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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Digital Enhanced Cordless Telecommunications (DECT).

The present document contains text pertaining to testing of the layer 1 (radio) of the DECT-2020 New Radio (NR) as defined by ETSI TS 103 636-2 [i.9] and ETSI TS 103 636-3 [i.10]. Such text should be considered as guidance to approval (or licensing) authorities.

Modal verbs terminology

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1 Scope

The present document specifies technical characteristics and methods of measurements for equipment employing DECT-2020 NR (New Radio) as specified in by the multi-part technical specification ETSI TS 103 636 (see [i.8] for an overview).

These radio equipment types can operate in all or any part of the frequency bands given in table 1.

Table 1: Operating band numbering

Band number	Receiving band (MHz)	Transmitting band (MHz)
1	1 880 to 1 900	1 880 to 1 900
2	1 900 to 1 920	1 900 to 1 920
3	2 400 to 2 483,5	2 400 to 2 483,5
4	902 to 928	902 to 928
5	450 to 470	450 to 470
6	698 to 806	698 to 806
7	716 to 728	716 to 728
8	1 432 to 1 517	1 432 to 1 517
9	1 910 to 1 930	1 910 to 1 930
10	2 010 to 2 025	2 010 to 2 025
11	2 300 to 2 400	2 300 to 2 400
12	2 500 to 2 620	2 500 to 2 620
13	3 300 to 3 400	3 300 to 3 400
14	3 400 to 3 600	3 400 to 3 600
15	3 600 to 3 700	3 600 to 3 700
16	4 800 to 4 990	4 800 to 4 990
17	5 725 to 5 875	5 725 to 5 875
18	5 150 to 5 350	5 150 to 5 350
19	5 470 to 5 725	5 470 to 5 725

National regulation can allow additional frequency bands. The limits and test procedures included in the present document are applicable for DECT-2020 NR use in frequency ranges below 6 GHz.

The present document provides test methods and technical parameters directly applicable for testing in the following bands: band 1 (1 880 - 1 900), band 2 (1 900 - 1 920), band 9 (1 910 - 1 930) and band 10 (2 010 - 2 025).

Table 1a: Operating bands where the present document is directly applicable

Band number	Receiving band (MHz)	Transmitting band (MHz)
1	1 880 to 1 900	1 880 to 1 900
2	1 900 to 1 920	1 900 to 1 920
9	1 910 to 1 930	1 910 to 1 930
10	2 010 to 2 025	2 010 to 2 025

Testing in all other bands is considered feasible using the test methods defined in the present document, however no guarantee in the validity and accuracy of the testing parameters is given. The present document may be used as reference guideline for testing in such bands.

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.

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

- [1] [ETSI TS 103 636-4](#): "DECT-2020 New Radio (NR); Part 4: MAC layer; Release 1".

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] [ERC Recommendation 74-01](#): "Unwanted emissions in the spurious domain", Edition May 2019.
- [i.2] ETSI EG 203 367 (V1.1.1) (06-2016): "Guide to the application of harmonised standards covering articles 3.1b and 3.2 of the Directive 2014/53/EU (RED) to multi-radio and combined radio and non-radio equipment".
- [i.3] ETSI TR 100 028-1 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1".
- [i.4] ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".
- [i.5] ETSI TR 102 273-2 (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; Part 2: Anechoic chamber".
- [i.6] ETSI TR 102 273-3 (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; Part 3: Anechoic chamber with a ground plane".
- [i.7] ETSI TR 102 273-4 (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; Part 4: Open area test site".
- [i.8] ETSI TS 103 636 (all parts): "DECT-2020 New Radio (NR)".
- [i.9] ETSI TS 103 636-2: "DECT-2020 New Radio (NR); Part 2: Radio reception and transmission requirements; Release 1".

[i.10] ETSI TS 103 636-3: "DECT-2020 New Radio (NR); Part 3: Physical layer; Release 1".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

antenna assembly: combination of the antenna (integral or dedicated), its coaxial cable and if applicable, its antenna connector and associated switching components

NOTE 1: This term (antenna assembly) refers to an antenna connected to one transmit chain.

NOTE 2: The gain of an antenna assembly G in dBi, does not include the additional gain that may result out of beamforming techniques.

burst: one or multiple subslot(s) as defined in ETSI TS 103 636-3 [i.10], clause 4.4

channel plan: combination of the centre frequencies and for each of the centre frequencies, the declared nominal bandwidth(s)

dedicated antenna: antenna external to the equipment, using an antenna connector with a cable or a wave-guide and which has been designed or developed for one or more specific types of equipment

Fixed Termination (FT): operational mode of RD where RD initiates coordinates local radio resources, provides information how other RDs may connect and communicate with it

integral antenna: antenna designed as a fixed part of the equipment (without the use of an external connector) which cannot be disconnected from the equipment by a user with the intent to connect another antenna

NOTE: An integral antenna may be fitted internally or externally. In the case where the antenna is external, a non-detachable cable or wave-guide can be used.

nominal transmit power: mean transmitter output power at the antenna connector measured over the transmission bandwidth to deliver to a load with resistance equal to the nominal load impedance of the transmitter

operating channel: single continuous part of radio spectrum with a defined bandwidth where RDs transmit and/or receive

Portable Termination (PT): operational mode of RD where RD selects another RD, which is in FT mode, for association

Radio Device (RD): equipment with radio transmission and reception capability, which can operate in FT and/or PT mode

receive chain: receiver circuit with an associated antenna, which may be shared with a transmit chain

resource: variable length time unit defined in subslot(s) in single operating channel that RD is using for transmission or reception of physical layer packet

smart antenna systems: equipment that combines multiple transmit and/or receive chains with a signal processing function to increase the throughput and/or to optimize its radiation and/or reception capabilities

NOTE: These are techniques such as spatial multiplexing, beamforming, cyclic delay diversity, MIMO, etc.

transmission bandwidth: maximum bandwidth of active subcarriers of the transmitted signal

NOTE: As defined in ETSI TS 103 636-2 [i.9], clause 5.3.2.

transmit chain: transmitter circuit with an associated antenna, which may be shared with a receive chain

3.2 Symbols

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

B	Nominal Channel Bandwidth
B_{occupied}	Occupied Channel Bandwidth
dB _i	dB(isotropic) - the forward gain of an antenna compared with the hypothetical isotropic antenna, which uniformly distributes energy in all directions
dBm	Absolute power level relative to 1 milliwatt, expressed in dB
f_c	Nominal Centre Frequency
$f_{c,a}$	Actual Centre Frequency
f_n	Nominal Centre Frequencies of the operating channel with absolute channel number n as defined in ETSI TS 103 636-2 [i.9]
log()	logarithm to base 10

3.3 Abbreviations

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

ACK	Acknowledgement
ACS	Adjacent Channel Selectivity
AWGN	Additive White Gaussian Noise
BPSK	Binary Phase Shift Keying
BW	Bandwidth
CRC	Cyclic Redundancy Check
CW	Continuous Wave
e.i.r.p.	effective isotropic radiated power
e.r.p.	effective radiated power
ER	Error Rate
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FT	Fixed Termination
HARQ	Hybrid Automatic Repeat Request
LPDA	Logarithmic Periodic Dipole Antennas
MIMO	Multiple-Input Multiple-Output
NACK	Negative Acknowledgement
NF	Noise Figure
NR	New Radio
OATS	Open Area Test Site
OOB	Out Of Band
PER	Packet Error Rate
PT	Portable Termination
QPSK	Quadrature Phase-Shift Keying
RBW	Resolution Bandwidth
RD	Radio Device
RF	Radio Frequency
RMS	Root Mean Square
RSSI-1	Radio Signal Strength Indicator 1
RX	Receiver
SAR	Semi Anechoic Room
SNR	Signal to Noise Ratio
UE	User Equipment
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 in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 General requirements

The equipment 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.

The equipment supplied for testing shall be market conform.

Equipment submitted for testing shall support operation with at least one Nominal Channel Bandwidth B as defined in clause 4.3.3.

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

NOTE: Equipment operating on multiple RF channels concurrently (e.g. multi-transceiver operation) is handled like multiple, co-located equipment, where each has to assess the RF channel and operate on it independently from each other.

4.3 Conformance requirements for transmitter

4.3.1 Transmitter RF Output Power

4.3.1.1 Definition

The *Transmitter RF Output Power* is the effective isotropic radiated power (e.i.r.p.) including any additional gain by antenna, additional (beamforming) gain in smart antenna systems (devices with multiple transmit chains), and/or supporting circuitry.

The maximum output power is measured as the mean power over a transmission burst. A transmission burst consists of one or multiple subslot(s) as defined in ETSI TS 103 636-3 [i.10], clause 4.4. The transmission signal bandwidth is the maximum bandwidth of active subcarriers of the transmitted signal as defined in ETSI TS 103 636-2 [i.9], clause 5.3.2.

4.3.1.2 Limit

The maximum allowed transmitter RF output power for equipment operating on a single *Nominal Channel Bandwidth* is up to:

- 26 dBm e.i.r.p. for use with omni-directional antennas;
- 30 dBm e.i.r.p. for use with directional antennas, with a maximum nominal transmit power of 24 dBm.

NOTE 1: National regulation can define a different maximum transmitter RF output power limit, which might be dependent on frequency range.

NOTE 2: Individual licensing might allow a higher maximum transmitter RF output power.

For equipment employing multiple transmit antennas, the total transmitter RF output power of the multi-antenna assembly is limited as a total by the maximum transmitter RF output power limit. The use of transmit beamforming is considered as directional antenna.

For equipment operating on multiple radio channels independently (e.g. multi-transceiver operation), the maximum transmitter RF output power limit applies to each of the radio channels independently.

4.3.1.3 Conformance

Conformance tests as defined in clause 5.4.1 shall be carried out.

4.3.2 Nominal Centre Frequencies

4.3.2.1 General

The equipment operates with a channel plan consisting of nominal channels with bandwidth B and nominal centre frequencies f_n .

4.3.2.2 Definitions

The *Nominal Centre Frequency* is the centre of the *Nominal Channel* with bandwidth B .

The *Measured Centre Frequency* is the centre of the *Operating Channel*.

The transmitter frequency error is determined by the difference between the *Nominal Centre Frequency* and the *Measured Centre Frequency* of the device.

4.3.2.3 Limit

In general, the Nominal Centre Frequencies f_n are given by equation:

$$f_n = f_{0,1} + n \times 0,864 \text{ MHz, below 3 GHz for } n = 1 \dots 951$$

$$f_n = f_{0,2} + (n-2\ 952) \times 1,728 \text{ MHz, above 3 GHz for } n = 2\ 952 \dots 8\ 192$$

where:

$$f_{0,1} = 450,144 \text{ MHz and } f_{0,2} = 3\ 000,596 \text{ MHz}$$

Equipment operating in the frequency band 1 880 MHz to 1 900 MHz shall be capable of working on the channel number ranges listed in Table 2.

Equipment operating in the frequency band 1 880 MHz to 1 900 MHz and operating with a nominal channel bandwidth $B = 1,728$ MHz shall be restricted to the specific absolute channel numbers as given in Table 2.

NOTE: Equipment is allowed to support one or more nominal channel bandwidth(s) B .

Table 2: Applicable Channel Number Ranges for 1 880 MHz to 1 900 MHz

Nominal channel Bandwidth B	Absolute channel number range	Operation restricted to the following specific absolute channel numbers
1,728 MHz	1 657 to 1 677	1 657, 1 659, 1 661, 1 663, 1 665, 1 667, 1 669, 1 671, 1 673, 1 675 and 1 677
3,456 MHz	1 658 to 1 676	1 658, 1 660, 1 662, 1 664, 1 666, 1 668, 1 670, 1 672, 1 674, 1 676
6,912 MHz	1 660 to 1 674	1 660, 1 662, 1 664, 1 666, 1 668, 1 670, 1 672, 1 674

The measured transmitter centre frequency shall be within ± 15 ppm of the Nominal Centre Frequency.

4.3.2.4 Conformance

Conformance tests as defined in clause 5.4.2 shall be carried out.

4.3.3 Nominal Channel Bandwidth

4.3.3.1 Definitions

The *Nominal Channel Bandwidth* B is the widest band of frequencies, including guard bands, assigned to a transmission signal.

4.3.3.2 Limit

In general, the Nominal Channel Bandwidth B shall be $1,728 \text{ MHz} \times 2^N$, where N is an integer value, e.g. 0, 1, 2, ..., N .

Table 3 provides examples.

Table 3: Examples of Nominal Channel Bandwidth B

N	B
0	1,728 MHz
1	3,456 MHz
2	6,912 MHz

If the equipment supports multiple Nominal Channel Bandwidths B , the equipment may change it during the operation.

If the equipment supports multiple transmitter chains, each of transmitter chains shall meet this requirement.

For equipment operating in the frequency band 1 880 MHz to 1 900 MHz the value of N shall be no greater than 2, so that the Nominal Channel Bandwidth B is restricted to a maximum of 6,912 MHz.

4.3.3.3 Conformance

Conformance shall be verified via the spectrum emission mask requirement defined in clause 4.3.4.2.

4.3.4 Transmitter unwanted emissions

4.3.4.1 Transmitter unwanted emissions in the spurious domain

4.3.4.1.1 Definition

Transmitter unwanted emissions in the spurious domain are emissions on a frequency or frequencies immediately outside the limit of 250 % of the nominal channel bandwidth B above and below the centre frequency of the transmitted signal emissions.

4.3.4.1.2 Limits

The level of transmitter unwanted emissions in the spurious domain shall not exceed the limits given in Table 4, where F_{upper} shall be at least the 5th harmonic of the upper band edge frequency of the service band (see Table 1 or as defined in national regulation) the EUT is designed for operation.

In case of equipment with antenna connectors, these limits shall apply to emissions at the antenna port (conducted). For emissions radiated by the cabinet or emissions radiated by integral antenna equipment (without antenna connectors), these limits shall be in e.r.p. for emissions below or on 1 GHz and e.i.r.p. for emissions above 1 GHz.

Table 4: Transmitter unwanted emission limits outside the operational band based on ERC Recommendation 74-01 [i.1]

Frequency range	Maximum power	Measurement bandwidth
$9 \text{ kHz} \leq f < 87,5 \text{ MHz}$	-36 dBm	100 kHz
$87,5 \text{ MHz} \leq f < 118 \text{ MHz}$	-54 dBm	100 kHz
$118 \text{ MHz} \leq f < 174 \text{ MHz}$	-36 dBm	100 kHz
$174 \text{ MHz} \leq f < 230 \text{ MHz}$	-54 dBm	100 kHz
$230 \text{ MHz} \leq f < 470 \text{ MHz}$	-36 dBm	100 kHz
$470 \text{ MHz} \leq f < 694 \text{ MHz}$	-54 dBm	100 kHz
$694 \text{ MHz} \leq f \leq 1 \text{ GHz}$	-36 dBm	100 kHz
$1 \text{ GHz} < f \leq F_{\text{upper}}$	-30 dBm	1 MHz

NOTE: Applicable radio communication service frequency bands are given in Table 1 or are defined in national regulation. Operation in 1 880 MHz to 1 900 MHz results in F_{upper} being at least 9,5 GHz.

4.3.4.1.3 Conformance

Conformance tests as defined in clause 5.4.3.1 shall be carried out.

4.3.4.2 Transmitter unwanted emissions in the out of band domain

4.3.4.2.1 Definition

Transmitter unwanted emissions in the out of band domain are emissions on a frequency or frequencies immediately outside the nominal channel bandwidth B denoted as Δf_{OOB} and are within the limit of 250 % of the nominal channel bandwidth B above and below the actual centre frequency of the transmitted signal $f_{c,a}$.

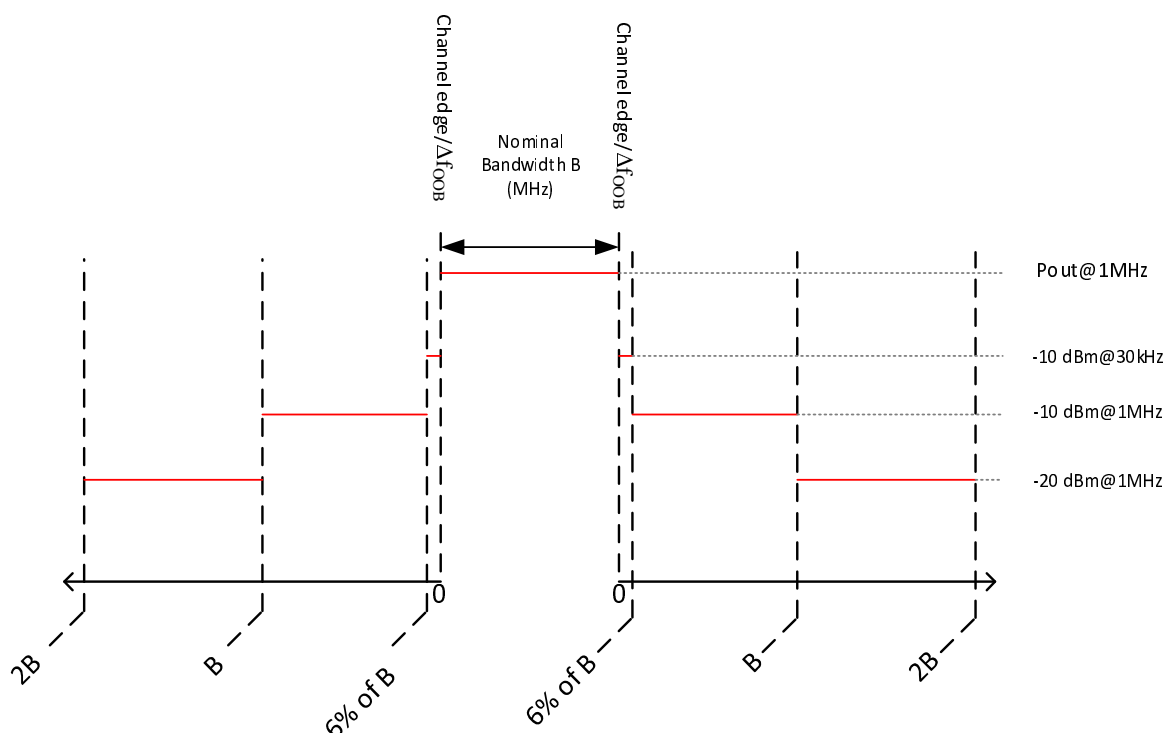


Figure 1: Illustration of the emission limits outside of the channel edge

4.3.4.2.2 Limits

The spectrum emission limits as specified in Table 5 shall apply to frequencies $f = f_{c,a} \pm (B/2 + \Delta f_{\text{OOB}})$, which are starting from the lower or higher edge of the assigned nominal channel with bandwidth B and actual centre frequency $f_{c,a}$.

Figure 1 provides an illustration of the emission limits outside of the channel edge.

Table 5: Spectrum emission limit for B

$\Delta f_{\text{OOB}}/\text{MHz}$	Spectrum emission limit (dBm)	Measurement bandwidth
$0 < \Delta f_{\text{OOB}} \leq 6 \% B$	-10	30 kHz
$6 \% B < \Delta f_{\text{OOB}} \leq B$	-10	1 MHz
$B < \Delta f_{\text{OOB}} \leq 2 B$	-20	1 MHz
NOTE 1: The first measurement point is 15 kHz offset from channel edge (Δf_{OOB}) with 30 kHz measurement bandwidth.		
NOTE 2: The first measurement point is 0,5 MHz offset from emission requirement frequency limit with 1 MHz measurement bandwidth.		

4.3.4.2.3 Conformance

Conformance tests as defined in clause 5.4.3.2 shall be carried out.

4.4 Conformance requirements for receiver

4.4.1 Receiver Minimum Performance Criterion

The minimum performance criterion shall be a measured bit rate of at least 90 % of the maximum achievable throughput of the EUT.

For equipment not supporting a throughput test, the minimum performance criterion shall be a Packet Error Rate (PER) of less than or equal to 10 %.

For equipment that does not support a throughput test and PER test to be performed, the minimum performance criterion shall be no loss of the wireless transmission function needed for the intended use of the equipment.

Descriptions of tests to the receiver minimum performance criterion are provided in clause 5.3.5.

4.4.2 Receiver Sensitivity

4.4.2.1 Definition

Receiver sensitivity is the ability to receive a wanted signal at low input power level while providing a pre-determined level of performance. Receiver sensitivity is defined as:

$$R_{x_{\text{sensitivity}}} = -174 \text{ dBm} + 10 \times \log(B) + \text{NF} + \text{SNR}_{\text{needed}}$$

with:

- NF = noise figure of the receiver in [dB]
- B = nominal channel bandwidth in [Hz], assumed as receiver bandwidth
- $\text{SNR}_{\text{needed}}$ = minimum needed signal-to-noise ratio for a given operation mode in [dB]

4.4.2.2 Limit

The receiver sensitivity of the equipment shall be $R_{x_{\text{sensitivity}}} \leq -80 \text{ dBm} + c$, where $c = 10 \times \log (B / 1,728 \text{ MHz})$ and where $B = 1,728 \text{ MHz} \times 2^N$ with N being an integer value starting with 0, see clause 4.3.3.

The receiver minimum performance criterion according to clause 4.4.1 shall be fulfilled at the $R_{x_{\text{sensitivity}}}$ signal level for the applicable Nominal Channel Bandwidth B .

4.4.2.3 Conformance

Conformance tests as defined in clause 5.5.1 shall be carried out.

4.4.3 Adjacent Channel Selectivity

4.4.3.1 Definition

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive the wanted signal assigned to its nominal channel frequency in the presence of an adjacent channel signal interference of power $P_{\text{Interferer}}$ at a given frequency offset $\Delta f_{\text{Interferer}}$ from the centre frequency f_c of the nominal channel.

ACS is the ratio of the receive filter attenuation on the assigned nominal channel frequency to the receive filter attenuation on the adjacent nominal channel bandwidth B .

4.4.3.2 Limit

For the operation under each supported nominal channel bandwidth B the performance criterion of clause 4.4.1 shall be fulfilled, when the received signal and the adjacent channel interfering signal parameters are present as defined in Table 6, where interference signal and own signal shall have the same transmitted signal bandwidth.

Table 6: Adjacent channel selectivity requirement

Rx Parameter	Values	Units
Value c	$c = 10 \times \log (B / 1,728 \text{ MHz})$	dB
Wanted signal input level	$-77 + c$	dBm
$P_{\text{Interferer}}$	-55	dBm
$B_{\text{Interferer}}$	Same signal bandwidth as transmitted wanted signal bandwidth	MHz
$\Delta f_{\text{Interferer}}$ (offset)	$\pm B$	MHz

4.4.3.3 Conformance

Conformance tests as defined in clause 5.5.2 shall be carried out.

4.4.4 Receiver out of band blocking

4.4.4.1 Definition

Receiver out of band blocking is a measure of the capability of the equipment to receive a wanted signal on its operating channel without exceeding a given degradation due to the presence of an unwanted input signal (blocking signal) on frequencies other than those of the operating bands provided in Table 1 or the operating bands defined in national regulation.

Out-of-band blocking is defined for an unwanted Continuous Wave (CW) interfering signal falling more than one adjacent channel below or above the receive band of the equipment. For the first adjacent nominal channel bandwidth B below or above the receive band the adjacent channel selectivity limits in clause 4.4.3 apply.

The lowest operating band frequency is $\text{Band}_{\text{low edge}}$ and the highest operating band frequency is $\text{Band}_{\text{high edge}}$ for the applicable service band as given in Table 1 or in national regulation.

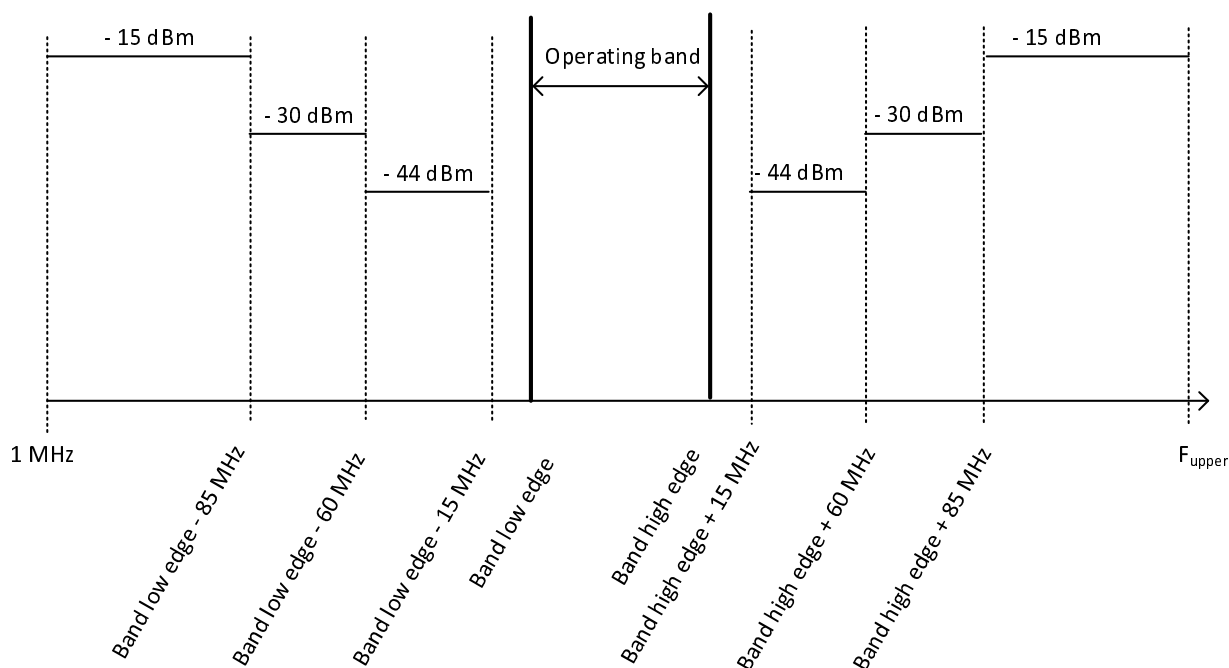


Figure 2: Illustration of out of band blocking requirements

4.4.4.2 Limit

For the operation under each supported nominal channel with nominal channel bandwidth B the performance criterion of clause 4.4.1 shall be fulfilled, when the received signal and the interfering signal parameters are present as defined in Table 7, where F_{upper} shall be at least the 5th harmonic of the upper band edge frequency of the service band (see Table 1 or in national regulation) the EUT is designed for operation.

The requirement specified in Table 7 for the frequency ranges 1, 2 and 3 allows to identify up to a number of $\max(24,8 \times (B / 1,728 \text{ MHz}))$ spurious response frequencies in each assigned frequency channel when measured using a 1 MHz step size. For these identified spurious response frequencies, only the requirements of clause 4.4.5 are applicable.

Table 7: Out of band blocking requirement

Rx Parameter	Values			Units
Value c	$c = 10 \times \log (B / 1,728 \text{ MHz})$.			dB
Wanted signal input level	$-77 + c$			dBm
$f_{\text{interferer}}$ of CW	Range 1	Range 2	Range 3	
	Band _{low edge} - 15	Band _{low edge} - 60	Band _{low edge} - 85	MHz
	Band _{low edge} - 60	Band _{low edge} - 85	down to 1 MHz	
	Band _{high edge} + 15	Band _{high edge} + 60	Band _{high edge} + 85	MHz
	Band _{high edge} + 60	Band _{high edge} + 85	up to F_{upper}	
$P_{\text{interferer}}$	-44	-30	-15	dBm

NOTE: Applicable radio communication service frequency bands are given in Table 1 or in national regulation. Operation in 1 880 MHz to 1 900 MHz results in F_{upper} being at least 9,5 GHz.

4.4.4.3 Conformance

Conformance tests as defined in clause 5.5.3 shall be carried out.

4.4.5 Spurious response

4.4.5.1 Definition

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained, i.e. on spurious response frequencies as identified in clause 4.4.4.

4.4.5.2 Limit

For the operation under each supported nominal channel with nominal channel bandwidth B the performance criterion of clause 4.4.1 shall be fulfilled, when the received signal and the interfering signal parameters are present as defined in Table 8.

Table 8: Receiver spurious response requirement

Rx Parameter	Values	Units
Value c	$c = 10 \times \log (B / 1,728 \text{ MHz})$	dB
Wanted signal input level	$-77 + c$	dBm
$f_{\text{Interferer}}$ of CW	Spurious response frequencies	
$P_{\text{Interferer}}$	-44	dBm

4.4.5.3 Conformance

Conformance tests as defined in clause 5.5.4 shall be carried out.

4.4.6 Receiver Intermodulation

4.4.6.1 Definition

Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

4.4.6.2 Limit

For the operation under each supported nominal channel with nominal channel bandwidth B the receiver minimum performance criterion according to clause 4.4.1 shall be fulfilled at the presence of two interfering signals as defined in Table 9.

Table 9: Test parameters for Wideband intermodulation

Rx Parameter	Values	Units
Value c	$c = 10 \times \log (B / 1,728 \text{ MHz})$	dB
Wanted signal input level	$-77 + c$	dBm
$P_{\text{interferer 1}}$ (CW)	-46	dBm
$P_{\text{interferer 2}}$ (Modulated)	-46	dBm
$B_{\text{Interferer 2}}$	Same as wanted signal	MHz
$f_{\text{Interferer 1}}$ (Offset)	$\pm 2 \times B$	MHz
$f_{\text{Interferer 2}}$ (Offset)	$2 \times f_{\text{Interferer 1}}$ (offset)	MHz

4.4.6.3 Conformance

Conformance tests as defined in clause 5.5.5 shall be carried out.

4.4.7 Receiver unwanted emissions in the spurious domain

4.4.7.1 Definition

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the RD antenna connector or emitted by the antenna.

Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products.

4.4.7.2 Limit

The measured spurious emission power shall not exceed the limits of Table 10, where F_{upper} shall be at least the 5th harmonic of the upper band edge frequency of the service band the EUT is designed for operation.

NOTE: Applicable radio communication service frequency bands are given in Table 1 or in national regulation. Operation in 1 880 MHz to 1 900 MHz results in F_{upper} being at least 9,5 GHz.

Table 10: Limits for receiver spurious emissions based on ERC Recommendation 74-01 [i.1]

Frequency range	Measurement bandwidth	Maximum power
$9 \text{ kHz} \leq f \leq 1 \text{ GHz}$	100 kHz	-57 dBm
$1 \text{ GHz} < f \leq F_{\text{upper}}$	1 MHz	-47 dBm

4.4.7.3 Conformance

Conformance test as defined in clause 5.5.6 shall be carried out.

4.5 Conformance requirements on Channel Access

4.5.1 General

4.5.1.1 Requirements

The EUT (radio device) may support FT mode and PT mode, or only FT mode, or only PT mode.

The EUT (radio device) shall support random access operation whereas the support of scheduled data transfer operation is dependent on the capabilities of the EUT.

4.5.1.2 Conformance

Requirements on the channel access of an EUT in FT mode are specified in clause 4.5.2.

Additional requirements for random access operation are specified in clause 4.5.3 (PT mode).

Additional requirements for the support of scheduled data transfer operation are specified in clause 4.5.4 (FT mode) and clause 4.5.5 (PT mode).

Additional requirements on the maximum transmission time of a radio device are specified in clause 4.5.6.

4.5.2 Channel Access of a Radio Device in FT mode

4.5.2.1 Definition

An EUT (radio device) in FT mode scans the radio frequency channels and selects operating channels for its transmission from a service band given in Table 1 or in national regulation.

The measured values are categorized according to Table 11 into channel categories named "Free", "Possible", and "Busy".

The *RSSI_THRESHOLD_MIN* and *RSSI_THRESHOLD_MAX* values are defined in ETSI TS 103 636-4 [1].

Table 11: Channel status categories

Channel status categories	Measured RSSI-1 value in [dBm]
Free	$\max(\text{RSSI-1}) \leq \text{RSSI_THRESHOLD_MIN}$
Possible	$\text{RSSI_THRESHOLD_MIN} < \max(\text{RSSI-1}) \leq \text{RSSI_THRESHOLD_MAX}$
Busy	$\max(\text{RSSI-1}) > \text{RSSI_THRESHOLD_MAX}$

4.5.2.2 Requirements

The present clause shall apply to an EUT which supports FT mode.

The EUT in FT mode shall scan the operating radio frequency channels and measure their receiver signal RSSI-1 values.

The EUT in FT mode shall select operating channel(s) from the "Free" category and if none such is available from the "Possible" category and if not possible it may select from the "Busy" channel category only if no other choice is available as outlined in clause 4.5.2.1.

The EUT in FT mode shall transmit in the selected operating channel(s).

4.5.2.3 Conformance

Conformance tests as defined in clause 5.6.2 shall be carried out.

4.5.3 Channel Access of a Radio Device in PT mode and Random Access

4.5.3.1 Definition

A companion radio device in FT mode is configured to broadcast *random access resource allocations* in a beacon transmission on one of the available channels of a service band given in Table 1 or in national regulation.

An EUT (radio device) operating in PT mode monitors and decodes the beacon transmissions of the companion device operating in FT mode. An EUT in PT mode performs *random access* transmissions accordingly. The companion device in FT mode transmits beacons according to clauses 5.1.5 and 5.3 in ETSI TS 103 636-4 [1].

4.5.3.2 Requirements

The present clause shall apply to an EUT which supports PT mode.

The EUT in PT mode shall scan and select the companion device to initiate communication with companion device in FT mode as defined in ETSI TS 103 636-4 [1], clause 5.1.4. An EUT in PT mode shall perform random access as defined in ETSI TS 103 636-4 [1], clause 5.3.

The EUT operating in PT mode shall transmit only on the operating channel instructed by the companion device operating in FT mode.

The EUT in PT mode shall monitor the companion device in FT mode and:

- 1) The EUT in PT mode shall cease its transmission on the operating channel of the companion device in FT mode within 10 seconds after having received instruction (e.g. revoking of resources, changing operating channel) from the companion device in FT mode.
- 2) The EUT in PT mode shall cease its transmission on the operating channel of the companion device in FT mode within 30 seconds after losing its connection to the companion device in FT mode.

4.5.3.3 Conformance

Conformance tests as defined in clause 5.6.3 shall be carried out.

4.5.4 Channel Access of Radio Device in FT mode for Scheduled Access

4.5.4.1 Definition

An EUT (radio device) in FT mode had performed steps defined in clause 4.5.2 for selecting the operating channel and in clause 4.5.3 for providing random access information.

An EUT (radio device) operating in FT mode and supporting scheduled data transfer assigns and informs the companion device in PT mode of resources for scheduled data transfer as defined in ETSI TS 103 636-4 [1], clause 5.4.

4.5.4.2 Requirements

The present clause shall apply to an EUT which supports both FT mode and scheduled data transfer.

The EUT operating in FT mode shall assign and inform the companion device in PT mode of resources for scheduled data transfer to enable PT operation.

The EUT in PT mode may start operation on the assigned resources.

4.5.4.3 Conformance

Conformance tests as defined in clause 5.6.4 shall be carried out.

4.5.5 Channel Access of Radio Device in PT mode for Scheduled Access

4.5.5.1 Definition

An EUT (radio device) operating in PT mode monitors and decodes the beacon transmissions of the companion device operating in FT mode. An EUT in PT mode performs *scheduled access* transmissions accordingly. The companion device in FT mode transmits beacons according to clauses 5.1.5 in ETSI TS 103 636-4 [1] and employs the scheduled resources as defined in ETSI TS 103 636-4 [1], clause 5.4.

A companion radio device in FT mode is configured to broadcast *random access resource allocations* in beacon transmission on one of the available channels of a service band given in Table 1 or in national regulation.

An EUT in PT mode shall scan and select the companion device to initiate communication with companion device in FT mode as defined in ETSI TS 103 636-4 [1], clause 5.1.4. An EUT (radio device) in PT mode shall perform random access as defined in ETSI TS 103 636-4 [1], clause 5.3.

4.5.5.2 Requirements

The present clause shall apply to an EUT which supports both PT mode and scheduled data transfer.

A companion radio device in FT mode is configured to provide information on *scheduled resources*.

The EUT in PT mode shall perform scheduled access as defined in ETSI TS 103 636-4 [1], clause 5.4.

The EUT operating in PT mode is monitoring and decoding the transmissions of the companion device operating in FT mode. The transmissions of the companion device shall contain information on resources for *scheduled data transfer*. The EUT in PT mode shall perform a *scheduled data transfer* accordingly.

The EUT operating in PT mode shall transmit on scheduled resources and it may transmit on random access resources instructed by the companion device operating in FT mode. An EUT in PT mode may not transmit in all scheduled resources.

The EUT in PT mode shall monitor the companion device in FT mode and:

- 1) The EUT in PT mode shall cease its transmission on operating channel of the companion device in FT mode within 10 seconds after having received instruction (e.g. revoking of resources, changing operating channel) from the companion device in FT mode.
- 2) The EUT in PT mode shall cease its transmission on the operating channel of the companion device in FT mode within 10 seconds after losing its connection to the companion device in FT mode.

4.5.5.3 Conformance

Conformance tests as defined in clause 5.6.5 shall be carried out.

4.5.6 Maximum Transmission Time of a Radio Device

4.5.6.1 Definition

The Maximum Transmission Time is the maximum duration of all transmission(s) of an EUT (radio device) in a 10 ms interval.

Short control signalling (e.g. ACK/NACK of the HARQ process) is not counted.

4.5.6.2 Requirements

The Maximum Transmission Time of the EUT shall be no greater than $23/24 \times 10$ ms in a 10 ms interval.

For operation in 1 880 MHz - 1 900 MHz and in case of operation with a Nominal Channel Bandwidth of $B = 6,912$ MHz, the Maximum Transmission Time of the EUT shall be no greater than $18/24 \times 10$ ms in a 10 ms interval.

The idle period(s) after transmission(s) should be configured in a way so that obtaining feedback from the receiving side is possible for the radio device considering the different numerologies.

4.5.6.3 Conformance

Conformance tests as defined in clause 5.6.6 shall be carried out.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

5.1.1 General

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

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 operational environmental profile defined by its intended use) to give confidence of compliance for the affected technical requirements.

For each test defined in the present document, the environmental condition(s) at which the test has to be performed is specified in the clause on test conditions for that particular test.

5.1.2 Normal test conditions

5.1.2.1 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 % (non-condensing).

The actual values during the tests shall be recorded.

5.1.2.2 Normal power source

The normal test voltage for the equipment shall be the nominal voltage for which the equipment is designed.

5.1.3 Extreme test conditions

If tests in the present document need to be repeated at extreme temperatures and/or relative humidity it will be specifically mentioned in the test method.

When that is the case, measurements shall be made over the extremes of the operating temperature range and/or relative humidity as defined in the product information, see clause 5.3.1 item 1 c).

For equipment intended for outdoor use, the temperature conditions for tests shall be at least a minimum of -20 °C and at least a maximum of +45 °C.

5.2 Interpretation of the measurement results

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

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report.

Informative values in Table A.1 can be used for the interpretation of the results.

5.3 Definition of other test conditions

5.3.1 Product information for testing

The information requested in the present clause shall be included in the test report. This information is required in order to carry out the test suites and/or to declare compliance to technical requirements (e.g. technical requirements for which no conformance test is included in the present document):

- 1) in general:
 - a) whether the equipment is FT only, PT only, or both PT and FT mode capable;
 - b) whether the equipment provides means to establish or support scheduled data transmissions;
 - c) the applicable operational environmental profile(s);

- d) the applicable power source; e.g. battery, internal, or external supply;
 - e) whether the equipment is stand-alone equipment, combined equipment, or multi-radio equipment;
 - f) the applicable test setup(s), if special information or instructions are required to improve testability, such as radio configuration parameters impacting the device activity such as beacons transmission intervals;
 - g) for each of the tests to be performed, the proposed normal and/or worst case operational mode (e.g. power settings, modulation, antennas, etc.) with respect to the test being performed and the intended use of the equipment;
 - h) the applicable test fixture(s), if required;
- 2) with regards to antenna:
- a) whether the antenna(s) is/are integral or dedicated antenna(s);
 - b) the antenna gain, if applicable;
 - c) whether the equipment is for use with multiple antennas and if so, information on the applicable configuration for testing;
- 3) with regards to transmitter or transmitting part of transceiver:
- a) the start and stop frequencies of the tuning range(s) supported by the equipment;
 - b) the channel bandwidth(s) supported by the equipment;
 - c) the centre frequencies supported by the equipment;
 - d) the maximum transmit power e.i.r.p. of the equipment;
 - e) whether a companion device is required to initiate transmissions;
 - f) whether simultaneous transmission in one or more channels is used;
 - g) the transmitter operational modes reaching the conditions as stated in clause 5.3.3;
- 4) with regards to receiver or receiving part of transceiver:
- a) the start and stop frequencies of the frequency range(s) supported by the equipment;
 - b) the channel bandwidth(s) supported by the equipment;
 - c) the receiver operational mode reaching the conditions as stated in clause 5.3.3.

5.3.2 Test signals

5.3.2.1 Overview

Test signals and operational modes of an EUT used in the test procedures for essential radio test suites are given in Table 12.

Table 12: Overview of Test Signal(s) and EUT operational Mode(s)

Test	Clause	Test signal(s)	EUT operational Modes(s)
Transmitter RF Output Power	4.3.1		5.3.3.1
Nominal Centre Frequencies	4.3.2		5.3.3.1
Nominal Channel Bandwidth	4.3.3		5.3.3.1
Transmitter unwanted emissions in the spurious domain	4.3.4.1		
Transmitter unwanted emissions in the out of band domain	4.3.4.2		
Receiver Sensitivity	4.4.2		5.3.3.1
Adjacent Channel selectivity	4.4.3	5.3.2.2	5.3.3.1
Receiver out of band blocking	4.4.4	Continuous Wave (CW)	5.3.3.1
Spurious response	4.4.5	Continuous Wave (CW)	5.3.3.1
Receiver Intermodulation	4.4.6	Continuous Wave (CW) and 5.3.2.2	5.3.3.1
Receiver unwanted emissions in the spurious domain	4.4.7	5.3.2.2	5.3.3.1
Channel Access	4.5.1	5.3.2.3	5.3.3.1
Channel Access of radio device in FT mode	4.5.2	5.3.2.3	5.3.3.1
Channel Access of radio device in PT mode and Random Access	4.5.3	5.3.2.3	5.3.3.1
Channel Access of radio device in FT mode for Scheduled Access	4.5.4	5.3.2.3	5.3.3.1
Channel Access of radio device in PT mode for Scheduled Access	4.5.5	5.3.2.3	5.3.3.1
Maximum Transmission Time of a Radio Device	4.5.6		5.3.3.1

5.3.2.2 Interfering signal for receiver performance tests

The interference signal used for receiver adjacent channel selectivity test is a band limited noise signal with same bandwidth as the transmitted signal bandwidth of wanted signal as defined in ETSI TS 103 636-2 [i.9] and having a 100 % duty cycle.

The flatness, bandwidth and power spectral density of the interference signal can be verified with the following procedure.

Connect the signal generator for generating the interference signal to a spectrum analyser and use the settings given in Table 13.

Table 13: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Equal to the channel frequency to be tested
Span	2 × the Nominal Channel Bandwidth
Resolution BW	30 kHz
Video BW	3 × the Resolution BW
Sweep Points	2 × the Span divided by the Resolution BW; for spectrum analysers not supporting this number of sweep points, the frequency band may be segmented
Detector	Peak
Trace Mode	Trace Averaging
Number of sweeps	Sufficient to let the signal stabilize
Sweep time	Auto

The level of interference signal can be measured with a spectrum analyser using the settings given in Table 14.

Table 14: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Equal to the channel frequency to be tested
Span	Zero
Resolution BW	1 MHz
Video BW	3 x the Resolution BW
Detector	RMS
Trace Mode	Clear Write
Number of sweeps	Single
Sweep time	1 second
NOTE:	The measured power bandwidth conversion [$10 \times \log(\text{transmission bandwidth (MHz)}/1 \text{ MHz})$] to the defined test signal bandwidth shall be performed.

5.3.2.3 AWGN Interference signal used for Channel Access Tests

The inference signal used in the channel access tests described in clauses 5.6.2 to 5.6.5 shall be a band limited noise signal with a 100 % duty cycle. The 99 % bandwidth (the bandwidth containing 99 % of the power) of this inference signal shall be able to cover 50 % of the applicable operating band given in Table 1. The power difference between the lowest and highest nominal channel shall be in maximum 4 dB.

The flatness, bandwidth and power spectral density of the interference signal can be verified with the following procedure.

Connect the signal generator for generating the interference signal to a spectrum analyser and use the settings given in Table 15.

Table 15: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Equal to the channel frequency to be tested
Span	2 x the Nominal Channel Bandwidth
Resolution BW	300 kHz
Video BW	3 x the Resolution BW
Sweep Points	2 x the Span divided by the Resolution BW; for spectrum analysers not supporting this number of sweep points, the frequency band may be segmented
Detector	Peak
Trace Mode	Trace Averaging
Number of sweeps	Sufficient to let the signal stabilize
Sweep time	Auto

The level of interference signal can be measured with a spectrum analyser using the settings given in Table 16.

Table 16: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Equal to the channel frequency to be tested
Span	Zero
Resolution BW	1 MHz
Video BW	3 x the Resolution BW
Detector	RMS
Trace Mode	Clear Write
Number of sweeps	Single
Sweep time	1 second
NOTE:	The measured power bandwidth conversion [$10 \times \log(\text{transmission bandwidth (MHz)}/1 \text{ MHz})$] to the defined test signal bandwidth shall be performed.

5.3.3 Test operational modes

5.3.3.1 Device under representative test signal

An operational mode with a reliable and fixed physical layer configuration shall be provided in the product information (see clause 5.3.1). Physical layer configurations based on BPSK shall be excluded.

This operational mode shall ensure a transmitter activity in a period of 10 ms to the maximum extent the device is supporting.

Table B.1 provides information on a representative mode considering a physical layer configuration supported by ETSI TS 103 636 [i.8].

5.3.4 Antennas

5.3.4.1 Integrated and dedicated antennas

The equipment can have either integral antennas or dedicated antennas. Dedicated antennas, further referred to as *dedicated external antennas*, are antennas that are physically external to the equipment and are assessed in combination with the equipment against the requirements in the present document. It should be noted that assessment does not necessarily lead to testing.

An antenna assembly referred to in the present document is understood as the combination of the antenna (integral or dedicated), its coaxial cable and if applicable, its antenna connector and associated switching components. The gain of an antenna assembly G in dBi, does not include the additional gain that may result out of beamforming techniques. Smart antenna systems may use beamforming techniques which may result in additional (antenna) gain. This beamforming gain Y is specified in dB.

Although the measurement methods in the present document allow conducted measurements to be performed, it should be noted that the equipment together with all its intended antenna assemblies shall comply with the applicable technical requirements defined in the present document.

5.3.5 Tests of the receiver performance criterion

5.3.5.1 General

The receiver performance shall be measured using a fixed physical layer configuration providing the reliable, representative transmission (see clause 5.3.3.1) the EUT supports.

The test criterion provided in clause 5.3.5.3 shall be applicable only for equipment that does not support performing receiver statistical testing as given in clause 5.3.5.2.

5.3.5.2 Receiver statistical testing

The reference for statistical testing is the maximum achievable throughput of the EUT using a fixed physical layer configuration.

The receiver statistical testing is done according to the clause E.1.

5.3.5.3 Receiver no loss of the wireless transmission function testing

The loss of the wireless transmission function needed for the intended use of equipment should be objectively observable and reproducible by adding or removing attenuation to/from the transmission path.

The receiver no loss of wireless transmission testing is done according to clause E.2.

5.3.6 Presentation of equipment

Stand-alone equipment shall be tested against all requirements of the present document. For testing combined or multi-radio equipment against the requirements of the present document, specific guidance is given by ETSI EG 203 367 [i.2], clause 6.

The product information (see clause 5.3.1) shall state whether the equipment is stand-alone equipment, combined equipment or multi-radio equipment.

5.3.7 Conducted measurements, radiated measurements, relative measurements

Unless otherwise specified, either conducted or radiated measurements may be used.

For integral antenna equipment, connectors may be provided to allow conducted measurements to be performed.

In the case of integral antenna equipment that has no antenna connector(s), the manufacturer may be required to supply a test fixture, to allow relative measurements to be made. The test fixture and its use are further described in clause C.4.

5.4 Method of measurement for transmitters

5.4.1 Transmitter RF Output Power

5.4.1.1 Test conditions

The conformance requirements in clause 4.3.1 shall be verified. The measurements on the lowest, the middle, and highest channel on which the equipment can operate shall be recorded.

These measurements shall be performed under normal test conditions (see clause 5.1.2) and extreme test conditions (see clause 5.1.3).

The measurements shall be performed with the operational mode specified in clause 5.3.3.1.

The EUT shall transmit with its maximum RF output power.

The gain of the antenna assembly G in dBi, does not include the additional gain that may result out of beamforming techniques. Smart antenna systems may use beamforming techniques which may result in additional (antenna) gain. This beamforming gain Y is specified in dB.

5.4.1.2 Test method

5.4.1.2.1 Conducted measurement

5.4.1.2.1.1 Introduction

In case of conducted measurements, the transmitter shall be connected to the measuring equipment. The RF power as defined in clause 4.3.1.2 shall be measured and recorded.

The reference transmitter test setup is shown in Figure 3.

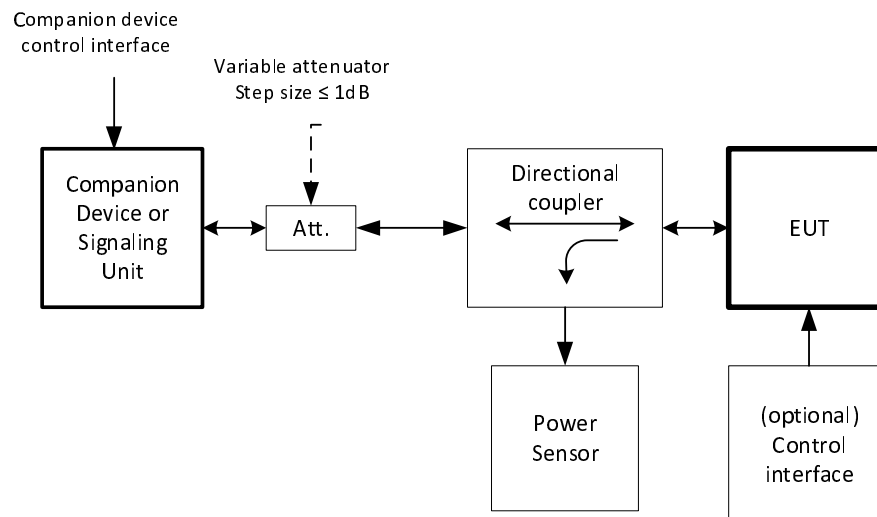


Figure 3: Reference setup for transmitter RF output power testing

5.4.1.2.1.2 RF Output Power

The test procedure shall be as follows:

Step 1:

- Use a fast power sensor with a minimum sensitivity of -40 dBm and capable of minimum 1 MS/s.
- Use the following settings:
 - Sample speed 1 MS/s or faster.
 - The samples shall represent the RMS power of the signal.
 - Measurement duration: At least 10 bursts shall be fully captured.

Step 2:

- For conducted measurements on devices with one transmit chain:
 - Connect the power sensor to the transmit port, sample the transmit signal and store the raw data. Use these stored samples in all following steps.
- For conducted measurements on devices with multiple transmit chains:
 - Connect one power sensor to each transmit port for a synchronous measurement on all transmit ports.
 - Trigger the power sensors so that they start sampling at the same time. Make sure the time difference between the samples of all sensors is less than 500 ns.
 - For each individual sampling point (time domain), sum the coincident power samples of all ports and store them. Use these summed samples as the new stored data set.

Step 3:

- Find the start and stop times of each burst in the stored measurement samples:
 - The start and stop times are defined as the points where the power is at least 30 dB below the highest value of the stored samples in step 2.
 - In case of radiated measurements, the sensitivity of the power sensor might be insufficient, so that the value of 30 dB may need to be reduced appropriately.

Step 4:

- Between the start and stop times of each individual burst calculate the RMS power over the burst using the formula below. The start and stop points shall be included. Save these P_{burst} values, as well as the start and stop times for each burst:

$$P_{burst} = \frac{1}{k} \sum_{n=1}^k P_{sample}(n)$$

with k being the total number of samples and n the actual sample number.

Step 5:

- The highest of all P_{burst} values (value A in dBm) will be used for maximum e.i.r.p. calculations.

Step 6:

- Add the (stated) antenna assembly gain G in dBi of the individual antenna.
- In case of smart antenna systems operating in mode with beamforming (see clause 5.3.4), add the additional beamforming gain Y in dB.
- If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used.
- The RF Output Power (P_{out}) shall be calculated using the formula below:

$$P_{out} = A + G + Y$$

- This value shall not exceed the limit given in clause 4.3.1.2 and shall be recorded in the test report.

5.4.1.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a power sensor connected to the measurement antenna.

The test procedure is as described under clause 5.4.1.2.1.

5.4.2 Nominal Centre Frequencies**5.4.2.1 Test Conditions**

The conformance requirements in clause 4.3.2 shall be verified under normal test conditions (see clause 5.1.2) and extreme test conditions (see clause 5.1.3).

The EUT shall be configured to operate at a normal RF Output Power level. In addition, the EUT shall be configured to operate on a single channel.

In case of conducted measurements on smart antenna systems (devices with multiple transmit chains) the measurements shall be performed on only one of the active transmit chains.

An reference test setup for measurement is shown in Figure 4.

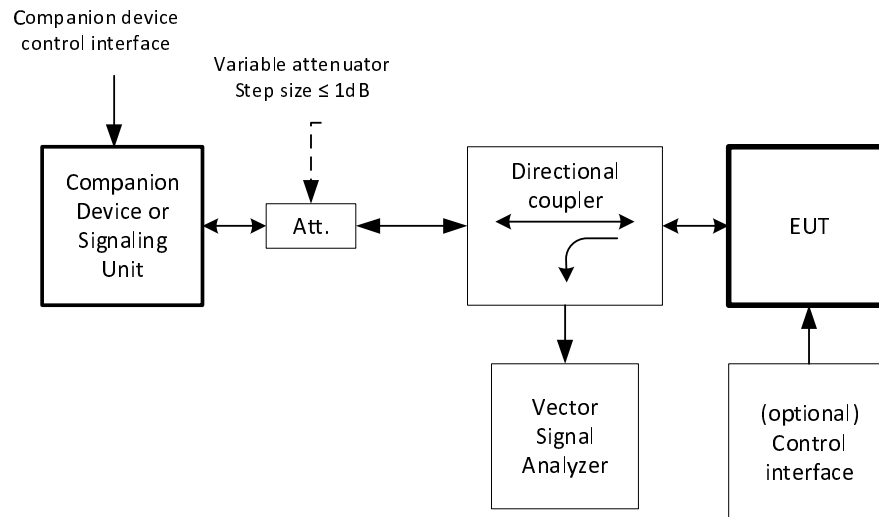


Figure 4: Reference setup for nominal centre frequency testing

5.4.2.2 Test Method

5.4.2.2.1 Conducted measurement

5.4.2.2.1.1 Equipment operating without modulation

This test method requires that the EUT can be operated in an unmodulated test mode.

The EUT shall be connected to a suitable frequency measuring device (e.g. a frequency counter or a spectrum analyser) and operated in an unmodulated mode. The EUT is controlled via optional controlling interface during the test without the companion device.

The measured centre frequency shall meet the requirements defined in clause 4.3.2.2.

5.4.2.2.1.2 Equipment operating with modulation

This method is an alternative to the above method in case the EUT is not tested in an unmodulated mode.

The EUT shall be connected to a vector signal analyser capable of analysing DECT-2020 NR transmission signal. The EUT shall transmit periodic test transmission signal defined in Table B.1. Vector signal analyser shall record the modulated signal and report the modulated signal centre frequency.

The measured centre frequency shall meet the requirements defined in clause 4.3.2.2.

5.4.2.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a vector signal analyser connected to the measurement antenna.

The test procedure is as described under clause 5.4.2.2.1.

5.4.3 Transmitter unwanted emissions

5.4.3.1 Transmitter unwanted emissions in the spurious domain

5.4.3.1.1 Test Conditions

These measurements shall only be performed at normal test conditions.

The level of spurious emissions shall be measured as, either:

- a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or
- b) their effective radiated power when radiated by cabinet and antenna in case of integral antenna equipment with no antenna connectors.

The measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These operating channels shall be recorded.

The equipment shall be configured to operate under its worst-case situation with respect to output power.

If the equipment can operate with different Nominal Channel Bandwidths, then the equipment shall be configured to operate under its worst-case situation with respect to spurious emissions.

5.4.3.1.2 Test Method

5.4.3.1.2.1 Conducted measurement

5.4.3.1.2.1.1 Pre-scan

The reference test setup is described in Figure 4.

The EUT shall be connected to a spectrum analyser capable of RF power measurements.

This pre-scan test procedure shall be used to identify potential unwanted emissions of the EUT.

The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in clause 4.3.4.1.2.

Step 1:

- The unwanted emissions over the range 30 MHz to 1 000 MHz shall be identified. For the spectrum analyser use the settings given in Table 17.

Table 17: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Filter mode	Channel
Detector mode	Peak
Trace Mode	Max Hold
Sweep Points	≥ 9 700 (see note)
Sweep time	The sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two transmissions of the EUT
NOTE:	For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.4.3.1.2.1.2 (step 1, last point on adjusting the frequency) may be omitted.

- Allow the trace to stabilize. Any emissions identified that are above or have a margin of less than 6 dB to the limits given in clause 4.3.4.1.2 shall be individually measured using the procedure in clause 5.4.3.1.2.1.2 and shall not exceed the limits given in clause 4.3.4.1.2.

Step 2:

- The unwanted emissions over the range 1 000 MHz to F_{upper} defined in clause 4.3.4 shall be identified. For the spectrum analyser use the settings given in Table 18.

Table 18: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Filter mode	Channel
Detector mode	Peak
Trace Mode	Max Hold
Sweep points	≥ 8 500 (see note)
Sweep time	The sweep time shall be sufficiently long, such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the EUT
NOTE:	For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.4.3.1.2.1.2 (step 1, last point on adjusting the frequency) may be omitted.

- Allow the trace to stabilize. Any emissions identified that are above or have a margin of less than 6 dB the limits given in clause 4.3.4.1.2 shall be individually measured using the procedure in clause 5.4.3.1.2.1.2 and shall not exceed the limits given in clause 4.3.4.1.2.

5.4.3.1.2.1.2 Measurement of the emissions identified during the pre-scan

The limits for transmitter unwanted emissions in clause 4.3.4.1.2 refer to average power levels.

The steps below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above.

Periodic transmit signals:

For periodic transmit signals, the measurement shall be made only over the "on" part of the burst.

Step 1:

- The level of the emissions shall be measured in the time domain, using the spectrum analyser settings given in Table 19.

Table 19: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Frequency of emission identified during the pre-scan
RBW	100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
VBW	300 kHz (< 1 GHz) / 3 MHz (> 1 GHz)
Filter mode	Channel
Frequency Span	0 Hz
Sweep mode	Single Sweep
Sweep Time	Suitable to capture one transmission burst. Additional measurements may be needed to identify the length of the transmission burst. In case of continuous signals, the Sweep Time shall be set to 30 ms
Sweep points	Sweep time [μs] / 1 μs with a maximum of 30 000
Trigger	Video (burst signals) or Manual (continuous signals)
Detector	RMS
Trace Mode	Clear/Write

- Adjust the centre frequency (fine tune) to capture the highest level of one burst of the emission to be measured.

This fine tuning can be omitted for spectrum analysers capable of supporting twice this number of sweep points required in step 2 and step 3 from the pre-scan procedure in clause 5.4.3.1.2.1.2.

Step 2:

- Adjust the trigger level to select the transmissions with the highest power level.
- Set a window (start and stop lines) to match with the start and end of the burst and in which the RMS power shall be measured using the Time Domain Power function. If the spurious emission to be measured is a continuous signal, the measurement window shall be set to match the start and stop times of the sweep.
- Select RMS power to be measured within the selected window and note the result which is the RMS power of this particular spurious emission. This value shall not exceed applicable limit provided by clause 4.3.4.1.2.

Repeat this procedure for every emission identified during the pre-scan. The values and companion frequencies shall be recorded.

In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements shall be repeated for each of the active transmit chains. The applicable limits shall be evaluated using either of the options given below:

- Option 1 (preferred): the results for each of the transmit chains for the companion 1 MHz segments shall be added and evaluated as not exceeding the limits provided in clause 4.3.4.1.2.
- Option 2: the results for each of the transmit chains shall be individually evaluated as not exceeding the limits provided in clause 4.3.4.1.2 after these limits have been reduced by $10 \times \log_{10}(T_{ch})$ (number of active transmit chains).

5.4.3.1.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.4.3.1.2.1.

5.4.3.2 Transmitter unwanted emissions in the out of band domain

5.4.3.2.1 Test Conditions

The conformance requirements in clause 4.3.4.2.2 shall be verified only under normal operating conditions, and when operating on those channels and channel bandwidths provided by clause 5.3.1.

The equipment shall be configured to operate under its worst case situation with respect to unwanted emissions within the operating band and nominal channel bandwidth B .

For EUT without an integral antenna and for an EUT with an integral antenna but with a temporary antenna connector(s), conducted measurements should be performed. Alternatively, if the EUT has an integral antenna(s), but no temporary antenna connector(s), radiated measurements may be used.

In case of conducted measurements on smart antenna systems (devices with multiple transmit chains) operating in a mode with more than one transmit chain being active simultaneously, measurements shall only be performed on one of the transmit chains (antenna outputs), but one after the other.

5.4.3.2.2 Test Method

5.4.3.2.2.1 Conducted measurement

The test setup is according to Figure 3.

Step 1: Determination of the average power level.

- For the spectrum analyser use the settings given in Table 20.

Table 20: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz or 1 MHz, see clause 4.3.4.2.2, Table 5
Video bandwidth	3 × RBW
Filter mode	Channel
Detector mode	RMS
Trace Mode	Average
Sweep time	The sweep time shall be sufficiently long, the measurement time is greater than two transmissions of the EUT
Centre Frequency	Centre frequency of the channel being tested
Span	2 × Nominal Channel Bandwidth
NOTE: As a general rule, the resolution bandwidth of the measurement equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.	

- Adjust the frequency range of the spectrum analyser to allow the measurement to be performed in frequencies as defined in Table 1. No other parameter of the spectrum analyser should be changed.

Step 2:

- Assure the measured power of the active transmission ON period defined in clause 6.5.3 of ETSI TS 103 636-2 [i.9] of the EUT is not exceeding the limits defined in clause 4.3.4.2.2.

5.4.3.2.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.4.3.2.2.1.

5.5 Method of measurement for receiver**5.5.1 Receiver Sensitivity****5.5.1.1 Test Conditions**

See clause 5.3 for the environmental test conditions. These measurements shall only be performed at normal test conditions.

The test for conformance requirements defined in clause 4.4.2.2 shall be verified at lowest and highest channels of operating band.

The EUT shall use the operational mode and performance criterion as defined in clause 5.3.5.

If the equipment can be configured to operate with different *Nominal Channel Bandwidths* and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.4.1.

It shall be verified that the minimum performance criteria are achieved during the receiver sensitivity test.

5.5.1.2 Test Method

5.5.1.2.1 Conducted measurement

In case a device is using multiple receive chains only one chain needs to be tested. All other receiver inputs shall be terminated appropriately, e.g. a 50 Ohm termination if a matching circuit to this impedance is implemented.

Figure 5 shows the reference test setup for performing the receiver sensitivity test. The companion device and EUT may require appropriate shielding or may need to be put in a shielded room to prevent it may have a negative impact on the measurement. The companion device transmitter output power shall be at least 20 dB lower than the EUT transmitted power to ensure a reliable communication from EUT to companion device.

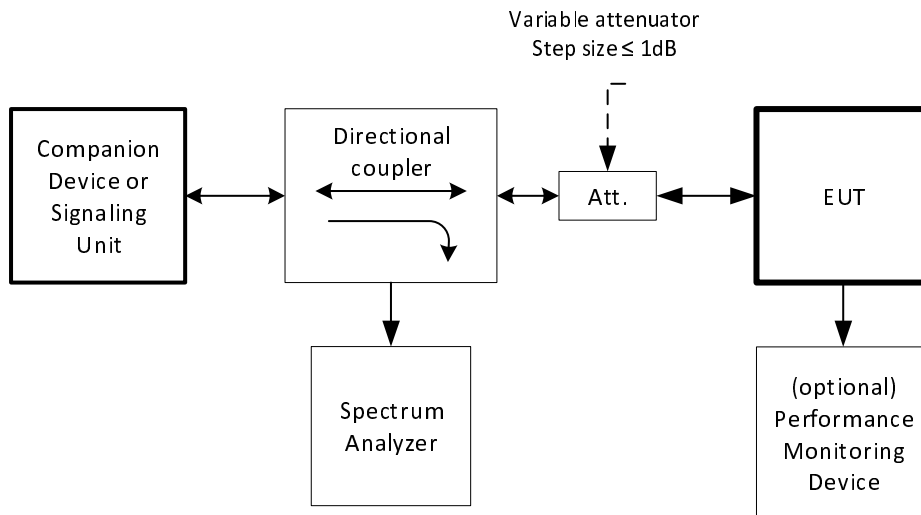


Figure 5: Reference setup for receiver sensitivity testing

The steps below define the procedure to verify the receiver sensitivity requirement as described in clause 4.4.2.

Step 1:

- The associated companion device shall be set to the lowest operating channel frequency supported (see clause 5.3.1).
- The associated companion device shall use the operational mode as defined in clause 5.3.5.

Step 2:

- A communication link is set up between the EUT and the associated companion device using the test setup shown in Figure 5.

Step 3:

- The attenuation of the variable attenuator shall be increased to a value of reference sensitivity level as specified in clause 4.4.2.2. For the spectrum analyser use the settings given in Table 21.

Table 21: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Detector mode	RMS
Trace Mode	Clear/Write
Sweep points	1 001
Sweep time	≥ 10 seconds
Centre Frequency	Centre frequency of the channel being tested
Span	2 x Nominal Channel Bandwidth
NOTE 1: Channel power is the integrated power over the Nominal Channel Bandwidth with centre frequency same as the channel during the test.	
NOTE 2: Spectrum analyser shall be configured so that its measurement sweeps occur only during periods when RF transmission is active.	

- Pass-fail decision criteria shall be verified against the criteria specified in clause 4.4.2.2 and recorded in the test report.

Step 4:

- Repeat step 2 to step 3 with the EUT operating at the highest operating channel frequency at which the receiver sensitivity can be performed (see clause 5.3.1). Record each measurement frequency the result into test report.

5.5.1.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.5.1.2.1.

5.5.2 Adjacent Channel Selectivity**5.5.2.1 Test Conditions**

See clause 5.1 for the environmental test conditions. These measurements shall only be performed at normal test conditions.

The test for conformance requirements defined in clause 4.4.3.2 shall be verified at lowest and highest channels of operating band.

The EUT shall use the operational mode and performance criterion as defined in clause 5.3.5.

If the equipment can be configured to operate with different *Nominal Channel Bandwidths* and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.4.1.

It shall be verified that the performance criteria are achieved during the adjacent channel selectivity test.

5.5.2.2 Test Method**5.5.2.2.1 Conducted measurement**

In case the EUT is using multiple receive chains only one chain needs to be tested. All other receiver inputs shall be terminated appropriately, e.g. a 50 Ohm termination if a matching circuit to this impedance is implemented.

Figure 6 shows the reference test setup which can be used for performing the receiver adjacent channel selectivity test. The companion device and EUT may require appropriate shielding or may need to be put in a shielded room to prevent it may have a negative impact on the measurement. The companion device transmitter output power shall be at least 20 dB lower than the EUT transmitted power to ensure a reliable communication from EUT to companion device.

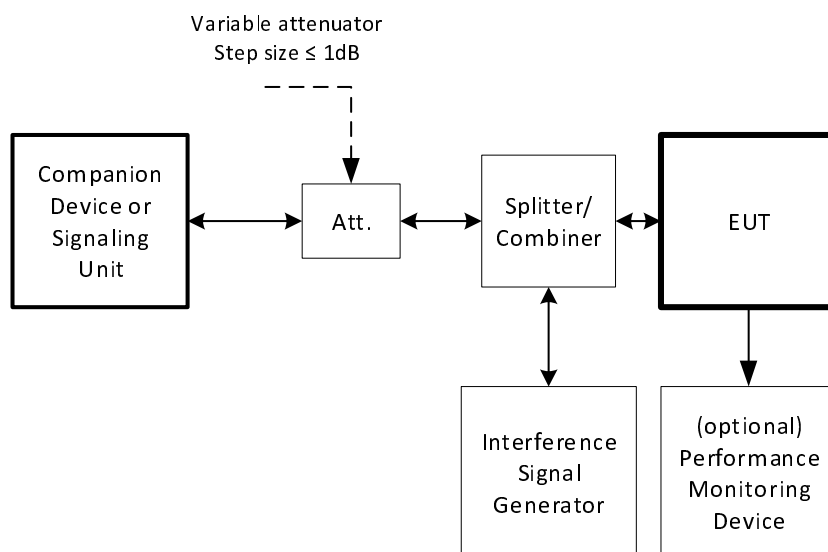


Figure 6: Reference setup for receiver adjacent channel selectivity testing

The steps below define the procedure to verify the receiver adjacent channel requirement as described in clause 4.4.3.

Step 1:

- The EUT shall be set to the lowest operating channel frequency supported (see clause 5.3.1).

Step 2:

- The interfering signal generator is set to the first adjacent channel frequency as defined in clause 4.4.3.2. The interference signal power at adjacent frequency channel and the associated companion device transmitted power on wanted signal frequency shall be adjusted at the EUT receiver input as specified in clause 4.4.3.2.

Step 3:

- With the interfering signal generator switched off, a communication link is set up between the EUT and the associated companion device using the test setup shown in Figure 6. The attenuation of the variable attenuator shall be set to a value of wanted signal as specified in clause 4.4.3.2. For the spectrum analyser use the settings given in Table 22.

Table 22: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Detector mode	RMS
Trace Mode	Clear/Write
Sweep points	1 001
Sweep time	≥ 10 seconds
Centre Frequency	Centre frequency of the channel being tested
Span	2 × Nominal Channel Bandwidth
NOTE 1: Channel power is the integrated power over the Nominal Channel Bandwidth with centre frequency same as the channel during the test.	
NOTE 2: Spectrum analyser shall be configured so that its measurement sweeps occur only during periods when RF transmission is active.	

Step 4:

- The adjacent channel interference signal is switched on and pass-fail decision criteria shall be verified against the criteria specified in clause 4.4.3.2 and recorded in the test report.

Step 5:

- Repeat step 2 to step 4 with the EUT operating at the highest operating channel frequency (see clause 5.3.1).

5.5.2.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.4.2.2.1.

5.5.3 Receiver out of band blocking**5.5.3.1 Test Conditions**

Refer to clause 5.1 for the environmental test conditions. These measurements shall only be performed at normal test conditions.

The test for conformance requirements defined in clause 4.4.4.2 shall be verified at lowest or highest channel of each operating band.

The EUT shall use the operational mode and performance criterion as defined in clause 5.3.5.

If the equipment can be configured to operate with different *Nominal Channel Bandwidths* and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.4.4.2 as provided in the product information for testing (see clause 5.3.1) and shall be described in the test report.

It shall be verified that this performance criteria of clause 4.4.4.2 is achieved during the blocking test.

5.5.3.2 Test Method**5.5.3.2.1 Conducted measurement**

In case device is using multiple receive chains only one chain needs to be tested. All other receiver inputs shall be terminated.

Figure 6 shows the test set-up which can be used for performing the receiver out of band blocking test. The companion device and EUT may require appropriate shielding or may need to be put in a shielded room to prevent it may have a negative impact on the measurement.

The steps below define the procedure to verify the receiver blocking requirement as described in clause 4.4.4.

Step 1:

- The EUT shall be set to the highest or lowest operating channel frequency of the band (see clause 5.3.1).

Step 2:

- The blocking signal generator is set to the first frequency as defined in clause 4.4.4.2. The interference signal power at blocking test frequency and the associated companion device transmitted power on wanted signal frequency shall be adjusted at the EUT receiver as specified in clause 4.4.4.2.

Step 3:

- With the blocking signal generator switched off a communication link is set up between the EUT and the associated companion device using the test setup shown in Figure 6. The attenuation of the variable attenuator shall be increased to a value of wanted signal as specified in clause 4.4.4.2. For the spectrum analyser use the following settings given in Table 23.

Table 23: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Detector mode	RMS
Trace Mode	Clear/Write
Sweep points	1 001
Sweep time	10 seconds
Centre Frequency	Centre frequency of the channel being tested
Span	2 x Nominal Channel Bandwidth
NOTE 1: Channel power is the integrated power over the Nominal Channel Bandwidth with centre frequency same as the channel during the test.	
NOTE 2: Spectrum analyser shall be configured so that its measurement sweeps occur only during periods when RF transmission is active.	

Step 4:

- The blocking signal is switched on and pass-fail decision criteria shall be verified against the criteria specified in clause 4.4.4.2 and recorded in the test report.

Step 5:

- Repeat step 2 to step 4 for each remaining combination of frequency ranges 1 to 3 and levels as specified in clause 4.4.4.2.

Step 6:

- Repeat step 2 to step 5 for all bands EUT is supporting.

5.5.3.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.5.3.2.1.

The level of the blocking signal at the EUT referred to in step 4 is assumed to be the level in front of the EUT antenna(s). The EUT shall be positioned with its main beam pointing towards the antenna radiating the blocking signal.

5.5.4 Receiver spurious response**5.5.4.1 Test Conditions**

Test conditions are the same as in clause 5.5.3.1.

It shall be verified that performance criteria of clause 4.4.5.2 is achieved.

5.5.4.2 Test Method

5.5.4.2.1 Conducted measurement

In case device is using multiple receive chains only one chain needs to be tested. All other receiver inputs shall be terminated.

Figure 6 shows the test set-up which can be used for performing the test. The companion device and EUT may require appropriate shielding or may need to be put in a shielded room to prevent it may have a negative impact on the measurement.

The steps below define the procedure to verify the spurious response requirement as described in clause 4.4.5.

Step 1:

- The EUT shall be set to operating channel frequency selected in clause 5.5.3.2.1.

Step 2:

- The blocking signal generator is set to the first spurious frequency as defined in clause 4.4.5.2. The interference signal power at blocking test frequency and the associated companion device transmitted power on wanted signal frequency shall be adjusted as specified in clause 4.4.5.2.

Step 3:

- With the blocking signal generator switched off a communication link is set up between the EUT and the associated companion device using the test setup shown in Figure 6. The attenuation of the variable attenuator shall be increased to a value of wanted signal as specified in clause 4.4.5.2. For the spectrum analyser use the following settings given in Table 24.

Table 24: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Detector mode	RMS
Trace Mode	Clear/Write
Sweep points	1 001
Sweep time	10 seconds
Centre Frequency	Centre frequency of the channel being tested
Span	2 × Nominal Channel Bandwidth
NOTE 1: Channel power is the integrated power over the Nominal Channel Bandwidth with centre frequency same as the channel during the test.	
NOTE 2: Spectrum analyser shall be configured so that its measurement sweeps occur only during periods when RF transmission is active.	

Step 4:

- The blocking signal is switched on and pass-fail decision criteria shall be verified against the criteria specified in clause 4.4.5.2 and recorded in the test report.

Step 5:

- Repeat step 2 to step 4 for each of the spurious frequencies as specified in clause 4.4.5.2.

5.5.4.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.5.4.2.1.

The level of the blocking signal at the EUT referred to in step 4 is assumed to be the level in front of the EUT antenna(s). The EUT shall be positioned with its main beam pointing towards the antenna radiating the blocking signal.

5.5.5 Receiver Intermodulation

5.5.5.1 Test Conditions

Refer to clause 5.1 for the environmental test conditions. These measurements shall only be performed at normal test conditions.

The test for conformance requirements defined in clause 4.4.6.2 shall be verified at lowest or highest channels of each operating band.

The EUT shall use the physical layer configuration and performance criterion as defined in clause 5.3.5.

If the equipment can be configured to operate with different *Nominal Channel Bandwidths* and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.4.6.2 as provided in the product information for testing (see clause 5.3.1) and shall be described in the test report.

It shall be verified that this performance criteria of clause 4.4.6.2 is achieved during the test.

5.5.5.2 Test Method

5.5.5.2.1 Conducted measurement

In case device is using multiple receive chains only one chain needs to be tested. All other receiver inputs shall be terminated.

Figure 7 shows the test set-up which can be used for performing the receiver intermodulation test. The companion device and EUT may require appropriate shielding or may need to be put in a shielded room to prevent it may have a negative impact on the measurement.

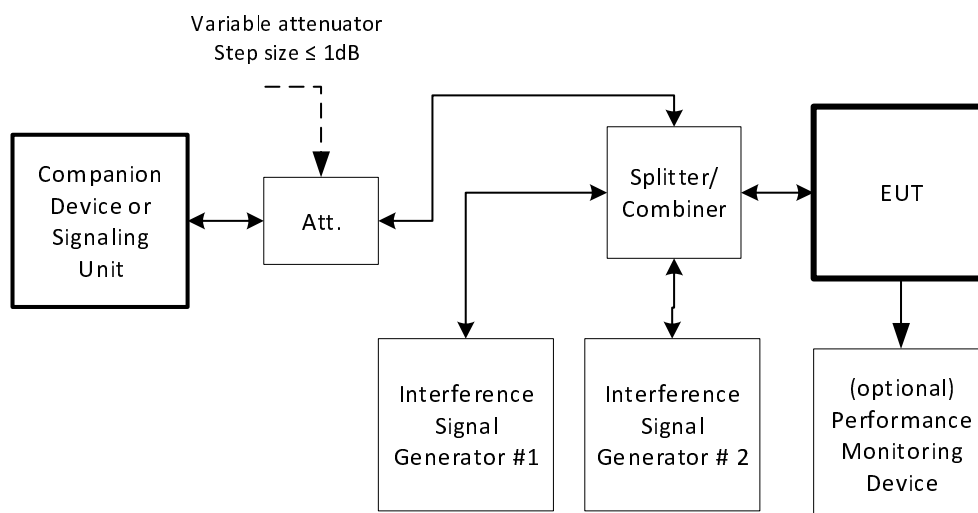


Figure 7: Reference setup for receiver intermodulation testing

The steps below define the procedure to verify the intermodulation requirement as described in clause 4.4.6.

Step 1:

- The EUT shall be set to the highest or lowest operating channel frequency of the band (see clause 5.3.1).

Step 2:

- The interference signal generators are set to the appropriate frequencies as defined in clause 4.4.6.2. The interference signal powers and the associated companion device transmitted power on wanted signal frequency shall be adjusted as specified in clause 4.4.6.2.

Step 3:

- With the interference signal generators switched off a communication link is set up between the EUT and the associated companion device using the test setup shown in Figure 7. The attenuation of the variable attenuator shall be increased to a value of wanted signal as specified in clause 4.4.6.2. For the spectrum analyser use the following settings given in Table 25.

Table 25: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Detector mode	RMS
Trace Mode	Clear/Write
Sweep points	1 001
Sweep time	10 seconds
Centre Frequency	Centre frequency of the channel being tested
Span	2 x Nominal Channel Bandwidth
NOTE 1: Channel power is the integrated power over the Nominal Channel Bandwidth with centre frequency same as the channel during the test.	
NOTE 2: Spectrum analyser shall be configured so that its measurement sweeps occur only during periods when RF transmission is active.	

Step 4:

- The interference signal is switched on and pass-fail decision criteria shall be verified against the criteria specified in clause 4.4.6.2 and recorded in the test report.

5.5.5.2.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.5.5.2.1.

The level of the interference signals at the EUT referred to in step 4 is assumed to be the level in front of the EUT antenna(s). The EUT shall be positioned with its main beam pointing towards the antenna radiating the blocking signal.

5.5.6 Receiver unwanted emissions in the spurious domain**5.5.6.1 Purpose**

The objective of these tests is to ensure that the EUT receiver spurious emissions comply with the specifications set out in clause 4.4.7.

5.5.6.2 Test Conditions

For the duration of the test, the EUT shall be configured to operate in a continuous receive mode or is operated in a mode where no transmissions occur at receiving intervals during measurements.

These measurements shall only be performed at normal test conditions.

The level of spurious emissions shall be measured as, either:

- their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or
- their effective radiated power when radiated by cabinet and antenna in case of integral antenna equipment with no temporary antenna connectors.

The measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.

5.5.6.3 Test Method

5.5.6.3.1 Conducted measurement

The EUT shall be connected to a spectrum analyser.

The frequency scan test procedure below shall be used to identify potential receiver spurious emissions of the EUT.

a) Frequency scan

Step 1:

- The sensitivity of the measurement set-up shall be such that the noise floor is at least 12 dB below the limits given in clause 4.4.7.2. The EUT receiver is set on lowest frequency channel the equipment can operate.

Step 2:

- The emissions shall be measured over the range 30 MHz to 1 000 MHz, with the spectrum analyser settings given in Table 26.

Table 26: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace Mode	Max Hold
Sweep Points	≥ 9 700 (see note)
Sweep time	For non-continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two receptions of the EUT
NOTE:	For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.4.3.1.2.1.2 (step 1, last point on adjusting the frequency) may be omitted.

- Any emissions identified during the above sweeps which fall above the applicable limit, or within the 6 dB range below the applicable limit given in clause 4.4.7.2 shall be individually measured using the *measurement of identified emissions* procedure below.

Step 3:

- The emissions shall now be measured over the range 1 GHz to F_{upper} with the following spectrum analyser settings, where F_{upper} shall be at least the 5th harmonic of the upper band edge frequency of the service band the EUT is designed for operation. For the spectrum analyser use the settings given in Table 27.

Table 27: Spectrum analyser settings

Parameter	Settings
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace Mode	Max Hold
Sweep points	≥ 8 500 (see note)
Sweep time	For non-continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 1 MHz frequency step, the measurement time is greater than two receptions of the EUT
NOTE:	For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.4.3.1.2.1.2 (step 1, last point on adjusting the frequency) may be omitted.

- Any emissions identified during the above sweeps which fall above the applicable limit, or within the 6 dB range below the applicable limit in clause 4.4.6.2, shall be individually measured using the measurement of emissions identified during frequency scan procedure below.

Step 4:

- Repeat step 2 to step 3 with the EUT receiver operating at the highest channel frequency the equipment can operate.

b) Measurement of the emissions identified during the frequency scan

Step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions identified during the frequency scan measurements above.

Step 1:

- The level of the emissions shall be measured using the settings given in Table 28.

Table 28: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Frequency of emission identified during the frequency scan
Resolution Bandwidth	100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
Video Bandwidth	300 kHz (< 1 GHz) / 3 MHz (> 1 GHz)
Frequency Span	0 Hz
Sweep Mode	Single sweep
Sweep Time	Suitable to capture one transmission burst. Additional measurements may be needed to identify the length of the transmission burst. In case of continuous signals, the Sweep Time shall be set to 30 ms
Sweep points	Sweep time [μs] / 1 μs with a maximum of 30 000
Trigger	Video (for burst signals) or Manual (for continuous signals)
Detector	RMS
Trace Mode	Clear/Write

Step 2:

In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 1 needs to be repeated for each of the active receive chains.

The trace data for each receive chain shall be recorded.

Sum the power in each of the traces for each individual frequency bin.

Step 3:

Use the marker function to find the highest peak within the measurement trace and record its value and its frequency.

Step 4:

The measured values shall not exceed the limits defined in clause 4.4.6.2.

Repeat the above procedures for every emission identified during the frequency scan.

5.5.6.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.5.6.3.1.

5.6 Test methods for Channel Access**5.6.1 Generic Test procedure for measuring channel or frequency use****5.6.1.1 Purpose**

The purpose of the tests specified in clause 5.6 is to verify the channel access requirements set in clause 4.5 for device operating in FT and PT modes. Clause 5.6.1 provides a generic test procedure for measuring channel or frequency use.

5.6.1.2 Test Conditions

These tests are performed in normal test conditions as defined in clause 5.1.2.

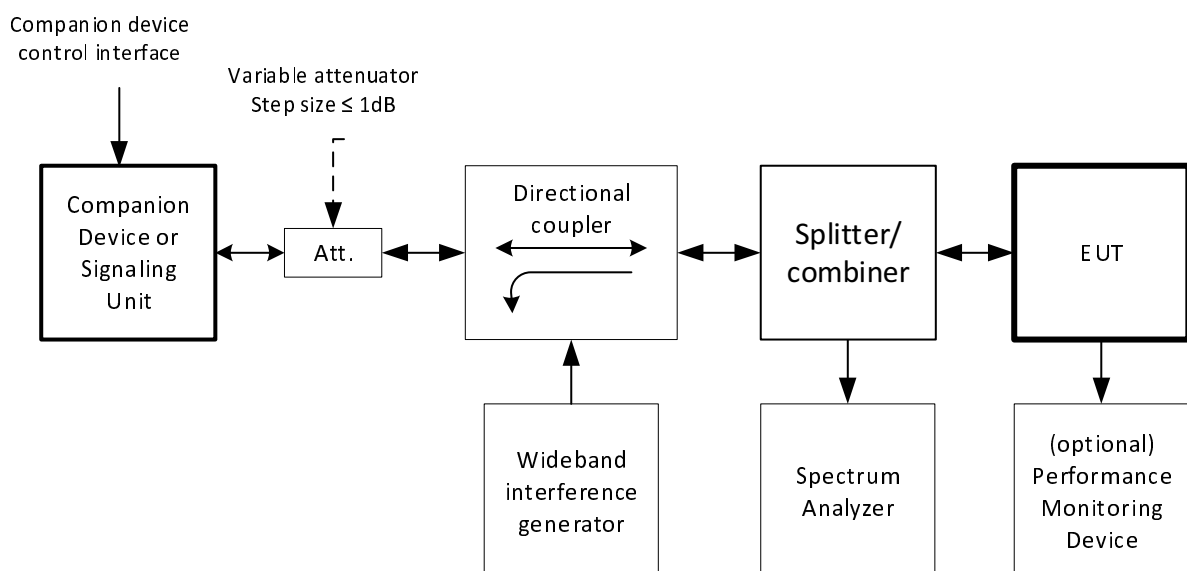
5.6.1.3 Test Method**5.6.1.3.1 Conducted measurement**

Figure 8: Reference setup for channel access testing

Figure 8 shows the reference setup for channel access testing. This is a generic test method to evaluate transmissions on the operating frequency being investigated. This test is performed as part of the procedures described in clause 5.6.2 to clause 5.6.5.

The test procedure shall be as follows:

Step 1:

- The spectrum analyser shall be set as in Table 29.

Table 29: Spectrum analyser settings

Parameter	Settings
Centre Frequency	Centre frequency of the channel being investigated
Frequency Span	0 Hz
RBW	~50 % of the Nominal Channel Bandwidth (if the analyser does not support this setting, the highest available setting shall be used)
VBW	≥ RBW (if the analyser does not support this setting, the highest available setting shall be used)
Detector Mode	RMS
Sweep time	> 100 ms Note that if the transmission is non-contiguous, the sweep time shall be sufficient to cover the period over which the transmission time is spread out
Number of sweep points	The time resolution is adjusted to be sufficient to meet the maximum measurement uncertainty of 5 % for the period to be measured
Trace mode	Clear/Write
Trigger	Video

Step 2:

- Save the trace data to a file for further analysis by a computing device using an appropriate software application or program.

Step 3:

- Identify the data points related to the frequency being investigated by applying a threshold.
- Count the number of consecutive data points identified as resulting from a single transmission on the frequency being investigated and multiply this number by the time difference between two consecutive data points. Repeat this for all the transmissions within the measurement window.
- For measuring silent periods, count the number of consecutive data points identified as resulting from a single transmitter off period on the frequency being investigated and multiply this number by the time difference between two consecutive data points. Repeat this for all the transmitter off periods within the measurement window.

5.6.1.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.1.3.1.

5.6.2 Channel Access of a Radio Device in FT mode

5.6.2.1 Purpose

The purpose of this test is to verify the operating channel selection by a device operating in FT mode.

5.6.2.2 Test Conditions

Test is performed in normal conditions as defined in clause 5.1.2. The interference signal defined in clause 5.3.2.3 is applied in the operating band with centre frequencies as defined in clause 4.3.2.3 from 1 885 MHz to 1 895 MHz.

5.6.2.3 Test Method

5.6.2.3.1 Conducted measurement

Step 1 to step 4 below define the procedure to verify the radio device in FT mode compliance to operating channel selection requirement.

For systems using multiple receive chains only one chain (antenna port) needs to be tested. All other receiver inputs shall be terminated.

Step 1:

- The AWGN interference signal generator(s), the spectrum analyser and the EUT are connected as given by Figure 8.
- Set the interference signal generator(s) to produce wide band interference which covers at least 40 % up to 80 % of the operating band. The power spectral density level (at the input of the EUT) of the interference signal level at the EUT receiver input shall be at least 3 dB above the detection threshold defined as $-52 \text{ dBm} - P_{\text{out max}}$ in ETSI TS 103 636-4 [1].
- Verify with spectrum analyser that the interference level at EUT receiver input is according to the limits set above.
- The spectrum analyser is used to monitor the transmissions of the EUT.

Step 2:

- Power on and configure the EUT to transmit with maximum transmitter activity supported by the EUT based on product information (see clause 5.3.1).
- The EUT shall select operating channel frequency during the test based on its measurements according to clause 4.5.2.2.

Step 3: Verification of operating channel selection

- Using spectrum analyser and the procedure defined in clause 5.6.1, verify that transmissions of the EUT are operating on channels not interceded by interference generator(s).

Step 4:

- Power off the EUT and repeat step 1 to step 3 with one different interfering channel position.

5.6.2.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.2.3.1.

5.6.3 Channel Access of a Radio Device in PT mode and Random Access

5.6.3.1 Purpose

The purpose of this test is to verify that a device operating in PT mode follows the random-access resource configuration of the companion device operating in FT mode and in absence of companion device information stops transmission.

5.6.3.2 Test Conditions

Test is performed in normal condition on the operating channel defined by the companying device.

5.6.3.3 Test Method

5.6.3.3.1 Conducted measurement

Step 1 to step 7 below define the procedure to verify that the radio device in PT mode complies to the random access requirements.

For systems using multiple receive chains only one chain (antenna port) needs to be tested. All other receiver inputs shall be terminated.

Step 1: Setup

- The EUT shall connect to a companion device during the test according to clause 4.5.3.2. The spectrum analyser, the EUT and the companion device are connected using a set-up equivalent to the example given by Figure 8. The spectrum analyser is used to monitor the transmissions of both the EUT and the companion device and it should be possible to distinguish between either transmission.
- Adjust the received signal level from the companion device to the receiver input of the EUT to the value of free or possible as defined in clause 4.5.2.2. For the spectrum analyser use the settings given in Table 21.

Step 2: Verification of EUT behaviour on random access resources provided by the companion device

- Configure the EUT to transmit with maximum transmitter activity supported by the EUT based on product information (see clause 5.3.1).
- Configure the companion device to broadcast Random Access Resource allocations as defined in clause 4.5.3.1.
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT follows the instructions of the companion device as defined in clause 4.5.3.2. For the spectrum analyser use the settings given in Table 29.

Step 3: The companion device revoke the resources for random access or changes operating frequency of its random access resources

- The companion device is configured to revoke or to no longer advertise the resources for random access or to change operating frequency of its random access resources.
- The companion device shall inform via control interface when it has revoked or no longer advertise the resources for random access or when it has changed operating frequency of its random access resources and instructed the EUT.

Step 4: Verification of EUT reaction to no longer valid resource allocation for random access

- The spectrum analyser shall be used to monitor the transmissions of the EUT on the selected operating channel. For the spectrum analyser use the settings given in Table 29.
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT stops its transmissions on the current operating channel as defined in clause 4.5.3.2.
- After execution of step 3, the end of the next transmission occurrence by the EUT is considered as reference for the time limit to cease transmissions on the current operating channel.

Step 5: Restart with step 1, but skip step 3 and step 4, and continue with step 6

Step 6: Removing companion device transmission

- The companion device transmission is removed, by disconnecting the device or significantly increasing its attenuation.

Step 7: Verification of EUT reaction to the lack of companion device signal

- The spectrum analyser shall be used to monitor the transmissions of the EUT on the selected operating channel. For the spectrum analyser use the settings given in Table 29.

- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT stops its transmissions on the current operating channel as defined in clause 4.5.3.2.
- After execution of step 6, the end of the 10th transmission occurrence by the EUT is considered as reference start time for the time limit to cease transmissions on the current operating channel.

5.6.3.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.3.3.1.

5.6.4 Channel Access of a Radio Device in FT mode for Scheduled Access

5.6.4.1 Purpose

A radio device in FT mode had performed steps defined in clause 4.5.2 for selecting the operating channel and in clause 4.5.3 for providing random access information.

The radio device operating in FT mode and supporting scheduled data transfer assigns and informs the companion device in PT mode of resources for scheduled data transfer as defined in ETSI TS 103 636-4 [1], clause 5.4.

5.6.4.2 Test Conditions

The EUT is configured to be in FT mode only and to assign resources for scheduled data transfer to the companion device in PT mode on the same carrier.

The companion device is successfully associated to the EUT and configured to transmit on scheduled resources to the maximum extent possible based on product information (see clause 5.3.1).

5.6.4.3 Test Method

5.6.4.3.1 Conducted measurement

It is verified with the generic procedure given in clause 5.6.1 that the EUT is able to instruct the companion device in PT mode to employ certain resources for scheduled data transfer.

5.6.4.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.4.3.1.

5.6.5 Channel Access of a Radio Device in PT mode for Scheduled Access

5.6.5.1 Purpose

The purpose of this test is to verify that the device operating in PT mode obeys the scheduled resource allocation supplied by the companion device operating in FT mode, and in the absence of information from the companion device stops its own transmission.

5.6.5.2 Test Conditions

Test is performed in normal test condition on the operating channel defined by the companion device.

The EUT is configured to PT mode only and the companion device operates in FT mode.

Before starting the test, the EUT (PT mode) should have successfully performed an association to the companion device in FT mode.

Further, the companion device in FT mode is configured to assign only resources for scheduled access to the EUT on the same carrier.

5.6.5.3 Test Method

5.6.5.3.1 Conducted measurement

Step 1 to step 7 below define the procedure to verify that the radio device in PT mode complies to scheduled resource access requirements.

For systems using multiple receive chains only one chain (antenna port) needs to be tested. All other receiver inputs shall be terminated.

Step 1: Setup

- The EUT shall connect to a companion device during the test according to clause 4.5.5.2. The spectrum analyser, the EUT and the companion device are connected using a set-up equivalent to the example given by Figure 8. The spectrum analyser is used to monitor the transmissions of both the EUT and the companion device and it should be possible to distinguish between either transmission.
- Adjust the received signal level from the companion device to the receiver input of EUT to the value of free or possible as defined in clause 4.5.2.1. For the spectrum analyser use the settings given in Table 21.

Step 2: Verification of EUT reaction to the scheduled data transfer procedure initiated by the companion device (FT mode)

- The companion device in FT mode is configured to assign resources for scheduled access to the EUT on the same carrier.
- The EUT is configured to transmit on the scheduled resources to the maximum extent supported based on product information (see clause 5.3.1).
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT follows the instructions of the companion device as defined in clause 4.5.3.2. For the spectrum analyser use the settings given in Table 29.

Step 3: The companion devices revoke the resources for scheduled data transfer

- The companion device is configured to revoke or to no longer advertise the resources for scheduled data transfer.
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT follows the instructions of the companion device. For the spectrum analyser use the settings given in Table 29.

Step 4: Verification of EUT reaction to a no longer valid resource allocation for scheduled data transfer

- The spectrum analyser shall be used to monitor the transmissions of the EUT on the selected operating channel. For the spectrum analyser use the settings given in Table 29.
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT stops its transmissions on scheduled resources in the current operating channel as defined in clause 4.5.3.2.
- After execution of step 3, the end of the next transmission occurrence by the EUT is considered as reference for the time limit requirement to cease transmissions on scheduled resources on the current operating channel.

Step 5: Restart with step 1, but skip step 3 and step 4, and continue with step 6

Step 6: Removing companion device transmission

- The companion device transmission is removed, by disconnecting the device or significantly increasing its attenuation.

Step 7: Verification of EUT reaction to the lack of companion device signal

- The spectrum analyser shall be used to monitor the transmissions of the EUT on the selected operating channel.
- Using the procedure defined in clause 5.6.1, it shall be verified that the EUT stops its transmissions on the current operating channel as defined in clause 4.5.3.2. For the spectrum analyser use the settings given in Table 29.
- After execution of step 6, the end of the 10th transmission occurrence by the EUT is considered as reference for the time limit requirement to cease transmissions on the current operating channel.

5.6.5.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.5.3.1.

5.6.6 Maximum Transmission Time of a Radio Device**5.6.6.1 Purpose**

The purpose of this test is to verify the compliance regarding the Maximum Transmission Time requirement of a radio device in a 10 ms interval.

5.6.6.2 Test Conditions

These measurements shall only be performed at normal test conditions.

The device shall be configured to operate at its maximum output power level.

The operational mode of the device shall ensure a transmitter activity in a period of 10 ms to the maximum extent the device is supporting according to product information (see clause 5.3.1). The representative transmission according to clause 5.3.3.1 may be applied for this purpose.

All measurements shall have temporal resolution of less than or equal to 1 μ s.

The measurement equipment shall be able to observe the EUT behaviour for a duration of at least 250 ms at the aforementioned temporal resolution.

5.6.6.3 Test Method**5.6.6.3.1 Conducted measurement**

Step 1 to step 3 below define the procedure to verify that the radio device complies to the maximum transmission time requirements.

Step 1:

- For the spectrum analyser use the settings given in Table 21.

- The EUT shall connect to a companion device during the test according to clause 4.5.5.2. The spectrum analyser, the EUT and the companion device are connected using a set-up equivalent to the example given by Figure 8. The spectrum analyser is used to monitor the transmissions of both the EUT and the companion device and it should be possible to distinguish between either transmission. The interference signal generator is switched off as it is not required in this test.

Adjust the received signal level from the companion device to the receiver input of EUT to the value of free or possible as defined in clause 4.5.2.1.

Step 2:

- Perform a measurement with the EUT transmitting according to clause 5.6.6.2 and record a trace only containing transmissions by the EUT. For the spectrum analyser use the settings given in Table 29.

Step 3:

- Identify all transmissions of the EUT and their durations based on 6 dB above -50 dBm (Tx-off power) criterium for transmissions.
- Analyse the transmission time(s) observed in each 10 ms interval containing transmission activity during the measurement time. The analysis starts with the beginning of the first transmission in a 10 ms interval. The duration of the individual transmissions within a 10 ms interval is summed up and provides the maximum transmission time in 10 ms. A transmission that does not fall entirely within a 10 ms interval is taken into account by only considering the duration that falls within the 10 ms interval.
- Verify that the transmission time(s) of the EUT complies with the requirements defined in clause 4.5.6.2.

5.6.6.3.2 Radiated measurement

Radiated measurements shall only be used for an EUT with integral antenna(s) and without a temporary antenna connector(s)/test fixture.

The test set up as described in annex C shall be used with a spectrum analyser connected to the measurement antenna.

The test procedure is as described under clause 5.6.6.3.1.

Annex A (informative): Maximum measurement uncertainty

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit is 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 is included in the test report.

Table A.1 shows the recommended values for the maximum measurement uncertainty figures.

Table A.1: Maximum measurement uncertainty

Parameter	Uncertainty
Radio frequency	± 10 ppm
RF power conducted	$\pm 1,5$ dB
RF power radiated	± 6 dB
Spurious emissions, conducted	± 3 dB
Spurious emissions, radiated	± 6 dB
Humidity	± 5 %
Temperature	± 2 °C
Time	± 10 %

Annex B (informative): Physical layer measurement channel configuration

The receiver performance can be measured by using fixed (static modulation and coding scheme) physical layer measurement channel configuration defined in Table B.1. The physical measurement channel is specified in ETSI TS 103 636-3 [i.10].

Table B.1: Physical layer measurement channel configuration

Parameter	Value	Unit
Nominal channel bandwidth	BW_{Nominal}	MHz
Subcarrier scaling factor $\mu = 1$	27	kHz
Fourier transform scaling factor β	$\beta = 1$ for $BW_{\text{Nominal}} = 1,728$ MHz $\beta = 2$ for $BW_{\text{Nominal}} = 3,456$ MHz $\beta = 4$ for $BW_{\text{Nominal}} = 6,912$ MHz	
Modulation	QPSK	
Coding	$\frac{1}{2}$	
Test channel	Static AWGN	

Annex C (normative): Test sites and arrangements for radiated measurements

C.1 Introduction

This annex describes the use of test sites (including antennas) to perform radiated measurements in accordance with the present document.

In addition the present annex describes the use of a test fixture to perform conducted (relative) measurements on equipment with integral antennas. It also defines the interference signal to be used in the adaptivity tests.

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 C.2. Clause C.3 describes the antennas used in these test sites.

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 [i.7] for the OATS, in clause 6 of ETSI TR 102 273-3 [i.6] for the SAR, and in clause 6 of ETSI TR 102 273-2 [i.5] 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 [i.3] and ETSI TR 100 028-2 [i.4], ETSI TR 102 273-2 [i.5], ETSI TR 102 273-3 [i.6] and ETSI TR 102 273-4 [i.7].

C.2 Radiation test sites

C.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 C.1.

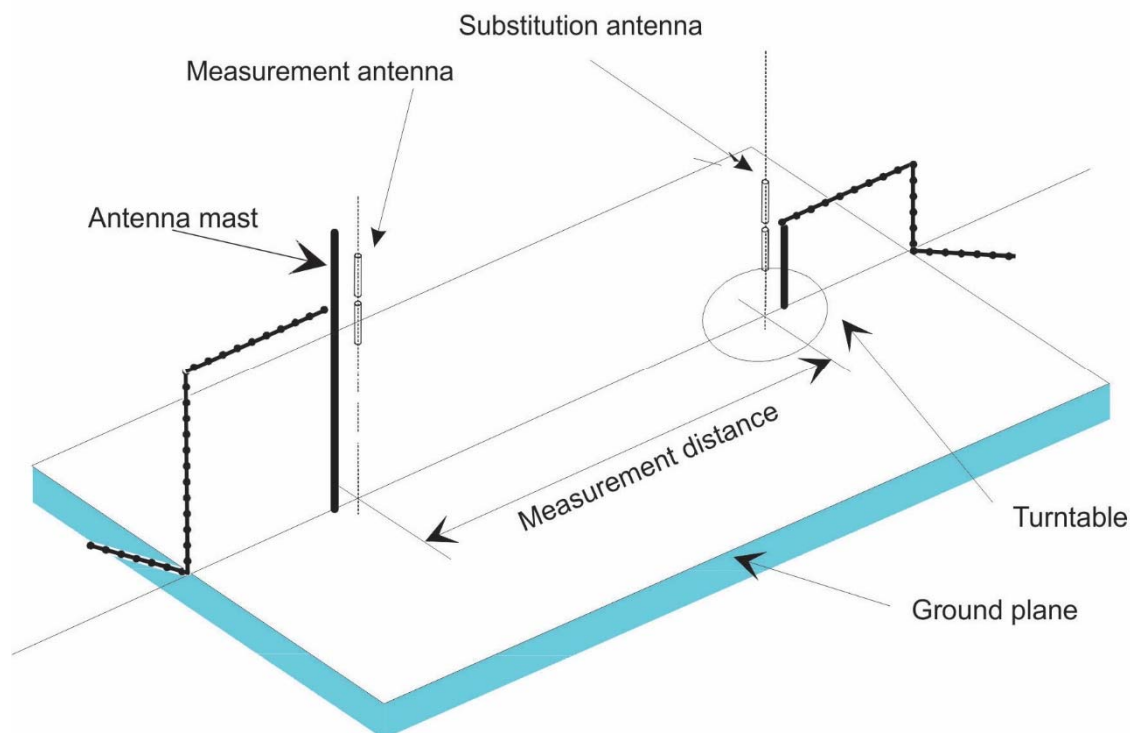


Figure C.1: A typical Open Area Test Site

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 an 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 height of usually 1,5 m above the ground plane.

The measurement distance and minimum chamber dimensions can be found in clause C.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 [i.7].

C.2.2 Semi Anechoic Room (SAR)

A Semi Anechoic Room - 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 C.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.

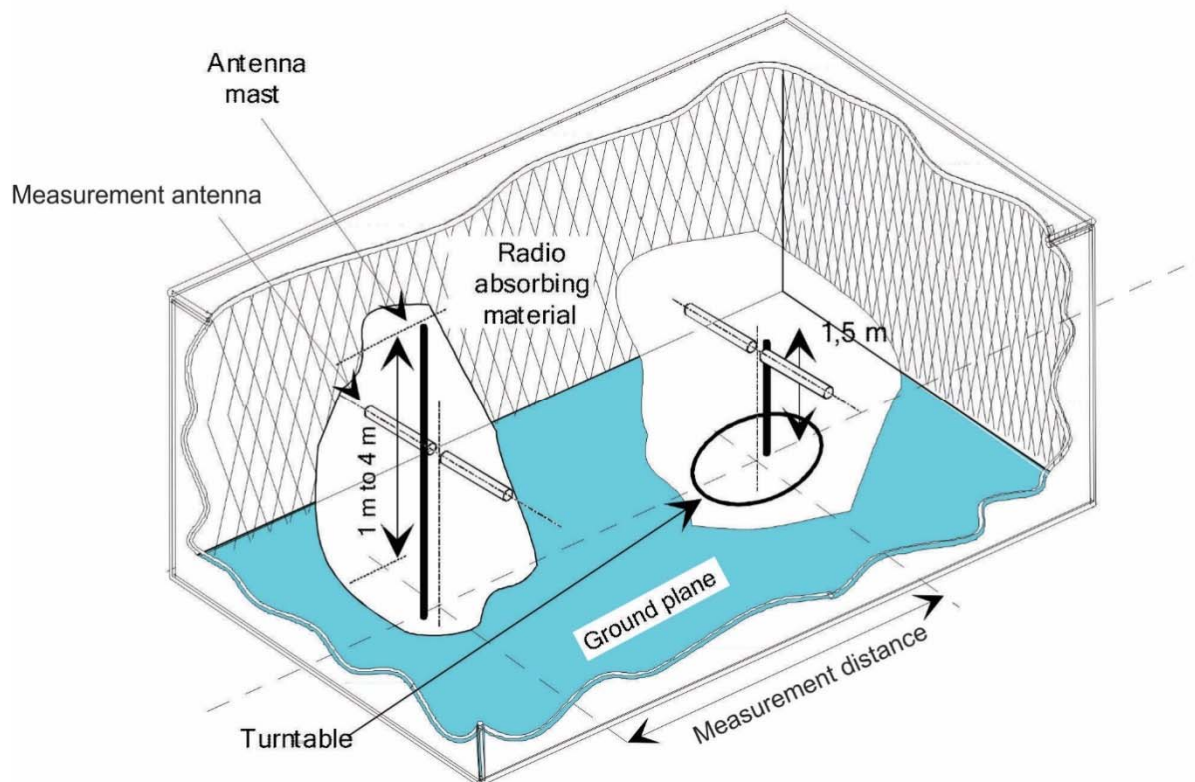


Figure C.2: A typical Semi Anechoic Room

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 an 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 height of usually 1,5 m above the ground plane.

The measurement distance and minimum chamber dimensions can be found in clause C.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 [i.6].

C.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 C.3.

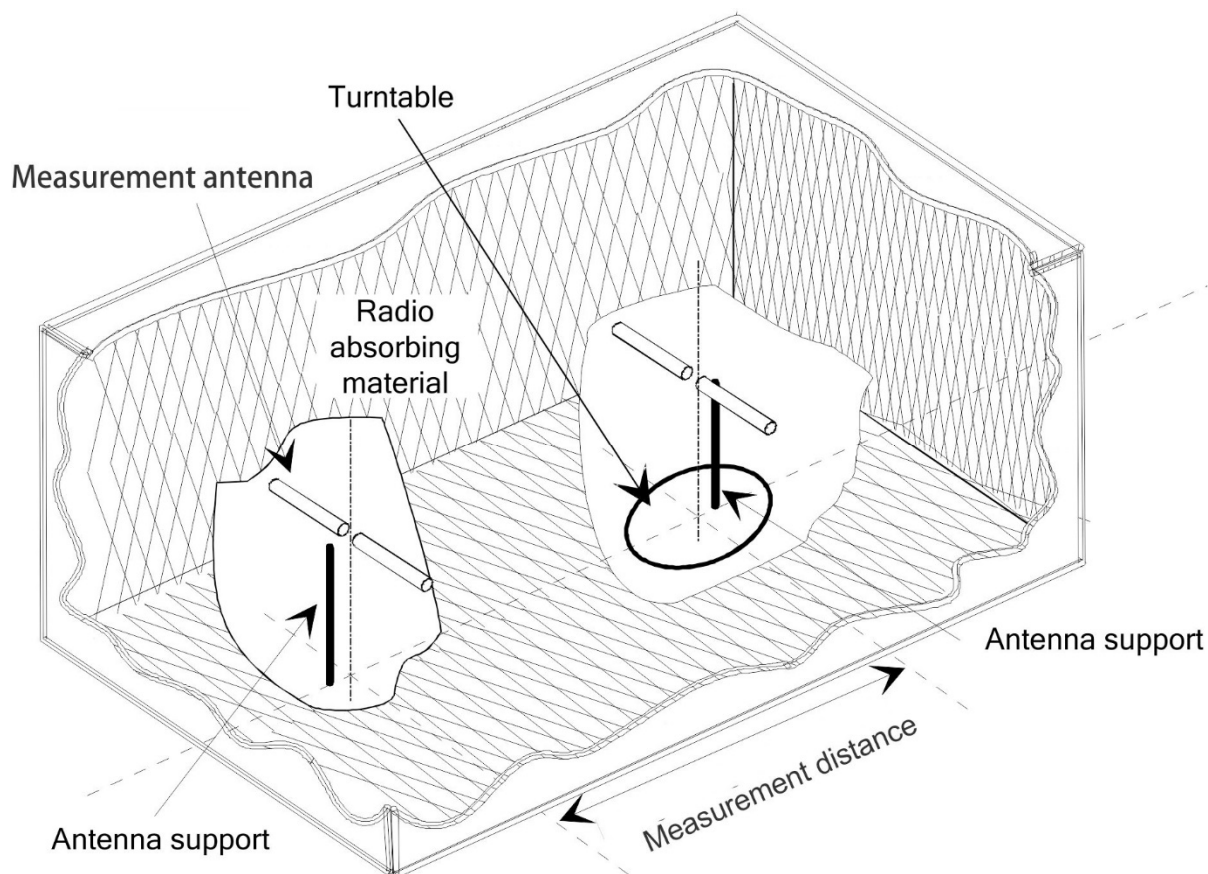


Figure C.3: A typical Fully Anechoic Room

The chamber shielding and radio absorbing material 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 have to be measured.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the EUT at a height of usually 1 m above the absorbing material.

The measurement distance and minimum chamber dimensions can be found in clause C.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 [i.5].

C.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 $r_m \gg \frac{D^2}{\lambda}$, 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.

C.3 Antennas

C.3.1 Introduction

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

C.3.2 Measurement antenna

The measurement antenna is used to determine the field from the EUT and from the substitution antenna. 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.

C.3.3 Substitution antenna

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

The substitution antenna 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 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 below 1 GHz, the calibration is relative to a half wave dipole, while above 1 GHz, an isotropic radiator is the reference.

C.4 Test fixture

C.4.1 Introduction

Conducted measurements may be applied to equipment provided with a (temporary) antenna connector, e.g. by means of a spectrum analyser.

In the case of integral antenna equipment with no external (temporary) antenna connector(s) provided, a test fixture can be used to allow relative measurements to be performed at the extremes of temperature.

C.4.2 Description of the test fixture

The test fixture shall provide a means of coupling to the radio frequency output(s) of the EUT.

The impedance of the external connection to the test fixture shall be 50 Ω at the working frequencies of the equipment.

The performance characteristics of this test fixture under normal and extreme conditions shall be such that:

- a) the coupling loss shall be limited to ensure a sufficient dynamic range of the setup;
- b) the variation of coupling loss with frequency shall not cause errors exceeding ± 2 dB;
- c) the coupling device shall not include any non-linear elements.

C.4.3 Using the test fixture for relative measurements

The different steps below describe the principle for performing relative measurements for those requirements where testing needs to be repeated at the extremes of the temperature.

Step 1:

Perform the measurement under normal conditions on a test site for radiated measurements as described in clause C.2. This will result in an absolute value for the requirement being tested. This value shall be recorded.

Step 2:

Put the equipment with the test fixture in the temperature chamber. Perform the same measurement at normal conditions in this environment and normalize the measuring equipment to get the same reading as before in step 1.

Step 3:

Ensure that the RF coupling accuracy remains within the range specified in clause C.4.2, item b).

Step 4:

Change the temperature in the temperature chamber and perform the measurement again. Due to the normalization done in step 2, the result will be the value for this requirement at the extreme condition.

C.5 Guidance on the use of radiation test sites

C.5.1 Introduction

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 D.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. $\frac{\epsilon}{\epsilon_0} < 1,5$) material(s) such as expanded polystyrene, balsawood, etc.

C.5.2 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 "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).

C.5.3 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: $\pm 0,5$ dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

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

C.6 Coupling of signals

C.6.1 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).

C.6.2 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.

Annex D (normative): Procedures for radiated measurements

D.1 Introduction

The present annex gives the general procedures for radiated measurements using the test sites and arrangements described in annex C.

Preferably, radiated measurements shall be performed in a FAR, see clause D.3. Radiated measurements in an OATS or SAR are described in clause D.2.

D.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 C. The measurement set-up shall be calibrated according to the procedure defined in the present 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 D.1) shall be oriented initially for vertical polarization unless otherwise stated and the EUT (device 1 in Figure D.1) shall be placed on the support in its standard position and switched on.
- b) The measurement equipment (device 3 in Figure D.1) shall be connected to the measurement antenna and set-up according to the specifications of the test.

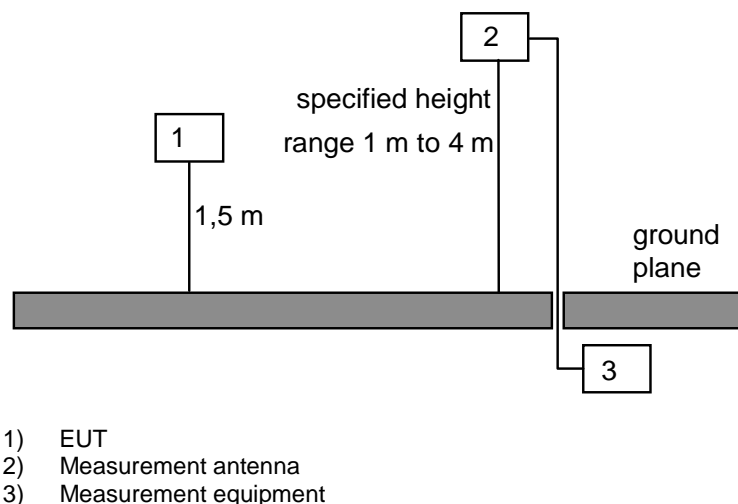


Figure D.1: Measurement arrangement

- c) The EUT shall be rotated through 360° in a horizontal plane until a higher maximum signal is received.
- d) The measurement antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be recorded. This maximum may be a lower value than the value obtainable at heights outside the specified limits.
- e) This measurement procedure in step c) and step d) above shall be repeated for horizontal polarization.

D.3 Radiated measurements in a FAR

For radiated measurements using a FAR, the procedure is identical to the one described in clause C.2, except that the height scan in step d) is omitted.

D.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 C.1. The substitution antenna shall have vertical polarization.
- 2) Connect a 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 height shall be varied within the range provided in Figure C.1 to ensure that the maximum signal is received.
- 4) Subsequently, the power of the signal generator is 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 with the substitution antenna gain minus the cable losses (values in dB).
- 6) This measurement procedure described in step 2) to step 5) above shall be repeated with horizontal polarization for the substitution antenna.

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

Annex E (normative): Receiver Testing

E.1 Statistical testing of receiver characteristics

E.1.1 Description

The test of receiver characteristics is twofold:

- 1) A signal or a combination of signals is offered to the RX port(s) of the EUT.
- 2) The ability of the EUT to demodulate/decode this signal is verified by measuring the throughput.

The maximum achievable throughput shall be verified in good signal conditions.

The signal conditions shall be set at least to a value of the test limit, where the minimum requirement is to reach > 90 % of the maximum throughput supported by the EUT.

All receiver tests are performed in static propagation conditions. No fading conditions are applied.

E.1.2 Mapping the throughput to error ratio

E.1.2.1 Defining throughput and bitrate

The measured information bit throughput is defined as the sum of the information bit payloads successfully received during the test interval, divided by the duration of the test interval (in seconds).

The physical bitrate performance can be observed by deducting the detected physical layer payload packet errors from the total amount of the physical layer packets transmitted during the observation time.

$$\text{Bitrate} = \text{Maximum averaged throughput} - \text{Error Rate (ER)} \times \text{Maximum averaged throughput}$$

E.1.2.2 Mapping the ACK/NACK to error ratio

In measurement practice the EUT indicates successfully received information bit payload by signalling an ACK to the Companion Device. If payload is received, but damaged and cannot be decoded, the UE signals a NACK.

The time in the measurement interval is composed of successfully received subframes (ACK), unsuccessfully received subframes (NACK).

The pass-fail decision is done by observing the:

- number of NACKs
- number of ACKs

The measured physical layer Error Rate (ER) is calculated:

$$ER = \frac{NACK}{ACK + NACK}$$

Where:

NACK = not successfully received physical layer payload packet; and

ACK = successfully received physical layer payload packet.

E.1.2.3 Mapping the received packet count to error ratio

The EUT records successfully received information bit payload packets and is able to report the number of successfully received packets within the measurement interval.

The measured physical layer Error Rate (ER) is calculated:

$$ER = \frac{TRANSMITTED\ PACKETS - SUCCESSFULLY\ RECEIVED\ PACKETS}{TRANSMITTED\ PACKETS}$$

The following examples of methods are provided for information:

- Method 1: Obtain the raw data bits received by the EUT and compare them with the sent ones to determine whether packet reception was successful.
- Method 2: Read out EUT-internal CRC based counter of correctly received packets.
- Method 3: Read out the physical layer Error Rate (ER) measurement of the EUT.

E.1.3 Design of the test

The test is defined by the following parameters:

- 1) Limit the Error Rate (ER) = 0,10 (Throughput limit = 90 %)
- 2) Confidence level C = 99 % and reliability R = 90 %

E.1.4 Numerical definition of the pass-fail limits

Using Bayes success-run theorem the required sample size n_S is based on the confidence level $C = 0,99$ and reliability $R = 0,90$ with a maximum number of failures n_e allowed is given by:

$$n_S = \frac{0,5 \times X_{2(n_e+1)}^2(1-C)}{1-R},$$

where $X_{2(n_e+1)}^2(1-C)$ is a Chi-square value for given confidence level C and $2(n_e + 1)$ degrees of freedom.

Table E.1 has pass-fail limits given by the equation above tabulated.

Table E.1: Pass-Fail limits

n_e	n_s	n_e	n_s	n_e	n_s	n_e	n_s
0	47	30	455	60	807	90	1 147
1	67	31	467	61	818	91	1 158
2	85	32	479	62	830	92	1 169
3	101	33	491	63	841	93	1 181
4	117	34	503	64	853	94	1 192
5	132	35	515	65	864	95	1 203
6	146	36	527	66	875	96	1 214
7	160	37	538	67	887	97	1 225
8	175	38	550	68	898	98	1 237
9	188	39	562	69	910	99	1 248
10	202	40	574	70	921	100	1 259
11	215	41	586	71	932	101	1 270
12	229	42	598	72	944	102	1 281
13	242	43	609	73	955	103	1 292
14	255	44	621	74	967	104	1 303
15	268	45	633	75	978	105	1 315
16	281	46	645	76	989	106	1 326
17	294	47	656	77	1 001	107	1 337
18	306	48	668	78	1 012	108	1 348
19	319	49	680	79	1 023	109	1 359
20	332	50	691	80	1 034	110	1 370
21	344	51	703	81	1 046	111	1 381
22	357	52	714	82	1 057	112	1 392
23	369	53	726	83	1 068	113	1 403
24	381	54	738	84	1 080	114	1 415
25	394	55	749	85	1 091	115	1 426
26	406	56	761	86	1 102	116	1 437
27	418	57	772	87	1 113	117	1 448
28	430	58	784	88	1 125	118	1 459
29	442	59	795	89	1 136	119	1 470

E.1.5 Pass-Fail decision rules

The pass-fail decision rules apply for a single test, comprising one component in the test vector:

- having observed 0 errors, pass the test at 47+ samples;
- having observed 1 error, pass the test at 67+ samples;
- ...
- having observed 118 errors, pass the test at 1 459+ samples;
- having observed 119 errors, pass the test at 1 470+ samples;
- having observed more than 119 errors, fail the test;
- where x+ means: x or more.

NOTE 1: An ideal EUT passes after 47 samples. The maximum test time is 1 470 samples.

NOTE 2: It is allowed to deviate from the early decision concept by postponing the decision (pass-fail or continue). Postponing the decision to or beyond the end of Table E.1 requires a pass-fail decision against the test limit: pass for the EUT with ER < 0,10, otherwise fail.

NOTE 3: Each sample is a received data packet including CRC.

E.2 No loss of transmission testing of receiver characteristics

E.2.1 Description

This criterion is only for equipment that does not support receiver statistical testing of clause E.1.

The test of receiver characteristics is three-fold:

- 1) Test system has a bidirectional link setup EUT and a companion device or a test system.
- 2) A signal or a combination of signals is offered to the RX port(s) of the EUT.
- 3) The ability of the EUT to demodulate/decode this signal is verified by verifying transmissions of the EUT.

Wireless transmission is lost when in a bidirectional test setup EUT stops transmissions after it has lost the capability of receiving transmissions from a companion device or from the test system providing the other end of the bidirectional test setup.

No loss of transmission shall be verified in good signal conditions.

The signal conditions shall be set at least to a value of the test limit where the no loss of transmission is verified.

All receiver tests are performed in static propagation conditions. No fading conditions are applied.

E.2.2 Pass-Fail decision rules

No loss of transmission shall be verified at least over a period of 60 seconds.

NOTE: Pass-Fail decision rule of no loss of transmission testing compared to receiver statistical testing of clause E.1 may lead to significant increase in test durations.

Annex F (informative): Bibliography

- ETSI EG 203 336: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".
- ERC Decision (98)22: "Exemption from Individual Licensing of DECT equipment", Amended 8 November 2013.
- ETSI TS 103 636-5: "DECT-2020 New Radio (NR); Part 5: DLC and Convergence layers; Release 1".

Annex G (informative): Change history

Version	Information about changes
1.1.1	First version

History

Document history		
V1.1.1	September 2023	Publication