



BSI Standards Publication

Maritime navigation and radiocommunication equipment and systems — Automatic identification system (AIS)

Part 1: AIS Base Stations — Minimum operational and performance requirements, methods of testing and required test results

National foreword

This British Standard is the UK implementation of EN 62320-1:2015. It is identical to IEC 62320-1:2015. It supersedes BS EN 62320-1:2007+A1:2009 which will be withdrawn on 24 February 2018.

The UK participation in its preparation was entrusted to Technical Committee EPL/80, Maritime navigation and radiocommunication equipment and systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2015

ISBN 978 0 580 86734 7

ICS 47.020.70

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2015.

Amendments/corrigenda issued since publication

Date	Text affected
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English Version

Maritime navigation and radiocommunication equipment and systems - Automatic identification system (AIS) - Part 1: AIS Base Stations - Minimum operational and performance requirements, methods of testing and required test results (IEC 62320-1:2015)

Equipements et systèmes de navigation et de radiocommunication maritimes - Systèmes d'identification automatique (AIS) - Partie 1: Stations de base AIS - Exigences minimales opérationnelles et de performance, méthodes de mesure et résultats de test minimum attendus (IEC 62320-1:2015)

Navigations- und Funkkommunikationsgeräte und -systeme für die Seeschifffahrt - Automatische Identifikationssysteme (AIS) - Teil 1: AIS-Basisstationen - Mindest-Betriebs- und Leistungsanforderungen, Prüfverfahren und geforderte Prüfergebnisse (IEC 62320-1:2015)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 80/736/CDV, future edition 2 of IEC 62320-1, prepared by IEC/TC 80 "Maritime navigation and radiocommunication equipment and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62320-1:2015.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-11-24
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-02-24

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here:

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<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61108-1	-	Maritime navigation and radiocommunication equipment and systems - Global navigation satellite systems (GNSS) -- Part 1: Global positioning system (GPS) - Receiver equipment - Performance standards, methods of testing and required test results	and EN 61108-1	-
IEC 61162-1	2010	Maritime navigation and radiocommunication equipment and systems - Digital interfaces -- Part 1: Single talker and multiple listeners	and EN 61162-1	2011
IEC 61993-2	-	Maritime navigation and radiocommunication equipment and systems - Automatic Identification Systems (AIS) -- Part 2: Class A shipborne equipment of the automatic identification system (AIS) - Operational and performance requirements, methods of test and required test results	and EN 61993-2	-
IEC 62287-1	2010	Maritime navigation and radiocommunication equipment and systems - Class B shipborne equipment of the automatic identification system (AIS) -- Part 1: Carrier-sense time division multiple access (CSTDMA) techniques	and EN 62287-1	2011
IEC 62320-2	-	Maritime navigation and radiocommunication equipment and systems - Automatic identification system (AIS) -- Part 2: AIS AtoN stations - Operational and performance requirements, methods of testing and required test results	and EN 62320-2	-
IALA Recommendation A-124	-	On Automatic Identification System (AIS)-Shore Station networking aspects relating to the AIS Service		-
IMO Resolution-MSC.74(69)	-	Performance standards for an Universal-shipborne automatic identification systems (AIS)		-
ITU-R Recommendation M.1084-4	-	Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service		-

ITU-R	-	Technical characteristics for a universal-	-
Recommendation		shipborne automatic identification system	
M.1371-1		using time division multiple access in the	
		VHF maritime mobile band	
RTCM	10402-	RTCM Recommended Standards for-	-
version 2.4		Differential GNSS (Global Navigation	
		Satellite Systems) Service	

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INTRODUCTION

Chapter V of the International Convention for the Safety of Life at Sea 1974 (SOLAS) requires mandatory carriage of Automatic Identification System (AIS) equipment on all vessels constructed on or after 01 July 2002. Carriage for other types and sizes of SOLAS Convention vessels was required to be completed not later than 31 December 2004.

SOLAS Chapter V, Regulation 19, states that AIS shall:

- a) provide automatically to appropriate equipped shore stations, other ships and aircraft information, including ship's identity, type, position, course, speed, navigational status and other safety-related information;
- b) receive automatically such information from similarly fitted ships;
- c) monitor and track ships; and
- d) exchange data with shore-based facilities.

In addition, the IMO performance standards for AIS state that:

- The AIS should improve the safety of navigation by assisting in the efficient navigation of ships, protection of the environment, and operation of Vessel Traffic Services (VTS), by satisfying the following functional requirements:
 - 1) in a ship-to-ship mode for collision avoidance;
 - 2) as a means for littoral States to obtain information about a ship and its cargo; and
 - 3) as a VTS tool, i.e. ship-to-shore (traffic management).
- The AIS should be capable of providing to ships and to competent authorities, information from the ship, automatically and with the required accuracy and frequency, to facilitate accurate tracking. Transmission of the data should be with the minimum involvement of ship's personnel and with a high level of availability.

The provision of Shore Based AIS is necessary to attain the full benefit of the SOLAS Convention requirements.

This part of IEC 62320 provides the minimum operational and performance requirements, methods of test and the required test results for AIS Base Stations. The testing is divided into three sections, the transceiver tests, the logical tests and the Presentation Interface tests. These are captured in Clauses 8, 9 and 10 respectively. The method used for testing is that the EUT should meet all the tests requirements of Clause 8 before proceeding to Clause 9. Likewise, the unit should meet all of the test requirements before proceeding to Clause 10. Clause 10 has also been prioritised so that the tests are progressive.

Clauses 5 to 7 provide functional requirement information and Clause 8 provides the general test environment for the EUT.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – AUTOMATIC IDENTIFICATION SYSTEM (AIS) –

Part 1: AIS Base Stations – Minimum operational and performance requirements, methods of testing and required test results

1 Scope

This part of IEC 62320 specifies the minimum operational and performance requirements, methods of testing and required test results for AIS Base Stations, compatible with the performance standards adopted by IMO Resolution MSC.74 (69), Annex 3, Universal AIS. It incorporates the technical characteristics of non-shipborne, fixed station AIS equipment, included in recommendation ITU-R M.1371 and IALA Recommendation A-124. Where applicable, it also takes into account the ITU Radio Regulations. This standard takes into account other associated IEC international standards and existing national standards, as applicable.

This standard is applicable for AIS Base Stations. It does not include specifications for the display of AIS data on shore.

2 Normative references

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

IEC 61108-1, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61162-1:2010, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IEC 61993-2, *Maritime navigation and radiocommunication equipment and systems – Automatic identification systems (AIS) – Part 2: Class A shipborne equipment of the automatic identification system (AIS) – Operational and performance requirements, methods of test and required test results*

IEC 62287-1:2010, *Maritime navigation and radiocommunication equipment and systems – Class B shipborne equipment of the automatic identification system (AIS) – Part 1: Carrier-sense time division multiple access (CSTDMA) techniques*
IEC 62287-1:2010/AMD1:2013

IEC 62320-2, *Maritime navigation and radiocommunication equipment and systems – Automatic identification system (AIS) – Part 2: AIS AtoN Stations – Operational and performance requirements, methods of testing and required test results*

IMO Resolution MSC.74 (69), Annex 3, *Recommendation on performance standards for an universal shipborne automatic identification system (AIS)*

ITU-R Recommendation M.1084-4, *Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service*

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

RTCM 10402 – *RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service*

IALA Recommendation A-124 *on Automatic Identification System (AIS). Shore Station and networking aspects relating to the AIS Service*

3 Abbreviations

AIS	Automatic Identification System
AtoN	Aids to Navigation
BER	Bit Error Rate
BIIT	Built-In Integrity Tests
BT	Bandwidth Time product
CommState	Communication State

NOTE Communication state is defined in Recommendation ITU-R M.1371-4. It is used to indicate whether the AIS is using the message structure for SOTDMA or ITDMA.

DGNSS	Differential Global Navigation Satellite System
EPFS	Electronic position fixing system
EUT	Equipment under test
FATDMA	Fixed Access Time Division Multiple Access
GNSS	Global Navigation Satellite System
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organization
ITU	International Telecommunication Union
LFR	Limited Frequency Range
MAC	Medium Access Control
MMSI	Maritime Mobile Service Identity
NM	Nautical Mile
NRZI	Non-Return to Zero Inverted
PER	Packet Error Rate
P _c	Carrier Power
PI	Presentation Interface
PPS	Pulse Per Second
PSS	Physical Shore Station
RAIM	Receiver Autonomous Integrity Monitoring
RATDMA	Random Access Time Division Multiple Access
RSSI	Received signal strength indicator
Rx	Receive
SFI	Specific Frequency of Interest

TDMA	Time Division Multiple Access
Tx	Transmit
UI	Unique Identifier
UTC	Universal Time Co-ordinated
VDL	VHF Data Link
VSWR	Voltage Standing Wave Ratio
VTs	Vessel Traffic Services

4 Functional layout of an AIS Base Station

4.1 General

The Base Station may be designed for dependent only operation or independent operation. Both are under some control of the Physical Shore Station (PSS) as defined in the IALA Recommendation A-124.

- dependent Base Station accesses the VHF data link (VDL) using only the combination of linked TSA+VDM sentences (see Table 1), as provided by the PSS.
- An independent Base Station accesses the VDL using either the combination of linked TSA+VDM sentences as provided by the PSS or by using internal control. When operated as an independent Base Station the unit may be delegated certain autonomous functionality under the supervisory control of the PSS.

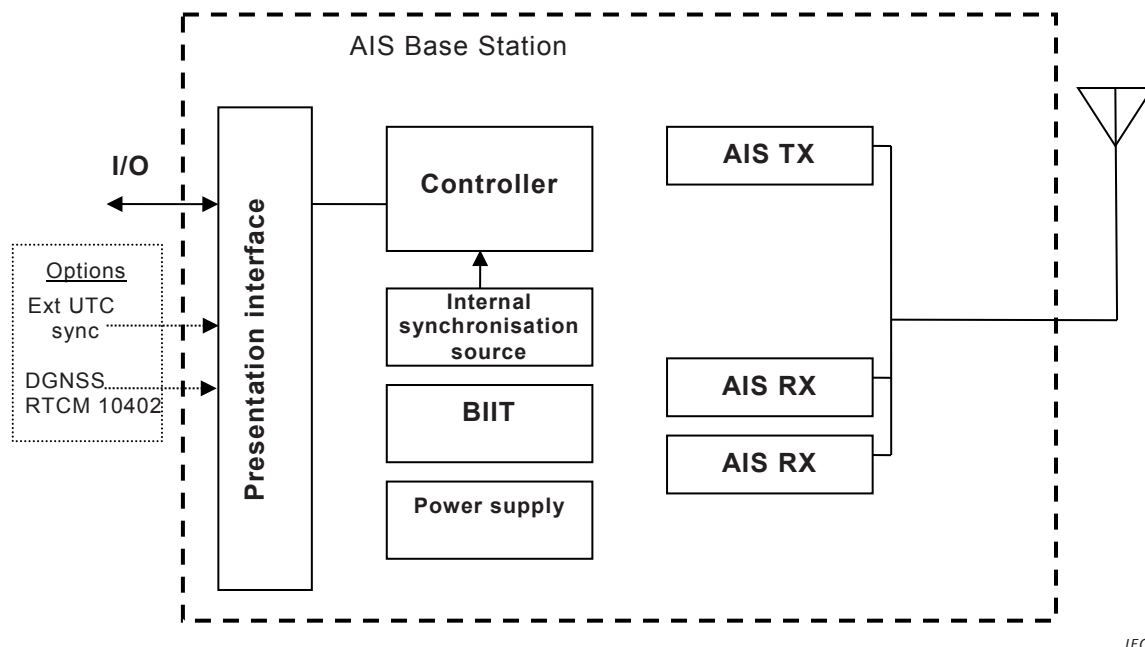
The PSS, or external controlling entity, is responsible for Base Station configuration, transmission scheduling, and processing of received information. Presentation Interface (PI) text sentences are used to configure the Base Station, schedule message transmissions, and output information.

When TSA and VDM sentences are used, the PSS is responsible for ensuring the integrity of the VDL.

The tests in this standard are for all Base Stations. Additional tests for independent Base Stations are indicated by a note located at the beginning of each appropriate test section.

4.2 Functional block diagram of an AIS Base Station

Figure 1 shows the principal components of the AIS Base Station.



IEC

Figure 1 – Functional block diagram of an AIS Base Station

As a minimum, the following functional elements are required for the AIS Base Station:

- two multi-channel receivers;
- one multi-channel TDMA transmitter;

NOTE Since the minimum configuration of the AIS Base Station has only one transmitter, the AIS Base Station cannot transmit on both AIS Channels (AIS A and AIS B) simultaneously.

- a controlling unit;
- an internal synchronisation source, which may also be used as a position sensor for independent Base Stations. If used as a position source, the internal GNSS receiver shall meet the appropriate requirements of IEC 61108-1;
- a Built-In-Integrity-Test unit (BIIT), which shall provide alarms;
- a power supply;
- a Presentation Interface (PI), which allows the AIS Base Station to exchange sentences with the PSS;
- optional features, for example: DGNSS (RTCM 10402); external synchronisation; DSC functionality.

4.3 General VDL requirements

4.3.1 Sources of VDL messages for transmission

The AIS Base Station interacts with the VDL by receiving and transmitting VDL messages.

In order to transmit VDL messages, the Base Station may derive the messages to be transmitted from three sources:

- generate and transmit VDL messages autonomously as per the configuration received via sentences;
- generate and transmit VDL messages automatically based on data input received via the PI, using different sentences from that of the VDM;

- c) transmit predefined VDL messages input via the PI. The VDM sentence shall be used to input the content of the VDL messages via the PI to the AIS Base Station. The VDL message shall then be transmitted by the Base Station on the VDL.

When operating the Base Station independently, these three VDL message sources shall be supported in parallel.

When operating the Base Station dependently, only VDM messages received via the PI shall be transmitted as noted in item c) above.

4.3.2 Use of access schemes

4.3.2.1 Dependent operation

When operating as a dependent Base Station the FATDMA access scheme shall be used. The Base Station shall use the slot(s) provided by the combination of linked TSA+VDM sentences. The TSA sentence provides the channel and start slot information. The actual number of slots used is based on the number of bits conveyed by the VDM sentence(s).

Dependent operation shall not use the RATDMA access scheme.

4.3.2.2 Independent operation

The default access scheme for a Base Station shall be FATDMA.

The AIS Base Station may also use RATDMA access schemes if implemented. The AIS Base Station may use the FATDMA and RATDMA access schemes concurrently. The use of pre-reserved FATDMA slots shall take priority over RATDMA access.

When using the FATDMA access scheme, the absolute slot numbers for transmission shall be determined by one of the following methods:

- the PI combination of linked TSA+VDM sentences shall provide the absolute slot number in which the AIS Base Station transmits;
- the AIS Base Station shall autonomously select an appropriate pre-reserved FATDMA slot as determined by its configuration.

Both methods shall be available and operate concurrently.

4.4 Functional diagram for operation of a Base Station

Figure 2 shows the principal components of an AIS Base Station. The diagram identifies the elements of the AIS Base Station and the PI with the PSS.

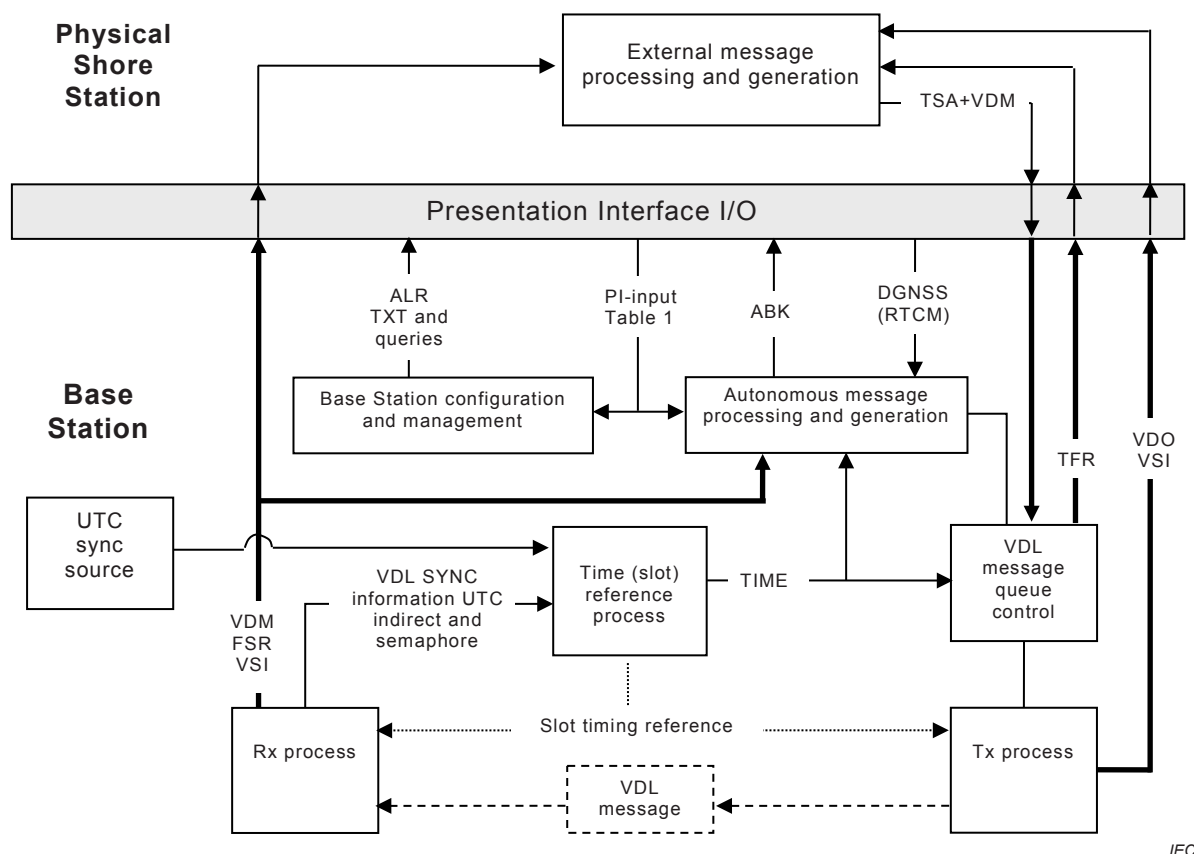


Figure 2 – Functional block diagram dependent and independent operation

The PI of an AIS Base Station consists of at least one input/output port. A specific choice for the physical input/output port is not specified. The purpose of the PI is to:

- exchange VDL messages with the PSS;
- configure the Base Station;
- enable real time control of the Base Station;
- provide an output for BIIT alarms and status.

The information exchange of the PI is supported by a combination of IEC 61162-1 sentences and Base Station sentences (see Table 1).

4.5 Base Station input/output sentence formatters

Table 1 lists sentence formatters used with a Base Station. It includes existing sentence formatters and sentence formatters developed for use with Base Stations. Annex A contains the details for each of the sentence formats developed for AIS Base Stations

Table 1 presents both input and output sentence formatters for dependent and independent operation. For Base Stations that support both independent and dependent operation, both sets of sentences are applicable. For Base Stations that only support dependent operation, the sentences for dependent operation are applicable and all other sentences are ignored.

The TAG block configuration sentences are not included in Table 1. They are in the separate Table 14.

The manufacturer shall declare if legacy configuration sentences are supported (see Annex B). Additionally, the manufacturer shall declare if the legacy comment blocks are

supported. If the manufacturer chooses to support the legacy sentences, all four legacy sentences should be supported. Legacy sentences are marked with footnote ^b in Table 1.

If the manufacturer declares that legacy sentences are supported the input of command sentences without sentence status flags shall be accepted.

Table 1 – Base Station input/output sentence formatters

Sentence formatter	Input independent	Input dependent	Output independent	Output dependent	Description
ABK ^d			X		Addressed and binary broadcast acknowledgement
ABM ^d	X				Addressed binary and safety related message
ACA ^e	X		Q		AIS regional channel assignment message
ACM ^a	X				Preparation and initiation of an AIS Base Station addressed channel message (VDL Message 22)
ACK ^e	X	X			Acknowledge alarm
ADS ^a			X	X	AIS Device Status (output interval configured by BCG and upon status change)
AGA ^a	X		Q		Preparation and initiation of an AIS Base Station broadcast of a group assignment message (Message 23)
AIR ^e	X				AIS interrogation request (VDL Message 15)
ALR ^e			X	X	Set alarm state
ASN ^a	X				Preparation and initiation of an AIS Base Station broadcast of assignment VDL Message 16
BBM ^d	X				Broadcast binary message
BCG ^a	X	X	Q	Q	Base Station configuration, General Command
BCL ^a	X	X	Q	Q	Base Station configuration, Location Command
CBR ^c	X		Q		Configure Broadcast Rate for Message 26
DLM ^a	X		Q		Data Link Management slot allocations for Base Station (VDL Message 20 – FATDMA reservations)
ECB ^a	X		Q		Configure broadcast rates for Base Station messages with epoch planning support
FSR ^a			X	X	Frame summary of AIS reception, defined by SPO. The manufacturer shall declare the parameters that are supported
MEB ^c	X		Q		Message input for Broadcast for Message 26
NAK ^c			X	X	Negative Acknowledgement
RST ^a	X	X	X	X	Equipment Reset Command
SID ^a	X	X	Q	Q	Installation of a station's identification
SPO ^a	X	X	Q	Q	Select AIS device's reception processing and output
TFR ^a			X	X	Transmit feed-back report – Base Station report on status of requested transmission. Automatic

Sentence formatter	Input independent	Input dependent	Output independent	Output dependent	Description
					status response of TSA+VDM
TPC ^a	X				Transmit Slot Prohibit command
TSA ^a	X	X			Transmit Slot Assignment – used to identify AIS time slot used to transmit the content of a VDM sentence. TSA shall precede the VDM sentence
TSR ^a			X		Transmit Slot Prohibit status Report. Automatic status response of TPC
VDM ^e	X	X	X	X	VHF Data-link message
VDO ^e			X	X	VHF Data-link Own-vessel message
VER ^e			Q	Q	Version information about equipment. Provided in response to ABQ
VSI ^a			X	X	VDL Signal Information, defined by SPO. The manufacturer shall declare the parameters that are supported and the corresponding accuracy. The VSI shall follow its associated VDM/VDO
BCE ^b	X	X	Q	Q	General Base Station configuration extended (Replaced by BCG)
BCF ^b	X	X	Q	Q	General Base Station configuration (Replaced by BCL)
CAB ^b	X	X	Q	Q	Control AIS Base Station (Replaced by RST)
TSP ^b	X				Transmit Slot Prohibit command (Replaced by TPC)
NOTE “X” indicates input to, or output from, the AIS Base Station. “Q” indicates that the sentence may be externally requested using the IEC 61162-1 query method.					
^a	See Annex A.				
^b	Optional legacy sentences for backward compatibility. See Annex B.				
^c	See Annex C.				
^d	See IEC 61993-2.				
^e	See IEC 61162-1.				

The AIS Base Station shall output, autonomously and periodically, the ADS sentence on the PI indicating the Base Station status. This shall be output by default once per minute or when there is a change in the status.

The Equipment Status Field of RST shall reflect the reason for reset or restart.

5 Functional definition of the radio interface of the AIS Base Station

5.1 General requirements of the physical layer

The following general requirements apply to all receivers and transmitter:

- a Base Station shall use simplex channels or duplex channels in either full-duplex or half-duplex mode;
- a Base Station shall be capable of 25 kHz emission/reception in accordance with ITU-R M.1084-4, Annex 3 (as referenced by Recommendation ITU-R M.1371);

- a Base Station shall be capable of transmitting using at least two different power settings, as provided for by ITU-R M.1371. The Base Station shall have the capability to set its power level as stipulated by an input command;
- a Base Station shall be capable of measuring RSSI of received messages on either channel.

5.2 Required parameter settings for the physical layer of the AIS Base Station

Table 2, Table 3 and Table 4 are derived from Recommendation ITU-R M.1371 and give the parameters required for an AIS Base Station.

NOTE For the meaning of the symbols and additional information refer to the appropriate clause of Recommendation ITU-R M.1371.

The constants of the physical layer of the AIS Base Station shall comply with the values given in Table 3 and Table 4.

Table 2 – Required parameter settings for an AIS Base Station

Symbol	Parameter name	Low setting	High setting
PH.RFR	Regional frequencies	156,025 MHz	162,025 MHz
PH.CHS	Channel spacing	25 kHz	25 kHz
PH.AIS1	AIS 1 (default channel 1)	161,975 MHz	161,975 MHz
PH.AIS2	AIS 2 (default channel 2)	162,025 MHz	162,025 MHz
PH.CHB	Channel bandwidth	25 kHz	25 kHz
PH.BR	Bit rate	9 600 bit/s	9 600 bit/s
PH.TS	Training sequence Always start with a zero (0101010...)	24 bit	24 bit
PH.TST	Transmitter settling time (Transmit power within 20 % of final value, frequency stable to within 1,0 kHz of final value)	≤1,0 ms	≤1,0 ms

Table 3 – Required settings of physical layer constants

Symbol	Parameter name	Value
PH.DE	Data encoding	NRZI
PH.FEC	Forward error correction	Not used
PH.IL	Interleaving	Not used
PH.BS	Bit scrambling	Not used
PH.MOD	Modulation	Bandwidth adapted; GMSK (see Table 4)

Table 4 – Bandwidth related parameters of the physical layer of the AIS Base Station

Symbol	Parameter name	PH.CHB
PH.TXBT	Transmit BT-product	0,4
PH.RXBT	Receive BT-product	0,5
PH.MI	Modulation index	0,50

5.3 Minimum requirements for the TDMA transmitter of the AIS Base Station

The minimum technical characteristics as specified in Table 5 shall apply to the TDMA transmitters.

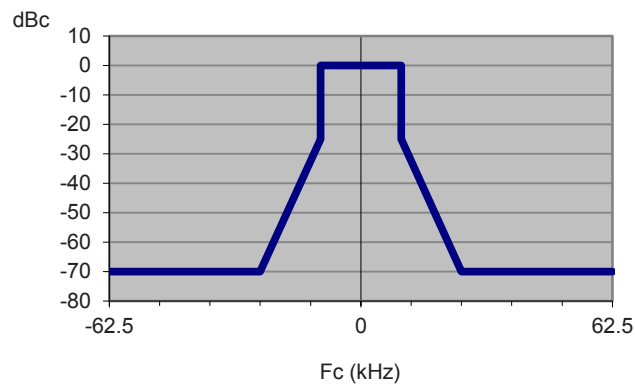
Table 5 – Minimum required TDMA transmitter characteristics

Transmitter parameters	Requirement	Condition
Frequency error	± 500 Hz normal $\pm 1\,000$ Hz extreme	
Carrier power (P_{ss})	41 dBm high power setting 30 dBm low power setting	$\pm 1,5$ dB normal and ± 3 dB extreme, conducted
Modulation spectrum (slotted transmission)	0 dBc below straight line between -25 dBc at ± 10 kHz and -70 dBc at ± 25 kHz -70 dBc or -36 dBm whatever is higher.	$\Delta f_c < \pm 10$ kHz ± 10 kHz $< \Delta f_c < \pm 25$ kHz ± 25 kHz $< \Delta f_c < \pm 62,5$ kHz
Intermodulation attenuation	≥ 40 dB	
Modulation accuracy	$< 3\,400$ Hz $2\,400$ Hz ± 480 Hz $2\,400$ Hz ± 240 Hz normal ± 480 Hz extreme $1\,740$ Hz ± 175 Hz normal ± 350 Hz extreme $2\,400$ Hz ± 240 Hz normal ± 480 Hz extreme	Bit 0, 1 Bit 2, 3 Bit 4 ... 31 Test signal 0101... Test signal 00001111...
Power versus time characteristics	Transmission delay: 0 s Ramp up time: 833 μ s Ramp down time: 833 μ s Transmission duration: $\leq 26\,624$ μ s	See Figure 4 and Table 6 Nominal 1 time slot transmission
Spurious emissions	-36 dBm -30 dBm	9 kHz 1 GHz 1 GHz 4 GHz

The emission mask for 25 kHz channel mode is:

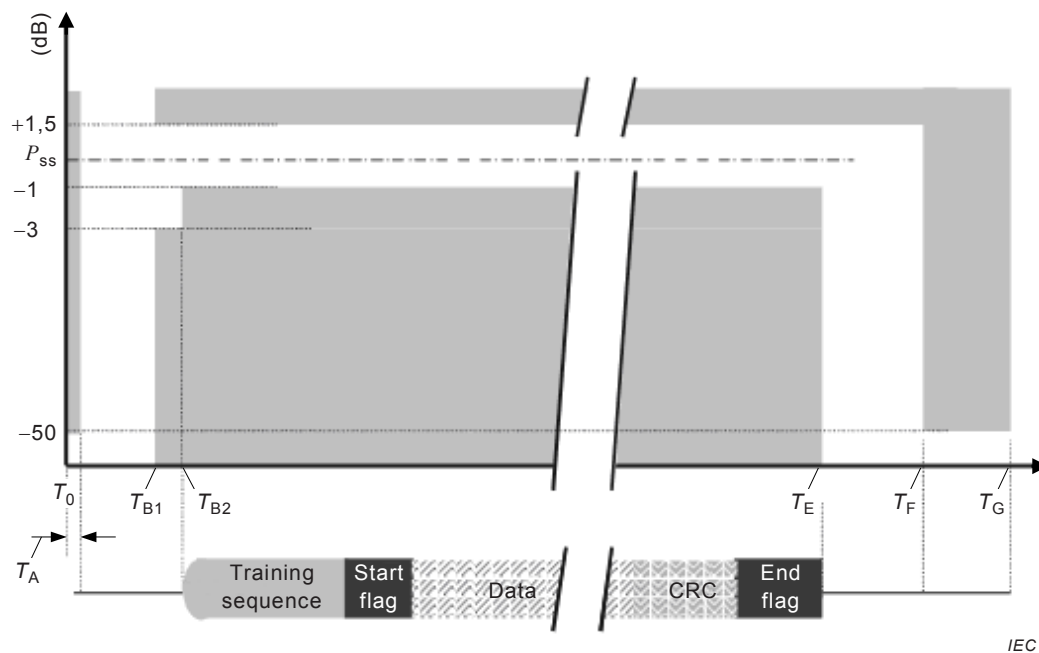
- at ± 10 kHz removed from the carrier, the modulation sidebands are below -25 dBc;
- at ± 25 kHz to $\pm 62,5$ kHz removed from the carrier, the modulation sidebands are below -70 dBc, with no need to be below -36 dBm;
- in the region between ± 10 kHz and ± 25 kHz removed from the carrier, the modulation sidebands shall be below a line specified between these two points.

The emission mask for 25 kHz channel mode (see Figure 3) is as follows.



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Figure 3 – Modulation spectrum for slotted transmission



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Figure 4 – Power versus time mask

Table 6 – Definition of timings for Figure 4

Reference	Bits	Time	Definition
T_0	0	0 ms	Start of transmission slot. Power shall NOT exceed -50 dB of P_{ss} before T_0
T_A	0 to 6	0 ms to 0,625 ms	Power exceeds -50 dB of P_{ss}
T_B	T_{B1} 6	0,625 ms	Power shall be within $+1,5$ or -3 dB of P_{ss}
	T_{B2} 8	0,833 ms	Power shall be within $+1,5$ or -1 dB of P_{ss}
T_E (includes 1 stuffing bit)	233	24,271 ms	Power shall remain within $+1,5$ or -1 dB of P_{ss} during the period T_{B2} to T_E
T_F (includes 1 stuffing bit)	241	25,104 ms	Power shall be -50 dB of P_{ss} and stay below this
T_G	256	26,667 ms	Start of next transmission time period

There shall be no modulation of the RF after the termination of transmission (T_E) until the power has reached zero and next slot begins (T_G). Note that bits take priority over time in applying the mask. Milliseconds are provided for guidance.

The AIS installation, when operating, should not be damaged by the effects of open circuited or short circuited antenna terminals.

5.4 Minimum requirements for the TDMA receivers of the AIS Base Station

The minimum technical characteristics as specified in Table 7 shall apply to the TDMA receivers.

Table 7 – Minimum TDMA receiver characteristics

Receiver parameters	25 kHz channels
Sensitivity	20 % PER at –107 dBm
Maximum error at high input levels	1 % PER at –7 dBm 1 % PER at –77 dBm
Co-channel rejection	20 % PER at –10 dB
Adjacent channel selectivity	20 % PER at 70 dB
Spurious response rejection	20 % PER at 70 dB
Intermodulation response rejection	20 % PER at 74 dB
Blocking	20 % PER at 86 dB
Accuracy of RSSI measurement	±3 dB at –50 to –107 dBm
Spurious emissions	9 kHz 1 GHz: –57 dBm 1 GHz 4 GHz: –47 dBm

5.5 Shutdown procedure for an AIS Base Station

An automatic transmitter hardware shutdown procedure and indication shall be provided in case a transmitter continues its transmission at the end of its transmission period. This feature shall be independent of the Base Station software control. The AIS Base Station shall shut down the TDMA transmitter in less than 2 s.

6 Requirements for AIS Base Station

6.1 General

This clause describes the requirements for a Base Station operating as a dependent or independent station.

The Base Station may be operated as an independent station that contains all of the functionality or as a dependent station that relies on external functionality. It is the responsibility of the competent authority to ensure proper operation.

When operated as a dependent Base Station, the unit operates under full control of the PSS.

When operated as an independent Base Station, the unit may be delegated certain autonomous functionality under the supervisory control of the PSS.

6.2 Dependent Base Station requirements

6.2.1 General rules

When operating as a dependent Base Station, the unit shall comply with the following general rules:

- each dependent AIS Base Station shall, as a default, be identified by its own individual MMSI on the VDL interface and the unique identifier on the PI interface. The AIS Base Station MMSI and unique identifier shall be configurable by means of a SID sentence via the PI;
- the dependent AIS Base Station shall be capable of transmitting messages with a different MMSI provided by the PSS by means of a standard VDM input sentence;
- the dependent AIS Base Station shall be able to receive all VDL messages;
- every received VDL message shall be passed to the PI as a VDM sentence without further data content processing;
- every received PI VDM sentence shall be transmitted on the VDL channel and beginning in the slot indicated by the linked TSA sentence without further data content processing;
- every message transmitted on the VDL shall be passed to the PI as a VDO sentence linked with a VSI sentence;
- the dependent AIS Base Station does not transmit Message 4 without PSS control;
- all transmissions are done via TSA+VDM PI input sentences;
- the dependent AIS Base Station shall not be semaphore qualified and shall not operate autonomously;
- when the UTC sync source is unavailable, the AIS Base Station shall use UTC indirect or shall be synchronised to another Base Station. Propagation delay shall be taken into consideration;
- upon request via the sentence VER, the dependent AIS Base Station shall provide its hardware and software version information.

6.2.2 General processing diagram

The AIS Base Station shall internally process data in accordance with Figure 5.

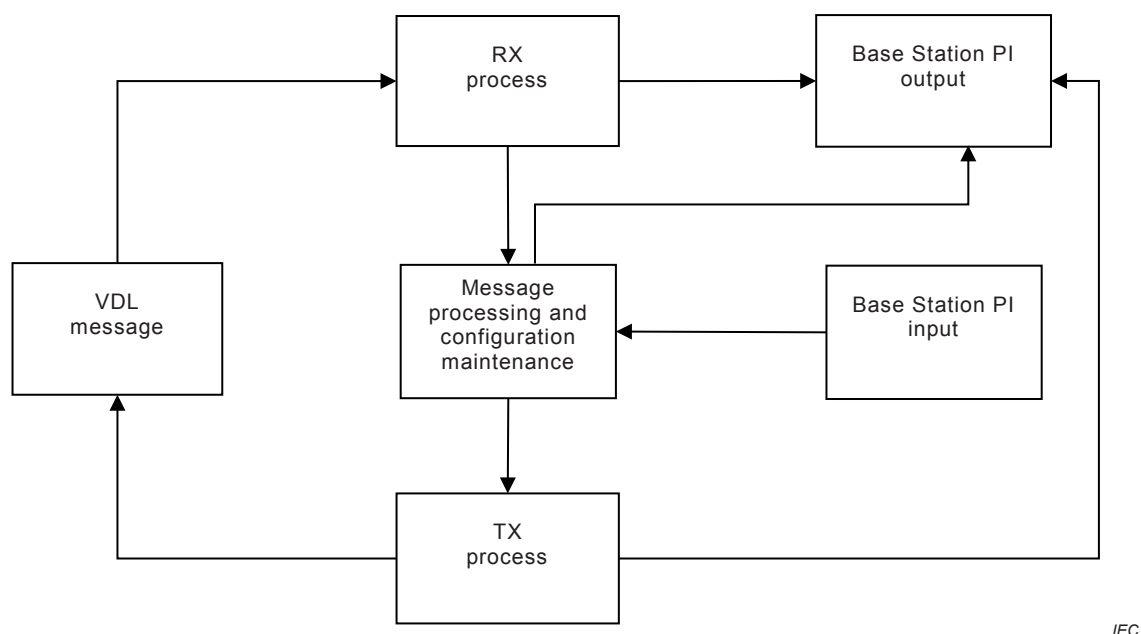


Figure 5 – General processing diagram

6.2.3 AIS Base Station response to PI input

The AIS Base Station shall respond to input sentences from the PI in accordance with Table 1, “output dependent” when operating as a dependent Base Station.

6.2.4 AIS Base Station response to VDL input

The AIS Base Station shall respond to input messages from the VDL in accordance with Table 8.

Table 8 – Base Station response to input messages from the VDL

VDL input	Resulting PI output	Resulting VDL output	Resulting VDL reporting rate
Any message (regardless of MMSI)	VDM, VSI	Nil	Nil
All messages in a frame (regardless of MMSI)	FSR	Nil	Nil

The required content of the FSR output is given in Table 10.

6.3 Independent Base Station requirements

6.3.1 General rules

Requirements for Base Stations operating as independent units are in addition to the requirements for Base Stations operating as a dependent unit.

When operating as an independent Base Station, the unit shall comply with the following general rules:

- with regard to the access schemes to the VDL, refer to 6.3.4 AIS Base Station interaction on the VDL;

- the independent AIS Base Station shall, as a default, use a surveyed position. When using a surveyed position, the “position accuracy” flag in VDL Message 4 shall be set upon configuration, and the “RAIM” flag shall be set to 0;
- when the UTC sync source is unavailable, the independent AIS Base Station shall use UTC indirect or the semaphore rules as defined by ITU-R M.1371;
- the independent AIS Base Station shall revert to semaphore behaviour upon detection of semaphore condition on the VDL;
- all VDL messages shall be as short as possible.

Note that in order to behave as a semaphore, the independent AIS Base Station is transmitting Message 4. The required increase of the reporting rate is autonomous. This behaviour is not influenced by FATDMA or RATDMA.

6.3.2 General processing diagram

The AIS Base Station shall internally process data in accordance with Figure 6.

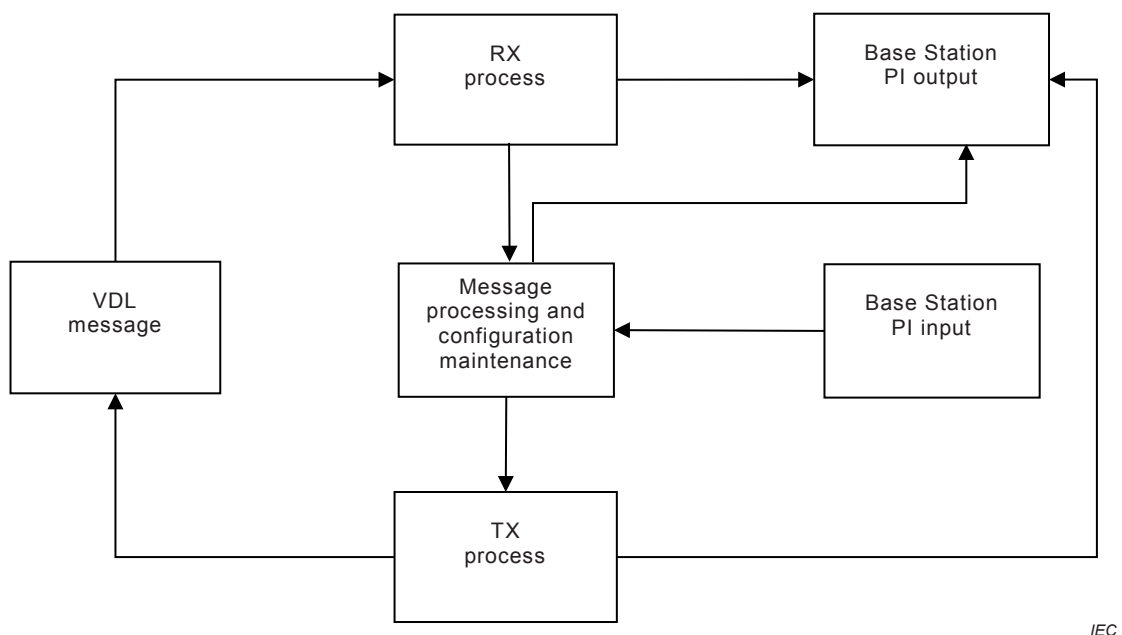


Figure 6 – General processing diagram

6.3.3 AIS Base Station response to PI input

6.3.3.1 General

The AIS Base Station shall respond to input sentences from the PI in accordance with Table 1, “output independent” when operating as an independent Base Station.

6.3.3.2 Requirements for configuration of FATDMA access scheme (Link Management Message)

Use of FATDMA is reserved for Base Stations operating as either dependent or independent.

6.3.3.3 Slot reuse

A Base Station’s transmission slots are protected by reservation of slots (Message 4 and 20) and the 120 nautical mile rule. Slots allocated or reserved by other Base Stations should not be used for RATDMA unless the other Base Station is located over 120 nautical miles from the Base Station.

6.3.3.4 Configuration of Data Link Management Messages

The Data Link Management Message (Message 20) is a continuously scheduled and transmitted message. The Data Link Management Message applies only to the frequency channel on which it is transmitted.

The Data Link Management Message shall be used by Base Station(s) to pre-announce the fixed allocation schedule (FATDMA) for one or more Base Station(s) and it shall be repeated as often as required.

The AIS Base Station shall use the ECB sentence to schedule the autonomously and continuously transmission of Data Link Management Messages, which refresh the FATDMA reservations.

6.3.4 AIS Base Station interaction on the VDL

6.3.4.1 General

The interaction of the AIS Base Station on the VDL is presented in Table 9. The required content of the VSI sentence is given in Table 10.

Table 9 – Base Station response to input messages from the VDL

VDL input	Resulting PI output	Resulting VDL output	Resulting VDL reporting rate
Any message (regardless of MMSI)	VDM, VSI ^c	Nil	Nil
Message 6 own MMSI	VDM, VSI ^c , VDO	Message 7	Once
Message 7 own MMSI	VDM, VSI ^c , ABK	Nil	Nil
Message 10 own MMSI	VDM, VSI ^c , VDO	Message 4	Once
Message 12 own MMSI	VDM, VSI ^c , VDO	Message 13	Once
Message 13 own MMSI	VDM, VSI ^c , ABK	Nil	Nil
Message 15 own MMSI	VDM, VSI ^c , VDO	Message 4 ^a or 24A/B ^b	Once
Semaphore qualified	VDO, VSI ^c	Message 4	3 1/3 s
Not semaphore qualified	VDO, VSI ^c	Message 4	10 s
^a If the AIS Base Station is set up for autonomous transmission, then the reply is on the next scheduled transmission. If the Base Station is not set up for autonomous transmission, then the Base Station shall respond within 4 s only if it is configured for RATDMA or FATDMA. ^b A base station shall respond with Message 24A and 24B within 4 s only if it is configured for RATDMA or FATDMA. ^c If VSI enabled.			

Table 10 – Required content of FSR and VSI output

Sentence	Field	Requirement
FSR	Hour, minute and second of report generation	Required
FSR	Channel being reported	Required
FSR	Total slots occupied by valid message received previous frame	Required
FSR	Total slots occupied by this station's transmissions previous frame	Required
FSR	Number of slots with CRC failures in the previous frame	Required
FSR	Total external slot reservations for current frame	Required
FSR	Average noise level during previous frame	Optional
FSR	Number of slots with received signal strength (at least 10 dB over average noise level). This includes slots with valid messages.	Optional
VSI	Hour, minute and second, and fractional-second of measurement	Required
VSI	First slot number of message	Required
VSI	Signal strength (dBm) of received VDL message.	Required
VSI	Signal to noise ratio (dB)	Optional

6.3.4.2 Transmission of DGNSS corrections

There are two possible ways to accept DGNSS corrections for transmission:

- as a result of a VDM sentence via the PI. All required information for transmission is included in the VDM sentence;
- via the dedicated optional DGNSS input port.

This standard provides tests for the VDM DGNSS corrections. A separate test for RTCM 10402 input data via the dedicated optional DGNSS port is provided in 10.6.

6.3.4.3 Autonomous Base Station report Message 4

The independent Base Station shall periodically generate the Base Station report (Message 4) with a reporting interval of 10 s according to its given configuration. The Base Station shall operate in this state until it detects that it is required to operate as semaphore. The Base Station shall then increase its update rate of Message 4 to MAC SyncBaseRate (one report per 3 1/3 s). Three minutes after the requirement for the Base Station to be semaphore has ceased it shall revert to the 10 s reporting interval.

6.3.4.4 Autonomous Tx of data link management messages

The DLM PI sentence shall be used to set up the link for use by the Base Station.

6.3.4.5 Requirements for acknowledgement/retries configuration

The number of retries for addressed messages as described in ITU-R M.1371 shall be input by configuration sentence BCG.

6.3.4.6 Requirements for assigned mode commands

Assignment commands shall be transmitted by a Base Station when operating as a controlling entity. The Base Station shall be able to assign a specified transmission schedule to a mobile station.

The reporting rate assigned by a Base Station shall be, as a minimum, 20 reports per 10 min and, as a maximum, 1 report per second.

The Base Station shall be capable of assigning two mobile stations simultaneously.

6.3.4.7 Autonomous response to interrogation

When a Base Station receives a Message 15 from a mobile station, it shall automatically provide a single response with the message number indicated by the Message 15 (see Table 9).

6.3.4.8 Requirements for the preset of the repeat-indicator

The independent Base Station shall preset the repeat indicator for own transmissions of all VDL messages to a value between 0 and 3 in accordance with Recommendation ITU-R M.1371. If no configuration was received, the AIS Base Station shall use the default value of zero.

NOTE By pre-set of the repeat indicator by non zero, the Base Station is disqualified from becoming an indirect sync source.

6.3.4.9 Requirements for messages initiated by ABM, BBM or AIR

The independent Base Station shall be able to receive ABM, BBM and AIR sentences on the PI, and it shall transmit the messages according to Table 11 in response to these sentences. The access scheme shall be either FATDMA or RATDMA according to the description in 6.3.4.10.

Table 11 – Base Station response to ABM, BBM and AIR input on the PI

Message type	PI input	PI output	Remarks
Message 6	ABM	VDO, ABK	
Message 8	BBM	VDO, ABK	
Message 10	AIR	VDO, ABK	
Message 12	ABM	VDO, ABK	
Message 14	BBM	VDO, ABK	
Message 15	AIR	VDO, ABK	
Message 25 Addressed	ABM	VDO, ABK	
Message 25 Broadcast	BBM	VDO, ABK	
Message 26 Addressed	ABM	VDO, ABK	
Message 26 Broadcast	BBM	VDO, ABK	

6.3.4.10 AIS Base Station response to VDM input

The Base Station shall transmit, on the VDL, VDM sentences received on the PI.

FATDMA shall be used as the access scheme for transmission. RATDMA may also be configured for use.

A transmission initiated by a VDM input shall not replace a scheduled message.

Messages 4, 11 and 20 shall not be transmitted.

Messages 15 and 16 shall not be transmitted if a slot offset is provided unless the slot offset is recalculated by the base station. Messages that have a Comm.state shall have the

Synch.state bits of the Comm.state set to the current status of the station. The remaining Comm.state bits shall be set to zero to prevent false slot allocations.

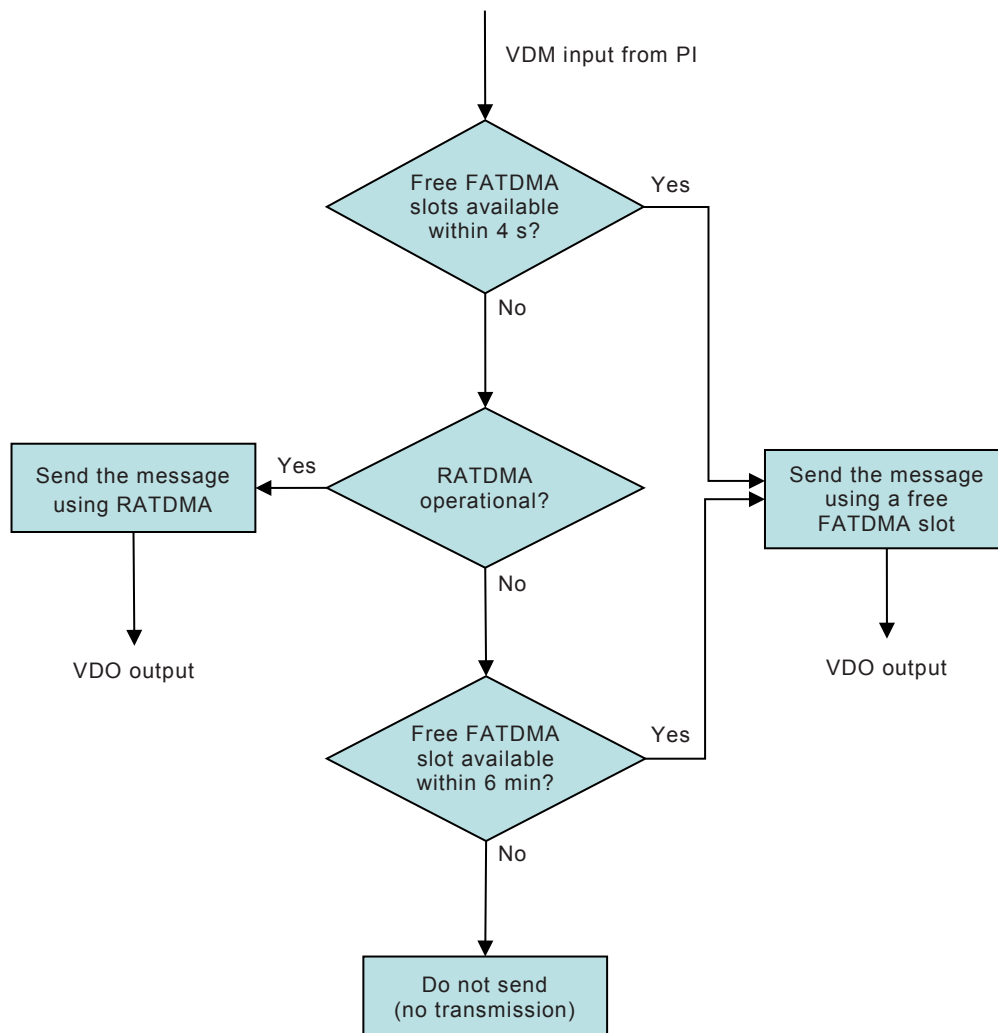
The repeat indicator shall be set to greater than zero before transmitting.

Any Message up to 27 shall be transmitted according to these rules.

After receiving a VDM sentence, the Base Station responds with the appropriate TFR sentence.

The following rules shall be used for VDL transmission (as shown in Figure 7):

- the VDL message shall be transmitted in available FATDMA slots;
- NOTE Available FATDMA slots are local 'L' slots without planned ECB transmissions.
- if FATDMA slots are not available within 4 s and RATDMA is available, then RATDMA shall be used;
 - if RATDMA is not available, and if there is an available FATDMA slot within 6 min, it shall be used;
 - if FATDMA and RATDMA are not available, there shall be no transmission and the VDM is discarded.



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Figure 7 – Flow diagram for AIS Base Station response to VDM input

6.3.4.11 Scheduled transmission of Message 24A

The Base Station shall be configurable for a scheduled transmission of Message 24A providing the base station name. This will be configured using the ECB sentence. The definition of the ECB sentence includes the definition of a transmission schedule for Message 24. The base station name is set using the BCL sentence.

6.3.4.12 Scheduled transmission of Message 26

The Base Station shall be configurable for up to 4 transmission schedules for Message 26. These will be configured using the CBR sentence. The content of Message 26 is set using the MEB sentence. A payload can be stored for each message ID index of the scheduled Message 26. If a MEB has not been provided for a particular message ID index, there shall be no transmission of the associated Message 26.

6.3.4.13 Requirements for management of mobile AIS stations by AIS Base Station

The following operational settings for mobile AIS stations shall be controlled by an AIS Base Station:

- a) regional area designation;
- b) regional working frequencies assignment;
- c) power level;
- d) Tx/Rx mode;
- e) transitional zone size;
- f) reporting rate;
- g) slot use (reservation);
- h) control of long-range broadcast Message 27.

The Base Station shall be able to control the transmission of Message 27 from the mobile stations within its coverage area. The coverage area is transmitted to the mobile stations using Message 23.

The Base Station shall be capable of storing a group assignment area for each station type.

To delete a group assignment area, an AGA sentence with station type (that is to be deleted) and default position, shall be sent to the Base Station.

Message 4 contains a bit called “transmission control for long-range broadcast message”. When this bit is set to 1, the mobile station shall transmit Message 27 if located within the coverage area of the Base Station transmitting the Message 4, as defined by Message 23.

6.3.5 Autonomous channel management

The ACA sentence shall be used to set up the channel management information for the AIS Base Station which shall result in transmission of Message 22. Transmission shall be in a sequential order.

The “in use” data field of the ACA sentence defines the status of the region (0 = not in use, 1 = in use). The Base Station shall support 8 regions.

If optional DSC functionality is included, the ACA sentence may be used for DSC channel management.

6.4 BIIT conditions

The AIS Base Station shall monitor the following BIIT conditions and shall generate the appropriate ALR sentences on the PI. The ALR sentence shall be output at least once per minute. The alarm conditions are noted in Table 12 and the resulting alarm status is sent via PI sentence ADS. If an alarm is active (acknowledged or not), the ADS alarm status field is set to A; if no alarm is active the field is set to V.

Table 12 – BIIT alarm conditions monitored by an AIS Base Station

Alarms description text	Alarm condition threshold exceeded	Alarm condition not exceeded	Alarm ID or text identifier	Reaction of the system to the alarm condition threshold exceeded
AIS: Tx malfunction	A	V	001	Stop transmission
AIS: Antenna VSWR exceeds limit	A	V	002	Continue operation
AIS: Rx channel A malfunction	A	V	003	Stop transmission on affected channel
AIS: Rx channel B malfunction	A	V	004	Stop transmission on affected channel
AIS: General failure	A	V	006	Stop transmission
AIS: Clock lost	A	V	007	Independent – follow synchronisation rules including semaphore. Dependent – follow synchronisation rules. Stop transmission when there is no synchronisation source.
AIS: No sensor position in use	A	V	026	Continue operation
AIS: Frame synchronisation failure	A	V	037	Stop transmission
AIS: DGNSS input failed ^a	A	V	038	Continue operation
A Alarm.				
V Valid.				
^a Optional.				

6.5 Default settings after reset

The Base Station shall have the configuration settings after a reset command given in Table 13.

Table 13 – Settings after reset command

Parameter	Sentence	Reset value/ action
Channel management area settings	ACA	No channel management areas
RATDMA on/ off	BCG (BCE)	0 = off
UTC source selection	BCG (BCE)	1 = internal source
ADS interval	BCG (BCE)	60 s
Rx and Tx channel A	BCG (BCF)	2 087
Rx and Tx channel B	BCG (BCF)	2 088
Power level channel A and B	BCG (BCF)	0 = high power
VDL message retries	BCG (BCF)	3
Message repeat indicator	BCG (BCF)	0

Parameter	Sentence	Reset value/ action
Talker ID	BCG (BCF)	Not changed
Position source	BCL (BCF)	1 = internal EPFS in use
Own position, Latitude	BCL (BCF)	91°
Own position, Longitude	BCL (BCF)	181°
Position accuracy	BCL (BCF)	0
Base station name	BCL	No name
Message 27 transmission control bit in Message 4	BCL	Tx control bit = 0
Slot reservations	DLM	No reservations
Transmission schedules for Message 4, 17, 20, 22, 23, 24	ECB	No active transmission schedules
Transmission schedules for Message 26	CBR	No active transmission schedules
Content of scheduled Message 26	MEB	No content stored
Unique identifier	SID	Not changed
MMSI	SID	Not changed
VSI and FSR output	SPO	VSI and FSR disabled, All output values disabled
TAG blocks g = grouping	CPG	Not changed
TAG blocks d = destination	CPD	Not changed
TAG blocks s = source	CPS, TBS	Not changed
TAG blocks c = UNIX time	CPC	Not changed
TAG blocks n = line-count	CPC	Not changed
Legacy support		
Channel A transmission	(CAB)	1 = Tx on
Channel B transmission	(CAB)	1 = Tx on
Comment Block Control	(BCE)	Not Changed

6.6 Further requirements for optional features

6.6.1 General

This subclause describes features that are optional for both dependent and independent operation of AIS Base Stations. If an option is selected, then the AIS Base Station shall comply with the requirements of the option selected, and this option shall be tested.

NOTE Tests for all optional features are not included within this standard.

6.6.2 External synchronisation source option

The AIS Base Station may use an external synchronisation source via a dedicated input port. If used, the external synchronisation source shall have accuracy sufficient for the base station to maintain slot jitter within the $\pm 52 \mu\text{s}$ requirement.

The UTC synchronisation source in use shall be configurable by the sentence BCG.

The dedicated input port for external UTC synchronisation may consist of:

- pulse per second (PPS) detailed setting subject to configuration;
- UTC date and time.

6.6.3 DGNSS dedicated port option

The AIS Base Station may be configured to transmit DGNSS corrections (Message 17) that are input via a dedicated RTCM 10402 format DGNSS port.

Base Stations shall convert the RTCM 10402 format to VDL format before transmission.

This option shall only be available for the independent operation and care should be taken to minimise the impact on the VDL.

7 Functional definition of the presentation interface of the AIS Base Station

7.1 Physical requirements for the presentation interface

An interface shall be provided to handle the data bandwidth requirements of the PI.

7.2 Presentation interface data exchange

7.2.1 General

Regardless of the physical interface used, the AIS Base Station shall exchange data using the sentences defined in Table 1 and Table 14.

7.2.2 Base Station presentation interface output

Table 1 includes the list of output sentences.

All transmitted VDL messages shall be output by VDO sentences. The UTC hour, UTC minute (frame), and slot number of the slot or the first slot of a multi-slot message in which each VDL message was transmitted shall be provided by linking a VDO to a VSI sentence.

Each output sentence is identified by the talker identifier as configured by the BCG sentence.

7.2.3 Base Station presentation interface input

Regardless of the physical interface implemented, the AIS Base Station shall accept data input conforming to Table 1 which lists the mandatory sentences for each type of Base Station.

7.2.4 TAG blocks on presentation interface

Table 14 shows the TAG block functions required for a Base Station as defined in Annex D. A description of the use of TAG blocks is given in NMEA 0183.

Table 14 – Required TAG block functions

Sentence	Associated parameter	Required input function	Required output function
CPC	"c" = Unix time parameter	No evaluation on input required	Output of time tag (current UTC time) with all output sentences, 0 if not available. Required accuracy of ± 1 s.
CPD	"d" = Destination-Identification	Filtering of input sentences based on own UI (configured by SID sentence)	Output of Destination identification Tag in all responses
CPG ^a	"g" = sentence Grouping	No evaluation required	Grouping of related sentences, VDM and VDO with a VSI sentence and multi-part sentences
CPN ^b	"n" = line count	No evaluation required	Output of line count Tag with all

Sentence	Associated parameter	Required input function	Required output function
			output sentences
CPS	"s" = Source identification	Filtering of input sentences based on Source identifications configured by TBS sentence	Output of Source identification TAG with own UI attached to NAK responses or to all output sentences
TBR	TAG block report request	Response with at least CPD, CPG, CPS, CPC, CPN	No TBR output
TBS	"s" = Source identification	Configuration of at least 5 different Source identifications for input filtering	Response on query for TBS
^a The minimum required: Group-code Increment = 1. The Reset Event = 0. Initial Group-code = 1. Group-code Limit = 1-999999999. ^b The minimum required: Count Increment = 1. The Reset Event = 0. Initial Line-count = 1. Line-count Limit = 1-999999999.			

8 Tests of AIS Base Stations – Method of measurement and required results

8.1 General

Physical test parameters and testing subject to national requirements may override parameters stated below. These parameters are stated as a guideline only.

8.2 Test conditions

8.2.1 Normal test conditions

8.2.1.1 Temperature and humidity

Temperature and humidity shall be within the following range:

Temperature +15 °C to + 35 °C

Humidity 20 % to 75 %

8.2.1.2 Power supply

The normal power supply for the tests shall be as specified by the manufacturer.

8.2.2 Extreme test conditions

The extreme temperature conditions are –15 °C and +55 °C. Where required, tests under extreme test conditions shall be a combination of

- dry heat and upper limit of supply voltage applied simultaneously, and
- low temperature and lower limit of supply voltage applied simultaneously.

During type testing, the power source to the equipment may be replaced by a test power source, capable of producing normal and extreme test voltages.

8.2.3 Standard test environment

The EUT is tested in an environment using test equipment to simulate and to log VDL messages. Standard environment consists of at least 5 simulated targets. The signal input level at the RF input port of the EUT for any simulated target shall be at least –100 dBm. Own position sensor inputs to the EUT will be simulated by the test system or other means.

Channels in use shall be selected by manual input before starting the tests.

8.2.4 Test signals

8.2.4.1 Standard test signal number 1

For TDMA Type 1: A test signal consisting of a 26 ms packet (1 slot) of 010101.

8.2.4.2 Standard test signal number 2

For TDMA Type 2: A test signal consisting of a 26 ms packet (1 slot) of 00001111.

8.2.4.3 Standard test signal number 3

This test signal consists of 200 packets grouped into clusters of 4 as described in Figure 8 Figure 8 and Table 15. Each cluster consists of 2 consecutive transmissions of packets. NRZI shall be applied to every packet. After sending packet 1 and 2, the initial state of the NRZI process shall be inverted and then packet 1 and 2 repeated.

Between every transmitted packet there shall be at least 2 free slots. The RF carrier shall be switched off between packets to simulate slotted behaviour.

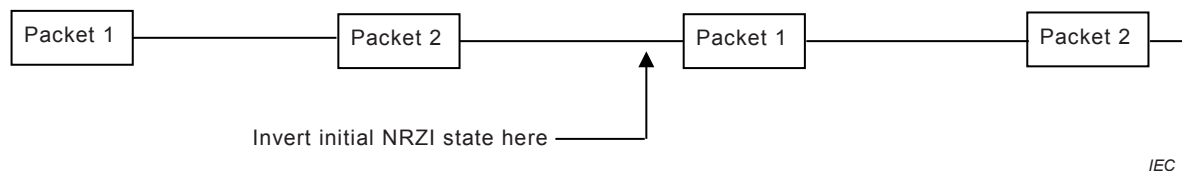


Figure 8 – Format for repeating four-packet cluster

Table 15 – Content of first two packets

Packet	Parameter	Bits	Contents	Comment
1	Training	24	0101....0101	
	Start flag	8	01111110	
	Data	168	Pseudo random	As per Table 16
	CRC	16	Calculated	
	End flag	8	01111110	
2	Training	24	1010....1010	
	Start flag	8	01111110	
	Data	168	Pseudo random	As per Table 16
	CRC	16	Calculated	
	End flag	8	01111110	

Table 16 – Fixed PRS data derived from ITU-T O.153

Address	Contents (HEX)							
0-7	0x04	0xF6	0xD5	0x8E	0xFB	0x01	0x4C	0xC7
	0000.0100	1111.0110	1101.0101	1000.1110	1111.1011	0000.0001	0100.1100	1100.0111
8-15	0x76	0x1E	0xBC	0x5B	0xE5	0x92	0xA6	0x2F
	0111.0110	0001.1110	1011.1100	0101.1011	1110.0101	1001.0010	1010.0110	0010.1111
16-20	0x53	0xF9	0xD6	0xE7	0xE0	21 B = 168 bit (+4 stuffed bit), CRC = 0x3B85		
	0101.0011	1111.1001	1101.0110	1110.0111	1110.0000			

8.2.5 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the source impedance presented to the receiver input is 50 Ω .

The impedance shall be met irrespective of whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals at the receiver input terminals (RF socket) shall be expressed in terms of dBm.

The effects of any intermodulation products and noise produced in the test signal sources shall be negligible.

8.2.6 Encoder for receiver measurements

Whenever needed, and in order to facilitate measurements on the receiver, an encoder for the data system shall accompany the EUT, together with details of the normal modulation process. The encoder is used to modulate a signal generator for use as a test signal source.

Complete details of all codes and code format(s) used shall be given.

8.2.7 Waiver for receivers

If the manufacturer declares that both TDMA receivers are identical, the test shall be limited to one receiver and the test for the second receiver shall be waived. The test report shall include this.

8.2.8 Impedance

In this standard, the term "50 Ω " is used for a 50 Ω non-reactive impedance.

8.2.9 Artificial antenna (dummy load)

Tests shall be carried out using an artificial antenna, which shall be a non-reactive, non-radiating load of 50 Ω connected to the antenna connector.

8.2.10 Facilities for access

All tests shall be performed using the standard ports of the EUT. Where access facilities are required to enable any specific test, these shall be provided by the manufacturer.

8.2.11 Operation of the transmitter

For the purpose of the measurements according to this standard, there shall be a facility to operate the transmitter unmodulated.

Alternatively, the method of obtaining an unmodulated carrier or special types of modulation patterns may also be decided by agreement between the manufacturer and the test laboratory. The method used shall be described in the test report and may involve suitable temporary internal modifications of the equipment under test.

NOTE For example, in the case of direct Frequency Shift Keying (FSK), a means to continuously transmit a sequence containing only "zeros" and a sequence containing only "ones" is preferable.

8.2.12 Measurement uncertainties

Maximum values of absolute measurement uncertainties are given in Table 17.

Table 17 – Maximum values of absolute measurement uncertainties

RF frequency	$\pm 1 \times 10^{-7}$
RF power	$\pm 0,75$ dB
Adjacent channel power	± 5 dB
Conducted spurious emission of transmitter	± 4 dB
Conducted spurious emission of receiver	± 3 dB
Two-signal measurement	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of transmitter	± 6 dB
Radiated emission of receiver	± 6 dB
Transmitter attack time	± 20 %
Transmitter release time	± 20 %

For the test methods according to this standard, these uncertainty figures are valid to a confidence level of 95 %.

The interpretation of the results recorded in a test report for the measurements described in this standard shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether equipment meets the requirements of this standard;
- the actual measurement uncertainty of the test laboratory carrying out the measurements, for each particular measurement, shall be included in the test report;
- the values of the actual measurement uncertainty shall be, for each measurement, equal to or lower than the figures given in this clause (absolute measurement uncertainties).

9 Physical radio tests

9.1 Remark

Unless otherwise stated, all physical radio tests are performed for 25 kHz channel spacing.

9.2 General transceiver tests

9.2.1 Transceiver protection test

9.2.1.1 Purpose

This test demonstrates that the transceiver is properly protected against malfunction due to faults in the antenna system. This shall be the first test applied to the EUT.

9.2.1.2 Method of measurement

While the transmitter is transmitting at the highest output power, the antenna port shall first be short-circuited and then open-circuited, in each case for a period of 5 min.

The EUT shall transmit 225 single slot messages evenly spread across the 5 min period during the short-circuit condition and the open-circuit condition.

A method for transmitting these messages should be provided by the manufacturer.

9.2.1.3 Required results

The proof that the transceiver is protected against malfunctions at the antenna terminal is substantiated by the ability to pass the remainder of the tests in this clause.

9.2.2 Transmitter shutdown procedure

9.2.2.1 Purpose

This verifies that an automatic transmitter hardware shutdown procedure is implemented.

9.2.2.2 Method of measurement

Check manufacturer's documentation on transmitter shutdown procedure.

9.2.2.3 Required result

Verify that a transmitter shutdown procedure, independent of the operating software, is provided.

9.3 TDMA transmitter

9.3.1 General

Unless otherwise stated, all transmitter tests are performed at the highest power setting.

9.3.2 Frequency error

9.3.2.1 Purpose

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and its required frequency.

9.3.2.2 Method of measurement

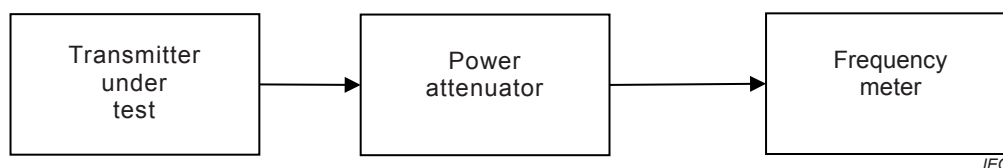


Figure 9 – Measurement arrangement for frequency error

The measurement procedure shall be as follows:

- the equipment shall be connected as illustrated in Figure 9;
- the carrier frequency shall be measured in the absence of modulation;
- the measurement shall be made under normal test conditions and extreme test conditions;
- the test shall be performed at 156,025 MHz and 162,025 MHz.

9.3.2.3 Required results

The frequency error shall not exceed $\pm 0,5$ kHz, under normal test conditions and ± 1 kHz under extreme test conditions.

9.3.3 Carrier power

9.3.3.1 Purpose

The transmitter carrier power conducted (P_C) is the mean power delivered to a nominal $50\ \Omega$ load during a radio frequency cycle. The rated nominal high power setting shall be 12,5 W and the rated nominal low power setting shall be 1 W. If there is a requirement for different nominal power settings, the carrier power accuracy shall be tested at all settings.

9.3.3.2 Method of measurement

The measurement procedure shall be as follows:

- the equipment shall be connected as illustrated in Figure 10;
- the carrier power shall be measured in the absence of modulation;
- the measurement shall be made under normal test conditions and extreme test conditions;
- the test shall be performed at 156,025 MHz and 162,025 MHz;
- the carrier power accuracy shall be tested at all settings.

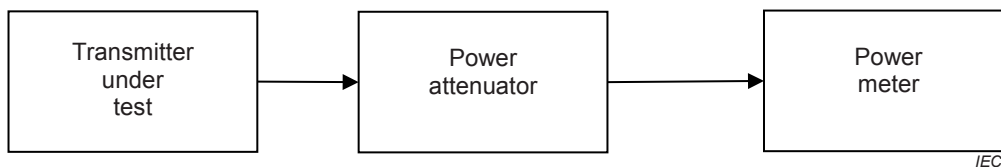


Figure 10 – Measurement arrangement for carrier power

9.3.3.3 Required results

P_C shall be within $\pm 1,5$ dB of the rated carrier power conducted.

P_C under extreme test conditions shall be within ± 3 dB of the rated carrier power conducted.

9.3.4 Modulation spectrum slotted transmission

9.3.4.1 Purpose

This test is to ensure that the modulation sidebands produced by the specified test patterns fall within the allowable masks.

9.3.4.2 Method of measurement

The measurement procedure shall be as follows:

- the EUT shall be connected to a spectrum analyser;
- the test shall be carried out using slotted transmission of test signal number 1;
- a minimum resolution bandwidth of 300 Hz and video bandwidth of 3 kHz and positive peak detection (maximum hold) shall be used for this measurement;
- a sufficient number of sweeps and transmission packets shall be measured to ensure that the emission profile is developed;
- repeat steps a) through d) using test signal number 2;
- tests shall be performed at 156,025 MHz and 162,025 MHz.