

Final draft **ETSI EN 300 220-1** V1.3.1 (2000-07)

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-RP08-0403-1

Keywords

radio, testing, SRD

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Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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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 Voting 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 multi-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: "Supplementary parameters not intended for conformity purposes";
- Part 3: "Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive".(Radio and Telecommunications Terminal 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 manufacturer should provide.

Clauses 5 and 6 gives guidance on the test and general conditions for testing of the device. Clause 7 gives the maximum measurement uncertainty values.

Clause 8 and 9 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.

Annex A provides specifications concerning radiated measurements.

Annex B contains specifications for adjacent channel power measurement arrangements.

Annex C provides information on the spectrum analyser specification.

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

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 to 1 000 MHz and with power levels ranging up to 500 mW;
- 2) receivers in the range from 25 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 [5].

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 It is a product family standard which may be completely or partially superseded by specific standards covering specific applications.

The present document applies to 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, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.

The present document covers fixed stations, mobile stations and portable stations. 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 subclauses 8.5 or 8.6, whichever is applicable, are met.

The radio equipment, covered by SRDs is divided into several power classes based on maximum output power (see table 1). The power class designation is based on CEPT/ERC Recommendation 70-03 [5].

Table 1

Power class	Power level (conducted or radiated) mW
5a	0,025
7a	5
8	10
9	25
11	100
12	500

For non-harmonized parameters, national regulatory conditions can apply regarding the type of modulation, channel/frequency separations, maximum transmitter output power/effective radiated power, duty cycle, equipment marking and the inclusion of an automatic transmitter shut-off facility as a condition of the issue of an individual or general licence, or, as a condition of use under licence exemption. The extreme temperature ranges are fixed and are given in subclause 5.4.1.2.

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] 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: Supplementary parameters not intended for conformity purposes".
- [2] ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific requirements for Short Range Devices (SRD) operating on frequencies between 9 kHz and 25 GHz".
- [3] "Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications equipment and the mutual recognition of their conformity".
- [4] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- [5] CEPT/ERC Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".
- [6] ITU-T Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".
- [7] ETSI ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".
- [8] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [9] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".
- [10] "Council Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations".
- [11] ETSI EN 300 220-3: "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 3: Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive".
- [12] ETSI ETR 273: "Electromagnetic compatibility and Radio Spectrum Matters (ERM): Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties".
- [13] ANSI C63.5 (1988): "Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas".

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

full tests: all tests specified in the present document

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

limited tests: limited tests (see subclauses 4.2.1 to 4.2.10) are as follows:

- transmitter frequency error, see subclause 8.1;
- transmitter carrier power conducted, see subclause 8.2;
- transmitter effective radiated power, see subclause 8.3;
- transmitter adjacent channel power, see subclause 8.5.

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

mobile station: equipment normally fixed in a vehicle

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

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

transponder: a 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 25 kHz, or to be used in a channelized frequency band with a channel spacing greater than 25 kHz

3.2 Symbols

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

AR0, AR1, ...	categories of Alignment Range (see subclause 4.2.3)
dB	decibel
E	field strength
FR _L	Lower end of Frequency Range
FR _C	Centre of Frequency Range
FR _H	Higher end of Frequency Range
FT	Full Test (see subclause 3.1)

LT	Limited Tests (see subclause 3.1)
NaCl	sodium chloride
E _o	reference field strength
R	distance
R _o	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
EMC	ElectroMagnetic Compatibility
emf	electromotive force
ERP	Effective Radiated Power
IF	Intermediate Frequency
MPAD	Maximum Permissible Amplitude modulation Depth
MPFD	Maximum Permissible Frequency Deviation
OFR	Operating Frequency Range
R&TTE	Radio and Telecommunications Terminal Equipment
RE	Radio Equipment
RF	Radio Frequency
rms	root-mean-square
Rx	Receiver
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 2, each having its own set of minimum performance criteria. This classification is based upon the impact on persons in case the equipment does not operate above the specified minimum performance level.

Table 2

Receiver class	Relevant receiver clauses	Risk assessment of receiver performance
1	9.1, 9.2, 9.3 and 9.4	Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person)
2	9.3 and 9.4	Medium reliable SRD communication media e.g. causing Inconvenience to persons, which cannot simply be overcome by other means
3	9.4	Standard reliable SRD communication media e.g. Inconvenience to persons, which can simply be overcome by other means (e.g. manual)
NOTE:	With reference to the present document manufacturers are recommended to declare classification of their devices in accordance with table 2 and EN 300 220-3 [11], subclause 4.2, as relevant. In particular where an SRD which may have an inherent safety of human life implications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.	

4.1.2 General performance criteria

For the purpose of the receiver performance tests, the receiver will produce an appropriate output under normal conditions as indicated below. Where the indicated performance cannot be achieved, the manufacturer shall declare and publish the performance criteria used to determine the performance of the receiver:

- a SND/ND ratio of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in ITU-T Recommendation O.41 [9]; or
- after demodulation, a data signal with a bit error ratio of 10^{-2} ; or
- after demodulation, a message acceptance ratio of 80 %.

4.2 Presentation of equipment for testing purposes

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

Where appropriate the manufacturer should choose the appropriate frequencies for testing in consultation with the Administration(s) from whom conformity to the R&TTE Directive[3] or type approval is sought and in accordance with subclauses 4.2.4 to 4.2.12 (see annex D).

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 subclauses 4.2.1 to 4.2.12 (see also annex D).

These subclauses 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 manufacturer 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 manufacturer and agreed by the test laboratory.

In the case of hand portable equipment without a 50 Ω external antenna connector, see subclause 4.2.12.

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

4.2.2.1 Definition of SR

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

The SR is the maximum frequency range, as specified by the manufacturer, 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 manufacturer 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 subclause 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 subclause 3.1) shall be carried out on a frequency within 50 kHz of the highest frequency of the alignment range, and full tests (see subclause 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 subclause 3.1) shall be carried 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 subclause 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 subclause 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 subclause 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 subclauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, for frequency separations of 10 kHz, 12,5 kHz, 20 kHz or 25 kHz as indicated in table 3.

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 subclause 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 subclause 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 subclause 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 subclause 4.2.7.

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

Table 3: Measurements for equipment with more than one frequency separation

Alignment Range	10, 12,5, 20 or 25 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 subclause 3.1)		
LT	Limited tests (see subclause 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 10/12,5 kHz or 20/25 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 subclause 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 alignments 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 subclause 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 subclause 4.2.3.

Full tests (see subclause 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 subclause 4.2.6.

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

See clause D.3 for examples.

4.2.11 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 subclause 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 manufacturer and/or test laboratory and shall be agreed with the Administration(s), based on the requirements of subclause 4.2.

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

4.2.12.1 Equipment with an internal permanent or temporary antenna connector

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated by the manufacturer with the aid of a diagram. The fact that use has been made of the internal antenna connection, 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 manufacturer.

4.2.12.2 Equipment with a temporary antenna connector

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

4.3.4.1 Regulatory marking

The equipment shall be marked in accordance with CEPT/ERC Recommendation 70-03 [5] or the R&TTE Directive [3], whichever is applicable. Where this is not applicable the equipment shall be marked in accordance with national regulatory requirements.

4.3.4.2 Equipment identification, additional marking

The marking should be based on the CEPT/ERC Recommendation 70-03 [5] eg : duty cycle, (see subclause 8.9.1) and in addition:

- receiver classification, see subclause 4.1.1;
- temperature range, see subclause 5.4.1;
- other relevant information.

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 manufacturer

The manufacturer 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 6 (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 subclauses 5.2 to 5.5.

5.2 Test power source

The equipment shall be tested using the appropriate test power source as specified in subclauses 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 subclause 5.2.1 then repeated using the internal power source as specified in subclause 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 subclauses 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 $< \pm 1$ % 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 manufacturer. If internal batteries are used, at the end of each test the voltage shall be within a tolerance of $< \pm 5$ % 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 manufacturer and where appropriate agreed by the accredited test laboratory. 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 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements.

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

5.4.1.1.1 Procedure for equipment designed for continuous operation

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

- before tests at the upper extreme temperature, the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit 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 manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature, the equipment shall be placed in the test chamber and left until thermal balance is attained in the oven. The equipment shall then either:
 - transmit on and off according to the manufacturers declared duty cycle for a period of five minutes;
 - or, if the manufacturers 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 subclause 5.4.1.1, at the upper and lower temperatures of one of the ranges specified in table 4.

Table 4: 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 +55°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.	

In order to comply with the present document, the device shall meet the requirements over the appropriate temperature range stated in table 4. However, the manufacturer may specify a wider temperature range than those stated above.

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 $\pm 10\%$.

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 manufacturer.

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 manufacturer and the accredited 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 manufacturer 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 manufacturer.

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 [6]. 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 accredited test laboratory and the manufacturer 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 manufacturer 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 manufacturer, 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 manufacturer may supply a test fixture (see also subclause 4.2.12).

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, 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 this annex.

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 unmodulated state. The method of achieving an unmodulated carrier frequency, or special types of modulation patterns, may also be decided by the manufacturer and where applicable the accredited 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 unmodulated carrier then this shall be stated.

For purposes of testing, the normal test signal (see subclause 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 5.

Table 5

Frequency being measured: f	Measuring receiver bandwidth (6 dB)	Spectrum analyser bandwidth (3 dB)
$f < 150 \text{ kHz}$	200 Hz or	1 kHz
$150 \text{ kHz} \leq f < 25 \text{ MHz}$	9 kHz or	10 kHz
$25 \text{ MHz} \leq f < 1\,000 \text{ MHz}$	120 kHz or	100 kHz
$1\,000 \text{ MHz} \leq f$		1 MHz

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 6.

Table 6: Measurement uncertainty

RF frequency	$\pm 1 \times 10^{-7}$
RF power, conducted	$\pm 0,75$ dB
Maximum frequency deviation:	
- within 300 Hz and 6 kHz of audio frequency	± 5 %
- within 6 kHz and 25 kHz of audio frequency	± 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

For the test methods, according to the present document the uncertainty figures shall be calculated according to the methods described in the ETR 028 [7] 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 6 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 manufacturer. The equipment shall then be set to the lowest carrier power setting, as declared by the manufacturer, and the measurements for spurious emissions shall be repeated (see subclause 8.7).

When making transmitter tests on equipment designed for intermittent operation, the maximum duty cycle of the transmitter, as declared by the manufacturer, 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.

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 subclause 8.3);
- spurious emissions (see subclause 8.7).

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

8.1 Frequency error

8.1.1 Definitions

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 manufacturer under normal and extreme conditions (see subclause 5.4).

If the equipment is not capable of producing an unmodulated carrier, then the adjacent channel power (see subclause 8.5) shall be measured under extreme test conditions (see subclause 5.4) and the limits in subclause 8.5.3 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 subclause 5.3) and the frequency measured under extreme conditions (see subclause 5.4).

8.1.2 Narrow band

The manufacturer 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 subclause 6.3) connected to an artificial antenna. The measurement shall be made under normal test conditions (see subclause 5.3) and extreme test conditions (see subclause 5.4) (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 sub-clause 3.1. This measurement is not applicable for spread spectrum systems, however, the requirements of subclause 8.6 shall be fulfilled.

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 subclause 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 $f_e - f$, shall not exceed 100 ppm relative to the maximum frequency of the assigned band.

Where:

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

f_e = 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 7 under normal or extreme conditions.

Table 7

Frequency separation (kHz)	Frequency error limit (kHz)				
	< 47 MHz	47 to 137 MHz	> 137 to 300 MHz	> 300 to 500 MHz	> 500 to 1 000 MHz
10/12,5	±0,60	±1	±1(b) ±1,50(m) ±2(p)	±1(b) ±1,50(m) ±2,5(p)	No value specified
20/25	±0,60	±1,35	±2	±2(mb) ±2,50(p)	±2,50(mb) ±3(p)
Wide band	±100 ppm				
NOTE 1: b = fixed station (base) m = mobile station p = portable station					
NOTE 2: For wide band devices; the frequency error figure is subject to investigation with the aim to review/reduce the frequency error, by the year 2005 (Reference ITU Radio Regulations Appendix S.2 and Article S.3.5 and S.3.8)					

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 manufacturer.

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

8.2.1 Definition

The carrier power is the average power delivered to the artificial antenna (see subclause 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, subclause 8.3 applies.

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

In the case of an 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 subclause 6.6 and peak detector set in accordance with the specification of CISPR 16 [8] section one for the bands C and D.

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

8.2.3 Limits

Under normal and extreme test conditions (see subclauses 5.3 and 5.4), the carrier output power (conducted) shall not exceed the power class value given in table 8.

Table 8

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

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 manufacturer.

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.

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 manufacturer.

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 subclause 6.6 and peak detector set in accordance with the specification of CISPR 16 [8] 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, subclause 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.

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 9.

Table 9

Power class	Power level 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 subclause 5.3).

8.4 Response of the transmitter to modulation frequencies

These measurements are not applicable for wide band equipment.

8.4.1 Frequency deviation

This measurement is only applicable for analogue speech (angle modulation).

8.4.1.1 Definition

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

8.4.1.2 Analogue signals within the audio bandwidth

8.4.1.2.1 Method of measurement

The transmitter shall be connected to the artificial antenna (see subclause 6.2). A transmitter without a 50 Ω output connector shall be placed in the test fixture (see subclause 6.3) connected to an artificial antenna. The frequency deviation shall be measured by means of a deviation meter capable of measuring the maximum permissible frequency deviation, including that due to any harmonics and intermodulation products which may be produced in the transmitter. The deviation meter bandwidth shall be suitable to accommodate the highest modulation frequency and to achieve the required dynamic range.

The modulation frequency shall be varied between 300 Hz and 3 000 Hz for equipment operating with 20 kHz or 25 kHz channel separations and between 300 Hz and 2 550 Hz for equipment operating with 10 kHz or 12,5 kHz channel separations. The level of the test signal shall be 20 dB above the level of the normal test signal A-M1 (see subclause 6.1.1), or 10 dB above in case of a transmitter with an integrated microphone.

The maximum (positive or negative) frequency deviation shall be recorded.

8.4.1.2.2 Limits

The maximum frequency deviation for transmitters equipped with speech facilities shall not exceed the values given in table 10.

Table 10

Channel separation	Maximum permissible frequency deviation
10 kHz	±2 kHz
12,5 kHz	±2,5 kHz
20 kHz	±4 kHz
25 kHz	±5 kHz

8.4.1.3 Analogue signals above the audio bandwidth

8.4.1.3.1 Method of measurement

The transmitter shall be connected to the artificial antenna (see subclause 6.2). A transmitter without a 50 Ω output connector shall be placed in the test fixture (see subclause 6.3) connected to an artificial antenna. The frequency deviation shall be measured by means of a deviation meter capable of measuring the maximum frequency deviation, including that due to any harmonics and intermodulation products which may be produced in the transmitter. The deviation meter bandwidth shall be suitable to accommodate the highest modulation frequency and to achieve the required dynamic range.

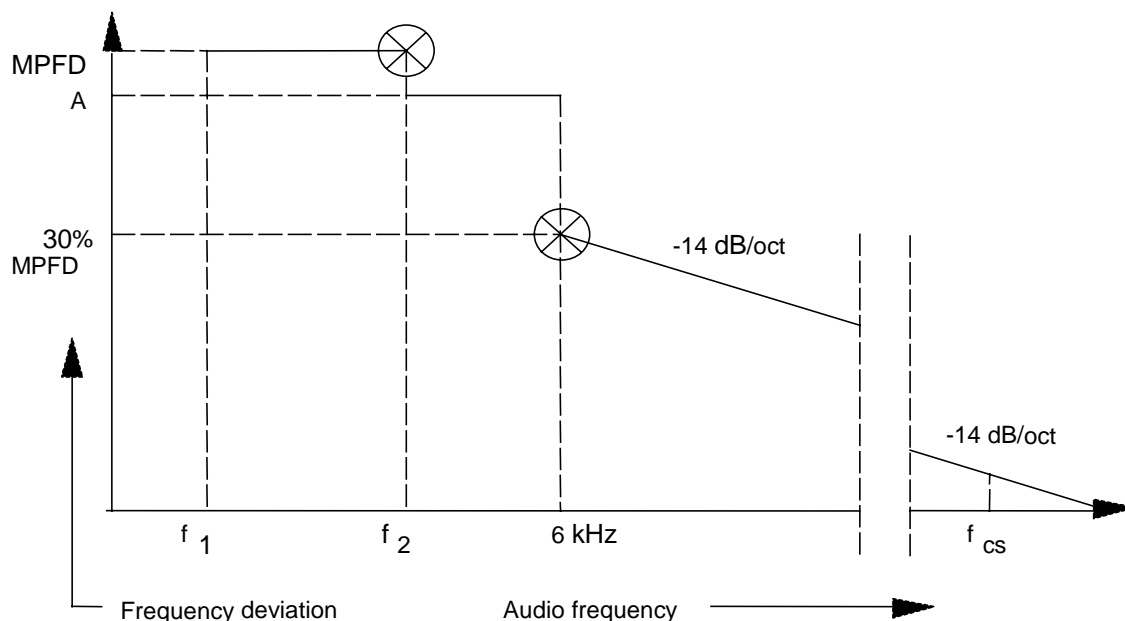
The modulation frequency shall be varied between 3 kHz for equipment operating with 20 kHz or 25 kHz channel separations or 2,55 kHz for equipment operating with 10 kHz or 12,5 kHz channel separations and the frequency equal to the channel separation with a level of the normal test signal A-M1 (see subclause 6.1.1).

The maximum (positive or negative) frequency deviation shall be recorded.

8.4.1.3.2 Limits

The frequency deviation at modulation frequencies below 6 kHz, shall not exceed the frequency deviation at a modulation frequency of 3 kHz/2,55 kHz. At 6 kHz, the deviation shall be not more than 30,0 % of the maximum permissible frequency deviation (see table 10).

The frequency deviation at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed the value given by a linear representation of the frequency deviation (dB) relative to the modulation frequency, starting at the 6 kHz limit and having a slope of -14 dB per octave. These limits are illustrated in figure 1.



NOTE:

- f_1 : 300 Hz
- f_2 : 3,0 kHz (for 20 kHz or 25 kHz channel separation); or
2,55 kHz (for 10 kHz or 12,5 kHz channel separation)
- MPFD: maximum permissible frequency deviation (see subclause 8.4.1.2.2)
- A: measured frequency deviation at f_2
- f_{cs} : frequency equal to channel separation

Figure 1

8.4.2 Modulation depth

This measurement is only applicable for analogue speech (amplitude modulation).

8.4.2.1 Definition

The modulation depth is the ratio of the difference between the maximum and minimum amplitude of the wave to the sum of these amplitudes.

8.4.2.2 Analogue signals within the audio bandwidth

8.4.2.2.1 Method of measurement

The transmitter shall be connected to the artificial antenna (see subclause 6.2). A transmitter without a 50 Ω output connector shall be placed in the test fixture (see subclause 6.3) connected to an artificial antenna. The modulation depth shall be measured by means of a modulation depth meter. The modulation depth meter shall be suitable to cover the required dynamic range.

The modulation frequency shall be varied between 300 Hz and 3 000 Hz for equipment operating with 20 kHz or 25 kHz channel separations, and between 300 Hz and 2 550 Hz for equipment operating with 10 kHz or 12,5 kHz channel separations. The level of the test signal shall be the level which produces a modulation depth of 60 %, or any lower value as declared by the manufacturer using A-M2 (see subclause 6.1.1). The level of the test signal shall then be increased by 20 dB, or 10 dB in the case of a transmitter with an integrated microphone. At each test frequency, the resulting modulation depth shall be recorded.

8.4.2.2.2 Limits

The maximum modulation depth is 100 % for frequencies within the audio bandwidth.

8.4.2.3 Analogue signals above the audio bandwidth

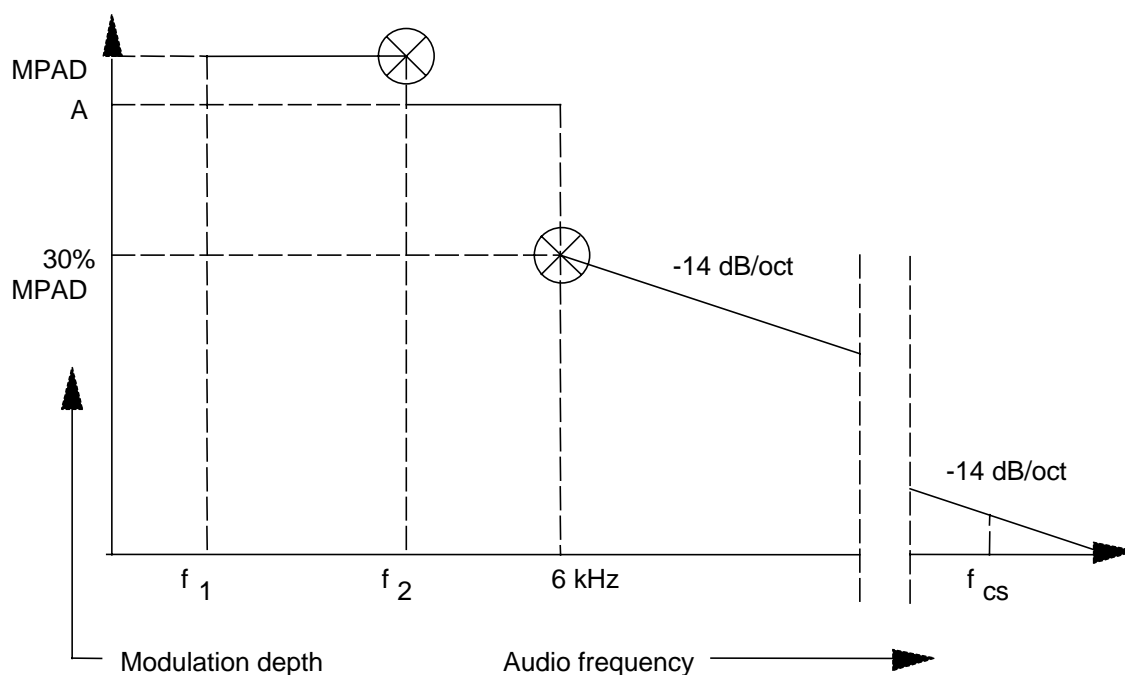
8.4.2.3.1 Method of measurement

The transmitter shall be connected to the artificial antenna (see subclause 6.2). A transmitter without a 50 Ω output connector shall be placed in the test fixture (see subclause 6.3) connected to an artificial antenna. The modulation depth shall be measured by means of a modulation depth meter. The modulation depth meter shall be suitable to cover the required dynamic range.

The modulation frequency shall be varied between 3 kHz for equipment operating with 20 kHz or 25 kHz channel separations, or 2,55 kHz for equipment operating with 10 kHz or 12,5 kHz channel separations and the frequency equal to the channel separation for which the equipment is intended to operate. The level of the test signal shall be the level which produces a modulation depth of 60 %, or any lower value as declared by the manufacturer using A-M2 (see subclause 6.1.1). The level of the test signal shall then be increased by 20 dB, or 10 dB in the case of a transmitter with integrated microphone. At each test frequency, the resulting modulation depth shall be recorded.

8.4.2.3.2 Limits

The modulation depth at modulation frequencies between the audio bandwidth and 6 kHz shall not exceed the modulation depth measured at the audio bandwidth. At 6 kHz the modulation depth shall be not more than 30 %. The modulation depth at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended to operate shall not exceed the value given by a linear representation of the modulation depth (dB) relative to the modulation frequency, starting at the 6 kHz limit and having a slope of -14 dB per octave. These limits are illustrated in figure 2.



NOTE:

f_1 : 300 Hz

f_2 : 3,0 kHz (for 20 kHz or 25 kHz channel separation); or
2,55 kHz (for 10 kHz or 12,5 kHz channel separation)

MPAD: maximum permissible amplitude modulation depth (see subclause 8.4.2.2.2)

A: measured modulation depth at f_2

f_{cs} : frequency equal to channel separation

Figure 2

8.5 Adjacent channel power

These measurements are not applicable for wide band equipment. For wide band equipment, the range of modulation bandwidth shall be measured (see subclause 8.6).

8.5.1 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 a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

8.5.2 Method of measurement

8.5.2.1 Method of measurement using a power measuring receiver

The adjacent channel power shall be measured with a power measuring receiver which conforms with the requirements given in annex B.

When using the test fixture (see subclause 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:

- a) the transmitter under test shall be connected via the test load to a power measuring receiver calibrated to measure rms power level. The level at the receiver input shall be within its allowed limit. The transmitter shall be operated at the maximum operational carrier power level under normal conditions;
- b) the tuning of the power measuring receiver shall be adjusted away from the carrier so that its -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal frequency of the carrier as given in table 11.

Table 11

Channel separation (kHz)	Displacement (kHz)
10	5,75
12,5	8,25
20	13
25	17

The same result may be obtained by tuning the power measuring receiver (point 0 in figure B.1 of the power measuring filter shape) to the nominal frequency of the adjacent channel, if it has been suitably calibrated.

- c) the transmitter shall be modulated as follows:
 - equipment for analogue speech and angle modulation shall be modulated with test signal A-M2 (see subclause 6.1.1) at a level 20 dB above the level of the normal test signal, or 10 dB in case of a transmitter with an integrated microphone;
 - equipment for analogue speech and amplitude modulation shall be modulated with a test signal A-M2 (see subclause 6.1.1) at a level which is 20 dB higher than the level that is required to produce a modulation depth of 60 %, or 10 dB in case of a transmitter with an integrated microphone;
 - equipment using data streams shall be modulated with the test modulation D-M2 (see subclause 6.1.2) at the agreed deviation or modulation depth;
 - equipment for messages shall be modulated with the test modulation D-M3 (see subclause 6.1.2) repeated continuously at the agreed deviation or modulation depth.
- d) the absolute value of the adjacent channel power shall be recorded;
- e) steps b) to d) shall be repeated with the power measuring receiver tuned to the other side of the carrier;
- f) the measurement shall be made under normal conditions and, if applicable, under extreme conditions (see clause 8).

8.5.3 Limits

The adjacent channel power shall not exceed the maximum values given in table 12.

Table 12

	Channel separation < 20 kHz	Channel separation ≥ 20 kHz
Normal test conditions	10 μ W	200 nW
Extreme test conditions	32 μ W	640 nW

8.6 Range of modulation bandwidth for wide band equipment (> 25 kHz)

8.6.1 Definition

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.

8.6.2 Method of measurement

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

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

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

The output power of the transmitter, with or without a test fixture, shall 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 subclause 8.2 or 8.3. The calculated relation will be used to calculate absolute levels of RF power.

The test laboratory shall ensure that the spectrum analyser's span and bandwidth is sufficiently wide enough and scan time slow enough, to ensure that the emission and all its major modulation side bands are captured. The spectrum analyser shall be put in "Maximum hold" mode and the measurement shall be made under normal test conditions (see subclause 5.3). The frequencies of the upper and lower points, where the displayed power envelope of modulation equals the appropriate spurious emission level (see subclause 8.7.5) is recorded.

8.6.3 Limits

The permitted range of modulation bandwidth including the frequency error or drift as measured in subclause 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 25 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.

8.7 Spurious emissions

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 subclause 6.6 and quasi-peak detector set in accordance with the specification of CISPR 16 [8] section one for the bands C and D. For measurements above 1 000 MHz the peak value shall be measured using a spectrum analyser.

8.7.1 Definition

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

- a) 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.

8.7.2 Method of measuring the power level in a specified load, subclause 8.7.1 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. The transmitter shall be switched on with modulation, in the case of pulse modulation, and without modulation, for other types of modulation. If an unmodulated carrier cannot be obtained, then the measurements shall be made with the transmitter modulated by the normal test signal D-M3 (see subclause 6.1.2) in which case this fact shall be recorded in the test report.

The measuring receiver, (see subclause 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.

8.7.3 Method of measuring the effective radiated power, subclause 8.7.1 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 manufacturer.

The transmitter antenna connector shall be connected to an artificial antenna (see subclause 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 transmitter shall be switched on with modulation, in the case of pulse modulation, and without modulation, for other types of modulation. If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the normal test signal D-M3 (see subclause 6.1.2) in which case this 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 subclauses 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 or A.1.2 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.

8.7.4 Method of measuring the effective radiated power, subclause 8.7.1 b)

This method applies only to equipment without an external antenna connector. The method of measurement shall be performed according to subclause 8.7.3, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

8.7.5 Limits

The power of any spurious emission, conducted or radiated, shall not exceed the following values given in table 13.

Table 13

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 μ W
Standby	2 nW	2 nW	20 nW

8.8 Frequency stability under low voltage conditions

This test is for battery operated equipment.

8.8.1 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.

8.8.2 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 subclause 6.3) connected to an artificial antenna. The measurement shall be made under normal temperature and humidity conditions (see subclause 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.

8.8.3 Limits

The equipment shall either:

- a) remain on channel, for channelized equipment within the limits stated in subclause 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 manufacturers declared operating voltage.

8.9 Duty Cycle

8.9.1 Definitions

For the purpose of the present document the term duty cycle refers to the ratio of the total on time of the "message" to the total off time in any one hour period. The device may be triggered either automatically or manually and depending on how the device is triggered will also depend on whether the duty cycle is fixed or random.

8.9.2 Declaration

For software controlled or pre-programmed devices, the manufacturer shall declare the duty cycle class or classes for the equipment under test, see table 14.

For manually operated or event dependant devices, with or without software controlled functions, the manufacturer shall declare whether the device once triggered, follows a pre-programmed cycle, or whether the transmission is constant until the trigger is released or manually reset. The manufacturer 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 manufacturer shall be used to determine the duty cycle and hence the duty class, see table 14.

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

8.9.3 Duty cycle class

In a period of 1 hour the duty cycle shall not exceed the class values given in table 14.

Table 14

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

9 Receiver parameters

9.1 Adjacent channel selectivity - in band

This measurement is required where a channel plan is stated.

9.1.1 Definition

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

9.1.2 Method of measurement

This measurement shall be conducted under normal conditions.

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

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. 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 4.1.2) is just exceeded. This level shall be recorded.

The measurements shall be repeated immediately below the wanted signal.

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

9.1.3 Limits

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 \leq 25 kHz	Channel spacing $>$ 25 kHz
1	60,0 dB	70,0 dB

9.2 Adjacent band selectivity

9.2.1 Definition

The adjacent band selectivity is a measure of the capability of the receiver to operate satisfactorily in the presence of an unwanted signal which is situated at the edge of the assigned band.

9.2.2 Method of measurement

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

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 upper band test frequency.

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria (see 4.1.2) is just exceeded. This level shall be recorded.

The measurements shall be repeated at the lower band edge.

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

9.2.3 Limits

The band edge selectivity of the equipment under specified conditions shall be equal to or greater than the unwanted signal as stated in table 16.

Table 16

Receiver class	At band edge
1	60,0 dB

9.3 Blocking or desensitization

9.3.1 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 subclauses 9.1 and 9.2.

9.3.2 Method of measurement

This measurement shall be conducted under normal conditions.

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

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 1 to 10 MHz above that of the upper band edge.

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria (see subclause 4.1.2) is just exceeded. This level shall be recorded.

The measurements shall be at approximately +1 MHz, +2 MHz, +5 MHz and +10 MHz from the upper band edge.

The tests shall be repeated at approximately -1 MHz, -2 MHz, -5 MHz and -10 MHz from the lower band edge.

The blocking or desensitization shall be recorded as the ratio in dB of the lowest level of the unwanted signal to the level of the wanted signal.

9.3.3 Limits

The blocking ratio, 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	84 dB
2	±1	30 dB
	±2	35 dB
	±5	50 dB
	±10	60 dB

9.4 Spurious radiation

9.4.1 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.

9.4.2 Method of measuring the power level in a specified load, subclause 9.4.1 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.

9.4.3 Method of measuring the effective radiated power, subclause 9.4.1 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 manufacturer. The receiver antenna connector shall be connected to an artificial antenna (see subclause 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 subclause 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.

9.4.4 Method of measuring the effective radiated power, subclause 9.4.1 b)

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

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

9.4.5 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 annex 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 ETR 273 [12] relevant parts 2, 3 & 4.

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.

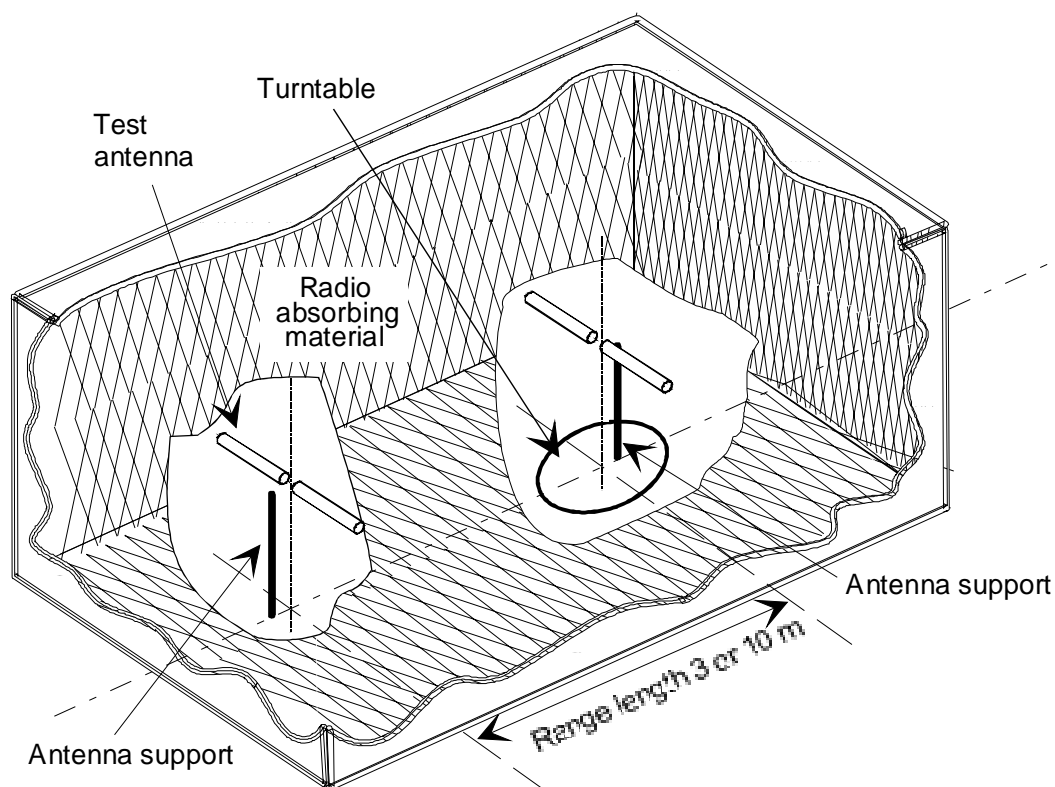


Figure A.1: A typical Anechoic Chamber

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 subclause 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.

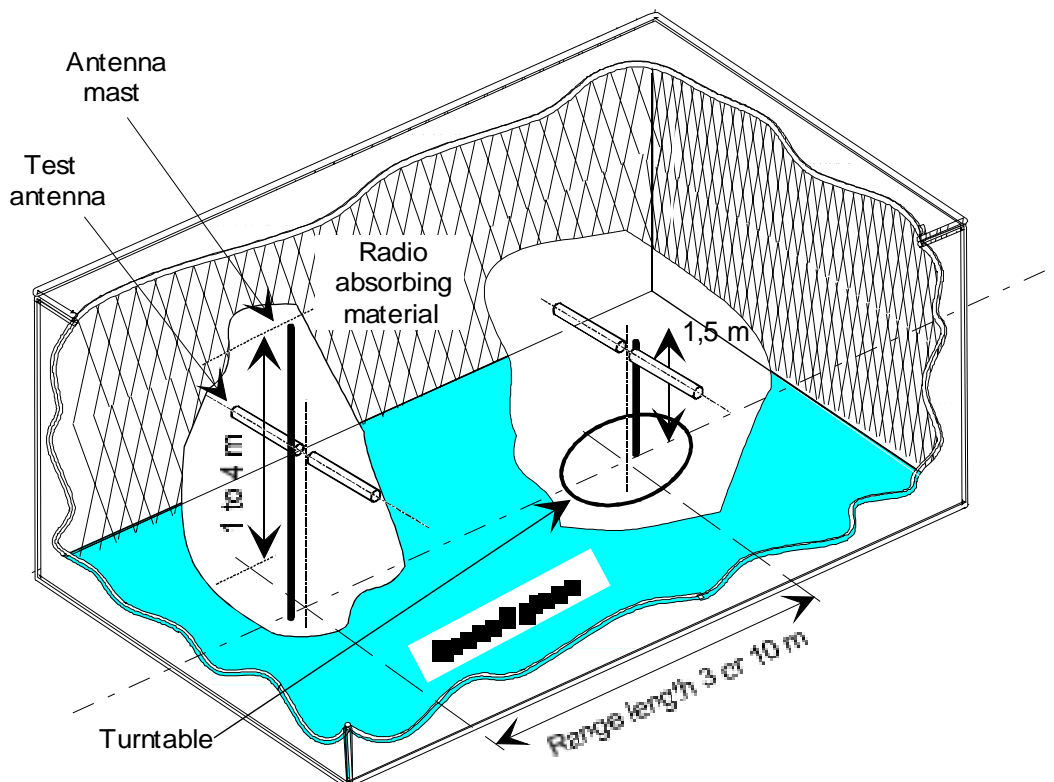


Figure A.2: A typical Anechoic Chamber with a conductive ground plane

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 subclause 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.

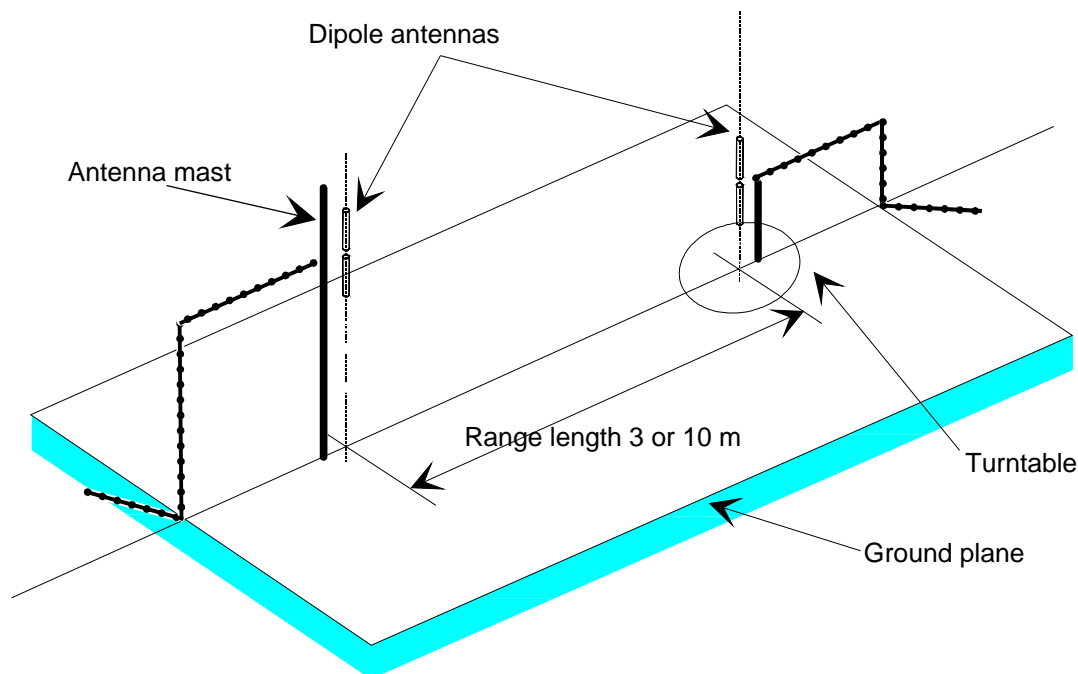


Figure A.3: A typical Open Area Test Site

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.

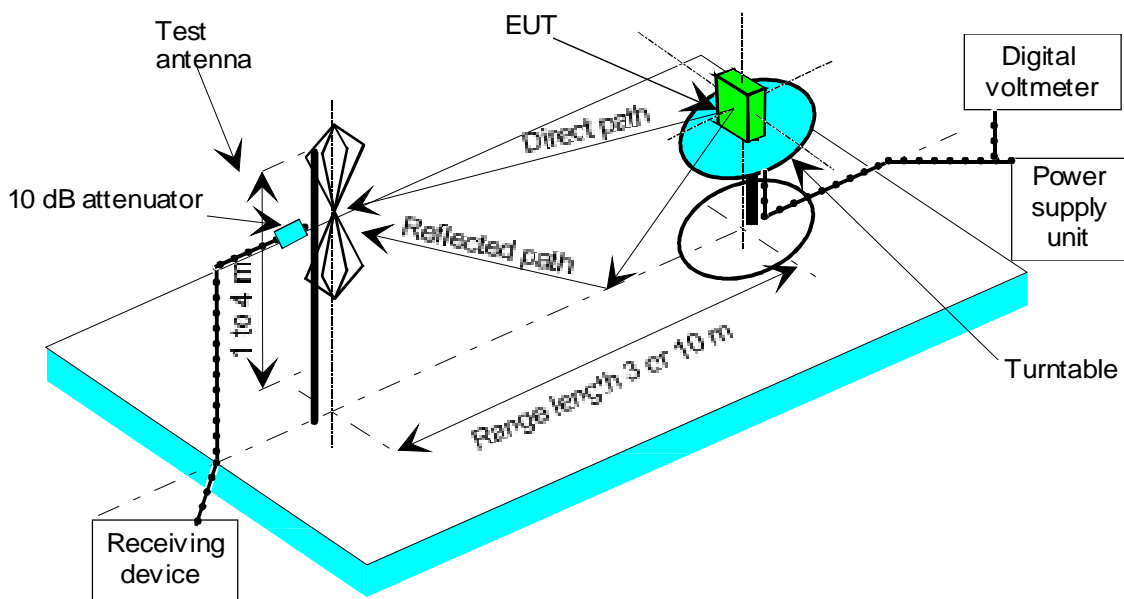


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

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 [13]) are 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 [13]). 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 field strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [13]). 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.

Two examples of stripline characteristics are given below:

		IEC 489-3 App. J	FTZ N°512 TB 9
Useful frequency range	MHz	1 to 200	0,1 to 4000
Equipment size limits	length	200 mm	1 200 mm
(antenna included):	width	200 mm	1 200 mm
	height	250 mm	400 mm

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 ETR 273 [12] Parts 2, 3 and 4, respectively.

A.2.2 Preparation of the EUT

The manufacturer 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 minutes 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 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: $\pm 0,5$ 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 manufacturer, 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 (see IEC 489-3 Appendix F [A.6]).

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, 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 manufacturer;
- 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: $1,7 \pm 0,1$ m;
- Inside diameter: 300 ± 5 mm;
- Sidewall thickness: $5 \pm 0,5$ 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 50Ω 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 manufacturer.

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.

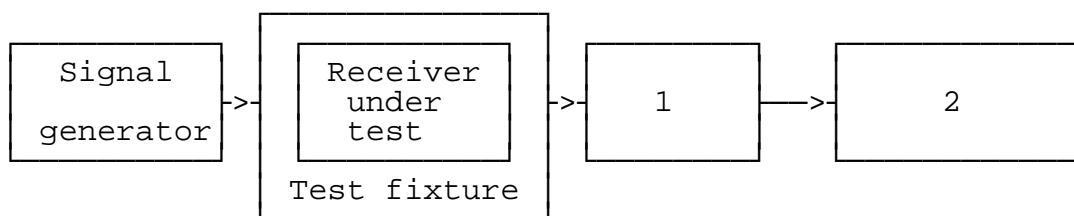
The characteristics and calibration shall be included in the test report.

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.7: 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 dB μ V/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 dB μ V/m and the signal generator level in dB μ V 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 particular 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): Specifications for adjacent channel or adjacent band power measurement arrangements

B.1 Power measuring receiver specification

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

B.1.1 IF filter

The IF filter shall be within the limits of the selectivity characteristic of figure B.1.

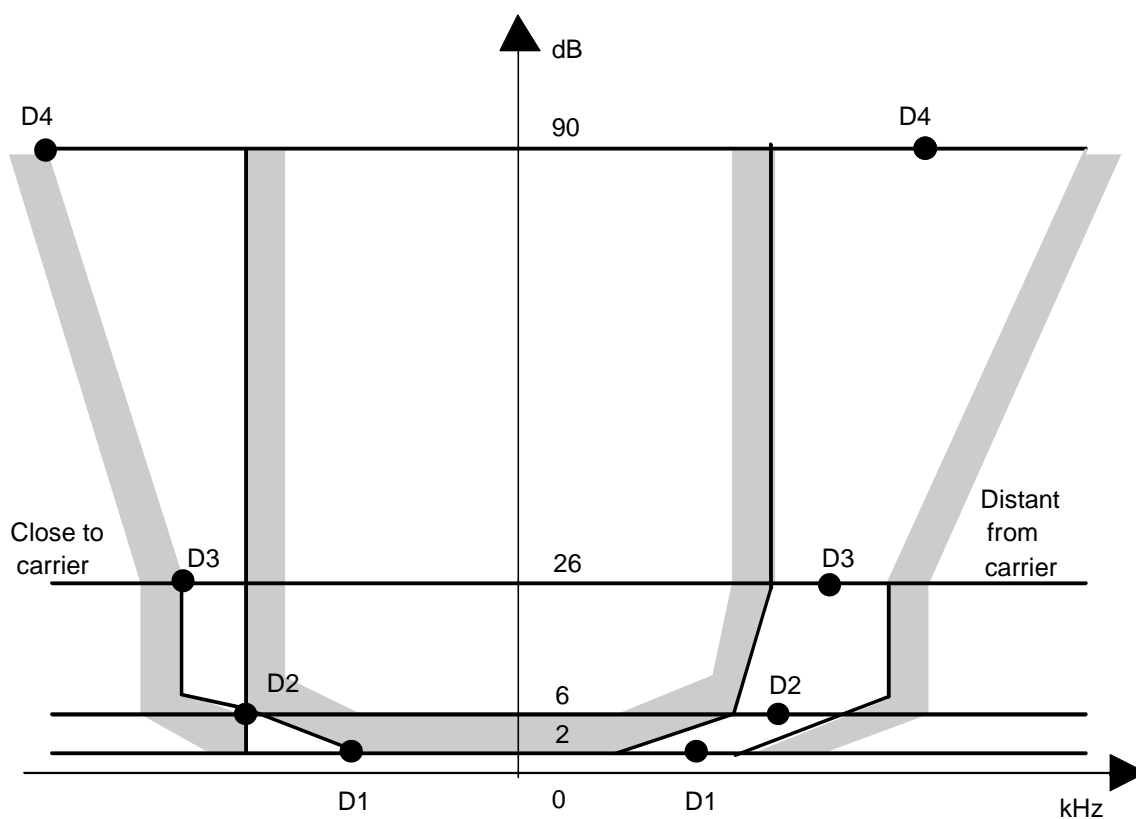


Figure B.1

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

Table B.1: Selectivity characteristic

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
10/12,5	3,0	4,25	5,5	9,5
20	4,0	7,0	8,25	12,25
25	5,0	8,0	9,25	13,25

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

Table B.2: Attenuation points close to carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
10/12,5	+1,35	$\pm 0,1$	-1,35	-5,35
20	+3,1	$\pm 0,1$	-1,35	-5,35
25	+3,1	$\pm 0,1$	-1,35	-5,35

Table B.3: Attenuation points distant from the carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
10/12,5	$\pm 2,0$	$\pm 2,0$	$\pm 2,0$	+2,0 -6,0
20	$\pm 3,0$	$\pm 3,0$	$\pm 3,0$	+3,0 -7,0
25	$\pm 3,5$	$\pm 3,5$	$\pm 3,5$	+3,5 -7,5

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

B.1.2 Variable attenuator

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

B.1.3 Rms value indicator

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

B.1.4 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ -90 dB for channel separations of 20 kHz and 25 kHz, and of ≤ -80 dB for a channel separation of 10 kHz and 12,5 kHz, referred to the carrier of the oscillator.

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

The specification shall include the following requirements:

It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser as displayed on the screen, to an accuracy of ± 2 dB in the presence of a signal separated in frequency by:

- a) 10 kHz, at a level 90 dB above that of the signal to be measured for 25 kHz and 20 kHz channel separations; and
- b) 6,25 kHz, at a level 80 dB above that of the signal to be measured for a 12,5 kHz channel separation; and
- c) 5 kHz at a level 80 dB above that of the signal to be measured for a 10 kHz channel separation.

The reading accuracy of the frequency marker shall be within ± 2 % of the channel separation.

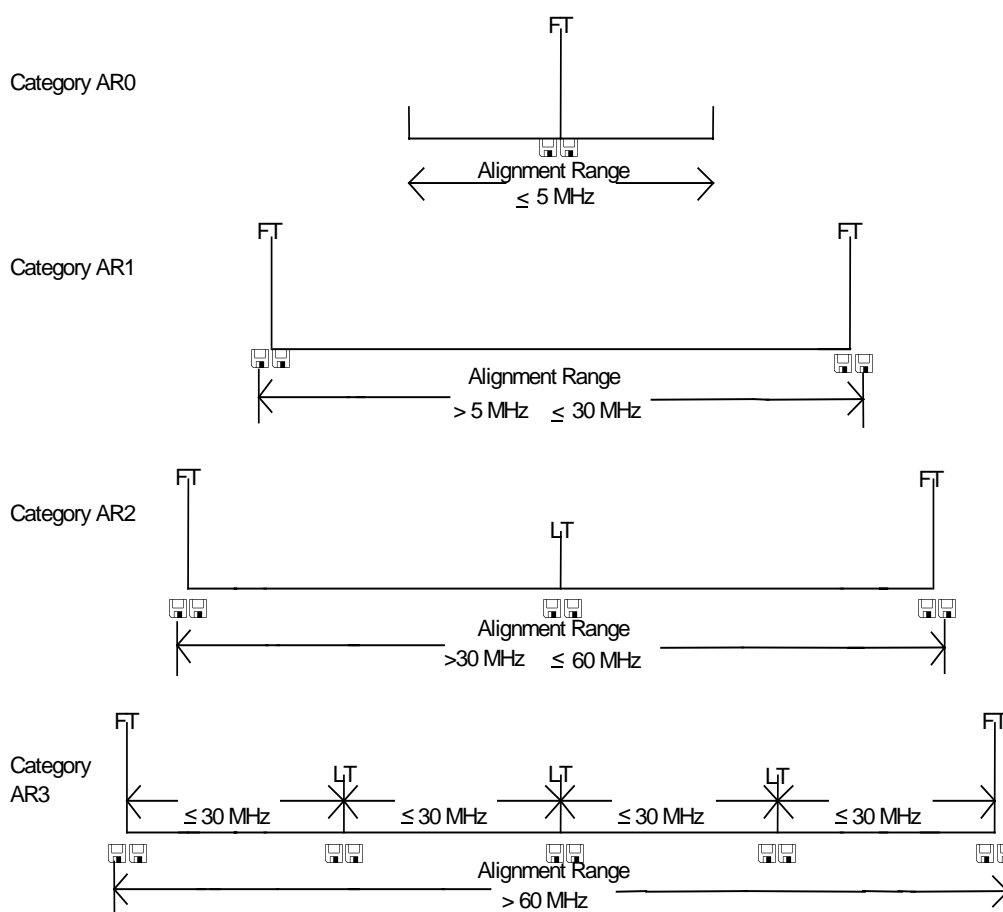
The accuracy of relative amplitude measurements shall be within ± 1 dB.

It shall be possible to adjust the spectrum analyser to allow the separation, on the display, of two components with a frequency difference of 1 kHz.

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.



Legend:


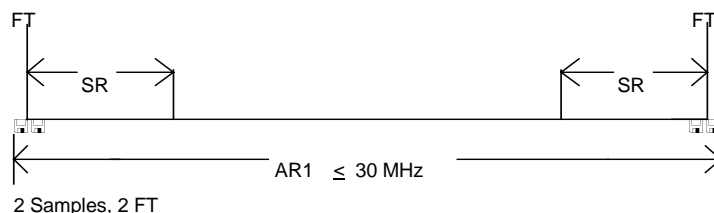
AR0	First category of alignment range, see subclause 4.2.3
AR1	Second category of alignment range, see subclause 4.2.3
AR2	Third category of alignment range, see subclause 4.2.3
AR3	Fourth category of alignment range, see subclause 4.2.3
LT	Limited tests, see subclause 3.1
FT	Full tests, see subclause 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

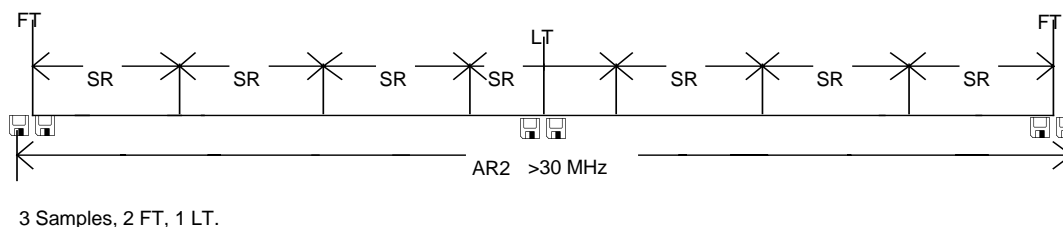
D.2 Tests and samples needed when the switching range is a subset of the alignment range

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 subclauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, as appropriate. The following examples assume a SR of 5 MHz.

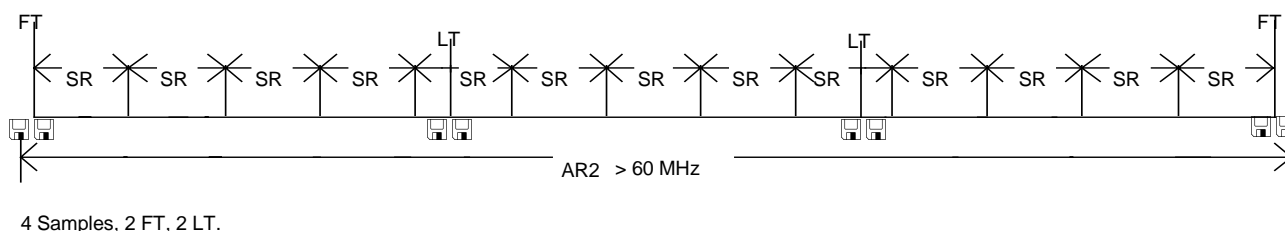
Category AR1



Category AR2



Category AR3



Legend:


SR	Switching Range, see subclause 4.2.2
AR1	Second category of alignment range, see subclause 4.2.3
AR2	Third category of alignment range, see subclause 4.2.3
AR3	Fourth category of alignment range, see subclause 4.2.3
LT	Limited tests, see subclause 3.1
FT	Full tests, see subclause 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 subclauses 4.2.4, 4.2.5, 4.2.6, and 4.2.7, as appropriate.

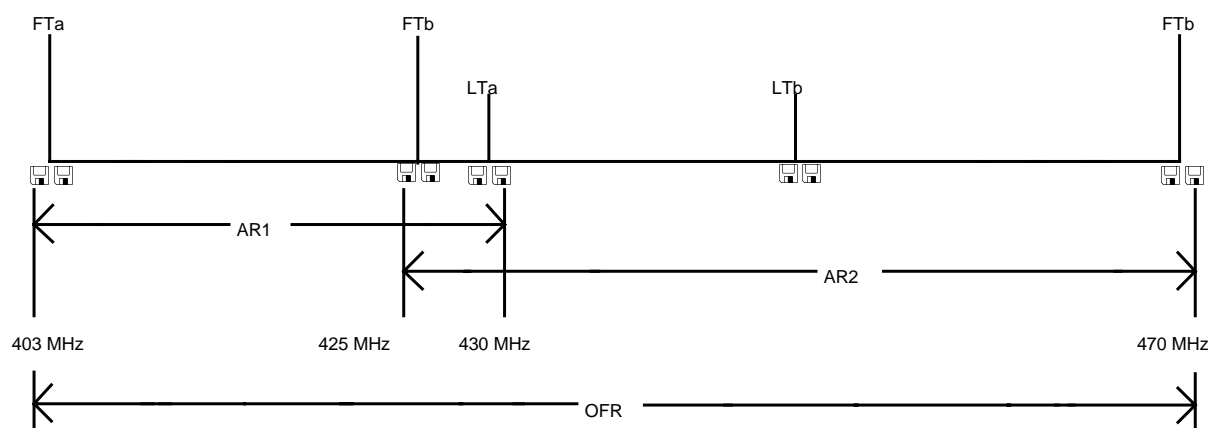
For example, the manufacturer seeks type approval for a family of equipment having an operating frequency range of 403 MHz to 470 MHz. The equipment to be tested does not cover this range with one category of alignment range.

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.



Legend:

OFR	Operational frequency range, see subclause 4.2.2
AR1	Second category of alignment range, see subclause 4.2.3
AR2	Third category of alignment range, see subclause 4.2.3
AR3	Fourth category of alignment range, see subclause 4.2.3
Fta	Full tests on sample(s) a). See subclause 3.1
Lta	Limited tests on sample(s) a). See subclause 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

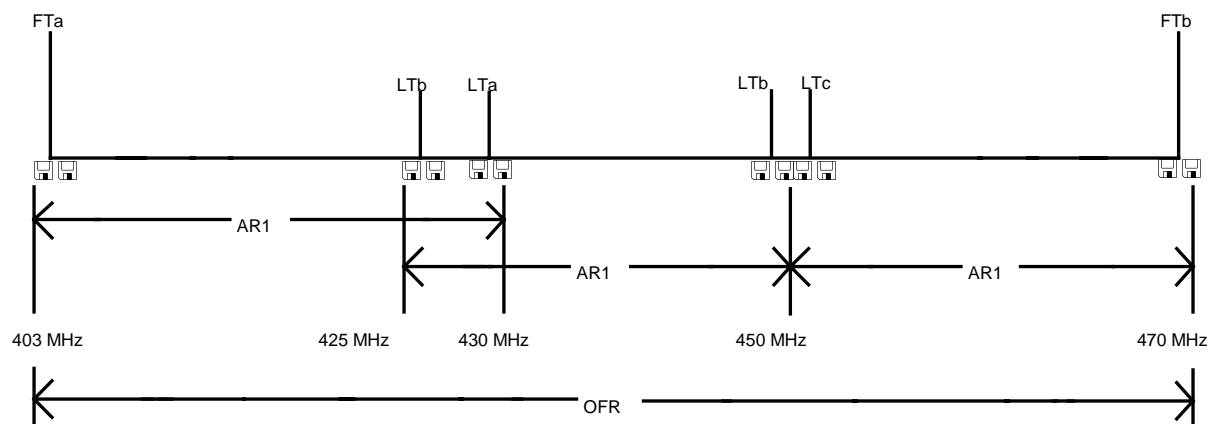
Figure D.3: Tests on family member equipment having alignment ranges that are subsets of the total operating frequency range - Example 1

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.



Legend:


OFR	Operational frequency range, see subclause 4.2.2
AR1	Second category of alignment range, see subclause 4.2.3
AR2	Third category of alignment range, see subclause 4.2.3
AR3	Fourth category of alignment range, see subclause 4.2.3
Fta	Full tests on sample(s) a). See subclause 3.1
Lta	Limited tests on sample(s) a). See subclause 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

Bibliography

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.

IEC Publication 489-3 Second edition (1988) Appendix F pages 130 to 133.

IEC Publication 489-3 Second edition (1988) Appendix J pages 156 to 164.

Construction of a Stripline. Technical Report FTZ N° 512 TB 9.

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

History

Document history		
Edition 1	October 1993	Publication as I-ETS 300 220
V1.2.1	November 1997	Publication
V1.3.1	January 2000	Public Enquiry PE 200020: 2000-01-19 to 2000-05-19
V1.3.1	July 2000	Vote V 20000901: 2000-07-03 to 2000-09-01