EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 086

January 1991

Source: ETSI TC-STC RES 2

Reference: DE/RES-02002

ICS: 33.060.20, 33.060.30

Key words: land mobile radio, analogue speech, testing

Radio Equipment and Systems
Land mobile service
Technical characteristics and test conditions for radio equipment with an internal or external RF connector intended primarily for analogue speech

ETSI

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Foreword

This European Telecommunication Standard has been prepared by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI). The draft has undergone the ETSI public enquiry process, and is now published.

The standard which is based upon CEPT Recommendation T/R 24-01, is a general standard which may be superseded by specific standards covering specific applications.

Angle modulation shall be used for radio equipment covered by this standard, but individual national administrations are free to choose the type of modulation. Channel separations, temperature range, maximum transmitter output power/effective radiated power, class of transmitter intermodulation attenuation and the inclusion of automatic transmitter shut-off facility may all be conditions attaching to the issue of a licence by the appropriate administration.

Additional standards or specifications may be required for equipment such as that intended for connection to the public switched telephone network (PSTN).

This standard does not cover requirements for radiated emissions below 30 MHz. It is anticipated that methods of measurements and minimum standards for such emissions will be covered by specifications supporting EMC Directive 89/336 EEC.

Annex A provides additional information concerning radiated measurements.

Annex B contains normative specifications for adjacent channel power measurement arrangements.

Annex C is a graphic representation of the normative subclause 3.1, referring to the presentation of equipment for testing purposes.

Introduction

This standard is intended to specify the minimum performance and the methods of measurement of radio equipment for use in the land mobile service as specified in the Scope. Clause 4 provides the corresponding limits. These limits have been chosen to ensure an acceptable grade of service and to minimise harmful interference to other equipment and services. They are based on the interpretation of the measurement results described in subclause 3.3.

This standard will also be used by accredited test laboratories for the assessment of the performance of the equipment. The performance of the equipment submitted for type testing shall be representative for the performance of the corresponding production model. In order to avoid any ambiguity in that assessment, this standard contains instructions for the presentation of equipment for type testing purposes (clause 3), conditions (clause 5) and measurement methods (clauses 7 and 8).

This standard was drafted on the assumption that:

- the type test measurements will be performed only once, in one of the accredited test laboratories, and the measurements accepted by the various authorities in order to grant type approval,

- if equipment available on the market is required to be checked it shall be tested in accordance with the methods of measurement specified in this standard.

This standard covers base stations, mobile stations and two categories of handportable stations. One category is fitted with a 50 Ω external antenna socket or connector. The other category has no external antenna socket, but:

- either it is fitted with a permanent internal 50 Ω RF connector,

- or it can be fitted with a temporary internal 50 Ω RF connector,so that conducted measurements can be performed.

The means to access and/or implement the internal connector shall be provided by the manufacturer.

Details of the means used during type testing shall be provided by the accredited test laboratory with the test report, subclause 3.1.12.

1 Scope

This standard covers the minimum characteristics considered necessary in order to make the best use of the available frequencies. It does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable. It applies to angle modulation systems for use in the land mobile service, operating on radio frequencies between 30 MHz and 1000 MHz, with channel separations of 12.5 kHz, 20 kHz and 25 kHz, and intended primarily for analogue speech.

In this standard different requirements are given for the different radio frequency bands, channel separations, environmental conditions and types of equipment, where appropriate.

The types of equipment covered by this standard are as follows:

- Base station: equipment fitted with an antenna socket.

- Mobile station: equipment fitted with an antenna socket.

- Handportable stations:

    a) fitted with an antenna socket,

or

    b) without an external antenna socket (integral antenna equipment) but fitted with a permanent internal or a temporary internal 50 Ω R.F. connector which allows access to the transmitter output and the receiver input.

For the type of equipment defined in (b) the additional measurements which shall be made using the equipment antenna connected to the station (and not using any connector) are as follows:

- Transmitter effective radiated power

- Transmitter radiated spurious emissions

- Receiver maximum usable sensitivity (field strength)

- Receiver radiated spurious emissions

Handportable equipment without an external or internal RF connector and without the possibility of having a temporary internal 50 Ω RF connector is not covered by this standard.

2 Definitions, abbreviations and symbols

2.1 Definitions

For the purpose of this standard, the following definitions apply:

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

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

Handportable station: equipment either fitted with an antenna socket 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: an antenna designed to be connected to the equipment without the use of a 50 Ω external connector and considered to be part of the equipment. An integral antenna may be fitted internally or externally to the equipment.

Angle modulation: either phase modulation (G3) or frequency modulation (F3).

Full tests: in all cases except where qualified as "limited", tests shall be performed according to this standard.

Limited tests: the limited tests, subclause 3.1, are as follows:

- receiver maximum usable sensitivity (conducted), subclause 8.1,
- receiver maximum usable sensitivity (field strength), subclause 8.2, integral antenna equipment only,
- receiver adjacent channel selectivity, subclause 8.5,
- transmitter frequency error, subclause 7.1,
- transmitter carrier power conducted, subclause 7.2,
- transmitter effective radiated power, subclause 7.3, integral antenna equipment only,
- transmitter adjacent channel power, subclause 7.5.

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

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

2.2 Abbreviations

SND/ND	(signal + noise + distortion)/(noise + distortion),
dBc	dB relative to the carrier power,
RF	radio frequency,
IF	intermediate frequency,
Tx	transmitter,
Rx	receiver.

2.3 Symbols

Eo	reference field strength, annex A,
Ro	reference distance, annex A.

3 General

3.1 Presentation of equipment for testing purposes

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

To simplify and harmonise the type testing procedures between the different test laboratories, measurements shall be performed, according to this standard, on samples of equipment defined in subclause 3.1.1 to 3.1.12.

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

3.1.1 Choice of model for type approval

The manufacturer shall provide one or more production model(s) of the equipment, as appropriate, for type approval testing.

If type approval is given on the basis of tests on a preliminary model, then the corresponding production models must be identical in all respects with the preliminary model tested.

In the case of handportable equipment without a 50 Ω external antenna connector, see subclause 3.1.12.

3.1.2 Definitions of alignment range and switching range

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

The alignment range is defined as the frequency range over which the receiver and the transmitter can be programmed and/or realigned to operate, without any physical change of components other than programmable read only memories or crystals (for the receiver and the transmitter).

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

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

For the purpose of all measurements, the receiver and transmitter shall be considered separately.

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

The alignment range falls into one of two categories.

The first category corresponds to a limit of the alignment range, of the receiver and the transmitter, which is less than 10 % of the highest frequency of the alignment range for equipment operating on frequencies up to 500 MHz, or less than 5 % for equipment operating above 500 MHz. This category is defined as AR1.

The second category corresponds to an alignment range of the receiver and transmitter which is greater than 10 % of the highest frequency of the alignment range for equipment on frequencies up to 500 MHz, or greater than 5 % for equipment operating above 500 MHz. This category is defined as AR2.

3.1.4 Choice of frequencies

The frequencies for testing shall be chosen by the manufacturer in consultation with the appropriate authority, in accordance with subclauses 3.1.5 to 3.1.11 and annex C. The manufacturer selects the frequencies for testing and will ensure that the chosen frequencies are within one or more of the national bands for which type approval is required.

3.1.5 Testing of single channel equipment of category AR1.

In the case of equipment of the category AR1, one sample of the equipment shall be tested.

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

3.1.6 Testing of single channel equipment of category AR2

In the case of equipment of the category AR2, three samples of the equipment shall be tested. Tests shall be carried out on a total of three channels.

The frequency of the channel of the first sample shall be within 100 kHz of the highest frequency of the alignment range.

The frequency of the channel of the second sample shall be within 100 kHz of the lowest frequency of the alignment range.

The frequency of the channel of the third sample shall be within 100 kHz of the centre frequency of the alignment range.

Full tests shall be carried out on all three channels.

3.1.7 Testing of two channel equipment of category AR1

In the case of equipment of category AR1, one sample of the equipment shall be tested. Tests shall be carried out on the two channels.

The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range.

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

Full tests shall be carried out on the upper channel and limited tests on the lower channel.

3.1.8 Testing of two channel equipment of category AR2

In the case of equipment of the category AR2, three samples of the equipment shall be tested. Tests shall be carried out on a total of four channels.

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

Full tests shall be carried out on the upper channel and limited tests on the lower channel.

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

Full tests shall be carried out on this channel.

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

Full tests shall be carried out on this channel.

3.1.9 Testing of multi channel equipment (more than two channels) of category AR1.

In the case of equipment of the category AR1, one sample of the equipment shall be tested.

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

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

3.1.10 Testing of multi channel equipment (more than two channels) of category AR2 (switching range less than alignment range).

In the case of equipment of the category AR2, three samples of the equipment shall be tested. Tests shall be carried out on a total of five channels.

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

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

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

Full tests shall be carried out on this channel.

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

Full tests shall be carried out on this channel.

3.1.11 Testing of multi channel equipment (more than two channels) of category AR2 (switching range equals the alignment range).

In the case of equipment of the category AR2, one sample of the equipment shall be tested.

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

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

3.1.12 Testing of equipment without an external 50 ê RF connector.

3.1.12.1 Equipment with a temporary or internal permanent antenna connector

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated by the manufacturer with the aid of a diagram.

The fact that use has been made of the internal antenna connection to facilitate measurements shall be recorded in the test report.

3.1.12.2 Equipment with a temporary antenna connector

The manufacturer, or an authorised representative, may submit one set of equipment with the normal antenna connected, to enable the radiated measurements to be made.

The manufacturer, or an authorised representative, shall attend the test laboratory at conclusion of the radiated measurements, to disconnect the antenna and fit the temporary connector.

The test laboratory staff shall not connect or disconnect any temporary antenna connector.

Alternatively the manufacturer, or an authorised representative, may submit two sets of equipment to the test laboratory, one fitted with a temporary antenna connector with the antenna disconnected and the other with the antenna connected.

Each equipment shall be used for the appropriate tests.

3.2 Mechanical and electrical design

3.2.1 General

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

3.2.2 Controls

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

3.2.3 Transmitter shut-off facility

When a timer for an automatic shut-off facility is operative, at the moment of the time-out the transmitter shall automatically be switched off. The activation of the transmitter key shall reset the timer.

3.2.4 Marking

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

The marking shall include:

- the name of the manufacturer or his trade mark
- the type number of designation and serial number
- the type approval number (when allocated by appropriate authorities).

3.3 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in this standard shall be as follows.

The measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the standard.

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 be, for each measurement, equal to or lower than the figures in subclause 10 (table of measurement uncertainty).

NOTE: This procedure for using Maximum Acceptable Uncertainty values is valid until superseded by other appropriate publications of ETSI covering this subject.

The use of the measured value has been chosen because there is no other ETSI standard covering the subject at the time of publication of this standard. Therefore the measurement uncertainty shall be used as a quality of the actual measurement. The Measurement Uncertainty values can also be used by Accreditation Authorities during their accreditation procedures to ensure compliance/conformity with the requirements of type testing to ETSI Standards.

4 Technical characteristics

This clause contains the limit values of the parameters defined in clauses 7 to 9.

4.1 Transmitter parameter limits

4.1.1 Frequency error

For the definition and the measuring method see subclause 7.1.

The frequency error shall not exceed the values given in table 1 under normal, extreme or any intermediate set of conditions.

For practical reasons the measurements will be performed only under normal and extreme test conditions as stated in subclause 7.1.

Table 1:

Channel separation (kHz)	Frequency error limit (kHz)				
	below 47MHz	47 to 137MHz	above 137 to 300MHz	above 300 to 500MHz	above 500 to 1000MHz
20 & 25	± 0.60	± 1.35	± 2.00	± 2.00	± 2.50(a)
12.5	± 0.60	± 1.00	± 1.00(B) ± 1.50(M)	± 1.00 (B) ± 1.50 (a) (M)	No value specified

B = base station
M = mobile or handportable station
(a) For handportable stations having integral power supplies, the frequency error shall not be exceeded over a temperature range of 0 to +30°C.
Under extreme temperature conditions (subclause 5.4.1), the frequency error shall not exceed ± 2.50 kHz for a channel separation of 12.5kHz between 300 and 500MHz, and ± 3.00kHz for channel separations of 20 and 25kHz between 500 and 1000MHz.

4.1.2 Carrier power (conducted)

For the definition and the measuring method see subclause 7.2.

The carrier output power (conducted) under normal test conditions shall be within ± 1.50 dB of the rated output power.

Furthermore, the carrier output power (conducted) shall not exceed the maximum value allowed by the Administrations.

The carrier output power (conducted) under extreme test conditions shall be within + 2.0 dB and - 3.0 dB of the rated output power.

4.1.3 Effective radiated power

This measurement applies only to equipment without an external 50 Ω antenna connection.

For the definition and the measuring method see subclause 7.3.

The effective radiated power under normal test conditions shall be within ± 7.5 dB of the rated effective radiated power.

Furthermore, the effective radiated power shall not exceed the maximum value allowed by the Administrations.

The measurement shall be carried out under normal conditions only.

4.1.4 Frequency deviation

For the definition and the measuring method see subclause 7.4.

4.1.4.1 Maximum permissible frequency deviation

The maximum permissible frequency deviation for modulation frequencies from the lowest frequency transmitted (f1) by the equipment (as declared by the manufacturer) up to (f2) shall be as given in table 2.

Table 2

Channel separation (KHz)	Maximum permissible frequency deviation (kHz)
12.5	± 2.5
20	± 4.0
25	± 5.0

4.1.4.2 Response of the transmitter to modulation frequencies above 3 kHz

The frequency deviation at modulation frequencies between 3.0 kHz (for equipment operating with 20 kHz or 25 kHz channel separations) and 2.55 kHz (for equipment operating with 12.5 kHz channel separation) and 6.0 kHz shall not exceed the frequency deviation at a modulation frequency of 3.0 kHz/2.55 kHz. At 6.0 kHz the deviation shall be not more than 30.0 % of the maximum permissible frequency deviation.

The frequency deviation at modulation frequencies between 6.0 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed that given by a linear representation of the frequency deviation (dB) relative to the modulation frequency, starting at the 6.0 kHz limit and having a slope of - 14.0 dB per octave. These limits are illustrated in figure 1.

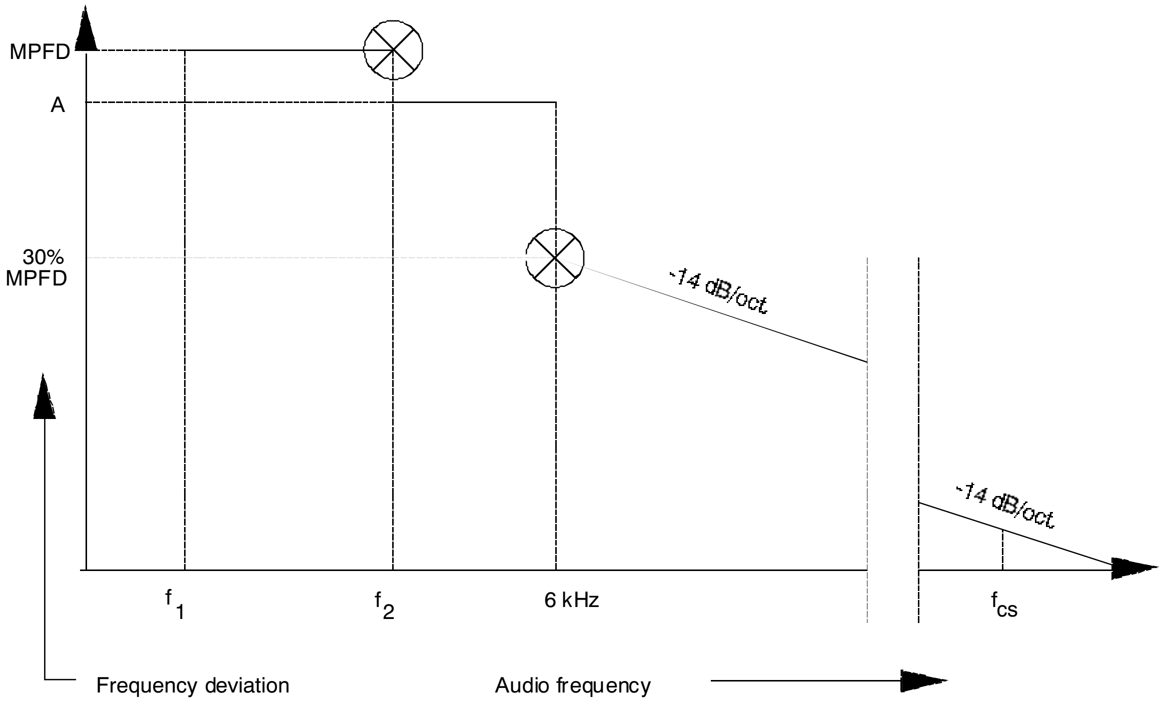


Figure 1

Abbreviations:
f1 lowest appropriate frequency
f2 3.0 kHz (for 20 kHz or 25 kHz channel separation), or
2.55 kHz (for 12.5 kHz channel separation)
MPFD maximum permissible frequency deviation, subclause 4.1.4.1,
A measured frequency deviation at f2,
fcs frequency equal to channel separation.

4.1.5 Adjacent channel power

For the definition and the measuring method see subclause 7.5.

For channel separations of 20 kHz and 25 kHz, the adjacent channel power shall not exceed a value of 70.0 dB below the carrier power of the transmitter without the need to be below 0.20 µW. For channel separations of 12.5 kHz, the adjacent channel power shall not exceed a value of 60.0 dB below the transmitter carrier power without the need to be below 0.20 µW.

4.1.6 Spurious emissions

For the definition and the measuring method see subclause 7.6.

The power of any spurious emission shall not exceed the values given in tables 3 and 4.

Table 3: Conducted emissions

Frequency range	9 kHz to 1 GHz	above 1 to 4 GHz, or above 1 to 12.75 GHz, see subclause 7.6.2.
Tx operating	0.25 µW (-36.0 dBm)	1.00 µW (-30.0 dBm)
Tx standby	2.0 nW (-57.0 dBm)	20.0 nW (-47.0 dBm)

Table 4: Radiated emissions

Frequency range	30 MHz to 1 GHz	above 1 to 4 GHz
Tx operating	0.25 µW (-36.0 dBm)	1.00 µW (-30.0 dBm)
Tx standby	2.0 nW (-57.0 dBm)	20.0 nW (-47.0 dBm)

In the case of radiated measurements for handportable stations the following conditions apply:

- internal integral antenna: the normal antenna shall be connected,

- external antenna socket: an artificial load shall be connected to the socket for the test.

4.1.7 Intermodulation attenuation

This requirement applies only to transmitters to be used in base stations (fixed).

For the definition and the measurement method see subclause 7.7.

Two classes of transmitter intermodulation attenuation are defined, the equipment shall fulfil one of the requirements as follows:

- the intermodulation attenuation ratio shall be at least 40.0 dB for any intermodulation component.

- for base stations to be used in special service conditions (e.g. at sites where more than one transmitter will be in service) or when the regulatory authority makes it a condition of the licence, the intermodulation attenuation ratio shall be at least 70.0 dB for any intermodulation component. In the case where the performance is achieved by additional internal or external isolating devices (such as circulators) these shall be supplied at the time of type testing and shall be used for the measurements.

4.1.8 Transient frequency behaviour of the transmitter

For the definition and the measurement method see subclause 7.8.

The transient periods are given in table 5 and shown in figure 4, subclause 7.8.

Table 5

	30 to 300 MHz	above 300 to 500 MHz	above 500 to 1000 MHz
t1 (ms)	5.0	10.0	20.0
t2 (ms)	20.0	25.0	50.0
t3 (ms)	5.0	10.0	10.0

During the periods t1 and t3 the frequency difference shall not exceed the value of 1 channel separation.

During the period t2 the frequency difference shall not exceed the value of half a channel separation.

In the case of handportable stations with a transmitter output power of less than 5 W, the frequency deviation during t1 and t3 may be greater than one channel. The corresponding plot of frequency versus time during t1 and t3 shall be recorded in the test report.

4.2 Receiver parameter limits

4.2.1 Maximum usable sensitivity

For the definition and the measurement method see subclause 8.1.

The maximum usable sensitivity shall not exceed an e.m.f. of 6.0 dBμV under normal test conditions, and an e.m.f. of 12.0 dBμV under extreme test conditions.

4.2.2 Maximum usable sensitivity (field strength)

This measurement applies only to equipment without a 50 Ω external antenna connector.

For the definition and the measurement method see subclause 8.2.

The maximum usable sensitivity shall not exceed the field strength value shown in table 6.

Table 6

Frequency band MHz	Field strength in dB relative to 1 μV/m
	Normal test conditions
30 to 100	14.0
100 to 230	20.0
230 to 470	26.0
470 to 1000	32.0

4.2.3 Amplitude characteristic

For the definition and the measurement method see subclause 8.3.

Within the specified change in radio frequency input signal level, the change of audio output level shall not exceed 3.0 dB.

4.2.4 Co-channel rejection

For the definition and the measurement method see subclause 8.4.

The value of the co-channel rejection ratio, expressed in dB, at any frequency of the unwanted signal within the specified range, shall be between:

- -8.0 dB and 0 dB for channel separations of 20 kHz and 25 kHz,
- -12.0 dB and 0 dB for channel separation of 12.5 kHz.

4.2.5 Adjacent channel selectivity

For the definition and the measurement method see subclause 8.5.

For channel separations of 20 kHz and 25 kHz, the adjacent channel selectivity shall not be less than 70.0 dB under normal test conditions and not less than 60.0 dB under extreme test conditions.

For channel separations of 12.5 kHz, the adjacent channel selectivity shall not be less than 60.0 dB under normal test conditions and not less than 50.0 dB under extreme test conditions.

4.2.6 Spurious response rejection

For the definition and the measurement method see subclause 8.6.

At any frequency separated from the nominal frequency of the receiver by more than one channel, the spurious response rejection ratio shall not be less than 70.0 dB.

4.2.7 Intermodulation response rejection

For the definition and the measurement method see subclause 8.7.

The intermodulation response rejection ratio shall not be less than 70.0 dB for base stations and 65.0 dB for mobile and handportable stations.

4.2.8 Blocking or desensitisation

For the definition and the measurement method see subclause 8.8.

The blocking ratio, for any frequency within the specified ranges, shall not be less than 84.0 dB, except at frequencies on which spurious responses are found, subclause 8.6.

4.2.9 Spurious radiations

For the definition and the measurement method see subclause 8.9.

The power of any spurious radiation shall not exceed the values given in tables 7 and 8.

Table 7: Conducted components

Frequency range	9 kHz to 1 GHz	above 1 to 4 GHz, or above 1 to 12.75 GHz, see subclause 8.9.2.
Limit	2.0 nW (-57.0 dBm)	20.0 nW (-47.0 dBm)

Table 8: Radiated components

Frequency range	30 MHz to 1 GHz	above 1 to 4 GHz
Limit	2.0 nW (-57.0 dBm)	20.0 nW (-47.0 dBm)

In the case of radiated measurements for handportable stations the following conditions apply:

- internal integral antenna: the normal antenna shall be connected,

- external antenna socket: an artificial load shall be connected to the socket for the test.

4.3 Duplex operation - receiver limits

With simultaneous transmission and reception.

4.3.1 Receiver desensitisation and maximum usable sensitivity.

For the definition and the measurement method see subclause 9.1.

The desensitisation shall not exceed 3.0 dB, and the limit of maximum usable sensitivity under normal test conditions, subclause 4.2.1, shall be met.

4.3.2 Receiver spurious response rejection

For the definition and the measurement method see subclause 9.2.

At any frequency separated from the nominal frequency of the receiver by more than two channels, the spurious response rejection ratio shall not be less than 67.0 dB.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

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

5.2 Test Power source

During type approval tests the power source of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in subclauses 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.

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

In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable.

During tests the power source voltages shall be maintained within a tolerance of < ± 3 % relative to the voltage at the beginning of each test. The value of this tolerance is critical to 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 this standard, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.

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

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 (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 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 subclause 5.5, at the upper and lower temperatures of one of the following ranges:

- -25 °C to + 55 °C
- -15 °C to + 55 °C
- -10 °C to + 55 °C

For the purpose of subclause 4.1.1 (a) an additional extreme temperature range of 0 °C to + 30 °C shall be used.

Type approval test reports shall state which range is used.

5.4.2 Extreme test source voltages

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 ± 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 (6 V, 12 V, etc).

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using the following batteries shall be:

- for the Leclanché or the lithium type of battery: 0.85 times the nominal voltage of the battery,

- for the mercury or nickel-cadmium type of battery: 0.9 times the nominal voltage of the battery.

No upper extreme test voltages apply.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing authority and shall be recorded in the test report.

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 stabilising period

In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation 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 to the rest of the equipment.

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

5.5.1 Procedure for equipment designed for continuous operation

If the manufacturer 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 conditions for a period of half an 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 to the standby or receive condition for a period of one minute after which the equipment shall meet the specified requirements.

5.5.2 Procedure for equipment designed for intermittent operation

If the manufacturer 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. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.

For tests at the lower extreme temperature the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

6 General conditions

6.1 Normal test modulation

For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1. The test signal shall be substantially free from amplitude modulation.

6.2 Artificial antenna

Tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load of 50 Ω connected to the antenna connector.

6.3 Test sites and general arrangements for radiated measurements

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

6.4 Transmitter automatic shut-off facility

If the equipment is fitted with an automatic transmitter shut-off facility it shall be made inoperative for the duration of the type test.

6.5 Arrangement for test signals at the input of the transmitter

For the purpose of this standard, the transmitter audio frequency modulation signal shall be applied the microphone input terminals with the internal microphone disconnected, unless otherwise stated.

6.6 Arrangements for test signals at the input of the receiver

Test signal sources which are applied to the receiver shall present an impedence of 50Ω to the receiver input. This requirement shall be met irrespective whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the e.m.f. at the receiver input connector.

The effects of any intermodulation products and noise produced in the test signal sources shall be negligible.

6.7 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 type approval tests.

6.8 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 this standard are met. With normal test modulation, subclause 6.1, the audio output 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.

6.9 Tests of equipment with a duplex filter

If the equipment is provided with a built-in duplex filter or a separate associated filter, the requirements of this standard shall be met when the measurements are carried out using the antenna connector of this filter.

7 Methods of measurement for transmitter parameters

7.1 Frequency error

7.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and the nominal frequency of the transmitter.

7.1.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to a 50 Ω power attenuator.

The measurement shall be made under normal test conditions, subclause 5.3, and repeated under extreme test conditions, subclauses 5.4.1 and 5.4.2 applied simultaneously.

7.2 Carrier power (conducted)

It is assumed that Administrations will state the maximum transmitter output power/effective radiated power; this could be a condition for issuing the licence.

If the equipment is designed to operate with different carrier powers, the rated power for each level or range of levels shall be declared by the manufacturer. The power adjustment control shall not be accessible to the user.

The requirements of this standard shall be met for all power levels at which the transmitter is intended to operate. For practical reasons measurements shall be performed only at the lowest and the highest power level at which the transmitter is intended to operate.

7.2.1 Definitions

The transmitter carrier power (conducted) is the mean power delivered to the artificial antenna during a radio frequency cycle, in the absence of modulation.

The rated output power is the carrier power (conducted) of the equipment declared by the manufacturer.

7.2.2 Method of measurement

The transmitter shall be connected to a 50 Ω power attenuator, and the power delivered to this artificial antenna shall be measured.

The measurements shall be made under normal test conditions, subclause 5.3, and extreme test conditions, subclauses 5.4.1 and 5.4.2 applied simultaneously.

7.3 Effective radiated power (field strength)

This measurement applies only to equipment without an external antenna connector.

7.3.1 Definitions

The effective radiated power is the power radiated in the direction of the maximum field strength under specified conditions of measurements, in the absence of modulation

The rated effective radiated power is the effective radiated power of the equipment as declared by the manufacturer.

7.3.2 Method of measurement

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

The test antenna shall be orientated for vertical polarisation 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 and 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 subclause A.2.3.

The substitution antenna shall be orientated for vertical polarisation 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 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 polarisation.

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.

7.4 Frequency deviation

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

7.4.1 Maximum permissible frequency deviation

7.4.1.1 Definition

The maximum permissible frequency deviation is the maximum value of frequency deviation stated for the relevant channel separation.

7.4.1.2 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected to a 50 Ω power attenuator, by means of 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 shall be varied between the lowest frequency considered to be appropriate, and 3 kHz.[1)]

The level of this test signal shall be 20 dB above the level of the normal test modulation, subclause 6.1.

7.4.2 Response of the transmitter to modulation frequencies above 3 kHz[1)]7.4.2.1 Definition

The response of the transmitter to modulation frequencies above 3 kHz[1)] is expressed as the frequency deviation in relation to the modulation frequencies above 3 kHz[1)].

7.4.2.2 Method of measurement

The transmitter shall be operated under normal test conditions, subclause 5.3, and connected via a 50 Ω power attenuator to the deviation meter.

The transmitter shall be modulated by normal test modulation, subclause 6.1.

With a constant input level of the modulation signal, the modulation frequency shall be varied between 3 kHz[1)] and a frequency equal to the channel separation for which the equipment is intended.

The frequency deviation shall be measured by means of the deviation meter.

7.5 Adjacent channel power

7.5.1 Definition

The adjacent channel power is that part of the total output power of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels.

This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

[1)] 2.55kHz for transmitters intended for 12.5kHz channel separation.

7.5.2 Methods of measurement

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

a) The transmitter shall be operated at the carrier power determined in subclause 7.2 under normal test conditions, subclause 5.3.

The output of the transmitter shall be connected to the input of the "receiver" by a 50 Ω power attenuator, to ensure that the impedance presented to the transmitter is 50 Ω and the level at the "receiver" input is appropriate.

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. If an unmodulated carrier cannot be obtained then the measurement shall be made with the transmitter modulated with normal test modulation, subclause 6.1, in which case this fact shall be recorded in the test report.

c) The frequency of the "receiver" shall be adjusted above the carrier so that the "receiver" - 6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in table 9.

Table 9: Frequency displacement

Channel separation (kHz)	Specified necessary bandwidth (kHz)	Displacement from the -6 dB point (kHz)
12.5	8.5	8.25
20	14	13
25	16	17

d) The transmitter shall be modulated by a test signal of 1250 Hz at a level which is 20 dB higher than that required to produce 60 % of the maximum permissible deviation, subclause 4.1.4.1.

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 frequency of the "receiver" adjusted below the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in table 9.

7.6 Spurious emissions

7.6.1 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:

either,

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 r.f. connector.

7.6.2 Method of measuring the power level in a specified load, subclause 7.6.1 a

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

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, annex A, shall be tuned over the frequency range 9 kHz to 4 GHz for equipment operating on frequencies below 470 MHz, or in the frequency range of 9 kHz to 12.75 GHz for equipment operating on frequencies above 470 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 stand-by.

7.6.3 Method of measuring the effective radiated power, subclause 7.6.1 b

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

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

The transmitter antenna connector shall be connected to an artificial antenna, subclause 6.2.

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

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 30 MHz to 4 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

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

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

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

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

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

The test antenna shall be raised and lowered through the specified range of 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 polarisation.

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

The measurements shall be repeated with the transmitter on stand-by.

7.6.4 Method of measuring the effective radiated power, subclause 7.6.1 c

This measurement applies only to equipment without an external antenna connector.

The method of measurement shall be performed according to subclause 7.6.3, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

7.7 Intermodulation attenuation

This requirement applies only to transmitters to be used in base stations (fixed).

7.7.1 Definition

Intermodulation attenuation is the capability of a transmitter to avoid the generation of signals in the non-linear elements caused by the presence of the carrier and an interfering signal entering the transmitter via the antenna.

It is specified as the ratio, in dB, of the power level of the third order intermodulation product to the carrier power level.

7.7.2 Method of measurement

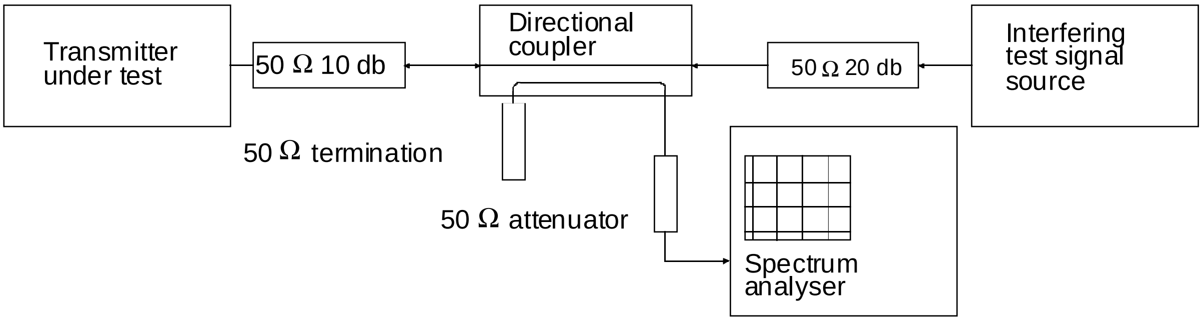


Figure 2: Measurement arrangement

The measurement arrangement shown in figure 2 shall be used.

The transmitter shall be connected to a 50 Ω 10 dB power attenuator and via a directional coupler to a spectrum analyser. An additional attenuator may be required between the directional coupler and the spectrum analyser to avoid overloading the spectrum analyser.

In order to reduce the influence of mismatch errors it is important that the 10 dB power attenuator is coupled to the transmitter under test with the shortest possible connection.

The interfering test signal source is connected to the other end of the directional coupler via a 50 Ω 20 dB power attenuator.

The interfering signal source may be a either a transmitter providing the same power output as the transmitter under test and be of a similar type or a signal generator and a linear power amplifier capable of delivering the same output power as the transmitter under test.

The directional coupler shall have an insertion loss of less than 1 dB, a sufficient bandwidth and a directivity of more than 20 dB.

The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation.

The transmitter under test shall be unmodulated and the spectrum analyser adjusted to give a maximum indication with a frequency scan width of 500 kHz.

The interfering test signal source shall be unmodulated and the frequency shall be within 50 kHz to 100 kHz above the frequency of the transmitter under test.

The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious components.

The power output of the interfering test signal source shall be adjusted to the carrier power level of the transmitter under test by the use of a power meter.

The intermodulation component shall be measured by direct observation on the spectrum analyser and the ratio of the largest third order intermodulation component to the carrier recorded.

This measurement shall be repeated with the interfering test signal source at a frequency within 50 kHz to 100 kHz below the frequency of the transmitter under test.

7.8 Transient frequency behaviour of the transmitter

7.8.1 Definitions

The transient frequency behaviour of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when the RF output power is switched on and off.

t_{on}: according to the method of measurement described in subclause 7.8.2 the switch-on instant ton of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0.1 % of the nominal power.

t_1: period of time starting at ton and finishing according to table 5, subclause 4.1.8.

t_2: period of time starting at the end of t1 and finishing according to table 5, subclause 4.1.8.

t_{off}: switch-off instant defined by the condition when the nominal power falls below 0.1 % of the nominal power.

t_3: period of time that finishing at t_{off} and starting according to table 5, subclause 4.1.8.

7.8.2 Method of measurement

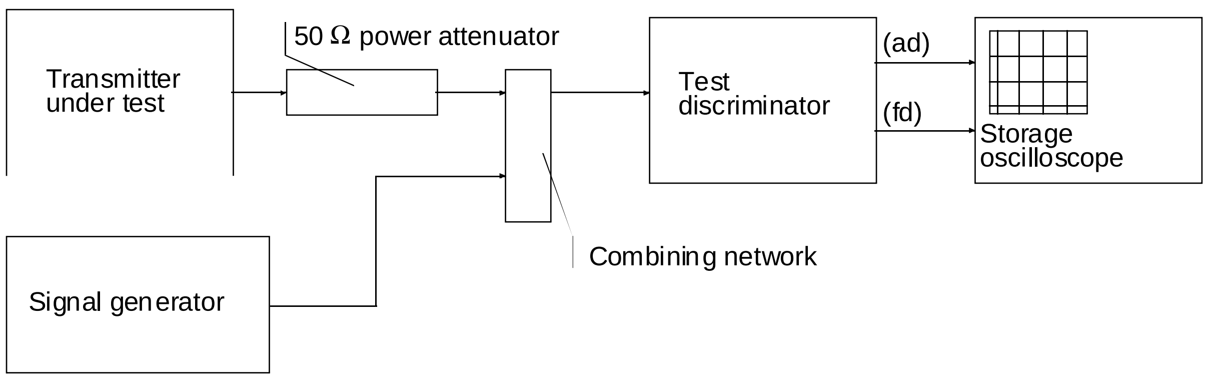


Figure 3: Measurement arrangement.

The measurement arrangement shown in figure 3 shall be used.

Two signals shall be connected to the test discriminator via a combining network, subclause 6.6.

The transmitter shall be connected to a 50 Ω power attenuator.

The output of the power attenuator shall be connected to the test discriminator via one input of the combining network.

A test signal generator shall be connected to the second input of the combining network.

The test signal shall be adjusted to the nominal frequency of the transmitter.

The test signal shall be modulated by a frequency of 1 kHz with a deviation equal to ± the value of the relevant channel separation.

The test signal level shall be adjusted to correspond to 0.1 % of the power of the transmitter under test measured at the input of the test discriminator. This level shall be maintained throughout the measurement.

The amplitude difference (ad) and the frequency difference (fd) output of the test discriminator shall be connected to a storage oscilloscope.

The storage oscilloscope shall be set to display the channel corresponding to the (fd) input up to ± 1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

The storage oscilloscope shall be set to a sweep rate of 10 ms/div and set so that the triggering occurs at 1 div from the left edge of the display.

The display will show the 1 kHz test signal continuously.

The storage oscilloscope shall then be set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

The transmitter shall then be switched on, without modulation, to produce the trigger pulse and a picture on the display.

The result of the change in the ratio of power between the test signal and the transmitter output will, due to the capture ratio of the test discriminator, produce two separate sides on the picture, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

The moment when the 1 kHz test signal is completely suppressed is considered to provide ton.

The periods of time t_1 and t_2 as defined in table 5, subclause 4.1.8, shall be used to define the appropriate template.

During the period of time t_1 and t_2 the frequency difference shall not exceed the values given in subclause 4.1.8.

The frequency difference, after the end of t_2, shall be within the limit of the frequency error, subclause 4.1.1.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

The storage oscilloscope shall be set to trigger on the channel corresponding to the amplitude difference (ad) input at a high input level, decaying and set so that the triggering occurs at 1 div. from the right edge of the display.

The transmitter shall then be switched off.

The moment when the 1 kHz test signal starts to rise is considered to provide t_{off}.

The period of time t_3 as defined in table 5, subclause 4.1.8, shall be used to define the appropriate template.

During the period of time t_3 the frequency difference shall not exceed the values given in subclause 4.1.8.

Before the start of t_3 the frequency difference shall be within the limit of the frequency error, subclause 4.1.1.

The result shall be recorded as frequency difference versus time.

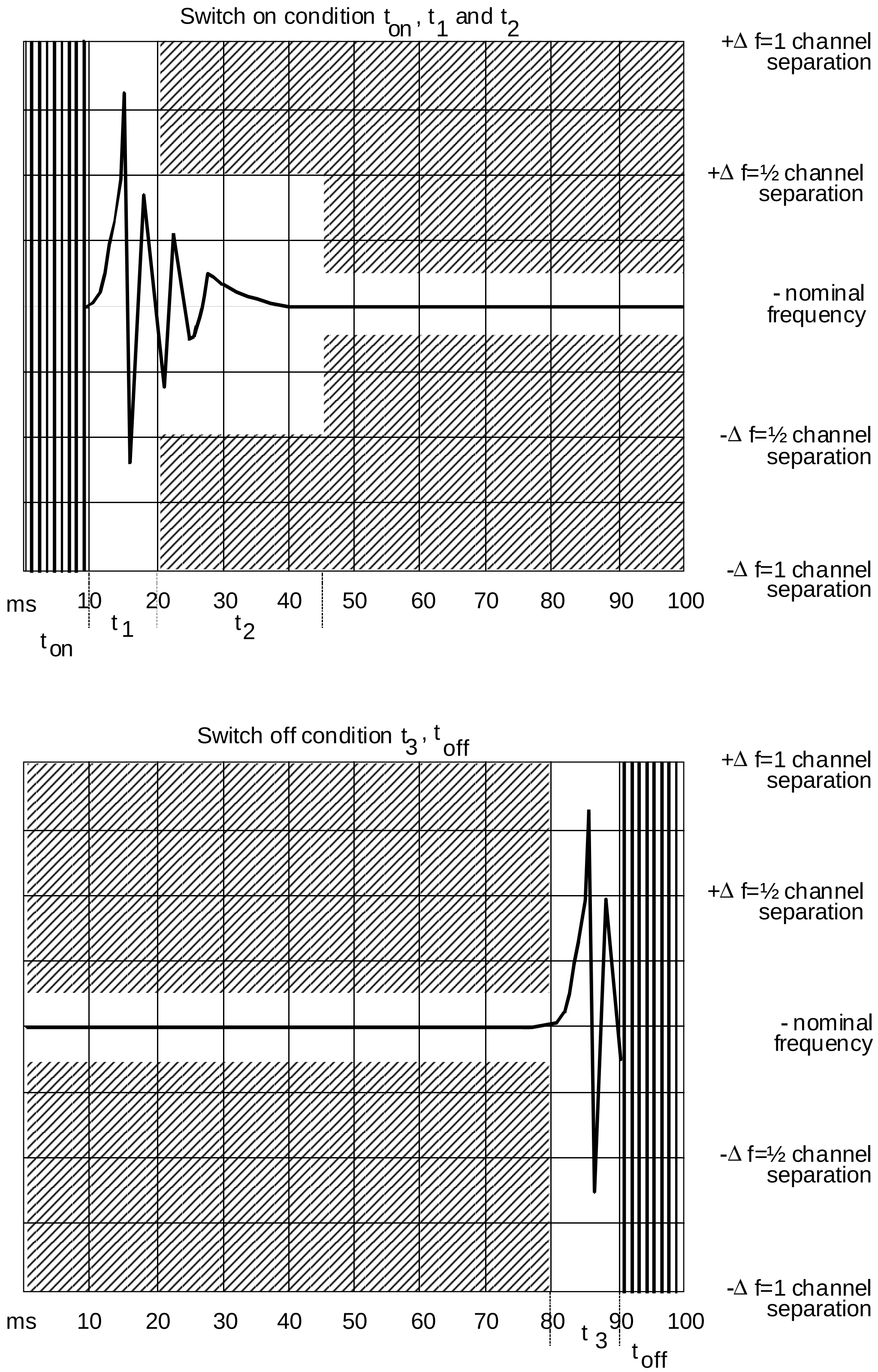


Figure 4: Storage oscilloscope view t1, t2 and t3

8 Methods of measurement for receiver parameters

8.1 Maximum usable sensitivity (conducted)

8.1.1 Definition

The maximum usable sensitivity (conducted) of the receiver is the minimum level of signal (e.m.f.) at the receiver input, at the nominal frequency of the receiver and with normal test modulation, subclause 6.1, which will produce:

- an audio frequency output power of at least 50 % of the rated power output, subclause 6.8, and

- a SND/ND ratio of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in CCITT Recommendation 0.41 Red Book 1984.

8.1.2 Method of measuring the SND/ND ratio

The test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector.

An audio frequency output load, a SINAD meter and a psophometric telephone weighting network as mentioned in subclause 8.1.1, shall be connected to the receiver output terminals.

Where possible, the receiver volume control shall be adjusted to give at least 50 % of the rated output power, subclause 6.8 or, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated 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.

The measurement shall be made under normal test conditions, subclause 5.3 and repeated under extreme test conditions, subclauses 5.4.1 and 5.4.2 applied simultaneously.

Under extreme test conditions, the receiver audio output power shall be within ± 3.0 dB of the value obtained under normal test condition.

8.2 Maximum usable sensitivity (field strength)

This method applies only to equipment without an external antenna connector.

8.2.1 Definition

The maximum usable sensitivity of the receiver is the minimum fieldstrength present at the location of the receiver, at the nominal frequency of the receiver and with normal test modulation, subclause 6.1, which will fulfil the requirements of subclause 8.1.1.

8.2.2 Method of measurement

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

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

The input of the test antenna shall be connected to a signal generator.

The signal generator shall be tuned to the frequency of the receiver under test and its output level shall be adjusted to 100 dBµV.

The signal generator shall be modulated with normal test modulation according to subclause 6.1.

An audio frequency output load, a SINAD meter and a psophometric telephone weighting network as mentioned in subclause 8.1.1 shall be coupled to the receiver loudspeaker/transducer via an acoustic measuring arrangement described in subclause A.2.6.

Where possible, the receiver volume control shall be adjusted to give at least 50 % of the rated output power, subclause 6.8, or, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power.

The test signal output level shall be reduced until the acoustic SND/ND ratio of 20 dB is obtained.

The test antenna shall be raised and lowered through the specified range of height to find the lowest level of the test signal, that produces an acoustic SND/ND ratio of 20 dB.

The receiver shall then be rotated through 360° in the horizontal plane, to find the lowest level of the test signal, that produces an acoustic SND/ND ratio of 20 dB.

The input signal level to the test antenna shall be maintained.

The receiver shall be replaced by a substitution antenna as defined in subclause A.2.3.

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

The substitution antenna shall be connected to a calibrated 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 signal level measured with the calibrated measuring receiver shall be recorded as the field strength in dBµV/m.

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

The measure of the maximum usable sensitivity expressed as field strength is the minimum of the two signal levels recorded as the input to the calibrated measuring receiver, corrected for the gain of the antenna if necessary.

8.3 Amplitude characteristic of the receiver

8.3.1 Definition

The amplitude characteristic of the receiver is the relationship between the radio frequency input level of a specified modulated signal and the audio frequency level at the receiver output.

8.3.2 Method of measurement

The test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector.

The audio output level shall be adjusted to approximately 25 % of the rated output power, subclause 6.8.

The audio output level shall be recorded.

The input signal shall be increased to an e.m.f. of 100 dBµV and the level of the audio output shall again be measured.

The audio output level shall be recorded.

The measure of the amplitude characteristics of the receiver is the ratio between the two obtained audio output levels recorded in dB.

8.4 Co-channel rejection

8.4.1 Definition

The co-channel rejection 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 at the nominal frequency of the receiver.

8.4.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, subclause 6.6.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, 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 the nominal frequency of the receiver, modulated with a frequency of 400 Hz at a deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1, 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 co-channel rejection 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 for displacements of the unwanted test signal of ± 1500 Hz and ± 3000 Hz.

The lowest value of the five measurement results noted shall be recorded as the co-channel rejection.

8.5 Adjacent channel selectivity

8.5.1 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.

8.5.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network subclause 6.6.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, 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 the frequency of one channel separation above the nominal frequency of the receiver, modulated with a frequency of 400 Hz at a deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1, 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.

The measurements shall be repeated under extreme test conditions, subclauses 5.4.1 and 5.4.2 applied simultaneously, with the amplitude of the wanted test signal adjusted to an e.m.f. of 12 dBμV.

8.6 Spurious response rejection

8.6.1 Definition

The spurious response rejection is the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

8.6.2 Introduction to the method of measurement

To determine the frequencies at which spurious responses can occur the following calculations shall be made:

a) calculation of the "limited frequency range".

The "limited frequency range" is equal to:

the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver ± the sum of the intermediate frequencies (if_1,...if_n) and a half the switching range (sr) of the receiver, clause 3.

Hence:

the "limited frequency range" = $f_{lo} \pm (if_1 + if_2 + ... + if_n + sr/2)$.

b) calculation of frequencies outside the "limited frequency range".

A calculation of the frequencies at which spurious responses can occur outside the range determined in (a) is made for the remainder of the frequency range of interest, as appropriate, subclause 8.6.2.2.

The frequencies outside the "limited frequency range" are equal to:

the harmonics of the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver ± the numeric value of the 1st intermediate frequency (if_1) of the receiver. Hence:

The frequencies of these spurious responses = $nf_{lo} \pm if_1$.

where 'n' is an integer greater than or equal to 2.

For the calculations (a) and (b) above the manufacturer shall state the frequency of the receiver, the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver, the intermediate frequencies (if_1, if_2 etc.) and the switching range (sr) of the receiver.

8.6.2.1 Method of search over the "limited frequency range"

The two input signals shall be connected to the receiver via a combining network, subclause 6.6.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, 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, modulated with a frequency of 400 Hz at a deviation of ± 5 kHz, at an e.m.f. of 86 dBµV, shall be applied to the receiver input connector via the second input of the combining network.

The frequency of the unwanted signal shall be varied incrementally over the "limited frequency range".

The incremental steps of the frequency of the unwanted signal shall be 5 kHz.

The frequency of any spurious response detected during the search shall be recorded for the use in measurements in accordance with subclause 8.6.2.2.

8.6.2.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, subclause 6.6.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, 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, modulated with a frequency of 400 Hz at a deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1, at an e.m.f. of 86 dBµV, shall be applied to the receiver input connector via the second input of the combining network.

The measurement shall be performed at all spurious response frequencies found during the search over the "limited frequency range", subclause 8.6.2.1, and at frequencies calculated for the remainder of the spurious response frequencies in the frequency range 100 kHz to 2 GHz for equipment operating on frequencies below 470 MHz, or in the frequency range of 100 kHz to 4 GHz for equipment operating on frequencies above 470 MHz.

At each frequency at which a spurious response occurs, the input level shall be adjusted until the SND/ND ratio, psophometrically weighted, is reduced to 14 dB.

The measure of the spurious response rejection 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.

The ratio shall be recorded as the spurious response rejection for each spurious response obtained.

8.7 Intermodulation response rejection

8.7.1 Definition

The intermodulation 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.

8.7.2 Method of measurement

Three input signals shall be connected to the receiver via a combining network, subclause 6.6.

The wanted test signal (A), at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, 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 (B), at the frequency 25 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 the frequency 50 kHz above the nominal frequency of the receiver, modulated with a frequency of 400 Hz at a deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1, shall be applied to the receiver input connector via the third input of the combining network.

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 intermodulation 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 measurement shall be repeated with the unwanted signal from signal generator (B) at a frequency 50 kHz above the wanted signal and with the unwanted signal from signal generator (C) at a frequency 100 kHz above the wanted signal.

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.

8.8 Blocking or desensitisation

8.8.1 Definition

Blocking is a change (generally a reduction) in the wanted audio output power of a receiver or a reduction of the SND/ND ratio due to an unwanted signal on another frequency.

8.8.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, subclause 6.6.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, subclause 6.1, at an e.m.f. of 6 dBµV, value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector via one input of the combining network.

Where possible, the receiver volume control shall be adjusted to give at least 50 % of the rated output power, subclause 6.8, or, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power.

The obtained audio output level shall be noted.

The unwanted test signal, at a frequency from 1 MHz to 10 MHz offset from the nominal frequency of the receiver, without modulation, shall be applied to the receiver input connector via the second input of the combining network.

For practical reasons the measurements will be carried out at frequencies of the unwanted signal at approximately ± 1 MHz, ± 2 MHz, ± 5 MHz and ± 10 MHz.

The amplitude of the unwanted test signal shall be adjusted until:

- a reduction of 3 dB in the audio output level of the wanted signal; or
- the SND/ND ratio, psophometrically weighted, at the output of the receiver is reduced to 14 dB,.

whichever occurs first. This level shall be noted.

The measure of the blocking or desensitisation 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 audio output level or in the SND/ND ratio occurs.

This ratio shall be recorded for each of the eight noted levels as the blocking or desensitisation.

8.9 Spurious radiations

8.9.1 Definition

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

The level of spurious radiations shall be measured by either;

a) 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.

8.9.2 Method of measuring the power level in a specified load, subclause 8.9.1.a

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

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 4 GHz for equipment operating on frequencies below 470 MHz, or in the frequency range of 9 kHz to 12.75 GHz for equipment operating on frequencies above 470 MHz.

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.

8.9.3 Method of measuring the effective radiated power, subclause 8.9.1.b

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

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

The receiver antenna connector shall be connected to an artificial antenna, subclause 6.2.

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

The output of the test antenna shall be connected to a measuring receiver.

The receiver shall be switched on and the measuring receiver shall be tuned over the frequency range 30 MHz to 4 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 subclause A.2.3.

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

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

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

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

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

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

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

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

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

8.9.4 Method of measuring the effective radiated power, subclause 8.9.1.c

This measurement applies only to equipment without an external antenna connector.

The method of measurement shall be performed according to subclause 8.9.3, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

9 Duplex operation

If the equipment is designed for duplex operation, when submitted for type testing it shall be fitted with a duplex filter and the following additional measurements shall be carried out to ensure satisfactory duplex operation.

9.1 Receiver desensitisation with simultaneous transmission and reception

9.1.1 Definition

The receiver desensitisation 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 (the attenuated power from the transmitter).

9.1.2 Method of measurement when the equipment operates with a duplex filter

The antenna connector shall be connected to a 50 Ω power attenuator, through a coupling device.

The test signal, with normal test modulation, subclause 6.1, shall be connected to the coupling device in such a way as not to affect the impedance matching.

The transmitter shall be operated at the rated output power as defined in subclause 7.2.

The transmitter shall be modulated by a frequency of 400 Hz with a frequency deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1.

The receiver sensitivity shall be measured in accordance with subclause 8.1.

The output level of the signal generator shall be recorded as C in dBµV.

The transmitter shall be switched off and the receiver sensitivity measured.

The output level of the signal generator shall be recorded as D in dBµV.

The desensitisation is the difference between the values of C and D.

9.1.3 Measuring method when the equipment operates with two antennas

The transmitter shall be connected to an artificial antenna, subclause 6.2.

The output of the artificial antenna shall be connected to the receiver input through a coupling device.

The attenuation between transmitter and receiver shall be 30 dB.

The test signal, with normal test modulation, subclause 6.1, shall be connected to the coupling device in such a way as not to affect the impedance matching.

The transmitter shall be operated at the rated output power as defined in subclause 7.2.

The transmitter shall be modulated by a frequency of 400 Hz with a frequency deviation of 60 % of the maximum permissible frequency deviation, subclause 4.1.4.1.

The receiver sensitivity shall be measured in accordance with subclause 8.1.

The output level of the signal generator shall be recorded as C in dBµV.

The transmitter shall be switched off and the receiver sensitivity measured.

The output level of the signal generator shall be recorded as D in dBµV.

The desensitisation is the difference between the values of C and D.

9.2 Receiver spurious response rejection

The receiver spurious response rejection is measured as specified in subclause 8.6 with the equipment arrangement described in subclause 9.1.2 or 9.1.3, except that the transmitter shall be unmodulated.

The transmitter shall be operated at the rated output power as defined in subclause 7.2.

10 Measurement uncertainty

Table 10: Absolute measurement uncertainties: maximum values

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

RF frequency	$< \pm 1x10^{-7}$
RF power	< ± 0.75 dB
Maximum frequency deviation:	
- within 300 Hz to 6 kHz of audio frequency	< ± 5 %
- within 6 kHz to 25 kHz of audio frequency	< ± 3 dB
Deviation limitation	< ± 5 %
Adjacent channel power	< ± 5 dB
Conducted emission of transmitter	< ± 4 dB
Conducted emission of transmitter, valid to 12.75 GHz	< ± 7 dB
Audio output power	< ± 0.5 dB
Amplitude characteristic of receiver limiter	< ± 1.5 dB
Sensitivity at 20 dB SINAD	< ± 3 dB
Conducted emission of receiver	< ± 3 dB
Conducted emission of receiver, valid to 12.75 GHz	< ± 6 dB
Two-signal measurement, valid to 4 GHz	< ± 4 dB
Three-signal measurement	< ± 3 dB
Radiated emission of transmitter, valid to 4 GHz	< ± 6 dB
Radiated emission of receiver, valid to 4 GHz	< ± 6 dB
Transmitter transient time	< ± 20 %
Transmitter transient frequency	< ± 250 Hz
Transmitter intermodulation	< ± 3 dB
Receiver desentisation (duplex operation)	< ± 0.5 dB

For the test methods according to this standard these uncertainty figures are valid to a confidence level of 95 % calculated according to the methods to be described in a future ETSI technical report on **Guidelines for estimating uncertainties in measuring methods.**

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. 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.

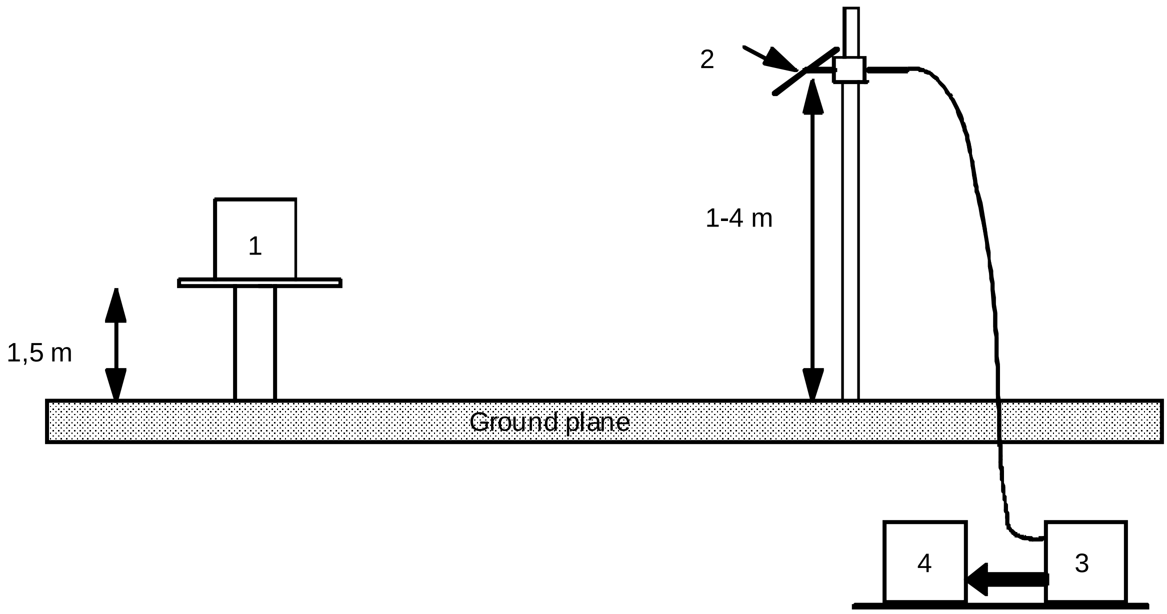


Figure A.1

Key:

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

A.1.2 Test antenna

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

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1 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. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 and 4 GHz either a lambda/2 dipole or a horn radiator may be used. 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 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 be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

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

A.1.4 Optional additional indoor site

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

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2.7 m in height.

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

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarised measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarised measurements. For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed. For practical reasons, the 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 lambda 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 ± 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.

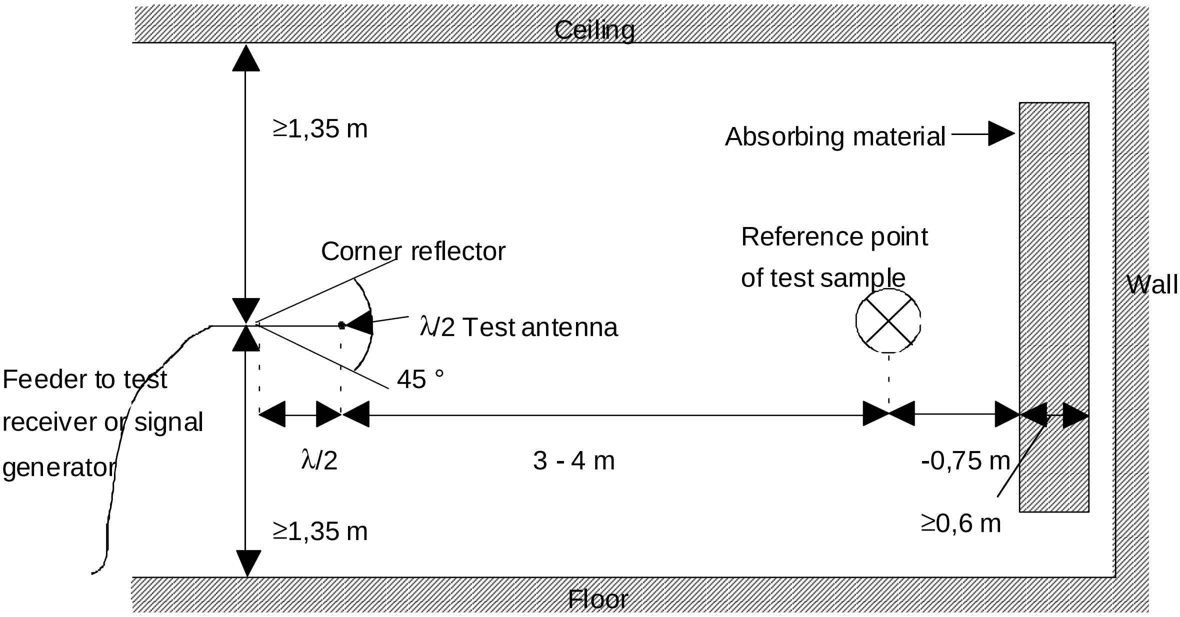


Figure A.2: Indoor site arrangement (shown for horizontal polarisation)

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 subclause A.1 of this annex. 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, 5, 10 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 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.2.6 Acoustic measuring arrangement

When carrying out measurements of the maximum usable sensitivity (radiated) of the receiver, the audio output shall be monitored by acoustically coupling the audio signal from the receiver loudspeaker/transducer to the test microphone. On the radiation test site all conducting materials shall be placed below the ground surface and the acoustic signal is conveyed from the receiver to the test microphone in a non-conducting acoustic pipe.

The acoustic pipe shall have an appropriate length. The acoustic pipe shall have an inner diameter of 6 mm and a wall thickness of 1.5 mm. A plastic funnel of a diameter corresponding to the receiver loudspeaker/transducer shall be attached to the receiver surface centred in front of the receiver loudspeaker/transducer. The plastic funnel shall be very soft at the attachment point to the receiver in order to avoid mechanical resonance. The narrow end of the plastic funnel shall be connected to the one end of the acoustic pipe and the test microphone to the other.

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

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

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

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high.

Walls and ceiling should be coated with RF absorbers of 1 m height.

The base should be covered with absorbing material 1 m thick, and a wooden floor, able to carry test equipment and operators.

A measuring distance of 3 to 5 m in the long middle axis of the chamber can be used for measurements up to 12.75 GHz.

The construction of the anechoic chamber is described in the following subclauses.

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 2 lambda.

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 m^3 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=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 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 subclause A.3 at low frequencies up to 100 MHz there are no far field conditions, and therefore reflections are stronger so that careful calibration is necessary.

In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well.

In the frequency range of 1 to 12.75 GHz, because more reflections will occur, the dependence of the field strength on the distance will not correlate so closely.

A.3.3 Calibration of the shielded anechoic chamber

Careful calibration of the chamber shall be performed over the range 30 MHz to 12.75 GHz.

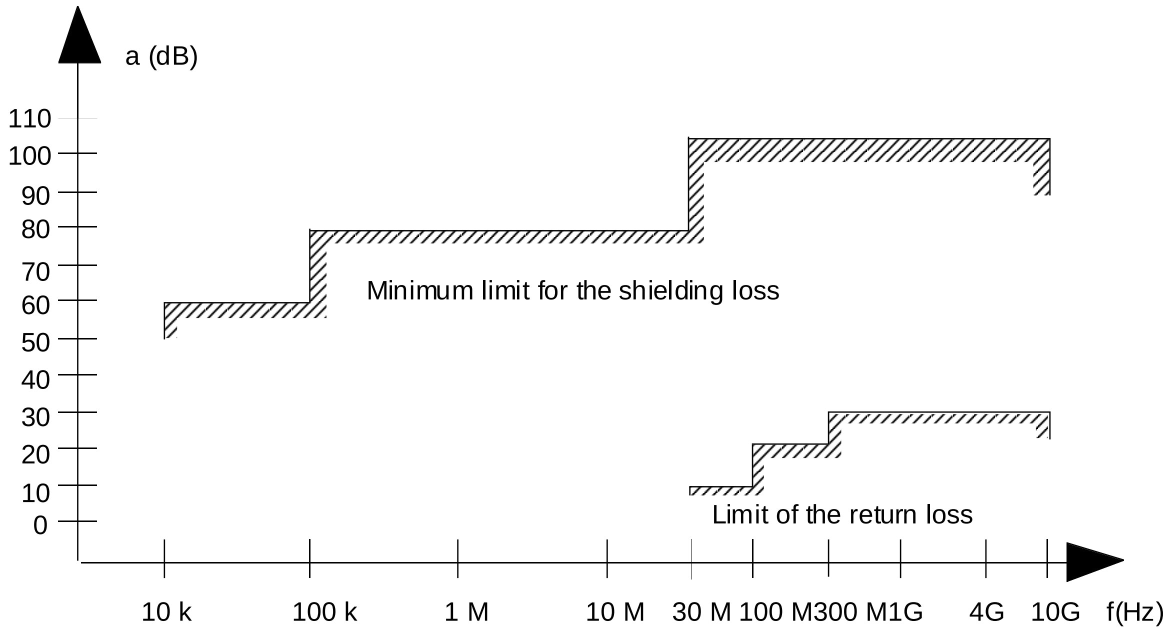


Figure A.3: Specifications for shielding and reflections

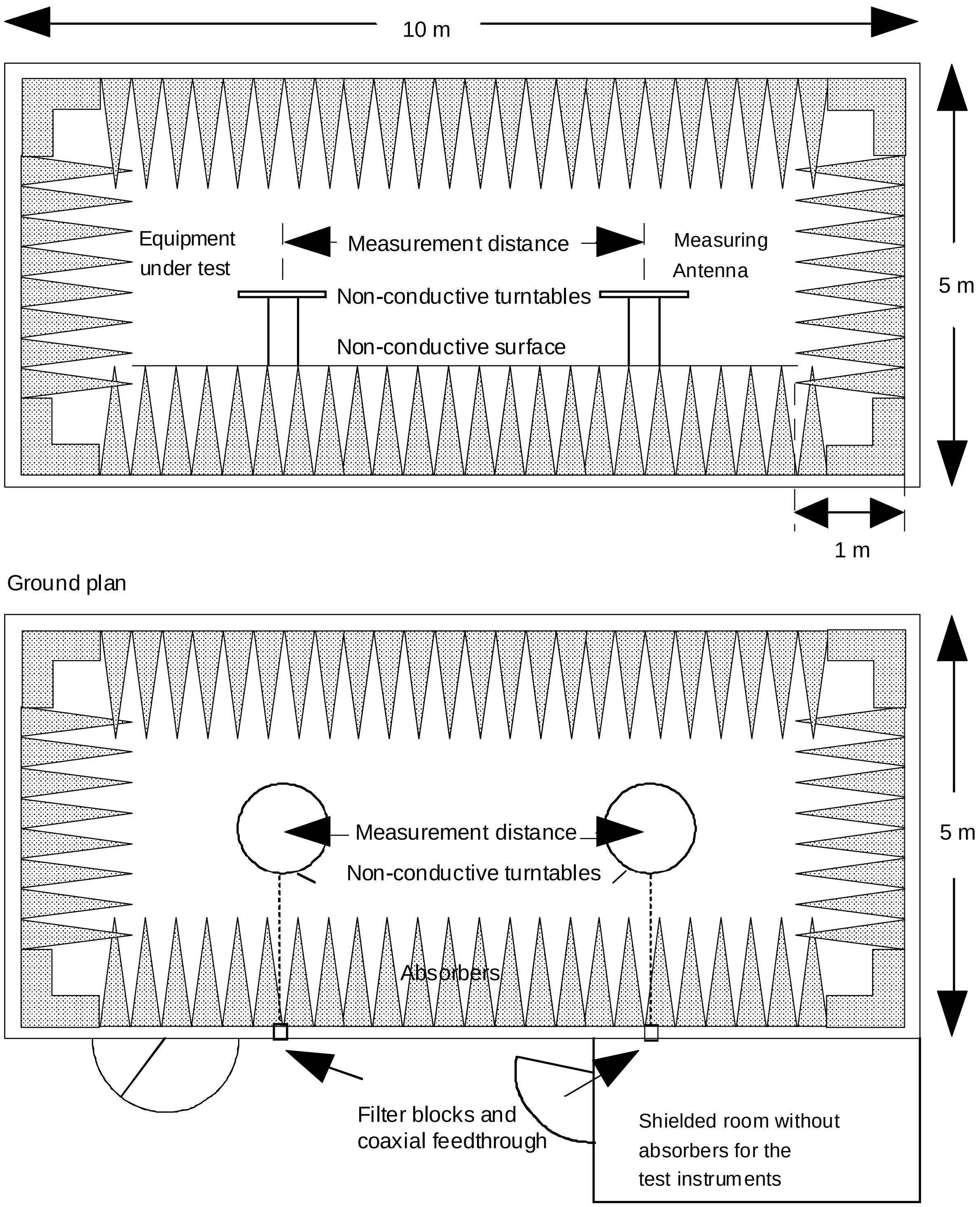


Figure A.4: Example of construction of an anechoic shielded chamber

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

B.1 Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF filter, and 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 subclause B.1.1 to B.1.4.

B.1.1 IF filter

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

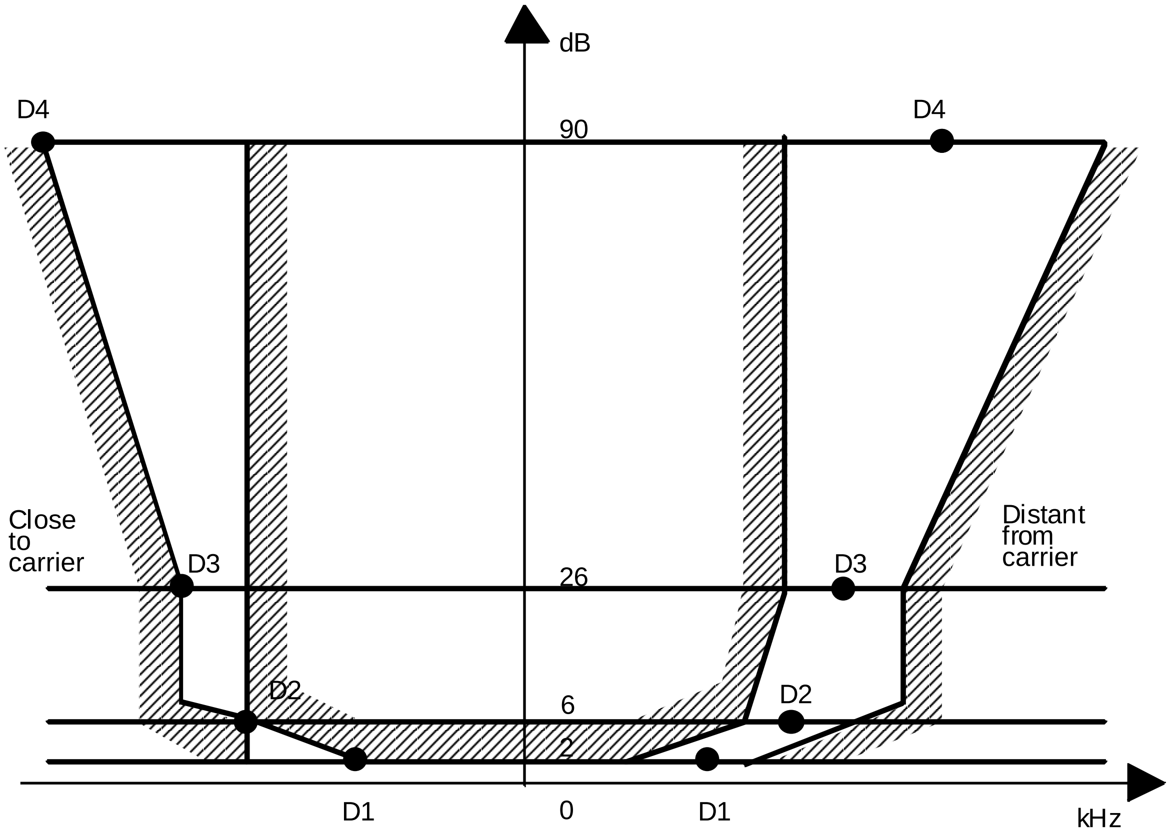


Figure B.1

Depending on the channel separation, the selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel:

Table B.1: Selectivity characteristic

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	3	4.25	5.5	9.5
20	4	7.0	8.25	12.25
25	5	8.0	9.25	13.25

Depending on the channel separation, the attenuation points shall not exceed the tolerances given in table B.2 and table B.3

Table B.2: Attenuation points close to carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.5	+ 1.35	± 0.1	- 1.35	- 5.35
20	+ 3.1	± 0.1	- 1.35	- 5.35
25	+ 3.1	± 0.1	- 1.35	- 5.35

Table B.3: Attenuation points distant from the carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.5	± 2.0	± 2.0	± 2.0	+ 2.0 - 6.0
20	± 3.0	± 3.0	± 3.0	+ 3.0 - 7.0
25	± 3.5	± 3.5	± 3.5	+ 3.5 - 7.5

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

Table B.4: Frequency displacement

Channel separation (kHz)	Specified necessary bandwidth (kHz)	Displacement from the -6 dB point (kHz)
12.5	8.5	8.25
20	14	13
25	16	17

The tuning of the power measuring receiver shall be adjusted away from the carrier so that the - 6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in table B.4.

B.1.2 Variable attenuator

The variable attenuator shall have a minimum range of 80 dB and a resolution of 1 dB.

B.1.3 Rms value indicator

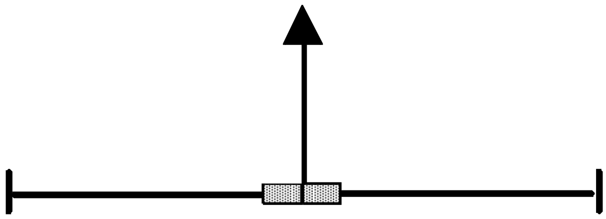
The instrument shall accurately indicate non-sinusoidal signals in a ratio of up to 10:1 between peak value and rms value.

B.1.4 Oscillator and amplifier

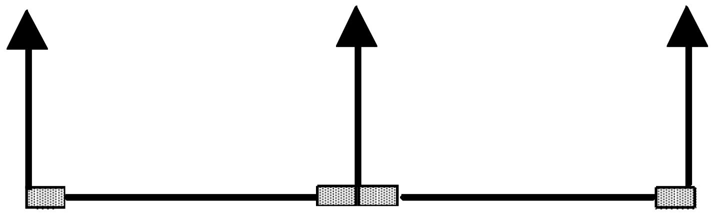
The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ - 90 dB for channel separations of 20 and 25 kHz and of ≤ - 80 dB for a channel separation of 12.5 kHz, referred to the carrier of the oscillator.

Annex C: Graphic representation of the selection of equipment and frequencies for testing of single and multi channel equipment

SINGLE CHANNEL EQUIPMENT

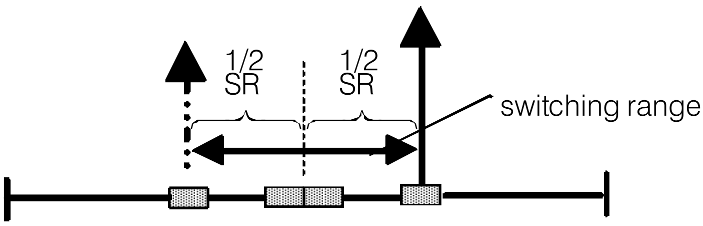


Equipment of category AR1 see subclause 3.1.5

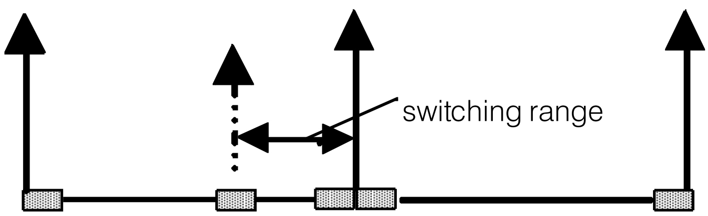


Equipment of category AR2 see subclause 3.1.6

TWO CHANNEL EQUIPMENT

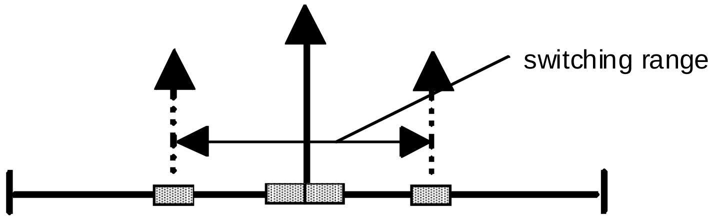


Equipment of category AR1 see subclause 3.1.7

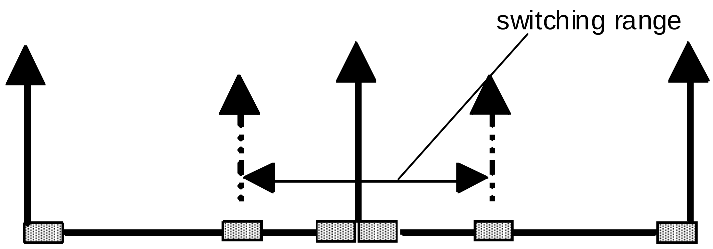


Equipment of category AR2 see subclause 3.1.8

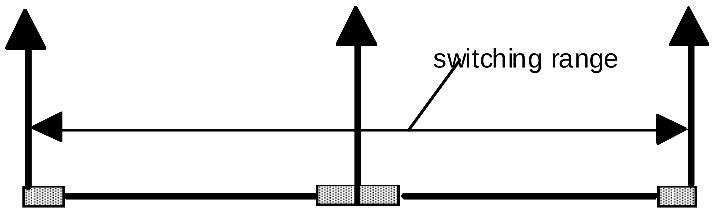
MULTI CHANNEL EQUIPMENT



Equipment of category AR1 see subclause 3.1.9



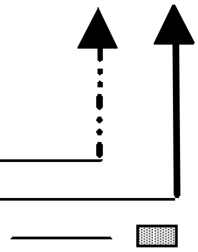
Equipment of category AR2 see subclause 3.1.10



Equipment of category AR2 see subclause 3.1.11
AR = SR

Legend:

AR1 - First category of alignment range, see subclause 3.1.3.
AR2 - Second category of alignment range, see subclause 3.1.3.
Limited test, see subclause 2.1.
Full test, see subclause 2.1.
100 kHz range in which the test shall be carried out.



History

Document history	
January 1991	First Edition
March 1996	Converted into Adobe Acrobat Portable Document Format (PDF)