# Draft ETSI EN 301 893 V2.0.7 (2016-11)


## 5 GHz RLAN;
## Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

Reference

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# Contents

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# Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Broadband Radio Access Networks (BRAN), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

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

| **National transposition dates** | |
|---|---|
| Date of latest announcement of this EN (doa): | 3 months after ETSI publication |
| Date of latest publication of new National Standard or endorsement of this EN (dop/e): | 6 months after doa |
| Date of withdrawal of any conflicting National Standard (dow): | 18 months after doa |

# Modal verbs terminology

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

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

# Introduction

5 GHz wireless access systems (WAS) including RLAN equipment are used in wireless local area networks which provide high speed data communications in between devices connected to the wireless infrastructure. The present document also addresses ad-hoc networking where devices communicate directly with each other, without the use of a wireless infrastructure.

The spectrum usage conditions for equipment within the scope of the present document are set in the ECC Decision (04)08 [i.8] and the Commission Decision 2005/513/EC [i.9] as amended by the Commission Decision 2007/90/EC [i.10].

# 1 Scope

The present document specifies technical characteristics and methods of measurements for 5 GHz wireless access systems (WAS) including RLAN equipment.

The present document also describes spectrum access requirements to facilitate spectrum sharing with other equipment.

These radio equipment are capable of operating in all or parts of the frequency bands given in table 1.

**Table 1: Service frequency bands**

| | Service frequency bands |
|---|---|
| Transmit | 5 150 MHz to 5 350 MHz |
| Receive | 5 150 MHz to 5 350 MHz |
| Transmit | 5 470 MHz to 5 725 MHz |
| Receive | 5 470 MHz to 5 725 MHz |

The present document covers the essential requirements of article 3.2 of Directive 2014/53/EU under the conditions identified in annex A.

# 2 References

## 2.1 Normative references

References are specific, identified by date of publication and/or edition number or version number. Only the cited version applies.

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

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

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

[1] Void.

[2] Void.

[3] Void.

[4] Void.

[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".

[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".

[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".

[8] ETSI TS 136 141 V13.5.0 (2016-10): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (3GPP TS 36.141 version 13.5.0 Release 13)".

[9] IEEE 802.11™-2012: "IEEE Standard for Information Technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[10] IEEE 802.11ac™-2013: "IEEE Standard for Information Technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications - Amendment 4: Enhancements for Very High Throughput for Operation in Bands below 6 GHz".

## 2.2 Informative references

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

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

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

[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] Void.

[i.3] Void

[i.4] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.5] 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.6] 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.7] 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.8] ECC/DEC/(04)08: ECC Decision of 9 July 2004 on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs) (30/10/2009).

[i.9] Commission Decision 2005/513/EC of 11 July 2005 on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs).

[i.10] Commission Decision 2007/90/EC of 12 February 2007 amending Decision 2005/513/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs).

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in Directive 2014/53/EU [i.1] and the following apply:

**5 GHz RLAN bands:** total frequency range that consists of the 5 150 MHz to 5 350 MHz and the 5470 MHz to 5 725 MHz sub-bands

**adaptive equipment:** equipment operating in an adaptive mode

**adaptive mode:** mechanism by which equipment can adapt to its environment by identifying other transmissions present in the band

**ad-hoc mode:** operating mode in which an RLAN device establishes a temporary wireless connection with other RLAN devices without a controlling network infrastructure

**antenna array:** two or more antennas connected to a single device and operating simultaneously

**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.

**available channel:** channel identified as available for immediate use as an *Operating Channel*

NOTE: *Usable Channels* whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz can be considered as *Available Channels* without further testing.

**backoff procedure:** procedure that facilitates the sharing of the medium by randomizing the transmission attempts from multiple devices competing for access to an *Operating Channel*

**beamforming gain:** additional (antenna) gain realized by using beamforming techniques in smart antenna systems

NOTE: Beamforming gain as used in the present document does not include the gain of the antenna assembly.

**burst:** period during which radio waves are intentionally transmitted, preceded and succeeded by periods during which no intentional transmission is made

**channel:** minimum amount of spectrum used by a single RLAN device

NOTE: An RLAN device is permitted to operate (transmit/receive) in one or more adjacent or non-adjacent channels simultaneously.

EXAMPLE: For the purpose of the present document, an IEEE 802.11™ [9] device operating in a 40 MHz mode may be considered as operating in 2 adjacent 20 MHz channels simultaneously.

**Channel Access Engine (CAE):** mechanism that determines when a transmission attempt is permitted

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

**clear channel assessment:** mechanism used by an equipment to identify other transmissions in the channel

**combined equipment:** equipment consisting of two or more products where at least one of which is radio equipment within the scope of the present document

**Contention Window (CW):** main parameter that determines the duration of the *Backoff Procedure*

**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

**energy detect:** mechanism used by an adaptive system to determine the presence of another device operating on the channel based on detecting the signal level of that other device

**environmental profile:** range of environmental conditions under which equipment within the scope of the present document is required to comply with the provisions of the present document

**Frame Based Equipment (FBE):** is equipment where the transmit/receive structure has a periodic timing with a periodicity equal to the *Fixed Frame Period*

**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.

**Listen Before Talk (LBT):** mechanism by which an equipment applies clear channel assessment (CCA) before using the channel

**Load Based Equipment (LBE):** equipment where the transmit/receive structure is not fixed in time but demand-driven

**master mode:** mode which relates to the DFS functionality where the RLAN device uses a Radar Interference Detection function and controls the transmissions of RLAN devices operating in slave mode

**multi-radio equipment:** combined equipment consisting of two or more radio products (transmitters, receivers or transceivers) or a single radio product operating in two or more bands simultaneously

**Observation Slot:** period during which the operating channel is checked for the presence of other RLAN transmissions

**operating channel:** *Available Channel* on which the RLAN has started transmissions

**Post Backoff :** Backoff procedure that is applied after every successful transmission

**Prioritization Period:** period consisting of an initial deferral period followed by an observation period during which the Operating Channel is checked for the presence of other RLAN transmissions

**receive chain:** receiver circuit with an associated antenna

**RLAN devices:** 5 GHz wireless access systems (WAS) including RLAN equipment

**simulated radar burst:** series of periodic radio wave pulses for test purposes

**slave mode:** mode which relates to the DFS functionality where the transmissions of the RLAN are under control of an RLAN device operating in master mode

**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.

**stand-alone radio equipment:** equipment that is intended primarily as radio communications equipment and that is normally used on a stand-alone basis

**sub-band:** portion of the 5 GHz RLAN bands

NOTE: See definition for "5 GHz RLAN bands".

**total occupied bandwidth:** total of the *Nominal Channel Bandwidths* in case of simultaneous transmissions in adjacent or non-adjacent channels

**transmit chain:** transmitter circuit with an associated antenna

**Transmit Power Control (TPC):** technique in which the transmitter output power is controlled resulting in reduced interference to other systems

**unavailable channel:** channel which cannot be considered by the RLAN device for a certain period of time *(Non Occupancy Period)* after a radar signal was detected on that channel

**unusable channel:** channel from the declared channel plan which may be declared as permanently unavailable due to one or more radar detections on the channel

**usable channel:** any channel from the declared channel plan, which may be considered by the RLAN for possible use

# 3.2 Symbols

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

| | |
|---|---|
| A | Measured power output |
| $T_{ch}$ | Number of active transmit chains |
| B | Radar burst period |
| $Ch_r$ | Channel in which radar test signals are inserted to simulate the presence of a radar |
| $CW_{min}$ | Minimum Contention Window size |
| $CW_{max}$ | Maximum Contention Window size |
| D | Measured power density |
| dB | decibel |
| dBm | dB relative to 1 mW |
| DC | Direct Current |
| E | Field strength |
| $E_o$ | Reference field strength |
| $f_c$ | Carrier frequency |
| G | Antenna gain |
| GHz | gigahertz |
| Hz | hertz |
| kHz | kilohertz |
| L | Radar burst length |
| MHz | megahertz |
| ms | millisecond |
| Samples/s | Samples per second |
| mW | milliwatt |
| n | Number of channels |
| p | Pioritization period related counter |
| $P_H$ | Calculated e.i.r.p. at highest power level |
| $P_L$ | Calculated e.i.r.p. at lowest power level |
| Pburst | RMS (mean) power over the transmission burst |
| PD | Calculated power density |
| $P_d$ | Detection Probability |
| q | Backoff procedure related counter |
| R | Distance |
| $R_{ch}$ | Number of active receive chains |
| $R_o$ | Reference distance |
| S0 | Signal power |
| T0 | Time instant |
| T1 | Time instant |
| T2 | Time instant |
| T3 | Time instant |
| W | Radar pulse width |
| x | Observed duty cycle |
| Y | Beamforming (antenna) gain |

## 3.3 Abbreviations

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

| | |
|---|---|
| AC | Alternating Current |
| ACK | ACKnowledgement |
| AWGN | Additive White Gaussian Noise |
| BIT | Burst Interval Time |
| BW | BandWidth |
| CAC | Channel Availability Check |
| CCA | Clear Channel Assessment |
| COT | Channel Occupancy Time |
| CSD | Cyclic Shift Diversity |
| CW | Contention Window |
| DFS | Dynamic Frequency Selection |
| e.i.r.p. | equivalent isotropically radiated power |
| ED | Energy Detect |
| FAR | Fully Anechoic Room |
| FBE | Frame Based Equipment |
| HT | High Throughput |
| HT20 | High Throughput in a 20 MHz channel |
| HT40 | High Throughput in a 40 MHz channel |
| IEEE | Institute of Electrical and Electronic Engineers |
| LBE | Load Based Equipment |
| LBT | Listen Before Talk |
| LPDA | Logarithmic Periodic Dipole Antenna |
| MCS | Modulation Coding Scheme |
| MIMO | Multiple Input, Multiple Output |
| NACK | Negative ACKnowledgement |
| OATS | Open Area Test Site |
| OFDM | Orthogonal Frequency Division Multiplexing |
| PER | Packet Error Rate |
| PPB | Pulses Per Burst |
| ppm | parts per million |
| PPS | Pulses Per Second |
| PRF | Pulse Repetition Frequency |
| RBW | Resolution BandWidth |
| RF | Radio Frequency |
| RLAN | Radio Local Area Network |
| RMS | Root Mean Square |
| SAR | Semi Anechoic Room |
| TL | Threshold Level |
| TPC | Transmit Power Control |
| Tx | Transmit, Transmitter |
| UUT | Unit Under Test |
| VBW | Video BandWidth |
| VSWR | Voltage Standing Wave Ratio |
| WAS | Wireless Access Systems |

# 4 Technical requirements specifications

## 4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the manufacturer. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

Where multiple combinations of radio equipment and antenna (antenna assemblies) are intended, each combination shall comply with all the technical requirements of the present document.

## 4.2 Conformance requirements

### 4.2.1 Nominal Centre frequencies

#### 4.2.1.1 General

RLAN equipment typically operates on one or more fixed frequencies. The equipment is allowed to change its normal operating frequency when interference is detected, or to prevent causing interference to other equipment or for frequency planning purposes.

#### 4.2.1.2 Definition

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

#### 4.2.1.3 Limits

The *Nominal Centre Frequencies* (fc) for a *Nominal Channel Bandwidth* of 20 MHz are defined by equation (1). See also figure 3.

$$fc_n = 5\,160 + (g \times 20) \text{ MHz, where } 0 \leq g \leq 9 \text{ or } 16 \leq g \leq 27 \quad (1)$$

A maximum offset of the *Nominal Centre Frequency* of ± 200 kHz is permitted. Where the manufacturer decides to make use of this frequency offset, the manufacturer shall declare the actual centre frequencies used by the equipment. See clause 5.4.1, item a).

The actual centre frequency for any given channel shall be maintained within the range $f_c$ ± 20 ppm.

Equipment may have simultaneous transmissions on more than one *Operating Channel* with a *Nominal Channel Bandwidth* of 20 MHz.

#### 4.2.1.4 Conformance

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

### 4.2.2 Nominal Channel Bandwidth and Occupied Channel Bandwidth

#### 4.2.2.1 Definition

The *Nominal Channel Bandwidth* is the widest band of frequencies, inclusive of guard bands, assigned to a single channel.

The *Occupied Channel Bandwidth* is the bandwidth containing 99 % of the power of the signal.

When equipment has simultaneous transmissions in adjacent channels, these transmissions may be considered as one signal with an actual *Nominal Channel Bandwidth* of "n" times the individual *Nominal Channel Bandwidth* where "n" is the number of adjacent channels. When equipment has simultaneous transmissions in non-adjacent channels, each power envelope shall be considered separately.

#### 4.2.2.2 Limits

The *Nominal Channel Bandwidth* for a single *Operating Channel* shall be 20 MHz.

Alternatively, equipment may implement a lower *Nominal Channel Bandwidth* with a minimum of 5 MHz, providing they still comply with the *Nominal Centre Frequencies* defined in clause 4.2.1 (20 MHz raster).

The *Occupied Channel Bandwidth* shall be between 80 % and 100 % of the *Nominal Channel Bandwidth*. In case of smart antenna systems (devices with multiple transmit chains) each of the transmit chains shall meet this requirement. The *Occupied Channel Bandwidth* might change with time/payload.

During a *Channel Occupancy Time (COT)*, equipment may operate temporarily with an *Occupied Channel Bandwidth* of less than 80 % of its *Nominal Channel Bandwidth* with a minimum of 2 MHz.

#### 4.2.2.3 Conformance

Conformance tests as defined in clause 5.4.3 shall be carried out to determine the *Occupied Channel Bandwidth*.

### 4.2.3 RF output power, Transmit Power Control (TPC) and power density

#### 4.2.3.1 Definitions

##### 4.2.3.1.1 RF Output Power

The *RF Output Power* is the mean equivalent isotropically radiated power (e.i.r.p.) during a transmission burst.

##### 4.2.3.1.2 Transmit Power Control (TPC)

*Transmit Power Control (TPC)* is a mechanism to be used by the RLAN device to ensure a mitigation factor of at least 3 dB on the aggregate power from a large number of devices. This requires the RLAN device to have a TPC range from which the lowest value is at least 6 dB below the values for mean e.i.r.p. given in table 2 for devices with TPC.

##### 4.2.3.1.3 Power Density

The *Power Density* is the mean equivalent isotropically radiated power (e.i.r.p.) density during a transmission burst.

#### 4.2.3.2 Limits

##### 4.2.3.2.1 General

The limits below are applicable to the system as a whole and in any possible configuration. This means that the antenna gain of the integral or dedicated antenna has to be taken into account as well as the additional (beamforming) gain in case of smart antenna systems (devices with multiple transmit chains).

In case of multiple (adjacent or non-adjacent) channels within the same sub-band, the total *RF Output Power* of all channels in that sub-band shall not exceed the limits defined in table 2 and table 3.

In case of multiple, non-adjacent channels operating in separate sub-bands, the total *RF Output Power* in each of the sub-bands shall not exceed the limits defined in table 2 and table 3.

##### 4.2.3.2.2 Limits for RF output power and power density at the highest power level

TPC is not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.

For devices with TPC, the RF output power and the power density when configured to operate at the highest stated power level of the TPC range shall not exceed the levels given in table 2.

Devices are allowed to operate without TPC. See table 2 for the applicable limits that shall apply in this case.

**Table 2: Mean e.i.r.p. limits for RF output power and power density at the highest power level**

| Frequency range (MHz) | Mean e.i.r.p. limit (dBm) | | Mean e.i.r.p. density limit (dBm/MHz) | |
|---|---|---|---|---|
| | with TPC | without TPC | with TPC | without TPC |
| 5 150 to 5 350 | 23 | 20/23 (see note 1) | 10 | 7/10 (see note 2) |
| 5 470 to 5 725 | 30 (see note 3) | 27 (see note 3) | 17 (see note 3) | 14 (see note 3) |
| NOTE 1: The applicable limit is 20 dBm, except for transmissions whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz, in which case the applicable limit is 23 dBm.<br>NOTE 2: The applicable limit is 7 dBm/MHz, except for transmissions whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz, in which case the applicable limit is 10 dBm/MHz.<br>NOTE 3: Slave devices without a *Radar Interference Detection* function shall comply with the limits for the frequency range 5 250 MHz to 5 350 MHz. | | | | |

#### 4.2.3.2.3 Limit for RF output power at the lowest power level of the TPC range

For devices using TPC, the *RF Output Power* during a transmission burst when configured to operate at the lowest stated power level of the TPC range shall not exceed the levels given in table 3. For devices without TPC, the limits in table 3 do not apply.

**Table 3: Mean e.i.r.p. limits for RF Output Power at the lowest power level of the TPC range**

| Frequency range | Mean e.i.r.p. (dBm) |
|---|---|
| 5 250 MHz to 5 350 MHz | 17 |
| 5 470 MHz to 5 725 MHz | 24 (see note) |
| NOTE: Slave devices without a *Radar Interference Detection* function shall comply with the limits for the band 5 250 MHz to 5 350 MHz. | |

### 4.2.3.3 Conformance

Conformance tests as defined in clause 5.4.4 shall be carried out.

## 4.2.4 Transmitter unwanted emissions

### 4.2.4.1 Transmitter unwanted emissions outside the 5 GHz RLAN bands

#### 4.2.4.1.1 Definition

Transmitter unwanted emissions outside the 5 GHz RLAN bands are radio frequency emissions outside the 5 GHz RLAN bands defined in clause 3.1.

#### 4.2.4.1.2 Limits

The level of transmitter unwanted emissions outside the 5 GHz RLAN bands shall not exceed the limits given in table 4.

In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted) and to the emissions radiated by the cabinet. In case of integral antenna equipment (without temporary antenna connectors), these limits apply to emissions radiated by the equipment.

**Table 4: Transmitter unwanted emission limits outside the 5 GHz RLAN bands**

| Frequency range | Maximum power | Bandwidth |
|---|---|---|
| 30 MHz to 47 MHz | -36 dBm | 100 kHz |
| 47 MHz to 74 MHz | -54 dBm | 100 kHz |
| 74 MHz to 87,5 MHz | -36 dBm | 100 kHz |
| 87,5 MHz to 118 MHz | -54 dBm | 100 kHz |
| 118 MHz to 174 MHz | -36 dBm | 100 kHz |
| 174 MHz to 230 MHz | -54 dBm | 100 kHz |
| 230 MHz to 470 MHz | -36 dBm | 100 kHz |
| 470 MHz to 862 MHz | -54 dBm | 100 kHz |
| 862 MHz to 1 GHz | -36 dBm | 100 kHz |
| 1 GHz to 26 GHz | -30 dBm | 1 MHz |

#### 4.2.4.1.3 Conformance

Conformance tests as defined in clause 5.4.5 shall be carried out.

### 4.2.4.2 Transmitter unwanted emissions within the 5 GHz RLAN bands

#### 4.2.4.2.1 Definition

Transmitter unwanted emissions within the 5 GHz RLAN bands are radio frequency emissions within the 5 GHz RLAN bands defined in clause 3.1.

#### 4.2.4.2.2 Limits

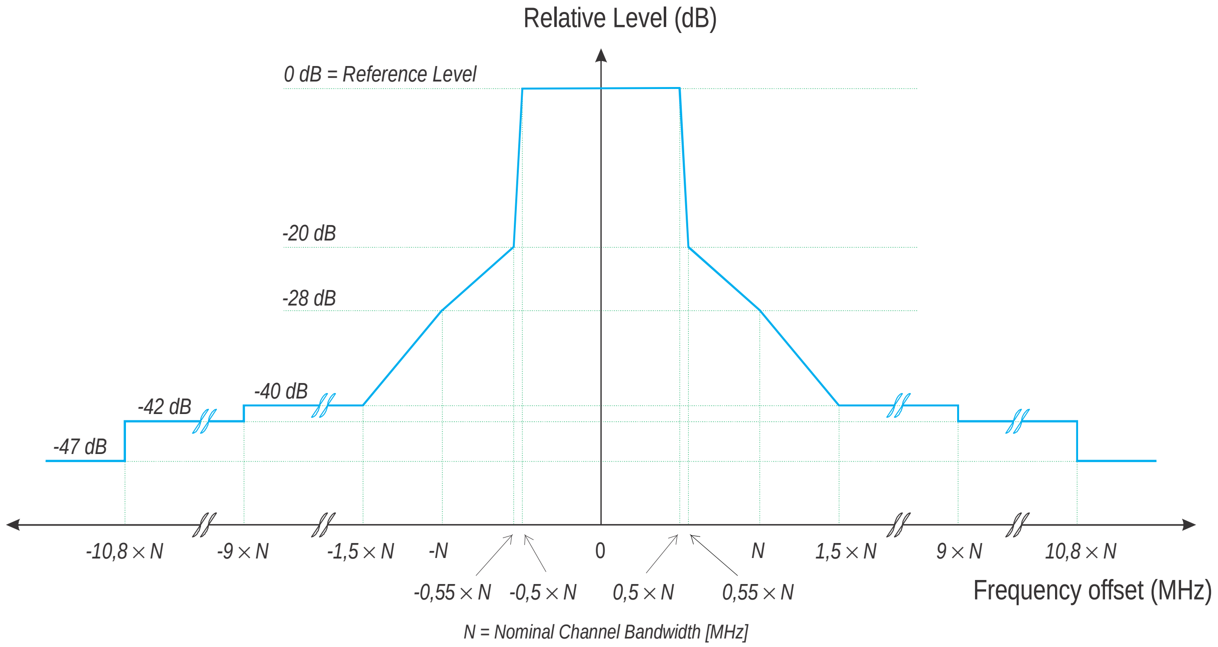



**Figure 1: Transmit spectral power mask**

The average level of transmitter unwanted emissions within the 5 GHz RLAN bands shall not exceed the limits of the mask provided in figure 1 or an absolute level of –30 dBm with a 1 MHz measurement bandwidth, whichever is greater. The limits in figure 1 are relative to the maximum spectral power density of the transmitted signal and apply with a reference bandwidth of 1 MHz.

The mask is only applicable within the band of operation. Beyond the band edges the requirements of clause 4.2.4.1 apply.

In case of smart antenna systems (devices with multiple transmit chains) each of the transmit chains shall meet the limits provided in figure 1.

For transmitter unwanted emissions within the 5 GHz RLAN bands, simultaneous transmissions in adjacent channels may be considered as one signal with an actual *Nominal Channel Bandwidth* of "n" times the individual *Nominal Channel Bandwidth* where "n" is the number of adjacent channels used simultaneously.

For simultaneous transmissions in multiple non-adjacent channels, the overall transmit spectral power mask is constructed in the following manner. First, a mask as provided in figure 1 is applied to each of the channels. Then, for each frequency point, the greatest value from the spectral masks of all the channels assessed shall be taken as the overall spectral mask requirement at that frequency.

##### 4.2.4.2.3 Conformance

Conformance tests as defined in clause 5.4.6 shall be carried out.

### 4.2.5 Receiver spurious emissions

#### 4.2.5.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

#### 4.2.5.2 Limits

The spurious emissions of the receiver shall not exceed the limits given in table 5.

In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted) and to the emissions radiated by the cabinet. In case of integral antenna equipment (without temporary antenna connectors), these limits apply to emissions radiated by the equipment.

**Table 5: Spurious radiated emission limits**

| Frequency range | Maximum power | Measurement bandwidth |
|---|---|---|
| 30 MHz to 1 GHz | -57 dBm | 100 kHz |
| 1 GHz to 26 GHz | -47 dBm | 1 MHz |

#### 4.2.5.3 Conformance

Conformance tests as defined in clause 5.4.7 shall be carried out.

### 4.2.6 Dynamic Frequency Selection (DFS)

#### 4.2.6.1 Introduction

##### 4.2.6.1.1 General

An RLAN shall employ a *Dynamic Frequency Selection (DFS)* function to:

- detect interference from radar systems (radar detection) and to avoid co-channel operation with these systems;
- provide on aggregate a near-uniform loading of the spectrum *(Uniform Spreading).*

The DFS function as described in the present document is not tested for its ability to detect frequency hopping radar signals.

Whilst the DFS function described in this clause defines conditions under which the equipment may transmit, transmissions are allowed providing they are not prohibited by the Adaptivity requirement in clause 4.2.7.

#### 4.2.6.1.2 DFS applicable frequency range

Radar detection shall be used when operating on channels whose nominal bandwidth falls partly or completely within the frequency ranges 5 250 MHz to 5 350 MHz or 5 470 MHz to 5 725 MHz. This requirement applies to all types of RLAN devices regardless of the type of communication between these devices.

*Uniform Spreading* is required across the frequency ranges 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz. *Uniform Spreading* is not applicable for equipment that only operates in the band 5 150 MHz to 5 250 MHz.

#### 4.2.6.1.3 DFS operational modes

Within the context of the operation of the DFS function, an RLAN device shall operate as either a master or a slave. RLAN devices operating as a slave shall only operate in a network controlled by an RLAN device operating as a master. A device which is capable of operating as either a master or a slave shall comply with the requirements applicable to the mode in which it operates.

Some RLAN devices are capable of communicating in ad-hoc manner without being attached to a network. RLAN devices operating in this manner on channels whose nominal bandwidth falls partly or completely within the frequency ranges 5 250 MHz to 5 350 MHz or 5 470 MHz to 5 725 MHz shall employ DFS and shall be tested against the requirements applicable to a master.

Slave devices used in fixed outdoor point to point or fixed outdoor point to multipoint applications shall behave as slave with radar detection independent of their output power. See table 6.

#### 4.2.6.1.4 DFS operation

The operational behaviour and individual DFS requirements that are associated with master and slave devices are as follows:

**Master devices:**

a) The master device shall use a *Radar Interference Detection* function in order to detect radar signals.

   The master device may rely on another device, associated with the master, to implement the *Radar Interference Detection* function. In such a case, the combination shall comply with the requirements applicable to a master.

   An RLAN network always has at least one RLAN device operating in master mode when operating in the bands 5 250 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz.

b) A master device shall only start operations on *Available Channels*. At installation (or reinstallation) of the equipment, the RLAN is assumed to have no *Available Channels* within the band 5 250 MHz to 5 350 MHz and/or 5 470 MHz to 5 725 MHz. In such a case, before starting operations on one or more of these channels, the master device shall perform either a *Channel Availability Check* or an *Off-Channel CAC* to ensure that there are no radars operating on any selected channel. If no radar has been detected, the channel(s) becomes an *Available Channel(s)* and remains as such until a radar signal is detected during the *In-Service Monitoring* after the channel became an *Operating Channel*. The *Channel Availability Check* or the *Off-Channel CAC* may be performed over a wider bandwidth such that all channels within the tested bandwidth become *Available Channels.*

   The initial *Channel Availability Check* may be activated manually at installation or reinstallation of the equipment.

c) A master device may initiate a network by sending enabling signals to other RLAN (slave) devices. Once the RLAN has started operations on an *Available Channel*, then that channel becomes an *Operating Channel.* During normal operation, the master device shall monitor all O*perating Channels (In-Service Monitoring)* to ensure that there is no radar operating within these channel(s). If no radar was detected on an *Operating Channel* by the *In-Service Monitoring* but the RLAN stops operating on that channel, then the channel becomes again an *Available Channel*.

   An RLAN is allowed to start transmissions on multiple (adjacent or non-adjacent) *Available Channels*. In this case all these channels become *Operating Channels*.

d) If the master device has detected a radar signal on an *Operating Channel* during *In-Service Monitoring*, the master device shall instruct all its associated slave devices to stop transmitting on this channel which becomes an *Unavailable Channel*. When operating on multiple (adjacent or non-adjacent) *Operating Channels* simultaneously, only the *Operating Channel* containing the frequency on which radar was detected shall become an *Unavailable Channel*.

e) An *Unavailable Channel* can become a *Usable Channel* again after the *Non-Occupancy Period*. A new *Channel Availability Check* or an *Off-Channel CAC* is required to verify there is no radar operating on this channel before it becomes an *Available Channel* again.

f) In all cases, if radar detection has occurred, then the channel containing the frequency on which radar was detected becomes an *Unavailable Channel*. Alternatively, the channel may be marked as an *Unusable Channel*.

**Slave devices:**

a) A slave device shall not transmit before receiving an appropriate enabling signal from an associated master device.

b) A slave device shall stop its transmissions on a channel whenever instructed by a master device. The slave device shall not resume any transmissions on this channel until it has received an appropriate enabling signal from an associated master device.

c) A slave device which is required to perform radar detection (see table D.2, note 2), shall stop its own transmissions on an *Operating Channel* if it has detected a radar on that channel. That *Operating Channel* becomes an *Unavailable Channel* for the slave device. It shall not resume any transmissions on this *Unavailable Channel* for a period of time equal to the *Non-Occupancy Period*. A C*hannel Availability Check* or an *Off-Channel CAC* is required by the slave device to verify there is no radar operating on this channel before the slave may use it again.

### 4.2.6.2 DFS technical requirements specifications

#### 4.2.6.2.1 Applicability

Table 6 lists the DFS related technical requirements and their applicability for every operational mode. If the RLAN device is capable of operating in more than one operational mode then every operating mode shall be assessed separately.

**Table 6: Applicability of DFS requirements**

| Requirement | DFS Operational mode | | |
|---|---|---|---|
| | **Master** | **Slave without radar detection (see table D.2, note 2)** | **Slave with radar detection (see table D.2, note 2)** |
| Channel Availability Check | Required | Not required | Required (see note 2) |
| Off-Channel CAC (see note 1) | Required | Not required | Required (see note 2) |
| In-Service Monitoring | Required | Not required | Required |
| Channel Shutdown | Required | Required | Required |
| Non-Occupancy Period | Required | Not required | Required |
| Uniform Spreading | Required | Not required | Not required |
| NOTE 1: Where implemented by the manufacturer.<br>NOTE 2: A slave with radar detection is not required to perform a CAC or *Off-Channel CAC* at initial use of the channel but only after the slave has detected a radar signal on the *Operating Channel* by *In-Service Monitoring* and the *Non-Occupancy Period* resulting from this detection has elapsed. | | | |

The radar detection requirements specified in clause 4.2.6.2.2 to clause 4.2.6.2.4 assume that the centre frequencies of the radar signals fall within the central 80 % of the *Occupied Channel Bandwidth* of the RLAN (see clause 4.2.2).

##### 4.2.6.2.2 Channel Availability Check

###### 4.2.6.2.2.1 Definition

The *Channel Availability Check (CAC)* is defined as a mechanism by which an RLAN device checks channels for the presence of radar signals. This mechanism is used for identifying *Available Channels*.

There shall be no transmissions by the RLAN device on the channels being checked during this process.

If no radars have been detected on a channel, then that channel becomes an *Available Channel.*

For devices that support multiple *Nominal Channel Bandwidths*, the *Channel Availability Check* may be performed once using the widest *Nominal Channel Bandwidth*. All narrower channels within the tested bandwidth become *Available Channels* providing no radar was detected.

###### 4.2.6.2.2.2 Limit

The *Channel Availability Check* shall be performed during a continuous period in time (*Channel Availability Check Time*) which shall not be less than the value defined in table D.1.

During the *Channel Availability Check*, the RLAN device shall be capable of detecting any of the radar test signals that fall within the ranges given by table D.4 with a level above the *Radar Detection Threshold* defined in table D.2.

The RLAN device shall comply with the minimum detection probability as defined in table D.5.

###### 4.2.6.2.2.3 Conformance

Conformance tests for this requirement are defined in clause 5.4.8.

##### 4.2.6.2.3 Off-Channel CAC (Off-Channel Channel Availability Check)

###### 4.2.6.2.3.1 Definition

*Off-Channel CAC* is defined as an optional mechanism by which an RLAN device monitors channel(s), different from the *Operating Channel(s)*, for the presence of radar signals. The *Off-Channel CAC* may be used in addition to the *Channel Availability Check* defined in clause 4.2.6.2.2, for identifying *Available Channels*.

*Off-Channel CAC* is performed by a number of non-continuous checks spread over a period in time. This period, which is required to determine the presence of radar signals, is defined as the *Off-Channel CAC Time*.

If no radars have been detected in a channel, then that channel becomes an *Available Channel.*

###### 4.2.6.2.3.2 Limit

Where implemented, the *Off-Channel CAC Time* shall be declared by the manufacturer. However, the declared *Off-Channel CAC Time* shall be within the range specified in table D.1.

During the *Off-Channel CAC*, the RLAN device shall be capable of detecting any of the radar test signals that fall within the ranges given by table D.4 with a level above the *Radar Detection Threshold* defined in table D.2.

The RLAN device shall comply with the minimum detection probability as defined in table D.5.

###### 4.2.6.2.3.3 Conformance

Conformance tests for this requirement are defined in clause 5.4.8.

##### 4.2.6.2.4 In-Service Monitoring

###### 4.2.6.2.4.1 Definition

The *In-Service Monitoring* is defined as the process by which an RLAN device monitors each *Operating Channel* for the presence of radar signals.

##### 4.2.6.2.4.2 Limit

The *In-Service Monitoring* shall be used to monitor each *Operating Channel*.

The *In-Service-Monitoring* shall start immediately after the RLAN device has started transmissions on a channel.

During the *In-Service Monitoring*, the RLAN device shall be capable of detecting any of the radar test signals that fall within the ranges given by table D.4 with a level above the *Radar Detection Threshold* defined in table D.2.

The RLAN device shall comply with the minimum detection probability associated with a given radar test signal as defined in table D.5.

##### 4.2.6.2.4.3 Conformance

Conformance tests for this requirement are defined in clause 5.4.8.

#### 4.2.6.2.5 Channel Shutdown

##### 4.2.6.2.5.1 Definition

The *Channel Shutdown* is defined as the process initiated by the RLAN device on an *Operating Channel* after a radar signal has been detected during the *In-Service Monitoring* on that channel.

The master device shall instruct all associated slave devices to stop transmitting on this channel, which they shall do within the *Channel Move Time*.

Slave devices with a Radar Interference Detection function, shall stop their own transmissions on an *Operating Channel* within the *Channel Move Time* upon detecting a radar signal within this channel.

The aggregate duration of all transmissions of the RLAN device on this channel during the *Channel Move Time* shall be limited to the *Channel Closing Transmission Time*. The aggregate duration of all transmissions shall not include quiet periods in between transmissions.

For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, only the channel(s) containing the frequency on which radar was detected is subject to the *Channel Shutdown* requirement. The equipment is allowed to continue transmissions on other *Operating Channels*.

##### 4.2.6.2.5.2 Limit

The *Channel Move Time* shall not exceed the limit defined in table D.1.

The *Channel Closing Transmission Time* shall not exceed the limit defined in table D.1.

##### 4.2.6.2.5.3 Conformance

Conformance tests for this requirement are defined in clause 5.4.8.

#### 4.2.6.2.6 Non-Occupancy Period

##### 4.2.6.2.6.1 Definition

The *Non-Occupancy Period* is defined as the time during which the RLAN device shall not make any transmissions on a channel after a radar signal was detected on that channel.

For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, only the channel(s) containing the frequency on which radar was detected is subject to the *Non-Occupancy Period* requirement. The equipment is allowed to continue transmissions on other *Operating Channels*.

After the *Non-Occupancy Period*, the channel needs to be identified again as an *Available Channel* before the RLAN device may start transmitting again on this channel.

###### 4.2.6.2.6.2 Limit

The *Non-Occupancy Period* shall not be less than the value defined in table D.1.

###### 4.2.6.2.6.3 Conformance

Conformance tests for this requirement are defined in clause 5.4.8.

##### 4.2.6.2.7 Uniform Spreading

###### 4.2.6.2.7.1 Definition

The *Uniform Spreading* is a mechanism to be used by the RLAN to provide, on aggregate, a uniform loading of the spectrum across all devices. The *Uniform Spreading* is limited to the usable channels being declared as part of the channel plan.

The required spreading may be achieved by various means. These means include network management functions controlling large numbers of RLAN devices as well as the channel selection function in an individual RLAN device.

###### 4.2.6.2.7.2 Limit

Each of the declared Channel Plans (see clause 3.1) shall make use of at least 60 % of the spectrum available in the applicable sub-band(s).

The *Uniform Spreading* is limited to the usable channels being declared as part of the channel plan.

Usable channels do not include channels which are precluded by either:

1) the intended outdoor usage of the RLAN; or

2) previous detection of a radar on the channel (*Unavailable Channel or Unusable Channel*); or

3) national regulations; or

4) the restriction to only operate in the band 5 150 MHz to 5 250 MHz for RLAN devices without a radar detection capability.

Each of the *Usable Channels* shall be used with approximately equal probability. RLAN equipment for which the declared channel plan includes channels whose nominal bandwidth falls completely or partly within the band 5 600 MHz to 5 650 MHz may omit these channels from the list of *Usable Channels* at initial power up or at initial installation. Channels being used by other RLAN equipment may be omitted from the list of *Usable Channels.*

## 4.2.7 Adaptivity (Channel Access Mechanism)

### 4.2.7.1 Applicability

The present requirement applies to all equipment within the scope of the present document.

The present document defines two types of adaptive equipment:

- *Frame Based Equipment*;
- *Load Based Equipment*.

Whilst the mechanisms described in this clause define conditions under which the equipment may transmit, transmissions are only allowed providing they are not prohibited by any of the DFS requirements in clause 4.2.6.

### 4.2.7.2 Definition

*Adaptivity (Channel Access Mechanism)* is an automatic mechanism by which a device limits its transmissions and gains access to an *Operating Channel*.

Adaptivity is not intended to be used as an alternative to DFS to detect radar transmissions, but to detect transmissions from other RLAN devices operating in the band. DFS requirements are covered by clause 4.2.6.

## 4.2.7.3 Requirements and limits

### 4.2.7.3.1 Frame Based Equipment (FBE)

#### 4.2.7.3.1.1 Introduction

*Frame Based Equipment* shall implement a *Listen Before Talk (LBT)* based *Channel Access Mechanism* to detect the presence of other RLAN transmissions on an *Operating Channel.*

*Frame Based Equipment* is equipment where the transmit/receive structure has a periodic timing with a periodicity equal to the *Fixed Frame Period*. A single *Observation Slot* as defined in clause 3.1 and as referenced by the procedure in clause 4.2.7.3.1.4 shall have a duration of not less than 9 µs.

#### 4.2.7.3.1.2 Device Types (Adaptivity)

A device that initiates a sequence of one or more transmissions is denoted as the *Initiating Device*. Otherwise, the device is denoted as a *Responding Device*. *Frame Based Equipment* may be an *Initiating Device*, a *Responding Device*, or both.

The *Initiating Device* shall implement a Channel Access Mechanism as further described in clause 4.2.7.3.1.4.

A *Responding Device* shall implement a Channel Access Mechanism as further described in clause 4.2.7.3.1.5.

#### 4.2.7.3.1.3 Multi-channel Operation

*Frame Based Equipment* being capable of simultaneous transmissions in adjacent or non-adjacent *Operating Channels* (see clause 4.2.1) may use any combination/grouping of 20 MHz *Operating Channels* out of the list of channels (*Nominal Centre Frequencies*) provided in clause 4.2.1, if it satisfies the channel access requirements (*Channel Access Mechanism*) for an *Initiating Device* as described in clause 4.2.7.3.1.4 on each such 20 MHz *Operating Channel*.

#### 4.2.7.3.1.4 Initiating Device Channel Access Mechanism

The *Initiating Device (Frame Based Equipment)* shall implement a Channel Access Mechanism that complies with the following requirements:

1) The *Fixed Frame Periods* supported by the equipment shall be declared by the manufacturer. See clause 5.4.1, item q). This shall be within the range of 1 ms to 10 ms. Transmissions can start only at the beginning of a *Fixed Frame Period*. See figure 2 below. An equipment may change its *Fixed Frame Period* but it shall not do more than once every 200 ms.

2) Immediately before starting transmissions on an *Operating Channel* at the start of a *Fixed Frame Period*, the *Initiating Device* shall perform a *Clear Channel Assessment (CCA)* check during a single *Observation Slot*. The *Operating Channel* shall be considered occupied if the energy level in the channel exceeds the threshold corresponding to the power level given in point 6) below. If the *Initiating Device* finds the *Operating Channel(s)* to be clear, it may transmit immediately. See figure 2.

   If the *Initiating Device* finds an *Operating Channel* occupied, then there shall be no transmissions on that channel during the next *Fixed Frame Period*. The *Frame Based Equipment* is allowed to continue *Short Control Signalling Transmissions* on this channel providing it complies with the requirements given in clause 4.2.7.3.3.

   For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) *Operating Channels*, the equipment is allowed to continue transmissions on other *Operating Channels* providing the CCA check did not detect any signals on those channels.

   The total time during which *Frame Based Equipment* can have transmissions on a given channel without re-evaluating the availability of that channel, is defined as the *Channel Occupancy Time (COT)*.

The equipment can have multiple transmissions within a *Channel Occupancy Time* without performing an additional CCA on this *Operating Channel* providing the gap between such transmissions does not exceed 16 µs.

If the gap exceeds 16 µs, the equipment may continue transmissions provided that an additional CCA detects no RLAN transmissions with a level above the threshold defined in point 6). The additional CCA shall be performed within the gap and within the observation slot immediately before transmission. All gaps are counted as part of the *Channel Occupancy Time*.

3) An Initiating Device is allowed to grant an authorization to one or more associated *Responding Devices* to transmit on the current *Operating Channel* within the current *Channel Occupancy Time.* A *Responding Device* that receives such a grant shall follow the procedure described in clause 4.2.7.3.1.5.

4) The *Channel Occupancy Time* shall not be greater than 95 % of the *Fixed Frame Period* defined in point 1) and shall be followed by an *Idle Period* until the start of the next *Fixed Frame Period* such that the *Idle Period* is at least 5 % of the *Channel Occupancy Time*, with a minimum of 100 µs.

5) The equipment, upon correct reception of a packet which was intended for this equipment, can skip CCA and immediately proceed with the transmission of management and control frames (e.g. ACK and Block ACK frames). A consecutive sequence of such transmissions by the equipment, without it performing a new CCA, shall not exceed the *Maximum Channel Occupancy Time* as defined in point 4) above.

For the purpose of multi-cast, the ACK transmissions (associated with the same data packet) of the individual devices are allowed to take place in a sequence.

6) The *CCA Threshold Level (TL)*, at the input of the receiver, shall be proportional to the maximum transmit power ($P_H$) according to the formula which assumes a 0 dBi receive antenna and $P_H$ to be specified in dBm e.i.r.p.

$$TL = Min (-75 \text{ dBm/MHz}, Max (-85 \text{ dBm/MHz}, -85 \text{ dBm/MHz} + (23 \text{ dBm} - P_H))) \quad (2)$$

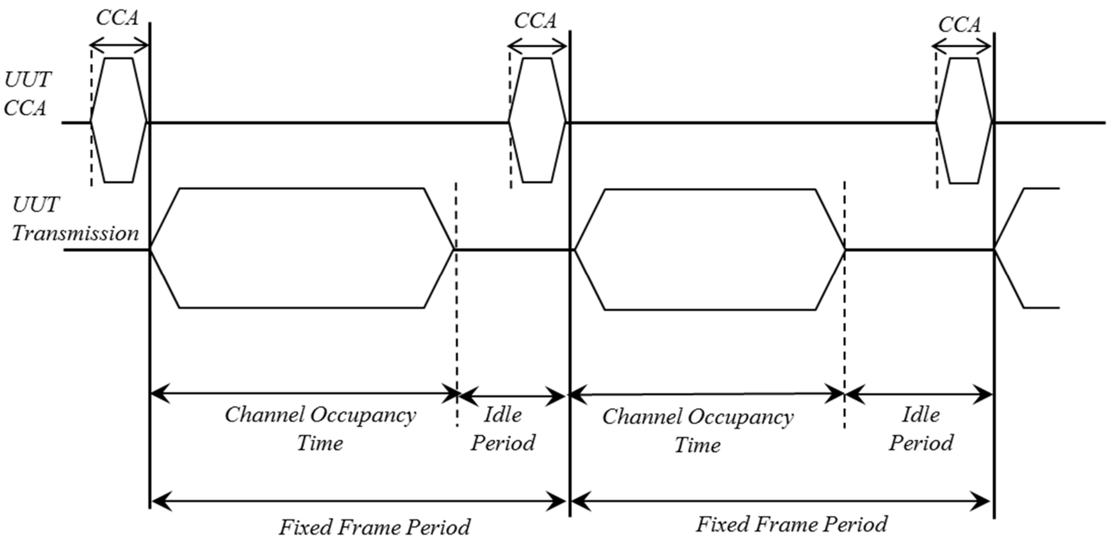



**Figure 2: Example of timing for Frame Based Equipment**

#### 4.2.7.3.1.5 Responding Device Channel Access Mechanism

Clause 4.2.7.3.1.4, point 3) describes the possibility whereby an *Initiating Device* grants an authorization to one or more associated *Responding Devices* to transmit on the current *Operating Channel* within the *current Fixed Frame Period.* A *Responding Device* that receives such a grant shall follow the procedure described in step 1) to step 3):

1) A *Responding Device* that received a transmission grant from an associated *Initiating Device* may proceed with transmissions on the current *Operating Channel*:

    a) The *Responding Device* may proceed with such transmissions without performing a *Clear Channel Assessment* (CCA) if these transmissions are initiated at most 16 µs after the last transmission by the *Initiating Device* that issued the grant.

    b) The *Responding Device* that does not proceed with such transmissions within 16 µs after the last transmission from the *Initiating Device* that issued the grant, shall perform a *Clear Channel Assessment* (CCA) on the *Operating Channel* during a single observation slot within a 25 µs period ending immediately before the granted transmission time. If energy was detected with a level above the *CCA Threshold Level* defined in clause 4.2.7.3.1.4, point 6), the *Responding Device* shall proceed with step 3). Otherwise, the *Responding Device* shall proceed with step 2).

2) The *Responding Device* may perform transmissions on the current *Operating Channel* for the remaining *Channel Occupancy Time* of the current *Fixed Frame Period*. The *Responding Device* may have multiple transmissions on this *Operating Channel* provided that the gap in between such transmissions does not exceed 16 µs. When the transmissions by the *Responding Device* are completed the *Responding Device* shall proceed with step 3).

3) The transmission grant for the *Responding Device* is withdrawn.

### 4.2.7.3.2 Load Based Equipment (LBE)

#### 4.2.7.3.2.1 Introduction

*Load based Equipment* shall implement a *Listen Before Talk (LBT)* based *Channel Access Mechanism* to detect the presence of other RLAN transmissions on an *Operating Channel.*

#### 4.2.7.3.2.2 Device Types (Adaptivity)

With regard to *Adaptivity* for *Load Based Equipment*, a device that initiates a sequence of one or more transmissions is denoted as the *Initiating Device*. Otherwise, the device is denoted as a *Responding Device*. *Load Based Equipment* may be an *Initiating Device*, a *Responding Device*, or both.

The *Initiating Device* shall implement a *Channel Access Mechanism* with prioritized, truncated exponential back off mechanism as further described in clause 4.2.7.3.2.6.

A *Responding Device* shall implement a *Channel Access Mechanism* as further described in clause 4.2.7.3.2.7.

Each transmission belongs to a single *Channel Occupancy Time (COT)*. A *Channel Occupancy Time (COT)* consists of one or more transmissions of an *Initiating Device* and zero or more transmissions of one or more *Responding Devices*.

An equipment that controls (non-DFS related) operating parameters of one or more other equipment is denoted as a *Supervising Device*. Otherwise, the equipment is denoted as a *Supervised Device*. The roles of a *Supervising Device* and *Supervised Device* has only to be seen in relation to *Adaptivity* and are different from the roles of a *Master device* and a *Slave Device* in the context of DFS as defined in clause 4.2.6.

#### 4.2.7.3.2.3 Multi-channel Operation

*Load Based Equipment* being capable of simultaneous transmissions in adjacent or non-adjacent *Operating Channels* (see clause 4.2.1) shall implement either option 1 or option 2 below:

Option 1: *Load Based Equipment* may use any combination/grouping of 20 MHz *Operating Channels* out of the list of channels (*Nominal Centre Frequencies*) provided in clause 4.2.1, if it satisfies the channel access requirements (*Channel Access Mechanism*) for an *Initiating Device* as described in clause 4.2.7.3.2.6 on each such 20 MHz *Operating Channel*.

Option 2: Figure 3 defines bonded 40 MHz, 80 MHz or 160 MHz channels (see also clause 4.2.1.3 for the channel number). *Load Based Equipment* that uses a combination/grouping of 20 MHz *Operating Channels* that is a subset of bonded 40 MHz, 80 MHz or 160 MHz channels, may transmit on any of the 20 MHz *Operating Channels*, if:

- The equipment satisfies the channel access requirements (*Channel Access Mechanism*) for an *Initiating Device* as defined in clause 4.2.7.3.2.6 on one of the 20 MHz *Operating Channels* (*Primary Operating Channel*), and
- The equipment performs a *Clear Channel Assessment* (CCA) of at least 25 µs immediately before the intended transmissions on each of the other *Operating Channels* on which transmissions are intended, and no energy was detected with a level above the *Energy Detect Threshold* defined in clause 4.2.7.3.2.5.

The choice of the *Primary Operating Channel* shall follow one of the following procedures:

- The *Primary Operating Channel* is chosen uniformly randomly whenever the contention window (CW), corresponding to a completed transmission on the current *Primary Operating Channel* is set to its minimum value ($CW_{min}$). For this procedure, a contention window (CW) is maintained for each *Priority Class* (see clause 4.2.7.3.2.4) within each 20 MHz *Operating Channel* within the bonded channel.
- The *Primary Operating Channel* is arbitrarily determined and not changed more than once per second.

The bonded 40 MHz, 80 MHz or 160 MHz channel that the combination/grouping of 20 MHz operating channels is a subset of shall not be changed more than once per second.

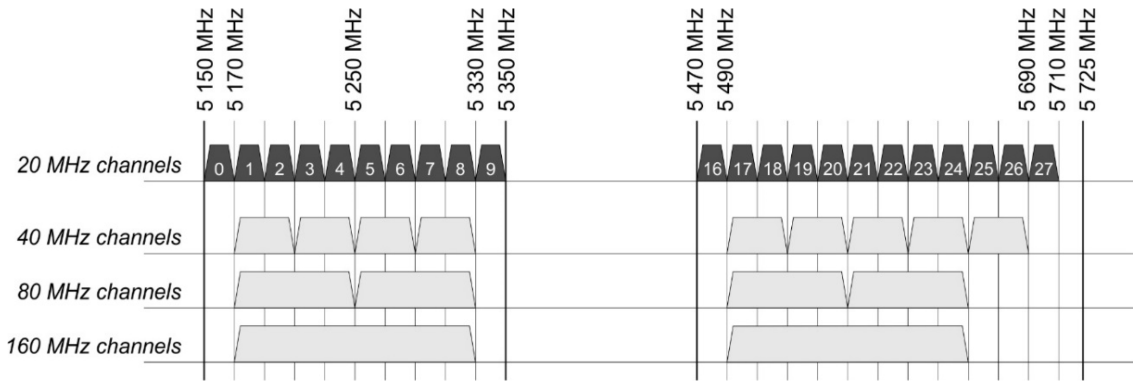



**Figure 3: Channel Bonding for option 2**

#### 4.2.7.3.2.4 Priority Classes

Table 7 and table 8 each contain four different sets of Channel Access parameters for *Supervised Devices* and *Supervising Devices* respectively, resulting in different *Priority Classes* and different maximum *Channel Occupancy Times*. These parameters are used by the *Channel Access Mechanism* for the *Initiating Device* described in clause 4.2.7.3.2.6 to gain access to an *Operating Channel*.

If a *Channel Occupancy* consists of more than one transmission the transmissions may be separated by gaps. The *Channel Occupancy Time* is the total duration of all transmissions and all gaps of 25 µs duration or less within a *Channel Occupancy* and shall not exceed the maximum *Channel Occupancy Time* in table 7 and table 8. The duration from the start of the first transmission within a *Channel Occupancy* until the end of the last transmission in that same *Channel Occupancy* shall not exceed 20 ms.

The *Initiating Device* may have data to be transmitted in different *Priority Classes* and therefore the *Channel Access Mechanism* is allowed to operate different *Channel Access Engines* as described in clause 4.2.7.3.2.6 simultaneously (one for each implemented *Priority Class*).

**Table 7: Priority Class dependent Channel Access parameters for *Supervised Devices***

| Class # | $p_0$ | $CW_{min}$ | $CW_{max}$ | Maximum Channel Occupancy Time (COT) |
|---|---|---|---|---|
| 4 | 2 | 3 | 7 | 2 ms |
| 3 | 2 | 7 | 15 | 4 ms |
| 2 | 3 | 15 | 1 023 | 6 ms (see note 1) |
| 1 | 7 | 15 | 1 023 | 6 ms (see note 1) |
| NOTE 1: The maximum *Channel Occupancy Time* (COT) of 6 ms may be increased to 8 ms by inserting one or more pauses. The minimum duration of a pause shall be 100 µs. The maximum duration (Channel Occupancy) before including any such pause shall be 6 ms. Pause duration is not included in the channel occupancy time. | | | | |
| NOTE 2: The values for $p_0$, $CW_{min}$, $CW_{max}$ are minimum values. Greater values are allowed. | | | | |

**Table 8: Priority Class dependent Channel Access parameters for *Supervising Devices***

| Class # | $p_0$ | $CW_{min}$ | $CW_{max}$ | maximum Channel Occupancy Time (COT) |
|---|---|---|---|---|
| 4 | 1 | 3 | 7 | 2 ms |
| 3 | 1 | 7 | 15 | 4 ms |
| 2 | 3 | 15 | 63 | 6 ms (see note 1 and note 2) |
| 1 | 7 | 15 | 1 023 | 6 ms (see note 1) |
| NOTE 1: The maximum *Channel Occupancy Time* (COT) of 6 ms may be increased to 8 ms by inserting one or more pauses. The minimum duration of a pause shall be 100 µs. The maximum duration (Channel Occupancy) before including any such pause shall be 6 ms. Pause duration is not included in the channel occupancy time. | | | | |
| NOTE 2: The maximum Channel Occupancy Time (COT) of 6 ms may be increased to 10 ms by extending CW to CW × 2 + 1 when selecting the random number q for any backoff(s) that precede the Channel Occupancy that may exceed 6 ms or which follow the Channel Occupancy that exceeded 6 ms. The choice between preceding or following a Channel Occupancy shall remain unchanged during the operation time of the device. | | | | |
| NOTE 3: The values for $p_0$, $CW_{min}$, $CW_{max}$ are minimum values. Greater values are allowed. | | | | |

#### 4.2.7.3.2.5 Energy Detect Threshold (ED Threshold)

Equipment shall consider a channel to be occupied as long as other RLAN transmissions are detected at a level greater than the ED Threshold. The ED Threshold level is integrated over the total *Nominal Channel Bandwidth* of all *Operating Channels* used by the equipment.

The *ED Threshold* level depends on the type of equipment:

Option 1: For equipment that for its operation in the 5 GHz bands is conforming to IEEE 802.11™ac-2013 [10], clause 22, or to IEEE 802.11™-2012 [9], clause 18 or clause 20, or any combination of these clauses, the *Energy Detect Threshold (ED Threshold)* is independent of the equipment's maximum transmit power (PH). The *Energy Detect Threshold (ED Threshold)* shall be:

$$TL = -75 \text{ dBm/MHz} \quad (3)$$

Option 2: For equipment conforming to one or more of the clauses listed in Option 1, and to at least one other operating mode, and for equipment conforming to none of the clauses listed in Option 1, the *Energy Detect Threshold (ED Threshold)* shall be proportional to the equipment's maximum transmit power ($P_H$). Assuming a 0 dBi receive antenna the *Energy Detect Threshold (ED Threshold)* shall be:

$$TL = Min\ (-75\ dBm/MHz,\ Max\ (-85\ dBm/MHz,\ -85\ dBm/MHz + (23\ dBm - P_H))) \qquad (4)$$

Equipment shall consider a channel to be occupied as long as other RLAN transmissions are detected at a level greater than the TL.

#### 4.2.7.3.2.6 Initiating Device Channel Access Mechanism

Before a transmission or a burst of transmissions on an *Operating Channel*, the *Initiating Device* shall operate at least one *Channel Access Engine* that executes the procedure described in step 1) to step 8) below. This *Channel Access Engine* makes use of the parameters defined in table 7 or table 8 in clause 4.2.7.3.2.4.

A single *Observation Slot* as defined in clause 3.1 and as referenced by the procedure in the present clause shall have a duration of not less than 9 µs.

An *Initiating Device* shall operate at least one and no more than four different *Channel Access Engines* each with a different *Priority Class* as defined in clause 4.2.7.3.2.4.

1) The *Channel Access Engine* shall set CW to $CW_{min.}$

2) The *Channel Access Engine* shall select a random number q from a uniform distribution over the range 0 to CW. Note 2 in table 8 defines an alternative range for q when the previous or next *Channel Occupancy Time* is greater than the maximum *Channel Occupancy Time* specified in table 8.

3) The *Channel Access Engine* shall initiate a *Prioritization Period* as described in step 3) a) to step 3) c):

   a) The *Channel Access Engine* shall set p according to the *Priority Class* associated with this *Channel Access Engine*. See clause 4.2.7.3.2.4.

   b) The *Channel Access Engine* shall wait for a period of 16 µs.

   c) The *Channel Access Engine* shall perform a *Clear Channel Assessment (CCA)* on the *Operating Channel* during a single *Observation Slot*:

      i) The *Operating Channel* shall be considered occupied if other transmissions within this channel are detected with a level above the *ED threshold* defined in clause 4.2.7.3.2.5. In this case, the *Channel Access Engine* shall initiate a new *Prioritization Period* starting with step 3) a) after the energy within the channel has dropped below the *ED threshold* defined in clause 4.2.7.3.2.5.

      ii) In case no energy within the *Operating Channel* is detected with a level above the *ED threshold* defined in clause 4.2.7.3.2.5, p may be decremented by not more than 1. If p is equal to 0, the *Channel Access Engine* shall proceed with step 4), otherwise the *Channel Access Engine* shall proceed with step 3) c).

4) The *Channel Access Engine* shall perform a *Backoff Procedure* as described in step 4) a) to step 4) d):

   a) This step verifies if the *Channel Access Engine* satisfies the *Post Backoff* condition. If q < 0 and the *Channel Access Engine* is ready for a transmission, the *Channel Access Engine* shall set CW equal to $CW_{min}$ and shall select a random number q from a uniform distribution over the range 0 to CW before proceeding with step 4) b). Note 2 in table 8 defines an alternative range for q when the previous or next *Channel Occupancy Time* is greater than the maximum *Channel Occupancy Time* specified in table 8.

   b) If q < 1 the *Channel Access Engine* shall proceed with step 4) d). Otherwise, the *Channel Access Engine* may decrement the value q by not more than 1 and the *Channel Access Engine* shall proceed with step 4) c).

   c) The *Channel Access Engine* shall perform a *Clear Channel Assessment (CCA)* on the *Operating Channel* during a single *Observation Slot*:

i) The *Operating Channel* shall be considered occupied if energy was detected with a level above the *ED threshold* defined in clause 4.2.7.3.2.5. In this case, the *Channel Access Engine* shall continue with step 3).

ii) If no energy was detected with a level above the *ED threshold* defined in clause 4.2.7.3.2.5, the *Channel Access Engine* shall continue with step 4) b).

d) If the *Channel Access Engine* is ready for a transmission the *Channel Access Engine* shall continue with step 5). Otherwise, the *Channel Access Engine* shall decrement the value q by 1 and the *Channel Access Engine* shall proceed with step 4) c). It should be understood that q can become negative and keep decrementing as long as the *Channel Access Engine* is not ready for a transmission.

5) If only one *Channel Access Engine* of the *Initiating Device* is in this stage (see note 1) the *Channel Access Engine* shall proceed with step 6). If the *Initiating Device* has a multitude of *Channel Access Engines* in this stage (see note 2), the *Channel Access Engine* with highest *Priority Class* in this multitude shall proceed with step 6) and all other *Channel Access Engines* in the current stage shall proceed with step 8).

NOTE 1: This is equivalent to the equipment having no internal collision.

NOTE 2: This is equivalent to the equipment having one or more internal collisions.

6) The *Channel Access Engine* may start transmissions belonging to the corresponding or higher *Priority Classes*, on one or more *Operating Channels.* If the initiating device transmits in more than one *Operating Channels,* it shall comply with the requirements contained in clause 4.2.7.3.2.3.

a) The *Channel Access Engine* can have multiple transmissions without performing an additional CCA on this *Operating Channel* providing the gap in between such transmissions does not exceed 16 µs. Otherwise, if this gap exceeds 16 µs and does not exceed 25 µs, the *Initiating Device* may continue transmissions provided that no energy was detected with a level above the *ED threshold* defined in clause 4.2.7.3.2.5 for a duration of one *Observation Slot*.

b) The *Channel Access Engine* may grant an authorization to transmit on the current *Operating Channel* to one or more *Responding Devices*. If the *Initiating Device* issues such a transmission grant to a *Responding Device*, the *Responding Device* shall operate according to the procedure described in clause 4.2.7.3.2.7.

c) The *Initiating Device* may have simultaneous transmissions of *Priority Classes* lower than the *Priority Class* of the *Channel Access Engine*, provided that the corresponding transmission duration (*Channel Occupancy Time*) is not extended beyond the time that is needed for the transmission(s) corresponding to the *Priority Class* of the *Channel Access Engine*.

7) When the *Channel Occupancy* has completed, and it has been confirmed that at least one transmission that started at the beginning of the *Channel Occupancy* was successful, the *Initiating Device* proceeds with step 1) otherwise the *Initiating Device* proceeds with step 8).

8) The *Initiating Device* may retransmit. If the *Initiating Device* does not retransmit the *Channel Access Engine* shall discard all data packets associated with the unsuccessful *Channel Occupancy* and the *Channel Access Engine* shall proceed with step 1). Otherwise, the *Channel Access Engine* shall adjust CW to $((CW + 1) \times m) - 1$ with $m \geq 2$. If the adjusted value of CW is greater than $CW_{max}$ the *Channel Access Engine* may set CW equal to $CW_{max}$. The Channel Access Engine shall proceed with step 2).

According to clause 4.2.7.3.2.4 where four different *Priority Classes* are defined, an *Initiating Device* shall operate only one *Channel Access Engine* for each *Priority Class* implemented.

CW may take values that are greater than the values of CW in step 1) to step 8).

##### 4.2.7.3.2.7 Responding Device Channel Access Mechanism

Clause 4.2.7.3.2.6, step 6) b) describes the possibility whereby an *Initiating Device* grants an authorization to one or more associated *Responding Devices* to transmit on the current *Operating Channel* . A *Responding Device* that receives such a grant shall follow the procedure described in step 1) to step 3):

1) A *Responding Device* that received a transmission grant from an associated *Initiating Device* may proceed with transmissions on the current *Operating Channel* .

   a) The *Responding Device* may proceed with such transmissions without performing a *Clear Channel Assessment* (CCA) if these transmissions are initiated at most 16 µs after the last transmission by the *Initiating Device* that issued the grant.

   b) The *Responding Device* that does not proceed with such transmissions within 16 µs after the last transmission from the *Initiating Device* that issued the grant, shall perform a *Clear Channel Assessment* (CCA) on the *Operating Channel* during a single observation slot within a 25 µs period ending immediately before the granted transmission time. If energy was detected with a level above the *ED Threshold* defined in clause 4.2.7.3.2.5, the *Responding Device* shall proceed with step 3). Otherwise, the *Responding Device* shall proceed with step 2).

2) The *Responding Device* may perform transmissions on the current *Operating Channel* for the remaining *Channel Occupancy Time*. The *Responding Device* may have multiple transmissions on this *Operating Channel* provided that the gap in between such transmissions does not exceed 16 µs. When the transmissions by the *Responding Device* are completed the *Responding Device* shall proceed with step 3).

3) The transmission grant for the *Responding Device* is withdrawn.

#### 4.2.7.3.3 Short Control Signalling Transmissions (FBE and LBE)

##### 4.2.7.3.3.1 General

Frame Based Equipment and Load Based Equipment are allowed to have *Short Control Signalling Transmissions* on the *Operating Channel* providing these transmissions comply with the requirements in clause 4.2.7.3.3. It is not required for adaptive equipment to implement Short Control Signalling Transmissions.

##### 4.2.7.3.3.2 Definition

Short Control Signalling Transmissions are transmissions used by the equipment to send management and control frames without sensing the channel for the presence of other signals.

##### 4.2.7.3.3.3 Limits

The use of Short Control Signalling Transmissions is constrained as follows:

- within an observation period of 50 ms, the number of *Short Control Signalling Transmissions* by the equipment shall be equal to or less than 50; and
- the total duration of the equipment's *Short Control Signalling Transmissions* shall be less than 2 500 µs within said observation period.

### 4.2.7.4 Conformance

The conformance tests for this requirement are defined in clause 5.4.9.

## 4.2.8 Receiver Blocking

### 4.2.8.1 Applicability

The present requirement applies to all equipment within the scope of the present document.

### 4.2.8.2 Definition

Receiver 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.

### 4.2.8.3 Performance Criteria

The minimum performance criterion shall be a PER of less than or equal to 10 %. The manufacturer may declare alternative performance criteria as long as that is appropriate for the intended use of the equipment (see clause 5.4.1, item t)).

### 4.2.8.4 Limits

While maintaining the minimum performance criteria as defined in clause 4.2.8.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined in table 9.

**Table 9: Receiver Blocking parameters**

| **Wanted signal mean power from companion device (dBm)** | **Blocking signal frequency (MHz)** | **Blocking signal power (dBm) (see note 2)** | | **Type of blocking signal** |
|---|---|---|---|---|
| | | **Master or Slave with radar detection (see table D.2, note 2)** | **Slave without radar detection (see table D.2, note 2)** | |
| Pmin + 6 dB | 5 100 | -53 | -59 | Continuous Wave |
| Pmin + 6 dB | 4 900<br>5 000<br>5 975 | -47 | -53 | Continuous Wave |

NOTE 1: $P_{min}$ is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined clause 4.2.8.3 in the absence of any blocking signal.

NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the same levels should be used at the antenna connector irrespective of antenna gain.

### 4.2.8.5 Conformance

The conformance tests for this requirement are defined in clause 5.4.10.

## 4.2.9 User Access Restrictions

### 4.2.9.1 Definition

User Access Restrictions are constraints implemented in the RLAN device to restrict access of the user to any hardware and/or software settings of the equipment, including software replacement(s), which may impact (directly or indirectly) the compliance of the equipment with the requirements in the present document.

NOTE: The user should be understood as the end user, the operator or any person not responsible for the compliance of the equipment against the requirements in the present document.

### 4.2.9.2 Requirement

The equipment shall be so constructed that settings (hardware and/or software) related to DFS shall not be accessible to the user if changing those settings result in the equipment no longer being compliant with the DFS requirements in clause 4.2.6.

The above requirement includes the prevention of indirect access to any setting that impacts DFS. The following is a non-exhaustive list of examples of such indirect access.

EXAMPLE 1: The equipment should not allow the user to change the country of operation and/or the operating frequency band if that results in the equipment no longer being compliant with the DFS requirements.

EXAMPLE 2: The equipment should not accept software and/or firmware which results in the equipment no longer being compliant with the DFS requirements, e.g.:

- software and/or firmware provided by the manufacturer but intended for other regulatory regimes;
- modified software and/or firmware where the software and/or firmware is available as open source code;
- previous versions of the software and/or firmware (downgrade).

### 4.2.10 Geo-location capability

#### 4.2.10.1 Applicability

This requirement only applies to equipment with geo-location capability as defined in clause 4.2.10.2.

#### 4.2.10.2 Definition

Geo-location capability is a feature of the RLAN device to determine its location at installation, at reinstallation and at each power up of the equipment, with the purpose to configure itself according to the regulatory requirements applicable at the location where it operates.

The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographic location during the initial power up of the equipment. The geographic location may also be available in equipment already installed and operating at the same geographic location.

#### 4.2.10.3 Requirements

The geographic location determined by the equipment as defined in clause 4.2.10.2 shall not be accessible to the user.

If the equipment cannot determine the geographic location, it shall operate in a mode compliant with the requirements applicable in any of the geographic locations where the equipment is intended to operate.

#### 4.2.10.4 Conformance

The manufacturer shall declare whether the equipment complies with the requirements contained in clause 4.2.10.3. See clause 5.4.1.

# 5 Testing for compliance with technical requirements

## 5.1 Environmental conditions for testing

### 5.1.1 Introduction

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile, see clause 5.4.1, item m).

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

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

Unless otherwise declared by the manufacturer, 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 %.

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 was designed.

## 5.1.3 Extreme test conditions

Some tests in the present document need to be repeated at extreme temperatures. Where that is the case, measurements shall be made over the extremes of the operating temperature range as declared by the manufacturer.

# 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;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 10.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028-1 [i.6] and ETSI TR 100 028-2 [i.7], in particular in annex D of the ETSI TR 100 028-2 [i.7].

Table 10 is based on such expansion factors.

**Table 10: Maximum measurement uncertainty**

| Parameter | Uncertainty |
|---|---|
| Radio frequency | ±10 ppm |
| RF power conducted | ±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 % |

## 5.3 Definition of other test conditions

### 5.3.1 Test sequences and traffic load

#### 5.3.1.1 General test transmission sequences

Except for the DFS tests or if mentioned otherwise, all the tests in the present document shall be performed by using a test transmission sequence that shall consist of regularly transmitted packets (e.g. with an interval of 2 ms). The test transmissions shall be fixed in length in a sequence and shall exceed the transmitter minimum activity ratio of 10 %.

The general structure of the test transmission sequence is shown in figure 4.

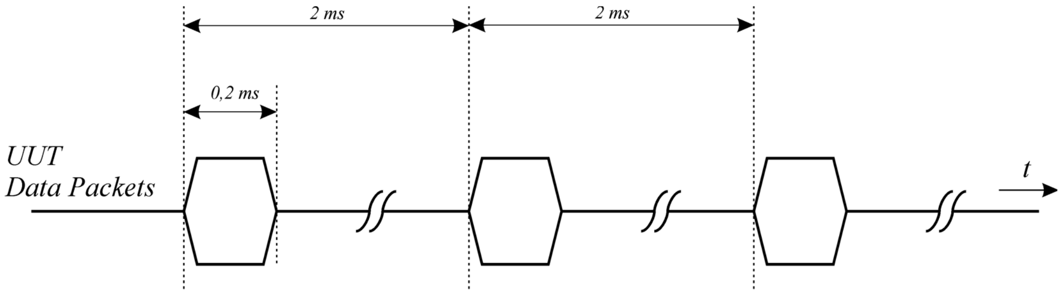



**Figure 4: General structure of the test transmission sequences**

#### 5.3.1.2 Test transmission sequences for DFS tests

The DFS tests related to the *Off-Channel CAC Check* (clause 5.4.8.2.1.4) and the *In-Service Monitoring* (clause 5.4.8.2.1.5) shall be performed by using a test transmission sequence on the *Operating Channel* that shall consist of packet transmissions that together exceed the transmitter minimum activity ratio of 30 % measured over an interval of 100 ms.

There shall be no transmissions on channels being checked during a *Channel Availability Check* or during an *Off Channel CAC check.*

### 5.3.2 Test channels

Unless otherwise stated in the test procedures for essential radio test suites (see clause 5.4), the channels to be used for testing shall be as given in table 11.

When testing devices that support simultaneous transmissions in adjacent or non-adjacent channels, DFS testing does not need to be performed simultaneously in these different channels.

**Table 11: Test channels**

| **Test** | **Clause** | **Test channels** | | |
|---|---|---|---|---|
| | | **Lower sub-band (5 150 MHz to 5 350 MHz)** | | **Higher sub-band 5 470 MHz to 5 725 MHz** |
| | | **5 150 MHz to 5 250 MHz** | **5 250 MHz to 5 350 MHz** | |
| Centre frequencies | 5.4.2 | C7 (see note 1) | | C8 (see note 1) |
| Occupied Channel Bandwidth | 5.4.3 | C7 | | C8 |
| Power, power density | 5.4.4 | C1 | C2 | C3, C4 |
| Transmitter unwanted emissions outside the 5 GHz RLAN bands | 5.4.5 | C7 (see note 1) | | C8 (see note 1) |
| Transmitter unwanted emissions within the 5 GHz RLAN bands | 5.4.6 | C1 | C2 | C3, C4 |
| Receiver spurious emissions | 5.4.7 | C7 (see note 1) | | C8 (see note 1) |

| Test | Clause | Test channels | | |
|---|---|---|---|---|
| | | **Lower sub-band (5 150 MHz to 5 350 MHz)** | | **Higher sub-band 5 470 MHz to 5 725 MHz** |
| | | **5 150 MHz to 5 250 MHz** | **5 250 MHz to 5 350 MHz** | |
| Transmit Power Control (TPC) | 5.4.4 | n.a. (see note 2) | C2 (see note 1) | C3, C4 (see note 1) |
| Dynamic Frequency Selection (DFS) | 5.4.8 | n.a. (see note 2) | C5 | C6 (see note 3) |
| Adaptivity | 5.4.9 | C9 | | |
| Receiver Blocking | 5.4.10 | C7 | | C8 |

C1, C3: The lowest declared channel for every declared *Nominal Channel Bandwidth* within this band. For the power density testing, it is sufficient to only perform this test using the lowest *Nominal Channel Bandwidth*.

C2, C4: The highest declared channel for every declared *Nominal Channel Bandwidth* within this band. For the power density testing, it is sufficient to only perform this test using the lowest *Nominal Channel Bandwidth*.

C5, C6: One channel out of the declared channels for this frequency range. If more than one *Nominal Channel Bandwidth* has been declared for this sub-band, testing shall be performed using the lowest and highest *Nominal Channel Bandwidth*.

C7, C8: One channel out of the declared channels for this sub-band. For *Occupied Channel Bandwidth*, testing shall be repeated for every declared *Nominal Channel Bandwidth* within this sub-band.

C9: One channel out of the declared channels.

NOTE 1: In case of more than one channel plan has been declared, testing of these specific requirements need only be performed using one of the declared channel plans.

NOTE 2: Testing is not required for *Nominal Channel Bandwidths* that fall completely within the frequency range 5 150 MHz to 5 250 MHz.

NOTE 3: Where the declared channel plan includes channels whose *Nominal Channel Bandwidth* falls completely or partly within the 5 600 MHz to 5 650 MHz band, the tests for the *Channel Availability Check* (and where implemented, for the *Off-Channel CAC)* shall be performed on one of these channels in addition to a channel within the band 5 470 MHz to 5 600 MHz or within the band 5 650 MHz to 5 725 MHz.

## 5.3.3 Antennas

### 5.3.3.1 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.

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

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.

### 5.3.3.2 Transmit operating modes

#### 5.3.3.2.1 Operating mode 1 (single antenna)

The equipment uses only one antenna when operating in this mode.

The following types of equipment and/or operating modes are examples covered by this category:

- Equipment with only one antenna.
- Equipment with two diversity antennas but at any moment in time only one antenna is used.
- Smart antenna system with two or more antennas, but operating in a mode where only one antenna is used.

#### 5.3.3.2.2 Operating mode 2 (multiple antennas, no beamforming)

The equipment that can operate in this mode contains a smart antenna system using two or more transmit chains simultaneously but without beamforming.

#### 5.3.3.2.3 Operating mode 3 (multiple antennas, with beamforming)

The equipment that can operate in this mode contains a smart antenna system using two or more transmit chains simultaneously with beamforming.

In addition to the antenna assembly gain G, the beamforming gain Y may have to be taken into account when performing the measurements described in the present document.

### 5.3.4 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.5], clause 6.

The manufacturer shall declare whether his equipment is stand-alone equipment, combined equipment or multi-radio equipment. See clause 5.4.1, item o).

## 5.4 Essential radio test suites

### 5.4.1 Product information

The information requested in the present clause shall be declared by the manufacturer and shall be included in the test report. The form included in annex G can be used for this purpose. 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):

a) The channel plan(s), being the Nominal Centre Frequencies and the associated *Nominal Channel Bandwidth(s).*

b) If the Load Based Equipment can support multi-channel operation (see clause 4.2.7.3.2.3), the following shall be provided:

- whether the LBE equipment uses Option 1 and/or Option 2 (see clause 4.2.7.3.2.3) for its multi-channel operation;
- the maximum number of channels that can be used for the multi-channel operation;
- whether or not these channels are adjacent or non-adjacent;
- whether or not these channels are in different sub-bands;
- for equipment implementing option 1 (see clause 4.2.7.3.2.3), the number of channels used for multi-channel operation when performing the test described in clause 5.4.9.3.2.3.1.

c) The different transmit operating modes in which the equipment can operate (see clause 5.3.3.2).

d) For each of the modes declared under c) the following shall be provided:

- the number of transmit chains;
- if more than one transmit chain is active, whether the power is distributed equally or not;
- the number of receive chains;
- whether or not antenna beamforming is implemented, and if so the maximum beamforming gain Y for this transmit operating mode.

e) Whether or not the device has a TPC feature containing one or more TPC ranges.

NOTE: The equipment can have more than one TPC range to accommodate different antennas and/or the different applicable power limits.

The manufacturer may decide to declare that the equipment can operate both with and without a TPC feature in which case the manufacturer may provide details in response to both point f) and point g).

f) For devices with a TPC feature, for each TPC range:

- the lowest and highest transmitter output power level (or lowest and highest e.i.r.p level in case of integrated antenna equipment). If the equipment supports simultaneous transmissions in both sub-bands, the lowest and highest transmitter output power or e.i.r.p. level for each of the sub-bands;

  in case of smart antenna systems with different transmit operating modes (see clause 5.3.3.2) the transmitter power levels may differ depending on the transmitter operating mode;

- the intended antenna assembly(ies), their corresponding maximum gain(s) G, the resulting e.i.r.p. values (taking also into account the beamforming gain Y if applicable) and the corresponding DFS threshold level(s);

- the applicable operating frequency range(s).

g) For devices operating in a mode without a TPC feature:

- the maximum transmitter output power level (or maximum e.i.r.p. level in case of integrated antenna equipment). If the equipment supports simultaneous transmissions in both sub-bands, the maximum transmitter output power or e.i.r.p. level for each of the sub-bands;

  in case of smart antenna systems with different transmitter operating modes (see clause 5.3.3.2) the transmitter output power levels may differ depending on the operating mode;

- the intended antenna assembly(ies), their corresponding maximum gain(s) G, the resulting e.i.r.p. values (taking also into account the beamforming gain Y if applicable) and the corresponding DFS threshold level(s);

- The applicable operating frequency range(s).

h) With regards to DFS, the DFS operational modes in which the equipment can operate (master, slave with radar detection, slave without radar detection).

i) With regards to User Access Restrictions, to confirm that the equipment is constructed to comply with the requirements contained in clause 4.2.9.

j) With regards to DFS, to confirm if the equipment has implemented the *Off-Channel CAC* function as given in clause 4.2.6.2.3. If an *Off-Channel CAC* function is implemented, the manufacturer shall specify the *Off-Channel CAC Time* required to determine the presence of a radar on a given channel. The *Off-Channel CAC Time* for channels whose nominal bandwidth falls partly or completely within the band 5 600 MHz to 5 650 MHz (equivalent to the 10 minutes CAC) may be different than for other channels (equivalent to the 60 s CAC) in which case both values shall be specified.

k) Whether or not the device can operate in ad-hoc mode, and if so, the operating frequency range when operating in ad-hoc mode.

l) The operating frequency range(s) of the equipment.

m) The operational environmental profile (e.g. the normal test conditions and the extreme test conditions) that applies to the equipment.

n) The test sequence/test software used by the UUT.

o) Type of Equipment: stand-alone equipment, combined equipment or multi-radio equipment.

p) With regards to Adaptivity, whether the equipment is Frame Based Equipment (FBE) or Load Based Equipment (LBE).

q) With regards to Adaptivity for Frame Based Equipment:

- whether the FBE equipment operates as an Initiating Device and/or as a Responding Device, see clause 4.2.7.3.1.2.
- the Fixed Frame Period(s) implemented by the FBE equipment.

r) With regards to Adaptivity for Load Based Equipment:

- whether the LBE equipment operates as a Supervising Device and/or as a Supervised Device, see clause 4.2.7.3.2.2;
- whether the LBE equipment makes use of note 1 in table 7 or note 1 in table 8;
- if the LBE equipment is a Supervising Device, whether the equipment is capable to make use of note 2 in table 8;
- whether the LBE equipment operates as an Initiating Device and/or as a Responding Device, see clause 4.2.7.3.2.6 and clause 4.2.7.3.2.7;
- all the *Priority Classes* implemented by the LBE equipment, see clause 4.2.7.3.2.4;
- whether the LBE equipment implemented option 1 or option 2 for the *Energy Detection Threshold* (see clause 4.2.7.3.2.5).Where the procedures contained in clause 5.4.9.3.2.4.1 and clause 5.4.9.3.2.5.1 have not been performed:

    i) whether the LBE equipment complies with the requirements contained in clause 4.2.7.3.2.6 and clause 4.2.7.3.2.7;

    ii) whether the LBE equipment complies with the maximum Channel Occupancy Time(s) defined in clause 4.2.7.3.2.4.

s) Whether or not the equipment supports a geo-location capability as defined in clause 4.2.10:

    i) If the equipment supports a geo-location capability, whether the equipment complies with the requirements contained in clause 4.2.10.3.

t) Where applicable, the minimum performance criteria (see clause 4.2.8.3) that corresponds to the intended use of the equipment.

u) The theoretical maximum radio performance of the equipment (e.g. maximum throughput).

## 5.4.2 Carrier frequencies

### 5.4.2.1 Test conditions

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

The channels on which the conformance requirements in clause 4.2.1 shall be verified are defined in clause 5.3.2.

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

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector(s) provided, conducted measurements shall be used.

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.

For a UUT with integral antenna(s) and without a temporary antenna connector(s), radiated measurements shall be used.

#### 5.4.2.2 Test methods

##### 5.4.2.2.1 Conducted measurement

###### 5.4.2.2.1.1 Equipment operating without modulation

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

The UUT 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 result shall be recorded.

###### 5.4.2.2.1.2 Equipment operating with modulation

This method is an alternative to the above method in case the UUT cannot be operated in an un-modulated mode.

The UUT shall be connected to spectrum analyser.

Max Hold shall be selected and the centre frequency adjusted to that of the UUT.

The peak value of the power envelope shall be measured and noted. The span shall be reduced and the marker moved in a positive frequency increment until the upper, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f1.

The marker shall then be moved in a negative frequency increment until the lower, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f2.

The centre frequency is calculated as (f1 + f2) / 2.

##### 5.4.2.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser attached to the test antenna.

The test procedure is as described under clause 5.4.2.2.1.

### 5.4.3 Occupied Channel Bandwidth

#### 5.4.3.1 Test conditions

The conformance requirements in clause 4.2.2 shall be verified only under normal operating conditions, and on those channels and channel bandwidths defined in clause 5.3.2.

The measurements shall be performed using normal operation of the equipment with the test signal applied (see clause 5.3.1.1).

The UUT shall be configured to operate at a typical RF power output level used for normal operation.

When equipment has simultaneous transmissions in adjacent channels, these transmissions may be considered as one signal with an actual *Nominal Channel Bandwidth* of "n" times the individual *Nominal Channel Bandwidth* where "n" is the number of adjacent channels. When equipment has simultaneous transmissions in non-adjacent channels, each power envelope shall be considered separately.

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector(s) provided, conducted measurements shall be used.

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

For a UUT with integral antenna(s) and without a temporary antenna connector(s), radiated measurements shall be used.

### 5.4.3.2 Test method

#### 5.4.3.2.1 Conducted measurement

The measurement procedure shall be as follows:

**Step 1:**

- Connect the UUT to the spectrum analyser and use the following settings:
    - Centre Frequency: The centre frequency of the channel under test
    - Resolution Bandwidth: 100 kHz
    - Video Bandwidth: 300 kHz
    - Frequency Span: 2 × Nominal Bandwidth (e.g. 40 MHz for a 20 MHz channel)
    - Sweep time: > 1 s; for larger Nominal Bandwidths, the sweep time may be increased until a value where the sweep time has no impact on the RMS value of the signal
    - Detector Mode: RMS
    - Trace Mode: Max Hold

**Step 2:**

- Wait for the trace to stabilize.

**Step 3:**

- Make sure that the power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals left and right from the power envelope being taken into account by this measurement.
- Use the 99 % bandwidth function of the spectrum analyser to measure the *Occupied Channel Bandwidth* of the UUT. This value shall be recorded.

The measurement described in step 1 to step 3 above shall be repeated in case of simultaneous transmissions in non-adjacent channels.

#### 5.4.3.2.2 Radiated measurement

The test set up as described in annex B and the applicable measurement procedures described in annex C shall be used.

The test procedure is as described under clause 5.4.3.2.1.

## 5.4.4 RF output power, Transmit Power Control (TPC) and power density

### 5.4.4.1 Test conditions

The conformance requirements in clause 4.2.3 shall be verified on those channels and channel bandwidths defined in clause 5.3.2.

The measurements described in the present clause may need to be repeated to cover:

- each of the TPC ranges (or transmitter output power levels for equipment without TPC) and corresponding antenna assemblies declared by the manufacturer (see clause 5.4.1, item e), item f) and item g));
- each of the transmit operating modes declared by the manufacturer (see clause 5.3.3.2 and clause 5.4.1, item c)).

The measurements shall be performed with test signal specified in clause 5.3.1.1 applied. Alternatively, if special test functions are available, the equipment may also be configured in a continuous transmit mode or with a constant duty cycle (e.g. frame based systems) which is at least 10 %.

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector(s) provided, conducted measurements shall be used in conjunction with the stated antenna assembly gain(s).

In the case of equipment intended for use with an integral antenna and where no external (temporary) antenna connectors are provided, a test fixture as described in clause B.4 may be used to perform relative measurements at the extremes of the operating temperature range.

### 5.4.4.2 Test method

#### 5.4.4.2.1 Conducted measurement

##### 5.4.4.2.1.1 RF output power at the highest power - $P_H$

###### 5.4.4.2.1.1.1 Additional test conditions

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

The UUT shall be configured to operate at:

- the highest stated transmitter output power level of the TPC range; or
- the maximum stated transmitter output power level in case the equipment has no TPC feature.

###### 5.4.4.2.1.1.2 Option 1: For equipment with continuous transmission capability or for equipment operating (or with the capability to operate) with a constant duty cycle (e.g. Frame Based equipment)

This option is for equipment that operates only in one sub-band or that is capable for operation in two sub-bands simultaneously but, for the purpose of the testing, the equipment can be configured to:

- operate in a continuous transmit mode or with a constant duty cycle (x), and
- operate only in one sub-band.

**Step 1:**

For equipment configured into a continuous transmit mode (x = 1), proceed immediately with step 2.

- The output power of the transmitter shall be coupled to a matched diode detector or equivalent thereof. The output of the diode detector shall be connected to the vertical channel of an oscilloscope.
- The combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the duty cycle of the transmitter output signal.
- The observed duty cycle of the transmitter (Tx on / (Tx on + Tx off)) shall be noted as x ($0 < x \leq 1$), and recorded in the test report.

**Step 2:**

- The RF output power shall be determined using a wideband RF power meter with a thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be noted as A (in dBm).
- In case of conducted measurements on smart antenna systems operating in a mode with multiple transmit chains active simultaneously, the output power of each transmit chain shall be measured separately to calculate the total power (value A in dBm) for the UUT.

**Step 3:**

- The RF output power at the highest power level $P_H$ (e.i.r.p.) shall be calculated from the above measured power output A (in dBm), the observed duty cycle x, the stated antenna gain G in dBi and if applicable the beamforming gain Y in dB, according to the formula below. This value shall be recorded in the test report.

If more than one antenna assembly is intended for this power setting or TPC range, the gain of the antenna assembly with the highest gain shall be used.

$$P_H = A + G + Y + 10 \times \log (1 / x) \text{ (dBm)}. \quad (5)$$

- This value $P_H$ shall be compared to the applicable limit contained in table 2 of clause 4.2.3.2.2.

#### 5.4.4.2.1.1.3 Option 2: For equipment without continuous transmission capability and operating (or with the capability to operate) in only one sub-band

This option is for equipment that is either:

- equipment capable of operation in both sub-bands, but not simultaneously; or
- equipment capable of operation in both sub-bands simultaneously but which, for the purpose of the testing, can be configured to transmit only in one sub-band.

Equipment having simultaneous transmissions in both sub-bands and which cannot be configured to transmit only in one sub-band, shall be tested using option 3 given in clause 5.4.4.2.1.1.4.

- The test procedure shall be as follows:

**Step 1:**

- Sample the transmit signal from the device using a fast power sensor suitable for 6 GHz. Save the raw samples. The samples shall represent the RMS power of the signal.
- Settings:
  - Sample speed: $\geq 10^6$ Samples/s.
  - Measurement duration: Sufficient to capture a minimum of 10 transmitter bursts (see clause 5.3.1.1).

**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 a 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 in the following steps.

**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 insufficient dynamic range, 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 (mean) power over the burst ($P_{burst}$) using the formula below:

$$\boldsymbol{P}_{\text{burst}} = \frac{1}{k} \sum_{n=1}^{k} \boldsymbol{P}_{\text{sample}}(n) \quad (6)$$

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

- The highest of all $P_{burst}$ values is the value A in dBm.

**Step 5:**

- The RF output power (e.i.r.p) at the highest power level $P_H$ shall be calculated from the above measured power output A (in dBm), the stated antenna assembly gain G in dBi and if applicable the beamforming gain Y in dB, according to the formula below. If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used:

$$P_H = A + G + Y \text{ (dBm)} \quad (7)$$

- This value $P_H$ shall be compared to the applicable limit contained in table 2 of clause 4.2.3.2.2 and shall be recorded in the report.

###### 5.4.4.2.1.1.4 Option 3: For equipment without continuous transmission capability and having simultaneous transmissions in both sub-bands

- This option is for equipment having simultaneous transmissions in both sub-bands but which cannot be configured to transmit only in one sub-band.
- This procedure first measures the peak power in each sub-band separately, then measures the Peak to Mean Power ratio for the overall transmission and uses this to calculate the RF Output Power (e.i.r.p.) in each sub-band separately using the measured values for peak power.
- The test procedure shall be as follows:

**Step 1: Measuring the Total Peak Power within the lower sub-band.**

- Connect the UUT to the spectrum analyser and use the following settings:
  - Start Frequency: 5 100 MHz
  - Stop Frequency: 5 400 MHz
  - RBW: 1 MHz
  - VBW: 3 MHz
  - Detector Mode: Peak
  - Trace Mode: Max Hold
  - Sweep Time: Auto
- Ensure that the noise floor of the spectrum analyser is at least 30 dB to 40 dB below the peak of the power envelope. If this is not possible (e.g. radiated measurements) reduce the bandwidth of the channel power function to a value which is still slightly above the *Nominal Channel Bandwidth* (e.g. +10 %) to avoid the noise floor influencing the measurement result.
- When the trace is complete, use the "Channel Power" function to measure the total peak power of the transmissions within the band 5 150 MHz to 5 350 MHz.
- For conducted measurements on devices with multiple transmit chains, the procedure above shall be repeated for each of the active transmit chains. The results shall be summed to provide the total peak power of the transmissions within the band 5 150 MHz to 5 350 MHz.

**Step 2: Measuring the Total Peak Power within the upper sub-band.**

- Change the Start Frequency to 5 420 MHz and the Stop Frequency to 5 775 MHz.

- Ensure that the noise floor of the spectrum analyser is at least 30 dB to 40 dB below the peak of the power envelope. If this is not possible (e.g. radiated measurements) reduce the bandwidth of the channel power function to a value which is still slightly above the *Nominal Channel Bandwidth* (e.g. +10 %) to avoid the noise floor influencing the measurement result.
- When the trace is complete, use the "Channel Power" function to measure the total peak power of all transmissions with the band 5 470 MHz to 5 725 MHz.
- For conducted measurements on devices with multiple transmit chains, the procedure above shall be repeated for each of the active transmit chains. The results shall be summed to provide the total peak power of the transmissions within the band 5 470 MHz to 5 725 MHz.

**Step 3: Calculating the Total Peak Power.**

- Calculate the total peak power by adding the measured value for the band 5 150 MHz to 5 350 MHz in step 1 to the value measured for the band 5 470 MHz to 5 725 MHz in step 2.
- Modern spectrum analysers may be able to measure the peak power in both sub-bands in one measurement in which case step 1 and step 2 can be combined.

**Step 4: Measuring Total Mean Output Power.**

- Sample the transmit signal from the device using a fast power sensor suitable for 6 GHz. Save the raw samples. The samples shall represent the RMS power of the signal.
- Settings:
  - Sample speed: $\geq 10^6$ Samples/s.
  - Measurement duration: Sufficient to capture a minimum of 10 transmitter bursts (see clause 5.3.1.1).
- 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 in all following steps.
- 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 case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.
- Between the start and stop times of each individual burst, calculate the RMS (mean) power over the burst (Pburst) using the formula below:

$$\boldsymbol{P}_{\text{burst}}=\frac{\boldsymbol{1}}{\boldsymbol{k}}\sum_{\boldsymbol{n=1}}^{\boldsymbol{k}}\boldsymbol{P}_{\text{sample}}\,(\boldsymbol{n}) \qquad (8)$$

  with 'k' being the total number of samples and 'n' the actual sample number
- The highest of all Pburst values is the Total Mean Output Power and this value will be used for further calculations.

**Step 5: Calculating the Peak to Mean Power Ratio.**

- Using the value for Total Peak Power calculated in step 3 and the highest value for Total Mean Output Power measured in step 4, calculate the Peak to Average Power ratio in dB.

**Step 6: Calculating the RF Output Power (e.i.r.p.) for each sub-band.**

- The RF output power (e.i.r.p.) at the highest power level $P_H$ shall be calculated for each of the sub-bands from the Peak to Mean Power Ratio obtained in step 5 and the measured values for Peak Power in each of the sub-bands (see step 1 and step 2). These values (values A in dBm) will be used for maximum e.i.r.p. calculations:
  - Add the (stated) antenna assembly gain G in dBi of the individual antenna element.
  - If applicable, 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:
- For each sub-band, $P_H$ (e.i.r.p.) shall be calculated using the formula below:

$$P_H = A + G + Y \text{ (dBm)}. \qquad (9)$$

- These values for PH shall be compared to the applicable limits contained in table 2 of clause 4.2.3.2.2 and shall be recorded in the report.

#### 5.4.4.2.1.2 RF output power at the lowest power level of the TPC range - $P_L$

##### 5.4.4.2.1.2.1 Additional test conditions

This test is only required for equipment with a TPC feature.

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

The UUT shall be configured to operate at the lowest stated transmitter output power level of the TPC range.

##### 5.4.4.2.1.2.2 Option 1: For equipment with continuous transmission capability or for equipment operating (or with the capability to operate) with a constant duty cycle (e.g. Frame Based equipment)

This option is for equipment that operates only in one sub-band or that is capable for operation in two sub-bands simultaneously but, for the purpose of the testing, the equipment can be configured to:

- operate in a continuous transmit mode or with a constant duty cycle (x); and
- operate only in one sub-band.

**Step 1 and step 2:**

- See step 1 and step 2 in clause 5.4.4.2.1.1.2.

  The duty cycle measurement done in step 1 of clause 5.4.4.2.1.1.2 may not need to be repeated.

**Step 3:**

- The RF output power at the lowest power level $P_L$ (e.i.r.p.) shall be calculated from the above measured power output A (in dBm), the observed duty cycle x, the stated antenna gain G in dBi and if applicable the beamforming gain Y in dB, according to the formula below. This value shall be recorded in the test report. If more than one antenna assembly is intended for this power setting or TPC range, the gain of the antenna assembly with the highest gain shall be used:

$$P_L = A + G + Y + 10 \times \log (1 / x) \text{ (dBm)}. \qquad (10)$$

- This value $P_L$ shall be compared to the applicable limit contained in table 3 of clause 4.2.3.2.3.

#### 5.4.4.2.1.2.3 Option 2: For equipment without continuous transmission capability and operating (or with the capability to operate) in only one sub-band

This option is for equipment that is either:

- equipment capable of operation in both sub-bands, but not simultaneously; or
- equipment capable of operation in both sub-bands simultaneously but which, for the purpose of the testing, can be configured to transmit only in one sub-band.

Equipment having simultaneous transmissions in both sub-bands and which cannot be configured to transmit only in one sub-band, shall be tested using option 3 given in clause 5.4.4.2.1.2.4.

The test procedure shall be as follows:

**Step 1 to step 4:**

- See step 1 to step 4 in clause 5.4.4.2.1.1.3.

**Step 5:**

- The RF output power (e.i.r.p.) at the lowest power level $P_L$ shall be calculated from the above measured power output A (in dBm), the stated antenna assembly gain G in dBi and if applicable the beamforming gain Y in dB, according to the formula below. This value shall be recorded in the test report. If more than one antenna assembly is intended for this TPC range, the gain of the antenna assembly with the highest gain shall be used:

$$P_L = A + G + Y \text{ (dBm)}. \qquad (11)$$

- This value $P_L$ shall be compared to the applicable limit contained in table 3 of clause 4.2.3.2.3 and shall be recorded in the report.

#### 5.4.4.2.1.2.4 Option 3: For equipment without continuous transmission capability and having simultaneous transmissions in both sub-bands

This option is for equipment having simultaneous transmissions in both sub-bands but which cannot be configured to transmit only in one sub-band.

This procedure first measures the peak power in each sub-band separately, then measures the Peak to Mean Power ratio for the overall transmission and uses this to calculate the RF Output Power (e.i.r.p.) in each sub-band separately using the measured values for peak power.

The test procedure shall be as follows:

**Step 1: Measuring the Total Peak Power within the lower sub-band.**

- Connect the UUT to the spectrum analyser and use the following settings:
  - Start Frequency: 5 100 MHz
  - Stop Frequency: 5 400 MHz
  - RBW: 1 MHz
  - VBW: 3 MHz
  - Detector Mode: Peak
  - Trace Mode: Max Hold
  - Sweep Time: Auto
- Ensure that the noise floor of the spectrum analyser is at least 30 dB to 40 dB below the peak of the power envelope. If this is not possible (e.g. radiated measurements) reduce the bandwidth of the channel power function to a value which is still slightly above the *Nominal Channel Bandwidth* (e.g. +10 %) to avoid the noise floor influencing the measurement result.

- When the trace is complete, use the "Channel Power" function to measure the total peak power of all transmissions with the band 5 150 MHz to 5 350 MHz.
- For conducted measurements on devices with multiple transmit chains, the procedure above shall be repeated for each of the active transmit chains. The results shall be summed to provide the total peak power of the transmissions within the band 5 150 MHz to 5 350 MHz.

**Step 2: Measuring the Total Peak Power within the upper sub-band.**

- Change the Start Frequency to 5 420 MHz and the Stop Frequency to 5 775 MHz.
- Ensure that the noise floor of the spectrum analyser is at least 30 dB to 40 dB below the peak of the power envelope. If this is not possible (e.g. radiated measurements) reduce the bandwidth of the channel power function to a value which is still slightly above the *Nominal Channel Bandwidth* (e.g. +10 %) to avoid the noise floor influencing the measurement result.
- When the trace is complete, use the "Channel Power" function to measure the total peak power of all transmissions with the band 5 470 MHz to 5 725 MHz.
- For conducted measurements on devices with multiple transmit chains, the procedure above shall be repeated for each of the active transmit chains. The results shall be summed to provide the total peak power of the transmissions within the band 5 470 MHz to 5 725 MHz.

**Step 3: Calculating the Total Peak Power.**

- Calculate the total peak power by adding the measured value for the band 5 150 MHz to 5 350 MHz in step 1 to the value measured for the band 5 470 MHz to 5 725 MHz in step 2. Modern spectrum analysers may be able to measure the peak power in both sub-bands in one measurement in which case step 1 and step 2 can be combined.

**Step 4: Measuring Total Mean Output Power.**

- Sample the transmit signal from the device using a fast power sensor suitable for 6 GHz. Save the raw samples. The samples shall represent the RMS power of the signal.
- Settings:
  - Sample speed: $\geq 10^6$ Samples/s.
  - Measurement duration: Sufficiently to capture a minimum of 10 transmitter bursts (see clause 5.3.1.1).
- 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 in all following steps.
- 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 case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.

- Between the start and stop times of each individual burst calculate the RMS (mean) power over the burst ($P_{burst}$) using the formula below:

$$\boldsymbol{P}_{\text{burst}} = \frac{1}{k}\sum_{n=1}^{k} \boldsymbol{P}_{\text{sample}}(\boldsymbol{n}) \quad (12)$$

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

- The highest of all $P_{burst}$ values is the Total Mean Output Power and this value will be used for further calculations.

**Step 5: Calculating the Peak to Mean Power ratio.**

- Using the value for Total Peak Power calculated in step 3 and the highest value for Total Mean Output Power measured in step 4, calculate the Peak to Average Power ratio in dB.

**Step 6: Calculating the RF Output Power (e.i.r.p.) for each sub-band.**

- The RF output power (e.i.r.p.) at the lowest power level $P_L$ of the TPC range shall be calculated for each of the sub-bands from the Peak to Mean Power Ratio obtained in step 5 and the measured values for Peak Power in each of the sub-bands (see step 1 and step 2). These values (values A in dBm) will be used for maximum e.i.r.p. calculations:
  - Add the (stated) antenna assembly gain G in dBi of the individual antenna element.
  - If applicable, 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.
  - For each sub-band, PL (e.i.r.p.) shall be calculated using the formula below. These values shall be recorded in the test report:

$$P_L = A + G + Y \text{ (dBm)} \quad (13)$$

- These values shall be compared to the applicable limits contained in table 3 of clause 4.2.3.2.3.

### 5.4.4.2.1.3 Power density

#### 5.4.4.2.1.3.1 Additional test conditions

These measurements shall only be performed at normal test conditions (see clause 5.1.2).

The UUT shall be configured to operate at the lowest *Nominal Channel Bandwidth* with:

- the highest stated transmitter output power level of its TPC range; or
- the maximum stated transmitter output power level in case the equipment has no TPC feature.

#### 5.4.4.2.1.3.2 Option 1: For equipment with continuous transmission capability or for equipment operating (or with the capability to operate) with a constant duty cycle (e.g. Frame Based equipment)

This option is for equipment that can be configured to operate in a continuous transmit mode or with a constant duty cycle (x).

**Step 1:**

- Connect the UUT to the spectrum analyser and use the following settings:
  - Centre Frequency: The centre frequency of the channel under test
  - RBW: 1 MHz
  - VBW: 3 MHz

- Frequency Span: 2 × Nominal Bandwidth (e.g. 40 MHz for a 20 MHz channel)
- Detector Mode: Peak
- Trace Mode: Max Hold

**Step 2:**

- When the trace is complete, find the peak value of the power envelope and record the frequency.

**Step 3:**

- Make the following changes to the settings of the spectrum analyser:
  - Centre Frequency: Equal to the frequency recorded in step 2
  - Frequency Span: 3 MHz
  - RBW: 1 MHz
  - VBW: 3 MHz
  - Sweep Time: 1 minute
  - Detector Mode: RMS
  - Trace Mode: Max Hold

**Step 4:**

- When the trace is complete, the trace shall be captured using the "Hold" or "View" option on the spectrum analyser.
- Find the peak value of the trace and place the analyser marker on this peak. This level is recorded as the highest mean power (power density) D in a 1 MHz band.
- Alternatively, where a spectrum analyser is equipped with a function to measure spectral power density, this function may be used to display the power density D in dBm / MHz.
- In case of conducted measurements on smart antenna systems operating in a mode with multiple transmit chains active simultaneously, the power density of each transmit chain shall be measured separately to calculate the total power density (value D in dBm / MHz) for the UUT.

**Step 5:**

- The maximum spectral power density e.i.r.p. is calculated from the above measured power density D, the observed duty cycle x (see clause 5.4.4.2.1.1.2, step 1), the applicable antenna assembly gain G in dBi and if applicable the beamforming gain Y in dB, according to the formula below. This value shall be recorded in the test report. If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used:

$$PD = D + G + Y + 10 \times \log (1 / x) \text{ (dBm / MHz)} \quad (14)$$

###### 5.4.4.2.1.3.3 Option 2: For equipment without continuous transmission capability and without the capability to transmit with a constant duty cycle

This method can be used if the equipment has non-continuous transmissions and cannot be configured to transmit continuously or with a constant duty cycle.

For devices having simultaneous transmissions in both sub-bands, the Power Density in each of the sub-bands shall be measured separately and compared with the applicable limits contained in table 2 of clause 4.2.3.2.2.

The test procedure shall be as follows:

**Step 1:**

- Connect the UUT to the spectrum analyser and use the following settings:
  - Start Frequency: lower band edge of applicable sub-band (e.g. 5 150 MHz or 5 470 MHz)
  - Stop Frequency: upper band edge of applicable sub-band (e.g. 5 350 MHz or 5 725 MHz)
  - RBW: 10 kHz
  - VBW: 30 kHz
  - Sweep Points: > 20 000 (for 5 150 MHz to 5 350 MHz)

    > 25 500 (for 5 470 MHz to 5 725 MHz)

    For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented.
  - Detector: RMS
  - Trace Mode: Max Hold
  - Sweep time: 30 s
- For non-continuous signals, wait for the trace to be stabilized. Save the (trace) data set to a file.

**Step 2:**

- For conducted measurements on smart antenna systems using either operating mode 2 or operating mode 3 (see clause 5.3.3.2), repeat the measurement for each of the transmit ports. For each sampling point (frequency domain), add up the coincident power values (in mW) for the different transmit chains and use this as the new data set.

**Step 3:**

- Add up the values of power for all the samples in the file using the formula below:

$$\boldsymbol{P}_{\text{Sum}} = \sum_{\boldsymbol{n}=1}^{\boldsymbol{k}} \boldsymbol{P}_{\text{sample}}(\boldsymbol{n}) \quad (15)$$

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

**Step 4:**

- Normalize the individual values for power (in dBm) so that the sum is equal to the RF Output Power (e.i.r.p.) ($P_H$) measured in clause 5.4.4.2.1.1 for this sub-band. The following formulas can be used:

$$\boldsymbol{C}_{\text{Corr}} = \boldsymbol{P}_{\text{Sum}} - \boldsymbol{P}_{\boldsymbol{H}\text{e.i.r.p}} \quad (16)$$

$$\boldsymbol{P}_{\text{Samplecorr}}(\boldsymbol{n}) = \boldsymbol{P}_{\text{Sample}}(\boldsymbol{n}) - \boldsymbol{C}_{\text{Corr}} \quad (17)$$

with 'n' being the actual sample number

**Step 5:**

- Starting from the first sample $\boldsymbol{P}_{\textbf{Samplecorr}}(\boldsymbol{n})$ in the file (lowest frequency), add up the power (in mW) of the following samples representing a 1 MHz segment and record the results for power and position (i.e. sample #1 to sample #100). This is the Power Density (e.i.r.p.) for the first 1 MHz segment which shall be saved.

**Step 6:**

- Shift the start point of the samples added up in step 5 by one sample and repeat the procedure in step 5 (i.e. sample #2 to sample #101).

**Step 7:**

- Repeat step 6 until the end of the data set and save the radiated power density values for each of the 1 MHz segments.
- From all the saved results, the highest value is the maximum Power Density (e.i.r.p.) for the UUT. This value, which shall comply with the limit contained in table 2 of clause 4.2.3.2.2, shall be recorded in the test report.

#### 5.4.4.2.2 Radiated measurement

When performing radiated measurements on a UUT with a directional antenna (including smart antenna systems and systems capable of beamforming), the UUT shall be configured/positioned for maximum e.i.r.p. in the horizontal plane. This configuration/position shall be recorded for future use (see clause 5.2.4).

A test site as described in annex B and using the applicable measurement procedures as described in annex C shall be used.

The test procedure is further as described under clause 5.4.4.2.1. However, the following shall be taken into account when performing radiated measurements.

For measuring Output Power:

- When using Option 1 as in clause 5.4.4.2.1.1.2 and clause 5.4.4.2.1.2.2, the values G and Y used in step 3 shall be ignored.
- When using Option 2 as in clause 5.4.4.2.1.1.3 and clause 5.4.4.2.1.2.3, the values G and Y used in step 5 shall be ignored.
- When using Option 3 as in clause 5.4.4.2.1.1.4 and clause 5.4.4.2.1.2.4, the values G and Y used in step 6 shall be ignored.

For measuring Power Density:

- When using Option 1 as in clause 5.4.4.2.1.3.2, the values G and Y used in step 5 shall be ignored.

For measuring the RF output power at the highest and lowest power level, it is likely that a radiated measurement would be performed using a spectrum analyser or measurement receiver, rather than a wide band power sensor. If this is the case and if the resolution bandwidth capability of the measurement device is narrower than the *Occupied Channel Bandwidth* of the UUT signal measured, then the method of measurement shall be documented in the test report.

## 5.4.5 Transmitter unwanted emissions outside the 5 GHz RLAN bands

### 5.4.5.1 Test conditions

The conformance requirements in clause 4.2.4.1 shall be verified only under normal operating conditions, and when operating on those channels defined in clause 5.3.2.

The equipment shall be configured to operate under its worst case situation with respect to unwanted emissions outside the 5 GHz RLAN bands.

If possible, the UUT shall be set to continuous transmit (duty cycle = 1) for the duration of this test.

If continuous transmit is not possible, the UUT should be configured to operate at its maximum duty cycle.

The level of transmitter unwanted emissions shall be measured as, either:

a) their power in a specified load (conducted 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 temporary antenna connectors.

### 5.4.5.2 Test method

#### 5.4.5.2.1 Conducted measurement

##### 5.4.5.2.1.1 Pre-scan

The UUT 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 UUT.

**Step 1:**

- The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in clause 4.2.4.1.2, table 4.

**Step 2:**

- The unwanted emissions over the range 30 MHz to 1 000 MHz shall be identified.
- Spectrum analyser settings:
  - Resolution bandwidth: 100 kHz
  - Video bandwidth: 300 kHz
  - Detector mode: Peak
  - Trace Mode: Max Hold
  - Sweep Points: ≥ 9 700

    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 5.4.5.2.1.2 (step 1, last bullet) may be omitted.
  - 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 transmissions of the UUT.

EXAMPLE 1: For non-continuous transmissions, if the UUT is using a test sequence as described in clause 5.3.1.1 with a transmitter on + off time of 2 ms, then the sweep time has to be greater than 4 ms per 100 kHz.

- Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.2.4.1.2, table 4 shall be individually measured using the procedure in clause 5.4.5.2.1.2 and compared to the limits given in clause 4.2.4.1.2, table 4.

**Step 3:**

- The unwanted emissions over the range 1 GHz to 26 GHz shall be identified.
- Spectrum analyser settings:
  - Resolution bandwidth: 1 MHz
  - Video bandwidth: 3 MHz
  - Detector mode: Peak
  - Trace Mode: Max Hold

- Sweep points: ≥ 25 000

  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 5.4.5.2.1.2 (step 1, last bullet) may be omitted.

- 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 transmissions of the UUT.

EXAMPLE 2: For non-continuous transmissions, if the UUT is using a test sequence as described in clause 5.3.1.1 with a transmitter on + off time of 2 ms, then the sweep time has to be greater than 4 ms per 1 MHz.

- Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.2.4.1.2, table 4 shall be individually measured using the procedure in clause 5.4.5.2.1.2 and compared to the limits given in clause 4.2.4.1.2, table 4.

##### 5.4.5.2.1.2 Measurement of the emissions identified during the pre-scan

The limits for transmitter unwanted emissions in clause 4.2.4.1 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.

**Continuous transmit signals:**

For continuous transmit signals, a simple measurement using the RMS detector of the spectrum analyser is permitted. The measured values shall be recorded and compared with the limits in clause 4.2.4.1.2, table 4.

**Non-continuous transmit signals:**

For non-continuous 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 following spectrum analyser 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)
  - 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: Sweeptime [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 5.4.5.2.1.1.

**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. Compare this value with the applicable limit provided by clause 4.2.4.1.2, table 4.

Repeat this procedure for every emission identified during the pre-scan. The values and corresponding 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. Comparison with the applicable limits shall be done using either of the options given below:

- Option 1: the results for each of the transmit chains for the corresponding 1 MHz segments shall be added and compared with the limits provided by table 4 in clause 4.2.4.1.2.
- Option 2: the results for each of the transmit chains shall be individually compared with the limits provided by table 4 in clause 4.2.4.1.2 after these limits have been reduced by $10 \times \log_{10} (T_{ch})$ (number of active transmit chains).

##### 5.4.5.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser attached to the test antenna.

The test procedure is as described under clause 5.4.5.2.1.

### 5.4.6 Transmitter unwanted emissions within the 5 GHz RLAN bands

#### 5.4.6.1 Test conditions

The conformance requirements in clause 4.2.4.2 shall be verified only under normal operating conditions, and when operating on those channels and channel bandwidths defined in clause 5.3.2.

The equipment shall be configured to operate under its worst case situation with respect to unwanted emissions within the 5 GHz RLAN bands.

For UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector(s), conducted measurements shall be performed. Alternatively, if UUT has an integral antenna(s), but no temporary antenna connector(s), radiated measurements can 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).

#### 5.4.6.2 Test method

##### 5.4.6.2.1 Conducted measurement

###### 5.4.6.2.1.1 Option 1: For equipment with continuous transmission capability

The UUT shall be configured for continuous transmit mode (duty cycle equal to 100 %). If this is not possible, then option 2 shall be used.

**Step 1: Determination of the reference average power level.**

- Spectrum analyser settings:
  - Resolution bandwidth: 1 MHz
  - Video bandwidth: 30 kHz
  - Detector mode: Peak
  - Trace mode: Video Average
  - Sweep Time: Coupled
  - Centre Frequency: Centre frequency of the channel being tested
  - Span: 2 × *Nominal Channel Bandwidth*
- Use the marker to find the highest average power level of the power envelope of the UUT. This level shall be used as the reference level for the relative measurements.

**Step 2: Determination of the relative average power levels.**

- Adjust the frequency range of the spectrum analyser to allow the measurement to be performed within the sub-bands 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz. No other parameter of the spectrum analyser should be changed.
- Compare the relative power envelope of the UUT with the limits defined in clause 4.2.4.2.2.

##### 5.4.6.2.1.2 Option 2: For equipment without continuous transmission capability

This method shall be used if the UUT is not capable of operating in a continuous transmit mode (duty cycle less than 100 %). In addition, this option can also be used as an alternative to option 1 for systems operating in a continuous transmit mode.

**Step 1: Determination of the reference average power level.**

- Spectrum analyser settings:
  - Resolution bandwidth: 1 MHz
  - Video bandwidth: 30 kHz
  - Detector mode: RMS
  - Trace Mode: Max Hold
  - Sweep time: ≥ 1 min
  - Centre Frequency: Centre frequency of the channel being tested
  - Span: 2 × *Nominal Channel Bandwidth*
- Use the marker to find the highest average power level of the power envelope of the UUT. This level shall be used as the reference level for the relative measurements.

**Step 2: Determination of the relative average power levels.**

- Adjust the frequency range of the spectrum analyser to allow the measurement to be performed within the sub-bands 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz. No other parameter of the spectrum analyser should be changed.
- Compare the relative power envelope of the UUT with the limits defined in clause 4.2.4.2.2.

#### 5.4.6.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser attached to the test antenna.

The test procedure is as described under clause 5.4.6.2.1.

## 5.4.7 Receiver spurious emissions

### 5.4.7.1 Test conditions

The conformance requirements in clause 4.2.5 shall be verified only under normal operating conditions, and when operating on those channels defined in clause 5.3.2.

For equipment having different operating modes (see clause 5.3.3.2) the measurements described in the present clause may not need to be repeated for all the operating modes.

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

a) their power in a specified load (conducted 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 temporary antenna connectors.

The test method in clause 5.4.7.2 below assumes, that for the duration of the test, the UUT is configured into a continuous receive mode, or is operated in a mode where no transmissions occur.

### 5.4.7.2 Test method

#### 5.4.7.2.1 Conducted measurement

##### 5.4.7.2.1.1 Pre-scan

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

**Step 1:**

- The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in clause 4.2.5.2, table 5.

**Step 2:**

- The emissions shall be measured over the range 30 MHz to 1 000 MHz.
- Spectrum analyser settings:
  - Resolution bandwidth: 100 kHz
  - Video bandwidth: 300 kHz
  - Detector mode: Peak
  - Trace Mode: Max Hold
  - Sweep Points: ≥ 9 700

    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 5.4.7.2.1.2 (step 1, last bullet) may be omitted.
  - Sweep time: Auto

- Wait for the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.2.5.2, table 5, shall be individually measured using the procedure in clause 5.4.7.2.1.2 and compared to the limits given in clause 4.2.5.2, table 5.

**Step 3:**

- The emissions shall now be measured over the range 1 GHz to 26 GHz.
- Spectrum analyser settings:
  - Resolution bandwidth: 1 MHz
  - Video bandwidth: 3 MHz
  - Detector mode: Peak
  - Trace mode: Max Hold
  - Sweep Points: ≥ 25 000

    For spectrum analysers not supporting this high number of sweep points, the frequency band may need to be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.4.7.2.1.2 (step 1, last bullet) may be omitted.
  - Sweep time: Auto
- Wait for the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.2.5.2, table 5, shall be individually measured using the procedure in clause 5.4.7.2.1.2 and compared to the limits given in clause 4.2.5.2, table 5.

###### 5.4.7.2.1.2 Measurement of the emissions identified during the pre-scan

The limits for receiver spurious emissions in clause 4.2.5 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. This method assumes the spectrum analyser has a Time Domain Power function.

**Step 1:**

- The level of the emissions shall be measured using the following spectrum analyser settings:
  - Measurement Mode: Time Domain Power
  - Centre Frequency: Frequency of the emission identified during the pre-scan
  - Resolution Bandwidth: 100 kHz (emissions < 1 GHz) / 1 MHz (emissions > 1 GHz)
  - Video Bandwidth: 300 kHz (emissions < 1 GHz) / 3 MHz (emissions > 1 GHz)
  - Frequency Span: Zero Span
  - Sweep mode: Single Sweep
  - Sweep time: 30 ms
  - Sweep points: ≥ 30 000
  - Trigger: Video (for burst signals) or Manual (for continuous signals)
  - Detector: RMS
- 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 5.4.7.2.1.1.

**Step 2:**

- Set a window where the start and stop indicators match the start and end of the burst with the highest level and record the value of the power measured within this window.
- If the spurious emission to be measured is a continuous transmission, the measurement window shall be set to the start and stop times of the sweep.

**Step 3:**

- In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 shall be repeated for each of the active receive chains.
- Sum the measured power (within the observed window) for each of the active receive chains.

**Step 4:**

- The value defined in step 3 shall be compared to the limits defined in clause 4.2.5.2, table 5.

##### 5.4.7.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser attached to the test antenna.

The test procedure is as described under clause 5.4.7.2.1.

### 5.4.8 Dynamic Frequency Selection (DFS)

#### 5.4.8.1 Test conditions

##### 5.4.8.1.1 General

The conformance requirements in clause 4.2.6 shall be verified only under normal operating conditions.

The channels and the channel bandwidths to be used for testing are defined in clause 5.3.2.

Some of the tests may be facilitated by disabling certain operational features of the UUT for the duration of the test.

It should be noted that once a UUT is powered on, it will not start its normal operating functions immediately, as it will have to finish its power-up cycle first ($T_{power\_up}$). As such, the UUT, as well as any other device used in the set-up, may be equipped with a feature that will indicate its status during the testing, e.g. power-up mode, normal operation mode, channel check status, radar detection event, etc.

The UUT is capable of transmitting a test transmission sequence as described in clause 5.3.1.2. The UUT shall be configured to operate at its maximum Channel Occupancy Time without the use of any pauses in between transmissions. This is defined in clause 4.2.7.3.1 for Frame Based Equipment and in clause 4.2.7.3.2 for Load Based Equipment.

The signal generator is capable of generating any of the radar test signals defined in table D.3 and table D.4.

A spectrum analyser or equivalent shall be used to measure the aggregate transmission time of the UUT.

Clause 5.4.8.1.3.1 to clause 5.4.8.1.3.3 describe the different set-ups to be used during the measurements.

##### 5.4.8.1.2 Selection of radar test signals

The radar test signals to be used during the DFS testing are defined in table D.3 and table D.4.

For each of the variable radar test signals in table D.4, an arbitrary combination of Pulse Width, Pulse Repetition Frequency and if applicable the number of different PRFs, shall be chosen from the ranges given in table D.4 and recorded in the test report.

The radar test signals given in table D.4 simulate real radar systems. They take into account the combined effect of antenna rotation speed, antenna beam width and pulse repetition frequency for a particular type of radar. The given values for Pulses Per Burst (PPB) represent the number of pulses for a given PRF, seen at the RLAN device for each scan of the radar.

$$PPB = [\{\text{antenna beamwidth (deg)}\} \times \{\text{pulse repetition rate (PPS)}\}] / [\{\text{scan rate (deg/s)}\}] \qquad (18)$$

Table D.5 provides for each radar test signal the required detection probability (Pd). Pd represents a minimum level of detection performance under defined conditions. Therefore Pd does not represent the overall detection probability for any particular radar under real life conditions.

The pulse widths given in the table D.3 and table D.4 shall have an accuracy of ±5 %.

The tests related to the Channel Availability Check, In-Service Monitoring, Channel Shut Down and Non-Occupancy Period (see clause 5.4.8.2.1.2, clause 5.4.8.2.1.3, clause 5.4.8.2.1.5 and clause 5.4.8.2.1.6) are performed with a single burst radar test signal while the tests related to the Off-Channel CAC (see clause 5.4.8.2.1.4) are performed with a repetitive burst radar test signal (see note 4 in table D.4).

### 5.4.8.1.3 Test set-ups

#### 5.4.8.1.3.1 Set-up A

*Set-up A* is a set-up whereby the UUT is an RLAN device operating in master mode. Radar test signals are injected into the UUT. This set-up also contains an RLAN device operating in slave mode which is associated with the UUT.

Figure 5 shows an example for *Set-up A*. The set-up used shall be documented in the test report.

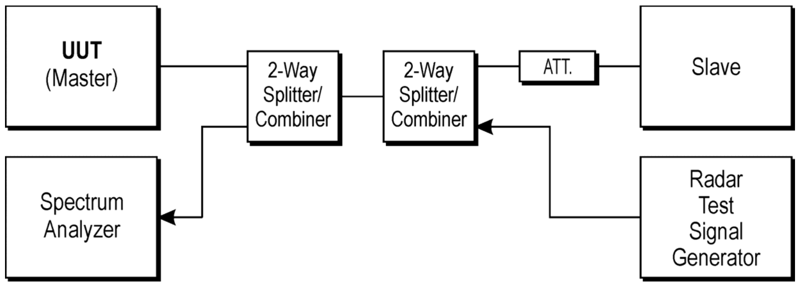



**Figure 5: Set-up A**

#### 5.4.8.1.3.2 Set-up B

*Set-up B* is a set-up whereby the UUT is an RLAN device operating in slave mode, with or without Radar Interference Detection function. This set-up also contains an RLAN device operating in master mode. The radar test signals are injected into the master device. The UUT (slave device) is associated with the master device.

Figure 6 shows an example for *Set-up B*. The set-up used shall be documented in the test report.

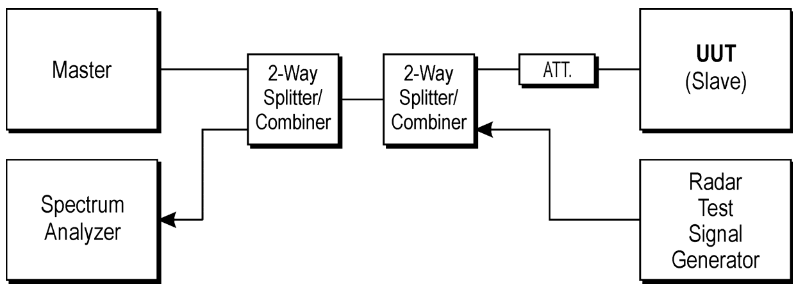



**Figure 6: Set-up B**

##### 5.4.8.1.3.3 Set-up C

The UUT is an RLAN device operating in slave mode with Radar Interference Detection function. Radar test signals are injected into the slave device. This set-up also contains an RLAN device operating in master mode. The UUT (slave device) is associated with the master device.

Figure 7 shows an example for *Set-up C*. The set-up used shall be documented in the test report.

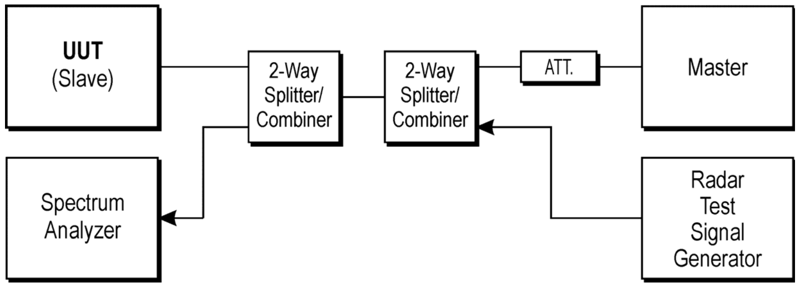



**Figure 7: Set-up C**

### 5.4.8.2 Test method

#### 5.4.8.2.1 Conducted measurement

##### 5.4.8.2.1.1 Additional test conditions

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector(s) provided, conducted measurements shall be used.

When performing DFS testing on smart antenna systems, a power splitter/combiner shall be used to combine all the receive chains (antenna inputs) into a single test point. The insertion loss of the splitter/combiner shall be taken into account.

The UUT shall be configured to operate at the highest transmitter output power setting.

If the UUT has a Radar Interference Detection function, the output power of the signal generator producing the radar test signals, as selected using clause 5.4.8.1.2, shall (unless otherwise specified) provide a received signal power at the antenna connector of the UUT with a level equal to applicable *Radar Detection Threshold* level defined in table D.2. Parameter G [dBi] in table D.2 corresponds to the gain of the antenna assembly stated by the manufacturer. If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the lowest gain shall be used.

Beamforming gain Y of smart antenna systems, operating in a mode where beamforming is active, is ignored in order to test the worst case.

The centre frequencies of the radar test signals used in the test procedures below shall fall within the central 80 % of the *Occupied Channel Bandwidth* of the RLAN channel under test.

##### 5.4.8.2.1.2 Channel Availability Check

###### 5.4.8.2.1.2.1 Additional Test Conditions

The clauses below define the procedure to verify the *Channel Availability Check* and the *Channel Availability Check Time* ($T_{ch\_avail\_check}$) on the selected channel $Ch_r$ by ensuring that the UUT is capable of detecting radar pulses at the beginning and at the end of the *Channel Availability Check Time.* This is illustrated in figure 8. There shall be no transmissions by the UUT on $Ch_r$ during this time.

A test channel shall be identified in accordance with clause 5.3.2. This channel is designated as $Ch_r$ (see clause 3.2). For the purpose of the test, the UUT shall be configured to ensure that the *Channel Availability Check* is performed on $Ch_r$.

#### 5.4.8.2.1.2.2 Tests with a radar burst at the beginning of the Channel Availability Check Time

The steps below define the procedure to verify the radar detection capability on the selected channel $Ch_r$ when a radar burst occurs at the beginning of the *Channel Availability Check Time*:

a) The signal generator and UUT are connected using *Set-up A* as described in clause 5.4.8.1.3.1. The power of the UUT is switched off.

b) The UUT is powered on at T0. T1 denotes the instant when the UUT has completed its power-up sequence ($T_{power\_up}$) and is ready to start the radar detection. The *Channel Availability Check* is expected to commence on $Ch_r$ at instant T1 and is expected to end no sooner than T1 + $T_{ch\_avail\_check}$ unless the radar test signal is detected sooner.

   Additional verification may be needed to define T1 in case it is not exactly known or indicated by the UUT.

c) A single radar burst is generated on $Ch_r$ using the reference test signal defined in table D.3 at a level of up to 10 dB above the level defined in clause 5.4.8.2.1.1. This single-burst radar test signal shall commence within 2 s after time T1.

d) It shall be recorded if the radar test signal was detected.

e) A timing trace or description of the observed timing and behaviour of the UUT shall be recorded.

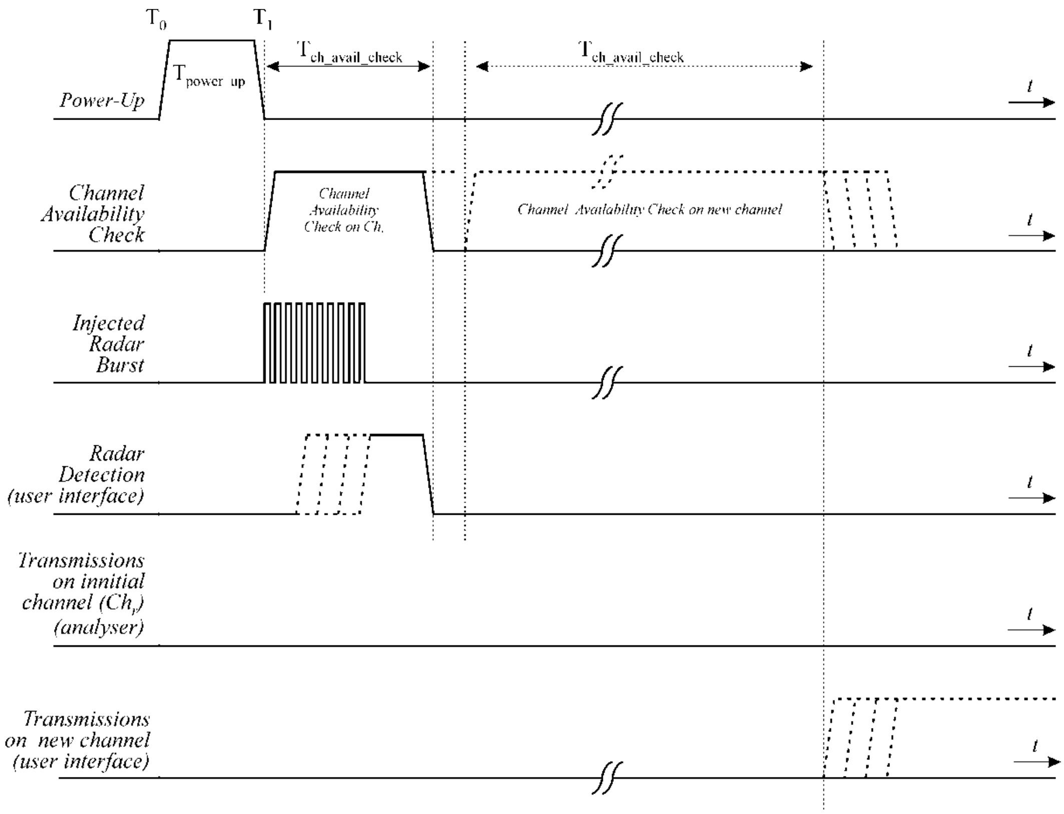



**Figure 8: Example of timing for radar testing at the beginning of the Channel Availability Check Time**

#### 5.4.8.2.1.2.3 Tests with radar burst at the end of the Channel Availability Check Time

The steps below define the procedure to verify the radar detection capability on the selected channel $Ch_r$ when a radar burst occurs at the end of the *Channel Availability Check Time* (see note). This is illustrated in figure 9.

NOTE: The applicable *Channel Availability Check Times* are given by table D.1.

a) The signal generator and UUT are connected using *Set-up A* described in clause 5.4.8.1.3.1. The power of the UUT is switched off.

b) The UUT is powered up at T0. T1 denotes the instant when the UUT has completed its power-up sequence ($T_{power\_up}$) and is ready to start the radar detection. The *Channel Availability Check* is expected to commence on $Ch_r$ at instant T1 and is expected to end no sooner than T1 + $T_{ch\_avail\_check}$ unless the radar test signal is detected sooner.

Additional verification may be needed to define T1 in case it is not exactly known or indicated by the UUT.

c) A single radar burst is generated on $Ch_r$ using the reference test signal defined in table D.3 at a level of up to 10 dB above the level defined in clause 5.4.8.2.1.1. This single-burst radar test signal shall commence towards the end of the minimum required *Channel Availability Check* Time but not before time T1 + $T_{ch\_avail\_check}$ - 2 s.

d) It shall be recorded if the radar test signal was detected.

e) A timing trace or description of the observed timing and behaviour of the UUT shall be recorded.

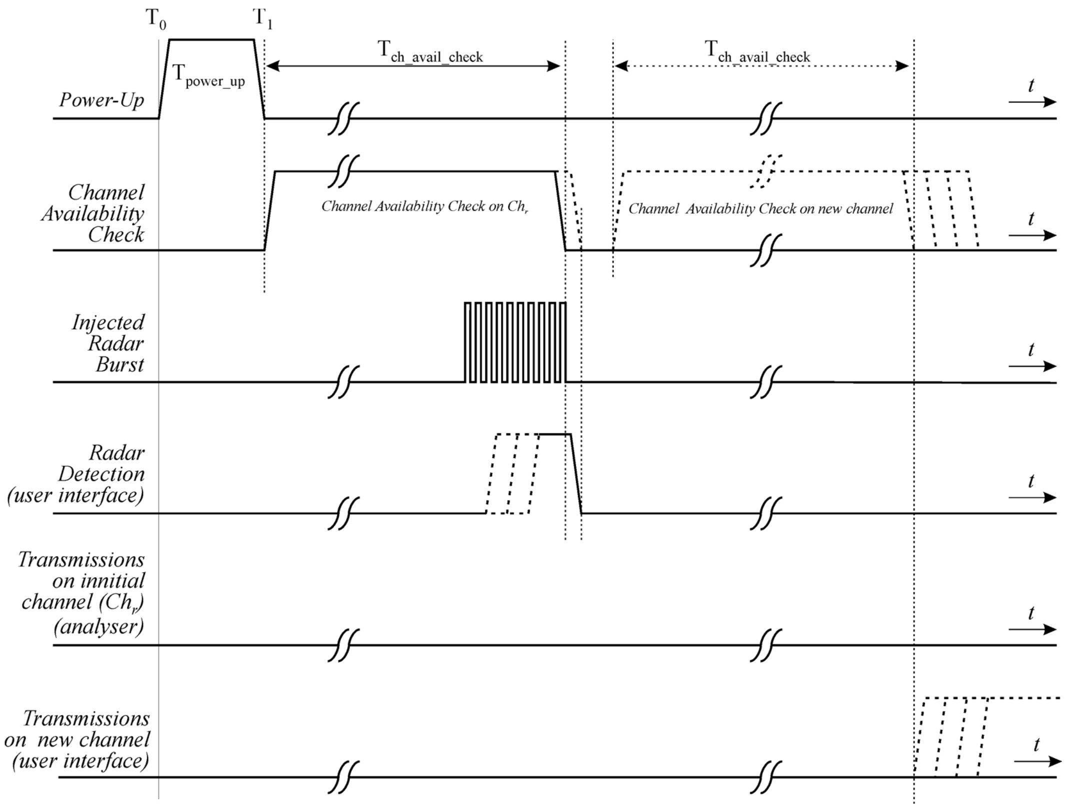



**Figure 9: Example of timing for radar testing towards the end of the Channel Availability Check Time**

#### 5.4.8.2.1.3 Radar Detection Threshold (during the Channel Availability Check)

The different steps below define the procedure to verify the *Radar Detection Threshold* during the *Channel Availability Check Time* for channels outside the 5 600 MHz to 5 650 MHz band. This is illustrated in figure 10.

a) The signal generator and UUT are connected using *Set-up A* described in clause 5.4.8.1.3.1. The power of the UUT is switched off.

b) The UUT is powered on at T0. T1 denotes the instant when the UUT has completed its power-up sequence ($T_{power\_up}$) and is ready to start the radar detection. The *Channel Availability Check* on $Ch_r$ is expected to commence at instant T1 and is expected to end no sooner than T1 + $T_{ch\_avail\_check}$ unless the radar test signal is detected sooner.

   Additional verification may be needed to define T1 in case it is not exactly known or indicated by the UUT.

c) A single burst radar test signal is generated on $Ch_r$ using any of the radar test signals defined in table D.4 at a level defined in clause 5.4.8.2.1.1. This single-burst radar test signal may commence at any time within the applicable *Channel Availability Check Time*.

   For the purpose of reducing test time, it is recommended that the single-burst radar test signal starts approximately 10 s after T1.

d) It shall be recorded if the radar test signal was detected.

e) Step c) to step d) shall be performed 20 times and each time a unique radar test signal shall be generated from options provided in table D.4. When selecting these 20 unique radar test signals, the radar test signals #1 to #6 from table D.4 shall be included as well as variations of pulse width, pulse repetition frequency and number of different PRFs (if applicable) within the ranges given. The radar test signals used shall be recorded in the report. The radar test signal shall be detected at least 12 times out of the 20 trials in order to comply with the detection probability specified for this frequency range in table D.5.

   Where the declared channel plan includes channels whose nominal bandwidth falls completely or partly within the 5 600 MHz to 5 650 MHz band, additional testing as described in the steps below shall be performed on a channel within this band.

f) A single burst radar test signal is generated on $Ch_r$ using any of the radar test signals defined in table D.4 (except signals #3 and #4) at a level of 10 dB above the level defined in clause 5.4.8.2.1.1. This single burst radar test signal may commence at any time within the applicable *Channel Availability Check Time*.

   For the purpose of reducing test time, it is recommended that the single burst radar test signal starts approximately 10 s after T1.

g) Step f) shall be performed 20 times, each time a different radar test signal shall be generated from options provided in table D.4 (except signals #3 and #4). The radar test signals used shall be recorded in the report. The radar test signal shall be detected during each of these tests and this shall be recorded.

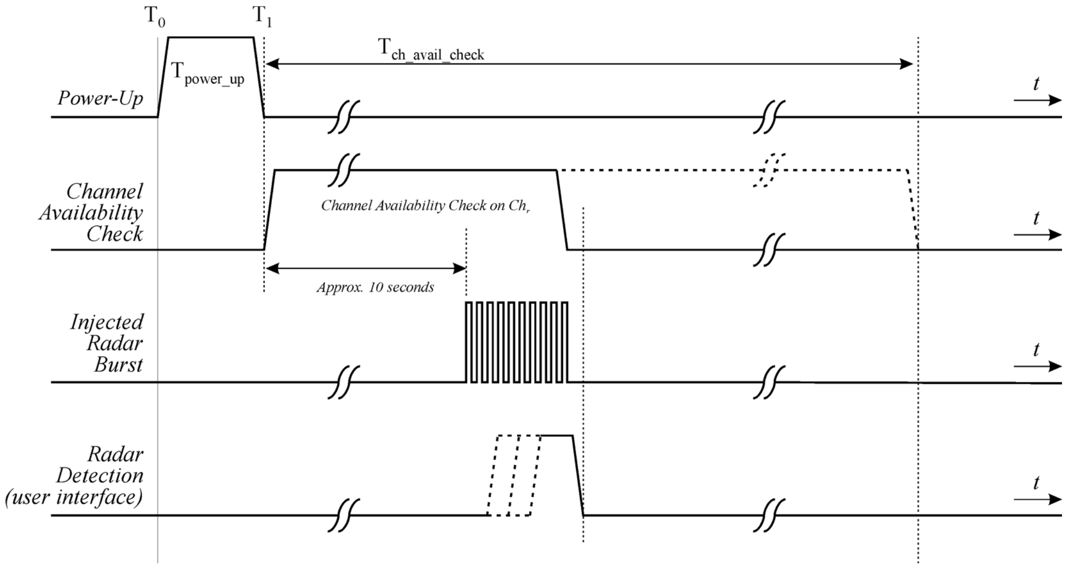



**Figure 10: Example of timing for radar testing during the Channel Availability Check**

#### 5.4.8.2.1.4 Off-Channel CAC

##### 5.4.8.2.1.4.1 Additional Test Conditions

The channel, on which the *Off-Channel CAC* test will be performed, shall be selected in accordance with clause 5.3.2. This channel is designated as $Ch_r$.

For the purpose of the test, the UUT shall be configured to select the *Operating Channel(s)* different from $Ch_r$. There shall be no transmissions by the UUT on $Ch_r$ during the *Off-Channel CAC Time.*

##### 5.4.8.2.1.4.2 Radar Detection Threshold (during Off-Channel CAC)

The different steps below define the procedure to verify the *Radar Detection Threshold* during the *Off-Channel CAC.*

Where the declared channel plan includes channels whose nominal bandwidth falls completely or partly within the 5 600 MHz to 5 650 MHz band, the test shall be performed on one of these channels in addition to a channel outside this band. See clause 5.3.2.

a) The signal generator, the UUT (master device) and a slave device associated with the UUT, are connected using *Set-up A* described in clause 5.4.8.1.3.1.

b) The UUT shall transmit a test transmission sequence in accordance with clause 5.3.1.2 on (all) the *Operating Channel(s)*.

c) A multi burst radar test signal is generated on $Ch_r$ using any of the radar test signals defined in table D.4 at a level defined in clause 5.4.8.2.1.1. The radar test signal used shall be recorded in the report. This multi burst radar test signal shall commence at T3 and shall continue for the total duration of the *Off-Channel CAC Time* ($T_{Off\text{-}Channel\_CAC}$) as declared by the manufacturer in accordance with table D.1. For channels within the 5 600 MHz to 5 650 MHz band test signals #3 and #4 shall not be used and the Burst Interval Time (BIT) during the test shall be varied between 8 min and 10 min. For channels outside this band, the Burst Interval Time (BIT) during the test shall be varied between 45 s and 60 s.

d) The UUT shall detect the radar test signal before the end of the *Off-Channel CAC Time* and this shall be recorded.

For the purpose of reducing test time, the test may be terminated immediately once the UUT has reported detection of the radar test signal.

#### 5.4.8.2.1.4.3 Detection Probability ($P_d$)

This test may be facilitated by disabling the *Channel Shutdown* feature for the duration of the test.

For channels outside the 5 600 MHz to 5 650 MHz band, the test in clause 5.4.8.2.1.4.2 is sufficient to demonstrate that the UUT meets the Detection Probability ($P_d$) defined in table D.5.

Where the declared channel plan includes channels whose nominal bandwidth falls completely or partly within the 5 600 MHz to 5 650 MHz band, the procedure in the steps below has to be performed on one of these channels. See clause 5.3.2.

a) A multi burst radar test signal is generated on $Ch_r$ using any of the radar test signals defined in table D.4 (except signals #3 and #4) at a level of 10 dB above the level defined in clause 5.4.8.2.1.1. The radar test signal used shall be recorded in the report. This multi burst radar test signal shall commence at T3 and shall continue for the total duration of the Off-Channel CAC Time ($T_{Off\text{-}Channel\_CAC}$) as declared by the manufacturer in accordance with table D.1. The Burst Interval Time (BIT) during the test shall be varied between 8 minutes and 10 minutes.

b) It shall be recorded how many bursts have been detected by the UUT at the end of the *Off-Channel CAC Time*. The minimum number of bursts that the UUT shall detect in order to comply with the detection probability defined for this frequency range in table D.5 is given by table 12.

**Table 12: Minimum number of burst detections for channels within the 5 600 MHz to 5 650 MHz band**

| Off-Channel CAC Time (Minutes) | Number of Bursts generated assuming a BIT of 10 minutes | Minimum Number of burst detections |
|---|---|---|
| 60 | 6 | 5 |
| 90 | 9 | 6 |
| 160 | 16 | 7 |
| 320 | 32 | 8 |
| 1 440 | 144 | 9 |

For the purpose of reducing test time, the test may be terminated immediately the UUT has reported the minimum number of burst detections required.

Figure 11 provides an example of the timing of a UUT when radar signals are detected during the Off-Channel CAC testing.

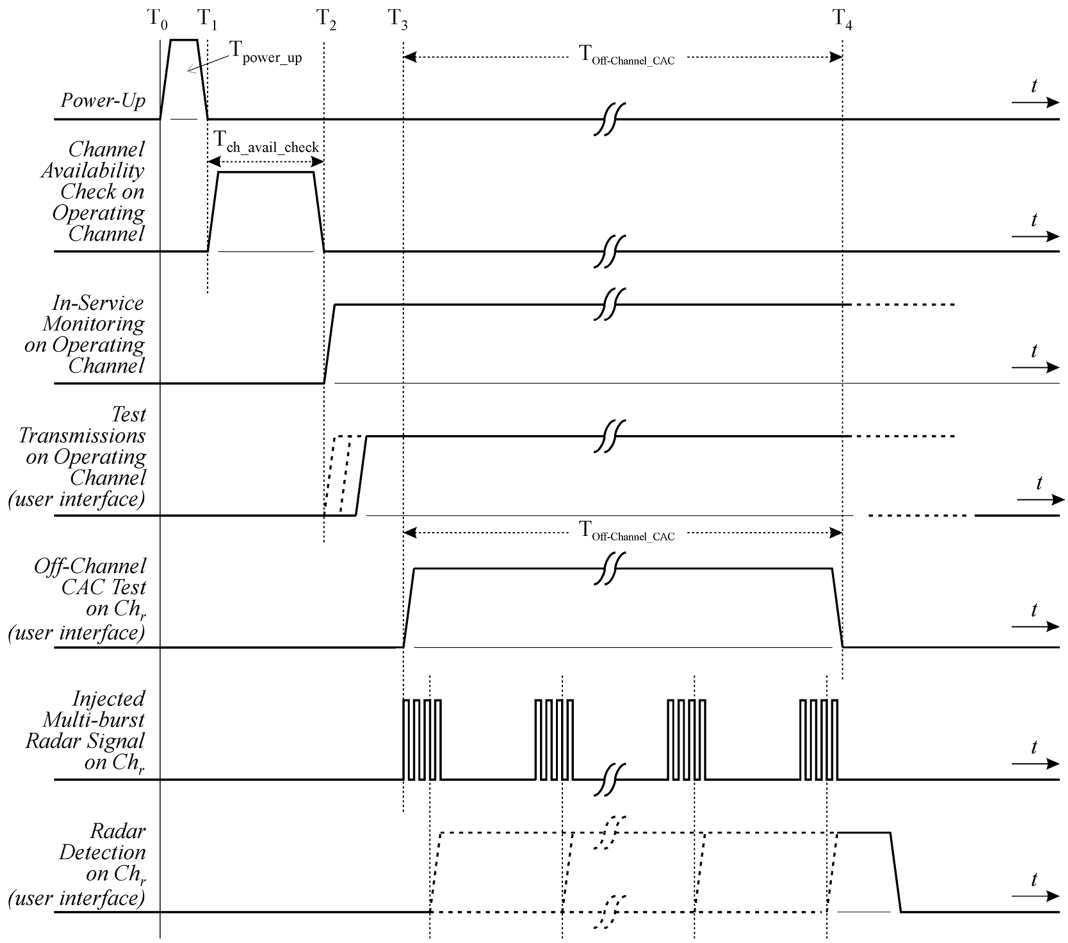



**Figure 11: Example of timing for radar testing during the Off-Channel CAC**

#### 5.4.8.2.1.5 In-Service Monitoring

The steps below define the procedure to verify the In-Service Monitoring and the Radar Detection Threshold during the In-Service Monitoring.

The channel, on which the In-Service Monitoring test will be performed, shall be selected in accordance with clause 5.3.2. This channel, designated as $Ch_r$, is an Operating Channel.

a) When the UUT is a master device, a slave device will be used that associates with the UUT. The signal generator and the UUT are connected using *Set-up A* described in clause 5.4.8.1.3.1.

   When the UUT is a slave device with a Radar Interference Detection function, the UUT shall associate with a master device. The signal generator and the UUT are connected using *Set-up C* described in clause 5.4.8.1.3.3.

b) The UUT shall transmit a test transmission sequence in accordance with clause 5.3.1.2 on the selected channel $Ch_r$. While the testing is performed on $Ch_r$, the equipment is allowed to have simultaneous transmissions on other adjacent or non-adjacent operating channels.

c) At a certain time T0, a single burst radar test signal is generated on $Ch_r$ using radar test signal #1 defined in table D.4 and at a level defined in clause 5.4.8.2.1.1. T1 denotes the end of the radar burst.

d) It shall be recorded if the radar test signal was detected.

e) Step b) to step d) shall be performed 20 times, each time a random value shall be chosen for pulse width and pulse repetition frequency from the corresponding ranges provided in table D.4. For radar test signal #5 and radar test signal #6 provided in table D.4 the number of PRF values shall vary between 2 or 3. The radar test signal shall be detected at least 12 times out of the 20 trials in order to comply with the detection probability specified in table D.5.

f) Step b) to step e) shall be repeated for each of the radar test signals defined in table D.4 and as described in clause 5.4.8.1.2.

Figure 12 provides an example of the timing of a UUT when radar signals are detected during the In-Service Monitoring.

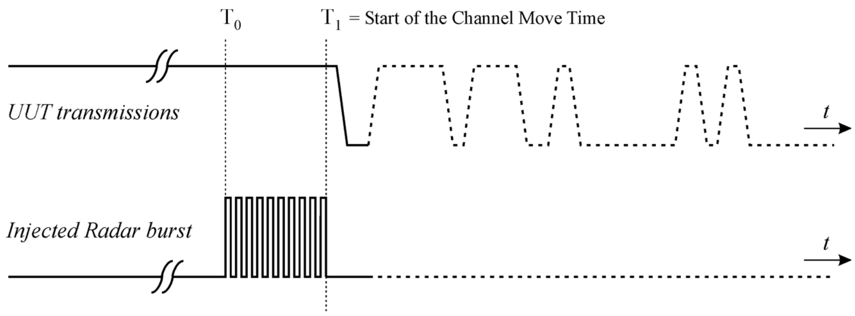



**Figure 12: Example of timing for radar testing during In-Service Monitoring**

#### 5.4.8.2.1.6 Channel Shutdown and Non-Occupancy period

The steps below define the procedure to verify the *Channel Shutdown* process and to determine the *Channel Closing Transmission Time*, the *Channel Move Time* and the *Non-Occupancy Period.* This is illustrated in figure 13.

The channel, on which these tests will be performed, shall be selected in accordance with clause 5.3.2. This channel, designated as $Ch_r$, is an *Operating Channel*.

a) When the UUT is a master device, a slave device will be used that associates with the UUT. The signal generator and the UUT shall be connected using *Set-up A* described in clause 5.4.8.1.3.1.

When the UUT is a slave device (with or without a Radar Interference Detection function), the UUT shall associate with a master device. The signal generator and the UUT shall be connected using *Set-up B* described in clause 5.4.8.1.3.2.

In both cases, it is assumed that the channel selection mechanism for the *Uniform Spreading* requirement is disabled in the master.

b) The UUT shall transmit a test transmission sequence in accordance with clause 5.3.1.2 on the selected channel $Ch_r$. While the testing is performed on $Ch_r$, the equipment is allowed to have simultaneous transmissions on other adjacent or non-adjacent operating channels.

c) At a certain time T0, a single burst test signal is generated on $Ch_r$ using the reference DFS test signal defined in table D.3 and at a level of up to 10 dB above the level defined in clause 5.4.8.2.1.1 on the selected channel. T1 denotes the end of the radar burst.

d) The transmissions of the UUT following instant T1 on the selected channel $Ch_r$ shall be observed for a period greater than or equal to the *Channel Move Time* defined in table D.1. The aggregate duration (*Channel Closing Transmission Time)* of all transmissions from the UUT on $Ch_r$ during the *Channel Move Time* shall be compared to the limit defined in table D.1. For equipment capable of having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, the equipment is allowed to continue transmissions on other *Operating Channels* (different from $Ch_r$).

The aggregate duration of all transmissions of the UUT does not include quiet periods in between transmissions of the UUT.

e) T2 denotes the instant when the UUT has ceased all transmissions on the channel $Ch_r$. The time difference between T1 and T2 shall be measured. This value *(Channel Move Time*) shall be noted and compared with the limit defined in table D.1.

f) Following instant T2, the selected channel $Ch_r$ shall be observed for a period equal to the *Non-Occupancy Period* (T3-T2) to verify that the UUT does not resume any transmissions on this channel.

g) When the UUT is a slave device with a Radar Interference Detection function step b) to step f) shall be repeated with the generator connected to the UUT using *Set-up C* as described in clause 5.4.8.1.3.3. See also note 2 in table D.2.

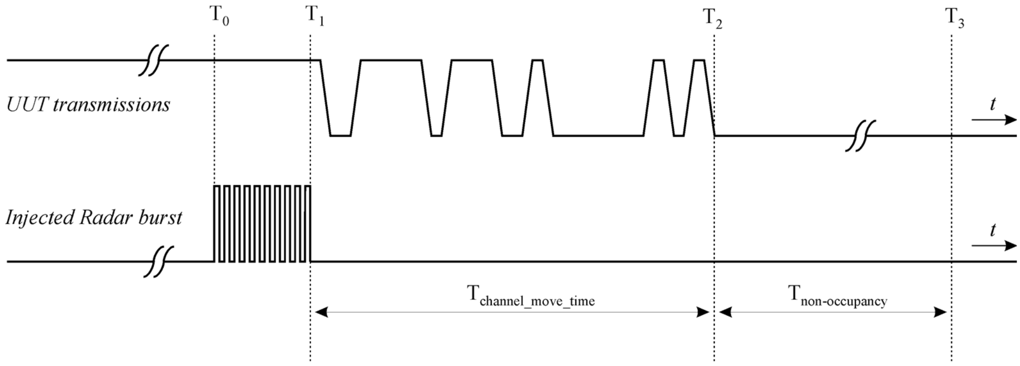



**Figure 13: Channel Closing Transmission Time, Channel Move Time and Non-Occupancy Period**

#### 5.4.8.2.2 Radiated measurement

For a UUT with integral antenna(s) and without temporary antenna connector(s), radiated measurements shall be used.

If the UUT has a Radar Interference Detection function, the output power of the signal generator shall (unless otherwise specified) provide a signal power at the antenna of the UUT with a level equal to *Radar Detection Threshold* level defined in table D.2.

When performing radiated DFS testing on a UUT with a directional antenna (including smart antenna systems and systems capable of beamforming), the wanted communications link (between the UUT and the associated device) and the DFS radar test signals shall be aligned to the direction corresponding to the UUT's maximum antenna gain.

The test set up as described in annex B and applicable measurement procedures as described in annex C shall be used to test the different DFS features of the UUT. The test procedure is further as described under clause 5.4.8.2.1.

## 5.4.9 Adaptivity (channel access mechanism)

### 5.4.9.1 Test conditions

These measurements shall only be performed at normal test conditions.

The channel to be used for testing is defined in clause 5.3.2. The device shall be configured to operate at its maximum output power level.

### 5.4.9.2 Test method for Frame Based Equipment

#### 5.4.9.2.1 Additional test conditions

The manufacturer shall declare if the UUT is an *Initiating Device* and/or a *Responding Device* (see also clause 5.4.1, item q)).

The manufacturer shall declare the *Fixed Frame Period(s)* implemented by the *Frame Based Equipment* (see also clause 5.4.1, item q)).

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

The measurement equipment shall be able to observe the UUT behaviour for a duration of at least 250 ms at the aforementioned temporal resolution. If the data is recorded in segments then the *Fixed Frame Periods* shall be extracted from each data segment. The combined set of all *Fixed Frame Periods* shall be analysed as described in clause 5.4.9.2.2.4.

#### 5.4.9.2.2 Conducted measurements

##### 5.4.9.2.2.1 Initialisation of the test

Figure 14 shows an example of the test set-up.

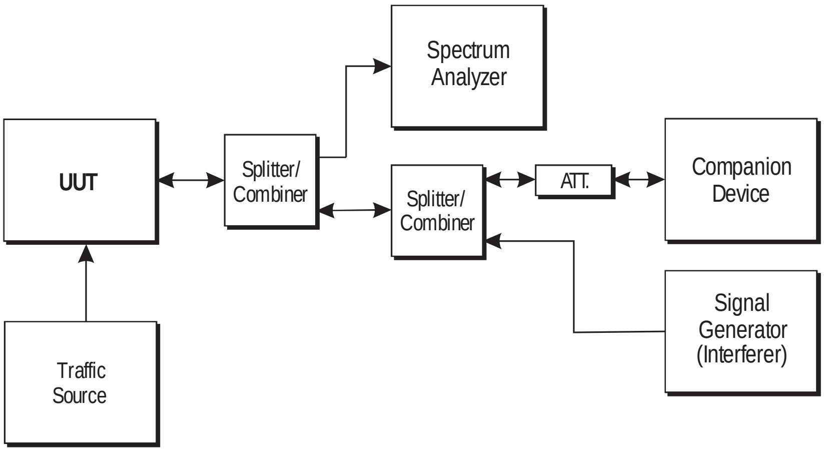



**Figure 14: Example Test Set-up for verifying the adaptivity of an equipment**

The different steps below define the procedure to verify the efficiency of the adaptivity mechanism of the equipment.

**Step 1:**

- The UUT shall connect to a companion device during the test. The signal generator, the spectrum analyser, the UUT, the traffic source and the companion device are connected using a set-up equivalent to the example given by figure 14 although the interference source is switched off at this point in time. The spectrum analyser is used to monitor the transmissions of the UUT in response to the interference signal. The traffic source might be part of the UUT itself.
- The received signal level (wanted signal from the companion device) at the UUT shall be sufficient to maintain a reliable link for the duration of the test. A typical value for the received signal level which can be used in most cases is -50 dBm/MHz.
- The analyser shall be set as follows:
  - RBW: ≥ *Occupied 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
  - Centre Frequency: Equal to the centre frequency of the operating channel
  - Span: 0 Hz
  - Sweep time: > 2 × Channel Occupancy Time
  - Trace Mode: Clear/Write
  - Trigger Mode: Video or RF/IF Power

**Step 2:**

- Configure the traffic source so that it fills the UUT's buffers to a level causing the UUT to always have transmissions queued (buffer-ready-for-transmission condition) towards the companion device.

  Where this is not possible, the UUT shall be configured to occupy the *Channel Occupancy Time* of the *Fixed Frame Period* to the highest extent possible.

#### 5.4.9.2.2.2 Procedure to verify the capability to detect other RLAN transmissions on the Operating Channel when operating on a single channel

**Step 1: Setting up the communications link**

- The UUT shall be configured to operate on a single *Operating Channel.*

**Step 2: Adding the interference signal.**

- One of the three interference signals as defined in clause B.7 is injected on the current *Operating Channel* of the UUT. The level (at the input of the UUT) of this interference signal shall be equal to the applicable *CCA Threshold Level* defined in clause 4.2.7.3.1.4.

**Step 3: Verification of reaction to the interference signal.**

- The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected *Operating Channel* after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
- Using the procedure defined in clause 5.4.9.2.3, it shall be verified that:

  i) The UUT shall not have transmissions on the current *Operating Channel* during the *Fixed Frame Period* following the first *Clear Channel Assessment* after the interference signal was injected. The UUT is allowed to have *Short Control Signalling Transmissions* on the current operating channel, see ii) and iii).

  ii) Apart from *Short Control Signalling Transmissions* there shall be no subsequent transmissions while the interfering signal is present.

  iii) The *Short Control Signalling Transmissions* shall comply with the limits defined in clause 4.2.7.3.3.

  The verification of the *Short Control Signalling Transmissions* may require the analyser settings to be changed (e.g. sweep time).

- To verify that the UUT is not resuming normal transmissions as long as the interference signal is present, the monitoring time may need to be 60 s or more, in which case a segmented measurement may need to be performed in order to achieve the required resolution.
- Once the test is completed and the interference signal is removed, the UUT may start transmissions again on this channel; however, this is not a requirement and therefore does not require testing.

**Step 4:**

- Step 2 and step 3 shall be repeated for each of the interference signals defined in clause B.7.

#### 5.4.9.2.2.3 Procedure to verify the capability to detect other RLAN transmissions in case of multi-channel operation

**Step 1: Setting up the communications link**

- The UUT shall be configured to operate on a set of at least two and at most on six adjacent 20 MHz *Operating Channels*. The number of channels used for the multi-channel operation during this test shall be declared and be noted in the test report. See clause 5.4.1, item b).
- It shall be verified that the UUT started transmissions on all these channels.

**Step 2: Adding the interference signal.**

- One of the three interference signals as defined in clause B.7 is switched on.
- When using the interference signal specified in clause B.7.1, the centre frequency and the bandwidth of this signal shall be such that it covers all *Operating Channels* used for the multi-channel operation during this test. Alternatively, or when using the interference signal specified in clause B.7.2 and clause B.7.3, this test may be performed sequentially by which each of the *Operating Channels* is tested separately using an interference signal that only covers a single *Operating Channel*.

- The level (at the input of the UUT) of this interference signal shall be equal to the applicable *CCA Threshold Level* defined in clause 4.2.7.3.1.4.

**Step 3: Verification of reaction to the interference signal.**

- The spectrum analyser shall be used to monitor the transmissions of the UUT after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
- Using the procedure defined in clause 5.4.9.2.3, it shall be verified that:

  i) The UUT shall not have transmissions on any of the *Operating Channels* configured in step 1 and on which the interference signal was inserted during the *Fixed Frame Period* following the first *Clear Channel Assessment* after the interference signal was detected. The UUT is allowed to have *Short Control Signalling Transmissions* on any of the current operating channels, see ii) and iii).

  ii) Apart from *Short Control Signalling Transmissions* there shall be no subsequent transmissions of the UUT on any of the *Operating Channels* configured in step 1 and on which the interference signal was inserted, while the interfering signal is present in those channels.

  iii) The *Short Control Signalling Transmissions* shall comply with the limits defined in clause 4.2.7.3.3.

  The verification of the *Short Control Signalling Transmissions* may require the analyser settings to be changed (e.g. sweep time).

- To verify that the UUT is not resuming normal transmissions on any of the *Operating Channels* configured in step 1 as long as the interference signal is present, the monitoring time may need to be 60 s or more, in which case a segmented measurement may need to be performed in order to achieve the required resolution.
- Once the test is completed and the interference signal is removed, the UUT may start transmissions again on any of the *Operating Channels* used for the multi-channel operation configured in step 1; however, this is not a requirement and therefore does not require testing.

**Step 4:**

- Step 2 and step 3 shall be repeated for each of the interference signals defined in clause B.7.

##### 5.4.9.2.2.4 Medium Access Mechanism

The below steps define the test procedure to verify the *Channel Occupancy Time* and *Idle Period* as part of the *Medium Access Mechanism*.

**Step 1:**

- See clause 5.4.9.2.2.1, step 1.

**Step 2:**

- See clause 5.4.9.2.2.1, step 2.

**Step 3: Recording transmissions**

- Record start time and duration of every transmission on the *Operating Channel* and record start time and duration of every gap in between transmissions on the *Operating Channel*.
- Let $t_x$ denote a point in time the *Operating Channel* becomes occupied and let $d_x$ denote the duration the *Operating Channel* is subsequently occupied. Let $i_y$ denote a point in time the *Operating Channel* becomes unoccupied and let $g_y$ denote the duration the *Operating Channel* is subsequently unoccupied. Figure 15 presents an example.

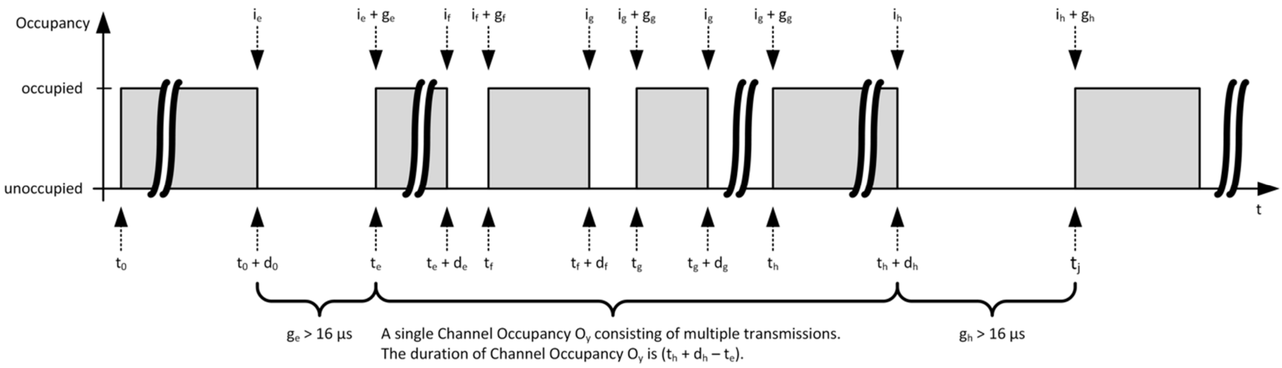



**Figure 15: Example of UUT transmissions**

**Step 4: Measurement of Unoccupied Periods and Channel Occupancy Times**

- Any *Channel Occupancy Time* (COT) $O_x$ is defined as ($t_h + d_h - t_e$) with $t_e < t_h$ if within the interval [$t_e$, $t_h + d_h$] all periods $g_y$ that the *Operating Channel* is unoccupied have duration of less than or equal to 16 µs. As defined in clause 4.2.7.3.1.4, any *Channel Occupancy Time* may consist of one or more transmissions of the UUT. If the companion device acts as a responding device (see clause 4.2.7.3.1.4), any *Channel Occupancy Time* may consist of one or more transmissions of the UUT and zero or more transmissions of the companion device.

- Using the values recorded in step 3, the duration of any of the *Channel Occupancy Times* shall be determined and the duration of any of the Unoccupied Periods between such *Channel Occupancy Times* shall be determined. An Unoccupied Period is defined as any period $g_y$ in between transmissions that has a duration greater than 18 µs (corresponds to 16 µs gap duration plus measurement tolerance). All other gaps in between transmissions are considered as part of the *Channel Occupancy Time.*

**Step 5: Indentification of the Fixed Frame Period**

- Based on the measurement results of step 4 and the declared *Fixed Frame Period(s)* of UUT, identify the start point and duration of each *Fixed Frame Period.*

- The contiguous Unoccupied Period immediately before the start of a *Fixed Frame Period* is classified as *Idle Period* that belongs to the preceding *Fixed Frame Period* as defined in clause 4.2.7.3.1.4.

**Step 6: Verification of Requirements**

- Using the results of step 5 it shall be verified that the UUT complies with the maximum Channel *Occupancy Time* and the minimum *Idle Period* for each of the *Fixed Frame Periods* implemented and as defined in clause 4.2.7.3.1.4.

### 5.4.9.2.3 Generic test procedure for measuring channel/frequency usage

This is a generic test method to evaluate transmissions on the operating channel being investigated. This test is only performed as part of the procedure described in clause 5.4.9.2.2.2.

The test procedure shall be as follows:

**Step 1:**

- The analyser shall be set as follows:
  - Centre Frequency: equal to the centre frequency of the channel being investigated
  - Frequency Span: 0 Hz
  - RBW: approximately 50 % of the *Occupied 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: > 2 × the Channel Occupancy Time
- Sweep points: at least one sweep point per µs
- Trace mode: Clear/Write
- Trigger: Video or RF/IF Power

**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 channel being investigated by applying a threshold.
- Count the number of consecutive data points identified as resulting from a single transmission on the channel 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 idle or silent periods, count the number of consecutive data points identified as resulting from a single transmitter off period on the channel 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.

#### 5.4.9.2.4 Radiated measurements

For a UUT with integral antenna(s) and without temporary antenna connector(s), radiated measurements shall be used.

The output power of the signal generator simulating the interference signal shall provide a signal power at the antenna of the UUT with a level equal to *CCA Threshold Level (TL)* defined in clause 4.2.7.3.1.4.

When performing radiated testing on a UUT with a directional antenna (including smart antenna systems and systems capable of beamforming), the wanted communications link (between the UUT and the companion device) and the interference test signals shall be aligned to the direction corresponding to the UUT's maximum antenna gain.

The test set up as described in annex B and applicable measurement procedures as described in annex C shall be used to test the adaptivity of the UUT. The test procedure is further as described under clause 5.4.9.2.2.

### 5.4.9.3 Test method for Load Based Equipment

#### 5.4.9.3.1 Additional test conditions

A UUT that can operate as a Supervising and as a Supervised Device (see clause 4.2.7.3.2.2, last paragraph) shall be tested for both functionalities.

The manufacturer shall declare if the UUT is capable to make use of note 1 in table 7 or note 1 in table 8, see also clause 5.4.1, item r).

If the UUT is a Supervising Device the manufacturer shall declare if the UUT is capable to make use of note 2 in table 8 in clause 4.2.7.3.2.4, see also clause 5.4.1, item r).

The manufacturer shall declare if the UUT is an Initiating Device and/or a Responding Device, see also clause 5.4.1, item r).

The manufacturer shall declare the UUT's theoretical maximum radio performance, see also clause 5.4.1, item u).

The manufacturer shall declare all *Priority Classes* the UUT implements, see also clause 5.4.1, item r).

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

The measurement equipment shall be able to observe UUT behaviour of at least 2 000 Channel Occupancy Times (COTs) at the aforementioned temporal resolution. This data may be recorded in segments. In that case, the COTs shall be extracted from each data segment. The combined set of all COTs shall be analysed as described in clause 5.4.9.3.2.4.

The *Priority Class* used for testing is selected as follows

- If the UUT implements *Priority Class* 2 (and potentially other classes), the UUT shall be tested against the requirements of *Priority Class* 2 as outlined in table 7 or table 8 in clause 4.2.7.3.2.4.
- If the UUT does not implement *Priority Class* 2 but the UUT implements *Priority Class* 1 (and potentially other *Priority Classes*), the UUT shall be tested against the requirements of *Priority Class* 1 as outlined in table 7 or table 8 in clause 4.2.7.3.2.4.
- If the UUT implements neither *Priority Class* 2 nor *Priority Class* 1 but the UUT implements *Priority Class* 3 (and optionally *Priority Class* 4), the UUT shall be tested against the requirements of *Priority Class* 3 as outlined in table 7 or table 8 in clause 4.2.7.3.2.4.
- If the UUT implements no *Priority Classes* other than *Priority Class* 4, the UUT shall be tested against the requirements of *Priority Class* 4 as outlined in table 7 or table 8 in clause 4.2.7.3.2.4.

### 5.4.9.3.2 Conducted measurements

#### 5.4.9.3.2.1 Initialization of the test

Figure 16 shows an example of the test set-up.

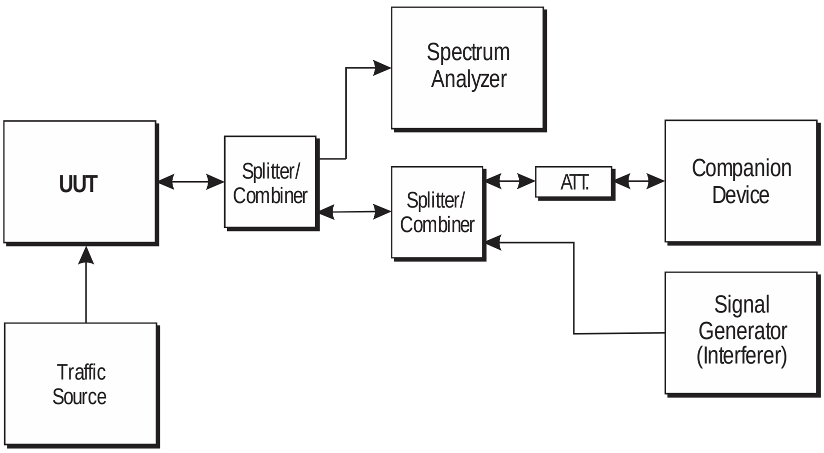



**Figure 16: Example Test Set-up for verifying the adaptivity of an equipment**

The different steps below define the procedure to verify the efficiency of the adaptivity mechanism of the equipment.

**Step 1:**

- The UUT shall connect to a companion device during the test. The signal generator, the spectrum analyser, the UUT, the traffic source and the companion device are connected using a Set-up equivalent to the example given by figure 16 although the interference source is switched off at this point in time. The spectrum analyser is used to monitor the transmissions of the UUT in response to the interference signal. The traffic source might be part of the UUT itself.
- The received signal level (wanted signal from the companion device) at the UUT shall be sufficient to maintain a reliable link for the duration of the test. A typical value for the received signal level which can be used in most cases is -50 dBm/MHz.
- The analyser shall be set as follows:
    - RBW: ≥ *Occupied Channel Bandwidth* (if the analyser does not support this setting, the highest available setting shall be used)

- VBW: 3 × RBW (if the analyser does not support this setting, the highest available setting shall be used)
- Detector Mode: RMS
- Centre Frequency: Equal to the centre frequency of the operating channel
- Span: 0 Hz
- Sweep time: > 2 × *Channel Occupancy Time*
- Trace Mode: Clear/Write
- Trigger Mode: Video or RF/IF power

**Step 2:**

- Configure the traffic source so that it exceeds the UUT's theoretical radio performance. The traffic source shall fill the UUT's buffers causing the UUT to always have transmissions queued (full buffer condition) towards the companion device.

#### 5.4.9.3.2.2 Procedure to verify the capability to detect other RLAN transmissions on the Operating Channel when operating on a single channel

**Step 1: Setting up the communications link**

- The UUT shall be configured to operate on a single *Operating Channel.*

**Step 2: Adding the interference signal.**

- One of the three interference signals as defined in clause B.7 is injected on the current *Operating Channel* of the UUT. The level (at the input of the UUT) of this interference signal shall be equal to the applicable CCA threshold level defined in clause 4.2.7.3.2.5.

**Step 3: Verification of reaction to the interference signal.**

- The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected *Operating Channel* after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
- Using the procedure defined in clause 5.4.9.3.3, it shall be verified that:

  i) The UUT stops transmissions on the current *Operating Channel.*

  The UUT is assumed to stop transmissions within a period equal to the maximum *Channel Occupancy Time* that corresponds to the *Priority Class* being tested (see table 7 and table 8). The UUT is allowed to have *Short Control Signalling Transmissions* on the current operating channel, see ii) and iii).

  ii) Apart from *Short Control Signalling Transmissions* there shall be no subsequent transmissions while the interfering signal is present.

  iii) The *Short Control Signalling Transmissions* shall comply with the limits defined in clause 4.2.7.3.3.

  The verification of the *Short Control Signalling Transmissions* may require the analyser settings to be changed (e.g. sweep time).

- To verify that the UUT is not resuming normal transmissions as long as the interference signal is present, the monitoring time may need to be 60 s or more, in which case a segmented measurement may need to be performed in order to achieve the required resolution.
- Once the test is completed and the interference signal is removed, the UUT may start transmissions again on this channel however this is not a requirement and therefore does not require testing.

**Step 4:**

- Step 2 and step 3 shall be repeated for each of the interference signals defined in clause B.7.

#### 5.4.9.3.2.3 Procedure to verify the capability to detect other RLAN transmissions in case of multi-channel operation

##### 5.4.9.3.2.3.1 Equipment implementing Option 1 for multi-channel operation

**Step 1: Setting up the communications link.**

- The UUT shall be configured to operate on a set of at least two and at most on six adjacent 20 MHz *Operating Channels*. The number of channels used for the multi-channel operation during this test shall be declared and be noted in the test report, see clause 5.4.1, item b).
- It shall be verified that the UUT started transmissions on all these channels.

**Step 2: Adding the interference signal.**

- One of the three interference signals as defined in clause B.7 is switched on.
- When using the interference signal specified in clause B.7.1, the centre frequency and the bandwidth of this signal shall be such that it covers all *Operating Channels* used for the multi-channel operation during this test. Alternatively, or when using the interference signal specified in clause B.7.2 and clause B.7.3, this test may be performed sequentially by which each of the *Operating Channels* is tested separately using an interference signal that only covers a single *Operating Channel*.
- The level (at the input of the UUT) of this interference signal shall be equal to the applicable *Energy Detect Threshold* level defined in clause 4.2.7.3.2.5.

**Step 3: Verification of reaction to the interference signal.**

- The spectrum analyser shall be used to monitor the transmissions of the UUT after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
- Using the procedure defined in clause 5.4.9.3.3, it shall be verified that:

  i) The UUT stops transmissions on any of the *Operating Channels* configured in step 1 and on which the interference signal was inserted.

     The UUT is assumed to stop transmissions on any of the *Operating Channels* used for the multi-channel operation (see step 1) during this test, and on which the interference signal was inserted, within a period equal to the maximum *Channel Occupancy Time* that corresponds to the *Priority Class* being tested (see table 7 and table 8). The UUT is allowed to have *Short Control Signalling Transmissions* on any of the *Operating Channels* configured in step 1, see also ii) and iii) below.

  ii) Apart from *Short Control Signalling Transmissions* there shall be no subsequent transmissions of the UUT on the Operating Channels while the interfering signal is present in those channels.

  iii) The *Short Control Signalling Transmissions* shall comply with the limits defined in clause 4.2.7.3.3.

     The verification of the *Short Control Signalling Transmissions* may require the analyser settings to be changed (e.g. sweep time).

- To verify that the UUT is not resuming normal transmissions in an Operating Channel as long as the interference signal is present in that channel, the monitoring time may need to be 60 s or more, in which case a segmented measurement may need to be performed in order to achieve the required resolution.
- Once the test is completed and the interference signal is removed, the UUT may start transmissions again on any of the *Operating Channels* used for the multi-channel operation configured in step 1; however, this is not a requirement and, therefore, does not require testing.

**Step 4:**

- Step 2 and step 3 shall be repeated for each of the interference signals defined in clause B.7.

#### 5.4.9.3.2.3.2 Equipment implementing Option 2 for multi-channel operation

**Step 1: Setting up the communications link.**

- The UUT shall be configured to operate on a bonded 40 MHz channel. One of the two adjacent 20 MHz channels within this bonded channel is configured as the *Primary Operating Channel* (see clause 4.2.7.3.2.3, Option 2).
- It shall be verified that the UUT started transmissions within the bonded 40 MHz channel.

**Step 2: Adding the interference signal.**

- One of the three interference signals as defined in clause B.7 is switched on.
- The centre frequency and the bandwidth of the interference signal shall be as such that it covers only the adjacent (non-*Primary*) *Operating Channel*, it shall not cover the *Primary Operating Channel.* See clause B.7.
- The level (at the input of the UUT) of this interference signal shall be equal to the applicable *Energy Detect Threshold* level defined in clause 4.2.7.3.2.5.

**Step 3: Verification of reaction to the interference signal.**

- The spectrum analyser shall be used to monitor the transmissions of the UUT after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
- Using the procedure defined in clause 5.4.9.3.3, it shall be verified that:

  i) The UUT stops transmissions on the adjacent (non-*Primary*) *Operating Channel*.

  The UUT is assumed to stop transmissions on the adjacent (non-*Primary*) *Operating Channel* within a period equal to the maximum *Channel Occupancy Time* that corresponds to the *Priority Class* being tested (see table 7 and table 8). The UUT is allowed to have *Short Control Signalling Transmissions* on the adjacent (non-*Primary*) *Operating Channel*, see ii) and iii).

  ii) Apart from *Short Control Signalling Transmissions* there shall be no subsequent transmissions on the adjacent (non-*Primary*) *Operating Channel* while the interfering signal is present.

  iii) The *Short Control Signalling Transmissions* shall comply with the limits defined in clause 4.2.7.3.3.

  The verification of the *Short Control Signalling Transmissions* may require the analyser settings to be changed (e.g. sweep time).

- To verify that the UUT is not resuming normal transmissions on the adjacent (non-*Primary*) *Operating Channel* as long as the interference signal is present, the monitoring time may need to be 60 s or more, in which case a segmented measurement may need to be performed in order to achieve the required resolution.
- Once the test is completed and the interference signal is removed, the UUT may start transmissions again on the adjacent (non-*Primary*) *Operating Channel*, however, this is not a requirement and, therefore, does not require testing.

**Step 4:**

- Step 2 and step 3 shall be repeated for each of the interference signals defined in clause B.7.

#### 5.4.9.3.2.4 Medium Access Mechanism

#### 5.4.9.3.2.4.1 Option A: Procedure to verify the Medium Access Mechanism

The below steps define the test procedure to verify the Medium Access Mechanism implemented by the UUT.

**Step 1:**

- See clause 5.4.9.3.2.1, step 1).

**Step 2:**

- See clause 5.4.9.3.2.1, step 2).
- If the UUT is making use of note 1 in table 8 in clause 4.2.7.3.2.4 the following additionally applies:
  - Configure a second traffic source so that it exceeds the companion device's theoretical radio performance. The second traffic source shall fill the companion device's buffers causing the companion device to always have transmissions queued (full buffer condition) towards the UUT.
  - In this test, the *Supervising device* shall issue one or more grants with each *Channel Occupancy Time (COT)*. Per *Channel Occupancy Time (COT)* one and not more than one grant shall foresee inserting a single pause of at least 100 µs, see clause 4.2.7.3.2.4, table 8, note 1.

**Step 3: Recording transmissions.**

- Record start time and duration of every transmission (energy) on the *Operating Channel* and record start time and duration of every idle period on the *Operating Channel*.
- Let $t_x$ denote a point in time the *Operating Channel* becomes occupied and let $d_x$ denote the duration the Operating Channel is subsequently occupied. Let $i_y$ denote a point in time the *Operating Channel* becomes unoccupied and let $g_y$ denote the duration the *Operating Channel* is subsequently unoccupied. Figure 17 presents an example.

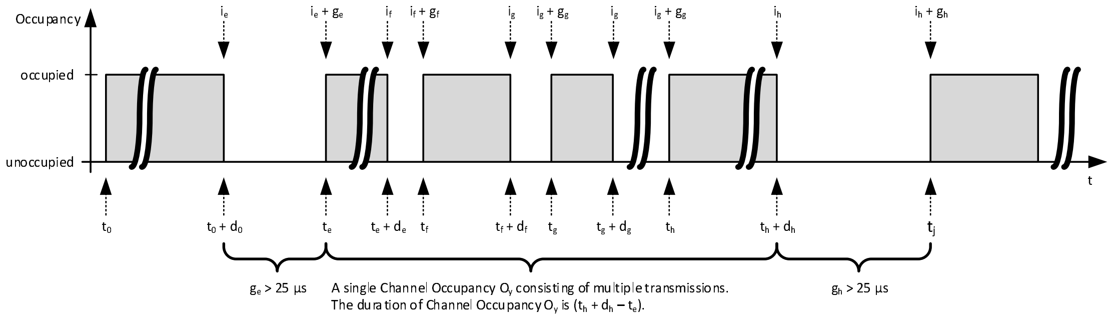



**Figure 17: Example of UUT transmissions**

**Step 4: Measurement of Idle Periods and Channel Occupancy Times.**

- Any *Channel Occupancy Time* (COT) $O_x$ is defined as $(t_h + d_h - t_e)$ with $t_e < t_h$ if within the interval $[t_e, t_h + d_h]$ all periods $g_y$ that the *Operating Channel* is unoccupied have duration of less than or equal to 25 µs. As defined in clause 4.2.7.3.2.2, any *Channel Occupancy Time* may consist of one or more transmissions of the UUT and zero or more transmissions of the companion device.
- Using the values recorded in step 3, the duration of any of the *Channel Occupancy Times* shall be determined and the duration of any of the Idle Periods between such Channel Occupancy Times shall be determined. An Idle Period is defined as any period $g_y$ that has a duration greater than 27 µs.

  The definition for the Idle Period is adjusted from 25 µs defined in clause 4.2.7.3.2.6 step 6 to 27 µs to account for measurement inaccuracies.

**Step 5: Classification of Idle Periods.**

- Let $k \in \mathbb{N}_0$.
- Assign all Idle Periods to one of $k + 1$ different bins. The value of $k$ depends on the *Priority Class* used for the test. A bin is denoted as $B_n$ with $0 \leq n \leq k$.
  - If the *Priority Class* used for the test is 1, then $k = 16$ and the bins are denoted $B_0 \dots B_{16}$.
  - If the *Priority Class* used for the test is 2, the following applies:
    - i) If the UUT makes use of note 2 in table 8 in clause 4.2.7.3.2.4, then $k = 32$ and the bins are denoted $B_0 \dots B_{32}$.

ii) If the UUT does not make use of note 2 in table 8 in clause 4.2.7.3.2.4, then $k = 16$ and the bins are denoted $B_0 \dots B_{16}$.

- If the *Priority Class* used for the test is 3, then $k = 8$ and the bins are denoted $B_0 \dots B_8$.
- If the *Priority Class* used for the test is 4, then $k = 4$ and the bins are denoted $B_0 \dots B_4$.

- If the *Priority Class* used for the test is 1, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 77[\ \mu s, n = 0 \\ [77 + 9 \times (n-1), 77 + 9 \times n[\ \mu s,\ 1 \le n \le 15 \\ [212, \infty[\ \mu s,\ n = 16 \end{cases}$$

- If the *Priority Class* used for the test is 2, bin $B_n$ is defined as below:
  - If the UUT is a *Supervising Device* making use of note 2 in table 8 in clause 4.2.7.3.2.4, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 41[\ \mu s,\ n = 0 \\ [41 + 9 \times (n-1), 41 + 9 \times n[\ \mu s,\ 1 \le n \le 31 \\ [320, \infty[\ \mu s,\ n = 32 \end{cases}$$

  - If the UUT is a *Supervised Device* or if the UUT is a *Supervising Device* not making use of note 2 in table 8 in clause 4.2.7.3.2.4, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 41[\ \mu s,\ n = 0 \\ [41 + 9 \times (n-1), 41 + 9 \times n[\ \mu s,\ 1 \le n \le 15 \\ [176, \infty[\ \mu s,\ n = 16 \end{cases}$$

- If the *Priority Class* used for the test is 3, bin $B_n$ is defined as below:
  - If the UUT is a *Supervised Device*, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 32[\ \mu s,\ n = 0 \\ [32 + 9 \times (n-1), 32 + 9 \times n[\ \mu s,\ 1 \le n \le 7 \\ [95, \infty[\ \mu s,\ n = 8 \end{cases}$$

  - If the UUT is a *Supervising Device*, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 23[\ \mu s,\ n = 0 \\ [23 + 9 \times (n-1), 23 + 9 \times n[\ \mu s,\ 1 \le n \le 7 \\ [86, \infty[\ \mu s,\ n = 8 \end{cases}$$

- If the *Priority Class* used for the test is 4, bin $B_n$ is defined as below:
  - If the UUT is a *Supervised Device*, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 32[\ \mu s,\ n = 0 \\ [32 + 9 \times (n-1), 32 + 9 \times n[\ \mu s,\ 1 \le n \le 3 \\ [59, \infty[\ \mu s,\ n = 4 \end{cases}$$

  - If the UUT is a *Supervising Device*, bin $B_n$ is defined as:

$$B_n = \begin{cases} [0, 23[\ \mu s,\ n = 0 \\ [23 + 9 \times (n-1), 23 + 9 \times n[\ \mu s,\ 1 \le n \le 3 \\ [50, \infty[\ \mu s,\ n = 4 \end{cases}$$

**Step 6: Idle Period probability evaluation.**

- Let $H(B_n)$ define the number of *Idle Periods* assigned to bin $B_n$.
- Let $E$ define the total number of *Idle Periods* observed. Then $E$ is the sum of events in all bins:

$$E = \sum_{n=0}^{k} H(B_n)$$

- Calculate the observed cumulative probabilities as follows:
  - Let *p(n)* define the probability that idle periods of duration less than the upper limit specified for bin $B_n$ occurred, *p(n)* = *p* (*Idle Period* < upper limit of bin $B_n$).
  - Then, for each n, $0 \leq n \leq k$, calculate *p(n)* as:

$$p(n) = \frac{\sum_{i=0}^{n} H(B_i)}{E}$$

- It shall be verified whether the UUT complies with the below maximum probabilities:
  - If the *Priority Class* used for the test is 1, each cumulative probability *p(n)* of all *Idle Periods* recorded in bins [$B_0 \ldots B_n$] shall not exceed the following maximum probability:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}12, & n = 1 \\ 0{,}12 + (n-1) \times 0{,}0625, & 2 \leq n \leq 15 \\ 1, & n > 15 \end{cases}$$

  - If the *Priority Class* used for the test is 2, each cumulative probability *p(n)* of all *Idle Periods* recorded in bins [$B_0 \ldots B_n$] shall not exceed the following maximum probability.
    - If the UUT makes use of note 2 in table 8 in clause 4.2.7.3.2.4:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}12, & n = 1 \\ 0{,}12 + (n-1) \times 0{,}03125, & 2 \leq n \leq 29 \\ 1, & n > 29 \end{cases}$$

    - If the UUT does not make use of note 2 in table 8 in clause 4.2.7.3.2.4:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}12, & n = 1 \\ 0{,}12 + (n-1) \times 0{,}0625, & 2 \leq n \leq 15 \\ 1, & n > 15 \end{cases}$$

    - If the UUT makes use of note 1 in table 8 in clause 4.2.7.3.2.4:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}09 + (n-1) \times 0{,}03125, & 1 \leq n \leq 7 \\ 0{,}59 + (n-1) \times 0{,}03125, & 8 \leq n \leq 14 \\ 1, & n > 14 \end{cases}$$

  - If the *Priority Class* used for the test is 3, each cumulative probability *p(n)* of all *Idle Periods* recorded in bins [$B_0 \ldots B_n$] shall not exceed the following maximum probability:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}18, & n = 1 \\ 0{,}18 + (n-1) \times 0{,}125, & 2 \leq n \leq 6 \\ 1, & n > 6 \end{cases}$$

  - If the *Priority Class* used for the test is 4, each cumulative probability *p(n)* of all *Idle Periods* recorded in bins [$B_0 \ldots B_n$] shall not exceed the following maximum probability:

$$p(n) \leq \begin{cases} 0{,}05, & n = 0 \\ 0{,}05 + n \times 0{,}25, & 1 \leq n \leq 3 \\ 1, & n > 3 \end{cases}$$

##### 5.4.9.3.2.4.2 Option B: Compliance by declaration for the Medium Access Mechanism

As an alternative to performing the procedure described in clause 5.4.9.3.2.4.1, the manufacturer is allowed to declare compliance with the requirements contained in clause 4.2.7.3.2.6 and clause 4.2.7.3.2.7, see clause 5.4.1, item r).

##### 5.4.9.3.2.5 Maximum Channel Occupancy Time(s)

###### 5.4.9.3.2.5.1 Option A: Procedure to verify the maximum Channel Occupancy Time(s)

The below steps define the test procedure to verify the maximum *Channel Occupancy Time(s)* implemented by the UUT.

A *Channel Occupancy* consists of transmissions from the UUT and may contain transmissions of the companion device. See clause 4.2.7.3.2.2, last paragraph.

The *Channel Occupancy* Times shall be determined using the results of step 4 in clause 5.4.9.3.2.4. These Channel Occupancy Times shall be noted in the test report.

The UUT complies with the limit for the maximum *Channel Occupancy Time* under the following conditions:

- If the *Priority Class* used for the test is 1, none of the *Channel Occupancy Times* shall exceed 6 ms.
- If the *Priority Class* used for the test is 2, none of the *Channel Occupancy Times* shall exceed the following limits:
  - 6 ms if the UUT makes use of note 1 in table 8 in clause 4.2.7.3.2.4.
  - 10 ms if the UUT makes use of note 2 in table 8 in clause 4.2.7.3.2.4.
  - 6 ms if the UUT does not make use of note 2 in table 8 in clause 4.2.7.3.2.4.
- If the *Priority Class* used for the test is 3, none of the *Channel Occupancy Times* shall exceed 4 ms.
- If the *Priority Class* used for the test is 4, none of the *Channel Occupancy Times* shall exceed 2 ms.

###### 5.4.9.3.2.5.2 Option B: Compliance by declaration for the maximum Channel Occupancy Time(s)

As an alternative to performing the procedure described in clause 5.4.9.3.2.5.1, the manufacturer is allowed to declare compliance with the maximum *Channel Occupancy Time(s)* defined in clause 4.2.7.3.2.4, see clause 5.4.1, item r).

#### 5.4.9.3.3 Generic test procedure for measuring channel/frequency usage

This is a generic test method to evaluate transmissions on the *Operating Channel* being investigated. This test is only performed as part of the procedure described in clause 5.4.9.3.2.2, clause 5.4.9.3.2.3.1 and clause 5.4.9.3.2.3.2.

The test procedure shall be as follows:

**Step 1:**

- The analyser shall be set as follows:
  - Centre Frequency: equal to the centre frequency of the channel being investigated
  - Frequency Span: 0 Hz
  - RBW: approximately 50 % of the *Occupied 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: > 2 × the *Channel Occupancy Time*
  - Sweep points: at least one sweep point per µs
  - Trace mode: Clear/Write

- Trigger: Video or RF/IF power

**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 channel being investigated by applying a threshold.
- Count the number of consecutive data points identified as resulting from a single transmission on the channel 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 idle or silent periods, count the number of consecutive data points identified as resulting from a single transmitter off period on the channel 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.

#### 5.4.9.3.4 Radiated measurements

For a UUT with integral antenna(s) and without temporary antenna connector(s), radiated measurements shall be used.

The output power of the signal generator simulating the interference signal shall provide a signal power at the antenna of the UUT with a level equal to the applicable *Energy Detect Threshold (ED Threshold)* defined in clause 4.2.7.3.2.5.

When performing radiated testing on a UUT with a directional antenna (including smart antenna systems and systems capable of beamforming), the wanted communications link (between the UUT and the companion device) and the interference test signals shall be aligned to the direction corresponding to the UUT's maximum antenna gain.

The test set up as described in annex B and applicable measurement procedures as described in annex C shall be used to test the adaptivity of the UUT. The test procedure is further as described under clause 5.4.9.3.2.

## 5.4.10 Receiver Blocking

### 5.4.10.1 Test conditions

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

The channels on which the conformance requirements in clause 4.2.8 shall be verified are defined in clause 5.3.2.

The UUT shall operate in its normal operational mode.

Devices which can change their operating frequency automatically (adaptive channel allocation), this function shall be disabled.

If the equipment can be configured to operate with different *Nominal Channel Bandwidths* (e.g. 20 MHz and 40 MHz) 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 4.2.8.3 as declared by the manufacturer (see clause 5.4.1, item t) and shall be described in the test report.

It shall be verified that this performance criteria as defined by the manufacturer is achieved during the blocking test.

### 5.4.10.2 Test Method

#### 5.4.10.2.1 Conducted measurements

For systems using multiple receive chains only one chain need to be tested. All other receiver inputs shall be terminated.

Figure 18 shows the test set-up which can be used for performing the receiver blocking test.

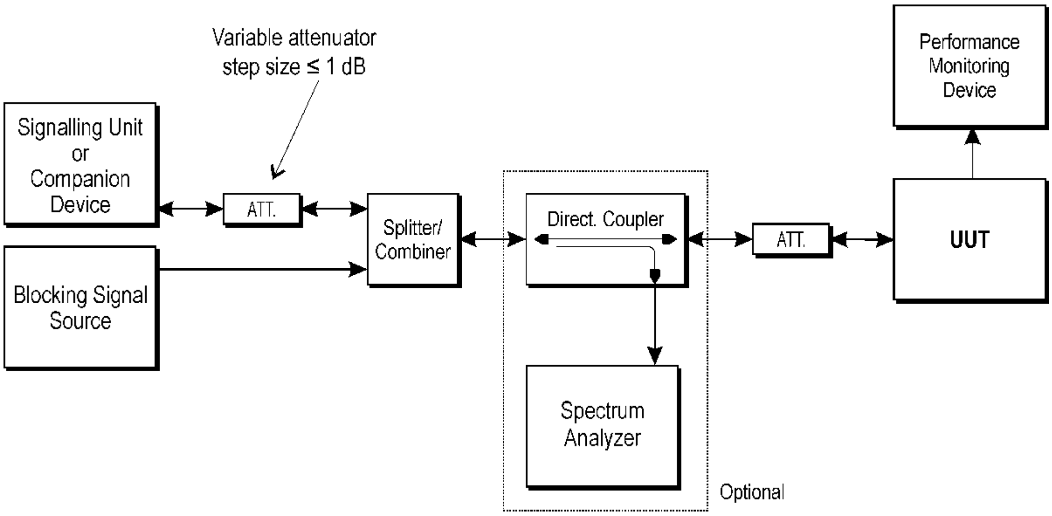



**Figure 18: Test Set-up for receiver blocking**

The steps below define the procedure to verify the receiver blocking requirement as described in clause 4.2.8.

**Step 1:**

- The UUT shall be set to the first operating frequency to be tested (see clause 5.3.2).

**Step 2:**

- The blocking signal generator is set to the first frequency as defined in table 9.

**Step 3:**

- With the blocking signal generator switched off a communication link is set up between the UUT and the associated companion device using the test setup shown in figure 18. The attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.2.8.3 is still met. The resulting level for the wanted signal at the input of the UUT is $P_{min}$.
- This signal level ($P_{min}$) is increased by 6 dB resulting in a new level (Pmin + 6 dB) of the wanted signal at the UUT receiver input.

**Step 4:**

- The level of the blocking signal at the UUT input is set to the level provided in table 9. It shall be verified and recorded in the test report that the performance criteria as specified in clause 4.2.8.3 is met.

**Step 5:**

- Repeat step 4 for each remaining combination of frequency and level as specified in table 9.

**Step 6:**

- Repeat step 2 to step 5 with the UUT operating at the other operating frequencies at which the blocking test has to be performed. See clause 5.3.2.

#### 5.4.10.2.2 Radiated measurements

When performing radiated measurements on equipment with dedicated antennas, measurements shall be repeated for each alternative dedicated antenna.

A test site as described in annex B and applicable measurement procedures as described in annex C shall be used.

The test procedure is further as described under clause 5.4.10.2.1.

The level of the blocking signal at the UUT referred to in step 4 is assumed to be the level in front of the UUT antenna(s). The UUT shall be positioned with its main beam pointing towards the antenna radiating the blocking signal. The position recorded in clause 5.4.4.2.2 can be used.

# Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

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

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

| Harmonised Standard ETSI EN 301 893 | | | | |
|---|---|---|---|---|
| **Requirement** | | | **Requirement Conditionality** | |
| **No** | **Description** | **Reference: Clause No** | **U/C** | **Condition** |
| 1 | Carrier frequencies | 4.2.1 | U | |
| 2 | Nominal, and occupied, channel bandwidth | 4.2.2 | U | |
| 3 | RF output power | 4.2.3 | U | |
| | Transmit Power Control (TPC) | 4.2.3 | C | 1) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>2) Not required for devices that operate at a maximum mean e.i.r.p. of 20 dBm when operating in 5 250 MHz to 5 350 MHz or 27 dBm when operating in 5 470 MHz to 5 725 MHz. |
| | Power Density | 4.2.3 | U | |
| 4 | Transmitter unwanted emissions outside the 5 GHz RLAN bands | 4.2.4.1 | U | |
| 5 | Transmitter unwanted emissions within the 5 GHz RLAN bands | 4.2.4.2 | U | |
| 6 | Receiver spurious emissions | 4.2.5 | U | |
| 7 | DFS: Channel Availability Check | 4.2.6.2.2 | C | 1) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>2) Not required for Slave devices with a maximum transmit power of less than 200 mW e.i.r.p.<br>3) Not required at initial use of a channel for slave devices with a maximum transmit power of 200 mW e.i.r.p. |

| Harmonised Standard ETSI EN 301 893 | | | | |
|---|---|---|---|---|
| Requirement | | | Requirement Conditionality | |
| **No** | **Description** | **Reference: Clause No** | **U/C** | **Condition** |
| 8 | DFS: Off-Channel CAC - Radar Detection Threshold | 4.2.6.2.3 | C | 1) Where implemented by the manufacturer.<br>2) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>3) Not required for slave devices with a maximum transmit power of less than 200 mW e.i.r.p.<br>4) Not required at initial use of a channel for Slave devices with a maximum transmit power of 200 mW e.i.r.p. |
| 9 | DFS: Off-Channel CAC - Detection Probability | 4.2.6.2.3 | C | 1) Where implemented by the manufacturer.<br>2) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>3) Not required for slave devices with a maximum transmit power of less than 200 mW e.i.r.p.<br>4) Not required at initial use of a channel for Slave devices with a maximum transmit power of 200 mW e.i.r.p. |
| 10 | DFS: In service Monitoring | 4.2.6.2.4 | C | 1) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>2) Not required for Slave devices with a maximum transmit power of less than 200 mW e.i.r.p. |
| 11 | DFS: Channel shutdown | 4.2.6.2.5 | C | Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz. |
| 12 | DFS: Non-occupancy period | 4.2.6.2.6 | C | 1) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>2) Not required for Slave devices with a maximum transmit power of less than 200 mW e.i.r.p. |
| 13 | DFS: Uniform spreading | 4.2.6.2.7 | C | 1) Not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.<br>2) Not required for slave devices. |
| 14 | Adaptivity | 4.2.7 | U | |
| 15 | Receiver Blocking | 4.2.8 | U | |
| 16 | User Access Restrictions | 4.2.9 | U | |
| 17 | Geo-location capability | 4.2.10 | C | Where implemented by the manufacturer. |

**Key to columns:**

**Requirement:**

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

**Description** A textual reference to the requirement.

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

**Requirement Conditionality:**

**U/C** Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

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

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

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

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

## B.1 Introduction

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

In addition this 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.
- Interference Signal used for Adaptivity Tests.

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

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

## B.2 Radiation test sites

### B.2.1 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, while good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in figure B.1.

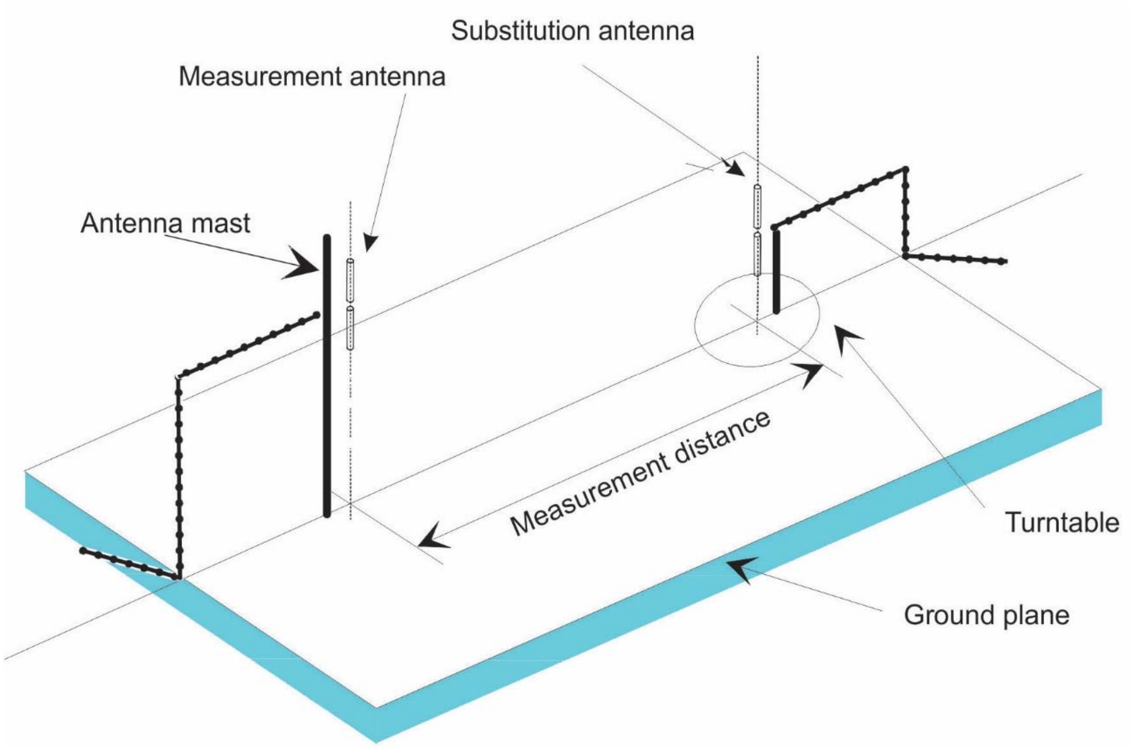



**Figure B.1: A typical Open Area Test Site**

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or UUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the measurement antenna can be optimized for maximum coupled signal between antennas or between a UUT 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 (UUT) at a height of usually 1,5 m above the ground plane.

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

Further information on Open Area Test Sites can be found in ETSI TR 102 273-4 [7].

## B.2.2 Semi Anechoic Room

A Semi Anechoic Room is - or anechoic chamber with a conductive ground plane - is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material. The floor, which is metallic, is not covered by absorbing material and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other end. A typical anechoic chamber with a conductive ground plane is shown in figure B.2.

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

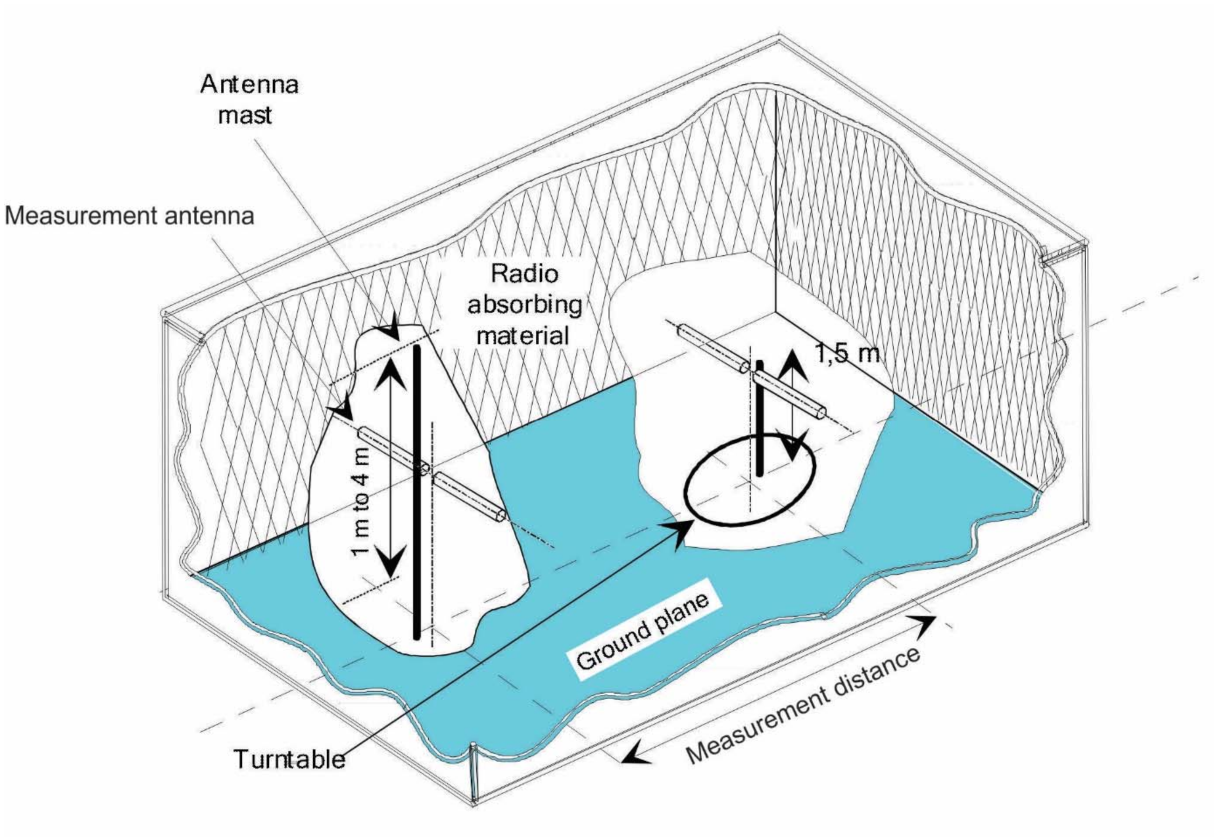



**Figure B.2: A typical Semi Anechoic Room**

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

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the measurement antenna can be optimized for maximum coupled signal between antennas or between a UUT 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 (UUT) at a height of usually 1,5 m above the ground plane.

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

Further information on Semi Anechoic Rooms can be found in ETSI TR 102 273-3 [6].

## B.2.3 Fully Anechoic Room (FAR)

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

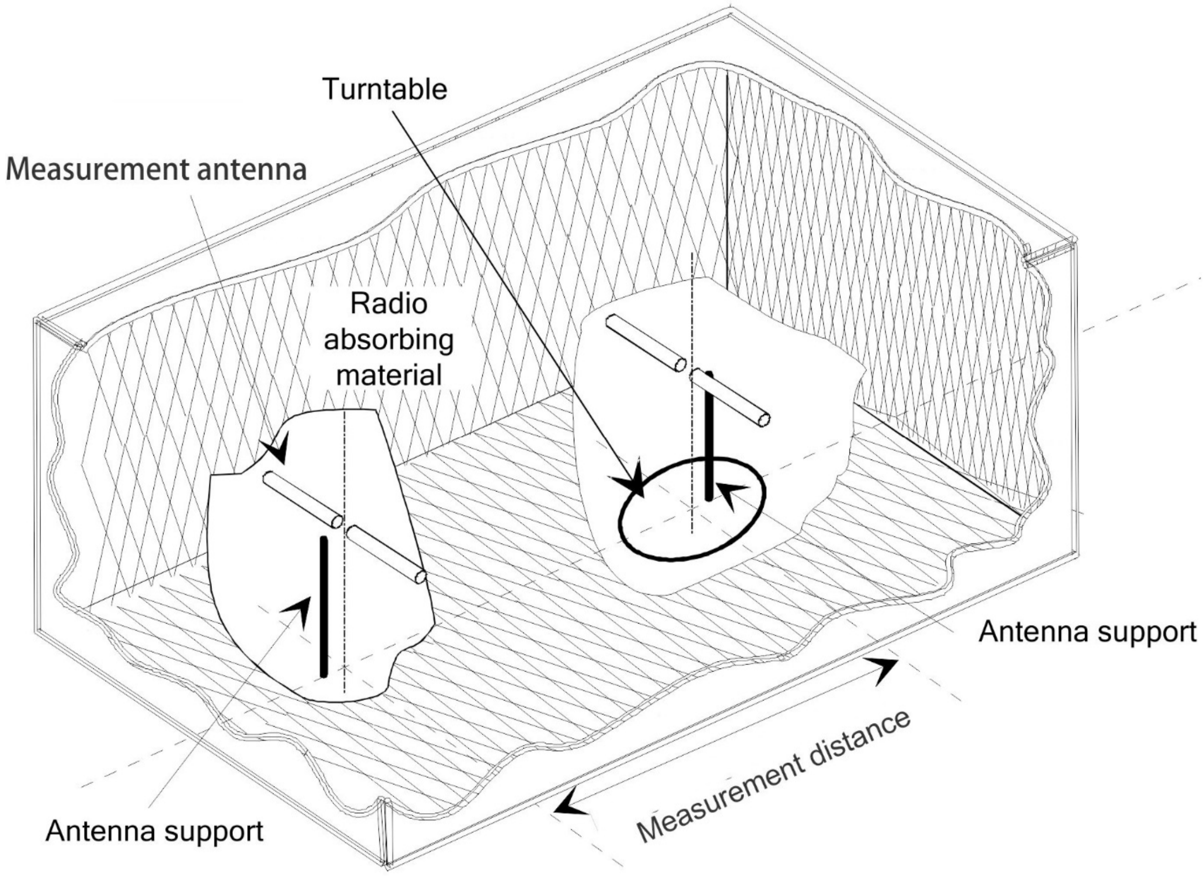



**Figure B.3: A typical Fully Anechoic Room**

The chamber shielding and radio absorbing material 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 UUT at a height of usually 1 m above the absorbing material.

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

Further information on Fully Anechoic Rooms can be found in ETSI TR 102 273-2 [5].

# B.2.4 Measurement Distance

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

λ = wavelength in m

$r_m$ = minimum measurement distance between UUT and measurement antenna in m

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

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

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

# B.3 Antennas

## B.3.1 Introduction

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

## B.3.2 Measurement antenna

The measurement antenna is used to determine the field from the UUT 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.

The measurement antenna does not require an absolute calibration.

## B.3.3 Substitution antenna

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

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 UUT when its antenna is internal, or the point where an external antenna is connected to the UUT.

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.

# B.4 Test fixture

## B.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.

### B.4.2 Description of the test fixture

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

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.

### B.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 B.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 B.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.

## B.5 Guidance on the use of radiation test sites

### B.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 B.2.

Where necessary, a mounting bracket of minimal size should be available for mounting the UUT on the turntable. This bracket should be made from low conductivity, low relative permittivity (i.e. $\frac{\varepsilon}{\varepsilon_0} < 1,5$) material(s) such as expanded polystyrene, balsawood, etc.

### B.5.2 Power supplies for the battery powered UUT

All tests should be performed using power supplies wherever possible, including tests on UUT designed for battery-only use. For battery powered equipment, power leads should be connected to the UUT'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 UUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the UUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

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

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

# B.6 Coupling of signals

## B.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).

## B.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.

# B.7 Interference Signals used for Adaptivity Tests

## B.7.1 Additive white Gaussian noise (AWGN)

The inference signal used in the adaptivity test described in clause 5.4.9, shall be a band limited noise signal with 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.

- Centre Frequency: Equal to the channel frequency to be tested
- Span: 2 × *Nominal Channel Bandwidth*
- Resolution BW: ~ 1 % of the *Nominal cCannel Bandwidth*
- Video BW: 3 × 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 99 % bandwidth (the bandwidth containing 99 % of the power) of this inference signal shall be equal to the *Nominal Channel Bandwidth* of the UUT, while the difference between the lowest level and the highest level within the *Occupied Channel Bandwidth* of the UUT shall be a maximum of 4 dB.

When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 1 (see clause 5.4.9.3.2.2.1), the 99 % bandwidth of this inference signal shall be equal to the combined *Nominal Channel Bandwidth*. However, if the test is performed sequentially (see clause 5.4.9.3.2.2.1, step 2, second bullet point), the 99 % bandwidth of this inference signal shall be equal to *Nominal Channel Bandwidth* of the Operating Channel being tested.

When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 2 (see clause 5.4.9.3.2.2.2), the 99 % bandwidth of this inference signal shall be equal to *Nominal Channel Bandwidth* of the adjacent (non-*Primary*) *Operating Channel*.

The level of this interference signal can be measured with a spectrum analyser using the following settings:

- Centre Frequency: Equal to the channel frequency to be tested
- Span: Zero
- Resolution BW: 1 MHz
- Video BW: 3 × Resolution BW
- Filter: Channel
- Detector: RMS
- Trace Mode: Clear Write
- Number of sweeps: Single

- Sweep time: 1 s; the sweep time may be increased until a value where the sweep time has no impact on the RMS value of the signal

# B.7.2 OFDM test signal

This signal resembles a continuous OFDM transmission without any preamble as defined in IEEE 802.11™-2012 [9], clause 18.

- When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 1 (see clause 5.4.9.3.2.2.1), the OFDM test signal shall be present in any of the *Operating Channels* used for the *Multi-Channel Operation.* However, if the test is performed sequentially (see clause 5.4.9.3.2.2.1, step 2, second bullet point), the OFDM test signal shall only be present in the *Operating Channel* being tested.
- When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 2 (see clause 5.4.9.3.2.2.2), the OFDM test signal shall only be present in the adjacent (non-*Primary*) *Operating Channel*.

# B.7.3 LTE test signal

This test signal shall be a continuous LTE-type signal of 20 MHz channel bandwidth as described in ETSI TS 136 141 [8], clause 6.1.1.1.

- When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 1 (see clause 5.4.9.3.2.2.1), the LTE test signal shall be present in any of the *Operating Channels* used for the *Multi-Channel Operation.* However, if the test is performed sequentially (see clause 5.4.9.3.2.2.1, step 2, second bullet point), the LTE test signal shall only be present in the *Operating Channel* being tested.
- When testing the capability to detect other RLAN transmissions in case of *Multi-Channel Operation* using Option 2 (see clause 5.4.9.3.2.2.2), the LTE test signal shall only be present in the adjacent (non-*Primary*) *Operating Channel*.

# Annex C (normative): Procedures for radiated measurements

## C.1 Introduction

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

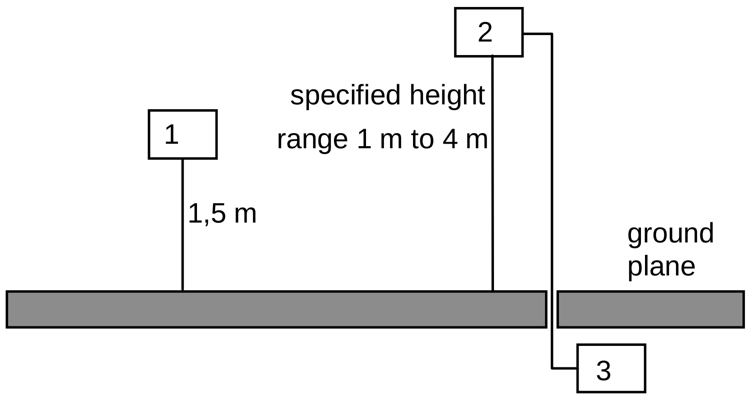
Preferably, radiated measurements shall be performed in a FAR, see clause C.3. Radiated measurements in an OATS or SAR are described in clause C.2.

## C.2 Radiated measurements in an OATS or SAR

Radiated measurements shall be performed with the aid of a measurement antenna and a substitution antenna, in test sites described in annex B. The measurement set-up shall be calibrated according to the procedure defined in the present annex. The UUT 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 C.1) shall be oriented initially for vertical polarization unless otherwise stated and the UUT (device 1 in figure C.1) shall be placed on the support in its standard position and switched on.

b) The measurement equipment (device 3 in figure C.1) shall be connected to the measurement antenna and set-up according to the specifications of the test.




1) UUT
2) Measurement antenna
3) Measurement equipment

**Figure C.1: Measurement arrangement**

c) The UUT 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.

# C.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.

# C.4 Substitution measurement

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

1) Replacing the UUT 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 UUT, correction values from a verified site calibration can be used alternatively.

# C.5 Guidance for testing technical requirements

## C.5.1 Radio test suites and corresponding test sites

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

**Table C.1: Radio test suites and corresponding test sites**

| Radio test suite | Clause | Corresponding test site - Clause number(s) |
|---|---|---|
| Carrier frequencies | 5.4.2 | B.2.1, B.2.2, B.2.3 |
| Occupied Channel Bandwidth | 5.4.3 | B.4.3 |
| RF output power, Transmit Power Control (TPC) and power density | 5.4.4 | B.2.1, B.2.2, B.2.3 |
| Transmitter unwanted emissions outside the 5 GHz RLAN bands | 5.4.5 | B.2.1, B.2.2, B.2.3 |
| Transmitter unwanted emissions within the 5 GHz RLAN bands | 5.4.6 | B.2.1, B.2.2, B.2.3 |
| Receiver spurious emissions | 5.4.7 | B.2.1, B.2.2, B.2.3 |
| Dynamic Frequency Selection (DFS) | 5.4.8 | |
| Adaptivity (channel access mechanism) | 5.4.9 | C.5.2 |
| Receiver Blocking | 5.4.10 | C.5.3 |

# C.5.2 Guidance for testing Adaptivity (Channel Access Mechanism)

## C.5.2.1 Introduction

This clause provides guidance on how the Adaptivity requirement (see clause 4.2.7) can be verified on integral antenna equipment using radiated measurements.

## C.5.2.2 Measurement Set-up

Figure C.2 describes an example of a set-up that can be used to perform radiated adaptivity tests.

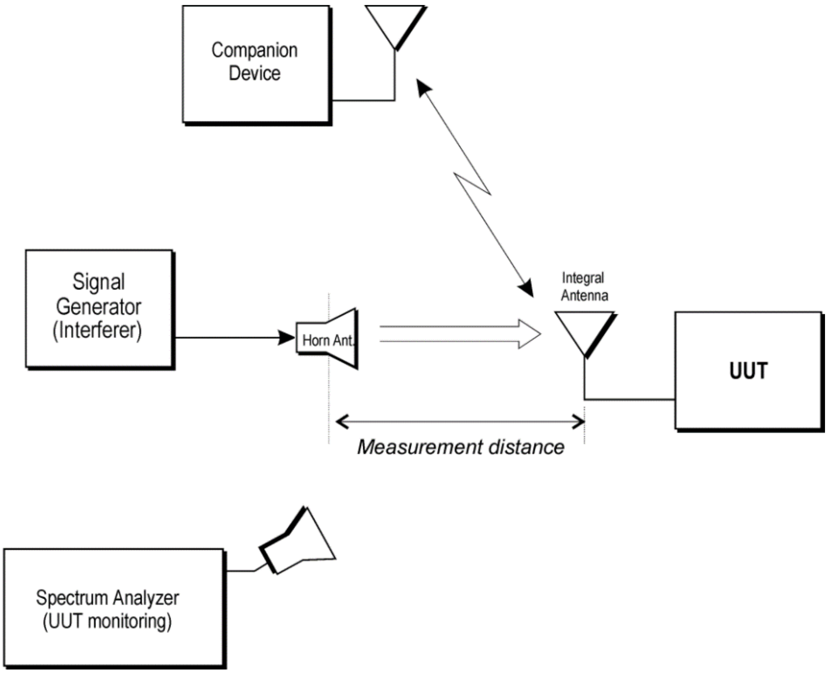



**Figure C.2: Measurement Set-up**

## C.5.2.3 Calibration of the measurement Set-up

Before starting the actual measurement, the setup shall be calibrated. Figure C.3 shows an example of a set-up that can be used for calibrating the set-up given in figure C.2 using a substitution antenna and a spectrum analyser. It shall be verified that the level of the interference signal at input of the substitution antenna correspond with the level used for conductive measurements assuming a 0 dBi antenna gain for the UUT (see clause 5.4.9).

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

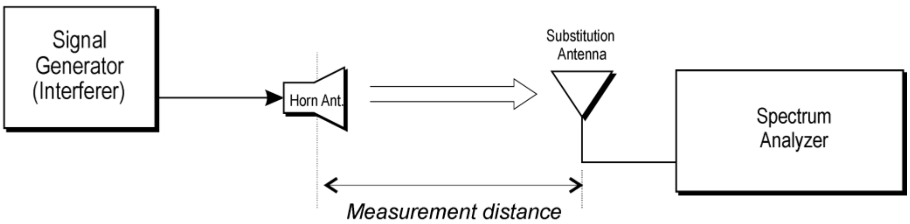



**Figure C.3: Measurement Set-up - Calibration**

### C.5.2.4 Test method

The test procedure shall be as follows:

- Replace the substitution antenna with the UUT once the calibration is performed.
- The UUT shall be positioned for maximum e.i.r.p. towards the horn antenna.

NOTE: This position was recorded as part of the procedure in clause 5.4.4.2.2, second paragraph.

The test method is further as described under clause 5.4.9.2.1.

## C.5.3 Guidance for testing Receiver Blocking

### C.5.3.1 Introduction

This clause provides guidance on how the Receiver Blocking (see clause 4.2.8) requirement can be verified on integral antenna equipment using radiated measurements.

### C.5.3.2 Measurement Set-up

Figure C.4 describes an example of a set-up that can be used to perform radiated receiver blocking tests.

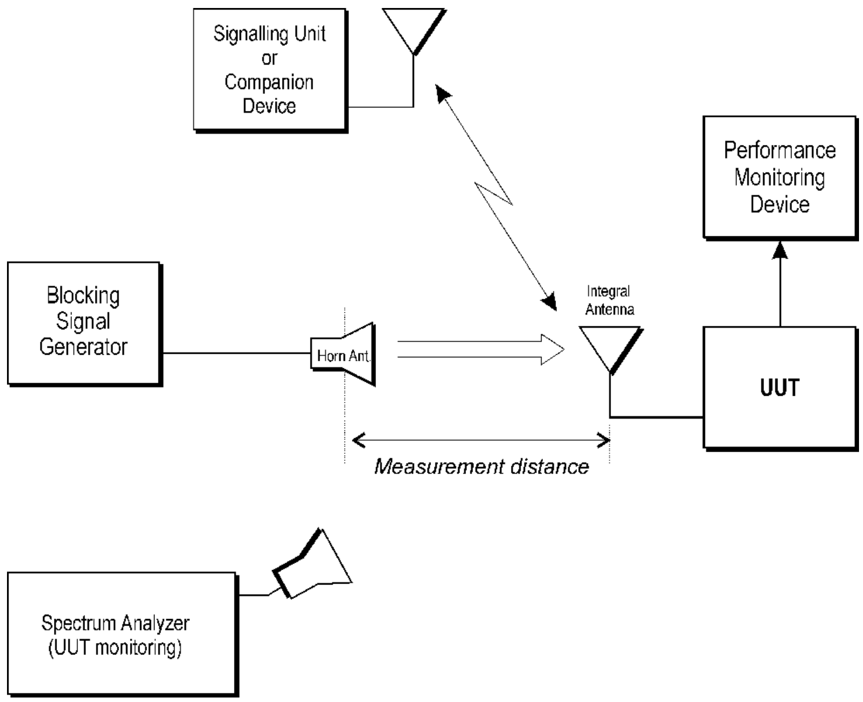



**Figure C.4: Measurement Set-up**

### C.5.3.3 Calibration of the measurement Set-up

Before starting the actual measurement, the setup shall be calibrated. Figure C.5 shows an example of a set-up that can be used for calibrating the set-up given in figure C.4 using a substitution antenna and a spectrum analyser. It shall be verified that the level of the blocking signal at the input of the substitution antenna corresponds to the levels used for conducted measurements (see clause 5.4.10).

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

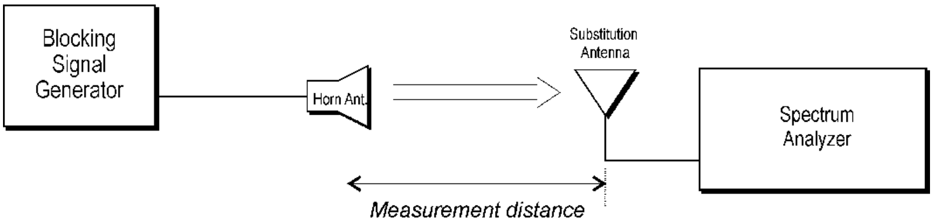



**Figure C.5: Measurement Set-up - Calibration**

### C.5.3.4 Test method

The test procedure shall be as follows:

- Replace the substitution antenna with the UUT once the calibration is performed.
- The UUT shall be positioned for maximum e.i.r.p. towards the horn antenna.

The test method is further as described under clause 5.4.10.2.1.

# Annex D (normative): DFS parameters

Table D.1 to table D.5 contain the values and limits for the DFS specific parameters referred to in clause 4.2.6 and clause 5.4.8.

Figure D.1 shows a single burst for a radar test signal using a constant PRF which is representative for the radar test signal 1 to signal 3 from table D.4. Figure D.2 shows multiple bursts of these same test signals.

Figure D.2 shows the general structure of a single burst radar test signal using a constant PRF. This structure is representative for the radar test signal 1 to signal 3 from table D.4.

Figure D.3 shows a single burst of a pulse based staggered PRF radar test signal. Figure D.4 shows a single burst of a packet based staggered PRF radar test signal which is representative for the radar test signal 5 and signal 6 from table D.4. Figure D.5 shows multiple bursts of these same test signals.

**Table D.1: DFS requirement values**

| Parameter | Value |
|---|---|
| Channel Availability Check Time | 60 s (see note 1) |
| Minimum Off-Channel CAC Time | 6 minutes (see note 2) |
| Maximum Off-Channel CAC Time | 4 hours (see note 2) |
| Channel Move Time | 10 s |
| Channel Closing Transmission Time | 1 s |
| Non-Occupancy Period | 30 minutes |
| NOTE 1: For channels whose nominal bandwidth falls completely or partly within the band 5 600 MHz to 5 650 MHz, the *Channel Availability Check Time* shall be 10 minutes.<br>NOTE 2: For channels whose nominal bandwidth falls completely or partly within the band 5 600 MHz to 5 650 MHz, the *Off-Channel CAC Time* shall be within the range 1 hour to 24 hours. | |

**Table D.2: Interference threshold values**

| e.i.r.p. Spectral Density (dBm/MHz) | Value (see note 1 and note 2) |
|---|---|
| 10 | -62 dBm |
| NOTE 1: This is the level at the input of the receiver of an RLAN device with a maximum e.i.r.p. density of 10 dBm/MHz and assuming a 0 dBi receive antenna. For devices employing different e.i.r.p. spectral density and/or a different receive antenna gain G (dBi) the DFS threshold level at the receiver input follows the following relationship:<br>DFS Detection Threshold (dBm) = -62 + 10 - e.i.r.p. Spectral Density (dBm/MHz) + G (dBi); however the DFS threshold level shall not be less than -64 dBm assuming a 0 dBi receive antenna gain.<br>NOTE 2: Slave devices with a maximum e.i.r.p. of less than 23 dBm do not have to implement radar detection unless these devices are used in fixed outdoor point to point or fixed outdoor point to multipoint applications (see clause 4.2.6.1.3). | |

**Table D.3: Parameters of the reference DFS test signal**

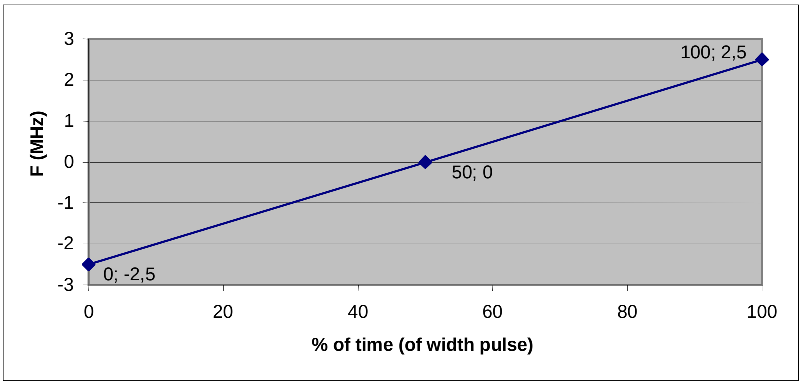
| Pulse width W (µs) | Pulse repetition frequency PRF (PPS) | Pulses per burst (PPB) |
|---|---|---|
| 1 | 700 | 18 |

### Table D.4: Parameters of radar test signals

| Radar test signal # (see note 1 to note 3) | Pulse width W (µs) | | Pulse repetition frequency PRF (PPS) | | Number of different PRFs | Pulses per burst for each PRF (PPB) (see note 5) |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | | |
| 1 | 0,5 | 5 | 200 | 1 000 | 1 | 10 (see note 6) |
| 2 | 0,5 | 15 | 200 | 1 600 | 1 | 15 (see note 6) |
| 3 | 0,5 | 15 | 2 300 | 4 000 | 1 | 25 |
| 4 | 20 | 30 | 2 000 | 4 000 | 1 | 20 |
| 5 | 0,5 | 2 | 300 | 400 | 2/3 | 10 (see note 6) |
| 6 | 0,5 | 2 | 400 | 1 200 | 2/3 | 15 (see note 6) |

NOTE 1: Radar test signals #1 to #4 are constant PRF based signals. See figure D.1. These radar test signals are intended to simulate also radars using a packet based Staggered PRF. See figure D.2.

NOTE 2: Radar test signal #4 is a modulated radar test signal. The modulation to be used is a chirp modulation with a ±2,5 MHz frequency deviation which is described below.




NOTE 3: Radar test signals #5 and #6 are single pulse based Staggered PRF radar test signals using 2 or 3 different PRF values. For radar test signal #5, the difference between the PRF values chosen shall be between 20 PPS and 50 PPS. For radar test signal #6, the difference between the PRF values chosen shall be between 80 PPS and 400 PPS. See figure D.3.

NOTE 4: Apart for the Off-Channel CAC testing, the radar test signals above shall only contain a single burst of pulses. See figure D.1, figure D.3 and figure D.4.
For the Off-Channel CAC testing, repetitive bursts shall be used for the total duration of the test. See figure D.2 and figure D.5. See also clause 4.2.6.2.3, clause 5.4.8.2.1.4.2 and clause 5.4.8.2.1.4.3.

NOTE 5: The total number of pulses in a burst is equal to the number of pulses for a single PRF multiplied by the number of different PRFs used.

NOTE 6: For the CAC and Off-Channel CAC requirements, the minimum number of pulses (for each PRF) for any of the radar test signals to be detected in the band 5 600 MHz to 5 650 MHz shall be 18.

### Table D.5: Detection probability

| Parameter | Detection Probability ($P_d$) | |
|---|---|---|
| | Channels whose nominal bandwidth falls partly or completely within the 5 600 MHz to 5 650 MHz band | Other channels |
| CAC, Off-Channel CAC | 99,99 % | 60 % |
| In-Service Monitoring | 60 % | 60 % |

NOTE: $P_d$ gives the probability of detection per simulated radar burst and represents a minimum level of detection performance under defined conditions. Therefore $P_d$ does not represent the overall detection probability for any particular radar under real life conditions.

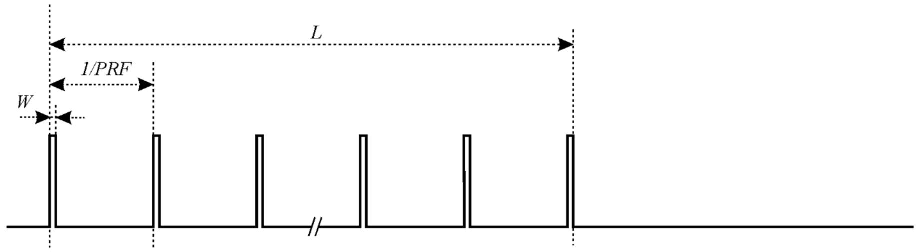



**Figure D.1: General structure of a single burst/constant PRF based radar test signal**

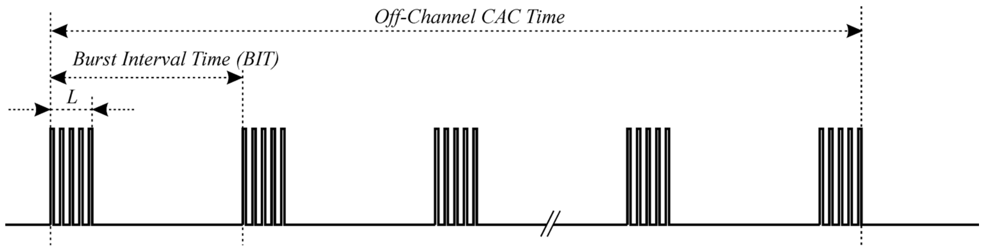



**Figure D.2: General structure of a multiple burst/constant PRF based radar test signal**

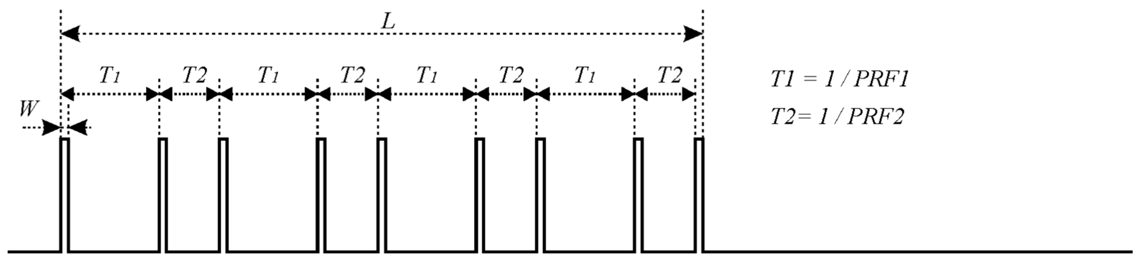



**Figure D.3: General structure of a single burst/single pulse based staggered PRF radar test signal**

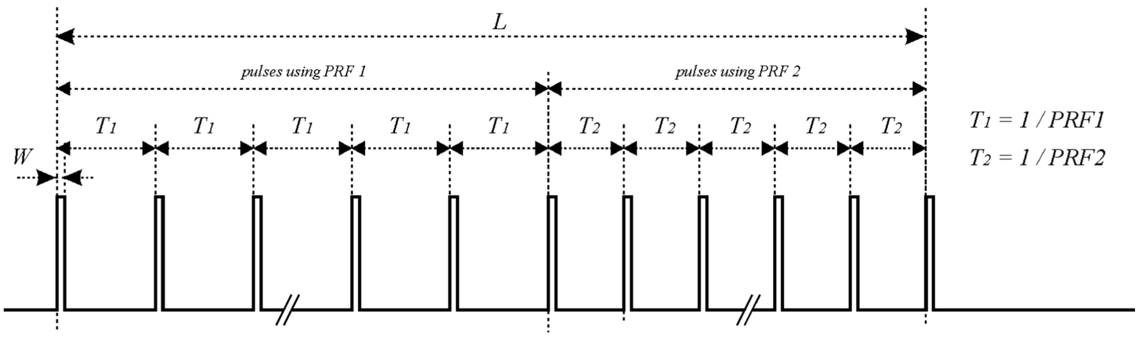



**Figure D.4: General structure of a single burst/packet based staggered PRF radar test signal**

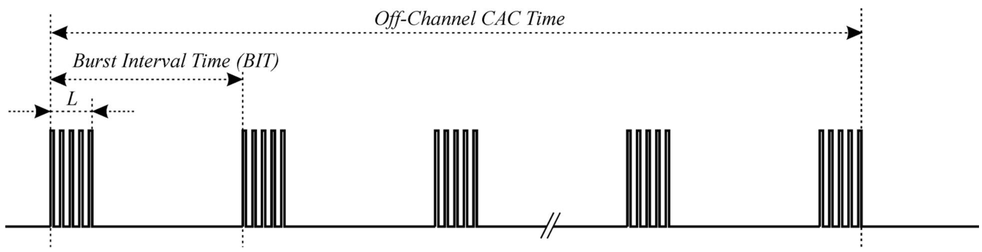



**Figure D.5: General structure of a multiple burst/packet based staggered PRF based radar test signal**

# Annex E (informative): Guidance for testing IEEE 802.11™ Devices

# E.1 Introduction

The following guidance may be used by test labs and manufacturers when evaluating compliance of IEEE 802.11 [9] radio devices to the present document. The technology-specific information in this annex *does not* constitute additional requirements and *does not* modify the technical requirements of the present document.

In addition to the mandatory and optional modes defined in the IEEE 802.11 [9] technology standard, Smart Antenna Systems may utilize additional modes of operation not defined in the IEEE 802.11 [9] standard. Therefore, this annex presents a non-exhaustive list of the most commonly expected modes and operating states for IEEE 802.11 [9] based devices with the associated references to the appropriate categories for testing in the present document.

The guidance provided in this informative annex assumes that the product utilizes two or more transmit and receive chains.

# E.2 Possible Modulations

## E.2.1 Most commonly used modulation types and channel widths

Listed below are the most common modulation types and channel widths used by 5 GHz IEEE 802.11 [9] devices:

- IEEE 802.11 [9] non-HT modulations using a single or multiple transmitters with or without transmit CSD.
- IEEE 802.11 [9] HT20: 20 MHz channels with one to four spatial streams (MCS 0 through MCS 76).
- IEEE 802.11 [9] HT40: 40 MHz channels with one to four spatial streams (MCS 0 through MCS 76).

NOTE: A spatial stream is a stream of bits transmitted over a separate spatial dimension. The number of spatial streams is not necessarily equivalent to the number of transmit chains.

## E.2.2 Guidance for Testing

### E.2.2.1 Objective

The objective is to test the equipment in configurations which result in the highest e.i.r.p. and e.i.r.p. density. These configurations are further referred to as the worst-case.

### E.2.2.2 Modulation Used for Conformance Testing

One worst case modulation type for 20 MHz operation (and one worst case modulation type for 40 MHz operation, if supported) should be identified and used for conformance testing per the present document.

Where the 20 MHz and 40 MHz modes support different numbers of transmit chains and spatial streams, testing may need to be performed to identify the worst case modes.

Comparison measurements of mean RF output power (or mean e.i.r.p.) and power density (or e.i.r.p. density), across all modulations can be used to establish the worst case modulation type for 20 MHz operation (and the worst case modulation type for 40 MHz if supported).

EXAMPLE: If comparison measurements determine that HT20 MCS 0 (6,5 Mbit/s, one spatial stream) is worst-case, then this mode should be used for conformance testing (and not any of the other modulations defined in IEEE 802.11 [9]). One worst-case modulation for HT40 operation should be identified and used for the conformance testing.

However, if the product has transmit power levels different for non-HT vs. HT20 operation, then the worst-case modulation type should be identified for both modes and used for testing the e.i.r.p. and e.i.r.p. density which need to be repeated for both the non-HT and HT20 operation. If in addition, the equipment supports 40 MHz operation, then in total three sets of Output Power and the Power Spectral Density conformance tests should be performed:

- Worst-case non-HT modulation.
- Worst-case HT20 modulation.
- Worst-case HT40 modulation.

NOTE 1: Non-HT operation means any of the modulations defined in IEEE 802.11 [9], clause 18.

NOTE 2: In some operating modes, the CSD feature may be disabled. Comparison testing between CSD enabled and CSD disabled will determine the worse-case configuration, and this configuration will then be used during the conformance testing.

# E.3 Possible Operating Modes

## E.3.1 Most commonly used operating modes of Smart Antenna Systems

Listed below are the most common operating states of multiple transmit/receive chains within Smart Antenna Systems:

- Beamforming feature implemented and enabled or disabled.
- All *available* transmit and receive chains enabled.
- A subset of the present transmit/receive chains temporarily disabled during normal operation (i.e. dynamically, based on link conditions or power requirements). In this case, a manufacturer may implement higher transmit power settings (dynamically) for the active transmit chains.
- Although not commonly expected, it is possible that a device may utilize different transmit power settings between one or more of the present transmit chains.

## E.3.2 Guidance for Testing

The e.i.r.p. and e.i.r.p. density tests should be repeated using the worst-case modulations described above and in the following operating states when supported by the equipment:

- Where one or more of the transmit chains is manually or automatically disabled during normal operation and different target RF output power levels are used depending on the number of active transmit chains, then e.i.r.p. and e.i.r.p. density conformance testing should be performed using each configuration.

EXAMPLE 1: A device with three transmit chains may support an operating mode using three transmit chains at one power level and another operating mode in which one transmit chain is using a higher power level while the other transmit chains are disabled. The e.i.r.p. and e.i.r.p. density conformance testing should be repeated (using the worst-case modulation types described above) for both of the above mentioned (three-transmit and single-transmit) operating modes.

EXAMPLE 2: For a device with three transmit chains, testing does not need to be repeated for all the transmit chains if that device does not change its (per transmit chain) RF output power based on the number of active chains.

- Where a beamforming feature is implemented, conformance testing should be performed as indicated for a device with a beamforming feature:
  - Where the beamforming feature may be disabled manually or automatically, conformance testing does not need to be repeated if the (per transmit chain) RF output power settings remain unchanged.

- Where the beamforming feature may be disabled manually or automatically, conformance testing needs to be repeated if different (per transmit chain) RF output power settings will be used.

# Annex F (informative): Adaptivity Flowchart

The flowchart contained in figure F.1 illustrates the Channel Access Mechanism (Adaptivity) for *Load Based Equipment* as defined in clause 4.2.7.3.2, and more in particular the mechanism defined in clause 4.2.7.3.2 (*Initiating Device Channel Access Mechanism*).

Figure F.1 does not consider note 2 in table 8 in clause 4.2.7.3.2.4.

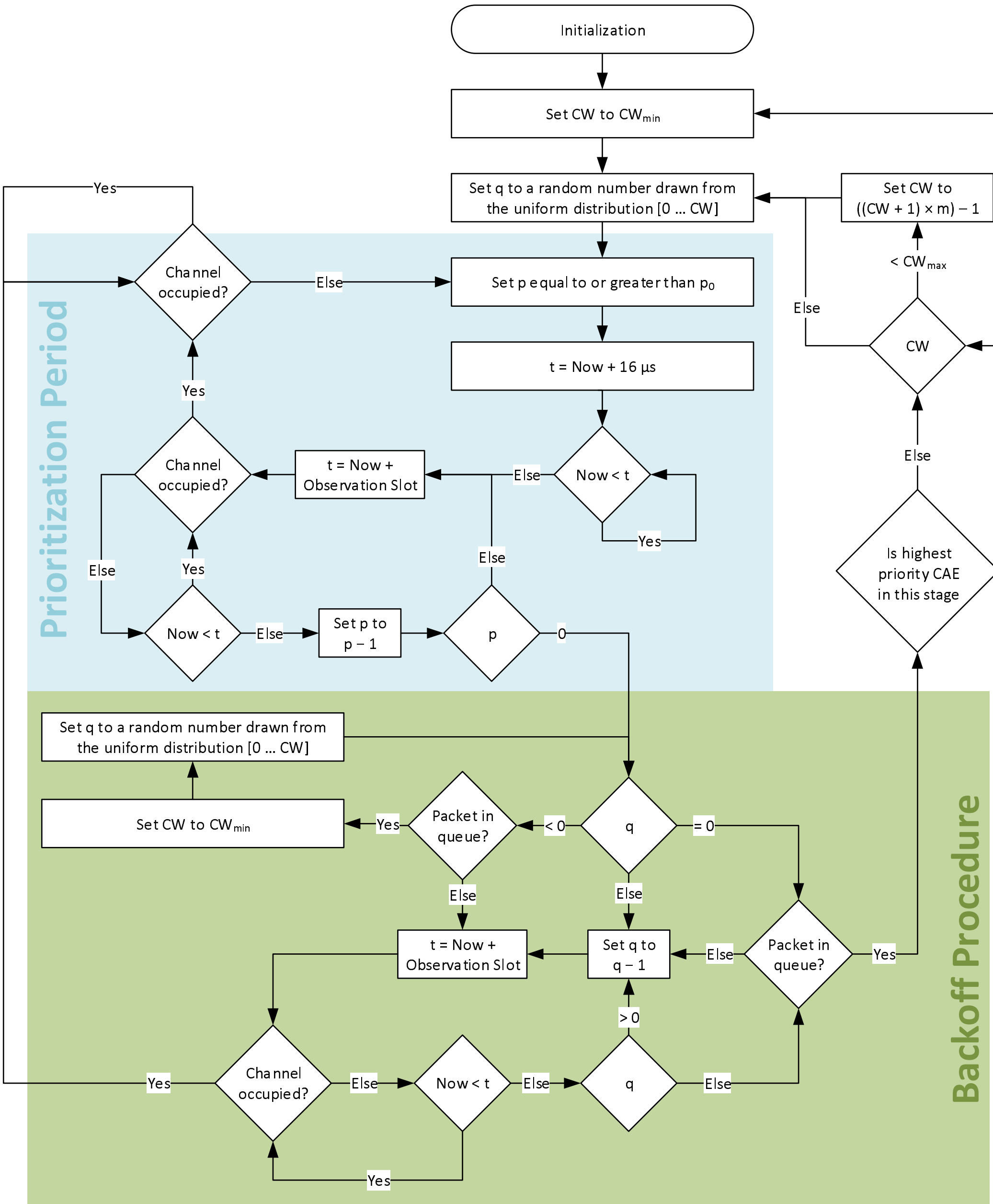



**Figure F.1: Flowchart for Adaptivity (Initiating Device)**

# Annex G (informative): Application form for testing

## G.0 The right to copy

Notwithstanding the provisions of the copyright clause related to the text of the present document, ETSI grants that users of the present document may freely reproduce the application form for testing so that it can be used for its intended purposes and may further publish the completed application form.

## G.1 Introduction

The form contained in this annex may be used by the manufacturer to comply with the requirements contained in clause 5.4.1 to provide the necessary information about the equipment to the test laboratory prior to the testing. It contains product information as well as other information which might be required to define which configurations are expected to be tested, which tests are expected to be performed as well as the test conditions.

If used, this application form should form an integral part of the test report.

## G.2 Information as required by ETSI EN 301 893 (V2.1.1), clause 5.4.1

In accordance with ETSI EN 301 893, clause 5.4.1, the following information is provided by the manufacturer.

**a) The Nominal Channel Bandwidth(s):**

Nominal Channel Bandwidth 1: ...... MHz

Nominal Channel Bandwidth 2: ...... MHz

Nominal Channel Bandwidth 3: ...... MHz

**The associated centre frequencies:**

For Nominal Channel Bandwidth 1:

for the band 5 150 MHz to 5 350 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

for the band 5 470 MHz to 5 725 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

For Nominal Channel Bandwidth 2:

for the band 5 150 MHz to 5 350 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

for the band 5 470 MHz to 5 725 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

For Nominal Channel Bandwidth 3:

for the band 5 150 MHz to 5 350 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

for the band 5 470 MHz to 5 725 MHz: ...... MHz; ...... MHz; ...... MHz; ...... MHz;

**b) For Load Based Equipment that supports multi-channel operation:**

☐ The LBE equipment supports Option 1 as described in clause 4.2.7.3.2.3

☐ The LBE equipment supports Option 2 as described in clause 4.2.7.3.2.3

- The (maximum) number of channels used for multi-channel operation: ......

- These channels are adjacent channels:

☐ Yes ☐ No

- In case of non-adjacent channels, whether or not these channels are in different sub-bands:

☐ Yes ☐ No

- for LBE equipment implementing option 1 (see clause 4.2.7.3.2.3), the number of channels used for multi-channel operation when performing the test described in clause 5.4.9.3.2.3.1: …………

In case of multi-channel operation, further information defining the channels used for these simultaneous transmissions may be required.

**c) The different transmit operating modes (see clause 5.1.4.2) (tick all that apply):**

☐ **Operating mode 1:** Single Antenna Equipment

☐ a) Equipment with only 1 antenna

☐ b) Equipment with diversity antennas but only 1 antenna active at any moment in time

☐ c) Smart Antenna Systems with 2 or more antennas, but operating in a (legacy) mode where only 1 antenna is used

☐ **Operating mode 2:** Smart Antenna Systems - Multiple Antennas without beamforming

☐ a) Single spatial stream/Standard throughput

☐ b) High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1

☐ c) High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

☐ **Operating mode 3:** Smart Antenna Systems - Multiple Antennas with beamforming

☐ a) Single spatial stream/Standard throughput

☐ b) High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1

☐ c) High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

**d) In case of Smart Antenna Systems or multiple antenna systems:**

- The number of Receive chains: ......
- The number of Transmit chains: ......
- Equal power distribution among the transmit chains: ☐ Yes ☐ No
- In case of beamforming, the maximum (additional) beamforming gain: ...... dB

NOTE: Beamforming gain does not include the basic gain of a single antenna (assembly).

**e) TPC feature available:**

☐ Yes

☐ No

**f) For equipment with TPC range:**

The lowest and highest power level (or lowest and highest e.i.r.p. level in case of integrated antenna equipment), intended antenna assemblies and corresponding operating frequency range for the TPC range (or for each of the TPC ranges if more than one is implemented).

**TPC range 1:** Applicable Frequency Range:

☐ 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz (Indoor)

Simultaneous transmissions in both sub-bands: ☐ Yes ☐ No

☐ 5 470 MHz to 5 725 MHz only (Outdoor only)

Indicate whether the power levels specified are Transmitter Output Power levels or e.i.r.p. levels in case of integrated antenna equipment.

Power levels are specified for: ☐ Tx out ☐ e.i.r.p

If more than one transmit chain is present (e.g. in the case of smart antenna systems), the power levels below represent the power settings per active transmit chain (and per sub-band in case of multi-channel operation).

**Table G.1: Power levels for TPC range 1**

| | Sub-band (MHz) | Operating Mode 1 (dBm) | Operating Mode 2 (dBm) | Operating Mode 3 (dBm) |
|---|---|---|---|---|
| **Lowest setting ($P_{low}$)** | 5 150 to 5 350 | ...... | ...... | ...... |
| | 5 470 to 5 725 | ...... | ...... | ...... |
| **Highest setting ($P_{high}$)** | 5 150 to 5 350 | ...... | ...... | ...... |
| | 5 470 to 5 725 | ...... | ...... | ...... |

Beamforming possible: ☐ Yes ☐ No

Intended Antenna Assemblies:

**Table G.2: Intended Antenna Assemblies for TPC range 1**

| Antenna Assembly name | Antenna Gain (dBi) | Operating Mode | Sub-band (MHz) | Beam forming gain (dB) | e.i.r.p. for $P_{low}$ (dBm) | e.i.r.p. for $P_{high}$ (dBm) |
|---|---|---|---|---|---|---|
| <Antenna 1> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| <Antenna 2> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| <Antenna 3> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |

DFS Threshold level: ...... dBm ☐ at the antenna connector

☐ in front of the antenna

**TPC range 2:** Applicable Frequency Range:

☐ 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz (Indoor)

Simultaneous transmissions in both sub-bands: ☐ Yes ☐ No

☐ 5 470 MHz to 5 725 MHz only (Outdoor only)

Indicate whether the power levels specified are Transmitter Output Power levels or e.i.r.p. levels in case of integrated antenna equipment.

Power levels are specified for: ☐ Tx out ☐ e.i.r.p

If more than one transmit chain is present (e.g. in the case of smart antenna systems), the power levels below represent the power settings per active transmit chain (and per sub-band in case of simultaneous transmissions).

**Table G.3: Power levels for TPC range 2**

| | Sub-band (MHz) | Operating Mode 1 (dBm) | Operating Mode 2 (dBm) | Operating Mode 3 (dBm) |
|---|---|---|---|---|
| **Lowest setting ($P_{low}$)** | 5 150 to 5 350 | ...... | ...... | ...... |
| | 5 470 to 5 725 | ...... | ...... | ...... |
| **Highest setting ($P_{high}$)** | 5 150 to 5 350 | ...... | ...... | ...... |
| | 5 470 to 5 725 | ...... | ...... | ...... |

Beamforming possible: ☐ Yes ☐ No

Intended Antenna Assemblies:

**Table G.4: Intended Antenna Assemblies for TPC range 2**

| Antenna Assembly name | Antenna Gain (dBi) | Operating Mode | Sub-band (MHz) | Beam forming gain (dB) | e.i.r.p. for $P_{low}$ (dBm) | e.i.r.p. for $P_{high}$ (dBm) |
|---|---|---|---|---|---|---|
| <Antenna 1> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| <Antenna 2> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| <Antenna 3> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... | ...... |

DFS Threshold level: ...... dBm ☐ at the antenna connector

☐ in front of the antenna

**g) For equipment without a TPC range:**

**Power Setting 1:** Applicable Frequency Range:

☐ 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz (Indoor)

Simultaneous transmissions in both sub-bands: ☐ Yes ☐ No

☐ 5 470 MHz to 5 725 MHz only (Outdoor only)

Indicate whether the power levels specified are Transmitter Output Power levels or e.i.r.p. levels in case of integrated antenna equipment.

Power levels are specified for: ☐ Tx out ☐ e.i.r.p.

If more than one transmit chain is present (e.g. in the case of smart antenna systems), the power levels below represent the power settings per active transmit chain (and per sub-band in case of simultaneous transmissions).

**Table G.5: Maximum Transmitter Output Power for Power Setting 1**

| Sub-band (MHz) | Operating Mode 1 (dBm) | Operating Mode 2 (dBm) | Operating Mode 3 (dBm) |
|---|---|---|---|
| 5 150 to 5 350 | ...... | ...... | ...... |
| 5 470 to 5 725 | ...... | ...... | ...... |

Beamforming possible: ☐ Yes ☐ No

Intended Antenna Assemblies:

**Table G.6: Intended Antenna Assemblies for Power Setting 1**

| Antenna Assembly name | Antenna Gain (dBi) | Operating Mode | Sub-band (MHz) | Beam forming gain (dB) | e.i.r.p. (dBm) |
|---|---|---|---|---|---|
| <Antenna 1> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| <Antenna 2> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| <Antenna 3> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |

DFS Threshold level: ...... dBm ☐ at the antenna connector

☐ in front of the antenna

**Power Setting 2:** Applicable Frequency Range:

☐ 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz (Indoor)

Simultaneous transmissions in both sub-bands: ☐ Yes ☐ No

☐ 5 470 MHz to 5 725 MHz only (Outdoor only)

Indicate whether the power levels specified are Transmitter Output Power levels or e.i.r.p. levels in case of integrated antenna equipment.

Power levels are specified for: ☐ Tx-out ☐ e.i.r.p.

If more than one transmit chain is present (e.g. in the case of smart antenna systems), the power levels below represent the power settings per active transmit chain (and per sub-band in case of simultaneous transmissions).

**Table G.7: Maximum Transmitter Output Power for Power Setting 2**

| Sub-band (MHz) | Operating Mode 1 (dBm) | Operating Mode 2 (dBm) | Operating Mode 3 (dBm) |
|---|---|---|---|
| 5 150 to 5 350 | ...... | ...... | ...... |
| 5 470 to 5 725 | ...... | ...... | ...... |

Beamforming possible: ☐ Yes ☐ No

Intended Antenna Assemblies:

**Table G.8: Intended Antenna Assemblies for Power Setting 2**

| Antenna Assembly name | Antenna Gain (dBi) | Operating Mode | Sub-band (MHz) | Beam forming gain (dB) | e.i.r.p. (dBm) |
|---|---|---|---|---|---|
| <Antenna 1> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| <Antenna 2> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| <Antenna 3> | ...... | Mode 1 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 2 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |
| | | Mode 3 | 5 150 to 5 350 | ...... | ...... |
| | | | 5 470 to 5 725 | ...... | ...... |

DFS Threshold level: ...... dBm ☐ at the antenna connector

☐ in front of the antenna

**h) The DFS related operating mode(s) of the equipment:**

☐ Master

☐ Slave with radar detection

☐ Slave without radar detection

If the equipment has more than one operating mode, tick all that apply.

**i) User access restrictions (please check box below to confirm):**

☐ The equipment is constructed to comply with the requirements contained in clause 4.2.9 in ETSI EN 301 893 V2.1.1

**j) For equipment with Off-Channel CAC functionality:**

The equipment has an *"Off-Channel CAC"* function: ☐ Yes ☐ No

If yes, specify the *"Off-Channel CAC Time"*

- For channels outside the 5 600 MHz to 5 650 MHz range: ......... hours
- If applicable, for channels (partially) within the 5 600 MHz to 5 650 MHz range: ......... hours

**k) The equipment can operate in ad-hoc mode:**

☐ no ad-hoc operation

☐ ad-hoc operation in the frequency range 5 150 MHz to 5 250 MHz without DFS

☐ ad-hoc operation with DFS

If more than 1 is applicable, tick all that apply.

**l) Operating Frequency Range(s):**

Range 1: ☐ 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz

Range 2: ☐ 5 470 MHz to 5 725 MHz

Range 3: ☐ 5 150 MHz to 5 250 MHz (ad-hoc without DFS)

Range 4: ☐ other, please specify: ……………..

If the equipment has more than one Operating Frequency Range, tick all that apply.

**m) The extreme operating temperature and supply voltage range that apply to the equipment:**

☐ -20 °C to +55 °C (Outdoor & Indoor usage)

☐ 0 °C to +35 °C (Indoor usage only)

☐ Other: ..................................................................................

The supply voltages of the stand-alone radio equipment or the supply voltages of the combined (host) equipment or test jig in case of plug-in devices:

Details provided are for the: ☐ stand-alone equipment

☐ combined (or host) equipment

☐ test jig

Supply Voltage ☐ AC mains State AC voltage: Minimum: … Nominal: ... Maximum: ...

☐ DC State DC voltage Minimum: … Nominal: ... Maximum: ...

In case of DC, indicate the type of power source:

☐ Internal Power Supply

☐ External Power Supply or AC/DC adapter

☐ Battery ☐ Nickel Cadmium

☐ Alkaline

☐ Nickel-Metal Hydride

☐ Lithium-Ion

☐ Lead acid (Vehicle regulated)

☐ Other .............................

**n) The test sequence/test software used (see also ETSI EN 301 893 (V2.1.1), clause 5.3.1.2):**

.................................................................................

.................................................................................

.................................................................................

**o) Type of Equipment:**

☐ Stand-alone

☐ Combined Equipment (Equipment where the radio part is fully integrated within another type of equipment)

☐ Plug-in radio device (Equipment intended for a variety of host systems)

☐ Other .................................................................................

**p) Adaptivity (Channel Access Mechanism)**:

☐ Frame Based Equipment

☐ Load Based Equipment

**q) With regards to Adaptivity for Frame Based Equipment**

☐ The Frame Based Equipment equipment operates as an Innitiating Device

☐ The Frame Based Equipment equipment operates as an Responding Device

☐ The Frame Based Equipment equipment can operate as an Innitiating Device and as a Responding Device

The Frame Based Equipment has implemented the following Fixed Frame Period(s):

………. ms

………. ms

………. ms

**r) With regards to Adaptivity for Load Based Equipment**

☐ The Load Based Equipment equipment operates as a Supervising Device

☐ The Load Based Equipment equipment operates as a Supervised Device

☐ The Load Based Equipment equipment can operate as a Supervising and as a Supervised Device

☐ The Load Based Equipment equipment makes use of note 1 in table 7 or note 1 in table 8 of ETSI EN 301 893 V2.1.1

☐ The Load Based Equipment equipment, when operating as a Supervising Device, makes use of note 2 in table 8 of ETSI EN 301 893 V2.1.1

The Priority Classes implemented by the Load Based Equipment

- When operating as a Supervising Device
  - ☐ Priority Class 4 (Highest priority)
  - ☐ Priority Class 3
  - ☐ Priority Class 2
  - ☐ Priority Class 1 (Lowest priority)
- When operating as a Supervised Device
  - ☐ Priority Class 4 (Highest priority)
  - ☐ Priority Class 3
  - ☐ Priority Class 2
  - ☐ Priority Class 1 (Lowest priority)

☐ The Load Based Equipment equipment operates as an Innitiating Device

☐ The Load Based Equipment equipment operates as an Responding Device

☐ The Load Based Equipment equipment can operate as an Innitiating Device and as a Responding Device

With regard to Energy Detection Threshold, the Load Based Equipment has implemented either option 1 of clause 4.2.7.3.2.5 of ETSI EN 301 893 V2.1.1 or option 2 of clause 4.2.7.3.2.5 of ETSI EN 301 893 V2.1.1:

☐ Option 1

☐ Option 2

Specify which protocol has been implemented: ☐ IEEE 802.11™ ☐ Other: ............

**s) The equipment supports a geo-location capability as defined in clause 4.2.10 of ETSI EN 301 893 V2.1.1:**

☐ Yes ☐ No

**t) The minimum performance criteria (see ETSI EN 301 893 V2.1.1, clause 4.2.8.3) that corresponds to the intended use of the equipment.**

....................................................................................

....................................................................................

....................................................................................

**u) The theoretical maximum radio performance of the equipment (e.g. maximum throughput) (see ETSI EN 301 893 V2.1.1, clause 5.4.9.3.1).**

....................................................................................

# G.3 Additional information provided by the manufacturer

## G.3.1 Modulation

Can the transmitter operate un-modulated? ☐ Yes ☐ No

## G.3.2 Duty Cycle

The transmitter is intended for : ☐ Continuous duty

☐ Intermittent duty

☐ Continuous operation possible for testing purposes

## G.3.3 About the UUT

☐ The equipment submitted are representative production models.

☐ If not, the equipment submitted are pre-production models?

☐ If pre-production equipment are submitted, the final production equipment will be identical in all respects with the equipment tested.

☐ If not, supply full details:

..................................................................................

..................................................................................

## G.3.4 List of ancillary and/or support equipment provided by the manufacturer

☐ Spare batteries (e.g. for portable equipment)

☐ Battery charging device

☐ External Power Supply or AC/DC adapter

☐ Test Jig or interface box

☐ RF test fixture (for equipment with integrated antennas)

☐ Host System Manufacturer: ....................

Model #: ....................

Model name: ....................

☐ Combined equipment Manufacturer: ....................

Model #: ....................

Model name: ....................

☐ User manual

☐ Technical documentation (Handbook and circuit diagrams)

# Annex H (informative): Bibliography


- Recommendation ITU-R M.1652: "Dynamic frequency selection (DFS) in wireless access systems including radio local area networks for the purpose of protecting the radio determination service in the 5 GHz band".

# Annex I (informative): Change history

| Version | Information about changes |
| --- | --- |
| 2.1.1 | First published version covering Directive 2014/53/EU.<br>Major changes are:<br>• Inclusion of Receiver Blocking as a new requirement.<br>• Revision of the Adaptivity Requirement to accommodate multiple technologies.<br>• Revised test method for Adaptivity.<br>• Modifications required for alignment with Directive 2014/53/EU. |

# History

| Document history | | | | |
|---|---|---|---|---|
| V1.2.3 | August 2003 | Publication | | |
| V1.3.1 | August 2005 | Publication | | |
| V1.4.1 | July 2007 | Publication | | |
| V1.5.1 | December 2008 | Publication | | |
| V1.6.1 | November 2011 | Publication | | |
| V1.7.1 | June 2012 | Publication | | |
| V1.8.1 | March 2015 | Publication | | |
| V2.0.7 | November 2016 | EN Approval Procedure | AP 20170227: | 2016-11-29 to 2017-02-27 |