# Draft ETSI EN 302 502 V1.1.1 (2005-08)

*Candidate Harmonized European Standard (Telecommunications series)*

# Broadband Radio Access Networks (BRAN); 5,8 GHz fixed broadband data transmitting systems; Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive

Reference

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# Foreword

This Candidate Harmonized European Standard (Telecommunications series) has been produced by ETSI Project Broadband Radio Access Networks (BRAN), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 98/34/EC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Directive 1999/5/EC [1] 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 ("the R&TTE Directive").

Technical specifications relevant to Directive 1999/5/EC are given in annex A.

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

# Introduction

The present document is part of a set of standards designed to fit in a modular structure to cover all radio and telecommunications terminal equipment under the R&TTE Directive [1]. Each standard is a module in the structure. The modular structure is shown in figure 1.

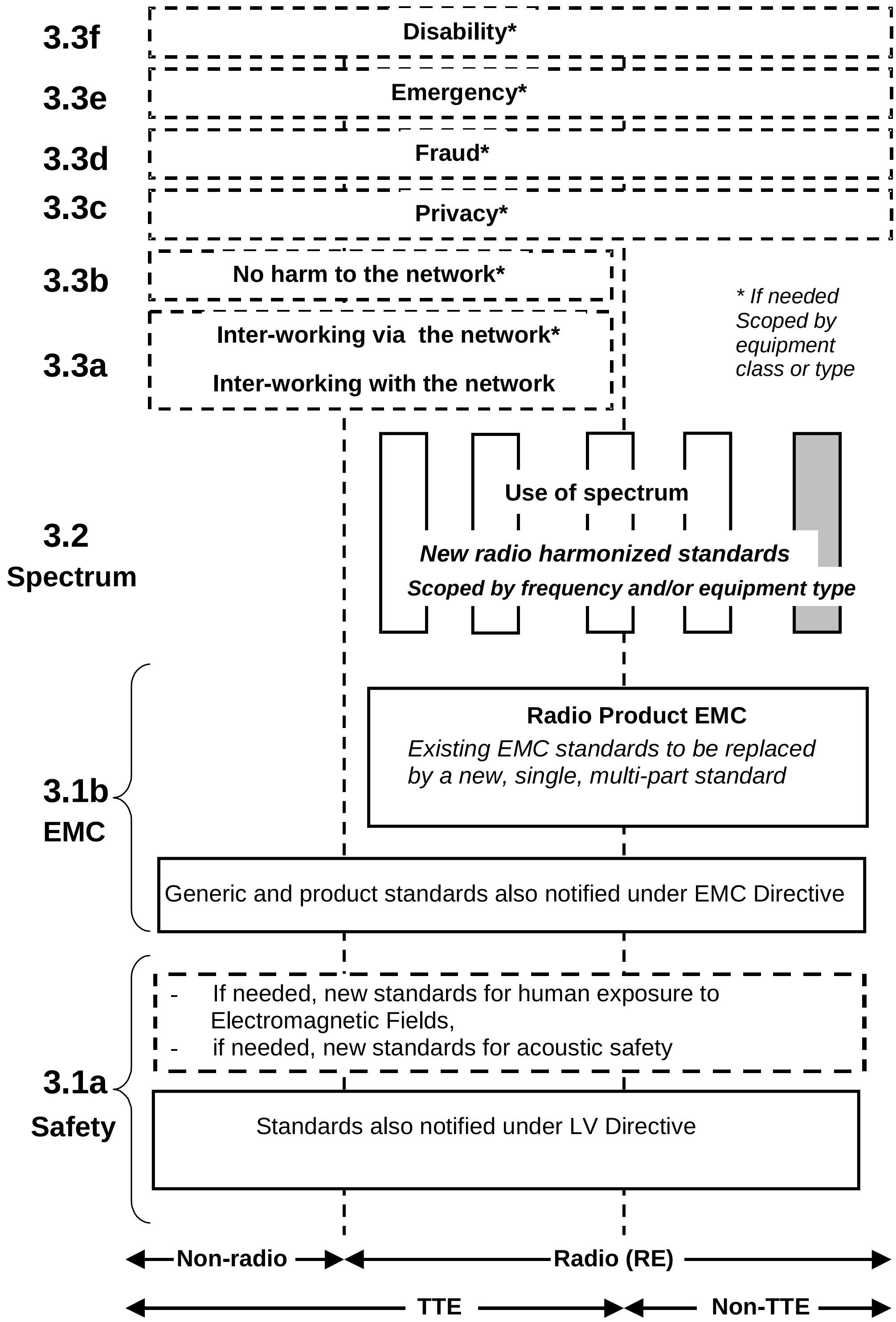



**Figure 1: Modular structure for the various standards used under the R&TTE Directive [1]**

The left hand edge of figure 1 shows the different clauses of Article 3 of the R&TTE Directive [1].

For article 3.3 various horizontal boxes are shown. Dotted lines indicate that at the time of publication of the present document essential requirements in these areas have to be adopted by the Commission. If such essential requirements are adopted, and as far and as long as they are applicable, they will justify individual standards whose scope is likely to be specified by function or interface type.

The vertical boxes show the standards under article 3.2 for the use of the radio spectrum by radio equipment. The scopes of these standards are specified either by frequency (normally in the case where frequency bands are harmonized) or by radio equipment type.

For article 3.1b the diagram shows the new single multi-part product EMC standard for radio, and the existing collection of generic and product standards currently used under the EMC Directive [2]. The parts of this new standard will become available in the second half of 2000, and the existing separate product EMC standards will be used until it is available.

For article 3.1a the diagram shows the existing safety standards currently used under the LV Directive [3] and new standards covering human exposure to electromagnetic fields. New standards covering acoustic safety may also be required.

The bottom of figure 1 shows the relationship of the standards to radio equipment and telecommunications terminal equipment. A particular equipment may be radio equipment, telecommunications terminal equipment or both. A radio spectrum standard will apply if it is radio equipment. An article 3.3 standard will apply as well only if the relevant essential requirement under the R&TTE Directive is adopted by the Commission and if the equipment in question is covered by the scope of the corresponding standard. Thus, depending on the nature of the equipment, the essential requirements under the R&TTE Directive may be covered in a set of standards.

The modularity principle has been taken because:

- it minimizes the number of standards needed. Because equipment may, in fact, have multiple interfaces and functions it is not practicable to produce a single standard for each possible combination of functions that may occur in an equipment;
- it provides scope for standards to be added:
    - under article 3.2 when new frequency bands are agreed; or
    - under article 3.3 should the Commission take the necessary decisions, without requiring alteration of standards that are already published;
- it clarifies, simplifies and promotes the usage of Harmonized Standards as the relevant means of conformity assessment.

# 1 Scope

The present document is applicable to radio equipment for Fixed Broadband Data Transmitting Systems operating in the 5,8 GHz band (5 725 MHz to 5 875 MHz) as covered by ERC Decision [TBD]. The document is equally applicable to systems utilizing integral or non integral antennas.

The present document is intended to cover the provisions of Directive 1999/5/EC [1] (R&TTE Directive) Article 3.2, which states that: "… radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference".

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

[1] 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).

[2] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).

[3] Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LVD Directive).

[4] ETSI EN 300 019: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[5] ETSI TR 100 028-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1".

[6] ETSI TR 100 028-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

[7] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in the R&TTE Directive [1] and the following apply:

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

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

**operating nominal RF channel width:** nominal amount of spectrum used by a single device operating on an identified centre frequency

**environmental profile:** declared range of environmental conditions under which equipment within the scope of EN 302 502 is required to be compliant

**in-service monitoring:** mechanism to check a channel in use by the device for the presence of a radar signal with a level above the Interference Detection Threshold

**Integral antenna:** antenna which is declared to be part of the radio equipment by the supplier

NOTE: Even when equipment with an integral antenna is concerned, it might still be possible to separate the antenna from the equipment using a special tool. In such cases the assessment of the radio equipment and of the antenna against requirements of this multipart EN may be done separately.

**Orthogonal Frequency Division Multiplexing (OFDM):** multiplexing method where the transmitted signal is composed of multiple narrow band OFDM-sub-carriers, all modulated in parallel

**Orthogonal Frequency Division Multiple Access (OFDMA):** access method related to the OFDM multiplexing method where only a subset of the OFDM-sub-carriers are used by any single transmitter, allowing multiple transmitters to transmit at the same time on disjoint sets of OFDM-sub-carriers

**OFDM-sub-carrier:** physical sub-division of the channel as determined by the manufacturer for OFDM and OFDMA systems.

NOTE: The complete set of discrete sub-carriers is distributed throughout the assigned channel. With OFDM (and OFDMA), individual symbols are represented by all (or some) of the sub-carriers operating in concert rather than by individual sub-carriers.

**OFDMA-sub-channel:** logical channel for transmission or control purposes, comprising a set of physical OFDM sub-carriers.

NOTE: The specific sub-carriers associated with a particular sub-channel are usually dynamically distributed throughout the whole channel bandwidth. The minimum number of sub-carriers that may comprise a sub-channel is dependent on the system design.

**simulated radar burst:** series of periodic radio wave pulses, separated by an interburst period during which no pulses are transmitted.

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

**Transmit Power Control Range:** power range over which the TPC is able to control the transmitter output power

## 3.2 Symbols

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

| | |
|---|---|
| A | Measured power output (dBm) |
| B | Radar burst period |
| $Ch_f$ | Channel free from radars |
| $Ch_r$ | Channel occupied by a radar |
| ChS | Nominal occupied channel bandwidth |
| D | Measured power density |
| E | Field strength |
| $E_o$ | Reference field strength |
| $f_c$ | Carrier frequency |
| G | Antenna gain (dBi) |
| L | Radar burst length |
| n | Number of channels |

| | |
|---|---|
| $P_{cond}$ | The conducted power level of the equipment |
| $P_{cond\_1}$ | The maximum useable conducted power level from the equipment |
| $P_{cond\_2}$ | The maximum conducted power level from the power range associated with the highest useable antenna assembly gain |
| $P_{cond\_3}$ | The minimum conducted power level from the equipment |
| $P_{eirp}$ | The EIRP of the equipment |
| PD | Calculated power density |
| R | Distance |
| $R_o$ | Reference distance |
| S0 | Signal power |
| T0 | Time instant |
| T1 | Time instant |
| T2 | Time instant |
| T3 | Time instant |
| W | Radar pulse width |
| x | Observed duty cycle |

## 3.3 Abbreviations

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

| | |
|---|---|
| DFS | Dynamic Frequency Selection |
| EIRP | Equivalent Isotropically Radiated Power |
| EMC | Electro-Magnetic Compatibility |
| ERP | Effective Radiated Power |
| LV | Low Voltage |
| ppm | parts per million |
| PRF | Pulse Repetition Frequency |
| OFDM | Orthogonal Frequency Division Multiplexing |
| OFDMA | Orthogonal Frequency Division Multiple Access |
| R&TTE | Radio and Telecommunications Terminal Equipment |
| TPC | Transmit Power Control |
| Tx | Transmit, Transmitter |
| UUT | Unit Under Test |

# 4 Essential requirements specification

With reference to Article 3.2 of Directive 1999/5/EC [1] the phenomena in this clause have been identified as relevant to the essential requirements.

## 4.1 Designation of centre frequencies and frequency error

### 4.1.1 Definition

The equipment shall only operate in channels centred on any of the nominal channel centre frequencies f c, identified by the following expression:

5 725 + (n * 2,5) MHz, where n = 2 to 58 for ChS = 10 MHz

where n = 4 to 56 for ChS = 20 MHz.

### 4.1.2 Limits

The manufacturer shall declare the centre frequencies on which the equipment can operate.

The actual carrier centre frequency shall be maintained within the range $f_c$ ±20 ppm of the nominal channel centre frequency.

### 4.1.3 Conformance

Conformance tests as defined in clause 5.3.2 shall be carried out.

## 4.2 Transmitter RF output power, EIRP and EIRP spectral density

### 4.2.1 Definition

The RF output power is the mean conducted power applied to the antenna during a transmission burst.

The EIRP spectral density is the mean EIRP spectral density in dBm per MHz during a transmission burst.

### 4.2.2 Limits

The maximum mean equivalent isotropically radiated power, RF power and spectral density when configured to operate at the highest stated power level shall not exceed the limits in table 1.

**Table 1: Maximum mean RF output power, EIRP and power density limits at the highest power level**

| Channel Width ChS | Maximum Mean RF power limit into antenna (dBm) | Maximum mean EIRP limit (dBm) | Maximum Mean EIRP spectral density limit (dBm/MHz) |
|---|---|---|---|
| 10 MHz | 27 | 33 | 23 |
| 20 MHz | 30 | 36 | 23 |

### 4.2.3 Conformance

Conformance tests as defined in clause 5.3.3 shall be carried out.

## 4.3 Transmitter unwanted emissions

### 4.3.1 Transmitter unwanted emissions outside the 5 725 MHz to 5 875 MHz band

#### 4.3.1.1 Definition

These are radio frequency emissions outside the band 5 725 MHz to 5 875 MHz.

#### 4.3.1.2 Limits

The level of unwanted emission shall not exceed the limits given in table 2.

**Table 2: Transmitter unwanted emission limits**

| Frequency range (MHz) | Maximum power EIRP (dBm) | Bandwidth (KHz) |
|---|---|---|
| 30 to 47 | -36 | 100 |
| 47 to 74 | -54 | 100 |
| 74 to 87,5 | -36 | 100 |
| 87,5 to 118 | -54 | 100 |
| 118 to 174 | -36 | 100 |
| 174 to 230 | -54 | 100 |
| 230 to 470 | -36 | 100 |
| 470 to 862 | -54 | 100 |
| 862 to 1 000 | -36 | 100 |
| 1 000 to 5 725 | -30 | 1 000 |
| 5 875 to 26 500 | -30 | 1 000 |

#### 4.3.1.3 Conformance

Conformance tests as defined in clause 5.3.4.1 shall be carried out.

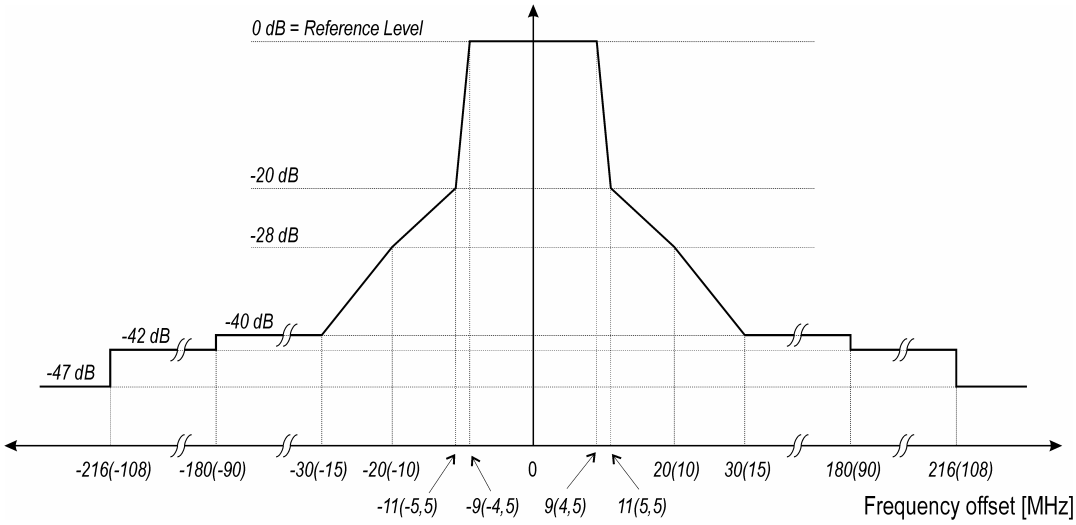
## 4.3.2 Transmitter unwanted emissions within the 5 725 MHz to 5 875 MHz band

#### 4.3.2.1 Definition

These are radio frequency emissions within the band 5 725 MHz to 5 875 MHz.

#### 4.3.2.2 Limits

The average level of the transmitted spectrum based on the declared ChS shall not exceed the limits given in figure 2 when operating under highest conducted output power conditions:




NOTE 1: 0 dB Reference Level is the spectral density relative to the maximum spectral power density of the transmitted signal.

NOTE 2: On the Frequency Offset axis, the figures apply to ChS = 20 MHz whereas the figures in parenthesis apply to ChS = 10 MHz.

**Figure 2: Emission Mask**

#### 4.3.2.3 Conformance

Conformance tests as defined in clause 5.3.4.2 shall be carried out.

# 4.4 Transmitter Power Control

## 4.4.1 Definition

Transmit Power Control (TPC) is a mechanism that shall be used by the equipment to ensure a mitigation factor on the aggregate power from a large number of devices to improve the spectrum sharing conditions.

## 4.4.2 Limit

The equipment shall have the capability to reduce the operating mean EIRP level to a level not exceeding 24 dBm for ChS = 20 MHz and 21 dBm for ChS = 10 MHz.

## 4.4.3 Conformance

Conformance tests as defined in clause 5.3.3 shall be carried out.

# 4.5 Receiver spurious emissions

## 4.5.1 Definition

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

## 4.5.2 Limit

The spurious emissions of the receiver shall not exceed the limits given in table 3.

**Table 3: Spurious radiated emission limits**

| Frequency range | Maximum power | ERP measurement bandwidth |
|---|---|---|
| 30 MHz to 1 GHz | -57 dBm | 100 KHz |
| 1 GHz to 26,5 GHz | -47 dBm | 1 MHz |

## 4.5.3 Conformance

Conformance tests as defined in clause 5.3.5 shall be carried out.

# 4.6 Dynamic Frequency Selection (DFS)

## 4.6.1 Introduction

The equipment shall employ a Dynamic Frequency Selection (DFS) function to detect interference from other systems and to avoid co-channel operation with these systems, notably radar systems.

Radar detection (DFS) is not required in the frequency range 5 850 to 5 875 MHz.

### 4.6.1.1 Operational Modes

Full DFS functionality shall be implemented in all equipment.

#### 4.6.1.2 DFS Operation

The operational behaviour and DFS requirements for all equipment are as follows:

a) the equipment shall use a Radar Interference Detection function in order to detect radar signals;

b) before transmitting on a channel, which has not been identified as an *Available Channel*, the equipment shall perform a *Channel Availability Check* to ensure that there is no radar operating on the channel;

c) during normal operation, the equipment shall monitor the operating channel *(In-Service Monitoring)* to ensure that there is no radar operating on the channel;

d) if the equipment has detected a radar signal during *In-Service Monitoring*, the Operating Channel is made unavailable;

e) the equipment shall not resume any transmissions on this unavailable channel during a period of time after a radar signal was detected. This period is referred to as the *Non-Occupancy Period*.

### 4.6.2 DFS Technical requirements specifications

#### 4.6.2.1 Channel Availability Check

##### 4.6.2.1.1 Definition

The *Channel Availability Check* is defined as the mechanism by which a device checks a channel for the presence of radar signals.

There shall be no transmissions by the device within the channel being checked during this process.

If no radars have been detected, the channel becomes an *Available Channel* valid for a period of time.

The device shall only start transmissions on Available Channels.

At power-up, the device is assumed to have no Available Channels.

##### 4.6.2.1.2 Limit

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

During the *Channel Availability Check*, the device shall be capable of detecting any of the radar signals that fall within the range given by table D.3 with a level above the *Interference Detection Threshold* defined in table D.2.

The detection probability for a given radar signal shall be greater than the value defined in table D.3.

Available Channels remain valid for a maximum period of 24 hours.

##### 4.6.2.1.3 Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

#### 4.6.2.2 In-Service Monitoring

##### 4.6.2.2.1 Definition

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

#### 4.6.2.2.2 Limit

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

The *In-Service-Monitoring* shall start immediately after the device has started transmissions on an *Operating Channel*.

During the *In-Service Monitoring*, the device shall be capable of detecting any of the radar signals that fall within the range given by table D.3 with a level above the *Interference Detection Threshold* defined in table D.2.

The detection probability for a given radar signal shall be greater than the value defined in table D.3.

#### 4.6.2.2.3 Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

### 4.6.2.3 Channel Shutdown

#### 4.6.2.3.1 Definition

The *Channel Shutdown* is defined as the process initiated by the equipment immediately after a radar signal has been detected on an Operating Channel.

The equipment shall stop transmitting on this channel, which it shall do within the *Channel Move Time*.

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

#### 4.6.2.3.2 Limit

The *Channel Shutdown* process shall start immediately after a radar signal has been detected.

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

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

#### 4.6.2.3.3 Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

### 4.6.2.4 Non-Occupancy Period

#### 4.6.2.4.1 Definition

The *Non-Occupancy Period* is defined as the time during which the device shall not make any transmissions on a channel after a radar signal was detected on that channel by either the *Channel Availability Check* or the *In-Service Monitoring*.

NOTE: A new Channel Availability Check is required before the channel can be identified again as an *Available Channel*.

#### 4.6.2.4.2 Limit

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

#### 4.6.2.4.3 Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

# 5 Testing for Compliance with Technical Requirements

## 5.1 Conditions of Testing

### 5.1.1 Environmental specifications

The technical requirements of the present document apply under the environmental profile, for intended operation of the equipment and antennas, declared by the manufacturer.

The environmental profile may be determined by the environmental class of the equipment according to the guidance given in [4].

The combination of the equipment and its antennas shall comply with all the requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

### 5.1.2 Test sequences and Traffic load

#### 5.1.2.1 General test transmission sequences

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

An example of the test transmission sequence is shown in figure 3.

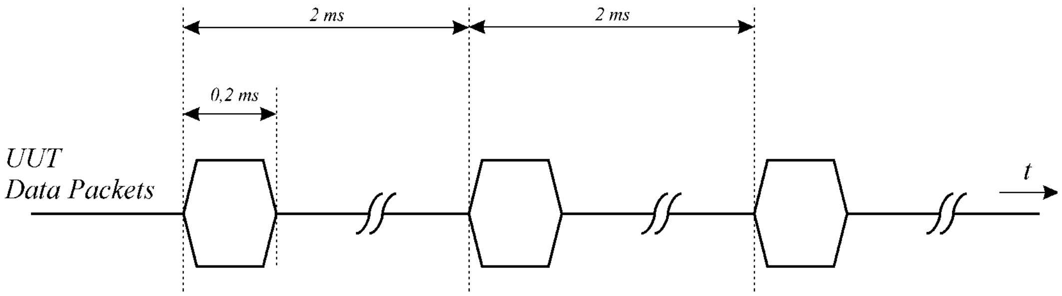



**Figure 3: An example of the test transmission sequences**

#### 5.1.2.2 Test transmission sequences for DFS tests

The DFS tests in the present document shall be performed by using a test transmission sequence that shall consist of packet transmissions that together exceed the transmitter minimum activity ratio of 30 % measured over an interval of 100 milliseconds. The duration of the sequence shall be adequate for the DFS test purposes.

### 5.1.3 Test frequencies

For all tests except those for DFS, the test frequencies to be used shall correspond to the lowest and highest nominal RF channel centre frequency from the operating centre frequency range declared by the manufacturer.

DFS tests shall be carried out on one nominal RF channel centre frequency from the range 5 725 MHz to 5 850 MHz as declared for the equipment.

## 5.1.4 Presentation of Equipment

### 5.1.4.1 Integrated and Dedicated antennas

The equipment can have either integral antennas or dedicated antennas. Dedicated antennas, further referred to as *dedicated external antennas*, are antennas that are physically external to the equipment and are assessed in combination with the equipment against the requirements in the present document.

NOTE: It should be noted that assessment does not necessarily lead to testing.

An antenna assembly referred to in the present document is understood as the combination of the antenna (integral or dedicated), its coaxial cable and if applicable, its antenna connector and associated switching components.

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

For combined equipment and for radio parts for which connection to or integration with host equipment is required to offer functionality to the radio, different alternative test approaches are permitted. Where more than one such combination is intended, testing shall not be repeated for combinations of the radio part and various host equipment where the latter are substantially similar.

Where more than one such combination is intended and the combinations are not substantially similar, one combination shall be tested against all requirements of the present document and all other combinations shall be tested separately for radiated spurious emissions only.

#### 5.1.4.2.1 The use of a host or test jig for testing Plug-In radio devices

Where the radio part is a plug-in radio device which is intended to be used within a variety of combinations, a suitable test configuration consisting of either a test jig or a typical host equipment shall be used. This shall be representative for the range of combinations in which the device may be used. The test jig shall allow the radio equipment part to be powered and stimulated as if connected to or inserted into host or combined equipment. Measurements shall be made to all requirements of the present document.

#### 5.1.4.2.2 Testing of combinations

##### 5.1.4.2.2.1 Alternative A: General approach for combinations

Combined equipment or a combination of a plug-in radio device and a specific type of host equipment may be used for testing according to the full requirements of the present document.

##### 5.1.4.2.2.2 Alternative B: For host equipment with a plug-in radio device

A combination of a plug-in radio device and a specific type of host equipment may be used for testing according to the full requirements of the present document.

For radiated spurious emission tests the most appropriate standard shall be applied to the host equipment. The plug-in radio device shall meet the radiated spurious emissions requirements as described in the present document.

##### 5.1.4.2.2.3 Alternative C: For combined equipment with a plug-in radio device

Combined equipment may be used for testing according to the full requirements of the present document.

For radiated spurious emissions the requirements of the most appropriate harmonized EMC standard shall be applied to the non-radio equipment. The plug-in radio device shall meet the radiated spurious emissions requirements as described in the present document.

In the case where the plug-in radio device is totally integrated and cannot operate independently, radiated spurious emissions for the combination shall be tested using the most appropriate harmonized standard with the radio part in receive and/or standby mode. If the frequency range is less then the one defined in the present document, additional measurements according to the requirements in the present document shall be performed to cover the remaining parts of the frequency range. With the radio in transmit mode, the radiated spurious emissions requirements of the present document shall be applied.

##### 5.1.4.2.2.4 Alternative D: For equipment with multiple radios

Multi-radio equipment, where at least one of the radio parts is within the scope of the present document, may be used for testing according to the full requirements of the present document. Additional requirements and limits for multi-radio equipment are set out in the relevant harmonized radio product standards applicable to the other radio parts.

When measuring spurious emissions in the receive and/or standby mode, it is essential that none of the transmitters within the combined equipment are transmitting.

###### 5.1.4.2.2.4.1 The spurious emissions from each radio can be identified

Where the spurious emissions from each radio can be identified, then the spurious emissions from each radio are assessed to the relevant harmonized radio standard.

###### 5.1.4.2.2.4.2 The spurious emissions from each radio cannot be identified

Where the spurious emissions from each radio cannot be identified, then the combined equipment is assessed to the spurious emission requirements contained in all of the relevant harmonized radio standards applicable to the radios contained within the combined product.

Where the applicable harmonized radio standards contain different limits and measuring conditions, then the combined product is assessed to the harmonized radio standard that specifies the least stringent limits for the common part of the frequency measurement ranges. To assess the remaining parts of the frequency measurement ranges the limits from the relevant harmonized radio standard should be used.

## 5.2 Interpretation of the measurement results

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

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 4;
- the shared risk approach shall be applied for the interpreting of all measurement results.

For the test methods to determine RF power levels, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028-1 [5] and TR 100 028-2 [6] and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Table 4 is based on such expansion factors.

**Table 4: Maximum measurement uncertainty**

| Parameter | Uncertainty |
|---|---|
| RF frequency | $\pm 1 \times 10^{-5}$ |
| RF power conducted | ±1,5 dB |
| RF power radiated | ±6 dB |
| Spurious emissions, conducted | ±3 dB |
| Spurious emissions, radiated | ±6 dB |
| Temperature | ±1°C |
| Humidity | ±5 % |
| Time | ±10 % |

# 5.3 Essential radio test suites

## 5.3.1 Product information

The following information shall be stated by the manufacturer in order to carry out the test suites:

- the operating RF channel centre frequency range of the equipment;
- the nominal occupied channel bandwidth ChS (ChS = 10 MHz or 20 MHz);
- the modulation format(s) employed by the equipment;
- declare the maximum useable conducted power level from the equipment ($P_{cond\_1}$ );
- declare the maximum conducted power level from the TPC range associated with the highest useable antenna assembly gain ($P_{cond\_2}$ );
- declare the minimum conducted power level from the equipment.($P_{cond\_3}$ );

NOTE: Some equipment configurations do not require this value to be declared, see clause 4.4.2.

- the intended range of antennas together with their respective antenna assembly gain(s) and for each of the specific antennas, the corresponding minimum and maximum conducted RF power settings for the equipment consistent with the TPC requirement;
- the test sequence(s) used;
- the operational environmental profile(s) applicable to the equipment.

## 5.3.2 Frequency error

### 5.3.2.1 Test conditions

The frequencies at which the conformance requirements in clause 4.1 shall be verified are defined in clause 5.1.3.

The UUT shall be set to operate at a normal RF power output level.

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

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

### 5.3.2.2 Test methods

#### 5.3.2.2.1 Conducted measurement

Equipment operating without modulation:

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

The UUT shall be connected to a frequency counter and operated in an unmodulated mode. The result shall be recorded.

Equipment operating with modulation.

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

The UUT shall be connected to spectrum analyser.

The settings of the spectrum analyser shall be adjusted to optimize the instruments frequency accuracy.

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

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

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

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

#### 5.3.2.3 Radiated Measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna (see clause 5.2).

The test procedure is as described under clause 5.3.2.2.1.

### 5.3.3 Transmitter RF Output Power, EIRP and EIRP Spectral Density

#### 5.3.3.1 Test conditions

The conformance requirements in clause 4.2 shall be verified at those carrier centre frequencies defined in clause 5.1.3. The measurements shall be performed using normal operation of the equipment with test signal applied (see clause 5.1.2.1).

NOTE: Special test functions may be needed in the UUT to make this test possible.

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

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

#### 5.3.3.2 Test Method

##### 5.3.3.2.1 Conducted Measurement

###### 5.3.3.2.1.1 RF output power, EIRP and TPC

**Step 1:**

The equipment shall be configured to operate with the $P_{cond\_1}$

**Step 2:**

a) using suitable attenuators, the output power of the transmitter shall be coupled to a matched diode detector or equivalent thereof. The output of the diode detector shall be connected to the vertical channel of an oscilloscope;

b) the combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the duty cycle of the transmitter output signal;

c) the observed duty cycle of the transmitter (Tx on/(Tx on + Tx off)) shall be noted as x ($0 < x \leq 1$), and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal to or greater than 0,1 (see clause 5.1.2.1).

**Step 3:**

a) the RF output power of the transmitter shall be determined using a wideband calibrated RF power meter with a matched thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be noted as "A" (in dBm);

b) calculate $P_{cond} = A + 10 \log (1/x)$ (dBm) where x is the observed duty cycle;

c) the EIRP shall be calculated from the above measured power output $P_{cond}$ (in dBm) using the antenna assembly gain G according to the formula $P_{eirp} = P_{cond} + G$ (dBm). If more then one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used. If no specific antenna assemblies have been declared, the declared maximum usable antenna gain for this power setting shall be used;

d) $P_{cond}$ and $P_{eirp}$ shall be recorded in the test report and shall be compared to the relevant limits.

**Step 4:**

a) If the equipment has only one TPC range, step 4 should be skipped.

b) The equipment shall be configured to operate with the conducted power setting $P_{cond\_2}$.

c) Steps 2 to 3 shall be repeated.

**Step 5:**

a) The equipment shall be configured to operate with the conducted power setting $P_{cond\_3}$.

b) Steps 2 and 3 shall be repeated.

**Step 6 :**

a) If the configurations described in Step 1 and Step 4b (overall lowest and highest conducted power settings) does not cover the configuration resulting in the overall highest eirp for the equipment as declared in clause 4.2.2, step 2 and 3 shall be repeated for the configuration resulting in the highest eirp.

#### 5.3.3.2.1.2 EIRP Spectral Power Density

The UUT shall be operated as described in clause 5.3.3.2.1.1 Step 1 although any intermediate power setting associated with a specific antenna assembly gain resulting in operation at the maximum EIRP can be used. Furthermore, for the purpose of this test, the minimum transmitter on-time should be 10 µs.

In the case of radiated measurements, using a test site as described in annex B and applicable measurement procedures as described in annex C, the power density as defined in clause 4.2 shall be measured and recorded.

In case of conducted measurements, the transmitter shall be connected to the measuring equipment via a suitable attenuator and the power density as defined in clause 4.2 shall be measured and recorded.

The power density shall be determined using a spectrum analyser of adequate bandwidth in combination with an RF power meter.

Connect an RF power meter to the narrow IF output of the spectrum analyser and correct its reading using a known reference source, e.g. a signal generator.

NOTE: The IF output of the spectrum analyser may be 20 dB or more below the input level of the spectrum analyser. Unless the power meter has adequate sensitivity, a wideband amplifier may be required.

The test procedure shall be as follows:

**Step 1:**

- the measurement set-up shall be calibrated with a CW signal from a calibrated source; the reference signal shall be set to a level equal to the value for the applicable limit for eirp power density (reduced by the highest applicable antenna gain) and at a frequency equal to the centre frequency of the channel being tested;
- the settings of the spectrum analyser shall be:
  - centre Frequency: equal to the signal source;
  - resolution BW: 1 MHz;
  - video BW: 1 MHz;

- detector mode: positive peak;
- averaging: off;
- span: zero Hz;
- reference level: equal to the level of the reference signal.

**Step 2:**

- the calibrating signal power shall be reduced by 10 dB and it shall be verified that the power meter reading also reduces by 10 dB.

**Step 3:**

- connect the UUT. Using the following settings of the spectrum analyser in combination with "max hold" function, find the frequency of highest power output in the power envelope:
  - centre Frequency: equal to operating frequency;
  - resolution BW: no change to the setting in step 1;
  - video BW: no change to the setting in step 1;
  - detector mode: no change to the setting in step 1;
  - averaging: no change to the setting in step 1;
  - span: 1,5 times the spectrum width;
  - reference level: no change to the setting in step 1.
- the frequency found shall be recorded;
- the centre frequency of the spectrum analyser shall be set to the recorded frequency, the span shall be further reduced to 1 MHz and the frequency of the highest power output shall be found. If this frequency is different from the previous recorded frequency, the new frequency shall be recorded.

**Step 4:**

- set the centre frequency of the spectrum analyser to the found frequency and switch to zero span. The power meter indicates the measured power density (D). The mean power density EIRP is calculated from the above measured power density (D), the observed duty cycle x (see clause 5.3.3.2.1.1 step 1), and the applicable antenna assembly gain "G" in dBi, according to the formula below. If more then one antenna assembly is intended for this power setting or TPC range, the gain of the antenna assembly with the highest gain shall be used:
  - $PD = D + G + 10 \log (1/x)$;
  - PD shall be recorded in the test report.

The above procedure shall be repeated for each of the frequencies identified in clause 5.1.3.

Where the spectrum analyser bandwidth is non-Gaussian, a suitable correction factor shall be determined and applied.

Where a spectrum analyser is equipped with a facility to measure power density, this facility may be used instead of the above procedure to measure the power density across the occupied channel bandwidth.

#### 5.3.3.2.2 Radiated Measurement

The test set up as described in annexes B and C shall be used with a RF power meter of sufficient accuracy attached to the test antenna (see clause 5.2).

The test procedure is as described under clause 5.3.3.2.1.

### 5.3.4 Transmitter unwanted emissions

#### 5.3.4.1 Transmitter unwanted emissions outside the 5 725 MHz to 5 875 MHz band

##### 5.3.4.1.1 Test Conditions

The conformance requirements in clause 4.4.1 shall be verified under normal operating conditions, and at those carrier centre frequencies defined in clause 5.1.3. The UUT shall be configured to operate at the highest nominal output power level of the equipment.

For UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

- the level of unwanted emissions shall be measured as their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment with the antenna connector terminated by a specified load (cabinet radiation); or
- the level of unwanted emissions shall be measured as their effective radiated power when radiated by cabinet and antenna.

In the case where the UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

##### 5.3.4.1.2 Test Method

###### 5.3.4.1.2.1 Conducted Measurement

The UUT shall be connected to a spectrum analyser capable of RF power measurements. The test procedure shall be as follows:

a) the settings of the spectrum analyser shall be as follows:

- sensitivity: at least 6 dB below the limit given in table 2;
- video bandwidth: 1 MHz;
- video averaging on, or peak hold.

The video signal of the spectrum analyser shall be "gated" such that the spectrum measured shall be measured between 4,0 µs before the start of the burst to 4,0 µs after the end of the burst.

NOTE: The "start of the burst" is the centre of the first sample of the preamble heading the burst. The "end of the burst" is the centre of the last sample in the burst.

This gating may be analogue or numerical, dependent upon the design of the spectrum analyser:

b) initially the power level shall be measured in the ranges:

- 47 MHz to 74 MHz;
- 87,5 MHz to 118 MHz;
- 174 MHz to 230 MHz;
- 470 MHz to 862 MHz;

with a resolution bandwidth of 1 MHz and in a frequency scan mode.

c) if any measurement is greater than -54 dBm then measurements shall be taken with a resolution bandwidth of 100 kHz, zero frequency scan, at the 11 frequencies spaced 100 kHz apart in a band ±0,5 MHz centred on the failing frequency;

EXAMPLE 1: A UUT fails at 495 MHz. Measurements are made in a 100 kHz bandwidth on 494,5 MHz, 494,6 MHz, 494,7 MHz, etc. up to 495,5 MHz.

d) initially the power level shall be measured in the ranges

- 25 MHz to 47 MHz;
- 74 MHz to 87,5 MHz;
- 118 MHz to 174 MHz;
- 230 MHz to 470 MHz;
- 862 MHz to 1 GHz;

with a resolution bandwidth of 1 MHz and in a frequency scan mode.

e) if any measurement in d) is greater than -36 dBm, then measurements shall be taken with a resolution bandwidth of 100 kHz, zero frequency scan, at the 11 frequencies spaced 100 kHz apart in a band ±0,5 MHz centred on the failing frequency;

EXAMPLE 2: A UUT fails at 285 MHz. Measurements are made in a 100 kHz bandwidth on 284,5 MHz, 284,6 MHz, 284,7 MHz, etc. up to 285,5 MHz.

f) the power level shall be measured in the ranges

- 1 GHz to 5,15 GHz;
- 5,725 GHz to 26,5 GHz;

with a resolution bandwidth of 1 MHz and in a frequency scan mode.

g) the power level shall be measured in the range:

- 5,35 GHz to 5,47 GHz;

with a resolution bandwidth of 1 MHz with zero frequency scan.

### 5.3.4.2 Transmitter unwanted emissions within the 5 725 MHz to 5 875 MHz band

#### 5.3.4.2.1 Test Conditions

The conformance requirements in clause 4.4.2 shall be verified under normal operating conditions, and at those carrier centre frequencies defined in clause 5.1.3. The UUT shall be configured to operate at the highest nominal output power level.

For UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

- the level of unwanted emissions shall be calculated from their measured power in a specified load (conducted spurious emissions); or
- the level of unwanted emissions shall be measured as their effective radiated power when radiated by cabinet and antenna.

In the case where the UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

##### 5.3.4.2.2 Test Method

###### 5.3.4.2.2.1 Conducted Measurement

The settings of the spectrum analyser shall be as follows:

- resolution bandwidth: 1 MHz;
- video bandwidth: 30 kHz;
- video averaging on.

The video signal of the spectrum analyser shall be "gated" such that the spectrum measured shall be measured between 4,0 µs before the start of the burst to 4,0 µs after the end of the burst.

NOTE: The "start of the burst" is the centre of the first sample of the preamble heading the burst. The "end of the burst" is the centre of the last sample in the burst.

This gating may be analogue or numerical, dependent upon the design of the spectrum analyser.

**Determination of the reference average power level**

The spectrum analyser shall be tuned to measurement frequencies at every 1 MHz interval within $f_c$ -9 (-4,5) MHz to $f_c$ + 9 (4,5) MHz, with zero frequency scan. The maximum average power within $f_c$ -9 (-4,5) MHz to $f_c$ + 9 (4,5) MHz (except $f_c$) is the reference level for relative power measurements on the channel centred at $f_c$ and shall be recorded to compute relative power levels as described below.

**Determination of the relative average power levels**

The power level shall be measured in the range:

- 5 725 MHz to 5 875 MHz;

excluding the interval $f_c$ -9 (-4,5) MHz to $f_c$ + 9 (4,5) MHz with a resolution bandwidth of 1 MHz and in a frequency scan mode. The average value of power relative to the reference average power level for the channel shall be noted.

###### 5.3.4.2.2.2 Radiated Measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna (see clause 5.2).

The test procedure is as described under 5.3.4.2 2.1.

## 5.3.5 Receiver spurious emissions

### 5.3.5.1 Test Conditions

The conformance requirements in clause 4.6 shall be verified under normal operating conditions, and at those carrier centre frequencies defined in clause 5.1.3.

For UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

- the level of unwanted emissions shall be measured as their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment with the antenna connector terminated by a specified load (cabinet radiation); or
- the level of unwanted emissions shall be measured as their effective radiated power when radiated by cabinet and antenna.

In the case where the UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

Test sequence (see clause 5.1.2.1) shall be applied to the receiver input at the reference sensitivity level according to the nominal bit rate.

### 5.3.5.2 Test Method

#### 5.3.5.2.1 Conducted Tests

Using a directional coupler, circulator or gating to remove the test data transmissions (and/or other means to isolate the emissions measurements instrument from the test data signals transmitted) the radio emissions from the UUT shall be measured while the UUT receives test data.

The settings of the spectrum analyser shall be as follows:

- frequency scan allowed;
- resolution bandwidth: 1 MHz or 100 kHz;
- video bandwidth: 1 MHz;
- video averaging on, or peak hold.

Tuning the spectrum analyser centre frequency over the measurement frequency bands specified in table 3, the power level of UUT receiver emissions shall be measured during test data transmissions. If gating is used to remove the unwanted energy from the test data transmissions, the tuning of the spectrum analyser shall not change during the gated-out time interval.

#### 5.3.5.2.2 Radiated Tests

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna (see clause 5.2).

The test procedure is as described under 5.3.5.2.1.

## 5.3.6 Dynamic Frequency Selection (DFS)

### 5.3.6.1 Test conditions

The conformance requirements in clause 4.6 shall be verified under normal operating conditions and at a carrier centre frequency defined in clause 5.1.3.

Some of the tests may be facilitated by disabling the *Non-Occupancy Period*.]

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

#### 5.3.6.1.1 Selection of Radar Test Signals

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

For each of the variable radar test signals, an arbitrary combination of Pulse Width and Pulse Repetition Frequency shall be chosen from the options given in the table D.3 and recorded in the test report.

#### 5.3.6.1.2 Test Set-Up

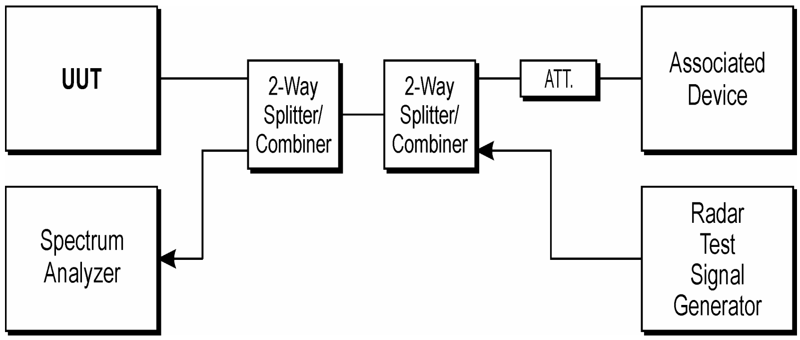
For the purposes of the test, the UUT as well as other devices used in the set-up may be equipped with a specific user interface to allow monitoring of the behaviour of the different devices of the set-up during the tests.

The UUT is capable of transmitting a test transmission sequence as described in clause 5.1.2.2. The signal generator is capable of generating any of the radar test signals defined in table D.3.

Adequate measurement equipment, e.g. spectrum analyser, shall be used to measure the aggregate transmission time of the UUT.

Radar test signals are injected into the UUT. The set-up also contains a device which is associated with the UUT.

Figure 4 shows an example test set-up.




NOTE: UUT can be any type of station under test (e.g. CS, TS or other device).

**Figure 4: Test Set-up**

### 5.3.6.2 Test Method

#### 5.3.6.2.1 Conducted measurement

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

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

The output power of the signal generator producing the radar test signals, as selected using clause 5.3.6.1.1, shall (unless otherwise specified) provide a received signal power at the antenna connector of the UUT with a level equal to (*Interference Detection Threshold* + G), see tables D.2. Parameter G [dBi] corresponds to the gain of the antenna assembly stated by the manufacturer. If more then one antenna assembly is intended for this power setting, the gain of the antenna assembly with the lowest gain shall be used.

A channel shall be selected in accordance with clause 5.1.3. This channel is designated as $Ch_r$ (channel occupied by a radar). The UUT shall be configured to select $Ch_r$ as the first operating channel.

##### 5.3.6.2.1.1 Channel Availability Check

The sub-clauses below define the procedure to verify the *Channel Availability Check* and the *Channel Availability Check Time* ($T_{ch\_avail\_check}$) by ensuring that the UUT is capable of detecting radar pulses at the beginning and at the end of the *Channel Availability Check Time.*

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

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

a) the signal generator and UUT are connected in the test set up as described in clause 5.3.6.1.2. and the power of the UUT is switched off;

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

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

c) a radar burst is generated on $Ch_r$ using radar test signal #1 defined in table D.3 at a level of 10 dB above the level defined in clause 5.3.6.2.1. This single-burst radar test signal shall commence within 2 sec after time T1;

d) it shall be recorded if the radar test signal was detected;

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

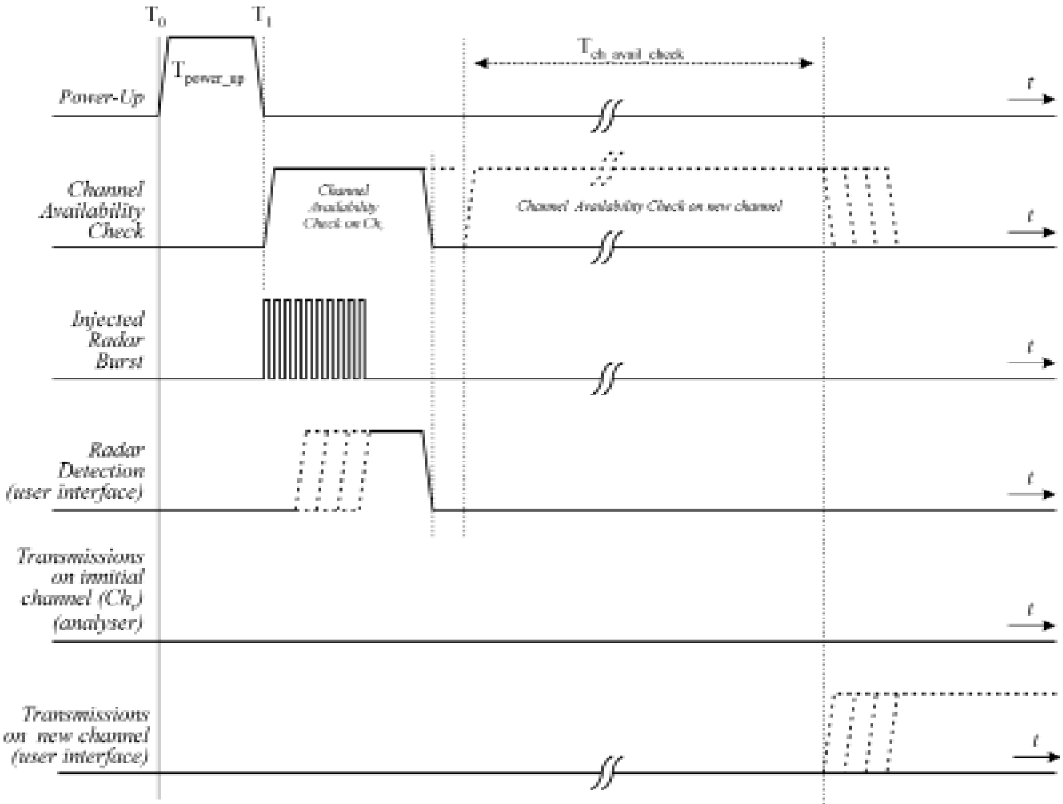



**Figure 5: Example of timing for radar testing at the beginning of the Channel Availability Check Time**

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

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

g) the signal generator and UUT are connected using the test set up described in clause 5.3.6.1.2 and the power of the UUT is switched off;

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

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

i) a radar burst is generated on $Ch_r$ using radar test signal #1 defined in table D.3 at a level of 10 dB above the level defined in clause 5.3.6.2.1. This single-burst radar test signal shall commence towards the end of the minimum required Channel Availability Check Time but not before time T1 + $T_{ch\_avail\_check}$ - 2 [sec];

j) it shall be recorded if the radar test signal was detected;

k) a timing trace or description of the observed timing and behaviour of the UUT shall be recorded.

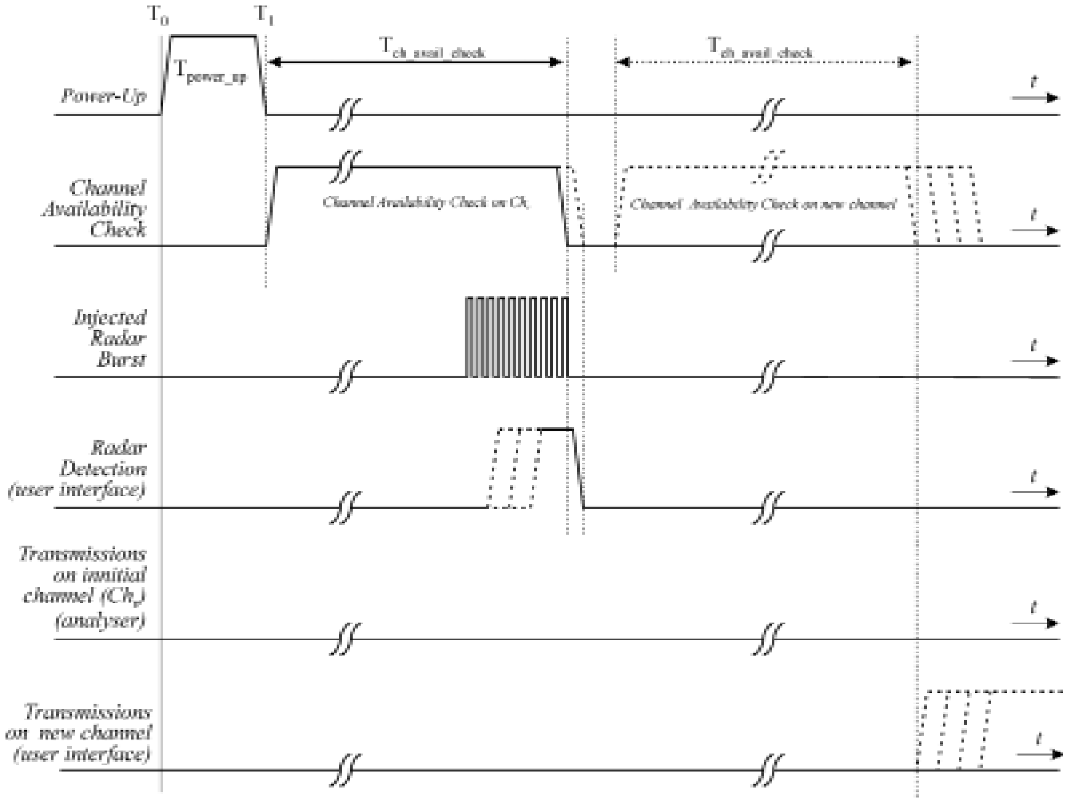



**Figure 6: Example of timing for radar testing towards the end of the Channel Availability Check Time**

#### 5.3.6..2.1.4 Interference Detection Threshold (during the Channel Availability Check)

The different steps below define the procedure to verify the *Interference Detection Threshold* during the *Channel Availability Check Time*.

a) the signal generator and UUT are connected using the test set up described in clause 5.3.6.1.2 and the power of the UUT is switched off;

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

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

c) a radar burst is generated on $Ch_r$ using radar test signal #1 defined in table D.3 at a level defined in clause 5.3.6.2.1. This single-burst radar signal shall commence at approximately 10 seconds after T1;

d) it shall be recorded if the radar test signal was detected;

e) the steps c) to d) shall be repeated at least 20 times in order to determine the detection probability for the selected radar test signal. The detection probability shall be compared with the limit specified in table D.3;

f) the steps c) to e) shall be repeated for each of the radar test signals defined in table D.3 and as described in clause 5.3.6.1.1.

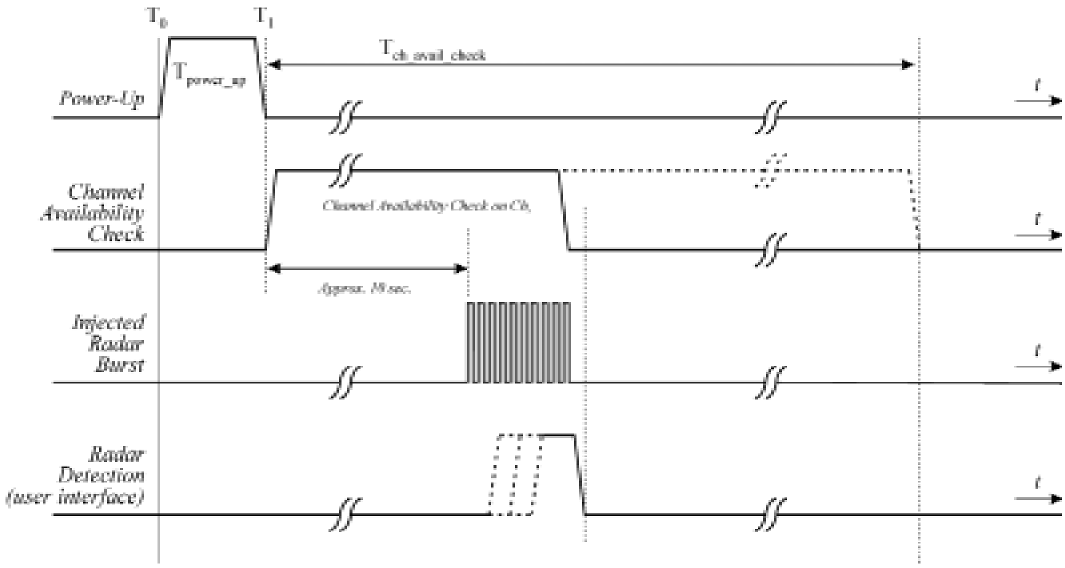



**Figure 7: Example of timing for radar testing during the Channel Availability Check**

#### 5.3.6.2.1.5 In-Service Monitoring

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

a) the signal generator and the UUT are connected using the test set up described in clause 5.3.6.1.2;

b) the UUT shall transmit a test transmission sequence in accordance with clause 5.1.2. on the selected channel $Ch_r$;

c) at a certain time T0, a radar burst is generated on $Ch_r$ using radar test signal #1 defined in table D.3 and at a level defined in clause 5.3.6.2.1. T1 denotes the end of the radar burst;

d) it shall be recorded if the radar test signal was detected;

e) the steps b) to d) shall be repeated at least 20 times in order to determine the detection probability for the selected radar test signal. The detection probability shall be compared with the limit specified in table D.3;

f) the steps b) to e) shall be repeated for each of the radar test signals defined in table D.3 and as described in clause 5.3.6.1.1.

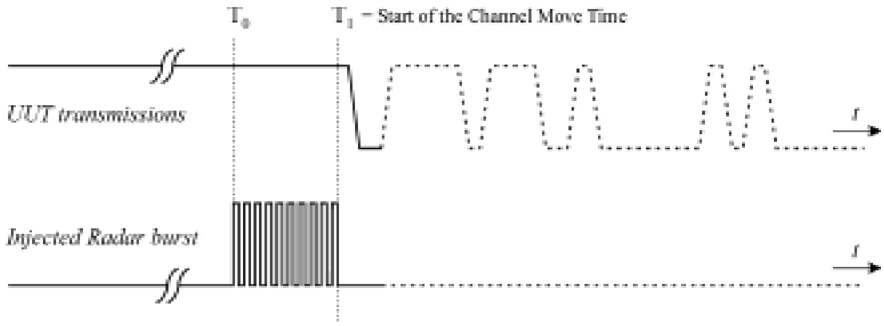



**Figure 8: Example of timing for radar testing during In-Service Monitoring**

5.3.6.2.1.7 Channel Shutdown and Non-Occupancy period

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

a) the signal generator and the UUT shall be connected using the test set up described in clause 5.3.6.1.2;

b) the UUT shall transmit a test transmission sequence in accordance with clause 5.1.2. on the selected channel $Ch_r$;

c) at a certain time T0, a radar burst is generated on $Ch_r$ using radar test signal #1 defined in table D.3 and at a level of 10 dB above the level defined in clause 5.3.6.2.1 on the selected channel. T1 denotes the end of the radar burst;

d) the transmissions of the UUT following instant T1 on the selected channel shall be observed for a period greater than or equal to the Channel Move Time defined in table D.1. The aggregate duration (*Channel Closing Transmission Time)* of all transmissions from the UUT during the Channel Move Time shall be compared to the limit defined in table D.1:

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

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

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

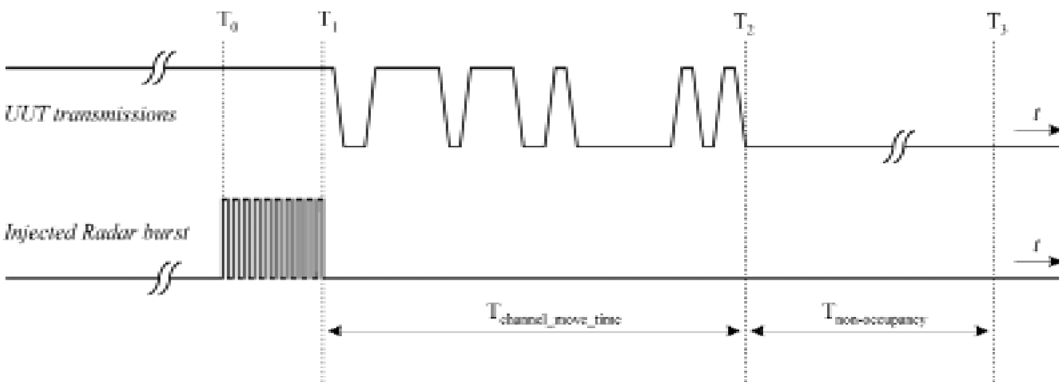



**Figure 9: Channel Closing Transmission Time, Channel Move Time & Non-Occupancy Period**

#### 5.3.6.2.2 Radiated measurement

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

The output power of the signal generator shall (unless otherwise specified) provide a signal power at the antenna of the UUT with a level equal to *Interference Detection Threshold* (table D.2).

The test set up as described in annex B and applicable measurement procedures as described in annex C shall be used to test the different DFS features of the UUT. The test procedure is further as described under clause 5.3.6.2.1.

# Annex A (normative): The EN Requirements Table (EN-RT)



The EN Requirements Table (EN-RT) serves a number of purposes, as follows:

- it provides a tabular summary of all the requirements;
- it shows the status of each EN-R, whether it is essential to implement in all circumstances (Mandatory), or whether the requirement is dependent on the supplier having chosen to support a particular optional service or functionality (Optional). In particular it enables the EN-Rs associated with a particular optional service or functionality to be grouped and identified;
- when completed in respect of a particular equipment it provides a means to undertake the static assessment of conformity with the EN.

**Table A.1: EN Requirements Table (EN-RT)**

| **EN Reference** | | **EN 302 502** | | | | **Comment** |
|---|---|---|---|---|---|---|
| **No.** | **Reference** | **EN-R** (see note) | **Status** | | | |
| 1 | 4.1 | Designation of Centre Frequencies and Frequency Error | M | | | |
| 2 | 4.2 | Transmitter RF Output Power, EIRP and EIRP Spectral Density | M | | | |
| 3 | 4.3 | Transmitter unwanted emissions | M | | | |
| 4 | 4.4 | Transmitter Power Control | M | | | |
| 5 | 4.5 | Receiver spurious emissions | M | | | |
| 6 | 4.6 | Dynamic Frequency Selection (DFS) | M | | | |
| NOTE: These EN-Rs are justified under article 3.2 of the R&TTE Directive [1]. | | | | | | |

**Key to columns:**

**No:** table entry number;

**Reference:** clause reference number of conformance requirement within the present document;

**EN-R:** title of conformance requirement within the present document;

**Status:** status of the entry as follows:

M mandatory, shall be implemented under all circumstances;
O optional, may be provided, but if provided shall be implemented in accordance with the requirements;
O.n this status is used for mutually exclusive or selectable options among a set. The integer "n" shall refer to a unique group of options within the EN-RT. A footnote to the EN-RT shall explicitly state what the requirement is for each numbered group. For example, "It is mandatory to support at least one of these options", or, "It is mandatory to support exactly one of these options".

**Comments** to be completed as required.

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

## B.1 Test sites

### B.1.1 Open air test sites

The term "open air" should be understood from an electromagnetic point of view. Such a test site may be really in open air or alternatively with walls and ceiling transparent to the radio waves at the frequencies considered.

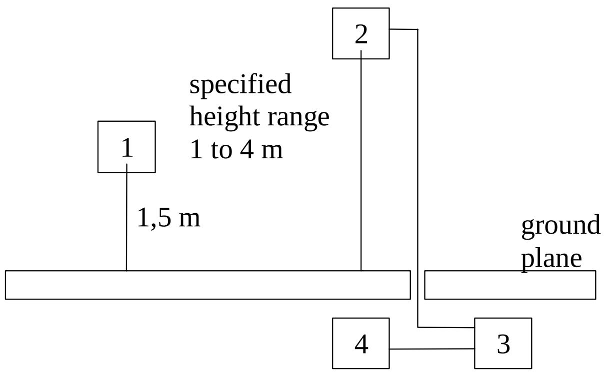
An open air test site may be used to perform the measurements using the radiated measurement methods described in clause 5. Absolute or relative measurements may be performed on transmitters or on receivers; absolute measurements of field strength require a calibration of the test site. Above 1 GHz, measurements should be done in anechoic conditions. This may be met by semi anechoic sites provided reflections are avoided.

For measurements at frequencies below 1 GHz, a measurement distance appropriate to the frequency shall be used. For frequencies above 1 GHz, any suitable measuring distance may be used. The equipment size (excluding the antenna) shall be less than 20 % of the measuring distance. The height of the equipment or of the substitution antenna shall be 1,5 m; the height of the test antenna (transmit or receive) shall vary between 1 m and 4 m.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurement results, in particular:

- no extraneous conducting objects having any dimension in excess of a quarter wavelength of the highest frequency tested shall be in the immediate vicinity of the site according to CISPR 16-1 [7];
- all cables shall be as short as possible; as much of the cables as possible shall be on the ground plane or preferably below; and the low impedance cables shall be screened.

The general measurement arrangement is shown in figure B.1.




1: Equipment under test.
2: Test antenna.
3: High pass filter (as required).
4: Spectrum analyser or measuring receiver.

**Figure B.1: Measuring arrangement**

## B.1.2 Anechoic chamber

### B.1.2.1 General

An anechoic chamber is a well shielded chamber covered inside with radio frequency absorbing material and simulating a free space environment. It is an alternative site on which to perform the measurements using the radiated measurement methods described in clause 5.7. Absolute or relative measurements may be performed on transmitters or on receivers. Absolute measurements of field strength require a calibration of the anechoic chamber. The test antenna, equipment under test and substitution antenna are used in a way similar to that at the open air test site, but are all located at the same fixed height above the floor.

### B.1.2.2 Description

An anechoic chamber should meet the requirements for shielding loss and wall return loss as shown in figure B.2. Figure B.3 shows an example of the construction of an anechoic chamber having a base area of 5 m by 10 m and a height of 5 m. The ceiling and walls are coated with pyramidically formed absorbers approximately 1 m high. The base is covered with special absorbers which form the floor. The available internal dimensions of the chamber are 3 m x 8 m x 3 m, so that a maximum measuring distance of 5 m in the middle axis of this chamber is available. The floor absorbers reject floor reflections so that the antenna height need not be changed. Anechoic chambers of other dimensions may be used.

### B.1.2.3 Influence of parasitic reflections

For free-space propagation in the far field, the relationship of the field strength E and the distance R is given by $E = E_o \times (R_o/R)$, where $E_o$ is the reference field strength and $R_o$ is the reference distance. This relationship allows relative measurements to be made as all constants are eliminated within the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

If the logarithm of the foregoing equation is used, the deviation from the ideal curve may be easily seen because the ideal correlation of field strength and distance appears as a straight line. The deviations occurring in practice are then clearly visible. This indirect method shows quickly and easily any disturbances due to reflections and is far less difficult than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions given above at low frequencies below 100 MHz there are no far field conditions, but the wall reflections are stronger, so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength to the distance meets the expectations very well. Above 1 GHz, because more reflections will occur, the dependence of the field strength to the distance will not correlate so closely.

## B.1.2.4 Calibration and mode of use

The calibration and mode of use is the same as for an open air test site, the only difference being that the test antenna does not need to be raised and lowered whilst searching for a maximum, which simplifies the method of measurement.

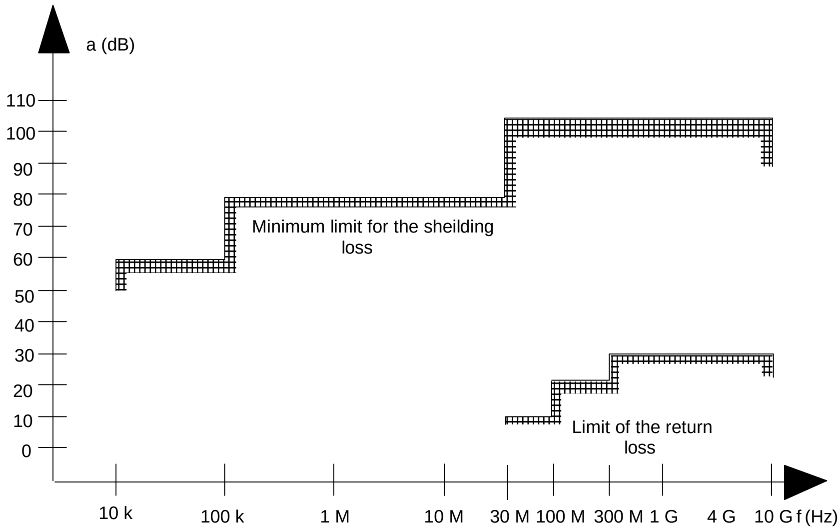



**Figure B.2: Specification for shielding and reflections**

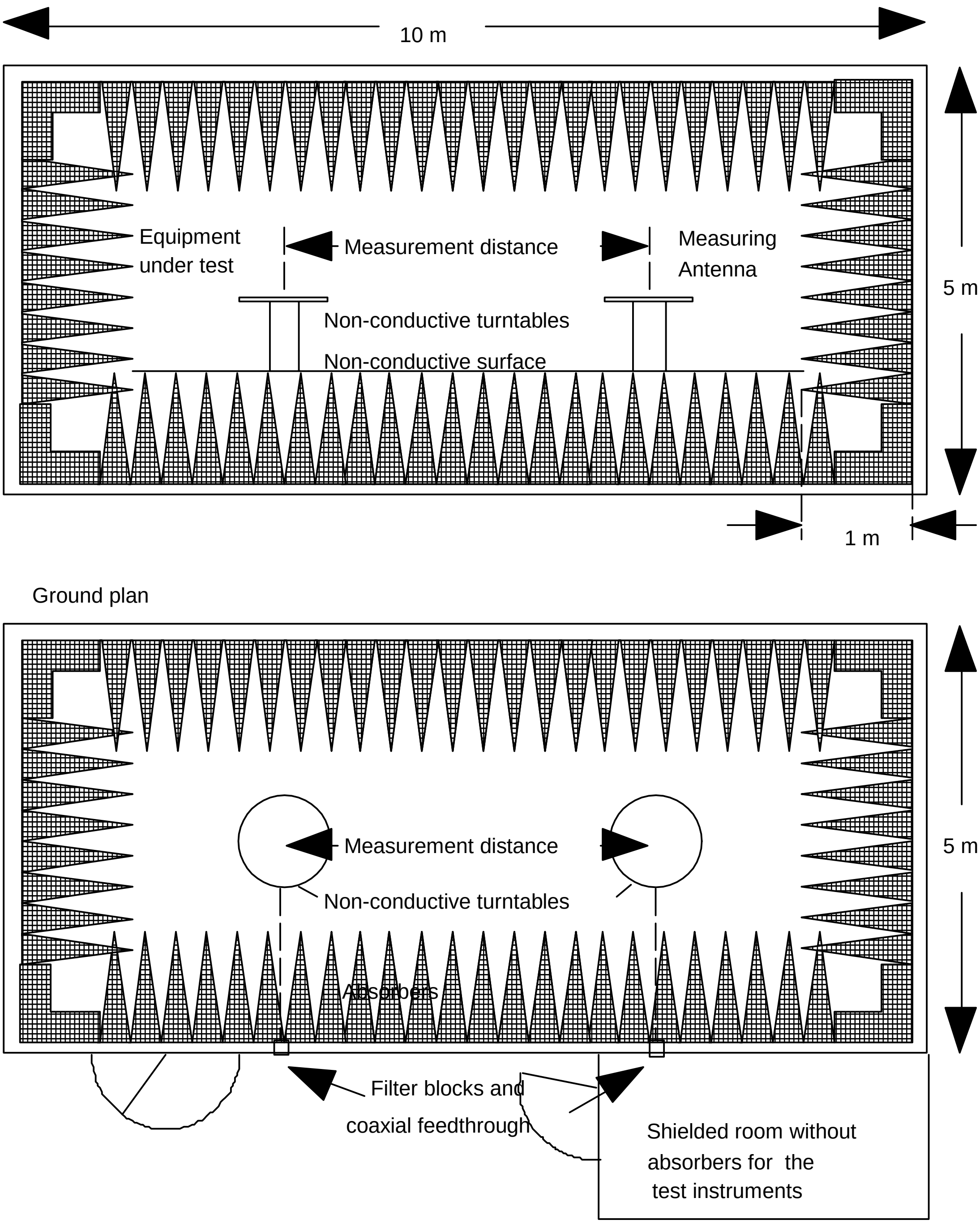



**Figure B.3: Anechoic shielded chamber for simulated free space measurements**

# B.2 Test antenna

When the test site is used for radiation measurements the test antenna shall be used to detect the field from both the test sample and the substitution antenna. When the test site is used for the measurement of receiver characteristics the antenna shall be used as a transmitting antenna. This antenna shall be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and for the height of its centre above the ground to be varied over the specified range. Preferably test antennas with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

# B.3 Substitution antenna

The substitution antenna shall be used to replace the UUT in substitution measurements. For measurements below 1 GHz the substitution antenna shall be a half wavelength dipole resonant at the frequency under consideration, or a shortened dipole, calibrated to the half wavelength dipole. For measurements between 1 GHz and 4 GHz either a half wavelength dipole or a horn radiator may be used. For measurements above 4 GHz a horn radiator shall be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet.

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

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

# Annex C (normative): General description of measurement

This annex gives the general methods of measurements for RF signals using the test sites and arrangements described in annex B.

# C.1 Conducted measurements

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

# C.2 Radiated measurements

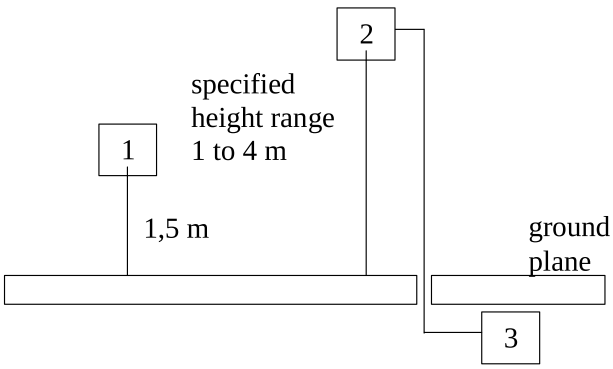
Radiated measurements shall be performed with the aid of a test antenna and measurement instruments as described in annex B. The test antenna and measurement instrument shall be calibrated according to the procedure defined in this annex. The equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted power level. This position shall be recorded in the measurement report. The frequency range shall be measured in this position.

Radiated measurements should be performed in an anechoic chamber. For other test sites corrections may be needed (see annex B). The following test procedure applies:

- a test site which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarization unless otherwise stated and the transmitter under test shall be placed on the support in its standard position (clause B.1.1) and switched on;
- for average power measurements a non-selective voltmeter or wideband spectrum analyser shall be used. For other measurements a spectrum analyser or selective voltmeter shall be used and tuned to the measurement frequency.

In either case a) or b), the test antenna shall be raised or lowered, if necessary, through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2.




1: Equipment under test.
2: Test antenna.
3: Spectrum analyser or measuring receiver.

**Figure C.1: Measurement arrangement 1**

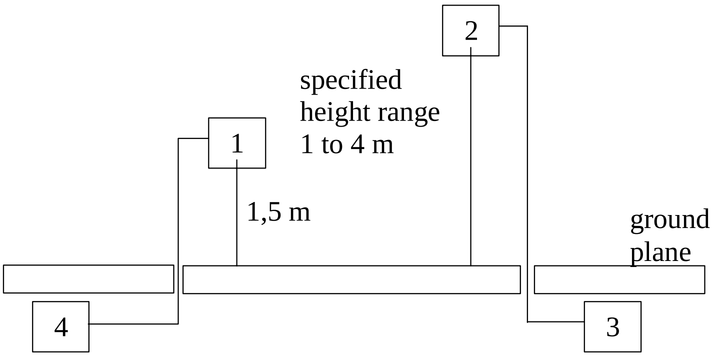
- the transmitter shall be rotated through 360° about a vertical axis until a higher maximum signal is received;
- the test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.

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

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2. This measurement shall be repeated for horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

# C.3 Substitution measurement

The actual signal generated by the measured equipment may be determined by means of a substitution measurement in which a known signal source replaces the device to be measured, see figure C.2. This method of measurement should be used in an anechoic chamber. For other test sites corrections may be needed, see annex B.




1: Substitution antenna.
2: Test antenna.
3: Spectrum analyser or selective voltmeter.
4: Signal generator.

**Figure C.2: Measurement arrangement 2**

Using measurement arrangement 2, figure C.2, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the measurement frequency. The test antenna shall be raised or lowered, if necessary, to ensure that the maximum signal is still received. The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2.

The radiated power is equal to the power supplied by the signal generator, increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.

This measurement shall be repeated with horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

# Annex D (normative): DFS parameters

**Table D.1: DFS requirement values**

| Parameter | Value |
|---|---|
| Channel Availability Check Time | 60 s |
| Channel Move Time | 10 s |
| Channel Closing Transmission Time | 260 ms |
| Non-Occupancy Period | 30 min |

**Table D.2: Interference Threshold values**

| Spectral Density dBm/MHz | Value (see note) |
|---|---|
| 23 | -69 dBm |
| NOTE: This is the level at the input of the receiver assuming a 0 dBi receive antenna. | |

For systems employing lower EIRP spectral density the threshold follows the following relationships:

DFS Detection Threshold (dBm) = -69 + 23 -EIRP Spectral Density (dBm/MHz).

See annex E for example calculations.

**Table D.3: Tentative Parameters of DFS test signals**

| Radar test signal | Pulse width W [µs] (see Note 5) choose 1 | Pulse repetition frequency PRF [pps] choose 1 | Pulses per burst (see note 1) | Detection probability with 30 % channel load |
|---|---|---|---|---|
| 1 - Fixed | 1 | 750 | 15 | $P_d$ > 60 % |
| 2 - Variable | 1, 2, 5 | 200, 300, 500, 800, 1 000 | 10 | $P_d$ > 60 % |
| 3 - Variable | 10, 15 | 200, 300, 500, 800, 1 000 | 15 | $P_d$ > 60 % |
| 4 - Variable | 1, 2, 5, 10, 15 | 1 200, 1 500, 1 600 | 15 | $P_d$ > 60 % |
| 5 - Variable | 1, 2, 5, 10, 15 | 2 300, 3 000, 3 500, 4 000 | 25 | $P_d$ > 60 % |
| 6 - Variable modulated (see note 6) | 20, 30 | 2 000, 3 000, 4 000 | 20 | $P_d$ > 60 % |

NOTE 1: This represents the number of pulses seen at the device per radar scan: N = [{antenna beamwidth (deg)} x {pulse repetition rate (pps)}] / [{scan rate (deg/s)}].
NOTE 2: The test signals above only contain a single burst of pulses.
NOTE 3: The number of pulses per burst given in this table simulate real radar systems and take into account the effects of pulse repetition rate and pulse width on the detection probability for a single burst.
NOTE 4: Pd gives the probability of detection per simulated radar burst and represents a minimum level of detection performance under defined conditions - in this case a 30 % traffic load.
Therefore Pd does not represent the overall detection probability for any particular radar under real life conditions. In general 5 sequential bursts are needed to achieve a real life detection rate of better that 99 % for any radar that falls within the scope of the above table.
NOTE 5: The pulse width used in these tests is assumed to be representative of real radar systems with different pulse widths and different modulations. The pulse width is assumed to have an accuracy of ±5 %.
NOTE 6: The modulation to be used for the radar test signal 6 is a chirp modulation with a ±2,5 MHz frequency deviation which is described below.

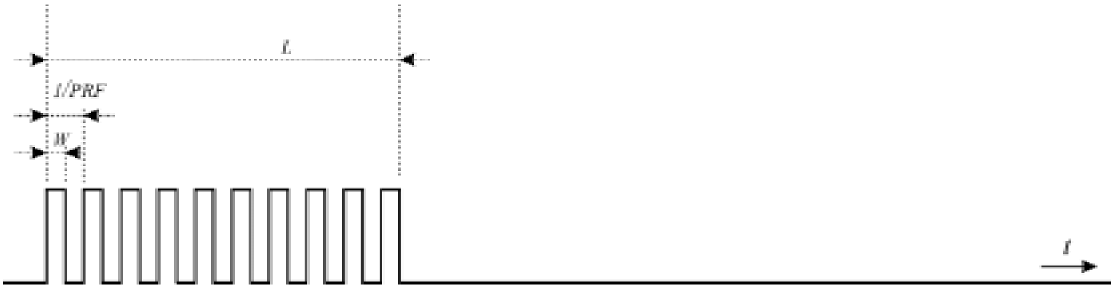



**Figure D.1: General structure of a single burst DFS test transmission**

# Annex E (informative): Example DFS Interference Threshold Values

**Table E.1: Example Interference Threshold values**

| Maximum EIRP (dBm) | Channel Width (MHz) ChS | Spectral Density dBm/MHz | DFS Threshold (dBm) |
|---|---|---|---|
| 36 | 20 | 23 | -69 |
| 33 | 20 | 20 | -66 |
| 33 | 10 | 23 | -69 |
| 30 | 20 | 17 | -63 |
| 30 | 10 | 20 | -66 |

# Annex F (informative): The EN title in the official languages

| Language | EN title |
| --- | --- |
| Czech | |
| Danish | |
| Dutch | |
| English | Broadband Radio Access Networks (BRAN); 5,8 GHz fixed broadband data transmitting systems; Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive |
| Estonian | |
| Finnish | |
| French | |
| German | |
| Greek | |
| Hungarian | |
| Icelandic | |
| Italian | |
| Latvian | |
| Lithuanian | |
| Maltese | |
| Norwegian | |
| Polish | |
| Portuguese | |
| Slovak | |
| Slovenian | |
| Spanish | |
| Swedish | |

# History

| Document history | | | | |
|---|---|---|---|---|
| V1.1.1 | August 2005 | Public Enquiry | PE 20051223: | 2005-08-24 to 2005-12-23 |
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