IEC 61097-14

Edition 1.0 2010-02

INTERNATIONAL STANDARD

colour inside

Global maritime distress and safety system (GMDSS) – Part 14: AIS search and rescue transmitter (AIS-SART) – Operational and performance requirements, methods of testing and required test results

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 61097-14

Edition 1.0 2010-02

INTERNATIONAL STANDARD

Global maritime distress and safety system (GMDSS) – Part 14: AIS search and rescue transmitter (AIS-SART) – Operational and performance requirements, methods of testing and required test results

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE W

ICS 47.020.70

ISBN 2-8318-1078-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –

Part 14: AIS search and rescue transmitter (AIS-SART) – Operational and performance requirements, methods of testing and required test results

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61097-14 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

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

FDIS	Report on voting
80/582/FDIS	80/589/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 the IEC 61097 series published under the general title *Global maritime distress and safety system (GMDSS),* 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.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –

Part 14: AIS search and rescue transmitter (AIS-SART) – Operational and performance requirements, methods of testing and required test results

1 Scope

This part of IEC 61097 specifies the minimum performance requirements, technical characteristics and methods of testing, and required test results, for Automatic Identification Systems (AIS) search and rescue transmitters (AIS-SART) which may be carried by ships as a search and rescue locating device as required by Chapters III and IV of the International Convention for Safety of Life at Sea (SOLAS), as amended. It takes account of IMO resolution A.694(17) and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this part of IEC 61097 takes precedence.

This standard incorporates the applicable parts of the performance standards included in IMO Resolution MSC.246(83) and the applicable technical characteristics included in Recommendation ITU-R M.1371 and is associated with IEC 61993-2 (Class A shipborne AIS).

All the text of this standard, whose wording is identical to that of IMO Resolution MSC.246(83), is printed in *italics,* and the Resolution and associated performance standard paragraph numbers are indicated in brackets.

NOTE IEC 61097-1 specifies the requirements for radar transponders for use in search and rescue operations (SART) which may alternatively be carried by ships as a search and rescue locating device.

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

IMO Resolution MSC.246(83), *Performance standards for survival craft AIS search and rescue transmitter (AIS-SART)*

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*

3 Performance requirements

3.1 General

(246/A2) *The AIS-SART* shall *be capable of transmitting messages that indicate the position, static and safety information of a unit in distress. The transmitted messages* shall *be compatible with existing AIS installations. The transmitted messages* shall *be recognized and displayed by assisting units in the reception range of AIS-SART, and clearly distinguish the AIS-SART from an AIS installation.*

3.2 Operational

(See 6.1)

(246/A2.1) *The AIS-SART* shall

a) be capable of being easily activated by unskilled personnel,

b) be fitted with means to prevent inadvertent activation,

c) be equipped with a means which is either visual or audible, or both visual and audible, to indicate correct operation,

d) be capable of manual activation and deactivation, provision for automatic activation may be included,

e) be capable of withstanding without damage drops from a height of 20 m into water,

f) be watertight at a depth of 10 m for at least 5 min,

g) maintain water tightness when subjected to a thermal shock of 45 °C under specified conditions of immersion,

h) be capable of floating (not neccesarily in an operating position) if it is not an integral part of the survival craft,

i) be equipped with a buoyant lanyard, suitable for use as a tether, if it is capable of floating,

The buoyant lanyard shall have a length not less than 10 m.

j) be not unduly affected by seawater or oil,

k) be resistant to deterioration in prolonged exposure to sunlight,

l) be of a highly visible yellow/orange colour on all surfaces where this will assist detection,

m) have a smooth external construction to avoid damaging the survival craft,

n) *be provided with an arrangement to bring the AIS-SART antenna to a level of at least 1 metre above sea level, together with illustrated instruction,*

The manufacturer shall provide a visible means of indicating the base of the antenna. The height of 1 metre shall be measured to the declared 1 metre mark from sea level. The instructions shall illustrate the minimum requirement of 1 metre above sea level during use along with the installation method.

o) be capable of transmitting with a reporting interval of 1 minute or less,

p) be equipped with an internal position source and be capable of transmitting its current position in each message, and

q) be capable of being tested for all functionalities using specific test information.

3.3 Battery

(See 6.2)

3.3.1 General

(246/A2.2) *The AIS-SART* shall *have sufficient battery capacity to operate for 96 h within a temperature range of −20 °C to +55 °C, and to provide for testing of the functions on the equipment.*

3.3.2 Battery life and expiry date

The life of the battery as defined by its expiry date shall be at least three years. The expiry date of the battery shall be the battery manufacturing date plus no more than half the useful life of the battery. The useful life of the battery is defined as the period of time after the date of battery manufacture that the battery will continue to meet the input power requirements of the AIS-SART for at least 96 h, after allowing for all losses over the useful life of the battery. To define the useful life of the battery, the following losses at the temperature of +20 °C ± 5 °C shall be included, in addition to the power required to operate the AIS-SART:

a) self-testing annually with Electronic Position Fixing System (EPFS) data available;

b) self-discharge of the battery;

c) stand-by loads.

The manufacturer shall provide evidence to support the above battery life calculations including the time for self testing and assuming typical EPFS acquisition time.

The AIS-SART shall be clearly and durably marked with the battery expiry date (see 3.8).

NOTE For example a battery that has a useful life of 10 years from the date of manufacture, cannot have an expiry date that exceeds 5 years from the date of manufacture and would have to be capable of providing enough power for 10 years of self-testing, self-discharge and stand-by loads in addition to the operational power requirement of the AIS-SART.

3.3.3 Reverse polarity protection

It shall not be possible to connect the battery with the polarity reversed.

3.4 Unique identifier (user ID)

(See 6.3)

(246/A2.2) *The AIS-SART* shall *have an unique identifier to ensure the integrity of the VHF data link.*

The user ID for an AIS-SART is 970xxyyyy, where xx = manufacturer ID[1] 01 to 99; yyyy = the sequence number 0000 to 9999.

The manufacturer ID xx = 00 is reserved for test purposes The unique identifier used for the purposes of type approval to this standard shall be in the format 97000yyyy.

After being programmed by the manufacturer, it shall not be possible for the user to change the unique identifier of the AIS SART.

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

---

[1] The manufacturer ID can be obtained from CIRM, South Bank House, Black Prince Road, London SE1 7SJ, UK. Telephone: +44 20 7587 1245. E-mail: secgen@cirm.org. Web-site: www.cirm.org. Each manufacturers ID will support 10 000 units. Further IDs can be issued when production exceeds 10 000 units.

3.5 Environment

(See 6.4)

(246/A2.3) *The AIS-SART* shall *be so designed as to be able to operate under ambient temperatures of −20 °C to +55 °C. It* shall *not be damaged in stowage throughout the temperature range of −30 °C to +70 °C.*

The AIS-SART shall meet the environmental condition requirements of IEC 60945 for equipment category Portable.

3.6 Range performance

(See 6.5)

(246/A2.4)*The AIS-SART shall be detectable at a range of 5 nautical miles over water.*

The nominal radiated power (EIRP[2]) of the AIS-SART shall be 1 W.

This radiated power provides the range performance of the AIS-SART as described in Annex A.

NOTE To a surface vessel the 5 nautical mile range is based on an antenna height for the AIS-SART of 1 m above sea level, and the antenna height for a receiving AIS Station of at least 15 m above sea level. The receiving AIS Station has the minimum sensitivity of a Class A mobile AIS station as defined in IEC 61993-2.

3.7 Transmission performance

(See 6.6)

3.7.1 Active mode

In active mode the AIS-SART transmits messages in a burst of 8 messages once per minute. The SOTDMA (Self-Organising Time Division Multiple Access) communication state of Message 1 is used to pre-announce its future transmissions.

The AIS-SART shall transmit Message 1 “Position report” with the Navigational Status set to 14 and Message 14 “Safety related broadcast message” with the text “SART ACTIVE”.

NOTE A future revision of Recommendation ITU-R M.1371 may define navigational status 14 as “AIS-SART”.

Message 14 shall be transmitted nominally every 4 min and replace one of the position reports on both channels.

The AIS-SART transmissions shall alternate between AIS 1 and AIS 2.

The 1st and 5th burst shall be as follows.

- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 1, Message 14 “SART ACTIVE”
- AIS 2, Message 14 “SART ACTIVE”
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)

2 Equivalent Isotropically Radiated Power

The 2nd, 4th, 6th burst shall be as follows.

- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)

The 3rd burst shall be as follows.

- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)

The 7th burst shall be as follows.

- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)

The 8th burst shall be as follows.

- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)

In the 8th burst the increment to the next burst (sub-message=incr) shall be randomly selected between 2 025 and 2 475 slots.

This pattern of transmissions is repeated. It is permissible to start the sequence on AIS 2.

Message 14 is transmitted at the 1st and 5th bursts (slot-time-out = 7 and 3) thereby ensuring that all future Message 14 messages are pre-announced.

(246/A.2.5) *The AIS-SART* shall *continue transmission even if the position and time synchronization from the positioning system is lost or fails.*

If position and time synchronization are lost the AIS-SART shall continue to transmit with last known position, COG (Course Over Ground), SOG (Speed Over Ground) and indicate that the positioning system is inoperative (Time stamp = 63) and synch state 3 (see 4.3.3).

(246/A.2.6) *The AIS-SART* shall *transmit within 1 minute of activation.*

The AIS-SART shall start transmitting within 1 min. If the position is unknown then it shall use default position (+91; +181). If time is not established the unit shall begin transmission unsynchronised. The unit shall begin synchronised transmission with the correct position within 15 min under normal operating conditions.

The position of the AIS-SART shall be determined every minute.

In conditions when the AIS-SART cannot get time and position within 15 min, the AIS-SART shall attempt to obtain a position for at least 30 min in the first hour after activation and at least 5 min in subsequent hours.

3.7.2 Test Mode

It shall be possible to put the AIS-SART in a test mode. When operating in the test mode there shall be one burst of 8 messages, 4 on each channel alternating.

- AIS 1, Message 14 “SART TEST”
- AIS 2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS 2, Message 14 “SART TEST”

It is permissible to start the sequence on AIS 2.

The test messages shall be transmitted in one burst after position, SOG, COG and time are available. If the AIS-SART does not acquire position, SOG, COG and time within 15 min it shall transmit the test messages but with appropriate field values (including default values) in Message 1 for position, SOG, COG and time stamp.

Activation of the test facility shall reset automatically after transmission of the burst.

3.8 Labelling

(See 6.7)

In addition to the items specified in IEC 60945*, the following* shall *be clearly indicated on the exterior of the equipment:*

a) brief operating and test instructions (in English);

b) expiry date (in English) *for the primary battery used and*

c) the unique identifier (user ID field of the AIS messages).

NOTE Expiry date is battery replacement date (see 3.3.2).

3.9 Manuals

(See 6.8)

In addition to the requirements of IEC 60945, the manuals shall include instructions for periodic testing and maintenance for the AIS-SART.

NOTE Instructions on how to operate the AIS-SART in a SART active mode should be part of the labelling on the device (see 3.8).

4 Technical requirements

4.1 Functional block diagram of an AIS-SART

4.1.1 General

Figure 1 shows the functional block diagram of an AIS-SART.

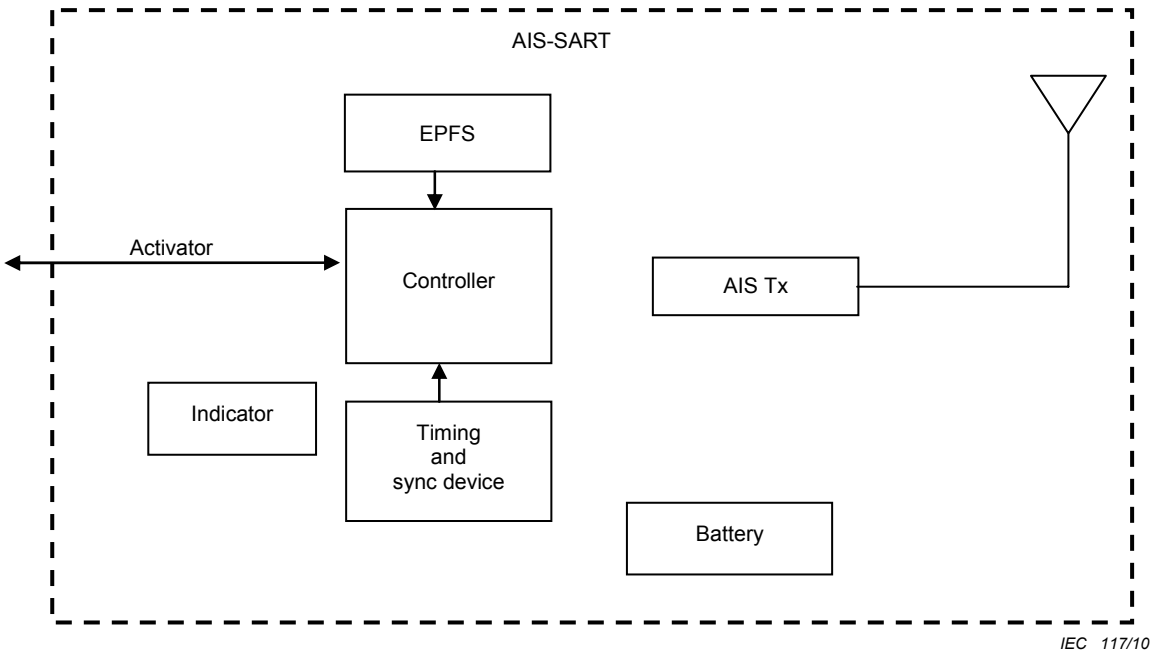


Figure 1 – Functional block diagram of an AIS-SART

The components of the AIS-SART are as listed below.

4.1.2 TDMA transmitter (AIS Tx)

The transmitter has the following characteristics:

- transmits using modified SOTDMA;
- has nominal 1 W (EIRP) transmitter power;
- has dual channel transmission (see 4.2).

4.1.3 Controller

The controller composes Message 1 and Message 14 and ensures the correct operation of the AIS-SART on the VHF Data Link (VDL) (see 4.3).

4.1.4 Timing and synchronisation device

This device provides the time and synchronisation for the controller (see 4.3.3).

4.1.5 Battery

The battery supplies the internal voltages (see 3.3).

4.1.6 Electronic position fixing system

4.1.6.1 General

(See 6.9)

Electronic Position Fixing System (EPFS) provides the current position of the AIS-SART.

4.1.6.2 Position source

An EPFS shall be used as the source for AIS-SART position reporting.

The internal EPFS shall be a GNSS receiver that meets the following requirements of the IEC 61108 series: position accuracy, acquisition, re-acquisition, receiver sensitivity, RF dynamic range, position update, effects of specific interfering signals but with an minimum update of once per minute, provide a resolution of one ten-thousandth of a minute of arc and use WGS 84 datum.

The manufacturer shall provide evidence that an internal EPFS device cold start is forced at every AIS-SART activation (cold start refers to the absence of time dependent or position dependent data in memory, which might affect the acquisition of the GNSS position).

4.1.6.3 Invalid position, COG and SOG

On activation, 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, COG = not available = default, SOG = not available = default, and the time stamp field shall be set to a value of 63.

If the EPFS data is lost then the AIS-SART shall continue to transmit with the last known position, COG and SOG, and the time stamp field shall be set to a value of 63 “positioning system inoperative” and with the synchronisation state set to 3.

4.1.7 Activator

(See 6.10)

The Activator provides a means for manual activation and deactivation of the AIS-SART. Manual activation shall provide a means to avoid inadvertent activation such as the use of not less than two simple but independent actions.

The AIS-SART shall be provided with means to indicate that the AIS-SART has been previously activated, to advise the users of a possible reduction of the required battery capacity. These means shall not be capable of reset by the user. For example, manual activation requires the breaking of a seal that cannot be replaced by the user.

This indication of previous activation shall be unaffected when initiating the test mode. The Activator provides a means for manual activation and deactivation of the AIS-SART test mode.

4.1.8 Indicator

(See 6.11)

The indicator shall be visual and/or audible.

The indicator shall indicate that the AIS-SART

- has been activated,
- is undergoing test,
- has completed test.

There shall be indication of the EPFS status whilst the AIS-SART is activated.

4.2 Physical layer requirement

(See Clause 7)

4.2.1 Transmitter requirements

4.2.1.1 Channel

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

4.2.1.2 Parameter settings

Table 1 and Table 3 are derived from Recommendation ITU-R M.1371 and give the parameters required for an AIS-SART. For the meaning of the symbols and additional information (footnotes) refer to the appropriate section of Recommendation ITU-R M.1371.

Table 1 – Required parameter settings for an AIS-SART

Symbol	Parameter name	Setting
PH.AIS1	AIS 1 (default channel 1)	161,975 MHz
PH.AIS2	AIS 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 ±1,0 kHz of final value). Tested at manufacturers declared transmit power.	≤1,0 ms
	Ramp down time	≤832 µs
	Transmission duration	≤26,6 ms

In addition, the constants of the physical layer of the AIS-SART shall comply with the values given in Table 2 and Table 3.

Table 2 – Required settings of physical layer constants

Symbol	Parameter name	Value
PH.DE	Data encoding	NRZI[a]
PH.FEC	Forward error correction	Not used
PH.IL	Interleaving	Not used
PH.BS	Bit scrambling	Not used
PH.MOD	Modulation	Bandwidth adapted GMSK
[a] Non-Return to Zero Inverted		

Table 3 – Modulation parameters of the physical layer of the AIS-SART

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

4.2.1.3 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 software.

Even if this function activates, the AIS-SART shall attempt to transmit at the next transmission schedule time.

4.2.1.4 Transmitter characteristics

The technical characteristics as specified in Table 4 shall apply to the transmitter.

Table 4 – Minimum required transmitter characteristics

Transmitter parameters	Requirements
Carrier power	nominal radiated power 1 W
Carrier frequency error	±500 Hz (normal). ± 1 000 Hz (extreme)
Slotted modulation mask	–20 dBc for Δf_c > ±10 kHz –40 dBc for ± 25 kHz < Δf_c < ±62,5 kHz see Figure 4.
Transmitter test sequence and modulation accuracy	For Bits 0, 1 <3 400 Hz (normal and extreme) For Bits 2, 3 2 400 Hz ± 480 Hz (normal and extreme) For Bits 4 ... 31 2 400 Hz ± 240 Hz (normal), 2 400 Hz ± 480 Hz (extreme) For Bits 32 ...199 1 740 Hz ± 175 Hz (normal), 1 740 Hz ± 350 Hz (extreme) for a bit pattern of 0101 2 400 Hz ± 240 Hz (normal), 2 400 Hz ± 480 Hz (extreme) for a bit pattern of 00001111
Transmitter output power versus time	Power within mask shown in Figure 6 and timings given in Table 8
Spurious emissions	maximum 25 μW 108 MHz to 137 MHz, 156 MHz to 161,5 MHz, 406,0 MHz to 406,1 MHz and 1 525 MHz to 1 610 MHz

4.3 Link layer requirements

4.3.1 General

(See Clause 8)

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.

4.3.2 AIS Messages

4.3.2.1 Message 1 format and content

In active mode the AIS-SART shall broadcast Message 1, as defined in Recommendation ITU-R M.1371 with the Navigational status set to “14”.

In test mode the AIS-SART shall broadcast Message 1, as defined in Recommendation ITU-R M.1371 with the Navigational status set to “15”.

4.3.2.2 Message 14 format and content

In active mode the AIS-SART shall broadcast Message 14 as defined in Recommendation ITU-R M.1371 with the text “SART ACTIVE”.

In test mode the AIS-SART shall broadcast Message 14, as defined in Recommendation ITU-R M.1371 with the text “SART TEST”.

4.3.3 Synchronisation

4.3.3.1 Synchronisation method

Synchronisation is used to determine the TDMA (Time Division Multiple Access) frames and individual slots so that the transmission of the AIS Message is performed within the desired slot. The synchronisation for the AIS-SART shall be UTC (Universal Time Coordinated) direct.

Upon activation, until the AIS-SART gets UTC it shall transmit unsynchronised, using sync state 3.

If UTC direct synchronisation is lost, the AIS-SART shall continue to transmit with last known position, COG, SOG, and indicate that the positioning system is inoperative (Time stamp = 63) and sync state 3 (see 3.7).

4.3.3.2 Synchronisation accuracy

During UTC direct synchronisation, the transmission timing error, including jitter, of the AIS-SART shall be ±3 bits (±312 μs).

4.3.4 VDL access scheme

The AIS-SART shall use modified SOTDMA for the transmission of Message 1 and Message 14.

The AIS-SART shall operate autonomously and determine its own schedule for transmission of its messages based on random selection of the first slot of the first burst. The other 7 slots within the first burst shall be fixed referenced to the first slot of the burst. The increment between transmission slots within a burst shall be 75 slots and the transmissions shall alternate between AIS 1 and AIS 2.

In active mode (see 3.7 and Figure 2), the AIS-SART shall set a slot-time-out = 7 in the Communication state of all Message 1 transmissions in the first burst, and thereafter the slot-time-out shall be decreased according to the rules of SOTDMA. Since the AIS-SART does not have receivers, all slots shall be regarded as candidates in the selection process. When time out occurs, the offset to the next set of 8 bursts is randomly selected between 1 min ± 6 s.

In test mode (see 3.7), the AIS-SART shall set a slot-time-out = 0 and sub-message = 0 in the Communication state of all Message 1 transmissions in the first and only burst.

All slot-time-out values of the Communication state of all Message 1 transmissions within every burst shall be the same.

In active mode, 2 Message 14 shall be transmitted every 4th minute one on each channel, starting in the first minute (i.e. slot-time-out = 7 and 3), and shall be the 5th and 6th message in the burst.

In test mode, 2 Message 14 shall be transmitted one on each channel, and shall be the 1st and 8th message in the burst.

Message 14 shall be transmitted alternately on AIS 1 and AIS 2.

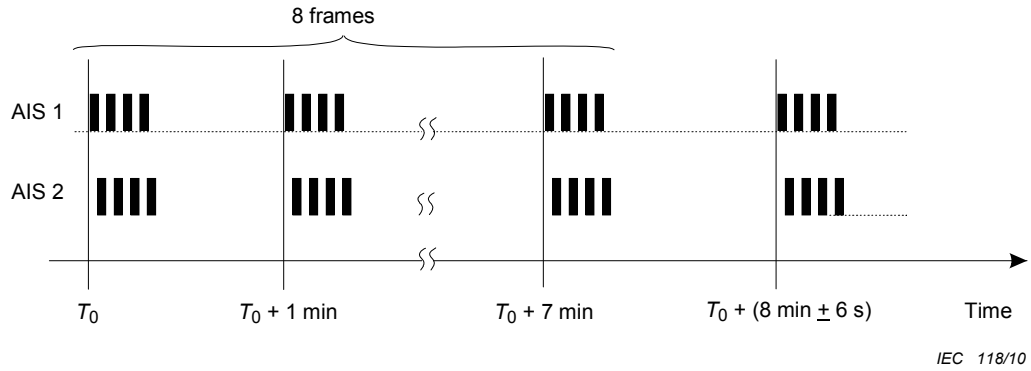


Figure 2 – Burst transmissions in active mode

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

Refer to Recommendation ITU-R M.1371 and 4.3.3 for synchronisation.

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

Refer to Recommendation ITU-R M.1371.

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

Refer to Recommendation ITU-R M.1371.

5 General methods of testing

5.1 Introduction

The manufacturer shall, unless otherwise agreed, set up the equipment and ensure it is operating normally before testing commences.

Electrical power shall be supplied during performance tests by the batteries which form a part of the equipment. Within 1 min of activation, the requirements of this standard shall be met.

5.2 General requirements

5.2.1 General

The equipment shall be tested against the general requirements contained in IEC 60945 as applicable to the equipment category “portable”. The low temperature test may be combined with the battery test (see 6.2). If measurements of compass safe distance are required then the equipment is not required to be in the powered condition. The radiated emission test is replaced by the spurious emission test (see 7.8).

For the purposes of IEC 60945 the following definitions apply.

5.2.2 Performance check

For the purposes of this standard, a performance check consists of activating the AIS-SART in test mode with EPFS data available, and checking the reception of Message 1 and Message 14 with an AIS receiver.

5.2.3 Performance test

For the purposes of this standard, a performance test consists of activating the AIS-SART in test mode with EPFS data available, and checking the integrity of the transmitted bursts as in 8.3.2.

5.3 Normal test conditions

Temperature and humidity shall be within the following range:

Temperature	+15° C to +35° C
Humidity	20 % to 75 %

5.4 Extreme test conditions

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

- low temperature with a battery near end of useful life (92 h), and
- high temperature with a full capacity battery.

5.5 Preparation of AIS-SART for type-approval testing

In addition to a standard AIS-SART, a modified AIS-SART shall be supplied so that the antenna port can be connected to the test equipment by a coaxial cable terminated by a 50 Ω load, and with means to allow for special test transmissions to verify RF parameters of the unit (Test signals 1, 2 and 3 and carrier only).

The manufacture shall submit the data of the power amplifier output power difference ratio (P_d) between two units using the following equation:

$$P_d(\text{dB}) = \text{standard unit power (dBm)} - \text{modified unit power (dBm)}$$

Unless otherwise stated all tests shall be conducted with the standard AIS-SART.

If a test fixture is supplied by the manufacturer then evidence of compliance with all the requirements of this subclause shall be submitted before testing commences.

5.6 Test signals

5.6.1 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 (Cyclic Redundancy Check), i.e. unaltered "On Air" data. The RF should be ramped up and down on either end of the AIS message frame.

5.6.2 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.

5.6.3 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.

5.7 Artificial antenna (dummy load)

All transmitter tests except radiated power may 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 setups in order to perform those measurements. The corresponding figures illustrate therefore one particular test setup, 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". The method of measurement used should be stated in the test report.

5.8 Facilities for access

Where access facilities are required to enable any specific test, these shall be provided by the manufacturer.

5.9 Modes of operation of the transmitter

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

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

5.10 Measurement uncertainties

Maximum values of absolute measurement uncertainties shall be as indicated in Table 5.

Table 5 – Maximum values of absolute measurement uncertainties

Parameter	Maximum value
RF frequency	$\pm 1 \times 10^{-7}$
Radiated RF power	±2,5 dB
Conducted RF power	±0,5 dB
Transmitter attack time	±20 %
Transmitter release time	±20 %

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

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

a) the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of this standard;

b) the actual measurement uncertainty of the test laboratory carrying out the measurements, for each particular measurement, shall be included in the test report;

c) 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).

6 Performance tests

6.1 Operational tests

(See 3.2)

The requirements of 3.2 shall be verified as follows (the subclause reference is given in brackets).

a) (See 3.2 a) By inspection.

b) (See 3.2 b) By inspection.

c) (See 3.2 c) By inspection

d) (See 3.2 d) By inspection.

e) (See 3.2 e) Confirmed by IEC 60945 Drop into water test.

f) (See 3.2 f) Confirmed by IEC 60945 Water immersion test (portable equipment).

g) (See 3.2 g) Confirmed by IEC 60945 Thermal shock test (portable equipment).

h) (See 3.2 h) If the device is not designed specifically to be an integral part of a survival craft, it shall be placed in fresh water for 5 min, as a check that it is capable of floating. The device complete with its one metre mounting system shall float.

i) (See 3.2 i) By inspection.

j) (See 3.2 j) Confirmed by IEC 60945 Corrosion and Oil resistance tests.

k) (See 3.2 k) Confirmed by IEC 60945 Solar radiation test.

l) (See 3.2 l) By inspection.

m) (See 3.2 m) By inspection.

n) (See 3.2 n) By inspection.

o) (See 3.2 o) By observation of the VDL.

p) (see 3.2 p) By observation of the VDL.

q) (see 3.2 q) By observation using manufacturer's instructions and observation of the VDL.

6.2 Battery

6.2.1 Battery capacity test

(See 3.3.2)

Using a fresh battery pack, the AIS-SART shall be activated (at the ambient temperature) for a period of time as stated by the manufacturer to be equivalent to the loss of battery capacity due to self-testing, stand-by loads as well as battery-pack self-discharge during the useful life of the battery pack (as defined in 3.3.2). The manufacturer shall substantiate the method used to determine this time.

Alternatively, at the manufacturer's discretion the pre-discharge of the battery (as outlined above) may be replaced by the equivalent extension beyond 96 h of the following battery capacity and low-temperature test. If using this test method the AIS-SART manufacturer shall apply a compensation figure to allow for the fact that the extension period due to loss in battery capacity is being carried out at the minimum operating temperature rather than at ambient temperature. This compensation figure shall be substantiated by the manufacturer.

The AIS-SART shall be placed in a chamber at normal room temperature. Then the temperature shall be reduced to and maintained at –20 °C ± 3 °C for a period of 10 h to 16 h.

Any climatic control device provided in the equipment may be switched on at the conclusion of this period. The equipment shall be activated in its mode of maximum current draw (for example EPFS drawing maximum current) 30 min after the end of the period and shall then be kept working continuously for a period of 96 h. The temperature of the chamber shall be maintained as specified above for the whole of the period of 96 h.

The operation of the AIS-SART during the test shall be verified.

In addition, at the end of the 96 h period, a performance test (see 5.2.3) shall be performed.

NOTE If employing the alternative test method described above all references to 96 h should be extended by the appropriate period.

6.2.2 Expiry date indication

(See 3.3.2)

By inspection.

6.2.3 Reverse polarity protection

(See 3.3.3)

By inspection.

6.3 Unique identifier

(See 3.4)

By observation of the VDL.

6.4 Environment

(See 3.5)

Confirmed by the tests in IEC 60945 (see 5.2).

6.5 Range performance

(See 3.6)

Compliance with the radiated power test (see 7.4) validates the range performance of the AIS-SART.

6.6 Transmission performance

(See 3.7)

By observation of the VDL (see also Clause 8).

6.7 Labelling

(See 3.8)

By inspection.

6.8 Manuals

(See 3.9)

By inspection.

6.9 Electronic position fixing system

(See 4.1.6)

By inspection of documented evidence.

6.10 Activator

(See 4.1.7)

By inspection.

6.11 Indicator

(See 4.1.8)

By inspection.

7 Physical radio tests

(See 4.2)

7.1 General description

The purpose of these tests is to verify that the AIS-SART complies with the RF requirements under normal and extreme conditions. The tests are accomplished by the following procedures.

All the physical radio tests can be performed on either AIS 1 or AIS 2 unless otherwise stated.

Unless otherwise stated all the physical radio tests shall be performed with the modified AIS-SART (see 5.5).

The following tests shall be performed under normal conditions:

- conducted output power;
- radiated output power with the standard AIS-SART;
- conducted spurious emissions;
- frequency error;
- modulation accuracy;
- modulation spectrum slotted transmission;
- power versus time function;
- power as a function of time.

The following tests shall be performed under extreme conditions:

- conducted power;
- frequency error;
- transmitter test sequence and modulation accuracy.

7.2 Frequency error

7.2.1 Purpose

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

7.2.2 Method of measurement

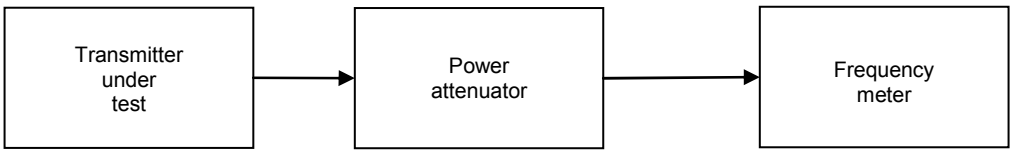


Figure 3 – Measurement arrangement

For the test proceed as follows.

a) The equipment shall be connected as illustrated in Figure 3.

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 AIS 1 and AIS 2.

7.2.3 Required results

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

7.3 Conducted power

7.3.1 Purpose

The purpose of this test is to verify that the output power from the AIS-SART is within the limits at extreme operating conditions.

7.3.2 Method of measurement

Connect the test unit to a power meter and record the conducted power at normal test conditions (P_{20}). Repeat the test for extreme low and high temperatures and record the values obtained from these measurements (P_{-20} and P_{55}).

Calculate the gain of the AIS-SART antenna using the following equation:

$$G = P_R - P_{20} - P_d$$

where

G is the antenna gain (dB);
P_R is the radiated power level as measured in 7.4.2 (dBm);
P_{20} is the conducted power level measured at normal test conditions (dBm);
P_d is the power output difference given in 5.5 (dB).

7.3.3 Required result

The conducted power, corrected for the antenna gain shall be at least the values given in Table 6.

Table 6 – Conducted power – Required results

Power	dBm
$P_{-20} + G + P_d$	27
$P_{55} + G + P_d$	27
NOTE This power equates to the radiated power at extreme temperatures.	

7.4 Radiated power

7.4.1 Purpose

The purpose of this test is to verify that the AIS-SART has a nominal radiated power (EIRP) of 1 W at normal operating conditions.

7.4.2 Method of measurement

This test is only required to be performed at normal test conditions and shall use an AIS-SART whose battery has been ON for a minimum of 92 h. If the test exceeds 4 h, the battery may be replaced by another which has been pre-conditioned with at least 92 h of ON time.

Measurement of the radiated signals shall be made at a point 5 m or more from the AIS-SART. The AIS-SART shall be mounted in its normal operating position with its antenna base 1 m above the ground plane on a non-conducting support.

The measurement antenna shall have vertical polarization mounted on a non-conducting support with its cable lying horizontally on the boom and run back to the supporting mast. The other end of the measurement antenna cable shall be connected to a measurement receiver located at the foot of the mast. The measurement shall be performed on a test site with a conductive ground plane of at least 3 m diameter and the height of the measurement antenna shall be adjusted to obtain the maximum reading on the measurement receiver up to a maximum of 30° elevation.

Precautions may be taken to eliminate reflections from the ground plane by using RF absorbing material at the position of the ground reflection.

Measure the received level at 4 different points in the azimuth plane by rotating the AIS-SART in steps of 90°. The minimum received level (P_{REC}) shall be recorded and used to calculate the radiated power at the normal operating temperature using the following equation:

$$P_R = P_{REC} - G_{REC} + L_C + L_P$$

where

P_R is the radiated power level from the AIS-SART (dBm);
P_{REC} is the measured power level from the measurement receiver (dBm);
G_{REC} is the antenna gain of the search antenna (dB);
L_C is the receive system attenuator and cable loss (dB);
L_P is the free space propagation loss (dB).

7.4.3 Required results

The radiated power shall be at least 27 dBm (500 mW).

NOTE This equates to a nominal radiated output power of 1 W with a −3 dB tolerance to allow for antenna gain characteristics and temperature variations.

7.5 Modulation spectrum slotted transmission

7.5.1 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, see 4.2.1.4.

7.5.2 Method of measurement

The following method shall be applied.

a) The test shall use test signal number 3.

b) The AIS-SART 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.

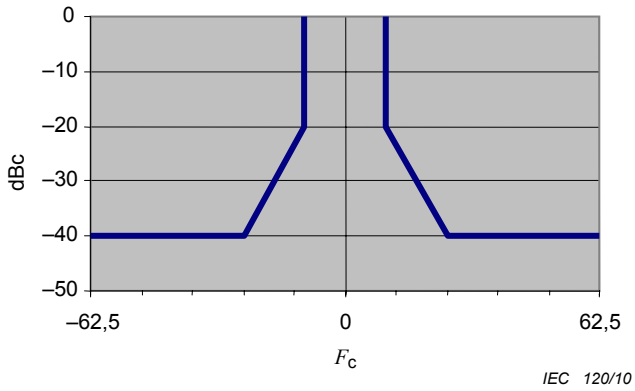
7.5.3 Required results

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 –20 dBc;
- at ±25 kHz to ±62,5 kHz removed from the carrier, the modulation and transient sidebands shall be below the lower value of –40 dBc;
- 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 7.3.

For information the emission mask specified above is shown in Figure 4.



F_c is the carrier frequency

Figure 4 – Emission mask

7.6 Transmitter test sequence and modulation accuracy

7.6.1 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.

7.6.2 Method of measurement

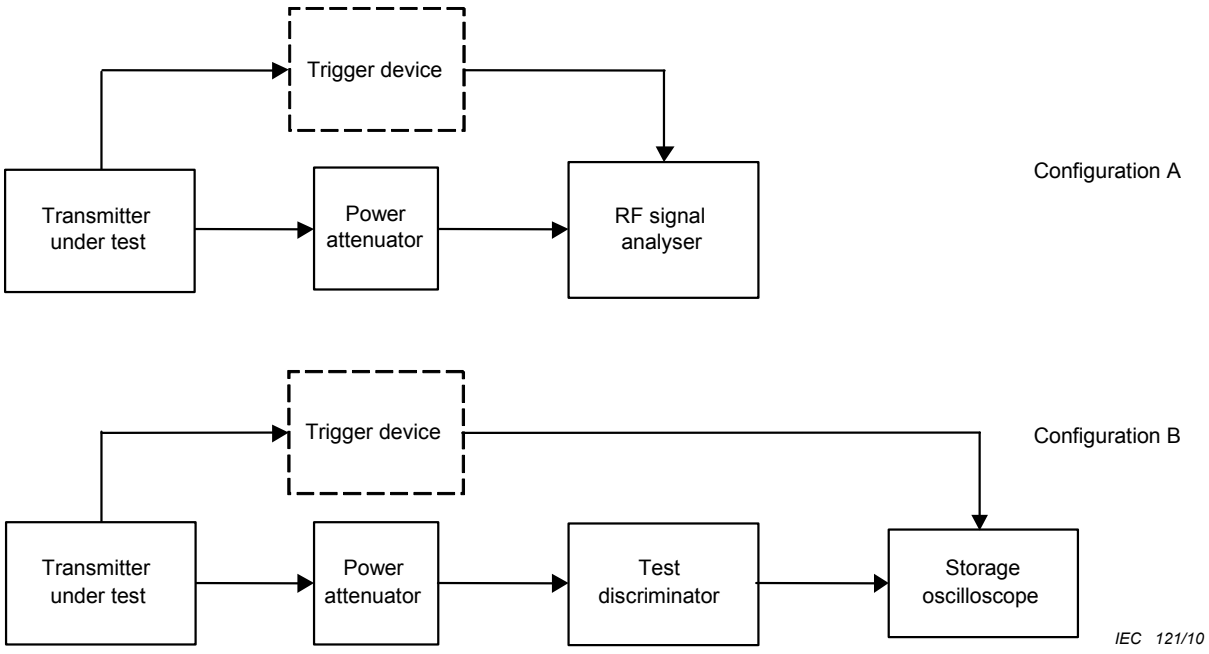


Figure 5 – Measurement arrangement for modulation accuracy

The measurement procedure shall be as follows:

a) the equipment shall be connected in either configuration A or configuration B as shown in Figure 5. The trigger device is optional if the test equipment is capable of synchronising to the transmitted bursts;

b) the transmitter shall be tuned to AIS 2 (162,025 MHz);

c) the transmitter shall be modulated with test signal number 1;

d) the deviation from the carrier frequency shall be measured as a function of time;

e) the transmitter shall be modulated with test signal number 2;

f) the deviation from the carrier frequency shall be measured as a function of time;

g) measurements shall be repeated at AIS 1;

h) the test shall be repeated under extreme test conditions.

7.6.3 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 7. These limits apply to both the positive and negative modulation peaks. Bit 0 is defined as the first bit of the training sequence.

Table 7 – 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 ± 480 Hz			
Bit 4 to bit 31	2 400 Hz ±240 Hz	2 400 Hz ±480 Hz	2 400 Hz ±240 Hz	2 400 Hz ±480 Hz
Bit 32 to bit 199	1 740 Hz ±175 Hz	1 740 Hz ±350 Hz	2 400 Hz ±240 Hz	2 400 Hz ±480 Hz

7.7 Transmitter output power versus time function

7.7.1 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 8 where

a) 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}),

b) 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 – 1 dB from P_{ss},

c) 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,

d) 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.

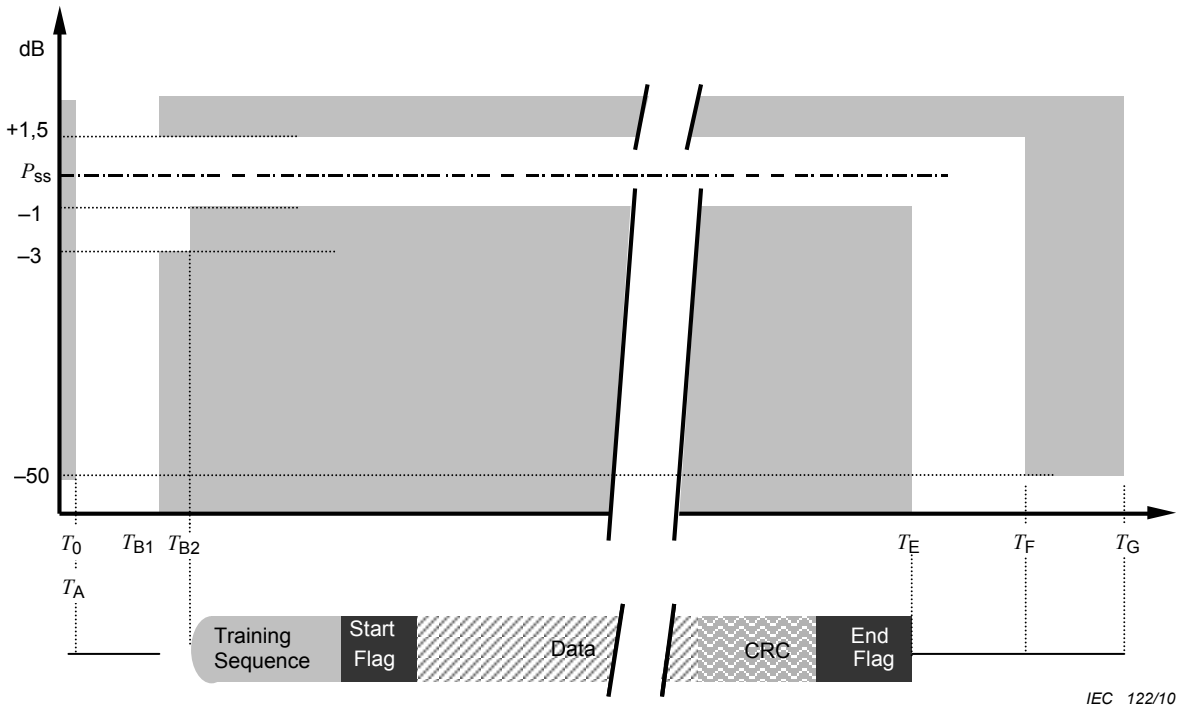


Figure 6 – Power versus time mask

Table 8 – Definition of timings

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

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

7.7.2 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).

The AIS-SART 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 AIS-SART.

7.7.3 Required results

The transmitter power shall remain within the mask shown in Figure 6 and associated timings given in Table 8.

7.8 Spurious emissions from the transmitter

7.8.1 Purpose

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

7.8.2 Method of measurement

The measurements shall be made at the transmitter output at 50 Ω using a receiver or a spectrum analyser with its bandwidth set to between 100 kHz and 120 kHz or its nearest setting thereto, over the following frequency bands:

108 MHz to 137 MHz, 156 MHz to 161,5 MHz, 406,0 MHz to 406,1 MHz and 1 525 MHz to 1 610 MHz.

7.8.3 Required results

No signal level within these bands shall exceed 25 μW.

8 Link layer tests

(See 4.3)

8.1 Tests for synchronisation accuracy

To measure the synchronisation error of the AIS-SART.

8.1.1 Method of measurement

Activate the AIS-SART with EPFS data available in active mode and record transmissions for 40 min.

Record VDL messages and measure the time between the transmission patterns as defined by ITU-R M.1371 and the actual transmission made by the AIS-SART. The transmission timing shall be measured and referenced to the beginning of the start of a transmission packet (start flag) according to ITU-R M.1371.

8.1.2 Required results

The synchronisation error with its additive jitter shall not exceed ±312 μs between minutes 15 and 40.

8.2 Active mode tests

These tests require analysis of the transmissions of the AIS-SART.

8.2.1 Method of measurement

Activate the AIS-SART in active mode and record transmissions for 40 min. Inhibit EPFS data and record transmissions for a further 20 min.

Record the activation time of the AIS-SART.

For all transmitted messages record:

- transmission time (UTC time);
- transmission slot;
- in-slot timing;
- transmission channel;
- message content.

The records will be evaluated in the following test items.

8.2.2 Initialisation period – Required results

The following is required.

a) The first message is transmitted within 1 min after activation.
b) The first message with a valid position is transmitted within 15 min.

8.2.3 Message content of Message 1 – Required results

For position reports transmitted after 15 min and before 40 min the following is required.

a) Message ID = 1.
b) Repeat indicator = 0.
c) User ID as configured in the AIS-SART.
d) Navigational status = 14.
e) Rate of turn = default.
f) SOG = actual SOG from GNSS receiver.
g) Position accuracy = according to the RAIM result if provided, otherwise 0.
h) Position = actual position from internal GNSS receiver.
i) Position is updated at least once per minute, for each burst.
j) COG = actual COG from internal GNSS receiver.
k) True heading = default.
l) Time stamp = actual UTC second (0...59).
m) Verify correct indication according to manufacturer's documentation.

8.2.4 Message content of Message 14 – Required results

The following is required.

a) Message ID = 14.
b) Repeat indicator = 0.
c) Source ID = as configured in the AIS-SART.
d) Text = "SART ACTIVE".

8.2.5 Transmission schedule for Message 1 – Required results

For position reports transmitted after 15 min and before 40 min the following applies.

a) Verify that the AIS-SART has operated in sync mode 0 (UTC direct).
b) The AIS-SART transmits one burst of messages once per minute.
c) The duration of a burst is 14 s.
d) A burst consists of 8 messages.
e) The transmissions in a burst are alternating between AIS 1 and AIS 2.
f) Consecutive messages are 75 slots apart and on the other channel.
g) The same set of slots are used in each burst for 8 min.
h) A new set of slots is randomly selected after 8 min.
i) The first slot of the new set of slots is within the interval of 1 min ± 6 s from the first slot of the previous set of slots, that is the increment is randomly selected in the range 2 025 to 2 475 slots.
j) The manufacturer is to provide documentation on how the increment is selected randomly.

8.2.6 Communication state of Message 1 – Required results

For position reports transmitted after 15 min and before 40 min the following applies.

a) The SOTDMA communication state as defined for message 1 is used.
b) The sync state = 0.
c) The time-out starts with 7 for all messages of the first burst after a change in slots.
d) The time-out value is decremented by 1 for each frame.
e) The time-out value is reset to 7 after time-out = 0.
f) The sub message for time-out 3,5,7 = number of received stations (0).
g) The sub message for time-out 2,4,6 = slot number.
h) The sub message for time-out 1 = UTC hour and minute.
i) The sub message for time-out 0 = slot offset to the transmission slot in the next frame.

8.2.7 Transmission schedule of Message 14 – Required results

The following is required.

a) Message 14 is transmitted every 4 min.
b) The transmissions of Message 14 are alternating between AIS 1 and AIS 2.
c) Message 14 is transmitted in a Message 1 slot, replacing the Message 1, on the channel for which the Message 1 was scheduled.
d) Message 14 did not replace a Message 1 with a time-out value = 0.

8.2.8 Transmission with lost EPFS – Required results

For position reports transmitted after 45 min the following applies.

a) The AIS-SART continues transmission.
b) The same transmission schedule is used as with EPFS data available.
c) Communication State Sync state = 3.
d) SOG = last valid SOG.
e) Position accuracy = low.
f) Position = last valid position.
g) COG = last valid COG.

h) Time stamp = 63.
i) RAIM-flag = 0.
j) Verify correct indication as per manufacturer's documentation.

8.3 Test mode tests

8.3.1 General

These tests require analysis of the transmissions of the AIS-SART.

8.3.2 Transmission with EPFS data available

8.3.2.1 Method of measurement

Activate the AIS-SART in test mode with EPFS data available and record transmissions.

8.3.2.2 Required results

The following is required.

a) The AIS-SART starts transmission after valid GNSS data is available.
b) A single burst of 8 messages in the correct order and correctly populated as per 3.7.2.
c) User ID as configured in the AIS-SART.
d) Navigational status = 15 (not defined).
e) SOG = actual SOG from GNSS receiver.
f) Position accuracy = according to the RAIM result if provided, otherwise 0.
g) Position = actual position from internal GNSS receiver.
h) COG = actual COG from internal GNSS receiver.
i) Time stamp = actual UTC second (0...59).
j) The communication state time-out always = 0 with sub message = 0.
k) The transmission of Messages 1 and 14 stops after one burst of 8 messages.
l) The text message in Message 14 is "SART TEST".
m) Verify correct indication as per manufacturer's documentation.

8.3.3 Transmission without EPFS data available

8.3.3.1 Method of measurement

Activate the AIS-SART in test mode with no EPFS data available and record transmissions.

8.3.3.2 Required results

The following is required.

a) The AIS-SART starts transmission within 15 min.
b) A single burst of 8 messages in the correct order and correctly populated as per 3.7.2.
c) User ID as configured in the AIS-SART.
d) Navigational status = 15 (not defined).
e) SOG = default value.
f) Position accuracy = low.
g) Position = default values.
h) COG = default value.
i) Time stamp = 63.

j) The communication state time-out always = 0 with sub message = 0.

k) RAIM-flag = 0.

l) The transmission of Messages 1 and 14 stops after one burst of 8 messages.

m) The text message in Message 14 is “SART TEST”.

n) Verify correct indication as per manufacturer’s documentation.

Annex A
(informative)

Results of trials to verify the range performance of the AIS-SART

A.1 General

The performance requirement is based on IMO resolution MSC.246(83) and is as stated below.

"The AIS-SART shall be detectable at a range of 5 nautical miles over water".

To be able to verify the range performance more precisely, there is a need to specify the antenna heights of both the AIS-SART and the search vessel. It has therefore been interpreted that the range performance be in line with the range performance requirement for the 9 GHz radar SART, or more precisely:

the 5 NM range is based on an antenna height for the AIS-SART of 1 m above sea level, and the antenna height for a receiving AIS Station of at least 15 m above sea level. The receiving AIS Station has the minimum sensitivity of a Class A Mobile AIS Station.

Range tests with the AIS-SART were performed on three different occasions during 2008 and 2009, as follows.

a) **Oban Bay, Scotland, 9 – 13 June 2008 (OBAN I)**

Range tests from a vessel. The tests were organized and performed by the Northern Lighthouse Board.

b) **Oban Bay, Scotland, 27 August 2008 (OBAN II)**

Range tests from a search and rescue helicopter at various altitudes. The tests were organized by the Northern Lighthouse Board and performed by the Maritime and Coastguard Agency.

c) **Key West, Florida, 14 January 2009 (KEY WEST)**

Range tests from a search and rescue aircraft at various altitudes. The tests were organized and performed by the US Coast Guard.

A.2 Test setup, test equipment and test units

A.2.1 OBAN I

To verify the AIS-SART to vessel performance test, 6 different AIS-SART prototypes were used. The AIS-SARTs were mounted on various heights on floating objects in the sea. The radiated output power from the AIS-SARTs were in the range 26 dBm to 29 dBm and the radiated pattern was set to produce 6 or 8 messages per min, organized as a burst transmission according to this standard. The search for the units was performed with M/V Pole Star on two following days. The signal strength and number of messages received were recorded using an AIS receiver (True Heading: AIS RX-PRO) and a PC. The range was also observed using the onboard AIS transponder (SAAB MX 420). The antenna height of M/V Pole Star was approximately 17 m.

A comparative test was also made with a 9 GHz radar SART.

A.2.2 OBAN II

The helicopter flight test was performed using four of same AIS-SART prototypes that were used in the first trial (Radiated output power 26 dBm to 29 dBm). The AIS-SARTs were mounted at various heights on floating objects in the sea.

The helicopter searched for the AIS-SART in the water by flying in at various altitudes with a Sikorsky S92, fitted with an AIS receiver. The helicopter crew noted when they first got a position fix from the AIS-SART.

A.2.3 KEY WEST

The final test with the aircraft was performed using five AIS-SART prototypes with radiated output power between 28 dBm to 31 dBm. Again the units were floating in the sea at various heights. The aircraft, a C130 fitted with a SAAB R4-A AIS transponder, flew in at different altitudes and recorded the distances where the first position fix from the AIS-SART were received.

In this test, searches using a 406 EPIRB with 121,5 MHz homing and a 9 GHz radar SART were also performed to compare the various systems.

A.3 Results

The results showed that an AIS-SART produced in accordance with this standard, will have a range performance that exceeds the requirement. The flight tests showed that the expected range of an AIS-SART from an aircraft is close to the line of sight.

The maximum ranges obtained for an AIS-SART mounted on a 1 m high pole was

AIS-SART to vessel with an antenna height of 15 m	9,5 NM
AIS-SART to helicopter at altitude 300 ft	32,5 NM
AIS-SART to helicopter at altitude 750 ft	26,5 NM
AIS-SART to helicopter at altitude 1 000 ft	40,0 NM
AIS-SART to helicopter at altitude 2 500 ft	39,8 NM [a]
AIS-SART to aircraft at altitude 1 000 ft	65,0 NM [b]
AIS-SART to aircraft at altitude 5 000 ft	79,0 NM [c]
AIS-SART to aircraft at altitude 10 000 ft	95,0 NM
AIS-SART to aircraft at altitude 20 000 ft	129,0 NM [d]

[a] Maximum search distance.

[b] Range seems to be higher that what should be expected at 1 000 ft. This could have been due to a reflection of a transmission off another aircraft.

[c] Range at heights 5 000 ft, 10 000 ft and especially 20 000 ft could have been limited because the aircraft's AIS receiver had a limitation of 200 AIS targets. More than 200 AIS targets were seen at these heights. This limitation will not be seen in open waters with less AIS targets within line of sight.

[d] The predicted range at this altitude using the propagation model in recommendation ITU-R P.1546-2 was calculated to be 126 nautical miles which compares closely with this result of 129 nautical miles.

For more detailed results, refer to Tables A.1, A.2 and A.3.

Table A.1 – Test results, AIS-SART to vessel (Oban Bay, Scotland)
Distances detected in nautical miles (NM)

Unit type	ID	EIRP	Unit height	Maximum range	Notes
		dBm	m	NM	
AIS-SART	9709900001	27	0,2	4,2	Mounted on a floating survival suit to simulate a person in the water.
AIS-SART	9709900002	26	0,5	6,8	Floating, mounted on a pole 0,5 m high.
AIS-SART	9709900003	29	0,5	8,4	Floating, mounted on a pole 0,5 m high.
AIS-SART	**9709900004**	**28**	**1,0**	**8,1**	**Floating, mounted on a pole 1,0 m high.**
AIS-SART	**9709900007**	**28**	**1,0**	**9,5**	**Floating, mounted on a pole 1,0 m high.**
AIS-SART	**9709900008**	**27**	**1,0**	**8,8**	**Floating, mounted on a pole 1,0 m high.**
9 GHz SART		26	1,0	6 to 7	Floating, mounted on a pole 1,0 m high.
9 GHz SART		26	0,5	5 to 6	Floating, mounted on a pole 0,5 m high.

Table A.2 – Test results, AIS-SART to helicopter (Oban Bay, Scotland)
Distances detected in nautical miles (NM)

Unit type	ID	EIRP	Unit height	Altitude ft				Notes
		dBm	m	**300**	**750**	**1 000**	**2 500**	
AIS-SART	9709900002	26	0,5	25,4	9,2 [a]	35	36	Floating, mounted on a pole 0,5 m high.
AIS-SART	9709900003	29	0,5	19,4	6,0 [a]	– [a]	– [a]	Floating, mounted on a pole 0,5 m high.
AIS-SART	**9709900007**	**28**	**1,0**	**32,5**	**26,5**	**40**	**39,8**	**Floating, mounted on a pole 1,0 m high.**
AIS-SART	9709900008	27	0,1	19,6	6,0 [a]	– [a]	26,4	Mounted on a floating survival suit to simulate a person in the water.

[a] At these heights the units marked were switched off during the start of the test due to a misunderstanding between the boat crew and the helicopter crew.

Table A.3 – Test results, AIS-SART to aircraft (Key West, Florida)
Distances detected in nautical miles (NM)

Unit type	ID	EIRP	Unit Height	Altitude ft				Notes
		dBm	m	1 000	5 000	10 000	20 000	
AIS-SART	970000002	31	3,0	30	70	94	119	Mounted on aux vessel Discovery at 3,0 m antenna height.
AIS-SART	970000003	30	0,1	53	65	94	132	Floating on a simulated person in the water, height 0,1 m above water surface.
AIS-SART	970990005	29	1,5	31	67	97	127	Mounted on aux vessel Discovery at 1,5 m antenna height.
AIS-SART	**970990007**	**28**	**1,0**	**65**	**79**	**95**	**129**	**Floating, mounted on a pole 1 m height.**
AIS-SART	970000008	31	0,0	28	59	84	129	Floating, mounted in the water surface, in and out of water
EPIRB	406 MHz	37 ± 2	0,0	60	78	132	145	Floating in the water, attached to the boat with the integral line
EPIRB Homer	121,5 MHz	17	0,0	4,8	6,0	8,5	9,1	Homer on the 406 MHz EPIRB
9GHzSART	9 GHz transponder	26	1,0	33	30	22	23	Floating in the water for the two first passes. At the two last passes a second radar transponder was switched on. This improved the results on the lowest altitudes.
Radio – line of sight			1,0	41	89	125	176	Calculated

Bibliography

IEC 61097-1, *Global maritime distress and safety system (GMDSS) – Part 1: Radar transponder – Marine search and rescue (SART) – Operational and performance 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 61993-2, *Maritime navigation and radiocommunication equipment and systems – Automatic Identification Systems (AIS) – Part 2: Class A shipborne equipment of the universal automatic identification system (AIS) – Operational and performance requirements, methods of test and required test results*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems – presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*

IMO International Convention for the Safety of Life at Sea (SOLAS) (1974), *Amendments concerning Radiocommunications for the Global maritime distress and safety system (GMDSS) (1988)*

IMO Resolution A.694 (17), *General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system and for electronic navigational aids*

ITU Radio Regulations Volume 2, *Appendix 18, Table of transmitting frequencies in the VHF maritime mobile band*

ITU-R Recommendation P.1546-3, *Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz*

———————

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch