Final draft ETSI EN 304 113 V1.1.0 (2026-04)

EUROPEAN STANDARD

Maritime satellite Emergency Position Indicating Radio Beacons (EPIRBs) for non-SOLAS vessels; Technical characteristics and methods of measurement

Reference

DEN/ERM-TGMAR-636

Keywords

EPIRB, maritime, radio, SAR, testing

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI IPR online database.

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™**, **LTE™** and **5G™** logo are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

BLUETOOTH® is a trademark registered and owned by Bluetooth SIG, Inc.

Foreword

This final draft European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Vote phase of the ETSI EN Approval Procedure (ENAP).

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

The present document details conformance tests for the ancillary functions of non-SOLAS EPIRBs, such as controls, indicators and labels; together with a GNSS receiver and ancillary transmitters operating on 121,5 MHz and AIS. The present document is set out as follows:

- Clause 4 - General operational requirements: controls, indicators, labels, etc. (normative);
- Clause 5 - Technical information to assist in understanding how the EPIRB operates (informative);
- Clause 6 - Measurement conditions (normative);
- Clause 7 - Environmental tests (normative);
- Clause 8 - Tests on 121,5 MHz homing transmitter (normative);
- Clause 9 - Tests on the AIS transmitter - for EPIRBs incorporating AIS (normative);
- Clause 10 - Radiated spurious emissions (normative);
- Clause 11 - AIS message content tests - for EPIRBs incorporating AIS (normative);
- Clause 12 - GNSS requirements (normative);
- Clause 13 - Lanyard test (normative);
- Clause 14 - Optical tests (normative);

1 Scope

The present document sets out the minimum performance requirements and technical characteristics for non-SOLAS satellite Emergency Position-Indicating Radio Beacons (EPIRBs), operating in the COSPAS-SARSAT satellite system (406,0 MHz to 406,1 MHz) and ancillary transmissions on 121,5 MHz and also AIS1 (169,975 MHz) and AIS2 (162,025 MHz).

The present document covers both first and second generation EPIRBs defined by the COSPAS-SARSAT standards C/S T.001 [1] and C/S T.018 [3]. The present document covers only category 2 EPIRBs in class 2 (-20 °C to +55 °C).

The present document only covers battery powered portable EPIRB. Category 1 (float free) EPIRBs are not covered by the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are necessary for the application of the present document.

[1] C/S T.001: "Specification for COSPAS-SARSAT 406 MHz Distress Beacons".

[2] C/S T.007: "COSPAS-SARSAT 406 MHz Distress Beacons Type Approval Standard".

[3] C/S T.018: "Specification for Second-Generation COSPAS-SARSAT 406-MHz Distress Beacons".

[4] C/S T.021: "COSPAS-SARSAT Second-Generation 406-MHz Distress Beacons Type Approval Standard".

[5] Recommendation ITU-R M.585-9 (05/2022): "Assignment and use of identities in the maritime mobile service".

[6] IEC 61108-1:2003: "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".

[7] IEC 61108-2:1998: "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".

[8] IEC 61108-3:2010: "Maritime navigation and radiocommunication equipment and systems - Global navigation satellite systems (GNSS) - Part 3: Galileo receiver equipment - Performance requirements, methods of testing and required test results".

[9] IEC 61108-5:2020: "Maritime navigation and radiocommunication equipment and systems - Global navigation satellite systems (GNSS) - Part 5: BeiDou navigation satellite system (BDS) - Receiver equipment - Performance requirements, methods of testing and required test results".

[10] Recommendation ITU-R M.1371-5 (02/2014): "Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile frequency band".

[11] Recommendation ITU-R M.690-3 (03/2015): "Technical characteristics of emergency position-indicating radio beacons operating on the carrier frequencies of 121,5 MHz and 243 MHz".

[12] ETSI TS 103 052 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

[13] Resolution MSC.481(102) (adopted on 9 November 2020): "Revised recommendation on the use and fitting of retro-reflective materials on life-saving appliances.

[14] Recommendation ITU-T O.153 (10/1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[15] EN 55016-2-3:2017/A2:2023: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements", (produced by CEN).

[16] EN IEC 55016-1-1:2019: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus", (produced by CEN).

[17] ST/SG/AC.10/11/Rev.8: "Manual of Tests and Criteria".

[18] IEC 60068-2-6:2007: "Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)".

[19] ISO 8217:2024: "Products from petroleum, synthetic and renewable sources — Fuels (class F) — Specifications of marine fuels".

[20] IMO Resolution MSC.81(70) (adopted on 11 December 1998) - MSC 70/23/Add.1: "Revised Recommendation on Testing of Life-Saving Appliances".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

[i.1] Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment and repealing Council Directive 96/98/EC.

[i.2] C/S T.012: "COSPAS-SARSAT 406 MHz Frequency Management Plan".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

activated: EPIRB that has been set off and is flashing and transmitting in active mode

category 1 EPIRB: EPIRB that is fitted in a housing and automatically deploys when submerged and floats free

category 2 EPIRB: EPIRB that needs to be manually deployed and activated

class 2: EPIRB intended for operation over the temperature range -20 °C to +55 °C

non-SOLAS: equipment not intended to be used under SOLAS carriage requirements nor to be covered by the Marine Equipment Directive 2014/90/EU (MED) [i.1]

switched off: neither flashing nor transmitting

3.2 Symbols

For the purposes of the present document, the following symbols apply:

bps	bits per second
mW/sr	milliwatts per steradian
P_{Norm}	conducted power measured under normal conditions
P_{-20}	conducted power measured at the lower extreme temperature
P_{+55}	conducted power measured at the upper extreme temperature
pps	pulses per second

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AIS	Automatic Identification System
C/S	COSPAS-SARSAT
cd	candella
CIRM	Comité International Radio-Maritime
COG	Course Over Ground
COSPAS	Cosmicheskaya Sistema Poiska Avariynyh Sudov
CRC	Cyclical Redundancy Check
CW	Carrier Wave
DST	Down-Swept Tone
EIRP	Equivalent Isotropic Radiated Power
EIRPEP	Equivalent Isotropic Radiated Peak Envelope Power
EMI	Electro Magnetic Interference
EPIRB	Emergency Position Indicating Radio Beacon
EUT	Equipment Under Test
FGB	First Generation Beacon
FM	Frequency Modulation
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GTEM	Giga Transverse Electro Magnetic (cell)
HDOP	Horizontal Dilution Of Position
ID	Identification
IMO	International Maritime Organization
IR	Infrared
LNA	Low Noise Amplifier
LPDA	Log-Periodic Dipole Array
MDO	Marine Diesel Oil

NOTE: Also known as Distillate Marine Diesel.

MID	Maritime Identification Digits
MMSI	Maritime Mobile Station Identity
NR	Not Required
NRZ	Non Return to Zero
NRZI	Non Return to Zero Inverted
OATS	Open Area Test Site
QPSK	Quadrature Phase Shift Keying

RAIM	Receiver Autonomous Integrity Monitoring
RBW	Reference Bandwidth
RF	Radio Frequency
RLS	Return Link Service
RSS	Received Signal Strength
SAC	Semi-Anechoic Chamber
SARSAT	Search And Rescue Satellite Aided Tracking
SGB	Second Generation Beacon
SINAD	Signal In Noise And Distortion
SL	Simulated Location
SOG	Speed Over Ground
SOLAS	International Convention for Safety of Life at Sea
SOTDMA	Self-Organized Time Division Multiple Access
SV	Space Vehicle
TDMA	Time Division Multiple Access
TL	Transmitted Location

NOTE: Transmitted by the EPIRB.

TTFFT	Time To First Fix Transmission
TX	Transmit
UTC	Coordinated Universal Time

NOTE: Literally Universel Temps Coordonné.

VDL	VHF Data Link
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio

4 General Requirements

4.1 Introduction

Compliance to the requirements of clause 4 are demonstrated by inspection of the EUT and/or relevant documentation, or by simple manual tests.

4.2 General Construction

The exterior of the EUT should have no sharp edges or projections that could easily damage inflatable rafts or injure personnel so as to minimize the risk of internal and external damage during use or stowage. The EUT shall be portable and be designed as one integral unit.

The EPIRB shall derive its energy from a battery forming a part of the EUT and incorporate a permanently attached antenna. At least half of the exterior of the EUT shall be of highly visible yellow or orange colour to assist visual location.

The EPIRB shall be fitted with retro-reflective material above the waterline to aid in visual detection. The minimum area of retro-reflective material shall be at least 25 cm^2 with at least 5 cm^2 visible from every angle on the horizon. The retro-reflective material shall also meet the performance requirements of annex 2 of IMO Resolution MSC.481(102) [13].

The EPIRB shall be a single integral unit, no part of it shall be detachable without the use of tools.

4.3 Operating Conditions

4.3.1 General

The EPIRB shall be equipped with a GNSS positioning device compliant to clause 12.

The EPIRB shall be designed to operate when floating in the sea but shall also operate satisfactorily on a ship's deck and in a survival craft when manually activated. This is tested in C/S T.007 [2] for FGBs and C/S T.021 [4] for SGBs.

The EPIRB shall float in water with its antenna out of the water and upright. This is tested in clause 7.13.

The EPIRB shall be supplied with a bracket. The bracket shall protect the EPIRB from inadvertent water activation. This is tested in clause 7.14.

The EPIRB shall also transmit its current position using Automatic Identification System (AIS) transmissions conforming to clause 9.

An EPIRB conforming to the present document may also have the following additional functions:

- Return Link Service RLS receiver (via GNSS).
- Other RF transmissions.
- Other RF receptions.

4.3.2 Conditions for activation

The EPIRB shall always be able to be activated manually as described in clause 4.6.1, whether in or out of its bracket.

The EPIRB shall always be activated automatically when out of its bracket and placed in water irrespective of the settings of any control.

Table 1 shows the all the possible combinations of conditions for activation of the EPIRB. These shall be verified by simple manual testing.

Table 1: EPIRB Control Functions

Control settings	EPIRB Condition	EPIRB in its bracket	Activation status
Manually Activated	Floating in water	No	Activated and transmitting
Manually Activated	Floating in water	Yes	Activated and transmitting
Manually Activated	Dry	No	Activated and transmitting
Manually Activated	Dry	Yes	Activated and transmitting
OFF/Standby	Floating in water	No	Activated and transmitting
OFF/Standby	Floating in water	Yes	Deactivated and not transmitting
OFF/Standby	Dry	No	Deactivated and not transmitting
OFF/Standby	Dry	Yes	Deactivated and not transmitting

4.4 COSPAS-SARSAT

The EPIRB shall comply with the COSPAS-SARSAT type approval requirements set out in C/S T.001 [1] for FGBs and C/S T.018 [3] for SGBs. These requirements take precedence over the requirements of the present document where they conflict.

First generation EPIRBs shall conform to the test requirements of the current version of C/S T.007 [2].

Second generation EPIRBs shall conform to the test requirements of the current version of C/S T.021 [4].

4.5 Lanyard

The EPIRB shall be provided with a firmly attached and tidily stowed line in order that it can be tethered in use. The lanyard shall float in water. The buoyant lanyard length shall be between 5 m and 8 m long. The lanyard shall be of highly visible yellow/orange colour and shall not deteriorate in the marine environment (see clause 7).

The tethering strength of the lanyard shall comply with clause 13.

4.6 Controls

4.6.1 General

Manual activation of the EPIRB shall be by the use of two simple, but independent mechanical actions, neither of which on its own shall activate the EUT.

It should only be possible to activate the EUT after a seal or other mechanical restraint has been removed from the first mechanical action. After activation it shall be simple to de-activate the EUT and the means to deactivate the EUT shall be clearly marked. It should be possible to determine that the EUT has been previously activated, by the absence of a seal or restraint. A non-volatile electronic witness may be substituted for the seal or mechanical restraint and shall provide a clear indication for the user that the unit has been previously activated.

The switch that operates any test facility shall be so designed that it returns automatically to the off-position when released. The seal or mechanical restraint shall not be broken when operating the test facility.

It shall be possible to manually activate and deactivate the EPIRB multiple times.

4.6.2 Operation whilst wearing gloves

All controls shall be of sufficient size for simple and satisfactory operation and also be capable of being operated by a person wearing 5 mm thick neoprene gloves.

The following actions shall be possible whilst wearing 5 mm neoprene gloves:

1) The EPIRB can be removed from its bracket.
2) Each individual control on the EPIRB can be operated.
3) A method to carry the EPIRB shall be available that does not require the user to hold the unit in hand. For example a loop in the lanyard to wrap around the wrist so that both hands are free to climb a ladder.
4) Deploy the lanyard from its stowed position.

4.7 Indicators

4.7.1 General

The EPIRB shall be provided with a low duty cycle strobe light which fulfils the requirements of clause 4.7.3. The low duty light (strobe light) shall begin flashing within 10 seconds of activation.

The EUT shall be provided with visual indications to show the operation of the EPIRB as specified in clause 4.7.2.

The EUT may optionally also be provided with audible indications.

4.7.2 Operational Indicators

The visual indicator shall clearly distinguish the following states with each indicator being described in the user manual:

i) The EPIRB has been activated.
ii) The EPIRB is actively transmitting signals.
iii) The EPIRB GNSS is active but does not have a position lock.
iv) The EPIRB has GNSS position lock and is transmitting its position.
v) The EPIRB has received an RLS message (for EPIRBs that can receive RLS).
vi) The EPIRB is undergoing functional self-test or GNSS self-test.
vii) The EPIRB has successfully passed functional self-test or GNSS self-test.

viii) The EPIRB has failed functional self-test or GNSS self-test.

4.7.3 Visible strobe light

A visible low-duty cycle white light indicator (strobe light) shall be fitted with a flash rate of 20 to 30 flashes per minutes and a flash duration between 1 ms and 300 ms for the duration of the operating lifetime of the EPIRB to indicate its position for the nearby survivors and rescue units.

The visible strobe light shall comply with clause 14.1.

4.7.4 Night vision indicator

The EPIRB may optionally have a night vision (IR) light fitted. If fitted it shall have a duty cycle of 20 to 30 times per minute, with flash duration between 66 ms and 500 ms.

If fitted the night vision indicator shall comply with clause 14.2.

4.8 Self-test

4.8.1 General

The EPIRB shall be capable of being tested without using the satellite system. The EPIRB shall have two separate self-test modes, one to test the operation and correct function of the transmitter (functional self-test) and a separate test to verify correct operation of the GNSS subsystem (GNSS self-test). Functional test is recommended to be executed at least monthly with the GNSS test at least annually. These may be combined into a single test. Consideration should be given to the additional battery consumption used by a combined GNSS and functional test.

EPIRBs shall be designed such that the test transmissions occur in ascending order of frequency.

4.8.2 Functional Self-test

The functional self-test for FGBs shall comply with C/S T.007 [2], clauses A.3.6.1 and A.3.6.2. The self-test for SGBs shall comply with C/S T.021 [4], clause B.13.

As a minimum, the functional self-test should check the following:

- the battery voltage is sufficient to meet the power input requirements of the EPIRB;
- the 406 MHz Radio Frequency (RF) output stage is operational; and
- if used, the phase lock of the 406 MHz Phase Locked Loop.

When this self-test mode is activated, the EPIRB shall emit first a full-power burst of 121,5 MHz as described in clause 8.7.1, followed by two AIS message 14 s as described in clause 11.3, followed by a single 406 MHz burst in accordance with clause 4.5.4 of C/S T.001 [1] for FGBs and C/S T.018 [3] for SGBs.

Visual indicators shall clearly distinguish states vi) to viii) of clause 4.7.2.

4.8.3 GNSS Self-test

The GNSS self-test shall comply with either C/S T.007 [2], clause A.3.6.3 for FGBs or C/S T.021 [4], clause B.13 for SGBs.

The contents of the AIS Locating test burst is specified in clause C.2 and tested in clause 11.2.

4.9 Equipment IDs

4.9.1 Hex ID

For COSPAS-SARSAT FGBs the Hex ID is a unique 15 character hexadecimal identity code as described in C/S T.001 [1] specification. For COSPAS-SARSAT SGBs the Hex ID is a unique 23 character hexadecimal identity code as described in COSPAS-SARSAT C/S T.018 [3] specification.

The Hex ID shall be included on the EPIRB Label.

In addition to transmitting the Hex ID as part of the 406 MHz signals the Hex ID shall also be included as part of the text in the AIS message 14 for both AIS Active and test transmissions. This is tested in clause 11.

4.9.2 Self ID (AIS)

EPIRBs shall have a freeform number identity (self ID).

The self ID for an EPIRB is 974xxyyyy, where xx = manufacturer ID 01 to 99; yyyy = the sequence number 0000 to 9999 allocated by the manufacturer as specified in Recommendation ITU-R M.585-9 [5], section 2.2 of annex 2. Manufacturers IDs are issued by CIRM (www.cirm.org). Manufacturers shall only use manufacturer IDs that have been issued to them by CIRM, except for training and conformance testing purposes where the ID xx = 00 may be used.

After being programmed by the manufacturer, it shall not be possible for the user to change the self ID of an EPIRB.

4.9.3 Own Vessel ID

The Own Vessel ID only applies to EPIRBs programmed with C/S MMSI protocols. The Own Vessel ID shall be an individual MMSI or the ship's radio call sign.

4.10 Operating Instructions

The operating instructions shall provide full instructions and information regarding:

- installation and stowage;
- operation and test procedures;
- procedures to limit the self-testing to the minimum necessary;
- battery replacement process;
- maintenance procedures;
- warnings on the avoidance of false alarms.

4.11 Battery Requirements

4.11.1 Battery life

The battery life as defined by its expiry date shall be at least 2 years.

The expiry date of the battery shall be the battery cell manufacturing date plus no more than half the useful life of the battery. The expiry date shall be clearly and durably marked on the EPIRB.

The useful life of the battery is defined as the period of time after the date of battery cell manufacture that the battery will continue to meet the power requirements of the EPIRB.

The useful life of the battery shall be determined with regard to the discharge phenomenon described in clause 7.5.5.1.

4.11.2 Safety Precautions

4.11.2.1 Reverse Polarity

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

4.11.2.2 Carriage Requirements

Batteries shall comply with UN carriage requirements for dangerous goods.

Batteries shall have passed testing against ST/SG/AC.10/11/Rev.8 [17].

The battery shall not release toxic or corrosive materials outside the EPIRB housing:

- During or subsequent to storage at temperatures between -55 °C and +75 °C.
- During a full or partial discharge at any rate up to and including an external short circuit.
- During a charge of forced discharge of a cell or cells by another cell or cells within the battery.
- After a full or partial discharge.
- The battery shall not be hazardous to any person handling, using or performing manufacturer approved servicing of the device or to any vehicle or equipment in which it is transported, housed or installed under any of the conditions specified in the present document.

4.12 Labelling

4.12.1 EPIRB labelling

The EPIRB shall be provided with a label, or labels, permanently affixed to the exterior of the EUT, containing the following information:

- Hex ID and self ID of the EUT (see clause 4.9).
- Country (i.e. name of country as programmed in MID).
- Adequate instructions to enable the EUT to be activated and deactivated.
- The type of battery as specified by the manufacturer of the EPIRB.
- Location of the GNSS antenna and a warning to provide a clear view of the sky and not block the GNSS antenna during operation.
- The compass safe distance as measured in clause 7.10.
- A warning to the effect that the EPIRB should not be operated except in an emergency.
- The date on which the battery will need to be replaced (the expiry date of the battery, including indication of day of the month) e.g. using 'end' before the month.
- The EPIRB Class (Class 2) and temperature range for operation.
- Name of the vessel and call sign or MMSI number of the vessel if clause 4.9.3 applies.
- Brief operating instructions to enable manual activation, deactivation and self-test. With any text used in at least English.
- A space for registration information as required by administrations.

4.12.2 Battery Labelling

The battery shall be marked indelibly and legibly with the battery type, voltage, expiration date (month and year) and as appropriate, precautions associated with handling and disposal.

Additionally, a label shall be applied to either the interior of the EPIRB in a conspicuous place or on the battery pack itself warning that unauthorized battery replacement may lead to failure for example:

- WARNING! lifesaving device. Unauthorized battery replacement may lead to failure.

4.13 Equipment manuals

The user manual shall provide adequate information to enable the EPIRB to be properly stowed, installed operated, tested and maintained. The equipment manual shall contain the following:

a) An overview of the COSPAS-SARSAT system.

b) Complete instructions for operation, self-test of the EPIRB including any GNSS testing, and testing of any other transmissions present within the EPIRB.

c) Cautions and recommendations to prevent false alerts.

d) Instructions on licencing and registration, registration renewal.

e) Instructions on recoding and re-registration of the beacon when change of ownership of EPIRB or vessel occurs.

f) Instructions on disposal of beacons at end of life, including measures to prevent inadvertent alerts during disposal and deregistration.

g) An instruction to replace the battery when the battery status indicator informs the user the beacon may not have sufficient energy to support beacon operation for the declared operating lifetime of the beacon.

h) The minimum operating lifetime and operating and stowage temperatures.

i) The purpose of the lanyard and a precaution against securing it to a ship in distress.

j) A warning such as the following: If this Beacon is kept above room temperature for prolonged periods of time then the Battery Capacity will be degraded and either the Battery should be replaced earlier than the date stated on the beacon, or the quoted 48 hour operating life of the beacon may be reduced. The effect is more pronounced as the temperature increases.

k) A warning to limit self-testing to that recommended by the manufacturer.

l) Information on how to maintain the EPIRB.

m) Instructions for safe transportation or shipping of the EPIRB or location where such information can be obtained.

n) A warning to the effect the EPIRB shall not be operated except in an emergency.

o) Not to install or operate the EPIRB in location subject to high intensity electromagnetic fields (e.g. radar or communications antennas).

p) The equipment manual shall include information explaining the necessity to report EPIRB false alarms by the most expedient means to the nearest search and rescue authorities. The information that should be reported includes the EPIRB Hex ID; date, time, duration and cause of activation; and position at time of deactivation.

5 Technical information

5.1 General

This type of equipment always contains a C/S transmitter operating in the band 406,0 MHz to 406,1 MHz, a 121,5 MHz transmitter, a GNSS receiver and optionally contain an AIS transmitter. The block diagram of a typical EPIRB is shown in Figure 1.

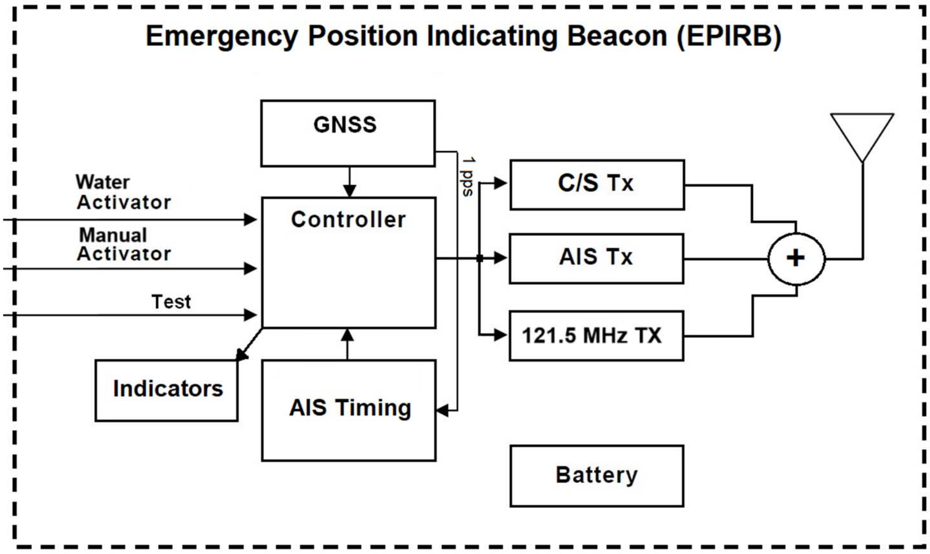


Figure 1: Functional block diagram of an EPIRB including AIS

5.2 COSPAS-SARSAT

5.2.1 Beacon Types

There are two types of C/S beacons:

- 1st generation (FGB) (see clause 5.2.2); and
- 2nd generation (SGB) (see clause 5.2.3).

5.2.2 First Generation Beacons (FGBs)

FGBs transmit in a narrow (3 kHz) channel assigned by COSPAS-SARSAT (Table 2). To determine which channel to use for approvals testing refer to C/S T.012 [i.2].

Table 2: COSPAS-SARSAT channel frequency table for FGBs

Channel	Centre Frequency	Channel	Centre Frequency	Channel	Centre Frequency	Channel	Centre Frequency
1 - A	406,022	2 - B	406,025	3 - C	406,028	4 - D	406,031
5 - E	406,034	6 - F	406,037	7 - G	406,040	8 - H	406,043
9 - I	406,046	10 - J	406,049	11 - K	406,052	12 - L	406,055
13 - M	406,058	14 - N	406,061	15 - O	406,064	16 - P	406,067
17 - Q	406,070	18 - R	406,073	19 - S	406,076		

FGBs use Manchester coded phase modulation at a fundamental bit rate of 800 bps giving an NRZ data rate of 400 bps (Figure 2).

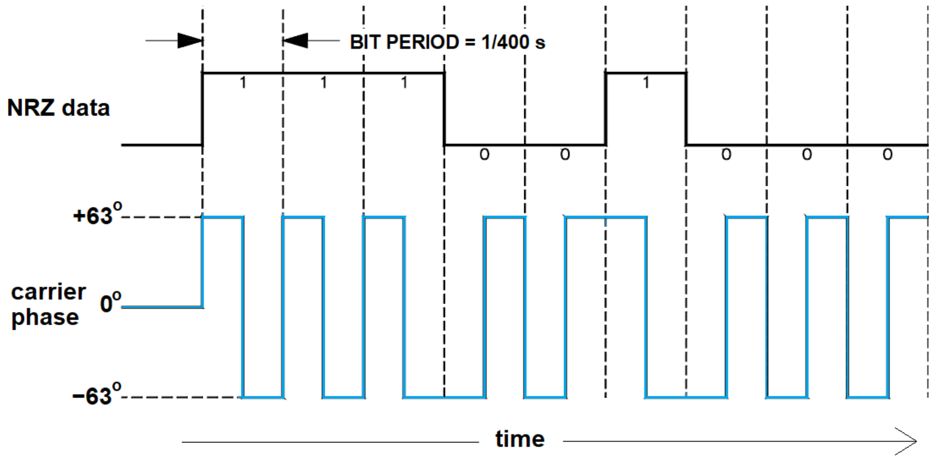


Figure 2: COSPAS-SARSAT modulation for FGBs

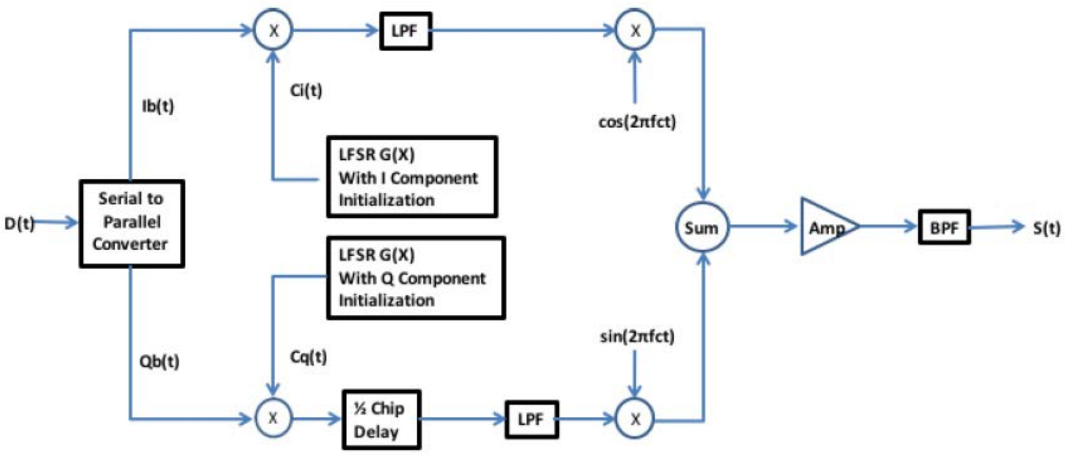
There are two FGB message lengths: short (112 bits) and long (144 bits), both with a preceding unmodulated carrier of 160 ms duration.

5.2.3 Second Generation Beacons (SGBs)

SGBs transmit in a wideband signal covering the entire band allocated for C/S transmissions (406,0 MHz to 406,1 MHz). The modulation is Quadrature Phase Shift Keying (QPSK) of a Direct Sequence Spread Spectrum signal generated by:

$$G(X) = X23 + X18 + 1 \quad (1)$$

The generator is used to create two chip streams at 38 400 chips/second. The data to be encoded is presented at a raw bit rate of 300 bps. It is split into two streams of odd and even bits which then modulate the in-phase (I) and quadrature (Q) chip streams respectively. The modulation process is summarized in Figure 3.



D(t) = digital message bit stream (300 bps)
Ib(t) = I component (odd) bit stream (150 bps)
Qb(t) = Q component (even) bit stream(150 bps)
LFSR = Linear Feedback Shift Register Function
G(x) = generator polynomial
Ci(t) = I component chipping stream generated by LFSR using I channel initialization (38,400 cps)
Cq(t) = Q component chipping stream generated by LFSR using Q channel initialization (38,400 cps)
fc = carrier frequency
LPF = low pass filter (if needed)
BPF = band pass filter (if needed)
S(t) = transmitted signal

Figure 3: COSPAS-SARSAT modulation for SGBs

There is just one SGB message length of one second duration of which the first 166⅔ ms contains continuous zeros (50) bits followed by message data (250 bits). The initial 166⅔ ms of chips are used by the COSPAS-SARSAT system for determining the position of an SGB independently of its transmitted GNSS position.

5.3 AIS position indication

5.3.1 Overview

When activated the EPIRB transmits AIS messages that indicate the position of the EPIRB. The transmitted messages should be recognized and displayed by AIS receivers and plotters in the reception range of the transmitter. AIS TDMA Synchronization is UTC direct; the EPIRB does not require an AIS receiver.

5.3.2 AIS transmission characteristics

The AIS transmitter transmits using modified SOTDMA on two channels AIS1 and AIS2. The GNSS receiver determines the current position of the beacon and facilitates TDMA synchronization in the UTC direct mode via its 1 pps output. Table 3 summarizes the transmission characteristics.

Table 3: AIS parameter settings

Symbol	Parameter name	Setting
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 ± 1,0 kHz of final value)	≤ 1,0 ms
PH.TXBT	Transmit Bandwidth time-product	0,4
PH.MI	Modulation index	0,5
	Ramp down time	≤ 832 µs
	Transmission duration	≤ 26,6 ms
	Transmitter output power	1 000 mW EIRP

5.3.3 AIS messages

The EPIRB broadcasts Message 1 and Message 14, as defined in annex 8 of Recommendation ITU-R M.1371-5 [10]. The content of the messages differs for active transmissions (active mode) and test transmissions (self-test mode). The combination of these messages in burst sequences is detailed in Annex C.

5.3.4 Loss of lock

The beacon continues transmission even if the position and UTC lock from the positioning system is subsequently lost or fails. If a position fix is lost, the equipment will continue to transmit with the last known good position using the best approximation for slot timing it can maintain.

5.4 121,5 MHz homing transmitter

When activated the EPIRB transmits a Down-Swept Tone (DST) conforming to Recommendation ITU-R M.690-3 [11]. This is amplitude modulated onto the 121,5 MHz carrier. The transmission may be continuous or duty cycled to reduce battery consumption (33 % to 100 % duty cycle). The transmission is momentarily interrupted to transmit signals on the other frequencies: C/S and AIS.

5.5 Priorities of receive and transmit functions

Priorities of EPIRB RF receive and transmit functions are listed in order below:

- 406 MHz COSPAS-SARSAT GMDSS transmission.

- Return Link Service RLS receiver (via GNSS).
- Automatic Identification System (AIS) optional transmissions.
- 121,5 Homing Transmissions.
- Other RF optional transmissions.
- Other RF optional receptions.

The priorities of each function are listed above. 406 MHz transmission has the highest priority and may not be interrupted or delayed for any other function. The 121,5 Homing transmission has a lower priority than some others, as specified in the above list. GNSS reception is not interrupted for other functions and operates at the same time or when the GNSS is in idle mode.

5.6 Accessories and additional functionality

The EPIRB may include accessories or additional functionality, but these should not prevent the EPIRB conforming fully to the requirements of the present document.

6 General conditions of measurement

6.1 Conformity testing

For the purpose of conformity testing, clauses 6.2 to 6.9 shall apply.

6.2 Unique identifiers (Hex ID and self ID)

The Hex ID pre-programmed into the EPIRB by the manufacturer shall be used during testing to the present document.

Where the self ID can be reprogrammed using the test interface described in clause D.2 it shall be reprogrammed in the format 97400yyyy for testing to the present document. The manufacturer ID = 00 is reserved for training and conformance test purposes. Where it is not possible to reprogram the EUT's self-ID for testing, the self-ID pre-programmed into the EPIRB by the manufacturer shall be used.

The appropriate authorities should be notified prior to any radiated testing where distress messages might be received. The Hex ID and self ID of the test sample(s) being tested shall be notified to those authorities in advance of testing.

6.3 Artificial Antenna

6.3.1 For EPIRBs with an integral antenna

In the case of an EPIRB with an integral antenna a 50 Ω antenna connector shall be used in place of the integral antenna to facilitate conducted testing.

6.3.2 For testing the RF transmitter output

Tests specified as conducted tests shall be carried out using an artificial antenna which shall be a non-reactive non-radiating load connected to the antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 Ω connector shall not be greater than 1,5:1 over the frequency range of the measurement.

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.

6.4 AIS TX Test Modulation

6.4.1 Standard test signal number 1

For AIS conformance testing purposes, the EUT shall have facilities to generate a series of reversals 010101… transmitted as all the bits within an AIS message frame, including header, start flag, end flag and CRC. NRZI is not applied to the reversals or Cyclic Redundancy Check (CRC), i.e. unaltered "On Air" data. The RF should be ramped up and down on either end of the AIS test message frame.

6.4.2 Standard test signal number 2

For AIS conformance testing purposes, the EUT shall have facilities to generate a series of 00001111… repeated as the data within an AIS message frame, including header, start flag, end flag and CRC. NRZI is not applied to the data or CRC. The RF should be ramped up and down on either end of the AIS message frame.

6.4.3 Standard test signal number 3

For AIS conformance testing purposes, the EUT shall have facilities to generate a 511-bit pseudo random sequence as specified in clause 2.1 of Recommendation ITU-T O.153 [14] shall be used as the data within an AIS message frame with header, start flag, end flag and CRC. NRZI is not applied to the pseudo random sequence or CRC. The RF should be ramped up and down on either end of the AIS message frame.

6.4.4 Unmodulated carrier

Additionally for conformance testing, the EUT shall have facilities for generating an unmodulated carrier.

6.4.5 Generation of test signals

Refer to clause D.3 for more information on the generation of the test signals specified in clause 6.4.

6.5 AIS Reference timing signal

For the timing tests in clauses 9.4, 9.5 and 9.6 access to the edge trigger timing signal corresponding to T_0 in Figure 10 of clause 9.4 is required. Refer to clause D.2 for more information.

6.6 Test conditions power sources and ambient temperatures

6.6.1 Normal and extreme test conditions

Conformity testing shall be carried out under normal test conditions (clause 6.7) and also, where stated under extreme test conditions (clauses 6.8.1 and 6.8.2 applied simultaneously).

6.6.2 Test power sources

Where stated, the battery of the EUT shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in clauses 6.7.2 and 6.8.2.

Either a bench supply or batteries suitably discharged can be used for testing. Where suitably discharged primary batteries are used in testing there is no requirement to determine the normal and extreme test voltages.

6.7 Normal test conditions

6.7.1 Normal temperature and humidity

Normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity, within the following ranges:

- Temperature: +15 °C to +35 °C.
- Relative humidity: not exceeding 75 %.

6.7.2 Normal test voltage

The normal test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that a fresh battery gives at normal temperature and humidity at a load equal to that of the EUT when activated and transmitting only its homing signal (AIS and C/S transmission loads being excluded).

6.8 Extreme test conditions

6.8.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedure specified herein at the lower and upper temperatures of -20 °C and +55 °C respectively.

The EUT shall be switched off during the temperature stabilization period.

Before tests are carried out, the EUT shall have obtained thermal balance in the test chamber.

6.8.2 Extreme test voltages

6.8.2.1 Upper extreme test voltage

The upper extreme test voltage shall be determined in each case except where tests are carried out using fresh batteries. The EUT fitted with a primary battery shall be placed in a climatic chamber and heated to +55 °C allowing a stabilization period of 2 hours. The EUT shall be switched off. After 1 minute the battery voltage shall be measured. This voltage shall be taken as the upper extreme test voltage and shall be measured before disconnecting the battery.

6.8.2.2 Lower extreme test voltage

The lower extreme test voltage shall be determined in each case except where tests are carried out using suitably discharged batteries. The EUT fitted with a primary battery shall be placed in a climatic chamber and cooled to -20 °C allowing a stabilization period of 2 hours. The EUT shall then be activated for a period of 48 hours. After this period the battery voltage shall be measured. This voltage shall be taken as the lower extreme test voltage and shall be measured before disconnecting the battery.

6.9 Reference Bandwidths for emission measurements

The reference bandwidths used shall be as stated in Table 4.

Table 4: Reference bandwidths to be used for the measurement of spurious emission

Frequency range	RBW
30 MHz to 1 GHz	100 kHz
1 GHz to 6 GHz	1 MHz

7 Environmental tests

7.1 Introduction

The requirements below specified have the purpose to demonstrate that the EPIRB is capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced in the ocean or on a ship in which the EPIRB is carried.

7.2 Procedure

Environmental tests specified in clause 7 may be carried out in any order, but the test specified in clause 7.14 shall always be carried out last so as to detect any damage to EUT's water seals caused by the other environmental tests.

7.3 Performance check

A performance check consists of activating the EPIRB in functional self-test and checking, using suitable test equipment (for example a hand held Beacon Tester), the 406 MHz transmitted frequency, the 406 MHz digital message (15 Hex ID and all 144 message bits (FGBs) or 23 Hex ID and all 250 message bits (SGBs) as appropriate), the presence of auxiliary radio-location device transmissions (Homing transmitter output) and the presence of an AIS locating device transmission in accordance with clause C.2.

7.4 Drop test

7.4.1 Definition

The immunity against the effects of dropping is the ability of the EUT to maintain the specified mechanical and electrical performance after being subjected to a series of drops onto a hard wooden test surface and into water.

7.4.2 Test conditions

During the test the EUT shall be switched off (deactivated) and removed from its bracket. The test shall be carried out under normal temperature and humidity conditions as detailed in clause 6.7.

The hard wooden test surface shall consist of a piece of solid hard wood 1 × 1 m, with a minimum thickness of 15 cm and a mass of at least 30 kg.

The water test surface shall be calm water of sufficient area and depth to ensure that the EUT is not constrained during the test.

The height of the lowest part of the EUT under test, relative to the test surface at the moment of release, shall be:

i) for drops onto the wooden test surface:

- 1 m;

ii) for drops into the water:

- 20 m.

7.4.3 Method of measurement

The test shall be carried out under normal conditions (see clause 6.7).

For drops on the wooden surface the test shall consist of six drops, once on each face, and the test shall be performed on the EUT without its mounting bracket.

For the drop into water the test shall consist of a single drop of the EUT without its mounting bracket.

7.4.4 Required results

After the drops have been completed the EUT shall be inspected visually for signs of damage. Inspection for mechanical damage, shall be carried out. Any damage shall not impair the operation of the EUT. In particular, parts like knobs, switches and the antenna shall operate in the normal manner. The act of dropping onto the wooden test surface shall not cause the EUT to activate, whereas the drop into water shall always cause the EUT to activate.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.5 Temperature tests

7.5.1 Definition

The immunity against the effects of temperature is the ability of the EPIRB to maintain the specified mechanical and electrical performance after the following tests have been carried out.

7.5.2 Dry heat test

7.5.2.1 Method of measurement

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall be placed in a chamber at normal temperature. The temperature shall then be raised to, and maintained between +67 °C and +73 °C for a period of at least 10 hours. The chamber shall be cooled to between +52 °C and +58 °C. The cooling of the chamber shall be completed within 30 minutes.

At the end of this period the EUT shall be subjected to the performance check.

The temperature shall then be maintained between +52 °C and +58 °C for a period of at least 10 hours.

At the end of this period the EUT shall again be subjected to the performance check. The temperature of the chamber shall be maintained at between +52 °C and +58 °C during the whole of the performance check periods.

At the end of the test, the EUT shall be returned to normal environmental conditions or to those at the start of the next test.

7.5.2.2 Requirements

The test shall not cause the EUT to activate or operate spuriously.

The requirement for the performance check (clause 7.3) shall also be met.

7.5.3 Damp heat test

7.5.3.1 Method of measurement

During the test the EUT shall be switched off (deactivated) and fitted in its bracket.

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be raised to between +38 °C and +42 °C, and the relative humidity raised to between 90 % and 96 % over a period of 3 hours. These conditions shall be maintained for a period of at least 10 hours.

The EUT shall be switched on 30 minutes later and shall be kept operational for at least 2 hours during which period the EUT shall be subjected to the performance check. The temperature and relative humidity of the chamber shall be maintained as specified during the whole test period.

At the end of the test period and with the EUT still in the chamber, the chamber shall be brought to room temperature in not less than 1 hour. At the end of the test the EUT shall be returned to normal environmental conditions or to those required at the start of the next test.

7.5.3.2 Required results

The test shall not cause the EUT to activate or operate spuriously.

The requirement for the performance check (clause 7.3) shall also be met.

7.5.4 Low temperature test

7.5.4.1 Method of measurement

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall be placed in a chamber at normal room temperature. Then the temperature shall be reduced to and maintained at between -33 °C and -27 °C for a period of at least 10 hours. The chamber shall be warmed to between -23 °C and -17 °C. The warming of the chamber shall be completed within 30 minutes.

At the end of this period the EUT shall be subjected to the performance check.

The temperature shall then be maintained at between -23 °C and -17 °C for a period of at least 10 hours.

At the end of this period the EUT shall again be subjected to the performance check. The temperature of the chamber shall be maintained at between -23 °C and -17 °C during the whole of the performance check periods.

7.5.4.2 Required results

The test shall not cause the EUT to activate or operate spuriously.

The requirement for the performance check (clause 7.3) shall also be met.

7.5.5 Low temperature battery endurance test

7.5.5.1 Determining the useful life of the battery

When determining the useful life of the battery the following losses at the temperature of 20 °C shall be included.

Functional self-test as recommended by the manufacturer (at a minimum rate of once a month), GNSS self-test as recommended by the manufacturer (at a minimum rate of once per annum), self-discharge of the cells/battery (since date of cell manufacture) and the quiescent current used by the EUT when in standby/off.

7.5.5.2 Method of measurement

Using a fresh battery that has been partially discharged to remove the amount of energy that would have been used by the EUT operating normally for the declared life of the battery (excluding activations) - see clause 7.5.5.1.

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall then be placed in a chamber at normal room temperature. Then the temperature shall be reduced to and maintained at between -23 °C and -17 °C for a period of at least 10 hours. The EUT shall be activated and the transmissions of the EUT during the test shall be verified for a period of 48 hours. The temperature of the chamber shall be maintained as specified above for the whole of the period of 48 hours. At the end of the test the EUT shall be returned to normal environmental conditions.

7.5.5.3 Required results

The EUT shall remain activated and transmitting for a minimum of 48 hours.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.6 Vibration test

7.6.1 Definition

The immunity against the effects of vibration is the ability of the EPIRB to maintain the specified mechanical and electrical performance when the following test is carried out.

7.6.2 Method of measurement

During the test the EUT shall be switched off (deactivated) and fitted in its bracket. The bracket (but not the EUT itself) shall be clamped to the vibration table in a vertical attitude.

The EPIRB's water contacts shall be shorted to simulate water immersion and cause the EPIRB to activate should it become dislodged from its bracket during the test.

Provisions may be made to reduce or nullify any adverse effect on the EUT performance which may be caused by the presence of any electro-magnetic fields from the vibration table.

Taking at least 15 minutes to cover each octave of frequency, the EUT shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 2 Hz or 5 Hz up to 13,2 Hz with an excursion of a peak amplitude between 0,9 mm and 1,1 mm;
- 13,2 Hz up to 100 Hz with a constant maximum acceleration of 7 m/s^2.

A resonance search shall be carried out during the vibration test. If any resonance of the EUT has Q greater than 5 measured relative to the base of the vibration table, the EUT shall be subjected to a vibration endurance test at each resonant frequency at the vibration level specified in the test with a duration of 2 hours. If no resonance with Q greater than 5 occurs the endurance test shall be carried out at one single observed frequency. If no resonance occurs the endurance test shall be carried out at a frequency of 30 Hz.

The test shall be repeated with the bracket in a horizontal attitude.

A performance check shall be carried out at the end of each test run.

The vibration table is described in clause 4 of IEC 60068-2-6 [18].

7.6.3 Required results

The test shall not cause the EUT to activate or operate spuriously.

No damage or mechanical deterioration shall be visible to the naked eye.

The EUT shall not become detached from its bracket.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.7 Saltwater spray test

7.7.1 Definition

The immunity against the effects of saltwater spray is the ability of the EPIRB to maintain the specified mechanical and electrical performance both during and after the following test has been carried out. This tests the immunity of the EPIRB to:

- False activation.
- Insulation faults.
- Corrosion of metals.

- Clogging or binding of moving parts as a result of salt deposits.

7.7.2 Method of measurement

7.7.2.1 The spraying apparatus

A chamber fitted with apparatus capable of spraying in the form of fine mist shall be used. The chamber capacity is irrelevant provided that the EUT is placed directly in the flow from the atomizer nozzle between 150 mm and 300 mm from the nozzle tip. The chamber, spraying equipment and spray nozzle atomizers shall be made of materials that are non-reactive to the salt solution.

The chamber apparatus shall provide a minimum flow rate of 10 ml/min, with a peak flow rate not exceeding 15 ml/min. Calibration of the testing apparatus using deposition collectors in not required,

For apparatus using compressed air as a propellant means shall be provided to humidify and warm the compressed air as required to meet the operating conditions. To avoid clogging the atomizers with salt deposits, the compressed air should be humidified to a relative humidity of at least 85 % at the point of release from the nozzle.

A sodium chloride (NaCl) solution shall be used comprising 5 parts sodium chloride by weight to 95 parts distilled or de-mineralized water by weight. The sodium chloride (NaCl) used for the solution shall contain, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.

The pH value of the solution shall be between 6,5 and 7,2 at a temperature of between 33 °C and 37 °C. The pH value shall be maintained within this range during conditioning. For this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

The spraying apparatus shall incorporate a filter or similar means to prevent clogging of the atomizers. Alternatively the saline solution used shall not be recirculated at all (total loss).

7.7.2.2 Preparation of EUT

Before testing the EUT shall be thoroughly cleaned of oil, dirt and grease as necessary until the outer surfaces are free from water beading. The cleaning solvents used shall not be corrosive or cause damage to EUT.

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

7.7.2.3 Test cycles

Step1 The EUT shall be sprayed simultaneously with the salt solution for a period of 24 hours in the spraying chamber maintained at a temperature of between 33 °C and 37 °C.

Step2 Following this the EUT shall be removed from the spraying chamber and left to dry at normal temperature and humidity (clause 6.7) for 24 hours. Care should be taken not to disturb the test item or adjust any mechanical features during the drying period.

Step3 Replace the EUT in the spraying chamber and repeat step 1 and then remove the EUT and repeat step 2 one more time.

7.7.2.4 Conclusion of testing

The EUT shall then be examined visually against clause 7.7.3.

Following test and checking against the required results the EUT shall then be cleaned prior to further environmental testing.

7.7.3 Required results

The test shall not cause the EUT to operate spuriously.

The test shall not cause the EUT to activate.

There shall be no deterioration or corrosion of the metal parts, finishes, material, or component parts visible to the naked eye.

All mechanical actions (including the action of disarming the EUT) shall be checked to ensure that they operate freely and are not binding or clogged with salt deposits.

7.8 Thermal shock test

7.8.1 Definition

The immunity against the effects of thermal shock is the ability of the EPIRB to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.8.2 Method of measurement

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall be placed in an atmosphere of +70 °C (±3 °C) for 1 hour. It shall then be immediately immersed in water at +25 °C (±3 °C) to a depth of 10 cm, measured from the highest point of the EUT to the surface of the water, for a period of 1 hour.

7.8.3 Required results

The first hour of the test (dry) shall not cause the EUT to activate or operate spuriously.

The second hour of the test (immersed) shall always cause the EUT to activate, and it shall remain activated for the full hour.

No damage shall be visible to the naked eye and the EUT shall not show any sign of significant external damage or harmful penetration of water.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.9 Bump test

7.9.1 Definition

The bump test is a test of the EPIRB's ruggedness and the ability of the bracket to hold the EPIRB properly.

7.9.2 Method of measurement

During the test the EUT shall be switched off (deactivated) and fitted in its bracket. The bracket (but not the EUT itself) shall be clamped to the testing equipment in a vertical attitude. Additional straps or other holding means shall not be used.

The EPIRB's water contacts shall be shorted to simulate water immersion and cause the EPIRB to activate should it become dislodged from its bracket during the test.

The EPIRB shall be subjected to the bump test according to the following profile:

- Peak acceleration: 98 m/s^2 with a tolerance of ±10 %.
- Pulse duration: 16 ms or 20 ms with a tolerance of ±10 %.
- Wave shape: Half-cycle sinewave.
- Test axis: Vertical.
- Number of bumps: 4 000.

The test shall be repeated with the bracket in a horizontal attitude.

A performance check shall be carried out at the end of each test run.

7.9.3 Required results

The test shall not cause the EUT to activate or operate spuriously.

No damage or mechanical deterioration shall be visible to the naked eye.

The EUT shall not become detached from its bracket.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.10 Compass safe distance test

7.10.1 Definition

The compass safe distance is the closest distance to compasses or compass sensors (flux gate, magnetometer) at which the EPIRB is safe to be stored.

The compass-safe distance D_{min} is defined as the distance between the nearest point of the EUT and the centre of the compass or magnetometer at which it will just produce a deviation in the measurement compass or compass sensor of X°/H where:

- X is 5,4° for the standard compass and 18° for the steering compass, the standby steering compass and the emergency compass.
- H is the horizontal component of the magnetic flux density in µT of the earth's Geomagnetic field at the place of testing.

7.10.2 Method of measurement

The EUT shall be tested in the position and attitude relative to the compass or compass sensor at which the error produced at the compass would be a maximum (Figure 4).

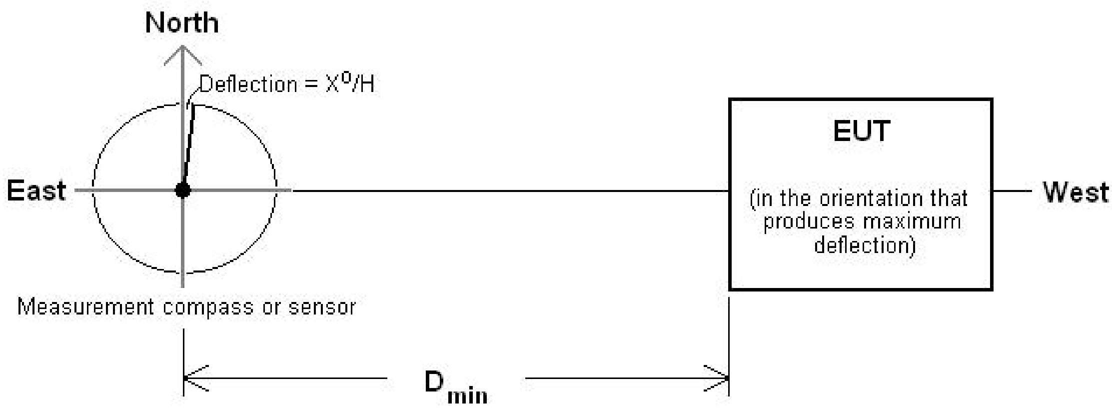


Figure 4: Compass safe distance test setup

Steps should be taken to ensure the Geomagnetic field at the test site is uniform.

With the EUT removed from the test site the measurement compass or compass sensor is aligned with magnetic north so that the measured deflection is 0°.

The EUT is then placed in the same plane and on an east west line passing through the centre of the measurement compass or compass sensor. The measurement compass or compass sensor remains stationary and the EUT is moved along the line until the required deflection X°/H is observed. At this position the EUT is re-oriented until the deflection is maximized. The EUT is then moved again along the east west line until the required deflection X°/H is again observed. The distance D_{min} between the centre of the measurement compass or compass sensor and the nearest point of the EUT is recorded.

7.10.3 Requirements

The minimum distance to obtain the required deflection D_{min} shall be recorded and this is printed on the label (see clause 4.12).

7.11 Solar radiation test

7.11.0 Applicability

This test need not be carried out if the manufacturer produces sufficient evidence that the components, materials, etc. maintain their specified mechanical and electrical performance against the effects of continuous solar radiation.

7.11.1 Definition

The immunity against the effects of continuous solar radiation is the ability of the EPIRB to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.11.2 Method of measurement

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall be placed on a suitable support and exposed continuously to a simulated solar radiation source (Table 5) for 80 hours.

The intensity at the test point, which shall also include any radiation reflected from the test enclosure, shall be 1 120 W/m^2 ± 10 % with a spectral distribution given in Table 5.

Table 5: Spectral distribution

Spectral Region	Ultra-violet B	Ultra-violet A	Visible			Infra-red
Bandwidth (µm)	0,28 to 0,32	0,32 to 0,40	0,40 to 0,52	0,52 to 0,64	0,64 to 0,78	0,78 to 3,00
Radiance (W/m^2)	5	63	200	186	174	492
Tolerance (%)	±35	±25	±10	±10	±10	±20
NOTE: Radiation shorter than 0,30 µm reaching the earth's surface is insignificant.						

7.11.3 Requirements

The test shall not cause the EUT to activate or operate spuriously.

No damage shall be visible to the naked eye and the EUT shall not show any sign of significant external damage.

7.12 Oil resistance test

7.12.0 Applicability

This test need not be carried out if the manufacturer produces sufficient evidence that the components, materials maintain their specified mechanical and electrical performance against the effects of deterioration from oil.

7.12.1 Definition

The immunity against the effects of immersion in mineral oil is the ability of the EPIRB to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.12.2 Method of measurement

During the test the EUT shall be switched off (deactivated) and removed from its bracket.

The EUT shall be immersed horizontally for a period of 24 hours under a 100 mm head of mineral oil as specified below at normal room temperature:

- aniline point: 120 °C;
- flash point: minimum 240 °C;
- viscosity: 10 cSt to 25 cSt at 99 °C.

The following oils shall be used:

- IRM 901 oil;
- IRM 903 oil;
- ISO 8217 [19] MDO fuel oil.

7.12.3 Requirements

The test shall not cause the EUT to activate or operate spuriously.

No sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities of the EUT, including labelling, shall be visible to the naked eye.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

7.13 Automatic activation and float upright test

7.13.1 Definition

A test that the EPIRB floats and when floating in water activate and start transmitting automatically irrespective of the settings of any control.

7.13.2 Method of measurement

The EUT shall be switched off (deactivated) and removed from its bracket.

Firstly the EUT shall be placed in a saline solution of normal sea saltiness (see corrosion test in clause 7.7.2.1). With the EPIRB floating the waterline shall be marked on the body of the EUT. The float line is then used as the baseline for various measurements in clauses 8.5, 9.7, 10, 14 and Annex B.

Secondly the EUT shall be removed from the saline solution and replaced in the solution upside down and then released.

7.13.3 Requirements

The EPIRB shall right itself when floating with its antenna out of the water.

The test shall cause the EPIRB to activate within 15 seconds of immersion. The EPIRB might not transmit within the first 15 seconds of activation but shall visually indicate that it has been activated.

7.14 Watertightness test

7.14.1 Definition

A test that the EPIRB remains water-tight after submission to all preceding environmental test, both at depth and for the specified duration.

7.14.2 Method of measurement

This test shall be carried out on the same sample of the EUT used for testing to all the preceding tests in clause 7, and after these tests have been carried out.

The EUT shall be switched off (deactivated) and fitted in its bracket.

The EUT and its bracket shall be completely immersed in water to a depth of at least 5 m for a period of 5 minutes, afterwards the unit shall be dried and opened to check for no water ingress.

Saline solution of normal sea saltiness (see corrosion test in clause 7.7.2.1) shall be used.

7.14.3 Required results

The EUT shall not activate or operate spuriously.

No damage shall be visible to the naked eye and the EUT shall not show any sign of significant external damage or water ingress.

Following the test the requirement of the performance check (clause 7.3) shall also be met.

8 Tests on the 121,5 MHz homing transmitter

8.1 Frequency error

8.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and its nominal value (121,5 MHz).

8.1.2 Method of measurement

This measurement is a conducted measurement.

The carrier frequency shall be measured with the EUT connected to an artificial antenna (see clause 6.3). The measurement shall be made using the test power source (see clause 6.6.2) under both normal (clause 6.7) and extreme (clause 6.8) test conditions. The carrier frequency shall be measured in the absence of modulation (see clause D.3).

8.1.3 Limit

The frequency error under normal and extreme conditions shall not exceed ±50 ppm (±6,075 kHz).

8.2 Audio modulation characteristics

8.2.1 Definition

The audio modulation characteristics of the radio carrier are:

i) Depth of modulation of the DST.

ii) Mark/space ratio of the DST.

iii) DST frequency range.

The depth of modulation is calculated from the formula:

$$\frac{A-B}{A+B} \times 100\ \% \qquad (2)$$

Where A and B are respectively the maximum and minimum value of the modulation envelope shown in Figure 5.

The mark/space ratio is calculated from the formula:

$$t1 / t2 \times 100\ \% \qquad (3)$$

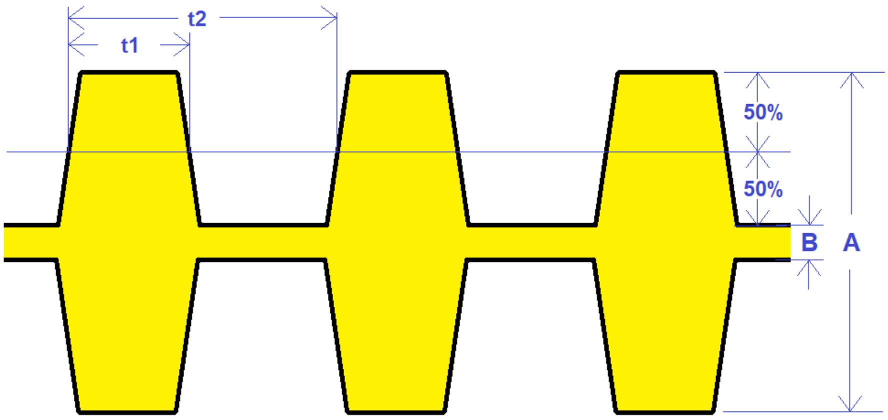


Figure 5: 121,5 MHz modulated waveform

The DST frequency range comprises the high and low audio frequencies delimiting the DST given by the formulas:

$$F_{low} = 1/t2 \text{ and } F_{high} = 1/t3 \text{ in Figure 6} \qquad (4)$$

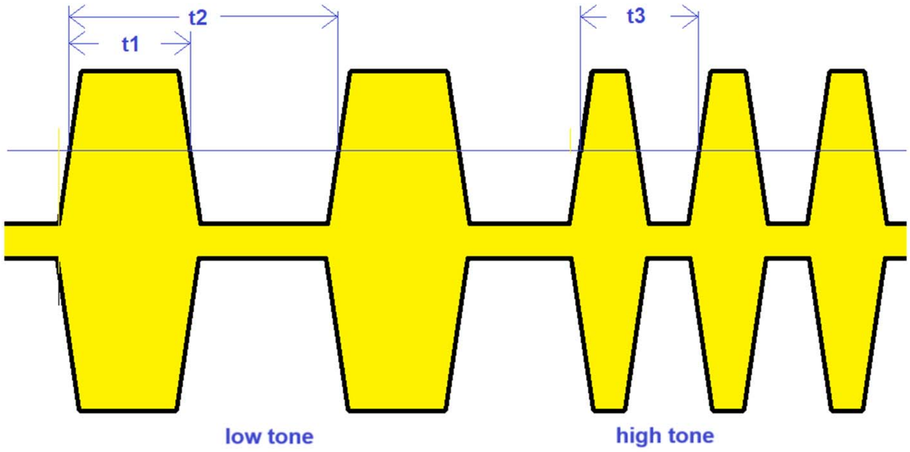


Figure 6: 121,5 MHz modulated waveform at the end of the DST cycle

8.2.2 Method of measurement

This measurement is a conducted measurement.

The radio beacon shall be placed in the test fixture (see clause 6.3). The radio signal is suitably applied to the input of a digital oscilloscope with a bandwidth greater than 121,5 MHz. The input impedance of the digital oscilloscope shall be switched to 50 Ω or a 50 Ω through terminator shall be used.

The timebase of the digital oscilloscope shall be set to 1 ms/div.

The DST frequency range is measured by capturing the point at which the DST resets from low back to a high tone as shown in Figure 6.

The mark/space ratio shall be measured for both the low audio tone and high audio tone portions of the DST.

8.2.3 Limits

F_{high} shall be less than 1 600 Hz.

F_{low} shall be more than 300 Hz.

The DST frequency range (F_{high} - F_{low}) shall be greater than 700 Hz.

The mark/space ratio in both cases (low tone and high tone) shall be more than 33 % and less than or equal to 55 %.

The modulation depth shall be at least 85 % but less than 100 %.

8.3 DST sweep rate and duty cycle

8.3.1 Definition

The DST sweep rate is given by the formula:

- 1/ts.

Where ts is the time taken for one complete DST sweep as shown in Figure 7.

The duty cycle is given by the formula:

- t_{on} / (t_{on} + t_{off}).

Where t_{on} is the 121,5 MHz transmitter on time and t_{off} the off time as shown in Figure 7.

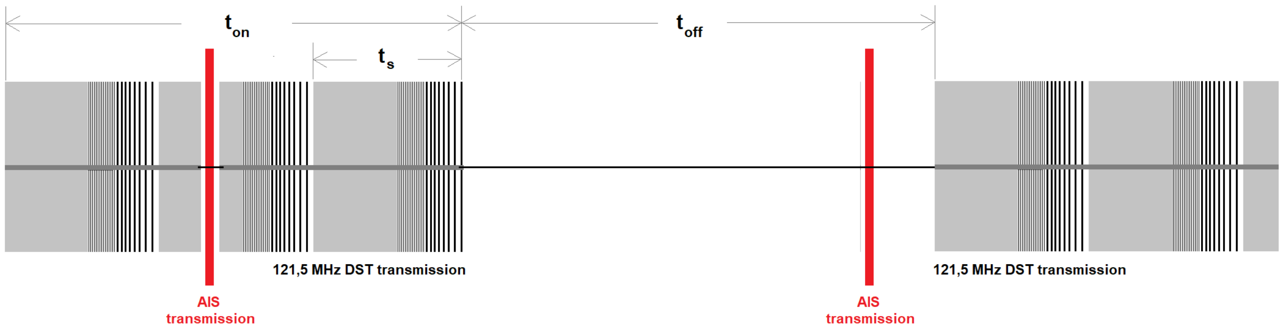


Figure 7: Transmission cycle

8.3.2 Method of measurement

This measurement is a conducted measurement.

The radio beacon shall be placed in the test fixture (see clause 6.3). The radio signal is suitably applied to the input of a digital oscilloscope with a bandwidth greater than 121,5 MHz. The input impedance of the digital oscilloscope shall be switched to 50 Ω or a 50 Ω through terminator shall be used.

The timebase of the digital oscilloscope shall be set to 500 ms/div.

A complete DST cycle shall be used to measure t_s because the cycle may be interrupted to transmit C/S and AIS packets.

NOTE: The DST cycle may not necessarily be synchronized to the duty cycle on and off periods.

Interruptions for transmissions other than 121,5 MHz (e.g. AIS and C/S message transmissions) shall be ignored. During the interruption the direction of the sweep should not change.

8.3.3 Limits

The DST sweep rate shall be at least 2 Hz and not more than 4 Hz.

The duty cycle shall be at least 33 %.

The 121,5 MHz transmitter on time t_{on} shall be at least 0,75 seconds.

The 121,5 MHz transmitter off time t_{off} shall be no more than 1,5 seconds.

8.4 Spectral carrier power ratio

8.4.1 Definition

The spectral carrier power ratio also known as the frequency coherence is the ratio of the total power of the emission to the power centred on the carrier in a bandwidth ±30 Hz.

8.4.2 Method of measurement

This measurement is a conducted measurement.

The measurement shall be performed under normal test conditions with the radio beacon placed in the test fixture (clause 6.3).

The EUT shall be placed in a mode where it transmits using only continuous audio modulation, all data modulation including more code and CW is suppressed, and the duty cycle is forced to 100 % (refer to clause D.3).

To determine the total power, the emission is suitably applied to the input of a spectrum analyser with the following settings:

- resolution bandwidth: 30 kHz;
- video bandwidth: 100 kHz;
- span: zero;
- centre frequency: Carrier frequency as measured in clause 8.1.

The total power is determined by noting the power measured on the spectrum analyser.

To determine the power in the ±30 Hz bandwidth, the spectrum analyser settings are as follows:

- resolution bandwidth: 100 Hz;

- video bandwidth: 1 kHz;
- span: zero;
- centre frequency: Carrier frequency as measured in clause 8.1.

The power in the ±30 Hz bandwidth is determined from the power measured on the spectrum analyser.

The difference between the total power and the power in the ±30 Hz bandwidth in dB is the spectral carrier power ratio:

$$\text{spectral carrier power ratio} = \text{Total power} - \text{power in the } \pm 30 \text{ Hz bandwidth} \quad (5)$$

8.4.3 Limit

The spectral carrier power ratio shall be less than 5,2 dB, which represents at least 30 % of the total power being contained within ±30 Hz of the carrier.

8.5 Maximum Effective Isotropic Radiated Peak Envelope Power (EIRPEP)

8.5.1 Definition

The maximum EIRPEP is defined as the EIRPEP in the direction of maximum field strength under the specific conditions of measurement.

The peak envelope power EIRPEP is the peak value of the Effective Isotropic Radiated Power (EIRP).

The measurements shall be made under normal test conditions.

8.5.2 Method of measurement under normal test conditions

In a Semi-Anechoic Chamber (SAC) as specified in clause 5.2.1 of ETSI TS 103 052 [12], the EUT shall be placed in the centre of the support disk described in Annex B with its float-line aligned with the surface of the support disk. An adaptor plate is fitted to extend the ground plane up to the float line of the EUT. The submerged part of the EUT (below the float line) is wrapped in conductive foil bonded to the support disk. The EUT shall then be activated and tested on 121,5 MHz.

As an alternative an Open Area Test Site (OATS) as specified in clause 5.1 of ETSI TS 103 052 [12] may be used, the EUT shall then be activated on a frequency within ±0,2 % of 121,5 MHz.

NOTE 1: 121,5 MHz (±12,5 KHz) should not be used when testing in an open area. A suitable alternative frequency between 121,35 MHz and 121,46 MHz, or 121,65 MHz should be used instead.

The minimum measurement distance from the receiving antenna to the EUT shall be 5 m. The receiving antenna shall either be a biconical antenna or a dipole tuned to 121,5 MHz.

NOTE 2: Other antenna types, particularly LPDAs and BiLogs can give spurious results at 5 m due to their extended far field and variable focal point and should not be used.

The EUT shall be placed in a mode where it transmits using only continuous audio modulation, all data modulation and CW is suppressed, and the duty cycle is forced to 100 % (refer to clause D.3).

The receiver shall be tuned to the transmitter carrier frequency. The receiving antenna shall be orientated for vertical polarization. The receiving antenna shall be raised or lowered from 1 m to 4 m until a maximum signal level is detected on the measuring receiver.

The transmitter shall be rotated through 360° around a vertical axis in order to find the direction of the maximum signal. From that position the transmitter shall be rotated in 30° steps to obtain 12 readings in all.

The maximum signal level detected by the measuring receiver shall be noted as 12 values of P_1.

The EUT and its Annex B support shall be replaced by a substitution antenna being a reference dipole, vertically polarized and tuned to the carrier frequency with a VSWR better than 1.5:1. The centre of the substitution dipole shall be fixed at the position of the centre of the EUT at the same height as the float line.

The substitution dipole shall be connected to a signal generator via a cable of sufficient length, with the output level set to 0 dBm and tuned to the carrier frequency.

The receiving antenna shall be raised or lowered through the specified range of heights to ensure that the maximum signal is received.

The maximum signal level detected by the measuring receiver shall be noted as P_2.

The substitution antenna shall be disconnected from the cable and the same cable then connected to the input of the measuring receiver. The signal level detected by the measuring receiver shall be noted as P_3.

The maximum EIRPEP in all 12 cases are given by the equation:

$$EIRPEP = P_1[i] - P_2 + P_3 + Gd + 6 \text{ dBi} \quad (6)$$

Where Gd is the specific calibrated antenna gain if the dipole has been calibrated at 121,5 MHz or extrapolated to 121,5 MHz (nominally 2,15 dB).

NOTE 3: 6 dB is added when the test is performed on an OATS or SAC as specified above but is not added when the test is performed in a fully anechoic chamber or OATS covered with a ground-plane absorber. This is because without absorption the reference dipole measurement peaks when the direct path and ground-bounce reflected path interfere coherently, whereas the measurement of the EUT on the Annex B support disk has no ground-bounce reflected path.

8.5.3 Limit

The EIRPEP in all 12 cases shall be at least 25 mW, and not more than 100 mW.

8.6 Transmitter spectrum mask

8.6.1 Definition

The transmitter spectrum mask defines the limits within the range fc ± 75 kHz for the peak power of all modulated signals including all side bands associated with the carrier.

8.6.2 Method of measurement

This measurement is a conducted measurement.

The EUT shall be placed in the test fixture connected to the artificial load with a means of measuring the power delivered to the load. The EUT shall be operated from the test power source (clause 6.6.2).

The measurement shall be made under normal test conditions.

The carrier power shall be measured with the EUT connected to an artificial antenna (see clause 6.3), using a spectrum analyser with the following preferred settings:

- resolution bandwidth: 100 Hz;
- video bandwidth: 1 kHz;
- scan bandwidth: 150 KHz;
- centre frequency: Carrier frequency as measured in clause 8.1;
- detector type: Peak hold.

To determine the reference peak power and measure the emissions close to the carrier, the EUT shall be activated. At least 10 minutes of emissions shall be measured and a reference carrier power calculated as being the maximum power within the frequency limits set in clause 8.1.3. The emission profile shall then be normalized so that the reference carrier power is set to 0 dBc. The result is compared to the mask given in Figure 8.

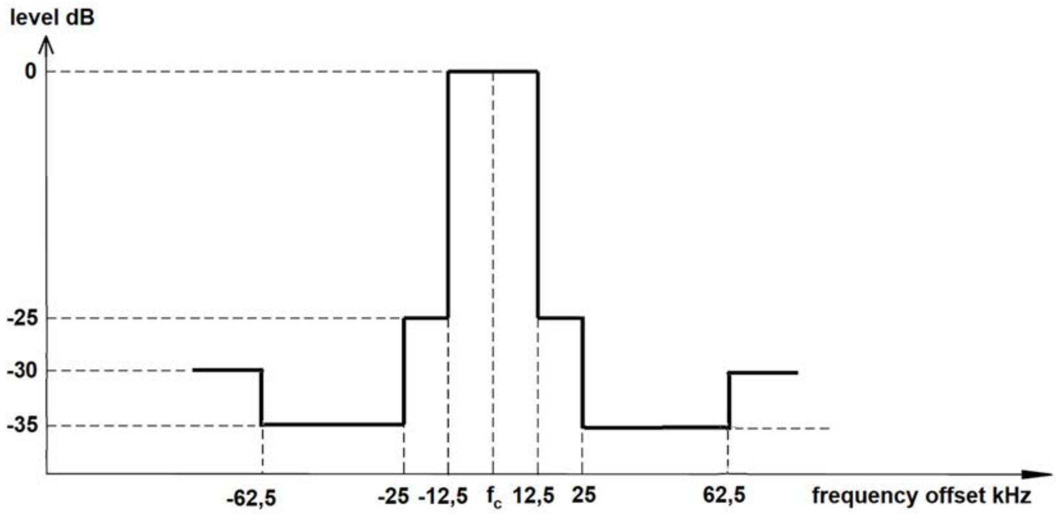


Figure 8: Spectrum mask

8.6.3 Limit

The normalized emission profile shall not exceed the mask of Figure 8.

8.7 Radiation produced by operation of the test function

8.7.1 Definition

Radiation produced by operation of the test function is the radiation at the nominal frequencies when the EUT is being tested:

- Mandatory full-power - high power emission (up to 100 mW) of limited duration (a maximum of 3 audio sweeps).
- Optional low-power - low power emission (up to 5 µW) of a longer duration.

NOTE: The duration of the low-power transmission will be limited by C/S requirements.

The EUT shall support the mandatory test power level, and may optionally support both.

8.7.2 Method of measurement

8.7.2.0 General

This measurement is a conducted measurement.

The carrier power shall be measured with the EUT connected to an artificial antenna (see clause 6.3), using a spectrum analyser with the following preferred settings:

- resolution bandwidth: 30 kHz;
- video bandwidth: 100 kHz;
- scan bandwidth: zero span;

- centre frequency: Carrier frequency as measured in clause 8.1;
- detector type: Peak hold;
- sweep time > 2 seconds.

8.7.2.1 Mandatory full-power test transmission

Firstly the EUT shall be activated in normal operation and the peak power noted.

Secondly the EUT shall be deactivated and then tested in the full-power mode and the peak power noted.

Finally the duration of the test transmission shall be measured using the delta marker.

8.7.2.2 Optional low-power test transmission

The EUT shall be tested in low-power mode and the peak power noted.

The low-power test EIRPEP is given by the equation:

low-power test EIRPEP = EIRPEP measured in clause 8.5.2 -
normal peak power measured in clause 8.7.2.1 + peak power measured in clause 8.7.2.2 (7)

8.7.3 Limits

The mandatory full-power peak test power shall be within ±3 dB of the normal peak power. The emission shall not exceed 1,5 s irrespective of how long the test facility is activated.

The optional low-power test EIRPEP shall be no more than 5 uW.

9 Tests on the AIS transmitter

9.1 AIS Frequency error

9.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and its required frequencies (AIS1 and AIS2).

9.1.2 Method of measurement

This measurement is a conducted measurement.

The carrier frequency shall be measured with the EUT connected to an artificial antenna (see clause 6.3). The measurement shall be made using the test power source (see clause 6.6.2) under both normal (clause 6.7) and extreme (clause 6.8) test conditions. The carrier frequency shall be measured in the absence of modulation (see clause 6.4.4). The test shall be performed on both AIS1 and AIS2.

9.1.3 Limit

The frequency error under normal conditions shall not exceed ±500 Hz, and under extreme test conditions shall not exceed ±1 kHz.

9.2 AIS Conducted power variation

9.2.1 Purpose

The purpose of this test is to verify that the output power from the EUT is within limits at extreme operating temperatures and to use these measurements to verify that the radiated power at the extremes of temperature is within limits.

9.2.2 Definition

Conducted power is the average or mean power delivered to the artificial antenna (see clause 6.3) in the absence of modulation. The conducted power variation is the variation in conducted power over the extreme temperature range.

9.2.3 Method of measurement

This measurement is a conducted measurement.

The transmitter shall be connected to an artificial antenna (see clause 6.3) and set to transmit on AIS1. The EUT shall be set to transmit continuously (see clause 6.4.4). The average or mean power delivered to this artificial antenna shall be measured under normal conditions (see clause 6.7), and at the extremes of temperature (see clause 6.8.1).

The measurement shall be made on AIS1 and then repeated on AIS2.

The mean power under normal conditions P_{Norm} shall be measured in dBm (this value shall be recorded as it is used in the test method of clauses 9.3 and 9.4).

The mean power under extreme conditions P_{-20} and P_{+55} shall be measured in dBm.

9.2.4 Limit

In both case the absolute difference in conducted power: $|P_{Norm} - P_{-20}|$ and $|P_{Norm} - P_{+55}|$, shall be less than 3 dB.

9.3 AIS Transmitter spectrum mask

9.3.1 Definition

The transmitter spectrum mask defines the limits within the range fc ± 62,5 kHz for the peak power of all modulated signals including all side bands associated with the carrier.

9.3.2 Method of measurement

This measurement is a conducted measurement.

The transmitter shall be connected to an artificial antenna (see clause 6.3) with a means of measuring the power delivered to the load. The EUT shall be operated from the test power source (clause 6.6.2). Standard test signal number 3 (see clause 6.4.3) shall be used to modulate the transmitter in repeated packets.

The measurement shall be made under normal test conditions (see clause 6.7).

To determine the reference peak power and measure the emissions in the adjacent channels, the emission is suitably applied to the input of a spectrum analyser with the following preferred settings:

- resolution bandwidth: 1 kHz;
- video bandwidth: 3 kHz;
- scan bandwidth: 125 kHz;
- centre frequency: Carrier frequency AIS1 and then AIS2;

- detector type: Peak hold.

The EUT shall continuously repeat the transmission of packets for one minute to ensure that the emission profile is fully developed. The reference carrier power P_{Norm} measured in clause 9.2.3 shall be used to normalize the emission profile so that the reference carrier power is set to 0 dBc.

The result is compared to the mask given in Figure 9.

A measurement for frequency AIS1 shall be made and repeated for AIS2.

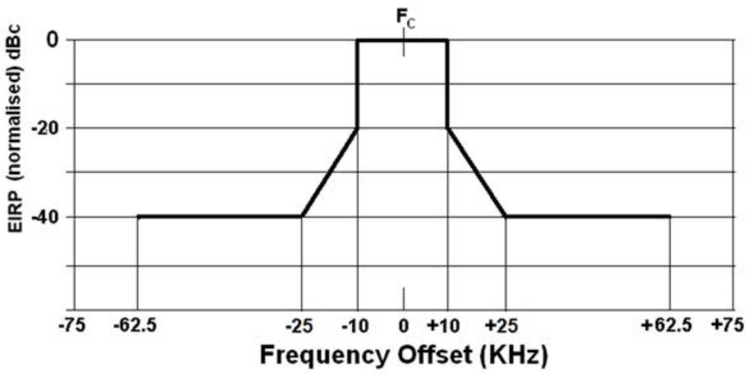


Figure 9: Transmitter spectrum mask

9.3.3 Limit

The normalized emission profile shall not exceed the mask of Figure 9.

9.4 AIS Transmitter transient behaviour (output power)

9.4.1 Definition

The transient behaviour (output power) of the transmitter is determined by the time-dependency of the transmitter power when the transmitter output power is switched on and off. Within the scope of the present document, only the transmit power as a function of time is tested as shown in Figure 10 and defined in Table 6 where:

a) transmitter delay time (TA - T0) 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 (TB2 - TA) 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 (TF - TE) 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 (TF - TA) is the time from when power exceeds -50 dBc to when the power returns to and stays below -50 dBc.

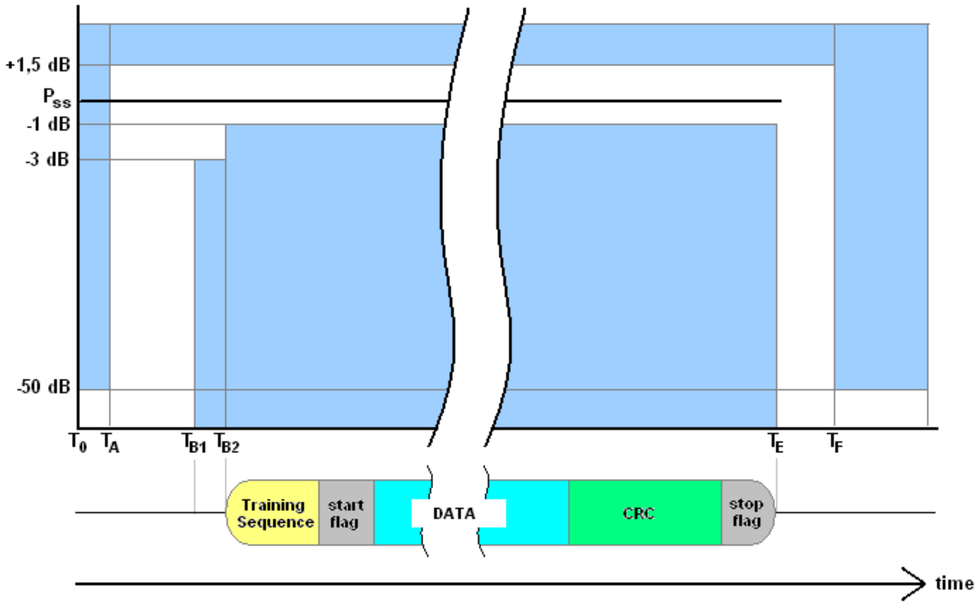


Figure 10: Power versus time mask

Table 6: Definitions of timings and limits

Reference		Bit Periods	Time (ms)	Definition
T_0		0	0	Start of transmission slot. Power shall NOT exceed -50 dB of P_{SS} before T_0
T_A		0 to 6	0 to 0,625	T_A = Point at which power exceeds -50 dB of P_{SS}
T_B	T_{B1}	6	0,625	Power shall be within +1,5 or -3 dB of P_{SS}
	T_{B2}	8	0,833	Power shall be within +1,5 or -1 dB of P_{SS}
T_E (includes 1 stuffing bit)		233	24,271	Power shall remain within +1,5 or -1 dB of P_{SS} during the period T_{B2} to TE (see note)
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
At no point shall the transmitted power exceed P_{Norm} (as measured in clause 9.2.3) during the transmitted sequence.				
NOTE: There shall be no modulation of the RF after the termination of transmission (TE) until the power has reached zero and the next slot begins (TG).				

9.4.2 Method of measurement

This measurement is a conducted measurement.

The measurement is made under normal conditions (see clause 6.7) for frequency AIS1 and repeated for AIS2.

The transmitter shall be connected to an artificial antenna (see clause 6.3). The measurement shall be carried out by transmitting test signal number 1 (see clause 6.4.1).

A spectrum analyser shall be used to make the measurements with the following preferred settings:

- resolution bandwidth: 1 MHz
- video bandwidth: 1 MHz
- scan bandwidth: zero span
- centre frequency: Carrier frequency as measured in clause 9.1

- detector type: sample detector [single sweep mode]
- trigger T0 from the EUT

The spectrum analyser shall be synchronized to the nominal start time of the slot (T_0) using the edge trigger timing signal described in clause 6.5.

9.4.3 Limit

The transmitter power shall remain within the mask shown in Figure 10 and associated timings and limits given in Table 6.

9.5 AIS Transmitter Transient Behaviour (frequency deviation)

9.5.1 Definition

The transient behaviour (frequency deviation) of the transmitter is determined by the time-dependency of the frequency deviation during the transmission of an AIS message, and to verify that the peak deviation of both 01010101 and 00001111 data sequences are as specified in Recommendation ITU-R M.1371-5 [10], table 35.

9.5.2 Method of measurement

This measurement is a conducted measurement.

The measurement is made under normal and extreme conditions (see clauses 6.7 and 6.8) for frequency AIS1 and repeated for AIS2.

The transmitter shall be connected to an artificial antenna (see clause 6.3) comprising a power attenuator and RF signal analyser (Figure 11).

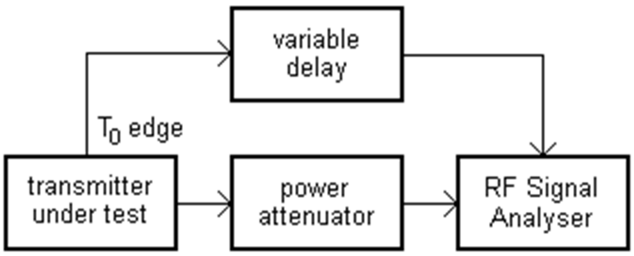


Figure 11: Measurement arrangement for modulation accuracy

The measuring device shall be synchronized to the nominal start time of the first preamble bit (T_B), using the edge trigger timing signal described in clause 6.5. Using test signal 2 the delay from the T_0 timing edge provided by EUT is adjusted until the centre position of the first data bit (bit 0) is determine as the trigger point T_B. Holding these settings test signal 2 is replaced with test signal 1 to confirm that T_B has been correctly determined.

NOTE: A spectrum analyser with an FM demodulation function and a trigger timing input can be used as a single alternative to the functions of the variable delay and RF signal analyser in Figure 11.

The transmitter shall be modulated with test signal number 1 (see clause 6.4.1).

The deviation from the carrier frequency shall be measured as a function of time.

The transmitter shall be modulated with test signal number 2 (see clause 6.4.2).

The deviation from the carrier frequency shall be measured as a function of time.

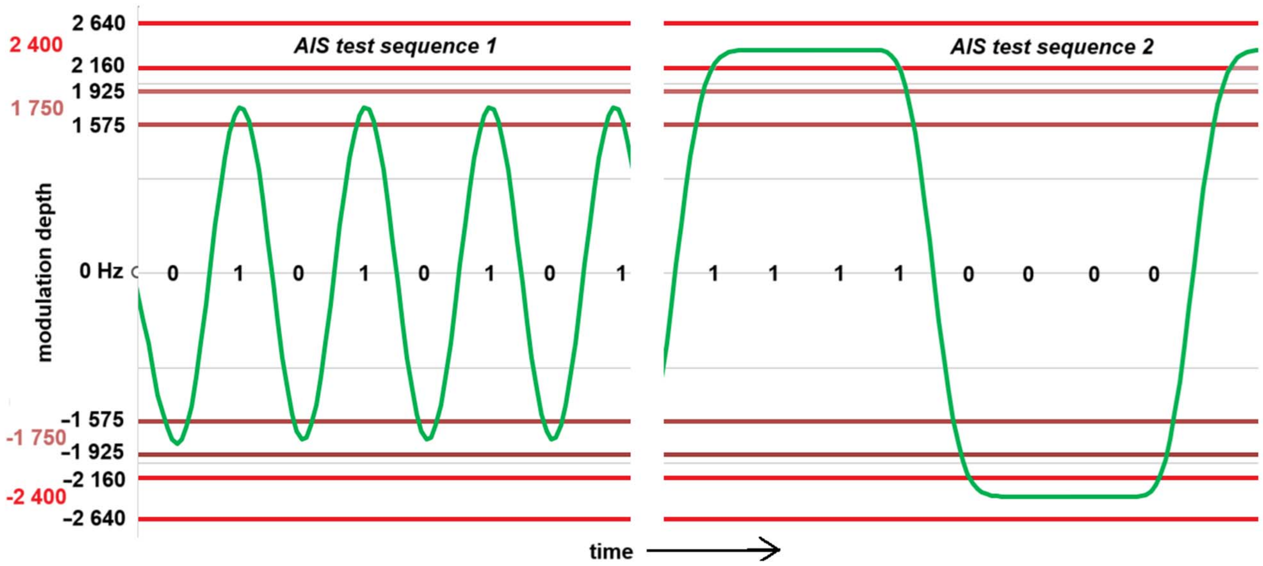


Figure 12: Example of modulation sequences of 01010101 and 11110000

9.5.3 Limit

In each case the observed training sequence shall begin with a '0'.

The peak frequency deviation error 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 error 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	< 1 000 Hz			
Bit 2 to bit 3	480 Hz			
Bit 4 to bit 31	240 Hz	480 Hz	240 Hz	480 Hz
Bit 32 to bit 199	175 Hz	350 Hz	240 Hz	480 Hz

9.6 AIS Synchronization accuracy

9.6.1 Definition

The synchronization accuracy defines the allowable time deviation including additive jitter in the transmission of an AIS message from ideal SOTDMA timing. The synchronization accuracy test verifies that the EUT transmission will be properly synchronized once UTC lock is acquired.

This test requires analysis of the transmissions of the EUT once activated.

9.6.2 Method of measurement

This measurement is a conducted measurement.

The measurement is made under normal and extreme conditions (see clauses 6.7 and 6.8) for frequency AIS1 and repeated for AIS2.

The transmitter shall be connected to an artificial antenna (see clause 6.3). The EUT's GNSS receiver shall be irradiated by a signal from a GNSS simulator simulating more than 3 satellites and that additionally provides a UTC output and a 1 pps reference output with an accuracy of 1 µs or better (Figure 13). The T_0 edge signal is the edge trigger timing signal described in clause 6.5.

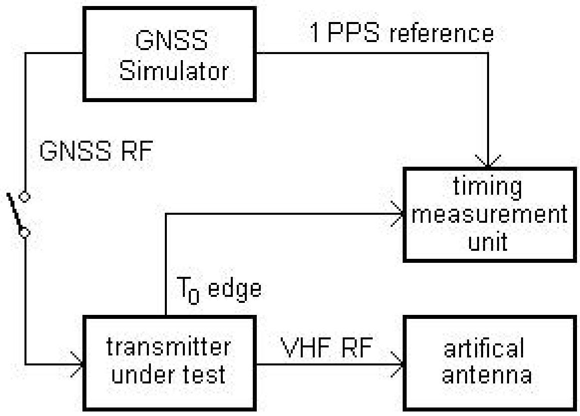


Figure 13: Measurement arrangement for synchronization accuracy

Activate the EUT in with GNSS signal enabled. After 15 minutes record AIS transmissions for 40 minutes.

Whenever a transmission is recorded the associated absolute difference in timing between the EUT generated T_0 edge and the GNSS simulator generated 1 pps reference shall be recorded. The EUT may pick any one of 75 slots in any two second period. The legitimate timings for both even and odd seconds are given in Table 8.

Table 8: Legitimate T0 Timings (µs) in any second

Even	Odd	Even	Odd	Even	Odd	Even	Odd
26 667	13 333	293 333	280 000	560 000	546 667	826 667	813 333
53 333	40 000	320 000	306 667	586 667	573 333	853 333	840 000
80 000	66 667	346 667	333 333	613 333	600 000	880 000	866 667
106 667	93 333	373 333	360 000	640 000	626 667	906 667	893 333
133 333	120 000	400 000	386 667	666 667	653 333	933 333	920 000
160 000	146 667	426 667	413 333	693 333	680 000	960 000	946 667
186 667	173 333	453 333	440 000	720 000	706 667	986 667	973 333
213 333	200 000	480 000	466 667	746 667	733 333	-	-
240 000	226 667	506 667	493 333	773 333	760 000	-	-
266 667	253 333	533 333	520 000	800 000	786 667	-	-

The UTC output from the simulator is used by the timing measurement unit to determine when even or odd slot timing measurements apply. The absolute difference between a legitimate slot start and the measured T_0 is the synchronization error.

9.6.3 Limit

Verify that all transmissions have a synchronization error (including additive jitter) of less than 312 µs.

9.7 AIS Effective Isotropic Radiated Power (EIRP)

9.7.1 Definition

The Equivalent Isotropic Radiated Power (EIRP) is the power radiated in the direction of the maximum field strength under the specified conditions of measurements.

9.7.2 Method of measurement

The measurement is made under normal conditions (see clause 6.7).

In a Semi-Anechoic Chamber (SAC) as specified in clause 5.2.1 of ETSI TS 103 052 [12], the EUT shall be placed in the centre of the support disk described in Annex B with its float-line aligned with the surface of the support disk. An adaptor plate is fitted to extend the ground plane up to the float line of the EUT. The submerged part of the EUT (below the float line) is wrapped in conductive foil bonded to the support disk.

A support disk height of 0,75 m above the ground plane can be used as an alternative. The height of the support disk above the ground plane shall be noted.

The minimum measurement distance from the receiving antenna to the EUT shall be 3 m. The receiving antenna shall either be a biconical antenna or a dipole tuned to 162,000 MHz.

NOTE 1: Other antenna types, particularly LPDAs and BiLogs can give spurious results at 3 m due to their extended far field and variable focal point and should not be used.

The EUT shall be set to transmit an unmodulated carrier on AIS1 (see clause 6.4.4).

The receiver shall be tuned to the transmitter carrier frequency. The receiving antenna shall be orientated for vertical polarization. The receiving antenna shall be raised or lowered from 1 m to 4 m until a maximum signal level is detected on the measuring receiver.

The transmitter shall be rotated through 360° around a vertical axis in order to find the direction of the maximum signal. From that position the transmitter shall be rotated in 30° steps to obtain 12 readings in all.

The signal level detected by the measuring receiver shall be noted as 12 values of P_1.

The EUT then shall be set to transmit an unmodulated carrier on AIS2 and the above test repeated to obtain 12 more values of P_1.

The EUT and its Annex B support shall be replaced by a substitution antenna being a reference dipole, vertically polarized and tuned to the 162,000 MHz with a VSWR better than 1.5:1. The centre of the substitution dipole shall be fixed at the position of the centre of the EUT at the same height as the float line.

The substitution dipole shall be connected to a signal generator via a cable of sufficient length, with the output level set to 0 dBm and tuned to the carrier frequency.

The receiving antenna shall be raised or lowered through the specified range of heights to ensure that the maximum signal is received.

The maximum signal level detected by the measuring receiver shall be noted as P_2.

The substitution antenna shall be disconnected from the cable and the same cable then connected to the input of the measuring receiver. The signal level detected by the measuring receiver shall be noted as P_3.

The maximum EIRP in all 12 cases of AIS and 12 cases of AIS2 are given by the equation:

$$EIRP = P_1[i] - P_2 + P_3 + Gd + 6\ dBi \quad (8)$$

Where Gd is the specific calibrated antenna gain if the dipole has been calibrated at 162,000 MHz or extrapolated to 162,000 MHz (nominally 2,15 dB).

NOTE 2: 6 dB is added when the test is performed on an OATS or SAC as specified above but is not added when the test is performed in a fully anechoic chamber or OATS covered with a ground-pane absorber. This is because without absorption the reference dipole measurement peaks when the direct path and ground-bounce reflected path interfere coherently, whereas the measurement of the EUT on the Annex B support disk has no ground-bounce reflected path.

9.7.3 Limits

The EIRP shall be at least 500 mW, and not more than 2 000 mW.

10 Spurious emissions

10.1 Definition

Unwanted emission(s) from 30 MHz to 6 GHz on frequencies other than the intended carrier frequencies and outside the spectrum mask frequency ranges. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products as well as emissions from microcontrollers and other devices.

10.2 Method of measurement

10.2.1 Modes of operation

The EUT shall be tested in the following modes:

i) Activated and transmitting and testing and transmitting repeatedly.

ii) In standby or off (not transmitting).

The EUT shall be tested in a Semi-Anechoic Chamber (SAC) as specified in clause 5.2.1 of ETSI TS 103 052 [12].

For the activated mode testing the EUT shall be placed in the centre of the support disk described in Annex B with its float-line aligned with the surface of the support disk. An adaptor plate is fitted to extend the ground plane up to the float line of the EUT. The submerged part of the EUT (below the float line) is wrapped in conductive foil bonded to the support disk.

For the other mode of testing (standby/off) the EUT shall be placed on a non-conducting support table at a height of 1 m.

NOTE: Receiver overload can occur when C/S or AIS transmitters are transmitting. Steps should be taken to mitigate these effects.

10.2.2 Test method

The test method shall be in accordance with EN 55016-2-3 [15], clause 7.3 for frequencies from 30 MHz to 1 GHz and clause 7.6 for frequencies from 1 GHz to 6 GHz with the modifications specified hereafter.

The measurement distance between the centre of the test antenna and the EUT shall be at least 3 m.

The measuring bandwidth shall be in accordance with clause 6.9.

The emissions shall be measured in the frequency range of 30 MHz to 6 GHz using the measuring receiver described in EN IEC 55016-1-1 [16] clause 5 (quasi-peak) and clause 6 for 1 GHz $< f \leq$ 6 GHz (peak).

The frequencies described in clause 10.2.3 shall be excluded from the measurement.

10.2.3 Exclusion bands

10.2.3.1 Active mode

The exclusion bands for all EUT types shall be the following:

- from 30 MHz to 108 MHz;
- from 121 MHz to 122 MHz;
- from 137 MHz to 156 MHz;
- from 162,1 MHz to 1,525 GHz;
- from 1,6265 GHz to 6 GHz.

10.2.3.2 Standby or off

There are no exclusion bands.

10.3 Limit

10.3.1 Activated mode

25 µW maximum.

10.3.2 Standby or off

2 nW between 30 MHz and 1 GHz and 20 nW between 1 GHz and 6 GHz maximum.

11 AIS VDL Link layer tests

11.1 Active mode tests

11.1.1 Method of measurement

Activate the EUT in and record transmissions for 40 minutes. Inhibit GNSS data and record transmissions for a further 20 minutes.

Record the activation time of the EUT.

For all transmitted messages record:

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

The records will be evaluated in the following test items.

11.1.2 Initialization period - Required results

The following is required:

a) The first message is transmitted within 60 seconds after activation.

b) The first message with a valid position is transmitted within 5 minutes.

11.1.3 Message content of Message 1 - Required results

For position reports transmitted after 5 minutes and before 40 minutes the following is required:

a) Message ID = 1.

b) Repeat indicator = 0.

c) Self ID as configured in the EUT (see clause 4.9.2).

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 visual indication according to clause 4.7.2 i).

11.1.4 Message content of first Message 14 - Required results

The message contents of message 14 in the first AIS burst (see clause C.1) are required to be:

a) Message ID = 14.

b) Repeat indicator = 0.

c) Self ID as configured in the EUT (see clause 4.9.2).

d) Text = "EPIRB ACTIVE".

11.1.5 Message content of second Message 14 - Required results

The message contents of message 14 in the fifth AIS burst (see clause C.1) are required to be:

a) Message ID = 14.

b) Repeat indicator = 0.

c) Self ID as configured in the EUT (see clause 4.9.2).

d) Text = "OHHHHHHHHHHHHHHH", where H…H is the Hex ID of the EUT.

NOTE: For Second Generation Beacons (SGB) the Hex ID is the first 15 characters of the 23 character ID.

11.1.6 Transmission schedule for Message 1 - Required results

For position reports transmitted after 15 minutes and before 40 minutes the following applies:

a) Verify that the EUT has operated in sync mode 0 (UTC direct).

b) The EUT transmits one burst of messages once per minute.

c) The duration of a burst is 14 seconds.

d) A burst consists of 8 messages.

e) The transmissions in a burst are alternating between AIS1 and AIS2.

f) Consecutive messages are 75 slots apart.

g) The same set of slots is used in each burst for 8 minutes.

h) A new set of slots is selected after 8 minutes.

i) The first slot of the new set of slots is within the interval of 1 minute ± 6 seconds from the first slot of the previous set of slots, that is the increment is selected in the range 2 025 slots to 2 475 slots.

11.1.7 Communication state of Message 1 - Required results

For position reports transmitted after 5 minutes and before 40 minutes 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.

11.1.8 Transmission schedule of Message 14 - Required results

The following is required:

a) Message 14 is transmitted every 4 minutes.

b) The transmissions of Message 14 are alternating between AIS1 and AIS2.

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.

11.1.9 Transmission with lost GNSS - Required results

For position reports transmitted after 45 minutes the following applies:

a) The EUT continues transmission.

b) The same transmission schedule is used as with GNSS 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 visual indication according to clause 4.7.2 i).

11.2 GNSS self-test

11.2.0 General

These tests require analysis of the transmissions of the EUT in GNSS self-test mode.

11.2.1 Method of measurement

Activate the EUT in GNSS self-test mode with a GNSS signal available and record transmissions.

11.2.2 Required results

The following is required:

a) The EUT starts transmission after valid GNSS fix has been obtained.

b) A single burst of 8 messages in the correct order and correctly populated as per clause C.2.

c) Self ID as configured in the EUT.

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 the first Message 14 is "EPIRB TEST".

m) The text message in the last Message 14 is "THHHHHHHHHHHHHHH", where H…H is the Hex ID of the EUT.

NOTE: For Second Generation Beacons (SGB) the Hex ID is the first 15 characters of the 23 character ID.

n) Verify correct indication as per manufacturer's documentation (see clause 4.7.2 vi) to viii)).

11.3 Functional self-test

11.3.0 General

These tests require analysis of the transmissions of the EUT in non-GNSS self-test mode.

11.3.1 Method of measurement

Activate the EUT in self-test mode.

11.3.2 Required results

The following is required:

a) Two Message 14s are transmitted, the first on AIS1 and the second on AIS2.

b) The text message in one Message 14 is "EPIRB TEST".

c) The text message in the other Message 14 is "THHHHHHHHHHHHHHH", where H…H is the Hex ID of the EUT.

NOTE: For Second Generation Beacons (SGB) the Hex ID is the first 15 characters of the 23 character ID.

12 GNSS receiver

12.1 General

The GNSS compliant receiver shall meet the requirements of the following clauses of EN 61108 series (GPS [6], GLONASS [7], Galileo [8] or Beidou [9]) for the manufacturer declared satellite constellations:

a) accuracy as stated in clause 4.3.3.2;

b) receiver sensitivity and dynamic range as stated in clause 4.3.7;

c) position update and resolution as stated in clause 4.3.9;

d) Blocking performance as specified in clause 4.2.1.

12.2 Protection from specific interfering signals

The GNSS receiver shall meet the protection from specific interfering signals requirements defined in clause 4.3.8 subclauses a) and b) of EN 61108 [6], [7], [8], [9] with all the manufacturer declared constellations active. The tests are performed once only and not repeated for each constellation.

12.3 Protection from internally generated interfering signals

12.3.1 Definition

The GNSS receiver shall be capable of obtaining a GNSS position in the presence of internally generated interfering signals at 121,5 MHz, AIS1 and AIS2 frequencies and at 406 MHz.

12.3.2 Method of measurement

12.3.2.1 Test setup

A typical test setup is shown in Figure 14. A suitable EMI shield enclosure shall be used as the test chamber for testing, for example a GTEM cell. Depending on the output power of the GNSS simulator used, an external amplifier and/or attenuator may be required. A suitable antenna transmitting at the relevant GNSS frequency shall be used to radiate the GNSS simulator signals in the chamber; herein referred to as the re-radiating antenna. Alternative setups may be used if the test provider can show that they are equivalent to the setup shown.

The test chamber shall provide shielding such that the EPIRB under test cannot receive any GNSS signals from outside of the chamber. In addition, the test chamber shall prevent signals transmitted by the EPIRB under test from being detected by outside sources.

The EPIRB shall transmit all signals at the same frequency and power level as it would when activated normally, no signals shall be offset in frequency or operate at a reduced power level.

A GNSS simulator shall be used to generate the test signals, using the manufacturer declared satellite constellations. If the EPIRB under test is fitted with a multi-constellation GNSS receiver, then the tests only need to be performed once.

The re-radiating antenna and the EPIRB under test shall be placed in direct line with one another such that the normal to the EPIRB's GNSS patch antenna is collinear with the bore sight of the re-radiating antenna at a spacing that puts the beacon under test in the far field of both antennas. The actual distance between the antennas is not critical provided that the beacon under test is in the far field of both antennas.

A beacon tester capable of decoding the 406 MHz location protocol bursts transmitted by the EPIRB shall be sited near the EPIRB but shall not interfere with the direct path between the re-radiating antenna and the EPIRB's GNSS antenna. Alternatively, an AIS receiver with position decoding software may be used.

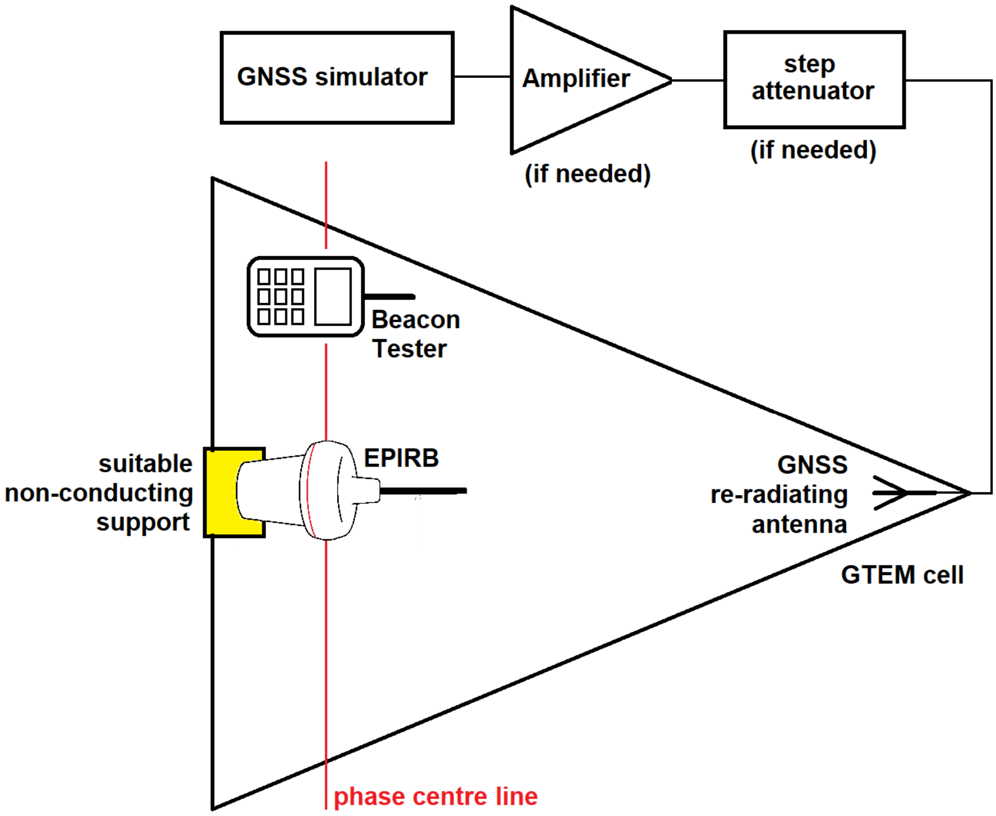


Figure 14: Test setup

Prior to commencing testing, the test setup shall be calibrated as described in clause 12.3.2.2.

12.3.2.2 Calibration of the test setup

The test setup shall be calibrated on a received signal level basis as detailed below to ensure that the signal levels at the surface of the EPIRB are correct.

Figure 15 illustrates a calibration setup. A power meter (as shown) or a calibrated spectrum analyser shall be used. A standard gain horn (as shown) or reference antenna (where the gain, phase centre location and polarization are known) shall be used. The equations below refer to a RefAnt (reference antenna). The top figure illustrates calibration of the external amplifiers and/or attenuators.

NOTE: Some GNSS simulators have a high power port that may be used for the test and the port's gain relative to the true output power port may be dependent on the number of satellites in the scenario. In this case the capability of adjusting the signal level by means of an external attenuator and/or amplifier is required.

The EPIRB shall be substituted with a standard gain horn or equivalent antenna (of known gain at the relevant GNSS frequency and known phase centre location) connected to the power meter or spectrum analyser and positioned such that the focal point (phase centre) of the horn or equivalent antenna is on the phase centre line of the EPIRB's GNSS antenna in the test setup.

A calibrated signal generator shall be used as the signal source to calibrate the system. For the purposes of calibration, the signal generator shall replace the GNSS simulator in Figure 14. A strong CW signal is needed in order for the power meter or spectrum analyser to properly determine the signal level. The "chamber system loss", defined as the loss measured from the output of the calibrated signal generator to the phase centre of the standard gain horn or equivalent antenna can then be determined. This loss will be exactly the same as the loss from the output port of the GNSS simulator in the test configuration to the phase centre of the EPIRB's GNSS antenna. All losses or gains of all elements including any polarization mismatch losses in both the calibration configuration and the actual test configuration shall be accounted for in a link calculation.

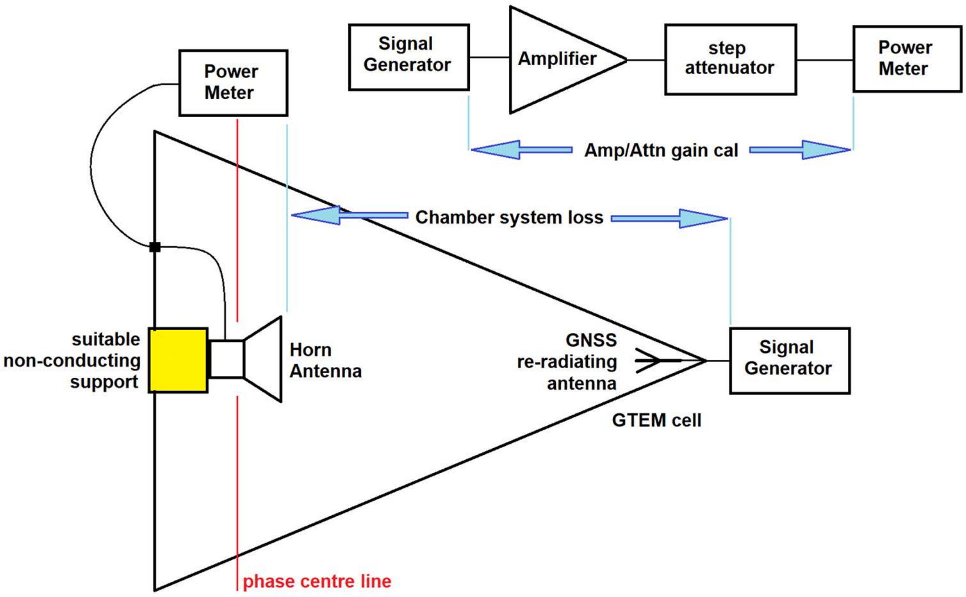


Figure 15: Calibration setup

The link equation for determining the Chamber Gain/Loss (GainChamber) in dBs is defined as follows:

$$P_{received} = P_{transmit} + Gain_{Chamber} + Gain_{RefAnt} + Gain_{line} + Gain_{Pol} \quad (9)$$

Where:

- $P_{transmit}$ is the signal generator transmit power level.
- $Gain_{Chamber}$ is the gain from the output of the signal generator to the EIRP incident on the reference antenna (will be a negative number if it is a loss). Figure 15 in this calibration section, this term is shown as a chamber system loss.
- $Gain_{RefAnt}$ is the gain of a reference antenna such as a standard gain horn (a positive number if there is a gain).
- $Gain_{line}$ is the reference antenna to receiver (power meter or spectrum analyser) cable gain (a negative number if a loss - a positive number if there is an LNA in the system).
- $Gain_{Pol}$ is a polarization gain (non zero if there is a polarization mismatch between the Ref Ant and the EPIRB's GNSS antenna). The polarization of the transmit antenna (re-radiating antenna is taken care of in the Chamber Gain number. Table 9 illustrates the GainPol values.
- $P_{received}$ is the received power level in a power meter or spectrum analyser.

It should be noted that any of the above quantities including $P_{transmit}$ and $P_{received}$ could be negative, thus it is important to correctly include the signs of these terms in evaluating all of the equations in this clause.

Table 9: $Gain_{Pol}$ values

Ref Antenna polarization	EPIRB's GNSS Antenna polarization	$Gain_{Pol}$
Circular	Circular	0
Linear	Circular	-3
Circular	Linear	+3

The Chamber Gain is given by:

$$Gain_{Chamber} = P_{received} - P_{transmit} - (Gain_{RefAnt} + Gain_{line} + Gain_{Pol}) \quad (10)$$

The required EIRP level into the EPIRB under test is defined as:

$$EIRP_{EPIRB} = P_{Scenario} + Gain_{Simulator\ high\ power\ port} + Gain_{Chamber} + Gain_{Amp/Attn} \quad (11)$$

Where:

- $P_{Scenario}$ is the scenario's power level coming out the GPS simulators normal power port.
- $Gain_{Simulator\ high\ power\ port}$ is the gain of the high power port relative to the normal simulators power output port (scenario will usually require use of a high power port - otherwise the losses in the chamber will have to be made up by amplification.
- $Gain_{Amp/Attn}$ is any other gain/loss required by the link. It may be an external amplifier or attenuator or both.

$EIRP_{EPIRB}$ is the EIRP incident upon the EPIRB's GNSS antenna.

For some GNSS simulators there may be a difference between the GNSS simulator's normal output port and a higher power monitor port which is dependent on the number of SV's (GNSS satellites) in the scenario. This number will be available from the vendor of the GNSS simulator. If this is the case, then different amplifier/attenuator settings are required and a calculation of the amplifier/attenuator setting should be done for the system when there are 7 SV's present.

Once the desired EIRP levels into the EPIRB are calculated, the setup is now calibrated and the reference antenna can be removed and replaced with the EPIRB under test and the signal generator can be replaced with the GNSS simulator.

It should be noted that once the system has been calibrated no further adjustments to the simulator output power levels shall be made during any of the simulator tests. If for some reason the level is adjusted or the setup is changed or there is reason to query the results obtained, then the setup shall be re-calibrated as described herein before carrying out any further tests.

12.3.2.3 Making the measurement

The measurement is made at normal test conditions (see clause 6.7).

The measurement comprises ten tests corresponding to each scenario specified in Table 10. Before each scenario is tested the EPIRB shall be switched off for sufficient time to ensure that no GNSS data from previous activations or tests is stored in the EUT and that the EUT cold starts for each test scenario described in Table 10.

With the equipment setup as described in clause 12.3.2.1 and after the setup has been calibrated as described in clause 12.3.2.2, Maritime Test Scenario #1 of Table 10 shall be loaded into the simulator. The scenario should then be started and within 10 seconds of the scenario starting the EPIRB shall be switched on and activated. At the same time as the EPIRB is activated a timer shall be started.

The scenario is then left to run until either a GNSS fix is obtained and a location protocol message containing position is received by the beacon tester or the scenario runs to completion plus one minute (to allow for just one missing 406 MHz burst) and no message containing position has been received by the beacon tester (i.e. only default locations have been received).

If a location is received on the beacon tester, then the timer shall immediately be stopped and both the time and received GNSS location recorded.

NOTE 1: The first transmitted location as received by the beacon tester is the one that is recorded; any subsequent updated locations should be ignored. If a location is not received within 13 minutes of starting the scenario, then a "Fail" will be indicated for that scenario in which case the scenario is not repeated and the next scenario is loaded as described below.

The GNSS indicator on the EPIRB shall be observed, this shall provide a visual indication that the GNSS reception is either satisfactory or unsatisfactory. On obtaining a GNSS fix this indicator shall provide a satisfactory indication, if during the test no position is obtained then this indicator shall provide an unsatisfactory indication. This can be used as an indicator that the next burst from the EPIRB should contain a valid location.

NOTE 2: The Time To First Fix Transmission (TTFFT) is the time until the EPIRB transmits a burst containing location data, not necessarily the time until the GNSS indicator on the EPIRB indicates that a GNSS fix has been obtained.

The EPIRB is then switched off and left turned off for sufficient time to ensure that no GNSS data from scenario just tested is stored in the EUT. During this period the next Scenario is loaded into the Simulator and both the Beacon Tester and timer are reset. Once the specified EPIRB off period has elapsed this procedure should be repeated for each scenario of Table 10.

Table 10: Maritime Test Scenarios

Scenario #	Min No of SVs	HDOP	Signal level at earth's surface RSS (dBm)	Pitch/Roll (Deg)	Rate of Pitch (Deg/s)	GNSS Location	GNSS Year
1	5	< 3	Nom	±15	15	No	0N, 0E
2	5	< 3	Nom	±60	60	No	0N, 0E
3	5	< 3	Nom	±60	5	80N, 0E	2016
4	5	< 3	Nom	±60	15	80N, 0E	2016
5	5	< 3	Nom	±60	60	80N, 0E	2016
6	5	< 3	Nom -5 dB	0	0	0N, 0E	2016
7	5	< 3	Nom -5 dB	±15	5	0N, 0E	2016
8	5	< 3	Nom	±15	5	44S, 174E	2016
9	5	< 3	Nom	±15	5	47N, 8W	2019
10	5	< 3	Nom -5 dB	±15	5	0N, 0E	2019

The delta location error (i.e. the difference between the simulator position and the EPIRB reported position) for each scenario shall be calculated and recorded using the following formula:

$$\text{Location Error (m)} = (((\text{SL Lat} - \text{TL Lat}) \times 111\,000)^2 + ((\text{SL Long} - \text{TL Long}) \times 111320 \times \cos \text{SL Lat})^2)^{1/2} \quad (12)$$

Where:

- SL Lat = The simulator location latitude in decimal degrees (e.g. 39.60000° N instead of 39° 36' N) to 5 decimal places.
- TL Lat = The EPIRB transmitted location latitude in decimal degrees to 5 decimal places.
- SL Long = The simulator location longitude in decimal degrees to 5 decimal places.
- TL Long = The EPIRB transmitted location longitude in decimal degrees to 5 decimal places.

12.3.3 Required results

The correct functioning of the EPIRB's GNSS indicator shall be checked against clause 4.7.2 iii) and iv).

At least 9 of the above 10 scenarios shall generate a TTFFT within 13 minutes.

At least 9 of the above 10 scenarios shall produce a location with an error of less than 650 m.

13 Lanyard Strength test

13.1 Definition

The breaking strength of the lanyard and its attachment to the EPIRB.

13.2 Method of measurement

The measurement is made at normal test conditions (see clause 6.7).

The EUT shall be rigidly mounted to a static test fixture by means of a clamp with the lanyard attachment point facing downwards. A weight of 24,5 kg ± 0,5 kg shall be attached to the lanyard at a distance of at least 1 m away from the EPIRB.

The weight shall be continuously moved in a pendulum motion without slacking the tension for a period of 5 minutes as follows: with the weight hooked through a cord loop, move the weight to the side through its arc until 15° ± 3° from the vertical. Release the weight and start a timer. When the weight is about to come to rest, promptly move the weight through its arc back to 15° ± 3° from vertical and release again ensuring a continuous motion.

13.3 Required result

The lanyard and attachment to the EPIRB shall not break.

14 Optical tests

14.1 Visible strobe light

14.1.1 Definition

The visible strobe light is a low-duty cycle white light indicator. It flashes when the EPIRB is active to indicate its position for the nearby survivors and rescue units.

14.1.2 Method of measurement

The measurement is made at normal test conditions (see clause 6.7).

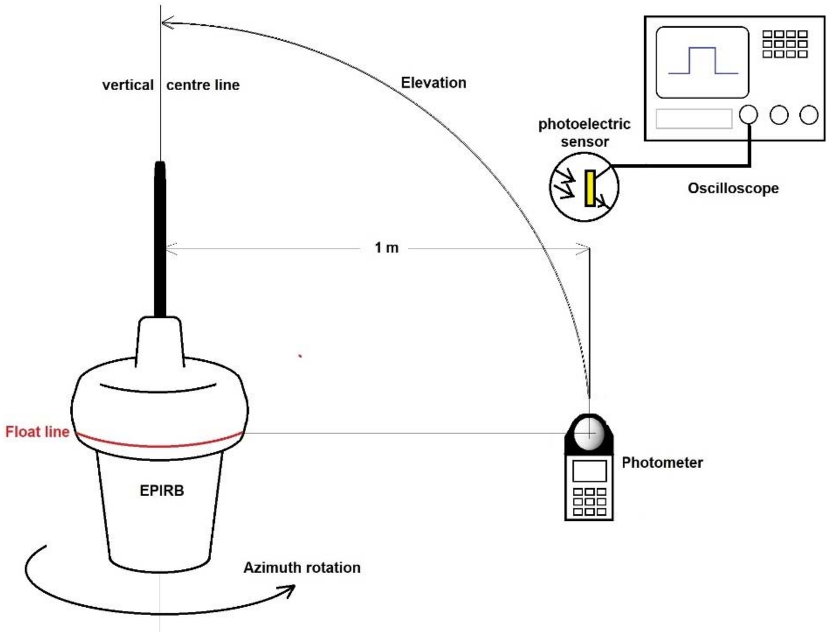


Figure 16: Optical test setup

The EUT shall be mounted vertically in a fixture with a calibrated photometer held at a constant distance of 1 m from a point along the vertical centre line of the EUT coincident with the float line determined in clause 7.13, so that the photometer/EPIRB can be moved through all the azimuth and elevation angles specified in table 11 (see Figure 16).

Alternatively, a larger distance can be used provided that the photometer is properly calibrated at that distance using a calibrated light source.

A photoelectric sensor connected to an oscilloscope shall be used to measure the pulse width and duration of the strobe light if the photometer does not have a suitable facility to make the measurement.

For SGBs a beacon tester capable of receiving the 406 MHz transmissions of the EPIRB shall be sited near the EPIRB but shall not interfere with optical measurements being made.

The Blondel-Rey formula, as described in IMO Resolution MSC.81 [20], clause 10.4.9, shall be applied to determine the effective luminous intensity.

$$\frac{\int_{t2}^{t1} i \cdot dt}{0{,}2+(t2-t1)} \qquad (13)$$

Where:

- i is the instantaneous intensity;
- 0,2 is the Blondel-Rey constant;
- $t2$ - $t1$ are the time limits of integration in seconds at which the intensity is i or greater.

The EUT shall be switched on and activated and a timer started at the point of activation. At each of the angles specified in Table 11 the effective luminous intensity shall be recorded, except for those elevation and azimuth combinations specified as Not Required (NR).

Table 11: Measured results table

Azimuth	Elevation								
	10°	**20°**	**30°**	**40°**	**50°**	**60°**	**70°**	**80°**	**90°**
0°									
45°					NR	NR	NR	NR	NR
90°									NR
135°					NR	NR	NR	NR	NR
180°									NR
225°					NR	NR	NR	NR	NR
270°									NR
315°					NR	NR	NR	NR	NR
NR: Measurement not required.									

Both activation methods (manual and automatic) shall be tested to determine the time to first flash only. The effective luminous intensity can be measured after either manual or automatic activation. To measure the time to first flash following automatic activation the water contacts shall be shorted to simulate water immersion.

14.1.3 Required results

The arithmetic mean of the light output over the entire upper hemisphere (the average of all the effective luminous intensity measurements in Table 11) shall not be less than 0,5 cd.

No measured points in Table 11 shall have an effective luminous intensity of less than 0,2 cd.

For FGBs the time from EPIRB activation to the commencement of the first flash of the low duty cycle strobe light shall be no more than 2 s when the EPIRB is manually operated and no more than 15 s when automatically activated.

For SGBs the first flash shall always be prior to the first 406 MHz transmission.

The flash rate of strobe shall be between 20 and 30 flashes per minute.

The flash duration shall be between 1 ms and 300 ms.

14.2 Optional night vision indicator

14.2.1 Definition

The night vision indicator light is a low-duty cycle (IR) strobe light. Fitting a night vision indicator is optional. It flashes when the EPIRB is active to indicate its position for the nearby rescue units.

14.2.2 Method of measurement

The measurement is made at normal test conditions (see clause 6.7).

The method is the same as that specified in clause 14.1.2 with the following modifications:

i) The photometer is replaced with an IR spectrophotometer.

ii) Measurements at the elevation of 0° are not required.

14.2.3 Required results

The arithmetic mean of radiant intensity of the IR output over the upper hemisphere above 20° (the average of all the radiant intensity measurements in Table 11 in the columns from 30° to 90°) shall be at least 2,5 mW/sr.

No measured points in Table 11 in columns from 20° to 90° shall have a radiant intensity of less than 0,25 mW/sr.

The emitted radiation shall have a dominant wavelength between 770 nm to 890 nm.

The time from EPIRB activation to the commencement of the first flash of the night vision indicator shall be no more than 1 minute.

The flash rate of night vision indicator shall be between 20 and 30 flashes per minute.

The flash duration shall be between 66 ms and 500 ms.

Annex A (informative): Maximum measurement uncertainty

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit is used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter is included in the test report.

Table A.1 shows the recommended values for the maximum measurement uncertainty figures. These apply where an uncertainty or tolerance is not specifically mentioned in the normative clauses.

Table A.1: Maximum measurement uncertainty

Parameter	Maximum uncertainty
Radio Frequency (RF)	$\pm 1 \times 10^{-7}$
Radiated emission of transmitter	±6 dB
Conducted RF power variations using a test fixture	±0,75 dB
Maximum frequency deviation: - within 300 Hz to 6 kHz of modulation frequency - within 6 kHz to 25 kHz of modulation frequency	 ±5 % ±3 dB
Deviation limitation	±5 %
Adjacent channel power	±5 dB
Conducted spurious emission of transmitter	±4 dB
Audio output power	±0,5 dB
Amplitude characteristics of receiver limiter	±1,5 dB
Sensitivity at 20 dB SINAD	±3 dB
Conducted emission of receiver	±3 dB
Two-signal measurement	±4 dB
Three-signal measurement	±3 dB
Transmitter transient time	±20 %
Transmitter transient frequency	±250 Hz
Timing measurement accuracy	±5 %

Annex B (normative): Additional Test Supports

B.1 EPIRB test support

The EUT shall be oriented vertically and placed on a circular support disk operating as a rotating ground plane capable of rotation through 360° in azimuth. As shown in Figure B.1, the rotating ground plane B shall have a minimum diameter of (2,5 m) and be made of highly conductive material (aluminium or copper). It shall be located at a reference height X = 1,00 ± 0,10 m above the test site's ground plane A, except where stated otherwise. The EUT, removed from its bracket, shall be mounted within the rotating ground plane B to a level such that its float line is aligned with the ground plane B and the antenna of the EUT orientated as normally deployed. This support disk surface shall be extended, via means of an adapter plate to be a close fit to the EUT. The below-waterline portion of the EUT shall be wrapped in a suitable conductive material (e.g. metal foil), electrically connected to the adapter plate. Alternatively, a bucket can be fitted containing salt water of the salinity specified clause 7.7 and the EUT floated in the bucket, again with the float line aligned with the support disk surface.

The receiving antenna shall either be a tuned dipole or a biconical antenna. As the receiving antenna is scanned in height its antenna axis shall be adjusted so that it always points towards the centre of the EUT at the float line.

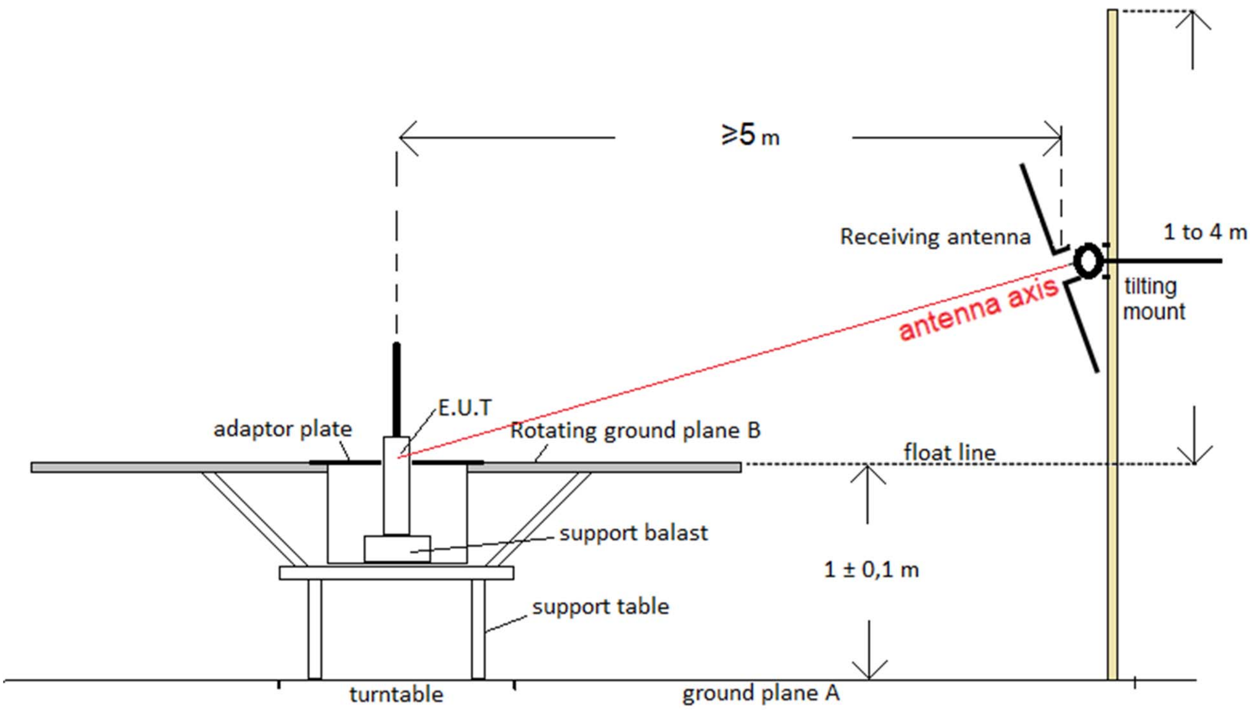


Figure B.1: EPIRB test support

Annex C (informative): AIS message bursts

C.1 Active mode

When activated the EPIRB transmits messages in a burst of 8 messages once per minute. The SOTDMA communication state of Message 1 is used to pre-announce future transmissions.

The EPIRB transmits Message 1 "Position report" with the Navigational Status set to 14 and Message 14 broadcast safety related message with the text "EPIRB ACTIVE". Message 14 is transmitted nominally every 4 minutes and replace one of the position reports on both channels.

The EPIRB transmissions alternate between AIS1 and AIS2.

The 1st and 5th burst are as follows:

- AIS1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS1, Message 14 "EPIRB ACTIVE"
- AIS2, Message 14 Text = "OHHHHHHHHHHHHHHH", where H…H is the Hex ID of the EUT.

NOTE: For Second Generation Beacons (SGB) the Hex ID is the first 15 characters of the 23 character ID.

- AIS1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)

The 2nd, 4th, 6th burst are as follows:

- AIS1, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out={6,4,2}, sub-message=slot)

The 3rd burst are as follows:

- AIS1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)

- AIS2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)

The 7th burst are as follows:

- AIS1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)

The 8th burst are as follows:

- AIS1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS2, 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) are randomly selected between 2 025 slots and 2 475 slots.

This pattern of transmissions is repeated. It is permissible to start the sequence on AIS2.

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.

C.2 GNSS self-test mode

When operating in the GNSS self-test mode there is one burst of 8 messages, 4 on each channel alternating:

- AIS1, Message 14 "EPIRB TEST"
- AIS2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS2, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)

- AIS1, Message 1, Nav Status = 15 not defined, comm-state (time-out=0, sub-message=0)
- AIS2, Message 14 Text = "THHHHHHHHHHHHHHH", where H…H is the Hex ID of the EUT.

NOTE 1: For Second Generation Beacons (SGB) the Hex ID is the first 15 characters of the 23 character ID.

NOTE 2: The first and last Message 14 may be swapped in position.

NOTE 3: It is permissible to start the sequence on AIS2.

C.3 Default message field values

On activation or if timed out in GNSS self-test mode, if the GNSS is unable to provide a valid position fix, then the reported position is longitude = 181° = not available = default and latitude = 91° = not available = default, COG = not available = default, SOG = not available = default, and the time stamp field is set to a value of 63.

If in active mode the GNSS is able to provide a valid position fix but that fix is subsequently lost, then the EPIRB continues to transmit with the last known position, COG and SOG. The time stamp field is set to a value of 63 and with the synchronization state set to 3.

Annex D (informative): Grey-box testing of EPIRBs

D.1 Definitions

A black-box test is one where no knowledge of the internal structure of the equipment to be tested is required to be known in order to fully perform the test. Black-box testing is preferred for compliance testing by market surveillance authorities because it can be performed on any sample of a product without any reference to the manufacturer. The present document specifies black-box tests wherever possible.

A white-box test is one where the tester has access to all the internal components of the equipment. This is the type of testing performed by manufacturers in order to debug and verify the correct operation of products during design, development and manufacture.

A grey-box test is one where some partial knowledge the internal structure of a product is required in order to complete the test. It may also require the use of equipment such as programming interfaces to put a product into a special test mode that is necessary to perform the test but would not normally be a mode the product would operate in. It is essential that manufacturers make available on request the equipment and instructions necessary to perform grey-box testing. Grey-box testing is only specified in the present document where a suitable black-box test is unavailable or inferior.

D.2 Test interface

It is essential that manufacturers incorporate a test interface whereby any sample of the equipment selected for testing can be placed into any of the required special test modes specified in clause D.3. In addition it is necessary for the test interface to permit easy access to the T_0 timing signal used for the AIS timing tests described in clauses 9.4, 9.5 and 9.6. That is the edge trigger timing signal corresponding to T_0 in Figure 10 of clause 9.4.

Given that EPIRBs are required to be watertight it is not unreasonable for a manufacture to hide the test interface within the watertight enclosure in such a way that access to it can only be achieved by opening the watertight enclosure and rendering the device no longer watertight.

How the test interface is accessed and the technical information necessary should be fully specified and available on request or published openly.

D.3 Special test modes and functions

The following special test modes should be supported by the test interface described in clause D.2 and their use fully documented:

i) The transmission on either channel AIS1 or AIS2 (as selected) of a single AIS frame containing AIS standard test signal number 1 as required by clause 6.4.1 followed by return to the not-transmitting state.

ii) The transmission on either channel AIS1 or AIS2 (as selected) of a single AIS frame containing AIS standard test signal number 2 as required by clause 6.4.2 followed by return to the not-transmitting state.

iii) The transmission on either channel AIS1 or AIS2 (as selected) of a single AIS frame containing AIS standard test signal number 3 as required by clause 6.4.3 followed by return to the not-transmitting state

iv) Continuous transmission on either channel AIS1 or AIS2 (as selected) with no modulation as required by clause 6.4.4.

v) Continuous transmission on 121.5 MHz or a nearby alternative test channel (as selected) with no modulation as required by clause 8.1.2.

vi) Continuous transmission on 121,5 MHz or a nearby alternative test channel (as selected) with continuous DST modulation at a duty cycle of 100 % as required by clauses 8.4.2 and 8.5.2.

vii) Operating the GNSS receiver on the manufacturer declared constellation(s) and transmitting the NMEA GNSS data strings on a suitable serial interface, either wired or via Bluetooth®/Wi-Fi® as required by clause 12.

Annex E (informative): Change history

Date	Version	Information about changes
April 2026	V1.1.1	First published version.

History

Version	Date	Status	
V1.0.0	December 2025	ENAP process	AP 20260303: 2025-12-03 to 2026-03-03
V1.1.0	April 2026	ENAP process	V 20260626: 2026-04-27 to 2026-06-26