

Australian/New Zealand Standard™

**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**



AS/NZS IEC 62287.1:2014

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee RC-004, Radiocommunications Equipment—Maritime and Safety of Life. It was approved on behalf of the Council of Standards Australia on 29 October 2014 and on behalf of the Council of Standards New Zealand on 10 November 2014.

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Australian/New Zealand Standard™

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

Originated as AS/NZS IEC 62287.1:2007.
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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee RC-004, Radiocommunications Equipment—Maritime and Safety of Life, to supersede AS/NZS IEC 62287.1:2007.

The objective of this Standard is to provide specifications for a type of automatic ship identification system (AIS) equipment used on vessels that are not covered by the mandatory carriage requirement of AIS under SOLAS Chapter V.

This Standard is identical with, and has been reproduced from IEC 62287-1 Ed. 2.1 (2013), *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*, which is the 2010 Edition 2.0 incorporating Amendment 1 (2013). The amended text is indicated by a vertical line in the margin of the source document. Additions and deletions appear in red with deletions being struck through.

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- (a) In the source text ‘this part of IEC 62287’ should read ‘Australian/New Zealand Standard’.
- (b) A full point substitutes for a comma when referring to a decimal marker.

<i>Reference to International Standard</i>		<i>Australian/New Zealand Standard</i>	
IEC		AS/NZS	
62320	Maritime navigation and radiocommunication equipment and systems—Automatic identification system (AIS)	62320	Maritime navigation and radiocommunication equipment and systems—Automatic identification systems (AIS)
62320-1	Part 1: AIS Base Stations—Minimum operational and performance requirements, methods of testing and required test results	62320.1	Part 1: AIS Base Stations—Minimum operational and performance requirements, methods of testing and required test results

Only normative references that have been adopted as Australian or Australian/New Zealand Standard have been listed.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

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NOTES

INTRODUCTION to Amendment 1

IEC Amendment 1 (2013) clarifies the conditions required for input of external GNSS position, the associated tests and required results.

AUSTRALIAN/NEW ZEALAND STANDARD

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****1 Scope**

This part of IEC 62287 specifies the minimum operational and performance requirements, methods of testing and required test results for Class B shipborne AIS equipment using CSTDMA techniques. This standard takes into account other associated IEC International Standards and existing national standards, as applicable.

It is applicable for AIS equipment used on craft that are not covered by the mandatory carriage requirement of AIS under SOLAS Chapter V.

An AIS station intended to operate in receive-only mode is not considered a Class B shipborne mobile AIS station.

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.

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

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

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

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

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

IMO MSC.140(76), *Recommendation for the protection of the AIS VHF data link*

ITU-R Recommendation M.493-13, *Digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.825-3, *Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification*

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.1371-4, *Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band*

ITU Radio Regulations, Appendix 18, <http://www.itu.int/publ/R-REG-RR/en>

3 Abbreviations

AIS	Automatic Identification System
BER	Bit Error Rate
BT	Bandwidth Time product
COG	Course Over Ground
CP	Candidate Period
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CS	Carrier-Sense
CSTDMA	Carrier-Sense Time Division Multiple Access
DGNSS	Differential Global Navigation Satellite System
DLS	Data Link Service
DSC	Digital Selective Calling
ECDIS	Electronic Chart Display and Information System
EPFS	Electronic Position Fixing System
ETA	Estimated Time of Arrival
EUT	Equipment Under Test
FCS	Frame Check Sequence
FM	Frequency Modulation
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
HDG	Heading
HDLC	High level Data Link Control
HSC	High Speed Craft
IHO	International Hydrographic Office
IMO	International Maritime Organization
Lat	Latitude
LME	Link Management Entity
Lon	Longitude
LR	Long Range
MAC	Medium Access Control
MMSI	Maritime Mobile Service Identity
NM	Nautical Miles (1 NM = 1 852 m)
NRZI	Non Return to Zero Inverted
NTT	Nominal Transmission Time

NUC	Not Under Command
OSI	Open System Interconnection model
P _{ss}	Steady state RF output power
PER	Packet Error Rate
PI	Presentation Interface
PRS	Pseudo Random Sequence
RAIM	Receiver Autonomous Integrity Monitoring
RF	Radio Frequency
RI	Reporting Interval
Rx	Receive
SINAD	Signal Interference Noise and Distortion ratio
SOG	Speed Over Ground
SOLAS	International Convention for the Safety Of Life At Sea
TDMA	Time Division Multiple Access
TI	Transmission Interval
Tx	Transmit
UTC	Universal Time Co-ordinated
VDL	VHF Data Link
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
VTS	Vessel Traffic Services

NOTE Abbreviations related to the IEC 61162 series are not included in the above list. For their meaning refer to that standard.

4 General requirements

4.1 General

4.1.1 Capabilities of the Class B“CS” AIS

The Class B“CS” AIS shall improve the safety of navigation by assisting in the efficient navigation of ships and small craft, protection of the environment, and operation of Vessel Traffic Services (VTS). Small craft are vessels which are not required to comply with the mandatory carriage requirements of SOLAS Chapter V, Regulation 19.

The Class B“CS” AIS shall be capable of providing information from small craft, automatically, continuously and with the required accuracy and update rate:

- in a ship-to-ship mode for collision avoidance;
- as a means for littoral States to obtain information about the craft; and
- as a VTS tool, i.e. ship-to-shore (traffic management).

The Class B“CS” AIS station shall be inter-operable and compatible with Class A or other Class B shipborne mobile AIS stations or any other AIS station operating on the AIS VHF Data Link. In particular, Class B“CS” AIS stations shall receive other stations, shall be received by other stations and shall not degrade the integrity of the AIS VHF Data Link.

The Class B“CS” AIS shall only transmit if it has verified that the time period intended for transmission does not interfere with transmissions made by AIS equipment defined in ITU-R

M.1371-4 A1/2 (excluding Class B"CS"). Transmissions of the Class B"CS" AIS shall not exceed one nominal time period (except when responding to a base station with Message 19).

4.1.2 Quality assurance

(see 10.1.1)

Manufacturers shall have a quality control system audited by a competent authority to ensure continuous compliance with the requirements of this standard. Alternatively, the manufacturer may use final product verification procedures where a competent authority verifies compliance with the requirements of this standard before the product is put to the market.

NOTE The ISO 9000 series, as applicable, meets the requirements of a quality control system.

4.1.3 Safety of operation

(see 10.1.2)

It shall not be possible for the operator to augment, amend or erase any program software in the equipment required for operation in accordance with the equipment standard. Data used during operation and stored in the system shall be protected in such a way, that necessary modifications and amendments by the user cannot affect its integrity and correctness.

4.1.4 Additional features

(see 10.1.3)

Where equipment provides a facility that is additional to the minimum requirements of this standard, the operation and, as far as is reasonably practicable, the malfunction of such an additional facility shall not degrade the performance of the equipment.

4.1.5 Modes of operation

4.1.5.1 General

The system shall be capable of operating in a number of modes as described below subject to the transmission of messages by a competent authority. It shall not retransmit received messages.

4.1.5.2 Autonomous and continuous mode

(see 10.2.1)

An "autonomous and continuous" mode for operation in all areas transmitting Message 18 for scheduled position reporting and Message 24 for static data.

The Class B"CS" AIS shall be able to receive and process messages at any time except during time periods of transmission.

4.1.5.3 Assigned mode

(see 10.2.2)

An "assigned" mode for operation in an area subject to a competent authority responsible for traffic monitoring so that the reporting interval, silent mode and/or transceiver behaviour may be set remotely by that authority using group assignment by Message 23.

4.1.5.4 Interrogation mode

(see 10.2.3)

A “polling” or “controlled” mode where the Class B“CS” AIS responds to interrogations by Messages 18 and 24 from a Class A AIS, a SAR aircraft or a base station. A base station interrogation for Message 19 specifying transmission offset shall also be answered. An interrogation overrides a silent period defined by Message 23 (see 7.3.4.4.4).

NOTE Since Message 19 is a message occupying two time periods, this requires the reservation of the respective time periods by Message 20 prior to interrogation.

A Class B“CS” AIS shall not interrogate other stations.

4.2 Manuals

The manuals shall include:

- the type of external connectors if applicable;
- the required information for correct siting of the antennas;
- the required information for compass safe distance.

4.3 Marking and identification

Each unit of the equipment shall be marked externally with the following information which, where practicable, shall be clearly visible when the equipment is installed in its recommended position:

- identification of the manufacturer;
- equipment type number or model identification;
- serial number of the unit;
- power supply requirements; and
- compass safe distance.

Alternatively, the marking may be presented on a display at equipment start-up.

The version of software shall be either marked or displayed on command on the equipment.

When the marking and the title and version of the software are presented only on the display, such information shall also be included in the equipment manual.

5 Environmental, power supply, interference and safety requirements

(see Clause 9)

In addition to the specific requirements of this standard, the Class B“CS” AIS shall fulfil the following general requirements as detailed in IEC 60945:

- inter-unit connection (interfaces other than IEC 61162 are allowed; see 6.7.3);
- power supply;
- extreme power supply;
- excessive conditions;
- power supply short-term variation and power supply failure (the Class B“CS” AIS shall not enter an undefined or unstable state in case of undervoltage);
- durability and resistance to environmental conditions;

- interference;
- electromagnetic compatibility;
- compass safe distance;
- safety precautions;
- protection against accidental access to dangerous voltages;
- electromagnetic radiofrequency radiation;
- X-radiation.

The manufacturer shall declare the category of the equipment as follows:

- a) portable;
- b) protected from the weather;
- c) exposed to the weather;
- d) submerged or in continuous contact with sea water.

6 Performance requirements

6.1 Composition

The B“CS” AIS shall comprise:

- a communication processor, capable of operating in a part of the VHF Maritime Mobile Service band, in support of short range (VHF) applications;
- at least one transmitter and three receiving processes, two for TDMA and one for DSC on channel 70. The DSC process may use the receiving resources on a time-share basis as described in 7.2.2.7. Outside the DSC receiving periods, the two TDMA receiving processes shall work independently and simultaneously on AIS channel A and channel B¹;
- a means for automatic channel switching in the maritime mobile band (by Message 22 and DSC). Manual channel switching shall not be provided;
- an internal GNSS position sensor, which provides a resolution of one ten thousandth of a minute of arc and uses the WGS-84 datum (see 6.3).

6.2 Operating frequency channels

(see 10.4)

The Class B“CS” AIS shall operate on the frequency channels with 25 kHz bandwidth at least in the range from 161,500 MHz to 162,025 MHz of the ITU Radio Regulations Appendix 18 and in accordance with Recommendation ITU-R M.1084-4, Annex 4. The DSC receiving process shall be tuned to channel 70.

The Class B“CS” AIS shall automatically revert to receive-only mode on the channels AIS 1 and AIS 2 when commanded to change to frequency channels outside its operating range and/or bandwidth.

6.3 GNSS receiver for position reporting

(see 10.5, 10.6.1.3)

The Class B“CS” AIS shall have an internal GNSS receiver as a source for position, COG and SOG.

¹ In some regions, the competent authority may not require DSC functionality.

The internal GNSS receiver shall meet the following requirements of a receiver as specified in the IEC 61108 series:

- ~~position accuracy, static and dynamic (5 s);~~
- datum information is received which indicates that the WGS-84 datum is in use;
- COG/SOG accuracy;
- ~~position update (5 s);~~
- internal position is available and the external position is within 26 m of the internal position, and
- interference susceptibility; and
- status indications (RAIM optional).

The internal GNSS receiver may be capable of being differentially corrected, for example by evaluation of Message 17.

An input port for an external GNSS receiver may be provided. The data of an external GNSS receiver shall only be used if:

- the manufacturer has stated, in the installation handbook, that this equipment shall only be connected to a position source that is using WGS-84 datum;
- RAIM information is received which indicates an expected error of less than 10 m in Lat or Lon;
- the external position is within 26 m of the internal position, and
- the input format complies with the IEC 61162 series including mode indicator and checksum.

6.4 Identification

For the purpose of ship and message identification, the appropriate Maritime Mobile Service Identity (MMSI) number shall be used. The unit shall only transmit if an MMSI has been programmed (see 6.5.1.2).

The unit shall be supplied with a default MMSI of “000000000” that is not a valid MMSI.

The unit shall check that the programming MMSI is between 200000000 and 799999999, otherwise the unit shall reject the programming and not be capable of transmitting.

6.5 AIS information

6.5.1 Information content

(see 10.6.1)

6.5.1.1 General

The information provided by the Class B“CS” AIS shall include the following.

6.5.1.2 Static

The list of static information includes:

- identification (MMSI);
- name of ship;
- type of ship;
- vendor ID (optional);

- call sign;
- dimensions of ship and reference for position.

The default value for type of ship shall be 37 (pleasure craft). Defaults for other static data shall be chosen such that it is obvious that the equipment has been properly initialised, in particular, the default MMSI shall be set to 000000000 and the equipment shall be designed such that transmissions are inhibited with this default setting (see 6.7.2).

6.5.1.3 Dynamic

The list of dynamic information includes:

- ship's position with accuracy indication and integrity status
- time in UTC;

NOTE Date to be established by receiving equipment.

- course over ground (COG);
- speed over ground (SOG);
- true heading (optional).

6.5.1.4 Configuration information

The following information about configuration and options active in the specific unit shall be provided:

- AIS Class B"CS" unit;
- availability of minimum keyboard/display facility;
- availability of DSC channel 70 receiver;
- ability to operate in the whole marine band or the upper 525 kHz part of the band (see 6.2);
- ability to process channel management Message 22.

6.5.1.5 Short safety-related messages

Short safety-related messages as described in ITU-R M.1371-4 (Message 14) shall not be provided.

NOTE IMO COMSAR.1/Circ.46 of February 2009 advises that short safety-related messages should not be incorporated in AIS equipment because there is no SAR infrastructure in place to accommodate them.

6.5.2 Information reporting intervals

(see 10.6.2)

The Class B"CS" AIS shall transmit position reports (Message 18) in reporting intervals of

- 30 s if $\text{SOG} > 2 \text{ kn}$,
- 3 min if $\text{SOG} \leq 2 \text{ kn}$,

provided that transmission time periods are available. A command received by Message 23 shall override the reporting interval. A reporting interval of less than 5 s is not required.

Static data submessages 24A and 24B shall be transmitted every 6 min in addition to and independent of the position report (see 7.4.2). Message 24B shall be transmitted within 1 min following Message 24A.

6.5.3 Permissible initialisation period

(see 10.7)

The AIS shall start transmitting position reports within

- cold start: 30 min;
- warm start (if off for less than 1 h): 5 min;
- short signal loss (GNSS signal lost for less than 5 min): resume within a time of twice the reporting interval.

6.6 Alarms and indications, fall-back arrangements

6.6.1 Integrity and protection

(see 10.8.1)

The Class B“CS” AIS shall be equipped with built-in integrity tests (BIIT). The BIIT shall run continuously or at appropriate intervals simultaneously with the standard functions of the equipment.

If any failure or malfunction is detected that will significantly reduce integrity or stop operation of the Class B“CS” AIS, a visual indication shall be given (for example a LED, see 6.7.1). This includes the detection of background noise above -77 dBm (see 7.3.2.4).

The Class B“CS” AIS installation, when operating, shall not be damaged by the effects of open-circuited or short-circuited antenna terminals.

6.6.2 Transmitter shutdown procedure

(see 10.8.3)

An automatic transmitter shutdown shall be provided in the case where a transmitter does not discontinue its transmission within 1 s of the end of its nominal transmission. This procedure shall be independent of the operating software.

6.6.3 Position sensor fallback conditions

(see 10.6.1.3, 10.8.4)

Priorities and affected position report data (refer to ITU-R M.1371-4 A8/3.16) shall be as indicated in Table 1.

Table 1 – Position sensor fallback conditions

Priority	Position sensor status		Affected data in Message 18			
			Position accuracy flag	Time stamp	RAIM-flag	Position Latitude/Longitude
1.	External DGNSS in use (corrected) ^a		1 ^d	UTC-s	1/0 ^d	Lat/Lon (external)
2.	Internal DGNSS in use (corrected; Message 17)		1 ^d	UTC-s	1/0 ^d	Lat/Lon (internal)
3.	Internal DGNSS in use (corrected; e.g. beacon) ^c		1 ^d	UTC-s	1/0 ^d	Lat/Lon (internal)
4.	External GNSS in use (uncorrected) ^a		0 ^d	UTC-s	1/0 ^d	Lat/Lon (external)
5.	Internal GNSS in use (uncorrected) ^b		0 ^d	UTC-s	1/0 ^d	Lat/Lon (internal)
6.	No sensor position in use	Manual position input	N/A	61	N/A	Do not transmit
		Dead reckoning position		62		Do not transmit
		No position		63		Do not transmit

^a Applicable only if an input from an external GNSS receiver is provided (see 6.3) which may only be used if the conditions specified in 6.3 are fulfilled.

^b Applicable in all configurations (minimum requirement).

^c Applicable only if (optionally) an internal beacon receiver is provided.

^d If RAIM available “1”; if not, default “0”.

If RAIM is available (indicated by a GBS sentence or equivalent information), the position accuracy flag shall be evaluated using Table 2.

Table 2 – Use of accuracy (PA) flag

		PA flag	RAIM flag
Uncorrected	No RAIM, GBS not provided	0	0
	GBS provided, expected error 5 m	1	1
	GBS provided, expected error 5 m	0	1
Corrected	No RAIM, GBS not provided	0	0
	GBS provided, expected error 15 m	1	1
	GBS provided, expected error 15 m	0	1

If the GNSS sensor is inoperative, the unit shall not transmit scheduled Messages 18 and 24 unless interrogated by a base station.

NOTE In this case, the synchronisation process will not take into account distance delays.

The Class B“CS” AIS shall automatically select the position source with the highest priority available. If data availability changes, the Class B“CS” AIS shall maintain the position source for the next scheduled position report and automatically switch to the position source with the highest priority available afterwards. During this period, the latest valid position shall be used for reporting.

6.6.4 SOG/COG sensor fallback conditions

(see 10.8.5)

SOG/COG information shall be of the same source as position and follow the same fallback rules. This is to avoid transmission of information referenced to different points on the ship.

6.7 User interface

6.7.1 Indicators and display

(see 10.9.1)

The Class B“CS” AIS shall be provided with the following indicators.

- Power: power on and fully operable (transmitting and receiving properly).
- Tx timeout: if the unit has not transmitted a position report during the last two reporting intervals (nominal reporting interval cannot be maintained for operational reasons, for example Message 23 quiet period, high VDL load).
- Error: detection of an error as a result of the BIIT (see 6.6.1).

If a display for received messages is provided, it shall:

- display received Messages 12 and 14 and the position report from AIS-SART in active mode;
- not display messages addressed to other stations.

6.7.2 Static data input

(see 10.9.3)

Means shall be provided to input and verify the static data prior to use. It shall not be possible for the user to alter the MMSI once programmed.

6.7.3 External interfaces

(see 10.9.4)

To enable a user to access, select and display the information on a separate system, the Class B“CS” AIS may be provided with an interface. If implemented, the formats and protocol for this data stream should be as defined by the IEC 61162 series. If provided, this interface shall not output information addressed to other stations.

The Class B“CS” AIS may be provided with an interface to input sensor data. If provided, an input interface for position sensor data shall be compliant with the IEC 61162 series.

6.8 Protection from invalid control commands

The Class B“CS” AIS shall not accept control commands sent from stations with invalid base station MMSI. Before accepting and processing the Messages 17, 20, 22 and 23, the unit shall check the MMSI of the sender station. When the MMSI is “00xyyyyy” where x is between 2 and 7, the unit shall accept and process the received command, otherwise the unit shall ignore it. (See 8.4.3).

7 Technical requirements

7.1 General

This clause covers layers 1 to 4 (Physical Layer, Link Layer, Network Layer, Transport Layer) of the Open System Interconnection (OSI) model.

Figure 1 illustrates the layer model of a Class B“CS” AIS station (Physical Layer to Transport Layer) and the layers of the applications (Session Layer to Application Layer).

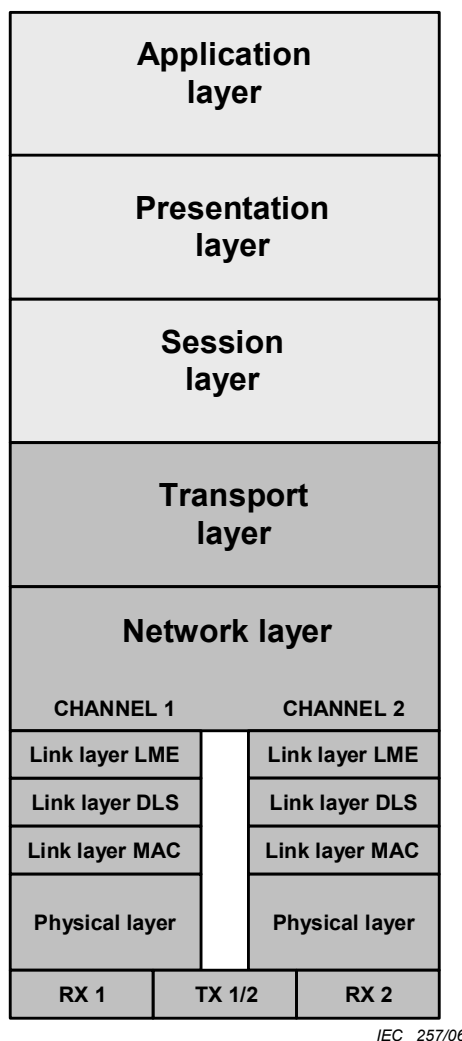


Figure 1 – OSI layer model

7.2 Physical layer

(see Clause 11)

7.2.1 General

The Physical Layer is responsible for the transfer of a bit-stream from an originator to the data link.

7.2.2 Transceiver characteristics

7.2.2.1 General

General transceiver characteristics shall be as specified in Table 3.

Table 3 – Transceiver characteristics

Symbol	Parameter name	Value	Tolerance
PH.RFR	Regional frequencies (range of frequencies within RR Appendix 18) ^a (MHz) Full range 156,025 to 162,025 is also allowed. This capability will be reflected in Message 18.	161,500 to 162,025	-
PH.CHS	Channel spacing (encoded according to RR Appendix 18 with footnotes) ^a (kHz)	25	-
PH.CHB	Channel bandwidth (kHz)	Wide 25	
PH.AIS1	AIS 1 (default channel 1) (2087) ^a (MHz)	161,975	3×10^{-6}
PH.AIS2	AIS 2 (default channel 2) (2088) ^a (MHz)	162,025	3×10^{-6}
PH.BR	Bit rate (bit/s)	9 600	50×10^{-6}
PH.TS	Training sequence (bits)	24	-
PH.TXTB	GMSK transmitter BT-product	0,4	
PH.RXBT	GMSK receiver BT-product	0,5	
PH.MI	GMSK modulation index	0,5	
^a See Recommendation ITU-R M.1084-4, Annex 4.			

7.2.2.2 Dual channel operation

The AIS shall be capable of operating on two parallel channels in accordance with 7.4.2. Two separate TDMA receive channels or processes shall be used to simultaneously receive information on two independent frequency channels. One TDMA transmitter shall be used to alternate TDMA transmissions on two independent frequency channels.

Data transmissions shall default to AIS 1 and AIS 2 unless otherwise specified by a competent authority, as described in 7.4.2 and Annex C.

7.2.2.3 Bandwidth

The Class B"CS" AIS shall operate on 25 kHz channels according to Recommendation ITU-R M.1084-4 and Appendix 18 of the Radio Regulations.

7.2.2.4 Modulation scheme

The modulation scheme is bandwidth adapted frequency modulated Gaussian filtered minimum shift keying (GMSK/FM). The NRZI encoded data shall be GMSK coded before frequency modulating the transmitter.

7.2.2.5 Training sequence

Data transmission shall begin with a 24-bit demodulator training sequence (preamble) consisting of one segment synchronisation. This segment shall consist of alternating zeros and ones (0101....). This sequence shall always start with a 0.

7.2.2.6 Data encoding

The NRZI waveform is used for data encoding. The waveform is specified as giving a change in the level when a zero (0) is encountered in the bit stream.

Forward error correction, interleaving or bit scrambling is not used.

7.2.2.7 DSC operation

The Class B"CS" AIS shall be capable of receiving DSC channel management commands. It shall either have a dedicated receive process, or it shall be capable of retuning its TDMA receivers to channel 70 on a time sharing basis, with each TDMA receiver taking alternate turns to monitor channel 70 (for details see Annex C).²

7.2.3 Transmitter requirements

Transmitter parameters shall be as given in Table 4.

Table 4 – Transmitter parameters

Transmitter parameters	Required results	Condition
Frequency error	500 Hz normal 1 000 Hz extreme	
Carrier power (P_{SS})	33 dBm 1,5 dB normal 3 dB extreme	Conducted
Modulation spectrum	–25 dBW –60 dBW	Δf_c 10 kHz 25 kHz Δf_c 62,5 kHz
Modulation accuracy	3 400 Hz normal and extreme 2 400 480 Hz normal and extreme 2 400 240 Hz normal 480 Hz extreme 1 740 175 Hz normal 350 Hz extreme 2 400 240 Hz normal 480 Hz extreme	Bit 0, 1 Bit 2, 3 Bit 4 ... 31 Bit 32 ...199: For a bit pattern of 0101 For a bit pattern of 00001111
Power versus time characteristics	Transmission delay: 2 083 μ s Ramp up time: $\leq 313 \mu$ s Ramp down time: $\leq 313 \mu$ s Transmission duration: $\leq 23\,333 \mu$ s	Nominal 1 time period transmission
Spurious emissions	–36 dBm –30 dBm	9 kHz ... 1 GHz 1 GHz ... 4 GHz

7.2.4 Receiver requirements

Receiver parameters shall be as given in Table 5.

² In some regions, the competent authority may not require DSC functionality.

Table 5 – Receiver parameters

Receiver parameters	Required results		
	Result in PER	Wanted signal	Unwanted signal(s)
Sensitivity	20 %	–107 dBm normal ^a –101 dBm extreme –104 dBm normal at 500 Hz offset	
Error at high input levels	2 %	–77 dBm	
	10 %	–7 dBm	
Co-channel rejection	20 %	–101 dBm	–111 dBm –111 dBm normal at 1 kHz offset
Adjacent channel selectivity	20 %	–101 dBm	–31 dBm normal
Spurious response rejection	20 %	–101 dBm	–31 dBm
Intermodulation response rejection	20 %	–101 dBm	–36 dBm
Blocking and desensitisation	20 %	–101 dBm	–23 dBm (5 MHz) –15 dBm (5 MHz)
Spurious emissions	–57 dBm	9 kHz ... 1 GHz	
	–47 dBm	1 GHz ... 4 GHz	
^a Normal and extreme test conditions as defined in 8.2.			

7.3 Link layer

(see Clause 12)

7.3.1 General

The Link layer specifies how data shall be packaged in order to apply error detection to the data transfer. The Link layer is divided into three sublayers.

7.3.2 Link sublayer 1: Medium access control (MAC)

7.3.2.1 General

The MAC sublayer provides a method for granting access to the data transfer medium, i.e. the VHF data link. The method used shall be Time Division Multiple Access (TDMA).

7.3.2.2 Synchronisation

7.3.2.2.1 CS time period

Synchronisation shall be used to determine the nominal start of the CS time period (T_0).

7.3.2.2.2 Sync mode 1: AIS stations other than Class B"CS" is received

If signals from other AIS stations complying with IEC 61993-2 or from base stations are received, the Class B"CS" shall synchronise its time-periods to their scheduled position reports (suitable account shall be taken of the propagation delays from the individual stations). This applies to Message types 1, 2, 3, 4 as far as they are providing position data and have not been repeated (repeat indicator = 0).

Synchronisation jitter shall not exceed 3 bits (312 μ s) from the average of the received position reports. The average shall be calculated over a rolling 60 s period.

If these AIS stations are no longer received, the unit shall maintain synchronisation for a minimum of 30 s and then switch back to sync mode 2.

Other synchronisation sources fulfilling the same requirements are allowed (optionally) instead of the above.

7.3.2.2.3 Sync mode 2: no station other than Class B"CS" is received

In the case of a population of Class B"CS" stations alone (in the absence of any other class of station that can be used as a synchronisation source) the Class B"CS" station shall determine the start of time-periods (T_0) according to its internal timing.

Time periods that are reserved by a base station using Message 20 shall be respected.

If the Class B"CS" unit receives an AIS station that can be used as a synchronisation source (being in sync mode 2) it shall evaluate timing and synchronise for its next transmission to this station.

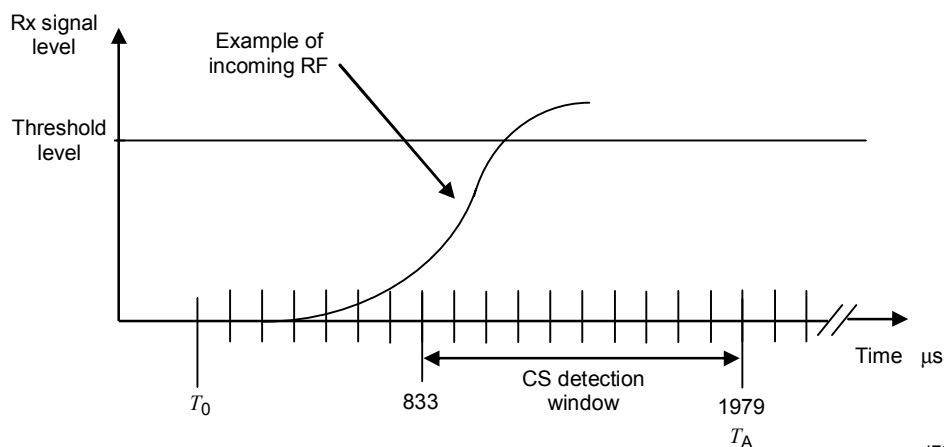
7.3.2.3 Carrier-sense (CS) detection method

Within a time window of 1 146 μs , starting at 833 μs and ending at 1 979 μs after the start of the time period intended for transmission (T_0), the AIS Class B"CS" shall detect if that time period is used (CS detection window).

NOTE Signals within the first 8 bit (833 μs) of the time period are excluded from the decision (to allow for propagation delays and ramp down periods of other units).

The Class B"CS" AIS shall not transmit on any time period in which, during the CS detection window, a signal level greater than the "CS detection threshold" (7.3.2.4) is detected.

The transmission of a CSTDMA packet shall commence 20 bits ($T_A = 2\,083\,\mu\text{s} + T_0$) after the nominal start of the time period (see Figure 2).



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Figure 2 – Carrier-sense timing

7.3.2.4 CS detection threshold

The CS detection threshold shall be determined over a rolling 60 s interval on each receive channel separately. The threshold shall be determined by measuring the minimum energy level (representing the background noise) plus an offset of 10 dB. The minimum CS detection threshold shall be $-107\,\text{dBm}$ and background noise shall be tracked for a range of at least 30 dB ($-77\,\text{dBm}$).

NOTE The following example is compliant with the requirement: Sample the RF signal strength at a rate 1 kHz, average the samples over a sliding 20 ms period and over a 4 s interval determine the minimum period value. Maintain a history of 15 such intervals. The minimum of all 15 intervals is the background level. Add a fixed 10 dB offset to give the CS detection threshold.

An indication shall be given if the background noise exceeds -77 dBm.

7.3.2.5 VDL access

The transmitter shall begin transmission by turning on the RF power immediately after the duration of the carrier-sense window (T_A).

The transmitter shall be turned off after the last bit of the transmission packet has left the transmitting unit; nominal transmission end (T_E assuming no bit stuffing).

The access to the medium is performed as shown in Figure 3 and Table 6.

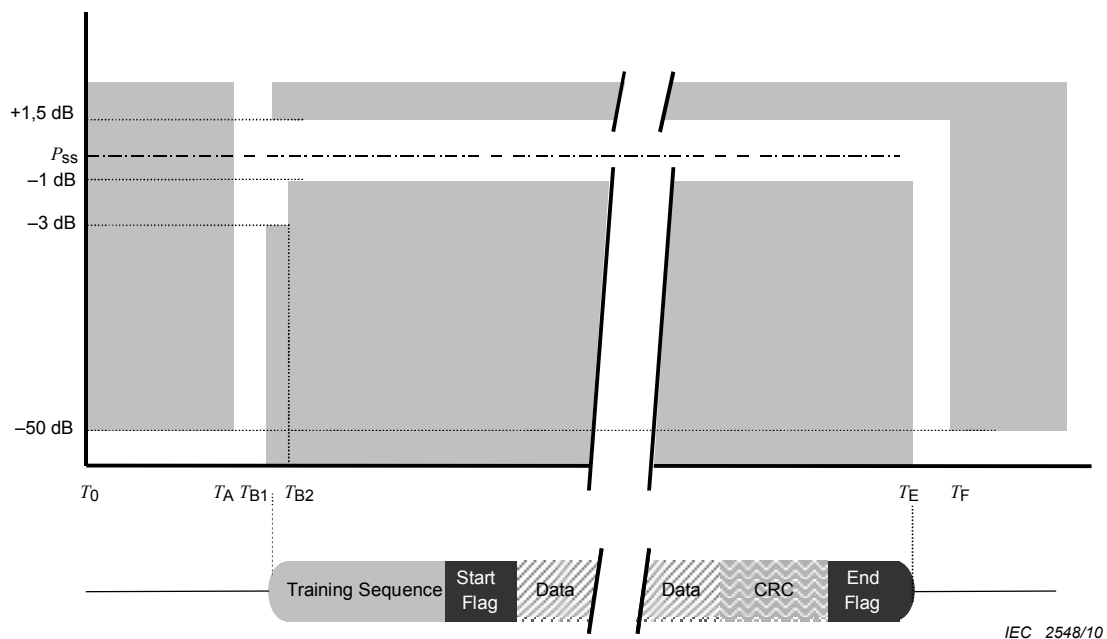


Figure 3 – Power versus time mask

Table 6 – Definition of timings for Figure 3

Reference		Bits	Time	Definition
T_0		0	0 ms	Start of candidate transmission time period
T_A		20	2,083 ms	Power shall not exceed -50 dB of P_{ss}
T_B	T_{B1}	23	2,396 ms	Power shall reach within $+1,5$ dB or -3 dB of P_{ss}
	T_{B2}	25	2,604 ms	Power shall reach within $+1,5$ dB or -1 dB of P_{ss}
T_E (plus 1 stuffing bit)		248	25,833 ms	Power shall still remain within $+1,5$ dB or -1 dB of P_{ss}
T_F (plus 1 stuffing bit)		251	26,146 ms	Power shall reach -50 dB of P_{ss} and stay below this

There shall be no modulation of the RF after the termination of transmission (T_E) until the power has reached zero and next time division begins (T_G).

7.3.2.6 VDL state

The VDL state is based on the result of the carrier-sense detection (7.3.2.3) for a time period. A VDL time period can be in one of the following states.

- **FREE:** the time period is available and has not been identified as used in reference to 7.3.2.3.
- **USED:** the VDL has been identified as used in reference to 7.3.2.3.
- **UNAVAILABLE:** time periods shall be indicated as “UNAVAILABLE” if they are reserved by base stations using Message 20 regardless of their range.

Time-periods indicated as “UNAVAILABLE” shall not be considered as a candidate time-period for use by own station and may be used again after a timeout. The timeout shall be 3 min if not specified or as specified in Message 20.

7.3.3 Link sublayer 2: Data Link Service (DLS)

7.3.3.1 General

The DLS sublayer provides methods for

- data link activation and release,
- data transfer, or
- error detection and control.

7.3.3.2 Data link activation and release

Based on the MAC sublayer the DLS will listen, activate or release the data link. Activation and release shall be in accordance with 7.3.2.5.

7.3.3.3 Data transfer

7.3.3.3.1 General

Data transfer shall use a bit-oriented protocol which is based on the high level data link control (HDLC) as described in ITU-R M.1371-4 A2/3.2. Information packets (I-Packets) shall be used with the exception that the control field is omitted (see Figure 4).

7.3.3.3.2 Bit stuffing

The bit stream shall be subject to bit stuffing. This means that if five consecutive ones (1's) are found in the output bit stream, a zero shall be inserted. This applies to all bits except the data bits of HDLC flags (start flag and end flag, see Figure 4).

7.3.3.3.3 Packet format

Data is transferred using a transmission packet as shown in Figure 4.

Start-buffer	Training sequence	Start flag	Data	FCS	End flag	End-buffer
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Figure 4 – Transmission packet

The packet shall be sent from left to right. This structure is identical to the general HDLC structure, except for the training sequence. The training sequence shall be used in order to synchronise the VHF receiver as described in 7.2.2.5. The total length of the default packet is 256 bits. This is equivalent to 26,7 ms.

7.3.3.3.4 Start-Buffer

The start-buffer (refer to Table 7) is 23 bits long and consists of

- CS delay 20 bits:
 - reception delay (sync jitter + distance delay);
 - own synchronisation jitter (relative to synchronisation source);
 - ramp up (received Message);
 - CS detection window;
- ramp up (own transmitter) 3 bits.

Table 7 – Start-buffer

Sequence	Description	Bits	Note
1	Reception delay (synchronisation jitter + distance delay)	5	Class A: 3 bits of jitter (IEC 61993-2) + 2 bits (30 NM) distance delay; Base station: 1 bit of jitter (IEC 61993-2) + 4 bits (60 NM) distance delay
2	Own synchronisation jitter (relative to synchronisation source)	3	3 bits according to ITU-R M.1371-4
3	Ramp up (received Message)	8	Referring to IEC 61993-2, start of detection window (from a practical observation all observed transponders were fully ramped up after 6 bits)
4	Detection window	3	
5	Internal processing delay	1	
6	Ramp up (own transmitter)	3	
	Total	23	

7.3.3.3.5 Training sequence

The training sequence shall be a bit pattern consisting of alternating 0's and 1's (010101010...).

Twenty-four bits of preamble are transmitted prior to sending the flag. This bit pattern is modified due to the NRZI mode used by the communication circuit. See Figure 5.

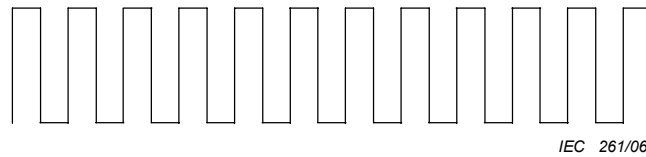


Figure 5a – Unmodified bit pattern

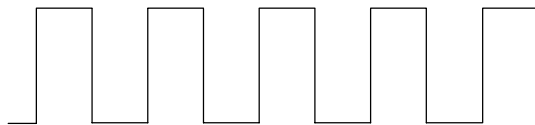


Figure 5b – Modified bit pattern by NRZI

Figure 5 – Training sequence

7.3.3.3.6 Start flag

The start flag shall be 8 bits long and consists of a standard HDLC flag. It is used to detect the start of a transmission packet. The start flag consists of a bit pattern, 8 bits long: 01111110 (7Eh). The flag shall not be subject to bit stuffing, although it consists of 6 bits of consecutive ones (1's).

7.3.3.3.7 Data

The data portion in the default transmission packet transmitted in 1 time period is a maximum of 168 bits.

7.3.3.3.8 Frame check sequence (FCS)

The FCS uses the cyclic redundancy check (CRC) 16-bit polynomial to calculate the checksum as described in ITU-R M.1371-4 A2/3.2. All the CRC bits shall be pre-set to one (1) at the beginning of a CRC calculation. Only the data portion shall be included in the CRC calculation (see Figure 6).

7.3.3.3.9 End flag

The end flag is identical to the start flag as described in 7.3.3.3.6.

7.3.3.3.10 End-buffer

- bit stuffing 4 bits

NOTE 1 The probability of 4 bits of bit stuffing is only 5 % greater than that of 3 bit; refer to ITU-R M.1371-4 A2, 3.2.2.8.

- ramp down 3 bits
- distance delay 2 bits

NOTE 2 A buffer value of 2 bits is reserved for a distance delay equivalent to 30 NM for own transmission.

A repeater delay is not applicable (duplex repeater environment is not supported).