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European Standard (Telecommunications series)

Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Float-free maritime satellite Emergency Position Indicating Radio Beacons (EPIRBs) operating in the 406,0 MHz to 406,1 MHz frequency band; Technical characteristics and methods of measurement

Reference

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Every EN prepared by ETSI is a voluntary standard. The present document contains text concerning conformance testing of the equipment to which it relates. This text should be considered only as guidance and does not make the present document mandatory.

National transposition dates	
Date of adoption of this EN:	12 January 2001
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1 Scope

The present document sets out the minimum performance requirements and technical characteristics for float-free satellite Emergency Position-Indicating Radio Beacons (EPIRB), operating in the COSPAS-SARSAT satellite system, concerning radio communications for the Global Maritime Distress and Safety System (GMDSS).

The equipment covered by the present document operates in the 406,0 MHz – 406,1 MHz frequency band, which is provided with a low power 121,5 MHz homing device. The present document covers also EPIRBs with integrated internal navigation device.

The present document incorporates all relevant provisions of the ITU Radio Regulations [1], of IMO assembly resolutions, as well as all relevant requirements in EN 60945 [7].

The present document is applicable for satellite EPIRBs operating over the temperature ranges of:

- -40°C to +55°C (Class 1); or
- -20°C to +55°C (Class 2);

with a float free release mechanism.

NOTE 1: The equipment meets the IMO requirements of chapter IV, regulations 7.1.6 and 14.1 of the 1988 amendments to the 1974 International Convention for Safety of Life at Sea (SOLAS) [2].

NOTE 2: The requirements for non float free satellite EPIRBs can be found in Annex A.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] International Telecommunication Union: "Radio Regulations".

[2] International Convention for Safety of Life at Sea (SOLAS) (1974), as amended.

[3] IMO Resolution A.658(16): "Use and fitting of retro-reflective materials on life-saving appliances".

[4] IMO Resolution A.689(17): "Testing of life-saving appliances".

[5] C/S T.001: "Specification for COSPAS-SARSAT 406 MHz distress beacons", rev. 3.

[6] C/S T.007: "COSPAS-SARSAT 406 MHz distress beacon type approval standard", rev.6.

[7] EN 60945: "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".

[8] ETSI ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

3 Definitions and abbreviations

3.1 Definitions

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

satellite EPIRB: earth station in the Mobile Satellite Service the emissions of which are intended to facilitate search and rescue operations.

release mechanism: arrangement which allows the satellite EPIRB to float free automatically.

homing device: 121,5 MHz beacon primarily intended for homing by aircraft.

remote control unit: unit which allows the satellite EPIRB, while mounted in the release mechanism, to be activated from another position than its installation point.

equipment: satellite EPIRB which includes the 121,5 MHz homing device, its release mechanism and remote control unit (when provided).

class 1: satellite EPIRB intended for operation over the temperature range -40°C to +55°C.

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

3.2 Abbreviations

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

AF	Antenna Factor
BCH	Bose-Chaudhuri-Hocquenghem
CW	Carrier Wave
e.i.r.p.	equivalent isotropically radiated power
EPIRB	Emergency Position Indicating Radio Beacon
ERPEP	Effective Radiated Peak Envelope Power
EUT	Equipment Under Test
GLONASS	Global Navigational Satellite System (Russia)
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System (USA)
ID	Identification
LHCP	Left Hand Circularly Polarized
LSB	Least Significant Bit
MID	Maritime Identification Digits
MMSI	Maritime Mobile Station Identity
MSB	Most Significant Bit
PLL	Phase Locked Loop
RF	Radio Frequency
RHCP	Right Hand Circular Polarized
SOLAS	International Convention for Safety of Life at Sea
VSWR	Voltage Standing Wave Ratio

4 General requirements

4.1 Introduction

The manufacturer shall declare that compliance to the requirements of clause 4 is achieved and shall provide relevant documentation.

4.2 Operating conditions

The satellite EPIRB shall be mounted in a release mechanism (clause 12) which automatically releases the EPIRB when submerged in water. When so released, the EPIRB shall float to the surface and start transmitting automatically irrespective of the settings of any control.

The satellite EPIRB shall be designed to operate when floating in the sea but shall also operate satisfactorily on a ship's deck and in a survival craft.

The satellite EPIRB may be equipped with a positioning device e.g. GPS or GLONASS.

The general construction and method of operation shall provide a high degree of proof against inadvertent operation, whilst still providing a simple means of operation in an emergency.

The satellite EPIRB shall be capable of being carried by one person and it shall be possible to release and operate the satellite EPIRB manually.

If the satellite EPIRB is manually removed from its release mechanism, it shall be activated only when floating in the water or manually activated (subclause 4.6).

After automatic or manual activation, no distress signal shall be emitted until at least 47 seconds and at most 5 minutes after the satellite EPIRB has been activated. The satellite EPIRB shall be a single integral unit incorporating a primary battery and a permanently attached antenna. No part of it shall be detachable without the use of tools. The fixed portion of the distress message shall be stored in such a way that it will not be affected by removal of all power sources. Any external connection shall not inhibit the release or activation of the satellite EPIRB.

4.3 Lanyard

The satellite EPIRB shall be provided with a firmly attached line in order that the equipment may be tethered in use. The lanyard shall be capable of floating in sea water and shall be arranged so as to prevent it being trapped in the ship's structure when floating free.

4.4 Colour and surface

The satellite EPIRB shall be finished with a highly visible yellow/orange colour and shall be fitted with a band of retro-reflecting material, which shall meet the performance requirements of IMO Resolution A.658 (16) [3], shall be at least 25 mm wide, encircling that part of the satellite EPIRBs body which is normally protruding above the waterline.

4.5 Low duty cycle light

The satellite EPIRB shall be provided with a low duty cycle light which fulfils the requirements of subclause 10.1.

4.6 Controls

All controls shall be of sufficient size for simple and satisfactory operation and also be capable of being operated by a person wearing gloves for immersion suits in accordance with Chapter III Regulation 33 of the 1983 amendments to the 1974 SOLAS Convention [2].

Manual activation of the satellite EPIRB shall break a seal which shall not be replaceable by the user and shall require two simple but independent mechanical actions neither of which, on its own, shall activate the equipment. The seal shall not be broken when using the test facility.

If the satellite EPIRB is installed in its release mechanism the manual activation shall require two simple but independent mechanical actions. The means for manual activation shall be protected against inadvertent activation.

After manual or automatic activation it shall be possible to manually deactivate the satellite EPIRB repetitively.

4.7 Indicators

If the satellite EPIRB is activated, the low duty cycle light (subclause 4.5) shall begin flashing within 10 seconds, in any lighting condition.

The satellite EPIRB shall be provided with either an audible or a visual indication that signals are being emitted. The visual indication could be combined with the low duty cycle light (e.g. triggered by the burst).

4.8 Self-test mode

The satellite EPIRB shall be capable of being tested, without using the satellite system, to determine that the satellite EPIRB is capable of operating properly, i. e. the following items under a full-load condition as a minimum shall be tested:

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

When the self-test mode is activated, the satellite EPIRB shall emit a single burst which shall be identical to its normal transmission burst, except that the frame synchronization pattern (subclause 9.2A.2) shall be "011010000" (i. e. the last 8 bits are complemented and the burst duration shall be 440 ms or 520 ms). Successful completion of the self-test shall be indicated after which the test facility shall deactivate automatically. The test mode shall be functional throughout the operating temperature range.

4.9 Labelling

The satellite EPIRB and its container, if any, shall be provided with a label or labels containing the following information at least in English:

- type designation, serial number, and the type of battery specified by the manufacturer for use in the equipment;
- the date on which the battery will need to be replaced;
- adequate instruction to enable manual activation and deactivation and self-test;
- a warning to the effect that the satellite EPIRB shall not be operated except in an emergency;
- space on which the ship name, Maritime Mobile Station Identity (MMSI) and call sign may be recorded;
- the class of the satellite EPIRB;
- the identity code programmed into the satellite EPIRB, namely hexadecimal representation of bits 26 to 85 of the digital message (beacon 15 hex ID);
- the compass-safe distance.

Administrations may require additional labelling.

4.10 Operating instructions

The equipment manufacturer shall provide full instructions and information regarding stowage, installation, and operation of the satellite EPIRB. This shall include proper operation, procedures to limit self-testing to the minimum necessary to ensure confidence in the operation of the satellite EPIRB, battery replacement, and the avoidance of false alarms.

4.11 Homing device

The satellite EPIRB shall be provided with a homing device operating on 121,5 MHz which shall fulfil the requirements of subclause 10.3.

4.12 Accessories

Where a unit of equipment provides a facility which is additional to requirements of the present document, the operation or malfunction of such an additional facility shall not prevent the satellite EPIRB conforming fully to the requirements of the present document during normal combined operation.

4.13 Power source

4.13.1 Battery requirements

The battery life as defined by its expiry date shall be at least 3 years.

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

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

To define the useful life of the battery, the following losses at the temperature of +20°C ± 5°C shall be included:

- self testing at a rate of once a week;
- self-discharge of the battery; and
- standby loads, if any.

4.13.2 Safety precautions

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

The battery shall not release toxic or corrosive products outside the satellite EPIRB:

- during or subsequent to storage at temperatures between -55°C and +75°C;
- during a full or partial discharge at any rate up to and including an external short circuit;
- during a charge or forced discharge of a cell or cells by another cell or cells within the battery;
- after a full or partial discharge.

The battery shall not be hazardous to any person handling, using or performing manufacturer approved servicing of the device or to any vehicle or equipment in which it is transported, housed or installed under any of the conditions specified in the present document.

5 Test conditions

5.1 General

The requirements of the present document shall be met after a maximum warm-up period of 15 minutes.

Adequate information shall be provided to enable the equipment to be properly set up, maintained and operated during the conformance testing.

If the equipment contains any additional facilities or auxiliary devices, they shall be operational for the duration of all tests, in the mode draining maximum battery energy. During testing all audible and visual indications including the low duty cycle light shall be functioning.

5.2 Performance check

For the purpose of the present document, the term "performance check" shall be taken to mean:

- to determine the characteristic frequency from four measurements of the carrier frequency of the unmodulated signal $f_c^{(1)}$ made under extreme test conditions (subclauses 5.11 and 5.12) during the interval S_1 (Figure 5) during four successive transmissions as follows:

$$f_o = f^{(1)} = \frac{1}{4}\sum_{i=1}^{4} f_{c\,i}^{(1)}$$

- for beacons with nominal frequency 406,025 MHz, the characteristic frequency shall be between 406,023 MHz and 406,027MHz.
- for beacons with nominal frequency 406,028 MHz, the characteristic frequency shall be between 406,027 MHz and 406,029MHz.
- to measure the output power of the satellite EPIRB under normal test conditions. The output power shall be 37 dBm ± 2 dB;
- to measure the output power of the 121,5 MHz homing device under normal test conditions. The output power shall be 17 dBm ± 3 dB;
- to measure the carrier frequency of the 121,5 MHz homing device under normal test conditions. The carrier frequency shall be 121,5 MHz ± 3,5 kHz;
- to check the operation of low duty cycle light.

5.3 Preparation of satellite EPIRB for testing

For the purpose of conformance testing, the satellite EPIRB shall be specially programmed to transmit data bursts encoded using the protocol of the appropriate type and format (as defined in clause 9),when the satellite EPIRB is activated. All homing devices should be prepared for test transmission. Care shall be taken not to transmit distress signals on distress and safety frequencies, for example by frequency offset or test coding.

The manufacturer shall supply a satellite EPIRB which is configured such that the antenna port can be connected to the test equipment by a coaxial cable, terminated by a 50 Ω load. If possible this connection shall be waterproof and able to withstand all environmental conditions. The configuration of the antenna port may be prepared by the manufacturer before the relevant test.

In cases where it is not possible to fit a watertight connector to the EPIRB due to the shape or size of the EPIRB, the manufacturer can supply two units for testing. One unit shall be a standard production unit, the other unit shall have a means to connect a coaxial cable, but may not withstand all environmental conditions. Both units shall be exposed to all environmental tests, except the tests which include submersion into fluid, which shall only be performed on the standard production unit.

5.4 Test sequence

The tests shall be carried out in the order described in the present document, and may be combined with the tests as described in the COSPAS-SARSAT specifications C/S T.001 [5], C/S T.007 [6].

All tests shall be performed on a single unit, prepared in accordance with subclause 5.3.

5.5 Test power source

All tests and performance checks shall be carried out using the internal battery.

For conformance tests, three sets of batteries shall be submitted.

5.6 Test site

The test site for radiation measurements shall be an area clear of any obstruction such as trees, bushes or metal fences within an elliptical boundary of dimensions shown in Figure 1. Objects outside this boundary may still affect the measurements and care shall be taken to choose a site as far as possible from large objects or metallic objects of any sort.

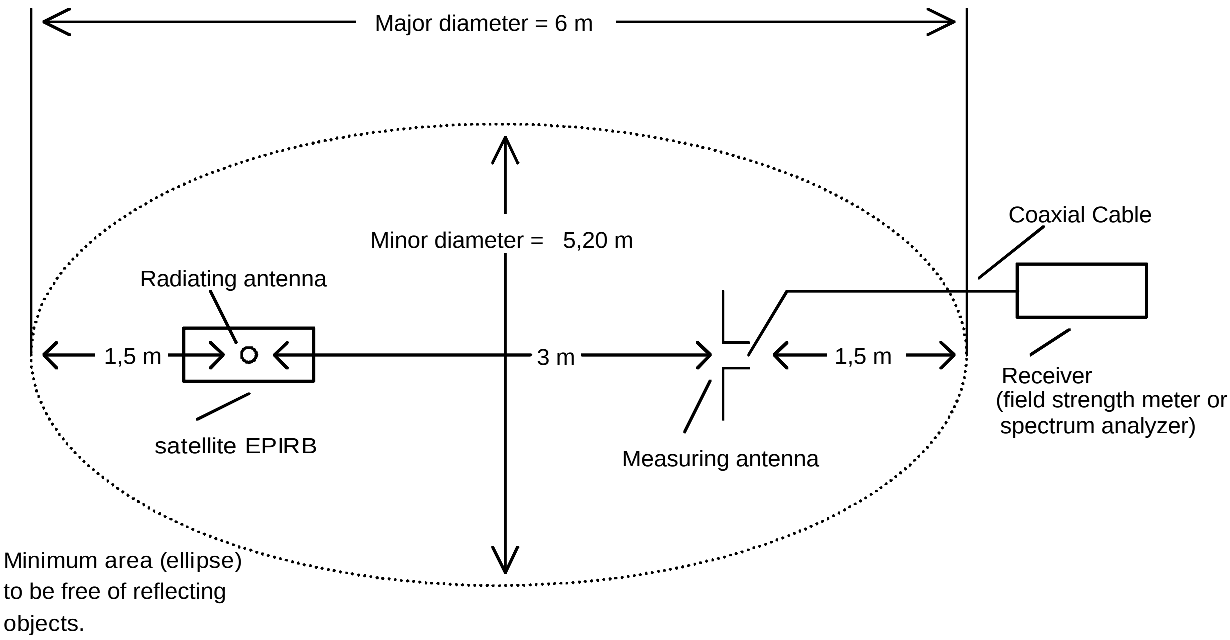


Figure 1: Sample test site

The terrain at an outdoor test site shall be flat. Any conducting object inside the area of the ellipse shall be limited to dimensions less than 7 cm. A metal ground plane or wire mesh covering at least the area of the ellipse and keeping the same major and minor axis as indicated in Figure 1 is preferred. All electrical wires and cables should be under the ground plane. The antenna cable shall be extended behind the measuring antenna along the major axis of the test site for a distance of at least 1,5 m from the dipole elements before being routed down to ground level.

All precautions shall be taken to ensure that reflections from surrounding structures are minimized. No personnel above ground shall be within 6 m of the satellite EPIRB during measurements. Test reports shall include a detailed description of the test environment. They shall specifically indicate what precautions were taken to minimize reflections.

Weather protection enclosures may be constructed either partially or entirely over the site. Fibreglass, plastics, treated wood or fabric are suitable materials for construction of an enclosure. Alternatively, the use of anechoic enclosure is acceptable.

5.7 Test set-up

The test set-up, as shown in Figure 2, shall be used to simulate water conductivity of the satellite EPIRB.

The satellite EPIRB shall be oriented in a manner in which it is designed to operate and placed on a circular ground plane capable of rotation through 360° in azimuth. As shown in Figure 2, the rotating ground plane B shall have a minimum radius of 1,7λ, (125 cm) and be made of highly conductive material (aluminium or copper). It shall be located at a reference height X = 0,75 ± 0,10 m above ground plane A. The satellite EPIRB shall be mounted within the rotating ground plane B to a level such that its float line is aligned with the ground plane B and the antenna of the satellite EPIRB is positioned at the centre. This ground plane shall be extended to fit closely around the satellite EPIRB and to surround the below-waterline portion of the unit (e.g. using metal foil). An adapter plate which has a close fit to the sides of the satellite EPIRB is recommended.

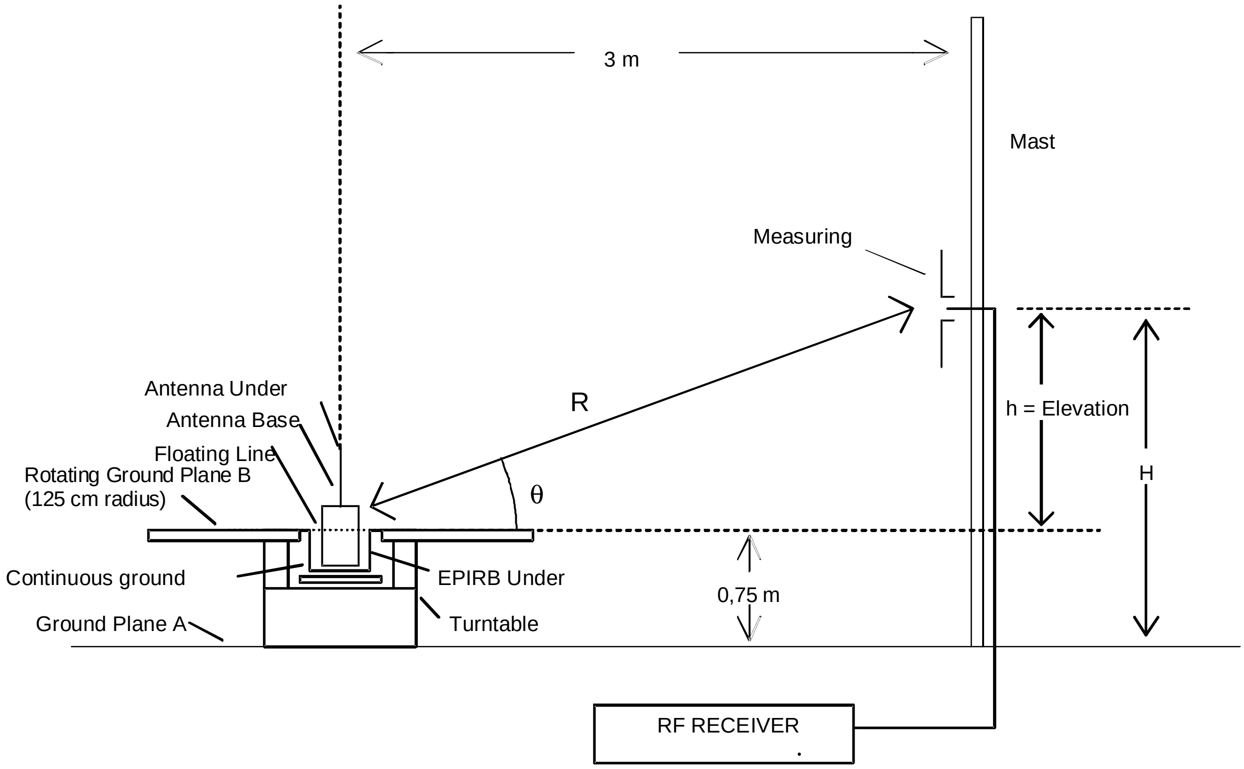


Figure 2: Test set-up

5.8 Test receiver

The test receiver (which may be a field strength meter or a spectrum analyser) should be calibrated as follows:

a) connect the equipment as shown in Figure 2. Install the satellite EPIRB as described in subclause 5.7;

b) turn on the satellite EPIRB for nominal transmission. Set the receiver bandwidth to measure the power of the transmission. The same receiver bandwidth shall be used during the antenna measurement process. Tune the receiver for maximum received signal. Position the measuring antenna in the plane (horizontal or vertical) that gives the greatest received signal. Rotate the satellite EPIRB antenna and determine an orientation which is representative of the average radiation field strength (not a peak or a null). Record the receiver level;

c) disconnect the measuring antenna and feed the calibrated RF source to the receiver through the measuring antenna cable. Adjust the signal source to give the same receiver level recorded in b) above;

d) disconnect the calibrated RF source from the measuring antenna cable and measure its RF output with a power meter;

e) reconnect the calibrated RF source to the measuring antenna cable and adjust the gain calibration of the receiver for a reading which is equal to the power.

5.9 Measuring antenna

The radiated field of the satellite EPIRB antenna shall be detected and measured using a tuned dipole. This dipole antenna shall be positioned at a horizontal distance of 3 m from the satellite EPIRB antenna and mounted on a non-conducting vertical mast that permits the height of the measuring antenna to be varied from 1,3 to 4,3 m (i.e. from 10 to 50 degrees relative to the ground plane B located at reference height X = 0,75 m, Figure 2). The height at which the measuring antenna shall be elevated on the supporting mast for a specific angle of elevation is calculated as follows:

$$h_{|metres} = 3\tan\theta \text{ and } H_{|metres} = h + X$$

where:

X is the reference height (0,75 m);

h is the height of the measuring antenna relative to the reference height X;

θ is the desired angle of elevation in degrees with respect to the rotating ground plane B (at reference height X);

H is the height of the measuring antenna above the ground plane A.

NOTE: The centre of the measuring dipole antenna is used as the reference to determine its height.

As the measuring antenna is vertically elevated, the distance (R) between the satellite EPIRB antenna and the measuring antenna increases. The distance (R) is a function of the elevation angle (θ) and it is calculated as follows:

$$R_{|metres} = \frac{3}{\cos\theta}$$

The antenna factor (AF) of the measuring antenna at 406 MHz shall be known.

This factor is normally provided by the manufacturer of the dipole antenna or from the latest antenna calibration data. It is used to convert the induced voltage measurement into electric field strength.

Since the value of AF depends on the direction of propagation of the received wave relative to the orientation of the receiving antenna, the measuring dipole should be maintained perpendicular to the direction of propagation. In order to minimize errors during measurement, it is recommended to adopt its practice (Figure 3) If the measuring antenna cannot be maintained perpendicular to the direction of propagation (Figure 4), a correction factor shall be considered due to the gain variation pattern of the measuring antenna. For a dipole, the corrected antenna factor (AF_C) is calculated as follows:

$$AF_c = \frac{AF}{P} \text{ and } P = \frac{\cos(90\sin\theta)}{\cos\theta}$$

where:

AF is the antenna factor of the measuring antenna at 406 MHz;

θ is the elevation angle;

P is the correction factor for the dipole antenna pattern.

NOTE: The correction factor (P) is equal to 1 when the measuring antenna elements are maintained perpendicular to the direction of propagation. P is therefore equal to 1 when the measuring antenna is horizontally polarized at any elevation angle. The correction factor applies only to vertically polarized measurements.

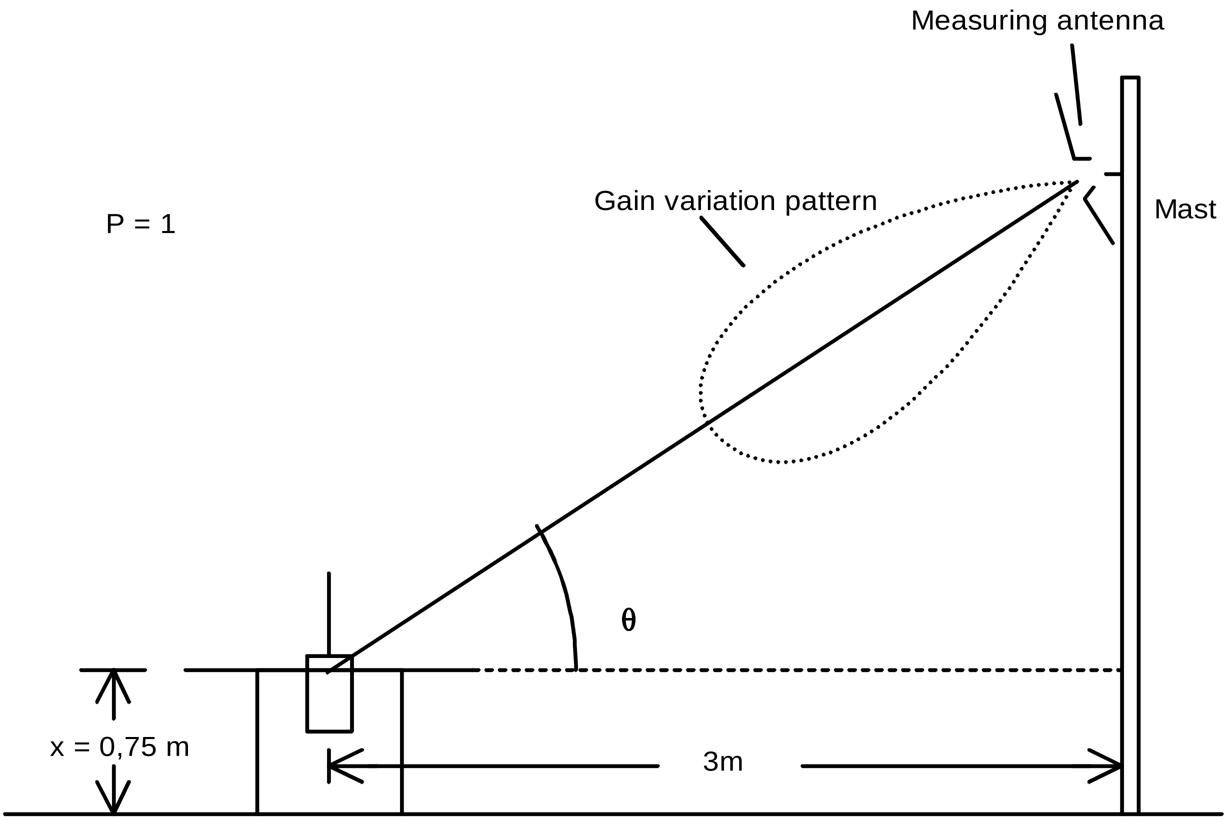


Figure 3: Measuring antenna perpendicular to the direction of propagation

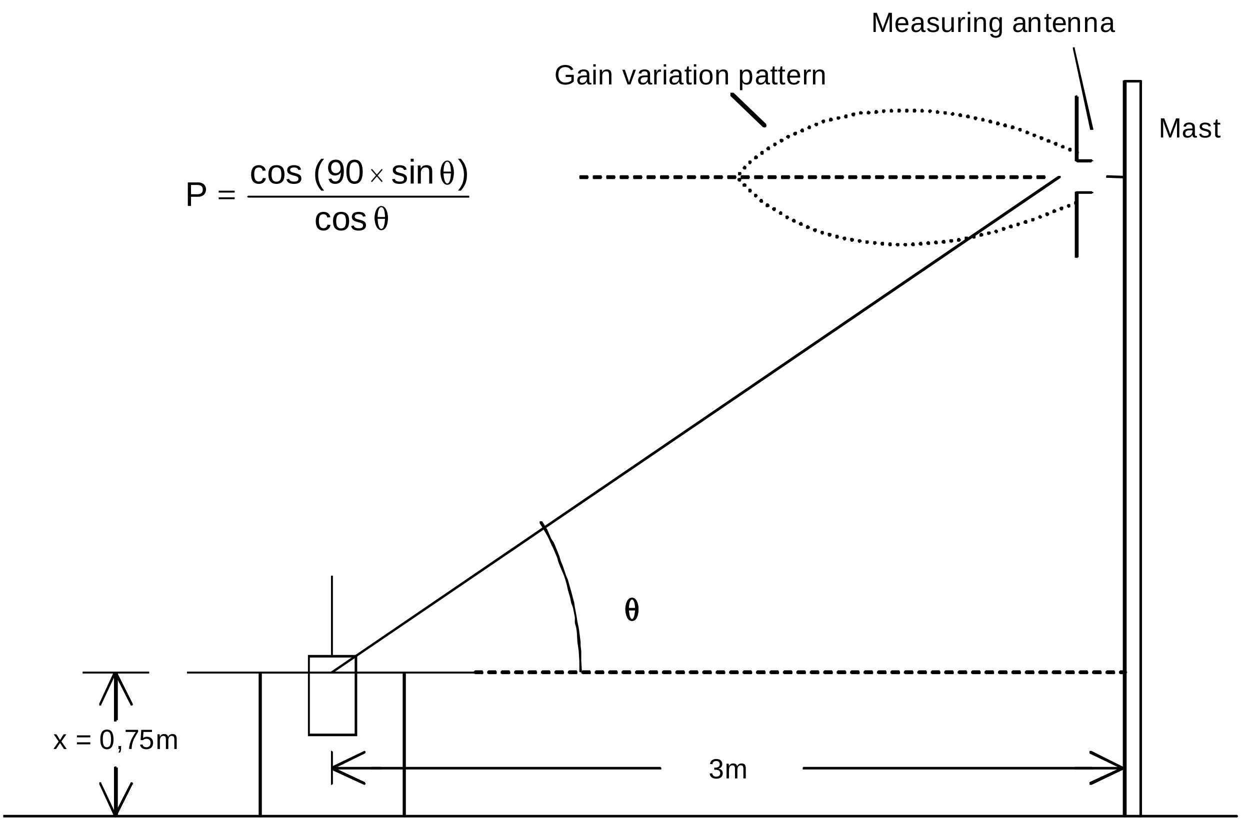


Figure 4: Measuring antenna not perpendicular to the direction of propagation

5.10 Normal test conditions

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

- temperature: +15°C to 35°C;
- relative humidity: 20 % to 75 %.

5.11 Extreme test conditions

For tests at extreme temperatures, measurements shall be made in accordance with the procedure specified in subclause 5.12 at the following lower and upper extreme temperatures:

- for the class 1 EPIRB -40°C and +55°C;
- for the class 2 EPIRB -20°C and +55°C.

For tests of the release mechanism at extreme temperature, the lower and upper temperature are -30°C and +65°C.

5.12 Procedure for tests at extreme temperatures

The equipment shall be switched off during the temperature stabilizing period.

Before tests are carried out, the equipment shall have obtained thermal balance in the test chamber and have been switched on for a period of 15 minutes.

NOTE: All electrical and functional tests under extreme temperatures may be combined with the relevant tests of the COSPAS-SARSAT specification (clause A.2.1 of C/S T.007 [6]).

5.13 Measurement uncertainties

Table 1: Absolute measurement uncertainties: maximum values

Parameter	Maximum uncertainty
Repetition Time	± 0,01 seconds
Total Transmission Time	± 1,0 ms
CW Preamble	± 1,0 ms
Bit Rate	± 0,6 bit/s
Nominal Frequency	± 100 Hz
Frequency Stability	$<1x10^{-10}$
Transmitted Power	± 0,5 dB
Spectrum mask	± 2 dB
Carrier Rise Time	± 0,5 ms
Modulation Rise	± 25µs
Modulation Symmetry	< 0,01
Phase Modulation	± 0,04 radians
Temperature	± 2°C
Antenna Measurement	± 3 dB

Where applicable for the test methods according to the present document the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028 [8].

6 Environmental tests

6.1 General

Environmental tests in this clause shall be carried out before any other tests and shall be performed under normal test conditions unless otherwise stated. The satellite EPIRB shall be installed in its release mechanism in operating conditions (subclause 4.2) but not transmitting unless otherwise stated.

The following tests shall be conducted in the order they appear in this clause unless otherwise stated.

6.2 Temperature tests

6.2.1 Definition

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

The maximum rate of raising or reducing the temperature of the chamber in which the equipment is being tested shall be 1°C/minute.

6.2.2 Dry heat test

6.2.2.1 Method of measurement

The equipment shall be placed in a chamber of normal room temperature. Then the temperature shall be raised to and maintained at +70°C (±3°C) for a period of between 10 hours and 16 hours.

After this period any climatic control device provided in the equipment may be switched on and the chamber cooled to +55°C (±3°C). The cooling of the chamber shall be completed within 30 minutes.

The equipment shall then be switched on and shall be kept working continuously for a period of 2 hours. The temperature of the chamber shall be maintained at +55°C (±3°C) during the 2 hour 30 minute period. The equipment shall be subjected to a performance check during the last 30 minutes.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 hour. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 hours before the next test is carried out.

6.2.2.2 Requirement

The requirement for the performance check shall be met.

6.2.3 Damp heat test

6.2.3.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature and humidity which, steadily, over a period 3 hours (±0,5 hours), shall be heated from room temperature to +40°C (±3°C) and shall during this period be brought to a relative humidity of 93 % (±2 %).

These conditions shall be maintained for a period of between 10 hours and 16 hours.

The equipment shall be switched on 30 minutes later, and shall then be kept working continuously for a period of 2 hours.

The temperature and relative humidity of the chamber shall be maintained at +40°C (±3°C) and 93 % (±2 %) during the 2 hour 30 minute period. The equipment shall be subjected to a performance check during the last 30 minutes.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 hour. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 hours, or until moisture has dispersed, whichever is longer, before the performance check is carried out.

6.2.3.2 Requirement

The requirement for the performance check shall be met.

6.2.4 Low temperature test

6.2.4.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. Then the temperature shall be reduced to, and maintained at -40°C (±3°C) for class 1 and -30°C (±3°C) for class 2 for a period of between 10 hours and 16 hours.

For class 2 equipment the chamber shall then be heated to -20°C (±3°C).

Any climatic control device provided in the equipment may be switched on. The action of the climatic control device and (for class 2 equipment) the heating of the chamber shall be completed within 25 minutes (±5 minutes).

The temperature of the chamber shall be then maintained during a period of 2 hours.

The equipment shall be subjected to a performance check during the last 30 minutes of the test.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 hour. The equipment shall then be exposed to normal room temperature for not less than 3 hours, or until moisture has dispersed, which ever is longer, before the next test is carried out.

Throughout the test the equipment shall be working normally.

6.2.4.2 Requirement

The requirement for the performance check shall be met.

6.3 Vibration test

6.3.1 Definition

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

6.3.2 Method of measurement

The equipment, complete with any shock absorbers which are part of it, shall be clamped to the vibration table by its normal means of support and in its normal attitude. The equipment may be suspended to compensate for weight not capable of being withstood by the vibration table.

Provision may be made to reduce or nullify any adverse effect on the equipment performance which could be caused by the presence of any electro-magnetic field due to the vibration unit.

The equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 2 Hz (-0/+3 Hz) and 13,2 Hz with an excursion of ± 1 mm ± 10 % (7 m/s^2 maximum acceleration at 13,2 Hz); and

- 13,2 Hz and 100 Hz with a constant maximum acceleration of 7 m/s^2.

The frequency sweep rate shall be slow enough to allow the detection of resonances in any part of the Equipment Under Test (EUT).

A resonance search shall be carried out during the vibration test. If any resonance of any part of any component is observed, the equipment shall be subjected to a vibration endurance test at each resonance frequency with the duration of not less than 2 hours at the vibration level specified above. The test shall be repeated with vibration in each of the mutual perpendicular direction in the horizontal plane.

A performance check at the satellite EPIRB and from the remote control unit (when provided) shall be carried out during and after the test. At the end of the test, the equipment shall be examined for any mechanical deterioration.

6.3.3 Requirement

The satellite EPIRB shall not release from its mounting arrangement nor shall it automatically activate during the vibration test.

The requirement for the performance check shall be met. No damage or mechanical deterioration shall be visible to the naked eye.

6.4 Ruggedness test

6.4.1 Definition

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

6.4.2 Method of measurement

The satellite EPIRB and release mechanism installed in its bracket, if any, shall be mounted successively in each method intended for mounting on a ship. The equipment shall be subjected to the ruggedness test according to the following profile:

- peak acceleration: 98 m/s^2 ± 10 %;
- pulse duration: 18 ms ± 20 %;
- wave shape: half-cycle sine wave;
- test axis: vertical;
- number of bumps: 4 000.

At the end of the test, the equipment shall be examined for any mechanical deterioration. The self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

6.4.3 Requirements

The satellite EPIRB shall not release from its mounting arrangement nor shall it automatically activate during the ruggedness test.

Successful completion of the self-test shall be indicated.

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

6.5 Corrosion test

This test need not be carried out if the manufacturer is able to produce sufficient evidence that the components, materials etc. maintain their specified mechanical and electrical performance against the effects of corrosion.

6.5.1 Definition

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

6.5.2 Method of measurement

The equipment shall be placed in a chamber fitted with apparatus capable of spraying in the form of fine mist, such as would be produced by a spray gun, salt solution to the formula in table 2.

Table 2: Salt solution formula

sodium chloride	26,5	g	±10 %
magnesium chloride	2,5	g	±10 %
magnesium sulphate	3,3	g	±10 %
calcium chloride	1,1	g	±10 %
potassium chloride	0,73	g	±10 %
sodium bicarbonate	0,20	g	±10 %
sodium bromide	0,28	g	±10 %
plus distilled water to make the solution up to 1 l.			

Alternatively a 5 % sodium chloride (NaCl) solution may be used. The salt used for the test shall be high quality sodium chloride (NaCl) containing, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.

Salt solution concentration shall be 5 % (±1 %) by weight. The solution shall be prepared by dissolving 5 parts ±1 by weight of salt in 95 parts by weight of distilled or de-mineralized water.

The pH value of the solution shall be between 6,5 and 7,2 at temperature of 20°C (±2°C). The pH value shall be maintained within this range during conditioning. For this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

The spraying apparatus shall be such that the products of corrosion cannot mix with the salt solution contained within the spray reservoir.

The equipment shall be sprayed simultaneously on all its external surfaces with the salt solution for a period of 1 hour. This spraying shall be carried out 4 times with a storage period of 7 days; at 40°C (±2°C) after each spraying. The relative humidity during storage shall be maintained between 90 % and 95 %.

At the end of the total period the equipment shall be examined visually. The self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

6.5.3 Requirements

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

In the case of hermetically sealed equipment there shall be no evidence of moisture penetration.

Successful completion of the self-test shall be indicated.

6.6 Drop test into water

6.6.1 Definition

The immunity against the effects of dropping is the ability of the satellite EPIRB to maintain the specified mechanical and electrical performance after being subjected to a series of drops into water.

6.6.2 Method of measurement

The satellite EPIRB shall be removed from the release mechanism or mounting bracket and dropped into water. Three drops shall be performed, namely in normal floating position, satellite EPIRB vertically down and satellite EPIRB in 90° orientation to its normal floating position. The height of the lowest part of the satellite EPIRB relative to the water surface at the moment of release shall be 20 m ±1 m.

At the end of the test the self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

6.6.3 Requirement

No damage shall be visible to the naked eye. Successful completion of the self-test shall be indicated.

6.7 Thermal shock test

6.7.1 Definition

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

NOTE: This test is different form the thermal shock test required by COSPAS-SARSAT Specification C/S T.007 [6].

6.7.2 Method of measurement

The equipment shall be placed in an atmosphere of +65°C (±3°C) for 1 hour. It shall then be immersed in water at +20°C (±3°C) to a depth of 10 cm, measured from the highest point of the equipment to the surface of the water, for a period of 1 hour.

At the end of the test the self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

6.7.3 Requirements

Successful completion of the self-test shall be indicated.

No damage shall be visible to the naked eye.

6.8 Immersion test

6.8.1 Definition

The immunity against the effects of Immersion in water is the ability of the equipment to maintain the specified mechanical and electrical performance after the following test has been carried out.

6.8.2 Method of measurement

A hydraulic pressure of 100 kPa, corresponding to a depth of 10 m shall be applied for a period of 5 minutes.

At the end of the test the self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

6.8.3 Requirements

Successful completion of the self-test shall be indicated.

No damage shall be visible to the naked eye.

6.9 Hose stream test

6.9.1 Definition

The immunity against the effects of the water form the hose stream is the ability of the equipment to maintain the satellite EPIRB in its bracket and not to transmit a distress alert when the following test is carried out.

6.9.2 Method of measurement

The satellite EPIRB and release mechanism installed in its bracket, if any, shall be mounted successively in each method intended for mounting on a ship. A stream from a fire hose shall be directed at the satellite EPIRB for a period of 5 minutes. The hose shall have a nominal diameter of 63,5 mm and a water delivery rate of approximately 2 300 l of water per minute. The end of the hose shall be 3,5 m away from the satellite EPIRB and 1,5 m above the base of the antenna. The hose shall be moved during the test, so that water strikes the satellite EPIRB from all directions in an arc of at least 180° perpendicular to the normal mounting position of the satellite EPIRB.

6.9.3 Requirements

The satellite EPIRB shall not release from its bracket nor shall it automatically activate as a result of the water from the hose stream.

6.10 Buoyancy test

6.10.1 Definition

Buoyancy, expressed as a percentage, is its buoyant force divided by its gravity force.

6.10.2 Method of measurement

Satellite EPIRB shall again be submerged in calm fresh water.

One of the following methods of measurement shall be used:

- the buoyant force shall be measured when the satellite EPIRB is totally submerged in fresh water. The buoyant force shall be then divided by the measured gravity force. The result shall be recorded; or
- the buoyancy may be calculated by dividing the volume of the unit above the waterline by the total volume of the satellite EPIRB. The result shall be recorded.

6.10.3 Requirements

The value of buoyancy shall be at least 5 %.

6.11 Solar radiation test

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

6.11.1 Definition

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

6.11.2 Method of measurement

The equipment shall be placed on a suitable support and exposed continuously to a simulated solar radiation source (table 3) for 80 hours.

At the end of the test the self-test of the satellite EPIRB (subclause 4.8) shall be carried out.

The intensity at the test point, which shall also include any radiation reflected form the text enclosure, shall be 1 120 W/m^2 ± 10 % with a spectral distribution given in table 3:

Table 3: Spectral distribution

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

6.11.3 Requirements

Successful completion of the self-test shall be indicated.

No harmful deterioration of the equipment, including labelling, shall be visible to the naked eye.

6.12 Oil resistance test

This test need not be carried out if the manufacturer is able to produce sufficient evidence that the components, materials etc. maintain their specified mechanical and electrical performance against the effects of corrosion.

6.12.1 Definition

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

6.12.2 Method of measurement

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

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

The following oils may be used:

- ASTM Oil No. 1;
- ASTM Oil No. 5;
- ISO Oil No. 1.

At the end of the test the self-test of the satellite EPIRB (subclause 4.8) shall be carried out. The satellite EPIRB shall be cleaned in accordance with the manufacturer's instructions.

6.12.3 Requirements

Successful completion of the self-test shall be indicated.

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

7 Transmitter

7.1 Output power

7.1.1 Definition

The output power of the satellite EPIRB is the average power delivered to the 50 Ω RF-terminal during one radio frequency cycle.

7.1.2 Method of measurement

The power at the output socket of the satellite EPIRB shall be measured under normal test conditions and noted. This power shall be taken as the reference output power of the satellite EPIRB (P_r).

The measurement shall be repeated under the extreme test conditions. This values shall be recorded.

7.1.3 Limit

The output power shall be 37 dBm within ± 2 dB.

7.2 Characteristic frequency

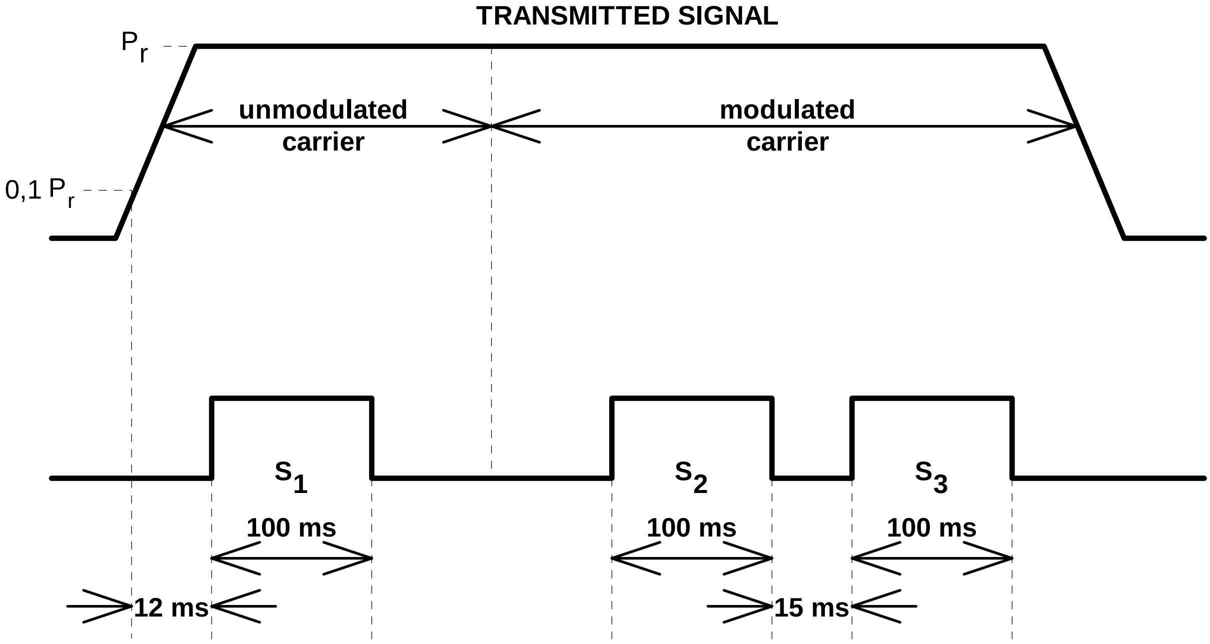
7.2.1 Definition

The characteristic frequency (f_o) is the frequency of the unmodulated signal transmitted by the satellite EPIRB.

7.2.2 Method of measurement

The characteristic frequency (f_o) shall be determined from 18 measurements of the carrier frequency of the unmodulated signal $f_c^{(1)}$ made under extreme test conditions (subclauses 5.11 and 5.12) during the interval S_1 (Figure 5) during 18 successive transmissions as follows:

$$f_o = f^{(1)} = \frac{1}{18}\sum_{j=1}^{18} f_{cj}^{(1)}$$



The S_1 pulse starts 12 ms after the beginning of the unmodulated carrier.

The S_2 pulse starts with bit 23.

The S_3 pulse starts 15 ms after the end of S_2.

Figure 5: Measurement intervals

7.2.3 Limit

The characteristic frequency shall be between 406,023 MHz and 406,027 MHz.

Until 1 January 2002 new 406 MHz beacon models submitted for testing may be set to transmit at 406,028 MHz ± 1 kHz.

After 1 January 2002, all new 406 MHz beacon models submitted for testing must be set at the frequency 406,028 MHz ± 1 kHz.

7.3 Short term frequency stability

7.3.1 Definition

The short term frequency stability is the stability during a predetermined number of transmissions.

7.3.2 Method of measurement

The short term frequency stability is derived from measurements-of $f_i^{(2)}$ and $f_i^{(3)}$ made under extreme test conditions (subclauses 5.11 and 5.12) during the intervals-S_2 and S_3 (Figure 5) during 18 successive transmissions as follows:

$$\sigma_{100ms} = \sqrt{\frac{1}{36}\sum_{i-1}^{18}\left(\frac{f_i^{(2)} - f_i^{(3)}}{f_i^{(2)}}\right)^2}$$

NOTE: The above relationship corresponds to the Allan variance. The measurement conditions used here are different (i.e. dead time between two measurements). Experience, however, has shown that the results obtained are very close to those achieved under the normal measurement conditions for the Allan variance.

To correctly measure the short term frequency stability it is essential that an equal number of positive and negative phase transitions are included in the gating intervals defined as S_2 and S_3 in Figure 5, hence these intervals are only approximately 100 ms duration.

7.3.3 Limit

The short term frequency stability shall be better than 2×10^{-9}.

7.4 Medium term frequency stability

7.4.1 Definition

The medium term frequency stability shall be defined by the mean slope of the frequency versus time over a pre-defined period and by the residual frequency variation about the mean slope.

7.4.2 Method of measurement

The medium term frequency stability is derived from measurements of $f_i^{(2)}$ made under extreme test conditions (subclauses 5.11 and 5.12) over successive transmissions at instants t_i for a period of 15 minutes (Figure 6).

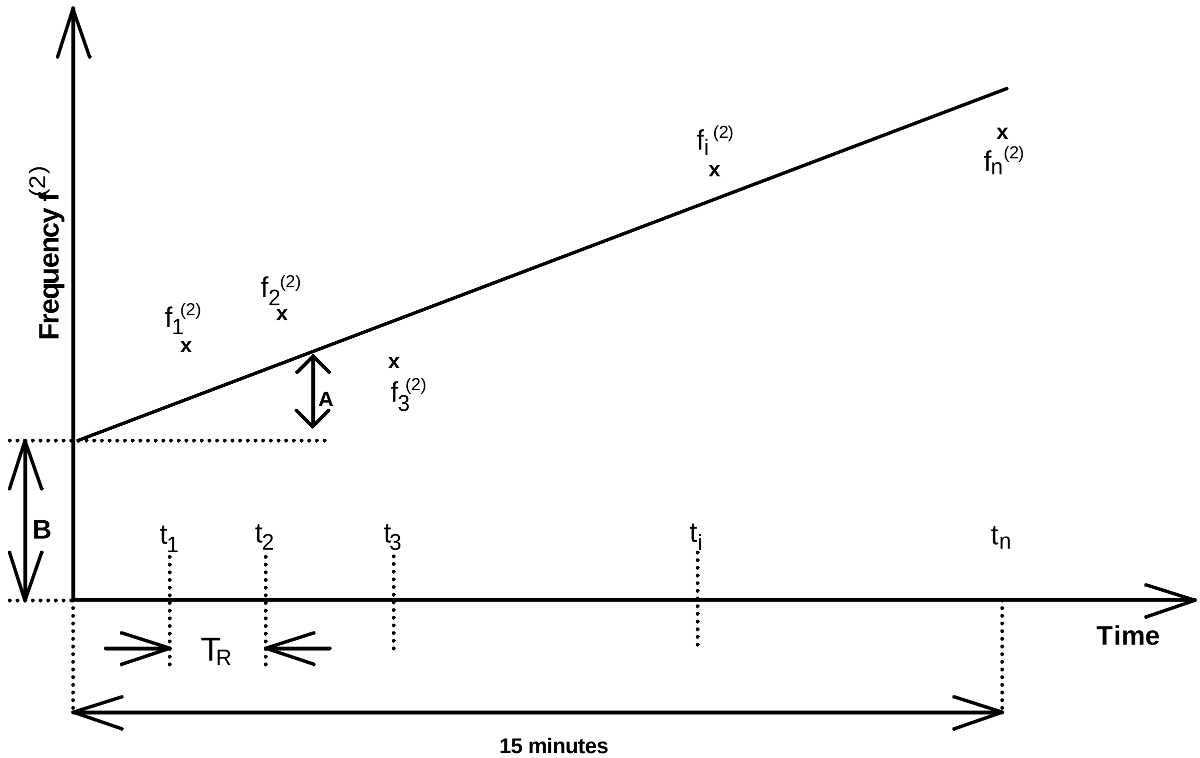


Figure 6: Medium-term frequency stability measurement

For a set of (n) measurements, the medium term frequency stability is defined by the mean slope of the least-squares straight line and the residual frequency variation about that line.

The mean slope is given by:

$$A = \frac{n\sum_{i=1}^{n} t_i f_i - \sum_{i=1}^{n} f_i \cdot \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2}$$

$$B = \frac{n\sum_{i=1}^{n} f_i \cdot \sum_{i=1}^{n} t_i^2 - \sum_{i=1}^{n} t_i \cdot \sum_{i=1}^{n} t_i f_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2}$$

The residual frequency variation is given by:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(f_i - At_i - B\right)^2}$$

With a transmission repetition period of 50 s, there will be 18 measurements during the 15 minute period (i.e. n=18).

7.4.3 Limits

The mean slope shall not exceed 1 x 10^{-9}.

Residual frequency variation shall not exceed 3 x 10^{-9}.

7.5 Temperature gradient

7.5.1 Definition

The immunity against the effects of temperature gradient is the ability of the satellite EPIRB to maintain the specified electrical performance when the following test is carried out.

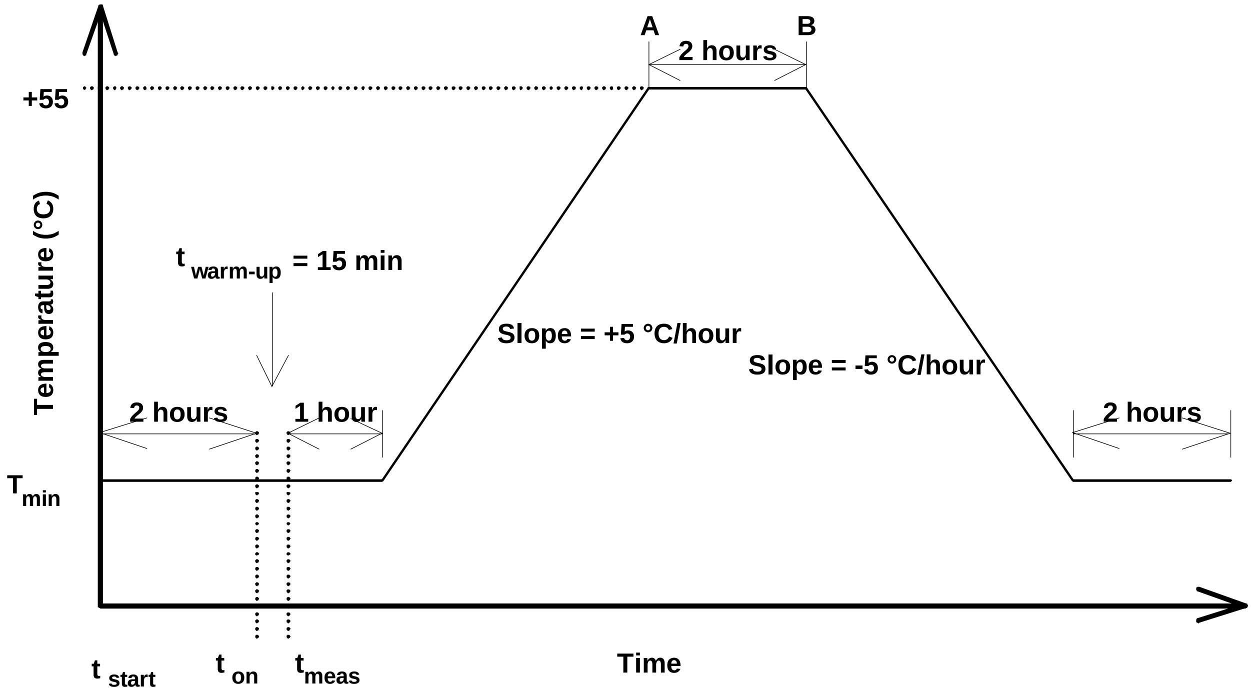
7.5.2 Method of measurement

The satellite EPIRB, while turned off, is allowed to stabilize for 2 hours at the minimum specified operating temperature. It is then turned on and subjected to temperature gradient specified in Figure 7, during which time the following tests are performed continually on each burst:

- characteristic frequency (subclause 7.2), short term frequency stability (subclause 7.3) and medium term frequency stability (subclause 7.4);
- transmitter output power (subclause 7.1);
- digital message (clause 8).

The 18-sample analysis window of the stability calculations is advanced in time through the period such that each succeeding data set includes the latest frequency sample and drops the earliest one.

When a battery replacement is required, two separate tests are performed. The up-ramp test is from t_{start} to point B (Figure 7) and the down-ramp test is from point A to t_{stop}. Before point A of the down-ramp, the satellite EPIRB under test, while turned off, is to stabilize for 2 hours at +55°C and is then turned on and allowed a 15 minute warm-up period.



- T_{min} = -40°C (Class 1 satellite EPIRB)
- T_{min} = -20°C (Class 2 satellite EPIRB)
- t_{on} = satellite EPIRB turn on after 2 hours "cold soak"
- t_{meas} = start time of frequency stability (t_{on} +15 minutes)

Figure 7: Temperature gradient

7.5.3 Limits

The requirements of subclauses 7.2 (characteristic frequency), 7.3 (short term frequency stability), 7.4 (medium term frequency stability), 7.1 (output power) and clause 9 (satellite EPIRB coding) shall be met.

7.6 RF spectrum mask

7.6.1 Definition

The RF spectrum mask is defined as the output power, relative to the maximum power in the frequency band 406,0 MHz to 406,1 MHz.

7.6.2 Method of measurement

The equipment is connected to a spectrum analyser.

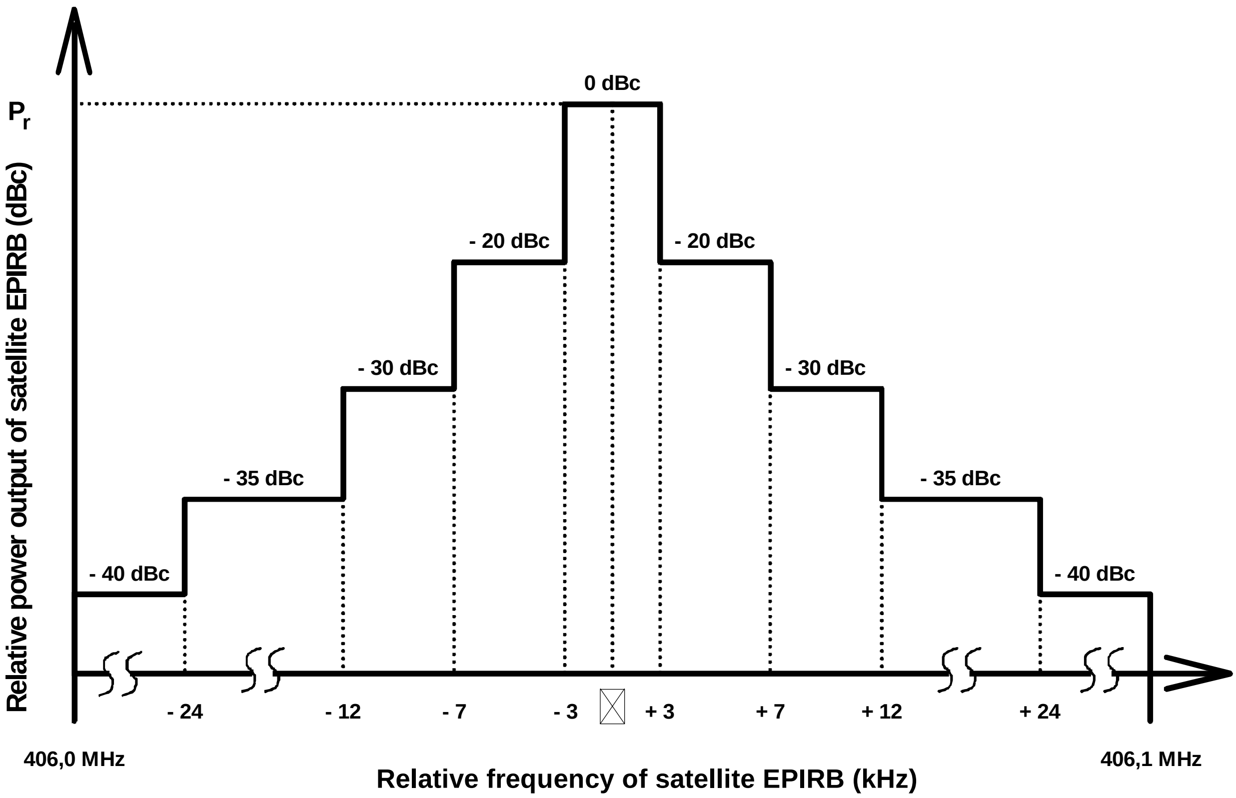
The satellite EPIRB transmits a modulated signal on the frequency f_c. The transmission is checked under extreme test conditions (subclauses 5.11 and 5.12).

The input impedance of the spectrum analyser shall be 50 Ω. The centre frequency of the spectrum analyser display system shall be the satellite EPIRB carrier frequency. The value of the resolution bandwidth of the spectrum analyser shall be 100 Hz.

The figure displayed on the screen shall be recorded.

7.6.3 Limit

The radiation shall not exceed the levels specified by the spectrum mask in Figure 8.



- P_r = Satellite EPIRB unmodulated carrier power output
- f_c = Satellite EPIRB carrier frequency
- dBc = Satellite EPIRB emitted signal power level in dB relative to P_r (measured in a 100 Hz resolution bandwidth)

Figure 8: Spectrum mask for 406,0 MHz to 406,1 MHz band

7.7 Phase deviation and data encoding

7.7.1 Definition

Phase deviation is the difference between the instantaneous phase of the modulated radio-frequency and the phase of the unmodulated carrier.

7.7.2 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator and a decoder.

The extreme values of the phase, $\phi 1$ and $\phi 2$ in Figure 9, are measured under extreme test conditions (subclauses 5.11 and 5.12) not taking into account transients.

7.7.3 Limits

The carrier shall be phase modulated (G1B) positive and negative 1,1 ± 0,1 radians peak, referenced to an unmodulated carrier. Modulation sense shall be as shown in Figure 9.

The data shall be encoded biphase L as shown in Figure 9.

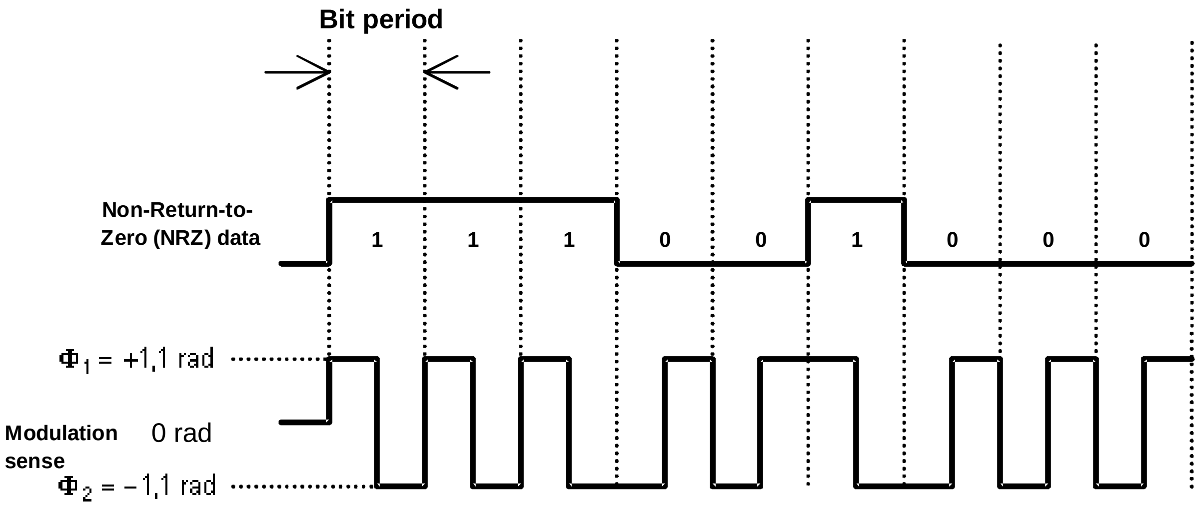


Figure 9: Data encoding and modulation sense

7.8 Rise and fall times

7.8.1 Definition

The rise time (T_R) and the fall time (T_F) of the modulated waveform is the time measured between the 0,9 points of the peak-to-peak phase transition (Figure 10).

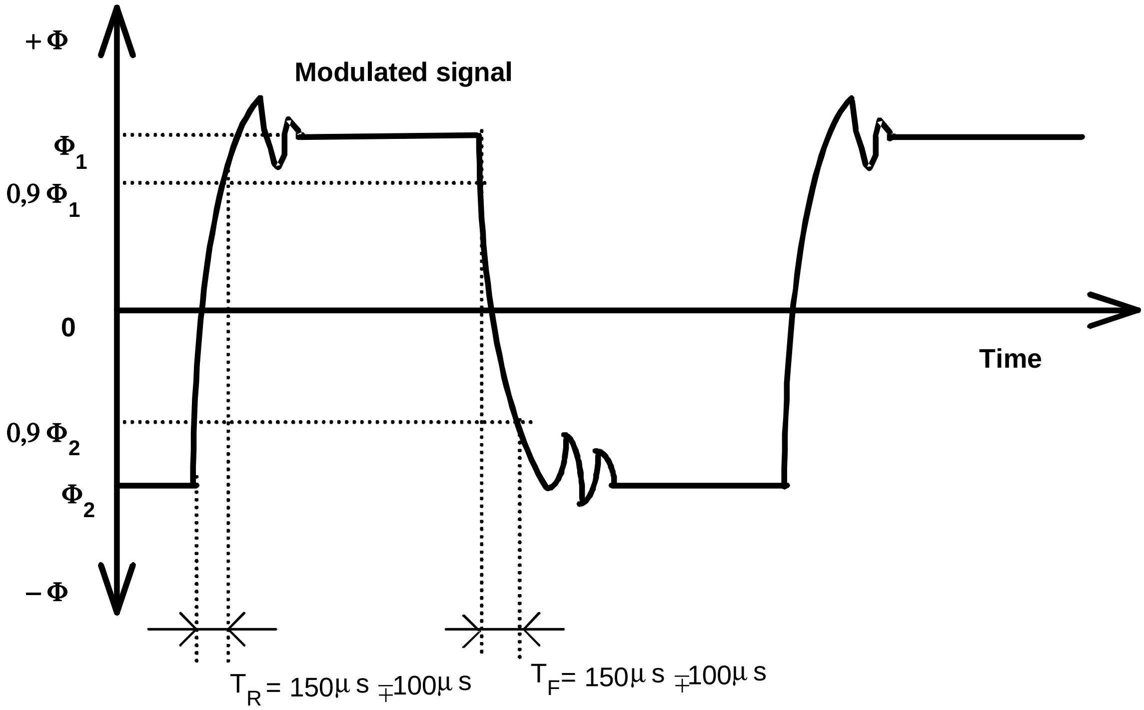


Figure 10: Modulation rise and fall times

7.8.2 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator. The rise time (T_R) and the fall time (T_F) shall be measured under extreme test conditions (subclauses 5.11 and 5.12) and recorded.

7.8.3 Limits

The rise (T_R) and fall (T_F) times of the modulated waveform shall be 150 µs ± 100 µs.

7.9 Modulation symmetry

7.9.1 Definition

The modulation symmetry is difference between the time durations T_1 and T_2 as defined in Figure 11.

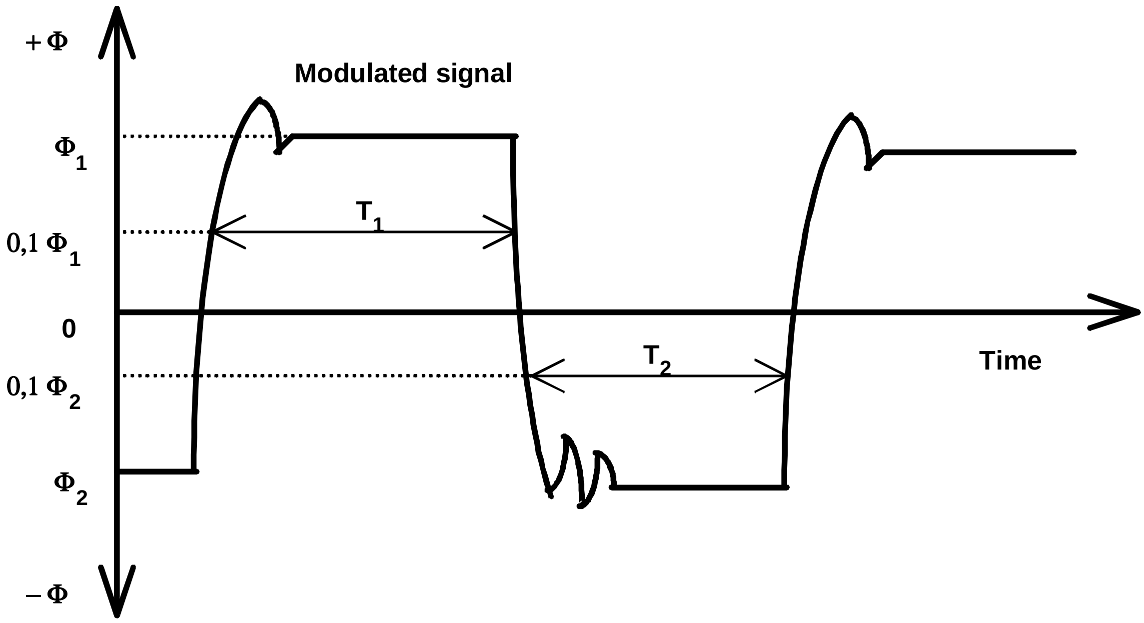


Figure 11: Modulation symmetry

7.9.2 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator.

The duration's T_1 and T_2 shall be measured under extreme test conditions (subclauses 5.11 and 5.12) and recorded.

7.9.3 Limit

The modulation symmetry shall be such that: $\frac{|T_1 - T_2|}{T_1 + T_2} \leq 0,05$.

8 Signal format

8.1 General

The emission of the satellite EPIRB is modulated by a digitally coded signal including a preamble, a message, and an error correcting code. The format shall be as defined in this clause.

NOTE: The measurements in clause 8 may be performed on the same set of 18 bursts.

8.2 Repetition period

8.2.1 Definition

The repetition period (T_R) is the time between the 90 % (0,9 P_N) power points of two successive transmissions, (Figure 12).

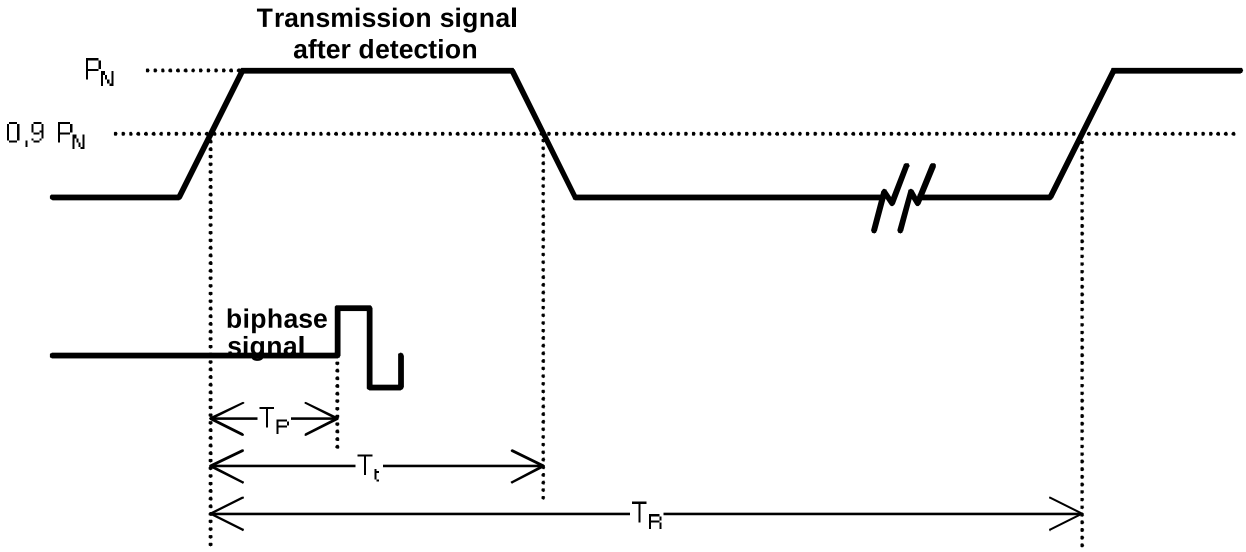


Figure 12: Transmission timing

8.2.2 Method of measurement

The repetition period is measured on 18 successive transmissions. The measurements shall be made under extreme test conditions (subclauses 5.11 and 5.12) and the difference between the maximum and minimum repetition periods shall be more than 1 s. The maximum and minimum values of T_R shall be recorded.

8.2.3 Limit

The values of T_R shall be in the range 47,5 s to 52,5 s.

If the satellite EPIRB has a fixed repetition period, it shall be in the range of 47,5 s to 52,5 s and the satellite EPIRB manufacturer shall provide the test facility with a technical explanation of how the repetition period will be varied to give at least 8 different values in different production runs of satellite EPIRB.

8.3 Total transmission time

8.3.1 Definition

The total transmission time is the time during which power is present on the characteristic frequency during one transmission.

8.3.2 Method of measurement

The total transmission time (T_t) shall be measured under extreme test conditions (subclauses 5.11 and 5.12) between the points where the output carrier power reaches 90 % of its end value (Figure 12).

8.3.3 Limits

Each of the 18 measurements shall lie within the following range:

- short message 435,6 ms to 444,4 ms;
- long message (optional) 514,8 ms to 525,2 ms.

8.4 Carrier Wave (CW) preamble

8.4.1 Definition

The CW preamble is the unmodulated carrier with a defined duration which precedes each digital message.

8.4.2 Method of measurement

The duration of the CW preamble (T_p) shall be measured under extreme test conditions (subclauses 5.11 and 5.12) between the point where the output carrier power reaches 90 % of its end value and the beginning of the digital message (Figure 12). This measurement shall be performed at 18 successive transmissions.

8.4.3 Limit

Each of the 18 measurements shall lie within the range 158,4 ms to 161,6 ms.

8.5 Bit rate

8.5.1 Definition

The bit rate is the number of bits/s.

8.5.2 Method of measurement

The bit rate (f_b) is measured under extreme test conditions (subclauses 5.11 and 5.12) over the first 15 bits corresponding to one transmission. This measurement shall be performed at 18 successive transmissions and the bit rate shall be recorded.

8.5.3 Limit

Each of the 18 measurements shall lie within the range 396 bit/s to 404 bit/s.

9 Satellite EPIRB coding

9.1 General

a) Short Message

The final 280 ms ±1 percent of the transmitted signal shall contain a 112-bit message at a bit rate of 400 bps ±1 percent;

b) Long Message

The final 360 ms ±1 percent of the transmitted signal shall contain a 144-bit message at a bit rate of 400 bps ±1 percent.

9.1.1 Bit Synchronization

A bit-synchronization pattern consisting of "1"s shall occupy the first 15-bit positions.

9.1.2 Frame Synchronization

A frame synchronization pattern consisting of 9 bits shall occupy bit positions 16 through 24. The frame synchronization pattern in normal operation shall be 000101111. However, if the beacon radiates a modulated signal in the self-test mode, the frame synchronization pattern shall be 011010000 (i.e. the last 8 bits are complemented).

9.1.3 Basic structure

The digital message which is transmitted by the 406 MHz beacon consists of:

a) 112 bits for the short message; and

b) 144 bits for the long message.

These bits are divided into five groups:

(1) The first 24 bits transmitted, positions 1 through 24, are system bits; they are defined in clause 2 and are used for bit and frame synchronization.

(2) The following 61 bits, positions 25 through 85, are data bits. This bit group is referred to as the first protected data field (PDF-1). The first data bit (position 25) indicates if the message is short or long: "0" = short message, "1" = long message.

(3) The following 21 bits, positions 86 through 106, are a Bose-Chaudhuri-Hocquenhem or BCH (82,61) error-correcting code. This bit group is referred to as the first BCH error correcting field (BCH-1). This code is a shortened form of a BCH (127,106) triple error-correcting code, as described in Annex B. This code can detect and correct up to three bit errors in the 82 bits of (PDF-1 + BCH-1). The combination of PDF-1 and BCH-1 is referred to as the first protected field.

(4) The following group consists of data bits, the number and definition of these bits depends on the message format, as follows:

a) Short message: the last 6 bits of the message in positions 107 through 112, these data bits are not protected. This bit group is referred to as the non-protected data field;

b) Long message: the following 26 bits of the message in positions 107 through 132. This bit group is referred to as the second protected data field (PDF-2).

(5) The last 12 bits of the long message, positions 133 through 144, are a Bose-Chaudhuri-Hocquenhem or BCH (38,26) error-correcting code. This bit group is referred to as the second BCH error correcting field (BCH-2). This code is a shortened form of a BCH (63,51) double error-correcting code, as described in Annex B. This code can detect and correct up to 2 bit errors in the 38 bits of (PDF-2 + BCH-2). The combination of PDF-2 and BCH-2 is referred to as the second protected field.

9.2 Coding

This clause defines the 406 MHz beacon digital message coding. The digital message is divided into various bit fields as follows:

Short Message Format (see Figure 13)

Bit Field Name	Bit Field Location
1. Bit synchronization	bit 1 through bit 15
2. Frame synchronization	bit 16 through bit 24
3. First protected data field (PDF-1)	bit 25 through bit 85
4. First BCH error correcting field (BCH-1)	bit 86 through bit 106
5. Non-protected data field	bit 107 through bit 112

Long Message Format (see Figure 14)

Bit Field Name	Bit Field Location
1. Bit synchronization	bit 1 through bit 15
2. Frame synchronization	bit 16 through bit 24
3. First protected data field (PDF-1)	bit 25 through bit 85
4. First BCH error correcting field (BCH-1)	bit 86 through bit 106
5. Second protected data field (PDF-2)	bit 107 through bit 132
6. Second BCH error correcting field (BCH-2)	bit 133 through bit 144

The first protected data field (PDF-1) and the non-protected data field of the short message are defined in clauses 9.1.3 and 9.4, and shown in Figures 13, 15 and 16.

The first protected data field (PDF-1) and the second protected data field (PDF-2) of the long message are defined in clauses 9.1.3 and 9.5, and shown in Figures 14, 17, 18, 19, 20 and 21.

The BCH error correcting fields BCH-1 and BCH-2 fields are defined in clause 9.1.3 and the corresponding 21 bit BCH error-correcting code and 12 bit BCH error-correcting code are described at Annex B of C/S T.001 [5].

9.2A Message Format Flag, Protocol Flag, and Country Code

The bit allocations for the message format flag, protocol flag and country code are identical in all beacon protocols. They are assigned in PDF-1 of the short and the long messages as follows:

Bits	Usage
25	format flag (F)
26	protocol flag (P)
27-36	country code

9.2A.1 Format Flag

The format flag (bit 25) shows whether the message is short or long using the following code:

F=0 short format

F=1 long format

9.2A.2 Protocol Flag

The protocol flag (bit 26) indicates which type of protocol is used to define the structure of encoded data, according to the following code:

P=0 standard-short location protocols, standard location protocols, national-short location protocol or national location protocol.

P=1 user protocols or user-location protocols.

The various protocols are identified by a specific protocol code, as described in clause A.1.3.

9.2A.3 Country Code

Bits 27-36 designate a three-digit decimal country code number expressed in binary notation. Country codes are based on the International Telecommunication Union (ITU) Maritime Identification Digit (MID) country code shown in Table 1 of Appendix 43 of the ITU Radio Regulations [1]. National administrations allocated more than one MID code may opt to use only one of these codes. However, when the 6 trailing digits of a MMSI are used to form the unique beacon identification, the country code shall always correspond to the first 3 digits of the MMSI code.

For all types of protocols, except the test protocols, the country code designates the country of beacon registration, where additional information can be obtained from a data base.

9.3 Protocol Codes

Each coding protocol is identified by a unique protocol code defined as follows:

- 3-bit code in bits 37 to 39, for the user protocols and the user-location protocols;
- 4-bit code in bits 37 to 40, for the standard-short location protocol, the standard location protocol, the national-short location protocol or the national location protocol.

Table 4 shows the combinations of the format flag and the protocol flag which identify each category of coding protocols. The protocol codes assignments are summarized in Table 5.

Table 4: Format Flag and Protocol Flag Combinations

Format Flag (bit 25) → **Protocol Flag (bit 26) ↓**	**0** **(short)**	**1** **(long)**
0 **(protocol code: bits 37-40)**	Standard-Short Location Protocols National-Short Location Protocol	Standard Location Protocols National Location Protocol
1 **(protocol code: bits 37-39)**	User Protocols	User Protocols User-Location Protocols

	Bit Synchronization	Frame Synchronization	First Protected Data Field (PDF-1)				BCH-1	Non-Protected Data Field
Unmodulated Carrier (160 ms)	Bit Synchronization Pattern	Frame Synchronization Pattern	Format Flag	Protocol Flag	Country Code	Identification or Identification plus Position Data	21-Bit BCH Code	Emergency Code/ National Use or Supplement. Data
Bit No.	1-15	16-24	25	26	27-36	37-85	86-106	107-112
	15 bits	9 bits	1 bit	1 bit	10 bits	49 bits	21 bits	6 bits

Figure 13: Data Fields of the Short Message Format

	Bit Synchronization	Frame Synchronization	First Protected Data Field (PDF-1)				BCH-1	Second Protected Data Field (PDF-2)	BCH-2
Unmodulated Carrier (160 ms)	Bit Synchronization Pattern	Frame Synchronization Pattern	Format Flag	Protocol Flag	Country Code	Identification or Identification plus Position Data	21-Bit BCH Code	Supplementary and Position or National Use Data	12-Bit BCH Code
Bit No.	1-15	16-24	25	26	27-36	37-85	86-106	107-132	133-
	15 bits	9 bits	1 bit	1 bit	10 bits	49 bits	21 bits	26 bits	12 bits

Figure 14: Data Fields of the Long Message Format

Table 5: Protocol Codes Assignments

5.A: User Protocol and User-Location Protocol **(F=0, P=1) short message**
(F=1, P=1) long message

			Protocol Codes (Bits 37 - 39)
1.	EPIRB - Maritime User Protocol:	(MMSI, 6 digits)	010
		(radio call sign, 6 characters)	010
2.	EPIRB - Radio Call Sign User Protocol		110
3.	ELT - Aviation User Protocol	(aircraft registration markings)	001
4.	Serial User Protocol:		011

bits 40, 41, 42 used to identify beacon type:
- 000 ELTs with serial identification number;
- 001 ELTs with aircraft operator designator & serial number;
- 010 float free EPIRBs with serial identification number;
- 100 non float free EPIRBs with serial identification number;
- 110 PLBs with serial identification number;
- 011 ELTs with aircraft 24-bit address;
- 101 & 111 spares.

bit 43 = 0: serial identification number is assigned nationally; or
bit 43 = 1: identification data include the C/S type approval certificate number.

5.	Test User Protocol		111
6.	Orbitography Protocol		000
7.	National User Protocol *		100
8.	Spare		101

5.B: Standard-Short and National-Short Location Protocols **(F=0, P=0) short message**
Standard Location and National Location Protocols **(F=1, P=0) long message**

			Protocol Codes (Bits 37 - 40)
	Standard-Short Location Protocols and Standard Location Protocols		
1.	EPIRB - MMSI/Location Protocol		0010
2.	ELT - 24-bit Address/Location Protocol		0011
3.	Serial Location Protocols	a) ELT - serial	0100
		b) ELT - aircraft operator designator	0101
		c) EPIRB-serial	0110
		d) PLB-serial	0111
4.	National-Short Location Protocol and National Location Protocol		
		a) ELT	1000
		b) Spare	1001
		c) EPIRB	1010
		d) PLB	1011
5.	Test location Protocols		
		a) Standard Test Location Protocol	1110
		b) National Test Location Protocol	1111
6.	Reserved (orbitography)		0000, 0001
7.	Spare		1100, 1101

* The National User Protocol has certain bits which are nationally defined, as described in clause A.2.8.

9.4 User Protocols

This clause defines the user protocol message formats which can be used to encode the beacon identification and other data in the message transmitted by a 406 MHz distress beacon.

9.4.1 Structure of User Protocols

The user protocols have the following structure:

bits	usage
25	format flag (short message =0, long message =1)
26	protocol flag (=1)
27-36	country code
37-39	protocol code
40-83	identification data
84-85	auxiliary radio-locating device type(s)

Bits 37-39 in the protocol code field designate one of the user protocol codes as listed in Table 5.A, and indicate how the remaining bits of identification data are encoded/decoded.

Bits 40-83 are used to encode the identification data of the beacon and, together with the protocol flag, the country code, the protocol code, and bits 84-85, shall form a unique identification for each beacon, i.e. the beacon 15 Hex ID. They will be discussed separately for each user protocol.

Bits 84-85 are used to indicate for all user protocols excluding the orbitography protocol, the type of auxiliary radio-locating device(s) forming part of the particular beacon. The assignment of bits is as follows:

bits 84-85	auxiliary radio-locating device type
00	no auxiliary radio-locating device
01	121,5 MHz
10	maritime 9 GHz Search and Rescue Radar Transponder (SART)
11	other auxiliary radio-locating device(s)

If other auxiliary radio-locating device(s) is (are) used in addition to 121,5 MHz, the code for 121,5 MHz (i.e. 01) should be used.

The bit assignments for user protocols, in PDF-1 of the 406 MHz beacon digital message, are summarized in Figure 15.

1. MARITIME USER PROTOCOL

Bits	25	26	27 36	37 39	40 81	82	83	84	85
.....	0	1	Country Code	0 1 0	MMSI or Radio Call Sign (42 bits)	0	0	R	L

2. RADIO CALL SIGN USER PROTOCOL

Bits	25	26	27 36	37 39	40 81	82	83	84	85
.....	0	1	Country Code	1 1 0	Radio Call Sign (42 bits)	0	0	R	L

3. SERIAL USER PROTOCOL

Bits	25	26	27 36	37 39	40 42	43	44 73	74 83	84	85
.....	0	1	Country Code	0 1 1	T T T	C	Serial Number and other Data	C/S Cert. No or National Use	R	L

4. AVIATION USER PROTOCOL							
Bits	25	26	27 36	37 39	40 81	82 83	84 85
.....	0	1	Country Code	0 0 1	Aircraft Registration Marking (42 bits)	0 0	R L

5. NATIONAL USER PROTOCOL					
Bits	25	26	27 36	37 39	40 85
......	F	1	Country Code	1 0 0	National Use (46 bits)

6. TEST USER PROTOCOL					
Bits	25	26	27 36	37 39	40 85
.....	F	1	Country Code	1 1 1	Test Beacon Data (46 bits)

7. ORBITOGRAPHY PROTOCOL					
Bits	25	26	27 36	37 39	40 85
......	F	1	Country Code	0 0 0	Orbitography Data (46 bits)

NOTES: RL = Auxiliary radio-locating device
TTT = 000 - ELT with serial number
010 - float free EPIRB with serial number
011 - ELT with 24-bit aircraft address
100 - non float free EPIRB with serial number
001 - ELT with aircraft operator
110 - personal locator beacon (PLB) with serial number designator and serial number
C = C/S Type Approval Certificate Flag:
"1" = C/S Type Approval Certificate number encoded in bits 74 to 83
"0" = other national use
F = Format Flag ("0" = short message, "1" = long message)

Figure 15: Bit Assignment for the First Protected Data Field (PDF-1) of User Protocols

Table 6: Modified-Baudot Code

Letter	Code MSB LSB	Letter	Code MSB LSB	Figure	Code MSB LSB
A	111000	N	100110	( )*	100100
B	110011	O	100011	(-)**	011000
C	101110	P	101101	/	010111
D	110010	Q	111101	0	001101
E	110000	R	101010	1	011101
F	110110	S	110100	2	011001
G	101011	T	100001	3	010000
H	100101	U	111100	4	001010
I	101100	V	101111	5	000001

Letter	Code MSB LSB	Letter	Code MSB LSB	Figure	Code MSB LSB
J	111010	W	111001	6	010101
K	111110	X	110111	7	011100
L	101001	Y	110101	8	001100
M	100111	Z	110001	9	000011

MSB: most significant bit * Space

LSB: least significant bit ** Hyphen

NOTE: The modified-Baudot code is used to encode alphanumeric characters in EPIRB messages containing MMSI or radio call sign identification, and in ELTs containing the aircraft registration marking or the 3-letter aircraft operator designator.

9.4.2 Maritime User Protocol

The maritime user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=010)
40-75	radio call sign or trailing 6 digits of MMSI
76-81	specific beacon number
82-83	spare (=00)
84-85	auxiliary radio-locating device type(s)

Bits 40-75 designate the radio call sign or the last 6 digits of the 9 digit maritime mobile service identity (MMSI) using the modified-Baudot code shown in Table 6.

This code enables 6 characters to be encoded using 36 bits (6x6 = 36). This data will be right justified with a modified-Baudot space (100100) being used where no character exists. If all characters are digits, the entry is interpreted as the trailing 6 digits of the MMSI.

Bits 76 to 81 are used to identify specific beacons on the same vessel (the first or only float free beacon shall be coded with a modified-Baudot zero (001101); additional beacons shall be numbered consecutively using modified-Baudot characters 1 to 9 and A to Z).

The maritime user and the radio call sign user protocols may be used for beacons that require coding with a radio call sign. The maritime user protocol may be used for radio call signs of 6 or fewer characters. Radio call signs of 7 characters must be encoded using the radio call sign user protocol.

9.4.3 Radio Call Sign User Protocol

The radio call sign user protocol is intended to accommodate a vessel's radio call sign of up to seven characters, where letters may be used only in the first four characters, thereby complying with the ITU practice on formation of radio call signs.

The radio call sign user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=110)
40-75	radio call sign
40-63	first 4 characters (modified-Baudot)
64-75	last 3 characters (binary-coded decimal)
76-81	specific beacon number
82-83	spare (=00)
84-85	auxiliary radio-locating device type(s)

Bits 40 to 75 contain the radio call sign of up to 7 characters. Radio call signs of fewer than 7 characters should be left justified in the radio call sign field (bits 40-75) and padded with "space" (1010) characters in the binary-coded decimal field (bits 64-75).

Bits 76 to 81 are used to identify specific beacons on the same vessel (the first or only float free beacon shall be coded with a modified-Baudot zero (001101); additional beacons shall be numbered consecutively using modified-Baudot characters 1 to 9 and A to Z).

9.4.4 Aviation User Protocol

The aviation user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=001)
40-81	aircraft registration marking
82-83	spare (=00)
84-85	auxiliary radio-locating device type(s)

Bits 40-81 designate the aircraft registration marking which is encoded using the modified-Baudot code shown in Table 6. This code enables 7 characters to be encoded using 42 bits (6x7=42). This data will be right justified with a modified-Baudot space (100100) being used where no character exists.

9.4.5 Serial User Protocol

The serial user protocol is intended to permit the manufacture of beacons whose 15 Hex ID will be identified in a data base giving specifics about the unit. The following types of serial identification data can be encoded in the beacon:

- serial number;
- 24-bit aircraft address number;
- aircraft operator designator and a serial number.

Bits 40-42 indicate the beacon type with serial identification data encoded, as follows:

000 indicates an aviation ELT serial number is encoded in bits 44-63

010 indicates a maritime float free EPIRB serial number is encoded in bits 44-63

100 indicates a maritime non float free EPIRB serial number is encoded in bits 44-63

110 indicates a personal locator beacon (PLB) serial number is encoded in bits 44-63

011 indicates the aircraft 24-bit address is encoded in bits 44-67 and each additional ELT on the same aircraft is numbered in bits 68-73

001 indicates an aircraft operator designator and a serial number are encoded in bits 44-61 and 62-73, respectively.

Bit 43 is a flag bit to indicate that the Cospas-Sarsat type approval certificate number is encoded.

If bit 43 is set to 1:

- bits 64-73 should either be set to all 0s or allocated for national use and control (and will be made public when assigned by the responsible administration) or used as defined for coding the aircraft 24-bit address or aircraft operator designator;
- bits 74-83 should be encoded with the Cospas-Sarsat type approval certificate number which is assigned by the Cospas-Sarsat Secretariat for each beacon model approved according to the type approval procedure of document C/S T.007. The certificate number is to be encoded in binary notation with the least significant bit on the right.

If bit 43 is set to 0:

- bits 64-83 are for national use and control (and will be made public when assigned by the responsible administration) or used as defined for coding the aircraft 24-bit address or aircraft operator designator.

Details of each type of serial identification data are given hereunder.

9.4.5.1 Serial Number

The serial user protocol using a serial number encoded in the beacon message has the following structure:

```
Bits  25 26 27         36 37    40      44              63 64         73 74         83  85
  ---+--+--+------------+-----+-----+-+-----------------+-------------+-------------+---+-
     ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦   (20 bits)     ¦  All "0" or ¦ C/S cert. No.   ¦
     ¦0 ¦1 ¦ Code       ¦0 1 1¦T T T¦C¦  Serial Number  ¦  Nat. Use   ¦ or Nat. Use ¦R L¦
   ------------------------------------------------------------------------------------------
```

Bits	Usage
25	format flag (= 0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=011)
40-42	beacon type (=000, 010, 100 or 110)

43 flag bit for Cospas-Sarsat type approval certificate number

44-63 serial number

64-73 all 0s or national use

74-83 C/S type approval certificate number or national use

84-85 auxiliary radio-locating device type(s)

Bits 44-63 designate a serial identification code number ranging from 0 to 1,048,575 (i.e. 2^{20}-1) expressed in binary notation, with the least significant bit on the right.

This serial number encoded in the beacon message is not necessarily the same as the production serial number of the beacon.

9.4.5.2 Aircraft 24-bit Address

The serial user protocol using the aircraft 24-bit address has the following structure:

```
Bits  25 26 27          36 37    40      44              67 68         73 74          83  85
   ---+--+--+------------+-----+-----+-+-----------------+-------------+-------------+---+-
      ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦   Aircraft      ¦ Additional  ¦ C/S Cert.No.¦   ¦
      ¦0 ¦1 ¦ Code       ¦0 1 1¦0 1 1¦C¦ 24-bit Address  ¦  ELT No.s   ¦ or Nat. Use ¦R L¦
    ---------------------------------------------------------------------------------------
```

<u>Bits</u> <u>Usage</u>

25 format flag (= 0)

26 protocol flag (=1)

27-36 country code

37-39 user protocol code (=011)

40-42 beacon type (=011)

43 flag bit for Cospas-Sarsat type approval certificate number

44-67 aircraft 24-bit address

68-73 ELT number of additional ELTs carried on same aircraft

74-83 C/S type approval certificate number or national use

84-85 auxiliary radio-locating device type(s)

Bits 44-67 are a 24-bit binary number assigned to the aircraft. Bits 68-73 contain the ELT number, in binary notation with the least significant bit on the right, of additional ELTs carried in the same aircraft or default to 0s when only one ELT is carried.

9.4.5.3 Aircraft Operator Designator and Serial Number

The serial user protocol using the aircraft operator designator and serial number has the following structure:

```
Bits  25 26 27          36 37    40      44                 61 62       73 74          83  85
   ---+--+--+------------+-----+-----+-+-------------------+-----------+-------------+---+-
      ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦ Operator 3-letter ¦  Serial   ¦ C/S Cert. No.   ¦
      ¦0 ¦1 ¦ Code       ¦0 1 1¦0 0 1¦C¦    Designator     ¦  Number   ¦ or Nat. Use ¦R L¦
    ---------------------------------------------------------------------------------------
```

<u>Bits</u> <u>Usage</u>

25 format flag (=0)

27-36 country code

37-39 user protocol code (=011)

40-42 beacon type (=001)

43 flag bit for Cospas-Sarsat type approval certificate number

44-61 aircraft operator designator

62-73 serial number assigned by operator

74-83 C/S type approval certificate number or national use

84-85 auxiliary radio-locating device type(s)

Bits 44-61 are a 3-letter aircraft operator designator from the list* of "Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services" published by the International Civil Aviation Organization (ICAO). The 3 letters are encoded using the modified-Baudot code of Table 6.

Bits 62 to 73 are a serial number (in the range of 1 up to 4095) as designated by the aircraft operator, encoded in binary notation, with the least significant bit on the right.

9.4.6 Test User Protocol

The test user protocol will be used for demonstrations, type approval, national tests, training exercises, etc.. Mission Control Centres (MCCs) will not forward messages coded with this protocol unless requested by the authority conducting the test.

The test user protocol has the following structure:

Bits Usage

25 format flag (short message = 0, long message = 1)

26 protocol flag (=1)

27-36 country code

37-39 test user protocol code (=111)

40-85 national use

9.4.7 Orbitography Protocol

The orbitography protocol is for use by special system calibration transmitters and is intended for use only by operators of the Local User Terminals. Therefore, it is not further described in the present document.

9.4.8 National User Protocol

The national user protocol is a special coding format having certain data fields, indicated as "national use", which are defined and controlled by the national administration of the particular country which is coded into the country code field.

The national user protocol may be either a short or a long message, as indicated by the format flag (bit 25). The correct BCH code(s) must be encoded in bits 86-106, and in bits 133-144 if a long message is transmitted.

The national user protocol has the following structure:

```
Bits  25 26 27      36¦37    ¦40                         85 86        106 107       132¦133  144¦
   ---+--+--+----------+-----+---------------------------+-------------+-------------¦--------¦
      ¦  ¦  ¦ Country  ¦     ¦       National Use         ¦    BCH Code ¦National Use  BCH Code¦
      ¦F ¦1 ¦ Code     ¦1 0 0¦        (46 bits)           ¦   (21 bits) ¦  (26 bits)  ¦(12 bits)
     ---------------------------------------------------------------------------------¦--------¦
```

Bits Usage

25 format flag (short message =0, long message =1)

26 protocol flag (=1)

27-36 country code

37-39 national user protocol code (=100)

40-85 national use

86-106 21-bit BCH code

107-112 national use

113-132 national use (if long message)

133-144 12-bit BCH code (if long message)

Once the beacon has been activated, the content of the message in bits 1 to 106 must remain fixed, but bits 107 onwards are permitted to be changed periodically, provided the correct 12-bit BCH code is also recomputed and that such changes do not occur more frequently than once every 20 minutes.

It should be noted that distress alert messages encoded with the national user protocol can be passed within the Cospas-Sarsat System only as hexadecimal data, and the content of the message can only be interpreted by the appropriate national administration.

9.4.9 Non-Protected Data Field

The non-protected data field consists of bits 107 to 112, which can be encoded with emergency code / national use data as described below. However, when neither the emergency code nor the national use data have been implemented, nor such data entered, the following default coding should be used for bits 107 to 112:

000000: for beacons that can be activated only manually, i.e. bit 108 = 0 (see below)

010000: for beacons that can be activated both manually and automatically, i.e. bit 108 = 1 (see below).

Bit 107 is a flag bit that should be automatically set to (=1) if emergency code data has been entered in bits 109 to 112, as defined below:

Bit 108 indicates the method of activation that has been built into the beacon:

- bit 108 set to (=0) indicates that the beacon is the type that can be activated only manually;
- bit 108 set to (=1) indicates that the beacon is the type that can be activated both manually and automatically.

9.4.9.1 Maritime Emergency code

The emergency code is an optional feature that may be incorporated in a beacon to permit the user to enter data in the emergency code field (bits 109-112) after beacon activation of any maritime protocol (i.e. maritime user protocol, maritime serial-user protocols, and radio call sign user protocol). If data is entered in bits 109 to 112 after activation, then bit 107 should be automatically set to (=1) and bits 109 to 112 should be set to an appropriate maritime emergency code shown in Table 7. If a beacon is pre-programmed, bits 109 to 112 should be coded as "unspecified distress" (i.e. 0000).

9.4.9.2 Non-Maritime Emergency code

The emergency code is an optional feature that may be incorporated in a beacon to permit the user to enter data in the emergency code field (bits 109-112) of any non-maritime protocol (i.e. aviation user protocol, serial user aviation and personal protocols, or other spare protocols). If data is entered in bits 109 to 112, then bit 107 should be automatically set to (=1) and bits 109 to 112 should be set to an appropriate non-maritime emergency code shown in Table 8.

Table 7: Maritime Emergency Codes in Accordance with the Modified (see Note 1) IMO Nature of Distress Indication

IMO Indication (see Note 2)	Binary Code	Usage
1	0001	Fire/explosion
2	0010	Flooding
3	0011	Collision
4	0100	Grounding
5	0101	Listing, in danger of capsizing
6	0110	Sinking
7	0111	Disabled and adrift
8	0000	Unspecified distress (see Note 3)
9	1000	Abandoning ship
	1001 to 1111	Spare (could be used in future for assistance desired or other information to facilitate the rescue if necessary)

NOTE 1: Modification applies only to code "1111", which is used as a "spare" instead of as the "test" code.

NOTE 2: IMO indication is an emergency code number, it is different from the binary encoded number.

NOTE 3: If no emergency code data has been entered, bit 107 remains set to (=0).

Table 8: Non-Maritime Emergency Codes

Bits	Usage [(1)]
109	No fire (=0); fire (=1)
110	No medical help (=0); medical help required (=1)
111	Not disabled (=0); disabled (=1)
112	Spare (=0)

If no emergency code data has been entered, bit 107 remains set to (=0).

9.4.9.3 National Use

When bit 107 is set to (=0), codes (0001) through (1111) for bits 109 to 112 may be used for national use and should be set in accordance with the protocol of an appropriate national authority.

B 25: Message format flag: 0 = short message, 1 = long message				
B 26: Protocol flag: 1 = User protocols				
B 27 - b 36: Country code number: 3 digits, as listed in Appendix 43 of the ITU Radio Regulations				
B 37 - b 39: User protocol code: 000 = Orbitography 110 = Radio call sign 001 = Aviation 111 = Test 010 = Maritime 100 = National 011 = Serial 101 = Spare				
B 37 - b 39: 010 = Maritime user B 40 - b 75: Trailing 6 digits of MMSI or radio call sign (modified-Baudot) b 76 - b 81: Specific beacon (modified-Baudot) b 82 - b 83: 00 = Spare	110 = Radio call sign user b 40 - b 63: First four characters (modified-Baudot) b 64 - b 75: Last three characters (binary coded decimal) b 76 - b 81: Specific beacon (modified-Baudot) b 82 - b 83: 00 = Spare	011 = Serial user b 40 - 42: Beacon type 000 = Aviation 001 = Aircraft Operator 011 = Aircraft Address 010 = Maritime (float free) 100 = Maritime (non float free) 110 = Personal b 43: C/S Certificate flag b 44 - b 73: Serial No. and other data b 74 - b 83: C/S Cert. No. or National use	001 = Aviation user b 40 - b 81: Aircraft Registration Marking (modified - Baudot) b 82 - b 83: 00 = Spare	100 = National User b 40 - 85: National use
b 84 – 85: Auxiliary radio-locating device type(s): 00 = No Auxiliary radio-locating device 01 = 121.5 MHz 10 = Maritime locating: 9 GHz SART 11 = Other auxiliary radio-locating device(s)				
b 86 - b 106: BCH code: 21-bit error-correcting code for bits 25 to 85				
b 107: Emergency code use of b 109 - b 112: 0 = National use, undefined (default = 0) 1 = Emergency code flag				b 107 - 112: National use
b 108: Activation type: 0 = Manual activation only type of beacon 1 = Automatic and manual activation type of beacon				
b 109 – b 112: Nature of distress: Maritime emergency codes (see Table 7) (default = 0000) Non-maritime emergency codes (see Table 8) (default = 0000)				

Figure 16: Summary of User Protocols Coding Options

9.5 Location Protocols

This clause defines the protocols which can be used with the 406 MHz beacon message formats for encoding beacon position data, as well as the beacon identification data, in the digital message transmitted by a 406 MHz distress beacon.

9.5.1 Summary

Five types of location protocols are defined for use either with the long message format or with the short message format, as shown in Figure 17.

9.5.1.1 User-Location Protocols

These location protocols are for use with the long message format. The beacon identification data is provided in PDF-1 by one of the user protocols defined in clause 9.4 (see Figure 15). Position data is provided as latitude and longitude, to 4-minute resolution, encoded into PDF-2.

9.5.1.2 Standard Location Protocols

These location protocols are for use with the long message format. The beacon identification data is provided in a standardized format in 24 bits of PDF-1. Position data to 15-minute resolution is also given in PDF-1, with position offsets to 4-second resolution in PDF-2.

9.5.1.3 Standard-Short Location Protocols

The short message format version of the standard location protocols provides for the same beacon identification methods as the long format version and allows encoding beacon position data to 15-minute resolution in PDF-1. The supplementary data in the non-protected data field (bits 107-112) is not protected by a BCH code.

9.5.1.4 National Location Protocol

These location protocols are for use with the long message format. The beacon identification data is provided in a nationally-defined format in 18 bits of PDF-1. Position data, to 2-minute resolution, is given in PDF-1, with position offsets to 4-second resolution in PDF-2.

9.5.1.5 National-Short Location Protocol

The short message format version of the national location protocols provides for the same beacon identification methods as the long format version and allows encoding beacon position data to 2-minute resolution in PDF-1. The supplementary data in the non-protected data field (bits 107-112) is not protected by a BCH code.

9.5.2 Default Values in Position Data

The following default values shall be used in all encoded position data fields of the location protocols, when no valid data is available:

a) all bits in degrees fields set to "1", with N/S, E/W flags set to "0";

b) all bits in the minutes fields set to "0", with Δ signs set to "1"; and

c) all bits in the seconds fields set to "1" (the value "1111" = 60 sec is out of range).

This pattern shall also be transmitted if the beacon radiates a 406 MHz message in the self-test mode.

User-Location Protocols							
Bit 26	bits 27-39	bits 40-83	bits 84-85	bits 86-106	bit 107	bits 108-132	bits 133-144
1	....	Identification Data (44 bits)	Radio-locating Device	21-Bit BCH code	Posit. Data Source	Position Data to 4 min Resolution (25 bits)	12-Bit BCH code

Standard Location Protocols							
bit 26	bits 27-40	bits 41-64	bits 65-85	bits 86-106	bits 107-112	bits 113-132	bits 133-144
0	....	Identification Data (24 bits)	Position Data to 15 min Resolution (21 bits)	21-Bit BCH code	Supplementary Data	Position Data to 4 sec Resolution (20 bits)	12-Bit BCH code
Standard-Short Location Protocols							

National Location Protocol								
bit 26	bits 27-40	bits 41-58	bits 59-85	bits 86-106	bits 107-112	bits 113-126	bits 127-132	bits 133-144
0	....	Identification Data (18 bits)	Position Data to 2 min Resolution (27 bits)	21-Bit BCH code	Supplementary Data	Position Data to 4 sec Resolution (14 bits)	National Use	12-Bit BCH code
National-Short Location Protocol								

Figure 17: Outline of Location Protocols

9.5.3 Definition of Location Protocols

The general structure of location protocols is illustrated in Figure 18.

9.5.3.1 Position Data

All position information is encoded as degrees, minutes and seconds of latitude or longitude, or as fractions of these units. Latitude and longitude data are rounded off (i.e. not truncated) to the available resolution. When a position is encoded in PDF-1, the higher resolution information given in PDF-2 is an offset (Δ latitude and Δ longitude) relative to position provided in PDF-1. In order to minimize the frequency of updates of the position data in PDF-1 the Δ latitude and Δ longitude offsets have a range of ± 2 times the resolution of PDF-1. It is recommended that an encoded co-ordinate should not be changed when position data supplied by a navigation device varies by less than 7″ relative to the encoded value.

The position is initially encoded as follows. The initial coarse position encoded in PDF-1 is selected to be as close as possible to the actual position. The initial offset encoded in PDF-2 (when applicable) is selected so that it may be summed with the coarse position to produce a finer position that is as close as possible to the actual position. Subsequent position updates (if applicable) are then encoded by retaining the coarse position and changing only the offset, provided that the required value is within the range of the offset. If the position update cannot be encoded by changing the offset alone, then both PDF-1 and PDF-2 are reset according to the above procedure for the initial position encoding.

The latitude and longitude values contained in PDF-1 are positive numbers regardless of their directions. The offset is applied by adding or subtracting the offset value in accordance with the offset sign in PDF-2. For example:

100° E. longitude + 30′ offset = 100° 30′ E. longitude

100° W. longitude + 30′ offset = 100° 30′ W. longitude (not 99° 30′ W. longitude)

100° W. longitude - 30′ offset = 99° 30′ W. longitude (not 100° 30′ W. longitude).

9.5.3.2 Supplementary Data

The following supplementary data are provided in location protocols, in addition to the required identification data and available position data.

9.5.3.3 Source of Position Data

This information is encoded in bit 107 for the user-location protocol or bit 111 for the standard and national location protocols (short and long versions) with the following interpretation:

"0" = the encoded position data is provided by an external navigation device

"1" = the encoded position data is provided by an internal navigation device

9.5.3.4 Auxiliary Radio Locating Device (homing transmitter) Code

The "121,5 MHz homing" data is encoded in bit 112 for the standard and national location protocols (short and long versions) where:

"1" = indicates a 121,5 MHz auxiliary radio locating device

"0" = indicates other or no auxiliary radio locating devices

and in bits 84-85 for the user-location protocols as follows:

"00" = no auxiliary radio locating device

"01" = 121.5 MHz auxiliary radio locating device

"10" = maritime locating: 9 GHz Search and Rescue Radar Transponder (SART)

"11" = other auxiliary radio-locating device(s)

9.5.3.5 Test Location Protocols

The test protocol for all coding methods (i.e. "user" and "location" protocols) is encoded by setting bits 37-39 (protocol code) to "111". In addition, bit 40 is used to distinguish between the test format of the standard location protocols (bit 40 = "0") and national location protocols (bit 40 = "1").

←1 24→	25 26	←27 36→	←37 39→	40	←41 83→	84 85	←86 106→	←107 112→	←113 132→	←133 144→
	←----------- 61 BITS PDF-1 ----------→						BCH-1	←------ 26 BITS PDF-2 ------→		BCH-2
	2	10	4		45		21	6	20	12
BIT & FRAME SYNCHRONIZAT. PATTERNS	F O R M A T & P R O T O C O L F L A G S	C O U N T R Y C O D E	3 010 110 001 011 111		USER-LOCATION PROTOCOLS (P=1) Identification Data (same as User Protocols) See Figure 19	2	21-BIT BCH ERROR CORRECTING CODE	USER-LOCATION PROTOCOLS Latitude / Longitude Data (4 Minute Resolution) See Figure 19		12-BIT BCH ERROR CORRECTING CODE
			4 0010 0011 0100 0101 0110 0111 1110		STANDARD LOCATION PROTOCOLS (P=0) Identification & Position Data (1/4 Degree Resolution) See Figure 20			STANDARD LOCATION PROTOCOLS Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data See Figure 20		
			4 1000 1001 1010 1011 1111		NATIONAL LOCATION PROTOCOLS (P=0) Identification & Position Data (2 Minute Resolution) See Figure 21			NATIONAL LOCATION PROTOCOLS Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data See Figure 21		
	↑ F= 1 P=0 /1	PROTOCOL CODE See Table 5	↑		SHORT MESSAGE FORMAT - 112 BITS→¦				LONG MESSAGE FORMAT - 144 BITS→	

Figure 18: General Format of Long Message for Location Protocols

9.6 User-Location Protocols (See Figure 19)

These protocols (identified by F=1, P=1) provide for encoding latitude / longitude data with resolution to 4 minutes in PDF-2. Beacon identification data shall be encoded in PDF-1 using any of the user protocols defined in clause 9.4, except the orbitography protocol and the national user protocol which are specific to a particular application or a particular country.

The protocol codes (bits 37 to 39) are defined in Table 5.A for user and user-location protocols.

The 26 bits available in PDF-2 are defined as follows:

a) bit 107: encoded position data source

"0" = the encoded position data is provided by an external navigation device

"1" = the encoded position data is provided by an internal navigation device

b) bits 108 to 119: latitude data (12 bits) with 4 minute resolution, including:

bit 108: N/S flag (N=0, S=1)

bits 109 to 115: degrees (0 to 90) in 1 degree increments

bits 116 to 119: minutes (0 to 56) in 4 minute increments

(default value of bits 108 to 119 = 0 1111111 0000) and

c) bits 120 to 132: longitude data (13 bits) with 4 minute resolution including:

bit 120: E/W flag (E=0, W=1)

bits 121 to 128: degrees (0 to 180) in 1 degree increments

bits 129 to 132: minutes (0 to 56) in 4 minute increments

(default value of bits 120 to 132 = 0 11111111 0000)

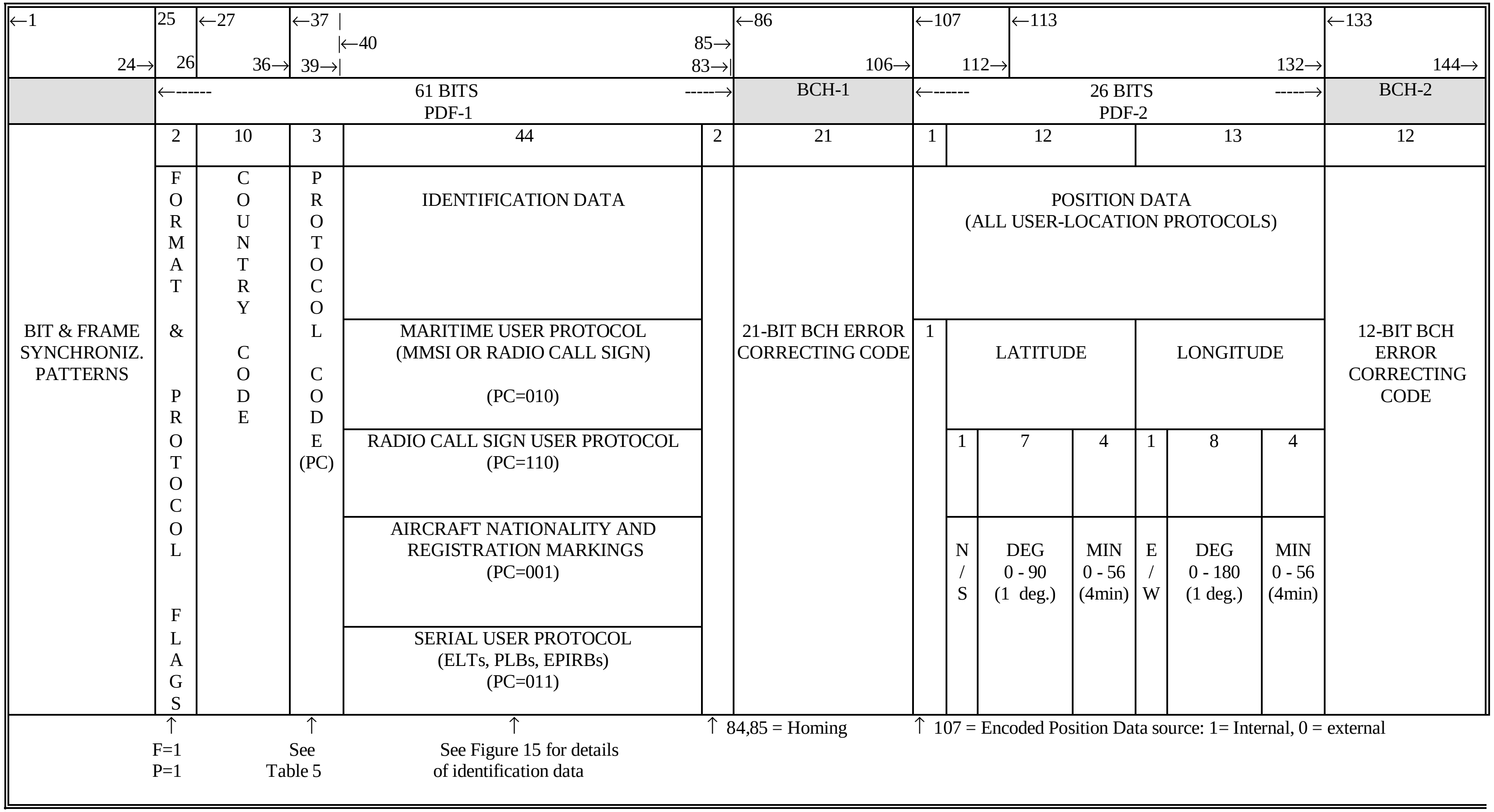


Figure 19: User-Location Protocols

9.7 Standard Location Protocols

9.7.1 Structure

The standard location protocols, identified by the flags F=1, P=0 and the protocol codes no. 1 to 3 of Table 5.B, have the following structure:

a) PDF-1:

bits 37 to 40: 4-bit protocol code as defined in Table 5.B

bits 41 to 64: 24 bits of identification data

bits 65 to 85: 21 bits of encoded position data to 15 minute resolution

b) PDF-2:

bits 107 to 112: 4 fixed bits and 2 bits of supplementary data

bits 113 to 132: 20-bit position offset (Δ latitude, Δ longitude), to 4 second resolution

9.7.2 Identification data

The 24 bits of identification data (bits 41 to 64) can be used to encode:

a) (PC=0010) the last six digits of MMSI in binary form in bits 41 to 60 (20 bits), plus a 4-bit specific beacon number (0 to 15) in bits 61 to 64, to distinguish between several EPIRBs on the same ship;

b) (PC=0011) a 24-bit aircraft address (only one ELT per aircraft can be identified using this protocol); or

c) (PC=01xx, see Note 1 in clause 9.7.5) a 24-bit unique serial identification including:

(i) the 10-bit Cospas-Sarsat type approval certificate number of the beacon (1 to 1,023) in bits 41 to 50, and a 14 bit serial number (1 to 16,383) in bits 51 to 64; or

(ii) a 15-bit aircraft operator designator (see Notes 1 & 2 in clause 9.7.5) in bits 41 to 55, and a 9-bit serial number (1 to 511) assigned by the operator in bits 56 to 64.

9.7.3 PDF-1 position data

The 21 bits of position data in PDF-1 are encoded as follows:

a) bits 65 to 74: latitude data (10 bits) providing 15 minute resolution, including:

- bit 65: N/S flag (N=0, S=1)
- bits 66 to 74: degrees (0 to 90) in 1/4 degree increments

(default value of bits 65 to 74 = 0 111111111) and

b) bits 75 to 85: longitude data (11 bits) providing 15 minute resolution, including:

- bit 75: E/W flag (E=0, W=1)
- bits 76 to 85: degrees (0 to 180) in 1/4 degree increments

(default value of bits 75 to 85 = 0 1111111111)

9.7.4 PDF-2 position data

The 26 bits available in PDF-2 are defined as follows:

a) bits 107 to 109: ="110" (fixed)

b) bit 110: ="1" (fixed)

c) bit 111: encoded position data source

"0" = the encoded position data is provided by an external navigation device

"1" = the encoded position data is provided by an internal navigation device

d) bit 112: 121,5 MHz auxiliary radio locating device included in beacon

(1 = yes, 0 = no)

e) bits 113 to 122: Δ latitude with 4 second resolution:

- bit 113: Δ sign (0 = minus, 1 = plus)
- bits 114 to 118: Minutes (0 to 30) in 1 minute increments
- bits 119 to 122: Seconds (0 to 56) in 4 second increments

(default value of bits 113 to 122 = 1 00000 1111) and

f) bits 123 to 132: Δ longitude with 4 second resolution:

- bit 123: Δ sign (0 = minus, 1 = plus)
- bits 124 to 128: Minutes (0 to 30) in 1 minute increments
- bits 129 to 132: Seconds (0 to 56) in 4 second increments

(default value of bits 123 to 132 = 1 00000 1111)

9.7.5 Test protocol

The test protocol using the above format is encoded by setting bits 37-39 to "111" and bit 40 to "0".

NOTE 1: The last two bits of the protocol code (bits 39-40) are used as follows (see also Table 5):

00 ELT-serial 10 EPIRB-serial

01 ELT-aircraft operator designator 11 PLB-serial

NOTE 2: The aircraft operator designator (3 letters) can be encoded in 15 bits using a shortened form of the modified-Baudot code (i.e.: all letters in the modified-Baudot code are coded in 6 bits, with the first bit = "1". This first bit can, therefore, be deleted to form a 5-bit code).

9.8 Standard-Short Location Protocols

The standard-short location protocols are for use with the short message format (F=0). The structure of PDF-1 for standard-short location protocols is identical to the structure of PDF-1 of the standard location protocols, as defined in clause 9.7.

The supplementary data in bits 107 to 112 (6 bits) of the non-protected data field have the same definition as the corresponding bits in the standard location protocols, as defined in clause 9.7.

<table>
<tr><td>←1
24→</td><td>25
26</td><td>←27
36→</td><td colspan="2">←37
40→</td><td colspan="8">|←41
85→</td><td>←86
106→</td><td>107
112</td><td colspan="6">←113
132→</td><td>←133
144→</td></tr>
<tr><td></td><td colspan="12">←----------- 61 BITS PDF-1 ------------→</td><td>BCH-1</td><td colspan="7">←------- 26 BITS PDF-2 ---------→</td><td>BCH-2</td></tr>
<tr><td rowspan="9">BIT & FRAME SYNCHRONIZ PATTERNS</td><td>2</td><td>10</td><td colspan="2">4</td><td colspan="8">45</td><td>21</td><td>6</td><td colspan="6">20</td><td>12</td></tr>
<tr><td rowspan="8">F O R M A T & P R O T O C O L F L A G</td><td rowspan="8">C O U N T R Y C O D E</td><td colspan="2">PC</td><td colspan="4">24 BITS IDENTIFICATION DATA</td><td colspan="4">21 BITS LATITUDE LONGITUDE</td><td rowspan="8">21-BIT BCH ERROR CORRECTING CODE</td><td rowspan="8">S U P P L E M E N T A R Y D A T A</td><td colspan="3">Δ LATITUDE</td><td colspan="3">Δ LONGITUDE</td><td rowspan="8">12-BIT BCH ERROR CORRECTING CODE</td></tr>
<tr><td rowspan="2">00</td><td rowspan="2">10</td><td colspan="3">20</td><td>4</td><td>1</td><td>9</td><td>1</td><td>10</td><td>1</td><td>5</td><td>4</td><td>1</td><td>5</td><td>4</td></tr>
<tr><td colspan="3">MMSI
(last 6 digits, binary)</td><td>B.No
0 -15</td><td rowspan="6">N S</td><td rowspan="6">LAT DEG
0 - 90
(1/4 d.)</td><td rowspan="6">E W</td><td rowspan="6">LON DEG
0 - 180
(1/4 d.)</td><td rowspan="6">- +</td><td rowspan="6">M I N U T E S
0 - 30
(1min)</td><td rowspan="6">S E C O N D S
0-56
(4s)</td><td rowspan="6">- +</td><td rowspan="6">M I N U T E S
0-30
(1min)</td><td rowspan="6">S E C O N D S
0-56
(4s)</td></tr>
<tr><td>00</td><td>11</td><td colspan="4">AIRCRAFT 24 BIT ADDRESS</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">01</td><td colspan="2">15</td><td colspan="2">9</td></tr>
<tr><td colspan="2">AIRCRAFT OPER. DESIGNATOR</td><td colspan="2">SERIAL No
1 - 511</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">00
10
11</td><td>10</td><td colspan="3">14</td></tr>
<tr><td>C/S TA No
1 - 1023</td><td colspan="3">SERIAL No
1 - 16383</td></tr>
</table>

↑ F=1 P=0

↑ 0100 ELT-Serial
0110 EPIRB-Serial
0111 PLB
1110 Test

↑ 107 = "1"
↑ 108 = "1"
↑ 109 = "0"
↑ 110 = "1"
↑ 111 = Encoded Position Data Source: 1= int., 0 = ext.
↑ 112 = 121.5 MHz Homing: 1=Yes, 0 = No

Figure 20: Standard Location Protocols

9.9 National Location Protocol (see Figure 21)

The national location protocol, identified by the flags F=1, P=0 and the protocol codes in series no. 4 of Table 5.B, has the following structure:

9.9.1 Structure

a) PDF-1:

bits 37 to 40: 4-bit protocol code as defined in Table 5.B

bits 41 to 58: 18-bit identification data consisting of a serial number

assigned by the appropriate national authority

bits 59 to 85: 27 bits of position data to 2 minute resolution

b) PDF-2:

bits 107 to 112: 3 fixed bits set to "110", 1-bit additional data flag, describing the use of bits 113 to 132, and 2 bits of supplementary data

bits 113 to 126: 14-bit position offset (Δ latitude, Δ longitude) to 4 second resolution, or alternate national use, and

bits 127 to 132: 6 bits reserved for national use (additional beacon type identification or other)

9.9.2 PDF-1 position data

The 27 bits of position data in PDF-1 are encoded as follows:

a) bits 59 to 71: latitude data (13 bits) with 2 minute resolution:

- bit 59: N/S flag (N=0, S=1)
- bits 60 to 66: degrees (0 to 90) in 1 degree increments
- bits 67 to 71: minutes (0 to 58) in 2 minute increments

(default value of bits 59 to 71 = 0 1111111 00000) and

b) bits 72 to 85: longitude data (14 bits) with 2 minute resolution:

- bit 72: E/W flag (E=0, W=1)
- bits 73 to 80: degrees (0 to 180) in 1 degree increments
- bits 81 to 85: minutes (0 to 58) in 2 minute increments

(default value of bits 72 to 85 = 0 11111111 00000)

9.9.3 PDF-2 position data

The 38 bits available in PDF-2 are defined as follows:

a) bit 107 to 109: ="110" (fixed)

b) bit 110: additional data flag (1 = Δ position data as described below in bits 113 to132;

0 = other to be defined nationally)

c) bits 111: encoded position data source

"0" = the encoded position data is provided by an external navigation device

"1" = the encoded position data is provided by an internal navigation device

d) bit 112: 121,5 MHz auxiliary radio locating device included in beacon

(1 = yes, 0 = no)

e) bits 113 to 119: Δ latitude with 4 second resolution:

- bit 113: Δ sign (0 = minus, 1 = plus)
- bits 114 to 115: minutes (0 to 3) in 1 minute increments
- bits 116 to 119: seconds (0 to 56) in 4 second increments

(default value of bits 113 to 119 = 1 00 1111)

f) bits 120 to 126: Δ longitude with 4 second resolution:

- bit 120: Δ sign (0 = minus, 1 = plus)
- bits 121 to 122: minutes (0 to 3) in 1 minute increments
- bits 123 to 126: seconds (0 to 56) in 4 second increments

(default value of bits 120 to 126 = 1 00 1111) and

g) bits 127 to 132: Additional beacon identification (national use)

(default value of bits 127 to 132 = 000000)

The test protocol using the above format is encoded by setting bits 37-39 to "111" and bit 40 to "1".

9.10 National-Short Location Protocol

The national-short location protocol is for use with the short message format (F=0). The structure of PDF-1 for the national-short location protocol is identical to the structure of PDF-1 of the national location protocol, as defined in clause 9.9.

The supplementary data in bits 107-109 and bits 111-112 of the non-protected data field have the same definition as the corresponding bits in the national location protocol, as defined in clause 9.9. Bit 110 should be set to "1".

←1 24→	25 26	←27 36→	←37 40→	←41					85→	←86 106→	107 112	←113					132→		←133 144→
	←------ 61 BITS PDF-1 ------→									BCH-1	←------ 26 BITS PDF-2 ------→								BCH-2
	2	10	4	45						21	6	7		7			6		12
				18 BITS IDENTIFICATION	27 BITS LATITUDE			LONGITUDE				Δ LATITUDE			Δ LONGITUDE				
				18	1	7	5	1	8	5		1	2	4	1	2	4		
BIT & FRAME SYNCHRONIZ. PATTERNS	FORMAT & PROTOCOL FLAG	COUNTRY CODE	PROTOCOL CODE	NATIONAL ID NUMBER	N S	DEGREES 0 - 90 (1 deg)	MINUTES 0 - 58 (2 m)	E W	DEGREES 0 - 180 (1 deg)	MINUTES 0 - 58 (2m)	21-BIT BCH ERROR CORRECTING CODE	SUPPLEMENTARY DATA	- +	MINUTES 0 - 3 (1m)	SECONDS 0 - 56 (4 s.)	- +	MINUTES 0 - 3 (1m)	SECONDS 0 - 56 (4 s.)	NATIONAL USE	12-BIT BCH ERROR CORRECTING CODE

↑ F=1 P=0

↑ See Table 5
1000 ELT
1010 EPIRB
1011 PLB
1111 Test

↑ 107 = "1"
↑ 108 = "1"
↑ 109 = "0"
↑ 110 = Additional Data Flag: 1 = Δ Position, 0 = Nat. Assignment
↑ 111 = Encoded Position Data Source: 1 = Internal, 0 = external
↑ 112 = 121.5 MHz Homing: 1= Yes, 0 = No

Figure 21: National Location Protocol

10 Other Technical requirements

10.1 Effective luminous intensity of the low duty cycle light

10.1.1 Definition

The effective luminous intensity is a calculated value, which is defined by a formula as indicated in IMO Resolution A.689 (17) [4].

10.1.2 Method of measurement

The luminous intensity shall be measured under normal and extreme test conditions.

The effective luminous intensity shall be than calculated by the following formula:

$$I_{eff|cd} = \frac{\int_{t_1}^{t_2} I(t)dt}{0{,}2 + (t_2 - t_1)}$$

where:

- I_{eff} is the effective intensity (candela);
- I(t) is the instantaneous intensity as a function of time;
- $(t_2 - t_1)$ is the flash duration (seconds).

10.1.3 Limit

The effective luminous intensity shall be at least 0,75 cd. The flashing rate shall be at least 20 times per minute, with a flash duration of between 10^{-6} s and 1 s.

The low duty cycle light shall be visible over at least 75 % of the horizontal plane, but may have a cone, whose angle of elevation is not greater then 30°, of lower effective luminous intensity in the vertical direction.

10.2 Battery capacity

10.2.1 Definition

Battery capacity is the ability of the internal power source of the equipment to deliver sufficient power for an uninterrupted operation of the equipment in a specified time period.

10.2.2 Method of measurement

Using a fresh battery pack, the satellite EPIRB 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 as well as battery pack self-discharge during the useful life of the battery pack (as defined in clause 4.1.3.). The manufacturer shall substantiate the method used to determine this time.

The satellite EPIRB shall be placed in a chamber of normal room temperature. Then the temperature shall be reduced to and maintained at -40°C (± 3°C) for class 1 or -30°C (± 3°C) for class 2 equipment for a period of 10 hours.

Any climatic control device provided in the equipment may be switched on and for class 2 equipment the chamber heated to -20°C (± 3°C), at the conclusion of the period specified above. The action of the climatic control device and for class 2 equipment, the heating of the chamber, shall be complete within 20 minutes.

The equipment shall be activated 30 minutes after this period and shall then be kept working continuously for a period of 48 hours. The temperature of the chamber shall be maintained for the whole of the 48 hour period.

This test may be combined with the relevant environmental tests of the COSPAS-SARSAT specification (clause 4.2 of C/S T.001 [5] and clause A.2.3 of C/S T.007 [6]).

10.2.3 Limit

The satellite EPIRB shall comply with the requirements of the subclauses 7.1 (output power) 7.2 (characteristic frequency), 7.3 (short term frequency stability), 7.4 (medium term frequency stability) and clause 9 (satellite EPIRB coding) for 48 hours.

10.3 Homing device

10.3.1 General

10.3.1.1 Class of emission

The radio frequency transmission shall be amplitude modulated with full carrier and both sidebands (A3X).

10.3.1.2 Modulation frequency

An audio signal shall sweep downward within a range of not less than 700 Hz between 1 600 Hz and 300 Hz.

10.3.1.3 Transmitter duty cycle

The transmitter shall have a continuous duty cycle except that it may be interrupted for up to a maximum of 2 s during transmission of the 406 MHz signal.

10.3.1.4 Sweep repetition rate

The sweep repetition rate of the transmitter shall be 2 Hz to 4 Hz.

10.3.2 Frequency error

10.3.2.1 Definition

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

10.3.2.2 Method of measurement

The carrier frequency shall be measured under normal and extreme test conditions with a frequency counter or a spectrum analyser.

10.3.2.3 Limit

The carrier frequency shall be 121,5 MHz ± 50 ppm.

10.3.3 Modulation duty cycle

10.3.3.1 Definition

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:

$$\textbf{Duty cycle} = \frac{T_1}{T_2} \cdot 100\,\%$$

where:

- T_1 is the duration of the positive half cycle of the audio modulation measured at the half amplitude points of the modulation envelope; and
- T_2 is the period of the fundamental of the audio modulation.

10.3.3.2 Method of measurement

The transmitter output shall be connected to a storage oscilloscope. T_1 and T_2 shall be measured near the start, midpoint and end of the modulation period. The modulation duty cycle shall be calculated.

10.3.3.3 Limit

The modulation duty cycle shall be between 33 % and 55 %.

10.3.4 Modulation factor

10.3.4.1 Definition

Modulation factor is defined with respect to the maximum and minimum amplitudes of the modulation envelope by the following formula:

$$\textbf{Modulation factor} = \frac{A + B}{A - B}$$

where:

- A is the maximum value of the envelope curve; and
- B is the minimum value of the envelope curve.

10.3.4.2 Method of measurement

The transmitter output shall be connected to a storage oscilloscope. A and B shall be measured near the start, midpoint and end of the modulation period. The modulation factor shall be calculated.

10.3.4.3 Limit

The modulation factor shall be between 0,85 and 1,0.

10.3.5 Effective radiated peak envelope power

10.3.5.1 Definition

The effective radiated peak envelope power is defined as the ERPEP in the direction of maximum field strength under specific conditions of measurement.

The peak envelope power is the average power supplied to the antenna transmission line by a transmitter during one radio cycle at the crest of the modulation envelope taken under normal operating conditions.

10.3.5.2 Method of measurement

The measurement shall be performed at normal temperature conditions and shall use a satellite EPIRB whose battery has been on for a minimum of 44 hours. If the test exceeds 4 hours, the battery may be replaced by another battery, which has been preconditioned with at least 44 hours of on time.

For the purpose of testing outside a screened room, care shall be taken not to transmit distress signals on distress and safety frequencies, for example by frequency offset.

The measurements shall be made under normal temperature conditions.

On the test site described in clauses 5.6 and 5.7, the equipment shall be placed on the support in its standard position and activated.

The receiver shall be tuned to the transmitter carrier frequency. The test antenna shall be orientated for vertical polarization. The test antenna shall be raised or lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The transmitter shall be rotated through 360° around a vertical axis in order to find the direction of the maximum signal.

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

The transmitter shall be replaced by a substitution antenna.

The frequency of the calibrated signal generator shall be adjusted to the transmit carrier frequency.

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

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

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 detected from the equipment under test, corrected for the change in input attenuator setting of the measuring receiver.

The maximum ERPEP is equal to the power supplied by the signal generator, increased by the gain of the substitution antenna and corrected for the change in the attenuator.

10.3.5.3 Limit

The ERPEP shall be between 25 mw and 100 mW.

10.3.6 Spurious emissions

10.3.6.1 Definition

Spurious emission is emission 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.

10.3.6.2 Method of measurement

Spurious emissions shall be measured in the frequency bands 108 MHz to 137 MHz, 156 MHz to 162 MHz 406,0 MHz to 406,1 MHz and 450 MHz to 470 MHz at the test site described in subclause 5.6.

10.3.6.3 Limit

The power of any spurious emission component shall not exceed 25 μW on any frequency.

11 Radiation measurements

11.1 General

The radiated power and antenna characteristics of the satellite EPIRB shall be measured in an open field test site (subclause 5.6) or a shielded anechoic room.

The radiated power procedure provides data which characterize the antenna by measuring the vertical and horizontal wave polarization.

In order to keep the potential disturbance to the COSPAS-SARSAT system to a minimum, these antenna tests shall be conducted using a satellite EPIRB operating at its nominal repetition rate and coded with the test user protocol (subclause 9.3.6).

11.2 Radiated power

11.2.1 Definition

The radiated power is the effective isotropically radiated power (e.i.r.p.). The e.i.r.p. is the apparent power which is radiated through 360° azimuth and at elevation angles between 5° and 60° and expressed as power in Watts (W) ± variation (dB).

11.2.2 Method of measurement

The satellite EPIRB shall be transmitting normally with a fresh battery. The signal received by the measuring antenna should be coupled to a spectrum analyser or a field strength meter and the radiated power output should be measured during the satellite EPIRB transmission. The receiver should be calibrated according to the range of level expected, as described in subclause 5.8. The satellite EPIRB should be rotated through 360° of azimuth with a minimum of twelve equal steps 30 °(± 3°) and measurements made.

The measuring antenna should be linearly polarized and positioned twice to align with both the vertical and horizontal components of the radiated signal in order to measure the total e.i.r.p.

Measurements are then taken with the measuring antenna positioned at elevation angle (± 3°) of 10°, -20°, 30°, 40° and 50° for azimuth angles (± 3°) of 0° to 360° in 30° steps and the induced voltages for both polarization are measured for each one of the 60 positions.

The values of V_h and V_v for each measured position shall be recorded.

The following steps are performed for each set of measured voltages and the results are recorded:

Step 1: Calculate the total induced voltage V_{rec} in dBV using:

$$V_{rec|(dBV)} = 20\log\sqrt{{V_v}^2 + {V_h}^2}$$

where:

- V_v and V_h are the induced voltage measurements (in V) when the measuring antenna is oriented in the vertical and the horizontal plane respectively.

Step 2: Calculate the field strength E in dBV/m at the measuring antenna using:

$$E_{|(dBV/m)} = V_{rec} + 20\log AF_c + L_c$$

where:

- V_{rec} is the calculated signal level from Step 1 (dBV);
- AF_c is the corrected antenna factor of the measuring antenna;
- L_c is the receiver system attenuation and cable loss (dB).

The receiver system attenuation is compensated for when performing the calibration procedure (subclause 5.8). Otherwise, it shall be calculated separately.

Step 3: Calculate the e.i.r.p.:

Calculate the e.i.r.p. for each set of angular co-ordinates from $e.i.r.p._{|W} = \frac{E^2 \cdot R^2}{30}$

where:

- R is the distance between the satellite EPIRB and the measuring dipole antenna;
- E is the field strength converted from Step 2 into V/m.

The measurements shall be performed under normal test conditions.

11.2.3 Limits

The radiated power shall be within the limits of +6 dB and -5 dB relative to 5 W e.i.r.p.

11.3 Antenna characteristics

11.3.1 Definition

The following antenna characteristics are defined for elevation angles greater than 5° and less than 60°.

11.3.2 Method of measurement

The antenna gain shall be calculated for each set of angular co-ordinates from:

$$G_i = \frac{e.i.r.p.}{P_t}$$

where:

- e.i.r.p. is the radiated power measured in subclause 11.2;
- P_t is the power transmitted into the satellite EPIRB antenna;
- G_i is the satellite EPIRB antenna numerical gain relative to an isotropic antenna.

An analysis of the raw data (V_v, V_h) obtained during the antenna test should be sufficient to determine if the polarization of the satellite EPIRB antenna is linear or circular.

If the induced voltage measurements V_v and V_h for each specific angular co-ordinates (azimuth, elevation) differ by at least a factor of 10, the polarization should be linear. The polarization will be vertical or horizontal if V_v or V_h is greater respectively.

If the induced voltage measurements (V_v, V_h) are within 10 dB of each other for most of the surface scanned, the satellite EPIRB antenna is considered to be circularly polarized. Since the sense of the polarization is Right Hand Circular Polarized (RHCP), determine the sense of polarization using the following method, and report the results.

Compare the signals received using known Right Hand Circularly Polarized (RHCP) and Left Hand Circularly Polarized (LHCP) antennas when the satellite EPIRB antenna is radiating. The antenna resulting in the largest received signal determines the sense of polarization.

11.3.3 Limits

The antenna shall have the following characteristics:

- pattern: hemispherical;
- polarization: right hand circular polarized (RHCP) or linear;
- gain (vertical of the plane): between -3 dBi and +4 dBi over 90 % above region;
- gain variation (azimuth plan): less than 3 dB;
- antenna Voltage Standing Wave Ratio (VSWR): not greater than 1,5:1.

12 Release mechanism

12.1 General

12.1.1 Operating conditions

The release mechanism shall be constructed of non-corrosive compatible materials, so as to prevent deterioration, which may cause any malfunction of the unit. Galvanising or other forms of metallic coating on parts of the release mechanism shall not be accepted.

The release mechanism shall be designed to minimize the formation of ice and prevent the effects of ice from hindering the release of the satellite EPIRB.

It shall be possible to assess the proper functioning of the automatic release mechanism by a simple method without activation of the satellite EPIRB.

The release mechanism shall be fitted with adequate means to prevent inadvertent release or activation of the satellite EPIRB.

It shall be possible to release the satellite EPIRB manually without tools.

12.1.2 Labelling

The release mechanism shall be provided with a label or labels affixed in such a position as to be visible when the mechanism is installed and containing the following information at least in English:

- type designation;
- operating instructions for manual release of the satellite EPIRB;
- compass safe distance;
- maintenance and/or replacement date for the release mechanism, if applicable.

Administrations may require additional labelling.

If this label or labels are not readily visible in the installed arrangement, they shall be provided in addition, for installation close to the float free arrangement. These instructions may in addition be shown in pictorial form.

12.1.3 Operating instructions

The equipment manufacturer shall provide all instructions and information regarding stowage, installation, and operation of the release mechanism. This shall include a description of the method to assess its proper operation.

12.2 Automatic release of the satellite EPIRB

12.2.1 Definition

Automatic release is the ability of the release mechanism to release the satellite EPIRB after having been submerged in water under specified conditions.

12.2.2 Method of measurement

The satellite EPIRB installed in the release mechanism shall be submerged in non-freezing water. The temperature of the water shall be recorded.

This shall be performed six times with the equipment rotated each time as follows:

- normal mounting position;
- rolling 90° to starboard;
- rolling 90° to port;
- pitching 90° bow down;
- pitching 90° stern down;
- upside-down position.

The test under extreme temperature test conditions (subclause 5.11) shall be performed in the normal mounting position only.

12.2.3 Requirement

The satellite EPIRB shall be automatically released and float free of the mounting before reaching a depth of 4 m at any orientation.

The release mechanism shall be capable of operating throughout the temperature range of -30°C to +65°C.

Annex A (normative): Requirements for non float free satellite EPIRBs

Non-float free satellite EPIRBs shall meet all requirements of the present document but the following subclauses are superseded by:

Table A.1: Requirements for non-float-free satellite EPIRBs

Subclause	Replacement text
4.2 Operating conditions	The satellite EPIRB shall be mounted in a mounting bracket. The satellite EPIRB shall be designed to operate when floating in the sea but shall also operate satisfactorily on a ships deck and in a survival craft. The general construction and method of operation shall provide a high degree of proof against inadvertent operation, whilst still providing a simple means of operation in an emergency. The satellite EPIRB shall be capable of being carried by one person and it shall be possible to release and operate the satellite EPIRB manually. If the satellite EPIRB is manually removed from its mounting bracket, it shall be activated only when floating in the water or manually activated (subclause 4.6). After activation, no distress signal shall be emitted until at least 47 seconds and at most 5 minutes after the satellite EPIRB has been activated. The satellite EPIRB shall be a single integral unit incorporating a primary battery and a permanently attached antenna. No part of it shall be detachable without the use of tools. The fixed portion of the distress message shall be stored in such a way that it will not be affected by removal of all power sources. Any external connection shall not inhibit the activation of the satellite EPIRB.
4.6 Controls	All controls shall be of sufficient size for simple and satisfactory operation and also be capable of being operated by a person wearing gloves for immersion suits in accordance with Chapter III Regulation 33 of the 1983 amendments to the 1974 SOLAS Convention. Manual activation of the satellite EPIRB, after it has been removed from the mounting bracket, shall require two simple but independent mechanical actions neither of which, on its own, shall activate the equipment. Manual activation of the satellite EPIRB shall break a seal, which shall not be replaceable by the user. This seal shall not be broken when using the test facility. If the satellite EPIRB is installed in its mounting bracket the manual activation shall require two simple but independent mechanical actions. The means for manual activation shall be protected against inadvertent activation. After activation it shall be possible to manually deactivate the equipment.
6.1 General	Environmental tests in this clause shall be carried out before any other tests and shall be performed under normal test conditions unless otherwise stated. The satellite EPIRB shall be installed in its mounting bracket in operating conditions (subclause 4.2) but not transmitting unless otherwise stated. The following tests shall be conducted in the order they appear in this clause unless otherwise stated.
12 Release mechanism	Deleted

Bibliography

An Introduction to Error Correcting Codes, Shu Lin, Prentice-Hall 1970.

IMO Resolution A.694(17): "General requirements for ship borne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids".

IMO Resolution A.810(19): "Performance standards for float-free satellite emergency position-indicating radio beacons (EPIRBs) operating on 406 MHz".

IMO Resolution A.662(16): "Performance standards for float-free release and activation arrangements for emergency radio equipment".

IMO Resolution A.696(17): "Type approval of satellite emergency position-indicating radio beacons operating in the COSPAS-SARSAT system".

ITU-R Recommendation M.633-2: "Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) system operating through a low polar-orbiting satellite system in the 406 MHz band".

ISO Recommendation 694: "Method B".

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