60 seconds. The valid range is 1 second to a maximum defined in IEC 62320-1 (3600 seconds). This data field sets the interval between the output of AIS device status sentences (See ADS Sentence). The ADS will also be provided when there is a change in status.

9) The default Base Station talker identifier should be set to the primary design of the equipment. Equipment designed to IEC 62320-1 should have a default of AB.

U# ($0 \leq \# \leq 9$) = user configured talker identifier: An assigned talker identifier (U0 through U9) does not convey the nature of the device transmitting the sentence, and should not be "fixed" into a unit at manufacturing. This is intended for special purpose applications. The "U#" talker identifier indicates that the device's default talker identifier has been changed through external control.

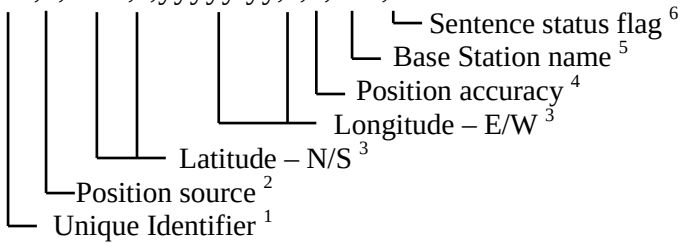
10) This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

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.

BCL – Base Station Configuration, Location Command

This sentence and the BCG sentence are used to configure the static Base Station parameters when it is initially installed, and later in order to make changes to the way it operates. Dynamic parameters (e.g. UTC and position of a moving Base Station) are input in a different way. This sentence supports system administration of the AIS Base Station operation.

\$--BCL, c--c,x,llll.ll,a,yyyyy.yy,a,x,c--c,a*hh<CR><LF>



Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

2) Identifies the source of the position:
0 = surveyed position (should always be used for Fixed AIS Base Station)
1 = internal EPFD in use
2 = external EPFD in use
3 = internal EPFD in use with automatic fall back to surveyed position
4 = internal EPFD in use with automatic fall back to external EPFD upon failure of internal EPFD
5 = external EPFD in use with automatic fall back to surveyed position
6 = external EPFD in use with automatic fall back to internal position source upon failure of external position source
Position sources 1, 2, 4 or 6 use automatic fall back to invalid position (181 degrees Longitude and 91 degrees Latitude)
When external EPFD is used (position sources 2, 4, 5 and 6), type of electronic position fixing device is provided by talker ID of the EPFD.

3) Surveyed position of the Base Station.

4) 0 = low >10m
   1 = high <10m; differential mode of DGNSS

5) This is the VDL message 24, part A, Name: range 0 to 20 alphanumeric characters. The characters that can be used in the name are listed in the ITU-R 1371 6-bit ASCII table. Some of these characters are reserved characters as defined in Section 6.1. If reserved characters are used, they must be represented using the"^" method in Section 5.1.3. A null field indicates that the previously entered name is unchanged. The string of characters "@@@@@@@@@@@@@@@@@@@@" is used to indicate that the Name is not available.

6) 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.

CBR – Configure Broadcast Rates for AIS AtoN Station Message Command.

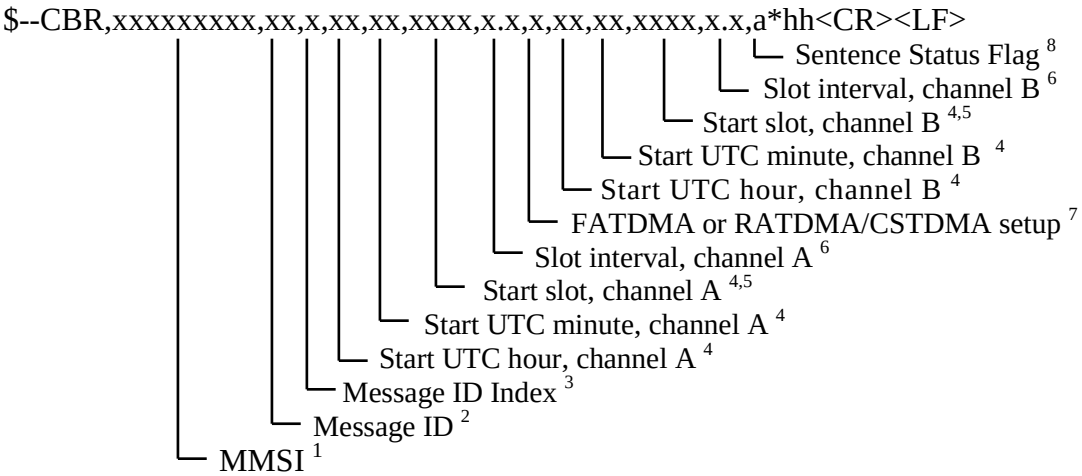
This sentence configures slots and transmission intervals that will be used to broadcast AIS AtoN Station messages (See IEC 62320-2). The sentence supports scheduling of messages with real, virtual, and synthetic MMSI's (See AID Sentence). The messages are assigned to the AIS AtoN Station for each channel.

Message 21 is defined by the content of the ACG and ACF sentences and is identified by the MMSI and the message ID 21. Message ID Index = 0 is reserved to define the on-position message 21 transmission schedule. Message ID Index = 1 is reserved to define the off-position message 21 transmission schedule. The off-position schedule is optional (see ACG sentence, Off-position behavior).

Other than message 21, the combination of MMSI, Message ID, and Message ID Index are used to: (1) configure, (2) reference the AIS AtoN stations transmission slots, and (3) link to the MEB sentence.
Each message's transmission schedule is defined by the combination of Start UTC Hour, Start UTC Minute, Start Slot, and Slot Interval.

The AIS AtoN Station should apply this sentence to autonomously and continuously transmit VDL messages until revised by a subsequent CBR sentence. Subsequent CBR assignments override existing CBR assignments.

This sentence can be queried. The query response may contain one or more sentences and will continue until the transfer of all current schedule information is complete.



Notes:
1) This is a MMSI previously defined for the AIS AtoN station (See AID Sentence.).

2) Message ID is the number of the message being scheduled (See ITU-R M.1371). When Message ID is 0 this indicates that the slots being defined will be used for either chaining messages or MEB single transmissions (See IEC 62320-2).

3) Message ID Index is used to distinguish multiple occurrences of the same MMSI and Message ID combination. Valid range is 0 to 7.

4) Nominal start slot for each channel is determined by the combination of Start UTC hour, Start UTC minute, and Start slot.

5) Starting slot valid range is -1 to 2249.
   - A value of –1 clears the schedule and discontinues the broadcasts for the indicated channel(s).
   - A null field indicates no change to the current start slot setting when sent to the AtoN Station. In response to a query this field cannot be null.
   - A value of -1 indicates that the message is not scheduled for broadcast on the indicated channel.

6) Message transmission slot interval, valid range is -1 to 3 240 000 slots (24*60*2250 = 3 240 000 is once per day). A null field indicates no change to the current slot interval setting when sent to the AtoN Station. In response to a query this field cannot be null, -1 indicates that the slot interval is not set.

7) Used to select whether the CBR is configuring a FATDMA schedule or RATDMA/CSTDMA schedule (0 indicates FATDMA, 1 indicates RATDMA, and 2 indicates CSTDMA). For RATDMA/CSTDMA mode, scheduled transmissions are between the slot interval and the slot interval plus 150 slots.

8) 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.

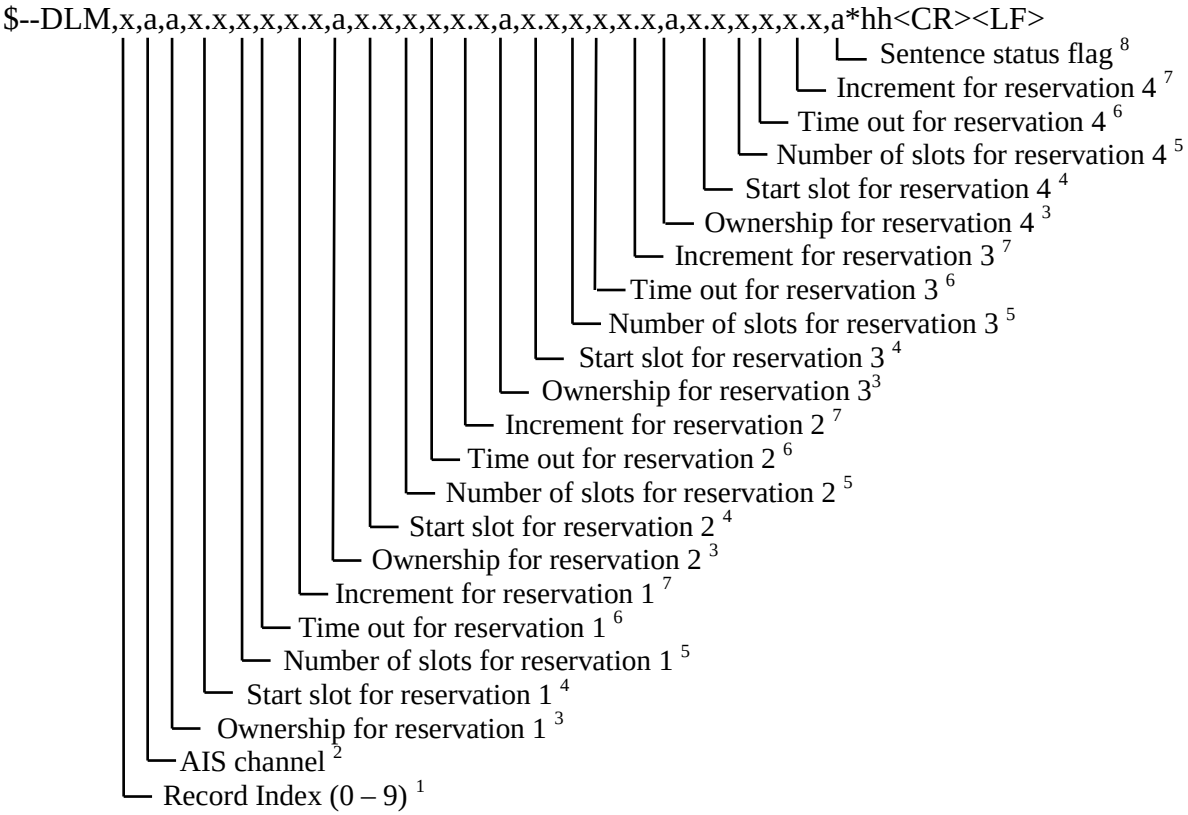
DLM – Data Link Management Slot Allocations for Base Station Command

This sentence provides the Base Station with the slot allocations to be reserved for FATDMA Base Station broadcasts. This sentence provides the Base Station with the information necessary to broadcast an ITU-R M.1371 Message 20 Data link management message, which informs mobile AIS units of the reserved FATDMA slots. Upon receipt of this sentence the Base Station will reserve the provided FATDMA slot allocations within its frame map, and will be ready to generate Message 20 when instructed to do so via the ECB sentence. This is the information that is broadcast on the VDL using Message 20. Reference ITU-R M.1371 (Also, see ECB Sentence).

The FATDMA slot reservations are determined using a set of 5 DLM data fields - Ownership, Start, Number, Time, and Increment. Each DLM sentence supports four sets of FATDMA slot reservation parameters.

The AIS Base Station, upon receipt of a query for this sentence, will generate a response to the requestor consisting of 20 DLM sentences containing all the FATDMA slot reservation parameters (set). When a set is empty (not defined or cleared), all 5 data fields of the set are returned as null.

The shore station is responsible for filtering out slot reservation conflicts that may exist. The Base Station is not responsible for detecting these conflicts. These conflicts in the shore station network should be resolved separately from entering the data.



Notes:

1) The Record Index is used to identify and address each record of DLM sentence data. A maximum of 10 records can be stored for each AIS channel. The Record Index is used to associate the DLM sentence data with each VDL Message 20 broadcast by the Base Station.

2) The AIS channel defines the broadcast channel. This cannot be a null field.
   A = Channel A
   B = Channel B

3) This field identifies the ownership of the reservation. Possible values are as follows:
   L = Local ownership. The Base Station receiving this sentence owns and may utilize these FATDMA slots. The Base Station should broadcast these FATDMA slot reservations.
   R = Remote ownership Remote AIS Stations own and may use these FATDMA slots. The Base Station should transmit these FATDMA slot reservations.
   C = Clear the reservation. This instructs the Base Station receiving this sentence to clear this reservation from its frame map. If this field is set to "C", then the following four data fields (Start, Number, Time, and Increment) should be set to null, and will be ignored if set otherwise.

   First reservation "ownership" – indication of shore station ownership for each set of slot reservations; "L" for local, "R" for remote. A Base Station should transmit slot reservations for remote (R) stations. The Base Station is not allowed to use the slots reserved for remote (R) stations unless commanded to do so by use of TSA+VDM pairs. The Base Station is allowed to broadcast on local (L) slots. Final slot selection is a process internal to the Base Station.

4) Start slot range: 0 to 2249. A null field indicates no change to the staring slot for this FATDMA reservation.

5) Number of slots range: 1 to 5 (consecutive slots reserved for FATDMA broadcasts). A null field indicates no change to the number of consecutive slots reserved when sent to the AIS equipment.

6) Time out range in minutes: 0 to 7. A null field indicates no change to the Time out when sent to the AIS equipment.

7) Increment range: 0 to 1125 in slots. A value of 0 indicates one reservation block in the frame. A null field indicates no change to the current slot increment setting when sent to the AIS equipment. When the increment is not "0" the following formula should apply to ensure the periodical slot reservation from frame to frame (see ITU-R M.1371, Message 20): 2250 mod increment = 0

8) 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.

ECB – Configure Broadcast Schedules for Base Station Messages, Command

This sentence assigns the schedule of slots that will be used to broadcast the specified Message: 4, 17, 20, 22, 23, or 24. It provides the start slot and interval between the slots used for consecutive transmissions for the message. The interval span supports creation of broadcast schedules based upon a 6 min FATDMA epoch. The AIS Base Station should apply the information provided by this sentence to autonomously and continuously transmit the VDL message indicated until revised by a new ECB sentence.

Cautionary Note: The interval span in this sentence supports FATDMA planning where 6 min epochs are used. When planning the FATDMA use of VDL slots, time can be organized into 6 min periods identified using FATDMA "epoch numbers" (0 to 9). The start of a FATDMA epoch is correlated with the beginning of the hour. A FATDMA epoch starts with the first second of the first minute, and ends with the end of last second of the sixth minute of the epoch. The FATDMA epoch number of each FATDMA epoch in 1 hour is correlated to an absolute start minute within the hour (FATDMA epoch number × 6).

For example, FATDMA epoch "0" is minute 0 through 5, and FATDMA epoch "9" is minute 54 through 59.

The AIS Base Station, upon receipt of an ECB query for this information, will generate a sentence for each Message type (4, 17, 20, 22, 23, and 24) providing the current broadcast schedule. The reply also reports messages (4, 17, 20, 22, 23, and 24) not scheduled.

A new ECB assignment for a message will override the existing ECB assignment.

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

- Sentence status flag [6]
- Number of slots channel B [5]
- Slot interval channel B [4]
- Reference slot channel B [2,3]
- Reference UTC minute for channel B start slot
- Number of slots channel A [5]
- Slot interval channel A [4]
- Reference slot channel A [2,3]
- Reference UTC minute for channel A start slot
- Message type
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

2) For Message 4, starting slot ranging from –1 to 749 should be used. The broadcasts should alternate between the channels A and B. The increment may vary; see ITU-R M.1371-1, Annex 1, 4.2.1, Table 1B and footnote 1 for details. A value of –1 discontinues broadcasts of Message 4 when the ECB sentence is sent to the Base Station, and indicates that Message 4 has been turned off if the ECB sentence is received from the Base Station. A null field indicates no change to the current start slot setting when sent to the Base Station, and indicates that the start slot has not been set when the ECB sentence is received from the Base Station.

3) For Messages 17, 20, 22, 23, or 24, starting slot ranging from -1 to 2249 should be used.

   When the ECB sentence is sent to the Base Station, a value of -1 clears the schedule and discontinues broadcasts for the indicated message. When the ECB sentence is received from the Base Station, a value of -1 indicates that no message is scheduled for broadcast. When the ECB sentence is sent to the Base Station, a null field indicates no change to the current start slot setting. When the ECB sentence is received from the Base Station, a null field indicates the start slot has not been set.

4) Slot interval ranging from 0 to 13500 in slots (epoch of 6 min) , between broadcasts of ITU-R M.1371 Messages 17, 20, 22, 23, or 24 on channels "A" or "B". Interval selection for Message 17 should consider the timing needs for both DGNSS corrections and integrity warnings. 5 s or less is recommended.
   - A value of 0 indicates only one broadcast.
   - A null field indicates no change to the current slot interval setting when sent to the Base Station, and indicates that the slot interval has not been set, i.e. is unavailable, when the ECB sentence is received from the Base Station.
   - When the value is 1 to 2249, the interval (i) should satisfy the formula: 2250 mod i = 0 to ensure the slot schedule is periodic from frame to frame.
   - When the value is greater than 2249 the only permissible intervals are 2250, 4500, 2675, and 13500.
   - When neither of these conditions are satisfied, the sentence should be rejected if the remainder is not zero and a "NAK (11)" may be returned.

5) For messages other than Message 17, this field is null. For Message 17, the number may range from 1 to 4 consecutive slots. A maximum of 3 slots is recommended for each DGNSS service.

   A null field indicates no change to the number of consecutive slots reserved when sent to the Base Station, and indicates that the number of consecutive slots has not been set, i.e. is unavailable, when the ECB sentence is received from the Base Station.

6) 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.

FSR – Frame Summary of AIS Reception

This sentence provides for one AIS channel: the average noise level and a summary of slot use during the previous frame; and expected slot use for the current frame. The sentence is output once at the start of the current frame as shown in Figure 8.

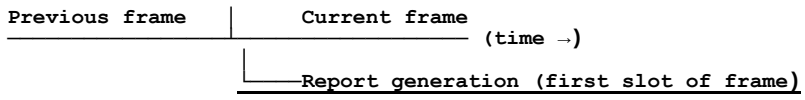


Figure 1 - Frame Summary Timing

Data fields 4 through 10 are enabled using data fields in the SPO sentence. If a data field is not enabled, the data field should contain the NMEA 0183 "null field" notation for no information.

\$--FSR,c--c,hhmmss.ss,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>

- Number of slots with received signal strength [9]
- Average noise level, previous frame (dBm) [8]
- Slots reserved by this station current frame [7]
- External slot reservations current frame [6]
- Number of CRC failures in the previous frame [5]
- Slots occupied by this station's transmissions, previous frame
- Slots occupied by messages received, previous frame [4]
- Channel being reported [3]
- Hour, minute, and second of report generation [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On output, this data field is the Base Station's Unique Identifier.

2) The time (UTC) when this sentence is assembled. This sentence is assembled at the beginning of a frame (See Figure 8)

3) A = channel A
B = channel B

4) Exclude slots occupied by this station's transmissions.

5) This count includes all cases where an AIS signal is detected but fails the Cyclic Redundancy Check (CRC).

6) Total external slot reservations, including FATDMA reservations. Exclude slots reserved by this station. The calculation of the current frame's slot reservations should be done during the first slot. The total should not include additional reservations made for slots in the current frame by messages received during the current frame.

7) Total number of reservations for the current frame. Total should not include additional reservations made during the current frame.

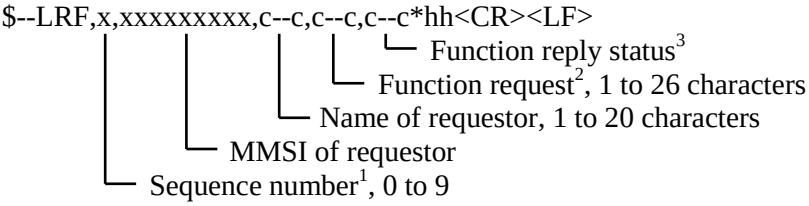
8) Measured value is always negative. Null when measurement not available

9) Number of slots with received signal strength (at least 10 dB) above the average noise level.

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 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 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.



Notes:

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

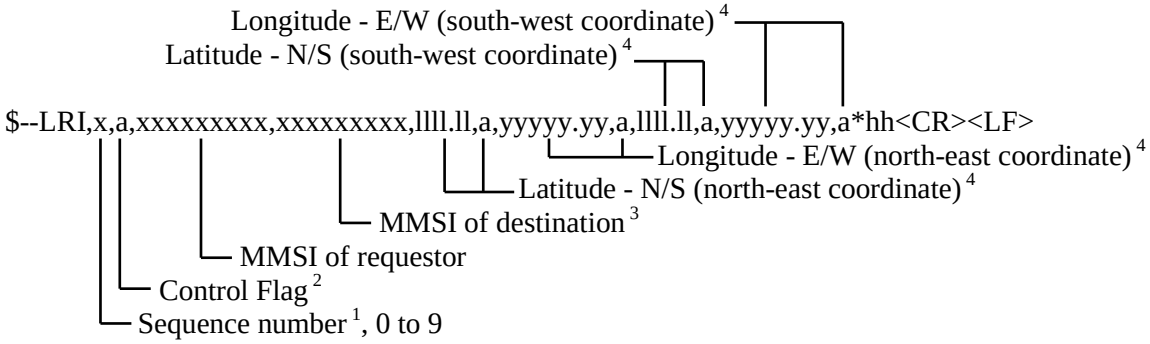
2) The Function request field uses alphabetic characters, based upon IMO Resolution A.851(20), to request specific information items. Specific information items are requested by including their function identification character in this string of characters. The order in which the characters appear in 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 from the AIS unit. The IMO Resolution defines the use of all characters from A to Z, but not all of defined information is available from 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 status characters for the Function request information. When a Long-range interrogation request is originated, the Function reply status field should be null. The Function reply status characters are organized 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 the AIS unit.
   4 = Information is available but not provided (i.e. restricted access determined by ship's master).

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 sentences, a LRI sentence followed by a LRF sentence, provides the information needed by a universal AIS unit to determine if it must 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.



Notes:

1) This is used to bind the contents of the LRI and LRF sentences together. The LRF sentence shall immediately follow the LRI sentence and use the same sequence number. The requestor process shall increment the sequence number each time a LRI/LRF pair is created. After 9 is used the process shall 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 the AIS unit's reply logic. The control flag cannot be a null field. When the Control Flag is "0", 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.

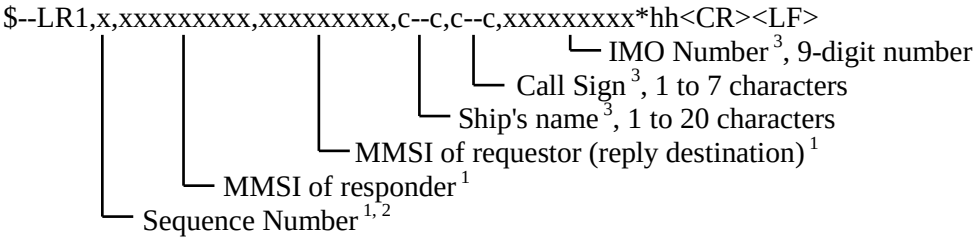
   When the Control Flag is "1", the AIS unit responds if:
   - The AIS unit is within the geographic rectangle provided.

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 coordinates of the region.

4) The geographic region 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 Note 2.

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).



Notes:

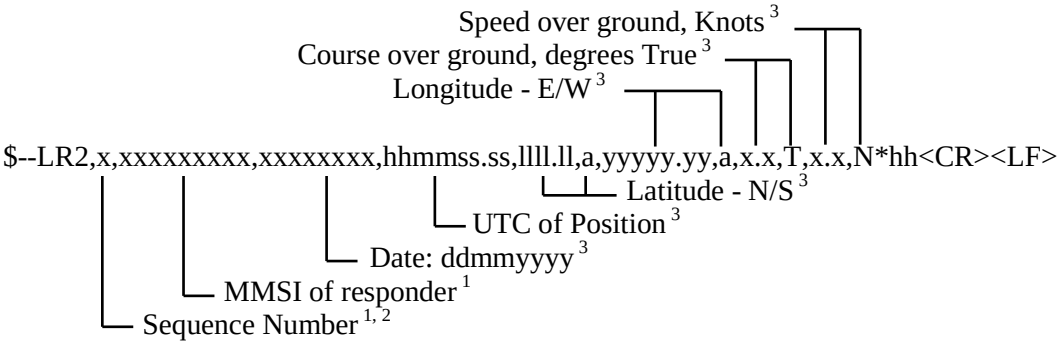
1) The three fields, Sequence Number, MMSI of responder, and MMSI of requestor, are always provided.

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 Table 14. Some of the acceptable characters in this 6-bit ASCII table are reserved characters within this standard, (See Table 4). These NMEA 0183 reserved characters shall be represented using the "^" method (See Section 5.1.1). 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.

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).



Notes:

1) The two fields, Sequence Number and MMSI of responder, are always provided.

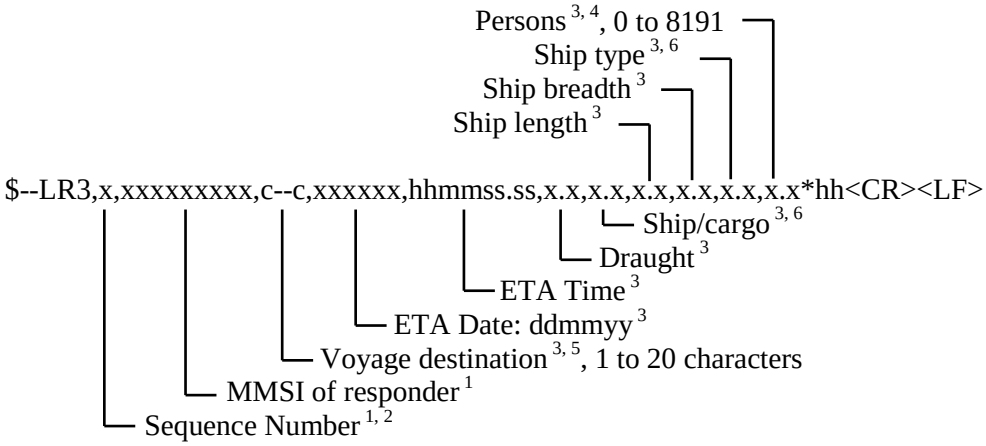
2) The sequence number should be the same as the sequence number of the LRI and LRF sentences that initiated this reply.

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.

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 characters (See LRF Sentence).



Notes:

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: 8191 = 8191 or more people.

5) The characters that can be used are listed in the ITU-R M.1371, 6-bit ASCII Table 14. Some of the acceptable characters in this 6-bit ASCII table are reserved characters within this standard in Table 4. These NMEA 0183 reserved characters shall be represented using the "^" method (See Section 5.1.1).

6) See ITU-R M.1371, Message 5: Ship static and voyage related data , Parameter "Type of ship and cargo type" for the range of valid values for this field.

SPO – Select AIS Device's Processing and Output, Command

This sentence is used to configure the content and output for measurements made on selected channels during operation of a Base Station or a Receiving Station. When a data field(s) is selected, the corresponding VSI and/or FSR sentence(s) will be output following the rules for those sentence formatters.

\$--SPO,c--c,a,x,x,x,x,x,x,x,x,x,x,x,x,a*hh<CR><LF>

- Sentence status flag [6]
- Provide FSR sentence after each frame [5]
- Provide VSI sentence with each VDO sentence output [5]
- VSI sentence with each VDM sentence output [5]
- Number of slots with received signal strength (see FSR data field 10) [4]
- Average noise level (see FSR data field 9) [4]
- Forecast channel load (see FSR data fields 7 and 8) [4]
- Number of messages with bad CRC (see FSR data field 6) [4]
- Previous frame channel load (see FSR data fields 4 and 5) [4]
- Signal to noise ratio (see VSI data field 6) [6]
- TOA, time of message arrival (see VSI data field 3) [5]
- First slot number of VDL message (see VSI data field 4) [4]
- Signal strength of received VDL message (see VSI data field 5) [3]
- Channel selection [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier. On output, this data field is the Base Station's Unique Identifier.

2) A = channel A
   B = channel B
   E = every channel
   N = no VSI or FSR sentences about any channel

3) 0 = no output
   1 = continuous output
   2 = output next frame only

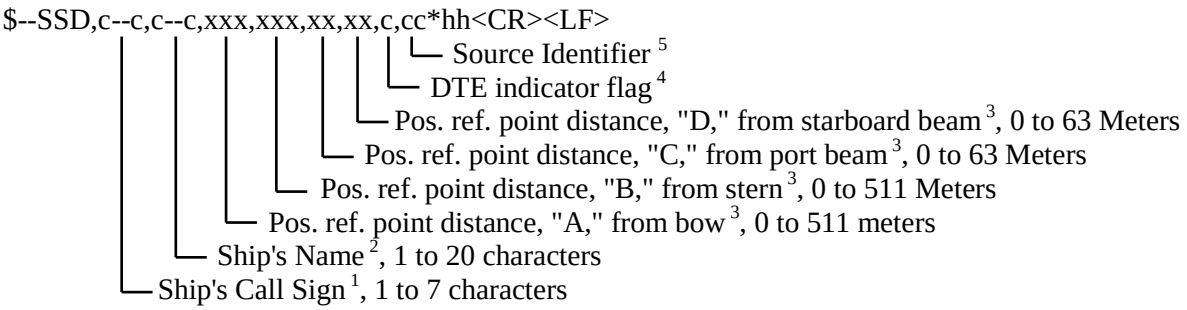
4) 0 = no output
   1 = output once per frame
   2 = output next frame only

5) 0 = off, disabled
   1 = on, enabled

6) 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.

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.



Notes:

1) Ship call sign. A null field indicates that the previously entered call sign is unchanged. The string of characters "@@@@@@@" are 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 Table. Some of these characters are reserved characters within this standard. They must be represented using the "^" method (see section 5.1.3). A null field indicates that the previously entered name is unchanged. The string of characters "@@@@@@@@@@@@@@@@@@@@" are 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 meters, and the sum of C + D is the width of the ship in meters. 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 unit’s internal position source. (See IEC 61993-2) 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 the position sensor antenna on the vessel.

TFR – Transmit Feed-Back Report

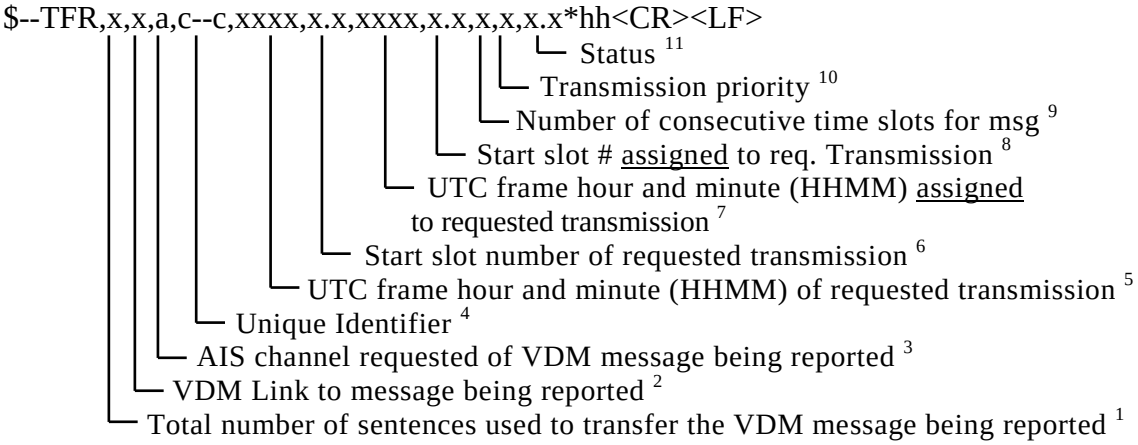
The TFR sentence is automatically generated by the Base Station to report to the Physical Shore Station the scheduled slot use and status of a requested transmission.

Several data fields are copied from the TSA and VDM sentences responsible for this TFR. They are provided to assist in linking this Base Station response to the responsible VDM or TSA/VDM sentence(s).

After receiving associated TSA and VDM sentences, the Base Station responds with a TFR sentence that provides status information about the requested transmission. The VDO+VSI will provide verification of the transmission itself.

After receiving a VDM sentence without an associated TSA sentence (as when requested transmissions are not assigned to a specific starting slot), the Base Station should respond with a TFR sentence.

This sentence cannot be queried.



Notes:

1) Exact copy of the first data field of the VDM sentence to which this TFR is responding – "total number of sentences needed to transfer the message."

2) This field is used to link the information in associated VDM sentence(s) with the information in this sentence. This data field contains the same value as the sequential message identifier of the associated VDM sentence(s). (For details concerning proper use, see IEC 62320-1.)

3) Actual channel scheduled for the requested transmission. It should be an exact copy of the fourth data field of the VDM sentence to which this TFR is responding – "AIS channel."

4) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On output, this data field is the Base Station's Unique Identifier.

5) UTC hour and minute scheduled for the requested transmission. This should be an exact copy of the fourth data field of the TSA sentence to which this TFR is responding – " UTC hour and minute of requested transmission." This data field should include leading zeros. This is null when there is no TSA sentence with the VDM sentence.

6) This should be an exact copy of the fifth data field of the TSA sentence to which this TFR is responding – "start slot number of requested transmission." This is null when there is no TSA sentence with the VDM sentence.

7) UTC hour and minute assigned for the requested transmission. This is determined by the Base Station for a received VDM sentence when no associated TSA sentence is received. This data field should include leading zeros. This is null when associated TSA and VDM sentences are received.

8) Start slot number assigned for requested transmission. This is determined by the Base Station for a received VDM sentence when no associated TSA sentence is received. This is null when associated TSA and VDM sentences are received.

9) Actual number of slots that are scheduled for the transmission of the requested message. This takes into consideration bit stuffing.

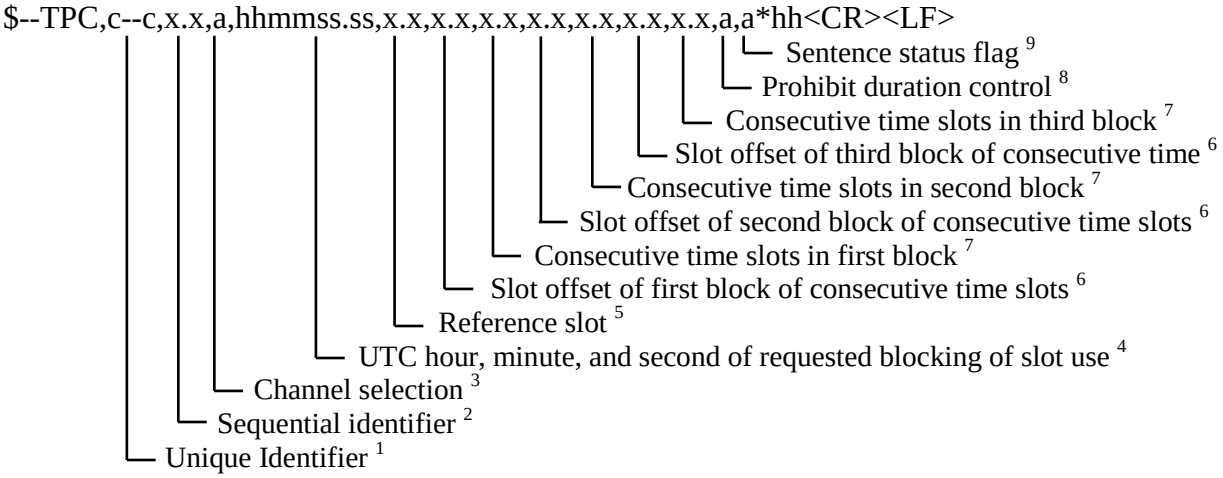
1) Priority is either that requested in the TSA sentence or that assigned by the Base Station.
1 = high priority
2 = low priority (default value)

11) 0 = successfully scheduled for transmission
1 = successfully scheduled for transmission by overriding an internal message with a lower priority
2 = successfully scheduled for a transmission time greater than 12 hours from the present time
3 = not scheduled because requested transmission exceeded available memory
4 = successfully removed from schedule
5 = not scheduled because requested transmission conflicted with slot(s) requested by an internal Base Station process that has the same or higher priority
6 = not scheduled because requested message type is not allowed by the Base Station configuration
7 = not scheduled because requested message conflict to prohibit slots.
8 = configuration error.
9 = not scheduled because requested transmission is for a disabled channel
10 = not scheduled because of invalid TSA content (e.g. invalid slot number)
11 = successfully scheduled for transmission by overriding an externally requested message with a lower priority
12 = not scheduled because requested transmission conflicts with previously scheduled transmission with same or higher priority

TPC – Transmit Slot Prohibit, Command

This sentence is used to prohibit an AIS station from transmitting in the specified slots. This sentence is designed to be used by stations, such as AtoN, where the temporary prohibit sentence (See TSP Sentence) is inadequate. For an AtoN Station the Unique Identifier is the AtoN Station real MMSI.

This sentence can be queried.



Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum (See AID Sentence). On input, this sentence should be accepted only if this data field matches the AtoN Station's Unique Identifier. On output, this data field is the AtoN Station's Unique Identifier.

2) The sequential identifier provides an identification number from 0 to 99 that is sequentially assigned and is incremented for each new TPC sentence. The count resets to 0 after 99 is used. This sequential identifier is used to identify the AIS station's response to this TPC sentence when the station replies with a slot prohibit status report (See TSR Sentence).

3) A = channel A
B = channel B

4) This is for record keeping. It contains the hour, minute, and second of this request.

5) This is the slot from which the following slot offsets are referenced.

6) 0 = no prohibited slots
1 to 2249 = Slot offset from the "Reference slot" to the first slot of the consecutive slots to be blocked from use by the AIS Station.

7) Total number of consecutive slots to be blocked from use. The first slot of the block is also part of the count. Therefore, the minimum value is 1.
1-5 = number of prohibited slots

8) This field is used to control the prohibited slots. This field should not be null for AIS AtoN Stations.
C = immediately restore for use all slots currently prohibited from use
E = the slot prohibition expires for the slots identified in this sentence after their next occurrence
P = prohibit the use of slots identified in this sentence. Slots are restored for use using "C" or "R"
R = restore the use of slots identified in this sentence.

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 for AIS AtoN Stations.
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.

TSA – Transmit Slot Assignment

This sentence is used to provide the AIS Base Station with the information for the broadcast of the VDL message encapsulated in the associated VDM sentence(s) beginning in the specified time slot. The TSA/VDM sentence combination is used for individual message transmissions only. This sentence is only used in combination with a VDM sentence. (For details concerning proper use, see IEC 62320-1.) This sentence should precede the referenced VDM sentence.

If TAG Blocks are used, the TSA sentence is also linked to the associated VDM sentence(s) using TAG Block "sentence-grouping" (See Section 7.7). A long VDL message may require the use of several VDM sentences.

This sentence cannot be queried.

```
$--TSA,c--c,x,a,xxxx,x.x,x*hh<CR><LF>
                          └─ Priority [5]
                        └─ Start slot number of requested transmission
                    └─ UTC frame hour and minute of requested transmission [4]
                  └─ Channel selection [3]
                └─ VDM Link [2]
              └─ Unique Identifier [1]
```

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On input, this sentence and any associated VDM sentence(s) should be accepted only if this data field matches the Base Station's Unique Identifier.

2) This field is used to link the information in associated VDM sentence(s) with the information in this sentence. This data field contains the same value as the sequential message identifier of the associated VDM sentence(s). (For details concerning proper use, see IEC 62320-1.)

3) This should be the same channel as indicated in the associated VDM sentence(s).
A = channel A
B = channel B

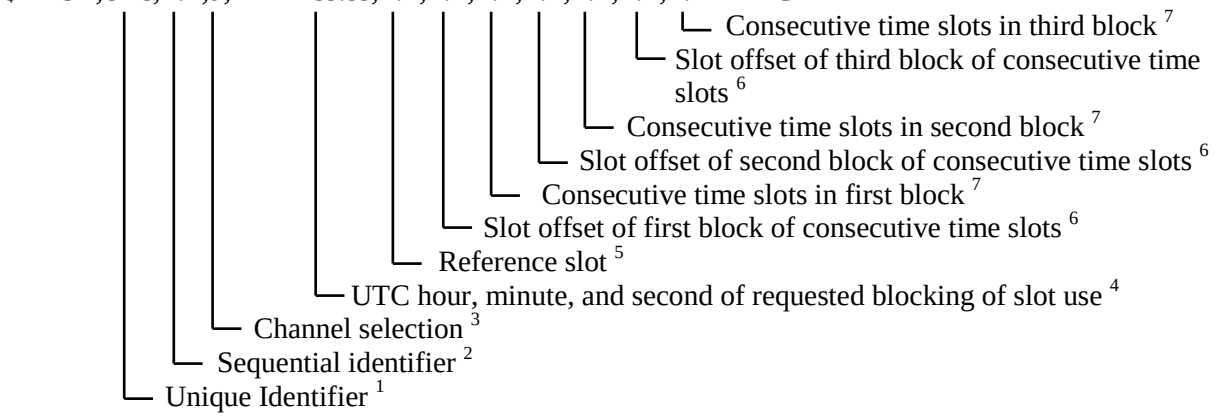
4) identification of slot frame for the start slot number. Format is HHMM (hours, minutes) in the range 0000 to 2359. When null, the start slot number is for the next occurrence of the slot.

5) 0 = cancel the scheduled transmission identified by the Channel selection, UTC frame hour and minute, and Start slot number.
   1 = high priority, should overrule internal Base Station schedule. It may not interfere with multi-slot transmissions already in progress.
   2 = low priority, will transmit if slot is available
   3 to 9 reserved for future use.
   Default is priority 2

TSP – Temporary Transmit Slot Prohibit

This sentence is used to temporarily prohibit an AIS station from transmitting in the specified slots. The AIS station receiving this sentence should not use the next occurrence of the indicated slots. This sentence is designed to be used to protect interrogation responses from co-slot interference from Base Station transmissions, or for use of the slots as response slots for other interrogations.

This sentence cannot be queried.



Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence) On input, this sentence should be accepted only if this data field matches the Base Station's Unique Identifier.

2) The sequential identifier provides an identification number from 0 to 99 that is sequentially assigned and is incremented for each new TSP sentence. The count resets to 0 after 99 is used. This sequential identifier is used to identify the Base Station's response to this TSP-sentence when it replies with a slot prohibit status report (See TSR Sentence).

3) A = channel A
   B = channel B

4) This is for record keeping. It contains the hour, minute, and second of this request.

5) This is the slot from which the following slot offsets are referenced. This is frequently the slot assigned to a message 15 interrogation.

6) 0 = no prohibited slots
   1 to 2249 = Slot offset from the "Reference slot" to the first slot of the consecutive slots to be blocked from use by the AIS Station.

7) Total number of consecutive slots to be blocked from use. The first slot of the block is also part of the count. Therefore, the minimum value is 1.
   0 = no prohibited slots
   1-5 = number of prohibited slots

TSR – Transmit Slot Prohibit Status Report

This sentence is automatically generated to report the results of a TSP sentence.

This sentence cannot be queried.

$--TSR,c--c,x.x,a,hhmmss.ss,x.x*hh<CR><LF>

- Unique Identifier [1]
- TSP - Sequential identifier [2]
- TSP - Channel selection [3]
- TSP - UTC hour, minute, and second of requested blocking of slot use [4]
- Status of prohibit request [5]

Notes:

1) 1 The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On output, this data field is the Base Station's Unique Identifier.

2) Exact copy of the second data field (sequential identifier) provided in the TSP sentence to which this TSR is responding. It is an identification number from 0 to 99 that is sequentially assigned and is incremented for each new TSP sentence. The count resets to 0 after 99 is used. This sequential identifier is used to identify the Base Station's TSR transmit slot prohibit status report.

3) Exact copy of the third data field (channel selection) provided in the TSP sentence to which this TSR is responding.
   A = channel A
   B = channel B

4) Exact copy of the fourth data field (hour, minute, and second) provided in the TSP sentence to which this TSR is responding.

5) 0 = successfully blocked prohibited slots
   1 = not successful because of internal reservation
   2 = not successful because action is not allowed by the Base Station configuration
   3 = not successful because action is for a disabled channel
   4 = not successful because of invalid TSA content (e.g. invalid slot number)

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>

- Type of ship and cargo category [1], 0 to 255
- Maximum present static draught [2], 0 to 25.5 Meters
- Persons on-board [3], 0 to 8191
- Destination [4], 1-20 characters
- Estimated UTC of arrival at destination [5]
- Estimated day of arrival at destination [6], 00 to 31 (UTC)
- Estimated month of arrival at destination [6], 00 to 12 (UTC)
- Navigational status [7], 0 to 15
- Regional application flags [8], 0 to 15

Notes:

1) Type of ship and cargo category are defined under Message 5 of ITU-R M.1371. The description of ship and cargo are indicated by a number. A null field indicates that this is unchanged.

2) The Draught is reported in units of Meters. Valid range is 0 to 25.5. The value 0 = not available, and the value 25.5 indicates that the draught is 25.5 meters or more. A null field indicates that this is unchanged.

3) Current number of persons on-board, including crew. Valid range is 0 to 8191. The value 0 = not available, and the value 8191 = 8191 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 Table. Some of these characters are reserved characters within this standard. They must be represented using the "^" method (See Section 5.1.1). 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" shall be set to 24. If the minute of arrival is not available, "mm" shall be set to 60. The seconds' portion "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" shall be the number for day. If the month of arrival is not available, "00" shall 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 (ref. ITU-R M.1371, Messages 1, 2, 3: Position reports , parameter "Navigational Status" for the most up to date values) (Table 45 from ITU-R M.1371-3 is provided in Table 28 (below) of this standard for convenience)

Table 258 - VSD Navigational Status Values (excerpt from ITU-R M.1371-3 Table 45)

0 = under way using engine	4 = constrained by draught	9 = reserved for future amendment of navigational status for ships carrying DG, HS, or MP, or IMO hazard or pollutant category C, high speed craft (HSC)
1 = at anchor	5 = moored	10 = reserved for future amendment of navigational status for ships carrying dangerous goods (DG), harmful substances (HS) or marine pollutants (MP), or IMO hazard or pollutant category A, wing in grand (WIG)
2 = not under command	6 = aground	11 to 14 = reserved for future use
3 = restricted maneuverability	7 = engaged in fishing	15 = not defined = default
	8 = under way sailing	

8) Definition of values 1 to 15 provided by a competent regional authority. Value shall be set to zero (0), if not used for any regional application. Regional applications shall not use zero. A null field indicates that this is unchanged (ref. ITU-R M.1371, Message 1, Reserved for regional applications parameter).

VSI – VDL Signal Information

This sentence provides measurement information associated with a VDL message. This sentence is also used to identify the first slot of a VDL message. This sentence is only used in combination with either a VDM or VDO sentence. This sentence should follow the referenced VDM or VDO sentence.

The measurement data fields of this sentence are enabled using the SPO sentence.

This sentence cannot be queried.

```
$--VSI,c--c,x,hhmmss.ss,x.x,x.x,x.x*hh<CR><LF>
       |    |    |       |   |   └─ Signal to noise ratio (dB) 5
       |    |    |       |   └─ Signal strength (dBm.) of received VDL message 5
       |    |    |       └─ First slot number of VDL message 4
       |    |    └─ TOA, time of message arrival 3
       |    └─ VDM/VDO link 2
       └─ Unique Identifier 1
```

Notes:

1) The Unique Identifier is used for system level identification of a station, 15 characters maximum. (See SID Sentence). On output, this data field is the Base Station's Unique Identifier.
2) This field is used to link the information in either an associated VDM or VDO sentence(s) with the information in this sentence. This data field contains the same value as the sequential message identifier of the associated VDM or VDO sentence(s). (For details concerning proper use, see IEC 62320-1.)
3) This is the UTC hour, minute, and second and decimal fraction of second measurement for when an AIS message signal is received. When the decimal fraction portion of this measurement is provided, the precision may be given to 1 ns.
   246060 = requested data field but not available (See SPO Sentence).
4) 9999 = requested data field but not available (See SPO Sentence).
5) 0 = requested data field but not available (See SPO Sentence).

9.2 Approved AIS Encapsulation Sentences

General format of printed sentence information:

*{**mnemonic**} **-** {**name**}
{definition paragraph}

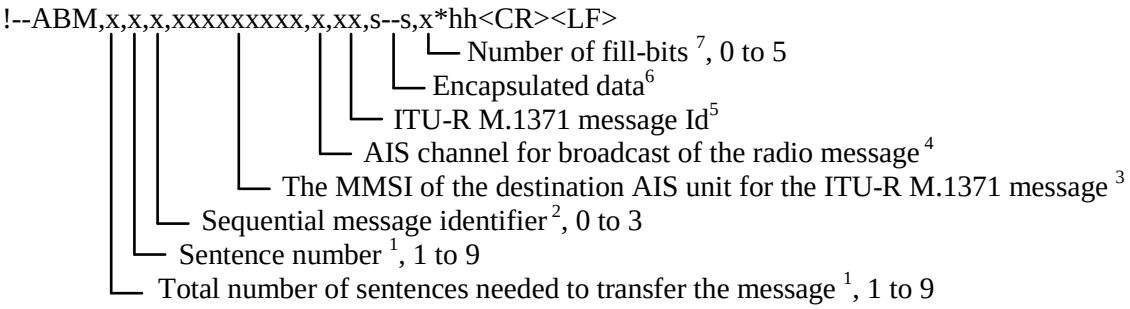
```
!--{sentence}
 |    └─ {field descriptions}
 └─ Start of sentence and Talker ID
```

9.2.1 Approved AIS Encapsulation Formatters

ABM – AIS Addressed Binary and Safety Related Message. 170
BBM – AIS Broadcast Binary Message. 171
MEB – Message Input for Broadcast, Command 172
VDM – AIS VHF Data-link Message 173
VDO – AIS VHF Data-Link Own-Vessel Report 174

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 NMEA 0183 interface, the transponder initiates a VDL broadcast of message 6, 12, 25, or 26. The AIS unit will make up to four broadcasts of message 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.



Notes:

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 Section 5.3.4 of this standard, 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. (See ABK Sentence).

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).

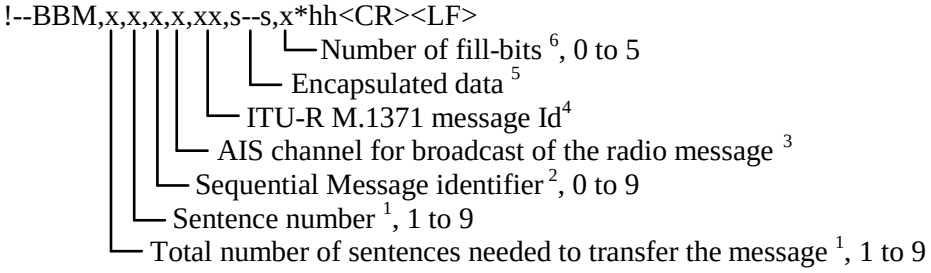
6) This is the content of the "binary data" parameter for ITU-R M.1371 message 6, or the "Safety related Text" parameter for message 12, or the “binary data” parameter for message 25, or the “binary data” parameter for message 26. The first sentence may contain up to 48 valid Six Bit codes (288 bits). Following sentences may contain up to 60 valid Six Bit codes (360 bits), if fields 4, 5, and 6 are unchanged from the first sentence and set

to null. The actual number of valid characters must 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 Section 5.3.4 "Fill Bits field" description.

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 NMEA 0183 interface, the transponder initiates a VHF broadcast of message 8, 14, 25, or 26 within four seconds. 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.



Notes:

1) The total number of 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, or the "Safety related Text" parameter for message 14, or the “binary data” parameter for message 25, or the “binary data” parameter for message 26. The first sentence may contain up to 58 valid Six Bit codes (348 bits). Following sentences may

contain up to 60 valid Six Bit codes (360 bits), if fields 4 and 5 are unchanged from the first sentence and set to null. The actual number of characters must 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 Section 5.3.4 "Fill Bits field" description.

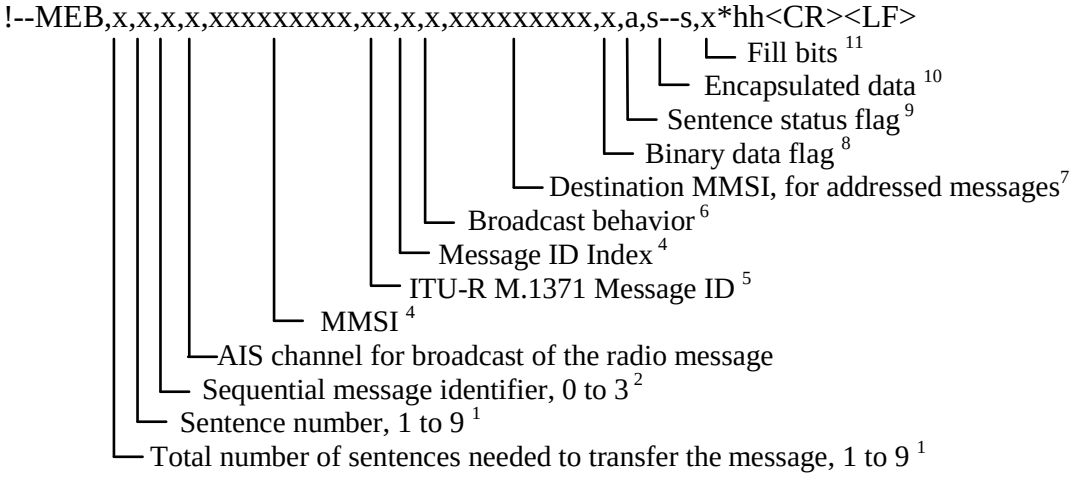
MEB – Message Input for Broadcast, Command

This sentence is used to input a message for storage or immediate broadcast. The sentence associates messages with real, virtual, and synthetic MMSI's (See AID sentence).

The stored message is associated by the MMSI, Message ID, and Message ID Index. The combination of MMSI, Message ID, and Message ID Index are used to reference the stored message and link the message to a transmission schedule as defined by a CBR sentence. The stored message's broadcast begins when both the message content and schedule (See CBR sentence) have been entered.

For immediate message broadcast, the binary data will be broadcast using the slots reserved by the CBR sentence with both Message ID and Message ID Index = 0, or will be broadcast using the next available slot. The channel for the immediate message broadcast is specified by the "AIS channel for broadcast of the radio message" (parameter field 4).

This sentence can be queried. When queried, the query response may contain one or more sentences and will continue until the transfer of all stored information is complete.



Notes:

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, 6, 7, 8, 9, and 10.

2) This sequential message identifier serves two purposes. It meets the requirements as stated in Section 5.3.4 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. (See ABK Sentence).

3) The AIS channel that should 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,
   For an immediate message broadcast, this cannot be null. For a stored message it should be null.

4) For the message to be broadcast, this MMSI must match a previously entered a real, virtual, or synthetic MMSI (See AID and CBR Sentences).

5) ITU-R M.1371 messages supported by this sentence: 6, 8, 12, 14, 25, and 26. See IEC 62320-2 for the ITU-R M.1371 messages that are supported by an AIS AtoN Station.

6) 0 = For an AtoN device, the message is stored for autonomous continuous transmission as defined by a CBR sentence. The message is identified by the combination of MMSI, Message ID, and Message ID Index.
1 = For an AtoN device, a single transmission (not stored in the "message table") using the next available slot following slot selection priority:
   - use CBR definition, id 0, index 0 – if available).
   - use RATDMA (if supported by AtoN unit)
   - – 9 = reserved for future use.

7) The "Destination MMSI, for Addressed Messages" should be a null field when the message is not destination specific, and is intended to be destination broadcast on the VHF Data Link.

8) The "Binary data flag" field has a range from 0 to 1 with the following meaning:
   0 = unstructured binary data (no Application Identifier bits used)
   1 = binary data coded as defined by using the 16-bit Application Identifier (See ITU-R M.1371, messages 25 and 26)

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 (use for a reply to a query).
   C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.

10) This is the content of the "binary data" parameter for either ITU-R M.1371 MESSAGE 6, 8, 25, or 26, or the "Safety related Text" parameter for either message 12 or 14. The actual number of "6-bit" symbols in a sentence must be adjusted so that the total number of characters in a sentence does not exceed the "82-character" limit.

11) This field cannot be null.

VDM – AIS VHF Data-link Message

This sentence is used to transfer the entire contents 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.

```
!--VDM,x,x,x,a,s--s,x*hh<CR><LF>
                  |  |  |  |  |
                  |  |  |  |  +- Number of fill-bits [5], 0 to 5
                  |  |  |  +---- Encapsulated ITU-R M.1371 radio message [4]
                  |  |  +------- AIS Channel [3]
                  |  +---------- Sequential message identifier [2], 0 to 9
                  +------------- Sentence number [1], 1 to 9
                  +------------- Total number of sentences needed to transfer the message [1], 1 to 9
```

Notes:

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 transponder when the packet is received. This shall be a null field when the channel identification is not provided. The frequencies for channels A and B are obtained by a query (See Section 5.3.5) of the AIS unit for an ACA sentence(s).

4) This field supports a maximum of 60 valid characters for messages transferred using multiple sentences, and 62 valid characters for messages using a single sentence.

5) This cannot be a null field. See Section 5.3.4.1 "Fill Bits Field" description.

VDO – AIS VHF Data-Link Own-Vessel Report

This sentence is used to transfer the entire contents 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 structure provides for the transfer of long binary messages by using multiple sentences. 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 [5], (0 to 5)
                    |  |  |  |  +---- Encapsulated ITU-R M.1371 radio message [4]
                    |  |  |  +------- AIS Channel [3]
                    |  |  +---------- Sequential message identifier [2], 0 to 9
                    |  +------------- Sentence number [1], 1 to 9
                    +---------------- Total number of sentences needed to transfer the message [1], 1 to 9
```

Notes:
Refer to VDM sentence notes.

10. TAG Block Sentences

10.1 Approved TAG Block Parametric Formatters

CPC – Configure Parameter-code for UNIX Time Parameter (c) 174
CPD – Configure Parameter-code for Destination-identification Parameter (d) 175
CPG – Configure Parameter-code for the Sentence-Grouping Parameter (g) 176
CPN – Configure Parameter-code for the Line-count Parameter (n) 178
CPR – Configure Parameter-code for Relative (epoch / event) Time Parameter (r) 179
CPS – Configure Parameter-code for the Source-identification Parameter(s) 181
CPT – Configure Parameter-code for a Text-string Parameter (t) 181
TBR – TAG Block Report Request 183
TBS – TAG Block Listener Source-identification Configuration Command 183

CPC – Configure Parameter-code for UNIX Time Parameter (c)

This sentence configures and controls the addition of a UNIX time parameter to a talker TAG Block or its use as a listener. This is a command sentence.

Enabling this parameter-code talker: (1) causes a TAG Block containing this parameter-code to be linked to each talker sentence, (2) for different talker sentences linked using “sentence-grouping,” the grouped

TAG Blocks (having the same "group-code" value) need only contain a single occurrence of this parameter-code. (See Section 7)

The UNIX time parameter-code listener may be used to enable a time based process. The time based process details are not defined by this standard, but defined by the application or equipment performance standard specifying the use of this listener parameter code.

$--CPC,c--c,a,a,a,x*hh<CR><LF>

- Time precision / format [5]
- Listener UNIX time function [4]
- Talker UNIX time function [3]
- Sentence status flag [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.

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

3) Configuration or status of Talker UNIX time function, parameter-code "c" for all output sentences (talker):
   V = UNIX time function parameter disabled (off).
   A = UNIX time function parameter enabled (on).
   N = UNIX time function parameter enabled for a NAK sentence reply only. A TAG Block containing a UNIX time tag parameter will be linked to any NAK sentence reply.
   U = unsupported.(status reply only).

4) Configuration or status of Listener UNIX time function, parameter-code "c" for all input sentences (listener):
   V = UNIX time function parameter disabled (off).
   A = UNIX time function parameter enabled (on).
   U = unsupported.(status reply only).

5) This controls the format of the UNIX time tag.
   1 = integer seconds
   2 = integer milliseconds (integer with units of milliseconds)

For Example:

$xxCPC,Uniq.Identifier,C,A,V,1*hh<CR><LF>
Activates UNIX time in seconds being appended to every sentence.

$xxCPC,Uniq.Identifier,C,V,V,1*hh<CR><LF>
UNIX time deactivated.

CPD – Configure Parameter-code for Destination-identification Parameter (d)

This sentence controls the addition of a destination-identification parameter to a talker TAG Block or its use as a listener. This is a command sentence.

Enabling the "talker destination-identification" causes a TAG Block containing a destination-identification parameter to be linked to some talker sentences, when they are required. The destination-identification parameter is not required in all TAG Blocks. (See Sections 7.6.2.2 and 7.13)

Enabling the "listener destination-identification" requires the listener to apply the logic in Section 7.6.1 to each received line (TAG Block + sentence).

$--CPD,c--c,a,a,a*hh<CR><LF>

- Listener destination-identification function [4]
- Talker destination-identification function [3]
- Sentence status flag [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.

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

3) Configuration or status of Talker destination-identification function, parameter-code "d" for output sentences that require a destination-identification parameter (talker):
   V = Talker destination-identification function parameter disabled (off).
   A = Talker destination-identification function parameter enabled (on). When a reply to an input sentence (e.g. Query, command, sentence requiring a NAK, etc.) is necessary, the response may be a sentence linked to a TAG Block containing a destination-identification (See Section 7.6.2.2)
   U = unsupported.(status reply only).

4) Configuration or status of Listener destination-identification function, parameter-code "d" for all input sentences (listener):
   V = Listener destination-identification function parameter disabled (off).
   A = Listener destination-identification function parameter enabled (on).
   U = unsupported.(status reply only)

For Example:

$xxCPD,Uniq.Identifier,C,A,A*hh<CR><LF>

Activates destination-identification being appended to output lines where required. Also filtering input lines based upon destination-identification value. Destination-identification in input lines must match Unique Identifier (Uniq.Identifier) before the associated sentence(s) is (are) accepted and processed.

$xxCPD,Uniq.Identifier,C,V,A*hh<CR><LF>

TAG Block containing destination-identification not appended to any output sentence. Also filtering input based upon destination-identification value. Destination-identification in input lines must match Unique Identifier (Uniq.Identifier) before the sentence(s) is (are) accepted and processed.

CPG – Configure Parameter-code for the Sentence-Grouping Parameter (g)

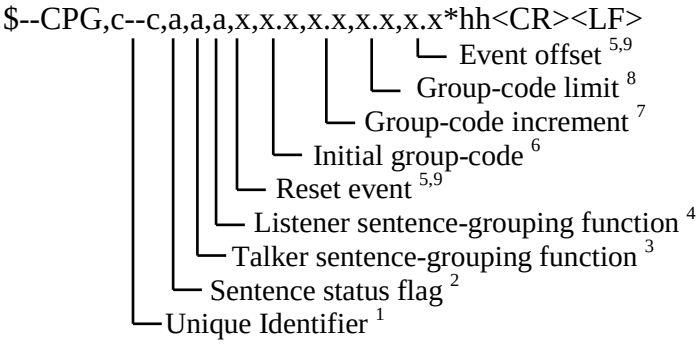
This sentence controls the use of the sentence-grouping parameter information as a listener and talker within a TAG Block. This is a command sentence.

Enabling the "talker sentence-grouping" parameter permits a talker's output sentences to be linked using the TAG Block sentence-grouping method, when required.

A sentence-grouping string is not required for a single sentence and is not required in all TAG Blocks. If only the sentence-grouping TAG Block feature is enabled, single sentence lines do not require a TAG Block (i.e., the notation "g:1-1-code" is not necessary. (See 7.9.3 and 7.13).

Although TAG Block parameters may be in any order, when the sentence-grouping parameter is used, it should appear as the first parameter in the TAG Block.

Enabling the “listener sentence-grouping” parameter permits the listener to associate grouped sentences. If the listener sentence-grouping parameter is disabled, the sentence-grouping strings should be ignored, and the grouped sentences should not be handled as associated.



Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device’s or process’s Unique Identifier. On output, this data field is the device’s or process’s Unique Identifier.

2) 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 or TBR sentence).
   C = Sentence is a configuration command to change settings. A sentence without “C” is not a command.

3) Configuration or status of Talker sentence-grouping function, parameter-code “g” for all output sentences (talker):
   V = sentence-grouping function parameter disabled (off).
   A = sentence-grouping function parameter enabled (on)
   U = unsupported.(status reply only)

4) Configuration or status of Listener sentence-grouping function, parameter-code “g” for all input sentences (listener):
   V = sentence-grouping function parameter disabled (off).
   A = sentence-grouping function parameter enabled (on)
   U = unsupported.(status reply only)

5) The “Reset event” field defines the event that causes the group-code to return to the “Initial group-code” value. For “Reset event” > 0, the event is a time that utilizes the equipment’s time reference. The event time needs to include the information from the “Event offset” field. Applying the “Event offset” value changes the time of the event by the sign of the “Event offset” (i.e. A negative offset moves the event to an earlier time, and a positive offset moves the event to a later time.). Default value of 1.
   0 = using the group-code limit. The “Event offset” data field does not apply.
   1 = daily (beginning next day)
   2 = hourly (beginning of hour)
   3 = every minute (beginning of minute)
   4 = weekly (beginning of Sunday)
   5 = monthly (beginning of month)
   6 = yearly (beginning of year)

6) This is the initial group-code value (integer) after the group-code is reset. Default value of 1.

7) This is the Group-code increment value (integer). Default value of 1. A negative increment will decrement the group-code.

8) This data field may contain a floating numeric or integer value. The current group-code value (see g:) is compared to the group-code limit and is used to reset the group-code to the value of the Initial group-code. If the Group-code increment is positive, the group-code is reset to the Initial group-code when the group-code is greater than this value. If the Group-code increment is negative, the group-code is reset when the group-code is less than this value. This test is done before the group-code is output in the TAG Block. The group-code is incremented after it is output. The group-code limit may be a real number with a fractional part to ensure there is no ambiguity during the limit test.

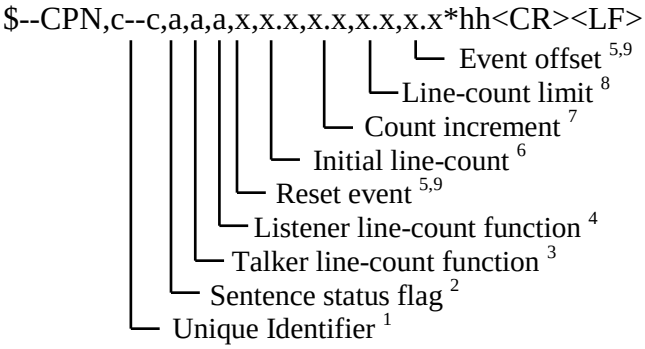
9) This is the offset in (+/-) seconds (See Note 5.). Null value indicates no change

CPN – Configure Parameter-code for the Line-count Parameter (n)

This sentence configures and controls the addition of a line-count parameter to a talker TAG Block or its use as a listener. This is a command sentence.

Enabling this parameter-code talker causes a TAG Block containing this (n) parameter–code to be linked to each talker line or sentence.

The line-count parameter-code listener may be used to enable a line-count reception process. The reception process details are not defined by this standard, but defined by the application or equipment performance standard specifying the use of this listener parameter code.



Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.

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

3) Configuration or status of Talker line-count function, parameter-code "n" for all output sentences (talker):
   V = line-count function parameter disabled (off)
   A = line-count function parameter enabled (on).
   U = unsupported.(status reply only).

4) Configuration or status of Listener line-count function, parameter-code "n" for all input sentences (listener):
   V = line-count function parameter disabled (off)
   A = line-count function parameter enabled (on).
   U = unsupported.(status reply only).

5) The "Reset event" field defines the event that causes the line-count to return to the "Initial line-count" value. For "Reset event" > 0, the event is a time that utilizes the equipment's time reference. The event time needs to include the information from the "Event offset" field. Applying the "Event offset" value changes the time of the event by the sign of the "Event offset" (i.e. A negative offset moves the event to an earlier time, and a positive offset moves the event to a later time.). Default value of 1.
   0 = using the line-count limit. The "Event offset" data field does not apply.
   1 = daily (beginning next day)
   2 = hourly (beginning of hour)
   3 = every minute (beginning of minute)
   4 = weekly (beginning of Sunday)
   5 = monthly (beginning of month)
   6 = yearly (beginning of year)
6) This is the initial line-number value (integer) after the line number is reset. Default value of 1.
7) This is the increment value (integer). Default value of 1. A negative increment will decrement the line number.
8) This data field may contain a floating numeric or integer value. The current line-count value (see n:) is compared to the line-count limit and is used to reset the line-count to the value of the Initial line-count. If the Count Increment is positive, the line-count is reset to the Initial line-count when the line-count is greater than this value. If the Count Increment is negative, the line-count is reset when the line-count is less than this value. This test is done before the line-count is output in the TAG Block. The line-count is incremented after it is output. The line-count limit may be a real number with a fractional part to ensure there is no ambiguity during the limit test.
9) This is the offset in (+/-) seconds (See Note 5). Null value indicates no change

For Example:

$xxCPN,Uniq.Identifier,C,A,V,0,1,1,100.5,*hh<CR><LF>

Line-count begins at 1 and attaches line-counts at intervals of 1 until 100 is reached at which time the line-count automatically resets to one and continues the process. Input line-counts are not processed.

$xxCPN,Uniq.Identifier,C,A,V,1,1,1,,*hh<CR><LF>

Line-count begins at 1 and increments in steps of 1 until midnight when it resets to 1. Input line-counts are not processed.

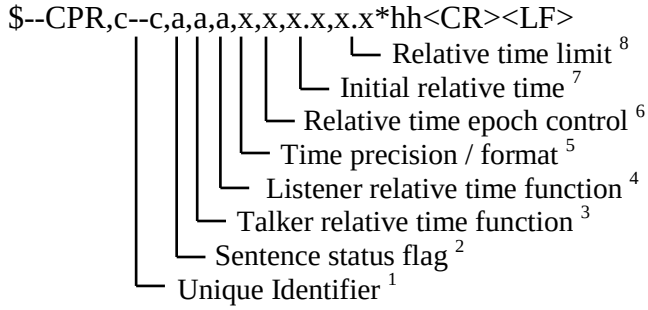
CPR – Configure Parameter-code for Relative (epoch / event) Time Parameter (r)

This sentence configures and controls the addition of a relative time parameter to a talker TAG Block or its use as a listener. This is a command sentence.

Enabling this parameter-code talker:

(1) causes a TAG Block containing this parameter-code to be linked to each talker sentence,
(2) for different talker sentences linked using "sentence-grouping," the grouped TAG Blocks (having the same "group-code" value) need only contain a single occurrence of this parameter-code. (See Section 7.13)

The relative time parameter-code listener may be used to enable a time based process. The time based process details are not defined by this standard, but defined by the application or equipment performance standard specifying the use of this listener parameter code.



Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.

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

3) Configuration or status of Talker relative time function, parameter-code "r" for all output sentences (talker):
   V = relative time function parameter disabled (off).
   A = relative time function parameter enabled (on).
   N = relative time function parameter enabled for a NAK sentence reply only. A TAG Block containing a relative time tag parameter will be linked to any NAK sentence reply.
   U = unsupported.(status reply only).

4) Configuration or status of Listener relative time function, parameter-code "r" for all input sentences (listener):
   V = relative time function parameter disabled (off).
   A = relative time function parameter enabled (on).
   U = unsupported.(status reply only).

5) This controls the format of the relative time tag
   1 = integer seconds
   2 = units defined by manufacturer

6) Configuration of the relative time epoch or the status of the devices relative time epoch. Epoch control defines the event or "epoch" that begins the relative time counting process.
   1 = Start of relative time epoch is defined by the equipment receiving this sentence.
   2 = Relative time epoch begins upon receipt of this sentence, this resets the relative time to the value in the "Initial relative time" field.
   3 = Relative time epoch begins upon receipt of this sentence, this resets the relative time to the value in the "Initial relative time" field when the "Relative time limit" is exceeded.
   4 = Relative time epoch begins upon power up of the equipment.

7) This is the initial relative time value (integer) after the relative time is reset.

8) When the relative time value (r:) becomes greater than the "Relative time limit," the relative time value is reset to the value provided in the "Initial relative time" field. This test is done before the relative time value (r:) is output in the TAG Block. The "Relative time limit" may be a value with a fractional part to ensure there is no ambiguity during the limit test

CPS – Configure Parameter-code for the Source-identification Parameter(s)

This sentence controls the addition of a source-identification parameter to a talker TAG Block or its use as a listener. This sentence is not used to enter a source-identification parameter. The SID sentence may be used to enter the source-identification parameter value. This is a command sentence.

Enabling the talker source-identification parameter-code causes a TAG Block containing a source-identification parameter to be linked to some talker sentences, as required. The talker source-identification parameter is not required in all TAG Blocks. (See Section 7.13.)

Enabling the listener source-identification parameter-code requires the listener to use the logic in Section 7.6.1 to be applied to each received line. The TBS sentence is used to enter the recognized source-identification values.

```
$--CPS,c--c,a,a,a*hh<CR><LF>
        |  |  |  |  |
        |  |  |  |  └ Listener source-identification function [4]
        |  |  |  └ Talker source-identification function [3]
        |  |  └ Sentence status flag [2]
        |  └ Unique Identifier [1]
```

Notes:

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.

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

3) Configuration or status of Talker source-identification function parameter-code "s" for all output sentences (talker):
   V = source-identification function parameter disabled (off)
   A = source-identification function parameter enabled (on).
   N = source-identification parameter enabled for a NAK sentence reply only. A TAG Block containing a source-identification parameter will be linked to any NAK sentence reply.
   U = unsupported.(status reply only).

4) Configuration or status of Listener source-identification function, parameter-code "s" for all input sentences (listener):
   V = source-identification function parameter disabled (off).
   A = source-identification function parameter enabled (on).
   U = unsupported.(status reply only).

   For Example:
   $xxCPS,Uniq.Identifier,C,A,V*hh<CR><LF>
   Activates addition of source-identification to output lines.

CPT – Configure Parameter-code for a Text-string Parameter (t)

This sentence controls the addition of an text-string parameter(s) to a talker TAG Block or its use as a listener. This is a command sentence.

Enabling the text-string parameter-code talker causes a TAG Block containing a text-string parameter to be linked to some talker sentences, when they are required. The text-string parameter is not required in all TAG Blocks. (See 7.13)

The text-string parameter-code listener may be used to enable a text based process. The text based process details are not defined by this standard, but defined by the application or equipment performance standard specifying the use of this listener parameter code

$--CPT,c--c,a,a,a*hh<CR><LF>

- Listener text-string function [4]
- Talker text-string function [3]
- Sentence status flag [2]
- Unique Identifier [1]

1) The Unique Identifier is used for system level identification of a device or process, 15 characters maximum. On input and if the device or process has a Unique Identifier, this sentence should be accepted only if this data field matches the device's or process's Unique Identifier. On output, this data field is the device's or process's Unique Identifier.
2) 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 or TBR sentence).
   C = Sentence is a configuration command to change settings. A sentence without "C" is not a command.
3) Configuration or status of Talker text-string function, parameter-code "t" for all output sentences (talker):
   V = text-string function parameter disabled (off)
   A = text-string function parameter enabled (on).
   U = unsupported.(status reply only).
4) Configuration or status of Listener text-string function, parameter-code "t" for all input sentences (listener):
   V = text-string function parameter disabled (off)
   A = text-string function parameter enabled (on).
   U = unsupported.(status reply only)

For Examples

$xxCPT,Uniq.Identifier,C,A,A*hh<CR><LF>

Activates text parameter for both listening and talking.

$xxCPT,Uniq.Identifier,C,V,V*hh<CR><LF>

Deactivates text parameter. Text not appended to any sentence and ignored on input.

TBR – TAG Block Report Request

The TBR sentence is used to request the identity and the data field contents for all parameter-codes supported by a device.

Upon receiving a TBR sentence, the listener should reply with a separate "Configure Parameter-code" sentence (CPx) for each parameter-code that it supports. The reply should provide all the Data Field configuration values for each "Configure Parameter-code" sentence.

The TBR cannot be queried.

$--TBR,c--c,a*hh<CR><LF>

- Request flag for supported Parameter-codes [2]
- Unique Identifier [1]

Notes:

1) The Unique Identifier is used for system level identification of a device, 15 characters maximum. If the device has a Unique Identifier, this sentence should be ignored when this data field does not match the device's Unique Identifier.

2) A = Report all active (enabled) parameter-codes supported, their current status, and data field values
S = Report all supported parameter-codes, their current status, and data field values
I = Report all inactive (disabled) parameter-codes supported, their current status, and data field values

TBS – TAG Block Listener Source-identification Configuration Command

This sentence configures a listener's source-identification value(s). The value(s) are used by the "listener" device when the listener source-identification process function is enabled. This is a command sentence.

When the listener source-identification process function is enabled and a TAG Block containing a source-identification parameter code is received, the listener compares the received "s:" value with the value(s) configured by the TBS sentence. If there is no match, the line is not processed by the listener (See 7.6.1 and Table 12).

The TBS sentence does not set the device's "talker" source-identification value (See the SID and AID sentences).

This sentence provides a simple mechanism for properly routing sentences to and from listeners and talkers, but it does not provide a mechanism for maintaining the security of the routing.

This sentence can be queried. When queried, the query response may contain one or more sentences and will continue until the transfer of all current source-identification values is complete. The query response will not report the default source-identification, "DEFAULTSOURCE".

$--TBS,c--c,a,x,c--c*hh<CR><LF>

- Source-identification value [4]
- Action [3]
- Sentence status flag [2]
- Unique Identifier [1]

1) The Unique Identifier is used for system level identification of a device, 15 characters maximum. If the device has a Unique Identifier, this sentence should be ignored when this data field does not match the device's Unique Identifier.

2) 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.

3) The field specifies the specific configuration action. This field should not be null when field two is set to "C". This field should be null when field two is set to "R".
   1 = Add the provided source-identification value (field 4) to the list of recognized sources.
   2 = Remove the provided source-identification value (field 4) from the list of recognized sources.
   3 = Remove all source-identification values from the list of recognized sources. The default value of "DEFAULTSOURCE" remains as the only recognized source.

4) Unique Identifier of recognized source, 15 character maximum. When this sentence is a reply to a query, the reply should not include a sentence reporting the "DEFAULTSOURCE" source-identification.

10.2 Approved TAG Block Encapsulation Formatters

These have not yet been defined in this version of the standard.

Appendix A.
GLOSSARY

accuracy (in navigation)	a 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, the 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-seawater path when the signal transit time is based on the free-space velocity.
AIS	Universal Shipborne Automatic Identification System (AIS). AIS operates primarily on VHF radio frequencies, with a coverage range of 20 to 30 nautical miles. AIS provides a means to automatically exchange information between ships and with shore stations, information that can be used for identification purposes or for monitoring and tracking the movements of ships. Ship information updates range from between every 2 seconds to 6 minutes, depending upon the speed of the ship. Information broadcast by each AIS equipped ship and any information from land such as from Vessel Traffic Services (VTS) is automatically received by each AIS equipped ship within VHF radio range.
AIS base station	the processes and hardware needed for the bi-directional translation and transfer of data between the presentation interface and AIS VHF data-link (VDL). A base station is capable of simultaneous operation on two radio channels. The geographic coverage of a base station is limited, but may overlap the coverage of other base stations.
alarm	denotes a condition that has to be recognized, or acted upon immediately, for example depth minimum limit exceeded, anchor deep.
apparent wind	(see **relative wind**).
approved sentence	a sentence that has been approved for general use by the NMEA general assembly and is listed in this standard and attached Appendices.
arrival alarm	an alarm signal issued by a voyage-tracking unit that indicates arrival at or at a pre-determined distance from a waypoint. - (see **arrival circle**)
arrival circle	an 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	the 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 7 bit wide serial code describing numbers, upper and lower case alpha, characters, special and non-printing characters. See American National Standards Institute documents 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	an automatic device for steering a vessel so as to maintain its 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.
bearing	the 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	a numerical scale for indicating wind speed. Beaufort numbers (or forces) range from force 0 (calm) to force 12 (hurricane).
blink	in Loran-C, a signal used to indicate that a station is malfunctioning. Intended to prevent use of that signal for navigation.
Checksum	for this standard, a validity check performed on the data contained in the sentences, calculated by the talker, appended to the message, then recalculated by the listener for comparison to determine if the message was received correctly.
communication protocol	a 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 signaling requirements such as baud rate, stop bits, parity, and bits per character.
course	the 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)	the 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 traveled.
cycle lock	in Loran C, the 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 an NMEA 0183 sentence, a field that contains a data value.
dead reckoning	the 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.

Decca chain	a group of associated stations of the Decca Navigator System. A Decca chain normally consists of a master and three secondary stations. Each station is called by the color of associated pattern of hyperbolic lines as printed on the chart, i.e., red, green, and purple.
Decca Navigator System	a short to medium range low frequency (70-130 kHz) radio-navigation system by which a hyperbolic line of position of high accuracy is obtained. The system is an arrangement of fixed, phase locked, continuous wave transmitters operating on harmonically related frequencies and special receiving equipment located on a vessel. The operation of the system depends on phase comparison of the signals from the transmitters brought to a common comparison frequency with the receiver.
delimiter	in this standard, a 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: <CR><LF> is not required preceding the first sentence transmitted]
deprecated sentence	sentence not to be used for new designs
depth sounder	an 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	the 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	the 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.
diagnostic	usually denotes a failure, or warning of deterioration in a system, for example engine failure malfunction.
Doppler speed log	an 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	the speed of a current.
echo sounder	(see **depth sounder**).
envelope-to-cycle distortion (ECD)	the 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, a character or string of characters immediately preceded by a field delimiter (see **delimiter**).
fixed field	in this standard, a 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 that fall into this category are the address field and the checksum field
Galileo	a European Union project for a satellite navigation system.
Geoid	a surface along which the gravity potential is everywhere equal (equipotential surface) and to which the direction of gravity is always perpendicular.
geometric dilution of precision (GDOP)	a 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.
global positioning system (GPS)	(full name NAVSTAR Global Positioning System) an all-weather, continuous satellite navigation system being developed by the Department of Defense under Air Force management. 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. Although developed primarily for military missions, current policy calls for civil availability with a degradation in system accuracy in order to protect U.S. national security interests.
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 four satellites will be in view to users worldwide to provide position dilution of precision (PDOP) of 6 or less.
great circle	the intersection of the surface of a sphere and a plane through its center.
great circle chart	a chart on which a great circle appears approximately as a straight line.
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, the 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	a 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	an automatic device for steering a vessel by means of control signals received from a gyrocompass (see autopilot).
gyroscope	a rapidly rotating mass free to move about one or both axes perpendicular to the axis of rotation and to each other.
heading	the horizontal direction in which a ship actually points or heads at any instant, expressed in angular units from a reference direction, usually from 000^{o} at the reference direction clockwise through 359^{o}. (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	the 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 dilution of precision (HDOP)	similar to GDOP, except elevation factors are ignored.
instance	Usually will indicated an enumeration of devices
keel	a longitudinal timber or plate extending along the center of the bottom of a ship and often projecting from the bottom.
line of position (LOP)	in Loran or Decca navigation systems, a vector obtained by measurement of the time difference between the receipt of the master and slave signals which is then used to selected a corresponding LOP from a chart or table. Two or more intersecting LOPs are required to obtain a position fix.
listener	in this standard, the recipient of messages across an the interconnecting link.
log	an instrument for measuring the speed or distance or both traveled by a vessel.
Loran	the 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, a three character manufacturer identifier, usually an acronym derived from the company name, which has been approved by NMEA, for use by a manufacturer as part of the address field in formulation of proprietary sentences.
Mercator map projection	a 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	A message consists of 2 or more sentences with the same sentence formatter. Messages are used when 2 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 the key fields supporting multi-sentence messages. See section 5.3.7
Navigation Leg	the 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.

Navy Navigation Satellite System (TRANSIT)	an operational satellite navigation system of the United States conceived and developed by the Applied Physics Laboratory of John Hopkins University for the U.S. Navy. It is an all-weather, worldwide, and passive system used primarily for the navigation of surface ships and submarines. Also known by the acronyms NAVSAT or TRANSIT, it consists of a constellation of orbiting satellites, a ground system of tracking stations, and any number of user stations (navigators). The user stations are radionavigation devices composed of a receiver, a frequency cycle-counter, and a computer. The minimum constellation for system operation is four satellites (five satellites in orbit provide redundancy). The satellite orbits are controlled by the tracking stations. Satellites broadcast current known positions while orbiting the earth. The NAVSAT system utilizes the Doppler shift of radio signals transmitted from the satellite to measure the relative velocity between the satellite and the navigator. Knowing the satellite orbit precisely, the navigator's absolute position can be accurately determined from this time rate of change of range to the satellite.
null field	in this standard, 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 2C2A). [Note: the ASCII Null character (HEX 00) is not to be used for null fields!]
Omega Navigation System	a worldwide, continuous, radionavigation system of medium accuracy that provides hyperbolic lines of position through phase comparisons of VLF (10-14kHz) continuous wave signals transmitted on a common frequency on a time-shared basis. The fully implemented system is comprised of only eight transmitting stations.
one-way communication protocol	a protocol established between a talker and a listener in which only the talker may send messages [compare to **two-way communication protocol**].
origin waypoint	the starting point of the present navigation leg.
Physical Shore Station (PSS)	the processes external to the base station that provides (“talker”) or uses (“listener”) data exchanged with the base station via the presentation interface. These external process may be responsible for simultaneous communications with more than one AIS base station. See IALA Recommendation A-124 for detailed information about the PSS.
precision	a 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**].
Presentation interface (PI)	the communications pathway between the internal base station controller and external PSS talker(s) and listener(s) processes. It is not necessary that this physical communications pathway be an NMEA 0183 series electrical interface.

proprietary sentence	a 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 shall contain a unique talker identifier that 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	a 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**).
RMA sentence	Recommended Minimum Acceptable sentence, a composite sentence recommended by this standard to insure interoperability between talkers and listeners and to insure that all data considered necessary for navigation is sent by a particular navigation unit.
route	a 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 use 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	the waypoint currently selected to be the point toward which the vessel is travelling. Also called **"TO" Waypoint**, **destination** or **destination waypoint**.
sentence formatter	in this standard, a 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 attached appendices.
set	he direction towards which a current flows.
signal-to-noise ratio (SNR)	the ratio of the magnitude of a signal to that of the noise (interference), often expressed in decibels.
speed log	an instrument for measuring vessel 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. (Also see **Doppler speed log**).
speed made good	the 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)	the speed of a vessel along the actual path of travel over the ground.
talker	in the NMEA 0183 Standard, the originator of messages across an NMEA 0183 link.
talker identifier	the first two characters following the "$" (HEX 24) in an NMEA 0183 sentence (address characters 1 and 2); selected from Table - Talker Identifier, Mnemonics of the NMEA 0183 Standard.

time difference (TD)	in Loran-C, the time difference measured from the time of reception of the master station signal to the time of reception of the slave station signal.
track	the 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	the single resultant direction from a point of departure to a point of arrival at any given time.
transducer	a device that converts one type of energy to another, as a loudspeaker that changes electrical energy into acoustical energy.
Transport, Annotate, and Group (TAG) Block:	additional information associated with NMEA 0183 "single-talker multi-listener" sentences.
true bearing	bearing relative to true north; compass bearing corrected for compass error.
true heading	heading relative to true north.
two-way communication protocol	a 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	See AIS
UART	Universal Asynchronous Receiver-Transmitter that 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.
Unicode	The Unicode standard is a fixed-width, uniform encoding scheme from written characters and text. The Unicode character encoding treats alphabetic characters, ideographic characters, and symbols identically, which means they can be used in any mixture and with equal facility. The Unicode Standard is molded on the ASCII character set, but uses 16 bit encoding to support full multilingual text. No escape sequence or control code is required to specify any character in any language. See the TUT sentence for application of Unicode within the NMEA 0183 standard.
Universal Time Coordinated (UTC)	a time scale based on the rotation of the earth that is disseminated by most broadcast time services [compare with **atomic time**].
variable field	in NMEA 0183 sentences, a 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	the 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.
VHF data-link (VDL):	as a minimum this consists of two independent radio channels referred to as "AIS1" (channel A) and "AIS2" (channel B). Data is assumed to arrive at the base station simultaneously on both radio channels A and B, but can only be sent by a base station on one radio channel at a time. The characteristics, rules, and messaging structure of VDL data are described in the ITU-R M.1371 standard.
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	a reference point on a track.
wide area augmentationsystem (WAAS)	an augmentation to GNSS which uses geostationary satellites to broadcast GNSS integrity and correction data, and additional ranging signals.

Appendix B.
Approved NMEA 0183 Manufacturer's Mnemonic Codes

This appendix identifies the Mnemonic Codes used to identify equipment manufacturers. Check www.nmea.org or standards.nmea.org for the latest updates

As of June 2012

3SN	3 S NAVIGATION
AAR	ASIAN AMERICAN RESOURCES
ACE	AUTO COMM ENGINEERING CORP.
ACR	ACR ELECTRONICS, INC.
ACS	ARCO SOLAR, INC.
ACT	ADVANCED CONTROL TECHNOLOGY
ADI	ADITEL
AGI	AIRGUIDE INSTRUMENT CO.
AHA	AUTOHELM OF AMERICA
AIP	AIPHONE CORP.
ALD	ALDEN ELECTRONICS, INC.
AMC	ALLTEK MARINE ELECTRONICS CORP.
AMI	ADVANCED MARINE INSTRUMENTATION, LTD.
AMR	AMR SYSTEMS
AMT	AIRMAR TECHNOLOGY
AND	ANDREW CORPORATION
ANS	ANTENNA SPECIALISTS
ANX	ANALYTYX ELECTRONIC SYSTEMS
ANZ	ANSCHUTZ OF AMERICA
AOB	AEROBYTES LTD
APC	APELCO
APN	AMERICAN PIONEER, INC.
APW	AUTOMATIC POWER, INC. / PHAROS MARINE
APX	AMPEREX, INC.
AQC	AQUA CHEM, INC.
AQD	AQUADYNAMICS, INC.
AQM	AQUA METER INSTRUMENT CO.
ARL	ACTIVE RESEARCH LIMITED
ASH	ASHTECH
ASP	AMERICAN SOLAR POWER
ATC	ADVANCED C TECHNOLOGY, LTD
ATE	AETNA ENGINEERING
ATM	ATLANTIC MARKETING COMPANY
ATR	AIRTRON
ATV	ACTIVATION, INC.
AVN	ADVANCED NAVIGATION, INC.
AWA	AWA NEW ZEALAND, LTD.

AXN AXIOM NAVIGATION, INC.

BBG BBG INCORPORATED
BBL BBL INDUSTRIES, INC.
BBR BBR AND ASSOCIATES
BDV BRISSON DEVELOPMENT, INC.
BEC BOAT ELECTRIC CO.
BFA BLUEFLOW AMERICAS
BGG BODENSEE GRAAVITYMETER GEOSYSTEMS GmbH
BGS BARRINGER GEOSERVICE
BGT BROOKES AND GATEHOUSE, INC.
BHE BH ELECTRONICS
BHR BAHR TECHNOLOGIES, INC.
BLB BAY LABORATORIES
BMC BMC
BME BARTEL MARINE ELECTRONICS
BMT BOSCH REXROTH AG MARINE TECHNIQUE
BNI NEIL BROWN INST. SYSTEMS
BNS BOWDITCH NAVIGATION SYSTEMS
BRM MEL BARR COMPANY
BRO BROADGATE, LTD
BRY BYRD INDUSTRIES
BTH BENTHOS, INC.
BTK BALTEK CORP.
BTS BOAT SENTRY, INC.
BVE BV ENGINEERING
BXA BENDIX AVALEX, INC.

CAI CAMBRIDGE AERO INSTRUMENTS
CAT CATEL
CBN CYBERNET MARINE PRODUCTS
CCA COPAL CORP OF AMERICA
CCC COASTEL COMMUNICATIONS CO.
CCL COASTAL CLIMATE COMPANY
CCM COASTAL COMMUNICATIONS
CDC CORDIC COMPANY
CDI CHETCO DIGITAL INSTRUMENTS
CDL CDLTD INC
CEC CECO COMMUNICATONS, INC.
CEI CAMBRIDGE ENGINEERING, INC.
CHI CHARLES INDUSTRIES, LTD.
CIN CANADIAN AUTOMOTIVE INSTRUMENTS
CKM CINKEL MARINE ELECTRONICS
CMA SOC. NOUVELLE D'EQUIP. CALVADOS
CMC COE MANUFACTURING CO.
CME CUSHMAN ELECTRONICS, INC.
CML CML MICROSYSTEMS, PLC
CMN COMNAV MARINE, LTD.
CMP C MAP, s.r.l.
CMS COASTAL MARINE SALES CO.
CMV COURSEMASTER USA, INC.
CNI CONTINENTAL INSTRUMENTS
CNS C.N.S. SYSTEMS AB
CNV COASTAL NAVIGATOR
CNX CYNEX MANUFACTURING CO.

CPL COMPUTROL, INC.
CPN COMPUNAV
CPS COLUMBUS POSITIONING, LTD
CPT CPT, INC.
CRE CRYSTAL ELECTRONICS, LTD
CRO THE CARO GROUP
CRY CRYSTEK CRYSTALS CORP.
CSI COMMUNICATION SYSTEMS INTL
CSM COMSAT MARITIME SERVICES
CSR CSR STOCKHOLM
CSS CNS INC
CST CAST, INC.
CSV COMBINED SERVICES
CTA CURRENT ALTERNATIVES
CTB CETEC BENMAR
CTC CELL TECH COMMUNICATIONS
CTE CASTLE ELECTRONICS
CTL C TECH, LTD.
CTS C-TECH SYSTEMS
CUS CUSTOMWARE
CWD CUBIC WESTERN DATA
CWV CELWAVE R.F., INC.
CYZ CYZ, INCORPORATED

DAS DASSAULT SERCEL NAVIGATION-POSITIONING
DBM DEEP BLUE MARINE
DCC DOLPHIN COMPONENTS CORP.
DEB DEBEG GMBH
DEC DECCA DIVISION, LITTON MARINE SYSTEMS, BV
DFI DEFENDER INDUSTRIES, INC.
DGC DIGICOURSE, INC.
DGY DIGITAL YACHT LTD
DME DELORME
DMI DATAMARINE INTERNATIONAL
DNS DORNIER SYSTEM GMBH
DNT DEL NORTE TECHNOLOGY, INC.
DOI DIGITAL OACEANS INC.
DPS DANAPLUS, INC.
DRL R.L.DRAKE COMPANY
DSC DYNASCAN CORP.
DTN DYTECHNA, LTD
DYN DYNAMOTE CORPORATION
DYT DYTEK LABORATORIES, INC.

EAN EURO AVIONICS NAVIGATIONSSYSTEME GmbH
EBC EMERGENCY BEACON CORP.
ECT ECHOTEC, INC.
EDO EDO CORPORATION ELECTROACOUSTICS DIV.
EDV EDV KRAJKA
EEV EEV, INC.
EFC EFCOM COMMUNICATION SYSTEMS
EKC EASTMAN KODAK
ELA ALLIED SIGNAL ELAC NAUTIK
ELD ELECTRONIC DEVICES, INC.
ELM ELMAN s.r.l

EMC ELECTRIC MOTION COMPANY
EMS ELECTRO MARINE SYSTEMS, INC.
ENA ENERGY ANALYSTS, INC.
ENC ENCRON, INC.
EPM EPSCO MARINE
EPT EASTPRINT, INC.
ERC THE ERICSSON CORPORATION
ESA EUROPEAN SPACE AGENCY
ESC ELECTRONICS EMPORIUM, DIVISION OF ESC PRODUCTS
ESY E-SYSTEMS, ECI DIVISION

FDN FLUIDDYNE
FEC FURUNO ELECTRIC CO.
FHE FISH HAWK ELECTRONICS
FJN JON FLUKE CO.
FLA FLARM TECHNOLGY GMBH (SWITZERLAND)
FLO FLOSCAN INCORPORATED
FMM FIRST MATE MARINE AUTOPILOTS
FMS FUGRO SEASTAR AS (MARINESTAR)
FNT FRANKLIN NET AND TWINE, LTD
FRC THE FREDERICKS COMPANY
FST FASTRAX OY
FTG T.G.FARIA CORPORATION
FUJ FUJITSU TEN CORPORATION OF AMERICA
FUR FURUNO USA, INC.

GAM GRE AMERICA, INC.
GCA GULF CELLULAR ASSOCIATES
GEC GEC PLESSEY SEMICONDUCTORS
GES GEOSTAR CORPORATION
GFC GRAPHIC CONTROLS, CORP.
GFV GFV MARINE LTD.
GIS GALAX INTEGRATED SYSTEMS
GNV GEONAV INTERNATIONAL
GPI GLOBAL POSITIONING INSTRUMENT CORP.
GPP GEO++ GmbH
GPR GLOBAL POSITIONING SYSTEM JOINT PROGRAM OFFICE (ROCKWELL COLLINS)
GRF GRAFINTA (SPAIN)
GRM GARMIN CORPORATION
GSC GOLD STAR COMPAPNY, LTD
GTI GENESIS TECHNOLOGY INTERNATIONAL LTD
GTO GRO ELECTRONICS
GVE GUEST CORPORATION
GVT GREAT VALLEY TECHNOLOGY
HAI HYDRAGRAPHIC ASSOCIATES, LTD
HAL HAL COMMUNICATIONS CORP.
HAR HARRIS CORPORATION
HHS HYDEL HELLAS SKALTSARIS LTD (SHANGHAI)
HIG HY GAIN
HIL PHILIPS NAVIGATION A/S
HIT HI TEC
HMS HYDE MARINE SYSTEMS, INC.
HPK HEWLETT PACKARD
HRC HARCO MANUFACTURING CO.
HRT HART SYSTEMS, INC.

HTI HEART INTERFACE, INC.
HUL HULL ELECTRONICS COMPANY
HWM HONEYWELL MARINE SYSTEMS

IBM IBM MICROELECTRONICS
ICO ICOM OF AMERICA, INC.
ICG INITIATIVE COMPUTING USA, INC. INITIATIVE COMPUTING AG
IDS ICAN MARINE (CANADA)
IFD INTERNATIONAL FISHING DEVICES
IFI INSTRUMENTS FOR INDUSTRY
IME IMPERIAL MARINE EQUIPMENT
IMI INTERNATIONAL MARINE INSTRUMENTS
IMM ITT MACKAY MARINE
IMP IMPULSE MANUFACTURING, INC.
IMR IDEAL TECHNOLOGIES INC
IMT INTERNATIONAL MARKETING AND TRADING, INC.
INM INMAR ELECTRONIC AND SALES
INT INTECH, INC.
IRT INTERA TECHNOLOGIES, LTD
IST INNERSPACE TECHNOLOGY, INC.
ITM INTERMARINE ELECTRONICS, INC.
ITR ITERA, LTD
IWW INLAND WATERWAYS (GERMANY)

JAN JAN CRYSTALS
JAS JASCO RESEARCH LTD.
JFR RAY JEFFERSON
JMT JAPAN MARINE TELECOMMUNICATIONS
JPI J.P. INSTRUMENTS
JRC JAPAN RADIO COMPANY, LTD
JRI J R INDUSTRIES, INC.
JTC J TECH ASSOCIATES, INC.
JTR JOTRON RADIOSEARCH, LTD

KBE KB ELECTRONICS, LTD
KBM KENNEBEC MARINE COMPANY
KEL KNUDSEN ENGINEERING, LTD
KHU KELVIN HUGHES LTD
KLA KLEIN ASSOCIATES, INC.
KME KYUSHU MATSUSHITA ELECTRIC
KMR KING MARINE RADIO CORP.
KNC KONGSBERG NORCONTROLS
KNG KING RADIO CORPORATION
KOD KODEN ELECTRONICS CO., LTD
KRP KRUPP INTERNATIONAL, INC.
KST KONGSBERG SEATEX AS
KVH KVH COMPANY
KYI KYOCERA INTERNATIONAL, INC.

L3A L3 COMMUNICATIONS RECORDERS DIVISION
LAT LATITUDE CORPORATION
L3I L-3 INTERSTATE ELECTRONICS COPORATION
LCI LASERCRAFT INC.
LEC LORAIN ELECTRONICS CORP
LEI LEICA GEOSYSTEMS PTY LTD.

LIT LITTON LASER SYSTEMS
LMM LAMARCHE MANUFACTURING CO.
LRD LORAD
LSE LITTLEMORE SCIENTIFIC ENG.
LSP LASER PLOT, INC.
LST LITE SYSTEMS ENGINEERING
LTF LITTLEFUSE, INC.
LTI LASER TECHNOLOGY, INC.
LWR LOWRANCE ELECTRONICS CORP.

MCA CANADIAN MARCONI COMPANY
MCI MATSUSHITA COMMUNICATIONS
MCL MICROLOGIC, INC.
MDL MEDALLION INSTRUMENTS, INC.
MDS MARINE DATA SYSTEMS
MEC MARINE ENGINE CENTER, INC.
MEG MARITEC ENGINEERING G.m.b.H.
MES MARINE ELECTRONICS SERV. INC.
MEW MATSUSHITA ELECTRIC WORKS
MFR MODERN PRODUCTS, LTD
MFW FRANK W. MURPHY MFG.
MGN MAGELLEN SYSTEMS CORP.
MGS MG ELECTRONIC SALES CORP.
MIE MIECO, INC.
MIM MARCONI INTERNATIONAL MARINE
MLE MARTHA LAKE ELECTRONICS
MLN MATLIN COMPANY
MLP MARLIN PRODUCTS
MLT MILLER TECHNOLOGIES
MMB MARSH MCBIRNEY, INC.
MME MARKS MARINE ENGINEERING
MMP METAL MARINE PILOT, INC.
MMS MARS MARINE SYSTEMS
MMT MICRO MODULAR TECHNOLOGIES
MNI MICRO NOW INSTRUMENT CO.
MNT MARINE TECHNOLOGY
MNX MARINEX
MOT MOTOROLA COMMUNICATIONS & ELECTRONICS
MPI MEGAPULSE, INC.
MPN MEMPHIS NET AND TWINE CO.
MQS MARQUIS INDUSTRIES, INC.
MRC MARINECOMP, INC.
MRE MORAD ELECTRONICS CORP.
MRP MOORING PRODUCTS OF NEW ENGLAND
MRR II MORROW, INC.
MRS MARINE RADIO SERVICE
MSB MITSUBISHI ELECTRIC CO., LTD
MSF MICROSOFT CORPORATION
MSE MASTER ELECTRONICS
MSM MASTER MARINER, INC.
MST MESOTECH SYSTEMS, LTD
MTA MARINE TECHNICAL ASSOCIATES
MTD MARITEL DATA SERVICES
MTG MARINE TECHNICAL ASSISTANCE GROUP
MTI MOBILE TELESYSTEMS, INC.

MTK MARTECH, INC.
MTR MITRE CORPORATION, THE
MTS METS, INC.
MUR MURATA ERIE NORTH AMERICA
MVX MAGNAVOX ADVANCED PRODUCTS AND SYSTEMS CO.
MXS MAXSEA INTERNATIONAL
MXX MAXXIMA MARINE

NAT NAUTECH, LTD
NAU NAUTICALL
NAV NAVTEC, INCORPORATED
NCT NAVCOM TECHNOLOGY, INC.
NEF NEW ENGLAND FISHING GEAR
NGS NAVIGATION SCIENCES, INC.
NIX L-3 NAUTRONIX
NMR NEWMAR
NOM NAV COM, INC.
NOR NORTECH SURVEYS (CANADA)
NOV NovAtel COMMUNICATIONS, LTD
NSI NOREGON SYSTEMS INC
NSL NAVITRON SYSTEMS LTD
NSM NORTHSTAR MARINE
NTI NORTHSTAR TECHNOLOGIES, INC.
NTK NOVATECH DESIGNS, LTD
NTS NAVTECH SYSTEMS
NUT NAUTITECH PTY, LTD
NVC NAVICO
NVG NVS TECHNOLOGIES AG
NVO NAVIONICS, s.p.a.
NVS NAVSTAR
NVT NOVARIANT, INC
NWC NAVAL WARFARE CENTER

OAR O.A.R. CORPORATION
ODE OCEAN DATA EQUIPMENT CORP.
ODN ODIN ELECTRONICS, INC.
OHB OHB SYSTEMS
OIN OCEAN INSTRUMENTS, INC.
OKI OKI ELECTRIC INDUSTRY CO.
OLY NAVSTAR, LTD (POLYTECHNIC ELECTRONICS)
OMN OMNETICS
OMT OMNITECH AS
ORB ORBCOMM
ORE OCEAN RESEARCH
OSI OFFSHORE SYSTEMS INTL.
OSL OFFSHORE SYSTEMS, LTD.
OTK OCEAN TECHNOLOGY

PCE PACE
PCM P SEA MARINE SYSTEMS
PDM PRODELCO MARINE SYSTEMS
PLA PLATH,C.DIV OF LITTON
PLI PILOT INSTRUMENTS
PMI PERNICKA MARINE INSTRUMENTS
PMP PACIFIC MARINE PRODUCTS

PNI PNI SENSORS INC
PNL POINTS NORTH, LTD
PRK PERKO, INC.
PSM PEARCE SIMPSON
PST POINTSTAR A/S
PTC PETRO COM
PTG P.T.I./GUEST
PTH PATHCOM, INC.

QWE QWERTY ELEKTRONIK AB
Q2N QQN NAVIGATION AB

RAC RACAL MARINE, INC.
RAE RCA ASTRO ELECTRONICS
RAY RAYTHEON MARINE COMPANY
RCA RCA SERVICE COMPANY
RCH ROACH ENGINEERING
RCI ROCHESTER INSTRUMENTS, INC.
RDC USCG R&D CENTER
RDI RADAR DEVICES
RDM RAY DAR MANUFACTURING CO.
REC ROSS ENGINEERING CO.
RFP ROLFITE PRODUCTS, INC.
RGC RCA GLOBAL COMMUNICATIONS
RGL RIEGL LASER MEASUREMENT SYSTEMS
RGY REGENCY ELECTRONICS, INC.
RHO RHOTHETA ELEKTRONIK GmbH
RLK REELEKTRONIKA.NL
RME RACAL MARINE ELECTRONICS
RMR RCA MISSILE AND RADAR
RSL ROSS LABORATORIES, INC.
RSM ROBERTSON SHIPMATE, USA
RTH PARTHUS
RTN ROBERTSON TRITECH NYASKAIEN
RWI ROCKWELL INTERNATIONAL

SAA SATRONIKA SL
SAE STN ATLAS ELEKTRONIC GmbH
SAF SAFEMINE
SAI SAIT, INC.
SAJ SAJ INSTRUMENT AB
SAM SAM ELECTRONICS GmbH
SAL CONSILIUM MARINE AB
SAP SYSTEMS ENGINEERING & ASSESSMENT, LTD
SAT SATLOC
SBR SEA BIRD ELECTRONICS, INC.
SCL SOKKIA COMPANY, LTD
SCO SIMOCO TELECOMMUNICATIONS LTD
SCR SIGNALCRAFTERS, INC.
SEA SEA, INC.
SEC SERCEL ELECTRONICS OF CANADA
SEE SEETRAC AKA GLOBAL MARINE TRACKING
SEM SEMTECH LTD
SEP STEEL AND ENGINE PRODUCTS
SER SERCEL FRANCE

SFN SEAFARER NAVIGATION INT'L,
SGC SGC, INC.
SGN SIGNAV
SHI SHINE MICRO
SIG SIGNET, INC.
SIM SIMRAD, INC
SKA SKANTEK CORPORATION
SKP SKIPPER ELECTRONICS A/S
SLI STARLINK INCORPORATED
SMD SHIPMODUL CUSTOMWARE
SME SHAKESPEARE MARINE ELECTRONICS
SMF SEATTLE MARINE AND FISHING SUPPLY CO.
SMI SPERRY MARINE, INC.
SML SIMERL INSTRUMENTS
SMT SRT-MARINE
SNP SCIENCE APPLICATIONS INTERNATIONAL CORP
SNV STARNAV CORPORATION
SNY SONY CORPORATION – MOBILE ELECTRONICS
SOM SOUND MARINE ELECTRONICS
SON SONARDYNE INTERNATIONAL LTD
SOV SELL OVERSEAS AMERICA
SPL SPELMAR
SPT SOUND POWERED TELEPHONE
SRC STELLAR RESEARCH GROUP
SRD SRD LABS
SRF SIRF TECHNOLOGY, INC.
SRS SCIENTIFIC RADIO SYSTEMS, INC.
SRT STANDARD RADIO AND TELEFON
SSC SWEDISH SPACE CORPORATION
SSD SAAB AB, SECURITY & DEFENSE SOLUTIONS, COMMAND AND CONTROL SYSTEMS DIVISION
SSE SEVEN STAR ELECTRONICS
SSI SEA SCOUT INDUSTRIES
SSN SEPTENTRIO
STC STANDARD COMMUNICATIONS
STI SEA TEMP INSTRUMENT CORP.
STK SEATECHNIK
STL STREAMLINE TECHNOLOGY, LTD
STM SI TEX MARINE ELECTRONICS
STO STOWE MARINE ELECTRONICS
STT SAAB TRANSPONDERTECH AB
SVY SAVOY ELECTRONICS
SWI SWOFFER MARINE INSTRUMENTS

TBB THOMPSON BROTHERS BOAT MFG.
TCN TRADE COMMISSION OF NORWAY
TDL TIDELAND SIGNAL
TEL PLESSEY TELLUMAT
THR THRANE AND THRANE A/A
TKI TOKYO KEIKI INC
TLS TELESYSTEMS
TMT TAMTECH, LTD
TNL TRIMBLE NAVIGATION
TOP TOPCON POSITIONING SYSTEMS, INC.
TRC TRACOR, INC.

TRS TRAVROUTE SOFTWARE
TSI TECHSONIC INDUSTRIES, INC.
TTK TALON TECHNOLOGY CORP.
TTS TRANSTECTOR SYSTEMS
TYC VINCOTECH (FORMERLY TYCO ELECTRONICS)
TWC TRANSWORLD COMMUNICATIONS
TWS TELIT LOCATION SOLUTIONS a division of TELIT WIRELESS SOLUTIONS
TXI TEXAS INSTRUMENTS, INC.

UBX U-BLOX AG
UEL ULTRA ELECTRONICS LTD
UME UMEC
UNF UNIFORCE ELECTRONICS CO.
UNI UNIDEN CORP. OF AMERICA
UNP UNIPAS, INC.
URS URSANAV, INC

VAN VANNER, INC.
VAR VARIAN EIMAC ASSOCIATES
VCM VIDEOCOM
VEX VEXILAR
VIS VESSEL INFORMATION SYSTEMS
VMR VAST MARKETING CORP
VSP VESPER MARINE
VXS VERTEX STANDARD

WAL WALPORT U.S.A.
WBE WAMBLEE S.R.L.
WBG WESTBERG MANUFACTURING,
WBR WESBAR CORPORATION
WEC WESTINGHOUSE ELECTRIC CORP.
WCI WI-SYS COMMUNICATIONS
WDC WEATHERDOCK CORP
WHA W H AUTOPILOTS
WMM WAIT MANUFACTURING AND MARINE SALES CO.
WMR WESMAR ELECTRONICS
WNG WINEGARD COMPANY
WSE WILSON ELECTRONICS CORP.
WST WEST ELECTRONICS LIMITED
WTC WATERCOM

XEL 3XEL SRL

YAS YAESU ELECTRONICS

ZNS ZINNOS

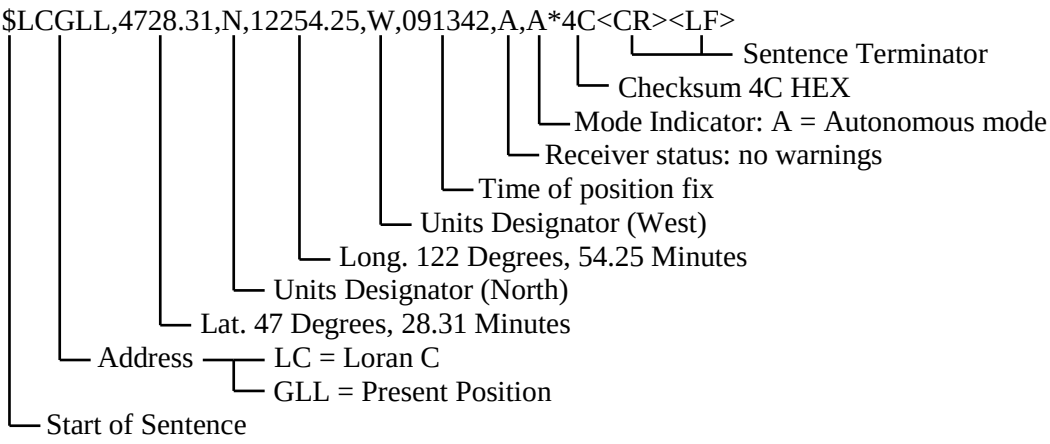
Appendix C.
Sentence Applications and Examples

C.1 Example Parametric Sentences

These examples are intended as samples of correctly constructed sentences. They are representative samples only and show part of the wide range of legal variations possible with sentences. They should not necessarily be used as templates for sentences.

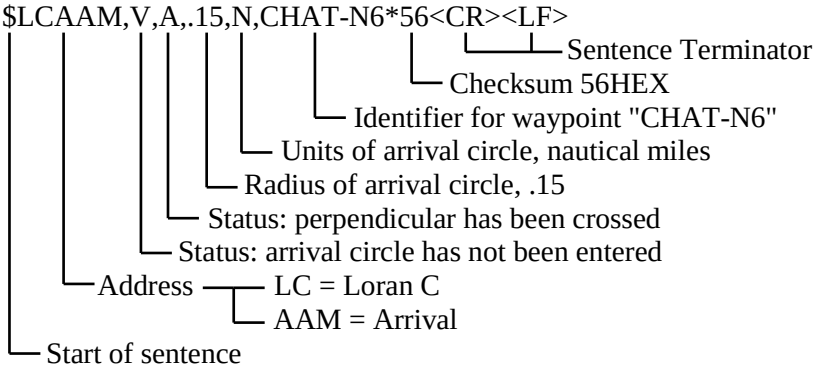
C.1.1 Parametric Example #1 – Loran C LAT/LON

This example gives present position in Latitude-Longitude, as determined by Loran C. The 3-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 hours, 13 minutes and 42 seconds. 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' and Mode Indicator = “A”.



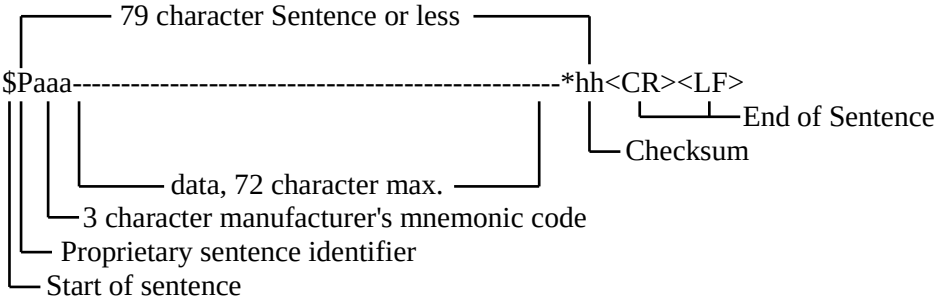
C.1.2 Parametric Example #2 – Loran C Arrival Alarm

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 five is the Waypoint Identifier field of valid characters.

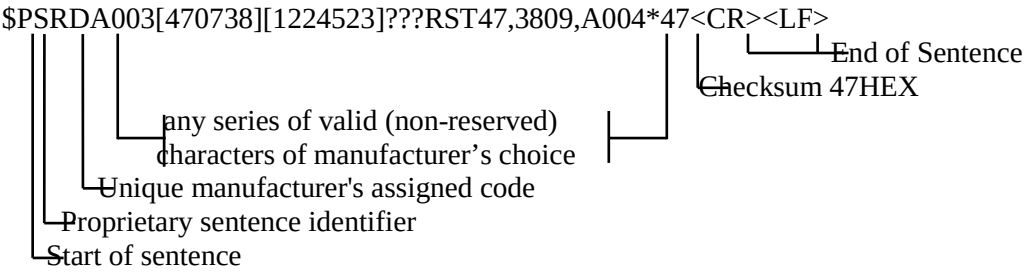


C.1.3 Parametric Example #3 – Proprietary Sentence

A proprietary sentence has the following general format:



A specific example will have little meaning to someone other than the particular manufacturer that designed the sentence:



C.1.4 Parametric Example #4 – RMA Examples

The following 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 Lat/Lon 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 problem

f) $LCRMA,A,4226.265,N,07125.890,W,14172.33,26026.71,8.53,275.,14.0,W,D*3B<CR><LF>
Loran operating in high-resolution mode.

C.1.5 Parametric 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 2023 kHz, receiver 2614 kHz, mode J3E, telephone, standby.

b) $CTFSI,020230,026140,m,5*11<CR><LF>
MF/HF radiotelephone set transmit 2023 kHz, receive 2614 kHz, mode J3E, telephone, medium power.

c) $CTFSI,,021820,o,*2D<CR><LF>
Set receiver 2182 kHz, mode H3E, telephone.

d) $CDFSI,900016,,d,9*08<CR><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 e.g. transmit 8255 kHz, receive 8779 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 e.g. transmit 4172.5 kHz, receive 4210.5 kHz, mode F1B/J2B, teleprinter, medium power.

g) $CTFSI,416193,,s,0*00<CR><LF>
MF/HF radiotelephone tuned to teletype channel 193 in 16 MHz band e.g. 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 4162 kHz, receive 4302 kHz, mode F1C/F2C/F3C, FAX-machine, high power.

i) $CXFSI,,021875,t,*3A<CR><LF>
Scanning receiver set 2187.5 kHz, mode F1B/J2B, receive only, teleprinter/DSC.

C.1.6 Parametric Example #6 – MSK/MSS Examples

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>

C.1.7 Parametric 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 as specified in IEC 62238.

$CVDSC,12,3601234560,12,05,00,1474712519,0817,,,S,E,*xx
$CVDSE,1,1,A,3601234560,00,12345678*yy

The field values of the first sentence indicate:

1. distress call
2. from MMSI 360123456
3. category distress (implicit in a distress call)
4. sinking (code 105)
5. respond by radiotelephony (G3E/F3E code 100)
6. position 47 47N 125 19W
7. time of position 08:1
8. null
9. null
10. end of sequence (no acknowledgement request)
11. expansion sentence to follow
12. NMEA sentence checksum

$xxDSE,1,1,A,3601234560,00,12345678*hh

The field values of the second sentence indicate:

1. an expansion sentence
2. the first (and in this case only) expansion sentence
3. message sent automatically (not requested) (this field probably is 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. NMEA 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*hh

All ships safety call from 011234567 to work J3E on 4125 kHz RX only

$CTDSC,16,0112345670,08,09,26,041250,,,,S*C9

C.1.8 Example of use of FIR, DOR and WAT sentences

C.1.8.1 Example of the use of system status messages

Some sentences, currently FIR, DOR and WAT, are constructed to send the 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 the NMEA 0183 standard is a broadcast type protocol without any means for retransmissions or acknowledgements from the receiver, system status transfers will normally require period transmissions. The NMEA 0183 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 (e.g., 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 (e.g., a voyage data recorder) to a listener should continuously transmit sentences with the interval between transmissions not exceeding 5 minutes. 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 minutes.

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 hours. This ensures that rarely occurring changes of state will be detected.

Note: This can be achieved by sending all individual status messages every 2 hours or by sending summary status for each and then individual status for only those units that are not normal (e.g., summary status for fire zone and then individual status for 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.

C.1.8.2 Use of system division codes

These sentences allow the specification of where in the system a measurement point is located. The division may be made based on the ship’s physical subdivision (e.g., into decks and fire zones) or may be made based on subdivisions within the system (e.g., sub central and data acquisition communication loop).

Figure 9 shows the example system diagram that will be used for the examples in the remainder of this section.

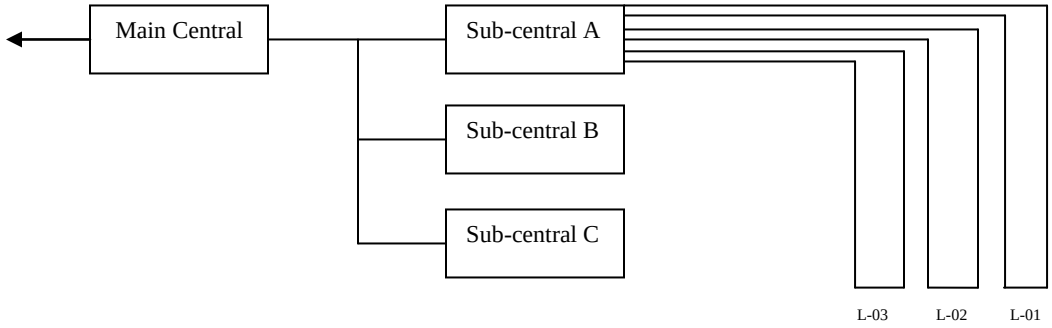


Figure 2 - Example System Diagram

The Main Central has the NMEA 0183 link to external system status receivers. The system itself is subdivided 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 the first division indicator and the loop number “01”, “02”, etc. as the second division indicator.

Note: The first division indicator must be exactly two alphanumeric characters (e.g., coded as “CA” for sub-central A). The second division indicator must be numeric and exactly three digits long (e.g., coded as 001 for loop 01).

C.1.8.3 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.

C.1.8.4 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: A fault in one unit should be signaled 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.

C.1.8.5 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 until 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 in the below sequence.

$--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>

C.1.8.6 Failure in a sub-system

If a complete sub-system fails (e.g., Sub-central B), this should be signaled by an '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 must 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.

C.1.8.7 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>

Note: The sub-system fault message should also be repeated in the status block.

C.1.8.8 Signal a correction of a sub-system fault

Any new message indicating a valid status for a sub-system should be interpreted as the sub-system being back to normal state. Any new message for any unit in a sub-system should be interpreted as the unit being back to normal state. The following sentences illustrate how this would occur.

$--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 (e.g., "closed" for fire doors). Thus, the sender should send a sub-system status block immediately after the sub-system has been put back into normal operation.

C.1.9 Examples of TAG Block Sentences

This Section left intentionally blank.

C.2 Example Encapsulation Sentences

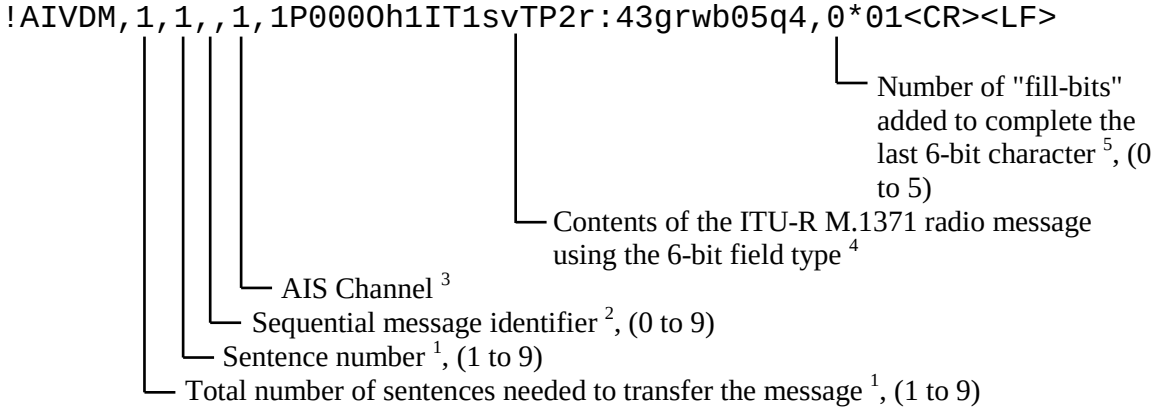
The following are representative samples only and show part of the wide range of legal variations possible with sentences. They should not necessarily be used as templates for sentences.

C.2.1. Example #1 – AIS VHF Data-link Message VDM Sentence Encapsulation

C.2.1.1 Introduction

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 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 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.



Also included with this example are:

- A worksheet for decoding and interpreting encapsulated fields (See Figure 11),
- A copy of Messages 1,2,3: Position Reports from ITU-R M.1371 (See Table 29).

C.2.1.2 Background Discussion - Encapsulation Coding

Before beginning the decoding process, it is useful to understand the source of the binary bits encapsulated in this string. AIS uses radio technology that broadcasts messages using channels in the marine VHF band. There are a number of messages that can 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 international standard for AIS. As an example, Table 29 in this document replicates Messages 1,2,3: Position Reports from ITU-R M.1371. This table identifies all of the information needed to convert the

encapsulated binary bits into individual parameters. Table 29 identifies each parameter, the bits that make up the parameter, and provides a description of the parameter.

The bits listed in Table 29 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 10 shows the message data portions of the "radio packet" that is created and broadcast by an AIS unit. Only the message data bits described in the tables (such as Table 29) are encapsulated in the string contained in the VDM sentence.

Message Data (168 bits maximum in one slot, 1008 bits maximum in five slots)

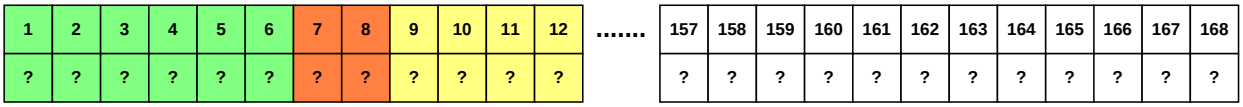


Figure 3 - AIS Message Data Bits Encapsulated in VDM Sentence

For example, assume that the first 12 bits of the message data in Figure 10 (bits 1 to 12) are: 000001100000. These would be the first 12 bits coded into the VDM encapsulate string. The VDM sentence encapsulates data using the symbols of the "6-bit" Field Type. Each of the 64 possible combinations of ones and zeros that can make up a 6-bit string has been assigned a unique valid character. These assignments are listed in Section 6.2.4, Table 11.

For example, the first 12 bits would be divided into 6-bit strings, that is: 000001 and 100000. Using Table 11, 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 11.

The maximum number of message data bits that can be contained in an AIS radio message is 1008 bits. This number of bits requires 168 6-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 ordered 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,2,1,7,1,1P000Oh1IT1svT,0*58<CR><LF>
!AIVDM,2,2,7,1,P2r:43grwb05q4,0*0C<CR><LF>

!AIVDM,2,1,9,1,1P000Oh1IT1svTP2r:43,0*7B<CR><LF>
!AIVDM,2,2,9,1,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 does change. Using either VDM encapsulation pair, the encapsulated string remains: **"1P000Oh1IT1svTP2r:43grwb05q4".**

Message data can be shown in different ways. For example, Figure 10 shows the message data as a horizontal table of bits. However, the left grid in Figure 11 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 grid positions indicates the message data position of the bit in the AIS unit's broadcast. Organizing the bits in this manner allows easy use of the conversion information shown in Table 29.

C.2.1.3 Decoding the Encapsulated String

Section C.2.1.2 states that the AIS unit codes receive binary message data bits as the characters of an encapsulation string. Therefore, the AIS unit:

- Receives a broadcast message,
- Organizes the binary bits of the Message Data into 6-bit strings,
- Converts the 6-bit strings into their representative valid characters - see Section 6.2.4, Table 11,
- 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,,1,1P000Oh1IT1svTP2r:43grwb05q4,0*01<CR><LF>
```

A calculation shows that the checksum, 71_{HEX}, is correct. This permits the interpretation of the sentence contents 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 "AIS1" 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 executed in three steps:

1. The string symbols are converted back into the binary strings that they represent.
2. The binary strings are organized or parsed using the rules contained in the referenced document (in this case, ITU-R M.1371, Table 29).
3. The referenced document rules are used to convert the binary strings into the relevant information.

C.2.1.4 Conversion from symbols to binary bits

The following discussion illustrates how to decode the encapsulated string using a “table lookup" method. The reader should also be aware that this standard also contains binary mathematical methods that a computer would use to accomplish the same results. Figure 11 is a visual aid that can be used to follow “table lookup” decoding process for the example string. The grid on the left side of Figure 11, “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”. The use of this "reference grid" will become clearer as the example is discussed.

Down the center of Figure 11 is a column into which the example string has been entered from top to bottom. The arrows in Figure 11 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 Section 6.2.4, Table 11 is "000001". The binary string is entered in the grid to the right of the "1", as indicated by the arrow. These six bits 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 11.

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 encapsulate 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.

C.2.1.5 Organizing the Binary Message Data

The right side grid in Figure 11 has been filled in to decode an "AIS Message 1". Notice that the two grids in Figure 11 have a variety of shaded (colored) blocks. This was 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 bits 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 30.

The parameters listed in Table 29 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 29 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 - 5 of ITU-R M.1371.

The process of organizing the decoded binary message data requires:

1. Identification of the message number, and
2. Organizing or parsing the binary bits following the appropriate message table(s).

C.2.1.6 Interpreting the Decoded Binary Strings

Final conversion of the organized bits into useful information involves the use of the:

1. Organized bits - right side of Figure 11, and
2. The descriptive parameter information defined in ITU-R M.1371 Messages 1,2,3: Position Reports (See Table 29 in this document).

The parameter “Repeat Indicator” is a two bit field – bits 7 – 8. Inspection of message data bits 7 – 8, Figure 11, containing the two bit value $10_2 = 2_{10}$. The result is recorded in the space to the right of Figure 11.

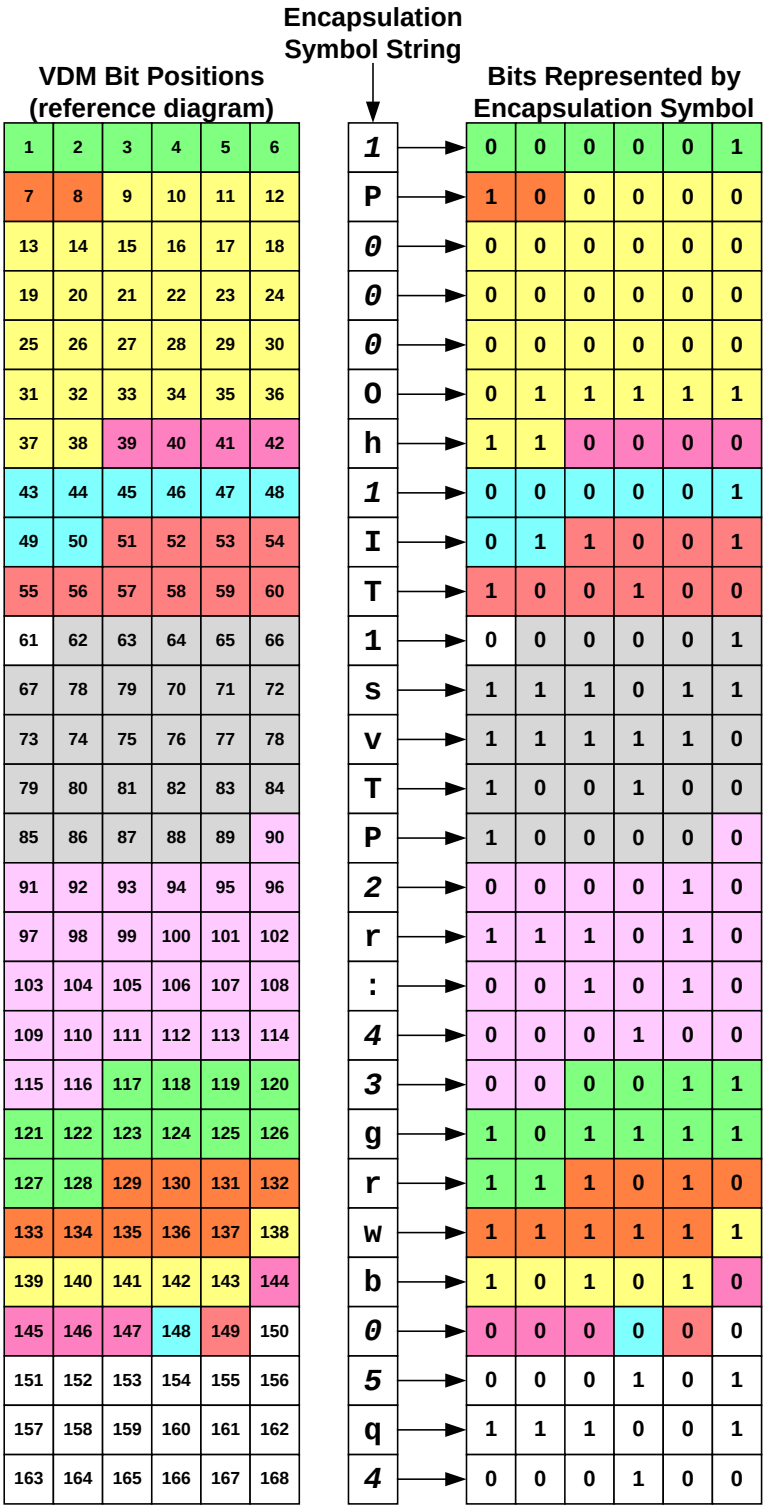
The next parameter in Table 29 is the "User ID" (the MMSI number of the unit that broadcast this message). This is a 30 bit binary integer. The conversion, $1111111_2 = 127_{10}$, discloses this unit’s MMSI number as 127.

This process continues down Table 29. The results of all the interpretations of the decoded binary message data are shown on the worksheet to the right and below Figure 11.

C.2.1.7 Encapsulated String Decoding and Interpretation Worksheet

The following example shows how to decode and interpret the encapsulated string.

`1P000Oh1IT1svTP2r:43grwb05q4`



Bits 1-6 = Identifier for this message
000001 = **message 1** (Reference Messages 1,2,3: Position Reports of ITU-R M.1371 to interpret following bits 7-168.)

Bit 7-8 = Repeat Indicator
10 = 2 = **message repeated twice**

Bits 9-38 = MMSI number of broadcasting unit
00000000000000000000001111111 =**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 meters)**

Bits 62-89 = Longitude in 1/10000 minutes
00001111011111111010010010000 = **27 degrees 5 minutes East**

Bits 90-116 = Latitude in 1/10000 minutes
00000101110100010100010000 = **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 = Regional Application
0000 = **no regional application**

Bit 148 = Spare

Bit 149 = RAIM Flag
0 = **RAIM not in use**

Bits 150-168 = Communications State
00 = **UTC Direct**
001 = **1 frame remaining until a new slot is selected, UTC hour and minute follow,**
011110010001 = 01111: 0010001 = **15:17 UTC**
Bits 167-168 not used for UTC Sub-message

Figure 4 - Binary Symbol Conversion

Table 269 - AIS Message 1, 2 and 3 Position Reports

From ITU-R M.1371 AIS Messages 1,2,3: Position Reports

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 Section 4.6.1; 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 - 14 = reserved for future use, 15 = not defined = default
Rate of turn ROT[AIS]	8	± 127 (–128 (80 hex) indicates not available, which should be the default). Coded by ROT [AIS] =4.733 SQRT (ROT [IND]) degrees/min ROT [IND] is the Rate of Turn (720 degrees per minute), as indicated by an external sensor. + 127 = turning right at 720 degrees per minute or higher; - 127 = turning left at 720 degrees per minute or higher
SOG	10	Speed over ground in 1/10 knot steps (0-102.2 knots) 1023 = not available, 1022 = 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 1/10º (0-3599). 3600 (E10 hex)= not available = default; 3601 – 4095 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)
Reserved for regional applications	4	Reserved for definition by a competent regional authority. Should be set to zero, if not used for any regional application. Regional applications should not use zero.
Spare	1	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 Sections 3.3.7.2.2 and 3.3.7.3.2
Total Bits	**168**	

Appendix D.
Data Requirements of the AIS Base Station

D.1 General data interface requirements

The Presentation Interface (PI) data requirements for a base station were developed and expressed using the structure of sentence formatters.

Cautionary Note:
In this standard, the structure of the sentence formatters and data field definitions vary from those published in the first edition of IEC 62320-1 Annex A. Some of the proposed sentence formatters in the informative Annex A of IEC 62320-1 were informative only, not adopted, or have been changed. (See Table 30).

D.2 Base Station input/output sentence formatters

Table 30 lists sentence formatters used with a Base Station. It includes existing sentence formatters (grey rows) and sentence formatters developed for use with Base Stations (white rows), and also contains the details for each of the sentence formats developed or modified for AIS Base Stations.

A sentence linking method is described in Section 7. Use of this method improves the integrity of data relationships between sentences, and improves the reliability and clarity of communications with the Base Station.

Table 30 - Base Station input/output sentence formatters

(This new table is based upon a combination of IEC 62320-1 Table 1, and application of NMEA 0183 rules and behavior requirements.)

Sentence formatter	Input independent	Input dependent	Output independent	Output dependent	Description
ABK			X		Addressed and binary broadcast acknowledgement
ABM	X				Addressed binary and safety related message
ACA	X		Q		AIS regional channel assignment message
ACM)	X				Preparation and initiation of an AIS Base Station addressed channel message (VDL Message 22), command
ACK	X	X			Acknowledge alarm
ADS			X	X	AIS Device Status, output upon status change and at interval configured by BCG
AGA	X		Q		Preparation and Initiation of an AIS Base Station broadcast of a group assignment message (Message 23), command.
AIR	X				AIS interrogation request (VDL Message 15)
ALR			X	X	Set alarm state
ASN	X				Preparation and initiation of an AIS Base Station broadcast of assignment VDL Message 16, command
BBM	X				Broadcast binary message
BCG	X	X	Q	Q	Base Station configuration, General command
BCL	X		Q		Base Station configuration, Location command
RST	X	X	X	X	Equipment Reset command
DLM	X		Q		Data Link Management slot allocations for Base Station (VDL Message 20 – FATDMA reservations), command
ECB	X		Q		Configure broadcast rates for Base Station messages with epoch planning support, command
FSR			X	X	Frame summary of AIS reception, defined by SPO.
NAK			X	X	Negative Acknowledgement
SID	X	X	Q	Q	Installation of a stations Identification command
SPO	X	X	Q	Q	Select AIS device's reception processing and output, command

Sentence formatter	Input independent	Input dependent	Output independent	Output dependent	Description
TFR			X	X	Transmit feed-back report – Base Station report on status of requested transmission. Automatic status response of TSA+VDM.
TSA	X	X			Transmit Slot Assignment, command – used to identify AIS time slot used to transmit the content of a VDM sentence. Shall preceed the VDM sentence.
TSP	X				Transmit Slot Prohibit command
TSR			X		Transmit Slot Prohibit status Report. Automatic status response of TSP.
VDM	X	X	X	X	VHF Data-link message
VDO			X	X	VHF Data-link Own-vessel message
VER			Q	Q	Version information about equipment. Provided in response to query.
VSI			X	X	VDL Signal Information, defined by SPO.
NOTE 1 "X" indicates input to, or output from, the AIS Base Station. "Q" indicates that the sentence may be externally requested using the NMEA 0183 "$xxABQ, xxx" query sentence method(s) in order for the identified sentence to be output. NOTE 2 Sentence formatters shown in shaded rows are described in NMEA 0183.					

The Presentation Interface (PI) provides a method of communication with the Base Station, including a method for linking PI sentences together.
The AIS Base Station shall output, autonomously and periodically, the ADS sentence on the PI indicating the Base Station status. This shall be output once per minute or when there is a change in the status.

D.3 Physical requirements for the presentation interface

An interface shall be provided to handle the data bandwidth requirements of the PI.

D.4 Presentation interface data exchange

Regardless of the physical interface used, the AIS Base Station shall exchange data using the sentences defined in Section 9, this document. A method for linking sentences has been provided in 7.

D.5 Base Station presentation interface output

Table 30 includes the list of NMEA 0183 output sentences.

All transmitted VDL messages shall be output by VDO sentences. The UTC hour, UTC minute (frame), and slot number of the slot or the first slot of a multi-slot message in which each VDL message was transmitted shall be provided by linking a VDO to a VSI sentence.

Each output sentence is identified by the talker identifier (first two characters of an NMEA 0183sentence) as configured by the BCG sentence.

D.6 Base Station presentation interface input

Regardless of the physical interface implemented, the AIS Base Station shall accept data input conforming to NMEA 0183. Table 30 lists the mandatory sentences for each type of Base Station.

Appendix E.
Data requirements of the AIS AtoN Station

E.1 General data interface requirements

The PI data requirements for an Aid to Navigation (AtoN) station were developed and expressed using the structure of sentence formatters. The PI data requirements and sentence formatters can be found in Section 5.3.1.1 of this Standard

Note:
In this standard, the structure of the sentence formatters and data field definitions vary from those published in IEC 62320-2.

E.2 AtoN Station input/output sentence formatters

Table 30 lists sentence formatters used with an AtoN Station. It includes existing sentence formatters (shown with an asterisk) and sentence formatters developed for use with AtoN Stations. Section 9 contains the details for each of the sentence formats developed or modified for AIS AtoN Stations.

Note:
Some of the proposed sentence formatters in the informative Annex A of IEC 62320-2 were not adopted or have been changed.

Table 31 - AtoN Station input/output sentence formatters

(This new table is based upon a combination of the IEC 62320-2 FDIS, Table 13 and application of NMEA 0813rules and behavior requirements.)

Sentence formatter	Input			Output			Description / comments
	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	
ACF	**X**	**X**	**X**	**Q**	**Q**	**Q**	General AIS AtoN Station configuration
ACG	**X**	**X**	**X**	**Q**	**Q**	**Q**	Extended general AIS AtoN Station configuration
AFB	**X**	**X**	**X**				Force broadcast
AID	**X**	**X**	**X**	**Q**	**Q**	**Q**	Configure or change MMSI
CBR	**X**	**X**	**X**	**Q**	**Q**	**Q**	Configure Broadcast Rates for AIS AtoN Station messages.
CEK		**X**	**X**		**Q**	**Q**	Define Encryption Key
COP		**X**	**X**		**Q**	**Q**	Receiver turn on times
DCR				**Q**	**Q**	**Q**	AtoN Station function capability
MEB	**X**	**X**	**X**				Message payload rebroadcast
TPC	**X**	**X**	**X**	**Q**	**Q**	**Q**	Configure prohibited slots
VER				**Q**	**Q**	**Q**	Version
ABM	**X**	**X**	**X**				Addressed binary message
BBM	**X**	**X**	**X**				Broadcast binary message
ABK				**X**	**X**	**X**	Acknowledgement message
VDM	**X**	**X**	**X**		**X**	**X**	VHF data link message
VDO				**X**	**X**	**X**	VHF data link own-vessel message

X – Indicates input to or output from the AIS AtoN Station.

Q – Indicates that the sentence may be externally requested using the NMEA0183 standard query sentences.

E.3 Additional sentence formatters in this standard that are also used for handling AIS Base Station or AtoN data requirements

ABK – AIS addressed and binary broadcast acknowledgement.
ABM – AIS addressed binary and safety related message.
ACA – AIS channel assignment message.
ACK – Acknowledge alarm.
AIR – AIS interrogation request
ALR – Set alarm state.
BBM – AIS broadcast binary message.
TXT – Text transmission, general purpose.
VDM – AIS VHF data-link message.
VDO – AIS VHF data-link own-vessel report.

Appendix F.
Data Requirements of the VDR (from IMO A.861)

- Date and time
- Ship's position
- Speed
- Heading
- Bridge Audio
- Communications audio
- Radar data, post-display selection
- Echo-sounder
- Main alarms
- Rudder order and response
- Engine order and response
- Hull openings status
- Watertight and fire door status
- Accelerations and hull stresses
- Wind speed and direction

Appendix G.
Example Receiver Diagrams

The illustrative diagrams in Figure 12 and Figure 13 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.

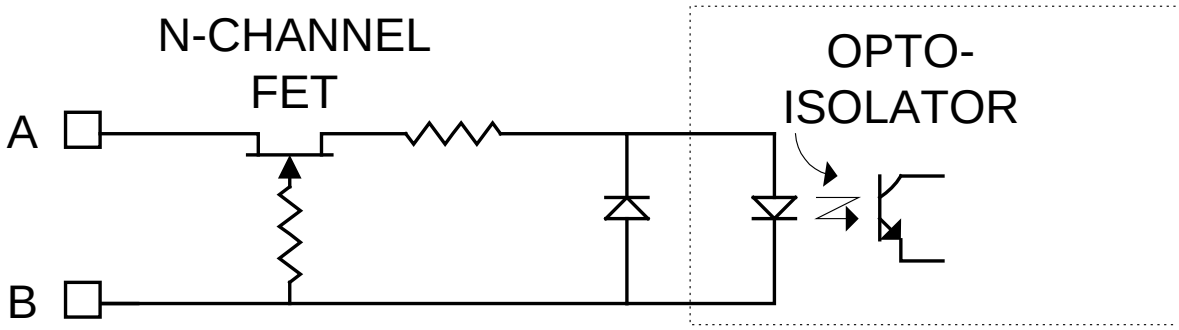


Figure 5 - Opto-isolator Based Receiver (a)

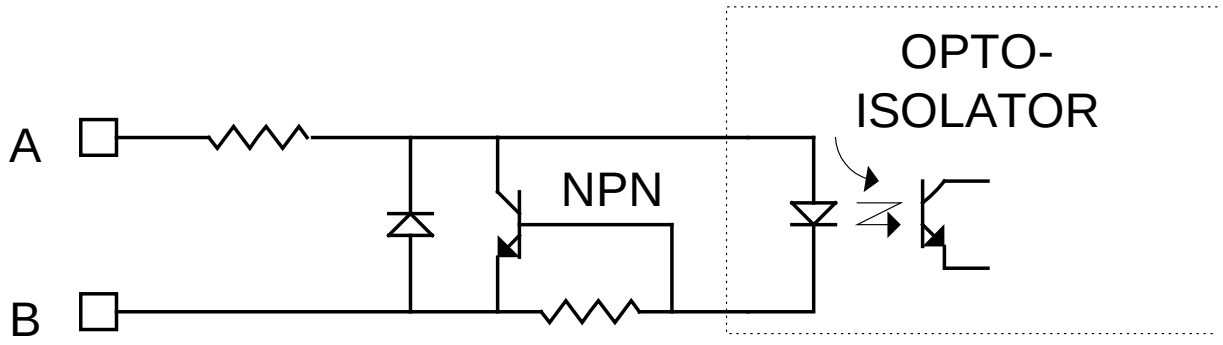


Figure 6 - Opto-isolator Based Receiver (b)

Appendix H.
Talker Identifiers & Sentences Not Recommended for New Designs

The following identifiers and sentences are no longer recommended for sole use in new or revised designs. The sentences are valid sentences, but due to changing circumstances it is desirable to delete or replace these sentences as indicated below.

Generally in each of the sentence descriptions below reference is made to a sentence in the current Version 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 the new sentences.

H.1 Talker Identifier Mnemonics Not Recommended for New Designs

TALKER DEVICE	IDENTIFIER
COMPUTER	
Programmed Calc.	CC
Memory data	CM
DECCA Navigator	DE
LORAN: Loran A	LA
Microwave Positioning System	MP
OMEGA Navigation System	OM
Distress Alarm System	OS
TRANSIT Navigation System	TR
TRANSDUCERS	
Temperature	YC
Displacement, Angular or Linear	YD
Frequency	YF
Level	YL

Pressure	YP
Flow Rate	YR
Tachometer	YT
Volume	YV

H.2 Sentences Not Recommended For New Designs

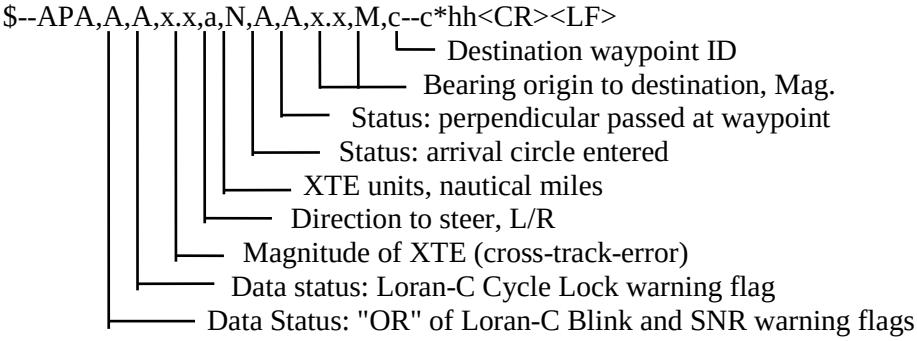
APA – Autopilot Sentence "A" 225
BER – Bearing & Distance to Waypoint, Dead Reckoning, Rhumb Line 226
BPI – Bearing & Distance to Point of Interest 226
DBK – Depth Below Keel 226
DBS – Depth Below Surface 226
DCN – DECCA position 227
DRU – Dual Doppler Auxiliary Data 227
Gda – Dead Reckoning Positions 227
Gla – Loran-C Positions 228
Goa – OMEGA Positions 228
GXA – TRANSIT Positions 229
GTD – Geographical Position, Loran-C TDs 230
HCC – Compass Heading 230
HCD – Heading and Deviation 230
HDM – Heading, Magnetic 231
HDT – Heading, True 231
HVD – Magnetic Variation, Automatic 231
HVM – Magnetic Variation, Manually Set 231
IMA – Vessel Identification 232
MDA – Meteorological Composite 232
MHU – Humidity 232
MMB – Barometer 232
MTA – Air Temperature 233
MWH – Wave Height 233
MWS – Wind & Sea State 233
OLN – Omega Lane Numbers 233
OLW – Omega Lane Width 233
OMP – OMEGA 234
ONZ – Omega Zone Number 234
Rnn – Routes 234
SBK – Loran-C Blink Status 234
SCY – Loran-C Cycle Lock Status 234
SCD – Loran-C ECDs 235
SDB – Loran-C Signal Strength 235
SGD – Position Accuracy Estimate 235
SGR – Loran-C Chain Identifier 235
SIU – Loran-C Stations in Use 235
SLC – Loran-C Status 236
SNC – Navigation Calculation Basis 236

SNU – Loran-C SNR Status 236
SPS – Loran-C Predicted Signal Strength 237
SSF – Position Correction Offset 237
STC – Time Constant 237
STR – Tracking Reference 237
SYS – Hybrid System Configuration 237
TEC – TRANSIT Satellite Error Code & Doppler Count 238
TEP – TRANSIT Satellite Predicted Elevation 238
TGA – TRANSIT Satellite Antenna & Geoidal Heights - 238
TIF – TRANSIT Satellite Initial Flag 238
TRF – TRANSIT Fix Data 238
TRP – TRANSIT Satellite Predicted Direction of Rise 239
TRS – TRANSIT Satellite Operating Status 239
VCD – Current at Selected Depth 239
VPE – Speed, Dead Reckoned Parallel to True Wind 239
VTA – Actual Track 239
VTI – Intended Track 240
VWE – Wind Track Efficiency 240
VWR – Relative (Apparent) Wind Speed and Angle 240
VWT – True Wind Speed and Angle 240
WDC – Distance to Waypoint 241
WDR – Waypoint Distance, Rhumb Line 241
WFM – Route Following Mode 241
WNR – Waypoint-to-Waypoint Distance, Rhumb Line 241
YWP – Water Propagation Speed 241
YWS – Water Profile 242
ZAA – Time, Elapsed/Estimated 242
ZCD – Timer 243
ZEV – Event Timer 243
ZLZ – Time of Day 243
ZZU – Time, UTC 243

APA – Autopilot Sentence "A"

Commonly used by autopilots this sentence contains navigation receiver warning flag status, cross-track-error, waypoint arrival status and initial bearing from origin waypoint to the destination waypoint for the active navigation leg of the journey.

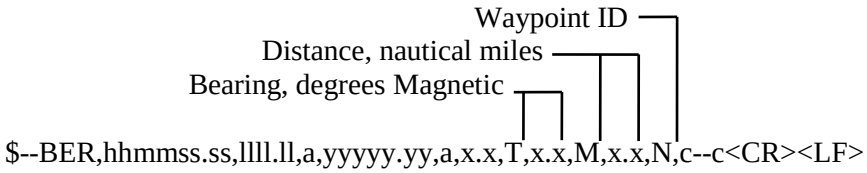
Use of **$--APB** with additional data fields of heading-to-steer and bearing from present position to destination is recommended.



BER – Bearing & Distance to Waypoint, Dead Reckoning, Rhumb Line

Time (UTC) and distance & bearing to, and location of, a specified waypoint from present position:

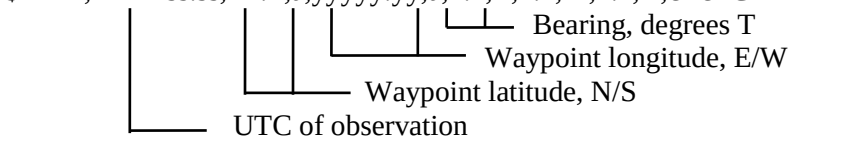
BER: Calculated along the rhumb line from a dead reckoned present position. The use of **$--BEC** using great circle calculations is recommended.



BPI – Bearing & Distance to Point of Interest

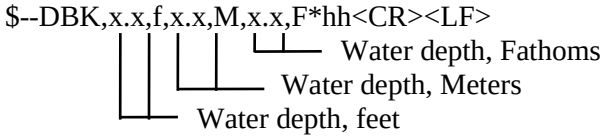
Time (UTC) and distance & bearing to, and location of, a specified waypoint from present position:

BPI: Calculated along a great circle path from a measured present position. Redundant with BWC, the use of **$--BWC** is recommended.



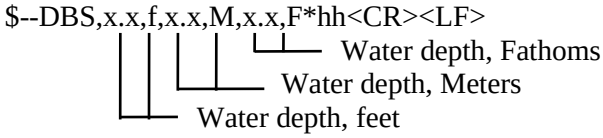
DBK – Depth Below Keel

Water depth referenced to the vessel's keel (DBK) or to the water surface (DBS).
The use of **$--DPT** is recommended.



DBS – Depth Below Surface

Water depth referenced to the vessel's keel (DBK) or to the water surface (DBS).
The use of **$--DPT** is recommended.



DCN – DECCA position

Status and lines-of-position for a specified DECCA chain.

$ -- DCN,xx,cc,x.x,A,cc,x.x,A,cc,x.x,A,A,A,A,x.x,N,x*hh<CR><LF>

- Fix data basis[1]
- Position uncertainty, n. miles
- Purple-line navigation use
- A = Valid V = Data not valid
- Green-line navigation use
- A = Valid V = Data not valid
- Red-line navigation use
- A = Valid V = Data not valid
- Purple
- Green
- Status: Red-master line, A = Valid V = Data not valid
- Red line of position (LOP)
- Red zone identifier, number-letter
- DECCA chain identifier

Notes Fix data basis:
1 = Normal pattern
2 = Lane identification pattern
3 = Lane identification transmissions

DRU – Dual Doppler Auxiliary Data

Depth, turn rate and % RPM in support of Doppler velocity systems.

The use of **$--DPT** is recommended for depth data, **$--RPM** for shaft rotation and **$--ROT** for rate of turn.

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

- Propeller shaft rotation, % of maximum, "-" = astern
- Status: Rate of turn
- Rate of turn, degrees per minute, "-" = port
- Status: Depth
- Depth, meters

GDA – Dead Reckoning Positions

Dead reckoned positions:

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

- Waypoint ID
- Longitude - E/W
- Latitude - N/S
- UTC of position fix

GLA – Loran-C Positions

Loran-C determined positions:

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

- UTC of position fix
- Latitude - N/S
- Longitude - E/W
- Waypoint ID

GLC – Geographic Position – Loran-C

Loran-C GRI, status and Time Difference (TD) lines of position for present vessel position.

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

- GRI, tens of microseconds
- Master TOA[1], microseconds
- TD1[2], microseconds
- TD2[2]
- TD3[2]
- TD4[2]
- TD5[2]
- Signal Status, in order of priority
  - B = blink warning
  - C = cycle warning
  - S = SNR warning
  - A = valid

Notes:

3) Master TOA provides for direct ranging operation. It may be the actual range to the Master in microseconds or be offset and track the arrival of the Master signal.

4) Time difference numbers in microseconds are in the Loran-C Coding Delay order with null fields used when values are unavailable.

GOA – OMEGA Positions

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

- UTC of position fix
- Latitude - N/S
- Longitude - E/W
- Waypoint ID

GXA – TRANSIT Positions

Location and time at waypoint "c--c":
$--aF: predicted or estimated time
$--aaP: present position and time
$--aaA: past position and time

The use of waypoint location **$--WPL** (for past positions) or **$--GLL** (for present position) followed by time tag **$--ZDA** is recommended for reporting past or present waypoint times; **$--WPL** followed by **$--ZTG** is recommended for estimated time.

Dead reckoned positions:
$--GDF,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GDP,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GDA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
Loran-C determined positions:
$--GLF,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GLP,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GLA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
Omega determined positions:
$--GOF,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GOP,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
$--GOA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>

- Waypoint ID
- Longitude - E/W
- Latitude - N/S
- UTC of position fix

TRANSIT determined positions:
$--GXF,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,x*hh<CR><LF>
$--GXP,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,x*hh<CR><LF>

- Satellite number
- Waypoint ID
- Longitude - E/W
- Latitude - N/S
- UTC of position fix

Location and time of TRANSIT fix at waypoint "c--c".
TRANSIT system is not operational, no recommended replacement.

$--GXA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,x*hh<CR><LF>

- Satellite number
- Waypoint ID
- Longitude - E/W
- Latitude - N/S
- UTC of position fix

GTD – Geographical Position, Loran-C TDs

Loran-C Time Difference (TD) lines of position for present vessel position.

The use of **$--GLC** is recommended.

$--GTD,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
- TD 5, micro-seconds
- TD 4, micro-seconds
- TD 3, micro-seconds
- TD 2, micro-seconds
- TD 1, micro-seconds

HCC – Compass Heading

Vessel compass heading, which differs from magnetic heading by the amount of uncorrected magnetic deviation.

The use of **$--HDG** is recommended.

$--HCC,x.x*hh<CR><LF>
- Compass heading, degrees

HCD – Heading and Deviation

Actual vessel magnetic heading, indicated compass heading and the difference (deviation) between them.

The use of **$--HDG** is recommended.

$--HCD,x.x,M,x.x,H,x.x,a*hh<CR><LF>
Magnetic deviation, degrees E/W[1]
Compass heading, degrees
Magnetic heading, degrees

Notes:
1) Easterly deviation (E) subtracts from Compass Heading
Westerly deviation (W) adds to Compass Heading

HDM – Heading, Magnetic

Actual vessel heading in degrees Magnetic.
The use of **$--HDG** is recommended.

$--HDM,x.x,M*hh<CR><LF>
Heading, degrees Magnetic

HDT – Heading, True

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

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

HVD – Magnetic Variation, Automatic

Magnetic variation, automatically derived (calculated or from a data base) (HVD), or manually entered (HVM).
The use of **$--HDG** is recommended.

$--HVD,x.x,a*hh<CR><LF>
$--HVM,x.x,a*hh<CR><LF>
Magnetic variation, degrees E/W[1]
1) Easterly variation (E) subtracts from True Heading
Westerly variation (W) adds to True Heading

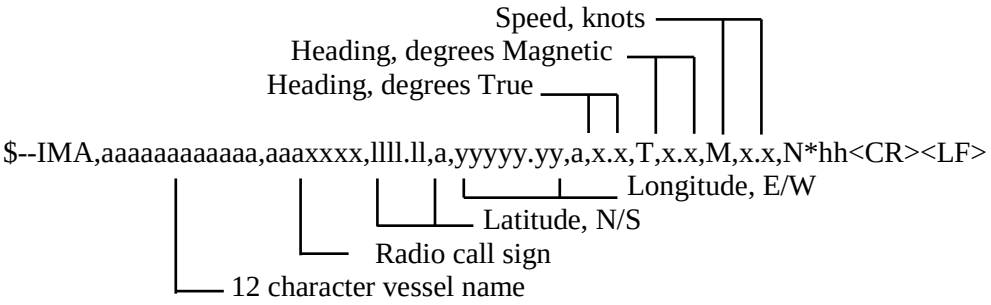
HVM – Magnetic Variation, Manually Set

Magnetic variation, automatically derived (calculated or from a data base) (HVD), or manually entered (HVM).
The use of **$--HDG** is recommended.

$--HVD,x.x,a*hh<CR><LF>
$--HVM,x.x,a*hh<CR><LF>
Magnetic variation, degrees E/W[1]
1) Easterly variation (E) subtracts from True Heading
Westerly variation (W) adds to True Heading

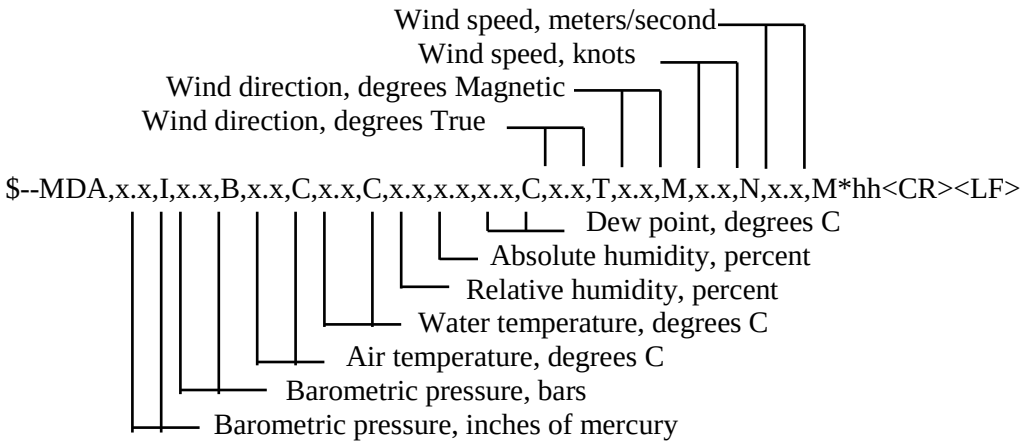
IMA – Vessel Identification

Limited utility, no recommended replacement.



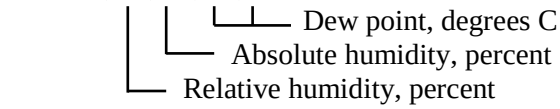
MDA – Meteorological Composite

Barometric pressure, air and water temperature, humidity, dew point and wind speed and direction relative to the surface of the earth.
The use of **$--MTW, $--MWV** and **$--XDR** is recommended.



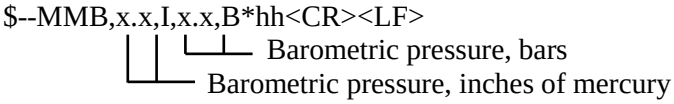
MHU – Humidity

The use of **$--XDR** is recommended.



MMB – Barometer

The use of **$--XDR** is recommended.



MTA – Air Temperature

The use of **$--XDR** is recommended.

$--MTA,x.x,C*hh<CR><LF>
Temperature, degrees C

MWH – Wave Height

Limited utility, no recommended replacement.

$--MWH,x.x,f,x.x,M*hh<CR><LF>
Wave height, meters
Wave height, feet

MWS – Wind & Sea State

Limited utility, no recommended replacement.

$--MWS,xx,xx*hh<CR><LF>
Beaufort Sea State Code
Beaufort Wind Force Code

OLN – Omega Lane Numbers

Omega Lines of Positions (LOPs).

OMEGA system is not operational, no recommended replacement.

$--OLN,aa,xxx,xxx,aa,xxx,xxx,aa,xxx,xxx*hh<CR><LF>
Centilane number
Lane number
Pair 3, AB-GH
Pair 2
Pair 1

OLW – Omega Lane Width

OMEGA system is not operational, no recommended replacement.

$--OLW,x.x,N,xxxx,M*hh<CR><LF>
Lane width, meters
Lane width, nautical miles

OMP – OMEGA

OMEGA system is not operational, no recommended replacement.

$--OMP,1,aa,2,aa,3,aa*hh<CR><LF>

Pair 3, AB-GH
Pair 2
Pair 1

ONZ – Omega Zone Number

OMEGA system is not operational, no recommended replacement.

$--ONZ,a*hh<CR><LF>

Station identifier, A-H

Rnn – Routes

Waypoint identifiers, listed in order with starting waypoint first, for route number "nn".

The use of **$--RTE** is recommended.

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

14 field sequence of route waypoint IDs
nn = Route number

SBK – Loran-C Blink Status

Loran-C warning flags for Blink (SBK) and Cycle Lock (SCY) indicating that one or more Loran-C stations being used to produce Lat/Lon and other navigation data are unreliable.

The use of **$--GLC** is recommended.

$--SBK,A*hh<CR><LF>

Warning Flag

SCY – Loran-C Cycle Lock Status

Loran-C warning flags for Blink (SBK) and Cycle Lock (SCY) indicating that one or more Loran-C stations being used to produce Lat/Lon and other navigation data are unreliable.

The use of **$--GLC** is recommended.

$--SCY,A*hh<CR><LF>

Warning Flag

SCD – Loran-C ECDs

The use of **$--LCD** is recommended.

$--SCD,0,xxx,1,xxx,2,xxx,3,xxx,4,xxx,5,XXX*hh<CR><LF>
- 1, 2, 3, 4 — Secondary 5 ECD
- Master signal ECD

SDB – Loran-C Signal Strength

Limited utility, no recommended replacement.

$--SDB,x.x*hh<CR><LF>
- Signal strength, dB

SGD – Position Accuracy Estimate

Estimate of position accuracy based on geometric dilution of precision (GDOP) and system noise, in feet and nautical miles.
Limited utility, no recommended replacement.

$--SGD,x.x,N,x.x,f*hh<CR><LF>
- Accuracy, feet
- Accuracy, nautical miles

SGR – Loran-C Chain Identifier

The unique Loran-C Chain identifier, representing Group Repetition Interval (GRI) in tens of microseconds (Group Repetition Interval = {Chain ID}*10, microseconds).
The use of **$--GLC** is recommended.

$--SGR,xxxx*hh<CR><LF>
- GRI, tens of microseconds

SIU – Loran-C Stations in Use

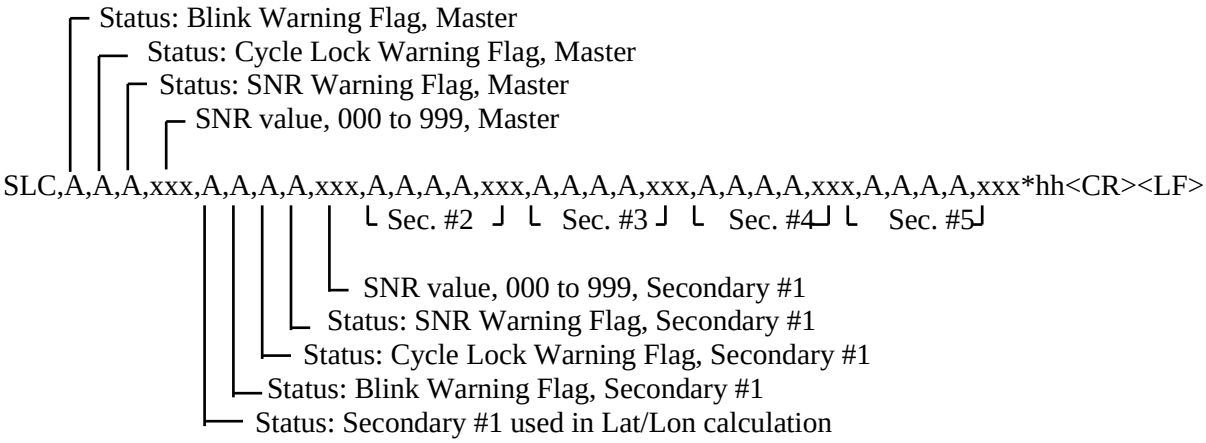
The use of **$--GLC** is recommended.

$--SIU,1,2,3,4,5,6,7,8*hh<CR><LF>
- Stations in use, null fields for stations not in use

SLC – Loran-C Status

Blink, Cycle, and SNR warning status and SNR value for all stations. Stations used in lat/lon conversion are identified.

The use of **$--GLC** and/or **$--LCD** is recommended.



SNC – Navigation Calculation Basis

Basis for navigation calculations, Great Circle or Rhumb Line.

Limited utility, no recommended replacement.

$--SNC,a*hh<CR><LF>
└ Great Circle or Rhumb Line, G/R

SNU – Loran-C SNR Status

Loran-C warning flag for Signal-To-Noise-Ratio indicating that one or more Loran-C stations being used to produce Lat/Lon and other navigation data are unreliable.

The use of **$--GLC** is recommended.

$--SNU,A*hh<CR><LF>
└ Warning Flag

SPS – Loran-C Predicted Signal Strength

Limited utility, no recommended replacement.

$--SPS,xx*hh<CR><LF>
└ Signal strength, dB

SSF – Position Correction Offset

Amount of offset, and direction of offset, applied to measured position Lat/Lon to produce a displayed position Lat/Lon.
Limited utility, no recommended replacement.

$--SSF,x.x,a,x.x,a*hh<CR><LF>
└└ Longitude offset, minutes E/W
└└ Latitude offset, minutes N/S

STC – Time Constant

Time constant specified manually for use in navigation calculations.
Limited utility, no recommended replacement.

$--STC,xxx*hh<CR><LF>
└ Time constant, 000 to 999 seconds

STR – Tracking Reference

Transmitted prior to a sentence containing velocity-based data to indicate when velocity is measured over-the-ground or relative to the water.

The use of appropriate ground or water-referenced approved sentences such as **$--VBW, $--VHW or $--VTG** is recommended.

$--STR,a*hh<CR><LF>
└ A = Ground reference, V = Water reference

SYS – Hybrid System Configuration

Limited utility, no recommended replacement.

$--SYS,L,O,T,G,D*hh<CR><LF>
└ DECCA
└ GPS
└ TRANSIT
└ OMEGA
└ LORAN-C
Null fields for systems not in use

TEC – TRANSIT Satellite Error Code & Doppler Count

TRANSIT system is not operational, no recommended replacement.

$--TEC,A,A,A*hh<CR><LF>
- Status: Iteration number
- Status: Doppler count
- Status: Maximum angle

TEP – TRANSIT Satellite Predicted Elevation

TRANSIT system is not operational, no recommended replacement.

$--TEP,x.x,D*hh<CR><LF>
- Elevation, degrees

TGA – TRANSIT Satellite Antenna & Geoidal Heights -

TRANSIT system is not operational, no recommended replacement.

$--TGA,x.x,M,x.x,M,x.x,M*hh<CR><LF>
- Antenna geoidal height, meters
- Geoidal height, meters
- Antenna height, meters

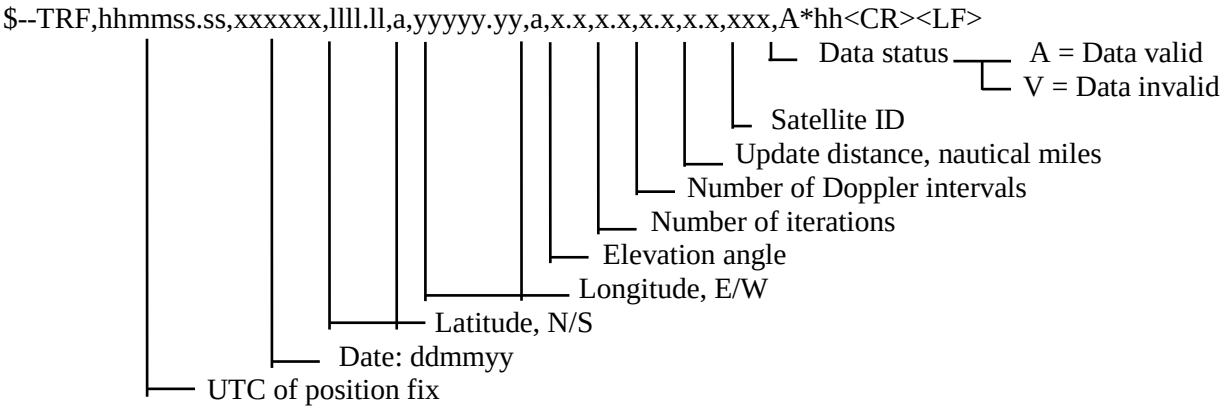
TIF – TRANSIT Satellite Initial Flag

TRANSIT system is not operational, no recommended replacement.

$--TIF,a*hh<CR><LF>
- Normal operation = A
  Set initialization data = V
  Initialization data complete = J

TRF – TRANSIT Fix Data

Time, date, position and information related to a TRANSIT fix.
TRANSIT system is not operational, no recommended replacement.



TRP – TRANSIT Satellite Predicted Direction of Rise

TRANSIT system is not operational, no recommended replacement.

$--TRP,aa*hh<CR><LF>
└ Southeasterly = SE, southwesterly = SW

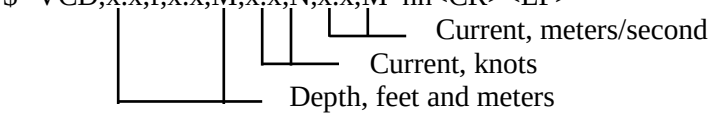
TRS – TRANSIT Satellite Operating Status

TRANSIT system is not operational, no recommended replacement.

$--TRS,a*hh<CR><LF>
└ Acquiring = A Calculating = c Error = e
Message = m Test = T Dead reckoning = U

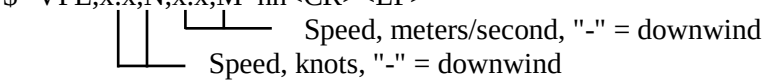
VCD – Current at Selected Depth

Limited utility, no recommended replacement.



VPE – Speed, Dead Reckoned Parallel to True Wind

Limited utility, no recommended replacement.



VTA – Actual Track

Limited utility, possible use of **$--VTG** for a portion of the data.

```
$--VTA,x.x,T,x.x,M,x.x,N,x.x,N*hh<CR><LF>
       |   |   |   |   |   |   |
       |   |   |   |   |   |   Distance made good, naut. miles
       |   |   |   |   |   Speed made good, knots
       |   |   |   |   Track made good, degrees Magnetic
       |   |   |   Track made good, degrees True
```

VTI – Intended Track

Limited utility, no recommended replacement.

```
$--VTI,x.x,T,x.x,M,x.x,N,x.x,N*hh<CR><LF>
       |   |   |   |   |   |   |
       |   |   |   |   |   |   Distance made good, naut. miles
       |   |   |   |   |   Speed made good, knots
       |   |   |   |   Intended track, degrees Magnetic
       |   |   |   Intended track, degrees True
```

VWE – Wind Track Efficiency

Limited utility, no recommended replacement.

```
$--VWE,x,x*hh<CR><LF>
       |
       Efficiency, percent
```

VWR – Relative (Apparent) Wind Speed and Angle

Wind angle in relation to the vessel's heading and wind speed measured relative to the moving vessel.

The use of **$--MWV** is recommended.

```
$--VWR,x.x,a,x.x,N,x.x,M,x.x,K*hh<CR><LF>
       |   |   |   |   |   |   |
       |   |   |   |   |   |   Wind speed, Km/Hr
       |   |   |   |   |   Wind speed, meters/second
       |   |   |   |   Measured wind Speed, knots
       |   |   |   Measured wind angle relative to the vessel, 0 to 180°, left/right L/R of vessel heading
```

VWT – True Wind Speed and Angle

True wind angle in relation to the vessel's heading and true wind speed referenced to the water. True wind is the vector sum of the Relative (Apparent) wind vector and the vessel's velocity vector relative to the water along the heading line of the vessel. It represents the wind at the vessel if it were stationary relative to the water and heading in the same direction.

The use of **$--MWV** is recommended.

```
$--VWT,x.x,a,x.x,N,x.x,M,x.x,K*hh<CR><LF>
       |   |   |   |   |   |   |
       |   |   |   |   |   |   Wind speed, Km/Hr
       |   |   |   |   |   Wind speed, meters/second
       |   |   |   |   Calculated wind Speed, knots
       |   |   |   Calculated wind angle relative to the vessel, 0 to 180°, left/right L/R of vessel heading
```

WDC – Distance to Waypoint

Distance from present position to the specified waypoint.

The use of **$--BWC** is recommended.

$--WDC,x.x,N,c--c*hh<CR><LF>
- Waypoint identifier
- Distance, nautical miles

WDR – Waypoint Distance, Rhumb Line

The use of **$--WDC** using great circle calculations is recommended.

$--WDR,x.x,N,c--c*hh<CR><LF>
- Waypoint ID
- Distance, nautical miles

WFM – Route Following Mode

Limited utility, no recommended replacement.

$--WFM,a*hh<CR><LF>
- Mode: "A" = automatic, "V" = manual

WNR – Waypoint-to-Waypoint Distance, Rhumb Line

The use of **$--WNC** using great circle calculations is recommended.

$--WNR,x.x,N,x.x,K,c--c,c--c*hh<CR><LF>
- FROM waypoint ID
- TO waypoint ID
- Distance, kilometers
- Distance, nautical miles

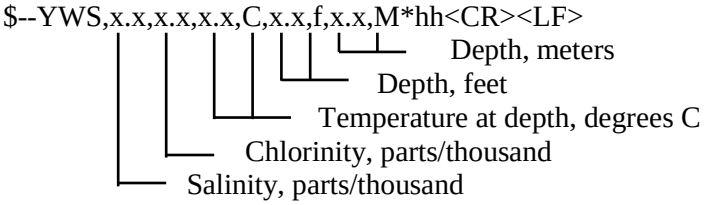
YWP – Water Propagation Speed

Limited utility, no recommended replacement.

$--YWP,x.x,f,x.x,M*hh<CR><LF>
- Speed, meters/second
- Speed, feet/second

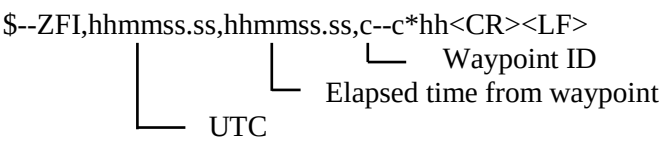
YWS – Water Profile

Limited utility, no recommended replacement.

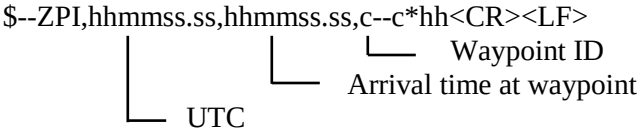


ZAA – Time, Elapsed/Estimated

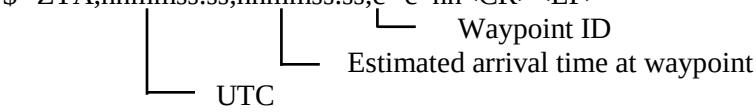
Elapsed time from point-of-interest.
The use of **$--ZFO** is recommended.



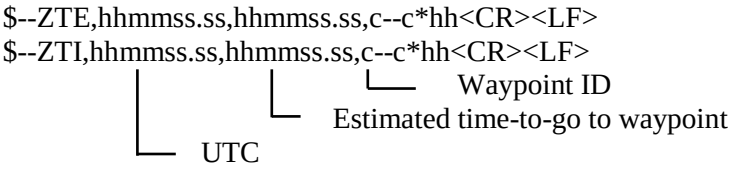
Arrival time at point-of-interest.
The use of **$--ZTG** is recommended.



Estimated time of arrival at waypoint.
The use of **$--ZTG** is recommended.



Estimated time to event/point-of-interest.
The use of **$--ZTG** is recommended.



Arrival time at waypoint.
The use of **$--ZTG** is recommended.

```
$--ZWP,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
       |        |        |
       |        |        +-- Waypoint ID
       |        +-- Arrival time at waypoint
       +-- UTC
```

ZCD – Timer

Limited utility, no recommended replacement.

```
$--ZCD,xxxxxx,a*hh<CR><LF>
       |      |
       |      +-- Control: "+" = count up
       |                   "-" = count down
       |                   "V" = stop count
       +-- Timer initial value, seconds
```

ZEV – Event Timer

Limited utility, no recommended replacement.

```
$--ZEV,hhmmss.ss,hhmmss.ss,a,c--c*hh<CR><LF>
       |         |         | |
       |         |         | +-- Waypoint ID
       |         |         +-- Control: "+" = count up
       |         |                      "-" = count down
       |         |                      "V" = stop count
       |         +-- Timer initial value
       +-- UTC
```

ZLZ – Time of Day

Time of day in hours-minutes-seconds, both with respect to (UTC) and the local time zone.

The use of **$--ZDA** is recommended.

```
$--ZLZ,hhmmss.ss,hhmmss.ss,xx*hh<CR><LF>
       |         |         |
       |         |         +-- Local zone description[1], 00 to12
       |         +-- Local time
       +-- UTC
```

Notes:
1) Zone description is the number of whole hours <u>added to local time</u> to obtain GMT, Zone description is negative for East longitudes.

ZZU – Time, UTC

The use of **$--ZDA** is recommended.

```
$--ZZU,hhmmss.ss*hh<CR><LF>
       |
       +-- UTC
```

Appendix I.
Notes Addressing ITU M.1371 Messages 25 & 26

March 17, 2011
NMEA 0183 / 61162-1 updates.

Notes and Input from IEC Working Group 15 and NMEA 0183 Committee

Addressing ITU-R M.1371 messages 25 and 26 for input and processing on mobile AIS equipment.

During October 2009, a means to provide ITU-R M.1371 message 25 and 26 input for use with mobile shipboard AIS equipment was identified by both WG6 and WG15. At that time, there existed the CBR and MEB sentences designed for AIS AtoN equipment. These two sentences were developed for specific AtoN applications by competent authorities, and included support for messages 25 and 26. Because CBR and MEB were not sentences for shipboard equipment, they were not part of 61162-1, and were published initially in the AtoN equipment standard and then in the NMEA 0183 standard. IEC now only publishes shipboard sentences in 61162-1.

A proposal was made to (October 2009) modify the existing 61162-1 ABM and BBM sentences, by adding new fields to accommodate messages 25 and 26, similar to what was done for AtoN with the CBR and MEB sentences. At that time, the determination was made that structural modifications to the ABM and BBM sentences was not something that could be done. This was because the rules for extending normal parametric sentences are not the same for encapsulation sentences, specifically with respect to appending fields to an existing sentence. The result of the deliberations by all involved at that time was to use the AtoN designed sentences (CBR and MEB) for mobile AIS equipment and to add them to 61162-1. This was a quick fix that seemed appropriate at the time, with the only other alternative being a change to the fundamental rules for encapsulation sentences in 61162-1 and 0183.

After that decision, and during the FDIS stages of 61162-1 Ed 4, the U.S. National Committee recognized some significant concerns over this approach, and recommended that the CBR and MEB not be used to input messages 25 and 26 to shipboard mobile AIS equipment. When the U.S. made those recommendations (November 2010), a final solution was not yet identified, only that the CBR and MEB were not the right technical solution.

The problem with using the CBR and MEB for shipboard use from an AIS ”System” perspective, is both a safety and security issue. The CBR and MEB were designed to allow control of the AIS VHF Data Link with respect to when a transmission would be made/scheduled (slot number) and with respect to instructing the AtoN to use a specific AIS communications state. These powerful controls were intended only to be used a competent authority. Introducing these capabilities on shipboard AIS equipment provides a means to “externally” control how the VDL is used from shipboard systems. This opens the door to misuse, either intentional or unintentional and violates the basic operating principals of Class-A AIS. AIS works because all

the decisions for using the VDL in mobile equipment are autonomously controlled by fixed methods designed into the equipment. Until CBR and MEB were introduced for shipboard use, there has never been any external means to override, alter, or influence the actual way in which the Class A equipment interacts with the VDL. This opens the door to potential spoofing, jamming, and undesired VDL manipulation by other than a competent authority.

A final solution to the above stated problems surfaced over the past few months (between November 2010 and March 2011), and is very similar to the original proposal, i.e. use the ABM and BBM for message 25 and 26 input to mobile AIS equipment. This solution has been vetted (March 2011) by multiple U.S. AIS experts, multiple AIS experts within the Swedish National Committee, WG6, and NMEA.

The solution proposed does not alter the structure of the ABM and BBM sentences, yet provides a safe and secure method to input messages 25 and 26 to shipboard AIS equipment, leaving critical VDL broadcast decisions in the control of the fixed internal autonomous rules of the AIS equipment. Further, with support for message 25 and 26 being added to ABM and BBM, there is no need to retain the use of CBR and MEB for mobile shipboard AIS equipment, and these sentences should be withdrawn from 61162-1. Further, the changes made to the CBR sentence as published in 61162-1 are not technically correct with respect to message 26. The original CBR sentence remains in NMEA 0183. The CBR and MEB will remain in NMEA 0183, and IEC (TC80 Plenary 2009 decision) will reference the NMEA 0183 standard for the AtoN sentences in the Edition 2 of the AtoN standard.

Appendix J.
Revisions to NMEA 0183

Version 4.00 Nov. 2008	Version 4.10 June 2012			