

ETSI EN 302 066 V2.2.1 (2020-06)



**Short Range Devices (SRD);  
Ground- and Wall- Probing Radar applications Radio  
determination (GPR/WPR) imaging systems devices;  
Harmonised Standard ~~covering the essential requirements for~~  
access to radio spectrum  
~~of article 3.2 of the Directive 2014/53/EU~~**

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**Reference**

REN/ERM-TGUWB-146

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# Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.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 adoption of this EN:   | <u>9 June 2020</u>       |
| Date of latest announcement of this EN (doa):  | <u>30 September 2020</u> |
| Date of latest publication of new National Standard or endorsement of this EN (dop/e): | <u>31 March 2021</u>     |
| Date of withdrawal of any conflicting National Standard (dow):                         | <u>31 March 2022</u>     |

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# Modal verbs terminology

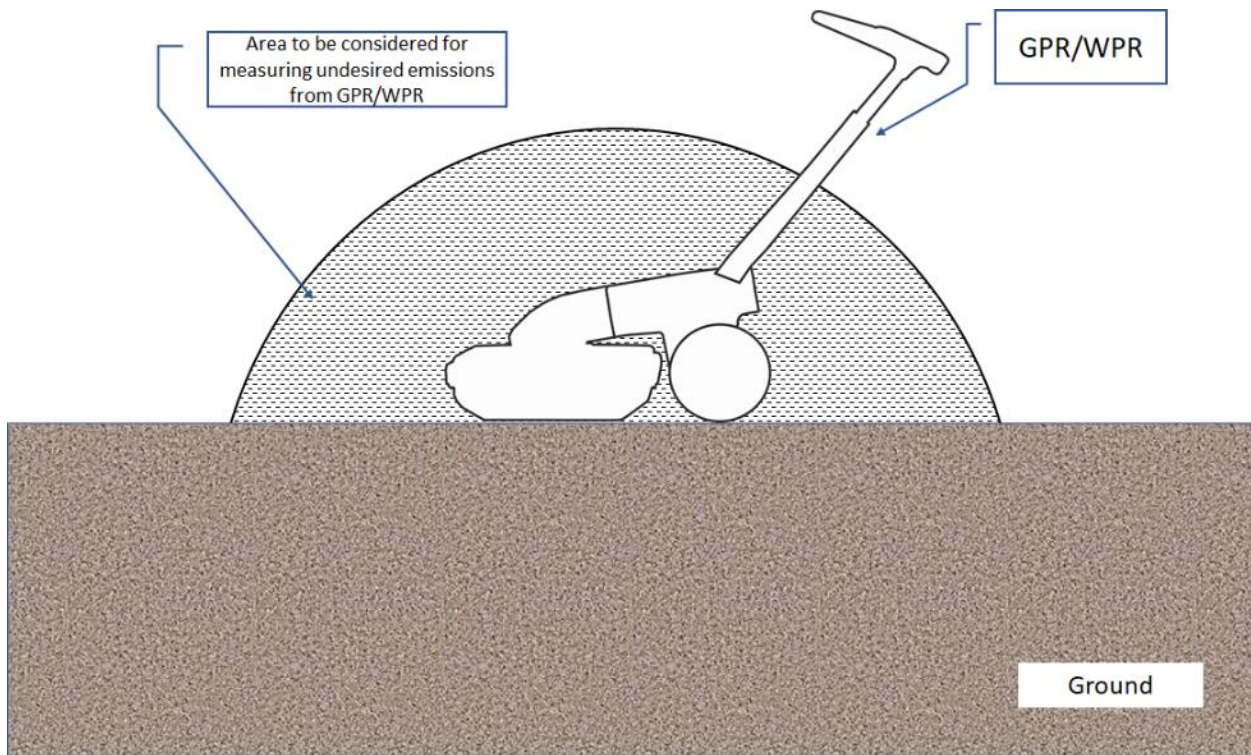
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## Introduction

GPR and WPR radars are imaging systems designed to operate while in contact with, or in close proximity to the ground or the wall, and their emissions are directed into the ground or wall (e.g. measured by a proximity sensor or imposed by the mechanical design).

The GPR/WPR applications in the present document are not intended for communications purposes, and the intended signal is not radiated into free space. The emissions into the air resulting from the operation of GPR/WPR imaging systems are defined as those emissions radiated in all directions above the ground from the GPR/WPR equipment, including direct emissions from the housing/structure of the equipment and emissions reflected or passing through the media under inspection (referred in ECC/DEC/(06)08 [i.2] and in the present document as "undesired emissions"); they are therefore dependent on the operational conditions and are meaningful only if the GPR/WPR are coupled with the material being investigated. Figure 1 shows the scenario to be considered for the emissions radiated into the air by GPR/WPR.



**Figure 1: Hatched area around the GPR/WPR shows the emissions to be considered in this clause**

# 1 Scope

The present document specifies the requirements for Ground- and Wall- Probing Radar imaging systems applications. Ground Probing Radars (GPR) and Wall Probing Radars (WPR) are used in survey and detection applications. These do not include radars operated from aircraft or spacecraft.

~~The scope is limited to GPR and WPR radars, in which the system is in close proximity to the materials being investigated. It does not include radars operated from aircraft or spacecraft.~~

~~The GPR/WPR applications in the present document are not intended for communications purposes, and the intended signal is not radiated into free space.~~

~~NOTE: Equipment covered by the present document is intended to be used by competent professional personnel.~~

The present document applies to:

- 1) Ground Probing Radars (GPR) operating in the frequency range 30 MHz to 12,4 GHz radiating directly downwards into the ground.
- 2) Wall Probing Radars (WPR) operating in the frequency range 30 MHz to 12,4 GHz radiating directly into a "wall". The "wall" is a building material structure, the side of a bridge, the wall of a mine or another physical structure that absorbs a significant part of the signal transmitted by the radar.

These equipment can either:

- 1) be fitted with integral antennas and without antenna connector; or
- 2) use different imaging heads (antennas) with an antenna connector, to allow operation at different operating bandwidths frequencies.

NOTE 1: Equipment covered by the present document operates in accordance with ECC/DEC(06)08 [i.2].

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

**Table 1: Permitted ranges of operation**

| Permitted range of operation   |                    |
|--|--------------------|
| Transmit   | 30 MHz to 12,4 GHz |
| Receive  | 30 MHz to 12,4 GHz |
| NOTE 1: Limits in table 2, clause 4.3.4 are to be met.   |                    |
| NOTE 2: The frequency usage conditions for GPR/WPR are not fully harmonised in the EU and CEPT. Some National Regulatory Authorities (NRAs) may not have a general frequency allocation for GPR/WPT and may have established individual licensing requirements (e.g. registration of the user). Annex 2 of <u>ECC/DEC/(06)08 [i.2]</u> gives some guidance to administrations. |                    |

NOTE 2: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] is given in annex A.

## 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) (09-2016): "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".
- [3] ~~CISPR 16 (CENELEC EN 55016-1-1 (March 2010 + A1 October 2010 + A2 September 2014) (parts 1-1, 1-4 and 1-5): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".~~

## 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] ECC/DEC/(06)08: "ECC Decision of 1 December 2006 on the conditions for use of the radio spectrum by Ground- and Wall- Probing Radar (GPR/WPR) imaging systems, ECC/DEC/(06)08."
- [i.3] ANSI C63.5 2004: "American National Standard for Electromagnetic Compatibility Radiated Emission Measurements in Electromagnetic Interference (EMI) Control Calibration of Antennas (9 kHz to 40 GHz)".
- ~~[i.4] ETSI TR 102 273/TS 103 051 (V1.2.1) (all parts.1) (08-2011): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding Expanded measurement uncertainties uncertainty for the measurement of radiated electromagnetic fields".~~
- ~~[i.4] Void.~~
- [i.5] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

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## ~~3 Definitions, symbols and abbreviations~~

### ~~3.1 Definitions~~

- ~~[i.6] ETSI EG 203 336 (V1.1.1) (08-2015): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".~~
- ~~[i.7] Recommendation ITU-R SM.1755: "Characteristics of ultra-wideband technology".~~



## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

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~~

**footsize:** outside dimension of the DUT in the horizontal plane

**large GPR/WPR:** GPR/WPR with the largest dimension in the horizontal plane 1 metre or more

**Pulse Repetition Frequency (PRF):** inverse of the Pulse Repetition Interval (PRI), averaged over a sufficiently long time to cover all PRI variations

**Pulse Repetition Interval (PRI):** time between the rising edges of the transmitted (pulsed) output power

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

**small GPR/WPR:** GPR/WPR with all dimensions in the horizontal plane below 1 metre

**time window:** length of time that the GPR/WPR receiver is activated to collect reflections from a single transmitted signal

**undesired emissions:** emissions radiated in all directions above the ground from the GPR/WPR equipment, including direct emissions from the housing/structure of the equipment and emissions reflected or passing through the media under inspection (see ETSI EG 203 336 [i,6])

**user manual:** end user documentation to be included with the device

### 3.2 Symbols

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

|                                 |  |
|---------------------------------|--|
| <del>dB</del>                   | <del>DeciBel</del> DeciBel   |
| <del>dBi</del>                  | <del>gain</del> Gain in decibels relative to an isotropic antenna        |
| <u>D1</u>                       | <u>Difference between M and N</u>  |
| <u>D2</u>                       | <u>Difference between M and I</u>  |
| E                               | Electrical field strength  |
| <del><math>f_c</math></del>     | <del>Frequency at which the emission is the peak power at maximum</del>  |
| <del><math>\lambda</math></del> | <del>wavelength</del>  |
| <u>I</u>                        | <u>Signal recorded by the receiver in presence of the interferer</u>     |
| <u><math>\lambda</math></u>     | <u>Wavelength</u>  |
| <u>M</u>                        | <u>Maximum signal for the receiver in the linear region of operation</u> |
| <u>N</u>                        | <u>Receiver noise level</u>  |

### 3.3 Abbreviations

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

|                   |   |
|-------------------|---|
| <del>CEPT</del>   | <del>European Conference of Postal and Telecommunications Administrations</del> administrations |
| DT                | DwellTime   |
| DUT               | Device Under Test   |
| <del>e.r.p.</del> | <del>effective radiated power</del>   |
| GPR               | Ground Probing Radar, Ground Penetrating Radar  |
| <del>OATS</del>   | <del>Open Area Test Site</del>  |
| <del>PRF</del>    | <del>Pulse Repetition Frequency</del>   |
| <del>PRI</del>    | <del>Pulse Repetition Interval</del>  |

|           |                                    |
|-----------|------------------------------------|
| RNSS      | Radio Navigation Satellite Service |
| <u>RX</u> | <u>Receiver</u>                    |
| SA        | Spectrum Analyser                  |
| ST        | ScanTime                           |
| <u>TX</u> | <u>Transmitter</u>                 |
| WPR       | Wall Probing Radar                 |

## 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 manufacturer. The equipment shall comply with all the technical requirements of the present document which are identified as applicable in annex A 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 12,4 GHz, as defined in table 1.

In order to clearly identify the required limits and thus measurement procedures it is essential to define the ~~operational~~operating bandwidth of the UWB equipment under test, The operating bandwidth of the UWB equipment under test shall be the ~~-10 dB~~-10 dB bandwidth of the intended UWB signal under normal operational conditions as defined in clause 4.3.1.

A single UWB device can have more than one ~~operational~~operating bandwidth. All UWB related emissions shall be measured in the identified ~~operational~~operating bandwidth of the UWB device under test. The required mitigation techniques are only valid in the ~~operational~~operating bandwidth.

The ~~RX interference signal handling deals with~~conformance test considers the performance ~~dynamic range and the resilience~~ of the receiver ~~and is focused on~~against interference signals in the ~~operational~~operating bandwidth and on some clearly identified frequencies inside and outside the ~~operational~~operating bandwidth(s), see clause 4.4.34.

Test site and general arrangements for compliance measurements are defined in clauses 6.1.1 and 6.1.2.

### 4.3 Transmitter Conformance Requirements

#### 4.3.1 Operating Bandwidth

##### 4.3.1.1 Applicability

This requirement shall apply to all ~~DUT~~kind of GPR/WPR.

##### 4.3.1.2 ~~Description~~Definition

The operating bandwidth(s) of GPR/WPR is/are the ~~-10 dB~~-10 dB bandwidth(s) of ~~effective~~the undesired emissions radiated into the air by the equipment.

NOTE: This definition is in accordance with the -10 dB bandwidth as defined in Annex 1 of Recommendation ITU-R SM.1755 [i.7].

### 4.3.1.3 Limits

Any operating bandwidth of all the DUT shall lie within the permitted frequency range of operation of the device (see table 1) and shall be > 50 MHz.

### 4.3.1.4 Conformance

The conformance test suite for operating bandwidth shall be as defined in clause 6.5.3 of the present document 2.2.

~~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.~~

## 4.3.2 Maximum value of mean power spectral density

~~Intentional emissions can't be tested due to the nature of the GPR/WPR applications and thus only unintentional emissions into the air will be tested (see clause 4.3.4 on exterior limit).~~

There is no regulatory limit for the UWB maximum mean power spectral density in the main lobe of the GPR/WPR antenna (towards ground or wall) due to the nature of the GPR/WPR applications (see scope of the present document). The relevant mean power spectral density emissions (according to ECC/DEC/(06)08 [i.2]) of the GPR/WPR device is considered in clause 4.3.4 (undesired emission limit) and annex C (calculation of the mean power density).

### 4.3.3 Maximum value of peak power

~~Intentional emissions cannot be tested. There is no regulatory limit for the UWB maximum peak power in the main lobe of the GPR/WPR antenna (towards ground or wall) due to the nature of the GPR/WPR applications and thus only unintentional emissions into the air will be tested (see scope of the present document). The relevant peak power emissions (according to ECC/DEC/(06)08 [i.2]) of the GPR/WPR device is tested under clause 4.3.4 on exterior (undesired emissions limit).~~

### 4.3.4 Exterior Limits All undesired emissions

#### 4.3.4.1 Applicability

This requirement shall apply to all ~~DUT~~ kind of GPR/WPR.

#### 4.3.4.2 ~~Description~~ Definition

~~The emissions into the air resulting from the operation of GPR/WPR imaging systems are defined as those emissions radiated in all directions above the ground from the GPR/WPR equipment, including direct emissions from the housing/structure of the equipment and emissions reflected or passing through the media under inspection; they are therefore dependent on the operational conditions and are meaningful only if the GPR/WPR are coupled with the material being investigated.~~

Term "undesired emissions" see clause 3.1.

See also clause 4.3.5 for the other emissions.

#### 4.3.4.3 Limits

The effective radiated power of any emission from GPR/WPR shall not exceed the values given in table 2.

**Table 2-2: Power limits of radiated emissions  
(based on ECC/DEC/(06)08 [i.2], Annex 1)**

| Frequency range (MHz) | Peak power limit values for emission |
|-----------------------|--------------------------------------|
| 30 to 230             | -44,5 dBm/120 kHz (e.i.r.p.)         |
| > 230 to 1 000        | -37,5 dBm/120 kHz (e.i.r.p.)         |
| > 1 000 to 18 000     | -30 dBm/MHz (e.i.r.p.)               |

The maximum mean e.i.r.p. spectral density shall not exceed the values in table F.1 (i.2) and shall be calculated as set out in annex F.

#### ~~4.3.4.4~~ Conformance

The conformance test suite for Exterior Limit shall be as defined in clause 6.5.6.

The maximum mean e.i.r.p. spectral density which is based on the peak values measured according to clause 6.2.5.6, shall be calculated as set out in annex F and shall not exceed the values in table F.1 (i.2).

#### ~~4.3.4.4~~ Conformance

Conformance shall be established under normal ~~The conformance~~ test conditions (see clause 4.1).

The interpretation of the results for the measurements uncertainty ~~suite~~ shall be as given ~~defined~~ in clause 5.36.2.6.

#### 4.3.5 ~~Total Power~~ Other Emissions

This requirement does not apply to any DUT.

#### ~~4.3.6~~ Other Emissions

This requirement does not apply to any DUT.

This requirement does not apply for GPR/WPR. The total undesired emissions from a GPR/WPR already include direct non UWB based (TX/RX) emissions from the housing/structure/electronics; therefore this clause does not apply because covered by the measurement of all undesired emissions in clause 4.3.4 (see ECC/DEC/(06)08 [i.2]).

#### ~~4.3.7~~ Transmitter unwanted emissions

This requirement does not apply to any DUT.

Transmitter unwanted emissions are specified as Out-Of-Band (OOB) and spurious emissions. For GPR/WPR these emissions are covered by the spectrum mask as defined in clause 4.3.4 and annex C and is tested under clause 4.3.4 (undesired emissions limit).

## 4.4 Receiver Conformance Requirements

### 4.4.1 General

~~Detailed~~ For a detailed description for related UWB GPR/WPR receiver requirements, see ETSI TS 103 361 [2] annex D.

### 4.4.2 Receiver spurious emissions

Receiver spurious emissions are measured as part of the emissions resulting from the operation of GPR/WPR imaging systems, see clause 4.3.4.

### 4.4.3 Receiver interference handling dynamic range (sensitivity) for GPR/WPR

#### 4.4.3.1 Applicability

This requirement shall apply to all ~~DUT~~ kind of GPR/WPR.

#### 4.4.3.2 ~~Description~~ Definition

~~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.~~

Receiver dynamic range is defined in ETSI EG 203 336 [i.6] as the range of input signal levels over which a receiver functions at a specified performance level.

For GPR/WPR this performance criterion is set upon the difference D1 between the maximum signal M for the RX in the linear region of operation and the noise level N.

$$D1[\text{dB}] = M[\text{dB}] - N[\text{dB}] \quad (1)$$

NOTE: More details on this RX-requirement are given in clause D.1.

~~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]. 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 level of performance of the chosen performance criterion shall meet the minimum requirement defined in the recommended test case, see ETSI TS 103 361 [2].~~

$$D1 \geq 40 \text{ dB} \quad (2)$$

#### 4.4.3.4 Conformance

~~The conformance tests for Interference Signal Handling Receiver dynamic range shall be as defined in clause 6.63.2.~~

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

### ~~4.4.5~~ Requirements ~~4~~ Receiver blocking for spectrum access GPR/WPR

#### ~~4.54.4.1~~ Detect and Avoid (DAA) Applicability

~~This requirement does not~~ shall apply to ~~any~~ DUT all kind of GPR/WPR.

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

~~This requirement does not apply to any DUT.~~

#### ~~4.5.3~~ Low Duty Cycle (LDC)

~~This requirement does not apply to any DUT.~~

### ~~4.6~~ Antenna Requirements

~~This requirement does not apply to any DUT.~~

#### 4.4.4.2 Description

For GPR/WPR, receiver blocking is defined as the measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequency within the operating bandwidth; it evaluates the capability of the GPR/WPR to operate as intended in coexistence with interferers. This parameter is also defined as "Interferer signal handling" in ETSI TS 103 361 [2].

Operation as intended is evaluated using a performance criterion. <sup>7</sup>For GPR/WPR this performance criterion is set upon the difference D2 between the maximum signal M for the RX in the linear region of operation and output signal I in presence of the interferer.

$$D2[\text{dB}] = M [\text{dB}] - I [\text{dB}] \quad (3)$$

NOTE: More details on this RX-requirement are given in clause D.1.

#### 4.4.4.3 Limits

$$D2 \geq 20 \text{ dB} \quad (4)$$

#### 4.4.4.4 Conformance

The conformance tests for GPR/WPR receiver blocking shall be as defined in clause 6.3.2.

## 4.5 Other Requirements and Mitigation techniques

### ~~4.7.1 Adaptive/Transmit Power Control (TPC)~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.2 Activity factor~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.3 Frequency Domain Mitigation~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.4 Shielding effects~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.5 Thermal Radiation~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.6 Site registration~~

~~This requirement does not apply to any DUT.~~

### ~~4.7.7 4.5.1 Deactivation mechanism~~

#### 4.5.1.1 Applicability

This requirement shall apply to all kind of GPR/WPR.

### 4.5.1.2 Description

GPR/WPR applications are not intended for communications purposes. Their intended usage excludes radiation into the free space and this should be avoided due to a proper mechanism that deactivates the equipment when normal use is interrupted.

### 4.5.1.3 Limits

The deactivation mechanism requirements are defined in annex ~~DB~~.

### 4.5.1.4 Conformance

The conformance tests for the deactivation mechanism shall be as defined in clause 6.4.

## 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)~~ points within the boundary limits of the declared operational environmental profile.

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

### 5.2 General conditions for testing

#### Clause 5.2.1 Product information

~~The requirements for the product information shall be as given in 4 of ETSI EN 303 883 [1], clause 5.2.~~

~~A application form for DUT testing is provided in annex B.~~

#### ~~5.2.2 Requirements for the 1] provides information on test modulation~~

~~This requirement does not apply to any DUT.~~

#### ~~5.2.3 Test conditions, power supply and ambient ~~temperature~~ temperature.~~

~~The test conditions, power supply and ambient ~~temperatures~~ shall be as given in ETSI EN 303 883 TS 103 051 [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~~

~~This requirement does not apply to any DUT.~~

#### ~~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 [3] provides additional information on 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 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~~

~~This clause does not apply any DUT.~~

## 6 Conformance test suites

### 6.1 Introduction

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

~~GPR/WPR shall be compliance tested under conditions that are representative of normal operating conditions.~~

~~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~~

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

~~Absolute power measurements shall be made using an appropriate method to ensure that the wave front is properly formed (i.e. operating in far field conditions). The test site shall meet the appropriate requirements as defined in published guidelines/standards.~~

~~It may not be possible to measure at the power limits without low noise amplification to reduce the overall noise figure of the overall measurement system at a separation of approximately 3 meters in an RF quiet environment. A lower separation distance may be required since the instrumentation noise floor should be at least 10 dB above the limit within the instrument bandwidth.~~



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

~~Test sites and general arrangements for measurements shall be as described in clause C.1.~~

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

#### 6.3.3.1 — ~~General~~

~~Guidance is given clause C.2.~~

#### 6.3.3.2 — ~~Range length~~

~~Range length shall be as in clause C.2.4.~~

### 6.3.4 — ~~Coupling of signals~~

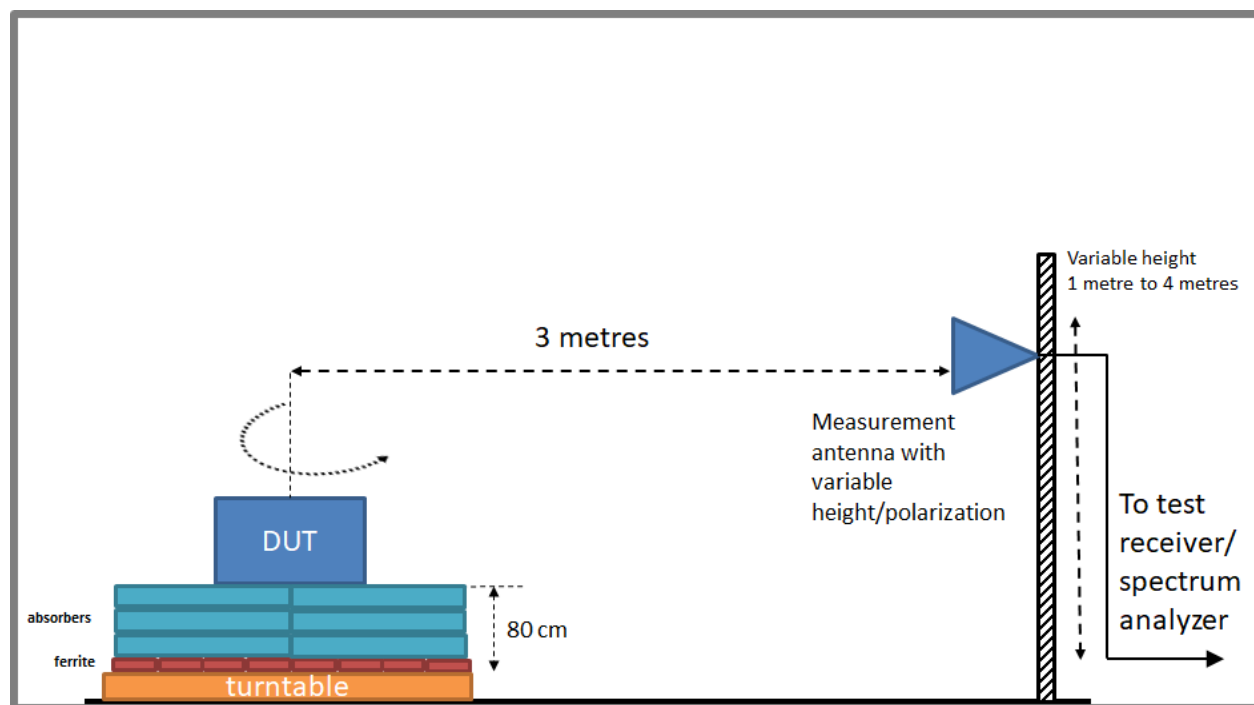
~~This requirement does not apply to any DUT.~~

### 6.3.5 — ~~Standard test methods~~

#### 6.3.5.1 — ~~Generic measurement method~~

#### 6.3.5.1.1 6.1.1 Setup description for small GPR/WPR

An semi-anechoic chamber with a conductive ground plane is the test site to be used for radiated testing of small GPR/WPR.



**Figure 2: Calibrated setup for small GPR/WPR**

In this case the DUT shall be placed at a height of 80 cm on a non-conducting support with the emitter directed downwards. A layer of ferrite tile should be placed directly on the floor and above the turntable.

A stack of broadband, flat RF absorbers up to 80 cm in height shall be placed directly below the DUT.

The stack of absorbers shall guarantee an absorption greater than 20 dB for normal incident energy above 500 MHz; the layer of ferrite tile shall guarantee an absorption greater than 20 dB for normal incident energy below 500 MHz.

If flat RF absorbers are not available, pyramidal or wedge-shaped RF absorbers may be used; in this case, some sections of absorber may be inverted and placed over other absorbers to form a solid block.

Care shall be taken not to place any RF absorber between the end of the turntable and the measurement antenna, as this would prevent energy not directed downwards from reflecting from the ground plane. The placement of the absorber shall not be disturbed when the device is rotated. This arrangement prevents energy directed downwards from consideration in the measurement. The DUT shall be tested

The measurement antenna is placed three metres away from the boresight (vertical centre axis) of the DUT; it should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization. Moreover the support should additionally allow the height of antenna centre above the ground to be varied from 1 metre to 4 metres.

For both the horizontal and vertical polarization of the test antenna, measurements in azimuth and elevation shall be taken for each frequency of interest to ensure that the maximum emission value has been recorded.

### 6.1.2 Setup description for large GPR/WPR

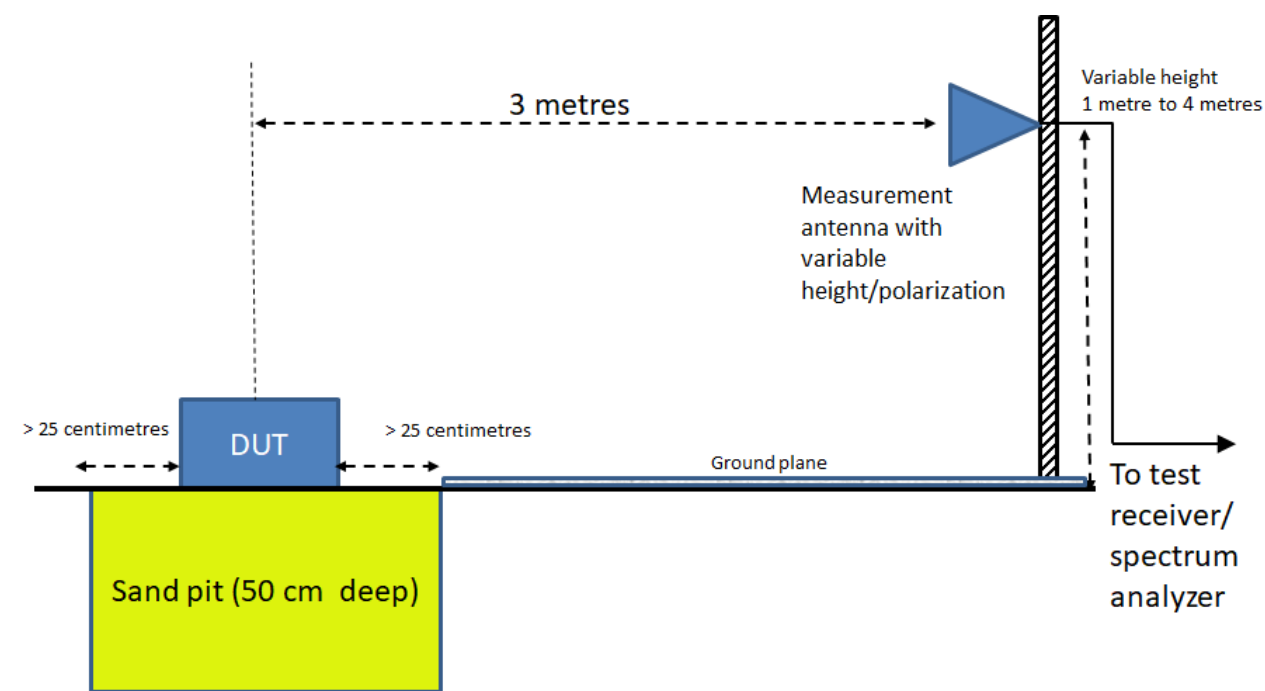
An open area test site is to be used for radiated testing of large GPR/WPR.

Large GPR/WPR shall be tested in an open area Test site over a dry sand pit (i.e. emission). Characteristics of the sand to be used for filling up the pit are listed in annex E.

Emission of GPR/WPR is to be directed towards the sand pit) which is. The sand pit shall be 50-cm deep and which is greater in area a minimum 50 cm larger than the DUT, set into (see figure 3). The DUT shall be placed in the ground with a middle of the sand pit. A thin plastic sheet or other suitable barrier to all around the pit will preserve sand condition.

The open area test site comprises the sand pit and an antenna mast of variable height above a ground plane, which in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited.

The ground plane shall extend up to the edges of the sand pit (see figure 3).



**Figure 3: Calibrated setup for large GPR/WPR and measurements below 960 MHz**

During the measurement, the DUT shall be placed on the testbed of sand with its antenna pointing directly into the sand and the test antenna is placed three metres away from the boresight (vertical centre axis) of the DUT.

~~Measurements shall be taken at a sufficient number of radials and polarizations to ensure that the maximum emission is measured.~~

~~An alternative method for testing GPR/WPR devices is to place the DUT at a height of 80 cm on a non-conducting support with the emitter directed downwards. If the DUT emissions are expected to have components below 500 MHz, a layer of ferrite tile should be placed directly on the floor below the DUT. Pyramidal or wedge-shaped RF absorbers not less than 60 cm in height should be placed directly below the DUT. Some sections of absorber may be inverted and placed over other absorbers to form a solid block. Care shall be taken not to place any RF absorber between the device and the search antenna, as this would prevent energy not directed downwards from reflecting from the ground screen. The placement of the absorber shall not be disturbed when the device is rotated. This arrangement prevents energy directed downwards from consideration in the measurement. A search in azimuth and elevation for indirect emissions may now be performed.~~

#### ~~6.3.5.1.2 Substitution method~~

~~This requirement does not apply to any DUT.~~

#### ~~6.3.6 Standard calibration method~~

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

### ~~6.4 Conducted measurements~~

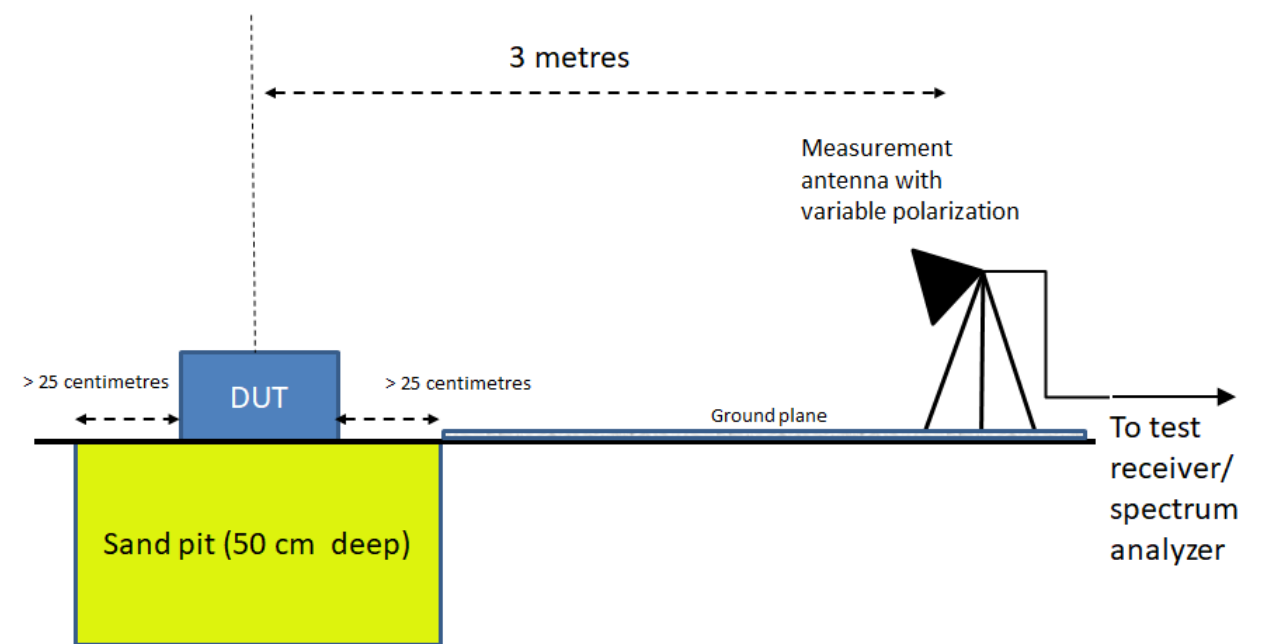
#### ~~6.4.1 General Setup~~

~~This requirement does not apply to any DUT.~~

#### ~~6.4.2 Specific Setup~~

~~This requirement does not apply to any DUT.~~

~~6.5 For measurement below 960 MHz, the test antenna is placed three metres away from the boresight (vertical centre axis) of the DUT; it should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization. Moreover the support should additionally allow the height of antenna centre above the ground to be varied from 1 metre to 4 metres to ensure that the maximum emission is recorded. Measurement shall be repeated for both the test antenna polarizations, by rotating the DUT from 0° to 360° with 45° step increment.~~



**Figure 4: Calibrated setup for large GPR/WPR and measurements above 960 MHz**

For measurement above 960 MHz, the test antenna is placed three metres away from the boresight (vertical centre axis) of the DUT; it should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization. The test antenna is pointed in the direction of the DUT to ensure that the maximum emission is recorded. Measurement shall be repeated by rotating the DUT from 0° to 360° degrees with 45° step increment.

## 6.2 Conformance methods of measurement for transmitter

### 6.5.2.1 General

The DUT shall be measured for:

- the operating bandwidth(s);
- the exterior limits undesired emissions.

The following methods of measurement shall apply to the testing of stand-alone units and to the equipment configurations identified in clause 5.6.2.6.

### 6.5.2 ~~Method of measurements of the Ultra Wideband Emissions from GPR/WPR~~

Where the transmitter is designed with adjustable carrier power, then all transmitter parameters shall be measured using the highest peak power level, as declared by the provider. When making transmitter tests on equipment designed for intermittent operation, the duty cycle of the transmitter, as declared by the provider, shall not be exceeded. The actual duty cycle used shall be recorded and stated in the test report.

**NOTE:** The maximum duty cycle of the transmitter under test should not be confused with the duty cycle of the equipment under normal operating conditions.

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

### 6.5.3 Operating Bandwidth(s)

The DUT shall be tested with the setup described in clause ~~6.3.5.4.1~~ 6.1.1 or 6.1.2 depending on DUT dimensions.

Measurement shall be repeated for both test antenna polarizations, and by rotating the DUT from 0° to 360° degrees with 45° step increment. Test antenna's height shall be varied from 1 metre to 4 metres to ensure that the maximum peak of the emission is recorded.

The dimensions of the DUT and the setup used shall be recorded in the test report.

In both measurements for the lower and upper frequency bound  $f_L$  and  $f_H$ , there shall be no point in the emission below  $f_L$  and above  $f_H$  where the level increases above the level recorded at  $f_L$  and  $f_H$ . This ensures that peaks and valleys occurring near  $f_C$  are not used prematurely as the upper and lower bounds of the emission.

The peak of the radiated emission shall be determined by a peak power measurement, that indicates the maximum of the emission,  $f_C$ .

The peak power of the emission shall be measured by:

- Set the spectrum analyser detector to positive peak.
- Centre the span on the peak of the emission and set the span to a value large enough to display the full emissions spectrum.
- Set the RBW to no less than 1 MHz and the VBW to no less than the RBW.
- A VBW of three times the RBW is preferred to eliminate video averaging.

The DUT shall be tested by directly coupling the normal operational transmitted signal, via a free-line-of-sight towards the measuring test antenna in a manner to ensure the test antenna receives a sufficient signal.

For the lower frequency bound  $f_L$ , the emission shall be searched from a frequency lower than the peak that has, by inspection, a much lower PSD than the peak PSD -10 dB and increasing in frequency towards the peak until the PSD indicates a level of 10 dB less than at the peak of the radiated emission.

The process shall be repeated for the upper frequency bound  $f_H$ , beginning at a frequency higher than the peak that has, by inspection, a much lower PSD than the peak PSD -10 dB.

The results for  ~~$f_L$ ,  $f_H$~~ , the operating bandwidth and  $f_C$  shall be reported in the test report.

### 6.5.4.3 Mean power spectral density measurements

~~This requirement does not apply to any DUT.~~

~~6.5.5~~ The mean power spectral density (according to ECC/DEC/(06)08 [i.2]) of the GPR/WPR device is considered under clause 6.2.5 (undesired emissions).

### 6.2.4 Peak power measurements

~~This requirement does not apply to any DUT.~~

~~6.5.6~~ Exterior limit The peak power (according to ECC/DEC/(06)08 [i.2]) of the GPR/WPR device is considered under clause 6.2.5 (undesired emissions).

## 6.2.5 All undesired emissions measurement

The DUT shall be tested with the setup described in clause 6.3.5.4.1.1 or 6.1.2 depending on DUT dimensions.

Measurement shall be repeated for both test antenna polarizations, and by rotating the DUT from 0° to 360° degrees with 45° step increment. Test antenna's height shall be varied from 1 metre to 4 metres to ensure that the maximum emission is recorded. The dimensions of the DUT and the setup used shall be recorded in the test report.

It may be necessary for specific DUTs to perform this measurement by inserting a low noise amplifier in the measuring arrangement to ensure sufficient signal level.

In all measurements the normal operational signal shall be used.

For measurements below 1 GHz, a ~~CISPR 16-1 [3]~~ quasi-peak detector according to CENELEC EN 55016-1-1 [3], clause 4 shall be used. For measurements above 1 GHz, a peak detector shall be used.

Using a spectrum analyser the following settings shall be applied:

- a) ~~a)~~—Set the RBW below 1 GHz to 120 kHz and above 1 GHz to 1 MHz and the VBW to be at least equal or greater than the RBW.
- b) ~~b)~~—Record over the frequency range  $f_L$  to  $f_H$  (see clause 6.5.32.2) the maximum level  $P_m$  received by the test antenna in the direction of the maximum emission of the DUT.
- c) ~~e)~~—Calculate and record the peak power according the ~~following formula:~~ equation (5).

$$\text{Power}_{\text{peak}} = P_m - G_R + L_C + L_{\text{Atten}} - G_{\text{Amp}} + 20 \text{Log} \left( 4 \pi \frac{D}{\lambda} \right) \quad (4)(5)$$

where:

$P_m$  = measured power,

$G_R$  = gain of the receive (measurement) antenna, in dBi,

$L_C$  = signal loss in the measurement cable, in dB,

$L_{\text{Atten}}$  = value of external attenuation (if used), in dB,

$G_{\text{Amp}}$  = value of external amplification (if used), in dB,

$D$  = measurement distance, in ~~meters~~metres, taken from the centre of the DUT to the antenna reference point at the position in its height scan where the maximum signal was detected.

$\lambda$  = wavelength computed on the centre frequency of radiated DUT signal,

- d) The maximum observed values for the peak power and the maximum mean e.i.r.p. spectral density computed according to annex ~~F,C~~ shall be recorded in the test report.

**NOTE:** ~~Limits in clause 4.3.4.3 may be converted to a peak field strength level at 3 meters (see annex C). e.i.p. limits in clause 4.3.4.3 can be converted to e.i.r.p. limits using e.i.r.p. = e.r.p. + 2,15 dB.~~

In order to obtain the required sensitivity a narrower bandwidth may be necessary, this shall be stated in the test report form.

The measurement shall be repeated in the frequency bands 1 164 MHz to 1 215 MHz and 1 559 MHz to 1 610 MHz measured in a 1 kHz resolution bandwidth. Using a spectrum analyser the following is applicable:

- a) Search for the highest narrowband emission/spectral line and record the frequency.
- b) Set the RBW to 1 kHz and the VBW to 3 kHz.
- c) Set the centre frequency of the SA to the frequency recorded in a).
- d) Measure and record the level of the emission recorded in step a).

The measuring receiver configuration shall use a low noise preamplifier and a dipole antenna (for frequencies below 1 GHz) or horn antenna (for frequencies above 1 GHz). Details are given in ~~annex E~~ ETSI EN 303 883 [1]. For the emission measurements, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could also be used to cover the entire 30 MHz to 1 000 MHz band.

~~A test site such as one selected from annex C (i.e. indoor test site or open area test site), which fulfils the requirements of the specified frequency range of this measurement shall be used.~~

If the test site is disturbed by radiation coming from outside the site, ~~this qualitative search~~ measurements may be performed ~~in a screened room~~ with reduced distance between the transmitter and the test antenna and limits consequently increased.

Proper pre-select filtering can be incorporated to protect the measurement system low-noise pre-amplifier from overload. In addition, persistent ambient signals can be detected to remove the ambient signal contributions present in the measured spectra. This ~~will require~~ requires post-processing of the measurement data utilizing a computer and data analysis software.

## ~~6.5.7~~ Total Power

## 6.2.6 Other emissions

This requirement does not apply to any DUT because it is covered by the measurement of all undesired emissions in clause 6.2.5.

## ~~6.5.8~~ 2.7 Transmitter unwanted emissions

~~This requirement does not apply to any DUT.~~

~~6.6~~ For GPR/WPR these emissions are covered by the measurement of all undesired emissions in clause 6.2.5.

## 6.3 Conformance methods of measurement for receiver

### ~~6.6~~ 3.1 Receiver spurious emissions

Receiver spurious emissions are measured as part of the emissions by GPR/WPR, see clause 6.2.5-6.

### ~~6.6~~ 3.2 Receiver ~~interference handling~~ dynamic range (sensitivity) and blocking

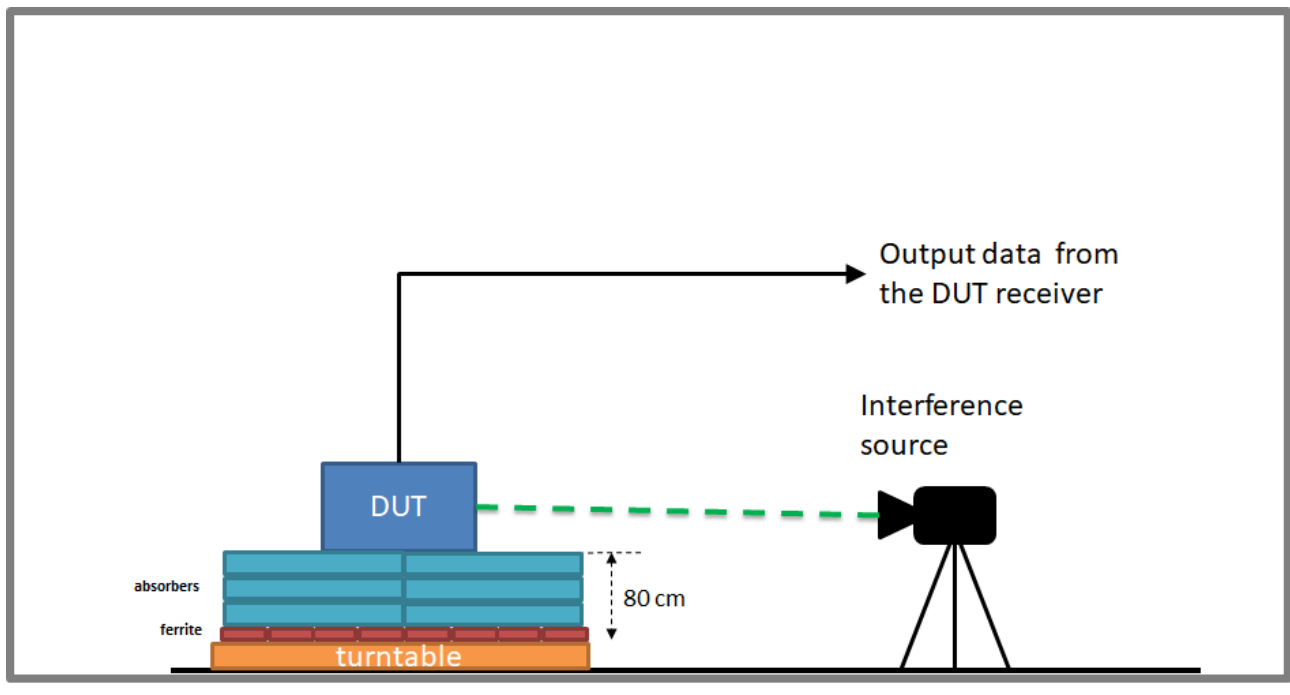
#### ~~Interference signal handling measurements~~ 6.3.2.0 General

~~The receiver dynamic range and blocking conformance shall be as given~~ tested in the test scenario described in clause 9 of ETSI TS 103 361 [2]. 6.3.2.1.

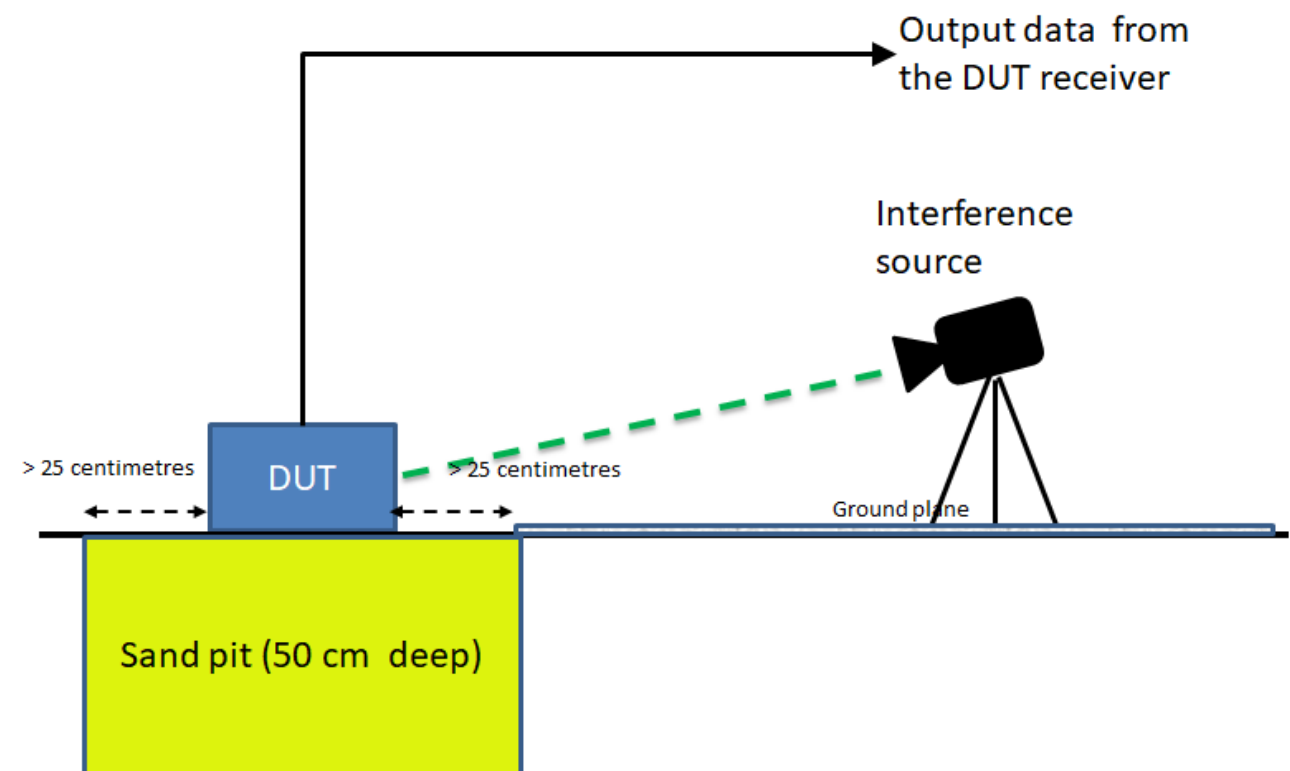
The interferer test frequency range, interferers and interferer power levels, test scenario, performance criterion and level of performance shall be recorded in the test report.

### ~~6.7~~ 3.2.1 Test scenario

The DUT shall be tested with the setup described in clause 6.1.1 or 6.1.2 depending on the dimension of the DUT. Figure 5 or figure 6 are visualizing these two scenarios for the receiver tests.



**Figure 5: Scenario for receiver testing for small GPR/WPR**



**Figure 6: Scenario for receiver testing for large GPR/WPR**



### 6.3.2.2 Interferer test suits for spectrum access frequencies and interferer power levels

#### ~~6.7.1 Detect and Avoid (DAA)~~

~~This requirement does not apply to any DUT.~~

#### ~~6.7.2 Listen Before Talk~~

~~This requirement does not apply to any DUT.~~

#### ~~6.7.3 Low Duty Cycle~~

~~This requirement does not apply to any DUT.~~

### ~~6.8 Conformance test suites for antenna requirements~~

~~This requirement does not apply to any DUT.~~

~~6.9 The interferer test frequency range shall be as defined in clause 9.1.2 of ETSI TS 103 361 [2], using the receiver operating frequency range as equal to the operating bandwidth (see clause 6.2.2 of the present document).~~

~~The selection of interferes shall be as given in ETSI TS 103 361 [2], clause 9.3 and table 7.~~

### 6.3.2.3 Measurement of the maximum signal M for the receiver

The maximum signal M for the receiver in the linear region of operation shall be determined from the signal produced when the DUT is suspended 5 cm above a plane metal. The size of the metal plate shall be at least the DUT footsize. During this measurement, the interferer shall be deactivated. At least 100 measurements shall be recorded and averaged; M is defined as the maximum absolute value in Volts occurring in the averaged result.

### 6.3.2.4 Measurement of the noise level N with the interferer deactivated

Using the setup described in figure 5 or figure 6 and with the interference source switched off, at least 100 measurements shall be recorded collected and averaged. The result for N is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window.

### 6.3.2.5 Measurement of the received signal I with the interferer activated

Using the setup described in figure 5 or figure 6 and the interfering signal based on clause 6.3.2.2, at least 100 measurements shall be recorded collected and averaged. The result for I is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window.

### 6.3.2.6 Calculation of D1

D1 is evaluated as the difference between the value M[dB] and N[dB], with:

$$M[\text{dB}] = 20 \log(M[\text{V}]) = 10 \log(M[\text{W}]) \quad (6)$$

$$N[\text{dB}] = 20 \log(N[\text{V}]) = 10 \log(N[\text{W}]) \quad (7)$$

### 6.3.2.7 Calculation of D2

D2 is evaluated as the difference between the value M[dB] and I[dB], with:

$$I[\text{dB}] = 20 \log(I[\text{V}]) = 10 \log(I[\text{W}]) \quad (8)$$

$$M[\text{dB}] = 20 \log(M[\text{V}]) = 10 \log(M[\text{W}]) \quad (9)$$

## 6.4 Other test suites

### ~~6.9.1~~ — ~~Transmit Power control~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.2~~ — ~~Activity factor~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.3~~ — ~~Frequency domain mitigation~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.4~~ — ~~Shielding Effects~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.5~~ — ~~Thermal Radiations~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.6~~ — ~~Installation requirements/site registration~~

~~This requirement does not apply to any DUT.~~

### ~~6.9.7~~ Deactivation mechanism

~~Verification of the deactivation mechanism according to the requirements defined in annex D shall be performed.~~

~~The DUT shall be tested with the setup described in clause 6.1.1 or 6.1.2 depending on DUT dimensions.~~

~~Any emission from the DUT shall cease within 10 seconds of the de-activation mechanism being switched off or released by the operator (ECC/DEC/(06)08 [i.2]).~~

NOTE: There are particular cases where the equipment is mounted in a vehicle for the collection of data where the de-activation time required is 60 seconds.

The result shall be recorded in the test report.

## Annex A (normative/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.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.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 302 066  |   |                                     |   |                            |           |
|--|---|-------------------------------------|---|----------------------------|-----------|
| The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.1] |   |                                     |   |                            |           |
| Requirement  |   |                                     |   | Requirement Conditionality |           |
| No   | Description                                     | Essential requirements of Directive | Reference: Clause No(s) of the present document | U/C                        | Condition |
| 1  | Operating bandwidth<br>Bandwidth(s)             | 3.2                                 | 4.3.1   | U                          |           |
| 2  | Exterior limits<br>All undesired emissions      | 3.2                                 | 4.3.4   | U                          |           |
| 3  | <del>Deactivation mechanism</del>               |                                     | <del>4.7.7</del>                                | <del>U</del>               |           |
| 4  | Receiver spurious emissions                     | 3.2                                 | 4.4.2   | U                          |           |
| 5  | Receiver interference handling<br>dynamic range | 3.2                                 | 4.4.3   | U                          |           |
| 6  | Receiver blocking                               | 3.2                                 | 4.4.4   | U                          |           |
| 6  | <del>Deactivation mechanism</del>               | 3.2                                 | <del>4.5.1</del>                                | <del>U</del>               |           |

### 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.

#### Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

#### Clause Number(s) of the present document

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

#### Requirement Conditionality:

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

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

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

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

## ~~Annex B (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 manufacturer 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 General Information by ETSI EN 302 066, 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 by ETSI EN 302 066, clause 4.3~~

### ~~B.3.1 — Introduction~~

~~In accordance with ETSI EN 302 066, clause 4.3, the following information is provided by the manufacturer.~~

### ~~B.3.2 — Operational bandwidth(s) of the equipment~~

- ~~• Operational Bandwidth 1: ..... MHz to ..... MHz~~
- ~~• Operational 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, etc.~~

- ~~• Operational bandwidth(s)~~

~~.....~~

- ~~• Exterior Limits~~

~~.....~~

## ~~B.4 — RX test Information by ETSI EN 302 066, clause 4.4~~

### ~~B.4.1 — Introduction~~

~~In accordance with ETSI EN 302 066, clause 4.4, the following information is provided by the manufacturer.~~

### ~~B.4.2 — Performance criterion and level of performance~~

- ~~• performance criterion (e.g. accuracy, sensitivity)~~  
~~.....~~
- ~~• level of performance (e.g. for accuracy  $\pm 10$  %, level of sensitivity)~~  
~~.....~~

### ~~B.4.3 — Interfering signals~~

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

## ~~B.5 Additional information provided by the applicant~~

### ~~B.5.1 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:~~

.....

.....

### ~~B.5.2 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): Radiated measurements~~

### ~~C.1 — Test sites and general arrangements for measurements involving the use of radiated fields~~

#### ~~C.1.0 — General~~

~~Both, an Open Area Test Site (OATS) or indoor test site may be used for radiated tests.~~

~~The distance used in actual measurements shall be recorded with the test results.~~

~~Test sites shall be flat, with no artificial ground plane and clear of underground obstructions. The test bed shall be constructed such that the surface is flat with the surrounding test site. The DUT shall be deployed in the manner of intended use as described in the manufacturer's literature.~~

~~The method of measurement shall be in accordance with that described in CISPR 16-1 [3], as far as possible.~~

~~Near noise correction (radiometric) methods can also be used to perform accurate measurements at and below the noise floor of a spectrum analyser. The radiometer consists of a band pass filter, a low noise amplifier and a spectrum analyser. The DUT is set 3 metres away from the measuring test antenna and remotely operated from a measurement room.~~

~~To minimize coupling loss, the test antenna, filter and LNA shall be connected directly.~~

~~When the measurement equipment combines a spectrum analyser with an oscilloscope (i.e. the SA puts the IF signal as external output signal which is measured by the oscilloscope), the oscilloscope input bandwidth shall be over 500 MHz.~~

#### ~~C.1.1 — Test antenna~~

~~A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the DUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.~~

~~The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 metre to 4 metres).~~

~~In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [i.3]) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.~~

~~NOTE: — The gain of a horn antenna is generally expressed relative to an isotropic radiator.~~



## ~~C.1.2 Measuring antenna~~

The measuring antenna is used in tests on a DUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric field strength in the vicinity of the DUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [i.3]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the DUT.

## ~~C.2 Guidance on the use of radiation test sites~~

### ~~C.2.0 General~~

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

### ~~C.2.1 Verification of the test site~~

Verification procedures, as far as applicable, for different types of test sites are given in the relevant part of ETSI TR 102 273 [i.4] or equivalent.

### ~~C.2.2 Preparation of the DUT~~

The manufacturer should supply information about the DUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of DUT should include, where relevant, carrier power and whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 minute on, 4 minutes off).

Where necessary, a mounting bracket of minimal size should be available for mounting the DUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsawood, etc.

### ~~C.2.3 Power supplies to the DUT~~

All tests should be performed using power supplies wherever possible, including tests on DUT designed for battery only use. In all cases, power leads should be connected to the DUT'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 DUT. 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 DUT and down to either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

### ~~C.2.4 Range length~~

The range length for all these types of test facility should be adequate to allow for testing in the far field of the DUT i.e. it should be equal to or exceed:

$$\frac{2(d_1 + d_2)^2}{\lambda} \quad (\text{C.1})$$

where:

$d_1$  — is the largest dimension of the DUT/dipole after substitution (m);

$d_2$  — is the largest dimension of the test antenna (m);

$\lambda$  — is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far field testing would be:

$$2\lambda$$

It should be noted in test reports when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

## C.2.5 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m 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.

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 logbook results sheet for the specific test.

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

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

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

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

## C.2.6 Conversion of field strength to power limits

The limits in clause 4.3.4.3 are given as power limit. In order to do the conversion of a field strength level to a power level, the following equation shall be used:

$$E = \frac{\sqrt{30 \times e.r.p.}}{R} \quad (C.2)$$

where R is the distance in metres between the equipment under test and the measurement point, e.r.p. is the effective radiated power in Watts of the equipment.

---

## Annex D (normative): Deactivation mechanism

The deactivation mechanism of the equipment is a function which deactivates the equipment when normal use is interrupted.

The following requirements shall be fulfilled according to the provisions of ECC/DEC/(06)08 [i.2]:

- Manually operated GPR and WPR, which is intended to be used as handheld equipment, shall contain a manually operated non-locking switch (e.g. it may be a sensor for the presence of the operators hand or a movement sensor) which ensures that the equipment de-activates (i.e. the transmitter switches off) within 10 seconds of being released by the operator.
- In the case of remotely/computer controlled imaging equipment, the equipment shall be de-activated via the control system provided that de-activation takes place within 10 seconds of the control system being switched off or released by the operator.
- GPR and WPR equipment shall be designed to operate while in contact with, or in close proximity, or within one ~~meter~~metre of, to the ground or the wall, and their emissions being directed into the ground or wall (e.g. measured by a proximity sensor or imposed by the mechanical design). Manufacturers shall provide instruction manuals for the equipment which include a description for its use and deployment (positioning) during operation.
- There are particular cases where the equipment is mounted in a vehicle for the collection of data where the de-activation time required is 60 seconds.

## Annex E (informative): Measurement antenna and preamplifier specifications

The radiated measurements set up in clause 6.3 specifies the use of the wide band horn antenna and a wide band, high gain preamplifier in order to measure the very low radiated power density level from the DUT.

Table E.1 gives examples of recommended data and features for the horn antenna and preamplifier to be used for the test set up.

**Table E.1: Recommended performance data for preamplifier and horn antenna**

| Pre-amplifier                  |                               |
|--------------------------------|-------------------------------|
| Parameter                      | Data                          |
| Bandwidth                      | < 1 GHz to > 15 GHz           |
| Noise figure                   | < 2 dB                        |
| Output at 1 dB compression     | > +10 dBm                     |
| Gain                           | > 30 dB                       |
| Gain flatness across band      | ±1,5 dB                       |
| Phase response                 | Linear across frequency range |
| Impulse response overshoot     | < 10 %                        |
| Impulse response damping ratio | 0,3 to 0,5                    |
| VSWR in/out across band        | 2:1                           |
| Nominal impedance              | 50 Ω                          |
| Horn antenna                   |                               |
| Parameter                      | Data                          |
| Gain                           | > 4 dBi                       |
| 1 dB bandwidth                 | < 1 GHz to > 15 GHz           |
| Nominal impedance              | 50 Ω                          |
| VSWR across band               | < 1,5:1                       |
| Cross polarization             | > 20 dB                       |
| Front to back ratio            | > 20 dB                       |
| Tripod mountable               | Yes                           |
| Robust precision RF connector  | Yes                           |

Measuring the complete emission spectrum of the operating frequency range, several measurement antennas will be required, each optimized over a distinct frequency range.

**Table E.2: Recommended measurement antennas**

| Antenna type                         | Frequency range      |
|--------------------------------------|----------------------|
| $\lambda/2$ - dipole or biconical    | 30 MHz to 200 MHz    |
| $\lambda/2$ - dipole or log periodic | 200 MHz to 1 000 MHz |
| Horn                                 | > 1 000 MHz          |

## CF (normative): Calculation of the Mean Power Density

### FC.0 General

Maximum mean power densities and peak power densities of any emission emanating from GPR/WPR imaging systems are defined below. For pragmatic reasons and for taking the mitigation factors into account, the mean power density shall be determined by formula (FC.1) or (FC.2) and the peak values shall be measured according to clause 6.2.5-6.

NOTE: GPR/WPRs operate across a wide range of spectrum where established radio services operate. These services have diverse bandwidths, some may be susceptible to peak signal levels and others to average signal levels. There are technical and practical issues, related to bandwidth, the effective loading of the GPR/WPRs radiation by earth materials and the limitations of instrumentation. Peak signal levels are measured according to clause 6.2.5.6 and average signal levels calculated based upon the duty cycle of the GPR/WPR.

a) ~~a)~~—The mean power density of any emission emanating from GPR/WPR imaging systems shall be kept to a minimum and not exceed the limits in table ~~FC.1~~.

**Table ~~F-4~~C.1: Maximum mean e.i.r.p. of any emission emanating from GPR/WPR imaging systems ~~[i.2]~~(based on ECC/DEC/(06)08 [i.2], Annex 1)**

| Frequency range (MHz) | Maximum mean e.i.r.p. density (dBm/MHz) |
|-----------------------|---|
| < 230                 | -65                                     |
| 230 to 1 000          | -60                                     |
| 1 000 to 1 600        | -65 (see note)                          |
| 1 600 to 3 400        | -51,3                                   |
| 3 400 to 5 000        | -41,3                                   |
| 5 000 to 6 000        | -51,3                                   |
| > 6 000               | -65                                     |

NOTE: In addition to the maximum mean e.i.r.p. density given above, a maximum mean e.i.r.p density of ~~-75~~ dBm/kHz applies in the RNSS bands 1 164 MHz to 1 215 MHz and 1 559 MHz to 1\_610\_MHz in case of spectral lines in these bands. Peak power shall be measured according to clause 6.2.5.6 of the present document and mean power density shall be determined from formula (~~FC.1~~) or (~~FC.2~~) set out below.

e)b) ~~b)~~—The measured radiated peak power of any emission emanating from GPR/WPR imaging systems shall not exceed the limits as given in clause 4.3.4.3 (table 2), measured according to clause 6.2.5.6.

f)c) ~~e)~~—The time domain architecture of GPR/WPRs and patterns of use imply that there is wide variation in the total power emitted in any time period. For pulsed systems this includes the duration of pulses compared to the time between pulses, the time between bursts of pulses when the system is being moved to the next measurement position and other operational factors. This should be taken into account when considering the mean power that may be incident upon a vulnerable radio service. In order to accommodate all these factors a conversion factor shall be used to evaluate the mean power that should be compared to the limits in table ~~FC.1~~. This conversion factor has been established as a simple and practical way to assess mean power levels based on the measurement of peak power levels.

When determining mean power values, for pulsed systems, to be compared with the values in table ~~FC.1~~ the following formula shall be used:

$$\text{Power}_{\text{mean}} = \text{Power}_{\text{peak}} + \text{conversion\_factor} \quad (\text{F-4})\text{C.1}$$

with:

$$\text{conversion factor} = 10 \log(\text{PRF} \times \tau) \quad (\text{C.2})$$

where:

$\tau$  is the pulse width of the GPR/WPR transmitter measured at the 50 % amplitude points of the envelope at boresight with an UWB probe and a suitable oscilloscope. When performing this measurement, care should be taken that the pulse is properly gated, i.e. no reflectors should be allowed to influence the pulse while travelling from the GPR/WPR transmitter to the UWB probe. The UWB probe/antenna shall have a bandwidth wide enough to capture the UWB signal from the GPR/WPR properly.

PRF is the pulse repetition frequency.

For systems using step-frequency waveforms, the wideband signal is formed by transmitting a sequence of discrete frequencies each having a DwellTime (DT). The length of the total sequence is referred to as the ScanTime (ST). The Scan Time is identical to the Cycle Time in frequency hopping systems, and it is the interval between each time the transmitter is hopping back to the first frequency in the sequence.

For calculating the mean power value for a step-frequency system, the following formula shall be used:

$$\text{Power}_{\text{mean}} = \text{Power}_{\text{peak}} + \text{conversion\_factor} \quad (\text{F.2})\text{C.3}$$

with:

$$\text{conversion\_factor} = 10 \log(\text{DT}/\text{ST}) \quad (\text{C.4})$$

where:

- DT is measured at the 50 % amplitude points of the envelope at boresight with an UWB probe and a spectrum analyser in zero-span mode at a frequency near the maximum of the radiated spectrum using 1-MHz resolution bandwidth. ST is measured in the same way using a spectrum analyser in zero-span mode and 1 MHz resolution bandwidth.

## FC.1 Measurement of $\tau$ , transmit pulse width

### C.1.0 Introduction

There are two ways of measuring  $\tau$ , time domain (see clause C.1.1) and frequency domain methods (see clause C.1.2).

### C.1.1 Time domain

The GPR antenna is lifted off the ground and pointed directly towards the measurement antenna, see figure FC.1. The distance between the DUT and receive antenna shall be greater than one wavelength (at the lowest frequency radiated). Care shall be taken so that there are no unwanted multipath reflections included in the time interval where the pulse width measurement is carried out. The non-dispersive antenna/UWB-probe shall have a fractional bandwidth wide enough to represent the UWB, signal (GPR/WPR typically have a fractional bandwidth greater than 100 %).

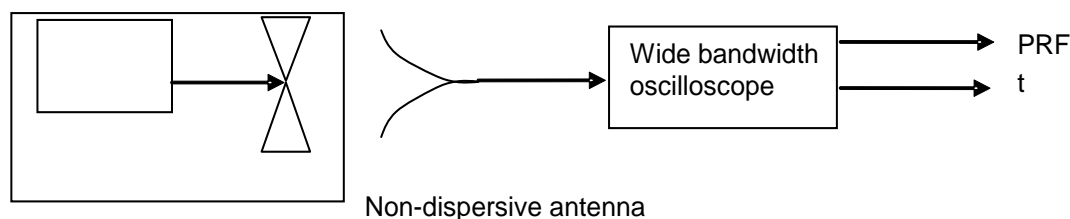


Figure F.4:C.1: Test setup 1

### C.1.2 Frequency domain

The RF bandwidth of a single pulse modulated carrier is approximately equal to  $1/\tau$ . By measuring the occupied bandwidth an equivalent pulse width is calculated. There is no need to have a non-dispersive antenna or oscilloscope any more, the measurement is done with the same antenna and spectrum analyser as for the peak power measurement as per clause 6.5.32.2, but with the GPR and measurement antenna facing each other, see figure FC.2.

To avoid multipath reflections distorting the measurement, this test shall be carried out in an open test area or in an anechoic room.

$$\tau = 1/(\text{F}_H - \text{F}_L), -10 \text{ dB measurement points (see clause 6.5.3)} \quad (\text{F.3})\text{2.2}$$

(C.5)

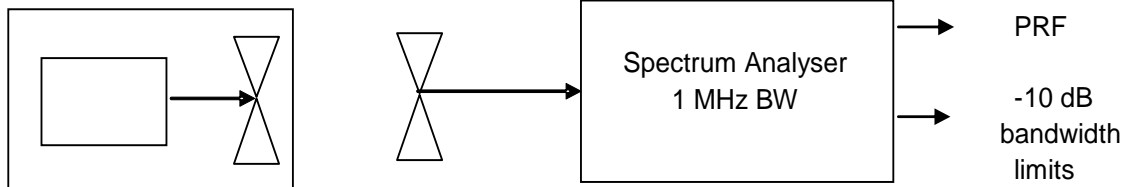


Figure F.2:C.2: Test setup 2

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## Annex D (normative): Receiver parameters for GPR/WPR

### D.0 General

Ground- and Wall- Probing Radar imaging systems applications and are used in survey and detection applications. GPR/WPR systems are not intended for communications purposes, and the intended signal is not radiated into free space. Thus, "classical" parameters for a radiocommunications receiver as provided in ETSI EG 203 336 [i.6] are inappropriate to GPR/WPR because of the peculiar unique sensing (non-traditional communications and radar) use of this technology.

Specifically, GPR/WPR are imaging devices where detection is ultimately based on the minimum acceptable Signal to Noise Ratio (SNR<sub>min</sub>) to perform a detection; in other words, the minimum input signal at the receiver stage recalled in ETSI EG 203 336 [i.6], is the one that surpass the received noise by a specific amount, so that the relevant target becomes detectable by the operator.

This "detection threshold" is largely dependent on the operator's skill and experience, but is generally considered 3 dB minimum; thus a target would become detectable by the GPR/WPR user if its signal produced by such target exceeds the received noise level by at least 3dB. However, in the following this threshold is set to 0 dB (worst case).

It is also important noting that the received noise level is dependent on the gain of the receiver signal chain which could not be measurable in GPR/WPRs (e.g. in integral antenna devices); thus, an absolute specification for this parameter cannot be given. However, the difference between the maximum signal that the receiver signal detection circuitry can tolerate before clipping or distorting the signal and such received noise level, is not affected by that gain; further, this parameter also affects another important feature for the GPR/WPRs which is the maximum detection range (i.e. the maximum exploration range for the system).

Given the considerations above, it was concluded that the receiver dynamic range and the receiver blocking can be used as a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted input signal.

---

## D.1 Resilience of GPR/WPR receiver against interferences

### D.1.0 Introduction

A GPR/WPR is designed to be moved for scanning and detecting targets that are embedded in a lossy dielectric media (e.g. the ground); this is obtained by measuring the electromagnetic field back-scattered by those targets. Because of the need of working even in presence of large signal absorption by the propagation medium and the desire to detect the smallest size of object possible, the resilience against any interfering signal is crucial to not reducing the exploration depth.

GPR/WPR performance is maximized by processes that will ultimately increase the desired signal and minimize all undesired signals; the most common undesired signals for a GPR/WPR are:

- a) electronic noise generated in the receiver electronics;
- b) signals generated in the transmitter system that are undesired and enter the receiver electronics by any path (also called "direct transmit/receive antenna leakage");
- c) electromagnetic signals from external sources (radio transmissions, cell phones, etc.) that enter the receiver electronics via the receive antenna or some other path;
- d) signals from extraneous features in the propagation medium that may mask the response of the desired target (often referred to as clutter noise).

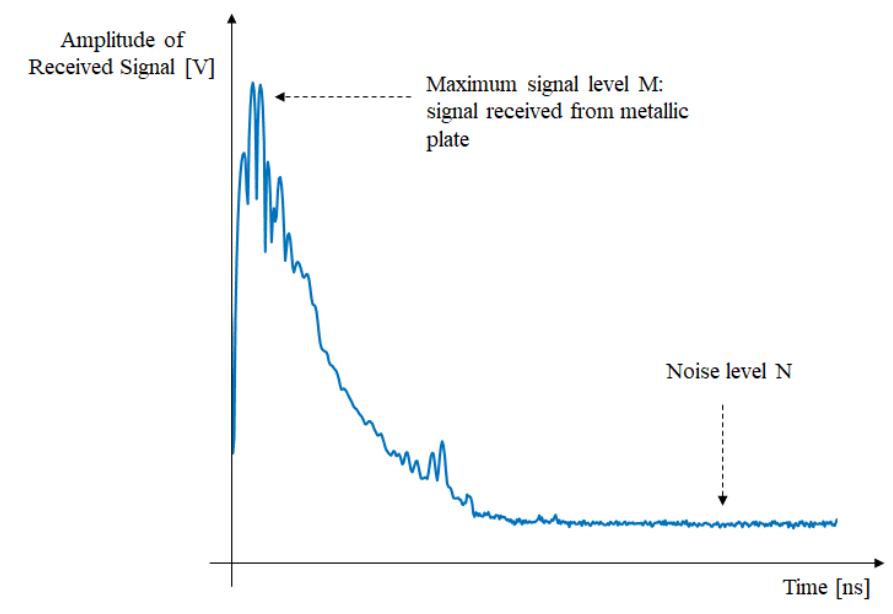


Obviously, receiver resilience against the latter's cannot be evaluated and even specified; as explained in the following paragraphs, the performance criterion used for the receiver requirement for GPR/WPR (clauses 4.4.3 and 4.4.4) takes into consideration signals a), b) and c) above.

### D.1.1 Maximum signal M for the RX in the linear region of operation

The maximum signal M for the receiver in the linear region of operation is defined as the maximum absolute value (in Volts) occurring in the signal received by the GPR/WPR when suspended 5 cm above a plane metal.

In this setup, with the interfering signal switched off, M overvalues the direct transmit/receive antenna leakage and represents the maximum signal the GPR/WPR can receive when operating. The graph in figure D.1 represents that received signal which is decaying with respect to time and hence distance from the GPR/WPR.



**Figure D.1: Example of GPR/WPR received and averaged signal - the maximum level is the reflection from the metallic plate**

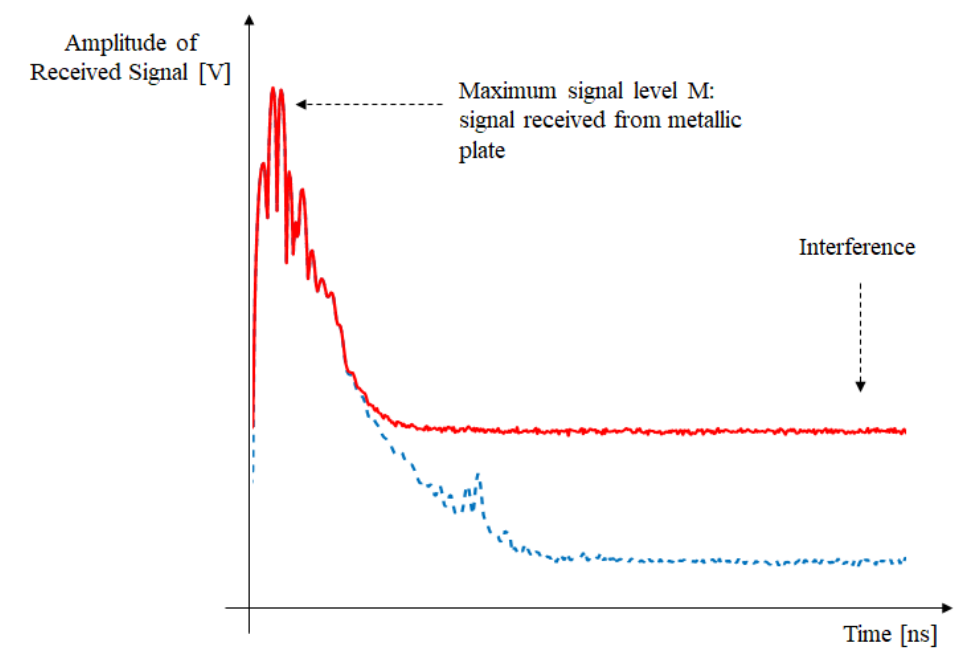
### D.1.2 Noise level N for the RX in the linear region of operation

The noise level N is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window with the interferer deactivated. This constitutes the minimum signal that the GPR/WPR can receive in this setup.

### D.1.3 Signal I recorded in presence of the interferer

The signal I is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window with the interferer activated.

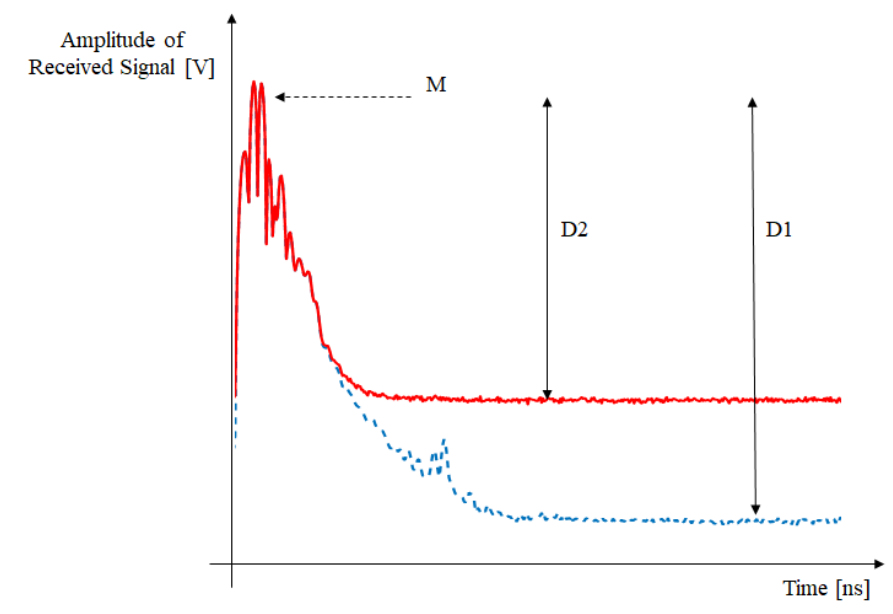
In this condition, the presence of the interferer may produce an increase of the noise received by the GPR/WPR which can hide reflections from weaker targets (figure D.2).



**Figure D.2: Example of GPR/WPR received with the interferer activated**

## D.2 Performance criteria for GPR/WPR

Basing on concepts illustrated above, for GPR/WPR the receiver performance criteria are set upon the dynamic range D1 and the difference D2 between the maximum signal M and output signal I in presence of the interferer (see figure D.3).



**Figure D.3: Performance criterion for GPR/WPR**

As indicated above, M is the maximum signal that the receiver senses, whereas N is the noise floor below which detectable return signals are not discernible; in this sense, it can be concluded that the low input signal level at the receiver ("wanted signal") is the one that exceeds by some amount the noise floor; this, in fact, is the minimum signal the operator of a GPR/WPR can detect, no matter of the characteristics of the target detected by the GPR/WPR which is producing such signal.

According to that, the term dynamic range for a GPR/WPR is specified by the parameter D1 in clause 4.4.3.2; this requires the evaluation of the DUT maximum signal, M and the noise floor, N.

The parameter so defined in dB ( $D1 = M - N$ ) establishes a specified level of performance to be reached by the equipment (i.e. this can be interpreted as the "pre-determined level of performance" for a GPR/WPR in the specific test scenario), so that can be used to set a specification for the receiver sensitivity.

Performance of the GPR/WPR receiver in the presence of an external noise source is also assessed based on comparison with the parameter D1. The presence of a noise source will obviously impact the noise floor and change the value reducing the system sensitivity to weak signals. Setting a minimum required value for the parameter D2 is a meaningful method for assessing the resilience of GPR/WPR against interferences.

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## D.3 Justification for missing RX requirements from ETSI EG 203 336

ETSI EG 203 336 [i.6] uses the signal interferer handling concept from ETSI TS 103 361 [2], which has been developed for very broadband UWB applications (e.g. having more than 500 MHz bandwidth); these devices have a so called underlay regulation, with extremely low emission limits in the order of the EMC limits and even below.

The interferer signal handling concept requires a receiver test with the three strongest expected interferer within the operating bandwidth; in the present document (ETSI EN 302 066) this test is described as "blocking". It is therefore assumed that a GPR/WPR complying with such strong inband interferer will automatically comply with signals with the same magnitude in adjacent bands; therefore receiver tests outside the operating band are deemed as unnecessary.

Given that, other parameters listed in ETSI EG 203 336 [i.6] are linked to the selected receiver performance criteria in this standard as explained here below:

- Sensitivity: the received noise is measured and used in the dynamic range clause.
- Adjacent channel selectivity: this parameter is included in the clause on GPR/WPR blocking.
- Co-channel rejection: this parameter is covered by the signal interferer handling concept used with the receiver blocking test.
- Spurious response rejection, Intermodulation and Reciprocal Mixing: these parameters are covered by the signal interferer handling concept used with the receiver blocking test.
- Desensitization this is covered by the signal interferer handling concept with the three strongest inband interferer used with the dynamic range test.

## Annex GE (normative): Characteristics of the sand for the conformance test suites

### E.1 General

The setup for testing the compliance of large GPR/WPR includes a pit filled with dry sand.

The purpose of this pit is to maximize the energy coupling into the subsurface, thus enabling the measurement of emissions that are radiated by GPR/WPR in all directions above the ground ("undesired emissions"). The specification of the sand for the pit is given in clause E.2.

The requirement of maximizing the energy coupling into the subsurface, imposes the use of a non-conductive, high impedance material directly under the GPR/WPR antenna; in fact, the use of an high conductivity, low impedance soil just below the antenna, will essentially 'short out the antenna', thus resulting in a wrong measurement of the undesired emissions.

For that reason, the pit in the test setup for large GPR/WPR is filled with dry, non-conductive sand that allows energy to transition to much lower impedance soil (wet and possibly high conductivity soil) that appears at greater depth.

In this sense, the dry sand play much the same role as tapered foam absorber used in test facilities. The goal for the absorber is to graduate the impedance with distance to minimize spurious reflections from the test facility structure.

### E.2 Physical characteristics of the sand for the test setup

Sand to be used for filling up the pit in the test setup for large GPR/WPR shall have the following characteristics:

- a) Name: silica sand
- b) Origin: river sand or crushed stone sand
- c) Chemical Composition: SiO<sub>2</sub> > 80 %
- d) Classification: Coarse sand (i.e. passing through a sieve with clear openings of 3,175 mm)
- e) Loss on ignition (LOI): < 2,2 %

NOTE: The Loss On Ignition parameter is obtained by measuring the weight change of a sample after it has been heated to high temperature causing some of its content to burn or to volatilise. In the case of silica sand, this parameter is related to the humidity content (as lower the parameter, as drier the sand). The verification procedure to assess the LOI of the sand is described in clause E.3.

### E.3 Verification of the humidity content of the sand

In order to verify the dryness of the sand in the test setup for large GPR/WPR, the measurement of the Loss On Ignition (LOI) parameter is required.

Loss on ignition describes the process of measuring the weight change of a sample after it has been heated to high temperature causing some of its content (i.e. the water in this case) to burn or to volatilise.

A sample of the sand extracted from the test setup is placed in weighed container and weighed; weight loss is measured after heating the sample overnight at 100°C to remove water.

When determining the Loss On Ignition (LOI) to be compared with the value in clause E.2, the following formula shall be used:

$$LOI = 100 \times \frac{(\text{weigh before heating} - \text{weight after heating})}{\text{weight before heating}} \quad (E.1)$$

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## Annex F (informative): Bibliography

- ETSI EN 301 489-33 (V2.1.1) ~~(02-2017)~~: "ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Harmonised Standard covering the essential requirements of article 3.1b of the Directive 2014/53/EU; Part 33: Specific conditions for Ultra-~~Wide Band~~-WideBand (UWB) devices".
- EC Decision 2014/702/EU: "Commission Decision of 7 October 2014 amending 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community".
- 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).

## Annex H<sub>G</sub> (informative): Change History

Table to cover paragraph 2 of Article 5 of the Standardization request.

| Date                     | Version | Information about changes  |
|--------------------------|---------|--|
| <del>February 2008</del> | 1.2.1   | Last publication as HS under <del>RTT&amp;ER</del> TTE   |
| <del>October 2016</del>  | 2.1.1   | Revision for compliance with Directive 2014/53/EU<br>Out-sourcing of standard measurement procedures into a separate ETSI EN 303 883 (V1.1.1)<br>New requirement on Interferer signal handling<br>New annex B "Application form for testing" |
| <u>2.2.1</u>             |         | Revision of requirement on receiver conformance  |

## History

| <b>Document history</b> |                         |  |
|-------------------------|-------------------------|--|
| V1.1.1                  | September 2005          | Publication as ETSI EN 302 066 part 1 and part 2                       |
| V1.2.1                  | February 2008           | Publication as ETSI EN 302 066 part 1 and part 2                       |
| <del>V2.1.0</del>       | <del>April 2016</del>   | <del>EN Approval Procedure AP 20160705: 2016-04-06 to 2016-07-05</del> |
| <del>V2.1.1</del>       | <del>October 2016</del> | <del>Vote V 20161223: 2016-10-24 to 2016-12-23</del>                   |
| V2.1.1                  | January 2017            | Publication  |
| <u>V2.2.0</u>           | <u>April 2019</u>       | <u>EN Approval Procedure AP 20190715: 2019-04-16 to 2019-07-15</u>     |
| <u>V2.2.1</u>           | <u>April 2020</u>       | <u>Vote V 20200609: 2020-04-10 to 2020-06-09</u>                       |
| <u>V2.2.1</u>           | <u>June 2020</u>        | <u>Publication</u>   |