ETSI TS 102 754 V1.3.1 (2013-03)

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

Reference
RTS/ERM-TGUWB-019

Keywords
radar, radio, SRD, UWB

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://ipr.etsi.org).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

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

1 Scope

The present document provides the technical specifications of Detect And Avoid (DAA) mitigation techniques. These techniques are focused on the protection of active radio services.

The following DAA mechanisms have been identified to protect the:

- radio location services in the band 3,1 GHz to 3,4 GHz;
- broadband wireless access services in the band 3,4 GHz to 3,8 GHz;
- radio location services in the band 8,5 GHz to 9,0 GHz.

NOTE: The DAA mitigation techniques are to some extent generic and may also be used with modifications for the protection of other radio services in the future if the technical requirements are identified. The proposed methods can be deployed by all kinds of Ultra WideBand (UWB) based applications and can be extended to other radio technologies.

2 References

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

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

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

2.1 Normative references

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

[1] ETSI TS 102 883 (V1.1.1) (2012-08): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".

2.2 Informative references

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

[i.1] ECC DEC(06)04: "ECC Decision of 24 March 2006 on the harmonised conditions for devices using UWB technology in bands below 10.6 GHz; amended 9 December 2011".

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

[i.3] 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.4] Void.

[i.5] Void.

[i.6] Void.

[i.7] Void.

[i.8] Void.

[i.9] Void.

[i.10] Void.

[i.11] Recommendation ITU-R SM.1754 (2006): "Measurement techniques of ultra-wideband transmissions".

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}

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

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

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
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
BW	Bandwidth
BWA	Broadband Wireless Access
CEPT	European Conference of Postal and Telecommunications Administrations
CON	Condition
CPC	Cognitive Pilot Channels
DAA	Detect And Avoid
dBm	Power emission relative to 1 mW
DFS	Dynamic Frequency Selection
DUT	Device Under Test
e.i.r.p.	equivalent isotropically radiated power
ECC	Electronic Communications Committee
EIRP	Effective Isotropic Radiated Power
ERM	Electromagnetic compatibility and Radio spectrum Matters
FDD	Frequency Division Duplex
ICS	Implementation Conformance Statement
LDC	Low Duty Cycle
LFM	Linear Frequency Modulation
LNA	Low Noise Amplifier
NIM	Non Interference Mode
OFDMA	Orthogonal Frequency Division Multiple Access
PPB	Pulses Per Burst
PRF	Pulse Repetition Frequency
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RQ	Requirement
SRD	Short Range Device
TDD	Time Division Duplex
TPC	Transmit Power Control
TX	Transmitter
UL	Uplink
UUT	Unit Under Test
UWB	Ultra WideBand
WLAN	Wireless Local Area Network

4 User defined clause(s) from here onwards

4.1 User defined subdivisions of clause(s) from here onwards

The present clause defines a Detect And Avoid (DAA) based interference mitigation architecture for UWB devices to protect active victim services. In the following clauses the basis for and the individual DAA parameters for protection of specific services will be given.

4.2 Zone model

The flexible DAA concept is based on the definition of different zones for which an appropriate UWB emission power level is authorized. Each zone corresponds to a minimum isolation between the potential victim system and the potential UWB interferer. Based on the minimum isolation an equivalent degree (see note below) of victim service protection is derived. This concept is embodied in the zone model.

As existing systems are subject to technological change and other systems may be deployed or developed in the future e.g. IMT-Advanced, it should be noted that different zone parameters and transmission levels may be required.

The zone model is based on the isolation between the victim device and the UWB device. By deriving the distances based on the isolation it is possible to segment the region of space around the victim receiver into discrete zones. In the first zone, zone 1, the UWB device shall operate in the non-interference mode (NIM) as defined in the non DAA regulatory framework [i.1] using the parameters give in table 1. In the last zone, zone *N*, the UWB device can operate without restrictions up to the maximum permitted power level of -41,3 dBm/MHz or as defined in a future DAA regulation for the corresponding operational frequency range. Between the zone 1 and zone *N* an arbitrary number of transition zones 2 to *N*-1 may be defined, provided equivalent protection can be assured. Based on the result of the detection process (clause 5) the UWB device has to determine the corresponding zone it occupies.

Table 1: Non-interference mode parameters in the band 3,1 GHz to 9,0 GHz

Operational Frequency	NIM Power levels (e.i.r.p.)	NIM Power levels (e.i.r.p.) with LDC implemented
3,1 GHz to 3,4 GHz	-70 dBm/MHz average. -36 dBm peak (see notes 2 and 3)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
3,4 GHz to 3,8 GHz	-80 dBm/MHz average. - 40 dBm peak (see notes 2 and 3)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
3,8 GHz to 4,2 GHz	-70 dBm/MHz average. -30 dBm peak (see notes 2 and 3)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
4,2 GHz to 4,8 GHz	-70 dBm/MHz average. -30 dBm peak (see notes 2 and 3)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
6,0 GHz to 8,5 GHz	-41,3 dBm/MHz average. 0 dBm peak (see note 2)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
8,5 GHz to 9,0 GHz	-65 dBm/MHz average. -25 dBm peak (see notes 2 and 3)	-41,3 dBm/MHz average. 0 dBm peak Standard LDC parameters as in [i.1]
NOTE 1: As defined in the scope of the present document, the DAA mitigation only affects the frequency bands 3,1 GHz to 3,4 GHz, 3,4 GHz to 3,8 GHz and 8,5 GHz to 9 GHz. NIM power levels for the other frequency bands are included in this table for informative purposes. NOTE 2: Devices installed in road or rail vehicle not using LDC need to implement TPC as defined in [i.1]. NOTE 3: Devices fitted with DAA mitigation may operate to the maximum permissible limit of -41,3 dBm/MHz average and 0 dBm peak.		

The zone model is illustrated in figure 1 for *N* = 4. This example has been taken from the CEPT ECC TG3 regulatory discussion [i.3]. The transition zones in this example are defined based on a 10 dB pathloss step size.

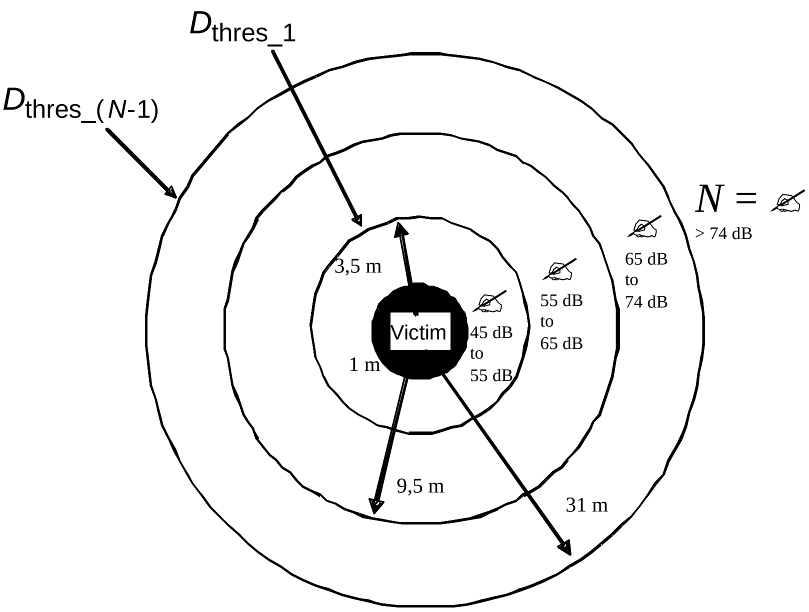

Figure 1: Zone model segmentation and corresponding path loss with LoS distance in meters for *N* = 4

4.3 Detect and Avoid operational flow

The defined zone model is incorporated into the overall detect and avoid operational flow. This flow is depicted in figure 2.

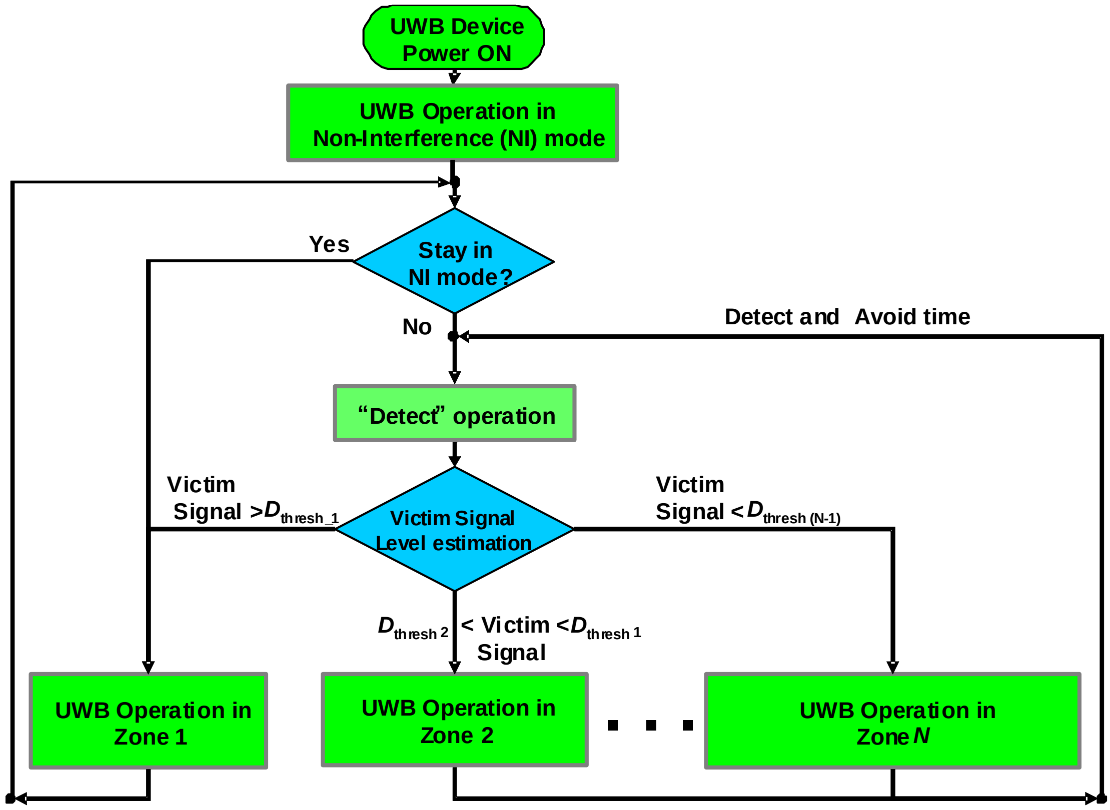

Figure 2: Detect and Avoid overview, including *N* zones

All UWB devices enter a non-interference mode at start-up. 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_{thres_n}, n = 1…N-1.

The non-interference mode operational zone can be subdivided into zones of equivalent protection where appropriate avoidance techniques are implemented. This gives rise to additional operational zones between the non-interference and free mode operational zones based on technical considerations. This multi zone concept is illustrated in figure 3 taking into account the reduction of the UWB transmit power after the application of the appropriate avoidance technique.

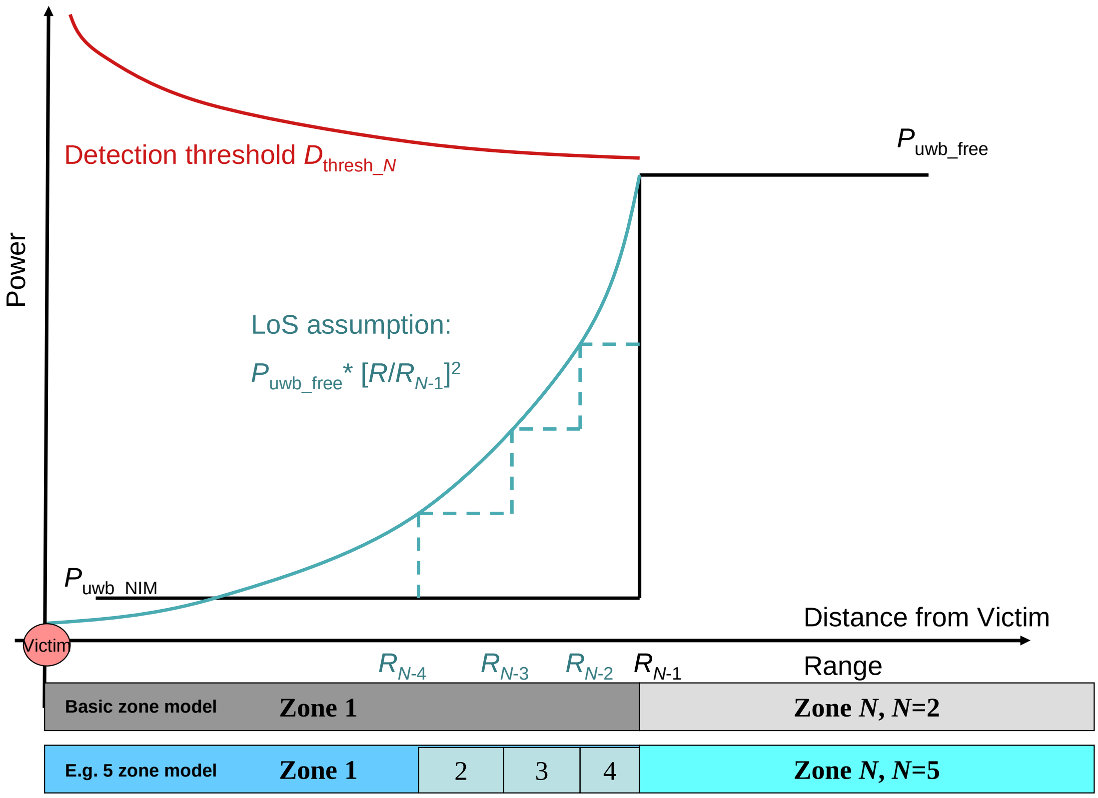

Figure 3: Illustration of multi zone concept based on equivalent protection levels

The basic zone model consists of two zones, the non-interference mode operational zone, zone 1, and the free mode operational zone, zone N, $N = 2$. The basic threshold level $D_{thresh\_(N-1)}$, separating free mode operational zone and the non-interference mode operational zone, is defined by two key parameters:

- Minimum needed isolation I, including margins for an interference free operation of the victim receiver, when in the presence of a UWB device operating in zone N.
- The transmit power of the victim device P_{TX_vic}.

Then $D_{thresh\_(N-1)}$ is given as:

$$D_{thresh\_(N-1)} = P_{TX\_vic} - I$$

During the detection and estimation process performed by the UWB device, a received victim signal level will be compared to the threshold level $D_{thresh\_(N-1)}$. If the received victim signal level exceeds the threshold level $D_{thresh\_(N-1)}$ the UWB device shall operate in the non-interference mode. This signal level estimation is periodically updated in order to accommodate the potential changing RF environmental conditions. When changes in the RF conditions are detected the operational mode of the UWB device shall be adapted accordingly.

4.4 Applicable frequency ranges

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 [i.11] points.

The operational frequency bands required are given in table 2. The UWB system bandwidth as defined by the -10 dBc [i.11] points shall at least partly include the victim service. Where the frequency span of the UWB radio device is insufficient to cover the victim service's bandwidth, the frequency range shall 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

4.5 DAA operational modes

To assure the repeatability of tests it will be necessary to ensure that all UWB radio 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 shall be dependent upon the test being undertaken. The suggested status is given in table 3.

Table 3: UWB radio 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 radio 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 radio 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_005 and TD_BWA_009	Transmitting/Receiving data at Payload levels identified in the relevant test section at max permitted mean power level	Payload shall be 50 % For a two zone system, the max mean power level will normally be -41,3 dBm/MHz

5 Detect framework

5.1 Introduction

The clause introduces the detection options and victim service related detection parameters for the definition of the DAA test specification requirements. The limits for the test are given in the victim service related annexes A to C and are determined in the relevant ECC deliverable [i.2].

5.2 Detect options

5.2.1 Measurement of received victim signal strength

The approach of the measurement of the received victim signal strength is depicted in figure 4. The reliability of the decision process in comparing the zone thresholds with the measured victim signals shall depend on the type of signal measured and the signal to noise level of the measurement. The signal to noise ratios achievable by the UWB devices will be dependent upon the manufacturers' implementation.

The frequency band selection shall take into account the operational frequency band of the UWB device and all potential victim services. For convenience this frequency band may be segmented to enhance both characterization and measurement procedure of amplitudes. Where any amplitudes are detected which are higher than the background noise of the receiver/measurement subsystem these shall be characterized.

If no signals are detected above the background noise no additional steps have to be taken. This implies that the minimum usable sensitivity (including a specified blocking capability) of the detector shall allow measurement of DAA threshold values. Regarding figure 4, i.e. the noise figure of the equipment shall not impair the detection capability of the DAA mechanism.

The process of characterization shall include not only the identification of the parameters of the received signals but also the comparison against a known and specified set of parameter (e.g. a pattern) of the potential victim services in the relevant frequency band. The details on how the characterization is performed will be left to the individual UWB implementation design. The more comprehensive the characterization information is, the better the possible match with the avoidance techniques and hence the higher the spectrum efficiency will be.

If none of the detected signals correspond to a potential victim service no further action is needed.

If at least one signal corresponds to a potential victim service, the relevant threshold sets of the zone model shall be selected. In the following step the members of the relevant threshold sets shall be compared to the corresponding characterized signal levels. Based on this comparison the UWB operational parameters shall be adapted.

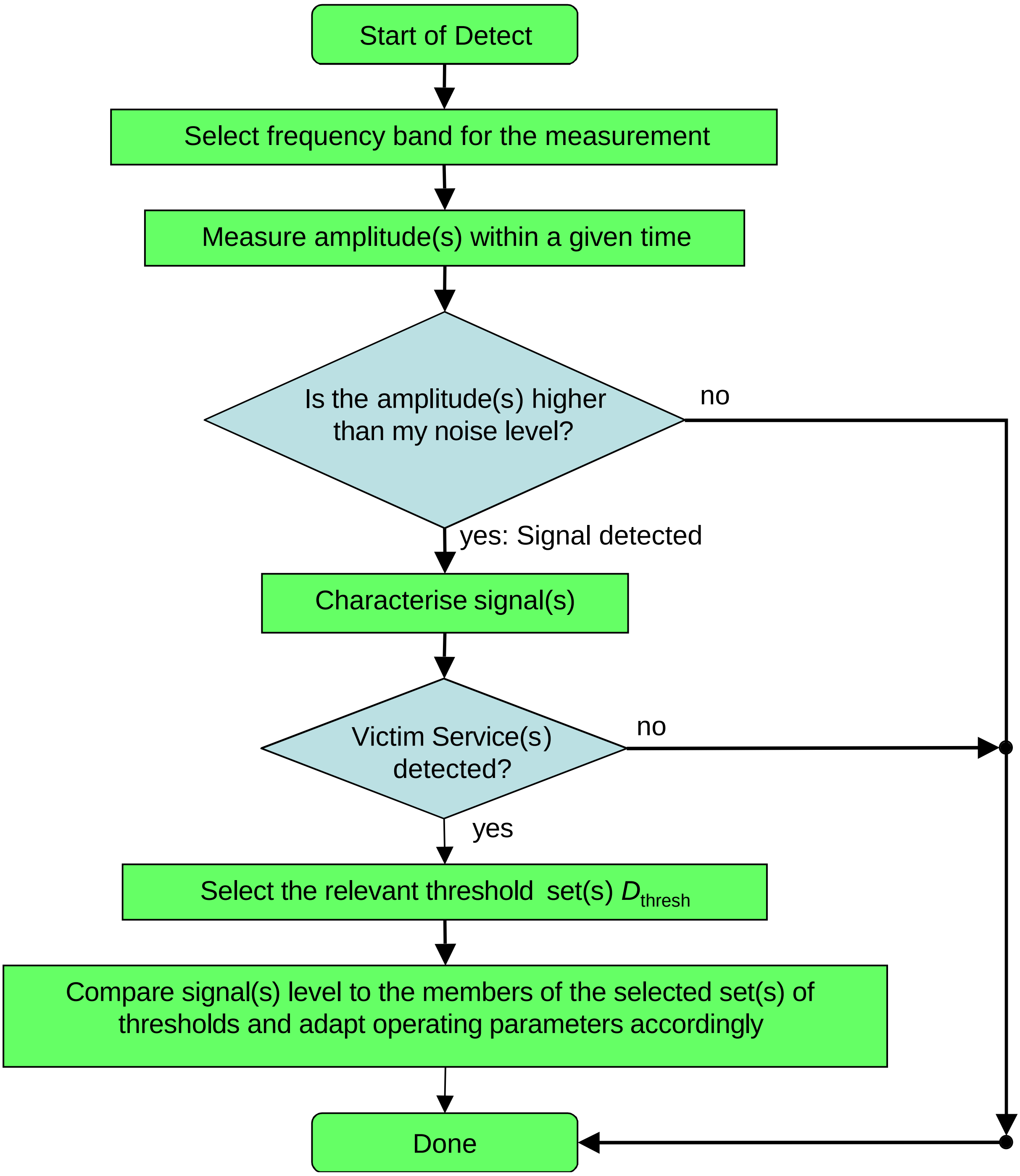

Figure 4: Detect flow diagram for victim signal strength measurement

5.2.2 Processing of available external victim service information

An alternative to the measurement approach (depicted in clause 5.2.1) is the use of current DAA information obtained from other devices or systems within the receive range of the UWB device (e.g. a centralized DAA detector). This information can be used by the UWB device to set its own DAA parameters for its local environment, e.g. membership of the peer group.

Received information comprises but is not restricted to:

- victim service information available from peer UWB devices;
- victim service information available on pilot channels, such as Cognitive Pilot Channels (CPC);

- control information from potential victim systems.

The scope of the information available to any UWB device is dependent on its specific implementation. The use of such information carries some risk, e.g. in a mobile environment the zone information may be rapidly outdated, under certain conditions potential victim service may be hidden from peer groups. The maximum distance among UWB devices processing external victim service information depends on the definition of the applicable zone model and the maximum distance shall be specified in case of the information originating from peer UWB devices.

The benefits to be accrued in using such information include increased reliability, detection speeds and lower processing overheads, e.g. information from collocated devices where common control information is shared.

The use of such information is both context specific and time critical.

The approach is depicted in figure 5.

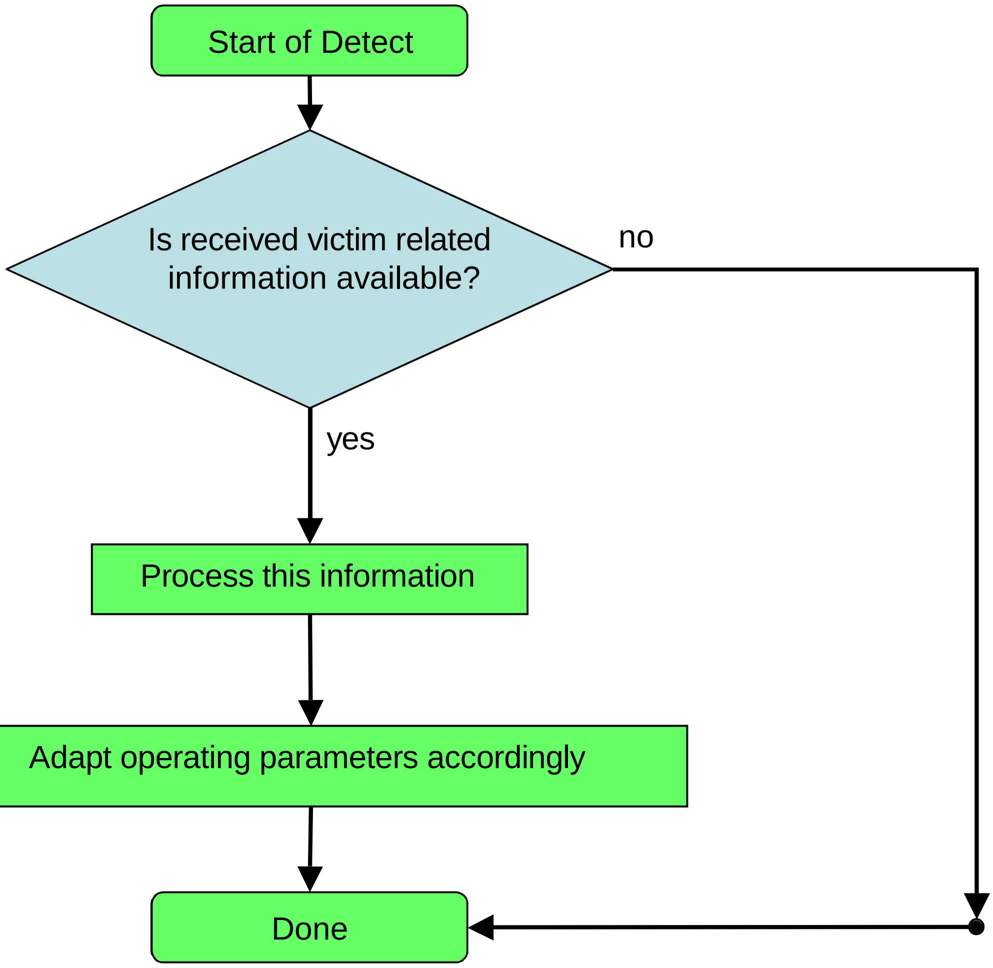

Figure 5: Detect flow diagram for processing of external information

5.2.3 Combination of both

It is expected that systems will use a combination of the local measurements and the available external information. The operational flow using the combined approach is given in figure 6.

This combined approach will optimize the UWB resource usage, improve detection performance, improve spectrum efficiency and minimize processing overhead.

This improvement is mainly reached by including the additional external information in the characterization step and the adaptation step of figure 4. This information flow is depicted in figure 6 by the dotted lines.

The particular implementation of these disparate sets of information will ultimately determine the extent of the possible improvements.

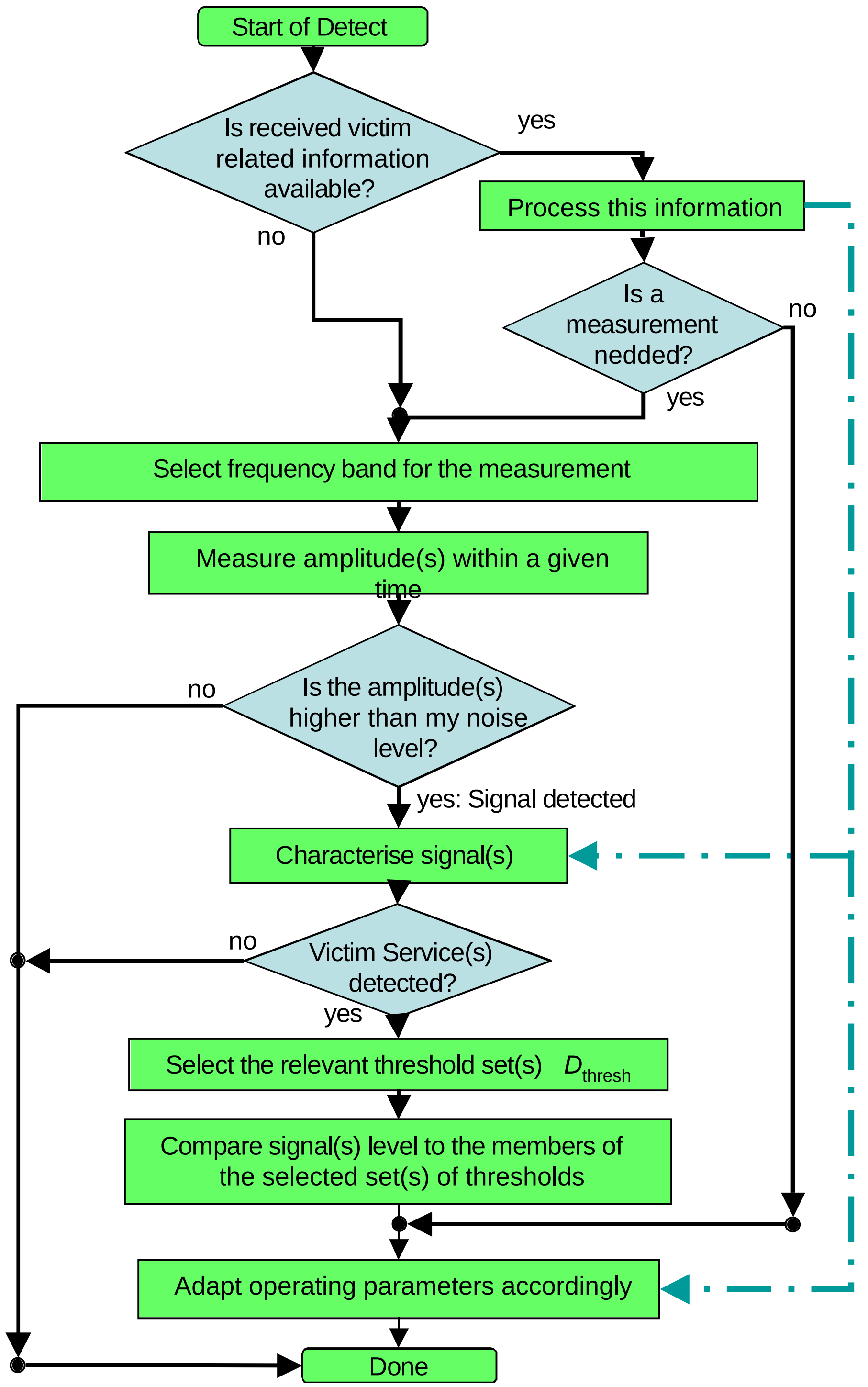

Figure 6: Detect flow diagram for the combination of internal measurements and external information

5.3 Detection parameters

5.3.1 Initial Channel availability check time

The UWB device shall perform victim system monitoring and shall be required to detect any actively operating victim system signals within a minimum time given by *Minimum Initial Channel Availability Check Time*, $T_{avail,\ Time}$. During the *Minimum Initial Channel Availability Check Time*, the device may operate in the non interference mode (NIM).

5.3.2 Maximum Detect and Avoid time, t_{avoid}

Time duration between a change of the external RF environmental conditions and update or adaptation of the corresponding UWB operational parameters.

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

- Channel Availability Check Periodicity: $T_{\text{avail, Period}}$.
- In Operation Channel Availability Check Time: $T_{\text{in op avail, Time}}$.
- Avoid Implementation Time: $T_{\text{avoid impl}}$.

The Detect and Avoid time is depicted in figure 2. The detect and avoid time shall be tested and a functional test will be specified for this.

5.3.3 Signal detection threshold, D_{thresh}

The UWB device shall employ a signal detection function that enables it to detect signals from active victim services. The currently identified services are BWA and radio location.

This function shall be 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. This detection threshold is specified at the antenna input/connector assuming a 0 dBi antenna gain for each detection operation and may be based on multiple levels.

The signal detection performance will depend upon the type of signal from the victim service as well as the signal-to-noise ratio when measured at the UWB device. The signal detection shall ultimately determine the detection probability achievable. An example calculation is shown in annex G.

The signal detection threshold shall be verified and a functional test specified for this parameter.

5.3.4 Detection probability

The detection probability is the probability that the DAA enabled UWB device reacts appropriately to a signal detection threshold crossing within the maximum detect and avoid time (see also clause 7.4). A minimum number of test runs shall be specified to express the required detection probability with a specified confidence level.

Where multiple detection thresholds or detection probabilities are defined a test shall be undertaken for each relevant threshold/probability combination.

6 Avoidance options

6.1 Introduction

The aim of the avoidance process is to protect the victim service receiver while maintaining an operational link with peer UWB devices.

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

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.

The currently qualified techniques for use with UWB devices are given in clauses 6.2 to 6.7, however, other techniques may be used where equivalent protection can be demonstrated.

6.2 Transmit power management

Transmit power management is the reduction of the UWB transmission power over the complete UWB operational band to the required level.

6.3 Band relocation

Band relocation is an avoidance technique where the transmit band of the UWB device is relocated in the frequency domain to eliminate interference with the victim service. This protection may either be done by band shifting or band switching.

Band shifting is a partial relocation of the active transmission band of the UWB device within the original operational frequency band whereas band switching means that a new operational frequency band is selected by the UWB device.

6.4 Frequency band notching

Frequency band notching is a frequency dependent transmit power management technique which protects the victim services frequency band. This technique has the advantage that out-of-victim-band UWB transmissions may be made at the maximum permitted power for the operational band in use (see also clause 6.8.1).

6.5 LDC

Low duty cycle techniques reduce 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.

This technique is an unsynchronized time sharing avoidance method. As a consequence the LDC technique does not eliminate interference to the victim services but it may reduce the effect of the interference.

6.6 Antenna techniques

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.

6.7 Combinations

In order to achieve the protection criteria and maintain an operational link with peer devices it may be necessary to combine a number of the avoidance techniques mentioned above.

6.8 Avoidance parameters

6.8.1 Minimum avoidance bandwidth

This is the minimum bandwidth over which the UWB devices shall reduce their transmission power below the maximum avoidance level. The values for the minimum avoidance bandwidth are given in annexes A to C.

6.8.2 Default Avoidance bandwidth

This is the default bandwidth for the avoidance operation. This bandwidth has to be protected in the case a DAA enabled UWB device does not implement an enhanced victim service bandwidth identification mechanism. The values for the default avoidance bandwidth are given in annexes A to C.

6.8.3 Maximum avoidance power level

The maximum avoidance power level is the UWB transmit power assuring the equivalent protection of the victim service. In the basic two zone model the maximum avoidance power level is equivalent to the NIM power level given in table 1. 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.

6.9 Switching to LDC

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 as shown in table 4.

Table 4: 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

7 Test considerations

7.1 General considerations

Any test must verify that the UWB device can detect a victim service and react within a specified time. Therefore the tests must be able to measure the detect and avoid times and the chosen avoid options.

As far as possible tests shall be representative of the normal deployment of UWB devices which may be static, walking or vehicle-based. In the case of moving devices, the interfering signals from the UWB devices and the received signals from victim services will vary in amplitude with time and distance from the victim. This was illustrated in figure 3. The UWB device will react only if a victim signal crosses a given threshold and the amplitude of the specified test signal shall, as far as possible, reflect the changing conditions of the signal.

Under certain conditions it may be that multiple victim services will be in use in the same UWB operational band. In this case it will be important that the test establishes that the UWB device reacts to the simultaneous presence of these signals in such a way that all services are adequately protected. In any operational band the test set-up used shall simulate all the victim services present.

The preferred test set-up shall be a radiated test set-up. For equipment that have detachable antennas and provide a 50 ohm antenna port, conducted measurements can be made providing suitable antenna calibrations can be provided.

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

7.2 Considerations for radio location services

A set of representative test patterns, simulating the full set of operational modes of radio location services will be specified. These patterns will use a combination of radar signal parameters such as pulse repetition interval, pulse width, modulation, bandwidth or burst repetition frequency.

NOTE: This is comparable to the DFS mechanism used by 5 GHz WLAN for the protection of radio location services.

7.3 Considerations for BWA services

The peak and average power of a BWA system based on OFDM is governed by the number of subcarriers and not the individual carrier modulation. In this case the use of a specific modulation scheme emulating the victim signal for test is assumed not to be critical.

During test the emulated victim signal must have the same peak to average ratio given by the BWA OFDM modulation scheme. The bandwidth of the signal shall be the maximum and the minimum of the victim service. The carrier frequency shall be within the victim service operational band.

In the particular case of frequency duplexing systems the test must differentiate between up- and down-link frequency bands in order to allow the optimum selection of the avoidance technique. Where FDD systems are deployed the duplex spacing for the particular region shall be used to assess the detection capabilities of the UWB device under test.

In the event that this differentiation cannot be made by the UWB device the complete victim service band must be protected.

In the case of the BWA services a set of four critical applications have been identified [i.2] and shall be tested. The corresponding timing patterns are illustrated in figure 7. These timing parameters are used to define the BWA detect and avoid timing in annex B.

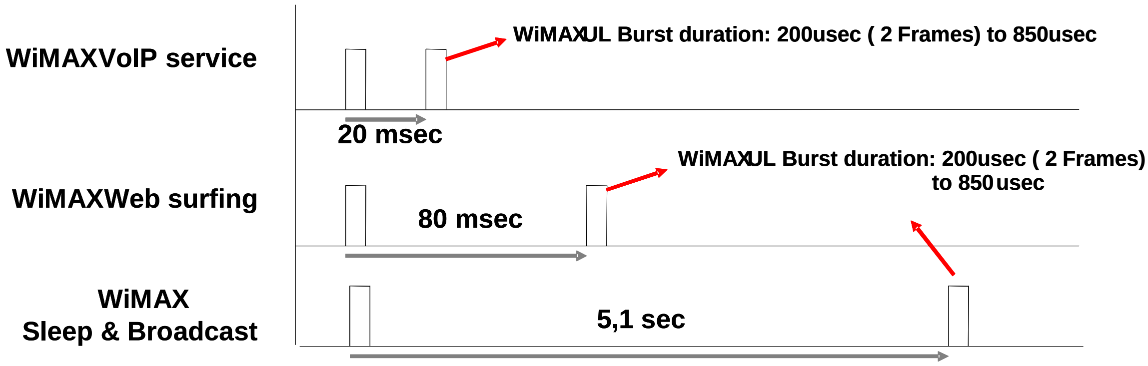

Figure 7: Typical BWA timing patterns for victim signal emulation

7.4 Maximum allowable measurement uncertainty

The measurement uncertainty for the measurement of each DAA parameter shall be defined.

Measurements shall be repeated in order to determine an adequate detection probability with acceptable uncertainty for the selected victim signals.

The reliability of the decision process in comparing the zone thresholds with the measured victim signals will depend on the type of signal measured and the signal to noise level of the measurement. The signal to noise ratios achievable by the UWB devices will be dependent upon the manufacturers' implementation.

A minimum number of tests shall be specified to express the required detection probability with a specified confidence level.

Annex A (normative): Radio location services in the band 3,1 GHz to 3,4 GHz

Table A.1: Band 3,1 GHz to 3,4 GHz: Radio Location 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 Tx Power density)		-70 dBm/MHz	-41,3 dBm/MHz
Avoidance Level (UWB maximum peak power in 50 MHz)		-36 dBm	-0 dBm
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 shall be capable of selecting an operating channel anywhere within the band 3,1 GHz to 4,8 GHz.

Annex B (normative): 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 Tx Power density)		-80 dBm/MHz in the frequency range from 3,4 GHz to 3,8 GHz	-65 dBm/MHz	-41,3 dBm/MHz
Avoidance Level (UWB maximum peak power in 50 MHz)		-40 dBm	-25 dBm	0 dBm
Default Avoidance Bandwidth		3,4 GHz to 3,6 GHz, 3,6 GHz to 3,8 GHz		
Possible Avoidance Options		All		

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 shall provide an equivalent protection of the potential victim device. These test modes must be verified in the corresponding test setup for the harmonized ETSI standard.

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

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

Annex C (normative): Radio location services in the band 8,5 GHz to 9,0 GHz

Table C.1: Band 8,5 GHz to 9,0 GHz: Radio Location 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 g		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 Tx Power density)		-65 dBm/MHz	-41,3 dBm/MHz
Avoidance Level (UWB maximum peak power in 50 MHz)		-25 dBm	0 dBm
Default Avoidance Bandwidth		8,5 GHz to 9,0 GHz (500 MHz)	
Possible Avoidance Options		All without LDC	

Annex D (normative): DAA Test Procedure for Radiolocation Services

D.1 Introduction

In the present clause the test procedure for the radiolocation DAA test is described. The UWB DAA radio device under test (DUT) shall be verified under normal operational conditions. Measurements shall be performed in accordance with the procedures and techniques defined in TS 102 883 [1].

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 radio device during the initial start-up when the DAA UWB radio device intends to operate directly in a non NIM. Thus the UWB DAA radio device need to be set in an operational condition in which this is guaranteed. The test verifies that the UWB DAA radio 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 radio device under test. During this test the UWB DAA radio device under test shall operate in a normal dynamic operational mode. The manufacturer has to declare this normal operational mode taking into account the zone model.

Exemplary configurations for the radiated and conducted test setups are shown in annex G.

D.2 Initial Start-up test

The clauses below define the procedure to verify the *Minimum Initial Channel Availability Check* by ensuring that the UWB DAA radio device is capable of detecting radar pulses at the beginning and at the end of the *Minimum Channel Availability Check Time.* Furthermore, one initial test shall guarantee that the UWB radio device does not switch into a NIM operation before the end of the *Minimum Initial Channel Availability Check time,* $T_{\text{avail\_time\_min}}$.

D.2.1 Test without a radiolocation test signal during the *Minimum Initial Channel Availability Check Time,* $T_{\text{avail\_time\_min}}$

Summary:

Verify the UWB DAA radio 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 D.1.

Test description identifier: TD_Radar_001.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio 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 radio device is powered on at T_0. T_1 denotes the instant when the UWB DAA radio 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 radio device shall not switch into a mode other than a NIM before the end of $T_1 + T_{avail\_time\_min}$ after switch on of the radio device, where the NIM operation is either the LDC mode or the power level defined in annex A or annex C 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 radio device.

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

c) Repeat a) and b) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests. If one failure occurs go to d). For more than one failure the test has not been passed.

d) Repeat a) and b) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

e) End of test.

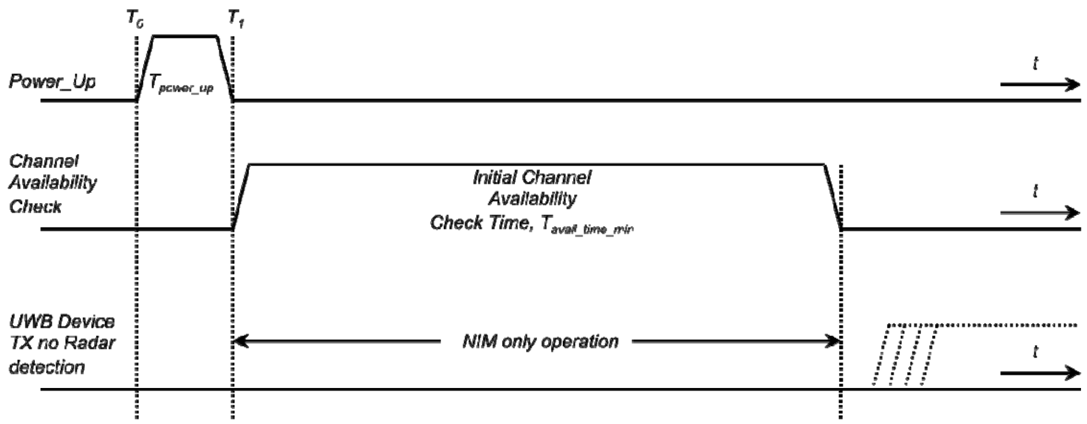

Figure D.1: Example of timing for radiolocation testing of the Minimum Initial Channel Availability Check Time T_{avail_time}, UWB DAA devise intent to operate in a non NIM mode

D.2.2 Tests with a radiolocation test signal at the beginning of the *Minimum Initial Channel Availability Check Time, $T_{avail\_time\_min}$*

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 D.2.

Test description identifier: TD_Radar_002.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio device will be switched off. The signal generator used to generate the test patterns in table D.1 will be connected to an antenna of suitable characteristics to permit the UWB DAA radio 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 radio device is powered on at T_0. T_1 denotes the instant when the UWB DAA radio 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.

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 D.1 at a level of 10 dB above the level defined in annexes E and F and at exactly the threshold levels as defined in annexes E and F. This single-burst radar test signal shall commence within 2 seconds after time T_1.

CON-1: The *Minimum initial Channel Availability Check* is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time\_min}$ 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 radio device.

CON-2: It shall be recorded if the radiolocation test signal was detected. This can be done by verifying that the UWB DAA radio device stays in a NIM operation in the relevant operational band using the *default avoidance bandwidth* of the regarded radiolocation service beyond $T_1 + T_{avail\_time\_min}$.

d) Repeat a) to c) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests. If CON-3 is fulfilled go to f). If one failure occurs go to e). For more than one failure the test has not been passed.

e) Repeat a) to c) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

f) Repeat b) to e) for each of the relevant radar test signals for the UWB operational frequency range as defined in table D.1 at a level of 10 dB above the defined threshold level as defined in annexes E and F and at exactly the threshold levels as defined in annexes E and F.

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

g) Repeat c) to f) for each of the identified radar frequencies.

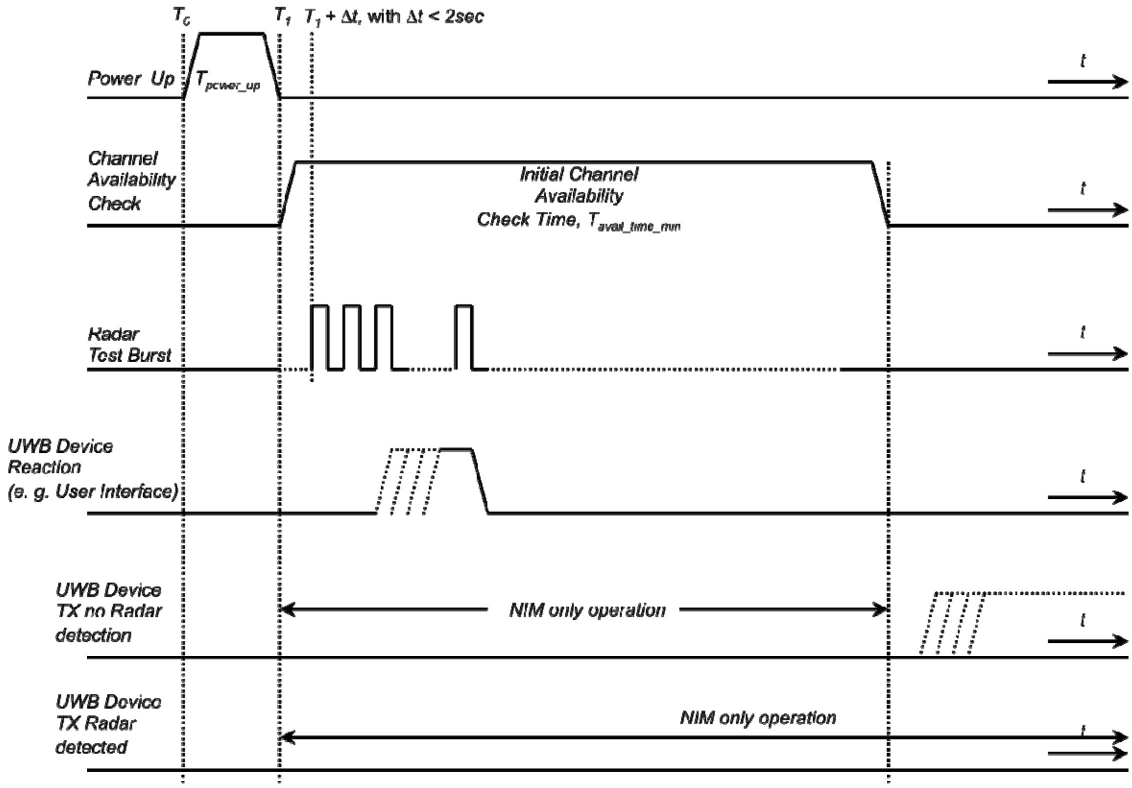

Figure D.2: Example of timing for radiolocation testing at the beginning of the Minimum Initial Channel Availability Check Time, UWB DAA radio device intent to operate in a non-NIM mode

D.2.3 Tests with radiolocation test signal at the end of the *Minimum Initial Channel Availability Check Time,* $T_{avail\_time\_min}$

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 D.3.

Test description identifier: TD_Radar_003.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio device will be switched off. The signal generator used to generate the test patterns in table D.1 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 radio device is powered up at T_0. T_1 denotes the instant when the UWB DAA radio 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_{avail_time} is expected to commence at instant T_1 and is expected to end no sooner than $T_1 + T_{avail\_time}$ 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 radio 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 D.1 at a level of 10 dB above the level defined in annexes D and F. This single-burst radar test signal shall commence towards the end of the minimum required *Minimum Initial Channel Availability Check* Time but not before time T_1 +10 seconds.

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

d) Repeat a) to c) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests. If CON-3 is fulfilled go to f). If one failure occurs go to e). For more than one failure the test has not been passed.

e) Repeat a) to c) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

f) Repeat a) to e) for each of the relevant radar test signals for the UWB operational frequency range as defined in table D.1 at a level of 10 dB above the defined threshold level as defined in annexes E and F and at exactly the threshold levels as defined in annexes E and F.

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

g) Repeat a) to f) for each of the identified radar frequencies.

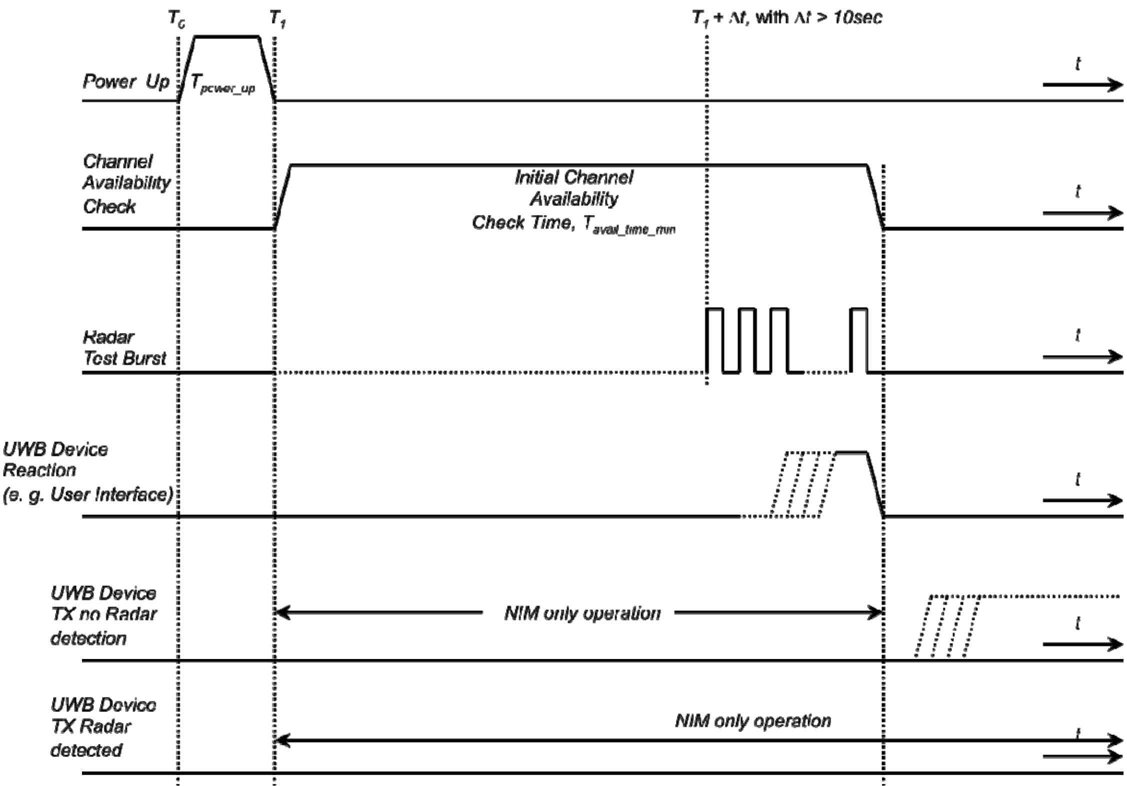

Figure D.3: Example of timing for radar testing towards the end of the Minimum initial Channel Availability Check Time

D.3 In-operation test

The clauses below define the procedure to verify the *Detect and Avoid Time*, T_{avoid} by ensuring that the UWB DAA radio device is capable of detecting radiolocation system pulses during the normal operation of the UWB DAA radio 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 UWB DAA radio device in relation to a potential victim radiolocation radio device. In figure D.4 an example for the used test signal is depicted. After the reach of the detection threshold level given in tables D.1 or F.1 respectively, the UWB DAA radio device shall switch into a NIM operation not later than T_{avoid}.

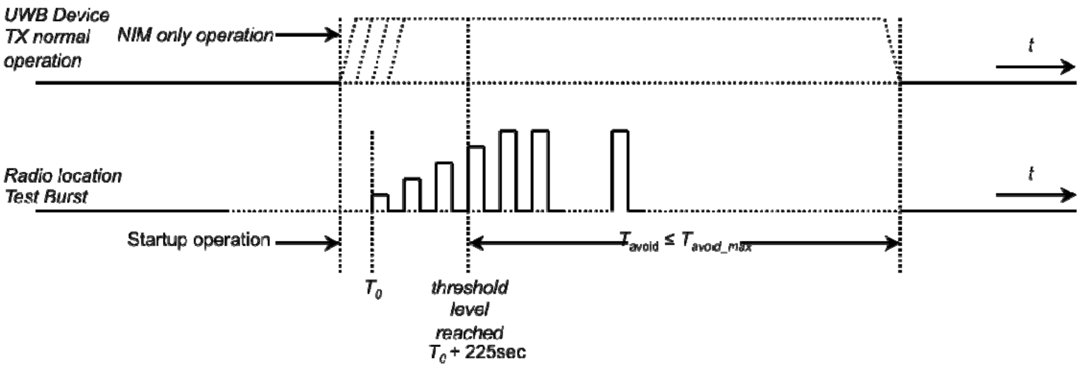

Figure D.4: Example of timing for radiolocation signal in-operation testing of the Detect and Avoid Time, here with increasing Radiolocation test signal level larger than the threshold

During the test, the existing data link might be disrupted. This should then not lead to an uncontrolled operation but to an operation equivalent to the NIM mode.

D.3.1 In-operation test procedure

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 D.4.

Test description identifier: TD_Radar_005.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) Both UWB DAA radio devices shall be 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 D.1 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 in accordance with table D.1 at a power level 15 dB below the threshold identified in annex A and will be increased in 20 steps of 1 dB every 15 seconds progressively to reach the threshold +5 dB value at T_0 + 300 seconds.

CON-1: The measurement of the actual "Detect and Avoid Time" T_{avoid} of the DUT is expected to commence at instant T_0 + 225 seconds. The actual detect and avoid time of the radio device under test shall be smaller or equal to the Maximum Detect and Avoid time T_{avoid_max} as defined in annex A or annex C. The actual Detect and Avoid time T_{avoid} of the radio device under test can be negative.

CON-2: It shall be recorded if the radar test signal was detected before T_0 + 225 seconds + T_{avoid_max}. This can be done by verifying that the UWB DAA radio device is switched into a NIM operation in the relevant operational band using the default avoidance bandwidth of the regarded radiolocation service.

c) Repeat a) and b) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests, then go to e). If one failure occurs go to d). For more than one failure the test has not been passed.

d) Repeat a) and b) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

e) Repeat b) to d) for each of the relevant radar test signals for the UWB operational frequency range as defined in table D.1 for the threshold levels as defined in annexes E and F.

CON-5: A timing trace or description of the observed timing and behaviour of the UWB DAA radio device shall be recorded.

f) Repeat a) to e) for each of the radar frequencies.

D.4 Test patterns for the radiolocation DAA test

The general structure of radiolocation bursts is given in figure D.5. The test patterns to be used throughout testing, together with the relevant radar frequencies of operation are given in table D.1.

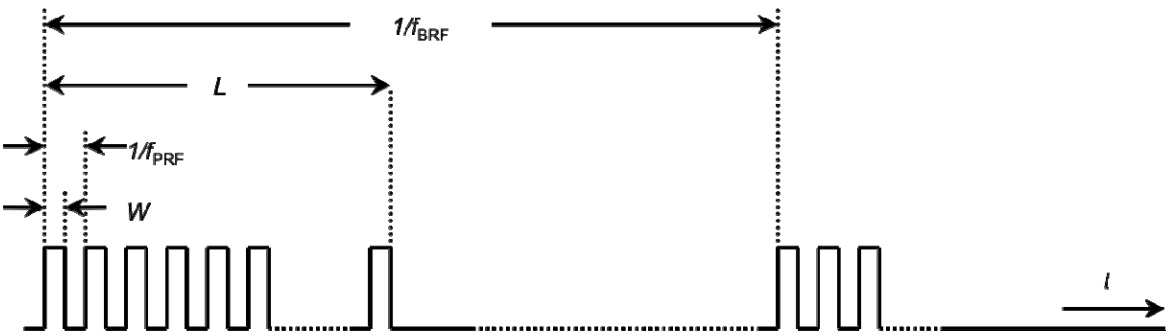

Figure D.5: General structure of the bursts for DAA radiolocation test transmissions

Table D.1: 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] (see note 13)	Pulses per burst [PPB] (see notes 1 and 12)	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 to 1 400 (see note 6)	10 to 60	0,2 to 0,08	P_d > 90 %
f_1= 3,1 GHz $f_1 < f_2 < f_3$ f_3= 3,4 GHz	2 - Variable	1 (see note 14), 10, 20, 40, 60, 100	100 to 500 (see note 6)	2 to 5	0,2 to 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 to 15 000	20 to 560	2,0 to 0,22	P_d > 90 %

NOTE 1: This represents the number of pulses seen at the UWB DAA radio 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: P_d 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 P_d 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 that 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 radio 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 radio device test in the 8,5 GHz to 9 GHz.

NOTE 10: Pulses have instantaneous bandwidth of 0,5 MHz, 1 MHz, 2 MHz or 5 MHz. Modulation types can be LFM, BPSK.

NOTE 11: The Radar Test Frequency f_2 shall be arbitrarily chosen between the f_1 and f_3.

NOTE 12: Suitable combinations of PPB and f_{BRF} are to be selected whereby for radar test signals 1 to 3, the minimum number of pulses per second is 2, 5 and 40 respectively. This clarifies note 1.

NOTE 13: The granularity for each radar test signal is 11 evenly distributed cases. The respective step sizes for radar test signals 1 to 3 are 100, 40 and 1 000.

NOTE 14: For the pulse width of 1 µs the number pulses/burst should be arbitrarily chosen between 20 PPB and 50 PPB.

Annex E (normative): DAA Test Procedure for BWA systems in the 3,4 GHz to 3,8 GHz band

E.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 radio device. The possible range of performance evaluation tests might include assessment during preamble, data exchange and call termination between the two radio devices. In all cases the tests undertaken would establish that the minimum threshold detection levels, identified in the ECC decision 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 radio 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.

E.1.1 UWB radio 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 radio device whilst assuring the victim service operation. The manufacturer will identify at the time of test whether the UWB radio device is equipped with victim service identification and the associated avoidance mechanisms implemented. These associated avoidance mechanisms will be evaluated.

E.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 radio 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 radio devices need to be set in a typical operational mode where a non NIM operation is required. Following the power up procedure the UWB radio device will enter the state identified in table 3. The start-up test needs to be performed using all defined thresholds and optionally with a downlink signal deployed.

E.2.1 Test without a BWA test signal during the Minimum Initial Channel Availability Check Time, $T_{avail\_time\_min}$

Summary:

Verify that the UWB DAA radio 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 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio devices will be switched off. No victim signal generator is connected to the test setup or the signal generator is switched off in radiated test set-ups.

b) The UWB DAA radio device is powered on at T_0. T_1 denotes the instant when the UWB DAA radio 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 radio device shall not switch into a mode other than a NIM before the end of $T_1 + T_{avail\_time\_min}$ after switch on of the radio device, where the NIM operation is either the LDC mode or the power level defined in annex E 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 radio device.

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

c) Repeat a) and b) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests. If one failure occurs go to d). For more than one failure the test has not been passed.

d) Repeat a) and b) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

e) End of test.

E.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 radio device shall protect the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA radio devices. Where the UWB radio 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 shall be specified and conformance established.

Test description identifier: TD_BWA_007.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio device will be switched off. The signal generator used to generate the test patterns in table E.1 will be connected to an antenna of suitable characteristics to permit the UWB DAA radio 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 radio device is powered on at T_0. T_1 denotes the instant when the UWB DAA radio 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.

c) A BWA signal is generated in the relevant BWA frequency band using the web surfing test pattern defined in table E.1 at a level of 10 dB above each of the threshold levels defined in annex B. This BWA test signal shall commence within 1 second after time T_1 and repeat for a minimum of 240 seconds.

CON-1: The *Minimum initial Channel Availability Check* time is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time\_min}$ 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 radio device.

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

- *default avoidance bandwidth* for the BWA service identified and where relevant.
- *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.
- LDC operational parameter if applicable.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA radio device shall be recorded for each avoidance mechanism.

d) Repeat a) to c) for 5 times in a row.

CON-4: CON-1, CON-2 and CON-3 shall be fulfilled in all 5 tests. If one failure occurs go to d). For more than one failure the test has not been passed.

e) Repeat a) to c) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

f) Repeat a) to e) at each of the threshold levels in annex B.

g) Repeat a) to f) for each BWA operating frequency identified.

h) If the UWB radio device has optional avoidance mechanisms, repeat a) to g) for each optional avoidance mechanism identified.

i) If the UWB radio devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table E.1 and repeat steps a) to h) for each of the associated victim service identification avoidance mechanisms.

E.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 radio device shall protect the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA radio devices. Where the UWB radio 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 shall be specified and conformance established.

Test description identifier: TD_BWA_008.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) The UWB DAA radio device will be switched off. The signal generator used to generate the test patterns in table E.1 will be connected to an antenna of suitable characteristics to permit the UWB DAA radio 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 radio device is powered on at T_0. T_1 denotes the instant when the UWB DAA radio 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.

c) A BWA signal is generated in the relevant BWA frequency band using the web surfing test pattern defined in table E.1 a level of 10 dB above each of the threshold levels defined in annex B. This BWA test signal shall commence towards the end of the minimum required Minimum Initial Channel Availability Check Time but not before time T1 + 3 seconds and repeat for a minimum of 240 seconds.

CON-1: The *Minimum initial Channel Availability Check* time is expected to commence at T_1 and is expected to end no sooner than $T_1 + T_{avail\_time\_min}$ 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 radio device.

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

- *default avoidance bandwidth* for the BWA service identified and where relevant.
- *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.
- LDC operational parameter if applicable.

CON-3: A timing trace or description of the observed timing and behaviour of the UWB DAA radio device shall be recorded for each avoidance mechanism.

d) Repeat a) to c) for 5 times in a row.

CON-4: CON-1, CON-2 and CON-3 shall be fulfilled in all 5 tests. If one failure occurs go to d). For more than one failure the test has not been passed.

e) Repeat a) to c) for 10 times in a row.

CON-5: CON-1, CON-2 and CON-3 shall be fulfilled in all 10 tests.

f) Repeat a) to e) at each of the threshold levels in annex B.

g) Repeat a) to f) for each BWA operating frequency identified.

h) If the UWB radio device has optional avoidance mechanisms, repeat a) to g) for each *optional avoidance mechanism* identified.

i) If the UWB radio devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table E.1 and repeat steps a) to h) for each of the *associated victim service identification avoidance mechanisms*.

E.3 In-operation test

This series of tests evaluates the UWB radio 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 radio 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.

During the test, the existing data link might be disrupted. This should then not lead to an uncontrolled operation but to an operation equivalent to the NIM mode.

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 radio devices.

The UWB DAA radio device shall protect the complete *default avoidance bandwidth* as defined in annex B; this is a mandatory test for all UWB DAA radio devices. Where the UWB radio 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 shall be specified and conformance established.

Test description identifier: TD_BWA_009.

Requirement Reference: See table 3.

Pre-test Condition:

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

Test Sequence:

a) Both UWB DAA radio devices shall be 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 E.1 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 test signal will be switched on at T_0 with the test pattern in accordance with table E.1 at a power level 15 dB below the threshold identified in annex B and will be increased in 20 steps of 1 dB every 15 seconds progressively to reach the threshold +5 dB value at T_0 + 300 seconds.

CON-1: The measurement of the actual "Detect and Avoid Time" T_{avoid} of the DUT is expected to commence at instant T_0 + 225 seconds. The actual detect and avoid time of the radio device under test shall be smaller or equal to the Maximum Detect and Avoid time T_{avoid_max}. The actual Detect and Avoid time T_{avoid} of the radio device under test can be negative. The following avoid operations shall be verified:

- *default avoidance bandwidth* for the BWA service identified and where relevant.
- *optional avoidance mechanisms* identified by the manufacturer for the BWA service identified.
- LDC operational parameter if applicable.

CON-2: A timing trace or description of the observed timing and behaviour of the UWB DAA radio device shall be recorded for each test case.

c) Repeat a) to c) for 5 times in a row.

CON-3: CON-1 and CON-2 shall be fulfilled in all 5 tests. If one failure occurs go to d). For more than one failure the test has not been passed.

d) Repeat a) to c) for 10 times in a row.

CON-4: CON-1 and CON-2 shall be fulfilled in all 10 tests.

e) Repeat a)and b) for each threshold in annex B.

NOTE: Instead of repeating the test for each threshold, continuous testing for the different thresholds can also be performed. Depending on the implemented avoidance strategy, some threshold tests may be redundant, i.e. one test already covers another case.

f) Repeat a) to c) for each service identified in table E.1.

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

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

i) If the UWB radio devices have Victim Service Identification implemented, re-establish the victim service as an Up-link down-link pair as identified in table E.1 and repeat steps c) to f) for each of the associated victim service identification avoidance mechanisms.

E.4 Test Patterns for BWA Testing

The test patterns to be used throughout testing for the services identified in table B.2, will display the periodicity of signals given in figure E.1. The details of each burst for each service is given are given in table E.1.

Table E.1: Test patterns for BWA testing

		Test Pattern
Service/Operational Status	Operational Frequencies (see note 1)	BW 7 MHz (see note 2)
VoIP	3,41 GHz, 3,5 GHz, 3,459 GHz, 3,61 GHz, 3,7 GHz, 3,79 GHz	9 OFDMA symbols frame each at intervals identified in figure E.1
Web Surfing		
Broadcast		
NOTE 1: Where Up-link down-link pairs are required these shall be centred symmetrically around the frequencies 3,5 GHz and 3,7 GHz. The down link level shall 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 shall be chosen (QPSK, 16QAM or 64QAM).		
NOTE 3: For a 7 MHz-bandwidth WiMAX signal the number of physical radio subcarriers is fixed and it is 1 024 where 841 subcarriers are used within a symbol and the rest are guard (left, right) subcarriers. The number of subchannels used (groups of logical subcarriers) can be varied between 0 and 34 but this variation has almost no impact in the final transmitted spectrum power and there is no variation in the bandwidth of the WiMAX signal. This may have little impact on the number of detections reported by the DUT. The influence of using different modulation schemes (QPSK, 16QAM and 64QAM) may also have little impact in the detection results from one scheme to another.		

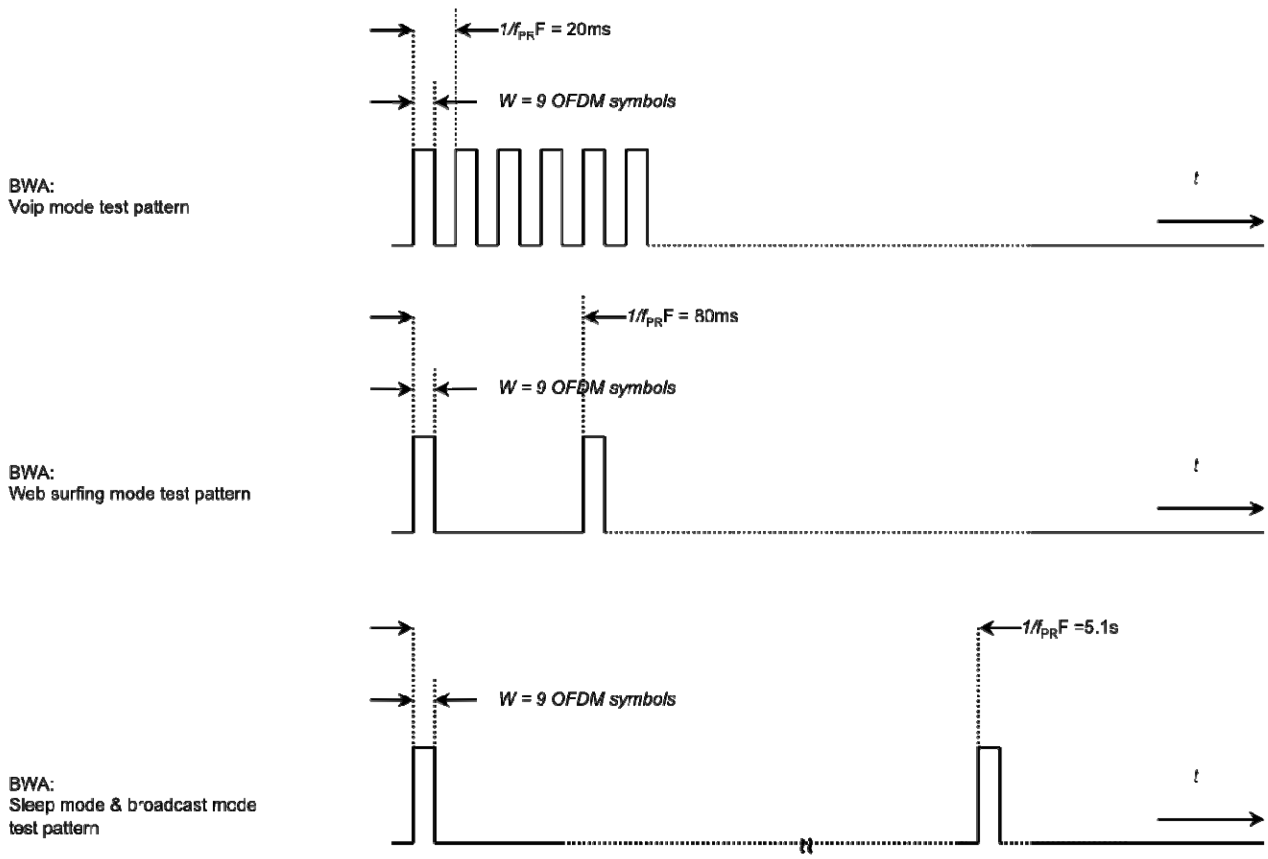

Figure E.1: Timing of BWA test signals

Annex F (informative): Detection threshold and range

In the present annex the detection thresholds defined in the present document, annexes A to C are further explained.

As an example the detection of a radio location victim service operating in the frequency range between 3,1 GHz and 3,4 GHz is used.

In table F.1 five cases for the detection of an S-band radio location victim system are depicted.

Table F.1: Calculation of radar detection threshold in the S-Band for different cases; source: ECC Report 120 [i.2]

	Case A	Case B	Case C	Case D	Case E
f/GHz	3,10	3,10	3,10	3,10	3,10
Victim power dBm e.i.r.p.	65,00	65,00	65,00	65,00	55,00
max antenna gain dBi	40,00	40,00	40,00	40,00	25,00
p_eirp_Victim dBm	105,00	105,00	105,00	105,00	80,00
p_eirp max W	3,16E+07	3,16E+07	3,16E+07	3,16E+07	1,00E+05
Victim thermal noise dBm/MHz	-114,00	-114,00	-114,00	-114,00	-114,00
I/N dB	-6,00	-6,00	-6,00	-6,00	-6,00
Imax/Victim dBm/MHz	-120,00	-120,00	-120,00	-120,00	-120,00
PSD_uwb dBm/MHz e.i.r.p.	-41,00	-50,00	-65,00	-70,00	-41,00
protection distance/m Free space loss	6817,71	2419,01	430,17	241,90	1212,38
protection distance/m NLOSs (Exp 3.5)	155,11	85,80	31,98	23,02	57,82
Power flux density at the UWB device at the protection distance W/m^2	5,41E-02	4,30E-01	1,36E+01	4,30E+01	5,41E-03
Power flux density at the UWB device at the protection distance dBm/m^2	17,34	26,34	41,34	46,34	7,34
Antenna Gain UWB dBi	0	0	0	0	0
Received power at the UWB Device at the protection distance dBm	-14,00	-5,00	10,00	15,00	-24,00
Detection Threshold at UWB device antenna in dBm	-38	-38	-38	-38	-38
Distance to Radar victime device at threshold level in m	108053,37	108053,37	108053,37	108053,37	6076,29
Difference to needed minimum protection distance	101235,66	105634,35	107623,20	107811,47	4863,91

The worst case is given in case E where the radio location system uses a very low peak TX power and a very low antenna gain. The received power at the UWB device from the radio location system can be calculated as follows:

- Received power = Victim e.i.r.p. power (dBm) + Victim Antenna gain (dB) + UWB Antenna gain (dB) - Pathloss; and
- Pathloss = 32,5 dB + 20 log (f) (in GHz) + 20 log (protection distance relative to 1m for free space loss).

Taking into account the defined detection threshold D_{thres_1} of - 38 dBm gives a margin of 14 dB. This margin can be translated into a protection distance at the threshold level.

In case E the protection distance at the detection threshold is 6 076 m. Taking into account the minimum protection distance needed we can observe an additional distance of around 5 km. A car driving with a speed of 100 km/h in the direction of the main beam of the radio location system takes 3 minutes to cover the additional protection distance.

For cases A to D this additional distance is in the range of 100 km. It would take a car more than one hour to cross the additional protection distance.

The defined detection threshold is thus directly related to the *Detect and Avoid time* for the dynamic update of the protection status of the UWB DAA device. The lower the detection threshold for a given parameter set of the victim service the longer the potential *Detect and Avoid time* without increasing the risk of interference towards the potential victim service.

Annex G (informative): DAA Test setup examples

Proposed configurations for the radiated and conducted test setups are shown in figures G.1 and G.2, respectively.

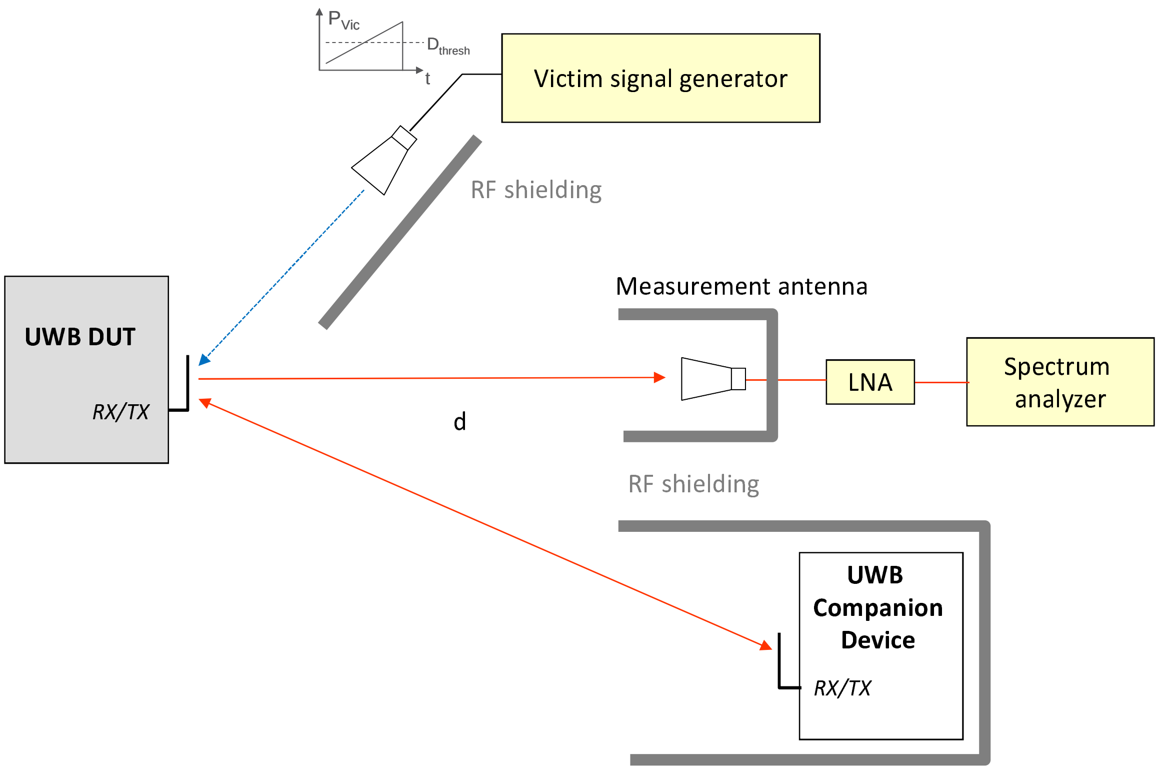

Figure G.1: Exemplary configuration of a radiated DAA test setup

For equipment that have detachable antennas and provide a 50 ohm antenna port, conducted measurements can be made providing suitable antenna calibrations can be provided. In the present document, test suites for conducted measurements are only provided for DAA conformance measurements. All transmitter emissions of the radio device are expected to be measured using the radiated measurement setup.

NOTE: In the radiated setup the UWB companion device should be about 2 meters away from the DUT. This distance is equivalent to about 50 dB of attenuation in the 3,1 GHz to 4,8 GHz range and about 56 dB in the 8,5 GHz to 9,0 GHz range between the DUT and companion devices in the conducted set-up.

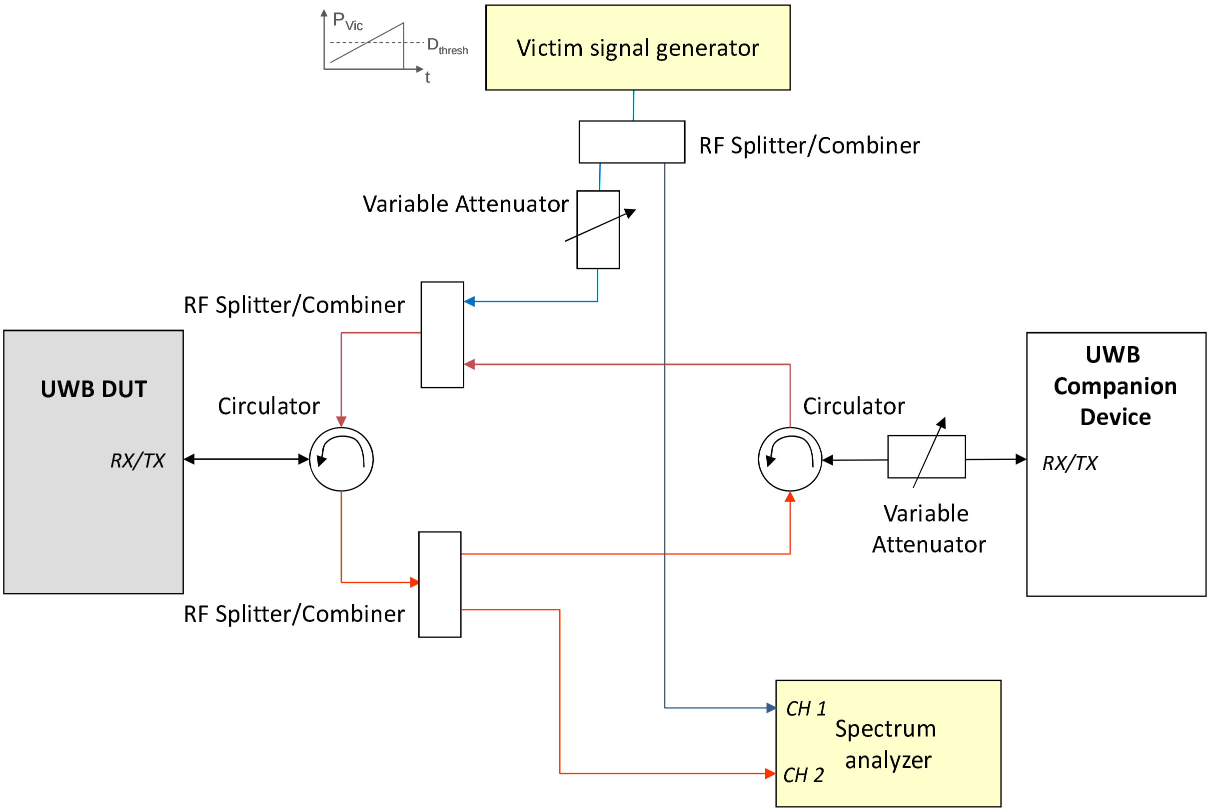

Figure G.2: Exemplary configuration of a conducted DAA test setup

Annex H (informative): Bibliography

ECC Report 37: "Compatibility of planned srd applications with currently existing radiocommunication applications in the frequency band 863 - 870 MHz".

Decision 2009/343/EC amending decision 2007/131/EC on allowing the use of radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community.

ETSI EN 302 065 (V1.2.1) (2010-10): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

ETSI EN 302 065-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 1: Common technical requirements".

ETSI EN 302 065-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM) Short Range Devices (SRD) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 2: Requirements for UWB location tracking".

ETSI EN 302 065-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM) Short Range Devices (SRD) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 3: Requirements for UWB devices for road and rail vehicles".

ETSI EN 302 500 (all parts) (V2.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra WideBand (UWB) technology; Location Tracking equipment operating in the frequency range from 6 GHz to 9 GHz".

History

Document history		
V1.1.1	June 2008	Publication
V1.2.1	November 2008	Publication
V1.3.1	March 2013	Publication