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Technical Specification

Electromagnetic compatibility and Radio Spectrum Matters (ERM); Maritime Very High Frequency (VHF) distress radio equipment operating on aeronautical frequencies

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio Spectrum Matters (ERM).

1 Scope

The present document gives guidance on minimum technical limits for maritime two-way Very High Frequency (VHF) radiotelephone apparatus for communications between ships in distress and rescuing aircrafts. The report incorporates relevant provisions of the ITU Radio Regulations [1], of the International Convention for the Safety Of Life At Sea (SOLAS) [2], relevant Assembly Resolutions and of Annex 10 to the ICAO Convention [3].

The maritime VHF equipment described in the present document is intended for communications on the aeronautical frequencies 121,5 MHz and 123,1 MHz for distress and safety purposes.

The present document is applicable to portable and fixed installed equipment.

The intention of the present document is to define equipment that in all respects have mechanical and electrical design, construction and finish in conformance with good engineering practice and that is suitable for use on board ships at sea in distress situations.

2 Normative references

The present document incorporates by dated or undated reference provisions from other publications. These normative references are citied at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent reference to, or revision of any of these publications apply to the present document only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] ITU Radio Regulations.

[2] IMO International Convention for the Safety Of Life At Sea (SOLAS).

[3] ICAO Convention on International Civil Aviaton, annex 10.

[4] ETS 300 225: "Technical characteristics and methods of measurement for survival craft portable VHF radiotelephone apparatus".

[5] ISO/Recommendation 694 : "Positioning of magnetic compasses in ships".

[6] EUROCAE ED-14C: "Environmental conditions and test procedures for airborne equipment".

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

3 Definition, symbols and abbreviations

3.1 Definition

For the purposes of the present document, the following definition applies:

SINAD Signal + Noise + Distortion / Noise + Distortion

3.2 Symbols

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

A3E amplitude modulation with double sideband and full carrier
dBA acoustic level in dB relative to 2×10^{-5} Pa
dBi antenna gain in dB relative to isotropic radiation

3.3 Abbreviations

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

emf	electromotive force
pep	peak envelope power
RF	Radio Frequency
rms	root mean square
VHF	Very High Frequency

4 General requirements

4.1 Construction

Portable equipment shall in one unit comprise at least transmitter, receiver, antenna, battery, operating controls including press-to-transmit switch, microphone and loudspeaker.

For portable equipment, the antenna gain shall be at least -10 dBi.

Equipment intended for fixed installations shall have an 50 Ω RF socket.

Portable equipment shall be of small size and light in weight.

The equipment shall have a colour which distinguishes it from the portable VHF equipment specified in ETS 300 225 [4].

The equipment shall be operational within five seconds of switching on.

Any part of the equipment required to be checked during inspection or maintenance operations as laid down by the manufacturer, shall be readily accessible.

4.2 Controls

The number of controls shall be the minimum necessary for simple operation. With the possible exception of channel selection, it shall be possible to operate the equipment using only one hand.

The equipment shall be provided with an on-off switch and a visual indication that the equipment is switched on.

The equipment shall be provided with a manual volume control by which the audio output may be varied.

The press-to-transmit switch shall be non-locking and return to standby (receive) mode when released. The time necessary to change from transmission to reception, or vice versa, shall not exceed 0,3 s.

The equipment shall have a channel selector and shall clearly indicate which frequency the equipment is set to. The channel switching arrangement shall be such that the time necessary to change from one frequency to the other does not exceed five seconds. It shall not be possible to transmit during channel switching operations. Independent selection of transmitting and receiving frequencies shall not be possible. In the transmission mode, the output of the receiver shall be muted.

If the equipment includes a test facility, the switch which operates this facility shall be so designed that it automatically returns to normal position when released.

4.3 Operating frequencies

The equipment shall be capable of operating on the single frequency channels 121,5 MHz and 123,1 MHz only, with manual control (simplex).

The equipment shall operate with class of emission A3E (Amplitude modulation with double side band and full carrier).

4.4 Labelling

The labels on the equipment shall be permanently fixed to the exterior of the equipment.

All controls and indicators shall be clearly labelled.

The labelling shall at least comprise the following information:

- text containing the words: "Only for emergency communications with aircraft";
- brief operating instructions;
- type designation of the equipment and serial number;
- expiry date for any primary batteries;
- for portable equipment, compass safe distance, according to ISO Recommendation 694 [5] or EUROCAE ED-14C [6], section 15.0.

4.5 Battery

For portable equipment, the source of energy shall be a primary battery that may be replaceable by the user without the use of special tools and without degrading the performance of the equipment. In addition, provisions may be made to operate the equipment using an external source of electrical energy.

Fixed radio installations shall be powered from the ship’s main source of electrical energy. In addition, it shall be possible to operate the installation from an alternative source of electrical energy. Alternatively, the source of energy may be a primary battery integrated in the equipment and may be replaceable by the user.

Primary batteries shall have a shelf life of at least two years.

Provisions shall be made for protecting the equipment from damage due to accidental reversal of the polarity of the battery or of any external power supply.

The capacity of the primary battery shall be sufficient to operate the equipment continuously for at least 10 hours at any temperature condition (see subclause 5.4.1) with the following duty cycle:

- six seconds transmit without modulation followed by;
- six seconds reception with an RF input signal at the nominal frequency of the receiver at a level of +60 dBµV using normal test modulation (subclause 6.4) with the audio volume control set to give minimum 200 mW output power; followed by ;
- 48 seconds reception without input signal under muted condition (operational squelch condition).

5 Test conditions, power sources and ambient temperatures

5.1 Determination of lower extreme test voltage

When determining the lower extreme test voltage, the battery voltage shall be measured at the end of the duration test. During the duration test, when activated, the transmitter shall be modulated to give maximum output power peak envelope power (pep) at 100 % modulation. However, this measurement would require an acoustic modulation signal and is complicated to perform. This test shall therefore be performed with no modulation (unmodulated carrier) of the transmitter during the periods when the transmitter shall be activated and it is estimated that an eight hours duration test with the transmitter modulated to 100 % modulation depth corresponds to a 10 hours duration test with the transmitter keyed without modulation for the following duty cycle:

- six seconds transmission followed by:
- six seconds reception with an RF input signal at the nominal frequency of the receiver at a level of +60 dBµV using normal test modulation (subclause 6.4) with the audio volume control set to give minimum 200 mW output power; followed by;
- 48 seconds reception without input signal under muted condition (operational squelch condition).

5.2 Normal and extreme test conditions

Testing of the equipment shall be made under normal test conditions and also, where stated, under extreme test conditions.

5.3 Test power source

During testing, the equipment shall be supplied from a test power source capable of producing normal and extreme test voltages as specified in subclauses 5.4.2 and 5.5.2. The effect of the test power source on the measurements shall be negligible. The power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of ±3 % relative to the voltage level at the beginning of each test.

5.4 Normal test conditions

5.4.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be a combination of temperature and humidity within the following limits:

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

5.4.2 Normal power source

For portable equipment, the normal test voltage shall be the nominal voltage of the battery as declared by the manufacturer.

For fixed installation equipment, the normal test voltage shall be the nominal mains voltage. The frequency of the test voltage shall be 50 Hz ± 1 Hz.

5.5 Extreme test conditions

5.5.1 Extreme temperatures

5.5.1.1 Upper extreme temperature

Tests at the upper extreme temperature shall be made at a temperature of +55°C.

5.5.1.2 Lower extreme temperature

Tests at the lower extreme temperature shall be made at a temperature of -20°C.

5.5.2 Extreme test power supply values

5.5.2.1 Upper extreme test voltage

For portable equipment, the upper extreme test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that the battery gives at the upper extreme temperature at the beginning of the battery test cycle with a load equal to that of the equipment in the muted receive condition.

For fixed installation equipment, the upper extreme test voltage shall be the nominal mains voltage +10 %. The frequency shall be 50 Hz ± 1Hz.

5.5.2.2 Lower extreme test voltage

The equipment fitted with an unused primary battery shall be placed in a climatic chamber and cooled to -20°C allowing a stabilization period of two hours. The equipment shall be activated as described in subclause 4.5. After this test the battery voltage shall be measured during equipment transmission. This voltage shall be taken as the lower extreme test voltage, and shall be measured before disconnecting the load.

For fixed installation equipment, the lower extreme test voltage shall be the nominal mains voltage -10 %. The frequency shall be 50Hz ± 1Hz.

5.6 Procedure for tests at extreme temperatures

The equipment shall be switched off during the temperature-stabilizing periods.

Before conducting tests at the upper temperature, the equipment shall be placed in the test chamber and left until thermal equilibrium is reached. The equipment shall then be switched on for half an hour during which the transmitter shall be keyed with a duty cycle of five minutes transmission and five minutes reception.

For tests at the lower temperature, the equipment shall be left in the test chamber until thermal equilibrium is reached and shall then be switched to the standby or receive position for one minute.

6 General conditions of measurement

6.1 Test connections

For the purpose of testing, the equipment shall be provided with suitable connections to test points within the equipment or suitable test fixture, which allow easy access to:

- the transmitter output (for 50 Ω connection);
- the receiver input (for 50 Ω connection);
- the transmitter audio input(s);
- the receiver audio output(s);
- the push-to-talk switch;
- power supply input.

6.2 Arrangements for test signals applied to receiver input

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

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

The effects of any intermodulation product and noise product in the test signal generators shall be negligible.

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

6.3 Squelch

Unless otherwise stated, the receiver squelch facility, if any, shall be made inoperative for the duration of the conformance tests.

6.4 Normal test modulation

For signals applied to the receiver, the normal test modulation frequency shall be 1 kHz and the modulation depth shall be 30 %, unless otherwise stated.

6.5 Artificial antenna

When tests are conducted with an artificial antenna, this shall be a 50 Ω non-reactive, non-radiating load.

6.6 Test channel

Tests shall be made on 123,1 MHz, unless otherwise stated. When testing on 121,5 MHz, care shall be taken to avoid radiation that could cause false distress alerts.

6.7 Measurement uncertainty and interpretation of the measuring results

6.7.1 Measurement uncertainty

Table: 1

Absolute measurement uncertainties: maximum values	
RF frequency	$\pm 1 \times 10^{-7}$
RF power	±0,75 dB
Audio output power	±0,5 dB
Sensitivity at 12 dB SINAD	±3 dB
Two signal measurement	±4 dB

For the test methods according to the present document the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028 [7].

6.7.2 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 limits of the present document;
- the measurement uncertainty value 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 maximum values given above.

7 Environmental tests

7.1 Introduction

The tests in this clause are performed in order to simulate the environment in which the equipment is intended to operate.

7.2 Procedure

Environmental tests shall be carried out before tests of the same equipment in respect to the other limits of this specification are performed. The following tests shall be carried out in the order they appear in this clause.

Unless otherwise stated, the equipment shall be connected to an electrical power source only during the periods for which it is specified that electrical tests shall be carried out. These shall be done with normal test voltage.

7.3 Performance check

The term performance check shall be taken to mean an inspection to check if there is any visible damage or deterioration and the following measurements:

For the transmitter:

> Carrier frequency and output power. The transmitter shall be set to 123,1 MHz and activated without modulation. The carrier frequency shall be within ±2,0 kHz of the nominal carrier frequency. For fixed installation equipment, the carrier power shall be between 50 mW and 200 mW. For portable equipment, the carrier output power shall be between 50 mW and 200 mW as corrected by the declared antenna gain, c.f. subclause 4.1.

For the receiver:

> Maximum usable sensitivity. The receiver shall be set to 123,1 MHz and a normal test signal shall be applied to the receiver input. The level of the input signal shall be adjusted until the Signal + Noise + Distortion / Noise + Distortion (SINAD) at the output of the receiver is 12 dB and the output power at least 200mW. The level of the input signal shall be less than +30 dBµV.

7.4 Drop test on hard surface

This test is applicable only for portable equipment.

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 Method of measurement

The test shall consist of a series of six drops, one on each surface of the equipment. 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.

The hard wooden test surface shall consist of a piece of solid hard wood with a thickness of minimum 15 cm and a mass of 30 kg or more.

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.

If the equipment is intended to be used with external accessories, for example, a separate microphone and/or loudspeaker, the test shall be carried out for those accessories separately.

Following the test, the equipment shall be subjected to a performance check.

7.4.3 Limit

The limit for the performance check shall be met.

7.5 Vibration test

7.5.1 Method of measurement

For portable equipment, the equipment with any accessory for storing, shall be clamped to the vibration as it is intended to be stored on board a ship.

Equipment for fixed installations shall be clamped to the vibration table in its intended normal installation attitude.

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

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

The frequency sweep rate shall be slow enough to allow detection of resonances in any part of the equipment.

A resonance search shall be carried out throughout the test. If any resonance of the equipment with Q greater than or equal to 5 relative to the base of the vibration table is measured, the equipment shall be subjected to a two hour vibration endurance test at each of the found resonance frequencies at the level specified above. If no resonance with Q greater than or equal to 5 occurs, the two hour endurance test shall be carried out at the frequency 30 Hz with acceleration 7 m/s^2.

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

The procedure shall be repeated with vibration in each of the two mutually perpendicular directions in the horizontal plane.

After conducting the vibration tests, the equipment shall be inspected for any mechanical deterioration.

7.5.2 Limits

The limit for the performance check shall be fulfilled.

There shall be no visible deterioration of the equipment.

7.6 Temperature tests

7.6.1 General

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

7.6.2 Dry heat cycle

7.6.2.1 Method of measurement

The equipment shall be placed in a chamber of normal temperature. The temperature shall then be raised to and maintained at +65°C (±3°C) for a period of at least 10 hours. After this period any climatic control device provided in the equipment may be switched on and the chamber cooled to 55°C (±3°C). The cooling of the chamber shall be completed within 30 minutes.

The equipment shall then be switched on and shall be kept working continuously for a period of two hours. The transmitter shall be keyed with a duty cycle of five minutes transmission and five minutes reception. The equipment shall be subjected to a performance check during the two hour period.

The temperature of the chamber shall be maintained at +55°C (±3°C) during the two hour period.

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

7.6.2.2 Limit

The limit for the performance check shall be fulfilled.

7.6.3 Damp heat cycle

7.6.3.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature and humidity which, steadily, over a period 3 (±0,5) hours, shall be heated from room temperature to +40°C (±3°C) and shall during this period be brought to a relative humidity of 93 % (±2 %) so that excessive condensation is avoided. These conditions shall be maintained for a period of at least 10 hours.

30 minutes later the equipment shall be switched on, and shall then be kept working continuously for a period of two hours. The transmitter shall be keyed with a duty cycle of five minutes transmission and five minutes reception.

The equipment shall be subjected to a performance check during the two hour period.

The temperature and relative humidity of the chamber shall be maintained at +40° ±3°C and 93 % ±2 % during the two hour, 30 minute period.

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

7.6.3.2 Limit

The limit for the performance check shall be fulfilled.

7.6.4 Low temperature cycle

7.6.4.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. Then the temperature shall be reduced to, and maintained at, -25°C (±3°C) for a period of at least 10 hours.

The chamber shall be warmed up to - 20°C (±3°C). The warming of the chamber shall be completed within 30 (± five) minutes.

The temperature of the chamber shall be then maintained at - 20°C (±3°C) during a period of one hour 30 minutes.

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

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

Throughout the test the equipment shall be in the receive condition.

7.6.4.2 Limit

The limits for the performance check shall be fulfilled.

8 Transmitter

8.1 Carrier power

8.1.1 Definition

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

8.1.2 Method of measurement

The transmitter shall be connected to an artificial antenna (subclause 6.5) and activated without modulation. The power delivered to the antenna shall be measured.

The measurement shall be made on both 121,5 MHz and 123,1 MHz, and under normal test conditions and also under extreme test conditions.

8.1.3 Limit

For fixed installation equipment, the carrier power shall be between 50 mW and 200 mW.

For portable equipment, the carrier power shall be between 50 mW and 200 mW as corrected by the declared antenna gain, c.f. subclause 4.1.

8.2 Frequency error

8.2.1 Definition

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

8.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna (subclause 6.5) and activated without modulation. The carrier frequency shall be measured under normal test conditions and also under extreme test conditions.

8.2.3 Limit

The frequency error shall be less than ±2 kHz.

8.3 Sensitivity of the transmitter modulator

8.3.1 Definition

The sensitivity of the transmitter modulator including microphone is the sound level that produces 70 % depth of modulation at the transmitter output when applied to the microphone.

8.3.2 Method of measurement

An acoustic signal with a frequency of 1 kHz and a level of 94 dBA ± 3dB at the microphone shall be applied and the depth of modulation at the transmitter output shall be measured.

8.3.3 Limit

The transmitter depth of modulation shall be at least 70 %.

8.4 Conducted spurious emissions conveyed to the antenna

8.4.1 Definition

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

8.4.2 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna (subclause 6.5).

The measurements shall be made over the range from 9 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

The measurements for each spurious emission shall be made using a selective measuring devices such as a tuned radio measuring instrument or a spectrum analyser.

8.4.3 Limit

The power of any conducted spurious emission on any discrete frequency shall not exceed 0,25 μW.

9 Receiver

9.1 Harmonic distortion and audio frequency output power

9.1.1 Definition

The harmonic distortion at the receiver output is defined as the ratio, expressed as a percentage, of the total root mean square (rms) voltage of all the harmonic components of the modulation audio frequency to the total rms voltage of the signal delivered by the receiver.

The audio-frequency output power is the maximum power available at the output, for which the harmonic distortion is below a certain level.

9.1.2 Method of measurement

A signal with normal test modulation (subclause 6.4) at a level of +120 dBμV at 123,1 MHz of the receiver shall be applied to the receiver input.

The output of the receiver shall be replaced with a resistive load simulating the receiver's operating load.

The harmonic distortion and output power shall be measured.

The audio frequency volume control of the receiver shall be set so as to obtain a harmonic distortion of 10 %.

9.1.3 Limit

The audio frequency output power shall be at least 200 mW.

9.2 Maximum usable sensitivity

9.2.1 Definition

The maximum usable sensitivity of the receiver is the minimum level of the RF signal at the nominal frequency of the receiver which, when applied to the receiver input with normal test modulation will produce an audio frequency output power equal to at least 50 % of the maximum audio frequency output power (see subclause 9.1) and a SINAD ratio of 12 dB.

9.2.2 Method of measurement

A test signal modulated with normal test modulation (subclause 6.4) at one of the two nominal frequencies of the receiver shall be applied to the receiver input.

The output of the receiver shall be replaced with a resistive load simulating the receiver's operating load and a measuring instrument for measuring the SINAD ratio shall be connected to the receiver audio frequency output.

The level of the test signal shall be adjusted until a SINAD ratio of 12 dB is obtained, using the receiver's audio frequency power control adjusted to produce 50 % of the maximum audio frequency output power measured in subclause 9.1.

The measurement shall be made on both 121,5 MHz and 123,1 MHz, and under normal test conditions and also under extreme test conditions.

9.2.3 Limit

The maximum usable sensitivity shall be better than +30 dBμV.

9.3 Spurious response rejection

9.3.1 Definition

The spurious response rejection is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

9.3.2 Method of measurement

Two input signals shall be applied to the receiver input via a combining network (subclause 6.2). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (subclause 6.4).

The unwanted signal shall be amplitude modulated by 400 Hz with a modulation depth of 80 %.

The wanted input signal shall be set to the level corresponding to the measured maximum usable sensitivity (subclause 9.2). The amplitude of the unwanted input signal shall be adjusted to an emf of +100 dBμV. The frequency of the unwanted signals shall then be stepped over the frequency range from 100 kHz to 2 GHz except in the frequency band ±100 kHz of the nominal frequency of the receiver, in steps not larger than 12,5 kHz. At any frequency at which a response is obtained, the input level of the unwanted signal shall be adjusted until the SINAD ratio is reduced to six dB.

The spurious response rejection ratio shall be expressed as the ratio in dB between the unwanted signal and the wanted signal at the receiver input when the specified reduction in the SINAD ratio is obtained.

9.3.3 Limit

At any frequency separated from the nominal frequency of the receiver by more than 100 kHz, the spurious response rejection ratio shall be not less than 70 dB.

9.4 Conducted spurious emissions

9.4.1 Definition

Conducted spurious emissions from the receiver are defined as components at any frequency, conducted to the antenna of the equipment.

9.4.2 Method of measurement

Conducted spurious emissions shall be measured with the receiver switched on and connected to the artificial antenna (subclause 6.5).

The measurements shall be made over the range from 9 kHz to 2 GHz.

The measurements for each spurious emission shall be made using a selective measuring device such as a tuned radio measuring instrument or a spectrum analyser.

9.4.3 Limit

The power of any conducted spurious emission shall not exceed 2 nW.

History

Document history		
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