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INTERNATIONAL STANDARD

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

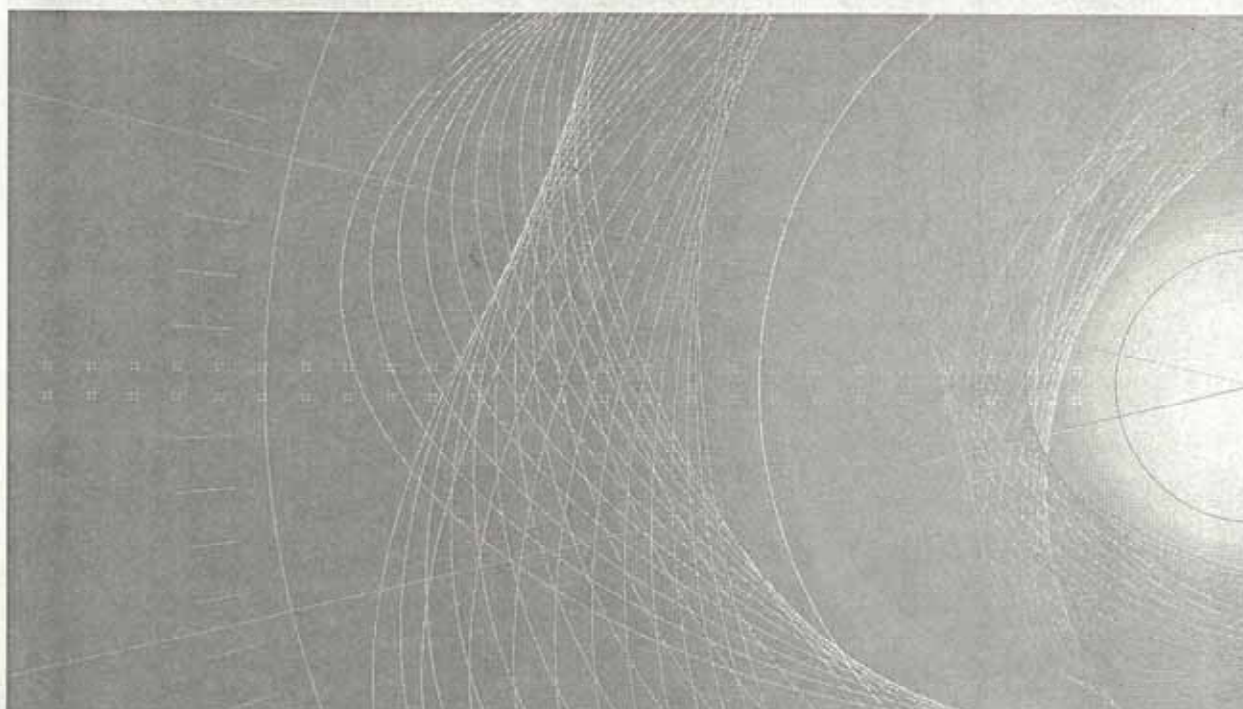
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methods of testing and required test results**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: AIS AtoN Stations – Operational and performance requirements, methods of testing and required test results

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The text of this standard is based on the following documents:

FDIS	Report on voting
80/507/FDIS	80/518/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62320 series, under the general title: *Maritime navigation and radiocommunication equipment and systems – Automatic Identification System (AIS)* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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

**Part 2: AIS AtoN Stations –
Operational and performance requirements,
methods of testing and required test results**

1 Scope

This part of IEC 62320 specifies the operational and performance requirements, methods of testing and required test results for AIS AtoN 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 AIS AtoN equipment, included in Recommendation ITU-R M.1371 and IALA Recommendation A-126. 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 Automatic Identification System (AIS) installations on Aids to Navigation (AtoN).

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

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

IEC 61108-2, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 2: Global navigation satellite system (GLONASS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61108-4, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 4: Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment – Performance requirements, methods of testing and required results*

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

IEC 62287-1, *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*

ITU Radio Regulations, Appendix 18, *Table of transmitting frequencies in the VHF maritime mobile band*

ITU-R Recommendation M.1371, *Technical characteristics for an 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*

IALA Recommendation A-126, *The Use of Automatic Identification System (AIS) in Marine Aids to Navigation*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1 Definitions

3.1.1

Aids to Navigation (AtoN)

device or system external to vessels that is designed and operated to enhance the safe and efficient navigation of vessels and/or vessel traffic

3.1.2

Message 21

AtoN report transmitted on the VHF data link by an AIS station

3.1.3

Real AIS AtoN

AIS AtoN station which is physically located on the AtoN

3.1.4

Synthetic AIS AtoN

Message 21 transmitted from an AIS station located remotely from the AtoN

3.1.5

Virtual AIS AtoN

Message 21 transmitted from an AIS station for an AtoN which does not physically exist

3.2 Abbreviations

AES	Advanced Encryption Standard
AIS	Automatic Identification System
BIIT	Built-in Integrity Tests
BT	Bandwidth Time Product
CSTDMA	Carrier Sense Time Division Multiple Access
DGNSS	Differential Global Navigation Satellite System
EPFS	Electronic Position Fixing System
EUT	Equipment Under Test
FATDMA	Fixed Access Time Division Multiple Access
GNSS	Global Navigation Satellite System
IMO	International Maritime Organisation
MAC	Medium Access Control
MMSI	Maritime Mobile Service Identity
NRZI	Non-Return to Zero Inverted

PER	Packet Error Rate
PI	Presentation Interface
RAIM	Receiver Autonomous Integrity Monitoring
RATDMA	Random Access Time Division Multiple Access
RF	Radio Frequency
Rx	Receive
SBAS	Satellite-Based Augmentation System
SOTDMA	Self Organizing Time Division Multiple Access
TDMA	Time Division Multiple Access
Tx	Transmit
UTC	Universal Time Co-ordinated
VDL	VHF Data Link
VSWR	Voltage Standing Wave Ratio

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

4 Description

4.1 Types of AIS AtoN Stations

There are three types of AIS AtoN Stations as defined in Table 1. The AIS AtoN Stations may optionally include additional capabilities as defined in the "Alternatives" column.

Table 1 – Description of AIS AtoN Stations

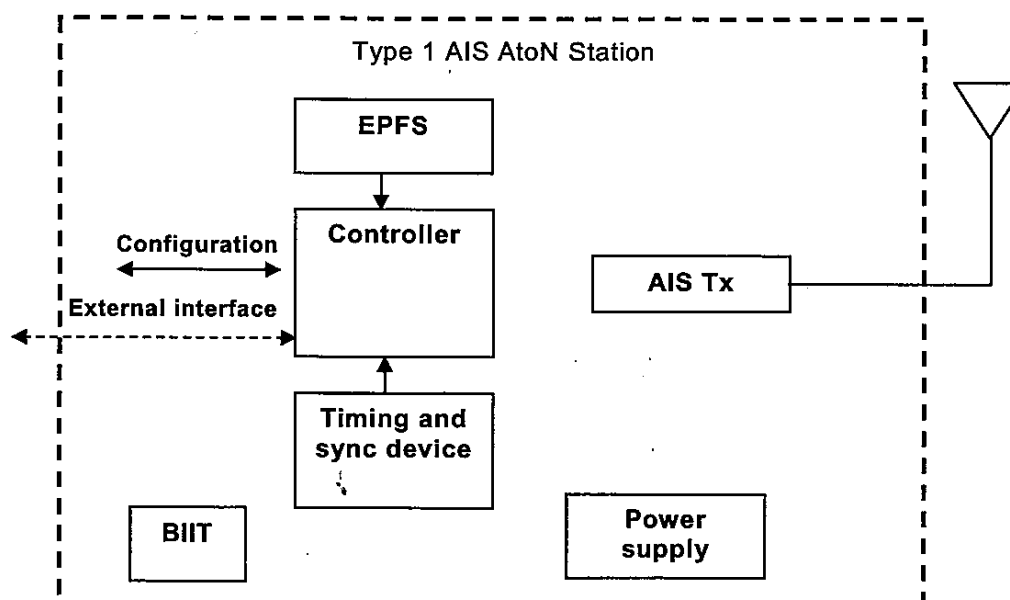
Requirements	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	Alternatives
VDL receiver	No receiver	Receiver for control functions only	Two receiving processes for autonomous mode	
Transmitted messages	21			21 plus one or more of 6, 8, 12, 14, 25 and other appropriate messages (Types 1, 2 and 3) plus 7, 13 (Type 3 only)
Access mode for Message 21	FATDMA			FATDMA and RATDMA (Type 3 only)
Access Mode for messages other than 21, if implemented				FATDMA (Types 1 and 2) One or more of FATDMA, RATDMA or CSTDMA (Type 3)
Configuration / communication method	Defined by manufacturer			Defined by the manufacturer with standard sentences (Types 1, 2 and 3)

Table 1 (continued)

Requirements	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	Alternatives
Physical communication interface	None			The electrical and physical characteristics shall be defined by the manufacturer. (Types 1, 2 and 3)
Transmit power	12,5 W			As defined by the manufacturer (Types 1, 2 and 3)
Transmitter capability	Dual channel			Single channel (Types 1, 2 and 3)
Synthetic and Virtual AtoN	No			Yes (Types 1, 2 and 3)
Positioning device	EPFS and surveyed position			Surveyed position only (no EPFS) (Types 1, 2 and 3)
UTC synchronisation	Direct only			Direct, indirect or semaphore (Type 3)
Assignment	Shall not respond to assignment Messages 16 and 23			
Interrogation	Shall not respond to interrogation Message 15			

4.2 Type 1 AIS AtoN Station

Type 1 AIS AtoN Station has no receiver. It transmits on FATDMA slots given in its configuration. Figure 1 shows the functional block diagram of a Type 1 AIS AtoN Station.



IEC 285/08

Figure 1 – Functional block diagram of a Type 1 AIS AtoN Station

4.2.1 Type 1 AIS AtoN Station characteristics

The characteristics of the Type 1 AIS AtoN Station are:

- transmits using FATDMA;
- no receive capability, therefore:
 - cannot be configured via the VDL,
 - cannot synchronise to other stations;
- configuration interface as defined by the manufacturer;
- 12,5 W transmitter power;
- dual channel transmission.

4.2.1.1 Controller

The controller composes Message 21 and ensures the correct operation of the AIS AtoN Station on the VDL.

4.2.1.2 Timing and synchronisation device

This device provides the time and synchronisation for the controller.

4.2.1.3 Power supply

The power supply generates the internal voltages.

4.2.1.4 BIIT

The Built-in Integrity Tests (BIIT) shall provide integrity monitoring.

4.2.1.5 EPFS

Electronic Position Fixing System (EPFS) provides the current position of the AtoN.

4.2.1.6 Configuration

The interface used to configure the AIS AtoN Station.

4.2.2 Capability

Type 1 AIS AtoN Station is capable of transmitting Message 21 using FATDMA.

4.2.3 Type 1 AIS AtoN Station – Alternatives

4.2.3.1 Additional controller capability

In addition to Message 21, the controller shall compose optional output messages to the VDL using FATDMA as described in Table 2.

Table 2 – Summary of optional Type 1 AIS AtoN Station messages

Msg ID	Message name	Message description	Application examples
6	Binary addressed message	Binary data for addressed communication	Monitoring of AtoN lantern, power supply, etc.
8	Binary broadcast message	Binary data for broadcast communication	Meteorological and hydrological data
12	Addressed safety related message	Safety related data for addressed communication	Warn AtoN malfunctioning
14	Broadcast safety related message	Safety related data for broadcast communication	Warn AtoN malfunctioning
25	Single slot binary message	Binary data for addressed or broadcast communication	Status report

NOTE The Type 1 AIS AtoN Station should not retransmit the addressed binary message (Messages 6 and 12). The number of retries should be set to 0.

4.2.3.2 Configuration method

The Type 1 AIS AtoN Station may be configured using standard configuration sentences. (IEC 61162-1 and as described in Annex A).

4.2.3.3 No EPFS

When a surveyed position is used, the EPFS may not be required.

4.2.3.4 TDMA transmitter (AIS Tx)

The TDMA transmitter may operate on a single channel.

4.2.3.5 External interface

The external interface(s) may be used for communication with external devices (for example AtoN lantern, AtoN power supply, hydrological and meteorological instruments, etc.).

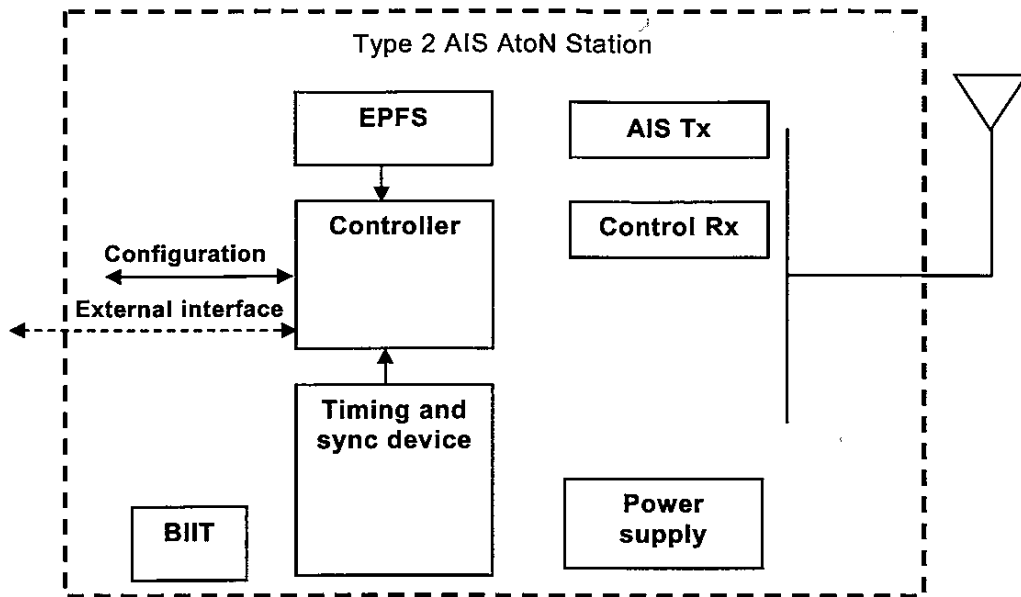
4.2.3.6 Synthetic and Virtual AtoN

The AIS AtoN Station may be capable of transmitting Message 21 for Synthetic and Virtual AIS AtoN.

4.3 Type 2 AIS AtoN Station

Type 2 AIS AtoN Station transmits on FATDMA slots.

Type 2 AIS AtoN Station has a control receiver for messages containing configuration sentences (see Annex B). Figure 2 shows the functional block diagram of a Type 2 AIS AtoN Station.



IEC 286/08

Figure 2 – Functional block diagram of a Type 2 AIS AtoN Station

4.3.1 Type 2 AIS AtoN Station characteristics

The characteristics of the Type 2 AIS AtoN Station are:

- transmits using FATDMA;
- limited receiver capability, therefore cannot maintain a slot map and cannot use RATDMA access scheme;
- configuration interface as defined by the manufacturer;
- 12,5 W transmitter power;
- dual channel transmission.

4.3.2 Capability

A Type 2 AIS AtoN Station has the capabilities of a Type 1 AIS AtoN Station, with the addition of a control receiver.

4.3.3 Control receiver

The Type 2 AIS AtoN Station shall have a receiver operating on an AIS channel for control functions only.

4.3.4 Type 2 AIS AtoN Station – alternatives

The Type 2 AIS AtoN Station alternatives include all the Type 1 AIS AtoN Station alternatives.

4.4 Type 3 AIS AtoN Station

Type 3 AIS AtoN Station has AIS receive and transmit capabilities in accordance with Recommendation ITU-R M.1371. Figure 3 shows the functional block diagram of a Type 3 AIS AtoN Station.

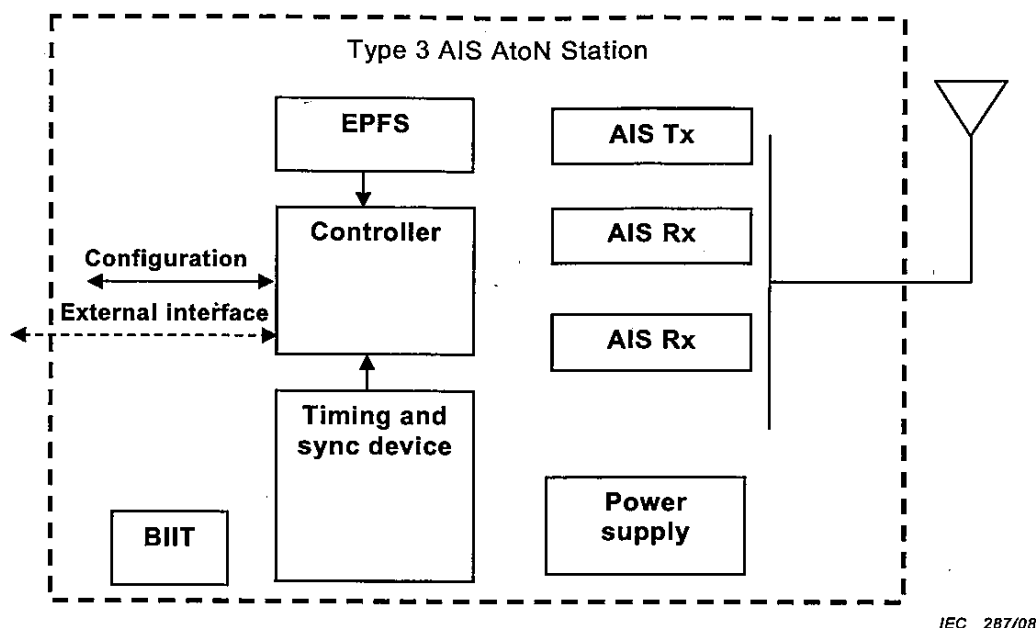


Figure 3 – Functional block diagram of a Type 3 AIS AtoN Station

4.4.1 Type 3 AIS AtoN Station characteristics

The characteristics of the Type 3 AIS AtoN Station are:

- receiving capability on both AIS channels,
- transmits using FATDMA.

4.4.2 Type 3 AIS AtoN Station capability

A Type 3 AIS AtoN Station has the capability of a Type 1 AIS AtoN Station, with the addition of AIS receivers.

4.4.3 AIS receiver (AIS Rx)

The Type 3 AIS AtoN Station shall have two AIS (TDMA) receiving processes to produce and maintain a slot map for autonomous interaction with the VDL.

4.4.4 Type 3 AIS AtoN Station – alternatives

The Type 3 AIS AtoN Station alternatives include all the Type 1 and Type 2 AIS AtoN Station alternatives, with the additions of 4.4.4.1, 4.4.4.2 and 4.4.4.3.

4.4.4.1 Additional controller capability

In addition to Message 21, the controller composes optional output messages to the VDL as described in Table 3.

Table 3 – Summary of optional Type 3 AIS AtoN Station messages

Msg ID	Message name	Message description	Application examples
6	Binary addressed message	Binary data for addressed communication	Monitoring of AtoN equipment
7	Binary acknowledge message	Acknowledge of addressed binary message	
8	Binary broadcast message	Binary data for broadcast communication	Meteorological and hydrological data
12	Addressed safety related message	Safety related data for addressed communication	Warn AtoN malfunctioning
13	Safety related acknowledge message	Acknowledge of addressed safety related message	
14	Broadcast safety related message	Safety related data for broadcast communication	Warn AtoN malfunctioning
25	Single slot binary message	Binary data for addressed or broadcast communication	Status report

4.4.4.2 Access mode

4.4.4.2.1 Message 21

Transmits using FATDMA or RATDMA.

4.4.4.2.2 Messages other than Message 21

For each message other than Message 21, the Type 3 AIS AtoN Station may use FATDMA, CSTDMA or RATDMA.

4.4.4.3 Indirect and semaphore synchronisation

A Type 3 AIS AtoN Station may optionally synchronise to other AIS Stations using UTC indirect synchronisation or other AIS Stations acting as semaphore.

4.5 Optional chaining of AIS AtoN Stations (Types 2 and 3)

A chain of AIS AtoN Stations allows for communication from an AIS Base Station to AIS AtoN Stations that are remotely located and unable to communicate directly with the Base Station. Messages are passed from station to station until the intended recipient is reached.

The concept requires an AIS AtoN Station to have knowledge of other AIS AtoN Stations in the chain, namely its parent and all children below it in the chain. A “parent station” is a station that is in the direction of the Base Station. A “child station” is a station that is directed away from a Base Station. In order to prevent unnecessary retransmission of the messages, each AIS AtoN Station in a chain may have only one parent, but may have multiple children (this includes all Synthetic and Virtual AIS AtoN).

Messages 6 and 25 are used for the transfer of the encrypted binary field. It is assumed that the whole chain has the same encryption key. The source ID and “MMSI of AtoN” fields of Message 6 or 25 are used to determine whether the received message is from a parent or child station. If not, then the received message is ignored.

The encrypted binary data field is decrypted to obtain the function ID and “MMSI of AtoN”. If the source ID of the message is set to the parent station ID and the function ID is a configuration, query request or function, and the MMSI of the AIS AtoN Station is in the chain, then the message shall be retransmitted, with the source ID set to own MMSI. If the source ID

of the message is set to the station's MMSI and the function ID is a query response, then the message shall be retransmitted, with the "MMSI of AtoN" set to the parent MMSI. Any other combination of known or unknown MMSI is ignored (see Table 4).

The chaining algorithm may be ignored by setting the source ID field to "#####". The AIS AtoN Station shall attempt to decrypt the binary data field, and check that it is the intended recipient of the message before processing the message any further.

Table 4 – Chaining of AIS AtoN Stations

Source ID	Application Identifier	MMSI of AtoN from Encrypted Binary Field	Action by Own Station
Parent	Function ID = query response	Responding AIS AtoN Station	In all cases, if function ID = query response, then ignore
Parent	Function ID = configuration or query request or functional	Intended recipient	If function ID = configuration or query request or functional, then verify intended recipient is in the chain and re-transmit message with source ID set to own station MMSI
Parent	Function ID = configuration or query request or functional	Own station	If function ID = configuration or query request or functional, then verify that the intended recipient is own station and then process
Responding child	Function ID = query response	Own station	In all cases, if function ID = query response, then re-transmit the message with "MMSI of AtoN" set to own station's parent MMSI
Child	Function ID = configuration or query request or functional	Intended recipient	In all cases, if Function ID = configuration or query request or functional, then ignore
"#####"		Own station	Process
"#####"		Other	Ignore
Other		Ignore	Ignore

5 Requirements for AIS AtoN Stations

5.1 Physical layer requirement

5.1.1 Transmitter requirements

5.1.1.1 Channel

The AIS AtoN Station shall operate on dual channels, Channel 1 and Channel 2, in the VHF Maritime Mobile Service band, using 25 kHz bandwidth, according to the ITU Radio Regulations, Appendix 18.

5.1.1.2 Channel alternatives

The Type 1, Type 2 and Type 3 AIS AtoN Stations may transmit on a single channel only, either Channel 1 or Channel 2.

5.1.1.3 Parameter settings

Table 5 and Table 7 are derived from Recommendation ITU-R M.1371 and give the parameters required for an AIS AtoN Station. For the meaning of the symbols and additional information (footnotes) refer to the appropriate section of Recommendation ITU-R M.1371.

Table 5 – Required parameter settings for an AIS AtoN Station

Symbol	Parameter name	Setting (FATDMA, RATDMA)	Setting (CSTDMA)
PH.RFR	Regional frequencies	Two channels between 156,025 MHz and 162,025 MHz	
PH.AIS1	Channel 1 (default Channel 1)	161,975 MHz	
PH.AIS2	Channel 2 (default Channel 2)	162,025 MHz	
PH.BR	Bit rate	9 600 bps	
PH.TS	Training sequence	24 bits	
PH.TST	Transmitter settling time (Transmit power within 20 % of final value. Frequency stable to within $\pm 1,0$ kHz of final value). Tested at manufacturers declared transmit power	$\leq 1,0$ ms	≤ 313 μ s
	Ramp down time	≤ 832 μ s	≤ 313 μ s
	Transmission duration	≤ 80 ms	$\leq 23\,333$ μ s
	Transmission delay	No delay	2 083 μ s
	Transmitter output power	12,5 W or as defined by manufacturer	

In addition, the constants of the physical layer of the AIS AtoN Station shall comply with the values given in Table 6 and Table 7.

Table 6 – Required settings of physical layer constants

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

Table 7 – Modulation parameters of the physical layer of the AIS AtoN Station

Symbol	Name	Value
PH.TXBT	Transmit BT-product	0,4
PH.RXBT	Receive BT-product	0,5
PH.MI	Modulation index	0,5

5.1.1.4 Transmitter shutdown

An automatic transmitter shutdown shall be provided to ensure that transmission does not continue for more than 2 s. This shutdown shall be independent of the operating system software.

5.1.1.5 Transmitter requirements

The technical characteristics as specified in Table 8 should apply to the TDMA transmitter.

Table 8 – Minimum required TDMA transmitter characteristics

Transmitter parameters	Requirements
Carrier power error	$\pm 1,5$ dB (normal), ± 3 dB (extreme)
Carrier frequency error	± 500 Hz (normal), $\pm 1\,000$ Hz (extreme)
Slotted modulation mask	-25 dBc $\Delta f_c < \pm 10$ kHz -60 dBc ± 25 kHz $< \Delta f_c < \pm 62,5$ kHz
Transmitter test sequence and modulation accuracy	$< 3\,400$ Hz for Bit 0, 1 (normal and extreme) $2\,400$ Hz ± 480 Hz for Bits 2, 3 (normal and extreme) $2\,400$ Hz ± 240 Hz for Bits 4... 31 (normal, $2\,400 \pm 480$ Hz extreme) For Bits 32 ...199 $1\,740 \pm 175$ Hz (normal, $1\,740 \pm 350$ Hz extreme) for a bit pattern of 0101 $2\,400$ Hz ± 240 Hz (normal, $2\,400 \pm 350$ Hz extreme) for a bit pattern of 00001111
Transmitter output power versus time	Power within mask shown in Figure 4 and timings given in Table 11
Spurious emissions	-36 dBm 9 kHz... 1 GHz -30 dBm 1 GHz... 4 GHz

5.1.2 Receiver requirements

The technical characteristics as specified in Table 9 should apply to the TDMA receivers.

Table 9 – Required receiver characteristics

Receiver parameters	Required result (Max PER or absolute level in dBm)	Type 3 (TDMA receiver)		Type 2 (Control receiver)	
		Wanted signal	Unwanted signals	Wanted signals	Unwanted signals
Sensitivity	20 %	-107 dBm normal -104 dBm normal at ± 500 Hz offset -101 dBm extreme	-	-97 dBm normal -94 dBm normal at ± 500 Hz offset -91 dBm extreme	-
Error at high input levels	2 % 10 %	-77 dBm -7 dBm	- -	-77 dBm -7 dBm	- -
Co-channel rejection	20 %	-101 dBm	-111 dBm -111 dBm at $\pm 1\,000$ Hz offset	-91 dBm	-107 dBm -107 dBm at $\pm 1\,000$ Hz offset
Adjacent channel selectivity	20 %	-101 dBm	-31 dBm	-91 dBm	-31 dBm

Table 9 (continued)

Receiver parameters	Required result (Max PER or absolute level in dBm)	Type 3 (TDMA receiver)		Type 2 (Control receiver)	
		Wanted signal	Unwanted signals	Wanted signals	Unwanted signals
Spurious response rejection	20 %	–101 dBm	–31 dBm	–91 dBm	–31 dBm
Intermodulation response rejection	20 %	–101 dBm	–36 dBm	–91 dBm	–36 dBm
Blocking and desensitisation	20 %	–101dBm	–23 dBm (< 5 MHz) –15 dBm (> 5 MHz)	–91 dBm	–33 dBm (< 5 MHz) – 25 dBm (> 5 MHz)
Spurious emissions	–57 dBm or less (9 kHz–1 GHz) –47dBm or less (1 GHz–4 GHz)	-	-	-	-

5.1.3 Power consumption

The manufacturer shall state the average power consumed by the AIS AtoN Station under defined test conditions.

5.1.4 Environmental requirements

The AIS AtoN Station shall meet the environmental conditions requirements as declared by the manufacturer. These environmental conditions shall be one of

- IEC 60945 "Protected",
- IEC 60945 "Exposed", or
- as defined by manufacturer.

5.2 Link layer requirements

The link layer specifies how data shall be formatted and transmitted on the VDL.

The link layer requirements are referenced to Recommendation ITU-R M.1371.

5.2.1 AIS Messages

5.2.1.1 Message 21 format and content

The AIS AtoN Station shall broadcast Message 21, as defined in Recommendation ITU-R M.1371.

5.2.1.1.1 AtoN status bits

In Message 21, the status bits (7 6 5 4 3 2 1 0) are numbered so that bit 7 is the most significant bit, and bit 0 is the least significant bit. The first three bits (i.e. 7, 6 and 5) shall be used to define a Page ID. The Page ID can range from 0 to 7, allowing 8 pages. Page ID 0 shall not be used for the Regional/International application. Page IDs 1 to 6 are reserved for future use.

Page ID 7 (binary 111) shall be as defined in this standard (see Annex C).

If the regional bits are not used, they shall be set to '0'.

5.2.1.1.2 Virtual and Synthetic AIS AtoN message

An AIS AtoN Station, when broadcasting Message 21 for Virtual and Synthetic AtoN, shall use the MMSIs allocated to the Virtual and Synthetic AtoN as issued under the same series for Real AIS AtoN Stations. For Synthetic AIS AtoN messages, the repeat indicator field shall be set to 1, 2 or 3 to signify that the message is transmitted from a position other than that provided in the message.

5.2.1.2 Additional messages

In addition to Message 21, the AIS AtoN Station may transmit other messages, in accordance with Recommendation ITU-R M.1371. These are summarised in Table 1.

5.2.1.2.1 Types 1 and 2

In addition to Message 21, allowed messages shall be one or more of 6, 8, 12, 14, 25 and other appropriate messages.

5.2.1.2.2 Type 3

In addition to Message 21, allowed messages shall be one or more of 6, 7, 8, 12, 13, 14, 25 and other appropriate messages.

5.2.2 Synchronisation

Synchronisation is used to determine the TDMA frames and individual slots so that the transmission of the AIS Message is performed within the desired slot. The synchronisation for the AtoN AIS Station shall be UTC direct.

If UTC direct synchronisation is lost, the AIS AtoN Station shall cease transmitting or optionally behave as declared by the manufacturer.

5.2.2.1 Optional indirect synchronisation

When UTC synchronisation has failed, the Type 3 AIS AtoN Station may use indirect synchronisation or synchronise to a station acting as a semaphore.

5.2.2.2 Synchronisation accuracy

The transmission timing error, including jitter, of the AtoN AIS shall be within the limits as defined in Table 10, referring to an ideal transmission as defined by Recommendation ITU-R M.1371.

Table 10 – Maximum allowed time error

Synchronisation mode	Maximum allowed time error
UTC direct synchronisation	$\pm 1\text{bit } (\pm 104 \mu\text{s})$
UTC indirect synchronisation	$\pm 3\text{bits } (\pm 312 \mu\text{s})$
Semaphore synchronisation	$\pm 3\text{ bits } (\pm 312 \mu\text{s})$

5.2.3 VDL access schemes

The AIS AtoN Station shall use FATDMA for the transmission of Message 21.

The AIS AtoN Station may optionally transmit Message 6, 7, 8, 12, 13, 14 and 25. The maximum length of Messages 6, 8, 12, and 14 is three slots per message when using FATDMA or RATDMA (if implemented). CSTDMA may be used for one slot messages only.

5.2.3.1 Type 3 AIS AtoN Station

The Type 3 AIS AtoN Station shall use FATDMA and may use RATDMA (if implemented) for Message 21. The Type 3 AIS AtoN Station shall use the VDL access scheme defined by its configuration.

Single slot binary and safety related messages may be transmitted using FATDMA or RATDMA or CSTDMA, if implemented. If an acknowledgement procedure is implemented the manufacturer shall state under which conditions the 4 s requirements are met. Single slot acknowledgement Messages 7 and 13 should be transmitted within 4 s of receiving Messages 6 and 12 using FATDMA, CSTDMA or RATDMA.

5.2.3.2 FATDMA and RATDMA VDL access

The transmitter shall begin transmission by turning on the RF power after slot start (T_0). The unit shall and reach -3 dB before T_{B1} (see Figure 4).

The transmitter shall be turned off after the last bit of the transmission packet has left the transmitting unit; nominal transmission end is T_e .

RATDMA shall use slots according to Recommendation ITU-R M.1371.

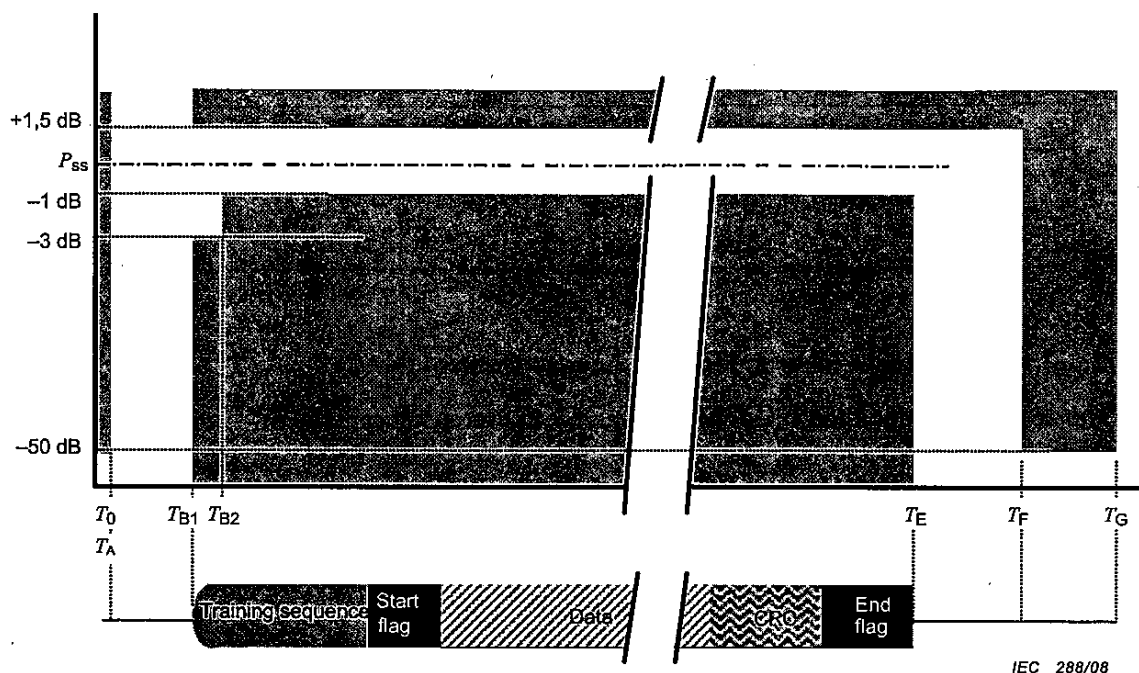


Figure 4 – Power versus time mask

The access to the medium is performed as shown in Figure 4 and Table 11.

Table 11 – Definitions of timing for Figure 4

Reference	Bits	Time in milliseconds	Definition
T_0	0	0	Start of transmission slot. Power shall NOT exceed – 50 dB of P_{ss} before T_0
T_A	0-6	0-0,624	Power exceeds –50 dB of P_{ss}
T_B	T_{B1}	6	Power shall be within + 1,5 dB or – 3 dB of P_{ss}
	T_{B2}	8	Power shall be within + 1,5 dB or – 1 dB of P_{ss}
T_E	104 - 748	10,833 – 77,917	<p>Power shall remain within + 1,5 dB or – 1 dB of P_{ss} during the period T_{B2} to T_E</p> <p>The T_E can vary depending on message type, data content and bit stuffing bits from minimum 104 bits for the shortest possible message (Message 14 and no text content) to maximum length of 740 bits for a three slot message.</p> <p>T_E shall not exceed;</p> <ul style="list-style-type: none"> • 236 bits for a one slot message • 492 bits for a two slot message • 748 bits for a three slot message <p>A station may occupy at maximum three consecutive slots for one continuous transmission. Only a single application of the overhead (ramp up, training sequence, flags, FCS, buffering) is required for a long transmission packet. The length of a long transmission packet should not be longer than necessary to transfer the data; i.e. the AIS should not add filler.</p>

Table 11 (continued)

Reference	Bits	Time in milliseconds	Definition
T_F	112 - 756	11,667 – 78,787	Power shall be – 50 dB of P_{ss} and stay below this
T_G	256, 512 or 768	26,667 one slot TX 53,333 two slot TX 80,000 three slot TX	Start of next transmission time period

5.2.3.2.1 Link sub-layer 1: Medium Access Control (MAC)

Refer to Recommendation ITU-R M.1371 and 5.2.2 for synchronisation.

5.2.3.2.2 Link sub-layer 2: Data Link Service (DLS)

Refer to Recommendation ITU-R M.1371.

5.2.3.2.3 Link sub-layer 3: Link Management Entity (LME)

Refer to Recommendation ITU-R M.1371.

5.2.3.3 CSTDMA VDL access mode

The operation of CSTDMA in the AIS AtoN Station shall be in accordance with Recommendation ITU-R M.1371 and tested according to IEC 62287-1, however the AIS AtoN Station is allowed to use the same transmit power setting for CSTDMA as for RATDMA and FATDMA.

All CSTDMA transmissions shall be limited to one slot.

5.2.4 Autonomous mode

The AIS AtoN Station shall always operate autonomously and determine its own schedule for transmission of its messages based on its configuration. The station shall automatically resolve scheduling conflicts with other stations when using CSTDMA and RATDMA.

5.2.4.1 Message 21 reporting intervals

The reporting interval for Message 21 shall be 3 min by default. This shall be configurable to other reporting intervals.

The AIS AtoN Station shall be configurable to decrease the reporting interval for Message 21 when the AtoN is off-position.

5.2.4.2 Channel operation

The AIS AtoN Station shall use channels as identified in this subclause.

5.2.4.2.1 Reporting modes for Message 21

The AIS AtoN Station shall transmit Message 21 at the configured reporting interval. As indicated in Figure 5, transmissions shall be:

- **Mode A operation** – Message 21 transmission alternates between Channel 1 and Channel 2 in a subsequent frame that is nominally one reporting interval later. Message 21 content is updated for each message, or

- **Mode B operation** – The same Message 21 transmitted on Channel 1 and Channel 2 in quick (nominally 4 s) succession. The first transmission of each Message 21 may be on either Channel 1 or Channel 2. The second transmission shall be on the other channel, or
- **Mode C operation** – Message 21 transmitted on a single channel, either Channel 1 or Channel 2. Message 21 content updated at each reporting interval.

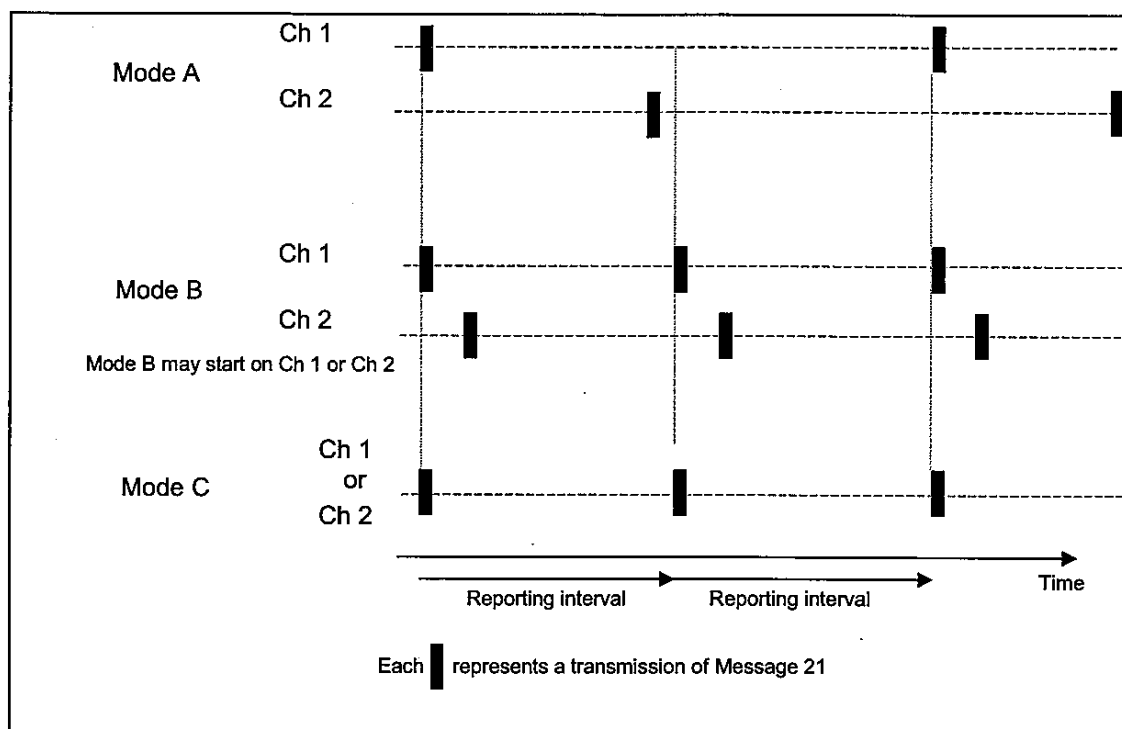


Figure 5 – Reporting modes for Message 21

5.2.4.2.2 Single channel operation for Message 21

The Type 1 and Type 2 AIS AtoN Stations shall transmit on the designated channel using FATDMA slots of the selected frames in the UTC hour (as per mode C, Figure 5).

5.2.5 Electronic position fix system

5.2.5.1 Position source

An EPFS shall be used as the source for AtoN position reporting unless a surveyed position is used.

If the internal EPFS is a GNSS receiver it shall meet the following requirements of IEC 61108 series: position accuracy, acquisition, re-acquisition, receiver sensitivity, RF dynamic range, interference susceptibility, position update, failure warnings, status indications and integrity flag, provide a resolution of one ten-thousandth of a minute of arc and use WGS 84 datum.

If another type of EPFS is used, then it shall meet the requirements of the applicable standard and use WGS 84 datum.

5.2.5.1.1 Augmentation systems

The EPFS may be capable of being corrected using any suitable augmentation system (for example, SBAS, radiobeacon DGNSS, evaluation of Message 17, etc.). The manufacturer shall declare which augmentation systems can be used, and that the augmentation system does not adversely affect Message 21 transmissions.

The manufacturer shall declare if the EPFS is not capable of being corrected.

5.2.5.1.2 Invalid position

If the EPFS device is unable to provide a valid position fix, then the reported position shall be longitude = 181° = not available = default and latitude = 91° = not available = default and the time stamp field shall be set to a value of 63.

5.2.5.1.3 Off-position monitoring

If the floating AtoN is within its on-position limits, the off-position indicator shall be set to "0" in the transmitted Message 21.

If a floating AtoN is off-position, the AIS AtoN Station shall identify this condition and the off-position indicator shall be set to "1" in the transmitted Message 21. The reporting interval when the AIS AtoN Station is off-position shall be determined by its configuration (see 5.2.4.1).

5.2.5.2 Position source alternatives for Types 1, 2 and 3

If a surveyed position is used, an EPFS is not required.

When a surveyed position is used, the latitude and longitude fields of the transmitted Message 21 shall contain the surveyed position, the "type of electronic position fixing device" is set to "7" (surveyed), the "RAIM-Flag" field is set to "0", the off-position indicator field is set to "0" and the "position accuracy" field is set in accordance with the accuracy of the surveyed position (i.e. "1" if better than 10 m, otherwise "0").

5.2.6 Built-in integrity test

The AIS AtoN Station shall have a Built-in Integrity Test (BIIT) process which tests for conditions as described Table 12. If standard configuration sentences are used, the warning / notification conditions shall be sent via sentence ADS. The ADS sentence should be output as defined by the manufacturer.

Table 12 – AIS AtoN Station reaction to BIIT conditions

Condition	Alarm condition threshold exceeded	Alarm condition not exceeded	Reaction of the AIS AtoN Station
AIS: Tx malfunction	A	V	Stop transmission
AIS: Antenna VSWR exceeds limit (only if external interface used)	A	V	Continue operation
AIS: Rx Channel 1 malfunction	A	V	Stop RATDMA and CSTDMA transmissions on affected channel
AIS: Rx Channel 2 malfunction	A	V	Stop RATDMA and CSTDMA transmissions on affected channel
AIS: General failure	A	V	Stop transmission
AIS: EPFS failure	A	V	Continue operation
AIS: Direct synchronisation failure	A	V	As defined by manufacturer
AIS: Synchronisation lost	A	V	As defined by manufacturer
AIS: DGNSS input failed	A	V	Continue operation
A alarm. V valid.			

5.3 Requirements for the configuration method

The configuration method shall be as defined by the manufacturer and held in non-volatile memory.

Configuration may use standard configuration sentences either directly or via the VDL.

The configuration method shall:

- configure the content for Message 21;
- configure transmission parameters for Message 21 and any other messages supported by the manufacturer;
- configure the behaviour of the AIS AtoN Station when synchronisation is lost;
- configure the behaviour of the AIS AtoN Station when off position.

The manufacturer shall provide a means to verify configuration and version information of the AIS AtoN Station.

5.3.1 Alternative for Types 1, 2 and 3

5.3.1.1 Standard IEC 61162 sentences

The standard configuration sentences shall be as defined in the IEC 61162 series.

Table 13 provides an overview of the sentences that may be used for configuration of AIS AtoN applications. It includes existing sentences from IEC 61162 with additional AtoN sentences as provided in Annex A.

Table 13 – Standard sentences

Sentence formatter	Input			Output			Description/comments
	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	Type 1 AIS AtoN Station	Type 2 AIS AtoN Station	Type 3 AIS AtoN Station	
AAR	X	X	X	Q	Q	Q	Configure broadcast rates for AIS AtoN Station messages
ACE	X	X	X	Q	Q	Q	Extended general AIS AtoN Station configuration
ACF	X	X	X	Q	Q	Q	General AIS AtoN Station configuration
AFB	X	X	X				Force broadcast
AFC				Q	Q	Q	AtoN Station function capability
AID	X	X	X	Q	Q	Q	Configure or change MMSI
AKE		X	X		Q	Q	Define encryption key
ARW		X	X		Q	Q	Receiver turn on times
MCR	X	X	X	Q	Q	Q	Proprietary AtoN control
MPR	X	X	X				Message payload rebroadcast
TSP	X	X	X	Q	Q	Q	Configure prohibited slots
VER				Q	Q	Q	Version
ABM*	X	X	X				Addressed binary message
BBM*	X	X	X				Broadcast binary message
ABK*				X	X	X	Acknowledgement message
VDM*	X	X	X		X	X	VHF data link message
VDO*				X	X	X	VHF data link own-vessel message
<p>* See 61162-1.</p> <p>X indicates input to or output from the AIS AtoN Station.</p> <p>Q indicates that the sentence may be externally requested using the IEC 61162 standard query sentences.</p>							

5.3.1.2 Chaining of AIS AtoN Stations

The AIS AtoN Station may support chaining to communicate messages to other AIS AtoN Stations (see 4.5).

No additional IEC 61162 sentences are required to support this functionality.

5.4 Other requirements

5.4.1 Additional features

Additional features shall not adversely affect the transmission of Message 21.

5.4.2 Manufacturer's information

The information shall describe:

- factory default MMSI;
- external interfaces;

- configuration of the AIS AtoN Station;
- hardware and electrical specifications;
- average power consumption;
- implementation method for firmware upgrades.

5.4.3 Marking and identification

The AIS AtoN Station shall be marked with the following information:

- identification of the manufacturer;
- model identification;
- serial number of the unit, and
- operating voltage.

The title and version of each software element included in the installed software system shall be either marked on the equipment or displayed on command.

6 Tests of AIS AtoN Stations – Method of measurement and required results

6.1 General

Physical test parameters and testing subject to national requirements may override parameters stated below.

6.2 Test conditions

6.2.1 Normal test conditions

6.2.1.1 Temperature and humidity

Temperature and humidity shall be within following ranges:

Temperature +15° C to +35° C

Humidity 20 % to 75 %

6.2.1.2 Power supply

The normal supply power used for the tests shall be in accordance with the nominal power of the EUT declared by the manufacturer and taking into account the variations set by local safety regulations concerning power supplies for example IEC 60950 as applicable in many countries.

6.2.2 Extreme test conditions

Extreme test conditions are as specified in IEC 60945. Where required, tests under extreme test conditions shall be a combination of

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

6.2.3 Standard test environment

The EUT is tested in an environment using test equipment to measure the transmitted messages. The EUT will be configured via the configuration interface prior to the tests. Operation is checked on channels in the maritime mobile band. Refer to Figure 6.

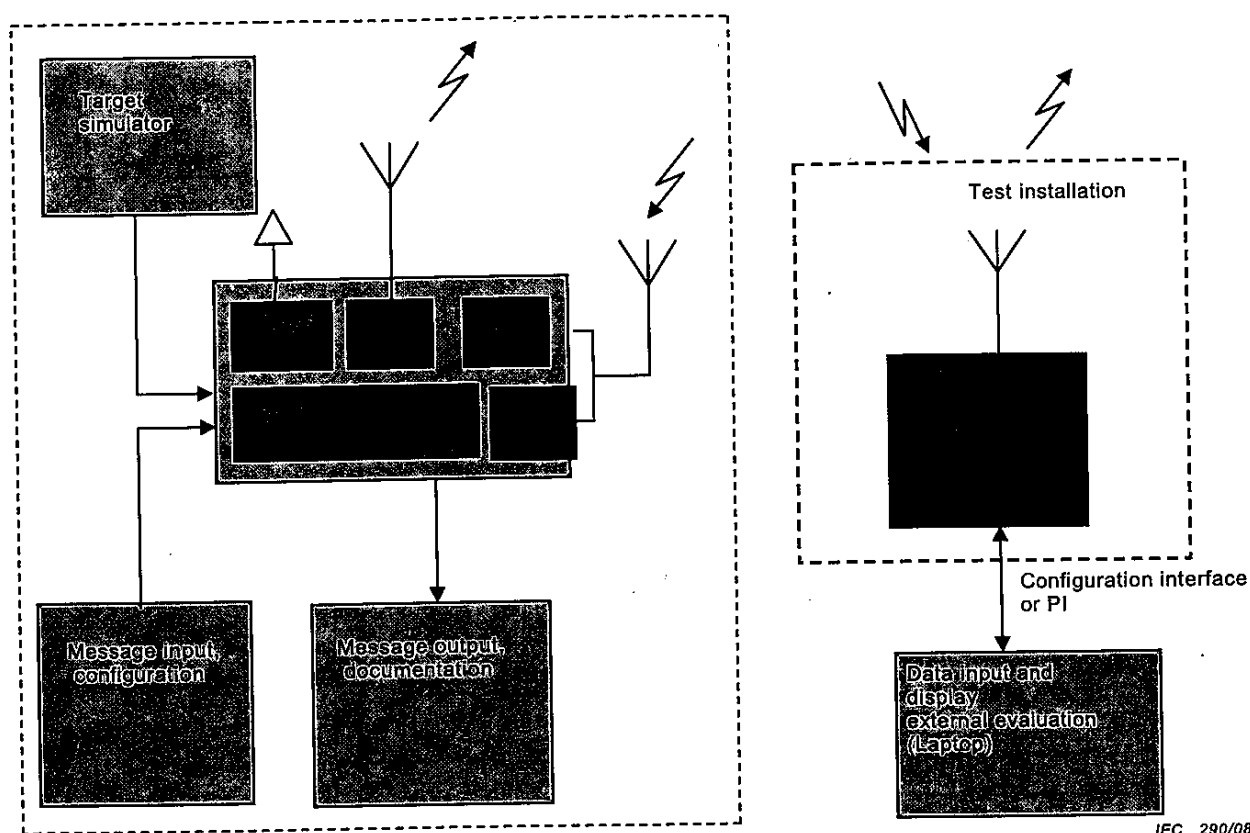


Figure 6 – Block diagram of AIS AtoN test setup

6.2.4 Test signals

6.2.4.1 Standard test signal number 1

A series of 010101 as the data within an AIS message frame, with header, start flag, end flag and CRC. NRZI is not applied to the 010101 bit stream or CRC (i.e. unaltered "On Air" data). The RF should be ramped up and down on either end of the AIS message frame.

6.2.4.2 Standard test signal number 2

A series of 00001111 as the data within an AIS message frame, with header, start flag, end flag and CRC. NRZI is not applied to the 00001111 bit stream or CRC. The RF should be ramped up and down on either end of the AIS message frame.

NOTE Transmitters may have limitations concerning their maximum continuous transmit time and/or their transmission duty cycle. It is intended that such limitations are respected during testing.

6.2.4.3 Standard test signal number 3

A Pseudo Random Sequence (PRS) as specified in Recommendation ITU-T O.153 as the data within an AIS message frame with header, start flag, end flag and CRC. NRZI is not applied to the PRS stream or CRC. The RF should be ramped up and down on either end of the AIS message frame.

6.2.4.4 Standard test signal number 4

This test signal consists of 200 packets grouped into clusters of 4 as described in Figure 7. Each cluster consists of 2 consecutive transmissions of the packets described in Table 14.

NRZI shall be applied to every packet. After sending packet 1 and 2 the notional initial state of the NRZI process shall be inverted and then packet 1 and 2 repeated.

Between every transmitted packet there shall be at least 2 free time periods. The RF carrier shall be switched off between packets to simulate normal operation.



IEC 291/08

Figure 7 – Format for repeating four-packet cluster

Table 14 – Content of first two packets

Packet	Parameter	Bits	Contents	Comment
1	Training	22	0101....0101	Preamble reduced by 2 bits because of ramp-up overlap
	Start flag	8	01111110	
	Data	168	Pseudo random	As per Table 15
	CRC	16	Calculated	
	End flag	8	01111110	
2	Training	22	1010....1010	Preamble reduced by 2 bits because of ramp-up overlap
	Start flag	8	01111110	
	Data	168	Pseudo random	As per Table 15
	CRC	16	Calculated	
	End flag	8	01111110	

Table 15 – Fixed PRS data derived from ITU-T O.153

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

6.2.5 Arrangements for test signals applied to the receiver input

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

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

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

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

6.2.6 Encoder for receiver measurements

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

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

6.2.7 Waiver for receivers

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

6.2.8 Impedance

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

6.2.9 Artificial antenna (dummy load)

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

NOTE Some of the methods of measurement described in this standard for the transmitter(s), allow for two or more different test set ups in order to perform those measurements. The corresponding figures illustrate therefore one particular test set up, and are given as examples. In many of those figures, power attenuators (providing a non-reactive non-radiating load of 50 Ω to the antenna connector) have been shown. These attenuators are not "artificial antennas" as defined in 6.2.9. The method of measurement used should be stated in the test report.

6.2.10 Facilities for access

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

6.2.11 Modes of operation of the transmitter

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

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

6.2.12 Measurement uncertainties

Maximum values of absolute measurement uncertainties shall be as indicated in Table 16.

Table 16 – Maximum values of absolute measurement uncertainties

Parameter	Maximum value
RF frequency	$\pm 1 \times 10^{-7}$
RF power	$\pm 0,75$ dB
Adjacent channel power	± 5 dB
Conducted spurious emission of transmitter	± 4 dB
Conducted spurious emission of receiver	± 3 dB
Two-signal measurement	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of transmitter	± 6 dB
Radiated emission of receiver	± 6 dB
Transmitter attack time	± 20 %
Transmitter release time	± 20 %
Transmitter transient frequency (frequency difference)	± 250 Hz

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

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

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

7 AIS AtoN Station tests

7.1 RF tests (transmitter and receiver)

7.1.1 TDMA transmitter

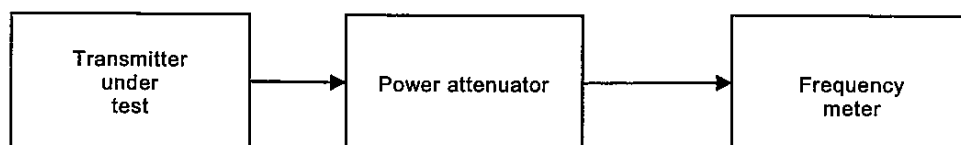
Unless otherwise stated, all transmitter tests shall be performed at the highest power setting.

7.1.1.1 Frequency error

7.1.1.1.1 Purpose

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

7.1.1.1.2 Method of measurement



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Figure 8 – Measurement arrangement

- a) The equipment shall be connected as illustrated in Figure 8.
- b) The carrier frequency shall be measured in the absence of modulation.
- c) The measurement shall be made under normal test conditions and extreme test conditions.
- d) The test shall be performed on the lowest operating frequency and the highest operating frequency as declared by the manufacturer.

7.1.1.1.3 Required results

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

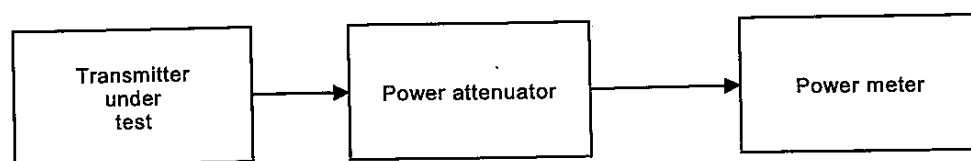
7.1.1.2 Carrier power

7.1.1.2.1 Purpose

The transmitter carrier power conducted (P_c) is the mean power delivered to a nominal 50Ω load during a radio frequency cycle. The rated power shall be nominally 12,5 W or as declared by the manufacturer. The carrier power accuracy shall be tested at the nominal level of 12,5 W or the level declared by the manufacturer.

7.1.1.2.2 Method of measurement

- a) The equipment shall be connected as illustrated in Figure 9.
- b) The carrier power shall be measured in the absence of modulation.
- c) The measurement shall be made under normal test conditions and extreme test conditions.
- d) The test shall be performed at the lowest and highest operating frequencies as declared by the manufacturer
- e) If the manufacturer optionally declares multiple power settings then the carrier power test shall be repeated at those settings at both the lowest and highest operating frequency of the EUT.



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Figure 9 – Measurement arrangement

7.1.1.2.3 Required results

P_c shall be within $\pm 1,5$ dB of the rated nominal power under normal conditions and within ± 3 dB of the rated nominal power under extreme conditions.

7.1.1.3 Modulation spectrum slotted transmission

7.1.1.3.1 Purpose

This test is to ensure that the modulation and transient sidebands produced by the transmitter under normal operating conditions fall within the allowable mask.

7.1.1.3.2 Method of measurement

- a) The test shall use test signal number 3.
- b) The EUT shall be connected to a spectrum analyser. A resolution bandwidth of 1 kHz, video bandwidth of 3 kHz or greater and positive peak detection (maximum hold) shall be used for this measurement. A sufficient number of sweeps shall be used and sufficient transmission packets measured to ensure that the emission profile is developed.
- c) Tests shall be performed on the lowest operating frequency on which the EUT can transmit according to the manufacturers specification and Channel 2 (162,025 MHz).

7.1.1.3.3 Required results

The spectrum for slotted transmission shall be within the emission mask as follows:

- in the region between the carrier and ± 10 kHz removed from the carrier, the modulation and transient sidebands shall be below 0 dBc;
- at 10 kHz removed from the carrier, the modulation and transient sidebands shall be below -25 dBc;
- at 25 kHz to $\pm 62,5$ kHz removed from the carrier, the modulation and transient sidebands shall be below the lower value of -60 dBc or -30 dBm;
- in the region between ± 10 kHz and ± 25 kHz removed from the carrier, the modulation and transient sidebands shall be below a line specified between these two points.

The reference level for the measurement shall be the carrier power (conducted) recorded for the appropriate test frequency in 7.1.1.2.

For information, the emission mask specified above is shown in Figure 10.

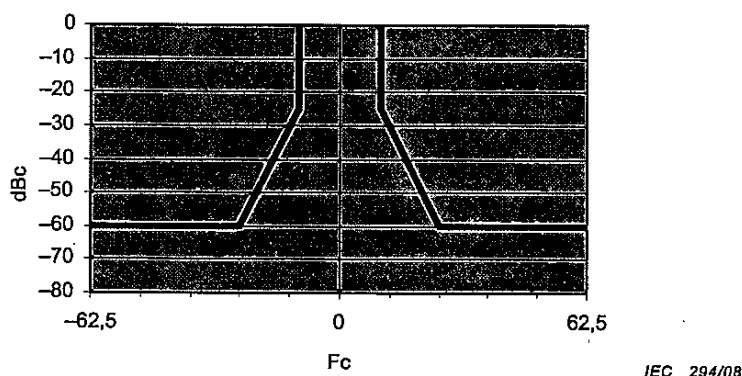


Figure 10 – Emission mask

7.1.1.4 Transmitter test sequence and modulation accuracy

7.1.1.4.1 Purpose

The test is to verify that the training sequence starts with a 0 and is a 0101 pattern of 24 bits. The peak frequency deviation is derived from the baseband signal to verify modulation accuracy.

7.1.1.4.2 Method of measurement

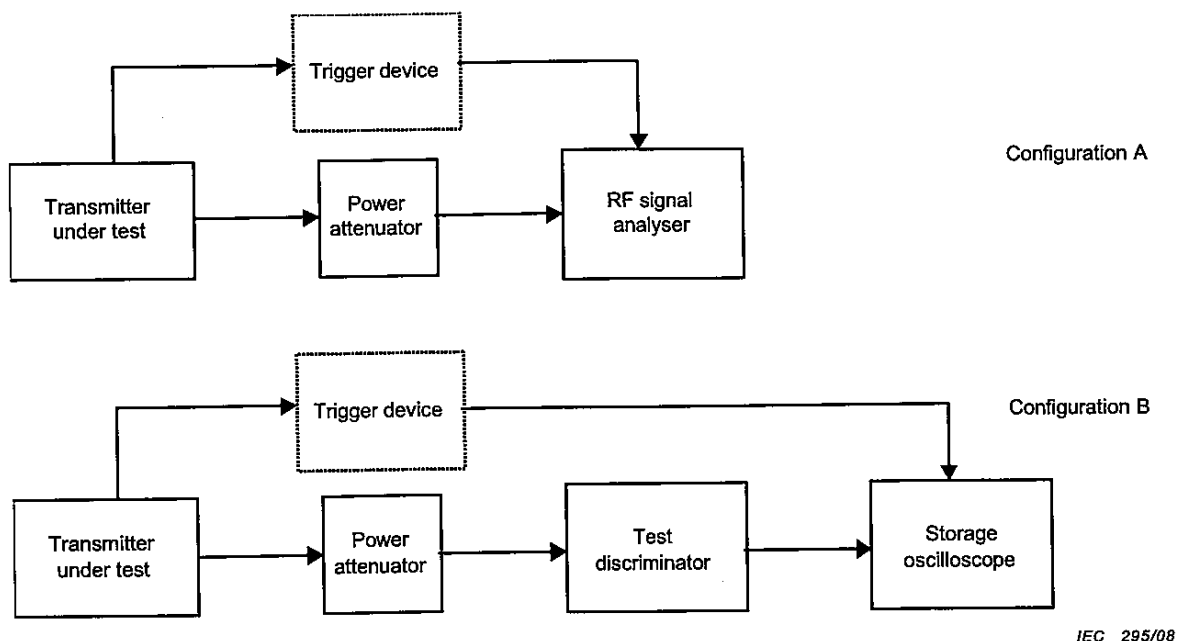


Figure 11 – Measurement arrangement for modulation accuracy

The measurement procedure shall be as follows:

- the equipment shall be connected in either Configuration A or Configuration B as shown in Figure 11. The trigger device is optional if the equipment is capable of synchronising to the transmitted bursts;
- the transmitter shall be tuned to Channel 2 (162,025 MHz);
- the transmitter shall be modulated with test signal number 1;
- the deviation from the carrier frequency shall be measured as a function of time;
- the transmitter shall be modulated with test signal number 2;
- the deviation from the carrier frequency shall be measured as a function of time;
- measurements shall be repeated at the lowest frequency on which the EUT can transmit, according to the manufacturer's specification;
- testing shall be repeated under extreme test conditions.

7.1.1.4.3 Required results

In each case, verify that the training sequence begins with '0'.

Peak frequency deviation at various points within the data frame shall comply with Table 17. These limits apply to both the positive and negative modulation peaks. Bit 0 is defined as the first bit of the training sequence.

Table 17 – Peak frequency deviation versus time

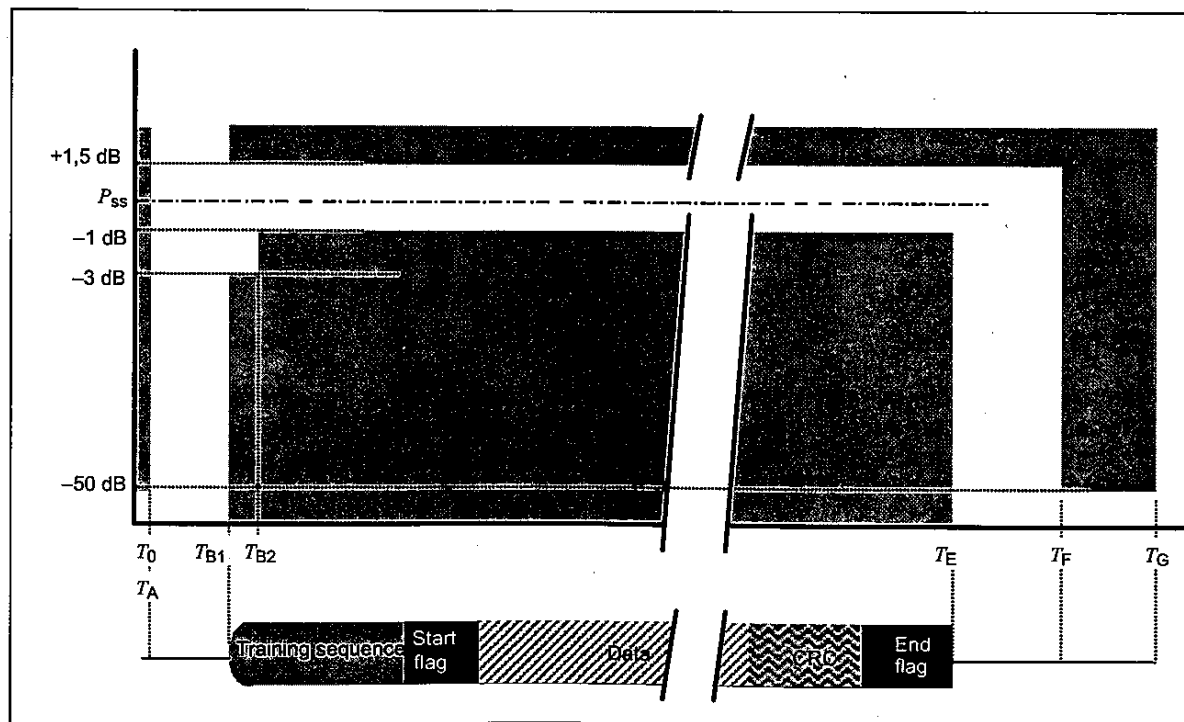
Measurement period from centre to centre of each bit	Test signal 1		Test signal 2	
	Normal	Extreme	Normal	Extreme
Bit 0 to bit 1	<3 400 Hz			
Bit 2 to bit 3	2 400 Hz \pm 480 Hz			
Bit 4 to bit 31	2 400 Hz \pm 240 Hz	2 400 Hz \pm 480 Hz	2 400 Hz \pm 240 Hz	2 400 Hz \pm 480 Hz
Bit 32 to bit 199	1 740 Hz \pm 175 Hz	1 740 Hz \pm 350 Hz	2 400 Hz \pm 240 Hz	2 400 Hz \pm 480 Hz

7.1.1.5 Transmitter output power versus time function (FATDMA and RATDMA)

7.1.1.5.1 Definition

Transmitter output power versus time function is a combination of the transmitter delay, attack time, release time and transmission duration as defined in Table 18 where:

- transmitter delay time ($T_A - T_0$) is the time between the start of the slot and the moment when the transmit power may exceed -50 dB of the steady-state power (P_{ss});
- transmitter attack time ($T_{B2} - T_A$) is the time between the transmit power exceeding -50 dBc and the moment when the transmit power maintains a level within $+1,5$ dB from P_{ss} ;
- transmitter release time ($T_F - T_E$) is the time between the end flag being transmitted and the moment when the transmitter output power has reduced to a level 50 dB below P_{ss} and remains below this level thereafter.
- transmission duration ($T_F - T_A$) is the time from when power exceeds -50 dBc to when the power returns to and stays below -50 dBc.



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Figure 12 – Power versus time mask

Table 18 – Definition of timings for Figure 12

Reference	Bits	Time	Definition
T_0	0	0 ms	Start of transmission slot. Power shall NOT exceed –50 dB of P_{ss} before T_0 .
$T_0 - T_A$	0-6	0-0,624 ms	Power may exceed –50 dB of P_{ss} *
T_B	T_{B1} 6	0,624 ms	Power shall be within +1,5 dB or –3 dB of P_{ss} *
	T_{B2} 8	0,8324 ms	Power shall be within +1,5 dB or –1 dB of P_{ss} *
T_E (includes 1 stuffing bit)	231	24,024 ms	Power shall remain within +1,5 dB or –1 dB of P_{ss} during the period T_{B2} to T_E *
T_F (includes 1 stuffing bit)	239	26,146 ms	Power shall be –50 dB of P_{ss} and stay below this
T_G	256	26,624 ms	Start of next transmission time period
* There shall be no modulation of the RF after the termination of transmission (T_E) until the power has reached zero and next slot begins (T_0).			

7.1.1.5.2 Method of measurement

The measurement shall be carried out by transmitting test signal number 1 (note that this test signal generates one additional stuffing bit within its CRC portion).

Tests shall be performed on 2 channels (lowest declared frequency and 162,025 MHz).

The EUT shall be connected to a spectrum analyser.

A resolution bandwidth of 1 MHz, video bandwidth of 1 MHz and a sample detector shall be used for this measurement.

The analyser shall be in zero-span mode for this measurement. The spectrum analyser shall be synchronised to the nominal start time of the slot (T_0), which may be provided externally, or from the EUT.

7.1.1.5.3 Required results

The transmitter power shall remain within the mask shown in Figure 12 and associated timings given in Table 18.

7.1.2 TDMA receivers (Types 2 and 3)

7.1.2.1 Sensitivity

7.1.2.1.1 Purpose

The maximum usable sensitivity (data or messages, conducted) is the minimum signal level at the receiver input, produced by a carrier at the specified frequency of the receiver, modulated with the specified test signal, which will, without interference, produce a data signal with a specified packet error rate (PER) after demodulation.

7.1.2.1.2 Method of measurement

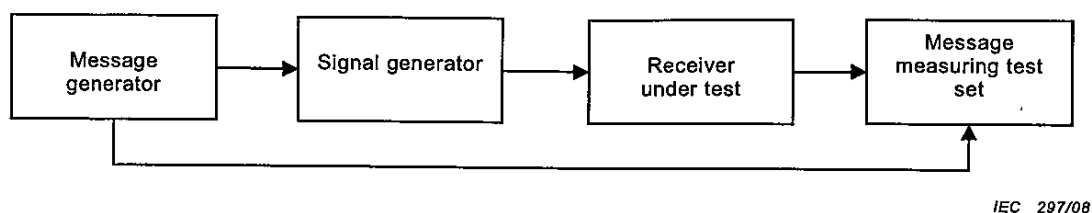


Figure 13 – Measurement arrangement

The measurement procedure shall be as follows with reference to Figure 13:

- a) the signal generator shall be at the lowest frequency of the receiver as declared by the manufacturer and shall be modulated to generate test signal number 4;
- b) the signal level at the input of the receiver shall be set to -107 dBm for a Type 3 device and -97 dBm for a Type 2 device;
- c) the message measuring test set shall be monitored and the packet error rate observed. The PER shall be derived by the following formula:

$$PER = (P_{TX} - P_{RX}) / P_{TX} \times 100 \text{ (\%)} \quad (1)$$

where

P_{RX} is the number of packets received without errors,

P_{TX} is the number of transmitted packets;

- d) the test shall be repeated at a $+500$ Hz offset from the lowest frequency declared by the manufacturer;
- e) the test shall be repeated at a -500 Hz offset from the lowest frequency declared by the manufacturer;
- f) the test shall be at the highest frequency declared by the manufacturer;
- g) the test shall be repeated at a $+500$ Hz offset from the highest frequency declared by the manufacturer;
- h) the test shall be repeated at a -500 Hz offset from the highest frequency declared by the manufacturer;
- i) repeat under extreme conditions, at either the lowest or the highest declared frequency. The signal generator shall be adjusted so the level at the input to the receiver is -101 dBm for a Type 3 device and -91 dBm for a Type 2 device.

7.1.2.1.3 Required results

Maximum PER of 20 %.

7.1.2.2 Error behaviour at high input levels

7.1.2.2.1 Purpose

The error behaviour (performance) at high input levels is defined in the same manner as for the measurement of the maximum usable sensitivity when the level of the wanted signal is 100 dB above the maximum wanted sensitivity.

7.1.2.2.2 Method of measurement

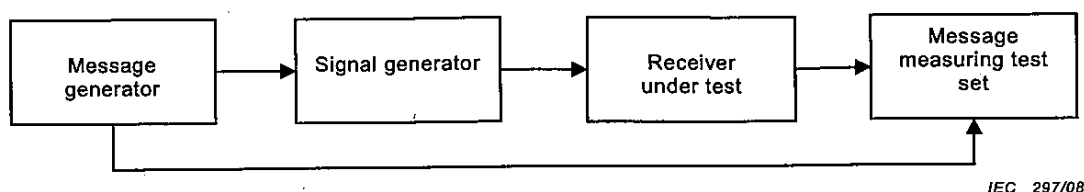


Figure 14 – Measurement arrangement

The measurement procedure shall be as follows:

- the measurement configuration shall be as shown in Figure 14;
- the signal generator shall be modulated to generate test signal number 4. The test shall be carried out at the lowest and the highest TDMA frequencies declared by the manufacturer. The message measuring test set shall be monitored and the packet error rate observed;
- the level of the input signal shall be adjusted to a level of -77 dBm;
- the level of the input signal shall be adjusted to a level of -7 dBm;
- 200 packets shall be transmitted and the PER shall be calculated.

7.1.2.2.3 Required results

The PER shall not exceed 2 % under c) and 10 % under d).

7.1.2.3 Co-channel rejection

7.1.2.3.1 Purpose

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the specified frequency of the receiver.

7.1.2.3.2 Method of measurement

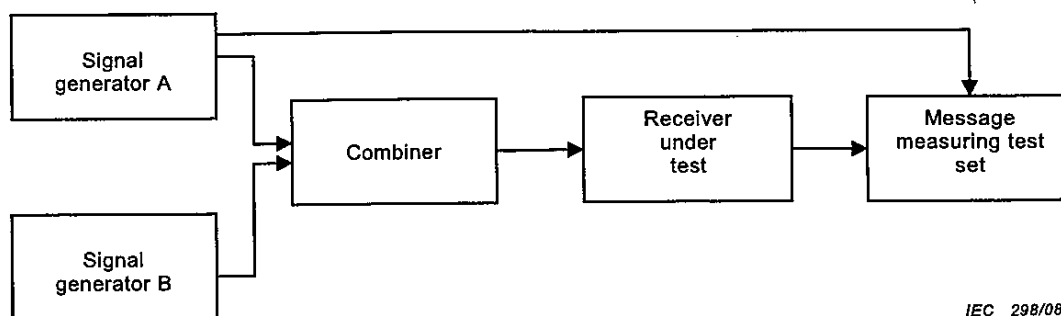


Figure 15 – Measurement arrangement

The measurement procedure shall be as follows with reference to Figure 15:

- two generators A and B, shall be connected to the receiver via a combining network;
- the wanted signal, provided by signal generator A, shall be at the lowest declared frequency of the receiver and shall be modulated to generate test signal number 4;

- c) the unwanted signal, provided by generator B, shall also be at the lowest declared frequency of the receiver. Generator B shall be modulated to generate test signal number 3, either continuously or in the same time period as that used by generator A for test signal number 4. The content of the wanted and unwanted signals shall not be synchronised;
- d) the level of the wanted signal from generator A shall be adjusted to -101 dBm for a Type 3 device and to -101 dBm for a Type 2 device;
- e) the level of the unwanted signal from generator B shall be adjusted to -111 dBm for a Type 3 device and -117 dBm for a Type 2 device;
- f) the message measuring test set shall be monitored and the packet error rate (PER) observed;
- g) the test shall be repeated at +1000 Hz offset from the lowest frequency declared by the manufacturer;
- h) the test shall be repeated at -1000 Hz offset from the lowest frequency declared by the manufacturer;
- i) the test shall be repeated at the highest declared frequency of the receiver;
- j) the test shall be repeated at +1000 Hz offset from the highest frequency declared by the manufacturer;
- k) the test shall be repeated at -1000 Hz offset from the highest frequency declared by the manufacturer.

7.1.2.3.3 Required results

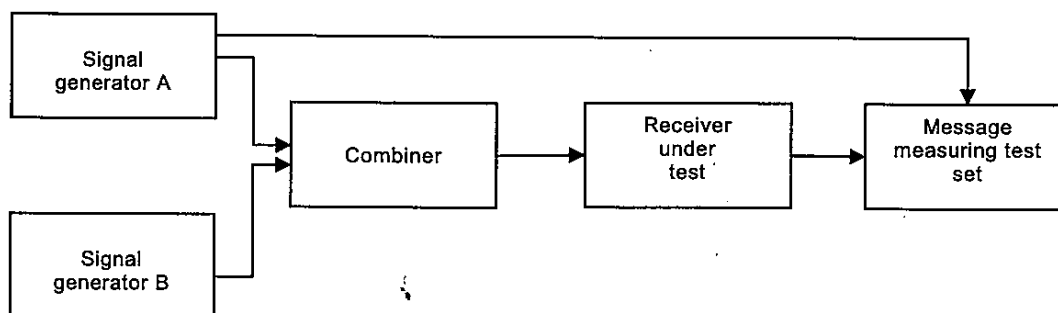
The PER shall not exceed 20 %.

7.1.2.4 Adjacent channel selectivity

7.1.2.4.1 Purpose

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

7.1.2.4.2 Method of measurement



IEC 299/08

Figure 16 – Measurement arrangement with messages

The measurement procedure shall be as follows with reference to Figure 16:

- a) two generators A and B shall be connected to the receiver via a combining network;
- b) the wanted signal, provided by signal generator A, shall be at the lowest declared frequency of the receiver and shall be modulated to generate test signal number 4;

- c) the unwanted signal, provided by generator B, shall be frequency modulated with a 400 Hz sine wave with a deviation of ± 3 kHz. Generator B shall be at a frequency 25 kHz above that of the wanted signal;
- d) the level of the wanted signal from generator A shall be adjusted to a level of -101 dBm for a Type 3 device and to -101 dBm for a Type 2 device;
- e) the level of the unwanted signal from generator B shall be adjusted to -31 dBm for a type 3 receiver and -41 dBm for a Type 2 receiver;
- f) the message measuring test set shall be monitored and the packet error rate observed;
- g) repeat the above measurement with the unwanted signal 25 kHz below the wanted signal;
- h) the test shall be repeated, steps b) through g), at the highest TDMA frequency declared by the manufacturer.

7.1.2.4.3 Required results

The PER shall not exceed 20 %.

7.1.2.5 Spurious response rejection

7.1.2.5.1 Purpose

The spurious response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal at any other frequency, at which a response is obtained.

7.1.2.5.2 Manufacturers' declarations

The manufacturer shall declare the following in order to calculate the "limited frequency range" over which the initial part of the test will be performed:

- a) list of intermediate frequencies: IF_1, IF_2, \dots, IF_N in Hz;
- b) switching range of the receiver¹: sr ;
- c) frequency of the local oscillator² at Channel 2 and at the lowest TDMA channel: f_{LOH}, f_{LOL}

7.1.2.5.3 Introduction to the method of measurement

The initial evaluation of the unit shall be performed over the "limited frequency range" and shall then be performed at the frequencies identified from this test and at "specific frequencies of interest" (as defined below).

To determine the frequencies at which spurious responses can occur the following calculations shall be made:

- a) calculation of the "limited frequency range":

The limits of the limited frequency range (LFR_{HI} LFR_{LO}) are determined from the following calculations:

$$LFR_{HI} = f_{LOH} + (IF_1 + IF_2 + \dots + IF_N + sr/2) \quad (2)$$

$$LFR_{LO} = f_{LOL} - (IF_1 + IF_2 + \dots + IF_N + sr/2) \quad (3)$$

- b) calculation of specific frequencies of interest (SFI) outside the limited frequency range:

These are determined by the following calculations:

¹ Switching range corresponds to the frequency range over which the receiver can be tuned.

² This may be a VCO, crystal, sampling clock, BFO, Numerically Controlled Oscillator depending on the design of the equipment.

$$SFI_1 = (K \times f_{LOH}) + IF_1 \quad (4)$$

$$SFI_2 = (K \times f_{LOL}) - IF_1 \quad (5)$$

where K is an integer from 2 to 4.

7.1.2.5.4 Method of measurement over the limited frequency range

Two methods are available for the measurements over the limited frequency range, one based on SINAD measurements and the other based on PER measurements. Either method may be used, but in each case shall be followed by the method of measurement at identified frequencies.

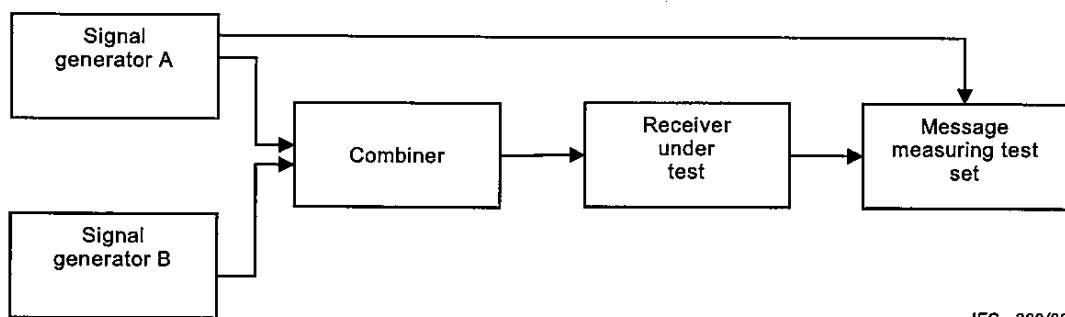


Figure 17 – PER/BER or SINAD measuring equipment

7.1.2.5.5 Method of search over the "limited frequency range" using SINAD measurement

The measurement procedure shall be as follows with reference to Figure 17:

- a) Two generators A and B shall be connected to the receiver via a combining network.
- b) The wanted signal, provided by generator A, shall be at 161,975 MHz and shall be modulated with a 1 kHz sine wave at $\pm 2,4$ kHz deviation.
- c) The unwanted signal, provided by generator B, shall be frequency modulated with a 400 Hz sine wave giving a deviation of ± 3 kHz.
- d) Initially, generator B (unwanted) shall be switched off (maintaining the output impedance).
- e) The signal level from generator A (wanted) shall be adjusted to -101 dBm for Type 3 or -91 dBm for Type 2 at the receiver.
- f) The SINAD value shall be noted (and shall be greater than 14 dB)
- g) Signal generator B shall be switched on and adjusted to -31 dBm at the receiver.
- h) The frequency of the unwanted signal shall be varied in steps of 5 kHz over the limited frequency range (from LFR_{LO} to LFR_{HI}).
- i) The frequency of any spurious response detected (by a decrease in SINAD of 3 dB or more) during the search shall be recorded for use in the next measurement.

NOTE If the manufacturer's specified receiver frequencies do not include 161,975 MHz, one of the manufacturer's specified receiver frequencies may be used as an alternative.

7.1.2.5.6 Method of search over the "limited frequency range" using PER or BER measurement

The measurement procedure shall be as follows with reference to Figure 17:

- a) Two generators A and B shall be connected to the receiver via a combining network.

- b) The wanted signal, provided by generator A, shall be at 161,975 MHz and shall be modulated to generate test signal number 3.
- c) The unwanted signal, provided by generator B, shall be frequency modulated with a 400 Hz sine wave giving a deviation of ± 3 kHz.
- d) Initially, generator B (unwanted) shall be switched off (maintaining the output impedance).
- e) The signal level from generator A (wanted) shall be adjusted to – 101 dBm for Type 3 or – 91 dBm for Type 2 at the receiver.
- f) The PER or BER shall be noted.
- g) Signal generator B shall be switched on and adjusted to – 31 dBm at the receiver.
- h) The frequency of the unwanted signal shall be varied in steps of 5 kHz over the limited frequency range (from LFR_{LO} to LFR_{HI}).
- i) The frequency of any spurious response detected (by an increase in either PER or BER) during the search shall be recorded for use in the next measurements.
- j) In the case where operation using a continuous packet stream is not possible, a similar method may be used.

NOTE If the manufacturer's specified receiver frequencies do not include 161,975 MHz, one of the manufacturer's specified receiver frequencies may be used as an alternative.

7.1.2.5.7 Method of measurement (at identified frequencies)

The measurement procedure shall be as follows with reference to Figure 17:

- a) Two generators A and B shall be connected to the receiver via a combining network.
- b) The wanted signal, provided by generator A, shall be at 161,975 MHz and shall be modulated to generate test signal number 3.
- c) The unwanted signal, provided by generator B, shall be frequency modulated with a 400 Hz sine wave giving a deviation of ± 3 kHz. Generator B shall be at the frequency of that spurious response being considered.
- d) Initially, signal generator B (unwanted) shall be switched off (maintaining the output impedance).
- e) The signal level from generator A (wanted) shall be adjusted – 101 dBm for Type 3 or – 91 dBm for Type 2 at the receiver.
- f) Signal generator B shall be switched on, and the level of the unwanted signal set to – 31 dBm.
- g) For each frequency noted during the tests over the limited frequency range and the specific frequencies of interest (SFI_1 and SFI_2), transmit 200 packets to the EUT and note the PER.

NOTE If the manufacturer's specified receiver frequencies do not include 161,975 MHz, one of the manufacturer's specified receiver frequencies may be used as an alternative.

7.1.2.5.8 Required results

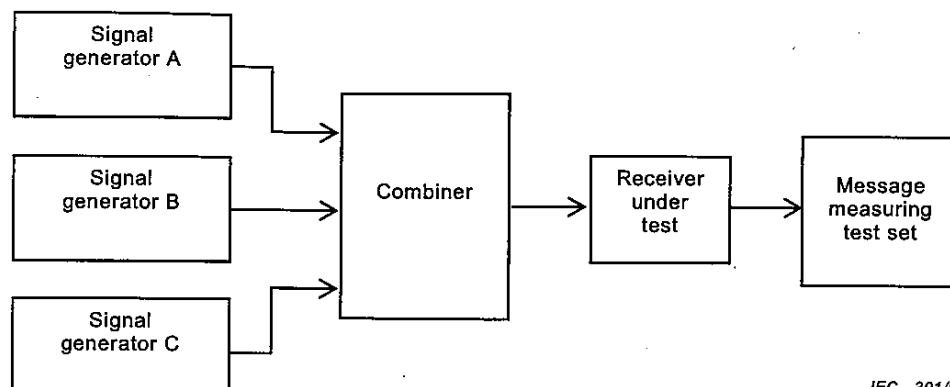
At any frequency separated from the specified frequency of the receiver by 50 kHz or more, the PER shall not exceed 20 %.

7.1.2.6 Inter-modulation response rejection

7.1.2.6.1 Purpose

The inter-modulation response rejection is the capability of the receiver to receive a wanted modulated signal, without exceeding a given degradation due to the presence of two close-spaced unwanted signals with a specific frequency relationship to the wanted signal frequency.

7.1.2.6.2 Method of test



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Figure 18 – Measurement arrangement for inter-modulation

The measurement procedure shall be as follows with reference to Figure 18:

- three signal generators shall be connected to the receiver via a combining network;
- the wanted signal, provided by signal generator A, shall be at the specified frequency of the receiver and shall be modulated to generate test signal number 3;
- the unwanted signal from generator B shall be unmodulated;
- the unwanted signal from generator C shall be frequency modulated with a 400 Hz sine wave at a deviation of ± 3 kHz;
- the signal level from generator A (wanted) shall be set for -101 dBm for Type 3 or -91 dBm for Type 2 at the receiver input;
- the signal level from generators B and C shall be set for -36 dBm at the receiver input;
- the frequencies of generators A, B, C shall be set as per test number 1 of Table 19;
- the message measuring test set shall be monitored and the PER observed over 200 transmissions;
- repeat the measurement with frequencies set as per test number 2 of Table 19.

Table 19 – Frequencies for inter-modulation test

Test number	Generator A Wanted AIS Signal	Generator B Unmodulated (± 500 kHz)	Generator C Modulated (± 1000 kHz)
1 (RATDMA receiver)	162,025 MHz	161,525 MHz	161,025 MHz
1 (Non-RATDMA receiver)	Highest operating frequency on which the EUT can operate	Highest operating frequency on which the EUT can operate – 500 kHz	Highest operating frequency on which the EUT can operate – 1 000 kHz
2 (both RATDMA and non-RATDMA receiver)	Lowest operating frequency on which the EUT can operate	Lowest operating frequency on which the EUT can operate + 500 kHz	Lowest operating frequency on which the EUT can operate + 1 000 kHz

7.1.2.6.3 Required results

The PER shall not exceed 20 %.

7.1.2.7 Blocking or desensitization

7.1.2.7.1 Purpose

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequency other than those of the spurious responses or the adjacent channels.

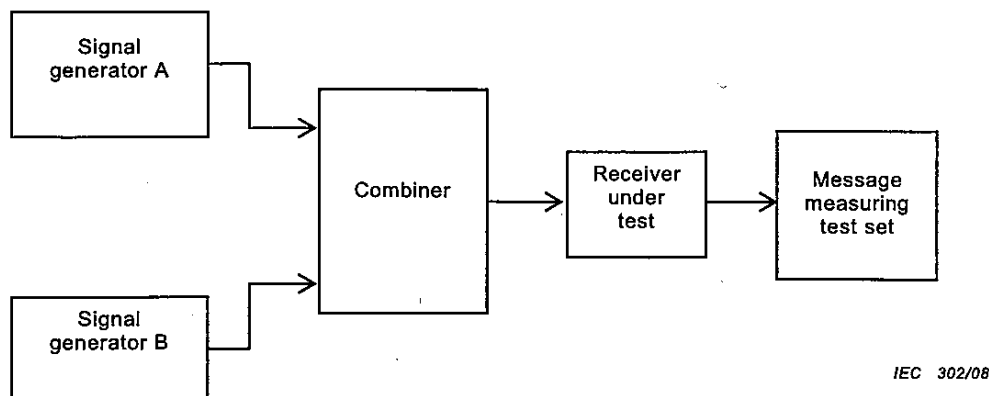


Figure 19 – Measurement arrangement for blocking or desensitisation

7.1.2.7.2 Method of measurement

The measurement procedure shall be as follows:

- a) two generators A and B, shall be connected to the receiver via a combining network as shown in Figure 19;
- b) the wanted signal, provided by signal generator A, shall be at the lowest operating frequency on which the EUT can transmit (or receive for a non-RATDMA receiver) according to the manufacturers specification and be modulated with test signal number 3;
- c) the unwanted signal from generator B shall be unmodulated and shall be at a frequency 0,5 MHz to 10 MHz away from the lowest declared frequency of the receiver. Measurements shall be carried out at frequencies of the unwanted signal at ± 500 kHz, ± 1 MHz, ± 2 MHz, ± 5 MHz and ± 10 MHz avoiding those frequencies where spurious responses could occur;
- d) initially, signal generator B (unwanted signal) shall be switched off (maintaining the output impedance). The level of the wanted signal from generator A shall be adjusted to -101 dBm for Type 3 and -91 dBm for Type 2 at the receiver input;
- e) the RF signal level for signal generator B (unwanted signal) shall be adjusted to -23 dBm when the frequency setting is less than ± 5 MHz with respect to the frequency setting of RF signal generator A. For frequency settings of signal generator B that are equal to or greater than ± 5 MHz with respect to the frequency setting of generator A, the RF signal level shall be adjusted to -15 dBm. This applies to Type 3 receivers only;
- f) the RF signal level for signal generator B (unwanted signal) shall be adjusted to -33 dBm when the frequency setting is less than ± 5 MHz with respect to the frequency setting of RF signal generator A. For frequency settings of signal generator B that are equal to or greater than ± 5 MHz with respect to the frequency setting of generator A, the RF signal level shall be adjusted to -25 dBm. This applies to Type 2 receivers only;
- g) 200 packets shall be transmitted and the PER recorded;
- h) repeat the test steps a) to f) with signal generator A tuned to the highest operating frequency on which the EUT can receive as declared by the manufacturer.

7.1.2.7.3 Required results

The PER shall not exceed 20 %.

7.1.3 Conducted spurious emissions at the antenna

7.1.3.1 Spurious emissions from the receiver

7.1.3.1.1 Purpose

Conducted spurious emissions to the antenna are any RF emissions generated in the receiver and conveyed to the antenna terminal.

7.1.3.1.2 Method of measurement

Conducted spurious emissions shall be measured as the power level of any frequency component to the antenna terminals of the receiver. The receiver antenna terminals are connected to a spectrum analyser or selective voltmeter having an input impedance of 50 Ω and the receiver is switched on.

The measurement shall extend over the frequency range 9 kHz to 4 GHz.

7.1.3.1.3 Required results

The power of any spurious emission in the specified range at the antenna terminal shall not exceed – 57 dBm in the frequency range 9 kHz to 1 GHz and – 47 dBm in the frequency range 1 GHz to 4 GHz.

7.1.3.2 Spurious emissions from the transmitter

7.1.3.2.1 Purpose

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation.

7.1.3.2.2 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna. The measurement shall be made over a frequency range from 9 kHz to 4 GHz, excluding the frequencies within $\pm 62,5$ kHz of the transmitting frequency.

7.1.3.2.3 Required results

The power of any spurious emission outside $\pm 62,5$ kHz of the transmitting frequency shall not exceed – 36 dBm in the frequency range 9 kHz to 1 GHz and – 30 dBm in the frequency range 1 GHz to 4 GHz.

8 Functional tests

8.1 Tests for configuration method

For all of the functional tests the setup for the method of measurement shall be as defined by the manufacturer:

- using standard configuration sentences via direct connection to an interface, or
- using standard configuration sentences via VDL, or
- using the manufacturer's proprietary method.

8.1.1 Configure test Message 21

8.1.1.1 Purpose

The purpose of this test is to ensure that Message 21 parameters can be entered into the EUT and are retained after the power off/on cycle.

8.1.1.2 Method of measurement

Set-up the standard test environment.

a) Configure the EUT with the following parameters for transmission of Message 21:

- MMSI number: 991234567;
- type of AtoN: "20" – Cardinal Mark North;
- name of AtoN: "TEST FLOATING AIS ATON STATION";
- position accuracy: to accuracy of EPFS;
- assigned position (longitude and latitude): "within off-position threshold of current EPFS position";
- dimension/reference for position: "A=B=C=D=5";
- type of EPFS: Enter EUT's EPFS type (for example "1" for GPS);
- off-position threshold: 200 m;
- set power level;
- channel 1 set to channel 2087; if receiver supported, set channel 1 receiver to same;
- channel 2 set to channel 2088; if receiver supported, set channel 2 receiver to same;
- Virtual AtoN Flag set to 0 = default = Real AtoN at indicated position;
- set AtoN status default (00000000);
- off-position behaviour set to "maintain current transmission schedule";
- set UTC lost behaviour as per manufacturer's declaration;
- read configuration from EUT.

b) Remove power from the EUT for 5 min. Switch on the EUT. Read configuration from EUT.

NOTE Standard configuration sentences via configuration port: the Message 21 content is configured using the AID, ACF and ACE sentence combination.

Standard configuration sentences via VDL: the Message 21 content is configured via VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier and binary data.

8.1.1.3 Required results

Verify that configuration is:

- a) accepted by EUT and that the parameters have been correctly set;
- b) retained after power cycle.

8.1.2 Schedule mode A FATDMA Message 21 (single report, alternating channel operation)

8.1.2.1 Purpose

Test that the AIS AtoN Station operates in accordance with the configured reporting schedule (see 5.2.4.1).

8.1.2.2 Method of measurement

Set-up the standard test environment and use the configuration as defined in 8.1.1.

a) Configure reporting of Message 21 to have the following parameters:

- start on Channel 2;
- start slot: 512;
- reporting interval: 3 min;
- frame for the first transmission in every UTC hour: UTC minute: 1;
- start the EUT 2 min ahead of a schedule transmission.

b) Run the test over the hour and day boundary.

If Synthetic and Virtual AIS AtoN Message 21 reports are implemented (see 5.2.1.1.2):

- c) Change the configuration of the EUT to be a Synthetic AIS AtoN. Repeat the test.
- d) Change the configuration of the EUT to be a Virtual AIS AtoN. Repeat the test.

NOTE Standard configuration sentences via configuration port: the Schedule for Mode A FATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode A FATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.2.3 Required results

Verify that the:

- a) EUT transmits Test Message 21 in the configured slots on both channels. EUT starts transmission in the correct UTC frames and alternates channels at the reporting interval within one reporting interval (3 min in this case), and should not wait until UTC minute 1. (The channel 1 transmissions shall occur in minutes 4, 10, 16, 22, 28, 34, 40, 46, 52 or 58 with an increment of 6 min, The channel 2 transmissions shall occur in minutes 1, 7, 13, etc. with an increment of 6 min.);
- b) reporting behaviour is consistent through the hour and day boundaries and transmitted data is correct;

If Synthetic and Virtual AIS AtoN Message 21 reports are implemented:

- c) Message 21 repeat indicator is 3;
- d) Message 21 Virtual flag is set.

8.1.3 Schedule mode B FATDMA Message 21 (dual report, dual channel operation)

8.1.3.1 Purpose

Test that the AIS AtoN Station operates in accordance with configured reporting schedule 5.2.4.2.1 and transmits correct data.

8.1.3.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1.

a) Configure reporting of Message 21 to have the following parameters:

- start Channel 1: start slot 512;
- Channel 2: start slot: 612;
- reporting interval: 3 min,
- frame for the first transmission in every UTC hour: UTC minute 2;
- start the EUT 2 min ahead of a schedule transmission.

b) Run the test over the hour and day boundary.

NOTE Standard configuration sentences via configuration port: the schedule for Mode B FATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode B FATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.3.3 Required results

Verify that the:

- a) EUT transmits Test Message 21 in the configured slots on both channels. EUT starts transmission in the correct UTC frame and continues with the correct increment within one reporting interval and should not wait until UTC minute 2;
- b) reporting behaviour is consistent through the hour and day boundaries and transmitted data is correct.

8.1.4 Schedule mode C FATDMA Message 21 (Single report, single channel operation)

8.1.4.1 Purpose

The purpose is to test that the AIS AtoN Station operates in accordance with the configured reporting.

8.1.4.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1.

- a) Configure reporting of Message 21 to have the following parameters:

- transmit channel: A or B;
- start slot: 512;
- reporting interval: 3 min;
- frame for the first transmission in every UTC hour: UTC minute: 1;
- start the EUT 2 min ahead of a schedule transmission;

- b) Run the test over the hour and day boundary.

NOTE Standard configuration sentences via configuration port: the schedule for Mode C FATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode C FATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.4.3 Required results

Verify that the:

- a) EUT transmits test Message 21 in the configured slots on the designated transmit channel, EUT starts transmission in the correct UTC frame on the designated transmit channel at the reporting interval within one reporting interval and should not wait until UTC minute 1;
- b) reporting behaviour is consistent through the hour and day boundaries and transmitted data is correct.

8.1.5 Schedule mode A RATDMA Message 21 (Type 3) (single report, alternating channel operation)

8.1.5.1 Purpose

The purpose of this test is to ensure that the EUT can be configured to operate in accordance with 5.2.4.2, ensuring the slot selection is random within the 1 min interval and that the slot reuse algorithm is properly implemented.

8.1.5.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 with a VDL loading of 10 %.

- a) Configure reporting of Message 21 with the following parameters:
- FATDMA setup or RATDMA setup: RATDMA;
 - UTC minute for CH1: 1;
 - UTC minute for CH2: 4;
 - time interval CH1: 360 (6 min);
 - time interval CH2: 360 (6 min).
- b) Apply a VDL load that necessitates intentional slot reuse and repeat the test.

NOTE Standard configuration sentences via configuration port: the schedule for Mode A RATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode A RATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.5.3 Required results

- a) Verify that the EUT transmits Test Message 21:
- using RATDMA so that the slot selection is random within the correct frames, and alternates the transmission channel between successive reports;
 - with the correct reporting intervals;
 - with the correct data.

Verify that the EUT selects its slots randomly.

- b) Verify that the EUT applies the slot reuse algorithm as defined in Recommendation ITU-R M.1371.

8.1.6 Schedule mode B RATDMA Message 21 (Type 3) (dual report, dual channel operation)

8.1.6.1 Purpose

The purpose of this test is to ensure that the AIS AtoN Station can be configured to operate in accordance with 5.2.4.2.

8.1.6.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 with a VDL loading of 10 %.

Configure reporting of Message 21 with the following parameters:

- FATDMA setup or RATDMA setup: RATDMA;
- UTC minute for CH1: 1;
- UTC minute for CH2: 4;
- time interval CH1: 180 (3 min);
- time interval CH2: 180 (3 min).

NOTE Standard configuration sentences via configuration port: the schedule for Mode B RATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode B RATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.6.3 Required results

Verify that the EUT transmits Test Message 21:

- using RATDMA so that the slot selection is random within the 1 min interval, with dual reports on both channels;
- sending in correct intervals;
- with correct transmitted data.

8.1.7 Schedule mode C RATDMA Message 21 (Type 3) (single channel operation)

8.1.7.1 Purpose

The purpose of this test is to ensure that the AIS AtoN Station can be configured to operate in accordance with 5.2.4.2.

8.1.7.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 with a VDL loading of 10 %.

Configure reporting of Message 21 with the following parameters:

- FATDMA setup or RATDMA setup: RATDMA;
- UTC minute for CH1: 1;
- time interval CH1: 180 (3 min).

NOTE Standard configuration sentences via configuration port: the schedule for Mode C RATDMA transmission is configured using the AAR sentence.

Standard configuration sentences via VDL: the schedule for Mode C RATDMA transmissions via VDL is configured using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.1.7.3 Required results

Verify that the EUT transmits Test Message 21:

- using RATDMA so that the slot selection is random within the 1 min interval with single reports on a single channel;
- sending in correct intervals;
- with correct transmitted data.

8.1.8 Addressed binary data Message 6

8.1.8.1 Purpose

The purpose of this test is to verify that the Message 6 operation of the EUT using the implemented access methods.

8.1.8.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2 with an "intended recipient" MMSI. The recipient shall acknowledge the message.

- a) Configure the EUT as defined by manufacturer's documentation for transmission of a scheduled addressed binary data Message 6 with test binary data consisting of the bit pattern Hex "7E 3B 3C 3E 7E" forming a message by setting the parameters for the following operation modes, where implemented:
 - FATDMA (see 8.1.2 for mode A setup; 8.1.3 for mode B setup; 8.1.4 for mode C setup);

- RATDMA (see 8.1.5 for mode A setup; 8.1.6 for mode B setup; 8.1.7 for mode C setup);
 - CSTDMA: time (hour, minute), channel(s), reporting interval.
- b) Repeat the test without an acknowledgement from the intended recipient.
 - c) If possible to use externally generated data, repeat the test exceeding the maximum length of Message 6.
 - d) Repeat the test for the maximum length of Message 6 by repeating the bit pattern Hex "7E 3B 3C 3E 7E" sequence in the binary data field.

8.1.8.3 Required results

Verify that the EUT continues transmitting Message 21 in all cases and that:

- a) the message sent by the EUT conforms to message content, access method, channel, slot number and reporting interval;
- b) the EUT behaves as configured;
- c) the message is not sent;
- d) the message is sent with the correct content.

NOTE CSTDMA access of Message 6 should comply with IEC 62287-1 with regard of VDL access and message length.

8.1.9 Unscheduled transmission

8.1.9.1 Purpose

Unscheduled transmissions are those transmissions that are not planned, and the competent authority wishes the AtoN Station to broadcast autonomously such as an unexpected alarm condition. The VDL access method for these message types is as defined by manufacturer. This test will verify the AtoN operation when such a message is input.

8.1.9.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2 with an "intended recipient" MMSI.

- a) Introduce a transmission of an unscheduled Binary Message as defined by the manufacturer's documentation using the access modes declared by the manufacturer.
- b) For an Addressed Message repeat the test, but without an acknowledgment from the intended recipient.

NOTE Standard IEC 61162 sentences: an unscheduled message using standard format would be ABM, ABK or BBM.

8.1.9.3 Required results

Check that the EUT continues to transmit Message 21 in all cases.

- a) Check the message transmitted by the EUT conforms to message content, access method.
- b) Check that the EUT retransmits as configured.

8.1.10 Test Message 8

8.1.10.1 Purpose

The purpose of this test is to verify that Message 8 can be entered into the EUT.

8.1.10.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2.

- a) Configure the EUT as defined by the manufacturer's documentation for transmission of a scheduled binary data Message 8 with test binary data consisting of the bit pattern Hex "7E 3B 3C 3E 7E" forming a message by setting the parameters for the following operation modes, where implemented:
 - FATDMA (see 8.1.2 for mode A setup; 8.1.3 for mode B setup; 8.1.4 for mode C setup);
 - RATDMA (see 8.1.5 for mode A setup; 8.1.6 for mode B setup; 8.1.7 for mode C setup);
 - CSTDMA: time (hour, minute), channel(s), reporting interval.
- b) If possible, use externally generated data, repeat the test exceeding the maximum length of Message 8.
- c) Repeat the test for the maximum length of Message 8 by repeating the bit pattern Hex "7E 3B 3C 3E 7E" sequence in the binary data field.

8.1.10.3 Required results

Verify that:

- a) the message sent by the EUT conforms to message content, access method, channel, slot number and reporting interval;
- b) message is not sent;
- c) message is sent with the correct content.

In all cases, the EUT should continue transmitting Message 21.

NOTE CSTDMA access of Message 6 should comply with IEC 62287-1 with regard to VDL access and message length.

8.1.11 AIS AtoN configuration Messages 12

Repeat tests 8.1.8 and 8.1.9 for Message 12.

8.1.12 AIS AtoN configuration Messages 14

Repeat tests 8.1.10 for Message 14.

8.2 Tests for synchronisation accuracy

8.2.1 Implemented synchronisation modes and synchronisation error

8.2.1.1 Purpose

The purpose is to verify the implemented synchronisation modes and measure the synchronisation error of the EUT.

8.2.1.2 Method of measurement

Set up the standard test environment and operate EUT in normal mode. Set the EUT reporting interval to 1 min for Message 21 and all other implemented messages.

Operate the EUT in all implemented synchronisation modes:

- EUT using UTC direct synchronisation;
- EUT using UTC indirect synchronisation;

- EUT using semaphore synchronisation.

Record VDL messages and measure the time between the nominal beginning of the slot interval and the initiation of the 'transmitter on' function by evaluating the start flag and calculating back to T_o .

8.2.1.3 Required results

The synchronisation error with its additive jitter shall not exceed:

- $\pm 104 \mu\text{s}$ using UTC direct synchronisation;
- $\pm 312 \mu\text{s}$ using UTC indirect synchronisation;
- $\pm 312 \mu\text{s}$ referenced to the semaphore's synchronisation.

8.2.2 Synchronisation test without UTC (Types 2 and 3)

8.2.2.1 Purpose

The purpose of this test is to verify that the EUT can synchronise without UTC.

8.2.2.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1. Choose test conditions in a way that EUT receives messages from a synchronisation source with the following synchronisation states:

- a) Base Station direct acting as a semaphore synchronisation and no stations with direct or UTC indirect synchronisation. Disable internal synchronisation source;
- b) mobile direct acting as a semaphore synchronisation and no stations with direct or UTC indirect synchronisation. Disable internal synchronisation source;
- c) mobile station indicating UTC indirect synchronisation and receiving no stations with direct synchronisation or Base Stations with UTC indirect synchronisation. Disable internal synchronisation source;
- d) enable internal synchronisation source.

Record transmitted messages.

8.2.2.3 Required results

Verify that the EUT transmits according to its implemented synchronisation modes in each case.

- a) Verify that the EUT synchronises to the Base Station acting as semaphore.
- b) Verify that the EUT synchronises to the mobile station acting as semaphore.
- c) Verify that the EUT does not synchronise to any station.
- d) Verify that the EUT returns to UTC direct synchronisation.

8.3 Tests for EPFS

8.3.1 Position source

8.3.1.1 Purpose

The purpose of this test is to verify that the position source correctly populates the fields in Message 21.

8.3.1.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1.

- a) Using the transmission schedule for Message 21 as defined in 8.1.2, record the EUT transmissions.
- b) Repeat the test with a surveyed position.

8.3.1.3 Required results

Verify that:

- a) the position and time stamp fields are valid;
- b) the EUT has the correct parameter settings for "type of electronic position fixing device" and "RAIM-flag".

8.3.2 Invalid position

8.3.2.1 Purpose

The purpose of this test is to verify that the EUT responds correctly when the EPFS outputs an invalid position.

8.3.2.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2. Prevent the EPFS receiver from generating position fixes.

8.3.2.3 Required results

If the EUT is configured to continue transmission, verify the EUT transmits Message 21 with the parameters latitude and longitude set to "not available" and the time stamp is set to "63".

8.3.3 Off-position monitor

8.3.3.1 Purpose

The purpose of this test is to verify that the EUT responds correctly when it is off position.

8.3.3.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2.

- a) Set the EUT EPFS antenna at its assigned position and with off-position behaviour set to maintain current broadcast schedule.
- b) After verification of the off-position indicator in Message 21, the EUT EPFS antenna shall be moved to off-position.
- c) Move the EUT EPFS antenna to be on-position.
- d) If implemented, configure the EUT with off-position behaviour set to a new reporting interval and the EUT EPFS antenna shall be moved to off-position.
- e) After verification of the off-position indicator in Message 21, the EUT EPFS antenna shall be moved to on-position.

8.3.3.3 Required results

Verify that:

- a) message 21 has the off-position indicator field set to "0";
- b) message 21 has the off-position indicator field set to "1" within a time period stated by the manufacturer and that the original reporting schedule has not changed;

- c) message 21 has the off-position indicator field set to "0" within a time period stated by the manufacturer;
- d) message 21 has the off-position indicator field set to "1" within a time period stated by the manufacturer and that the original reporting schedule has changed to the new reporting interval;
- e) message 21 has the off-position indicator field set to "0" within a time period stated by the manufacturer and the reporting interval returns to the original reporting schedule.

8.4 Additional messages

8.4.1 Receive addressed message (Types 2 and 3)

8.4.1.1 Purpose

The purpose of this test is to verify that the EUT correctly receives and, if so configured, processes an addressed message.

8.4.1.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2. Record received messages and frame structure.

- a) Apply an addressed binary message (Message 6; EUT as destination) to the VDL.
- b) Apply an addressed binary message (Message 6; other station as destination) to the VDL.

8.4.1.3 Required results

Verify that:

- a) EUT receives and processes the message in accordance with the manufacturer's specification;
- b) EUT does not process the received message.

8.5 Additional functionality

Tests for additional functionality as implemented by the manufacturer.

8.5.1 Test for configuration of the receiver turn-on times (Types 2 and 3)

8.5.1.1 Purpose

The purpose of this test is to ensure that the operational time period for the receivers can be configured using the configuration port of the EUT or the appropriate VDL message.

8.5.1.2 Method of measurement

Set up the standard test environment and operate EUT in normal mode.

- a) Configure the receiver turn-on times of the EUT with the following parameters:

- MMSI of the AtoN Station,
- receiver on or interval,
- time of first turn on period,
- duration of receiver wake up,
- interval between receiver activation.

Using the implemented methods (one or both) enter the appropriate data with the parameter "receiver on or interval".

- b) Enter the appropriate data with a definition of a turn on interval.

- c) Query the ARW configuration of the receiver turn-on times via the configuration port using the query sentence or other means provided by the manufacturer.
- d) Query the ARW configuration of the receiver turn-on times via the VDL and define a FATDMA slot for the VDL replay.

NOTE Standard configuration sentences via configuration port: the receiver turn-on times are configured using the ARW sentence.

Standard configuration sentences via VDL: the receiver turn-on times are configured via the VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data

8.5.1.3 Required results

Verify that:

- a) the EUT receiver is turned on all the time;
- b) the EUT receiver is turned on during the defined time period and interval;
- c) the EUT returns on a query with the appropriate message content via PI using the ARW sentence;
- d) the EUT returns on a query via the VDL with the appropriate VDL message on the assigned slot and channel using the appropriate application identifier and binary data.

8.5.2 Test for configure proprietary AtoN control

8.5.2.1 Purpose

The purpose of this test is to ensure that the payload of this sentence is used to control the AtoN. The payload can be entered into the EUT using the configuration port of the EUT or the appropriate VDL message.

8.5.2.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode.

- a) Configure the proprietary AtoN control function of the EUT with the following parameters:

- MMSI of the AtoN Station,
- payload for proprietary AtoN control.

Using the implemented methods (one or both) enter the appropriate proprietary AtoN control data.

- b) Query the proprietary AtoN control data via configuration port using the query sentence or other means provided by the manufacturer.
- c) Query the proprietary AtoN control data via the VDL and define a FATDMA slot for the VDL replay.

NOTE Standard configuration sentences via configuration port: the proprietary AtoN control data is configured using the MCR sentence.

Standard configuration sentences via VDL: the proprietary AtoN control data is configured via the VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.5.2.3 Required results

Verify that:

- a) the EUT acts upon the received proprietary AtoN control data;
- b) the EUT returns on a query with the appropriate message content via the PI using the MCR PI sentence;
- c) the EUT returns on a query via the VDL with the appropriate VDL message on the assigned slot and channel using the appropriate application identifier and binary data.

8.5.3 Test for configuration of payload re-broadcast

8.5.3.1 Purpose

The purpose of this test is to ensure that the EUT can be commanded to rebroadcast the payload or to define a new message for autonomous, continuous transmission. The payload or new message type can be entered into the EUT using the configuration port of the EUT or the appropriate VDL message.

If standard sentences are used, the AAR configuration with message type/id for a specific MPR must precede the MPR to identify it as autonomous continuous transmission. If it is a single transmission, this payload will be broadcast using the slots reserved by the AAR with message id/type = 0, otherwise it will use the schedule defined by the AAR for this message id/type.

8.5.3.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode. Configure the payload re-broadcast function of the EUT with the following parameters:

- message type;
- message identifier;
- total number of sentences;
- sequence number;
- payload (encapsulated data, as defined by IEC 61162-1).

Using the implemented methods (one or both):

- enter the appropriate AAR data to configure broadcast rates for AtoN Station messages for the following payload re-broadcast.
- enter the appropriate payload re-broadcast data.

NOTE Standard configuration sentences via configuration port: the payload re-broadcast data is configured using the MPR sentence.

Standard configuration sentences via VDL: the payload re-broadcast data is configured via the VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.5.3.3 Required results

Verify that the EUT re-broadcasts the appropriate VDL message with the correct data content.

8.5.4 Test for forced broadcast

8.5.4.1 Purpose

The purpose of this test is to ensure that the EUT can be forced to broadcast a specified VDL message via the PI or the VDL.

8.5.4.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode. Enter the forced broadcast data to the EUT with the following parameters:

- message type;
- message identifier;
- VDL channel for message transmission;
- time and slot message transmission;
- number of consecutive slots for message transmission.

Using the implemented methods (one or both) enter the appropriate forced broadcast data to the EUT.

NOTE Standard configuration sentences via configuration port: the forced broadcast data is configured using the AFB sentence.

Standard configuration sentences via VDL: the forced broadcast data is configured via the VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.5.4.3 Required results

Verify that the EUT transmits the requested VDL message at the defined time and slot.

8.5.5 Test for version information

8.5.5.1 Purpose

The purpose of this test is to ensure that the EUT can provide version information.

8.5.5.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode. Enter the query for version information to the EUT using the manufacturer implemented methods.

NOTE Standard configuration sentences via configuration port: the version information is queried using the QVER sentence and the response is provided using VER.

Standard configuration sentences via VDL: the version information is queried via VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data

8.5.5.3 Required results

Verify that the EUT provides with the requested version information.

8.5.6 Test for AFC – AtoN function ID capability

8.5.6.1 Purpose

The purpose of this test is to ensure that the EUT can provide a list of supported functionality.

8.5.6.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2. Enter the query for the function supported.

NOTE Standard configuration sentences via configuration port: the list of supported functions is queried using the QAFC sentence and the response is provided using AFC.

Standard configuration sentences via VDL: the list of supported functions is queried via the VDL using Message 25 or Message 6 with the appropriate application identifier/function identifier, and binary data.

8.5.6.3 Required results

Verify that the EUT provides the list of functions that are supported by the AtoN Station.

8.5.6.4 Test for assigning an encryption key for VDL configuration

8.5.6.4.1 Purpose

The purpose of this test is to ensure that the encryption key for VDL configuration can be entered into the EUT using the configuration port or the appropriate VDL message.

In order to reset this key via the PI, the user must know the current encryption key. The initial encryption key, when shipped from the manufacturer, will be all 0's.

8.5.6.4.2 Method of measurement

Set up standard test environment and operate the EUT in normal mode.

a) Configure the encryption key of the EUT with the following parameters:

- MMSI of the AtoN Station;
- current AES encryption key;
- new AES encryption key.

Using the implemented methods (one or both) enter the appropriate data with the correct MMSI and the correct current AES encryption key.

b) Enter the appropriate data with the correct MMSI and false current AES encryption key.

c) Query the AES encryption key via configuration port using the query sentence or other means provided by the manufacturer.

NOTE Query via the VDL for the encryption key is not allowed.

NOTE Via configuration port: enter the encryption key via the configuration port using the AKE PI sentence or any other means provided by the manufacturer. The sentence used on the configuration port allows for the entire 128 bit encryption key to be entered.

Via VDL: enter the encryption key via the VDL using Message 25 or Message 6 with the appropriate application identifier and binary data. The VDL message only allows the least significant 56 bits to be modified.

8.5.6.4.3 Required results

Verify that:

- a) the new encryption key is accepted by changing the transmission behaviour of the EUT using an encrypted VDL configuration message;
- b) the new encryption key is not accepted by changing the transmission behaviour of the EUT using an encrypted VDL configuration message;
- c) the EUT returns on a query with the appropriate message content via the PI using the AKE sentence.

8.5.7 Test for VDL configuration using chaining (Types 2 and 3)

8.5.7.1 Purpose

The purpose of this test is to verify that, if chaining is implemented, the AtoN Station supports receiving information from a Base Station via intermediate AtoN Stations and then transmits the response back through the intermediate AtoN Stations to the Base Station.

8.5.7.2 Method of measurement

Set up the standard test environment and use the configuration as defined in 8.1.1 and transmission schedule for Message 21 as defined in 8.1.2. Introduce a Base Station that will be issuing the configuration VDL sentences and at least two other AtoN Stations transmitting Message 21, one of which is the EUT.

Using the implemented method(s) establish a chain by configuring each AtoN Station with the MMSI numbers for the parent and all child AtoN Stations. (for example the first AtoN in the chain would have the Base Station as its "parent" and all other AtoN stations in the chain would be "child" AtoN stations, the next AtoN in the chain would have that first AtoN Station as the parent and all other AtoN Stations in the chain would be "child" AtoN Stations, and so on).

Query the AtoN stations to verify the chain has been correctly established.

Introduce, via the Base Station, a Message 25 with configuration information addressed to the last AtoN Station in the chain.

Query the last AtoN Station to verify configuration.

NOTE Standard configuration sentences via configuration port: using the AID sentence, a chain is established by defining the parent and all known children within each AtoN station in the link.

Standard configuration sentences via VDL: a chain is established by defining the parent and all known children within each AtoN station in the link via VDL using Message 25 or Message 6 with the appropriate application/function identifier and binary data.

8.5.7.3 Required results

Verify that:

- a) the chain is established;
- b) the EUT functions correctly within the chain and at the end of the chain, for transferring, receiving and initiating messages.

8.6 Test for BIIT

8.6.1 Purpose

The purpose of this test is to prove the correct response by the EUT to its BIIT.

8.6.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode.

- a) Disconnect the antenna from the EUT.
- b) Apply fault to the Channel 1 receiver.
- c) Apply fault to the Channel 2 receiver.
- d) Disable the augmentation system, if fitted.

8.6.3 Required results

Verify that:

- a) the EUT shall cease transmissions;
- b) RATDMA and CSTDMA transmissions shall cease on Channel 1;
- c) RATDMA and CSTDMA transmissions shall cease on Channel 2;
- d) the EUT shall continue to operate.

8.7 Transmitter shutdown procedure

8.7.1 Purpose

The purpose of this test is to verify that the transmitter has an automatic shutdown.

8.7.2 Method of measurement

Review the manufacturer's declaration.

8.7.3 Required results

The manufacturer shall provide a declaration in the documentation that states the EUT will function as required.

8.8 Tests for power supply

8.8.1 Average power consumption

8.8.1.1 Purpose

The purpose of this test is to ensure that the power consumption of the AIS AtoN Station is as stated in the manufacturer's documentation.

8.8.1.2 Method of measurement

Set up the standard test environment and operate the EUT in normal mode. Configure reporting of Message 21 to have the following parameters:

- transmit power level: 12,5 W, or the manufacturer's declared level;
- Channel 1 slots: 512 and 513;
- Channel 2 slots: 612 and 613;
- reporting interval: 3 min.

The test shall be run for 30 min with 10 full duty cycles to measure the average power consumption.

Optionally, repeat the test for RATDMA for the same transmit power and reporting interval.

8.8.1.3 Required results

Verify that for 10 full duty cycles, the average power consumption of the EUT does not exceed 110 % of the value stated in the manufacturer's documentation.

8.9 Environmental tests

Tests shall be done in accordance with IEC 60945, 'Durability and resistance to environmental conditions'; Protected or Exposed, or as defined by manufacturer.

8.10 Other tests

8.10.1 Quality assurance

The manufacturer shall declare the quality assurance standard to which the EUT is manufactured.

8.10.2 Additional features

The manufacturer shall declare any additional features of the EUT. These features are not tested in accordance with this standard. The manufacturer's declaration shall confirm that additional features, including position accuracy augmentation, do not adversely affect Message 21 transmissions.

8.10.3 Manual

The manual shall include information concerning:

- external connectors, if applicable;
- correct installation of the unit and antennae;
- configuration;
- power consumption;
- firmware upgrades, if applicable;

- configuration interface, including hardware and electrical details.

8.10.4 Marking and identification

Verify that marking and identification complies with 5.4.3.

Annex A (informative)

Proposed additional IEC 61162 AIS AtoN Station sentences

A.1 Standard IEC 61162 sentences

The standard configuration sentences should be as defined in the IEC 61162 series. The electrical characteristics should be as specified by the manufacturer.

Subclause 5.3.1.1 provides an overview of the sentences that should be used for data exchange and for configuration of AIS AtoN applications. It includes existing sentences from IEC 61162-1 with additional AtoN sentences as provided in this annex.

This annex defines the format of input/output sentences specifically defined for AIS AtoN Stations in accordance with the data structures of IEC 61162.

A.2 AAR – Configure broadcast rates for AtoN Station message command

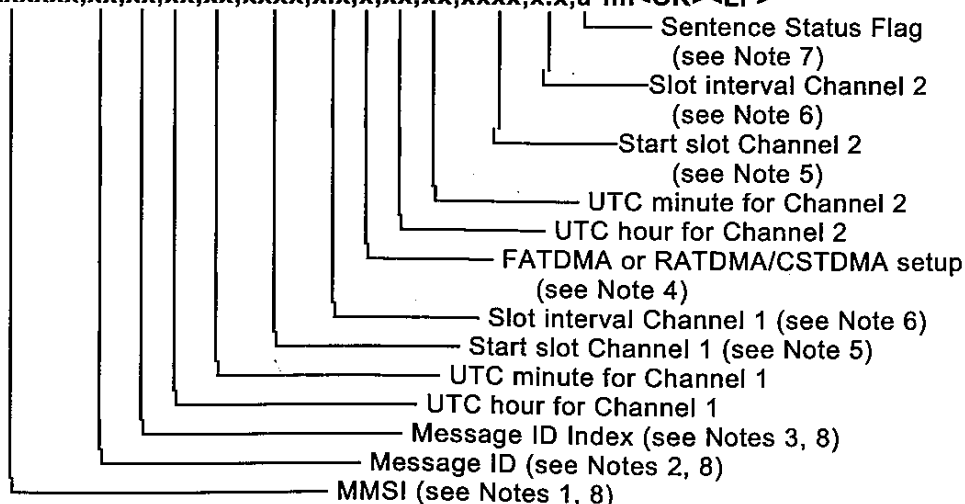
A.2.1 Description

This sentence assigns the schedule of slots that will be used to broadcast Message 21 and other allowed AIS AtoN Station messages. It provides the start slot and interval between the slots used for consecutive transmissions for the message. The AIS AtoN Station should apply the information provided by this sentence to autonomously and continuously transmit the VDL messages until revised by a new AAR sentence.

The AIS AtoN Station, upon receipt of an AAR Query for this information, will generate sentences for configured messages providing the current broadcast schedule. New AAR assignments will override existing AAR assignments.

A.2.2 Configuration via the configuration port using the AAR sentence

\$--AAR,xxxxxxxx,xx,xx,xx,xx,xxxx,x.x,x,xx,xx,xxxx,x.x,a*hh<CR><LF>



NOTE 1 The MMSI is defined in the AID sentence. This field contains the linkage between the MMSI definition (AID), Message 21 configuration (ACF, and ACE) and scheduling (AAR) of Message 21 transmissions.

NOTE 2 Message ID is the message identification of the message being scheduled. When Message ID is 0 this indicates that the slots being defined will be used for chaining messages. These slots are not reserved on

the VDL via a Message 20 until the competent authority requires their use and will reserve the slots at that time for the proper duration. These slots can be used for chaining or for MPR single transmission.

NOTE 3 Message ID Index is used when there are multiple versions of a Message ID. This index value should start at 1.

NOTE 4 Used to select whether the AAR is configuring an FATDMA schedule or RATDMA/CSTDMA schedule (0 indicates FATDMA, 1 indicates RATDMA and 2 indicates CSTDMA)

NOTE 5 For all messages which need to be transmitted in FATDMA mode, starting slot ranging from –1 to 2249 should be used. A value of –1 discontinues broadcasts of the message when the AAR sentence is sent to the AtoN Station, and indicates that no message has been broadcast if the AAR sentence is received from the AtoN Station. A null field indicates no change to the current start slot setting when sent to the AtoN Station, and indicates that the start slot has not been set, i.e. is unavailable, when the AAR sentence is received from the AtoN Station. For an RATDMA/CSTDMA transmission schedule, this field will be Null.

NOTE 6 For all messages which need to be transmitted, in FATDMA mode slot Interval ranging from 0 to (24*60*2250;once per day) and in RATDMA/CSTDMA mode, time interval ranges from 0 to (24*60*60) s. A null field indicates no change to the current slot interval setting when sent to the AtoN Station, and indicates that the slot interval has not been set, i.e. is unavailable, when the AAR sentence is received from the AtoN Station.

NOTE 7 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

“R” = sentence is a query response

“C” = sentence is a configuration command to change settings.

NOTE 8 The MMSI/Message ID/Message ID index are used to reference a table of messages loaded using MPR, ACF/ACE; this sentence defines the broadcast schedule for each message. Each message in this table is referenced by the combination of MMSI, Message ID, and Message ID index.

A.2.3 Query via the configuration port for AAR

To query this sentence, use the standard IEC 61162-1 query structure. The query response will continue until all message IDs/payload identification /and schedules have been transferred.

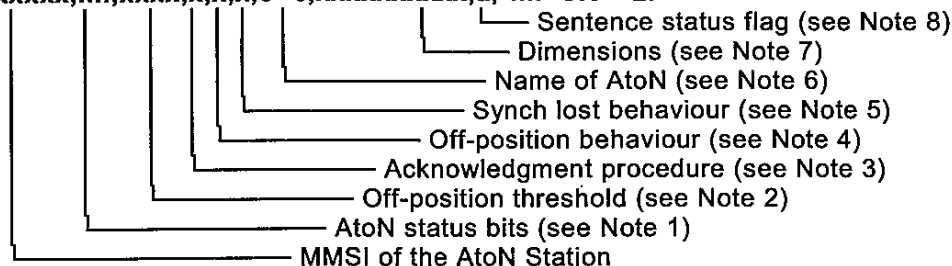
A.3 ACE – Extended general AtoN Station configuration command

A.3.1 Description

This sentence and the ACF sentence are used to configure the AtoN Station parameters when it is initially installed, and later in order to make changes to the way it operates. This sentence supports system administration of the AIS AtoN Station operation.

A.3.2 Configuration via the configuration port using the ACE sentence

\$--ACE,xxxxxxxx,hh,xxxx,x,x,x,c--c,xxxxxxxxxx,a,*hh<CR><LF>



NOTE 1 AtoN status bits, indication of the AtoN status, default “00_{hex}”: for a Virtual AtoN, this field should be 00_{hex}. The three most significant bits represent the page ID.

NOTE 2 The off-position indicator is generated when this threshold is exceeded (distance in metres).

NOTE 3 Determines the behaviour of AtoN for message acknowledgement (Message 7 and 13):

0 will provide acknowledgement as defined by manufacturer,

1 will not provide acknowledgement.

NOTE 4 Off-position behaviour:

0 – maintain current transmission schedule,

1 – use new reporting interval configured by AAR using message ID index.

NOTE 5 Synch lost behaviour:

0 – silent,

1 – continue as before.

NOTE 6 Name of the AtoN: maximum 34 characters.

NOTE 7 Reference point of reported position; should be given as dimension (aaabbbccdd) of the buoy.

NOTE 8 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

A.3.3 Query via the configuration port for ACF and ACE

To query these sentences use the standard IEC 61162-1 query structure.

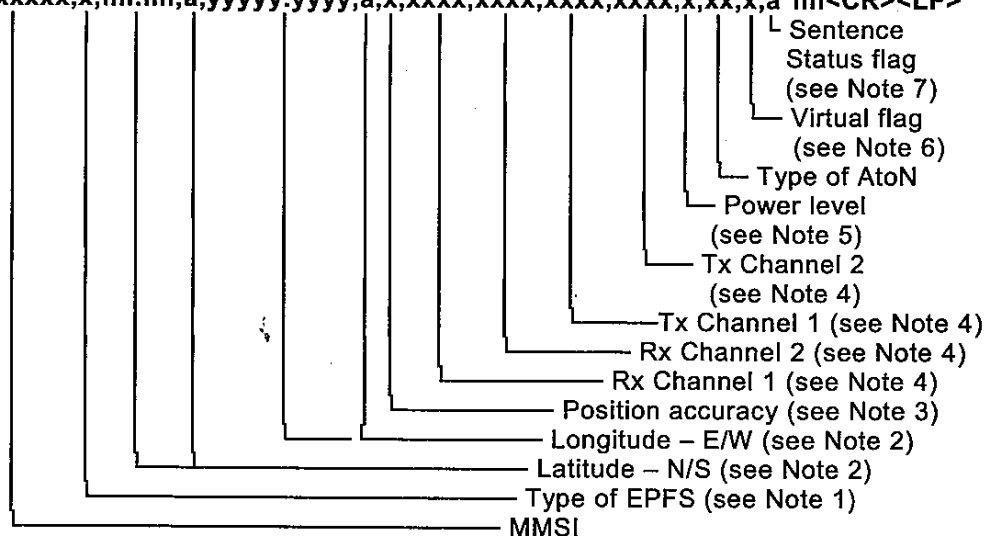
A.4 ACF – General AtoN Station configuration command

A.4.1 Description

This sentence and the ACE sentence are used to configure Message 21 content for the AtoN Station and all of the Synthetic/Virtual AtoN Stations associated with the AtoN Station.

A.4.2 Configuration via the configuration port using the ACF sentence

\$--ACF,xxxxxxxx,x,IIII.IIII,a,yyyyy.yyyy,a,x,xxxx,xxxx,xxxx,xxxx,x,xx,x,a*hh<CR><LF>



NOTE 1 Identifies the source of the position, see ITU-R M.1371 Message 21 parameter (type of electronic position fixing device).

NOTE 2 Nominal or charted position.

NOTE 3 0 = low > 10 m,

1 = high < 10 m; differential mode of DGNSS.

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

NOTE 5 0 = default manufacturer power level (nominally 12,5 W),

1 to 9 as defined by the manufacturer.

NOTE 6 Virtual AtoN flag

0 = Real AtoN at indicated position (default),

1 = Virtual AtoN,

2 = Synthetic AtoN (flag remains 0 in message 21 but the repeat indicator must be > than 0).

NOTE 7 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

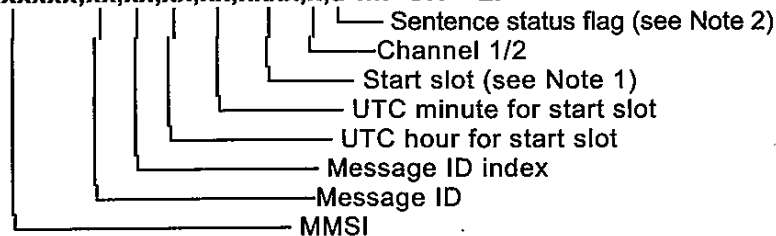
A.5 AFB – Forced broadcast command

A.5.1 Description

This sentence is used to force a transmission of the indicated VDL message, this message is already known to the AIS AtoN Station through AAR/MPR or ACE/ACF/AAR configuration commands.

A.5.2 Function via the configuration port for AFB

\$--AFB,xxxxxxxx,xx,xx,xx,xx,xxxx,x,a*hh<CR><LF>



NOTE 1 If the start slot is null, the AtoN Station will use RATDMA for transmission.

NOTE 2 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response

"C" = sentence is a configuration command to change settings.

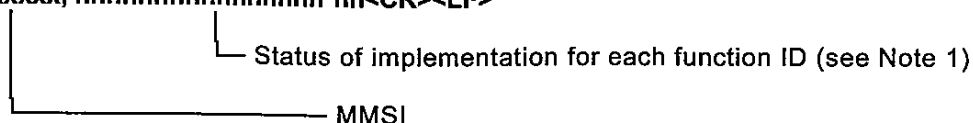
A.6 AFC – AtoN function ID capability

A.6.1 Description

This sentence is used to provide the capability information of implemented function ID by the EUT. This sentence is initiated with a QAFC and the response is the AFC.

A.6.2 Query response via the configuration port for AFC

\$--AFC,xxxxxxxx, hhhhhhhhhhhhhhh*hh<CR><LF>



NOTE 1 Each bit corresponds to the function ID number and the bit value "0" indicates the function ID number is not supported and "1" indicates supported. The most significant bit is function ID "0".

A.6.3 Query request via the configuration port for AFC

To query this sentence, use the standard IEC 61162-1 query structure

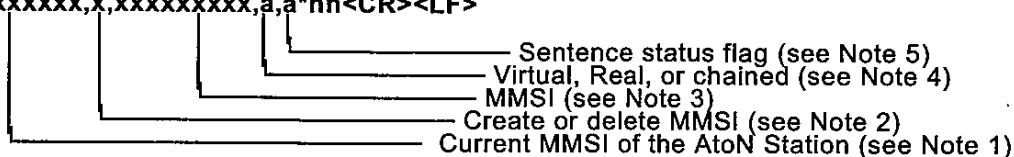
A.7 AID – MMSI configuration for command

A.7.1 Description

This sentence is used to load, for an AtoN Station, its Real, Virtual and chained MMSI(s). The MMSI from the factory shall be as defined by the manufacturer. Each AtoN Station will maintain a table of its MMSI(s) and the messages associated with these MMSI(s).

A.7.2 Configuration via the configuration port using the AID sentence

\$--AID,xxxxxxxx,x,xxxxxxxx,a,a*hh<CR><LF>



NOTE 1 The MMSI of the station being addressed. The initial factory setting should be defined by the manufacturer, for example 000000000.

NOTE 2 The indicator to define if the MMSI is being created/changed (1) or deleted (0). If own station MMSI is deleted it should revert to the factory setting. If a Virtual AtoN is deleted, then all associated messages for that Virtual AtoN are also deleted.

NOTE 3 The current MMSI to be created/changed/or deleted.

NOTE 4 Real AtoN, chained, or Virtual AtoN – Real is own station, chained indicates an MMSI that this station is responsible for relaying messages to and from, a Virtual AtoN indicates an MMSI that this station is responsible for generating at least a Message 21.

"R" – Real AtoN;

"V" = Virtual/Synthetic AtoN;

"P" = parent AtoN in the chain;

"C" = child AtoN in the chain.

NOTE 5 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response;

"C" = sentence is a configuration command to change settings.

A.7.3 Query via the configuration port for AID

To query this sentence, use the standard IEC 61162-1 query structure. The query response will continue until all known AtoN MMSIs and types have been transferred.

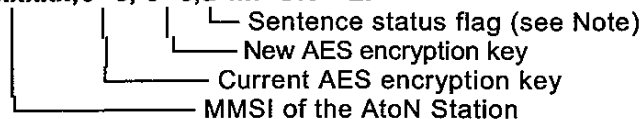
A.8 AKE – Configure encryption key command

A.8.1 Description

This sentence assigns the encryption key that will be used by the AES algorithm to communicate configuration and status information via the VDL. This sentence allows for the entire 128 bit encryption key to be entered, the user must know the current encryption key. The initial encryption key, when shipped from the manufacturer, will be all 0's.

A.8.2 Configuration via the configuration port for AKE

\$--AKE,xxxxxxxx,c--c, c--c,a*hh<CR><LF>



NOTE This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

A.8.3 Query via the configuration port for AKE

To query this sentence use the standard IEC 61162-1 query structure.

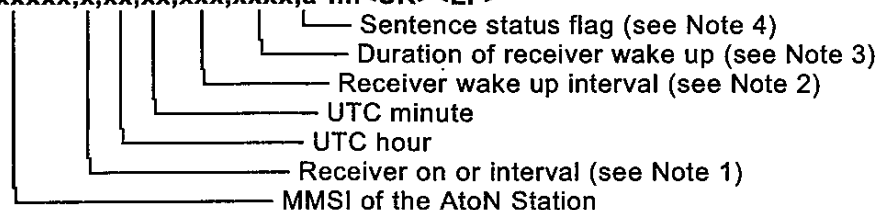
A.9 ARW –Configure the receiver turn-on times command

A.9.1 Description

This sentence defines the operational period for the receivers. When chaining the duration of receiver wake up time must be sufficient to allow correct operation of a chain.

A.9.2 Configuration via the configuration port for ARW

\$--ARW,xxxxxxxx,x,xx,xx,xxx,xxxx,a*hh<CR><LF>



NOTE 1 0 = use interval setting as defined below;

1 = turn receiver on.

NOTE 2 Interval between receiver activation:

1 – 60 min if UTC hour is set to 24;

1 – 256 h if UTC hour is 0- 23;

(Note: 168 h is once per week).

NOTE 3 Maximum awake time (1 440 min is 24 h).

NOTE 4 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

A.9.3 Query via the configuration port for ARW

To query this sentence use the standard IEC 61162-1 query structure.

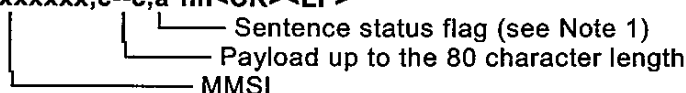
A.10 MCR – Configure proprietary AtoN control command

A.10.1 Description

The payload of this sentence will be proprietary information used to control the AtoN Station.

A.10.2 Configuration via the configuration port for MCR

\$--MCR,xxxxxxxx,c--c,a*hh<CR><LF>



NOTE 1 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

A.10.3 Query via the configuration port for MCR

To query the message, use the IEC 61161-2 mechanism.

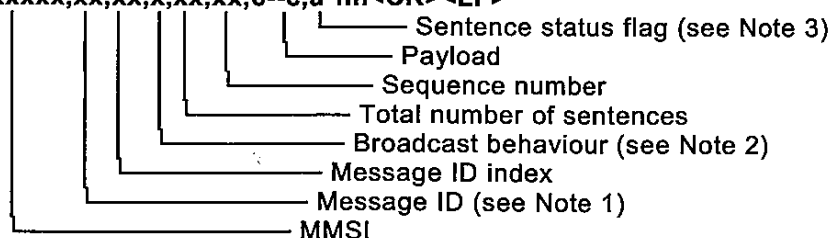
A.11 MPR – Message configuration of payload re-broadcast command

A.11.1 Description

This message will be used to command the AIS AtoN Station to rebroadcast the payload or to define a new message for autonomous, continuous transmission. The AAR configuration with message ID/message ID index for a specific MPR must precede the MPR to identify it as autonomous continuous transmission. If it is a single transmission, this payload will be broadcast using the slots reserved by the AAR with message ID/message ID Index = 0, or it will use the next available slot.

A.11.2 Configuration or function via the configuration port for MPR

\$--MPR,xxxxxxxx,xx,xx,x,xx,xx,c--c,a*hh<CR><LF>



NOTE 1 The following messages are supported by ITU-R M.1371 Messages 6, 8, 12, 14, 25, 26 and other appropriate messages.

NOTE 2 0 = use AAR definition,

1 = use next available slot.

"C" = sentence is a configuration command to change settings.

To query this sentence, use the standard IEC 61162-1 query structure.

A.12.1 Description

A.12.2 Configuration via the configuration port using the TSP sentence

Diagram illustrating the structure of the MMSI code (10 bits):

- Bit 1: MMSI (see Note 1)
- Bit 2: Sequential identifier (see Note 2)
- Bit 3: Channel selection (see Note 3)
- Bit 4: UTC hour, minute, and second of requested blocking of slot use (see Note 4)
- Bit 5: Reference slot (see Note 5)
- Bit 6: Slot offset of first block of consecutive time slots (see Note 6)
- Bit 7: Slot offset of second block of consecutive time slots (see Note 6)
- Bit 8: Slot offset of third block of consecutive time (see Note 6)
- Bit 9: Consecutive time slots in second block (see Note 7)
- Bit 10: Consecutive time slots in third block (see Note 7)
- Bit 11: Prohibit duration control (see Note 8)
- Bit 12: Sentence status flag (see Note 9)

NOTE 8 This field is used to control the prohibited slots. This field should not be null.

C = immediately restore for use all slots currently prohibited from use,

E = the slot prohibition expires for the slots identified in this sentence after their next occurrence,

P = prohibit the use of slots identified in this sentence. Slots are restored for use using "C" or "R",

R = restore the use of slots identified in this sentence.

NOTE 9 This field is used to indicate a sentence that is a status report of current settings or a configuration command changing settings. This field should not be null.

"R" = sentence is a query response,

"C" = sentence is a configuration command to change settings.

A.12.3 Query via the configuration for TSP

To query this sentence, use the standard IEC 61162-1 query structure.

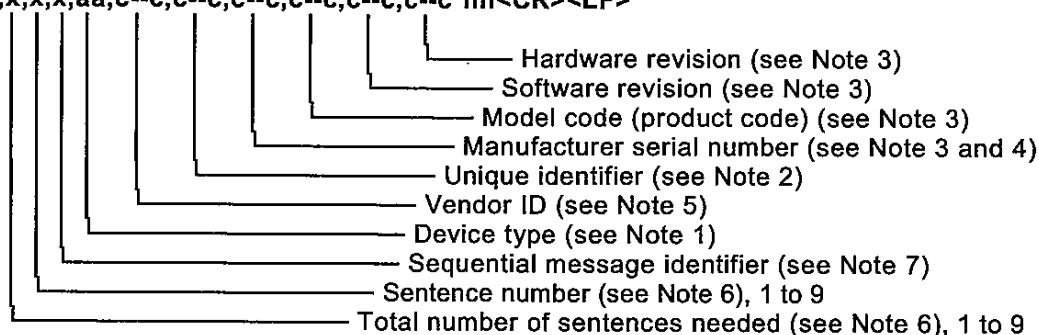
A.13 VER – Version

A.13.1 Description

This sentence is used to provide identification and version information about a talker device. This sentence is produced either as a reply to a query sentence. The contents of the data fields, except for the unique identifier, should be manufactured into the talker device. The unique identifier is the AtoN Station Real MMSI. In order to meet the 79-character requirement, a "multi-sentence message" may be needed to convey all the data fields.

A.13.2 Configuration via the configuration port for VER

\$--VER,x,x,x,aa,c--c,c--c,c--c,c--c,c--c*hh<CR><LF>



NOTE 1 The device type is used to identify the manufactured purpose of the device. Choice of the device type identifier is based upon the designed purpose of the device. It is set into the equipment based upon the primary design of the device and remains constant even if the user defined talker identifier feature is used (see BCF-sentence). For AIS device types, use one of the following talker identifier mnemonics:

AB: independent AIS Base Station;

AD: dependent AIS Base Station;

AI: mobile class A or B (see IEC 61993-2 and IEC 62287-1) AIS station;

AL: limited AIS Base Station;

AN: AIS aids to navigation station;

AR: AIS receiving station;

AS: AIS physical shore station;

AT: AIS transmitting station;

AX: AIS simplex repeater station;

DU: duplex repeater station;

UP: microprocessor controller;

U#: ($0 \leq \# \leq 9$) user configured talker identifier.

NOTE 2 The unique identifier is used for system level identification of a station, 15 alphanumeric character maximum. For an AtoN Station, this is the Real AtoN MMSI number.

NOTE 3 The data field length may be 32 characters maximum. The length of 32 characters is chosen in order to be consistent with similar data field lengths in the IEC 61162 standard. When large character lengths are used and the 80 character sentence limit would be exceeded for a single sentence, a series of successive VER sentences should be used to avoid the problem (using data fields 1 and 2 to ensure the multiple VER sentences are properly associated by the listener). Null fields can be used for data fields contained in other sentences of the series. Every VER sentence shall contain the unique identifier.

NOTE 4 The manufacturer's serial number for the unit. Note, this "internal" manufacturer's serial number may or may not match the physical serial number of the device.

NOTE 5 Vendor identification.

NOTE 6 Depending on the number of characters in each data field, it may be necessary to use a "multi-sentence message" to convey a "VER reply." The first data field specifies the total number of sentences needed, minimum value 1. The second data field identifies the sentence number, minimum value 1.

NOTE 7 The third data field provides the sequential message identifier. The sequential message identifier provides a message identification number from 0 to 9 that is sequentially assigned and is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a VER reply requiring multiple sentences, each sentence of the message contains the same sequential message identification number. It is used to identify the sentences containing portions of the same VER reply. This allows for the possibility that other sentences might be interleaved with the VER reply that, taken collectively, contain a single VER reply. This data field may be a null field for VER replies that fit into one sentence.

Annex B (informative)

AIS AtoN Station configuration structures

B.1 AIS AtoN Station configuration structures

This annex defines the binary data fields of VDL Messages 6 and/or 25 used by AIS AtoN Stations to establish a communication protocol that allows for secure communication between AIS AtoN Stations and Base Stations. This communication can establish a chain of AIS AtoN Stations allowing for communication with AIS AtoN Stations that are remote and unable to communicate directly with the Base Station. The tables in this annex only describe the binary data fields. The choice of Message (6 or 25) is left to the competent authority.

The AIS AtoN Station uses Message 25, or Message 6, with an AES encrypted binary data field for secure communication. Message 25 requires one slot for the 128 bit boundary required for AES encrypted data in the binary data field. Message 6 requires two slots for the 128 bit boundary required for AES encrypted data in the binary data field.

Table B.1 – Parameter setting in Message 25 for AIS AtoN Station applications

Parameter	Number of bits	Description
Message ID	6	Identifier for Message 25; always 25
Repeat indicator	2	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Source ID	30	MMSI of station broadcasting message (must be changed by intermediate AIS AtoN Stations in a chain)
Destination indicator	1	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Binary data flag	1	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Binary data	128	AES encrypted binary data; 120 bits of data 8 bits AES checksum
Total number of bits	168	Occupies 1 slot

Table B.2 – Parameter setting in Message 6 for AIS AtoN Station applications

Parameter	Number of bits	Description
Message ID	6	Identifier for Message 6; always 6
Repeat indicator	2	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Source ID	30	MMSI of station broadcasting message (must be changed by intermediate AIS AtoN Stations in a chain)
Sequence number	2	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Destination ID	30	Set to "#####" (is not changed by intermediate AIS AtoN Stations in a chain)
Retransmit flag	1	Set to 0 (is not changed by intermediate AIS AtoN Stations in a chain)
Spare	1	Not used. Should be zero. Reserved for future use.
Binary data	144	Application identifier (16 bits)
		AES encrypted binary data (128 bits)
Total number of bits	216	Occupies 2 slots

Table B.3 – Message 25 or 6 function identifier used for configuration and query via the VDL

For the application identifier the DAC is always 990 for an AIS AtoN station.

Function Identifier	Description	Type
000000 (dec 0)	AID - change/create/delete AtoN MMSI	Configuration
000001 (dec 1)	AID - query	Query - request
000010 (dec 2)	AID - query	Query - response
000011 (dec 3)	ACF/ACE Part 1	Configuration
000100 (dec 4)	ACF/ACE Part 2	Configuration
000101 (dec 5)	ACF/ACE Part 3	Configuration
000110 (dec 6)	ACF/ACE Part 4 First 12 characters of AtoN name	Configuration
000111 (dec 7)	ACF/ACE Part 5 Second 12 characters of AtoN name	Configuration
001000 (dec 8)	ACF/ACE Part 6 Third (last) 10 characters of AtoN name	Configuration
001001 (dec 9)	ACF/ACE content query	Query - request
001010 (dec 10)	ACF/ACE content query Part 1	Query - response
001011 (dec 11)	ACF/ACE content query Part 2	Query - response
001100 (dec 12)	AAR for FATDMA	Configuration
001101 (dec 13)	AAR for RATDMA	Configuration
001110 (dec 14)	AAR query	Query - request
001111 (dec 15)	AAR query	Query - response
010000 (dec 16)	AKE - encryption key	Configuration
010001 (dec 17)	ARW - receiver turn on	Configuration
010010 (dec 18)	ARW query	Query - request
010011 (dec 19)	ARW query	Query - response
010100 (dec 20)	MCR - manufacturer's AtoN control	Functional
010101 (dec 21)	MCR - query	Query - request
010110 (dec 22)	MCR - query	Query - response
010111 (dec 23)	MPR - message payload re-broadcast	Functional
011000 (dec 24)	AFB - force a broadcast	Functional
011001 (dec 25)	VER - query for version information	Query - request
011010 (dec 26)	VER - version information	Query - response
011011 (dec 27)	AFC - query for AtoN function ID capability	Query - request
011100 (dec 28)	AFC - AtoN function ID capability	Query - response
011101 (dec 29)	TSP - AIS AtoN prohibited slots	Configuration
011110 (dec 30)	TSP - query	Query - request
011111 (dec 31)	TSP - response	Query - response
100000 (dec 32)	ACF/ACE content query	Query - request
100001 (dec 33)	ACF/ACE content query response	Query - response

B.2 AAR –Configure broadcast rates for AtoN Station message command

B.2.1 Description

This structure assigns the schedule of slots that will be used to broadcast Message 21 and other allowed AIS AtoN Station messages. It provides the start slot and interval between the slots used for consecutive transmissions for the message. The AIS AtoN Station should apply the information provided by this structure to autonomously and continuously transmit the VDL messages until revised by a new AAR structure.

The AIS AtoN Station, upon receipt of an AAR query for this information, will generate structures for configured messages providing the current broadcast schedule. New AAR assignments will override existing AAR assignments.

B.2.2 Configuration via the VDL for AAR for FATDMA/CSTDMA

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001100_2 = 12_{10}$ Function identifier AAR structure – FATMDA/CSTDMA
MMSI of AtoN	30	MMSI of AtoN
Channel	1	Select channel Ch 1 = 0 Ch 2 = 1
Enable/disable	1	Enable or disable slot reservation Enable = 1 Disable = 0
Message ID	6	This is an allowed message ID for AIS AtoN Stations. When the message ID is 0 this indicates that the slots being defined will be used for chaining messages. These slots are not reserved on the VDL via a Message 20 until the competent authority requires their use and will reserve the slots at that time for the proper duration
Message ID index	3	To identify different versions of application specific messages per message type – for example Message 8 may have more than one use. This index should start at 1
FATDMA UTC hour	5	0-23; 24 = UTC hour not available = default; 25-31 not used
FATDMA UTC minute	6	0-59; 60 = UTC minute not available = default; 61-63 not used
FATDMA start slot	12	For all messages which need to be transmitted in FATDMA mode, starting slot ranging from 0 to 2249 should be used. A value of 4095 (FFF) discontinues broadcasts of the message when the AAR structure is sent to the AtoN Station, and indicates that no message has been broadcast if the AAR structure is received from the AtoN Station. A null field indicates no change to the current start slot setting when sent to the AtoN Station, and indicates that the start slot has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
FATDMA slot interval	24	For all messages which need to be transmitted in FATDMA mode, Slot Interval ranging from 0 to $(24 \times 60 \times 2250)$. A null field indicates no change to the current slot interval setting when sent to the AtoN Station, and indicates that the slot interval has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
Spare	16	Spare bits needed for 120 bits message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.2.3 Configuration via the VDL for AAR for RATDMA/CSTDMA

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001101_2 = 13_{10}$ Function identifier for AAR – RATDMA/CSTDMA
MMSI of AtoN	30	MMSI of AtoN
Message ID	6	This is an allowed message ID for AIS AtoN Stations
Message ID index	3	To identify different versions of application specific messages per message ID – for instance Message 8 may have more than one use
RATDMA or CSTDMA	1	0 – RATDMA; 1 – CSTDMA
RATDMA/CSTDMA UTC hour for start slot Channel 1	5	0-23; 24 UTC hour not available; 25- 31 not used
RATDMA/CSTDMA UTC minute for Channel 1	6	0-59; 60 UTC minute not available; 61-63 not used
RATDMA/CSTDMA UTC hour for start slot Channel 2	5	0-23; 24 UTC hour not available; 25- 31 not used
RATDMA/CSTDMA UTC minute for Channel 2	6	0-59; 60 UTC minute not available; 61-63 not used
RATDMA/CSTDMA Time interval for Channel 1	17	RATDMA/CSTDMA time interval ranges from 0 to $(24 \times 60 \times 60)$ s. A null field indicates no change to the current time interval setting when sent to the AtoN Station, and indicates that the time interval has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
RATDMA/CSTDMA Time interval for Channel 2	17	RATDMA/CSTDMA time interval ranges from 0 to $(24 \times 60 \times 60)$ s. A null field indicates no change to the current time interval setting when sent to the AtoN Station, and indicates that the time interval has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
Spare	8	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.2.4 Query request via the VDL for AAR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001110_2 = 14_{10}$ Function identifier for a query retrieving all message types and their broadcast schedule
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 – RATDMA/CSTDMA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content

Parameter	Number of bits	Description
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.2.5 Query response via the VDL for AAR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001111_2 = 15_{10}$ Function identifier response to query retrieving all message types and their broadcast schedule
MMSI of AtoN	30	MMSI of responding AtoN
Number of messages to report	6	Total number of messages being broadcast by this AtoN – if the total exceeds what will fit in the number of slots in the query, then it is the competent authority's responsibility to query again with the correct number of slot allocation
Message ID	6	This is an allowed Message ID for AIS AtoN Stations
Message Identifier	3	To identify different versions of application specific messages per message ID – for example Message 8 may have more than one use
Channel Selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
FATDMA UTC hour	5	0-23; 24 RATDMA is used all other FATDMA fields ignored; 25-31 not used
FATDMA UTC minute	6	0-59; 60 UTC minute not available default; 61-63 not used
FATDMA start slot	12	For all messages to be transmitted in FATDMA mode, starting slot ranging from 0 to 2249 should be used. A value of 4095 (FFF) discontinues broadcasts of the message when the AAR structure is sent to the AtoN Station, and indicates that no message has been broadcast if the AAR structure is received from the AtoN Station. A null field indicates no change to the current start slot setting when sent to the AtoN station, and indicates that the start slot has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
FATDMA slot interval	24	For all messages to be transmitted in FATDMA mode, slot interval ranging from 0 to $(24 \times 60 \times 2250)$. A null field indicates no change to the current slot interval setting when sent to the AtoN station, and indicates that the slot interval has not been set, i.e. is unavailable, when the AAR structure is received from the AtoN Station
Enable/disable	1	Enable or disable slot reservation Enable = 1 Disable = 0
Spare	10	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3 ACE/ACF – Extended/general AtoN Station configuration command

B.3.1 Description

The ACE and the ACF structures are used to configure the AtoN Station parameters when it is initially installed, and later in order to make changes to the way it operates. This structure supports the system administration of the AIS AtoN Station operation.

B.3.2 Configuration via the VDL for ACE and ACF

B.3.2.1 Configuration via the VDL for ACE and ACF Part 1

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $000011_2 = 03_{10}$ Function identifier for Message 21 content (ACF/ACE Part 1)
MMSI of AtoN	30	MMSI of AtoN
Position accuracy	1	1 = high; 0 = low = default
Lat	27	Latitude in 1/10 000 min of aids-to-navigation ($\pm 90^\circ$, North = positive, South = negative. 91 = (3412140h) = not available = default)
Lon	28	Longitude in 1/10 000 min of position of aids-to-navigation ($\pm 180^\circ$, East = positive, West = negative. 181 = (6791AC0h) = not available = default)
EPFS type	4	As defined in ITU-R M.1371
Off-position threshold	12	Off-position indicator is generated when this threshold is exceeded (distance in metres)
Acknowledgement procedure	1	Determines behaviour for message acknowledgement 0 = will provide acknowledgement as defined by manufacturer 1 = will not providing acknowledgement
Spare	1	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.2.2 Configuration via the VDL for ACE and ACF part 2

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $000100_2 = 04_{10}$ Function identifier for Message 21 content (ACF /ACE part 2)
MMSI of AtoN	30	MMSI of AtoN
Type of AtoN	5	0 = not available = default; refer to appropriate definition set up in ITU-R M.1371
Dimensions	30	Reference point for reported position; also indicates the dimension of aids-to-navigation (see ITU-R M.1371)

Parameter	Number of bits	Description
		should be given as aaabbbccdd
AtoN status bits	8	Indication of the AtoN status, default "00000000 ₂ "
Virtual AtoN flag	2	0 = Real 1 = Virtual AtoN 2 = Synthetic AtoN (flag remains 0 in Message 21 but the repeat indicator must be > 0)
Spare	29	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.2.3 Configuration via the VDL for ACE and ACF part 3

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = 1111011110 ₂ = 990 ₁₀ Bits 5-0 = 000101 ₂ = 05 ₁₀ Function identifier for Message 21 content (ACF/ACE Part 3)
MMSI of AtoN	30	MMSI of AtoN
Receive Channel 1	12	25 kHz channel number according to Recommendation ITU-R M.1084
Receive Channel 2	12	25 kHz channel number according to Recommendation ITU-R M.1084
Transmit Channel 1	12	25 kHz channel number according to Recommendation ITU-R M.1084
Transmit Channel 2	12	25 kHz channel number according to Recommendation ITU-R M.1084
Power level	4	0 = default manufacturer power level (nominally 12,5 W) 1 to 9 as defined by the manufacturer
Off-position behaviour	1	0 – maintain current broadcast schedule 1 – use New Reporting Rate
Synch lost behaviour	1	0 – go silent 1 – continue as before
Spare	20	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.2.4 Configuration via the VDL for ACE and ACF Part 4 (first 12 characters of AtoN name)

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $000110_2 = 06_{10}$ Function identifier for Message 21 content (ACF/ACE Part 4) First 12 characters of AtoN name
MMSI of AtoN	30	MMSI of AtoN
Name of AtoN	72	First 12 characters of 34 characters for Name of AtoN
Spare	2	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.2.5 Configuration via the VDL for ACE and ACF Part 5 (second 12 characters of AtoN name)

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $000111_2 = 07_{10}$ Function identifier for Message 21 content (ACF/ACE part 5) Second 12 characters of AtoN name
MMSI of AtoN	30	MMSI of AtoN
Name of AtoN	72	Second 12 characters of 34 characters for name of AtoN
Spare	2	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.2.6 Configuration via the VDL for ACE and ACF Part 6 (third (last) 10 characters of AtoN name)

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001000_2 = 08_{10}$ Function identifier for Message 21 content (ACF/ACE part 6) Last 10 characters of AtoN name
MMSI of AtoN	30	MMSI of AtoN
Name of AtoN	60	Last 10 characters of 34 characters for name of AtoN
Spare	14	Spare bits needed for 120bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.3 Query via the VDL for ACE and ACF

If the AtoN Station is not chained and within VDL range of the Base Station query via the VDL for ACE and ACF verification is done using both a forced broadcast of Message 21 and additional functional queries.

Forced Message 21 provides the query information for the following settings:

- position accuracy;
- EPFS type;
- type of AtoN;
- dimensions;
- AtoN status bits;
- receiver and transmitter channels (query via the VDL does not work, unless at least one channel is known and functional);
- AtoN name;
- Virtual AtoN flag.

If the AtoN Station is chained and not within the VDL range of the Base Station the following queries shall be used to obtain:

- position accuracy;
- EPFS type;
- type of AtoN;
- dimensions;
- AtoN Status bits;
- receiver and transmitter channels (Query via the VDL does not work, unless at least one channel is known and functional);
- AtoN name;
- Virtual AtoN flag.

B.3.3.1 Query request via the VDL for Message 21 content

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $100000_2 = 32_{10}$ Function identifier for query for Message 21 content
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.3.2 Query response via the VDL for Message 21 content

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $100001_2 = 33_{10}$ Function identifier for answer to query for Message 21 content
Message 21 content	272-360	VDL Message 21 content as defined in Recommendation ITU-R M.1371
Spare		The number of spare bits should be adjusted in order to observe byte boundaries

This message requires multiple slots for a complete response; however the message does not need to be encrypted.

The following additional functional queries must be used to obtain setup information not contained within the Message 21.

B.3.3.3 Query request via the VDL for ACE/ACF content

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001001_2 = 09_{10}$ Function identifier for query for ACF/ACE content query
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.3.4 Query response via the VDL for ACE/ACF content part 1

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $001010_2 = 10_{10}$ Function identifier for answer to query for ACF and ACE part 1 providing the following: Off-position threshold LAT LON Invalid position behaviour UTC sync loss behaviour

Parameter	Number of bits	Description
		Channel operation Power level
MMSI of AtoN	30	MMSI of responding AtoN
Off-position threshold	12	Off-position indicator is generated when this threshold is exceeded (distance in metres)
LAT	27	Latitude in 1/10 000 min of aids-to-navigation ($\pm 90^\circ$, North = positive, South = negative. 91 = (3412140 _h) = not available = default)
LON	28	Longitude in 1/10 000 min of position of aids-to-navigation ($\pm 180^\circ$, East = positive, West = negative. 181 = (6791AC0 _h) = not available = default)
Behaviour for sync loss	1	0 – go silent 1 – continue as before
Power level	4	0 = default manufacturer power level (nominally 12,5 W) 1 to 9 as defined by the manufacturer
Spare	2	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.3.3.5 Query response via the VDL for ACE/ACF content Part 2

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = 1111011110 ₂ = 990 ₁₀ Bits 5-0 = 001011 ₂ = 11 ₁₀ Function identifier for answer to query for ACF and ACE Part 2 providing the following: off-position behaviour slot interval when off position receive Channel 1 receive Channel 2 transmit Channel 1 transmit Channel 2
MMSI of AtoN	30	MMSI of responding AtoN
Off-position behaviour	1	0 – maintain current broadcast schedule 1 – use new reporting rate
Receive Channel 1	12	25 kHz channel number according to Recommendation ITU-R M.1084
Receive Channel 2	12	25 kHz channel number according to Recommendation ITU-R M.1084
Transmit Channel 1	12	25 kHz channel number according to Recommendation ITU-R M.1084
Transmit Channel 2	12	25 kHz channel number according to Recommendation ITU-R M.1084
Spare	25	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.4 AFB – Forced broadcast command

B.4.1 Description

This structure is used to force a transmission of the indicated VDL message, this message is already known to the AIS AtoN Station through AAR/MPR or ACE/ACF/AAR configuration commands.

B.4.2 Function via the VDL for PRB

This VDL function is used to force the broadcast of a message already defined by an AAR.

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011000_2 = 24_{10}$ Function identifier forced broadcast
MMSI of AtoN	30	MMSI of AtoN
Message ID	6	This is an allowed message ID for AIS AtoN Stations
Message ID index	3	To identify different versions of application specific messages per message ID – for example Message 8 may have more than one use
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response; a value of 2251 indicates an RATDMA transmission
Spare	41	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.5 AFC – AtoN function ID capability

B.5.1 Description

This structure is used to provide the capability information of implemented function ID by the EUT.

B.5.2 Query request via the VDL for AFC

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011011_2 = 27_{10}$ Function identifier query for AtoN function ID capability
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel

Parameter	Number of bits	Description
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.5.3 Query response via the VDL for AFC

This VDL Function is used by the EUT to transmit the AtoN function ID capability.

Parameter	Number of Bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011010_2 = 28_{10}$ Function identifier version information
MMSI of AtoN	30	MMSI of AtoN
Status of implementation for each function ID	64	Each bit corresponds to the function ID number and the bit value "0" indicates the function ID number is not supported and "1" indicates supported (see example below)
Spare	10	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

<Example>

Bit	0	1	2	...	63
	(FI=0)	(FI=1)	(FI=2)	...	(FI=63)
Value	1	0	1	...	0

This example indicates that function ID =0 and function ID =2 are supported and function ID =1 is not supported.

B.6 AID – MMSI configuration for command

B.6.1 Description

This structure is used to load, for an AtoN Station, its Real, Virtual and chained MMSI(s). The MMSI from the factory shall be as defined by the manufacturer. Each AtoN Station will maintain a table of its MMSI(s) and the messages associated with these MMSI(s).

B.6.2 Configuration via the VDL for AID

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $000000_2 = 00_{10}$ Function identifier for changing or creating MMSI numbers
MMSI of addressed AtoN	30	MMSI of the station being addressed the initial factory setting should be defined by manufacturer. All Real AtoNs must receive initial MMSI configuration in a lab not over the VDL
Create/delete	1	Define if the MMSI is being created/changed (1) or deleted (0). If own station MMSI is deleted it must revert to the factory setting. If a Virtual AtoN is deleted, then all associated messages for that

Parameter	Number of bits	Description
		Virtual AtoN are also deleted
MMSI of AtoN	30	MMSI to be created/changed/or deleted
Virtual, Real or chained	2	00 own station (Real), 01 Virtual (Synthetic), 10 chained parent, 11 chained child. Real is own station, chained indicates to an MMSI that this station is responsible for relaying messages to and from, a Virtual AtoN indicates to an MMSI that this station is responsible for generating at least a Message 21
Spare	41	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.6.3 Query via the VDL for AID

Parameter	Number of bits	Description
Application identifier	16	Bits15-6 = 1111011110 ₂ = 990 ₁₀ 5-0 = 000001 ₂ = 01 ₁₀ Function identifier to query for a list of all AtoN MMSIs and types
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available =default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.6.4 Query – response via the VDL for AID

Parameter	Number of bits	Description
Application identifier	16	Bits15-6 = 1111011110 ₂ = 990 ₁₀ 5-0 = 000010 ₂ = 02 ₁₀ Function identifier answer to query for AtoN lists
MMSI of AtoN	30	MMSI of responding AtoN
Number of MMSI's to report	10	The total number of MMSI that will be reported – could take multiple responses to report all known AtoNs – competent authority responsible for reserving enough slots
MMSI	30	MMSI of AtoN
Virtual, Real or chained	2	00 own station (Real), 01 Virtual (Synthetic), 10 chained parent, 11 chained child
MMSI	30	MMSI of AtoN
Virtual, Real or chained	2	00 own station (Real), 01 Virtual (Synthetic), 10 chained parent, 11 chained child

Parameter	Number of bits	Description
Spare	0	Spare bits needed for 120bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.7 AKE – Configure encryption key command

B.7.1 Description

This structure assigns the encryption key that will be used by the AES algorithm to communicate configuration and status information via the VDL. The structure only allows the least significant 56 bits to be modified. This restriction is required in order to keep the VDL function to a single message. The initial encryption key, when shipped from the manufacturer, will be all 0's.

B.7.2 Configuration via the VDL for AKE

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010000_2 = 16_{10}$ Function identifier setting the encryption key
MMSI of AtoN	30	MMSI of AtoN
Encryption key	56	LSB of a new AES encryption key
Spare	18	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.7.3 Query via the VDL for AKE

Query via the VDL for the encryption key is not allowed.

B.8 ARW – Configure the receiver turn-on times command

B.8.1 Description

This structure defines the operational period for the receivers. When chaining the duration of the receiver wake-up time must be sufficient to allow correct operation of a chain.

B.8.2 Configuration via the VDL for ARW

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010001_2 = 17_{10}$ Function identifier setting receiver power on
MMSI of AtoN	30	MMSI of AtoN
Receiver on or interval	1	0 = use interval setting as defined below; 1 = turn receiver on
Set up receiver wake-up time UTC hour	5	0-23; 24 = interval will be in minutes; 25-31 not used;
Set up receiver wake-up time UTC minute	6	0-59; 60 = indicates hourly activation (no minute increment); 61-63 not used

Parameter	Number of bits	Description
Set up receiver wake-up interval	8	Interval between receiver activation 1 min - 60 min if UTC hour is set to 24 1 h - 256 h if UTC hour is 0- 23 (Note 168 h is once per week.)
Duration of setup receiver wake up time in UTC minutes	12	Maximum awake time Note 1 440 min is 24 h 1 441 to 4 095 reserved for future use
Spare	42	Spare bits needed for 120 bits message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.8.3 Query request via the VDL for ARW

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010010_2 = 18_{10}$ Function identifier for ARW query
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available =default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.8.4 Query response via the VDL for ARW

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010011_2 = 19_{10}$ Function identifier answer to query for ARW The receiver turn on schedule
MMSI of AtoN	30	MMSI of responding AtoN
Receiver status	1	0 = using interval; 1 = on
Receiver turn on UTC hour	5	0-23; 24 = interval will be in minutes; 25-31 not used
Receiver turn on UTC minute	6	0-59; 60 = indicates hourly activation (no minute increment) 61-63 not used
Set up receiver wake-up interval	8	Interval between receiver activation 1 min - 60 min if UTC hour is set to 24

Parameter	Number of bits	Description
		1 h - 256 h if UTC hour is 0- 23 (Note 168 h is once per week.)
Duration of setup receiver wake up time in UTC minutes	12	Maximum awake time Note 1 440 min is 24 h 1 441 to 4 095 reserved for future use
Spare	42	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.9 MCR –Configure proprietary AtoN control command

B.9.1 Description

The payload of this structure will be proprietary information used to control the AtoN Station.

B.9.2 Configuration via the VDL for MCR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010100_2 = 20_{10}$ Function identifier AtoN control as defined by competent authority
MMSI of AtoN	30	MMSI of AtoN
Payload		As defined by competent authority
Spare		Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.9.3 Query request via the VDL for MCR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010101_2 = 21_{10}$ Function identifier AtoN query control settings
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available =default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.9.4 Query response via the VDL for MCR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010110_2 = 22_{10}$ Function identifier answer to query
MMSI of AtoN	30	MMSI of responding AtoN
Payload		As defined by manufacturer
Spare		Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.10 MPR – Message configuration of payload rebroadcast command

B.10.1 Description

This message will be used to command the AIS AtoN Station to rebroadcast the payload or to define a new message for autonomous, continuous transmission. The AAR configuration with Message ID/Message ID index for a specific MPR must precede the MPR to identify it as autonomous continuous transmission. If it is a single transmission, this payload will be broadcast using the slots reserved by the AAR with Message ID/Message ID index = 0, or it will use the next available slot.

B.10.2 Configuration or function via the VDL for MPR

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $010111_2 = 23_{10}$ Function identifier payload rebroadcast
MMSI of AtoN	30	MMSI of AtoN
Message ID	6	This is an allowed Message ID for AIS AtoN Stations
Message ID index	3	To identify different versions of application specific messages per Message ID – for example Message 8 may have more than one use
Total number of structures	4	Total number of structures required to be received before a complete AIS message can be constructed; minimum of 3 is needed to broadcast a single slot message
Sequence number	4	Sequence number within the total number of structures required; must be sequential
Broadcast behaviour	1	0 = based upon AAR configuration 1 = use next available slot
Payload		The encapsulated data, as defined by IEC 61162-1, for a valid AIS AtoN Station message.
Spare		Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.10.3 Query via the VDL for MPR

There is no VDL query for this message. Confirmation is done via reception of the broadcast message or the AAR may be queried to confirm that the message has been scheduled for autonomous transmission.

B.11 TSP – Transmit slot prohibit command

B.11.1 Description

This structure is used to prohibit an AIS station from transmitting in the specified slots and is applicable for RATDMA. The AIS station receiving this structure should not use the next occurrence of the indicated slots. This structure is designed to be used to protect interrogation responses from interference from Base Station transmissions and for use with AtoN Stations. For an AtoN Station the unique identifier is the AtoN Station Real MMSI.

B.11.2 Configuration via the VDL for TSP

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011101_2 = 29_{10}$ Function identifier TSP structure – prohibited slots
MMSI of AtoN	30	MMSI of AtoN
Channel	1	Select channel 0 = Channel 1 1 = Channel 2
Establish/cancel	1	Establish or cancel prohibited slots 0 = establish 1 = cancel
Prohibited setting number of this report	4	This is an allowed up to 16 prohibited settings for AIS AtoN Stations
UTC hour of the first prohibited block	5	0-23; 24 = UTC hour not available = default; 25-31 not used
UTC minute of the first prohibited block	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot of the first prohibited block	12	Starting slot ranging from 0 to 2249
Slot interval Channel 1 or 2	24	Slot interval ranging from 0 to $(24 \times 60 \times 2250)$
Number of consecutive slots in each prohibited block Channel 1 or 2	12	The number may range from 1 to 2250 consecutive slots
Prohibit duration control	2	0 = immediately restore for use all prohibited slots 1 = slot prohibition expires after next occurrence 2 = prohibit the use of identified slots 3 = restore the use of identified slots
Spare	7	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.11.3 Query request via the VDL for TSP

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011110_2 = 30_{10}$ Function identifier for a query retrieving all prohibited slots

Parameter	Number of bits	Description
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Spare	50	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.11.4 Query response via the VDL for TSP

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011111_2 = 31_{10}$ Function identifier response to query retrieving all prohibited slots
MMSI of AtoN	30	MMSI of responding AtoN
Total number of prohibited settings to report	4	Total number of prohibited settings being configured by this AtoN – each prohibited setting requires an own report (message)
Prohibited setting number of this report	4	This is an allowed up to 16 prohibited settings for AIS AtoN Stations
Channel	1	Select channel 0 = Channel 1 1 = Channel 2
UTC hour of the first prohibited block	5	0-23; 24 = UTC hour not available = default; 25-31 not used
UTC minute of the first prohibited block	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot of the first prohibited block	12	Starting slot ranging from 0 to 2249
Slot interval between the prohibited slots Channel 1 or 2	24	Slot interval ranging from 0 to $(24 \times 60 \times 2250)$
Number of consecutive slots in each prohibited block Channel 1 or 2	12	The number may range from 1 to 2250 consecutive slots
Spare	6	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.12 VER - Version

B.12.1 Description

This structure is used to provide identification and version information about a talker device. This structure is produced either as a reply to a query structure. The contents of the data

fields, except for the unique identifier, should be manufactured into the talker device. The unique identifier is the AtoN Station Real MMSI. In order to meet the single slot requirement, a multi-structure message may be needed to convey all the data fields.

B.12.2 Query request via the VDL for VER

Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011001_2 = 25_{10}$ Function identifier query for version information
MMSI of AtoN	30	MMSI of AtoN
Channel selection	1	0 – indicates Channel 1 1 – indicates Channel 2 The query response will only be sent on a single channel
UTC hour for start slot	5	0-23; 24 = RATMDA is used all other FATDMA fields ignored; 25-31 not used
UTC minute for start slot	6	0-59; 60 = UTC minute not available = default; 61-63 not used
Start slot	12	Starting slot for the query response
Kind of requested version information	4	0 = device type 1 = vendor ID 2 = unique identifier 3 = manufacturer serial number 4 = model code (product code) 5 = software revision 6 = hardware revision 7-15 = not used, for future use
Spare	46	Spare bits needed for 120 bit message content
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

B.12.3 Query response via the VDL for VER

This VDL function is used by the EUT to transmit the version information.

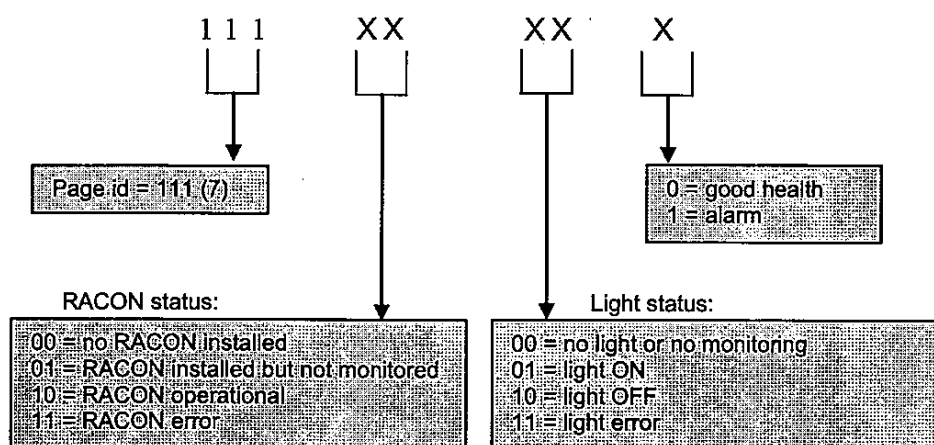
Parameter	Number of bits	Description
Application identifier	16	Bits 15-6 = $1111011110_2 = 990_{10}$ Bits 5-0 = $011010_2 = 26_{10}$ Function identifier version information
MMSI of AtoN	30	MMSI of AtoN
Kind of requested version information	4	0 = device type 1 = vendor ID 2 = unique identifier 3 = manufacturer serial number 4 = model code (product code) 5 = software revision 6 = hardware revision 7-15 = not used, for future use

Parameter	Number of bits	Description
Requested version information	up to 192	Version information as requested; up to 32 * 6 bit ASCII characters
Spare		Spare bits needed for 120 bit message content. Note This message may require multiple slots
AES encryption checksum	8	Required for AES algorithm
Total bits	128	

Annex C (normative)

Message 21 – AtoN status bits

As indicated in IALA Recommendation A-126 in Message 21, 8 bits are reserved for AtoN status. The diagram below represents the recommended use of these bits.



These bits shall be employed as follows:

- the first three bits shall be used to define a page ID. The page ID can range from 0 to 7, allowing 8 pages. The first page (page 0 (000)) is not used for the regional/international application and is defined as the default "not used" condition in Recommendation ITU-R M.1371. Page 7 (binary 111) is used in this standard. Pages 1 to 6 are reserved for future use. The future use is envisaged as being for monitoring of AtoN parameters such as voltages, currents, temperatures, etc.
- page 7 may be implemented in all types of AIS AtoN Stations. The final 5 data bits are defined as in the diagram above.

NOTE

- Manufacturer's default setting for the AtoN status bits of Message 21 should be all zeros.
- Health flag alarm should be set to 1 to indicate a fault in or failure of the AtoN system or AIS AtoN Station, at this location. Further indication of the fault or failure detail can be achieved by use of additional pages within the regional bits, or addressed binary Message 6.
- By using only page 7 there is no need to toggle through the messages, only Message id 7 has to be read thus allowing an immediate filtering.

One bit is used for alerting the competent authority that there is a problem at the AIS AtoN Station. This allows a competent authority to avoid using Message 6, if there is pressure on VDL slots, while still receiving some monitoring information every time Message 21 is sent by the AIS AtoN Station.

For further details on the use of the remaining pages refer to IALA documentation.

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