

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Citizens' Band (CB) radio equipment;
Part 1: Technical characteristics
and methods of measurement**



Reference

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering Citizens' Band (CB) radio equipment, as identified below:

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

Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

National transposition dates	
Date of adoption of this EN:	5 July 2011
Date of latest announcement of this EN (doa):	31 October 2011
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1 Scope

The present document covers the technical requirements for transmitters and receivers used in stations of angle modulated, Double Side Band (DSB) modulated and/or Single Side Band (SSB) modulated Citizens' Band (CB) radio equipment operating in all or part of the frequency band 26,960 MHz to 27,410 MHz with a channel spacing of 10 kHz, and intended for analogue speech and/or data transmission.

Citizens' Band radio equipment operation is in accordance with Draft ECC Decision on the harmonised use of frequencies for Citizens' Band (CB) radio equipment [i.2].

The equipment operates on one or more channels of the carrier frequencies as shown in table 1.

Table 1: Carrier frequencies

Carrier frequencies	Channel Number	Carrier frequencies	Channel Number
26,965 MHz	1	27,215 MHz	21
26,975 MHz	2	27,225 MHz	22
26,985 MHz	3	27,235 MHz	24
27,005 MHz	4	27,245 MHz	25
27,015 MHz	5	27,255 MHz	23
27,025 MHz	6	27,265 MHz	26
27,035 MHz	7	27,275 MHz	27
27,055 MHz	8	27,285 MHz	28
27,065 MHz	9	27,295 MHz	29
27,075 MHz	10	27,305 MHz	30
27,085 MHz	11	27,315 MHz	31
27,105 MHz	12	27,325 MHz	32
27,115 MHz	13	27,335 MHz	33
27,125 MHz	14	27,345 MHz	34
27,135 MHz	15	27,355 MHz	35
27,155 MHz	16	27,365 MHz	36
27,165 MHz	17	27,375 MHz	37
27,175 MHz	18	27,385 MHz	38
27,185 MHz	19	27,395 MHz	39
27,205 MHz	20	27,405 MHz	40

Transmission and reception takes place on the same channel (single frequency simplex mode).

Any equipment using national regulations on Citizens' Band (CB) permitting the use of channels outside of the carrier frequencies shown in table 1 within the frequency range from 26 MHz to 28 MHz can use the present document.

The types of equipment covered by the present document are as follows:

- Base station: equipment fitted with antenna connector.
- Mobile station: equipment fitted with antenna connector.
- Hand portable stations:
 - a) either fitted with an antenna connector; or
 - b) without an external antenna connector but fitted with a permanent internal or a temporary internal 50 Ω RF connector which allows access to the transmitter output and the receiver input.

Hand portable station equipment without an external or internal Radio Frequency (RF) connector and without the possibility of having a temporary internal 50 Ω RF connector is not covered by the present document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

- [1] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [2] CISPR 16 (2006) (parts 1-1, 1-4 and 1-5): "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [3] ITU-T Recommendation O.41 (1994): "Psophometer for use on telephone-type circuits".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI EN 300 135-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Citizens' Band (CB) radio equipment; Angle-modulated Citizens' Band radio equipment (PR 27 Radio Equipment); Part 1: Technical characteristics and methods of measurement".
- [i.2] FM38(10)37rev2: "Draft ECC/DEC/(11)XX on the harmonised use of frequencies for Citizen's Band (CB) radio equipment".
- [i.3] ITU Radio Regulations.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

angle modulations: F3E/G3E classes of emission as defined in the ITU Radio Regulations, corresponding to modulation with an audio pre-emphasis characteristic for the FM transmitter and an audio de-emphasis characteristic for the receiver

base station: equipment fitted with an antenna socket, for use with an external antenna, and intended for use in a fixed location

Double Side Band (DSB) modulation: A3E class of emission as defined in the ITU Radio Regulations, corresponding to double side band amplitude modulation

hand portable station: equipment either fitted with an antenna connector or an integral antenna, or both, normally used on a stand-alone basis, to be carried on a person or held in the hand

integral antenna: antenna designed as a fixed part of the equipment, without the use of an external connector and as such which cannot be disconnected from the equipment by the user

NOTE: An integral antenna may be fitted internally or externally.

mobile station: mobile equipment fitted with an antenna connector, for use with an external antenna, normally used in a vehicle or as a transportable station

Single Side Band (SSB) modulation: J3E class of emission as defined in the Sub-Section IIA of Volume II Appendices of the ITU Radio Regulations [i.3], corresponding to single side band suppressed carrier amplitude modulation, using either USB or LSB

3.2 Symbols

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

λ	Wavelength
E_o	Reference field strength

NOTE: See annex A.

R_o	Reference distance
-------	--------------------

NOTE: See annex A.

3.3 Abbreviations

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

AC	Alternating Current
CB	Citizen's Band
DC	Direct Current
DSB	Double Side Band
emf	electromotive force
FM	Frequency Modulation
IF	Intermediate Frequency
ITU	International Telecommunication Union
LSB	Lower Side Band
ND	Noise + Distortion
PEP	Peak Envelope Power
PTT	Push-To-Talk
RF	Radio Frequency
RMS	Root Mean Square
RX	Receiver/reception
SND	Signal + Noise + Distortion
SSB	Single Side Band
TX	Transmitter/Transmission
USB	Upper Side Band

4 General

4.1 Presentation of equipment for testing purposes

Each equipment to be tested shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

The provider or manufacturer shall declare the frequency ranges, the range of operating conditions and power requirements as applicable, to establish the appropriate test conditions.

The equipment shall be tested to the present document using the type of modulation signal defined in clause 6.5 that is relevant to the operational mode being tested, i.e. angle modulation, DSB or SSB. Angle modulation is considered as equivalent to frequency modulation (FM) with pre-emphasis in transmit mode and de-emphasis in receive mode.

Equipment capable of using two or three types of modulation among angle modulation, DSB and SSB shall be tested to the present document using the respective type of modulation for each mode (see clause 6.5).

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

4.1.1 Choice of model for testing

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

Stand alone equipment shall be 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 to be performed on the equipment configured with that combination of features considered to be the most complex.

Where practicable, equipment to be tested 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 an internal permanent 50 Ω connector then a second sample of the equipment shall be supplied with a temporary antenna connector fitted to facilitate testing.

The performance of the equipment to be tested shall be representative of the performance of the corresponding production model. If type approval is given on the basis of tests on a preliminary model, the corresponding production models shall be identical in all respects with the preliminary model tested.

Tests shall be carried out on the highest and lowest channel within the switching range of the equipment and on a channel near the middle of the switching range. The switching range of the receiver and transmitter shall be declared by the manufacturer. The switching range is the maximum frequency range over which the receiver or the transmitter can be operated without reprogramming or realignment. In the case of equipment fitted with one channel only, all tests are carried out on that channel. In the case of equipment fitted with two channels, all tests are carried out on both channels.

4.1.1.1 Auxiliary test equipment

All necessary test signal sources, setting up instructions and other product information shall accompany the equipment to be tested.

4.1.1.2 Declarations by the provider

The provider or manufacturer shall declare the necessary information of the equipment with respect to all technical requirements set by the present document.

In the case of hand portable equipment without a 50 Ω external antenna connector see clause 4.2.

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

Where equipment has an internal 50 Ω connector it shall be permitted to perform the tests at this connector.

Equipment may also have a temporary internal 50 Ω connector installed for the purposes of testing.

No connection shall be made to any internal permanent or temporary antenna connector during the performance of radiated emissions measurements, unless such action forms an essential part of the normal intended operation of the equipment, as declared by the manufacturer.

4.3 Mechanical and electrical design

4.3.1 General

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

4.3.2 Controls

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

4.3.3 PTT and voice- activated switch

Switching between the transmit and receive mode of operation shall only be possible by means of a non-locking PTT switch or by means of a non-locking voice-activated switch. If a voice-activated switch is used it shall not respond to ambient acoustic noise.

For SSB CB equipment with a microphone jack, the threshold level adjustment shall be accessible to the user. For DSB/angle modulated and/or CB equipment with a microphone jack, the threshold level adjustment may be accessible to the user.

All adjustments accessible by the user that have influence on the threshold shall be safe against unintended change of setting.

4.3.4 Combination with other equipment

The equipment shall not be combined with any other form of transmitting or receiving equipment, which can produce unwanted modulation of the transmitter. The equipment shall not be provided with any terminals or other connection points, internal or external, for modulating sources other than those required for either a separate or a built-in microphone, or for selective calling or data transmission devices.

Terminals or other connecting points are permitted for the connection of external devices that shall not modulate the transmitters (e.g. a voice synthesizer device to give an aural indication of channel).

4.4 Declaration of conformity

The declaration of conformity should include the information about the applicable national regulation under which the equipment can be operated if the provider uses the present document for other carrier frequencies than PR 27 (see table 1).

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Testing shall be performed 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 5.5.

5.2 Test power source

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

For battery operated equipment the battery shall be removed and the test power source shall be applied as close to the battery terminals as practicable.

During tests of DC powered equipment the power source voltages shall be maintained within a tolerance of $< \pm 1\%$ relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements, using a smaller tolerance will provide better measurement uncertainty values.

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 the 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 used on vehicles

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles the normal test voltage shall be 1,1 times the nominal voltage of the battery (e.g. for nominal voltages of 12 V and 24 V, these are 13,2 V and 26,4 V respectively).

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 manufacturer.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.5, at the upper and lower temperatures of one of the following two ranges:

- -10 °C to +55 °C;
All mobile and hand portable equipment.
Base stations for outdoor/uncontrolled climate conditions.
- 0 °C to +40 °C;
Base stations for indoor/controlled climate conditions.

In the case of base stations equipment, the manufacturer shall declare which conditions the equipment is intended to be installed in.

5.4.2 Extreme test power source

5.4.2.1 Mains voltage

The extreme test voltage for equipment to be connected to an AC mains source shall be the nominal mains voltage $\pm 10\%$.

5.4.2.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (e.g. for a nominal voltage of 12 V, these are 10,8 V and 15,6 V respectively and for a nominal voltage of 24 V, these are 21,6 V and 31,2 V respectively).

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment powered by batteries shall be as follows:

- for nickel-metal hydride, leclanché or lithium/lithium-ion batteries: 0,85 times the nominal battery voltage;
- for mercury or nickel-cadmium batteries: 0,9 times the nominal battery voltage.

No upper extreme test voltages apply.

In the case where no upper extreme test voltage applies then the nominal voltage is applicable and the corresponding four extreme test conditions are:

- V_{\min}/T_{\min} , V_{\min}/T_{\max} ;
- $(V_{\max} = \text{nominal})/T_{\min}$, $(V_{\max} = \text{nominal})/T_{\max}$.

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 declared by the equipment manufacturer.

5.5 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 may be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements. For such equipment the manufacturer shall provide for the power source circuit feeding the crystal oven to be independent of the power source for the rest of the equipment.

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or a longer period as may be decided by the testing 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.

6 General test conditions

6.1 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 Ω .

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

The levels of the test signals shall be expressed in terms of the voltage at the receiver input terminals.

The effects of any intermodulation products and noise produced in the signal generators should be negligible. The test generators shall be substantially free from static amplitude modulation.

6.2 Receiver mute or squelch facility

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

6.3 Receiver rated audio output power

The rated audio output power shall be the maximum power, declared by the manufacturer, for which all the requirements of the present document are met. With normal test modulation (clause 6.5), the audio power shall be measured in a resistive load, simulating the load with which the receiver normally operates. The value of this load shall be declared by the manufacturer.

6.4 Transmitter rated RF power

The rated transmitter RF power shall be the maximum transmitter RF power declared by the manufacturer. The transmitter RF power measured under normal conditions shall be within ± 2 dB of the rated transmitter RF power.

6.5 Normal test modulation

6.5.1 DSB modulation

- a) Modulation for the transmitter tests:

The transmitter shall be modulated by a test signal of 1 250 Hz at a level that is 20 dB higher than that required to produce a modulation depth of 60 %.

- b) Modulation for the receiver tests:

The modulation shall be at a frequency of 1 kHz and at a level resulting in a modulation depth of 60 %.

6.5.2 SSB modulation

- a) Two tone modulation for transmitter tests:
- For the two-tone modulation, two audio frequency generators are required, the signals of which shall be combined and simultaneously available at the microphone input of the unit under test. The generators shall not influence each other.
 - One of the generators shall be switched off. With the other one, the transmitter shall be modulated as described in clause 6.5.2 b), but by an audio frequency of 400 Hz.
 - This generator shall be switched off, and the other one shall then be switched on.
 - The transmitter shall be modulated as described in clause 6.5.2 b), but by an audio frequency of 2,5 kHz.
 - Then both generators shall be switched on.
- b) One-tone modulation for transmitter tests:
- The transmitter shall be modulated by an audio frequency of 1 kHz.
 - The normal test modulation level shall be 20 dB higher than the audio frequency level which produces the maximum RF output power declared by the manufacturer.
 - For the measurement of the frequency error, the normal test modulation level shall be the audio frequency level which produces the maximum RF output power declared by the manufacturer.
- c) One-tone modulation for receiver tests:
- The unmodulated carrier of the RF test generator shall be adjusted 1 kHz up (for USB) or down (for LSB) in respect to the frequencies given in table 1 of clause 1.

6.5.3 Angle modulation (FM modulation with Preemphasis/Deemphasis)

- a) Modulation for transmitter tests: For normal test modulation the transmitter shall be modulated with 1 250 Hz at a level that is 20 dB higher than that required to produce a frequency deviation of $\pm 1,2$ kHz.
- b) Modulation for receiver tests: For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be $\pm 1,2$ kHz.

6.6 Artificial antenna

Tests on the transmitter shall be carried out with a non-reactive non-radiating load of 50 Ω connected to the antenna terminals.

Tests on the transmitter requiring the use of the test fixture shall be carried out with a 50 Ω non-reactive non-radiating load connected to the test fixture.

6.7 Test fixture

In the case of equipment intended for use with an integral antenna, the manufacturer may be required to supply a test fixture, suitable to allow relative measurements to be made on the submitted sample.

The test fixture shall provide means of making external connection to the audio frequency input and radio frequency output and of replacing the power source by external power supplies.

The test fixture shall provide a 50 Ω radio frequency terminal at the working frequencies of the equipment.

The performance characteristics of this test fixture under normal and extreme conditions are subject to the approval of the test laboratory.

The characteristics of interest to the test laboratory will be that:

- a) the coupling loss shall not be greater than 30 dB;
- b) the variation of coupling loss with frequency shall not cause errors exceeding 2 dB in measurements using the test fixture;
- c) the coupling device shall not include any non-linear elements; the test laboratory may provide its own test fixture.

6.8 Arrangement for test signals at the input of the transmitter

The transmitter audio frequency modulation signal shall be supplied by a generator applied at the connections of the microphone insert, unless otherwise stated.

6.9 Test site and general arrangements for radiated measurements

Detailed descriptions of the radiated measurement arrangements are included in annex A.

7 Method of measurement for transmitter parameters

7.1 Frequency error

For equipment that can be measured for frequency error, under this clause, the manufacturer may choose to omit this test if the adjacent channel power is measured under extreme test conditions in clause 7.4.2.

7.1.1 Definition

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

7.1.2 Method of measurement

The carrier frequency shall be measured in angle modulation and/or DSB in the absence of modulation and/or in SSB with modulation (see clause 6.5.2 b)) with the transmitter connected to an artificial antenna (clause 6.6).

NOTE: When testing in SSB the RF nominal frequency is shifted by the modulation frequency, i.e. 1 kHz, and the resulting frequency is displayed.

Equipment with an integral antenna shall be placed in the test fixture (clause 6.7) connected to the artificial antenna (clause 6.6).

The measurement shall be made under normal test conditions (clause 5.3) and repeated under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

7.1.3 Limit

The frequency error shall not exceed 0,6 kHz.

7.2 Transmitter power

7.2.1 Definition

The transmitter power in DSB and angle modulated equipment is the carrier power as defined in ITU RR 1.159 as the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle, or in the case of equipment with integral antenna the effective radiated power in the direction of maximum field strength under the specified conditions of measurement (clause 6.8) in the absence of modulation. In SSB with suppressed carrier there is no carrier component present and the PEP (peak envelope power) is defined as transmitter power. PEP is the average power delivered to the antenna transmission line by a transmitter during one radio frequency cycle at the highest crest of the modulation envelope.

7.2.2 Method of measurement

The measurements shall be made under normal test conditions (clause 5.3) and extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

7.2.2.1 Method of measurement (for equipment other than equipment with integral antenna only)

The transmitter shall be connected to an artificial antenna (clause 6.6), and the power delivered to this artificial antenna shall be measured.

In DSB and angle modulation the carrier power without modulation shall be measured.

In SSB the PEP shall be measured with modulation (clause 6.5.2 a)) by a RF watt-meter with direct reading of the PEP or by a RF power analyser.

7.2.2.2 Method of measurement for equipment with integral antenna

On a test site selected from annex A the equipment shall be placed on the support in the following position:

- a) for equipment with an internal antenna, it shall stand so that the axis of the equipment which in its normal use is closest to the vertical, shall be vertical;
- b) for equipment with a rigid external antennas, the antenna shall be vertical;
- c) for equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the frequency of the transmitter. The output of the test antenna shall be connected to a measuring receiver.

The transmitter shall be switched on without modulation in DSB and angle modulation or with modulation (clause 6.5.2, b)) in SSB. The modulation shall be supplied by a loudspeaker; the connecting wires shall be lead vertically downwards. The measuring receiver shall be tuned to the frequency of the transmitter under test. The test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver.

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 transmitter shall be replaced by a substitution antenna as defined in clause A.2.3.

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the transmitter.

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

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

The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the transmitter radiated power was measured, corrected for the change of input attenuator setting of the measuring receiver.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

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

7.2.3 Limits

The transmitter power, or the effective radiated power of equipment with an integral antenna, shall not exceed 4 W (carrier power) for angle modulation signals, 4 W (carrier power) for DSB amplitude modulated signals and/or 12 W PEP for SSB amplitude modulated signals.

Any adjustment that may raise the transmitter power above these limits shall not be accessible to the user.

7.3 Maximum permissible frequency deviation (angle modulation only)

7.3.1 Definition

The maximum frequency deviation is the maximum difference between the instantaneous frequency of the angle-modulated radio frequency signal and the carrier frequency in the absence of modulation.

The maximum permissible frequency deviation is the maximum value of frequency deviation.

7.3.2 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected via a 50 Ω power attenuator, to a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency of the test signal shall be varied between the lowest frequency considered to be appropriate, and 10 kHz. The level of this test signal shall be 20 dB above the level required to give a frequency deviation of 1,2 kHz at an audio frequency of 1 250 Hz.

The measurements shall be made under normal test conditions (clause 5.3).

7.3.3 Limit

The maximum permissible frequency deviation shall be ± 2 kHz.

7.4 Adjacent channel power

7.4.1 Definition

The adjacent channel power is that part of the total output power of a transmitter, modulated under defined conditions, which falls within a specified bandwidth centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation process and by residual modulation caused by hum and noise of the transmitter.

7.4.2 Method of measurement

7.4.2.1 Method of measurement (for angle modulation)

The adjacent channel power shall be measured with a power measuring receiver which conforms with the requirements given in annex B and is referred to in this clause as the "receiver":

- a) The transmitter shall be operated at the carrier power measured in clause 7.2 under normal test conditions (clause 5.3). The output of the transmitter shall be linked to the input of the "receiver" by a connecting device such that the impedance presented to the transmitter is 50 Ω and the level at the "receiver" input is appropriate. For equipment with an integral antenna the connecting device is a test fixture as described in clause 6.7.
- b) With the transmitter unmodulated, the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB reference point. The "receiver" variable attenuator setting and the reading of the RMS value indicator shall be recorded.
- c) The tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement of 5,75 kHz from the nominal carrier frequency;
- d) The transmitter shall be modulated by a test signal of 1 250 Hz at a level which is 20 dB higher than that required to produce a deviation of $\pm 1,2$ kHz.
- e) The "receiver" variable attenuator shall be adjusted to obtain the same reading as in step b) or a known relation to it.
- f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the RMS value indicator.
- g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

The measurements shall be made under normal test conditions (clause 5.3) and may also be performed under extreme conditions. The manufacturer may choose to omit the test specified in clause 7.1.2 if the adjacent channel power is also measured under extreme test conditions.

7.4.2.2 Method of measurement (for DSB and/or SSB)

The adjacent channel power shall be measured with a power measuring receiver that conforms with the requirements given in annex B and is referred to in this clause as the "receiver":

- a) The transmitter RF output power shall be measured (see clause 7.2) without modulation in DSB or with one tone modulation (see clause 6.5.2, b)) in SSB.
- b) The output of the transmitter shall be linked to the input of the measuring receiver by a connecting device such that the impedance presented to the transmitter is 50 Ω s and the level at the "receiver" input is appropriate.

For the equipment with an integral antenna the connecting device is a test fixture as described in clause 6.7. With the equipment under normal test conditions (clause 5.3) the transmitter shall be unmodulated in DSB or shall be modulated with one tone (see clause 6.5.2 b)) in SSB, the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB reference point. The "receiver" variable attenuator setting and the reading of the RMS value indicator shall be recorded.
- c) The tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" 6 dB response nearest to the transmitter carrier frequency is located at a displacement of 5,75 kHz from the nominal carrier frequency.
- d) The transmitter shall be modulated in DSB (see clause 6.5.1, a)) or shall be modulated with two tones (see clause 6.5.2, a)) in SSB.
- e) The "receiver" variable attenuator shall be adjusted to obtain the same reading as in step b) or a known relation to it.
- f) The ratio of adjacent channel power to RF power in step a) is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the RMS value indicator.

- g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

7.4.3 Limit

The adjacent channel power shall not exceed a value of 20 microwatts.

7.5 Unwanted emissions in the spurious domain

7.5.1 Definition

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

- a) power level in a specified load (conducted spurious emission); and
- b) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);
or
- c) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of hand portable equipment fitted with such an antenna and no external RF connector.

7.5.2 Method of measurement

7.5.2.1 Method of measuring the power level in a specified load (clause 7.5.1 a))

7.5.2.1.1 Method of measuring the power level in a specified load (for angle modulation)

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver.

The transmitter shall be switched on without modulation, and the measuring receiver shall be tuned over the frequency range 9 kHz to 2 GHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load, except for the channel on which the transmitter is intended to operate and the adjacent channels.

The measurements shall be repeated with the transmitter on standby/reception.

7.5.2.1.2 Method of measuring the power level in a specified load (for DSB and/or SSB)

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver.

The transmitter shall be switched on with modulation in DSB (clause 6.5.1, a)) or with 2-tone modulation in SSB (clause 6.5.2, a)).

The measuring receiver shall be according to CISPR 16 [2], with a peak detector, and shall be tuned over the frequency range from 9 kHz to 2 GHz (or 4 GHz, see last paragraph in this clause). The measurement bandwidth below 1 GHz shall be in accordance with CISPR 16 [2] and above 1 GHz, it shall be 1 MHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load, except for the channel on which the transmitter is intended to operate and the adjacent channels.

The measurements shall be repeated with the transmitter on standby/reception.

If spurious emissions are detected in the frequency range 1,5 GHz to 2 GHz with a level exceeding 0,1 μ W (transmitter operating) or 1 nW (transmitter on standby/reception), the measurement of spurious emissions shall be extended to the frequency range 2 GHz to 4 GHz.

7.5.2.2 Method of measuring the effective radiated power (clause 7.5.1 b))

On a test site, selected from annex A, the equipment shall be placed at the specified height on the appropriate support and in the position closest to normal use as declared by the manufacturer.

The transmitter antenna connector shall be connected to an artificial antenna, clause 6.6.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver.

For angle modulation only:

- The output of the test antenna shall be connected to a measuring receiver. The transmitter shall be switched on without modulation, and the measuring receiver shall be tuned over the frequency range 25 MHz to 2 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

For DSB and/or SSB only:

- The output of the test antenna shall be connected to a measuring receiver. The transmitter shall be switched on with modulation in DSB (clause 6.5.1 a)) or with one tone modulation in SSB (clause 6.5.2 b)). The modulation shall be supplied by an acoustical source. The connecting wires shall be placed leading downwards vertically.
- The measuring receiver with a peak detector shall be tuned over the frequency range from 25 MHz to 2 GHz (or 4 GHz, see last paragraph in this clause). The measurement bandwidth below 1 GHz shall be in accordance with CISPR 16 [2] and above 1 GHz, it shall be 1 MHz.

At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until the 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 transmitter shall be replaced by a substitution antenna as defined in clause A.2.3.

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

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

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

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

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

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

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

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

For DSB/SSB only: if the spurious component exceeds the limit level, the measurement at this frequency shall be repeated with a quasi-peak detector.

The measurements shall be repeated with the transmitter on standby/reception.

For DSB/SSB only: If spurious emissions are detected in the frequency range 1,5 GHz to 2 GHz with a level exceeding 0,1 μ W (transmitter operating) or 1 nW (transmitter on standby/reception), the measurement of spurious emissions shall be extended to the frequency range 2 GHz to 4 GHz.

7.5.2.3 Method of measuring the effective radiated power (clause 7.5.1 c))

The method of measurement shall be performed according to clause 7.5.2.2, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

7.5.3 Limits

The power of any spurious emission, occurring more than $2,5 \times$ channel bandwidth from the centre of the channel on which the transmitter is intended to operate, shall not exceed the values given in tables 2 to 4.

Table 2: Conducted spurious emissions

Frequency range	9 kHz to 1 GHz (other than in table 4)	1 GHz to 2 GHz (or 4 GHz, see clause 7.5.2.1)
TX operating	0,25 μ W (-36,0 dBm)	1,0 μ W (-30,0 dBm)
TX standby/reception	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 3: Radiated spurious emissions

Frequency range	30 MHz to 1 GHz (other than in table 4)	1 GHz to 2 GHz (or 4 GHz, see clause 7.5.2.2)
TX operating	0,25 μ W (-36,0 dBm)	1,0 μ W (-30,0 dBm)
TX standby/reception	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 4: Conducted and radiated spurious emissions

Frequency range	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz
TX operating	4 nW (-54,0 dBm)
TX standby/reception	2 nW (-57,0 dBm)

The reference bandwidths shall be as in table 5.

Table 5: Reference bandwidths to be used for the measurement of spurious emissions

Frequency range	RBW
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
1 kHz to 2 GHz (or 4 GHz, see clause 7.5.2.2)	1 MHz

Best measurement practice:

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in table 4. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the reference bandwidth. When the resolution bandwidth is smaller than the reference bandwidth, the result should be integrated over the reference bandwidth. When the resolution bandwidth is greater than the reference bandwidth, the result for broadband spurious emissions should be normalized to the bandwidth ratio. For discrete spurious emissions, normalization is not applicable, while integration over the reference bandwidth is still applicable.

7.6 Transient behaviour of the transmitter

7.6.1 Definitions

These tests are to be used for radio equipment with cyclic keying during data transmissions and not single (e.g. manual) on/off keying. This measurement applies only to equipment with an external antenna connector.

The transient frequency behaviour of the transmitter is the variation with respect to time of the transmitter frequency distance from the nominal frequency of the transmitter when the RF output power is switched on and off.

t_{on}: according to the method of measurement described in clause 7.6.2 the switch-on instant defined by the condition when the output power, measured at the antenna terminal, exceeds 10 % of the nominal power.

t₁: period of time starting at t_{on} and finishing according to clause 7.6.2, figure 2.

t₂: period of time starting at end of t₁ and finishing according to clause 7.6.2, figure 2.

t_{off}: switch-off instant defined by the condition when the output power falls below 10 % of the nominal power.

t₃: period of time finishing at t_{off} and starting according to clause 7.6.2, figure 2.

7.6.2 Method of measurement

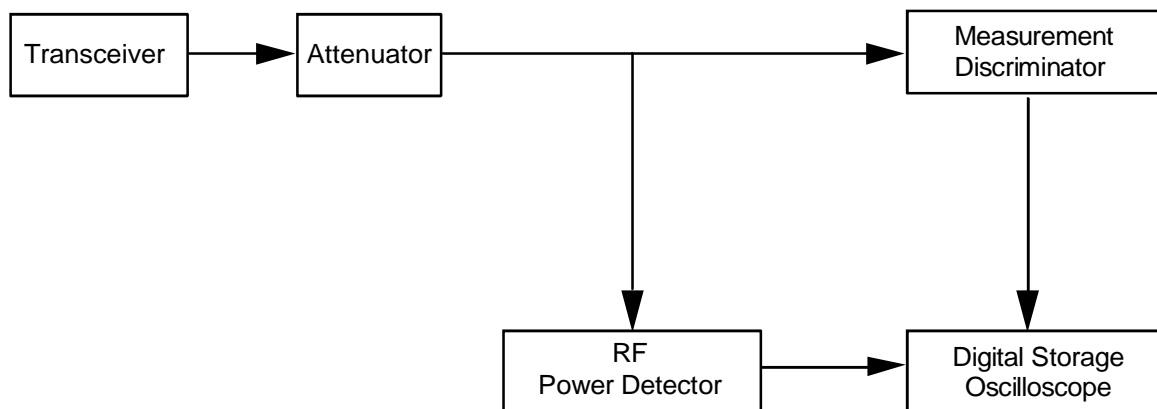


Figure 1: Measurement arrangement

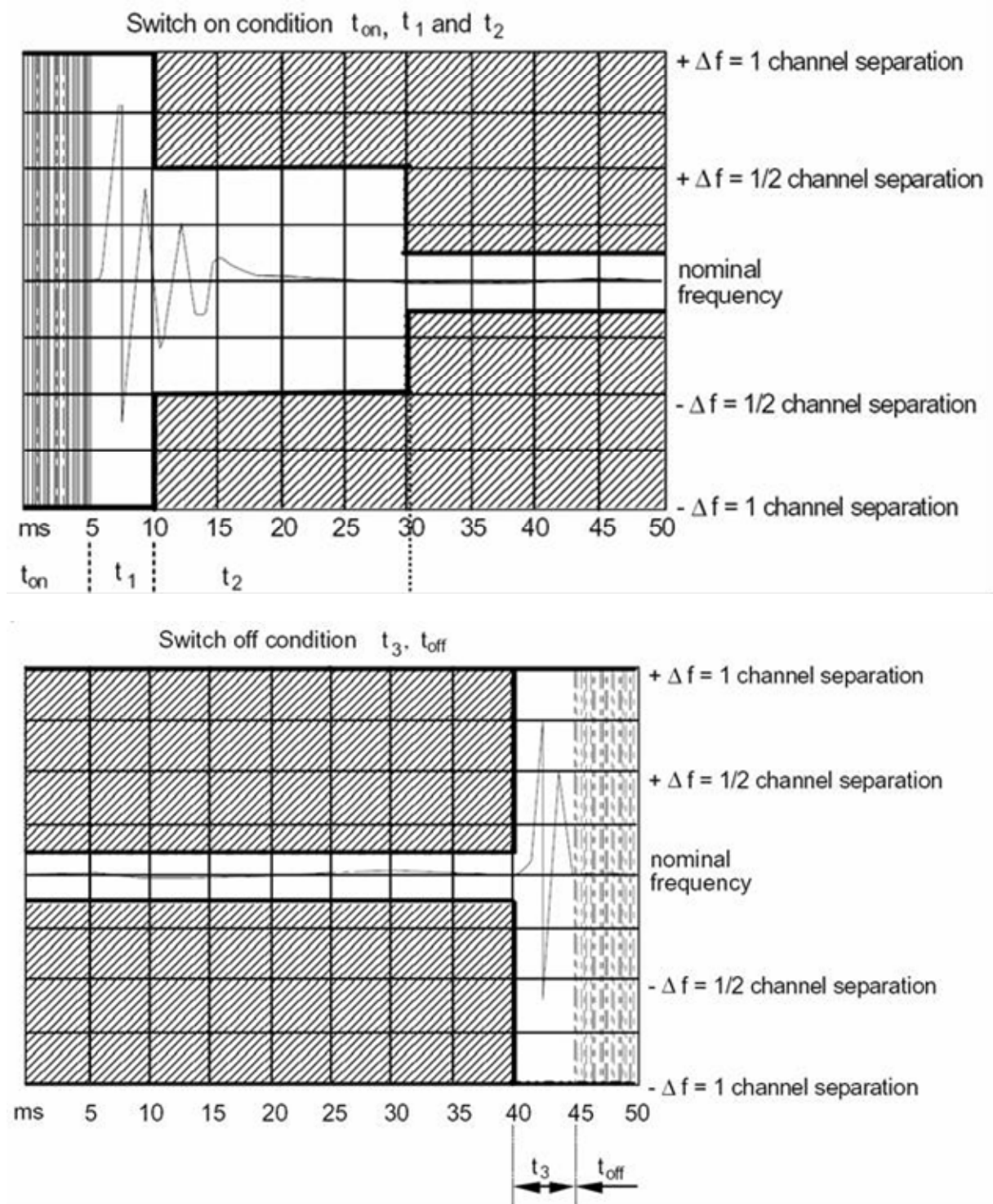
The measurement set up shall be assembled according to figure 1, but instead of the transceiver a test signal generator shall be connected. The frequency shall be set to the nominal carrier frequency. The attenuator shall give a termination with correct impedance to the transceiver. It shall be adjusted, so that the limiting amplifier works in the limiting area, when the generator level exceeds the nominal output power of the transceiver by 10 %. The calibration of the test discriminator is checked by setting the test signal generator to a defined frequency deviation.

a) Transient behaviour, switch ON condition:

- The trigger threshold on the digital storage oscilloscope shall be set such that it triggers as soon as the level exceeds 10 % of the nominal output power. The oscilloscope shall display the time frame after the point of triggering.
- The generator shall be replaced by the transmitter to be tested.
- In angle modulation/DSB mode the transmitter is not modulated, in SSB mode the transmitter shall be modulated according to clause 6.5.2 b). If the transmitter is equipped with a socket for an external microphone, then in SSB mode, the modulating signal shall be present at this socket, even when the transmitter is not switched on.
- The transient behaviour is measured by activating the transmit switching circuit from RX to TX.

b) Transient behaviour, switch OFF condition:

- The trigger threshold on the digital storage oscilloscope shall be set such, that it triggers, as soon as the level falls below 10 % of the nominal output power. The oscilloscope shall display the time frame before the point of triggering.
- In angle modulation/DSB mode the transmitter is not modulated, in SSB mode the transmitter shall be modulated according to clause 6.5.2 b). If the transmitter is equipped with a socket for an external microphone, then in SSB mode, the modulating signal shall be present at this socket, even when the transmitter is not switched on.
- The transmit switching circuit is activated.
- The transient behaviour is measured by switching the transmit circuit from TX to RX.



NOTE: The figures shown here are only examples of oscilloscope displays. Refer to clause 7.6.3 for the actual values of t_1 , t_2 and t_3 .

Figure 2: Example storage oscilloscope view t_1 , t_2 and t_3

7.6.3 Limits

The maximum transient periods are as follows:

- t_1 5,0 ms;
- t_2 20,0 ms;
- t_3 5,0 ms.

During the periods t_1 and t_3 the frequency difference shall not exceed the value of 1 channel separation.

During the period t_2 the frequency difference shall not exceed the value of half a channel separation.

In the case of hand portable stations, the frequency deviation during t_1 and t_3 may be greater than one channel. The corresponding plot of frequency versus time during t_1 and t_3 shall be recorded in the test report.

8 Methods of measurement for receiver parameters

8.1 Maximum usable sensitivity

This requirement applies only to equipment with an external antenna connector.

8.1.1 Definition

The maximum usable sensitivity of the receiver is the minimum level of signal (emf) at the receiver input, at the nominal frequency of the receiver and with normal test modulation, which will produce:

- an audio frequency output power of at least 25 % of the rated power output, (see clause 7.2); and
- 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 [3].

8.1.2 Method of measurement

The test signal, at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB and angle modulation), i.e. the value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector.

An audio frequency load-resistor, a SND/ND meter and a psophometric telephone weighting network, shall be connected to the receiver output terminals. Where possible, the receiver volume control shall be adjusted to give at least 25 % of the rated audio frequency output power, or, in the case of stepped volume controls, to the first step that provides an output power of at least 25 % of the rated audio frequency output power.

The test signal input level shall be reduced until a SND/ND ratio of 20 dB is obtained. The test signal input level under these conditions is the value of the maximum usable sensitivity.

8.1.3 Limits

The maximum usable sensitivity shall not exceed an electro motive force (emf) of +12 dB μ V for DSB equipment and +6 dB μ V for SSB and angle modulated equipment.

8.2 Adjacent channel selectivity

This requirement applies only to equipment with an external antenna connector.

8.2.1 Definition

The adjacent channel selectivity is the capability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted modulated signal in the adjacent channel.

8.2.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, clause 6.1.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB and angle modulation), i.e. the value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector via one input of the combining network.

The unwanted test signal, at a frequency of 10 kHz above the nominal frequency of the receiver, frequency modulated with 400 Hz with a deviation of $\pm 1,2$ kHz shall be applied to the receiver input connector via the second input of the combining network.

The amplitude of the unwanted test signal shall be adjusted until the SND/ND ratio, psophometrically weighted, at the output of the receiver is reduced to 14 dB.

The measure of the adjacent channel selectivity is the ratio in dB of the level of the unwanted test signal to the level of the wanted test signal at the receiver input for which the specified reduction in SND/ND ratio occurs. This ratio shall be noted.

The measurement shall be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal.

The two noted ratios shall be recorded as the upper and lower adjacent channel selectivity.

8.2.3 Limits

The adjacent channel selectivity shall not be less than 60 dB.

8.3 Intermodulation response rejection

This requirement applies only to equipment with an external antenna connector.

8.3.1 Definition

The inter-modulation response rejection is the capability of a receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

8.3.2 Method of measurement

Three input signals shall be connected to the receiver via a combining network, clause 7.1.

The wanted test signal (A), at the nominal frequency of the receiver, with normal test modulation modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB), i.e. the value of the limit for the maximum useable sensitivity, shall be applied to the receiver input connector via input of the combining network.

The unwanted test signal (B), at the frequency 20 kHz above the nominal frequency of the receiver, without modulation, shall be applied to the receiver input connector via the second input of the combining network.

The unwanted test signal (C), at a frequency of 40 kHz above the nominal frequency of the receiver, DSB amplitude modulated by 400 Hz to a modulation depth of 60 % shall be applied to the receiver input connector via the third input of the combining network.

The frequency of the unwanted test signals (B) and (C) may be slightly adjusted to search for maximum intermodulation.

The amplitude of the unwanted test signals (B) and (C) shall be maintained equal and adjusted until the SND/ND ratio, psophometrically weighted, at the output of the receiver is reduced to 14 dB.

The measure of the inter-modulation response rejection is the ratio in dB of the level of the unwanted test signals to the level of the wanted test signal at the receiver input for which the specified reduction in SND/ND ratio occurs. This ratio shall be recorded.

The two sets of measurements described above shall be repeated with the unwanted signals below the nominal frequency of the receiver by the specified amounts.

8.3.3 Limits

The intermodulation response rejection ratio shall not be less than 48 dB.

8.4 Spurious radiations

8.4.1 Definition

The present clause applies only to receive only equipment.

NOTE: Spurious radiations in standby/reception mode are measured under clause 7.5.2.

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

The level of spurious radiations shall be measured by:

- a) their power level in a specified load (conducted spurious emission); and
- b) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);
or
- c) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of handportable equipment fitted with such an antenna and no external RF connector.

8.4.2 Method of measurement

8.4.2.1 Method of measuring the power level in a specified load

The receiver shall be connected to a 50 Ω attenuator. The output of the attenuator shall be connected to a measuring receiver. The receiver shall be switched on, and the measuring receiver shall be tuned over the frequency range 9 kHz to 2 GHz.

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

8.4.2.2 Method of measuring the effective radiated power

On a test site, selected from annex A, the equipment shall be placed at the specified height on the appropriate support and in the position closest to normal use as declared by the manufacturer. The receiver antenna connector shall be connected to an artificial antenna, clause 6.5.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instant frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver. The receiver shall be switched on and the measuring receiver shall be tuned over the frequency range 25 MHz to 2 GHz. At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver. The receiver shall then be rotated through 360° in the horizontal plane until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.

The receiver shall be replaced by a substitution antenna as defined in clause A.2.3. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected. The substitution antenna shall be connected to a calibrated signal generator. The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

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

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

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

8.4.2.3 Method of measuring the effective radiated power

The measurement shall be performed according to clause 8.4.2.2, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

8.4.3 Limits

The power of any spurious radiations shall not exceed the values given in tables 6 and 7.

Table 6: Conducted components

Frequency range	9 kHz to 1 GHz	Above 1 GHz to 2 GHz
Limit	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 7: Radiated components

Frequency range	30 MHz to 1 GHz	Above 1 GHz to 2 GHz
Limit	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

The reference bandwidths from table 8 shall be used.

Table 8: Reference bandwidths to be used for the measurement of spurious radiations

Frequency range	RBW
9 to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
1 to 2 GHz	1 MHz

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 absolute values of the figures in table 9.

Table 9: Measurement uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-7}$
RF Power	$\pm 0,75$ dB
Maximum frequency deviation	± 5 %
Radiated RF power	± 6 dB
Adjacent channel power	± 5 dB
Conducted spurious emission	± 4 dB
Conducted spurious emission of receiver	± 7 dB
Two-signal measurement	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of the transmitter	± 6 dB
Radiated measurement of receiver	± 6 dB
Temperature	± 1 °C
Humidity	± 10 %
NOTE: Valid up to 4 GHz for all RF parameters.	

For the test methods, according to the present document the uncertainty figures shall be calculated according to the principles of the methods described in the TR 100 028 [1] 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)).

Table 9 is based on such expansion factors.

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

Annex A (normative): Radiated measurement

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

A.1.1 Outdoor test site

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

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

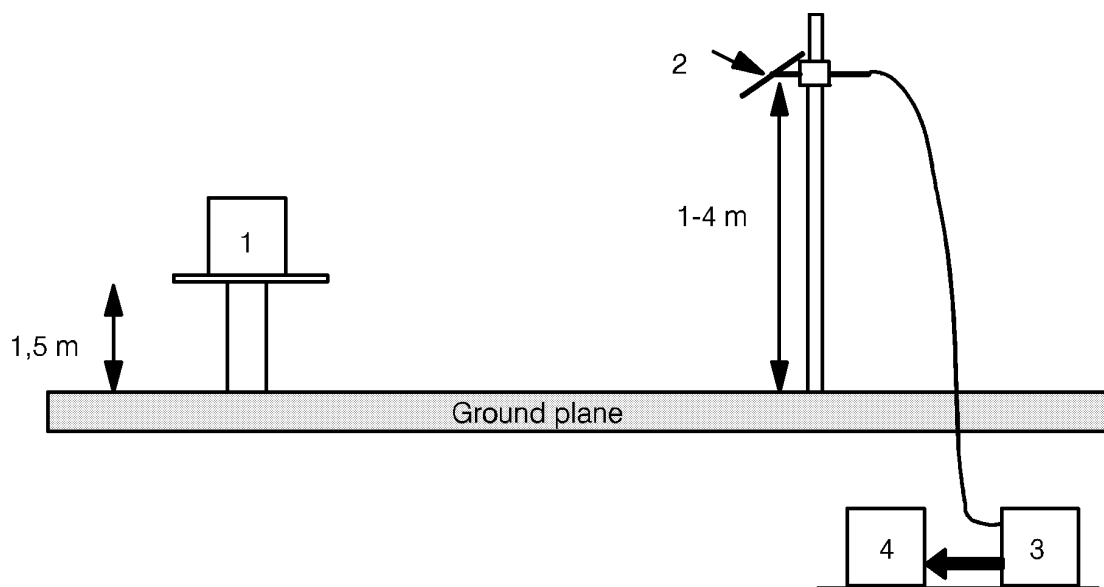
A.1.1.1 Test site for hand portable stations

The test site shall be on a reasonably level surface or ground. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of at least 6 metres. The distance actually used shall be recorded with the results of the test carried out on the site.

At one point on the site, a ground plane of at least 5 metres diameter shall be provided. In the middle of this ground plane, a support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1,5 metres above the ground plane. This support consists of a plastic tube, which is filled with salt water (9 grams NaCl per litre). The tube shall have a length of 1,5 metres and an internal diameter of $10 \pm 0,5$ cm. The upper end of the tube is closed by a metal plate with a diameter of 15 cm, which is in contact with the water.

The sample shall be placed with its side of largest area on the metal plate. To meet the requirement that the antennas are vertical while maintaining contact with the metal plate, it may be necessary to use a second metal plate, attached to the first. This metal plate shall be 10 x 15 cm in size and shall be hinged to the first plate by its 10 cm edge in such a way that the angle between the plates can be adjusted between 0° and 90°. The hinge point shall be adjustable so that the centre of the sample can be placed above the centre of the circular plate. In the cast of samples whose length along the antenna axis is less than 15 cm, the sample shall be arranged so that the base of the antennas is at the edge of the hinged plate.

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



Key:

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

Figure A.1

A.1.2 Test antenna

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

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical 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. For receiver radiated sensitivity measurements the test antenna is connected to a signal generator.

A.1.3 Substitution antenna

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

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

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

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

A.1.4 Optional additional indoor site

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

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

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

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally 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 direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ± 10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction. If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-sited until a change of less than 2 dB is obtained.

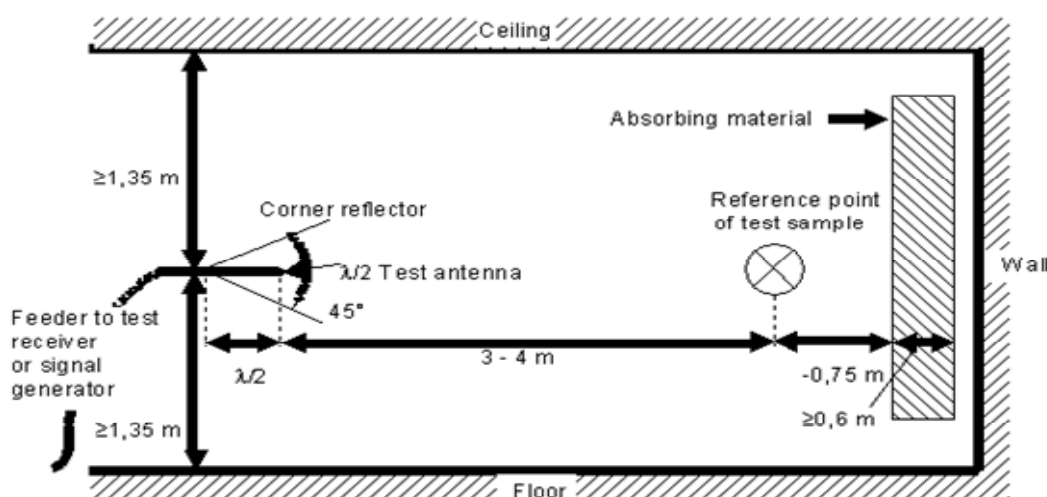


Figure A.2: Indoor site arrangement (shown in horizontal polarization)

A.2 Guidance on the use of radiation test sites

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

A.2.1 Measuring distance

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

A.2.2 Test antenna

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

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

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

A.2.3 Substitution antenna

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

A.2.4 Artificial antenna

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

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

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

A.2.5 Auxiliary cables

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

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

For radiation measurements when the frequency of the signals being measured is greater than 25 MHz, use may be made of an indoor site being a well-shielded anechoic chamber simulating free space environment. If such a chamber is used, this shall be recorded in the test report.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method, clause A.1. In the range between 25 MHz and 100 MHz some additional calibration may be necessary.

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high. Walls and ceiling should be coated with RF absorbers of 1m height. The base should be covered with absorbing material 1m thick, and a wooden floor, able to carry test equipment and operators. A measuring distance of 3 m to 5 m in the long middle axis of the chamber can be used for measurements. The construction of the anechoic chamber is described in the following clauses.

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

Free-field measurements can be simulated in a shielded measuring chamber where the walls are coated with RF absorbers. Figure A.3 shows the requirements for shielding loss and wall return loss of such a room. As dimensions and characteristics of usual absorber materials are critical below 100 MHz (height of absorbers < 1 m, reflection attenuation < 20 dB) such a room is preferably suitable for measurements above 100 MHz. Figure A.4 shows the construction of a shielded measuring chamber having a base area of 5 m by 10 m and a height of 5 m. Ceilings and walls are coated with pyramidal formed absorbers approximately 1 m high. The base is covered with absorbers which are able to carry and which forms a sort of floor. The available internal dimensions of the room are 3 m x 8 m x 3 m, so that a measuring distance of maximum 5 m length in the middle axis of this room is available.

At 100 MHz the measuring distance can be extended up to a maximum of 2λ . The floor absorbers reject floor reflections so that the antenna height need not be changed and floor reflection influences need not be considered. All measuring results can therefore be checked with simple calculations and the measuring tolerances have the smallest possible values due to the simple measuring configuration.

For special measurements it can be necessary to re-introduce floor reflections. Taking away the floor absorbers would mean a removal of approximately 24 m³ absorber material. Therefore the floor absorbers are covered with metal plates of metallic nets instead.

A.3.2 Influence of parasitic reflections in anechoic chambers

For free-space propagation in the far field condition the correlation $E=E_0 (R_0/R)$ is valid for the dependence of the field strength E on the distance R , whereby E_0 is the reference field strength in the reference distance R_0 . It is useful to use just this correlation for comparison measurements, as all constants are eliminated with the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance. Deviations from the ideal curve can be seen easily if the logarithm of the above equation is used, because the ideal correlation of field strength and distance can then be shown as a straight line and the deviations occurring in practice are clearly visible. This indirect method shows the disturbances due to reflections more readily and is far less problematical than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions suggested in clause A.3 at low frequencies up to 100 MHz there are no far field conditions, and therefore reflections are stronger so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well. In the frequency range of 1 GHz to 2 GHz, because more reflections will occur, the dependence of the field strength on the distance will not correlate so closely.

A.3.3 Calibration of the shielded anechoic chamber

Careful calibration of the chamber shall be performed over the range 25 MHz to 2 GHz.

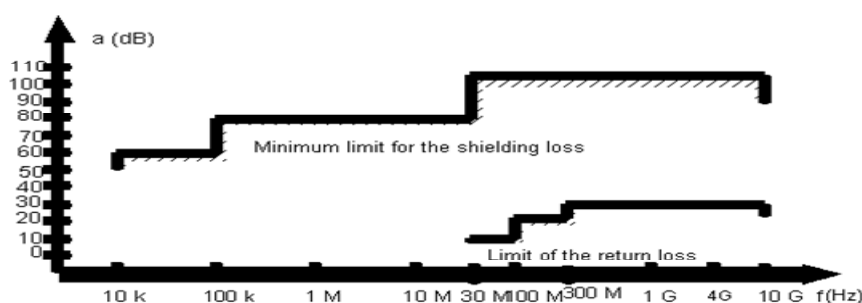


Figure A.3: Specifications for shielding and reflections

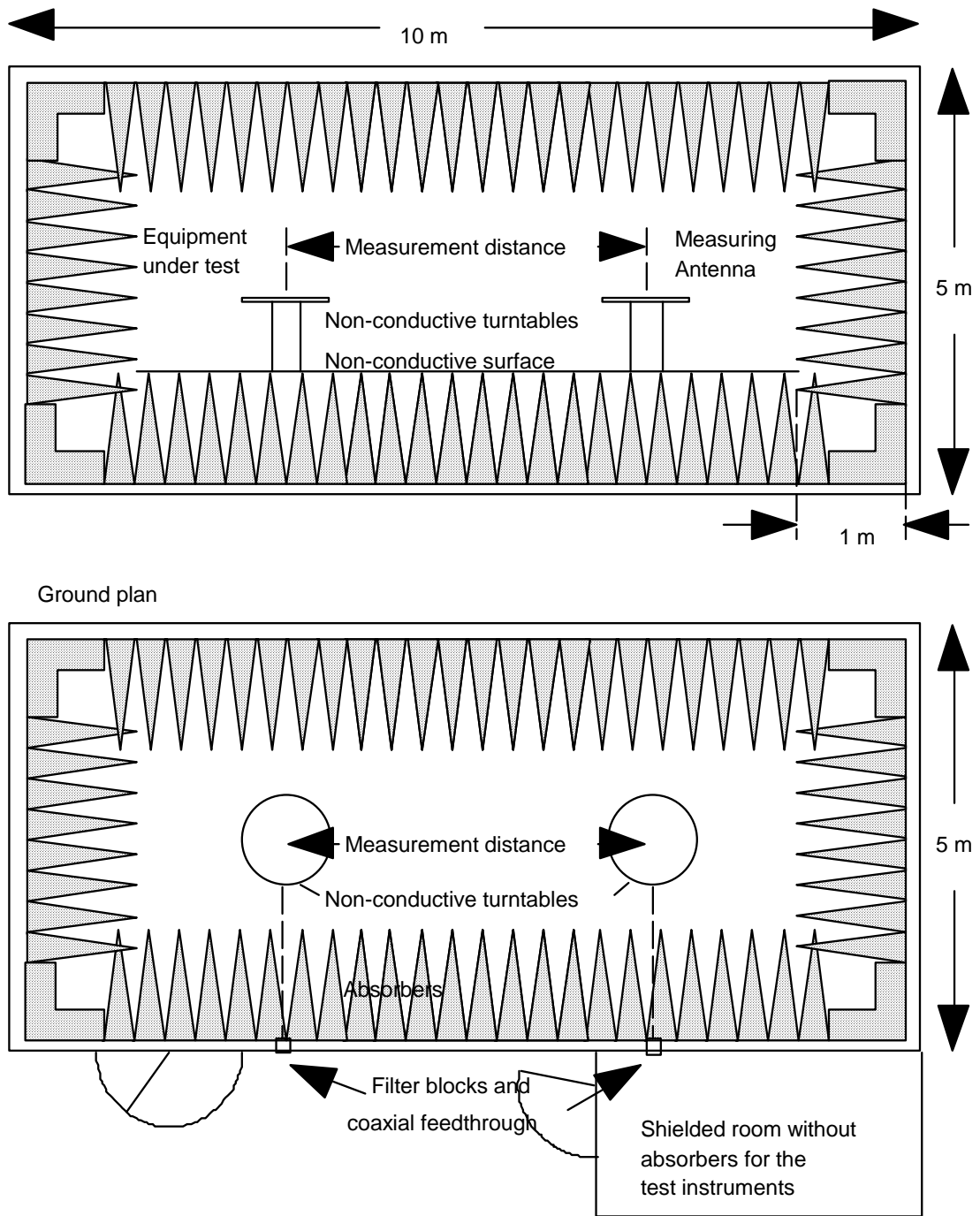


Figure A.4: Example of construction of an anechoic shielded chamber

Annex B (normative): Specification for adjacent channel power measurement arrangements

B.1 Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF filter, an oscillator, an amplifier, a variable attenuator and an RMS value indicator. Instead of the variable attenuator with the RMS value indicator it is also possible to use an RMS voltmeter calibrated in dB as the RMS value indicator. The technical characteristics of the power measuring receiver are given in clauses B.1.1 to B.1.4.

An alternative measuring method shall consist in using, in place of the IF filter, a spectrum analyser with a resolution bandwidth of 100 Hz and integrating the power of all the 100 Hz sub-band measurements, over a total bandwidth of $\pm D2$ (see table B.1).

B.1.1 IF filter

The IF filter shall be within the limits of the following selectivity characteristic.

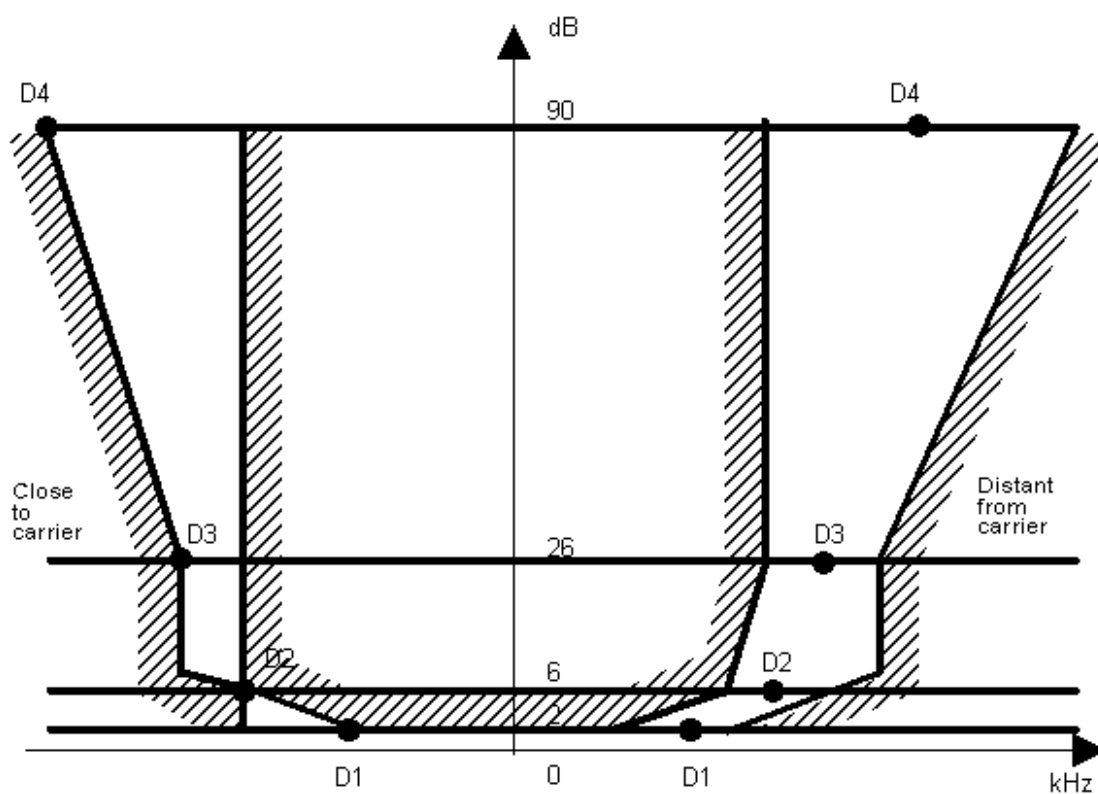


Figure B.1

The selectivity characteristic shall keep the frequency separations from the nominal centre frequency of the adjacent channel as mentioned in column 2 of table B.1.

The attenuation points on the slope towards the carrier shall not exceed the tolerances, as mentioned in column 3 of table B.1.

The attenuation points on the slope, distant from the carrier, shall not exceed the tolerances, as mentioned in column 4 of table B.1.

Table B.1: Selectivity characteristics of the "receiver"

1 Attenuation Points	2 Frequency Separations	3 Tolerance towards C	4 Tolerance distant from C
D1 (2 dB)	3 kHz	+1,35 kHz	±2 kHz
D2 (6 dB)	4,25 kHz	±0,1 kHz	±2 kHz
D3 (26 dB)	5,5 kHz	-1,35 kHz	±2 kHz
D4 (90 dB)	9,5 kHz	-5,35 kHz	+2 kHz and -6 kHz

The minimum attenuation of the filter outside the 90 dB attenuation points must be equal to or greater than 90 dB.

B.1.2 Variable attenuator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB.

B.1.3 RMS value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio of up to 10:1 between peak value and RMS value.

B.1.4 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ -80 dB referred to the carrier of the oscillator.

Annex C (informative): Bibliography

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 (R&TTE Directive).

ETSI TR 102 273 (all parts) (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

ETSI EN 301 489-1 (V1.7.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

ETSI EN 301 489-13 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 13: Specific conditions for Citizens' Band (CB) radio and ancillary equipment (speech and non-speech)".

Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).

History

Document history		
Edition 1	November 1995	Publication as ETS 300 433
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