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Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz; Part 1: Technical characteristics and test methods

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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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); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 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:	15 June 2001
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1 Scope

The present document applies to Short Range Devices (SRDs) transmitters and receivers:

a) - transmitters operating in the range from 9 kHz to 25 MHz; and
   - inductive loop transmitters operating from 9 kHz to 30 MHz;

b) - receivers operating from 9 kHz to 30 MHz.

The present document contains the technical characteristics for radio equipment and is referencing in CEPT/ERC Recommendation 70-03 [3] 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 It is a product family standard which may be completely or partially superseded by specific standards covering specific applications.

The present document applies to generic SRDs:

- inductive loop systems;

- with an antenna connection and/or with an integral antenna;

- for alarms, identification systems, telecommand, telemetry, etc.;

- applications with or without speech.

When selecting parameters for new SRDs, 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 7.3 are met.

The radio equipment, covered by the classification SRD is divided into several power classes based on maximum radiated field strength or output power (see table 1). The power class designation is based on CEPT/ERC Recommendation 70-03 [3] and ERC Decisions.

Table 1: Maximum radiated H-field or power (e.i.r.p)

Power Class	Radiated H-field or power level
1	7 dBµA/m at 10 m
2	42 dBµA/m at 10 m
3	72 dBµA/m at 10 m (at 9 kHz to 30 kHz, descending 3 dB/octave from 30 kHz 135 kHz)
4	37,7 dBµA/m at 10 (at 135 kHz, descending 3 dB/octave from 135 kHz to 1 MHz)
	29 dBµA/m at 10 m (at 1,0 MHz descending 9 dB/oct from 1 MHz to 4,642 MHz)
5	9 dBµA/m at 10 m (4,642 MHz to 30 MHz)

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.

Three 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 RF carrier current, another measures the radiated H-field and the third the conducted 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.

[1] ETSI EN 300 330-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive".

[2] 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.

[3] CEPT/ERC Recommendation 70-03 (1997): "Relating to the use of Short Range Devices (SRD)".

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

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

[6] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

customized antenna: antenna build according to manufacturers antenna design rules inside tested limits

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

magnetic dipole moment: product of (Number of coil turns) $\times$ (coil area) $\times$ (coil current)
(Air coils only)

mobile station: equipment normally installed in a vehicle

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
Eo	reference electrical field strength, (see annex A)
e.i.r.p	effective isotropic radiated power
f	frequency
H	magnetic field strength
Ho	reference magnetic field strength, (see annex A)
m	magnetic dipole moment
P	Power
PSTN	Public Switched Telephone Network
R	distance
Ro	Reference distance, (see annex A)
t	time

3.3 Abbreviations

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

EMC	ElectroMagnetic Compatibility
ISM	Industrial, Scientific and Medical
RF	Radio Frequency
R&TTE	Radio and Telecommunications Terminal Equipment
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 class	Relevant receiver clauses	Risk assessment of receiver performance
1	8.1, 8.2, and 8.3	Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person)
2	8.2 and 8.3	Medium reliable SRD communication media e.g. causing Inconvenience to persons, which cannot simply be overcome by other means
3	8.3	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 and EN 300 330-2 [1], clause 4.2, as relevant. In particular where an SRD 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:

- a SND/ND ratio of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in ITU-T Recommendation O.41 [6]; or
- after demodulation, a data signal with a bit error ratio of 10^{-2}; or
- after demodulation, a message acceptance ratio of 80 %.

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 clauses 6.3). For equipment supplied without an antenna i.e. Product Class 3, the applicant will supply either a tuned reduced radiating load (see clause 6.2.1) or an artificial antenna as defined by annex G.

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 and 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 Ω connector for conducted RF power level measurements.

In the case of integral antenna equipment, if the equipment does not have a internal permanent 50 Ω 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, eirp 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. In these cases equivalent measurements to the present document shall be made at a representative installation of the equipment (on-site).

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 shall be made inoperative for the duration of the tests.

4.3.5 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible and durable. Where this is not possible due to physical constraints, the marking shall be included in the users manual.

4.3.5.1 Equipment identification

The marking shall include as a minimum:

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

4.3.5.2 Regulatory marking

The equipment shall be marked, where applicable, in accordance with CEPT/ERC Recommendation 70-03 [3] or the EC Council Directive 1999/5/EC (R&TTE Directive) [2], whichever is applicable. Where this is not applicable the equipment shall be marked in accordance with the National Regulatory requirements.

4.4 Declarations by the applicant

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

The performance of the equipment submitted for type 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 type testing.

4.6 Interpretation of the measurement results

The interpretation of the results recorded on 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 in the table of measurement uncertainty (clause 9).

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

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

The test conditions and procedures shall be as specified in 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 type tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in 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 so 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 +55°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 analogue speech

Normal test signals for analogue speech are specified as follows:

- A-M1: a 1 000 Hz tone;
- A-M2: a 1 250 Hz tone.

For angle modulation, the normal level of the test signals A-M1 and A-M2 shall be adjusted to produce a deviation of 12 % of the channel separation or any lower value as declared by the applicant as the normal operating level.

In the case of amplitude modulation, the normal modulation depth shall be 60 % or any lower value as declared by the applicant. This shall be used as the normal level of operation and shall be stated in the test report.

6.1.2 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 [4]. 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.

For angle modulation, the normal level of the test signal D-M3 shall produce a deviation of 20 % of the channel separation or any other value as declared by the applicant as the normal operating level.

In case of amplitude modulation, the modulation ratio shall be 60 %, or any value, as declared by the applicant, as the normal operating level.

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 inductive transmitters (non 50 Ohm)

For measurements of inductive transmitters without a 50 Ω antenna impedance, a tuned reduced radiating load connected to the antenna connector shall be used as agreed with the accredited test laboratory.

The impedance shall be equal to the nominal load of the equipment specified by the applicant.

This method facilitates conducted measurements to be made of the following:

- transmitter carrier loop currents up to 30 MHz;
- transmitter spurious loop currents up to 30 MHz; and
- conducted spurious measurements in the range 30 MHz to 1 GHz.

The use of this non-50 Ω load during test shall be stated in the test report form.

6.2.2 Artificial antenna for transmitters with 50 Ohm impedance connector

For measurements on transmitters with a normal 50 Ω antenna impedance, tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating 50 Ω load 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.

This method may also facilitate conducted measurements to be made of the following:

- transmitter carrier loop currents up to 30 MHz;
- transmitter spurious loop currents up to 30 MHz; and
- conducted spurious measurements in the range 30 MHz to 1 GHz.

The use of 50 Ω 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 Ω RF output connector, a suitable test fixture shall be used as agreed with the accredited test laboratory, where applicable.

This fixture is a RF coupling device for coupling the integral antenna to a 50 Ω RF terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using conducted measuring methods. However, only relative measurements may be performed. The test fixture is normally only required for extreme temperature measurements and shall be calibrated only with the equipment under test.

The test fixture shall be fully described by the applicant. The accredited test laboratory, where applicable shall calibrate the test fixture by carrying out the required field measurements at normal temperatures at the prescribed test site. Then the same measurements shall be repeated on the equipment under test using the test fixture for all identified frequency components.

In addition, the test fixture may provide:

- a connection to an external power supply;
- an audio interface either by direct connection or by an acoustic coupler;
- a connection to a data interface.

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

- the circuit 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 the surrounding objects or people;
- the coupling loss shall be reproducible when the equipment under test is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

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 Modes of operation of the transmitter

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

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

For the purpose of type testing, the normal test signal, see clauses 6.1.1 and 6.1.2, shall be applied to the input of the transmitter under test with the normal input device disconnected (e.g. microphone).

6.6 Measuring receiver

The term "measuring receiver" refers to a selective voltmeter or a spectrum analyser. 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 Hz to 10 kHz
30 MHz ≤ f ≤ 1 000 MHz	Quasi Peak	100 Hz to 120 kHz

Exceptionally, different bandwidth may be used if agreed with the accredited test laboratory. This 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, conducted current or power level as declared by the applicant.

Where the transmitter is designed with an adjustable carrier H-field or RF current, 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 7.4).

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 Ω antenna connector and a dedicated antenna, the full tests shall be carried out using the external connector and in addition:

- radiated H-field (see clauses 7.2.1);
- spurious emissions (see clause 7.4 and annex A);

tests shall be carried out with the dedicated antenna.

7.1 Transmitter definitions

Transmitters are divided into Power Classes based on their radiated field and Product Classes depending on the antenna type to be used. Product Class 2 and Product Class 3 transmitters may allow the customer to use his own loop antenna design based on the manufacturers design guidelines. The user's manual shall include the guidelines for the design of the antennas. These guidelines may be evaluated by the accredited laboratory as part of the test of the equipment and compared to actual radiated measurements.

7.1.1 The inductive loop coil transmitters

These transmitters are characterized by:

a) the loop coil antenna area A shall be < 30 m^2;

b) the length of any antenna loop element shall be $<\frac{\lambda}{4}$ ($<\frac{75}{f}$, where f is in MHz) or < 30 m whichever is shorter;

c) antenna coil may have one or multiple turns.

7.1.2 The large size loop transmitters

These transmitters are characterized by:

- large loop antenna area A > 30 m^2;
- large loop antenna with one turn only;
- frequency range limited from 9 kHz to 135 kHz only.

7.1.3 Other transmitters

These transmitters are characterized as either:

- E-field transmitters, or;
- loop antenna transmitters which are not meeting the criteria in clauses 7.1.1 and 7.1.2.

7.1.4 Product Classes

The equipment are divided into Product Classes depending of the antenna type used. The Product Classes shall not be confound with Equipment Classes, see clause 4.1.1 or with Power Classes, see clause 1 and clause 7.2.1.3.
The different antenna types are referencing CEPT/ERC Recommendation 70-03 [3].

The Product Classes are:

Product Class 1:

Inductive loop coil transmitter, tested with an antenna as either:

- an integral antenna (antenna type 1); or
- a dedicated antenna supplied with the equipment (antenna type 2).

The following restrictions apply to this product class:

- 9 kHz to 30 MHz frequency range;
- no field customization of the antenna(s);
- loop antenna area < 30 m^2; and
- the length of any antenna loop element shall be $< \frac{\lambda}{4}$ ($< \frac{75}{f}$, where f is in MHz) or < 30 m whichever is shorter.

The transmitter carrier and spurious are limited by the maximum generated H-field, (see clause 7.2.1 and clauses 7.4.3 and 7.4.4 respectively).

Where a manufacturer provides a range of standard antennas, the equipment will be tested as Product Class 1 equipment, with the antenna(s) attached. The measurements shall be repeated for each of such antenna.

Product Class 2:

Inductive loop coil transmitter, allowing field customization of the loop antenna.

Customization is only allowed according to the manufacturers antenna design rules published in the equipment manual.

Product Class 2 equipment is tested as Product Class 1 with two representative antennas supplied with the equipment. The two antennas shall meet the manufacturers design rules published in the equipment manual and shall have maximum and minimum loop area respectively. Both antennas shall have the maximum magnetic dipole moment as declared by the manufacturer. The following additional restrictions apply to this Product Class:

- 9 kHz to 30 MHz frequency range;
- loop antenna area < 30 m^2; and

the length of any antenna loop element shall be $<\frac{\lambda}{4}$ ($< \frac{75}{f}$, where f is in MHz) or < 30 m whichever is shorter.

The transmitter carrier and spurious are limited by the maximum generated H-field, (see clause 7.2.1 and clauses 7.4.3 and 7.4.4 respectively).

In cases where it, due to size constraints, is not practical to ship and test a large antenna together with the equipment, the equipment is tested either:

- at an open test site together with a maximum and minimum size custom made antenna build by the manufacturer; or
- at a representative installation (on-site) according to clause 4.2.4.

Product Class 3:

This Product Class is intended for use with customized large size loop antennas only. The loop coil transmitter is tested without an antenna by using an artificial antenna.

The following additional restrictions apply to this Product Class:

- 9 kHz to 135 kHz frequency range;
- loop antenna area > 30 m^2;
- single loop only.

The transmitter carrier and spurious are limited by the maximum output loop current multiplied by the loop antenna area and shall comply with the radiated H-field limit (see clause 7.2.1.3, 7.2.2.3 and clauses 7.4.2.1, 7.4.2.1.1, 7.4.3 and 7.4.4 respectively). The manufacturer shall declare the maximum size of the loop in the users manual and the application form.

Product Class 4:

E-field transmitter, tested with each type of antenna to be used.

The transmitter carrier and spurious are limited by the maximum generated E-field, measured as the equivalent H-field, (see clause 7.2.3 and clauses 7.4.3 and 7.4.4 respectively).

7.2 Transmitter carrier output levels

7.2.1 H-field (radiated)

7.2.1.1 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.

7.2.1.2 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 6.6.

The equipment under test shall operate where possible, without modulation. Where this is not possible, it shall be stated in the test report.

For transmitters using a continuous wideband swept carrier, the measurement shall be made with the sweep off. When it is not possible to turn the sweep off the measurements shall be made with the sweep on and this shall be stated in the test report.

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

7.2.1.3 Limits

The limits presented in the present document are the required field strengths to allow satisfactory operation of inductive systems. These levels were determined after careful analysis within ETSI and ERC/CEPT.

Maximum field strength under normal and extreme conditions is given in table 4.

For the purpose of type approval, the limits from table 4 apply. Exceptionally, some administrations may have a need to provide additional protection to some existing services operating on frequencies covered by this table.

In all cases SRDs operate on a non-interference basis. Solutions can range from site engineering to field strength modification and can be used on a case by case basis.

Additional information is available in CEPT/ERC Recommendation 70-03 [3] or ERC Decisions.

Table 4: H-field limits at 10 m

Power Class	Frequency range (MHz)	H-field strength limit (H_f) dBμA/m at 10 m
3	$0,009 \leq f < 0,03$	72 or according to note
3	$0,03 \leq f < 0,07$ $0,119 \leq f < 0,135$	72 MHz at 0,03 MHz descending 3 dB/oct or according to note
2	$0,05975 \leq f < 0,06025$ $0,07 \leq f < 0,119$	42
4	$0,135 \leq f < 1,0$	37,7 MHz at 0,135 MHz descending 3 dB/oct
4	$1,0 \leq f < 4,642$	29 MHz at 1,0 MHz descending 9 dB/oct
5	$4,642 \leq f < 30$	9
2 and 8	$6,765 \leq f \leq 6,795$ $13,553 \leq f \leq 13,567$ $26,957 \leq f \leq 27,283$	42
NOTE: For the frequency ranges 9 to 70 kHz and 119 to 135 kHz, the following additional restrictions apply to the higher limits: - for loop coil antennas with an area $\geq 0,16\ m^2$ table 4 applies directly; - for loop coil antennas with an area between $0,05\ m^2$ and $0,16\ m^2$ table 4 applies with a correction factor. The limit is: table value + $10 \times \log(\text{area}/0,16\ m^2)$; - for loop coil antennas with an area $< 0,05\ m^2$ the limit is 10 dB below table 4.		

For equivalent graphical representation of table 4, see annex B.

7.2.2 RF carrier current

7.2.2.1 Definition

This applies to Product Class 3 only.

RF carrier current is defined as the current delivered to an artificial load under specified conditions of measurement. The manufacturer shall declare the maximum antenna loop size.

7.2.2.2 Methods of measurement

The transmitter shall be connected to an artificial antenna, see clause 6.2.1 and annex G. The RF current delivered to this artificial antenna during a transmission duty cycle shall be measured up to 30 MHz. The current shall be measured either by using:

- a calibrated current probe connected to a measuring receiver; or
- a derived output from a calibrated artificial antenna connected to a measuring receiver, see annex G.

The measuring bandwidth and detector type shall be in accordance with clause 6.6.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep off. Where this is not possible the measurements may be made with the sweep on. This shall be stated in the test report.

This method of measurement for the transmitter carrier current is used for Product Class 3 equipment operating at a frequency up to 135 kHz.

The measurements shall be made under normal and extreme test conditions, see clause 5.4.

A detailed explanation of the relationship between the RF carrier current, antenna factor (N × A) and the equivalent generated H-field is given in annex F.

7.2.2.3 Limits

The limit for the RF carrier current multiplied with the antenna area for Product Class 3 Large size loop transmitters is given in table 5.

Table 5: RF carrier current × antenna area

Frequency range, MHz	RF carrier current × antenna area, $dBAm^2$
$0,009 \leq f < 0,03$	40
$0,03 \leq f < 0,07$ $0,119 \leq f < 0,135$	40 at 30 kHz descending 3 dB/oct
$0,059\ 75 \leq f < 0,060\ 25$ $0,07 \leq f < 0,119$	10

See annex C for a graphical representation.

7.2.3 Radiated E-field (Product Class 4)

7.2.3.1 Definition

The radiated E-field is defined as the E-field in the direction of maximum field strength under the specified conditions of measurement. This is defined for a transmitter with an integral antenna.

7.2.3.2 Methods of measurement

The transmitter radiated E-field is based on the equivalent H-field, measured at 10 m.

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 6.6.

For a detailed explanation of the relationship between E-field and H-field, see annex H.

7.2.3.3 Limits

In the frequency range 9 kHz to 4,78 MHz, the limits of H_{ef} follow the H-fields limits, H_f, as given in clauses 7.2.1.3, table 4 with an additional correction factor C. The factor given below is specific for a 10 m measuring distance.

The limit $H_{ef} = H_f + C$

where:

$$C = 20 \times \log (f_c / 4{,}78 \times 10^6) \text{ dB};$$

and where:

f_c is the carrier frequency in Hz.

For a graphical representation of the correction factor C see annex D.

In the frequency range 4,78 MHz to 25 MHz limits are identical to the limits in clause 7.2.1.3, table 2, without any correction factor.

7.3 Permitted frequency range of the modulation bandwidth

The permitted frequency range shall be stated by the applicant.

7.3.1 Definition

The modulation bandwidth contains all associated side bands above the following level:

a) for carrier frequencies below 135 kHz at the highest level of either:

- 30 dB below the carrier or the appropriate spurious limit, see clause 7.4;

b) for carrier frequencies in the range 135 kHz to 30 MHz:

- at the appropriate spurious limit, see clause 7.4.

Where the assigned frequency band has been divided into sub-bands by the regulatory body, the above measuring levels and bandwidths apply inside these sub-bands.

For the modulation products inside the adjacent bands, see special cases in annex L.

7.3.2 Method of measurement

The transmitter shall be connected to an artificial antenna or if the transmitter has an integral antenna a test fixture shall be used (see clause 6.3). The RF output of the equipment shall be connected to a spectrum analyser via a 50 Ω variable attenuator.

The transmitter shall be operated at the nominal carrier power or field strength measured under normal test conditions in clause 7.2. The attenuator shall be adjusted to an appropriate level displayed at the spectrum analyser screen.

The transmitter shall be modulated with standard test modulation (see clauses 6.1.1 and 6.1.2). If the equipment cannot be modulated externally, the internal modulation shall be used.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

The output of the transmitter, with or without test fixture, shall be measured by using a spectrum analyser with a resolution bandwidth appropriate to accept all major side bands. The power level calibration of the spectrum analyser shall then be related to the power level or field strength measured in clause 7.2. The calculation will be used to calculate the absolute level of the sideband power.

The test laboratory shall ensure that the spectrum analyser's span is sufficiently wide enough to ensure that the carrier and all its major side bands are captured.

The frequencies of the upper and lower points, where the displayed power envelope of the modulation including frequency drift is equal to the appropriate level defined in clause 7.3.1 is recorded as the modulation bandwidth.

The measurements shall be made during normal and extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

7.3.3 Limits

The permitted range of the modulation bandwidth shall be within the limits of the assigned frequency band stated in CEPT/ERC Recommendation 70-03 [3] or ERC Decisions.

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 test modulation (clause 6.1). The level of spurious emissions shall be measured at normal conditions (clause 5.3) as either:

1) a) their power or current level 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.

7.4.2 Conducted spurious emissions

This clause refers to the requirements in clause 7.4.1; indent 1 a) and applies to Product Class 3 only.

7.4.2.1 Methods of measurement (< 30 MHz)

The transmitter shall be connected to an artificial antenna according to clause 6.2.1. The measuring receiver shall be connected to the output of the artificial antenna and the current for both the carrier and the spurious components shall be measured. For further details of the artificial antenna, see annex G.

The method for deriving the spurious current limit I_s is calculated by the following formula:

$$I_c - I_s = H_c - H_s$$

where:

I_s is the measured conducted spurious current limit expressed in dBµA;

I_c is the measured RF carrier current limit expressed in dBµA, see clause 7.2.2.3;

H_c is the limit for the generated H-field expressed in dBµA/m, see clause 7.2.1.3;

H_s is the limit for H-field spurious expressed in dBµA/m, see clause 7.4.3.2.

The term (H_c - H_s) in the above formula is the required attenuation in dB of the spurious H -field. This requirement may vary with frequency due to varying limits with frequency.

The term (I_c - I_s) (in dB) is the attenuation in dB of the spurious current below the carrier current.

7.4.2.2 Limits

Under normal test conditions the following condition shall be fulfilled:

$$(I_C - I_S) \geq (H_C - H_S)$$

7.4.2.3 Methods of measurement (≥ 30 MHz)

The transmitter shall be connected to an artificial antenna according to clause 6.2.2. The spurious components are measured by means of a selective voltmeter connected to the output of the transmitter by means of an appropriate coupling device. For details of the artificial antenna, see annex G.

7.4.2.4 Limits

The power of any conducted spurious emission shall not exceed the values given in table 6.

Table 6

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	250 nW
Standby	2 nW	2 nW

7.4.3 Radiated field strength

This clause refers to clause 7.4.1; indent 1 b) and 2).

7.4.3.1 Methods of measurement (< 30 MHz)

This applies to all Product Classes.

The 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 Product Class 3 the transmitter antenna connector of 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 signal used shall be stated on the test report. The measuring receiver shall be tuned over the frequency range 9 kHz to 30 MHz, except for the frequency band on which 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.

7.4.3.2 Limits

Radiated emissions below 30 MHz shall not exceed the generated H-field dBμA/m at 10 m given in table 7.

Table 7

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

For a graphical representation see annex E.

7.4.4 Effective radiated power

This clause refers to the requirements of clause 7.4.1 1) b) and 2).

7.4.4.1 Methods of measurement (≥ 30 MHz)

This method applies to all Product Classes.

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.

For Product Class 3 the transmitter 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 transmitter shall be switched on with normal modulation, 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 transmitter 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.3 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 an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the normal test signal (see clause 6.1.2) in which case this fact shall be recorded in the test report.

If standby mode is available, the measurements shall be repeated in that mode.

7.4.4.2 Limits

The power of any radiated emission shall not exceed the values given in table 8.

Table 8

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	250 nW
Standby	2 nW	2 nW

7.5 Duty cycle

7.5.1 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 off 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.

7.5.2 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 9.

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 9.

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

7.5.3 Duty cycle classes

In a period of 1 hour the duty cycle shall not exceed the values given in table 9.

Table 9

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

8 Receiver requirement

8.1 Adjacent channel selectivity - in band

This measurement is only required where a frequency plan with standard channel spacing is consistently used, for example at 27 MHz.

This measurement shall not be performed if:

a) the transmitter cannot be switched off and the spacing between the transmit and the receiver frequency is less than ten times the declared receiver 3 dB bandwidth; or

b) the transmitter and receiver are operating at the same frequency and the transmitter cannot be switched off as the carrier is used as receiver injection signal (e.g, for homodyne systems).

In the case where a) and/or b) above applies, this shall be stated in the test report.

8.1.1 Definition

The adjacent channel selectivity is a measure of the capability of the receiver to operate satisfactorily in the presence of an unwanted signal that differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

8.1.2 Method 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 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 the test frequency for the adjacent channel immediately above that of the wanted signal.

Initially signal generator B shall be switched off and using signal generator A the level that still gives 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 the level is adjusted until the wanted criteria is met. This level shall be recorded.

The measurements shall be repeated with signal generator B adjusted to the test frequency on the adjacent channel immediately below the wanted signal.

The adjacent channel selectivity shall be recorded for the upper and lower adjacent channels as the ratio in dB of the unwanted signal to the level of the wanted signal.

For tagging systems (e.g., RF identification, anti-theft, access control, location and similar systems) signal generator A may be replaced by a physical tag positioned at 70 % of the measured system range in metres. In this case, the adjacent selectivity shall be recorded as the ratio in dB of lowest level of the unwanted signal (generator B) to the declared sensitivity of the receiver +3 dB.

8.1.3 Limits

The adjacent channel selectivity of the equipment under specified conditions shall not be less than stated in table 10.

Table 10

Equipment class	Channel spacing ≤ 25 kHz	Channel spacing > 25 kHz
1	60 dB	70 dB

8.2 Blocking or desensitization

8.2.1 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 adjacent selectivity, see clause 8.1.

8.2.2 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 either a) or b) below whichever is greater:

a) For the frequency range 9 kHz to < 500 kHz, the measurements shall be at approximately +50 kHz, +100 kHz, +200 kHz, 300 kHz and +500 kHz from the highest receiver operating frequency + the 3dB receiver bandwidth. The tests shall be repeated at approximately -50 kHz, -100 kHz, -200 kHz, 300 kHz and -500 kHz from the lowest receiver operating frequency – the 3dB receiver bandwidth.

   For the frequency range ≥ 500 kHz to 30 MHz, 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.

   or:

b) The frequency for generator B is determined as an offset by using the upper and lower receiver operating frequencies plus or minus receiver 3dB bandwidth times a multiplier, (N+1). The values for N are given in clause 8.2.3 table 11

   The upper and lower test frequencies for generator B are defined as follows:
   Upper test frequencies: Highest operating receiver frequency + (receiver 3 dB bandwidth) × (N+1).
   Lower test frequencies: Lowest operating receiver frequency – (receiver 3 dB bandwidth) × (N+1).

   The manufacturer shall declare the receiver operating frequencies and 3 dB receiver bandwidth.

For systems with swept operating frequencies:
Upper test frequencies: High end of sweep range + (receiver 3 dB bandwidth) × (N+1).
Lower test frequencies: Low end of sweep range – (receiver 3 dB bandwidth) × (N+1).

The manufacturer shall declare the receiver operating frequencies, 3 dB receiver bandwidth and sweeping range.

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).

For tagging systems (e.g. RF identification, anti-theft, access control, location and similar systems) signal generator A may be replaced by a physical tag positioned at 70 % of the measured or defined system range in metres. In this case, the blocking or desensitization shall be recorded as the ratio in dB of lowest level of the unwanted signal (generator B) to the declared sensitivity of the receiver +3 dB.

Generator B frequencies below 9 kHz are not defined and shall not be measured.

8.2.3 Limits

The blocking ratio, for any frequency within the specified ranges, shall not be less than the values given in table 11, except at frequencies on which spurious responses are found. The limit value is determined by a reference limit (Ref) plus a correction factor (dB) depending of the appropriate receiver classification.

Table 11: Receiver blocking or desensitization limits

Receiver Class	**Generator B frequency offset, $\lvert f_A - f_B \rvert$, either by a) or b) whichever is greater (see note 2)**			**Limit (dB)**
	a) per clause 8.2.2, indent a)		b) per clause 8.2.2, indent b)	
	f_A < 500 kHz	$f_A \geq$ 500 kHz	value of N, see below.	
1	For all offset frequencies	For all offset frequencies	2, 4, 8 and 20	Reference Limit
2	± 100 kHz	± 500 kHz	2	Reference Limit × 1/2 Note 1
	± 200 kHz	± 1 MHz	4	Reference Limit × 2/3, Note 1
	± 300 kHz	± 2 MHz	8	Reference Limit × 5/6, Note 1
	± 500 kHz	± 5 MHz	20	Reference limit
Reference limit (Ref) = 30 dB at 9 kHz increasing with 10 dB/decade to 65,2 dB at 30 MHz.				
NOTE 1: The limit is a fractional dB value of the reference limit. NOTE 2: Generator B frequencies below 9 kHz are not specified.				

8.3 Receiver spurious radiation

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 (see clause 7.4).

8.3.1 Definition

Spurious radiation from receivers are emissions radiated from the antenna, the chassis and case of the receiver. It is specified as the radiated power of a discrete signal.

8.3.2 Methods of measurement

1) For radiation below 30 MHz, see clause 7.4.3.1.

2) For radiation at or above 30 MHz, see clause 7.4.4.1.

Convert reading by 51,5 dB for measuring equipment calibrated in dBμV or dBμV/m.

8.3.3 Limits

8.3.3.1 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 12.

Table 12: Receiver spurious radiation limits

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

For a graphical representation see annex E.

8.3.3.2 Radiated emissions above 30 MHz

The measured values shall not exceed 2 nW.

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 ETR 028 [5] 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 measurements

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

A.1.1 Outdoor test site

The outdoor test site shall be on a reasonably level surface or ground. For measurements at frequencies below 30 MHz no artificial ground plane shall be used. For measurements at frequencies 30 MHz and above, a conducting ground plane of at least 5 m diameter shall be provided at one point on the site. In the middle of this ground plane, a non-conducting support, capable of rotation through 360º in the horizontal plane, shall be used to support the test sample in its standard position, at 1 m above the ground plane, with the exception of equipment with floor standing antenna. For this equipment, the antenna shall be raised, on a non-conducting support, 100 mm above the turntable, the point(s) of contact being consistent with normal use. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of 10 m or optionally 30 m. The distance actually used shall be recorded with the results of the tests carried out on the site.

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

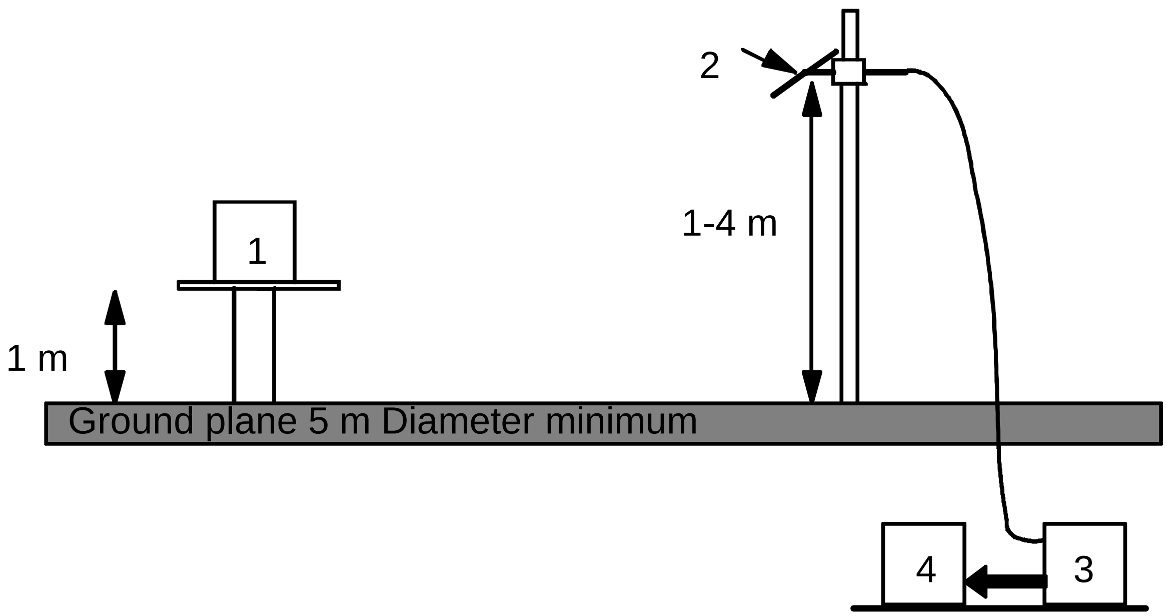


Figure A.1

A.1.1.1 Standard position

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

- for equipment with an integral antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;
- for equipment with a rigid external antenna, the antenna shall be vertical;
- for equipment with non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

For equipment intended to be worn close to the body or hand held, the non-conducting support may, at the request of the applicant be replaced with a simulated man, if appropriate. The use of the simulated man shall be stated in the test report.

The simulated man shall consist of an acrylic tube, filled with salt water (1,5 g NaCl per litre of distilled water). The tube shall have a length of 1,7 m ± 0,1 m and an internal diameter of 300 mm ± 5 mm with side wall thickness of 1,5 mm ± 0,5 mm.

To reduce the weight of the simulated man it may be possible to use an alternative tube, which has a hollow centre of 200 mm maximum diameter.

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

A.1.2 Test antenna

A.1.2.1 Below 30 MHz

A calibrated loop antenna shall be used to detect the field strength from the test sample. The antenna shall be supported in the vertical plane and be rotated about a vertical axis. The lowest point of the loop shall be 1 m above ground level.

A.1.2.2 Above 30 MHz

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

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

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

A.1.3 Substitution antenna

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a $\lambda/2$ dipole, resonant at the operating frequency, or a shortened dipole, calibrated to the $\lambda/2$ dipole. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

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

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

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

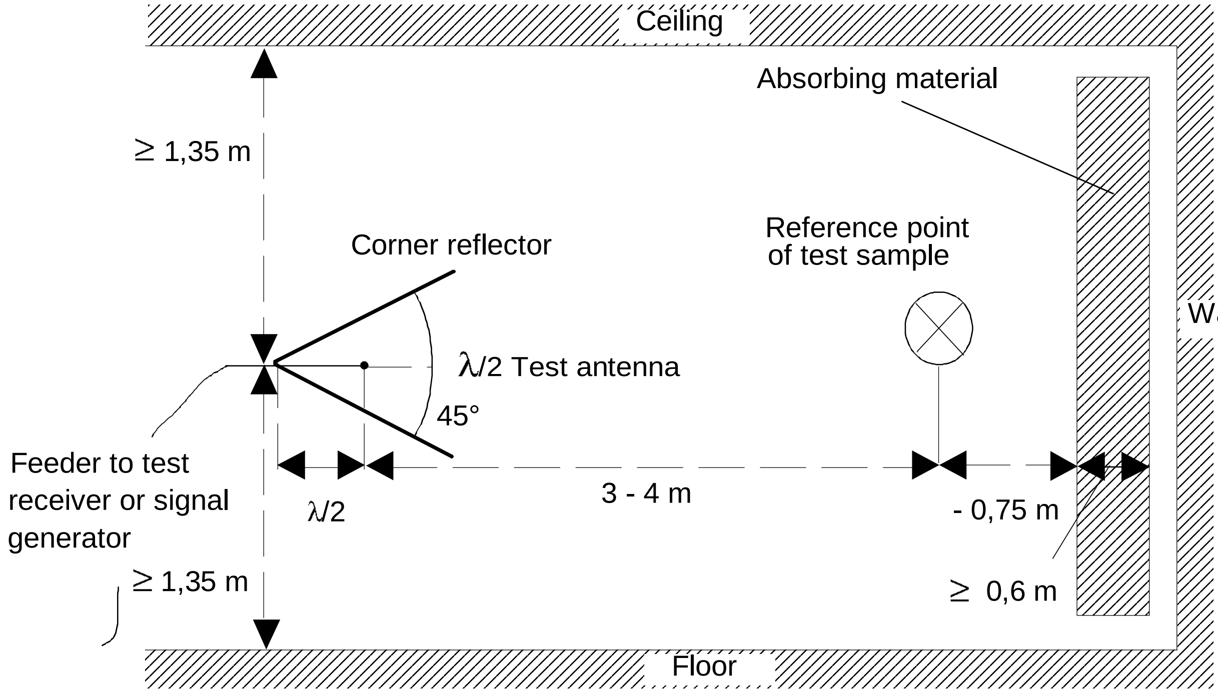


Figure A.2: Indoor site arrangement (shown for horizontal polarization)

A.1.4 Optional additional indoor site

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

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

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

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

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method. To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between the direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of $\pm 0,1$ m in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

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

A.2 Guidance on the use of radiation test sites

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

A.2.1 Measuring distance

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and that the precautions described in this annex are observed. Measurements at low frequencies and distances less than $\lambda/2$ are considered in the present document and shall be followed. Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in European test laboratories. Measurements at distances different to 10 m need to have a correction factor added to give a resultant at 10 m so that comparison with the limit is possible. The correction factor used shall be stated in the test report.

A.2.2 Test antenna

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

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

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

A.2.3 Substitution antenna

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

A.2.4 Artificial antenna

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

Where possible, a direct connection should be used between the artificial antenna and the test sample. In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores or double screened cables.

A.2.5 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables etc.) which are not adequately de-coupled, may cause variations in the measurement results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non conducting support), or as specified in the technical documentation supplied with the equipment.

Care shall be taken to ensure that test cables do not adversely effect the measuring result.

A.3 Further optional alternative indoor test site using an anechoic chamber

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

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

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high. Walls and ceiling should be coated with RF absorbers of 1 m height. The base should be covered with absorbing material 1 m thick, and a wooden floor, capable of carrying test equipment and operators. The construction of the anechoic chamber is described in the following clauses.

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

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

Ceilings and walls are coated with pyramidal formed RF absorbers approximately 1 m high. The base is covered with absorbers forming a non-conducting sub-floor or with special ground floor absorbers. The available internal dimensions of the room are 3 m × 8 m × 3 m, so that a maximum measuring distance of 5 m length in the middle axis of this room is available.

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

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

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

A.3.2 Influence of parasitic reflections in anechoic chambers

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

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

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

With an anechoic chamber of the dimensions suggested in clause A.3 at low frequencies up to 100 MHz, there are no far field conditions and therefore reflections are stronger so that careful calibration is necessary; in the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well.

A.3.3 Calibration of the shielded RF anechoic chamber

Careful calibration of the chamber shall be performed over the range 30 MHz to 1 GHz.

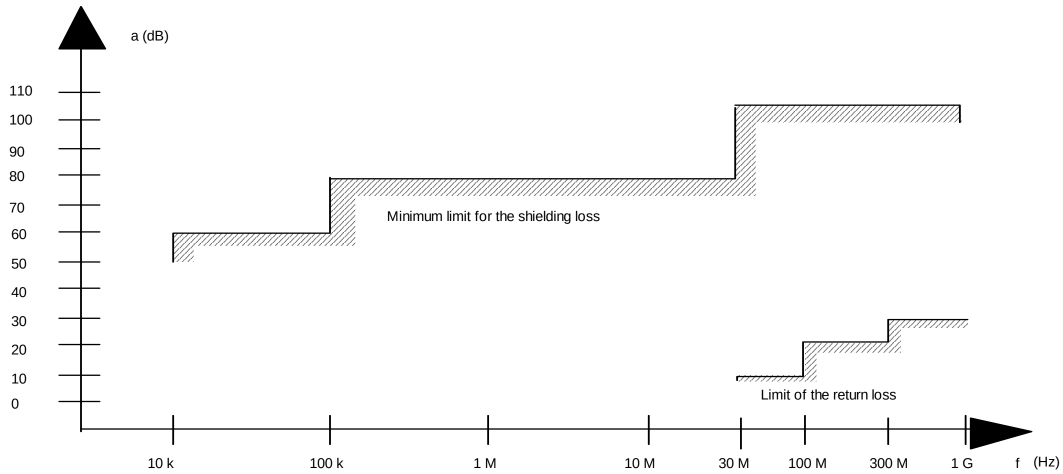


Figure A.3: Specification for shielding and reflections

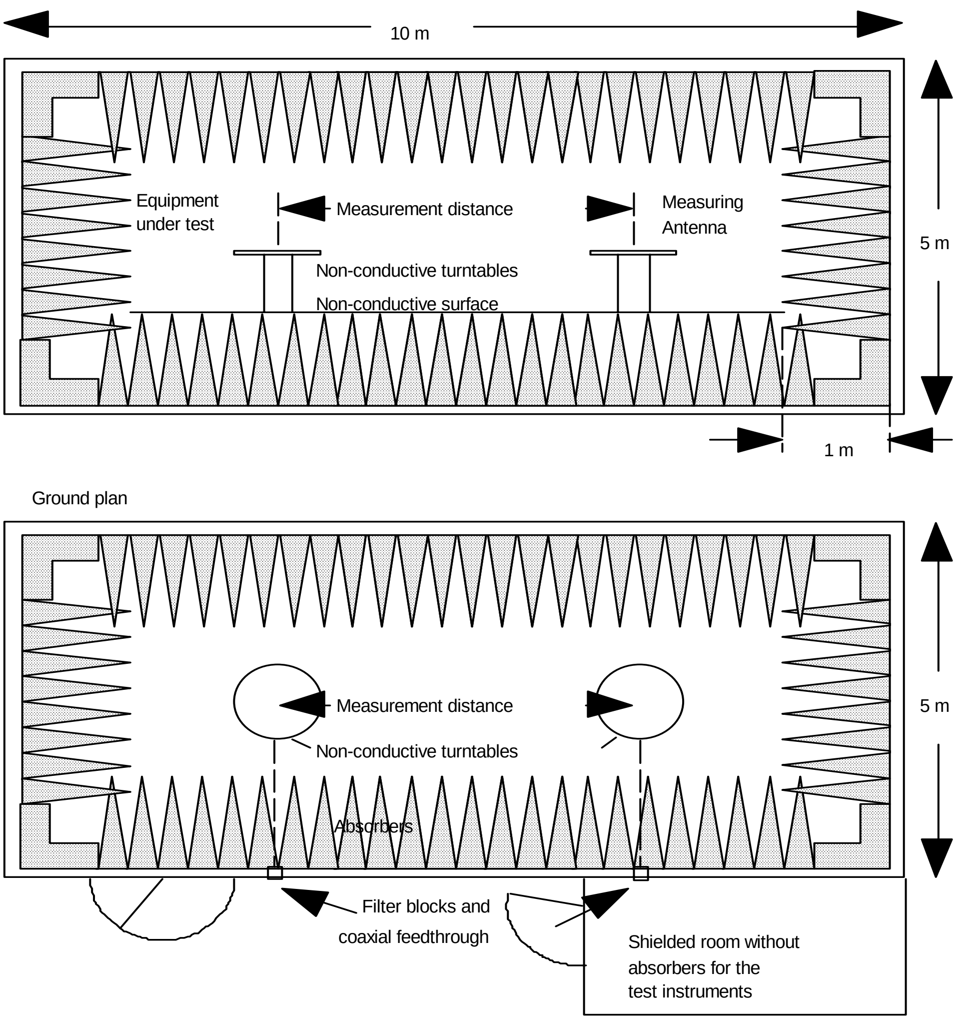


Figure A.4: Example of construction of an anechoic shielded chamber

Annex B (normative): Transmitter carrier limits

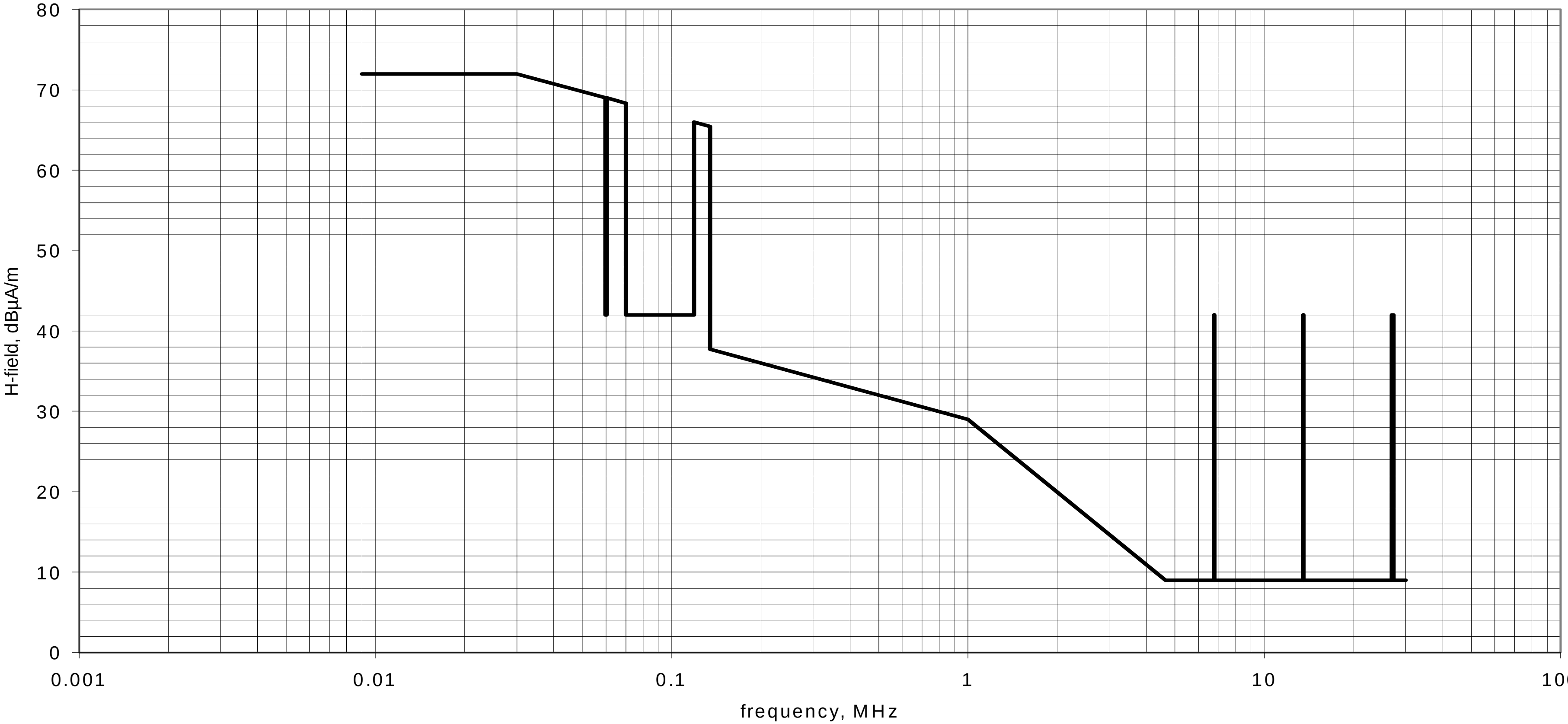


Figure B.1: Radiated H-field at 10 m distance

Annex C (normative): Transmitter (RF carrier current × antenna area) limit for large size loop

Figure C.1

Annex D (normative): H-field limit correction factor for generated E-fields

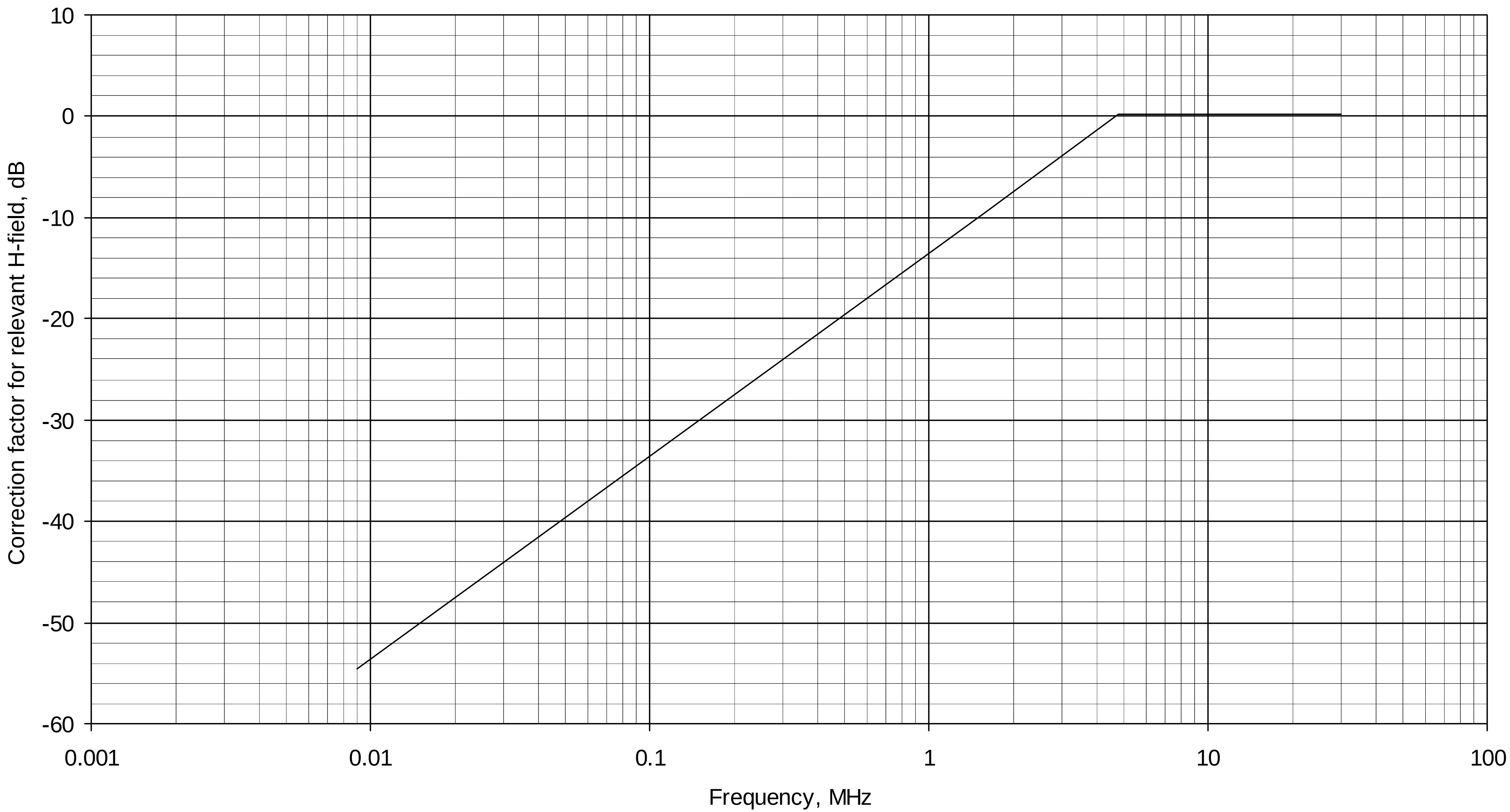


Figure D.1

Annex E (normative): Spurious limits, radiated H-field at 10 m distances

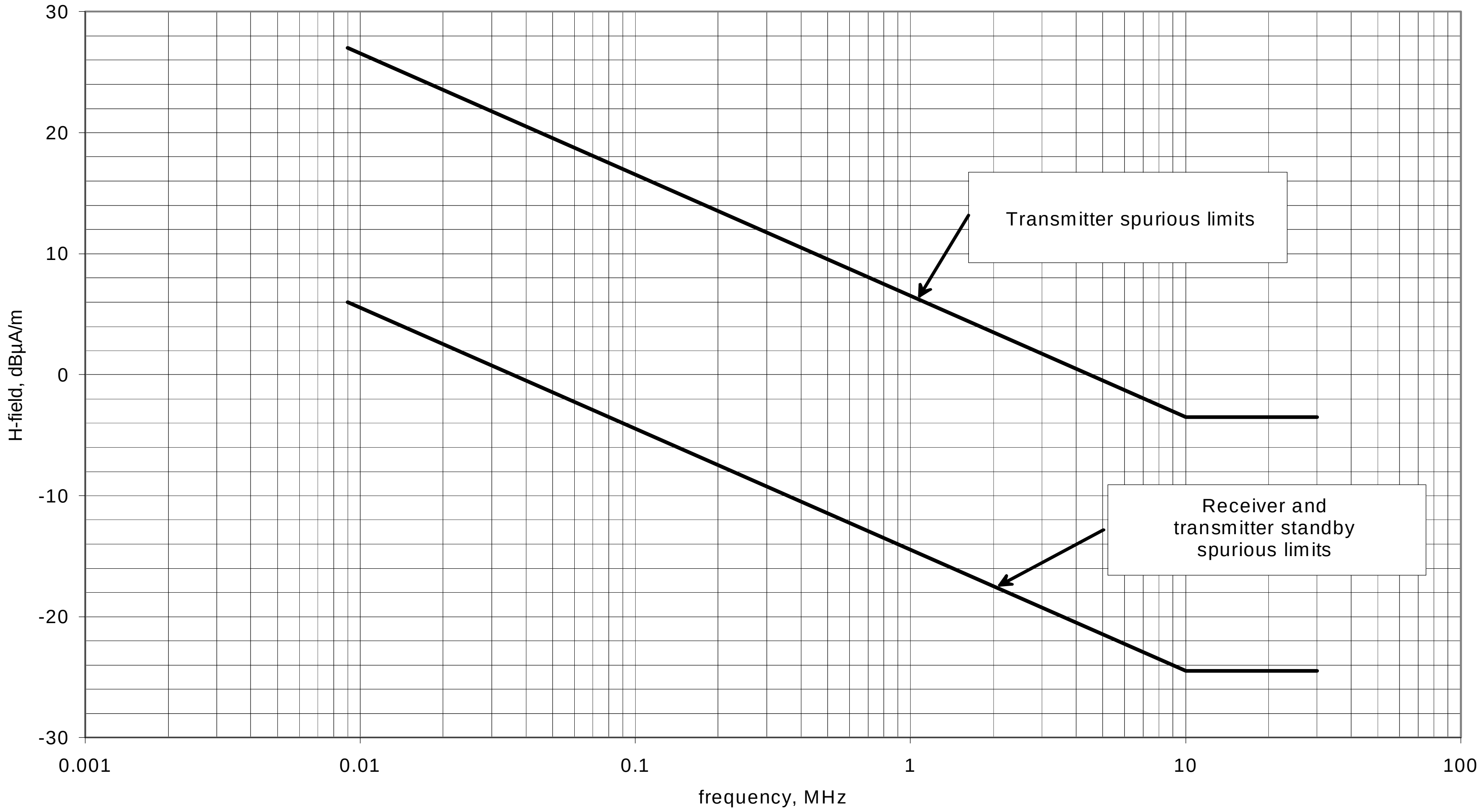


Figure E.1

Annex F (normative): Customized loop antennas

F.1 Product classes related to the antenna loop

The present document allows customization of loop antennas under the following restrictions:

- Product Class 1 is tested with an integral or dedicated antenna. No antenna customization allowed;
- Product Class 2 is restricted to loop antenna areas < 30 m^2 and a length of the antenna loop of less than $\lambda/4$ or less than 30 m whichever is shorter;
- Product Class 2 equipment is tested with two representative maximum and minimum size loop antennas supplied by the manufacturer. Product Class 2 allows:
  - customization of the loop antenna according to the manufacturers design rules documented in the equipment manual.
- Product Class 3 is restricted to loop antenna sizes > 30 m^2. The equipment is tested with an artificial antenna only:
  - allow customization of a single turn large loop.

The design formulas given under clauses F.1.1 and F.1.2 are given as guidelines only.

F.1.1 Antenna loops below 1 MHz

The radiated magnetic field H from a loop coil antenna in the near field is given by:

$$H = \frac{NIA}{2\pi d^3} \text{ A / m} \qquad (1)$$

where:

N is the number of turns of the loop coil antenna;

I is the current in Ampere in the loop coil antenna;

A is the area in m^2 of the loop coil antenna;

d is the distance in metre from the transmitter.

The formula is valid at low frequencies under the following conditions:

- Length of the coil wire: $l < \lambda / 2\pi$
- Distance from coil: $d < \lambda / 2\pi$

The product of NIA is the magnetic dipole moment m of the coil.

Equation (1) gives:

$$m = NIA = H\ 2\pi\, d^3 \qquad (\mathrm{Am}^2) \tag{2}$$

In the present document the reference measuring distances d are 10 m or 30 m.

If 10 m is inserted into (2):

$$m = NIA = H_{10}\ \mathrm{x}\ 6283 \qquad (\mathrm{Am}^2) \tag{3}$$

where:

H_{10} is the H-field limit at 10 m in A/m (see clause 7.1.1).

The equation is only valid up to 1 MHz.

For method of measurement for loop current into an artificial antenna, see annex G.

F.1.2 Antenna loops above 1 MHz

For frequencies above 1 MHz the maximum dipole moment can be derived from:

$$P = \frac{8\mu_0 \pi^3 m^2 f^4}{3c^3} (Werp) \tag{4}$$

Equation (4) after rearrangement:

$$m = NIA = \frac{1}{f^2}\sqrt{\frac{3c^3}{8\mu_0 \pi^3} P}\,(Werp) \tag{5}$$

Above 1 MHz the NAI limit is determined by equation (5) and is descending with f^2 or 12 dB/oct.

Below 1 MHz the NAI limit is determined by equation (3), see clause F.1.1.

Relevant erp limits are 250 nW, 2,5 µW and 10 mW all erp.

The corresponding N × I × A products are calculated in examples (6), (7) and (8):

For erp = 250 nW erp in (5):

$$NIA = \frac{0{,}255}{f^2} (A \times m^2) \tag{6}$$

For erp = 2,5 µW erp in (5):

$$NIA = \frac{0{,}806}{f^2} (A \times m^2) \tag{7}$$

For erp = 10 mW erp in (5):

$$NIA = \frac{50{,}98}{f^2} (A \times m^2) \tag{8}$$

where the frequency f is in MHz in (6), (7) and (8).

For method of measurement for loop current into an artificial antenna, see annex G.

Annex G (informative): Test fixture for measuring inductive transmitter carrier and harmonic currents by use of an artificial antenna (Product Class 3 only)

The artificial antenna is used for equipment with an antenna connector and submitted for type testing without an antenna. The radiated fields for the carrier and spurious are proportional to the RF carrier and spurious currents. Therefore, measurements are made to determine the RF carrier and spurious currents in the artificial antenna.

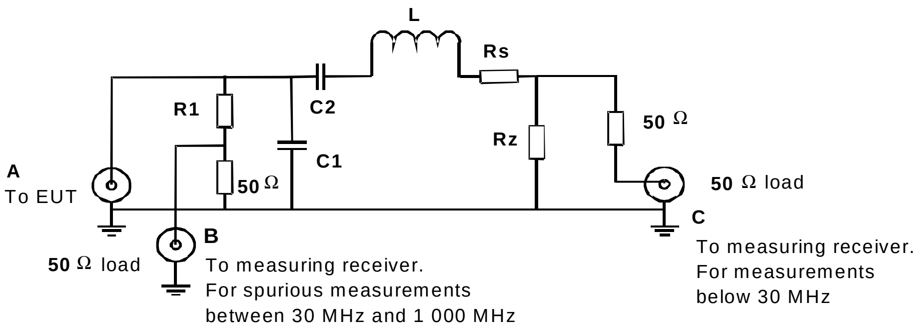


Figure G.1

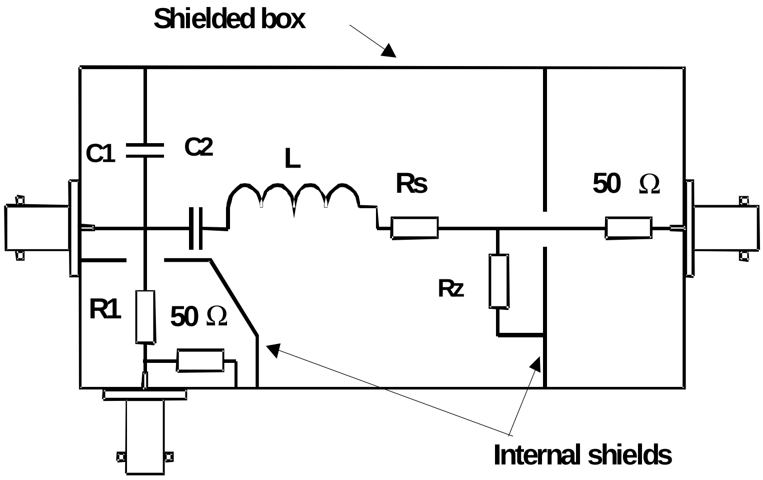


Figure G.2

An example of the mechanical layout and the equivalent electric circuit of the components is given in figures G.2 and G.1 respectively.

If the manufacturer uses several values of antenna inductance, two artificial antennas having maximum and minimum inductance L should be supplied as agreed with the accredited test laboratory. This fact is stated in the test report.

Rz is a low value non-reactive resistor. The voltage across Rz is proportional to the conducted carrier and spurious loop currents. These can be measured at connector C.

Rs in combination with Rz ensures that the artificial antenna has the same Q as the actual loop antenna.

Resistor R1 together with a 50 Ω load resistor provides an attenuation of EUT output signal at connector B used for conducted spurious measurements between 30 MHz and 1 GHz.

Capacitors C1, C2 are optional components together with L to be used as appropriate by the manufacturer to simulate the actual loop antenna configuration. Other possible configurations are shown in figure G.3.

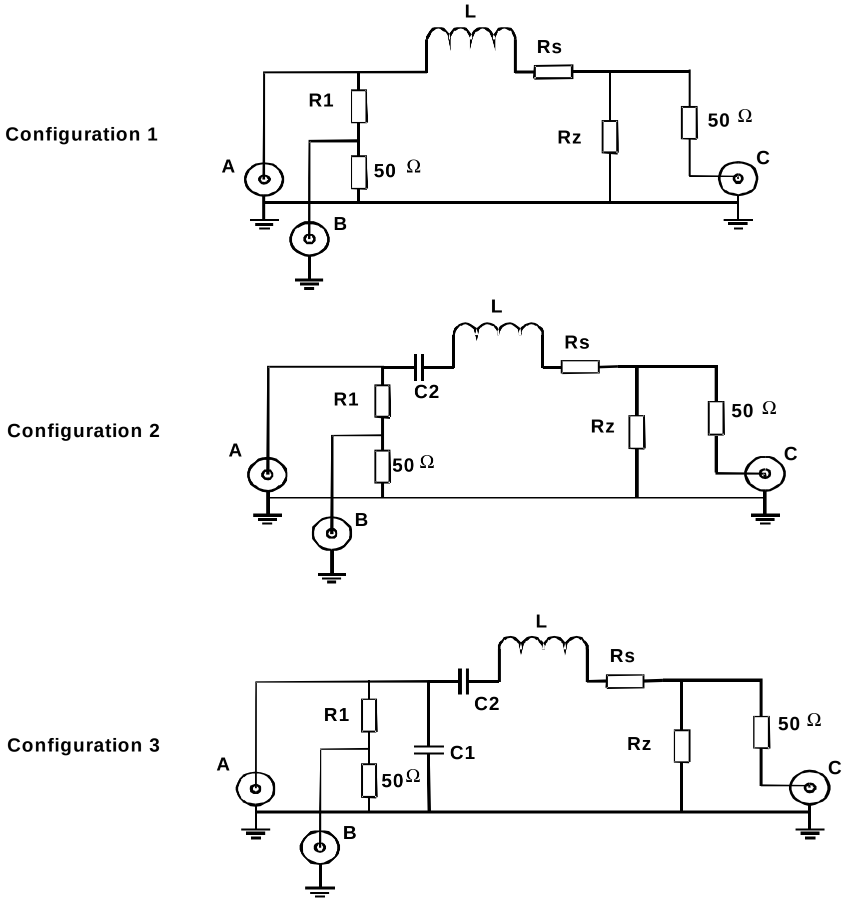


Figure G.3

The test fixture configuration used by the manufacturer is stated in the application and test report.

Annex H (informative): E-fields in the near field at low frequencies

E-field at low frequencies is often in the near field and it is in reality only possible to measure the H-field component with the shielded loop antenna; in this case there is also a relation between the E-field and the H-field by the wave impedance Z. In the near field the wave impedance is highly dependent on the type of radiating antenna (loop or open end wire) and the wavelength. If the power density at a certain distance is the same for a H-field and an E-field generated signal, the following calculation can be made:

In the direction of maximum power in the near field, the power density S is:

$$S = \frac{E^2}{Z_e} = H_e^2 Z_e = H_m^2 Z_m \qquad (1)$$

where:

- S = power density;
- E = electrical field generated by an E-field antenna at distance d;
- $H_e =$ magnetic field generated by an E-field antenna at distance d;
- $H_m =$ magnetic field generated by a H-field antenna at distance d;
- $Z_e =$ wave impedance of a field generated by an E-field antenna at distance d;
- $Z_m =$ wave impedance of a field generated by an H-field antenna at distance d.

$$Z_m = Z_o 2\pi \frac{d}{\lambda} \quad if \quad d < \frac{\lambda}{2\pi} \; (\text{near field}) \qquad (2)$$

$$Z_e = Z_0 \frac{\lambda}{2\pi d} \quad \text{if} \quad \text{d} < \frac{\lambda}{2\pi} \; (\text{near field}) \qquad (3)$$

Equation (1) gives:

$$H_e = H_m \sqrt{\frac{Z_m}{Z_e}} \; (A/m) \qquad (4)$$

Equation (2) and (3) into (4) gives:

$$H_e = H_m \frac{2\pi d}{\lambda} = H_m \frac{2\pi d f_c}{300} \qquad (5)$$

where fc is the carrier frequency in MHz.

For $2\pi d/\lambda = 1$, d = 10 and f_c = 4,78 MHz, and using equation (5), this gives:

$$H_e = H_m \frac{f_c}{4{,}78} \; (f \text{ in MHz}) \qquad (6)$$

For $2\pi d/\lambda < 1$ if f_c < 4,78 MHz then equation (5) is valid, (i.e. near field).

For $2\pi d/\lambda \geq 1$ if f_c > 4,78 MHz then $H_e = H_m$, (i.e. far field).

The method allows an electric generated E-field to be measured as a magnetic generated H-field by adding a correction factor derived from (6).

For a graphical representation of the correction factor, see annex D.

Annex J (normative): H-field measurements at other distances than 10 m

Measurements at longer distances than 10 m may be relevant for equipment using combination loop antennas having an increased reduction of the radiated H-field versus distance. An example of this performance is a "configure eight antenna" having two identical but physical spaced antenna loops driven with opposite phased currents.

The present document allows field measurements to be made at other distances than 10 m. In this case, the appropriate H-field limit, H_x, for applicant requested measurement distance, d_x, shall be calculated. The calculation of the new limit, H_x, shall be made by the applicant. Both the calculation of new limit and the requested measurement distance shall be stated in the Application and Test Report.

The following procedure shall be used:

A) For $\frac{\lambda}{2\pi} \geq 3d(m)$

where d is either 10 m or the new measurements distance, d_x, whichever is the longest).

The new limit H_x in dBμA/m at distance d_x is determined from the 10 m limit H_{10} in dBμA/m by:

$$H_x = H_{10} + 60 \times \log \frac{10}{d_x} (dB\mu A/m) \quad (1)$$

B) For $\frac{\lambda}{2\pi} \leq 0{,}3d(m)$

where d is either 10 m or the new measurements distance d_x whichever is the shortest.

The new limit H_x in dBμA/m at distance d_x is determined from the 10 m limit H_{10} in dBμA/m by:

$$H_x = H_{10} + 20 \times \log \frac{10}{d_x} (dB\mu A/m) \quad (2)$$

C) If $\frac{\lambda}{2\pi}$ is between the two boundaries determined in A and B above the following steps shall be followed:

Step 1: Calculate the radian wave length, x:

$$x = \frac{\lambda}{2\pi} = \frac{300}{2\pi f} (m), \text{ where f is in MHz} \quad (3)$$

Step 2: Calculate the magnetic dipole moment from the 10 m limit, H_{10} in A/m by either:

a) for $x \times 2{,}354 \geq 10\ m$

$$m = H_{10} \frac{2\pi x \times 10^3}{\sqrt{x^2 + 10^2}} \left(Am^2\right) \text{ or;} \quad (4)$$

b) for $x \times 2{,}354 < 10\ m$

$$m = H_{10} \frac{x^2 \times 10^3 \times 4\pi}{\sqrt{x^4 + x^2 \times 10^2 + 10^4}} \left(Am^2\right) \quad (5)$$

Step 3: Calculate the new limit H_x in A/m for the new measurements distance, d_x is calculated by either:

a) for $d_x \le x \times 2{,}354$;

$$H_x = \frac{m\sqrt{x^2 + d_x^{\,2}}}{2\pi\left(x + d_x^{\,3}\right)} (A/m) \qquad (6)$$

or;

b) for $d_x > x \times 2{,}354$;

$$H_x = \frac{m\sqrt{x^4 + x^2 d_x^{\,2} + d_x^{\,4}}}{4\pi\left(x^2 + d_x^{\,3}\right)} (A/m) \qquad (7)$$

The calculated value for H_x in A/m may be converted to dBµA/m as appropriate.

As an example, the H-field limits at 10 m is converted to 30 m by using the above method. The resulting curve is shown for a straight line approximation in table J.1.

Table J.1: H-field limits at 30 m

Frequency range (MHz)	H-field strength limit (H_f) dBµA/m at 30 m
$0{,}009 \le f < 0{,}03$	43,5 or according to note
$0{,}03 \le f < 0{,}07$ $0{,}119 \le f < 0{,}135$	43,5 at 0,03 MHz descending 3 dB/oct or according to note
$0{,}05975 \le f < 0{,}06025$ $0{,}07 \le f < 0{,}119$	13,5
$0{,}135 \le f < 1{,}26$	8,7 at 0,135 MHz descending 3 dB/oct
$1{,}26 \le f < 30$	-1
$6{,}765 \le f \le 6{,}795$ $13{,}553 \le f \le 13{,}567$ $26{,}957 \le f \le 27{,}283$	32,5
NOTE: For the frequency ranges 9 kHz to 70 kHz and 119 kHz to 135 kHz, the following additional restrictions apply to the higher limits: - for loop coil antennas with an area ≥ 0,16 m^2, table J.1 applies directly; - for loop coil antennas with an area between 0,05 m^2 and 0,16 m^2, table J.1 applies with a correction factor. The limit is: table J.1 value + 10 × log (area/0,16 m^2); - for loop coil antennas with an area < 0,05 m^2 the limit is 10 dB below table J.1.	

For a graphical representation of table J.1, see figure J.1.

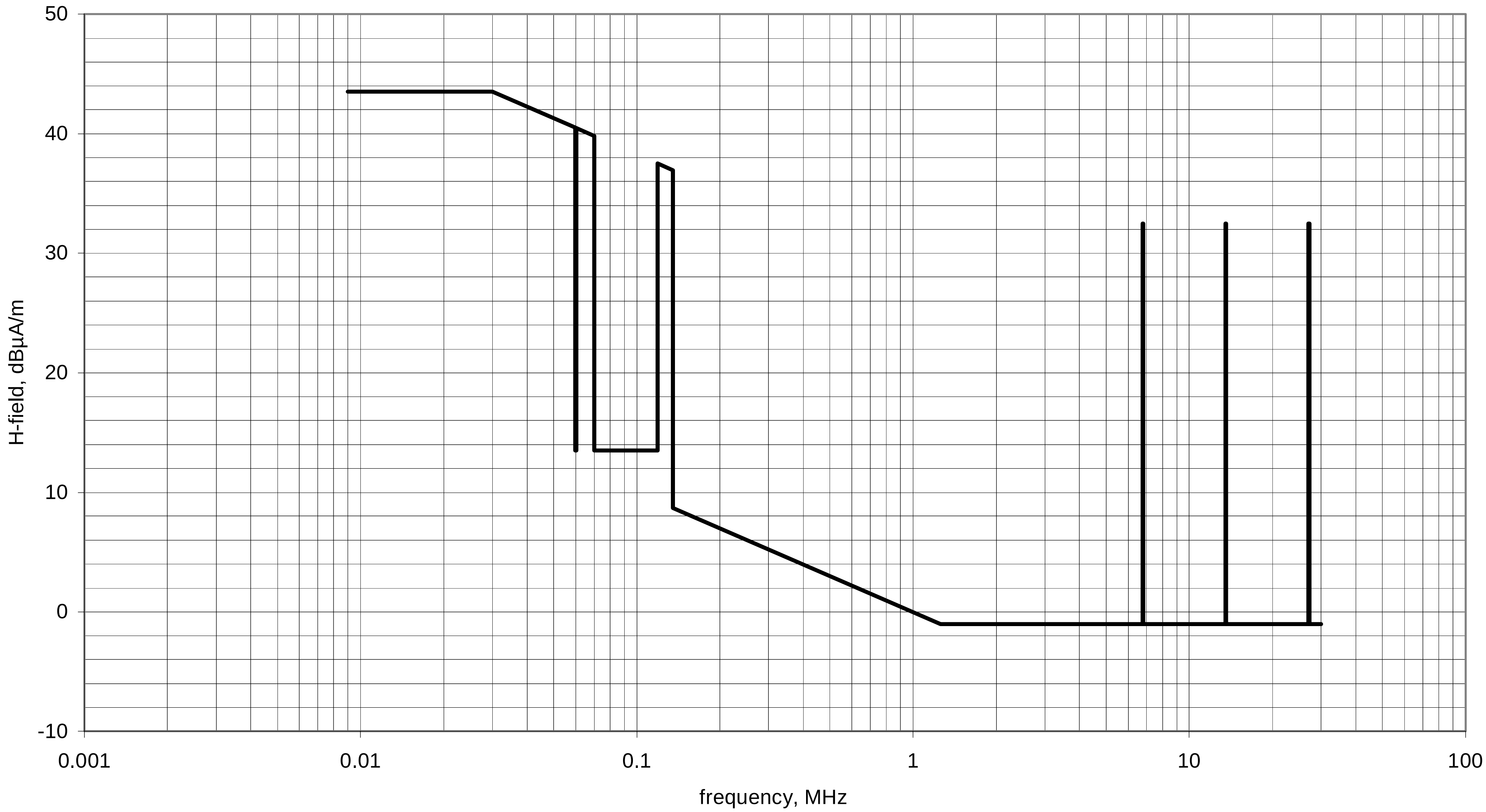
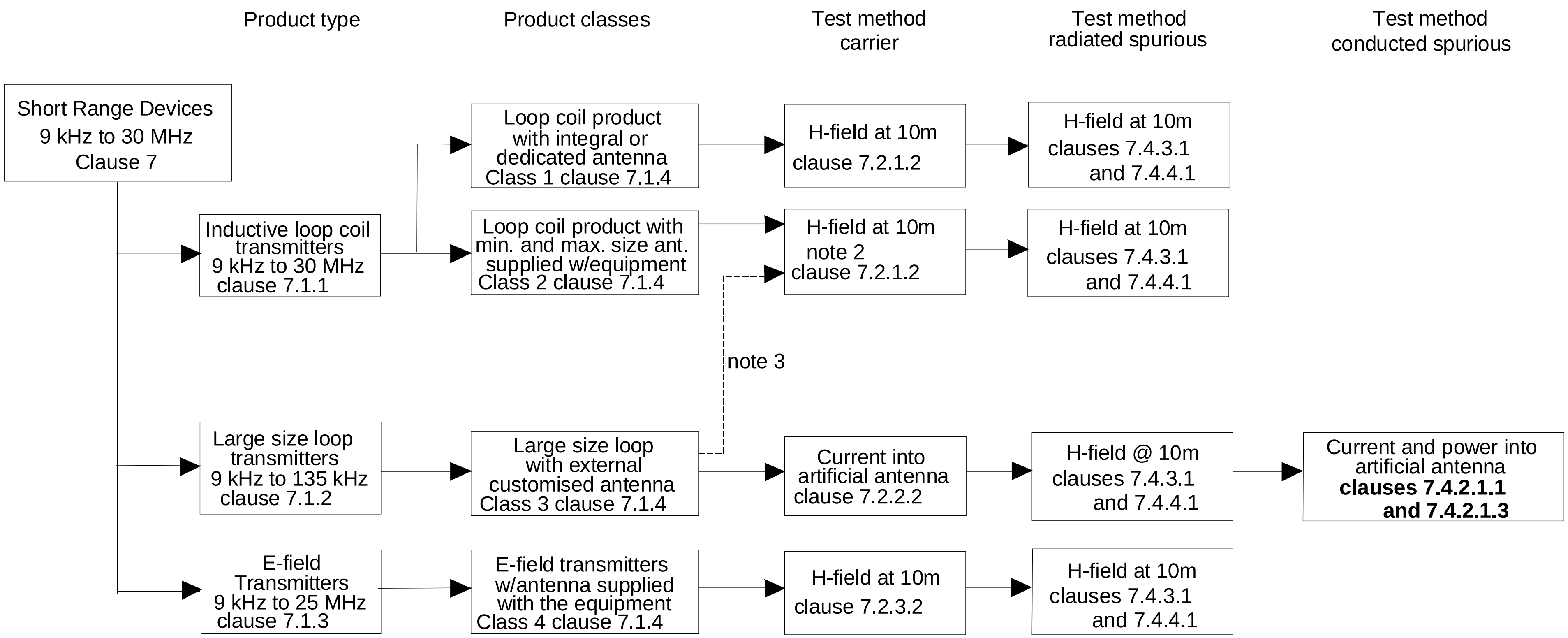


Figure J.1: Radiated H-field at 30 m distance

Annex K (normative): Transmitter requirements overview



NOTE 1: The artificial antenna supplied by the manufacturer shall be equivalent to antenna with the maximum, magnetic moment intended to be to be used with the product.
NOTE 2: H-field measurements is required with maximum and minimum size sample antennas supplied by the manufacturer.
NOTE 3: On-site measurements may be required.

Figure K.1

Annex L (normative): Low level transmitter spectrum mask measurements

The present document allows low level, transmitter spectrum mask measurements to be made. The measurements may be relevant for Short Range Devices operating at ISM frequency bands.

The spectrum mask shall be declared by the manufacturer and shall comply with the limits in table 2 and the application given the appropriate annex of CEPT/ERC Recommendation 70-03 [3].

An example of the low level spectrum mask is given in figure L.1:

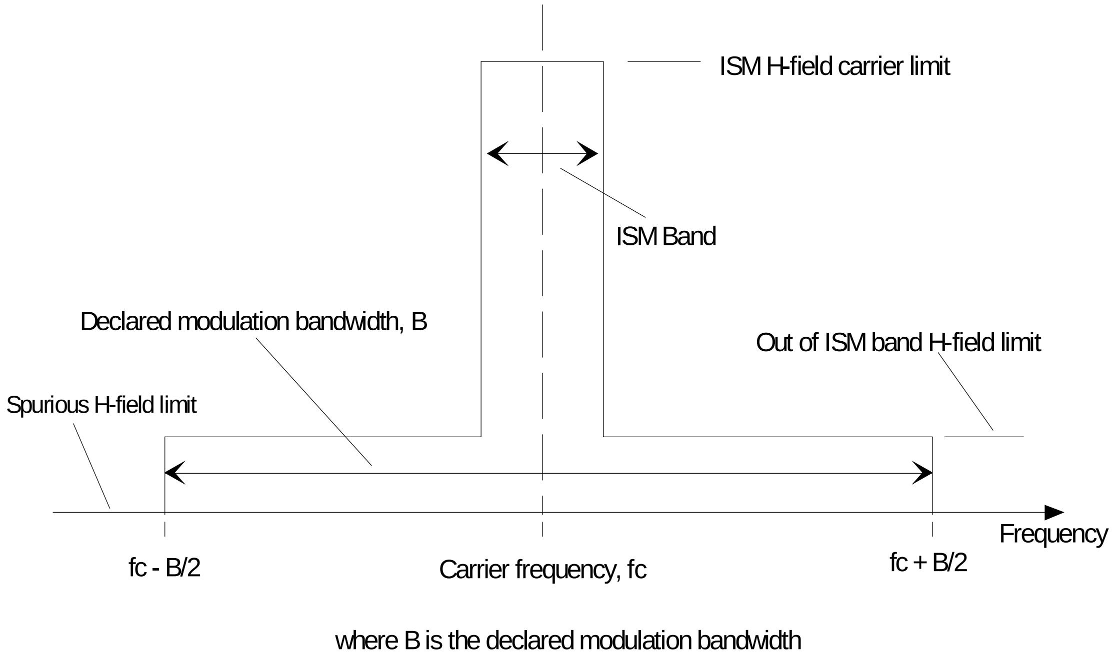


Figure L.1

Annex M (informative): Clauses of the present document relevant for compliance with the essential requirements of relevant EC Council Directives

M.1 Compliance with 1999/5/EC (R&TTE Directive) article 3.3e

The clauses noted are necessary to ensure access to emergency services. At the time of publication, this has not been invoked as an essential requirement of the Council Directive 1999/5/EC (R&TTE Directive) [2] for equipment covered by the present document.

Table M.1: Clauses of the present document relevant to ensure access to emergency services

Clause/sub-clause number and title		Corresponding article of the R&TTE Directive	Qualifying remarks
8.1	Adjacent channel selectivity - in band	3.3 e	Applies to Equipment Class 1 receivers
8.2	Blocking or desensitization	3.3 e	Applies to Equipment Class 1 and 2 receivers

M.2 Compliance with 1999/5/EC (R&TTE Directive) article 3.3f

The clauses noted are necessary to facilitate the use of equipment by users with a disability. At the time of publication, this has not been invoked as an essential requirement of the Council Directive 1999/5/EC (R&TTE Directive) [2] for equipment covered by the present document.

Table M.2: Clauses of the present document relevant in order to facilitate the use of equipment by users with a disability

Clause/sub-clause number and title		Corresponding article of the R&TTE Directive	Qualifying remarks
8.1	Adjacent channel selectivity - in band	3.3 f	Applies to Equipment Class 1 receivers
8.2	Blocking or desensitization	3.3 f	Applies to Equipment Class 1 and 2 receivers

Annex N (informative): Bibliography

ERC Report 44 (1997): "Sharing between inductive systems and radiocommunications systems in the band 9 kHz to 135 kHz".

CISPR 16-1: "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

ETSI EN 301 489-3 (V1.2.1): "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".

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.

History

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