

**NATIONAL COMMUNICATIONS
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**GUIDELINES FOR THE OPERATION OF
DATA SERVICES USING TELEVISION
WHITE SPACES (TVWS) IN GHANA**

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GUIDELINES FOR THE OPERATION OF DATA SERVICES USING TELEVISION WHITE SPACES (TVWS) IN GHANA

1. PURPOSE

This Guidelines will allow data radio transmitters to operate in the UHF band, which is allocated on a primary basis to broadcast television services, on frequencies and at locations where that spectrum is not assigned to licensed services, while protecting licensed television broadcasting users operating in these frequencies from receiving harmful interference.

2. DEFINITIONS AND ABBREVIATIONS

“Adjacent Channel Leakage Ratio (ACLR)” – The ratio of the in-band transmit power measured in an eight-megahertz (8 MHz) TV channel, to the out-of-band emission measured in 100 kHz in an adjacent TV channel.

“Altitude” – The height above the reference level defined by WGS84.

“Authentication” – The ability to verify that a message was truly sent by the asserted sender.

“Available channel” - A 8 MHz television channel in the UHF TV Band which is not being used by a licensed service at or near the same geographic location as the TVWS device and is acceptable for use by a device under the provisions of these technical rules.

“Client device” – See “Mode I Personal/Portable Device”

“Contact verification signal” – An encoded signal broadcast by a fixed or Mode II device for reception by Mode I devices to which the fixed or Mode II devices has provided a list of available channels for operation. A fixed or Mode II device shall provide the information needed by a Mode I device to decode the contact verification signal at the same time it provides the list of available channels.

“Device emission class” – The classification declared by the manufacturer that identifies the level of ACLR for the device

“ETSI” – European Technical Standards Institute

“ETSI EN 301 598” – The ETSI Harmonised European Standard for “White Space Devices (WSD); Wireless Access Systems operating in the 470 MHz to 790 MHz TV broadcast band; Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive”, final draft V1.0.9 (2014-02).

“Fixed device” – A TVWS device that transmits and/or receives communications at a specified fixed location and obtains information on available channels from a geo-location database. A fixed TVWS device is required to have an internal geo-location capability. A fixed TVWS device may initiate and operate a network by sending enabling signals to one or more fixed TVWS devices and/or personal/portable TVWS devices.

“Geo-location capability” – The capability of a TVWS device to determine and report the latitude, longitude and altitude coordinates of its antenna.

“Geo-location uncertainty” – The positioning error in all three dimensions defined by the difference in meters between the point reported by the TVWS device to the database and the actual position of the TVWS antenna.

“Integral antenna” – The antenna designed as a fixed part of the equipment, without the use of an external connector, which cannot be disconnected from the equipment by a user with the intent to connect another antenna. An integral antenna may be fitted internally or externally. In the case where the antenna is external, a non-detachable cable can be used.

“Master device” – is a fixed or Mode II personal/portable device that uses a geo-location capability and access to a geolocation database, either through a direct connection to the Internet or through an indirect connection to the Internet by connecting to another master device, to obtain a list of available frequencies.

“Mobile TVWS device” – A TVWS device that transmits and receives communications while moving or from different unspecified fixed points that may change.

“Mode I device” – A personal / portable device that does not have an internal geolocation capability and does not directly access a TVWS database to obtain a list of available white space channels. Rather it obtains this information from a fixed or Mode II device. A Mode I device shall not initiate a network of white space devices nor provide a list of available white space channels to another Mode I device.

“Mode II device” – A personal / portable device that uses an internal geo-location capability to access a TVWS database either directly or through another mode II device.

“Network initiation” – The process by which a fixed or Mode II device sends control signals to one or more fixed or personal / portable devices and allows them to begin communications.

“Operating channel” - An available channel used by a TVWS device for transmission and/or reception.

“Out-of-block-emissions” – Unwanted emissions that fall within the 470 MHz to 694 MHz band.

“Personal / portable device” - A mobile TVWS device with an integral antenna that can be carried by the user.

“Primary basis” – The primary service, which is the main service allocated to a specific band in the national frequency allocation table for a particular region or country, has priority over all other users of the spectrum band.

“Sleep Mode” – This is a mode in which the device is inactive but is not powered-down.

“Time validity” – The period of time when a set of operational parameters provided by the geo-location database to a fixed or Mode II device is in force.

“TV” - Television

“TV White Spaces (TVWS)” – Frequencies within the 470 MHz to 694 MHz band which have been identified by a TVWS database for use by a TVWS device.

“TVWS database”- A database system approved by NCA that maintains records of all authorised services in the UHF band, can communicate with fixed and Mode II devices, and is capable of determining the available channels and power levels for such devices at a specific geographic location.

“TVWS device” - Radio equipment that operates in the TV white spaces of the UHF TV band.

“Ultra-High Frequency (UHF) TV band” The frequency band from 470 – 694 MHz

3. PERMITTED CHANNELS OF OPERATION

3.1. TVWS devices are allowed to operate in the UHF Band IV (470-528 MHz) and Band V (528-694 MHz) that are allocated on a primary basis to broadcast television services, subject to the interference protection requirements set forth in these technical rules and regulations.

3.2 TVWS devices shall operate on available frequencies determined in accordance with the interference avoidance mechanisms in Section 9.

3.3 TVWS devices shall not operate on a co-channel basis with broadcast television stations in the same region if the TVWS database indicates that the channel is not available for use in that region.

3.4 Client TVWS devices shall only operate on available frequencies determined by Master TVWS device.

4. LICENSING FRAMEWORK FOR TVWS SERVICES

4.1 TVWS Data Services will be treated as an Internet/Public Data Service with its attendant regulatory fees. The spectrum charge will be the same as for an ISM (Industrial, Scientific and Medical) assignment.

5. RADIATED POWER LIMITS

5.1 A TVWS device depending on the geo-location and database method of determining channel availability may be required to operate at lower power than the maximum permitted in order to meet the co-channel and adjacent channel separation requirements.

5.2 Fixed devices – Up to 4 W (36 dBm) EIRP within the six metropolitan districts and up to 10 W (40 dBm) ERP elsewhere, contingent on meeting the co-channel and adjacent channel separation distances required to protect licensed broadcast TV operations and other licensed users at that location.

5.3 Personal / portable devices – Up to 100 mW (20 dBm) EIRP, contingent on meeting the co-channel and adjacent channel separation distances required to protect licensed broadcast TV operations and other licensed users at that location.

6. CONDUCTED POWER LIMITS

6.1 Transmitted Power Control – A TVWS device shall incorporate transmit power control to limit its operating power to the minimum necessary for a successful communication to be completed.

6.2 Fixed Device – The maximum conducted power is 1 W (30 dBm) EIRP and the conducted power spectral density limit at the maximum conducted power level is 17.0 dBm EIRP as measured within any 100 kHz frequency block within the channel.

6.3 Personal / Portable Device – The maximum conducted power is 100 mW EIRP and the conducted power spectral density limit at the maximum conducted power level is 1.0 dBm EIRP as measured within any 100 kHz frequency block within the channel.

7. OUT OF BLOCK EMISSIONS LIMITS

7.1 TVWS Operating Channel Immediately Adjacent to a Protected Broadcast TV Channel

7.1.1 In the television channels immediately adjacent to the channel in which the TVWS device is operating, out-of-block-emissions from TVWS devices relying on the geo-location and database techniques of determining channel availability shall be based on the ACLR established for the TVWS device emission classes described in Section 4.2.4.2 of ETSI EN 301 598.

7.1.2 ACLR for TVWS Operations on the First Adjacent Channel

<u>Device Emission Class</u>	<u>ACLR (dB)</u>
Class 1	74
Class 2	74
Class 3	64
Class 4	54
Class 5	43

7.1.3 Out of block (OOB) EIRP spectral density limit – As measured in the first 100 kHz beyond the channel edge, the OOB is the greater of the measured in-block conducted power spectral density over 8 MHz (P_{IB}) minus the ACLR or -84 dBm. The equation is:

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

7.2 TVWS Operating Channel not immediately adjacent to a Protected Broadcast TV Channel

7.2.1 At frequencies beyond 8 MHz from the protected broadcast TV Channel, TVWS device's field strength must be no greater than 200 microvolts per meter as measured from a distance of 3 meters away.

7.3 TVWS Operations Near International Borders

7.3.1. TVWS devices will have to operate in a manner that will not cause harmful interference to broadcasting and other services in the neighboring countries. All signals propagated from a TVWS device reaching the Ghana borders will be at the noise floor level of -115 dBm.

8. ANTENNA REQUIREMENTS AND LIMITS

8.1 Fixed Devices

8.1.1 Fixed devices must be professionally installed.

8.1.2 The TVWS device shall automatically store its antenna height at the time of installation, first power on, and at any time after it is relocated.

8.1.3 The transmit antenna height shall not exceed 30 meters above ground level and shall not be located where the height above average terrain, as calculated by the TVWS database, is greater than 250 meters.

8.1.4 The maximum radiated power of 4 W (36 dB) EIRP in the six metropolitan districts can be achieved using any combination of conducted power levels up to 1 W (30 dB) EIRP and antenna with the corresponding gain, after compensation for cable and other loss mechanisms.

8.1.5 The maximum radiated power of 10 W ERP in rural areas can be achieved using 1 W EIRP conducted power combined with a 10 dBi gain antenna, after compensating for cable and other loss mechanisms.

8.2 Personal/Portable Devices

- 8.2.1 The transmit antenna of a personal/portable device shall have permanently attached or integral transmit and receive antenna(s).
- 8.2.2 The antenna height of a personal/portable device shall be taken by the white spaces database as 1.5 meters above ground level, unless the TVWS device notifies the databases otherwise.
- 8.2.3 If the personal/portable device does report its height information, and that height is more than 2.0 meters above ground, the device is presumed to be operating in-doors, and an additional 7 dB of power may be permitted to compensate for building loss.

9. INTERFERENCE AVOIDANCE

9.1 GEO-LOCATION REQUIRED

9.1.1 TVWS devices shall rely on a geo-location capability and database access mechanisms to protect television broadcasters and other authorised services operating in UHF Bands IV and V.

9.2 GEO-LOCATION REQUIREMENTS OF FIXED DEVICES

9.2.1 Each fixed device must be registered with a TVWS database provider at the time of installation and prior to first activation.

9.2.2 The geographic coordinates of a fixed device shall be determined to an accuracy of ± 50 meters by means of an automated internal geolocation capability. The geographic coordinates and antenna height above ground level of a fixed device shall be determined at the time of installation and first activation from a power-off condition, and this information shall be stored by the device.

9.2.3 If the fixed device is moved to another location or if its stored coordinates become altered, the operator shall re-establish the device's geographic location by means of an automated internal geolocation capability.

9.2.4 A fixed device will query an authorized geo-location TVWS database over the Internet with its operating location (coordinates in longitude and latitude), altitude of its transmitting

antenna, device emission class, and geo-location uncertainty prior to its initial service transmission at a given location. In addition to the above information, the device must provide:

- a) The unique TVWS device Identifier
- b) The name of the individual or business that is responsible for the TVWS device
- c) Name, address, email and phone number of the contact person responsible for the TVWS device's operation

9.2.5 Operation is permitted only on channels and at power levels that are indicated in the database as being available for fixed devices. Operation on a channel must cease immediately or the power must be reduced to a permissible level if the database indicates that the channel is no longer available at the current operating level.

9.3 GEO-LOCATION REQUIREMENT FOR MODE II DEVICES

9.3.1 A Mode II master device shall use automated geolocation to determine its location. The device shall report its geographic coordinates as well as the accuracy of its geolocation capability (e.g., +/- 50 meters, +/- 100 meters) to the database.

9.3.2 A Mode II master device must also re-establish its position each time it is activated from a power-off condition and use its geolocation capability to check its location at least once every 60 seconds while in operation, except while in sleep mode, i.e., a mode in which the device is inactive but not powered down.

9.3.3 A Mode II master device will query an authorised geo-location TVWS database over the Internet with its operating location (coordinates in longitude and latitude), device emission class, geo-location uncertainty prior to its initial service transmission at a given location. It may report its height information.

9.3.4 Operation is permitted only on channels and at power levels that are indicated in the database as being available for the Mode II master device. Operation on a channel must cease immediately or power must be reduced to a permissible level if the database indicates that the channel is no longer available at the current operating level.

9.4 GEO-LOCATION REQUIREMENT FOR MODE I DEVICES

9.4.1 A Mode I device may only transmit upon receiving a list of available channels from a fixed or Mode II device. A fixed or Mode I device may provide a Mode I device with a list of available channels only after it contacts its database, provides the white space database with the NCA Identifier of the Mode I device requesting available channels, and receives verification from the white space database that the NCA Identifier is valid for operation.

9.4.2 A Mode II device must provide a list of channels to the Mode I device that is the same as the list of channels available to the Mode II personal / portable TVWS device. A Mode I device shall not operate at a conducted power level greater than that of the Mode II device that provides it the list of available channels at that location.

9.4.3 A fixed device may provide a list of available channels to a Mode I device only if the device altitude as verified by the white space database does not exceed any height restriction put in place by NCA. The fixed device must provide a list of all available channels to the Mode I device.

9.4.4 To initiate contact with a fixed Mode II device, a Mode I device may transmit on an available channel used by a fixed or Mode II device.

9.5 FREQUENCY OF DATABASE ACCESS

9.5.1. Fixed device – Each fixed device shall access the database at least once every twelve (12) hours to verify that the operating channels continue to remain available. Each fixed device must adjust its use of channels accordingly. A fixed device can only operate after it has successfully queried an authorised geo-location database and has received channel availability and maximum transmission power information from it. Alternatively, the TVWS database can provide the fixed device a time validity for the operation of the channel.

9.5.2 Mode II device

9.5.2.1 The location of a Mode II device must be checked at least once every 60 seconds while in operation, except while in sleep mode.

9.5.2.2 A Mode II device that has been in a powered state shall re-check its location and access the database every twelve (12) hours to verify that the operating channel(s) and corresponding levels continue to be available. A Mode II device must adjust its use of channels and power levels accordingly. Alternatively, the white space database can provide the Mode II device a time validity for the operation of the channel.

9.5.3 Mode I personal / portable TVWS device – Except while in sleep mode, a Mode I personal /portable device must either receive a contact verification signal from the Mode II or fixed TVWS device that provided its current list of available channels or contact a Mode II or fixed device to re-verify / re-establish channel availability at least once every 60 seconds.

9.5.4 Continuing operations

9.5.4.1 If a fixed or Mode II device fails to successfully contact the white space database during any given 12-hour period, it may continue to operate until 11:59 pm of the following day at which time it must cease operations until it re-establishes contact with the white space database and re-verifies its list of available channels.

9.5.4.2 Mode I device – A Mode I device must cease operation immediately if it does not receive a contact verification signal or is not able to re-establish a list of available channels through contact with a fixed or Mode II device within 60 seconds of last contact. The Mode I device must then re-initiate contact.

9.6 GEOLOCATION DATABASE SECURITY MECHANISMS

9.6.1. Communications security and authentication procedures shall be instituted to ensure that geo-location databases are protected from unauthorised data input or alteration of stored data.

9.6.2. Communications between the database and TVWS devices shall be secured in a manner to prevent unauthorised parties from accessing information during transit.

9.6.3 TVWS devices shall incorporate adequate security measures to prevent the devices from accessing databases not approved by NCA.

10. INFORMATION DISPLAY REQUIREMENTS

10.1 Display of available channels – A TVWS device must incorporate the capability to display a list of available channels and its operating channel

10.2 Labeling Requirements – TVWS device shall bear the following statement in conspicuous location on the device:

“This device complies with all applicable NCA Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

10.3 Instructions to User Regarding Correction of Harmful Interference

10.3.1 The text of the TVWS user manual regardless of the form it is provided in (paper, computer disk, on-line) shall include the following statement placed in a prominent location within the manual

“This equipment has been tested and found to comply with the technical rules and regulations for TVWS devices, consistent with all applicable NCA regulations.

These rules have been formulated to furnish reasonable protection against harmful interference. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- (1) Reorient or relocate the receiving antenna.
- (2) Increase the separation between the equipment and the receiver.
- (3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

(4) Consult the manufacturer, dealer or an experienced radio / TV technician for help.

10.4 Compliance with radio frequency exposure requirements

10.4.1 Fixed Devices – A fixed device shall be accompanied by instructions on measures to take to ensure that persons maintain a distance of at least 40 cm from the device, as well as any necessary hardware that may be needed to implement that protection. These instructions shall be displayed in all formats of the user manual.

11. SPECTRUM SENSING IN THE BROADCAST TELEVISION FREQUENCY BANDS

TVWS Master Devices that rely on spectrum sensing must implement the following requirements:

- 11.1 Channel Selection: The device will scan the UHF Bands IV and V and only select a second adjacent channel from an occupied TV channel.
- 11.2 Frequency availability check time: The device may start operating on a frequency channel selected in (1) above if no TV signals above the detection threshold are detected within a minimum time interval of 30 seconds.
- 11.3 In-service monitoring: The device must perform in-service monitoring of the frequencies it uses at least once every 60 seconds.
- 11.4 Frequency move-time: After a TV signal is detected on a frequency channel used by the TVWS device, all transmissions by the TVWS device must cease within 2 seconds.
- 11.5 A TVWS service provider using spectrum sensing should submit a quarterly report on spectrum usage to the National Communications Authority.