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Radio Equipment and Systems (RES); Land mobile service Technical characteristics and test conditions for radio equipment transmitting signals to initiate a specific response in the receiver

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

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Foreword

This Interim European Telecommunication Standard (I-ETS) has been prepared by the Radio Equipment and Systems (RES) Technical Committee, and having passed through the Voting phase of the ETSI standards approval procedure, is now published.

This I-ETS is based upon CEPT Recommendation T/R 24-01 Annex V [1].

For combined speech/non-speech equipment this I-ETS is complementary to ETS 300 086 [2], which covers radio equipment for use in the land mobile service intended primarily for analogue speech. Limits stated in this I-ETS are in line with ETS 300 086 [2]. However it is anticipated that figures for limits for receiver sensitivity (field strength) will be revised.

Angle modulation with constant envelope should be used for radio equipment covered by this I-ETS.

Channel separations, temperature range, maximum transmitter output power/effective radiated power and the type and characteristics of modulation, class of transmitter intermodulation attenuation and the inclusion of automatic transmitter shut-off facility may be conditions required for the issue of a licence by the appropriate regulatory authority.

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

It should be noted that radio equipment for data is covered by I-ETS 300 113 [3].

This I-ETS 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 contains normative specifications and 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 5.1, referring to the presentation of equipment for testing purposes.

The means of system identification for non-speech equipment, or the non-speech part of combined speech/non-speech equipment, should be approved by the appropriate national regulatory authority.

Introduction

This I-ETS 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 6 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 5.3.

This I-ETS 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 I-ETS contains instructions for the presentation of equipment for type testing purposes (Clause 5), conditions (Clauses 7 and 8) and measurement methods (Clauses 9 and 10).

This I-ETS 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 should be tested in accordance with the methods of measurement specified in this I-ETS.

This I-ETS 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 should be provided by the manufacturer.

Details of the means used during type testing should be recorded by the accredited test laboratory in the test report (see subclause 5.1.12).

1 Scope

This I-ETS 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 non-speech and to the non-speech part of combined speech/non-speech constant envelope angle modulated equipment for use in the land mobile service operating on radio frequencies between 30 MHz and 1 000 MHz, with channel separations of 12,5 kHz, 20 kHz and 25 kHz.

In this I-ETS, a non-speech radio equipment is defined as a radio equipment transmitting a signal to initiate a specific response in the receiver. The equipment shall comprise of a transmitter and associated encoder and/or a receiver and associated decoder. The encoder and/or decoder may be a separate piece of equipment, in which case compliance to this I-ETS covers the encoder and/or decoder in connection with the transmitter and/or receiver equipment.

In this I-ETS 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 I-ETS 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 RF 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:

- subclause 9.3: Transmitter effective radiated power;
- subclause 9.5.4: Transmitter radiated spurious emissions;
- subclause 10.3: Receiver maximum usable sensitivity (response, field strength);
- subclause 10.9.4: Receiver radiated spurious radiations.

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 I-ETS.

In the case of combined speech/non-speech equipment the speech part shall be tested to ETS 300 086 [2] and additionally the tests described in the following subclauses of this I-ETS shall be carried out:

- subclause 9.4: Adjacent channel power;
- subclause 10.2: Maximum usable sensitivity (responses,conducted);
- subclause 10.3: Maximum usable sensitivity (responses, field strength).

These requirements also apply for equipment with an analogue output facility provided for test purposes only.

Where an equipment has already been type approved to ETS 300 086 [2], and is resubmitted for type testing to this I-ETS, additionally the tests described in the following subclauses of this I-ETS shall be carried out:

- subclause 9.4: Adjacent channel power;

- subclause 10.2: Maximum usable sensitivity (responses, conducted);
- subclause 10.3: Maximum usable sensitivity (responses, field strength);
- subclause 9.5: Spurious emissions.

2 Normative references

This I-ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this I-ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] CEPT Recommendation T/R 24-O1 Annex V: "Technical characteristics and test conditions for non-speech and combined speech/non-speech radio equipment (using signalling to initiate a specific response in the receiver) in the land mobile service".

[2] ETS 300 086: "Radio Equipment and Systems; Land mobile group; Technical characteristics and test conditions for radio equipment with an internal or external RF connector intended primarily for analogue speech".

[3] I-ETS 300 113: "Radio Equipment and Systems; Land mobile service; Technical characteristics and test conditions for non-speech and combined analogue speech/non-speech equipment with an internal or external antenna connector, intended for the transmission of data".

[4] ETR 028: "Radio Equipment and Systems; Uncertainties in the measurement of mobile radio equipment characteristics".

3 Definitions

For the purposes of this I-ETS, the following definitions apply:

Angle modulation: either phase modulation or frequency modulation.

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

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

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

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.

Limited tests: the limited tests, referred to in subclauses 5.1 to 5.1.10, are as follows:

- Transmitter frequency error, subclause 9.1;

- Transmitter carrier power (conducted), subclause 9.2;

- Transmitter effective radiated power, subclause 9.3, integral antenna equipment only;

- Transmitter adjacent channel power, subclause 9.4;

- Receiver maximum usable sensitivity (responses, conducted), subclause 10.2;

- Receiver maximum usable sensitivity (responses, field strength), subclause 10.3, integral antenna equipment only;

- Receiver adjacent channel selectivity, subclause 10.5.

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.

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

4 Symbols and abbreviations

The following symbols and abbreviations are used within this I-ETS.

AR1	(see subclause 5.1.3)
AR2	(see subclause 5.1.3)
emf	electro-motive force
Eo	Reference field strength (see Annex A)
IF	Intermediate Frequency
RF	Radio Frequency
Ro	Reference distance (see Annex A)
Rx	Receiver
Tx	Transmitter

5 General

5.1 Presentation of equipment for testing purposes

Each equipment submitted for type testing shall fulfil the requirements of this I-ETS 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 I-ETS, on samples of equipment defined in subclauses 5.1.1 to 5.1.12.

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

5.1.1 Choice of model for type testing

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 5.1.12.

5.1.2 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.

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

The alignment range falls into one of two categories.

a) 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.

b) 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.

5.1.4 Choice of frequencies

The frequencies for testing shall be chosen by the manufacturer in consultation with the appropriate authority, in accordance with subclauses 5.1.5 to 5.1.11 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.

5.1.5 Testing of single channel equipment of category AR1

In the case of single channel 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.

5.1.6 Testing of single channel equipment of category AR2

In the case of single channel 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.

5.1.7 Testing of two channel equipment of category AR1

In the case of two channel 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 (see Clause 3) on the lower channel.

5.1.8 Testing of two channel equipment of category AR2

In the case of two channel 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 (see Clause 3) 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.

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

In the case of multi channel 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 (see Clause 3) shall be carried out within 100 kHz of the lowest and also within 100 kHz of the highest frequency of the switching range.

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

In the case of multi channel equipment of the category AR2, with switching range less than the alignment range 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 (see Clause 3) 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.

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

In the case of multi channel equipment of the category AR2, with switching range equal to the alignment range 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.

5.1.12 Testing of equipment without an external 50 Ω RF connector

5.1.12.1 Equipment with an internal permanent or temporary antenna connector

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated by the 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.

5.1.12.2 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.

5.2 Mechanical and electrical design

5.2.1 General

The equipment submitted for type testing 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.

5.2.2 Controls

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

The power adjustment control, if fitted, shall not be accessible to the user.

5.2.3 Transmitter shut-off facility (time-out)

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.

5.2.4 Labelling

The equipment shall be marked in a visible place.

This marking shall be legible, tamperproof and durable.

As a minimum 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).

5.3 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in this I-ETS shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of this I-ETS;

- 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 Clause 12 (table of measurement uncertainty).

6 Technical characteristics

This Clause contains the limit values for the Transmitter (Tx) and Receiver (Rx) measurement parameters defined in Clauses 9 and 10.

6.1 Transmitter parameter limits

6.1.1 Frequency error

For the definition and the measuring method see subclause 9.1.

If an unmodulated carrier cannot be obtained, the adjacent channel power shall also be measured under extreme test conditions and the limits given in subclause 6.1.4 shall be met.

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 defined in subclause 9.1.

Table 1: Frequency error

Channel separation (kHz)	Frequency error limits (kHz)				
	< 47 MHz	47 MHz to 137 MHz	> 137 to 300 MHz	> 300 to 500 MHz	> 500 to 1 000 MHz
20 and 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

KEY:

B: Base station

M: Mobile or handportable station

a: For handportable stations having integral power supplies, the figures given in the table with the suffix (a) only apply to the limited temperature range 0°C to +30°C. However for the full extreme temperature conditions (subclause 7.4.1), exceeding the limited temperature range, the following frequency error limits apply:

±2,50 kHz between 300 MHz and 500 MHz;
±3,00 kHz between 500 MHz and 1 000 MHz.

6.1.2 Carrier power (conducted)

For the definition and the measuring method see subclause 9.2.

The carrier output power (conducted) under normal test conditions shall be within ± 1,5 dB of the rated output power.

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

The carrier output power (conducted) under extreme test conditions shall be within + 2,0 dB and - 3,0 dB of the rated output power.

6.1.3 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 9.3.

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 appropriate regulatory authority.

The measurement shall be carried out under normal test conditions only (see Clause 7).

6.1.4 Adjacent channel power

For the definition and the measuring method see subclause 9.4.

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.

In the case where the equipment is not capable of producing an unmodulated carrier these measurements shall also be performed under extreme test conditions. Under these extreme test conditions the measured adjacent channel power shall not exceed a value of 65 dB below the carrier for equipment with channel separations of 20 and 25 kHz and 55 dB for channel separations of 12,5 kHz, without the need to be below 0,20 µW.

6.1.5 Spurious emissions

For the definition and the measuring method see subclause 9.5.

The power of any spurious emission shall not exceed the values given in tables 2 and 3.

Table 2: Conducted emissions

Frequency range	9 kHz to 1 GHz	> 1 to 4 GHz, or > 1 to 12,75 GHz, see subclause 9.5.2.
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 3: Radiated emissions

Frequency range	30 MHz to 1 GHz	> 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 antenna (see subclause 8.2) shall be connected to the socket for the test.

6.1.6 Intermodulation attenuation

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

For the definition and the measurement method see subclause 9.6.

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

- the intermodulation attenuation ratio shall be ≥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 ≥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.

6.1.7 Transient frequency behaviour of the transmitter

For the definition and the measurement method see subclause 9.7.

The transient periods are given in table 4. The transient periods for the frequency range >300 to 500 MHz are shown as an example in figure 3, subclause 9.7.

Table 4: Transient periods

	30 to 300 MHz	> 300 to 500 MHz	>500 to 1 000 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 equipment where an unmodulated carrier cannot be obtained, an extra ½ channel separation will be accepted for the limit of the peak frequency difference.

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 the value of one channel separation. The corresponding plot of frequency versus time during t1 and t3 shall be recorded in the test report.

6.2 Receiver parameter limits

The majority of the receiver measurements are based on the message acceptance method ("up-down method").

6.2.1 Reference sensitivity (response)

For the definition see subclause 10.1.

The reference sensitivity (response) for normal test conditions is a level of + 6 dBµV emf or a field strength 3dB above the values in table 5.

6.2.2 Maximum usable sensitivity (response, conducted)

For the definition and the measurement method see subclause 10.2.

The maximum usable sensitivity shall not exceed an emf of + 3 dBµV under normal test conditions, and an emf of +9 dBµV under extreme test conditions.

6.2.3 Maximum usable sensitivity (response, field strength)

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

For the definition and the measurement method see subclause 10.3.

The maximum usable sensitivity shall not exceed the field strength value shown in table 5.

Table 5: Sensitivity limits

Frequency band MHz	Field strength in dB relative to 1 µV/m (Normal test conditions)
30 to 100	11,0
> 100 to 230	17,0
> 230 to 470	23,0
> 470 to 1 000	29,0

6.2.4 Co-channel rejection

For the definition and the measurement method see subclause 10.4.

The value of the co-channel rejection ratio, expressed in dB, at the signal displacements given in the method of measurement shall be:

- between - 8,0 dB and 0dB for channel separations of 20 kHz and 25 kHz;

- between - 12,0 dB and 0dB for channel separation of 12,5 kHz.

Any positive value is also accepted.

6.2.5 Adjacent channel selectivity

For the definition and the measurement method see subclause 10.5.

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.

6.2.6 Spurious response rejection

For the definition and the measurement method see subclause 10.6.

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.

6.2.7 Intermodulation response rejection

For the definition and the measurement method see subclause 10.7.

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.

6.2.8 Blocking or desensitisation

For the definition and the measurement method see subclause 10.8.

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 (see subclause 10.6).

6.2.9 Spurious radiations

For the definition and the measurement method see subclause 10.9.

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

Table 6: Conducted components

Frequency range	9 kHz to 1 GHz	> 1 to 4 GHz, or > 1 to 12,75 GHz, see subclause 10.9.2.
Limit	2,0 nW (- 57,0dBm)	20,0 nW (- 47,0 dBm)

Table 7: Radiated components

Frequency range	30 MHz to 1 GHz	> 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 antenna (see subclause 8.2) shall be connected to the socket for the test.

6.3 Duplex operation - receiver limits

6.3.1 Receiver desensitisation and maximum usable sensitivity (with simultaneous transmission and reception)

For the definition and the measurement method see subclause 11.1.

The desensitisation shall not exceed 3,0 dB, and the limit of maximum usable sensitivity under normal test conditions, subclause 6.2.2, shall be met.

6.3.2 Receiver spurious response rejection

For the definition and the measurement method see subclause 11.2.

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.

7 Test conditions, power sources and ambient temperatures

7.1 Normal and extreme test conditions

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

7.2 Test power source

During type 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 7.3.2 and 7.4.2. 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.

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

During the tests the power source voltages shall be maintained within a tolerance of < ± 1 % 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.

7.3 Normal test conditions

7.3.1 Normal temperature and humidity

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

- temperature + 15 ^{o}C to + 35 ^{o}C;

- relative humidity: 20 % to 75 %.

When it is impracticable to carry out the tests under these conditions, the ambient temperature and relative humidity during the tests shall be stated in the test report.

7.3.2 Normal test power source

7.3.2.1 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 I-ETS, 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.

7.3.2.2 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 x the nominal voltage of the battery (6 V, 12 V etc.).

7.3.2.3 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.

7.4 Extreme test conditions

7.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in subclause 7.5, at the upper and lower temperatures of one of the following ranges:

- - 25 ^{o}C to + 55 ^{o}C;

- - 15 ^{o}C to + 55 ^{o}C;

- - 10 °C to + 55 °C.

For the purpose of subclause 6.1.1 an additional extreme temperature range of 0 °C to + 30 °C shall be used.

Type testing reports shall state which range is used.

7.4.2 Extreme test source voltages

7.4.2.1 Mains voltage

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

7.4.2.2 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 x the nominal voltage of the battery (6 V, 12 V, etc.).

7.4.2.3 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 x the nominal voltage of the battery;

- for the mercury or nickel-cadmium type of battery: 0,9 x the nominal voltage of the battery.

No upper extreme test voltages apply.

7.4.2.4 Other power sources

For equipment using other power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the test laboratory and shall be recorded in the test report.

7.4.2.5 Variety of power sources

For equipment capable of operation from a variety of power sources, the extreme test voltages shall correspond to those of the sources referred to in subclauses 7.4.2.1, 7.4.2.2 and 7.4.2.3, if appropriate.

7.5 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 test laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

7.5.1 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.

7.5.2 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.

8 General conditions

8.1 Normal test signals, test conditions and the unwanted test signals

The normal test signal D-M3 for initiating responses shall be trains of correctly coded bits or correctly coded signals (messages), if possible of length 22 bits. For sequential tone coded information, each information (eg selective call) shall not be longer than about 400 ms. These test signals D-M3 shall be separated from each other by a time of not less than the reset time of the receiver.

For measurements using the up-down method it must be possible to trigger single test signals D-M3 either manually or by an automatic testing system.

The test signal D-M4 consists of coded signals, messages or tones transmitted sequentially, one by one, without gaps between them. This transmission is necessary for measurements such as adjacent channel power (subclauses 6.1.4 and 9.4), spurious emissions (subclauses 6.1.5 and 9.5), radiated emissions and others.

All these signals shall be defined such that they require the greatest occupied radio modulation bandwidth. Details of these test signals and the test modulation shall be included in the test report.

The unwanted signal A-M3 is a RF signal modulated with a continuous 400 Hz tone and with a deviation of 12 % of the channel separation. it is used for measurements such as co-channel rejection (subclauses 6.2.4 and 10.4), adjacent channel selectivity (subclauses 6.2.5 and 10.5) and others.

The normal analogue test signal A-M1 is a RF signal modulated with a continuous 1 000 Hz tone and with a deviation of 12 % of the channel separation. It is necessary for measurements such as the search for the minimum of the field strength (subclause 10.3.3).

8.2 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.

8.3 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.

8.4 Transmitter automatic shut-off facility (Time-out)

If the equipment is fitted with an automatic transmitter shut-off facility, it shall be made inoperative for the duration of the type test. The operation of the equipment shall not exceed the manufacturers stated duty cycle.

8.5 Modes of operation of the transmitter

For the purpose of the measurements according to this I-ETS, there should preferably be a facility to operate the transmitter in an unmodulated state. The method of achieving an unmodulated carrier frequency, or, special types of modulation patterns, may also be decided by agreement between the manufacturer and the test laboratory. It shall be described in the test report. It may involve suitable temporary internal modifications of the equipment under test.

8.6 Arrangements for test signals at the input of the receiver

Test signal sources which are applied to the receiver shall present an impedance of 50 Ω to the receiver input. This requirement shall be met irrespective of 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 emf at the receiver input connector.

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

8.7 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.

8.8 Encoder for receiver measurements

To facilitate measurements on the receiver, an encoder for the signalling system should accompany the model submitted, complete with details of the normal modulation process. The encoder shall be used to modulate a signal generator for use as a test signal source.

If possible, the encoder should be capable of operation in a repetitive mode, with intervals between each code that are not less than the reset time.

Complete details of all codes and code format(s) shall be given.

Details concerning the interconnection of the encoder and the signal generator shall be agreed between the manufacturer and the test laboratory.

8.9 Facilities for access between the receiver demodulator output and its decoder

When possible, in order to simplify the measurement in subclauses 10.3 and 10.6 a temporary access between the receiver demodulator output and its decoder input shall be provided for the equipment to be tested.

By that means the measurements in subclauses 10.3 and 10.6 can be more efficiently carried out using the methods of measurement of ETS 300 086 [2] (see subclauses 8.2 and 8.6) to determine the points of interest and then to make measurements at those points using the methods of this I-ETS.

8.10 Calling indicator

Any suitable means of indicating that the receiver has responded to a correctly coded input signal may be used.

8.11 Reset

The reset may be a manual or automatic method of cancelling the calling indication and resetting the decoder, enabling it to respond to the next correctly coded input signal.

8.12 Reset time

The reset time of the receiver is the minimum elapsed time between two calls in order that they may both be successfully registered. The reset time shall be declared by the manufacturer in order that the formation of the normal test signal may be derived.

8.13 Test 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 I-ETS shall be met when the measurements are carried out using the antenna connector of this filter.

9 Methods of measurement for transmitter parameters

9.1 Frequency error

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

This measurement is made if the equipment is capable of producing an unmodulated carrier. Otherwise the adjacent channel power shall also be measured under extreme test conditions and the limits given in subclause 6.1.4 shall be met.

9.1.1 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.

9.1.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna (subclause 8.2).

The measurement shall be made under normal test conditions, subclause 7.3, and repeated under extreme test conditions, subclauses 7.4.1 and 7.4.2 applied simultaneously.

9.2 Carrier power (conducted)

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

If the equipment is designed to operate with different carrier powers, the rated power for each level or range levels shall be declared by the manufacturer.

The requirements of this I-ETS 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.

9.2.1 Definitions

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

When it is not possible to measure the power in the absence of modulation this fact shall be stated in the test report.

The rated output power is the carrier power (conducted) of the equipment declared by the manufacturer. Its value shall be declared under normal test conditions.

9.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna (subclause 8.2), and the power delivered to this artificial antenna shall be measured.

The measurements shall be made under normal test conditions, subclause 7.3, and extreme test conditions, subclauses 7.4.1 and 7.4.2 applied simultaneously.

9.3 Effective radiated power (field strength)

This measurement need not be carried out if this parameter has already beem measured according to the requirements of ETS 300 086 [2].

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

9.3.1 Definition

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

When it is not possible to measure the power in the absence of modulation, this fact shall be stated in the test report.

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

9.3.2 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, whenever possible) 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.

When a test site according to Annex A, Clause A.3, is used there is no need to vary the height of the antenna.

The transmitter shall then be rotated through 360^{o} 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 Annex A, 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.

When a test site according to Annex A, Clause A.3, is used there is no need to vary the height of the antenna.

The input signal to the substitution antenna shall be adjusted so that it 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 a 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.

9.4 Adjacent channel power

This measurement shall be carried out even though the equipment has been tested to the requirements of ETS 300 086 [2].

9.4.1 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.

9.4.2 Methods of measurement

The adjacent channel power shall be measured with a power measuring receiver which conforms to the requirements given in Annex B, referred to in this subclause as the "receiver".

a) The transmitter shall be operated at the carrier power determined in subclause 9.2 under normal test conditions (see subclause 7.3).

   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 test signal D-M4 (see subclause 8.1) 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 8.

Table 8: 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 the test signal D-M4 (see subclause 8.1).

e) The "receiver" variable attenuator shall be adjusted to obtain the same reading as in step b) or a known relation to it.

   The adjustment of the variable attenuator shall be made during the time when the test signal is effectively modulated by the normal test signal (see subclause 8.1).

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 8.

h) For the purpose of equipment which is not capable of producing an unmodulated carrier (see subclause 9.1), the measurement shall be repeated under extreme test conditions (subclauses 7.4.1 and 7.4.2 applied simultaneously).

9.5 Spurious emissions

This measurement need not be carried out on equipment which is simultaneously submitted for approval to the requirements of ETS 300 086 [2] and this I-ETS.

9.5.1 Definition

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

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.

9.5.2 Method of measuring the power level in a specified load, subclause 9.5.1, paragraph 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 (see 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.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M4 (see subclause 8.1) in which case this fact shall be recorded in the test report.

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.

9.5.3 Method of measuring the effective radiated power, subclause 9.5.1, paragraph 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 (see subclause 8.2).

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.

When a test site according to Annex A, Clause A.3, is used there is no need to vary the height of the antenna. The transmitter shall then be rotated through 360^{o} 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 Annex A, 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.

When a test site according to Annex A, Clause A.3, is used there is no need to vary the height of the antenna.

The input signal to the substitution antenna shall be adjusted so that it 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 standby.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M4 (see subclause 8.1) in which case this fact shall be recorded in the test report.

9.5.4 Method of measuring the effective radiated power, subclause 9.5.1, paragraph c)

This method applies only to equipment without an external antenna connector. The method of measurement shall be performed according to subclause 9.5.3, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

9.6 Intermodulation attenuation

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

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

9.6.1 Definition

Intermodulation attenuation is the capability of a transmitter to avoid the generation of signals within its 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 carrier power level to the level of the third order intermodulation product.

9.6.2 Method of measurement

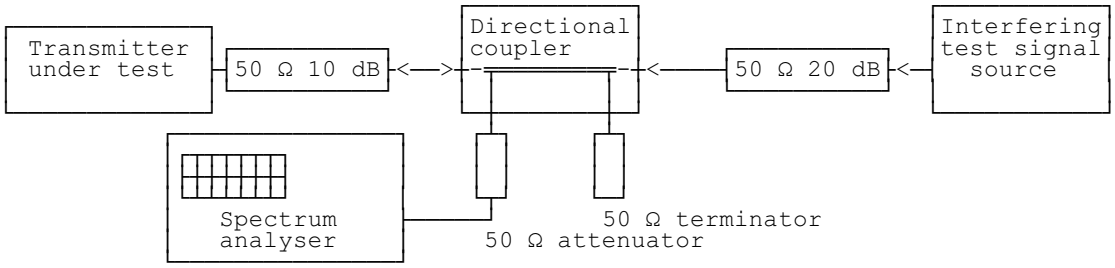


Figure 1: Measurement arrangement

The measurement arrangement shown in figure 1 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 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 carrier to the largest third order intermodulation component 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.

If an unmodulated carrier cannot be obtained then the measurement shall be made with the transmitter modulated by the test signal D-M4 (see subclause 8.1) in which case this fact shall be recorded in the test report.

9.7 Transient frequency behaviour of the transmitter

This measurement does not apply to equipment designed for continuous operation only.

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

9.7.1 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 versus time when the RF output power is switched on and off.

t_{on}: According to the method of measurement described in subclause 9.7.2 the switch-on instant t_{on} 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 t_{on} and finishing according to table 4 (see subclause 6.1.7).

t_2: Period of time starting at the end of t_1 and finishing according to table 4 (see subclause 6.1.7).

t_{off}: Switch-off instant defined by the condition when the output power falls below 0,1 % of the nominal power.

t_3: Period of time finishing at t_{off} and starting according to table 4 (see subclause 6.1.7).

9.7.2 Method of measurement

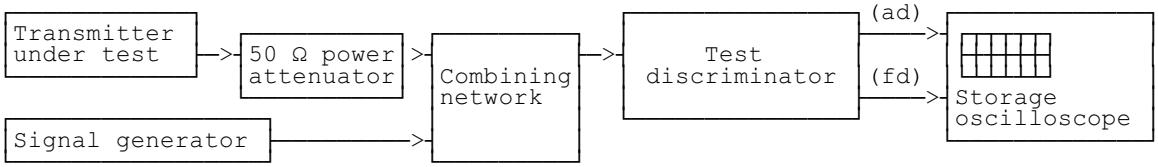


Figure 2: Measurement arrangement

The measurement arrangement shown in figure 2 shall be used.

Two signals shall be connected to the test discriminator via a combining network (see subclause 8.6).

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), that is the level of 0,1 % of the power of the tested transmitter for a rising input level.

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 t_{on}.

The periods of time t_1 and t_2 as defined in table 4, subclause 6.1.7, 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 6.1.7.

The frequency difference, after the end of t_2, shall be within the limit of the frequency error (see subclause 6.1.1).

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 4, subclause 6.1.7, 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 6.1.7.

Before the start of t_3 the frequency difference shall be within the limit of the frequency error, subclause 6.1.1.

The result shall be recorded as frequency difference versus time.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M4 (see subclause 8.1) and an extra ½ channel separation will be accepted for the limit of the peak frequency difference.

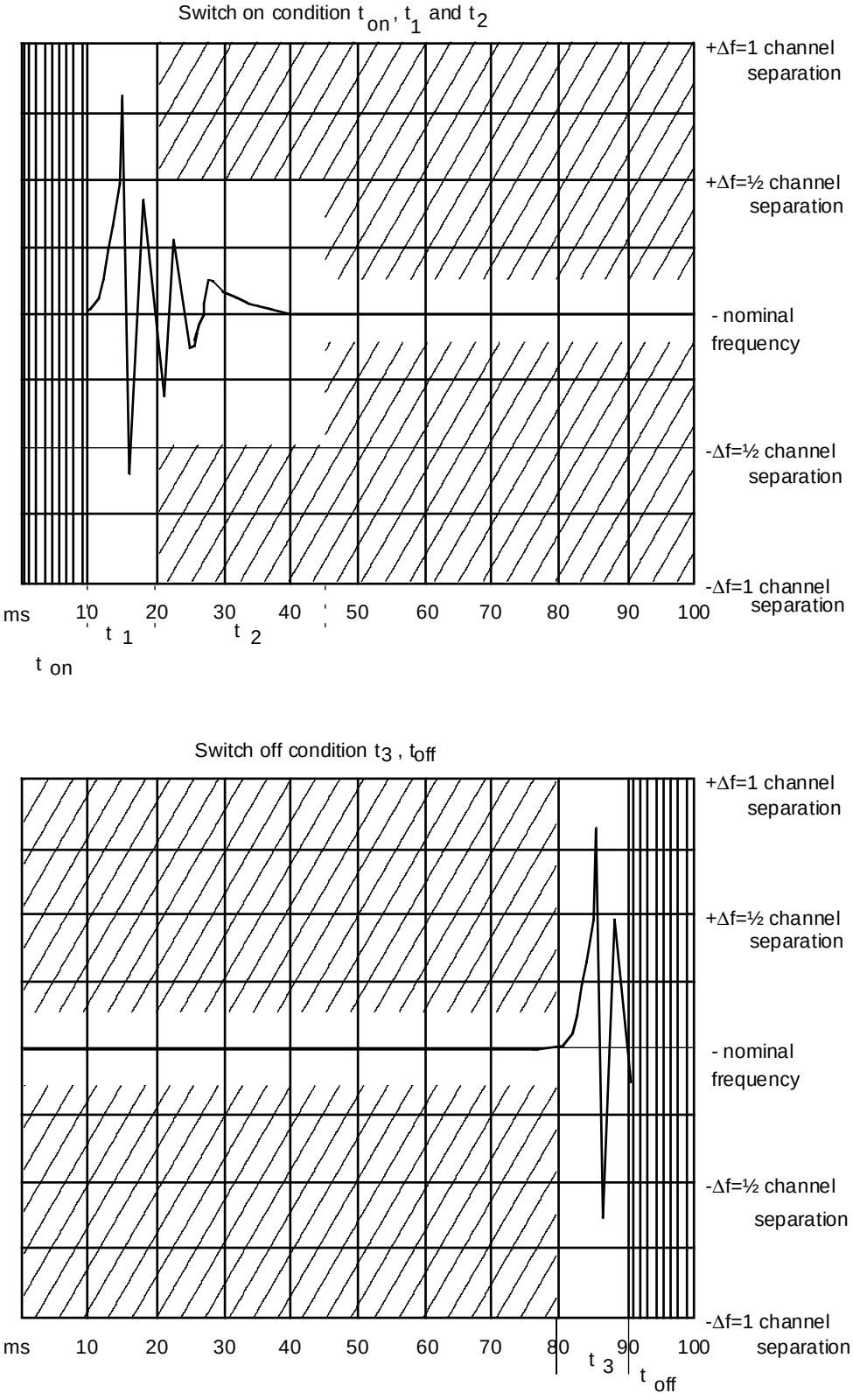


Figure 3: Storage oscilloscope view t_1, t_2 and t_3

10 Methods of measurement for receiver parameters

10.1 Reference sensitivity (response)

10.1.1 Definition

In the case of degradation measurements, the following definition of reference sensitivity is used:

The reference sensitivity (response) of the receiver is the level of signal, to be provided at the receiver input terminals as emf or as field strength, by a generator operating at the nominal frequency of the receiver and modulated with the normal test signal (see subclause 8.1), which will be used as a reference for the degradation measurements. Its level is given in subclause 6.2.1.

10.2 Maximum usable sensitivity (responses, conducted)

This measurement shall be carried out even though the equipment has been tested to the requirements of ETS 300 086 [2].

10.2.1 Definition

The maximum usable sensitivity (responses, conducted) of the receiver is the minimum level of the RF signal (emf) at the receiver input, at the nominal frequency of the receiver, with normal test signal D-M3 (see subclause 8.1), which will produce after demodulation a specified successful response rate, without interference.

10.2.2 Method of measurement ("up-down method")

a) A signal of carrier frequency equal to the nominal frequency of the receiver and modulated with the normal test signal D-M3 (see subclause 8.1) in accordance with instructions of the manufacturer (and approved by the type test laboratory) shall be applied to the receiver input terminals.

b) The level of this signal shall be such that a successful response rate of less than approximately 10 % is obtained.

c) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The input level shall be increased by 2 dB for each occasion that a successful response is not obtained. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall be recorded.

d) The input signal shall be reduced by 1 dB and the new value recorded. The normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained the input level shall be increased by 1 dB and the new value recorded. If a successful response is obtained, the input level shall not be changed until three consecutive successful responses have been obtained. In this case, the input level shall be reduced by 1 dB and the new value recorded.

   No input signal levels shall be recorded unless preceded by a change in level.

e) The maximum usable sensitivity is the average of the values recorded in steps c) and d).

f) The measurement shall be repeated under extreme test conditions (subclauses 7.4.1 and 7.4.2 applied simultaneously).

10.3 Maximum usable sensitivity (responses, field strength)

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

This measurement shall be carried out even though the equipment has been tested to the requirements of ETS 300 086 [2].

10.3.1 Definition

The maximum usable sensitivity of the receiver is the minimum field strength present at the location of the receiver, at the nominal frequency of the receiver and with normal test modulation (see subclause 8.1) which will fulfil the requirements of subclause 10.2.1.

10.3.2 Test conditions

Three test conditions are specified:

a) the manufacturer declares the direction corresponding to the maximum usable sensitivity, in this case this position shall be used to perform the measurement in subclause 10.3.3;

b) if the manufacturer does not declare the position corresponding to the maximum usable sensitivity but provides an analogue output according to subclause 8.9, then this output shall be used to determine the direction of the maximum usable sensitivity. This shall be the position used for the measurement in subclause 10.3.3;

c) if the direction corresponding to the maximum usable sensitivity cannot be determined as specified in a) or b) above, then an initial position shall be used and the measurement in subclause 10.3.3 shall be repeated with eight positions, 45° apart. The maximum usable sensitivity shall be determined from the minimum field strength recorded.

10.3.3 Method of measurement

Arrangements shall be made by the manufacturer to provide a facility to give access to the analogue information (see also subclause 8.9), in a way that does not affect the radiated field. This analogue access shall be used to find the minimum of field strength for the maximum sensitivity, as indicated in the following text.

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. This position shall be recorded in the test report.

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 by test signal A-M1. The analogue information shall be monitored and used to find the two minima of field strength.

First the test antenna shall be raised and lowered through the specified range of height to find the lowest level of the test signal necessary, that is, one of the minima mentioned above. The receiver shall then be rotated through 360^{o} in the horizontal plane, to find again the lowest level of the test signal necessary, that is, the second of the minima.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to Annex A, Clause A.3.

Under these test conditions and positions, the actual sensitivity will be measured using the "up down method" described in subclause 10.2.2 using the test antenna and the signal generator connected to it.

The input signal level to the test antenna shall be set to the average of the values recorded (see subclause 10.2.2, e)).

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

The substitution antenna shall be orientated for the 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 test antenna need not be raised or lowered if the measurement is carried out on a test site according to Annex A, Clause A.3.

The measured signal level shall be noted as field strength in dBµV/m.

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

The maximum usable sensitivity, expressed as a field strength, is equal to the minimum of the two signal levels noted at the input to the calibrated measuring receiver, corrected for the known relationship when necessary.

10.4 Co-channel rejection

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.4.1 Definition

The co-channel rejection is the capability of the receiver to achieve a specific successful response ratio when receiving the wanted signal in the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

10.4.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network (see also subclause 8.6).

a) The wanted test signal D-M3 (see subclause 8.1), at the nominal frequency of the receiver, at an emf of 6 dBµV (the value of the reference sensitivity, see subclause 6.2.1) shall be applied to the input connector via one input of the combining network.

b) The unwanted test signal A-M3 (see subclause 8.1), at the nominal frequency of the receiver, shall be applied to the receiver input connector via the second input of the combining network.

c) The level of the unwanted signal A-M3 shall be adjusted until a successful response rate of less than 10 % is obtained.

d) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained.

The level of the unwanted signal A-M3 shall be reduced by 2 dB for each occasion that a successful response is not obtained.

The procedure shall be continued until three consecutive successful responses are observed.

The level of the input signal shall then be noted.

e) The level of the unwanted input signal A-M3 shall be increased by 1 dB and the new value noted.

The normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained the level of the unwanted signal shall be reduced by 1 dB and the new value noted.

If a successful response is obtained the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained.

In this case the unwanted signal A-M3 shall be increased by 1 dB and the new value noted.

No levels of the unwanted input signal level shall be noted unless preceded by a change in level.

f) The ratio in dB of the average of the levels of the unwanted signal noted in steps d) and e), to the level of the wanted signal, at the receiver input shall be recorded.

g) The measurement shall be repeated for displacements of the unwanted signal of ± 1 500 Hz and ± 3 000 Hz.

The lowest value of the five measurement results expressed in dB, recorded in step f, shall be the co-channel rejection.

10.5 Adjacent channel selectivity

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.5.1 Definition

The adjacent channel selectivity is the capability of the receiver to achieve a specific successful response ratio when receiving the wanted signal in the presence of an unwanted signal which differs in its frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

10.5.2 Method of measurement

a) Two signal generators A and B shall be connected to the receiver via a combining network (see also subclause 8.6).

Signal generator A shall be at the nominal frequency of the receiver and shall be modulated by the normal test signal D-M3 (see subclause 8.1).

Signal generator B shall be modulated with signal A-M3 and shall be adjusted to the frequency of the channel immediately above that of the wanted signal.

b) Initially signal generator B shall be switched off. Signal generator A will be used for the wanted signal whose amplitude shall be adjusted to the level of the reference sensitivity (response) at the receiver input terminals, according to subclause 10.1 (6 dBµV).

c) The unwanted signal (generator B) shall then be switched on, and the input level adjusted until a successful response rate of less than 10 % is obtained.

d) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The level of the unwanted signal A-M3 shall be reduced by 2 dB for each occasion that a successful response is not obtained. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall then be recorded.

e) The level of the unwanted input signal A-M3 shall be increased by 1 dB and the new value recorded. The normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.

No levels of the unwanted input signal shall be recorded unless preceded by a change in level.

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

g) The adjacent channel selectivity is the ratio in dB of the average of the levels recorded in steps d) and e) to the reference level (generator A) of 6 dBµV emf. The adjacent channel selectivity for the equipment under test is the lower value measured in the upper and lower channel nearest to the receiving channel.

h) The measurement shall be repeated under extreme test conditions (subclauses 7.4.1 and 7.4.2 applied simultaneously), using the level of the reference sensitivity (response) (see subclause 10.1) increased by 6 dB to an emf of 12 dBµV.

10.6 Spurious response rejection

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.6.1 Definition

The spurious response rejection is the capability of the receiver to achieve a specific successful response ratio when receiving a wanted modulated signal in the presence of an unwanted modulated signal at any other frequency at which a response is obtained.

10.6.2 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 half the switching range (sr of the receiver, Clause 5), 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, (see subclause 10.6.2.2).

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 and the harmonics of any other oscillator used to generate reference frequencies in the receiver (f_r) present at 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 ($n \geq 2$).

The measure of the first image response of the receiver shall initially be made to verify the calculation of spurious response frequencies.

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.

10.6.2.1 Method of search over the "limited frequency range"

The search is performed using the analogue access (see subclause 8.9).

Two input signals shall be applied to the receiver input via a combining network (see subclause 8.6).

The wanted signal A-M1 (see subclause 8.1) shall be at the nominal frequency of the receiver at an emf of 6 dBµV (the value of the reference sensitivity) and 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 with a deviation of ±5 kHz, at an emf of + 86dBµV, 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 use in measurements in accordance with subclause 10.6.2.2.

10.6.2.2 Method of measurement

a) Two input signals shall be applied to the receiver input via a combining network (see subclause 8.6).

The wanted test signal D-M3 (see subclause 8.1) at the nominal frequency of the receiver at an emf of + 6 dBµV (the value of the reference sensitivity) shall be applied to the receiver input connector via one input of the combining network.

b) The unwanted test signal A-M3 (see subclause 8.1) at an emf of +86 dBµV, shall be applied to the receiver input connector via the second input of the combining network.

c) At each frequency where a spurious response occurs, the level of the unwanted signal A-M3 shall be adjusted until a successful response rate of less than 10 % is obtained.

d) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained.

The level of the unwanted signal A-M3 shall be reduced by 2 dB for each occasion that a successful response is not obtained.

The procedure shall be continued until three consecutive successful responses are observed.

The level of the input signal shall then be noted.

e) The unwanted input signal level shall be increased by 1 dB and the new value noted.

The normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained the level of the unwanted signal shall be reduced by 1 dB and the new value noted.

If a successful response is obtained the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained.

In this case the unwanted signal shall be increased by 1 dB and the new value noted.

No levels of the unwanted input signal level shall be noted unless preceded by a change in level.

f) The ratio in dB of the average of the levels of the unwanted signal noted in steps d) and e) to the level of the wanted signal, at the receiver input shall be recorded.

The measurement shall be performed at all spurious response frequencies found during the search over the "limited frequency range" (see subclause 10.6.2.1) and those frequencies calculated for the remainder of the spurious response frequencies in the frequency range 100 kHz to 2 GHz, for equipment operating on frequencies not exceeding 470 MHz, and over the frequency range of 100 kHz to 4 GHz, for equipment operating on frequencies above 470 MHz.

The value of the measured results recorded in step f) shall be the spurious response rejection.

10.7 Intermodulation response

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.7.1 Definition

The intermodulation response is the capability of the receiver to achieve a specific response ratio when receiving a wanted modulated signal in the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

10.7.2 Method of measurement

Three signal generators A, B and C shall be applied to the receiver via a combining network (see also subclause 8.6).

a) The wanted test signal D-M3 (see subclause 8.1) from signal generator A, at the nominal frequency of the receiver, at an emf of 6 dBµV, value of the reference sensitivity (see subclause 6.2.1), shall be applied to the receiver input connector via one input of the combining network.

b) The unwanted test signal from signal generator B, at the frequency 50 kHz above the nominal frequency of the receiver and without modulation, shall be applied to the receiver input connector via the second input of the combining network.

c) The unwanted test signal A-M3 (see subclause 8.1) from signal generator C, at the frequency of 100 kHz above the nominal frequency of the receiver, shall be applied to the receiver input connector via the third input of the combining network.

d) The levels of the test signals B and C shall be maintained equal and adjusted to a value such that a successful response rate of less than 10 % is obtained.

e) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The levels of the unwanted signals shall be reduced by 2 dB for each occasion that a successful response is not obtained. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signals shall then be noted.

f) The level of the unwanted input signals shall be increased by 1 dB and the new value recorded; the normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained the level of the unwanted signals shall be reduced by 1 dB and the new value recorded. If a successful response is obtained, the input level of the unwanted signals shall not be changed until three consecutive successful responses have been obtained. In this case the level of the unwanted signals shall be increased by 1 dB and the new value recorded.

   No input signal level shall be recorded unless preceded by a change in input level.

g) The ratio in dB of the average of the levels of the unwanted signals noted in steps e) and f) to the level of the wanted signal at the receiver input shall be recorded.

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

i) The lower value of the measured results recorded in steps g) and h) shall be the intermodulation response rejection.

10.8 Blocking or desensitisation

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.8.1 Definition

Blocking is the capability of the receiver to achieve a specific successful response ratio when receiving the wanted signal in the presence of an unwanted unmodulated high level signal on frequencies other than those of spurious responses or adjacent channels.

10.8.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network (see subclause 8.6).

a) The wanted test signal D-M3 (see subclause 8.1), at the nominal frequency of the receiver and at an emf of 6 dBµV (the value of the reference sensitivity, see subclause 6.2.1) shall be applied to the input connector via one input of the combining network.

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

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

c) The level of the unwanted signal shall be adjusted until a successful response rate of less than 10 % is obtained.

d) The normal test signal D-M3 shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained.

The level of the unwanted signal shall be reduced by 2 dB for each occasion that a successful response is not obtained.

This procedure shall be continued until three consecutive successful responses are observed.

The level of the input signal shall then be noted.

e) The unwanted input signal level shall be increased by 1 dB and the new value noted.

The normal test signal D-M3 shall then be transmitted 20 times. In each case if a response is not obtained the level of the unwanted signal shall be reduced by 1 dB and the new value noted.

If a successful response is obtained the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained.

In this case the unwanted signal level shall be increased by 1 dB and the new value noted.

No level of the unwanted input signal shall be noted unless preceded by a change in level.

f) The ratio in dB of the average of the levels of the unwanted signal noted in steps d) and e) to the level of the wanted signal, at the receiver input shall be recorded.

The lowest value of the eight measurement results in step f) shall be recorded as the blocking or desensitisation.

10.9 Spurious radiations

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

10.9.1 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 adiation); 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.

10.9.2 Method of measuring the power level in a specified load, subclause 10.9.1, paragraph 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 over 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.

10.9.3 Method of measuring the effective radiated power, subclause 10.9.1, paragraph b)

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

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 (see subclause 8.2).

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.

When a test site according to Annex A, Clause A.3, is used there is no need to vary the height of the antenna.

The receiver shall then be rotated through 360^{o} 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 Annex A, 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 a 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.

10.9.4 Method of measuring the effective radiated power, subclause 10.9.1, paragraph c)

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

The method of measurement shall be performed according to subclause 10.9.3, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

11 Duplex operation

This measurement need not be carried out if this parameter has already been measured according to the requirements of ETS 300 086 [2].

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.

11.1 Receiver desensitisation with simultaneous transmission and reception

11.1.1 Definition

The desensitisation is the degradation of the sensitivity of the receiver resulting from the transfer of power from the transmitter to the receiver due to coupling effects. It is expressed as the difference in dB between the maximum usable sensitivity levels, with and without simultaneous transmissions.

11.1.2 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 normal test signal D-M3 (see subclause 8.1) 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 9.2.

The transmitter shall be modulated by the test signal D-M4 (see subclause 8.1).

The receiver sensitivity shall be measured in accordance with subclause 10.2.

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.

11.1.3 Measuring method when the equipment operates with separate Tx and Rx antennas

The transmitter shall be connected to an artificial antenna (see subclause 8.2). 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 (see subclause 8.1) 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 9.2.

The transmitter shall be modulated by the test signal D-M4.

The receiver sensitivity shall be measured in accordance with subclause 10.2.

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.

11.2 Receiver spurious response rejection

11.2.1 Definition

The spurious response rejection is the capability of the receiver to achieve a specific successful response ratio when receiving a wanted modulated signal in the presence of:

a) an unwanted unmodulated signal, which is added at any other frequency at which a response may be obtained; and

b) the unmodulated signal of the transmitter operating at duplex frequency distance at the rated output power and attenuated by the duplex filter or the distance between the antennas.

11.2.2 Method of measurement

The receiver spurious response rejection is measured as specified in subclause 10.6 with the equipment arrangement described in subclauses 11.1.2 or 11.1.3, except that the transmitter shall be unmodulated. If an unmodulated carrier cannot be obtained, the transmitter shall be modulated by the test signal D-M4 (see subclause 8.1). The transmitter shall be operated at the rated output power as defined in subclause 9.2.

The measurement shall be performed around frequencies (f_m) derived from the expressions:

$(p)f_t + (q)f_m = f_r$ and $f_m = (n)f_t \pm f_{if1}$;

where f_t is the transmitter frequency;

where f_r is the receiver frequency; and

f_{if1} is the first IF of the receiver.

$n = \geq 2$.

Particular attention should be made to the following values:

$(p) = -1, (q) = 2$ and $(p) = 2, (q) = -1$.

It should be noted that the method of measurement described may cause errors at certain frequencies due to the effect of signal generator intermodulation. To overcome such errors, a band stop filter at the transmitting frequency may be inserted between the output of the signal generator combining network and the equipment under test.

12 Measurement uncertainty

Absolute measurement uncertainties: Maximum values.

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

RF frequency	± $1x10^{-7}$
RF power, valid up to 160 W	± 0,75 dB
Adjacent channel power	± 5 dB
Conducted emission of transmitter,valid up to 12,75 GHz	± 4 dB
Sensitivity (response)	± 3 dB
Conducted emission of receiver,valid up to 12,75 MHz	± 3 dB
Two-signal measurement, valid up to 4 GHz	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of transmitter,valid up to 4 GHz	± 6 dB
Radiated emission of receiver, valid up to 4 GHz	± 6 dB
Transmitter transient time	± 20 %
Transmitter transient frequency	± 250 Hz
Transmitter intermodulation	± 3 dB
Receiver desensitisation (duplex operation)	± 0,5 dB

For the test methods according to this I-ETS the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028 [4].

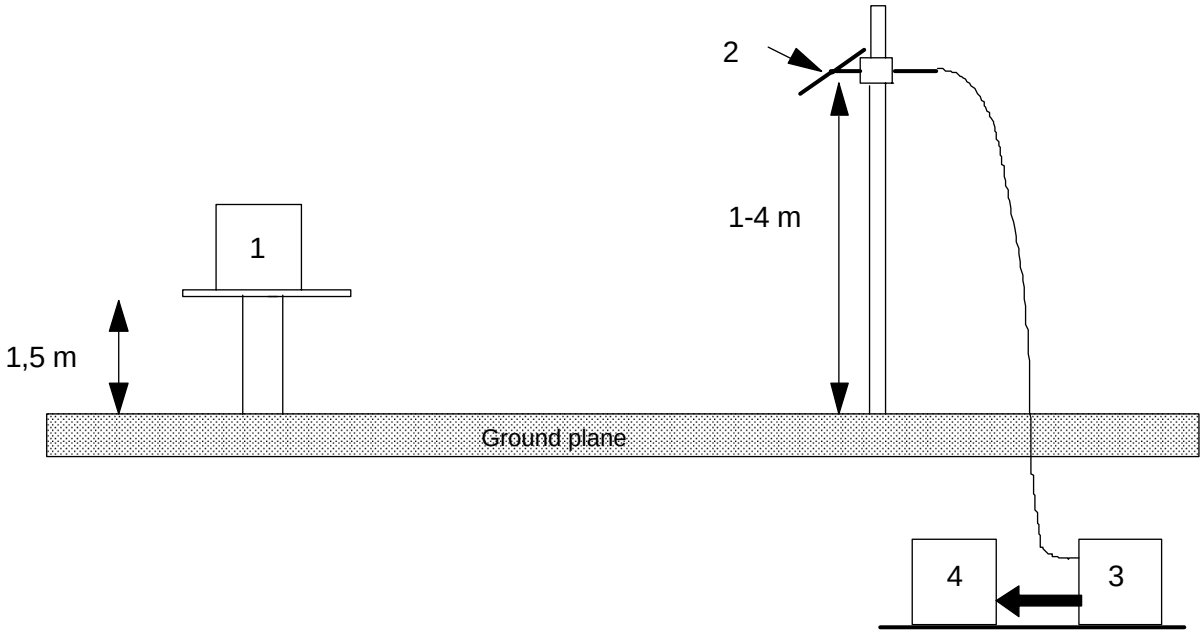
Annex A (normative): Radiated measurements

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.



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

Figure A.1

A.1.2 Test antenna

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

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical 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 can be 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 λ at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of $\lambda/2$ to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method. To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals

occurs, the substitution antenna shall be moved through a distance of ± 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.

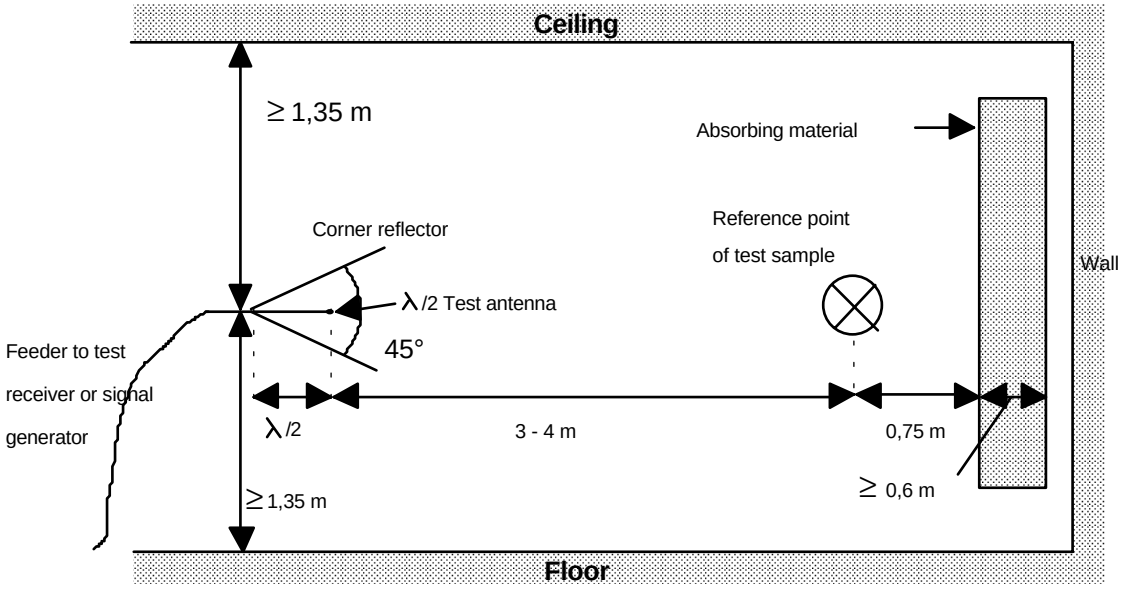


Figure A.2: Indoor site arrangement (shown for horizontal polarisation)

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 Clause 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 approximately 100 MHz.

A.2.3 Substitution antenna

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below approximately 80 MHz. Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the 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.2.7 Identification of radiated components

The method of measurement for conducted spurious emissions (subclause 9.5.2) can be used to identify some radiated spurious emissions and radiations.

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, given in Clause 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 radio frequency absorbers approximately 1 m high. The base is covered with absorbers which form a non-conducting sub-floor, or with special ground floor absorbers. The available internal dimensions of the room are 3 m x 8 m x 3 m, so that a measuring distance of maximum 5 m length in the middle axis of this room is available.

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

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

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

For special measurements it can be necessary to re-introduce floor reflections. Taking away the floor absorbers would mean a removal of approximately 24 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.

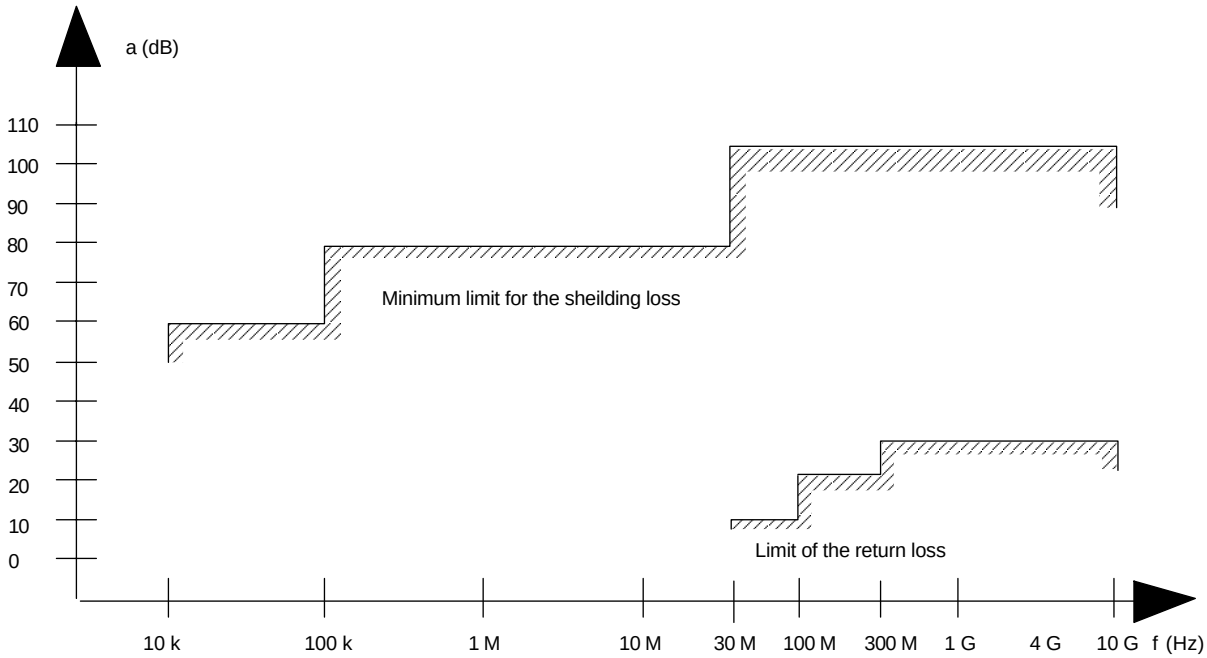
It is useful to use just this correlation for comparison measurements, as all constants are eliminated with the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

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 Clause A.3 at low frequencies up to 100 MHz there are no far field conditions, and therefore reflections are stronger so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well. In the frequency range of 1 to 12,75 GHz, because more refections 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.



NOTE: a = attenuation, f = frequency

Figure A.3: Specifications for shielding and reflections

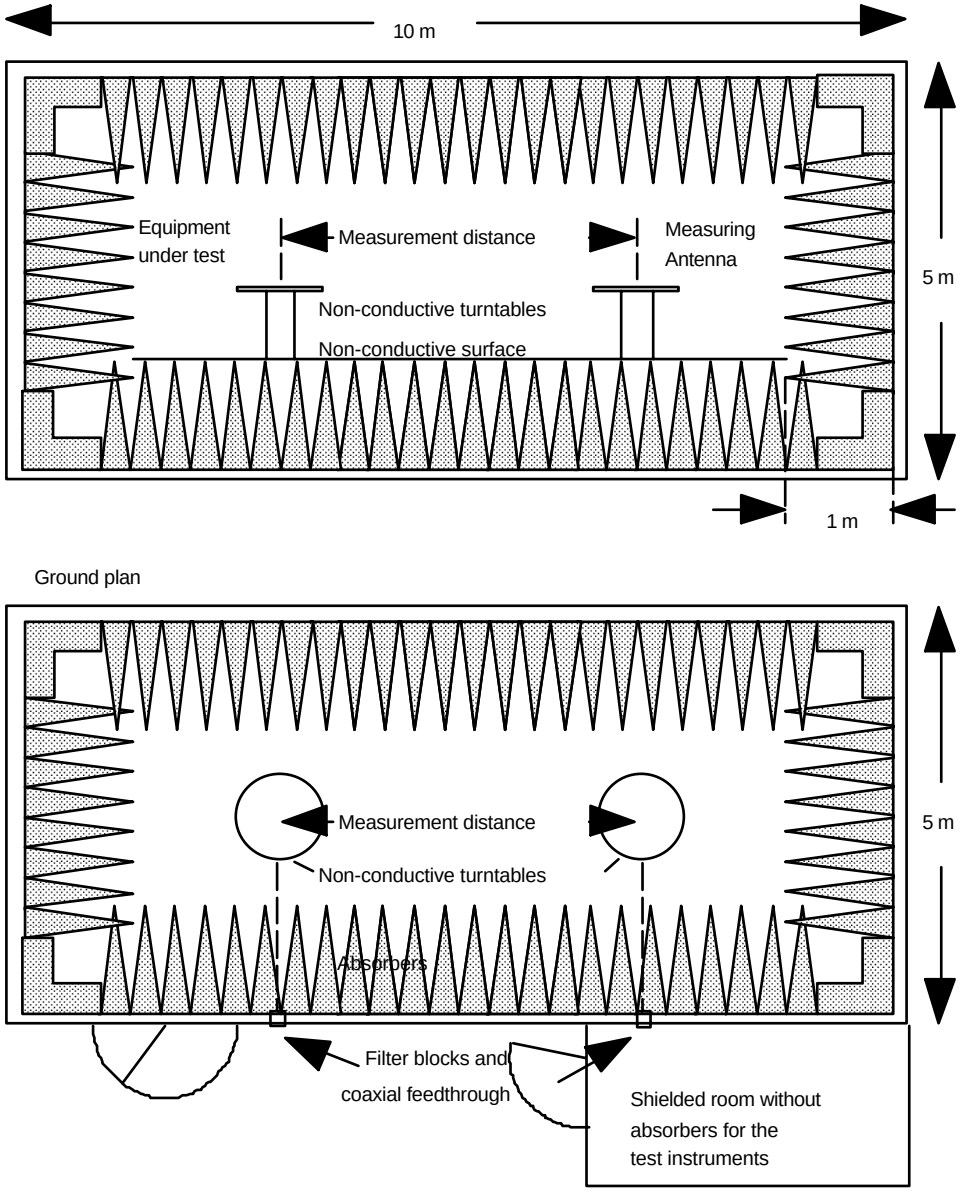


Figure A.4: Example of the construction of an anechoic chamber

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 Intermediate Frequency (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 subclauses B.1.1 to B.1.4.

B.2 Technical characteristics

B.2.1 IF filter

The IF filter shall be within the limits of the selectivity characteristic of figure B1.

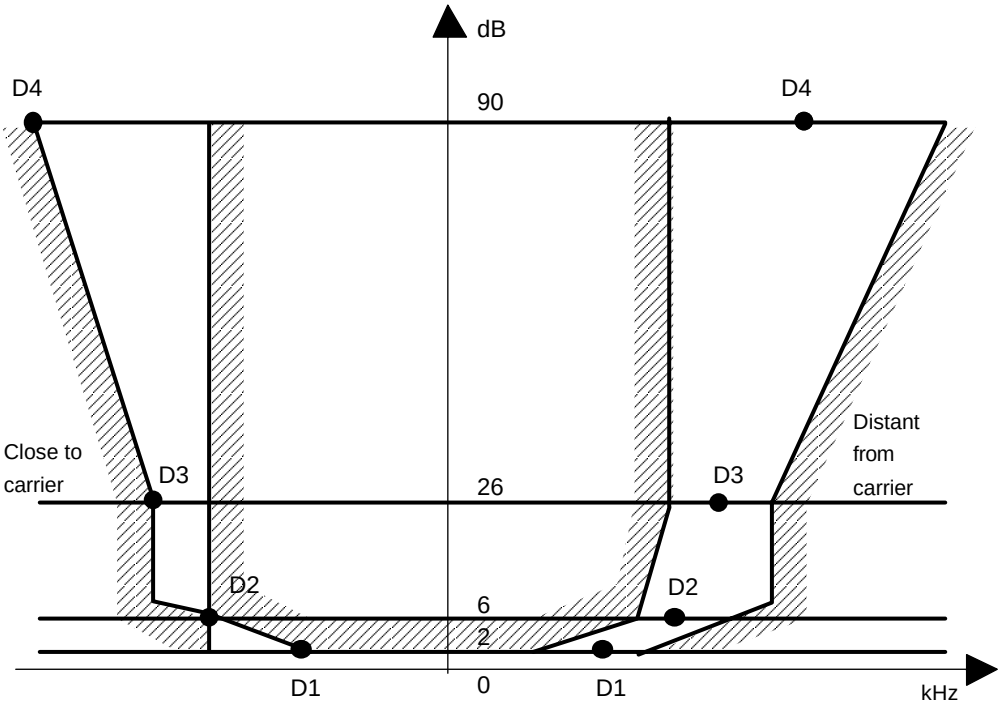


Figure B.1: Selectivity characterisitic

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 20 25	3 4 5	4,25 7,0 8,0	5,5 8,25 9,25	9,5 12,25 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 greater than or equal to 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.2.2 Variable attenuator

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

B.2.3 rms value indicator

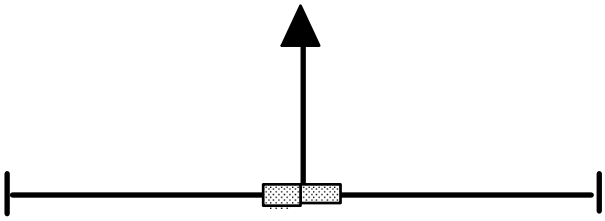
The instrument shall accurately indicate non-sinusoidal signals in a ratio of up to 10:1 between peak value and rms value.

B.2.4 Oscillator and amplifier

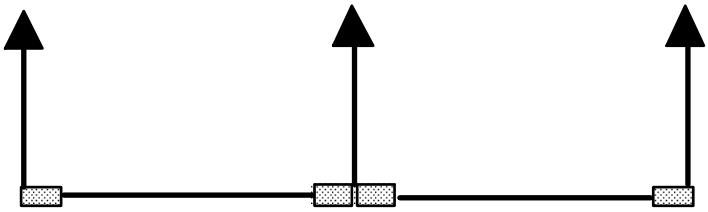
The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ 90 dB for channel separations of 20 and 25 kHz and of ≤ 80 dB for a channel separation of 12,5 kHz, referred to the carrier of the oscillator.

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

SINGLE CHANNEL EQUIPMENT

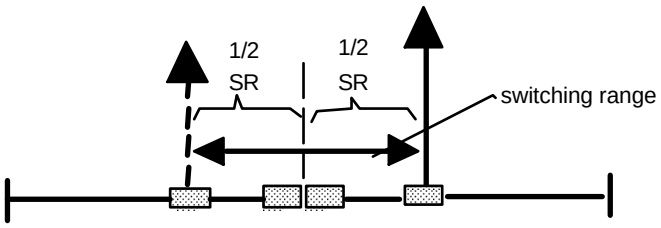


Equipment of category AR1 see subclause 5.1.5

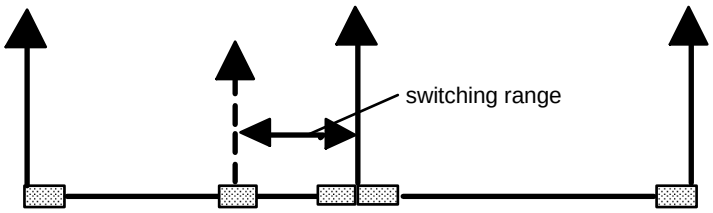


Equipment of category AR2 see subclause 5.1.6

TWO CHANNEL EQUIPMENT



Equipment of category AR1 see subclause 5.1.7

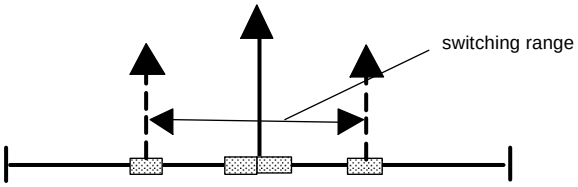


Equipment of category AR2 see subclause 5.1.8

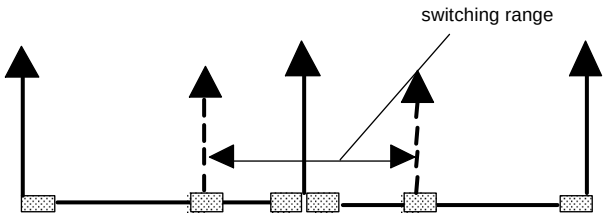
NOTE: For legend see figure C.2.

Figure C.1: Single channel/two channel equipment

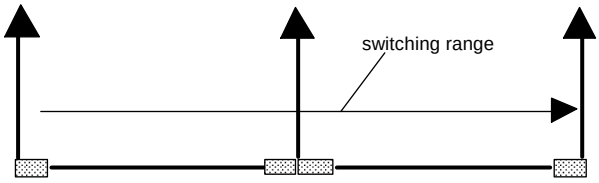
MULTI CHANNEL EQUIPMENT



Equipment of category AR1 see subclause 5.1.9



Equipment of category AR2 see subclause 5.1.10



Equipment of category AR2 see subclause 5.1.11

AR = SR

Legend:

AR1 - First category of alignment range, see subclause 5.1.3.
AR2 - Second category of alignment range, see subclause 5.1.3.
Limited test, see Clause 3.
Full test, see Clause 3.
100 kHz range in which the test shall be carried out.

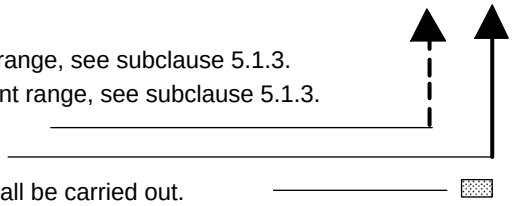


Figure C.2: Multi channel equipment

History

Document history	
October 1993	First Edition
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