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Radio Equipment and Systems (RES); Short range devices; Technical characteristics and test methods for radio equipment to be used in the 1 GHz to 25 GHz frequency range

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Foreword

This Interim European Telecommunication Standard (I-ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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

Proposed announcement date	
Date of adoption of this I-ETS:	13 October 1995
Date of latest announcement of this I-ETS (doa):	31 March 1996

Introduction

This I-ETS was drafted on the assumption that type test measurements, performed in an accredited test laboratory, will be accepted by the various national regulatory authorities in order to grant type approval, provided the national regulatory requirements are met. This is in compliance with CEPT/ERC Recommendation 01-06 [1].

Clauses 1 and 3 provide a general description on the types of equipment covered by this I-ETS and the definitions and abbreviations used. Clause 4 provides a guide as to the number of samples required in order that type tests may be carried out and any markings on the equipment which the manufacturer should provide.

Clauses 5 and 6 provide a description on the test conditions.

Clauses 7 and 8 provide the limits of the parameters which are required to be tested. These limits have been chosen to minimise harmful interference to other equipment and services. It also provides details on how the equipment should be tested and the conditions which should be applied.

Clause 9 states the maximum measurement uncertainty values.

Annex A provides normative specifications concerning radiated measurements.

Annex B provides normative description of measurement methods.

Annex C provides information on specific applications covered by this I-ETS.

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1 Scope

This Interim European Telecommunication Standard (I-ETS) covers the minimum characteristics considered necessary for Short Range Devices (SRDs) in order to make the best use of the available frequencies.

This I-ETS does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable.

This I-ETS applies to SRDs:

- either with a Radio Frequency (RF) output connection and specified antenna, or with an integral antenna;
- for alarms, identification systems, radiodetermination, telecommand, telemetry etc. applications;
- for all types of modulation;
- with or without speech;
- operating on radio frequencies between 1 and 25 GHz, with peak power levels up to 2 W equivalent isotropically radiated power (eirp).

This I-ETS also applies to Low Power Devices (LPDs), as defined in CEPT Recommendation T/R 01-04 [2].

This I-ETS is based upon CEPT Recommendations T/R 01-04 [2], T/R 22-04 [3] and T/R 60-01 [4]. It is a general standard which may be superseded by specific standards covering specific applications.

This I-ETS covers fixed stations, mobile stations and portable stations. If the system includes a transponder, this should be measured together with the transmitter.

For regulatory purposes the equipment is divided into three main classes based on frequency range and maximum radiated output power eirp (see table 1).

Table 1: Maximum radiated peak power (eirp)

Class	**Frequency (GHz)**		
	> 1,0 to 5,0	> 5,0 to 20,0	> 20,0
I	10 mW	25 mW	100 mW
II (note)	500 mW	500 mW	
III	500 mW	2 W	
NOTE: This class is only applicable for reflective transponder systems using the bands according to CEPT Recommendation T/R 60-01 [4].			

For non-harmonized parameters, national administrations may impose conditions on the type of modulation, channel/frequency separations, maximum eirp, equipment marking and the inclusion of an automatic transmitter shut-off facility, as a condition of the issue of an individual or general licence or as a condition of use under licence exemption. The extreme temperature ranges are fixed and are given in subclause 5.4.1.2.

In order to permit the greatest freedom of design of equipment, whilst protecting other radio services from interference, a balance is required between the permitted range of frequencies on which the equipment may be used, and its frequency stability and modulation characteristics. This I-ETS does not specify the operating frequencies or system bandwidths, these parameters will be covered by national regulations, since these parameters are not harmonised. However, the method to determine the permitted range of operating frequencies is to be found in subclause 7.2 of this I-ETS. This range of frequencies should be stated in the test report.

The performance of the equipment submitted for type testing should be representative of the performance of the corresponding production model. In order to avoid any ambiguity in that assessment, this I-ETS contains instructions for the presentation of equipment for type testing purposes (see subclause 4.1) conditions of testing (see clause 5) and measurement methods, (see clauses 7 and 8).

This I-ETS does not cover requirements for radiated emissions below 25 MHz.

Additional standards or specifications may be required for equipment such as that intended for direct connection to the Public Switched Telephone Network (PSTN).

2 Normative references

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

[1] CEPT/ERC Recommendation 01-06: "Procedure for mutual recognition of type testing and type approval for radio equipment ".

[2] CEPT Recommendation T/R 01-04: "Use of low power devices (LPD) using integral antennas and operating in harmonized frequency bands".

[3] CEPT Recommendation T/R 22-04: "Harmonisation of frequency bands for Road Transport Information systems (RTI)".

[4] CEPT Recommendation T/R 60-01: "Low-power radiolocation equipment for detecting movement and for alert".

[5] EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

[6] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods Part 1: Radio disturbance and immunity measuring apparatus".

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

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of this I-ETS, the following definitions apply:

alarm: The use of radio communication for indicating an alarm condition at a distant location.

assigned frequency band: The frequency band within which the device is authorised to operate.

chip: A unit of modulation used in Direct Sequence Spread Spectrum (DSSS) modulation.

chip rate: The number of chips per second.

Direct Sequence Spread Spectrum (DSSS): A form of modulation where a combination of data to be transmitted and a fixed code sequence (chip sequence) is used to directly modulate a carrier, e.g. by phase shift keying. The code sequence length determines the occupied bandwidth.

fixed station: Equipment intended for use in a fixed location.

Frequency Hopping Spread Spectrum (FHSS): A spread spectrum technique in which the transmitter signal occupies a number of frequencies in time, each for some period of time, referred to as the dwell time. Transmitter and receiver follow the same frequency hop pattern. The number of hop positions and the bandwidth per hop position determine the occupied bandwidth.

integral antenna: An antenna, with or without a connector, designed as an indispensable part of the equipment.

mobile station: Equipment normally fixed in a vehicle.

portable station: Equipment intended to be carried, attached or implanted.

operating frequency: The nominal frequency at which equipment is operated; this is also referred to as the operating centre frequency. Equipment may be able to operate at more than one operating frequency.

operating frequency range: The range of operating frequencies over which the equipment can be adjusted through tuning, switching or reprogramming.

radiated measurements: Measurements which involve the absolute measurement of a radiated field.

radiodetermination: The determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

spread spectrum: A modulation technique in which the energy of a transmitted signal is spread throughout a large portion of the frequency spectrum.

telecommand: The use of radio communication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance.

telemetry: The use of radio communication for indicating or recording data at a distance.

transponder: A device which responds to an interrogation signal.

wideband: Equipments to be used in a non-channelized continuous frequency band, or to be used in a channelized frequency band using more than one consecutive channel.

3.2 Symbols

For the purposes of this I-ETS, the following symbols apply:

E	field strength
Eo	reference field strength (see annex A)
R	distance (see annex A)
Ro	reference distance (see annex A)
λ	wavelength

3.3 Abbreviations

For the purposes of this I-ETS, the following abbreviations apply:

dBi	gain in decibels relative to an isotropic antenna
DSSS	Direct Sequence Spread Spectrum
eirp	equivalent isotropically radiated power
ERC	European Radiocommunication Committee
FHSS	Frequency Hopping Spread Spectrum
ISM	Industrial, Scientific and Medical

NOTE: This I-ETS includes the following designated ISM frequency bands:

- 2 400 - 2 483,5 MHz;
- 5,725 - 5,875 GHz;
- 24,00 - 24,25 GHz.

ITE	Information Technology Equipment
LPD	Low Power Device
OEM	Original Equipment Manufacturers'
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RTI	Road Transport Information
SRD	Short Range Device
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

4 General

4.1 Presentation of equipment for testing purposes

4.1.1 Presentation

Each equipment submitted for type testing shall fulfil the requirements of this I-ETS on all frequencies over which it is intended to operate.

Stand alone equipment shall be offered complete with any ancillary equipment needed for testing. Original Equipment Manufacturers' (OEM) plug-in cards may be offered for testing together with a suitable test fixture. The manufacturer shall declare the frequency range(s), the range of operating conditions and power requirements, as applicable, in order to establish the appropriate test conditions.

Plug-in cards may be offered with the host equipment or with a test fixture and three host equipments, see subclause 6.4.

To simplify and harmonise the type testing procedures between the different test laboratories, measurements shall be performed, according to this I-ETS, on samples of equipment defined in subclauses 4.1.2 and 4.1.3.

These subclauses are intended to give confidence that the requirements set out in this I-ETS have been met without the necessity of performing measurements on all frequencies.

4.1.2 Choice of model for type testing

The manufacturer shall provide one or more production models of the equipment, as appropriate, for type testing. If type approval is given on the basis of tests on a preliminary model, the corresponding production models shall be identical in all respects with the preliminary model tested.

Where practicable, equipment offered for testing shall provide a 50 Ω connector for conducted RF power measurements.

If a temporary 50 Ω RF connector is used, this shall be stated on the test report form. The way the temporary 50 Ω connector is implemented shall be stated by the manufacturer with the aid of a diagram.

4.1.3 Choice of operating frequencies

Where equipment can be adjusted to operate at different operating frequencies, a minimum of two operating frequencies shall be chosen such that the lower and higher limits of the declared operating range(s) of the equipment are covered.

For frequency hopping systems the manufacturer shall supply a means of selecting the upper, mid and lower hop frequencies for measurement purposes.

4.2 Mechanical and electrical design

4.2.1 General

The equipment submitted by the manufacturer, or his representative, shall be designed, constructed and manufactured in accordance with sound engineering practice, and with the aim of minimising harmful interference to other equipment and services.

4.2.2 Controls

Those controls which if maladjusted might increase the interfering potential of the equipment shall not be easily accessible to the user.

4.2.3 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative by the applicant for the duration of the test.

4.2.4 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible and durable.

The marking shall include as a minimum:

- the name of the applicant or his trade mark; and
- the type designation.

Where this is not possible due to dimension constraints. The documentation which accompanies the equipment shall contain as a minimum the information required above.

4.2.5 Receiver mute or squelch

If the receiver is equipped with a mute, squelch or battery-saving circuit, this circuit shall be made inoperative for the duration of the tests.

4.3 Declarations by the manufacturer

When submitting equipment for type testing, the manufacturer shall supply the necessary information according to the appropriate application form.

4.4 Auxiliary test equipment

All necessary test signal sources and setting up information shall accompany the equipment when it is submitted for type testing.

4.5 Interpretation of the measurement results

The interpretation of the results recorded in the appropriate test report form for the measurements described in this I-ETS shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of this I-ETS;
- 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 figures of measurement uncertainty given in clause 9.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Type testing shall be made under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in subclauses 5.2 to 5.4.

5.2 External test power source

During type tests the power source of the equipment shall be replaced by an external test power source, capable of producing normal and extreme test voltages as specified in subclauses 5.3.2 and 5.4.2. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment.

For battery operated equipment the battery shall be removed and the external test power source shall be suitably decoupled and applied as close to the equipment battery terminals as practicable. For radiated measurements any external power leads should be so arranged so as not to affect the measurements. If necessary, the external test power source may be replaced with the supplied or recommended internal batteries at the required voltage. This shall be stated on the test report. For radiated measurements on portable equipments with integral antenna, fully charged internal batteries should be used. The batteries used should be as supplied or recommended by the applicant.

If the equipment is powered from an external source, the test voltage shall be that measured at the point of connection of the power cable to the equipment.

During tests the external test power source voltages shall be within a tolerance of less than ± 1 % relative to the voltage at the beginning of each test. The value of this tolerance can be critical for certain measurements. Using a smaller tolerance will provide a better uncertainty value for these measurements. If internal batteries are used, at the end of each test the voltage shall be within a tolerance of less than ± 5 % relative to the voltage at the beginning of each test.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

The 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 %.

When it is impracticable to carry out tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.3.2 Normal test power source

5.3.2.1 Mains voltage

For the purpose of this I-ETS, the normal test voltage shall be the declared voltage, or any of the declared voltages, for which the equipment was designed.

The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 51 Hz.

5.3.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source the normal test voltage shall be 1,1 multiplied by the nominal voltage of the battery (6 V, 12 V etc.).

5.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test power source shall be that declared by the applicant and shall be stated in the test report.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

5.4.1.1 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period.

In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits shall be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements.

If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the test laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.4.1.1.1 Procedure for equipment designed for continuous operation

If the applicant states that the equipment is designed for continuous operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of half an hour after which the equipment shall meet the specified requirements;

- for tests at the lower extreme temperature the equipment shall be left in the test chamber until thermal balance is attained, then switched to the on condition for a period of one minute after which the equipment shall meet the specified requirements.

5.4.1.1.2 Procedure for equipment designed for intermittent operation

If the applicant states that the equipment is designed for intermittent operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained; the equipment shall then either:

    - transmit on and off according to the applicant’s declared duty cycle for a period of five minutes; or

      if the applicant‘s declared "on" period exceeds one minute then:

    - transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes;

after which the equipment shall meet the specified requirements;

- before tests at the lower extreme temperature the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements when switched on in the transmit mode.

5.4.1.2 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in subclause 5.4.1.1, at the upper and lower temperatures of one of the following ranges:

Category I (General): - 20 °C to + 55 °C;

Category II (Portable): - 10 °C to + 55 °C;

Category III (indoor use only): 0 °C to + 55 °C.

NOTE: Indoor use only, is for equipment which is intended for use in areas where the temperature is controlled within the stated range.

The test report form shall state which range has been used.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an ac mains source shall be the nominal mains voltage ± 10 %.

5.4.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation from the usual type of regulated lead-acid battery power sources the extreme test voltages shall be 1,3 and 0,9 multiplied by the nominal voltage of the battery (6 V, 12 V etc.).

For float charge applications using "gel-cell" type batteries the extreme test voltages shall be 1,15 and 0,85 multiplied by the nominal voltage of the declared battery voltage.

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using batteries shall be as follows:

- for equipment with a battery indicator, the end point voltage as indicated;

- for equipment without a battery indicator the following end point voltage shall be used:

  - for the Leclanché or the lithium type of battery:
    0,85 multiplied by the nominal voltage of the battery;

  - for the nickel-cadmium type of battery:
    0,9 multiplied by the nominal voltage of the battery;

  - for other types of battery the lower extreme test voltage for the discharged condition shall be declared by the equipment applicant.

No upper extreme test voltages apply.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the applicant and the test laboratory and shall be recorded in the test report.

6 General conditions

6.1 Test signals and test modulation

Where appropriate, a test signal shall be used with the following characteristics:

- representative of normal operation as declared;
- causes greatest occupied RF bandwidth as declared.

For equipment using intermittent transmissions the test signal shall be such that:

- the generated RF signal is the same for each transmission;
- transmissions occur regularly in time;
- sequences of transmissions can be accurately repeated.

Details of the test signal shall be recorded in the test report.

Normal operating modulation shall be used, where there is no provision for external test modulation. For narrow band speech (≤ 120 kHz RF bandwidth) an unmodulated signal shall be used.

6.2 Test sites and general arrangements for radiated measurements

For guidance on radiation test sites see annex A. Detailed descriptions of the radiated measurement arrangements are included in this annex.

6.3 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load of 50 Ω, connected to the antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 Ω connector shall not be greater than 1,2:1 over the frequency range of the measurement.

6.4 Testing of host equipment and plug-in radio devices

For equipment for which connection to or integration with host equipment is required to offer functionality, two alternative approaches are permitted. The manufacturer shall declare which shall be used.

6.4.1 Alternative A: combined equipment

A combination of a radio equipment part and a specific type of host equipment may be used for testing according to this I-ETS.

Where more than one such combination is intended, each combination shall be tested separately.

Type testing shall not be repeated for combinations of radio parts and host equipment where the latter are substantially similar in terms of mechanical and electrical characteristics as those offered for type testing.

6.4.2 Alternative B: use of a test fixture and three hosts

Where the radio equipment part is intended for use with a variety of host systems, the manufacturer shall supply a suitable test fixture. The test fixture shall be designed such that alteration of the radio equipment's intrinsic emissions is minimised. Where connection between the radio equipment part and the host is by means of cables, optical fibres or similar means between control and/or power ports, the connection to the host shall be considered a suitable test fixture.

The test fixture shall allow the radio equipment part to be powered and stimulated in a way similar to the way it would be powered and stimulated when connected to or installed into host equipment. Measurements shall be made to all requirements of this I-ETS.

In addition to tests on the test fixture, the radio equipment part shall be tested when connected to or inserted into three different hosts, e.g. Information Technology Equipment (ITE). These hosts shall be provided by the manufacturer.

For tests with the radio equipment part connected to, or inserted in, host equipment, the combination shall be tested against the requirements of this I-ETS except for cabinet radiation from the enclosure which shall be measured according to the requirements that apply to the host equipment. In the case where the host equipment is ITE, the requirements of EN 55022 [5] apply. The applicable class under EN 55022 [5], as identified in the user manual, shall be declared by the manufacturer and recorded in the test report.

7 Methods of measurement and limits for transmitter parameters

Where the transmitter is designed with adjustable carrier power, first, all transmitter parameters shall be measured using the highest power level, as declared by the applicant. The equipment shall then be set to the lowest carrier power setting, as declared by the applicant, and the measurements for spurious emissions shall be repeated (see subclause 7.3).

When making transmitter tests on equipment designed for intermittent operation, the duty cycle of the transmitter, as declared by the manufacturer in the application form, shall not be exceeded. The actual duty cycle used shall be stated in the test report form.

If the equipment to be tested is designed with an antenna connector, then this connector may be used, via a calibrated coupler or attenuator, if required to provide the correct termination impedance, to facilitate the measurements. The equivalent isotropically radiated power is then calculated from the declared antenna gain.

7.1 Equivalent isotropically radiated power (eirp)

7.1.1 Definition

The eirp is defined as the peak power of the transmitter and calculated according to the procedure given in the following subclause. See clause 5 for the test conditions.

7.1.2 Method of measurement

Using the applicable measurement procedure as described in annex B, the power output shall be measured and recorded in the test report. The method of measurement shall be documented in the test report.

If the transmitter power is adjustable by the user, the power level shall be set to the highest level available from the equipment.

7.1.2.1 Transmitters with continuous operation and with a - 6 dB bandwidth equal to or less than 1 MHz

This method of measurement shall be used for equipment with a - 6 dB bandwidth of 1 MHz or less. The equipment shall be able to operate in a continuous transmit mode.

This method may also be used for FHSS equipment if the transmitter can operate in continuous transmit mode at defined frequencies and if the - 6 dB bandwidth is less than or equal to 1 MHz.

For peak power measurements, a spectrum analyser or selective voltmeter shall be used and tuned to the transmitter carrier at which the highest level is detected.

The measurement shall be made using a test signal, see subclause 6. 1.

Measurements shall be performed at normal and extreme conditions (see subclauses 5.3 and 5.4).

For FHSS systems, the hop frequency which provides the maximum indicated level shall be used (see subclause 4.1.3). The frequency shall be indicated on the test report.

The eirp is calculated according to the relevant method stated in annex B.

7.1.2.2 Transmitters with intermittent operation and/or a - 6 dB bandwidth greater than 1 MHz

This method of measurement shall be used for:

- equipment with a - 6 dB bandwidth greater than 1 MHz;
- equipment transmitting intermittently;
- FHSS equipment when the hop frequency cannot be fixed at defined frequencies.

The measurement shall be performed using normal operation of the equipment with test modulation applied.

The test procedure shall be as follows:

Step 1:

- using suitable attenuators, the output power of the transmitter shall be coupled to a diode detector. The output of the diode detector shall be connected to the vertical channel of an oscilloscope;
- the combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the envelope peaks and the duty cycle of the transmitter output signal;
- the observed duty cycle of the transmitter (Tx on/(Tx on + Tx off)) shall be noted as x ($0 < x \leq 1$), and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal to or greater than 0,1. Where this duty cycle is not possible, then this shall be stated on the test report and the actual duty cycle shall be declared.

Step 2:

- the average output power of the transmitter shall be determined using a wideband calibrated RF power meter with a thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be noted as "A" (in dBm);

- the eirp shall be calculated from the above measured power output A (in dBm) the observed duty cycle x, and the declared antenna gain(s) "G" in dBi, according to the formula:

  $$P = A + G + 10 \log (1/x) \text{ (dBm)};$$

- P, converted from dBm into mW, shall not exceed the value specified in table 2, and shall be recorded in the test report.

Step 3:

- the measurement set up as given under step 1 shall be used to determine, on the oscilloscope, the peak of the envelope of the output signal of the transmitter;

- the maximum (peak) deviation of the Y-trace of the oscilloscope shall be noted as "B".

Step 4:

- the transmitter shall be replaced by a signal generator. The output frequency of the signal shall be made equal to the centre of the frequency range occupied by the transmitter;

- the signal generator shall be unmodulated. The output power of the signal generator shall be raised to a level such that the deviation of the Y-trace of the oscilloscope reaches level B, as indicated in step 3;

- this output level "C" (in dBm) of the signal generator shall be determined using a wideband, calibrated RF power meter with a thermocouple detector or an equivalent thereof;

- level C shall not exceed by more than 3 dB the value specified in table 2, converted into dBm, minus the antenna gain(s) G in dBi;

- the measurement shall be repeated at the lowest, the middle, and the highest frequency of the declared frequency range. These frequencies shall be recorded in the test report;

- for FHSS systems, the hop frequency which provides the maximum indicated level shall be used (see subclause 4.1.3). The frequency shall be indicated on the test report.

Measurements shall be performed at normal and extreme conditions (see subclause 5.3 and 5.4).

7.1.3 Limits

The transmitter maximum eirp under normal and extreme test conditions shall not exceed the values given in table 2.

Table 2: Maximum radiated peak power (eirp)

Class	**Frequency GHz**		
	> 1,0 to 5,0	> 5,0 to 20,0	> 20,0
I	10 mW	25 mW	100 mW
II (note)	500 mW	500 mW	
III	500 mW	2 W	
NOTE: This Class is only applicable for reflective transponder systems using the bands according to CEPT Recommendation T/R 60-01 [4].			

For equipment with an integral antenna and no RF connector, measurements under extreme conditions are not required.

7.2 Permitted range of operating frequencies

The frequency range of the equipment is determined by the lowest and highest frequencies occupied by the power envelope.

f_H is the highest frequency of the power envelope, it is the frequency furthest above the frequency of maximum power where the output power drops below the level of - 80 dBm/Hz spectral power density (- 30 dBm if measured in a 100 kHz bandwidth) eirp.

f_L is the lowest frequency of the power envelope; it is the frequency furthest below the frequency of maximum power where the output power drops below the level of - 80 dBm/Hz spectral power density (- 30 dBm if measured in a 100 kHz bandwidth) eirp.

7.2.1 Definition

The permitted range of operating frequencies includes all frequencies on which the equipment may operate within an assigned frequency band. The operating frequency range shall be declared by the manufacturer.

The range of frequencies, determined by subclause 7.2, shall be specified in the test report.

7.2.2 Frequency range

The method of measurement for equipment employing FHSS modulation is given in subclause 7.2.3.

Using applicable conducted measurement procedures, as described in annex B, the frequency range(s) shall be measured and recorded in the test report.

During these measurements the test data sequence as specified in subclause 6.1 shall be used. The transmitter power level shall be set to the rated power level.

These measurements shall be performed under both normal and extreme operating conditions.

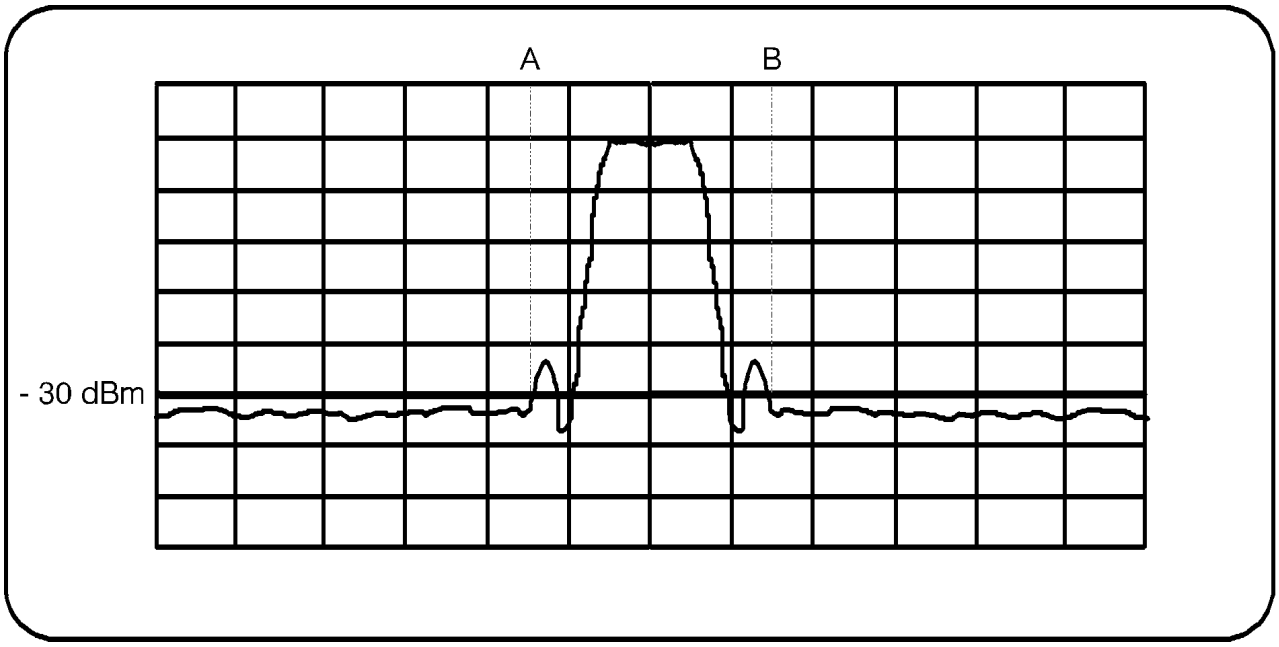


Figure 1: Measuring the extreme frequencies of the power envelope

The measurement procedure shall be as follows:

a) put the spectrum analyzer in video averaging mode with a minimum of 50 sweeps selected;

b) select the lowest operating frequency of the equipment under test and activate the transmitter with modulation applied. The RF emission of the equipment shall be displayed on the spectrum analyzer. The display will form an image like that shown in figure 1;

c) using the marker of the spectrum analyzer, find lowest frequency below the operating frequency at which spectral power density drops below the level given in subclause 7.2 (see A in figure 1). This frequency shall be recorded in the test report;

d) select the highest operating frequency of the equipment under test and find the highest frequency at which the spectral power density drops below the value given in subclause 7.2 (see B in figure 1). This frequency shall be recorded in the test report;

e) the difference between the frequencies measured in steps c) and d) is the operating frequency range. It shall be recorded in the test report.

This measurement shall be repeated for each frequency range declared by the manufacturer.

7.2.3 Frequency range of equipment using FHSS modulation

Using an applicable conducted measurement procedure as described in annex B the frequency range of the equipment shall be measured and recorded in the test report.

During these measurements the test data sequence, as specified in subclause 6.1, shall be used.

The transmitter power level shall be set to the rated power level.

These measurements shall be performed under both normal and extreme operating conditions.

The measurement procedure shall be as follows:

a) put the spectrum analyzer in video averaging mode with a minimum of 50 sweeps selected;

b) select the lowest hop frequency of the equipment under test and activate the transmitter with modulation applied. The display will form an image similar to that shown in figure 1;

c) find the lowest frequency below the operating frequency at which spectral power density drops below the level given in subclause 7.2 (see A in figure 1). This frequency shall be recorded in the test report;

d) select the highest hop frequency of the equipment under test and find the highest frequency at which the spectral power density drops below the level given in subclause 7.2 (see B in figure 1). This frequency shall be recorded in the test report;

e) the difference between the frequencies measured in steps c) and d) is the frequency range. It shall be recorded in the test report.

This measurement shall be repeated for each operating frequency range declared by the manufacturer.

7.2.4 Limit

The width of the power envelope is f_H - f_L for a given operating frequency. In equipment that allows adjustment or selection of different operating frequencies, the power envelope takes up different positions in the allowed band. The frequency range is determined by the lowest value of f_L and the highest value of f_H resulting from the adjustment of the equipment to the lowest and highest operating frequencies.

For all equipment the frequency range shall lie within the frequency band allocated for use. For non-harmonised frequency bands the available frequency range may differ between national administrations.

7.3 Spurious emissions

7.3.1 Definition

Spurious emissions are emissions at frequencies, other than those of the carrier and sidebands associated with normal modulation. The level of spurious emissions shall be measured as either:

a)
- i) their power level in a specified load (conducted emission); and
- ii) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of equipment fitted with such an antenna and no permanent RF connector.

7.3.2 Measuring receiver

The term "measuring receiver" refers to either a selective voltmeter or spectrum analyser. The bandwidth of the measuring receiver shall, where possible, be according to CISPR 16-1 [6]. In order to obtain the required sensitivity a narrower bandwidth may be necessary, this shall be stated in the test report form. The maximum bandwidth of the measuring receiver is given in table 3.

Table 3: Measuring receiver bandwidths

Frequency being measured (f)	Measuring receiver bandwidth
f < 1 000 MHz	100 - 120 kHz
f ≥ 1 000 MHz	1 MHz

7.3.3 Method of measurement conducted spurious emission

This method of measurement applies to transmitters having a permanent antenna connector.

Additional requirements for equipment employing FHSS modulation are given in subclause 7.3.6.

a) The transmitter shall be connected to a measuring receiver through a test load, 50 Ω power attenuator, and if necessary, an appropriate filter to avoid overloading of the measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in table 4, see subclause 7.3.7. This bandwidth shall be recorded in the test report.

   For the measurement of spurious emissions below the second harmonic of the carrier frequency the filter used shall be a high "Q" (notch) filter centred on the transmitter carrier frequency and attenuating this signal by at least 30 dB.

   For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the filter used shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1,5 times the transmitter carrier frequency.

   Precautions may be required to ensure that the test load does not generate or that the high pass filter does not attenuate, the harmonics of the carrier.

b) The transmitter shall be unmodulated and operating at the maximum limit of its specified power range. If modulation cannot be inhibited then the test shall be carried out with modulation (see subclause 6.1) and this fact shall be recorded in the test report.

c) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 10 times the carrier frequency, not exceeding 40 GHz. The frequency and level of every spurious

emission found shall be noted. The emissions within the channel occupied by the transmitter carrier and, for channelized systems its adjacent channels, shall not be recorded.

d) If the measuring receiver has not been calibrated in terms of power level at the transmitter output, the level of any detected components shall be determined by replacing the transmitter by the signal generator and adjusting it to reproduce the frequency and level of every spurious emission noted in step c). The absolute power level of each of the emissions shall be noted.

e) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

f) If a user accessible power adjustment is provided then the tests in steps c) to e) shall be repeated at the lowest power setting available.

g) The measurement in steps c) to f) shall be repeated with the transmitter in the standby condition if this option is available.

7.3.4 Method of measurement cabinet spurious radiation

This method of measurement applies to transmitters having a permanent antenna connector. For equipment without a permanent antenna connector see subclause 7.3.5.

Additional requirements for equipment employing FHSS modulation are given in subclause 7.3.6.

a) A test site selected from annex A which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarisation and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in table 4, see subclause 7.3.7. This bandwidth shall be recorded in the test report.

   The transmitter under test shall be placed on the support in its standard position, connected to an artificial antenna (see subclause 6.3) and switched on without modulation. If modulation cannot be inhibited then the test shall be carried out with modulation, (see subclause 6.1), and this fact shall be recorded in the test report.

b) The radiation of any spurious emission shall be detected by the test antenna and measuring receiver over the frequency range 25 MHz to 10 times the carrier frequency, not exceeding 40 GHz, except for the channel on which the transmitter is intended to operate and for channelized systems, its adjacent channels. The frequency of each spurious emission detected shall be noted. If the test site is disturbed by interference coming from outside the site, this qualitative search may be performed in a screened room, with a reduced distance between the transmitter and the test antenna.

c) At each frequency at which a emission has been detected, the measuring receiver shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver.

d) The transmitter shall be rotated through 360° about a vertical axis, to maximise the received signal.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be noted.

f) The substitution antenna (see subclause A.2.3) shall replace the transmitter antenna in the same position and in vertical polarisation. It shall be connected to the signal generator.

g) At each frequency at which a emission has been detected, the signal generator, substitution antenna, and measuring receiver shall be tuned. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver. The level of the signal generator giving the same signal level on the measuring receiver as in item e) above shall be noted. After corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious emission at this frequency.

h) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

j) Steps c) to h) above shall be repeated with the test antenna oriented in horizontal polarisation.

k) If a user accessible power adjustment is provided then the tests in steps c) to h) shall be repeated at the lowest power setting available.

l) Steps c) to j) above shall be repeated with the transmitter in the standby condition if this option is available.

7.3.5 Method of measurement radiated spurious emission

This method of measurement applies to transmitters having an integral antenna.

Additional requirements for equipment employing FHSS modulation are given in subclause 7.3.6.

a) A test site selected from annex A which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarisation and connected to a measuring receiver, through a suitable filter to avoid overloading of the measuring receiver if required. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in table 4, see subclause 7.3.7. This bandwidth shall be recorded in the test report.

   For the measurement of spurious emissions below the second harmonic of the carrier frequency the optional filter used shall be a high 'Q' (notch) filter centred on the transmitter carrier frequency and attenuating this signal by at least 30 dB.

   For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the optional filter used shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1,5 times the transmitter carrier frequency.

   The transmitter under test shall be placed on the support in its standard position and shall be switched on without modulation. If modulation cannot be inhibited then the test shall be carried out with modulation (see subclause 6.1) and this fact shall be recorded in the test report.

b) The same method of measurement as steps b) and k) of subclause 7.3.4 shall be used.

7.3.6 Additional requirements for equipment employing FHSS modulation

Measurements shall be carried out while the equipment is hopping between two frequencies separated by the maximum hop frequency change declared by the manufacturer, one of which is the lowest hop frequency.

The measurements shall be repeated on two frequencies separated by the maximum hop frequency change declared by the manufacturer, one of which is the highest hop frequency.

7.3.7 Limits

The power of any spurious emission shall not exceed the following values given in table 4.

Table 4: Radiated spurious emissions

State	**47 to 74 MHz 87,5 to 118 MHz 174 to 230 MHz 470 to 862 MHz**	**Other frequencies ≤ 1 000 MHz**	**Frequencies > 1 000 MHz**
Operating	4 nW	250 nW	1 μW
Standby	2 nW	2 nW	20 nW

8 Receiver

8.1 Spurious emissions

8.1.1 Definition

Spurious radiations from the receiver are components at any frequency, radiated by the equipment and antenna.

The level of spurious radiations shall be measured by either:

a)
   i) their power level in a specified load (conducted spurious emission); and

   ii) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of portable equipment fitted with such an antenna and no permanent RF connector.

8.1.2 Method of measurement conducted spurious components

This method of measurement applies to receivers having a permanent antenna connector.

A test load, 50 Ω power attenuator, may be used to protect the measuring receiver (see subclause 7.3.2) against damage when testing a receiver combined in one unit with a transmitter.

The measuring receiver used shall have sufficient dynamic range and sensitivity to achieve the required measurement accuracy at the specified limit. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in subclause 8.1.5. This bandwidth shall be recorded in the test report.

a) The receiver input terminals shall be connected to a measuring receiver having an input impedance of 50 Ω and the receiver is switched on.

b) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 10 times the associated transmitter carrier frequency, not exceeding 40 GHz. The frequency and the absolute power level of each of the spurious components found shall be noted.

c) If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by replacing the receiver by the signal generator and adjusting it to reproduce the frequency and level of every spurious component noted in step b). The absolute power level of each spurious component shall be noted.

d) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

8.1.3 Method of measurement cabinet radiation

This method of measurement applies to receivers having a permanent antenna connector.

a) A test site selected from annex A which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarisation and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in subclause 8.1.5. This bandwidth shall be recorded in the test report.

   The receiver under test shall be placed on the support in its standard position and connected to an artificial antenna, see subclause 6.3.

b) The radiation of any spurious component shall be detected by the test antenna and measuring receiver over the frequency range 25 MHz to 10 times the associated transmitter carrier frequency, not exceeding 40 GHz. The frequency of each spurious component shall be noted. If the test site is disturbed by radiation coming from outside the site, this qualitative search may be performed in a screened room with reduced distance between the transmitter and the test antenna.

c) At each frequency at which a component has been detected, the measuring receiver shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver.

d) The receiver shall be rotated up to 360° about a vertical axis, to maximise the received signal.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be noted.

f) The substitution antenna (see subclause A.2.3) shall replace the receiver antenna in the same position and in vertical polarisation. It shall be connected to the signal generator.

g) At each frequency at which a component has been detected, the signal generator, substitution antenna and measuring receiver shall be tuned. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver. The level of the signal generator giving the same signal level on the measuring receiver as in step e) above shall be noted. This level, after correction due to the gain of the substitution antenna and the cable loss, is the radiated spurious component at this frequency.

h) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

j) Measurements b) to h) above shall be repeated with the test antenna oriented in horizontal polarisation.

8.1.4 Method of measurement radiated spurious components

This method of measurement applies to receivers having an integral antenna.

a) A test site selected from annex A which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarisation and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in subclause 8.1.5. This bandwidth shall be recorded in the test report.

   The receiver under test shall be placed on the support in its standard position.

b) The same method of measurement as items b) to j) of subclause 8.1.3 shall apply.

8.1.5 Limits

The power of any spurious emission shall not exceed 2 nW in the range 25 MHz to 1 GHz and shall not exceed 20 nW on frequencies above 1 GHz.

9 Measurement uncertainty

The accumulated measurement uncertainties of the test system in use, for the parameters to be measured, should not exceed those given in table 5, to ensure that the measurements remain within an acceptable standard.

Table 5: Measurement uncertainty

Parameters	Uncertainty
RF power (conducted)	± 4 dB
Radiated emission of transmitter, valid to 40 GHz	± 6 dB
Radiated emission of receiver, valid to 40 GHz	± 6 dB
Temperature	± 1° C
Humidity	± 5 %

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

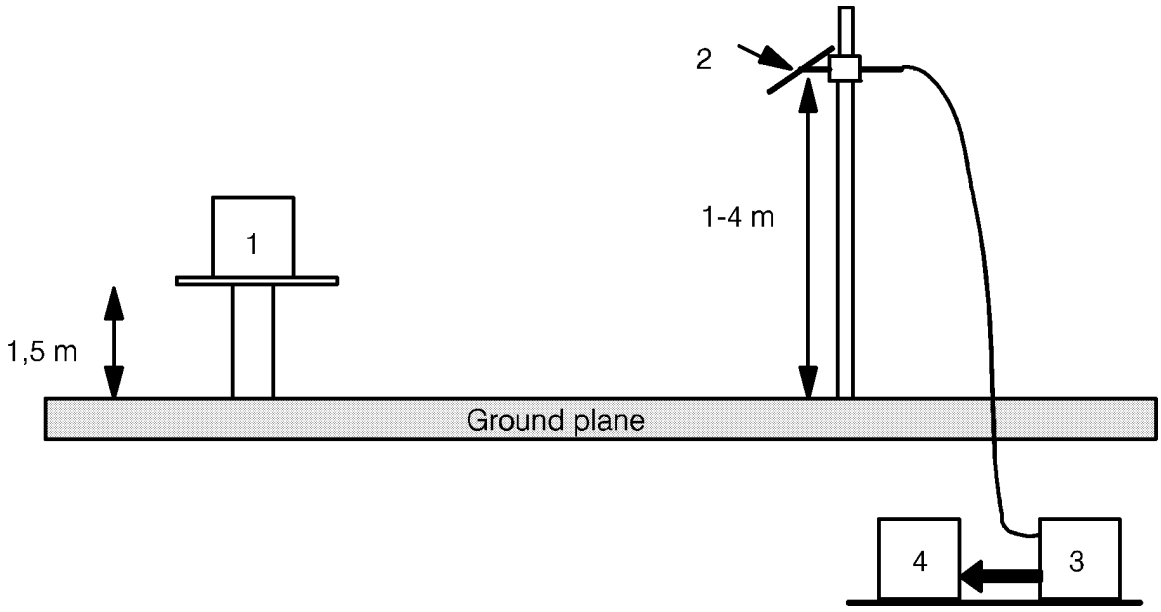
Annex A (normative): Radiated measurements

A.1 Test sites and general arrangements for measurements involving the use of radiated fields

A.1.1 Outdoor test site

The outdoor test site shall be on a reasonably level surface or ground. At one point on the site, a ground plane of at least 5 m diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360^{o} in the horizontal plane, shall be used to support the test sample in its standard position, at 1,5 m above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 m whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

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



Key:

1) equipment under test;
2) test antenna;
3) high pass filter (may not be necessary);
4) spectrum analyser or measuring receiver.

Figure A.1: Outdoor test site

A.1.2 Standard position

The standard position in all test sites, shall be as follows:

- for equipment with integral antenna, the equipment under test shall be placed in the position closest to normal use as declared by the manufacturer;

- for equipment with a rigid external antenna, the antenna shall be vertical;

- for equipment with non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

A.1.3 Test antenna

The test antenna is used to detect the radiation from the test sample, when the site is used for radiation measurements.

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1 to 4 m. Preferably a test antenna with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

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

When measuring in the frequency range up to 1 GHz the test antenna shall be a $\lambda/2$ dipole, resonant at the operating frequency, or a shortened dipole, calibrated to the $\lambda/2$ dipole. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 and 4 GHz either a $\lambda/2$ dipole or a horn radiator may be used.

The distance between the lower extremity of the dipole and the ground shall not be less than 0,3 m.

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

A.1.4 Optional additional indoor site

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

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2,7 m in height.

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

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

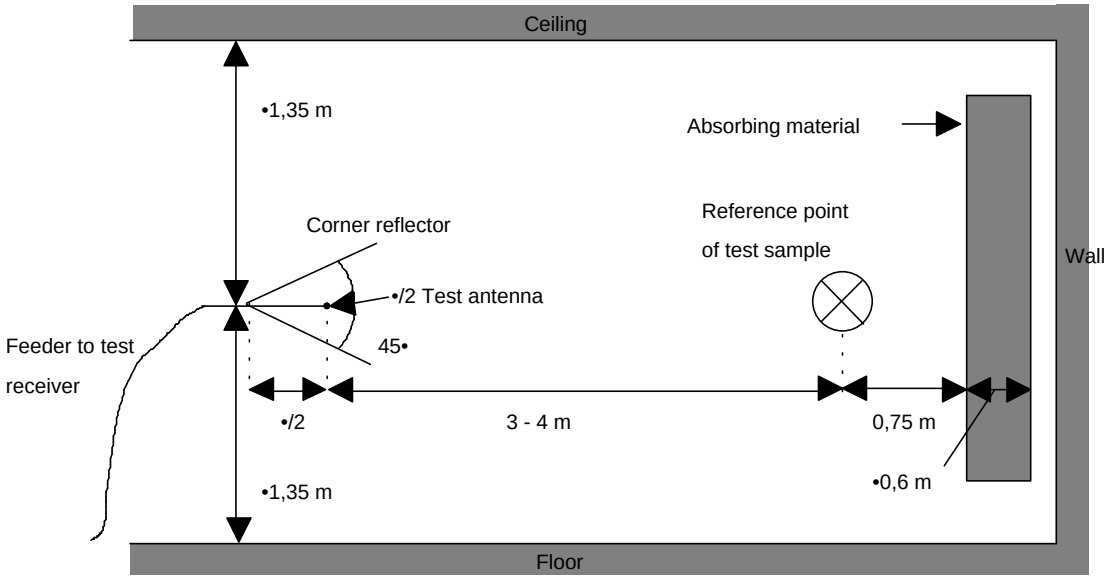


Figure A.2: Indoor site arrangement (shown for horizontal polarisation)

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

A.2 Guidance on the use of radiation test sites

For measurements involving the use of radiated fields, use may be made of a test site in conformity with the requirements of clause A.1. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

A.2.1 Measuring distance

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and the precautions described in this annex are observed. Measuring distances of 3, 5, 10 and 30 m are in common use in European test laboratories.

A.2.2 Test antenna

Different types of test antenna may be used, since performing substitution measurements reduces the effect of the errors on the measuring results.

Height variation of the test antenna over a range of 1 to 4 m is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at the lower frequencies below about 100 MHz.

A.2.3 Substitution antenna

The substitution antenna and signal generator is used to replace the equipment under test in substitution measurements. For measurements below 1 GHz the substitution antenna shall be a λ/2 dipole resonant at the frequency under consideration, or a shortened dipole, calibrated to the λ/2 dipole. For measurements between 1 and 4 GHz either a λ/2 dipole or a horn radiator may be used. For measurements above 4 GHz a horn radiator shall be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet. The distance between the lower extremity of the dipole and the ground shall be at least 300 mm.

A.2.4 Auxiliary cables

The position of auxiliary cables (power supply etc.) which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non conducting support).

A.3 Further optional alternative indoor test site using a fully anechoic RF chamber

For radiation measurements when the frequency of the signals being measured is greater than 30 MHz, use may be made of an indoor site being a well-shielded anechoic chamber simulating a free space environment. If such a chamber is used, this shall be recorded in the test report.

The test antenna and measuring receiver, are used in a way similar to that of the general method, clause A.1. In the range between 30 MHz and 100 MHz some additional calibration may be necessary.

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high. Walls and ceiling should be coated with RF absorbers of 1 m height. The base should be covered with absorbing material 1 m thick, and a wooden floor, able to carry test equipment and operators. A measuring distance of 3 to 5 m in the long middle axis of the chamber can be used for measurements up to 12,75 GHz. For frequencies above 12,75 GHz the chamber may be used provided it has been calibrated for use at the frequency being measured. The construction of the anechoic chamber is described in the following subclauses.

A.3.1 Example of the construction of a shielded anechoic chamber

Free-field measurements can be simulated in a shielded measuring chamber where the walls are coated with RF absorbers. Figure A.3 shows the requirements for shielding loss and wall return loss of such a room. As dimensions and characteristics of usual absorber materials are critical below 100 MHz (height of absorbers < 1 m, reflection attenuation < 20 dB) such a room is preferably suitable for measurements above 100 MHz. Figure A.4 shows the construction of a shielded measuring chamber having a base area of 5 m by 10 m and a height of 5 m.

Ceilings and walls are coated with pyramidal formed radio frequency absorbers approximately 1 m high or equivalent material with the same performance. The base is covered with absorbers which form a non-conducting sub-floor, or with special ground floor absorbers. The available internal dimensions of the room are 3 m x 8 m x 3 m, so that a measuring distance of maximum 5 m length in the middle axis of this room is available.

At 100 MHz the measuring distance can be extended up to a maximum of 2λ.

The floor absorbers reduce floor reflections so that the antenna height need not be changed and floor reflection influences need not be considered.

All measuring results can therefore be checked with simple calculations and the measurement uncertainties have the smallest possible values due to the simple measuring configuration.

A.3.2 Influence of parasitic reflections in anechoic chambers

For free-space propagation in the far field condition the correlation E = Eo $\times$ (Ro/R) is valid for the dependence of the field strength E on the distance R, whereby Eo is the reference field strength in the reference distance Ro.

It is useful to use just this correlation for comparison measurements, as all constants are eliminated with the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

Deviations from the ideal curve can be seen easily if the logarithm of the above equation is used, because the ideal correlation of field strength and distance can then be shown as a straight line and the deviations occurring in practice are clearly visible. This indirect method shows the disturbances due to reflections more readily and is far less problematical than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions suggested in clause A.3 at low frequencies up to 100 MHz there are no far field conditions, and therefore reflections are stronger so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well. In the frequency range of 1 to 40 GHz, because more reflections occur, the dependence of the field strength on the distance does not correlate so closely.

A.3.3 Calibration of the shielded RF anechoic chamber

Calibration of the chamber shall be performed over the range 30 MHz to 40 GHz.

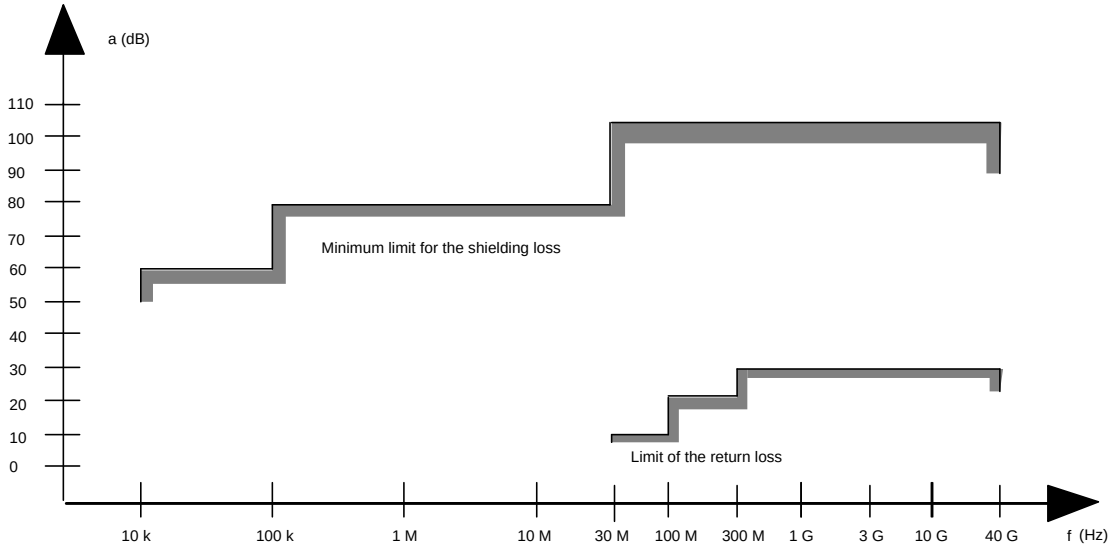


Figure A.3: Specification for shielding and reflections

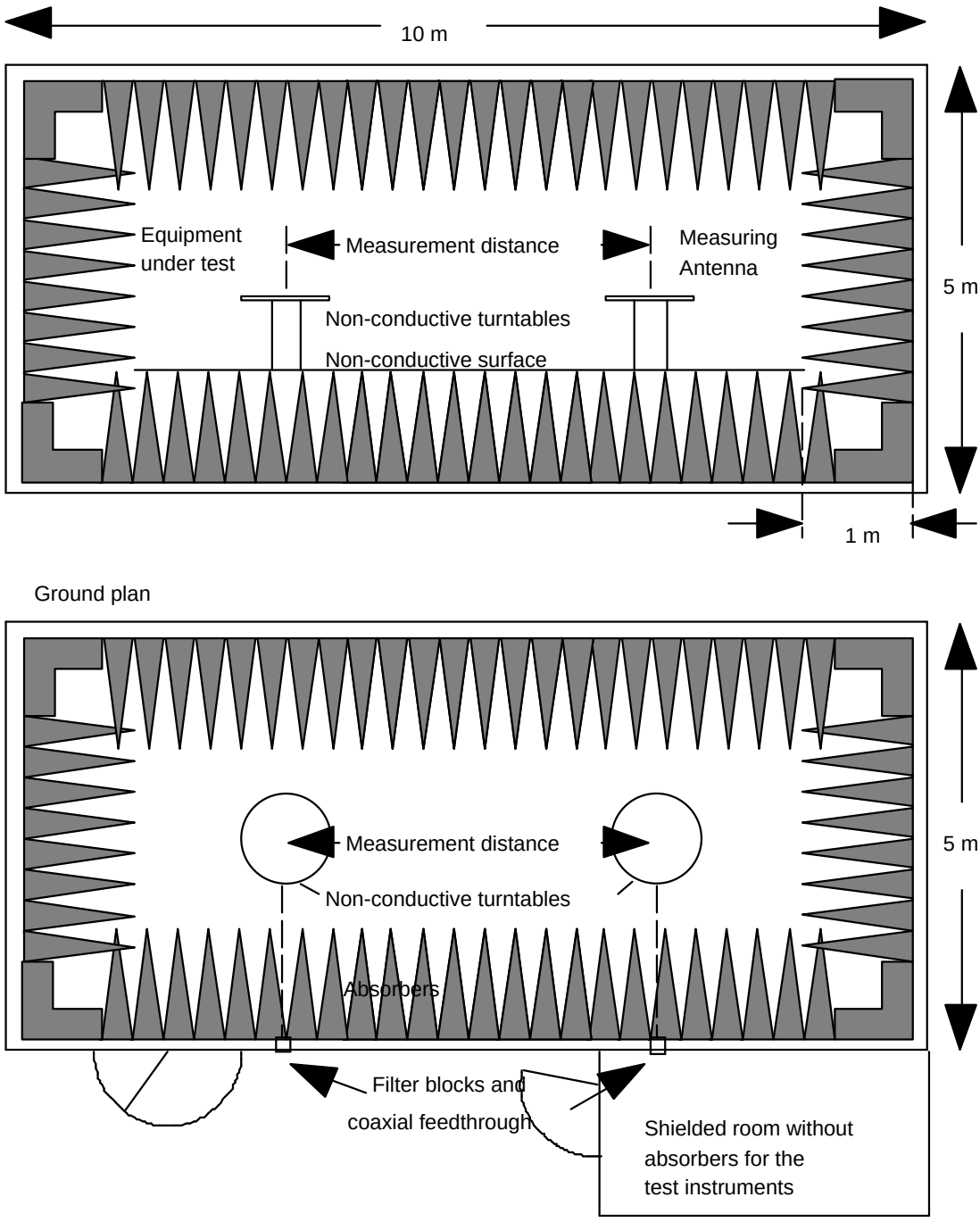


Figure A.4: Example of construction of an anechoic shielded chamber

Annex B (normative): General description of measurement methods

This annex gives the general methods of measurements for RF signals using the test sites and arrangements described in annex A. In addition, this annex gives a simple measurement method for radiated emissions based on a calculated rather than measured path loss.

B.1 Conducted measurements

In view of the low power levels of the equipment to be tested under this I-ETS, conducted measurements may be applied to equipment provided with an antenna connector. Where the equipment to be tested does not provide a suitable termination, a coupler or attenuator that does provide the correct termination value shall be used.

The equivalent isotropically radiated power is then calculated from the measured value, the known antenna gain, relative to an isotropic antenna, and if applicable, any losses due to cables and connectors in the measurement system.

B.2 Radiated measurements

Radiated measurements shall be performed with the aid of a test antenna and measurement receiver as described in annex A. The test antenna and measurement receiver, spectrum analyser or selective voltmeter, shall be calibrated according to the procedure defined in this annex. The equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted power level. This position shall be recorded in the measurement report. The frequency range shall be measured in this position.

Preferably, radiated measurements shall be performed in an anechoic chamber. For other test sites corrections may be needed (see annex A).

a) A test site which fulfils the requirements of the specified frequency range of this measurement shall be used.

b) The transmitter under test shall be placed on the support in its standard position (subclause A.1.2) and switched on.

c) The test antenna shall be oriented initially for vertical polarization unless otherwise stated. The test antenna shall be raised or lowered, through the specified height range until the maximum signal level is detected on the measuring receiver.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause A.3.

d) The transmitter shall be rotated through 360° about a vertical axis to maximise the received signal.

e) The test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.

   (This maximum may be a lower value than the value obtainable at heights outside the specified limits).

f) This measurement shall be repeated for horizontal polarization.

g) The substitution antenna, shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the transmitter (carrier) frequency.

h) Steps c) to f) shall be repeated.

j) The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.

k) This measurement shall be repeated with horizontal polarization.

l) The radiated power is equal to the power supplied by the signal generator, increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.

Annex C (informative): Defined applications using I-ETS 300 440

C.1 Application: Low Power Devices (LPD)

C.1.1 General

This subclause covers LPDs as recommended by the CEPT Recommendation T/R 01-04 [2] and adopted by the European Radiocommunication Committee (ERC).

C.1.2 Definition

Non-public radio devices with integral antenna which radiate in one of the specified frequency bands up to a power level of 100 mW, working on a non-interference and non-protected basis and which do not require frequency planning.

C.1.3 Technical parameters

Table C.1: Technical parameters

Parameter	Limit	Measuring method
Power	Class I	subclause 7.1
Permitted operating frequency bands	note	subclause 7.2
Bandwidth	Any bandwidth may be used provided that the occupied bandwidth of emission does not exceed the permitted operating frequency band	
Modulation	Any type of modulation may be used.	
Extreme temperature range: (subclause 5.4.1.2)	Category I: - 20°C to + 55°C Category II: - 10°C to + 55°C Category III: 0°C to + 55°C	
Spurious emissions		
Transmitter:	Limits: subclause 7.3.7, table 4	subclause 7.3
Receiver:	Limits: subclause 8.1.5	subclause 8.1
NOTE: The frequency bands may change. The latest version of CEPT T/R 01-04 [2] should be used as the reference document.		

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