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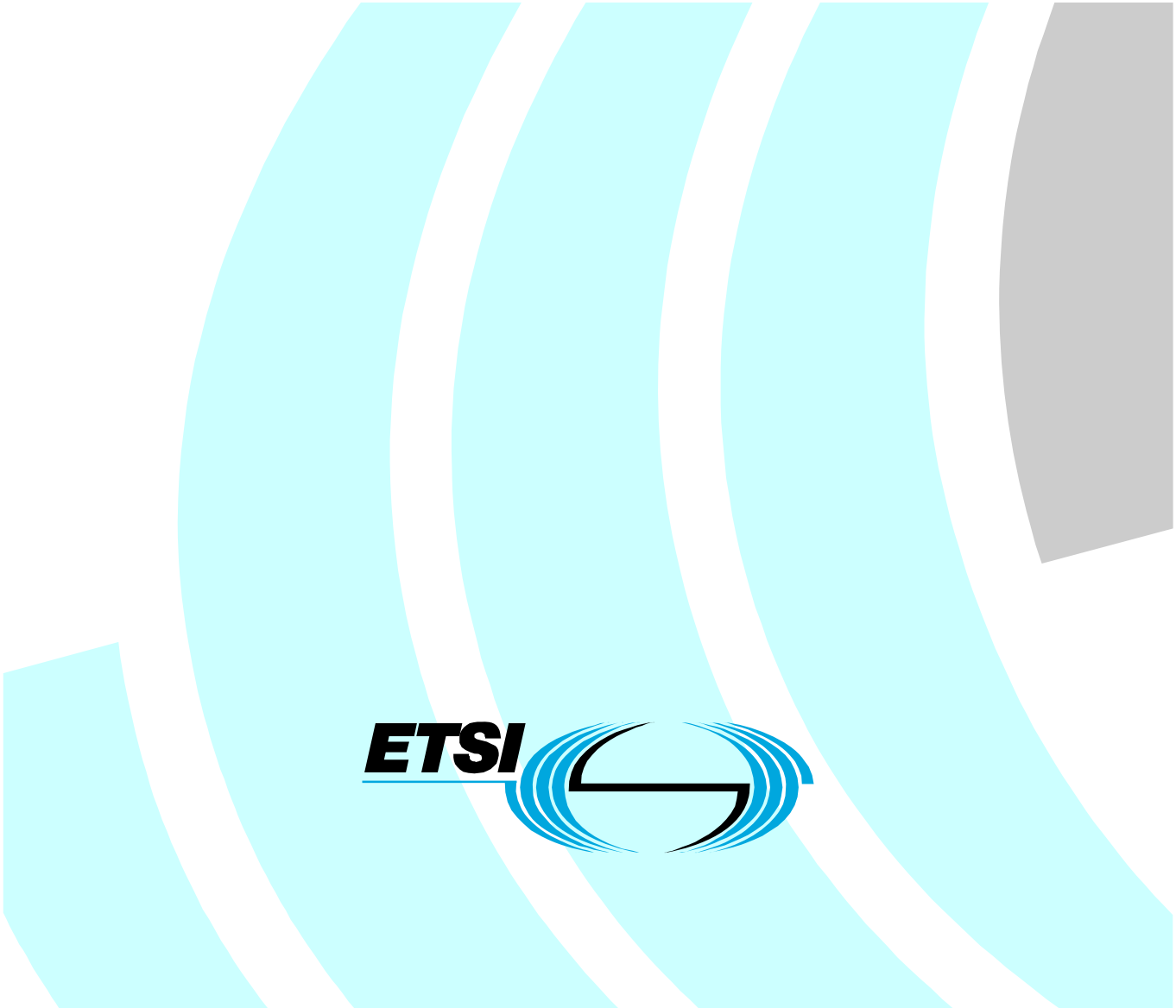
Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics of Detect-And-Avoid (DAA) mitigation techniques for SRD equipment using Ultra Wideband (UWB) technology



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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document contains only the test procedure description, based on the requirement catalogue in annex E and the Technical Specification on DAA enabled UWB devices. The physical test configurations and test results are not included as no DAA UWB devices were available for test during the lifetime of the task force. The report will be updated with the corresponding physical test setups and test results as soon as a stable body of information becomes available.

Introduction

The present document describes a set of tests to evaluate the response of UWB devices equipped with Detect and Avoid algorithms in the presence of Radar signals in the range 3,1 GHz to 3,4 GHz and 8,5 GHz to 9 GHz and BWA systems in the range 3,4 GHz to 3,8 GHz.

The present document identifies the general test criterion and operational states of the UWB device under test as well as the test signal definition for the potential victims, namely radiolocation systems and BWA systems.

1 Scope

The present document provides the description of the test setups and test procedures for the compliance of DAA ("Detect And Avoid") enabled UWB ("Ultra WideBand") devices based on the ECC regulatory framework for DAA enabled UWB devices.

2 References

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.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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

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

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ECC DEC(06)04: "ECC Decision of 24 March 2006 amended 6 July 2007 at Constanta on the harmonized conditions for devices using Ultra-Wideband (UWB) technology in bands below 10.6 GHz".

[i.2] ECC DEC(06)12 amended: "ECC Decision of 1 December 2006 amended 31 October 2008 on supplementary regulatory provisions to Decision ECC/DEC/(06)04 for UWB devices using mitigation techniques".

[i.3] ECC Report 120 (March 2008): "ECC Report on Technical requirements for UWB DAA (Detect and avoid) devices to ensure the protection of radiolocation in the bands 3.1-3.4 GHz and 8.5-9 GHz and BWA terminals in the band 3.4 - 4.2 GHz".

[i.4] ECC TG3#18-18R0: "Flexible DAA mechanism based on "isolation criteria" between victim service and UWB devices", ECC TG3 Meeting 18, Mainz, March 2007.

[i.5] ETSI TS 102 754 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics of Detect-And-Avoid (DAA) mitigation techniques for SRD equipment using Ultra Wideband (UWB) technology".

[i.6] ICT project WALTER: "Wireless alliances for testing experiment and research".

NOTE: http://www.walter-uwb.eu/.

[i.7] ETSI TR 102 070-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide to the application of harmonized standards to multi-radio and combined radio and non-radio equipment; Part 2: Effective use of the radio frequency spectrum".

[i.8] Decision 2008/411/EC: "Commission decision of 21 May 2008 on the harmonization of the 3 400-3 800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community".

[i.9] ETSI EN 302 065: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering essential requirements of Article 3.2 of the R&TTE Directive".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

avoid implementation time: maximum time taken to adjust to a new TX parameter set following signal level measurement and identification, Parameter: $T_{avoid\ impl}$

avoidance level: maximum amplitude to which the UWB transmit power is set for the relevant protection zone

channel availability check interval: maximum time between two consecutive detect operations, Parameter: T_{avail}

detect and avoid time: time duration between a change of the external RF environmental conditions and adaptation of the corresponding UWB operational parameters

detection probability: probability that the DAA enabled UWB device reacts appropriately to a signal detection threshold crossing within the detect and avoid time

in operation channel availability check time: minimum time the UWB device spends searching for victim signals during normal operation, Parameter: $T_{in\ op\ avail}$

maximum avoidance power level: UWB transmit power assuring the equivalent protection of the victim service

minimum avoidance bandwidth: portion of the victim service bandwidth requiring protection

default avoidance bandwidth: portion of the victim service bandwidth to be protected if no enhanced service bandwidth identification mechanisms are implemented in the DAA enabled devices

minimum initial channel availability check time: minimum time the UWB device spends searching for victim signals after power on, Parameter: $T_{avail,\ Time}$

Non-Interference Mode operation (NIM): operational mode that allows the use of the radio spectrum on a non-interference basis without active mitigation techniques

signal detection threshold: amplitude of the victim signal which defines the transition between adjacent protection zones, Parameter: D_{thresh}

signal detection threshold set: set of amplitudes of the victim signal which defines the transition between adjacent protection zones

victim signal: signal(s) of the service to be detected and protected by the DAA mitigation technique

3.2 Symbols

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

T	time
f	frequency
D	detection threshold
dBm	deciBel relative to 1 mW
I	Isolation in dB
P	Power in dBm

3.3 Abbreviations

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

BPSK	Binary Phase Shift Keying
BWA	Broadband Wireless Access
CEPT	European Conference of Postal and Telecommunications Administrations
CON	CONformance test results
CPC	Cognitive Pilot Channels
CW	Continuous Wave
DAA	Detect And Avoid
e.i.r.p.	equivalent isotropically radiated power
ECC	Electronic Communications Committee
ERM	Electromagnetic compatibility and Radio spectrum Matters
FDD	Frequency Division Duplex
ICS	Implementation Conformance Statement
LDC	Low Duty Cycle
LFM	Linear Frequency Modulation
NIM	Non Interference Mode
RF	Radio Frequency
SRD	Short Range Device
TDD	Time Division Duplex
TPC	Transmit Power Control
UWB	Ultra WideBand

4 Recommended Applicability of Test Descriptions

The test descriptions are derived from the requirement catalogue based on the technical specification TS 102 754 [i.5]. The essential elements of this requirement catalogue have been recorded in annex E.

The applicability of each individual test description is identified in table 1 and cross referenced to the requirements catalogue. The applicability of test descriptions is formally expressed by the use of Boolean expression that is based on (ICS) parameters included in annex F.

NOTE: The applicability is just a recommendation based on the purpose for which the test description was written.

The columns in table 1 have the following meaning:

TD Id: The TD Id column indicates the test description identifier.

RQ Id: The RQ Id column gives the requirement catalogue cross reference.

Summary: The Summary column is the summary field of the test description.

Applicability: The following notations are used for the applicability column:

M mandatory - the test case is mandatory.

O optional - the test case is optional.

N/A not applicable - in the given context, the test case is not recommended.

O.i qualified optional - for mutually exclusive or selectable options from a set. "i" is an integer which identifies a unique group of related optional items.

C.i conditional - the test is recommended ("R") or not ("N/A") depending on the support of other items. "i" is an integer identifying a unique conditional status expression which is defined immediately following the table. For nested conditional expressions, the syntax "IF ... THEN (IF ... THEN ... ELSE...) ELSE ..." is used to avoid ambiguities.

Comments: This column contains a verbal description of the condition included in the applicability column.

Table 1: Applicability of tests

TD Id	RQ Id	Summary	Applicability	Comments
Radiolocation System DAA				
TD_RADAR_001	RQ_NM_001, 002, 003	Verify the NIM operation for at least *Minimum Initial Channel Availability Check Time* in the radiolocation bands when no radiolocation system is present	Mandatory	
TD_RADAR_002	RQ_Detect_008, 009, 010	Verify the radiolocation signal detection capability and avoidance for the selected UWB operational frequency when a radiolocation signal occurs at the beginning of the *Minimum Initial Channel Availability Check Time*	Mandatory	
TD_RADAR_003	RQ_Detect_008, 009, 010	Verify the radiolocation detection capability and avoidance for the selected UWB operational frequency when a radiolocation signal occurs at the end of the *Minimum Initial Channel Availability Check Time*	Mandatory	
TD_RADAR_004	RQ_Detect_008, 009, 010	Verify the radiolocation detection and avoidance capability for the selected UWB operational frequency in normal UWB operation using a constant radiolocation test signal	Mandatory	
TD_RADAR_005	RQ_Detect_008, 009, 010	Verify the radiolocation detection and avoidance capability for the selected UWB operational frequency in normal UWB operation using a increasing radiolocation test signal	Mandatory	
BWA System DAA				
TD_BWA_006	RQ_NM_001, 002, 003	Verify the NIM operation for at least *Minimum Initial Channel Availability Check Time* in the BWA bands when no BWA system is present	Mandatory	
TD_BWA_007	RQ_Detect_008, 009, 010	Verify the BWA signal detection capability and avoidance for the selected UWB operational frequency when a BWA signal occurs at the beginning of the *Minimum Initial Channel Availability Check Time*. Without the capability of a victim bandwidth identification	Mandatory	
TD_BWA_008	RQ_Detect_008, 009, 010	Verify the BWA signal detection capability and avoidance for the selected UWB operational frequency when a BWA signal occurs at the end of the *Minimum Initial Channel Availability Check Time*. Without the capability of a victim bandwidth identification	Mandatory	
TD_BWA_009	RQ_Detect_008, 009, 010	Verify the BWA signal detection and avoidance capability for the selected UWB operational frequency in normal UWB operation using a constant BWA test signal	Mandatory	

5 Test Configurations

5.1 Introduction

In this clause the two basic test configurations will be presented and described. The test setup can be split into a conducted and a radiated test setup. A general example for the test set-up for the conducted test is given in figure 1 and for the radiated test in figure 2.

Due to the very low levels to be measured the conducted test setup is the preferred setup up. Nevertheless, a radiated setup will be needed in case of devices with integrated antennas, non accessible antenna connectors and devices deploying antenna techniques as an avoidance technique.

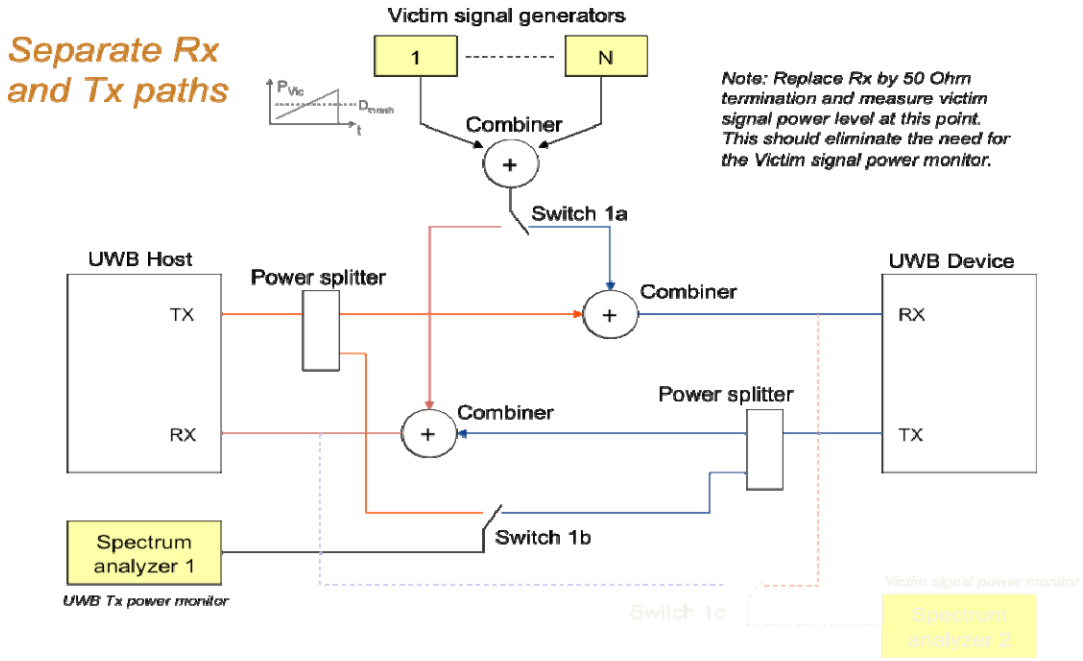

Figure 1: Proposal for a test configuration for a conducted DAA test setup [i.6]

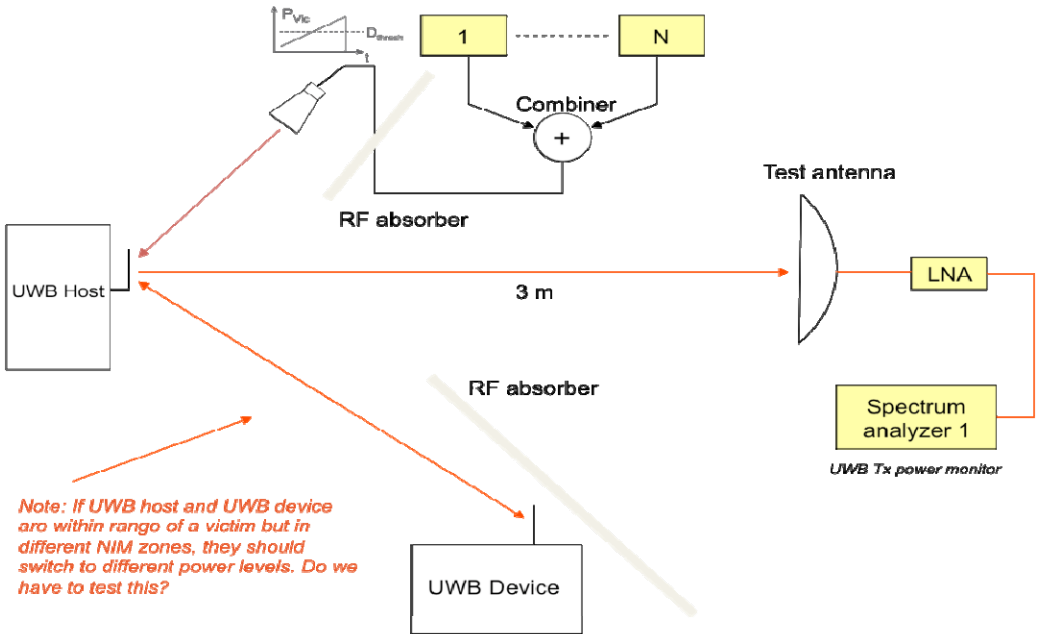

Figure 2: Proposal for a test configuration for a radiated DAA test setup [i.6]

5.2 General Test conditions

This clause covers the general laboratory requirements for power supply, environmental conditions, as well as the operational requirements for the UWB devices under test.

5.2.1 Test conditions

Testing is performed under normal test conditions.

The test conditions and procedures are be performed as specified in the following clauses.

5.2.2 Power sources

5.2.2.1 Power sources for stand-alone equipment

During testing, the power source of the equipment ise replaced by a test power source capable of producing test voltages as specified in clause 5.2.3.2. The internal impedance of the test power source should be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source is measured at the input terminals of the equipment.

For battery operated equipment the battery is removed and the test power source is applied as close to the battery terminals as practicable.

During tests the power source voltages are maintained within a tolerance of ±1 % relative to the voltage at the beginning of each test. The value of this tolerance is critical to power measurements; using a smaller tolerance will provide better measurement uncertainty values.

5.2.2.2 Power sources for plug-in radio devices

The power source for testing plug-in radio devices is provided by a test fixture or host equipment.

Where the host equipment and/or the plug-in radio device is battery powered, the battery may be removed and the test power source applied as close to the battery terminals as practicable.

5.2.3 Normal test conditions

5.2.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests should be any convenient combination of temperature and humidity within the following ranges:

- temperature: +15 °C to +35 °C;
- relative humidity: 20 % to 75 %.

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, should be recorded.

The actual values during the tests are recorded.

5.2.3.2 Normal power source

5.2.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains are the nominal mains voltage. For the purpose of the present document, the nominal voltage should be the voltage(s) for which the equipment was designed.

The frequency of the test power source corresponding to the AC mains is between 49 Hz and 51 Hz.

5.2.3.2.2 Lead-acid battery power sources used on vehicles

When radio equipment is intended for operation from the usual, alternator fed lead-acid battery power source used on vehicles, then the normal test voltage is 1,1 times the nominal voltage of the battery (6 V, 12 V, etc.).

5.2.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the nominal test voltage should be as stated by the equipment manufacturer. This is recorded.

5.3 Choice of equipment for test suites

5.3.1 Choice of model

The tests are carried out on one or more production models or equivalent preliminary models, as appropriate. If testing is performed on (a) preliminary model(s), then the corresponding production models should be identical to the tested models in all respects relevant for the purposes of the present document.

If an equipment has several optional features that are considered to affect directly the RF parameters then tests need only be performed on the equipment configured with the considered worst case combination of features as declared by the manufacturer.

Some radiated RF power measurements are difficult to carry out at the limits described in the present document, and therefore conducted measurements may be used in accordance with the specified test procedures. In these cases equipment used for testing may be provided with a suitable 50 ohm connector for conducted RF power measurements.

Where the UWB device has a 50 ohm antenna system this may be removed and replaced directly with a 50 ohm connector.

In the case where the antenna impedance deviates significantly from 50 ohm, a matching network will be mounted on a suitable test fixture and inserted between the UWB device's RF output and the 50 ohm measurement system. This matching network-test fixture is calibrated and the characteristics recorded. The performance characteristics of the test fixture should be approved by the testing laboratory.

The typical antenna's parameters is provided to the test lab in order to determine the radiation levels of the DAA UWB device based on the conducted measurement results.

If a 50 ohm impedance cannot be provided at the test point for conducted testing then the test is performed as a radiated test using the radiated test procedure presented in the relevant test procedure in the following clauses.

5.3.2 Presentation

Stand-alone equipment is tested complete with any ancillary equipment.

Plug-in radio devices may be tested together with a suitable test fixture and/or typical host equipment (see clause 5.4).

5.4 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 should 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 is tested against all requirements of the present document and all other combinations should be tested separately for radiated spurious emissions only.

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 fixture or a typical host equipment is used. This should be representative for the range of combinations in which the device may be used. The test fixture allows the radio equipment part to be powered and stimulated as if connected to or inserted into host or combined equipment. Measurements are made to all requirements of the present document.

NOTE: For further information on this topic, see TR 102 070-2 [i.7].

5.5 UWB Test conditions

5.5.1 UWB configuration

The preferred test set-up is a radiated test set-up. The UWB devices under test will be configured as a master-slave pair or equivalent where at least one of the devices has a DAA capability. The separation of these devices will be such that a good link between the two devices can be assured at all times. Only the DAA equipped device need be illuminated in the Victim service field. If this is not possible and where both devices are DAA enabled, then care should be taken to prevent false triggering.

5.5.2 UWB operational Frequencies

The required UWB operational frequencies are defined by the victim services. For the purposes of the present document the measurements are made at the -10 dBc points.

The operational frequency bands required are given in table 2. The UWB system bandwidth as defined by the - 10 dBc points should at least partly include the victim service. Where the frequency span of the UWB device is insufficient to cover the victim service's bandwidth, the frequency range is be split into two bands and tests repeated for the higher and lower frequency ranges.

Table 2: UWB System bandwidth for test

Victim Service	Bandwidth	Comments
S-band Radiolocation	3,1 GHz to 3,4 GHz	NIM power level: -70 dBm/MHz mean -36 dBm peak in 50 MHz
BWA	3,4 GHz to 3,8 GHz	NIM power level: -80 dBm/MHz mean -40 dBm in 50 MHz peak
X-Band Radiolocation	8,5 GHz to 9 GHz	NIM power level: -65 dBm/MHz mean -25 dBm in 50 MHz peak

5.5.3 UWB operational modes during test

To assure repeatability of the tests it will be necessary to ensure that all UWB devices under test follow a predefined start up and enter a known status following the start up. The condition at the end of the start up is dependent upon the test being undertaken. The suggested status is given in table 3.

Table 3: UWB device status during test

Test ID	UWB Status after start-up	Comments
TD_Radar_001 & BWA_006	NIM operation: LDC NIM power level	The UWB DAA device should be set into a operational state where it intend to operate in a non NIM operation after the *Minimum Initial Channel Availability Check Time*
TD_Radar_002, 003 and BWA_007, 008	NIM operation: LDC NIM power level	The UWB DAA device should be set into a operational state where it intend to operate in a non NIM operation after the *Minimum Initial Channel Availability Check Time*
TD_Radar_004, 005 and TD_BWA_009	Transmitting/Receiving data at Payload levels identified in the relevant test section at max permitted mean power level	Payload is 50 % For a two zone system, the max mean power level will normally be -41,3 dBm/MHz

6 Test Procedure for the radiolocation systems DAA test

6.1 Introduction

In the present clause the test procedure for the radiolocation DAA test is depicted. The UWB DAA device under test is verified under normal operational conditions.

The DAA test is split into two main test conditions:

- start-up test with and without radiolocation test signal and;
- in-operation test.

The start-up test verifies the operation of the UWB DAA device during the initial start-up when the DAA UWB device intends to operate directly in a non NIM. Thus the UWB DAA device need to be set in an operational condition in which this is guaranteed. The test verifies that the UWB DAA device respects the defined *Minimum Initial Channel availability Check Time*.

The in-operation test is intended to verify the dynamic behaviour of the UWB DAA device under test. During this test the UWB DAA device under test operates in a normal dynamic operational mode. The manufacturer has to declare this normal operational mode taking into account the zone model.

6.2 Start-up test

The clauses 6.2.1 to 6.2.3 define the procedure to verify the *Minimum Initial Channel Availability Check* by ensuring that the UWB DAA device is capable of detecting radar pulses at the beginning and at the end of the *Minimum Channel Availability Check Time.*

6.2.1 Test without a radiolocation test signal during the *Minimum Initial Channel Availability Check Time,* T_{avail_time}

Summary:

Verify the UWB DAA device will not start transmitting in a non NIM operation before the end of the *Minimum Initial Channel Availability Check Time* when no radiolocation test signal is present. This is illustrated in figure 3.

Test description identifier: TD_Radar_001.

Requirement Reference: See table 1

Pre-test Condition:

- Two UWB devices at least one supporting DAA.
- Both UWB devices switched off.

Test Sequence:

a) The UWB DAA device will be switched off. No signal generator is connected to the test setup or the signal generator is switched off.

b) The UWB DAA device is powered on at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}) , enters into the operational mode defined in table 3 and is ready to start the radar detection.

CON-1: The UWB DAA device should not switch into a mode other than a NIM before the end of T_1 + T_{avail_time} after switch on of the device, where the NIM operation is either the LDC mode or the power level defined in annex A for the relevant victim band.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

CON-2: A timing trace or description of the observed timing and behaviour of the UWB DAA device is recorded.

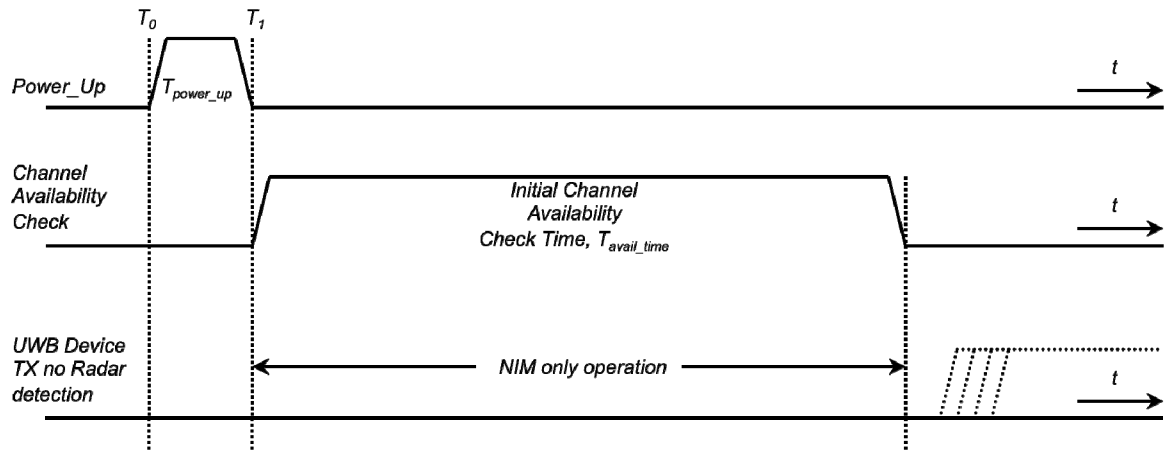

Figure 3: Example of timing for radiolocation testing of the Minimum Initial Channel Availability Check Time T_{avail_time}, UWB DAA device intent to operate in a non NIM mode

6.2.2 Tests with a radiolocation test signal at the beginning of the *Minimum Initial Channel Availability Check Time*, T_{avail_time}

Summary:

Verify the radar detection and avoidance capability for the selected UWB operational frequency when a radar burst occurs at the beginning of the *Minimum Initial Channel Availability Check Time*. This is illustrated in figure 4.

Test description identifier: TD_Radar_002.

Requirement Reference: See table 1

Pre-test Condition:

- Two UWB devices at least one supporting DAA.
- Both UWB devices switched off.

Test Sequence:

a) The UWB DAA device will be switched off. The signal generator used to generate the test patterns in table 4 will be connected to an antenna of suitable characteristics to permit the UWB DAA device to be illuminated with a field equal to the threshold detection limit or connected to the corresponding connectors in the case of a conducted measurement setup.

b) The UWB DAA device is powered on at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}) , enters into the operational mode defined in table 3 and is ready to start the radar detection.

CON-1: The *Minimum initial Channel Availability Check* is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time}$ unless a radiolocation signal is detected sooner.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

c) A radar burst is generated in the relevant radiolocation frequency band using the radar test frequency and radar test signal #1 defined in table 4 at a level of 10 dB above the level defined in annexes A and C and at exactly the threshold levels as defined in annexes A and C. This single-burst radar test signal should commence within 2 s after time T_1.

CON-2: It should be recorded if the radiolocation test signal was detected. This can be done by verifying that the UWB DAA device is switched into a NIM operation in the relevant operational band using the *default avoidance bandwidth* of the regarded radiolocation service.

d) Repeat b) and c) for each of the relevant radar test signals for the UWB operational frequency range as defined in table 4 at a level of 10 dB above the defined threshold level as defined in annexes A and C and at exactly the threshold levels as defined in annexes A and C.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded.

e) Repeat c) and d) for each of the identified radar frequencies.

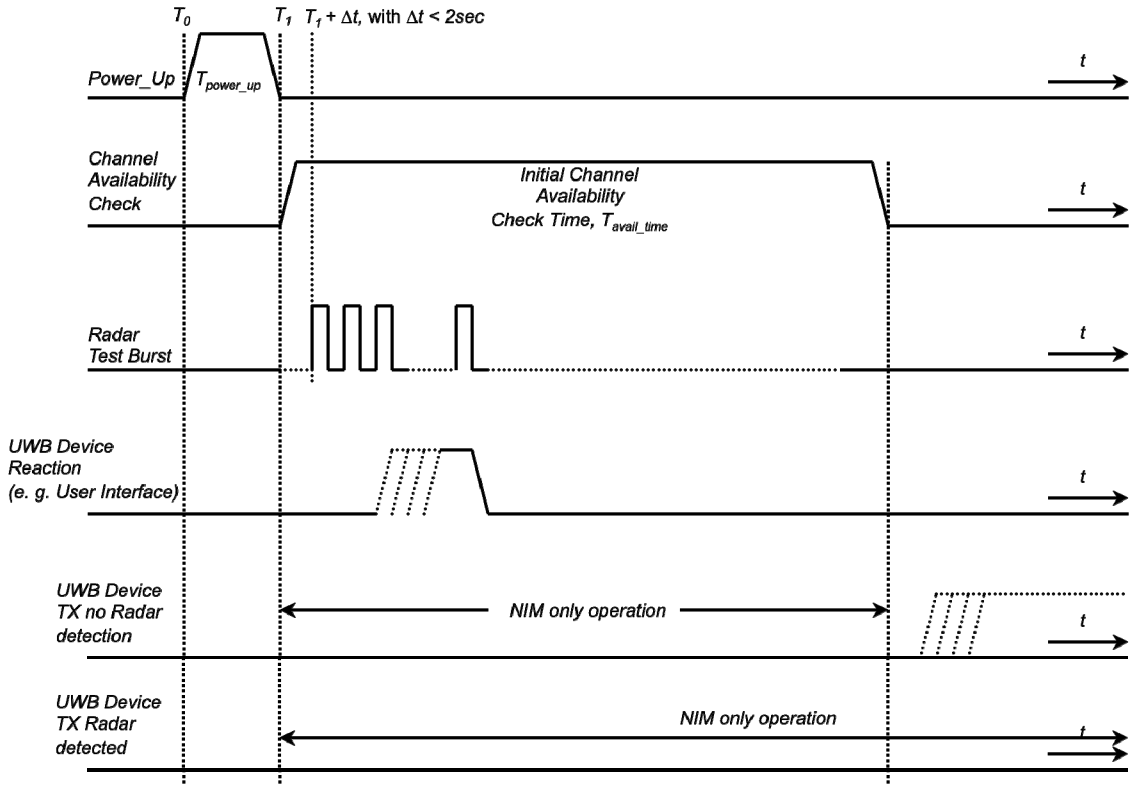

Figure 4: Example of timing for radiolocation testing at the beginning of the Minimum Initial Channel Availability Check Time, UWB DAA device intent to operate in a non-NIM mode

6.2.3 Tests with radiolocation test signal at the end of the *Minimum Initial Channel Availability Check Time,* T_{avail_time}

Summary:

Verify the radar detection capability for the selected UWB operational frequency when a radar burst occurs at the end of the *Minimum Initial Channel Availability Check Time*. This is illustrated in figure 5.

Test description identifier: TD_Radar_003.

Requirement Reference: See table 1.

Pre-test Condition:

- UWB device supporting DAA.
- UWB device switched off.

Test Sequence:

a) The UWB DAA device will be switched off. The signal generator used to generate the test patterns in table 4 will be connected to an antenna of suitable characteristics to permit the UUT to be illuminated with a field equal to the threshold detection limit or connected to the corresponding connectors in the case of a conducted measurement setup.

b) The UWB DAA device is powered up at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}), enters into the operational mode defined in table 3 and is ready to start the radar detection.

CON-1: The *Minimum Initial Channel Availability Check* $T_{\text{avail\_time}}$ is expected to commence at instant T_1 and is expected to end no sooner than $T_1 + T_{\text{avail\_time}}$ unless a radar is detected sooner.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

c) A radar burst is generated in the relevant radiolocation frequency band using the radar test frequency and radar test signal #1 defined in table 4 at a level of 10 dB above the level defined in annexes A and C. This single-burst radar test signal should commence towards the end of the minimum required *Minimum Initial Channel Availability Check* Time but not before time T_1 + 10 s.

CON-2: It should be recorded if the radar test signal was detected. This can be done by verifying that the UWB DAA device is switched into a NIM operation in the relevant operational band using the *default avoidance bandwidth* of the regarded radiolocation service.

d) Repeat b) and c) for each of the relevant radar test signals for the UWB operational frequency range as defined in table 4 at a level of 10 dB above the defined threshold level as defined in annexes A and C and at exactly the threshold levels as defined in annexes A and C.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded.

e) Repeat c) and d) for each of the identified radar frequencies.

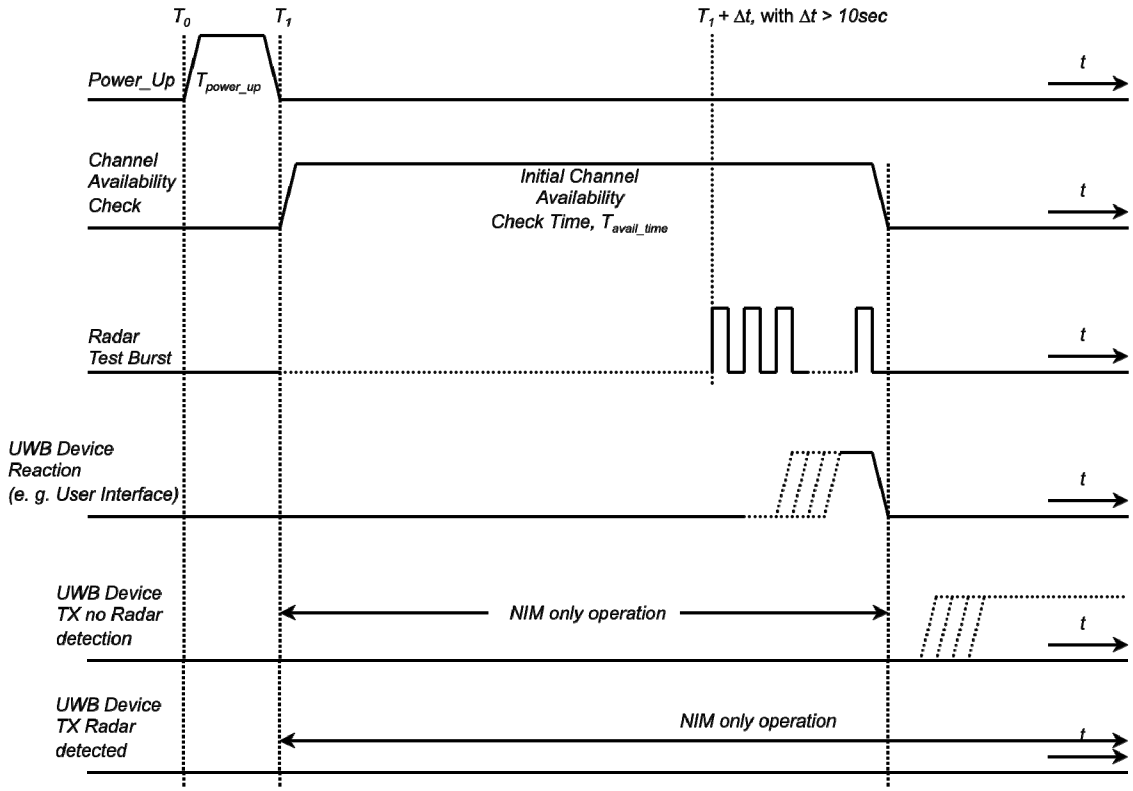

Figure 5: Example of timing for radar testing towards the end of the Minimum initial Channel Availability Check Time

6.3 In-operation test

The clauses 6.3.1 and 6.3.2 define the procedure to verify the *Detect and Avoid Time*, T_{avoid} by ensuring that the UWB DAA device is capable of detecting radiolocation system pulses during the normal operation of the UWB DAA device using a maximum mean EIRP power of -41,3 dBm/MHz which corresponds to a Zone 2 operation in the Radiolocation bands. This test should represent the relative movement of an UBW DAA device in relation to a potential victim radiolocation device. In figure 6 an example of signal diagram for the in-operation test is depicted for a constant radiolocation test signal above the detection threshold given in tables A.1 or C.1 respectively. After the first appearance of the radiolocation test signal the UWB DAA devices should switch into a NIM operation not later than T_{avoid}. In figure 7 a similar diagram is depicted for the case of an increasing radiolocation test signal level. After the reach of the detection threshold level given in tables A.1 or C.1 respectively, the UWB DAA device should switch into a NIM operation not later than T_{avoid}.

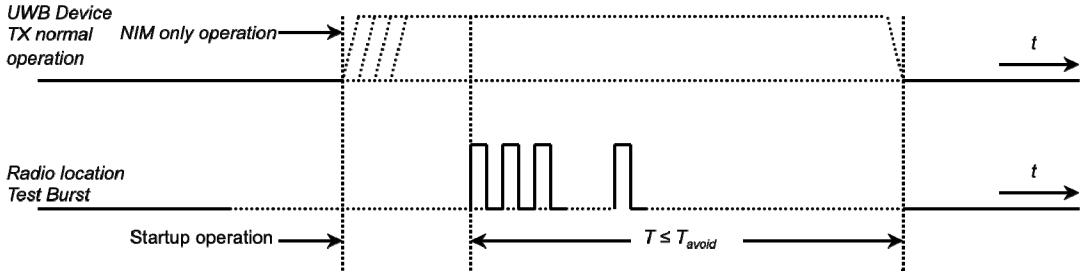

Figure 6: Example of timing for radiolocation signal in-operation testing of the *Detect and Avoid Time*, here with constant Radiolocation test signal level larger than the threshold

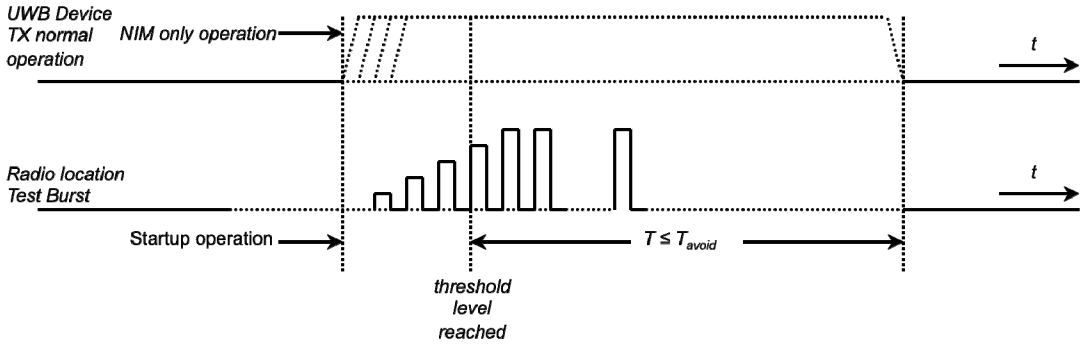

Figure 7: Example of timing for radiolocation signal in-operation testing of the Detect and Avoid Time, here with increasing Radiolocation test signal level larger than the threshold

6.3.1 In-operation test procedure with constant radiolocation test signal level

Summary:

Verify the radiolocation detection and avoidance capability for the selected UWB operational frequency in normal UWB operation using a constant radiolocation test signal. In this test the *Detect and Avoid time* and verifies that the UWB DAA device switches into a NIM operation in the default avoidance bandwidth. This is illustrated in figure 5.

Test description identifier: TD_Radar_004.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices at least one supporting DAA.
- Both UWB devices switched on.
- UWB device in communication mode with a channel load of 50 % .

Test Sequence:

a) The UWB DAA device is switched on, enter the correct operational frequency band table 2, and in a stable operational mode as defined in table 3. The signal generator used to generate the test patterns in table 4 will be connected to an antenna of suitable characteristics to permit the UUT to be illuminated with a field equal to the threshold detection limit or connected to the corresponding connectors in the case of a conducted measurement setup.

b) The radiolocation test signal will be switched on at an arbitrary time T_{arb} after the UWB pair has reached operational stability with a signal level equal to the threshold level given in annexes A and C.

   1) **CON-1:** The Maximum Detect and Avoid Time T_{avoid} is expected to commence at instant T_{arb} and is expected to end no later than $T_{arb} + T_{avoid}$ unless a radar is detected sooner.

   2) **CON-2:** It should be recorded if the radar test signal was detected. This can be done by verifying that the UWB DAA device is switched into a NIM operation in the relevant operational band using the *default avoidance bandwidth* of the regarded radiolocation service.

c) Repeat b) for each of the relevant radar test signals for the UWB operational frequency range as defined in table 4 at the threshold levels as defined in annexes A and C.

   1) **CON-3:** A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded.

d) Repeat b) and c) for each of the radar frequencies.

6.3.2 In-operation test procedure with increasing radiolocation test signal level

Summary:

The procedure below verifies the radiolocation detection and avoidance capability for the selected UWB operational frequency in normal UWB operation using an increasing radiolocation test signal level. In this test the *Detect and Avoid time* and the corresponding avoidance operation will be verified. This is illustrated in figure 6.

Test description identifier: TD_Radar_005.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices at least one supporting DAA.
- Both UWB devices switched on.
- UWB device in normal communication mode with a channel load of 50 %.

Test Sequence:

a) The UWB DAA device is switched on, enter the correct operational frequency band table 2, and in a stable operational mode as defined in table 3. The signal generator used to generate the test patterns in table 4 will be connected to an antenna of suitable characteristics to permit the UUT to be illuminated with a field equal to the threshold detection limit or connected to the corresponding connectors in the case of a conducted measurement setup.

b) The radiolocation test signal will be switched on at T_0 with the test pattern an accordance with table 4 at a power level 20 dB below the threshold identified in annex A and will be increased progressively to reach the threshold value at T_0 + 105 s Insert by SE.

1) **CON-1:** The Maximum Detect and Avoid Time T_{avoid} is expected to commence at instant T_0 + 105 s and is expected to end no later than T_0 + 105 s + T_{avoid} unless a radar is detected sooner.

2) **CON-2:** It should be recorded if the radar test signal was detected. This can be done by verifying that the UWB DAA device is switched into a NIM operation in the relevant operational band using the *default avoidance bandwidth* of the regarded radiolocation service.

c) Repeat b) for each of the relevant radar test signals for the UWB operational frequency range as defined in table 4 at the threshold levels as defined in annexes A and C.

1) **CON-3:** A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded.

d) Repeat b) and c) for each of the radar frequencies.

6.4 Test patterns for the radiolocation DAA test

The general structure of radiolocation bursts is given in figure 8. The test patterns to be used throughout testing, together with the relevant radar frequencies of operation are given in table 4.

Table 4: Parameters of radiolocation test signals

Radar Test Frequencies (see note 11)	Radar test signal	Pulse width W [µs] (see note 5)	Pulse repetition frequency f_{PRF} [pps]	Pulses per burst [PPB] (see note 1)	Burst repetition frequency f_{BRF} [bps]	Detection probability with 50 % channel load
f_1= 3,1 GHz $f_1 < f_2 < f_3$ f_3= 3,4 GHz	1 - Variable	20, 30, 40	400 - 1 400 (see note 6)	10 - 60	0,2 - 0,08	P_d > 90 %
f_1= 3,1 GHz $f_1 < f_2 < f_3$ f_3= 3,4 GHz	2 - Variable	10, 20, 40, 60, 100	100 - 500 (see note 6)	2 - 5	0,2 - 0,08	P_d > 90 %
f_1= 8,55 GHz $f_1 < f_2 < f_3$ f_3= 8,95 GHz	3 - Variable	1, 2, 5, 10, 15	5 000 - 15 000	20 - 560	2,0 - 0,22	P_d > 90 %

NOTE 1: This represents the number of pulses seen at the UWB DAA device per radar scan:
N = [{antenna beamwidth (deg)} × {pulse repetition rate (pps)}] / [{scan rate (deg/s)}].
Chose randomly a number of pulses in the given limits.
L = PPB*1/f_{PRF}, Burst length in seconds.
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 simulates real radar systems and takes 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 50 % traffic load.
Therefore Pd does not represent the overall detection probability for any particular radar under real life conditions. In general 2 sequential bursts are needed to achieve a real life detection rate of better than 99 % for any radar that falls within the scope of this 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 ±10 %.
NOTE 6: Chose PRF randomly in the given range.
NOTE 7: The burst repetition frequency f_{BRF} is used in the In-Service Monitoring test setup.
NOTE 8: The radar test signals 1 and 2 are to be used for the DAA device test in the band 3,1 GHz to 3,4 GHz.
NOTE 9: The radar test signals 3 are to be used for the DAA device test in the 8,5 GHz to 9 GHz.
NOTE 10: Pulses have instantaneous bandwidth of 0,5 MHz, 1, 2 MHz or 5 MHz. Modulation types can be CW, LFM, and BPSK.
NOTE 11: The Radar Test Frequency f_2 is arbitrarily chosen between the f_1 and f_3.

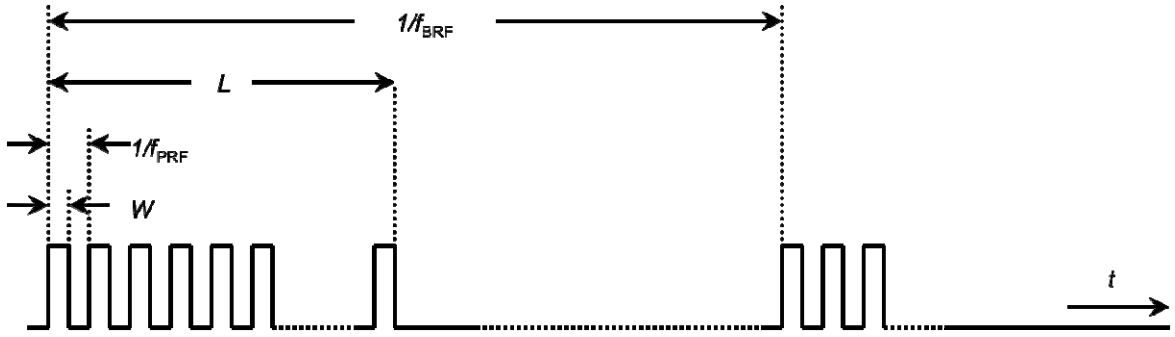

Figure 8: General structure of the bursts for DAA radiolocation test transmissions

7 Test Procedure for BWA systems in the band 3,4 GHz to 3,8 GHz

7.1 Introduction

The series of tests described in this clause emulates the operational conditions of a WiMax base station communicating with a WiMax subscriber collocated with a UWB enabled device. The possible range of performance evaluation tests might include assessment during preamble, data exchange and call termination between the two devices. In all cases the tests undertaken would establish that the minimum threshold detection levels, identified in the ECC decision and reproduced in annex B of TS 102 754 [i.5], can be met.

The current BWA systems deployed in Europe are all Time Division Duplex (TDD) however more recent developments have introduced Frequency Division Duplex (FDD) systems where the separation of carriers is approximately 200 MHz. The presently deployed BWA systems are fixed in nature although mobile systems are available these do not have significant market penetration. Nonetheless these further developments are anticipated in the present document and are tested for through the selective use of common bandwidth sizes and modulation schemes.

In both configurations, fixed or mobile, using either FDD or TDD in general the base station to subscriber link will present the lower power level to the UWB device and the nature of the signal, particularly the payload density, will correspond to the traffic type being carried. In the case of a collocated subscriber waking from idle and entering the start-up negotiation, the levels to be detected will be very much higher and, until data transfer begins, the signals periodic with no payload.

7.1.1 In service operating modes of BWA

The deployed BWA systems will support different classes of service representing different payload types and the bandwidth and modulation scheme of the traffic will depend on the distance between the base station and terminal. At the BWA cell perimeter the bandwidth/modulation will be the smallest/lowest to assure a stable link. This minimum bandwidth/modulation will be analogous to a terminal seeking a base station at wake up before operational parameters are negotiated however in this case the amplitude of the signal falling on the UWB device will be larger . The other extreme of operation will be when the base station and terminal are in close proximity and the bandwidth modulation scheme will be at its maximum. These conditions can be summarized in table 5.

Table 5: Summary of operating conditions

Operating Condition	Terminal/Base Station proximity	B/W-Modulation/coding scheme	Amplitude of Signal falling on the UWB device
Normal Data Exchange	Close	High/High	High
Normal Data Exchange	Remote	Low/Low	Low
Start-Up	Undefined	Low/Low	High

However, at the physical layer where the measurements are to be made the only parameters which can be observed are the payload and power levels. These two parameters are for the moment assumed to be mutually exclusive.

For each type of payload, different response times will be required of the detect and avoid performance of the UWB device; these are identified in annex B. The ability of the UWB device to detect the presence of a BWA signal is likely to be determined not only by the signal strength and bandwidth of the BWA signal but also the activity of the UWB devices. These UWB devices will also carry different traffic types and can reasonably be expected to have different payloads. Although UWB devices will generally have power control implemented to simplify testing it is assumed that all UWB transmissions will be at the maximum permitted mean value.

The UWB payload figure is drawn from the ECC report 120 [i.3] where 50 % was found to be a realistic loading for the UWB link and studies showed the onset of interference between UWB and BWA devices. This 50 % payload figure has been retained from these tests. The BWA payload is defined by the service supported.

Based on available figures from certification laboratories and real deployment scenarios in different European countries (France, Germany, and UK) the majority of BWA systems presently deployed are the mobile version of WiMax (802.16e) with operational bandwidths of 5, 7 and 10 MHz. The current licensing conditions defined by the EC decision 2008/411/EC [i.8] are technology neutral, offering the operator flexibility in the selection of infrastructure hardware. However, given the flexibility and availability of 802.16e equipment over 802.16d, future BWA systems are also expected to use the mobile version of WiMax. For these reasons all certification testing of DAA UWB equipment, will be undertaken with a reference bandwidth of 7 MHz which is considered a representative value of all systems presently or likely to be deployed.

7.1.2 UWB devices with and without victim service identification

To enhance spectrum utilization, manufacturers may chose to implement victim service identification. Such a scheme allows the use of an extended range of optional avoidance mechanisms which will permit enhanced performance of the UWB device whilst assuring the victim service operation. The manufacturer will identify at the time of test whether the UWB device is equipped with victim service identification and the associated avoidance mechanisms implemented. These associated avoidance mechanisms will be evaluated.

7.1.3 UWB responses to the detection of a victim signal

For each detection of a victim signal , there is a mandated response identified in annex B. However, alternative responses, are permitted provided they offer an equivalent level of protection. A non-exhaustive selection of these is given in annex E. Where implemented these is identified, and justified by the manufacturer, before testing begins, together with the method to demonstrate the successful execution of the avoidance mechanism. Where this assessment relies on measurement of parameters other than those at the physical layer, then the manufacturer provides the necessary tools to access this data at the time of test.

The range of avoidance mechanisms to be evaluated can be determined from figure 9. These are identified in table F.1 of the manufacturer's ICS file, the key elements of which are shown in annex F.

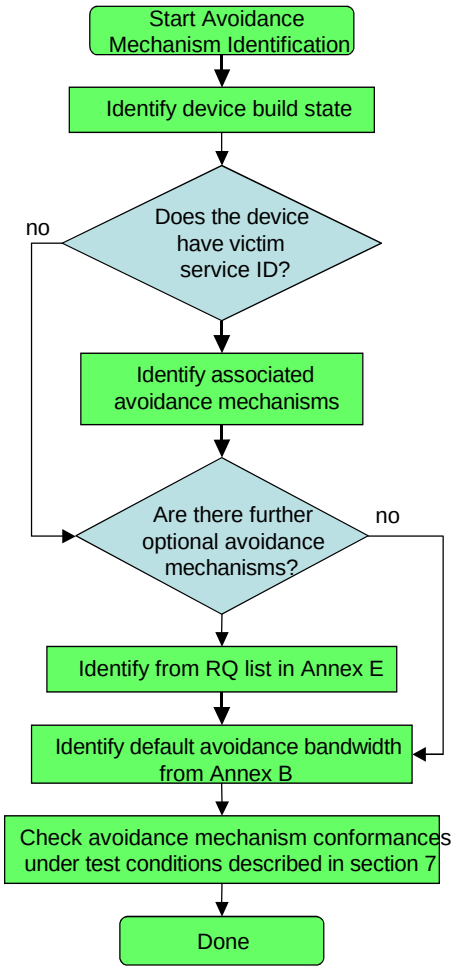

Figure 9: Determination of Conformance tests

7.2 Initial start-up test

The clauses below define the procedure to verify that the *Minimum Initial Channel Availability Check* time is met and that the UWB DAA device is capable of detecting BWA systems at the beginning and at the end of the *Minimum Channel Availability Check Time*. Thus the UWB DAA devices need to be set in a typical operational mode where a non NIM operation is required. Following the power up procedure the UWB device will enter the state identified in table 3. The startup test needs to be performed using all defined thresholds and optionally with a downlink signal deployed.

7.2.1 Test without a BWA test signal during the *Minimum Initial Channel Availability Check Time,* T_{avail_time}

Summary:

Verify that the UWB DAA device will not start transmitting in a non NIM operation before the end of the *Minimum Initial Channel Availability Check Time* under the condition that no BWA test signal is present.

Test description identifier: TD_BWA_006.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices with at least one supporting DAA.
- Both UWB devices switched off.

Test Sequence:

a) The UWB DAA devices will be switched off. No signal generator is connected to the test setup or the signal generator is switched off.

b) The UWB DAA devices are powered on at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}), has entered the correct operational frequency band shown in table 2 is in a known state, identified in table 3 and is ready to start the BWA detection.

CON-1: The UWB DAA device should not switch into a mode other than a NIM before the end of $T_1 + T_{avail\_time}$ after switch on of the device, where the NIM operation is either the LDC mode or the power level defined in annex B for the relevant victim band.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

CON-2: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded. An example is shown in figure 3.

7.2.2 Tests with a BWA test signal at the beginning of the *Minimum Initial Channel Availability Check Time, T_{avail_time}*

Summary:

Verify the BWA detection and avoidance capability for the selected UWB operational frequency when a BWA signal occurs at the beginning of the *Minimum Initial Channel Availability Check Time*.

The UWB DAA device protects the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA devices. Where the UWB device is equipped with victim service identification, the *associated victim service identification avoidance mechanisms* and any other *optional avoidance mechanisms* identified by the manufacturer drawn from the avoidance RQ should be specified and conformance established.

Test description identifier: TD_BWA_007.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices with at least one supporting DAA.
- Both UWB devices switched off.

Test Sequence:

a) The UWB DAA device will be switched off. The signal generator used to generate the test patterns in table 6 will be connected to an antenna of suitable characteristics to permit the UWB DAA device to be illuminated with a field intensity quantified below or connected to the corresponding connectors in the case of a conducted measurement setup deploying the same threshold limits defined in annex B.

b) The UWB DAA device is powered on at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}), has entered the correct operational frequency band table 2 and in a predefined state table 3 and is ready to start the BWA detection.

CON-1: The *Minimum initial Channel Availability Check* is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time}$ unless a BWA signal is detected sooner.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

c) A BWA signal is generated in the relevant BWA frequency band using the web surfing test pattern defined in table 6 at a level of 10 dB above each of the threshold levels defined in annex B. This BWA test signal should commence within 1 s after time T_1 and repeat for a maximum of 5,1 s.

CON-2: It should be recorded if the BWA test signal was detected. This can be done by verifying that the UWB DAA device is switched into an avoid operation corresponding to the investigated threshold level in the relevant operational band. The following avoid operations are verified:

i. *default avoidance bandwidth* for the BWA service identified and where relevant;

ii *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded for each avoidance mechanism. An example is shown in figure 4.

d) Repeat a) to c) at each of the threshold levels in annex B.

e) Repeat a) to d) for each BWA operating frequency identified.

f) If the UWB device has optional avoidance mechanisms, repeat a) to e) for each *optional avoidance mechanism* identified.

g) If the UWB devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table 6 and repeat steps a) to f) for each of the *associated victim service identification avoidance mechanisms*.

7.2.3 Tests with a BWA test signal at the end of the *Minimum Initial Channel Availability Check Time, T_{avail_time}*

Summary:

Verify the BWA detection and avoidance capability for the selected UWB operational frequency when a BWA signal occurs at the end of the *Minimum Initial Channel Availability Check Time.*

The UWB DAA device protects the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA devices. Where the UWB device is equipped with victim service identification, the *associated victim service identification avoidance mechanisms* and any other *optional avoidance mechanisms* identified by the manufacturer drawn from the avoidance RQ should be specified and conformance established.

Test description identifier: TD_BWA_008.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices with at least one supporting DAA.
- Both UWB devices switched off.

Test Sequence:

a) The UWB DAA device will be switched off. The signal generator used to generate the test patterns in table 6 will be connected to an antenna of suitable characteristics to permit the UWB DAA device to be illuminated with a field intensity quantified below or connected to the corresponding connectors in the case of a conducted measurement setup deploying the same threshold limits defined in annex B.

b) The UWB DAA device is powered on at T_0. T_1 denotes the instant when the UWB DAA device has completed its power-up sequence (T_{power_up}), has entered the correct operational frequency band (table 2) and in a predefined state (table 3) and is ready to start the BWA detection.

CON-1: The *Minimum initial Channel Availability Check* is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time}$ unless a BWA signal is detected sooner.

NOTE: Additional verification may be needed to define T_1 in case it is not exactly known or indicated by the UWB DAA device.

c) A BWA signal is generated in the relevant BWA frequency band using the web surfing test pattern defined in table 6 a level of 10 dB above each of the threshold levels defined in annex B. This BWA test signal should commence towards the end of the minimum required *Minimum Initial Channel Availability Check* Time but not before time T_1 + 3 s and repeat for a maximum of 2,1 s.

CON-2: It should be recorded if the BWA test signal was detected. This can be done by verifying that the UWB DAA device is switched into an avoid operation corresponding to the investigated threshold level in the relevant operational band. The following avoid operations are verified:

i. *default avoidance bandwidth* for the BWA service identified and where relevant;

ii. *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded for each avoidance mechanism. An example is shown in figure 5.

d) Repeat a) to c) at each of the threshold levels in annex B.

e) Repeat a) to d) for each BWA operating frequency identified.

f) If the UWB device has optional avoidance mechanisms, repeat a) to e) for each *optional avoidance mechanism* identified.

g) If the UWB devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table 6 and repeat steps a) to f) for each of the *associated victim service identification avoidance mechanisms.*

7.3 In-operation test

This series of tests evaluates the UWB device's response to the presence of different payload types which the victim service may carry. The range of services was defined by the ECC and is reproduced in annex B. Each service requires a different response time from the UWB device and these are also recorded in annex B.

The in-operation is different from the start-up tests previously identified only in as much as the UWB pair will be actively exchanging data and the victim signal will also be an established transmission. In this test the *Detect and Avoid time* will be recorded and the corresponding avoidance operation will be verified.

Summary:

Verify the BWA detection and avoidance capability for the selected UWB operational frequency when a BWA signal occurs during the normal exchange of data between two active UWB devices.

The UWB DAA device protects the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA devices. Where the UWB device is equipped with victim service identification, the *associated victim service identification avoidance mechanisms* and any other *optional avoidance mechanisms* identified by the manufacturer drawn from the avoidance RQ should be specified and conformance established.

Test description identifier: TD_BWA_009.

Requirement Reference: See table 1.

Pre-test Condition:

- Two UWB devices with at least one supporting DAA.
- Both UWB devices switched on and exchanging data.

Test Sequence:

a) The UWB DAA device is switched on, enter the correct operational frequency band table 2 and in a stable operational mode and the payload defined in table 3. The signal generator used to generate the test patterns in table 6 will be connected to an antenna of suitable characteristics to permit the UUT to be illuminated with a field intensity defined below or connected to the corresponding connectors in the case of a conducted measurement setup.

b) The BWA service will be established with the test pattern in accordance with table 6 at a power level 20dB below the lowest threshold identified in annex B.

c) The amplitude of the BWA test signal will be continuously raised to the first of the thresholds to be tested in not less than 45,0 s, at an arbitrary time T_{arb} after the UWB pair has reached operational stability.

CON-1: The Maximum Detect and Avoid Time T_{avoid} is expected to commence at instant T_{arb} and detection should occur no later than $T_{arb} + T_{avoid}$. It should be recorded when the BWA test signal was detected, and the avoidance operation executed. The following avoid operations are verified:

i. *default avoidance bandwidth* for the BWA service identified and where relevant;

ii. *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.

CON-2: A timing trace or description of the observed timing and behaviour of the UWB DAA device should be recorded for each test case. An example is shown in figure 7.

d) Repeat c) for each threshold in annex B.

e) Repeat b) and c) for each service identified in table 6.

f) Repeat c) to e) for each BWA operating frequency identified.

g) If the UWB device has optional avoidance mechanisms, repeat c) to f) for each *optional avoidance mechanism* identified.

h) If the UWB devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table 6 and repeat steps c) to f) for each of the *associated victim service identification avoidance mechanisms.*

7.4 Test Patterns for BWA Testing

The test patterns to be used throughout testing for the services identified in annex B, will display the periodicity of signals given in figure 10. The details of each burst for each service is given are given in table 6.

Table 6: Test patterns for BWA testing

<table>
<tr><th></th><th></th><th>Test Pattern</th></tr>
<tr><td>Service/Operational Status</td><td>Operational Frequencies
See note 1</td><td>BW 7 MHz
see note 2</td></tr>
<tr><td>VoIP</td><td rowspan="3">3,41 GHz, 3,5 GHz,
3,459 GHz, 3,61 GHz,
3,7 GHz, 3,79 GHz</td><td rowspan="3">8 OFDM symbols frame each at intervals identified in figure 10</td></tr>
<tr><td>Web Surfing</td></tr>
<tr><td>Broadcast</td></tr>
<tr><td colspan="3">NOTE 1: Where Up-link down-link pairs are required these are centred symmetrically around the frequencies 3,5 GHz and 3,7 GHz. The down link level should be at each of the threshold levels.
NOTE 2: Most BWA systems operated in the future in Europe will be based on mobile WiMax with a bandwidth of 5 MHz, 7 MHz or 10 MHz. Thus the chosen 7 MHz test signal bandwidth is representative of the current and future BWA deployment in Europe. A relevant subcarrier modulation scheme is chosen (QPSK, 16QAM or 64QAM).</td></tr>
</table>

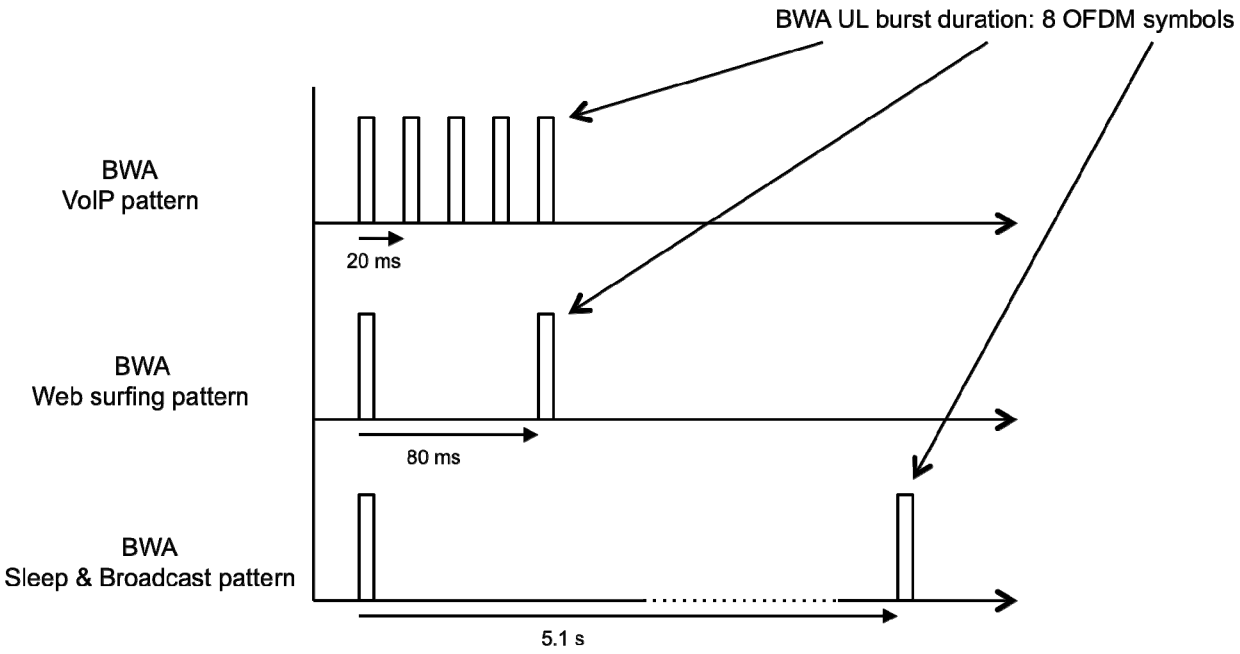

Figure 10: Periodicity of BWA test signals

Annex A:
Radiolocation services in the band 3,1 GHz to 3,4 GHz

Table A.1: Band 3,1 GHz to 3,4 GHz: Radiolocation systems Detect and avoid parameter set

Parameter		Zone 1	Zone 2
Minimum Initial channel availability Check time	T_{avail}	14 s	
Detect and Avoid time		150 s	
Detection probability		99 %	
Detection probability in Continuous detection operation during UWB device operation		97 %	
Signal detection threshold (Peak Detector)	D_{thresh}	D_{thresh_1} = -38 dBm	
Avoidance Level (UWB maximum mean Tx Power density)		-70 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		3,1 GHz to 3,4 GHz (300 MHz)	
Possible Avoidance Options		All	

Additional requirement for operation in the band 3,1 GHz to 4,8 GHz

UWB DAA devices is capable of selecting an operating channel anywhere within the band 3,1 GHz to 4,8 GHz.

Annex B:
Broadband wireless access services in the band 3,4 GHz to 3,8 GHz

Table B.1: BWA Detect and avoid parameter set

Parameter		Zone 1	Zone 2	Zone 3
Minimum Initial channel availability Check time	$T_{avail, Time}$	5,1 s		
Detection Probability for initial detect operation after UWB device power on		99 %		
Signal detection threshold (UL)	$D_{thresh(UL)}$	D_{thresh_1} = -38 dBm	D_{thresh_2} = -61 dBm	
Avoidance Level (UWB Maximum mean Tx Power density)		-80 dBm/MHz in the frequency range from 3,4 GHz to 3,8 GHz and	-65 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		3,4 GHz to 3,6 GHz, 3,6 GHz to 3,8 GHz		
Possible Avoidance Options		All		
NOTE: Detection mechanism needs to be validated to protect existing operation of victim stations of radio services such as BWA terminals in the band 3,4 GHz to 3,8 GHz.				

Table B.2: BWA Detect and avoid timings

BWA system / mode	*Detect and Avoid Time*	*Detection Probability* (for continuous detect operation)
VoIP	2 s	95 %
Web surfing	15 s	95 %
Sleep mode	60 s	95 %
Multimedia broadcasting	15 s	95 %

Taking into account moving devices, the detect and avoid parameters in the table above provide an equivalent protection of the potential victim device. These test modes need to be verified in the corresponding test setup for the harmonized ETSI standard.

Additional requirement for operation in the band 3,1 GHz to 4,8 GHz

UWB DAA devices are capable of selecting an operating channel anywhere within the band 3,1 GHz to 4,8 GHz.

Annex C:
Radiolocation services in the band 8,5 GHz to 9,0 GHz

Table C.1: Band 8,5 GHz to 9,0 GHz: Radiolocation systems Detect and avoid parameter set

Parameter		Zone 1	Zone 2
Minimum Initial channel availability Check time	T_{avail}	14 s	
Detect and Avoid time		150 s	
Detection probability		99 %	
Detection probability in Continuous detection operation during UWB device operation		97 %	
Signal detection threshold (Peak Detector)	D_{thresh}	D_{thresh_1} = -61 dBm	
Avoidance Level (UWB maximum mean Tx Power density)		-65 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		8,5 GHz to 9,0 GHz (500 MHz)	
Possible Avoidance Options		All	

Annex D:
LDC limits

UWB devices having LDC and DAA implemented and operating in all or part of the frequency band from 3,1 GHz to 4,8 GHz may switch on the LDC parameter set to avoid interference to BWA services and radiolocation services as shown in table D.1.

Table D.1. LDC Limits

LDC parameter	Value
Maximum Tx on	≤ 5 ms
Minimum Mean Tx off	≥ 38 ms (mean value averaged over one (1) second)
Accumulated minimum Tx off (Σ Tx off)	≥ 950 ms in one (1) second
Maximum accumulated transmission time (Σ Tx on)	18 s in one (1) hour

Annex E:
Requirements Catalogue

E.1 Definitions

The following terms and definitions apply:

conditionally mandatory: requirement that is supported by a standard conformant equipment if and only if the condition(s) stated within its requirement text are met

NOTE: If one of these conditions is not met the requirement is considered to be not applicable.

EXAMPLE: Such a condition may be the support of an optional higher level requirement by the equipment.

conditionally optional: requirement that may be supported by a standard conformant equipment if and only if the condition(s) stated within its requirement text are met

NOTE: If one of these conditions is not met the requirement is considered to be not applicable.

mandatory: requirement that is supported by a standard conformant equipment

optional: requirement that may be supported by a standard conformant equipment

not applicable: requirement that does not have to be met by a standard conformant equipment

E.2 Non Interference Mode requirements

E.2.1 General Requirements

RQ_NIM_001 General NIM

TS 102 754 [i.5] Clause: 4.3. *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: All UWB devices switch into a non interference mode at start-up.

Specification Text: All UWB devices enter a non interference mode at start-up.

RQ_NIM_002 General NIM

TS 102 754 [i.5] Clause: 4.3. *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: Remain in the non interference mode until a signal detect is undertaken.

Specification Text: This non-interference mode can only be changed after a signal detect, estimation and decision process has been performed.

RQ_NIM_003 General NIM

TS 102 754 [i.5] Clause: 4.3. *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: The switch into a higher avoidance zone is only allowed after a detection process.

Specification Text: This non-interference mode can only be changed after a signal detect, estimation and decision process has been performed. Estimations are done against threshold levels D_{thresh_n} , $n = 1…N-1$.

E.2.3 NIM power levels

RQ_POWER_004 NIM power levels

TS 102 754 [i.5] Clause: 4.2. *Type:* Mandatory

Applies to: All DAA and all LDC enabled devices.

Requirement: All DAA enabled UWB devices are capable of operating in one of the defined "Non Interference Modes" given by a power level and an activity pattern. The activity patterns might be a normal pattern or the LDC pattern.

Specification Text: See table E.1.

Table E.1

Operational Frequency	NIM Power levels (e.i.r.p.) for normal pattern	NIM Power levels (e.i.r.p.) with LDC implemented
3,1 GHz to 3,4 GHz	- 70 dBm/MHz average -36 dBm peak	- 41,3 dBm/MHz average 0 dBm peak
3,4 GHz to 3,8 GHz	- 80 dBm/MHz average - 40 dBm peak	- 41,3 dBm/MHz average 0 dBm peak
3,8 GHz to 4,8 GHz	- 70 dBm/MHz average -30 dBm peak	- 41,3 dBm/MHz average 0 dBm peak
6,0 GHz to 8,5 GHz	-41,3 dBm/MHz average 0 dBm peak	- 41,3 dBm/MHz average 0 dBm peak
8,5 GHz to 9,0 GHz	- 65 dBm/MHz average - 25 dBm peak	- 41,3 dBm/MHz average 0 dBm peak

E.3 Normal operational mode

The normal operation mode of a DAA enabled UWB device is the mode where no avoidance operation is needed. These modes are addressed in the current EN 302 065 [i.9]. They are repeated here for completeness.

RQ_normal_005 Normal operation mode

TS 102 754 [i.5] *Clause:* None. *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: All DAA enabled UWB devices do not transmit more than -41,3dBm/MHz in the band 3,1 GHz to 4,8 GHz and 6,0 GHz to 9,0 GHz.

Specification Text: None.

RQ_normal_006 Normal operation mode in road and rail vehicles

TS 102 754 [i.5] *Clause:* None. *Type:* Mandatory

Applies to: All DAA enabled devices operated in vehicles in non LDC mode.

Requirement: A DAA enabled UWB device operated in road or rail vehicles not deploying a LDC mode are capable of deploying a power control scheme with at least 12 dB control range.

Specification Text: None.

RQ_normal_007 Normal operation mode in road and rail vehicles

TS 102 754 [i.5] *Clause:* None. *Type:* Mandatory

Applies to: All DAA enabled devices operated in road and rail vehicles without LDC and power control.

Requirement: A DAA enabled UWB device operated in road or rail vehicles not deploying LDC mode and without the capability of a power control scheme with at least 12dB control range does not transmit more than -53,3 dBm/MHz in the band 3,1 GHz to 4,8 GHz and 6,0 GHz to 9,0 GHz.

Specification Text: None.

E.4 Detection requirements

RQ_Detect_008 Detection Requirements (Initial channel availability check time)

TS 102 754 [i.5] Clause: 5.3.1 *Type:* Mandatory

Applies to: All DAA & LDC enabled devices.

Requirement: All DAA & LDC devices is able to detect victim system signals.

Specification Text: The UWB device performs victim system monitoring and is required to detect any actively operating victim system signals within a minimum time given by *Minimum Initial Channel Availability Check Time,* $T_{avail,\ Time.}$

RQ_Detect_009 Detection Requirements (Max detect and avoid)

TS 102 754 [i.5] Clause: 5.3.2 *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: All DAA devices have a maximum detect and avoid time not exceeding that identified in the relevant annex of TS 102 754 [i.5].

Specification Text: The combined detect and avoid time includes a number of parameters which are not accessible from the physical layer. These include:

channel availability check Periodicity;

in Operation Channel Availability Check Time; and

avoid implementation time.

RQ_Detect_010 Detection Requirements (Signal detection threshold)

TS 102 754 [i.5] Clause: 5.3.3 *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: **All DAA devices have adequate discrimination to accurately measure the Detection** threshold, D_{thresh} defined in the relevant annex of TS 102 754 [i.5].

Specification Text: This function is able to detect victim service signals and measure if the power level is above or below the *Signal Detection Threshold,* D_{thresh} in any of the relevant frequency bands. See table E.2.

Table E.2

Operational frequency	3,1 GHz to 3,4 GHz	3,4 GHz to 4,8 GHz	8,5 GHz to 9 GHz
Signal Detection threshold A	-38 dBm	-38 dBm	-61 dBm
Signal Detection threshold B	-	-61 dBm	-

RQ_Detect_011 Detection Requirements (Detection probability)

TS 102 754 [i.5] Clause: 5.3.4. *Type:* Mandatory

Applies to: All DAA enabled devices.

Requirement: All DAA enabled devices respond correctly to a signal detection threshold.

Specification Text: Where multiple detection thresholds or detection probabilities are defined a test is undertaken for each relevant threshold/probability combination.

E.5 Avoidance requirement

Following the detection and identification of a victim system the selected avoidance option should ensure the required protection level at the victim receiver.

RQ_avoid_012	**Avoidance Requirements (General Requirement for Avoidance operation)**
TS 102 754 [i.5]	Clause: 6. *Type:* Mandatory
Applies to:	All DAA enabled devices.
Requirement:	A DAA enabled UWB device is capable of deploying at least one of the avoidance methods defined in the RQ_Avoid_010 to RQ_Avoid_017
Specification Text	The avoidance options fall into four major categories: power reduction; spatial avoidance; frequency avoidance; time sharing. Any of these techniques may be used individually or in combination to protect the victim services provided that the avoidance levels given in the victim service related annexes are met.
RQ_Avoid_013	**Avoidance Requirements (Transmit Power Management)**
TS 102 754 [i.5]	Clause: 6.2. *Type:* Optional
Applies to:	All DAA enabled devices.
Requirement:	A DAA enabled UWB device is capable of reducing power over the UWB operational band.
Specification Text:	Transmit power management is the reduction of the UWB transmission power over the complete UWB operational band to the required level.
RQ_Avoid_014	**Avoidance Requirements (Transmit Power Management in vehicles)**
TS 102 754 [i.5]	Clause: 6.2. *Type:* Conditionally Mandatory Optional
Applies to:	All DAA enabled devices operated in vehicles.
Requirement:	A DAA enabled UWB device operated in road or rail vehicles is capable of deploying a power control scheme with at least 12dB control range.
Specification Text:	Transmit power management is the reduction of the UWB transmission power over the complete UWB operational band to the required level.
RQ_Avoid_015	**Avoidance Requirements (Transmit Power Management in vehicles)**
TS 102 754 [i.5]	Clause: 6.2. *Type:* Conditionally Mandatory Optional
Applies to:	All DAA enabled devices in vehicles.
Requirement:	A DAA enabled UWB device operated in road or rail vehicles without a power control scheme is capable of reducing power over the UWB operational band.
Specification Text:	Transmit power management is the reduction of the UWB transmission power over the complete UWB operational band to the required level.

RQ_Avoid_016 Avoidance Requirements (Band relocation)

TS 102 754 [i.5] Clause: 6.3.1.2*Type:* Optional

Applies to: All DAA enabled devices.

Requirement: A DAA enabled UWB device is capable of band relocation.

Specification Text: This protection may either be done by band shifting or band switching.

RQ_Avoid_017 Avoidance Requirements (Frequency band notching)

TS 102 754 [i.5] Clause: 6.4. *Type:* Optional

Applies to: All DAA enabled devices using frequency band notching.

Requirement: All DAA enabled devices using frequency band notching is capable of generating a notch adequate to protect the intended service.

Specification Text: This is a frequency dependent transmit power management technique which protects the victim service.

RQ_Avoid_018 Avoidance Requirements (LDC)

TS 102 754 [i.5] Clause: 6.5. *Type:* Optional

Applies to: All DAA enabled devices using LDC.

Requirement: A DAA enabled UWB device is capable of switching into the LDC in the event of a victim service detection in the required frequency band.

Specification Text: Low duty cycle techniques decrease the total transmitted energy integrated over a period of time. This is achieved by transmitting at the maximum power for the given frequency band but restricting the transmission in duration.

RQ_Avoid_019 Avoidance Requirements (Antenna techniques)

TS 102 754 [i.5] Clause: 6.6. *Type:* Optional

Applies to: All DAA enabled devices using antenna techniques.

Requirement: A DAA enabled using antenna techniques is capable of using techniques such as beam forming or antenna switching to reduce the interference potential to a victim system.

Specification Text: Antenna techniques in general rely on the spatial distribution of the transmitted UWB signal. The spatial distribution of the signal may be controlled by the directivity of the antenna used. Possible examples include: switching, re-orientation, phased arrays.

NOTE: It is assumed that antenna techniques are important avoidance techniques in future DAA UWB implementations and equipment. Nevertheless, owing to the lack of detailed experience in the test procedures and test setups for these kind of avoidance methods no details regarding the required tests are included in the present document. Further investigations and evaluations of possible solutions should be included into a future version of the present document as soon as the relevant and stable results are available.Test laboratories which are required to perform tests on equipment deploying antenna avoidance techniques should record the test configurations and procedures used, based on the available test equipment and test experience. The text configurations and procedures should be recorded in sufficient detail to permit the tests to be repeated elsewhere at a later date.

RQ_Avoid_020 Avoidance Requirements (Future techniques)

TS 102 754 [i.5] Clause: 6.1. *Type:* Optional

Applies to: All DAA enabled devices using future techniques.

Requirement: A DAA enabled UWB devices are capable of using an avoidance method that provides an equivalent level of protection of a potential victim system to the non interference mode.

Specification Text: The currently qualified techniques for use with UWB devices are given in clauses 6.2 to 6.7 of TS 102 754 [i.5] however, other techniques may be used where equivalent protection can be demonstrated.

RQ_Avoid_021 Avoidance Parameters

TS 102 754 [i.5] Clause: 6.8.2. *Type:* Conditionally mandatory

Applies to: All DAA enabled devices without victim service bandwidth identification.

Requirement: If a DAA device is not capable of identifying the victim services bandwidth to be protected it protects the default avoidance bandwidth for the service to be protected.

Specification Text: The default avoidance bandwidths are given in annexes A,B &C.

Q_Avoid_022 Avoidance Parameters (Maximum avoidance power level)

TS 102 754 [i.5] Clause: 6.8.3. *Type:* Conditionally mandatory

Applies to: All DAA enabled devices using power control techniques for the avoidance.

Requirement: If a DAA enabled UWB devices use power reduction for the avoidance operation it should have adequate attenuation to achieve the identified thresholds between the maximum permitted power level of -41.3dBm./MHz and the NIM level.

Specification Text: The maximum avoidance power level is the UWB transmit power assuring the equivalent protection of the victim service. In the multizone model there is be a hierarchy of avoidance power levels associated with each zone where the lowest maximum avoidance power level in the hierarchy equals the NIM power level.

RQ_Avoid_022 Avoidance Parameters

TS 102 754 [i.5] Clause: 6.9. *Type:* Conditionally mandatory

Applies to: LDC enabled devices

Requirement: The LDC limits are given in table E.3.

Table E.3

LDC parameter	Value
Maximum Tx on	≤ 5 ms
Minimum Mean Tx off	≥ 38 ms (mean value averaged over one (1) second)
Accumulated minimum Tx off (Σ Tx off)	≥ 950 ms in one (1) second
Maximum accumulated transmission time (Σ Tx on)	18 s in one (1) hour

LDC Limits

Specification Text: UWB devices having LDC and DAA implemented and operating in all or part of the frequency band from 3,1 GHz to 4,8 GHz may also switch on the LDC parameter set to avoid interference to BWA services and radio navigation services.

Annex F:
ICS Proforma for DAA device

F.1 Identification of the protocol

This ICS proforma applies to the DAA standard listed in the informative references clause of the present document.

F.2 ICS proforma table

F.2.1 Avoidance Modes

These are detailed in table F.1

Table F.1: Avoidance Modes for Radar and BWA operation

Item	Avoidance Mode	Reference clauses	Support (Y/N)	Values supported
1	Does the UWB device support a victim service ID?	TS 102 754 [i.5] clause 5.2.2		-
2	Does the UWB device support optional avoidance mechanisms?	TS 102 754 [i.5] clause 6		

History

Document history		
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