VNS 2188 – Voluntary National Specification 2188

White space devices operating in the 470 MHz to 790 MHz band

DRAFT

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Section 1

Foreword

1.1 The Radio and Telecommunications Terminal Equipment (R&TTE) Directive came into force on the 8th April 2000. This directive removes the need for national type approval regimes, allowing manufacturers to self declare conformance to the R&TTE Directive, via a number of possible routes detailed in the directive. Once a declaration of conformance has been made, and notification procedures with the relevant spectrum management authorities have been completed, where applicable, the manufacturer is free to sell the equipment in all European Union (EU) member states. In the UK the spectrum management authority is the Office of Communications (Ofcom).

1.2 In order to declare conformance with the R&TTE Directive, the manufacturers must satisfy the “essential requirements” the directive lays out. It is the responsibility of the European Telecommunication Standards Institute (ETSI) to develop harmonised standards under mandate from the European Commission. Compliance with these harmonised standards gives a presumption of conformity with the essential requirements of the directive.

1.3 ETSI is currently developing draft ETSI harmonised standard EN 301 598 for white space devices (WSD) operating in the 470 – 790 MHz band. Whilst awaiting a publication of the standard, this VNS is an interim document intended to provide guidance for manufacturers to declare conformance to the essential requirements.

1.4 This VNS takes the relevant essential parameters and technical limits directly from the draft ETSI standard and provides further guidance on these and the test methods where these are yet to be developed in the draft ETSI standard.

1.5 This document gives no presumption of conformity to the R&TTE Directive. Manufacturers shall consult annexes II, III, IV and V in the directive which detail the various routes to the directive’s conformance.

1.6 This VNS shall be used in conjunction with the IR 2088, R&TTE Directive and relevant publications that relate to the use of WSDs in this frequency band.

1.7 This VNS will be suppressed when the ETSI standard is available.

1.8 Further information on this VNS can be obtained from the technical enquiry contact given at the back of this document.

Section 2

Scope

2.1 This VNS applies to TV white space devices. These devices are wireless telegraphy equipment which transmit in all or any part of the 470 – 790 MHz band according to operational parameters received from a TV white space database. This VNS is technology and application agnostic.

2.2 The present document is intended to cover the provisions of article 3.2 of R&TTE Directive which states that: ".....radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference".

Section 3

Reference

[1]	Draft ETSI EN 301 598	White space devices (WSDs): Wireless access systems operating in the 470 MHz to 790 MHz frequency band.
[2]	ETSI TR 100 028 1 V1.4.1	Electromagnetic compatibility and radio spectrum matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1.
[3]	ETSI TR 100 028 2 V1.4.1	Electromagnetic compatibility and radio spectrum matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2.
[4]	EN 300 328 V1.8.1	Electromagnetic compatibility and radio spectrum matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2.4 GHz ISM band and using wideband modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive.

Section 4

Definitions, symbols and abbreviations

Definitions

4.1 For the purposes of the present document, the following definitions apply:

- **Altitude** – Height above sea level.
- **Association** – The process whereby a slave WSD initially identifies itself to its serving master WSD (typically, but not necessarily via transmissions in the TV white spaces).
- **Channel Usage parameters** – These parameters are used by a WSD to inform the WSDB of the actual radio resources that it will use.
- **Device parameters** – These are parameters that relate to a specific WSD. They can be either master device parameters or slave device parameters;
- **Digital terrestrial television (DTT)** – Terrestrial platform for the delivery of TV content via broadcasting in the UHF band.
- **DTT channel** – A 8 MHz channel in accordance with the European harmonised DTT channel raster.
- **Generic operational parameters** – The technical parameters received by a master WSD from the WSDB (or by a slave WSD from the WSDB through its serving master WSD) for the slave WSD's transmissions in the TV white spaces, but not specific to the slave's device parameters. Generic operational parameters apply, for instance, to a slave WSD's initial transmissions for purposes of association with its serving master WSD.
- **Geographic validity** – This is the geographic area within which the operational parameters for a geo-located WSD are valid. That geographic area is the area within a 50 metre radius of the latitude and longitude coordinates of the geo-located WSD, determined at the time of that geo-located WSD last reported its latitude and longitude coordinates to a qualifying white space database;
- **Geo-location capability** – This is the ability of a WSD to determine and report its latitude and longitude coordinates. Some WSDs may also have the ability to determine and report their altitude which is the height of their antenna above sea level.
- **Horizontal geo-location capability** – Capability of a WSD to determine its geographic latitude and longitude coordinates.
- **In-block emissions** – These are emissions that fall within a DTT channel that is used by a WSD for purposes of transmitting information to a receiver. For a WSD which transmits simultaneously in k DTT channels, the in-block emissions fall within k segments of the signal's frequency spectrum, each 8 MHz wide. Emissions are specified here as equivalent isotropic radiated power (EIRP).

- **Master operational parameters** – These are the parameters which a master WSD receives from a WSDB for the purposes of the master WSD's transmissions in the 470-790 MHz band;

- **Master WSD** – This is geo-located WSD that obtains master operational parameters for its own transmissions and slave operational parameters for the transmissions of any slave WSDs that it may serve, both specific to its geographic location. Master WSDs must have horizontal geo-location capability.

- **Out-of-block emissions** – These are emissions that fall outside the in-block segments of a radiated signal's frequency spectrum. These correspond to unintended radiations. Emissions are specified here as equivalent isotropic radiated power (EIRP).

- **PMSE –** Programme making and special events.

- **Qualifying white space database** – A white space database which has qualified to communicate with white space devices and to provide operational parameters to those white space devices under the terms of a contract between Ofcom and the person providing the white space database and which white space database is listed in Schedule 1 of Statutory Instrument 2012 No.xx, Electronic Communications, The Wireless Telegraphy (White Space Devices) (Exemption) Regulations [●];

- **Slave operational parameters –** These are the parameters which a master WSD receives from a WSDB and then communicates to a slave WSD for the purposes of the slave WSD's transmissions in the 470-790 MHz band.

- **Slave WSD –** This is a WSD which does not communicate directly with a WSDB, but which obtains slave operational parameters directly from a master WSD. The slave WSD is then a served device. The master WSD is then a serving device.

- **Test equipment (TE)** – This is an equipment (or a number of equipments) provided by the manufacturer. The TE provides the means to operate and control a UUT. The TE also emulates the operation of all the entities that a master WSD would normally interface with in order to obtain Ofcom's list of qualifying databases, and to exchange parameters with one of the WSDBs on the Ofcom list. A key component of the TE is a test WSDB.

- **Test master WSD –** A hardware or software test set up that emulates the functionalities of a master WSD for purposes of testing a slave WSD.

- **Test slave WSD –** A hardware or software test set up that emulates the functionalities of a slave WSD for purposes of testing a master WSD.

- **Test WSDB** – This is provided by the manufacturer and emulates the functionalities of a WSDB. A test WSDB is a key component of the TE.

- **TV white spaces –** Frequencies within the 470-790 MHz band which have been identified by a WSDB for use by a WSD under the operational conditions specified by the WSDB.

- **Type A WSD** – A WSD whose antennas are permanently mounted on a non-moving outdoor platform.

- **Type B WSD –** A WSD whose antennas are not permanently mounted on a non-moving outdoor platform. A type B WSD must have an integral antenna.

- **TV white space database (WSDB) –** A database system which can communicate with WSDs and provide information on TV white space availability.

- **UHF TV band** – This is defined as the 470-790 MHz band (DTT channels 21-60).

- **Vertical geo-location capability –** Capability of a WSD to determine its geographic altitude.

- **White space device (WSD)** – A wireless telegraphy equipment which operates in TV white spaces.

Symbols

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

- dB decibel
- dBm decibel relative to 1 milliwatt
- mW milliwatt
- kHz Kilohertz
- MHz Megahertz

Abbreviations

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

- AFLR Adjacent Frequency Leakage power Ratio
- EIRP Equivalent Isotropically Radiated Power
- IB In block
- OOB Out of Block
- RF Radio Frequency
- R&TTE Radio equipment and Telecommunications Terminal Equipment
- Rx Receive, Receiver
- TVWS TV whitespace
- Tx Transmit, Transmitter
- TE Test Equipment
- UUT Unit Under Test
- WSD White Space Device
- WSDB White Space Database

Section 5

Technical specifications

5.1 The technical requirements for the operation of master and slave WSDs and their interactions with a WSDB are specified in this section. The testing of device compliance with these specifications is described in Section 6.

5.2 NOTE: The tests in Section 6 do not explicitly examine compliance with every specification described in this section. The absence of a compliance test for a specification a) shall not prejudice compliance with that specification, and b) implies that the manufacturer shall declare compliance with that specification.

5.3 The technical specifications can be described as two broad categories: RF *emission* characteristics, and *control* characteristics.

5.4 The RF emission characteristics relate to such parameters such as bandwidth, power, and spectral leakage of the signals radiated by a WSD.

5.5 European harmonised standards for wireless devices typically specify such RF emission characteristics. Therefore, these are also defined in this document for WSDs. However, the RF emissions of a WSD are subject to the control of a WSDB. As, such, it is also necessary to specify additional control characteristics for WSDs.

5.6 Control characteristics here refer to those functionalities of a WSD which relate solely to the exchange of information to and from WSDs for the purposes of:

a) database discovery and request for parameters (query);
b) communicating master and slave WSD parameters (“device parameters”) to WSDBs;
c) communicating permitted frequencies, powers, and other instructions (“operational parameters”) from WSDBs to WSDs; and
d) communicating radio resource usage parameters (“channel usage parameters”) from WSDs to WSDBs.

5.7 The control specifications are defined to ensure that:

a) a master WSD only transmits in the 470-790 MHz band in accordance with the master operational parameters (see 5.71) and other instructions which it has received from a qualifying WSDB; and in a geographic area which does not exceed the geographic validity of those operational parameters.

b) a slave WSD only transmits in the 470-790 MHz band in accordance with the slave operational parameters (see 5.71) and other instructions which it has received from a master white space device; and, if the slave WSD is a geo-located device, in a geographic area which does not exceed the geographic validity of the operational parameters which it has received from a master WSD.

5.8 NOTE1: The control functions described in this standard do not relate to the control plane of the WSD’s radio interface. These are defined in the relevant wireless technology standards.

5.9 NOTE2: The details of the wireless/wireline communications protocols used for data transfer among WSDs, between a master WSD and a WSDB, and the architecture and functionalities of WSDBs, are outside the scope of this specification.

5.10 A detailed description of the specified sequence of operations that WSDs shall perform is presented in Annex 1. Figure 1 below illustrates the sequence of data exchange between WSDs and WSDBs.

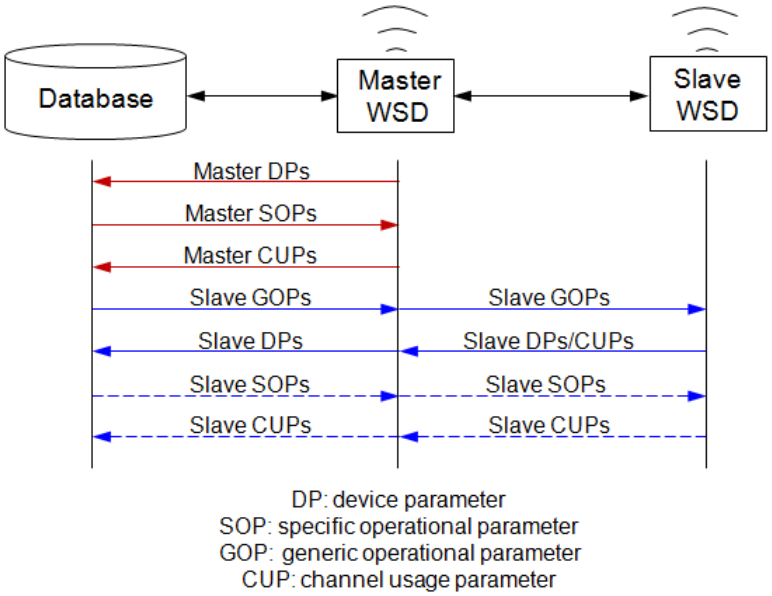

Figure 1. Sequence of data exchange.

5.11 In this section we first describe the RF emission specifications and then the key control operations that a WSD is required to perform. Some of these operations form part of a defined sequence of data exchange between WSDs and between WSDs and WSDBs. Other operations relate to instructions transmitted proactively by a WSDB, and may occur at any time.

Nominal and occupied channel bandwidths

Definition

5.12 A nominal channel is defined as one or more DTT channels that are used by a WSD for its wanted transmissions. The lower and upper edge frequencies of a nominal channel must coincide with the European harmonised DTT channel raster shown in Figure 2 below.

DTT channel raster (MHz)	470 to 478	478 to 486	486 to 494	.....	766 to 774	774 to 782	782 to 790
DTT channel numbers	21	22	23	.....	58	59	60

Figure 2. WSDB channel edge frequencies and corresponding DTT channels.

5.13 The nominal channel bandwidth is the bandwidth of a nominal channel.

5.14 A WSD may transmit in a single DTT channel, or it may transmit simultaneously in a group of contiguous DTT channels, multiple non-contiguous DTT channels, or a mixture of contiguous and non-contiguous DTT channels.

5.15 Where a WSD transmits in a single DTT channel, it shall be considered to have a single nominal channel with a bandwidth of 8 MHz. See Figure 3a.

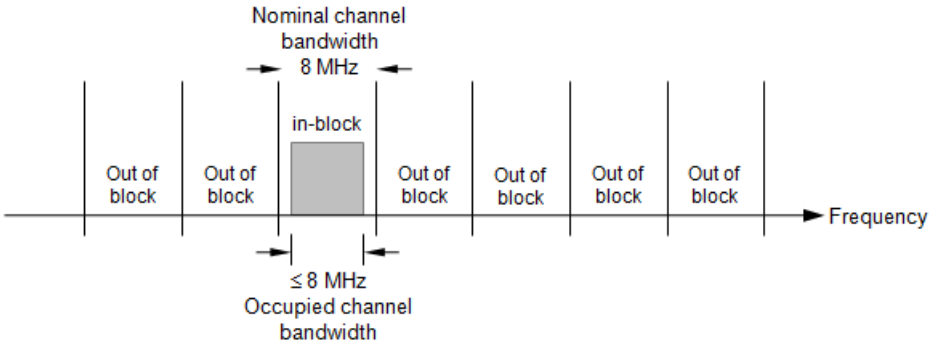

Figure 3a. Single DTT channel. Nominal channel bandwidth is 8 MHz.

5.16 Where a WSD transmits simultaneously in a group of contiguous DTT channels, it shall be considered to have a single nominal channel with a nominal channel bandwidth which is the sum of the individual DTT channel bandwidths (i.e., a multiple of 8 MHz). See Figure 3b.

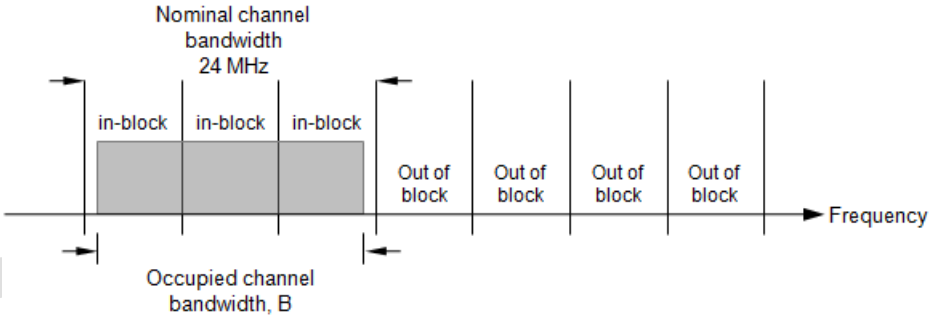

Figure 3b. Group of contiguous DTT channels. Nominal channel bandwidth is 24 MHz. The total nominal channel bandwidth is also 24 MHz.

5.17 Where a WSD transmits simultaneously in multiple non-contiguous DTT channels, it shall be considered to have multiple nominal channels each with a nominal channel bandwidth of 8 MHz; i.e., each nominal channel shall be considered separately. See Figure 3c.

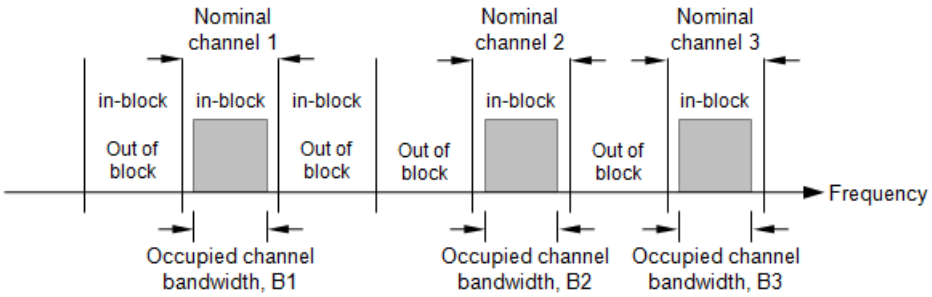

Figure 3c. Multiple non-contiguous DTT channels. Nominal channel bandwidth is 8 MHz. The total nominal channel bandwidth is 24 MHz.

5.18 Where a WSD transmits simultaneously in a mixture of contiguous and non-contiguous DTT channels, each group of contiguous DTT channels shall be considered as a single nominal channel. See Figure 3d.

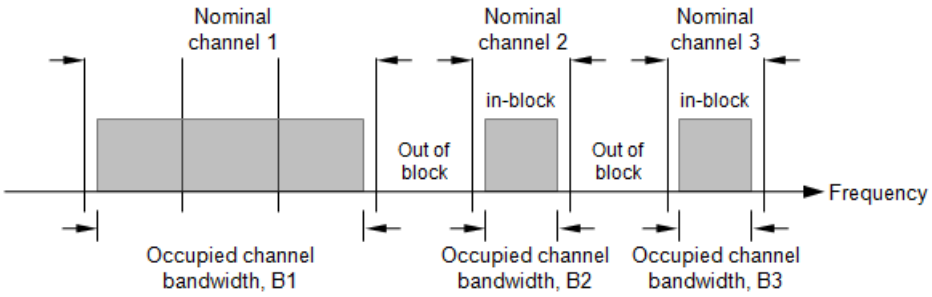

Figure 3d. Mixture of contiguous and non-contiguous DTT channels. Nominal channel bandwidths are 8 and 24 MHz. The total nominal channel bandwidth is 40 MHz.

5.19 In each of the above cases, the *total* nominal channel bandwidth is equal to the sum of the individual nominal channel bandwidths.

5.20 The occupied channel bandwidth is the bandwidth which contains 99% of the signal power within a nominal channel. See Figures 3(a-d).

5.21 In each of the above cases, the *total* occupied channel bandwidth is equal to the sum of the individual occupied channel bandwidths.

5.22 NOTE: The signal power within a nominal channel is referred to as in-block power. The signal power outside a nominal channel is referred to as out-of-block power. The *total* in-block power is the sum (in watts) of the powers in each nominal channel.

Limits

5.23 The lower and upper edge frequencies of the DTT channels that are available for use, the maximum permitted nominal channel bandwidth, and the maximum permitted *total* nominal channel bandwidth shall all be specified by the WSDB. See Table 5.

5.24 Each occupied channel must fall entirely within a nominal channel. Consequently, each occupied channel bandwidth must be less than the corresponding nominal channel bandwidth.

5.25 In case of devices with multiple transmit antennas, the above requirement shall apply to the signals radiated from each of the antennas.

Conformance

5.26 Conformance tests as defined in 6.56 and 6.67 shall be carried out.

In-block EIRP and EIRP spectral density

Definition

5.27 The in-block EIRP spectral density is defined as the mean in-block power of the radiated signal averaged over the time period of a transmission burst and over a specified bandwidth of 100 kHz or 8 MHz.

5.28 The *total* in-block EIRP is defined as the mean in-block power of the radiated signal averaged over the time period of a transmission burst and over the total nominal channel bandwidth.

Limits

5.29 The specifications below apply to the overall emissions of a WSD and in any possible configuration. The overall emissions from a WSD shall not exceed the limits below, irrespective of the number of transmit antennas.

5.30 A WSDB will specify and communicate to a WSD the maximum permitted in-block EIRP spectral density, P0 dBm/(0.1 MHz), and in-block EIRP spectral density, P1 dBm/(8 MHz), for each 8 MHz DTT channel.

5.31 For a WSD which transmits in a single DTT channel, the in-block EIRP spectral density shall not exceed the limits, P0 dBm/(0.1 MHz) and P1 dBm/(8 MHz), as specified by the WSDB for the said DTT channel.

5.32 For a WSD which transmits simultaneously over multiple (contiguous, non-contiguous, or a mixture of contiguous and non-contiguous) DTT channels, the following requirements apply:

5.32.1 The in-block EIRP spectral density in each DTT channel shall not exceed the limit, P0 dBm/(0.1 MHz), as specified by the WSDB for that channel;

5.32.2 The total in-block EIRP (measured over the total nominal channel bandwidth) shall not exceed the lowest of the limits, P1 dBm/(8 MHz), as specified by the WSDB for each of the DTT channels in which the WSD transmits.

Example

5.33 Consider a case where a WSDB specifies in-block EIRP spectral density limits P0_n dBm/(0.1 MHz) and P1_n dBm/(8 MHz), where n = 21…60, corresponding to DTT channels 21 to 60.

5.34 Consider a WSD which transmits in DTT channel k. If the in-block EIRP spectral density of the WSD in channel k is A_k dBm/(0.1 MHz) and B_k dBm/(8 MHz), then it is required that $A_k \leq P0_k$ and $B_k \leq P1_k$.

5.35 Consider a WSD which transmits simultaneously in DTT channels k and m. If the in-block EIRP spectral densities of the WSD in channels k and m are {A_k, A_m} dBm/(0.1 MHz) and {B_k, B_m} dBm/(8 MHz), then it is required that

a) $A\_k \leq P0\_k$ and $A\_m \leq P0\_m$, and

b) $10 \log_{10}\{10^{(B\_k/10)} + 10^{(B\_m/10)}\} \leq \min(P1\_k , P1\_m)$.

Conformance

5.36 Conformance tests as defined in 6.80 and 6.97 shall be carried out.

Transmitter unwanted emissions within the 470 – 790 MHz band

Definition

5.37 These are characterised via the out-of-block EIRP spectral density of a WSD within the 470 – 790 MHz band.

Limits

5.38 The specifications below apply to the overall emissions of a WSD and in any possible configuration. The overall emissions from a WSD shall not exceed the limits below, irrespective of the number of transmit antennas.

5.39 The out-of-block EIRP spectral density, P_{OOB}, of a WSD must satisfy the following requirement:

$$P_{OOB}\ (\text{dBm/(100 kHz)}) \leq \max\{ P_{IB}\ (\text{dBm/(8 MHz)}) - \text{AFLR (dB)}, -84 \}$$

where P_{IB} is the in-block EIRP spectral density, and AFLR is the adjacent channel frequency leakage ratio outlined in Table 1 below for different declared device emission classes.

Where POOB falls within the n^{th} adjacent DTT channel	AFLR (dB)			
	Class 1	Class 2	Class 3	Class 4
n= ± 1	74	74	64	54
n= ± 2	79	74	74	64
n ≥ +3 or n ≤ -3	84	74	84	74

Table 1. Adjacent frequency leakage ratios for different device emission classes.

5.40 Table 1 is only applicable within the 470-790 MHz band. Beyond the band edges, the specifications in 5.42 apply. The P_{OOB} values specified in 5.39 apply to the total out-of-block power radiated by the device irrespective of the number of transmit antennas used. Figures 4 to 7 below illustrate the values of –AFLR in dB, i.e., the P_{OOB} limits (in 100 kHz) in relation to P_{IB} (in 8 MHz) for the different device emission classes. The figures do not illustrate the absolute limit of –84 dBm/(100 kHz) which is triggered at low values of P_{IB} .

Conformance

5.41 Conformance tests as defined in 6.142 shall be carried out.

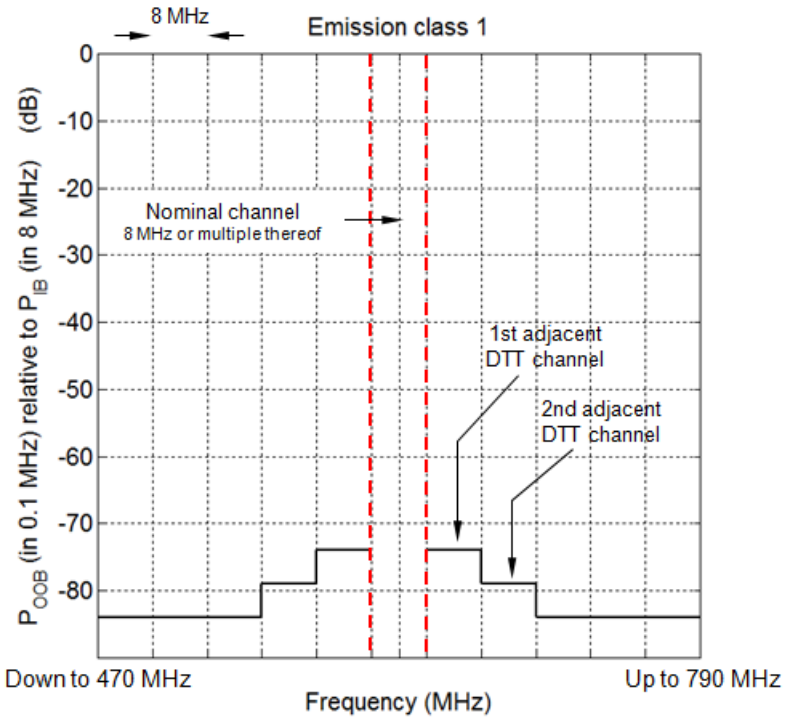

Figure 4. Out-of-block EIRP spectral density P_{OOB} relative to in-block EIRP spectral density for Class 1 devices.

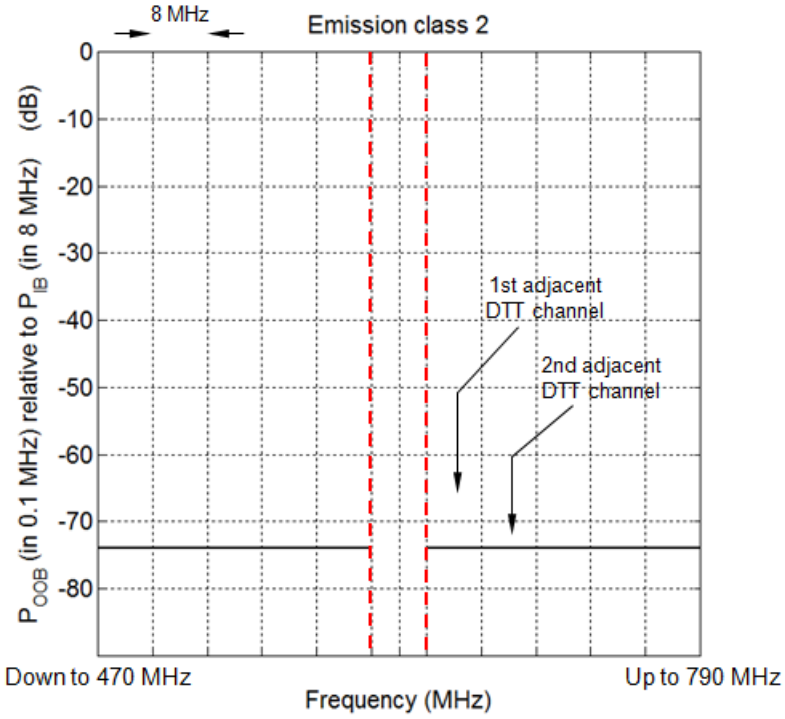

Figure 5. Out-of-block EIRP spectral density P_{OOB} relative to in-block EIRP spectral density for Class 2 devices.

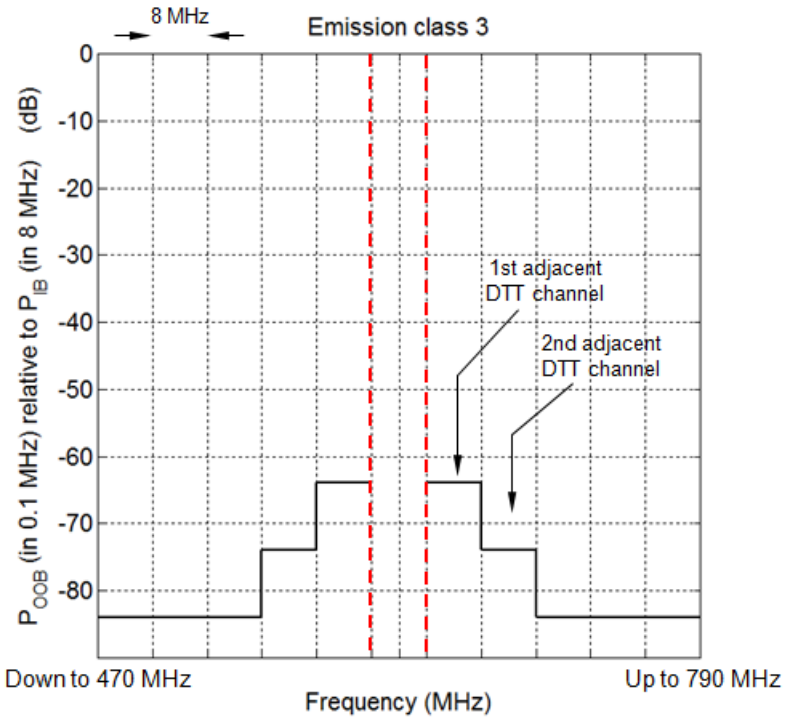

Figure 6. Out-of-block EIRP spectral density P_{OOB} relative to in-block EIRP spectral density for Class 3 devices.

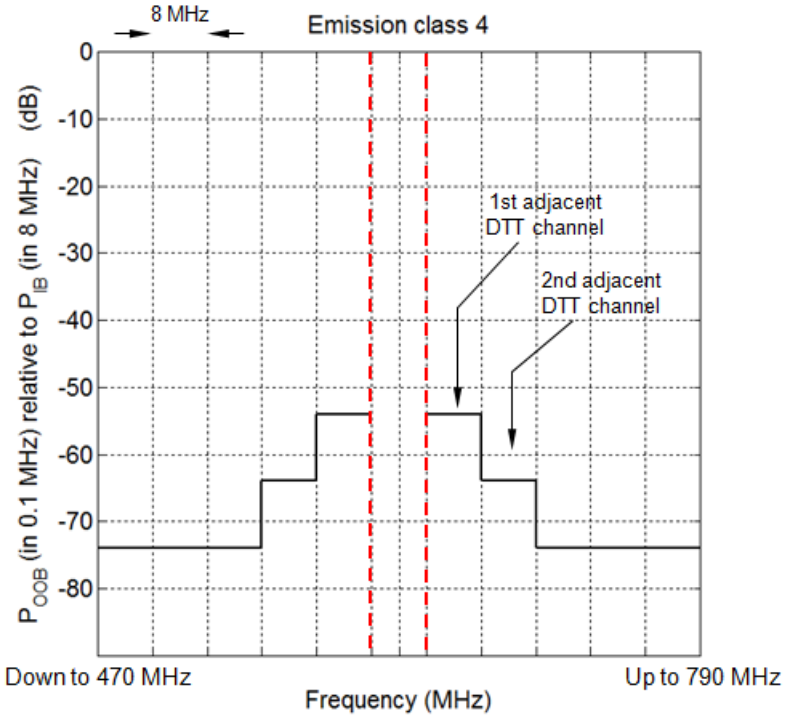

Figure 7. Out-of-block EIRP spectral density P_{OOB} relative to in-block EIRP spectral density for Class 4 devices..

Transmitter unwanted emissions outside the 470 – 790 MHz band

Definition

5.42 These are unwanted RF emissions from a WSD outside the 470-790 MHz band and include both transmitter out of band and spurious emissions.

Limits

5.43 The specifications below apply to the overall emissions of a WSD and in any possible configuration. The overall emissions from a WSD shall not exceed the limits below, irrespective of the number of transmit antennas.

5.44 The level of unwanted emissions shall not exceed the limits given in Table 2 [1].

Frequency Range	Maximum permitted level (dBm)	Measurement Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87.5 MHz	-36 dBm	100 kHz
87.5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
790 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 4 GHz	-30 dBm	1 MHz

Table 2. Transmitter unwanted emission limits outside the 470 – 790 MHz band.

Conformance

5.45 Conformance tests as defined in 6.153 shall be carried out.

Receiver spurious emissions

Definition

5.46 These are unwanted RF emissions from a WSD at any frequency when the equipment is in receiving mode.

Limits

5.47 The specifications below apply to the overall emissions of a WSD and in any possible configuration. The overall emissions from a WSD shall not exceed the limits below, irrespective of the number of transmit antennas.

5.48 The level of spurious emissions of the receiver shall not exceed the limits given in Table 3 [1].

Frequency band	Measurement bandwidth	Maximum level
30 MHz ≤ f < 1 GHz	100 kHz	-57 dBm
1 GHz ≤ f ≤ 4 GHz	1 MHz	-47 dBm

Table 3. Receiver spurious emission limits.

Conformance

5.49 Conformance tests as defined in 6.173 shall be carried out.

Database discovery and database query

Definition

5.50 This is the process by which a master WSD consults a listing of WSDBs that have satisfied the relevant national regulatory agency that they are qualified to provide services to WSDs ("qualifying WSDBs"), when operating in the territories of a member state of the European Union, and then proceeds to contact one of the qualifying WSDBs.

5.51 NOTE: In this document, database discovery is described in the context of WSD operation in the UK, and WSDBs that have demonstrated to Ofcom that they meet Ofcom's qualification requirements.

Specifications

5.52 At start up, and before initiating any transmissions in the 470-790 MHz band, the master WSD shall obtain a list of qualifying WSDBs from Ofcom.

5.53 A master WSD shall treat a WSDB as a qualifying WSDB provided that

5.53.1 no more than N minutes have elapsed since the master WSD last accessed the list of qualifying WSDBs at https://TVWS-Databases.ofcom.org.uk, where the value of the timer, N, is also provided by Ofcom at the same website; and

5.53.2 the WSDB was on the list of qualifying WSDBs at the time when the master WSD last accessed the list.

5.54 A master WSD must not request operational parameters from (i.e., query) a WSDB that is not on Ofcom's list of qualifying WSDBs.

5.55 Once the time specified by N has expired, the master WSD must again access Ofcom's list of qualifying WSDBs before contacting a WSDB

5.56 If the list at https://TVWS-Databases.ofcom.org.uk is not accessible at the time the device wishes to access the list, the WSD shall

a) continue to use the previously accessed list, if it has already accessed a list before, and

b) re-consult the website at least every hour thereafter, until such time as when the list can be accessed.

5.57 NOTE: This specification is based on the working assumption that the list of qualifying WSDBs will be available at https://TVWS-Databases.ofcom.org.uk from which WSDs shall download the list and the value of N.

5.58 The list of qualifying WSDBs and the value of N will be specified in xml format, with UTF-8 encoding.

Conformance

5.59 Conformance tests as defined in 6.184 shall be carried out.

Sequence of data exchange

Definition

5.60 These relate to the sequence in which data is exchanged (directly or indirectly) between a WSD and a WSDB, and how they may constrain the start of RF emissions by the WSD. A detailed description of the specified sequence of operations that WSDs shall perform is presented in Annex 1.

Specifications

5.61 The exchange of data between WSDs and a WSDB shall comply with the following sequences:

Specific operational parameters for a master WSD

5.61.1 A master WSD shall communicate a “query” message to a WSDB, request specific operational parameters for itself, and communicate its device parameters to the WSDB. The master WSD shall then receive specific operational parameters from the WSDB. The master WSD shall then communicate its channel usage parameters to the WSDB. The master WSD can then start transmissions in the 470-790 MHz band according to its reported channel usage parameters.

Generic operational parameters for a slave WSD

5.61.2 A master WSD shall communicate a “query” message to a WSDB and request generic operational parameters for its slaves. The master WSD shall then receive generic operational parameters from the WSDB. The master WSD shall then broadcast the generic operational parameters (or a subset thereof) to its slave WSDs. A slave WSD can only then start transmissions in the 470-790 MHz band in accordance with the generic operational parameters in order to associate with the master WSD. The slave WSD shall then communicate its device parameters and channel usage parameters to its serving master WSD. The master WSD shall forward the slave device parameters and channel usage parameters to the WSDB.

Specific operational parameters for a slave WSD

5.61.3 A slave WSD may contact its serving master WSD and request specific operational parameters. The master WSD shall forward this request to the WSDB. Alternatively, a master WSD may itself request specific operational parameters from the WSDB for the slave WSD. The master WSD shall then

receive the slave's specific operational parameters from the WSDB, and then forward these (or a subset thereof) to the slave WSD. The slave WSD shall communicate its channel usage parameters to the master WSD. The slave WSD can submit its channel usage parameters by transmitting in the UHF TV band according to its reported channel usage parameters. The master WSD shall then forward the channel usage information to the WSDB.

Conformance

5.62 Conformance tests as defined in 6.198 shall be carried out.

Communication of device parameters

Definition

5.63 The device parameters of a master WSD are communicated from the master WSD to a qualifying WSDB. The device parameters of a slave WSD are communicated from the slave WSD to a qualifying WSDB via a master WSD.

5.64 The device parameters are used by a WSDB to generate operational parameters relevant to the transmissions of a WSD in the 470-790 MHz band.

Specifications

5.65 A master WSD shall successfully communicate its device parameters to a qualifying WSDB after discovering such a WSDB, when initiating a request for specific operational parameters for its own transmissions, and prior to initiating transmissions within the 470-790 MHz band.

5.66 A master WSD shall make a new request (for operational parameters) to a WSDB if it intends to continue or resume transmission upon expiry of the time validity of its specific operational parameters as received from the WSDB.

5.67 A master WSD (or a slave WSD which has reported its geo-location coordinates) shall make a new request (for operational parameters) to the WSDB, or cease transmission, if it moves by more than 50 m with respect to the latitude and longitude coordinates determined at the time of its previous request from a WSDB.

5.68 A slave WSD shall successfully communicate its device parameters to its serving master (which the master WSD must successfully communicate to a WSBD) when associating with the master WSD.

5.69 WSD device parameters are shown in Table 4 below.

Device parameter	Format / Definition	Remark
Unique device identifier	Manufacturer name in ASCII format followed by a serial number or other identifier unique to the device.	Shall also be declared by the manufacturer.
Emission class	Class 1, 2, 3 or 4. See Table 1 for definition of emission class.	Shall also be declared by the manufacturer.
Technology identifier	ASCII format with the following fields: 1) title of the organisation responsible for the technology specifications, 2) title of the technology, 3) version of the specifications, 4) issue date of the specifications.	Shall also be declared by the manufacturer. Examples: “IEEE/802.11af/v1.2.1/2011-10”, “Weightless SIG/Weightless/v0.9/ 2012-09”, “3GPP/LTE/v1.2.3/2012-10”.
Device type	Type A or B.	Shall also be declared by the manufacturer.
Model identifier	ASCII format indicating the manufacturer’s model number or product family.	Shall also be declared by the manufacturer.
Device category	Master or slave.	Shall also be declared by the manufacturer.
Antenna location	Latitude, longitude, and altitude coordinates in WGS84 format. If a WSD cannot report its horizontal geo-location coordinates, it shall report “*no horizontal geo-location*” to the WSDB. If a WSD cannot report its vertical geo-location coordinates, it shall report “*no vertical geo-location*” to the WSDB.	Horizontal and vertical geo-location capabilities shall be separately declared by the manufacturer. Horizontal geo-location capability is mandatory for master WSDs. The “*no geo-location*” message corresponds to cases where a) the WSD does not have geo-location capability, or b) the WSD does have geo-location capability but is not currently capable of geo-location.
Antenna location uncertainty	Latitude, longitude, and altitude coordinate uncertainties specified as $\pm\Delta x$, $\pm\Delta y$ and $\pm\Delta z$ metres respectively, corresponding to a 95% confidence level. If a WSD cannot determine its horizontal geo-location uncertainty, it shall report “*no horizontal geo-location uncertainty reported*” to the WSDB. If a WSD cannot determine its vertical geo-location uncertainty, it shall report “*no vertical geo-location uncertainty reported*” to the WSDB.	

Table 4. Device parameters.

Conformance

5.70 Conformance tests as defined in 6.206 shall be carried out.

Communication of operational parameters

Definition

5.71 These are parameters that a) a master WSD shall be able to receive from a qualifying WSDB and b) a slave WSD shall be able to receive from a qualifying WSDB through its serving master WSD.

5.72 Among other things, operational parameters include the available lower and upper DTT channel edge frequencies and the corresponding maximum permitted EIRP spectral densities permitted in each channel.

5.73 A WSD shall configure its transmissions to comply with the latest received operational parameters prior to initiating or continuing transmissions within the 470-790 MHz band.

5.74 Specific operational parameters are the parameters received by a master WSD from a WSDB (or by a slave WSD from its serving master WSD) for the WSD's transmissions in the TV white spaces based on the reported device parameters.

5.75 Generic operational parameters are the parameters received by a master WSD from a WSDB and forwarded to served slave WSDs for the slave WSDs' transmissions in the TV white spaces. Generic operational parameters are not based on any reported slave device parameters. Generic operational parameters apply to a slave WSD's initial transmissions for purposes of association with its serving master WSD in the 470–790 MHz band. A slave WSD has the option of continuing to use generic operational parameters for subsequent transmissions. Alternatively, it can request specific operational parameters in order to benefit from increased TVWS availability.

Specifications

5.76 A master WSD shall be able to receive from a WSDB specific operational parameters for its own transmissions after having communicated its device parameters to the WSDB.

5.77 A master WSD shall be able to receive from a WSDB generic operational parameters for the transmissions of served slave WSDs, after having communicated its own channel usage parameters to the WSDB. A master WSD shall subsequently communicate these operational parameters to its served slave WSDs. The communicated operational parameters may include the full set (or a subset) of the DTT channel frequency boundaries and the corresponding maximum permitted in-block EIRP spectral densities which were received from the WSDB.

5.78 A master WSD shall be able to receive from a WSDB specific operational parameters for the transmissions of a slave WSD, after having communicated the slave's device parameters to the WSDB. A master WSD shall subsequently communicate these operational parameters to the served slave WSD. The communicated operational parameters may include the full set (or a subset) of the DTT channel frequency boundaries and the corresponding maximum permitted in-block EIRP spectral densities which were received from the WSDB.

5.79 A master WSD shall only transmit in the 470-790 MHz band in accordance with the master operational parameters (and other instructions) which it has received from a WSDB.

5.80 A slave WSD shall be able to receive “specific” or “generic” operational parameters from its serving master WSD.

5.81 A slave WSD shall only transmit in the 470-790 MHz band in accordance with the slave operational parameters (and other instructions) which it has received from its serving master WSD

5.82 Operational parameters are described in Table 5 below.

Parameter	Format / Definition	Remark
List of lower and upper DTT channel edge frequencies	The i^{th} lower and upper edges shall be specified as $F_{L,i}$ = (470 + 8k_i) MHz, and $F_{U,i}$ = (470 + 8k_i + 8) MHz, where $0 \le k_i \le 39$.	These parameters are applicable to the conformance requirements in 5.12.
Maximum in-block EIRP spectral densities for each DTT channel edge frequency pair	Specified as $P_{0,i}$ (dBm/0.1 MHz) and $P_{1,i}$ (dBm/8 MHz) over the frequency interval $F_{L,i}$ to $F_{U,i}$.	This parameter is applicable to conformance requirements in 5.27.
Maximum nominal channel bandwidth, and maximum total nominal channel bandwidth	$B_C = K_C \times 8$ MHz (contiguous), $B_T = K_T \times 8$ MHz where K_T, $K_C > 0$.	This parameter is applicable to conformance requirements in 5.12.
Time validity of operational parameters	T_{Val} specified in 24 hour clock format (hour:min) with reference to GMT.	This parameter is applicable to conformance requirements in 5.90.

Table 5: Operational parameters.

Conformance

5.83 Conformance tests shall be carried out implicitly as defined in Section 6 for the testing of bandwidths, EIRPs, and time validity.

Communication of channel usage parameters

Definition

5.84 Channel usage parameters are communicated from a master WSD to a qualifying WSDB (and from a slave WSD to its serving master WSD). These parameters describe the frequencies and powers that the master WSD and its served slave WSDs intend to use.

Specifications

5.85 A master WSD shall communicate to a WSDB the channel usage parameters for its own transmissions prior to initiating transmissions within the 470-790 MHz band.

5.86 A slave WSD shall communicate to a serving master WSD the channel usage parameters for its own transmissions.

5.87 A master WSD shall communicate to a WSDB the channel usage parameters of its serve slave WSDs.

5.88 Channel usage parameters are described in Table 6.

Parameter	Format / Definition	Remark
List of lower and upper DTT channel edge frequencies within which a WSD intends to transmit	The i^{th} lower and upper edges shall be specified as $f_{L,i} = (470 + 8k_i)$ MHz, and $f_{U,i} = (470 + 8k_i + 8)$ MHz, where $0 \le k_i \le 39$.	These parameters are applicable to the conformance requirements in 6.213.
In-block EIRP spectral densities which a WSD intends to use within each DTT channel	Specified as $p_{0,i}$ (dBm/0.1 MHz) and $p_{1,i}$ (dBm/8 MHz) over the frequency interval $f_{L,i}$ to $f_{U,i}$.	This parameter is applicable to conformance requirements in 6.213.

Table 6. Channel usage parameters.

Conformance

5.89 Conformance tests as defined in 6.213 shall be carried out.

Time validity of operational parameters

Definition

5.90 The time validity is defined as the instant in time beyond which the operational parameters communicated by a WSDB to a WSD become invalid.

5.91 A WSD is permitted to transmit in the 470-790 MHz band only in accordance with received operational parameters, and for a time period which does not exceed the time validity of those parameters. The time validity itself is an operational parameter.

Specifications

5.92 The time validity of operational parameters is specified by the WSDB as an absolute time, T_{Val}, defined in a 24 hour clock format (hour:min) with reference to GMT (see also Table 5).

5.93 A WSD shall cease transmission after time Tval.

5.94 The value of T_{Val} may be different for master and slave WSDs. The value of T_{Val} for a master WSD shall be communicated explicitly as an operational parameter from a WSDB to a master WSD. The value of T_{Val} for a slave WSD shall be communicated explicitly from a WSDB to a master WSD and then communicated implicitly or explicitly from a master WSD to a served slave WSD.

5.95 If a master WSD receives new operational parameters from a WSDB, then the value of T_{Val} for the master WSD and slave WSDs shall be appropriately updated.

Conformance

5.96 Conformance tests as defined in 6.114 shall be carried out.

Device shutdown

Definition

5.97 This is the instruction from a WSDB requesting that a master WSD and its associated slave WSDs cease transmission within a certain time interval.

Specifications and limits

5.98 A master WSD shall cease transmission within 60 seconds of receiving the WSD shut-down instruction from a WSDB.

5.99 A slave WSD shall cease transmission within 1 second, when instructed to do so by its serving master WSD.

5.100 Additionally, a slave WSD shall cease transmission if it loses communications with its serving master WSD for a period of more than 5 seconds.

Conformance

5.101 Conformance tests as defined in 6.128 shall be carried out.

Slave to slave WSD communications

Definition

5.102 This corresponds to scenarios where a slave WSD communicates directly with another slave WSD.

Specification

5.103 A slave WSD may communicate with another slave WSD provided that it maintains communication over the UHF TV band with its serving master WSD and remains under the control of the said master WSD.

Conformance

5.104 No specific conformance tests are described in this document other than the requirement that the manufacturer shall declare whether the presented slave WSD is capable of communicating directly with another slave WSD. If the device has such capability, the manufacturer shall also declare that the slave WSD maintains under the control of its serving master WSD when operating in this mode. See 6.52.

Geo-location and geo-location validity

Definition

5.105 The specifications in this section apply to a WSD that has the capability to automatically determine its antenna latitude, longitude and/or altitude coordinates.

5.106 Location uncertainty – This is the difference in meters between the latitude, longitude, and altitude coordinates reported by a WSD to a WSDB, and the actual coordinates of the WSD.

5.107 Success rate – The success rate is the percentage of times that the location uncertainty reported by the WSD to the WSDB is no greater than the location uncertainty limit.

Specifications and limits

5.108 A WSD which has geo-location capability shall be able to report to a WSDB its geo-location coordinates (in WGS 84 format) and geo-location uncertainty (in metres).

5.109 The geo-location uncertainty reported to the WSDB for a WSD shall comply with a 95% success rate.

5.110 If a WSD cannot report its horizontal geo-location coordinates, it shall report the message “no horizontal geo-location” to the WSDB. If a WSD cannot report its vertical geo-location coordinates, it shall report the message “*no vertical geo-location*” to the WSDB. The messages correspond to cases where

a) the WSD does not have geo-location capability, or
b) the WSD does have geo-location capability but is not currently capable of geo-location.

5.111 If a WSD cannot report its horizontal geo-location uncertainty, it shall report “*no horizontal geo-location uncertainty reported*” to the WSDB. If a WSD cannot report its vertical geo-location coordinates, it shall report the message “*no vertical geo-location uncertainty reported*” to the WSDB.

5.112 A WSD which has geo-location capability shall also be capable of determining whether its horizontal location has changed by more than 50 metres with respect to its horizontal position determined at the time when the WSD last reported its location. Such a WSD shall not continue to transmit with its current operational parameters if its horizontal location has changed by more than 50 metres with respect to its horizontal position determined at the time when the WSD last reported its location.

5.113 A master WSDs shall have horizontal geo-location capability.

Conformance

5.114 Conformance tests as defined in 6.221 shall be carried out. In addition, the manufacturer shall declare the geo-location capabilities of the presented WSD (see list of declared parameters in Section 6).

User access restrictions

Definition

5.115 User access restrictions are features implemented in the WSD to restrict access for the user of the equipment to certain hardware and/or software settings of the equipment.

Specifications

5.116 The hardware/software settings that relate to the exchange of the parameters in Tables 4, 5 and 6 communicated between a WSD and a WSDB, and any hardware/software settings that control the operation of the equipment, shall not be accessible nor be able to be readily altered by the user of the equipment.

Conformance

5.117 The manufacturer shall declare the measures it has taken to restrict the ability of a user to readily control of the WSD functionality (see list of declared parameters in Section 6).

Integral antenna

Definition

5.118 An integral antenna is designed as a fixed part of the equipment, without the use of an external connector, and as such, cannot be disconnected from the equipment by a user with the intent to connect another antenna.

Specification

5.119 An integral antenna shall be used in all type B WSDs.

Conformance

5.120 The manufacturer shall declare the integral antenna design used by the presented WSD (see list of declared parameters in Section 6).

Security requirements

Specification

5.121 Communications between a master WSD and a qualifying WSDB must be performed using secure protocols that avoid malicious corruption or unauthorized modification of data.

5.122 Communications between a master WSD and a slave WSD for purposes of relaying operational parameters and device parameters must be performed using secure protocols that avoid malicious corruption or unauthorized modification of data.

Conformance

5.123 The manufacturer shall declare the measures it has taken to comply with the security requirements.

Section 6

Essential tests for compliance with technical specifications

6.1 The testing of device compliance with the technical specifications of Section 5 is described in this section.

6.2 NOTE: The tests describe here do not explicitly examine compliance with every specifications described in Section 5. The absence of a compliance test for a specification a) shall not prejudice compliance with that specification, and b) implies that the manufacturer shall declare compliance with that specification.

6.3 A WSD supplied by a manufacturer for testing is referred to as a unit under test (UUT).

6.4 If the UUT is a master WSD, the manufacturer shall supply a compatible “test slave WSD” in order to allow the testing of master-slave communications. The test slave WSD shall be configured to request specific operational parameters from the UUT.

6.5 If the UUT is a slave WSD, the manufacturer shall supply a compatible “test master WSD” in order to allow the testing of master-slave communications.

6.6 The manufacturer shall provide the means to operate and control the UUT during the tests. This will include the provision of test equipment (TE) by the manufacturer which will include a “test WSDB”. In addition to being able to configure a UUT via its test WSDB (by specifying appropriate operational parameters), the TE will emulate the operation of all the entities that a master WSD would normally interface with in order to

a) obtain Ofcom’s list of qualifying WSDBs, and
b) exchange parameters with one of the WSDBs on the Ofcom list.

Conditions for testing

Normal and extreme test conditions

6.7 Unless otherwise stated in the test procedures for essential test suites, the tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile (see 6.54).

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

Antennas

6.9 Type A WSDs (fixed outdoor) can have either integral antennas or external antennas. Type B WSDs (all devices other than Type A) must have integral antennas.

6.10 Integral antennas are designed as a fixed part of the equipment, without the use of an external connector, and as such, cannot be disconnected from the equipment by a

user with the intent to connect another antenna. Integral antennas may be provided with temporary connectors for purposes of testing.

6.11 External antennas are physically external to the equipment, are attached via antenna connectors, and are assessed in combination with the equipment against the requirements in the present document. NOTE: It should be noted that assessment does not necessarily lead to testing.

6.12 An antenna assembly referred to in the present document is understood as the combination of the antenna (integral or external), its coaxial cable, and, if applicable, its antenna connector and associated switching components. The gain of an antenna assembly, G in dBi, does not include the additional gain that may result from beamforming.

6.13 Multiple antenna systems may use beamforming techniques which may result in additional antenna gain. This beamforming gain, Y, is specified in dB. Beamforming gain does not include the gain of the antenna assembly, G, or the gain resulting from adding the transmit powers from the antennas.

Conducted and radiated tests

6.14 For a UUT with external antennas and antenna connectors, or for a UUT with integral antennas and temporary antenna connectors, conducted measurements of transmit powers shall be performed. Radiated powers shall then be derived by accounting for the declared antenna assembly and beamforming gains.

6.15 When performing the conducted measurements on multiple antenna systems (devices with multiple transmit chains) a power splitter/combiner shall be used to combine all the transmit chains (antenna outputs) into a single test point. The insertion loss of the power splitter/combiner shall be taken into account.

6.16 NOTE: Special care should be taken with selecting the power splitter/combiner; i.e., it should be capable of handling the output power of the UUT and it should have sufficient isolation between the ports to avoid inter-modulation products being produced in the UUT.

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

6.18 When performing radiated measurements, the UUT shall be configured and antenna(s) positioned (including smart antenna systems and systems capable of beamforming) for maximum EIRP towards the measuring antenna.

6.19 For radiated measurements, a test site as described in Annex B of [4] and applicable measurement procedures as described in Annex C of [4] shall be used, taking into account the calibration factor from the measurement site.

Multi-antenna transmit operating modes

Operating mode 1 (single antenna)

6.20 The equipment uses only one antenna when operating in this mode.

6.21 The following types of equipment and/or operating modes are examples covered by this category:

6.21.1 Equipment with only one antenna.

6.21.2 Equipment with two or more diversity antennas, but where at any moment in time only one antenna is used for transmission.

6.21.3 Equipment with two or more antennas, but operating in a mode where only one antenna is used for transmission.

Operating mode 2 (multiple antennas, no beamforming)

6.22 The equipment that operates in this mode transmits simultaneously from multiple antennas but without beamforming.

Operating mode 3 (multiple antennas, with beamforming)

6.23 The equipment that operates in this mode transmits simultaneously from multiple antennas with beamforming.

6.24 In addition to the antenna assembly gain, G, the beamforming gain, Y, shall have to be taken into account when performing the conducted measurements described in the present document.

Requirements for the test modulation

6.25 The modulation/multiple-access scheme used by the UUT for the purposes of testing shall be representative of normal use of the equipment. Where the equipment is not capable of continuous RF transmission, the test modulation/multiple-access scheme shall be such that transmissions occur regularly in time, and

6.26 If the equipment uses multiple modulation methods with different RF characteristics, the modulation that produces the worst measured values (values which comply with the limits by the smallest margin) for each essential test shall be used, and this modulation shall be declared along with the rationale for why this modulation produces worse values than other modulation methods used by the equipment.

Communications between the test WSDB and UUT

6.27 For the purpose of the tests defined in the essential test suites, a master UUT shall be connected to a compatible TE (which incorporates a test WSDB) using a non-radio link. The TE shall be configured to allow a master UUT or master test WSD to readily discover (or otherwise consult) its test WSDB upon connection.

6.28 The master UUT shall be configured to operate with a compatible TE (test WSDB). It is recommended that the IETF PAWS standard currently under development is used for the communications between the master UUT and the TE.

6.29 For the purpose of the tests defined in the essential test suites, a slave UUT shall be connected to a compatible test master WSD using a non-radio link, and a master UUT shall be connected to a compatible slave WSD using a non-radio link. However, devices shall be configured to operate as if connected over the UHF TV band.

6.30 The communication protocol between the slave and master WSDs will be defined by the radio technology specifications of the WSDs being tested.

6.31 The above are illustrated in Figure 8 below.

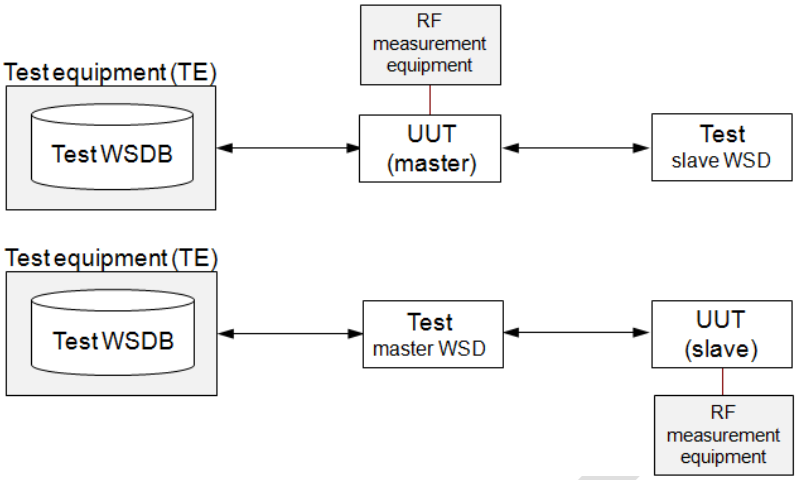

Figure 8. Test set up.

Interpretation of measurement results

6.32 The interpretation of the results recorded in the test report of the measurements described in this document shall be as follows:

6.32.1 The measured values will be compared to the corresponding limit specified in this document to decide whether the equipment meets the requirements.

6.32.2 The value of the measurement uncertainty for the measurement of each parameter shall be included in the test report.

6.32.3 The recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in Table 7.

6.32.4 The shared risk approach shall be applied for the interpretation of all measurement results.

6.33 For the test methods described in this document for determining RF power levels, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 1 [2] and TR 100 028 2 [3] and shall correspond to an expansion factor (coverage factor) k = 1.96 or k = 2 (which provide confidence levels of 95% and 95.45% respectively in the case where the distributions characterizing the actual measurement uncertainties are Gaussian).

6.34 Table 7 is based on such expansion factors.

Parameter	Uncertainty
RF frequency	±1 × 10-5
RF power conducted	±1,5 dB
RF power radiated	±6 dB
Spurious emissions, conducted	±3 dB
Spurious emissions, radiated	±6 dB
Humidity	±5 %
Temperature	±1 °C
Time	±10 %

Table 7. Maximum measurement uncertainty.

Declaration of product information

6.35 The information relating to the UUT which shall be declared by the manufacturer is described in this section.

6.36 The manufacturer shall declare the unique identifier, emission class (1,2,3 or 4), technology identifier, type (A or B), model identifier, and category (master or slave) of the UUT;

6.37 The manufacturer shall declare the operating frequency range(s) of the UUT within the 470-790 MHz band.

6.38 The manufacturer shall declare if the UUT can support simultaneous transmissions in multiple DTT channels.

6.39 The manufacturer shall declare:

a) The nominal channel bandwidths supported (8n MHz where n ≥ 1);
b) The maximum *total* nominal channel bandwidth supported (multiple of 8 MHz).

6.40 NOTE: If the declared nominal channel bandwidths are 8 and 16 MHz, and the declared maximum total nominal channel bandwidth is 32 MHz, then the following DTT channel combinations are possible (where "-" separates non-contiguous channels): 1, 1-1, 1-1-1, 1-1-1-1, 1-1-2, 2-2.

6.41 The manufacturer shall declare the maximum in-block EIRP spectral densities in 100 kHz supported by the UUT.

6.42 The manufacturer shall declare the maximum total EIRP supported by the UUT.

6.43 The manufacturer shall declare the types of modulation/multiple access scheme employed by the UUT.

6.44 NOTE: Examples of modulation scheme might include GMSK or M-QAM, and examples of multiple access scheme may include TDMA, FDMA, CDMA, OFDMA, TDMA with CSMA/CA, etc.

6.45 The manufacturer shall declare the modulation/multiple access scheme used by the UUT for each of the tests in the essential suite of RF tests.

6.46 The manufacturer shall declare the integral antenna design used by the UUT, and measures to prevent the user from connecting a different antenna.

6.47 For a type A UUT with external antenna(s), the manufacturer shall declare the antenna gain of the antenna assembly, and any beamforming gain (beyond the summation of the emissions from each antenna), intended to be used in combination with the equipment.

6.48 The manufacturer shall declare the different multi-antenna transmit operating modes in which the UUT can operate (see 6.20).

6.49 For a master UUT, the manufacturer shall confirm that the UUT has automatic horizontal geo-location capability and shall declare whether it has automatic vertical geo-location capability.

6.50 For a slave UUT, the manufacturer shall declare if the UUT has automatic geo-location capability, and whether this includes vertical geo-location.

6.51 For a slave UUT, the manufacturer shall declare if the UUT is capable of requesting specific operational parameters from a master WSD.

6.52 For a slave UUT, the manufacturer shall declare whether the UUT is capable of communicating directly with another slave WSD. If the UUT has such capability, the manufacturer shall also declare that the UUT maintains under the control of its serving master WSD when operating in this mode.

6.53 With regards to user access restrictions, the manufacturer shall declare that that the controls (hardware or software) related to the exchange of information (directly or indirectly) between the UUT and a WSDB, and the controls (hardware or software) that define the operation of the UUT have been made inaccessible to the user (see 5.115).

6.54 The manufacturer shall declare the normal and the extreme operating conditions (e.g. voltage and temperature) that apply to the UUT.

6.55 The manufacturer shall also declare the parameters described above for any test master WSD or test slave WSD which it provides for the purposes of testing the UUT.

Essential test suite:
Nominal channel bandwidth and occupied channel bandwidth

6.56 The objective of these tests is to confirm that the occupied channel bandwidths for a UUT's transmissions fall within the nominal channels specified by the test WSDB (see specifications 5.24). These tests can be performed in combination with those defined in 6.67.

Test conditions

6.57 If the UUT is a master WSD, the UUT shall be connected to a TE. The UUT shall be configured to communicate with the test WSDB in the TE.

6.58 If the UUT is a slave WSD, the UUT shall be connected to a compatible test master WSD which is configured to receive slave operational parameters from the test WSDB.

6.59 In the case of multiple antenna systems, these tests shall be applied to the transmissions from all antennas. UUT shall be configured to deliver the highest maximum power to the measurement equipment, and the method to do this shall be documented in the test report.

6.60 For a UUT that can at most transmit in a single DTT channel, the test WSDB shall be configured as follows:

6.60.1 Set the permitted lower channel edge frequency and upper channel edge frequency so that they coincide with those of a DTT channel that falls within the operating frequency range declared by the manufacturer.

6.60.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.61 For a UUT that can also transmit simultaneously in a group of contiguous DTT channels, the test shall be repeated with the WSDB configured as follows:

6.61.1 Set the permitted lower and upper channel edge frequencies so that they coincide with those of a group of contiguous DTT channels that fall within the operating frequency range declared by the manufacturer. The number of contiguous DTT channels shall be selected in accordance with a nominal channel bandwidth declared by the manufacturer; i.e., if the nominal channel bandwidth declared by the manufacturer is 24 MHz, then the channel edge frequencies shall be selected by the test WSDB for three contiguous DTT channels.

6.61.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.62 The test shall be repeated for every declared value of nominal channel bandwidth.

6.63 For a UUT that can also transmit simultaneously in multiple non-contiguous DTT channels – or a mixture of contiguous and non-contiguous DTT channels – the occupied channel bandwidth shall be tested as outlined in 6.79, Step 3.

Test method

6.64 The test method applies to conducted measurements.

6.65 Step 1

- The UUT shall be connected to a spectrum analyser with the following settings:

Centre frequency:	Centre frequency of the nominal channel under test.
Frequency span:	2× nominal channel bandwidth of the UUT (e.g., 16 MHz for a 8 MHz nominal channel).
Resolution bandwidth:	100 kHz if occupied channel bandwidth is greater than 100 kHz. Reduce proportionally for lower occupied bandwidths.
Video Bandwidth:	300 kHz (or ×3 occupied channel bandwidth).
Detector mode:	Peak
Trace mode:	Max hold
Sweep time:	Auto

- Wait for the spectrum analyser trace to complete. Capture the trace, for example using the “view" option on the analyser. Find the peak value of the trace and place the analyser marker on this peak.

6.66 Step 2

- Use the 99% bandwidth (or equivalent) function of the spectrum analyser to measure the occupied channel bandwidth of the UUT. This value shall be recorded. Confirm that the measured occupied channel bandwidth falls within the edge frequencies of the nominal channel as specified by the test WSDB.

Essential test suite: Limits on maximum and total nominal channel bandwidths

6.67 The objective of these tests is to confirm that the nominal channel bandwidths and total nominal channel bandwidth within which the UUT transmits do not exceed the maximum permitted values specified by the test WSDB (see specifications 5.23). These tests can be performed in combination with those defined in 6.56.

Test conditions

6.68 If the UUT is a master WSD, the UUT shall be connected to a TE. The UUT shall be configured to communicate with the test WSDB in the TE.

6.69 If the UUT is a slave WSD, the UUT shall be connected to a compatible test master WSD which is configured to receive slave operational parameters from the test WSDB.

6.70 In the case of multiple antenna systems, these tests shall be applied to the transmissions from all antennas. UUT shall be configured to deliver the highest maximum power to the measurement equipment, and the method to do this shall be documented in the test report.

6.71 These tests apply to a UUT that can transmit simultaneously in multiple DTT channels. The UUT shall be configured to operate at the maximum nominal channel bandwidth or maximum total nominal channel bandwidth declared by the manufacturer.

6.72 For a UUT that can transmit simultaneously in a group of contiguous DTT channels, the test WSDB shall be configured as follows:

6.72.1 Set the permitted lower and upper channel edge frequencies so that they coincide with those of all DTT channels that fall within the operating frequency range declared by the manufacturer.

6.72.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.72.3 Set the limit on the maximum nominal channel bandwidth to a value that is less than the maximum value declared by the manufacturer.

6.73 The test shall be repeated for every declared value of nominal channel bandwidth.

6.74 For a UUT that can also transmit simultaneously in multiple non-contiguous (or a mixture of contiguous and non-contiguous) DTT channels, the test shall be repeated with the test WSDB configured as follows:

6.74.1 Set the permitted lower and upper channel edge frequencies so that they coincide with those of all DTT channels that fall within the operating frequency range declared by the manufacturer.

6.74.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.74.3 Set the limit on the maximum *total* nominal channel bandwidth to a value that is less than the maximum value declared by the manufacturer.

6.75 The tests shall be repeated for every declared grouping of used DTT channels.

Test method

6.76 The test method applies to conducted measurements.

6.77 Step 1

- The UUT shall be connected to a spectrum analyser with the following setting:

Frequency span:	UUT operating frequency range declared by the manufacturer.
Resolution bandwidth:	100 kHz if occupied channel bandwidth is greater than 100 kHz. Reduce proportionally for lower occupied bandwidths.
Video Bandwidth:	300 kHz (or ×3 occupied channel bandwidth).
Detector mode:	Peak
Trace mode:	Max hold
Sweep time:	Auto

- Wait for the spectrum analyser trace to complete. Capture the trace, for example using the “view" option on the analyser. Find the peak value of the trace and place the analyser marker on this peak.

6.78 Step 2

- For a UUT that can transmit simultaneously in multiple contiguous DTT channels, use the 99% bandwidth (or equivalent) function of the spectrum analyser to measure the occupied channel bandwidth of the UUT. This value shall be recorded.

- Confirm that the measured occupied channel bandwidth is no greater than the limit on the maximum nominal channel bandwidth specified by the test WSDB.

6.79 Step 3

- For a UUT that can transmit simultaneously in non-contiguous DTT channels, the power envelope shall be considered separately in each 8 MHz DTT channel used. Use the 99% bandwidth (or equivalent) function of the spectrum analyser to measure the occupied channel bandwidth of the UUT in each 8 MHz channel used. These values shall be recorded.

- For a UUT that can transmit simultaneously in a mixture of contiguous and non-contiguous DTT channels, the power envelope shall be considered separately in each nominal channel used. Use the 99% bandwidth (or equivalent) function of

the spectrum analyser to measure the occupied channel bandwidth of the UUT in each nominal channel used. These values shall be recorded.

- Confirm that the measured occupied channel bandwidth for each nominal channel falls within the edge frequencies for that nominal channel as specified by the test WSDB.

- Confirm that the measured contiguous occupied channel bandwidths and total occupied channel bandwidth are no greater than corresponding limits on the maximum nominal channel bandwidth and maximum total nominal channel bandwidth, respectively, as specified by the test WSDB.

Essential test suite: Transmitter EIRP (RF output power)

6.80 The objective of these tests is to confirm that the UUT total in-block EIRP (measured during a transmission burst) does not exceed the maximum permitted value, P1 specified by the test WSDB (see specifications in 5.29).

6.81 NOTE: The measured transmitter EIRP serves as a proxy for the total in-block EIRP.

Test conditions

6.82 If the UUT is a master WSD, the UUT shall be connected to a TE. The UUT shall be configured to communicate with the test WSDB in the TE.

6.83 If the UUT is a slave WSD, the UUT shall be connected to a compatible test master WSD which is configured to receive slave operational parameters from the test WSDB.

6.84 In the case of multiple antenna systems, the UUT shall be configured to deliver the highest maximum power to the measurement equipment, and the method to do this shall be documented in the test report.

6.85 For a UUT that can at most transmit in a single DTT channel, the test WSDB shall be configured as follows

6.85.1 Set the permitted lower channel edge frequency and upper channel edge frequency so that they coincide with those of a DTT channel that falls within the operating frequency range declared by the manufacturer.

6.85.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.86 For a UUT that can also transmit simultaneously in a group of contiguous DTT channels, the test shall be repeated with the WSDB configured as follows:

6.86.1 Set the permitted lower and upper channel edge frequencies so that they coincide with those of a group of contiguous DTT channels that fall within the operating frequency range declared by the manufacturer. The number of contiguous DTT channels shall be selected in accordance with a nominal channel bandwidth declared by the manufacturer.

6.86.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.87 The test shall be repeated for every declared value of nominal channel bandwidth.

6.88 For a UUT that can also transmit simultaneously in multiple non-contiguous (or a mixture of contiguous and non-contiguous) DTT channels, the test shall be repeated with the test WSDB configured as follows:

6.88.1 Set the permitted lower and upper channel edge frequencies so that they correspond to multiple DTT channels that fall within the operating frequency range declared by the manufacturer. The number of DTT channels shall be

selected in accordance with the maximum total nominal channel bandwidth declared by the manufacturer.

6.88.2 Set the maximum permitted in-block EIRP (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.89 The tests shall be repeated for every declared grouping of used DTT channels.

Test method

6.90 The test method applies to conducted measurements.

6.91 Step 1

- The UUT shall be connected to a fast power sensor with the following settings:

i) Sample speed 1 MS/s or faster.
ii) The samples must represent the power of the signal.
iii) The measurement duration shall be long enough to ensure a minimum of 100 bursts are captured.

6.92 Step 2

- For conducted measurements on devices with one transmit chain, connect the power sensor to the transmit port, sample the transmit signal and store the raw data. Use these stored samples in all following steps.

- For conducted measurements on devices with multiple transmit chains, connect one power sensor to each transmit port for a synchronous measurement on all transmit ports. Trigger the power sensors so that they start sampling at the same time. Make sure the time difference between the samples of all sensors is less than half the time between two samples. For each instant in time, sum the power of the individual samples of all ports and store them. Use these stored samples in all following steps.

6.93 Step 3

- Find the start and stop times of each burst in the stored measurement samples.

  NOTE: The start and stop times are defined as the points where the power is at least 20 dB below the RMS burst power calculated in step 4.

6.94 Step 4

- Between the start and stop times of each individual burst calculate the RMS power over the burst. Save these Pburst values, as well as the start and stop times for each burst.

6.95 Step 5

- The highest of all Pburst values (value A in dBm) will be used for maximum EIRP calculations.

6.96 Step 6

- Add the declared antenna assembly gain G in dBi of the individual antennas. If applicable, add the additional beamforming gain Y in dB. If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used.

- The EIRP, P in dBm, shall be calculated using the formula

  P = A + G + Y (dBm).

- This value shall be recorded in the test report. Confirm that the measured value P does not exceed the maximum permitted in-block EIRP (in 8 MHz) specified by the test WSDB in each of the DTT channels used by the UUT.

Essential test suite: Transmitter in-block EIRP spectral density

6.97 The objective of these tests is to confirm that the UUT in-block EIRP spectral density, (over 100 kHz) within a DTT channel does not exceed the maximum permitted in-block EIRP spectral density specified by the test WSDB for that DTT channel (see specifications in 5.29).

Test conditions

6.98 If the UUT is a master WSD, the UUT shall be connected to a TE. The UUT shall be configured to communicate with the test WSDB in the TE.

6.99 If the UUT is a slave WSD, the UUT shall be connected to a compatible test master WSD which is configured to receive slave operational parameters from the test WSDB.

6.100 The power density to be measured is the highest mean power level found in any 100 kHz bandwidth within each 8 MHz DTT channel used by the UUT.

6.101 In the case of multiple antenna systems, the UUT shall be configured to deliver the highest maximum power spectral density to the measurement equipment, and the method to do this shall be documented in the test report.

6.102 For a UUT that can at most transmit in a single DTT channel, the test WSDB shall be configured as follows:

6.102.1 Set the permitted lower channel edge frequency and upper channel edge frequency so that they coincide with those of a DTT channel that falls within the operating frequency range declared by the manufacturer.

6.102.2 Set the maximum permitted in-block EIRP spectral density (in 100 kHz) to a value that is less than the UUT maximum in-block EIRP spectral density (in 100 kHz) declared by manufacturer.

6.103 For a UUT that can also transmit simultaneously in a group of contiguous DTT channels, the test shall be repeated with the test WSDB configured as follows:

6.103.1 Set the permitted lower and upper channel edge frequencies so that they coincide with those of a group of contiguous DTT channels that fall within the operating frequency range declared by the manufacturer. The number of contiguous DTT channels shall be selected in accordance with a nominal channel bandwidth declared by the manufacturer.

6.103.2 Set the UUT maximum permitted mean in-block EIRP spectral density (in 100 kHz) for each DTT channel to a value that is less than the maximum in-block EIRP spectral density (in 100 kHz) declared by the manufacturer.

6.104 The test shall be repeated for every value of nominal channel bandwidth declared by the manufacturer.

6.105 For a UUT that can also transmit simultaneously in multiple non-contiguous (or a mixture of contiguous and non-contiguous) DTT channels, the test shall be repeated with the test WSDB configured as follows:

6.105.1 Set the permitted lower and upper channel edge frequencies so that they correspond to multiple DTT channels that fall within the operating frequency range declared by the manufacturer. The number of DTT channels shall be selected in accordance with the maximum total nominal channel bandwidth declared by the manufacturer.

6.105.2 Set the maximum permitted mean EIRP spectral density (in 100 kHz) for each DTT channel to a value that is less than the UUT maximum EIRP spectral density (in 100 kHz) declared by the manufacturer.

6.106 The tests shall be repeated for every declared grouping of DTT channels.

Test method

6.107 The test method applies to conducted measurements.

6.108 Step 1

- The UUT shall be connected to a spectrum analyser with the following settings:

Centre frequency:	Centre frequency of the DTT channel under test.
Frequency span:	8 MHz
Resolution bandwidth:	10 kHz
Video Bandwidth:	30 kHz
Detector mode:	RMS
Trace mode:	Max hold
Sweep time:	Auto

- Wait for the spectrum analyser trace to complete. Save the (trace) data set to a file. Repeat by aligning the spectrum analyser's centre frequency with the centre frequency of each DTT channel used by the UUT.

6.109 Step 2

- For conducted measurements on smart antenna systems using either operating mode 2 or 3 (see 6.22), repeat the measurement for each of the transmit ports. For each frequency point, add up the power values for the different transmit chains and use this as the new data set.

6.110 Step 3

- Add up the values of power for all the samples in the file.

- Normalize the individual values for amplitude so that the sum is equal to the transmitter EIRP (RF output power) measured in 6.80. The measured transmitter EIRP is used as a proxy for the total in-block EIRP.

6.111 Step 4

- Starting from the first sample in the file (lowest frequency), add up the power of the following samples representing a 100 kHz segment and record the results for

power and position (i.e. samples #1 to #10). This is the EIRP spectral density for the first 100 kHz segment which shall be recorded.

6.112 Step 5

- Shift the start point of the samples added up in Step 4 by 1 sample and repeat the procedure in Step 4 (i.e., with samples #2 to #11).

6.113 Step 6

- Repeat Step 5 until the end of the data set and record the EIRP spectral density values for each of the 100 kHz segments.

- From all the recorded results which fall within a DTT channel, the highest value, PD, is the maximum EIRP spectral density of the UUT in the said DTT channel. Confirm that the measured values, PD, do not exceed the maximum permitted in-block EIRP spectral densities (in 100 kHz) specified by the test WSDB in each of the DTT channels used by the UUT.

Essential test suite: Time validity of operational parameters

6.114 The objective of these tests is to verify that the UUT ceases transmissions upon expiry of the time validity of the operational parameters which it receives from the test WSDB (see specifications in 5.92).

Test conditions

6.115 If the UUT is a master WSD, the UUT shall be connected to a TE. The UUT shall be configured to communicate with the test WSDB in the TE.

6.116 If the UUT is a slave WSD, the UUT shall be connected to a compatible test master WSD which is configured to receive slave operational parameters from the test WSDB.

6.117 The UUT shall be configured to request operational parameters from the test WSDB and to subsequently transmit according to these operational parameters.

6.118 If possible, the UUT shall be configured to transmit continuously (duty cycle = 1) or at maximum duty cycle for the duration of this test.

6.119 In the case of multiple antenna systems, these tests shall be applied to the combined transmissions from all antennas. UUT shall be configured to deliver the highest maximum power to the measurement equipment, and the method to do this shall be documented in the test report.

6.120 For a UUT that can at most transmit in a single DTT channel, the test WSDB shall be configured as follows:

6.120.1 Set the permitted lower channel edge frequency and upper channel edge frequency so that they correspond to those of a DTT channel that falls within the operating frequency range declared by the manufacturer.

6.120.2 Set the maximum permitted in-block EIRP spectral density (in 8 MHz) to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.120.3 Set the time validity of transmission to be no greater than 3 hours.

6.121 For a UUT that can also transmit simultaneously in multiple contiguous (or mix of contiguous and non-contiguous) DTT channels, the UUT shall be configured to operate at the maximum number of DTT channels declared by the manufacturer. The test WSDB shall be configured as follows:

6.121.1 Set the permitted lower and upper channel edge frequencies so that they correspond to multiple DTT channels that fall within the operating frequency range declared by the manufacturer. The number of DTT channels shall be selected in accordance with the maximum total nominal channel bandwidth declared by the manufacturer.

6.121.2 Set the maximum permitted in-block EIRP (in 8 MHz) for each DTT channel to a value that is less than the UUT maximum total EIRP declared by the manufacturer.

6.121.3 Set the time validity of transmission to be no greater than 3 hours.

6.122 If a UUT can support transmissions in both contiguous and non-contiguous DTT channel arrangements, the test shall be performed for one mode only.

6.123 The test WSDB shall be configured such it communicates a “request declined” message (or equivalent) in response to subsequent requests (i.e., following the first request) by the UUT for operational parameters.

Test method

6.124 The test method applies to conducted measurements and the measurement procedure shall be as follows:

6.125 Step 1

- Where the UUT is a master WSD, connect the UUT to the test WSDB and a RF power meter. Switch off the UUT and test slave WSD. Measure the UUT transmit power.

- Where the UUT is a slave WSD, connect the UUT to a test master WSD (which is itself connected to the test WSDB) and a RF power meter. Switch off the UUT and test master WSD. Measure the UUT transmit power.

6.126 Step 2

- The UUT and accompanying test device are powered on. Observe that the UUT consults the TE (test WSDB) and communicates its device parameters to the TE. Observe that the TE then responds with operational parameters. Observe that the UUT starts transmissions.

6.127 Step 3

- Let T denote the absolute instant in time (hour:minute) at which the validity of the operational parameters expire.

- The transmissions of the UUT shall be observed using the RF power meter over a window of 1 minute on either side of the absolute time T. The ceasing of transmissions within this window shall be confirmed (by comparing the measured value of conducted power with that measured prior to the commencement of transmissions) and noted.

Essential test suite: Device shutdown

6.128 The objective of these tests is to verify that

i) the UUT ceases transmissions upon receiving instructions to do so (see specifications in 5.98); and

ii) a slave UUT ceases transmissions upon losing communications with the test master WSD (see specifications in 5.100).

Test conditions

6.129 The UUT and test WSDB shall be configured as described in 6.114.

Test method

6.130 The test method below applies to the case where a UUT receives a shutdown message from a test WSDB. The test method applies to conducted measurements.

6.131 Step 1

- Where the UUT is a master WSD, connect the UUT to the test WSDB and a RF power meter. Switch off the UUT and test slave WSD. Measure the UUT transmit power.

- Where the UUT is a slave WSD, connect the UUT to a test master WSD (which is itself connected to the test WSDB) and a RF power meter. Switch off the UUT and test master WSD. Measure the UUT transmit power.

6.132 Step 2

- The UUT and accompanying test device are powered on. Observe that the TE provides the UUT with operational parameters. Observe that the UUT starts transmissions.

6.133 Step 3

- Configure the test WSDB or test master WSD to send a shutdown message to the UUT. Let T1 denote the instant when the UUT receives the shutdown message from the test WSDB or test master WSD.

  NOTE: Additional verification may be needed to quantify T1 if this is not indicated by the UUT. The instant when the shutdown message is transmitted can be used as a proxy for T1.

6.134 Step 4

- The transmissions of the UUT following instant T1 shall be observed for a period greater than 60 seconds if the UUT is a master WSD and 1 second if the UUT is a slave WSD.

6.135 Step 5

- T2 denotes the instant when the UUT has ceased all transmissions as instructed by the test WSDB. The ceasing of transmissions shall be confirmed by comparing

the measured value of UUT conducted power with that measured prior to the commencement of transmissions. The time difference between T1 and T2 shall be measured. This value shall be noted and compared with the limits specified in 5.98 to 5.99.

6.136 The test method below applies to the case where a slave UUT loses communications with the master test WSD. The test method applies to conducted measurements and the measurement procedure shall be as follows:

6.137 Step 1

- Connect the UUT to a test master WSD (which is itself connected to the test WSDB) and a RF power meter. Switch off the UUT and test master WSD. Measure the UUT transmit power.

6.138 Step 2

- The UUT and accompanying test device are powered on. Observe that the TE provides the UUT with operational parameters. Observe that the UUT starts transmissions.

6.139 Step 3

- Switch off the test master WSD. Let T1 denote the instant when the test master WSD is switched off.

6.140 Step 4

- The transmissions of the UUT following instant T1 shall be observed for a period greater than 5 second.

6.141 Step 5

- T2 denotes the instant when the UUT has ceased all transmissions after losing communications with test master UUT. The ceasing of transmissions shall be confirmed by comparing the measured value of UUT conducted power with that measured prior to the commencement of transmissions. The time difference between T1 and T2 shall be measured. This value shall be noted and compared with the limit specified in 5.100.

Essential test suite: Transmitter unwanted emissions within the 470-790 MHz bands

6.142 The objective of these tests is to ensure that the UUT unwanted out-of-block emissions within the 470-790 MHz band comply with the specifications set out in 5.38.

Test conditions

6.143 The UUT shall be configured to transmit under normal operating conditions which result in the lowest adjacent frequency leakage ratios inside the 470-790 MHz band. These operating conditions include the mutli-antenna transmit operating mode (as described in 6.20), and the modulation/multiple access scheme.

6.144 The UUT shall be configured to operate at the maximum total EIRP declared by the manufacturer.

6.145 For a UUT which is capable of transmitting simultaneously in multiple DTT channels, the UUT shall be configured to transmit in one group of contiguous DTT channels, with equal power in each DTT channel, and at the maximum total nominal channel bandwidth declared by the manufacturer.

6.146 The UUT shall be configured such that the occupied nominal channels are tested near the upper and lower ends of the operating frequency range declared by the manufacturer.

Test method

6.147 The test method applies to conducted measurement.

6.148 The following tests shall be repeated with the occupied channels near the upper and lower ends of the operating frequency range declared by the manufacturer.

6.149 Step 1

- The unwanted out-of-block power shall be measured over a measurement bandwidth of 100 kHz within the 470-790 MHz band and across the first four adjacent 8 MHz DTT channels on either side of the group of occupied nominal channels.

  The UUT shall be connected to a spectrum analyser capable of RF power measurements and with the following settings:

Resolution Bandwidth:	100 kHz
Video Bandwidth:	300 kHz
Detector mode:	RMS
Trace mode:	Max Hold
Sweep time:	≥ 1 minute
Centre Frequency:	Centre frequency of the out-of-block DTT channel being tested
Span:	3 × 8 MHz

- Use the spectrum analyser measurements to record the UUT maximum average power level in a measurement bandwidth of 100 kHz across each of the first four 8 MHz DTT channels on either side of the group of occupied nominal channels. These eight values shall be used as the out-of-block emission levels, P_{OOB} (dBm/100 kHz).

6.150 Step 2

- The UUT in-block power shall be measured over a measurement bandwidth of 8 MHz and across the group of occupied nominal channels used for wanted emissions.

- Adjust the frequency span of the spectrum analyser to align with the group of occupied nominal channels. No other parameter of the spectrum analyser shall be changed compared to Step 1.

- Measure the UUT maximum average in-block power in each 8 MHz DTT channel within the group of occupied nominal channels. Record the lowest of the measured values. This value shall be used as the in-block level, P_{IB} (dBm/8 MHz).

6.151 Step 3

- Confirm that the differences between P_{IB} (dBm/8 MHz) and the values of P_{OOB} (dBm/100 kHz) derived in Steps 1 and 2 comply with the specifications set out in 5.37.

6.152 In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. Compliance with the applicable limits shall be performed by adding (in mW) the results of measurements for each of the transmit chains, and comparing these with the specifications set out in 5.37.

Essential test suite:
Transmitter unwanted emissions outside the 470-790 MHz band

6.153 The objective of these tests is to ensure that the UUT unwanted emissions outside the 470-790 MHz band comply with the specifications set out in 5.43.

Test conditions

6.154 The UUT shall be configured to transmit under normal operating conditions which result in the highest unwanted emissions outside the 470-790 MHz band. Operating conditions here include the multi-antenna transmit operating mode (as described in 6.20), and modulation/multiple access scheme.

6.155 The UUT shall be configured to operate at the maximum total EIRP declared by the manufacturer.

6.156 For a UUT which is capable of transmitting simultaneously in multiple DTT channels, the UUT shall be configured to transmit in one group of contiguous DTT channels, with equal power in each DTT channel, and at the maximum total nominal channel bandwidth declared by the manufacturer.

6.157 The UUT shall be configured such that the occupied nominal channels are tested at the upper and lower ends of the operating frequency range declared by the manufacturer.

Test method

6.158 The test method applies to conducted measurement.

6.159 The following tests shall be repeated with the occupied channel(s) at the upper and lower ends of the operating frequency range declared by the manufacturer.

6.160 The UUT shall be connected to a spectrum analyser capable of RF power measurements.

6.161 The pre-scan test procedure below shall be used to identify potential unwanted emissions of the UUT.

Pre-scan

6.162 Step 1

- The sensitivity of the spectrum analyser shall be such that the noise floor is at least 12 dB below the limits given in Table 1.

6.163 Step 2

- The emissions shall be measured over the range 30 MHz to 1000 MHz (but excluding the 470-790 MHz band) with the following spectrum analyser settings:

Resolution Bandwidth:	100 kHz
Video Bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Sweep points:	≥ 9970
Sweep time:	For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two transmissions of the UUT.

- Any emissions identified during the above sweeps which fall within the 6 dB range below the applicable limit given in Table 2 shall be individually measured using the *measurement of identified emissions* procedure below

6.164 Step 3

- The emissions shall now be measured over the range 1 GHz to 4 GHz with the following spectrum analyser settings:

Resolution Bandwidth:	1 MHz
Video Bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold
Sweep points:	3,000
Sweep time:	For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two transmissions of the UUT.
NOTE 1: For spectrum analysers which do not support this number of sweep points, the frequency band may be segmented.	
Sweep Time:	For non continuous transmissions (duty cycle less than 100%), the sweep time shall be sufficiently long, such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the UUT.

- Any emissions identified during the above sweeps which fall within the 6 dB range below the applicable limit given in Table 2 shall be individually measured using the *measurement of identified emissions* procedure below.

6.165 The steps below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above.

Measurement of identified emissions

6.166 For continuous transmit signals, a simple measurement using the RMS detector of the spectrum analyser is permitted. The measured values shall be recorded. Confirm that the measured values do not exceed the limits in Table 2.

6.167 For non-continuous transmit signals, the measurements shall be made only over the "on" part of the burst as described in the following steps.

6.168 Step 1

- The level of the emissions shall be measured in the time domain, using the following spectrum analyser settings:

Centre Frequency:	Frequency of emission identified during the pre-scan.
Resolution Bandwidth:	100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
Video Bandwidth:	100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
Frequency Span:	0 Hz
Sweep Mode	Continuous
Sweep Time:	Suitable to capture one transmission burst.
Trigger:	Video Trigger
Detector:	Peak
Trace Mode:	Clear/Write

- Adjust the centre frequency (fine tune) to capture the highest level of one burst of the emission to be measured.

6.169 Step 2

- Change the settings of the spectrum analyser as follows:

Sweep points:	5000
Sweep Time:	Suitable to capture one transmission burst

6.170 Step 3

- Adjust the trigger level to select the transmissions with the highest power level.
- Set a window (start and stop lines) to match with the start and end of the burst in which the RMS power shall be measured using the Time Domain Power function.
- Select RMS power to be measured within the selected window and note the result which is the RMS power of this particular spurious emission. The power value and corresponding frequency shall be recorded. Confirm that the power value does not exceed the relevant limit in Table 1.

6.171 Repeat the above procedures for every emission identified during the pre-scan.

6.172 In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. Comparison with the applicable limits shall be performed using either of the options given below:

- Option 1 – the results for each of the transmit chains for the corresponding 1 MHz segments shall be added (in mW) and compared with the limits provided in Table 2.

- Option 2 – the results for each of the transmit chains shall be individually compared with the limits provided in Table 2, after these limits have been reduced by $10 \times \log_{10}$ (Tch), where Tch is the number of active transmit chains.

Essential test suite: Receiver spurious emission

6.173 The objective of these tests is to ensure that the UUT receiver spurious emissions outside the 470-790 MHz band comply with the specifications set out in 5.46.

Test conditions

6.174 For the duration of the test, the UUT shall be configured to operate in a continuous receive mode, or is operated in a mode where no transmissions occur.

6.175 The level of spurious emissions shall be measured as, either:

i) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or

ii) their effective radiated power when radiated by cabinet and antenna.

Test method

6.176 The test method applies to conducted measurement.

6.177 The UUT shall be connected to a spectrum analyser capable of RF power measurements.

6.178 The pre-scan test procedure below shall be used to identify potential receiver spurious emissions of the UUT.

Pre-scan

6.179 Step 1

- The sensitivity of the spectrum analyser shall be such that the noise floor is at least 12 dB below the limits given in Table 3.

6.180 Step 2

- The emissions shall be measured over the range 30 MHz to 1000 MHz, with the following spectrum analyser settings:

Resolution Bandwidth:	100 kHz
Video Bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

- Any emissions identified during the above sweeps which fall within the 6 dB range below the applicable limit given in Table 3 shall be individually measured using the *measurement of identified emissions* procedure below.

6.181 Step 3:

- The emissions shall now be measured over the range 1 GHz to 4 GHz with the following spectrum analyser settings:

Resolution Bandwidth:	1 MHz
Video Bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

- Any emissions identified during the above sweeps which fall within the 6 dB range below the applicable limit in Table 3, shall be individually measured using the *measurement of emissions identified during pre-scan* procedure below.

Measurement of emissions identified during pre-scan

- The limits for receiver spurious emissions in Table 3 refer to average power levels.

- The emissions identified during pre-scan shall be measured via the RMS detector using trace averaging of the spectrum analyser. The measured values shall be recorded and compared with the limits in Table 3.

6.182 Repeat the above procedures for every emission identified during the pre-scan.

6.183 In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. Comparison with the applicable limits shall be performed using either of the options given below:

- Option 1 – the results for each of the transmit chains for the corresponding 1 MHz segments shall be added (in mW) and compared with the limits provided in Table 1.

- Option 2 – the results for each of the transmit chains shall be individually compared with the limits provided in Table 1, after these limits have been reduced by 10 $\log_{10}$ (Tch), where Tch is the number of active transmit chains.

Essential test suite: Database discovery and database query

6.184 The objective of this test is to assess compliance with the requirements described in 5.52.

6.185 NOTE: The requirements in 0 are based on the working assumption that the list of qualifying WSDBs will be available at a website from which WSDs shall download the list and the value of N as an xml file with UTF-8 encoding.

6.186 The test verifies that

1) a master WSD obtains the list of qualifying WSDBs from Ofcom's website before contacting a WSDB, and

2) subsequently, a master WSD does not request operational parameters from a WSDB that it is not on Ofcom's list of qualifying WSDBs.

6.187 This test does not verify the behaviour of the UUT when the list of qualifying WSDBs is not accessible (see specifications in 5.56).

6.188 This test is only applicable to UUTs that are master WSDs.

Test condition

6.189 In this test, the UUT is configured to operate normally. The data port of the UUT (i.e., the port that it uses to connect to the internet) will be connected to the test port of the test equipment (TE). The UUT data port and the TE test port must be able to communicate at the data link level; i.e., they must be part of the same link layer broadcast domain. This is to ensure that they are part of the same IP network.

6.190 The TE will emulate all the entities that the UUT would normally interface with in order to a) obtain Ofcom's list of qualifying WSDBs, and b) send a query to one of the WSDBs on the list.

6.191 The TE must provide the following functions:

- Act as IP DNS[1] name server and DHCP[2] server.
- Act as a web server that replicates https://TVWS-Databases.ofcom.org.uk.
- Logging of all the IP traffic to and from the UUT.
- Provide internet connection and ability to download the WSDB list from https://TVWS-Databases.ofcom.org.uk
- Act as a WSDB server capable of receiving a request for operational parameters from a master WSD, and of responding with a "request declined" message to that query. For this, the TE needs to support the WSDB access protocol implemented by the master WSD.

[1] Domain Name System.
[2] Dynamic Host Configuration Protocol.

6.192 This test shall be performed with the test configurations below. Both test configurations apply irrespective of whether the UUT has a preferred WSDB or not.

6.193 The objective of the first test configuration is to examine cases where the UUT has a preferred WSDB and this preferred WSDB is on the actual Ofcom list. The test verifies that the UUT discovers its preferred WSDB and subsequently consults that WSDB.

6.194 The objective of the second test configuration is to examine cases where the UUT has a preferred WSDB but this preferred WSDB is not on the actual Ofcom list. The test verifies that the UUT meets the requirements in 0 in such circumstances.

1) Ofcom's WSDB list: the TE must be configured as follows:

- The IP parameters provided by the TE's DHCP server must include the TE's own name server as DNS server.
- The TE's web server that replicates Ofcom's site must be configured to
  - Provide the exact copy of the list of qualifying WSDBs available at Ofcom's web site (at the internet address https://TVWS-Databases.ofcom.org.uk). Note that to be able to do this, the TE must be able to access the internet and Ofcom's web site and to download the WSDB list.
  - Provide a value of N corresponding to up to 2 hours, where N is the maximum permitted time interval before a master WSD must consult Ofcom's list of qualifying databases.
- The TE's DNS name server must be configured to
  - associate the TVWS-Databases.ofcom.org.uk domain to the address of its own web server,
  - associate the domain names of the WSDBs in the list to the address of its own WSDB server.

2) Mock WSDB list: the TE must be configured as follows:

- The IP parameters provided by the TE's DHCP server must include the TE's own DNS server as the name server.
- The TE's web server that replicates Ofcom's site must be configured to
  - Provide a list of 6 dummy WSDB domain names (such as DummyDB1.com, DummyDB2.com, etc.).
  - Provide a value of N corresponding to up to 2 hours, where N is the maximum permitted time interval before a master WSD must consult Ofcom's list of qualifying databases.
- The TE's DNS name server must be configured to
  - associate WSDB.ofcom.org.uk domain to the address of its own web server.

- o associate the domain names of the 6 dummy WSDBs to the address of its own WSDB web server.

6.195 The test arrangement is illustrated in Figure 9 below.

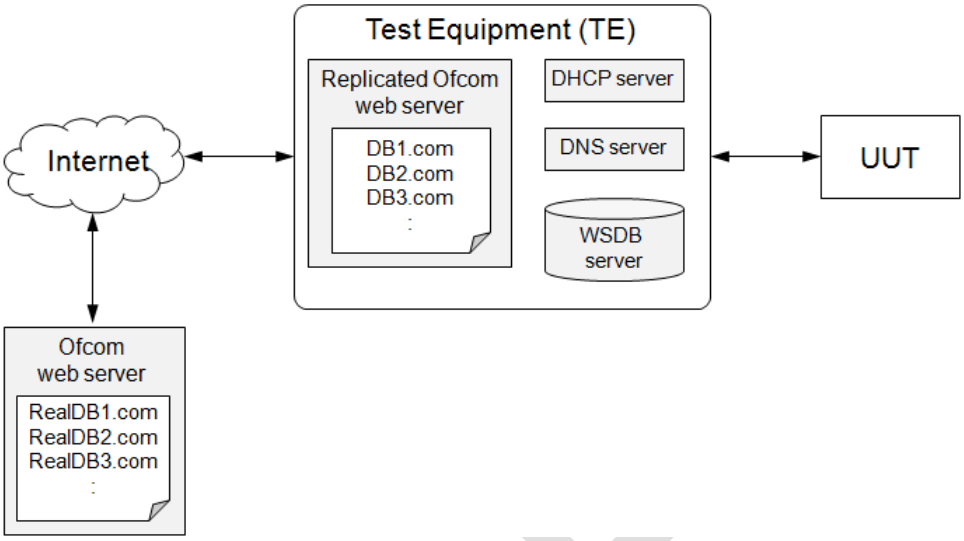

Figure 9. Test arrangement for database discovery and access.

Test method

6.196 The following test procedure must be carried out for test configuration 1) Ofcom's WSDB list, and for test configuration 2) mock WSDB list.

a) The UUT must be switched off at the start of the test. The UUT data port must be connected to the test port of the TE.

b) The UUT must be switched on. The UUT must be set up to obtain its IP configuration from a DHCP server.

c) The TE must record that the UUT makes a DCHP request (for IP configuration), and the TE's DHCP server must serve that request.

d) The TE must record that the UUT makes a DNS query to look up the address of TVWS-Databases.ofcom.org.uk domain, and the TE's DNS server must respond to that query.

e) The TE must record that the UUT makes an HTTPS request to its web server (which is configured as TVWS-Databases.ofcom.org.uk) to obtain the list of WSDBs and the value of N. The TE must respond with the xml file containing the data with the list of WSDBs and the value of N.

f) The UUT must remain switched on for at least N minutes plus another 30 minutes. The TE must record all IP traffic from and to the UUT and verify that

1) The UUT does not make a DNS query to look up the address of a domain name that is not in the list of WSDBs that the TE provided the UUT.

2) The UUT does not make a request for operational parameters to an IP address other than that of its WSDB web server.

3) After N minutes AND before making any other request for operational parameters, the UUT makes another HTTPS request to the TE web server to renew the list of WSDBs and the value of N.

g) If the UUT makes a request for operational parameters to the TE's WSDB server, the TE must acknowledge the request and respond with a "request declined" message or equivalent, as specified in the relevant WSDB access protocol.

6.197 Compliance with the specifications is verified if

1) The UUT makes a request for the list of WSDBs correctly. This is achieved if steps a) to e) are completed successfully.

2) The UUT does not make a request for operational parameters to a WSDB that is not in the list. This is achieved if step f(1) and f(2) are successful.

3) If the UUT makes a request for operational parameters after the N timer has expired, the UUT must already have initiated and completed a new database discovery process. This is achieved if step f(3) is successful.

Essential test suite: Sequence of data exchange

6.198 The objective of this test is to verify that a UUT follows the appropriate sequence of operations in its interactions with the TE (see specifications in 5.61).

Test conditions

6.199 If the UUT is a master WSD, the device shall be configured such that it first discovers (or otherwise consults) the test WSDB in the TE, and then operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The manufacturer must supply a compatible test slave WSD in order to allow the testing of the UUT's functionality in relation to master-slave communications. The test slave WSD shall be configured to request generic and specific operational parameters from the WSDB.

6.200 If the UUT is a slave WSD, the manufacturer must supply a compatible test master WSD in order to allow the testing of the UUT's functionality in relation to master-slave communications. The UUT shall be configured such that it operates normally in terms of its data exchange with the test master WSD. The test master WSD shall be configured such that it operates normally in terms of its data exchange with a WSDB (as emulated by the TE). A test master WSD need not be tested for TE discovery.

6.201 The TE shall be configured such that it a) allows the master WSD (be this the UUT or a test master device) to discover the test WSDB in the TE, and b) emulates the normal operations of a WSDB in terms of its data exchange with a master device. The TE shall also be configured as follows:

6.201.1 Set the permitted channel edge frequencies for the UUT such that they correspond to those of a DTT channel that falls within the operating frequency range declared by the manufacturer.

6.201.2 Set the UUT maximum permitted mean in-block EIRP spectral densities (in 100 kHz and 8 MHz) within the permitted channel frequency boundaries to values that are no greater than the corresponding values declared by the manufacturer.

6.202 Where the UUT is a slave WSD, the permitted channel edge frequencies and the maximum permitted EIRP spectral densities shall be set differently for generic operational parameters and specific operational parameters.

Test method

6.203 The following test method shall be applied in the case where the UUT is a master WSD.

6.203.1 Step 1 – Switch off the UUT. Switch off the test slave WSD. Connect the UUT to the TE. Connect the test slave WSD to the UUT. Connect the UUT to a RF power meter.

6.203.2 Step 2 – Switch on the UUT. Switch on the test slave WSD. Confirm that the UUT consults the TE and communicates its device parameters to the TE. Confirm that the TE then responds with operational parameters. Confirm that the UUT then communicates its channel usage parameters to the TE.

6.203.3 Step 3 – Confirm, via the RF power meter, that the UUT does not commence transmissions until it has communicated its channel usage parameters to the TE.

6.203.4 Step 4 – Confirm that the UUT consults the TE and requests generic operational parameters for the test slave WSD. Confirm that the TE then responds with generic operational parameters. Confirm (via the test slave WSD) that the UUT appropriately communicates the operational parameters to the test slave WSD. Confirm that the UUT then communicates the device parameters and channel usage parameters of the test slave WSD to the TE.

6.203.5 Step 5 – Confirm that the UUT consults the TE and requests specific operational parameters for the test slave WSD. Confirm that the TE then responds with specific operational parameters for the test slave WSD. Confirm (via the test slave WSD) that the UUT appropriately communicates the operational parameters to the test slave WSD. Confirm that the UUT then communicates the channel usage parameters of the test slave WSD to the TE.

6.204 The following test method shall be applied in the case where the UUT is a slave WSD.

6.204.1 Step 1 – Switch off the test master WSD. Switch off the UUT. Connect the test master WSD to the TE. Connect the UUT to the master test WSD. Connect the UUT to a RF power meter.

6.204.2 Step 2 – Switch on the UUT. Switch on the test master WSD. Note: At this point a number of interactions occur between the TE and the test master WSD. These need not be tested. Confirm that the test master WSD communicates generic operational parameters to the UUT.

6.204.3 Step 3 – Confirm, via the RF power meter, that the UUT does not commence transmissions until it has received generic operational parameters from the test master WSD. Note: For simplicity, the time of reception of operational parameters may be approximated by the time of transmission of operational parameters.

6.204.4 Step 4 – Confirm that the TE receives (via the test master WSD) the device parameters and channel usage parameters of the UUT.

6.205 The following test method shall be applied in the case where the UUT is a slave WSD which is declared by the manufacturer as capable of requesting specific operational parameters.

6.205.1 Follow steps 1 to 4 above.

6.205.2 Step 5 – Confirm that the TE communicates specific operational parameters to the test master WSD.

6.205.3 Step 6 – Confirm that the test master WSD communicates the specific operational parameters to the UUT.

6.205.4 Step 7 – Confirm, via the RF power meter, that the UUT does not change its transmissions until it has received specific operational parameters from

the test master WSD. Note: For simplicity, the time of reception of operational parameters may be approximated by the time of transmission of operational parameters.

Essential test suite: Communication of device parameters

6.206 The objective of this test is to verify that a UUT successfully communicates its device parameters to the TE (see specifications in 5.65). These tests can be performed in combination with those defined in 6.198.

Test conditions

6.207 If the UUT is a master WSD, the device shall be configured such that it first discovers (or otherwise consults) the test WSDB in the TE, and then operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The manufacturer shall declare whether the UUT is capable of vertical geo-location. The manufacturer shall also supply a compatible test slave WSD in order to allow the testing of the UUT's functionality in relation to slave device parameters. The UUT shall be configured to communicate its device parameters and those of the test slave WSD to the TE.

6.208 If the UUT is a slave WSD, the manufacturer shall supply a test master WSD in order that the UUT's device parameters are communicated to the TE. The UUT shall be configured such that it operates normally in terms of its data exchange with the test master WSD. The manufacturer shall declare whether the UUT is capable of a) horizontal geo-location, and b) vertical geo-location. The test master WSD shall be configured such that it operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The test master WSD need not be tested for TE discovery.

6.209 The TE shall be configured such that it a) allows the master WSD (be this the UUT or a test master device) to discover the test WSDB in the TE, and b) emulates the normal operations of a WSDB in terms of its data exchange with a master device.

Test method

6.210 The following test method shall be applied in the case where the UUT is a master WSD.

6.210.1 Step 1 – Switch off the UUT. Switch off the test slave WSD. Connect the UUT to the TE. Connect the test slave WSD to the UUT.

6.210.2 Step 2 – Switch on the UUT. Switch on the test slave WSD. Confirm that the UUT device type, unique device identifier, technology identifier, model identifier, device category, and device emission class that are communicated from the UUT to the TE match those declared by the manufacturer.

6.210.3 Step 3 – Confirm that the UUT latitude and longitude coordinates and coordinate uncertainties that are communicated from the UUT to the TE match the actual location of the UUT, or that the UUT communicates a "no horizontal geo-location" message and/or a "no horizontal geo-location uncertainty reported" message.

6.210.4 Step 4 – If the UUT has vertical geo-location capability, confirm that the altitude coordinate and coordinate uncertainty that are communicated from the UUT to the TE match the actual location of the UUT, or that the UUT communicates a "no vertical geo-location" message and/or a "no vertical geo-location uncertainty reported" message.

6.210.5 Step 5 – Confirm that the test slave WSD latitude and longitude coordinates and coordinate uncertainties that are communicated from the UUT to the TE match the actual location of the test slave WSD, or that the UUT communicates a “no horizontal geo-location” message and/or a “no horizontal geo-location uncertainty reported” message.

6.210.6 Step 6 – If the test slave WSD has vertical geo-location capability, confirm that the altitude coordinate and coordinate uncertainty that are communicated from the UUT to the TE match the actual location of the test slave WSD, or that the UUT communicates a “no vertical geo-location” message and/or a “no vertical geo-location uncertainty reported” message.

6.211 The following test method shall be applied in the case where the UUT is a slave WSD.

6.212.1 Step 1 – Switch off the test master WSD. Switch off the UUT. Connect the test master WSD to the TE. Connect the UUT to the master test WSD.

6.212.2 Step 2 – Switch on the UUT. Switch on the test master WSD. Note: At this point a number of interactions occur between the TE and the test master WSD. These need not be tested.

6.212.3 Step 3 – Confirm that the UUT device type, unique device identifier, technology identifier, model identifier, device category, and device emission class that are communicated from the UUT to the TE (via the test master WSD) match those declared by the manufacturer.

6.212.4 Step 4 – If the UUT has horizontal geo-location capability, confirm that the latitude and longitude coordinates and coordinate uncertainties that are communicated from the UUT to the TE (via the test master WSD) match the actual location of the UUT, or that the test master WSD communicates a “no horizontal geo-location” message and/or a “no horizontal geo-location uncertainty reported” message on behalf of the UUT.

6.212.5 If the UUT has vertical geo-location capability, confirm that the altitude coordinate and coordinate uncertainty that are communicated from the UUT to the TE (via the test master WSD) match the actual location of the UUT, or that the test master WSD communicates a “no vertical geo-location” message and/or a “no vertical geo-location uncertainty reported” message on behalf of the UUT.

Essential test suite: Communication of channel usage parameters

6.213 The objective of this test is to verify that a UUT successfully communicates its channel usage parameters to the TE (see specifications in 5.85). These tests can be performed in combination with those defined in 6.198 and 6.97.

Test condition

6.214 If the UUT is a master WSD, the device shall be configured such that it first discovers (or otherwise consults) the test WSDB in the TE, and then operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The manufacturer shall also supply a compatible test slave WSD in order to allow the testing of the UUT's functionality in relation to slave channel usage parameters.

6.215 If the UUT is a slave WSD, the manufacturer shall supply a test master WSD in order that the UUT's channel usage parameters are communicated to the TE. The UUT shall be configured such that it operates normally in terms of its data exchange with the test master WSD. The test master WSD shall be configured such that it operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The test master WSD need not be tested for TE discovery.

6.216 The TE shall be configured such that it a) allows the master WSD (be this the UUT or a test master device) to discover the test WSDB in the TE, and b) emulates the normal operations of a WSDB in terms of its data exchange with a master device.

6.217 The TE shall also be configured as described in 6.201 in the context of specifying the permitted channel frequencies and in-block EIRP spectral densities.

6.218 NOTE: Only one arrangement of used DTT channels need to be considered in this test. Where the UUT is capable of transmitting simultaneously in multiple DTT channels, the arrangement tested shall consist of multiple channels (i.e., shall not be tested in a single-channel mode).

Test method

6.219 The following test method shall be applied in the case where the UUT is a master WSD.

6.219.1 Step 1 – Switch off the UUT. Switch off the test slave WSD. Connect the UUT to the TE. Connect the test slave WSD to the UUT.

6.219.2 Step 2 – Switch on the UUT. Switch on the test slave WSD. Measure the in-block EIRP spectral densities of the UUT and the test slave WSD (refer to the tests in 6.97).

6.219.3 Step 3 – Confirm that the UUT channel usage parameters (see Table 6) that are communicated from the UUT to the TE match the used channels and measured EIRP spectral densities of the UUT.

6.219.4 Step 4 – Confirm that the test slave WSD channel usage parameters (see Table 6) that are communicated from the UUT to the TE match match the used channels and measured EIRP spectral densities of the test slave WSD.

6.220 The following test method shall be applied in the case where the UUT is a slave WSD.

6.220.1 Step 1 – Switch off the test master WSD. Switch off the UUT. Connect the test master WSD to the TE. Connect the UUT to the master test WSD.

6.220.2 Step 2 – Switch on the UUT. Switch on the test master WSD. Measure the in-block EIRP spectral densities of the UUT (refer to the tests in 6.97).

6.220.3 Step 3 – Confirm that the UUT channel usage parameters (see Table 6) that are communicated from the UUT to the TE (via the test master WSD) match the used channels and measured EIRP spectral densities of the UUT.

Essential test suite: Geo-location and geo-location validity

6.221 The objective of this test is to verify that a UUT will not continue to transmit with its current operational parameters if its horizontal position changes by more than 50 metres with respect to its position at the time when this was last reported to the TE (see specifications in 5.108).

Test conditions

6.222 This test only applies to master UUTs, or slave UUTs which have geo-location capability (and so request specific operational parameters). This test does not apply to type A devices.

6.223 If the UUT is a master WSD, the device shall be configured such that it first discovers (or otherwise consults) the test WSDB in the TE, and then operates normally in terms of its data exchange with a WSDB (as emulated by the TE).

6.224 If the UUT is a slave WSD, the manufacturer shall supply a test master WSD in order that the UUT's device parameters are communicated to the TE. The UUT shall be configured such that it operates normally in terms of its data exchange with the test master WSD. The test master WSD shall be configured such that it operates normally in terms of its data exchange with a WSDB (as emulated by the TE). The test master WSD need not be tested for TE discovery.

6.225 The TE shall be configured such that it a) allows the master WSD (be this the UUT or a test master device) to discover the test WSDB in the TE, and b) emulates the normal operations of a WSDB in terms of its data exchange with a master device. The TE shall also be configured as described in 6.201 in the context of specifying the permitted channel frequencies and in-block EIRP spectral densities.

6.226 The TE shall be configured such that if it receives a "no horizontal geo-location" message from a UUT, the TE responds with a "request declined" message to the UUT.

6.227 The TE shall be configured such that once the UUT had been moved following its first query to the TE, the TE communicates a "request declined" message (or equivalent) in response to subsequent queries from the UUT.

Test method

6.228 The following test method shall be applied to the case where the UUT is a master WSD.

6.228.1 Step 1 – Switch off the UUT. Connect the UUT to the TE. Switch on the UUT. Observe that the UUT consults the TE, requests specific operational parameters, and communicates to the TE its device parameters. Confirm that the TE responds with specific operational parameters. Alternatively, confirm that the UUT communicates a "no horizontal geo-location" message to the TE, and that the TE responds with a "request declined" message.

6.228.2 Step 2 – Move the UUT by more than 50 metres horizontally with respect to its location in Step 1 above. It is assumed that the UUT is still able to geo-locate in its new position. If not, the test shall be repeated in a location where geo-location is possible.

6.228.3 Step 3 – Confirm that the UUT re-consults the TE, requests updated specific operational parameters, and communicates to the TE its updated device parameters. The TE shall respond with a “request declined” message (or equivalent). This is to avoid transmissions by the WSD outside laboratory conditions.

6.229 The following test method shall be applied to the case where the UUT is a slave WSD.

6.229.1 Step 1 – Switch off the UUT. Switch off the test master WSD. Connect the test master WSD to the TE. Connect the UUT to the master WSD. Switch on the master test WSD. Switch on the UUT. Observe that the UUT consults the test master WSD and the TE, requests specific operational parameters, and communicates to the TE (via the test master WSD) its device parameters. Confirm that the TE responds with specific operational parameters. Alternatively, confirm that the UUT communicates a “no horizontal geo-location” message to the TE, and that the TE responds with a “request declined” message.

6.229.2 Step 2 – Move the UUT by more than 50 metres horizontally with respect to its location in Step 1 above. It is assumed that the UUT is still able to geo-locate in its new position. If not, the test shall be repeated in a location where geo-location is possible.

6.229.3 Step 3 – Confirm that the UUT re-consults the test master WSD and TE, requests updated specific operational parameters, and communicates to the TE (via the test master WSD) its updated device parameters. The TE shall respond with a “request declined” message (or equivalent). This is to avoid transmissions by the WSD outside laboratory conditions.

6.230 Compliance shall be presumed if the above steps are completed.

Annex 1

Specification of sequence of WSD operations

A1.1 In this annex we set out the sequence of procedures for the exchange of information between WSDBs, master WSDs, and slave WSDs. These procedures reflect the following high level operational requirements:

- A qualifying WSDB must receive information from a WSD about the characteristics of that WSD in order to generate operational parameters for that WSD.

- A qualifying WSDB must maintain a record of the actual usage of the TV white spaces. This means that each device must report back to the WSDB the actual frequencies and powers that it uses. We believe this is important for the purpose of spectrum management for two reasons:

  i) To enable offending WSDs to be readily identified if interference occurs.

  ii) To allow the WSDBs to know the extent to which available white spaces are being used.

A1.2 We acknowledge that a range of WSD wireless technologies are likely to emerge, therefore we have defined the requirements to be technology-neutral. In addition, we have specified the sequence of operations at a high level, with only enough detail to ensure that the necessary information is exchanged between WSDs and WSDBs.

A1.3 We do not believe that these requirements impose any constraints on industry-led innovation in this field, or the emergence of international technology standards which specify the details of the communications protocols among WSDs, and between WSDs and WSDBs.

A1.4 We recognise that the requirement to report back to the WSDB the actual usage parameters is an additional communications burden, which is not present in other licence exempt use. However, we believe that the circumstances of licence exemption in the UHF TV band – widespread primary use, allocation of radio resources by databases – make it important to keep track of actual use, in particular since the reporting of actual use is relatively easy to implement once the database and the communications infrastructure are in place.

A1.5 The proposed sequence of events in the interactions between master WSDs, slave WSDs and WSDBs is described below in the context of the following four separate phases:

b) Generation and communication of specific operational parameters for individual master WSDs.

c) Generation and communication of generic operational parameters for all slave WSDs in the coverage area of a particular master WSD.

d) Association of a slave WSD with a master WSD.

e) Generation and communication of specific operational parameters for individual slave WSDs.

A1.6 These phases are illustrated in Figure 7 below, along with the corresponding sequence of parameter exchanges illustrated in Figure 8.

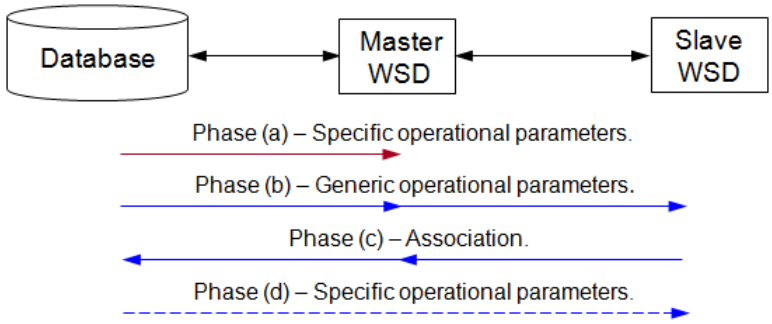

Figure 7. Illustration of operational phases.

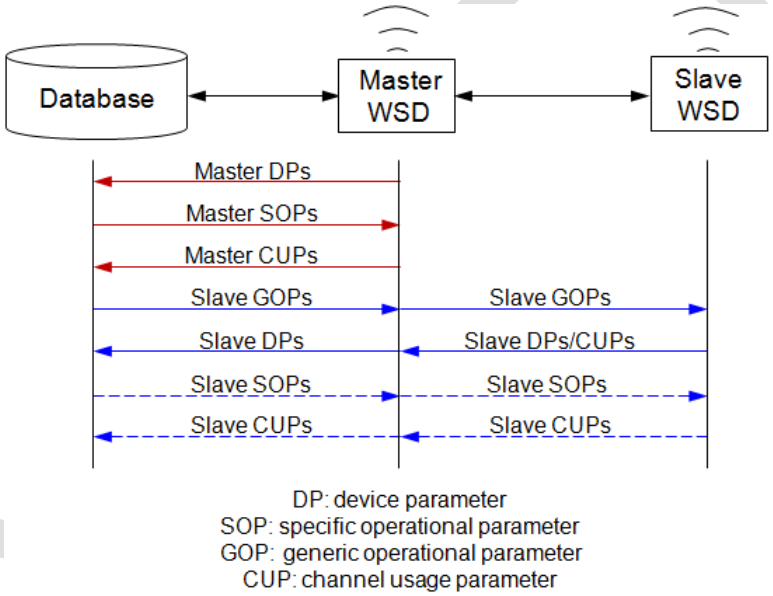

Figure 8. Sequence of data exchange.

A1.7 We recognise that the requirements set out here relating to the interactions between master and slave WSDs may be implemented in a variety of ways in industry-defined wireless technologies. However, it is important to note that, while the details of implementation may diverge from the sequence of events outlined here, this must not in any way alter a) the information exchange between the master WSDs and WSDBs or b) the operational parameters of the master and slave WSDs, all as set out in this document.

Phase (a) – Specific operational parameters for a master WSD

A1.8 This phase relates to the generation and communication of specific operational parameters for master WSDs. Any master WSD wishing to transmit in the UHF TV band must undertake the steps described below:

1.8.1 A master WSD wishing to transmit in the UHF TV band must first obtain a list of qualifying WSDBs from Ofcom's website.

1.8.2 The master WSD must contact one of the WSDBs in the list and request specific operational parameters for its own transmissions. As part of this process, the master WSD must communicate its device parameters (including its horizontal location) to the WSDB.

1.8.3 The WSDB will then generate the specific operational parameters that the master WSD must comply with for its transmissions in the UHF TV band. For this, the WSDB will use the "TVWS availability data"[3] obtained from Ofcom, and the device parameters provided by the master WSD.

1.8.4 The WSDB will communicate the specific operational parameters to the master WSD.

1.8.5 The master WSD must respond to the WSDB with its channel usage parameters, i.e., the channel(s) and radiated power(s) that it intends to use. The channels used will be a subset of those included in the specific operational parameters that the master WSD received from the WSDB.

1.8.6 The master WSD can only then start transmissions in the UHF TV band according to its reported channel usage parameters.

Phase (b) – Generic operational parameters for slave WSDs

A1.9 This phase relates to the generation and communication of generic operational parameters for slave WSDs in the coverage area of a particular master WSD. Any master WSD seeking to support the association of slave WSDs over the UHF TV band must undertake the steps described in paragraph A1.11 below. We use the term "association" to refer to the process whereby a slave WSD initially identifies itself to its serving master WSD.

A1.10 We recognise that there may be circumstances where the WSD wireless technology supports the association of slave WSDs via media other than the UHF TV band, e.g., via wireless access in other frequency bands, or wire-line access. As will become evident, in such cases "specific" (Phase d) rather than "generic" (Phase b) operational parameters apply.

A1.11 The sequence of events in this phase is as described below:

1.11.1 The master WSD must contact a qualifying WSDB, and request generic operational parameters for the transmissions of those slave WSDs within its coverage area.

1.11.2 The WSDB will generate the generic operational parameters that slave WSDs must comply with for their transmissions in the UHF TV band for the purpose of association with a master WSD. For this, the WSDB will use the "TVWS availability data" obtained from Ofcom and the channel usage parameters received from the master WSD (see 1.8.5) to calculate the coverage area in which slave WSDs are likely to operate. It will then calculate the generic operational parameters that apply within the coverage

[3] This data indicates the maximum power that a WSD is permitted to radiate within each DTT channel, when the device is located in a particular geographic pixel.

area based on a number of *default* (conservative) device parameters. Note that at this stage no slave device parameters will be available at the master WSD or at the WSDB. This is because the slave WSDs will not have yet associated with the master WSD, and will not have had the opportunity to communicate their device parameters to the master WSD

1.11.3 The WSDB will communicate the generic operational parameters to the master WSD.

1.11.4 The master WSD must then *broadcast*[4] the generic operational parameters to slave WSDs within its coverage area. The broadcast parameters will correspond to the full set (or a subset) of the channels identified and communicated by the WSDB[5] (see 1.11.3).

1.11.5 Slave WSDs must comply with the broadcast parameters when they transmit in the UHF TV band for purposes of association with the master WSD.

A1.12 Slave WSDs which have already associated with a master WSD may continue to comply with the broadcast parameters for all subsequent transmissions, or alternatively, may request specific operational parameters in order to benefit from increased TVWS availability (see Phase (d)). The choice here is a matter for the device manufacturers.

Phase (c) – Association of a slave WSD with a serving master WSD

A1.13 This phase relates to the association of slave WSDs with master WSDs. Any slave WSD wishing to transmit in the UHF TV band, irrespective of whether association is performed over the UHF TV band or not, must undertake the steps described below:

1.13.1 A slave WSD must associate with a master WSD by submitting its device parameters to the serving master WSD. Where association is performed over the UHF TV band, a slave WSD must also submit its channel usage parameters[6] to the serving master WSD. The channels used will correspond to the full set (or a subset) of those included in the generic operational parameters broadcast by the master WSD (see 1.11.4).

1.13.2 Where association is performed over the UHF TV band, the slave WSD can submit its device parameters and channel usage parameters by transmitting in the UHF TV band according to its reported channel usage parameters.

1.13.3 The master WSD must forward the device parameters and (where association is performed over the UHF TV band) the channel usage parameters of its associated slave WSDs to the WSDB.

[4] The broadcast may be explicit or implicit. By explicit, we mean that the relevant information is explicitly signalled to the slave WSDs via a broadcast channel. By implicit, we mean that the relevant information is inferred by the slave WSDs by monitoring the master WSD transmissions.
[5] The master may not be able to, or may not be willing to, receive transmissions from slave WSDs in the whole raster of channels provided by the WSDB.
[6] Note that the submission of "channel usage parameters" only applies if association is performed over the UHF TV band, where the slave WSD is aware of "generic operational parameters" broadcast by the serving master WSD.

Phase (d) – Specific operational parameters for a slave WSD

A1.14 This phase relates to the generation and communication of specific operational parameters for individual slave WSDs.

A1.15 A slave WSD which associates with a master WSD over the UHF TV band need not undertake the steps described in A1.17 below unless it wishes to obtain specific operational parameters. This is because a slave WSD will have the option to continue using the generic operational parameters for its transmissions following association. Note that a slave WSD which complies with specific operational parameters is likely to benefit from increased TVWS availability, as compared to the case where it complies with generic operational parameters.

A1.16 However, a slave WSD which associates with a master WSD over a medium other than the UHF TV band must undertake the steps described in A1.17 below. This is because generic operational parameters do not apply in such circumstances, and special operational parameters are necessary.

A1.17 The sequence of events in this phase is as described below:

1.17.1 A slave WSD may contact its serving master WSD and request specific operational parameters for its transmissions. In such a case, the master WSD must forward this request to the WSDB. Alternatively, a master WSD may itself request specific operational parameters from the WSDB for the transmissions of the slave WSD. Whether the request for specific operational parameters is directly from the slave WSD or the master WSD, is a matter for the device manufacturer.

1.17.2 The WSDB will[7] generate specific operational parameters that the associated slave WSD must comply with for its transmissions in the UHF TV band. For this, the WSDB must use the "TVWS availability data" obtained from Ofcom, and the slave device parameters provided previously by the master WSD (see 1.13.3).

1.17.3 The WSDB will communicate the specific operational parameters for a slave WSD to the master WSD.

1.17.4 The master WSD must then communicate the specific operational parameters to the associated slave WSD. The communicated parameters will correspond to the full set (or a subset[8]) of the channels identified and communicated by the WSDB.

1.17.5 The slave WSD must respond to the master WSDB with its channel usage parameters, i.e., the channel(s) and radiated power(s) that it intends to use. The channels used will be the full set (or a subset[9]) of those included in the specific operational parameters that the slave WSD has received from the master WSD.

[7] Note that the WSDB is not obliged to generate "specific operational parameters". This is a commercial matter for the WSDB provider.
[8] It may be that the master WSD does not support some of the channels that the WSDB has identified as suitable for the slave WSD, or that its own resource management function limits the channels it can receive transmissions on.
[9] It may be that the slave WSD cannot use all the channels indicated by the master WSD.

1.17.6 The slave WSD can submit its channel usage parameters by transmitting in the UHF TV band according to its reported channel usage parameters.

A1.18 The master WSD must forward the channel usage information to the WSDB.

Annex 3

Contact details

A2.1 Please direct any enquiries to Siew Yoon Tan / Reza Karimi.

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Annex 4

Document history

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