Draft ETSI EN 300 220-1 V2.1.1 (2005-04)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods

Reference

REN/ERM-TG28-0403-1

Keywords

radio, SRD, testing

ETSI

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

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

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

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

The present document is part 1 of a 2-part deliverable, covering the Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW, as identified below:

Part 1: "Technical characteristics and test methods";

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

Clauses 1 and 3 provide a general description on the types of equipment covered by the present document and the definitions and abbreviations used.

Clause 4 provides a guide as to the number of samples required in order that type tests may be carried out, and any markings on the equipment which the provider should provide.

Clauses 5 and 6 give guidance on the test and general conditions for testing of the device.

Clause 7 gives the maximum measurement uncertainty values.

Clause 8 specifies the spectrum utilization parameters which are required to be measured. These are the maximum limits which have been chosen to minimize harmful interference to other equipment and services. The clauses provide details on how the equipment should be tested and the conditions which should be applied.

Clause 9 specifies receiver parameters which are only required to be measured in cases where

- a Listen Before Talk (LBT) protocol is used to control the transmitter; or
- for special applications that requires an enhanced protection of the receiver, e.g. for fire alarms and social alarms.

The present document describes a generic classification of receiver performance in clause 4.1.1.

Annex A provides specifications concerning radiated measurements.

Annex B contains specifications for a filter for transmitter transient measurement arrangements.

Annex C provides information on the spectrum analyser specification.

Annex D is a graphical representation of clause 4.2, referring to the presentation of equipment for testing purposes.

Annex E covers normative requirements for social alarms.

Annex F covers supplementary requirements for receivers.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

1 Scope

The present document applies to short range device radio transmitters and receivers:

1) transmitters in the range from 25 MHz to 1 000 MHz and with power levels ranging up to 500 mW;
2) receivers in the range from 25 MHz to 1 000 MHz.

The present document contains the technical characteristics for radio equipment referencing CEPT/ERC Decisions and Recommendation CEPT ERC/Recommendation 70-03 [2].

The present document does not necessarily include all the characteristics that may be required by a user, nor does it necessarily represent the optimum performance achievable. It is a product family standard that may be completely or partially superseded by specific standards covering specific applications.

The present document applies to short range devices:

- either with a Radio Frequency (RF) output connection and/or with an integral antenna;
- for alarms, identification, telecommand, telemetry, etc., applications;
- with or without speech.

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

The present document covers fixed stations, mobile stations and portable stations. In the present document requirements are given for the different frequency bands, channel separations etc., where appropriate.

All types of modulation are covered, in the present document, provided the requirements of clauses 8.6 or 8.7, whichever is applicable, are met.

The present document should be read in conjunction with CEPT/ERC Recommendation 70-03 [2] together with the respective ECC Decisions. The Recommendation states the recommended transmitter parameters for the various SRD application in the appropriate annexes.

NOTE: National restrictions may apply.

In the case of systems employing transponders, the transponders should be measured together with the associated transmitter.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

[1] ETSI TR 102 313: "Electromagnetic compatibility and Radio Spectrum Matters (ERM); Frequency-agile Generic Short Range Devices using listen-Before-Transmit (LBT); Technical Report".

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

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

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

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

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

[7] ETSI EN 300 220-2: "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive ".

[8] ETSI TR 102 273: "Electromagnetic compatibility and Radio Spectrum Matters (ERM): Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties".

[9] ANSI C63.5 (2004): "American National Standard for Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control-Calibration of Antennas (9 kHz to 40 GHz)".

[10] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity. (R&TTE Directive)

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

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

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

fixed station: equipment intended for use in a fixed location

frequency agility: ability to determine an unoccupied sub-band or channel of operation in order to minimize interference with other users of the same band

full tests: all tests specified in EN 300 220-1

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

limited tests: limited tests are as follows:

- transmitter frequency error, see clause 8.1 of EN 300 220-1;
- transmitter carrier power conducted, see clause 8.2 of EN 300 220-1;
- transmitter effective radiated power, see clause 8.3 of EN 300 220-1;
- transmitter adjacent channel power, see clause 8.6 of EN 300 220-1.

NOTE: See clauses 4.2.1 to 4.2.10 of EN 300 220-1.

listen mode: action taken by an interrogator to detect an unoccupied sub-band or channel prior to transmitting

listen before talk: combination of the listen mode followed by the talk mode

provider: means the manufacturer, or his authorized representative or the person responsible for placing on the market

mobile station: equipment normally fixed in a vehicle

narrow band: equipment to be used in a non-channelized continuous frequency band of less than 200 kHz, or to be used in a channelized frequency band with a channel spacing of less than 200 kHz

non overlapping channels: hopping positions separated by channel bandwidth of 90 % or more below the maximum power as measured with a spectrum analyser.

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

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

talk mode: transmission of intentional radiation by a transmitter

transponder: device that responds to an interrogation signal

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

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

wide band: equipment to be used in a non-channelized continuous frequency band covering more than 200 kHz, or to be used in a channelized frequency band with a channel spacing greater than 200 kHz

3.2 Symbols

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

AR0, AR1, etc. categories of Alignment Range

NOTE: See clause 4.2.3.

dB	decibel
E	field strength
Eo	reference field strength
FR_C	Centre of Frequency Range
FR_H	Higher end of Frequency Range
FR_L	Lower end of Frequency Range
FT	Full Test (see clause 3.1)
LT	Limited Tests (see clause 3.1)
NaCl	sodium chloride
R	distance
Ro	reference distance
SND/ND	Signal + Noise + Distortion / Noise + Distortion
λ	wavelength

3.3 Abbreviations

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

ac/AC	alternating current
AFA	Adaptive Frequency Agility
BW	BandWidth in kHz
DSSS	Direct Sequence Spread Spectrum
EMC	ElectroMagnetic Compatibility
emf	electromotive force
ERP	Effective Radiated Power
EUT	Equipment Under Test
FHSS	Frequency Hopping Spread Spectrum
IF	Intermediate Frequency
LBT	Listen Before Talk
OATS	Open Area Test Site
OFR	Operating Frequency Range
R&TTE	Radio and Telecommunications Terminal Equipment
RE	Radio Equipment
RF	Radio Frequency
rms	root-mean-square
SR	Switching Range
SRD	Short Range Device
TX	Transmitter
VSWR	Voltage Standing Wave Ratio

4 Technical requirement specifications

4.1 General requirements

4.1.1 Receiver classification

The receiver used in short range radio devices is divided into three classes of receiver, see table 1, each having its own set of minimum performance criteria. This classification is based upon the impact on persons in case the equipment does not operate above the specified minimum performance level.

Table 1

Receiver class	Relevant receiver clauses	Risk assessment of receiver performance
1	9.1, 9.3, 9.4, 9.5, 9.6 and 9.7	Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person)
2	9.3, 9.5 and 9.7	Medium reliable SRD communication media e.g. causing Inconvenience to persons, which cannot simply be overcome by other means
3	9.7	Standard reliable SRD communication media e.g. inconvenience to persons, which can simply be overcome by other means (e.g. manual)
NOTE 1: With reference to the present document providers are recommended to declare classification of their devices in accordance with table 1 and EN 300 220-2 [7] clause 4.2, as relevant. In particular where an SRD which may have an inherent safety of human life implications, providers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands. NOTE 2: In case of the use of a Listen Before Talk protocol (LBT), requirements for receiver LBT threshold and blocking always apply, see clauses 9.2 and 9.5.		

4.1.2 General performance criteria

For the purpose of the receiver performance tests, the receiver will produce an appropriate output under normal conditions as indicated below.

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

Where the indicated performance cannot be achieved, the provider shall declare and publish the performance criteria used to determine the performance of the receiver.

4.2 Presentation of equipment for testing purposes

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

If an equipment is designed to operate with different carrier powers, measurement of each transmitter parameter shall be performed at the highest power level at which the transmitter is intended to operate.

To simplify and harmonize the testing procedures between the different testing laboratories, measurements shall be performed, according to the present document, on samples of equipment defined in clauses 4.2.1 to 4.2.12 (see also annex D).

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

4.2.1 Choice of model for testing

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

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

In the case of equipment without a 50 Ω external antenna connector, see clause 4.2.13.

4.2.1.1 Transmitter testing

To enable testing of the transmitter parameters under clause 8, the duty cycle, as defined in clause 8.10, may be exceeded, provided that the maximum transmit period declared by the provider is not exceeded.

Similarly, where a Listen Before Talk (LBT) facility is provided, this may be disabled to aid the testing of the transmitter parameters.

4.2.2 Definitions of Switching Range (SR), alignment range and operational frequency range

4.2.2.1 Definition of SR

The provider shall state the SR of the receiver and the transmitter (which may differ).

The SR is the maximum frequency range, as specified by the provider, over which the receiver or the transmitter can be operated within the alignment range without reprogramming or realignment.

4.2.2.2 Definition of alignment range

The provider shall also, when submitting equipment for testing, state the alignment ranges for the receiver and the transmitter.

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

Trimming is an act by which the value (in this case relating to frequency) of a component is changed within the circuit. This act may include the physical alteration, substitution (by components of similar size and type) or activation/de-activation (via the setting of soldered bridges) of components.

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

4.2.2.3 Definition of operating frequency range

The Operating Frequency Range (OFR) is the total range of frequencies covered either by one type, or by a family of equipment.

It is noted that a family of equipment may be capable of covering a wider frequency range than the alignment frequency range of one type of equipment.

4.2.3 Definition of the categories of the alignment range (AR0, AR1, AR2 and AR3)

The alignment range falls into one of four categories:

- the first category, defined as AR0, corresponds to equipment having an alignment range of less than or equal to 5 MHz;
- the second category, defined as AR1, corresponds to an alignment range greater than 5 MHz but less than or equal to 30 MHz;
- the third category, defined as AR2, corresponds to an alignment range greater than 30 MHz, but less than or equal to 60 MHz;
- the fourth category, defined as AR3, corresponds to an alignment range greater than 60 MHz.

4.2.4 Testing of equipment of category AR0

Full tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the centre frequency of the alignment range, category AR0.

4.2.5 Testing of equipment of category AR1

Full tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the highest frequency of the alignment range, and full tests (see clause 3.1) on a frequency within 50 kHz of the lowest frequency of the alignment range.

4.2.6 Testing of equipment of category AR2

Full tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the highest frequency of the alignment range and full tests on a frequency within 50 kHz of the lowest frequency of the alignment range.

Limited tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the centre frequency of the alignment range.

4.2.7 Testing of equipment of category AR3

Full test (see clause 3.1) shall be carried out on 2 frequencies, one within 50 kHz of the highest, and one within 50 kHz of the lowest frequency of the alignment range.

Limited tests (see clause 3.1) shall be carried out on intermediate test frequencies, equally spaced (±50 kHz) over the alignment range and chosen such that the gaps between the test frequencies do not exceed 30 MHz.

4.2.8 Testing of equipment capable of being aligned to operate with more than one frequency separation

If an equipment can be programmed and/or aligned to operate without any physical change of components other than programmable read only memories or crystals, with more than one frequency separation, the measurements shall be made in accordance with clauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, for frequency separations of 6,25 kHz, 10 kHz, 12,5 kHz, 20/25 kHz, 50 kHz 100 kHz and ≥ 200 kHz as indicated in table 2.

For wideband systems, where the above mentioned channel spacings are exceeded, the channel spacing and bandwidth shall be declared by the provider and noted in the test report.

4.2.9 Number of samples for testing

If the SR of each equipment corresponds to its alignment range category (AR0, AR1, AR2, or AR3), then only one sample shall be tested (see figure D.1).

If the SR of the equipment is a subset of the equipment's alignment range, then the following samples shall be tested in order to cover the whole of that assignment range:

- for category AR0, one sample shall be provided for testing on a frequency in the vicinity of the centre of the alignment range AR0, as specified in clause 4.2.4;
- for category AR1, two samples shall be provided, one sample for testing at a frequency close to the upper edge and the other sample for testing close to the lower edge of the alignment range AR1, as specified in clause 4.2.5;
- for category AR2, three samples shall be provided, one sample for testing at a frequency close to the upper edge, one sample for testing close to the lower edge and the other sample for testing in the vicinity of the centre of the alignment range AR2, as specified in clause 4.2.6;
- for category AR3, four or more samples shall be provided, one sample for testing at a frequency close to the upper edge, one sample for testing close to the lower edge, and two or more samples for testing at a corresponding number of intermediate frequencies, as specified in clause 4.2.7.
- For wideband systems one sample shall be supplied for the testing.

See clause D.2 for details of the number of samples and tests.

Table 2: Measurements for equipment with more than one frequency separation

Alignment Range	**6,25 kHz 10 kHz, 12,5 kHz, 20 kHz, 25 kHz, 50 kHz, 100 kHz, ≥ 200 kHz (see note 2)**		
	FR_L	FR_C	FR_H
AR0	-	FT	-
AR1	FT	-	FT
AR2	FT	LT (see note 1)	FT
AR3	FT	LT (see note 3)	FT

FT Full test (see clause 3.1)
LT Limited tests (see clause 3.1)
FR_L Lower end of frequency range
FR_C Centre of frequency range
FR_H Higher end of frequency range

NOTE 1: Limited tests for AR2 need only be performed on a frequency in the centre of the frequency range for either 6,25 kHz, 10/12,5 kHz, 20/25 kHz, 50 kHz, 100 kHz, ≥ 200 kHz frequency separation.
NOTE 2: If measurements are performed with a frequency separation of 10 kHz, there is no need to perform tests with a frequency separation of 12,5 kHz and vice-versa. Similarly, if measurements are performed with a frequency separation of 20 kHz, there is no need to perform tests with a frequency separation of 25 kHz and vice-versa.
NOTE 3: For equipment of category AR3, limited tests shall be performed on test frequencies at intermediate frequencies of the alignment range, see clause 4.2.7.
The alignment range and frequencies used for the measurements shall be noted in the test report.

4.2.10 Testing of a family of equipment with a total operating range in excess of each equipment's alignment range

A family of equipment may be capable of covering a wider frequency range than the alignment range of one type of equipment by the use of frequency range determining components other than those specified in clause 4.2.2 and fulfilling appropriate requirements.

If this is the case, then for the purposes of testing, the operational frequency range shall be presented as two or more alignment ranges, as appropriate, each of which is considered to be category AR0, AR1, AR2, or AR3, according to the definition in clause 4.2.3.

Full tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the highest frequency of the OFR and full tests shall be carried out on a frequency within 50 kHz of the lowest frequency of the OFR.

For category AR1, limited tests shall be carried out on a frequency within 50 kHz of the outer edges of the alignment range within the OFR.

For category AR2, tests shall be in accordance with clause 4.2.6.

For category AR3, tests shall be in accordance with clause 4.2.7.

See clause D.3 for examples.

4.2.11 Testing of frequency agile or hopping equipment

Where possible, full tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the highest frequency of the alignment range and full tests on a frequency within 50 kHz of the lowest frequency of the alignment range.

Limited tests (see clause 3.1) shall be carried out on a frequency within 50 kHz of the centre frequency of the alignment range.

For frequency hopping equipment specifically, three different tests shall be made under the conditions stated above:

a) The hopping sequence is stopped and the equipment is tested at three different channels as stated above.

b) The hopping sequence is in function and the equipment is tested with three hopping channels as stated above, the channels shall be visited sequentially and the number of visits to each shall be equal.

c) The hopping sequence is in normal function and the equipment is tested with all hopping channels as declared by the provider.

4.2.12 Testing of equipment with alternative power levels

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, or additionally has alternative frequency separations (as described in clause 4.2.8), then each module or add on stage shall be tested in combination with the equipment. The necessary samples and tests can be proposed by the provider and/or test laboratory and shall be agreed with the Administration(s) or a Notified body as applicable, based on the requirements of clause 4.2.

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

4.2.13.1 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 provider with the aid of a diagram. The fact that use has been made of the internal antenna connection, or of a temporary connection, to facilitate measurements shall be recorded in the test report.

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

4.2.13.2 Equipment with a temporary antenna connector

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

Alternatively, the provider 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. The provider shall declare that two sets of equipment are identical in all respects.

4.3 Mechanical and electrical design

4.3.1 General

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

Transmitters and receivers may be individual or combination units, but shall operate with the declared power source.

4.3.2 Controls

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

4.3.3 Transmitter shut-off facility

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

4.3.4 Marking

The equipment shall be marked in a visible place. This marking shall be legible and durable. If impossible, the marking shall be in users manual.

4.3.4.1 Equipment identification

Additional information shall be included in the users manual:

- receiver classification, see clause 4.1.1;
- transmitter duty cycle, see clause 8.10; or
- LBT, see clause 8.11.

4.3.5 Receiver mute or squelch

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

4.4 Declarations by the provider

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

4.5 Auxiliary test equipment

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

4.6 Interpretation of the measurement results

The interpretation of the results recorded in the test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 5 (see clause 7).

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

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

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

5.2 Test power source

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

The test power source used shall be recorded and stated.

5.2.1 External test power source

During tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment. The external test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements any external power, leads should be so arranged so as not to affect the measurements.

During tests, the external test power source voltages shall be within a tolerance < ±1 % relative to the voltage at the beginning of each test.

5.2.2 Internal test power source

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

If appropriate, the external test power source may replace the supplied or recommended internal batteries at the required voltage, for conducted measurements or where a test fixture is used, this shall be recorded and stated.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

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

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

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

5.3.2 Normal test power source

5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages, for which the equipment was designed.

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

5.3.2.2 Regulated lead-acid battery power sources

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

5.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment provider. Such values shall be recorded and stated.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

5.4.1.1 Procedure for tests at extreme temperatures

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

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

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

5.4.1.1.1 Procedure for equipment designed for continuous operation

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

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

5.4.1.1.2 Procedure for equipment designed for intermittent operation

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

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

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

  if the providers declared "on" period exceeds one minute then:

  - transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes;

  after which the equipment shall meet the specified requirements.

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

5.4.1.2 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.4.1.1, at the upper and lower temperatures of one of the ranges specified in table 3.

Table 3: Extreme temperature ranges

Category I (General):	-20°C to +55°C
Category II (Portable equipment):	-10°C to +55°C
Category III (Equipment for normal indoor use):	0°C to +35°C
NOTE: The term "equipment for normal indoor use" is taken to mean that the room temperature is controlled and the minimum indoor temperature is equal to or greater than 5°C.	

For special applications, the manufacturer can specify alternative temperature ranges. This shall be reflected in the providers product literature, e.g. the user manual.

The test report shall state which temperature range is used.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

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

5.4.2.2 Regulated lead-acid battery power sources

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

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

5.4.2.3 Power sources using other types of batteries

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

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

The nominal voltage is considered to be the upper extreme test voltage in this case.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment provider and the test laboratory and shall be recorded and stated.

6 General conditions

6.1 Normal test signals and test modulation

The test modulating signal is a signal which modulates a carrier and is dependent upon the type of equipment under test and also the measurement to be performed.

6.1.1 Normal test signals for analogue speech

Normal test signals for analogue speech are specified as follows:

A-M1: a 1 000 Hz tone;

A-M2: a 1 250 Hz tone.

For angle modulation the normal level of the test signals A-M1 and A-M2 shall be that which produces a deviation of 12 % of the channel separation or any lower value as declared by the provider as the normal operating level.

In the case of amplitude modulation, the normal level shall be that which produces a modulation ratio of 60 %, or any lower value, as declared by the provider.

6.1.2 Normal test signals for data

Normal test signals for data are specified as follows:

D-M2: a test signal representing a pseudo-random bit sequence of at least 511 bits in accordance with ITU-T Recommendation O.153 [3]. This sequence shall be continuously repeated. If the sequence cannot be continuously repeated then this and the actual method used shall be stated on the test report;

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

For angle modulation the normal level of the test signal D-M3 shall be that which produces a deviation of 20 % of the channel separation or any other value as declared by the provider as the normal operating level.

In the case of amplitude modulation, the normal level shall be that which produces a modulation ratio of 60 % or any other value as declared by the provider, as the normal operating level.

6.2 Artificial antenna

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

6.3 Test fixture

With equipment intended for use with an integral antenna, and not equipped with a 50 Ω RF output connector, the provider may supply a test fixture (see also clause 4.2.13).

This test fixture is a radio frequency coupling device for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using conducted measuring methods; however, in this case only relative measurements may be performed.

In addition, the test fixture shall provide, where applicable:

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

The performance characteristics of the test fixture shall conform to the following basic parameters:

- the circuitry associated with the RF coupling shall contain no active or non-linear devices;
- the coupling loss shall not influence the measuring results;
- the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people;
- the coupling loss shall be reproducible when the equipment under test is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

6.4 Test sites and general arrangements for radiated measurements

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

6.5 Modes of operation of the transmitter

For the purpose of the measurements according to the present document, there should be a facility to operate the transmitter in an un-modulated state. The method of achieving an un-modulated carrier frequency, or special types of modulation patterns decided by the provider where applicable the test laboratory, the details of which shall be described and stated. It may involve suitable temporary internal modifications of the equipment under test. If it is not possible to provide an un-modulated carrier then this shall be stated.

For purposes of testing, the normal test signal (see clause 6.1) shall be applied to the input of the transmitter under test with the normal input device (e.g. microphone) disconnected.

6.6 Measuring receiver

The term measuring receiver refers to either a selective voltmeter or a spectrum analyser. The bandwidth of the measuring receiver shall be as given in table 4.

Table 4

Frequency being measured: f	Measuring receiver bandwidth (6 dB)	Spectrum analyser bandwidth (3 dB)
f < 150 kHz	200 Hz or	300 Hz
150 kHz ≤ f < 25 MHz	9 kHz or	10 kHz
25 MHz ≤ f < 1 000 MHz	120 kHz or	100 kHz
1 000 MHz ≤ f		1 MHz
NOTE: Specific requirements in ERC/Recommendation 70-03 shall be applied.		

7 Measurement uncertainty

The interpretation of the results recorded in the test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be separately included in the test report;
- the value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 5.

Table 5: Measurement uncertainty

RF frequency	$\pm 1 \times 10^{-7}$
RF power, conducted	±0,75 dB
Maximum frequency deviation: - within 300 Hz and 6 kHz of audio frequency - within 6 kHz and 25 kHz of audio frequency	 ±5 % ±3 dB
Adjacent channel power	±3 dB
Conducted emission of transmitter, valid up to 12,75 GHz	[±4 dB]
Conducted emission of receivers	[±3 dB]
Radiated emission of transmitter, valid up to 12,75 GHz	±6 dB
Radiated emission of receiver, valid up to 12,75 GHz	±6 dB
Bit Error Ratio (BER)	[± 0,5 dB]
]Temperature	±1 K
Humidity	±10 %

For the test methods, according to the present document the uncertainty figures shall be calculated according to the methods described in the TR 100 028 [4] and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Table 5 is based on such expansion factors.

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

8 Methods of measurement and limits for transmitter parameters

Where the transmitter is designed with an adjustable carrier power, then all transmitter parameters shall be measured using the highest power level, as declared by the provider. The equipment shall then be set to the lowest carrier power setting, as declared by the provider, and the measurements for spurious emissions shall be repeated (see clause 8.8).

When making transmitter tests on equipment designed for intermittent operation, the maximum duty cycle of the transmitter, as declared by the provider, shall not be exceeded. The actual duty cycle used shall be recorded and stated.

NOTE: The maximum duty cycle of the transmitter should not be confused with the duty cycle of the device under normal operation conditions.

For frequency hopping spread spectrum (FHSS) the equipment shall be programmed so that measurements can be performed on a selected single carrier or hop frequencies as described in clause 4.2.11.

If the equipment is supplied with both a permanent external 50 Ω RF connector and a dedicated or integral antenna, then full tests shall be carried out using the external connector. In addition, the following tests shall be carried out with the dedicated or integral antenna:

- effective radiated power (radiated) (see clause 8.3);
- spurious emissions (see clause 8.8).

The submitted equipment shall fulfil the requirements of the stated measurement.

8.1 Frequency error

8.1.1 Equipment category

8.1.1.1 Narrow band systems

The frequency error of the transmitter is the difference between the measured unmodulated carrier frequency and the nominal frequency as stated by the provider under normal and extreme conditions (see clause 5.4).

If the equipment is not capable of producing an unmodulated carrier, then the adjacent channel power (see clause 8.6) shall be measured under extreme test conditions (see clause 5.4) and the limits for frequency error in clause 8.6.3 shall be met.

8.1.1.2 Wide band systems

The frequency error, known as frequency drift, is the difference between the frequency measured, of the device under test, under normal test conditions (see clause 5.3) and the frequency measured under extreme conditions (see clause 5.4).

8.1.2 Narrow band

The provider shall state whether the frequency error or adjacent channel power measurement is applicable.

8.1.2.1 Method of measurement

The carrier frequency shall be measured (in the absence of modulation) with the transmitter connected to an artificial antenna. A transmitter without a 50 Ω output connector may be placed in the test fixture (see clause 6.3) connected to an artificial antenna. The measurement shall be made under normal test conditions (see clause 5.3) and extreme test conditions (see clause 5.4) (worst case combination of extreme temperature and supply voltage simultaneously).

8.1.3 Wide band

The measurement shall be made on wide band equipment as defined in the present document, see clause 3.1.

8.1.3.1 Method of measurement

a) Under normal conditions:

Using a spectrum analyzer, a reference point at some level (for example 3 dB point) is selected on the slope of the wanted signal, and the frequency at this point is measured and recorded.

b) Under extreme conditions:

For each combination of extreme value of voltage and temperature (see clause 5.4), the frequency at the same reference point on the slope is measured and recorded. Four values are measured.

c) Maximum frequency drift:

The absolute value of fe-f, shall be recorded in the test report.

Where:

f = the frequency measured under normal conditions (see a) above).

fe = the maximum frequency drift as measured in (see b) above).

8.1.4 Limits

The frequency error or drift shall not exceed the values given in table 6a (for narrow band) or 6b (for wide band) under normal and extreme conditions.

Table 6a: Narrow band

Frequency separation (kHz)	**Frequency error limit (kHz)**				
	< 47 MHz	47 to MHz 137 MHz	> 137 MHz to 300 MHz	> 300 MHz to 500 MHz	> 500 MHz to 1 000 MHz
6,25	±0,75	±0,75	±0,75	±0,75	±0,75
10/12,5	±0,75	±1	±1,50	±1,50	±1,50
20/25	±1,2	±1,35	±2	±2	±2,50
50	±2,5	±2,5	±2,5	±3,0	±5,0
100	±5,0	±5,0	±5,0	±6,0	±10,0
200	±10,0	±10,0	±10,0	±12,0	±20,0

Table 6b: Wide band (BW > 200 kHz)

Frequency error limit (ppm)
±100

Additionally, it shall be noted that the transmitter frequency shall always be inside any allocated sub-band.

8.2 Carrier power (conducted)

If the equipment is designed to operate with different carrier powers, the rated power for each level or range of levels shall be declared by the provider. These measurements shall be performed at the highest power level at which the transmitter is intended to operate.

The gain of the dedicated antenna to be used together with the equipment shall be declared by the provider and this shall be recorded in the test report.

8.2.1 Definition

The carrier power is the average power delivered to the artificial antenna (see clause 6.2) during one 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.

8.2.2 Method of measurement

This method applies only to equipment with a permanent external antenna connector. For equipment with an external antenna connector and supplied with a dedicated antenna, clause 8.3 applies.

The transmitter shall be connected to an artificial antenna (see clause 6.2) and the carrier or mean power delivered to this artificial antenna shall be measured under normal test conditions (see clause 5.3).

In the case of amplitude modulated output, the mean power is measured.

In the case of pulse modulation equipment where it is not possible to make the measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and peak detector set in accordance with the specification of CISPR 16 [5], section one for the bands C and D.

For Direct Sequence Spread Spectrum (DSSS) and other non-Frequency Hopping Spread Spectrum (FHSS) equipment, the maximum power density in a 100 kHz resolution band shall be measured by means of a spectrum analyzer and recorded in the test report.

The measurement shall be repeated under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

8.2.3 Limits

Under normal and extreme test conditions (see clauses 5.3 and 5.4), the carrier output power (conducted) shall not exceed the power class value given in table 7.

Table 7: Carrier power limit, e.r.p.

Power class	Power level mW
5a	0,025
7a	5
8	10
9	25
11	100
12	500

The power density limits for DSSS and other non-FHSS spread spectrum equipment is given in clause 8.4.1.3.

8.3 Effective radiated power

This measurement applies to equipment with an integral antenna and to equipment supplied with a dedicated antenna.

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

These measurements shall be performed at the highest power level at which the transmitter is intended to operate.

8.3.1 Definition

The effective radiated power is the power radiated in the direction of the maximum level under specified conditions of measurements in the absence of modulation.

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

Information on specific modulation schemes is given clause 8.4.

8.3.2 Methods of measurement

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

The test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the frequency of the transmitter.

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

The transmitter shall be switched on, if possible, without modulation and the measuring receiver shall be tuned to the frequency of the transmitter under test.

In case of pulse modulation equipment where it is not possible to make the measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and peak detector set in accordance with the specification of CISPR 16 [5], section one for the bands C and D.

The test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver.

The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The test antenna shall be raised and lowered again through the specified range of height until a 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, clause A.1.5.

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

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

If necessary, 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 the A.1.1 is used, the height of the antenna shall not to be varied.

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

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

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

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

8.3.3 Limits

The effective radiated power shall not exceed the power class value given in table 8.

Table 8: Radiated power limit, e.r.p.

Power class	Power level, e.r.p. mW
5a	0,025
7a	5
8	10
9	25
11	100
12	500

The measurement shall be carried out under normal test conditions only (see clause 5.3).

The power density limits for DSSS and other non-FHSS spread spectrum equipment is given in clause 8.4.1.3.

8.4 Spread spectrum modulation

An equipment shall be tested with its intended modulation. If a product can operate with several modulation types it is considered to be a multi-mode equipment, which shall be tested in each of the modulation modes. For example, if an equipment can operate in both FHSS and non-FHSS then both modes shall be tested.

8.4.1 Frequency hopping spread spectrum devices (FHSS)

In order to maximize the use of the available channels and to minimize the potential of interference to other users, the minimum number of channels, the maximum dwell time on a channel and the maximum return time to a channel are stated in clause 8.4.1.2.

8.4.1.1 FHSS declarations

The following declarations for FHSS shall be made by the provider:

a) The provider shall declare the number of non-overlapping channels or hopping positions separated by the declared hop channel bandwidth. The minimum number of channels shall be greater than or equal to the limit given in clause 8.4.1.2.

b) The provider shall declare the dwell time per channel, which shall not exceed the time stated in clause 8.4.1.2.

c) The provider shall declare the maximum return time to a channel.
This is determined as the equipment is operating (transmitting and/or receiving) each channel of the hopping sequence shall be occupied at least once during a period not exceeding four times the product of the dwell time per hop and the number of channels.

d) The provider shall declare transmit duty cycle for the entire transmission, if LBT is not used.

8.4.1.2 Limits

a) The minimum number of hop channels required are given in table 9.

Table 9: Minimum of hop channels and other requirements for FHSS

Sub-band	Number of hop channels	Other requirements
865 MHz to 868 MHz	> 60	LBT or < 1 % TX duty cycle (see note 1)
865 MHz to 870 MHz (see note 2)	> 47	LBT or < 0,1 % TX duty cycle (see note 1)
863 MHz to 870 MHz (see note 2)	> 67	LBT or < 0,1 % TX duty cycle (see note 1)
NOTE 1: The duty cycle applies to the entire transmission (not at each hopping channel). NOTE 2: The frequency bands for alarms defined in ERC/Recommandation 70-03, annex 7 are excluded.		

b) The maximum dwell time per channel shall be equal to or less than 400 ms.
If the transmit on-time exceeds 400 ms then the equipment shall switch to a non-FHSS mode where duty cycle or LBT restrictions may apply.

c) The maximum return time to a hopping channel shall be equal to 4 x dwell time x number of channels and must not exceed 20 s.

d) In case of LBT being used for FHSS, this function shall be used at each hop channel

e) In the case of FHSS with a dwell time less than the LBT listen time defined in clause 8.11.2.2, a 0,1 % duty cycle restriction applies for the entire FHSS transmission mode.

f) Using the additional test conditions for FHSS in clause 4.2.11 indent b) and c), the conducted power, clause 8.2.3, or radiated power limit, clause 8.3.3, shall not be exceeded.

g) Using the additional test conditions for FHSS in clause 4.2.11 indent a) and b), the adjacent channel power, see clause 8.6.3 or 8.7.3 and spurious emissions, see clause 8.8.5 shall not be exceeded.

8.4.1.3 Direct sequence or spread spectrum other than FHSS

For Direct Sequence Spread spectrum or spread spectrum modulation other than FHSS the following limits given in table 10 apply to the conducted power, clause 8.2.3, or radiated power limit, clause 8.3.3.

Table 10: Maximum radiated power density and duty cycle limits for other spread spectrum than FHSS

Sub-band	Max radiated power density e.r.p	Requirements
865 MHz to 868 MHz	6,2 dBm/100 kHz	1 % TX duty cycle
865 MHz to 870 MHz	-1 dBm/100 kHz	0,1 % TX duty cycle
863 MHz to 870 MHz	-4,5 dBm/100 kHz	0,1 % TX duty cycle

The spurious emissions outside the allocated sub-band, see clause 8.8.5, shall not be exceeded.

8.5 Transient power

8.5.1 Definition

Transient power is the power falling into adjacent spectrum due to switching the transmitter on and off during normal operation (e.g. cyclic keying during data transmission).

8.5.2 Method of measurement

The transmitter under test shall be connected via the power attenuator to the "transient power measuring device" as described in clause 8.5.3, so that the level at its input is suitable, e.g. between 0 dBm and -10 dBm when the transmitter power is the steady state power.

The modulation test signal (as appropriate, see clause 6.1.1) shall be applied at the transmitter. For constant envelope modulation schemes it is not required to apply modulation. The modulation used, if any, shall be recorded in the test report.

The measurement procedure shall be as follows:

a) the transmitter shall be operated at the maximum rated carrier power level, under normal test conditions (see clause 5.3);

b) the tuning of the "transient power measuring device" shall be tuned to the operating channel and adjusted so that a maximum response is obtained. This is the 0 dBc reference level; The transmitter shall then be switched off;

c) the tuning of the "transient power measuring device" shall be adjusted away from the centre of the channel so that its frequency is located at the alternate channel;

d) the transmitter shall be switched on;

e) the spectrum analyser shall be used to record the envelope of the transient power as a function of time (approximately 50 ms duration). The peak envelope transient power shall be noted in dBc;

f) the transmitter shall be switched off;

h) steps d) to e) shall be repeated five times and the highest response during "switch-on" and "switch-off" conditions shall be recorded;

i) steps c) to e) shall be repeated with the "transient power measuring device" tuned to the other side of the wanted channel;

j) steps c) to i) shall be repeated with the tuning of the "transient power measuring device" adjusted away from the centre of the channel by respectively 4 and 10 times the channel spacing of the equipment;

k) the adjacent channel transient is the dBc value corresponding to the highest of the values recorded in step h and i); this value shall be recorded.

8.5.3 Characteristics of the transient power measuring device

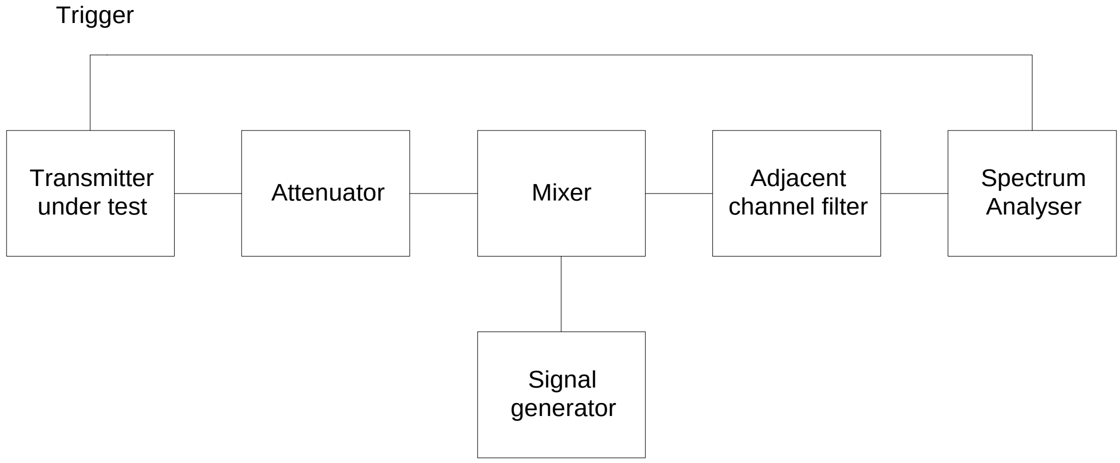


Figure 1: Transient power measuring device measurement arrangement

The adjacent channel transient power measuring device may be as follows:

- mixer: 50 Ω balanced diode mixer; with an appropriate local oscillator level, for example +7 dBm;
- adjacent channel filter: matched to 50 Ω (see annex B);
- spectrum analyser: 30 kHz bandwidth, peak detection, or power/time measurement provision.

Alternatively, a spectrum analyser may be used for the transient power measurement provided that the resolution bandwidth can be adjusted to be equivalent to the filter characteristics defined in annex B. The video bandwidth shall be substantially larger than the resolution bandwidth.

8.5.4 Limits

The transient power in the alternate channel shall not exceed a value of 40 dB below the power of the transmitter without the need to be below 2 μW (-27,0 dBm).

For measurements at 4 and 10 times the channel spacing the transient power shall not exceed 50 dB below power of the transmitter without the need to be below 200 nW (-37,0 dBm).

If the limit is exceeded the measurement in clause 8.5.3 shall be repeated with the attenuator value reduced by 6 dB to determine if transient effect is causing errors.

8.6 Adjacent channel power

These measurements are applicable for a given channel spacing equipment. For wide band equipment with channel spacing of 200 kHz and above, the range of modulation bandwidth shall be measured (see clause 8.7).

8.6.1 Definition

For devices with specified channel bandwidth, the adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation which falls within specified passbands 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.

8.6.2 Method of measurement

The adjacent channel power shall be measured with a spectrum analyzer which conforms with the requirements given in annex C.

For FHSS, the test conditions in clause 4.2.11 indent a) and b) apply.

When using the test fixture (see clause 6.3) for this measurement, it is important to ensure that direct radiation from the transmitter to the power measuring receiver does not affect the result or the loss introduced by the test fixture.

The following procedure shall be used:

The transmitter shall be modulated with test modulation (as appropriate, see clause 6.1). The modulation used shall be recorded in the test report.

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

The resolution bandwidth of the spectrum analyser shall be 100 Hz.

The rms power present in the nominal channel, measured on the spectrum analyser, shall be recorded (the wanted channel power, PR).

For the purpose of the remainder of this test the resolution bandwidth of the spectrum analyzer shall be 0,7 × the channel spacing. The resolution bandwidth shall be centred one channel spacing above the centre of the nominal channel. The rms power measured in the resolution bandwidth shall be recorded (the adjacent channel power).

The measurement shall be repeated with the resolution bandwidth centred one channel spacing below the centre of the nominal channel.

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

Measurement under extreme conditions (see clause 5.4) may be omitted if the equipment is capable of testing for frequency stability and such tests are carried out under clause 8.1.

Measurement under extreme conditions (see clause 5.4) may be omitted if the equipment is capable of testing for frequency stability and such tests are carried out under clause 8.1.

8.6.3 Limits

The power in the adjacent or alternate channels shall not exceed the maximum values given in table 11.

Table 11

	Channel separation < 20 kHz	Channel separation ≥ 20 kHz
Normal test conditions	10 μW	200 nW
Extreme test conditions	32 μW	640 nW
NOTE: These limits also apply to spread spectrum equipment, see clause 8.3.4.		

8.7 Modulation bandwidth for wide band equipment (> 200 kHz)

8.7.1 Definition

This measurements applies to equipment with a bandwidth above 200 kHz only, including spread spectrum modulation. The range of modulation bandwidth includes all associated side bands above the appropriate spurious level and the frequency error or drift under extreme test conditions.

8.7.2 Method of measurement

In case of equipment with integral antenna, the equipment shall be placed in the test fixture (see clause 6.3). The RF output of the equipment or the test fixture shall be connected to a spectrum analyser via a 50 Ω connector and attenuator.

The transmitter shall be operated at the carrier power measured under normal test conditions in clause 8.2 or 8.3. The attenuator shall be adjusted to an appropriate level displayed on the spectrum analyser screen.

For FHSS, the test conditions in clause 4.2.11 indent c) apply.

The transmitter shall be modulated by the normal test signal (see clause 6.1).

The output power of the transmitter, with or without a test fixture, shall first be measured using a spectrum analyser resolution bandwidth large enough to accept all major modulation side bands. The power level calibration of the spectrum analyser shall then be related to the power level measured in clause 8.2 or 8.3. The calculated relation will be used to calculate absolute levels of RF power.

The spectrum analyzers resolution bandwidth shall then be changed to 100 kHz. The frequencies of the upper and lower points, where the displayed power envelope of modulation equals the appropriate spurious emission level (see clause 8.8.5) is recorded.

The video bandwidth should be chosen by a factor 10 greater than the ascertained resolution bandwidth.

8.7.3 Limits

The permitted range of modulation bandwidth including the frequency error or drift as measured in clause 8.1.4 shall be within the limits of the assigned wide-band channel, subband or frequency band, as appropriate.

Where an assigned frequency band has been subdivided into channels with bandwidths greater than 200 kHz, the 250 nW limit shall apply to the adjacent channel. Where the band is divided into subbands the 250 nW limit shall apply to the subband edge frequencies.

This limit also applies to spread spectrum equipment.

8.8 Spurious emissions

In the case of pulse modulation equipment the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and quasi-peak detector set in accordance with the specification of CISPR 16 [5], section one for the bands C and D.

For measurements above 1 000 MHz the peak value shall be measured using a spectrum analyser.

In the case of pulse modulation equipment, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and quasi-peak detector set in accordance with the specification of CISPR 16 [5], section one for the bands C and D.

8.8.1 Definition

Spurious emissions are emissions at frequencies other than those of the wanted carrier frequency and its sidebands associated with normal test modulation.

For FHSS spread spectrum modulation the above definition is valid at any time and at any hopping channel.

The level of spurious emissions shall be measured as:

a) either:

  i) their power level in a specified load (conducted spurious emission); and

  ii) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);

b) or:

  their effective radiated power when radiated by the cabinet and the integral antenna, in the case of portable equipment fitted with such an antenna and no external RF connector.

8.8.2 Method of measuring the power level in a specified load, clause 8.8.1 a) i)

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.

- In the case of pulse modulation, the transmitter shall be switched on with test modulation D-M2.
- If this is not possible then the measurements shall be made with the transmitter modulated by the normal test signal D-M3 (see clause 6.1.2) in which case this fact shall be recorded in the test report.

The measuring receiver, (see clause 6.6) 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. To improve the accuracy of the measurement, a RF preselector may be added in order to avoid harmonic components being introduced by the mixer in the receiver.

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.

8.8.3 Method of measuring the effective radiated power, clause 8.8.1 a) ii)

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 provider.

The transmitter antenna connector shall be connected to an artificial antenna (see clause 6.2). The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver.

In the case of pulse modulation the transmitter shall be switched on with test modulation D-M2

If this is not possible, then the measurements shall be made with the transmitter modulated by the normal test signal D-M3 (see clause 6.1.2) in which case the fact shall be recorded in the test report.

The measuring receiver shall be tuned over the frequency range 25 MHz to 4 GHz, for equipment operating on frequencies below 470 MHz, or over the frequency range of 25 MHz to 12,75 GHz for equipment operating on frequencies above 470 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

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

The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver and the test antenna height shall be adjusted again for maximum signal level.

The maximum signal level detected by the measuring receiver shall be noted.

The transmitter shall be replaced by a substitution antenna as defined in clauses A.1.4 and A.1.5.

The substitution antenna shall be orientated for vertical polarization and calibrated for 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 clause A.1.1 is used, the height of the antenna need not be varied.

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 any 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 any change of input attenuator setting of the measuring receiver.

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

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

If applicable, the measurements shall be repeated with the transmitter on standby.

8.8.4 Method of measuring the effective radiated power, clause 8.8.1 b)

This method applies only to equipment without an external antenna connector. The method of measurement shall be performed according to clause 8.8.3, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

8.8.5 Limits

The power of any spurious emission, conducted or radiated, shall not exceed the following values given in table 12.

Table 12

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Operating	4 nW	250 nW	1 μW
Standby	2 nW	2 nW	20 nW

8.9 Frequency stability under low voltage conditions

This test is for battery operated equipment only.

8.9.1 Definition

The frequency stability under low voltage condition is the ability of the equipment to remain on channel, for channelized equipment, or within the assigned operating frequency band, for non-channelized equipment, when the battery voltage falls below the lower extreme voltage level.

8.9.2 Method of measurement

The carrier frequency shall be measured, where possible in the absence of modulation, with the transmitter connected to an artificial antenna. A transmitter without a 50 Ω output connector may be placed in a test fixture (see clause 6.3) connected to an artificial antenna. The measurement shall be made under normal temperature and humidity conditions (see clause 5.3.1), the voltage from the test power source shall be reduced below the lower extreme test voltage limit towards zero. Whilst the voltage is reduced the carrier frequency shall be monitored.

8.9.3 Limits

The equipment shall either:

a) remain on channel, for channelized equipment within the limits stated in clause 8.1.4 , or within the assigned operating frequency band, for non-channelized equipment, whilst the radiated or conducted power is greater than the spurious emission limits; or

b) the equipment ceases to function below the providers declared operating voltage.

8.10 Duty Cycle

For equipment with the listen before talk or access protocol facility together with a preferred option of Adaptive Frequency Agility (AFA), a duty cycle restriction does not apply, see clause 8.11.

The requirement for duty cycle or LBT does not apply if the radiated power is below -36 dBm.

8.10.1 Definitions

For the purposes of this present document the duty cycle is defined as the ratio, expressed as a percentage, of the maximum transmitter "on" time monitored over one hour, relative to a one hour period. The device may be triggered either automatically or manually and depending on how the device is triggered will also depend on whether the duty cycle is fixed or random.

8.10.2 Declaration

For automatic operated devices, either software controlled or pre-programmed devices, the provider shall declare the duty cycle class or classes for the equipment under test, see table 13.

For manual operated or event dependant devices, with or without software controlled functions, the provider shall declare whether the device once triggered, follows a pre-programmed cycle, or whether the transmitter remains on until the trigger is released or the device is manually reset. The provider shall also give a description of the application for the device and include a typical usage pattern. The typical usage pattern as declared by the provider shall be used to determine the duty cycle and hence the duty class, see table 13.

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

For devices with a 100 % duty cycle transmitting an unmodulated carrier most of the time, a time-out shut-off facility shall be implemented in order to improve the efficient use of spectrum. The method of implementation shall be declared by the provider.

8.10.3 Duty cycle class

In a period of 1 hour the duty cycle shall not exceed the class values given in table 13.

Table 13

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

It shall be noted that equipment with LBT and a preferred option of Adaptive Frequency Agility (AFA) does not need a duty cycle restriction, for further details, see clause 8.11.

8.11 Listen Before Talk (LBT)

In order to make maximum use of the available channels, an intelligent or polite equipment using Listen Before Talk (LBT) protocol with a preferred option of Adaptive Frequency Agility (AFA) does not have to comply with the duty cycle conditions as stated in clause 8.10, however, in this case the following paragraphs apply.

For LBT equipment, the device shall listen on the next intended frequency before transmitting. If it is intended to move to a different channel then this channel can be monitored whilst still transmitting at its first channel. If it is not intended to move to a different channel then it should be treated as a single frequency device waiting for a free channel.

The channel occupancy timings refer to the maximum time a device can transmit on a channel, in any one period, and the minimum "listening" period before the device can retransmit either on the same or, for frequency agile equipment, on another channel.

For a device with LBT some of the receiver parameters become essential requirements under the R&TTE Directive [10]. The receiver requirements are the following:

- LBT threshold, for further details, see clause 9.2.
- Blocking or desensitization, for further details, see clause 9.4.

Additional information is given in TR 102 313 [1].

Adjacent channel selectivity, see clause 9.3, is not a mandatory requirement for equipment using LBT, however, it shall be noted that insufficient adjacent channel selectivity may reduce the apparent channel availability.

For spread spectrum systems, LBT can be used if the required timing and threshold limits can be met, if not, then a duty cycle requirement applies, see clauses 8.4 to 8.4.1.3 and 8.11.1 to 8.11.5.
It shall be noted that the use of LBT may be restricted by the dwell time for Frequency Hopping Spread Spectrum systems. In case of fast frequency hopping where the dwell time is shorter than the LBT minimum listening time then a duty cycle requirement applies. See clause 8.4.1.2 indent e).

For equipment using a duty cycle restriction, this clause does not apply, see clause 8.10.

The requirement for LBT or duty cycle does not apply if the radiated power is below -36 dBm.

8.11.1 LBT timing parameters

8.11.1.1 Minimum transmitter off-time

The minimum TX off-time allows other users with LBT facility to get access to a channel.

8.11.1.2 Definition

TX-off is the minimum time the transmitter shall remain off following a transmission, a communication dialogue between units or a polling sequence of other units.

8.11.1.3 Limit

The limit for TX-off is > 100 ms.

The TX-off time shall be declared in the test report the by the equipment provider.

8.11.2 LBT minimum listening time

8.11.2.1 Definition

The minimum listening time is defined as the minimum time that the device listens for a received signal at or above the LBT threshold level (see clause 9.2) after it has decided to transmit in order to determine whether the channel is available for use. The device must listen to the intended channel, for at least the specified minimum period, immediately prior to transmission. The listening time shall consist of the "minimum fixed listening time" and an additional pseudo random part. If during the listening mode another user is detected then the device must not transmit before the channel is determined to be free again. Alternatively, the equipment may select another channel and again start the listen time before transmission.

8.11.2.2 Limit for minimum listening time

The total listen time, t_L, consists of a fixed part, t_F, and a pseudo random part, t_{PS}, as the following:

$$t_L = t_F + t_{PS}$$

a) The fixed part of the minimum listening time, t_F , shall be 5 ms.

b) The pseudo random listening time shall be randomly varied between 0 ms and a value of 5 ms or more as the following:

- If the channel is free at the start of the listen time, $t_{L,}$ then the pseudo random part, $t_{PS,}$ is automatically set to zero by the equipment itself.

- If the channel is busy at the start of the listen time, t_L, then pseudo random part, t_{PS} , should be randomly varied in 0,5 ms steps between 0 ms and a value of 5 ms or more.

The limit for total listen time for the receiver consists of the sum of a) and b) together.

Algorithmic details and values for a) and b) shall be declared by the provider of the equipment.

8.11.2.3 Acknowledge transmissions

There is no requirement for a listen time before an acknowledge can be performed. However, it shall be noted that if the start of an acknowledge is not received before the end of normal fixed part of the listen time (5 ms) then the channel might be taken by an other transmitter.

8.11.3 Maximum transmitter on-time

A transmitter shall only be allowed to transmit continuously for a maximum specified period. This will prevent a transmitter from occupying a channel for an extended period.
The maximum on-time shall always be as short as possible for the application since SRD applications are often battery operated.

8.11.3.1 Definition

The maximum transmitter on-time is defined as the maximum time the transmitter can be on during:

a) A single transmission.

b) Multiple transmissions and acknowledgements for a communication dialogue or polling sequence of other units under the condition that the channel is free.

An equipment intended for very long messages must be capable of switching to a "free" channel before the maximum transmitter on-time is reached for each channel of operation.

8.11.3.2 Limit

The limit for a single transmission TX on-time is < 1 s and this limit shall be declared by the provider. For further information on measurements of maximum transmitter on-time, see clause 9.2.

The time limit for a transmission dialogue or a polling sequence is < 4 s and this limit shall be declared by the provider.

In the case of the above timing, t, is above the limit then the TX-off time limit shall apply automatically.

8.11.4 Declaration of LBT parameters

For automatic operated LBT devices, either software controlled or pre-programmed devices, the provider shall declare all the channel LBT timings for the equipment under test.

8.11.5 Equipment with or without LBT using transmitter time-out-timer

For manual operated or event dependant devices, with or without software controlled functions, the provider shall declare whether the transmission once triggered, follows a pre-programmed time-out-timer, or whether the transmitter remains on until the trigger is released or the device is manually reset.

The provider shall also give a description of the application for the device and include a typical usage pattern. The typical usage pattern as declared by the provider shall be used to determine the channel occupancy timings.

9 Receiver parameters

9.1 Maximum usable sensitivity (conducted)

9.1.1 Definition

The usable sensitivity is the minimum level of signal (electromotive force (emf)) at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal modulation (see clause 6.1), which produces:

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

9.1.2 Method of measurement with continuous bit streams

The following test setup shall be used:

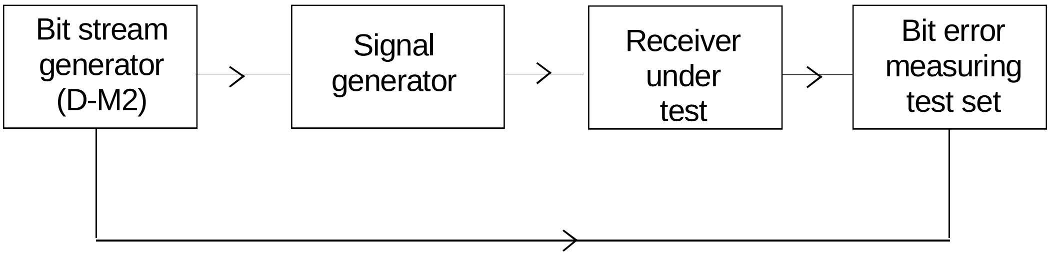


Figure 2: Measurement arrangement

The measurement procedure shall be as follows:

a) an input signal with a frequency equal to the nominal frequency of the receiver, modulated by the normal test signal as appropriate (see clause 6.1), shall be applied to the receiver input terminals.
For equipment with integrated antenna the signal generator is applied to the receiver via a calibrated test fixture (see clause 6.3);

b) the bit pattern of the modulating signal shall be compared to the bit pattern obtained from the receiver after demodulation;

c) the level of the input signal to the receiver is adjusted until the bit error ratio is 10^{-2} or better. (When the value of 10^{-2} cannot be reached exactly, this shall be taken into account in the evaluation of the measurement uncertainty (TR 100 028 [4]);

the maximum usable sensitivity is the emf of the input signal to the receiver.

This value shall be recorded.

d) the measurement shall be repeated under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

The limit(s) corresponding to this parameter can be found in clause 9.1.4.

9.1.3 Method of measurement with messages

The following test setup shall be used:

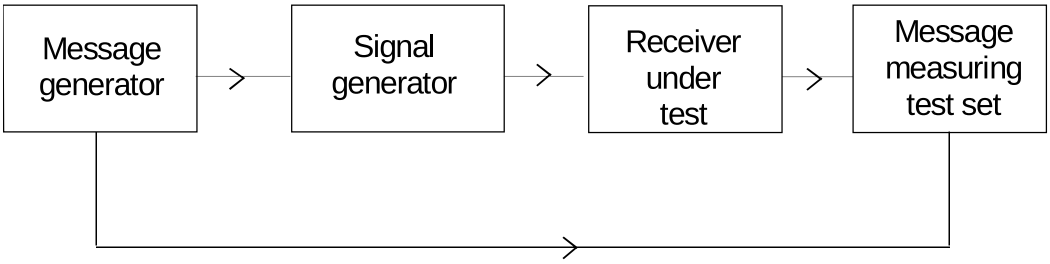


Figure 3: Measurement arrangement

The measurement procedure shall be as follows:

a) an input signal with a frequency equal to the nominal frequency of the receiver, having normal test modulation (see clause 6.1), in accordance with the instructions of the manufacturer (and accepted by the testing laboratory), shall be applied to the receiver input terminals.

   For equipment with integrated antenna the signal generator is applied to the receiver via a calibrated test fixture (see clause 6.3);

b) the level of this signal shall be such that a successful message ratio of less than 10 % is obtained;

c) the normal test signal (see clause 6.1) shall then be transmitted repeatedly whilst observing in each case whether or not a message is successfully received;

   the level of the input signal shall be increased by 2 dB for each occasion that a message is not successfully received;

   the procedure shall be continued until three consecutive messages are successfully received;

   the level of the input signal shall then be noted;

d) the level of the input signal shall be reduced by 1 dB and the new value noted;

   the normal test signal (see clause 6.1) shall then be transmitted 20 times. In each case, if a message is not successfully received the level of the input signal shall be increased by 1 dB and the new value noted;

   if a message is successfully received, the level of the input signal shall not be changed until three consecutive messages have been successfully received. In this case, the level of the input signal shall be reduced by 1 dB and the new value noted;

   no level of the input signal shall be noted unless preceded by a change in level;

   the maximum usable sensitivity is the average of the values noted in steps c) and d) (which provides the level corresponding to the successful message ratio of 80 %).

This value shall be recorded in the test report.

e) the measurement shall be repeated under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

The limit(s) corresponding to this parameter can be found in clause 9.1.4.

9.1.4 Limits

Under normal test conditions, the usable sensitivity for a 25 kHz channel spacing equipment with a 16 kHz bandwidth shall not exceed +6 dBμV emf for a 50 Ω receiver input impedance. This corresponds to a sensitivity of -107 dBm which shall not be exceeded.

The limit for usable sensitivity for other receiver bandwidths that 16 kHz is given by:

$$S = +6 + 10\log\frac{BW}{16} \quad dB\mu V\ emf$$

where:

S is the sensitivity in dBμV emf.

BW is the bandwidth in kHz.

For further information on field strength sensitivity for equipment with integral antenna, see clause F.2.

For equipment using a Listen Before Talk (LBT) protocol, see clause 9.2.

9.2 Receiver LBT threshold and transmitter max on-time

The measurements and limits apply to a transceiver that facilitates a receiver with a LBT protocol.

9.2.1 Definitions

The LBT threshold is defined as the received signal level above which the equipment can determine whether the channel is available for use or not.

The maximum transmitter on-time for an equipment with LBT facility is defined in clause 8.11.3.1.

9.2.2 Method of measurements

A signal generator and a power meter are each combined via appropriate attenuators into the equipment antenna connector. The following test set-up shall be used:

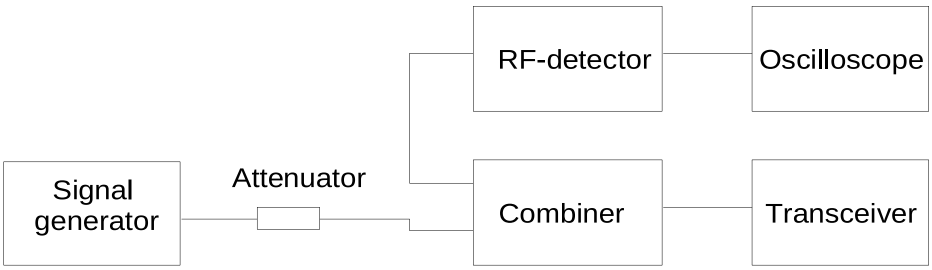


Figure 4: Measurement arrangement

For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, see clause 4.2.13, or via a calibrated test fixture, see clause 6.1.

a) The LBT function of the transceiver shall be active;

b) The attenuator shall provide sufficient attenuation to protect the signal generator from burn-out by the transmitter of the transceiver;

c) The signal generator with normal test modulation is adjusted to the receiving frequency. The level is increased to approximately 20 dB above the receiver sensitivity;

d) The equipment is switched to an intended transmit mode.

NOTE: The equipment shall not be transmitting as the transceiver recognizes a busy channel from the signal generator.

e) The level of the signal generator is reduced in steps of 1 dB until the equipment starts to transmit. This specific signal generator level present at the receiver input of the transceiver is the LBT threshold.

The level of the received LBT threshold shall be recorded in the test report.

f) The steps c) and d) shall be repeated; and

g) The level of the signal generator is reduced in steps of 1 dB until the equipment starts to transmit and the duration of the transmit on-time is measured at the oscilloscope.

The transmit on-time is recorded in the test report.

9.2.3 Limits

The maximum LBT threshold for the receiver in the listen mode is given in table 14.

Table 14: Receiver LBT threshold limit versus transmit power and channel spacing

Channel spacing	< 100 mW	500 mW	Maximum TX on-time
6,25 kHz	-102 dBm	-106 dBm	< 1 sec
12,5 kHz	-99 dBm	-103 dBm	
20/25 kHz	-96 dBm	-100 dBm	
50 kHz	-93 dBm	-97 dBm	
100 kHz	-90 dBm	-94 dBm	
200 kHz	-87 dBm	-91 dBm	
NOTE 1: The limit is independent of the receiver Class, see clause 4.1.1. NOTE 2: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.			

9.3 Adjacent channel selectivity

This measurement is only required where a channel plan is stated.

9.3.1 Definition

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

9.3.2 Method of measurement

This measurement shall be conducted under normal conditions. The following test set-up shall be used:

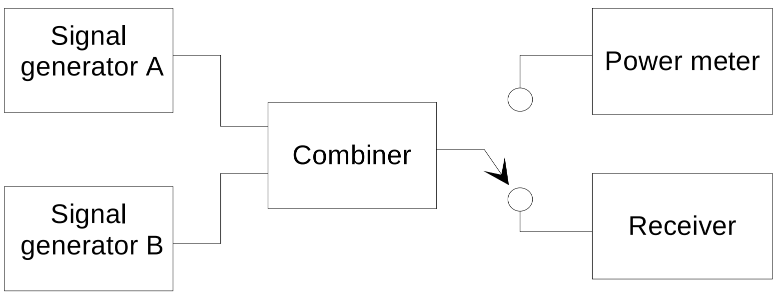


Figure 5: Measurement arrangement

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver antenna connector.

For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, see clause 4.2.13, or via a calibrated test fixture, see clause 6.1.

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

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established, however, the level at the receiver input shall not be below the sensitivity limit given in clause 9.1.4. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and the signal amplitude is adjusted until the wanted criteria, see clause 4.1.2, is just exceeded.

With signal generator B settings unchanged the power into the receiver is measured by replacing the receiver with a power meter or a spectrum analyzer. This power level shall be recorded.

The measurements shall be repeated immediately below the wanted channel.

For special protection requirements for receiver it may be necessary to determine the receiver saturation. In this case the above measurements are repeated with a +40 dB increased level for signal generator A.

9.3.3 Limits

9.3.3.1 Limit for adjacent channel selectivity

The adjacent channel selectivity of the equipment under specified conditions shall be equal to or greater than the unwanted signal as stated in table 15.

Table 15

Receiver class	Channel spacing 12,5 ≤ 25 kHz	Channel spacing > 25 kHz
1	≥ -44 dBm	≥ -34,0 dBm
NOTE: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.		

9.3.3.2 Limit for receiver saturation at adjacent channel

The receiver saturation at the adjacent channel shall be equal or greater than limit given in table 16.

Table 16

Receiver class	Channel spacing 12,5 ≤ 25 kHz	Channel spacing > 25 kHz
1	≥ -20 dBm	≥ -10 dBm
NOTE 1: Measured at a wanted receiving signal at +43 dB above the sensitivity. NOTE 2: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.		

9.4 Blocking or desensitization

9.4.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels or bands, see clauses 9.1 and 9.3.

9.4.2 Method of measurement

This measurement shall be conducted under normal conditions.

The following test set-up shall be used:

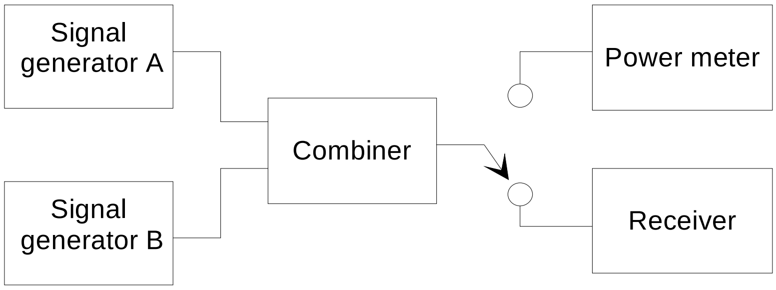


Figure 6: Measurement arrangement

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver antenna connector.
For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, see clause 4.2.13, or via a calibrated test fixture, see clause 6.1.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal. Signal generator B shall be unmodulated and shall be adjusted to a test frequencies of approximately ±2 and ±10 MHz relative to the nominal frequency of the receiver.

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established, however, the level at the receiver input shall not be adjusted below the sensitivity limit given in clause 9.1.4. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria (see clause 4.1.2) is just exceeded.

With signal generator B settings unchanged the power into the receiver is measured by replacing the receiver with a power meter. This level shall be recorded.

The measurements shall be made with the frequency of signal generator B at approximately +2 MHz and +10 MHz from the nominal frequency of the receiver.

The tests shall be repeated with the frequency of signal generator B at approximately at approximately -2 MHz and -10 MHz from nominal frequency of the receiver.

For equipment using LBT the above measurements shall be repeated with signal generator A level adjusted +13 dB higher than in the measurements above (this is equal to a level of +16 dB above the sensitivity).

For special protection requirements for receiver it may be necessary to determine the receiver saturation. The above measurements are repeated with a +40 dB increased level for signal generator A.

9.4.3.1 Limit for blocking

The blocking level, for any frequency within the specified ranges, shall not be less than the values given in table 17, except at frequencies on which spurious responses are found.

Table 17

Receiver class	Frequency offset (MHz)	Limit
1	All	≥ -20 dBm
2	±2	≥ -69 dBm
	±10	≥ -44 dBm
NOTE: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.		

9.4.3.2 Limit for blocking for receivers with LBT

For equipment with LBT the absolute blocking level into the receiver shall not be less than -35 dBm for a wanted signal level for generator A of +16 dB above the sensitivity as defined in clause 9.1.4. This limit is independent of the receiver class, see clause 4.1.1.

9.4.3.3 Limit for receiver saturation for blocking

The receiver saturation at the adjacent channel shall be equal or greater than limit given in table 18.

Table 18

Receiver class	At and outside ± 2 MHz
1	≥ -10 dBm (see note 1)
NOTE 1: Measured at a wanted receiving signal at +43 dB above the sensitivity, see clause 9.5.2. NOTE 2: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.	

9.5 Intermodulation response rejection

9.5.1 Definition

The intermodulation response rejection is a measure of the capability of the receiver to receive a wanted modulated signal, without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

9.5.2 Method of measurement

This measurement shall be conducted under normal conditions. The following test set-up shall be used:

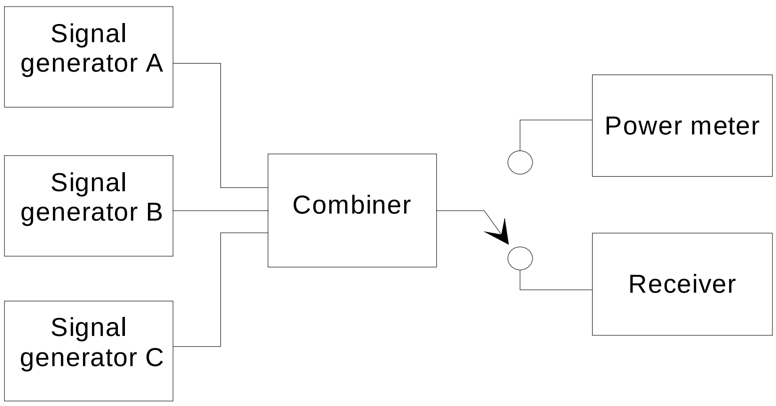


Figure 7: Measurement arrangement

Three signal generators A, B and C shall be connected to the receiver via a combining network to the receiver antenna connector. Precautions shall be taken to ensure adequate isolation between the three signal generators.
For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, see clause 4.2.13, or via a calibrated test fixture, see clause 6.1.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal.

Signal generator B shall be unmodulated on a frequency one channel spacing above the nominal frequency of the receiver.

Signal generator C shall be modulated with test modulation and shall be adjusted to a test frequency two times the channel spacing above nominal frequency of the receiver.

Signal generators B and C, when switched on, shall have identical output level.

Initially signal generators B and C shall be switched off and using signal generator A the level which still gives sufficient response shall be established, however, the level at the receiver input shall not be adjusted below the sensitivity limit given in clause 9.1.4. The output level of generator A shall then be increased by 3 dB.

Signal generators B and C are then switched on and adjusted with the same level until the wanted criteria (see clause 4.1.2) is just exceeded.

With signal generator B settings unchanged and signal generator C switched off, the power into the receiver is measured by replacing the receiver with a power meter. This level shall be recorded.

The above tests shall be repeated with:

- signal generator B adjusted one channel spacing below the nominal frequency of the receiver; and
- signal generator C to two times the channel spacing below nominal frequency of the receiver.

9.5.3 Limit for intermodulation rejection

The intermodulation rejection shall not be less than the values given in table 19.

Table 19

Receiver class	Limit
1	-39 dBm
NOTE: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.	

9.6 Spurious response rejection

9.6.1 Definition

The spurious response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal at any other frequency, at which a response is obtained.

9.6.2 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 defined as the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the intermediate frequency (IF) or where more than 1 IF is involved, at the image frequency of the first and subsequent frequency conversions.
   - at frequency separation corresponding to half of the first IF from the wanted receive frequency.

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 (f_{I1}, f_{I2} etc.).

9.6.2.1 Method of measurement

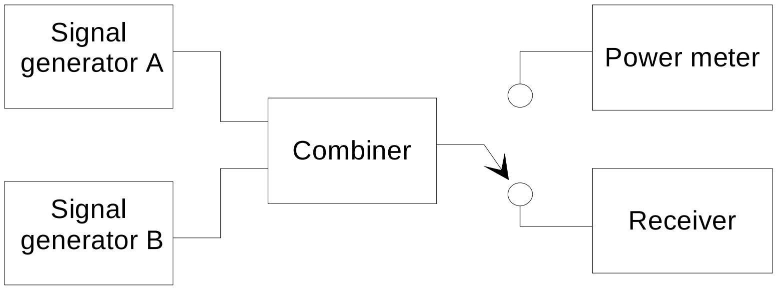


Figure 8: Measurement arrangement

The measurement procedure shall be as follows:

- Two signal generators A and B shall be connected to the receiver via a combining network to the receiver antenna connector.
- For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, see clause 4.2.13, or via a calibrated test fixture, see clause 6.1.
- Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal. Signal generator B shall be unmodulated and shall be adjusted to the test frequency as determined above.
- Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established, however, the level at the receiver input shall not be below the sensitivity limit given in clause 9.1.4. The output level of generator A shall then be increased by 3 dB.
- Signal generator B is then switched on and the signal amplitude is adjusted until the wanted criteria, see clause 4.1.2, is just exceeded.
- With signal generator B settings unchanged the power into the receiver is measured by replacing the receiver with a power meter or a spectrum analyzer. This power level shall be recorded.

9.6.3 Limits for spurious response rejection

The spurious response rejection of the equipment under specified conditions shall be equal to or greater than the unwanted signal as stated in table 20.

Table 20

Receiver class	Channel spacing 12,5 ≤ 25 kHz	Channel spacing > 25 kHz
1	≥ -44 dBm	≥ -34,0 dBm
NOTE: The limits are based on an antenna gain of +2 dBi. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.		

9.7 Receiver spurious radiation

9.7.1 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:

a) either:

 i) their power level in a specified load (conducted spurious emission); and

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

b) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of portable equipment fitted with such an antenna and no external RF connector.

9.7.2 Method of measuring the power level in a specified load, clause 9.7.1 a) i)

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.

9.7.3 Method of measuring the effective radiated power, clause 9.7.1 a) ii)

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

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver. The receiver shall be switched on and the measuring receiver shall be tuned over the frequency range 25 MHz to 4 GHz, for equipment operating on frequencies below 470 MHz, or over the frequency range 25 MHz to 12,75 GHz for equipment operating on frequencies above 470 MHz. 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 clauses A.1.1 or A.1.2 is used, there is no need to vary the height of the antenna.

The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver and the test antenna height shall be adjusted again for maximum signal level.

The maximum signal level detected by the measuring receiver shall be noted.

The receiver shall be replaced by a substitution antenna as defined in clause A.1.5.

The substitution antenna shall be orientated for vertical polarization and calibrated for 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 any change of input attenuator setting of the measuring receiver. The input level to the substitution antenna shall be recorded as power level, corrected for any change of input attenuator setting of the measuring receiver.

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

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

9.7.4 Method of measuring the effective radiated power, clause 9.7.1 b)

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

The method of measurement shall be performed according to clause 9.4.3, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

9.7.5 Limits

The power of any spurious emission, radiated or conducted, shall not exceed the values given below.

The limits are applicable to all receiver classes:

- 2 nW below 1 000 MHz;
- 20 nW above 1 000 MHz.

Annex A (normative): Radiated measurement

This annex has been drafted so that it could be used as well for the assessment of speech, data or equipment providing a specific response.

It covers test sites and methods to be used with integral antenna equipment or equipment having an antenna connector.

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

This clause introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in the relevant parts of TR 102 273 [8] or equivalent.

NOTE: To ensure reproducibility and tractability of radiated measurements only these test sites should be used in measurements in accordance with the present document.

A.1.1 Anechoic Chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure A.1.

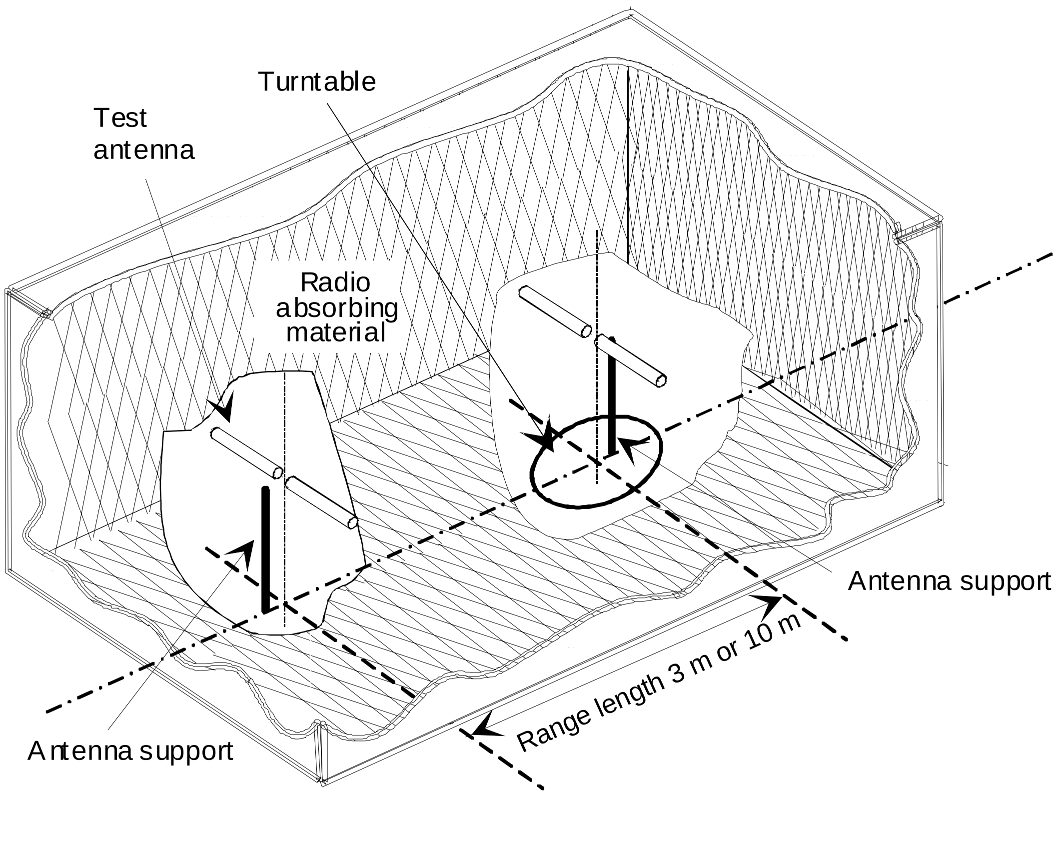


Figure A.1: A typical Anechoic Chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m.) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see to clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

A.1.2 Anechoic Chamber with a conductive ground plane

An anechoic chamber with a conductive ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a conductive ground plane is shown in figure A.2.

This type of test chamber attempts to simulate an ideal Open Area Test Site whose primary characteristic is a perfectly conducting ground plane of infinite extent.

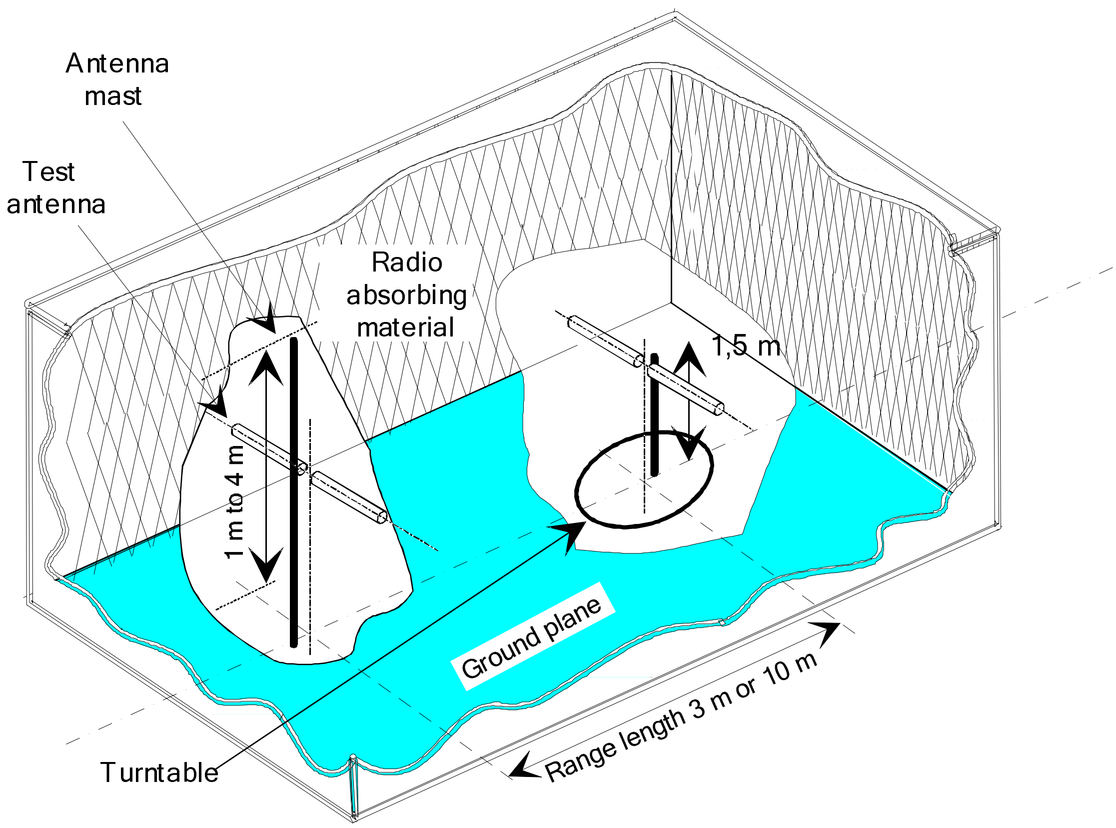


Figure A.2: A typical Anechoic Chamber with a conductive ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2 /\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the EUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

A.1.3 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in figure A.3.

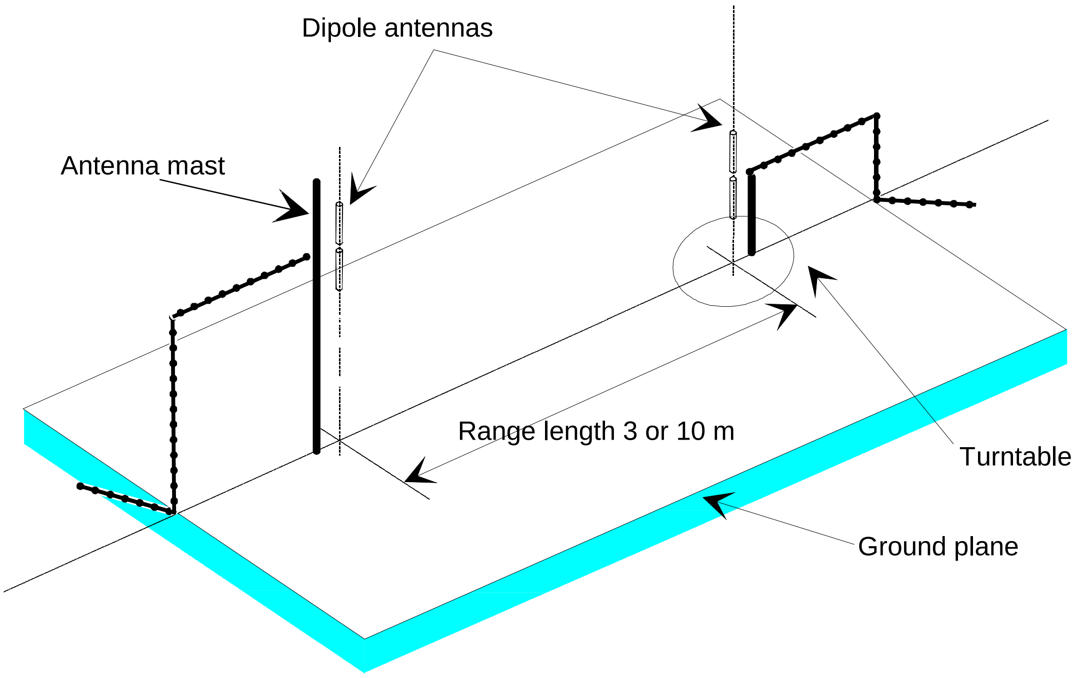


Figure A.3: A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

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

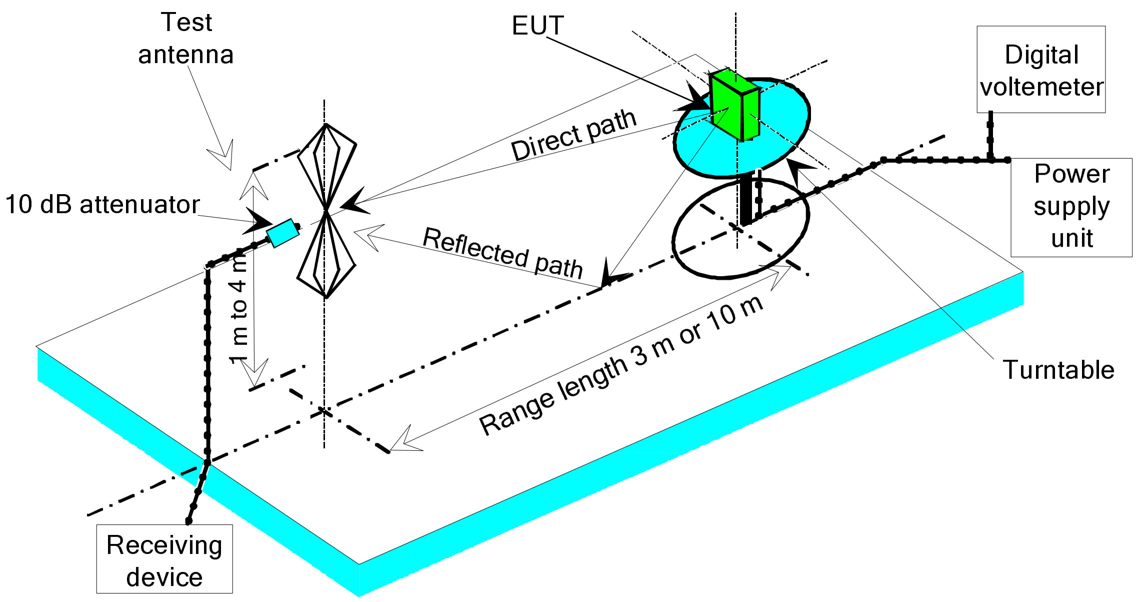


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the EUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 to 4 metres).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [9] generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

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

A.1.5 Substitution antenna

The substitution antenna is used to replace the EUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [9] For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre.

A.1.6 Measuring antenna

The measuring antenna is used in tests on an EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [9] For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT.

A.1.7 Stripline arrangement

A.1.7.1 General

The stripline arrangement is a RF coupling device for coupling the integral antenna of an equipment to a 50 Ω radio frequency terminal. This allows the radiated measurements to be performed without an open air test site but in a restricted frequency range. Absolute or relative measurements can be performed; absolute measurements require a calibration of the stripline arrangement.

A.1.7.2 Description

The stripline is made of three highly conductive sheets forming part of a transmission line which allows the equipment under test to be placed within a known electric field. They shall be sufficiently rigid to support the equipment under test.

A.1.7.3 Calibration

The aim of calibration is to establish at any frequency a relationship between the voltage applied by the signal generator and the field strength at the designated test area inside the stripline.

A.1.7.4 Mode of use

The stripline arrangement may be used for all radiated measurements within its calibrated frequency range.

The method of measurement is the same as the method using an open air test site with the following change. The stripline arrangement input socket is used instead of the test antenna.

A.2 Guidance on the use of radiation test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated test are undertaken. These schemes are common to all types of test sites described in annex A.

A.2.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in annex A (i.e. anechoic chamber, anechoic chamber with a ground plane and Open Area Test Site) are given in the relevant parts of TR 102 273 [8] or equivalent.

A.2.2 Preparation of the EUT

The provider should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, channel separation, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 minute on, 4 min off).

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsa wood, etc.

A.2.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

A.2.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the rated audio output power. In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the rated audio output power. This control should not be readjusted between normal and extreme test conditions in tests.

A.2.5 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the EUT i.e. it should be equal to or exceed:

$$\frac{2(d_1 + d_2)^2}{\lambda}$$

where:

- d_1 is the largest dimension of the EUT/dipole after substitution (m);
- d_2 is the largest dimension of the test antenna (m);
- λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: **For the fully anechoic chamber**, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: **For the anechoic chamber with a ground plane**, a full height scanning capability, i.e. 1 m to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of Anechoic Chamber, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: **For both the anechoic chamber with a ground plane and the Open Area Test Site**, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

A.2.6 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of anechoic chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (i.e. anechoic chambers with ground planes and Open Area Test Sites) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: ±0,5 dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

A.3 Coupling of signals

A.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

A.3.2 Data Signals

Isolation can be provided by the use of optical, ultra sonic or infra red means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infra red radiated connections require suitable measures for the minimization of ambient noise.

A.3.3 Speech and analogue signals

Where an audio output socket is not available an acoustic coupler should be used.

When using the acoustic coupler, care should be exercised that possible ambient noise does not influence the test result.

A.3.3.1 Acoustic coupler description

The acoustic coupler comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier. The materials used to fabricate the funnel and pipe should be of low conductivity and of low relative dielectric constant (i.e. less than 1,5).

- The acoustic pipe should be long enough to reach from the EUT to the microphone which should be located in a position that will not disturb the RF field. The acoustic pipe should have an inner diameter of about 6 mm and a wall thickness of about 1,5 mm and should be sufficiently flexible so as not to hinder the rotation of the turntable.

- The plastic funnel should have a diameter appropriate to the size of the loudspeaker in the EUT, with soft foam rubber glued to its edge, it should be fitted to one end of the acoustic pipe and the microphone should be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the EUT, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the EUT in a close fitting acoustic mounting jig, supplied by the provider, of which the funnel is an integral part.

- The microphone should have a response characteristic flat within 1 dB over a frequency range of 50 Hz to 20 kHz, a linear dynamic range of at least 50 dB. The sensitivity of the microphone and the receiver audio output level should be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the EUT. Its size should be sufficiently small to couple to the acoustic pipe.

- The frequency correcting network should correct the frequency response of the acoustic coupler so that the acoustic SINAD measurement is valid.

A.3.3.2 Calibration

The aim of the calibration of the acoustic coupler is to determine the acoustic SINAD ratio which is equivalent to the SINAD ratio at the receiver output.

A.4 Standard test position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand-held equipment, shall be on a non conducting support with an ε_r as close as possible to one, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

a) for equipment with an internal antenna, it shall be placed in the position closest to normal use as declared by the provider;

b) for equipment with a rigid external antenna, the antenna shall be vertical;

c) for equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

Equipment which is intended to be worn on a person may be tested using a simulated man as support.

The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

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

The container shall be filled with a salt (NaCl) solution of 1,5 g per litre of distilled water.

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

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube which has a hollow centre of 220 mm maximum diameter.

In the stripline arrangement the equipment under test or the substitution antenna is placed in the designated test area in the normal operational position, relative to the applied field, on a pedestal made of a low dielectric material (dielectric constant less than 2).

A.5 Test fixture

The test fixture is only needed for the assessment of integral antenna equipment.

A.5.1 Description

The test fixture is a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements may be performed and only those at or near frequencies for which the test fixture has been calibrated.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) in the case of assessment of speech equipment, an audio interface either by direct connection or by an acoustic coupler.

In the case of non-speech equipment, the test fixture can also provide the suitable coupling means e.g. for the data output.

The test fixture shall normally be provided by the provider.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;

c) circuitry associated with the RF coupling shall contain no active or non-linear devices;

d) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced;

f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

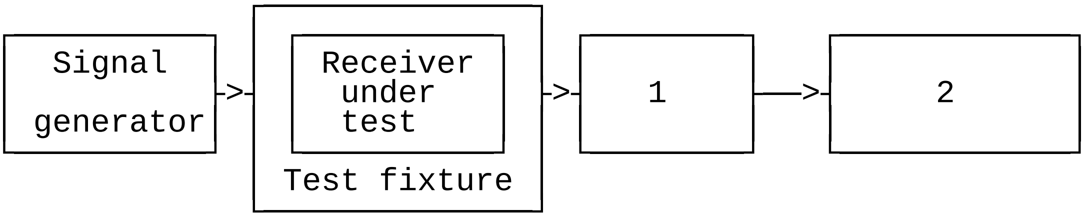
The characteristics and calibration shall be included in the test report.

A.5.2 Calibration

The calibration of the test fixture establishes a relationship between the output of the signal generator and the field strength applied to the equipment placed in the test fixture.

The calibration is valid only at a given frequency and for a given polarization of the reference field.

The actual set-up used depends on the type of the equipment (e.g. data, speech etc.)



1) Coupling device, e.g. AF load/acoustic coupler (in the case of speech equipment).
2) Device for assessing the performance, e.g. distortion factor/audio level meter, BER measuring device etc.

Figure A.5: Measuring arrangement for calibration

Method of calibration:

a) Measure the sensitivity expressed as a field strength, as specified in the present document and note the value of this field strength in dBµV/m and the polarization used.

b) Place the receiver in the test fixture which is connected to the signal generator. The level of the signal generator producing:

- a SINAD of 20 dB;
- a bit error ratio of 0,01; or
- a message acceptance ratio of 80 %, as appropriate;

shall be noted.

The calibration of the test fixture is the relationship between the field strength in dBµV/m and the signal generator level in dBµV emf. This relationship is expected to be linear.

A.5.3 Mode of use

The test fixture may be used to facilitate some of the measurements in the case of equipment having an integral antenna.

It is used in particularly for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under the extreme conditions.

For the transmitter measurements calibration is not required as relative measuring methods are used.

For the receiver measurements calibration is necessary as absolute measurements are used.

To apply the specified wanted signal level expressed in field strength, convert it into the signal generator level (emf) using the calibration of the test fixture. Apply this value to the signal generator.

Annex B (normative):
Specification for measurement filter

Methods of measurement in clause 8.5 refer to the use of a filter. The IF filter shall be within the limits of the selectivity characteristic of figure B.1.

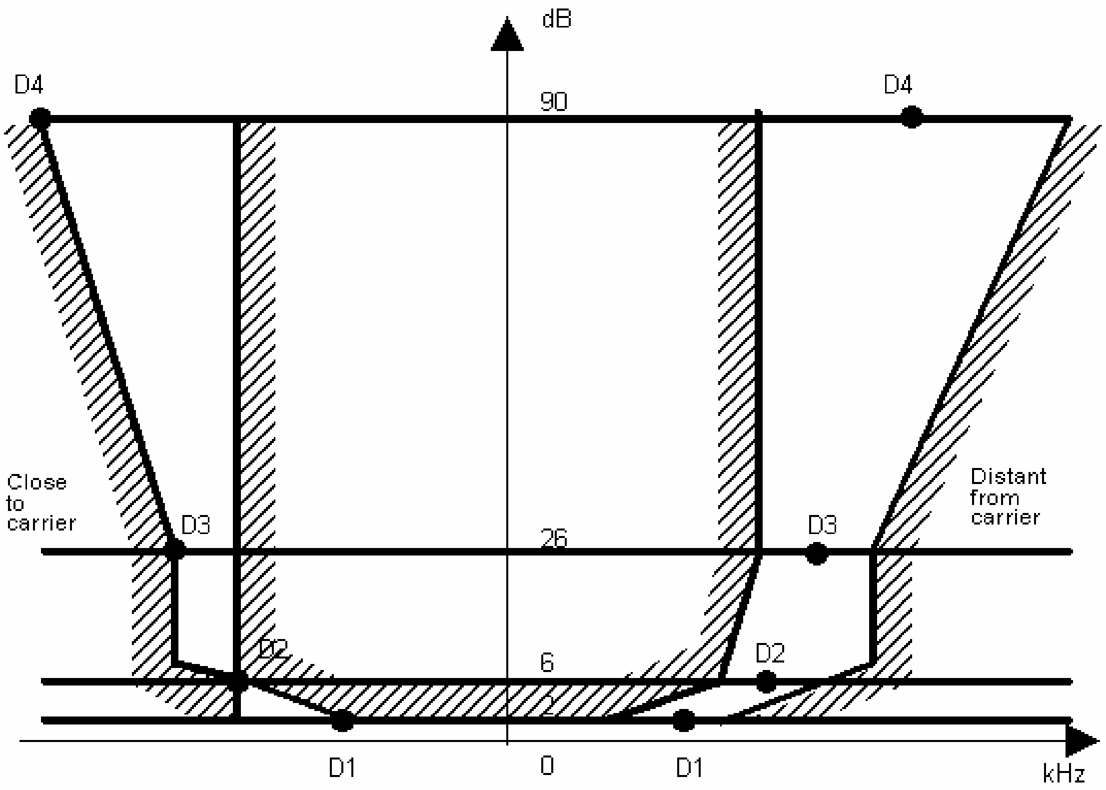


Figure B.1: IF filter

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

Table B.1: Selectivity characteristic

Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
D1	D2	D3	D4
3	4,25	5,5	9,5

The attenuation points shall not exceed the tolerances as stated in tables B.2 and B.3.

Table B.2: Attenuation points close to carrier

Tolerances range (kHz)			
D1	D2	D3	D4
+1,35	±0,1	-1,35	-5,35

Table B.3: Attenuation points distant from the carrier

Tolerance range (kHz)			
D1	D2	D3	D4
± 2,0	± 2,0	± 2,0	+2,0 -6,0

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

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

Methods of measurement in clause 8.6 refer to the use of a spectrum analyser. The characteristics of the spectrum analyser shall meet at least the following requirements:

- the reading accuracy of the frequency marker shall be within ±100 Hz;
- the accuracy of relative amplitude measurements shall be within ±3,5 dB.

It shall be possible to adjust the spectrum analyser to allow the separation on its screen of two equal amplitude components with a frequency difference of 100 Hz.

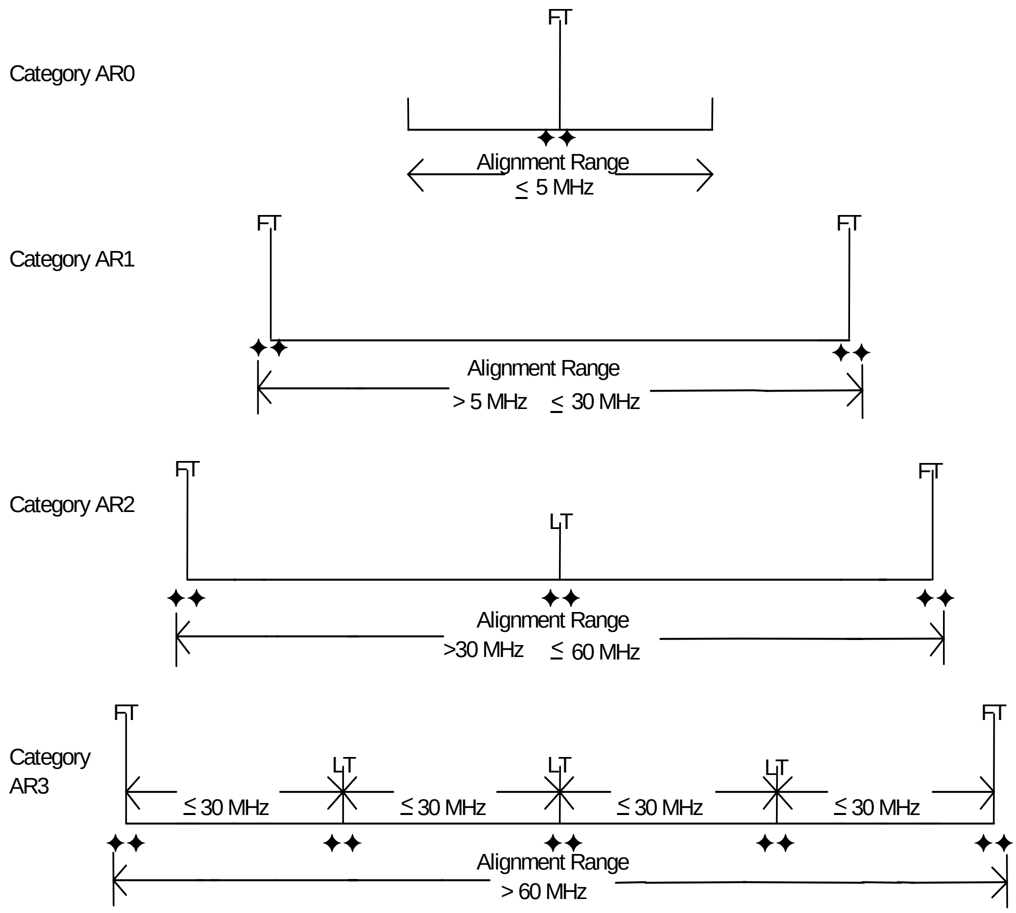
For statistically distributed modulations, the spectrum analyser and the integrating device (when appropriate) needs to allow determination of the power spectral density (energy per time and bandwidth), which has to be integrated over the bandwidth in question.

The spectrum analyser should have a dynamic range greater than 80 dB and the average phase noise in the adjacent and alternate channels shall be such that measurement of adjacent and alternate channel power (see clause 8.6) is not limited by phase noise. In order to confirm this the selected measurement technique for clause 8.6.2 shall be used to measure the adjacent and alternate channel power with a unmodulated signal source with phase noise of less than -110 dBc/Hz at one channel spacing offset and -120 dBc/Hz at two channel spacing offset. The maximum adjacent channel power observed with these conditions shall not exceed -60 dBc, and the maximum alternate channel power measured with these conditions shall not exceed -70 dBc.

Annex D (normative): Graphic representation of the selection of equipment and frequencies for testing

D.1 Tests on a single sample

If the operating frequency range of each equipment corresponds to its alignment range (AR0, AR1, AR2, or AR3), then only one sample shall be tested.

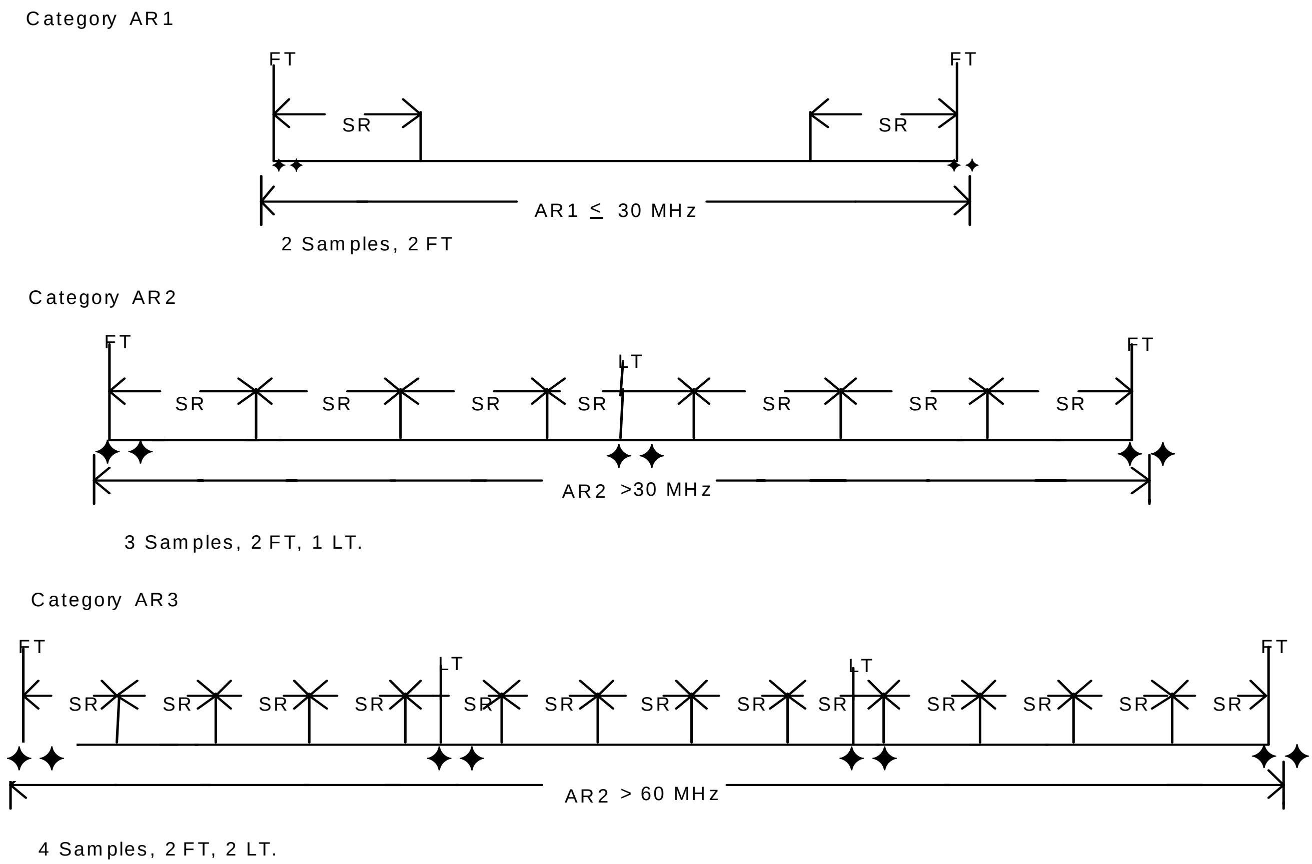


NOTE:
AR0 First category of alignment range, see clause 4.2.3
AR1 Second category of alignment range, see clause 4.2.3
AR2 Third category of alignment range, see clause 4.2.3
AR3 Fourth category of alignment range, see clause 4.2.3
LT Limited tests, see clause 3.1
FT Full tests, see clause 3.1
✦✦ 50 kHz range in which tests are carried out

Figure D.1: Tests on a single sample for equipment that has a SR equal to its alignment range

D.2 Tests and samples needed when the switching range is a subset of the alignment range

In order to cover an alignment range several separate samples, having different SRs within the alignment range, may be needed. Samples shall be then provided for testing in accordance with clauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, as appropriate. The following examples assume a SR of 5 MHz.



NOTE:	SR	Switching Range, see clause 4.2.2
	AR1	Second category of alignment range, see clause 4.2.3
	AR2	Third category of alignment range, see clause 4.2.3
	AR3	Fourth category of alignment range, see clause 4.2.3
	LT	Limited tests, see clause 3.1
	FT	Full tests, see clause 3.1
	✦✦	50 kHz range in which tests are carried out

Figure D.2: Tests on equipment having switching ranges that are subsets of their alignment range

D.3 Tests and samples for a family of equipment where the alignment range is a subset of the total operating frequency range

If the alignment range of a piece of equipment is a subset of the total operating frequency range, then the operating frequency range shall be divided into appropriate categories of alignment range. Samples shall be then provided for testing in accordance with clauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, as appropriate.

For example, the provider seeks type approval for a family of equipment having an operating frequency range of 403 MHz to 470 MHz. The equipment to be tested does not cover this range with one category of alignment range.

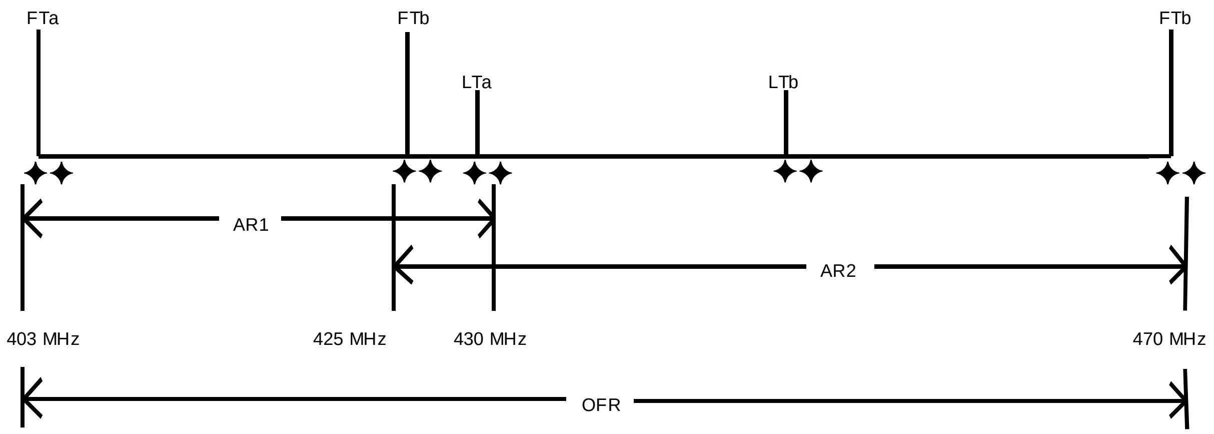
D.3.1 Test scenario 1

The OFR could be covered by two alignment ranges a) and b).

a) 403 MHz to 430 MHz: this is category AR1;

b) 425 MHz to 470 MHz: this is category AR2.

This example requires a minimum of two test samples and a maximum of five test samples to cover the operating frequency range.



NOTE:		
	OFR	Operational frequency range, see clause 4.2.2
	AR1	Second category of alignment range, see clause 4.2.3
	AR2	Third category of alignment range, see clause 4.2.3
	AR3	Fourth category of alignment range, see clause 4.2.3
	Fta	Full tests on sample(s) a). See clause 3.1
	Lta	Limited tests on sample(s) a). See clause 3.1
	FTb	Full tests on sample(s) b)
	LTb	Limited test on sample(s) a)
	✦✦	50 kHz range in which tests are carried out

Figure D.3: Tests on family member equipment having alignment ranges that are subsets of the total operating frequency range - Example 1

D.3.2 Test scenario 2

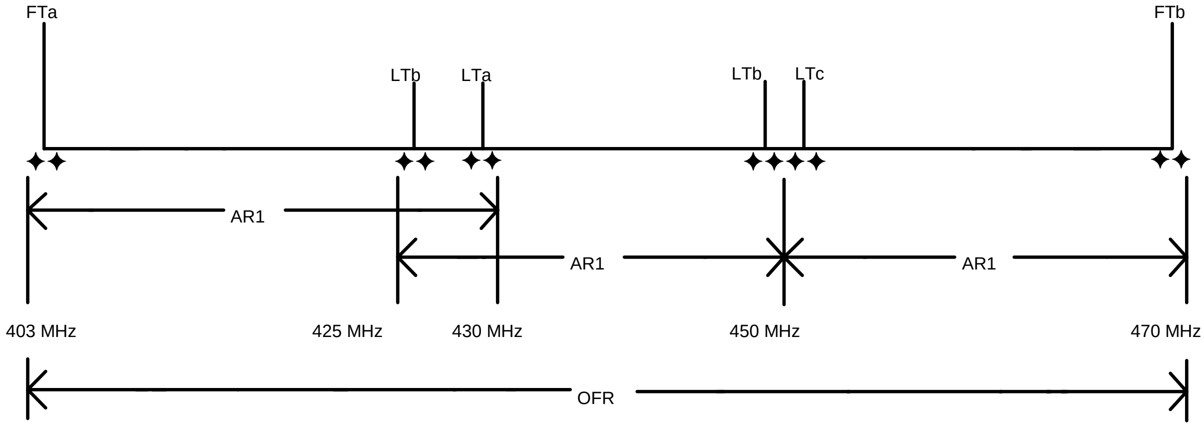
The OFR could alternatively be covered by three alignment ranges of category AR1:

a) 403 MHz to 430 MHz: this is category AR1;

b) 425 MHz to 450 MHz: this is category AR1;

c) 450 MHz to 470 MHz: this is category AR1.

This example requires a minimum of three test samples and a maximum of six test samples to cover the operating frequency range.



NOTE:
- OFR Operational frequency range, see clause 4.2.2
- AR1 Second category of alignment range, see clause 4.2.3
- AR2 Third category of alignment range, see clause 4.2.3
- AR3 Fourth category of alignment range, see clause 4.2.3
- Fta Full tests on sample(s) a). See clause 3.1
- Lta Limited tests on sample(s) a). See clause 3.1
- LTb Limited test on sample(s) a)
- FTc Full tests on sample(s) c)
- LTc Limited tests on sample(s) c)
- ✦✦ 50 kHz range in which tests are carried out

Figure D.4: Tests on family member equipment having alignment ranges that are subsets of the total operating frequency range - Example 2

Annex E (normative): Application: Social alarm systems

E.1 General

This annex covers equipment operating in a domestic or residential environment. It covers fixed, mobile or portable transmitters working into fixed receivers.

This annex assumes a certain path loss if the equipment has to operate with adequate reliability. The minimum power level recommended in this annex takes into account the effects of:

- non uniform radiation patterns of the transmitter and receiver antennas;
- reflections caused by the construction of the building, moveable objects and persons;
- attenuation by commonly used building materials;
- path loss assuming a distance of typically 10 m;
- operating frequency;
- interference by other transmitters.

E.2 Classification of effective radiated power levels

There are four classes of Effective Radiated Power (ERP) as detailed in table E.1.

Table E.1

Power Class	Radiated level ERP
A	≥ 2 mW to 10 mW
B	≥ 100 µW to 2 mW
C	≥ 10 µW to < 100 µW
D	< 10 µW
NOTE: Power class A shall be used to avoid interference from co-located or near-by high power transmitters.	

E.3 Receiver parameters and limits

The receiver parameters and limits are stated in clause 9 of the present document. This clause also contains the method of measurement of the receiver parameters.

Social Alarm receivers shall meet the following requirements for class 1 receivers of the present document as stated in table E.2.

Table E.2: Requirements for Social Alarm receivers

Receiver parameter	≤ 200 MHz	> 200 MHz	Receiver class
Sensitivity	See clause 9.1.4	See clause 9.1.4	
Adjacent channel selectivity	See clauses 9.3.3.1 and 9.3.3.2	See clause 9.3.3.1	Class 1
Blocking and desensitization	See clause 9.5.3.1	See clause 9.5.3.1	Class 1
Intermodulation rejection	See clauses 9.4.3.1 and 9.4.3.2	See clause 9.4.3.1	Class 1
Spurious response rejection	See clause 9.6.3	See clause 9.6.3	Class 1

Additional information for field strength sensitivity and other supplementary receiver parameters, see annex F.

Annex F (normative): Supplementary parameters for receivers

F.1 Maximum usable sensitivity (conducted)

For details see clause 9.

F.2 Average usable sensitivity (field strength)

This measurement only applies to equipment with an integral or dedicated antenna.

The average, E_{mean}, is calculated from eight measurements of field strength, where the receiver is rotated in 45° increments, starting at an arbitrary orientation.

$$E_{mean} = 20\log_{10}\sqrt{\frac{8}{\sum_{i=1}^{i=8}\frac{1}{x_i^2}}}$$

Where x_i represents the eight field strengths in μV/m.

F.2.1 Definition

The average usable sensitivity of the receiver is the average field strength at the antenna, expressed in dBμV/m, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal which produces:

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

F.2.2 Limits

The average radiated usable sensitivity is given in table 1.

Table 1

Frequency range (MHz)	Average usable sensitivity dBμV/m
Integral antenna fully within the case	
30 to 400	27,0
> 400 to 750	28,5
> 750 to 1 000	30,0
Integral or dedicated antenna with an external length ≤ 20 cm to the case	
30 to 130	18,0
> 130 to 300	19,5
> 300 to 440	21,5
> 440 to 600	23,5
> 600 to 800	25,5
> 800 to 1 000	28,0
Integral or dedicated antenna with an external length > 20 cm to the case	
30 to 130	18,0 - k
> 130 to 300	19,5 - k
> 300 to 375	21,5 - k
> 375 to 440	21,5
> 440 to 600	23,5
> 600 to 800	25,5
> 800 to 1 000	28,0

Where:

$k = 20 \log_{10} ((l + 20) / 40)$; and

l is the length of the external part of the antenna in cm.

Annex E (informative): Bibliography

Ketterling, H-P: "Verification of the performance of fully and semi-anechoic chambers for radiation measurements and susceptibility/immunity testing", 1991, Leatherhead/Surrey.

ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz".

History

Document history		
Edition 1	October 1993	Publication as I-ETS 300 220
V1.2.1	November 1997	Publication
V1.3.1	September 2000	Publication
V2.1.1	April 2005	Public Enquiry PE 20050805: 2005-04-06 to 2005-08-05