ETSI EN 302 291-1 V1.1.1 (2005-07)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Close Range Inductive Data Communication equipment operating at 13,56 MHz; Part 1: Technical characteristics and test methods

Reference

DEN/ERM-TG23-015-1

Keywords

data, inductive, radio, short range, SRD

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Sous-Préfecture de Grasse (06) N° 7803/88

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).

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

The present document is part 1 of a multi-part deliverable covering the Short Range Devices (SRD); Close Range Inductive Data Communication equipment operating at 13,56 MHz as identified below:

Part 1: "Technical characteristics and test methods";

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

National transposition dates	
Date of adoption of this EN:	8 July 2005
Date of latest announcement of this EN (doa):	31 October 2005
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 April 2006
Date of withdrawal of any conflicting National Standard (dow):	30 April 2006

1 Scope

The present document applies to Close Range Inductive Data transmitters and receivers operating at 13,56 MHz.

The present document contains the technical characteristics for radio equipment and is referencing in CEPT/ERC Recommendation 70-03 [1] and ERC Decisions.

The present document does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable. It is a specific product standard covering specific close range inductive data equipment:

- with an inductive loop antenna;
- with an antenna connection and/or with an integral antenna;
- for alarms, identification systems, telecommand, telemetry, etc.

When selecting new applications, which may have inherent safety of human life implications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.

The present document covers fixed stations, mobile stations and portable stations. If a system includes transponders, these are measured together with the transmitter.

All types of modulation for radio devices are covered by the present document, provided the requirements of clause 7 are met.

The radio equipment, covered by the present document has a maximum radiated field strength given in table 1.

Table 1: Maximum radiated H-field at 13,56 MHz

Radiated H-field
+25 dBµA/m at 10 m

On non-harmonized parameters, national administrations may impose conditions on the type of modulation, frequency, channel/frequency separations, maximum transmitter radiated field strength/maximum output current to a defined antenna, duty cycle, equipment marking and the inclusion of an automatic transmitter shut-off facility, as a condition for the issue of an individual or general licence, or as a condition for use under licence exemption.

Two types of measuring methods are defined in the present document due to the varied nature of the types of equipment used in this band. One method measures the radiated H-field and the second the radiated power.

The present document covers requirements for radiated emissions below as well as above 30 MHz.

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

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] CEPT/ERC Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".

[2] ITU-T Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".

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

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

[5] ETSI TR 102 273 (parts 2 to 4): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

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

3 Definitions, symbols and abbreviations

3.1 Definitions

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

artificial antenna: tuned reduced-radiating dummy load equal to the nominal impedance specified by the applicant

assigned frequency band: frequency band within which the device is authorized to operate

conducted measurements: measurements which are made using a direct connection to the equipment under test

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

fixed station: equipment intended for use in a fixed location

H-field test antenna: electrically screened loop or equivalent antenna, with which the magnetic component of the field can be measured

identification system: equipment consisting of a transmitter(s), receiver(s) (or a combination of the two) and an antenna(s) to identify objects by means of a transponder

integral antenna: permanent fixed antenna, which may be build-in, designed as an indispensable part of the equipment

portable station: equipment intended to be carried, attached or implanted

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

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

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

transponder: device, that responds to an interrogation signal

3.2 Symbols

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

E	Electrical field strength
e.r.p	effective radiated power
f	frequency
f_C	carrier frequency
H	magnetic field strength
oct	octave
P	Power
PSTN	Public Switched Telephone Network
R	distance
t	time

3.3 Abbreviations

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

e.r.p.	effective radiated power
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
OATS	Open Area Test Site
PSTN	Public Switched Telephone Network
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
SRD	Short Range Device
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 General requirements

4.1.1 Receiver classification

The product family of short range radio devices is divided into three Equipment Classes, see table 2, each having its own set of minimum performance criteria. This classification is based upon the impact on persons in case the equipment does not operate above the specified minimum performance level.

Table 2: Receiver classification

Receiver class	Relevant receiver clauses	Risk assessment of receiver performance
1	8.1 and 8.2	Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person)
2	8.1 and 8.2	Medium reliable SRD communication media e.g. causing Inconvenience to persons, which cannot simply be overcome by other means
3	8.2	Standard reliable SRD communication media e.g. Inconvenience to persons, which can simply be overcome by other means (e.g. manual)
NOTE: With reference to the present document manufacturers are recommended to declare classification of their devices in accordance with table 2 as relevant. In particular where the equipment which may have an inherent safety of human life implications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.		

4.1.2 General performance criteria

For the purpose of the receiver performance tests, the receiver will produce an appropriate output under normal conditions as indicated below. Where the indicated performance cannot be achieved or if it defined differently, the manufacturer shall declare and publish the performance criteria used to determine the performance of the receiver:

- after demodulation, a data signal with a bit error ratio of 10^{-2} or better; or
- after demodulation, a message acceptance ratio of 80 % or better.

4.2 Presentation of equipment for testing purposes

Each equipment submitted for testing where type approval is still in force shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

The applicant shall declare the frequency ranges, the range of operating conditions and power requirements in consultation with the Administration(s), as applicable, to establish the appropriate test conditions.

Additionally, technical documentation and operating manuals, sufficient to make the test, shall be supplied.

A test fixture for equipment with an integral antenna may be supplied by the applicant (see clause 6.3). For equipment supplied without an antenna, the connector shall be 50 ohm for artificial antenna measurements.

If an equipment is designed to operate with different radiated field strengths or power level, measurement of each transmitter parameter shall be performed, according to the present document, on samples of equipment defined in clause 4.2.1.

To simplify and harmonize the testing procedures between different testing laboratories, measurements shall be performed, according to the present document, on samples defined in clauses 4.2.1 to 4.2.4.

4.2.1 Choice of model for testing

The applicant shall provide one or more samples of the equipment, as appropriate for testing.

Stand alone equipment shall be offered by the applicant complete with any ancillary equipment needed for testing.

If an equipment has several optional features, considered not to affect the RF parameters then the tests need only to be performed on the equipment configured with that combination of features considered to be the most complex, as proposed by the applicant and agreed by the test laboratory.

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

In the case of integral antenna equipment, if the equipment does not have a internal permanent 50 ohm connector then it is permissible to supply a second sample of the equipment with a temporary antenna connector fitted to facilitate testing, see clause 4.2.3.

4.2.2 Testing of equipment with alternative radiated field or power levels

If a family of equipment has alternative radiated field strengths or output power levels provided by the use of separate power modules or add on stages, then these shall be declared by the applicant. Each module or add on stage shall be tested in combination with the equipment. As a minimum, measurements of the radiated power (e.r.p.) and spurious emissions shall be performed for each combination and shall be stated in the test report.

4.2.3 Testing of equipment that does not have an external 50 ohm RF connector (integral antenna equipment)

4.2.3.1 Equipment with an internal permanent or temporary antenna connector

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated by the applicant with the aid of a diagram. The fact that use has been made of the internal antenna connection, or of a temporary connection, to facilitate measurements shall be recorded in the test report.

4.2.3.2 Equipment with a temporary antenna connector

The applicant, may submit one set of equipment with the normal antenna connected, to enable radiated measurements to be made. The applicant shall attend the test laboratory at the conclusion of the radiated measurements, to disconnect the antenna and fit the temporary connector. The testing laboratory staff shall not connect or disconnect any temporary antenna connector.

Alternatively, the applicant may submit two sets of equipment to the test laboratory, one fitted with a temporary antenna connector with the antenna disconnected and another equipment with the antenna connected. Each equipment shall be used for the appropriate tests. The applicant shall declare that the two sets of equipment are identical in all aspects except for the antenna connector.

4.2.4 On-site testing

In certain cases it may not be possible to provide representative samples of antennas and/or equipment due to physical constraints if the equipment is part of an other large installation. In these cases equivalent measurements to the present document shall be made at a representative installation of the equipment (on-site testing).

4.3 Mechanical and electrical design

4.3.1 General

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

Transmitters and receivers may be individual or combination units.

4.3.2 Controls

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

4.3.3 Transmitter shut-off facility

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

4.3.4 Receiver mute or squelch

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

4.3.5 CE Marking

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

In cases where the devices are too small to carry legible marking, it is sufficient to provide the relevant information in the users' manual and on the product packaging.

4.3.5.1 Equipment identification

The marking should be based on CEPT/ERC Recommendation 70-03 [1] and include as a minimum:

- the name of the manufacturer or his trade mark;
- temperature range, see clause 5.4.1;
- the type designation; and
- equipment classification, see clause 4.1.1.

4.4 Declarations by the applicant

When submitting equipment for testing, the applicant shall supply the necessary information required by the appropriate application form.

The performance of the equipment submitted for testing shall be representative of the performance of the corresponding production model.

4.5 Auxiliary test equipment

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

4.6 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 relating 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 included in the test report;
- the recorded value of the measurement uncertainty shall, for each measurement, be equal to, or lower than, the figures for measurement uncertainty in clause 9.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

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

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

5.2 Test power source

The equipment shall be tested using the appropriate test power source as specified in clauses 5.2.1 or 5.2.2. Where equipment can be powered using either external or internal power sources, then the equipment shall be tested using the external power source as specified in clause 5.2.1 then repeated using the internal power source as specified in clause 5.2.2.

The test power source used shall be stated in the test report.

5.2.1 External test power source

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

During tests the test 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 will provide a better uncertainty value for these measurements.

5.2.2 Internal test power source

For radiated measurements on portable equipment with integral antenna, fully charged internal batteries should be used. The batteries used should be as supplied or recommended by the applicant. If internal batteries are used, at the end of each test the voltage shall be within a tolerance of < ±5 % relative to the voltage at the beginning of each test.

If appropriate, for conducted measurements or where a test fixture is used, an external power supply at the required voltage may replace the supplied or recommended internal batteries. This shall be stated on the test report.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

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

- temperature: +15°C to +35°C;
- relative humidity: 20 % to 75 %.

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

5.3.2 Normal test power source

5.3.2.1 Mains voltage

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 voltage, or any of the declared voltages, for which the equipment was designed.

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

5.3.2.2 Regulated lead-acid battery power sources

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

5.3.2.3 Other power sources

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

5.4 Extreme test conditions

5.4.1 Extreme temperatures

5.4.1.1 Procedure for tests at extreme temperatures

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

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

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

5.4.1.1.1 Procedure for equipment designed for continuous operation

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

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

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

5.4.1.1.2 Procedure for equipment designed for intermittent operation

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

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

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

- if the applicant's declared on period exceeds one minute, then transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes; after which the equipment shall meet the specified requirements.

- 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.

5.4.1.2 Extreme temperature ranges

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

- Category I (General): -20°C to +55°C;
- Category II (Portable): -10°C to +55°C;
- Category III (Equipment for normal indoor use): 0°C to +40°C.

NOTE: The term "Equipment for normal indoor use" is taken to mean the minimum indoor temperature is equal to or greater than 5°C.

For special applications, the manufacturer can specify wider temperature ranges than given as a minimum above. This shall be reflected in manufacturers' product literature.

The test report shall state which range is used.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an ac mains source shall be the nominal mains voltage ±10 %. For equipment operating over a range of mains voltages clause 5.4.2.4 applies.

5.4.2.2 Regulated lead-acid battery power sources

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

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

5.4.2.3 Power sources using other types of batteries

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

- for equipment with a battery indicator, the end point voltage as indicated;
- for equipment without a battery indicator the following end point voltages shall be used:
  a) for the Leclanché or the lithium type of battery:
     - 0,85 multiplied by the nominal voltage of the battery.
  b) for the nickel-cadmium type of battery:
     - 0,9 multiplied by the nominal voltage of the battery.
- for other types of battery or equipment, the lower extreme test voltage for the discharged condition shall be declared by the equipment applicant.

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 applicant and the accredited test laboratory. This shall be recorded in the test report.

6 General conditions

6.1 Normal test signals and test modulation

The test modulating signal is a signal which modulates a carrier, is dependent upon the type of equipment under test and also the measurement to be performed. Modulation test signals only apply to products with an external modulation connector. For equipment without an external modulation connector, normal operating modulation shall be used.

6.1.1 Normal test signals for data

Normal test signals for data are specified as follows:

D-M2: A test signal representing a pseudo-random bit sequence of at least 511 bits in accordance with ITU-T Recommendation O.153 [2]. This sequence shall be continuously repeated. If the sequence cannot be continuously repeated, the actual method used shall be stated in the test report.

D-M3: A test signal shall be agreed between the accredited test laboratory and the applicant in case selective messages are used and are generated or decoded within the equipment.
The agreed test signal may be formatted and may contain error detection and correction.

The type and characteristics of the modulation shall be declared by the applicant.

6.2 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna which shall simulate the actual antenna configuration specified by the applicant.

6.2.1 Artificial antenna for transmitters with 50 ohm impedance connector

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

The use of 50 ohm load during test shall be stated in the test report form.

6.3 Test fixture

With equipment intended for use with an integral antenna, and not equipped with a 50 ohm output connector, a suitable test fixture shall be used as agreed with the test laboratory, where applicable. For further details see clause A.5.

6.4 Test sites and general arrangements for radiated measurements

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

6.5 Measuring receiver

CISPR 16-1 [4] specifies a reference bandwidth for the measurement of unwanted emissions by measurement receivers. The term "measuring receiver" refers to a selective voltmeter or a spectrum analyser (refer to annex B). The bandwidth and detector type of the measuring receiver are given in table 3.

Table 3

Frequency (f)	Detector type	Bandwidth
9 kHz ≤ f < 150 kHz	Quasi Peak	200 Hz to 300 Hz
150 kHz ≤ f < 30 MHz	Quasi Peak	9 kHz to 10 kHz
30 MHz ≤ f ≤ 1 000 MHz	Quasi Peak	100 kHz to 120 kHz

Different bandwidth may be used if agreed with the test laboratory, for further guidance see below.

The reference bandwidth ($BW_{REFERENCE}$) cannot always be used as the measurement bandwidth ($BW_{MEASUREMENT}$). This is particularly the case if the measurement is to be made for example on the slope of a spectrum mask or a receiver selectivity curve. In such situations the measurement shall be made with a sufficiently low bandwidth in order not to distort the reading.

The actual measured value, A, shall be referred back to the reference bandwidth by either:

a) correcting the measured value, A, for any signal having a flat level spectrum with the following formula:

$$B = A + 10 \log \frac{BW_{REFERENCE}}{BW_{MEASURED}}$$

where A is the measured level, B, transferred to the reference bandwidth; or

b) use the measured value, A, directly if the measured spectrum is a discrete spectral line.

A discrete spectrum line is defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth.

The measurement bandwidth and any related calculations shall be stated in the test report.

7 Transmitter requirements

To meet the requirements of the present document, the transmitter shall be measured at the radiated H-field, or radiated power level as declared by the applicant.

Where the transmitter is designed with an adjustable carrier H-field, all parameters shall be measured using the highest output level as declared by the applicant. The equipment shall then be adjusted to the lowest setting, as declared by the applicant, and the spurious emissions measurement shall be repeated (see clause 7.2).

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

If the equipment is supplied with both a permanent 50 ohm antenna connector and a dedicated antenna, the full tests shall be carried out using the external connector and in addition:

- radiated H-field (see clause 7.1.1);
- spurious emissions (see clause 7.2 and annex A).

Tests shall be carried out with the dedicated antenna.

7.1 Transmitter carrier output levels

7.1.1 H-field (radiated)

7.1.1.1 Definition

In the case of a transmitter with an integral or dedicated antenna, the H-field is measured in the direction of maximum field strength under specified conditions of measurement.

7.1.1.2 Methods of measurement

The measurements shall be made on an open field test site as specified in annex A. Any measured values shall be at least 6 dB above the ambient noise level.

The H-field produced by the equipment shall be measured at standard distance of 10 m. Where this is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m and stated in the test report.

The H-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with clause 6.5.

The equipment under test shall be operated with modulation as defined in clause 6.1. For measuring equipment calibrated in dBμV, the reading should be reduced by 51,5 dB to be converted to dBμA/m.

7.1.1.3 Limits

The limits presented in the present document are the required field strengths to allow satisfactory operation of inductive systems. Maximum field strength under normal and extreme conditions is given in table 4.

Additional information is available in CEPT/ERC Recommendation 70-03 [1] or ERC Decisions.

Table 4: H-field limits at 10 m

Frequency range (MHz)	H-field strength limit (H_f) dBμA/m at 10 m
13,56 to ± 7 kHz	+25
13,410 to 13,553 13,567 to 13,710	+9
13,110 to 13,410 13,710 to 14,010	-3,5
12,660 to 13,110 14,010 to 14,460	-10
Outside 12,660 to 14,460	-16

These values are illustrated by the transmitter spectrum mask in figure 1.

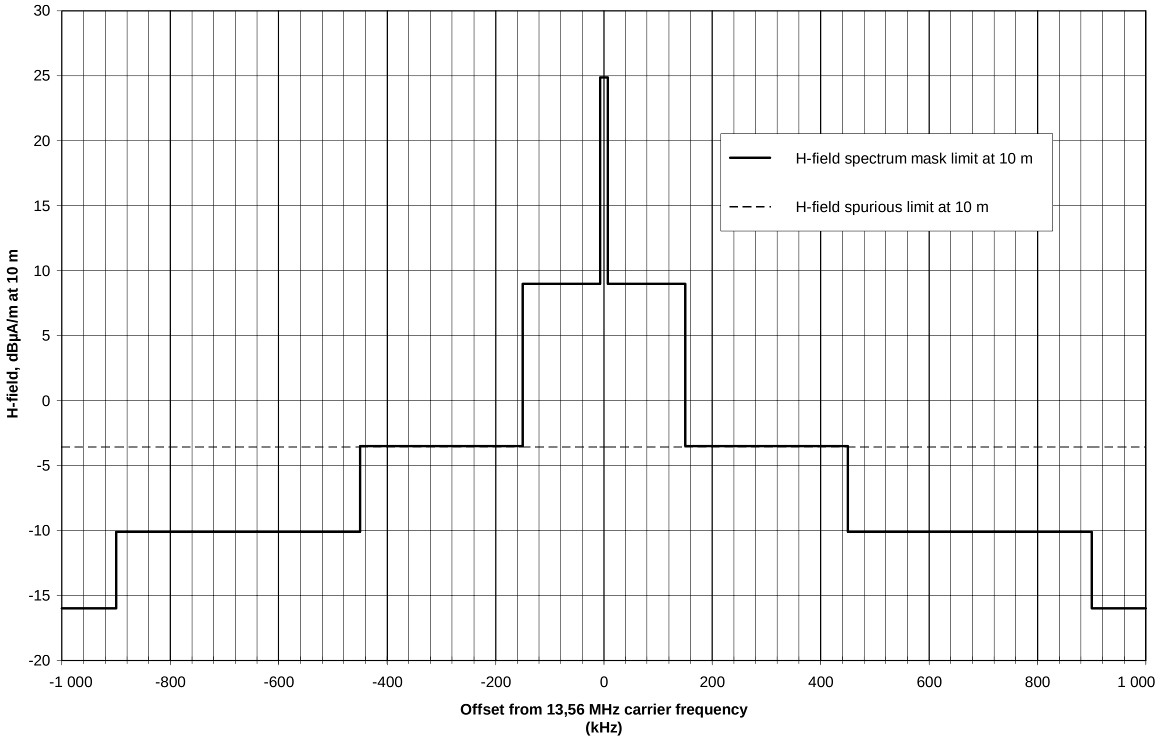


Figure 1: Transmitter spectrum mask

7.2 Transmitter spurious emissions

7.2.1 Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal test modulation (clause 6.1).

The level of spurious emissions shall be measured at normal conditions (see clause 5.3) as either:

1) a) their power in an artificial antenna (conducted spurious emission); and

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

2) their effective radiated power or field strength when radiated by the cabinet and the integral antenna.

7.2.2 Conducted spurious emissions

7.2.2.1 Methods of measurement (≥ 30 MHz)

The transmitter shall be connected to an artificial antenna according to clause 6.2.1. The spurious components are measured by means of a measuring receiver connected to the output of the transmitter by means of an appropriate coupling device. For details of the artificial antenna, see clause 6.2.

7.2.2.2 Limits

The power of any conducted spurious emission shall not exceed the values given in table 5.

Table 5

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies between 30 MHz to 1 000 MHz
Operating	4 nW e.r.p.	250 nW e.r.p.
Standby	2 nW e.r.p.	2 nW e.r.p.

7.2.3 Radiated spurious emissions

7.2.3.1 Methods of measurement (< 30 MHz)

The radiated magnetic field strength shall be measured for frequencies below 30 MHz. The equipment under test shall be measured at a distance of 10 m on an outdoor test site. The test antenna shall be a calibrated shielded magnetic field antenna. The equipment under test and test antenna shall be arranged as stated in clause A.1.

For equipment with an antenna connector, the equipment under test shall be connected to an artificial antenna (see clause 6.2) and the output connector terminated.

The equipment under test shall be switched on with normal modulation. The characteristics of the modulation shall be stated in the test report. The measuring receiver shall be tuned over the frequency range 9 kHz to 30 MHz, except for the frequency band within the spectrum mask (see clause 7.1.1.3) where the transmitter is intended to operate.

At each frequency at which a relevant spurious signal is detected the equipment under test and the test antenna shall be rotated until maximum field strength is indicated on the measuring receiver. This level shall be noted.

If the transmitter can be operated in the standby mode, then the measurements shall be repeated in the standby mode.

For measuring equipment calibrated in dBμV, the reading should be reduced by 51,5 dB to be converted to dBμA/m.

7.2.3.2 Limits

Radiated emissions below 30 MHz shall not exceed the generated H-field in dBμA/m at 10 m given in table 6.

Table 6

State	Frequency 9 kHz ≤ f < 10 MHz	Frequency 10 MHz ≤ f < 30 MHz
Transmit	27 dBμA/m descending 3 dB/oct	-3,5 dBμA/m
Standby	6 dBμA/m descending 3 dB/oct	-24,5 dBμA/m

7.2.4 Effective radiated spurious power

7.2.4.1 Methods of measurement (≥ 30 MHz)

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 applicant.

The antenna connector shall be connected to an artificial antenna (see clause 6.2).

The test antenna shall be oriented for vertical polarization. The output of the test antenna shall be connected to a measuring receiver.

The equipment shall be switched on. The transmitter shall use its normal modulation. If this cannot be obtained then the measurements shall be made with the transmitter modulated by the normal test signal (see clause 6.1.1) in which case this fact shall be recorded in the test report. and the measuring receiver shall be tuned over the frequency range 30 MHz to 1 000 MHz.

At each frequency at which a relevant spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The equipment 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 substitution antenna shall be oriented for vertical polarization and calibrated for the frequency of the spurious component detected.

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 heights to ensure that the maximum signal is received.

When a test site according to clause A.1.1 is used, there is no need to vary the height of the antenna.

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

The input signal to the substitution antenna shall be recorded as a power level and corrected for any change of input attenuator setting of the measuring receiver.

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 substitution antenna if necessary.

If a receive standby mode is available, the measurements shall be repeated in that mode, see clause 8.2.2.

7.2.4.2 Limits

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

Table 7

Transmitter state	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies between 30 MHz to 1 000 MHz
Operating	4 nW e.r.p.	250 nW e.r.p.
Standby	2 nW e.r.p.	2 nW e.r.p.

7.3 Duty cycle

7.3.1 Definitions

For the purpose of the present document the term duty cycle refers to the ratio of the total on-time of the "message" to the total time in any one hour period. The device may be triggered either automatically or manually and depending on how the device is triggered will also depend on whether the duty cycle is fixed or random.

7.3.2 Declaration

For software controlled or pre-programmed devices, the applicant shall declare the duty cycle class or classes for the equipment under test, see table 8.

For manually operated or event dependant devices, with or without software controlled functions, the applicant shall declare whether the device once triggered, follows a pre-programmed cycle, or whether the transmission is constant until the trigger is released or manually reset. The applicant shall also give a description of the application for the device and include a typical usage pattern. The typical usage pattern as declared by the applicant shall be used to determine the duty cycle and hence the duty class, see table 8.

Where an acknowledgement is required, the additional transmitter on-time shall be included and declared by the manufacturer.

7.3.3 Duty cycle classes

In a period of 1 hour the duty cycle shall not exceed the values given in table 8.

Table 8: Duty cycle Classes

Duty cycle class	Duty cycle ratio
1	< 0,1 %
2	< 1,0 %
3	< 10 %
4	Up to 100 %

8 Receiver requirement

8.1 Blocking or desensitization

8.1.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or adjacent selectivity.

8.1.2 Methods of measurement

This measurement shall be conducted under normal conditions.

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver either:

a) via a test fixture or a test antenna coupling to the receiver integral, dedicated or test antenna; or

b) directly to the receiver permanent or temporary antenna connector.

The method of coupling to the receiver shall be stated in the test report.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal. Signal generator B shall be unmodulated and shall be adjusted to a test frequency as defined below.

Initially signal generator B shall be switched off and by using signal generator A the minimum level giving sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criterion is met. This level shall be recorded.

The frequency for generator B is defined by the following:

- The measurements shall be at approximately +500 kHz, +1 MHz, +2 MHz and +5 MHz from the highest receiver operating frequency + the 3dB receiver bandwidth.
- The tests shall be repeated at approximately -500 kHz, -1 MHz, -2 MHz and -5 MHz from the lowest receiver operating frequency - the 3dB receiver bandwidth.
- The manufacturer shall declare the receiver operating frequencies and 3 dB receiver bandwidth.

The blocking or desensitization shall be recorded as the ratio in dB of lowest level of the unwanted signal (generator B) to the level of the wanted signal (generator A).

8.1.3 Limits

The blocking ratio, for any frequency within the specified ranges, shall not be less than the values given in table 9, except at frequencies on which spurious responses are found.

Table 9: Receiver blocking or desensitization limits

Receiver Class	Offset frequency	Limit
1	For all offset frequencies	60 dB
2	±500 kHz	30 dB
	±1 MHz	40 dB
	±2 MHz	50 dB
	±5 MHz	60 dB

8.2 Receiver spurious emissions

These requirements do not apply to receivers used in combination with permanently co-located transmitters continuously transmitting. Co-located is defined as less than 3 m. In these cases the receivers will be tested together with the transmitter in operating mode (see clause 7.2).

8.2.1 Definition

Spurious emissions by the receiver are either:

1) a) their conducted power in an artificial antenna (conducted spurious emission); and

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

2) their effective radiated power or field strength when radiated by the cabinet and the integral antenna.

8.2.2 Methods of measurement

The level of spurious emissions shall be measured at normal conditions (clause 5.3):

1) For conducted measurements at and above 30 MHz, see clause 7.2.2.1.

2) For radiated measurements below 30 MHz, see clause 7.2.3.1.

3) For radiated measurements at and above 30 MHz, see clause 7.2.4.1.

8.2.3 Limits

8.2.3.1 Radiated emissions below 30 MHz

The spurious components below 30 MHz shall not exceed the generated H-field dBμA/m values at 10 m according to table 10.

Table 10: Receiver spurious radiation limits

Frequency 9 kHz ≤ f < 10 MHz	Frequency 10 MHz ≤ f < 30 MHz
6 dBμA/m descending 3 dB/oct	-24,5 dBμA/m

8.2.3.2 Radiated and conducted emissions above 30 MHz

The measured values shall not exceed 2 nW e.r.p.

9 Measurement uncertainty

The interpretation of the results recorded in the 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 value of the measurement uncertainty for the measurement of each parameter shall be separately included in the test report.
- The value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures given below:
  - RF frequency $\pm 1 \times 10^{-7}$;
  - RF power, conducted ±1 dB;
  - RF power, radiated ±6 dB;
  - Temperature ±1°C;
  - Humidity ±5 %.

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

The measurement uncertainties given above are based on such expansion factors.

The particular expansion factor used for the evaluation of the measurement uncertainty shall be stated.

Annex A (normative): Radiated measurement

This annex is applicable to the assessment of 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.

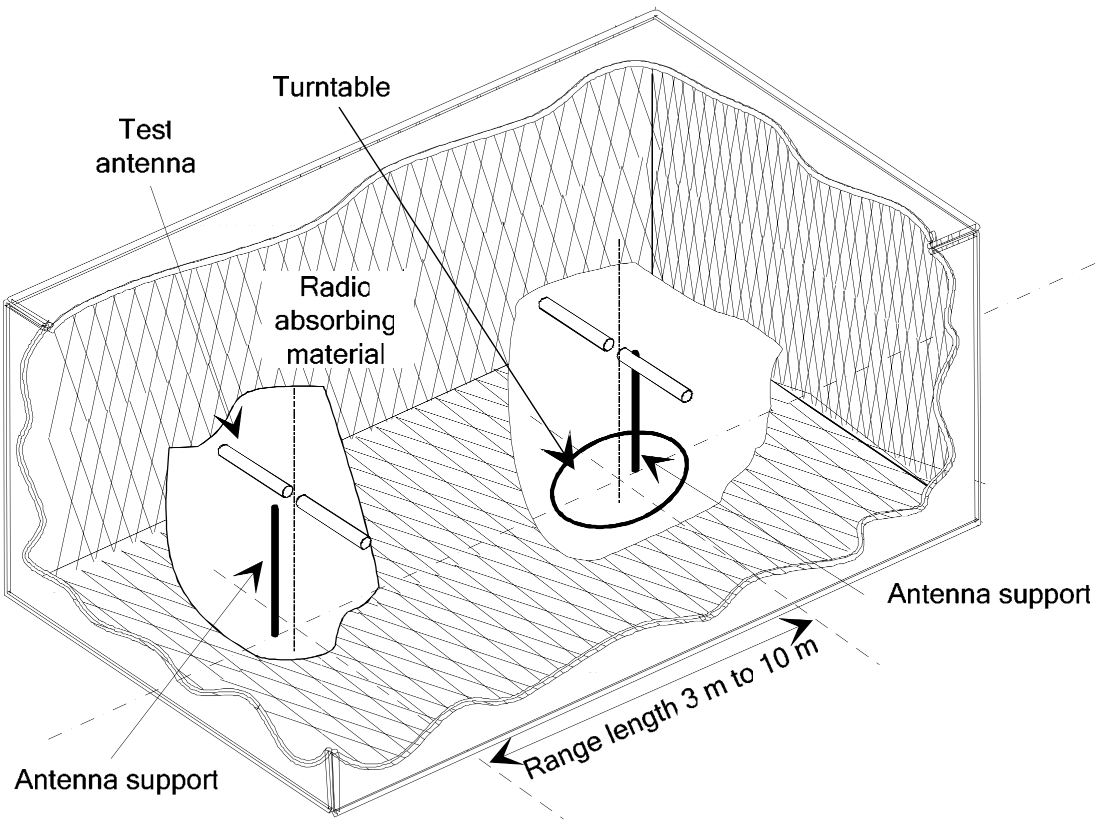


Figure A.1: A typical anechoic chamber

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.2.4). 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.

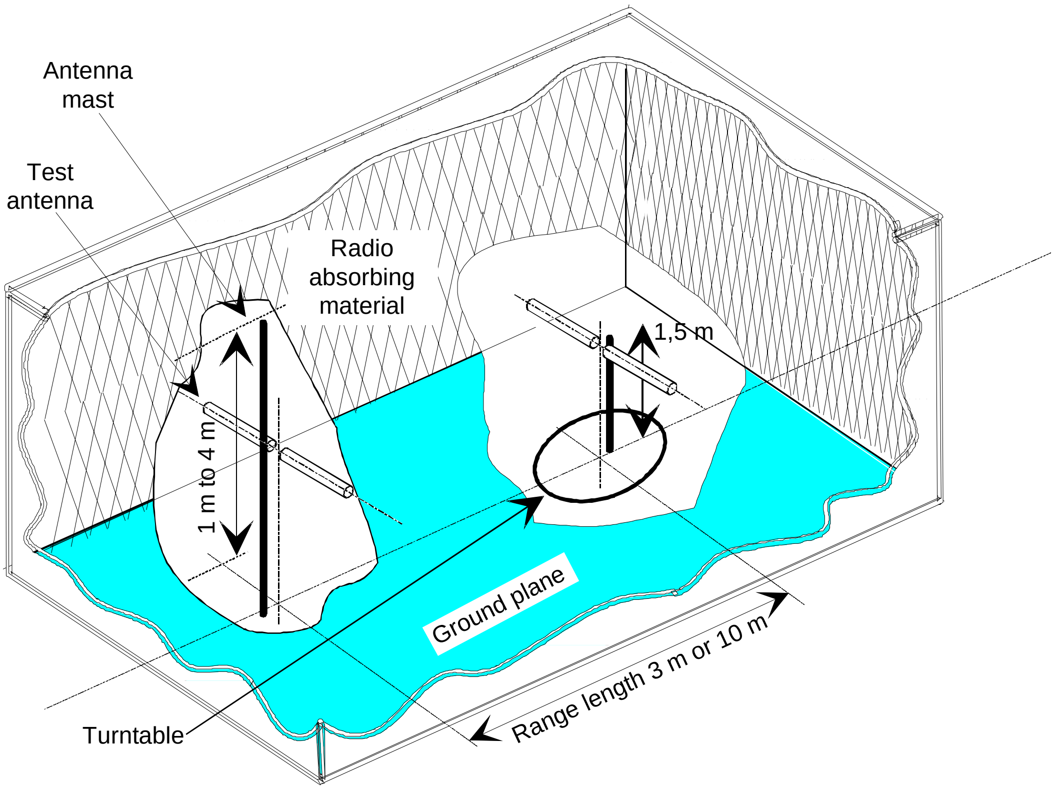


Figure A.2: A typical anechoic chamber with a conductive ground plane

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.2.4). 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 (OATS) is shown in figure A.3.

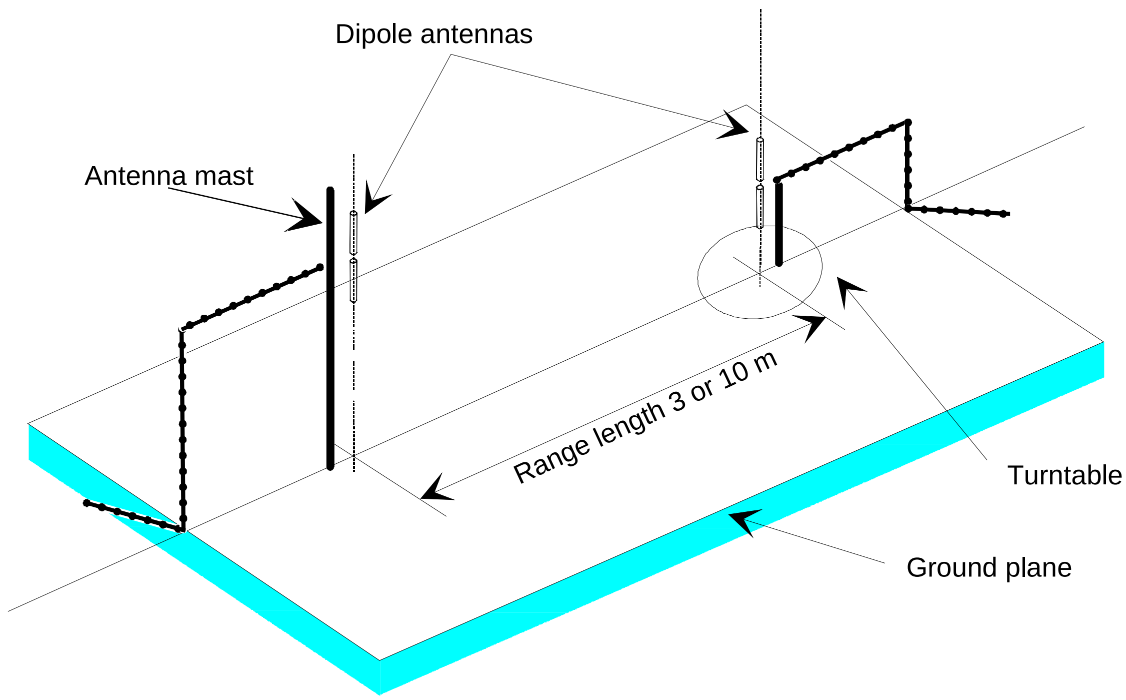


Figure A.3: A typical Open Area Test Site (OATS)

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.

For measurements below 30 MHz tests may be made according to CISPR 16-1 [4]. The measurements are made with an inductive shielded loop test antenna, which reads the magnetic field (H-field) only. These measurements are valid for both the far-field and the near-field situations. In this case the OATS shall not have a ground plane using a magnetic conductive material. Therefore, such measurements are normally made without a ground plane.

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

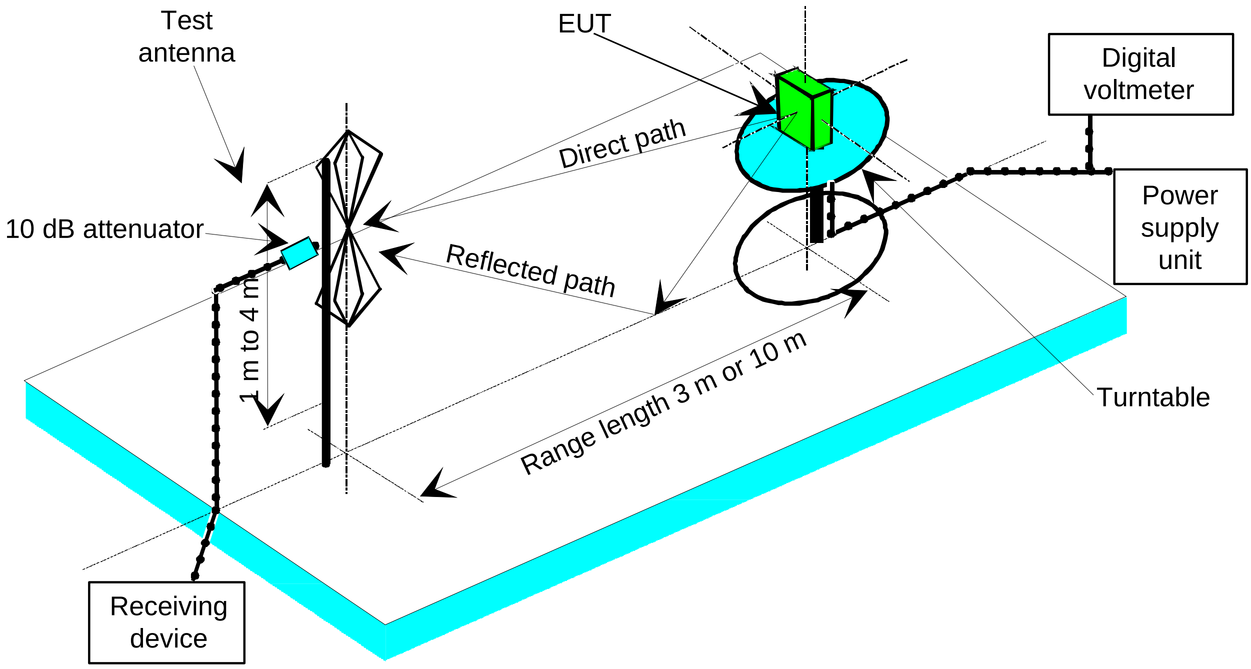


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

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 sub-band 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 range 9 kHz to 30 MHz, inductive shielded loop antennas according to CISPR 16-1 [4] are generally recommended. This test antenna method supports measurements in both the far-field and near-field.

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [6] 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 sub-band 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 [6]). 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.
Below 30 MHz substitution measurements are not used as the radiated H-field is measured with a shielded loop antenna according to CISPR 16-1 [4].

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 [6]. 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.

For measurements on inductive loop systems operating below 30 MHz, the measurement antenna is a calibrated loop antenna.

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 ohm 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 489-3 App. J	FTZ Nº512 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 tests 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 provider 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, sub-band 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 min 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 1,5) 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 Range length

A.2.4.1 Far-field length above 30 MHz

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 m 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.2.4.2 Near-field and Far-field length below 30 MHz

Inductive systems below 30 MHz can be measured both in the near-field and far-field regions at an open test site by means of a shielded loop antenna according to CISPR 16-1 [4].

The minimum measurement distance, d is determined by:

$$d \geq 3D$$

where D is the maximum dimension in metre of the inductive loop.

A.2.5 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 (OATS)) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with. In this case the cable routing shall be described in the test report.

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, ultrasonic or infrared means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infrared radiated connections require suitable measures for the minimization of ambient noise.

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 provider;

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 a rotateable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

- Height: 1,7 m ± 0,1 m;
- Inside diameter: 300 mm ± 5 mm;
- Sidewall thickness: 5 mm ± 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 ohm 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 provider.

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 ohm 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.

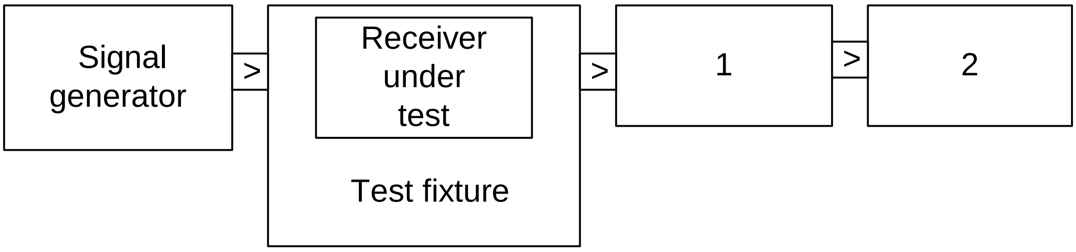
The characteristics and calibration shall be included in the test report.

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.).



1) Coupling device.
2) Device for assessing the performance, e.g. distortion factor, 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 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 particular for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under 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 using the calibration of the test fixture. Apply this value to the signal generator.

Annex B (normative): Technical performance of the spectrum analyser

It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser as displayed on the screen, to an accuracy of ±2 dB in the presence of a signal separated in frequency by 10 kHz, at a level 90 dB above that of the signal to be measured.

The reading accuracy of the frequency marker shall be within ±2 % of the sub-band separation.

The accuracy of relative amplitude measurements shall be within ±1 dB.

It shall be possible to adjust the spectrum analyser to allow the separation, on the display, of two components with a frequency difference of 1 kHz.

Annex C (informative): Bibliography

- ETSI EN 302 291-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Close Range Inductive Data Communication equipment operating at 13,56 MHz; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive".
- ERC Report 69: "Propagation model and interference range calculation for inductive systems 10 kHz 30 MHz".
- ERC Report 74: "Compatibility between Radio Frequency Identification Devices (RFID) and the Radioastronomy service at 13 MHz".
- ECC Report 1: "Compatibility between inductive LF and HF transponder and other radio communication systems in the frequency ranges 135-148.5 kHz, 4.78-8.78 MHz and 11.56-15.56 MHz".
- Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.
- Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.
- ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".
- ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz".
- ETSI TS 102 190: "Near Field Communication (NFC) IP-1; Interface and Protocol (NFCIP-1)".
- IEC Publication 489-3 (Second edition - 1988) Appendix J, pages 156 to 164.
- Technical Report FTZ No 512 TB 9: "Construction of a Stripline".

History

Document history				
V1.1.1	July 2004	Public Enquiry	PE 20041105:	2004-07-07 to 2004-11-05
V1.1.1	May 2005	Vote	V 20050708:	2005-05-09 to 2005-07-08
V1.1.1	July 2005	Publication		