# Draft ETSI EN 302 065-4 V1.1.0 (2016-04)


**Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 4: Material Sensing devices using UWB technology below 10,6 GHz;**

Reference
DEN/ERM-TGUWB-132

Keywords
Harmonised standard, radio, SRD, testing, UWB

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# Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), 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.11] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table 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.

The present document is part 4 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.10].

| **Proposed 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).

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# Introduction

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the Directive 2014/53/EU [i.4].

# 1 Scope

The present document specifies the requirements for **material sensing** applications using UWB technology operating in all or part of the frequency band from 2,2 GHz to 8,5 GHz. Additionally, it specifies reduced emissions in the ranges from 0,96 GHz to 2,2 GHz and 8,5 GHz to 10,6 GHz.

The present document applies to:

1) Material Sensing devices: a device enabling radio determination application designed to detect the location of objects within a structure or to determine the physical properties of a material.

2) Equipment fitted with a non-user changeable antenna.

3) The main categories are:

   a) Non fixed material sensors;

   b) Non fixed building material sensors;

   c) Fixed material sensors.

The present document does not apply to:

- UWB communication devices;
- Ground and wall probing radar devices;
- Through-wall radar imaging devices; and
- (Tank) Level Probing devices.

Equipment covered by the present document operates in accordance with ECC/DEC(07)01 [i.7] and Commission Decision 2009/343/EC [i.6].

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

**Table 1: Permitted range of operation [i.6]**

| **Intended frequency bands** | |
|---|---|
| Transmit | 2,2 GHz to 8,5 GHz |
| Receive | 2,2 GHz to 8,5 GHz |
| **Permitted range of operation** | |
| Transmit | 30 MHz to 10,6 GHz |
| Receive | 30 MHz to 10,6 GHz |
| NOTE: The UWB radio device can also operate outside of the intended range of operation and inside the permitted range of operation provided that the limits in clause 4.3.2 and 4.3.4.2, table 2 or table 3 are met. | |

# 2 References

## 2.1 Normative references

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

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

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

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

[1] ETSI EN 303 883 (V1.1.1) (02-2016): "Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".

[2] ETSI TS 103 361 (V1.1.1) (03-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Receiver technical requirements, parameters and measurement procedures to fulfil the requirements of the Directive 2014/53/EU".

## 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] CEPT ECC/DEC/(06)04 of 24 March 2006 amended 9 December 2011: "The harmonised conditions for devices using Ultra-Wideband (UWB) technology in bands below 10.6 GHz".

[i.2] ECC Report 120 (March 2008): "ECC Report on Technical requirements for UWB DAA (Detect and avoid) devices to ensure the protection of radiolocation in the bands 3.1-3.4 GHz and 8.5-9 GHz and BWA terminals in the band 3.4-4.2 GHz".

[i.3] CEPT/ERC Recommendation 74-01: "Unwanted emissions in the spurious domain".

[i.4] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.5] CEPT report 45: "Report from CEPT to the European Commission in response to the Fifth Mandate to CEPT on ultra-wideband technology to clarify the technical parameters in view of a potential update of Commission Decision 2007/131/EC"; Report approved on 21 June 2013 by the ECC.

[i.6] Commission Decision 2009/343/EC of 21 April 2009 amending Decision 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonized manner in the Community (notified under document number C(2009) 2787) (Text with EEA relevance).

[i.7] ECC/DEC/(07)01: "ECC Decision of 30 March 2007 on specific Material Sensing devices using Ultra-Wideband (UWB) technology (amended 26 June 2009)".

[i.8] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[i.9] Commission Decision 2007/131/EC of 21 February 2007 on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community (notified under document number C(2007) 522).

[i.10] ETSI EN 302 065-1 (V2.1.0) "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Requirements for Generic UWB applications".

[i.11] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI EN 303 883 [1] and the following apply:

**exterior limits:** regulatory limits defined and measured around a specific setup or measurement scenario

**fixed installation:** installation of the UWB equipment where the relative spatial emission characteristics do not change during the operation of the equipment

**narrowband:** equipment to be used in a non-channelized continuous frequency band with an occupied bandwidth of equal or less than 25 kHz, or equipment to be used in a channelized frequency band with a channel spacing of equal or less than 25 kHz

**transmitter on time ($T_{on}$):** duration of a burst irrespective of the number of pulses contained

**transmitter off time ($T_{off}$):** time interval between two consecutive bursts when the UWB emission is kept idle

## 3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 303 883 [1] and the following apply:

| | |
|---|---|
| c | velocity of light in a vacuum |
| cl1 | cable loss 1 |
| cl2 | cable loss 2 |
| E | Electrical field strength |
| $E_R$ | relative dielectric constant of earth materials |
| $E_{rms}$ | Average electrical field strength measured as root mean square |
| $f_M$ | frequency at which the peak power emission occurs |
| G(f) | Antenna gain over frequency |
| $G_A$ | Gain of the measurement antenna |
| $G_{LNA}$ | Gain of the measurement LNA |
| $P_{e.i.r.p.}$ | spectral power density |
| $P_m$ | measured spectral power |
| $P_{victim}$ | power of a different device at the material sensor |
| $P_{wall, e.i.r.p.}$ | undesired spectral power density, here: wall as absorbing material |
| R | Distance |
| rms | Root mean square |
| $T_P$ | pulse rise time |
| $Z_{F0}$ | Free space wave impedance |
| δR | range resolution |
| δt | time interval between the arrivals of two signals from targets separated in range by δR |
| k | coverage factor |

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 303 883 [1] and the following apply:

| | |
|---|---|
| BMA | Building Material Analysis |
| CEPT | Conférence Européenne des administrations de Postes et des Télécommunications |
| CW | Continuous Wave |
| dB | deciBel |
| dBi | gain in deciBel relative to an isotropic antenna |
| dBm | deciBel reference to 1 mW |
| e.r.p. | equivalent radiated power |
| EC | European Commission |
| EN | European Norm |

| | |
|---|---|
| ERC | European Radiocommunication Committee |
| IT | Information Technology |
| LBT | Listen Before Talk |
| MSS | Mobile Satellite Service |
| NF | Noise Figure |
| PRI | Pulse Repetition Interval |
| R&TTE | Radio and Telecommunications Terminal Equipment |
| SRD | Short Range Device |
| TH | ThresHold |
| TP | Total Power |
| TP-UE | Total Power of Undesired (UWB) Emissions |
| TR | Technical Report |
| TRP | Total Radiated Power |
| TS | Technical Specification |
| UMTS | Universal Mobile Telecommunication System |

# 4 Technical requirements specifications

## 4.1 Environmental conditions

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the supplier. 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. The normal test conditions are defined in clause 5.4.3 of ETSI EN 303 883 [1].

## 4.2 General

UWB devices in the scope of the present document can operate in a broad permitted range of frequencies from 30 MHz to 10,6 GHz, as defined in table 1 of the present document. The intended range of operation gives the preferred range of operational frequencies for the UWB operation based on the allowed spectrum mask with increased permitted emission levels in the intended range of operation.

In order to clearly identify the required limits and thus measurement procedures it is essential to define the operational bandwidth of the UWB equipment under test. The operating bandwidth of the UWB equipment under test shall be the -10 dBc bandwidth of the intended UWB signal under normal operational conditions as defined in ETSI EN 303 883 [1], clause 5.4.3.

A single UWB device can have more than one operational bandwidth. The basic concept is depicted in Figure 1. Here two separate operational bandwidths are depicted, one with a UWB operational bandwidth in the lower frequency range and one in the upper frequency range. All UWB related emissions shall be measured in the identified operational bandwidth of the UWB device under test. The required mitigation techniques are only valid in the operational bandwidth.

The RX interferer signal handling is focused in the operational bandwidth and some clearly identified frequencies outside the operational bandwidth(s).

The operating bandwidth(s) is/are parts of the permitted range of operation, see table 1.

The test of required mitigation techniques are only relevant inside the operating bandwidth(s).

Receiver interferer signal handling are relevant on the operating bandwidth and at defined frequencies below and above the operating range limits.

TE: Total emission including UWB emission (mean power spectral density) and Other Emissions (OE) (e.g. RX spurious, TX spurious and unwanted emission not belonging to the UWB emissions)

OE shall only be considered in the operational bandwidth if the given UWB mean power limits are not met. In this case OE shall be clearly identified.

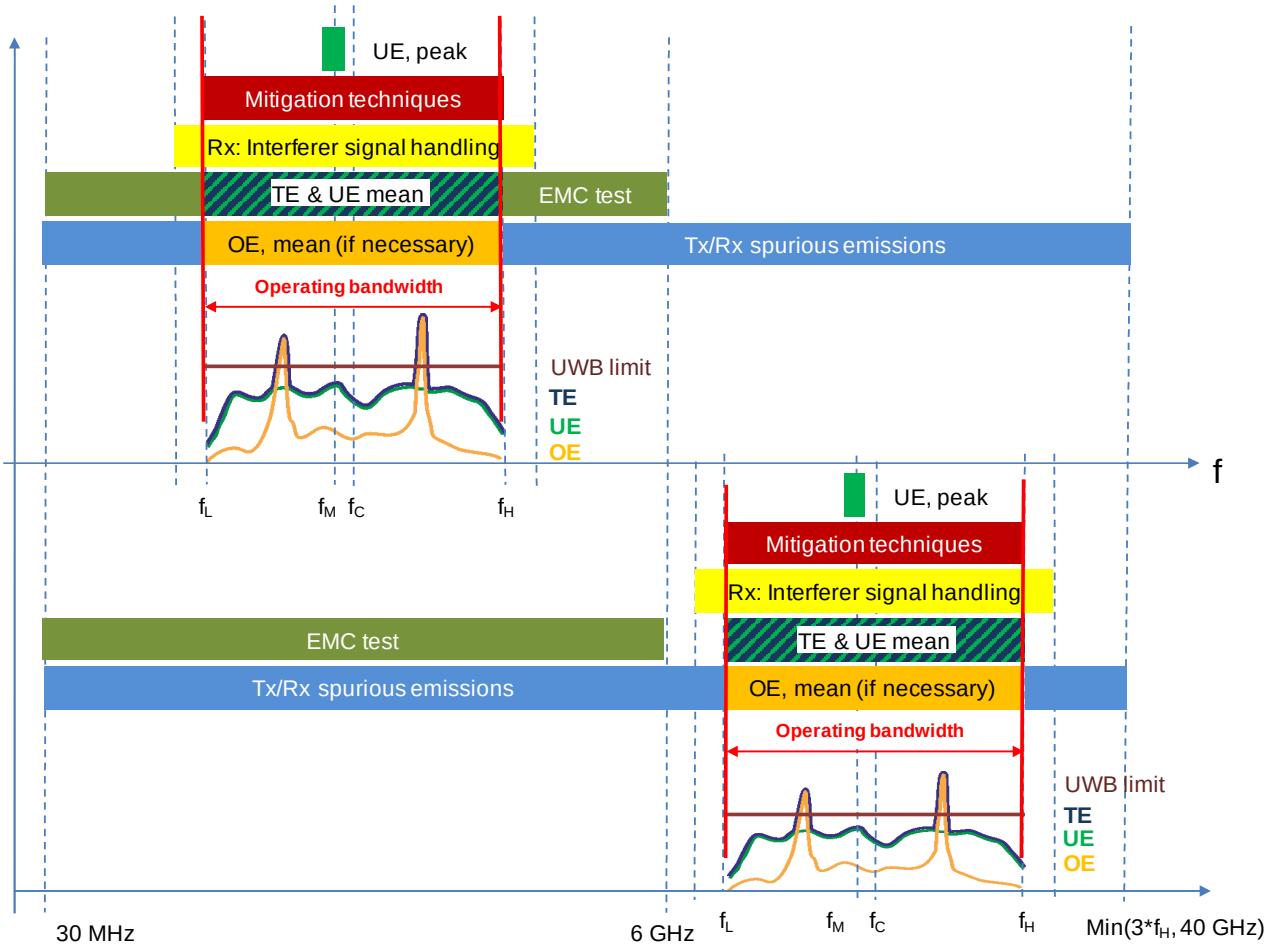



**Figure 1: Concept of operational bandwidth including the relevant UWB related parameter**

# 4.3 Transmitter conformance requirements

## 4.3.1 Operating bandwidth

### 4.3.1.1 Applicability

This requirement shall apply to all equipment under test.

### 4.3.1.2 Description

See Reference to definition in ETSI EN 303 883 [1], clause 7.2.2.

### 4.3.1.3 Limits

The measured results of the operating bandwidth shall be recorded. The operating bandwidth shall be in the permitted range of operation as given in table 1.

The limits of operating bandwidth shall be met under normal test conditions as defined in clause 5.4.3 of ETSI EN 303 883 [1].

### 4.3.1.4 Conformance

The conformance test suite for operating bandwidth shall be as defined in clause 6.5.3.

Conformance shall be established under normal test conditions; see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

## 4.3.2 Maximum value of mean power spectral density

### 4.3.2.1 Applicability

This shall only apply to fixed material sensors.

### 4.3.2.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.3 applies.

### 4.3.2.3 Limits

The mean power limits for fixed material sensors are dependent on the elevation angle, see figure 2.

The maximum mean power spectral density shall not exceed the limits given in table 2.

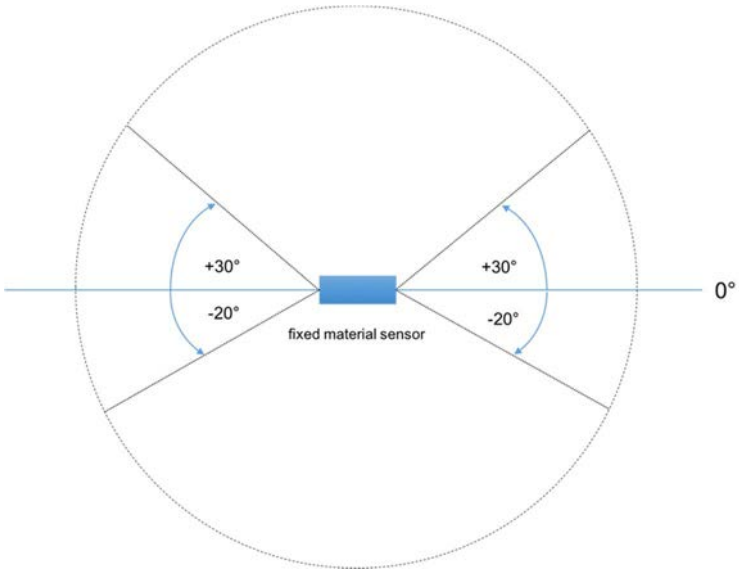



**Figure 2: Definition of elevation angles in Table 2**

**Table 2: Limits for Maximum mean e.i.r.p. spectral density for fixed material sensing devices [i.6]**

| Frequency range [GHz] | Max e.i.r.p (-90° to -20° and 30° to 90° elevation with respect to the horizontal plane) [dBm/MHz] | Max e.i.r.p (-20° to 30° elevation with respect to the horizontal plane) [dBm/MHz] |
|---|---|---|
| f < 1,73 | -85 | |
| 1,73 ≤ f < 2,2 | -65 | -70 |
| 2,2 ≤ f < 2,5 | -50 | |
| 2,5 ≤ f < 2,69 | -65 (see note 1) | -70 |
| 2,69 ≤ f < 2,7 (see note 2) | -55 | -75 |
| 2,7 ≤ f < 2,9 | -50 | -70 |
| 2,9 ≤ f < 3,4 | -50 | -70 |
| 3,4 ≤ f < 3,8 (see note 2) | -50 | -70 |
| 3,8 ≤ f < 4,8 | -50 | |
| 4,8 ≤ f < 5 (see note 2) | -55 | - 75 |
| 5 ≤ f < 5,25 | -50 | |
| 5,25 ≤ f < 5,35 | -50 | - 60 |
| 5,35 ≤ f < 5,6 | -50 | |
| 5,6 ≤ f < 5,65 | -50 | -65 |
| 5,65 ≤ f < 5,725 | -50 | -60 |
| 5,725 ≤ f < 8,5 | -50 | |
| 8,5 ≤ f < 10,6 | -65 | |
| f ≥ 10,6 | -85 | |

NOTE 1: Devices using a Listen Before Talk (LBT) mechanism, as described in the present document are permitted to operate in frequency range 2,5 GHz to 2,69 GHz with a maximum mean e.i.r.p. spectral density of -50 dBm/MHz.
NOTE 2: Limitation of the Duty Cycle to 10 % per second.

#### 4.3.2.4 Conformance

The conformance test suite for maximum value of mean power spectral density shall be as defined in clause 6.5.4.

Conformance shall be established under normal test conditions; see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.3.3 Maximum value of Peak power

#### 4.3.3.1 Applicability

This shall only applicable for fixed material sensors.

#### 4.3.3.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.4 applies.

#### 4.3.3.3 Limits

The peak power limits for fixed material sensors shall be less than the limit that is obtained by adding a conversion factor of 25dB to the mean power limits given in clause 4.3.2.

#### 4.3.3.4 Conformance

The conformance test suite for maximum value of peak power shall be as defined in clause 6.5.5.

Conformance shall be established under normal test conditions; see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

## 4.3.4 Exterior Limits

### 4.3.4.1 Introduction

Exterior limits of the UWB devices covered in the scope of the present document are power limits defined and measured in a specific scenario extracted from the typical usage scenarios. The specific usage scenarios are based on the regulatory considerations and the corresponding mitigation factors taken into account in the coexistence investigations. For the purpose of the definition of limits these mitigation factors have to be modelled in the measurement scenarios and the definition of the limits. In the measurement procedure these scenarios have to be taken into account. The power limits shall be measured around the specified measurement scenarios. Examples for such measurement scenarios are:

- Reference wall for BMA devices including attenuation and absorption characteristics.
- Measurement scenarios for non-fixed sensor applications.

For the purpose of the measurements deployed in the present document the manufacturer shall define the corresponding typical measurement scenario. The defined scenario shall provide at least the equivalent mitigation factors as defined in the relevant regulations as given in annex D. If the typical scenarios for the specific device does not reach these mitigation factors the limits shall be reduced correspondingly.

### 4.3.4.2 Exterior maximum value of mean power spectral density

#### 4.3.4.2.1 Applicability

This requirement shall apply to non-fixed material sensor and building material sensor devices under test.

#### 4.3.4.2.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.3 applies.

#### 4.3.4.2.3 Limits

The exterior maximum mean power spectral density shall not exceed the limits given in table 3.

**Table 3: Limits for exterior maximum mean e.i.r.p. spectral density for non-fixed material sensing devices [i.6]**

| Frequency range [GHz] | | maximum mean e.i.r.p. spectral density for category B equipment [dBm/MHz] |
|---|---|---|
| f < 1,73 | | -85 |
| 1,73≤ f < 2,2 | | -70 |
| 2,2 ≤ f < 2,5 | | -50 |
| 2,5 ≤ f < 2,69 | see note 1 | -65 |
| 2,69 ≤ f < 2,7 | see note 2 | -70 |
| 2,7 ≤ f < 2,9 | | -70 |
| 2,9 ≤ f < 3,4 | see note 1 | -70 |
| 3,4 ≤ f < 3,8 | see note 2 | -50 |
| 3,8 ≤ f < 4,8 | | -50 |
| 4,8 ≤ f < 5 | see note 2 | -55 |
| 5 ≤ f < 5,25 | | -50 |
| 5,25 ≤ f < 5,35 | | -60 |
| 5,35 ≤ f < 5,6 | | -50 |
| 5,6 ≤ f < 5,65 | | -65 |
| 5,65 ≤ f < 5,725 | | -60 |
| 5,725 ≤ f < 8,5 | | -50 |
| 8,5 ≤ f < 10,6 | | -65 |
| f ≥ 10,6 | | -85 |

NOTE 1: Devices using a Listen Before Talk (LBT) mechanism, as described in the present document, are permitted to operate in frequency ranges 2,5 GHz to 2,69 GHz and 2,9 GHz to 3,4 GHz with a maximum mean e.i.r.p. spectral density of -50 dBm/MHz.
NOTE 2: Limitation of the Duty Cycle to 10 % per second.

**Table 4: Limits for exterior maximum mean e.i.r.p. spectral density for building material sensors [i.6]**

| Frequency range (GHz) | Limit values of undesired emissions (dBm/MHz) - without LBT | Limit values of undesired emissions (dBm/MHz) - with LBT |
|---|---|---|
| f < 1,215 | -85 | -85 |
| 1,215 ≤ f < 1,73 | -85 | -70 |
| 1,73 ≤ f < 2,2 | -65 | -65 |
| 2,2 ≤ f < 2,5 | -50 | -50 |
| 2,5 ≤ f < 2,69 | -65 | -50 |
| 2,69 ≤ f < 2,7 | -55 | -55 |
| 2,7 ≤ f < 3,4 | -70 | -50 |
| 3,4 ≤ f < 4,8 | -50 | -50 |
| 4,8 ≤ f < 5,0 | -55 | -55 |
| 5,0 ≤ f < 8,5 | -50 | -50 |
| 8,5 ≤ f < 10,6 | -85 | -85 |
| f ≥ 10,6 | -85 | -85 |

#### 4.3.4.2.4 Conformance

The conformance test suite for maximum value of mean power spectral density shall be as defined in clause 6.5.6.2.

Conformance shall be established under normal test conditions; see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.3.4.3 Exterior maximum value of peak power

#### 4.3.4.3.1 Applicability

This requirement shall apply to non-fixed sensor and building material sensor devices under test.

#### 4.3.4.3.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.4 applies.

#### 4.3.4.3.3 Limits

The exterior maximum peak e.i.r.p. (in dBm) measured in a bandwidth of 50 MHz shall be less than a limit that is obtained by adding a conversion factor (in dB) to the 'maximum mean e.i.r.p. spectral density' (in dBm/MHz) limit given in table 3 and table 4 of the present document. The conversion factor for non-fixed sensing devices using UWB technology is 25 dB. In case of building material analyses devices, this conversion factor is 40 dB.

#### 4.3.4.3.4 Conformance

The conformance test suite for maximum value of mean power spectral density shall be as defined in clause 6.5.6.3.

Conformance shall be established under normal test conditions, see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.3.4.4 Exterior Other Emissions (OE)

#### 4.3.4.4.1 Applicability

This requirement shall apply to non-fixed and building material sensor devices under test in the operating bandwidth.

#### 4.3.4.4.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.5 applies.

#### 4.3.4.4.3 Limits

The equivalent isotropically radiated power of any of these exterior other emissions (OE) shall not exceed the values given in table 5.

**Table 5: Exterior Other Emission (OE) limits (radiated) [i.3]**

| Frequency range | Limit values for OE |
|---|---|
| 47 MHz to 74 MHz | -54 dBm/100 kHz |
| 87,5 MHz to 118 MHz | -54 dBm/100 kHz |
| 174 MHz to 230 MHz | -54 dBm/100 kHz |
| 470 MHz to 862 MHz | -54 dBm/100 kHz |
| otherwise in band 30 MHz to 1 000 MHz | -36 dBm/100 kHz |
| 1 000 MHz to 40 000 MHz (see note) | -30 dBm/1 MHz |
| NOTE: Not applicable for UE emissions within the operating bandwidth of the equipment as defined in clause 4.3.1. | |

#### 4.3.4.4.4 Conformance

The conformance tests for Exterior Other Emissions (OE) shall be as defined in clauses 6.5.2 and 6.5.4.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.3.4.5 Exterior Total Power

#### 4.3.4.5.1 Applicability

This requirement shall apply to non-fixed sensor and building material sensor devices under test.

#### 4.3.4.5.2 Description

The Total Power spectral density of undesired UWB emissions (UE-TP) is the integration of the time-averaged power density S of the UWB mean power spectral density (UE) from clause 4.3.2 (fixed material sensors) or clause 4.3.4.2 (building material sensors or non fixed material sensors) across the entire spherical surface enclosing the UWB sensor under test (DUT).

Measuring the field strength of the electric field, the average power flux density is given by:

$$PSD = \frac{\left|E_{rms}\right|^2}{Z_{F0}} \tag{1}$$

where $Z_{F0} = 120\pi\Omega$ represents the wave impedance of free space.

The RMS value of the field strength can be obtained using:

$$E_{rms} = \frac{|E|}{\sqrt{2}} \tag{2}$$

where $|E|$ is the amplitude of the electric field.

Using a spectrum analyser, the power flux is given by:

$$S = \frac{P_r}{A_r} \tag{3}$$

where $P_r$ is the power at the connector of the receiving antenna and $A_r$ is the effective area of the receiving antenna.

The Total Power is then given by:

$$TP = \int_{\Theta=0}^{\pi} \int_{\Phi=0}^{2\pi} S \times r^2 \times \sin(\Theta) d\Theta d\Phi \tag{4}$$

where r is the radius of the sphere, $\Theta$ is the elevation angle, and $\Phi$ is the azimuth angle.

#### 4.3.4.5.3 Limits

The limits of the total power spectral density (UE-TP) shall not exceed the limits in table 6.

**Table 6: Limits of Total Power spectral density (UE-TP) [i.6]**

| Frequency range (GHz) | Limit values (dBm/MHz) - without LBT | Limit values(dBm/MHz) - with LBT |
|---|---|---|
| f < 1,215 (see notes 1 and 2) | -90 | -90 |
| 1,215 ≤ f < 1,73 (see notes 1 and 2) | -90 | -75 |
| 1,73 ≤ f < 2,2 (see notes 1 and 2) | -70 | -70 |
| 2,2 ≤ f < 2,5 | -55 | -55 |
| 2,5 ≤ f < 2,69 (see notes 1 and 2) | -70 | -55 |
| 2,69 ≤ f < 2,7 | -65 | -65 |
| 2,7 ≤ f < 3,4 (see notes 1 and 2) | -75 | -55 |
| 3,4 ≤ f < 4,8 | -55 | -55 |
| 4,8 ≤ f < 5,0 | -65 | -65 |
| 5,0 ≤ f < 8,5 | -55 | -55 |
| f ≥ 8,5 (see notes 1 and 2) | -90 | -90 |
| NOTE 1: If during the emission measurement (TE and OE measurement) it was not possible to identify clearly the UWB Emissions (UE) limits at one frequency because of the presence of a stronger non-UWB signal component or of the noise floor of the measurement setup (see table 4, note 2), a UE-TP limit for this frequency cannot be specified. At this frequency the UE-TP limits shall be considered as complied.<br>NOTE 2: If UE limits can only be identified and measured clearly at some parts of the measurement sphere then the UE-TP limit shall be calculated only in the sphere's parts where it was possible to identify the UE limits. | | |

#### 4.3.4.5.4 Conformance

The conformance test suite for the receiver spurious emissions shall be as defined in clause 6.5.6.5.

Conformance shall be established under normal test conditions; see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

## 4.3.5 Total Power

This requirement does not apply to any DUT, see Exterior Limit clause 4.3.4.5.

## 4.3.6 Other Emissions (OE)

### 4.3.6.1 Applicability

This requirement shall apply to fixed material sensor devices under test in the operating bandwidth.

### 4.3.6.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.5 applies.

### 4.3.6.3 Limits

The equivalent isotropically radiated power of any of these other emissions (OE) shall not exceed the values given in table 5.

### 4.3.6.4 Conformance

The conformance tests for Other Emissions (OE) shall be as defined in clause 6.5.2 and 6.5.4 of the present document.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.3.7 Transmitter unwanted emissions

This requirement does not apply to any device covered by the present document, see other emission clause 4.3.6 and exterior other emissions clause 4.3.4.4.

## 4.4 Receiver Conformance requirements

### 4.4.1 Receiver requirements

Detailed description for related UWB receiver requirements, see ETSI TS 103 361 [2].

### 4.4.2 Receiver spurious emissions

#### 4.4.2.1 Applicability

This requirement shall apply to all devices under test with a receive only mode without a simultaneously operational transmitter.

#### 4.4.2.2 Description

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

#### 4.4.2.3 Limits

The narrowband spurious emissions of the receiver shall not exceed the values in table 7 in the indicated bands (see CEPT/ERC/REC 74-01 [i.3]).

**Table 7: Narrowband spurious emission limits for receivers [i.3]**

| Frequency range | Limit |
|---|---|
| 30 MHz to 1 GHz | -57 dBm (e.r.p.) |
| above 1 GHz to 40 GHz | -47 dBm (e.i.r.p.) |

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage.

Wideband spurious emissions shall not exceed the values given in table 8.

**Table 8: Wideband spurious emission limits for receivers [i.3]**

| Frequency range | Limit |
|---|---|
| 30 MHz to 1 GHz | -47 dBm/MHz (e.r.p.) |

#### 4.4.2.4 Conformance

The conformance test suite for receiver spurious emissions shall be as defined in clause 6.6.1.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.4.3 Receiver Interferer signal handling

#### 4.4.3.1 Applicability

This requirement shall apply to all devices under test.

#### 4.4.3.2 Description

Interferer signal handling, defined as the capability of the device to operate as intended in coexistence with interferers, is the receiver parameter for UWB applications.

Operation as intended is evaluated using a performance criterion. For common applications, recommended performance criteria and test cases are defined in clause 9.4 of ETSI TS 103 361 [2]. For other applications the manufacturer shall choose an appropriate performance criterion according to clause 9.2.1 of ETSI TS 103 361 [2]. The performance criterion shall be stated in the user manual, see clause 9.2.2 of ETSI TS 103 361 [2].

#### 4.4.3.3 Limits

The limits are met, if the requirements in clause 9 of ETSI TS 103 361 [2] are met.

#### 4.4.3.4 Conformance

The conformance tests for Interferer Signal Handling shall be as defined in clause 6.6.2.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

## 4.5 Requirements for spectrum access

### 4.5.1 Detect and Avoid (DAA)

This requirement does not apply to any device covered by the present document.

### 4.5.2 Listen-before-talk (LBT)

#### 4.5.2.1 Applicability

This requirement shall apply to all devices under test intended to deploy LBT methods, see table 4 and see note 1 in table 2 and table 3.

#### 4.5.2.2 Description

Listen before talk is a mechanism to protect other operating services from interference in the same band.

The LBT function identifies the presence of signals within the band of operation and only allows activation of the sensing devices when no signals are detected. For non-fixed sensors and building material sensors the measurements are performed in the measurement scenarios defined in clause 4.3.4. For the fixed material sensors no scenario is deployed. In the related example figures 7 to 9 in clause 6.7.2, the measurements are depicted in a scenario for a building material sensor.

Figure 3 depicts the basic operation of LBT for non fixed and building material sensors. Figure 4 depicts the operation for fixed material sensors.

The receiver of the equipment deploying LBT methods shall monitor the frequency band with regard to the limits give in clause 4.5.2.3.

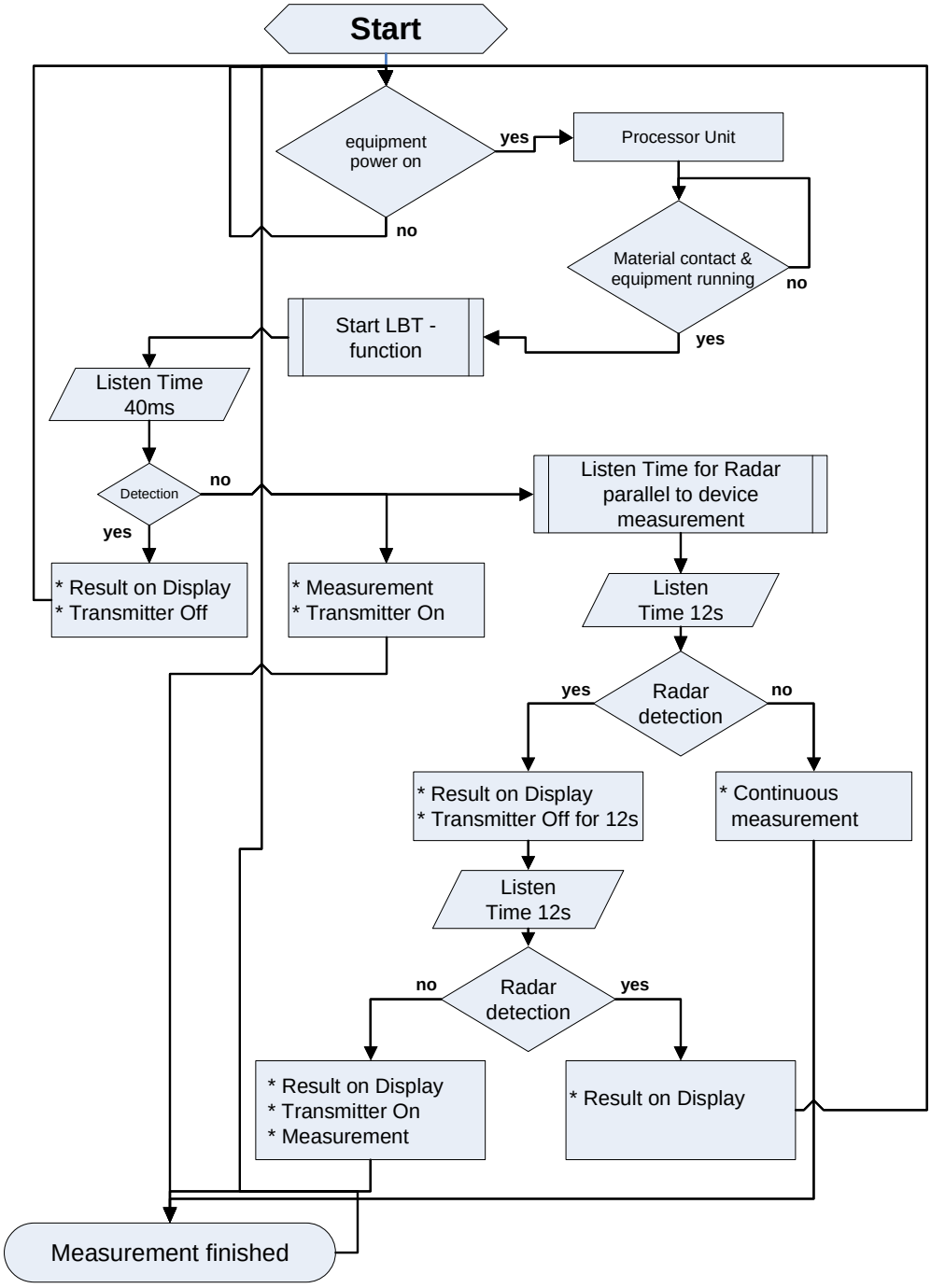



**Figure 3: Flow diagram of LBT mechanism for non fixed material and building material sensors**

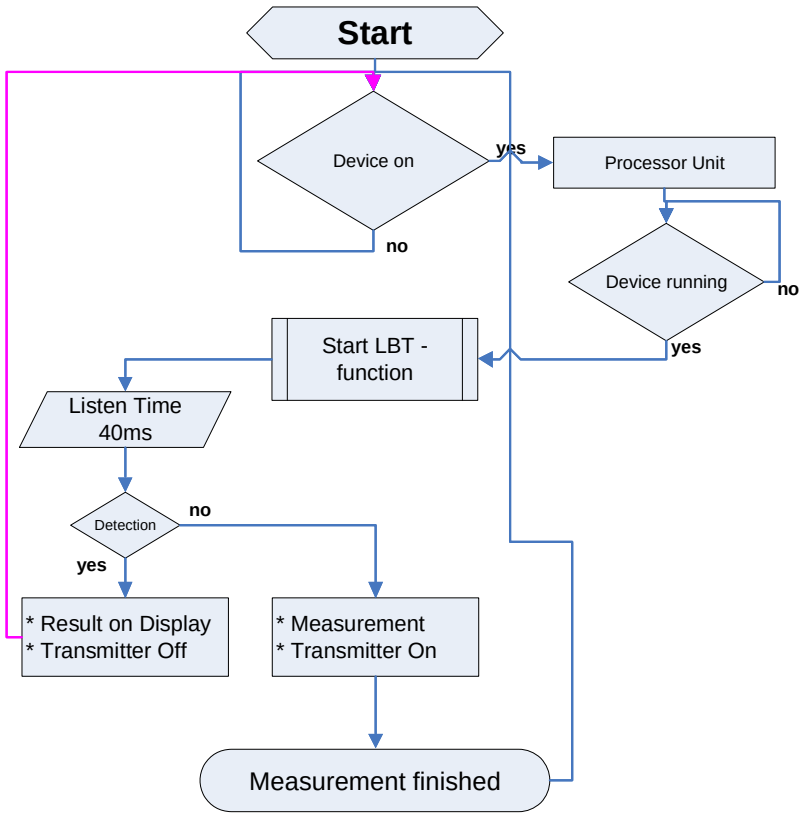



**Figure 4: Flow diagram of LBT mechanism for fixed material sensors**

### 4.5.2.3 Limits

The LBT mechanism of the UWB receiver shall meet the minimum threshold values of table 9. In case the UWB equipment covers only part of the frequency range of table 9, the LBT function shall only be implemented for the actually operational range of the UWB devices as specified in clause 4.3.2.

A "Listen Before Talk" (LBT) mechanism is mandatory with threshold levels at the input of the UWB receiver as defined within table 9. The limits given in table 9 shall be defined and measured in the measurement scenarios defined in clause 4.3.4.

**Table 9: LBT threshold limits [i.6]**

| Frequency range | Threshold value (dBm) | Reaction time |
|---|---|---|
| Radar L-Band<br>1,215 GHz to 1,35 GHz | +8 | Continuous listening of 12 s is required and automatic switch-off feasible each 10 ms if the threshold value is exceeded. In the case of detecting and switching off the transmitter, a silent time of at least 12 seconds while listening continuously is necessary. |
| MSS<br>1,55 GHz to 1,66 GHz | -43 | Minimum continuous listening time of 40 ms before initial transmission of the device. |
| UMTS<br>2,5 GHz to 2,69 GHz | -44<br>-50 | Minimum continuous listening time of 40 ms before initial transmission of the device.<br>Remark:<br>-44 dBm: for receiver BW ≤ 3,84 MHz<br>-50 dBm: for receiver BW > 3,84 MHz |
| Radar S-Band<br>2,7 GHz to 3,4 GHz | -7 | Continuous listening of 12 seconds is required and automatic switch-off feasible each 10 ms if the threshold value is exceeded. In the case of detecting and switching off the transmitter, a silent time of at least 12 seconds while listening continuously is necessary. |
| NOTE 1: If the UE in the respective band are lower than the limit as defined in table 3, the threshold value can be decreased by the difference.<br>NOTE 2: If the transmitter of the material sensor device is only active in one or more parts of the frequency range of the external service, the LBT receiver of the material sensor device has to be sensitive only in these parts. In this case the test signal frequency has to be adjusted accordingly. | | |

#### 4.5.2.4 Conformance

The conformance test suite for Listen before talk shall be as defined in clause 6.7.2.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

### 4.5.3 Low Duty Cycle (LDC)

#### 4.5.3.1 Applicability

This requirement applies to fixed material sensor and non-fixed material sensor devices under test that implement the LDC mitigation technique as defined in table 2 and table 3.

#### 4.5.3.2 Description

The description in ETSI EN 303 883 [1], clause 7.2.9 applies.

#### 4.5.3.3 Limits

The duty cycle for LDC shall not exceed 10 %.

An LDC trade off, power versus time, shall be seen as equivalent mitigation [i.5] as detailed in annex C.

#### 4.5.3.4 Conformance

The conformance test suite for Low Duty Cycle shall be as defined in clause 6.7.3.

Conformance shall be established under normal test conditions see clause 4.1.

The interpretation of the results for the measurements uncertainty shall be as given in clause 5.3.

## 4.6 Antenna Requirements

This requirement does not apply to any device covered by the present document.

## 4.7 Other Requirements and Mitigation techniques

These requirements do not apply to any device covered by the present document.

# 5 Testing for compliance with technical requirements

## 5.1 Environmental conditions for testing

Tests defined in the present document shall be carried out at one or more representative point(s) within the boundary limits of the declared operational environmental profile.

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

## 5.2 General conditions for testing

### 5.2.1 Product information

The requirements for the product information shall be as given in ETSI EN 303 883 [1], clause 5.2.

An application form for the DUT testing is provided in annex B.

### 5.2.2 Requirements for the test modulation

The requirements for the test modulation shall be as given in ETSI EN 303 883 [1], clause 5.3.

### 5.2.3 Test conditions, power supply and ambient temperatures

The test conditions, power supply and ambient temperatures shall be as given in ETSI EN 303 883 [1], clause 5.4.

### 5.2.4 Choice of equipment for test suites

The choice of the equipment for the test suites shall be as given in ETSI EN 303 883 [1], clause 5.5.

### 5.2.5 Multiple Operating bandwidths and multiband equipment

Where equipment has more than one operating bandwidth (e.g. 500 MHz and 1 300 MHz), a minimum of two operating bandwidths shall be chosen such that the lower and higher limits of the operating range(s) of the equipment are covered (see clause 4.2). All operating bandwidths of the equipment shall be declared by the equipment manufacturer.

In case of multiband equipment (i.e. equipment that can operate with an operating bandwidth below 4,8 GHz and above 6,0 GHz), the lowest and highest channel in operation of each band shall be tested.

### 5.2.6 Testing of host connected equipment and plug-in radio devices

Testing of host connected equipment and plug-in radio devices measurements shall be as given in ETSI EN 303 883 [1], clause 5.6.

## 5.3 Interpretation of the measurement results

### 5.3.0 General

Interpretation of the measurement results shall be as given in ETSI EN 303 883 [1], clause 5.7.

### 5.3.1 Measurement uncertainty is equal to or less than maximum acceptable uncertainty

If measurement uncertainty is equal to or less than maximum acceptable uncertainty the interpretation shall be as given in ETSI EN 303 883 [1], clause 5.7.2.

### 5.3.2 Measurement uncertainty is greater than maximum acceptable uncertainty

If measurement uncertainty is greater than maximum acceptable uncertainty the interpretation shall be as given in ETSI EN 303 883 [1], clause 5.7.3.

### 5.3.3 Emissions

The provisions of ETSI EN 303 883 [1], clause 5.8 shall apply.

# 6 Conformance methods of measurement

## 6.1 Introduction

In this clause the general setup of a test bed for the test of UWB equipment will be described.

A detailed introduction shall be considered as in ETSI EN 303 883 [1], clause 6.1.

## 6.2 Initial Measurement steps

In initial measurement steps shall be done as described in ETSI EN 303 883 [1], clause 6.2.

# 6.3 Radiated measurements

## 6.3.1 General

The provisions of ETSI EN 303 883 [1], clause 6.3.1 shall apply.

## 6.3.2 Test sites and general arrangements for measurements involving the use of radiated fields

The provisions of ETSI EN 303 883 [1], clause 6.3.2 shall apply.

## 6.3.3 Guidance on the use of a radiation test site

### 6.3.3.1 General

The provisions of ETSI EN 303 883 [1], clause 6.3.3 shall apply.

### 6.3.3.2 Range length

The provisions of ETSI EN 303 883 [1], clause 6.3.3.5 shall apply.

## 6.3.4 Coupling of signals

The provisions of ETSI EN 303 883 [1], clause 6.3.4 shall apply.

## 6.3.5 Standard test methods

### 6.3.5.1 Generic measurement method

#### 6.3.5.1.1 Calibrated setup

The provisions of ETSI EN 303 883 [1], clause 6.3.5.2 shall apply.

#### 6.3.5.1.2 Substitution method

The provisions of ETSI EN 303 883 [1], clause 6.3.5.3 shall apply.

## 6.3.6 Standard calibration method

The provisions of ETSI EN 303 883 [1], clause 6.3.6 shall apply.

# 6.4 Conducted measurements

Not applicable.

# 6.5 Conformance methods of measurement for transmitter

## 6.5.1 General

First the complete signal device shall be measured for:

- Operating bandwidth.
- Maximum mean power spectral density (e.i.r.p.) for fixed material sensors.
- Maximum peak power (e.i.r.p.) for fixed material sensors.
- Exterior-Limits: Maximum value of mean power spectral density, not for fixed material sensors.
- Exterior-Limits: Maximum value of peak power, not for fixed material sensors.
- Exterior-Limits: Other emissions (OE), not for fixed material sensors, and if necessary.

- Exterior-Limits: Total Power spectral density, not for fixed material sensors.
- Other emissions (OE) for fixed material sensors, and if necessary.
- Receiver spurious emissions.
- Receiver interferer signal handling.
- Low duty cycle (LDC), when applicable.
- Listen-before-talk parameters, when applicable.

The following methods of measurement shall apply to the testing of stand-alone units and to the equipment configurations identified in clause 5.2.6.

## 6.5.2 Method of measurements of the Ultra Wideband Emissions

Method of measurements of the Ultra Wideband Emissions shall be as given in ETSI EN 303 883 [1], clause 7.3.

## 6.5.3 Operating bandwidth

Method of measurements of the operating bandwidth shall be as given in ETSI EN 303 883 [1], clause 7.4.2. The measurement shall be performed in the measurement scenario as defined in clause 4.3.3 (Exterior limits).

The operating bandwidth shall be measured using the setup shown in figure 5 in the direction of the recorded maximum means spectral density. For the evaluation of the operational bandwidth the results of the mean spectral density measurements given in clause 6.5.6.2. can be reused.

In the case of fixed material sensors no absorbing material shall be included in the setup.

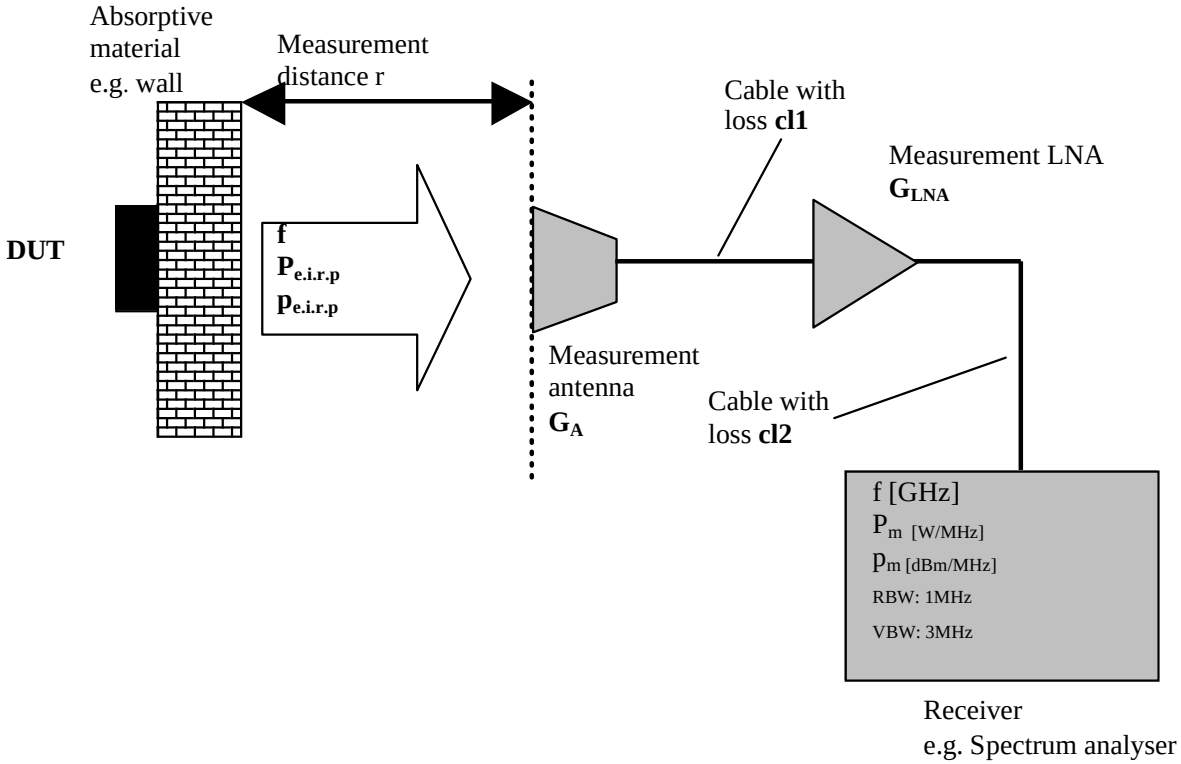



**Figure 5: Test set-up for measuring the operating frequency range**

The $P_{e.i.r.p.}$ is the power density referenced to the surface of the absorbing material taking the frequency dependent, free space attenuation and the measurement equipment into account. For fixed installed sensors the $P_{e.i.r.p.}$ the power density reference is at the position of the sensor itself.

A test site such as one selected from ETSI EN 303 883 [1] (i.e. indoor test site or open area test site), which fulfils the requirements of the specified frequency range and undisturbed lowest specified emission levels of this measurement shall be used.

Operating bandwidth measurements shall be performed as given in ETSI EN 303 883 [1], clause 7.4.2.

The results for $f_L$, $f_H$, $f_M$, OBW, and $f_C$ shall be reported in the test report.

## 6.5.4 Mean power spectral density measurements

Mean power spectral density measurements shall be as given in ETSI EN 303 883 [1], clause 7.4.3.

To classify the Ultra wide band part (clauses 4.3.2 and 4.3.4.2) and the other emissions (clause 4.3.4.4) of the radiated emission the initial measurement steps given in ETSI EN 303 883 [1], clause 7.3.2 shall be used.

The measurement method used and the maximum observed value for the mean power spectral density shall be recorded in the test report.

## 6.5.5 Peak power spectral density measurements

Peak power measurements shall be as given in ETSI EN 303 883 [1], clause 7.4.4.

To classify the Ultra wide band part (clauses 4.3.3 and 4.3.4.3) and the other emissions (clause 4.3.4.4) of the radiated emission the initial measurement steps given in ETSI EN 303 883 [1], clause 7.3.2 shall be used.

The measurement method used and the maximum value for the peak power shall be recorded in the test report.

## 6.5.6 Exterior limit measurement

### 6.5.6.1 General

The power measurements of non-fixed sensors and building material sensors in the scope of the present document shall be performed in a measurement scenario representing the typical defined use case of the devices under test as radiated measurements. The deployed measurement scenarios shall be defined by the device manufacturer in accordance with the typical use case of the device.

Some typical measurement scenarios are given in annex C.

### 6.5.6.2 Exterior Mean power spectral density measurements

All emission measurements shall be performed on a complete sphere around the sensor device including the measurement scenario as given in figure 6.

During the measurement, the DUT shall be placed on the absorbing structure or material for all non-fixed sensors with its antenna pointing directly into the structure and the test antenna is placed in the range of 0,8 m to 1,5 m (quasi farfield distance of used measurement antenna is relevant) away from the device under test, see figure 6.

The polarization of the measurement antenna shall meet the polarization of the main field component at each measurement point. Therefore, the measurement antenna can be rotated at each point until the highest value is obtained. Another possible method is to use a measurement antenna with two orthogonal polarization directions.

The relevant measurement value is the maximum value over the sphere and over all polarization angles. The maximum spatial resolution of the measurements shall be equal or less than 15° in vertical and horizontal direction.

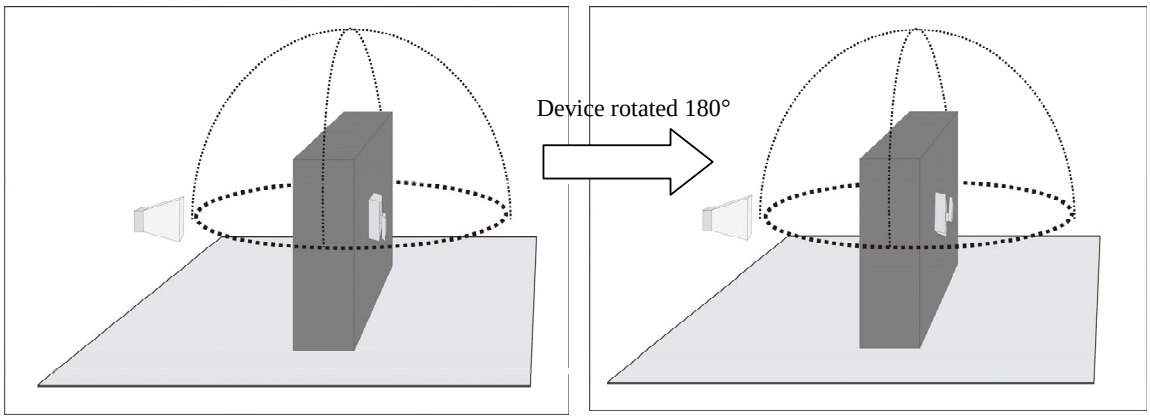



**Figure 6: Measurement arrangement for all emission measurements in clauses 6.5.6.3, 6.5.6.4, 6.5.6.5 and 6.6.1**

The measuring receiver configuration uses a low noise preamplifier and a dipole antenna (for frequencies below 1 GHz) or horn antenna (for frequencies above 1 GHz). For the spurious emission measurements, outside the permitted range of frequencies, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodic") could also be used to cover the entire 30 MHz to 1 000 MHz band. The test set-up is the same as used for the operational bandwidth in clause 6.5.3 as shown in figure 3.

Mean power spectral density measurements shall be as given in ETSI EN 303 883 [1], clause 7.4.3.

The measurement method used and the maximum observed value for the mean power spectral density shall be recorded in the test report. The highest measured value including the direction of this value shall be recorded.

#### 6.5.6.3 Exterior Peak power spectral density measurements

The measurement scenario set-up deployed for the peak power spectral density measurement shall be the same as given in clause 6.5.6.2. The peak power spectral density shall be measured in the direction of the maximum mean power spectral density as recorded in clause 6.5.6.2.

Peak power measurements shall be as given in ETSI EN 303 883 [1], clause 7.4.4.

The measurement method used and the maximum value for the peak power shall be recorded in the test report.

#### 6.5.6.4 Exterior Other emissions

Exterior other emissions measurements shall be as given in ETSI EN 303 883 [1], clause 7.3.2.

#### 6.5.6.5 Exterior Total Power spectral density (UE-TP)

The measurement procedure is identical to clause 6.5.6.2.

### 6.5.7 Total Power spectral density (UE-TP)

Not applicable, covered under exterior limits clause 6.5.6.

### 6.5.8 Other emissions (OE)

Other emissions measurements shall be as given in ETSI EN 303 883 [1], clause 7.3.2.

## 6.6 Conformance methods of measurement for receiver

### 6.6.1 Receiver spurious emissions

Receiver spurious emissions measurements shall be as given in ETSI EN 303 883 [1], clause 7.4.5.

### 6.6.2 Interferer signal handling

Interferer signal handling measurements shall be as given in ETSI TS 103 361 [2], clause 9.

The interferer test frequency range, interferer frequencies and interferer power levels, test scenario, performance criterion and level of performance shall be recorded in the test report.

## 6.7 Conformance test suites for spectrum access

### 6.7.1 Detect and Avoid Mechanisms

Not applicable.

### 6.7.2 Listen Before Talk

#### 6.7.2.1 Measurement procedure

A test transmitter simulating the victim (e.g. UMTS) shall transmit a calibrated signal of the threshold levels of clause 4.5.2.3 towards the material sensor DUT receiver.

With the equipment operated in a continuous mode, the individual frequency ranges and levels according to clause 4.5.2.3 shall be applied to the DUT.

For each frequency range from the direction of the maximum mean power conform to clauses 4.3.2 and 4.3.4.2 the DUT shall be tested for the deactivation threshold to stop UWB emissions at the defined threshold levels as defined in clause 4.5.2.3.

#### 6.7.2.2 Test set-up

Figure 7 shows the test set-up for the LBT measurements for a building material sensor.

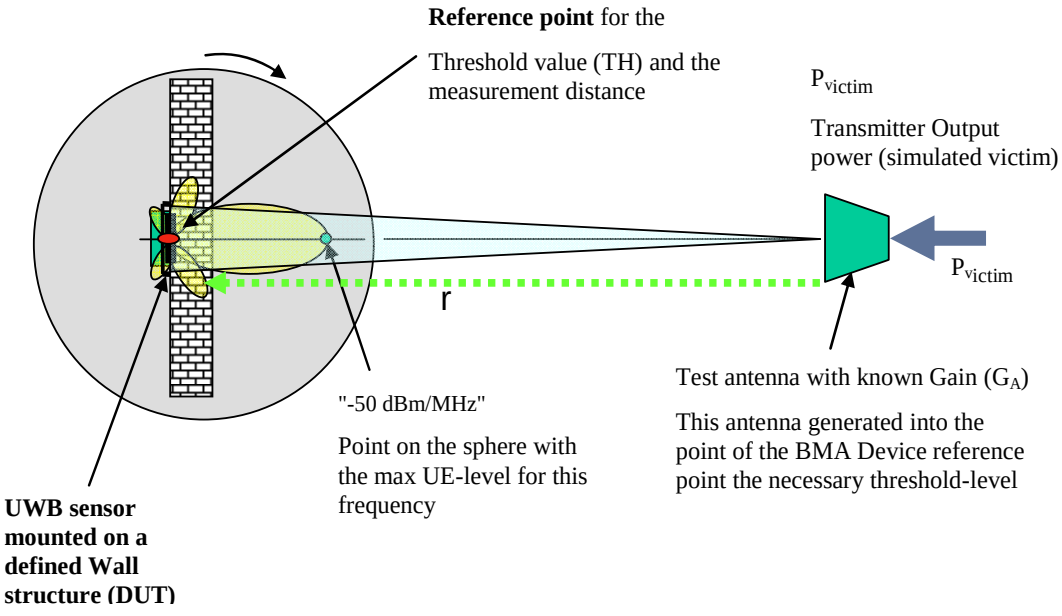



**Figure 7: Test set-up for LBT function, example: Building Material sensor**

Power Flux Density at the building material sensor (W/m2):

Equation 5 (Values linear):

$$TH = \frac{P_{victim} \cdot G_{A(f)}}{4 \cdot r^2 \cdot \pi} \quad \text{(mW/(m2 MHz))} \tag{5}$$

Power Flux Spectral Density at the building material sensor (dBm/m$^2$):

Equation 6 (Values (dB)):

$$g_A = 10 \cdot \log\left(G_A\right) \tag{6}$$

$$p_{victim} = 10 \cdot \log\left(P_{victim}\right) \tag{7}$$

$$th = p_{victim} + g_A - 10 \cdot \log\left(4 \cdot \pi \cdot r^2\right) \tag{8}$$

Verification procedure for the LBT threshold levels:

Figure 8 and figure 9 explain the two possible calculation principles for the threshold levels.

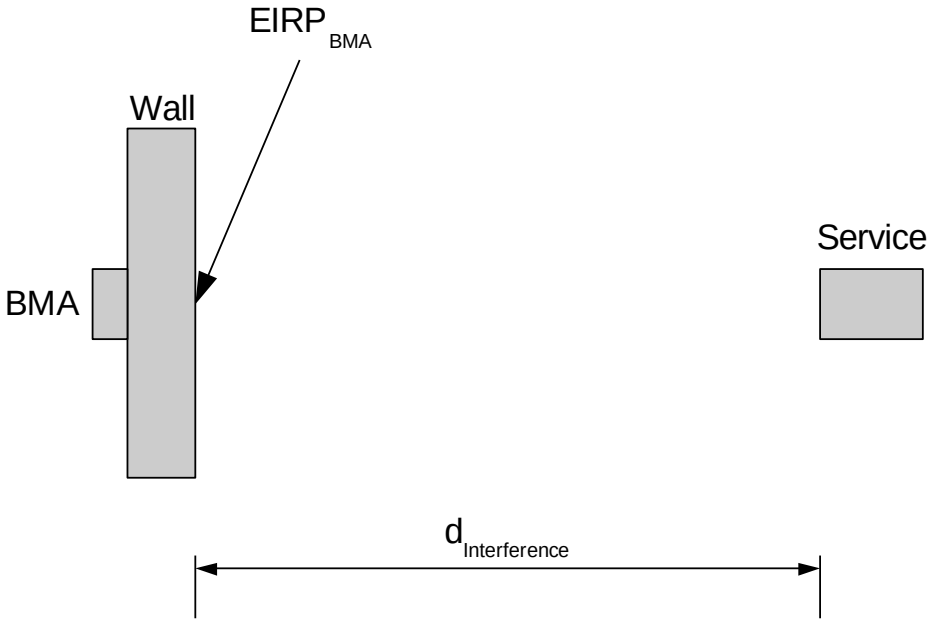



**Figure 8: Calculation principle (1)**

The material sensor device (here: building material sensor, BMA) emits an $EIRP_{BMA}$ through the wall. If a service is located within a distance of $d_{Interference}$, it will be at the threshold of being interfered. This distance can be calculated using:

$$d_{Interference} = 10^{\frac{EIRP_{BMA} - EIRP_{Interference}}{20}} \frac{\lambda}{4\pi} \tag{9}$$

With a service radiating in this distance, the material sensor device shall switch off. The position of the service to the material sensor device is irrelevant for the functionality of the LBT mechanism, as the material sensor antenna is reciprocal regarding receive and transmit. However, within one measurement the position shall be fixed.

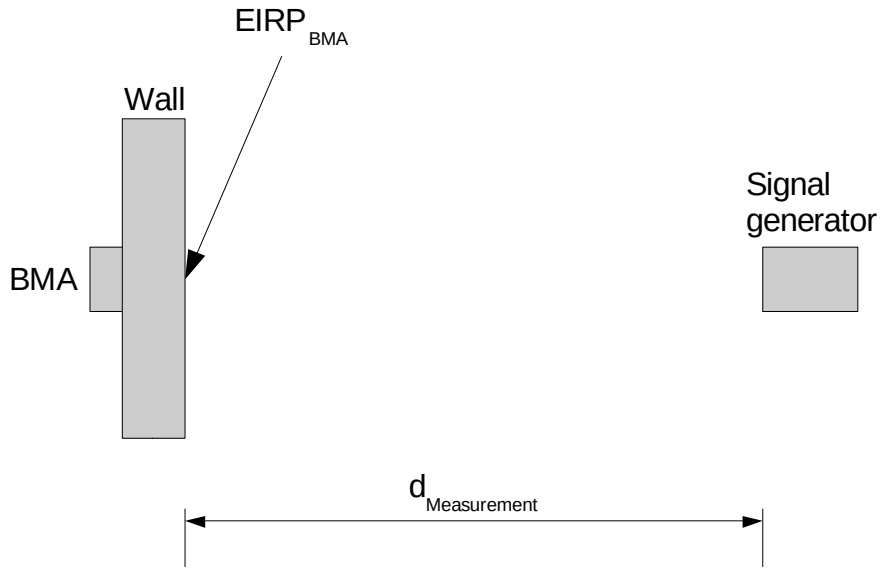



**Figure 9: Calculation principle (2)**

To check the LBT functionality of the material sensor device (here: building material sensor, BMA), a distance of $d_{Interference}$ is not practical. Therefore, a measurement distance of $d_{Measurement}$ = 3 m shall be selected. The output power of the signal generator is attenuated by:

$$a = 20 \log_{10} \left( \frac{d_{Interferen\ ce}}{d_{Measuremen\ t}} \right) \quad (10)$$

### 6.7.2.3 Listen Before Talk (LBT) requirements for radar: threshold levels and reception times to protect Radar services.

For radar services the LBT mechanism has to be as quick as possible to avoid the second suppression of an echo of a target at the second rotation of the antenna dish. Normally, the air traffic control uses 3 consecutive echoes each received during the next consecutive rotation to validate "target" as "true" (the response of a transponder by a secondary radar is not taken into account here). Radar devices emits its PSD with a certain PRF (for example with a PRF of 1 100 Hz and a rotational speed of 0,25 Hz (1 rotation per 4 seconds)). The shortest pulse duration is 1 µs. The radar main beam width is 1,5°. Every 0,9 µs the radar device emits 1 impulse. In this example the material sensor beam (here: building material sensor, BMA) width may be 20° (with a directivity/gain of 5 dB it is approximately 60°). The receiving time frame of the material sensor until the next switch off decision may be repetitive 20 ms. The criteria to switch off the sensor is to receive 5 times the main beam of the radar (5 × 1/PRF). In this example 5 × 1/1 100 ± 5 ms during 1 dish rotation. That means after 4 ms the sensor switches off (display will show a "hit", e.g. "interference signal"). Now a latency time of 12 seconds has to be introduced during which the material sensor device only receives (no transmission, i.e. to cover the window for the slowest rotation rate of radar device). If during this 12 s the main beam is detected again, the display hint will continue. If not, the measurement procedure can start again, because the interferer does not belong to a radar service.

The radar pulse train has to be detected after max. 10 ms. Then the transmitter shall be switched off. After detecting the radar signal a waiting time of > 12 seconds shall be implemented in which the material sensor is only receiving. If a next radar signal is detected the timer (12 seconds) shall be triggered again.

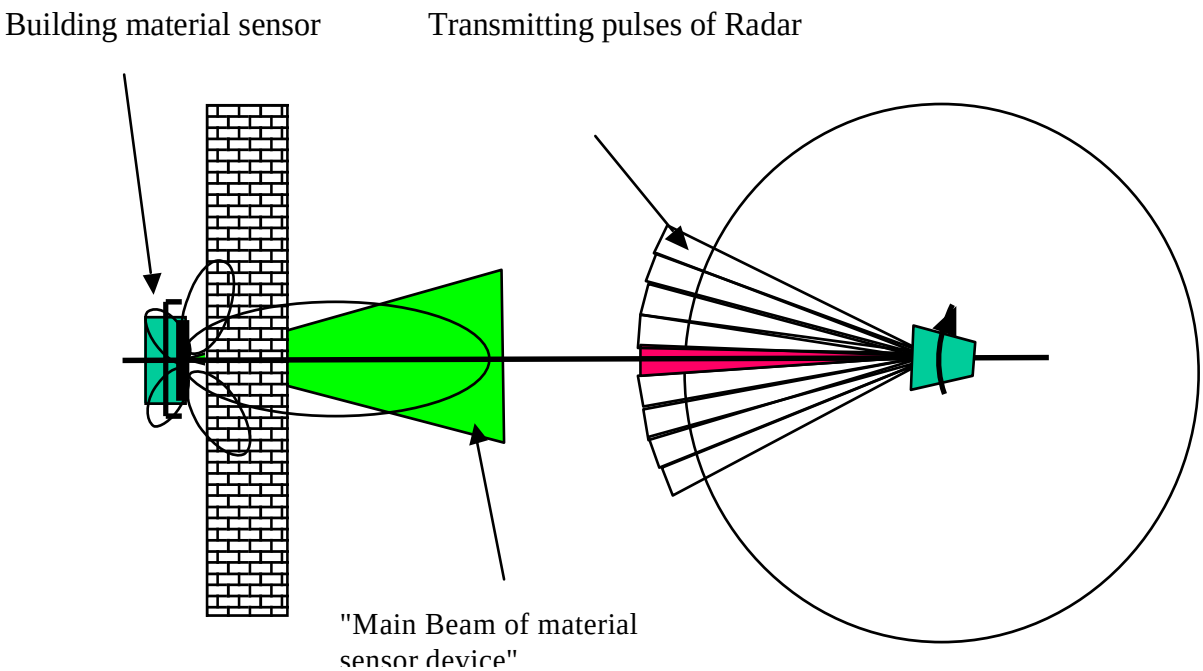



**Figure 10: Material sensor scenario, here: non-fixed and building material sensor**

### 6.7.3 Low Duty Cycle

Low Duty Cycle shall be as given in ETSI EN 303 883 [1], clause 7.4.8.

## 6.8 Conformance test suites for antenna requirements

Not applicable.

## 6.9 Other test suites

Not applicable.

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.11] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table 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 302 065-4**<br>The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.4] | | | | |
|---|---|---|---|---|
| **Requirement** | | | **Requirement Conditionality** | |
| **No** | **Description** | **Reference: Clause No** | **U/C** | **Condition** |
| 1 | Operational bandwidth | 4.3.1 | C | All transmitting devices |
| 2 | Mean power spectral density | 4.3.2 | C | for fixed material sensors |
| 3 | Peak power spectral density | 4.3.3 | C | for fixed material sensors |
| 4 | Exterior Limits: Mean power spectral density | 4.3.4.2 | C | for non-fixed material sensors and building material sensors |
| 5 | Exterior Limits: Peak power spectral density | 4.3.4.3 | C | for non-fixed material sensors and building material sensors |
| 6 | Exterior Limits: Other emissions | 4.3.4.4 | C | for non-fixed material sensors and building material sensors |
| 7 | Exterior Limits: Total Power | 4.3.4.5 | C | for non-fixed material sensors and building material sensors |
| 8 | Other emissions | 4.3.6 | C | for fixed material sensors |
| 9 | Receiver spurious emissions | 4.4.2 | C | for receive only devices under test |
| 10 | Receiver interferer signal handling | 4.4.3 | C | All receiving devices |
| 11 | LBT | 4.5.2 | C | for devices deploying LBT methods |
| 12 | LDC | 4.5.3 | C | for fixed material sensors and non-fixed material sensors |

**Key to columns:**

**Requirement:**

**No** A unique identifier for one row of the table which may be used to identify a requirement or its test specification.

**Description** A textual reference to the requirement.

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

**Requirement Conditionality**:

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

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

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

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

# Annex B (informative): Application form for testing

## B.1 Introduction

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 proforma in this annex so that it can be used for its intended purposes and may further publish the completed application form.

The form contained in this annex may be used by the supplier to comply with the requirement contained in clause 4 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 to be tested, which tests are to be performed as well the test conditions.

This application form should form an integral part of the test report.

## B.2 Product Information for ETSI EN 302 065-4, clause 5.2.1

### B.2.1 Type of Equipment (stand-alone, combined, plug-in radio device, etc.)

☐ 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 .....

### B.2.2 The nominal voltages of the stand-alone radio equipment or the nominal 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 …….. V

☐ DC State DC voltage …….. V

In case of DC, indicate the type of power source

☐ Internal Power Supply

☐ External Power Supply or AC/DC adapter

☐ Battery

☐ Other: .....

# B.3 Signal related Information for ETSI 302 065-4, clause 4.3

## B.3.1 Introduction

In accordance with ETSI EN 302 065-1, clause 4.3, the following information is provided by the supplier.

## B.3.2 Operating bandwidth(s) of the equipment:

- Operating bandwidth 1: ..... MHz to ..... MHz
- Operating bandwidth 2: ..... MHz to ..... MHz

NOTE: Add more lines if more Frequency Ranges are supported.

## B.3.3 The worst case mode for each of the following tests:

NOTE: In this clause specify the Operational mode and not the measured value. E.g. test mode 1…

- Operating bandwidth(s)

  .....

- Mean Power Spectral Density / Peak Power Spectral Density / Other Emissions

  .....

# B.4 RX test Information for ETSI EN 302 065-4, clause 4.4

## B.4.1 Introduction

In accordance with ETSI EN 302 065-1, clause 4.4, the following information is provided by the supplier.

## B.4.2 Performance criterion and level of performance

.....

.....

.....

## B.4.3 Applicable Interferers

| Frequency [MHz] | Power [dBm] | Type of signal (e.g. CW, CW with DC, other modulation) |
|---|---|---|
| | | |
| | | |
| | | |

# B.5 Information on spectrum access by ETSI EN 302 065-4, clause 4.5

## B.5.1 Introduction

In accordance with ETSI EN 302 065-1, clause 4.5, the following information is provided by the supplier.

## B.5.2 Spectrum access

NOTE 1: If there is a specific mode for testing the manufacture have to declare.

NOTE 2: Table with different parameters for different mitigation techniques.

☐ DAA

☐ LDC

a) ☐ Frequency range A

☐ Frequency range B

☐ Frequency range C

b) Ton, max

c) Toff, mean

d) ∑Toff in1s

e) ∑Ton in 1h

f) Tdis

# B.6 Additional information provided by the applicant

## B.6.1 About the DUT

☐ 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:

.....

.....

☐ The equipment submitted is CE marked.

☐ In addition to the CE mark, the Class-II identifier (Alert Sign) is affixed.

## B.6.2 Additional items and/or supporting equipment provided

☐ 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 C (normative): Equivalent mitigation techniques

## C.1 Equivalent mitigation techniques and LDC limits

Different mitigation techniques and mitigation factors can be taken into account for the calculation of the maximum allowed TX power of a UWB radio device as long as they reached mitigation factors are equivalent or higher than the mitigation factors reached using the presented techniques which have been accepted by the CEPT/ECC (e.g. ECC report 120 [i.2]).

EXAMPLE: Deployment of the radio device on a vehicle, which operates only in a restricted indoor area with higher wall attenuation, shielding or the deployment and installation of the UWB system in a controlled manner. The additional mitigation factors need to be weighed against the specific services to be protected and a similar approach has to be taken like e.g. in ECC report 120 [i.2].

The manufacturer shall provide compliance with the transmission emission limits in tables 2, table 3 and table 4 using equivalent mitigation techniques.

NOTE: Regulations in the Commission Decision 2007/131/EC [i.9] and its amendment allow for other equivalent mitigation techniques to be used across all frequency bands, where these offer at least equivalent protection to that provided by the limits in the decision.

Based on CEPT report 45 [i.5] the combinations of LDC limits and the transmitter emission limits as shown in table C.1, may give an equivalent protection as the current baseline LDC limits (see ECC/DEC/(06)04 [i.1], table 6).

## C.2 Test Procedure

The manufacturer shall provide sufficient information for determining compliance with the limits given in table C.1.

## C.3 Limit

The limits for equivalent LDC shall be as given in table C.1. These values are defined in CEPT report 45 [i.5].

**Table C.1: Limits for low duty cycle to have appropriate mitigation**

| mean power spectral density limit (e.i.r.p.) [dBm/MHz] | Maximum transmitter on time % in 1 second | $T_{on}$ max [ms] | $T_{off}$ mean [ms] | $\sum T_{on}$ / 1sec [ms] | min $\sum T_{off}$ / 1sec [ms] | Long term LDC [sec in 1hr] |
|---|---|---|---|---|---|---|
| -41,3 | 5 | 5 | ≥ 38 | < 50 | > 950 | 18 |
| -44,3 | 10 | 10 | ≥ 38 | < 100 | > 900 | 36 |
| -47,3 | 20 | 20 | ≥ 38 | < 200 | > 800 | 72 |
| -50,3 | 40 | 40 | ≥ 38 | < 400 | > 600 | 144 |
| -51,3 | 50 | 50 | ≥ 38 | < 500 | > 500 | 180 |

# Annex D (normative): Definition of the representative absorbing material and procedure for measurement of the undesired emissions

## D.1 Representative absorbing material definition for measuring the undesired emissions and LBT function

Undesired emissions are caused by leaked emissions from the antenna/device, and/or scattered/reflected emissions from the investigated material, and/or transmitted emissions through the investigated material. Therefore, a measurement scenario with a representative absorbing material (e.g. wall) has to be defined within the present document.

## D.2 Representative wall

The representative wall (e.g. for building material sensors) shall meet the attenuation values within table D.1.

**Table D.1: Representative wall attenuation values**

| Frequency (GHz) | Attenuation values for the representative wall in dB | |
|---|---|---|
| | average | maximum |
| 1 | 7,00 | 9,00 |
| 2 | 10,00 | 12,00 |
| 3 | 12,00 | 14,00 |
| 4 | 14,00 | 16,00 |
| 5 | 16,00 | 18,00 |
| 6 | 18,00 | 20,00 |
| 7 | 20,00 | 22,00 |
| 8 | 22,00 | 24,00 |

If the wall attenuation is lower than the average value given in table D.1 the provisions of clause D.3 apply.

For a practical handling the size of an absorbing wall should be about 1 × 1 meter.

## D.3 Other absorbing materials

For other absorbing material the attenuation characteristics as exemplified in table D.1 of the representative absorbing object used in the measurements specified in the present document shall match the characteristics of the typical target absorbing material. Justifications shall be provided in the test report.

If it is impractical to match the absorption characteristics for the representative absorbing object lower attenuation values can be utilized. In this case the exterior limits in clause 4.3.4.2.3, clause 4.3.4.3.3, clause 4.3.4.4.3 and clause 4.3.4.5.3 can be increased by the difference between the actual and modelled attenuation values used in the representative absorbing object. In case of the representative wall the difference to the average value in table D.1 shall be used. Higher attenuation values shall not be permitted.

The physical size of the representative absorbing object should approximate the size of the typical target absorbing material.

# D.4 Procedure for measurement the attenuation

The measurement principle is shown in figures D.1 and D.2. In a first step, calibration is performed using the setup shown in figure D.1.

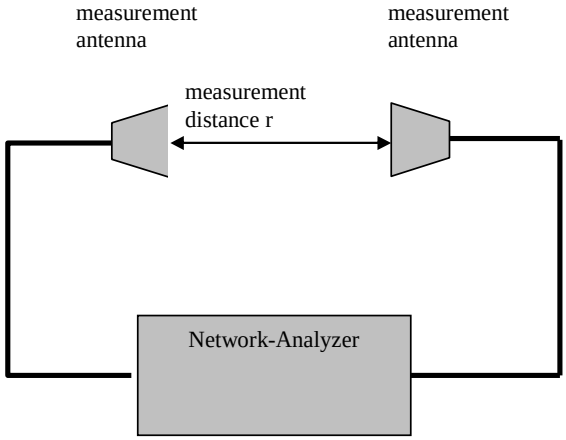



**Figure D.1: Calibration setup**

It is important that both antennae are aligned to each other exactly and the distance between the two identical antennae shall be larger than 2 × minimal far field distance.

The antenna beamwidth of the measurement antennas shall be lower than:

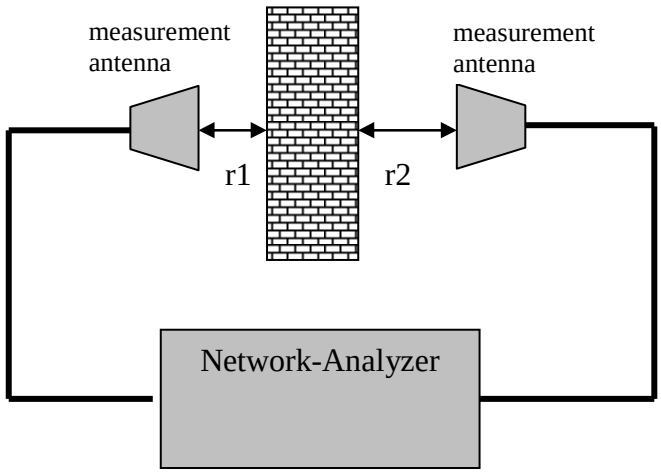
$$\frac{ant\_beam_{(f)}}{2} < \arctan\left(\frac{size\_of\_the\_wall}{r}\right) \quad \text{(D.1)}$$

Calibration Steps:

1) Set the network analyser to the minimum and maximum frequency range (960 MHz to 10,6 GHz). The frequency range depends on the measurement antennas.

2) Calibrate the system in the S21 Mode.

In the second step the wall attenuation measurement is performed.




$$r = r1 + r2 + wall\_thickness$$

**Figure D.2: Attenuation measurement, example: wall**

After calibration of the setup, the representative wall shall be placed between the two antennas.

The network analyser shall then be used with the time gating option. This is important because with this option it is possible to obtain the necessary signal parts for the attenuation measurement (more signal components or more signal reflexions can yield to wrong results).

Other setups can be used if the presented method in this clause is not feasible for the typical absorbing material used for the measurements of the devices under test.

## D.5 Typical representative measurement result

Measurement result of a representative absorbing material, as described in clause D.1.

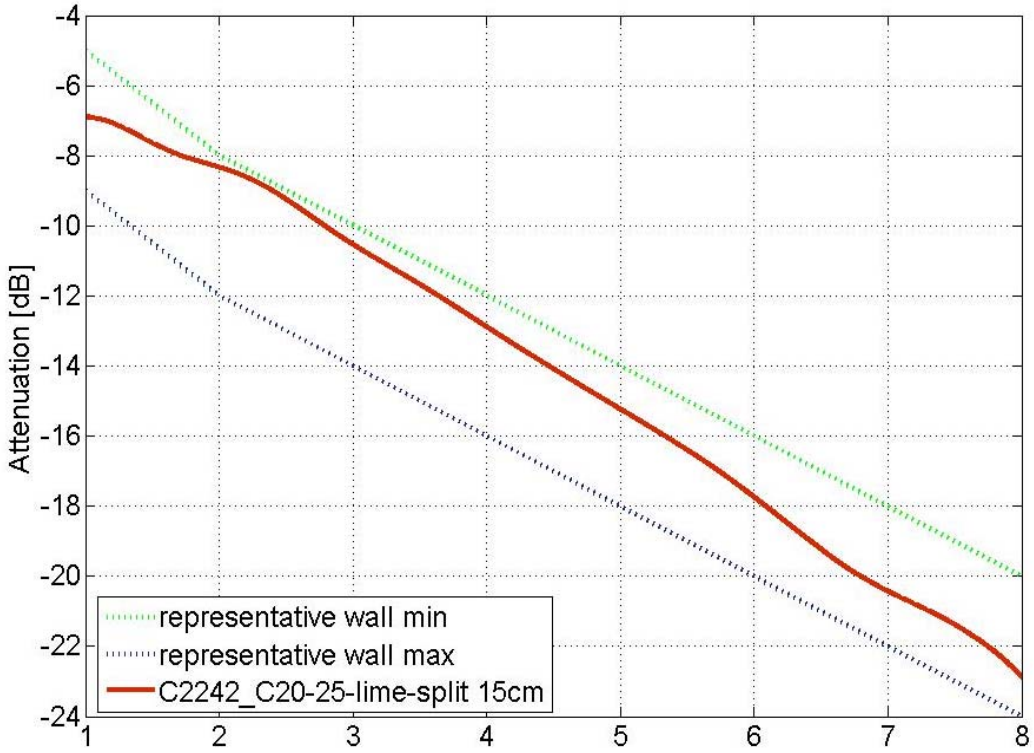



**Figure D.3: Typical result for a typical absorbing material, here: wall**

# Annex E (informative): Bibliography


- ETSI TS 102 754 (V1.3.1) (03-2013): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics of Detect And Avoid (DAA) mitigation techniques for SRD equipment using Ultra Wideband (UWB) technology".

- ETSI EN 301 489-33 (V1.1.1) (02-2009): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 33: Specific conditions for Ultra Wide Band (UWB) communications devices".

- ETSI EG 201 399 (V2.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".

- ETSI TR 103 086: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Conformance test procedure for the exterior limit tests in EN 302065-3 UWB applications in the ground based vehicle environment".

- ETSI TS 102 902 (02-2011): "Electromagnetic compatibility and radio spectrum matters (ERM); Methods, parameters and test procedures for cognitive interference mitigation towards ER-GSM for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".

- Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down procedure for the provision of information in the field of technical standards and regulations.

- Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 amending Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations.

# Annex F (informative): Change History

| Date | Version | Information about changes |
|---|---|---|
| | | |
| 11.10.2015 | 0.0.1 | Initial draft version created, FB |
| 19.1.2016 | 0.0.3 | Main part added, FB |
| | 0.0.4 | Annex A and B added, FB |
| 21.1.2016 | 0.0.5 | Added: General part and Annex D, FB |
| 02.02.2016 | 0.0.6 | Updated with RX parameter and formatting during TGUWB meeting in Cambridge |
| 03.02.2016 | 1.0.1 | Approved version for ENAP |

# History

| Document history | | | |
|---|---|---|---|
| V1.1.0 | April | EN Approval Procedure | AP 20160717: 2016-04-18 to 2016-07-18 |
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