

ETSI EN 300 433 V2.1.1 (2016-05)



HARMONISED EUROPEAN STANDARD

**Citizens' Band (CB) radio equipment;
Harmonised Standard covering the essential requirements
of article 3.2 of the Directive 2014/53/EU**

Reference

REN/ERM-TGDMMR-346

Keywords

CB, radio, testing

ETSI

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

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

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

Important notice

The present document can be downloaded from:
<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:
<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2016.
All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are Trade Marks of ETSI registered for the benefit of its Members.
3GPP™ and **LTE™** are Trade Marks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.
GSM® and the GSM logo are Trade Marks registered and owned by the GSM Association.

Contents

Intellectual Property Rights	6
Foreword.....	6
Modal verbs terminology.....	6
1 Scope	7
2 References	7
2.1 Normative references	7
2.2 Informative references.....	8
3 Definitions, symbols and abbreviations	8
3.1 Definitions.....	8
3.2 Symbols.....	9
3.3 Abbreviations	9
4 General and operational requirements.....	10
4.0 General	10
4.1 Choice of model for testing	10
4.1.0 General.....	10
4.1.1 Auxiliary test equipment.....	11
4.1.2 Declarations by the provider.....	11
4.2 Testing of equipment that does not have an external 50 Ω RF connector (integral antenna equipment)	11
4.3 Mechanical and electrical design.....	11
4.3.1 General.....	11
4.3.2 Controls	11
4.3.3 PTT and voice- activated switch.....	11
4.3.4 Combination with other equipment	11
4.4 Operating frequencies.....	12
4.5 Marking.....	12
5 Test conditions, power sources and ambient temperatures	12
5.0 Environmental profile.....	12
5.1 Normal and extreme test conditions	12
5.2 Test power source.....	13
5.3 Normal test conditions.....	13
5.3.1 Normal temperature and humidity	13
5.3.2 Normal test power source	13
5.3.2.1 Mains voltage.....	13
5.3.2.2 Regulated lead-acid battery power sources used on vehicles.....	13
5.3.2.3 Other power sources.....	13
5.4 Extreme test conditions	13
5.4.1 Extreme temperatures	13
5.4.2 Extreme test power source.....	14
5.4.2.1 Mains voltage.....	14
5.4.2.2 Regulated lead-acid battery power sources used on vehicles.....	14
5.4.2.3 Power sources using other types of batteries.....	14
5.4.2.4 Other power sources.....	14
5.5 Procedure for tests at extreme temperatures.....	14
6 General test conditions	14
6.1 Arrangements for test signals applied to the receiver input.....	14
6.2 Receiver mute or squelch facility	15
6.3 Receiver rated audio output power.....	15
6.4 Transmitter rated RF power.....	15
6.5 Normal test modulation	15
6.5.1 DSB modulation	15
6.5.2 SSB modulation	15
6.5.3 Angle modulation (FM modulation with Preemphasis/Deemphasis)	16
6.6 Artificial antenna.....	16
6.7 Test fixture	16

6.8	Arrangement for test signals at the input of the transmitter	16
6.9	Test site and general arrangements for radiated measurements.....	16
7	Technical characteristics of the transmitter	16
7.1	Frequency error	16
7.1.0	Applicability	16
7.1.1	Definition.....	16
7.1.2	Method of measurement	17
7.1.3	Limit	17
7.2	Transmitter power	17
7.2.1	Definition.....	17
7.2.2	Method of measurement	17
7.2.2.1	Method of measurement (conducted).....	17
7.2.2.2	Method of measurement (effective radiated power)	17
7.2.3	Limits.....	18
7.3	Maximum permissible frequency deviation	18
7.3.0	Applicability	18
7.3.1	Definition.....	18
7.3.2	Method of measurement	18
7.3.3	Limit	19
7.4	Adjacent and alternate channel power.....	19
7.4.1	Definition.....	19
7.4.2	Method of measurement	19
7.4.3	Limits.....	20
7.5	Unwanted emissions in the spurious domain.....	20
7.5.1	Definition.....	20
7.5.2	Method of measurement	21
7.5.2.1	Method of measuring the power level in a specified load (clause 7.5.1 a))	21
7.5.2.1.1	Method of measuring the power level in a specified load (for angle modulation)	21
7.5.2.1.2	Method of measuring the power level in a specified load (for DSB and/or SSB)	21
7.5.2.2	Method of measuring the effective radiated power (clause 7.5.1 b))	21
7.5.2.3	Method of measuring the effective radiated power (clause 7.5.1 c))	22
7.5.3	Limits.....	22
7.6	Transient behaviour of the transmitter.....	23
7.6.0	Applicability	23
7.6.1	Definitions	23
7.6.2	Method of measurement	24
7.6.3	Limits.....	26
8	Methods of measurement for receiver parameters	26
8.1	Maximum usable sensitivity.....	26
8.1.0	Applicability	26
8.1.1	Definition.....	26
8.1.2	Method of measurement	26
8.1.3	Limits.....	26
8.2	Adjacent channel selectivity.....	26
8.2.0	Applicability	26
8.2.1	Definition.....	27
8.2.2	Method of measurement	27
8.2.3	Limits.....	27
8.3	Intermodulation response rejection	27
8.3.0	Applicability	27
8.3.1	Definition.....	27
8.3.2	Method of measurement	27
8.3.3	Limits.....	28
8.4	Spurious radiations	28
8.4.1	Definition.....	28
8.4.2	Method of measurement	28
8.4.2.1	Method of measuring the power level in a specified load.....	28
8.4.2.2	Method of measuring the effective radiated power	28
8.4.2.3	Method of measuring the effective radiated power	29
8.4.3	Limits.....	29

8.5	Blocking and Spurious Response Rejection	29
8.5.0	Applicability	29
8.5.1	Definition	29
8.5.2	Method of measurement	30
8.5.3	Limits	30
9	Testing for compliance with technical requirements.....	30
9.1	Test conditions, power supply and ambient temperatures	30
9.2	Interpretation of the measurement results	30
Annex A (normative): Radiated measurement.....		32
A.1	Test sites and general arrangements for measurements involving the use of radiated fields	32
A.1.0	General	32
A.1.1	Anechoic chamber	32
A.1.2	Anechoic chamber with a conductive ground plane	33
A.1.3	Open Area Test Site (OATS)	34
A.1.4	Test antenna.....	35
A.1.5	Substitution antenna	36
A.1.6	Measuring antenna	36
A.2	Guidance on the use of radiation test sites	36
A.2.0	General	36
A.2.1	Verification of the test site	36
A.2.2	Preparation of the EUT.....	36
A.2.3	Power supplies to the EUT	36
A.2.4	Volume control setting for analogue speech tests	37
A.2.5	Range length.....	37
A.2.6	Site preparation	37
A.3	Coupling of signals.....	38
A.3.1	General	38
A.3.2	Data signals	38
A.3.3	Speech and analogue signals	38
A.3.3.0	General.....	38
A.3.3.1	Acoustic coupler description.....	38
A.3.3.2	Calibration	39
Annex B (normative): Specification for some particular measurement arrangements.....		40
B.1	Power measuring receiver specification.....	40
B.1.0	General	40
B.1.1	IF filter	40
B.1.2	Attenuation indicator.....	41
B.1.3	RMS value indicator.....	41
B.1.4	Oscillator and amplifier.....	41
B.2	Spectrum analyser specification.....	42
B.2.1	Adjacent and alternate channel power measurement.....	42
B.2.2	Unwanted emissions measurement.....	42
B.3	Integrating and power summing device	42
Annex C (normative): Relationship between the present document and the essential requirements of Directive 2014/53/EU		43
History		45

Intellectual Property Rights

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

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

Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table C.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

National transposition dates	
Date of adoption of this EN:	2 May 2016
Date of latest announcement of this EN (doa):	31 August 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 2017
Date of withdrawal of any conflicting National Standard (dow):	28 February 2018

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document covers the technical requirements for transmitters and receivers used in stations of angle modulated, Double Side Band (DSB) modulated and/or Single Side Band (SSB) modulated Citizens' Band (CB) radio equipment operating in all or part of the frequency band 26,960 MHz to 27,410 MHz with a channel spacing of 10 kHz, and intended for analogue speech and/or data transmission.

Citizens' Band radio equipment operation is in accordance with ECC Decision (11)03 on the harmonised use of frequencies for Citizens' Band (CB) radio equipment [i.2].

Any equipment using national regulations on Citizens' Band (CB) permitting the use of channels outside of the carrier frequencies shown in table 1 within the frequency range from 26 MHz to 28 MHz can use the present document.

The types of equipment covered by the present document are as follows:

- Base station: equipment fitted with antenna connector.
- Mobile station: equipment fitted with antenna connector.
- Hand portable stations:
 - a) either fitted with an antenna connector; or
 - b) without an external antenna connector but fitted with a permanent internal or a temporary internal 50 Ω RF connector which allows access to the transmitter output and the receiver input.

Hand portable station equipment without an external or internal Radio Frequency (RF) connector and without the possibility of having a temporary internal 50 Ω RF connector is not covered by the present document (integral antenna equipment).

The present document contains requirements to demonstrate that "*... Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference*" and that "*....radio equipment supports certain features ensuring access to emergency services*".

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the Radio Equipment Directive [i.4] may apply to equipment within the scope of the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

- [1] ETSI TR 100 028 (V1.4.1) (all parts) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [2] CISPR 16-2 (All parts) (2014): "Specifications for radio disturbance and immunity measuring apparatus and methods".
- [3] Recommendation ITU-T O.41 (10-1994): "Psophometer for use on telephone-type circuits".

- [4] IEC 60489-3 (1988): "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions", appendix F.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI TR 102 273 (V1.2.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [i.2] ECC Decision (11)03: "The harmonised use of frequencies for Citizen's Band (CB) radio equipment".
- [i.3] ITU Radio Regulations (2012).
- [i.4] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.5] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.6] ANSI C63.5 (2006): "American National Standard for Electromagnetic Compatibility - Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration and Qualification of Antennas (9 kHz to 40 GHz)". ANSI C63.5 (2006): "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electro Magnetic Interference".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

adjacent channels: channel offset from the wanted channel by the channel spacing

NOTE: See figure 0.

alternate channels: two channels offset from the wanted channel by double the channel spacing

NOTE: See figure 0.

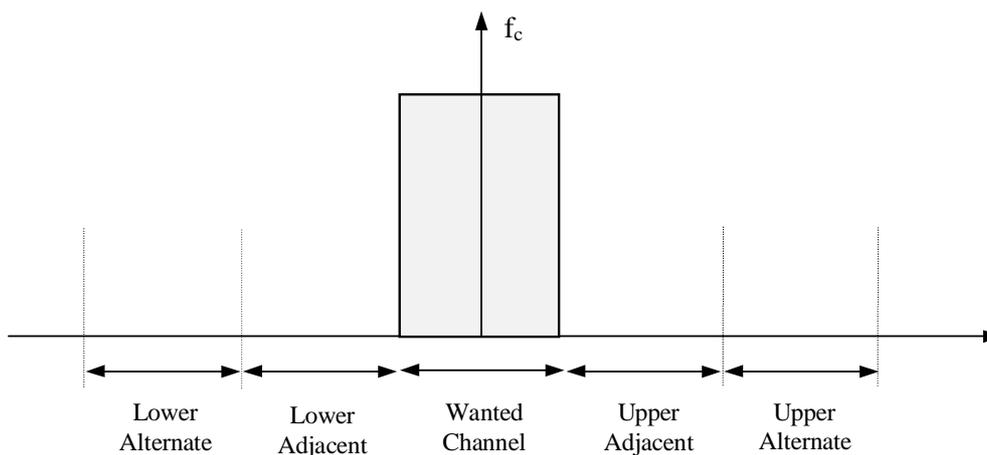


Figure 0: Adjacent and alternate channel definitions

angle modulations: F3E/G3E classes of emission

NOTE: As defined in the ITU Radio Regulations [i.3], corresponding to modulation with an audio pre-emphasis characteristic for the FM transmitter and an audio de-emphasis characteristic for the receiver.

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

Double Side Band (DSB) modulation: A3E class of emission

NOTE: As defined in the ITU Radio Regulations [i.3], corresponding to double side band amplitude modulation (AM).

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

integral antenna: antenna designed as a fixed part of the equipment, without the use of an external connector and as such which cannot be disconnected from the equipment by the user

NOTE: An integral antenna may be fitted internally or externally.

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

Single Side Band (SSB) modulation: J3E class of emission

NOTE: As defined in the Sub-Section IIA of Volume II Appendices of the ITU Radio Regulations [i.3], corresponding to single side band suppressed carrier amplitude modulation, using either USB or LSB.

3.2 Symbols

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

λ	Wavelength
Ω	Ohms

3.3 Abbreviations

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

AC	Alternating Current
AM	Amplitude Modulation
CB	Citizen's Band
CEPT	European Conference of Postal and Telecommunications Administrations
CISPR	Comité International Spécial des Perturbations Radioélectriques

CW	Continuous Wave
DC	Direct Current
DSB	Double Side Band
EC	European Commission
ECC	Electronic Communications Committee
EFTA	European Free Trade Association
emf	electromotive force
EUT	Equipment Under Test
FM	Frequency Modulation
IEC	International Electrotechnical Commission
IF	Intermediate Frequency
ITU	International Telecommunication Union
LSB	Lower Side Band
ND	Noise + Distortion
OATS	Open Area Test Site
PEP	Peak Envelope Power
PTT	Push-To-Talk
RBW	Resolution BandWidth
RF	Radio Frequency
RMS	Root Mean Square
RR	Radio Regulations
RX	Receiver/reception
SINAD	(Signal + Noise + Distortion)/(Noise + Distortion) ratio
SND	Signal + Noise + Distortion
SSB	Single Side Band
TR	Technical Report
TX	Transmitter/Transmission
USB	Upper Side Band
VSWR	Voltage Standing Wave Ratio

4 General and operational requirements

4.0 General

Equipment shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

The provider or supplier shall declare the frequency ranges, the range of operating conditions and power requirements as applicable, to establish the appropriate test conditions.

The equipment shall be tested to the present document using the type of modulation signal defined in clause 6.5 that is relevant to the operational mode being tested, i.e. angle modulation, DSB or SSB. Angle modulation is considered as equivalent to frequency modulation (FM) with pre-emphasis in transmit mode and de-emphasis in receive mode.

Equipment capable of using two or three types of modulation among angle modulation, DSB and SSB shall be tested to the present document using the respective type of modulation for each mode (see clause 6.5).

4.1 Choice of model for testing

4.1.0 General

Stand alone equipment shall be complete with any ancillary equipment needed for testing.

If an equipment has several optional features, considered not to affect the RF parameters then the tests to be performed on the equipment configured with that combination of features considered to be the most complex.

Where practicable, equipment to be tested shall provide a 50 Ω connector for conducted RF power level measurements.

In the case of integral antenna equipment, if the equipment does not have an internal permanent 50 Ω connector then a second sample of the equipment shall be used with a temporary antenna connector fitted to facilitate testing.

Tests shall be carried out on the highest and lowest channel within the switching range of the equipment and on a channel near the middle of the switching range. The switching range of the receiver and transmitter shall be declared by the supplier. The switching range is the maximum frequency range over which the receiver or the transmitter can be operated without reprogramming or realignment. In the case of equipment fitted with one channel only, all tests are carried out on that channel. In the case of equipment fitted with two channels, all tests are carried out on both channels.

4.1.1 Auxiliary test equipment

All necessary test signal sources, setting up instructions and other product information shall accompany the equipment to be tested.

4.1.2 Declarations by the provider

All necessary setting up instructions and other product information shall be made available with the equipment to be tested, in accordance with article 10.8 of Directive 2014/53/EU [i.4].

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

Where equipment has an internal 50 Ω connector it shall be permitted to perform the tests at this connector.

Equipment may also have a temporary internal 50 Ω connector installed for the purposes of testing.

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

4.3 Mechanical and electrical design

4.3.1 General

The equipment should be designed, constructed and manufactured in accordance with good engineering practice, and with the aim of minimizing harmful interference to other equipment and services.

4.3.2 Controls

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

4.3.3 PTT and voice- activated switch

Switching between the transmit and receive mode of operation shall only be possible by means of a non-locking PTT switch or by means of a non-locking voice-activated switch. If a voice-activated switch is used it shall not respond to ambient acoustic noise.

For SSB CB equipment with a microphone jack, the threshold level adjustment shall be accessible to the user. For DSB/angle modulated and/or CB equipment with a microphone jack, the threshold level adjustment may be accessible to the user.

All adjustments accessible by the user that have influence on the threshold shall be safe against unintended change of setting.

4.3.4 Combination with other equipment

The equipment shall not be combined with any other form of transmitting or receiving equipment, which can produce unwanted modulation of the transmitter. The equipment shall not be provided with any terminals or other connection points, internal or external, for modulating sources other than those required for either a separate or a built-in microphone, or for selective calling or data transmission devices.

Terminals or other connecting points are permitted for the connection of external devices that shall not modulate the transmitters (e.g. a voice synthesizer device to give an aural indication of channel).

4.4 Operating frequencies

Citizen's Band radio equipment operating in accordance with ECC Decision (11)03 [i.2] shall use on one or more channels of the carrier frequencies as shown in table 1. The channel separation is 10 kHz.

Table 1: Carrier frequencies

Carrier frequencies	Channel Number	Carrier frequencies	Channel Number
26,965 MHz	1	27,215 MHz	21
26,975 MHz	2	27,225 MHz	22
26,985 MHz	3	27,235 MHz	24
27,005 MHz	4	27,245 MHz	25
27,015 MHz	5	27,255 MHz	23
27,025 MHz	6	27,265 MHz	26
27,035 MHz	7	27,275 MHz	27
27,055 MHz	8	27,285 MHz	28
27,065 MHz	9	27,295 MHz	29
27,075 MHz	10	27,305 MHz	30
27,085 MHz	11	27,315 MHz	31
27,105 MHz	12	27,325 MHz	32
27,115 MHz	13	27,335 MHz	33
27,125 MHz	14	27,345 MHz	34
27,135 MHz	15	27,355 MHz	35
27,155 MHz	16	27,365 MHz	36
27,165 MHz	17	27,375 MHz	37
27,175 MHz	18	27,385 MHz	38
27,185 MHz	19	27,395 MHz	39
27,205 MHz	20	27,405 MHz	40

Citizen's Band radio equipment operating under other national regulations shall use frequencies within the 26 MHz to 28 MHz band and the frequencies used shall be clearly listed in the user information, along with details of those national regulations that it complies with.

Transmission and reception takes place on the same channel (single frequency simplex mode).

4.5 Marking

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

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

5 Test conditions, power sources and ambient temperatures

5.0 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the supplier, but as a minimum, shall be that specified in the test conditions contained in the present document.

All necessary setting up instructions and other product information shall be made available with the equipment to be tested, in accordance with article 10.8 of Directive 2014/53/EU [i.4].

5.1 Normal and extreme test conditions

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

The test conditions and procedures shall be as specified in clauses 5.2 to 5.5.

5.2 Test power source

During testing 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 clauses 5.3.2 and 5.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.

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 of DC powered equipment the power source voltages shall be maintained within a tolerance of $< \pm 1\%$ relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements, using a smaller tolerance will provide better measurement uncertainty values.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

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

Temperature: $+15\text{ }^{\circ}\text{C}$ to $+35\text{ }^{\circ}\text{C}$;

Relative humidity: 20 % to 75 %.

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

5.3.2 Normal test power source

5.3.2.1 Mains voltage

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

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

5.3.2.2 Regulated lead-acid battery power sources 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 (e.g. for nominal voltages of 12 V and 24 V, these are 13,2 V and 26,4 V respectively).

5.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment supplier.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.5, at the upper and lower temperatures of one of the following two ranges:

- $-10\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$;
All mobile and hand portable equipment.
Base stations for outdoor/uncontrolled climate conditions.
- $0\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$;
Base stations for indoor/controlled climate conditions.

In the case of base stations equipment, the supplier shall declare which conditions the equipment is intended to be installed in.

5.4.2 Extreme test power source

5.4.2.1 Mains voltage

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

5.4.2.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (e.g. for a nominal voltage of 12 V, these are 10,8 V and 15,6 V respectively and for a nominal voltage of 24 V, these are 21,6 V and 31,2 V respectively).

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment powered by batteries shall be as follows:

- for nickel-metal hydride, leclanché or lithium/lithium-ion batteries: 0,85 times the nominal battery voltage;
- for mercury or nickel-cadmium batteries: 0,9 times the nominal battery voltage.

No upper extreme test voltages apply.

In the case where no upper extreme test voltage applies then the nominal voltage is applicable and the corresponding four extreme test conditions are:

- V_{\min}/T_{\min} , V_{\min}/T_{\max} ;
- $(V_{\max} = \text{nominal})/T_{\min}$, $(V_{\max} = \text{nominal})/T_{\max}$.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those declared by the equipment supplier.

5.5 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature 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 supplier shall provide for the power source circuit feeding the crystal oven to be independent of the power source for 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 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 General test conditions

6.1 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 Ω .

This requirement shall be met irrespective of whether one or more signals are supplied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the voltage at the receiver input terminals.

The effects of any intermodulation products and noise produced in the signal generators should be negligible. The test generators shall be substantially free from static amplitude modulation.

6.2 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 tests.

6.3 Receiver rated audio output power

The rated audio output power shall be the maximum power, declared by the supplier, for which all the requirements of the present document are met. With normal test modulation (clause 6.5), the audio power shall be measured in a resistive load, simulating the load with which the receiver normally operates. The value of this load shall be declared by the supplier.

6.4 Transmitter rated RF power

The rated transmitter RF power shall be the maximum transmitter RF power declared by the supplier. The transmitter RF power measured under normal conditions shall be within ± 2 dB of the rated transmitter RF power.

6.5 Normal test modulation

6.5.1 DSB modulation

- a) Modulation for the transmitter tests:

The transmitter shall be modulated by a test signal of 1 250 Hz at a level that is 20 dB higher than that required to produce a modulation depth of 60 %.

- b) Modulation for the receiver tests:

The modulation shall be at a frequency of 1 kHz and at a level resulting in a modulation depth of 60 %.

6.5.2 SSB modulation

- a) Two tone modulation for transmitter tests:

- For the two-tone modulation, two audio frequency generators are required, the signals of which shall be combined and simultaneously available at the microphone input of the unit under test. The generators shall not influence each other.
- One of the generators shall be switched off. With the other one, the transmitter shall be modulated as described in clause 6.5.2 b), but by an audio frequency of 400 Hz.
- This generator shall be switched off, and the other one shall then be switched on.
- The transmitter shall be modulated as described in clause 6.5.2 b), but by an audio frequency of 2,5 kHz.
- Then both generators shall be switched on.

- b) One-tone modulation for transmitter tests:

- The transmitter shall be modulated by an audio frequency of 1 kHz.
- The normal test modulation level shall be 20 dB higher than the audio frequency level which produces the maximum RF output power declared by the supplier.
- For the measurement of the frequency error, the normal test modulation level shall be the audio frequency level which produces the maximum RF output power declared by the supplier.

- c) One-tone modulation for receiver tests:

- The unmodulated carrier of the RF test generator shall be adjusted 1 kHz up (for USB) or down (for LSB) in respect to the frequencies given in table 1 of clause 4.4.

6.5.3 Angle modulation (FM modulation with Preemphasis/Deemphasis)

- a) Modulation for transmitter tests: For normal test modulation the transmitter shall be modulated with 1 250 Hz at a level that is 20 dB higher than that required to produce a frequency deviation of $\pm 1,2$ kHz.
- b) Modulation for receiver tests: For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be $\pm 1,2$ kHz.

6.6 Artificial antenna

Tests on the transmitter shall be carried out with a non-reactive non-radiating load of 50 Ω connected to the antenna terminals.

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

6.7 Test fixture

In the case of equipment intended for use with an integral antenna, the supplier may be required to supply a test fixture, suitable to allow relative measurements to be made on the submitted sample.

The test fixture shall provide means of making external connection to the audio frequency input and radio frequency output and of replacing the power source by external power supplies.

The test fixture shall provide a 50 Ω radio frequency terminal at the working frequencies of the equipment.

The performance characteristics of this test fixture under normal and extreme conditions are subject to the approval of the test laboratory.

The characteristics of interest to the test laboratory will be that:

- a) the coupling loss shall not be greater than 30 dB;
- b) the variation of coupling loss with frequency shall not cause errors exceeding 2 dB in measurements using the test fixture;
- c) the coupling device shall not include any non-linear elements; the test laboratory may provide its own test fixture.

6.8 Arrangement for test signals at the input of the transmitter

The transmitter audio frequency modulation signal shall be supplied by a generator applied at the connections of the microphone insert, unless otherwise stated.

6.9 Test site and general arrangements for radiated measurements

Detailed descriptions of the radiated measurement arrangements are included in annex A.

7 Technical characteristics of the transmitter

7.1 Frequency error

7.1.0 Applicability

For equipment that can be measured for frequency error, under this clause, the supplier may choose to omit this test if the adjacent channel power is measured under extreme test conditions in clause 7.4.2.

7.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

7.1.2 Method of measurement

The carrier frequency shall be measured in angle modulation and/or DSB in the absence of modulation and/or in SSB with modulation (see clause 6.5.2 b)) with the transmitter connected to an artificial antenna (clause 6.6).

NOTE: When testing in SSB the RF nominal frequency is shifted by the modulation frequency, i.e. 1 kHz, and the resulting frequency is displayed.

Equipment with an integral antenna shall be placed in the test fixture (clause 6.7) connected to the artificial antenna (clause 6.6).

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

7.1.3 Limit

The frequency error shall not exceed 0,6 kHz.

7.2 Transmitter power

7.2.1 Definition

The transmitter power in DSB and angle modulated equipment is the carrier power as defined in ITU RR 1.159 as the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle, or in the case of equipment with integral antenna the effective radiated power in the direction of maximum field strength under the specified conditions of measurement (clause 6.8) in the absence of modulation. In SSB with suppressed carrier there is no carrier component present and the PEP (peak envelope power) is defined as transmitter power. PEP is the average power delivered to the antenna transmission line by a transmitter during one radio frequency cycle at the highest crest of the modulation envelope.

7.2.2 Method of measurement

7.2.2.1 Method of measurement (conducted)

This measurement method applies to all equipment.

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

The transmitter shall be connected to an artificial antenna (clause 6.6), and the power delivered to this artificial antenna shall be measured.

In DSB and angle modulation the carrier power without modulation shall be measured.

In SSB the PEP shall be measured with modulation (clause 6.5.2 a)) by a RF watt-meter with direct reading of the PEP or by a RF power analyser.

7.2.2.2 Method of measurement (effective radiated power)

This measurement method applies only to equipment without an external antenna connector. The measurements shall be made under normal test conditions (clause 5.3).

On a test site selected from annex A the equipment shall be placed on the support in the following position:

- a) for equipment with an internal antenna, it shall stand so that the axis of the equipment which in its normal use is closest to the vertical, shall be vertical;
- b) for equipment with a rigid external antennas, 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.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the frequency of the transmitter. The output of the test antenna shall be connected to a measuring receiver.

The transmitter shall be switched on without modulation in DSB and angle modulation or with modulation (clause 6.5.2, b)) in SSB. The modulation shall be supplied by a loudspeaker; the connecting wires shall be lead vertically downwards. The measuring receiver shall be tuned to the frequency of the transmitter under test. The test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver.

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

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

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

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

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

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

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

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

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

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

7.2.3 Limits

The transmitter power, or the effective radiated power of equipment with an integral antenna, shall not exceed 4 W (carrier power) for angle modulation signals, 4 W (carrier power) for DSB amplitude modulated signals and/or 12 W PEP for SSB amplitude modulated signals.

NOTE: No user adjustment that may raise the transmitter power above these limits, see clause 4.3.2.

7.3 Maximum permissible frequency deviation

7.3.0 Applicability

This requirement is only applicable to equipment that uses angle modulation.

7.3.1 Definition

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

The maximum permissible frequency deviation is the maximum value of frequency deviation.

7.3.2 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected via a 50 Ω power attenuator, to a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency of the test signal shall be varied between the lowest frequency considered to be appropriate, and 10 kHz. The level of this test signal shall be 20 dB above the level required to give a frequency deviation of 1,2 kHz at an audio frequency of 1 250 Hz.

The measurements shall be made under normal test conditions (clause 5.3).

7.3.3 Limit

The maximum permissible frequency deviation shall be ± 2 kHz.

7.4 Adjacent and alternate channel power

7.4.1 Definition

The adjacent channel power is that part of the total output power of a transmitter, modulated under defined conditions, which falls within a specified bandwidth centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation process and by residual modulation caused by hum and noise of the transmitter.

7.4.2 Method of measurement

7.4.2.1 Method of measurement (for angle modulation)

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

- a) The transmitter shall be operated at the carrier power measured in clause 7.2 under normal test conditions (clause 5.3). The output of the transmitter shall be linked to the input of the "receiver" by a connecting device such that the impedance presented to the transmitter is 50 Ω and the level at the "receiver" input is appropriate. For equipment with an integral antenna the connecting device is a test fixture as described in clause 6.7.
- b) With the transmitter unmodulated, the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB reference point. The "receiver" variable attenuator setting and the reading of the RMS value indicator shall be recorded.
- c) The tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement of 5,75 kHz from the nominal carrier frequency.
- d) The transmitter shall be modulated by a test signal of 1 250 Hz at a level which is 20 dB higher than that required to produce a deviation of $\pm 1,2$ kHz.
- e) The "receiver" variable attenuator shall be adjusted to obtain the same reading as in step b) or a known relation to it.
- f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the RMS value indicator.
- g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.
- h) The measurement shall be repeated with the "receiver" tuned to each of alternate channels in turn (i.e. the tuning of the "receiver" adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement of 10,75 kHz from the nominal carrier frequency).

The measurements shall be made under normal test conditions (clause 5.3) and may also be performed under extreme conditions. The supplier may choose to omit the test specified in clause 7.1.2 if the adjacent channel power is also measured under extreme test conditions.

7.4.2.2 Method of measurement (for DSB and/or SSB)

The adjacent channel power shall be measured with a power measuring receiver that conforms with the requirements given in annex B and is referred to in this clause as the "receiver":

- a) The transmitter RF output power shall be measured (see clause 7.2) without modulation in DSB or with one tone modulation (see clause 6.5.2, b)) in SSB.
- b) The output of the transmitter shall be linked to the input of the measuring receiver by a connecting device such that the impedance presented to the transmitter is 50 Ω s and the level at the "receiver" input is appropriate.

For the equipment with an integral antenna the connecting device is a test fixture as described in clause 6.7. With the equipment under normal test conditions (clause 5.3) the transmitter shall be unmodulated in DSB or shall be modulated with one tone (see clause 6.5.2 b)) in SSB, the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB reference point. The "receiver" variable attenuator setting and the reading of the RMS value indicator shall be recorded.

- c) The tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" 6 dB response nearest to the transmitter carrier frequency is located at a displacement of 5,75 kHz from the nominal carrier frequency.
- d) The transmitter shall be modulated in DSB (see clause 6.5.1, a)) or shall be modulated with two tones (see clause 6.5.2, a)) in SSB.
- e) The "receiver" variable attenuator shall be adjusted to obtain the same reading as in step b) or a known relation to it.
- f) The ratio of adjacent channel power to RF power in step a) is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the RMS value indicator.
- g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.
- h) The measurement shall be repeated with the "receiver" tuned to each of alternate channels in turn i.e. the tuning of the "receiver" adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement of 10,75 kHz from the nominal carrier frequency.

7.4.3 Limits

The adjacent channel power shall not exceed a value of 20 microwatts.

The alternate channel power shall not exceed a value of 20 microwatts.

7.5 Unwanted emissions in the spurious domain

7.5.1 Definition

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

- a) power level in a specified load (conducted spurious emission); and
- b) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);
or
- c) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of hand portable equipment fitted with such an antenna and no external RF connector.

NOTE: There only two options allowed either both a) and b) or only c).

7.5.2 Method of measurement

7.5.2.1 Method of measuring the power level in a specified load (clause 7.5.1 a))

7.5.2.1.1 Method of measuring the power level in a specified load (for angle modulation)

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver.

The transmitter shall be switched on without modulation, and the measuring receiver shall be tuned over the frequency range 9 kHz to 2 GHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load, except for the channel on which the transmitter is intended to operate and the adjacent channels.

The measurements shall be repeated with the transmitter on standby/reception.

7.5.2.1.2 Method of measuring the power level in a specified load (for DSB and/or SSB)

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver.

The transmitter shall be switched on with modulation in DSB (clause 6.5.1, a)) or with 2-tone modulation in SSB (clause 6.5.2, a)).

The measuring receiver shall be according to CISPR 16 [2], with a peak detector, and shall be tuned over the frequency range from 9 kHz to 2 GHz (or 4 GHz, see last paragraph in this clause). The measurement bandwidth below 1 GHz shall be in accordance with CISPR 16 [2] and above 1 GHz, it shall be 1 MHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load, except for the channel on which the transmitter is intended to operate and the adjacent channels.

The measurements shall be repeated with the transmitter on standby/reception.

If spurious emissions are detected in the frequency range 1,5 GHz to 2 GHz with a level exceeding 0,1 μ W (transmitter operating) or 1 nW (transmitter on standby/reception), the measurement of spurious emissions shall be extended to the frequency range 2 GHz to 4 GHz.

7.5.2.2 Method of measuring the effective radiated power (clause 7.5.1 b))

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

The transmitter antenna connector shall be connected to an artificial antenna, clause 6.6.

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

For angle modulation only:

- The output of the test antenna shall be connected to a measuring receiver. The transmitter shall be switched on without modulation, and the measuring receiver shall be tuned over the frequency range 25 MHz to 2 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

For DSB and/or SSB only:

- The output of the test antenna shall be connected to a measuring receiver. The transmitter shall be switched on with modulation in DSB (clause 6.5.1 a)) or with one tone modulation in SSB (clause 6.5.2 b)). The modulation shall be supplied by an acoustical source. The connecting wires shall be placed leading downwards vertically.

- The measuring receiver with a peak detector shall be tuned over the frequency range from 25 MHz to 2 GHz (or 4 GHz, see last paragraph in this clause). The measurement bandwidth below 1 GHz shall be in accordance with CISPR 16 [2] and above 1 GHz, it shall be 1 MHz.

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

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

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

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

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

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

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

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

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

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

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

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

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

For DSB/SSB only: if the spurious component exceeds the limit level, the measurement at this frequency shall be repeated with a quasi-peak detector.

The measurements shall be repeated with the transmitter on standby/reception.

For DSB/SSB only: If spurious emissions are detected in the frequency range 1,5 GHz to 2 GHz with a level exceeding 0,1 µW (transmitter operating) or 1 nW (transmitter on standby/reception), the measurement of spurious emissions shall be extended to the frequency range 2 GHz to 4 GHz.

7.5.2.3 Method of measuring the effective radiated power (clause 7.5.1 c))

The method of measurement shall be performed according to clause 7.5.2.2, except that the transmitter output shall be connected to the integral antenna and not to an artificial antenna.

7.5.3 Limits

The power of any spurious emission, occurring more than $2,5 \times$ channel bandwidth from the centre of the channel on which the transmitter is intended to operate, shall not exceed the values given in tables 2 to 4.

Table 2: Conducted spurious emissions

Frequency range	9 kHz to 1 GHz (other than in table 4)	1 GHz to 2 GHz (or 4 GHz, see clause 7.5.2.1)
TX operating	0,25 µW (-36,0 dBm)	1,0 µW (-30,0 dBm)
TX standby/reception	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 3: Radiated spurious emissions

Frequency range	30 MHz to 1 GHz (other than in table 4)	1 GHz to 2 GHz (or 4 GHz, see clause 7.5.2.2)
TX operating	0,25 μ W (-36,0 dBm)	1,0 μ W (-30,0 dBm)
TX standby/reception	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 4: Conducted and radiated spurious emissions

Frequency range	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz
TX operating	4 nW (-54,0 dBm)
TX standby/reception	2 nW (-57,0 dBm)

The reference bandwidths shall be as in table 5.

Table 5: Reference bandwidths to be used for the measurement of spurious emissions

Frequency range	RBW
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
1 GHz to 2 GHz (or 4 GHz, see clause 7.5.2.2)	1 MHz

Best measurement practice:

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in table 5. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the reference bandwidth. When the resolution bandwidth is smaller than the reference bandwidth, the result should be integrated over the reference bandwidth. When the resolution bandwidth is greater than the reference bandwidth, the result for broadband spurious emissions should be normalized to the bandwidth ratio. For discrete spurious emissions, normalization is not applicable, while integration over the reference bandwidth is still applicable.

7.6 Transient behaviour of the transmitter

7.6.0 Applicability

These tests are to be used for radio equipment with cyclic keying during data transmissions and not single (e.g. manual) on/off keying.

7.6.1 Definitions

The transient frequency behaviour of the transmitter is the variation with respect to time of the transmitter frequency distance 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 clause 7.6.2 the switch-on instant defined by the condition when the output power, measured at the antenna terminal, exceeds 10 % of the nominal power.

t₁: period of time starting at t_{on} and finishing according to clause 7.6.2, figure 2.

t₂: period of time starting at end of t₁ and finishing according to clause 7.6.2, figure 2.

t_{off}: switch-off instant defined by the condition when the output power falls below 10 % of the nominal power.

t₃: period of time finishing at t_{off} and starting according to clause 7.6.2, figure 2.

7.6.2 Method of measurement

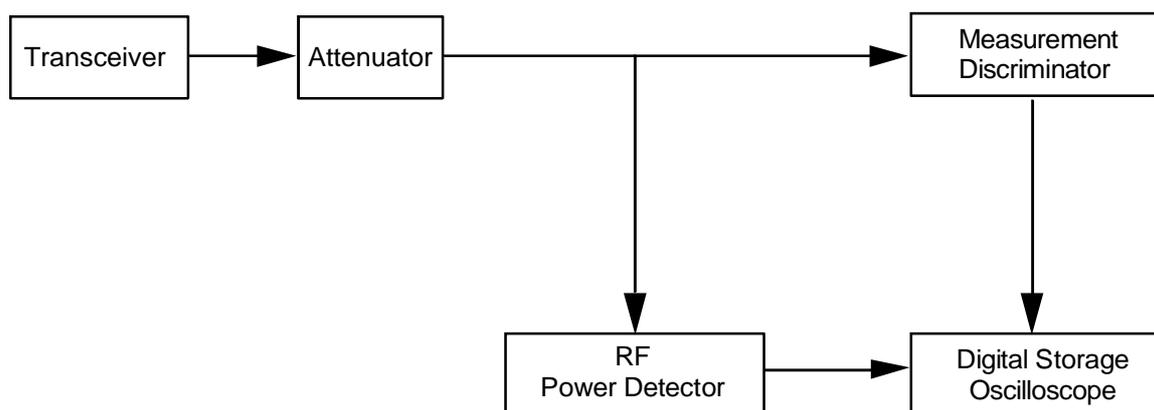


Figure 1: Measurement arrangement

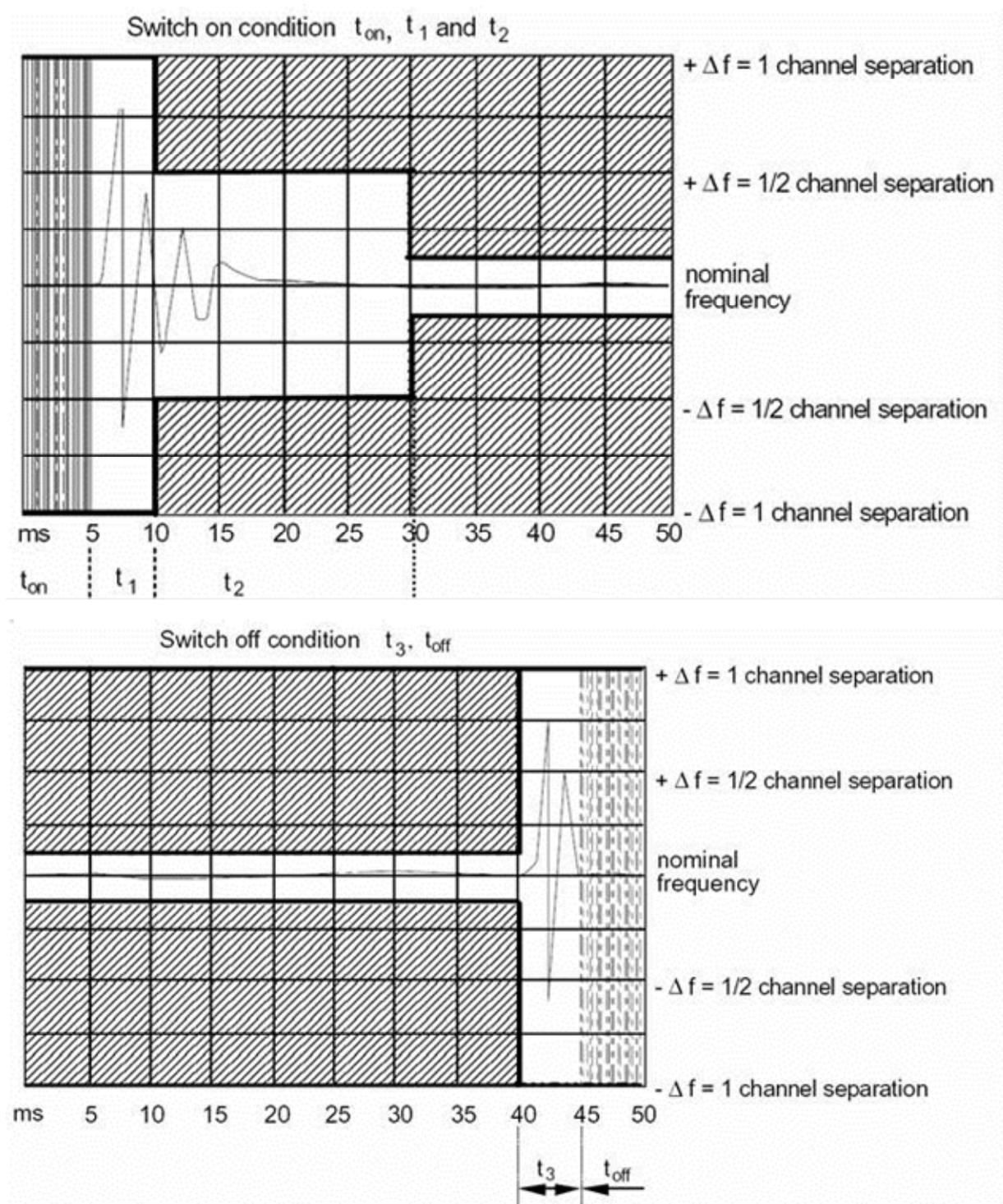
The measurement set up shall be assembled according to figure 1, but instead of the transceiver a test signal generator shall be connected. The frequency shall be set to the nominal carrier frequency. The attenuator shall give a termination with correct impedance to the transceiver. It shall be adjusted, so that the limiting amplifier works in the limiting area, when the generator level exceeds the nominal output power of the transceiver by 10 %. The calibration of the test discriminator is checked by setting the test signal generator to a defined frequency deviation.

a) Transient behaviour, switch ON condition:

- The trigger threshold on the digital storage oscilloscope shall be set such that it triggers as soon as the level exceeds 10 % of the nominal output power. The oscilloscope shall display the time frame after the point of triggering.
- The generator shall be replaced by the transmitter to be tested.
- In angle modulation/DSB mode the transmitter is not modulated, in SSB mode the transmitter shall be modulated according to clause 6.5.2 b). If the transmitter is equipped with a socket for an external microphone, then in SSB mode, the modulating signal shall be present at this socket, even when the transmitter is not switched on.
- The transient behaviour is measured by activating the transmit switching circuit from RX to TX.

b) Transient behaviour, switch OFF condition:

- The trigger threshold on the digital storage oscilloscope shall be set such, that it triggers, as soon as the level falls below 10 % of the nominal output power. The oscilloscope shall display the time frame before the point of triggering.
- In angle modulation/DSB mode the transmitter is not modulated, in SSB mode the transmitter shall be modulated according to clause 6.5.2 b). If the transmitter is equipped with a socket for an external microphone, then in SSB mode, the modulating signal shall be present at this socket, even when the transmitter is not switched on.
- The transmit switching circuit is activated.
- The transient behaviour is measured by switching the transmit circuit from TX to RX.



NOTE: The figures shown here are only examples of oscilloscope displays. Refer to clause 7.6.3 for the actual values of t_1 , t_2 and t_3 .

Figure 2: Example storage oscilloscope view t_1 , t_2 and t_3

7.6.3 Limits

The maximum transient periods are as follows:

- t_1 5,0 ms;
- t_2 20,0 ms;
- t_3 5,0 ms.

During the periods t_1 and t_3 the frequency difference shall not exceed the value of 1 channel separation.

During the period t_2 the frequency difference shall not exceed the value of half a channel separation.

In the case of hand portable stations, the frequency deviation during t_1 and t_3 may be greater than one channel. The corresponding plot of frequency versus time during t_1 and t_3 shall be recorded in the test report.

8 Methods of measurement for receiver parameters

8.1 Maximum usable sensitivity

8.1.0 Applicability

This requirement applies to all equipment.

8.1.1 Definition

The maximum usable sensitivity of the receiver is the minimum level of signal (emf) at the receiver input, at the nominal frequency of the receiver and with normal test modulation, which will produce:

- an audio frequency output power of at least 25 % of the rated power output, (see clause 7.2); and
- a SND/ND ratio of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in Recommendation ITU-T O.41 [3].

8.1.2 Method of measurement

The test signal, at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB and angle modulation), i.e. the value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector.

An audio frequency load-resistor, a SND/ND meter and a psophometric telephone weighting network, shall be connected to the receiver output terminals. Where possible, the receiver volume control shall be adjusted to give at least 25 % of the rated audio frequency output power, or, in the case of stepped volume controls, to the first step that provides an output power of at least 25 % of the rated audio frequency output power.

The test signal input level shall be reduced until a SND/ND ratio of 20 dB is obtained. The test signal input level under these conditions is the value of the maximum usable sensitivity.

8.1.3 Limits

The maximum usable sensitivity shall not exceed an electro motive force (emf) of +12 dB μ V for DSB equipment and +6 dB μ V for SSB and angle modulated equipment.

8.2 Adjacent channel selectivity

8.2.0 Applicability

This requirement applies to all equipment.

8.2.1 Definition

The adjacent channel selectivity is the capability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted modulated signal in the adjacent channel.

8.2.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, clause 6.1.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB and angle modulation), i.e. the value of the limit for the maximum usable sensitivity, shall be applied to the receiver input connector via one input of the combining network.

The unwanted test signal, at a frequency of 10 kHz above the nominal frequency of the receiver, frequency modulated with 400 Hz with a deviation of $\pm 1,2$ kHz shall be applied to the receiver input connector via the second input of the combining network.

The amplitude of the unwanted test signal shall be adjusted until the SND/ND ratio, psophometrically weighted, at the output of the receiver is reduced to 14 dB.

The measure of the adjacent channel selectivity is the ratio in dB of the level of the unwanted test signal to the level of the wanted test signal at the receiver input for which the specified reduction in SND/ND ratio occurs. This ratio shall be noted.

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

The two noted ratios shall be recorded as the upper and lower adjacent channel selectivity.

8.2.3 Limits

The adjacent channel selectivity shall not be less than 60 dB.

8.3 Intermodulation response rejection

8.3.0 Applicability

This requirement applies to all equipment.

8.3.1 Definition

The inter-modulation response rejection is the capability of a receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

8.3.2 Method of measurement

Three input signals shall be connected to the receiver via a combining network, clause 6.1.

The wanted test signal (A), at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB), i.e. the value of the limit for the maximum useable sensitivity, shall be applied to the receiver input connector via input of the combining network.

The unwanted test signal (B), at the frequency 20 kHz above the nominal frequency of the receiver, without modulation, shall be applied to the receiver input connector via the second input of the combining network.

The unwanted test signal (C) at a frequency of 40 kHz above the nominal frequency of the receiver shall be applied to the receiver input connector via the third input of the combining network; the signal shall be DSB amplitude modulated by 400 Hz to a modulation depth of 60 % except for angle modulation equipment where the unwanted signal shall be FM modulated with a 400 Hz signal having a deviation of $\pm 1,2$ kHz.

The frequency of the unwanted test signals (B) and (C) may be slightly adjusted to search for maximum intermodulation.

The amplitude of the unwanted test signals (B) and (C) shall be maintained equal and adjusted until the SND/ND ratio, psophometrically weighted, at the output of the receiver is reduced to 14 dB.

The measure of the inter-modulation response rejection is the ratio in dB of the level of the unwanted test signals to the level of the wanted test signal at the receiver input for which the specified reduction in SND/ND ratio occurs. This ratio shall be recorded.

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

8.3.3 Limits

The intermodulation response rejection ratio shall not be less than 50 dB.

8.4 Spurious radiations

8.4.1 Definition

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

The level of spurious radiations shall be measured by:

- a) their power level in a specified load (conducted spurious emission); and
- b) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);
or
- c) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of handportable equipment fitted with such an antenna and no external RF connector.

NOTE: There only two options allowed either both a) and b) or only c).

8.4.2 Method of measurement

8.4.2.1 Method of measuring the power level in a specified load

The receiver shall be connected to a 50 Ω attenuator. The output of the attenuator shall be connected to a measuring receiver. The receiver shall be switched on, and the measuring receiver shall be tuned over the frequency range 9 kHz to 2 GHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the spurious level delivered into the specified load.

8.4.2.2 Method of measuring the effective radiated power

On a test site, selected from annex A, the equipment shall be placed at the specified height on the appropriate support and in the position closest to normal use as declared by the supplier. The receiver antenna connector shall be connected to an artificial antenna, clause 6.5.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instant frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver. The receiver shall be switched on and the measuring receiver shall be tuned over the frequency range 25 MHz to 2 GHz. At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver. The receiver shall then be rotated through 360° in the horizontal plane until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.

The receiver shall be replaced by a substitution antenna as defined in clause A.2.3. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected. The substitution antenna shall be connected to a calibrated signal generator. The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received. The input signal to the substitution antenna shall be adjusted to the level that produces a level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver. The input level to the substitution antenna shall be recorded as power level, corrected for the change of input attenuator setting of the measuring receiver.

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

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

8.4.2.3 Method of measuring the effective radiated power

The measurement shall be performed according to clause 8.4.2.2, except that the receiver input shall be connected to the integral antenna and not to an artificial antenna.

8.4.3 Limits

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

Table 6: Conducted components

Frequency range	9 kHz to 1 GHz	Above 1 GHz to 2 GHz
Limit	2,0 nW (-57,0 dBm)	20,0 nW (-47,0 dBm)

Table 7: Radiated components

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

The reference bandwidths from table 8 shall be used.

Table 8: Reference bandwidths to be used for the measurement of spurious radiations

Frequency range	RBW
9 to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
1 to 2 GHz	1 MHz

8.5 Blocking and Spurious Response Rejection

8.5.0 Applicability

This requirement applies to all equipment.

8.5.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency other than those of the spurious responses or of the adjacent channels.

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

8.5.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network, see clause 6.1.

The wanted test signal (A), at the nominal frequency of the receiver, with normal test modulation (DSB see clause 6.5.1, SSB see clause 6.5.2 and angle modulation see clause 6.5.3) at an emf of 12 dB μ V (DSB) or 6 dB μ V (SSB), i.e. the value of the limit for the maximum useable sensitivity, shall be applied to the receiver input connector via input of the combining network.

The unwanted test signal, DSB amplitude modulated by 0,4 kHz to a modulation depth of 60 % and at an emf of 80 dB μ V, shall be applied to the receiver input connector via the second input of the combining network. The unwanted test signal shall be tuned over the frequency range from 100 kHz to 1 GHz with frequency steps of 5 kHz but excluding two channels either side of the nominal frequency of the receiver .

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

The value of spurious response rejection is the ratio in dB of the level of the unwanted test signal to the level of the wanted test signal at the receiver input for which the specified reduction in SND/ND ratio occurs.

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

8.5.3 Limits

A spurious response shall be recorded at no more than 100 frequencies.

At any frequency separated from the nominal frequency of the receiver by more than two channels, the spurious response rejection ratio shall not be less than 48 dB.

9 Testing for compliance with technical requirements

9.1 Test conditions, power supply and ambient temperatures

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile which, as a minimum, shall be that specified in the test conditions contained in the present document.

As technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions as specified in the present document to give confidence of compliance for the affected technical requirements.

9.2 Interpretation of the measurement results

The interpretation of the 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 equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 9.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated 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)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [1] parts 1 and 2, in particular in annex D of the ETSI TR 100 028-2 [1].

Table 9 is based on such expansion factors.

Table 9: Maximum values of absolute measurement uncertainties

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-7}$
RF Power	$\pm 0,75$ dB
Radiated RF power	± 6 dB
Adjacent channel power	± 5 dB
Conducted RF power variations using a test fixture	$\pm 0,75$ dB
Sensitivity	± 3 dB
Two-signal measurement, radiated field	± 6 dB
Three-signal measurement, test fixture	± 3 dB
Radiated emission of the transmitter, valid up to 4 GHz	± 6 dB
Radiated emission of receiver, valid up to 4 GHz	± 6 dB
Transmitter attack time	± 20 %
Transmitter release time	± 20 %
Transmitter transient frequency (frequency difference)	± 250 Hz
Valid up to 1 GHz for the RF parameters unless otherwise stated.	

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

ETSI TR 102 273 [i.1] provides further information concerning the usage of test sites.

Annex A (normative): Radiated measurement

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

A.1.0 General

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 ETSI TR 102 273 [i.1] relevant parts 2, 3 and 4.

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

A.1.1 Anechoic chamber

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

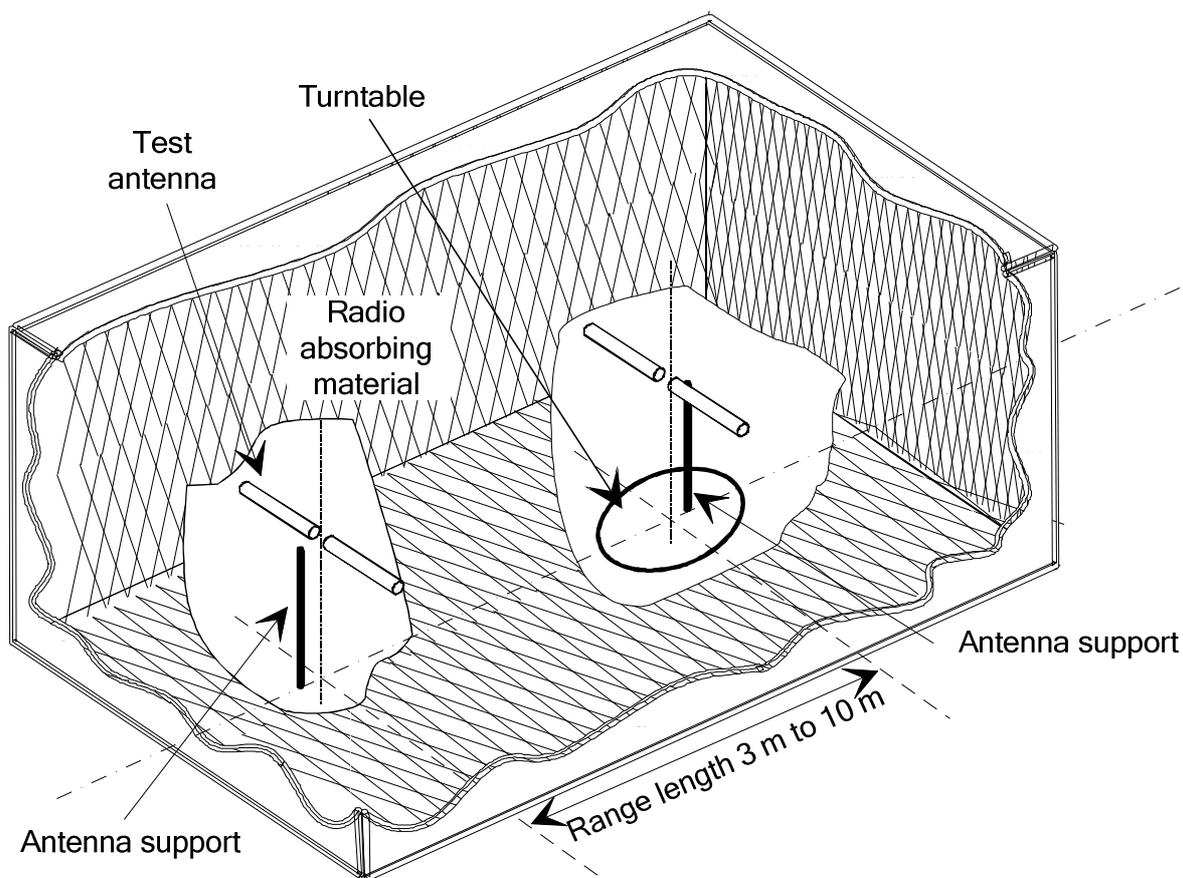


Figure A.1: A typical anechoic chamber

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

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

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

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

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

A.1.2 Anechoic chamber with a conductive ground plane

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

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

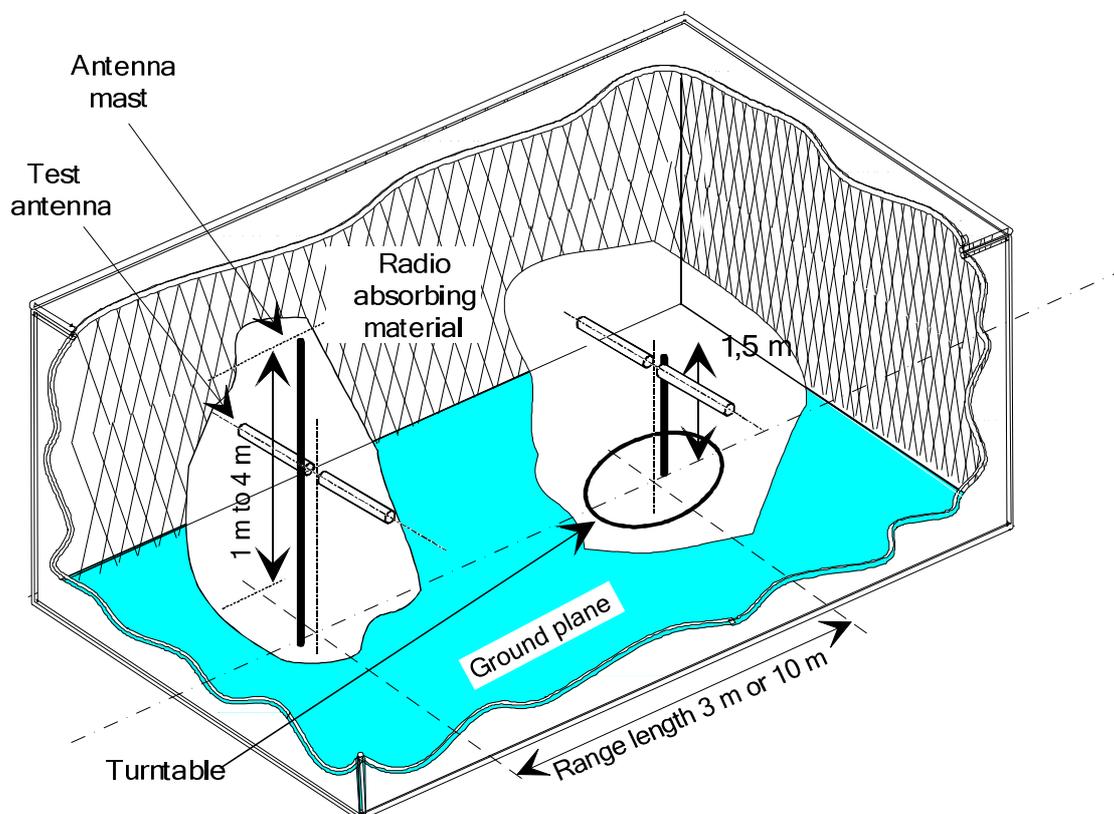


Figure A.2: A typical anechoic chamber with a conductive ground plane

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

The antenna mast provides a variable height facility (from 1 to 4 metres) 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 metres above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1 + d_2)/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

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

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

A.1.3 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, while 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.

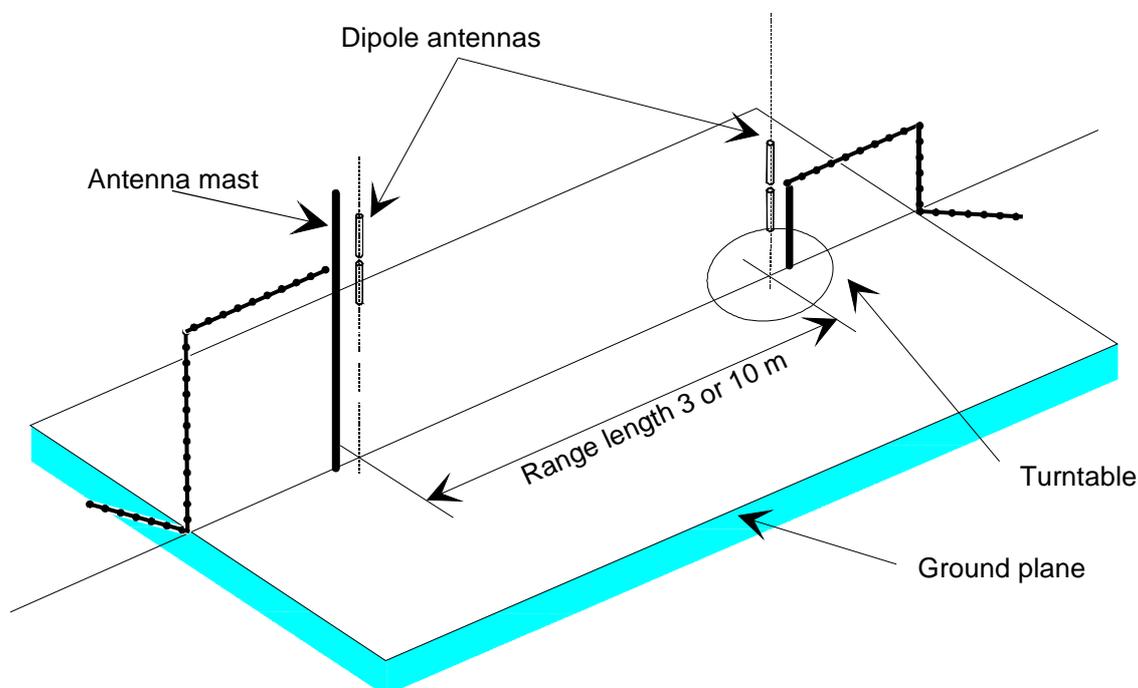


Figure A.3: A typical Open Area Test Site

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.

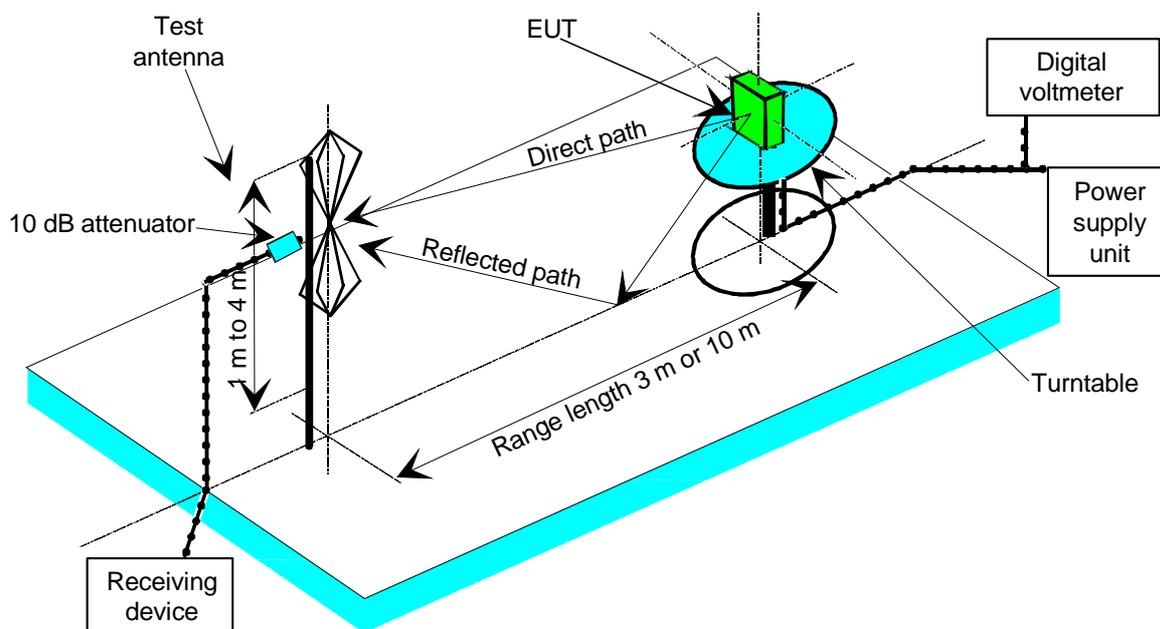


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

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 [i.6]) 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 biconical antennas (commonly termed "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 [i.6]). 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 field 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 [i.6]). 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.2 Guidance on the use of radiation test sites

A.2.0 General

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

A.2.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in annex A (i.e. Anechoic Chamber, Anechoic Chamber with a ground plane and Open Area Test Site) are given in ETSI TR 102 273 [i.1] parts 2, 3 and 4, respectively.

A.2.2 Preparation of the EUT

The supplier 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 metre 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, the 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 test reports 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/supplier. 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 metres, should be available for which no part of the test antenna should come within 1 metre 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 metre 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 metres (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 metres 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.

EXAMPLE:

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

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

A.3 Coupling of signals

A.3.1 General

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

A.3.2 Data signals

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

A.3.3 Speech and analogue signals

A.3.3.0 General

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 supplier, 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 60489-3 [4], appendix F).

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.

Annex B (normative): Specification for some particular measurement arrangements

B.1 Power measuring receiver specification

B.1.0 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).

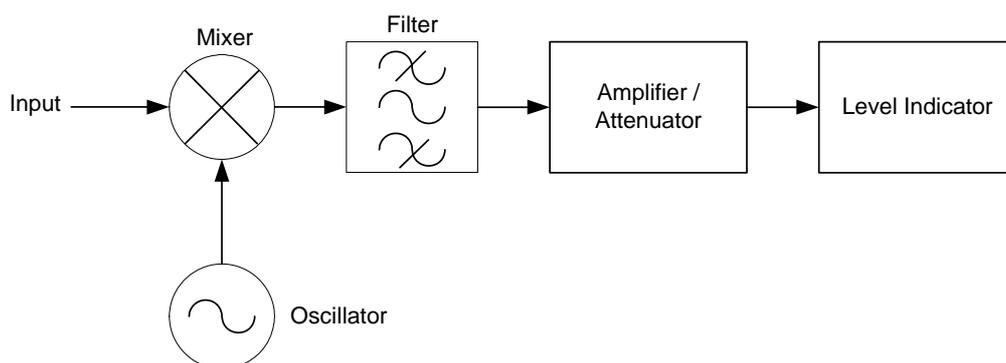


Figure B.1: Power measuring receiver

Instead of the Variable attenuator with the rms value indicator it is also possible to use a rms voltmeter calibrated in dB. The technical characteristics of the power measuring receiver are given in clauses B.1.1 to B.1.4.

B.1.1 IF filter

The IF filter shall be within the limits of the selectivity characteristic of figure B.2.

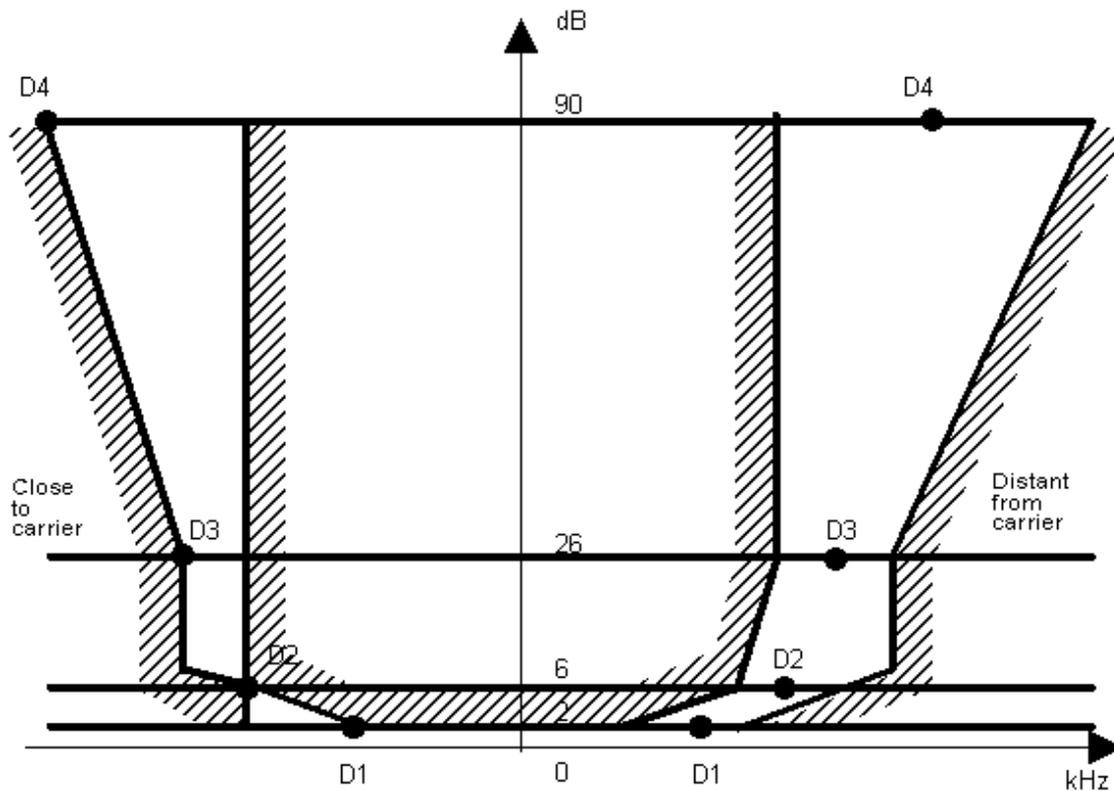


Figure B.2: IF filter

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

Table B.1: Selectivity characteristic

1 Attenuation Points	2 Frequency Separations	3 Tolerance towards C	4 Tolerance distant from C
D1 (2 dB)	3 kHz	+1,35 kHz	±2 kHz
D2 (6 dB)	4,25 kHz	±0,1 kHz	±2 kHz
D3 (26 dB)	5,5 kHz	-1,35 kHz	±2 kHz
D4 (90 dB)	9,5 kHz	-5,35 kHz	+2 kHz and -6 kHz

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

B.1.2 Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations, an attenuation of 90 dB or more is recommended.

B.1.3 RMS value indicator

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

B.1.4 Oscillator and amplifier

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

B.2 Spectrum analyser specification

B.2.1 Adjacent and alternate channel power measurement

The characteristics of the spectrum analyser shall meet at least the following requirements:

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

It shall be possible to adjust the spectrum analyser to allow the separation on its screen of two equal amplitude components with a frequency difference of 200 Hz.

For statistically distributed modulations, the spectrum analyser and the integrating device (when appropriate) needs to allow determination of the power spectral density (energy per time and bandwidth), which has to be integrated over the bandwidth in question. It shall be possible to sum the effective power of all discrete components, the spectral power density and the noise power in the selected bandwidth and to measure this as a ratio relative to the carrier power.

The spectrum analyser should have a dynamic range greater than 90 dB and the average phase noise in the adjacent channels shall be such that measurement of adjacent channel power is not limited by phase noise. In order to confirm this, the selected measurement technique for clause 7.4.2 shall be used to measure the adjacent channel power with a CW signal source with phase noise of less than -120 dBc/Hz in the centre of the adjacent channel. The following performance shall be achieved:

- the maximum adjacent channel power observed with these conditions shall not exceed -70 dBc;
- the maximum alternate channel power measured with these conditions shall not exceed -80 dBc.

NOTE: A resolution bandwidth of 500 Hz may be used for this measurement as an alternative to the usual 100 Hz to reduce measurement time.

B.2.2 Unwanted emissions measurement

The specification shall include the following requirements.

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

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

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

B.3 Integrating and power summing device

The integrating and power summing device is connected to the video output of the spectrum analyser, referred to in clause B.2.

It shall be possible to sum the effective power of all discrete components, the spectral power density and the noise power in the selected bandwidth and to measure this as a ratio relative to the carrier power.

Annex C (normative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table C.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table C.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 300 433				
The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.4]				
Requirement			Requirement Conditionality	
No	Description	Reference: Clause No	U/C	Condition
1	Transmitter frequency error	7.1	C	Does not apply if adjacent and alternate channel power is measured under extreme test conditions
2	Transmitter power	7.2	U	
3	Transmitter maximum permissible frequency deviation	7.3	C	Only applicable to equipment which uses angle modulation
4	Transmitter adjacent and alternate channel power	7.4	U	
5	Transmitter unwanted emissions in the spurious domain	7.5	U	
6	Transmitter transient frequency behaviour	7.6	C	Data equipment with cyclic keying
7	Receiver maximum useable sensitivity	8.1	U	
8	Receiver adjacent channel selectivity	8.2	U	
9	Receiver inter-modulation response rejection	8.3	U	
10	Receiver spurious radiations	8.4	U	
11	Receiver spurious responses	8.5	U	

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Clause Number Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the suppliers claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

History

Document history		
Edition 1	November 1995	Publication as ETSI ETS 300 433
Amendment 1	December 1996	Amendment 1 to 1 st Edition of ETSI ETS 300 433
Amendment 2	March 1997	Amendment 2 to 1 st Edition of ETSI ETS 300 433
V1.1.2/1.1.1	August 2000	Publication as ETSI EN 300 433 part 1 and part 2
V1.1.3/1.1.2	December 2000	Publication as ETSI EN 300 433 part 1 and part 2
V1.3.1	July 2011	Publication as ETSI EN 300 433 part 1 and part 2
V2.1.0	February 2016	EN Approval Procedure AP 20160501: 2016-02-01 to 2016-05-02
V2.1.1	May 2016	Publication