National Marine Electronics Association

NMEA 0183

Standard For Interfacing Marine Electronic Devices

Version 2.30

March 1, 1998

COPYRIGHT© NMEA 1998

CONTENTS

Preface

NMEA 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.

NMEA interface standards are developed with input from manufacturers, private and government organizations, and equipment operators. 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.

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 Standard defines electrical signal requirements, data transmission protocol and timing, and specific sentence formats for a 4800-baud serial data bus. 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 Radiocommunications Equipment and Systems. The IEC Standard is aligned closely with the NMEA 0183 Standard. Where possible, differences between the two documents, and sections that pertain specifically to IEC requirements, are indicated herein by the symbol "*" in the margin.

Availability and Updates of the Standard

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

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

For subscription information contact the NMEA National Office.

For additional or updated copies of this standard, contact:

NMEA National Office
P.O. Box 3435
New Bern, NC 28564-3435
U.S.A.

Telephone: (252) 638-2626
FAX: (252) 638-4885
E-mail:
http://www.nmea.org

For technical information, contact:
Chairman, NMEA 0183 Standards Committee:
Frank Cassidy
c/o the NMEA National Office

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.

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 messages and only limited error-checking capability, this standard should be used with caution in critical applications.

1.3 Definitions

1.3.1 General

Common terms are defined in Appendix II, 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 (Table 4).

1.3.3 LISTENERs

A LISTENER is any device that receives data from another device within this standard.

1.4 References

1.4.1 American National Standards Institute:

1. ANSI X 3.15 1976 ANSI Character Structure and Character Parity Sense for Serial-by-Bit Communication
2. ANSI X 3.16 1976 ANSI Bit Sequencing of the ANS Code for Information Interchange in Serial-By-Bit Data Transmission.
3. ANSI X 3.4 1977 ANSI Code for Information Interchange

1.4.2 Electronic Industries Association Standards:

A. EIA-422-A December 1978 (CCITT X.27/V.11)

1.4.3 International Electrotechnical Commission:

3, rue de Varembe
P.O. Box 131
1211 Geneva 20
SWITZERLAND

A. IEC 945, Marine Navigational Equipment - General Requirements
B. IEC 61162-1: Digital Interfaces, Maritime Navigation and Radiocommunications Equipment and Systems

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

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

1.4.6 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.

1.4.7 International Telecommunication Union (ITU) Recommendations:

A. ITU-R M.493-6, Digital Selective-Calling System For Use In The Maritime Mobile Service.
B. ITU-R M.821, Optional Expansion of the Digital Selective-Calling System For Use In The Maritime Mobile Service.
C. ITU-R M. 825-1, 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.541, Operational Procedures for the Use of Digital Selective Calling (DSC) Equipment in the Maritime Mobile Service.

1.4.8 GLONASS Interface Control Document, 1995

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

2. Manufacturer's Documentation

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

a) Identification of the A and B signal lines.
b) The output drive capability as a TALKER.
c) A list of approved sentences, noting unused fields, Proprietary sentences transmitted as a TALKER, and transmission interval for each sentence.
d) The load requirements as a LISTENER.
e) A list of sentences and associated data fields that are required as a LISTENER.
f) The current software and hardware revision if this is relevant to the interface.
g) An electrical description or schematic of the LISTENER/TALKER input/output circuits citing actual components and devices used, including connector type and part number.
h) The Version No. and date of update of the standard for which compliance is assured.

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

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

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

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 EIA-422-A (December 1978).

3.5.3 LISTENER Receive Circuits
Multiple LISTENERs may be connected to a single TALKER. The LISTENER receive circuit shall consist of an optoisolator and should have protective circuits to limit current, reverse bias and power dissipation at the optodiode as shown in Figure 1. Reference is made to example circuits in Section 7.2 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.

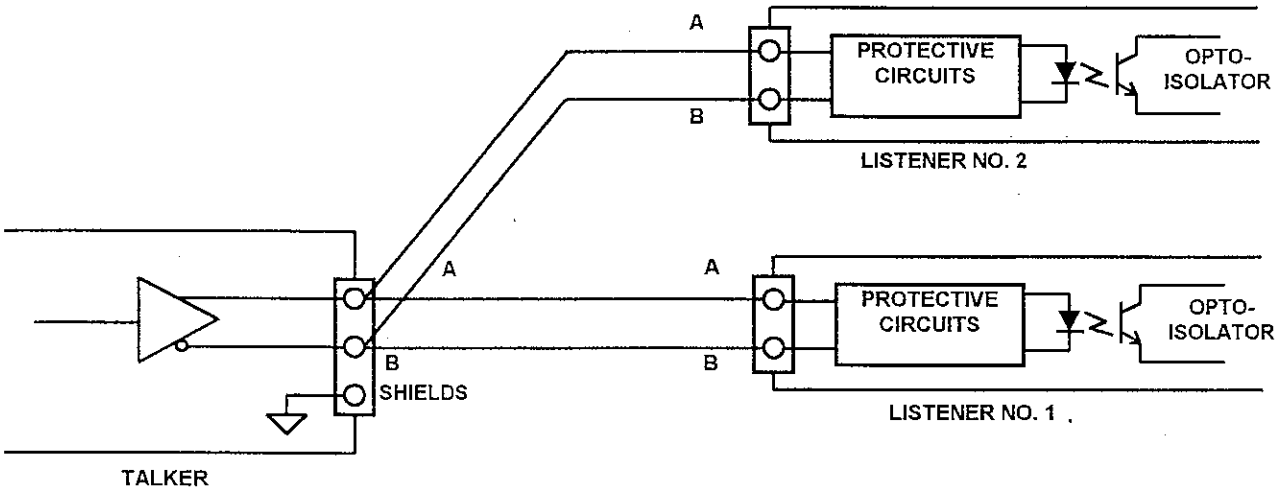


FIGURE 1

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 EIA-422 specification.

For protection against miswiring 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 (reference paragraph 1.4.1). The first bit is a start bit and is followed by data bits, least-significant-bit first as illustrated by Figure 2. The following parameters are used:

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

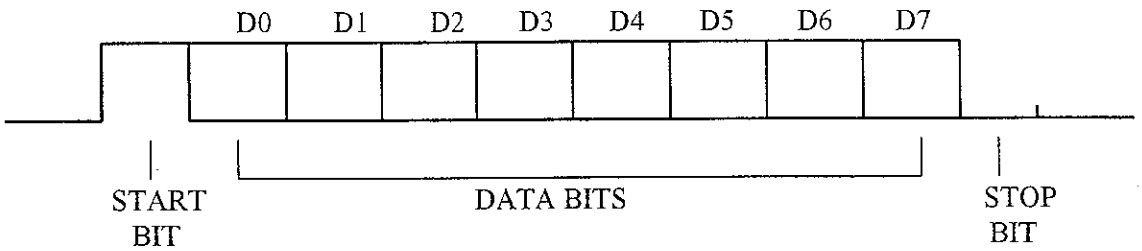


FIGURE 2

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 1). These characters are used for specific formatting purposes, such as sentence and field delimiting, and except for code delimiting shall not be used in data fields.

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 (Table 2) 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 (ASCII) that is a Reserved Character (Table 1) or not listed in Table 2 as a Valid Character (e.g., in a Proprietary Sentence or text sentence) three characters shall be used. The Reserved Character "^" (HEX 5E) is followed by two ASCII characters (0-9, A-F) representing the HEX value of the character to be communicated.

For example, to send heading as "127.5°" transmit: "127.5^F8"
to send the reserved characters <CR><LF> transmit: "^0D^0A"
to send the reserved character "^" transmit: "^5E"

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 (Table 3).

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 "$" delimiter, it serves to define the sentence. 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 6.2 (Table 4).

The Talker Identifier serves to define the nature of the data being transmitted. Devices that have the capability to transmit data from multiple sources shall transmit the appropriate Talker Identifier (e.g., a device with both a GPS receiver and a Loran-C receiver shall transmit GP when the position is GPS based, LC when the position is Loran-C, and IN for integrated navigation shall be used if lines of position from Loran-C and GPS are combined into a position fix). Devices capable of re-transmitting data from other sources shall use the appropriate identifier (e.g., 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. Section 6.2 (Table 5) and Appendix I 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 list of valid Manufacturer's Mnemonic Codes is contained in Appendix III.

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 (Table 6). 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 (Table 6), 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 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 "," delimiters, between but not including the "$" 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.

Examples of the use of checksum field are: $GPGLL,5057.970,N,00146.110,E,142451,A*27 and $GPVTG,089.0,T,,,15.2,N,,*7F

5.3 Sentences

This section describes the general structure of sentences. Details of specific sentence formats are found in Section 6.3 and Appendix I. 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, 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 "$" 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 "$" 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 Section 6.3 and Appendix I. Preferred sentences are contained in Section 6.3 and these sentences should be used wherever possible. Appendix I contains 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:

"$"	HEX 24 - 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

5.3.1.1 Approved Sentence Structure

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

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

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

5.3.2 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.

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

"$"	HEX 24 - Start of sentence
<aa>	TALKER Identifier of requester
<aa>	TALKER Identifier for device from which data is being requested
"Q"	Query character identifies Query address
","	Data field delimiter
<ccc>	Approved sentence formatter of data being requested
"*"<checksum field>	Checksum field
<CR><LF>	HEX 0D 0A - End of sentence

5.3.2.1 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.

5.3.3 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. This will generally be for one of the following reasons:

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

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

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

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

"$"	Hex 24 - Start of sentence
"P"	Hex 50 - Proprietary sentence ID
<aaa>	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.

5.3.4 Valid Sentences

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

5.3.5 Sentence Transmission Timing

Frequency of sentence transmission when specified shall be in accordance with the approved sentence definitions (Section 6.3 and Appendix I). 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.

5.3.6 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, "$" and "*" whether or not the LISTENER recognizes all fields.

6. Data Content

6.1 Character Definitions

TABLE 1 - RESERVED CHARACTERS

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

TABLE 2 - VALID CHARACTERS

	Hex	Dec		Hex	DEC		Hex	DEC
Space	20	32	@	40	64	`	60	96
Reserved			A	41	65	a	61	97
"	22	34	B	42	66	b	62	98
#	23	35	C	43	67	c	63	99
Reserved			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			J	4A	74	j	6A	106
+	2B	43	K	4B	75	k	6B	107
Reserved			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			|	7C	124
=	3D	61	]	5D	93	}	7D	125
>	3E	62	Reserved			Reserved		
?	3F	63	_	5F	95			

6.1 Character Definitions
(continued)

TABLE 3 - CHARACTER SYMBOL TABLE

A	Status symbol; Yes; Data Valid; Warning Flag Clear; Auto; Ampere
a	Alphabet character variable A through Z or a through z
B	Bars (pressure, 1000 Mb = 1 Std. Atm. = 100kPa); Bottom
C	Celsius (Degrees); Course-up
c	Valid character; Calculating
D	Degrees (of Arc)
E	Error; East; Engine
F	Fathoms
f	Feet
G	Great Circle; Green
g	Good
H	Compass Heading; Head-up; Hertz; Humidity
h	Hours; HEX number
I	Inches
J	Input operation completed
K	Kilometers; km/hour
k	Kilograms
L	Left; Local; Lost Target
l	Latitude; Liters; Liters/second
M	Meters; Meters/second; Magnetic; Manual; Cubic Meters
m	Minutes; message
N	Nautical miles; Knots; North; North-up; Newton
n	Numeral; address
P	Purple; Proprietary (only when following $); Position sensor; Percent; Pascal (pressure)
Q	Query; Target-Being-Acquired
R	Right; Rhumb line; Red; Relative; Reference; Radar Tracking; Rev/min (RPM)
S	South; Statute miles; Statute miles/hour; Shaft
s	Seconds
T	Time difference; True; Track; Tracked-Target
t	Test
U	Dead Reckoning Estimate
u	Sign, if minus "-" (HEX 2D)
V	Data invalid; No; Warning Flag Set; Manual; Volt
W	West; Water; Wheelover
x	Numeric character variable
y	Longitude
Z	Time

6.2 Field Definitions

TABLE 4 - TALKER IDENTIFIER MNEMONICS

(Address Characters 1 and 2)

TALKER DEVICE	IDENTIFIER
Heading Track Controller (Autopilot): General	AG*
Magnetic	AP
Automatic Identification System	AI
COMMUNICATIONS: Digital Selective Calling (DSC)	CD*
Data Receiver	CR
Satellite	CS*
Radio-Telephone (MF/HF)	CT*
Radio-Telephone (VHF)	CV*
Scanning Receiver	CX*
DECCA Navigator	DE
Direction Finder	DF*
Electronic Chart System (ECS)	EC
Electronic Chart Display & Information System (ECDIS)	EI
Emergency Position Indicating Beacon (EPIRB)	EP*
Engineroom Monitoring Systems	ER
GLONASS Receiver	GL
Global Navigation Satellite System (GNSS)	GN
Global Positioning System (GPS)	GP
HEADING SENSORS: Compass, Magnetic	HC*
Gyro, North Seeking	HE*
Gyro, Non-North Seeking	HN
Integrated Instrumentation	II
Integrated Navigation	IN
Loran C	LC
Proprietary Code	P
Radar and/or Radar Plotting	RA*
Sounder, depth	SD*
Electronic Positioning System, other/general	SN
Sounder, scanning	SS
Turn Rate Indicator	TI*
VELOCITY SENSORS: Doppler, other/general	VD*
Speed Log, Water, Magnetic	VM
Speed Log, Water, Mechanical	VW
Voyage Data Recorder	VR
Transducer	YX
TIMEKEEPERS, TIME/DATE: Atomic Clock	ZA
Chronometer	ZC
Quartz	ZQ
Radio Update	ZV
Weather Instruments	WI

*Designated by IEC for use with IMO maritime electronic devices. This is the minimum requirement for equipment that is required by IMO in the SOLAS Convention (1974, as amended).

6.2 Field Definitions

TABLE 5 - APPROVED SENTENCE FORMATTERS

*Designated by IEC for use with IMO maritime electronic devices as required by IMO in the SOLAS convention (1974 as amended).

6.2 Field Definitions

TABLE 6 - FIELD TYPE SUMMARY

Field Type	Symbol	Definition
Special Format Fields:		
Status	A	Single character field: A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set
Latitude	llll.ll	Fixed/Variable length field: 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", "yyyyy.yy"

6.2 Field Definitions

TABLE 6 FIELD TYPE SUMMARY
(continued)

Field Type	Symbol	Definition
Numeric Value Fields:		
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required. (example: 73.10 = 73.1 = 073.1 = 73)
Fixed HEX field	hh___	Fixed length HEX numbers only, MSB on the left
Information Fields:		
Variable text	c--c	Variable length valid character field.
Fixed alpha field	aa___	Fixed length field of upper-case or lower-case alpha characters
Fixed number field	xx___	Fixed length field of numeric characters
Fixed text field	cc___	Fixed length field of valid characters

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 value is positive.

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

6.3 Approved Sentences

General format of printed sentence information:

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

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

*Designated by IEC for use with IMO maritime electronic devices as required by IMO in the SOLAS convention (1974 as amended).

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

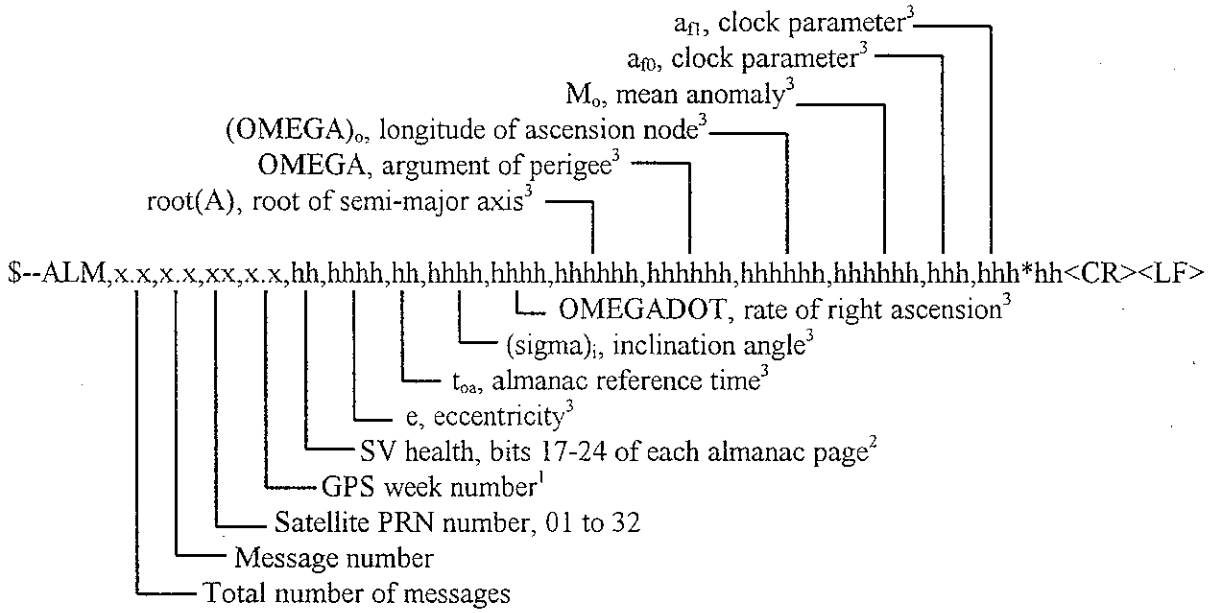
ACK – Acknowledge Alarm

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

$--ACK,xxx*hh<CR><LF>
Local alarm number (identifier)

ALM - GPS Almanac Data

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

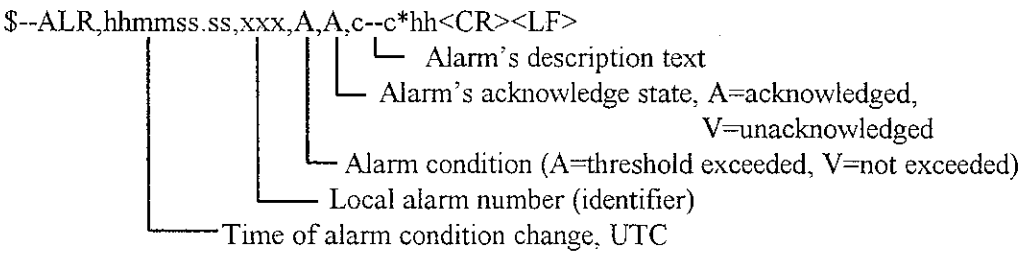


Notes: (Reference ICD-GPS-200, Rev. B)

1) Variable length integer, 4-digits maximum. Almanac reference week number beginning first week of January, 1980. The 8 least significant bits are from Page 25, Subframe 5, Word 3, bits 17 to 24. The most significant bits are provided by the GPS equipment.
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.

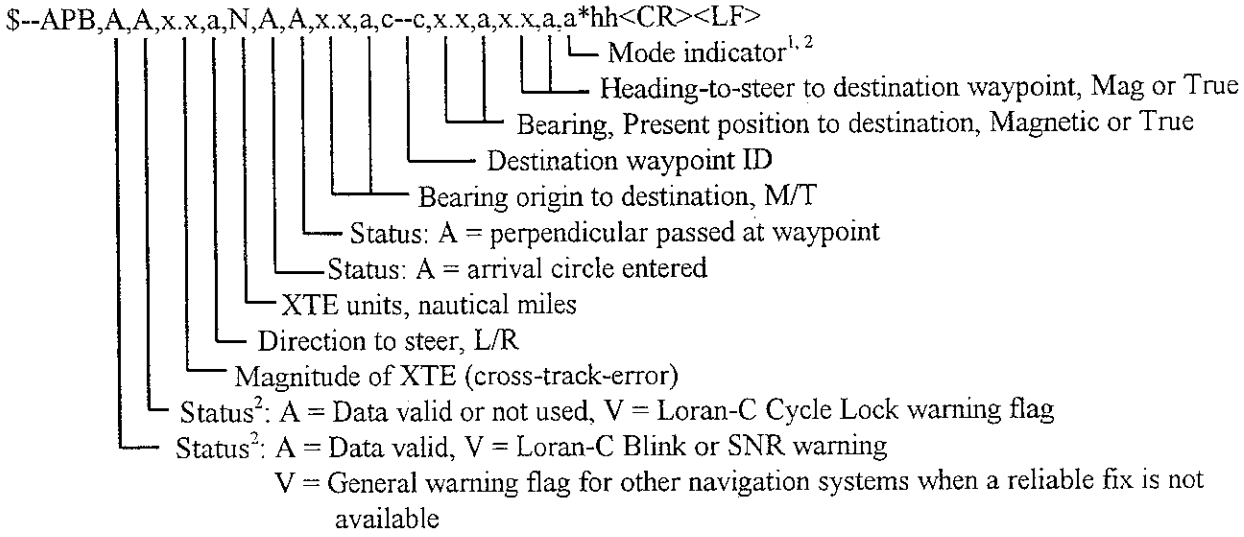
ALR – Set Alarm State

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



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.



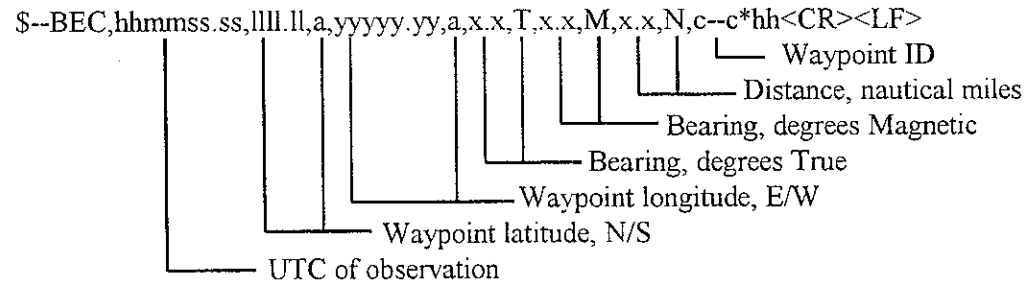
Notes:

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

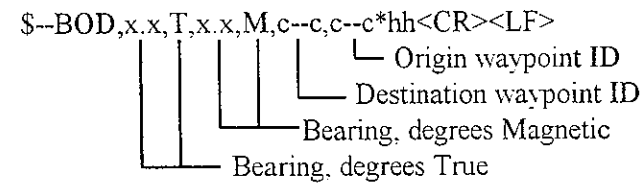
BEC - Bearing & Distance to Waypoint - Dead Reckoning

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



BOD - Bearing - Origin to Destination

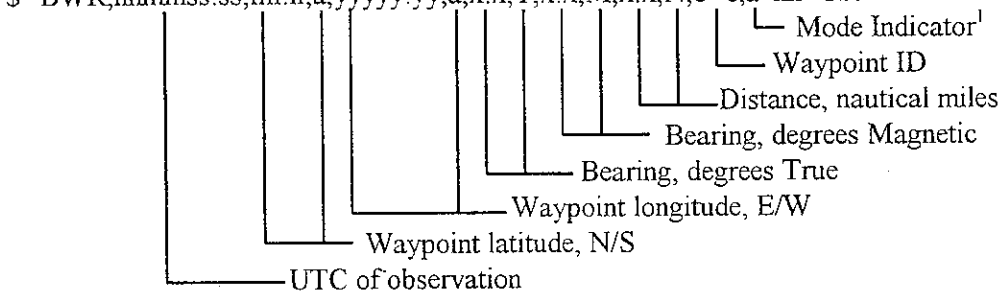
Bearing angle of the line, calculated at the origin waypoint, extending to the destination waypoint from the origin waypoint for the active navigation leg of the journey.



BWC - Bearing & Distance to Waypoint
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>



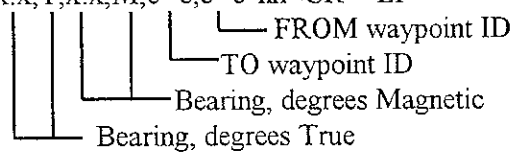
Notes:
1) Positioning system Mode Indicator: A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

The positioning system Mode Indicator 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.

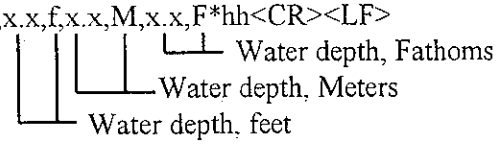
$--BWW,x.x,T,x.x,M,c--c,c--c*hh<CR><LF>



DBT - Depth Below Transducer

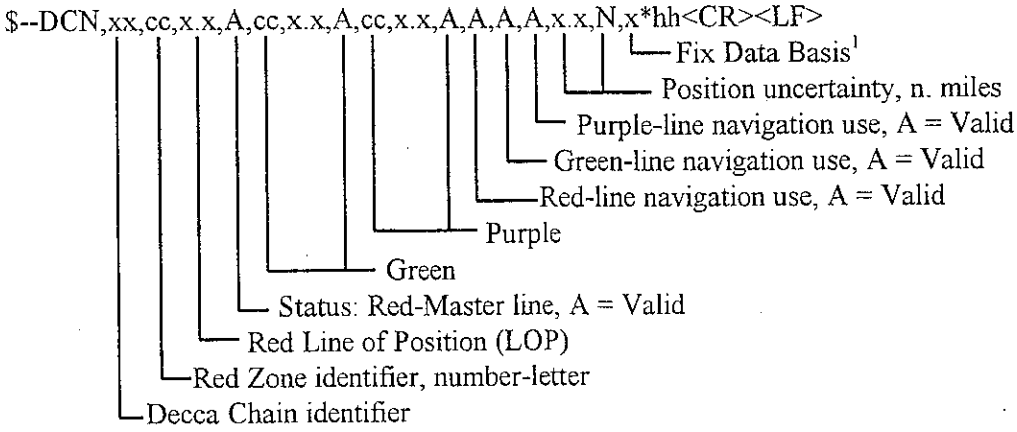
Water depth referenced to the transducer.

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



DCN - Decca Position

Status and lines-of-position for a specified Decca chain.

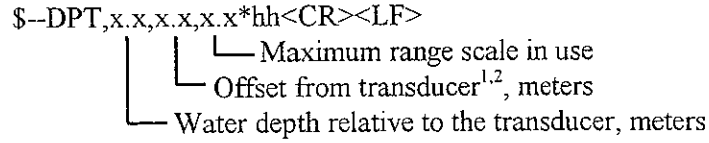


Notes:

1) Fix Data Basis: 1 = Normal pattern
2 = Lane identification pattern
3 = Lane identification transmissions

*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.



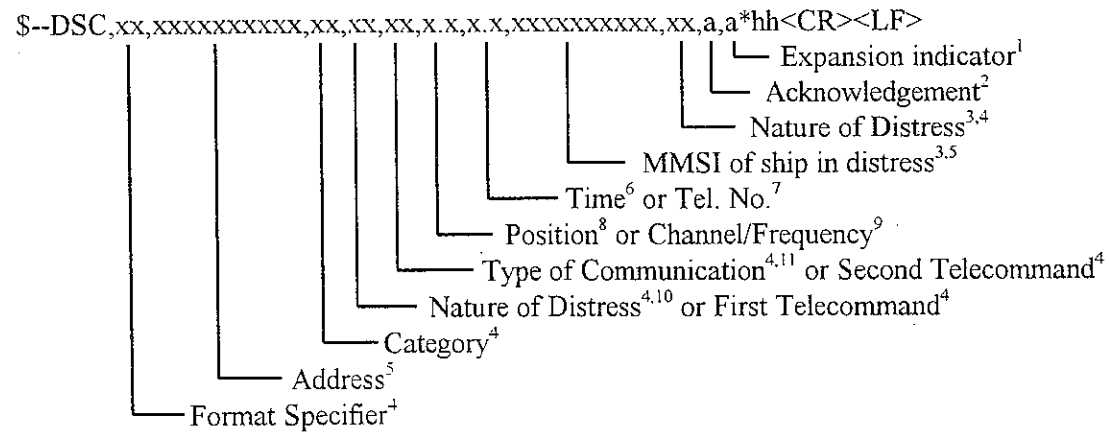
Notes:

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).



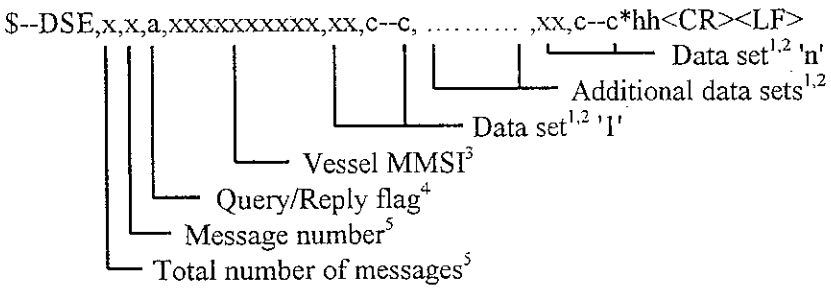
Notes:

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

2) Acknowledgement type: R = Acknowledge Request
B = Acknowledgement
S = Neither (end of sequence)
3) For Distress Acknowledgement, Distress Relay and Distress Relay Acknowledgement calls only, null otherwise
4) Use two least-significant digits of symbol codes in ITU-R M.493 Table 3
5) Maritime Mobile Service Identifier (MMSI) for the station to be called or the MMSI of the calling station in a received call. For a nine-digit MMSI "0" 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.
6) Time (UTC) of position, four digits, hhmm (hours and minutes)
7) Telephone number, 16 digits maximum, odd/even information to be inserted by the DSC equipment
8) Latitude/longitude, degrees and minutes, 10 digits, coded in accordance with ITU-R M.493 paragraph 8.1.2
9) Frequency or channel, six or twelve digits, coded in accordance with ITU-R M.493 Table 13.
10) Distress calls only
11) Distress, Distress Acknowledgment, Distress Relay, and Distress Relay Acknowledgment calls only.

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).

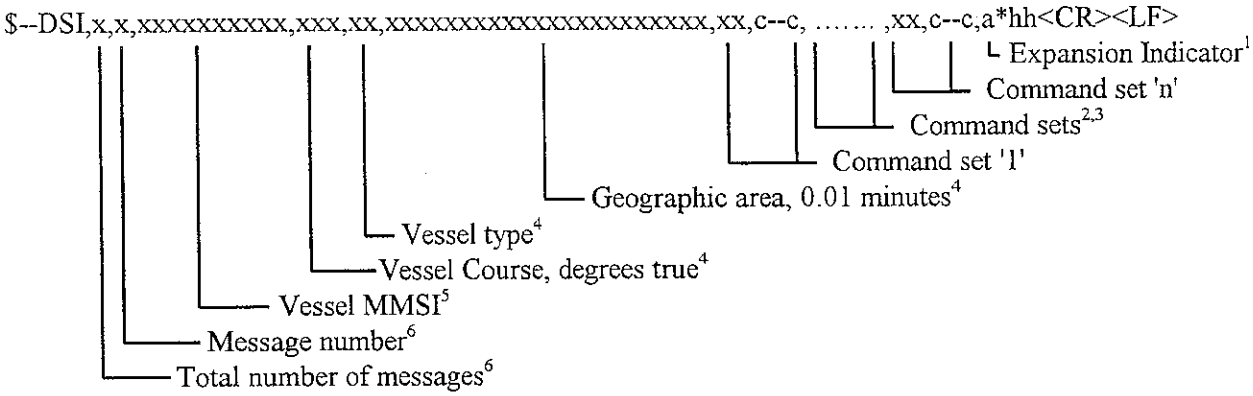


Notes:
1) Data sets consist of two fields. The first field is the code field: the two least significant digits of symbol codes in ITU-R 821 Table 1. The second field is the data field: the additional information required by ITU-R M.821, null otherwise. The digits appearing in these fields are the data 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.
2) 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.
3) Identical to the address field in the associated $--DSC, $--DSI or $--DSR sentence
4) "Q" = Query. A device is requesting expanded data. Code fields filled as desired, all data fields null
"R" = Reply. A device is responding with selected expanded data, in response to a query,
"A" = Automatic. A device is transmitting data automatically, not in response to a query request.

5) The number of Data Sets may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

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).

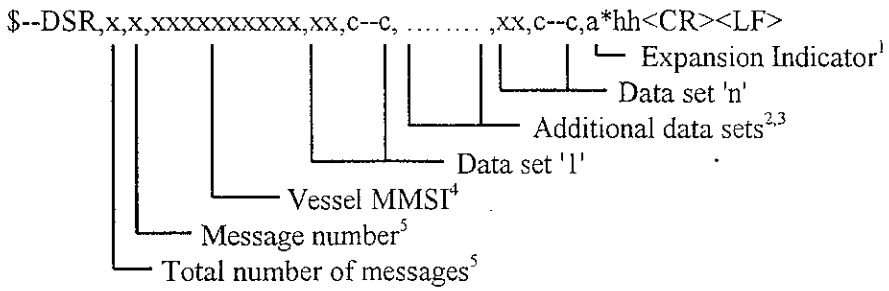


Notes:

1) 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.
2) 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.
3) 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.
4) 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.
5) 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
6) The number of Command Sets may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

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).

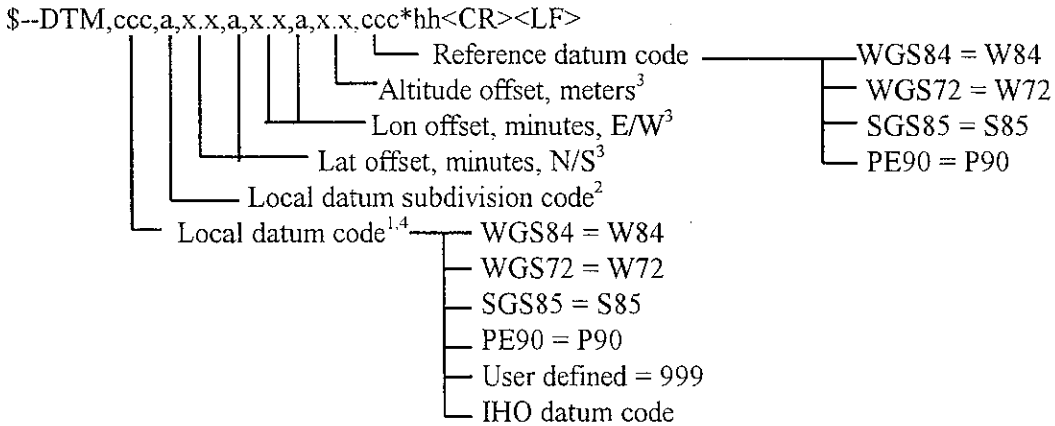


Notes:

1) 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.
2) 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.
3) 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.
4) Maritime Mobile Service Identifier (MMSI) of the station responding. For a nine-digit MMSI "0" shall be added as the tenth digit.
5) The number of Data Sets may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

*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) which 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.

*FSI - Frequency Set Information

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

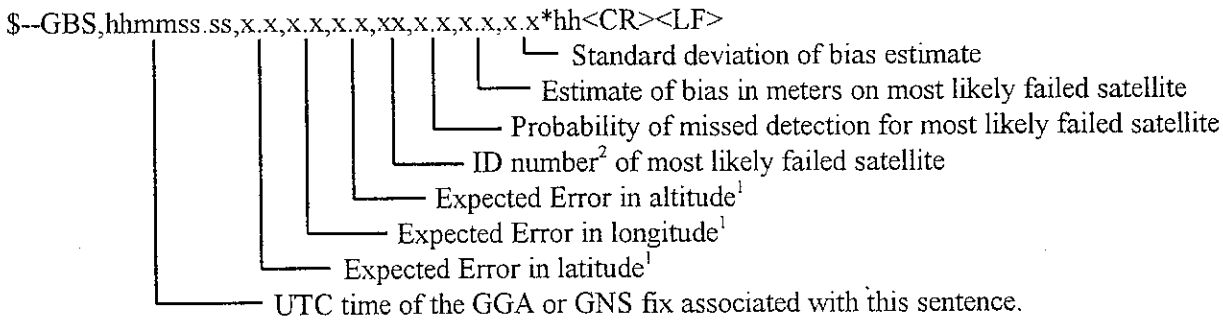
```
$--FSI,xxxxxx,xxxxxx,c,x*hh<CR><LF>
       |      |     |  |
       |      |     |  └── Power level ──── 0 = Standby
       |      |     └───── Mode of operation[1]  1 = lowest
       |      └─────────── Receiving frequency[2,3]  9 = highest
       └────────────────── Transmitting frequency[2,3]
```

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.

GBS - GNSS Satellite Fault Detection

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

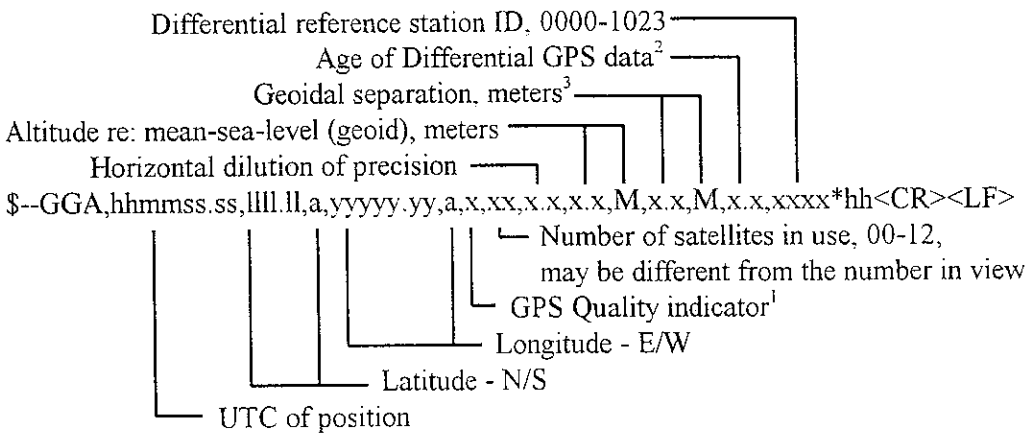


Notes:

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 WAAS system has reserved numbers 33-64 to identify its satellites.
   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.

GGA - Global Positioning System Fix Data

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



Notes:

1) GPS Quality Indicator:
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

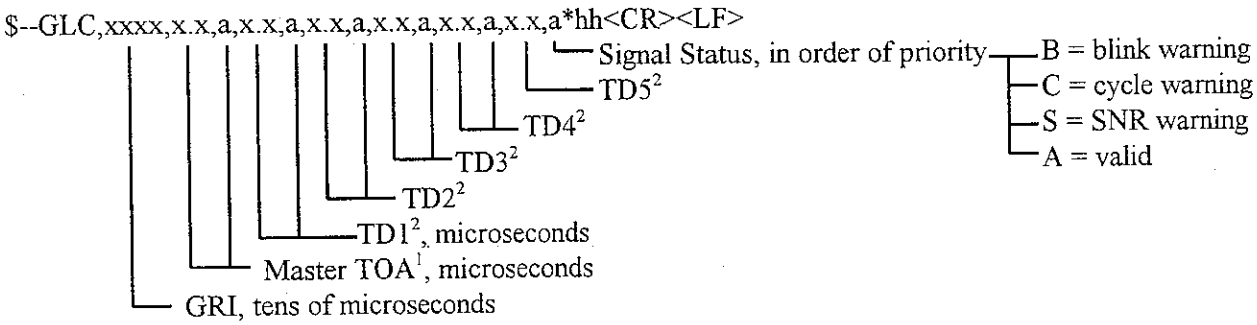
The GPS Quality Indicator field shall not be a null field.

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

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.



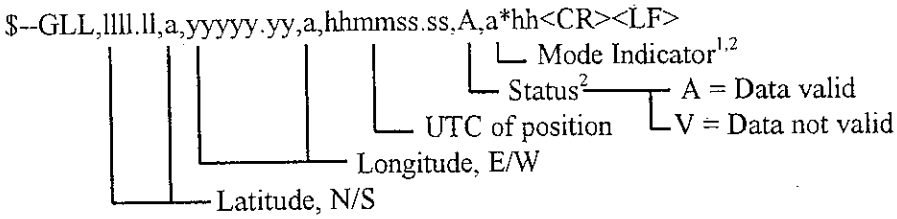
Notes:

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

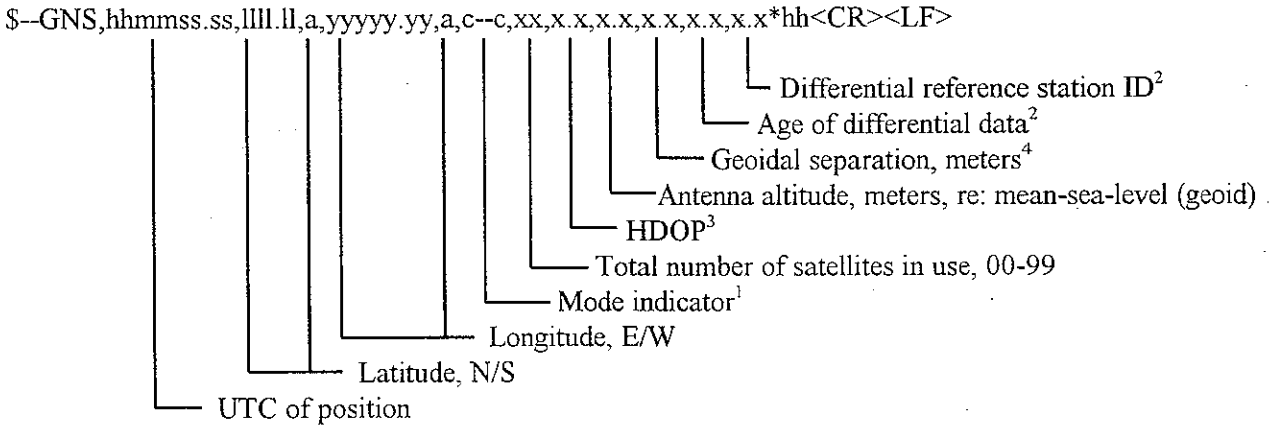
2) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to V = Invalid for all values of Indicator mode except for A= Autonomous and D = Differential. The positioning system Mode Indicator and Status fields shall not be null fields.

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, GN for GNSS combined systems, as well as future identifiers. Some fields may be null fields for certain applications, as described below.

If a GNSS receiver is capable simultaneously of producing a position using combined satellite systems, as well as a position using only one of the satellite systems, then separate $GPGNS, $GLGNS, etc. messages 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 two characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites. If another satellite system is added to the standard, the mode indicator will be extended to three characters, new satellite systems shall always be added on the right, so the order of characters in the Mode Indicator is: GPS, GLONASS, other satellite systems in the future. The characters shall take one of the following values:

   N = No fix. Satellite system not used in position fix, or fix not valid
   A = Autonomous. Satellite system used in non-differential mode in position fix
   D = Differential. Satellite system used in differential mode in position fix
   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
   R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers
   F = Float RTK. Satellite system used in real time kinematic mode with floating integers
   E = Estimated (dead reckoning) Mode
   M = Manual Input Mode
   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 messages with talker IDs of GP, GL, 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 message with the same time tag. The "Number of satellites" field may be used in these following messages to denote the number of satellites used from that satellite system.

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

$GNGNS,122310.2,3722.425671,N,12258.856215,W,DA,14,0.9,1005.543,6.5,5.2,23*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, and any future satellites) used in computing the solution reported in each GNS sentence.

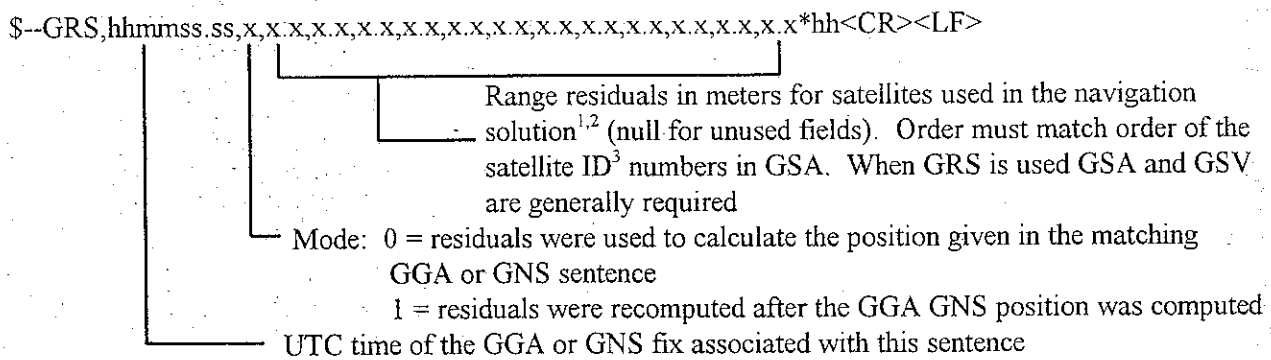
4) Geoidal Separation: the difference between the earth ellipsoid and mean-sea-level (geoid) defined by the reference datum used in the position solution, "-" = mean-sea-level below ellipsoid. The reference datum may be specified in the DTM sentence.

GRS - GNSS Range Residuals

This message 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 message. 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 messages to be sent.

If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the range residuals pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the position solution multiple GRS messages are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GRS messages 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.



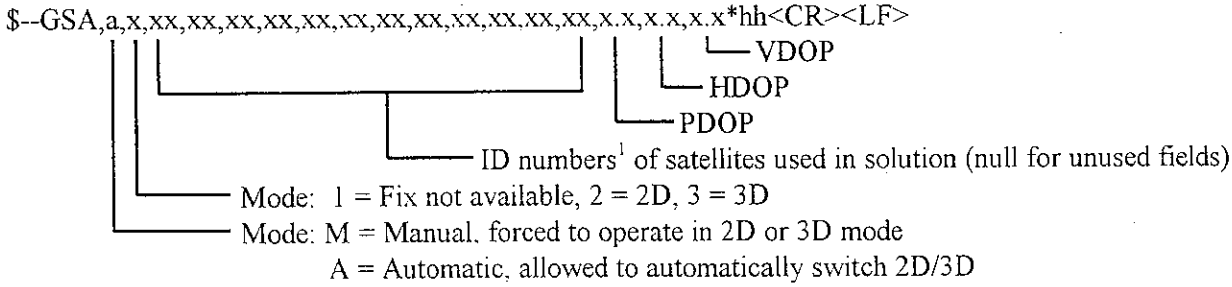
Notes:

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 messages are being sent then their order of transmission must match the order of corresponding GSA messages. Listeners shall keep track of pairs of GSA and GRS sentences and discard data if pairs are incomplete.

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, 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, etc. are combined to obtain the reported position solution multiple GSA messages are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GSA messages 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.



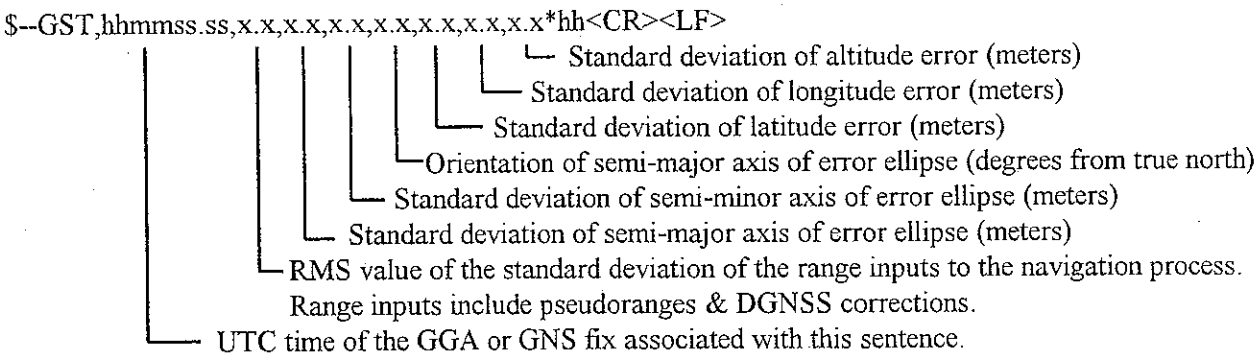
Notes:

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 WAAS system has reserved numbers 33-64 to identify its satellites.
   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.

GST - GNSS Pseudorange Error Statistics

This message 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.

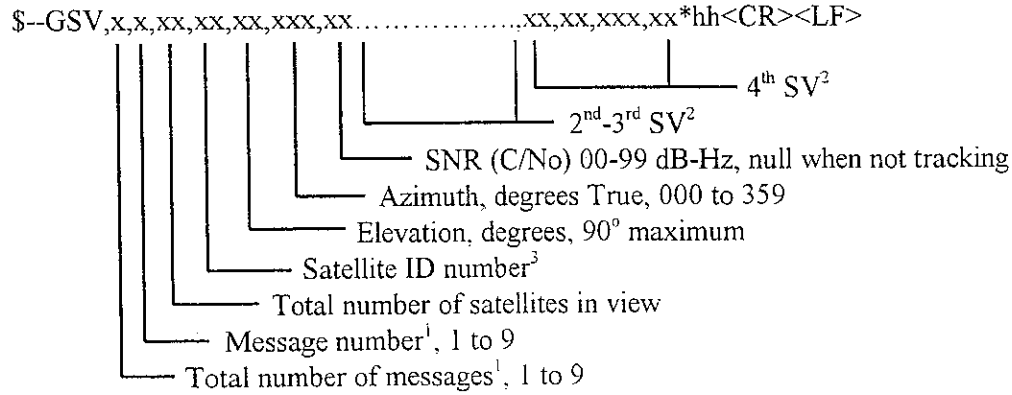
If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the error data pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution the talker ID is GN and the errors pertain to the combined solution.



GSV - GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission, additional satellite data sent in second or third message. Total number of messages being transmitted and the number of the message being transmitted are indicated in the first two fields.

If multiple GPS, GLONASS, 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, etc. The GN identifier shall not be used with this sentence.



Notes:

1) Satellite information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value 1. The second field identifies the order of this message (message number), minimum value 1.
2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per message. 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 WAAS system has reserved numbers 33-64 to identify its satellites.
   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.

*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.

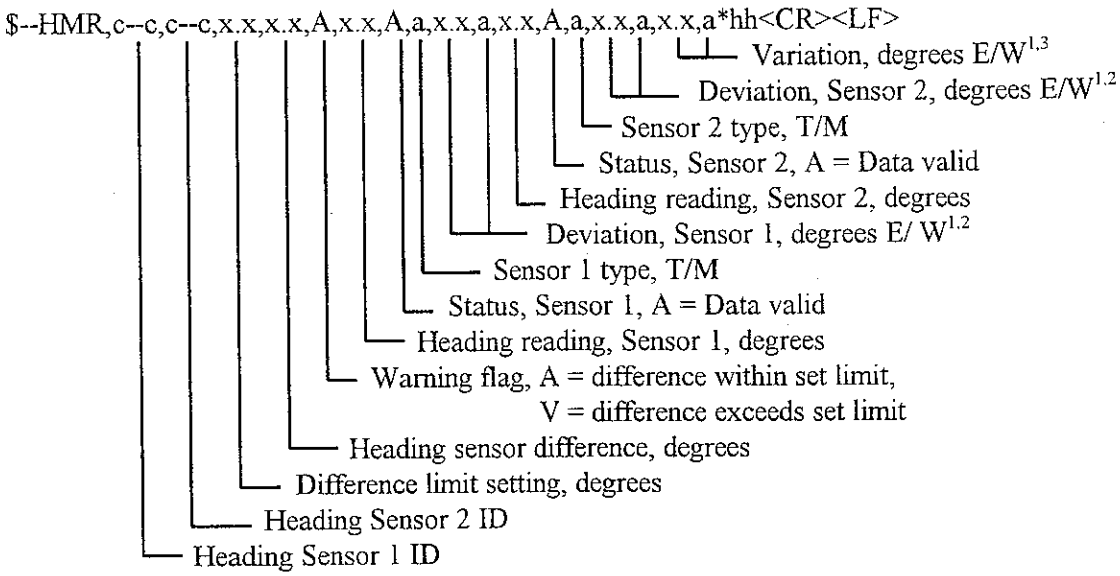
*HDT - Heading, True

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
```

*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.

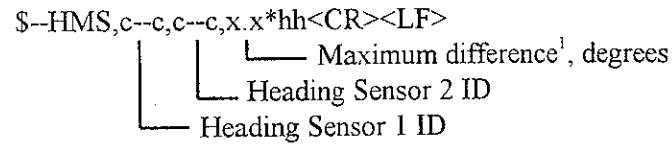


Notes:

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.

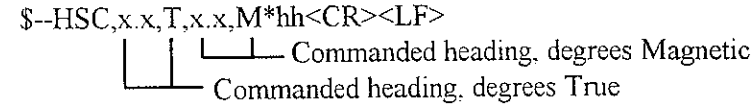


Notes:

1) Maximum allowed difference between sensors.

HSC - Heading Steering

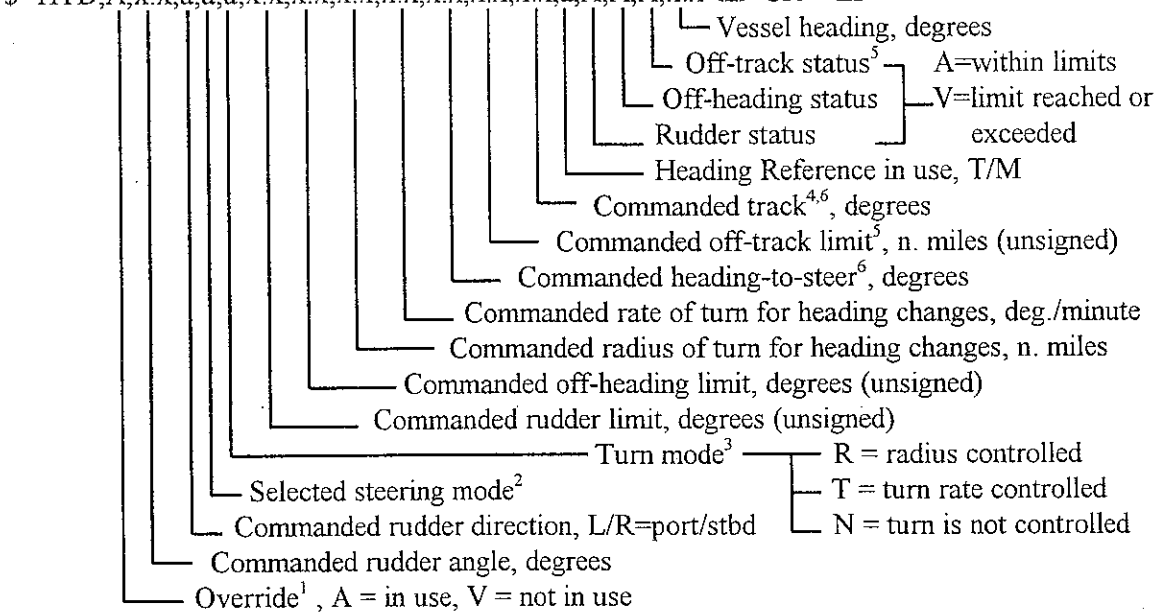
Commanded heading to steer vessel.



*HTC - Heading/Track Control Command
*HTD - Heading/Track Control Data

Commands to, and data from, heading control systems. 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.

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



Notes:

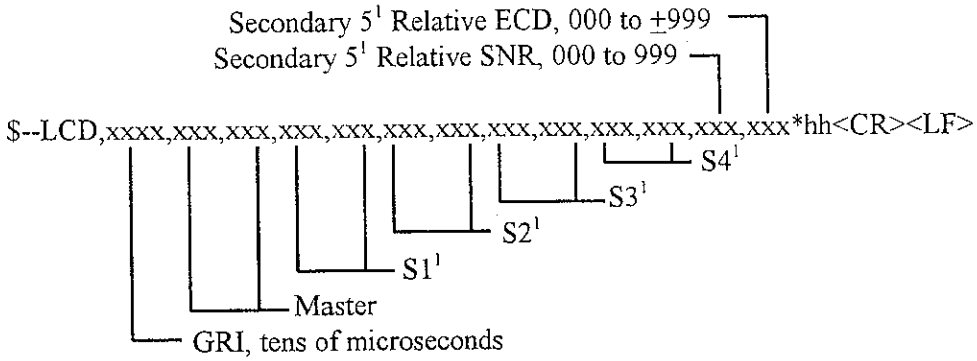
1. Override provides direct control of the steering gear. In the context of this sentence override means a temporary interruption of the selected steering mode. In this period steering is performed by special devices. As long as field "Override" is set to "A" both fields "Selected steering mode" and "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.

LCD - Loran-C Signal Data

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

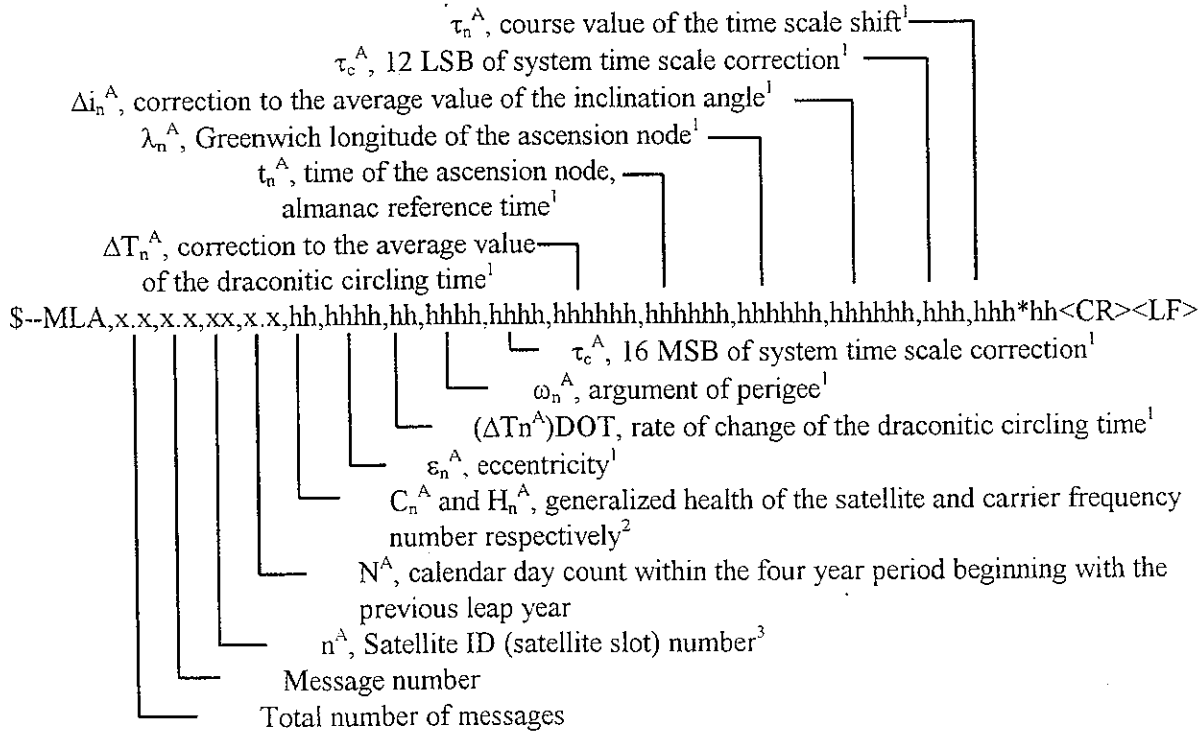


Notes:

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

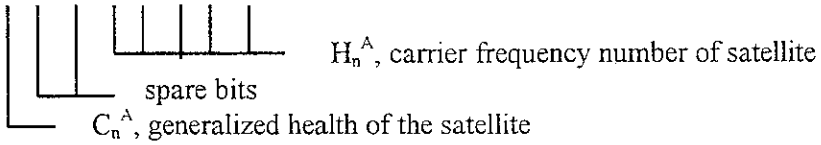
MLA - GLONASS Almanac Data

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



Notes: (Reference GLONASS Interface Control Document, 1995)

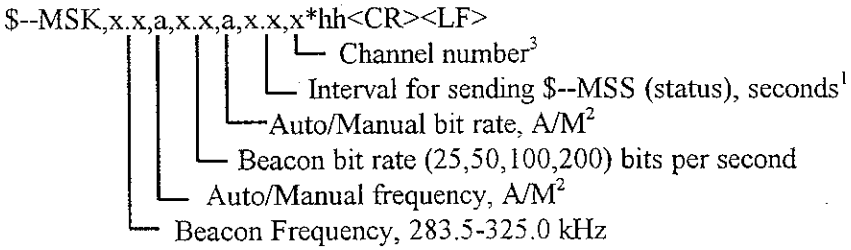
1) Section 4.5, Table 4.3. The least significant bits (LSB, low bits) of the HEX data field corresponds to the LSB of the word indicated in Table 4.3. If the number of available bits in the HEX field is greater than is necessary to represent the word in Table 4.3, then the most significant Bits (MSB, 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 message to a radiobeacon MSK receiver (beacon receiver) or reply from an MSK receiver to a query sentence.

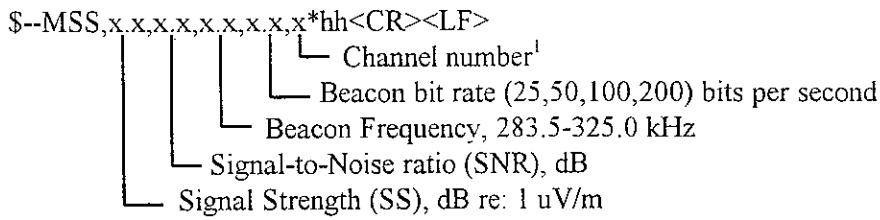


Notes:

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 receivers

MSS - MSK Receiver Signal

Signal-to-Noise ratio, signal strength, frequency and bit rate from a MSK (Beacon) receiver.



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. See S Section 7. Applications.

MTW - Water Temperature

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

MWD - Wind Direction & Speed

The direction from which the wind blows, 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>
- x.x: Wind speed, meters/second
- x.x: Wind speed, knots
- x.x: Wind direction, 0 to 359 degrees Magnetic
- x.x: Wind direction, 0 to 359 degrees True

MWV - Wind Speed and Angle

When the Reference Field is set to Relative, data is provided giving the wind angle in relation to the vessel's heading and wind speed, both relative to the (moving) vessel.

When the Reference Field is set to True, data is provided giving the wind angle relative to the vessel's heading and wind speed, both with reference to the (moving) water. True wind is the vector sum of the Relative (Apparent) wind vector and the vessel's velocity vector 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.

$--MWV,x.x,a,x.x,a,A*hh<CR><LF>
- A: Status, A = Data Valid
- a: Wind speed units, K/M/N
- x.x: Wind speed
- a: Reference, R = Relative, T = True
- x.x: Wind angle, 0 to 359 degrees

*OSD - Own Ship Data

Heading, course, speed, set and drift summary. Useful for, but not limited to radar and radar plotting applications.

$--OSD,x.x,A,x.x,a,x.x,a,x.x,x.x,a*hh<CR><LF>
- a: Speed units, K/N/S
- x.x: Vessel drift (speed) — Manually entered
- x.x: Vessel set, degrees True — Manually entered
- a: Speed reference, B/M/W/R/P[1]
- x.x: Vessel speed
- a: Course Reference, B/M/W/R/P[1]
- x.x: Vessel Course, degrees True
- A: Heading Status: A = Data valid, V = Data invalid
- x.x: Heading, degrees True

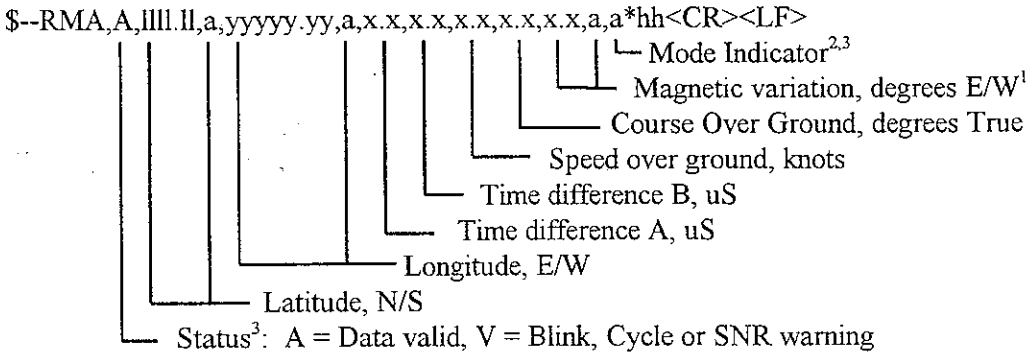
Notes:

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

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:

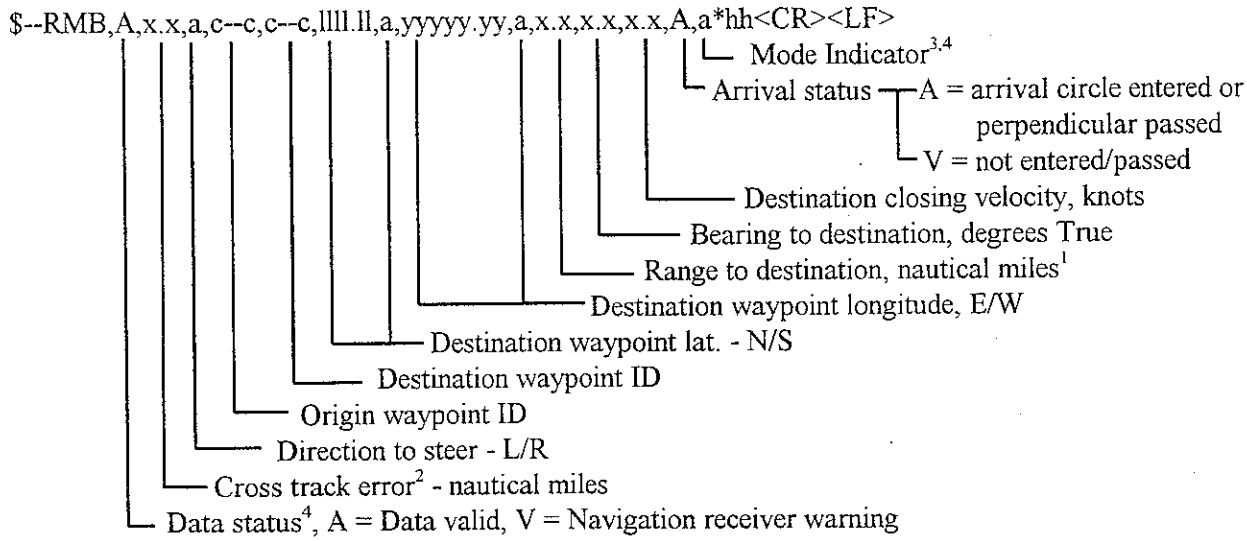
1) Easterly variation (E) subtracts from True course
Westerly variation (W) adds to True course

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

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

RMB - Recommended Minimum Navigation Information

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

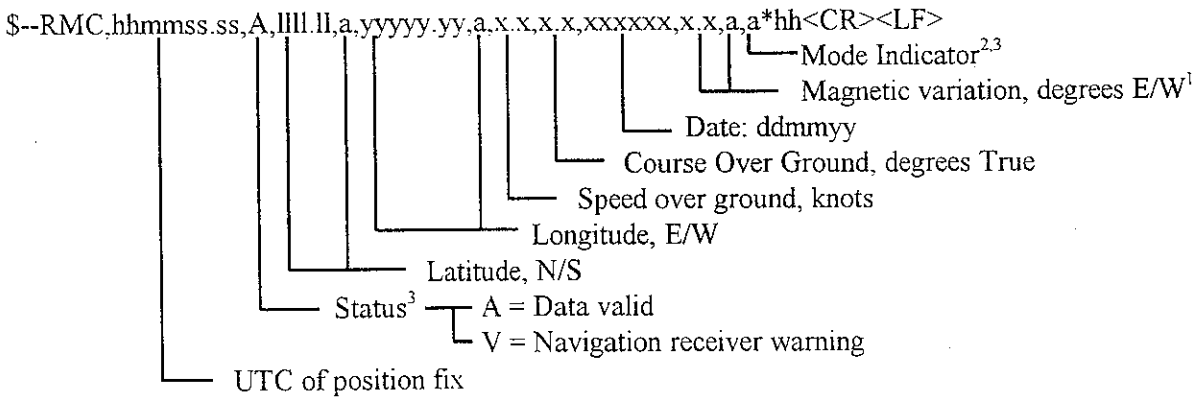


Notes:

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

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) Easterly variation (E) subtracts from True course
   Westerly variation (W) adds to True course
2) Positioning system Mode Indicator:
   A = Autonomous mode
   D = Differential mode
   E = Estimated (dead reckoning) mode
   M = Manual input mode
   S = Simulator mode
   N = Data not valid
3) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to V = Invalid for all values of Indicator mode except for A= Autonomous and D = Differential. The positioning system Mode Indicator and Status fields shall not be null fields.

*ROT - Rate Of Turn

Rate of turn and direction of turn.

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

- Rate of turn, degrees/minute, "-" = bow turns to port
- Status
  - A = Data valid
  - V = Data invalid

*RPM - Revolutions

Shaft or engine revolution rate and propeller pitch.

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

- Source, shaft/engine S/E
- Engine or shaft number, numbered from centerline
  - 0 = single or on centerline
  - odd = starboard
  - even = port
- Speed, rev/min, "-" = counter-clockwise
- Propeller pitch, % of max., "-" = astern
- Status:
  - A = Data valid
  - V = Data invalid

*RSA - Rudder Sensor Angle

Relative rudder angle, from rudder angle sensor.

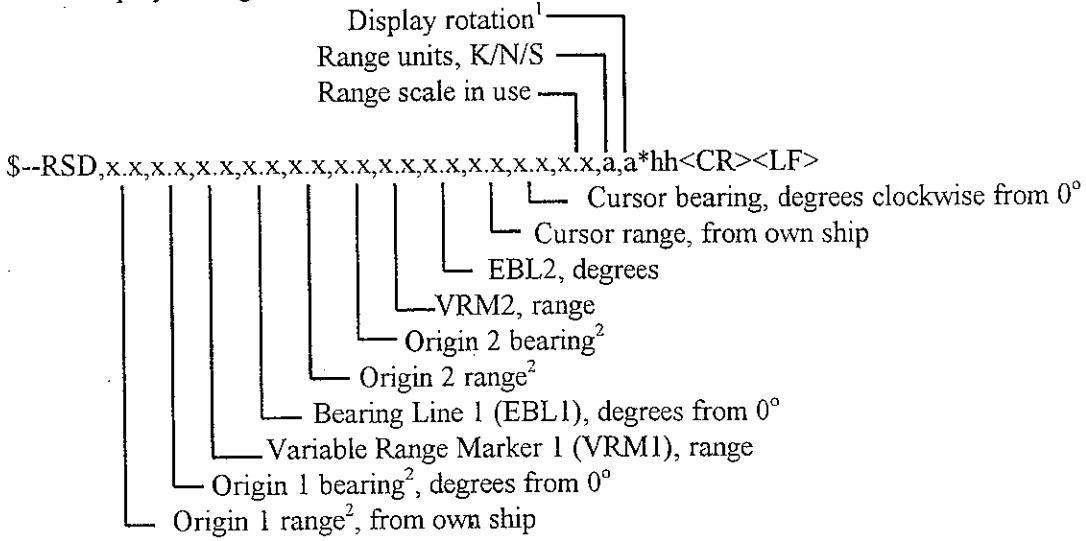
$--RSA,x.x,A,x.x,A*hh<CR><LF>

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

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

*RSD - Radar System Data

Radar display setting data.

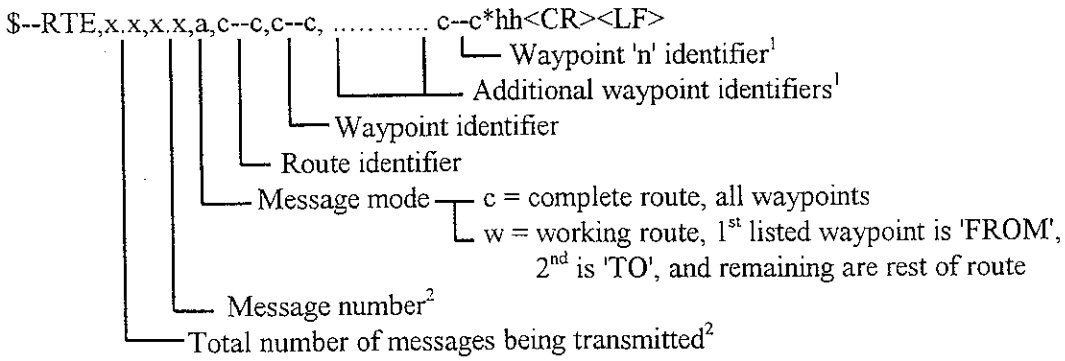


Notes:

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.

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.



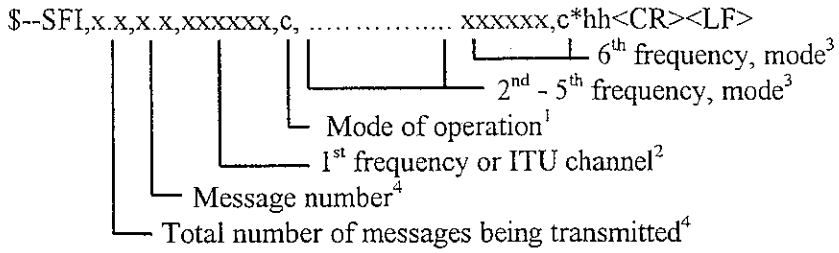
Notes:

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 messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

*SFI - Scanning Frequency Information

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

Note:
For DSC distress and safety watchkeeping 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) Mode of operation:

d = F3E/G3E simplex, telephone	x = A1A Morse, tape recorder
e = F3E/G3E duplex, telephone	{ = A1A Morse, Morse key/head set
m = J3E, telephone	| = F1C/F2C/F3C, FAX-machine
o = H3E, telephone	null for no information

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

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) A variable number of frequency-mode pair fields are allowed up to a maximum of six pairs. Null fields are not required for unused pairs when less than six pairs are transmitted.

4) Scanning frequency information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value = 1. The second field identifies the order of this message (message number), minimum value = 1.

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 depthsounding 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

TLB - Target Label

Common target labels for tracked targets. This sentence is used to specify labels for tracked targets to a device that provides tracked target data (e.g., via the TTM – Tracked Target Message). This will allow all devices displaying tracked target data to use a common set of labels (e.g., targets reported by two radars and displayed on an ECDIS).

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

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

Notes:

1. This message allows several target number/labels pairs to be sent in a single message, the maximum sentence length limits the number of labels allowed in a message.
2. Null fields indicate that no common label is specified, not that a null label should be used. The intent is to use a null field as a placeholder. A device that provides tracked target data should use its "local" label (usually the target number) unless it has received a TLB message specifying a common label.

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*h <CR><LF>

- R = Reference target[2], null otherwise
- Target status[1]
- UTC of data
- Target name
- Target longitude, E/W
- Target latitude, N/S
- Target number, 00 to 99

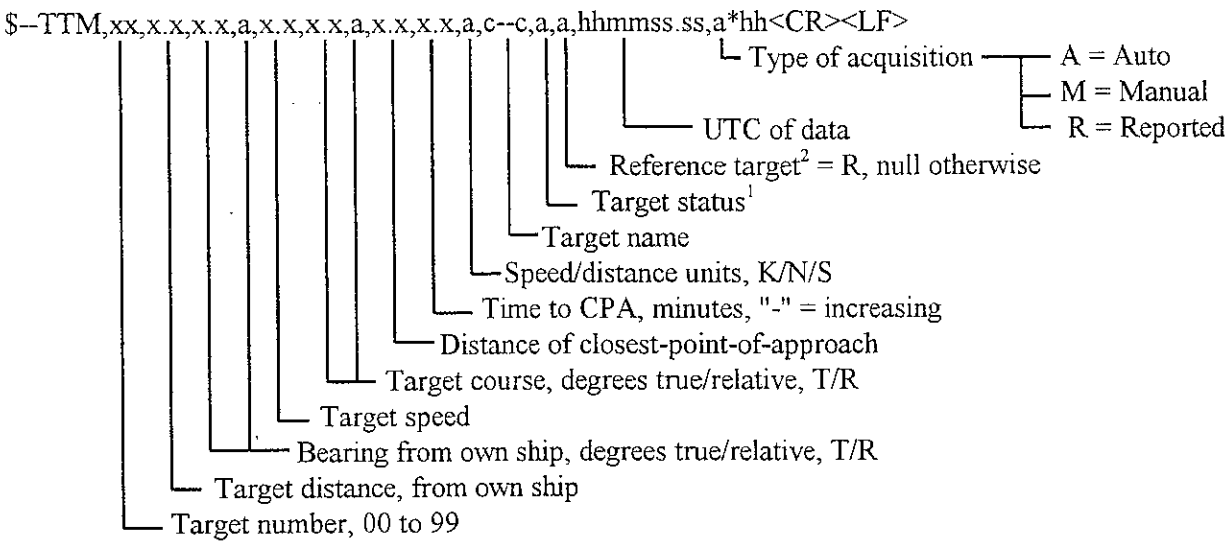
Notes

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.

*TTM - Tracked Target Message

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

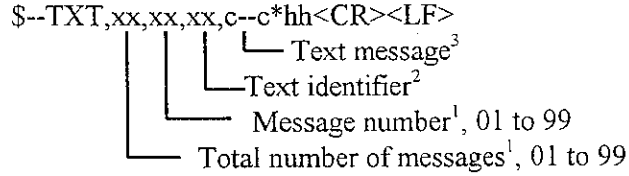


Notes:

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.

TXT - Text Transmission

For the transmission of short text messages, longer text messages may be transmitted by using multiple sentences.



Notes:

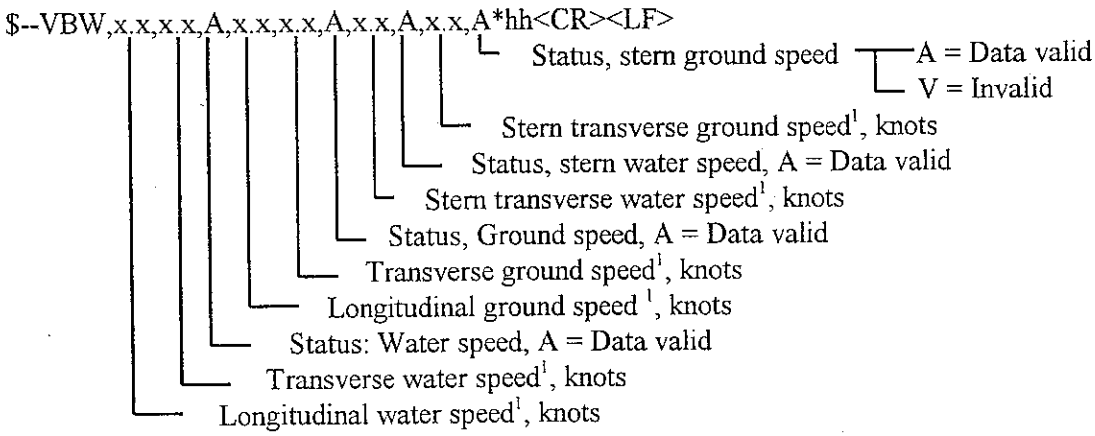
1) Text messages may consist of the transmission of multiple messages. The first field specifies the total number of messages, minimum value 1. The second field identifies the order of this message (message number), minimum value 1.
2) The text identifier is a number, 01 to 99, used to identify different text messages.
3) ASCII characters, and code delimiters if needed, up to the maximum permitted sentence length (i.e., up to 61 characters including any code delimiters).

Example: A GPS receiver sends a text alarm message (message ID 25, DR MODE - ANTENNA FAULT!) upon reverting to dead-reckoning mode due to an antenna fault.

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

*VBW - Dual Ground/Water Speed

Water referenced and ground referenced speed data.

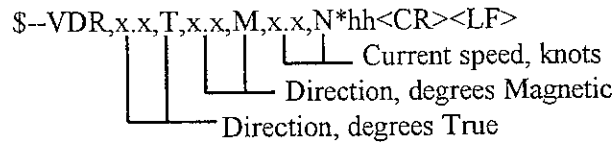


Notes:

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

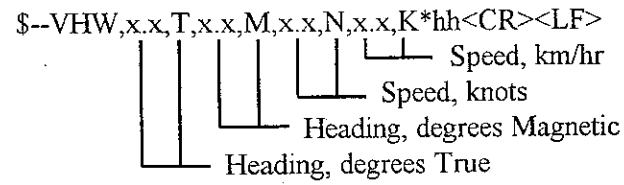
VDR - Set and Drift

The direction towards which a current flows (Set) and speed (Drift) of a current.



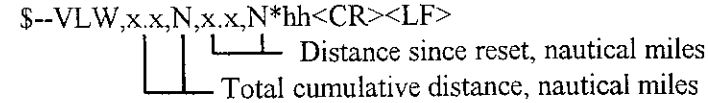
VHW - Water Speed and Heading

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



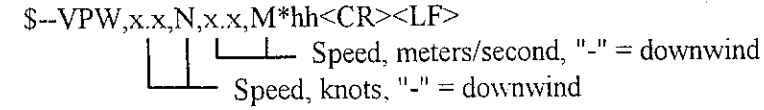
VLW - Distance Traveled through the Water

The distance traveled, relative to the water.



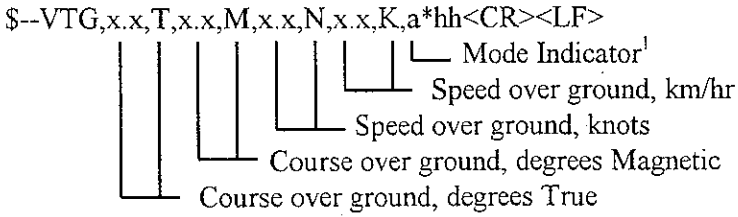
VPW - Speed - Measured Parallel to Wind

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".



VTG - Course Over Ground and Ground Speed

The actual course and speed relative to the ground.



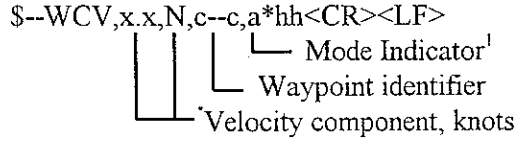
Notes:

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

The positioning system Mode Indicator field shall not be a null field.

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".



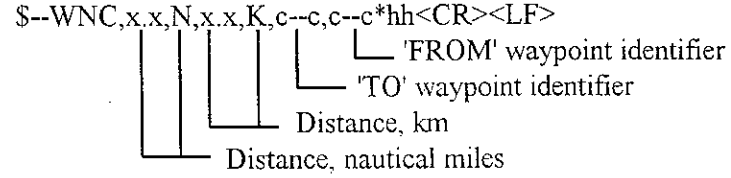
Notes:

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

The positioning system Mode Indicator field shall not be a null field.

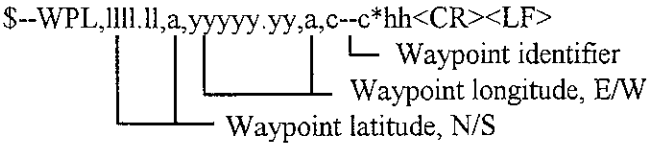
WNC - Distance - Waypoint to Waypoint

Distance between two specified waypoints.



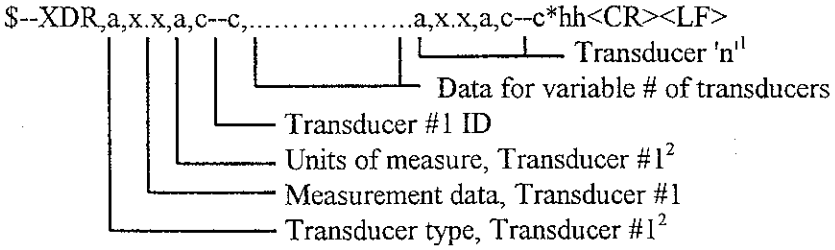
WPL - Waypoint Location

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:

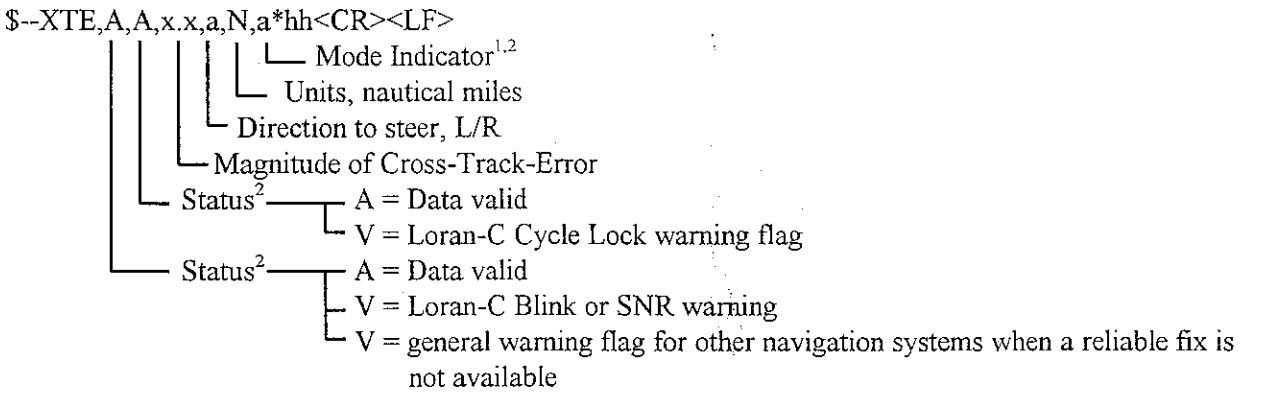
1) Sets of the four fields 'Type-Data-Units-ID' are allowed for an undefined number of transducers. Up to 'n' transducers may be included within the limits of allowed sentence length, null fields are not required except where portions of the 'Type-Data-Units-ID' combination are not available.

2) Allowed transducer types and their units of measure are:

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

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.



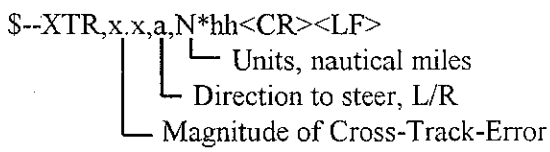
Notes:

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

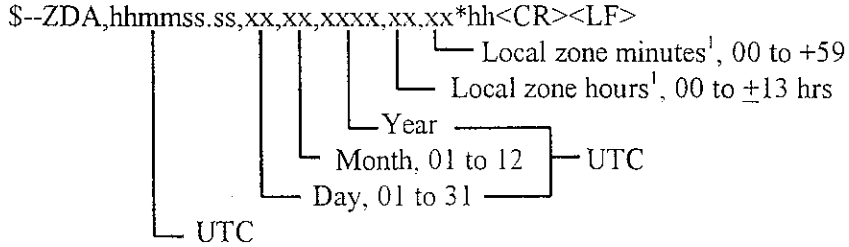
XTR - Cross-Track Error - Dead Reckoning

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.

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 and Distance to Variable Point

Time and distance to a point that may 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.)

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

- Time to point, 00 to 99 hours, minutes/seconds
- Distance to point, nautical miles
- Type of point
  - C = Collision
  - T = Turning point
  - R = Reference (general)
  - W = Wheelover

ZFO - UTC & Time from Origin Waypoint

UTC and elapsed time from origin waypoint.

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

- UTC of observation
- Elapsed time, hh = 00 to 99
- Origin waypoint ID

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>

- UTC of observation
- Time-to-go, hh = 00 to 99
- Destination waypoint ID

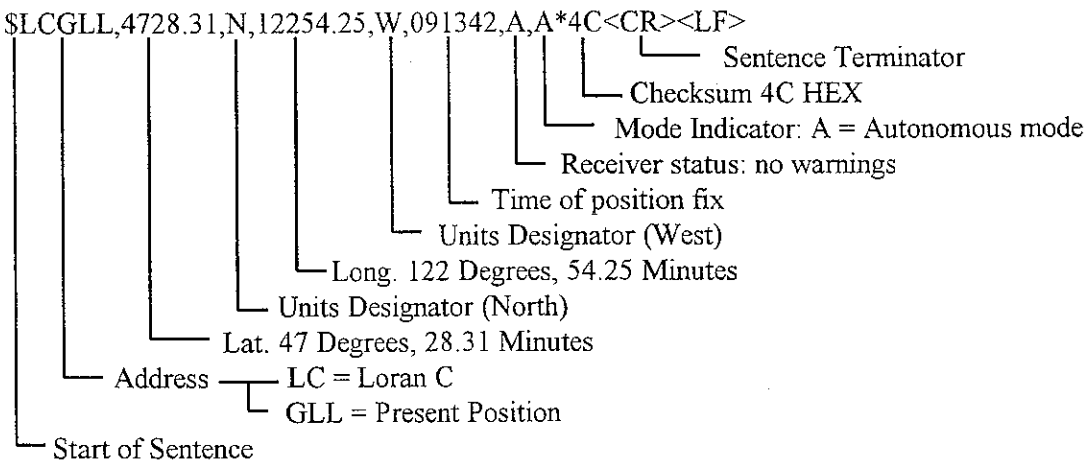
7. Applications

7.1 Example 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.

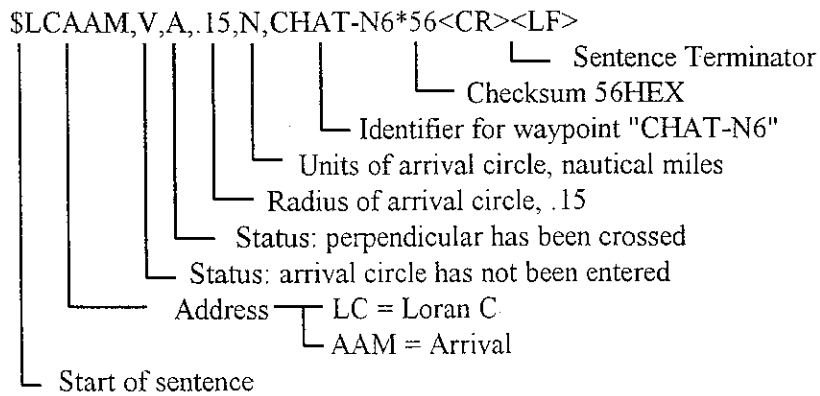
7.1.1 Example #1, Loran C LAT/LON

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".



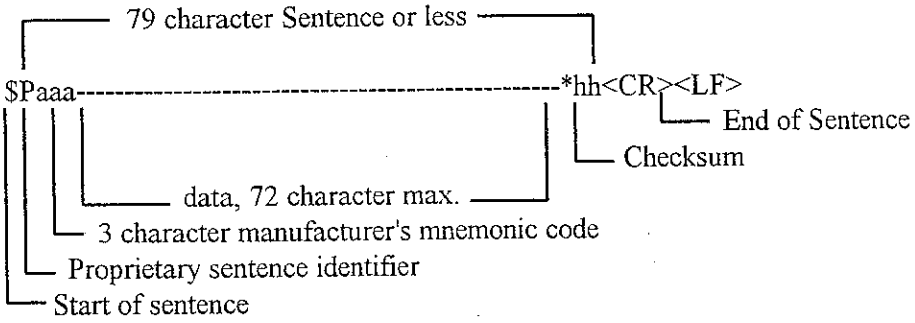
7.1.2 Example #2, Loran C Arrival Alarm

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.

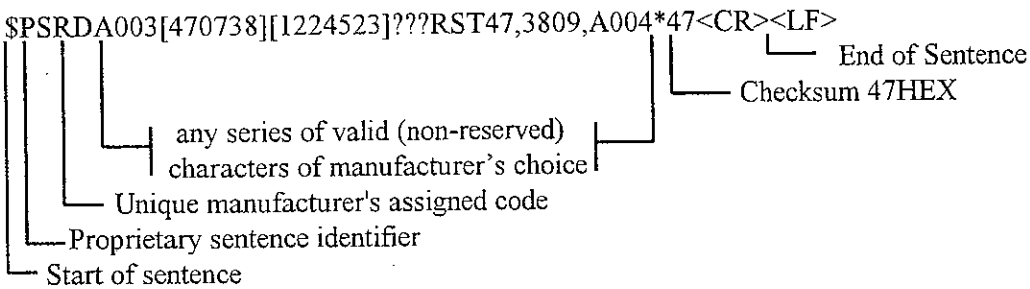


7.1.3 Example #3 - Proprietary Sentence

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:



7.1.4 Example #4 - RMA Examples

The following group of sentences show a typical progression of output data as a Loran C receiver acquires stations:

a) $LCRMA,V,,,,,14162.8,,,,,,N*6F<CR><LF>
Data invalid, only one TD acquired. Fields where data is not yet available are null fields.

b) $LCRMA,V,,,,,14172.3,26026.7,,,,,N*4C<CR><LF>
Two TDs acquired but not settled, data invalid.

c) $LCRMA,A,,,,,14182.3,26026.7,,,,,A*5B<CR><LF>
Data valid, two TDs cycled but 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.

7.1.5 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.

7.1.6 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>

7.2 Example Receiver Diagrams

The illustrative diagrams in Figure 3 and Figure 4 show the example structure of two optoisolator based LISTENER circuits that offer overvoltage, reverse voltage and power dissipation protection for the optoisolator and serve to limit the current drawn from the line.

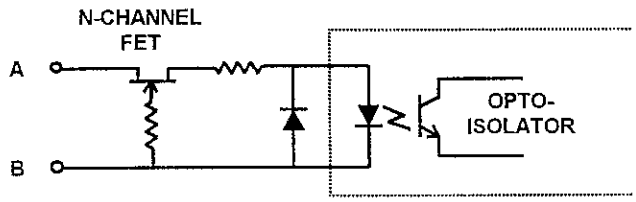


FIGURE 3

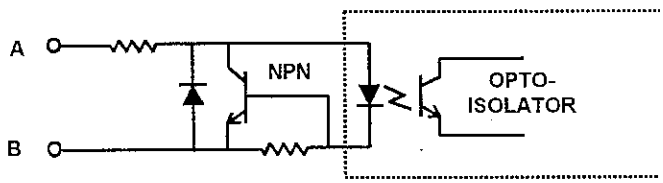


FIGURE 4

End of NMEA 0183 Version 2.30

NMEA 0183 APPENDIX I

Sentences Not Recommended for New Designs

Version 2.30

March 1, 1998

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.

TABLE I-1 - TALKER IDENTIFIER MNEMONICS

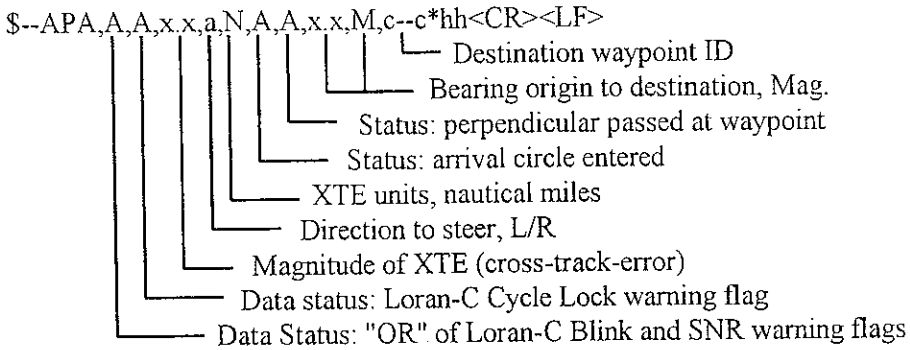
TALKER DEVICE	IDENTIFIER
COMPUTER	
Programmed Calc.	CC
Memory data	CM
LORAN: Loran A	LA
Microwave Positioning System	MP
OMEGA Navigation System	OM
Distress Alarm System	OS
TRANSIT Navigation System	TR
TRANSDUCERS	
Temperature	YC
Displacement, Angular or Linear	YD
Frequency	YF
Level	YL
Pressure	YP
Flow Rate	YR
Tachometer	YT
Volume	YV

TABLE I-2 - SENTENCE FORMATTERS NOT RECOMMENDED FOR NEW DESIGNS

TABLE I-3 - SENTENCES NOT RECOMMENDED FOR NEW DESIGNS

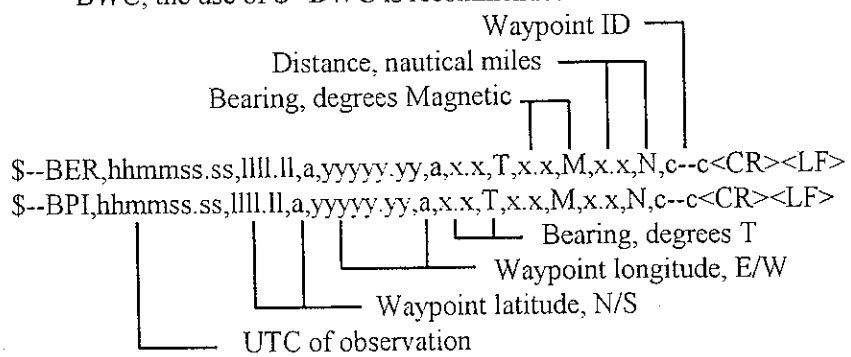
APA - Autopilot Sentence "A"
Commonly used by autopilots this sentence contains navigation receiver warning flag status, cross-track-error, waypoint arrival status and initial bearing from origin waypoint to the destination waypoint for the active navigation leg of the journey.

Use of **$--APB** with additional data fields of heading-to-steer and bearing from present position to destination is recommended.

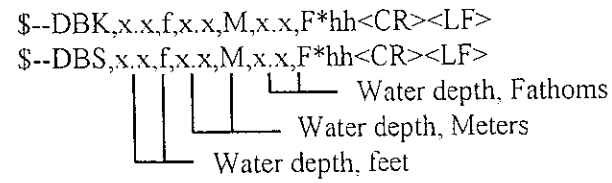


BER - Bearing & Distance to Waypoint, Dead Reckoning, Rhumb Line
BPI - Bearing & Distance to Point of Interest
Time (UTC) and distance & bearing to, and location of, a specified waypoint from present position:

BER: Calculated along the rhumb line from a dead reckoned present position. The use of **$--BEC** using great circle calculations is recommended.
BPI: Calculated along a great circle path from a measured present position. Redundant with BWC, the use of **$--BWC** is recommended.



DBK - Depth Below Keel
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 in place of either of these.



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
GLa - Loran-C Positions
GOa - OMEGA Positions
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

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

GXA - TRANSIT Position
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

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.

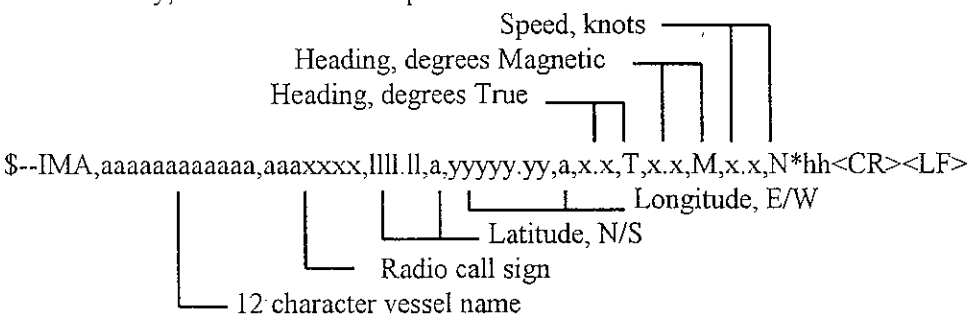
$--HDM,x.x,M*hh<CR><LF>
- Heading, degrees Magnetic

HVD - Magnetic Variation, Automatic
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.

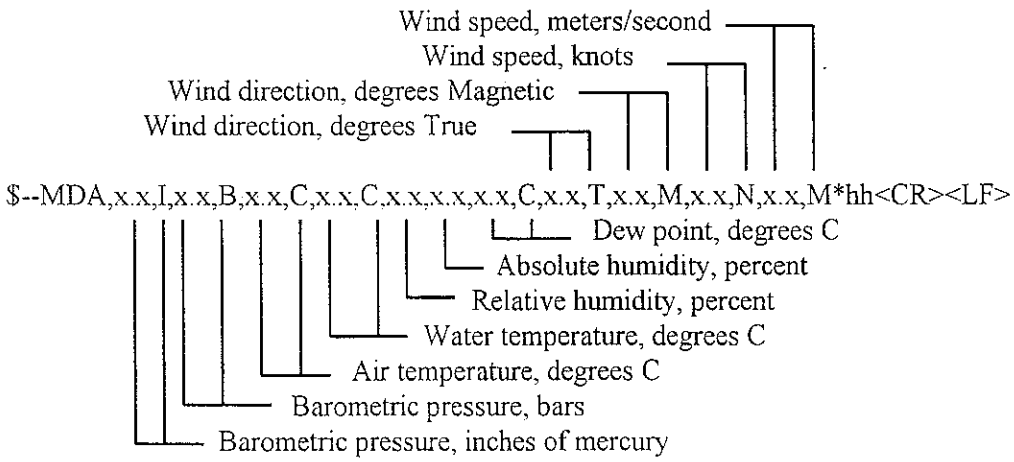
$--HVD,x.x,a*hh<CR><LF>
$--HVM,x.x,a*hh<CR><LF>
└┴ Magnetic variation, degrees E/W[1]

Notes:
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.

$--MHU,x.x,x.x,x.x,C*hh<CR><LF>
└┴ Dew point, degrees C
Absolute humidity, percent
Relative humidity, percent

MMB - Barometer
The use of **$--XDR** is recommended.

$--MMB,x.x,I,x.x,B*hh<CR><LF>
- x.x,I — Barometric pressure, inches of mercury
- x.x,B — Barometric pressure, bars

MTA - Air Temperature
The use of **$--XDR** is recommended.

$--MTA,x.x,C*hh<CR><LF>
- x.x,C — Temperature, degrees C

MWH - Wave Height
Limited utility, no recommended replacement.

$--MWH,x.x,f,x.x,M*hh<CR><LF>
- x.x,f — Wave height, feet
- x.x,M — Wave height, meters

MWS - Wind & Sea State
Limited utility, no recommended replacement.

$--MWS,xx,xx*hh<CR><LF>
- xx — Beaufort Wind Force Code
- xx — Beaufort Sea State 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>
- aa,xxx,xxx — Pair 1
- aa,xxx,xxx — Pair 2
- aa — Pair 3, AB-GH
- xxx — Lane number
- xxx — Centilane number

OLW - Omega Lane Width
OMEGA system is not operational, no recommended replacement.

$--OLW,x.x,N,xxxx,M*hh<CR><LF>
- x.x,N — Lane width, nautical miles
- xxxx,M — Lane width, meters

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
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.

```
$--SBK,A*hh<CR><LF>
$--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.

```
       |  |  |  |__ Status: Blink Warning Flag, Master
       |  |  |_____ Status: Cycle Lock Warning Flag, Master
       |  |________ Status: SNR Warning Flag, Master
       |___________ SNR value, 000 to 999, Master
SLC,A,A,A,xxx,A,A,A,A,xxx,A,A,A,A,xxx,A,A,A,A,xxx,A,A,A,A,xxx,A,A,A,A,xxx*hh<CR><LF>
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |__ SNR value, 000 to 999, Secondary #1
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |_____ Status: SNR Warning Flag, Secondary #1
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |________ Status: Cycle Lock Warning Flag, Secondary #1
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |___________ Status: Blink Warning Flag, Secondary #1
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |______________ Status: Secondary #1 used in Lat/Lon calculation
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |_________________ Sec. #2
                  |  |  |  |  |  |  |  |  |  |  |  |  |  |____________________ Sec. #3
                  |  |  |  |  |  |  |  |  |  |  |  |  |_______________________ Sec. #4
                  |  |  |  |  |  |  |  |  |  |  |  |__________________________ Sec. #5
```

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>
- A: Status: Iteration number
- A: Status: Doppler count
- A: Status: Maximum angle

TEP - TRANSIT Satellite Predicted Elevation
TRANSIT system is not operational, no recommended replacement.

$--TEP,x.x,D*hh<CR><LF>
- x.x: 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>
- x.x: Antenna geoidal height, meters
- x.x: Geoidal height, meters
- x.x: Antenna height, meters

TIF - TRANSIT Satellite Initial Flag
TRANSIT system is not operational, no recommended replacement.

$--TIF,a*hh<CR><LF>
- a: 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.

$--TRF,hhmmss.ss,xxxxxx,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,x.x,xxx,A*hh<CR><LF>
- A: Data status
  - A = Data valid
  - V = Data invalid
- xxx: Satellite ID
- x.x: Update distance, nautical miles
- x.x: Number of Doppler intervals
- x.x: Number of iterations
- x.x: Elevation angle
- a: Longitude, E/W
- llll.ll: Latitude, N/S
- xxxxxx: Date: ddmmyy
- hhmmss.ss: UTC of position fix

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.

$--VCD,x.x,f,x.x,M,x.x,N,x.x,M*hh<CR><LF>
└ Current, meters/second
└ Current, knots
└ Depth, feet and meters

VPE - Speed, Dead Reckoned Parallel to True Wind
Limited utility, no recommended replacement.

$--VPE,x.x,N,x.x,M*hh<CR><LF>
└ Speed, meters/second, "-" = downwind
└ Speed, knots, "-" = downwind

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.

$--YWS,x.x,x.x,x.x,C,x.x,f,x.x,M*hh<CR><LF>
└ Depth, meters
└ Depth, feet
└ Temperature at depth, degrees C
└ Chlorinity, parts/thousand
└ Salinity, parts/thousand

Zaa - Time, Elapsed/Estimated

Elapsed time from point-of-interest.
The use of **$--ZFO** is recommended.

$--ZFI,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
└ Waypoint ID
└ Elapsed time from waypoint
└ UTC

Arrival time at point-of-interest.
The use of **$--ZTG** is recommended.

$--ZPI,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
└ Waypoint ID
└ Arrival time at waypoint
└ UTC

Estimated time of arrival at waypoint.
The use of **$--ZTG** is recommended.

```
$--ZTA,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
       |         |         |
       |         |         └── Waypoint ID
       |         └──────────── Estimated arrival time at waypoint
       └────────────────────── UTC
```

Estimated time to event/point-of-interest.
The use of **$--ZTG** is recommended.

```
$--ZTE,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
$--ZTI,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
       |         |         |
       |         |         └── Waypoint ID
       |         └──────────── Estimated time-to-go to waypoint
       └────────────────────── UTC
```

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>
- hhmmss.ss: UTC
- hhmmss.ss: Local time
- xx: Local zone description[1], 00 to12

Notes:
1) Zone description is the number of whole hours added to local time 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>
- hhmmss.ss: UTC

End of Appendix I

NMEA 0183 APPENDIX II

GLOSSARY

Version 2.30
March 1, 1998

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.

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 it's 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]

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.

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.

field - in this standard, a character or string of characters immediately preceded by a field delimiter (see **delimiters**).

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

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° at the reference direction clockwise through 359°. (See **true heading** and **magnetic heading**).

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.

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 and is listed in Appendix III, 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.

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.

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**].

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 - the 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.

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**].

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.

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.

waypoint - a reference point on a track.

wide area augmentation system (WAAS) - an augmentation to GNSS which uses geostationary satellites to broadcast GNSS integrity and correction data, and additional ranging signals.

End of Appendix II

NMEA 0183 APPENDIX III

Version 2.30
March 1, 1998

Manufacturer's Mnemonic Codes

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.
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
APC	APELCO
APN	AMERICAN PIONEER, INC.
APX	AMPEREX, INC.
AQC	AQUA-CHEM, INC.
AQD	AQUADYNAMICS, INC.
AQM	AQUA METER INSTRUMENT CO.
ASH	ASHTECH
ASP	AMERICAN SOLAR POWER
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.
BGS	BARRINGER GEOSERVICE
BGT	BROOKES AND GATEHOUSE, INC.
BHE	BH ELECTRONICS
BHR	BAHR TECHNOLOGIES, INC.
BLB	BAY LABORATORIES
BMC	BMC
BME	BARTEL MARINE ELECTRONICS
BNI	NEIL BROWN INST. SYSTEMS
BNS	BOWDITCH NAVIGATION SYSTEMS
BRM	MEL BARR COMPANY
BRY	BYRD INDUSTRIES
BTH	BENTHOS, INC.
BTK	BALTEK CORP.
BTS	BOAT SENTRY, INC.
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
CEC	CECO COMMUNICATONS, INC.
CEI	CAMBRIDGE ENGINEERING, INC.
CHI	CHARLES INDUSTRIES, LTD.
CKM	CINKEL MARINE ELECTRONICS
CMA	SOC. NOUVELLE D'EQUIP. CALVADOS
CMC	COE MANUFACTURING CO.
CME	CUSHMAN ELECTRONICS, INC.
CMN	COMNAV MARINE, LTD.
CMP	C-MAP, s.r.l.
CMS	COASTAL MARINE SALES CO.
CMV	COURSEMASTER USA, INC.
CNI	CONTINENTAL INSTRUMENTS
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
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
CWD	CUBIC WESTERN DATA
CWV	CELWAVE R.F., INC.
CYZ	cYz, INCORPORATED
DAS	DASSAULT SERCEL NAVIGATION-POSITIONING
DCC	DOLPHIN COMPONENTS CORP.
DEB	DEBEG GMBH
DEC	DECCA DIVISION, LITTON MARINE SYSTEMS, BV
DFI	DEFENDER INDUSTRIES, INC.
DGC	DIGICOURSE, INC.
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.
DYN	DYNAMOTE CORPORATION
DYT	DYTEK LABORATORIES, INC.
EAN	EURO AVIONICS NAVIGATIONSSYSTEME GmbH
EBC	EMERGENCY BEACON CORP.
ECT	ECHOTEC, INC.
EDO	EDO CORPORATION ELECTROACOUSTICS DIV.
EEV	EEV, INC.
EFC	EFCOM COMMUNICATION SYSTEMS
ELA	ALLIED SIGNAL ELAC NAUTIK
ELD	ELECTRONIC DEVICES, INC.
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.
FLO	FLOSCAN INCORPORATED
FMM	FIRST MATE MARINE AUTOPILOTS
FNT	FRANKLIN NET AND TWINE, LTD
FRC	THE FREDERICKS COMPANY
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
GPI	GLOBAL POSITIONING INSTRUMENT CORP.
GRM	GARMIN CORPORATION
GSC	GOLD STAR COMPAPNY, LTD
GTO	GRO ELECTRONICS
GVE	GUEST CORPORATION
GVT	GREAT VALLEY TECHNOLOGY
HAL	HAL COMMUNICATIONS CORP.
HAR	HARRIS CORPORATION
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
ICO	ICOM OF AMERICA, INC.
ICG	INITIATIVE COMPUTING USA, INC. INITIATIVE COMPUTING AG
IFD	INTERNATIONAL FISHING DEVICES
IFI	INSTRUMENTS FOR INDUSTRY
IME	IMPERIAL MARINE EQUIPMENT
IMI	INTERNATIONAL MARINE INSTRUMENTS
IMM	ITT MACKAY MARINE
IMP	IMPULSE MANUFACTURING, 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
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.
KNG	KING RADIO CORPORATION
KOD	KODEN ELECTRONICS CO., LTD
KRP	KRUPP INTERNATIONAL, INC.
KVH	KVH COMPANY
KYI	KYOCERA INTERNATIONAL, INC.
LAT	LATITUDE CORPORATION
LEC	LORAIN ELECTRONICS CORP.
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
MCL	MICROLOGIC, INC.
MDL	MEDALLION INSTRUMENTS, INC.
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
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

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.
MXX	MAXXIMA MARINE
NAT	NAUTECH, LTD
NAV	NAVTEC, INCORPORATED
NEF	NEW ENGLAND FISHING GEAR
NGS	NAVIGATION SCIENCES, INC.
NMR	NEWMAR
NOM	NAV-COM, INC.
NOR	NORTECH SURVEYS (CANADA)
NOV	NovAtel COMMUNICATIONS, LTD
NSM	NORTHSTAR MARINE
NTI	NORTHSTAR TECHNOLOGIES, INC.
NTK	NOVATECH DESIGNS, LTD
NTS	NAVTECH SYSTEMS
NUT	NAUTITECH PTY, LTD
NVC	NAVICO
NVO	NAVIONICS, s.p.a.
NVS	NAVSTAR
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
ORE	OCEAN RESEARCH
OSI	OFFSHORE SYSTEMS INTL.
OSL	OFFSHORE SYSTEMS, LTD.
OTK	OCEAN TECHNOLOGY
PCE	PACE
PCM	pSEA MARINE SYSTEMS
PDM	PRODELCO MARINE SYSTEMS
PLA	PLATH,C.DIV OF LITTON
PLI	PILOT INSTRUMENTS
PMI	PERNICKA MARINE INSTRUMENTS
PMP	PACIFIC MARINE PRODUCTS
PRK	PERKO, INC.
PSM	PEARCE-SIMPSON
PTC	PETRO-COM
PTG	P.T.I./GUEST
PTH	PATHCOM, INC.
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.
RME	RACAL MARINE ELECTRONICS
RMR	RCA MISSILE AND RADAR
RSL	ROSS LABORATORIES, INC.
RSM	ROBERTSON-SHIPMATE, USA
RTN	ROBERTSON TRITECH NYASKAIEN
RWI	ROCKWELL INTERNATIONAL
SAE	STN ATLAS ELEKTRONIC GmbH
SAI	SAIT, INC.
SAJ	SAJ INSTRUMENT AB
SAL	CONSILIUM MARINE AB
SBR	SEA-BIRD ELECTRONICS, INC.
SCL	SOKKIA COMPANY, LTD
SCR	SIGNALCRAFTERS, INC.
SEA	SEA, INC.
SEC	SERCEL ELECTRONICS OF CANADA
SEP	STEEL AND ENGINE PRODUCTS
SER	SERCEL FRANCE
SFN	SEAFARER NAVIGATION INT'L,
SGC	SGC, INC.
SIG	SIGNET, INC.
SIM	SIMRAD, INC
SKA	SKANTEK CORPORATION
SKP	SKIPPER ELECTRONICS A/S
SLI	STARLINK INCORPORATED
SME	SHAKESPEARE MARINE ELECTRONICS
SMF	SEATTLE MARINE AND FISHING SUPPLY CO.

SMI	SPERRY MARINE, INC.
SML	SIMERL INSTRUMENTS
SNP	SCIENCE APPLICATIONS INTERNATIONAL CORP
SNV	STARNAV CORPORATION
SOM	SOUND MARINE ELECTRONICS
SOV	SELL OVERSEAS AMERICA
SPL	SPELMAR
SPT	SOUND POWERED TELEPHONE
SRD	SRD LABS
SRF	SiRF TECHNOLOGY, INC.
SRS	SCIENTIFIC RADIO SYSTEMS, INC.
SRT	STANDARD RADIO AND TELEFON
SSC	SWEDISH SPACE CORPORATION
SSI	SEA SCOUT INDUSTRIES
STC	STANDARD COMMUNICATIONS
STI	SEA-TEMP INSTRUMENT CORP.
STL	STREAMLINE TECHNOLOGY, LTD
STM	SI-TEX MARINE ELECTRONICS
STO	STOWE MARINE ELECTRONICS
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
TLS	TELESYSTEMS
TMT	TAMTECH, LTD
TNL	TRIMBLE NAVIGATION
TRC	TRACOR, INC.
TRS	TRAVROUTE SOFTWARE
TSI	TECHSONIC INDUSTRIES, INC.
TTK	TALON TECHNOLOGY CORP.
TTS	TRANSTECTOR SYSTEMS
TWC	TRANSWORLD COMMUNICATIONS
TXI	TEXAS INSTRUMENTS, INC.
UEL	ULTRA ELECTRONICS LTD
UME	UMEC
UNF	UNIFORCE ELECTRONICS CO.
UNI	UNIDEN CORP. OF AMERICA
UNP	UNIPAS, INC.
VAN	VANNER, INC.
VAR	VARIAN EIMAC ASSOCIATES
VCM	VIDEOCOM
VEX	VEXILAR
VIS	VESSEL INFORMATION SYSTEMS
VMR	VAST MARKETING CORP
WAL	WALPORT U.S.A.
WBG	WESTBERG MANUFACTURING,
WBR	WESBAR CORPORATION
WEC	WESTINGHOUSE ELECTRIC 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
YAS	YAESU ELECTRONICS

End of Appendix III

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.

Organizing the Binary Message Data

The work sheet has been filled in to decode an "AIS Message 1". Notice that the two grids in Figure 6 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 8.

The parameters listed in Table 8 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 8 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, bits 1-6 were 010011, the VDM message identified would be message 19 ($010011_2 = 19_{10}$). This references the "VTS Targets" message - Tables 31 and 32 of ITU-R M.1371 (2000). In the case of message 19, two tables would be referenced for the ordering and identification of the binary Message Data.

The process or 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.

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 6, and
2. The parameters descriptive information defined in ITU-R M.1371 (2000) Table 15 (See Table 8 in this document).

The parameter "DTE" is a single bit - bit 7. Inspection of Message Data bit 7, Figure 6, shows that its value is "1". The descriptive information in Table 8 for "DTE" indicates that a "1" should be interpreted as "not available". This conclusion is recorded in the space to the right of Figure 6.

Similar inspection of the "Data indicator", bit 8, shows that the indicated value of "0" should be interpreted as "not available". This conclusion is recorded in the space to the right of Figure 6.

The next parameter in Table 8 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 units MMSI as 127.

This process continues down Table 8. The results of all the interpretations of the decoded binary Message Data are shown on the worksheet to the right and below Figure 6.

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 7.

The following discussion will use "table lookup" methods to describe the decoding process. The reader should also be aware that this standard also contains binary mathematical methods that a computer would use to accomplish the same results.

Decoding the Encapsulated String

The **Background Discussion,** above, described how the AIS unit codes the received binary Message Data bits into the characters of an encapsulation string. It explained that the AIS unit:

- Receives a broadcast message,
- Organizes the binary bits of the Message Data into 6-bit strings,
- Converts the 6-bit strings into their representative valid characters - see Table 7,
- 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:43grwb0Eq4,0*71<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:43grwb0Eq4"`.

The process of decoding and interpreting the contents of the encapsulated string is a three step process:

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 (2000), Table 15.
3. The referenced document rules are used to convert the binary strings into the relevant information.

Conversion from symbols to binary bits

Figure 6 is a visual aid that can be used to follow this process for the example string. The table on the left side of Figure 6, **VDM bit positions,** is provided as a reference that can be used to identify the exact bit position of the corresponding binary bit in the table on the right side, **Bits represented by encapsulation symbol,** of Figure 6. The use of this "reference grid" will become clearer as the example is discussed.

Down the center of Figure 6 is a column into which the example string has been entered from top to bottom. The arrows in Figure 6 provide an idea about how the logic of the decoding process proceeds. Decoding of the VDM encapsulated string begins with the first symbol in the string. In this case the symbol is "1" and the corresponding binary string from Table 7 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 6.

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.