ETSI EN 303 204 V2.1.2 (2016-09)

Network Based Short Range Devices (SRD);
Radio equipment to be used in the 870 MHz to 876 MHz frequency range with power levels ranging up to 500 mW;
Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

Reference
REN/ERM-TG28-536

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Contents

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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.8] 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.1].

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 A.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 latest announcement of this EN (doa):	31 December 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 June 2017
Date of withdrawal of any conflicting National Standard (dow):	31 December 2019

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.

Introduction

The present document defines technical requirements to support the essential requirements of clause 3.2 of the Directive 2014/53/EU (Radio Equipment Directive) [i.1] which states "*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*".

The present document describes performance requirements and conformance test procedures for licence exempt Short Range Devices (SRDs) intending to use the frequency range 870 MHz - 876 MHz at power levels up to 500 mW and duty cycle up to 2,5 %. The frequency band is shared with other SRDs intended to support applications with more restrictive power levels and duty cycles as well as ER-GSM [i.4] assigned to the frequency range 873 MHz - 876 MHz. Less restrictive duty cycle limits may apply to certain infrastructure SRDs (Network Relay Points).

Equipment covered by the present document may operate on a specific frequency or may be channel agile and operate on a number of different frequencies:

- Channel agile SRDs operate on two or more channels with signals constrained to the same limits as non-agile devices.

Transmitter requirements include:

- Frequency accuracy and occupied bandwidth constraints to precisely locate the signal.
- Signal masks to ensure satisfactory out-of-band characteristics both within the operating frequency band and to protect frequencies above and below the operating frequency band.
- Transient emissions from switching of the radio transmitter on and off as occurs at the start and end of each packet or data transmission.
- Spurious domain behaviour to limit potential interference in frequencies far from the operating channel.
- Adaptive/automatic power control to reduce transmitted power in strong link conditions.

Taking into account that equipment operating channel widths are between 25 kHz and 200 kHz in a frequency range without specific centre frequency raster, receiver performance is assured by a combination of sensitivity and blocking:

- Sensitivity behaviour to ensure equipment operates effectively in the presence of other signals in, or overlapping, the operating channel.
- Adjacent channel selectivity performance to ensure equipment operates effectively in the presence of unwanted signals in frequencies adjacent to the operating channel.
- Blocking performance to ensure equipment operates effectively in the present of unwanted signals beyond the adjacent channels.

Equipment employing listen-before-talk procedures is subject to requirements governing channel sensing:

- Clear channel assessment threshold performance to ensure deferral in the presence of other signals, balanced by the sensitivity requirement to avoid unnecessary deferral where harmful interference would be unlikely.

Equipment is subject to duty cycle limits for both overall (long term) operation in the operational frequency band and over short intervals on any specific operating channel.

- Signal transmissions are constrained in maximum duration and devices are required to wait for specified intervals before again transmitting in a given channel. After transmission limits have been reached on a specific channel, channel agile device operation may continue on a different channel whilst respecting the limits on each channel and overall limits applicable in the operational frequency band.

Other constraints are defined for devices operating within range of ER-GSM [i.4] services operating within 873 - 876 MHz:

- When deployed in locations where GSM-R services are in operation, devices may implement cognitive procedures such as sensing the medium for GSM-R signalling information, or use a priori information from GSM-R operators to determine if additional sharing mechanisms are needed. In such cases, the preferred values of operating frequency should align with the channel raster of ER-GSM [i.4] to minimize potential interference.

The present document is intended to promote equitable sharing of the radio resource amongst a variety of devices and intended uses:

- Spectrum sharing is enhanced when transmissions occupy their channel for the shortest time. The specifications included in the present document are not intended for devices operating at low data rates and in narrow operating channels.
- Although no specific mechanism is defined, implementations which distribute devices uniformly over the available channels are preferred. Examples of suitable radio specifications and medium access techniques which promote such behaviour can be found in ETSI TS 102 887-1 [i.5], ETSI TS 102 887-2 [i.6] and FCC Part 15.247 Regulations [i.7].
- Other 'polite' spectrum access mechanisms are also described in the present document to emphasize the need to design for effective use of the shared spectrum.

The present document is structured as follows:

- Clause 1 provides a general description of the types of equipment covered by the present document.
- Clause 2 provides normative and informative references.
- Clause 3 provides the definitions of terms and abbreviations used in the present document.
- Clause 4 specifies the technical requirements.
- Clause 5 specifies the tests and general conditions for testing the conformance of the device to the technical requirements.
- Annex A (normative) provides the relationship between the present document and the essential requirements of the Directive 2014/53/EU [i.1].
- Annex B (normative) provides specifications concerning radiated measurements.
- Annex C (normative) contains specifications for the test fixture.
- Annex D (normative) provides the spectrum analyser specification.
- Annex E (informative) provides references to other supplementary information.

1 Scope

The present document applies to the following radio equipment types:

1) Network Based SRDs which are SRDs intended to operate in association with other SRDs to form network topologies supporting the intended application.

2) Network Relay Points which are specific Network Based SRDs supporting interconnection of a network of SRDs with an external network or service.

These radio equipment types are capable of operating in all or any part of the frequency bands given in Table 1a.

Table 1a: Frequency bands designated to Network Based Short Range Devices

Network Based SRD frequency bands	
Transmit	870,00 MHz to 875,6 MHz
Receive	870,00 MHz to 875,6 MHz

NOTE 1: The availability of the frequency band in Table 1a in European Union and CEPT countries can be obtained from the EFIS (http://www.efis.dk/) and is also listed in Appendices 1 and 3 of REC 70-03 [i.2].

NOTE 2: In addition, it should be noted that other frequency bands may be available for network based short range devices in a country. See National Radio Interfaces (NRI) as relevant for additional guidance.

NOTE 3: On non-harmonized parameters, national administrations may impose certain conditions such as the type of modulation, frequency, channel/frequency separations, maximum transmitter radiated power, duty cycle, and the inclusion of an automatic transmitter shut-off facility, as a condition for the issue of Individual Rights for use of spectrum or General Authorization, or as a condition for use under "licence exemption" as it is in most cases for Short Range Devices.

The present document covers equipment intended for use in a fixed location, equipment normally fixed in a vehicle and equipment intended to be carried or attached.

The present document contains requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.

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] Recommendation ITU-T O.153 (10-1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[2] ETSI TR 100 028 (all parts) (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[3] CISPR 16 (parts 1-1 and 1-4 (2010) part 1-5 (2014)): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

[4] ETSI TR 102 273 (all parts) (V1.2.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

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

[i.3] Void.

[i.4] UIC Code 951 (Version 15.3.0, 2012): "European Integrated Railway Radio Enhanced Network, System Requirements Specification".

[i.5] ETSI TS 102 887-1 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Smart Metering Wireless Access Protocol; Part 1: PHY layer".

[i.6] ETSI TS 102 887-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Smart Metering Wireless Access Protocol; Part 2: Data Link Layer (MAC Sub-layer)".

[i.7] "Code of Federal Regulations, Title 47 - Telecommunications, Section 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz".

NOTE: Available at http://www.gpo.gov/fdsys/pkg/CFR-2005-title47-vol1/xml/CFR-2005-title47-vol1-sec15-247.xml.

[i.8] 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.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

adjacent channel: frequency band equal to the width of the operating channel on either side of the operating channel

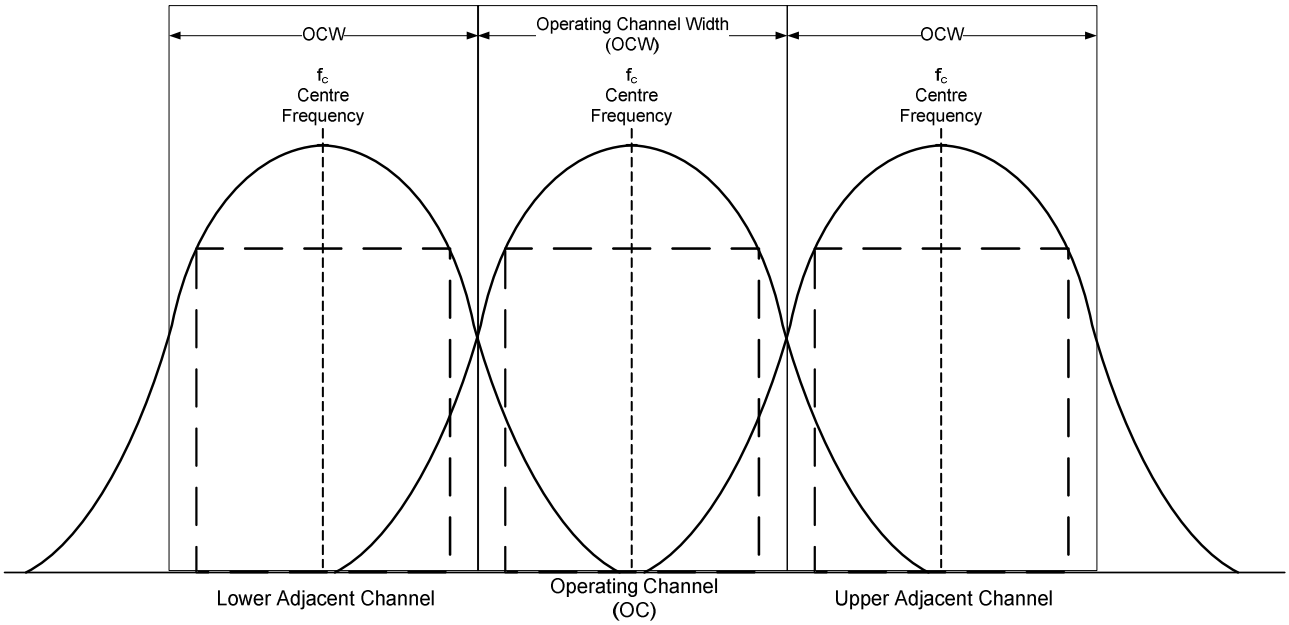


Figure 1: Adjacent channel definitions

channel adaptivity: capability of a device to avoid using permitted operating channels that it has determined are temporarily or permanently unsuitable for its use

channel spacing: distance, in hertz, between adjacent nominal operating frequencies

clear channel assessment: procedure of sensing the operating channel to determine whether or not it is occupied by a transmission

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

continuous transmission: modulated transmission without interruption for the period of the test

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

dialog: repeated transmit-response cycle between two devices within a transmission

dialog-response: interval ($T_{Dialog\text{-}Response}$) between the end of an emission by the first device in a dialog and the beginning of the response from the second device in a dialog

disregard time ($T_{Disregard}$): provider declared interval below which two separate radio emissions in a channel are considered a single continuous transmitted burst

duty cycle: ratio, expressed as a percentage, of the cumulative duration of transmissions in an observation bandwidth within an observation interval divided by the observation interval

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

maximum transmission duration ($T_{On\text{-}Max}$): longest permitted transmission

minimum inter-transmission interval ($T_{Off\text{-}Min}$): minimum interval in a channel between two transmissions by the same device

network relay point: class of device intended to provide network infrastructure to support communications between devices and an external communications network or service

occupied bandwidth: width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission

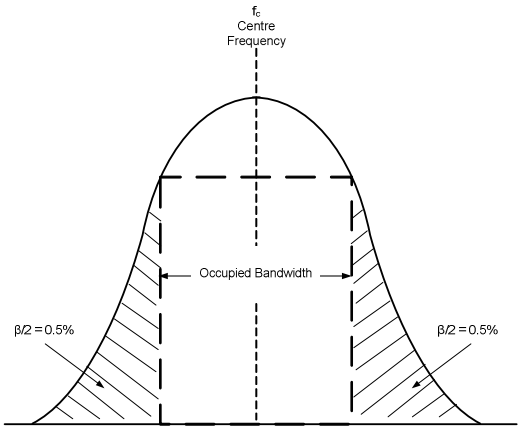


Figure 2: Signal Occupied Bandwidth

operating channel: frequency range in which transmissions from the device occur

operating channel width: difference between frequency values of the high and low operating channel edges

operating frequency: nominal centre frequency of a transmission

operating frequency band: frequency band or sub-band within which the device is authorized to operate and to perform the intended function of the equipment

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

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

signal threshold ($P_{Threshold}$): absolute signal level (in dBm) above which a transmission is considered to exist for a given receiver bandwidth

spurious emissions: emissions on a frequency or frequencies which are outside the occupied bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

transmission: continuous radio emission, or sequence of emissions each separated by an interval < $T_{Disregard}$, with a signal level greater than the signal threshold in an operating channel

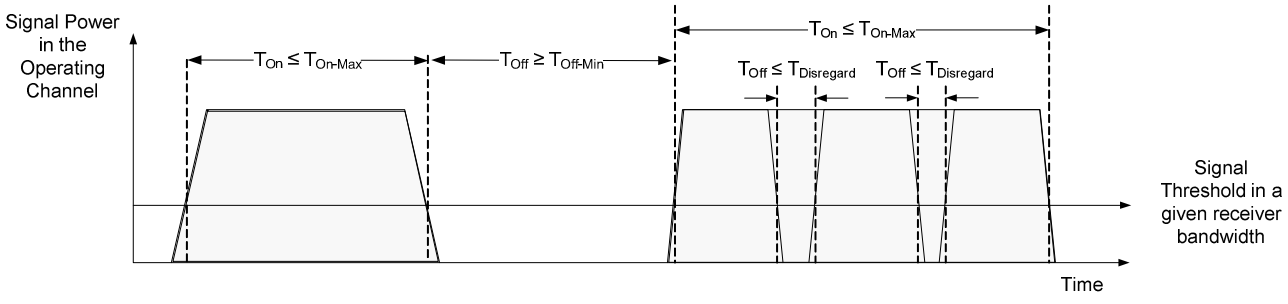


Figure 3: Transmission definitions

3.2 Symbols

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

dB	decibel
S	sensitivity of receiver
λ	wavelength

3.3 Abbreviations

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

AC	Alternating Current
APC	Automatic / Adaptive Power Control
ARQ	Automatic Repeat reQuest
BER	Bit Error Ratio
CCA	Clear Channel Assessment
CEPT	Commission Européenne des Postes et Télécommunications
CISPR	International Special Committee on Radio Interference
CS	Channel Spacing
e.r.p.	effective radiated power
EC	European Commission
EFIS	European Communications Office Frequency Information System
EMC	ElectroMagnetic Compatibility
ER-GSM	Extended Railway-GSM
EU	European Union
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FEC	Forward Error Correction
GSM-R	GSM for Railways
ITU-R	International Telecommunication Union - Radiocommunication
ITU-T	International Telecommunication Union - Telecommunication
LBT	Listen Before Talk
LPDA	Logarithmic Periodic Dipole Antenna
MSR	Message Success Ratio
NRI	National Radio Interfaces
NRP	Network Relay Point
OATS	Open Area Test Site
OBW	Occupied BandWidth
OCW	Operating Channel Width
OOB	Out-Of-Band
RBW	Resolution BandWidth
RBW_{REF}	Reference BandWidth
RF	Radio Frequency
RMS	Root Mean Square
Rx	Receiver
SAR	Semi-Anechoic Room
SCS	Short Control Signalling
SRD	Short Range Device
TR	Technical Report
Tx	Transmitter
VBW	Video Bandwidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 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 manufacturer. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

4.2 General requirements

4.2.1 General considerations

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

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

Where a manufacturer declares multiple operating frequencies, or highest and lowest operating frequencies and channel spacing, the difference between the values of two adjacent operating frequencies cannot be less than the value of the declared channel spacing.

4.2.2 Performance criteria

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

- after demodulation, a raw data signal with a Bit Error Ratio $\leq 10^{-3}$ without correction; or
- after demodulation, a message success ratio equivalent to the above Bit Error Ratio.

NOTE: The message success ratio (MSR) can be computed by the expression:

$$MSR = (1-p)^n$$

where p is the probability of a single bit error (10^{-3}) and n is the number of bits in the message.

Where the indicated performance cannot be achieved, the performance criteria used to determine the performance of the receiver shall be declared and published by the provider.

4.2.3 Limits

The general limits applying to all parameters in the present document are as shown in Table 1b.

Table 1b: Maximum radiated power limit, e.r.p., channel spacing/maximum occupied bandwidth, spectrum access and mitigation limits

Frequency Bands / frequencies	Maximum radiated power, e.r.p.	Channel spacing (CS) / Maximum Occupied Bandwidth (OBW)	Spectrum access and mitigation requirement
870 - 875,6 MHz	≤ 500 mW e.r.p.	25 ≤ CS ≤ 200 kHz	≤ 2,5 % duty cycle and APC required (see note 1) For ER-GSM protection (873 - 875,6 MHz, where applicable), the duty cycle is limited to ≤ 0,01 % and a maximum single transmitter on time of 5 ms/1 s (see note 2)
NOTE 1: A duty cycle of up to 10 % may be allowed for network relay points forming part of metropolitan/rural area networks such as for utilities or other applications for the purpose of data acquisition. NOTE 2: Except if the EUT employs a coordination procedure with the railway operator or a cognitive procedure in order to avoid channels within the ER-GSM bands. A cognitive procedure is the ability to detect ER-GSM transmissions and not transmit within occupied ER-GSM channels.			

4.3 Requirements for transmitters

4.3.1 Frequency Tolerance

4.3.1.1 Applicability

The frequency tolerance requirement shall apply to transmitters able to generate, or be modulated by, test signal D-M1. All other transmitters shall meet the limits in clause 4.3.4 under extreme test conditions.

4.3.1.2 Description

Frequency error is the difference between the measured unmodulated carrier frequency and the nominal operating frequency as stated by the manufacturer.

4.3.1.3 Limits

The measured frequency shall be within the operating frequency band and the measured frequency error shall not exceed the frequency tolerance given in Table 2.

Table 2: Frequency error

Operating frequency	Frequency tolerance (ppm), see note
870 000 MHz to 875 600 MHz (see note)	±20 ppm or ±10 % of the operating channel width, whichever is the smaller
NOTE: The operating channel width is declared by the provider.	

4.3.1.4 Conformance

The conformance test suite for the frequency tolerance requirement shall be as defined in clause 5.4.1 of the present document.

4.3.2 Effective radiated power

4.3.2.1 Applicability

The effective radiated power requirement shall apply to all transmitters.

4.3.2.2 Description

The effective radiated power (e.r.p.) is the power radiated in the direction of the maximum field strength under specified conditions of measurements for any condition of modulation. For transmitters with a permanent or temporary antenna connector, the effective radiated power is the power, adjusted for equipment antenna gain, delivered from that connector into an artificial antenna (clause 5.2.5.1).

4.3.2.3 Limits

The measured effective radiated power shall not exceed the maximum radiated power limit given in Table 1b.

4.3.2.4 Conformance

The conformance test suite for the effective radiated power requirement shall be as defined in clause 5.4.2 of the present document.

4.3.3 Transient power

4.3.3.1 Applicability

The transient power requirement shall apply to all transmitters.

4.3.3.2 Description

Transmitter transient power is power falling into frequencies other than the operating channel as a result of the transmitter being switched on and off.

4.3.3.3 Limits

The measured transient power shall not exceed the limits given in Table 3.

Table 3: Transmitter Transient Power limits

Offset from operating frequency	RBW_{REF}	Peak power limit
< 400 kHz	1 kHz	0 dBm
≥ 400 kHz	1 kHz	-27 dBm

4.3.3.4 Conformance

The conformance test suite for the transient power requirement shall be as defined in clause 5.4.3 of the present document.

4.3.4 Occupied bandwidth

4.3.4.1 Applicability

The occupied bandwidth requirement shall apply to all transmitters.

4.3.4.2 Description

Occupied bandwidth is the width of the band of frequencies that contain 99 % of the power of the signal.

4.3.4.3 Limits

The measured occupied bandwidth shall not exceed the limits given in Table 4.

Table 4: Occupied bandwidth limits

Requirement	Limit
Occupied bandwidth	≤ Operating channel width
NOTE: The occupied bandwidth shall reside entirely within the operating channel. The operating channel shall reside entirely within the operating frequency band as defined in Table 1a. The operating channel width is declared by the provider.	

4.3.4.4 Conformance

The conformance test suite for the occupied bandwidth requirement shall be as defined in clause 5.4.4 of the present document.

4.3.5 Unwanted emissions in the out-of-band domain

4.3.5.1 Applicability

The unwanted emissions in the out-of-band domain requirement shall apply to all transmitters.

4.3.5.2 Description

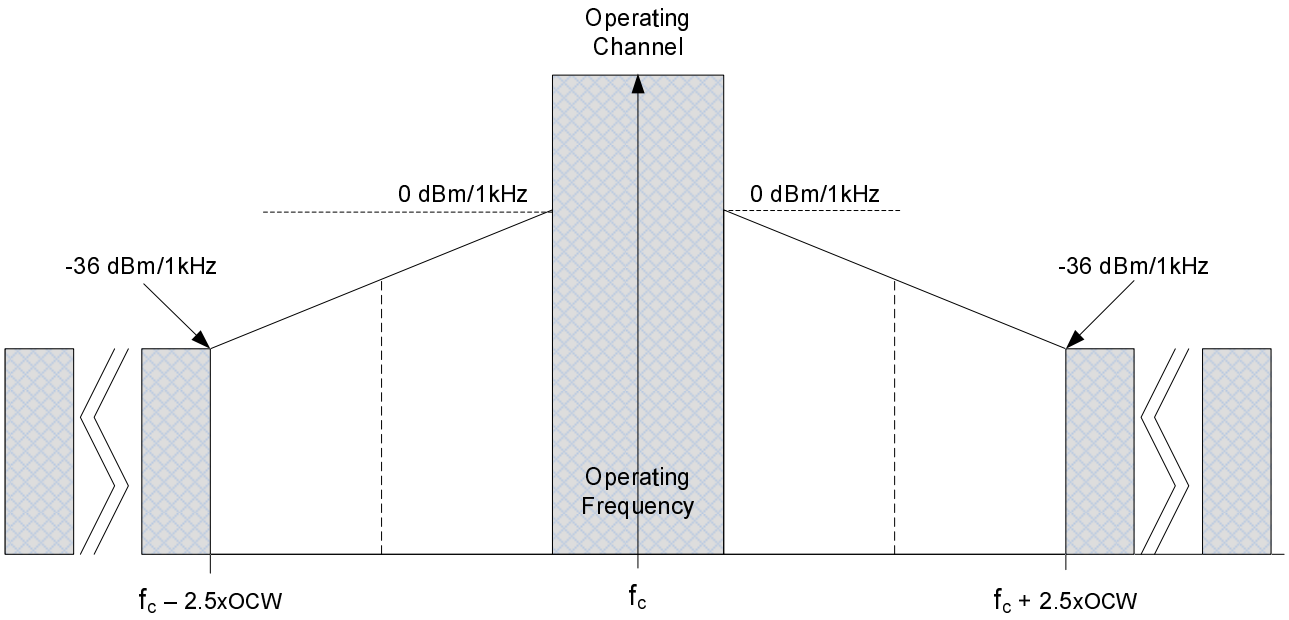


Figure 4: Out-of-Band Domain for Operating Channel

NOTE 1: In Figure 4, OCW is the operating channel width declared by the provider.

Unwanted emissions in the out-of-band domain are those falling in the frequency range immediately below the lower, and above the upper, frequency of the operating channel. The relevant out-of-band domain is shown in Figure 4 and applies within the operating frequency band.

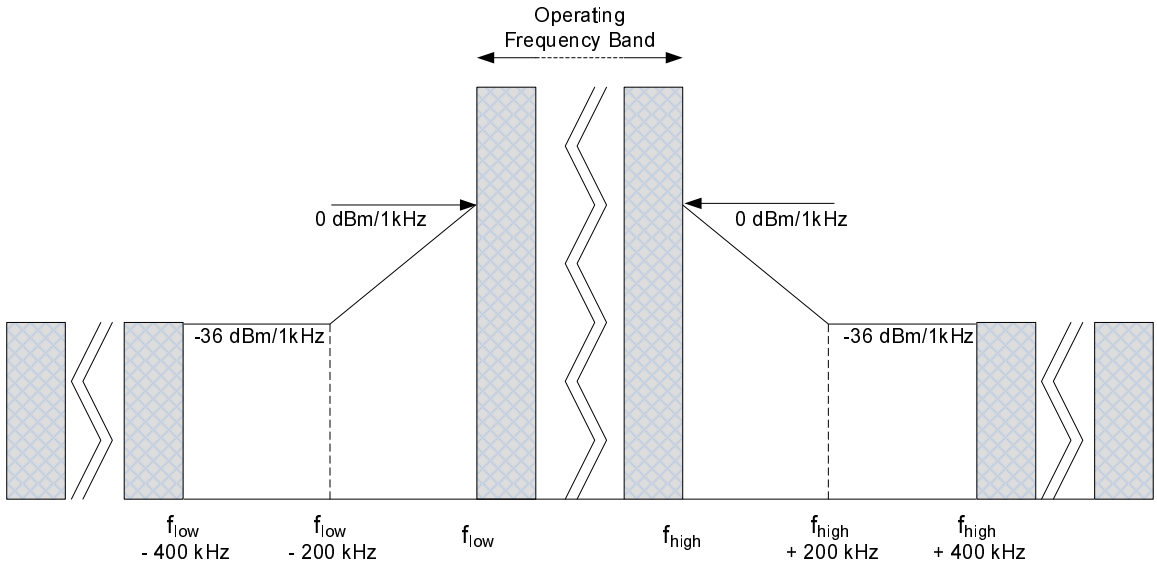


Figure 5: Out-of-Band Domain for Operating Frequency Band

Specific limits apply at frequencies immediately above and below the operating frequency band as shown in Figure 5.

NOTE 2: f_{low} is the lower edge of the operating frequency band defined in Table 1a.

f_{high} is the upper edge of the operating frequency band edge defined in Table 1a.

4.3.5.3 Limits

The measured lower frequencies in each test condition shall not be less than the corresponding lower frequency, and the measured upper frequencies in each test condition shall not be greater than the corresponding upper frequency given in Table 5.

Table 5: Emission limits in the out-of-band domain

Reference Bandwidth (RBW_{REF})	Peak power limit	Lower frequency	Upper frequency
1 kHz	-36 dBm / 250 nW	f_{low} - 200 kHz	f_{high} + 200 kHz
1 kHz	0 dBm / 1 mW	f_{low}	f_{high}
1 kHz	-36 dBm / 250 nW	f_c- 2,5xOCW	f_c+ 2,5xOCW
1 kHz	0 dBm / 1 mW	f_c- 0,5xOCW	f_c+ 0,5xOCW
NOTE: f_c is the operating frequency. f_{low} is the lower edge of the operating frequency band defined in Table 1a. f_{high} is the upper edge of the operating frequency band defined in Table 1a. OCW is the operating channel width declared by the provider.			

4.3.5.4 Conformance

The conformance test suite for the unwanted emissions in the spurious domain requirement shall be as defined in clause 5.4.5 of the present document.

4.3.6 Unwanted emissions in the spurious domain

4.3.6.1 Applicability

The unwanted emissions in the spurious domain requirement shall apply to all transmitters.

4.3.6.2 Description

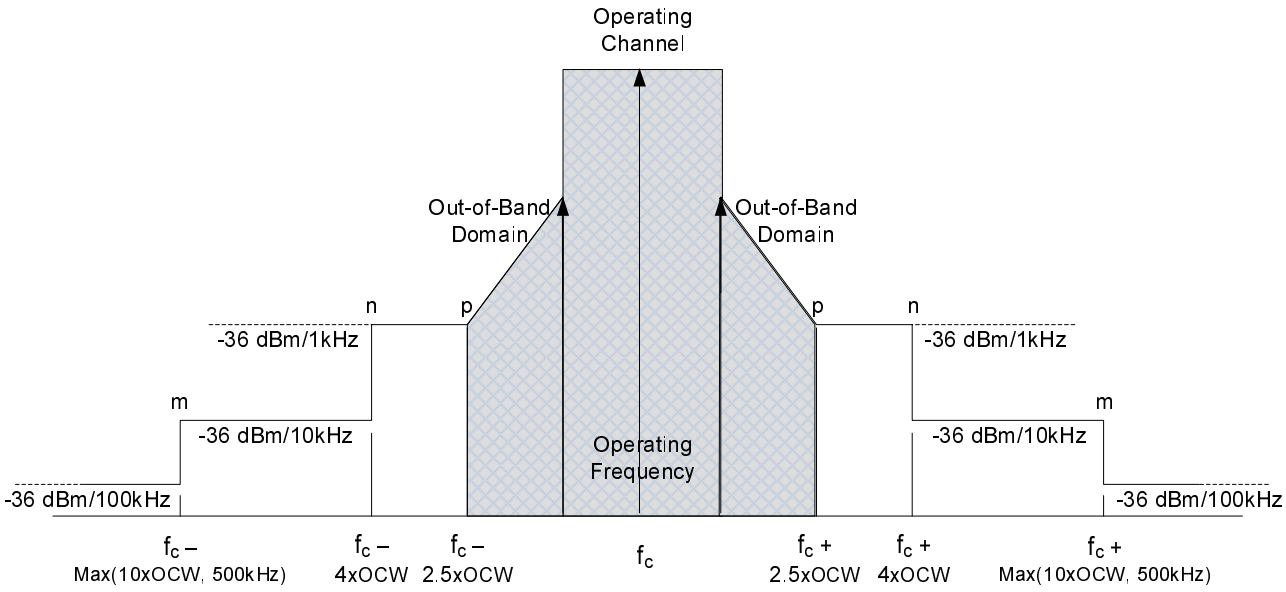


Figure 6: Spectrum Mask for Unwanted Emissions in the Spurious Domain

NOTE: In Figure 6, OCW is the operating channel width declared by the provider.

Spurious emissions are unwanted emissions in the spurious domain at frequencies other than those of the operating channel and its out-of-band domain. The relevant spurious domain is shown in Figure 6.

4.3.6.3 Limits

The power of any unwanted emission in the spurious domain shall not exceed the values given in Table 6.

Table 6: Spurious domain emission limits

Frequency / State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 790 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Operating	-54 dBm / 4 nW	-36 dBm / 250 nW	-30 dBm / 1 µW
Standby	-57 dBm / 2 nW	-57 dB / 2 nW	- 47 dBm / 20 nW

4.3.6.4 Conformance

The conformance test suite for the unwanted emissions in the spurious domain requirement shall be as defined in clause 5.4.6 of the present document.

4.3.7 Frequency stability under low-voltage conditions

4.3.7.1 Applicability

The frequency stability under low-voltage conditions requirement shall apply to all battery operated transmitters.

4.3.7.2 Description

Frequency stability under low voltage condition is the ability of the equipment to remain within the operating frequency band when the battery voltage falls below the lower extreme voltage level.

4.3.7.3 Limits

The measured centre frequencies shall not exceed the limits in Table 7.

Table 7: Frequency Stability under Low Voltage Conditions limits

Requirement	Limit
Highest recorded centre frequency	f_{high} - ½ Operating channel width
Lowest recorded centre frequency	f_{low} + ½ Operating channel width
NOTE: f_{high} is the upper operating frequency band limit. f_{low} is the lower operating frequency band limit. The operating frequency band limits are specified in Table 1a. The operating channel width is declared by the provider.	

4.3.7.4 Conformance

The conformance test suite for the frequency stability under low-voltage conditions requirement shall be as defined in clause 5.4.7 of the present document.

4.3.8 Duty cycle

4.3.8.1 Applicability

The duty cycle requirement shall apply to all transmitters.

4.3.8.2 Description

Table 8: Duty Cycle Parameters

Parameter	Value
Duty cycle observation bandwidth	Operating frequency band
Duty cycle observation period	3 600 seconds
Short term behaviour observation bandwidth	Operating channel width
Short term behaviour observation period	Period for 10 transmissions
NOTE: The operating frequency band is defined in Table 1a. The operating channel width is declared by the provider.	

Duty cycle is expressed with respect to two different observation intervals which apply to their respective observation bandwidths as shown in Table 8.

4.3.8.3 Duty cycle

Duty cycle describes the behaviour of transmissions within the duty cycle observation bandwidth over the duty cycle observation period.

4.3.8.4 Short term behaviour

Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals < $T_{Disregard}$, in the operating channel. The EUT shall wait a minimum period before beginning a subsequent transmission in the same operating channel.

The ratio of the longest transmission in the observation period comprised of the sum of the longest transmission + the shortest wait interval (Ton-max/(Ton-max + Toff-min)) defines the short term behaviour in the operating channel.

4.3.8.5 Limits

The declared duty cycle and the T_{On-Max} and $T_{Off-Min}$ values shall comply with the limits defined in Table 9.

Table 9: Duty Cycle and Transmission Timing Limits

Parameter	Limit	Notes
Duty cycle	Spectrum access duty cycle limit defined in Table 1b	
T_{On-Max}	400 ms	Maximum duration of a transmission from the EUT in the operating channel
$T_{Off-Min}$	400 ms	Minimum interval between transmissions from the EUT in the operating channel

4.3.8.6 Conformance

Conformance with the duty cycle requirement shall be as defined in clause 5.4.8 of the present document.

4.3.9 Automatic/Adaptive Power Control

4.3.9.1 Applicability

The automatic/adaptive power control requirement shall apply to all transmitters.

4.3.9.2 Description

Automatic / Adaptive Power Control (APC) modifies the power transmitted by a device when communicating with a neighbour device. APC requires bi-directional communications to exchange information used to manage the transmitted power level. Such information exchange is out of scope of the present document.

4.3.9.3 Limits

The peak measured power shall not exceed the value shown in Table 10.

Table 10: APC Power Limit

Parameter	Limit
Transmitted Power	+7 dBm / 5 mW

4.3.9.4 Conformance

The conformance test suite for the automatic/adaptive power control requirement shall be as defined in clause 5.4.9 of the present document.

4.4 Requirements for receivers

4.4.1 Receiver sensitivity

4.4.1.1 Applicability

The receiver sensitivity requirement shall apply to all receivers.

4.4.1.2 Description

Receiver sensitivity is the minimum signal power input to the receiver which produces the general performance criteria stated in clause 4.2.2 of the present document.

4.4.1.3 Limits

The receiver sensitivity shall not be higher than the limits given in Table 11.

Table 11: Limits for Receiver Sensitivity

Parameter	Limit
Rx sensitivity	-91 dBm
NOTE: The Rx sensitivity is based on a 50 kbps data rate. For other rates the sensitivity shall be adjusted according to the following formula: $S = 10\log\frac{R}{R'} - 91 \quad dBm$ where: • S is the sensitivity in dBm; • R is the EUT data rate in kbps; • R' is 50 kbps.	

4.4.1.4 Conformance

The conformance test suite for the receiver sensitivity requirement shall be as defined in clause 5.5.1 of the present document.

4.4.2 Clear channel assessment threshold

4.4.2.1 Applicability

The clear channel assessment threshold requirement shall apply to receivers with clear channel assessment capability.

4.4.2.2 Description

CCA threshold is the received signal level above which the receiver determines that the operating channel is not available for use.

4.4.2.3 Limits

The CCA threshold shall not exceed the limits given in Table 12.

Table 12: CCA threshold limit

Parameter	Value
CCA threshold	10 dB above Rx sensitivity limit as given in Table 11

4.4.2.4 Conformance

The conformance test suite for the clear channel assessment threshold requirement shall be as defined in clause 5.5.2 of the present document.

4.4.3 Adjacent channel selectivity

4.4.3.1 Applicability

The adjacent channel selectivity requirement applies to all receivers.

4.4.3.2 Description

Adjacent channel selectivity is a measure of the receiver capability to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal in the adjacent channels.

4.4.3.3 Limits

Table 13: Adjacent channel selectivity limit

Parameter	Value
Adjacent channel selectivity	35 dB - A
NOTE: A = 10 log (R / 16 kHz) where R is the receiver bandwidth in kHz. The receiver bandwidth is declared by the provider.	

4.4.3.4 Conformance

The conformance test suite for the adjacent channel selectivity requirement shall be as defined in clause 5.5.3 of the present document.

4.4.4 Blocking

4.4.4.1 Applicability

The blocking requirement shall apply to all receivers.

4.4.4.2 Description

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

4.4.4.3 Limits

The blocking level shall not be less than the values given in Table 14, except at frequencies on which spurious responses are found.

Table 14: Limits for receiver blocking

Frequency offset	Limit
±1 MHz	40 dB - A
±2 MHz	45 dB - A
±5 MHz	55 dB - A
±10 MHz	60 dB - A
NOTE: A = 10 log (R / 16 kHz) where R is the receiver bandwidth in kHz. The receiver bandwidth is declared by the provider. The limits apply also for the repeated tests in case of equipment using CCA reduced by 13 dB to account for the increased wanted signal level.	

4.4.4.4 Conformance

The conformance test suite for the blocking requirement shall be as defined in clause 5.5.4 of the present document.

4.4.5 Receiver spurious radiations

4.4.5.1 Applicability

The receiver spurious radiations requirement shall apply to all receivers.

4.4.5.2 Description

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

4.4.5.3 Limits

The power of any spurious emission, radiated or conducted, shall not exceed the values given in Table 15.

Table 15: Spurious Radiation Limits

Frequency range	Maximum Power
< 1 000 MHz	-57 dBm / 2 nW
≥ 1 000 MHz	-47 dBm / 20 nW

4.4.5.4 Conformance

The conformance test suite for the receiver spurious radiations requirement shall be as defined in clause 5.5.5 of the present document.

4.5 Requirements for spectrum access

4.5.1 General limits

The general limits applicable to all polite spectrum access parameters are shown in Table 16.

Table 16: General Limits for Polite Spectrum Access Parameters

Parameter	Limit	Notes
Minimum CCA period	160 µs	Minimum CCA listening period
Dead time	CCA Interval	Maximum time between the end of a listening interval and the start of a transmission
Minimum deferral period	CCA interval	Minimum value of the deferral interval
Minimum unit of deferral period	See note 1	Smallest interval between two adjacent deferral periods
Longest short control signalling transmission	$< T_{Disregard}$ See note 2	Maximum duration of any short control signalling transmission
Dialog response interval ($T_{Dialog-Response}$)	See note 3	Interval between emission and response in a dialog
NOTE 1: The minimum unit of deferral period is declared by the provider. NOTE 2: The longest short control signalling transmission is declared by the provider. $T_{Disregard}$ is declared by the provider. NOTE 3: $T_{Dialog-Response}$ is declared by the provider.		

4.5.2 Listen before talk

4.5.2.1 Applicability

The listen before talk requirement shall apply to NRPs. LBT is optional for non-NRP devices, but if it is implemented it shall be as described below.

4.5.2.2 Description

In order to make maximum use of the available channels, polite equipment uses a Listen Before Talk (LBT) protocol with a preferred option of channel adaptivity.

Before transmitting, a device implementing LBT senses the channel for at least the minimum clear channel assessment period to determine if it is free. If the average signal level over the clear channel assessment listening period is below the signal threshold the device proceeds with the transmission.

The time between the end of the CCA period and the start of the transmission is the dead time and should be kept as short as possible to avoid losing the channel to another device implementing LBT with different CCA period.

If the average signal level is above the signal threshold, the LBT device defers its transmission to a later time. The equipment shall not attempt re-transmission on the same channel until a random interval has expired. Alternatively, the equipment may select another channel and again start the listen before transmission procedure.

NOTE: The random interval should be consistent with the duration of transmissions of the EUT and may be associated with a contention resolution algorithm provided by medium access protocol specifications.

4.5.2.3 Limits

The declared listen before talk parameter values shall not exceed the values given in Table 16.

4.5.2.4 Conformance

The use of LBT shall be declared by all vendors - whether used or not. LBT shall be declared as given in clause 5.6.1 of the present document.

4.6 Other requirements

4.6.1 Channel adaptivity

4.6.1.1 Applicability

The channel adaptivity requirement shall apply to NRPs. Channel adaptivity is optional for non-NRP devices, but if it is implemented it shall be as described below.

4.6.1.2 Description

Further improvements in shared access can be achieved if polite short control signalling is combined with LBT and channel adaptivity. Various algorithms may be used to implement channel adaptivity including periodic and event driven decisions to change operating channel. Preferred algorithms distribute generated traffic uniformly over available channels and avoid use of channels permanently or temporarily occupied by other devices.

Although no specific timing constraints are imposed, it should be noted that the delays in switching between receive and transmit states, together with the corresponding processing delays of signals through the receiver and transmitter, should be less than the CCA interval in order to avoid losing the channel to another device using LBT procedures.

4.6.1.3 Limits

No limits are defined for channel adaptivity parameters.

4.6.1.4 Conformance

The use of channel adaptivity shall be declared by all vendors - whether used or not. Channel adaptivity shall be declared as given in clause 5.7.3.1 of the present document.

4.6.2 Short control signalling transmissions

4.6.2.1 Applicability

The short control signalling transmissions requirement shall apply to all equipment.

4.6.2.2 Description

Transmissions may be acknowledged by the receiving device and hence carry information to control whether a transmission should be repeated or considered successful. Since acknowledgement avoids unnecessary re-transmission, it is also considered part of polite spectrum access.

To avoid transmitting long data messages to a destination which is not available to receive them, a device may transmit a short polling message and expect a short confirmation response. If the response is successfully received the long message transmission can be attempted, otherwise the transmission attempt should be re-scheduled for a later time or a different channel.

A device may exploit the declared $T_{Disregard}$ parameter to permit short control signalling messages separated by intervals shorter than the minimum inter-transmission interval. Such exchanges within a transmission constitute a dialog:

- Within a dialog, accumulation of transmitter on time towards permitted duty cycle limits is as follows: Each emission (T_{On}), whether SCS or data, is followed by an interval ($T_{Dialog\text{-}Response}$) before the start of the corresponding response.
- Each device in the dialog accumulates, towards its duty cycle, only the duration of its emissions and response intervals:

$$TCumulative = TCumulative + \Sigma(TOn + TDialog\text{-}Response)$$

- The sum of the SCS emissions, data emissions and $T_{Dialog\text{-}Response}$ intervals of both devices in the dialog is equal to the duration of the transmission.

NOTE: The final emission in a dialog may have a corresponding response interval of zero.

4.6.2.3 Limits

The declared short control signalling transmission parameter values shall not exceed the values given in Table 16.

4.6.2.4 Conformance

The conformance test suite for short control signalling requirement shall be as defined in clause 5.7.3.2 of the present document.

4.6.3 Coordination of network relay points

4.6.3.1 Applicability

The coordination of network relay points shall apply to all equipment.

4.6.3.2 Description

Some configurations of network based SRDs may require network relay points to provide interconnection with external networks or services. In such cases, spectrum sharing may be improved by coordination between neighbouring NRPs.

Coordination may be used to manage channel assignments, coordinate traffic or services or determine optimum locations for NRPs as well as other factors which may affect sharing.

The means for coordination may include communications protocols specifically designed for the exchange of coordination and management information or access to, and maintenance of, data bases of NRP information. Such means are beyond the scope of the present document.

4.6.3.3 Limits

No limits are defined for coordination of network relay points parameters.

4.6.3.4 Conformance

The conformance test suite for the listen before talk requirement shall be as defined in clause 5.7.3.3 of the present document.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the declared operational environmental profile) to give confidence of compliance for the affected technical requirements.

5.2 General conditions for testing

5.2.1 General considerations

Technical documentation and operating manuals, sufficient to allow testing to be performed, shall be made available by the provider.

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

Unless stated otherwise, tests performed under extreme test conditions shall apply the worst case temperature and voltage conditions simultaneously.

For each test method, appropriate test equipment, configuration settings and operation shall be selected by the test laboratory. The test equipment used, together with relevant settings for the test method, shall be recorded in the test report.

5.2.2 Provider declared information

The provider shall declare the information shown in Table 17 which shall be recorded in the test report. Additional information may be provided to facilitate testing or operation of the EUT.

Table 17: Provider Declared Information

Parameter	Notes	
Highest operating frequency	The highest nominal operating frequency of the EUT (see note 1)	
Lowest operating frequency	The lowest nominal operating frequency of the EUT (see note 1)	
Channel spacing	Nominal separation of adjacent operating frequencies (see note 1)	
Operating channel width	The width, or widths, of the operating channel, or channels	
Receiver bandwidth	The bandwidth to be used for conversion of receiver measurements	
Maximum Tx power	Maximum RF output power If the equipment is designed to operate with different power levels, the rated power for each level or range of levels, frequency or range of frequencies	
Antenna gain	Gain in dB (i.e. relative to a dipole) of the antenna used by the equipment in normal operation (see note 2)	
Worst case modulation and operational mode	The set of modulation and operational parameters which create the worst case results for each specific test	
Maximum data rate	Highest data rate employed by EUT	
Unmodulated carrier	Whether the equipment can generate unmodulated carrier or not	
Transmitter duty cycle	Maximum duty cycle	
Disregard Time	Maximum duration of an inter-emission gap in a transmission	
Extreme temperature range	Category I, II or III or specific range (see clause 5.2.4.2.4)	
APC Settling Time	Time required for the EUT APC mechanism to adjust Tx Power to minimum level under test conditions	
Polite spectrum access mechanisms employed	CCA listen duration	Duration of the CCA channel sampling time
	Channel adaptivity	Whether the equipment employs channel adaptivity or not
	Channel agility	Whether the equipment is channel agile or not
	Dead time	The maximum time between the end of the CCA interval and the start of the transmission at the equipment local antenna
	Deferral period	The method used to randomize re-transmission attempts
	Minimum unit of deferral period	Unit of time slot used in the deferral method
	Maximum SCS transmission	Maximum short control signalling transmission duration
	Dialog response interval	$T_{Dialog\text{-}Response}$ (Min-Max or nominal value)
	NRP Coordination	Description of any NRP coordination methods employed
NOTE 1: Alternatively, a list of operating centre frequencies may be declared by the provider. NOTE 2: Declaration of antenna gain applies only to EUT with permanent or temporary external antenna connector.		

5.2.3 Presentation of equipment for testing purposes

5.2.3.1 General Considerations

To simplify and harmonize the testing procedures between the different testing laboratories, measurements shall be performed, according to the present document, on samples of equipment defined in clauses 5.2.3.2 to 5.2.3.3.

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

5.2.3.2 Choice of model for testing

5.2.3.2.1 General considerations

One or more samples of the EUT, as appropriate, shall be tested.

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

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

All necessary test signal sources special to the equipment and set-up information shall accompany the equipment when it is submitted for testing.

A companion device necessary to enable the EUT to operate normally may be provided.

5.2.3.2.2 EUT with an external RF connector

Where practicable, an EUT offered for testing shall provide a 50 Ω connector for conducted RF power measurements.

5.2.3.2.3 EUT without an external RF connector

5.2.3.2.3.1 General Considerations

Conducted measurements on an EUT with an integral antenna or with an antenna connection other than a conventional 50 Ω coaxial connector may be made by:

- access to an internal connector;
- fitting of a temporary connector;
- use of a test fixture.

5.2.3.2.3.2 EUT with an internal connector

Where the EUT has an internal conventional 50 Ω coaxial connector between the antenna and the circuitry, this may be utilized to perform conducted measurements. The means to access the connector, with the aid of a diagram, shall be stated by the provider.

Use of an internal antenna connection shall be recorded in the test report.

5.2.3.2.3.3 EUT with a temporary antenna connector

One EUT, with the normal antenna connected, may be tested using radiated measurement procedures. The provider shall attend the test laboratory at the conclusion of the radiated measurements to disconnect the antenna and fit the temporary antenna connector. The test laboratory staff shall not connect or disconnect any temporary antenna connector.

Alternatively, two EUTs may be submitted to the test laboratory, one fitted with a temporary antenna connector with the antenna disconnected and another with the antenna connected. The appropriate EUT shall be used for each test case. The provider shall declare that the two EUTs are identical in all respects except for the temporary antenna connector.

Use of an EUT with a temporary antenna connection shall be recorded in the test report.

5.2.3.2.3.4 Use of a Test Fixture

A test fixture is a structure for coupling an EUT with an integral antenna, at all frequencies for which measurements need to be performed, to a 50 Ω RF terminal.

A test fixture may only be used for relative measurements.

For further information on the test fixture, see annex C.

5.2.3.3 Testing of modular equipment

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, or additionally has alternative frequency coverage, then all these shall be declared.

Each module or add on stage shall be tested in combination with the equipment.

As a minimum, measurements of the effective radiated power and spurious emissions shall be performed for each combination and shall be stated in the test report.

5.2.3.4 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative for the duration of the test. In the case this not possible, a proper test method shall be described and documented.

5.2.3.5 Battery saving circuit

If the receiver is equipped with a battery-saving circuit, this circuit shall be made inoperative for the duration of the tests. In the case where this not possible, a proper test method shall be described and documented.

5.2.3.6 Test power source

5.2.3.6.1 General considerations

The equipment shall be tested using the appropriate test power source as specified in clauses 5.2.3.6.2 or 5.2.3.6.3. Where equipment can be powered using either external or internal power sources, then the equipment shall be tested using the external power source as specified in clause 5.2.3.6.2 then repeated using the internal power source as specified in clause 5.2.3.6.3.

The test power source used shall be stated in the test report.

5.2.3.6.2 External test power source

During testing, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in clauses 5.2.4.3 and 5.2.4.4. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment. The external test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements, any external power leads shall be so arranged so as not to affect the measurements.

During tests, the test power source voltages shall be within a tolerance of $< \pm 1$ % relative to the voltage at the beginning of each test. The value of this tolerance can be critical for certain measurements. Using a smaller tolerance will provide a better uncertainty value for these measurements.

For radiated measurements, any external power leads should be so arranged so as not to affect the measurements.

5.2.3.6.3 Internal test power source

For radiated measurements on portable equipment with integral antenna, fully charged internal batteries shall be used. The batteries used shall be as supplied or recommended by the provider. If internal batteries are used, at the end of each test the voltage shall be within a tolerance of $< \pm 5$ % relative to the voltage at the beginning of each test. Where this is not appropriate, a note to this effect shall be appended to the test report.

If appropriate, for conducted measurements or where a test fixture is used, an external power supply at the required voltage may replace the supplied or recommended internal batteries. This shall be stated on the test report.

5.2.4 Normal and extreme test conditions

5.2.4.1 Normal temperature and humidity

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

- Temperature +15 °C to +35 °C;
- Relative humidity 20 % to 75 %.

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

5.2.4.2 Extreme temperatures

5.2.4.2.1 Procedure for tests at extreme temperatures

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

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

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

5.2.4.2.2 Procedure for equipment designed for continuous operation

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

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

5.2.4.2.3 Procedure for equipment designed for intermittent operation

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

- Before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained in the oven. The equipment shall then either:
  - transmit on and off according to the providers declared duty cycle for a period of five minutes; or
  - if the provider's declared on period exceeds one minute, then:
    - transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes; after which the equipment shall meet the specified requirements.
- For tests at the lower extreme temperature, the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

5.2.4.2.4 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.2.4.2.1, at the upper and lower temperatures of one of the following ranges, either:

a) The temperature range as declared by the provider; or

b) One of the following specified temperature ranges:

- Temperature category I (General): -20 °C to +55 °C;
- Temperature category II (Portable): -10 °C to +55 °C;
- Temperature category III (Equipment for normal indoor use): +5 °C to +35 °C.

The test report shall state which range is used.

5.2.4.3 Normal test power source

5.2.4.3.1 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.

5.2.4.3.2 Regulated lead-acid battery power sources

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

5.2.4.3.3 Other power sources

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

Such values shall be stated in the test report.

5.2.4.4 Extreme test source voltages

5.2.4.4.1 Mains voltage

The extreme test voltages for equipment to be connected to an AC mains source shall be the nominal mains voltage ±10 %. For equipment that operates over a range of mains voltages clause 5.2.4.4.4 applies.

5.2.4.4.2 Regulated lead-acid battery power sources

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

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

5.2.4.4.3 Power sources using other types of batteries

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

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

The upper extreme voltage shall be declared by the equipment provider if different from the nominal voltage.

Such values shall be stated in the test report.

5.2.4.4.4 Other power sources

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

This shall be recorded in the test report.

5.2.5 Conducted measurements

5.2.5.1 Artificial antenna

Conducted tests shall be carried out using an artificial antenna (also called a dummy load) which shall be a substantially non-reactive non-radiating load connected to the EUT antenna connector and providing a 50 Ω coupling port for connection to test equipment.

5.2.5.2 Voltage Standing Wave Ratio (VSWR)

The VSWR at the 50 Ω output connector of:

- the artificial antenna
- the provider's specified test fixture

shall not be greater than 1,5:1 over the frequency range of the measurement.

5.2.6 Radiated measurements

For all radiated measurements a suitable test site, selected from those described in clause B.2, and applicable measurement procedures, as described in clause B.6, shall be used.

When performing radiated transmitter measurements, the EUT shall be configured and antenna(s) positioned (including smart antenna systems and systems capable of beam forming) and oriented for maximum radiated power into the measuring antenna. The measuring antenna shall use the same polarization as the EUT and be chosen according to the frequency of the transmitter.

When performing radiated receiver measurements, the EUT shall be configured and antenna(s) positioned (including smart antenna systems and systems capable of beam forming) for maximum sensitivity towards the test antenna. The test antenna shall use the same polarization as the EUT and be chosen according to the frequency of the transmitter.

5.2.7 Measuring receiver

5.2.7.1 General considerations

The term "measuring receiver" refers to a frequency-selective voltmeter or a spectrum analyser. Unless stated otherwise, an RMS detector shall be used.

5.2.7.2 Reference Bandwidth

In general, the resolution bandwidth of the measuring receiver (RBW) should be equal to the reference bandwidth (RBW_{REF}) given in Table 18.

Table 18: Resolution bandwidth for the measuring receiver

Measured frequency range: (f)	Measuring receiver resolution bandwidth (RBW_{REF})
f < 150 kHz	200 Hz or 300 Hz
150 kHz ≤ f < 25 MHz	9 kHz or 10 kHz
25 MHz ≤ f ≤ 1 000 MHz	100 kHz or 120 kHz
f > 1 000 MHz	1 MHz
NOTE: The frequency ranges and corresponding RBW_{REF} values are derived from CISPR 16 [3].	

To improve measurement accuracy, sensitivity and efficiency, RBW may be different from RBW_{REF}.

When RBW < RBW_{REF} the result should be integrated over RBW_{REF}.

When RBW > RBW_{REF} the result for broadband spurious emissions should be normalized to the bandwidth ratio according to the following formula:

$$B = A + 10 \log \frac{RBW_{REF}}{RBW_{MEASURED}}$$

Where:

- A is the measured value at the measurement bandwidth $RBW_{MEASURED}$;
- B is the corresponding value at the reference bandwidth RBW_{REF}.

For discrete spurious emissions, defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth, normalization is not applicable, while integration over RBW_{REF} is still applicable.

5.2.8 Transmitter test signals

For the purposes of the present document a test signal is a modulated or unmodulated carrier generated by the EUT. The EUT should be capable of generating the following test signals:

D-M1: a test signal consisting of an unmodulated carrier.

D-M2: a test signal representative of normal operation and generating the greatest occupied RF bandwidth. The preferred test signal shall consist of a pseudo-random bit sequence of at least 511 bits in accordance with Recommendation ITU-T O.153 [1]. This sequence shall be continuously repeated.

D-M2a: a test signal as described in D-M2 but generated intermittently. The generated RF signals shall be the same for each transmission except for the data sequence, occur regularly in time, be accurately repeatable and their timing duration shall represent normal operation of the EUT except for compliance with a duty cycle limit.

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

Test signals may be generated by applying test baseband signals to a modulation port on the device or be generated internally by the device. Operation in a test mode may involve suitable temporary internal modifications of the EUT or the use of special software. Details of the method employed shall be declared by the provider and be recorded in the test report.

For each test performed, the test signal used shall be recorded in the test report. Recommended test signals for each test are shown in Table 19.

Table 19: Recommended test signals

Clause	Requirement	Test Signal
5.4.1	Frequency error	D-M1
5.4.2	Effective radiated power	D-M1, D-M2, D-M2a, D-M3 (Conducted) D-M2, D-M2a, D-M3 (Radiated)
5.4.3	Transient power	D-M1, D-M2, D-M2a, D-M3
5.4.4	Occupied bandwidth	D-M2, D-M2a, D-M3
5.4.5	Unwanted emissions in the out-of-band domain	D-M2, D-M2a, D-M3
5.4.6	Unwanted emissions in the spurious domain	D-M2, D-M2a, D-M3
5.4.7	Frequency stability under low voltage conditions	D-M1, D-M2, D-M2a, D-M3
5.4.8	Duty cycle	D-M3
5.4.9	Automatic/adaptive power control	D-M3
5.5.1	Receiver sensitivity	D-M3
5.5.2	Clear channel assessment threshold	D-M3
5.5.3	Adjacent channel selectivity	D-M3
5.5.4	Blocking	D-M3
5.5.5	Receiver spurious radiations	N/A
5.6.1	Polite spectrum access	N/A

5.2.9 Applicable measurement methods

Although the measurement methods in the present document allow conducted measurements to be performed, the EUT together with all its intended antenna assemblies shall comply with the applicable technical requirements.

For any test method described using a conducted connection, an equivalent radiated measurement may be used instead. For certain measurements, an equivalent test using a test fixture may be used. In such cases, appropriate procedures to establish reference levels shall be used and recorded in the test report.

Where a test method uses a radiated measurement, it is not generally possible to substitute a conducted or a test fixture measurement. A preliminary conducted or test fixture measurement is permissible, for instance to identify at which frequencies a radiated measurement is needed. The results of a preliminary conducted or test fixture measurement may also be used to show that a radiated measurement is not required, for instance if it is clear that spurious emissions are significantly below the specified limits.

For equipment with pulse modulation, or where it is not possible to make a required measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with appropriate receiver bandwidth (see clause 5.2.7).

A summary of the applicable measurement methods for each test suite are shown in Table 20.

Table 20: Applicable test methods

Clause	Requirement	Test method		
		Radiated	Conducted	Test fixture
5.4.1	Frequency error	Yes	Yes	Yes
5.4.2	Effective radiated power	Yes	No	No
5.4.3	Transient power	Yes	Yes	No
5.4.4	Occupied bandwidth	Yes	Yes	Yes
5.4.5	Unwanted emissions in the out-of-band domain	Yes	Yes	No
5.4.6	Unwanted emissions in the spurious domain	Yes	Yes	No
5.4.7	Frequency stability under low voltage conditions	Yes	Yes	Yes
5.4.8	Duty cycle	Yes	Yes	Yes
5.4.9	Automatic/adaptive power control	Yes	Yes	No
5.5.1	Receiver sensitivity	Yes	Yes	No
5.5.2	Clear channel assessment threshold	Yes	Yes	No
5.5.3	Adjacent channel selectivity	Yes	Yes	No
5.5.4	Blocking	Yes	Yes	No
5.5.5	Receiver spurious radiations	Yes	Yes	No
5.6.1	Polite spectrum access	Yes	Yes	Yes
NOTE: See clause 5.2.3.2, 'Choice of model for testing'.				

5.2.10 Modes of operation

5.2.10.1 Test mode

Unless otherwise specified, the measurements shall be performed using normal operation of the equipment in the worst case operational mode. For each of the requirements in the present document, this worst case operational mode shall be declared by the manufacturer and documented in the test report. Special software may be used to operate the equipment in this mode.

NOTE: The worst case operational mode is that mode resulting in the worst results with regard to the requirement.

5.2.10.2 Transmitter operation

For each transmitter test an appropriate test signal shall be employed and recorded in the test report.

Unless stated otherwise, the transmitter shall be operated at its maximum transmit power level as declared by the provider.

Equipment able to operate with different modulations shall be tested for each modulation separately.

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

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

When performing transmitter tests on equipment designed for intermittent operation it may be necessary to exceed the duty cycle associated with normal operation. Where this is the case, care should be taken to avoid heating effects having an adverse effect on the equipment and the parameters being measured. The maximum transmission duration shall be stated by the test laboratory, where applicable. This on-time shall not be exceeded and details shall be stated in the test report.

5.2.10.3 Testing of multi-frequency or channel agile equipment

Unless stated otherwise, equipment intended to operate on multiple frequencies, or channel agile equipment, shall be tested on the highest operating frequency and lowest operating frequency declared by the provider.

Channel agile equipment should allow specific operating frequencies to be selected manually to facilitate some of the tests to be performed.

5.2.10.4 Non-uniform maximum transmit power

Where an EUT does not use the same power level on each operating frequency, specific test procedures are required for certain tests. Where the operating frequency does not materially impact the testing of the requirement, the highest and lowest operating frequencies on which the EUT operates at its highest power level shall be used in place of the highest and lowest operating frequencies declared by the provider.

Where the operating frequency does materially impact the testing of the requirement, the tests shall be performed on the highest and lowest operating frequencies declared by the provider. The tests shall then be repeated for each next highest and lowest operating frequency on which a greater power level is used until operating frequencies on which the highest power level is used have been tested.

The result of the test shall be recorded as the worst case of the sets of frequencies tested for the specific test suite.

The test suites where these specific procedures apply are shown in Table 21.

Table 21: Specific Test Procedures

Clause	Requirement	Specific Test Procedures
5.4.1	Frequency error	No
5.4.2	Effective radiated power	Yes
5.4.3	Transient power	No
5.4.4	Occupied bandwidth	No
5.4.5	Unwanted emissions in the out-of-band domain	Yes
5.4.6	Unwanted emissions in the spurious domain	Yes
5.4.7	Frequency stability under low voltage conditions	No
5.4.8	Duty cycle	No
5.4.9	Automatic/adaptive power control	Yes
5.5.1	Receiver sensitivity	No
5.5.2	Clear channel assessment threshold	No
5.5.3	Adjacent channel selectivity	No
5.5.4	Blocking	No
5.5.5	Receiver spurious radiations	No
5.6.1	Polite spectrum access	No

5.3 Interpretation of the measurement results

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

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be separately included in the test report;
- the value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in Table 22.

Table 22: Measurement uncertainty

Radio frequency	$\pm 1 \times 10^{-7}$
RF power, conducted	±1,5 dB
Conducted spurious emission of transmitter, valid up to 6 GHz	±3 dB
Conducted emission of receivers	±3 dB
Radiated emission of transmitter, valid up to 6 GHz	±6 dB
Radiated emission of receiver, valid up to 6 GHz	±6 dB
RF level uncertainty for a given BER	±1,5 dB
Temperature	±1 °C
Humidity	±10 %

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 [2], in particular in annex D of the ETSI TR 100 028-2 [2].

Table 22 is based on such expansion factors.

5.4 Conformance methods of measurement for transmitters

5.4.1 Frequency tolerance

5.4.1.1 Test conditions

1) The measurement shall be made under normal and extreme test conditions.
2) The measurement shall be performed on the highest and lowest operating frequencies declared by the provider.
3) The measurement shall be performed with an unmodulated carrier test signal.
4) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.1.2 or clause 5.4.1.4.
5) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.1.3.

5.4.1.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.1 and the measurements in clause 5.4.1.5 performed using corresponding radiated measurement methods described in clause B.6.

5.4.1.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connect to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.1.5 shall be performed.

5.4.1.4 Alternate conducted measurement

The EUT shall be installed in the provider's test fixture which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.1.5 shall be performed.

5.4.1.5 Measurement procedure

Step 1:

Operation of the EUT shall be started using test signal D-M1 on the highest operating frequency as declared by the provider.

The frequency of the unmodulated carrier shall be measured and noted.

Step 2:

The operation of the EUT shall be restarted using test signal D-M1 at the lowest operating frequency declared by the provider.

The frequency of the unmodulated carrier shall be measured and noted.

Step 3:

The test step 1 and step 2 shall be repeated under extreme test conditions.

Step 4:

The information shown in Table 23 shall be recorded in the test report for each test condition.

Table 23: Information Recorded in the Test Report For Frequency Error

Value	Notes
Test environment	Normal or Extreme test conditions
Carrier frequency (high) (A)	Measured unmodulated carrier frequency at highest frequency declared by the provider
Nominal operating frequency (high) (B)	Highest operating frequency declared by the provider
Carrier frequency (low) (A')	Measured unmodulated carrier frequency at lowest frequency declared by the provider
Nominal operating frequency (low) (B')	Lowest operating frequency declared by the provider
Frequency error (high)	Absolute value of (A-B)
Frequency error (low)	Absolute value of (A'-B')
NOTE: The highest and lowest operating frequencies are declared by the provider.	

5.4.2 Effective radiated power

5.4.2.1 Test conditions

1) The measurements for an EUT with a permanent or temporary antenna connector shall be performed under normal and extreme conditions.

2) The measurements for an EUT without a permanent or temporary antenna connector shall be performed under normal conditions and extreme voltage conditions.

3) The measurement shall be performed on the lowest and the highest frequency declared by the provider. Additional frequencies may be tested.

NOTE: See clause 5.2.10.4 for specific test procedures for non-uniform maximum transmit power.

4) For an EUT with non-constant-envelope modulation, test signal D-M1 shall not be used.

5) For an EUT with non-constant-envelope modulation, the average power shall be measured.

6) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.2.2.

7) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.2.3.

5.4.2.2 Radiated measurement procedure

A suitable test site shall be selected from those described in clause B.2 and the following measurements performed using corresponding radiated measurement methods described in clause B.6.

Table 24: Test Parameters for Effective Radiated Power Measurement

Setting	Value	Notes
Centre frequency	The nominal operating frequency	The highest or lowest operating frequency as declared by the provider
Detector Mode	RMS or Peak	RMS if EUT provides unmodulated carrier or uses non-constant-envelope modulation; otherwise Peak
NOTE: The highest and lowest operating frequencies are declared by the provider.		

The test equipment shall be configured as appropriate for the parameters shown in Table 24.

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The maximum average or mean power values measured for vertical and horizontal polarization shall be noted.

Step 2:

The substitution measurement as defined in clause B.6.4 shall be performed.

The equivalent radiated power for vertical and horizontal polarization shall be noted.

The measure of the effective radiated power is the larger of the two levels recorded at the input to the substitution antenna, corrected for the gain of the substitution antenna and applicable cable losses.

Step 3:

The measurements in step 1 and step 2 shall be repeated under extreme voltage conditions.

Step 4:

The information shown in Table 25 shall be recorded in the test report.

Table 25: Information Recorded in the Test Report for Effective Radiated Power

Value	Notes
Test environment	Normal operation or unmodulated carrier
Test signal	The test signal used (see clause 5.2.8)
Operating frequency	Nominal operating frequency
Measure of effective radiated power	Measured equivalent radiated power
NOTE: The nominal operating frequency is declared by the provider. The equipment antenna gain (in dB, i.e. relative to a dipole) is declared by the provider.	

5.4.2.3 Conducted measurement procedure

The EUT shall be connected to an artificial antenna which shall be connected to the measuring receiver via an appropriate attenuator.

Table 26: Test Parameters for Effective Radiated Power Measurement

Setting	Value	Notes
Centre frequency	The nominal operating frequency	The highest or lowest operating frequency
Detector Mode	RMS or Peak	RMS if EUT provides unmodulated carrier or uses non-constant-envelope modulation; otherwise Peak
NOTE: The highest and lowest operating frequencies are declared by the provider.		

The test equipment shall be configured as appropriate for the parameters shown in Table 26.

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The average or mean power, as appropriate, delivered to the artificial antenna shall be measured.

Step 2:

The measurement in step 1 shall be repeated for the lowest operating frequency as declared by the provider.

Step 3:

The measurements in step 1 and step 2 shall be repeated under extreme test conditions.

Step 4:

The information shown in Table 27 shall be recorded in the test report for each test condition.

Table 27: Information Recorded in the Test Report for Effective Radiated Power

Value	Notes
Test environment	Normal or Extreme test conditions
Test signal	The test signal used (see clause 5.2.8)
Operating frequency	Nominal operating frequency
Average output power (conducted)	Measured average or mean power plus equipment antenna gain in dB
NOTE: The nominal operating frequency is declared by the provider. The equipment antenna gain (in dB, i.e. relative to a dipole) is declared by the provider.	

5.4.3 Transient power

5.4.3.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurements shall be performed using a spectrum analyser or equivalent measuring equipment.

3) The measurements shall be performed on the highest and lowest operating frequencies as declared by the provider.

4) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.3.2.

5) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.3.3.

5.4.3.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.3.4 performed using corresponding radiated measurement methods described in clause B.6.

5.4.3.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.3.4 shall be performed.

5.4.3.4 Measurement procedure

Table 28: Measurement Offsets & RBW for Transient Power Measurement

Offset frequency (kHz)	Analyser RBW (kHz)	RBWREF (kHz)
OCW	Max (RBW pattern 1,3,10) ≤ Offset frequency/6	1
0,5xOCW+400 kHz	Max (RBW pattern 1,3,10) ≤ Offset frequency/4	1
0,50xOCW+1 200 kHz	Max (RBW pattern 1,3,10) ≤ Offset frequency/4	1
NOTE: Max (RBW pattern 1, 3, 10) means the maximum bandwidth that falls into the incremental 1,3,10 RBW filter bandwidth pattern commonly implemented in spectrum analysers. Operating channel width (OCW) is declared by the provider.		

Table 29: Test Parameters for Transient Power Measurement

Setting	Value	Notes
VBW/RBW	10	At higher RBW values VBW may be clipped to its maximum value
Sweep time	See note	Capture one full packet
RBW filter	Gaussian	
Scan Mode	Zero Span	Time domain power measurement
Trace Detector Function	Peak	Required to capture fast signal
Trace Mode	Clear Write	
NOTE: Long enough to accommodate at least one full transmitted packet.		

The spectrum analyser shall be configured as appropriate for the parameters shown in Table 29.

NOTE: If such a facility is provided, the analyser should be triggered from a signal generated by the EUT before packet transmission. In the absence of such a facility, the analyser should be configured in free run mode.

The operation of the EUT shall be started on the highest operating frequency, as declared by the provider, using the D-M3 test signal.

The analyser centre frequency shall be set to the Offset Frequency in the first row of Table 28 above the EUT operating frequency and the analyser RBW set to the corresponding RBW given in Table 28.

Step 1:

A single sweep shall be taken on the analyser and the peak value shall be noted.

Step 2:

The noted peak power value shall be converted to the equivalent power value measured in RBW_{REF} by the formula in clause 5.2.7, where A is the measured value and B is the value normalized to RBW_{REF} given in the corresponding row of Table 28.

Step 3:

The analyser centre frequency shall be set to the Offset Frequency in the first row of Table 28 below the EUT operating frequency.

Steps 1 and 2 shall be repeated.

Step 4:

Steps 1, 2 and 3 shall be repeated using the Offset Frequency and corresponding RBW and RBW_{REF} value from the 2nd and 3rd rows of Table 28.

Step 5:

Operation of the EUT shall be restarted on the lowest operating frequency, as declared by the provider, with the appropriate test signal.

The measurements in steps 1 through 4 shall be repeated.

Step 6:

The information shown in Table 30 shall be recorded in the test report for each test measurement.

Table 30: Information Recorded in the Test Report for Transmitter Transient Power

Value	Notes
Operating frequency	The highest or lowest operating frequency as declared by the provider and any other frequencies used in the test case
Peak measured power	The peak power value displayed by the spectrum analyser
Peak power	Calculated peak power in RBW_{REF}
NOTE: The highest and lowest operating frequencies are declared by the provider.	

5.4.4 Occupied bandwidth

5.4.4.1 Test conditions

1) The measurements shall be performed under normal and extreme test conditions.

NOTE: If the frequency error test (see clause 5.4.1) is performed then the measurements may be made under normal test conditions only with the upper and lower frequency error results added and subtracted to each frequency measurement obtained in this test.

2) The measurement shall be performed on the lowest and the highest frequency declared by the provider. Additional frequencies may be tested.

3) The measurement shall be performed with a spectrum analyser.

4) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.4.2 or clause 5.4.4.4.

5) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.4.3.

5.4.4.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.4.5 performed using corresponding radiated measurement methods described in clause B.6.

5.4.4.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.4.5 shall be performed.

5.4.4.4 Alternate conducted measurement

The EUT shall be installed in the provider's test fixture which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.4.5 shall be performed.

5.4.4.5 Measurement procedure

Table 31: Test Parameters for Occupied Bandwidth Measurement

Setting	Value	Notes
Centre frequency	The nominal operating frequency	The highest or lowest operating frequency as declared by the provider. Additional frequencies may be derived from these values using the declared channel spacing
RBW	1 kHz	
VBW	3 x RBW	Nearest available analyser setting to 3x RBW
Span	At least 2x operating channel width	Span should be large enough to include all major components of the signal and its side bands
Detector Mode	RMS	
Trace	Max. hold	
NOTE: The highest and lowest operating frequencies are declared by the provider. The channel spacing and operating channel width are declared by the provider.		

The spectrum analyser shall be configured as appropriate for the parameters shown in Table 31.

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The signal attenuation shall be adjusted to ensure that the signal power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals on either side of the power envelope being included in the measurement.

Step 2:

When the trace is completed the peak value of the trace shall be located and the analyser marker placed on this peak.

Step 3:

The 99 % occupied bandwidth function of the spectrum analyser shall be used to measure the occupied bandwidth of the signal.

Step 4:

Operation of the EUT shall be restarted on the lowest operating frequency, as declared by the provider, with the appropriate test signal.

The measurement in step 2 and step 3 shall be repeated.

The information shown in Table 32 shall be recorded in the test report for each test condition.

Table 32: Information Recorded in the Test Report for Occupied Bandwidth

Value	Notes
Test environment	Normal or extreme conditions
Test signal	The test signal used (see clause 5.2.8)
Operating frequency	The highest or lowest operating frequency as declared by the provider and any other frequencies used in the test case
Occupied Bandwidth	The value displayed by the spectrum analyser for the 99 % occupied bandwidth for each operating frequency measured
NOTE: The highest and lowest operating frequencies are declared by the provider.	

5.4.5 Unwanted emissions in the out-of-band domain

5.4.5.1 Test conditions

1) The measurements shall be performed under normal and extreme test conditions.

NOTE 1: If the frequency error test (see clause 5.4.1) is performed then the measurements may be made under normal test conditions only, with the upper and lower frequency error results added and subtracted to each frequency measurement obtained in this test.

2) The measurement shall be performed on the lowest and the highest frequency declared by the provider and an intermediate frequency on which the EUT operates at its maximum transmit power.

NOTE 2: See clause 5.2.10.4 for specific test procedures for non-uniform maximum transmit power.

The intermediate frequency should be chosen such that the out-of-band domain falls entirely within the operating frequency band.

3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.5.2.

4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.5.3.

5.4.5.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.5.4 performed using corresponding radiated measurement methods described in clause B.6.

5.4.5.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.5.4 shall be performed.

5.4.5.4 Measurement procedure

Table 33: Test Parameters for Upper Out-of-Band Measurement

Spectrum Analyser Setting	Value	Notes
Centre frequency	f_{high}	The upper band edge frequency
RBW	1 kHz (see note 2)	Resolution bandwidth for out-of-band domain measurements
Detector Function	Peak	
Trace Mode	Max. Hold	
NOTE 1: f_{low} is the lower band edge frequency defined in Table 1a.		
NOTE 2: See clause 5.2.7 if the value of RBW used is different from RBW_{REF} in Table 5.		

The test equipment shall be configured as appropriate for the parameters shown in Table 33.

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The highest frequency at which the EUT signal power envelope, corrected for attenuator values, equals the peak power limit for the first row of Table 5 is determined and noted.

Step 2:

The test equipment shall be reconfigured as appropriate for the parameter shown in Table 34.

Table 34: Test Parameter Setting for Lower Out-of-Band Measurement

Spectrum Analyser Setting	Value	Notes
Centre frequency	f_{low}	The lower band edge frequency

Operation of the EUT is restarted, with the appropriate test signal, on the lowest operating frequency as declared by the provider.

The lowest frequency at which the EUT signal power envelope, corrected for attenuator values, equals the peak power limit for the first row of Table 5 is determined and noted.

Step 3:

Step 1 and step 2 shall be repeated for the peak power limit of the second row of Table 5, adapting the test equipment configuration as required.

Step 4:

The information shown in Table 35 shall be recorded in the test report for each test condition.

Table 35: Information Recorded in the Test Report for OOB Emissions

Parameter	Value Recorded in the Test Report
Test condition	Normal or extreme test conditions
Test signal	The test signal used (see clause 5.2.8)
Centre frequency	Upper or lower edge of the operating frequency band
Operating frequency	Highest or lowest operating frequency as declared by the provider
Power limit	Peak power limit from the relevant row of Table 5
Upper frequencies	The measured values from step 3 for each row of Table 5
Lower frequencies	The measured values from step 4 for each row of Table 5

Step 5:

The test equipment shall be reconfigured as appropriate for the parameter shown in Table 36.

Table 36: Test Parameter Setting for Lower Out-of-Band Measurement

Spectrum Analyser Setting	Value	Notes
Centre frequency	f_c	Intermediate operating frequency

Operation of the EUT shall be re-started, with the appropriate test signal, on the intermediate operating frequency.

The highest and lowest frequencies at which the EUT signal power envelope, corrected for attenuator values, equals the peak power limit for the third row of Table 5 is determined and noted.

Step 6:

The highest and lowest frequencies at which the EUT signal power envelope, corrected for attenuator values, equals the peak power limit for the fourth row of Table 5 is determined and noted.

Step 7:

The information shown in Table 37 shall be recorded in the test report.

Table 37: Information Recorded in the Test Report for OOB Emissions

Parameter	Value Recorded in the Test Report
Test condition	Normal or extreme test conditions
Test signal	The test signal used (see clause 5.2.8)
Centre frequency	Test equipment centre frequency
Operating frequency	Intermediate operating frequency
Upper frequencies	The measured highest values from step 5 and step 6
Lower frequencies	The measured lowest values from step 5 and step 6

Step 8:

Where required (see clause 5.4.5.1 condition 1), the measurements in step 1 to step 7 shall be repeated under extreme test conditions.

5.4.6 Unwanted emissions in the spurious domain

5.4.6.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurements shall be performed on the highest and lowest frequencies declared by the provider.

3) The measurement shall be performed with the EUT operating at its maximum operating power level, as declared by the provider, and with the EUT in powered-on stand-by mode.

NOTE: See clause 5.2.10.4 for specific test procedures for non-uniform maximum transmit power.

4) For measurements on transmitters with an e.r.p. exceeding 100 mW, additional external filtering or a spectrum analyser internal filtering may be used to avoid significant amount of energy from the out-of-band emissions being measured when performing spurious emission measurements close to the out-of-band domain. If additional filtering is used, this shall be stated in the test report.

5) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.6.2.

6) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.6.3 and clause 5.4.6.4.

5.4.6.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

The EUT shall be connected to its normal operating antenna.

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

The measurements in clause 5.4.6.5.2 shall be performed using corresponding radiated measurement methods described in clause B.6.

5.4.6.3 Alternate Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

The EUT shall be connected to an artificial antenna (see clause 5.2.5.1). The output of the test antenna shall be connected to a measuring receiver.

The measurements in clause 5.4.6.5.2 shall be performed using corresponding radiated measurement methods described in clause B.6.

5.4.6.4 Conducted measurement

The EUT shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver. The measurements described in clause 5.4.6.5.1 shall be performed.

5.4.6.5 Measurement procedure

5.4.6.5.1 Conducted measurement

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The measuring receiver shall be tuned over the frequency range shown in Table 38.

Table 38: Conducted Spurious Radiations Measurement Frequency Range

Frequency Range	RBW_{REF} (see note 2)
9 kHz ≤ f < 150 kHz	1 kHz
150 kHz ≤ f < 30 MHz	10 kHz
30 MHz ≤ f < f_c - m	100 kHz
f_c - m ≤ f < f_c - n	10 kHz
f_c - n ≤ f < f_c - p	1 kHz
f_c + p < f ≤ f_c + n	1 kHz
f_c + n < f ≤ f_c + m	10 kHz
f_c + m < f ≤ 1 GHz	100 kHz
1 GHz < f ≤ 6 GHz	1 MHz
NOTE 1: f is the measurement frequency. f_c is the operating frequency. m is the larger of 10 x operating channel width or 500 kHz (see Figure 6). n is 4 x operating channel width. p is 2.5 x operating channel width. The operating channel width is declared by the provider. NOTE 2: See clause 5.2.7 if the value of RBW used for measurement is different from RBW_{REF}.	

Step 2:

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

Step 3:

Operation of the EUT shall be restarted, on the lowest operating frequency as declared by the provider, with the appropriate test signal.

The measurements in step 2 shall be repeated.

Step 4:

Operation of the EUT shall be restarted with the transmitter in stand-by mode.

Step 2 and step 3 shall be repeated.

Step 5:

The information shown in Table 40 shall be recorded in the test report for each spurious component.

5.4.6.5.2 Radiated measurement

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal.

The measuring receiver shall be tuned over the frequency range shown in Table 39.

Table 39: Radiated Spurious Radiations Measurement Frequency Range

Frequency Range	RBW_{REF} (see note 2)
$25\ MHz \le f < f_c - m$	100 kHz
$f_c - m \le f < f_c - n$	10 kHz
$f_c - n \le f < f_c - p$	1 kHz
$f_c + p < f \le f_c + n$	1 kHz
$f_c + n < f \le f_c + m$	10 kHz
$f_c + m < f \le 1\ GHz$	100 kHz
$1\ GHz < f \le 6\ GHz$	1 MHz
NOTE 1: f is the measurement frequency. f_c is the operating frequency. m is the larger of 10 x operating channel width or 500 kHz (see Figure 6). n is 4 x operating channel width. p is 2.5 x operating channel width. The operating channel width is declared by the provider. NOTE 2: See clause 5.2.7 if the value of RBW used for measurement is different from RBW_{REF}.	

Step 2:

For each frequency at which a spurious component is detected the appropriate measurement procedure for the selected test site as described in clause B.6 shall be performed.

The maximum signal level detected by the measuring receiver for vertical and horizontal polarization shall be noted.

The substitution measurement defined in clause B.6.4 shall be performed with the frequency of the calibrated signal generator set to the frequency of the spurious component detected and, if necessary, the input attenuator setting of the measuring receiver adjusted in order to increase the sensitivity of the measuring receiver.

The radiated power for vertical and horizontal polarization, corrected for any change of input attenuator setting of the measuring receiver, shall be noted.

The measure of the effective radiated power of the spurious component is the larger of the two power levels at the input to the substitution antenna and shall be noted.

Step 3:

Operation of the EUT shall be restarted, on the lowest operating frequency as declared by the provider, with the appropriate test signal.

The measurements in step 2 shall be repeated.

Step 4:

Operation of the EUT shall be restarted with the transmitter in stand-by mode.

Step 2 and step 3 shall be repeated.

Step 5:

The information shown in Table 40 shall be recorded in the test report for each spurious component.

Table 40: Information Recorded in the Test Report for Unwanted Emissions in the Spurious Domain

Value	Test condition	Notes
Test signal		The test signal used (see clause 5.2.8)
Frequency	Conducted or radiated	Measured frequency of the spurious component
Power level	Conducted or radiated	Measured conducted or effective radiated power level

5.4.7 Frequency stability under low-voltage conditions

5.4.7.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurements shall be performed on the highest and lowest frequencies declared by the provider.

3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.7.2 or clause 5.4.7.4.

4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.7.3.

5.4.7.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.7.5 performed using corresponding radiated measurement methods described in clause B.6.

5.4.7.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connect to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.7.5 shall be performed.

5.4.7.4 Alternate conducted measurement

The EUT shall be installed in the provider's test fixture which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.7.5 shall be performed.

5.4.7.5 Measurement procedure

Table 41: Test Parameters for Frequency Stability under Low Voltage Conditions Measurement

Setting	Value	Notes
Centre frequency	The nominal operating frequency	The highest or lowest operating frequency
NOTE: The highest and lowest operating frequencies are declared by the provider.		

The test equipment shall be configured as appropriate for the parameters shown in Table 41.

Step 1:

Operation of the EUT shall be started, on the highest operating frequency as declared by the provider, with the appropriate test signal and with the EUT operating at nominal operating voltage.

The centre frequency of the transmitted signal shall be measured and noted.

Step 2:

The operating voltage shall be reduced by an appropriate step.

The centre frequency of the transmitted signal shall be measured and noted.

Step 3:

Step 2 shall be repeated until either the EUT ceases to operate or the voltage reaches zero.

Step 4:

Operation of the EUT shall be restarted, on the lowest operating frequency as declared by the provider, with the appropriate test signal and with the EUT operating at nominal operating voltage.

The centre frequency of the transmitted signal shall be measured and noted.

Step 5:

Step 2 and step 3 shall be repeated.

Step 6:

The information shown in Table 42 shall be recorded in the test report:

Table 42: Information Recorded in the Test Report for Frequency Stability Under Low Voltage Conditions

Value	Notes
Test signal	The test signal used (see clause 5.2.8)
Highest centre frequency	Highest centre frequency valued noted
Lowest centre frequency	Lowest centre frequency value noted

5.4.8 Duty cycle

5.4.8.1 (Long Term Duty Cycle)

5.4.8.1.1 Measurement procedure

The maximum duty cycle shall be declared by the provider.

5.4.8.2 (Short Term Duty Cycle)

5.4.8.2.1 Test conditions

1) The measurements shall be performed under normal test conditions.
2) The measurement shall be performed on a frequency declared by the provider. The frequency shall correspond to a nominal operating frequency consistent with the highest and lowest operating frequencies and channel spacing declared by the provider.
3) This test is performed using a fast power sensing equipment suitable for measurements at 800 - 900 MHz. The test equipment shall be capable of not less than 1M samples/second to provide 1µ second resolution.
4) The EUT shall be configured to transmit its maximum length transmissions.
5) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.8.2.2 or clause 5.4.8.2.4.
6) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.8.2.3.

5.4.8.2.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.8.2.5 performed using corresponding radiated measurement methods described in clause B.6.

5.4.8.2.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.8.2.5 shall be performed.

5.4.8.2.4 Alternate conducted measurement

The EUT shall be installed in the provider's test fixture which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.8.2.5 shall be performed.

5.4.8.2.5 Measurement procedure

Table 43: Test Parameters Settings for Short Term Behaviour Measurement

Setting	Value	Notes
Sample rate	≥ 1M samples/second	Sampling rate for at least 1μ second resolution
Trigger	-	Trigger setting to capture leading edge of first transmission
$P_{Threshold}$	-	Threshold power level indicating presence of EUT transmission
NOTE: The trigger setting shall be determined by the test laboratory. The threshold power level shall be agreed between the test laboratory and the provider.		

The power sensing equipment shall be configured as appropriate for the parameters in Table 43 and the power envelope of the EUT transmission.

A suitable value for $P_{Threshold}$ shall be determined.

Step 1:

The EUT shall be set to operate for not less than 10 transmissions.

NOTE 1: For low activity EUT it may be agreed with the test laboratory that a smaller number of transmissions may be accepted.

The sampled power readings shall be saved.

Step 2:

Using suitable analysis software the start time and stop time of each sequence of samples above $P_{Threshold}$ shall be determined and saved.

Between the saved stop and start times of two subsequent bursts, the T_{Off} time shall be calculated. These T_{Off} values shall be saved.

NOTE 2: For low activity EUT, a note should be made if only a single transmission occurred.

Step 3:

Within the calculated T_{Off} times, any interval less than $T_{Disregard}$ shall be discarded. The lowest value of T_{Off} shall be noted.

The transmission duration is the time between two consecutive T_{Off} intervals. The highest value calculated for transmission duration shall be noted.

NOTE 3: If only a single transmission occurred the duration is calculated from the samples directly and the T_{Off} time is the duration from the end of the transmission to the end of the sampling interval.

Step 4:

The information shown in Table 44 shall be recorded in the test report.

Table 44: Results Recorded in the Test Report for Short Term Behaviour

Parameter	Value Recorded in the Test Report
Test signal	The test signal used (see clause 5.2.8)
Highest transmission duration T_{On-Max}	Highest calculated transmission duration
Lowest inter-transmission duration $T_{Off-Min}$	Lowest T_{Off} value

5.4.9 Automatic / Adaptive Power Control

5.4.9.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurement shall be performed on a frequency declared by the provider. The frequency shall correspond to a nominal operating frequency consistent with the highest and lowest operating frequencies and channel spacing declared by the provider.

3) The measurement shall be performed with the EUT operating at its highest supported maximum transmit power.

4) The EUT and companion device shall operate in normal operating mode.

5) The measurements shall be performed over the APC settling time interval declared by the provider.

NOTE 1: A test mode may be provided to ensure adequate traffic for the EUT APC mechanism to operate.

6) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.9.2.

NOTE 2: The path loss between the EUT and its companion device may be controlled by the separation distance between the two device, or by other means, to ensure an equivalent configuration to that shown in Figure 7.

7) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.9.3.

5.4.9.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2 and the measurements in clause 5.4.9.4 performed using corresponding radiated measurement methods described in clause B.6.

5.4.9.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment via an appropriate attenuator.

The measurements in clause 5.4.9.4 shall be performed.

5.4.9.4 Measurement procedure

Table 45: Test Parameters Settings for Automatic / Adaptive Power Control Measurement

Parameter	Value	Notes
RBW	Operating frequency band	Operating frequency band as defined in Table 1a
Detector Mode	Peak	

The test equipment shall be configured as appropriate for the parameters shown in Table 45.

Step 1:

Two EUTs shall be interconnected as shown in Figure 7. The attenuation between the two points A and B shall be measured, using an appropriate method, and noted.

Step 2:

The variable attenuator shall be adjusted such that the attenuation between points A and B is 75 dB.

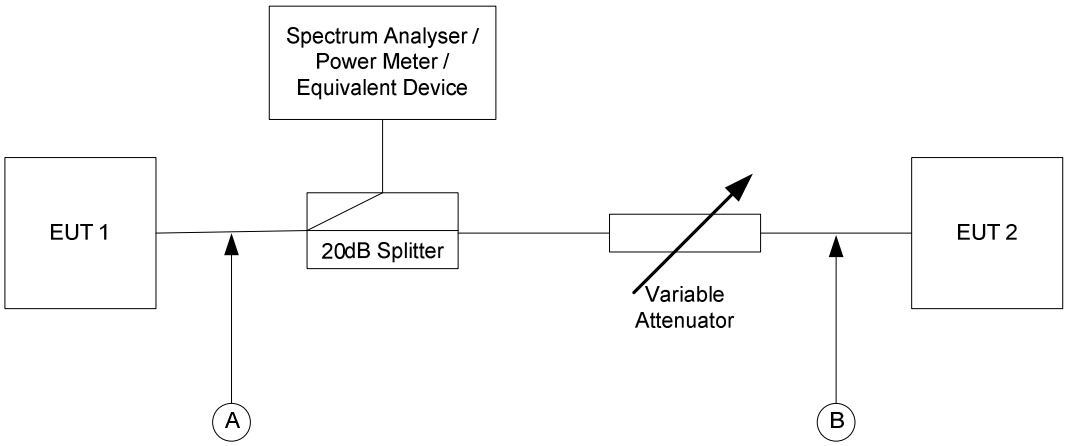


Figure 7: APC Measurement Setup

The EUTs shall be set to communicate with each other for at least the APC settling time.

The test equipment shall then be used to measure power for at least 60 seconds.

NOTE: The power measuring interval should be sufficiently long to capture transmissions from the EUT.

The information shown in Table 46 shall be recorded in the test report.

Table 46: Information Recorded in the Test Report

Value	Notes
Test signal	The test signal used (see clause 5.2.8)
Operating frequency	Operating frequency on which the EUTs operate
Settling time	APC settling time
Tx power level	Peak measured power
NOTE: The APC settling time is declared by the provider.	

5.5 Conformance test suites for receivers

5.5.1 Receiver sensitivity

5.5.1.1 Test Conditions

1) The measurements shall be performed under normal test conditions.

2) The measurements shall be performed on the highest and lowest operating frequencies as declared by the provider.

3) The EUT shall be operated with any FEC or automatic retransmission facility disabled.

NOTE: If it is not practical to disable such error correction, a suitable note should be made in the test report, together with any alternative test method used.

4) The measurements shall be performed for each data rate at which the EUT is able to operate.

5) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.1.2.

6) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.1.3.

5.5.1.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

The output of a signal generator shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurement in clause 5.5.1.4 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.1.3 Conducted measurement

The EUT shall be connected to the output of a signal generator.

The measurements in clause 5.5.1.4 shall be performed.

5.5.1.4 Measurement procedure

The signal generator, modulated with an appropriate test signal, shall be set to the highest operating frequency, as declared by the provider.

Step 1:

The operation of the EUT shall be started as a receiver on the highest operating frequency, as declared by the provider.

Step 2:

The level of the input signal to the EUT shall be adjusted until the wanted criteria (see clause 4.2.2) is just exceeded.

Step 3:

With the signal generator settings unchanged, the EUT shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

The receiver sensitivity is the measured signal power.

Step 4:

Steps 1 to 3 shall be repeated with the EUT and signal generator set to the lowest operating frequency, as declared by the provider.

Step 5:

Steps 1 to 4 shall be repeated for each data rate at which the EUT is able to operate.

Step 6:

The information shown in Table 47 shall be recorded in the test report.

Table 47: Information Recorded in the Test Report

Value	Notes
Test signal	The test signal used (see clause 5.2.8)
Data rate	EUT data rate
FEC or ARQ state	FEC / ARQ enabled or disabled
Operating frequency	Highest or lowest operating frequency
Receiver sensitivity	Measured signal generator power level
NOTE: The highest and lowest operating frequencies are declared by the provider.	

5.5.2 Clear channel assessment threshold

5.5.2.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurement is performed on an operating frequency declared by the provider. The frequency shall correspond to a nominal operating frequency consistent with the highest and lowest operating frequencies and channel spacing declared by the provider.

3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.2.2.

4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.2.3.

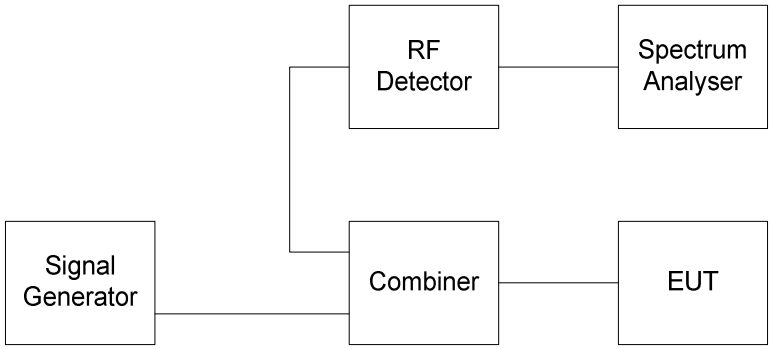


Figure 8: Measurement arrangement

5.5.2.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

The signal generator together with the combiner, shown in Figure 8, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurement in clause 5.5.2.4 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.2.3 Conducted measurement

A signal generator and a power meter shall each be combined via appropriate attenuators into the EUT antenna connector as shown in Figure 8.

The measurements in clause 5.5.2.4 shall be performed.

5.5.2.4 Measurement procedure

Table 48: Test Parameters Settings for CCA Threshold Measurement

Setting	Value
Centre frequency	The nominal EUT operating frequency
RBW	Approximately 3 x operating channel width
VBW	3 x RBW
Span	Zero span
Detector Mode	RMS
Trace Mode	Max. Hold
NOTE: The nominal operating frequency is agreed between the test laboratory and the provider. The nominal operating frequency shall be consistent with the highest and lowest operating frequencies and channel spacing as declared by the provider. Operating channel width is declared by the provider.	

The spectrum analyser shall be configured as shown in Table 48.

Step 1:

Operation of the EUT as a receiver shall be started with its CCA function active.

The signal generator, with normal test modulation, shall be adjusted to the nominal operating frequency.

The spectrum analyser levels shall be adjusted to provide satisfactory display of the signal generator signal.

Step 2:

The output power level of the signal generator shall be set to approximately 20 dB above the receiver sensitivity limit given in clause 4.4.1.

The EUT shall be instructed to transmit.

NOTE 1: The means of instructing the EUT to transmit is determined by the provider.

The presence of any signal from the EUT detected by the spectrum analyser shall be noted.

Step 3:

The level of the signal generator shall be reduced in steps of 1 dB until the equipment starts to transmit.

NOTE 2: There may be a delay due to collision avoidance operation before the EUT begins to transmit once the CCA threshold has been reached. Ensure that any such delay is taken into account in the rate at which the signal generator level is reduced.

Step 4:

With the signal generator settings unchanged, the EUT shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

The measured RF power level is the CCA threshold and shall be noted.

Step 5:

Step 2, step 3 and step 4 shall be repeated.

Step 6:

The information shown in Table 49 shall be recorded in the test report.

Table 49: Information Recorded in the Test Report

Value	Notes
Test signal	The test signal used (see clause 5.2.8)
CCA threshold (A)	First CCA threshold power level
CCA threshold (B)	Second CCA threshold power level
Presence of unexpected EUT signal	Any transmission detected at the spectrum analyser in step 2
NOTE: The presence of unexpected EUT transmission is a test failure.	

5.5.3 Adjacent channel selectivity

5.5.3.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurement is performed on an operating frequency declared by the provider. The frequency shall correspond to a nominal operating frequency consistent with the highest and lowest operating frequencies and channel spacing declared by the provider.

3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.3.2.

4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.3.3.

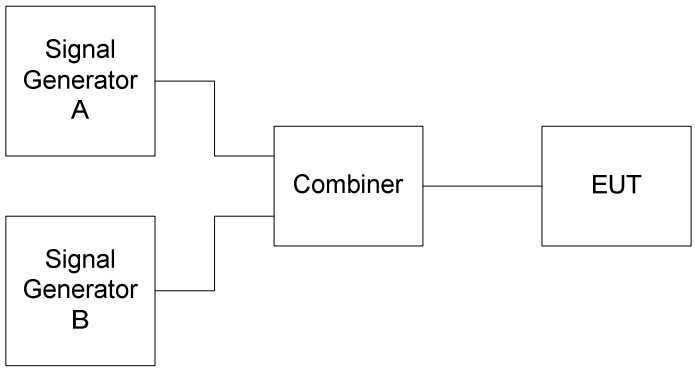


Figure 9: Measurement arrangement

5.5.3.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

Signal generators A and B together with the combiner, shown in Figure 9, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurements in clause 5.5.3.4 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.3.3 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 10.

The measurements in clause 5.5.3.4 shall be performed.

5.5.3.4 Measurement procedure

Signal generator A shall be set to the nominal operating frequency of the receiver, modulated with an appropriate test signal.

Signal generator B shall be unmodulated.

Step 1:

Signal generator B shall be powered off.

The level of signal generator A shall be adjusted to the lowest level that provides the wanted criteria (see clause 4.2.2).

NOTE 1: Ensure that the level at the receiver input is not below the sensitivity limit given in clause 4.4.1.

The output level of generator A shall then be increased by 3 dB.

Step 2:

Signal generator B is powered on and set to operate at the nominal operating frequency minus the operating channel width.

NOTE 2: The operating channel width is declared by the provider.

Step 3:

Signal generator B level shall be adjusted until the wanted criteria (see clause 4.2.2) is just exceeded.

With signal generator B settings unchanged, the receiver shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

With signal generator A settings unchanged its output is connected to the RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

Adjacent channel selectivity is the difference between the measured power levels of signal generator B and signal generator A.

Step 4:

Signal generator B is set to operate at the nominal operating frequency plus the operating channel width.

NOTE 3: The operating channel width is declared by the provider.

The procedure in step 3 is repeated.

Step 5:

The information shown in Table 50 shall be recorded in the test report for each test case.

Table 50: Information Recorded in the Test Report

Value	Notes
Operating frequency	Nominal operating frequency of the receiver
Signal generator B frequency	Lower or upper adjacent channel
Signal generator A	Power level of signal generator A
Signal generator B	Power level of signal generator B
Adjacent channel selectivity	Signal generator B - signal generator A
NOTE: The operating frequency is declared by the provider.	

5.5.4 Blocking

5.5.4.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The measurement is performed on an operating frequency declared by the provider. The frequency shall correspond to a nominal operating frequency consistent with the highest and lowest operating frequencies and channel spacing declared by the provider.

3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.4.2.

4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.4.3.

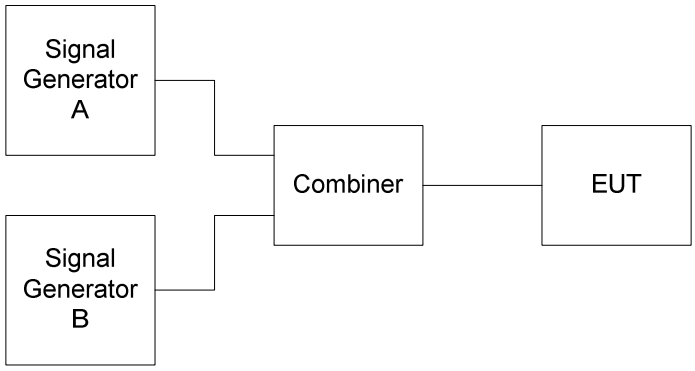


Figure 10: Measurement arrangement

5.5.4.2 Radiated measurement

A suitable test site shall be selected from those described in clause B.2.

Signal generators A and B together with the combiner, shown in Figure 10, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurements in clause 5.5.4.4 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.4.3 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 9.

The measurements in clause 5.5.4.4 shall be performed.

5.5.4.4 Measurement procedure

Signal generator A shall be set to the nominal operating frequency of the receiver, modulated with an appropriate test signal.

Signal generator B shall be unmodulated.

Measurements shall be carried out at frequencies of the unwanted signal at approximately ±1 MHz , ±2 MHz, ±5 MHz and ±10 MHz, avoiding those frequencies at which spurious responses occur.

Step 1:

Signal generator B shall be powered off.

The level of signal generator A shall be adjusted to the lowest level that provides the wanted criteria (see clause 4.2.2).

NOTE: Ensure that the level at the receiver input is not below the sensitivity limit given in clause 4.4.1.

The output level of generator A shall then be increased by 3 dB.

Step 2:

Signal generator B is powered on and set to operate at the nominal operating frequency -1 MHz.

Signal generator B level shall be adjusted until the wanted criteria (see clause 4.2.2) is just exceeded.

With signal generator B settings unchanged, the receiver shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

With signal generator A settings unchanged its output is connected to the RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

Blocking is the difference between the measured power levels of signal generator B and signal generator A.

Step 3:

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

Step 4:

The measurement in steps 1 to 3 shall be repeated with unwanted signal offsets of +1 MHz, -2 MHz , +2 MHz, -5 MHz, +5 MHz, -10 MHz and +10 MHz.

Step 5:

The information shown in Table 51 shall be recorded in the test report for each measured signal level and unwanted signal offset:

Table 51: Information Recorded in the Test Report

Value	Notes
Operating frequency	Nominal operating frequency of the receiver
Signal generator A	Power level of signal generator A
Signal generator B	Power level of signal generator B
Blocking level	Signal generator B - signal generator A
NOTE: The operating frequency is declared by the provider.	

5.5.5 Receiver spurious radiation

5.5.5.1 Test conditions

1) The measurements shall be performed under normal test conditions.

2) The EUT shall be operated with normal modulation at its maximum bit rate as declared by the provider on a frequency agreed with the test laboratory.

3) Radiated measurements shall be performed on a test site selected from clause B.2, with corresponding measurement procedures, which fulfils the measurement requirements for the specified frequency range.

4) An EUT without a permanent or temporary antenna connector shall be tested according to clause 8.5.2.2.

5) An EUT with a permanent or temporary antenna connector shall be tested according to clause 8.5.2.3 and clause 8.5.2.4.

5.5.5.2 Radiated measurement

The EUT shall be placed in a test site selected from those described in clause B.2 using a test antenna of length chosen to correspond to the frequency of the measuring receiver.

The EUT shall be connected to its normal operating antenna.

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

The measurements described in clause 5.5.5.5.2 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.5.3 Alternate radiated measurement

The EUT shall be placed in a test site selected from those described in clause B.2 using a test antenna of length chosen to correspond to the frequency of the measuring receiver.

The EUT shall be connected to an artificial antenna (see clause 5.2.5.1). The output of the test antenna shall be connected to a measuring receiver.

The measurements in clause 5.5.5.5.2 shall be performed using appropriate radiated measurement methods described in clause B.6.

5.5.5.4 Conducted measurement

The EUT shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver. The measurements described in clause 5.5.5.5.1 shall be performed.

5.5.5.5 Measurement procedure

5.5.5.5.1 Conducted measurement

Step 1:

The operation of the EUT as a receiver shall be started.

The measuring receiver shall be tuned over the frequency range shown in Table 52.

Table 52: Receiver Spurious Radiations Measurement Frequency Range

Frequency Range
9 kHz - 6 GHz
NOTE: The measurements need only to be performed over the frequency range 4 GHz to 6 GHz if emissions are detected within 10 dB of the of the specified limit between 1,5 GHz and 4 GHz.

Step 2:

At each frequency at which a spurious component is detected, the power level shall be measured and noted.

Step 3:

The information shown in Table 53 shall be recorded in the test report for each spurious component.

Table 53: Information Recorded in the Test Report

Value	Notes
Frequency	Frequency of spurious component
Power level	Measured power level of spurious component
NOTE: The power level is the spurious level delivered into the artificial antenna load.	

5.5.5.5.2 Radiated measurement

Step 1:

The operation of the EUT as a receiver shall be started.

The measuring receiver shall be tuned over the frequency range shown in Table 54.

Table 54: Receiver Spurious Radiations Measurement Frequency Range

Frequency Range
25 MHz - 6 GHz
NOTE: The measurements need only to be performed over the frequency range 4 GHz to 6 GHz if emissions are detected within 10 dB of the of the specified limit between 1,5 GHz and 4 GHz.

Step 2:

For each frequency at which a spurious component is detected the appropriate measurement procedure for the selected test site as described in clause B.6 shall be performed.

The maximum signal level detected by the measuring receiver for vertical and horizontal polarization shall be noted.

Step 3:

The substitution measurement defined in clause B.6.4 shall be performed with the frequency of the calibrated signal generator set to the frequency of the spurious component detected and, if necessary, the input attenuator setting of the measuring receiver adjusted in order to increase the sensitivity of the measuring receiver.

The radiated power for vertical and horizontal polarization, corrected for any change of input attenuator setting of the measuring receiver, shall be noted.

The measure of the effective radiated power of the spurious component is the larger of the two power levels at the input to the substitution antenna.

Step 4:

The information shown in Table 53 shall be recorded in the test report for each spurious component.

5.6 Conformance test suites for spectrum access

5.6.1 Listen before talk

5.6.1.1 Measurement procedure

The use of LBT shall be declared by the provider.

If the EUT uses LBT the provider shall also declare:

1) The minimum CCA interval employed.
2) The maximum dead time.
3) The method employed to randomize timing of re-transmission attempts on the same channel.
4) The units of the deferral period.
5) The minimum and maximum values of the deferral random period.

5.7 Other test suites

5.7.1 Transmitter test suites

Void.

5.7.2 Receiver test suites

Void.

5.7.3 Polite spectrum access test suites

5.7.3.1 Channel adaptivity

5.7.3.1.1 Measurement procedure

The use of channel adaptivity shall be declared by the provider.

5.7.3.2 Short control signalling transmissions

5.7.3.2.1 Measurement procedure

The use of short control signalling transmissions shall be declared by the provider.

5.7.3.3 Coordination of network relay points

5.7.3.3.1 Measurement procedure

The use of NRP coordination procedures shall be declared by the provider.

Annex A (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.8] 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.1].

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

Harmonised Standard ETSI EN 303 204 The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.1]				
Requirement			**Requirement Conditionality**	
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**
1	Frequency tolerance	4.3.1	C	Applies to transmitters capable of generating an unmodulated carrier
2	Effective radiated power	4.3.2	U	
3	Transient power	4.3.3	U	
4	Occupied bandwidth	4.3.4	U	
5	Unwanted emissions in the out-of-band domain	4.3.5	U	
6	Unwanted emissions in the spurious domain	4.3.6	U	
7	Frequency stability under low-voltage conditions	4.3.7	C	Applies to battery-operated transmitters
8	Duty cycle	4.3.8	U	
9	Automatic/Adaptive Power Control	4.3.9	U	
10	Listen before talk	4.5.2	C	Applies to network relay point operation
11	Channel adaptivity	4.6.1	C	Applies to network relay point operation
12	Receiver sensitivity	4.4.1	U	
13	Clear channel assessment threshold	4.4.2	C	Applies to receivers with CCA
14	Adjacent channel selectivity	4.4.3	U	
15	Blocking	4.4.4	U	
16	Receiver spurious radiation	4.4.5	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 manufacturer's 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.

Annex B (normative): Test sites and arrangements for radiated measurement

B.1 General considerations

This annex introduces three most commonly available test sites and a test fixture, to be used in the radiated measurements in accordance with the present document.

Subsequently the following items will be described:

- Open Area Test Site (OATS)
- Semi Anechoic Room (SAR)
- Fully Anechoic Room (FAR)
- Test fixture for relative measurements

The first three are generally referred to as free field test sites. Both absolute and relative measurements can be performed on these sites. They will be described in clause B.2. Clause B.3 describes the antennas used in these test sites. The test fixture can only be used for relative measurements, and will be described in annex C.

Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in clause 6 of ETSI TR 102 273-4 [4] for the OATS, in clause 6 of ETSI TR 102 273-3 [4] for the SAR, and in clause 6 of ETSI TR 102 273-2 [4] for the FAR.

Information for calculating the measurement uncertainty of measurements on one of these test sites can be found in ETSI TR 100 028-1 [2] and ETSI TR 100 028-2 [2], ETSI TR 102 273-2 [4], ETSI TR 102 273-3 [4] and ETSI TR 102 273-4 [4].

B.2 Radiation test sites

B.2.1 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 B.1.

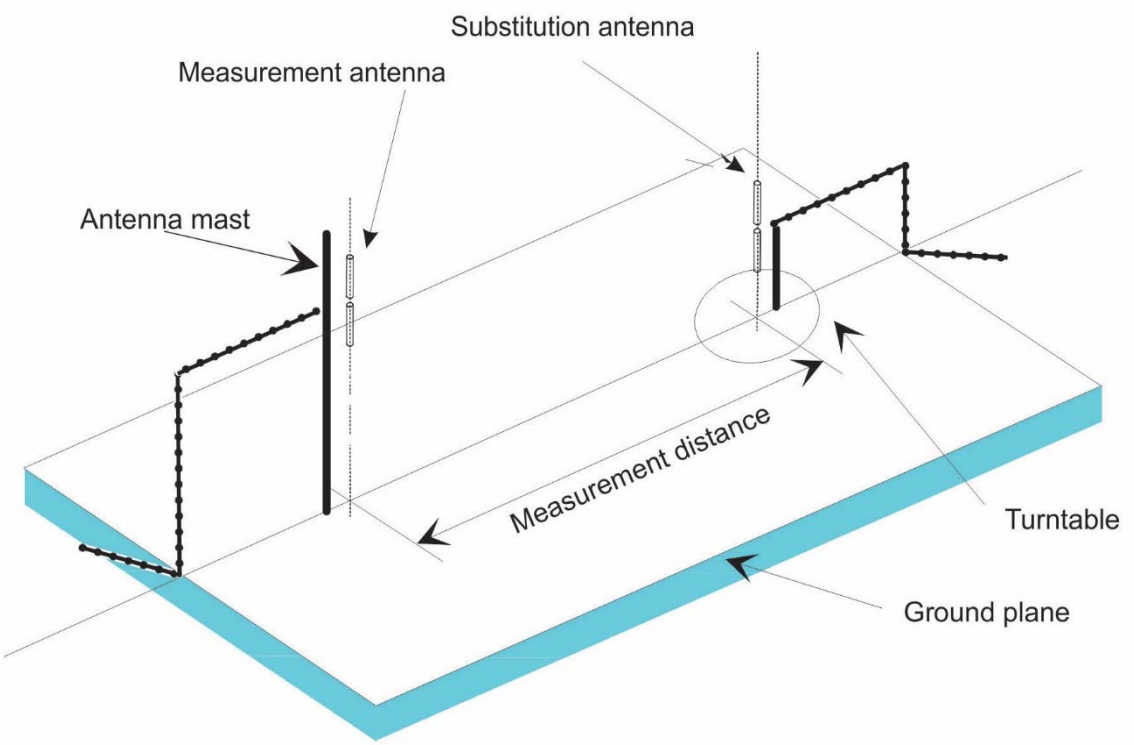


Figure B.1: A typical Open Area Test Site

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.

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

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane.

The measurement distance and minimum chamber dimensions can be found in clause B.2.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Open Area Test Sites can be found in ETSI TR 102 273-4 [4].

B.2.2 Semi Anechoic Room

A Semi Anechoic Room is - or anechoic chamber with a conductive ground plane - is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material. The floor, which is metallic, is not covered by absorbing material and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other end. A typical anechoic chamber with a conductive ground plane is shown in Figure B.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.

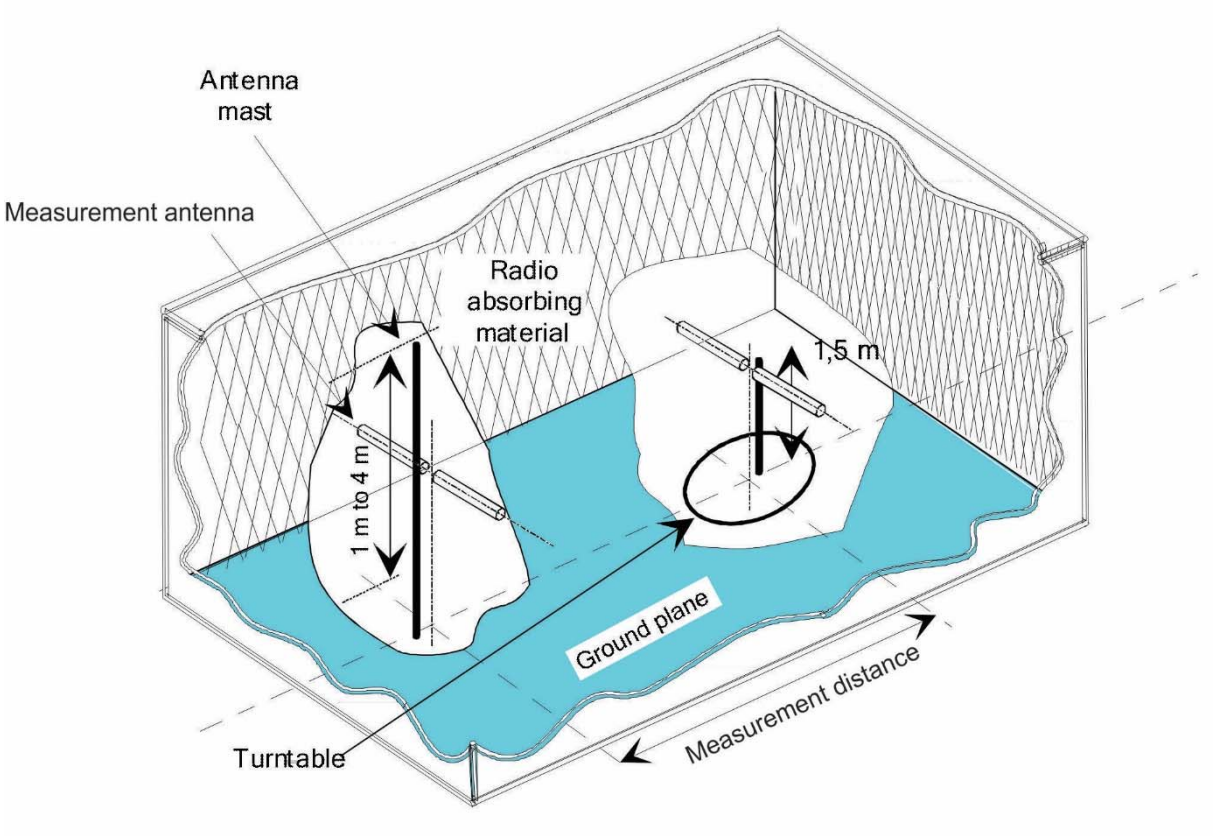


Figure B.2: A typical Semi Anechoic Room

In this facility 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.

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

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane.

The measurement distance and minimum chamber dimensions can be found in clause B.2.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Semi Anechoic Rooms can be found in ETSI TR 102 273-3 [4].

B.2.3 Fully Anechoic Room (FAR)

A Fully Anechoic Room is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material. The chamber usually contains an antenna support at one end and a turntable at the other end.
A typical Fully Anechoic Room is shown in Figure B.3.

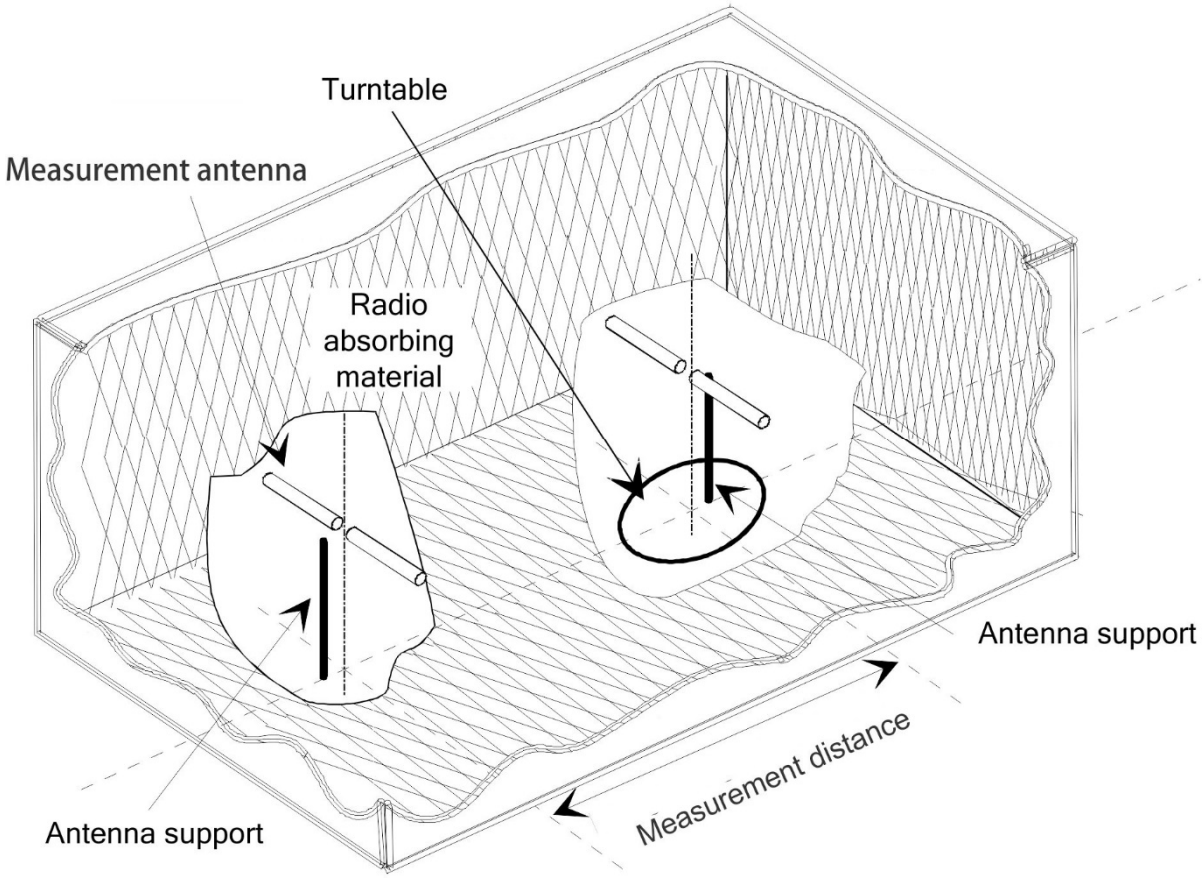


Figure B.3: A typical Fully Anechoic Room

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. The shielding should be sufficient to eliminate interference from the external environment that would mask any signals that shall be measured.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the EUT at a suitable height (e.g. 1 m) above the ground plane.

The measurement distance and minimum chamber dimensions can be found in clause B.2.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Fully Anechoic Rooms can be found in ETSI TR 102 273-2 [4].

B.2.4 Measurement Distance

The measurement distance should be chosen in order to measure the EUT at far-field conditions. The minimum measurement distance between the equipment and the measurement antenna should be λ or $r_{m >> } \frac{D^2}{\lambda}$, whichever is the greater.

λ = wavelength in m

r_m = minimum measurement distance between EUT and measurement antenna in m

D = largest dimension of physical aperture of the largest antenna in the measurement setup, in m

$\frac{D^2}{\lambda}$ = distance between outer boundary of radiated near field (Fresnel region) and inner boundary of the radiated far-field (Fraunhofer region) in m, also known as Rayleigh distance.

For those measurements where these conditions cannot be fulfilled, and where the measurement distance would result in measurements in the near field (e.g. while measuring spurious emissions), this should be noted in the test report and the additional measurement uncertainty should be incorporated into the results.

B.3 Antennae

B.3.1 General considerations

Antennae are needed for the radiated measurements on the three test sites described in clause B.2. Depending on its use, the antenna will be designated as "measurement antenna" or "substitution antenna".

B.3.2 Measurement antenna

In emission tests the measurement 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, the antenna is used as the transmitting device.

The measurement antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization. Additionally, on an OATS or SAR, the height of the centre of the antenna above the ground should be variable over the specified range (usually 1 m to 4 m).

In the frequency band 30 MHz to 1 000 MHz, biconical or logarithmic periodic dipole antennas (LPDA) are recommended. Above 1 GHz, horn antennas or logarithmic periodic dipole antennas 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.

The measurement antenna does not require an absolute calibration.

B.3.3 Substitution antenna

The substitution antenna shall be used to replace the equipment under test in substitution measurements.

Shall be suitable for the frequency range and the return loss of the antenna shall be taken into account when calculating the measurement uncertainty.

The phase centre of this antenna shall coincide with the reference point of the test sample it has replaced. Therefore antennas with a phase centre that changes as a function of frequency (such as a LPDA) are not suitable as a substitution antenna.

The reference point of the substitution antenna shall coincide with the volume centre of the EUT when its antenna is internal, or the point where an external antenna is connected to the EUT.

The distance between the lower extremity of the antenna and the ground shall be at least 30 cm.

The substitution antenna shall be calibrated for the test site (OATS, SAR, FAR) in which it will be used. For below 1 GHz, the calibration is relative to a half wave dipole, while above 1 GHz, an isotropic radiator is the reference.

NOTE: Calibration figures intended for use above a reflective surface cannot be used in an anechoic chamber or vice versa.

B.4 Guidance on the use of radiation test sites

B.4.1 General considerations

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 clause B.2.

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 permittivity (i.e. $\frac{\varepsilon}{\varepsilon_0} < 1,5$) material(s) such as expanded polystyrene, balsawood, etc.

B.4.2 Power supplies for the battery powered EUT

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

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

B.4.3 Site preparation

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

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

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

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

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

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

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

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

B.5 Coupling of signals

B.5.1 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 coupling).

B.5.2 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.

B.6 Measurement procedures for radiated measurement

B.6.1 General considerations

This annex gives the general procedures for radiated measurements using the test sites and arrangements described in clause B.2.

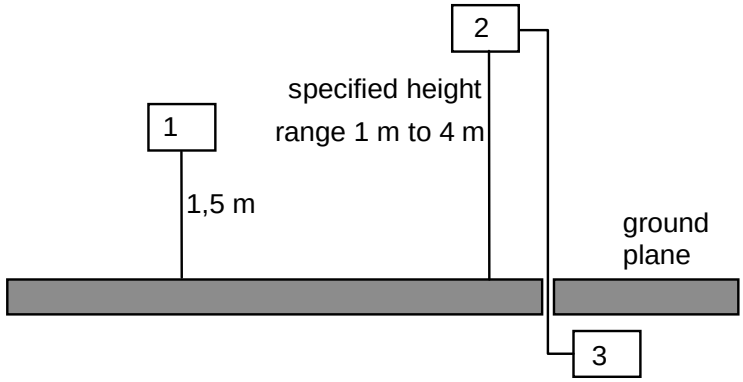
Preferably, radiated measurements shall be performed in a FAR, see clause B.6.3. Radiated measurements in an OATS or SAR are described in clause B.6.2.

B.6.2 Radiated measurements in an OATS or SAR

Radiated measurements shall be performed with the aid of a measurement antenna and a substitution antenna, in test sites described in annex B. The measurement set-up shall be calibrated according to the procedure defined in this annex. The EUT and the measurement antenna shall be oriented such as to obtain the maximum emitted power level. This position shall be recorded in the measurement report.

a) The measurement antenna (device 2 in Figure B.4) shall be oriented initially for vertical polarization unless otherwise stated and the EUT (device 1 in Figure B.4) shall be placed on the support in its standard position and switched on.

b) The measurement equipment (device 3 in Figure B.4) shall be connected to the measurement antenna and set-up according to the specifications of the test.



1) EUT
2) Measurement antenna
3) Measurement equipment

Figure B.4: Measurement arrangement No.1

c) The EUT shall be rotated through 360° in a horizontal plane until a maximum signal is received.

d) The measurement antenna shall be raised or lowered again through the specified height range until a maximum is obtained.

e) Steps c and d shall be repeated. The maximum signal level shall be recorded.

f) This measurement shall be repeated for horizontal polarization.

NOTE: This maximum may be a lower value than the value obtainable at heights outside the specified limits.

B.6.3 Radiated measurements in a FAR

For radiated measurements using a FAR, the procedure is identical to the one described in clause B.6.2, except that the height scan is omitted.

B.6.4 Substitution measurement

To determine the absolute measurement value a substitution measurement is performed. The following steps shall be performed:

1) Replacing the EUT with the substitution antenna that is depicted as device 1 in Figure B.4. The substitution antenna will have vertical polarization.

2) Connect a calibrated signal generator to the substitution antenna, and adjust it to the measurement frequency.

3) If an OATS or a SAR is used, the measurement antenna shall be raised or lowered, to ensure that the maximum signal is received.

4) Subsequently, the power of the signal generator shall be adjusted until the same level is obtained again at the measurement equipment.

5) The radiated power is equal to the power supplied by the signal generator, increased by the substitution antenna gain minus the cable losses (values in dB).

6) This measurement shall be repeated with horizontal polarization.

NOTE: For test sites with a fixed setup of the measurement antenna(e) and a reproducible positioning of the EUT, correction values from a verified site calibration can be used.

B.7 Guidance for testing technical requirements

B.7.1 Essential radio test suites and corresponding test sites

Table B.1 provides guidance on the test site to be used for each of the essential radio test suites when performing radiated measurements on integral antenna equipment.

Table B.1: Essential radio test suites and corresponding test sites

Essential radio test suite	Clause	Corresponding test site - Clause number(s)
Effective radiated power	5.4.2	B.2.1, B.2.2, B.2.3
Transient Power	5.4.3	B.2.1, B.2.2, B.2.3
Tx Spurious Emissions	5.4.6	B.2.1, B.2.2, B.2.3
Transmitter unwanted emissions in the out-of-band domain	5.4.5	B.2.1, B.2.2, B.2.3
Rx Sensitivity	5.5.1	B.2.3
Adjacent channel selectivity	5.5.3	B.2.3
Blocking	5.5.4	B.2.3
Rx Spurious Emissions	5.5.5	B.2.1, B.2.2, B.2.3

Annex C (normative): Test fixture

C.1 General considerations

With equipment intended for use with a small aperture integral antenna, and not equipped with a 50 Ω RF output connector, a suitable test fixture as shown in Figure C.1 shall be used.

Where a test fixture as defined in the present clause is used for measurements on integral antenna equipment, tests on radiated signals shall be carried out using the test fixture. For tests of unwanted emissions in the spurious domain, (clause 5.4.6), the test fixture bandwidth should exceed 5 times the operating frequency: If this is not the case, a radiated measurement according clause 5.4.6.2 shall be used.

This fixture is a radio frequency device for coupling the integral antenna to a 50 Ω RF terminal at all frequencies for which measurements need to be performed.

The test fixture shall be fully described.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) a method to provide the input to or output from the equipment. This may include coupling to or from the antenna. In case of assessment of speech equipment, an audio interface may be provided by direct connection or by an acoustic coupler or in case of non-speech equipment, the test fixture could also provide the suitable coupling means e.g. for data or video outputs.

The test fixture shall normally be supplied by the provider.

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

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

b) adequate bandwidth properties;

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

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

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

f) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced. Normally, the text fixture is in a fixed position and provides a location for the EUT;

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

The attenuation of the test fixture coupling should be such that the received signal at the measuring instrument is at least 10 dB above the measuring instrument noise floor. If the attenuation is too great it can be compensated by linear amplification outside the test-fixture.

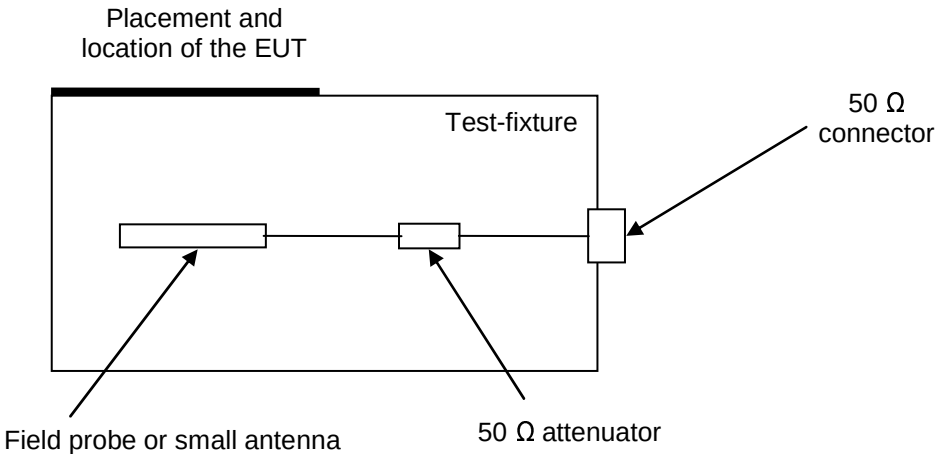


Figure C.1: Test fixture

The field probe (or small antenna) shall be properly terminated.

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

C.2 Validation of the test-fixture in the temperature chamber

This test is only needed if test fixture measurements are performed under extreme temperature conditions.

If it is not possible to use the present method, the method used for calibrating the test fixture over the temperature range shall be agreed with the testing laboratory, and fully documented in the test report.

The test fixture is brought into a temperature chamber.

Step 1:

A transmit antenna connected to a signal generator shall be positioned from the test-fixture at a far field distance of not less than one λ at the frequency. The test fixture consists of the mechanical support for the EUT, an antenna or field probe and a 50 Ω attenuator for proper termination of the field probe. The test fixture shall be connected to a spectrum analyser via the 50 Ω connector. A signal generator has to be set on the EUT's nominal frequency (see Figure C.2). The unmodulated output power of the signal generator has to be set to a value such that a sufficiently high level can be observed with the spectrum analyser. This determined value shall be recorded. The signal generator shall then be set to the upper and the lower band limit of the EUT's assigned frequency band. The measured values shall not deviate more than 1 dB from the value at the nominal frequency. The distance between test antenna and test fixture may be reduced to λ\2 for frequencies below 100 MHz.

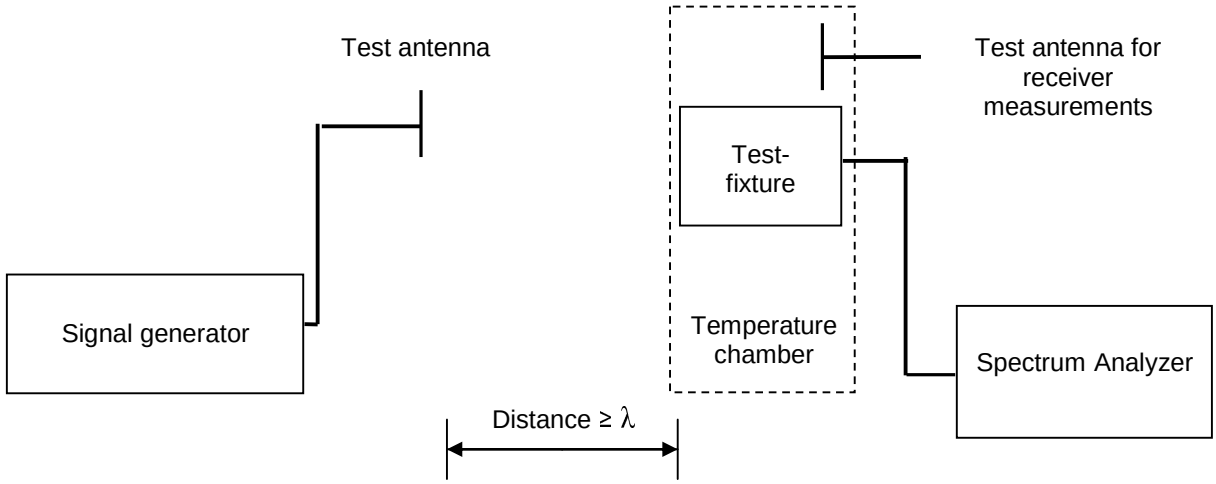


Figure C.2: Validation of test set-up without EUT

If receiver tests under extreme temperature conditions are performed, a receiver test antenna is also brought into the temperature chamber to ensure its influence in the chamber is known.

Step 2:

During validation and testing the EUT shall be fitted to the test fixture in a switched-off mode as shown in Figure C.3. Step 1 shall be repeated, this time with the EUT in place. The measured values shall be compared with those from step 1 and may not vary by more than 2 dB. This shows that the EUT does not cause any significant shadowing of the radiated power.

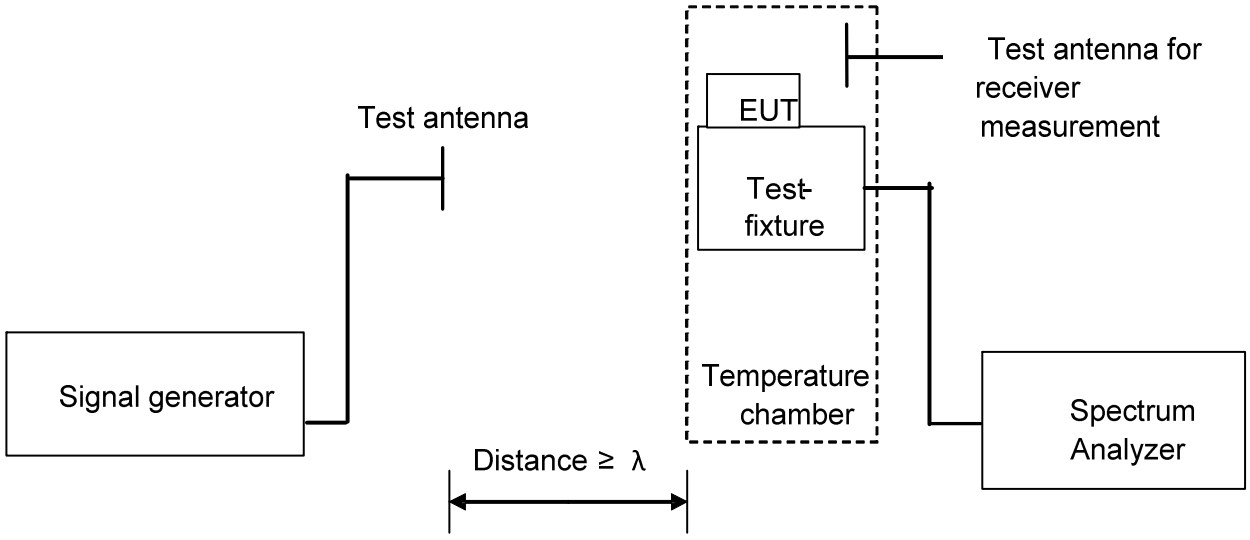


Figure C.3: Validation of test set-up with EUT in place

Step 3:

In case of a battery operated EUT that is supplied by a temporary voltage feed as well as temporary signal- and control line, a decoupling filter shall be installed directly at the EUT in order to avoid parasitic, electromagnetic radiation. See Figure C.4.

In this step the signal generator and the transmit antenna are removed.

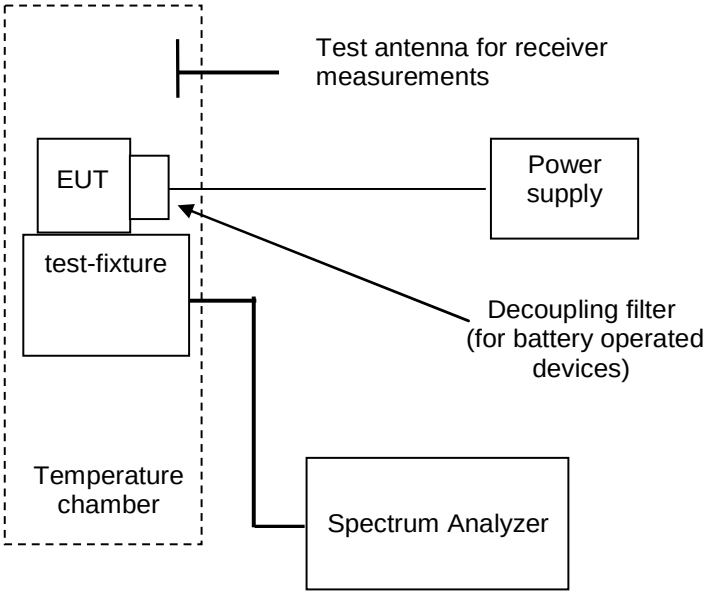


Figure C.4: Test of EUT

C.3 Mode of use

The test fixture may be used to facilitate some of the transmitter and receiver measurements in the case of equipment having an integral antenna. See clause 5.2.9 for guidance on applicable use of the test fixture in conformance methods of measurement for the present document.

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

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

- the reading accuracy of the frequency marker shall be within ±100 Hz;
- the accuracy of relative amplitude measurements shall be within ±3,5 dB;
- the dynamic range shall be greater than 80 dB;
- the shape factor shall be less than or equal to 12:1.

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

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

Annex E (informative): Bibliography

- Ketterling, H-P: "Verification of the performance of fully and semi-anechoic chambers for radiation measurements and susceptibility/immunity testing", 1991, Leatherhead/Surrey.
- ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz".
- ETSI TR 102 313 (V1.1.1): "Electromagnetic compatibility and Radio Spectrum Matters (ERM); Frequency-agile Generic Short Range Devices using listen-Before-Transmit (LBT); Technical Report".
- ANSI C63.5 (2006): "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electro Magnetic Interference".
- ITU-R Radio Regulations.
- Recommendation ITU-R SM 328: "Spectra and bandwidth of emissions".
- ETSI EN 300 220: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW".
- ETSI EG 203 336: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of Harmonised Standards for application under Directive 2014/53/EU".
- Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).
- ETSI EN 301 489: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services".
- Council Directive 73/23/EEC of 19 February 1973 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).
- Commission Decision 2013/752/EC on harmonisation of the radio spectrum for use by short-range devices as amended by subsequent Commission Decisions.

Annex F (informative): Change History

Date	Version	Information about changes
October 2014	1.1.1	First publication as a 2-part HS
February 2016	2.1.1	Revision for compliance with Directive 2014/53/EU. Single part HS. New Transient method of measurement removing use of Quasi-Peak detector. New Adjacent channel selectivity requirement and method of measurement. Updated Blocking performance limits.
September 2016	2.1.2	Clause 4.2.4 "Marking" is deleted

History

Document history		
V1.1.1	October 2014	Publication as ETSI EN 303 204 part 1 and part 2
V2.1.1	April 2016	Publication
V2.1.2	September 2016	Publication