RTCM 11901.1
RTCM Paper 119-2012-SC119-STD
with Amendment 1
RTCM Paper 119-2014-SC119-STD

RTCM STANDARD 11901.1

FOR

MARITIME SURVIVOR LOCATING DEVICES (MSLD)

DEVELOPED BY
RTCM SPECIAL COMMITTEE NO. 119

May 2, 2014

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Amendment 1
to
RTCM Standard 11901.1

Maritime Survivor Locating Devices (MSLD)

RTCM Standard 11901.1 – Maritime Survivor Locating Devices (MSLD) (RTCM Paper 119-2012-SC119-STD) is revised as follows:

> Replace pages 13-16 with new pages 13-16, Amending Annex A to provide for both "open loop" and "closed loop" operation.

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CONTENTS

RADIO TECHNICAL COMMISSION FOR MARITIME SERVICES

RTCM STANDARD FOR
MARITIME SURVIVOR LOCATING DEVICES
RTCM 11901.1

1 Scope

This document specifies the minimum functional and technical requirements for a Maritime Survivor Locating Device (MSLD) system.

MSLD Alerting Units (AUs) are intended to be carried by individuals engaged in on-deck activities on vessels, or in activities on shore where falls into the water are a risk, or in other marine activities where location of persons may be required.

The purpose of the AU is to send a local alert primarily to a mating Base Unit (BU) on one's own vessel or facility, and possibly also to other BUs on other vessels nearby. The MSLD system is not intended to perform the functions of an Emergency Position Indicating Radio Beacon (EPIRB). The AU may also serve as a locating beacon to assist in the individual's recovery.

The AU typically consists of a transmitter module, an integral antenna, and a power source, all contained in a wearable watertight case. The AU is typically used in conjunction with a mating BU on a vessel, but may be used with an existing receiver suited for the purpose. In addition, the system includes a Locating Function (LF) to aide in the search and rescue of the individual, which may or may not be part of the BU.

The MSLD system operates on a radio frequency authorized for this type of service.

The body of this standard is organized into two main parts:

- Common requirements for all MSLDs (Sections 1 through 8).
- Requirements for specific types of MSLDs (Annexes A through E).

2 Normative References

The following referenced documents are indispensable for the application of this document to the extent specified herein. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60529 - *Degrees of protection provided by enclosures (IP Code)*

IEC 60945 - *Maritime navigation and radio communication equipment and systems general requirements - methods of testing and required test results* (2002-08)

IEC 61097-3 – *Global maritime distress and safety system (GMDSS) - Part 3: Digital selective calling (DSC) equipment - Operational and performance requirements, methods of testing and required testing results*

IEC 61097-7 – *Global maritime distress and safety system (GMDSS) - Part 7: Shipborne VHF radiotelephone transmitter and receiver - Operational and performance requirements, methods of testing and required test results*

IEC 61108-1 - *Maritime navigation and radio communication 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* (2003-07)

IEC 62238 – *Maritime navigation and radiocommunication equipment and systems - VHF radiotelephone equipment incorporating Class 'D' Digital Selective Calling (DSC) - Methods of testing and required test results*

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

ITU-R M.690-1 - *Technical characteristics of emergency position-indicating radio beacons (EPIRBs) operating on the carrier frequencies of 121.5 MHz and 243 MHz*

ITU-R M.693 – *Technical characteristics of VHF emergency position-indicating radio beacons using digital selective calling (DSC VHF EPIRB)*

ITU-R M.821-1 - *Optional expansion of the digital selective-calling system for use in the maritime mobile service*

ITU-R SM.332-4 - *Selectivity of receivers*

ITU-R M.1371-4 – *Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile band.*

3 Definitions and Abbreviations

3.1 Marine Survivor Locating Device (MSLD)

A Marine Survivor Locating Device is part of a system consisting of at least one Alerting Unit (AU), at least one Base Unit (BU), and a Locating Function (LF). All MSLD systems shall provide as a minimum these functions:

1) Alert – The AU shall be capable of sending an RF signal to alert the BU and,
2) Alarm – The BU shall provide an on-board alarm to notify crew or nearby personnel of an overboard situation and,
3) Locate – The BU or other on-board component of the MSLD system shall provide some means for crew or nearby personnel to locate a person overboard.

3.2 Alerting Unit (AU)

A device carried or worn by a person which communicates by radio with a local base unit to indicate that the person has experienced an alerting condition such as: a) entering a body of water, or b) venturing beyond RF coverage range, or c) venturing outside a defined area.

3.3 Base Unit (BU)

A device that receives the radio signals from one or more AUs indicating that a person wearing the AU has experienced one or more of the alerting conditions above.

3.4 Locating Function (LF)

Some means for crew or nearby search and rescue personnel to determine a course to recover a person wearing an AU. This function may be satisfied by multiple means (e.g. RF transmission of location information from the AU, by visual light emanating from the AU, by homing in on an RF distress signal emanating from the AU). Additionally, for an AU with an RF homing transmitter, a radio direction finder Locating Unit (LU) either integral to or separate from BU may be used.

3.5 shall

describes attributes which RTCM considers necessary to meet the standard

NOTE – The use of the term "shall" is not intended to limit the possibility of amending the standard through the language of a regulation or contract which incorporates this Standard by reference. If an MSLD is produced to such an amended standard, any claim of compliance with this Standard on the MSLD or in its documentation, shall also describe the modification.

3.6 should

describes attributes recommended by RTCM, but not mandatory to claim compliance with this Standard

3.7 Abbreviations

AIS	Automatic Identification System
AU	Alerting Unit
BU	Base Unit
BUR	Base Unit Repeater
DSC	Digital Selective Calling
EIRP	Effective Isotropic Radiated Power
EMC	Electro Magnetic Compatibility
emf	electromotive force
EPFS	Electronic Position Fixing System
EPIRB	Emergency Position Indicating Radio Beacon
EUT	Equipment under Test
GHz	Gigahertz
GNSS	Global Navigation Satellite System
HDOP	Horizontal Dilution of Precision
IEC	International Electrotechnical Commission
ITU	International Telecommunication Union
kHz	Kilohertz
LF	Locating Function
LU	Locating Unit
MHz	Megahertz
MOB	Man Overboard
MSLD	Marine Survivor Locating Device
PEP	Peak Envelope Power
PERP	Peak Effective Radiated Power
PLL	Phase Locked Loop
RDF	Radio Direction Finder
RF	Radio Frequency
RMS	Root Mean Squared
RSSI	Received Signal Strength Indicator
SAR	Search and Rescue
SART	Search and Rescue Transponder
SOTDMA	Self-Organizing TDMA
SV	Space Vehicle
TDMA	Time Division Multiple Access
TTFF	Time to First Fix
VHF	Very High Frequency (radio band)
VDL	VHF Datalink
UTC	Universal Time Coordinated

4 Performance Requirements

The performance requirements in this section apply to all types of MSLD systems.

4.1 AU Controls and Indicators

All AU controls and indicators shall be:

- clearly and durably marked
- designed to prevent inadvertent activation

All AU controls and indicators should be:

- few in number
- kept simple to permit ease of operation.

The various modes of the controls should be readily apparent by visual observation.

AUs shall be designed for manual activation.

AUs should be designed for both manual and automatic activation.

Not less than two simple, independent actions shall be required for manual activation of the AU. Examples of independent actions include protection of a switch by a removable cover, or two independent switches.

All AU controls necessary for the correct operation of the AU shall be so designed that personnel wearing appropriately sized 5mm or more neoprene gloves can activate the AU.

A positive visual and/or audible indication that the AU is activated shall be provided.

4.1.1 User controls for AUs with only manual activation

AUs provided with only manual activation shall have as a minimum, clearly marked integral manual controls to operate the device in the following modes:

ON In the **ON** mode, the AU is manually activated.

TEST See paragraph 4.2.

OFF In the **OFF** mode, the AU is deactivated.

4.1.2 User Controls for AUs with both manual and automatic activation

AUs provided with both automatic and manual activation shall have, as a minimum, clearly marked integral manual controls to operate the device in the following modes:

READY or ARMED

In the **READY or ARMED** mode, the AU is normally deactivated, but automatically activates when the unit experiences an alerting condition as defined in Section 3.2. Once activated the unit should remain activated until it is switched to the **OFF** position or manually reset to the **READY or ARMED** mode.

ON In the **ON** mode, the AU is activated continuously, regardless of whether in or out of the water. This function must be provided by a separate mechanism in addition to the automatic actuator provided in the **READY or ARMED** mode. It is not sufficient to require the user to short the water contacts (or otherwise simulate automatic activation) for the function of manual activation.

TEST See paragraph 4.2.

OFF In the **OFF** mode, the AU is deactivated.

4.1.3 Function of the ON control

Transmission of the alert signal shall begin within 30 seconds of switching the control to the ON position. Consideration should be given to delaying transmission of the alert for some initial period not to exceed 30 seconds, to allow users to deactivate the device in the case of an inadvertent activation.

4.1.4 Indicators

4.1.4.1 Alerting

A visual and/or audible indicator detectable by the user shall commence within 5 seconds of the device being activated (both manually and/or automatically), and shall continue until the AU is no longer transmitting its alerting signal. The visual indicator should be visible in direct sunlight, low light, and no light conditions. The audible indicator should have a distinctive alarm tone with a minimum sound output of 85 dBA when measured 10 cm from the AU.

4.1.4.2 Self-test

A visual and/or audible indicator or indicators shall be provided to signal that a self-test was either successful or not successful. If the self-test takes longer than 5 seconds, a different indication should be given that the self-test is in progress.

4.1.5 Water activation function

The optional AU water-activation function should be protected against inadvertent activation from salt-water spray or rain.

4.2 Self-test function

The AU shall include a functional self-test designed to test as a minimum the following items under a full-load condition:

- battery, and
- RF output

The self-test shall be functional throughout the operating temperature range.

The manufacturer shall verify at the minimum: ambient and maximum operating temperatures, that the self-test pass/fail indicator(s) correctly identifies(y) any failure condition that has been detected by any of the self-test functions.

4.2.1 Battery self-test

The manufacturer shall verify during the battery self-test: ambient and maximum operating temperatures, that the AU battery experiences full-load current drain.

The battery self-test shall indicate when the battery is no longer capable of providing the minimum operating time.

4.2.2 RF self-test

The RF self-test shall include the connection of the transmitter to the antenna or an equivalent dummy load.

During the self-test function, the AU shall transmit in such a way that it will not cause a distress alert.

If the AU includes a 121.5 MHz radio-locating device, the signal transmitted during the self-test should not exceed 3 audio sweeps or 1 second, whichever is greater.

The means of activating the self-test feature should prevent the test signal from being continuously activated.

4.3 Buoyancy

Unless the AU is intended to be incorporated into a buoyant device, it should have sufficient positive buoyancy to float in fresh water and to operate while floating in fresh or salt water.

4.4 Environmental factors

The AU shall not be activated accidentally or damaged by:

a) dry heat

b) damp heat

c) low temperature

d) thermal shock

e) drop onto hard surface

f) drop into water

g) vibration sweep

h) water immersion (intrusion into the device)

i) solar radiation

j) oil contamination

k) corrosion

The electronic components should be protected to prevent malfunction under prolonged conditions of high humidity, including condensation.

5 Construction Requirements

5.1 General

The AU shall be wearable, or arranged to be attached to the user's clothing or Personal Floatation Device (PFD) without interfering with the user's activities. The AU should be provided with adequate means of attachment to the user in its "operational" position.

The AU should be designed for "hands free" operation, so that the user is not required to hold the unit out of the water for operation after activation.

The external design of the AU should avoid sharp edges or points to prevent injury or damage to equipment.

5.2 Battery

The AU shall have its own battery or batteries and should not depend upon any external source of power for its operation when activated. The batteries shall be an integral part of the equipment.

5.2.1 Battery hazards

The AU shall not be hazardous to personnel handling it, operating it, or performing manufacturer-approved servicing of it nor shall it release toxic or corrosive products outside the AU case:

a) during or subsequent to storage at temperatures between -55° C and +75° C;

b) during a full or partial discharge at any rate up to and including an external short circuit;

c) during a charge or forced discharge of a cell or cells by another cell or cells within the battery; and

d) after a full or partial discharge.

All AUs should be safe with respect to reversal of polarity, shorting, and the effects of self-heating, cell-to-cell charging, and forced discharging.

5.2.2 Battery life for primary battery

The AU manufacturer should establish a useful life and an expiration date for primary (non-rechargeable) batteries. The useful life is the period of time after the date of battery manufacture that the battery will continue to meet the input power requirements of the MSLD system (as defined in the appropriate Annex), over the entire specified operating temperature range. The following losses must be included (at a temperature of +20° C ± 5° C):

a) Testing, as recommended by the manufacturer or as required by the regulatory authority, whichever is the more demanding.

b) Self-discharge of the battery pack.

c) Standby loads, including any current drain in the READY mode of an AU.

The battery replacement date marked on the AU should be the date of battery installation in the AU plus no more than 50% of the rated life of the battery, provided that the battery cells are no older than 25% of the rated life of the battery.

5.2.3 Battery replacement

Replacement of the battery, if user-replaceable, should be possible with relative ease, and any interface connections required should be such as to prevent reversed polarity or incorrect installation. Provision should be made to ensure watertight integrity upon replacement of the battery.

5.3 Labeling

5.3.1 Battery

The MSLD documentation should include instructions on AU battery replacement intervals.

All batteries in the AU and BU (if used) should use polarized connectors or wires to battery connectors uniquely color coded. The wire to the most positive (+) terminal should be RED; the wire to the most negative (-) terminal should be BLACK. YELLOW, GREEN, and/or BLUE color coding (if used) should be used for wires connecting intermediate voltage levels in multi-voltage battery packs.

5.3.2 Identification and instructions

All labeling on the exterior of the AU shall be resistant to deterioration by prolonged exposure to sunlight, and shall not be unduly affected by seawater or oil, and shall be abrasion resistant. The outside of the AU shall be marked indelibly and legibly with the following:

a) Concise markings for operating controls as specified in Sections 4.1.1 or 4.1.2, including how to turn the AU on and how to clear an alarm.

b) Self-test instructions.

c) The name and address of the manufacturer.

d) The AU type number or model identification under which it was type tested.

e) The serial number or identification number of the AU.

f) Battery safety warning and disposal statement, if applicable.

g) Storage and operating temperature range of the AU.

h) Regulatory authority markings, if required.

i) Compass safe distance.

j) Warning to only activate device in an emergency.

k) If a GNSS receiver is included, a warning to not block the antenna.

6 Optional Performance Features

6.1 Lifesaving Equipment

The MSLD may include functions that remotely launch lifesaving equipment from the vessel, either automatically or by remote command.

6.2 Vessel Control

The MSLD may provide remote control of such vessel functions as steering, engine operation, and others as appropriate

7 Documentation

The manufacturer shall provide an operation manual including the following:

a) Intended use of the MSLD system.

b) Complete instructions for testing and operating the MSLD system.

c) Information explaining the BU and LF system compatibility requirements.

d) Cautions and recommendations to prevent false alarms.

e) General battery information (e.g., battery replacement instructions, battery type, safety information regarding battery use and disposal).

f) Information on when battery replacement is required.

g) Information related to the requirements of preventive maintenance.

h) Minimum operating life time, operating, and stowage temperature ranges.

i) Information explaining the requirement and procedure for licensing and registering MSLDs, as appropriate.

j) Information relating to the shipment of the MSLD.

k) Instructions on actions to be taken in the case of false alarms.

NOTE: In the case of accidental activation involving transmission of a 121.5 MHz signal, the user should de-activate the MSLD and notify the appropriate search and rescue authorities (e.g., U.S. Coast Guard or Rescue Coordination Center serving the geographic area) at the earliest possible time.

l) If a 121.5 MHz signal is transmitted during the self-test, information noting that the self-test should be performed only within the first 5 minutes of any hour and should not exceed 3 audio sweeps or 1 second, whichever is longer.

m) A warning to the effect that the device should only be activated in an emergency.

n) Instructions for fitting / attaching the AU to the user and for correct operation in the water in an emergency.

o) Instructions for BU installation, testing, use, and maintenance.

8 Performance Tests

8.1 Alerting Unit (AU)

8.1.1 Test conditions

Tests should be carried out under normal test conditions, unless otherwise stated.

8.1.1.1 Normal test conditions

Normal temperature and humidity conditions for tests should be any convenient combination of temperature and humidity within the following ranges:
Temperature: +15 °C to +35 °C
Relative humidity: 20 % to 75 %

8.1.1.2 Extreme test conditions

For tests at extreme temperatures, measurements should be made in accordance with the procedure specified in IEC 60945.

Applicable temperature range: -20 °C to +55 °C

8.1.1.3 Power supply

Electrical power should be supplied during performance tests normally by the batteries which form a part of the equipment.

8.1.1.4 Additional facilities

If the equipment contains any additional facilities such as electronic position fixing equipment, they should be operational for the duration of all tests, except if specified otherwise.

8.1.1.5 Audible and visual indications

During testing, all audible and/or visual indications should be operational.

8.1.1.6 Test radio transmissions

Care should be taken not to transmit distress signals on distress and safety frequencies without proper authorization.

8.1.2 Tests for durability and resistance to environmental conditions

The AU should be subjected to the tests for durability and resistance to environmental conditions in IEC 60945 applying to portable equipment. All tests should be performed on a single item of equipment. The tests should be carried out in the order given in IEC 60945.

8.1.3 Buoyancy test

Unless the AU is designed exclusively for incorporation in a buoyant device, it should be demonstrated to float in calm fresh water. If the AU is provided with a pouch or similar package that is not permanently affixed, the AU should be removed before conducting this test. Under conditions normally encountered in the maritime environment, the AU should have sufficient positive buoyancy to float with at least 5% reserve buoyancy.

8.1.4 Controls and indicators tests

8.1.4.1 Function

Function of the controls and indicators as required in 4.1 through 4.1.4.2 shall be verified by observation and by someone wearing the gloves specified in Section 4.1.

8.1.4.2 Controls durability

All manual controls should be operated for at least 500 cycles, without failure of the mechanism

8.1.4.3 Audible and visual indications

During testing, all audible and/or visual indications shall be detectable by the wearer when installed according to manufacturer’s recommendations.

8.1.5 Activation tests

8.1.5.1 Water activation test (for automatically-activated types only)

With the control in the **READY** mode, the AU should be floated in a 0.1 % salt solution and should activate within 60 seconds after being placed in the water. The salt used for the test should be sodium chloride (NaCl) containing, when dry, not more than 0.1 % sodium iodide and 0.03 % total impurities. The salt solution concentration should be (0.1 ± 0.01) % by weight. The solution should be prepared by dissolving 1 ± 0.1 parts by weight of salt in 1,000 parts by weight of distilled or demineralized water.

8.1.5.2 Rain/spray non-activation test

The AU should be mounted in a position simulating its normal operational position. The unit should be subjected to a simulated water spray in accordance with IEC 60529 (IP03) for a period of 10 minutes, except that the water used shall be a 3.5% salt solution. The AU should not activate at any time during this test. The salt water used for this test can either be normal sea water extracted from an area of sea not near a river or sewage outlet or subject to rain water or snow runoff, or can be made up using a solution of Sodium Chloride (NaCl) containing not more than 0.1% total impurities dissolved in distilled or demineralized water. The salt solution concentrate should be 3.5% +/- 0.5% by weight.

8.1.6 Test of the self-test mode

The self-test should be performed successfully at the minimum operating temperature (or colder), at the ambient temperature, and at the maximum operating temperature (or hotter).

8.1.7 Battery capacity and low-temperature test

Using a fresh battery pack, the AU should be activated under normal test conditions for a period of time as stated by the manufacturer to be equivalent to the loss of battery capacity due to self-testing, stand-by loads as well as battery-pack self-discharge during the useful life of the battery pack. The manufacturer should substantiate the method used to determine this time.

The AU should be placed in a chamber at normal test conditions. Then the temperature should be reduced to and maintained at -20° C ± 3° C for a period of 10 h. The unit should be activated within 30 min after the end of the 10 h period and should then be kept working continuously at that temperature for the period identified as the minimum operating time in the applicable annex.

Throughout the test period, the AU should function at the required power level and frequency as defined in the applicable annex.

8.1.8 Spurious and out-of-band emissions

The AU should be tested to determine that it conforms to the spurious and out-of-band emission limitations established by IEC 60945[1].

8.2 Base Unit (BU)

8.2.1 Tests for durability and resistance to environmental conditions

The BU should be subjected to the tests for durability and resistance to environmental conditions in IEC 60945 as declared by the manufacturer. A BU or any part of a BU intended for installation on an open deck should instead be subjected to the tests applying to exposed equipment. All tests should be performed on a single item of equipment. The tests should be carried out in the order given in IEC 60945.

8.2.2 Compass safe distance test

The BU should be subjected to the compass safe distance test in IEC 60945.

8.2.3 Conducted interference test

If there is a connection between the ship's power system and the BU, the equipment should, in addition, be tested for immunity to conducted radio frequency interference in accordance with IEC 60945.

8.3 Locating Unit (LU)

If an LU separate from the BU is provided as part of the MSLD system, it should be subjected to the tests for durability and resistance to environmental conditions in IEC 60945 applying to protected equipment. An LU or any part of an LU intended for installation or use on an open deck

[1] The regulatory authority certifying the alerting unit where it is to be sold may have stricter limitations.

should instead be subjected to the tests applying to exposed equipment. All tests should be performed on a single item of equipment. The tests should be carried out in the order given in IEC 60945.

8.3.1 Compass safe distance test

The LU should be subjected to the compass safe distance test in IEC 60945.

8.3.2 Conducted interference test

If there is a connection between the ship's power system and the LU, the equipment should, in addition, be tested for immunity to conducted radio frequency interference in accordance with IEC 60945.

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Annex A
(normative)

DSC type MSLD

A.1 Operational Scenario

The DSC-type MSLD system is designed to work as a component of the Digital Selective Calling (DSC) system integral to many VHF marine radios.

A victim is unexpectedly and inadvertently in the water or unable to return to the vessel or facility from which they departed due to weather, sea conditions, injury, fatigue, or other conditions.

Victims may be recovered by their own vessel, a dedicated small boat or aircraft from their own vessel.

Victims may potentially be in the water for up to 12 hours before they are recovered. Quick recovery of the victim is generally expected, however the victims may become separated from their vessel by strong currents in the area, or the vessel's high operating speed and/or lack of maneuverability.

Transmitter-operating times should be sufficient to allow for outside assistance.

A.2 System Components

A.2.1 Alerting unit (AU)

The AU shall be capable of immediately indicating its location and updating its position and transmitting this position to the BU at regular intervals. This may be achieved by several means, however if the AU incorporates a GNSS receiver, the GNSS receiver shall not be the only method of locating.

If the AU uses DSC messages addressed to 'all ships' as the alerting mechanism, the AU shall be fitted with a GNSS receiver to provide location in the transmitted message and a DSC receiver solely for the purpose of receiving acknowledgments of distress calls.

A.2.2 Base unit (BU)

The BU is a Class A or Class D DSC receiver, as defined in Recommendation ITU-R M.493-13 Annex 2, that decodes and displays the GNSS position of the AU. The Class A receiver shall comply with IEC 61097-3 and IEC 61097-7 and the Class D receiver shall comply with IEC 62238.

A.2.3 Locating unit (LU, Optional)

The Locating Function (LF) is normally provided by the integral GNSS receiver in the AU. However this function can be provided by a 121.5 MHz Direction Finder, or an integral part of the BU, or supplied as a separate standalone component. The Direction Finder shall be capable of providing a bearing to the AU and may indicate distance to the AU based upon Received Signal Strength (RSSI).

A.3 Performance Characteristics

A.3.1 Operating time

The AU shall operate for a minimum of 12 h. The BU (and LU if separate and applicable) should be capable of continuous operation for the same period either from the ship's power supply or through the incorporation of rechargeable batteries capable of being recharged from the ship's supply.

A.3.2 Interoperability

The AU shall be capable of communicating with nearby vessels using non-proprietary communications in accordance with ITU-R M.493-13, M.693 and M.821-1. The AU 121.5 MHz Homing signal (if applicable) shall be compliant with the relevant parts of ITU-R M.690-1.

A.3.3 Operational functions

As defined in the main body of this standard.

In addition, AUs using DSC messages addressed to all ships as the alerting mechanism shall be fitted with a visual indicator to indicate reception of a DSC distress alert acknowledgment message. This indicator shall be visible by the user when worn in the expected configuration in direct sunlight, low light and no light conditions.

A.3.4 Unique identifier (user ID)

The DSC MSLD AU shall have a unique identifier to ensure the integrity of the VHF data link.

The user ID for a DSC MSLD AU is 972xxyyyy, where xx = manufacturer ID1 01 to 99[1]; yyyy = the sequence number 0000 to 9999. When a manufacturer reaches sequence number 9999, they shall revert to sequence number 0000 and commence duplicating sequence numbers.

The manufacturer ID xx = 00 is reserved for test purposes. The unique identifier used for the purposes of type approval to this standard shall be in the format 97200yyyy.

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

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

A.3.5 DSC and AIS Combination MSLD Devices

If a manufacturer chooses to build an MSLD system that functions as both a DSC MSLD and an AIS MSLD (refer to Appendix E for detail), the AU transmitting both DSC and AIS messages shall transmit one common user ID.

If a conflict occurs during AIS and DSC transmission time occurs, the AIS transmission shall be given priority and the DSC transmission shall be delayed.

Note: For an AU fitted with DSC and AIS transmitters, the DSC receiver may be turned off for the period when the AIS transmitter is active.

A.3.6 Alerting signal

A DSC message shall be used for alerting the BU.

A.3.7 AU using DSC 'all ships' messages (open loop alerts)

On initial activation, the AU shall transmit a DSC message indicating Man Overboard (MOB).

The message shall be formatted as a Distress Alert as specified in line 1, table 4.1 of ITU-R M.493-13. The nature of distress field shall be set to symbol 110 (man overboard) and the subsequent communications field set to symbol 126 (no information).

[1] The manufacturer ID can be obtained from CIRM, 202 Lambeth Road, London SE1 7JW, UK.
Telephone: +44 (0) 20 3411 8345. E-mail: secgen@cirm.org. Web-site: www.cirm.org.

As the integral GNSS receiver will not be able to provide an accurate time and position from switch on, the position (message 2) and time (message 3) fields in the initial DSC message shall be replaced by the digits 9 and 8 respectively, in accordance with ITU-R M.493-13, paragraphs 8.2.3.4 and 8.2.4.3.

As soon as the integral GNSS receiver is able to provide an accurate position and time, the AU shall transmit a further Distress Alert with the position and time from the GNSS receiver automatically inserted into the message. The position expansion sequence of ITU-R M.821 shall also be used.

After this transmission, the DSC receiver in the AU shall turn on and monitor the DSC channel for acknowledgment messages. The DSC receiver may be turned off after reception of an acknowledgement message or after 2 minutes operation, whichever is the first to occur.

If a DSC Distress Alert acknowledgement message, formatted in accordance with table 4.2, line 1 of ITU-R M.493-13 is received by the AU, the DSC transmitter shall be switched off and not make any further transmissions. The indicator referred to in paragraph A.3.3 shall turn on.

If a DSC Distress Alert acknowledgment message is not received, the AU shall operate with a duty cycle of at least one message every 5 minutes for a period of 30 min, i.e. at least one transmission every 5 minutes for a 30 minute period (a minimum of 6 transmissions). The actual transmitter duty cycle shall be a randomly selected time of between 4.9 and 5.1 minutes. After each transmission, the DSC receiver shall turn on and monitor the DSC channel for acknowledgment messages. The DSC receiver may be turned off after reception of an acknowledgement message or after 2 minutes operation, whichever is the first to occur.

After 30 minutes have elapsed, the duty cycle may then change to 10 min. This will continue until an acknowledgment message is received, the batteries are exhausted or the MSLD transmitter is switched off. The actual transmitter duty cycle shall be a randomly selected time of between 9.9 and 10.1 minutes. After each transmission, the DSC receiver shall turn on and monitor the DSC channel for acknowledgment messages. The DSC receiver may be turned off after reception of an acknowledgement message or after 2 minutes operation, whichever is the first to occur.

If an acknowledgment message is received during these transmission cycles, the DSC transmitter shall be switched off and not make any further transmissions. The indicator referred to in A.3.3 shall turn on.

AU operation is summarized in the following table:

Table A.1 – Summary of DSC MSLD Operation

Time/event	Action	Comments
Initial switch on	• DSC Distress alert sent • GNSS rx on	Position and time fields replaced with digits 9 and 8 respectively.
GNSS lock	• Distress Alert with GNSS position and time sent • DSC rx on	DSC receiver may be turned off 2 minutes after each transmission or once an acknowledgement has been received
DSC Ack message received	• Indicator LED turns on • DSC rx off	Indicator to let user know their message has been received.

Time/event	Action	Comments
DSC Ack message not received		Beacon continues with a duty cycle of a DSC message at least every 5 mins for 30 mins, and then may be reduced to every 10 mins. The transmitter duty cycles shall be a randomly selected times of between 4.9 and 5.1 and 9.9 and 10.1 minutes respectively. DSC receiver may be turned off 2 minutes after each transmission or once an acknowledgement has been received This will continue until an acknowledgment message is received, the batteries are exhausted or the AU is switched to **OFF**.

A.3.8 AU using DSC individual station relay messages (closed loop alerts)

All messages shall be in accordance with ITU-R M.493-13. The message shall be a distress relay on behalf of another ship as specified in table 4.3 of ITU-R M.493-13.

Format Specifier – 120 distress relay
Address – Own ship MMSI
Category – 112
Self-Identification = Own ship MMSI or MSLD MMSI where applicable
Messages

- Message 0 – ID
- Message 1 – 110 (MOB)
- Message 2- Position (if used)
- Message 3 – Time (if used)

Message 4 – 100
End of Sequence 117

The above message format shall be transmitted once every 5 min for a period of 30 min. If after this period of time the AU has not been disabled then the DSC message shall change to a message calling a group in accordance with ITU-R M.493-13.

A.3.9 Position Data

The AU shall be capable of immediately indicating its location and updating its position, and transmitting this position to the BU at regular intervals. This may be achieved by several means, however if the AU incorporates a GNSS receiver, the GNSS receiver shall not be the only method of locating. The GNSS receiver shall be compliant with IEC 61108-1. The AU shall only transmit valid position data as defined by IEC 61108-1. The following Update Procedure shall apply.

The Time To First Fix (TTFF) of the GNSS receiver in the AU shall be less than 5 minutes regardless of the start configuration of the GNSS. If a valid GNSS fix has not been obtained, then the Position field in the DSC messages shall be replaced with the digit 9 repeated as necessary (and if applicable the Time field shall be replaced with the digit 8). If and when a valid GNSS fix has been obtained then the AU commences the transmission of DSC messages containing Position (and Time) as detailed above. The same GNSS position shall be transmitted for a minimum of 2 consecutive bursts without changing.

Once a fix has been obtained it shall be updated no more often than once every 10 minutes but at least once every 20 minutes and the new position shall then be encoded and transmitted for at least the next 2 consecutive bursts, whereupon the sequence repeats. If valid GNSS updates cannot be maintained, after an initial fix, then the last valid encoded position (and time) shall continue to be transmitted for a period of 3 hours. If within this time a valid fix is obtained then the new updated position shall be transmitted as described above. If however after 3 hours a valid fix has not been obtained, then the DSC message shall revert to the default values (of 9's and 8's) as if no valid fix had been obtained, until a valid fix is obtained.

A.3.10 Frequency and type of signal

156.525 MHz +/- 10 parts per million.

Phase Modulated G2B class of emissions (Channel 70 DSC)

The necessary bandwidth should be less than 16 kHz.

Frequency modulation with a pre-emphasis characteristic of 6 dB/octave (phase modulation) with a modulating sub-carrier shall be used.

A sub-carrier of 1700 Hz with frequency shift between 1300 Hz +/-10 Hz and 2100 Hz +/-10 Hz shall be used.

The modulation rate shall be 1200 baud and the index of modulation shall be 2.0 +/-10%.

A.3.11 Mandatory data included

As defined in ITU-R M.493-13

A.3.12 Optional data included

None

A.3.13 Radiated power output

Not less than 100 mW and not to exceed 500 mW vertically polarized

A.3.14 Radio locating signal (if applicable)

The radio locating signal shall consist of an Amplitude Modulated Continuous Swept Tone at 121.5 MHz to allow for a direction finder or similar type of Search and Rescue (SAR) equipment to locate the AU.

A.3.15 Frequency and type of emission

121.5 MHz +/- 50 parts per million

Double Sideband full carrier Amplitude Modulated (3K20A3X)

Emissions shall include a clearly defined carrier frequency component distinct from the modulation sideband components. At least 30% of the emitted power shall be contained within 250 parts per billion of the actual carrier frequency.

Transmitter Duty Cycle Continuous, except that transmissions maybe interrupted for a maximum of 1 second to permit the transmission of DSC messages.

Modulation – an audio swept signal upward or downward by not less than 700 Hz in the range 300 to 1600 Hz

Modulation Duty Cycle – 33% to 55%

Modulation Factor – between 0.85 and 1.0

Sweep Repetition Rate – 2 Hz to 4 Hz

A.3.16 Radiated power output

Not less than 25mW, not to exceed 100mW PERP

A.3.17 Method of Measurement of Frequency, Modulation and Radiated Power Output

The following test procedure is considered satisfactory for performing the subject test; however, it is recognized that alternate procedures may be performed. Such alternate procedures may be used if the test provider can show that they provide equivalent information.

Frequencies of 121.6, 121.65, 121.7, 121.75, 121.85, or 121.9 MHz should be used for testing outside of a screen room to avoid radiation at 121.5 MHz

The tests may be performed in any sequence and in conjunction with other electrical tests. In all cases, the tests should be conducted after the Equipment under Test (EUT) has been ON for at least 15 minutes.

A.3.17.1.1 Carrier Frequency Test

The carrier frequency test may be performed with a frequency counter or a spectrum analyzer. The carrier frequency, measured at the minimum and maximum operating temperatures, should be 121.5 MHz ± 50 parts/million.

A.3.17.1.2 Modulation Characteristics

The transmitter duty cycle, modulation frequency, modulation duty cycle, modulation factor, and sweep repetition rate may all be determined in a manner described below by observing the detected RF signal with a storage oscilloscope.

a) Transmitter Duty Cycle. Observe the transmitted signal and determine that the carrier is not interrupted (except in the case of a Morse or Voice encoded EUT).

b) Modulation Frequency and Sweep Repetition Rate. Observe the modulation envelope and determine the upper and lower audio-frequency sweep limits and sweep repetition rate.

c) Modulation Duty Cycle. Modulation duty cycle is the ratio of the positive modulation peak duration to the period of the instantaneous fundamental audio modulation frequency, observed at the half-amplitude points on the modulation envelope using the following formula (see Figure A.1):

$$Duty\ Cycle = \frac{A}{B}\ x\ 100\%$$

The modulation duty cycle should be measured near the start, midpoint, and end of the modulation sweep period.

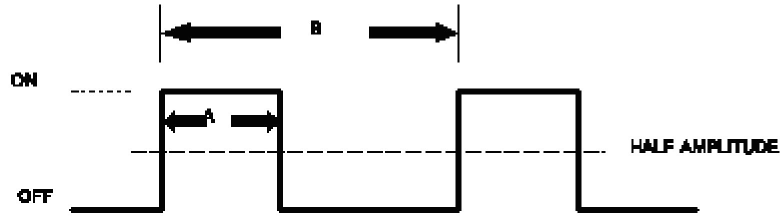

Figure A.1 – Typical Modulation Waveform

d) Modulation Factor. The modulation factor should be defined with respect to the maximum and minimum amplitudes of the modulation envelope by the following formula (see Figures A.2 and A.3):

$$Modulation\ Factor = \frac{A - B}{A + B}$$

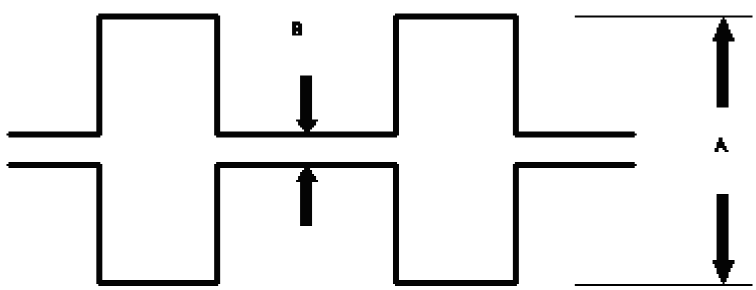

Figure A.2 – Typical Full-Wave Modulation Envelope

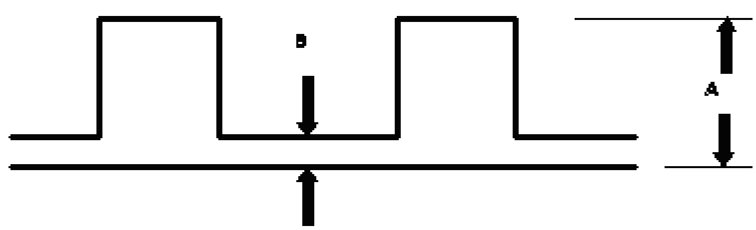

Figure A.3 – Typical One-Half Wave Modulation Envelope

e) As a minimum, if included, Morse or Voice encoded units may be verified by aural decoding and verification of the AU transmitted GNSS position compared to a known reference point. The Time to First Fix (TTFF) and thus transmission of encoded data shall be measured from the time the EUT is first activated. The received aural signal shall be clear and unambiguous. In addition, the Morse code rate and modulation frequency shall also be measured, or on Synthetic Voice transmissions the AM Index and transmitted modulation distortion shall be checked. The EUT shall then be moved in position by at least one mile and the update rate of the encoded position and the accuracy of the new location shall be checked. Finally the GNSS receiver in the EUT shall be masked so that it can no longer receive updates and the maintenance of the GNSS data in the transmitted message shall be established, the receiver shall then be unmasked and the renewed presence of transmitted data shall be confirmed within 5 minutes + 1 transmission cycle.

A.3.17.1.3 Peak Effective Radiated Power

The Peak Effective Radiated Power (PERP) is the Peak Envelope Power (PEP)[1] multiplied by the gain of the antenna.

This test is only required to be performed at ambient temperature and should use an EUT that has been ON for a minimum of 91.7% of its stated operational life. If the test length exceeds the remaining 8.3% of operational life, the battery may be replaced with another which has been preconditioned with at least 91.7% of its stated operational life discharged.

The measurement procedure consists of a determination of 12 values of PERP made by direct measurement of radiated power. The measurements are taken at an azimuth angle of 30º ± 3º. All PERP measurements should be made at the same elevation angle; the elevation used should be the angle between 5º and 20º for which the EUT exhibits a maximum antenna gain. The median value of PERP should be between 25 mW and 100 mW; the ratio of maximum to minimum of the 11 highest values of PERP should not exceed 2 to 1 (3-dB).

A.3.17.1.4 Radiated Power Test Condition

The test site should be on level ground which has uniform electrical characteristics. The site should be clear of metal objects, overhead wires, etc., and as free as possible from undesired signals such as ignition noise or other RF carriers. The distance from the EUT, or the search antenna to reflecting objects should be at least 30 m. The EUT should be placed in the center of a ground plane with a radius of no less than 75 cm ± 5 cm. The EUT should be positioned vertically.

The ground plane should be resting on the ground and should be extended so that it completely encloses and presents a snug fit to the EUT.

Measurement of the radiated signals should be made at a point 5 m or more from the EUT. At this point, a wooden pole or insulated tripod with a movable horizontal boom should be arranged so that a search antenna can be raised and lowered through an elevation angle of 5º to 20º. The search antenna should be mounted on the end of the boom with its cable lying horizontally on the boom and run back to the supporting mast. The other end of the search antenna cable should be connected to a spectrum analyzer located at the foot of the mast.

A.3.17.1.5 Method of Measurement

The elevation angle between 5º and 20º which produces a maximum gain is determined with the EUT at an arbitrary azimuth. The PEP should be measured and the elevation angle should be noted and should remain fixed for the remainder of the test. The remaining 11 measurements of PERP may be obtained by rotating the EUT in increments of 30º ± 3º. For each measurement the EUT PERP should be computed using the following equation:

$$PERP = \mathrm{LOG}^{-1} \frac{P_{REC} - G_{REC} + L_C + L_P}{10}$$

Where:

P_{rec}	=	Measured Power level from spectrum analyzer (dBm)
G_{rec}	=	Antenna gain of search antenna (dB)
L_c	=	Receive system attenuator and cable loss (dB)
L_p	=	Free space propagation loss (dB)

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[1] PEP is the RMS power supplied to the antenna by the transmitter measured at the highest crest of the modulation envelope.

A.3.18 Battery

The battery should be capable of operating the MSLD at the required radiated power output for at least 12 hours, see paragraph 6.2.

A.4 Performance Tests - DSC Transmitter

All tests on the AU shall be carried out with the output power set at its maximum, except where otherwise stated. When tests are carried out with an Artificial Antenna, this shall be a non-reactive, non-radiating 50 ohm load.

A.4.1 Frequency error

The frequency error is the difference between the measured carrier frequency and its nominal value.

A.4.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation, with the transmitter connected to an artificial antenna and tuned to channel 70. Measurements shall be made under normal test conditions (subclause 8.1.1.1) and under extreme test conditions (subclause 8.1.1.2). This test shall be carried out with the output power set at both maximum and minimum (if applicable).

A.4.3 Limits

The frequency error shall be within ±1.5 kHz.

A.4.4 Carrier power

The carrier power is the mean power delivered to the artificial antenna during one radio frequency cycle in the absence of modulation. The rated output power is the carrier power declared by the manufacturer.

A.4.5 Method of measurement

The transmitter shall be connected to an artificial antenna and the power delivered to this artificial antenna shall be measured. The measurements shall be made on channel 70, under normal test conditions (subclause 8.1.1.1) and under extreme test conditions (subclause 8.1.1.2).

A.4.6 Limits

A.4.6.1.1 Normal test conditions

With the output power set at maximum, the carrier power shall remain between 0.1 W and 0.5 W and be within ±1.5 dB of the rated output power under normal test conditions. The output power shall never however drop below 0.1 W.

A.4.6.1.2 Extreme test conditions

With the output power set at maximum, the carrier power shall remain between 0.1 W and 0.5 W and be within +2 dB, -3 dB of the rated output power under extreme conditions. The output power shall never however drop below 0.1 W.

A.4.7 Adjacent channel power

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation which falls within a specified passband centered on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation hum and noise of the transmitter.

A.4.8 Method of measurement

The adjacent channel power can be measured with a power measuring receiver (referred to in this subclause as the “receiver” – see A.6) which conforms to ITU-R Recommendation SM 332-4:

a) The transmitter shall be operated with the output power at maximum under normal test conditions. The output of the transmitter shall be linked to the input of the "receiver" by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the "receiver" input is appropriate.

b) With the transmitter unmodulated, the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The "receiver" attenuator setting and the reading of the meter shall be recorded.

c) The tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency of 17 kHz.

d) The transmitter shall be modulated with 1.25 kHz at a level which is 20 dB higher than that required to produce ±3 kHz deviation.

e) The "receiver" variable attenuator shall be adjusted to obtain the same meter reading as in step b) or a known relation to it.

f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the meter.

g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

The measurement may be made with the transmitter modulated with normal test modulation, in which case this fact shall be recorded with the test results.

A.4.9 Limits

The adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to be below 0.2 µW.

A.4.10 Conducted spurious emissions conveyed to the antenna

Conducted spurious emissions are emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions.

A.4.11 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna. The measurements shall be made over a range from 9 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels. The measurements for each spurious emission shall be made using a tuned radio measuring instrument or a spectrum analyzer.

A.4.12 Limit

The power of any conducted spurious emission on any discrete frequency shall not exceed 0.25 µW.

A.4.13 Cabinet radiation and conducted spurious emissions other than those conveyed to the antenna

Cabinet radiation consists of emissions at frequency, radiated by the equipment cabinet and structures.

Conducted spurious emissions other than those conveyed to the antenna are emissions at frequencies, other than those of the carrier and the sideband components resulting from the wanted modulation process, which are produced by conduction in the wiring and accessories used with the equipment.

A.4.14 Method of measurement

On a test site, detailed in A.4.14.1.1.1, the equipment shall be placed at the specified height on a non-conducting support and in position closest to normal use as declared by the manufacturer. The transmitter antenna connector shall be connected to an artificial antenna. The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver. The transmitter shall be switched on without modulation, and measuring receiver shall be tuned over the frequency range 30 MHz to 2 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

At each frequency at which a spurious component is detected:

a) The test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

b) The transmitter shall be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

c) The maximum signal level detected by the measuring receiver shall be noted.

d) The transmitter shall be replaced by a calibrated antenna (substitution antenna) and calibrated RF source.

e) The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

f) The substitution antenna shall be connected to a calibrated signal generator.

g) The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

h) The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

i) The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

j) The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

k) The input level to the substitution antenna shall be recorded as power level, corrected for the change of input attenuator setting of the measuring receiver.

l) The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

m) The measure of the effective radiated power of the spurious components is larger of the two power levels recorded for spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary;

n) The measurements shall be repeated with the transmitter on stand-by.

A.4.14.1.1.1 Radiated measurements

A.4.14.1.2 Test sites and general arrangements for measurements involving the use of radiated fields

A.4.14.1.2.1 Outdoor test site

The outdoor test site (Figure A.4) shall be on a reasonably level surface or ground. At one point on the site, a ground plane of at least 5 m diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1.5 m above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of lambda/2 or 3 m whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

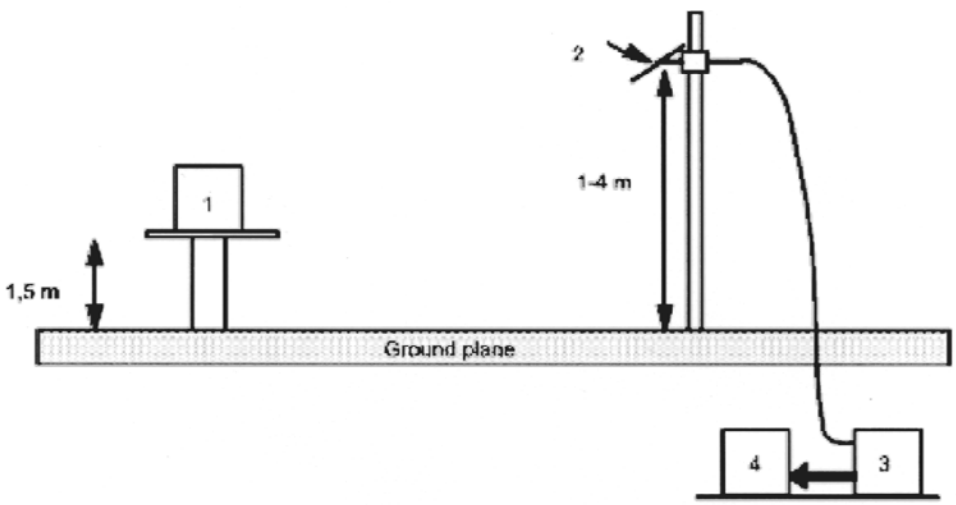

Figure A.4 – Outdoor Test Site

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurements results.

A.4.14.1.2.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics. This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarization and for the height of its centre above ground to be varied over the range 1 to 4 m. Preferably, a test antenna with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20% of the measuring distance.

For receiver and transmitter radiation measurements, the test antenna is connected to a measuring receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. For receiver radiated sensitivity measurements the test antenna is connected to a signal generator.

A.4.14.1.2.3 Substitution antenna

When measuring in the frequency range up to 1 GHz, the substitution antenna shall be a lambda/2 dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the lambda/2 dipole. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 and 4 GHz either a lambda/2 dipole or a horn radiator may be used. The center of this antenna shall coincide with the reference point of the test sample it has replaced.

This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 0.3 m.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

A.4.14.1.2.4 Optional alternative indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2.7 m in height (Figure A.5).

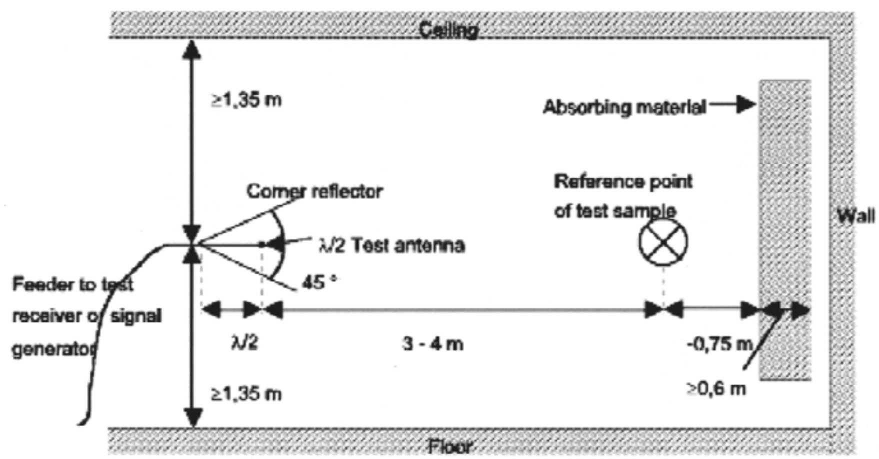

Figure A.5 – Indoor site arrangement (shown for horizontal polarization)

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarized measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements. For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed. For practical reasons, the lambda/2 antenna in Figure A.5 may be replaced by an antenna of constant length, provided that this length is between lambda/4 and lambda at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of lambda/2 to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ±0.1 m in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-sited until a change of less than 2 dB is obtained.

A.4.15 Limits

When the transmitter is in stand-by, the cabinet radiation and spurious emissions shall not exceed 2 nW;

When the transmitter is in operation the cabinet radiation and spurious emissions shall not exceed 0.25 μW.

A.4.16 Transient frequency behavior of the transmitter

The transient frequency behavior of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when the RF output power is switched on and off.

Timing:

- t_{on}: According to the method of measurement described in subclause A.4.17 the switch-on instant t_{on} of a transmitter occurs when the output power, measured at the antenna terminal, exceeds 0.1 % of the nominal power.
- t_{off}: The switch-off instant occurs when the power falls below 0.1 % of the nominal power.
- t_1: Period of time starting at t_{on} and finishing according to Table A.2 and Figure A.6
- t_2: Period of time starting at the end of t_1 and finishing according to Table A.2 and Figure A.6
- t_3: period of time finishing at t_{off} and starting according to Table A.2 and Figure A.6

Table A.2 – Transmitter transient timing

t1	5.0 ms
t2	20.0 ms
t3	5.0 ms
NOTE 1: During the periods t1 and t3 the frequency difference should not exceed the value of 1 channel separation. NOTE 2: During the period t2 the frequency difference should not exceed the value of half a channel separation. See Figure A.6	

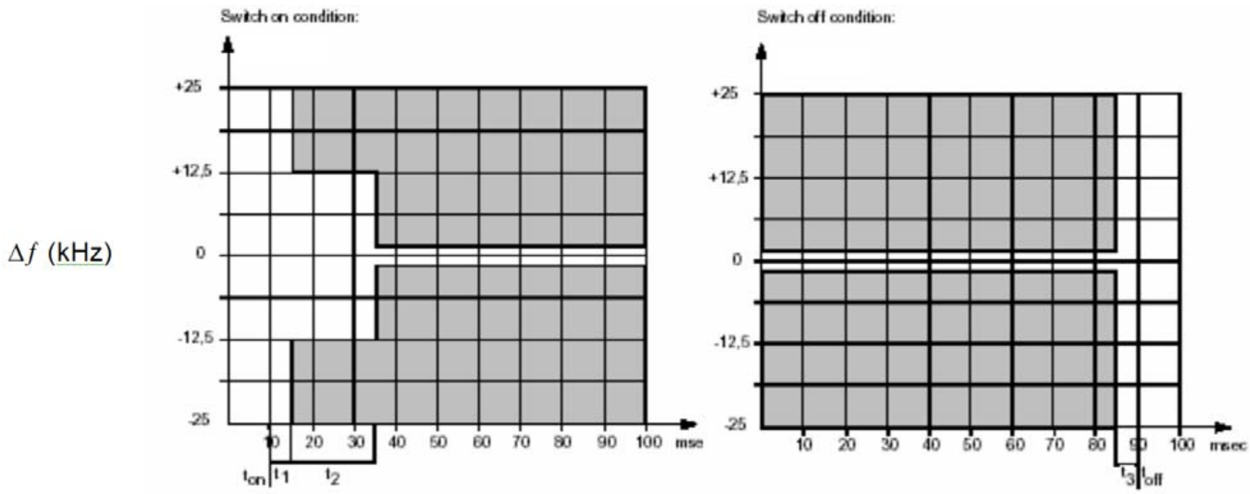

Figure A.6 – Switch on and switch off conditions

A.4.17 Method of measurement

Two signals shall be connected to the test discriminator via a combining network as shown in Figure A.7, such that the impedance presented to the input is 50 ohms, irrespective of whether one or more test signals are applied simultaneously.

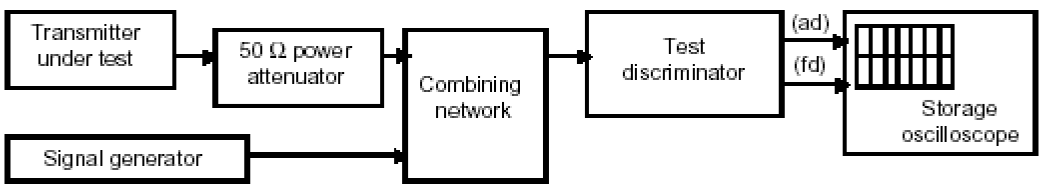

Figure A.7 – Test setup

The transmitter shall be connected to a 50 ohm power attenuator.

A test signal generator shall be connected to the second input of the combining network.

The test signal shall be adjusted to the nominal frequency of the transmitter.

The test signal shall be modulated by a frequency of 1 kHz with a deviation of ±25 kHz.

The test signal level shall be adjusted to correspond to 0.1% of the power of the transmitter under test measured at the input of the test discriminator. This level shall be maintained throughout the measurement.

The amplitude difference (ad) and the frequency difference (fd) output of the test discriminator shall be connected to a storage oscilloscope.

The storage oscilloscope shall be set to display the channel corresponding to the (fd) input up to ±25 kHz.

The storage oscilloscope shall be set to a sweep rate of 10 ms/division and set so that the triggering occurs at one division from the left edge of the display.

The display shall show the 1 kHz test signal continuously.

The storage oscilloscope shall then be set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

The transmitter shall then be switched on, without modulation, to produce the trigger pulse and a picture on the display.

The result of the change in the ratio of power between the test signal and the transmitter output will, due to the capture ratio of the test discriminator, produce two separate sides on the picture, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

The moment when the 1 kHz test signal is completely suppressed is considered to provide t_{on}.

The periods of time t_1 and t_2 as defined in Table A.2 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

The storage oscilloscope shall be set to trigger on the channel corresponding to the amplitude difference (ad) input at a high input level, decaying and set so that the triggering occurs at 1 division from the right edge of the display.

The transmitter shall then be switched off.

The moment when the 1 kHz test signal starts to rise is considered to provide t_{off}.

The period of time t_3 as defined in Table A.2 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

A.4.18 Limits

During the periods of time t_1 and t_3 the frequency difference shall not exceed ±25 kHz.

The frequency difference after the end of t_2 shall be within the limit of the frequency error given in subclause A.4.1.

During the period of time t_2 the frequency difference shall not exceed ±12.5 kHz.

Before the start of t_3 the frequency difference shall be within the limit of the frequency error given in subclause A.4.1.

A.4.19 Residual modulation of the transmitter

The residual modulation of the transmitter is the ratio, in dB, of the demodulated RF signal in the absence of wanted modulation, to the demodulated RF signal produced when the normal test modulation is applied.

A.4.20 Method of measurement

The normal test modulation (modulation frequency 1 kHz and frequency deviation ± 3 kHz) shall be applied to the transmitter. The high frequency signal produced by the transmitter shall be applied, via an appropriate coupling device, to a linear demodulator with a de-emphasis network of 6 dB per octave. The time constant of this de-emphasis network shall be at least 750 µs.

Precautions shall be taken to avoid the effects of emphasizing the low audio frequencies produced by internal noise.

The signal shall be measured at the demodulator output using an r.m.s. voltmeter.

The modulation shall then be switched off and the level of the residual audio frequency signal at the output shall be measured again.

A.4.21 Limit

The residual modulation shall not exceed -40 dB.

A.4.22 Frequency error (demodulated DSC signal)

The frequency error for the B- and the Y-state is the difference between the measured frequency from the demodulator and the nominal values.

A.4.23 Method of measurement

The transmitter shall be connected to the artificial antenna and a suitable FM demodulator.

The transmitter shall be set to channel 70.

The transmitter shall be set to transmit a continuous B- or Y- state.

The measurement shall be performed by measuring the demodulated output, for both the continuous B- and Y-state.

The measurements shall be carried out under normal test conditions (subclause 8.1.1.1) and extreme test conditions (subclause 8.1.1.2).

A.4.24 Limits

The measured frequency from the demodulator at any time for the B-state shall be within 2 100 Hz ± 10 Hz and for the Y-state within 1 300 Hz ± 10 Hz.

A.4.25 Modulation index for DSC

This test measures the modulation index in the B and Y states.

A.4.26 Method of measurement

The transmitter shall be set to transmit continuous B and then Y signals. The frequency deviations shall be measured.

A.4.27 Limits

The modulation index shall be 2.0 ± 0.2.

A.4.28 Modulation rate for DSC

The modulation rate is the bit stream speed measured in bits per second.

A.4.29 Method of measurement

The transmitter shall be set to transmit continuous dot pattern.

The RF output terminal of the transmitter, via a suitable attenuator, shall be connected to a linear FM demodulator. The output of the demodulator shall be limited in bandwidth by a low pass filter with a cut-off frequency of 1 kHz and a slope of 12 dB/octave.

The frequency of the output shall be measured.

A.4.30 Limits

The frequency shall be 600 Hz ± 30 ppm corresponding to a modulation rate of 1 200 baud.

A.4.31 Testing of generated call sequences

Generated call sequences are calls which comply with the requirements of ITU-R Recommendation M.493-13.

A.4.32 Method of measurement

The output of the transmitter shall be suitably connected to a calibrated apparatus for decoding and printing out the information content of the call sequences generated by the equipment.

The transmitter shall be set to transmit DSC calls as specified in A.3.4.

A.4.33 Requirement

The requirements of ITU-R Recommendation M.493-13 regarding message composition and content shall be met.

The generated calls shall be analyzed with the calibrated apparatus for correct configuration of the signal format, including time diversity.

It shall be verified that, if applicable, after transmission of a DSC call, the transmitter re-tunes to the original channel. However in the case of a distress call, if applicable, the transmitter shall tune to channel 16 and automatically select the maximum power.

The telecommands used and the channels tested for switching shall be stated in the test report.

A.5 Performance Tests – DSC Receiver

A.5.1 Maximum usable sensitivity

A.5.2 Definition

The maximum usable sensitivity of the receiver is the minimum level of the signal (e.m.f.) at the nominal frequency of the receiver which when applied to the receiver input with a test modulation will produce a bit error ratio of 10^{-2} .

A.5.3 Method of measurement

DSC standard test signal (see clause A.5.9) containing DSC calls shall be applied to the receiver input. The input level shall be 0 dBμV under normal test conditions (see clause 8.1.1.1) and +6 dBμV under extreme test conditions (see clause 8.1.1.2).

The measurement shall be repeated under normal test conditions at the nominal carrier frequency ±1,5 kHz.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

A.5.4 Limits

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.5 Co-channel rejection

A.5.6 Definition

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

A.5.7 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see clause A.5.8). The wanted signal shall be the DSC standard test signal (see clause A.5.9) containing DSC calls.

The level of the wanted signal shall be +3 dBμV. The unwanted signal shall be modulated by 400 Hz with a deviation of ±3 kHz. Both input signals shall be at the nominal frequency of the receiver under test and the measurement shall be repeated for displacements of the unwanted signal of up to ±3 kHz.

The input level of the unwanted signal shall be -5 dBμV.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

A.5.8 Limits

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.9 Adjacent channel selectivity

A.5.10 Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by 25 kHz.

A.5.11 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see clause A.5.8).

The wanted signal shall be the DSC standard test signal (see clause A.5.9) containing DSC calls. The level of the wanted signal shall be +3 dBμV under normal test conditions and +9 dBμV under extreme test conditions.

The unwanted signal shall be modulated to 400 Hz with a deviation of ±3 kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channel. The input level of the unwanted signal shall be 73 dBμV under normal test conditions and 63 dBμV under extreme test conditions.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

The measurement shall be carried out under normal test conditions (see clause 8.1.1.1) and under extreme test conditions (see clause 8.1.1.2).

A.5.12 Limits

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.13 Spurious response and blocking immunity

A.5.14 Definition

The spurious response and blocking immunity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the pass band of the receiver.

A.5.15 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see clause A.5.8).

The wanted signal shall be the DSC standard test signal (see clause 6.9) containing DSC calls. The level of the wanted signal shall be +3 dBµV.

For the spurious response test the unwanted signal shall be unmodulated. The frequency shall be varied over the range 9 kHz to 2 GHz with the exception of the channel of the wanted signal and its adjacent channels. The unwanted signal level shall be 73 dBµV. Where spurious response occurs, the bit error ratio shall be determined.

For the blocking test the unwanted signal shall be unmodulated. The frequency shall be varied between -10 MHz and -1 MHz and also between +1 MHz and +10 MHz relative to the nominal frequency of the wanted signal. The unwanted signal shall be at a level of 93 dBµV. Where blocking occurs, the bit error ratio shall be determined.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

A.5.16 Limits

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.17 Intermodulation response

A.5.18 Definition

The intermodulation response is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

A.5.19 Method of measurement

The three input signals shall be connected to the receiver input terminal via a combining network (see clause A.5.8).

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be the DSC standard test signal (see clause 6.9) containing DSC calls. The level of the wanted signal shall be +3 dBµV.

The unwanted signals shall be applied, both at the same level. The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above (or below) the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of ±3 kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The input level of the unwanted signals shall be 68 dBµV.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

A.5.20 Limits

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.21 Dynamic range

A.5.22 Definition

The dynamic range of the equipment is the range from the minimum to the maximum level of a radio frequency input signal at which the bit error ratio in the output of the decoder does not exceed a specified value.

A.5.23 Method of measurement

A test signal in accordance with the DSC standard test signal (see clause A.5.9) containing consecutive DSC calls, shall be applied to the receiver input. The level of the test signal shall alternate between 100 dBμV and 0 dBμV.

The bit error ratio in the decoder output shall be determined as described in clause A.5.10.

A.5.24 Limit

The bit error ratio shall be equal to or less than 10^{-2}.

A.5.25 Spurious emissions

A.5.26 Definition

Spurious emissions from the receiver are components at any frequency, present at the receiver input port.

The level of spurious emissions shall be measured as the power level at the antenna.

A.5.27 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyser or selective voltmeter having an input impedance of 50 Ω and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over the frequency range of 9 kHz to 2 GHz.

A.5.28 Limit

The power of any spurious emission shall not exceed 2 nW at any frequency in the range between 9 kHz and 2 GHz.

A.5.29 Arrangements for test signals applied to the receiver input

Test signal sources shall be connected to the receiver input in such a way that the impedance presented to the receiver input is 50 Ω, irrespective of whether one or more test signals are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the electromotive force (e.m.f.) at the terminals to be connected to the receiver.

The nominal frequency of the receiver is the carrier frequency of the selected channel.

A.5.30 Standard test signals for DSC

The standard test signal for a VHF DSC decoder shall be a phase-modulated signal at VHF channel 70 with modulation index = 2. The modulating signal shall have a nominal frequency of 1700 Hz and a frequency shift of ±400 Hz with a modulation rate of 1200 baud.

Standard test signals shall consist of a series of identical call sequences, each of which contain a known number of information symbols (format specifier, address, category, and identification, etc., of ITU-R Recommendation M.493-13).

Standard test signals shall be of sufficient length for the measurements to be performed or it shall be possible to repeat them without interruption to make the measurements.

A.5.31 Determination of the symbol error ratio in the output of the receiving part

The information content of the decoded call sequence displayed at the readout device of the receiving part shall be divided into blocks, each of which corresponds to one information symbol in the applied test signal (see clause A.5.9). The total number of incorrect information symbols relative to the total number of information symbols shall be registered. In the present document, bit error ratio measurements are taken to be equivalent to symbol error ratio measurements.

A.6 Power Measuring Receiver Specification (required for test 4.3.1)

A.6.1 IF filter

The IF filter shall be within the limits specified in Figure A.8.

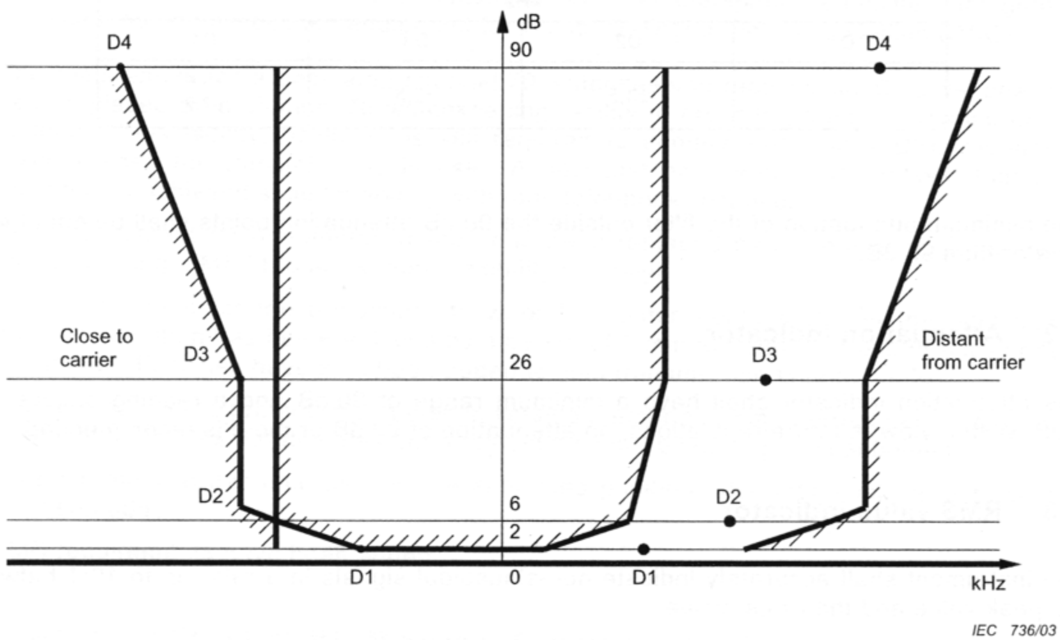

Figure A.8 – IF filter specification

The selectivity characteristics shall maintain the following frequency separations from the nominal center frequency of the adjacent channel given in Table A.3.

Table A.3 – Selectivity characteristic

Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
D1	D2	D3	D4
5	8.0	9.25	13.25

The attenuation points shall not exceed the tolerances in Tables A.4 and A.5

Table A.4 – Attenuation points close to carrier

Tolerance (kHz)			
D1	D2	D3	D4
+3.1	±0.1	-1.35	-5.35

Table A.5 – Attenuation points distant from carrier

Tolerance (kHz)			
D1	D2	D3	D4
±3.5	±3.5	±3.5	+3.5 -7.5

The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

A.6.2 Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations, an attenuation of 90 dB or more is recommended.

A.6.3 RMS value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio up to 10:1 between the peak value and the r.m.s. value.

A.6.4 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement results, yields a measured value of ≤90 dB.

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Annex B Normative)

121.5 MHz type MSLD

B.1 Operational Scenario

Victims will be recovered by their own vessel, a dedicated small boat or aircraft from their own vessel. Victims will potentially be in the water for up to 6 hours before they are recovered.

B.2 System Components

B.2.1 Alerting unit (AU)

The AU is a 121.5 MHz Homing Transmitter, which may optionally include either Morse coded transmissions or Synthetic Voice transmissions indicating the location of the AU. Position may be provided by external means or may be provided by an integral GNSS Receiver compliant with IEC 61108-1.

B.2.2 Base unit (BU)

The base unit is a 121.5 MHz Receiver, either incorporating a method of decoding and providing the user with a means of obtaining an alert and the transmitted position of the AU or incorporating a locating function as described in 3.4.

B.2.3 Locating unit (required unless AU indicates its location)

The Locating Function (LF), if incorporated, is provided by a 121.5 MHz direction finder, capable of providing a bearing to the AU and may include an indication of distance to the AU. Alternatively the AU may be fitted with a visible light of intensity not less than 1.0 effective candela flashing at 20 to 60 times per minute.

B.3 Performance Characteristics

B.3.1 Operating time

The AU should operate for a minimum of 6 hours. The BU should be capable of continuous operation either from the ship's power supply or through the incorporation of rechargeable batteries capable of being recharged from the ship's supply.

B.3.2 Interoperability

The AU transmitted signal shall be compliant with ITU-R M.690-1 and thus should be capable of being received by any other 121.5 MHz Receiver.

B.3.3 Operational functions

As defined in the main body of this standard.

B.3.4 Alerting signal

The alerting signal shall consist of an Amplitude Modulated Continuous Swept Tone at 121.5 MHz to allow for a direction finder or similar type of Search and Rescue (SAR) equipment to locate the AU.

B.3.5 Frequency and type of emission

121.5 MHz +/- 50 parts per million

Double Sideband full carrier Amplitude Modulated (3K20A3X)

Emissions shall include a clearly defined carrier frequency component distinct from the modulation sideband components. At least 30% of the emitted power shall be contained within 250 parts per billion of the actual carrier frequency.

Transmitter Duty Cycle Continuous, except that transmissions maybe interrupted for a maximum of 1 second.

Modulation – an audio swept signal upward or downward by not less than 700 Hz in the range 300 to 1600 Hz

Modulation Duty Cycle – 33% to 55%

Modulation Factor – between 0.85 and 1.0

Sweep Repetition Rate – 2 Hz to 4 Hz

B.3.5.1.1 Mandatory data included

None

B.3.5.1.2 Optional data included

The audio sweep may be interrupted once every two minutes to transmit the Morse code letters and numbers corresponding to the GNSS derived location (in WGS84 format) of the AU encoded in the following format. Latitude (N or S) XX.YYY, Longitude (E or W) XXX.YYY. That is a sequence of 13 Morse encoded characters where the relevant hemisphere is indicated by the letters N, S, E or W as appropriate and the position is encoded in degrees and decimal tenths, one hundredths and one thousandths of a degree. The decimal points are not transmitted, there is a 'word' space between the latitude and longitude positions and zeros (0) including leading zeros are always transmitted. This provides a location anywhere on the earth's surface to within +/- 0.049 miles (86 yards).

B.3.5.1.3 Morse code type of signal

The Morse coded transmission of position, if included, shall be in the following format (equivalent to Morse code transmitted at approximately 10WPM):

Double sideband Amplitude Modulated Telegraphy for Aural reception (A2A)

Modulation Frequency 1000 Hz ± 50 Hz

Morse burst keying rate 1 dot = 130 ms ± 5%
1 dash = 3 dots = 390 ms ± 5%

Space between Morse digits = 1 dot = 130 ms ± 5%

There shall be an unmodulated period of at least 1 dash (390 ms ± 5%) at both the beginning and end of the Morse transmission before the start and cessation of the audio swept signal.

Alternatively the audio sweep may be interrupted for not more than 30 s once every two minutes to transmit a synthetic voice message containing the word "Mayday" and the GNSS derived location (in WGS84 format) of the AU in the following format in the English language:

Mayday at North / South XX Degrees, Decimal YYY, East / West XXX Degrees, Decimal YYY

The time spent transmitting the synthetic voice message shall be kept to a minimum (without loss of clarity) to maximize the available time for swept tone transmissions.

B.3.5.1.4 Synthetic Voice Message type of signal

The Modulation Index shall be between 30% and 100%.

The ratio of the maximum modulation index to the minimum modulation index shall be less than 1.5.

The transmitter modulation distortion shall not exceed 15%.

The Audio Frequency Response of the transmitter shall not be less than 700 Hz to 3kHz.

B.3.5.1.5 Position Updates

The AU shall be capable of immediately indicating its location and updating its position and transmitting this position to the BU at regular intervals. This may be achieved by several means, however if the AU incorporates a GNSS receiver, the GNSS receiver shall not be the only method of locating and it shall be compliant with IEC 61108-1 Ed. 2.0. The AU shall only transmit valid position data as defined by IEC 61108-1 Ed. 2.0. The following Update Procedure shall apply.

The Time to First Fix (TTFF) of the GNSS receiver in the AU shall be less than [5] minutes regardless of the start configuration of the GNSS. If a valid GNSS fix has not been obtained, then the Position field in the DSC messages shall be replaced with the digit 9 repeated as necessary (and if applicable the Time field shall be replaced with the digit 8). If and when a valid GNSS fix has been obtained then the AU commences the transmission of DSC messages containing Position (and Time) as detailed above. The same GNSS position shall be transmitted for a minimum of 2 consecutive bursts without changing. Once a fix has been obtained it shall be updated no more often than once every 10 minutes but at least once every 20 minutes and the new position shall then be encoded and transmitted for at least the next 2 consecutive bursts, whereupon the sequence repeats. If valid GNSS updates cannot be maintained, after an initial fix, then the last valid encoded position (and time) shall continue to be transmitted for a period of 3 hours. If within this time a valid fix is obtained then the new updated position shall be transmitted as described above. If however after 3 hours a valid fix has not been obtained, then the DSC message shall revert to the default values (of 9's and 8's) as if no valid fix had been obtained, until a valid fix is obtained.

B.3.5.1.6 Radiated power output

Not less than 25mW, not to exceed 100mW PERP

B.3.5.1.7 Method of Measurement of Frequency, Modulation & Radiated Power Output

The following test procedure is considered satisfactory for performing the subject test; however, it is recognized that alternate procedures may be performed. Such alternate procedures may be used if the test provider can show that they provide equivalent information.

Frequencies of 121.6, 121.65, 121.7, 121.75, 121.85, or 121.9 MHz should be used for testing outside of a screen room to avoid radiation at 121.5 MHz.

The tests may be performed in any sequence and in conjunction with other electrical tests. In all cases, the tests should be conducted after the Equipment under Test (EUT) has been ON for at least 15 minutes.

B.3.5.1.8 Carrier Frequency Test

The carrier frequency test may be performed with a frequency counter or a spectrum analyzer. The carrier frequency, measured at the minimum and maximum operating temperatures, should be 121.5 MHz ± 50 parts/million.

B.3.5.1.9 Modulation Characteristics

The transmitter duty cycle, modulation frequency, modulation duty cycle, modulation factor, and sweep repetition rate may all be determined in a manner described below by observing the detected RF signal with a storage oscilloscope.

a) Transmitter Duty Cycle. Observe the transmitted signal and determine that the carrier is not interrupted (except in the case of a Morse or Voice encoded EUT).

b) Modulation Frequency and Sweep Repetition Rate. Observe the modulation envelope and determine the upper and lower audio-frequency sweep limits and sweep repetition rate.

c) Modulation Duty Cycle. Modulation duty cycle is the ratio of the positive modulation peak duration to the period of the instantaneous fundamental audio modulation frequency, observed at the half-amplitude points on the modulation envelope using the following formula (see Figure B.1):

$$Duty\ Cycle = \frac{A}{B} x\ 100\%$$

The modulation duty cycle should be measured near the start, midpoint, and end of the modulation sweep period.

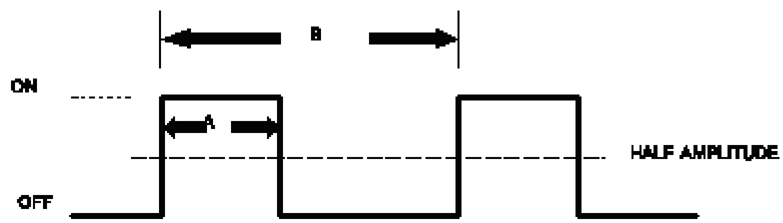

Figure B.1 – Typical Modulation Waveform

d) Modulation Factor. The modulation factor should be defined with respect to the maximum and minimum amplitudes of the modulation envelope by the following formula (see Figures B.2 and B.3):

$$Modulation\ Factor = \frac{A - B}{A + B}$$

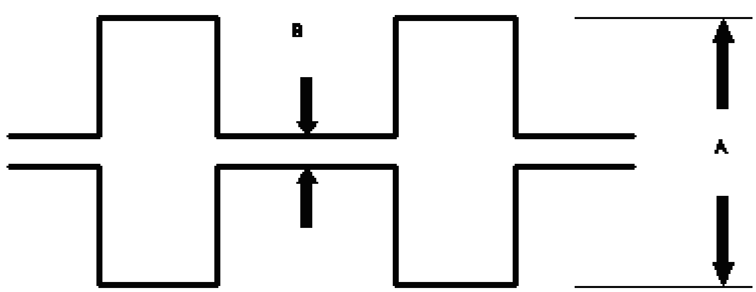

Figure B.2 – Typical Full-Wave Modulation Envelope

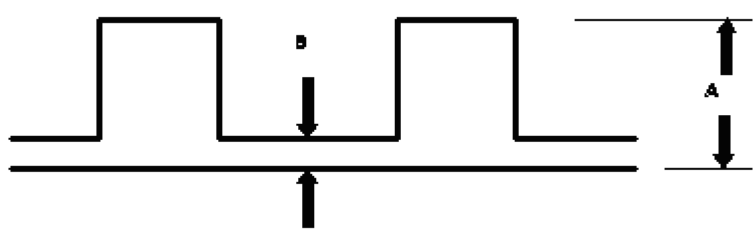

Figure B.3 – Typical One-Half Wave Modulation Envelope

e) As a minimum, if included, Morse or Voice encoded units may be verified by aural decoding and verification of the AU transmitted GNSS position compared to a known reference point. The time to first fix (TTFF) and thus transmission of encoded data shall be measured from the time the EUT is first activated. The received aural signal shall be clear and unambiguous. In addition the Morse code rate and modulation frequency shall also be measured or on Synthetic Voice transmissions the AM Modulation Index and transmitted modulation distortion shall be checked. The EUT shall then be moved in position by at least one mile and the update rate of the encoded position and the accuracy of the new location shall be checked. Finally the GNSS receiver in the EUT shall be masked so that it can no longer receive updates and the maintenance of the GNSS data in the transmitted message shall be established, the receiver shall then be unmasked and the renewed presence of transmitted data shall be confirmed within 5 minutes + 1 transmission cycle.

B.3.5.1.10 Peak Effective Radiated Power

The Peak Effective Radiated Power (PERP) is the Peak Envelope Power (PEP)[3] multiplied by the gain of the antenna.

This test is only required to be performed at ambient temperature and should use an EUT that has been ON for a minimum of 91.7% of its stated operational life. If the test length exceeds the remaining 8.3% of operational life, the battery may be replaced with another which has been preconditioned with at least 91.7% of its stated operational life discharged.

The measurement procedure consists in a determination of 12 values of PERP made by direct measurement of radiated power. The measurements are taken at an azimuth angle of 30º ± 3º. All PERP measurements should be made at the same elevation angle; the elevation used should be the angle between 5º and 20º for which the EUT exhibits a maximum antenna gain. The median value of PERP should be between 25 mW and 100 mW; the ratio of maximum to minimum of the 11 highest values of PERP should not exceed 2 to 1 (3-dB).

B.3.5.1.11 Radiated Power Test Condition

The test site should be on level ground which has uniform electrical characteristics. The site should be clear of metal objects, overhead wires, etc., and as free as possible from undesired signals such as ignition noise or other RF carriers. The distance from the EUT, or the search antenna to reflecting objects should be at least 30 m. The EUT should be placed in the center of a ground plane with a radius of no less than 75 cm ± 5 cm. The EUT should be positioned vertically.

The ground plane should be resting on the ground and should be extended so that it completely encloses and presents a snug fit to the EUT.

Measurement of the radiated signals should be made at a point 5 m or more from the EUT. At this point, a wooden pole or insulated tripod with a movable horizontal boom should be arranged so that a search antenna can be raised and lowered through an elevation angle of 5º to 20º. The search antenna should be mounted on the end of the boom with its cable lying horizontally on the boom and run back to the supporting mast. The other end of the search antenna cable should be connected to a spectrum analyzer located at the foot of the mast.

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3 PEP is the RMS power supplied to the antenna by the transmitter measured at the highest crest of the modulation envelope.

B.3.5.1.12 Method of Measurement

The elevation angle between 5º and 20º which produces a maximum gain is determined with the EUT at an arbitrary azimuth. The PEP should be measured and the elevation angle should be noted and should remain fixed for the remainder of the test. The remaining 11 measurements of PERP may be obtained by rotating the EUT in increments of 30º ± 3º. For each measurement the EUT PERP should be computed using the following equation:

$$PERP = \mathrm{LOG}^{-1} \frac{P_{REC} - G_{REC} + L_C + L_P}{10}$$

Where:

P_{rec} = Measured Power level from spectrum analyzer (dBm)
G_{rec} = Antenna gain of search antenna (dB)
L_c = Receive system attenuator and cable loss (dB)
L_p = Free space propagation loss (dB)

Annex C
(informative)

Intellectual Property

C.1 Policy

It is the intent of the Radio Technical Commission for Maritime Services (RTCM) to develop standards that do not require the use of patented technologies as the only means to comply with a standard (essential patents).

C.2 Essential patented technologies

RTCM has not been informed of any patented technologies that must be used in order to design or produce equipment covered by this standard.

C.3 Non-essential patented technologies

RTCM has been informed of the patented technologies listed in Table C.1 that may be used in the design and production of equipment covered by this standard. However, RTCM believes it is possible to design and produce equipment covered by this standard without using any of the patented technologies listed in the table.

Table C.1 is provided for the information of users of this standard. RTCM takes no responsibility for the accuracy or completeness of this list.

Table C.1 – Non-essential patents

Issuing Country	Patent Number	Patent Holder	Brief Description (See Note)
USA	5886635	BriarTek Incorporated [4] 112 E. Del Ray Avenue, Suite A Alexandria, VA 22302	Overboard alarm with localization system interface
USA	6183328	David Marshall Rescue Concepts, LLC [4] c/o Trachtenberg & Rodes 545 5th Avenue New York, NY 10017	Radio beacon that uses a light emitter as an antenna.
USA	6222484	Seiple; Ronald L., et. al. 1063 Koohoo Pl. Kailua, Oahu, HI 96734	Personal emergency location system comprising personal unit with GPS processor and base station.
USA	6567004	BriarTek Incorporated [4] 112 E. Del Ray Avenue, Suite A Alexandria, VA 22302	Automatically reporting event to remote location

NOTE: Do not rely on this summary as a complete description of the technology. See patent documents for a full description.

[4] Patent holder or related organization is a member of RTCM and Special Committee 119.

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Annex D
(normative)

Active Signalling Type MSLD System

D.1 Operational Scenario

The Active Signalling Type MSLD System provides a mechanism of operation where received signals indicate non-alerts and absence of signals indicate an alert.

When a person wearing a signalling device falls into the water, the signals from the Alerting Unit (AU) are assumed to be sufficiently attenuated by the water or distance from the Base Unit (BU) thus creating a break in the RF link. The Active MSLD system recognises this break as an alert.

The Active MSLD is generally suitable for single deck or double deck vessels up to 17m in length; this system is not recommended for larger vessels due to the difficulties in maintaining the RF link between the AU and BU and thus the potential for an increased false alert rate. It must be stressed that successful operation is dependent on correct installation which must ensure adequate RF link coverage in all areas of the vessel.

Victims would normally expect to be recovered by their own vessel or a dedicated small boat from their own vessel, however outside assistance from a boat or aircraft may also be used.

Victims may potentially be in the water for up to 6 hours before they are recovered. Quick recovery of the victim is generally expected, however the victims may become separated from their vessel by strong currents in the area, or the vessel's lack of maneuverability.

Locating Function (LF) operating times shall thus be sufficient to allow for outside assistance.

D.2 System Components

D.2.1 Alerting Unit (AU)

A device carried or worn by a person that communicates by radio with a BU and depending on the algorithms and schemes employed by the system enables the BU to, a) recognise a Man Over Board (MOB) incident, b) receive a manually generated emergency alert and c) optionally determine if the person is inside or outside a protected area. The AU shall be provided with a LF that provides the crew with a means to determine a course to recover the MOB.

- An AU is carried / worn by a person who will need recovery should he/she fall over board or get incapacitated on board.
- The AU in the Active MSLD system is a watertight unit which regularly transmits signals that are monitored by the BU.
- When the AU is immersed in water, its RF signals are sufficiently attenuated by the water to stop communication with the BU thus generating an alert at the BU. In addition the AU signals can also be sufficiently attenuated by moving them sufficiently far enough away from the BU.
- The AU shall have control(s) to raise a manual alert.
- The AU shall have indicators to show alerting and non-alerting modes.
- When not immersed in water the AU shall regardless of orientation -
  a) Continue to communicate regularly with the Base Unit at a distance of up to 50 meters.
  b) Stop communicating with the Base Unit at a maximum distance of 500 meters.

D.2.2 Base Unit (BU)

A BU is a device which communicates with one or more AUs and is able to determine if a person wearing an alerting device is either on board or not on board, or inside or outside a protected area. Optionally, when suitably fitted and configured, the BU is also capable of two way communication with a shore based station in order to transmit/receive vital MOB information (e.g. lat/lon, speed, heading etc) for launching SAR operations if deemed necessary.

- Each Active MSLD system must have at least one Base Unit (BU).
- The BU monitors signals from the AU(s) and keeps the system in the non-alerting mode as long as signals from an AU are being received.
- The BU places the system in an alerting mode when signals from the AU(s) are interrupted.
- In Alerting mode the BU would provide the necessary indicators and alarms which may be silenced or cancelled by operating dedicated control(s).
- The BU may also be fitted with the following capabilities:
  a) Ship to shore communications to transmit alerts to a shore based station to enable appropriate rescue operations to be mounted.
  b) Extension of RF coverage using a BU Repeater (BUR)
- The Active MSLD system (combination of a BU and optional BURs) shall be capable of operating with at least 4 AU(s).

D.2.3 Optional BU Repeater (BUR)

- A separate BUR or BUR(s) may be used to extend the BU's RF coverage range.
- The BUR shall be optimally sited to ensure widest possible area of coverage; suitable installation instructions and/or apparatus shall be provided to assist with installation.

D.2.4 Locating Function (LF)

The LF maybe provided by; an RF homing transmitter, RF transmission of location information, a visual strobe light or other similar means. For these means to be effective this function must be maintained at or above the surface of the water without user intervention. In addition by recording the initial MOB position, the BU may be capable of providing calculated distance and course to steer in order to locate the person in the water, but this does not remove the need for a means to provide a final method of locating the person in the water (e.g. by a visual strobe light).

D.3 Controls and Indicators

In addition to the requirements of paragraph 4.1, AUs shall be designed for both manual (by means of a control on the AU) and automatic (by breaking the RF link) activation.

D.3.1 User Controls

For the Active MSLD AU the Off, On and Test functions described in paragraph 4.1.2 shall be provided in the following manner:

READY	In the **READY** modes the AU is in regular communication with the BU via the RF link, that is the AU does not indicate an MOB incident.
ON	The **ON** function in an Active MSLD shall be interpreted to mean ALERTING. In the **ON** mode the AU ceases to communicate with the BU via the RF link, that is the AU is activated to indicate an MOB incident.
TEST	See paragraph D.6.

OFF **Function** as defined in paragraph 4.1.2 does not apply to an Active MSLD.

A manual control shall be provided on the AU that provides an ALERTING function when operated, even if the AU is within the RF link range to the BU. This manual control shall override the **READY** function.

D.3.2 Indication of an Alert

The BU shall clearly indicate which AU(s) is (are) alerting.

As described in paragraph 4.1.3, indication of an alert at the BU when the AU is ALERTING automatically (that is by breaking the RF link) may be delayed (by a maximum of 15 seconds) in order to reduce the risk of false alerts from the AU. At a predetermined point within this delay period the AU shall provide an indication that the RF link has failed in order to give the wearer a chance to take remedial action to restore the link. If within this delay period the RF link is re-established, then the AU shall revert to the **READY** condition and no further action shall be taken.

D.3.3 Self-test Indicators

Self-test visual and / or audible indication as required by paragraph 4.1.4.2 shall be provided at the AU. A distinctive visual and / or audible indication that the BU is in self-test mode shall be provided on the BU.

D.4 Additional Sources of Alerts

In addition to manual or automatic activation of the AU as defined in paragraph 4.1, additional alerts may be generated as follows:

- **Manual Alert** from the BU - when a suitably marked alert control provided on the BU is operated for at least 5 seconds. A cancel alarm facility shall also be provided, however the location of all alerts shall be retained for a period of 30 minutes.

D.5 Safeguards Against Accidental Manual Alerts

In order to minimize accidental generation of manual alerts, the system must incorporate the following safeguards:

- **Manual alert from the AU** - This shall require two independent actions and shall only be generated when a suitably marked alert control is operated for a duration of not less than 3 seconds. It shall be possible to cancel this alert by operating a suitably marked control on the BU.
- **Manual alert from the BU** – This shall require two independent actions and shall only be generated when a suitably marked alert control is operated for a duration of not less than 5 seconds. It shall be possible to cancel this alert by operating a suitably marked control on the BU.
- **Silencing of Alarms** – During false alerts, self-tests and when rescue action is underway, loud intrusive alarms can be distracting. Therefore after the initial alert, a mechanism shall be provided for silencing or reducing the volume of audible alarms without cancelling the alert or test.

D.6 Self-test

The following self-test functions shall be provided within the Active MSLD system.

D.6.1 Battery Self-Test

The AU battery self-test required by paragraph 4.2.1 shall be provided by the following means:

- The AU shall automatically monitor its remaining battery capacity and shall alert the user by visual and / or audible means when the battery needs to be recharged or replaced as the case may be. This alert shall occur when 6 hours of LF battery capacity remains. The facility to transmit the AU battery charge condition to the BU and to a shore station may also be incorporated.

D.6.2 Radio Link Self Test

The RF self-test required by paragraph 4.2.2 shall for the Active MSLD device be provided by the following means.

The active AU shall maintain a regular RF link with the BU while in its normal operating mode. The user shall be able to determine the presence of this link in two ways:

- **Continuous Indication** – A **READY** AU shall provide regular visual and / or audible indication of the presence of transmission to the BU.
- **Removal of RF link -** It shall be possible to put the BU into a self-test mode of operation, whereby activating the AU by either manual or automatic means provides a local indication at the BU of the breaking of the RF link. This indication shall be clearly identified as a self-test and shall not generate an alert on the vessel or ashore. It shall be possible to reset the AU / BU and if required repeat the self-test. Means shall be provided to ensure that the BU cannot inadvertently be left in the self-test mode of operation (possible methods include a timed self-test function or an alarm or a mechanical mechanism).

D.7 Buoyancy

In an Active MSLD system, buoyancy of the AU as required by paragraph 4.3 is not a mandatory requirement provided that the AU LF is not impaired.

D.8 Battery

In addition to the requirements of paragraphs 5.2 and 5.3, the following additional requirements apply to rechargeable batteries used in Active MSLD systems.

a) The manufacturer of the AU used in the Active MSLD system shall establish a minimum useable operating duration for an AU with a fully charged battery.

b) The useable duration of the AU between charges shall be at least 12 hours.

c) An indication that the AU battery is approaching the end of its useable duration shall be provided as detailed in paragraph D.6.1.

d) It shall be possible to fully recharge an AU with a flat battery in less than 24 hours.

e) The actual AU useable duration together with recharging instructions and times shall be published in the operating manual, together with guidance as to when an AU battery needs to be replaced.

f) If the AU recharging facility is not part of the BU, then a separate battery charger shall be provided for use on board the vessel.

D.9 Performance Tests

The following variations and exceptions apply to the tests detailed in Section 8. Apart from these variations and exceptions all other tests detailed in Section 8 shall be carried out as detailed therein.

D.9.1 Buoyancy test

If the AU is not buoyant then the test in paragraph 8.1.3 shall be waived and shall be replaced by the IEC 60945 Portable Equipment (Temporary Immersion) test.

D.9.2 Activation tests

The following test replaces paragraph 8.1.5.1.

With the AU control in the **READY** mode, the AU shall be submerged in a 0.1 % salt solution to a depth of 300 mm and shall generate an alert at the BU when the AU and BU are separated by 5 meters within 15 seconds after being placed in the water. The salt used for the test shall be sodium chloride (NaCl) containing, when dry, not more than 0.1 % sodium iodide and 0.03 % total impurities. The salt solution concentration shall be (0.1 ± 0.01) % by weight. The solution shall be prepared by dissolving 1 ± 0.1 parts by weight of salt in 1 000 parts by weight of distilled or demineralized water.

D.9.3 Battery capacity test

The following test replaces paragraph 8.1.7.

Using an AU with a fully charged battery pack, the AU together with its operational charger shall be placed in a chamber at normal test conditions. Then the temperature shall be reduced to and maintained at -20° C ± 3° C for a period of 10 h. The AU shall be removed from the charger within 30 min after the end of the 10 h period and shall then be kept within RF link range of the BU at that temperature for the period identified as the useable battery life time as stated by the manufacturer in the operating manual.

Throughout the test period, the AU shall continue to function and shall not generate an alert at the BU, in addition the low battery indication as defined in paragraph D.6.1 shall not activate. The AU shall be allowed to continue to function at that temperature until the low battery indication activates.. The BU shall then be removed from the vicinity of the AU such that the AU generates an alert. It shall then be confirmed that the Locating Function within the AU continues to operate within specification for a period of at least 6 hours.

D.10 Performance Characteristics

D.10.1 Suitability of an Active MSLD System

- The Active MSLD manufacturer shall specify the types (length, construction material, number of decks, etc.) of vessels that the Active MSLD system may be fitted to and also highlight any limitations of the system in the operating manual and on the retail packaging for the system.
- The Active MSLD system shall operate in single or double deck vessels up to 17 meters in length.
- Installations in vessels over 17 meters is not recommended unless expressly specified by the Active MSLD manufacturer.
- If the Active MSLD is to be installed in vessels over 17 meters, then the Active MSLD manufacturer shall carry out tests and verify suitability in the intended environments.

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Annex E
(normative)

AIS Type MSLD System

E.1 Operational Scenario

The AIS-type MSLD system is designed to work as a component of the overall Automatic Identification System (AIS) installed on many vessels and shore installations.

Victims may be recovered by their own vessel, a dedicated small boat or aircraft from their own vessel or by another vessel within the immediate vicinity.

Victims may potentially be in the water for up to 12 hours before they are recovered. Quick recovery of the victim is generally expected, however the victims may become separated from their vessel by strong currents in the area, or the vessel's high operating speed and/or lack of manoeuvrability.

Transmitter operating times should thus be sufficient to allow for outside assistance.

The AIS MSLD shall be capable of transmitting messages that indicate the position, static and safety information of the person overboard. The transmitted messages shall be compatible with existing AIS installations. The transmitted messages shall be recognized and displayed by assisting units in the reception range of the AIS MSLD.

The AIS MSLD messages shall clearly distinguish the AIS MSLD from any other type of AIS installation.

E.2 System Components

E.2.1 Alerting unit (AU)

The AU shall be capable of indicating its location and updating its position and transmitting this position to the BU at regular intervals. The AU shall incorporate a GNSS receiver to provide the locating function. In addition the AU shall include a secondary means of indicating its location to searchers in the near vicinity (e.g. by the inclusion of a flashing light).

E.2.2 Base unit (BU)

The BU will usually be an AIS shipborne station (either Class A or Class B), however it may also be an AIS Base Station or an AIS SAR mobile aircraft equipment. All BUs shall comply with Recommendation ITU-R M.1371-4 and shall decode and display the GNSS position of the AU.

The BU shall also comply with the relevant IEC standard for AIS equipment (e.g. IEC 61993-2 Class A and IEC 62287-2 Class B).

E.2.3 Locating Function (LF)

The LF is provided by the integral GNSS receiver in the AU.

E.3 Performance Characteristics

All requirements are as defined in the main body of this standard except where indicated below.

E.3.1 Operating time

The AU shall operate for a minimum of 12 hours.

E.3.2 Interoperability

The AU should be capable of communicating with nearby vessels by transmitting an ITU-R M.1371-4 Annex 9 compliant Burst Transmission.

E.3.3 Operational functions

The AU shall be capable of either Manual or Manual and Automatic Activation as defined in Sections 4.1.1 and 4.1.2 of this standard.

In addition to the indicators required in Section 4.1.4 of this standard, the AU shall also provide an indication that is visible to the user in the normal mode of operation of the device that a valid GNSS position has been obtained and that this is being transmitted as a part of the message. If the GNSS position is subsequently lost and is no longer being transmitted, then this shall be indicated to the user.

The RF Self-Test as defined in Section 4.2 of this standard shall be a single radiated Burst at the full transmit power as further defined in E.3.8.1.2.

E.3.4 Unique identifier (user ID)

The AIS MSLD AU shall have a unique identifier to ensure the integrity of the VHF data link.

The user ID for an AIS MSLD AU is 972xxyyyy, where xx = manufacturer ID 01 to 99;[5] yyyy = the sequence number 0000 to 9999. This reverts to 0000 once 9999 has been reached.

The manufacturer ID xx = 00 is reserved for test purposes. The unique identifier used for the purposes of type approval to this standard shall be in the format 97200yyyy.

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

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

E.3.5 AIS and DSC Combination MSLD Devices

If a manufacturer chooses to build an MSLD system that functions as both an AIS MSLD and a DSC MSLD (refer to Appendix A for detail), the AU transmitting both AIS and DSC messages shall transmit one common user ID.

If a conflict occurs during AIS and DSC transmission time occurs, the AIS transmission shall be given priority and the DSC transmission shall be delayed.

E.3.6 Battery

For an AIS MSLD, the AU shall not use a rechargeable battery. Only primary batteries as defined in Section 5.2 of this standard are permitted.

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5 The manufacturer ID can be obtained from CIRM, South Bank House, Black Prince Road, London SE1 7SJ, UK. Telephone: +44 20 7587 1245. E-mail: secgen@cirm.org. Web-site: www.cirm.org.

E.3.7 Output Power

The nominal radiated power (EIRP) of the AIS MSLD AU shall be 1 W.

E.3.8 Transmission performance

E.3.8.1.1 Active mode

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

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

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

The AIS MSLD AU transmissions shall alternate between VHF channels AIS 1 and AIS 2.

The 1st and 5th burst shall be as follows.
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 1, Message 14 “MOB ACTIVE”
- AIS 2, Message 14 “MOB ACTIVE”
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out={7,3}, sub-message=0)

The 2nd, 4th, 6th burst shall be as follows.
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 1, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)
- AIS 2, Message 1, Nav Status =14, comm-state (time-out={6,4,2}, sub-message=slot)

The 3rd burst shall be as follows.
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=5, sub-message=0)

The 7th burst shall be as follows.
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=1, sub-message=utc)

The 8th burst shall be as follows.
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 1, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)
- AIS 2, Message 1, Nav Status = 14, comm-state (time-out=0, sub-message=incr)

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

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

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

The AIS MSLD AU shall continue transmission even if the position and time synchronization from the positioning system is lost or fails.

If position and time synchronization are lost, the AIS MSLD AU shall continue to transmit with last known position, COG (Course Over Ground), SOG (Speed Over Ground) and indicate that the positioning system is inoperative (Time stamp = 63) and synch state 3 (see E.4.5.1.5).

The AU shall start transmitting within the maximum time period as defined in paragraph 4.1.3. If the position is unknown then it shall use default position (+91; +181). If time is not established, the unit shall begin transmission unsynchronized. The unit shall begin synchronized transmission with the correct position within 5 min under normal operating conditions.

The position of the AIS MSLD AU shall be determined at least every minute.

In conditions when the AIS MSLD AU cannot get time and position within 5 min, the AIS MSLD AU shall attempt to obtain a position for at least 30 min in the first hour after activation and at least 5 min every 20 minutes in subsequent hours.

E.3.8.1.2 Test Mode

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

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

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

It is permissible to start the sequence on AIS 2.

The test messages shall be transmitted in one burst after position, SOG, COG and time are available. If the AIS MSLD AU does not acquire position, SOG, COG and time within 5 min it shall transmit the test messages but with appropriate field values (including default values) in Message 1 for position, SOG, COG and time stamp.

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

E.3.9 Position Source and Data

A GNSS receiver shall be used as the source for AIS MSLD AU position reporting.

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

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

On activation, if the GNSS receiver is unable to provide a valid position fix, then the reported position shall be longitude = 181° = not available = default and latitude = 91° = not available = default, COG = not available = default, SOG = not available = default, and the time stamp field shall be set to a value of 63.

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

E.4 Transmitter Requirements and Characteristics

E.4.1 Channel

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

E.4.2 Parameter settings

Tables E.1, E.2 and E.3 are derived from Recommendation ITU-R M.1371 and give the parameters required for an AIS MSLD AU. For the meaning of the symbols and additional information (footnotes) refer to the appropriate section of Recommendation ITU-R M.1371.

Table E.1 - Required 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

Symbol	Parameter name	Setting
PH.TST	Transmitter settling time (transmit power within 20% of final value. Frequency stable to within ±1 kHz of final value). Tested at manufacturers declared transmit power	≤ 1.0 ms
	Ramp down time	≤ 832 μs
	Transmission duration	≤ 26.6 ms
	Transmitter output power	Nominal 1W EIRP

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

Table E.2 - Required settings of physical layer constants

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

Table E.3 - Modulation parameters of the physical layer

Symbol	Name	Value
PH.TXBT	Transmit BT-product	0.4
PH.MI	Modulation index	0.5

E.4.3 Transmitter shutdown

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

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

E.4.4 Transmitter characteristics

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

Table E.4 - Minimum required transmitter characteristics

Transmitter parameters	Requirements
Carrier power	Nominal radiated power 1 W
Carrier frequency error	±500 Hz (normal). +1 000 Hz (extreme)
Slotted modulation mask	E.4.4.1 –20 dBc Δfc > ±10 kHz –40 dBc ±25 kHz < Δfc < ±62.5 kHz See Figure E.3
Transmitter test sequence and modulation accuracy	< 3 400 Hz for Bit 0, 1 (normal and extreme) 2 400 Hz ± 480 Hz for Bit 2, 3 (normal and extreme) 2 400 Hz ± 240 Hz for Bit 4 ... 31 (normal,

Transmitter parameters	Requirements
	2 400 + 480 Hz extreme) For Bits 32 …199 1 740 ± 175 Hz (normal, 1 740 + 350 Hz extreme) for a bit pattern of 0101 2 400 Hz ± 240 Hz (normal, 2 400 + 350 Hz extreme) for a bit pattern of 00001111
Transmitter output power versus time	Power within mask shown in Figure E.5 and timings given in Table E.7
Spurious emissions	Maximum 25 μW 108 MHz to 137 MHz, 156 MHz to 161.5 MHz, 406.0 MHz to 406.1 MHz and 1 525 MHz to 1 610 MHz

E.4.5 Link layer requirements

E.4.5.1.1 General

The Link layer specifies how data shall be formatted and transmitted on the VDL. The link layer requirements are referenced to Recommendation ITU-R M.1371.

E.4.5.1.2 AIS Messages

E.4.5.1.3 Message 1 format and content

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

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

E.4.5.1.4 Message 14 format and content

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

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

E.4.5.1.5 Synchronization

E.4.5.1.6 Synchronization method

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

Upon activation, until the AU gets UTC it shall transmit unsynchronized, using sync state 3.

If UTC direct synchronization is lost, the AIS MSLD AU shall continue to transmit with last known position, COG, SOG, and indicate that the positioning system is inoperative (Time stamp = 63) and sync state 3 (see E.3.8).

E.4.5.1.7 Synchronization accuracy

During UTC direct synchronization, the transmission timing error, including jitter, of the AIS MSLD AU shall be +/- 3 bits (+/- 312 μs).

E.4.5.1.8 VDL access scheme

The AIS MSLD AU shall use modified SOTDMA for the transmission of Message 1 and Message 14.

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

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

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

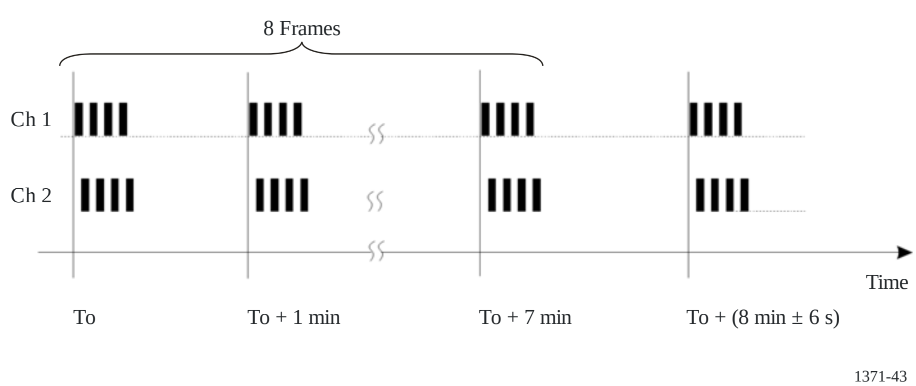
All slot-time-out values of the Communication state of all Message 1 transmissions within every burst shall be the same.

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

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

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

Figure E.1 - Burst transmissions in active mode



E.4.5.1.9 Link sub-layer 1: Medium Access Control (MAC)

Refer to Recommendation ITU-R M.1371 and **Error! Reference source not found.** for synchronization.

E.4.5.1.10 Link sub-layer 2: Data Link Service (DLS)

Refer to Recommendation ITU-R M.1371.

E.4.5.1.11 Link sub-layer 3: Link Management Entity (LME)

E.4.5.1.12 Refer to Recommendation ITU-R M.1371.

E.5 Documentation

The documentation requirements of Section 7 of this standard are replaced by the following:

“General instructions advising the user of the AU what to expect to see on the BU in both the normal and test modes of operation.”

E.6 Performance Tests

E.6.1 Introduction

BU testing as defined in Section 8.2 of this standard is not required for AIS receivers.

The AU shall be tested with an approved BU to ensure that both the normal signal and the self-test signal can be picked up and correctly displayed on the BU.

E.6.1.1.1 Performance Requirements

E.6.1.1.2 Performance Check

For the purposes of this standard, a performance check consists of activating the AU in test mode with GPS data available, and checking the reception of Message 1 and Message 14 with a BU.

E.6.1.1.3 Performance Test

For the purposes of this standard, a performance test consists of activating the AU in test mode with GPS data available, and checking the integrity of the transmitted bursts as in E.8.2.1.11.

E.6.2 Preparation of the AU for testing

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

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

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

Unless otherwise stated all tests shall be conducted with the standard AU.

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

E.6.2.1.1 Test Signals

E.6.2.1.2 Standard test signal number 1

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

E.6.2.1.3 Standard test signal number 2

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

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

E.6.2.1.4 Standard test signal number 3

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

E.6.3 Artificial antenna (dummy load)

All transmitter tests except radiated power may be carried out using an artificial antenna, which shall be a non-reactive non-radiating load of 50 Ω connected to the antenna connector.

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

E.6.4 Modes of operation of the transmitter

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

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

E.6.5 Battery capacity test

(See 5.2)

Using a fresh battery pack, the AU shall be activated (at the ambient temperature) for a period of time as stated by the manufacturer to be equivalent to the loss of battery capacity due to self-testing, stand-by loads as well as battery-pack self-discharge during the useful life of the battery pack (as defined in 5.2). The manufacturer shall substantiate the method used to determine this time.

Alternatively, at the manufacturer's discretion the pre-discharge of the battery (as outlined above) may be replaced by the equivalent extension beyond 12 h of the following battery capacity and low-temperature test. If using this test method the AU manufacturer shall apply a compensation figure to allow for the fact that the extension period due to loss in battery capacity is being carried out at the minimum operating temperature rather than at ambient temperature. This compensation figure shall be substantiated by the manufacturer.

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

Any climatic control device provided in the equipment may be switched on at the conclusion of this period. The equipment shall be activated in its mode of maximum current draw (for example EPFS drawing maximum current) 30 min after the end of the period and shall then be kept working continuously for a period of 12 h. The temperature of the chamber shall be maintained as specified above for the whole of the period of 12 h.

The operation of the AU during the test shall be verified.

In addition, at the end of the 12 h period, a performance test (see E.6.1.1.3) shall be performed.

NOTE If employing the alternative test method described above all references to 12 h should be extended by the appropriate period.

E.7 Physical Radio Tests

E.7.1 General description

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

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

Unless otherwise stated all the physical radio tests shall be performed with the modified AU (see E.6.2).

The following tests shall be performed under normal conditions:

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

The following tests shall be performed under extreme conditions:

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

E.7.1.1.1 Frequency error

E.7.1.1.2 Purpose

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

E.7.1.1.3

E.7.1.1.4 Method of measurement

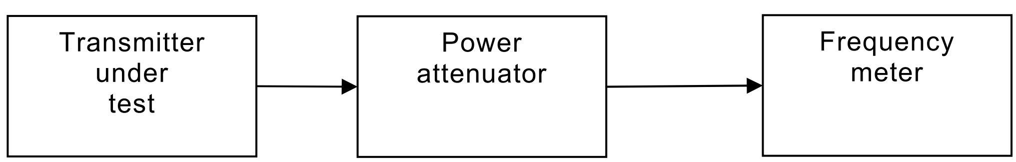


Figure E.2 – Measurement arrangement

For the test proceed as follows.

a) The equipment shall be connected as illustrated in Figure E.2.
b) The carrier frequency shall be measured in the absence of modulation.
c) The measurement shall be made under normal test conditions and extreme test conditions.
d) The test shall be performed on AIS 1 and AIS 2.

E.7.1.1.5 Required results

The frequency error shall not exceed ±0.5 kHz, under normal test conditions and ±1 kHz under extreme test conditions.

E.7.2 Conducted power

E.7.2.1.1 Purpose

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

E.7.2.1.2 Method of measurement

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

Calculate the gain of the AU antenna using the following equation:

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

where

G is the antenna gain (dB);
P_r is the radiated power level as measured in E.7.3 (dBm);
P_{20} is the conducted power level measured at normal test conditions (dBm);
P_d is the power output difference given in E.6.2 (dB).

E.7.2.1.3 Required result

The conducted power, corrected for the antenna gain shall be at least the values given in Table E.5.

Table E.5 – Conducted and radiated power – Required results

Power	Minimum limit
$P_{-20} + G$ [dBm]	27
$P_{55} + G$ [dBm]	27
NOTE This equates to the radiated power at extreme temperatures	

E.7.3 Radiated power

E.7.3.1.1 Purpose

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

E.7.3.1.2 Method of measurement

This test is only required to be performed at normal test conditions and shall use an AU whose battery has been ON for a minimum of 11 h. If the test exceeds 1h, the battery may be replaced by another which has been pre-conditioned with at least 11 h of ON time.

Measurement of the radiated signals shall be made at a point 5 m or more from the AU.

The ground plane should be resting on the ground. For an AU that floats autonomously the ground plane should be extended so that it completely encloses and presents a snug fit to the AU. For an AU that attaches to a life jacket or other buoyant device the AU shall be mounted on the buoyant device and deployed in a representative manner on the ground plane with its antenna base at a height of 10 ± 3cm.

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

Record the measured receive level at 4 different points in the azimuth plane by rotating the AU in steps of 90°. The minimum received level (PREC) shall be recorded and used to calculate the radiated power at the normal operating temperature using the following equation:

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

where

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

E.7.3.1.3 Required results

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

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

E.7.3.1.4 Modulation spectrum slotted transmission

E.7.3.1.5 Purpose

This test is to ensure that the modulation and transient sidebands produced by the transmitter under normal operating conditions fall within the allowable mask, see E.4.4.

E.7.3.1.6 Method of measurement

The following method shall be applied.

a) The test shall use test signal number 3.

b) The AU shall be connected to a spectrum analyser. A resolution bandwidth of 1 kHz, video bandwidth of 3 kHz or greater and positive peak detection (maximum hold) shall be used for this measurement. A sufficient number of sweeps shall be used and sufficient transmission packets measured to ensure that the emission profile is developed.

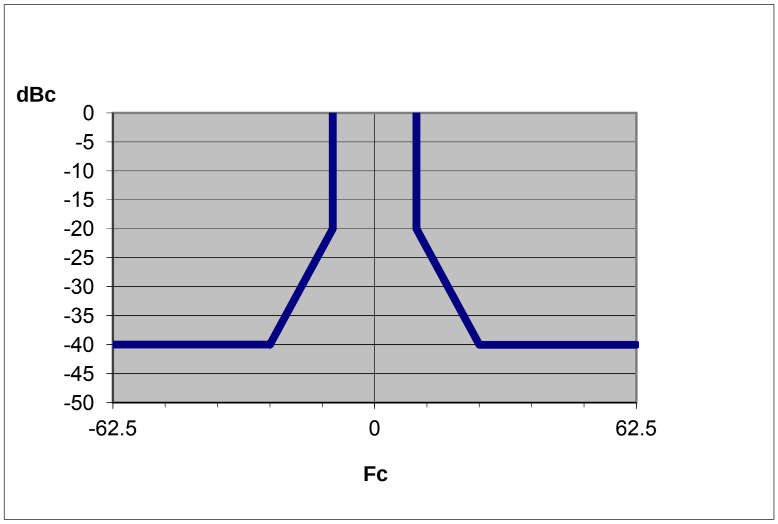
E.7.3.1.7 Required results

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

- in the region between the carrier and ±10 kHz removed from the carrier, the modulation and transient sidebands shall be below 0 dBc;
- at ±10 kHz removed from the carrier, the modulation and transient sidebands shall be below –20 dBc;
- at ±25 kHz to ±62,5 kHz removed from the carrier, the modulation and transient sidebands shall be below the lower value of –40 dBc;
- in the region between ±10 kHz and ±25 kHz removed from the carrier, the modulation and transient sidebands shall be below a line specified between these two points.

The reference level for the measurement shall be the carrier power (conducted) recorded for the appropriate test frequency in E.7.2.

For information the emission mask specified above is shown in Figure E.3.



Fc is the carrier frequency

Figure E.3 – Emission mask

E.7.4 Transmitter test sequence and modulation accuracy

E.7.4.1.1 Purpose

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

E.7.4.1.2 Method of measurement

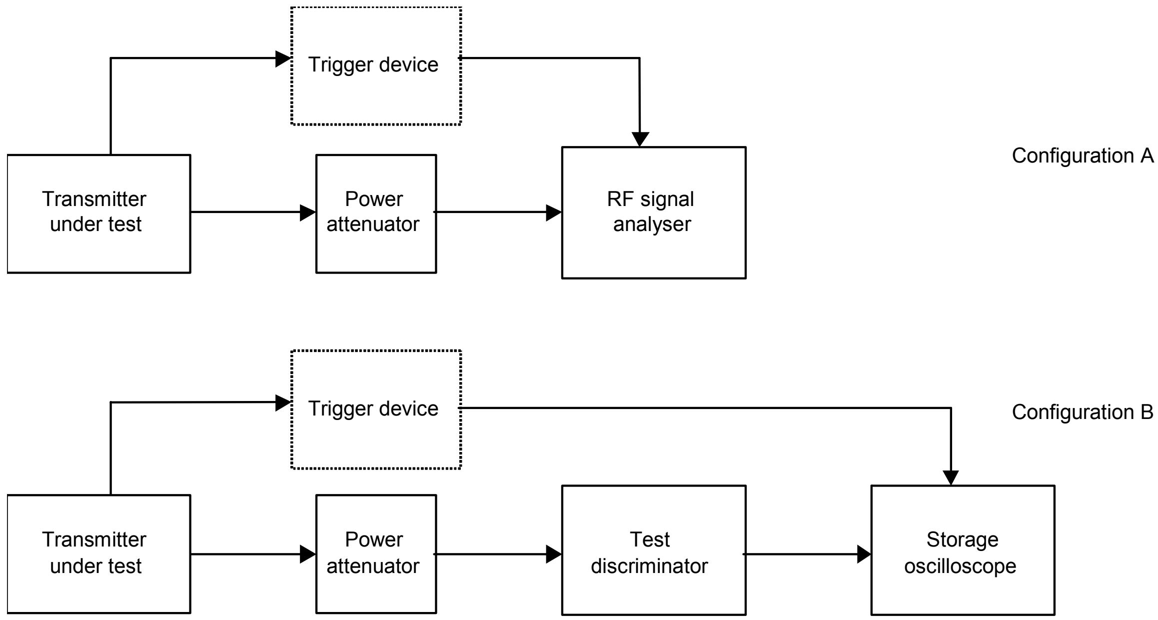


Figure E.4 – Measurement arrangement for modulation accuracy

The measurement procedure shall be as follows:

a) the equipment shall be connected in either configuration A or configuration B as shown in Figure E.4. The trigger device is optional if the test equipment is capable of synchronising to the transmitted bursts;
b) the transmitter shall be tuned to AIS 2 (162,025 MHz);
c) the transmitter shall be modulated with test signal number 1;
d) the deviation from the carrier frequency shall be measured as a function of time;
e) the transmitter shall be modulated with test signal number 2;
f) the deviation from the carrier frequency shall be measured as a function of time;
g) measurements shall be repeated at AIS 1;
h) the test shall be repeated under extreme test conditions.

E.7.4.1.3 Required results

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

Peak frequency deviation at various points within the data frame shall comply with Table E.6. These limits apply to both the positive and negative modulation peaks. Bit 0 is defined as the first bit of the training sequence.

Table E.6 – Peak frequency deviation versus time

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

E.7.5 Transmitter output power versus time function

E.7.5.1.1 Definition

Transmitter output power versus time function is a combination of the transmitter delay, attack time, release time and transmission duration as defined in Table E.7 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 (Pss),
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 Pss,
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 Pss 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.

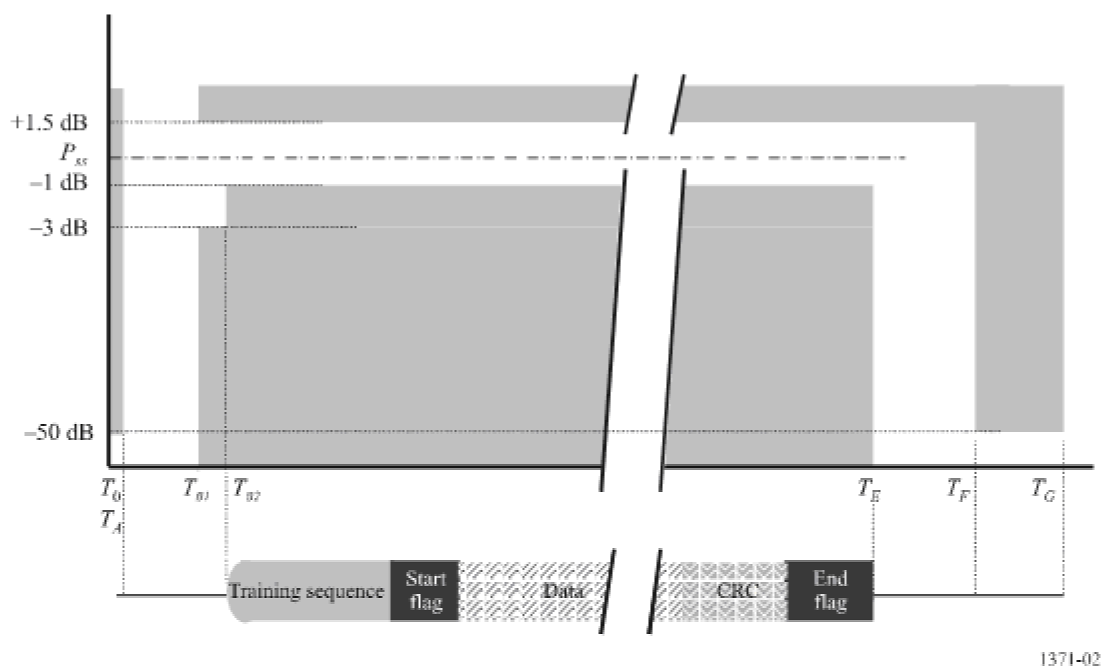


Figure E.5 – Power versus time mask

Table E.7 – Definition of timings

Reference		Bits	Time (ms)	Definition
T_0		0	0	Start of transmission slot. Power shall NOT exceed –50 dB of P_{SS} before T_0
T_A		0 to 6	0 to 0,625	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 T_E #
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
# There shall be no modulation of the RF after the termination of transmission (T_E) until the power has reached zero and the next slot begins (T_G).				

E.7.5.1.2 Method of measurement

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

The AU shall be connected to a spectrum analyser.

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

The analyser shall be in zero-span mode for this measurement. The spectrum analyser shall be synchronised to the nominal start time of the slot (T0), which may be provided externally, or from the AU.

E.7.5.1.3 Required results

The transmitter power shall remain within the mask shown in Figure E.5 and associated timings given in Table E.7.

E.7.6 Spurious emissions from the transmitter

E.7.6.1.1 Purpose

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

E.7.6.1.2 Method of measurement

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

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

E.7.6.1.3 Required results

No signal level within these bands shall exceed 25 µW.

E.8 Link layer tests

E.8.1 Tests for synchronization accuracy

These tests measure the synchronization error of the AU.

E.8.1.1.1 Method of measurement

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

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

E.8.1.1.2 Required results

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

E.8.2 Active mode tests

These tests require analysis of the transmissions of the AU.

E.8.2.1.1 Method of measurement

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

Record the activation time of the AU.

For all transmitted messages record:

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

The records will be evaluated in the following test items.

E.8.2.1.2 Initialisation period – Required results

The following is required.

a) The first message is transmitted within 30 sec after activation.
b) The first message with a valid position is transmitted within 5 min.

E.8.2.1.3 Message content of Message 1 – Required results

For position reports transmitted after 5 min and before 40 min the following is required.
a) Message ID = 1.
b) Repeat indicator = 0.
c) User ID as configured in the AU.

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

E.8.2.1.4 Message content of Message 14 – Required results

The following is required.

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

E.8.2.1.5 Transmission schedule for Message 1 – Required results

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

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

E.8.2.1.6 Communication state of Message 1 – Required results

For position reports transmitted after 5 min and before 40 min the following applies.

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

E.8.2.1.7 Transmission schedule of Message 14 – Required results

The following is required.

a) Message 14 is transmitted every 4 min.
b) The transmissions of Message 14 are alternating between AIS 1 and AIS 2.

c) Message 14 is transmitted in a Message 1 slot, replacing the Message 1, on the channel for which the Message 1 was scheduled.
e) Message 14 did not replace a Message 1 with a time-out value = 0.

E.8.2.1.8 Transmission with lost EPFS – Required results

For position reports transmitted after 45 min the following applies.

a) The AU continues transmission.
b) The same transmission schedule is used as with EPFS data available.
c) Communication State Sync state = 3.
d) SOG = last valid SOG.
e) Position accuracy = low.
f) Position = last valid position.
g) COG = last valid COG.
h) Time stamp = 63.
i) RAIM-flag = 0.
j) Verify correct indication as per manufacturer's documentation.

E.8.2.1.9 Test mode tests

E.8.2.1.10 General

These tests require analysis of the transmissions of the AU.

E.8.2.1.11 Transmission with EPFS data available

E.8.2.1.12 Method of measurement

Activate the AU in test mode with EPFS data available and record transmissions.

E.8.2.1.13 Required results

The following is required.

a) The AU starts transmission after valid GNSS data is available.
b) A single burst of 8 messages in the correct order and correctly populated as per E.3.8.1.2.
c) User ID as configured in the AU.
d) Navigational status = 15 (not defined).
e) SOG = actual SOG from GNSS receiver.
f) Position accuracy = according to the RAIM result if provided, otherwise 0.
g) Position = actual position from internal GNSS receiver.
h) COG = actual COG from internal GNSS receiver.
i) Time stamp = actual UTC second (0...59).
j) The communication state time-out always = 0 with sub message = 0.
k) The transmission of Messages 1 and 14 stops after one burst of 8 messages.
l) The text message in Message 14 is "MOB TEST".
m) Verify correct indication as per manufacturer's documentation.

E.8.2.1.14 Transmission without EPFS data available

E.8.2.1.15 Method of measurement

Activate the AU in test mode with no EPFS data available and record transmissions.

E.8.2.1.16 Required results

The following is required.

a) The AU starts transmission within 5 min.
b) A single burst of 8 messages in the correct order and correctly populated as per E.3.8.1.2.
c) User ID as configured in the AU.
d) Navigational status = 15 (not defined).
e) SOG = default value.
f) Position accuracy = low.
g) Position = default values.
h) COG = default value.
i) Time stamp = 63.
j) The communication state time-out always = 0 with sub message = 0.
k) RAIM-flag = 0.
l) The transmission of Messages 1 and 14 stops after one burst of 8 messages.
m) The text message in Message 14 is “MOB TEST”.
n) Verify correct indication as per manufacturer’s documentation.

Annex F
(normative)

Internal Navigation Device test methods and procedures

F.1 Introduction

This test procedure only applies to AU's fitted with Internal Navigation Devices (GNSS Receivers). The AU's shall be coded as per Type Approval requirements identified in A.3.4 or E.3.4. At this time the following tests are only applicable to AUs fitted with GPS Receivers, for any AUs fitted with any other type of GNSS Receiver (e.g. GALILEO or GLONASS) the manufacturer shall consult with the relevant national administration type approval authority for guidance.

The following test procedure is considered satisfactory for performing the subject tests; however, it is recognized that alternate procedures may be performed. Such alternate procedures may be used if the test provider can show that they provide equivalent information.

The tests specified herein are designed to simulate a range of typical operational scenarios in which AU's could be activated and required to obtain a GNSS fix for inclusion in a transmitted location protocol message. The tests measure how quickly the AU is able to obtain a GPS location (Time To First Fix (TTFF)) and how accurate that transmitted position is (Location Accuracy).

The scenarios may be performed in any sequence and in conjunction with other electrical tests. These tests shall be treated as Additional Tests and may be performed on a separate AU if required. In all cases, the tests shall be conducted after the AU has been temperature stabilized at ambient temperature for at least 1 hour.

The tests shall be performed on a fully packaged AU similar to the proposed production AU operating on its normal power source and equipped with its proper antenna. The tests shall be performed with the DSC or AIS 1 and AIS 2 transmitters radiating normally. The AU shall be specially programmed to transmit data bursts encoded using the Type Approval protocol identified in A.3.4 or E.3.4.

A test chamber with the appropriate level of RF shielding (seeF.3.1) shall be used, such that the AU may radiate normally on DSC or AIS1 and AIS2. Care shall be taken with the AU coding and test chamber shielding so as not to transmit alerting signals on safety frequencies. Frequency offsetting of DSC or AIS 1 and AIS 2 shall not be permitted.

The set of tests as specified in this Appendix shall be applied to all AU's equipped with Internal Navigation Devices regardless of their classification or class.

F.2 Test Description

F.2.1 General

The tests specified herein are designed to simulate typical operational scenarios in which AU's could be activated and required to obtain a GNSS fix for inclusion in a transmitted location message. Due to variations in GNSS satellite coverage in different locations and at different times of the day it was determined that testing could only be reliably and repeatably carried out in an anechoic chamber using a GNSS Simulator.

As well as the "typical" condition, various parameters of the GNSS simulator are then varied to provide a range of scenarios around the "typical" condition. Some of these scenarios are less arduous and other more so to provide a range of tests that together provide an assessment of the capability of the GNSS Receiver in the AU under test.

In addition other test scenarios are also included to check for issues such as GPS Week Rollover, change of AU location around the world and change of GPS Date as may be seen by an AU that is not activated for several years.

Each applicable scenario is run one after the other (the AU being turned off in between scenarios to force it to “Cold Start” each time) and the Time To First Fix (TTFF) and transmitted Location are recorded in each case. The results are then analysed and an assessment of the performance of the GNSS Receiver in the AU under test is made.

F.2.2 Scenarios

The scenarios are based around an AU floating in the open sea with a clear view of the sky from 0 degrees above the horizon with Wind Force 5 and Sea State 4, which represents typical sea conditions. Movement rates for the AU in the water due to large waves and for wave wash-over effects are then introduced to provide a range of operational conditions.

The key parameters that are varied in these simulations are:

- The Rate of Change (i.e. the speed the AU bobs at)
- The Degree of Change (i.e. the amount the AU tilt)
- “Wash-over” effects causing corruption of the Ephemeris data download and reduction in Received Signal Strength

The motion that has been created to simulate movement of the AU in the sea is a repeating sequence of; axial pitch up - roll right - pitch down - roll left. Note – In some simulators, the maritime conditions may be best simulated using an aviation type scenario where roll and pitch excursions and rate can be exactly specified.

The following table provides a list of the Maritime scenarios for testing the AU. Each scenario runs for approximately 12 minutes and there are 32 scenarios in total.

In the worse case if it takes 12 minutes to complete each scenario and then 3 minutes to set up for the next one it would take 8 hours (1 day) to complete all the tests.

However TTFF is normally well below 12 minutes and thus it should be possible to complete all the tests in 4 hours (half a day).

Further details on these scenarios including the data necessary to develop scenarios for different makes of GNSS simulator can be found inF5.2.

MARITIME SCENARIOS								
Scenario #	**No of SVs**	**HDOP**	**RSS dBm**	**Pitch/ Roll (Deg)**	**Rate (Deg/s)**	**Data Corrupt**	**GPS Location**	**GPS Year**
1	7	2	-130	15	5	No	0N, 0E	2008
2	7	2	-130	15	15	No	0N, 0E	2008
6	7	2	-130	30	60	No	0N, 0E	2008
7	7	2	-130	60	5	No	0N, 0E	2008
8	7	2	-130	60	15	No	0N, 0E	2008
9	7	2	-130	60	60	No	0N, 0E	2008
12	6	2	-130	15	60	No	80N, 0E	2008
13	6	2	-130	30	5	No	80N, 0E	2008
14	6	2	-130	30	15	No	80N, 0E	2008
16	6	2	-130	60	5	No	80N, 0E	2008
17	6	2	-130	60	15	No	80N, 0E	2008
18	6	2	-130	60	60	No	80N, 0E	2008
20	7	2	-130	15	5	Ephemer1	0N, 0E	2008
22	7	2	-130	15	5	Ephemer2	0N, 0E	2008
24	7	2	-130	15	5	Almanac	0N, 0E	2008
26	7	2	-130	15	5	Time	0N, 0E	2008
28	7	2	-130	15	5	E1 + A	0N, 0E	2008
30	7	2	-130	15	5	E1 + T	0N, 0E	2008
32	7	2	-130	15	5	A + T	0N, 0E	2008
33	7	2	-135	0	0	No	0N, 0E	2008
34	7	2	-135	15	5	No	0N, 0E	2008
35	7	2	-135	0	0	Ephemer1	0N, 0E	2008
36	7	2	-135	15	5	Ephemer1	0N, 0E	2008
37	7	2	-130	0	0	No	44S, 175E	2008
38	7	2	-130	0	0	No	47N, 8E	2019
39	7	2	-130	0	0	No	0N, 0E	2019

The above Scenarios are available free of charge as files to download and run on most Spirent GNSS Simulators. In order to obtain copies of the files please email Spirent at help@spirentcom.com quoting “RTCM Scenarios”.

F.3 Test Facility Requirements, Test Set Up, Calibration and Method of Measurement

F.3.1 Test Facility Requirements

The tests shall be performed in an independent test facility that meets the following requirements:

(1) First, that the selected facility shall provide shielding of external RF signals at the L1 GPS frequency. At least 35 dB of shielding must be provided. This is to keep signals from any operational GPS at least 20dB below the -137dBm signal level specified in some test scenarios. This will ensure that GPS signals from orbiting GPS Satellites are not received by the AU's GPS receiver and corrupt the test results.

(2) Second, the facility should have radiation absorbing material on the walls ceilings and floor to prevent signal reflections from distorting the direct path L1 GPS signal from the re-radiating antenna. Sufficient attenuation shall be provided to ensure that reflected signals off any surfaces are at least 20 dB below the direct path signal level measured at the AU's GPS receiver's antenna location.

(3) Third, that there is a way to calibrate the facility to obtain the desired level of the L1 GPS frequency EIRP as seen by the GPS receiver antenna at the AU's GPS antenna mounted in the proper position for the test and that that signal level is stable over time.

(4) Fourth, the facility must provide at least 50dB of attenuation at DSC or AIS 1 and AIS 2 to ensure that the AU signals cannot be picked up as an alerting signal by nearby vessels.

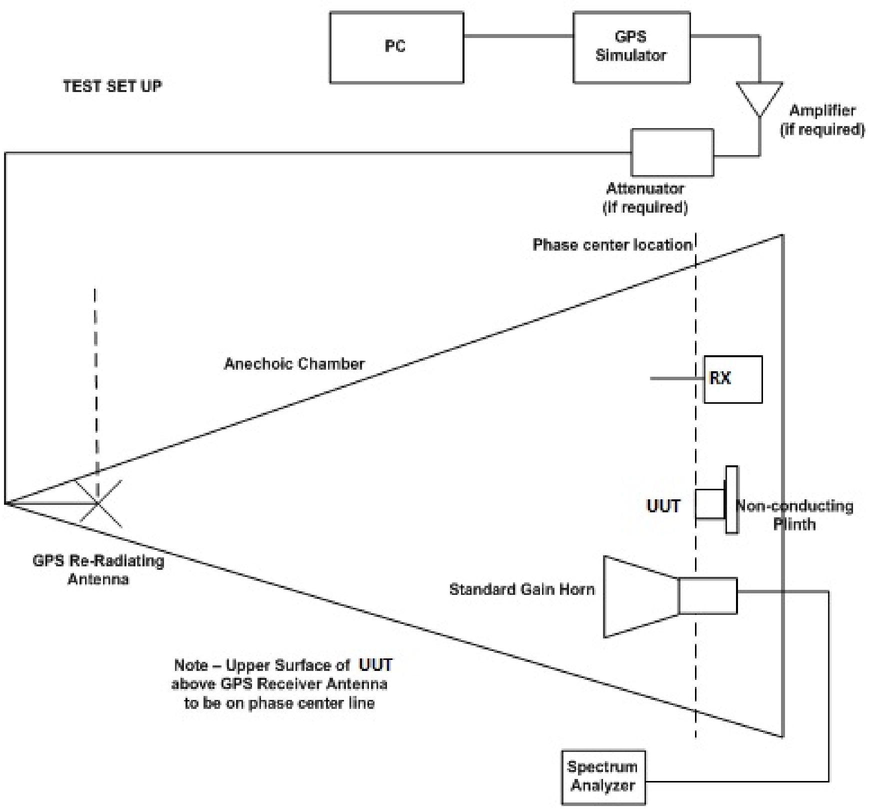
Examples of such facilities are an Anechoic Chamber, a TEM cell (also known as a Crawford Cell), and an EMI or RFI Quiet Room (a screen room with radiation absorbing material on the floor/ceiling and walls). Other types of test facilities could be used such as a screen room, but it must be shown that the above requirements are satisfied.

F.3.2 Test Set Up

A typical test set up is shown in the figure below. Depending on the output power of the GPS simulator used, an external Amplifier and/or Attenuator may be required.

A suitable antenna transmitting at the GPS L1 frequency shall be used to radiate the GPS Simulator signals in the chamber. This procedure calls it a re-radiating antenna.

Alternative set ups may be used if the test provider can show that they are equivalent to the set up shown.



The Re-radiating antenna and the AU under test shall be placed in direct line with one another such that the normal to the AU's GPS patch antenna is collinear with the bore sight of the re-radiating antenna at a spacing that puts the AU under test in the far field of both antennas. If an anechoic chamber or EMI Quiet room is used, the actual distance between the antennas isn't critical as long as the AU under test is in the far field of both antennas.

An AIS receiver capable of decoding AIS 1 and AIS 2 location protocol bursts transmitted by the AU shall be sited near the AU but must not interfere with the direct path between the re-radiating antenna and the AU's GPS antenna.

The manufacturer shall provide evidence of the time it takes all of the power supplies within the AU to drop to 0V (in this case 0V means less than 0.1Vdc). The minimum time between tests that the AU shall remain off for is the above time plus one minute.

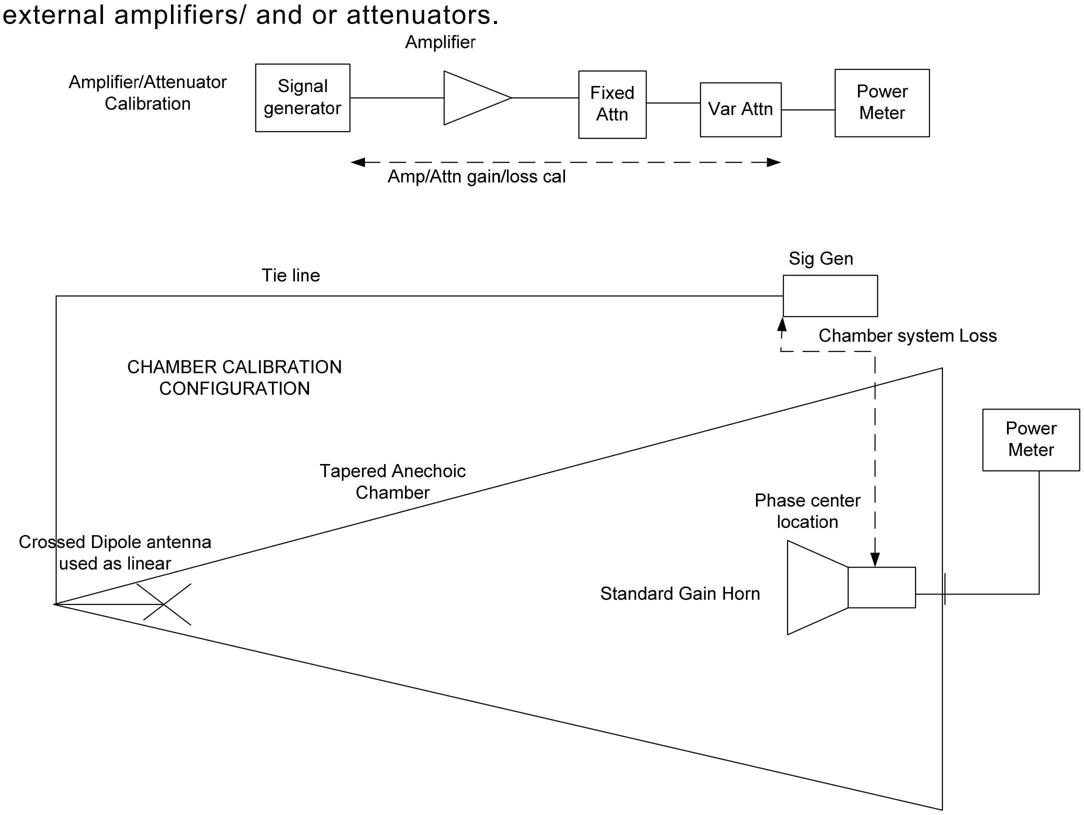
This is to ensure that no GNSS data from previous tests is stored in the GNSS Receiver and that it cold starts for each test scenario.

Prior to commencing testing, the Test Set Up shall be calibrated (see below) to ensure that the signal levels at the surface of the AU are correct

F.3.3 Calibration of the Test Set Up

The Test Set Up shall be calibrated on a Received Signal Level basis as detailed below.

The following figure illustrates a calibration setup. A power meter is shown although a calibrated spectrum analyzer could be used as well. A Standard gain horn is shown although any reference antenna (where the gain, phase centre location and polarization is known) could be used. The equations overleaf refer to a RefAnt (reference antenna). The top figure illustrates calibration of the external amplifiers/ and or attenuators.



Note that some GPS 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. If this is the case, one should have the capability of adjusting the signal level by means of an external attenuator and/or amplifier.

The AU shall be substituted with a Standard Gain Horn or equivalent antenna (of known gain at the GPS L1 frequency and known phase center location) connected to a spectrum analyser or power meter, and positioned such that the focal point (phase center) of the horn or equivalent antenna is on the phase center line .of the AU's GPS antenna when mounted.

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 GPS simulator in the above diagram. A strong CW signal is needed in order for the spectrum analyzer (or power meter) to see the signal. The "chamber system loss" is the loss one is trying to find and it is defined as the loss measured from the output of the calibrated signal generator to the phase center of the standard gain horn or equivalent antenna.

This loss will be exactly the same as the loss from the output port of the GPS simulator in the test configuration to the phase center of the AU's GPS 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. The link equation for determining the Chamber Gain/Loss ($Gain_{Chamber}$) in dBs is defined as follows:

$$P_{transmit} + Gain_{Chamber} + Gain_{RefAnt} + Gain_{line} + Gain_{Pol} = P_{received}$$

Where $\mathbf{P_{transmit}}$ is the Signal Generator transmit power level

$\mathbf{Gain_{Chamber}}$ 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). In the diagram in this calibration section, this term is shown as a chamber system loss.

$\mathbf{Gain_{RefAnt}}$ 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 analyzer) cable gain (a negative number if a loss – a positive number if there is an LNA in the system).

$\mathbf{Gain_{Pol}}$ is a polarization gain (non zero if there is a polarization mismatch between the Ref Ant and the AU GPS antenna). The polarization of the transmit antenna (re-radiating antenna is taken care of in the Chamber Gain number.

$\mathbf{P_{received}}$ is the received power level in a power meter or spectrum analyzer.

It should be noted that depending on the reference used for $P_{transmit}$ and $P_{received}$ either or both of these terms could be negative, thus it is important to include the signs of these terms in the following equations

The following table illustrates the $Gain_{Pol}$ values

Ref Antenna Polarization	AU's GPS Antenna polarization	$Gain_{Pol}$
CP	CP	0
Linear	CP	-3
CP	Linear	+3

Rewriting the above equation and solving for the Chamber Gain

$$Gain_{Chamber} = P_{received} – P_{transmit} – (Gain_{RefAnt} + Gain_{line} + Gain_{Pol})$$

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

$$EIRP_{AU} = P_{Scenario} + Gain_{Simulator\ high\ power\ port} + Gain_{Chamber} + Gain_{Amp/Attn}$$

Where:

$\mathbf{P_{Scenario}}$ is the scenario's power level coming out the GPS simulators normal power port

$\mathbf{Gain_{Simulator\ high\ power\ port}}$ 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.

$\mathbf{Gain_{Chamber}}$ is the number calculated above.

$\mathbf{Gain_{Amp/Attn}}$ is any other gain/loss required by the link. It may be an external amplifier or attenuator or both.

$\mathbf{EIRP_{AU}}$ is the EIRP incident upon the AU's GPS antenna. This number will be equivalent to the power number specified in the scenario.

For some GPS simulators there may be a difference between the GPS simulator's normal output port and a higher power monitor port which is dependent on the number of SV's (GPS satellites) in the scenario. This number will be available from the vendor of the GPS 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 is 3, 4, 5, 6 and 7 SV's present.

Once the desired EIRP levels into the AU are calculated, the set up is now calibrated and the reference antenna can be removed and replaced with the AU under test and the Signal Generator can be replaced with the GPS 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 set up is changed or there is reason to query the results obtained then the set up shall be re-calibrated as described herein before carrying out any further tests.

F.3.4 Method of Measurement

With the equipment set up as described in F.3.3 and after the set up has been calibrated Maritime Test Scenario 1 should be loaded into the Simulator. The Scenario should then be started and within 10 seconds of the scenario starting the AU shall be switched on. At the same time as the AU is activated a stop watch or similar timer is started.

The Scenario is then left to run until either a GPS fix is obtained and a location message containing position is received by the AIS receiver or the scenario runs to completion plus one minute (to allow for just missing a 1 minute burst) and no message containing position has been received by the AIS receiver (i.e. only default locations have been received).

If a location is received then the stop watch or timer shall immediately be stopped and the time and received location shall be recorded in the test results tables. Note that the first transmitted location as received by the AIS receiver is the one that should be recorded; any subsequent updated locations should be ignored.

If a location is not received within 13 minutes of starting the scenario then a “Fail” shall be indicated for that scenario in the Table, in which case the scenario is NOT repeated and the next scenario is loaded as described below.

It may be possible to observe a visual indication on the AU that a GPS fix has been obtained, in which case this can be used as an indicator that the next burst from the AU should contain location. Note that the TTFF is the time until the AU transmits a burst containing location data, not the time until an indicator on the AU indicates that a GPS fix has been obtained.

The AU is then switched off and left turned off for at least the specified time interval (seeF.3.2). During this period the next Scenario is loaded into the Simulator and the Beacon Tester and stop watch are reset. Once the specified AU off period has elapsed this procedure should be repeated.

Once all the results have been obtained they should be analysed as specified overleaf to determine if the AU has passed the tests.

F.3.5 Required Results

The TTFF for each Scenario along with the Transmitted Location shall be recorded in the Test Results Tables inF.4.1. If no location is obtained for a particular scenario then a "Fail" shall be recorded in both the TTFF and the AU Location columns.

Once all the Scenarios have been run the delta location error (i.e. the difference between the simulator position and the AU reported position) for each Scenario shall be calculated and recorded in the Test Results Tables using the following formula:

$$\text{Location Error (m)} = (((\text{SL Lat} - \text{TL Lat})*111000)^2 + ((\text{SL Long} - \text{TL Long})*111320*\cos \text{SL Lat})^2)^{1/2}$$

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 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 Transmitted Location Longitude in decimal Degrees to 5 decimal places.

The number of successful Maritime TTFF tests (those in which a location was obtained within 5 minutes) shall each be added up and the percentage pass rate is calculated. The AU shall be deemed to have passed the TTFF Test if the pass rate for the Maritime Scenarios is ≥70%.

The number of successful Maritime Location Accuracy tests (those with a location error of less than 30m shall each be added up and the percentage pass rate shall be calculated. The AU shall be deemed to have passed the Location Accuracy Test if the pass rate for the Maritime Scenarios is ≥70%.

The AU shall be required to pass both parts of the test (TTFF and Location Accuracy) in order to demonstrate compliance with this test procedure. All results shall be recorded in the Results Analysis Table in F.4.2

F.4 Test Results

F.4.1 Test Results Sheets

The results of the testing shall be documented on the following test results sheets and the necessary calculations (using the formula in F.3.5) should then be carried out to determine the location error for each scenario.

MARITIME SCENARIOS TEST RESULTS				
Scenario #	TTFF (min : sec)	Simulator Location	Transmitted Location	Location Error (m)
1		0° 0' N, 0° 0' E		
2		0° 0' N, 0° 0' E		
6		0° 0' N, 0° 0' E		
7		0° 0' N, 0° 0' E		
8		0° 0' N, 0° 0' E		
9		0° 0' N, 0° 0' E		
12		80° 0' N, 0° 0' E		
13		80° 0' N, 0° 0' E		
14		80° 0' N, 0° 0' E		
16		80° 0' N, 0° 0' E		
17		80° 0' N, 0° 0' E		
18		80° 0' N, 0° 0' E		
20		0° 0' N, 0° 0' E		
22		0° 0' N, 0° 0' E		
24		0° 0' N, 0° 0' E		
26		0° 0' N, 0° 0' E		
28		0° 0' N, 0° 0' E		
30		0° 0' N, 0° 0' E		
32		0° 0' N, 0° 0' E		
33		0° 0' N, 0° 0' E		
34		0° 0' N, 0° 0' E		
35		0° 0' N, 0° 0' E		
36		0° 0' N, 0° 0' E		
37		44° 0' S, 175° 0' E		
38		47° 0' N, 8° 0' E		
39		0° 0' N, 0° 0' E		

F.4.2 Results Analysis Tables

Calculate the following data and enter it in the results columns of the Tables below.

MARITIME SCENARIOS RESULTS ANALYSIS		
Criteria	**Limit / Condition**	**Result**
No of Successful Tests	TTFF ≤ 5 minutes	
Total No of Maritime Scenarios	26	N/A
TTFF Percentage Success Rate	(No Success Tests / 26) * 100	
TTFF Pass / Fail Limit	≥ 70%	N/A
No of Locations with Errors	≤ 30m	
No of Scenarios with Locations	Enter result	
Location Accuracy Percentage Pass Rate	(No Locations Errors ≤ 30m / No Scenarios with Location) * 100	
Location Accuracy Pass / Fail Limit	≥ 70%	N/A

PASS / FAIL ANALYSIS	
	Pass / Fail
Maritime TTFF Success Rate ≥ 70%	
Maritime Location Accuracy Pass Rate ≥ 70%	
F.4.2.1 Both results must be a “Pass” for the AU to pass, any one or more “Fails” indicates failure	

F.5 Scenario definitions

There are a total of 26 Maritime Scenarios used here. Copies of these Scenarios are available free of charge as files to download and run on most Spirent GNSS Simulators. In order to obtain copies of the files please email Spirent at help@spirentcom.com quoting “RTCM Scenarios”. For other makes of GNSS Simulator the data provided below shall be used to generate equivalent scenarios. The scenario provider shall provide evidence of the equivalence of the scenarios to the test laboratory performing the tests prior to any testing.

Scenario Length: The time duration of each scenario is 12 minutes zero seconds.

Reference date & time: The orbital reference date and time (UTC (SU)) defines the time and date at which orbit details are valid. This time is analogous to t_{oe} in the GPS satellite data message. For these scenarios the reference time is defined as 9/1/2002, at 00:00:00 UTC.

Gravity model WGS-84: The scenarios listed below are referenced to gravity model WGS-84. The simulator shall be capable of selecting a reference of WGS-84 or a calculation shall be made to set up an equivalent reference.

F.5.1 Maritime Scenarios

A maritime environment at 0 deg latitude and 0 degrees longitude is selected for most scenarios. Some scenarios are 80 deg N 0deg E and some others are located in New Zealand and Biscayne Beach Miami FL USA.

Various roll/pitch range and rate situations are simulated. The AU is essentially stationary, but a small velocity is selected to enable pitch and roll control. Some scenarios simulate antenna wash-over by corrupting certain words in the GPS digital downlink message. No elevation masking shall be done.

Satellite selection will determine the number of satellites visible in the scenario. All satellites will be turned off for the start of the scenario. Only those satellites selected for the scenario will be powered on at the start of the scenario.

The motion parameter is described with respect to an observer on deck facing forward in the direction of travel. For those scenarios where there is pitch and roll, the scenario shall start at scenario time =0 with a pitch up to the + pitch limit at the specified pitch rate and pitch rate duration, then pitch down to 0 deg at the specified rate and duration, then roll CW to the roll limit at the specified roll rate and roll duration, than roll CCW back to 0 deg at the specified roll rate and duration, then pitch down to – pitch limit at the specified pitch rate and pitch rate duration, then pitch up to 0 deg at the specified pitch rate and duration, then roll CCW to the roll limit at the specified roll rate and roll rate duration, then roll CW back to 0 at the specified roll rate and duration and then repeat this sequence for the remainder of the scenario.

Note that all scenarios do not have pitch and roll: some are motionless. Note that some simulators may require a selection of a certain type of vessel to activate the pitch/roll feature. For example, Spirent 7700 simulators require the use of an aircraft as the maritime vessel.

The following parameters apply to Maritime scenarios

Test #: This number is the file number used by Spirent. If a non-Spirent simulator is used, this number shall be used to reference the test to the Spirent test.

Spirent scenario name: This name is the name of the file used by Spirent. It is descriptive of most but not all of the parameters used in the scenario.

#SV's: Number of active GPS satellites in the scenario.**GPS SV's**: List of each active satellite by PRN number selected for use by the scenario. Satellites should be turned off prior to start of the scenario. This allows the test operator to quickly check the scenario's status.

Roll range: Limits of the roll used in the scenario. The form of the specification is ±dd. This in interpreted to mean the roll will vary from +dd degrees to –dd degrees.

Roll rate of change: This parameter is specified in the form dd for ss.s. The roll rate is specified as degrees per second (dd) for duration in seconds (ss.s). i.e. 5 for 34 seconds equates to 5 deg/sec for 34 seconds.

Pitch range: This parameters is the limit of the pitch used in the scenario. It takes the form ±dd. The pitch in the scenario will vary from +dd degrees to –dd degrees.

Pitch rate of change: This parameter is in the form dd for ss.s. The pitch rate is specified as degrees per second (dd) for duration in seconds (ss.s). i.e. 5 for 34 seconds equates to 5 deg/sec for 34 seconds.

Description of corruption: Some scenarios specify parts of the navigational message to be corrupted to simulate antenna wash over by waves. Corruption can occur in Ephemeris, Time or

Almanac parts of the navigation message. Specified navigational errors shall be added after parity correction so that parity will also be corrupted.

Target Power level: scenario output power level in dBm at the RF spigot.

Scenario start date: Date the scenario uses in the format mm/dd/yyyy.

Scenario start time: Time of the start of the scenario is in the form hh:mm:ss in 24 hour clock format UTC.

N/S?: Defines which hemisphere the user is located at the start of the scenario - Northern (N) or Southern (S).

Initial Latitude: Latitude of the user at the start of the scenario in the format dd:mm:ss. For stationary users this is the location used throughout the duration of the scenario.

E/W?: Defines which hemisphere the user is located at the start of the scenario – Eastern (E) or Western (W).

Initial Longitude: Longitude of the user at the start of the scenario in the format ddd:mm:ss.

Height above mean sea level: In meters (m).

WGS-84 Geiod Height: Height above mean sea level translated to WGS-84 reference (m).

Heading: Heading of the vessel measured in degrees clockwise from true North.

Speed: Speed of the vessel measured in meters/second.

GPS WN Rollover: GPS week number rolls over to 0 at 1024 weeks. This first (if 1 is specified) occurred on August 22nd, 1999, 1024 weeks after the GPS start date of 6 Jan 1980.

GPS wk No: GPS Week Number Defines the week from the most recent rollover.

Note that the term **EPIRB** in the tables refers to the AU under test.

F.5.2 Maritime Scenario Tables

Test #	March 2012 Version Identifier	Original Spirent Scenario file name	# SV's	GPS SV's	Roll range (deg)	Roll rate of change (deg/sec for # sec)	Pitch range (deg)	Pitch rate of change (deg/sec for # sec)	Description of Corruption	Test # (Spirent File #)	Target power level (dBm)	Scenario Start date	Scenario Start time (hr:min:sec) 24 hr clock	Initial Latitude (Deg:min:sec)	N/S?	Initial Longitude (deg:min:sec)	E/W?	Height above mean sea level (m)	Height above WGS-84 Geoid (m)	Heading (deg cw from N)	Speed (m/sec)	GPS WN roll-over	GPS Week No.
1	EPIRB_TEST_1_V1-01.scn	EPIRB 7 SVs 15 deg at 5 deg per sec power = -130.scn	7	3, 9, 18, 22, 4, 6, 19	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	none	1	-130	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	444
2	EPIRB_TEST_2_V1-01.scn	EPIRB 7 SVs 15 deg at 15 deg per sec power = -130.scn	7	3, 9, 18, 22, 4, 6, 19	±15	15 for 1.2 sec	±15	15 for 1.2 sec	none	2	-130	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	444
3	EPIRB_TEST_3_V1-01.scn	EPIRB 7 SVs 15 deg at 60 deg per sec power = -130.scn	7	3, 9, 18, 22, 4, 6, 19	±15	50 for 0.5 sec	±15	50 for 0.5 sec	none	3	-130	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	444
6	EPIRB_TEST_6_V1-01.scn	EPIRB 7 SVs 30 deg at 60 deg per sec power = -130.scn	7	20, 24, 14, 5, 9 ,13, 23	±30	60 for 0.7 sec	±30	60 for 0.7 sec	none	6	-130	3/1/2008	12:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	135.00	0.001	1	444
7	EPIRB_TEST_7_V1-01.scn	EPIRB 7 SVs 60 deg at 5 deg per sec power = -130.scn	7	6, 16, 13, 21, 22, 14, 4	±60	5 for 12.2 sec	±60	5 for 12.2 sec	none	7	-130	3/1/2008	21:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	180.00	0.001	1	444
8	EPIRB_TEST_8_V1-01.scn	EPIRB 7 SVs 60 deg at 15 deg per sec power = -130.scn	7	6, 16, 13, 21, 22, 14, 4	±60	15 for 4.2 sec	±60	15 for 4.2 sec	none	8	-130	3/1/2008	21:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	180.00	0.001	1	444
9	EPIRB_TEST_9_V1-01.scn	EPIRB 7 SVs 60 deg at 60 deg per sec power = -130.scn	7	6, 9, 16, 13, 21, 22, 4	±60	60 for 1.2 sec	±60	60 for 1.2 sec	none	9	-130	3/1/2008	21:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	180.00	0.001	1	444
12	EPIRB_TEST_12_V1-01.scn	EPIRB 80 deg lat 15 deg at 60 deg per sec power = -130.scn	7	3, 6, 13, 14, 16, 20, 24	±15	50 for 0.5 sec	±15	50 for 0.5 sec	none	12	-130	2/29/2008	23:30:00	80:00:00	N	0:00:00	E	0.000	-33.000	135.00	0.001	1	444
13	EPIRB_TEST_13_V1-01.scn	EPIRB 80 deg lat 30 deg at 5 deg per sec power = -130.scn	7	14, 24, 1, 16, 20, 5, 2	±30	5 for 6.2 sec	±30	5 for 6.2 sec	none	13	-130	3/1/2008	12:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	135.00	0.001	1	444
14	EPIRB_TEST_14_V1-01.scn	EPIRB 80 deg lat 30 deg at 15 deg per sec power = -130.scn	7	14, 24, 1, 16, 20, 5, 2	±30	15 for 2.2 sec	±30	15 for 2.2 sec	none	14	-130	3/1/2008	12:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	135.00	0.001	1	444
15	EPIRB_TEST_15_V1-01.scn	EPIRB 80 deg latitude 30 deg at 60 deg per sec power = -130.scn	7	9, 14, 24, 1, 16, 23, 2	±30	60 for 0.7 sec	±30	60 for 0.7 sec	none	15	-130	3/1/2008	12:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	135.00	0.001	1	444

Test #	March 2012 Version Identifier	Original Spirent Scenario file name	# SV's	GPS SV's	Roll range (deg)	Roll rate of change (deg/sec for # sec)	Pitch range (deg)	Pitch rate of change (deg/sec for # sec)	Description of Corruption	Test # (Spirent File #)	Target power level (dBm)	Scenario Start date	Scenario Start time (hr:min:sec) 24 hr clock	Initial Latitude (Deg:min:sec)	N/S?	Initial Longitude (deg:min:sec)	E/W?	Height above mean sea level (m)	Height above WGS-84 Geiod (m)	Heading (deg cw from N)	Speed (m/sec)	GPS WN roll-over	GPS Week No.
16	EPIRB_TEST_16_V1-01.scn	EPIRB 80 deg lat 60 deg at 5 deg per sec power = -130.scn	7	3, 7, 9, 10, 13, 17, 24	±60	5 for 12.2 sec	±60	5 for 12.2 sec	none	16	-130	3/1/2008	21:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	180.00	0.001	1	444
17	EPIRB_TEST_17_V1-01.scn	EPIRB 80 deg lat 60 deg at 15 deg per sec power = -130.scn	7	3, 7, 13, 24 , 10, 14, 6	±60	15 for 4.2 sec	±60	15 for 4.2 sec	none	17	-130	3/1/2008	21:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	180.00	0.001	1	444
18	EPIRB_TEST_18_V1-01.scn	EPIRB 80 deg lat 60 deg at 60 deg per sec power = -130.scn	7	3, 7, 13, 10, 17, 14, 6	±60	60 for 1.2 sec	±60	60 for 1.2 sec	none	18	-130	3/1/2008	21:00:00	80:00:00	N	0:00:00	E	0.000	-33.000	180.00	0.001	1	444
19	EPIRB_TEST_19_V1-01.scn	EPIRB 7 Svs; ephmeris 1 power = -130.scn	7	9, 13, 19, 20, 16, 22, 6	0	0	0	0	***Ephemeris 1 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then no nav errors for 30 seconds. This sequence repeats with no breaks until the end of the scenario. Otherwise, no nav errors.	19	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	90.00	0.000	1	441
20	EPIRB_TEST_20_V1-01.scn	EPIRB 7 SVs 15 deg pitch roll at 5 deg per sec; ephmeris 1 power = -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Ephemeris 1 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then no nav errors for 30 seconds. This sequence repeats with no breaks until the end of the scenario. Otherwise, no nav errors.	20	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
21	EPIRB_TEST_21_V1-01.scn	EPIRB 7 SVs; ephmeris 2 power = -130.scn	7	9, 13, 19, 20, 16, 22, 6	0	0	0	0	***Ephemeris 2 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are set to all zeros, then for a period of 30 seconds, words 4-9 in subframe #3 are set to all zero's. This sequence repeats with no breaks until end of scenario. Otherwise, no nav errors.	21	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	90.00	0.000	1	441

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22	EPIRB_TEST_22_V1-01.scn	EPIRB 7 SVs 15 deg pitch roll at 5 deg per sec; ephmeris 2 power = -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Ephemeris 2 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are set to all zeros, then for a period of 30 seconds, words 4-9 in subframe #3 are set to all zero's. This sequence repeats with no breaks until end of scenario. Otherwise, no nav errors.	22	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
24	EPIRB_TEST_24_V1-01.scn	EPIRB 7 SVs 15 deg pitch roll at 5 deg per sec almanac power -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Almanac only***: for all satellites, for the entire scenario, words 4-9 in subframe #5 are set to all zeroes	24	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
25	EPIRB_TEST_25_V1-01.scn	EPIRB 7 SVs Time power = -130.scn	7	9, 13, 19, 20, 16, 22, 6	0	0	0	0	***Time only***: for all satellites, Starting at 6 sec into scenario, words 4-9 in subframe #1 are all set to zeroes for 30 seconds, then no errors for 30 seconds. Sequence repeats without break for entire scenario	25	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	90.00	0.000	1	441
26	EPIRB_TEST_26_V1-01.scn	EPIRB 7 SVs 15 deg pitch roll at 5 deg per sec Time power -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Time only*** : for all satellites, starting at 6 sec into scenario, words 4-9 in subframe #1 are all set to zeroes for 30 seconds, the normal for 30 seconds. Sequence repeats without break for entire scenario	26	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
27	EPIRB_TEST_27_V1-01.scn	EPIRB 7 SVs ephemeris 1 + Almanac power -130.scn	7	9, 13, 19, 20, 16, 22, 6	0	0	0	0	***Both Ephemeris 1 and Almanac. For Almanac:*** for all satellites, for the entire scenario, words 4-9 in subframe #5 are set to all zero and ***for Ephemeris 1***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then no nav errors for 30 seconds. This sequence repeats with no breaks until the end of the scenario. Otherwise, no nav errors.	27	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	90.00	0.000	1	441

Test #	March 2012 Version Identifier	Original Spirent Scenario file name	# SV's	GPS SV's	Roll range (deg)	Roll rate of change (deg/sec for # sec)	Pitch range (deg)	Pitch rate of change (deg/sec for # sec)	Description of Corruption	Test # (Spirent File #)	Target power level (dBm)	Scenario Start date	Scenario Start time (hr:min:sec) 24 hr clock	Initial Latitude (Deg:min:sec)	N/S?	Initial Longitude (deg:min:sec)	E/W?	Height above mean sea level (m)	Height above WGS-84 Geiod (m)	Heading (deg cw from N)	Speed (m/sec)	GPS WN roll-over	GPS Week No.
28	EPIRB_TEST_28_V1-01.scn	EPIRB 7 SVs 15 deg roll + pitch at 5 deg per sec ephmeris 1 + Almanac power -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Both Ephemeris 1 and Almanac.* For Almanac**: for all satellites, for the entire scenario, words 4-9 in subframe #5 are set to all zero and **for ephemeris 1**: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then no nav errors for 30 seconds. This sequence repeats with no breaks until the end of the scenario. Otherwise, no nav errors	28	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
30	EPIRB_TEST_30_V1-01.scn	EPIRB 7SVs 15 deg roll at 5 deg per sec epheremis 1+time power -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Both Time and Ephemeris 1***: for all satellites, Starting at 6 sec into scenario, words 4-9 in subframes #1 (Time) and #2 (Ephemeris 1) are all set to zeroes for 30 seconds, then set to normal for 30 seconds. Sequence repeats without break for entire scenario	30	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
32	EPIRB_TEST_32_V1-01.scn	EPIRB 7SVs 15 roll and pitch at 5 deg sec almanac + time power -130.scn	7	9, 13, 19, 20, 16, 22, 6	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Almanac and Time*: For *Almanac***: for all satellites, for the entire scenario, words 4-9 in subframe #5 are set to all zeroes and ***for Time***: for all satellites, starting at 6 sec into scenario, words 4-9 in subframe #1 are all set to zeroes for 30 seconds, the normal for 30 seconds. Sequence repeats without break for entire scenario	32	-130	2/3/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	441
33	EPIRB_TEST_33_V1-01.scn	EPIRB 7 SVs no corruption power -135.scn	7	3, 9, 18, 22, 4, 6, 19	0	0	0	0	none	33	-135	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.000	1	444
34	EPIRB_TEST_34_V1-01.scn	EPIRB 7SVs 15 deg at 15 dec per sec no corruption power -135.scn	7	3, 9, 18, 22, 4, 6, 19	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	none	34	-135	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	444

Test #	March 2012 Version Identifier	Original Spirent Scenario file name	# SV's	GPS SV's	Roll range (deg)	Roll rate of change (deg/sec for # sec)	Pitch range (deg)	Pitch rate of change (deg/sec for # sec)	Description of Corruption	Test # (Spir-ent File #)	Target power level (dBm)	Scenario Start date	Scenario Start time (hr:min:sec) 24 hr clock	Initial Latitude (Deg:min:sec)	N/S?	Initial Longitude (deg:min:sec)	E/W?	Height above mean sea level (m)	Height above WGS-84 Geiod (m)	Heading (deg cw from N)	Speed (m/sec)	GPS WN roll-over	GPS Week No.
35	EPIRB_TEST_35_V1-01.scn	EPIRB 7SVs;ephemeris 1 ; power =-135.scn	7	3, 9, 18, 22, 4, 6, 19	0	0	0	0	***Ephemeris 1 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then set to normal for a period of 30 seconds. This sequence repeats with no breaks until end of scenario. Otherwise, no nav errors.	35	-135	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	90.00	0.000	1	444
36	EPIRB_TEST_36_V1-01.scn	EPIRB 7SVs 15 deg pitch + roll at 15 deg sec ephemeris 1; power= -135.scn	7	3, 9, 18, 22, 4, 6, 19	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	***Ephemeris 1 only***: for all satellites, starting at 6 seconds into the scenario, for a period of 30 seconds, words 4-9 in subframe #2 are all set to zeros, then set to normal for a period of 30 seconds. This sequence repeats with no breaks until end of scenario. Otherwise, no nav errors.	36	-135	3/1/2008	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	444
37	EPIRB_TEST_37_V1-01.scn	EPIRB 7SVs 15 deg at 15 deg sec New Zealand; power=-130.scn	7	4, 10, 11, 1, 8, 15, 17	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	none	37	-130	3/1/2008	0:00:00	44:03:00	S	174:09:00	E	0.000	-8.752	135.00	0.001	1	444
38	EPIRB_TEST_38_V1-01.scn	EPIRB 7SVs 15 deg at 15 deg se ;Biscay 2019 power -130.scn	7	4, 11, 14, 15, 17, 8, 10	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	none	38	-130	3/1/2019	0:00:00	47:21:00	N	8:27:00	W	0.000	-56.983	135.00	0.001	1	1018
39	EPIRB_TEST_39_V1-01.scn	EPIRB 7SVs 15 deg at 15 deg sec 2019 no corruption;power = -135.scn	7	8, 15, 24, 14, 10, 23, 17	±15	5 for 3.2 sec	±15	5.35714 for 3 sec	none	39	-135	3/1/2019	0:00:00	0:00:00	N	0:00:00	E	0.000	-18.000	135.00	0.001	1	1018