EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 066

November 1992

Source: ETSI TC-RES

Reference: DE/RES-1003

ICS: 33.060.50

Key words: Martime, EPIRB

Radio Equipment and Systems (RES); Float-free maritime satellite Emergency Position Indicating Radio Beacons (EPIRBs) operating on 406,025 MHz; Technical characteristics and methods of measurement

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

Contents

Blank page

Foreword

This European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI) and has undergone the ETSI standards approval procedure in Public Enquiry 13 and Vote 20.

This ETS sets out the minimum requirements for float-free maritime satellite Emergency Position-Indicating Radio Beacons (EPIRBs), used for maritime search-and-rescue. The requirements include the arrangements for the operation of EPIRBs on the 406,025 MHz frequency (and for the operation of optional homing devices on other frequencies), and for the operation of the release mechanism which allows EPIRBs to float freely in the water.

EPIRBs operate under the COSPAS-SARSAT satellite system, and this ETS incorporates the requirements of COSPAS-SARSAT specification C/S T001 [5]. This ETS incorporates the recommendations of the International Maritime Organisation (IMO) Assembly Resolutions A695(17) [1] and A662(16) [2], SOLAS Amendments and the relevant requirements of the International Radio Regulations [3], and of CCIR Recommendation 633 [4]. Signals from individual EPIRBs are coded in accordance with IMO requirements.

Descriptions of the environmental testing arrangements are laid down in Annex VI to CEPT Recommendation T/R 34-01 [6].

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

The subject matter of this ETS is covered by a recent repartition agreement between ETSI and CENELEC. Adopted and proposed ETSs in the field of maritime radio may be subject to revision to harmonise requirements as fully as possible with those of the International Electrotechnical Committee (IEC).

Blank page

1 Scope

This ETS states the minimum requirements for maritime float-free satellite Emergency Position-Indicating Radio Beacons (EPIRBs) operating on 406,025 MHz, with release mechanism, operating in the COSPAS-SARSAT system. This ETS incorporates the recommendations of IMO assembly resolutions A 695(17) [1] and A 662(16) [2], the relevant requirements of the International Telecommunications Union (ITU) Radio Regulations [3], CCIR Recommendation 633 [4], and the COSPAS-SARSAT specification C/S T001 [5].

Descriptions of the environmental testing arrangements are laid down in Annex VI to CEPT Recommendation T/R 34-01 [6].

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] A 695(17): "Performance standards for float free satellite emergency position indicating radio beacons operating on 406 MHz".

[2] A 662(16): "Performance standards for float free release and activation arrangements for emergency radio equipment".

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

[4] CCIR Recommendation 663: "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".

[5] C/S T001: "Specification for COSPAS-SARSAT 406 MHz distress beacons".

[6] CEPT Recommendation T/R 34-01: "Specifications for maritime mobile radio equipment".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETS, the following definitions shall apply:

Satellite EPIRBs: earth stations in the Mobile Satellite Service the emissions of which are intended to facilitate search and rescue operations. Class 1 Satellite EPIRBs operate over the temperature range of - 40 °C to + 55 °C. Class 2 satellite EPIRBs operate over the temperature range of - 20 °C to + 55 °C.

Release Mechanisms: a mounting which automatically allows the EPIRB to float free.

Equipment: an EPIRB and its release mechanism.

3.2 Abbreviations

e.i.r.p. equivalent isotropically radiated power

EPIRB Emergency Position Indicating Radio Beacon

ID	Identification
IMO	International Maritime Organisation
MID	Maritime Identification Digits
VSWR	Voltage Standing Wave Ratio

4 General requirements

4.1 Construction

The satellite EPIRB shall be mounted in a release mechanism (see Clause 13) which automatically releases the EPIRB when submerged in water. When so released, the EPIRB shall float to the surface and start transmitting automatically.

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

The equipment may include a homing function, operating on the frequency 121,5 MHz, or a 9 GHz radar transponder. Such a facility shall be approved to the appropriate standard. Where such a facility exists, all measurements shall be performed during combined operation.

In all respects the mechanical and electrical construction and finish of the equipment shall conform with good engineering practice.

The equipment shall be designed to minimise the risk of internal and external damage during use or stowage.

The exterior of the satellite EPIRB shall have no sharp edges or projections which could easily damage inflatable rafts or injure personnel.

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 be designed as one integral unit. It shall derive its energy from a battery forming a part of the equipment and incorporate a permanently attached antenna.

It shall be possible to release and operate the satellite EPIRB manually.

The satellite EPIRB shall be watertight, be capable of floating upright in calm water and have positive stability and sufficient buoyancy in all sea conditions.

The satellite EPIRB shall be provided with either an audible or a visual indication that alerting signals are being emitted. The visual indication shall be clearly discernible at a distance of 1 metre (m) under light conditions ranging from darkness to direct sunlight. The audible indication shall produce a sound level of at least 80 dBA at a distance of 1 m.

The satellite EPIRB shall be provided with a firmly attached line in order that the equipment may be tethered in use. The line shall have a length of at least 20 m and be capable of floating in sea water and should be arranged so as to prevent it being trapped in the ship's structure when floating free.

The satellite EPIRB shall be finished with a highly visible yellow or orange colour and shall be fitted with a band of retroflective material, at least 25 mm wide, encircling that part of the satellite EPIRB's surface which is normally protruding above the waterline.

The equipment, including labelling, shall not be unduly affected by sea water or oil and shall be resistant to deterioration by prolonged exposure to sunlight.

The satellite EPIRB shall be provided with a low duty cycle light of at least 0,75 effective candela operating continually or activated by darkness and flashing at a rate not less than 20 times per minute, with a flash duration of between 10^{-6} to 10^{-2} seconds. It shall be mounted so that it is visible over as great a portion of the upper hemisphere as is practical.

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 of the satellite EPIRB from the release mechanism.

The satellite EPIRB shall be able to meet all requirements, except for those in subclause 7.1 (Radiated power), at any VSWR between 1:1 and 3:1. The design of the equipment shall be such that it is not damaged by any mismatch.

The satellite EPIRB shall be designed to limit any inadvertent continuous transmission to a maximum of 45 seconds.

The transmitted frequency shall remain within the frequency band from 406,020 MHz - 406,030 MHz over a period of at least 5 years.

4.2 Controls and indicators

All controls shall be of sufficient size for simple and satisfactory operation and also be capable of being operated by personnel wearing gloves.

4.2.1 Activation

Manual activation of the satellite EPIRB 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.

After activation it shall be possible to manually deactivate the equipment.

Means shall be provided to prevent accidental deactivation.

4.2.2 Test mode

The satellite EPIRB shall include a manually activated test whereby the alerting transmitter output may be verified.

The Radio Frequency (RF) test transmission shall be limited to one burst of 440 ms maximum. The signal shall be modulated as described in subclause 10.4.4. Activation of the test facility shall reset automatically.

4.3 Labelling

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

- type designation, serial number, and the type of battery specified by the manufacturer for use in the equipment;

- adequate instructions to enable manual activation and deactivation;

- a warning to the effect that the satellite EPIRB shall not be operated except in an emergency;
- the date on which the battery will need to be replaced. Simple means shall be provided for changing this date when the battery is replaced;
- space on which the name and call-sign of the ship can be recorded;
- the temperature class of the satellite EPIRB, (see iv) in subclause 6.1);
- the safe distance of the equipment from the magnetic compass;
- any other identification that may be required by national administrations, (e.g. type approval identification).

4.4 Operating instructions

The equipment manufacturer shall provide all instructions and information regarding stowage, installation, and operation of the satellite EPIRB. This will 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.

4.5 Power source

The battery provided as a source of power shall have sufficient capacity to operate the complete equipment for an uninterrupted period of at least 48 hours.

The battery shall have a shelf life of at least 3 years and when fitted to the satellite EPIRB shall not require replacement within 2 years.

The battery shall be clearly and durably marked with the expiry date of the battery shelf life.

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

4.6 Antenna characteristics

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

Pattern:	hemispherical.
Polarisation:	Right Hand Circular Polarised (RHCP) or linear.
Gain (vertical plan):	between - 3 dBi and 4 dBi over 90 % of the above region.
Gain variation (azimuth plan):	less than 3 dB.
Antenna VSWR:	not greater than 1,5:1.

5 Test conditions, power sources and ambient temperatures

5.1 Test protocol

For the purpose of conformity testing, the satellite EPIRB shall be provided with a means to allow the test mode (see subclauses 4.2.2 and 10.4.4) to temporarily produce more than the permitted single burst, and all homing devices should be prepared for test transmission as required by the appropriate national authority.

5.2 Test fixture

The manufacturer shall supply an external test fixture permitting relative measurements to be made on the submitted sample. This test fixture shall provide a 50 Ω RF. terminal at the working frequencies of the equipment.

The performance characteristics of the test fixture, under normal and extreme conditions, shall be subjected to the approval of the testing authority. The following characteristics shall apply:

- the coupling loss shall be as low as possible and in no case greater than 30 dB;
- the variation of coupling loss with frequency shall not cause errors in the measurements exceeding 2 dB;
- the coupling device shall not incorporate any non-linear elements;
- the power consumption of the satellite EPIRB shall not substantially change when fitted in the test fixture.

Any connections provided on the equipment in order to facilitate relative measurements shall not affect the performance of the equipment either in the test fixture or when making measurements involving the use of radiated fields.

The test fixture supplier shall provide guidance as to the minimum distance the test fixture may be operated from other metallic objects without a significant effect being caused to the results obtained (e.g. the minimum size of environmental chamber needed).

5.3 Normal and extreme test conditions

Tests shall be carried out under normal and extreme test conditions, unless otherwise stated.

5.4 Additional facilities

If the equipment contains any additional facilities (e.g. transmitters for homing), they shall be operational for the duration of all tests.

During testing all audible and visual indications including the low duty cycle light shall be functioning.

5.5 Test power source

Where stated, the battery of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in subclauses 5.5.2 and 5.6.2.

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

5.5.1 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 %

5.5.2 Normal test voltage

The normal test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that the battery gives under normal temperature and humidity at a load equal to that of the equipment.

5.6 Extreme test conditions

5.6.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedure specified in subclause 5.7, at the lower and upper temperature of - 20 °C and + 55 °C for the Class 2 EPIRB or - 40 °C and + 55 °C for the Class 1 EPIRB.

5.6.2 Extreme test voltages

5.6.2.1 Upper extreme test voltages

The upper extreme test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that the battery gives under upper extreme temperature with a load equal to that of the equipment (see measurements in subclause 8.2).

5.6.2.2 Lower extreme test voltage

The lower extreme test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that the battery gives under the lower extreme temperature with a load equal to that of the equipment after 48 hours of operation at - 20 °C for the Class 2 EPIRB or - 40 °C for the Class 1 EPIRB (see measurements in subclause 8.3).

5.7 Procedure for tests at extreme temperatures

The equipment shall be switched off during the temperature stabilising 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 5 minutes.

5.8 Test sequence

All tests shall be performed on a single equipment. The tests shall be carried out in the order described in this ETS.

6 Environmental tests

Environmental tests are intended to assess the suitability of the construction of the equipment for its intended physical conditions of use.

During and after environmental tests (see subclause 6.1), the equipment shall be inspected for any mechanical deteriorations and for water penetration.

After each environmental test (see subclause 6.1), the following performance checks shall be made:

- frequency of the emission (see subclause 9.1.1);

- radiated power (see subclause 7.2).

6.1 Tests

The following tests shall be made under environmental conditions as detailed in the standard for "Environmental Testing of Maritime Radio Equipment" [1]. The corrosion and the vibration tests shall be performed with the satellite EPIRB installed in the release mechanism.

Vibration:	Clause 4;
Dry Heat Cycle:	subclause 5.1;
Damp Heat Cycle:	Clause 6;
Low Temperature Cycle:	Clause 7.1 exception that the lower storage temperature shall be - 30 °C for Class 2 and - 40 °C for Class 1, and the operating temperature shall be at the lower and upper temperature of - 20 °C and + 55 °C for the Class 2 EPIRB or - 40 °C and + 55 °C for the Class 1;
Corrosion tests:	subclauses 10.1 and 10.2.

i) Drop test:

the satellite EPIRB shall be held with the antenna upwards and dropped three times into water from a height of 20 metres.

ii) Immersion tests:

the equipment shall be placed in an atmosphere of + 65 °C for one hour. It shall then immediately be immersed in water at + 20 °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 one hour.

The satellite EPIRB shall be subjected to an external water pressure of 100 kPa for 5 minutes.

iii) Antenna mismatch:

the equipment whilst transmitting shall be immersed in salt water (nominal 3,5 % solution) to a depth of 10 cm, measured from the highest point of the equipment to the surface of the water, for the duration of 12 transmissions.

iv) Electrical tests over temperature range:

two standard classes of temperature range are defined inside which the system requirements shall be met:

Class 1: - 40 °C to + 55 °C;

Class 2: - 20 °C to + 55 °C.

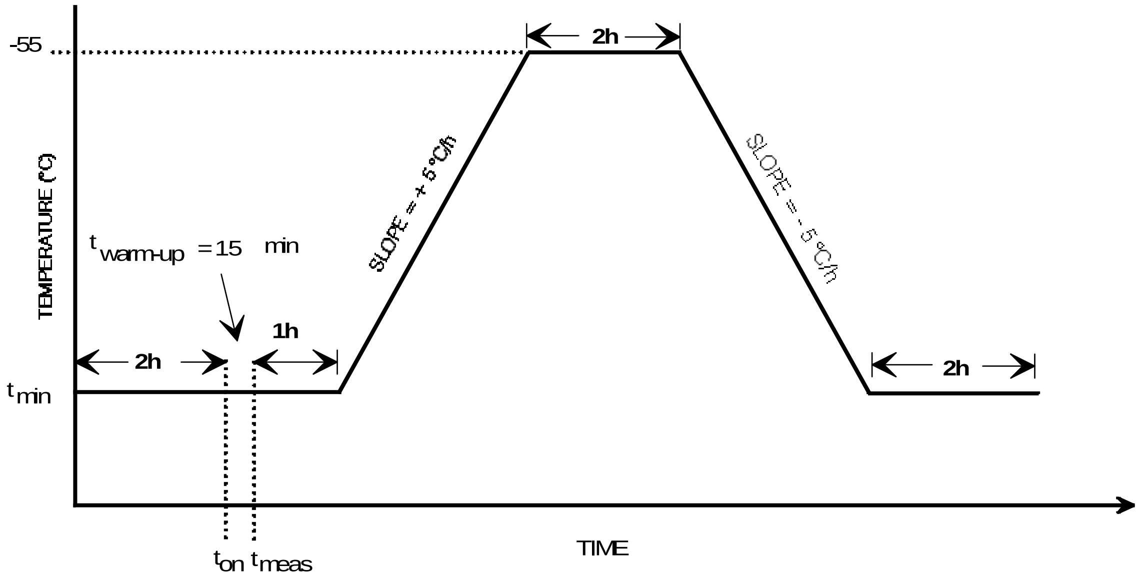
The temperature range shall be permanently marked on the satellite EPIRB.

All system requirements described in this ETS shall be met at the minimum, ambient, and maximum temperature.

---

1) At present still contained in Annex VI to CEPT Recommendation T/R 34-01 [6].

The short term frequency stability (see subclause 9.1.2), the medium term frequency stability (see subclause 9.1.3), and the frequency of the emission (see subclause 9.1.1), shall be verified when the fully packaged satellite EPIRB is subjected to the temperature gradient shown in figure 1.



t_{min} = - 40° C (Class 1 beacon)

t_{min} = - 20° C (Class 2 beacon)

t_{on} = beacon turn on after 2 hour "cold soak"

t_{meas} = start time of frequency stability (t_{on} + 15 min)

Figure 1: Temperature gradient

v) Thermal shock:

the equipment shall be placed in an atmosphere of - 20 °C for at least 2 hours. It shall then be switched on and immediately floated in water that is maintained at a temperature of +10 °C.

After 15 minutes the following measurements shall be made in addition to the performance check described in the third paragraph of Clause 6:

- short term frequency stability (see subclause 9.1.2);
- medium term frequency stability (see subclause 9.1.3);
- mean slope;
- residual frequency variation.

Subsequently, system requirements shall continue to be met for a minimum period of two hours.

7 Radiation measurements and reference output power

7.1 Radiated power

This test and the power in test fixture (see subclause 7.2) shall be performed immediately after each other without switching off the satellite EPIRB between measurements.

7.1.1 Definition

For this ETS, 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 nominal Watts (W) ± variation (dB).

7.1.2 Method of measurement

The measurement shall be performed with the equipment floating in salt water (nominal 3,5 % solution) in its ordinary operating position.

The test site shall consist of a still area of salt water (nominal 3,5 % solution) of at least 10 wavelengths (λ) diameter at 406,025 MHz (7,5 m).

The radiated signal shall be measured at a distance of at least 8 λ at the frequency of the emission being measured from the antenna of the satellite EPIRB. It shall be possible to vary the measuring antenna's height up to a level which allows exploration of elevation angles up to 60° in steps of 5°, and the strength of the received signal shall be registered by means of a peak reading detector suitably corrected for the change in distance between the EPIRB and the measuring antenna. For each 5°, either the EPIRB shall be rotated through 360°, or the measuring antenna shall be moved 360° around the EPIRB.

The maximum and minimum corrected peak readings shall be determined.

The measuring receivers shall have a bandwidth of 10 kHz.

The satellite EPIRB shall then be replaced by a substitution antenna, which shall be a quarter wave monopole antenna mounted so as to float vertically upright, and present a 50 Ω resistive load connected to the signal source. The signal source shall be set at a convenient power level (e.g. 1 Watt) and the elevation angle of the measuring antenna corresponding to the maximum corrected peak reading shall be determined. With the measuring antenna set at this elevation angle, the signal source output level shall be varied until the peak reading indicator corresponds to the minimum peak reading obtained for the EPIRB under test.

This signal source output level (L min.) shall be recorded. The signal source output level shall be increased until the peak reading indicator corresponds to the maximum corrected peak reading obtained for the EPIRB under test. This signal source output level (L max.) shall be recorded. The signal source output levels L max. and L min. shall be corrected for the gain of the substitution antenna (relative to an isotropic antenna).

The measurements shall be performed under ambient temperature conditions.

7.1.3 Limits

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

7.2 Power in test fixture

The satellite EPIRB shall be installed in a test fixture. The power on the output socket of the test fixture shall be measured and noted. This power shall be taken as the reference output power of the EPIRB (P_r) and shall be used for conducting measurements under extreme test conditions.

7.3 Spurious emission

7.3.1 Definition

Spurious emission(s) are emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions. See RR 138 and RR 139 in the ITU Radio Regulations [3].

7.3.2 Method of measurement

The methods of measurement described shall be used to search for spurious emissions in the frequency bands 108 - 137 MHz, 156 - 174 MHz, 450 - 470 MHz, 1 535 - 1 545,4 MHz and 1 636 - 1 646,5 MHz.

The measurement shall be performed only between bursts with the equipment floating in salt water in its ordinary operating position.

The test site shall consist of a still area of salt water of at least 10 λ diameter at the nominal frequency of the emission (406,025 MHz).

The radiated signal shall be measured at a distance of at least 8 λ, at the frequency of the emission being measured, from the antenna of the satellite EPIRB. It shall be possible to vary the measuring antenna's height above the ground by at least λ/2, and the strength of the received signal shall be registered by means of a peak reading indicator.

The measuring receiver shall have a bandwidth of 10 kHz.

For each spurious emission identified, the satellite EPIRB shall be rotated and the height of the measuring antenna shall be varied until maximum peak signal strength is found.

The satellite EPIRB shall then be replaced by a substitution antenna, which shall be a quarter wave monopole antenna mounted so as to float vertically upright, and present a 50 Ω resistive load when connected to the signal source. The height of the measuring antenna shall be varied until the maximum signal strength is registered. The level and the signal source shall be adjusted to give the same reading as the peak instantaneous reading from the satellite EPIRB. This output power from the signal source is defined as the effective radiated peak power of the emission. Allowance shall be made for cable attenuation.

Measurements shall be performed under ambient temperature conditions.

7.3.3 Limit

The effective radiated peak power of any spurious emission at any discrete frequency in the frequency bands as defined in subclause 7.3.2 shall not exceed 25 µW.

8 Determination of extreme test voltages

8.1 Method of measurement

The battery compartment shall be opened and the battery shall be replaced by a power supply. The EPIRB shall be placed in the test fixture and the voltage of the power supply shall be adjusted around the nominal value of the battery voltage until the reference output power of the EPIRB (P_r), (see subclause 7.2), is achieved. This determines the normal working voltage.

8.2 Upper extreme test voltage

The EPIRB fitted with an unused battery shall be placed in the climatic chamber and heated to the temperature of + 55 °C allowing for a stabilising period of 2 hours.

The EPIRB shall be activated for a period of 15 minutes. After this period, the battery voltage shall be measured during a 406 MHz transmission. This voltage shall be taken as the upper extreme test voltage.

8.3 Lower extreme test voltage

The EPIRB fitted with an unused battery shall be placed in the climatic chamber and cooled to the temperature of - 20 °C for the Class 2 satellite EPIRB or - 40 °C for the Class 1 allowing for a stabilising period of 2 hours.

The EPIRB shall be activated and the temperature maintained for 48 hours. After this period, the battery voltage shall be measured during a 406 MHz transmission. This voltage shall be taken as the lower extreme test voltage. The lower extreme test voltage shall be measured before disconnecting the load.

8.4 Power in test fixture at extreme test conditions

The measurements made in subclause 7.2 shall be repeated under the extreme test conditions.

8.4.1 Limit

The power measured in the test fixture under extreme test conditions shall be within ± 2 dB of the value, P_r, determined in subclause 7.2.

9 Transmitter

All tests in this chapter are performed using the test fixture (see subclause 5.2).

9.1 Frequency

9.1.1 Frequency of the emission

9.1.1.1 Definition

The frequency of the emission is the carrier frequency of the signal.

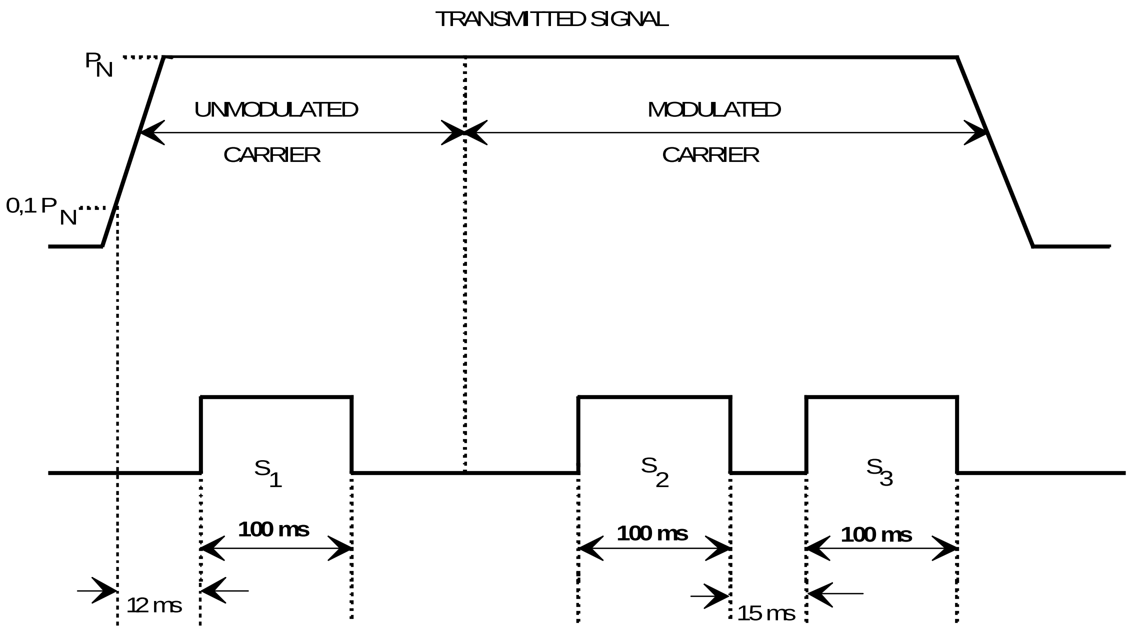
9.1.1.2 Method of measurement

The mean transmission frequency (f_o) shall be determined from 10 measurements of $f_i^{(1)}$ made during the interval S1 (see figure 2) during 10 successive transmissions as follows:

$$f_0 = f^{(1)} = \frac{1}{10} \sum_{i=1}^{10} f_i^{(1)}$$

9.1.1.3 Limit

The frequency of the emission shall be 406,025 MHz ± 2 kHz.



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 2: Message format and structure

9.1.2 Short term frequency stability

9.1.2.1 Definition

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

9.1.2.2 Method of measurement

The short term frequency stability is derived from measurements of $fi^{(2)}$ and $fi^{(3)}$ made during the intervals S2 and S3 (see figure 2) during 10 successive transmissions as follows:

$$\sigma\ 100ms = \left(\frac{1}{20} \sum_{i=1}^{10} \left(\frac{f_i^{(2)} - f_i^{(3)}}{f_i^{(2)}} \right)^2 \right)^{\frac{1}{2}}$$

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 and to avoid an error which might result from an unequal number of negative and positive phase transitions occurring during the 100 ms gating interval of a frequency counter used in the internal gate mode, the 406 MHz EPIRB test bench which demodulates the 400 bits per second (bps) bit stream shall use the bit clock to generate a gating signal of 100 ms ± 1 %

which contains the same number of positive and negative phase transitions. The gating signal shall be used with a frequency counter in the external gating mode.

9.1.2.3 Limit

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

9.1.3 Medium term frequency stability

9.1.3.1 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.

9.1.3.2 Method of measurement

The medium term frequency stability is derived from measurements of $f_i^{(2)}$ made over successive transmissions at instants t_i for a period of 15 minutes (see figure 3).

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:

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

The ordinate at the origin of the least-squares straight line is given by:

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

The residual frequency variation is given by:

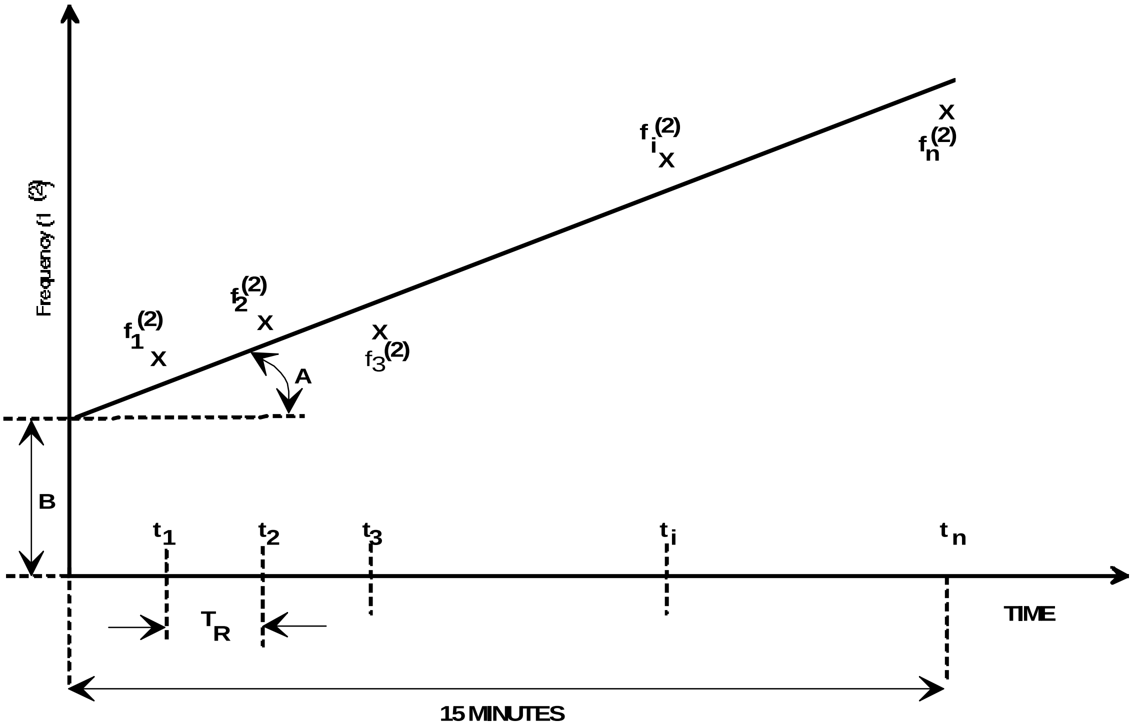
$$\sigma = \left(\frac{1}{n}\sum_{i=1}^{n}\left(f_i - At_i - B\right)^2\right)^{\frac{1}{2}}$$

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

9.1.3.3 Limits

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

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



This performance shall be met for all defined environmental conditions after a maximum warm-up period of 15 minutes.

Figure 3: Medium-term frequency stability measurement

9.2 Radiation in the frequency band 406 - 406,1 MHz

9.2.1 Method of measurement

The satellite EPIRB transmits a modulated signal on the frequency f_c.

The radiation shall be checked on a spectrum analyzer. The equipment shall be connected to the spectrum analyser using a test fixture (see subclause 5.2).

The input impedance of the analyzer shall be 50 Ω. The centre frequency of the spectrum analyzer display system shall be the satellite EPIRB carrier frequency. The value of the resolution bandwidth of the analyzer shall be chosen in the range 1 kHz - 10 kHz. The scanning speed of the analyser shall be calculated from the following formula:

$$T \cong \frac{D}{R^2}$$

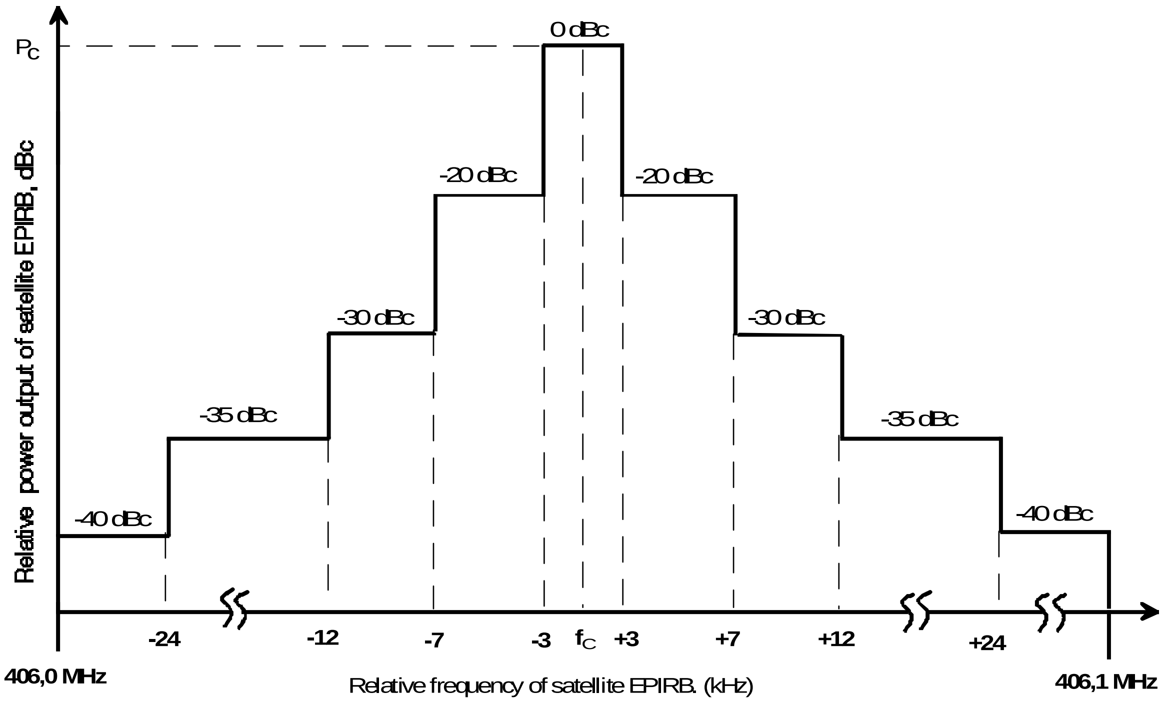
T: scanning time of the scanned bandwidth: D; D = 0,1 MHz

R: resolution bandwidth of the resolution filter

The figure displayed on the screen shall be recorded.

9.2.2 Limit

The radiation shall not exceed the levels specified by the signal mask in figure 4.



P_c = Satellite EPIRB unmodulated carrier power output

f_c = Satellite EPIRB carrier frequency

dBc = Satellite EPIRB emitted signal power level in dB relative to P_c

(measured in a 100 Hz resolution bandwidth)

Figure 4: Radiation mask for 406,0 to 406,1 MHz band

9.3 Modulation and data encoding

9.3.1 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator and a decoder. The demodulated and decoded signals shall be applied to an oscilloscope which shall be calibrated in terms of phase expressed in radians.

The extreme values of the phase, $\Phi 1$ and $\Phi 2$ in figure 6, are measured not taking into account overshoots.

9.3.2 Limits

The carrier shall be phase modulated plus and minus 1,1 ± 0,1 radians peak, referenced to an unmodulated carrier. Modulation sense shall be as shown in figure 5.

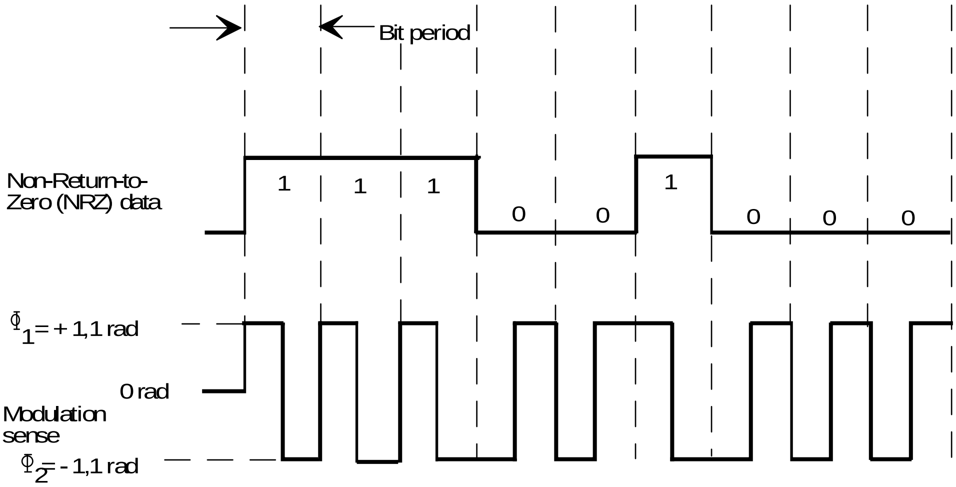


Figure 5: Data encoding and modulation sense

9.4 Rise and fall times

9.4.1 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator. The demodulated signal shall be applied to an oscilloscope which shall be calibrated in terms of phase expressed in radians.

The rise time (T_R) and the fall time (T_F) of the modulated waveform shall be measured between the 0,9 points of the phase transition as shown in figure 6.

9.4.2 Limit

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

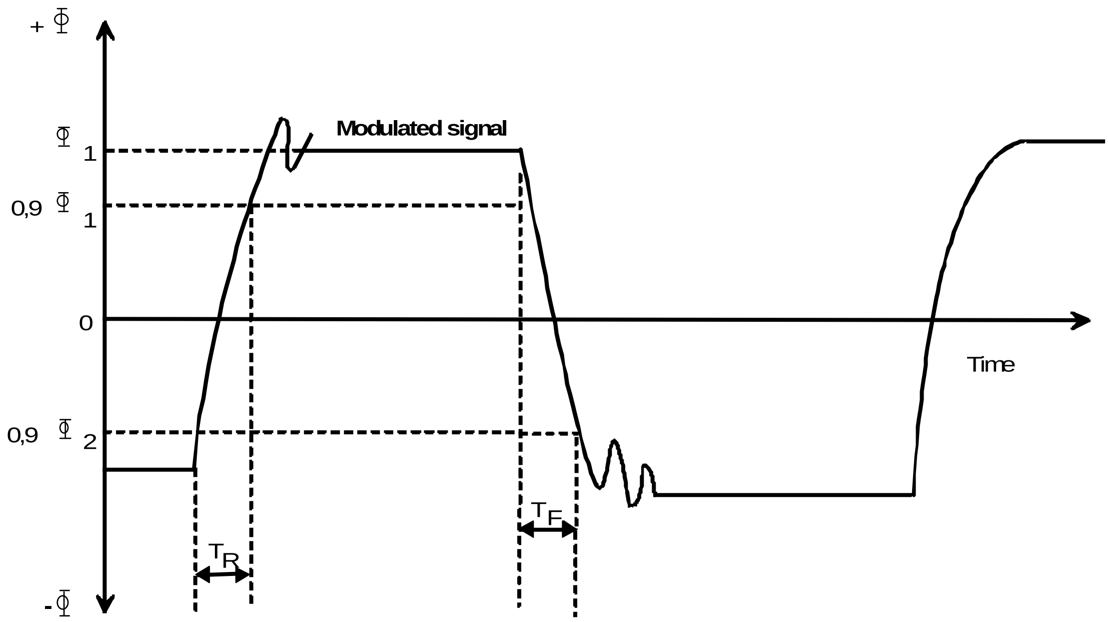


Figure 6: Modulation rise and fall times

9.5 Modulation symmetry

9.5.1 Method of measurement

The modulated RF signal shall be applied to the input of a linear demodulator. The demodulated signal shall be applied to an oscilloscope which shall be calibrated in terms of phase expressed in radians.

The durations T_1 and T_2 shall be measured as defined in figure 7.

9.5.2 Limit

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

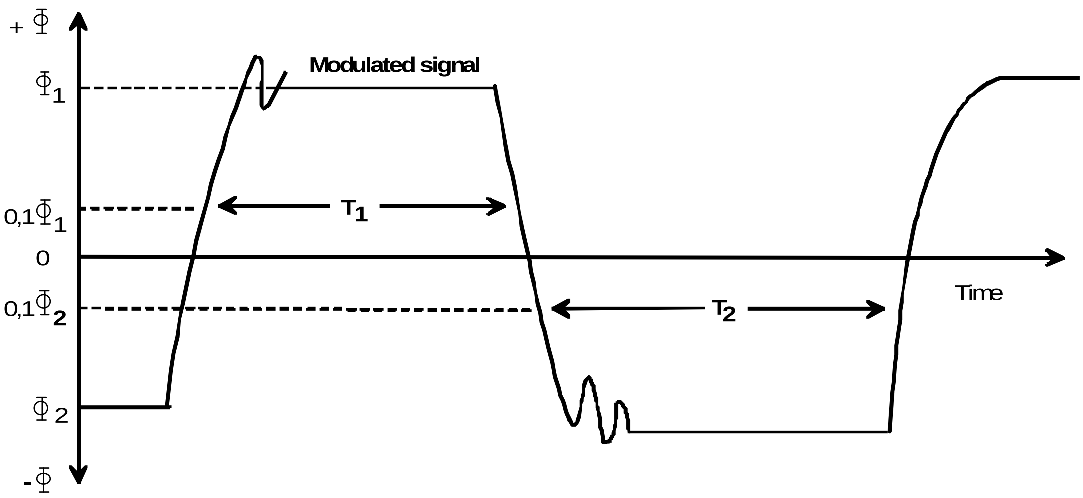


Figure 7: Modulation symmetry

10 Signal format

All tests in this chapter are performed using the test fixture (see subclause 5.2).

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

10.1 Repetition period

10.1.1 Definition

The repetition period (T_R) is the time between the 90 % (0,9 P_N) power points of two successive transmissions, (see figure 8).

10.1.2 Method of measurement

The repetition period is measured on 10 successive transmissions. The range 47,5 s to 52,5 s is divided into 5 equal intervals. The number of measured periods in each interval is noted.

10.1.3 Limit

The repetition periods shall be distributed so that all lie within the 5 intervals and the number in any one interval shall not exceed 3.

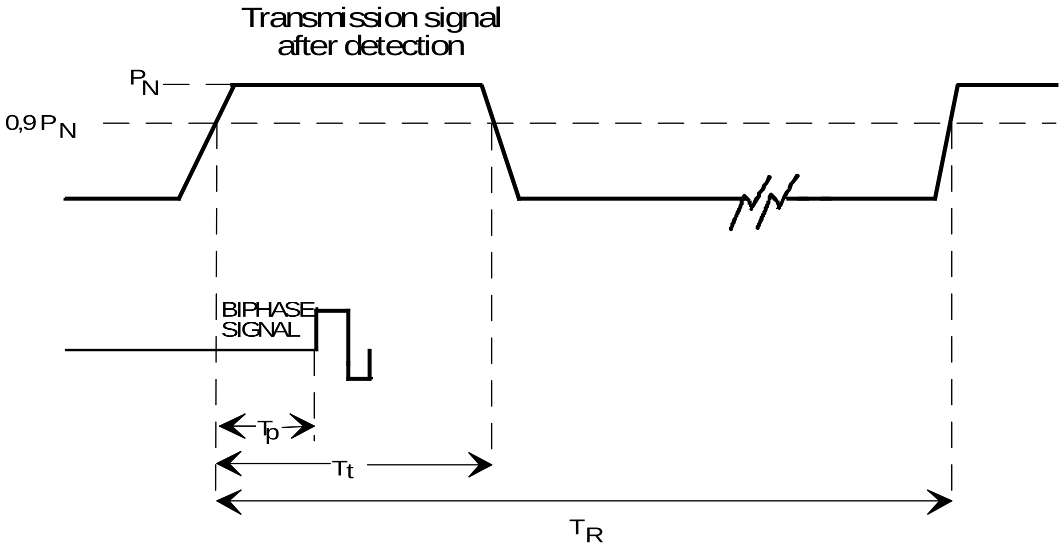


Figure 8: Timing

10.2 Total transmission time

10.2.1 Definition

The total transmission time is the time during which power is present on the frequency 406,025 MHz during one transmission.

10.2.2 Method of measurement

The total transmission time (T_t) shall be measured between the points where the output carrier power reaches 90 % of its end value, (see figure 8). The mean value (T_t) and the standard deviation (σ) are calculated for 10 successive transmissions.

10.2.3 Limits

The duration of the 10 measurements shall lie within the range:

a) short message:

$435,6 \text{ ms} < (T_t) \pm 3\ \sigma) < 444,4 \text{ ms}$;

b) long message:

$514,8 \text{ ms} < (T_t) \pm 3\ \sigma) < 525,2 \text{ ms}$.

10.3 CW preamble

10.3.1 Definition

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

10.3.2 Method of measurement

The duration of the CW preamble (T_p) shall be measured between the point where the output carrier power reaches 90 % of its end value and the beginning of the digital message (see figure 8). This measurement shall be performed at 10 successive transmissions and the mean value (T_p) and standard deviation (σ) shall be calculated.

10.3.3 Limit

Each of the 10 measurements shall lie within the range 158,4 ms to 161,6 ms.

10.4 Digital message

a) short message:

the final 280 ms ± 1 % of the transmitted signal shall contain a 112 - bit message;

b) long message:

the final 360 ms ± 1 % of the transmitted signal shall contain a 144 - bit message.

10.4.1 Bit rate

10.4.1.1 Definition

The bit rate is the number of bits/s.

10.4.1.2 Method of measurement

The bit rate (f_b) shall be measured over the first 50 bits corresponding to one transmission. The mean value (f_b) and the standard deviation (σ) are calculated for 10 successive transmissions.

10.4.1.3 Limit

Each of the 10 measurements shall lie within the range 396 bits/s to 404 bits/s.

10.4.2 Bit synchronisation

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

10.4.3 Frame synchronisation

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

10.4.4 Test mode

The test transmission shall be limited to one burst with a maximum duration of 440 ms. The signal shall be modulated and have a frame synchronisation pattern of 011010000. This bit pattern complements the last 8 bits of the normal frame synchronisation pattern so that this test burst will not be processed by the satellite equipment.

The synchronisation pattern defined in subclauses 10.4.2, 10.4.3 and 10.4.4 shall be checked.

10.4.5 Format flag

Bit 25, the first data bit of the message, is a flag bit used to indicate the length of the message to follow. Value "0" indicates a short message, value "1" indicates a long message.

10.4.6 Message content

The content of the remaining 87 bits (short message) and 119 bits (long message) is defined in Clause 11.

11 Message content

The digital message transmitted by the satellite EPIRB consists of:

a) 112 bits for the short message;

b) 144 bits for the long message.

These bits are divided into four groups:

- the first 24 bits transmitted, positions 1 through 24, are system bits. They are defined in Clause 10 and are used for the bit and frame synchronisation of the receiving system processor;

- the following 61 bits, positions 25 through 85, are data bits. The first data bit (position 25) indicates if the message is short or long: "0" for a short message, "1" for a long message;

- the following 21 bits, positions 86 through 106, are a Bose-Chaudhuri-Hocquenghem (BCH) (82,61) error-correction code calculated for the preceeding 61 data bits. This code is a shortened form of a BCH (127,106), triple error-correcting code obtained from the following generator polynomial:

  $g5(x) = g3(x).(7,4,3,2,0)$;
  $g3(x) = g1(x).(7,3,2,1,0)$;
  $g1(x) = (7,3,0)$.

  Since the message sent will be only 61 bits (i.e. less than the 106 bits), it is assumed that the unnecessary bits will be set to zero for computation of the error-correction bits. These zero message bits will be thought to be at the beginning of the message and will not be transmitted since they are always zero and contribute no new information.

  a) short message:

     the last 6 bits of the message in positions 107 through 112 are data bits;

  b) long message:

     the last 38 bits of the message in positions 107 through 144 are data bits, i.e. 6 bits as in a) above plus 32 bits of the long message proper (figure 9).

12 Satellite EPIRB coding

These checks are performed using the test fixture (subclause 5.2).

The content of the digital message defined in this chapter shall be checked against the one provided by the manufacturer. The compliance with the format for each data field shall be checked bit by bit. The accuracy of the error-correcting code shall also be checked.

12.1 General

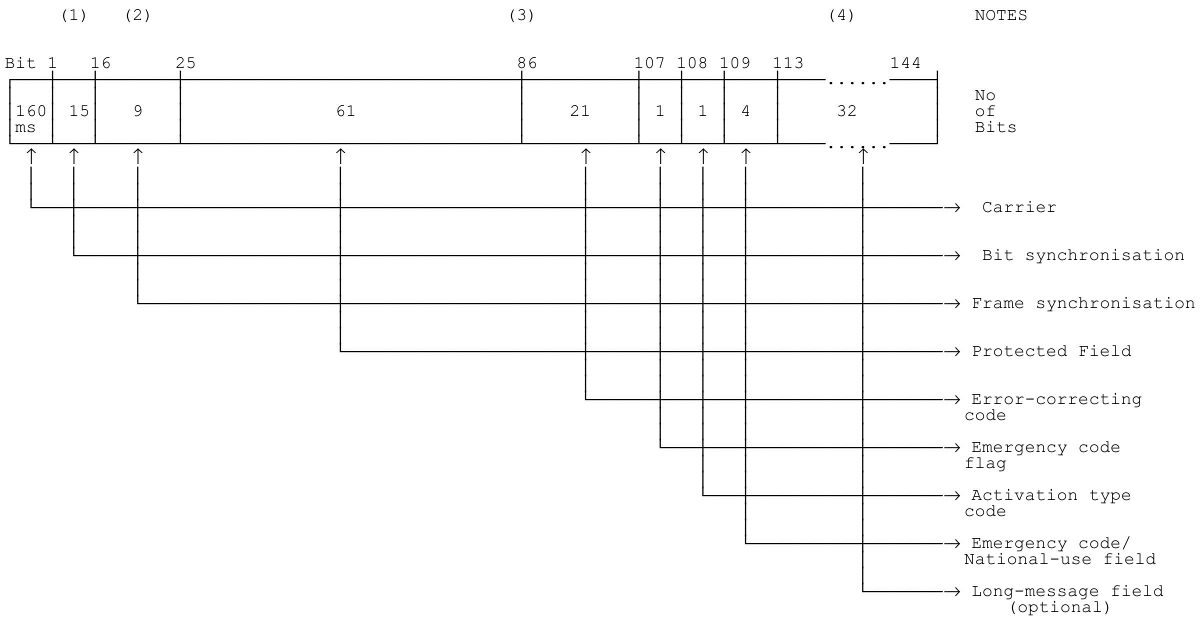
The digital message shown in figure 9 is divided into the following six bit fields:

	Bit Field Name	Bit Field Location
1)	Bit synchronisation	bit 1 through bit 15;
2)	Frame synchronisation	bit 16 through bit 24;
3)	Protected field	bit 25 through bit 85;
4)	Error-correcting field	bit 86 through bit 106;
5)	Emergency code field	bit 107 through bit 112;
6)	Long message (optional)	bit 113 through bit 144.

The bit synchronisation and frame synchronisation fields are defined in subclauses 10.4.2 and 10.4.3, respectively.

The error-correcting field is defined in the third bullet item of Clause 11.

The protected field, the emergency code field, and the long message field are shown in figure 9, and are defined in this section. Figure 10 shows the protected field for the available protocols, and figure 11 summarises all the coding options for the entire message.



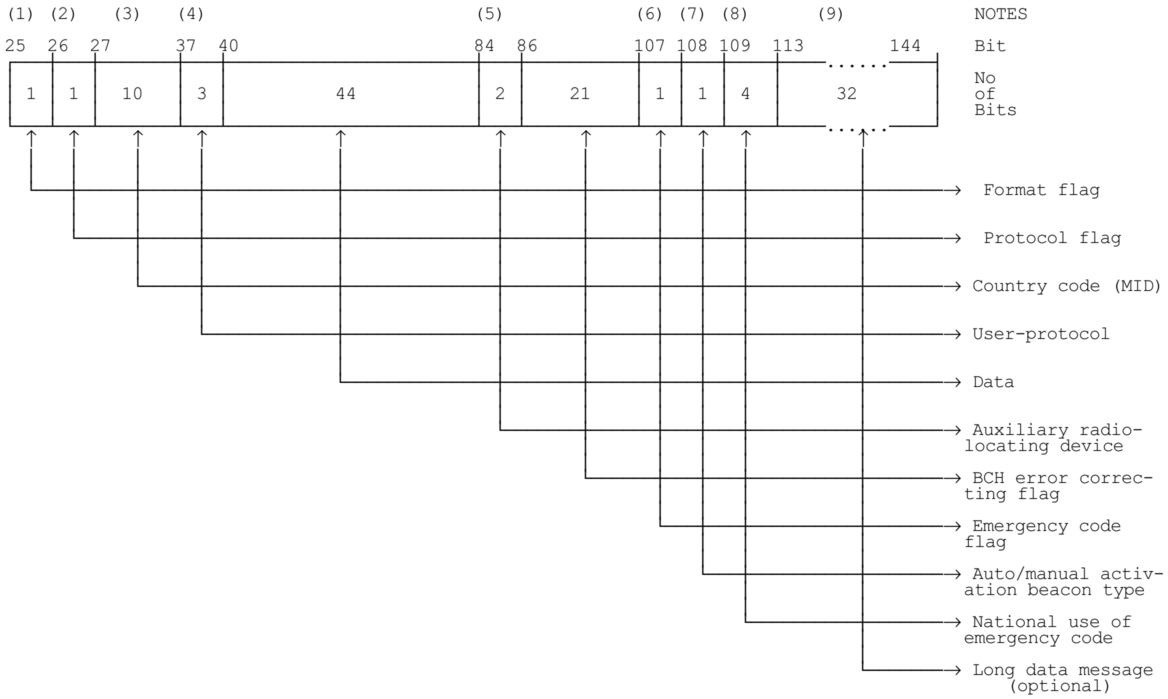
NOTE 1: Bit synchronisation - 15 "1" bits in all satellite EPIRBs.

NOTE 2: Frame synchronisation (for all satellite EPIRBs)
- 0 0010 1111 in normal operation
- 0 1101 0000 during on-air self test.

NOTE 3: Bits 25 through 112 form the basic satellite EPIRB coded information.

NOTE 4: Bits 113 through 144 contain supplementary information for the optional long message.

Figure 9: General message format



NOTE 1: "0" for short message and "1" for long message.

NOTE 2: Set to "1" for this format.

NOTE 3: Binary equivalent of the appropriate three digit decimal number (MSB on left). See subclause 12.2.2.

NOTE 4: Specific orbitography, aviation, maritime, serialised test or radio call-sign format (plus two spare formats).

NOTE 5: Specifies which auxiliary radio-locating device is incorporated in the beacon.

NOTE 6: "0" for national use or undesignated and "1" for emergency code use.

NOTE 7: "0" for manual activation only and "1" for automatic and manual type beacon.

NOTE 8: Four user-setable bits for national use or for emergency codes as in table 4.

NOTE 9: Optional data giving lattitude and longitude of beacon in degrees and minutes.

Figure 10: Unique data in the user protocols

b 25:	message format flag (0 = short message, 1 = long message)
b 26:	protocol flag (1 = user protocol)
b 27 - b 36:	Maritime Identification Digits (MID). Appendix 43 of the ITU Radio Regulations
	User Protocols (b 26 = 1) B 37 - B 39: user protocols type: 010 = Maritime 110 = radio call 111 = test
	Maritime user (b 37 - b 39 = 010) b 40 - B 75: SID or radio call sign (modified Baudot) b 76 - b 81: specific satellite EPIRB (modified Baudot) b 82 - b 83: 00 - spare
	b 84 - b 85: auxiliary radio-locating device type(s); 00 = no auxiliary radio locating device; 01 = 121,5 MHz (see NOTE 1); 10 = maritime locating: 9 GHz search and rescue radar transponder; 11 other auxiliary radio-locating device(s)
b 86 - b 106:	error-correcting code for b 25 - b 85
b 107:	emergency code use of b 100 - b 112 0 = national use undefined 1 = emergency code-flag
b 108:	0 = manual activation only type of satellite EPIRB; 1 = automatic and manual activation type of satellite EPIRB
b 109 - b 112:	nature of distress 0000 = unspecified distress 0001 = fire/explosion 0010 = flooding 0011 = collision 0100 = grounding 0101 = listing, in danger of capsizing 0110 = sinking 0111 = disabled and adrift 1000 = abandoning ship
NOTE 1 (relating to "b 84 - b 85" above): If other auxiliary radio-locating device(s) is (are) used in addition to 121,5 MHz, the code for 121,5 MHz (= 01) should be used.	b 113 - b 144: Optional Long Message for User Protocols b 113 - b 114: 00 = latitude/longitude flag; 01,10,11 = spares b 115 - b 121: latitude dagrees b 122 - b 127: latitude minutes b 128: 0 = north, 1 = south b 129 - b 136: longitude degrees b 137 - b 142: longitude minutes b 143: 0 = east, 1 = west b 144: even parity bit applied to b 113 - b 143

Figure 11: Summary of coding options

12.2 Protected field

The protected field consists of 61 bits (i.e. bit 25 through bit 85). The first bit (i.e. bit 25) is a format flag which shows whether the message is short or long using the following code:

0 - short format

1 - long format

The identification (ID) field which begins at bit 26 after the format flag and ends at bit 85 has the structure as given in table 1 following:

Table 1

Bits	Usage
26	protocol flag
27 - 36	MID number
37 - 85	data field

12.2.1 Protocol flag

Bit 26 in the ID field is used to identify the Maritime Protocol (bit 26 = 1).

12.2.2 MID number

Bits 27 to 36 in the ID field, designate the 3-digit decimal MID number expressed in a binary notation. These numbers are based on the Maritime Identification Digits (MID), assigned by the ITU from Appendix 43 of the Radio Regulations [3].

12.2.3 Maritime protocol

The maritime protocol has the structure as given in table 2 following:

Table 2

Bits	Usage
26	protocol flag (= 1)
27 - 36	MID number
37 - 39	user protocol type (= 010)
40 - 75	trailing 6 digits of ship station identity
76 - 81	specific satellite EPIRB
82 - 83	spare (= 00)
84 - 85	auxiliary radio-locating device

Bits 27 to 36 designate the country of vessel registration.

Bits 40 to 75 designate the radio call sign or the trailing 6 digits of the 9-digit ship station identity using the modified Baudot code shown in table 3. This code enables 6 characters (6 x 6 = 36) to be encoded using 36 bits. 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 ship station identity.

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

Table 3: Modified Baudot code

Letter	Code MSB LSB	Figure	Code MSB LSB
A	111000	(-)**	001000
B	110011		
C	101110		
D	110010		
E	110000	8	001100
F	110110		
G	101011		
H	100101	9	000011
I	101100	0	001101
J	111010	1	011101
K	111110	4	001010
L	101001	5	000001
M	100111	7	011100
N	100110	2	011001
O	100011	/	010111
P	101101	6	010101
Q	111101		
R	101010		
S	110100		
T	100001		
U	111100		
V	101111		
W	111001		
X	110111		
Y	110101		
Z	110001		
()*	100100		

NOTE: MSB: Most Significant Bit
LSB: Least Significant Bit
*: Space
**: Hyphen

12.3 Emergency code

The emergency code field consists of bits 107 to 112.

Bit 107 shall be (1) for the emergency code.

Bit 108 shall be (1) to indicate that the satellite EPIRB can be activated both manually and automatically.

When used, bits 109 to 112 shall be coded with the International Maritime Organisation (IMO) maritime emergency codes (Table 4) for all maritime distresses (i.e. maritime user protocol).

When the emergency code is not implemented, bit 107 shall be set to (0), and bits 109 to 112 shall all

be set to (0).

Table 4: Modified IMO maritime emergency codes[1)]

Code	Definition
0000	undesignated
0001	fire / explosion
0010	flooding
0011	collision
0100	grounding
0101	listing, in danger of capsising
0110	sinking
0111	disabled and adrift
1000	abandoning ship
1001	undesignated
1010	undesignated
1011	undesignated
1100	undesignated
1101	undesignated
1110	undesignated
1111	undesignated

12.4 Long message (optional)

The optional long message format permits the inclusion of an additional 32 bits of information in bit positions 113 through 144 of the data message.

Bits 113-114 define the 32 bit message encoding as follows:

00 - latitude/longitude flag;

01 - spare;

10 - spare;

11 - spare.

For the latitude/longitude message, bits 115 through 144 are decoded as given in table 5 following:

Table 5

Bits	Usage
115 - 121	degrees latitude
122 - 127	minutes latitude
128	0 = north; 1 = south
129 - 136	degrees longitude
137 - 142	minutes longitude
143	0 = east; 1 = west
144	even parity bit applied to bits 113 - 143

The message format flag (bit 25) should normally be set to = 0 and a short message be transmitted, however it should switch automatically to = 1 when data is entered in bits 113 to 144 for the long message

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

transmission. This will require two separate BCH codes: one for use with message format flag = 0 (short message format), and one for use with message format flag = 1 (long message format).

13 Release mechanism

13.1 General

The purpose of the release mechanism is to release the satellite EPIRB automatically if submerged in water when a ship capsizes or sinks.

The release mechanism shall be constructed of non-corroding and electrically compatible materials so as to prevent any deterioration which may cause any malfunction of the unit. Mechanical stress resulting from different thermal expansion coefficients, which could cause distortion in the material, shall be avoided. Galvanising or other forms of metallic coating on parts of the release mechanism shall not be accepted.

The release mechanism shall be constructed to prevent release when seas wash over the unit in normal ship deployment.

The release mechanism shall be designed to minimise the formation of ice and prevent the effects of ice from hindering the release of the EPIRB as far as is practicable.

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 activation.

It shall be possible to release the satellite EPIRB manually.

The release mechanism shall be capable of operating throughout the temperature range of - 30 °C to + 65 °C for Class 2, or - 40 °C to + 65 °C for Class 1.

13.2 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:

- type designation;

- instructions for the manual release of the satellite EPIRB;

- temperature range.

13.3 Practical tests

The satellite EPIRB installed in the automatic release mechanism shall be submerged in water.

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

History

Document history	
November 1992	First Edition
February 1996	Converted into Adobe Acrobat Portable Document Format (PDF)