IEC/PAS 61162-100

Edition 1.0
2002-04

**Maritime navigation and radiocommunication equipment and systems –
Digital interfaces –**

**Part 100:
Single talker and multiple listeners –
Extra requirements to IEC 61162-1
for the UAIS**

PUBLICLY AVAILABLE SPECIFICATION

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

**Reference number
IEC/PAS 61162-100**

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FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 61162-100 has been processed by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
80/330/PAS	80/338/RVD

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

This PAS document relates to International Standard IEC 61162-1. The document has been co-ordinated with the TC 80 Working Group preparing the AIS Standard IEC 61993 Part 2, and the NMEA Standards Committee.

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

INTRODUCTION

This document is issued as a IEC Publicly Available Specification according to the IEC/PAS approval process. This agreed process allows the new information needed for the development of UAIS to be placed in the public domain in a shorter timescale than revising the appropriate International standards.

This document provides information on the necessary interface standards for use with the UAIS, which are not available in the current issue of IEC 61162-1 Ed 2. The information in this PAS supersedes that in annex B (informative) of IEC 61993-2, the Standard for UAIS.

This PAS will include the interface standards, which are currently being adopted in the NMEA 0183 standard and alignment will be maintained.

This PAS will be replaced at a future date by, or be included within, a revision of the international standard IEC 61162-1.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 100: Single talker and multiple listeners – Extra requirements to IEC 61162-1 for the UAIS

1 Scope

All the requirements to effectively transmit the data of the mobile TDMA based AIS station are included in this PAS.

Whilst the established Standard IEC 61162-1 sentences are available for certain functions a number of new sentences are now required to permit all specified AIS data to be transmitted. The total requirements for the AIS are included in this PAS document but the current Standard IEC 61162-1 should be referred to for the reference data applicable to the existing format.

The reader should be aware that certain of the new sentences may include new features not currently included in IEC 61162-1. For this reason the PAS has been divided into three sections, namely: -

- Existing IEC 61162-1 sentences to be employed in the AIS (and elsewhere) – see clause 5
- Additional IEC 61162-1 sentences to cover new AIS requirements, but maintaining the standard format – see clause 6
- Proposed new sentence structures to meet specific AIS requirements and which cannot be accommodated in the standard IEC 61162-1 format. These new sentence standards are essentially designed to meet the AIS requirements and are not for general use – see clause 7 and annex A.

2 Normative references

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

The references contained in IEC 61162-1 apply to this PAS. In addition the following apply:

IEC Standard 61993 Part 2: *Universal Shipborne Automatic Identification System (AIS); Operational and Performance Requirements, Methods of Test and required Test Results.*

ITU-R M.1371-1:2001 *Technical characteristics for a Universal Shipborne Automatic Identification System (AIS) using TDMA in the VHF maritime mobile band*.

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

IMO SOLAS Convention, Chapter V (2002)

IMO HSC Code, Chapter 13

ISO/IEC 10646-1 (1993-05). *Unicode Standard*

3 Definitions

3.1 Parametric sentences

(See IEC 61162-1 clause 5 Data format protocol)

These sentences start with the “$” (HEX 24) delimiter and represent the majority of approved sentences defined by IEC 61162-1 and this PAS. This is the preferred method for conveying information. Refer to clauses 5 and 6 for details.

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 delimiter <CR><LF>.

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

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

The basic rules for parametric sentence structures are:

- The sentence begins with the “$” delimiter.
- Only approved sentence formatters are allowed. Formatters used by special-purpose encapsulation sentences cannot be re-used. (See IEC 61162-1, clause 6.2 (table 5).)
- Only valid characters are allowed. (See IEC 61162-1, clause 6.1 (tables 1 and 2).)
- Only approved field types are allowed. (See IEC 61162-1, clause 6.2 (table 6).)
- Data fields (parameters) are individually delimited, and their content is identified and often described in detail by this standard.
- Encapsulated non-delimited data fields are NOT ALLOWED.

3.2 Encapsulation sentences

(New definition not currently in IEC 61162-1)

These sentences start with the “!” (HEX 21) delimiter. The function of this special-purpose sentence structure is to provide a means to convey information, when the specific data content is unknown or greater information bandwidth is needed. This is similar to a modem that transfers information without knowing how the information is to be decoded or interpreted.

The basic rules for encapsulation sentence structures are:

- The sentence begins with the “!” delimiter.
- Only approved sentence formatters are allowed. Formatters used by conventional parametric sentences can not be re-used. (See clauses 5 and 6, and IEC 61162-1, clause 6.2 (table 5)).
- Only valid characters are allowed. (See IEC 61162-1, clause 6.1 (tables 1 and 2).)
- Only approved field types are allowed. (See annex B.5 and IEC 61162-1, clause 6.2 (table 6).)
- Only Six bit coding may be used to create encapsulated data fields. (See annex B.5.)
- Encapsulated data fields may consist of any number of parameters, and their content is not identified or described by this standard.
- The sentence must be defined with one encapsulated data field and any number of parametric data fields separated by the “,” data field delimiter. The encapsulated data

field shall always be the second to last data field in the sentence, not counting the checksum field. (See IEC 61162-1, clause 5.2.2.)

- The sentence contains a “Total Number Of Sentences” field. (See annex A.)
- The sentence contains a “Sentence Number” field. (See annex A.)
- The sentence contains a “Sequential Message Identifier” field. (See annex A.)
- The sentence contains a “Fill Bits” field immediately following the encapsulated data field. The Fill Bits field shall always be the last data field in the sentence, not counting the checksum field. (See annex A.)

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

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

Condition 2: When information requires a significantly higher data rate than can be achieved by the IEC61162-1 (4,800baud) and IEC61162-2 (38,400baud) standards utilising parametric sentences.

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

4 Data requirements of the AIS

A portion of the information broadcast by an AIS unit is obtained from sensors using existing IEC 61162-1 sentence formatters. The sensor data and the existing sentence formatters recognised by the AIS unit are listed in IEC 61993-2 (See IEC 61993-2 clauses : 6.10.1.1; 7.6.2.3, table 9 – preferred IEC 61162-1 sensor sentences; and 7.6.3.3.)

Expanded data requirements, not satisfied by the present IEC 61162-1 sentence formatters, are satisfied by the new sentence formatters described in clauses 6 and 7. The new sensor input sentence formatters include : ABM, ACA, AIR, BBM, LRF, LRI, SSD AND VSD.

5 Existing IEC 61162-1 sentences for the AIS

Listing of approved sentences as given in IEC 61162-1 that apply. Only the sentence header and description to be given here. Refer to IEC 61162-1 clause 6.3

Formatter	Meaning
ACK	**Acknowledgement alarm**
ALR	**Set alarm state**
DSI	**DSC transponder initialise**
DSR	**DSC transponder response**
DTM	**Datum reference**
GBS	**GNSS satellite fault detection**
GLL	**Geographic position, latitude/longitude**
GNS	**GNSS fix data**
HDT	**Heading true**
OSD	**Own ship data**
RMC	**Recommended minimum specific GNSS data**
ROT	**Rate of turn**
RTE	**Routes**
TXT	**Text transmission**
VBW	**Dual ground/water speed**
VTG	**Course over ground and ground speed**
WPL	**Waypoint location**

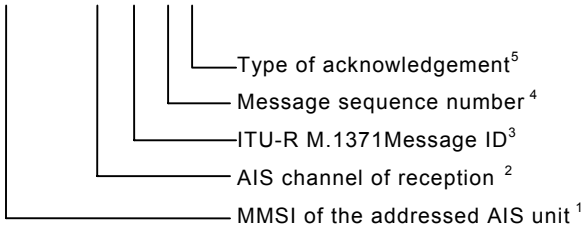
6 Additional IEC 61162-1 parametric sentences for the AIS

Listing of the new approved sentences, including structure and notes

ABK - AIS addressed and binary broadcast acknowledgement

The ABK-sentence is generated when a transaction, initiated by reception of an ABM, AIR, or BBM sentence, is completed or terminated. This sentence provides information about the success or failure of a requested ABM broadcast of either ITU-R M.1371 messages 6 or 12. The ABK process utilises the information received in ITU-R M.1371 messages 7 and 13. Upon reception of either a VHF Data-link message 7 or 13, or the failure of messages 6 or 12, the AIS unit delivers the ABK sentence to the external application. This sentence is also used to report to the external application the AIS unit's handling of the AIR (ITU-R M.1371 message 15) and BBM (ITU-R M.1371 messages 8, 14, 19, and 21) sentences. The external application initiates an interrogation through the use of the AIR-sentence, or a broadcast through the use of the BBM sentence. The AIS unit generates an ABK sentence to report the outcome of the AIR, or BBM broadcast process.

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



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

NOTE 2 Indication of the VHF Data Link channel upon which a message type 7 or 13 acknowledgement was received. An "A" indicates reception on channel A. A "B" indicates reception on channel B.

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

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

ITU-R M.1371 Message ID	Message Sequence Number source
6	sequential message identifier from ABM-sentence, (See clause 5, ABM sentence)
7	addressed AIS unit's message 7, sequence number, ITU-R M.1371-1
8	sequential message identifier from BBM-sentence, (See clause 5, BBM sentence)
12	sequencial message identifier from ABM-sentence, (See clause 5, ABM sentence)
13	addressed AIS unit's message 13, sequence number, ITU-R M.1371-1
14	sequential message identifier from BBM-sentence, (See clause 5, BBM sentence)
15	no source, the Message sequence number shall be null

NOTE 5 Acknowledgements provided are:

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

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

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

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

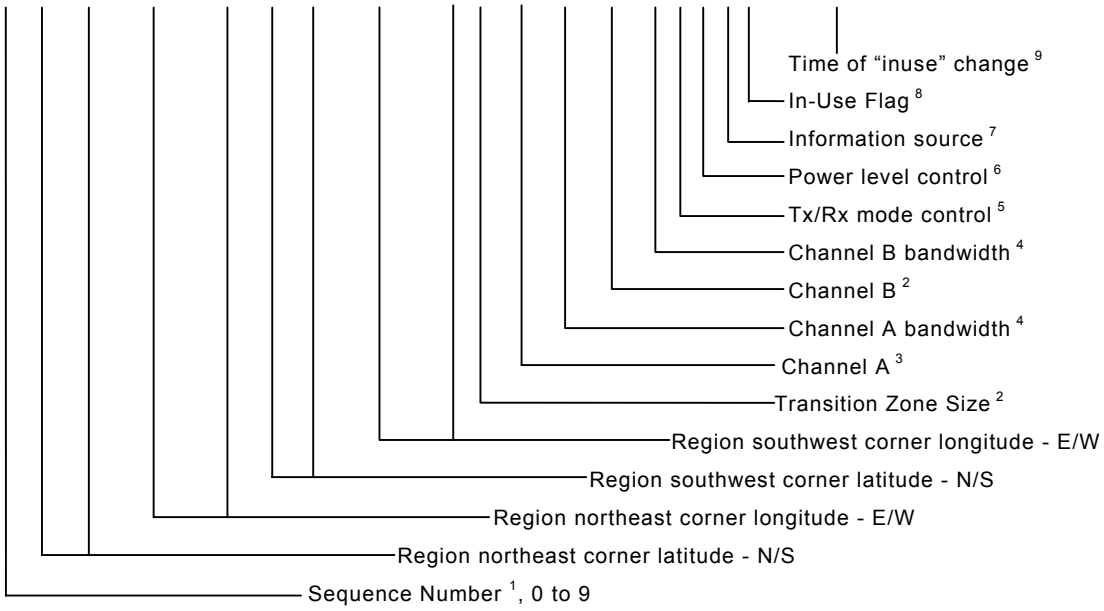
4 =late reception of a message 7 or 13 acknowledgement that was addressed to this AIS unit (own-ship) and referenced as a valid transaction

ACA – AIS Channel assignment message

An AIS device can receive regional channel management information in four ways: ITU-R M.1371-1 message 22, DSC telecommand received on channel 70, manual operator input, and an ACA sentence. The AIS unit may store channel management information for future use. Channel management information is applied based upon the actual location of the AIS device. An AIS unit is “using” channel management information when the information is being used to manage the operation of the VHF receiver and/or transmitter inside the AIS unit.

This sentence is used both to enter and obtain channel management information. When sent to an AIS unit, the ACA sentence provides regional information that the unit stores and uses to manage the internal VHF radio. When sent from an AIS unit, the ACA sentence provides the current channel management information retained by the AIS unit. The information contained in this sentence is similar to the information contained in an ITU-R M.1371-1 message 22. The information contained in this sentence directly relates to the Initialisation Phase and Dual Channel Operation and Channel Management functions of the AIS unit as described in ITU-R M. 1371.

$--ACA,x,llll.ll,a,yyyyy.yy,a,llll.ll,a,yyyyy.yy,a,x,xxxx,x,xxxx,x,x,x,a,x,hhmmss.ss*hh<CR><LF>



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

NOTE 2 Range of 1 to 8 nautical miles.

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

NOTE 4 Value of 0, bandwidth is specified by channel number, see ITU-R M.1084, Annex 4
Value of 1, bandwidth is 12.5 kHz.

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

NOTE 6 Value of 0, high power
Value of 1, low power

NOTE 7 Source identifiers:

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

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

C = IEC 61162-1 AIS Channel Assignment sentence,

D = DSC Channel 70 telecommand, and

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

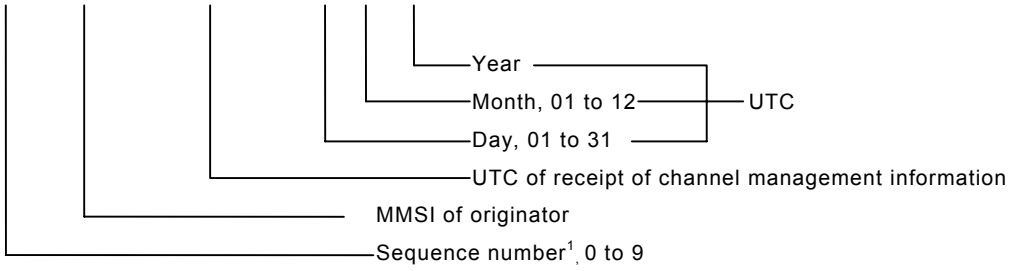
NOTE 8 This value is set to indicate that the other parameters in the sentence are “in-use” by an AIS unit at the time that the AIS unit sends this sentence. A value of “0” indicates that the parameters are not “in-use,” and a value of “1” indicates that the parameters are “in-use.” This field should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

NOTE 9 This is the UTC time that the “In-Use Flag” field changed to the indicated state. This field should be null when the sentence is sent to an AIS unit

ACS - AIS Channel management information Source

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

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



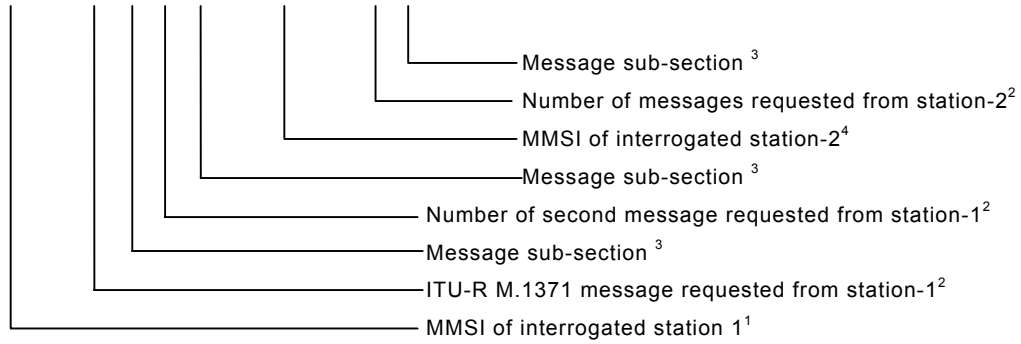
NOTE 1 This is used to bind the contents of the ACA and ACS sentences together. The ACS sentence, when provided by the AIS unit, shall immediately follow the related ACA sentence, containing the same sequence number. The AIS unit generating the ACA and ACS sentences, shall increment the sequence number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

AIR - AIS Interrogation request.

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

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

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



NOTE 1 Identifies the first distant AIS unit being interrogated. Two messages can be requested from the first AIS unit.

NOTE 2 Examples of messages that may be requested from a distant mobile AIS unit include :

Message 3, = Position Report,

Message 5, = Ship static and voyage related data, see additional information in Note 3.

Message 9, Standard SAR Aircraft Position Report

Message 18, Standard Class B equipment position report.

Message 19, Extended Class B equipment position report

Message 21, Aids-to-navigation report.

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

Message 4 = Base Station Report

Message 17 = GNSS Broadcast Binary Message. Message 20 = Data Link Management Message

Message 20 = Data link management message

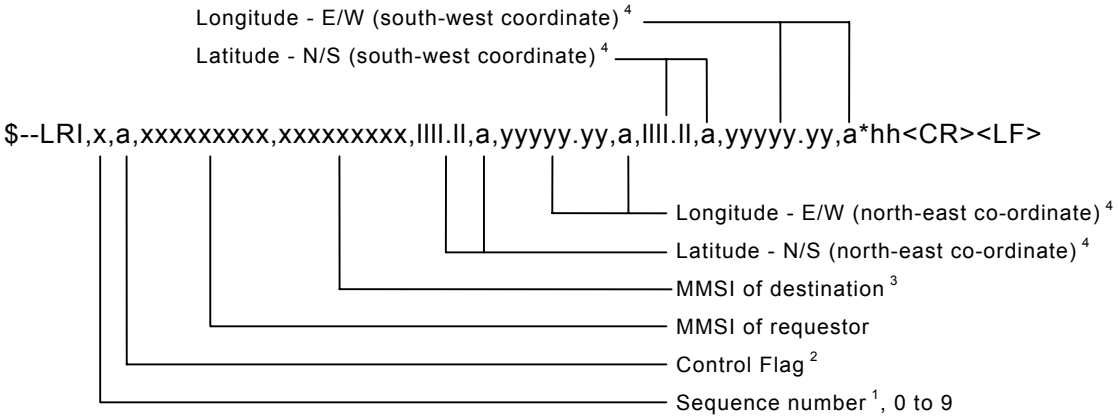
Message 22 = Channel Management

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

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

LRI - AIS Long-range Interrogation

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



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

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

- The AIS unit is within the geographic rectangle provided, **and**

- the AIS unit has not responded to the requesting MMSI in the last 24 hours **and**

- the MMSI "destination" field is null.

or

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

When the Control Flag is "1", the AIS unit responds if :

- The AIS unit is within the geographic rectangle provided.

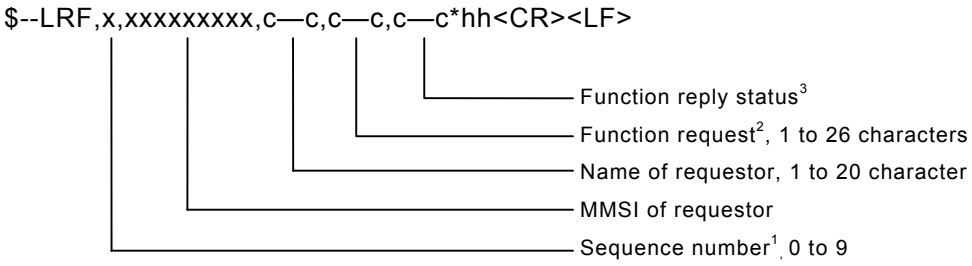
NOTE 3 This is the nine digit number that uniquely identifies the specific AIS unit that should respond. This field should be null when the interrogation is for a geographic region. When addressing a specific AIS unit, it is not necessary to provide the geographic co-ordinates of the region.

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

LRF - AIS Long-Range Function

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

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



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

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

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

B = Date and time of message composition

C = Position

E = Course over ground

F = Speed over ground

I = Destination and Estimated Time of Arrival (ETA)

O = Draught

P = Ship / Cargo

U = Ship's: length, breadth, type

W = Persons on board

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

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

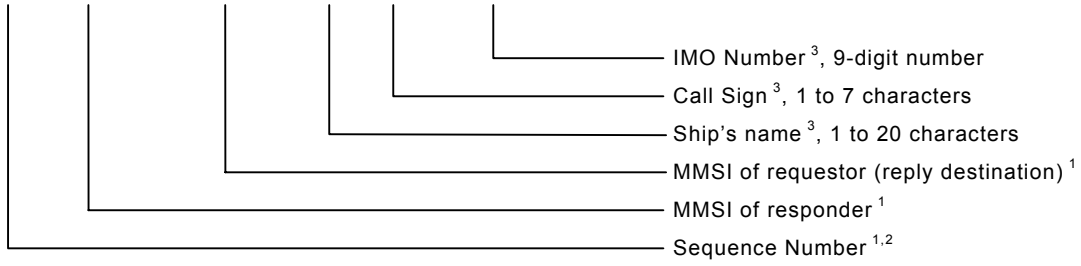
3 = information not available from AIS unit,

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

LR1 - AIS Long-range Reply Sentence 1

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

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



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

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

NOTE 3 The characters that can be used are listed in the ITU-R M.1371, 6-bit ASCI Table 14. Some of the acceptable characters in this 6-bit ASCI table are the reserved characters within this standard IEC 61162-1, Table 1. These characters must be represented using the “^” method (see IEC 61162-1 clause 5.1.3). The individual information items shall be a null field if any of the following three conditions exist:

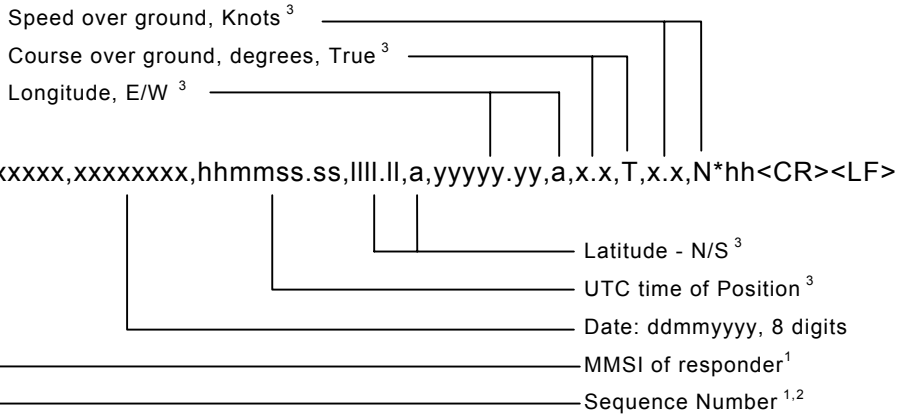
The information item was not requested,

the information item was requested but is not available,

the information item was requested but is not being provided.

LR2 - AIS Long-range Reply Sentence 2

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



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

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

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

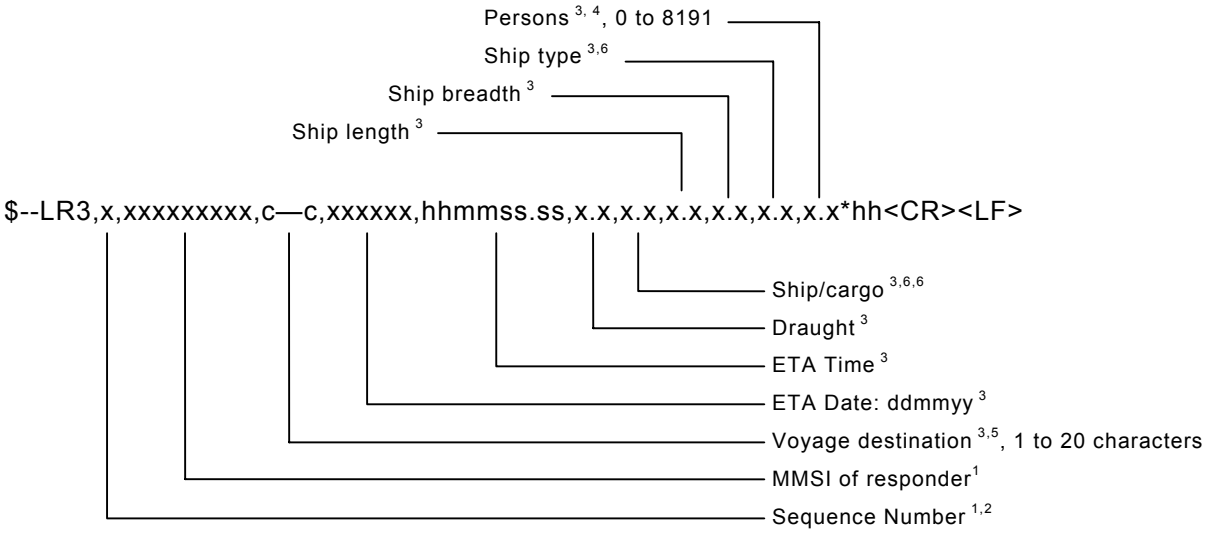
The information item was not requested,

the information item was requested but is not available,

the information item was requested but is not being provided.

LR3 - AIS Long-range Reply Sentence 3

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



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

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

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

the information item was not requested,

the information item was requested but is not available,

the information item was requested but is not being provided.

NOTE 4 Current number of persons on-board, including crew members : [0 to 8191,

0 = default (not available),]

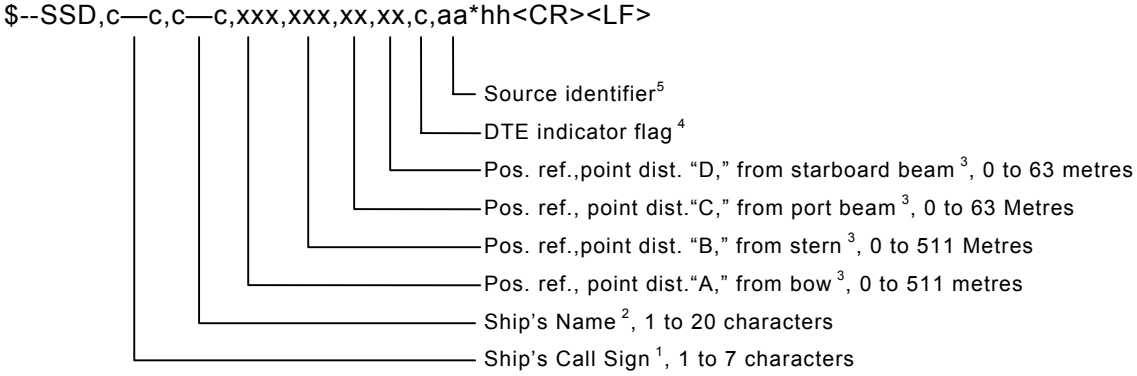
8191 = 8191 or more people.

NOTE 5 The characters that can be used are listed in the ITU-R M.1371, 6-bit ASCI Table 14. Some of the acceptable characters in this 6-bit ASCI table are the reserved characters within this standard IEC 61162-1, Table 1. These characters must be represented using the “^” method (see IEC 61162-1 clause 5.1.3).

NOTE 6 See ITU-R M.1371, Table 17, Parameter “Type of ship and cargo type” for the range of valid values for this field.

SSD – AIS Ship static data

This sentence is used to enter static parameters into a shipboard AIS unit. The parameters in this sentence support a number of the ITU-R M.1371 messages.



NOTE 1 Ship call sign. A null field indicates that the previously entered call sign is unchanged. The string of characters “@@@@@@@” are used to indicate that the call sign is not available.

NOTE 2 The characters that can be used in the name are listed in the ITU-R M.1371, 6-bit ASCI Table 14. Some of the acceptable characters in this 6-bit ASCI table are the reserved characters within this standard IEC 61162-1, Table 1. These characters must be represented using the “^” method (see IEC 61162-1 clause 5.1.3). A null field indicates that the previously entered name is unchanged. The string of characters “@@@@@@@@@@@@@@@@@@@@” is used to indicate that the ship’s name is not available.

NOTE 3 These are the four dimensions from the bow, stern, port beam, and starboard beam to the horizontal reference point on the ship for which the current “position reports” are valid. The sum of A + B is the length of the ship in meters, and the sum of C + D is the width of the ship in meters. Refer to the ITU-R M.1371, Message 5, “Reference Point for reported position and Dimensions of Ship.” If the reference point of “reported position” is not available, but the dimensions of the ship are available: A = C = 0 and B > 0 and D > 0. If neither the reference point for the reported position nor the dimensions of the ship are available: A = B = C = D = 0 (default). Use of a null field for A, B, C, and/or D indicates that the previously entered dimension for that parameter is unchanged. In many cases, the ship’s reference point for “reported position” will be the location of the positioning antenna.

NOTE 4 The DTE indicator is an abbreviation for Data Terminal Equipment indicator. The purpose of the DTE indicator is to inform distant receiving applications that, if set to “available,” the transmitting station conforms, at least, to the minimum keyboard and display requirements. The DTE indicator is only used as information provided to the application layer - indicating that the transmitting station is available for communications. On the transmitting side, the DTE indicator may be set by an external application using this sentence. DTE indicator flag values are:

0 = Keyboard and display are a standard configuration, and communication is supported.

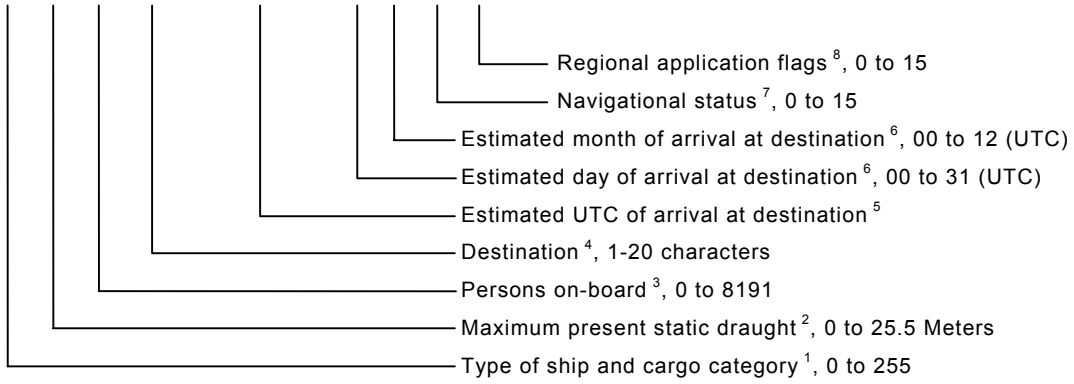
1= Keyboard and display are either unknown or unable to support communication.

NOTE 5 The source identifier contains the Talker ID of the equipment at this location

VSD – AIS Voyage static data

This sentence is used to enter information about a ship's transit that remains relatively static during the voyage. However, the information often changes from voyage to voyage. The parameters in this sentence support a number of the ITU-R M.1371 messages.

$--VSD,x.x,x.x,x.x,c—c,hhmmss.ss,xx,xx,x.x,x.x*hh<CR><LF>



NOTE 1 Type of ship and cargo category are defined under Message 5 of ITU-R M.1371. The descriptions of ship and cargo are indicated by a number. The values are defined in ITU-T M. 1371, message 5. A null field indicates that this is unchanged.

NOTE 2 The draught is reported in units of metres. valid range is 0 to 25.5. The value 0 = not available and the value 25.5 indicates that the draught is 25.5 metres or more. A null field indicates that this is unchanged.

NOTE 3 Current number of persons on-board including crew. Valid range is 0 to 8191.The value 0 = not available and the value 8191 = 8191 or more people. A null field indicates that this is unchanged.

NOTE 4 The characters that can be used in the destination are listed in the ITU-R M.1371, 6-bit ASCI Table 14. Some of these characters are reserved characters in IEC 61162-1, table 1. These characters must be represented using the "A" method (see IEC 61162-1, clause 5.1.3). A null field indicates that the previously entered destination is unchanged. The string of characters "@@@@@@@@@@@@@@@@@@@@" are used to indicate that the ship's destination is not available.

NOTE 5 If the hour of arrival is not available, "hh" shall be set to 24. If the minute of arrival is not available, "mm" shall be set to 60. The seconds option "ss.ss" of the field may be set to "00" as the AIS unit only broadcasts hours and minutes. A null field indicates that this is unchanged.

NOTE 6 The day and month of arrival are in UTC. The field is a fixed two-digit number requiring leading zeros. If the day of arrival is not available, "00" shall be the number for the day. If the month of arrival is not available, "00" shall be the number for the month. A null field indicates that this is unchanged.

NOTE 7 The Navigational status is indicated using the following values, a null field indicates the status is unchanged (ref. ITU-R M.1371, Message 1, Navigational status parameter):

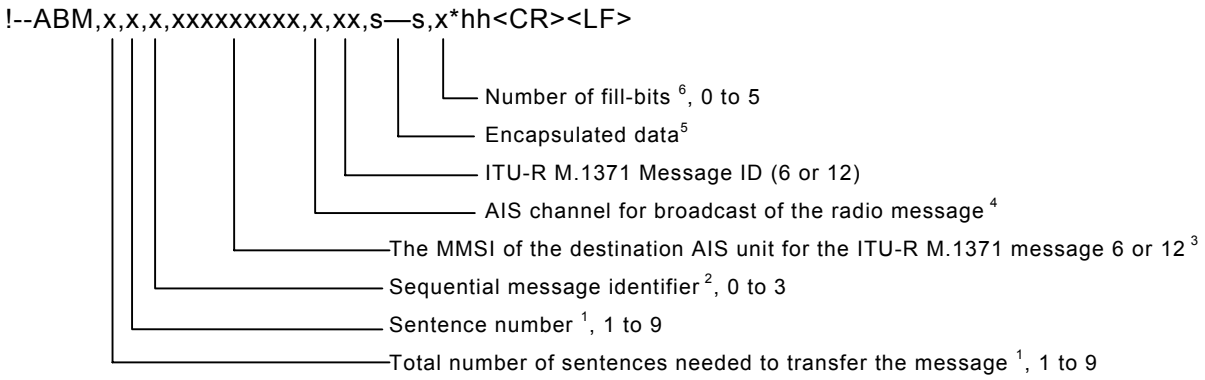
0 = under way using engine	4 = constrained by draught	9 = reserved for High Speed Craft (HSC)
1 = at anchor	5 = moored	10 = reserved for Wing In Ground (WIG)
2 = not under command	6 = aground	11 to 14 = reserved for future use
3 = restricted manoeuvrability	7 = engaged in fishing	15 = default
	8 = under way sailing	

NOTE 8 Definition of values 1 to 15 provided by a competent regional authority. Value shall be set to zero (0), if not used for any regional application. Regional applications shall not use zero. A null field indicates that this is unchanged (ref. ITU-R M.1371, Message 1, reserved for regional applications parameter).

7 New encapsulation sentence structures for the AIS

ABM – AIS Addressed binary and safety related

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



NOTE 1 The total number of sentences required to transfer the binary message data to the AIS unit. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. All sentences contain the same number of fields. Successive sentences may use null fields for fields that have not changed, such as fields 4, 5, and 6.

NOTE 2 This sequential message identifier serves two purposes. It meets the requirements as stated in clause 1.3.2, and it is the sequence number utilised by ITU-R M.1371 in message types 6 and 12. The range of this field is restricted by ITU-R M1371 to 0 - 3. The sequential message identifier value may be re-used after the AIS unit provides the "ABK" acknowledgement for this number. (See the ABK sentence)

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

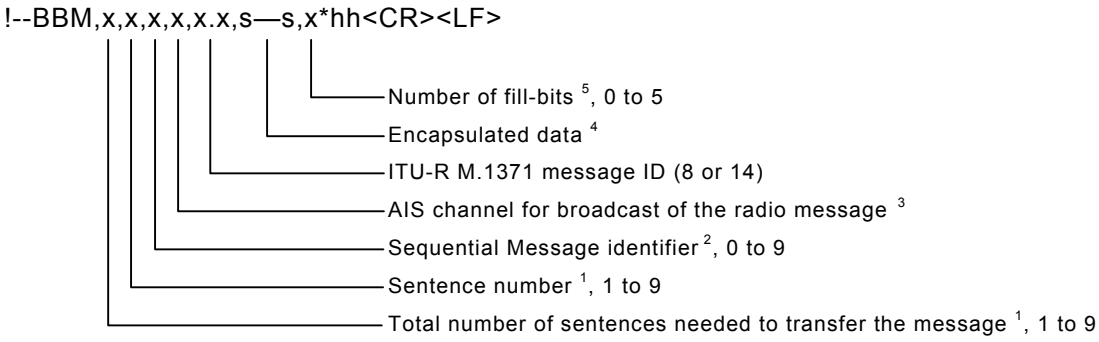
NOTE 4 The AIS channel that shall be used for the broadcast: 0 = no broadcast channel preference, 1 = Broadcast on AIS channel A, 2 = Broadcast on AIS channel B, 3 = Broadcast message on both AIS channels, A and B.

NOTE 5 This is the content of the "binary data" parameter for ITU-R M.1371 messages 6, or the "Safety related Text" parameter for message 12. Up to 936 bits of binary data (156 Six Bit coded characters) using multi-line sentences. The first sentence may contain up to 48 valid Six-bit codes (288 bits). Following sentences may contain up to 60 valid Six-bit codes (360 bits), if fields 4, 5, and 6 are unchanged from the first sentence and set to null. The actual number of valid characters must be such that the total number of characters in a sentence does not exceed the "82-character" limit.

NOTE 6 This cannot be a null field. See "x^4 " in annex A, "Fill bits field" description.

BBM - AIS Broadcast Binary Message.

This sentence supports generation of ITU-R M.1371 Binary messages 8 and 14. This provides the application with a means to broadcast data, as defined by the application only. Data is defined by the application only – not the AIS. This message offers great flexibility for implementing system functions that use the AIS unit as a digital broadcast device. After receiving this sentence, via the IEC 61162-2 interface, the AIS unit initiates a VHF broadcast of either message 8 or 14 within four seconds. (See the ABK sentence for acknowledgement of the BBM).



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

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

NOTE 3 The AIS channel that shall be used for the broadcast: 0 = no broadcast channel preference, 1 = Broadcast on AIS channel A, 2 = Broadcast on AIS channel B, 3 = Broadcast the message on both AIS channels A and B.

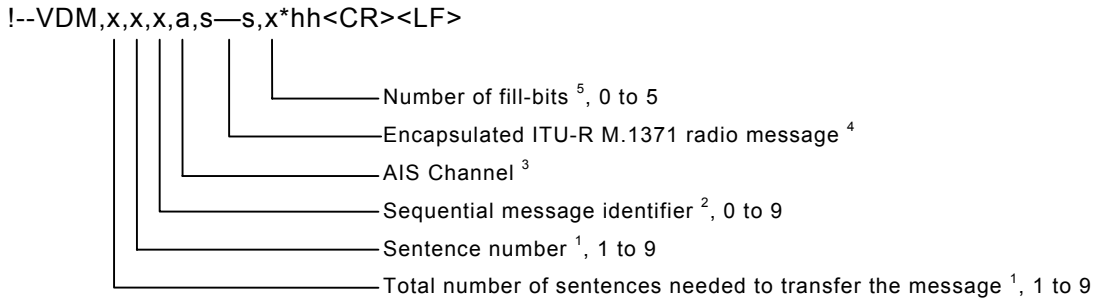
NOTE 4 This is the content of the “binary data” parameter for ITU-R M.1371 messages 8,19 and 21, or the “Safety related Text” parameter for message 14. The first sentence may contain up to 58 valid “Six-bit” symbols (348 bits). The following sentences may contain up to 60 valid “Six-bit” symbols (360 bits), if fields 4 and 5 are unchanged from the first sentence and set to null. The actual number of characters must be such that the total number of characters in a sentence does not exceed the “82-character” limit.

NOTE 5 This cannot be a null field. See “x^4” in annex A, “Fill bits field” description.

VDM – AIS VHF data-link message

This sentence is used to transfer the entire contents of a received AIS message packet, as defined in ITU-R M.1371 and as received on the VHF Data Link (VDL), using the “six-bit” field type. The structure provides for the transfer of long binary messages by using multiple sentences.

Data messages should be transmitted in as few sentences as possible. When a data message can be accommodated in a single sentence, then it shall not be split.



NOTE 1 The length of an ITU-R M.1371 message may require the transmission of multiple sentences. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These cannot be null fields.

NOTE 2 The Sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This shall be a null field for messages that fit into one sentence.

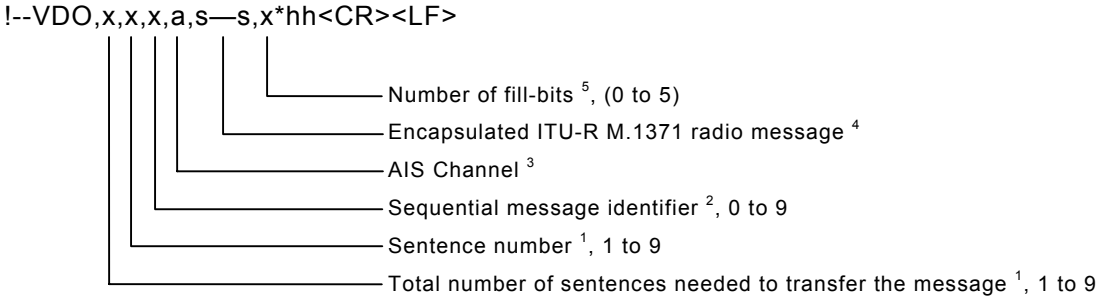
NOTE 3 The AIS channel is indicated as either “A” or “B”. This channel indication is relative to the operating conditions of the AIS unit when the packet is received. This shall be a null field when the channel identification is not provided. The VHF channel numbers for channels “A” and “B” are obtained by using a “query” (See IEC 61162-1, clause 5.3.2) of the AIS unit for an ACA sentence.

NOTE 4 This field supports a maximum of 62 valid characters for messages transferred using multiple sentences, and 63 valid characters for messages using a single sentence.

NOTE 5 This cannot be a null field. See “x^4” in annex A, “Fill bits field” description.

VDO - AIS VHF Data-link Own-vessel report

This sentence is used to transfer the entire contents of an AIS unit's broadcast message packet, as defined in ITU-R M.1371 and as sent out by the AIS unit over the VHF Data Link (VDL) using the "Six-bit" field type. The sentence uses the same structure as the VDM sentence formatter.



NOTES 1-5 See VDM sentence notes. .

8 Data format protocol errors – error detection and handling

(New to IEC 61162-1)

Listening devices shall detect errors in data transmission including:

6.1 Checksum error

6.2 Invalid characters

6.3 Incorrect length of Talker identifier, sentence formatter and data fields.

6.4 Time out of sentence transfer

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

Annex A
(normative)

Approved encapsulation sentence structure

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

!aaccc,x^1,x^2,x^3,c—c,x^4*hh<CR><LF>

ASCII	HEX	DESCRIPTION
"!"	21	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.
x^1		Total Number Of Sentences field. Encapsulated information often requires more than one sentence. This field represents the total number of encapsulated sentences needed. This may be fixed or variable length, and is defined by the sentence definitions in clause 5.
x^2		Sentence Number field. Encapsulated information often requires more than one sentence. This field identifies which sentence of the total number of sentences this is. This may be fixed or variable length, and is defined by the sentence definitions in clause 5.
x^3		Sequential Message Identifier field. This field distinguishes one encapsulated message consisting of one or more sentences, from another encapsulated message using the same sentence formatter. This field is incremented each time an encapsulated message is generated with the same formatter as a previously encapsulated message. The value is reset to zero when it is incremented beyond the defined maximum value. The maximum value and size of this field is determined by the applicable sentence definitions in clause 5.
c—c		Data Sentence block. Follows sequential message identifier field and is a series of data fields consisting of one or more parametric data fields and one encapsulated data field. Data field sequence is fixed and identified by 3rd and subsequent characters of the address field (the "Sentence Formatter"). Individual data fields may be of variable length and are preceded by delimiters ",". The encapsulated data field shall always be the second to last data field in the sentence.
x^4		Fill Bits field. This field represents the number of fill bits added to complete the last Six bit coded character. This field is required and shall immediately follow the encapsulated data field. To encapsulate, the number of binary bits must be a multiple of six. If it is not, one to five Fill bits are added. The Fill Bits field shall always be the last data field in the sentence. This shall not be a null field.
"*"	2A	Checksum Delimiter. Follows last data field of the sentence. It indicates that the following two alphanumeric characters show the HEX value of the Checksum.
hh		Checksum Field. The absolute value calculated by exclusive-OR'ing the 8 data bits (no start bits or stop bits) of each character in the Sentence, between, but excluding "!" and "*". The hexadecimal value of the most significant and least significant 4 bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first. The Checksum field is required in all transmitted sentences.
<CR><LF>	0D 0A	Terminates Sentence.

Annex B
(normative)

Summary of changes to existing IEC 61162-1 clauses which have been modified to include encapsulation sentences

B.1 Message

(New definition to IEC 61162-1)

Message: A message consists of 2 or more sentences with the same sentence formatter. Messages are used when 2 or more sentences are needed to convey related data that exceeds the maximum sentence length. This only applies to those sentence formatters that are defined with the key fields supporting multi-sentence messages. See B.3 below.

B.2 Sequential Message Identifier

(New note to IEC 61162-1)

This field is critical to identifying groups of 2 or more sentences that make up a multi-sentence message. This field is incremented each time a new multi-sentence message is generated with the same sentence formatter. The value is reset to zero when it is incremented beyond the defined maximum value. The maximum value, size and format of this field is determined by the applicable sentence definition in clause 7. This is one of three key fields supporting the multi-sentence message capability. See B.3 below.

B.3 Multi-sentence Messages

(New note to IEC 61162-1)

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

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

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

B.4 Proprietary Sentences

(See IEC 61162-1 clause 5.3.3)

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:

"$" or "!"	Hex 24 or Hex 21- 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.

B.5 Future additions to Approved sentences

(New note to IEC 61162-1)

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

B.6 Changes to the Reserved Character List

(See IEC 61162-1 clause 6.1 Table 10)

Changes to the reserved character list are as follows:

Table 1 - reserved characters

ASCII	HEX	DEC	Description
!	21	33	Start of Encapsulation sentence delimiter
<del>	7F	127	Reserved for future use

B.7 Changes to Character Symbol Table

(See IEC 61162-1 clause 6.1 Table 3)

Table 3 - Character symbol table

S	South; Statute miles; Statute miles/hour; Shaft; Salinity in parts per thousand
s	Seconds; Six bit number

B.8 Additions to field type summary :

(See IEC 61162-1 clause 6.2, Table 6)

Three new data field types have been added.

Field Type	Symbol	Definition
Variable HEX field	h—h	Variable length HEX numbers only, MSB on the left.
Fixed Six-bit field	ss___	Fixed length Six bit coded characters only. See table C-1 and figures C-1 and C-2 for field conversions
Variable Six -bit field	s—s	Variable length Six bit coded characters only. See table C-1 and figures C-1 and C-2 for field conversions

In addition a new note has been added describing the representation of fixed field types in sentence definitions.

NOTE 4: Fixed length field definitions show the actual number of characters. For example, a field defined to have a fixed length of 5 HEX characters is represented as hhhhh between delimiters in a sentence definition.

Annex C
(normative)

Six bit binary field conversion

Valid Characters (see IEC 61162-1 Table 2)

Binary Field, Most Significant Bit on the left. The two MSB's of the Valid Characters are not used.

Table C-1 -.Six-bit binary field conversion table :

Valid Character	Binary Field
0	000000
1	000001
2	000010
3	000011
4	000100
5	000101
6	000110
7	000111
8	001000
9	001001
:	001010
;	001011
<	001100
=	001101
>	001110
?	001111
@	010000
A	010001
B	010010
C	010011
D	010100
E	010101
F	010110
G	010111
H	011000
I	011001
J	011010
K	011011
L	011100
M	011101
N	011110
O	011111

Valid Character	Binary Field
P	100000
Q	100001
R	100010
S	100011
T	100100
U	100101
V	100110
W	100111
‘	101000
a	101001
b	101010
c	101011
d	101100
e	101101
f	101110
g	101111
h	110000
i	110001
j	110010
k	110011
l	110100
m	110101
n	110110
o	110111
p	111000
q	111001
r	111010
s	111011
t	111100
u	111101
v	111110
w	111111

The six bit binary field conversion can be done mathematically as well as with table C-1.

The algorithm to convert a 6-bit binary field to the appropriate 8-bit valid IEC 61162-1 character field is shown in figure C-1, (see below). Similarly, an algorithm can also be used to convert the valid IEC 61162-1 characters to the 6-bit binary values as shown in figure C-2 (see below).

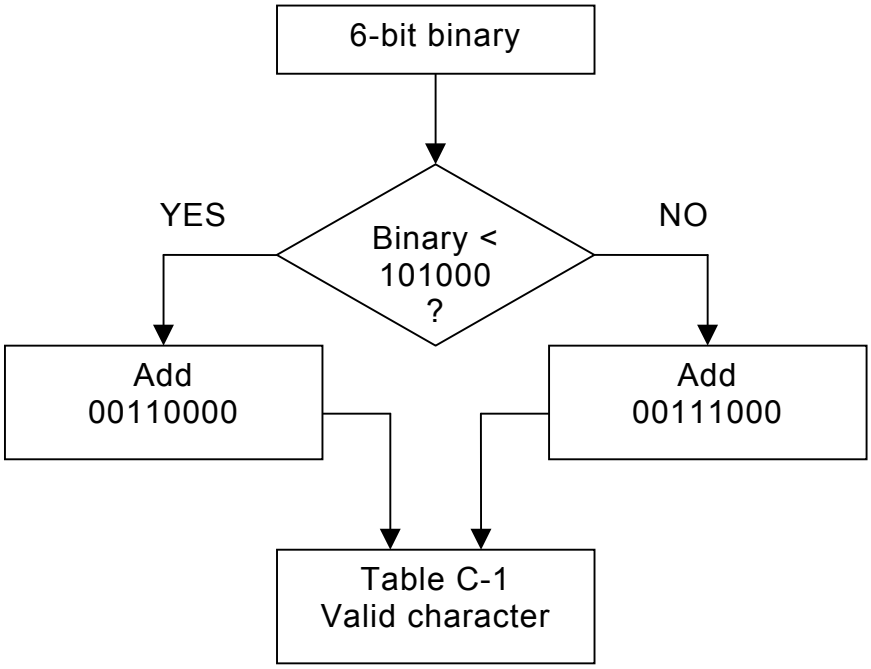


Figure C-1 - 6-bit binary code converted to valid IEC 61162-1 character

Consider the following examples:

000001 is less than 101000, therefore add 00110000

00110000

00110001 = 31_{hex} = 1 (see IEC 61162-1, Table 2)

000010 is less than 101000, therefore add 00110000

00110000

00110010 = 32_{hex} = 2 (see IEC 61162-1, Table 2)

111010 is not less than 101000, therefore add 00111000

00111000

01110010 = 72_{hex} = r (see IEC 61162-1, Table 2)

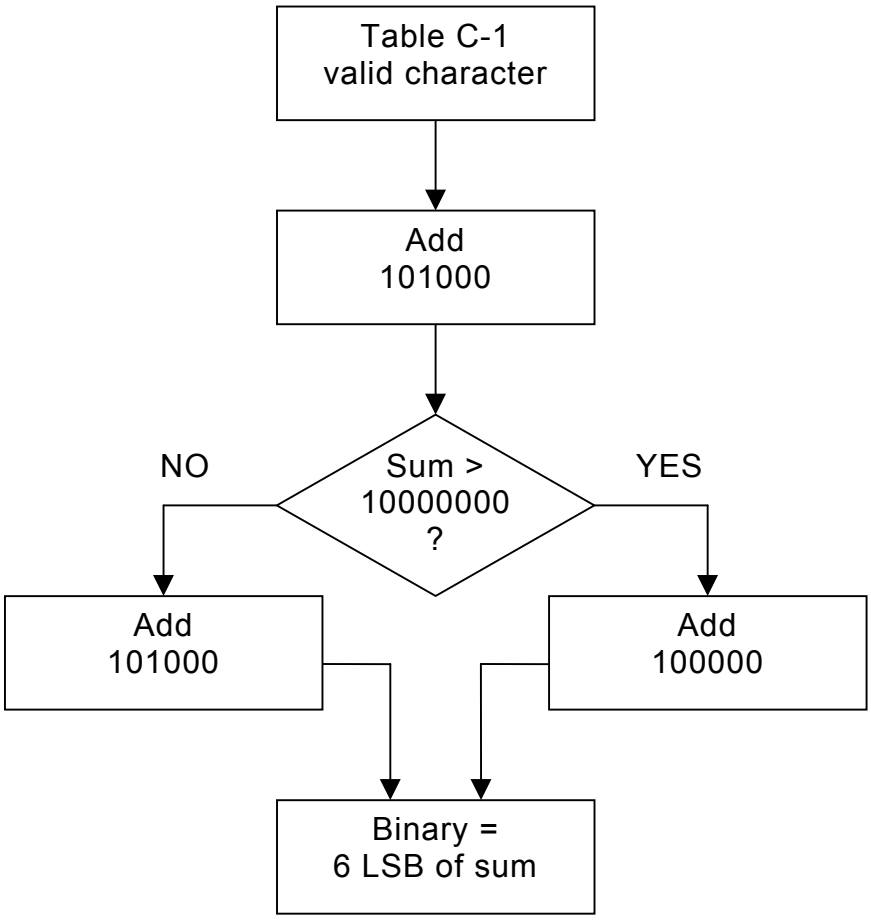


Figure C-2 - Valid IEC 61162-1 character converted to 6-bit binary code

Consider the previous examples:

The valid character “1” (00110001):

00110001 + 101000 = 01011001 which is not greater than 10000000.
Therefore, add 101000 to 01011001 = 10000001 and take the six right bits.
000001 are the six binary bits represented by a “1”.

The valid character “2” (00110010):

00110010 + 101000 = 01011010 which is not greater than 10000000.
Therefore, add 101000 to 01011010 = 10000010 and take the six right bits.
000010 are the six binary bits represented by a “2”.

The valid character “r” (01110010):

01110010 + 101000 = 10011010 which is greater than 10000000.
Therefore, add 100000 to 10011010 = 10111010 and take the six right bits.
111010 are the six binary bits represented by a “r”.

Annex D
(informative)

Example encapsulation sentences

D.1 New clause 7 to IEC 61162-1

7.2 Example Encapsulation Sentences

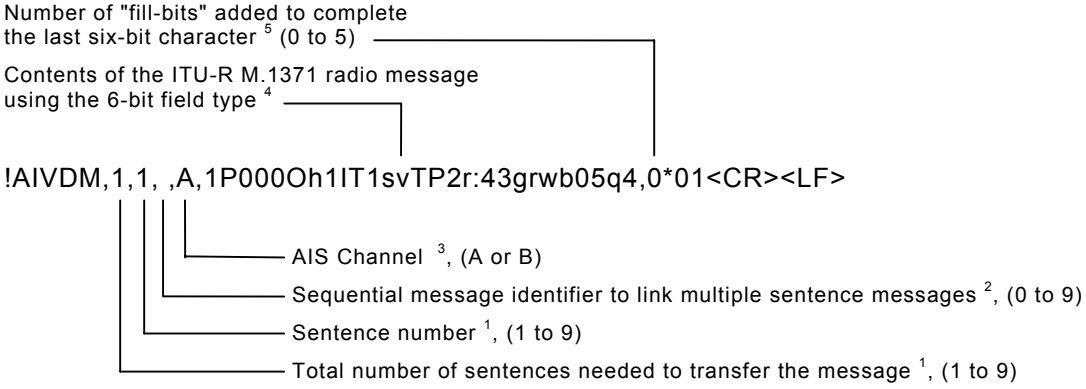
These examples are intended as samples of correctly constructed encapsulation sentences. They are representative samples only and show part of the wide range of legal variations possible with sentences. They should not necessarily be used as templates for sentences.

7.2.1 AIS VHF data-link message VDM sentence encapsulation example

Introduction

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

What follows is a practical example of how encapsulated binary coded data might be translated into meaningful information. The example is drawn from the operation of universal Automatic Identification System (AIS) equipment built to the ITU-R M.1371 recommendations. The sample sentence that will be used in this example is:



NOTES 1-5 See VDM sentence notes.

Also included with this example are:

- A worksheet for decoding and interpreting and encapsulated field,
- Annex E, a copy of Table 15 from ITU-R M.1371-1:2000.

D.2 Background Discussion - encapsulation coding

Before considering the decoding process, it is necessary to understand the source of the binary bits encapsulated in this string. AIS is a series of radio broadcasts that use the marine VHF band. A number of messages may be broadcast by an AIS unit. The bit-by-bit descriptions of the contents of these messages are documented in tables contained in the ITU-R M.1371 international standard for AIS. Annex E is a sample from ITU-R M.1371-

1:2000. This table identifies all of the information needed to convert the encapsulated binary bits into information. The table identifies the bits, gives them parametric names, and units.

The bits listed in ITU-R M.1371, Table 15 are the Message Data portion of a larger packet of binary bits that are created and broadcast by an AIS unit. The sample VDM-sentence shown above is an example of the output that would be created by every AIS unit that properly received a single AIS unit's broadcast. The following diagram, Figure 5, shows the message data portions of the "radio packet" that is created and broadcast by an AIS unit. Only the message data bits (those described in the tables - such as ITU-R M.1371, Table 15) are encapsulated in the string contained in the VDM-sentence.

Message Data (maximum of 168 bits for one-slot, maximum of 1008 bits for five-slot)

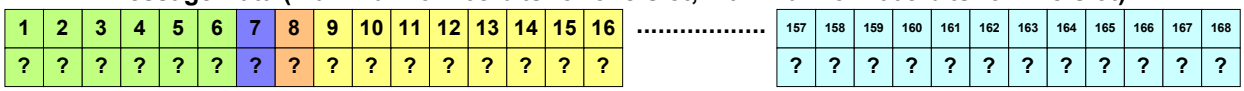


Figure D-1 - Message Data format

Assume, as an example, that the first 12 bits of the Message Data in Figure 5 (bits 1 to 12) are: 000001100000. These would be the first 12 bits coded into the VDM encapsulate string. The VDM-sentence encapsulates data using the symbols of the "Six-bit" Field Type. Each of the 64 possible combinations of one's and zero's that can make up a six bit binary string has been assigned a unique valid character. These assignments are listed in the "table C-1 - Six-bit binary field conversion table" (see annex C).

For example, the first 12 bits would be divided into six bit strings, that is: 000001 and 100000. Using table C-1, the binary string 000001 can be represented by a "1", and the binary string 100000 can be represented by a "P". The first two characters in the VDM-sentence encapsulated string would then be "1P". Note that observing upper and lower case letters is important when using table C-1.

The maximum number of Message Data bits that can be contained in an AIS radio message is 1008 bits. This number of bits requires 168 Six-bit symbols. This quantity of characters is greater than can be accommodated by a single standard sentence. The encapsulation sentence structure has been designed to allow an encapsulation field to be broken into smaller strings that are transferred using multiple sentences. The important point to remember is that the encapsulation fields from a multiple sentence group, identified by the sequence number field and order by sentence number fields, be recombined into one continuous encapsulation string.

Although the string being used in this example can fit into one sentence, it could also be split and transferred using two sentences. In fact, it need not be split at any specific point. The two sentence pairs below are equivalent and are proper sentences for the transfer of the same encapsulation string.

```
!AIVDM,2,1,7,A,1P000Oh1IT1svT,0*58<CR><LF>
!AIVDM,2,2,7,A,P2r:43grwb05q4,0*0C<CR><LF>


!AIVDM,2,1,9,A,1P000Oh1IT1svTP2r:43,0*7B<CR><LF>
!AIVDM,2,2,9,A,grwb05q4,0*2F<CR><LF>
```

Note that the complete encapsulated Message Data string itself does not change in the two pairs, but that the "checksum" for the sentences does change. Using either VDM encapsulation pair, the encapsulated string remains: `1P000Oh1IT1svTP2r:43grwb05q4`.

Figure D-1 shows the Message Data as a horizontal table of bits. This can be shown in other ways. The left table in figure D-2 shows how the Message Data bits can be redrawn in a table with 6 columns and as many rows as are needed to hold all the Message Data bits. The numbers in each of the table positions indicates the Message Data position of the bit in the AIS unit's broadcast. Organising the bits in this manner allows easy use of the conversion information shown in table C-1 (see annex C).

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

D.3 Decoding the Encapsulated String

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

- Receives a broadcast message,
- Organises the binary bits of the Message Data into 6-bit strings,
- Converts the 6-bit strings into their representative valid characters - see table C-1,
- Assembles the valid characters into an encapsulation string, and
- Transfers the encapsulation string using the VDM sentence formatter.

Again, the sample sentence that will be used in this decoding and interpretation example is:

!AIVDM,1,1,,A,1P000Oh1IT1svTP2r:43grwb05q4,0*01<CR><LF>

A calculation shows that the checksum, 71_{HEX}, is correct. This permits the interpretation of the sentence 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 "A" channel. Also, no bits were added to the binary string when it was encapsulated. The remainder of this example will focus on the proper interpretation of string: **"1P000Oh1IT1svTP2r:43grwb05q4".**

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

1) The string symbols are converted back into the binary strings that they represent.
2) The binary strings are organised or parsed using the rules contained in the referenced document, in this case ITU-R M.1371-1:2000, Table 15.
3) The referenced document rules are used to convert the binary strings into the relevant information.

D.4 Conversion from symbols to binary bits

Figure D-2 is a visual aid that can be used to follow this process for the example string. The table on the left side of figure D-2, **VDM bit positions**, is provided as a reference that can be used to identify the exact bit position of the corresponding binary bit in the table on the right side, **Bits represented by encapsulation symbol**, of figure D-2. The use of this "reference grid" will become clearer as the example is discussed.

Down the centre of figure D-2 is a column into which the example string has been entered from top to bottom. The arrows in figure D-2 provide an idea about how the logic of the decoding process proceeds. Decoding of the VDM encapsulated string begins with the first

symbol in the string. In this case the symbol is "1" and the corresponding binary string from table C-1 is "000001". The binary string is entered in the grid to the right of the "1", as indicated by the arrow. These six 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 D-2.

The second symbol in the string, "P", is processed next. The "P" represents the binary string "100000". This binary string is entered into the next row of the right grid - VDM bit positions 7 to 12. The same process is followed for each of the symbols of the encapsulate string down to the last one, which is a "4". The "4" represents the binary string "000100". This binary string is entered into the "last" row of the right grid - VDM bit positions 163 to 168.

The process of loading up the right grid with binary strings is a mechanical process that has nothing to do with the information content of the encapsulated binary data. It is simply the reverse process from what the AIS unit did to create the encapsulation string during the process of creating the VDM-sentence.

D.5 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 D-2 have a variety of shaded (grey) 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 Annex E.

The parameters listed in ITU-R M.1371-1:2000, Table 15 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 ITU-R M.1371-1:2000, Table 15 is used to establish the bits that apply to each of the parameters. Once established, this ordering of bits will be the same for every "message 1". That is, until the reference table itself is changed.

This same ordering should be done for each of the referenced AIS message tables. For example, if, after the decoding process was complete, and bits 1-6 were 000101, the VDM message identified would be message 5 ($000101_2 = 5_{10}$). This references the "Ship Static and Voyage related data" message - Table 17 of ITU-R M.1371-1:2000.

The process or organising the decoded binary Message Data requires:

1) Identification of the message number, and
2) Organising or parsing the binary bits following the appropriate message table(s).

D.6 Interpreting the Decoded Binary Strings

Final conversion of the organised bits into useful information involves the use of the:

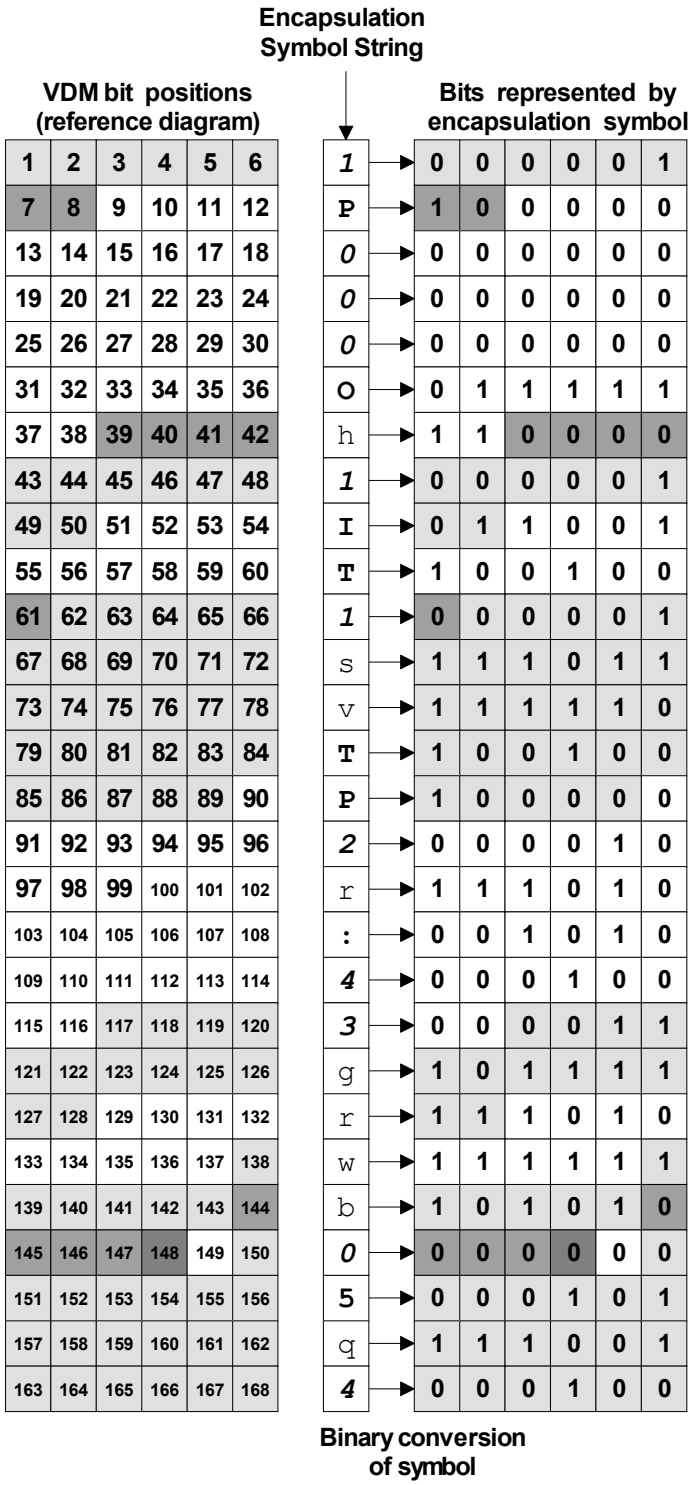
a) Organised bits - right side of figure D-2, and
b) The parameters descriptive information defined in annex E.

For example, the parameter "Repeat Indicator" is two bits - bits 7 and 8. Inspection of Message Data bits 7-8, figure D-2, shows that the value is "10"$_2$. The descriptive information in annex E for "Repeat Indicator" explains that "10" should be interpreted as "repeated twice". This conclusion is recorded in the space to the right of figure D-2.

The next parameter in ITU-R M.1371-1:2000, Table 15, is the "User ID" (the MMSI number of the AIS unit that broadcast this message). This is a 30 bit binary integer. The conversion, $1111111_2 = 127_{10}$, discloses this unit's MMSI as 127.

This process continues down ITU-R M.1371-1:2000, Table 15. The results of each interpretation of the decoded binary Message Data are shown on the worksheet to the right of figure D2.

*1P000*Oh*1*IT*1*sv*TP2*r:*43*grwb*05*q*4*



1	2	3	4	5	6								
7	8	9	10	11	12	P	1	0	0	0	0	0
13	14	15	16	17	18	0	0	0	0	0	0	0
19	20	21	22	23	24	0	0	0	0	0	0	0
25	26	27	28	29	30	0	0	0	0	0	0	0
31	32	33	34	35	36	O	0	1	1	1	1	1
37	38	39	40	41	42	h	1	1	0	0	0	0
43	44	45	46	47	48	1	0	0	0	0	0	1
49	50	51	52	53	54	I	0	1	1	0	0	1
55	56	57	58	59	60	T	1	0	0	1	0	0
61	62	63	64	65	66	1	0	0	0	0	0	1
67	68	69	70	71	72	s	1	1	1	0	1	1
73	74	75	76	77	78	v	1	1	1	1	1	0
79	80	81	82	83	84	T	1	0	0	1	0	0
85	86	87	88	89	90	P	1	0	0	0	0	0
91	92	93	94	95	96	2	0	0	0	0	1	0
97	98	99	100	101	102	r	1	1	1	0	1	0
103	104	105	106	107	108	:	0	0	1	0	1	0
109	110	111	112	113	114	4	0	0	0	1	0	0
115	116	117	118	119	120	3	0	0	0	0	1	1
121	122	123	124	125	126	g	1	0	1	1	1	1
127	128	129	130	131	132	r	1	1	1	0	1	0
133	134	135	136	137	138	w	1	1	1	1	1	1
139	140	141	142	143	144	b	1	0	1	0	1	0
145	146	147	148	149	150	0	0	0	0	0	0	0
151	152	153	154	155	156	5	0	0	0	1	0	1
157	158	159	160	161	162	q	1	1	1	0	0	1
163	164	165	166	167	168	4	0	0	0	1	0	0

Bits 1-6 = Identifier for this message

000001 = **message 1** (Reference Annex E of ITU-R M.1371-1:2000 to interpret following bits 7-168.)

Bit 7-8 = Repeat Indicator

2 = **message repeated twice**

Bits 9-38 = MMSI number of broadcasting unit

000000000000000000000001111111 = **127**

Bits 39-42 = Navigational status

0000 = **underway using engine**

Bits 43-50 = Rate of turn (equation used)

00000101 **= +1.1 degrees/minute**

Bits 51-60 = Speed over ground

1001100100 = **61.2 knots**

Bit 61 = Position accuracy

0 = **low (greater than 10 meters)**

Bits 62-89 = Longitude in 1/10000 minutes

000011110111111101001001000 0 =
27 degrees 5 minutes East

Bits 90-116 = Latitude in 1/10000 minutes

000001011101000101000010000 =
5 degrees 5 minutes North

Bits 117-128 = Course over ground in 1/10 degrees

001110111111 = **95.9 degrees true**

Bits 129-137 = True Heading

101011111 = **351 degrees true**

Bits 138-143 = UTC second when report generated

110101 = **53 seconds past the minute**

Bits 144-147 = Regional Application

0000 = **no regional application**

Bits 148 = Spare

Bit 149 = RAIM Flag

0 = **RAIM not in use**

Bit 150-168 = Communications State

00 = **UTC Direct**
001 = **1 frames remaining until a new slot is selected, UTC hour and minute follow,**
01111001000100 = 01111:0010001 = **15 : 17 UTC**
Bits 167-168 not used for UTC Sub-message

Figure D-2 - Work sheet for decoding and interpreting encapsulated string

Annex E
(informative)

Copy of ITU-R M.1371-1:2000, TABLE 15

Table E-1 - Messages 1, 2, and 3: position reports

Parameter	Number of bits	Description
Message ID	6	Identifier for this message 1, 2 or 3
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Refer to § 4.6.1; 0 - 3; default = 0; 3 = do not repeat any more.
User ID	30	MMSI number
Navigational status	4	0 = under way using engine, 1 = at anchor, 2 = not under command,3 = restricted manoeuvrability, 4 = Constrained by her draught; 5= Moored; 6 = Aground; 7 = Engaged in Fishing; 8 = Under way sailing; 9 = reserved for future amendment of Navigational Status for HSC; 10 = reserved for future amendment of Navigational Status for WIG; 11 - 14 = reserved for future use; 15 = not defined = default
Rate of turn $ROT_{[AIS]}$	8	± 127 (–128 (80 hex) indicates not available, which should be the default). Coded by $ROT_{[AIS]}$=4.733 SQRT($ROT_{[IND]}$) degrees/min $ROT_{[IND]}$ is the Rate of Turn (720 degrees per minute), as indicated by an external sensor. + 127 = turning right at 720 degrees per minute or higher; - 127 = turning left at 720 degrees per minute or higher
SOG	10	Speed over ground in 1/10 knot steps (0-102.2 knots) 1023 = not available, 1022 = 102.2 knots or higher
Position accuracy	1	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10 m; Autonomous Mode of e. g. GNSS receiver or of other Electronic Position Fixing Device) ; default = 0
Longitude	28	Longitude in 1/10 000 min (±180 degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 min (±90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
COG	12	Course over ground in 1/10° (0-3599). 3600 (E10 hex)= not available = default; 3601 – 4095 should not be used
True Heading	9	Degrees (0-359) (511 indicates not available = default).
Time stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which should also be the default value, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 61 if positioning system is in manual input mode or 63 if the positioning system is inoperative)
Reserved for regional applications	4	Reserved for definition by a competent regional authority. Should be set to zero, if not used for any regional application. Regional applications should not use zero.
Spare	1	Not used. Should be set to zero
RAIM-Flag	1	RAIM (Receiver Autonomous Integrity Monitoring) flag of Electronic Position Fixing Device; 0 = RAIM not in use = default; 1 = RAIM in use)
Communication State	19	See § 3.3.7.2.2 and § 3.3.7.3.2
Total number of bits	168	

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