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**Navigations- und Funkkommunikationsgeräte und -systeme für die Seeschifffahrt –
Automatisches Identifikationssystem (AIS) –
Teil 3: Repeater Stationen – Mindest-Betriebs- und
-Leistungsanforderungen – Prüfverfahren und geforderte Prüfergebnisse
(IEC 62320-3:2015);
Englische Fassung EN 62320-3:2015**

Maritime navigation and radiocommunication equipment and systems –
Automatic identification systems (AIS) –
Part 3: Repeater stations – Minimum operational and performance requirements –
Methods of test and required test results
(IEC 62320-3:2015);
English version EN 62320-3:2015

Matériels et systèmes de navigation et de radiocommunication maritimes –
Systèmes d'identification automatique (AIS) –
Partie 3: Stations de répéteurs – Exigences de fonctionnement et de performance
minimales – Méthodes d'essai et résultats d'essai exigés
(IEC 62320-3:2015);
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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2015-03-04 angenommene Europäische Norm als DIN-Norm ist 2015-11-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 62320-3:2014-06.

Für dieses Dokument ist das nationale Arbeitsgremium K 738 „Elektronische Navigationsinstrumente“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

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Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN 62320-3 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, und deren Abschnitt 3, der die Abkürzungen festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für einige der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Nationaler Anhang NA (informativ)

1 Anwendungsbereich^{N1)}

Dieser Teil der IEC 62320 legt die Mindest-Betriebs- und Leistungsanforderungen, Prüfverfahren und geforderte Prüfergebnisse für AIS-Repeaterstationen, kompatibel zu den mit IMO Res. MSC.74 (69), Annex 3, Universal AIS, angenommenen Leistungsstandards, fest. Er beinhaltet die technischen Kennwerte für nicht-schiffsseitige AIS-Geräte für Feststationen nach ITU-R-Empfehlung M.1371 und IALA-Empfehlung A-124. Wo zutreffend, werden auch die ITU-Funkregulierungen mit berücksichtigt. Diese Norm berücksichtigt auch andere zugehörige internationale IEC-Normen sowie existierende nationale Normen.

Diese Norm ist anwendbar für AIS-Repeaterstationen. Sie enthält keine Festlegungen für die Anzeige von AIS-Daten an Land.

3 Abkürzungen

Für die Anwendung dieses Dokuments gelten die folgenden Abkürzungen.

Die deutschen Übersetzungen haben Empfehlungscharakter und können nur die ungefähre Begrifflichkeit in Deutsch wiedergeben. Unter Experten wird empfohlen, ausschließlich die englischen Fachbegriffe zu verwenden, um die Gefahr von Missverständnissen zu reduzieren.

AES	fortschrittlicher Verschlüsselungsstandard	(en: Advanced Encryption Standard)
AIS	automatisches Schiffs-Identifikationssystem	(en: Automatic Identification System)
AtoN	Schiffahrtszeichen	(en: Aids to Navigation)
BER	Bitfehlerrate	(en: Bit Error Rate)
BFO	Schwebungsoszillator	(en: Beat frequency oscillator)
BIIT	integrierte Integritätsprüfung	(en: Built-In Integrity Tests)
BT	Zeit-Bandbreite-Produkt	(en: Bandwidth Time product)
COG	Kurs über Grund	(en: Course Over Ground)
CS	Trägerprüfung	(en: Carrier Sense)
CSTDMA	Zeitmehrfachzugriff mit Trägerprüfung	(en: Carrier Sense Time Division Multiple Access)
DAC	Bereichskennung/Gebietscode	(en: Digital Area Code)
dBc	Signalpegel in Bezug zur Trägeramplitude in dB	(en: Decibel-carrier)
dBm	Dezibel Milliwatt	(en: Decibel-milliwatts)
EUT	Prüfling; (Gerät im Test)	(en: Equipment under test)
FATDMA	Zeitmehrfachzugriff mit festen Zeitschlitten	(en: Fixed Access Time Division Multiple Access)
FI	Funktionsidentifizierungsnummer/-index	(en: Function Identifier)
FIFO	First in – First out	(en: First in, first out)
GNSS	globales Satellitennavigationssystem	(en: Global Navigation Satellite System)

^{N1)} Nationale Fußnote: Die Nummerierung der IEC 62320-3:2015 wurde beibehalten.

IALA	Internationaler Verband der Schifffahrtszeichenverwaltungen	(en: International Association of Marine Aids to Navigation and Lighthouse Authorities)
ITDMA	schrittweiser Zeitmehrfachzugriff	(en: Incremental Time Division Multiple Access)
IMO	Internationale Seeschifffahrtsorganisation	(en: International Maritime Organization)
ITU	Internationale Fernmeldeunion	(en: International Telecommunication Union)
kn	Knoten	(en: Knots)
MMSI	Rufnummer des mobilen Seefunkdienstes	(en: Maritime Mobile Service Identity)
NavStatus	Navigationsstatus	(en: Navigational Status)
NM	Seemeile / Nautische Meile	(en: Nautical Mile)
NRZI	NRZI-Übertragungskodierung	(en: Non-Return to Zero Inverted)
PER	Paketfehlerrate	(en: Packet Error Rate)
Pc	Trägerleistung	(en: Carrier Power)
PI	Präsentationsschnittstelle	(en: Presentation Interface)
PPS	(präziser) Sekundenimpuls (im GPS)	(en: Pulse(s) Per Second)
RATDMA	Zeitmehrfachzugriff mit Direktzugriff	(en: Random Access Time Division Multiple Access)
RSSI	Empfangssignalstärkeanzeige	(en: Received Signal Strength Indication)
Rx	Empfang	(en: Receive)
AIS-SART	Suchen- und -Retten -Transponder	(en: Search and Rescue Transmitter)
SO	sich selbst organisierend	(en: Self-Organizing)
SOG	Geschwindigkeit über Grund	(en: Speed Over Ground)
SOTDMA	selbst organisierter Zeitmehrfachzugriff	(en: Self-Organizing Time Division Multiple Access)
TDMA	Zeitmehrfachzugriff	(en: Time Division Multiple Access)
Tx	Senden	(en: Transmit)
UTC	koordinierte Weltzeit	(en: Coordinated Universal Time)
VCO	spannungsgesteuerter Oszillator	(en: Voltage controlled oscillator)
VDL	VHF-Datenverbindung	(en: VHF Data Link)
VHF	Ultrakurzwelle	(en: Very High Frequency)
VSWR	Stehwellenverhältnis	(en: Voltage Standing Wave Ratio)
VTs	Schiffsverkehrsdienste	(en: Vessel Traffic Services)

ANMERKUNG Abkürzungen im Zusammenhang mit der Normenreihe IEC 61162 sind in der Liste oben nicht enthalten. Deren Bedeutung finden Sie im Anhang A jener Normenreihe.

English Version

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systems - Automatic identification systems (AIS) -
Part 3: Repeater stations - Minimum operational and
performance requirements -
Methods of test and required test results
(IEC 62320-3:2015)**

Matériels et systèmes de navigation et de
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- Méthodes d'essai et résultats d'essai exigés
(IEC 62320-3:2015)

Navigations- und Funkkommunikationsgeräte und -systeme
für die Seeschifffahrt - Automatisches Identifikationssystem
(AIS) - Teil 3: Repeater Stationen - Mindest-Betriebs- und -
Leistungsanforderungen - Prüfverfahren und geforderte
Prüfergebnisse
(IEC 62320-3:2015)

This European Standard was approved by CENELEC on 2015-03-04. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

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European Committee for Electrotechnical Standardization
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 80/744/FDIS, future edition 1 of IEC 62320-3, 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 62320-3:2015.

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- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-12-04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-03-04

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Endorsement notice

The text of the International Standard IEC 62320-3:2015 was approved by CENELEC as a European Standard without any modification.

IEC 61162-2	NOTE	Harmonized as EN 61162-2.
IEC 61162-450	NOTE	Harmonized as EN 61162-450.

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INTRODUCTION

Chapter V of the 1974 SOLAS Convention requires mandatory carriage of Automatic Identification System (AIS) equipment on all vessels constructed on or after 01 July 2002. Implementation 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, section 2.4.5 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 states 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 will be necessary to attain the full benefit of the SOLAS Convention requirements.

This standard provides the minimum operational and performance requirements, methods of test and the required test results for AIS repeater stations. The testing is divided into two parts, the logical tests and the transceiver tests. These are captured in Clause 6 and Clause 8 respectively.

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

Part 3: Repeater stations – Minimum operational and performance requirements – Methods of test 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 repeater stations, compatible with the performance standards adopted by IMO Res. 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 repeater 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 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

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

ITU-R Recommendation M.585, *Assignment and use of identities in the maritime mobile service*

ITU-R Recommendation M.1084, *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 a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band*

ITU-T Recommendation O.153, *Basic parameters for the measurement of error performance at bit rates below the primary rate*

ITU Radio Regulations, Appendix 18

3 Symbols and abbreviations

AES	Advanced Encryption Standard
AIS	Automatic Identification System
AtoN	Aids To Navigation
BER	Bit Error Rate
BFO	Beat frequency oscillator
BIIT	Built-In Integrity Tests
BT	Bandwidth Time product
COG	Course Over Ground
CS	Carrier Sense
CSTDMA	Carrier Sense Time Division Multiple Access
DAC	Digital Area Code
dBc	Decibel-carrier
dBm	Decibel-milliwatts
EUT	Equipment under test
FATDMA	Fixed Access Time Division Multiple Access
FI	Function Identifier
FIFO	First in, first out
GNSS	Global Navigation Satellite System
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ITDMA	Incremental Time Division Multiple Access
IMO	International Maritime Organization
ITU	International Telecommunication Union
kn	Knots
MMSI	Maritime Mobile Service Identity
NavStatus	Navigational Status
NM	Nautical Mile
NRZI	Non-Return to Zero Inverted
PER	Packet Error Rate
Pc	Carrier Power
PI	Presentation Interface
PPS	Pulse(s) Per Second
RATDMA	Random Access Time Division Multiple Access
RSSI	Received Signal Strength Indication
Rx	Receive
AIS-SART	Search And Rescue Transmitter
SO	Self-Organizing
SOG	Speed Over Ground
SOTDMA	Self-Organizing Time Division Multiple Access
TDMA	Time Division Multiple Access
Tx	Transmit
UTC	Coordinated Universal Time

VCO	Voltage controlled oscillator
VDL	VHF Data Link
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
VTs	Vessel Traffic Services

4 Functional requirements for a repeater station

4.1 General

4.1.1 Types of repeater stations

AIS repeater stations are designed to retransmit VDL messages in one or several steps to extend the receiving range in areas with impaired VHF coverage. Careful consideration needs to be taken not to overload the VDL with repeated messages, considering the additional load repeated messages generate. The AIS environment may also contain one or more repeaters.

A repeater station is a store and forward repeater process.

A repeater station is a non-controlling station on the VDL.

The repeater station can be one of two types.

Type 1:

- Radio requirements as per the AIS base station requirements
- A dedicated repeater station is a Type 1 device

Type 2:

- Radio requirements as per the AIS AtoN station requirements
- Restricted repeater capability
- Suitable for areas with low AIS activity only

These two types of repeater functions can be implemented in three different ways:

- As a dedicated repeater station (Type 1)
- As an internal process of an AIS Base Station (Type 1)
- As an internal process of an AIS AtoN device (Type 2)

4.1.2 Repeating operation

(See 6.2.1)

4.1.2.1 Modes of repeating operation

The repeater station is designed for independent operation in autonomous and assigned mode. No polled mode is allowed.

4.1.2.2 Message by message repeating

Each received message that shall be repeated is internally allocated for transmission using RATDMA, ITDMA, or FATDMA as supported and configured.

4.1.2.3 Message rescheduling

This mode is only applicable for scheduled position reports.

Received messages shall be analysed and the repeater station shall reschedule transmissions using an ITDMA schedule.

The repeater station may reschedule repeated messages using a reporting interval different from the original interval, depending on configuration.

4.1.3 Synchronisation

(See 6.2.4)

The repeater station shall primarily use an internal source for UTC direct synchronisation.

The repeater station can synchronise on any AIS station that has direct UTC (otherwise known as UTC indirect). The repeater station shall have UTC direct, or UTC indirect and only transmit when sync state is 0 or 1.

4.1.4 Access to the VDL

4.1.4.1 Means of access

Access to the VDL can be by using pre-configured transmission slots. Pre-configured transmission slots shall in this case be reserved by Message 20 from a base station.

If pre-configured slots are not available, RATDMA may be used for transmission.

A repeater station shall use as a minimum RATDMA, ITDMA and FATDMA to allocate and pre-announce transmissions.

The repeater station needs to take into account all received Message 20s. It shall respect slot reservations. If a base station reserves slots for the repeater station, the repeater station shall be configured to use FATDMA.

CSTDMA is not suitable for repeater stations and not permitted because of:

- slot start delay;
- no protection from collision with Class B CS units;
- only one slot messages;
- intentional slot reuse is not allowed.

4.1.4.2 RATDMA and FATDMA access scheme

(See 6.3.1, 6.3.2)

The repeater station shall not change the data content of the message, but shall change the SOTDMA communication state or ITDMA if relevant. The repeater station shall change the SOTDMA communication state as indicated in Table 1.

Table 1 – SOTDMA communication state of received station

Received parameter	Transmit parameters
Synch state	Change to Synch State of repeater station
Slot time out	Set to zero
Slot offset	Set to zero

The repeater station shall change the ITDMA communication state as indicated in Table 2.

Table 2 – ITDMA Communication state of received station

Received parameter	Transmit parameters
Synch state	Change to synch state of repeater
Slot increment	Set to zero
Number of slots	Set to zero
Keep flag	Set to FALSE (= 0)

4.1.4.3 ITDMA access scheme

(See 6.3.3)

The repeater station shall not change the data content of the message, but shall change the SOTDMA communication state or ITDMA as relevant. The repeater station shall change the SOTDMA or ITDMA communication state to an ITDMA communication state as described in Table 2. When using ITDMA to reschedule refer to Table 3.

If ITDMA is used and the repeater station receives a Message 1 that shall be repeated, the repeater station shall change the message ID from 1 to 3 to all ITDMA access scheme.

Table 3 – ITDMA communication state of received station with rescheduling

Received parameter	Transmit parameters
Synch state	Change to synch state of repeater station
Slot increment	Offset set to next transmission slot
Number of slots	As required for next repeated message
Keep flag	Set to FALSE (= 0)

ITDMA can be used to schedule transmissions that originate from different stations.

When using ITDMA reservations, the selection interval shall be 150 slots. Set the ITDMA communication state at time of transmission to the next scheduled transmission.

4.1.5 Configuration

(See 6.1.3)

Initial configuration shall be possible using the presentation interface of the repeater station as defined in Annex A.

The repeater station may use VDL Messages for configuration and status reports as defined in Clause A.3.

4.2 Functional block diagram of an AIS repeater station

Figure 1 shows the principal components of the AIS repeater station.

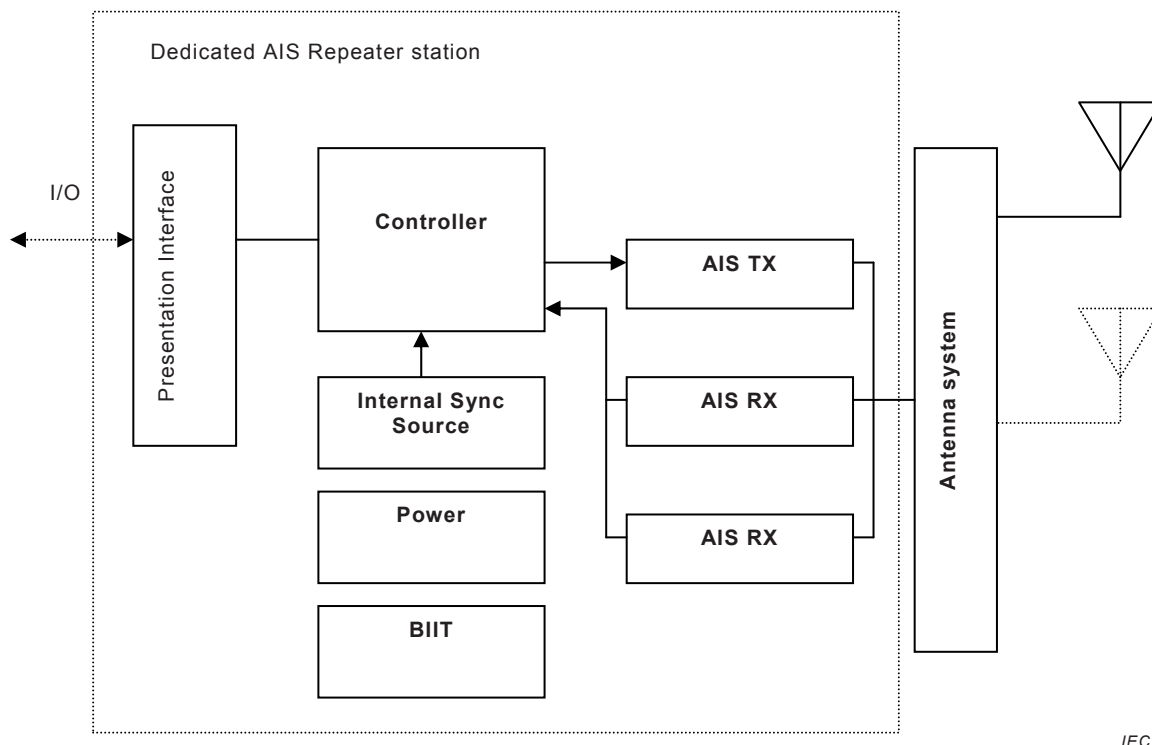


Figure 1 – Functional block diagram of an AIS repeater station

As a minimum, the following functional elements are required for the AIS repeater station:

- two multi-channel receiving processes;
- one multi-channel TDMA transmitter;

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

- a controlling unit, which includes a unique identifier to the repeater station;
- an internal synchronisation source capable of providing UTC;
- a Built-In-Integrity-Test unit (BIIT), which shall provide alarms;
- a power supply;
- an interface with data format conforming to IEC 61162-1. The physical interface will be determined by the manufacturer. The interface shall output VDO sentences for all transmitted messages, and VDM sentences for all received messages. Additionally, the repeater station shall be configurable using the PI. The repeater station shall be configurable for repeater enable via the VDL, and may optionally be configurable for all parameters via the VDL.

4.3 Repeating rules

4.3.1 General repeating rules

(See 6.2.1, 6.4.5)

The repeater station is a store-and-forward process and shall use the FIFO principle.

Retransmission of messages shall be performed as soon as possible, according to configuration, after receiving the relevant messages which are required to be retransmitted.

The maximum delay of the retransmission shall be within 9 s of reception in order to ensure one minute interval UTC time stamp in a position report that has undergone multiple repetitions. If RATDMA is used to transmit a message, the received message can be held for maximum 4 s and 10 slots.

With the exception of AIS-SART position reports, messages containing a time stamp older than 30 s shall not be repeated.

The repeater station shall be capable of retransmission of a message within 10 slots of reception of that received message.

Received position messages (Message 1, 2, 3 or 18) shall replace queued messages from the same MMSI (within a reasonable time limit to already scheduled transmission of the same MMSI. Updating a queued message shall not take longer than 2 slots.

Retransmission (repeat) shall be performed on the same channel in which the original message was received by the repeater station.

4.3.2 Repeater station use of repeat indicator

(See 6.2.3)

4.3.2.1 Repeat indicator value

Each time a received message is processed by the repeater station, the repeat indicator value shall, at least, be incremented by one (+1) before retransmitting the message.

If the received repeat indicator equals 3, the relevant message shall not be retransmitted.

4.3.2.2 Message repetition process

A message is repeated based on the repeat indicator if the repeat indicator is less than the "Max repeated RI" configuration value.

The repeat indicator of retransmitted message can be updated using two different methods.

- e) Increment repeat indicator by one (+1), to a maximum value of three.
- f) Set repeat indicator to the value defined by the "RI increment setting" configuration parameter.

4.3.2.3 Configuration of repetition process

There are three parameters to configure the repetition process:

- incoming repeat indicator value limit;
- set if above value is the maximum number of repeats or a value for exact match;
- increment rule. Set to either increase repeat indicator by one (+1), or replace repeat indicator with 3.

All repeater stations within coverage of one another should be set to the same number of repeats, in order to ensure that "Binary acknowledgement" Message 7 and "Safety related acknowledgement" Message 13 are delivered to the originating station.

4.3.3 Duplicate message filtering

(See 6.5.1)

The same message shall be repeated only once within 30 s, by the same repeater station using the filtering parameters of Table 4. To make sure this is the case, messages shall be checked using repeat history 30 s back in time.

Table 4 – Duplicate message filtering parameters

Message type	Filter parameters
Position reports (1,2,3,18, 21)	MMSI, Time stamp
Static data (5,19)	MMSI
Static data (24A,24B)	MMSI, Message part
Binary messages (6, 8, 25, 26)	MMSI, Binary data
Safety related messages (12,14)	MMSI, Data
Other messages	No filtering required

4.3.4 Content filtering

4.3.4.1 Filter by message type

(See 6.5.4)

Received messages shall be filtered according to Table 5.

Table 5 – Repeater station behaviour for message repeat

Message type	Repeating allowed	Action	Comment
1	Yes	Amend communication state.	
2	Yes	Amend communication state.	
3	Yes	Amend communication state.	
4	No		Message 4 transmissions are not candidates for slot reuse and shall therefore not be repeated. See ^a .
5	Yes		
6	Yes		
7	Yes		
8	Yes		
9	No		SAR units generally have great range and therefore do not require retransmission.
10	No		See ^a .
11	No		See ^a .
12	Yes		
13	Yes		
14	Yes		
15	Yes	Disallow repeat of Message 15 with slot offset.	
16	No		See ^b .
17	No		Time to alarm for unhealthy satellites may not be fulfilled. DGPS messages may also be long.
18	Yes	Amend communication state (check for CS).	Message 18 from CS and SOTDMA may be handled differently.
19	Yes		
20	No		See ^b .
21	Yes		
22	No		See ^b .
23	No		See ^b .
24	Yes		
25	Yes		
26	Yes	Amend communication state.	
27	No		Not intended to be received by mobiles. Different frequencies.
^a UTC time will not be accurate after retransmission, hence the message is not repeated.			
^b This is a VDL control message.			

Any message type can be switched off by configuration.

4.3.4.2 AIS-SART filtering rules

(See 6.5.6)

Received message filtering shall use the following rules:

- repetition of AIS-SART test messages is configurable with “default=don’t repeat” this includes the AIS-SART text messages while undergoing tests;
- active AIS-SART position reports without a position shall be repeated;
- capability to trigger binary and text messages on reception of an active AIS-SART message shall contain repeater ID and RSSI of the received AIS-SART message;
- only one message from the burst can be repeated;
- continue repetition once per minute for 15 min after last message received. In this case the timestamp in the repeated AIS-SART position report shall be set to 60 (unavailable);
- prioritise active AIS-SART messages over others under heavy VDL load;
- filtering shall be disabled for active AIS-SART.

NOTE The “SART” in this standard includes devices using AIS-SART technology such as AIS-SART, AIS-MOB and EPIRB-AIS as defined in Recommendation ITU-R M.1371.

4.3.4.3 Filter by position

(See 6.5.3)

4.3.4.3.1 Defined areas

Messages shall be filtered by position using defined areas. When a message that does not contain a position field is received from a station whose position is not yet known, no filtering shall be applied. For example if a Message 5 is received before a position message from the same station is received, the Message 5 shall not be filtered.

A position report received from a station with a “default=not available” position shall not be repeated.

4.3.4.3.2 Area filter rules

(See 6.5.3)

Include/Exclude rule set – Each area defined shall be for either inclusion or exclusion of retransmission. If no included area is defined, the repeater station shall not retransmit any VDL message.

Number of areas – Minimum number of configurable areas shall be 8 in total. Overlapping areas are allowed. Exclude from transmission areas have priority over include areas in case of overlapping. An area for filtering is defined by two points forming a rectangle at its NE/SW geographic coordinates.

Distance to areas – The distance to an area shall not be considered by the repeater station.

Area sizes – There shall be no minimum or maximum area size limit required.

4.3.4.4 Filter by other message content

(See 6.5.5)

It shall be possible to filter messages by specific parameters within the messages.

As a minimum it shall be possible to filter AIS units by:

SOG – A SOG threshold for exclusion when SOG is lower than the threshold value;

COG – A COG range shall be configurable for inclusion or exclusion;

NavStatus – A complete set of NavStatus values shall be configurable for inclusion or exclusion;

Ship/cargo type – A set of ship/cargo types for inclusion or exclusion;

MMSI – A list or ranges of MMSIs to include or exclude.

4.3.5 Reporting interval filtering

(See 6.4.1, 6.4.2)

Repeat position messages at a configured reporting interval greater than the received reporting interval. Reporting interval filtering only applies to Message 1, 2, 3, and 18.

The retransmitted position messages shall always use the most current received information for that AIS unit (see 4.4.4.2). The reporting interval shall be less than 6 min.

- Downsampling – Repeat interval depends on receive interval. A configured number of position reports shall be skipped before retransmission as long as the configured maximum interval has not been exceeded. There is one maximum interval for stationary ships and another for moving ships.
- Fixed repeat intervals. There is one for stationary ships and another for moving ships.

A Class A vessel shall be considered as stationary if it has a SOG of less than or equal to 3 kn and navigation status of 'at anchor' or 'moored'.

A Class B vessel shall be considered as stationary if it has a SOG of less than or equal to 2 kn.

The messages to be repeated shall be queued. Received position messages (Message 1, 2, 3 or 18) shall replace queued messages from the same MMSI.

4.3.6 Channel filtering

(See 6.5.2)

The channel used for repeating messages shall be selectable; channel A, channel B, or both. Repeat messages shall be repeated on the channel they were received.

4.3.7 Filtering procedure

4.3.7.1 General procedure

Filtering is performed by the following procedure in the described order. If it is detected that the message is excluded from repetition the filtering is stopped and the message is not repeated.

Otherwise the filtering continues until an exclude is found or the complete filtering process is finished with the final result.

All repeated stations shall have an include/exclude status, and all other messages from the same station shall follow this filtering status. The include/exclude status shall be updated on a message to message basis. Every time a message with information relevant to the applied filters is received it shall be re-evaluated to determine the current include/exclude status.

4.3.7.2 MMSI filtering

(See 6.5.5.5)

All MMSI sets have to be evaluated.

Filtering continues with the area filtering as follows:

- if there is no active MMSI filtering set;
- if there is any inclusive MMSI set and the AIS unit MMSI is in at least one inclusive MMSI set;
- if the AIS unit MMSI is not in any exclusive MMSI set.

If none of the above criteria is fulfilled that filtering process is stopped and the message is not repeated.

In case of a configuration conflict, if the AIS unit MMSI is in an inclusive and in an exclusive set, priority is set on the inclusive set and the filtering continues.

4.3.7.3 Area filtering

(See 6.5.3.1)

All inclusive and exclusive areas have to be evaluated. If no inclusive area is defined, no repetition of messages shall take place.

In case of overlapping areas, exclusive areas have priority over inclusive areas. Inclusive areas inside an exclusive area are not allowed. See Annex B.

4.3.7.4 SOG filtering

(See 6.5.5.1)

If the SOG configuration setting is 0 or the received message does not contain a SOG the filtering continues with the next step.

If the message SOG is greater than or equal to the SOG configuration setting the filtering continues, otherwise it is stopped and the message is not repeated.

4.3.7.5 COG filtering

(See 6.5.5.2)

If the COG filtering is disabled or the received message does not contain a COG the filtering continues with the next step.

If the COG filtering is set to inclusive:

- the filtering continues if the COG is in the COG range;
- the filtering is stopped and the message is not repeated if the COG is not in the COG range.

If the COG filtering is set to exclusive:

- the filtering continues if the COG is not in the COG range;
- the filtering is stopped and the message is not repeated if the COG is in the COG range.

4.3.7.6 Message type filtering

(See 6.5.4)

If the message filtering is disabled the filtering continues with the next step.

If the message filtering is enabled the setting for the received message type is examined:

- the filtering continues if the received message type is set to inclusive;
- the filtering is stopped and the message is not repeated if the received message type is set to exclusive.

4.3.7.7 NavStatus filtering

(See 6.5.5.3)

If the NavStatus filtering is disabled the filtering continues with the next step.

If the NavStatus filtering is enabled the setting for the NavStatus is examined as follows:

- the filtering continues if the NavStatus is set to inclusive;
- the filtering is stopped and the message is not repeated if the NavStatus is set to exclusive.

4.3.7.8 Ship type filtering

(See 6.5.5.4)

If the ship type filtering is disabled the filtering continues with the next step.

If the ship type filtering is enabled for inclusive or exclusive the setting for the actual ship type is examined as follows:

- when the actual ship type is set to inclusive the filtering continues;
- when the actual ship type is set to exclusive the filtering is stopped and the message is not repeated.

4.3.7.9 Stationary vessel filtering

(See 6.5.5.6)

If the stationary vessel filtering is disabled then the filtering process is complete and the message can be processed.

For the purpose of the filtering process a vessel is considered stationary if the navigational status is set to 'moored' or 'at anchor' and the SOG is less than or equal to 3 kn.

If the stationary vessel filtering is enabled then messages from stationary vessels are not repeated.

4.3.8 Message processing

(See 6.3)

A received message requires additional processing before being retransmitted. The following processing is required:

- the content of the message to be repeated shall not be changed, except for the repeat indicator and fields associated with the communication state;
- select additional slot(s), required for re-transmitting message(s);

- the communication state of relevant received messages shall be changed according to method of VDL access, and is subject to parameters required by the slot(s) selected for retransmission by the repeater station.

4.3.9 Overload protection

(See 6.4.3, 6.4.4)

Monitor VDL load and restrict repeater generated VDL load under high VDL load situations.

A repeater station shall not repeat more than 12 messages in any one UTC second, unless FATDMA is used to reserve the transmission schedule.

Type 1:

- Configurable slot usage limit with a default 50 slots per channel per frame.
- The maximum usage limit shall not exceed 400 slots per channel per frame.
- The downsampling factor or fixed interval shall automatically adapt to avoid exceeding the limit according to rules defined in 4.3.5.

Type 2:

- Configurable slot usage limit with a default 50 slots per channel per frame.
- The maximum usage limit shall not exceed 50 slots per channel per frame.
- The downsampling factor or fixed interval shall automatically adapt to avoid exceeding the limit according to rules defined in 4.3.5.

If the required number of repeat transmissions exceeds the configuration of the repeater station then an alarm status shall be transmitted in the station identification message, and repeating shall stop for that frame.

4.3.10 Slot selection using RSSI – RSSI measurement

(See 6.3.1.5)

The RSSI will increase when two or more stations are transmitting in the same slot at approximately the same distance from the repeater station. A high level of RSSI generally indicates that the transmitting stations are close to the repeater station and a low level indicates that the transmitting stations are far away. Repeater stations shall use the RSSI measured in the previous frame in determining free slots and slots for reuse. The first 2 ms of the slot shall be used to distinguish between Class B “CS” and Class A transmissions for free slot determination in the next frame.

A repeater station shall always prefer to use free slots when available. A slot shall be considered free if it contains no decodable message and has an RSSI of less than 16 dB above the noise floor. The requirement to determine the noise floor is described in Recommendation ITU-R M.1371. One compliant method is to 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.

When insufficient free slots are available, and there are slots that contain energy levels that exceed a free slot without a decodable message, then they shall be considered “garbled slots”. The algorithm shall then select “garbled slots” according to the lowest energy level first. Intentional slot reuse, in accordance with Recommendation ITU-R M.1371 shall be performed after free and “garbled slots” are exhausted.

4.4 Message scheduling

(See 6.6)

4.4.1 Station report

A repeater station has to identify itself by transmitting a repeater status report using Message 26 every 6 min by default (value shall be configurable within 60 min), alternating between channel A and B. The access scheme shall preferably be ITDMA or SOTDMA where possible. FATDMA or RATDMA may be used, depending on the reporting interval. If the access scheme is configured as depending on the reporting interval the following access scheme shall be used:

- <= 1min: SOTDMA
- >1 min and <= 7 min: ITDMA
- >7 min: RATDMA

In all cases FATDMA slots shall be used, if available.

If the repeater station is not programmed with a valid identifier (MMSI) or is not configured to transmit a repeater status report then all repeating functions shall be disabled. If the repeater station is configured to disable all repeating functions, the repeater status report transmission is not required.

If the repeater station is integrated into a base station or an AIS AtoN station, the repeater station shall have its own MMSI in accordance with Recommendation ITU-R M.585.

4.4.2 Repeater station identification message structure

Table 6 defines the contents of the Message 26 which identifies the repeater station on the VDL. If the repeater station is built into a base station or an AIS AtoN, this message transmission is also required.

Table 6 – Contents of Message 26 used for repeater station identification

Parameter	Number of bits	Description
Message ID	6	Always 26
Repeat indicator	2	Always 0
Source ID	30	The ID shall be as defined in 4.4.1
Destination indicator	1	Always 0 = Broadcast
Binary data flag	1	Always 1 = Structured message
Application identifier	16	DAC = 995, FI = 0
Longitude	28	Longitude in 1/10 000 min ($\pm 180^\circ$, East = positive (as per 2's complement), West = negative (as per 2's complement); 181 = (6791AC0h) = not available = default)
Latitude	27	Latitude in 1/10 000 min ($\pm 90^\circ$, North = positive (as per 2's complement), South = negative (as per 2's complement); 91 = (3412140h) = not available = default)
Alarm status	16	See Table 7
Messages repeated in last frame	9	0 to 400 messages
Spare	12	Not used. Shall be set to zero. Reserved for future use.
Communication state selector	1	0 = SOTDMA communication state follows 1 = ITDMA communication state follows
Communication state	19	SOTDMA communication state (see ITU-R M.1371-5, § 3.3.7.2.2, Annex 2), if communication state selector flag is set to 0, or ITDMA communication state (Recommendation ITU-R M.1371-5, § 3.3.7.3.2, Annex 2), if communication state selector flag is set to 1
Number of bits	168	Occupies 1 slot

Table 7 – Alarm status definition for Table 6

Alarm status bit	Alarm condition
0	0 = default , 1 = Automatic downsampling active
1	0 = default , 1 = Downsampling limit exceeded
2	0 = default , 1 = Transmitter malfunction
3	0 = default , 1 = Receiver malfunction – channel A
4	0 = default , 1 = Receiver malfunction – channel B
5	0 = default , 1 = UTC lost
6	0 = default , 1 = Internal position lost
7	0 = default , 1 = VSWR failure
8	0 = default , 1 = AIS-SART received
9	0 = default , 1 = Slot re-use during last frame
10	0 = default , 1 = Battery low
11–15	Shall be 0 = default. Reserved for future use

4.4.3 Broadcast active AIS-SART message

(See 6.5.6)

Only one message from the active AIS-SART burst shall be repeated. The active AIS-SART message takes priority over any other message in the transmit queue. Upon reception of an active AIS-SART message with no valid position, the repeater station shall transmit a broadcast binary Message 8 with DAC = 995, FI = 9 as shown in Table 8. The message shall contain the unique ID of the active AIS-SART and the RSSI level of the received message.

The AIS-SART shall not be subject to downsampling.

Table 8 – Message 8 structure with AIS-SART related content

Parameter	Number of bits	Description
Message ID	6	Always 8
Repeat indicator	2	Always 0
Source ID	30	The ID shall be as defined in 4.4.1
Spare	2	Always 0
Application identifier	16	DAC = 995, FI = 9
Received AIS-SART ID	30	ID of received active AIS-SART
RSSI level	8	RSSI level of received active AIS-SART; –127 to +30 dBm in binary
Spare	2	Not used. Shall be set to zero. Reserved for future use
Number of bits	96	Occupies one slot

4.4.4 Configuration parameters

4.4.4.1 Basic system parameters

(See 6.1.1, 6.2.2)

The configurable parameters are given in Table 9.

Table 9 – Configurable parameters

Parameter	Field	Remark
Identification	User ID	The ID shall be as defined in 4.4.1. Used as Source ID for identification messages (see 4.4.2) and as Destination ID for VDL configuration.
Position	Primary position source	0 = internal GNSS The average GNSS position shall be stored as a fallback in case of GNSS drop out. 1 = Surveyed position
	Surveyed Latitude	Resolution: 1/10 000 min Default: 91°
	Surveyed Longitude	Resolution: 1/10 000 min Default: 181°
Own identification report	UTC minute	MM of frame
	Start slot Channel A	0...2249
	Interval to next transmission	Slot interval 0 = no transmission (Default) Maximum 135 000 slots (1 hour) Note that if the interval is set to 0 the disable/enable repeater parameter is also set to disabled (0).
	Access scheme	0 = depending on reporting interval 1 = FATDMA 2 = ITDMA/RATDMA (RATDMA when interval >7min) 3 = SOTDMA (only if interval <= 1 min)
Transmit power	Transmit power level	0 = high power = 12,5 W or as defined by the manufacturer. 1 = low power = 1 W or as defined by the manufacturer. 2 ...9 as defined by the manufacturer (optional)
Channels	Channel A	Channel number according to Recommendation ITU-R M.1084 Setting the channel number "0" disables the transmission on the channel(s).
	Channel B	
Encryption key	128 bit AES key	Default to all zeros.

4.4.4.2 General repetition parameters

(See 6.1.1, 6.3.1.3)

The general repetition parameters are given in Table 10.

Table 10 – Repetition parameters

Parameter	Field	Remark
Disable/enable repeater	Repeater enabled	0 = Repeater disabled, no repetition of message (default) 1 = Repeater enabled It is required that this parameter can be set also via VDL
Disable/enable RATDMA	RATDMA enabled	0 = RATDMA disabled (default) 1 = RATDMA enabled
Max VDL usage	Max number of repetition slots	Defines the maximum number of slots per channel per frame which can be used for repetition Default: 50 Maximum: 400 for Type 1, 50 for Type 2
Assigned slots 10 sets per channel (A & B)	Usage flag	0 = default = not configured 1 = assigned for own use 2 = restricted from own use
	Start slot	Start slot of an assigned block
	Slot increment	Slot increment from start of one block to the start slot of the next block. A multiple of the slot increment shall equal 2 250 (2 250 mod slot increment = 0). Values 0 through 1 125, 0 = one reservation per frame.
	Number of slots	Number of assigned slots in a block, 1 through 5 slots
Downsampling	Downsampling factor	0 = Fixed interval 1 = default = each message is repeated, no downsampling 2 = every second message is repeated 3 = every 3 rd message is repeated . . 15 = every 15 th message is repeated
	Maximum repeat interval (moving vessel)	Maximum interval in case of downsampling, defined as number of slots
	Maximum repeat interval (stationary vessel)	If this interval is exceeded the next received message from a certain station is repeated even if the downsampling factor is not yet reached. The maximum configurable repeat interval shall be 33 750 slots (15 min).
Fixed repetition interval	Fixed repeat interval (moving vessel)	Fixed interval, number of slots 0 = default = no fixed interval
	Fixed repeat interval (stationary vessel)	If this interval is exceeded and all queued messages are older than 30 s then the next received message shall be repeated. The maximum configurable repeat interval shall be 33 750 slots (15 min).
Filter by MMSI Minimum 2 sets, maximum 16 sets Set 1 defines the default behaviour for MMSIs	Exclude or include	0 = no MMSI filtering 1 = Include MMSI range 2 = exclude MMSI range
	First MMSI	First MMSI of a range

Parameter	Field	Remark
outside of the defined range. e.g., if set 1 is configured as an include range all MMSIs outside this range are excluded by default.	Last MMSI	Last MMSI of a range, can be identical to first MMSI if only 1 MMSI shall be filtered
Enable repetition of AIS-SART test messages	Enabled/disabled	0 = repetition of AIS-SART test messages disabled (default) 1 = repetition of AIS-SART test messages enabled

4.4.4.3 Area related repetition parameters

(See 6.1.1)

The area related parameters are given in Table 11. This set of parameters is applied and stored for each of the 8 through 16 area definitions.

Table 11 – Area related configuration parameters

Parameter	Field	Remark
Exclude or include	0 = no area filtering 1 = Include area 2 = exclude area	The area related filter parameters below only apply in case of an include area
NE corner point	Latitude	Resolution 1/10 min
	Longitude	
SW corner point	Latitude	Resolution 1/10 min
	Longitude	
Maximum number of repeats	Max repeated RI	0 = no repetition 1 = Rx messages with RI = 0 are repeated 2 = Rx messages with RI = 0 and 1 are repeated 3 = Rx messages with RI = 0 ... 2 are repeated
RI increment	RI increment setting	Definition how the RI of the repeated message is set depending on the RI of the received message 0 = RI is incremented by 1, max 3 1 = RI is set to 1 (if received RI $\geq$ 1 the message is not repeated) 2 = RI is set to 2 (if received RI $\geq$ 2 the message is not repeated) 3 = RI is set to 3 (if received RI = 3 the message is not repeated)
Filter by SOG	Min. SOG for repeating	SOG in kn 0 = default = no SOG filtering Only stations which exceed this parameter are repeated
Filter by COG Applied clockwise between first and last COG	Exclude/include	0 = default = no COG filtering 1 = include, stations with COG in the range are repeated 2 = exclude, station with COG in the range are not repeated
	First COG	COG in °, first COG of the range
	Last COG	COG in °, last COG of the range
Filter by message type	Enable/disable	0 = message type filter is disabled, all messages are repeated 1 = Message filter is enabled
	Message 1	0 = excluded, message is not repeated 1 = included, message is repeated
	Message 2	
	Message 3	
	Message 5	
	Message 6,7	
	Message 8	
	Message 12, 13	
	Message 14	
	Message 15	
	Message 18 CS	
	Message 18 SO	

Parameter	Field	Remark
	Message 19	
	Message 21	
	Message 24 CS	
	Message 24 Other SO	
	Message 25	
	Message 26	
Filter by NavStatus	Enable/ DisableNavStatus	0 = NavStatus filter is disabled, all messages are repeated 1 = Message filter is enabled
	NavStatus 0NavStatus	0 = excluded, message is not repeated
	NavStatus 1	1 = included, message is repeated
	NavStatus	
	NavStatus 15	
Filter by Cargo/Ship	Default filtering behaviour	0 = Cargo/ Ship type filter is disabled, all messages are repeated 1 = Message filter is enabled, all ships types are repeated by default 2 = Message filter is enabled, all ships types are not repeated by default
	Exceptions to default	Cargo/ ship types that are an exception to the default (0 ... 255).
Stationary vessel filtering	Enabled/disabled	0 = stationary vessel filtering disabled 1 = stationary vessel filtering enabled

All parameters shall be configurable using the PI. Apart from the mandatory parameters, any parameter can optionally be configured using the VDL.

4.5 Repeater station input/output sentence formatters

Table 12 lists sentence formatters used with a repeater station. Clause A.2 contains the details for each of the sentence formats developed for repeater stations.

Table 12 – Repeater station input/output sentence formatters

Sentence formatter	Input	Output	Description
ACK ^a	X		Acknowledge alarm
ADS ^{b d}		X	AIS device status
ALR ^a		X	Set alarm state (Table 7)
EPV ^c	X	X, Q	Command or report equipment property value
FSR ^d		X	Frame summary of AIS reception, defined by SPO. The manufacturer shall declare the parameters that are supported
NAK ^a		X	Negative acknowledgement
RA1	X	Q	Repeater area part 1 Configuration, basic definition
RA2	X	Q	Repeater area part 2 Configuration, message type filtering
RA3	X	Q	Repeater area part 3 Configuration, navigation status filtering
RA4	X	Q	Repeater area part 4 Configuration, ship and cargo type filtering
RFS	X	Q	Repeater FATDMA slots
RMF	X	Q	Repeater MMSI filter
RST ^d	X	X	Equipment reset command
SPO ^d	X	Q	Select AIS device's reception processing and output
VDM ^a		X	VHF data-link message
VDO ^a		X	VHF data-link own-vessel message
VER ^a		Q	Version information about equipment. Provided in response to ABQ
VSI ^d		X	VDL signal information, defined by SPO. The manufacturer shall declare the parameters that are supported and the accuracy. The VSI shall follow its associated VDM/VDO.
"X" indicates input to, or output from, the repeater station. "Q" indicates that the sentence may be externally requested using the IEC 61162-1 "\$xxAXQ,xxx" query sentence (see Annex A) method(s) in order for the identified sentence to be output. ^a Sentence formatters are described in IEC 61162-1. ^b The repeater station shall output, autonomously and periodically, the ADS sentence on the PI indicating the repeater station status. This shall be output once per minute or when there is a change in the status. ^c Sentence formatters are described in IEC 61993-2. ^d Sentence formatters are described in IEC 62320-1.			

5 Performance requirements

5.1 Cyclic redundancy check

The repeater station shall only transmit messages with a valid CRC. The repeater station shall calculate a new CRC for the repeat message prior to transmission.

5.2 Physical layer requirement

5.2.1 Transmitter requirements

(See 8.1, 8.2)