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Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile service (RP 02); Radio equipment using an integral antenna transmitting signals to initiate a specific response in the receiver; Part 1: Technical characteristics and methods of measurement

Reference

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Foreword

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

The present document is part 1 of a multi-part standard covering Land Mobile service (RP 02); Radio equipment using an integral antenna transmitting signals to initiate a specific response in the receiver, as identified below:

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

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

Annex A provides additional information concerning radiated measurements.

Annex B contains specifications for adjacent channel power measurement arrangements.

Annex C is a graphic representation of subclause 4.1, referring to the presentation of equipment for testing purposes.

National transposition dates	
Date of adoption of this EN:	10 November 2000
Date of latest announcement of this EN (doa):	28 February 2001
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 August 2001
Date of withdrawal of any conflicting National Standard (dow):	31 August 2001

Introduction

The present document is intended to specify the minimum performance and the methods of measurement of radio equipment for use in the land mobile service as specified in the scope.

Clause 5 provides the corresponding limits. These limits have been chosen to ensure an acceptable grade of service and to minimize harmful interference to other equipment and services. They are based on the interpretation of the measurement results described in subclause 4.3.

The measurement methods have been adapted from TR 100 027 [4] where possible.

Channel separations, maximum transmitter effective radiated power, the type and characteristics of modulation and the inclusion of automatic transmitter shut-off facility may be conditions required for the issue of a licence by the appropriate administration.

The present document may be used, in particular, by accredited test laboratories for the assessment of the performance of the equipment. In this case, the performance of the equipment submitted for testing should be representative for the performance of the corresponding production model. In order to avoid any ambiguity in that assessment, the present document contains instructions for the presentation of equipment for testing purposes (clause 4), conditions (clause 6) and measurement methods (clauses 8 and 9).

1 Scope

The present document covers the minimum characteristics considered necessary in order to make the best use of the available frequencies. It does not necessarily include all the characteristics, which may be required by a user, nor does it necessarily represent the optimum performance achievable.

It applies to non-speech and to the non-speech part of combined speech/non-speech equipment with integral antennas, used in constant envelope angle modulation systems in the land mobile service, operating on radio frequencies between 30 MHz and 1 000 MHz, with channel separations of 12,5 kHz, 20 kHz and 25 kHz.

In the present document, a non-speech radio equipment is defined as a radio equipment transmitting a signal to initiate a specific response in the receiver. The equipment comprises a transmitter and associated encoder and/or a receiver and associated decoder. The encoder and/or decoder may be a separate piece of equipment, in which case compliance to the present document covers the combination of encoder and/or decoder and transmitter and/or receiver equipment.

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

The type of equipment covered by the present document is handportable stations with integral antennas.

The present document is complementary to EN 300 219-1 [1] which covers radio equipment with an internal or external RF connector transmitting signals to initiate a specific response in the receiver, for use in the land mobile service. It is primarily intended for omnidirectional applications.

For combined speech/non speech equipment the present document is complementary to EN 300 296-1 [7] which covers radio equipment using integral antennas for use in the land mobile service intended primarily for analogue speech.

Radio equipment for data is covered by EN 300 113-1 [3] and EN 300 390-1 [8].

Requirements to be fulfilled by equipment designed to meet the requirements of several ENs can be found in clause 4.

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 300 219 (V1.2): "Land mobile service; Technical characteristics and test conditions for radio equipment transmitting signals to initiate a specific response in the receiver".

[2] ETSI EN 300 086 (V1.2): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 1: Technical characteristics and test conditions".

[3] ETSI EN 300 113 (V1.3): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and speech) and having an antenna connector; Part 1: Technical characteristics and methods of measurement".

[4] ETSI TR 100 027: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Methods of measurement for private mobile radio equipment".

[5] ETSI TR 100 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

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

[7] ETSI EN 300 296-1 (V1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment using integral antennas intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement".

[8] ETSI EN 300 390-1 (V1.2): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna; Part 1: Technical characteristics and test conditions".

[9] ETSI EN 300 793 (V1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Presentation of equipment for type testing".

[10] 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".

[11] ANSI C63.5 (1988): "Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas".

[12] Council Directive of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations (98/34/EC).

[13] IEC Publication 489-3 Second edition (1988): "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions".Appendix F pages 130 to 133.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

audio frequency load: normally a resistor of sufficient power rating to accept the maximum audio output power from the equipment under test. The value of the resistor is that stated by the manufacturer and equal to the impedance of the audio transducer at 1 000 Hz. In some cases it may be necessary to place an isolating transformer between the output terminals of the receiver under test and the load.

audio frequency termination: any connection other than the audio frequency load which may be required for the purpose of testing the receiver. The termination device is agreed between the manufacturer and the testing authority and details included in the test report. If special equipment is required then it is provided by the manufacturer.

band-stop filter (for the SINAD meter): the characteristics of the band-stop filter used in the audio distortion factor meter and SINAD meter are such that, at the output, a 1 000 Hz tone will be attenuated by at least 40 dB, and at 2 000 Hz the attenuation will not exceed 0,6 dB. The filter characteristic is flat within 0,6 dB over the ranges 20 Hz to 500 Hz and 2 000 Hz to 4 000 Hz. In the absence of modulation the filter should not cause more than 1 dB attenuation of the total noise power of the audio frequency output of the receiver under test.

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

psophometric weighting network: described in CCITT Recommendation O.41 [6].

Types of measurements:

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

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

Types of station:

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

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

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

Types of tests:

full tests: in all cases except where qualified as "limited", tests are performed according to the present document.

limited tests: the limited tests, subclause 4.1, are as follows:

- receiver average usable sensitivity (field strength), subclause 9.1;
- receiver adjacent channel selectivity, subclause 9.3;
- transmitter frequency error, subclause 8.1;
- transmitter effective radiated power, subclause 8.2;
- transmitter adjacent channel power, subclause 8.3.

3.2 Symbols

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

Eo	Reference field strength (see annex A)
Ro	Reference distance (see annex A)
r.m.s	root mean square

3.3 Abbreviations

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

AR1	(see subclause 4.1)
AR2	(see subclause 4.1)
dBc	dB relative to the carrier power
emf	electro-motive force
IF	Intermediate Frequency
RF	Radio Frequency
Rx	Receiver
SINAD	Signal, Noise And Distortion (to noise and distortion ratio)
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

4 General

Equipment which also includes an external or internal RF connector can be type tested either to the requirements of the present document and/or EN 300 296-1 [7] or to the requirements of EN 300 086-1 [2] and/or EN 300 219-1 [1] using this connector.

In the case of combined speech/non-speech equipment the speech part should be tested to the requirements of EN 300 296-1 [7] and additionally the tests described in the following subclauses of the present document should be carried out:

- subclause 8.3: adjacent channel power;
- subclause 9.1: average usable sensitivity (responses).

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

Where an equipment has already been type approved to EN 300 296-1 [7], and is resubmitted for testing to the present document, additionally the tests described in the following subclauses of the present document should be carried out:

- subclause 8.3: adjacent channel power;
- subclause 8.4: radiated spurious emissions;
- subclause 9.1: average usable sensitivity (responses).

4.1 Presentation of equipment for testing purposes

For information regarding the presentation of equipment for testing purposes, refer to EN 300 793 [9].

4.2 Mechanical and electrical design

4.2.1 General

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

4.2.2 Controls

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

4.2.3 Transmitter shut-off facility

When a timer for an automatic shut-off facility is operative, at the moment of the time-out the transmitter shall automatically be switched off. The activation of the transmitter key shall reset the timer. A shut-off facility shall be inoperative for the duration of the measurements unless it has to remain operative to protect the equipment.

4.2.4 Marking

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

The marking shall be in accordance with EC Directives and/or CEPT decisions or recommendations as appropriate.

4.3 Interpretation of the measurement results

The interpretation of the results (e.g. results recorded in a 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 values of the actual measurement uncertainty shall be, for each measurement, equal to or lower than the figures in clause 10 (maximum acceptable value of measurement uncertainties);
- the actual measurement uncertainty of the laboratory carrying out the measurements, for each particular measurement, shall be included in the corresponding test report (if any).

5 Technical characteristics

This clause contains the limit values of the parameters defined in clauses 8 and 9.

5.1 Transmitter parameter limits

5.1.1 Frequency error

For the definition and the method of measurement see subclause 8.1.

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

For practical reasons the measurements shall be performed only under normal and extreme test conditions as stated in subclause 8.1.

Table 1: Frequency error

Channel separation (kHz)	Frequency error limit (kHz)				
	below 47 MHz	**47 to 137 MHz**	**above 137 to 300 MHz**	**above 300 to 500 MHz**	**above 500 to 1 000 MHz**
20 and 25	±0,60	±1,35	±2,00	±2,00	±2,50 (a)
12,5	±0,60	±1,00	±1,50	±1,50 (a)	No value specified
NOTE: For handportable stations having integral power supplies, the figures given in the table with the suffix (a) only apply to the limited temperature range 0°C to +30°C. However, for the full extreme temperature conditions (subclause 6.4.1) exceeding the limited temperature range above, the following frequency error limits apply: ±2,50 kHz between 300 MHz and 500 MHz; ±3,00 kHz between 500 MHz and 1 000 MHz.					

5.1.2 Effective radiated power

For the definition and the method of measurement see subclause 8.2.

5.1.2.1 Effective radiated power under normal test conditions

The maximum effective radiated power under normal test conditions shall be within df from the rated maximum effective radiated power.

The average effective radiated power under normal test conditions shall be within df from the rated average effective radiated power.

The allowance for the characteristics of the equipment (±1,5 dB) shall be combined with the actual measurement uncertainty in order to provide df, as follows:

- $df^2 = dm^2 + de^2$

where:

- dm is the actual measurement uncertainty;
- de is the allowance for the equipment (1,5 dB);
- df is the final difference.

All values shall be expressed in linear terms.

In all cases the actual measurement uncertainty shall comply with clause 10.

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

Example of the calculation of df:

dm = 6 dB (value acceptable, as indicated in the table of maximum uncertainties);

= 3,98 in linear terms;

de = 1,5 dB (fixed value for all equipment fulfilling the requirements of the present document);

= 1,41 in linear terms;

$df^2 = (3{,}98)^2 + (1{,}41)^2$;

therefore, df = 4,22 in linear terms, or 6,25 dB.

This calculation shows that in this case df is in excess of 0,25 dB compared to dm, the actual measurement uncertainty (6 dB).

5.1.2.2 Effective radiated power under extreme test conditions

The variation of power due to the change of temperature and voltage for the measurements under extreme test conditions shall not exceed +2 dB or -3 dB (the measurements shall be performed using the test fixture).

5.1.3 Adjacent channel power

For the definition and the method of measurement see subclause 8.3.

For channel separations of 20 kHz and 25 kHz, the adjacent channel power shall not exceed a value of 70,0 dB below the carrier power of the transmitter without the need to be below 0,20 µW. For channel separations of 12,5 kHz, the adjacent channel power shall not exceed a value of 60,0 dB below the transmitter carrier power without the need to be below 0,20 µW.

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

5.1.4 Transmitter Spurious emissions

For the definition and the method of measurement see subclause 8.4.

The power of any spurious emission shall not exceed the values given in table 2.

Table 2: Radiated emissions

Frequency range	30 MHz to 1 GHz	above 1 to 12,75 GHz
Tx operating	0,25 µW (-36,0 dBm)	1,00 µW (-30,0 dBm)
Tx standby	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

5.1.5 Transient frequency behaviour of the transmitter

For the definition and the method of measurement see subclause 8.5.

The transient periods are given in table 3. A graph of these transient periods for the case of equipment operating in the frequency range above 300 MHz to 500 MHz are shown in figure 9, subclause 8.5.

Table 3: Transient periods

	30 to 300 MHz	above 300 to 500 MHz	above 500 to 1 000 MHz
t1 (ms)	5,0	10,0	20,0
t2 (ms)	20,0	25,0	50,0
t3 (ms)	5,0	10,0	10,0

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

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

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

5.2 Receiver parameter limits

5.2.1 Average usable sensitivity (field strength)

For the definitions and the method of measurement see subclause 9.1.

For the average usable sensitivity limits, four categories of equipment are defined as follows:

Category A: equipment having an integral antenna fully within the case;

Category B: equipment having an extractable or fixed integral antenna, with an antenna length not exceeding 20 cm external to the case;

Category C: equipment having an extractable or fixed integral antenna, with an antenna length exceeding 20 cm external to the case;

Category D: equipment not covered by category A, B or C.

Under normal test conditions, the average usable sensitivity shall not exceed the following field strength values.

Table 4a: Sensitivity limits for Categories A and D

Frequency band (MHz)	Average usable sensitivity in dB relative to 1 µV/m
30 to 400	27,0
> 400 to 750	28,5
> 750 to 1 000	30,0

Table 4b: Sensitivity limits for Category B

Frequency band (MHz)	Average usable sensitivity in dB relative to 1 µV/m
30 to 130	18,0
> 130 to 300	19,5
> 300 to 440	21,5
> 440 to 600	23,5
> 600 to 800	25,5
> 800 to 1 000	28,0

Category C:

At frequencies greater than 375 MHz the limits shall be as specified in table 4b.

In the case of frequencies less than or equal to 375 MHz a correction factor K, shall be subtracted from the specified field strengths in table 4b:

- $K = 20 \log_{10} [(l+20)/40]$;

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

This correction only applies if the antenna length external to the case is less than ($15\ 000/f_o - 20$) in cm, where f_o is the frequency in MHz (applicable to frequencies below 375 MHz).

For all categories of equipment, add 6 dB to the limit under normal test conditions to obtain the limit under extreme test conditions.

5.2.2 Co-channel rejection

For the definition and the method of measurement see subclause 9.2.

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

- -8,0 dB and 0 dB for channel separations of 20 kHz and 25 kHz;
- -12,0 dB and 0 dB for a channel separation of 12,5 kHz.

5.2.3 Adjacent channel selectivity

For the definition and the method of measurement see subclause 9.3.

The adjacent channel selectivity of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to those given in table 5.

Table 5: Adjacent channel selectivity

Channel separation (kHz)	Adjacent channel selectivity limit (dBμV/m)			
	Unwanted frequencies ≤68 MHz		Unwanted frequencies >68 MHz	
	Normal test conditions	Extreme test conditions	Normal test conditions	Extreme test conditions
20 & 25	75	65	$20 \log_{10}(f) + 38,3$	$20 \log_{10}(f) + 28,3$
12,5	65	55	$20 \log_{10}(f) + 28,3$	$20 \log_{10}(f) + 18,3$
NOTE: f is the carrier frequency in MHz				

5.2.4 Spurious response rejection

For the definition and the method of measurement see subclause 9.4.

The spurious response rejection of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to:

- 75 dBμV/m for unwanted signal frequencies ≤68 MHz;
- ($20 \log_{10}(f) + 38,3$) dBμV/m for unwanted signal frequencies >68 MHz, where f is the frequency in MHz.

5.2.5 Intermodulation response rejection

For the definition and the method of measurement see subclause 9.5.

The intermodulation response rejection of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to:

- 70 dBμV/m for unwanted signal frequencies ≤68 MHz;
- ($20 \log_{10}(f) + 33,3$) dBμV/m for unwanted signal frequencies >68 MHz, where f is the frequency in MHz.

5.2.6 Blocking or desensitization

For the definition and the method of measurement see subclause 9.6.

The blocking level, for any frequency within the specified ranges, shall be:

- ≥89 dBμV/m for unwanted signal frequencies ≤68 MHz;
- ≥($20 \log_{10}(f) + 52,3$) dBμV/m for unwanted signal frequencies >68 MHz, where f is the frequency in MHz.

5.2.7 Receiver Spurious radiations

For the definition and the method of measurement see subclause 9.7.

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

Table 6: Radiated components

Frequency range	30 MHz to 1 GHz	above 1 to 12,75 GHz
Limit	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

6 Test conditions, power sources and ambient temperatures

6.1 Normal and extreme test conditions

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

6.2 Test power source

During type tests the power source of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in subclauses 6.3.2 and 6.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.

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

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

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

6.3 Normal test conditions

6.3.1 Normal temperature and humidity

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

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

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

6.3.2 Normal test power source

6.3.2.1 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 and 51 Hz.

6.3.2.2 Regulated lead-acid battery power sources used on vehicles

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles, the normal test voltage shall be 1,1 times the nominal voltage of the battery (for nominal voltages of 6 V and 12 V, these are 6,6 V and 13,2 V respectively).

6.3.2.3 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.

6.4 Extreme test conditions

6.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in subclause 6.5, at the upper and lower temperatures of the following range:

- -20°C to +55°C

For the purpose of subclause 5.1.1 (a) an additional extreme temperature range of 0°C to +30°C shall be used.

Type test reports shall state the temperature range used.

6.4.2 Extreme test source voltages

6.4.2.1 Mains voltage

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

6.4.2.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (for a nominal voltage of 6 V, these are 7,8 V and 5,4 V respectively and for a nominal voltage of 12 V, these are 15,6 V and 10,8 V respectively).

6.4.2.3 Power sources using other types of batteries

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

- for the Leclanché or the lithium type of battery: 0,85 times the nominal voltage of the battery;
- for the mercury or nickel-cadmium type of battery: 0,9 times the nominal voltage of the battery.

No upper extreme test voltages apply.

6.4.2.4 Other power sources

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

6.5 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature-stabilizing period. In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization circuits may be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements. For such equipment the manufacturer shall provide for the power source circuit feeding the crystal oven to be independent of the power source to the rest of the equipment.

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

6.5.1 Procedure for equipment designed for continuous operation

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

Before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit conditions for a period of half an hour after which the equipment shall meet the specified requirements.

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

6.5.2 Procedure for equipment designed for intermittent operation

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

Before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.

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

7 General conditions

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

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

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

The test signal D-M4 consists of coded signals, messages or tones transmitted sequentially, one by one, without gaps between them. This transmission is necessary for measurements such as adjacent channel power (see subclauses 5.1.3 and 8.3), spurious emissions (see subclauses 5.1.4 and 8.4), radiated emissions and others.

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

The unwanted signal A-M3 is a RF signal modulated with a continuous 400 Hz tone and with a deviation of 12 % of the channel separation. It is used for measurements such as co-channel rejection (see subclauses 5.2.2 and 9.2), adjacent channel selectivity (see subclauses 5.2.3 and 9.3) and others.

7.2 Artificial antenna

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

7.3 Test sites and general arrangements for radiated measurements

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

7.4 Transmitter automatic shut-off facility

If the equipment is fitted with an automatic transmitter shut-off facility it shall be made inoperative for the duration of the type test unless it has to be left operative to protect the equipment. If the shut off facility is left operative the status of the equipment shall be indicated.

7.5 Modes of operation of the transmitter

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

7.6 Arrangements for test signals at the input of the receiver via a test fixture or a test antenna

Sources of test signals for application to the receiver via a test fixture (annex A, clause A.5), a stripline (annex A, subclause A.1.7) or a test antenna (annex A, subclause A.1.4) shall be connected in such a way that the impedance presented to the test fixture, the stripline or the test antenna is 50 Ω. This requirement shall be met irrespective whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the emf at the output of the source prior to connection to the receiver input connector.

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

7.7 Receiver mute or squelch facility

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

7.8 Encoder for receiver measurements

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

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

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

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

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

When possible, in order to simplify the measurement in subclause 9.4, a temporary access between the receiver demodulator output and its decoder input shall be provided for the equipment to be tested.

By this means the measurements in subclause 9.4 may be more efficiently carried out using the method of measurement of EN 300 086-1 [2], subclause 8.6, to determine the points of interest and then to make measurements at those points using the methods of the present document.

7.10 Calling indicator

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

7.11 Reset

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

7.12 Reset time

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

8 Method of measurements for transmitter parameters

When performing transmitter tests on equipment designed for intermittent operation, the specified maximum transmit time shall not be exceeded.

8.1 Frequency error

This measurement need not be carried out if this parameter has been measured according to the requirements of EN 300 296-1 [7].

This measurement is made if the equipment is capable of producing an unmodulated carrier. Otherwise the adjacent channel power shall also be measured under extreme test conditions and the limits given in subclause 5.1.3 shall be met.

8.1.1 Definition

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

8.1.2 Method of measurement

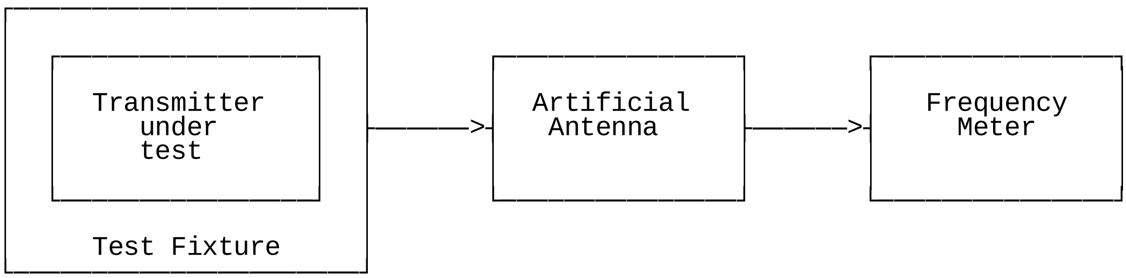


Figure 1: Measurement arrangement

The equipment shall be placed in a test fixture (see annex A, clause A.5) connected to the artificial antenna (see subclause 7.2). The carrier frequency shall be measured in the absence of modulation. The measurement shall be made under normal test conditions (see subclause 6.3) and repeated under extreme test conditions (subclauses 6.4.1 and 6.4.2 applied simultaneously).

8.2 Effective radiated power

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

Administrations may state the maximum value for the maximum effective radiated power of transmitters; this could be a condition for issuing the licence.

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

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

8.2.1 Definition

For the purpose of this measurement, the maximum effective radiated power is defined as the effective radiated power in the direction of maximum field strength under specific conditions of measurement in the absence of modulation.

The rated maximum effective radiated power is the maximum effective radiated power declared by the manufacturer.

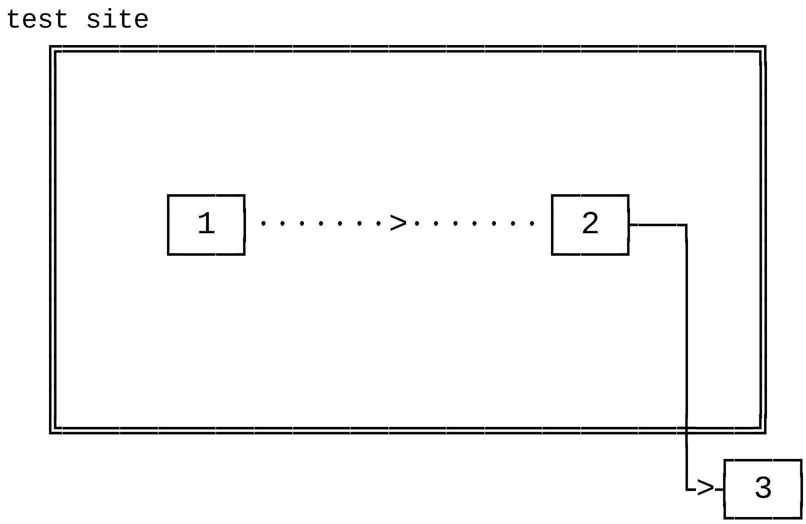
The average effective radiated power is defined as the average of the effective radiated power measured in 8 directions.

The rated average effective radiated power shall also be declared by the manufacturer.

8.2.2 Method of measurement

The measurements shall be made under normal test conditions, (see subclause 6.3), and extreme test conditions, (subclauses 6.4.1 and 6.4.2 applied simultaneously).

8.2.2.1 Maximum effective radiated power under normal test conditions



NOTE: 1) Transmitter under test
2) Test antenna
3) Spectrum analyser or selective voltmeter (test receiver)

Figure 2: Measurement arrangement

a) A test site which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarization unless otherwise stated.

   The transmitter under test shall be placed on the support in its standard position (see annex A) and switched on without modulation.

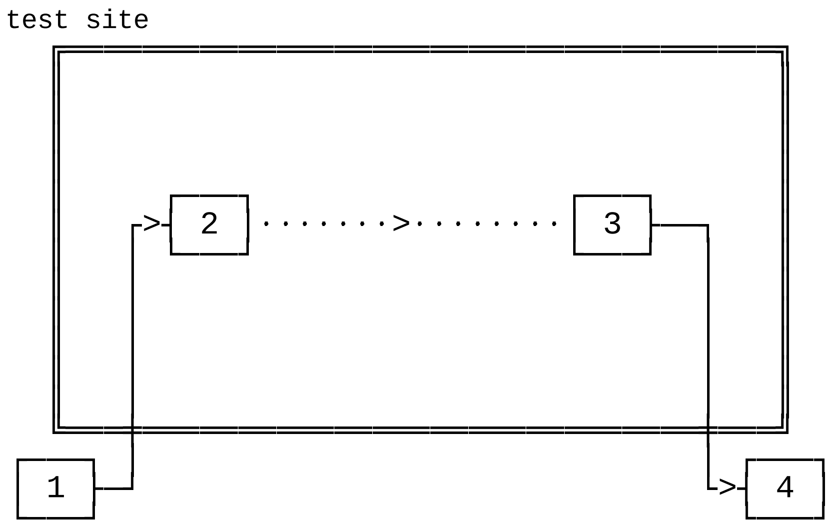
b) The spectrum analyser or selective voltmeter shall be tuned to the transmitter carrier frequency. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1 (i.e. an anechoic chamber).

c) The transmitter shall be rotated through 360° about a vertical axis until a higher maximum signal is received.

d) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be recorded. (This maximum may be a lower value than the value obtainable at heights outside the specified limits).

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1.



NOTE: 1) Signal generator
2) Substitution antenna
3) Test antenna
4) Spectrum analyser or selective voltmeter (test receiver)

Figure 3: Measurement arrangement

e) Using the measurement arrangement of figure 3 the substitution antenna, shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the transmitter carrier frequency. The test antenna shall be raised or lowered as necessary to ensure that the maximum signal is still received.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1.

The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver. The maximum carrier radiated power is equal to the power supplied by the signal generator, increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.

f) Steps b) to e) above shall be repeated with the test antenna and the substitution antenna oriented in horizontal polarization.

8.2.2.2 Average effective radiated power under normal test conditions

a) The procedures in steps b) to f) shall be repeated, except that in step c) the transmitter shall be rotated through 8 positions, 45° apart, starting at the position corresponding to maximum effective radiated power.

b) The average effective radiated power corresponding to the eight average values is given by:

$$average\ 8\ power = \frac{\sum_1^8 P_n}{8}$$

where P_n is the power corresponding to each of the eight positions.

8.2.3 Method of measurements of maximum and average effective radiated power under extreme test conditions

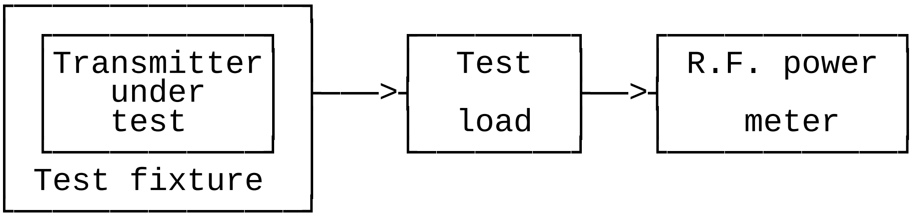


Figure 4: Measurement arrangement

a) The measurement specified in subclause 8.2.2 shall also be performed under extreme test conditions. Due to the impossibility of repeating the above measurement on a test site under extreme temperature conditions, only a relative measurement is performed, using the test fixture (see annex A, clause A.5) and the measurement arrangement of figure 4.

b) The power delivered to the test load under normal test conditions (see subclause 6.3) shall be measured and noted. Then the power under extreme test conditions (subclauses 6.4.1 and 6.4.2 applied simultaneously) shall be measured and noted. The difference in dB shall be calculated. This difference is algebraically added to the average effective radiated power under normal test conditions, in order to obtain the average effective radiated power under extreme test conditions.

c) A similar calculation will provide the maximum effective radiated power.

d) Additional uncertainties can occur under extreme test conditions due to the calibration of the test fixture.

8.3 Adjacent channel power

This measurement shall be carried out even though the equipment has been tested to the requirements of EN 300 296-1 [7].

8.3.1 Definition

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.

It is specified either as the ratio expressed in decibels of the carrier power to the adjacent channel power or as an absolute value.

8.3.2 Method of measurement

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

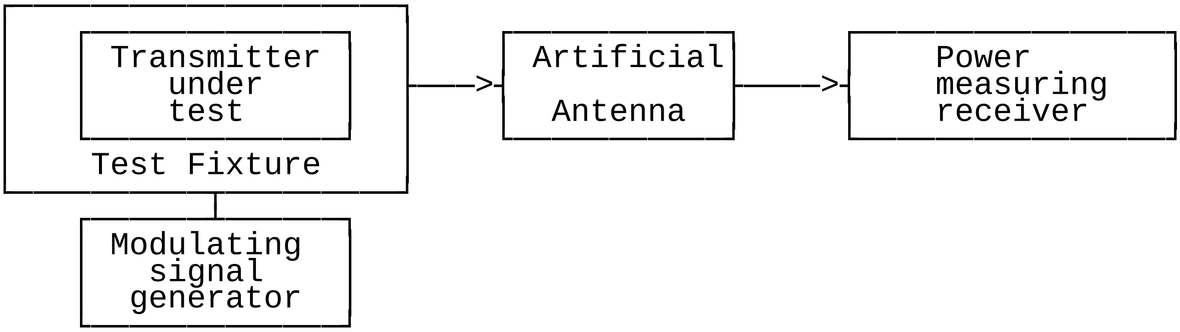


Figure 5: Measurement arrangement

a) The transmitter under test shall be placed in the test fixture (see annex A, clause A.5) connected via the artificial antenna (see subclause 7.2) to a power measuring receiver calibrated to measure root mean square (r.m.s.) 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.

b) With the transmitter unmodulated, the tuning of the power-measuring receiver shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The power measuring receiver attenuator setting and the reading of the meter shall be recorded.

c) 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 the following table:

Table 7: Frequency displacement

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

The same result may be obtained by tuning the power-measuring receiver (point D2 in the drawing of the power measuring filter shape) to the nominal frequency of the adjacent channel, if it has been suitably calibrated.

d) The transmitter shall be modulated by the test signal D-M4 (see subclause 7.1).

e) The power measuring receiver variable attenuator shall be adjusted to obtain the same meter reading as in step b) or a known relation to it. This value shall be recorded.

f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in step b) and e), corrected for any differences in the reading of the meter. Alternatively the absolute value of the adjacent channel power may be calculated from the above ratio and the transmitter carrier power.

g) Steps c) to f) shall be repeated with the power measuring receiver tuned to the other side of the carrier.

h) For the purpose of equipment which is not capable of producing an unmodulated carrier (see subclause 8.1), the measurement shall be repeated under extreme test conditions (subclauses 6.4.1 and 6.4.2 applied simultaneously).

8.4 Radiated spurious emissions

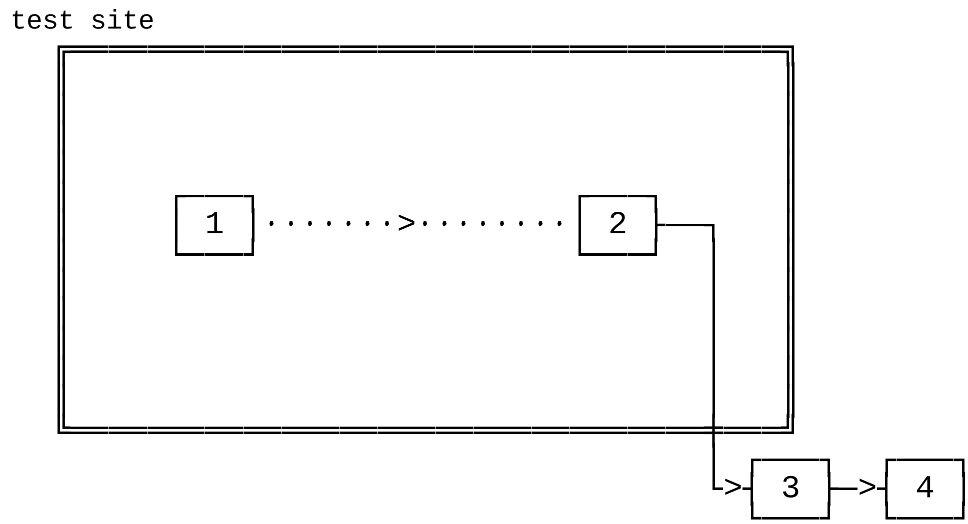
This measurement need not be carried out on equipment which is simultaneously submitted for testing to the requirements of EN 300 296-1 [7] and of the present document.

8.4.1 Definition

Spurious emissions are emissions at frequencies, other than those of the carrier and sidebands associated with normal modulation, radiated by the antenna and by the cabinet of the transmitter.

They are specified as the radiated power of any discrete signal.

8.4.2 Method of measurement



NOTE:
1) Transmitter under test
2) Test antenna
3) High 'Q' (notch) or high pass filter
4) Spectrum analyser or selective voltmeter (test receiver)

Figure 6: Measurement arrangement

a) A test site, which fulfils the requirements of the specified frequency range of this measurement, shall be used. The test antenna shall be oriented initially for vertical polarization and connected to a spectrum analyser or a selective voltmeter, through a suitable filter to avoid overloading of the spectrum analyser or selective voltmeter. In the case of measurements performed with an unmodulated carrier, the bandwidth of the spectrum analyser or selective voltmeter shall be between 10 kHz and 120 kHz, set to a suitable value to correctly perform the measurement.

   For the measurement of spurious emissions below the second harmonic of the carrier frequency the filter used shall be a high "Q" (notch) filter centred on the transmitter carrier frequency and attenuating this signal by at least 30 dB.

   For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the filter used shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1,5 times the transmitter carrier frequency.

   The transmitter under test shall be placed on the support in its standard position (see annex A) and shall be switched on without modulation.

   If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M4 (see subclause 7.1) in which case this fact shall be recorded in the test report.

b) The radiation of any spurious emission shall be detected by the test antenna and spectrum analyser or selective voltmeter over the frequency range 30 MHz to 4 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels. In addition, for equipment operating on frequencies above 470 MHz, measurements shall be repeated over the frequency range 4 GHz to 12,75 GHz. The frequency of each spurious emission detected shall be recorded. If the test site is disturbed by interference coming from outside, this qualitative search may be performed in a screened room, with a reduced distance between the transmitter and the test antenna.

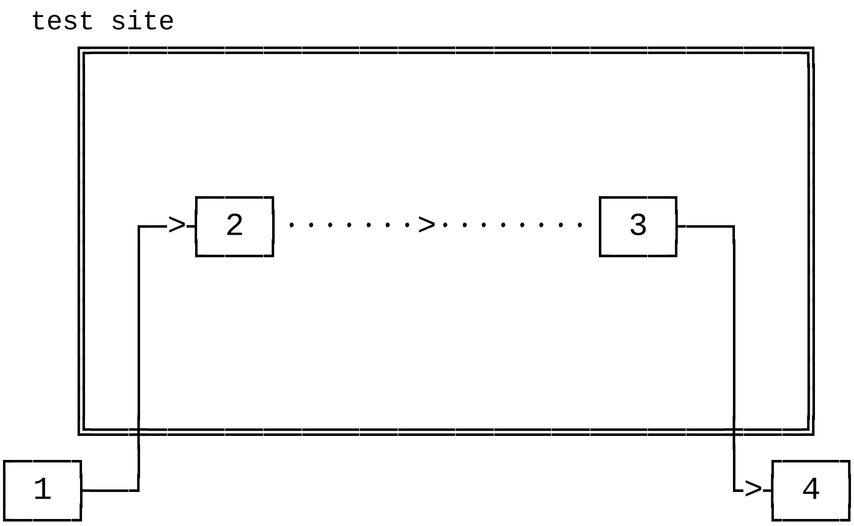
c) At each frequency at which an emission has been detected, the spectrum analyser or selective voltmeter shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1 (i.e. an anechoic chamber).

d) The transmitter shall be rotated through 360° about a vertical axis, until a higher maximum signal is received.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be recorded.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1.



NOTE: 1) Signal generator
2) Substitution antenna
3) Test antenna
4) Spectrum analyser or selective voltmeter (test receiver)

Figure 7: Measurement arrangement

f) Using the measurement arrangement of figure 7, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

g) At each frequency at which an emission has been detected, the signal generator, substitution antenna, and spectrum analyser or selective voltmeter shall be correspondingly tuned. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1.

   The level of the signal generator giving the same signal level on the spectrum analyser or selective voltmeter as in item e) above shall be recorded. This value, after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious emission at this frequency.

The resolution bandwidth of the measuring instrument shall be the smallest bandwidth available which is greater than the spectral width of the spurious component being measured. This shall be considered to be achieved when the next highest bandwidth causes less than 1 dB increase in amplitude. The conditions used in the measurement shall be recorded in the test report.

h) Steps c) to g) above shall be repeated with the test antenna oriented in horizontal polarization.

i) Steps c) to h) above shall be repeated with the transmitter in stand-by condition if this option is available.

8.5 Transient frequency behaviour of the transmitter

This measurement does not apply to equipment designed for continuous operation only. This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

8.5.1 Definitions

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

t_{on}: according to the method of measurement described in subclause 8.5.2 the switch-on instant t_{on} of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0,1 % of the nominal power (-30 dBc).

t_1: period of time starting at t_{on} and finishing according to table 3, subclause 5.1.5.

t_2: period of time starting at the end of t_1 and finishing according to table 3, subclause 5.1.5.

t_{off}: switch-off instant defined by the condition when the nominal power falls below 0,1 % of the nominal power (-30 dBc).

t_3: period of time that finishing at t_{off} and starting according to table 3, subclause 5.1.5.

8.5.2 Method of measurement

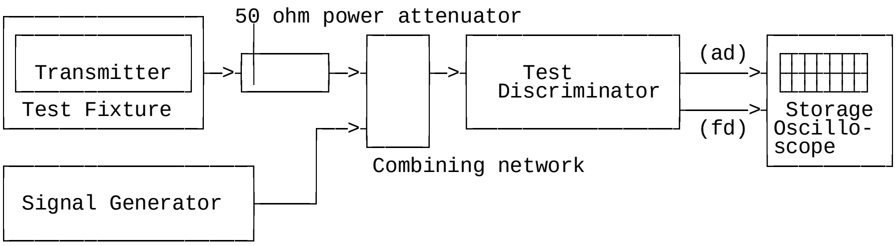


Figure 8: Measurement arrangement

The transmitter shall be placed in the test fixture (see annex A, clause A.5) and the measurement arrangement shown in figure 8 shall be used.

Two signals shall be connected to the test discriminator via a combining network, subclause 7.6.

The transmitter output from the test fixture shall be connected to a 50 Ω power attenuator.

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

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

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

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

The test signal level shall be adjusted to correspond to 0,1 % of the power of the transmitter under test measured at the input of the test discriminator. This level shall be maintained throughout the measurement.

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

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

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

The display will show the 1 kHz test signal continuously.

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

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

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

The moment when the 1 kHz test signal is completely suppressed is considered to provide t_{on}.

The periods of time t_1 and t_2 as defined in table 3, subclause 5.1.5, shall be used to define the appropriate template.

During the period of time t_1 and t_2 the frequency difference shall not exceed the values given in subclause 5.1.5.

The frequency difference, after the end of t_2, shall be within the limit of the frequency error, subclause 5.1.1.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

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

The transmitter shall then be switched off.

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

The period of time t_3 as defined in table 3, subclause 5.1.5, shall be used to define the appropriate template.

During the period of time t_3 the frequency difference shall not exceed the values given in subclause 5.1.5.

Before the start of t_3 the frequency difference shall be within the limit of the frequency error, subclause 5.1.1.

The result shall be recorded as frequency difference versus time.

Figure 9 represents the storage oscilloscope view t_1, t_2 and $_{t3}$ for the case of equipment operating in the frequency range 300 to 500 MHz.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M4 (see subclause 7.1) and an extra ½ channel separation will be accepted for the limit of the peak frequency difference.

If the display of the oscilloscope shows a large impulse immediately after the end of the calibration signal, there is a risk that this signal may be caused by the phase shift between the calibration signal and the transmitter.

To identify the source of the impulse, the following method can be used.

The impulse can be evaluated by repeating the test, e.g. for three times.

If the impulse remains constant in amplitude and exceeds the limit then the transmitter fails to meet the test.

If the impulse changes amplitude it is a phase shift occurring from the method of testing and this impulse shall be disregarded in the assessment of the test results.

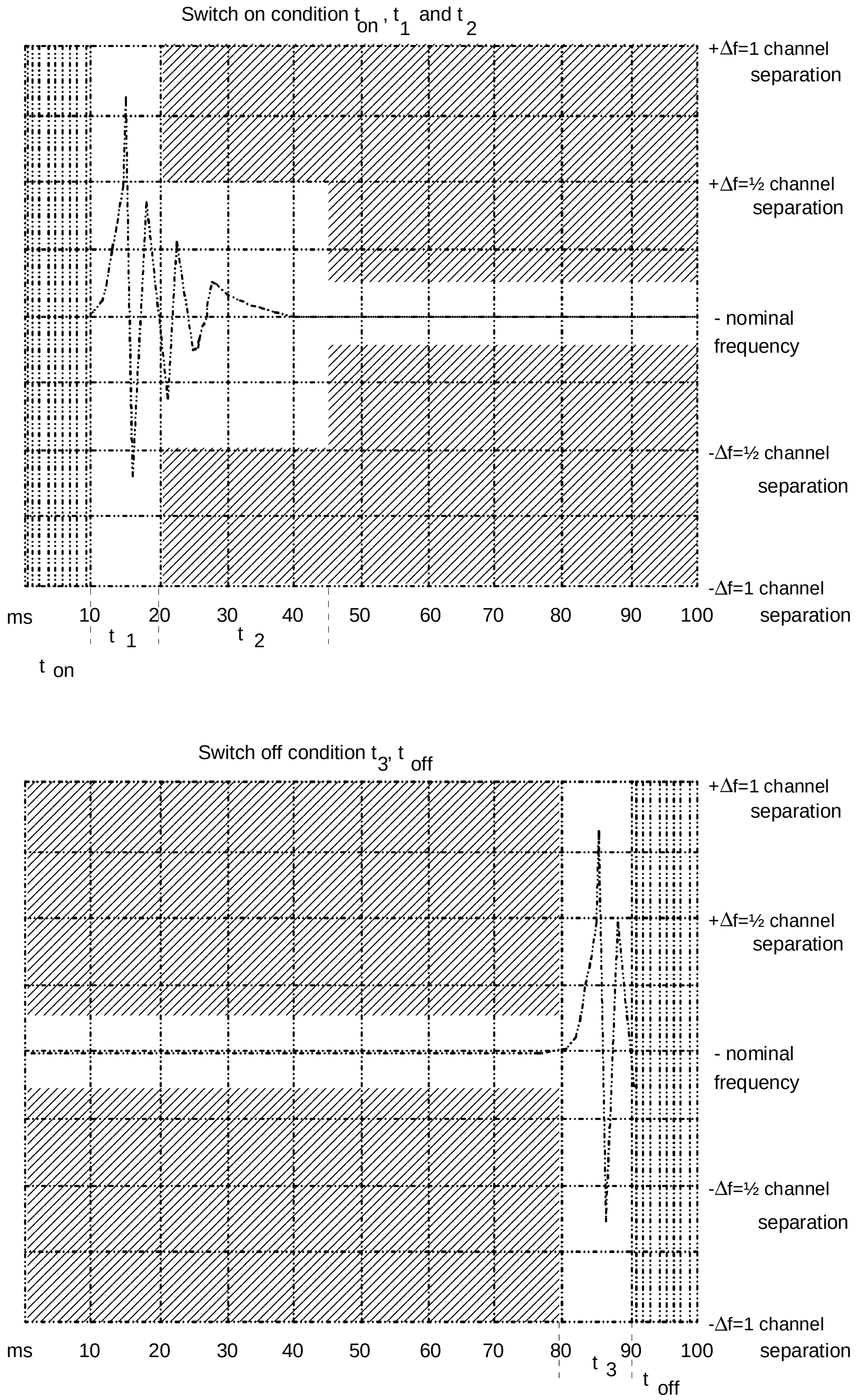


Figure 9: Storage oscilloscope view t_1, t_2 and t_3

9 Methods of measurement for receiver parameters

9.1 Average usable sensitivity (field strength, responses)

9.1.1 Definition

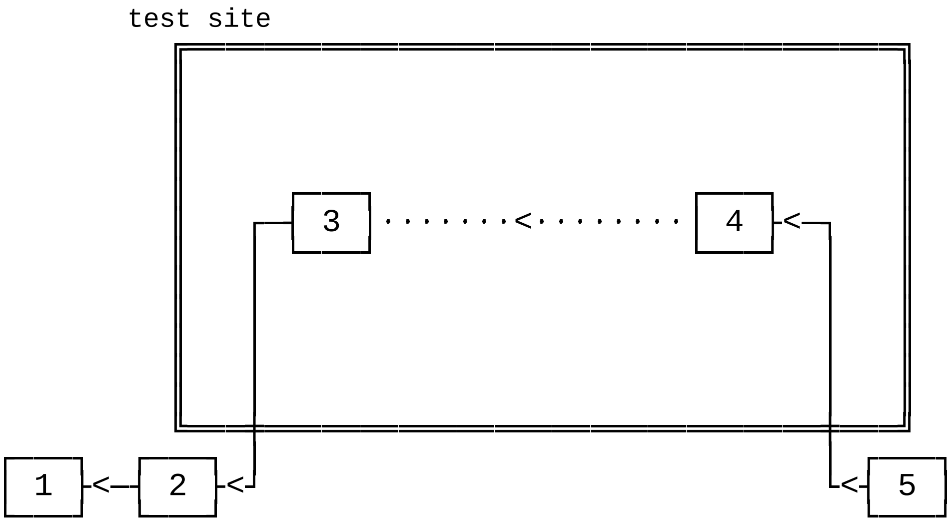
The average usable sensitivity (responses) expressed as field strength is the average field strength, expressed in dBμV/m, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal D-M3 (see subclause 7.1) which will, without interference, produce after demodulation a specified successful response ratio. The average is calculated from 8 measurements of field strength when the receiver is rotated in 45° increments starting at a particular orientation.

NOTE: The average usable sensitivity mostly differs only by a small amount from the maximum usable sensitivity to be found in a particular direction. This is due to the properties of the averaging process as used in the formula in subclause 9.1.2 j). For instance, an error not exceeding 1,2 dB can be found if the sensitivity is equal in seven directions and is extremely bad in the eighth direction. For the same reason the starting direction (or angle) can be selected randomly.

9.1.2 Method of measurement under normal test conditions

Arrangements shall be made to couple the equipment under test to the calling indicator by a method, which does not affect the radiated field (see annex A, clause A.3).

A test site, which fulfils the requirements of the specified frequency range of this measurement, shall be used. The test antenna shall be orientated for vertical polarization or for the polarization in which the equipment under test is intended to operate.



NOTE: 1) Calling indicator
2) Photo detector/acoustic coupler
3) Receiver under test
4) Test antenna
5) Signal generator

Figure 10: Measurement arrangement

a) A signal generator shall be connected to the test antenna.

The signal generator shall be at the nominal frequency of the receiver and shall be modulated with normal test signal D-M3.

The receiver under test shall be placed on the support in its standard position and in a random orientation. A calling indicator shall be connected to the receiver, preferably via a photo detector or an acoustic coupler (see annex A, clause A.3) in order to avoid disturbing the electromagnetic field in the vicinity of the equipment.

b) The level of the signal generator shall be adjusted until a successful response ratio of less than approximately 10 % is obtained.

c) The test antenna shall be raised or lowered through the specified height range to find the maximum response ratio.

The level of the test signal shall be re-adjusted to produce the response ratio specified in step b).

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1 (i.e. an anechoic chamber).

d) Note the minimum signal generator level from step b) or c) as appropriate.

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

The level of the test signal shall be increased by 2 dB for each occasion that a successful response is not obtained. The procedure shall be continued until three consecutive responses are observed.

NOTE: This level is the minimum signal generator level in this direction.

f) The level noted in step e) shall be reduced by 1 dB and the new value also noted. The normal test signal D-M3 shall then be transmitted 20 times. In each case, if a response is not obtained, the level shall be increased by 1 dB and the new value noted. If a successful response is obtained, the level shall not be changed until three consecutive successful responses have been observed. In this case, the level shall be reduced by 1 dB and the new value noted. No signal level shall be noted unless preceded by a change in level.

The average of the values noted corresponds to the successful response ratio of 80 %. It shall be used to calculate the field strength associated with each position in step h).

g) Steps b) to f) above shall be repeated for the remaining seven positions (45° apart) of the receiver, and the corresponding average values of the generator output (corresponding to successful response ratios of 80 %) shall be determined and recorded.

h) Using the relationship described in annex A, calculate and record the eight field strengths X_i in µV/m corresponding to the above average values.

i) The average sensitivity expressed as field strength E_{mean} (dBµV/m) is given by:

$$E_{mean} = 20 \log \left(\sqrt{ \left(\frac{8}{\sum_{i=1}^{i=8} \frac{1}{X_i^2}} \right) } \right)$$

where X_i represents each of the eight field strengths calculated in step h). The recorded result is the average usable sensitivity expressed in dBµV/m.

j) The reference direction is defined as the direction at which the maximum sensitivity level (ie the minimum field strength for the responses noted during the measurement) occurred in the eight measuring positions.

The corresponding direction, height (where applicable) and this reference field strength value shall be recorded.

9.1.3 Method of measurement of the average usable sensitivities under extreme test conditions

Using the test fixture in the measurement arrangement of figure 11, the measurement of the average usable sensitivity shall also be performed under extreme test conditions.

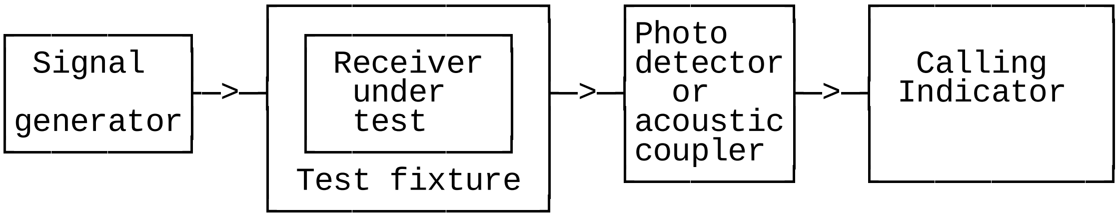


Figure 11: Measurement arrangement

The test signal input level providing a successful response ratio of 80 % shall be determined under extreme and under normal test conditions and the difference in dB shall be calculated. This difference shall be added to the average measured usable sensitivity to radiated fields expressed in dBµV/m, as calculated in subclause 9.1.2 j), under normal test conditions, to obtain the sensitivity under extreme test conditions.

9.1.4 References for degradation measurements

9.1.4.1 Definition

Degradation measurements are those measurements made on the receiver to establish the degradation of the performance of the receiver due to the presence of an unwanted (interfering) signal. For such measurements, the level of the unwanted signal shall be adjusted to a level, which is 3 dB above the limit of the average usable sensitivity.

Degradation measurements fall into two categories:

a) those carried out on a test site (see subclauses 9.4, 9.6, and annex A); and

b) those carried out using a test fixture (see subclauses 9.2, 9.3, 9.5 and annex A, clause A.5).

The test fixture is only used for those tests where the difference in frequency between the wanted and unwanted test signals is very small in relation to the actual frequency, so that the coupling loss is the same for the wanted and unwanted test signals fed into the test fixture.

9.1.4.2 Procedures for measurements using the test fixture

The test fixture is coupled to the signal generators via a combining network to provide the wanted and unwanted test input signals to the receiver in the test fixture. It is necessary therefore to establish the output level of the wanted test signal from the signal generator that results in a signal at the receiver (in the test fixture) which corresponds with the average usable sensitivity (radiated) as specified in subclause 5.2.1.

This test output level from the signal generator for the wanted test signal is then used for all the receiver measurements using the test fixture.

The method for determining the test output level from the signal generator is as follows:

a) the actual average usable sensitivity of the receiver is measured in accordance with subclause 9.1.2 j) and expressed as a field strength;

b) the difference between the limit of the average usable sensitivity specified in subclause 5.2.1, and this actual average usable sensitivity, expressed in dB, is noted;

c) the receiver is then mounted in the test fixture;

The signal generator providing the wanted input signal is coupled to the test fixture via a combining network. All other input ports of the combining network are terminated in 50Ω loads.

The output from the signal generator with normal test modulation D-M3 (see subclause 7.1) is adjusted so that the successful response ratio of 80 % is obtained (see subclause 9.1.2 f)). This output level is then increased by an amount equal to the difference expressed in dB calculated in subclause 9.1.4.2 b).

The output level of the signal generator A is defined as being the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (see subclause 5.2.1).

9.1.4.3 Procedures for measurements using the test site

When measurements are carried out on a test site, the wanted and unwanted signals shall be calibrated in terms of dBμV/m at the location of the equipment under test.

For measurements according to subclauses 9.4, 9.6 and annex A, the height of the test antenna and the direction (angle) of the equipment under test shall be that recorded in subclause 9.1.2 j) (reference direction).

9.2 Co-channel rejection

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

9.2.1 Definition

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

9.2.2 Method of measurement

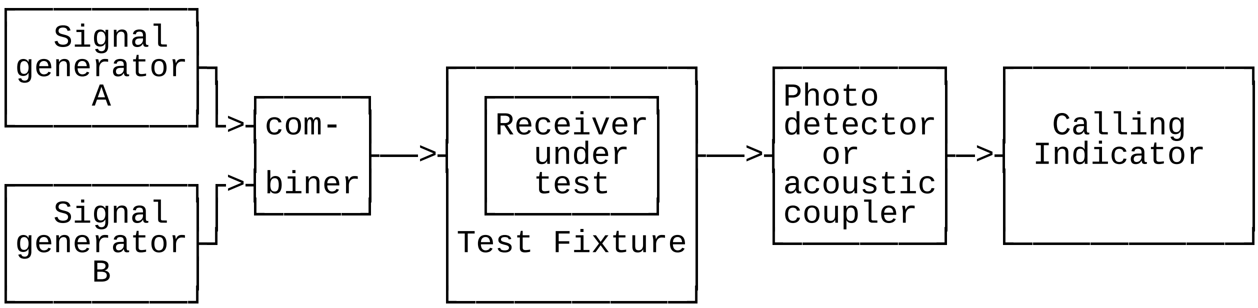


Figure 12: Measurement arrangement

a) The receiver shall be placed in the test fixture.

Two signal generators A and B shall be connected to the test fixture via a combining network. The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation D-M3 (see subclause 7.1).

The unwanted signal, represented by signal generator B, shall be modulated with signal A-M3 (see subclause 7.1). Both input signals shall be at the nominal frequency of the receiver under test.

b) Initially the unwanted signal shall be switched off (maintaining its output impedance).

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (subclauses 5.2.1 and 9.1.4).

c) The unwanted signal from generator B shall then be switched on and its level shall be adjusted until a successful response ratio of less than 10 % is obtained.

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

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

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

   The level of the input signal shall then be noted.

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

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

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

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

   No level of the unwanted signal shall be noted unless preceded by a change in level. The average of the values noted in steps d) and e) (which provides the level corresponding to the successful response ratio of 80 %) shall be recorded.

f) For each frequency of the unwanted signal, the co-channel rejection ratio shall be expressed as the ratio, in dB, of the average level recorded in step e) to the level of the wanted signal.

g) The measurement shall be repeated for displacements of the unwanted signal of ±12 % of the channel separation.

h) The co-channel rejection ratio of the equipment under test shall be expressed as the lowest of the three values expressed in dB, recorded in step f).

9.3 Adjacent channel selectivity

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

9.3.1 Definition

The adjacent channel selectivity 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 signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

9.3.2 Method of measurement

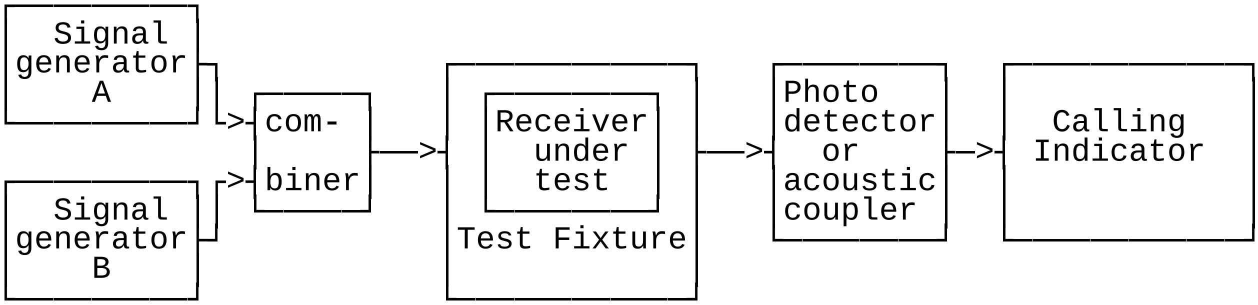


Figure 13: Measurement arrangement

a) The receiver shall be placed in the test fixture.

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

   The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation D-M3 (see subclause 7.1).

   The unwanted signal, represented by signal generator B, shall be modulated with signal A-M3 (see subclause 7.1) and shall be at the frequency of the channel immediately above that of the wanted signal.

b) Initially the unwanted signal shall be switched off (maintaining its output impedance).

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (see subclauses 5.2.1 and 9.1.4).

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

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

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

   The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall then be noted.

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

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

   If a successful response is obtained, the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value noted.

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

The average of the values noted in steps d) and e) (which provides the level corresponding to the successful response ratio of 80 %) shall be recorded.

f) For each adjacent channel, the selectivity shall be expressed as the ratio in dB of the average level recorded in step e) to the level of the wanted signal.

   It shall then be converted back into field strengths of the unwanted signals at the receiver location and expressed in dBμV/m.

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

h) The adjacent channel selectivity of the equipment under test shall be expressed as the lower of the two values measured in the upper and lower channel nearest to the receiving channel.

i) The measurement shall be repeated under extreme test conditions (subclauses 6.4.1 and 6.4.2 applied simultaneously), with the level of the wanted signal adjusted to a level which is 6 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (see subclauses 5.2.1 and 9.1.4).

9.4 Spurious response rejection

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

Spurious responses may occur at all frequencies throughout the frequency spectrum and the requirements of the present document shall be met for all frequencies. However, for practical reasons the measurements for type testing shall be performed as specified in the present document; more specifically, this method of measurement is not intended to capture all spurious responses but selects those that have a high probability of being present. However, in a limited frequency range close to the nominal frequency of the receiver, it has been considered impossible to determine the probability of a spurious response and therefore a search shall be performed over this limited frequency range. This method provides a high degree of confidence that the equipment also meets the requirements at frequencies not being measured.

9.4.1 Definition

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

9.4.2 Introduction to the method of measurement

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

a) calculation of the "limited frequency range":

   the limited frequency range is equal to the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver plus or minus the sum of the intermediate frequencies (f_{i1},...f_{in}) and a half the switching range (sr) of the receiver, clause 4.

   Hence the frequency f_l of the limited frequency range is:

$$f_{lo} - \sum_{i=1}^{i=n} f_i - \frac{sr}{2} \leq f_l \leq f_{lo} + \sum_{i=1}^{i=n} f_i + \frac{sr}{2}$$

b) calculation of frequencies outside the limited frequency range:

   a calculation of the frequencies at which spurious responses can occur outside the range determined in a) is made for the remainder of the frequency range of interest, as appropriate, subclause 9.4.5 g).

The frequencies outside the limited frequency range are equal to the harmonics of the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver plus or minus the 1st intermediate frequency (f_{i1}) of the receiver.

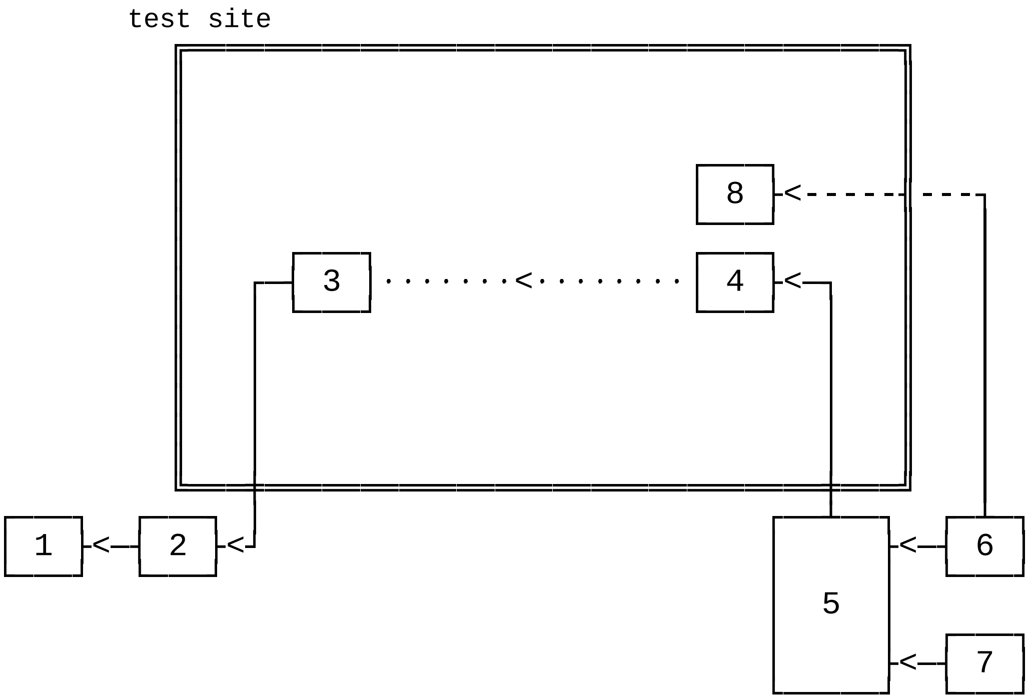
Hence:

- the frequencies of these spurious responses are $nf_{lo} \pm f_{i1}$;
- where n is an integer greater than or equal to 2.

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

For the calculations a) and b) above the manufacturer shall state the frequency of the receiver, the frequency of the local oscillator signal (f_{lo}) applied to the 1st mixer of the receiver, the intermediate frequencies (f_{i1}, f_{i2} etc.), and the switching range (sr) of the receiver.

9.4.3 Measurement arrangement



NOTE:
1) Calling indicator
2) Photo detector/acoustic coupler
3) Receiver under test
4) Wideband test antenna
5) Combining network (used only when one antenna is used)
6) Signal generator A
7) Signal generator B
8) Test antenna for the wanted signal (see subclause 9.4.3 e))

Figure 14: Measurement arrangement

a) A test site corresponding to that for the measurement of the average usable sensitivity shall be used (see subclause 9.1).

b) The height of the wideband test antenna and the direction (angle) of the equipment under test shall be positioned as indicated in subclause 9.1.4.

c) During the course of the measurement it may be necessary to radiate high powers in a broad frequency range, and care shall be taken to avoid the signals causing interference to existing services that may be operating in the neighbourhood.

d) In the presence of a reflective ground plane the height of the wideband test antenna has to be altered to optimize the reflections from the ground plane. This cannot be done simultaneously for two different frequencies.

   If vertical polarization is used, the ground floor reflection can be effectively eliminated by the use of an appropriate monopole located directly on the ground plane (rod antenna).

e) In case the wideband test antenna does not cover the necessary frequency range, alternatively two different and sufficiently decoupled antennas may be used.

f) The equipment under test shall be placed on the support in its standard position (see annex A) and in the reference direction on the support as indicated in subclauses 9.1.2 and 9.1.4.

9.4.4 Method of the search

a) Two signal generators A and B shall be connected to the wideband test antenna via a combining network, where appropriate, or alternatively to two different antennas in accordance with subclause 9.4.3 e).

   The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation D-M3 (see subclause 7.1).

   The unwanted signal, represented by signal generator B, shall be modulated with a frequency of 400 Hz at a deviation of ±5 kHz.

b) Initially the unwanted signal shall be switched off.

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength, and by using the calibration in the procedure of subclause 9.1.4.2 step d) (see subclauses 5.2.1 and 9.1.4).

c) The unwanted signal shall then be switched on and its level shall be adjusted to provide a field strength which is at least 10 dB above the limit of the spurious response rejection (see subclause 5.2.4) measured at the receiver location, even when on some types of test sites the level of the unwanted signal is varying considerably with the frequency due to ground reflections.

   The frequency of the unwanted signal shall be varied in increments of 10 kHz over the limited frequency range and according to calculations outside of this frequency range (see subclause 9.4.2 b)).

d) The normal test signal D-M3 shall be transmitted repeatedly whilst observing the responses.

e) If the successful response ratio is higher than 80 %, then no spurious response effects are detected and the measurement shall be continued on the next increment of frequency.

f) If three consecutive successful responses cannot be obtained then the level of the unwanted signal shall be reduced in steps of 1 dB until three successful responses are obtained.

g) In the case where a reflective ground floor is used the antenna height shall be varied at each change of unwanted signal level until three consecutive successful responses are obtained.

   The test antenna need not be raised or lowered if a test site according to annex A, subclause A.1.1 is used, or if the ground floor reflection can effectively be eliminated (see subclause 9.4.3 d)).

h) The frequency of any spurious response detected during the search, and the antenna position and its height shall be recorded for the use in measurements in accordance with subclause 9.4.5.

9.4.5 Method of measurement

At each frequency where a spurious response has been found, within and outside the limited frequency range, the measurement shall be performed as follows:

a) The measurement arrangement is identical to that in subclauses 9.4.4 a) and g).

   The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation D-M3 (see subclause 7.1).

   The unwanted signal, represented by signal generator B, shall be modulated with a frequency of 400 Hz with a deviation of 12 % of the channel separation (A-M3).

b) Initially the unwanted signal shall be switched off.

   The level of the wanted signal from signal generator A shall be adjusted to a level which is 3 dB above the limit of the average usable sensitivity (see subclause 9.1.4), for the category of equipment used (see subclause 5.2.1), expressed in field strength when measured at the receiver location.

c) The unwanted signal from generator B shall then be switched on and its level shall be adjusted until a successful response ratio of less than 10 % is obtained.

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

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

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

   The level of the input signal shall then be noted.

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

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

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

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

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

   The average of the values noted in steps d) and e) (which provides the level corresponding to the successful response ratio of 80 %) shall be recorded.

f) The unwanted signal shall be stepped up and down in increments of 20 % of the channel separation and steps d) and e) shall be repeated until the lowest average level recorded in step e) is obtained.

   For each frequency the spurious response rejection shall be expressed, as the level in dBμV/m of the field strength of the unwanted signal at the receiver location, corresponding to the lowest value recorded during this step.

g) The measurement shall be repeated at all spurious response frequencies found during the search over the limited frequency range, subclause 9.4.2, and at frequencies calculated for the remainder of the spurious response frequencies in the frequency range $f_{Rx}/3,2$ or 30 MHz, whichever is higher to $3,2*f_{Rx}$, where f_{Rx} is the nominal frequency of the receiver, with the antenna position and height noted in 9.1.2 j).

h) The spurious response rejection of the equipment under test shall be expressed as the level in dBμV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

9.5 Intermodulation response rejection

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

9.5.1 Definition

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

9.5.2 Method of measurement

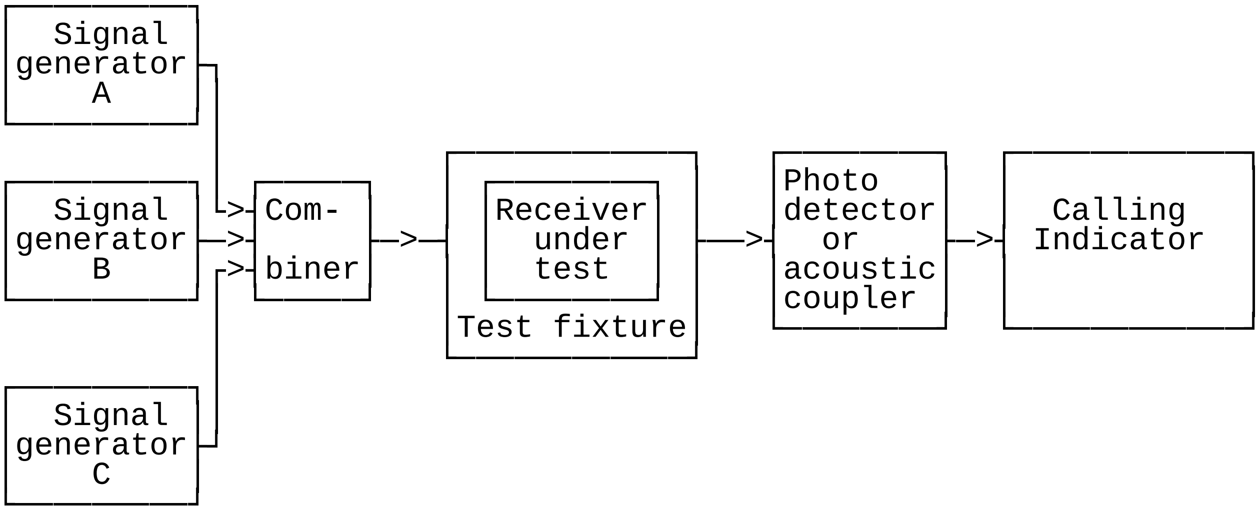


Figure 15: Measurement arrangement

a) The receiver shall be placed in the test fixture (see annex A, clause A.5).

   Three signal generators, A, B and C shall be connected to the test fixture via a combining network.

   The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation D-M3 (see subclause 7.1).

   The first unwanted signal, represented by signal generator B, shall be unmodulated and adjusted to the frequency 50 kHz above the nominal frequency of the receiver.

   The second unwanted signal, represented by signal generator C, shall be modulated with signal A-M3 (see subclause 7.1) and adjusted to a frequency 100 kHz above the nominal frequency of the receiver.

b) Initially the unwanted signals shall be switched off.

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (see subclauses 5.2.1 and 9.1.4).

c) The two unwanted signals from generators B and C shall then be switched on. Their levels shall be maintained equal and shall be adjusted until a successful response ratio of less than 10 % is obtained (see subclause 9.3.2 e)).

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

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

   The procedure shall be continued until three consecutive successful responses are observed. The level of the input signals shall then be noted.

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

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

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

   The average of the values noted in steps d) and e) (which provides the level corresponding to the successful response ratio of 80 %) shall be recorded.

f) For each configuration of the unwanted signals, the intermodulation response rejection shall be expressed as the ratio in dB of the average level recorded in step e) to the level of the wanted signal.

   It shall then be converted back into field strength of the unwanted signal at the receiver location and expressed in dBμV/m.

g) The measurement shall be repeated with the unwanted signal generator B at the frequency 50 kHz below that of the wanted signal and the frequency of the unwanted signal generator C at the frequency 100 kHz below that of the wanted signal.

h) The intermodulation response rejection of the equipment under test shall be expressed as the lower of the two values calculated in step f).

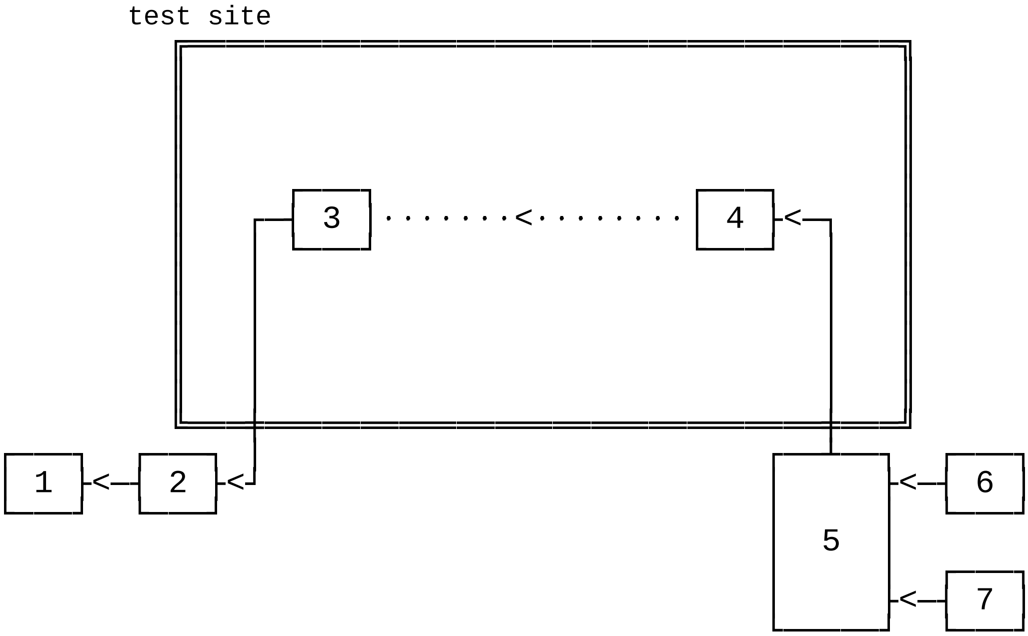
9.6 Blocking or desensitization

This measurement need not be carried out if this parameter has already been measured according to the requirements of EN 300 296-1 [7].

9.6.1 Definition

Blocking or desensitization 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 signal at any frequencies other than those of the spurious responses or adjacent channels.

9.6.2 Method of measurement



NOTE: 1) Calling indicator
2) Photo detector/acoustic coupler
3) Receiver under test
4) Wideband test antenna
5) Combining network
6) Signal generator A
7) Signal generator B

Figure 16: Measurement arrangement

A test site corresponding to that for the measurement of the average usable sensitivity shall be used (see subclause 9.1).

The equipment under test shall be placed on the support in its standard position (see annex A,) and in the reference direction (see subclause 9.1.2 j)) and the measurement shall be performed as follows.

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

   The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation (D-M3), (see subclause 7.1).

   The unwanted signal, provided by signal generator B, shall be unmodulated and shall be at a frequency from 1 MHz to 10 MHz away from the nominal frequency of the receiver.

   For practical reasons the measurements shall be carried out at frequencies of the unwanted signal at approximately ±1 MHz, ±2 MHz, ±5 MHz and ±10 MHz, avoiding those frequencies at which spurious responses occur (see subclause 9.4).

b) Initially the unwanted signal shall be switched off.

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level of the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (see subclauses 5.2.1 and 9.1.4).

c) The unwanted signal shall then be switched on and its level shall be adjusted until a successful response ratio of less than 10 % is obtained.

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

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

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

The level of the input signal shall then be noted.

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

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

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

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

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

The average of the values noted in steps d) and e) (which provides the level corresponding to the successful response ratio of 80 %) shall be recorded.

f) For each frequency, the blocking or desensitization shall be expressed as the level in dBuV/m of the field strength of the unwanted signal at the receiver location, corresponding to the average value recorded in step e).

g) The measurement shall be repeated for all the frequencies defined in step a).

h) The blocking or desensitization of the equipment under test shall be expressed as the level in dBμV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

9.7 Receiver Spurious radiations

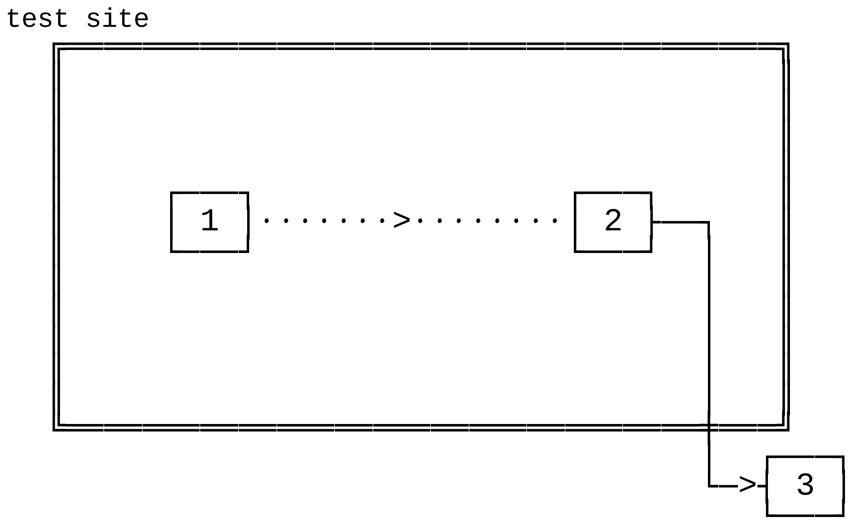
This measurement need not be carried out if this parameter has been measured according to the requirements of EN 300 296-1 [7].

9.7.1 Definition

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

They are specified as the radiated power of any discrete signal.

9.7.2 Method of measurement



NOTE: 1) Receiver under test
2) Test antenna
3) Spectrum analyser or selective voltmeter (test receiver)

Figure 17: Measurement arrangement

a) A test site, which fulfils the requirements of the specified frequency range of this measurement, shall be used. The test antenna shall be orientated for vertical polarization and connected to a spectrum analyser or a selective voltmeter. The resolution bandwidth of the spectrum analyser or selective voltmeter shall be between 10 kHz and 120 kHz, set to a suitable value to correctly perform the measurement.

b) The receiver under test shall be placed on the support in its standard position (see annex A). The radiation of any spurious component shall be detected by the test antenna and spectrum analyser or selective voltmeter over the frequency range 30 MHz to 4 GHz. In addition, for equipment operating on frequencies above 470 MHz, measurements shall be repeated over the frequency range 4 GHz to 12,75 GHz.

   The frequency of each spurious component shall be recorded. If the test site is disturbed by radiation coming from outside, this qualitative search may be performed in a screened room with reduced distance between the transmitter and the test antenna.

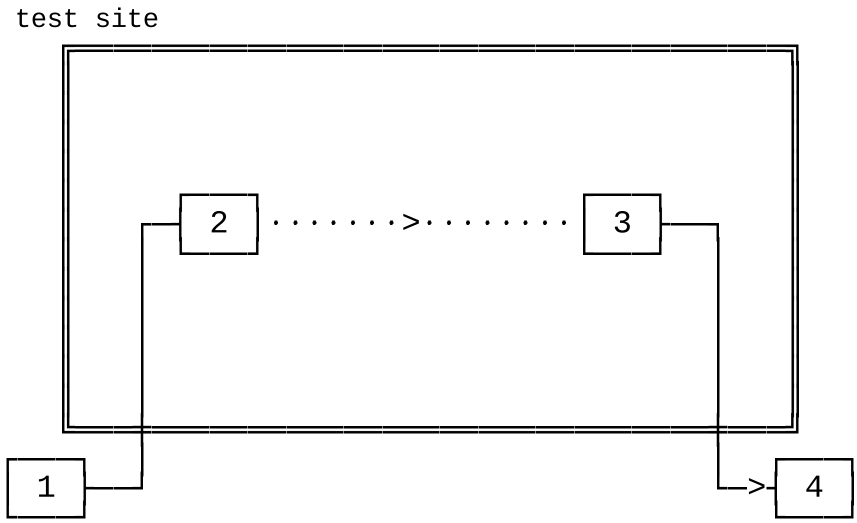
c) At each frequency at which a component has been detected, the spectrum analyser or selective voltmeter shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1 (i.e. an anechoic chamber).

d) The receiver shall be rotated up to 360° about a vertical axis, until a higher maximum signal is received.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be recorded.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1 (i.e. an anechoic chamber).



NOTE: 1) Signal generator
2) Substitution antenna
3) Test antenna
4) Spectrum analyser or selective voltmeter (test receiver)

Figure 18: Measurement arrangement

f) Using the measurement arrangement of figure 18 the substitution antenna shall replace the receiver antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

g) For each frequency at which a component has been detected, the signal generator and spectrum analyser or selective voltmeter shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to annex A, subclause A.1.1.

The level of the signal generator giving the same signal level on the spectrum analyser or selective voltmeter as in item e) above shall be recorded. This value, after correction due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious component at this frequency.

h) Measurements b) to g) above shall be repeated with the test antenna orientated in horizontal polarization.

10 Measurement uncertainty

Absolute measurement uncertainties: maximum values.

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

RF frequency	<±1 x 10^{-7}
Radiated RF power	<±6 dB
Conducted RF power variations using a test fixture	<±0,75 dB
Maximum frequency deviation:	
- within 300 Hz to 6 kHz of audio frequency	<±5 %
- within 6 kHz to 25 kHz of audio frequency	<±3 dB
Deviation limitation	<±5 %
Adjacent channel power	<±5 dB
Audio output power	<±0,5 dB
Amplitude characteristic of receiver limiter	<±1,5 dB
Sensitivity	<±3 dB
Two-signal measurement, valid to 4 GHz (using a test fixture)	<±4 dB
Two-signal measurements using radiated fields (note 1)	<±6 dB
Three-signal measurement (using a test fixture)	<±3 dB
Radiated emission of transmitter, valid to 12,75 GHz	<±6 dB
Radiated emission of receiver, valid to 12,75 GHz	<±6 dB
Transmitter transient time	<±20 %
Transmitter transient frequency	<±250 Hz

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [5] 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 the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

The maximum values of the absolute measurement uncertainties, given above, are based on such expansion factors.

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

NOTE: For blocking and spurious response rejection measurements.

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 [10] 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.

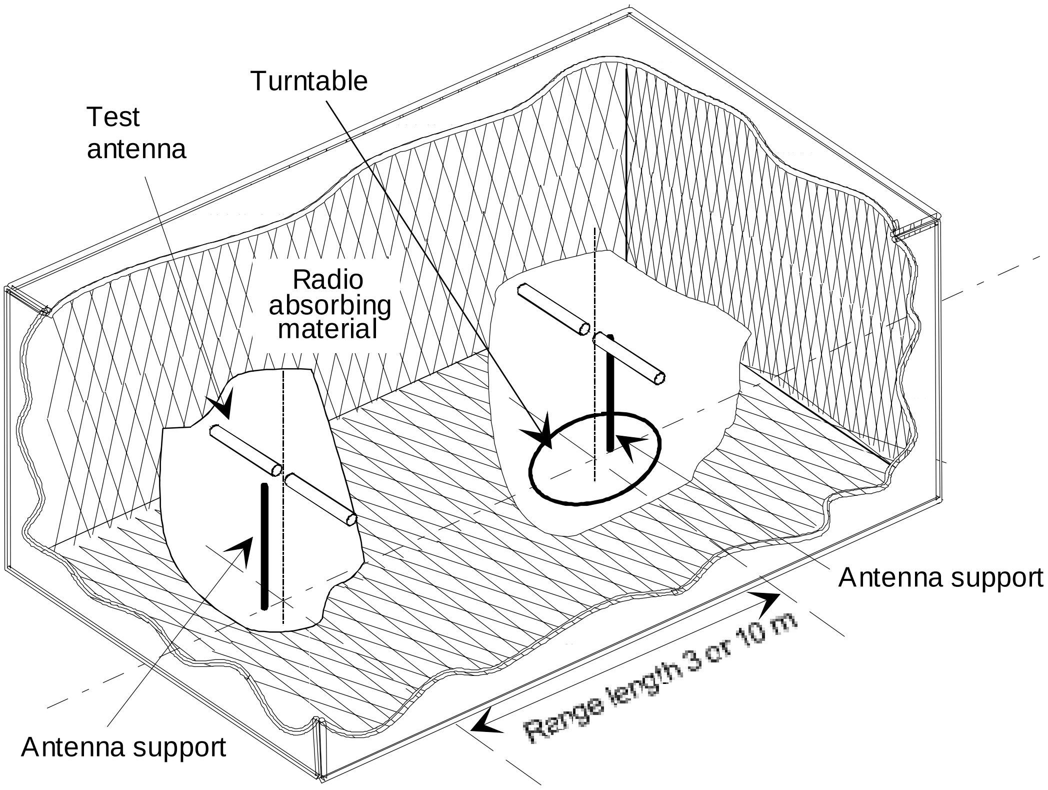


Figure A.1: A typical Anechoic Chamber

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.

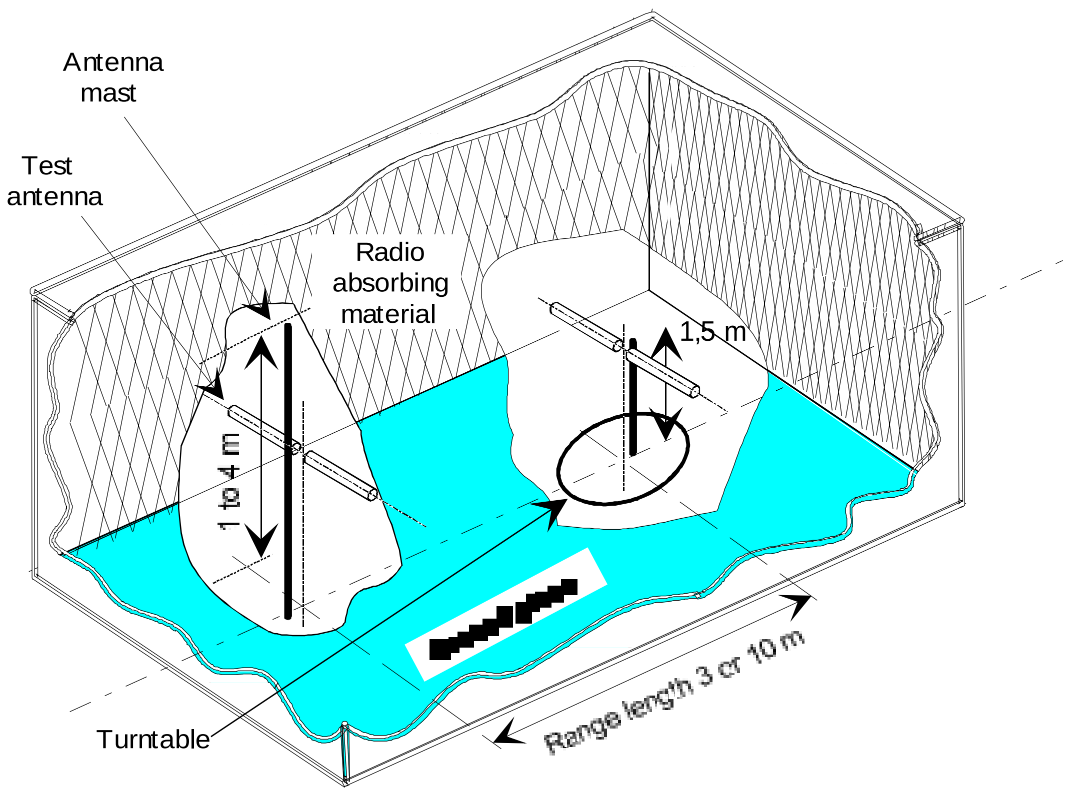


Figure A.2: A typical Anechoic Chamber with a conductive ground plane

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 a 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.

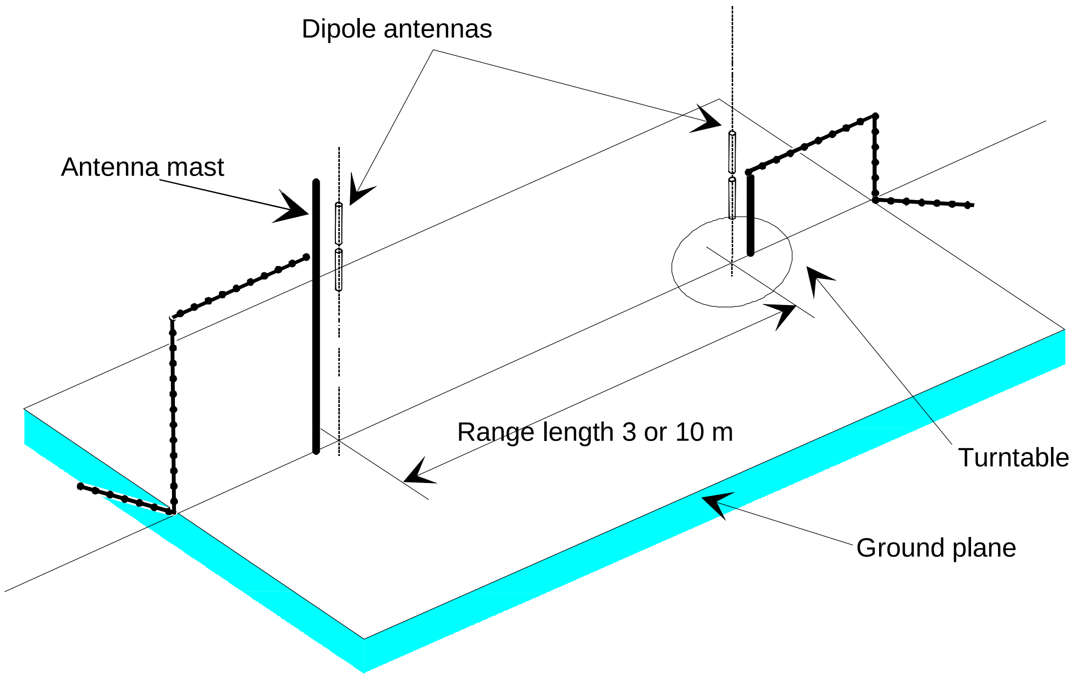


Figure A.3: A typical Open Area Test Site

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.

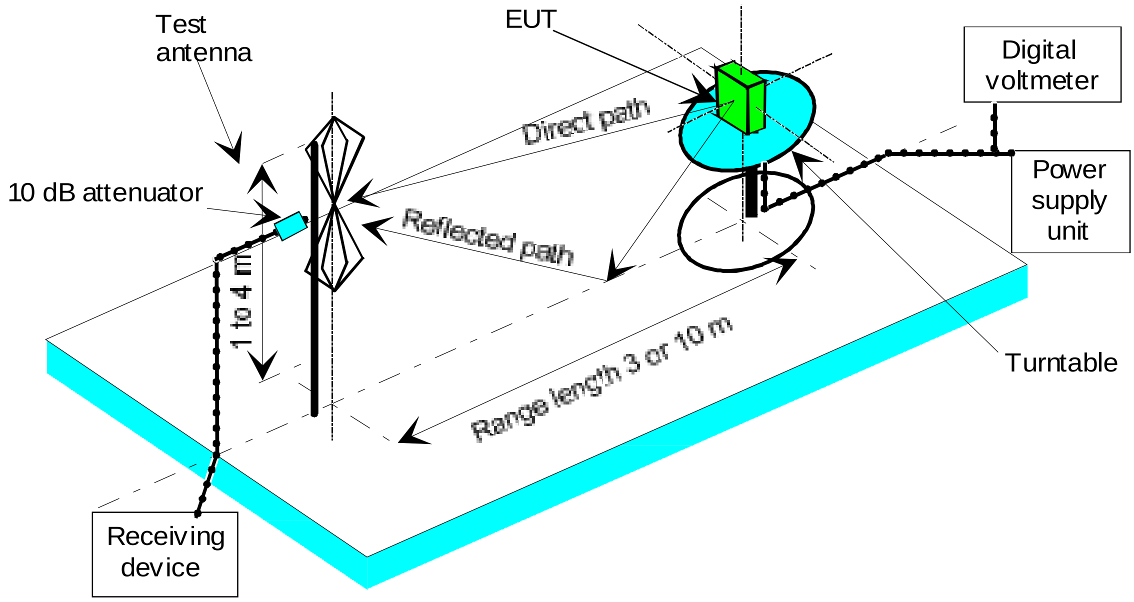


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

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 [11]) 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 [11]). 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 a EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [11]. 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^{o}512 TB 9
Useful frequency range	MHz	1 to 200	0,1 to 4 000
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 radiated emissions test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated tests 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 [10] 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, balsawood, 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: ±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, ultrasonic or infrared means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultrasonic or infrared 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 [13]).

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

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

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

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

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

A.5 Test fixture

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

A.5.1 Description

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

In addition, the test fixture may provide:

a) a connection to an external power supply;

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

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

The test fixture shall normally be provided by the 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.

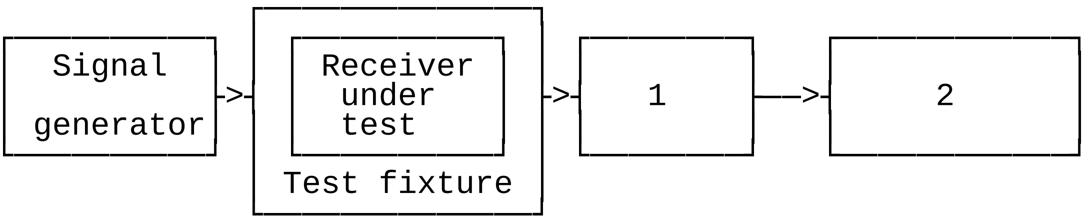
The characteristics and calibration shall be included in the test report.

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.)



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

Figure A.5: Measuring arrangement for calibration

Method of calibration:

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

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

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

shall be noted.

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

A.5.3 Mode of use

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

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

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

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

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

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

B.1 Power measuring receiver specification

B.1.1 General

The power-measuring receiver is used for the measurement of the transmitter adjacent channel power. It consists of a mixer and oscillator, an IF filter, an amplifier, a variable attenuator and a level indicator as shown below.

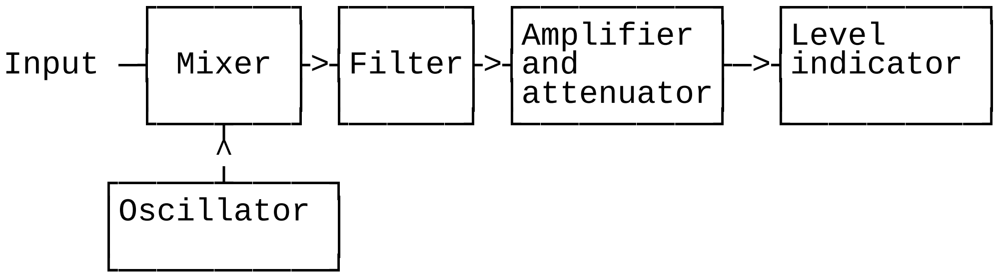


Figure B.1: Power measuring receiver

The technical characteristics of the power-measuring receiver are given below.

B.1.2 IF filter

The IF filter shall be within the limits of the selectivity characteristics given in the following diagram. Depending on the channel separation, the selectivity characteristics shall keep the frequency separations and tolerances given in the following table. The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

NOTE: A symmetrical filter can be used provided that each side meets the tighter tolerances and the D2 points have been calibrated relative to the -6 dB response. When a non-symmetrical filter is used the receiver shall be designed such that the tighter tolerance is used close to the carrier.

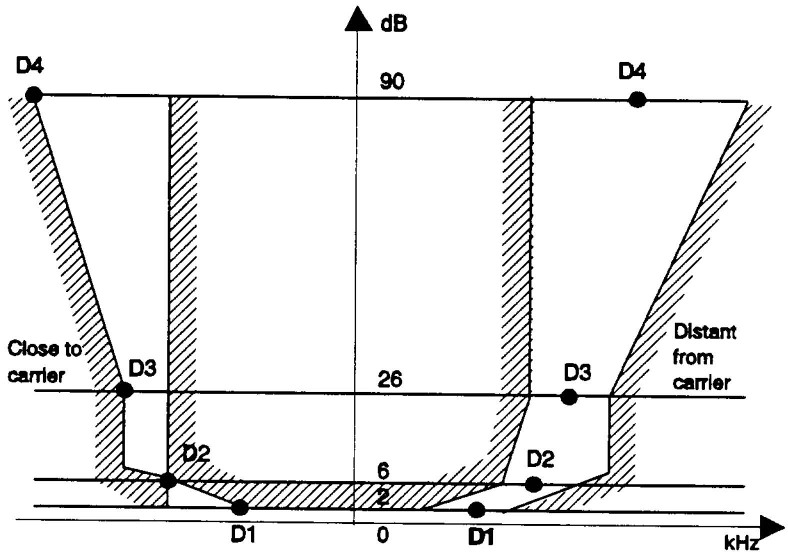


Figure B.2: Limits of the selectivity characteristic

Table B.1: Selectivity characteristic

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

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

Table B.2: Attenuation points close to carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12,5	+1,35	±0,1	-1,35	-5,35
20	+3,1	±0,1	-1,35	-5,35
25	+3,1	±0,1	-1,35	-5,35

Table B.3: Attenuation points distant from the carrier

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12,5	±2,0	±2,0	±2,0	+2,0 -6,0
20	±3,0	±3,0	±3,0	+3,0 -7,0
25	±3,5	±3,5	±3,5	+3,5 -7,5

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

Table B.4: Frequency displacement

Channel separation (kHz)	Specified necessary bandwidth (kHz)	Displacement from the - 6 dB point (kHz)
12,5	8,5	8,25
20	14	13
25	16	17

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

B.1.3 Oscillator and amplifier

The measurement of the reference frequencies and the setting of the local oscillator frequency shall be within ±50 Hz.

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

The linearity of the amplifier shall be such that an error in the reading of no more than 1,5 dB will be obtained over an input level variation of 100 dB.

B.1.4 Attenuation indicator

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

B.1.5 Level indicators

Two level indicators are required to cover the r.m.s and the peak transient measurement.

B.1.5.1 R.m.s level indicator

The r.m.s level indicator shall accurately indicate non-sinusoidal signals within a ratio of 10:1 between peak value and r.m.s value.

B.1.5.2 Peak level indicator

The peak level indicator shall accurately indicate and store the peak power level. For the transient power measurement the indicator bandwidth shall be greater than twice the channel separation. A storage oscilloscope or a spectrum analyser may be used as a peak level indicator.

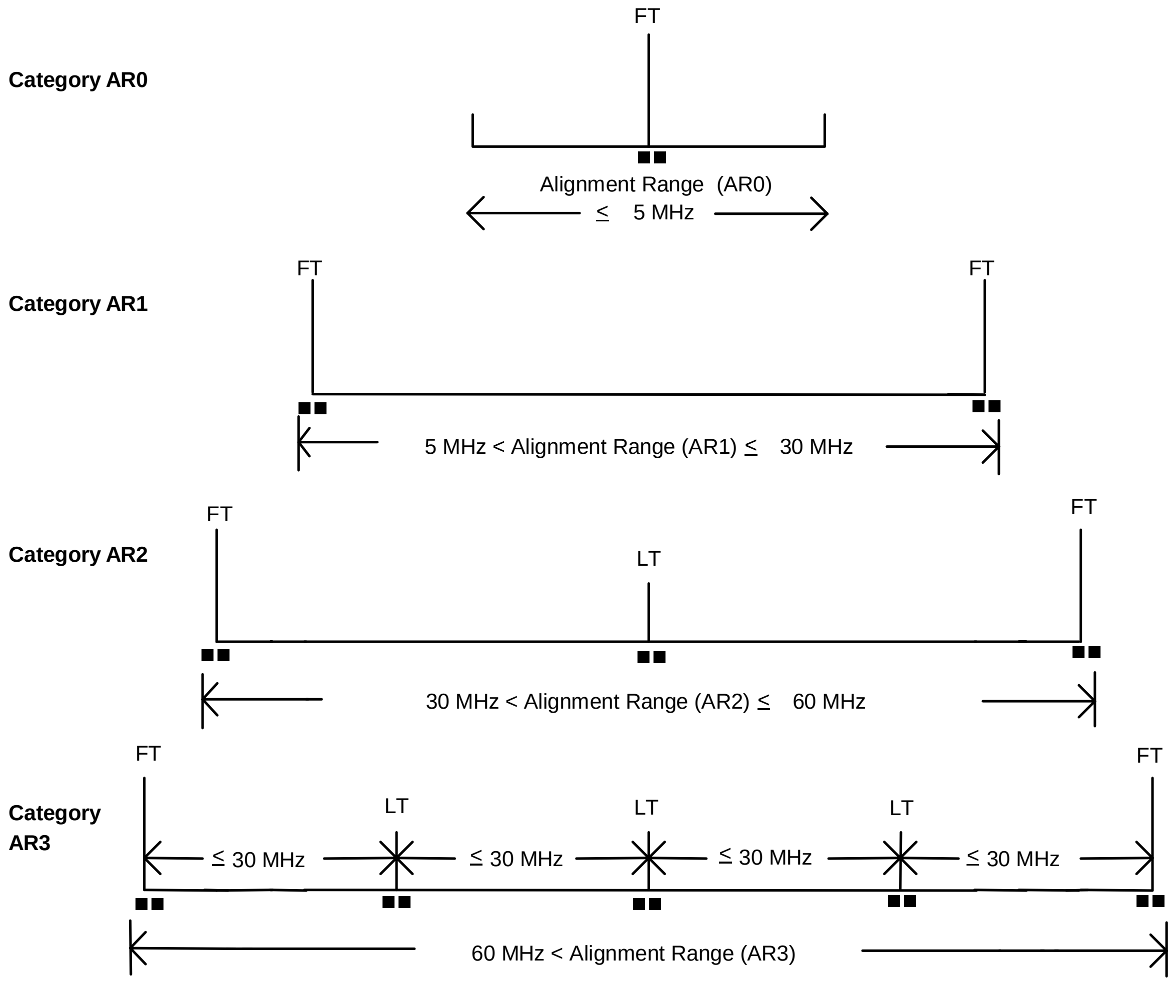
Annex C (normative): Graphical representation of the selection of equipment and frequencies for testing

Information regarding the selection of equipment for testing purposes can be found in EN 300 793 [9].

The following graphs, imported from EN 300 793 [9], illustrate the principles used in that standard, in particular, concepts such as full and limited tests. For further details concerning the present annex (e.g. definitions, references), please, refer to EN 300 793 [9].

C.1 Tests on a single sample

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



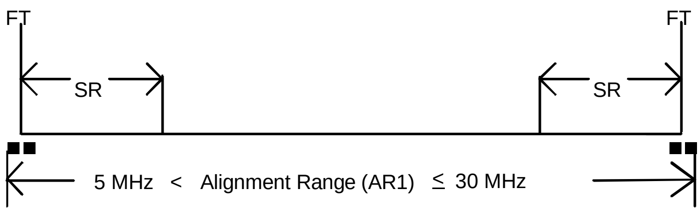
NOTE: AR0, AR1, AR2, AR3: Categories of alignment range, see subclause 4.3 in EN 300 793 [9]
FT: Full tests
LT: Limited tests
■■: 50 kHz range in which tests are carried out

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

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

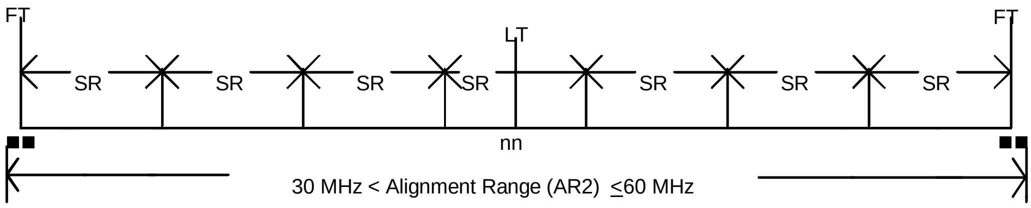
In order to cover an alignment range several separate samples, having different switching ranges (SR) within the alignment range, may be needed. Samples shall be then provided for testing in accordance with subclauses 4.4, 4.5, 4.6, and 4.7 in EN 300 793 [9], as appropriate. The following examples assume a switching range (SR) of 5 MHz.

Category AR1



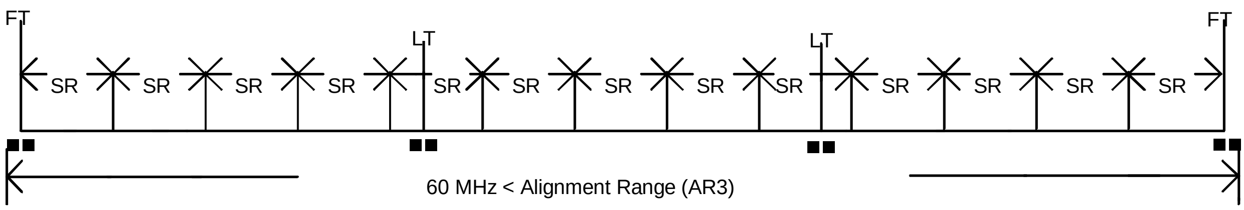
2 Samples, 2 FT

Category AR2



3 Samples, 2 FT, 1 LT.

Category AR3



4 Samples, 2 FT, 2 LT.

NOTE:
SR: Switching Range, see subclause 4.2
AR1, AR2, AR3: Categories of alignment range, see subclause 4.3 in EN 300 793 [9]
FT: Full tests
LT: Limited tests
■■: 50 kHz range in which tests are carried out

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

C.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 4.4, 4.5, 4.6, and 4.7 in EN 300 793 [9], as appropriate.

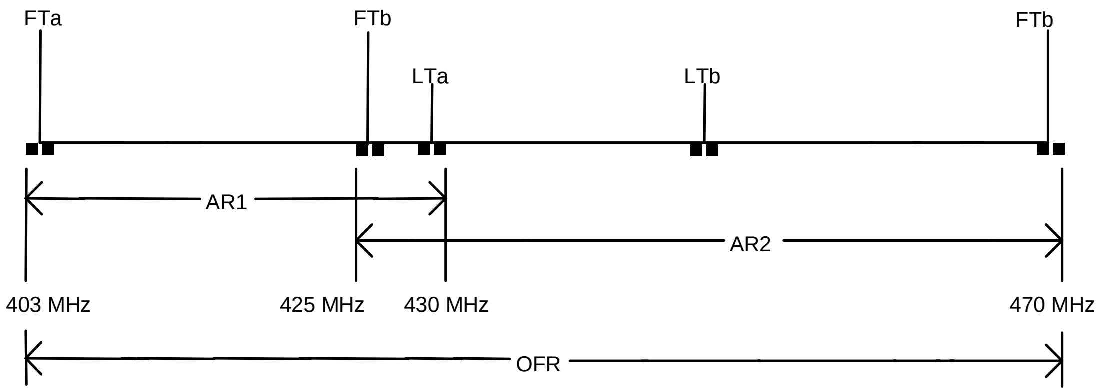
For example the applicant seeks type approval for a family of equipment having an operating frequency range of 403 MHz to 470 MHz. The equipment to be tested does not cover this range with one category of alignment range.

C.3.1 Test scenario 1

The Operating Frequency Range (OFR) could be covered by two alignment ranges a) and b), implemented in samples a) and b):

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

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



NOTE 1: OFR: Operating Frequency Range, see subclause 4.2 in EN 300 793 [9]
AR1, AR2: Categories of alignment range, see subclause 4.3 in EN 300 793 [9]
FTa: Full tests on sample(s) a)
LTa: Limited tests on sample(s) a)
FTb: Full tests on sample(s) b)
LTb: Limited test on sample(s) b)
■■: 50 kHz range in which tests are carried out

NOTE 2: This example requires a minimum of two test samples and a maximum of five test samples to cover the operating frequency range.

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

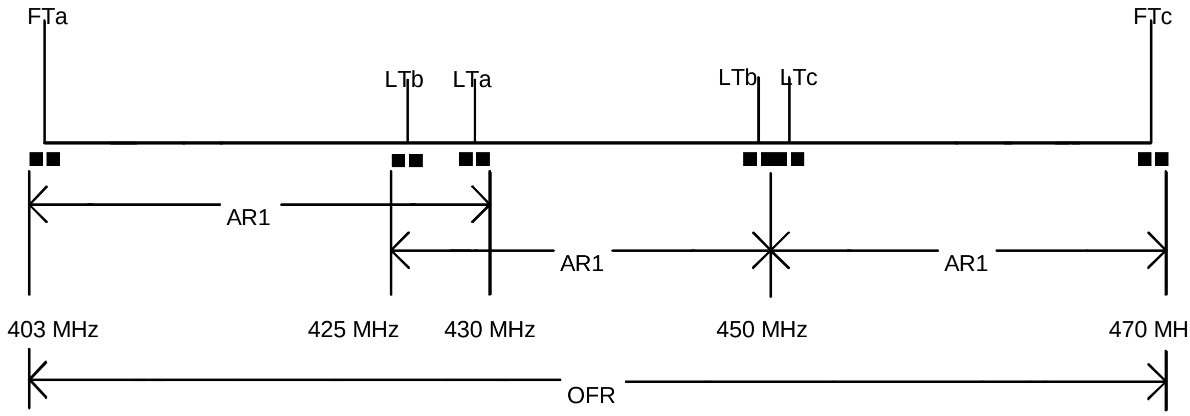
C.3.2 Test scenario 2

The Operating Frequency Range (OFR) could alternatively be covered by three alignment ranges of category AR1, implemented in samples a), b) and c):

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.



NOTE 1: OFR: Operating Frequency Range, see subclause 4.2 in EN 300 793 [9]
AR1: Second category of alignment range, see subclause 4.3 in EN 300 793 [9]
FTa: Full tests on sample(s) a)
LTa: Limited tests on sample(s) a)
LTb: Limited test on sample(s) b)
FTc: Full tests on sample(s) c)
LTc: Limited tests on sample(s) c)
■■: 50 kHz range in which tests are carried out

NOTE 2: This example requires a minimum of three test samples and a maximum of six test samples to cover the operating frequency range.

Figure C.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.

- CEPT Recommendation T/R 24-01: "Technical characteristics and test conditions for non-speech and combined speech/non-speech radio equipment (using signalling to initiate a specific response in the receiver) with integral antennas in the Land Mobile Service".Annex 6: Bibliography (Informative).

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History

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