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Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band; Part 1: Technical characteristics and methods of measurement

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Vote phase of the ETSI standards Two-step Approval Procedure.

For non-EU countries the present document may be used for regulatory (Type Approval) purposes.

The present document is part 1 of a multipart deliverable covering the technical characteristics and methods for Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band, as identified below:

Part 1: "Technical characteristics and methods of measurement";

Part 2: "Harmonized EN under article 3.2 of the R&TTE Directive".

Annex A provides normative specifications concerning radiated measurements.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The present document is intended to specify the minimum performance characteristics and the methods of measurement for Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band.

The present document provides the necessary parameters for equipment to obtain common approval throughout Europe. It also is intended to make it easier for the frequency management authorities to find harmonized frequency allocations.

Common technical specifications and harmonized frequency allocations are expected to reduce greatly the present problems of interference and illegal use.

The present document is a testing standard based on spectrum utilization parameters and does not include performance characteristics that may be required by the user or requirements for interfacing equipment.

In preparing the present document, 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.

1 Scope

The present document 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 that may be required by a user, nor does it necessarily represent the optimum performance achievable.

The present document applies to terrestrial wireless digital video link equipment operating on radio frequencies above 1,3 GHz. It does not preclude any digital modulation technique, provided that the modulated signal lies within the prescribed limits. Instructions for the presentation of equipment for testing purposes are included.

Electromagnetic Compatibility (EMC) requirements are covered by EN 301 489-28 (see Bibliography).

ES 202 239 [8] specifies the reference receiver performance parameters, which are required for the purpose of spectrum planning and methods of investigation including resolving interference issues. These parameters play an important role in the frequency planning and the respective compatibility analysis performed by responsible national administrations.

The present document contains instructions for the presentation of equipment for testing purposes.

Transmitter Power limits are defined in the terms and conditions of the users operating licence. Refer to annex C for recommended frequency ranges (ERC/REC 25-10 [2] annex 2).

The user categories covered, are as follows:

- Category 1: typically used by broadcasters and programme-makers. Users require the highest video contribution quality and or minimum processing delay times to allow both real time inserts into programmes and easy accurate editing. These users normally operate on licensed frequencies.
- Category 2: typically used by professional and business. Users have quality requirements similar to above but are maybe not concerned with delay issues that affect the broadcaster and can, therefore, operate within a smaller spectrum mask.
- Category 3: typically used by industrial users. Examples include civil and industrial users, emergency services, automobile associations, the utility industries, etc, who need the good quality available from digital-based systems and who operate on licensed allocations.
- Category 4: typically used by industrial users including industrial security. Most of these systems could operate either in ISM bands or frequencies specifically allocated for the purpose.
- Category 5: typically used by consumers. Caters for consumers, hobbyists and amateur users. The proposed 5 MHz mask can be subdivided into 2 × 2,5 for two way visual communication and is primarily intended for indoor use.

The maximum allowable channel bandwidths for the equipment covered by the present document are shown in table 1.

Table 1: Maximum allowable channel bandwidth

Equipment	Maximum allowable
Category 1	20 MHz
Category 2	10 MHz
Category 3	10 MHz
Category 4	10 MHz
Category 5	5 MHz

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

[1] ETSI TR 100 027 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Methods of measurement for private mobile radio equipment".

[2] ERC/REC 25-10 "Frequency ranges for the use of temporary terrestrial audio and video SAP/SAB links (incl. ENG/OB)".

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

[4] ANSI C63.5: "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI) Control Calibration of Antennas (9 kHz to 40 GHz)".

[5] ETSI TR 102 273 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

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

[7] IEC 60489-3: "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions".

[8] ETSI ES 202 239: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless Digital Video Links operating above 1,3 GHz; Specification of Typical Receiver Performance Parameters for Spectrum Planning".

[9] IEC 60489-1: "Methods of measurement for radio equipment used in the mobile services. Part 1: General definitions and standard conditions of measurement".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

dBc: decibels relative to the unmodulated carrier power of the emission

NOTE: In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power P.

carrier grid: evenly spaced raster in a given frequency band for the allocation of carrier frequencies

NOTE: The minimum distance of two carriers in use is a multiple of the raster dependent on type and usage of the equipment.

channel bandwidth (B): defined as the minimum declared bandwidth, within which the transmitter's necessary bandwidth can be contained

conducted measurements: measurements that are made using a direct connection to the EUT

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

mean power: average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation envelope taken under normal operating conditions

necessary bandwidth: for a given class of emission, the width of the frequency band which is sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

out of band emissions: emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions

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

quasi-error-free (DVB-T): is defined as BER 2×10^{-4} after Viterbi decoding, which virtually eliminates errors following the Reed-Solomon decode

radiated measurements: measurements that involve the absolute measurement of a radiated electromagnetic field

rated output power: or rated output power range is the mean power (or the range of power) that the transmitter shall deliver at its output under specified conditions of operation

reference bandwidth: bandwidth in which the spurious emission level is specified

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

unwanted emissions: consist of spurious emissions and out of band emissions

3.2 Symbols

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

λ	wavelength in metres
Γ	total symbol duration
µF	microFarad
µW	microWatt
B	channel bandwidth
dBc	dB relative to the carrier level
E	field strength
Eo	reference field strength, (see annex A)
fc	carrier frequency
fo	operating frequency
GHz	GigaHertz
H	Henry
kHz	kiloHertz
MHz	MegaHertz
mW	milliWatt
nW	nanoWatt
P_{max}	rated output power
P_0	the corresponding effective isotropic radiated power of Pmax
R	distance (see annex A)
Ro	reference distance (see annex A)

3.3 Abbreviations

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

ac	alternating current
B	declared channel Bandwidth (see table 1)
COFDM	Coded Orthogonal Frequency Division Multiplexing
DVB-T	Digital Video Broadcast - Terrestrial
eirp	effective isotropic radiated power
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
FWA	Fixed Wireless Access
OATS	Open Area Test Site
RBW	Resolution BandWidth
RF	Radio Frequency
SINAD	SIgnal to Noise And Distortion
Tx	Transmitter
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 General

4.1 Presentation of equipment for testing purposes

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

4.1.1 Choice of model for testing

4.1.1.1 Definitions of alignment and switching ranges

The alignment range is defined as the frequency range over which the receiver and the transmitter can be programmed and/or re-aligned, 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). These elements shall not be accessible to the end user and shall be declared by the applicant in the application form.

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

The applicant shall, when submitting equipment for test, state the alignment ranges for the receiver and transmitter. The applicant shall also state the switching range of the receiver and the transmitter (which may differ).

4.1.1.2 Alignment range

The alignment range for the receiver and transmitter, which may be different, shall be within the applicable band.

4.1.2 Choice of frequencies

The frequencies for testing shall be chosen by the applicant, in accordance with clauses 4.1.5 to 4.1.7.

4.1.3 Testing of single channel equipment

Full tests shall be carried out on a channel closest to the centre frequency of the alignment range on one sample of the equipment.

4.1.4 Testing of two channel equipment

One sample shall be submitted to enable full tests to be carried out on the highest frequency and the lowest frequency of the switching range.

4.1.5 Testing of multi-channel equipment (more than two channels)

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

Full tests shall be carried out on a frequency closest to the centre frequency, and at the lowest and highest frequencies of the switching range.

4.1.6 Testing of equipment without a permanent external RF port

To facilitate relative measurements, use may be made of a test fixture as described in clause 6.2, or the equipment may be supplied with a permanent internal or temporary internal/external RF port.

4.1.7 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 a permanent internal RF port shall be recorded in the test report.

4.1.8 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 EUT.

4.1.9 Frequency tolerance

The manufacturer shall declare the frequency tolerance which is the maximum permissible departure from the centre frequency of the frequency band occupied by an emission from the assigned frequency under normal and extreme test conditions.

4.2 Mechanical and electrical design

4.2.1 General

The equipment submitted by the applicant shall be designed, constructed and manufactured in accordance with sound engineering practice, and with the aim of minimizingg harmful interference to other equipment and services.

4.2.2 Controls

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

4.2.3 Performance testing with integral antenna

Performance testing of equipment with integral antenna only applies to that equipment together with the antenna originally supplied by the manufacturer for testing.

4.2.4 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 type approval (if required);
- modulation type.

Alternatively the marking shall consist of:

- a normally readable label; and
- the information detailed above, stored electronically in a secure format, which is easily readable by either:
  - the receiver provided by the manufacturer; or
  - a reading system provided by the manufacturer with each transmitter.

4.3 Interpretation of the measurement results

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

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;
- 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 table 8.

5 Test conditions, power sources and ambient conditions

5.1 Normal and extreme test-conditions

Performance 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 clauses 5.2 to 5.4.2.4.

5.2 Test power source

During performance 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 clauses 5.3.2 and 5.4.2. The internal impedance of the 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 power source shall be measured at the input terminals of the equipment.

For battery-operated equipment, the battery may be removed and the test power source shall be substituted, suitably decoupled 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 the equipment's 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 < ±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 provides 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.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

The manufacturer shall supply with the equipment documentation defining normal operational environmental conditions, including temperature and humidity operating ranges. This information should be included in the user manual.

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 voltage

5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared mains voltage, or any of the declared mains voltages, for which the equipment was designed.

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

5.3.2.2 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 agreed by the test laboratory. The values shall be stated in the test report.

5.4 Extreme test conditions

The following tests are required to ensure that no harmful interference is caused under extreme conditions. Refer to clause 5.3 for normal operating conditions (as declared by the manufacturer).

5.4.1 Extreme temperatures

For tests at extreme temperatures detailed in table 2, measurements shall be made in accordance with the procedures specified in clause 5.4.1.1.

Table 2: Extreme temperature ranges

General:	-20°C to +55°C
Portable equipment:	-10°C to +55°C
Equipment for normal indoor use:	0°C to +55°C
NOTE: The term "equipment for normal indoor use" is taken to mean that the room temperature is controlled and the minimum indoor temperature is equal to or greater than 5°C.	

5.4.1.1 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 stabilizingg period. If the thermal balance is not checked by measurements, a temperature stabilizing 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.

5.4.2 Extreme test power 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 %.

The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 61 Hz.

5.4.2.2 Rechargeable battery power sources

When the radio equipment is intended for operation from rechargeable 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.

5.4.2.3 Power sources using other types of batteries

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

- for Leclanché or lithium type of battery:
  - 0,85 times the nominal voltage of the battery;
- for mercury type of battery:
  - 0,9 times the nominal voltage of the battery;
- for other types of primary batteries:
  - end-point voltage declared by the equipment manufacturer.

The nominal voltage is considered to be the upper extreme test voltage in this case.

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 equipment manufacturer and the testing facility and shall be recorded with the results.

6 General conditions

6.1 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load with a 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.

6.2 Test fixture

Radiated RF power measurements are imprecise and, therefore, conducted measurements are the preferred method (excluding spurious emissions). Equipment used for testing should be provided with a suitable connector for conducted RF power measurements. Where this is not possible, a suitable test fixture provided by the manufacturer shall be used to convert the radiated signal into a conducted signal. Alternatively, radiated measurements shall be performed.

The applicant may 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.

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 antenna port at the working frequencies of the EUT. 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 test facility 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 EUT is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

6.3 Test site and general arrangements for radiated measurements

For guidance on test sites see IEC 60489-1 [9].

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

6.4 Arrangement for test signals at the input of the transmitter

For the purpose of the present document, the transmitter video and/or audio input signal shall be supplied by a generator at the correct impedance applied at the connections of the stated inputs, unless otherwise stated. The manufacturer shall specify a representative test signal.

7 Methods of measurement and limits for transmitter parameters

7.1 General

All tests shall be carried out under both normal and extreme conditions. The channel bandwidth B declared by the applicant in clause 4.1 shall be used to determine the limits described in clauses 7.1 and 7.2.

The approach is to specify the total allowable power in each region, together with a specified means of measurement. In this way the mask is not system or modulation specific, but deals only with allowable in-band power and out of band interference potential.

7.2 Rated output power

7.2.1 Definition

The rated output power (or rated output power range) is the mean power (or the range of power) that the transmitter shall deliver at its output under specified conditions of operation.

7.2.2 Method of measuring the eirp

The rated output power shall be that detected with a true mean power sensing instrument or an equivalent calibrated system using the applicable measurement procedure as described in annex B.

The transmitter shall be modulated with test signals defined in clause 6.4.

The EUT shall be operated at the highest, lowest and at the closest mid-point channels within its operating range.

7.2.3 Method of measurement at the antenna port

For guidance refer to TR 100 027 [1].

In general, quantifying output power relies on measuring either the thermal effects of the power dissipated in the test load or the RF voltage across it. The method chosen will depend largely on power output, category of service and characteristic frequency.

Examples are as follows:

a) calorimetric methods;

b) temperature dependent component.

7.2.4 Limit

The manufacturer shall declare the rated output power and the equivalent isotropic radiated power (eirp). For equipment that can be used with several different types of antenna the manufacturer shall declare in the documentation the maximum gain of the antennas.

7.3 Channel bandwidth

7.3.1 Definition

For the purpose of the present document 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 table 1. The necessary bandwidth of the transmitter shall be measured under the conditions laid down in clause 6.4.

7.3.2 Design considerations

Particular care should be taken when developing equipment to ensure that during the power up/down procedure unwanted emissions are kept to a minimum in line with good engineering practice.

7.3.3 Measurement of necessary bandwidth

The rated output power P_{max} shall first be measured with a true mean power sensing instrument or an equivalent calibrated system.

The corresponding effective isotropic radiated power (see note 1) (eirp) shall be termed P_0.

NOTE 1: When used with the specified antenna.

A spectrum analyser with the following settings should then be used:

- centre frequency: fc: Transmitter (Tx) nominal frequency;
- dispersion (Span): ≥ fc - 2B MHz to fc + 2B MHz;
- Resolution Bandwidth (RBW): 3 kHz;
- Video Bandwidth (VBW): 300 Hz;
- analyser detector mode : average or true rms;
- analyser display mode: average.

NOTE 2: If the transmitter incorporates any ancillary coding or signalling channels, these should be enabled prior to any spectral measurements.

NOTE 3: In the case of many forms of digital modulation, including COFDM signals, the modulation sinx/x components and intermodulation products caused by amplifier non-linearity have a high peak-to-mean ratio. A suitable resolution bandwidth must therefore be chosen to minimize the measurement errors between the true rms envelope level and the mean envelope level detected by a spectrum analyser. As a guideline, the maximum resolution bandwidth should not exceed 1/Γ, where Γ is the total symbol duration. A typical value for a DVB-T compliant COFDM system would be 3 kHz.

The transmitter output spectrum shall be considered with respect to the measurement mask in figure 1 where B is the declared channel bandwidth.

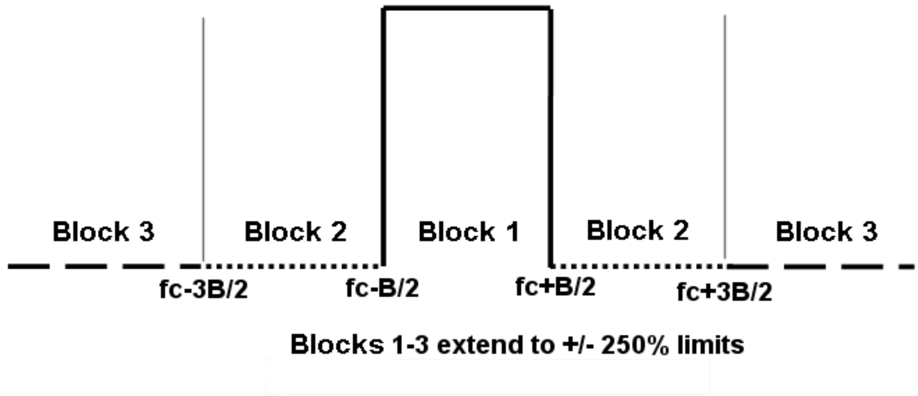


Figure 1: Measurement Mask normalized to channel bandwidth

The true power is required to be determined outside the channel bandwidth B within block 2 and block 3 as shown in figure 1.

Block 2 comprises the adjacent channels in the frequency ranges f_c - 3B/2 to f_c - B/2 and f_c + B/2 to f_c + 3B/2.

Block 3 relates to below f_c - 3B/2 and above f_c + 3B/2.

A measuring receiver can be used with a filter suitably tuned for the bandwidth of the channel. Alternatively the measuring receiver can take measurements across the frequency range for a given measurement bandwidth. The total power in the full bandwidth is then the sum of the powers of the individual bandwidths across these ranges.

7.3.4 Necessary bandwidth limits

7.3.4.1 Integrated power limits relative to P_{MAX}

P_0 < 0,3 W eirp

Table 3

	Each half of the region	Both halves of the region
Block 2	-36 dB	-33 dB
Block 3	-42 dB	-39 dB

P_0 > 0,3 W eirp

Table 4

	Each half of the region	Both halves of the region
Block 2	-36 dB - 10 log (P_0/0,3)	-33 dB - 10 log (P_0/0,3)
Block 3	-42 dB - 10 log (P_0/0,3)	-39 dB - 10 log (P_0/0,3)

7.3.4.2 Discrete spectral components relative to P_{MAX}

To catch discrete tones which may have disproportionate interference potential, a further restriction in these regions is as follows.

P_0 < 0,3 W eirp

Table 5

	Power in any 3 kHz bandwidth
Block 2_D	< -48 dB
Block 3_D	< -54 dB

P_0 > 0,3 W eirp

Table 5a

	Power in any 3 kHz bandwidth
Block 2_D	< - 48 dB - 10 log (P_0/0,3)
Block 3_D	< - 54 dB - 10 log (P_0/0,3)

7.4 Spurious emissions

7.4.1 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 or dedicated antenna, in the case of equipment fitted with such an antenna and no permanent RF connector.

7.4.2 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 6.

Table 6: Measuring receiver bandwidths

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

7.4.3 Method of measurement conducted spurious emission

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

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 6, see clause 7.3.6. 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) For carrier frequencies in the range 1 GHz to 20 GHz 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. For carrier frequencies above 20 GHz the measuring receiver shall be tuned over the range 25 MHz up to twice the carrier frequency. 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.

c) 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.

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

e) 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.

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

7.4.4 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 clause 7.3.5.

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 polarization 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 7, see clause 7.3.6. 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 clause 6.1).

b) Or carrier frequencies in the range 1 GHz to 20 GHz 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. For carrier frequencies above 20 GHz the measuring receiver shall be tuned over the range 25 MHz up to twice the carrier frequency, 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 an 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 maximize 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 clause A.2.3) shall replace the transmitter antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

g) At each frequency at which an 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) 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.

i) Steps c) to h) shall be repeated with the test antenna oriented in horizontal polarization.

j) 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.

k) Steps c) to i) shall be repeated with the transmitter in the standby condition if this option is available.

7.4.5 Method of measurement radiated spurious emission

This method of measurement applies to transmitters 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 polarization 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 6, see clause 7.3.6. 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.

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

7.4.6 Limits

The power of any spurious emission shall not exceed the following values given in table 7.

Table 7: Radiated spurious emissions

State	Other frequencies ≤ 1 000 MHz	Frequencies > 1 000 MHz
Operating	250 nW	1 µW
Standby	2 nW	20 nW

8 Receiver

8.1 Spurious emissions

These requirements do not apply to receivers used in combination with permanently co-located transmitters continuously transmitting. Co-located is defined as < 3 m. In these cases the receivers will be tested together with the transmitter in operating mode.

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 or dedicated 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 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 clause 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) For carrier frequencies in the range 1 GHz to 20 GHz 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. For carrier frequencies above 20 GHz the measuring receiver shall be tuned over the range 25 MHz up to twice the carrier frequency. 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 polarization 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 clause 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 clause 5.2.

b) For carrier frequencies in the range 1 GHz to 20 GHz 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. For carrier frequencies above 20 GHz the measuring receiver shall be tuned over the range 25 MHz up to twice the carrier frequency. 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 maximize 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 clause A.2.3) shall replace the receiver antenna in the same position and in vertical polarization. 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) 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.

i) Measurements b) to h) shall be repeated with the test antenna oriented in horizontal polarization.

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 polarization 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 clause 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 i) of clause 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 shall not exceed those given in table 8. This is in order to ensure that the measurements remain within an acceptable standard. Uncertainty values for the RF parameters are valid to 1 GHz unless otherwise stated.

Table 8: Measurement uncertainty

Parameters	Uncertainty
RF frequency	$\pm 1 \times 10^{-7}$
RF power (conducted)	±4 dB
Radiated emission of transmitter, valid to 80 GHz	±6 dB
Radiated emission of receiver, valid to 80 GHz	±6 dB
Temperature	±1°C
Humidity	±5 %

For the test methods, according to the present document, the uncertainty figures are Valid to a confidence level of 95 % calculated according to the methods described in TR 100 028 [3].

Annex A (normative): Radiated measurement

This annex has been drafted so that it could be used as well for the assessment of speech, data or equipment providing a specific response.

It covers test sites and methods to be used with integral antenna equipment or equipment having an antenna connector.

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

This annex introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in TR 102 273 [5] relevant parts 2, 3 and 4.

NOTE: To ensure reproducibility and tractability of radiated measurements only these test sites should be used in measurements in accordance with the present document.

A.1.1 Anechoic chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure A.1.

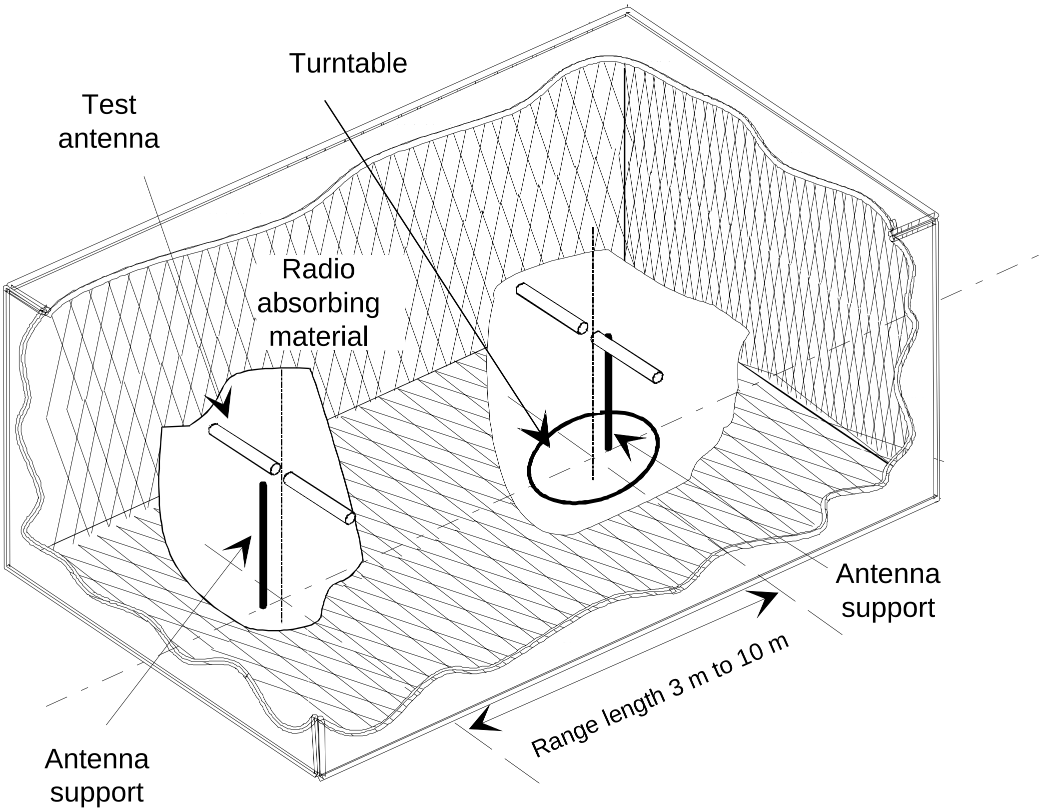


Figure A.1: A typical anechoic chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m.) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1 + d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

A.1.2 Anechoic chamber with a conductive ground plane

An anechoic chamber with a conductive ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a conductive ground plane is shown in figure A.2.

This type of test chamber attempts to simulate an ideal Open Area Test Site whose primary characteristic is a perfectly conducting ground plane of infinite extent.

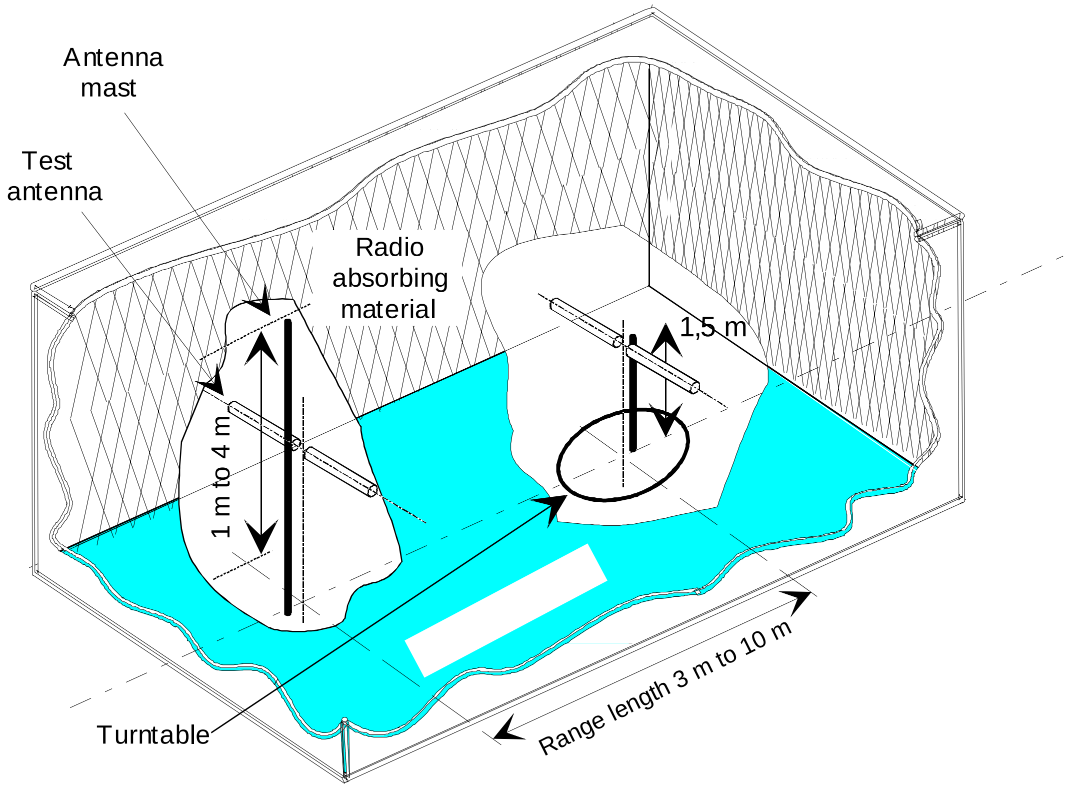


Figure A.2: A typical anechoic chamber with a conductive ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m. above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1 + d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the EUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

A.1.3 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in figure A.3.

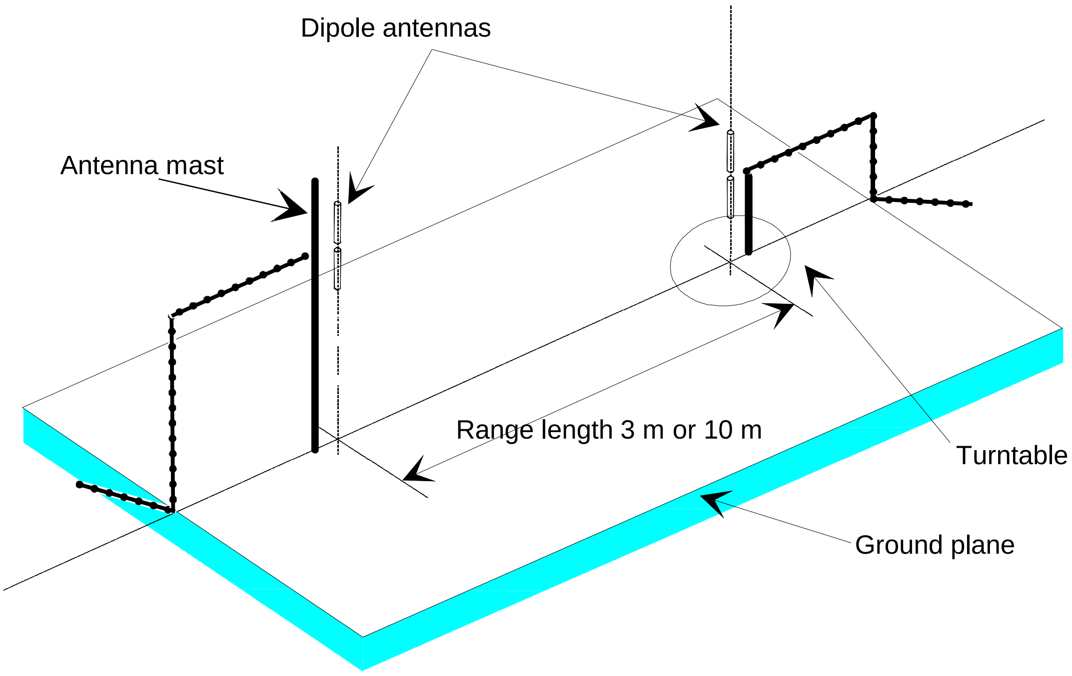


Figure A.3: A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

Typical measuring arrangement common for ground plane test sites is presented in the figure A.4.

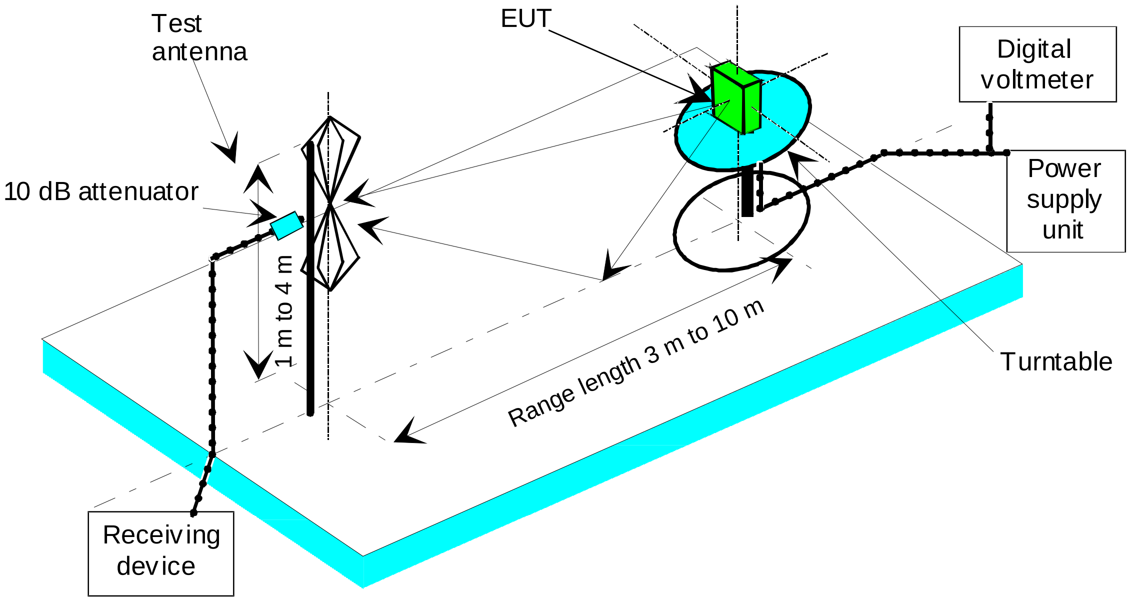


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the EUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [4]) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

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

A.1.5 Substitution antenna

The substitution antenna is used to replace the EUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [4]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre.

A.1.6 Measuring antenna

The measuring antenna is used in tests on an EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [4]. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT.

A.1.7 Stripline arrangement

A.1.7.1 General

The stripline arrangement is a RF coupling device for coupling the integral antenna of an equipment to a 50 Ω radio frequency terminal. This allows the radiated measurements to be performed without an open air test site but in a restricted frequency range. Absolute or relative measurements can be performed; absolute measurements require a calibration of the stripline arrangement.

A.1.7.2 Description

The stripline is made of three highly conductive sheets forming part of a transmission line which allows the equipment under test to be placed within a known electric field. They shall be sufficiently rigid to support the equipment under test.

Two examples of stripline characteristics are given below:

		IEC 60489-3 [7] App. J	**FTZ N^{o}512 TB 9**
Useful frequency range	MHz	1 to 200	0,1 to 4 000
Equipment size limits	length	200 mm	1 200 mm
(antenna included):	width	200 mm	1 200 mm
	height	250 mm	400 mm

A.1.7.3 Calibration

The aim of calibration is to establish at any frequency a relationship between the voltage applied by the signal generator and the field strength at the designated test area inside the stripline.

A.1.7.4 Mode of use

The stripline arrangement may be used for all radiated measurements within its calibrated frequency range.

The method of measurement is the same as the method using an open air test site with the following change. The stripline arrangement input socket is used instead of the test antenna.

A.2 Guidance on the use of radiation test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated test are undertaken. These schemes are common to all types of test sites described in annex A.

A.2.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in annex A (i.e. anechoic chamber, anechoic chamber with a ground plane and Open Area Test Site) are given in TR 102 273 [5] parts 2, 3 and 4, respectively.

A.2.2 Preparation of the EUT

The manufacturer should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, channel separation, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 min on, 4 mins off).

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 5) material(s) such as expanded polystyrene, balsa wood, etc.

A.2.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

A.2.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the rated audio output power. In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the rated audio output power. This control should not be readjusted between normal and extreme test conditions in tests.

A.2.5 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the EUT i.e. it should be equal to or exceed:

$$\frac{2(d_1 + d_2)^2}{\lambda}$$

where:

d_1: is the largest dimension of the EUT/dipole after substitution (m);

d_2: is the largest dimension of the test antenna (m);

λ: is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: For the fully anechoic chamber, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: For the anechoic chamber with a ground plane, a full height scanning capability, i.e. 1 to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of anechoic chamber, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: For both the anechoic chamber with a ground plane and the Open Area Test Site, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

A.2.6 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of anechoic chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (i.e. anechoic chambers with ground planes and Open Area Test Sites) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: ±0,5 dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

A.3 Coupling of signals

A.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

A.3.2 Data signals

Isolation can be provided by the use of optical, ultra sonic or infra red means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infra red radiated connections require suitable measures for the minimization of ambient noise.

A.3.3 Speech and analogue signals

Where an audio output socket is not available an acoustic coupler should be used.

When using the acoustic coupler, care should be exercised that possible ambient noise does not influence the test result.

A.3.3.1 Acoustic coupler description

The acoustic coupler comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier. The materials used to fabricate the funnel and pipe should be of low conductivity and of low relative dielectric constant (i.e. less than 1,5).

- The acoustic pipe should be long enough to reach from the EUT to the microphone which should be located in a position that will not disturb the RF field. The acoustic pipe should have an inner diameter of about 6 mm and a wall thickness of about 1,5 mm and should be sufficiently flexible so as not to hinder the rotation of the turntable.

- The plastic funnel should have a diameter appropriate to the size of the loudspeaker in the EUT, with soft foam rubber glued to its edge, it should be fitted to one end of the acoustic pipe and the microphone should be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the EUT, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the EUT in a close fitting acoustic mounting jig, supplied by the manufacturer, of which the funnel is an integral part.

- The microphone should have a response characteristic flat within 1 dB over a frequency range of 50 Hz to 20 kHz, a linear dynamic range of at least 50 dB. The sensitivity of the microphone and the receiver audio output level should be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the EUT. Its size should be sufficiently small to couple to the acoustic pipe.

- The frequency correcting network should correct the frequency response of the acoustic coupler so that the acoustic SINAD measurement is valid (see IEC 60489-3 [7] appendix F [A.6]).

A.3.3.2 Calibration

The aim of the calibration of the acoustic coupler is to determine the acoustic SINAD ratio which is equivalent to the SINAD ratio at the receiver output.

A.4 Standard test position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand-held equipment, shall be on a non conducting support, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

a) for equipment with an internal antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;

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

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

Equipment which is intended to be worn on a person may be tested using a simulated man as support.

The simulated man comprises of a rotatable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

- Height: 1,7 ± 0,1 m;
- Inside diameter: 300 ± 5 mm;

- Sidewall thickness: 5 ± 0,5 mm.

The container shall be filled with a salt (NaCl) solution of 1,5 g per litre of distilled water.

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube which has a hollow centre of 220 mm maximum diameter.

In the stripline arrangement the equipment under test or the substitution antenna is placed in the designated test area in the normal operational position, relative to the applied field, on a pedestal made of a low dielectric material (dielectric constant less than 2).

A.5 Test fixture

The test fixture is only needed for the assessment of integral antenna equipment.

A.5.1 Description

The test fixture is a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal 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.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) in the case of assessment of speech equipment, an audio interface either by direct connection or by an acoustic coupler.

In the case of non-speech equipment, the test fixture can also provide the suitable coupling means e.g. for the data output.

The test fixture shall normally be provided by the manufacturer.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;

c) circuitry associated with the RF coupling shall contain no active or non-linear devices;

d) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

e) 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;

f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

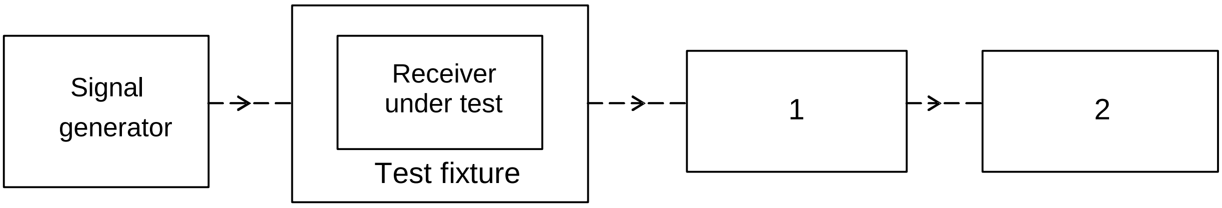
The characteristics and calibration shall be included in the test report.

A.5.2 Calibration

The calibration of the test fixture establishes a relationship between the output of the signal generator and the field strength applied to the equipment placed in the test fixture.

The calibration is valid only at a given frequency and for a given polarization of the reference field.

The actual set-up used depends on the type of the equipment (e.g. data, speech etc.).



NOTE 1: Coupling device, e.g. AF load/acoustic coupler (in the case of speech equipment).
NOTE 2: Device for assessing the performance, e.g. distortion factor/audio level meter, BER measuring device, etc.

Figure A.5: Measuring arrangement for calibration

Method of calibration:

a) Measure the sensitivity expressed as a field strength, as specified in the present document and note the value of this field strength in dBμV/m and the polarization used.

b) Place the receiver in the test fixture which is connected to the signal generator. The level of the signal generator producing:

- a SINAD of 20 dB;
- a bit error ratio of 0,01; or
- a message acceptance ratio of 80 %, as appropriate

shall be noted.

The calibration of the test fixture is the relationship between the field strength in dBμV/m and the signal generator level in dBμV emf. This relationship is expected to be linear.

A.5.3 Mode of use

The test fixture may be used to facilitate some of the measurements in the case of equipment having an integral antenna.

It is used in particularly for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under the extreme conditions.

For the transmitter measurements calibration is not required as relative measuring methods are used.

For the receiver measurements calibration is necessary as absolute measurements are used.

To apply the specified wanted signal level expressed in field strength, convert it into the signal generator level (emf) using the calibration of the test fixture. Apply this value to the signal generator.

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

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 (clause 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 maximize 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.

i) 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.

j) This measurement shall be repeated with horizontal polarization.

k) 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): Recommended frequency ranges for use by audio and video SAP/SAB links

Table: C.1: Excluding permanent fixed service links (refer to ERC/REC 25-10 [2])

Type of link	Recommended frequencies		Technical parameters
	Tuning ranges	**Preferred sub-bands**	
Cordless cameras	2 025 MHz to 2 110 MHz/ 2 200 MHz to 2 500 MHz 10,0 GHz to 10,60 GHz 21,2 GHz to 24,5 GHz 47,2 GHz to 50,2 GHz	10,3 GHz to 10,45 GHz 21,2 GHz to 21,4 GHz, 22,6 GHz to 23,0 GHz and 24,25 GHz to 24,5 GHz	ERC REP 38
Portable video links	2 025 MHz to 2 110 MHz/ 2 200 MHz to 2 500 MHz 2 500 MHz to 2 690 MHz (see note 4) 10,0 GHz to 10,60 GHz	10,3 GHz to 10,45 GHz	ERC REP 38
Mobile video links (airborne and vehicular)	2 025 MHz to 2 110 MHz/ 2 200 MHz to 2 500 MHz 2 500 MHz to 2 690 MHz (see note 4) 3 400 MHz to 3 600 MHz (see note 5)		ERC REP 38
Temporary point-to-point video links	Fixed service bands (see note 6) 10,0 GHz to 10,68 GHz (see note 3) 21,2 GHz to 24,5 GHz	10,3 GHz to 10,45 GHz 21,2 GHz to 21,4 GHz, 22,6 GHz to 23,0 GHz and 24,25 GHz to 24,5 GHz	ERC REP 38

NOTE 1: Only occasional temporary point-to-point links should be allowed in the frequency band 10,6 GHz to 10,68 GHz. Studies have concluded that even limited deployment of cordless cameras and portable video links in the band 10,6 GHz to 10,68 GHz will result in interference to the EESS (passive) services using this band (see ECC/REP17).

NOTE 2: The band 2 500 MHz to 2 690 MHz will not be available for video SAP/SAB links after the introduction of UMTS/IMT-2000 (see ECC/DEC/(02)06).

NOTE 3: In countries where the band 3 400 MHz to 3 600 MHz is widely used for Fixed Wireless Access (FWA), availability of this band for mobile video SAP/SAB links may be restricted.

NOTE 4: Temporary point-to-point video links are often accommodated in the "traditional fixed services" bands, following the same channel arrangements as the FS links.

NOTE 5: Users need to check with their national Administration to ascertain whether additional frequencies are available for use by civil low power video links.

NOTE 6: Users must also obtain details of national interface regulations.

Annex D (informative): Bibliography

- ETSI EN 301 489-28: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 28: Specific Requirements for digital wireless video links between 1,3 GHz and 78 GHz".
- ERC/REC 70-03: "Relating to the use of Short Range Devices (SRD)".
- ERC Report 038: "Handbook on radio equipment and systems video links for ENG/OB use".

History

Document history				
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