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Title: Proposed Certification Test Procedures for TV Band (White Space) Devices Authorized Under Subpart H of the Part 15 Rules

Short Title: White Space Test Procedures

Reason: New Publication
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First Category: Administrative Requirements

Second Category: Measurement Procedures

Third Category:

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 v01 below.

Attachment List:
416721 D01 White Space Test Procedures v01

Attachment 416721 D01 White Space Test Procedures v01

Certification Test Procedures for TV Band (White Space) Devices Authorized Under Subpart H of the Part 15 Rules

INTRODUCTION

Background

The Commission recently adopted rules to permit a category of unlicensed devices access to television (TV) broadcast frequency bands in order to provide wireless broadband services on those TV channels that are not occupied by licensed incumbent services (also known as TV white spaces).[1] The rules governing the operation of such Television Band Devices (TVBDs) are codified in Subpart H of the Part 15 rules in Title 47 of the Code of Federal Regulations (CFR).

Objective

This paper is intended to specify and document recommended measurement and validation procedures applicable to TVBDs that will provide sufficient data to demonstrate compliance to the applicable rules in Part 15; Subpart H – Television Band Devices.

In addition to demonstrating compliance with rules governing unlicensed intentional radiators, TVBDs are required to access one or more TV band databases which will provide the device with a list of TV white space channels available for operation. In order to demonstrate compliance to the rules, the requirements and procedures are divided into two parts.

Part 1 will specify verification tests and recommended measurement procedures that can be performed on TVBDs without the need to access a TV bands database, and thus will include guidance primarily intended for demonstrating compliance to the specific radio frequency (RF) requirements and limits.

Part 2 will specify verification tests and recommended procedures for demonstrating compliance with the rules requirements governing the connection between the TVBD and one or more TV band databases.

PART 1: RADIO FREQUENCY (RF) CERTIFICATION TESTS

The compliance tests described below can be performed on a stand-alone TVBD *(i.e.*, without requiring access to a TV bands database).

1. Test Mode Requirements

In order 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 TVBD submitted for evaluation. This test mode must at a minimum provide:

a) The ability to compel the device-under-test (DUT) to operate on a TV channel selectable by the test personnel.

b) The ability to vary the output power from the minimum to the maximum realizable levels and set it to a desired level.

[1] *See Second Report and Order and Memorandum Opinion and Order (Second Report and Order)* in ET Docket No. 04-186, 23 FCC Rcd 16807 (2008) and *Second Memorandum Opinion and Order (Second Memorandum Opinion and Order)* in ET Docket No. 04-186, FCC 10-174, adopted September 23, 2010.

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

2. Rules 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 TVBD user's manual.

b) §15.707 Permissible channels of operation

i. Verify that the DUT cannot be tuned to operate on unauthorized TV channels, based upon device type: fixed, Mode or Mode II, or frequencies outside of the authorized band(s).

ii. Note that the lockout of unauthorized channels may not be totally implemented in the DUT but rather, must be reliant upon limitations provided to the DUT by the database (*e.g.,* channels 36 and 38). See Part 2.

c) §15.709 Power Limits

i. Fixed TVBDs

The power limits for fixed TVBDs are specified in terms of conducted PSD; therefore, the recommended compliance verification measurement should utilize a conducted test configuration. The following paragraphs provide recommended settings and procedures for using a spectrum analyzer (with signal-processing capability) to perform the 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 TVBD, 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 (low, middle, and high channels within tuning range must be examined).
4. Employ the trace averaging analyzer function over a minimum of 10 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 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 in 6-MHz and 100-kHz, respectively.

8. Check that the reported DUT transmit antenna gain is in compliance with §15.709(a)(1). If necessary, reduce the PSD limits by the amount in dB that the transmit antenna gain exceeds 6 dBi.
9. Compare the recorded power levels to the applicable PSD limits to assess compliance.
10. Repeat until data is accumulated for the low, middle and high channels in the DUT tuning range.

ii. Personal/Portable TVBDs:

The power limits specified for personal/portable TVBDs are mixed in that the limit within the 6-MHz channel is specified as an EIRP whereas, the limit in any 100-kHz band segment is specified in terms of conducted power provided to the transmit antenna.

The antenna requirements subsection of the rules (§15.709(a)) specifies that the transmit/receive antennae of personal/portable devices shall be permanently attached to the DUT, potentially making conducted measurements difficult.

Although the 100-kHz PSD limits are specified in the rules in terms of conducted power, they were established under the assumption that these were the maximum levels that could be applied to an ideal isotropic radiating antenna. Therefore, the conducted limits can reasonably be interpreted to also represent the maximum permissible EIRP levels under the presumption that the antenna gain of an ideal isotropic radiating antenna is 0 dBi.

As such, although the preferred method for determining the maximum output power is to utilize a conducted measurement set-up, in those cases where there is no accessible antenna port to accommodate conducted measurements, a radiated measurement set-up can be used instead.

Conducted measurements:

The following recommended spectrum analyzer settings and procedures assume access to a 50-Ω RF output port incorporated within the DUT.

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.
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 (low, middle, and high channels within tuning range must be examined).
4. Employ the trace averaging analyzer function over a minimum of 10 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 amplitude 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 or pre-amplifier). Record the adjusted amplitude levels as the power measured in 6-MHz and 100-kHz, respectively.

8. Compare the recorded power levels to the applicable PSD limits to assess compliance.
9. Repeat until data is accumulated for the low, middle and high channels in the DUT tuning range.

Radiated measurements:

The following recommended measurement procedures assume that the DUT provides no accessible RF output port and thus, radiated measurements must be performed.

Refer to ANSI C63.4-2009 for general guidance on performing radiated measurements on unlicensed devices.

Once the azimuth and elevation associated with the maximum emission has been determined, use the following recommended analyzer settings and procedures for final measurements.

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 (low, middle, and high channels within tuning range must be examined).
4. Employ the trace averaging analyzer function over a minimum of 10 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 amplitude 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 measured in 6-MHz and 100-kHz, respectively.
8. Determine the associated EIRP levels using guidance provided in KDB Publication 412172.
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.

d) §15.709 Antenna Requirements

The transmit/receive antenna(s) of a personal/portable TVBD shall be examined to verify that they are permanently attached to the DUT.

The maximum gain of the transmitting antenna used with a Fixed TVBD must be declared by the manufacturer in the certification application. If the transmitting antenna gain exceeds 6 dBi, the conducted output power limits shall be reduced by the amount in dB by which the gain exceeds 6 dBi.

See KDB Publication 662911 for guidance on testing a TVBD transmitter utilizing multiple antenna outputs.

e) §15.709 Emission Limits

The out-of-band emission limit for all TVBDs, applicable both at the band-edges and in the adjacent channels (both lower and upper) is determined from:

Power/100 kHz = Power/6 MHz – 72.8.

As with the power measurements, the preferred methodology for determining the maximum band-edge and adjacent-channel emission power is to utilize 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 utilized (see C63.4-2009 for guidance).

i. Band-edge Measurement:

The band-edge measurements must be performed relative to both the lower (f_L) and upper (f_U) channel edge frequencies. The PSD is to be measured within a 100-kHz band segment relative to the channel edge (*i.e.*, f_L- 100 kHz and f_U + 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 f_L- 100 kHz and a stop frequency of f_L (where f_L 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. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel to be investigated (low, middle and high channels of tuning range must be tested).
3. Employ the trace averaging feature of the analyzer over a minimum of 10 traces.
4. Use the integrated band/channel power function of the analyzer to determine the maximum average power spectral density over the 100-kHz frequency span.
5. 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).
6. Repeat procedure with the analyzer start frequency set to f_U and the stop frequency set to f_U + 100 kHz.
7. 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 f_L- 6 MHz and a stop frequency of f_L- 100 kHz (where f_L 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. Activate the DUT test mode that provides continuous transmission of the output signal (no time bursting or signal gating) on the operating channel to be investigated (low, middle and high channels of tuning range must be tested).
3. Employ the trace averaging feature of the analyzer over a minimum of 10 traces.
4. Use the peak marker function of the analyzer to determine the maximum power spectral density in any 100-kHz segment within the frequency span.
5. 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).
6. Repeat the procedure with the analyzer start frequency set to f_U + 100 kHz and the stop frequency set to f_U + 6 MHz.
7. Repeat the entire procedure until data is accumulated for the lower, middle and upper channels in the DUT tuning range.

iii. Beyond Adjacent-Channel Measurements

Beyond the immediately adjacent channels to the operating channel, the general emission limits of §15.209 apply. See §15.31, §15.33, §15.35, and ANSI C63.4-2009 for guidance on performing these measurements.

iv. Measurements in the 602-620 MHz band (TV Channels 36-38)

§15.709(c)(4) provides a table of field strength limits applicable to emissions from TVBDs that fall within the frequency spectrum representing channels 36-38 (602-620 MHz). The emission levels within these channels should be measured on a radiated basis following the guidance provided in ANSI C63.4-2009.

PART 2: DATABASE INTERFACE CERTIFICATION TESTS

1. Test Mode Requirements

In order to perform the certification compliance tests described in this document, radio management software must be provided. The software may be the same package as will be available to end users; however administrative privileges must be available. The software must provide the following:

a) The ability to enter all required registration information.
b) The ability to view all information provided by the database to the radio.
c) The ability to register a low-power auxiliary device.

2. Rules Requirements

a) §15.713(f)(3) Fixed TVBD Registration

The Fixed TVBD must be able to provide the required information to the database and obtain a successful registration:

The database must indicate a failed device registration if any of the following data provided by the TVBD is invalid:

i. FCC ID
ii. Serial Number
iii. Restricted Coordinates
iv. HAAT> 76 m
v. Antenna Height AGL > 30 m
vi. Incomplete contact information

For a fixed TVBD 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(g) Mode II TVBD Initialization

Mode II TVBDs must be able provide the required information to the database for a successful initialization.

The database must not initialize a Mode II TVBD if any of the following data provided by the TVBD is invalid:

i. FCC ID
ii. Serial Number
iii. Restricted Coordinates

For a Mode II TVBD without a direct connection to the internet, confirm that registration through a registered device takes place only on a channel available to that registered device.

c) §15.711(b)(3)(iv) Mode I TVBD Validation

Through a Fixed or Mode II TVBD the Mode I TVBD must provide its FCC ID. Confirm that the database does not validate a Mode I TVBD if an invalid FCC ID is provided.

Confirm that validation only takes place on a channel available to the Fixed/Mode II device.

d) §15.707(a) Fixed TVBD Relocated

Confirm that the database will not provide a channel list for Fixed TVBD at a location other than that registered.

e) §15.711(b)(3)(iii) Fixed & Mode II TVDB Database Update

Using a programmable router, or similar, block access to the database URL or IP address from the TVBD. Confirm that the TVBD shuts down by 11:59 PM on the following day.

f) §15.711(b)(2),(3)(ii) Mode II TVBD Position Check

Using the system management software provided with the radio, validate that the TVBD executes a position check and database access as required. The TVBD should display the channel list to allow confirmation.

g) §15.711(b)(3)(iv) Mode II TVBD Power Loss

Remove power source from operating Mode II TVBD. Reconnect power and use the system management software to confirm the receipt of the new channel list.

f) §15.711(b)(3)(iv) Mode I Signal Verification

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

g) §15.711(b)(3)(iv) Mode II TVBD Channel List Update

Remove the power source and/or relocate a Mode II TVBD and confirm that an updated channel list is pushed to connected Mode I TVBDs. TVBDs should display the channel list to allow confirmation.

h) §15.711(b)(3)(i)(ii), §15.713(a)(1) 48 Hour Channel Scheduling

After receiving an available channel list, register a low-power auxiliary device on the TVBD operating channel. Repeat the available channel request after the update interval 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.

j) §15.707, §15.711(b)(3)(i)(ii)(iv),(c), §15.712 TVBD Channel Availability

Confirm that the channel list provided by the database conforms with those allowable to the class of TVBD under test. Confirm that the TVBD is operating on a channel from the list at authorized power and cannot be made to operate on an unauthorized channel.

k) §15.709(a)(2) 1st-Adjacent Power reduction

Using system management software, provide coordinates within the protected contour of a 1st-adjacent station and use the test procedures provided in Part 1 to confirm that the output power for the DUT is limited to 40 mW EiRP.

l) §15.715(f) 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 TVBD?

ii. How are communications initiated?
iii. How does the TVBD 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 TVBD?
vi. What encryption method is used?
vii. How does the database ensure secure registration of protected devices?