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Foreword

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

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

Annex A provides normative specifications concerning radiated measurements.

Annex B provides the test method for measurement of Necessary Bandwidth (BN).

Transposition dates	
Date of adoption of this ETS:	17 November 1995
Date of latest announcement of this ETS (doa):	31 March 1996
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	30 September 1996
Date of withdrawal of any conflicting National Standard (dow):	30 September 1996

Annex C presents a graphical representation of the equipment and frequencies for the testing of single and multi-frequency equipment.

Introduction

I-ETS 300 422 [1] has been a frame which led to many national prescriptions which differed, sometimes substantially, between European countries and did not directly refer to wide band audio links. The rapidly increasing use of wireless microphones with increased power for bridging longer distances (hereafter referred to as wide band audio links) in several European countries with different specifications, and the way forward to a Europe without borders, makes it necessary to set up common specifications.

This ETS provides the necessary parameters for equipment to obtain common approval throughout Europe. It should also make it easier for the frequency management authorities to find harmonized frequency allocations which, together with common technical specifications, will greatly reduce the present problems of multi-national use.

In preparing this ETS, much attention has been given to assure a low interference probability, while at the same time allowing a maximum flexibility and service to the end-user. The close relationship between radio microphones and wide band audio links has led to many identical characteristics. Nevertheless it was found to be better to create a separate ETS due to the higher power and the many extra facilities which were developed during recent years for this special use. This ETS does not include performance characteristics that may be required by the user or requirements for interfacing equipment.

Type test measurements should be performed in one of the accredited test laboratories, 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 Recommendation T/R 71-03 [2].

In addition, national administrations may accept a "certificate of conformity" based on a type test report. If equipment available on the market is required to be checked it should be tested in accordance with the methods of measurement specified in this ETS.

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1 Scope

This ETS specifies the minimum performance and the methods of measurement of wide band audio links.

This ETS covers the minimum characteristics considered necessary in order to make the best use of the available frequencies. It does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable.

This ETS applies to modulation systems operating on radio frequencies between 25 MHz and 3 GHz. Although analogue FM is at present used for the majority of wide band audio links, this ETS does not preclude any other constant carrier modulation technique, e.g. Gaussian Filtered Minimum Shift Keying (GMSK) or Generalised Tamed Frequency Modulation (GTFM), provided that the modulation spectrum lies within the specified spectral mask.

This ETS does not cover wide band audio links employing Time Division Multiple Access (TDMA), frequency hopping and spread spectrum or similar forms of modulation.

This ETS does not cover radiated emissions below 25 MHz. Specifications related to Electro-Magnetic Compatibility (EMC) are contained within prETS 300 445 [3].

This ETS has been developed from CEPT Recommendation T/R 20-06 [4].

Additional standards or specifications may be required for equipment intended to interface with the Public Switched Telephone Network (PSTN). This facility may be submitted to regulatory conditions.

This ETS may be used by accredited test laboratories for type testing of the equipment. The performance of the equipment submitted for type testing should be representative for the performance of the corresponding production models.

This ETS also contains instructions for the presentation of equipment for type testing purposes.

The types of equipment covered by this ETS are as follows (see clause 4):

- professional wide band audio links for one-way transmission;
- professional wide band audio links for two-way transmission;
- professional wide band audio links with extra facilities.

2 Normative references

This 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 are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition or the publication referred to applies.

[1] I-ETS 300 422: "Radio Equipment and Systems (RES); Technical characteristics and test methods for wireless microphones in the 25 MHz to 3 GHz frequency range".

[2] CEPT Recommendation T/R 71-03: "Procedures for type testing and approval for radio equipment intended for non-public systems".

[3] Final draft prETS 300 445: "Radio Equipment and Systems (RES); Electro-Magnetic Compatibility (EMC) standard for wireless microphones and similar Radio Frequency (RF) audio link equipment".

[4] CEPT Recommendation T/R 20-06: "Transmitters and receivers for low power cordless microphone systems".

[5] ITU-R Recommendation 559-2: "Objective measurement of radio-frequency protection ratios in LF, MF and HF broadcasting".

[6] IEC 244: "Methods of measurement for radio transmitters".

[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 ETS, the following definitions apply:

carrier grid: An evenly spaced raster in a given frequency band for the allocation of carrier frequencies. The minimum distance of two carriers in use is a multiple of the raster dependent on type and usage of the equipment.

channel bandwidth: A frequency band of defined width (as a multiple of the carrier grid) including safety margin for operation on adjacent channels, located symmetrically around a carrier frequency in the carrier grid.

conducted measurements: Those measurements which are made using a direct 50 Ω connection to the equipment under test.

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

integral microphone: A microphone, designed as, and declared as by the manufacturer, an indispensable fixed part of the equipment.

limiter threshold: The audio input (output) level at which the transmitter audio limiter action may be said to commence. It is specified with any accessible variable gain controls set according to the manufacturer's instructions, with a sinusoidal input signal of 500 Hz.

occupied bandwidth: That part of the channel bandwidth which is required for the modulated signal. The occupied bandwidth has to be smaller than the channel bandwidth following standardized limits.

port: A port is any connection point on or within the Equipment Under Test (EUT) intended for the connection of cables to or from that equipment.

radiated measurements: Those measurements which involve measurement of a radiated field.

Radio Frequency (RF) port: An RF port is any connection point on or within EUT intended for the connection of RF cable. The RF port will be treated as a 50 Ω connection point unless otherwise specified by the manufacturer.

wide band audio link: A radio microphone of sufficient power to allow wireless (sometimes referred to as link radio microphone) connection over greater distances mainly for portable use. It may include in one mechanical unit more transmitting and receiving facilities than only for high quality audio application.

3.2 Symbols

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

E	Field strength
Eo	Reference field strength, annex A
R	Distance, annex A
Ro	Reference distance, annex A

3.3 Abbreviations

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

AR1	Alignment Range category 1 (subclause 5.1.3)
AR2	Alignment Range category 2 (subclause 5.1.3)
B	declared channel Bandwidth (see table 1)
erp	effective radiated power
EMC	Electro-Magnetic Compatibility
EUT	Equipment Under Test
GMSK	Gaussian Filtered Minimum Shift Keying
GTFM	Generalised Tamed Frequency Modulation
PSTN	Public Switched Telephone Network
RBW	Resolution BandWidth
RF	Radio Frequency
TDMA	Time Division Multiple Access
Tx	Transmitter
VBW	Video BandWidth
µPa	micro Pascal

4 Functional characteristics

4.1 Wide band audio link descriptions

Wide band audio links covered by this ETS are privately owned, and operated, communications systems for high quality reproduction of the audio input and/or related data or control signals. The equipment operates on a continuous carrier basis and will often be in operation for many hours. A wide band audio link system will at least consist of one transmitter and the corresponding receiver. The number depends on the application, e.g. live news contributions from a widespread area of an actual event may make it necessary to use several systems on separate simultaneous frequencies.

The radio part of the transmitter and receiver are made up exclusively from equipment that has been approved according to this ETS. When radio equipment or parts covered by other standards are included in the wide band audio link these shall fulfil the specifications of the applicable standards. As an example modular solutions may include, beside the main wide band transmitter, an additional receiver for narrow band communication and/or a monitor receiver for foldback signals. At the receiver end of this link, a wide band receiver, coupled with a narrow band transmitter, would be required.

Other equipment that may be connected to it shall fulfil the standards applicable to that equipment (if any).

Wide band audio links normally use wide band frequency modulation to achieve the necessary audio performance. For the majority of applications the modulated transmitter signal covers a bandwidth allowing channel spacing of 200 kHz. This allows for the use of stereo multiplex encoded signals to transmit without the need for two separate wide band channels.

5 General

5.1 Presentation of equipment for testing purposes

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

The applicant shall complete the appropriate application form when submitting equipment for type testing.

Table 1: Channel bandwidth designation (channel allocation within 25 kHz carrier grid)

Declared channel bandwidth	Designation
50 kHz	L
75 kHz	M
100 kHz	P
150 kHz	Q
200 kHz	R

The applicant shall state:

- the channel bandwidth(s) within which the equipment is designed to operate chosen from table 1; and

- the audio input limiting threshold (see subclause 5.2.2).

The applicant shall also supply all relevant interface information to allow:

- dc connection;
- RF connection;
- audio connection;
- the limiting threshold for the transmitter; and
- the setting of any input audio - level controls for normal operation, for a sinusoidal input signal of 500 Hz. The manufacturer shall specify the settings of any other controls necessary to avoid invalidating the measurement.

The applicant should also supply an operating manual for the device(s).

To simplify and harmonise the type testing procedures between the different test laboratories, measurement shall be performed, according to this ETS, on samples of equipment defined in subclauses 5.1.1 to 5.1.12.2.

For audio links which are intended to use a variety of audio capsules the manufacturer shall supply the test sample with an audio test fixture to substitute the audio capsule with suitable input and output impedances.

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

5.1.1 Choice of model for type testing

The applicant shall provide one or more production model(s) of the equipment, including all antennae which are required to be covered by the 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.

In the case of wide band audio link equipment without a permanent external RF port, (see subclause 5.1.12).

5.1.2 Definitions of alignment and switching ranges

The applicant shall, when submitting equipment for test, state the alignment ranges for the receiver and transmitter.

The alignment range is defined as the frequency range over which the receiver and the transmitter can be programmed and/or realigned to operate with a single oscillator frequency multiplication, without any physical change of components other than:

- programmable read only memories supplied by the manufacturer or the manufacturer's nominee;
- crystals;
- frequency setting elements (for the receiver and transmitter).

The applicant shall also state the switching range of the receiver and the transmitter (which may differ).

The switching range is the maximum frequency range over which the receiver or the transmitter can be operated without reprogramming or realignment.

5.1.3 Definition of the categories of the alignment range (AR1 and AR2)

The alignment range for the receiver and transmitter, which may be different, falls into one of two categories, (see annex C):

AR1 this corresponds to a limit of less than or equal to 10 % of the highest frequency of the alignment range, which is equal to or less than 500 MHz, or less than 5 % where the highest alignment frequency is above 500 MHz; or

AR2 this corresponds to a limit of greater than or equal to 10 % of the highest frequency of the alignment range, which is equal to or less than 500 MHz, or greater than 5 % where the highest alignment frequency is above 500 MHz.

5.1.4 Choice of frequencies

The frequencies for testing shall be chosen by the applicant, in accordance with subclauses 5.1.5 to 5.1.11.

5.1.5 Testing of single channel equipment of category AR1

Full tests shall be carried out on a channel within 100 kHz of the centre frequency of the alignment range on one sample of the equipment.

5.1.6 Testing of single channel equipment of category AR2

Three samples shall be tested. Tests shall be carried out on a total set of three channels.

Sample one shall be within 100 kHz of the highest frequency of the alignment range.

Sample two shall be within 100 kHz of the lowest frequency of the alignment range.

Sample three shall be within 100 kHz of the centre frequency of the alignment range.

Full tests shall be carried out on all three channels.

5.1.7 Testing of two channel equipment of category AR1

One sample shall be submitted to enable tests to be carried out on both channels.

The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range. The frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range. In addition the average of the frequencies of the two channels shall be within 100 kHz of the centre frequency of the alignment range.

Full tests shall be carried out on both channels.

5.1.8 Testing of two channel equipment of category AR2

Three samples of the equipment shall be tested. Tests shall be carried out on a total of four channels.

The highest frequency of the switching range of one sample shall be within 100 kHz of the centre frequency of the alignment range. The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range and the frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range.

Full tests shall be carried out on both channels.

The frequency of one of the channels of the second sample shall be within 100 kHz of the highest frequency of the alignment range.

Full tests shall be carried out on this channel.

The frequency of one of the channels of the third sample shall be within 100 kHz of the lowest frequency of the alignment range.

Full tests shall be carried out on this channel.

5.1.9 Testing of multichannel equipment (more than two channels) of category AR1

One sample of the equipment shall be submitted to enable tests to be carried out on three channels. The centre frequency of the switching range of the sample shall correspond to the centre frequency of the alignment range.

Full tests shall be carried out on a frequency within 100 kHz of the centre, lowest and highest frequencies of the switching range.

5.1.10 Testing of multichannel equipment (more than two channels) of category AR2 where the switching range is less than the alignment range

Three samples of the equipment shall be tested. Tests shall be carried out on a total of five channels.

The centre frequency of the switching range of one sample shall be within 100 kHz of the centre frequency of the alignment range. The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range and the frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range.

Full tests shall be carried out on the centre and upper and lower channels.

The frequency of one of the channels of the second sample shall be within 100 kHz of the highest frequency of the alignment range.

Full tests shall be carried out on this channel.

The frequency of one of the channels of the third sample shall be within 100 kHz of the lowest frequency of the alignment range.

Full tests shall be carried out on this channel.

5.1.11 Testing of multichannel equipment (more than two channels) of category AR2 where the switching range is equal to the alignment range

One sample shall be submitted to enable tests to be carried out on three channels.

The centre frequency of the switching range of the sample shall correspond to the centre frequency of the alignment range.

Full tests shall be carried out on a frequency within 100 kHz of the centre frequency of the switching range and within 100 kHz of the lowest and also within 100 kHz of the highest frequency of the switching range.

5.1.12 Testing of equipment without a permanent external RF port

To facilitate relative measurements, use can be made of a test fixture as described in subclause 7.3 or the equipment can be supplied with a permanent internal or temporary internal/external RF port.

5.1.12.1 Equipment with a permanent internal RF port

The way to access a permanent internal RF port shall be stated by the applicant with the aid of a diagram. The fact that use has been made of the permanent internal RF port shall be recorded in the test report.

5.1.12.2 Equipment with a temporary RF port

The applicant shall submit two sets of equipment to the test laboratory, one fitted with a temporary 50 Ω RF connector with the antenna disconnected and the other with the antenna connected. Each equipment shall be used for the appropriate tests.

The way the temporary RF port is implemented shall be stated by the applicant with the aid of a diagram. The fact that use has been made of the temporary RF port to facilitate measurements shall be stated in the test report. The addition of a temporary RF port should not influence the performance of the equipment under test.

5.2 Mechanical and electrical design

5.2.1 General

The equipment submitted by the applicant 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.

5.2.2 Limiting threshold

The limiting threshold is defined as the minimum audio input level at which the slope of the audio input/output transfer curve, with the levels expressed in dB, is greater or equal to 4:1 (see figure 1). For non-linear or companded systems, this point is determined with a complementary audio decoding module connected to the test demodulator. The measurement is made at 500 Hz with any user accessible gain controls set according to the manufacturer's instructions.

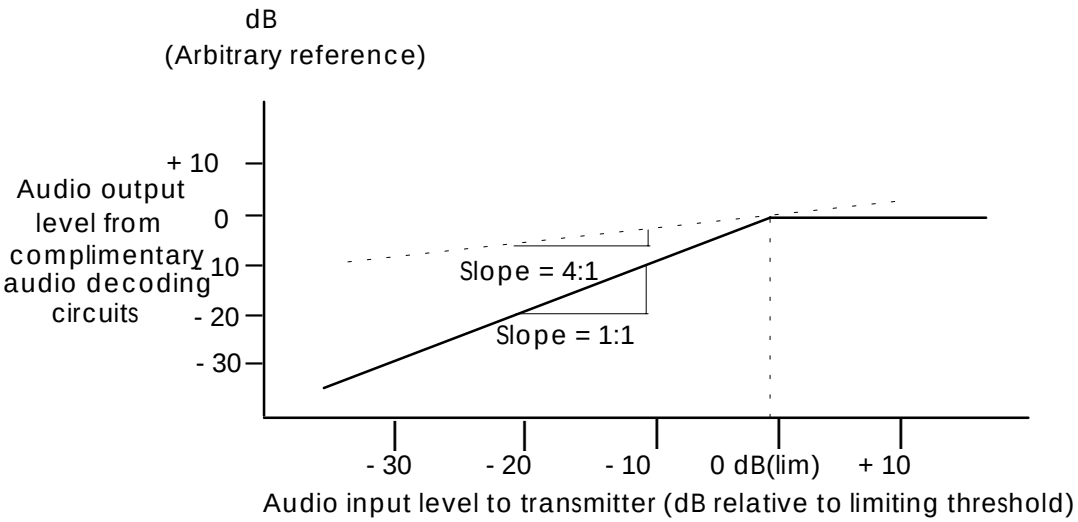


Figure 1: Determination of audio input limiting threshold

In the case of a transmitter designed for acoustical input only, with an integral microphone and no limiter, a sound pressure of 128 dB relative to 20 μPa is regarded as the limiting threshold.

5.2.3 Controls

Those controls which, if maladjusted, might increase the interfering potentialities of the equipment shall only be accessible by partial or complete disassembly of the device and requiring the use of tools.

5.2.4 Integral antenna

Type approval of equipment with integral antenna only applies to that equipment together with the antennas originally provided by the manufacturer for type testing.

5.2.5 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible, tamper-proof and durable.

The marking shall include:

- the name of the manufacturer or his trade mark;
- the type designation of the manufacturer;
- serial number;
- operational frequency range;
- national and/or international marking;
- modulation type;

or a normally readable label, plus:

- electronically, in a secure format, containing information as detailed above which is easily readable by either the receiver provided by the manufacturer or a reading system provided by the manufacturer with each transmitter.

5.3 Interpretation of the measurement results

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

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the ETS;

- the measurement uncertainty value for the measurement of each parameter shall be separately included in the test report;

- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in the table of measurement uncertainty as in clause 10.

6 Test conditions, power sources and ambient conditions

6.1 Normal and extreme test conditions

Type tests 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 6.2 to 6.4.2.4.

6.2 Test power source

During type tests the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in subclauses 6.3.2 and 6.4.2. The internal impedance of the test power shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the power source shall be measured at the input terminals of the equipment.

For battery operated equipment, the battery shall be removed and the test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements any external power leads should be arranged so as not to affect the measurements. If necessary the external power supply may be replaced with its own internal batteries at the required voltage, this shall be stated on the test report.

If the equipment is provided with a power cable or power socket, the test voltage shall be that measured at the point of connection of the power cable to the equipment.

During tests the power source voltages shall be within a tolerance of $< \pm 1$ % 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 < ± 1 % relative to the voltage at the beginning of each test.

6.3 Normal test conditions

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

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

6.3.2 Normal test power source voltage

6.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of this ETS, the nominal 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 and 51 Hz.

6.3.2.2 Nickel-Cadmium cells

When the radio equipment is intended for operation from the usual types of nickel-cadmium cell the nominal test voltage shall be 1,2 volts per cell.

6.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment manufacturer and approved by the test laboratory. Such values shall be stated in the test report.

6.4 Extreme Test Conditions

6.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in subclause 6.4.1.1, at the following temperatures:

a) - 10°C;

b) + 45°C.

6.4.1.1 Procedures 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. If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour 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.

Before tests at the higher temperatures, the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, 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 standby or receive condition for one minute after which the equipment shall meet the specified requirements.

6.4.2 Extreme test power source voltages

6.4.2.1 Mains voltage

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

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

6.4.2.2 Rechargeable battery power sources

When the radio equipment is intended for operation from nickel-cadmium cells, the extreme test voltage shall be 1,3 and 0,9 times the nominal voltage of the battery. For other types of battery the lower extreme test voltage for discharged condition shall be declared by the equipment manufacturer.

6.4.2.3 Power sources using other types of batteries

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

a) for the Leclanche' or the lithium type of battery:

   0,85 times the nominal voltage of the battery;

b) for the mercury type of battery:

   0,9 times the nominal voltage of the battery;

c) for other types of primary batteries:

   end point voltage declared by the equipment manufacturer.

No upper extreme test voltages apply.

6.4.2.4 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 equipment manufacturer and the testing laboratory and shall be recorded with the results.

7 General conditions

7.1 Normal test modulation

For normal test modulation, the audio frequency shall be a sinusoidal tone of a 500 Hz, set at an input level to the transmitter 8 dB below the audio limiting threshold defined in subclauses 5.1 and 5.2.2.

For the purpose of determining the transmitter necessary bandwidth, coloured noise according to ITU-R Recommendation 559-2 [5] shall be used, according to the method laid down in subclause 8.3.2. The resulting spectral distribution is shown in figure 2. This noise may be generated by a white noise source followed by passive filter shown in figure 3.

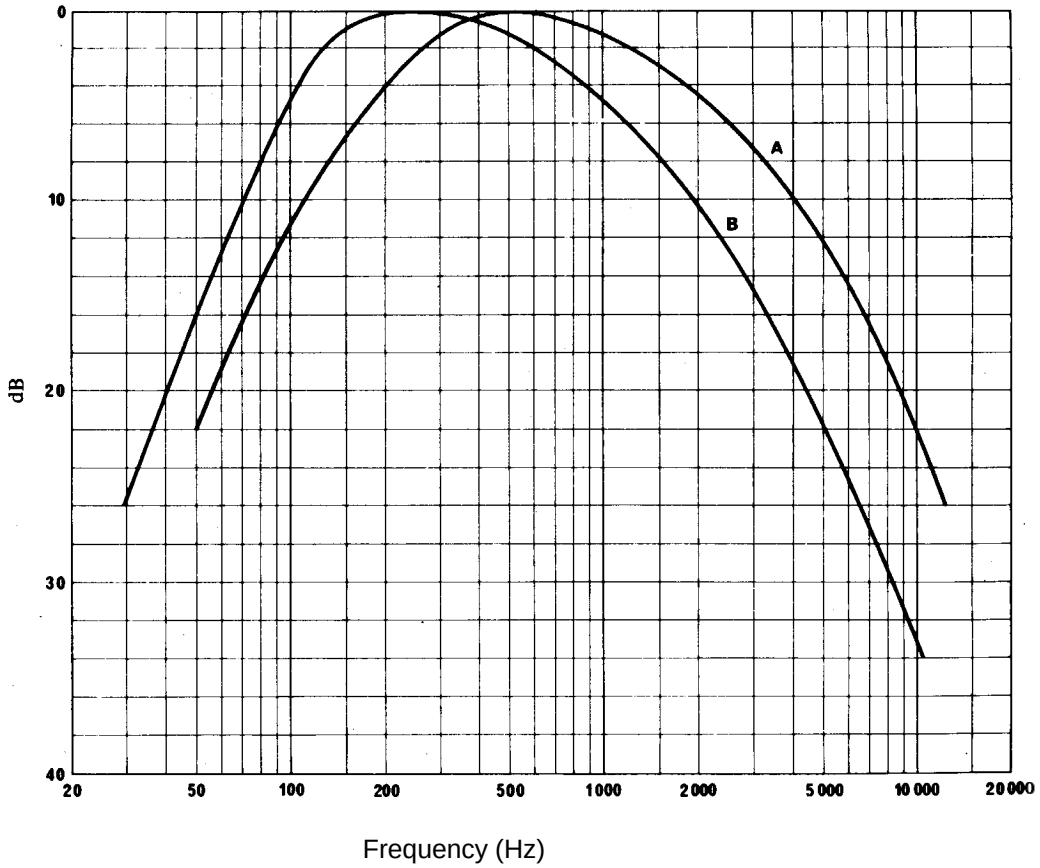


Figure 2: Spectral distribution for determining transmitter necessary bandwidth

Curve A = Frequency spectrum of standardized noise (measured with one-third octave filters).

Curve B = Frequency response characteristics of filter-circuit.

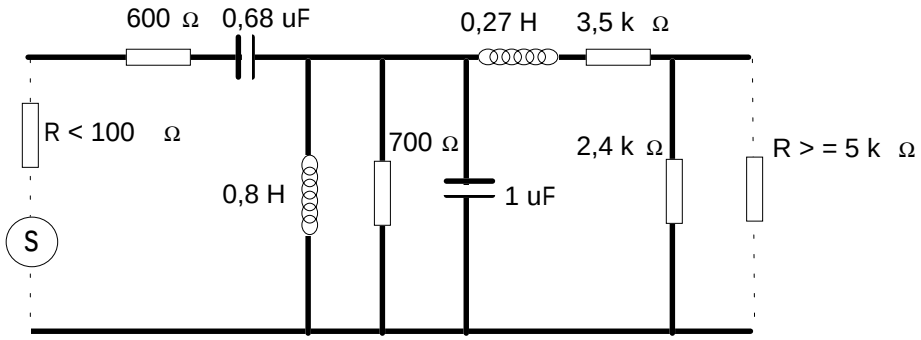


Figure 3: Filter circuit

7.2 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 The return loss measured at the 50 Ω connector shall be ≥ 20 dB at the operating frequency of the equipment under test and ≥ 14 dB at any measured unwanted frequency outside this band.

7.3 Test fixture

The applicant may be required to supply a test fixture suitable to allow relative measurements to be made on the submitted sample.

In all cases, the test fixture shall provide:

- a connection to an external power supply;

- an audio interface either by direct connection or by an acoustic coupler.

In addition the test fixture for integral antenna equipment shall contain a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to an RF port at the working frequencies of the equipment under test. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements may be performed and only those at or near frequencies for which the test fixture has been calibrated.

The performance characteristics of the test fixture shall be agreed upon with the accredited test laboratory and shall conform to the following basic parameters:

- the circuitry associated with the RF coupling shall contain no active or non-linear devices;
- the coupling loss shall not influence the measuring results;
- the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people;
- the coupling loss shall be reproducible when the equipment under test is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

7.4 Test site 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.

7.5 Modes of operation of the transmitter

For the purpose of the measurements, according to this ETS, there should preferably be a facility to operate the transmitter in an unmodulated state. The method of achieving an unmodulated carrier frequency or special types of modulation patterns may also be decided by agreement between the manufacturer and the testing laboratory. It shall be described in the test report. It may involve suitable temporary internal modifications of the equipment under test. If it is not possible to provide an unmodulated carrier then this shall be stated in the test report.

7.6 Arrangement for test signals at the input of the transmitter

For the purpose of this ETS, the transmitter audio frequency modulation signal shall be supplied by a generator at the correct impedance applied at the connections of the stated audio input, unless otherwise stated.

7.7 Arrangements for test signals applied to the receiver via a test fixture or a test antenna

Sources of test signals for application to the receiver via a test fixture (see subclause 7.3), or an artificial antenna (see subclause 7.2) shall be connected in such a way that the impedance presented to the test fixture, or the artificial antenna is 50 Ω.

This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.

The effects of any intermodulation products and noise produced in the signal generators should be negligible.

8 Methods of measurement and limits for transmitter parameters

All tests shall be carried out under normal conditions unless otherwise stated. The channel bandwidth declared by the applicant in subclause 5.1 shall be used to determine whether the limits in subclauses 8.1.3 and 8.3 are fulfilled.

8.1 Frequency error

8.1.1 Definition

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

8.1.2 Method of measurement

The carrier frequency shall be measured (in the absence of modulation) with the transmitter connected to an artificial antenna (see subclause 7.2). A transmitter without an RF port may be placed in the test fixture (see subclause 7.3) connected to an artificial antenna. The measurement shall be made under normal (see subclause 6.3) and extreme (see subclauses 6.4.1 and 6.4.2) test conditions.

Wide band audio links which also include an RF port for use with other external antennas shall be type tested using this port.

8.1.3 Limit

The frequency error shall not exceed the values given in table 2.

Table 2: Frequency error (kHz)

Operating frequency	Normal test conditions		Extreme test conditions	
	Channel bandwidths of 100, 150, and 200 kHz	Channel bandwidths of 75 and 50 kHz	Channel bandwidths of 100, 150, and 200 kHz	Channel bandwidths of 75 and 50 kHz
25 to 88 MHz	3 kHz	2 kHz	5 kHz	3 kHz
> 88 to 300 MHz	7 kHz	3 kHz	10 kHz	5 kHz
> 300 to 1 000 MHz	10 kHz	6 kHz	15 kHz	7 kHz
> 1 000 to 3 000 MHz	25 kHz	14 kHz	32 kHz	18 kHz

8.2 Carrier power

8.2.1 Definition

The transmitter carrier power is the mean power delivered to the artificial antenna during a radio frequency cycle or, in the case of equipment with integral antenna; the effective radiated power in the direction of maximum field strength under specified conditions of measurement (see subclause 7.5), if possible in the absence of modulation. The stated output power is the carrier power declared by the manufacturer. For equipment with a permanent external RF port, tests in subclause 8.2.2 shall apply.

8.2.2 Method of measurement for equipment without integral antenna

This subclause applies to equipment with a permanent RF port. The transmitter shall be connected to an artificial antenna (see subclause 7.2) and the power delivered to this artificial antenna shall be measured.

The measurements shall be made under normal test conditions (see subclause 6.3) and extreme test conditions (subclause 6.4, subclauses 6.4.1 and 6.4.2 applied simultaneously).

8.2.3 Method of measurement for equipment with integral antenna

8.2.3.1 Method of measurement under normal test conditions

On a test site, fulfilling the requirements of subclause 7.4 the sample shall be placed on the support in the following position:

- for equipment with internal antenna, it shall stand vertically, with that axis vertical which is closest to vertical in normal use;

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

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

The transmitters shall be switched on, without modulation, and the test receiver shall be tuned to the frequency of the signal being measured. The test antenna shall be oriented for vertical polarisation and shall be raised or lowered through the specified height range until a maximum signal level is detected on the test receiver.

The transmitter shall be rotated horizontally through 360° until the highest maximum signal is received.

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

The transmitter shall be replaced by the substitution antenna, as defined in subclause A.1.3 of annex A and the test antenna raised or lowered as necessary to ensure that the maximum signal is still received. 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.

The carrier power is equal to the power supplied to the substitution antenna, increased by the known relationship if necessary.

The measurement shall be repeated for any alternative antenna supplied by the applicant.

A check should be made at other planes of polarisation to ensure that the value obtained above is the maximum. If larger values are obtained, this fact should be recorded in the test report.

8.2.3.2 Method of measurement under extreme test conditions

The measurements shall also be performed under extreme test conditions. Due to the impossibility of repeating the measurement on a test site under extreme temperature conditions, a relative measurement is performed, using the test fixture (see subclause 7.3).

The equipment shall be placed in the test fixture and the power delivered to the artificial antenna is measured under normal test conditions (see subclause 6.3) and the extreme test conditions (subclauses 6.4.1 and 6.4.2 applied simultaneously). The difference in dB is noted. This difference is algebraically added to the effective radiated power measured in subclause 8.2.3.1 in order to obtain the effective radiated power under extreme test conditions.

8.2.4 Limit

The carrier power under normal test conditions (see subclause 6.3) and extreme test conditions (subclause 6.4, subclauses 6.4.1. and 6.4.2 applied simultaneously) shall not exceed 25 W conducted or 25 W effective radiated power (erp).

The test sample(s) shall be tested within + 0 to - 6 dB of the declared power limit and separate measurements of any alternative power output taken and recorded.

8.3 Channel bandwidth

8.3.1 Definition

For the purpose of this ETS the channel bandwidth (B) is defined as the minimum declared bandwidth, within which the transmitter's necessary bandwidth can be contained. A table of preferred channel bandwidths is given in subclause 5.1. The necessary bandwidth of the transmitter is measured under the conditions laid down in subclause 8.3.2.

8.3.2 Measurement of Necessary Bandwidth (BN)

The arrangement of test equipment as shown in annex B shall be used.

With the AF signal generator (1) set to 500 Hz, the audio input level to the EUT shall be adjusted to 8 dB below the limiting threshold (- 8 dB (lim)) as declared by the manufacturer.

The corresponding audio output level from the demodulator shall be measured and recorded.

NOTE 1: The input impedance of the noise meter should be sufficiently high to avoid more than 0,1 dB change in input level when the meter is switched between input and output.

The audio input level shall be increased by 20 dB, i.e. to + 12 dB (lim) and the corresponding change in output level shall be measured.

It shall be checked that the audio output level increased by ≤ 10 dB.

NOTE 2: If this condition is not met, the audio initial input level should be increased from - 8 dB (lim) in 1 dB steps until the above condition is fulfilled, and the input level recorded in the test report. This level replaces the value derived from the manufacturer's declaration and is defined as - 8 dB (lim).

The AF signal generator shall be replaced with the weighted noise source to ITU-R Recommendation 559 [5], band-limited to 15 kHz as described in IEC 244 [6], Part 13, and the level shall be adjusted such that the input to the transmitter corresponds to + 12 dB (lim) measured in the flat (unweighted) condition of the noise meter.

NOTE 3: If the transmitter incorporates any ancillary coding or signalling channels (e.g. pilot-tones), these should be enabled prior to any spectral measurements.

NOTE 4: If the transmitter incorporates more than one audio input, e.g. stereo systems, the second and subsequent channels should be simultaneously driven from the same noise source, attenuated to a level of - 6 dB (lim).

Measure the transmitter RF output spectrum, using a spectrum analyser with the following settings:

- centre frequency: fc - Tx nominal Frequency;
- dispersion (Span): between x2 and x3 the channel bandwidth;
- Resolution BandWidth (RBW): 1 kHz;
- Video BandWidth (VBW): 1 kHz;
- detector: Peak hold.

8.3.3 Limits

The transmitter output spectrum shall be within the mask defined in figure 4, where B is the declared channel bandwidth (see note).

NOTE: If the spectrum is outside the mask then the transmitter may be declared compliant within the next larger channel bandwidth defined in subclause 5.1, subject to the agreement of the manufacturer. If the spectrum is outside the 200 kHz mask, the equipment shall be deemed not compliant.

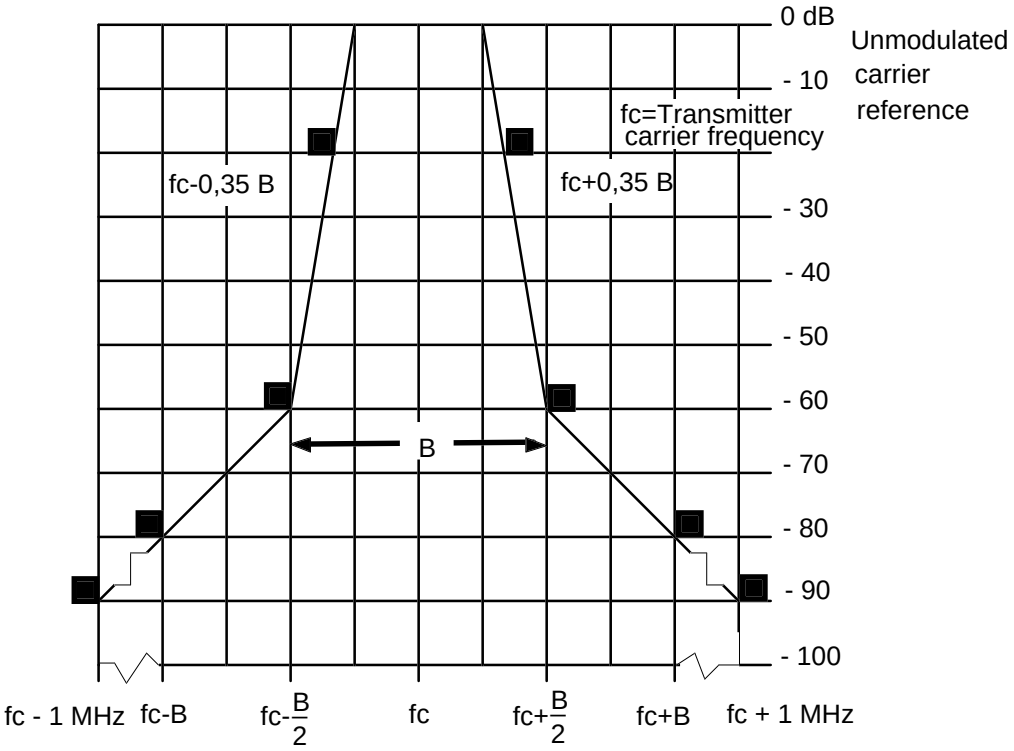


Figure 4: Spectral mask - normalized to channel bandwidth B (see table 1)

The measurement of transmitter (Tx) broad band noise floor shall be carried out in accordance with subclause 8.3.2. The - 90 dBc point shall be ± 1 MHz from fc measured with an average detector.

8.4 Spurious emissions

8.4.1 Definitions

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with modulation, radiated by the equipment and its antenna.

8.4.2 Method of measuring the effective radiated power

On a test site, fulfilling the requirements of annex A, the sample shall be placed at the specified height on a non-conducting support. The transmitter shall be operated at the carrier power specified under subclause 8.2, delivered to the antenna (see subclause 5.1.1) without modulation.

Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range specified below, excluding a 2 MHz band of frequencies centred on the channel on which the transmitter is intended to operate.

NOTE: The 2 MHz exclusion is covered by measurements carried out in subclause 8.3.

The measuring receiver shall be tuned over the frequency range 25 MHz to 4 GHz for equipment operating on frequencies below 1 GHz or in the frequency range of 25 MHz to 12,75 GHz for equipment operating on frequencies above 1 GHz.

At each frequency at which a spurious component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurement shall be repeated with the test antenna in the orthogonal polarization plane.

The measurement shall be repeated with the transmitter modulated with normal test modulation (see subclause 7.1).

If the transmitter allows for stand-by operation the tests shall be repeated in stand-by state.

8.4.3 Limits

Table 3: Radiated spurious power limits for frequencies greater than ± 1 MHz

Transmitter power	Radiated spurious power limit	
	Frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Up to 1 W	250 nW	1 µW
Up to 10 W	250 nW	1 µW
Above 10 W	250 nW	1 µW
Standby	2 nW	20 nW

NOTE: Spurious radiation within the range ± 1 MHz about the carrier frequency are covered by measurements carried out in subclause 8.3.

8.4.4 Measuring receiver

The term measuring receiver refers to either a selective voltmeter or a spectrum analyser. The bandwidth of the measuring receiver is given in table 4.

Table 4: Measuring receiver bandwidth

Frequency being measured: (f)	Measuring receiver bandwidth
150 kHz < f < 30 MHz	9 - 10 kHz
30 MHz < f < 1 000 MHz	100 - 120 kHz
f >1 000 MHz	1 MHz

8.5 Transient frequency behaviour of the transmitter

8.5.1 Definitions

The transient frequency behaviour of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when:

a) RF output power is switched on and off;

b) frequency is changed.

8.5.2 Method of measurement

The RF output port, in the case of equipment with integral antenna, the output of the RF coupling network (see subclause 7.3) is connected to a spectrum analyser and frequency counter (see figure 5). The transmitter should be set to operate at the required frequency (f_o) with no modulation applied, and the spectrum analyser controls set as follows:

- centre frequency: $f_c = f_o$;
- dispersion (span): ≈ 5 x B, when B = channel bandwidth;
- top of screen(reflection level): + 10 dBc;
- resolution bandwidth: 10 kHz;
- video bandwidth: 10 kHz;
- detector: Peak hold;
- sweep rate: Auto.

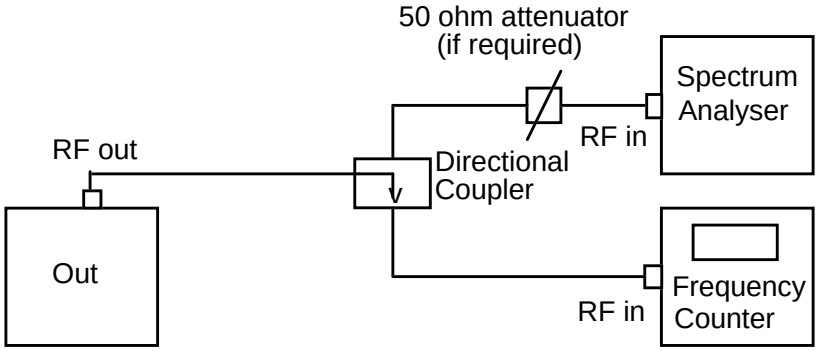


Figure 5: Transient frequency behaviour of the transmitter: method of measurement

a) set 0 dBc level on spectrum analyser 10 dB below top of screen (reference level);

b) switch off the transmitter and clear the spectrum analyser display;

c) switch on the transmitter and switch off again when the transmitter has achieved both nominal output power (0 dBc) and frequency (within the tolerance allowed in table 2). The transmitter shall remain off for 10 seconds;

d) repeat b) until a total of 10 cycles of switching have been completed.

The resulting spectrum analyser display shall lie within the mask shown in figure 6.

NOTE: A frequency monitor may be used instead of a spectrum analyser.

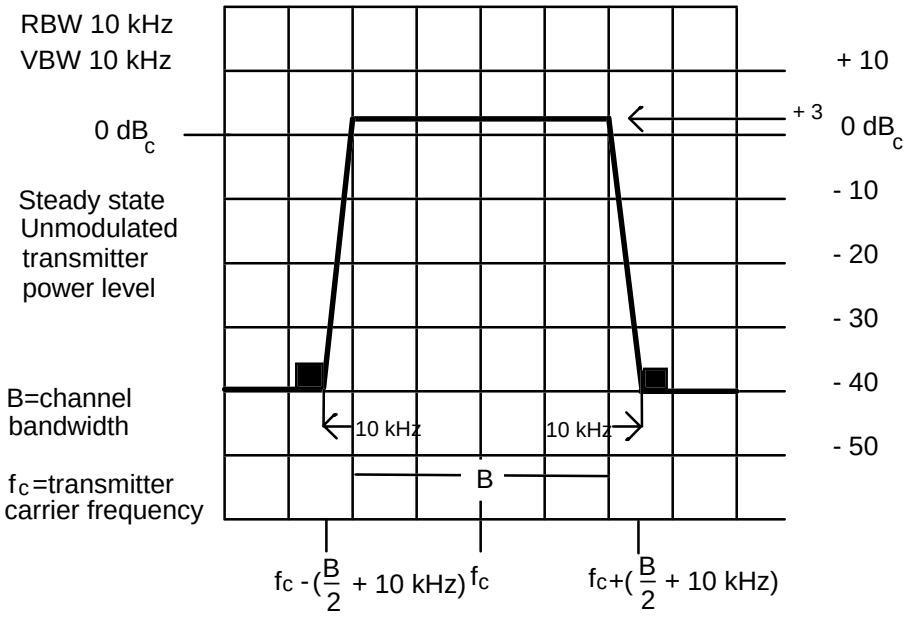


Figure 6: Mask for defining transient performance of unmodulated transmitter during switch on/off or frequency changing

8.5.3 Method of measurement for frequency changing

This test shall only be applied to multichannel equipment incorporating frequency selection which can be switched with the transmitter powered.

The test method and setup are similar to those specified in subclause 8.5.2 with the transmitter switched between the highest and lowest operational channels (fc1 and fc2). The spectrum analyser display shall be stored and compared to figure 6 for:

- 10 switching cycles between fc2 and fc1, with the display centred on fc1;

- 10 switching cycles between fc1 and fc2, with the display centred on fc1.

The resulting spectrum analyser display shall lie within the spectrum mask (figure 6).

8.5.4 Limits

The transmit output power shall be ≤ 30 dBc until the carrier frequency is within the channel bandwidth as defined by mask in figure 6.

NOTE: Measurement cycle starts when RF power exceeds 250 nW. The time at which the output power is less than - 30 dBc shall be limited to 5 seconds.

9 Receiver

9.1 Spurious emissions

9.1.1 Definitions

Spurious emissions from the receiver are radio frequency emissions at any frequency, generated by the equipment, antenna, aerial amplifier, down converters or filter.

Manufacturers shall provide a representative sample of the receiver system. The level of spurious emissions shall be measured by either:

a) - the power level from an external RF port; and

- 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 hand-portable equipment fitted with such an antenna and no external RF port.

9.1.2 Method of measuring the power level in a specified load

This method applies only to equipment with an external RF port.

The external RF port of the receiver under test shall be connected to a measuring receiver. The receiver under test shall be switched on, and the measuring receiver shall be tuned over the frequency range 25 MHz to 4 GHz for equipment operating on frequencies below 1 GHz, or in the frequency range of 25 MHz to 12,75 GHz for equipment operating on frequencies above 1 GHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the spurious level delivered into the specified load.

9.1.3 Method of measuring the effective radiated power of the enclosure

This method applies only to equipment with an external RF port.

On a test site, selected from annex A, the equipment shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the manufacturer. The receiver antenna connector shall be connected to an artificial antenna, see subclause 7.2.

The test antenna shall be oriented for vertical polarisation and the length of the test antenna shall be chosen to correspond to the instant frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver. The receiver shall be switched on and the measuring receiver shall be tuned over the frequency range as specified in subclause 9.1.2. At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver. When a test site according to annex A, clause A.3 is used there is no need to vary the height of the antenna. The receiver shall then be rotated through 360° in the horizontal plane until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.

The receiver shall be replaced by a substitution antenna as defined in annex A, subclause A.1.3.

The substitution antenna shall be oriented for vertical polarisation and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

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

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

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

The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received. The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver. The input level to the substitution antenna shall be recorded as power level, corrected for the change of input attenuator setting of the measuring receiver.

The measurement shall be repeated with the test antenna and the substitution antenna oriented for horizontal polarisation.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary.

9.1.4 Method of measuring the effective radiated power

This method applies only to equipment with an integral antenna.

The method of measurement shall be performed according to annex A, subclause A.1.3, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

9.2 Limits

Table 5: Spurious limits

	25 to 1 000 MHz	Frequencies above 1 000 MHz
erp or conducted	2 nW	20 nW

10 Measurement uncertainty

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

The tolerance for the measurement of the following parameters shall be as given below:

Valid to 1 GHz for the RF parameters unless otherwise stated.

Table 6: Measurement uncertainty

Parameter	Uncertainty
RF frequency	$< \pm 1 \times 10^{-7}$
Audio output power	< ± 0,5 dB
Radiated RF power	< ± 6 dB
Conducted RF power variations using a test fixture	< ± 0,75 dB
Maximum frequency deviation - within 300 Hz and 6 kHz of audio frequency - within 6 kHz and 25 kHz of audio frequency	 < ± 5 % < ± 3 dB
Deviation limitation	< ± 5 %
Adjacent channel power	< ± 5 dB
Amplitude characteristic of receiver limiter	< ± 1,5 dB
Sensitivity at 20 dB SINAD	< ± 3 dB
Two-signal measurement valid up to 4 GHz (using a test fixture)	< ± 4 dB
Two-signal measurement using radiated fields	< ± 6 dB
Three-signal measurement (using a test fixture)	< ± 3 dB
Radiated emission of transmitter, valid up to 12,75 GHz	< ± 6 dB
Radiated emission of receiver, valid up to 12,75 GHz	< ± 6 dB
Transmitter transient time	< ± 20 %
Transmitter transient frequency	< ± 250 Hz

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

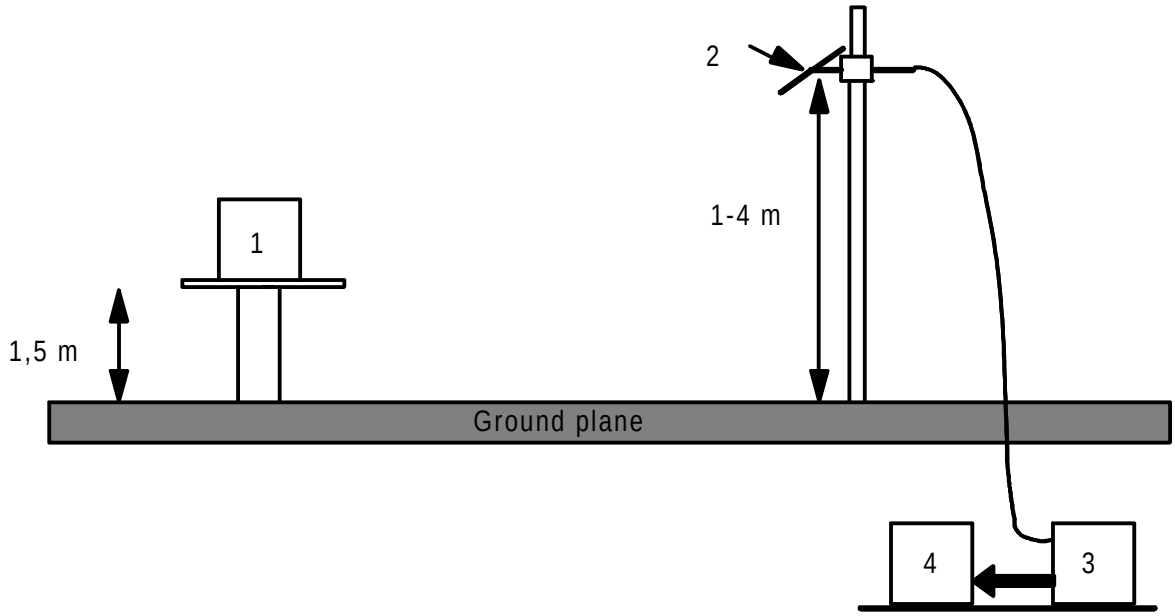
Annex A (normative): Radiated measurement

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 or rotation through 360° in the horizontal plane, shall be used to support the test sample 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 and ground reflections do not degrade the measurement result.



1) Equipment under test;
2) Test antenna;
3) High pass filter (necessary for strong fundamental Tx radiation);
4) Spectrum analyser or measuring receiver.

Figure A.1: Outdoor test site

A.1.1.1 Test support for body worn equipment

For equipment intended to be worn close to the body and operating on frequencies below 50 MHz, but excluding hand-held equipment, the non-conducting support shall be replaced with the simulated man.

The simulated man shall consist of a plastic tube, filled with salt water (9 g NaCl per litre). The tube shall have a length of 1,5 m and an internal diameter of 10 ± 0,5 cm. The upper end of the tube is closed by a metal plate with a diameter of 15 cm, which is in contact with the water. To meet the requirements made on equipment with rigid outside antenna that this antenna shall be in a vertical position during the measurement, the metal plate shall, if necessary, be prepared in such a way that a second hinged metal plate of 10 cm x 15 cm can be fastened to its narrow side. It should be possible to change the supporting point of the hinged plate as far as the centre.

The position of the hinged plate shall be adjusted within 0° to 90° with respect to the lower metal plate.

The sample shall be fastened in such a way that:

a) the centre of its largest area rests on the revolving metal plate; and

b) this centre, on its part, is located above the centre of the lower metal plate by changing the supporting point of the revolving plate.

In the case of samples, whose largest area is smaller than 10 cm x 15 cm, the centre of the sample shall (deviating from point a) above) be so changed in its longitudinal axis that the antenna base is at the edge outside the metal plate.

A.1.1.2 Standard position

The standard position on all test sites, except for equipment that is intended to be worn on a person, shall be as follows:

- for equipment with an integral antenna, it shall be placed in the position closest to normal use as declared by the applicant;

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

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

A.1.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics.

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 m 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. For receiver radiated sensitivity measurements the test antenna is connected to a signal generator.

A.1.3 Substitution antenna

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a $\lambda/2$ dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the $\lambda/2$ dipole. 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 external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

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

A.1.4 Optional additional indoor site

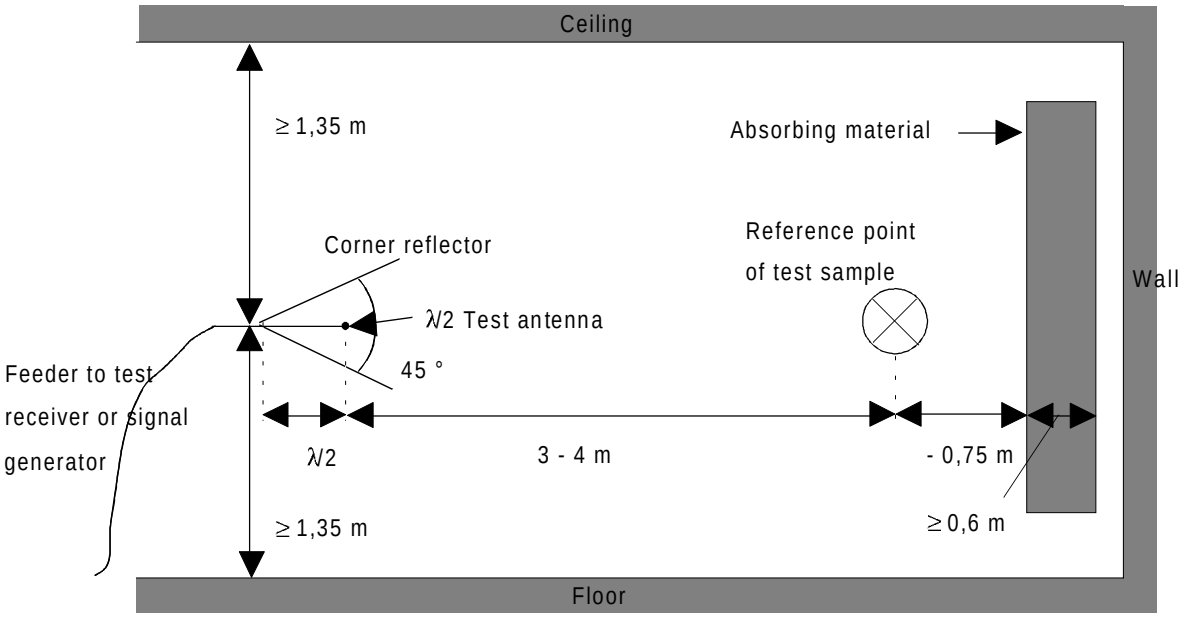


Figure A.2: Indoor site arrangement (shown in horizontal polarisation)

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 λ/2 antenna in figure A.2 may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of λ/2 to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method. To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ± 10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-sited until a change of less than 2 dB is obtained.

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 of this annex. When using such a test site, the conditions in the following subclauses 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 m, 5 m, 10 m 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 m 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

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below about 80 MHz. Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site. Correction factors shall be taken into account when shortened dipole antennas are used.

A.2.4 Artificial antenna

The dimensions of the artificial antenna used during radiated measurements should be small in relation to the sample under test.

Where possible, a direct connection should be used between the artificial antenna and the test sample.

In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores or double screened cables.

A.2.5 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables, etc.) which are not adequately de-coupled 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 an anechoic 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 free space environment. If such a chamber is used, this shall be recorded in the test report.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method, clause A.1. In the range between 25 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 m to 5 m in the long middle axis of the chamber can be used for measurements up to 12,75 GHz. The construction of the anechoic chamber is described in the following clauses.

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 absorbers approximately 1 m high. The base is covered with absorbers that are able to support a form of floor. 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 2 λ.

The floor absorbers reject 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 measuring tolerances 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 $E = E_o(R_o/R)$ is valid for the dependence of the field strength E on the distance R, whereby E_o is the reference field strength in the reference distance R_o.

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 12,75 GHz, because more reflections will occur, the dependence of the field strength on the distance will not correlate so closely.

A.3.3 Calibration of the shielded anechoic chamber

Careful calibration of the chamber shall be performed over the range 25 MHz to 12,75 GHz.

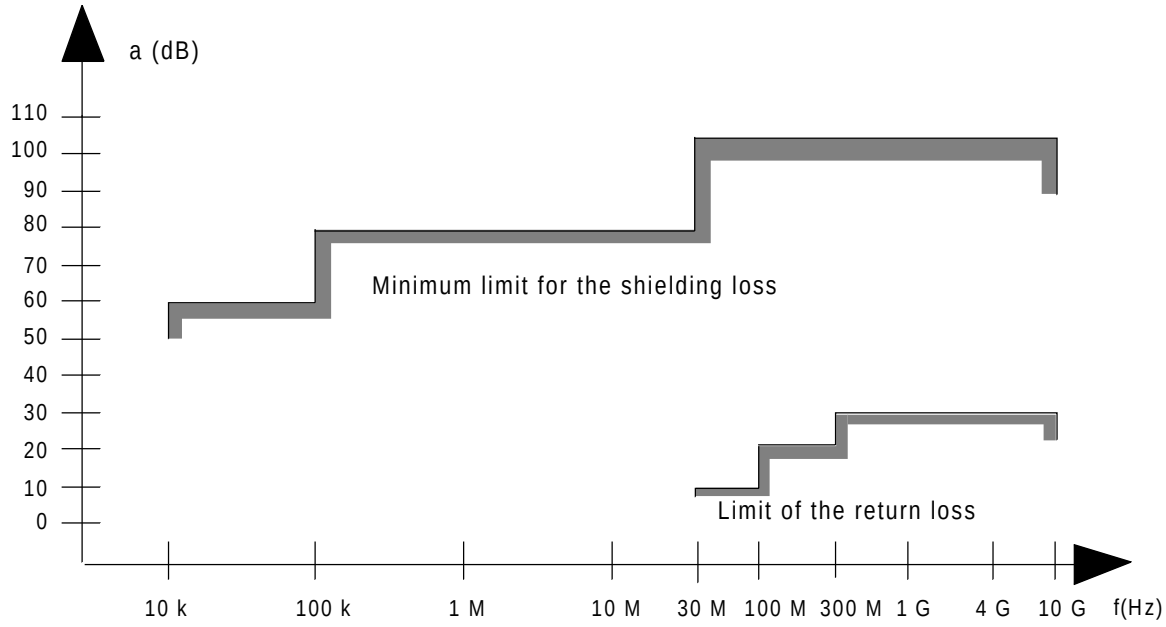


Figure A.3: Specifications for shielding and reflections

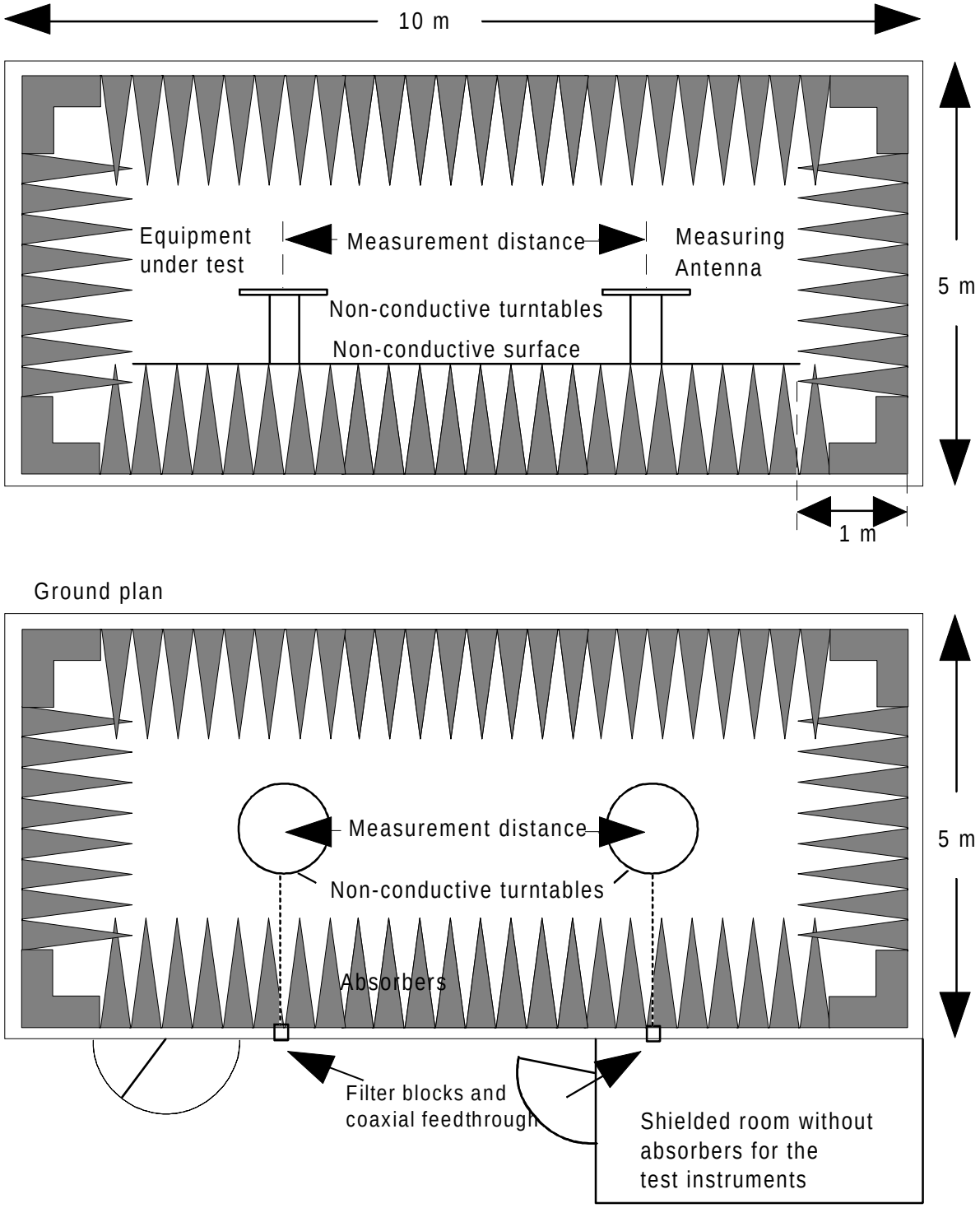
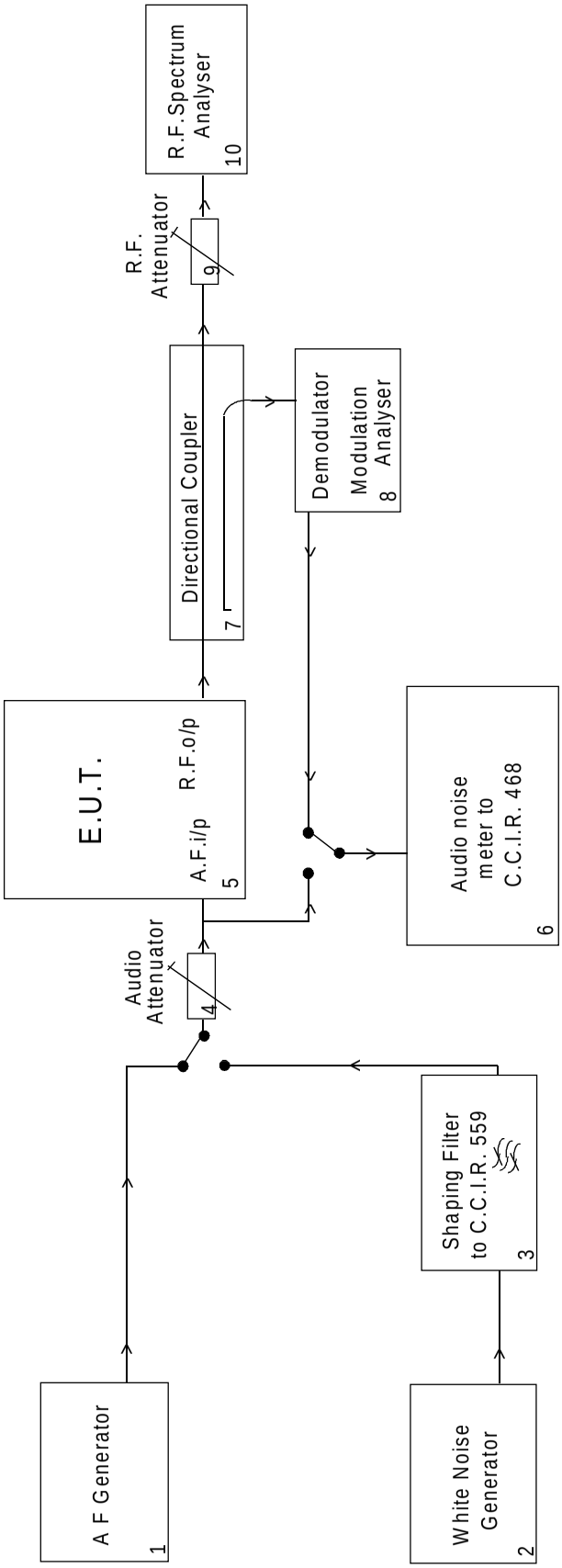


Figure A.4: Example of construction of an anechoic shielded chamber

Annex B (normative): Measurement of Necessary Bandwidth (BN)

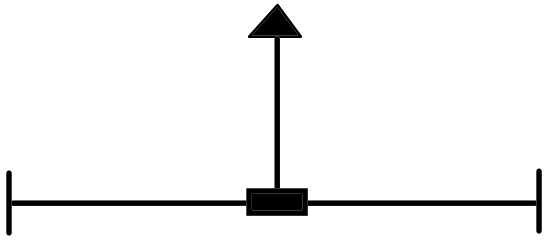


NOTE: If the E.U.T incorporates ancillary coding or signalling channels, for example, pilot tone, etc. there should be switched on prior to measuring the transmitter R.F. output spectrum.

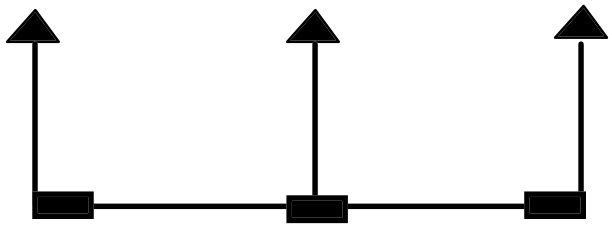
Figure B.1: Measurement of necessary bandwidth

Annex C (informative): Graphic representation of the selection of equipment and frequencies for testing of single and multi-frequency equipment

Single frequency equipment

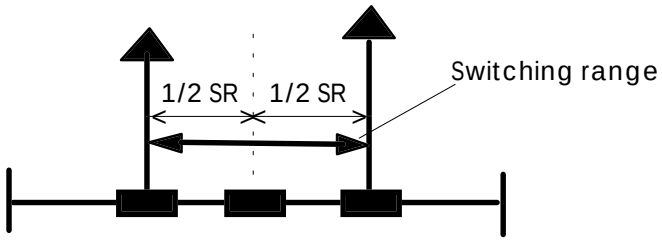


Equipment of category AR 1 (see subclause 5.1.5)

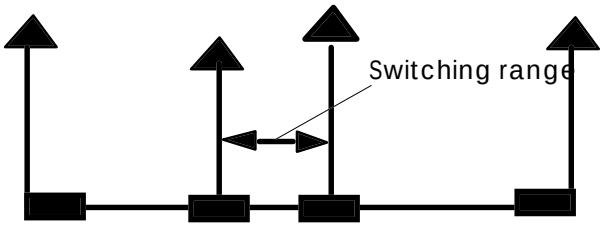


Equipment of category AR 2 (see subclause 5.1.6)

Two frequency equipment



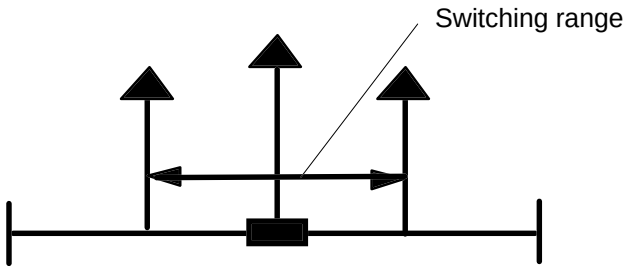
Equipment of category AR 1 (see subclause 5.1.7)



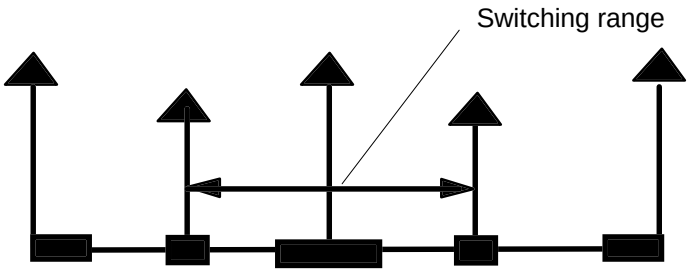
Equipment of category AR 2 (see subclause 5.1.8)

Figure C.1: Single/Two frequency equipment

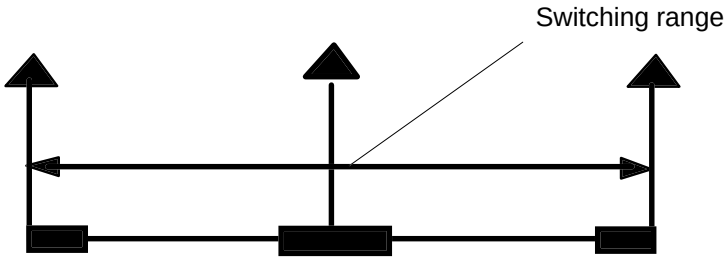
Multi frequency Equipment



Equipment of category AR 1 (see subclause 5.1.9)



Equipment of category AR 2 (see subclause 5.1.10)



Equipment of category AR 2 (see subclause 5.1.11)

AR = SR

Legend:

AR1 -- First category of alignment range (see subclause 5.1.3)

AR2 -- Second category of alignment range (see subclause 5.1.3)

100 kHz range in which the test is carried out.....

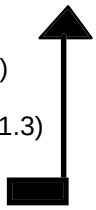


Figure C.2: Multi frequency equipment

History

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