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Maritime Personal Homing Beacon
intended for use on the frequency 121,5 MHz
for search and rescue purposes only;
Harmonised Standard covering the essential requirements
of article 3.2 of the Directive 2014/53/EU

Reference
REN/ERM-TG26-143

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Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

National transposition dates	
Date of adoption of this EN:	14 March 2016
Date of latest announcement of this EN (doa):	30 June 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 December 2016
Date of withdrawal of any conflicting National Standard (dow):	31 December 2017

Modal verbs terminology

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

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

1 Scope

The present document lays down the minimum requirements for maritime "Personal Homing Radio Beacon for 121,5 MHz search and rescue purposes", and incorporates the relevant provisions of the International Telecommunication Union (ITU) radio regulations.

Operational radio beacons described in the present document are intended only for transmission of radio signals on the frequency 121,5 MHz for locating purposes.

Beacons for training purposes will be frequency programmed in accordance with national licensing. It should be noted that licensing for such use is also dependent on the administration responsible for the waters where the equipment is operated and not the registered flag state.

The present document applies to radio beacons intended for short-range maritime personal homing applications. For this application, both the radiated power and the length of time of operation are reduced to enable the equipment to be sufficiently small and light to be worn comfortably at all times.

The present document also specifies technical characteristics, methods of measurement and required test results.

The present document contains requirements to demonstrate that "... *Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference*" [i.1].

2 References

2.1 Normative references

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

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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

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

[1] Recommendation ITU-R M.690-3 (03-2015): "Technical characteristics of emergency position-indicating radio beacons (EPIRBs) operating on the carrier frequencies of 121.5 MHz and 243 MHz".

[2] ETSI TS 103 052 (V1.1.1) (03-2011): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

2.2 Informative references

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

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

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] ETSI TR 100 028 (V1.4.1) (12-2001) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[i.3] ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

[i.4] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

dedicated antenna: removeable antenna supplied and tested with the equipment, designed as an indispensable part of the equipment

homing beacon: 121,5 MHz radio beacon primarily intended for transmitting homing signals

integral antenna: antenna designed to be connected to the equipment without the use of a 50 Ω external connector and considered to be part of the equipment

NOTE: An integral antenna may be fitted internally or externally to the equipment.

3.2 Symbols

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

cSt	centi-Stokes
dB	decibel
div	division
min	minutes
ppm	parts per million
S	seconds

3.3 Abbreviations

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

ASK	Amplitude Shift Keying
ASTM	American Society for Testing and Materials
CW	Continuous Wave
DF	Direction Finding
ERP	Effective Radiated Power
ERPEP	Effective Radiated Peak Envelope Power
EUT	Equipment Under Test
RF	Radio Frequency
VSWR	Voltage Standing Wave Ratio

4 General requirements

4.1 Construction

4.1.1 Common Requirements

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

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

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

The exterior of the equipment shall have no sharp edges or projections that 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 due to magnetic influences, handling, stowage and transit, whilst still providing a simple means of operation in an emergency.

The equipment shall be portable, lightweight, compact and be designed as one integral unit. The radio beacon shall derive its energy from a battery forming a part of the equipment and incorporate an integral or dedicated antenna which may be either fixed length or extendible.

The radio beacon may be fitted with a test facility by which the functioning of the transmitter and battery can be easily tested without the use of any external equipment.

The equipment shall be capable of being used by an unskilled person.

The radio beacon shall be watertight.

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

Necessary operating instructions shall be provided with the equipment.

4.1.2 Requirements for operational beacons

A substantial part of the equipment shall be of highly visible yellow or orange colour to assist visual location.

It shall not be possible for the user to change the frequency of operation from 121,5 MHz.

4.1.3 Requirements for training beacons

Beacons for training purposes shall not be substantially yellow or orange but shall be another clearly different colour.

It shall not be possible for the user to change the frequency of operation from the designated training frequency.

4.1.4 Categories of equipment

Two categories are defined:

- Category 1 radio beacons shall have sufficient positive buoyancy to float in fresh water.
- Category 2 radio beacons intended to be incorporated into or attached to a buoyancy device are not required to float.

The user manual or instructions for Category 2 beacons shall include necessary information to allow the user to fit or attach the beacon.

4.2 Controls

The equipment shall be initially activated by the use of two simple, but independent mechanical actions, neither of which on its own shall activate the equipment. The second mechanical action may be replaced by an immersion sensor. Where the second action is replaced by an immersion sensor then the first action shall be an arm function thus to ensure the device is armed for automatic activation when submerged.

It shall only be possible to activate the equipment after a seal or other mechanical restraint has been removed from the first mechanical action. After activation it shall be simple to de-activate the equipment and the means to deactivate the equipment shall be clearly marked.

The switch that operates any test facility (clause 4.1) shall be so designed that it returns automatically to the off-position when released.

4.3 Indicators

The equipment shall be provided with a visual indication that signals are being emitted. The indicator shall be sufficiently bright to be seen in bright sunlight. The indicator shall not be green in colour.

4.4 Labelling

4.4.1 Common Requirements

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

- frequency of operation of the equipment;
- serial number of the equipment;
- type designation of the equipment;
- adequate instructions to enable the equipment to be activated and de-activated;
- the type of battery as specified by the manufacturer of the radio beacon;
- the duty cycle (where a transmitting duty cycle of less than 100 % is used at any time);
- for Category 2 beacons a warning that this radio beacon does not float.

4.4.2 Requirements for operational beacons

For operational beacons the label shall additionally contain the following information:

- a warning to the effect that the radio beacon should 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.

4.4.3 Requirements for training beacons

Training beacons shall be clearly marked "for training use only".

4.5 Power source

4.5.1 Battery requirements

The type of battery and designation specified by the manufacturer for use in the equipment shall be clearly and indelibly marked on the equipment.

For operational beacons the battery shall be clearly and durably marked with the expiry date.

4.5.2 Safety precautions

Provisions shall be made for protecting the equipment from damage due to the accidental reversal of polarity of the battery.

5 Technical requirements

5.1 Radio beacon transmission characteristics

When activated, the radio beacon shall transmit continuously on the frequency 121,5 MHz (or the designated training frequency for training beacons) for at least 60 minutes, thereafter the transmitting duty cycle may be reduced to not less than 25 %.

Duty cycle shall be labelled on the device if less than 100 % after the first hour.

The class of emission shall be A3X as defined in Recommendation ITU-R M.690-3 [1]. However, the signal may include information of the identity of the beacon. If included, this information should be transmitted automatically as defined in clause 8.2.1.

5.2 Radio beacon power source

5.2.1 Battery requirements

The battery provided as a power source shall be a primary battery and have sufficient capacity to operate the equipment for an uninterrupted period of at least 6 hours, under all temperature conditions, (clause 6.5), within the requirements of the present document.

6 General conditions of measurement

6.1 Conformity Test frequencies

For the purpose of conformity testing all radiated measurements shall be performed in an anechoic chamber.

Radio beacons shall be tested on 121,5 MHz.

Beacons solely intended for training purposes shall be tested on their designated frequency.

6.2 Test fixture

In the case of integral antenna equipment, if the equipment does not have an internal permanent 50 Ω connector then it is permitted to supply a second sample of the equipment with a temporary antenna connector fitted to facilitate testing.

Where applicable, tests using this second sample shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load connected to the antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 Ω connector or the provider's specified test fixture shall not be greater than 1,5:1 over the frequency range of the measurement.

6.3 Test conditions power sources and ambient temperatures

6.3.1 Normal and extreme test conditions

Conformity testing shall be carried out under normal test conditions (clause 6.4) and also where stated under extreme test conditions (clauses 6.6.1 and 6.6.2 applied simultaneously).

6.3.2 Test power source

Where stated, the battery of the equipment shall be replaced by a test power source capable of producing normal (clause 6.4.2) and extreme test voltages as specified in clauses 6.6.2.1 and 6.6.2.2.

6.4 Normal test conditions

6.4.1 Normal temperature and humidity

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

- Temperature: +15 °C to +35 °C.
- Relative humidity: 20 % to 75 %.

6.4.2 Normal test voltage

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

6.5 Extreme test conditions

6.5.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the following procedure at the lower and upper temperatures of -20 °C and +55 °C respectively, except when installed within other equipment subject to more stringent temperature requirements, in which case the more stringent requirements shall apply.

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

Before tests are carried out, the equipment shall have obtained thermal balance in the test chamber and have been activated for a period of 5 minutes.

The location of the equipment under test in the climatic chamber shall not substantially influence the power output or the power consumption of the equipment under test.

6.5.2 Extreme test voltages

6.5.2.1 Upper extreme test voltage

The upper extreme test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that a fresh battery gives at the upper extreme temperature with a load equal to that of the equipment when activated.

6.5.2.2 Lower extreme test voltage

The lower extreme test voltage shall be determined in each case. The equipment fitted with a primary battery shall be placed in a climatic chamber and cooled to -20 °C allowing a stabilization period of 2 hours. The equipment shall then be activated for a period of 6 hours. After this period the battery voltage shall be measured. This voltage shall be taken as the lower extreme test voltage and shall be measured before disconnecting the battery.

7 Environmental tests

7.1 Introduction

The requirements of clause 7 demonstrate that the equipment is capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced on a ship in which it is carried.

7.2 Procedure

Environmental tests shall be carried out before tests in respect of the other requirements in the present document are performed on the same equipment. Environmental tests may be carried out in any order but the test specified in clause 7.13 shall always be carried out last so as to detect any damage to EUT's water seals caused by the other environmental tests.

7.3 Performance check

The term performance check as used in the present document shall be taken to mean a check of:

- Frequency error: the carrier frequency 121,5 MHz shall be measured with the equipment placed in the test fixture (clause 6.2). The frequency error shall not exceed ±10 ppm.
- Maximum effective radiated peak envelope power: the output power shall be measured with the equipment placed in the test fixture (clause 6.2). The measured power corrected with the reference factor (clause 8.4.3) shall be at least 25 mW.

The performance check shall be carried out only under normal test conditions unless otherwise stated.

7.4 Drop test

7.4.1 Definition

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

7.4.2 Test conditions

During the test, the equipment shall be fitted with a suitable set of batteries and antenna but it shall be switched off. The test shall be carried out under normal temperature and humidity conditions as detailed in clause 6.4.1.

The hard wooden test surface shall consist of a piece of solid hard wood with a minimum thickness of 15 cm and a mass of at least 30 kilograms.

The height of the lowest part of the equipment under test, relative to the test surface at the moment of release, shall be 1 m.

Equipment shall be subjected to this test in the configuration as it is normally used in operational circumstances.

7.4.3 Method of measurement

The test shall consist of six drops, once on each face.

Equipment that can be armed shall be armed before testing (see clause 4.2).

7.4.4 Requirements

After the drops have been completed the equipment shall be inspected visually for signs of damage. Inspection for mechanical damage, both internal and external, shall be carried out. Any damage shall not impair the operation of the equipment. In particular, parts like knobs, switches and the antenna shall operate in the normal manner. The act of dropping shall not cause the equipment to operate.

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

7.5 Temperature tests

7.5.1 Definition

The immunity against the effects of temperature is the ability of the 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.

7.5.2 Dry heat test

7.5.2.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The EUT and, if appropriate, any climatic control devices with which it is provided shall then be switched on. The temperature shall then be raised to and maintained at +55 °C (±3 °C). At the end of the period of 10 hours to 16 hours at +55 °C (±3 °C), the EUT shall be subjected to the performance check. The temperature of the chamber shall be maintained at +55 °C (±3 °C) during the whole of the performance check period. At the end of the test, the EUT shall be returned to normal environmental conditions or to those at the start of the next test.

7.5.2.2 Requirements

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

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

7.5.3 Damp heat test

7.5.3.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be raised to +40 °C (±2 °C), and the relative humidity raised to 93 % (±3 %) over a period of 3 hours ± 0,5 hours. These conditions shall be maintained for a period of 10 hours to 16 hours.

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

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

7.5.3.2 Requirements

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

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

7.5.4 Low temperature test

7.5.4.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be reduced to, and be maintained at, -15 °C (±3 °C) for a period of 10 hours to 16 hours. Any climatic control devices provided in the EUT may be switched on at the conclusion of this period. The EUT shall be switched on 30 minutes later, or after such period as agreed by the manufacturer, and shall be kept operational for at least 2 hours during which period the EUT shall be subjected to a performance check. The temperature of the chamber shall be maintained at -15 °C (±3 °C) during the whole of the test period. At the end of the test the EUT shall be returned to normal environmental conditions or to those required at the start of the next test.

Throughout the test the equipment shall be working normally.

7.5.4.2 Requirements

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

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

7.6 Vibration test

7.6.1 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.

7.6.2 Method of measurement

The equipment, complete with any detachable shock absorbers that are normally part of it (e.g. a life vest), 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.

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

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

- 2 Hz or 5 Hz and 13,2 Hz with an excursion of ±1 mm ± 10 %;
- 13,2 Hz and 100 Hz with a constant maximum acceleration of 7 m/s/s.

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

The test shall be repeated with vibration in each of the mutual perpendicular direction in the horizontal plane.

A performance check shall be carried out at least once during each endurance test period and once before the end of each endurance test period.

7.6.3 Requirements

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

The requirement for the performance check (clause 7.3) shall be met. No damage or mechanical deterioration shall be visible to the naked eye. The EUT if tested with a vibration absorber (e.g. a life jacket) shall not become detached.

7.7 Corrosion test

7.7.0 Applicability

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

7.7.1 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.

7.7.2 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 1.

Equipment that can be armed shall be armed before testing (see clause 4.2).

Table 1: 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 2 hours. 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.

7.7.3 Requirements

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

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.

7.8 Thermal shock test

7.8.1 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.

7.8.2 Method of measurement

The equipment shall be operational but not armed before testing (see clause 4.2).

The equipment shall be placed in an atmosphere of +65 °C (±3 °C) for 1 hour. It shall then be immersed in water at +4 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.

7.8.3 Requirements

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

The requirement for the performance check (clause 7.3) shall be met. No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water.

7.9 Buoyancy test

7.9.1 Definition

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

7.9.2 Method of measurement

The equipment shall be operational but disarmed before testing (see clause 4.2).

For Category 1 equipment the radio beacon shall be submerged in calm fresh water.

For Category 2 equipment the radio beacon and its buoyancy device shall be submerged in calm fresh water.

One of the following methods of measurement shall be used:

- the buoyant force shall be measured when the radio beacon 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 radio beacon. The result shall be recorded.

7.9.3 Requirements

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

The value of buoyancy shall be at least 5 %.

7.10 Compass safe distance test

7.10.1 Definition

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

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

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

7.10.2 Method of measurement

Equipment that can be armed shall be armed before testing (see clause 4.2).

The equipment shall be tested in the position and attitude relative to the compass or compass sensor at which the error produced at the compass would be a maximum (figure 1).

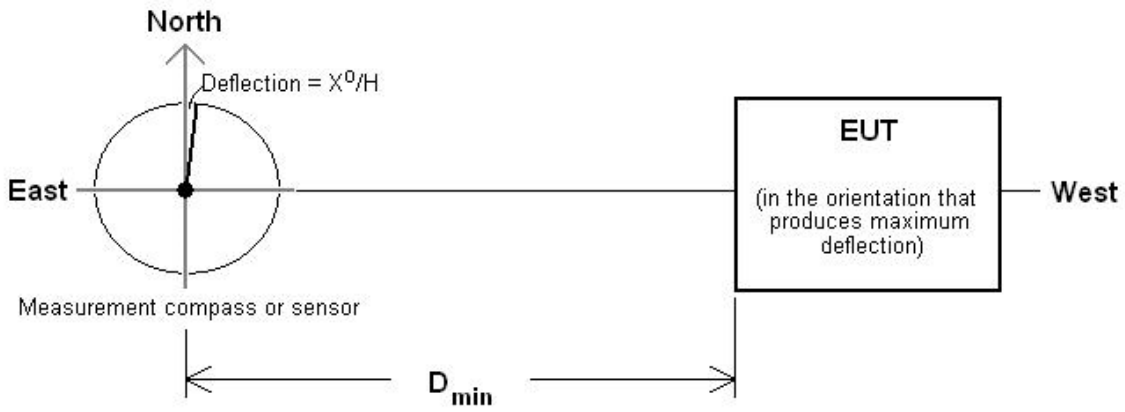

Figure 1: Compass safe distance test set up

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

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

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

7.10.3 Requirements

The minimum distance to obtain the required deflection D_{min} shall be recorded in the test report.

7.11 Solar radiation test

7.11.0 Applicability

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

7.11.1 Definition

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

7.11.2 Method of measurement

Equipment that can be armed shall be armed before testing (see clause 4.2).

The equipment shall be placed on a suitable support and exposed continuously to a simulated solar radiation source (table 2) for 80 hours.

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

Table 2: Spectral distribution

Spectral Region	Ultra-violet B	Ultra-violet A	Visible			Infra-red
Bandwidth {μm}	0,28 to 0,32	0,32 to 0,40	0,40 to 0,52	0,52 to 0,64	0,64 to 0,78	0,78 to 3,00
Radiance {W/m2}	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.						

7.11.3 Requirements

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

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

7.12 Oil resistance test

7.12.0 Applicability

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

7.12.1 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.

7.12.2 Method of measurement

Equipment that can be armed shall be armed before testing (see clause 4.2).

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 cSt to 25 cSt at 99 °C.

The following oils may be used:

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

7.12.3 Requirements

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

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

7.13 Protection of the transmitter

7.13.1 Definition

When operating, the locating device transmitter shall not be damaged due to antenna mismatching and shall remain water-tight.

7.13.2 Method of measurement

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

Saline solution of normal sea saltiness (see corrosion test in clause 7.7) shall be used.

With the transmitter operating, the equipment shall be completely immersed in water to a depth of 1 meter, measured from the highest point of the equipment to the surface of the water, for a period of 5 minutes. For equipment fitted with an extendible antenna, the test shall be carried out with the antenna fully extended, and repeated with the antenna fully retracted under normal test conditions.

7.13.3 Requirements

The test shall not cause the equipment to deactivate or operate spuriously.

No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water, and the requirements of the performance check (clause 7.3) shall be met.

8 Tests on the transmitter

8.1 Frequency error

8.1.1 Definition

The frequency error is the difference between the measured carrier frequency and its nominal value (clause 5.1).

8.1.2 Method of measurement

The carrier frequency shall be measured with the equipment placed in the test fixture (clause 6.2). The measurement shall be made using the test power source (see clause 6.3.2) under both normal and extreme test conditions.

8.1.3 Limit

The frequency error under normal conditions shall not exceed ±10 ppm, and under extreme test conditions shall not exceed ±15 ppm.

8.2 Modulation characteristics

8.2.0 General

The carrier shall be amplitude modulated with audio modulation interspersed with brief non-audio modulation. Non-audio modulation is used to support Direction Finding (DF) receivers and to transmit identity and position information data.

8.2.1 Modulation sequence

8.2.1.1 Definition

The modulation sequence comprises of cycles of audio and may include non-audio and data modulation as shown in figure 2.

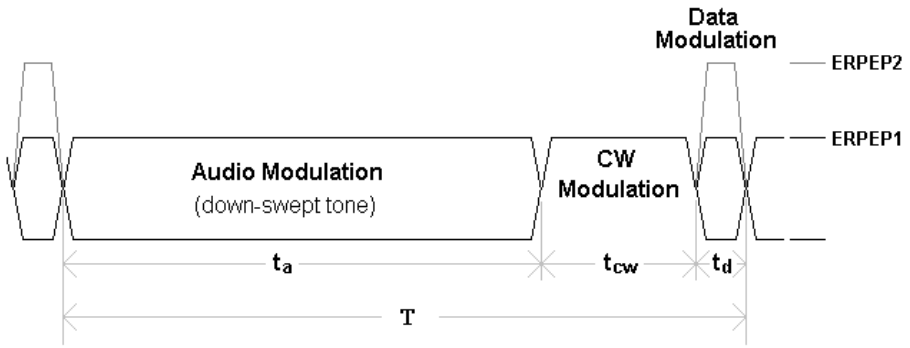

Figure 2

Continuous Wave (CW) modulation is non-audio modulation used to aid DF receivers in getting a bearing to target. CW is transmitted continuously at an average ERP approximately equal to the ERPEP of the audio modulation that it follows (ERPEP1 in figure 2).

Data modulation is non-audio modulation. It may be used to transmit information such as the identity and position of a radio beacon. Either ASK (A1D) or sub-carrier modulation shall be employed. Analog voice transmission (A3E) may also be used in this portion. The ERPEP of this transmitted portion (ERPEP2 in figure 2) may be significantly higher than used for the other modulation types in order to aid reception in a field where multiple beacons are transmitting simultaneously. The format for the transmission of data is not specified here. Note that the use of non-constant (randomized) values of T will assist in decoding of multiple beacons.

If data is replaced by voice transmission then the 0,5 second duration limit shall not apply, however the 80 % down swept tone portion of transmission shall be respected.

Audio modulation is mandatory whereas CW and data modulation are optional, however if all types are employed they shall always be in the sequence set out in figure 2.

8.2.2 Depth of audio modulation

8.2.2.1 Definition

The depth of modulation is calculated from the formula: $\frac{A-B}{A+B} \times 100\ \%$.

Where A and B are respectively the maximum and minimum value of the modulation envelope in figure 3.

8.2.3 Audio modulation duty-cycle

8.2.3.1 Definition

The modulation duty cycle is the ratio: $\frac{t_1}{t_2} \times 100\ \%$ 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, in figure 3.

8.2.4 Method of measurement

The modulation sequence timings (figure 1 t_a, t_{CW} and t_d), depth of modulation and the modulation duty cycle shall be measured with the radio beacon placed in the test fixture (clause 6.2). The demodulated signal is suitably applied to the input of a storage oscilloscope. A display of the type shown in figures 2 and 3 can be obtained on the storage oscilloscope. The modulation sequence timings are calculated as depicted in figure 2 with the storage scope timebase set to an appropriately long period (e.g. 5 S /div). Where the measurement of t_d is not practical due to the relative position of the data burst the manufacturer shall supply suitable equipment to decode the data burst such that the value of t_d may be determined. The modulation duty cycle and the depth of modulation are calculated as depicted in figure 3 with the storage scope timebase set to an appropriate period (e.g. 250 uS /div).

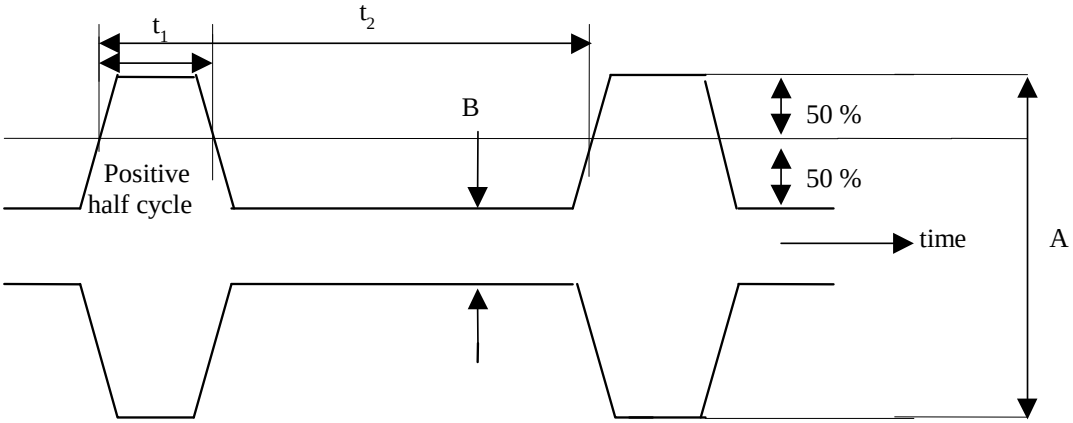

Figure 3

Audio modulation proportion: $\frac{t_a}{T} \times 100\ \%$

Audio modulation depth: $\frac{A-B}{A+B} \times 100\ \%$

Audio modulation duty cycle: $\frac{t_1}{t_2} \times 100\ \%$

Where data modulation is employed at least two consecutive modulation sequence periods shall be measured and compared and the difference ΔT shall be calculated.

NOTE: Low modulation duty cycle may occur by over-modulation.

8.2.5 Limits

The audio modulation proportion shall be at least 80 % of the overall cycle time T.

The depth of audio modulation shall be at least 85 %.

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

The period of CW modulation t_{CW} (if employed) shall be between 1 second and 5 seconds.

The data modulation period t_d (if employed) shall be no more than 0,5 seconds for a data transmission.

If data modulation is employed ΔT shall be greater than t_d.

8.2.6 Audio sweep characteristics

8.2.6.0 General

The audio part of modulation shall be a down-swept tone.

8.2.6.1 Audio sweep range

The audio sweep range is defined by the upper and lower frequencies with which the carrier is amplitude modulated.

8.2.6.2 Audio sweep repetition rate

The sweep repetition rate is defined as the rate at which the audio sweep is repeated.

8.2.6.3 Method of measurement

The sweep range and repetition rate shall be measured with the radio beacon placed in the test fixture (clause 6.2). The emission shall be applied to the input of a suitable receiver or analyser. If a spectrum analyser is used, it shall be tuned to the emission centre frequency and with the following settings:

- Resolution bandwidth: 30 kHz;
- Frequency span: 0 Hz;
- Vertical scale: Linear.

The reference line shall be set as close to full scale deflection as practicable. The video output of the spectrum analyser shall be applied to the input of a digital storage oscilloscope. The oscilloscope shall have deep memory capability (in the order of 50 000 samples) such that a complete sweep cycle can be captured without losing waveform detail.

8.2.6.4 Limits

The sweep shall be downwards (high frequency to low frequency).

The highest frequency shall not exceed 1 600 Hz.

The lowest frequency shall be greater than 300 Hz.

The total swept range shall be at least 700 Hz.

The sweep repetition rate shall be between 2 Hz and 4 Hz.

8.3 Spectral carrier power ratio

8.3.1 Definition

The spectral carrier power ratio is the ratio of the total power of the emission to the power centred on the carrier in a specified bandwidth, both measurements taken under normal audio modulated conditions.

8.3.2 Method of measurement

The measurement shall be performed under normal test conditions with the radio beacon placed in the test fixture (clause 6.2).

The manufacturer shall supply a sample with only audio modulation.

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

- Resolution bandwidth: 10 kHz;
- Video filter: off;
- Scan time: 100 ms/division (div);
- Centre frequency: Carrier frequency as measured in clause 8.1.

The total power is determined by noting the power measured from the amplitude reading on the spectrum analyser expressed in logarithmic form and adding it to the modulation duty cycle previously measured and converted to a figure in dB, i.e. 10 $\log_{10}$ (spectrum analyser power) +10 $\log_{10}$ (t_1/t_2) using relevant units. (For the definition of t_1 and t_2 see figure 3).

To determine the power in the specified bandwidth, the preferred spectrum analyser settings are as follows:

- Resolution bandwidth: 100 Hz or less;
- Video filter: off;
- Scan time: 10 s/div;
- Centre frequency: Carrier frequency as measured in clause 8.1.

The power in the specified bandwidth is determined from the amplitude reading on the spectrum analyser.

The difference between the total power and the power in the specified bandwidth in dB is the spectral carrier power ratio.

8.3.3 Limit

The spectral carrier power ratio shall be less than 5,2 dB.

8.4 Maximum Effective Radiated Peak Envelope Power (ERPEP)

8.4.1 Definition

The maximum ERPEP 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 of audio modulation (ERPEP1 in figure 2).

The measurements shall be made under normal test conditions and under extreme test conditions.

8.4.2 Method of measurement under normal test conditions

On a test site selected from clause 5 of ETSI TS 103 052 [2], the equipment shall be placed in the standard test position as defined in clause 6.8 of ETSI TS 103 052 [2]; for equipment intended to be worn on a person a simulated man shall be used as the support. The equipment shall then be activated. Note that beacons operating on 121,5 MHz shall not be tested using an open area test site, but an alternative site as defined in clause 5.2 of ETSI TS 103 052 [2] shall be used.

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 as defined in clause 5.3.2 of ETSI TS 103 052 [2].

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

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

The input attenuator setting of the measuring 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 noted to that 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.

8.4.3 Method of measurement under extreme test conditions

The equipment shall be placed in the test fixture (clause 6.2) connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.3.2).

The measurement shall be made under normal test conditions initially with the equipment on the support in the standard position (annex A or clause A.4 for equipment intended to be worn on a person) to enable a reference measurement to be made. This enables a reference factor to be determined. The measurement shall be repeated with the test fixture placed in the chamber under extreme test conditions (clause 6.5).

8.4.4 Limit

The ERPEP shall be at least 25 mW, and not more than 500 mW.

8.5 Effective Radiated Power during CW modulation (ERP(CW))

8.5.1 Definition

The ERP(CW) is defined as the ERP in the direction of maximum field strength under specific conditions of measurement during the CW transmission.

The measurements shall be made under normal test conditions.

8.5.2 Method of measurement under normal test conditions

The equipment shall be placed in the test fixture (clause 6.2) connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.3.2).

The measurement of ERPEP shall be made under normal conditions with only audio modulation to give a reference level. A measurement of the average power at the artificial load under the same conditions with only CW modulation will then be made.

8.5.3 Limit

The ERP(CW) shall equal ERPEP within ±3 dB.

8.6 Transmitter spectrum mask

8.6.1 Definition

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

8.6.2 Method of measurement

The equipment shall be placed in the test fixture (clause 6.2) connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.3.2).

The measurement shall be made under normal test conditions.

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

- Resolution bandwidth: 3 kHz;
- Video filter: off;
- Scan bandwidth: 150 KHz;

- Centre frequency: Carrier frequency as measured in clause 8.1;
- Detector type: Peak hold.

At least 10 minutes of emissions shall be measured and a reference carrier power calculated as being the maximum power within the frequency limits set in clause 8.1.3. The emission profile shall then be normalized so that the reference carrier power is set to 0 dBc. The result is compared to the mask given in figure 4.

The modulation sequence and the data content (if employed) during the test shall be representative of normal operation.

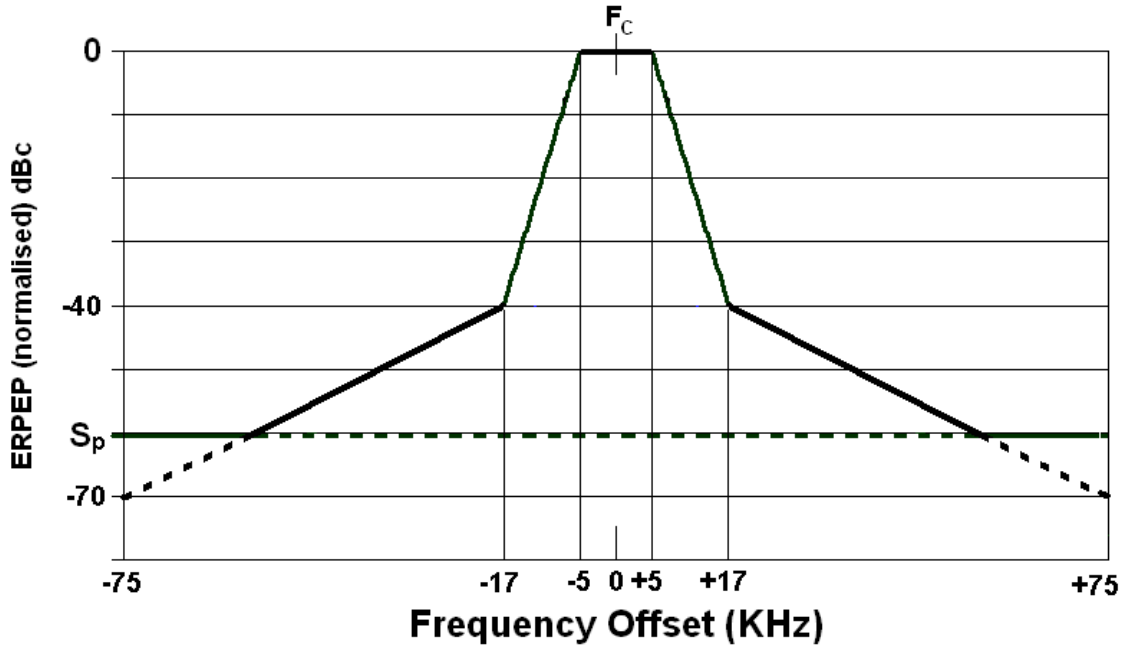

Figure 4

The mask comprises a set of straight lines determined as follows:

A straight line from (-75 KHz, -70 dBc) to (-17 KHz, -40 dBc), a straight line from (-17 KHz, -40 dBc) to (-5 KHz, 0 dBc), a straight line from (-5 KHz, 0 dBc) to (+5 KHz, 0 dBc), a straight line from (+5 KHz, 0 dBc) to (+17 KHz, -40 dBc), a straight line from (+17 KHz, -40 dBc) to (+75 KHz, -70 dBc). Where the mask falls below the line S_p then the line S_p shall be used as the mask.

S_p is the normalized spurious emission limit (clause 8.8.3): S_p = -37 - ERPEP (as measured in clause 8.4.2) dBc.

8.6.3 Limit

The normalized emission profile shall not exceed the mask of figure 4.

8.7 Radiation produced by operation of the test facility

8.7.1 Definition

Radiation produced by operation of the test facility is the radiation at the nominal frequencies when the equipment is being tested.

8.7.2 Method of measurement

The radio beacon shall be tested with the switch in the test position.

The method of measurement described in clause 8.4 shall be used, however, the test shall be performed at normal test conditions only.

The transmitter shall be rotated in all directions until the maximum radiation is detected.

8.7.3 Limit

The test facility provided to indicate the correct functioning of the radio beacon shall not produce an ERPEP greater than 5 uW.

8.8 Spurious emissions

8.8.1 Definition

Emission(s) 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.

8.8.2 Method of measurement

On a test site selected from clause 5 of ETSI TS 103 052 [2], the equipment shall be placed in the standard test position as defined in clause 6.8 of ETSI TS 103 052 [2]; for equipment intended to be worn on a person a simulated man shall be used as the support. The equipment shall then be activated. Note that beacons operating on 121,5 MHz shall not be tested using an open area test site, but an alternative site as defined in clause 5.2 of ETSI TS 103 052 [2] shall be used.

The method of measurement described in clause 8.4 shall be used to search for spurious emissions in the frequency band 30 MHz to 2 GHz, excluding the frequency band tested in clause 8.6.

The measuring receiver shall have a bandwidth of 100 kHz to 120 kHz.

The measurement shall only be performed under normal test conditions, the radio beacon being rotated until the maximum emission is detected. The measurement is made for all modulation types in the modulation sequence (clause 8.2.1). The measurement is then made for test transmission (clause 8.7.1). The measurement is also made when the radio beacon has been activated or armed but is not transmitting.

8.8.3 Limit

The power of any spurious emission component when transmitting shall not exceed 0,2 μW.

The power of any spurious emission component when not transmitting shall not exceed 2 nW between 30 MHz and 1 GHz and 20 nW between 1 GHz and 2 GHz.

8.9 Duty Cycle

8.9.1 Definition

For the purposes of the present document the term duty cycle refers to the ratio of the total transmitted on-time to the total time in any one hour period.

8.9.2 Declaration

It shall be declared whether the device once triggered, follows a pre-programmed cycle, or whether the transmitter remains on continuously until the device is deactivated.

Where the equipment reduces the duty cycle after the first 60 minutes from activation then the declaration shall also include the actual duty cycle employed for the remainder of the transmission.

8.9.3 Limits

The duty cycle requirements of clause 5.1 shall be met.

9 Testing for compliance with technical requirements

9.1 Environmental conditions for testing

These shall be as described clause 6.

9.2 Interpretation of the measurement results

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

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 3.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.2], in particular in annex D of the ETSI TR 100 028-2 [i.3].

Table 3 is based on such expansion factors.

Table 3: Absolute measurement uncertainties: maximum values

Parameter	Maximum uncertainty
RF frequency	$\pm 1 \times 10^{-7}$
Radiated emission of transmitter	±6 dB
Conducted RF power variations using a test fixture	±0,75 dB
Modulation depth	±5 %
Modulation duty cycle	±5 %
Spectral carrier power ratio	±0,75 dB
Audio frequency	±5 %
Sweep repetition rate	±5 %

Annex A (normative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 302 961 The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.1]				
Requirement			**Requirement Conditionality**	
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**
1	Transmitter frequency error	8.1	U	
2	Modulation characteristics	8.2	U	
3	Spectral carrier power ratio	8.3	U	
4	Maximum Effective Radiated Peak Envelope Power (ERPEP)	8.4	U	
5	Effective Radiated Power during CW modulation (ERP(CW))	8.5	U	
6	Transmitter spectrum mask	8.6	U	
7	Radiation produced by operation of the test facility	8.7	U	
8	Spurious emissions	8.8	U	
9	Duty cycle	8.9	U	

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Clause Number Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the manufacturers claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

History

Document history		
V1.2.1	July 2013	Publication as ETSI EN 302 961 part 1 and part 2
V2.1.0	December 2015	EN Approval Procedure AP 20160313: 2015-12-14 to 2016-03-14
V2.1.1	March 2016	Publication