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Wireless test report – 390290-2TRFWL

Applicant:

Technologies Humanware Inc

Product type:

Brail reader with BLE and Wi-Fi module

Model:

BRQT40

FCC ID:

XT5-BRQT40

ISED Registration number:

8670A-BRQT40

Specifications:

- ◆ **FCC 47 CFR Part 15 Subpart C, §15.247**

Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz

- ◆ **RSS-247, Issue 2, Feb 2017, Section 5**

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs)

and Licence-Exempt Local Area Network (LE-LAN) Devices

5) Standard specifications for frequency hopping systems and digital transmission systems operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz

Date of issue: May 7, 2020

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FCC 15.247 and RSS-247.docx; Date: Apr 2019



Test location(s)

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Site number (3 m SAC)	FCC: CA2041; IC: 2040G-5

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Technologies Humanware Inc
Address	1800, Rue Michaud
City	Drummondville
Province/State	Québec
Postal/Zip code	J2C 7G7
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247 RSS-247, Issue 2, Feb 2017, Section 5	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
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1.3 Test methods

558074 D01 15.247 Meas Guidance v05r02 (April 2, 2019)	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules.
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-102, Issue 5, March 19, 2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	May 7, 2020	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Table 2.1-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is an AC powered device.

2.2 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Table 2.2-1: FCC 15.247 results for DTS

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Pass
§15.247(b)(3)	Maximum peak output power in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247e(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247e(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 ISED RSS-Gen, Issue 5, test results

Table 2.3-1: RSS-Gen results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: ¹ According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

EUT is an AC powered device.

2.4 ISED RSS-247, Issue 2, test results for digital transmission systems (DTS)

Table 2.4-1: RSS-247 results for DTS

Part	Test description	Verdict
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3	Hybrid Systems	
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (f)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Unwanted emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	March 5, 2020
Nemko sample ID number	# 2

3.2 EUT information

Product type	Brail reader with BLE and Wi-Fi module
Model	BRQT40
Serial number	PROTO # 12
Software version	0d436ed81629f2f3cea04c556cfae38ac06be5d3

3.3 Technical information

Applicant ISED company number	8670A
ISED UPN number	BRQT40
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2412 (20 MHz channel); 2422 (40 MHz channel)
Frequency Max (MHz)	2462 (20 MHz channel); 2452 (40 MHz channel)
RF power Max (W), Conducted	0.22
Field strength, dB μ V/m @ 3 m	N/A
Measured BW (MHz), 99% OBW	19.11 (20 MHz channel); 36 (40 MHz channel)
Type of modulation	802.11b/g/n-HT20/n-HT40
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, dB μ V/m @ 3 m	39.28 dB μ V/m Quasi-peak@ 47.78 MHz at low channel
Power requirements	120 V _{AC} , 60 Hz
Antenna information & Gain	Antenova SR4W035. Gain of 3.5 dBi (Peak) and -1.5 dBi (Average - Linear)

3.4 Product description and theory of operation

- The EUT is a Braille Reader with 40 Braille cells with WIFI, BT.
- The EUT can be used to take notes using a Perkins keyboard, read books using the Braille cells.
- The EUT is powered by a Li-Ion battery that is recharged via a USB Type C port.
- The EUT has USB Type A, USB Type C and SD card port accessible to the user.

3.5 EUT exercise details

- The EUT runs a braille sequence continuously to create power spikes in the device.
- The EUT plays a song on the speaker and the headphones at the same time.
- The EUT is constantly transferring data from the SD card to the internal memory.
- The EUT is powered by the battery and the USB C connector at the same time.
- The firmware inside the EUT is the standard version used in development with no specific software settings.
- An SSH connection is established between the test PC and the EUT. This way, commands can be issued easily to the EUT to activate, modify and deactivate the Wifi capabilities. These capabilities are controlled using packages provided by FN-Link to control the Wifi module.
- Wifi package : rtwpriv_arm

3.6 EUT setup diagram

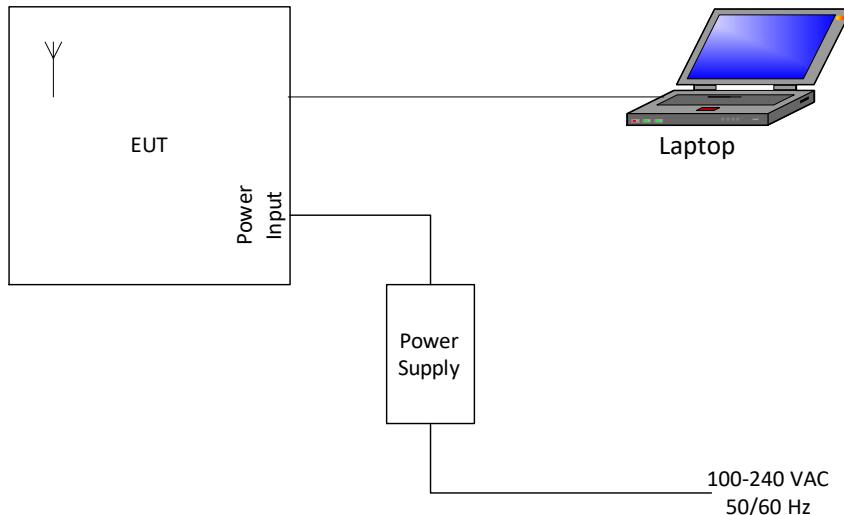


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
BRQT40	HumanWare	MN: BRQT40, PN: ASSY-0170	SN: PROTO # 12
AC/DC Adapter	INNO VISION INTERNATIONAL HOLDINGS LTD	MN: IN - CA - 310	N/A

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

As per customer, the PCB of BRQT40 unit (Q102168570) is same identical as BR20 unit (Q102163149r3) and the antenna, antenna gain is also same. In this report, we used technical data from BR20 (Q102163149r3) project except radiated emissions result.

The EUT can be powered either via internal batteries or via and external power adapter. All testing has been performed with the EUT powered via the external power adapter as representative worst case instructed by the customer.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Table 6.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber (Emissions)	TDK	SAC-3	FA002532e	2 year	February 25, 2022
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
3 Phase AC Power Source	apc AC Power	45 kVA	FA002677	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	December 9, 2020
Pre-amplifier (0.5–18 GHz)	Com-Power	PAM-118A	FA002561	1 year	September 18, 2020
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	January 28, 2021
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	February 5, 2021
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	April 12, 2020
2.4 GHz band Notch Filter	Microwave Circuits	N0324413	FA002693	—	VOU
Pre-amplifier (18–40 GHz)	Com-Power	PAM-840	FA002508	1 year	September 20, 2020
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	September 11, 2020
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002831	—	VOU

Note: NCR - no calibration required, VOU - verify on use



Section 8. Testing data

8.1 FCC 15.31(e) Variation of power source

8.1.1 Definitions and limits

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.1.2 Test date

Start date	November 21, 2019
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8.1.3 Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

- a) Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.
- b) For devices where operating at a supply voltage deviating $\pm 15\%$ from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.
- c) For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.
- d) For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

8.1.4 Test data

EUT Power requirements:

AC DC Battery

If EUT is an AC or a DC powered, was the noticeable output power variation observed?

YES NO N/A

If EUT is battery operated, was the testing performed using fresh batteries?

YES NO N/A

If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?

YES NO N/A

8.2 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies

8.2.1 Definitions and limits

FCC:

Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

ISED:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.2-1: Frequency Range of Operation

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Note: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.2.2 Test date

Start date

November 22, 2019

8.2.3 Observations, settings and special notes

Per ANSI C63.10 Subclause 5.6.2.1:

The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

- a) For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.
- b) If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

Per ANSI C63.10 Subclause 5.6.2.2:

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

- a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

8.2.4 Test data

Table 8.2-2: Test channels selection for 20 MHz channel

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2412	2437	2462

Table 8.2-3: Test channels selection for 40 MHz channel

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2422	2437	2452

8.3 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement

8.3.1 Definitions and limits

FCC:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

ISED:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.3.2 Test date

Start date

November 22, 2019

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

Must the EUT be professionally installed?

YES NO

Does the EUT have detachable antenna(s)?

YES NO

If detachable, is the antenna connector(s) non-standard?

YES NO N/A

8.4 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.4.1 Definitions and limits

FCC:

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

ANSI: C63.10 subclause 6.2

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

IC:

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.4-1: Conducted emissions limit

Frequency of emission, MHz	Quasi-peak	Conducted limit, dBμV	Average**
0.15–0.5	66 to 56*	56 to 46*	
0.5–5	56	46	
5–30	60	50	

Note: * - The level decreases linearly with the logarithm of the frequency.

** - A linear average detector is required.

**Section 8****Test name****Specification***Testing data**FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits**FCC Part 15 Subpart C and RSS-Gen, Issue 5***8.4.2 Test date****Start date**

November 1, 2019

8.4.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

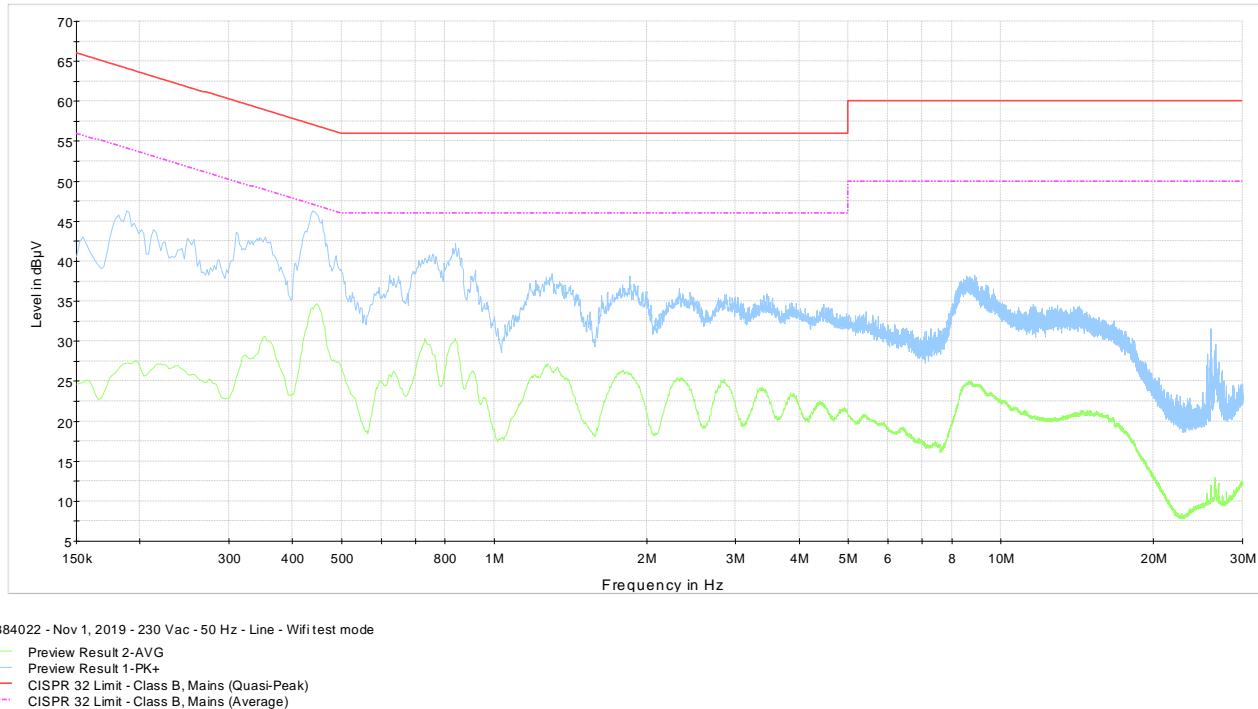
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.4.4 Test data



Plot 8.4-1: Conducted emissions on phase line

Table 8.4-2: Quasi-Peak conducted emissions results on phase line

Frequency, MHz	Q-Peak result, dB μ V	Correction, dB	Margin, dB	Limit, dB μ V
0.1883	35.7	10.1	28.4	64.1
0.4403	41.6	10.1	15.5	57.1
0.8408	36.4	9.9	19.6	56.0
1.8533	30.7	9.9	25.3	56.0
3.4530	28.8	10.0	27.2	56.0
8.5560	29.9	10.2	30.1	60.0
25.9975	22.2	10.8	37.8	60.0

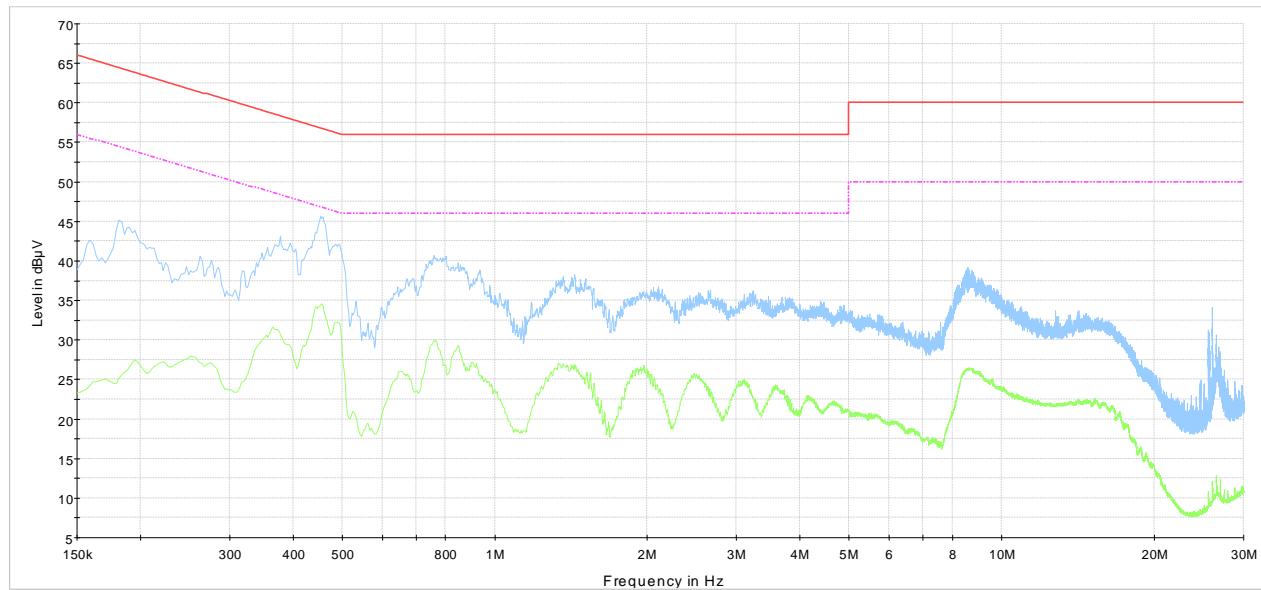
Note: $35.7 \text{ dB}\mu\text{V} = 15.4 \text{ dB}\mu\text{V} (\text{receiver reading}) + 10.1 \text{ dB} (\text{LISN factor IL}) + 0.2 \text{ dB} (\text{cable loss}) + 10 \text{ dB} (\text{attenuator})$

Table 8.4-3: Average conducted emissions results on phase line

Frequency, MHz	Average result, dB μ V	Correction, dB	Margin, dB	Limit, dB μ V
0.1973	27.2	10.0	26.5	53.7
0.4470	34.2	10.1	12.7	46.9
0.8385	28.9	9.9	17.1	46.0
1.7948	24.4	9.9	21.6	46.0
3.3810	21.8	10.0	24.2	46.0
8.7338	23.8	10.2	26.2	50.0
26.4475	9.6	10.8	40.4	50.0

Note: $27.2 \text{ dB}\mu\text{V} = 6.9 \text{ dB}\mu\text{V} (\text{receiver reading}) + 10.1 \text{ dB} (\text{LISN factor IL}) + 0.2 \text{ dB} (\text{cable loss}) + 10 \text{ dB} (\text{attenuator})$

8.4.4 Test data, Continued



NEX-384022 - Nov 1, 2019 - 230 Vac - 50 Hz - Neutral - Wifi test mode

— Preview Result 2-AVG
— Preview Result 1-PK+
— CISPR 32 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 32 Limit - Class B, Mains (Average)

Plot 8.4-2: Conducted emissions on neutral line

Table 8.4-4: Quasi-Peak conducted emissions results on neutral line

Frequency, MHz	Q-Peak result, dB μ V	Correction, dB	Margin, dB	Limit, dB μ V
0.1815	35.1	10.2	29.3	64.4
0.4583	36.8	10.1	19.9	56.7
0.7598	32.1	10.0	23.9	56.0
1.3650	29.3	9.9	26.7	56.0
8.5673	31.2	10.2	28.8	60.0
26.0290	15.2	10.9	44.8	60.0

Note: 35.1 dB μ V = 14.8 dB μ V (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.4-5: Average conducted emissions results on neutral line

Frequency, MHz	Average result, dB μ V	Correction, dB	Margin, dB	Limit, dB μ V
0.3705	27.6	10.0	20.8	48.5
0.4560	30.7	10.1	16.1	46.8
0.7620	25.3	10.0	20.7	46.0
1.3358	22.3	9.9	23.7	46.0
1.9680	24.0	9.9	22.0	46.0
8.5988	25.3	10.2	24.7	50.0

Note: 27.6 dB μ V = 7.3 dB μ V (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.5 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

8.5.1 Definitions and limits

FCC:

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

ISED:

The minimum 6 dB bandwidth shall be 500 kHz.

8.5.2 Test date

Start date

December 12, 2019

8.5.3 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.2 with reference to ANSI C63.10 subclause 11.8.

Spectrum analyser settings: 6 dB BW test:

Resolution bandwidth	100 kHz (20 MHz and 40 MHz channel)
Video bandwidth	$\geq 3 \times$ RBW for (20 MHz and 40 MHz channel)
Frequency span	30 MHz for 20 MHz channel and 80 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

The test was performed as per KDB 558074, section 8.2 with reference to ANSI C63.10 subclause 11.8.

Spectrum analyser settings: 99% occupied bandwidth test:

Resolution bandwidth	200 kHz (CCK modulation – 20 MHz); 1 MHz (OFDM, 802.11n.HT20 – 20 MHz); 1 MHz (802.11n.HT40 – 40 MHz) channel
Video bandwidth	$\geq 3 \times$ RBW for (20 MHz and 40 MHz channel)
Frequency span	30 MHz for 20 MHz channel and 80 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.5.4 Test data, CCK Modulation

Table 8.5-1: 6 dB bandwidth results

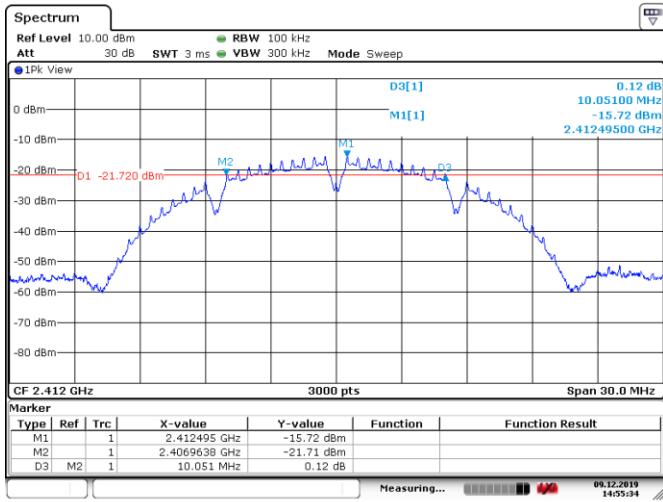
Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
2412	10.05	0.50	9.55
2437	9.96	0.50	9.46
2462	10.07	0.50	9.57

Table 8.5-2: 99% occupied bandwidth results

Frequency, MHz	99% occupied bandwidth, MHz
2412	14.93
2437	14.92
2462	14.93

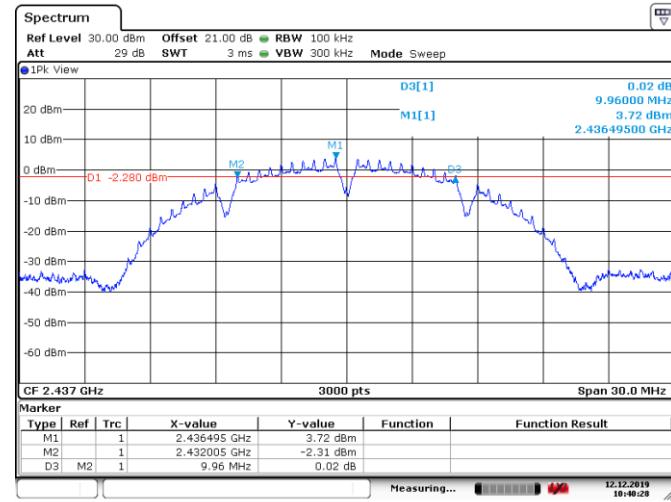
Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

8.5.3 Test data, CCK Modulation Continued,



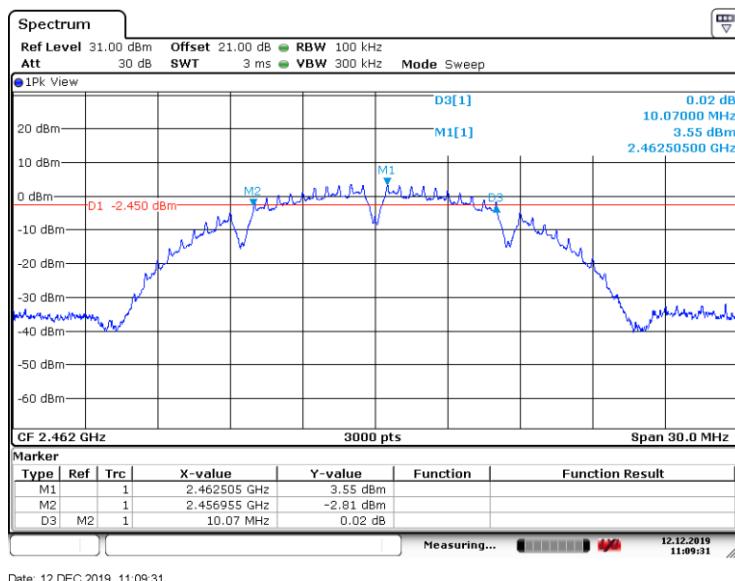
Date: 9.DEC.2019 14:55:34

Figure 8.5-1: 6 dB bandwidth on low channel



Date: 12.DEC.2019 10:40:28

Figure 8.5-2: 6 dB bandwidth on mid channel



Date: 12.DEC.2019 11:09:31

Figure 8.5-3: 6 dB bandwidth on high channel

8.5.3 Test data, CCK Modulation Continued

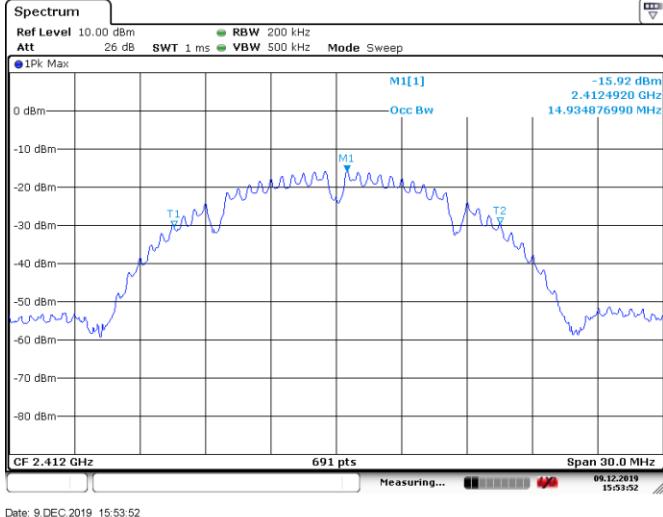


Figure 8.5-4: 99% occupied bandwidth on low channel

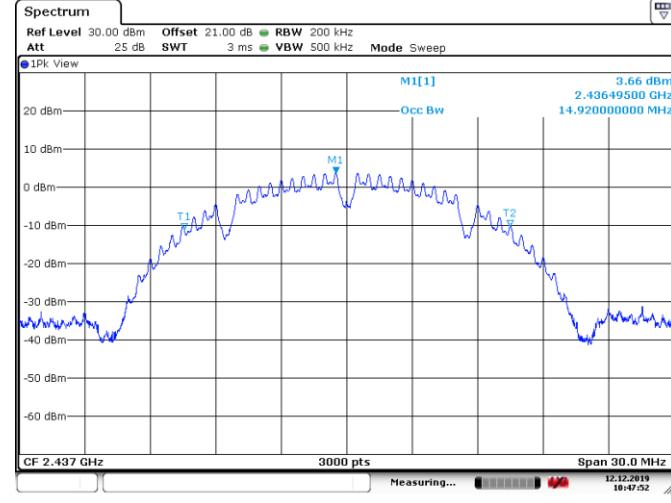


Figure 8.5-5: 99% occupied bandwidth on mid channel

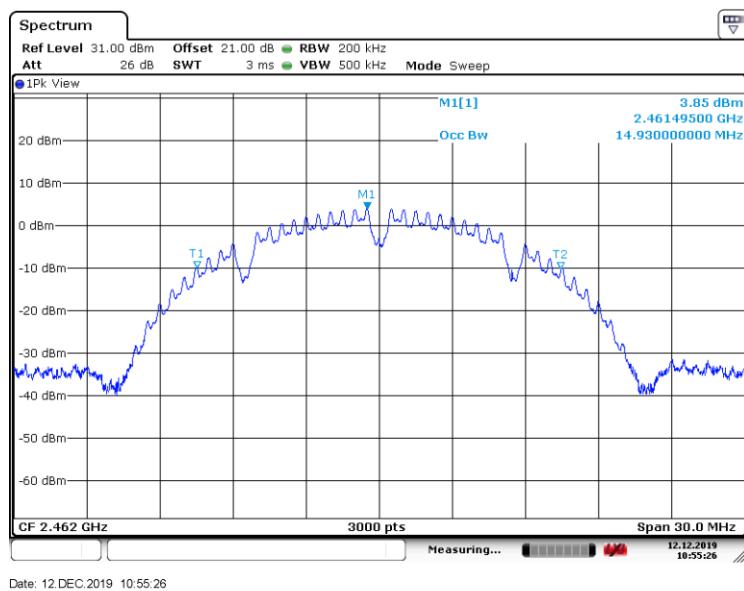


Figure 8.5-6: 99% occupied bandwidth on high channel

8.5.4 Test data, OFDM (g) Modulation

Table 8.5-3: 6 dB bandwidth results

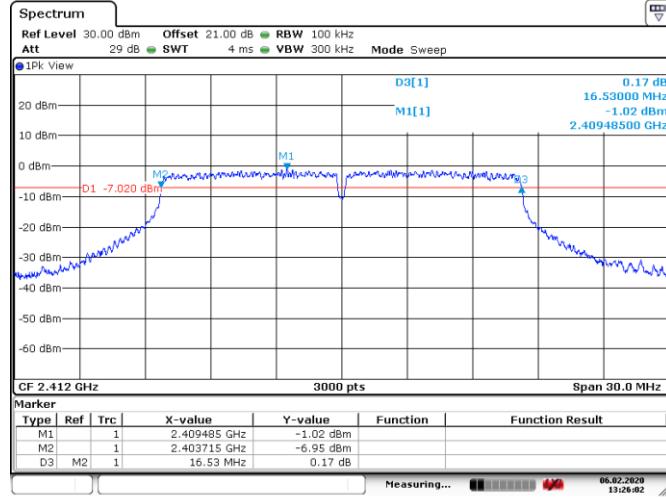
Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
2412	16.53	0.50	16.03
2437	16.53	0.50	16.03
2462	16.54	0.50	16.04

Table 8.5-4: 99% occupied bandwidth results

Frequency, MHz	99% occupied bandwidth, MHz
2412	18.35
2437	18.35
2462	18.33

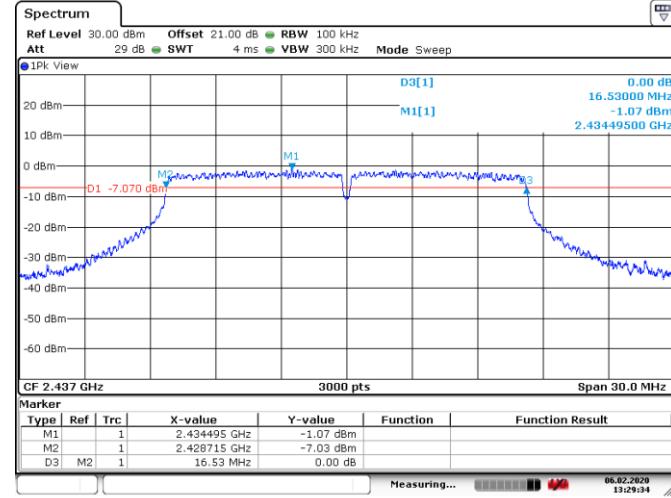
Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

8.5.5 Test data, OFDM (g) Modulation, Continued



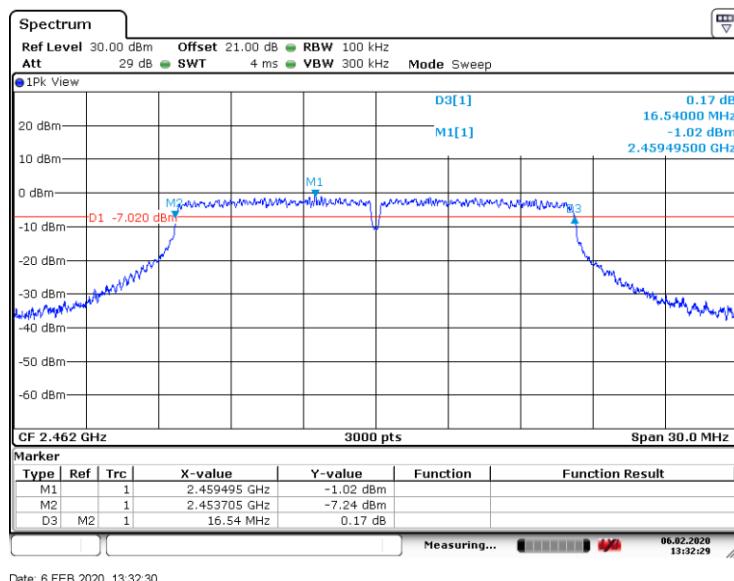
Date: 6 FEB. 2020 13:26:02

Figure 8.5-7: 6 dB bandwidth on low channel



Date: 6 FEB. 2020 13:29:34

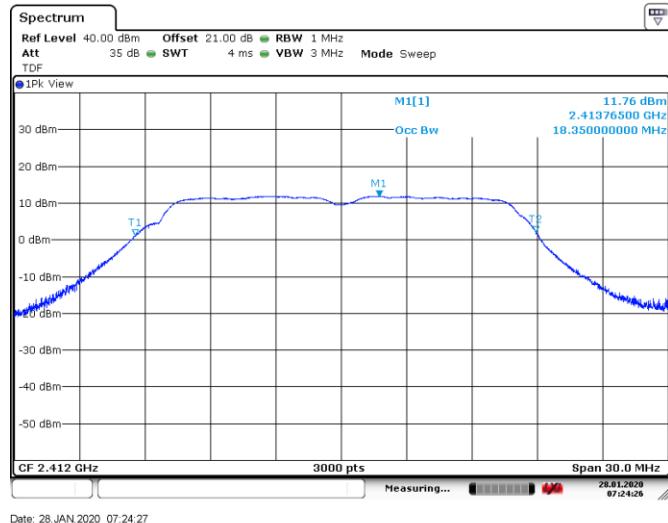
Figure 8.5-8: 6 dB bandwidth on mid channel



Date: 6 FEB. 2020 13:32:30

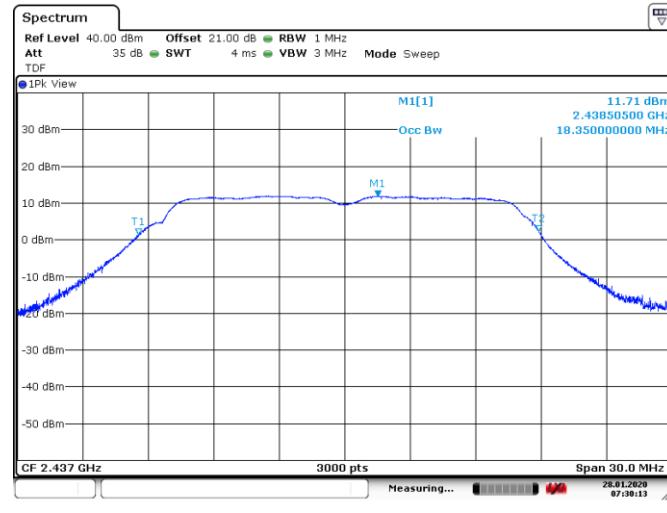
Figure 8.5-9: 6 dB bandwidth on high channel

8.5.6 Test data, OFDM (g) Modulation, Continued



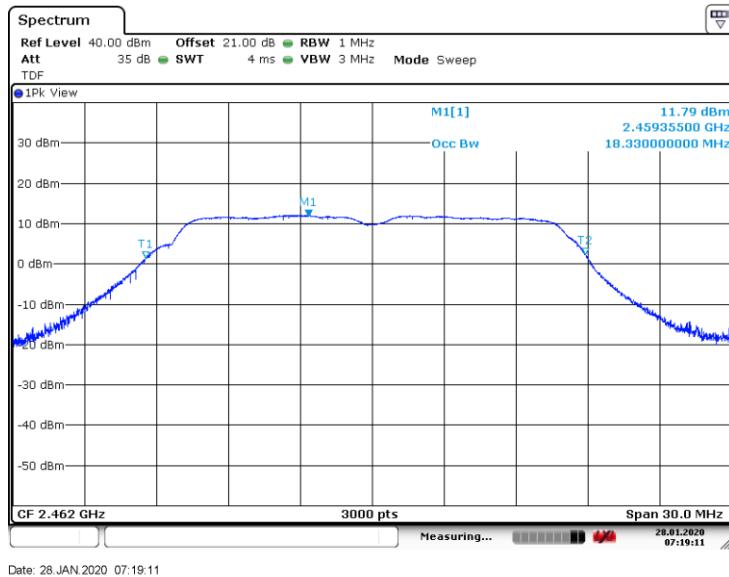
Date: 28 JAN 2020 07:24:27

Figure 8.5-10: 99% occupied bandwidth on low channel



Date: 28 JAN 2020 07:30:13

Figure 8.5-11: 99% occupied bandwidth on mid channel



Date: 28 JAN 2020 07:19:11

Figure 8.5-12: 99% occupied bandwidth on high channel

8.5.7 Test data, OFDM (802.11n.HT20) Modulation

Table 8.5-5: 6 dB bandwidth results

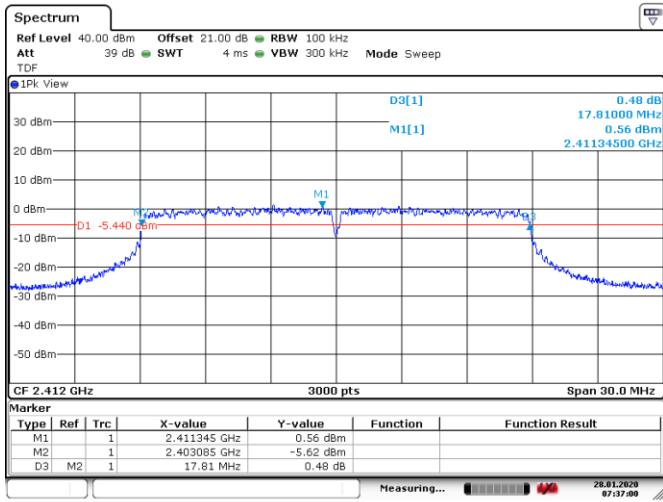
Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
2412	17.81	0.50	17.31
2437	17.81	0.50	17.31
2462	17.82	0.50	17.32

Table 8.5-6: 99% occupied bandwidth results

Frequency, MHz	99% occupied bandwidth, MHz
2412	19.09
2437	19.08
2462	19.11

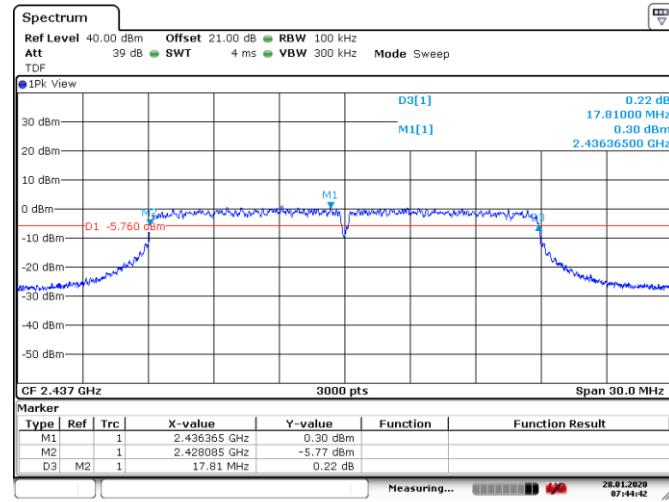
Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

8.5.5 Test data, OFDM (802.11n.HT20) Modulation, Continued,



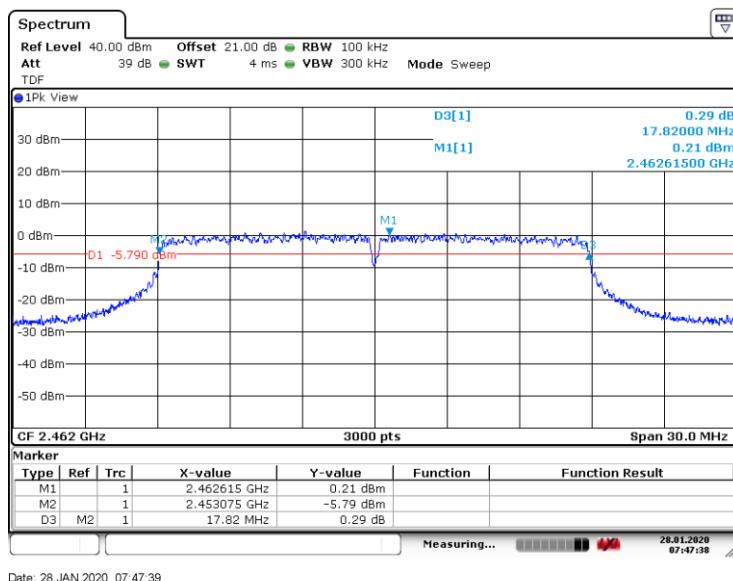
Date: 28.JAN.2020 07:37:00

Figure 8.5-13: 6 dB bandwidth on low channel



Date: 28.JAN.2020 07:44:43

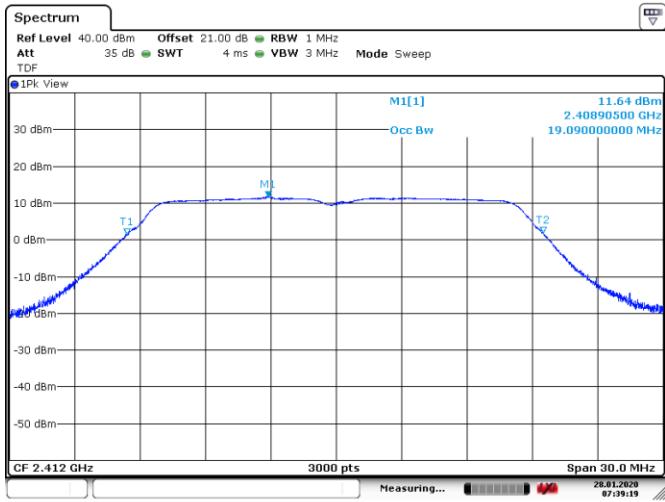
Figure 8.5-14: 6 dB bandwidth on mid channel



Date: 28.JAN.2020 07:47:39

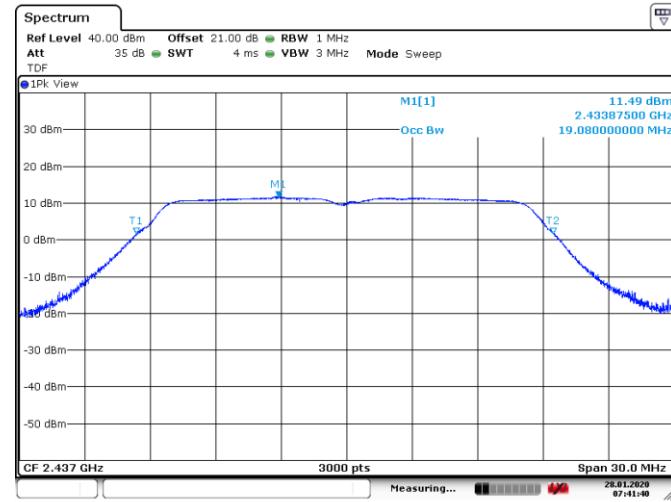
Figure 8.5-15: 6 dB bandwidth on high channel

8.5.5 Test data, OFDM (802.11n.HT20) Modulation, Continued,



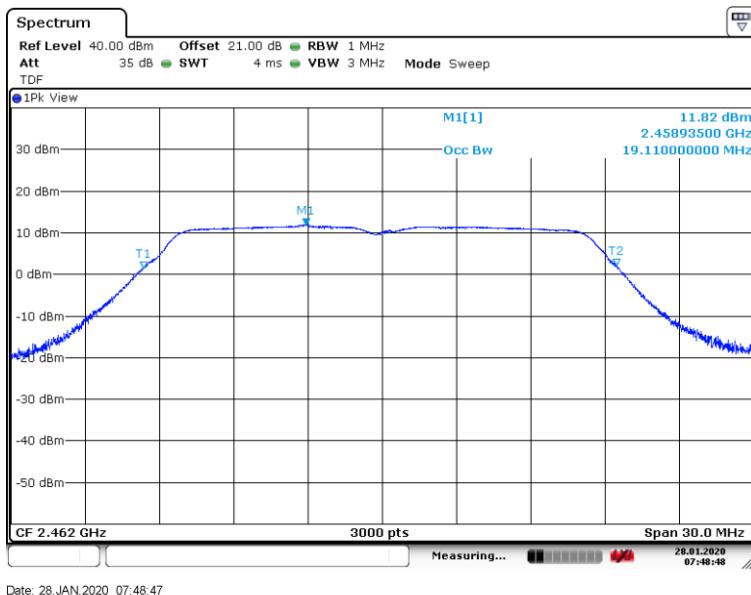
Date: 28.JAN.2020 07:39:19

Figure 8.5-16: 99% occupied bandwidth on low channel



Date: 28.JAN.2020 07:41:40

Figure 8.5-17: 99% occupied bandwidth on mid channel



Date: 28.JAN.2020 07:48:48

Figure 8.5-18: 99% occupied bandwidth on high channel

8.5.6 Test data, OFDM (802.11n.HT40) Modulation

Table 8.5-7: 6 dB bandwidth results

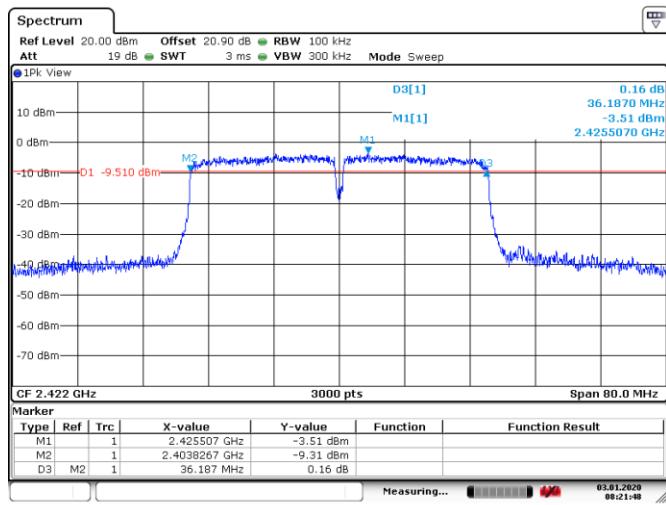
Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
2422	36.18	0.50	35.68
2437	36.24	0.50	35.74
2452	36.11	0.50	35.61

Table 8.5-8: 99% occupied bandwidth results

Frequency, MHz	99% occupied bandwidth, MHz
2422	36.00
2437	36.00
2452	36.00

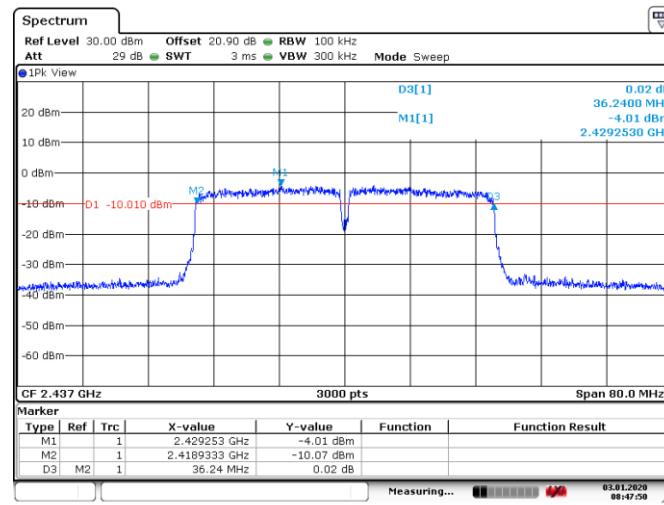
Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

8.5.6 Test data, OFDM (802.11n.HT40) Modulation, Continued



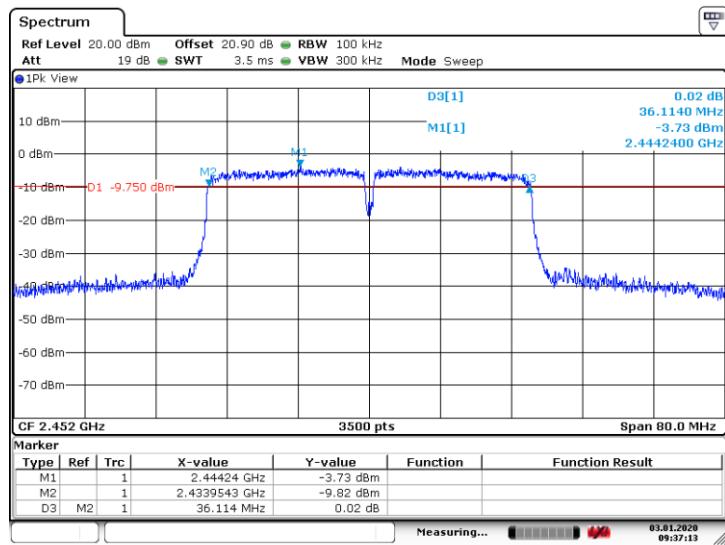
Date: 3.JAN.2020 08:21:49

Figure 8.5-19: 6 dB bandwidth on low channel



Date: 3.JAN.2020 08:47:51

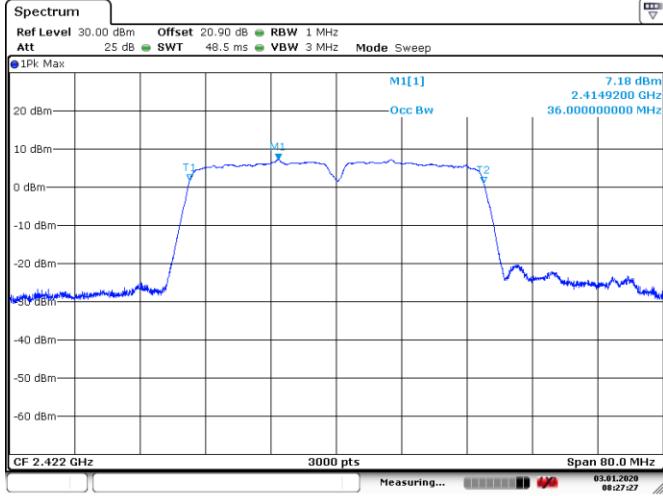
Figure 8.5-20: 6 dB bandwidth on mid channel



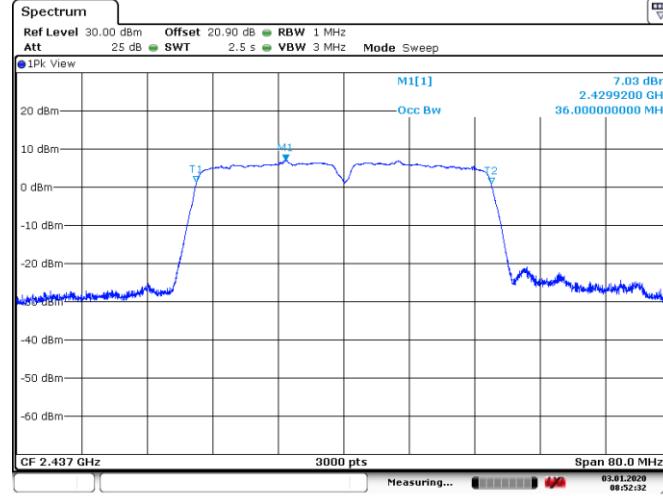
Date: 3.JAN.2020 09:37:13

Figure 8.5-21: 6 dB bandwidth on high channel

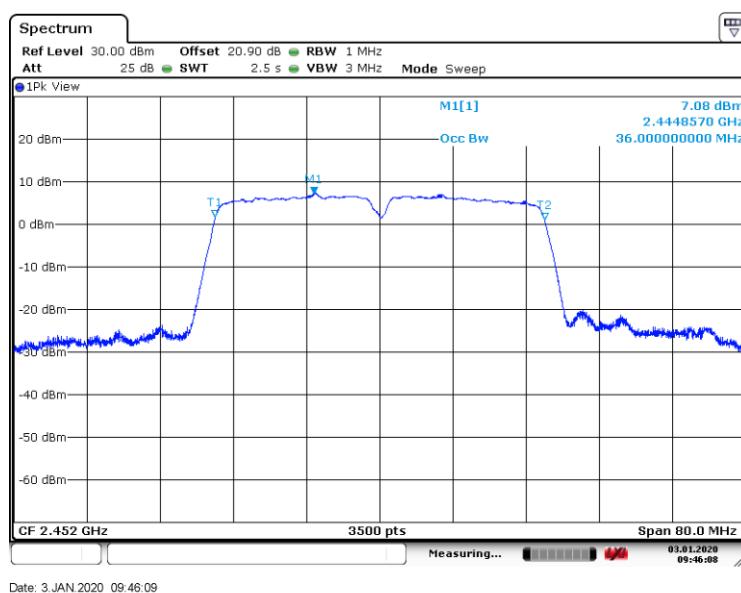
8.5.6 Test data, OFDM (802.11n.HT40) Modulation, Continued



Date: 3.JAN.2020 08:27:27



Date: 3.JAN.2020 08:52:32



Date: 3.JAN.2020 09:46:09

8.6 FCC 15.247(b) and RSS-247 5.4(d) Transmitter output power and e.i.r.p. requirements for DTS in 2 GHz (Wifi)

8.6.1 Definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (3) For systems using digital modulation in the 2400–2483.5 MHz band: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control 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.
- (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

- (i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
- (iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

- (i) Different information must be transmitted to each receiver.
- (ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:
 - (A) The directional gain shall be calculated as the sum of $10 \log$ (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.
 - (B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.
- (iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.
- (iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

**Section 8****Test name****Specification***Testing data**FCC 15.247(b) and RSS-247 5.4(d) Transmitter output power and e.i.r.p. requirements**FCC Part 15 Subpart C and RSS-247, Issue 2***ISED:**

d. For DTSs employing digital modulation techniques operating in the 2400–2483.5 MHz band, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

e. Fixed point-to-point systems in the 2400–2483.5 MHz band are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

f. Transmitters operating in the band 2400–2483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

i Different information must be transmitted to each receiver.

ii If the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable output power limit specified in sections 5.4(b) and 5.4(d). However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

iii If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 5.4(b) and 5.4(d). If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 5.4(b) and 5.4(d). In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 5.4(b) and 5.4(d) by more than 8 dB.

iv Transmitters that transmit a single directional beam shall operate under the provisions of sections 5.4(b), 5.4(d) and 5.4(e).

8.6.1 Test date

Start date	December 23, 2019
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8.6.2 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.3 with reference to ANSI C63.10 subclause 11.9.1

The test was performed using Integrated band power method

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥3 × RBW
Frequency span	40 MHz for 20 MHz channel and 80 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.6.3 Test data, CCK Modulation

Table 8.6-1: Output power measurements results

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
2412	17.02	30	12.98	3.5	20.52	36	15.48
2437	16.97	30	13.03	3.5	20.47	36	15.53
2462	17.05	30	12.95	3.5	20.55	36	15.45