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Title: White Space Test Procedures

Short Title: White Space Test Procedures

Reason: REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING FCC 20-156 FCC 20-156

Publication 416721

Keyword/Subject: Part 15 Subpart H, White Space, Certification Test Procedures

First Category: Unlicensed Service Rules and Procedures

Second Category: General Part 15 Transmitters (UnLic)

Question: What are the test procedures for certifying equipment to operate under the Part 15 Subpart H, White Space rules?

Answer: Test procedures for White Space devices are contained in the attached document 416721 D01 White Space Test Procedures v04 below.

Attachment List:

416721 D01 White Space Test Procedures v04

Note: Applicants may use this draft to obtain a certification until the time when the document "416721 D01 White Space Test Procedures v04" becomes published.

416721 D01 White Space Test Procedures v04

Office of Engineering and Technology
Laboratory Division

CERTIFICATION TEST PROCEDURES FOR WHITE SPACE DEVICES AUTHORIZED UNDER SUBPART H OF THE PART 15 RULES

TABLE OF CONTENTS

I. Introduction to White Space Devices
II. EMC Measurement Procedures
III. Database Interaction Verification

Appendixes: Guides for Certification

A. 731-application guide by rule and equipment Class for Part 15 Subpart H - White Space devices,
B. Tables 1 of §15.709 (b)(1)(iii) and Table 2 of §15.709 (b) (2) (ii) from the rules, provided for reference.
C. §15.709 (j) Guide to the Security operational description required for certification application for all White Space devices.
D. §15.717 Required procedure for certification applications for spectrum sensing devices.
E. §15.707 Permissible bands of operation for White Space devices by equipment class.

I. Introduction to White Space devices

1. Background

Part 15 Subpart H of the Commission's rules governs the use of White Space devices, which are used to provide unlicensed wireless services over spectrum in the television (TV) broadcasting bands and in portions of the 600 MHz band that was formerly used for TV broadcasting. In October 2020, the Commission revised its rules to increase the maximum permissible power and antenna height for fixed White Space devices operating in "less congested[1]" areas (generally rural and unserved areas) with additional requirements to ensure that broadcast television stations are protected from harmful interference, to provide for higher power mobile operations using White Space devices in "less congested" areas within defined geo-fenced areas, such as school bus routes or farm boundaries, and to permit greater use of narrowband White Space devices that can be used for Internet of Things (IoT) applications.[2]

2. White Space devices

This publication guides equipment authorization applications under the certification procedure of Part 2 Subpart J for White Space devices designed to operate under the Part 15 Subpart H rules. These devices can be permitted to

[1] §15.703 Geographic areas where at least half of the TV channels within a specific TV band are unused for broadcast and other protected services and available for white space device use. Less congested areas are determined separately for each TV band—the low VHF band (channels 2-6), the high VHF band (channels 7-13) and the UHF band (channels 14-36); i.e., one, two or all three bands or any combination could qualify as less congested. White space devices may only operate at the levels permitted for less congested areas within the area and the specific TV band(s) that qualify as a less congested area. For the purpose of this definition, a channel is considered available for white space device use if it is available for fixed devices operating with 40 milliwatts EIRP at 3 meters HAAT. Less congested areas in the UHF TV band are also considered to be less congested areas in the 600 MHz service band. Note that throughout this document the term less congested will be used as defined by this note.

[2] Unlicensed White Space Device Operations in the Television Bands, *Report and Order and Further Notice of Proposed Rulemaking*, ET Docket No. 20-36, FCC 20-156 (2021) FCC 20-156. Effective 03/29/2021.

operate in areas where spectrum is not being used by TV channels 2 to 36 (54-608 MHz) as well as in channel 37 (608-614 MHz) and portions of the 600 MHz band (614-698 MHz).

A White Space device must (1) be authorized to use TV channel bandwidth by an Internet connection to a real-time database system that has been approved by the FCC; or (2) operate as a Low Power (50 mw) device that scans and senses unused channels.

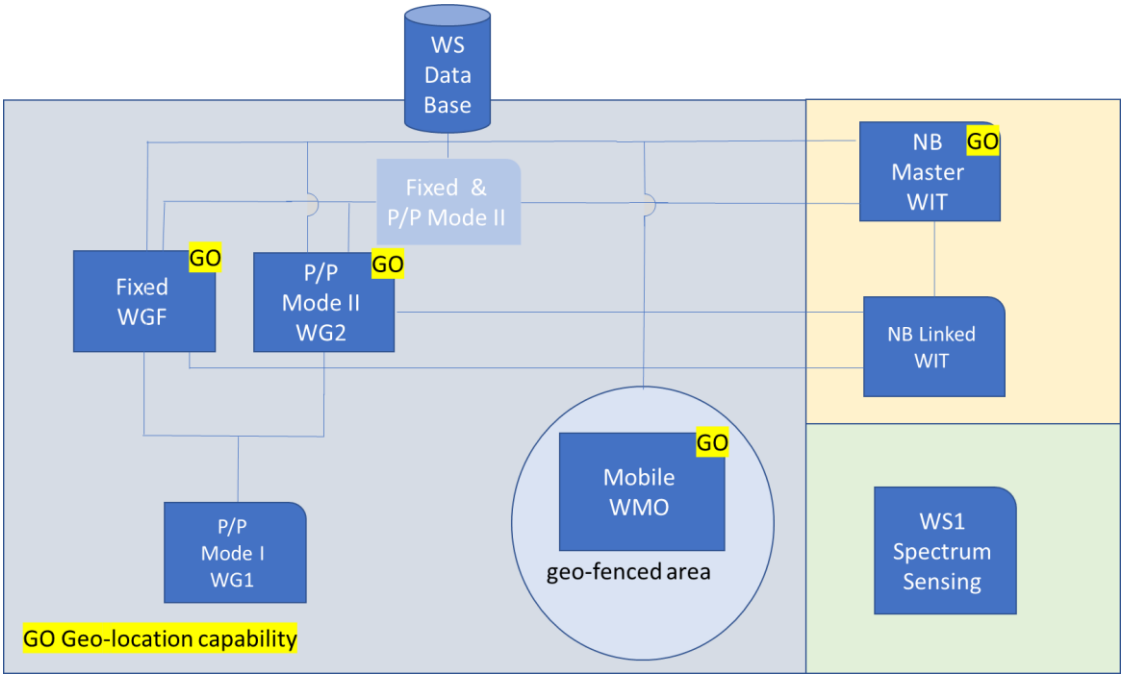

Figure 1 White Space Device Types

The types of White Space devices are illustrated in Figure 1 and are identified as follows:

Fixed (Equipment Class WGF) devices are fixed form factor[3] type devices and must incorporate a geo-location capability and a means to access a database directly through the Internet or through other fixed devices or Personal/Portable Mode II device to obtain an available channel. Fixed WGF devices must obtain a list of available channels and re-check channel availability with the White Space database at least once every day. Fixed White Space devices must be a type that is permanently mounted.

Personal/Portable (P/P) Mode II (Equipment Class WG2) devices must incorporate a geo-location capability and a means to access a database directly through the Internet or through a fixed or other Mode II device to obtain an available channel. Devices must obtain a list of available channels and communicate with the White Space database.

Personal/Portable (P/P) Mode I (Equipment class WG1) devices must obtain their operating channel from a fixed or Personal/Portable Mode II device.

Mobile[4] (Equipment class WMO) devices must incorporate a geo-location capability or can obtain their coordinates from an external geo-location unit on the same platform as the device. They must also incorporate a means to access a database through the Internet that provides a list of channels available to the mobile device at all points within the geo-fenced area and must re-check the database at least once a day to verify that the operating channels within the geo-fenced area continue to remain available. A mobile device must re-check its location every 60 seconds and automatically shut down when it comes within 1.9 kilometers of the geo-fenced boundary.

[3] A device designed to operate at a fixed location permanently mounted.

[4] A device that is ordinarily intended to operate while moving.

Spectrum Sensing Low Power (Equipment Class WS1) devices are low-power personal/portable (p/p) White Space devices (limited to 50 mw) that monitor TV channels 21-36 to detect whether the channel is occupied to obtain an available channel.

Narrowband White Space (Equipment Class WIT) devices **may be either fixed or personal/portable devices and** are divided into two types:

- A **Master device** must incorporate a geo-location capability and a means to access a database directly or through a fixed or other Mode II device to obtain a list of available TV channels.
- A **Client device** must select from a list of available TV channels from a master device, fixed (WGF) device or Personal/Portable Mode II (WS2) device.

3. Frequency Bands

White Space devices operate on TV channels 2-36 (54-608 MHz),[5] channel 37 (608-614 MHz), and in the 600 MHz band (614-698 MHz), excluding the 614-617 MHz Guard band (but including the 657-663 MHz portion of the Duplex Gap)[6].

The frequency range a device depends on the equipment class and power permitted (ERIP) as illustrated in Tables 1(a) and (b), below.

Table 1(a) White Space Frequency Bands (54-608 MHz)

Equip Class	Type	Channel Access	Ch	2-4	5 & 6	7-13	14-20	21-35	36
			MHz	54-72	76-88	174-216	470-512	512 -602	602 -608
WGF	Fixed Devices	Database (DB) or Fixed or P/P Mode II		4 W & 16[7] W	4 W & 16[8] W	4 W & 16[9] W	4 W & 16[10] W	4 W & 16[11] W	4 W
WG2	Personal/Portable (P/P) Mode II	DB or Fixed or P/P Mode II					100 mw	100 mw	100 mw
WG1	Personal/Portable (P/P) Mode I	linked to fixed or P/P Mode II					100 mw	100 mw	100 mw
WMO	Mobile[12]	DB		16 w	16 w	16 w	16 w	16 w	
WS1	Spectrum sensing	Sensing						50 mw	50 mw
WIT	Narrowband Master	DB or Fixed or P/P Mode II		18.6 dBm	18.6 dBm	18.6 dBm	18.6 dBm	18.6 dBm	
	Narrowband Client	Narrow-band Master		18.6 dBm	18.6 dBm	18.6 dBm	18.6 dBm	18.6 dBm	

[5] As part of the broadcast spectrum incentive auction, the Commission reassigned TV stations to new channels. Operations on channels 38-51 have been reassigned ("repacked") to channels below 37. This action was completed on July 13, 2020. *See* https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions/transition-schedule.

[6] See Appendix E for permissible channels and equipment class.

[7] 16 or 10 watts as indicated for limit in less congested areas:

[8] 16 or 10 watts as indicated for limit in less congested areas:

[9] 16 or 10 watts as indicated for limit in less congested areas:

[10] 16 or 10 watts as indicated for limit in less congested areas:

[11] 16 or 10 watts as indicated for limit in less congested areas:

[12] Mobile devices may only operate in less congested areas; see footnote 1.

Table 1(b) White Space Frequency Bands (608-698 MHz)

Equip Class	Type	Channel Access	Ch	37	Guard Band	600 Band		Duplex Gap[13]		600 Band
			MHz	608-614	614-617[14]	617-620	620-652	652-657	657-663	663-698
WGF	Fixed Devices	Database WGF WG2		40 mw	Prohibited	4 W	4 &10[15] W	Not Permitted	40 mw	4 & 10[16] W
WG2	Personal/ Portable (P/P) Mode II	Database WGF WG2		40 mw		100 mw	100 mw		40 mw	100 mw
WG1	Personal/ Portable (P/P) Mode I	Linked to WGF WG2		40 mw		100 mw	100 mw		40 mw	100 mw
WMO	Mobile	DB								
WS1	Spectrum sensing	Sensing								
WIT	Narrowband Master	Database WGF WG2I								
	Narrowband Client	Linked to WIT master WGF WG2								

4. Application for Certification.

This publication is not intended to be all-inclusive and substitute for the rules. It is intended to aid the certification process in accordance with §2.1033 Application for certification. Applications shall always primarily refer to the actual e-CFR[17] published rules along with this guide. The Appendices to this document provide additional help in filing form 731 certification applications, with references to rules, associated equipment classes, and the exhibits for application filing.

- Appendix A, Tables A2-A13 are references by key rule parts, equipment classes, and 731 exhibits.
- Appendix B provides for reference the tables of the technical limits of §15.709 (b)(1)(iii) and Table 2 of § 15.709 (b) (2) (ii).
- Appendix C: White Space devices are required by §15.709 (j) to incorporate adequate security measures and applicants must file security operational descriptions. Appendix C provides a step-by-step guide for the high-level operational security description required to be filed with the application.

[13] §15.707 (a) (2) limits: Fixed and personal/portable white space devices may operate in the 657-663 MHz segment of the 600 MHz duplex gap.

[14] §15.707 (4) White space devices are not permitted to operate in the band 614-617 MHz

[15] 16- or 10-watts limit as indicated for less congested areas:

[16] 16- or 10-watts limit as indicated for less congested areas: :

[17] https://www.ecfr.gov/cgi-bin/text-idx?SID=e7d8fb6bf845a30945daa6a264796667&mc=true&node=sp47.1.15.h&rgn=div6

- Appendix D describes certification application procedures for spectrum sensing devices (WS1). Under §15.717, WS1 devices require a pre-approval process involving a public notice and Commission confirmation testing.
- Appendix E permissible bands (§15.707) for White Space devices and equipment classes.

II. EMC Measurement procedures

The compliance tests described below can be performed on a stand-alone White Space device (i.e., without accessing a White Space database).

1. Test Mode Requirements for all Devices

To perform many of the certification compliance tests described in this document, a test mode accessible by test personnel (but not end-use customers) must be incorporated into a White Space device submitted for evaluation. This test mode must at a minimum provide:

a) The ability for the test personnel to compel the device-under-test (DUT) to operate on their selected channel.

b) The ability for the test personnel to vary the device output power from the minimum to the maximum realizable levels.

c) The ability of the device to continuously transmit a modulated signal (i.e., with no time bursting or signal gating applied).

2. Procedures Requirements

a) §15.706 Information to the user

i. Visually verify adherence to the labeling requirements specified in §15.19.

ii. Visually verify that the required statement, specified in §15.706(a), is included in the White Space device user manual.

b) §15.707 Permissible channels of operation

i. Verify that the DUT cannot be tuned to operate on unauthorized channels, based upon device type: fixed, Personal/Portable (Mode I or II), mobile, spectrum sensing, or narrowband, or on frequencies outside of the authorized band(s).

c) §15.709 Power Limits

i. **WGF** Fixed White Space devices

The basic power limits for a fixed White Space device are specified in terms of EIRP. Additional limits on conducted power and power spectral density for a fixed White Space device are specified in §15.709(b)(1)(iii).

The following paragraphs recommend spectrum analyzer (with signal processing capability) settings and procedures for performing the conducted power measurement:

1. Connect a patch cable of known attenuation (at the specific frequencies under consideration) between the antenna port of the DUT and a spectrum analyzer. For a fixed White Space device, it may be necessary to insert an external attenuator in the signal path to prevent overload damage to the analyzer.
2. Select the analyzer's power averaging (RMS) detector, a span of 10-MHz, a resolution bandwidth (RBW) of 100-kHz, a video bandwidth of 300 kHz, and a sweep speed that provides one millisecond per trace point integration time.
3. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel under investigation, as required by §15.709(c). Low, middle, and high channels within tuning range must be examined.
4. Employ trace averaging over a minimum of 100 traces.

5. Use the integrated band/channel power analyzer function to determine the average power within the 6-MHz channel bandwidth.
6. Use the peak marker function to determine the maximum power spectral density (PSD) in any 100 kHz band segment.
7. Make the necessary corrections to the measured amplitude levels to account for externalities inserted into the signal path (e.g., signal attenuation in patch cable and/or external attenuator). Record the adjusted amplitude levels as the power levels measured for power and PSD in 6-MHz and 100-kHz band, respectively.
8. If the device has multiple antenna ports, power must be summed across all antennas and antenna elements (§15.709(c)(2))
9. Compare the total conducted power levels and PSDs to the applicable conducted power and PSD limits to assess compliance. Add the necessary antenna gain of the DUT to determine EIRP levels.
10. Repeat until data is accumulated for the low, middle and high channels in the DUT tuning range.

The maximum gain of the transmitting antenna used with a Fixed White Space device must be declared by the manufacturer in the certification application. If the transmitting antenna gain exceeds 6 dBi for fixed White Space device operating at up to 36 dBm EIRP or exceeds 12 dBi for fixed White Space device operating at greater than 36 dBm EIRP, then the conducted output power, power spectral density, band edge emissions, and adjacent channel emissions limits shall all be reduced by the amount in dB by which the gain exceeds 6 dBi or 12 dBi, respectively.[18] The documentation filed with certification application must describe how this power level is controlled and compliance with limits ensured. For devices utilizing multiple antennas the appropriate antenna gain should be determined using KDB Publication 662911.

ii. **WG1 & WG2** Personal/Portable White Space devices and WS1 sensing devices

The basic power limits for Personal/Portable White Space devices are specified as radiated EIRP. Limits on power, power spectral density, and adjacent channel emissions are specified in §15.709(b)(2)(ii) and §15.709(b)(3).

The DUT must have an integrated antenna, and radiated measurements may be performed following ANSI C63.10.

1. Connect a patch cable of known attenuation (in the specific frequency range under consideration) between a measurement antenna of known receive gain and a spectrum analyzer.
2. Select the analyzer's power averaging (RMS) detector, a span of 10-MHz, a resolution bandwidth (RBW) of 100-kHz, a video bandwidth of 300-kHz, and a sweep speed that provides one millisecond per trace point integration time.
3. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel under investigation, as required by §15.709(c). Low, middle, and high channels within tuning range must be examined.
4. Employ trace averaging over a minimum of 100 traces.
5. Use the integrated band/channel power analyzer function to determine the average amplitude over the 6 MHz channel bandwidth.
6. Use the peak marker function to determine the maximum PSD in any 100 kHz band segment.
7. Make the necessary corrections to the measured amplitude levels to account for externalities inserted into the signal path (*e.g.*, signal attenuation in patch cable and the measurement antenna gain). Record the adjusted amplitude levels as the power levels measured for power and PSD in 6-MHz and 100-kHz band, respectively.

[18] As specified in §15.709(a)(2)(i)(B), fixed devices operating in the 600 MHz service bands in less congested areas are limited to a maximum EIRP of 40 dBm.

8. Determine the associated EIRP levels by adding antenna gain to conducted measurements.
9. Compare the EIRP levels to the applicable EIRP limits to assess compliance.
10. Repeat until data is accumulated for the low, middle, and high channels in the DUT tuning range.

All the transmit/receive antennas on a Personal/Portable White Space device shall be examined to verify that they are permanently attached to the DUT.

iii. **WMO** Mobile White Space devices

The basic power limits are specified in terms of EIRP. Additional limits on conducted power and power spectral density for fixed White Space devices are specified in §15.709(b)(1)(iii).

The following paragraphs recommend spectrum analyzer (with signal-processing capability) settings and procedures for performing the conducted power measurement:

Connect a patch cable of known attenuation (at the specific frequencies under consideration) between the antenna port of the DUT and a spectrum analyzer.

1. For a Mobile White Space device, it may be necessary to insert an external attenuator in the signal path to prevent overload damage to the analyzer.
2. Select the analyzer's power averaging (RMS) detector, a span of 10 MHz, a resolution bandwidth (RBW) of 100 kHz, a video bandwidth of 300-kHz, and a sweep speed that provides one millisecond per trace point integration time.
3. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel under investigation, as required by §15.709(c). Low, middle, and high channels within tuning range must be examined.
4. Employ trace averaging over a minimum of 100 traces.
5. Use the integrated band/channel power analyzer function to determine the average power within the 6-MHz channel bandwidth.
6. Use the peak marker function to determine the maximum PSD in any 100-kHz band segment.
7. Make the necessary corrections to the measured amplitude levels to account for externalities inserted into the signal path (*e.g.*, signal attenuation in patch cable and/or external attenuator). Record the adjusted amplitude levels as the power levels measured for power and PSD in 6-MHz and 100-kHz band, respectively.
8. If the device has multiple antenna ports, power must be summed across all antennas and antenna elements (§15.709(c)(2))
9. Compare the total conducted power levels and PSDs to the applicable conducted power and PSD limits to assess compliance. Add the necessary antenna gain of the DUT to determine EIRP levels.
10. Repeat until data is accumulated for the low, middle and high channels in the DUT tuning range.

iv. **WIT** Narrowband White Space devices

1. Connect a patch cable of known attenuation (in the specific frequency range under consideration) between a measurement antenna of known receive gain and a spectrum analyzer.
2. Select the analyzer's power averaging (RMS) detector, a span of 200 kHz, a resolution bandwidth (RBW) of 100-kHz, a video bandwidth of 300-kHz and a sweep speed that provides one millisecond per trace point integration time.
3. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel under investigation, as required by §15.709(c). Low, middle, and high channels within tuning range must be examined.
4. Employ trace averaging over a minimum of 100 traces.
5. Use the integrated band/channel power analyzer function to determine the average power over the 100 kHz channel bandwidth.

6. Use the peak marker function to determine the maximum PSD in any 100 kHz band segment.
7. Compare the measured values to the applicable limits to assess compliance.
8. Repeat until data is accumulated for the low, middle, and high channels in the DUT tuning range.

d) §15.709 Bandwidth

Set the analyzer as follows for measuring 99% BW:

1. Set RBW to 1-5 % of OBW
2. Set the VBW ≥ [3 × RBW].
3. Detector = peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Use instrument 99% BW function to measure BW.

e) §15.709 Emission Limits

The out-of-band emission limits for fixed, mobile and personal/portable White Space devices, applicable both at the band-edges and in the adjacent channels (both lower and upper), are provided in the following tables:

Fixed and Mobile White Space devices:

EIRP (6 MHz)	**Conducted power limit (6 MHz)**	**Conducted PSD limit (100 kHz)[19]**	**Conducted adjacent channel emission limit (100 kHz)**
16 dBm (40 mw)	10 dBm (10 mw)	-7.4 dBm	-62.8 dBm
20 dBm (100 mw)	14 dBm (25 mw)	-3.4 dBm	-58.8 dBm
24 dBm (250 mw)	18 dBm (63 mw)	0.6 dBm	-54.8 dBm
28 dBm (625 mw)	22 dBm (158 mw)	4.6 dBm	-50.8 dBm
32 dBm (1600 mw)	26 dBm (400 mw)	8.6 dBm	-46.8 dBm
36 dBm (4000 mw)	30 dBm (1000 mw)	12.6 dBm	-42.8 dBm
40 dBm (10000 mw)	30 dBm (1000 mw)	12.6 dBm	-42.8 dBm
42 dBm (16,000 mw)	30 dBm (1000 mw)	12.6 dBm	-42.8 dBm

[19] See §15.709(b)(1)(ii) for a note on fixed White Space devices operating at 40 mw.

Personal/Portable White Space devices:

EIRP (6 MHz)	Radiated PSD limit EIRP (100 kHz)[20]	Radiated adjacent channel emission limit EIRP (100 kHz)
16 dBm (40 mw)	-1.4 dBm	-56.8 dBm
20 dBm (100 mw)	2.6 dBm	-52.8 dBm

Narrowband White Space devices:

Conducted power limit (100 kHz)	Conducted PSD limit (100 kHz)	Conducted adjacent channel emission limit (100 kHz)
12.6 dBm	12.6 dBm	-42.8 dBm

Check that the reported DUT transmit antenna gain complies with §15.709(c). If required, reduce the band-edge and adjacent channel limits by the amount in dB that the transmit antenna gain exceeds 6 dBi.

As with the power measurements, the preferred methodology for determining the maximum band edge and adjacent channel emission power is to use a conducted measurement procedure; however, in those cases where there is no accessible antenna port for accommodating conducted measurements, a radiated measurement procedure can be used (see ANSI C63.10 for guidance). Out-of-band emission measurements are to be made with the DUT activated in the test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel to be investigated. For band edge, adjacent channel, and beyond adjacent channel measurements, the low, middle, and high channels of the DUT's tuning range must be tested. The DUT shall meet the above limits at all power levels. To meet this requirement testing at the highest power level is sufficient for the EMC test report. However, testing at lower levels is required during database testing and the tester must verify that the DUT meets the limits at all lower power levels.

i. Band edge measurement:

The band edge measurements must be performed relative to both the lower (fL) and upper (fU) channel edge frequencies. The PSD is to be measured within a 100-kHz band segment relative to the channel edge (*i.e.*, fL- 100 kHz and fU + 100 kHz). The following spectrum analyzer settings and procedures are recommended for this measurement:

1. Select the power averaging (RMS) detector, a start frequency of fL- 100 kHz and a stop frequency of fL (where fL is the lower edge frequency of the operating channel), a resolution bandwidth (RBW) of 10 kHz, a minimum video bandwidth of 30 kHz and a sweep speed that provides one millisecond per trace point integration time.
2. Employ trace averaging over a minimum of 100 traces.
3. Use the integrated band/channel power function of the analyzer to determine the maximum average power spectral density over the 100 kHz frequency span.
4. Adjust the measured amplitude level to account for externalities in the signal path (e.g., attenuation in the patch cable for conducted measurements) to include measurement antenna gain for radiated tests.

[20] See §15.709(a)(1)(ii) for a note on personal/portable White Space devices operating at 40 mw.

5. Repeat the procedure with the analyzer start frequency set to fU and the stop frequency set to fU + 100 kHz.
6. Repeat the entire procedure until data is accumulated for the lower, middle, and upper channels in the DUT tuning range.

ii. Adjacent channel measurement:

The adjacent channel emission limit applies in any 100-kHz band segment within either the lower- or upper-adjacent 6-MHz channels relative to the operating channel (N±1, where N represents the channel of operation).

The following spectrum analyzer settings and procedures are recommended for this measurement:

1. Select the power averaging (RMS) detector, a start frequency of fL- 6 MHz and a stop frequency of fL- 100 kHz (where fL is the lower edge frequency of the operating channel), a resolution bandwidth (RBW) of 100-kHz, a minimum video bandwidth of 300-kHz and a sweep speed that provides one millisecond per trace point integration time.
2. Employ trace averaging over a minimum of 10 traces.
3. Use the peak marker function of the analyzer to determine the maximum power spectral density in any 100-kHz segment within the frequency span.
4. Adjust the measured amplitude level to account for externalities in the signal path (*e.g.*, attenuation in the patch cable for conducted measurements and the measurement antenna gain for radiated tests).
5. Repeat the procedure with the analyzer start frequency set to fU + 100 kHz and the stop frequency set to fU + 6 MHz.
6. Repeat the entire procedure until data is accumulated for the lower, middle and upper channels in the DUT tuning range.

iii. Beyond adjacent channel measurement

Beyond the immediately adjacent channels to the operating channel, the general emission limits of §15.209 apply. See §§15.31, 15.33, and 15.35, and ANSI C63.10 for guidance on performing these measurements. The DUT must comply with radiated emission limits for a Class B digital device, except that authorization as a Class A device may be considered with appropriate justification for non-residential use.

iv. Channel bonding or aggregation

Devices that use multiple contiguous and/or non-contiguous channels must comply with the requirements of §15.709(d). The test report shall describe how the channel bonding or aggregation is done and must show how it complies with the adjacent channel emission limits in §15.709(b)(1) and (b)(2). To demonstrate compliance, include the worst-case measurements in the test report.

f) Sensing Requirements

See section I 8, above and §15.717 for White Space devices that rely on spectrum sensing (WS1) for certification procedures.

The test report must demonstrate all the requirements for Personal/Portable devices with the following additions:

- Compliance to §15.709(b)(3)(i) 50 mw, (ii) Radiated PSD Limit of-0.4 dBm, and (iii) Adjacent channel limit -55.8 dBm.
- Beyond the immediately adjacent channels to the operating channel, the general emission limits of §15.209 apply.
- Compliance to the detection at the threshold requirements of §15.717(c)

- ATSC Detection: -114 dBm averaged over a 6 MHz bandwidth
- NTSC: -114 dBm averaged over a 100 kHz bandwidth
- Low Power Microphone: -107 dBm averaged over a 200 kHz bandwidth

- Antenna gain of device must be in accordance with §15.717(c)(iii).
- A description of simulated threshold and equipment signals used for compliance.
- Compliance to §15.717(c)(ii)(2) channel availability check start time.
- Compliance to §15.717(c)(ii)(3) in service monitoring time.
- Compliance to §15.717(c)(ii)(4) the 2 second stop and move time.

In addition to the standard operational descriptions in §2.1033 Application for certification, the application must provide a brief description of the circuit functions of the device along with a statement describing how the device operates. The descriptions must address the following items:

- An explanation of how the device protects against interference, per §15.717(a)(i).
- A description of how the device is intended to be marketed.

Applicants shall follow ANSI C63.10 when applicable. When ANSI C63.10 or standard practices are not applicable, the applicant must clearly describe the procedure and the rationale for its test. When conducted measurements and a sensing test are used, the applicant must clearly demonstrate the test set up and antenna gains for the DUT.

III DATABASE INTERACTION VERIFICATION

1. Test Mode Requirements

Radio management software must be provided to perform the certification compliance tests described in this document. The software may be the same package that will be available to end users, but administrative privileges must be made available. The software must provide the following:

a) The ability to enter all required registration information.

b) The ability to view all information provided to the radio by the database.

2. Rule Requirements

a) §15.713(g)(3) Fixed White Space device registration

The Fixed White Space device must provide the required information to the database and obtain a successful registration.

The management software must be able to collect the data listed below. Confirm that the DUT will not operate unless a list of available channels is received from the database.

1. FCC ID
2. Serial Number
3. Contact information (Device owner and device contact)
4. Location Coordinates
5. Location uncertainty with 95% accuracy
6. Antenna Height AGL (must not be > 30 m)

Confirm that antenna HAAT exceeding 250 m generally, or 500 m in less congested areas receives no list of available channels.

For a fixed White Space device without a direct connection to the internet, confirm that registration through a registered fixed device takes place only on a channel available to that registered device.

b) §15.713(h) Mode II White Space device initialization

A Mode II White Space device must be able provide the required information to the database for a successful initialization.

The management software must be able to collect the data listed below. Confirm that the DUT will not operate unless a list of available channels is received from the database.

1. FCC ID
2. Serial Number
3. Location Coordinates

For a Mode II White Space device without a direct connection to the internet, confirm that initialization through another initialized or registered device takes place only on a channel available to that other device.

A mobile White Space device must provide the database with the boundaries of any geo-fenced area in which it will operate. Alternatively, the boundaries of the geo-fenced area may be loaded from the database into the mobile device.

c) §15.711(e)(1) Mode I White Space device validation

A Mode I White Space device must provide its FCC ID to a White Space database through a Fixed or Mode II White Space device. Confirm that the DUT will not operate unless a list of available channels is received from the database. Confirm that operation only takes place on a channel available to the Fixed or Mode II White Space device.

d) §15.711(c)(2)(ii) and (d)(3) Fixed and Mode II White Space devices channels of operation

Confirm that device only operates on channels provided by the database.

e) §15.709(b)(4)(i) Narrowband White Space device

A narrowband White Space device operating as a client must communicate with a master device (fixed, Mode II, mobile or narrowband) that contacts the database to obtain a list of available channels and operating powers at its location. A narrowband White Space device operating as a master must incorporate a geo-location mechanism and be capable of obtaining lists of available channels and operating powers from the database.

f) §15.711(h) Fixed & Mode II Database Update

To simulate that the White Space device fails to successfully contact the database, block access to the database from the White Space device by removing its connection to the database. All other radio functions, including internet connectivity, should be maintained. Confirm that the White Space device ceases operation by 11:59 PM on the following day.

g) §15.711(d) Mode II White Space device position check

Using the system management software provided with the radio, validate that the White Space device executes a position check and database access as required. The White Space device must display the position (coordinates) and channel list to allow confirmation.

h) §15.711(d)(1) Mode II White Space device power loss

Remove power source from operating Mode II White Space device. Reconnect power and use the system management software to confirm the device does not operate prior to receiving a new channel list from the database.

i) §15.711(e) Mode I White Space device signal verification

Use the system management software to confirm that a Mode I White Space device receives an available channel verification signal on power up, and every 60 seconds thereafter.

j) §15.711(e) Mode II to Mode I White Space device channel list update

Remove the power source and/or relocate a Mode II White Space device and confirm that an updated channel list is pushed to a connected Mode I White Space device. The White Space device should display the new position (coordinates) and channel list to allow confirmation.

k) §§15.711(c)(2)(iii) and 15.713(a)(1) 48-hour channel scheduling

After receiving an available channel list, register a low-power auxiliary device on the White Space device operating channel to operate on an available channel and in an upcoming time period when the device will be tested. Repeat the available channel request after the update interval and in the time period when the low-power auxiliary device is scheduled to operate and confirm that the low-power device is accounted for in the schedule. Using the system management software, confirm that the device changes channels at the scheduled time.

l) §§15.707, 15.711(c)(d), and 15.712 White Space device channel availability

Confirm that White Space device properly identifies itself as fixed or Personal/Portable to the database by comparing the channel list provided by the database with those allowable to the class of White Space device under test. Confirm that the White Space device is operating on a channel or channels from the list at the authorized power and cannot be made to operate on an unauthorized channel.

m) §§15.715(f), 15.713(l), and 15.711(j) security

The device operations procedures must include documentation with a detailed explanation of the following for each database the device is expected to work with:

i. What communication protocol is used between the database and the White Space device?
ii. How are communications initiated?
iii. How does the White Space device validate messages from the database?
iv. How does the device handle failure to communicate or authenticate the database?
v. How does the database validate messages from a White Space device?
vi. What encryption method is used?
vii. How does the database ensure secure registration of protected devices?

n) §15.711(i) push notification to fixed and Mode II White Space devices

Confirm that the White Space device changes channels (or ceases operation) when it receives 'push' notification from the database.

Using system management software, register the device at (specific coordinates) and wait for the database to send a push notification. Confirm that once the notification is received, the device responds to the new channel availability list provided by the database. This will include ceasing operation on a channel no longer available or ceases operation altogether if no channels are available.

o) §15.711(b) location accuracy

For fixed and Mode II White Space devices, provide details regarding the technologies used by the device to determine its location and how, in case of other than GPS technology, the location uncertainty is calculated with a 95% confidence level.

p) §15.712 interference protection requirement (fixed and Personal/Portable White Space devices)

Using system management software or the database, provide different location (coordinates) so that compliance with operating channel and power level is shown under each of the scenarios outlined in §15.712. Include a sample scan showing the total channel power and adjacent channel emission settings for test coordinates.

q) §§ 15.711(c)(2)(ii), (d)(3), and 15.715(e) fixed and Mode II White Space device power level reduction

Using system management software, make a channel availability request to the database. Using the spectrum analyzer, confirm that the White Space device operates at no more than the maximum power

level indicated by the database and that the power level cannot be set to a higher level than indicated by the database at that specific location. If the device cannot reduce power, it must cease operation.

CHANGE NOTICE

06/25/2012: 416721 D01 White Space Test Procedures v01 is replaced by 416721 D01 White Space Test Procedures v02 to reflect the rule changes adopted in the *Third Memorandum Opinion and Order* in ET Docket No. 04-186, FCC 12-36, adopted April 5, 2012.

12/22/2015: 416721 D01 White Space Test Procedures v02 is replaced by 416721 D01 White Space Test Procedures v03 to reflect the rule changes adopted in the *Report and Order* in ET Docket No. 14-165, FCC 15-99 (rel. August 11, 2015).

xx/xx/2021: 416721 D01 White Space Test Procedures v03 is replaced by 416721 D01 White Space Test Procedures v04 to reflect the rule changes adopted in the *Report and Order* in ET Docket No. 20-36, FCC 20-156 (rel. October 28, 2020).

Appendix A

A1. References to White Space rules

Tables A1-A13 below can be used to guide the certification process for White Space devices. These tables are not all-inclusive and are not meant to substitute or replace any applicable rule. They are intended to aid in filing an application for certification. Applicants shall always refer to the actual published e-CFR[21] rules.

A2. Information to the user (47 C.F.R. §15.706)

Table A1

§15.706 (a), (b) Information to the user.		Description		731	Eq. Class
(a)	In addition to the labeling requirements contained in §15.19, the specified statement must be placed in a prominent location in the text of the manual.	This equipment has been tested and found to comply with the rules for White Space devices, pursuant to part 15 of the FCC rules. These rules are designed to provide 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, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:		Manual	WGF WG2 WG1 WMO WS1 WIT
		(1)	Reorient or relocate the receiving antenna.		
		(2)	Increase the separation between the equipment and 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.		
(b)	Electronic manual	In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that		Manual[22] in pdf format	

A3. §15.709 General Technical Requirements

[21] https://www.ecfr.gov/cgi-bin/text-idx?SID=e7d8fb6bf845a30945daa6a264796667&mc=true&node=sp47.1.15.h&rgn=div6

[22] For Electronic manual exhibit in the 731 application a Pdf format is required to be uploaded.

Table A2

§15.709 (a) Radiated power limits. The maximum White Space device EIRP per 6 MH					Description	Limit	731	Eq. class
(a)	(1)	General requirements.	(i)		All White Space devices may be required to operate with less power than max subject to meet the co-channel and adjacent channel separation requirements of §15.712.		Noted	WGF WG2 WG1 WMO WS1 WIT
			(ii)		Any mode I personal/Portable devices -in any band- is limited to 40 mw if the White Space device that controls it is limited to 40 mw.	40mw	Demonstrated In Test Report	WG1
	(2)	TV bands & 600 MHz service bands (617-652 MHz and 663-698 MHz)	(i)	(A)	Fixed devices in the TV bands below 602 MHz: 4 W Except 16W in less congested areas[5]	4 W		WGF
						16 W		
					Fixed devices in the 602-608 MHz band segment.	4 W		
				(B)	Fixed devices in the 600 MHz service bands above 620 MHz 4 W except 10W in less congested areas	4/ W		
						10 W		
					Fixed devices in any portion of the 614- 620 MHz band segment	4 W		
			(ii)		Personal/Portable devices (both Modes I and II)	100 mw		WG1 WG2
	(3)	608-614 MHz band (channel 37)			608-614 MHz band (channel 37). Up to 40 mw (16 dBm) EIRP.	40 mw		WGF WG1 WG2
	(4)	600 MHz Duplex Gap 657-663 MHz- Fixed and Personal/Portable devices				40 mw		WGF WG1 WG2
		Guard Bands (614-617 MHz): §15.707 (a) (4) Channel 37 guard band. White Space devices are not permitted to operate in the band 614-617 MHz						NA
	(5)	Mobile devices	Limited to below 602 MHz (Channel 35) and must operate in less congested areas.			16 W		WMO

Table A3

Technical Limits §15.709 (b)					Description	Limit	731	Eq. class
(b)	(1)	Fixed and Mobile [23]	(i)		Technical limits in table (b)(1)(iii)	Table (b)(1)(iii)	Demonstrated In Test Report	WGF
			(ii)		ERIP levels linearly interpolated between values in table (b)(1)(iii)			WMO
			(iii)		Conducted PSD limits in 100 kHz band values in table (b)(1)(iii)			
	(2)	Personal/ Portable (Mode I & II)[24]	(i)		Technical limits in table (b)(2)(ii)	Table (b)(2)(ii)		WG2 WG1
			(ii)		Radiated PSD in Table (b)(2)(ii)			
	(3)	Sensing only devices			Sensing-only White Space devices are limited to 17 dBm (50 mw) EIRP and are subject to the requirements of this paragraph and of §15.717 of this part.	50 mw		W31
			(ii)		Radiated PSD Limit	-0.4 dBm		
			(i)		Adjacent channel emission limit	-55.8 dBm		
	(4)	Narrowband White Space devices	(i)		Client Master Operation[25]	channel operation		WIT
			(ii)		Maximum channel bandwidth	100 kHz.		
			(iii)		Conducted limits in 100 kHz band	12.6 dBm		
					EIRP limits in 100 kHz band	18.6 dBm		
			(iv)		Band edge Adjacent channel limits in 100 kHz band[26]	-42.8 dBm		
			(v)		If using directional gain antenna above 6 dBi, conducted power reduction required by the amount in dB antenna exceeds 6	18.6 dBm ERIP channel operation Limits		
			(vi)		Channel occupancy limit 36 seconds	channel operation		

[23] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix B of this document for convenience.

[24] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix B of this document for convenience.

[25] Client Master Operation: a client must communicate with a master device (fixed, Mode II, mobile or narrowband) that contacts the white space database to obtain a list of available channels and operating powers at its location. A narrowband white space device that acts as a master must incorporate a geo-location mechanism and be capable of obtaining lists of available channels and operating powers from the white space database.

[26] limited to −42.8 dBm in 100 kHz in a first adjacent 6-megahertz channel, starting at the edge of the 6-megahertz channel within which the narrowband device is operating. This limit shall not apply between the edge of the narrowband channel and the edge of the 6-MHz channel that contains it

Table A4

Conducted Technical Limits §15.709 (c) &(d)			Description	Limit	731	Eq. Class
(c)	(1)	Fixed devices[27]	Conducted power, PSD and adjacent channel limits operating at up to 36 dBm as shown table (b)(1)(iii)[28] are based on an antenna gain of 6 dBi. Directional gain greater than 6 dBi power must be reduced by the amount the antenna exceeds 6 dBi.	table (b)(1)(iii)	Test Report	WGF
	(2)	Fixed and mobile[29]	Conducted power, PSD and adjacent channel limits operating greater than 36 dBm as shown table (b)(1)(iii)[30] are based on an antenna gain of 12 dBi. Directional gain greater than 12 dBi power must be reduced by the amount the antenna exceeds 6 dBi.	table (b)(1)(iii)		WGF WMO
	(3)	Max conducted power	Maximum conducted power defined[31]			All
	(4)	AC Power	Must Comply with §15.207			
(d)	(1)		Adjacent channel emission limits shown in tables (b) (1) (iii) and (b) (2) (ii) [32]	tables (b) (1) (iii) and (b) (2) (ii)	Test Report	All
	(2)		Compliance with general limits beyond (immediate) adjacent White Space channel(s).	15.209		
	(3)		Adjacent band emission measurements: Minimum 100 kHz[33] resolution bandwidth.			

[27] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix B of this document for convenience.

[28] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix B of this document for convenience.

[29] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix B of this document for convenience.

[30] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix A of this document for convenience.

[31] Maximum conducted output power is the total transmit power over the occupied bandwidth delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

[32] Tables (b) (1) (iii) and (b) (2) (ii) of §15.709 (b) are also provided in Appendix A of this document for convenience.

[33] Emission measurements in the adjacent bands shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.

Table A5

Technical Limits §15.709 (e) & (f)		Description	731	Eq. Class
(e)	TPC required	Demonstrated in filing	Test Report[34]	WGF WG2 WG1 WMO WS1 WIT
(f)	Security (software)	Devices cannot access nonapproved databases and unauthorized parties cannot modify devices - Demonstrated in certification	Security Operational Description[35]	

[34] Transmit power control. White space devices shall incorporate transmit power control to limit their operating power to the minimum necessary for successful communication. Applicants for equipment certification shall include a description of the device's transmit power control feature mechanism.

[35] See appendix C for Security Operational Description Requirement.

Table A6

Antenna §15.709 (g)					Description	731	Eq. Class
(g)	(1)	Fixed devices [36]	(i)		Antenna height shall not exceed 10 meters above ground for fixed devices operating at 40 mw EIRP or less or 100 mw EIRP or less when operating across multiple contiguous TV channels.	Manual[37]	WGF
			(ii)		Height above average terrain (HAAT). Below 602 MHz, antenna shall not exceed 250 meters or 500 meters in less congested areas. All other bands not to exceeds 250 meters. The HAAT is calculated by the White Space database (§73.684(d)). For HAAT greater than 250 meters the following A-F procedures below are required:		
				A	The installing party must contact a White Space database, identify all TV broadcast station contours that would be potentially affected by operation at the planned HAAT and EIRP.	Manual[12,20]	
				B	Notification -The installing party must notify each of these licensees and provide geographic coordinates, relevant technical parameters and contact information.		
				C	Start operations, No earlier than four calendar days after the notification in paragraph (g)(1)(ii)(B) above		
				D	Upon request, the installing party must provide affected licensee the time periods of operations.		
				E	Conduct a new notification if increasing its power level, moving more than 100 meters horizontally from its location, or making an increase in the HAAT or EIRP that results in an increase in the minimum required separation distances from co-channel or adjacent channel TV station contours..		
				F	All notifications required by this section must be in written form (including email). To be kept by the White Space device operator for its records and supplied to the Commission upon request.		
	(2)	Personal/ Portable			Must have permanently attached antennas.	Photo exhibits	WG1 WG2
	(3)	Sensing-only devices (15.717)	(i)		§15.204(c)(4) does not apply		WS1
			(ii)		Separate sensing antenna shall use lowest gain for each type of antenna to be certified.	Test Report	

[36] See §15.709 (g) (1) for full text of requirements.

[37] Antenna Height restrictions shall be provided for installers in the manual or installation instructions.

Table A7

RF exposure §15.709 (h)		Description	731	Eq. Class
(h)		Must ensure compliance with the radio frequency exposure requirements in §§1.1307, 2.1091, and 2.1093 of the rules.	RF Exposure MPE, SAR or category excluded[38].	All

A4. Geo-Location-Interference avoidance

Table A8

Geo-location embedded device §15.711 (a) – (c)			Description	731	Eq. Class
(a)			Channel operation relies on geo-location and authorization by a White Space Database.	Test Report[39]	WGF WG2 WG1 WIT WMO
(b)	(1)		Accuracy. Fixed White Space devices and Mode II that incorporate a geo-location capability must demonstrate uncertainty with a confidence level of 95%		WGF WG2
	(2)		Must reference North American Datum of 1983 (NAD 1983)		
(c)	(1)		General requirement for fixed devices – conditions for when information must be ascertained, stored in memory, and transmitted to a White Space database	Test Report	WGF
		(i)	Geo-location and height info stored in device memory		
		(ii)	Registration with a White Space database		
		(iii)	Use of an external geo-location source is permitted		
		(iv)	Must demonstrate accuracy		
	(2)	(i)	Must access database over Internet connection		
		(ii)	May only use channels and power levels indicated by the database		
		(iii)	Database check (min. once a day, 48-hour schedule, recheck if coordinates change by more than 50 meters)	Attestation	
		(iv)	Provisions for devices without a direct connection to the Internet		

[38] Refer to KDB Publication 447498 for guidance.

[39] Demonstrated in test report see section III DATABASE INTERACTION VERIFICATION 416721 White Space Test Procedures.

Table A9

Mode II Personal/Portable devices §15.711 (d)			Description	731	Eq. Class
(d)	(1)		Has geo-location capability, checks location at least every 60 seconds during operation	Test Report	WG2
	(2)		Uses only channels allowed by database and obtains updated list if location changes by more than 100 meters		
	(3)		Operates on channels and power levels authorized by database		
	(4)		Checks database daily for a 48-hour schedule		
	(5)		(Optional) Ability to load and use channel availability information for multiple locations (i.e., for use over a defined area)		

Table A10

Mode I Personal/Portable devices §15.711(e)			Description	731	Eq. Class
(e)	(1)		Only transmits under the control of a fixed or Mode II P/P device	Test Report	WG1
	(2)		Is provided list of channels from a Mode II device that matches the channels available to the Mode II device		
	(3)		Fixed device providing channels to the Mode II device must not exceed 106 meters HAAT		
	(4)		Uses defined protocol for contact and verification between the Mode I device and a fixed or Mode II device		

Table A11

General requirements §15.711 (f)-(j)			Description	731	Eq. Class
(f)			Incorporates the capability to display channels	Manual/test report	WGF WG2 WG1 WIT WMO WS1
(g)			Transmits required identifying information	Test Report	WGF
(h)			If device fails to contact database, ceases operation no later than 11:59 p.m. the following day	Test Report[40]	WGF WG2
(i)	(i)		Procedures for database push notifications *(requirement currently waived)*	Database Administrator Requirement[41].	
		(1)	10 Min response to microphone push		
		(2)	Push microphone registration for fixed and Mode II devices		
		(3)	Database Administrators update their systems to comply with these requirements no later than December 23, 2016.		
(j)	(1)		General requirement that devices incorporate security measures	Security Description[42]	WGF WG2 WG1 WIT WMO WS1
	(2)		Provisions for Mode I devices to communicate with fixed or Mode II devices	Database administrator Requirement	WGF WG1 WG2
	(3)		Complies with authentication protocol	Security Description[43]	WGF WMO WG2 WIT (master only)
	(4)		Includes a high-level operational description		

[41] Not an equipment authorization Requirement.

[42] See appendix C for security description required.

Table A12

Mobile devices §15.711(k)		Description	731	Eq. Class
(k)	(1)	Operates within authorized geo-fenced area, including internally storing boundary areas	Test report & manual.	WMO
	(2)	Incorporates a geo-location capability		
	(3)	Demonstrates accuracy (per 15.711(b))		
	(4)	Determines and provides antenna height Manual or automatic means.	Test report and user Manual	
	(5)	Each mobile device must access the database over the internet to determine channel and power availability	Test report	
	(6)	Mobile devices must comply with the same separation distances from protected services in §15.712 as fixed devices.	Test report	
	(7)	Maximum EIRP requirements when using electrically steerable antennas	Include a List of antennas	
	(8)	Check's location at least once every 60 seconds	Test report	
	(9)	Checks with database at least once a day	Test report	
	(10)	May not operate on satellites or aircraft (including unmanned aerial vehicles)	User Manual	

A5. White Space devices that rely on spectrum sensing (WS1)

Table A13

Public notice procedures spectrum sensing & §15.717(a)-(c)			Description	731	Eq. Class
(a)[44]	(1)	(i)	Includes a description of how it protects incumbent authorized services against interference	Ops Exhibit	WS1
		(ii)	Pre-production device must be submitted as a PAG	TCB submits to the FCC Lab	
	(2)	(i)	Application will be placed on Public Notice; confidentiality requests permitted per §0.459. See procedure for White Space devices that rely on spectrum sensing below.	Commission/TCB action	
		(ii)	Commission conducts Laboratory and field test. See procedure for White Space devices that rely on spectrum sensing below.	Commission/TCB action	
		(iii)	Commission issues test report by Public Notice. See procedure for White Space devices that rely on spectrum sensing below.	Commission/TCB action	
(b)			Meets specified power limits	Test Report	
(c)	(1)	(i)	A: Meets ATSC digital TV signal detection threshold of -114 averaged over a 6 MHz bandwidth		
			B: Meets NTSC analog TV detection threshold of -114 averaged over a 100 kHz bandwidth		
			C: Meets Low Power Microphone detection threshold of -107 dBm averaged over a 200 kHz bandwidth		
		(ii)	The detection thresholds are referenced to an omnidirectional receive antenna with a gain of 0 dBi.		
	(2)		Meets detection threshold reference requirements		
	(3)		Monitors in-service channel at least once every 60 seconds		
	(4)		Meets 2 second channel move time requirement		

[44] See appendix C below for Certification procedures for spectrum sensing (WS1) devices.

APPENDIX B

TABLE 1 TO PARAGRAPH (b)(1)(iii) of §15.709 General technical requirements.

TABLE 1 TO PARAGRAPH (b)(1)(iii)

EIRP (6 MHz)	Conducted power limit (6 MHz)	Conducted PSD limit[1] (100 kHz) (dBm)	Conducted adjacent channel emission limit (100 kHz) (dBm)
16 dBm (40 mW)	10 dBm (10 mW)	−7.4	−62.8
20 dBm (100 mW)	14 dBm (25 mW)	−3.4	−58.8
24 dBm (250 mW)	18 dBm (63 mW)	0.6	−54.8
28 dBm (625 mW)	22 dBm (158 mW)	4.6	−50.8
32 dBm (1,600 mW)	26 dBm (400 mW)	8.6	−46.8
36 dBm (4,000 mW)	30 dBm (1,000 mW)	12.6	−42.8
40 dBm (1,0000 mW)	30 dBm (1,000 mW)	12.6	−42.8
42 dBm (16,000 mW)	30 dBm (1,000 mW)	12.6	−42.8

Table 2 to Paragraph (b)(2)(ii)

EIRP (6 MHz)	Radiated PSD limit EIRP (100 kHz) (dBm)	Radiated adjacent channel emission limit EIRP (100 kHz) (dBm)
16 dBm (40 mW)	−1.4	−56.8
20 dBm (100 mW)	2.6	−52.8

Appendix C

Security Description

§15.709 (f) Security Description.

White space devices shall incorporate adequate security measures to prevent the devices from accessing databases not approved by the FCC and to ensure that unauthorized parties cannot modify the device or configure its control features to operate in a manner inconsistent with the rules.

The purpose of §15.709 (f) is to prevent unauthorized modifications by users, dealers, retailers or third parties from modifying or disabling the hardware or software portions that controls compliance with the FCC technical requirements. The methods used by manufacturers to implement the RF security requirements shall be described and provided in the 731 applications as software security or operational description exhibits using the guidance below.

Hardware unauthorized modifications statement:

Manufactures shall not for any purposes, design the product such that end users can easily remove straps, traces, header pins, parts, etc. to disable or modify the device to operate outside of the rules that the device is authorized for. This includes simple modifications to operate between or among other regulatory domains. A simple confirmation statement in the security description is adequate for hardware purposes.

Software Security operational description:

The questions below refer to the security for the code, software, firmware that controls the transmitters RF parameters as certified. This does not include code for non-transmitter functions.

1. Describe the security method used that ensures that only the grantee's code(s) that guarantee compliance as granted are loaded or pushed to white space devices. That is, what prevents other parties from loading their own code.
2. Describe how the proper regulatory domain is managed on accordance with publication 594280.
3. Briefly describe the method used for segregating end users and third party's configuration or changeable software/firmware from the software/firmware portions that controls compliance with the RF parameters as granted.
4. Describer the detail how the device is prevented from accessing databases not approved by the FCC. See III DATABASE INTERACTION VERIFICATION 2. Rule Requirements m) §§15.715(f), 15.713(l), and 15.711(j) security for response format. The device operations procedures must include documentation with a detailed explanation of the following for each database the device is expected to work with:
    i. What communication protocol is used between the database and the White Space device?
    ii. How are communications initiated?
    iii. How does the White Space device validate messages from the database?
    iv. How does the device handle failure to communicate or authenticate the database?
    v. How does the database validate messages from a White Space device?
    vi. What encryption method is used?
    b. How does the database ensure secure registration of protected devices?
5. Describe the method any software/firmware is loaded or updates to device code or Operating System is secured and managed to ensure that devices comply to the conditions as granted.
6. Describe how updates to software/firmware that modify RF parameters without any hardware changes are distributed to end uses, the security method used ?
7. Explain the authentication protocols that are in place to ensure that the source of the RF-related software/firmware is valid. Describe how the RF-related software is protected against modification.
8. Describe any encryption methods used to support the use Grantee RF-related software/firmware.

9. If the device permits Other Equipment Manufactures or third parties to install manage RF parameters for different regulatory domains, the authorization for certification must be a Software Defined Radio (SDR) application under §2.944 (b). As an SDR, the requirements of §15.709 (f) are fulfilled for filing a security description as required by KDB Publication 442812 instead of this guidance.

Appendix D

§15.717 (a) (2) (i)-(iii) Procedures for White Space devices that rely on spectrum sensing.

Spectrum Sensing (WS1) devices are certified by a Telecommunication Certification Body (TCB) thorough the pre-approval guidance procedures and the following additional procedure:

1. An application for certification will be placed on a 30-day public notice to allow interested parties to review and make comments, plus 15 days if any objections are received for the objector to respond with comments. This is referred to as the first public notice and publicly posted at https://apps.fcc.gov/oetcf/kdb/reports/PublishedDocumentList.cfm.
2. The first public notice will reference the device by the proposed FCC ID, a test plan, test plan methodologies, and testing data on the device's: Band of operation (15.703), power limits (15.717(b), sensing and operation requirements of 15.717(c), exterior photos, user manual (shall explain the device function(s), required 15.706 information to users, a description of how the device will be marketed- 15.717(a)(1)(ii), and a description of how the device protects interference to incumbents 15.717(a)(i).
3. During the 30- or 45-day periods, the TCB's will coordinate with the manufacturer to arrange for a representative production sample to be shipped or hand-carried to FCC's laboratory in Columbia, Maryland. The FCC will conduct the necessary laboratory and or field testing to validate the accredited laboratory test reports filed by the TCB.
4. After the 30- or 45-day periods of the first public notice and review of comments, the Commission may proceed and conduct scheduled laboratory tests and field tests of the device to evaluate proof of performance of the device, including characterization of its sensing capability and interference potential. The testing will be open to the public. Scheduled dates and times will be posted at https://apps.fcc.gov/oetcf/kdb/reports/PublishedDocumentList.cfm.
5. After testing, the Commission will issue a second public notice, providing the Commission's test results, including recommendations if applicable. The second public notice will specify a minimum of 30 days for comments and an additional 15 days for reply comments if any objections are received. This second public notice is posted at https://apps.fcc.gov/oetcf/kdb/reports/PublishedDocumentList.cfm.
6. The second public notice may or may not contain any exhibit demonstrating the FCC's validation testing, indicating that the application has been approved or disapproved, referencing the first public notice by the proposed FCC ID.
7. After the 30- or 45-day periods of the second public notice, the Commission will approve or deny the PAG and the TCB can then proceed to certify the device or if denied the device will not be granted.

Other conditions for spectrum sensing devices are:

1. Modules are prohibited[45].
2. A Class 2 Permissive Change (C2PC) does not need to follow the public notice and validation procedure but still requires a PAG.
3. Changes to the electrical characteristics of the sensing circuitry and antenna system require a new FCC ID.
4. Additional devices under a new FCC ID, employing the identical electrical characteristics and antenna system, still require a PAG but may request forgoing the public notice procedure. The application will require proof in the filing of the identical electrical characteristics. A grant comment must identify the FCC ID that went through the public notice procedure that uses electrically identical circuitry.
5. A disposition record of denied devices will be maintained at https://apps.fcc.gov/oetcf/kdb/reports/PublishedDocumentList.cfm

[45] Since spectrum sensing (WS1) devices are required to go through commission testing under public view for a final product, procedures for host to use module certification to demonstrate compliance without further certification is not applicable.

Appendix E

§ 15.707 Permissible channels of operation for White Space devices by bands and equipment class

White Space devices operate on available TV channels in the broadcast television frequency bands, the 600 MHz band (including the guard bands and duplex gap), and in 608-614 MHz (channel 37).

I. TV channels in the broadcast television frequency bands,

1. 54-72 MHz (TV channels 2-4): WGF, WIT, WMO
2. 76-88 MHz (TV channels 5-6): WGF, WIT, WMO,
3. 174-216 MHz (TV channels 7-13): WGF, WIT, WMO
4. 470-512 MHz (TV channels 14-20): WGF, WG2, WG1, WIT, WMO
5. 512 – 602 MHz (TV channels 21-35): WGF, WG2, WG1, WIT, WS1, WMO
6. 602-608 MHz (TV channels 36): WGF, WG2, WG1, WS1

II 608-614 MHz (channel 37).

7. 608-614 MHz (channel 37): WGF, WG2, WG1

III 600 MHz band

8. 600 MHz Guard band 614-617 MHz: White Space devices not permitted.
9. 600 MHz Service band 617--652 MHz: WGF, WG2, WG1
10. 600 MHz duplex Gap:652 -657 MHz: Not available
11. 600 MHz duplex Gap:657-663 MHz: WGF, WG2, WG1
12. 600 MHz Service band 663-698 MHz: WGF, WG2, WG1