# TEST REPORT

**KCTL Inc.**
65, Sinwon-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 443-390, Korea
TEL: 82 70 5008 1021
FAX: 82 505 299 8311



http://www.kctl.co.kr

**1. Applicant**

| | |
|---|---|
| Name: | HUMAX Co., Ltd |
| Address: | HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, South Korea |

**2. Sample Description:**

| | |
|---|---|
| FCC ID: | O6ZH3 |
| IC ID: | 6117A-H3 |
| Type of equipment: | OTT BOX |
| Basic Model: | H3 |
| Variant Model: | L3 |

**3. Date of Test:** June 30 ~ July 10, 2016

**4. Test standard used:** FCC Part 15 Subpart E, 15.407
RSS-247 Issue 1 May 2015
RSS GEN Issue 4 November 2014

**5. Test Results**

| | |
|---|---|
| Test Item: | Refer to page 8 |
| Result: | Complied (Refer to page 9 ~ page 120) |
| Measurement Uncertainty: | Refer to page 8 |

This result shown in this report refer only to the sample(s) tested unless otherwise stated.

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name: SEUNG MAN, JANG | Technical Manager<br>Name: CHANG MIN, KIM |

2016. 07. 13

**KCTL Inc.**

# [ Contents ]

# 1. Client information

| | |
|---|---|
| **Applicant:** | HUMAX Co., Ltd |
| **Address:** | HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, South Korea |
| **Telephone number:** | +82-31 776 6748 |
| **Facsimile number:** | +82-31 776 6029 |
| **Contact person:** | In Seok, Seo / isseo@humaxdigital.com |

| | |
|---|---|
| **Manufacturer:** | HUMAX Co., Ltd |
| **Address:** | HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, South Korea |

# 2. Laboratory information

**Address**

**KCTL Inc.**
65 Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea (443-390)
Telephone Number: +82-70-5008-1016  Facsimile Number: +82-505-299-8311

**Certificate**

KOLAS No.: KT231
FCC Site Designation No.: KR0040
FCC Site Registration No.: 687132
VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849
IC Site Registration No.:8035A-2

**SITE MAP**

# 3. Description of E.U.T.

## 3.1 Basic description

| | |
|---|---|
| Applicant | HUMAX Co., Ltd |
| Address of Applicant | HUMAX Village, 11-4, Sunae-dong, Bundang-gu,<br>Seongnam city, Gyeonggi-do, South Korea |
| Manufacturer | HUMAX Co., Ltd |
| Address of Manufacturer | HUMAX Village, 11-4, Sunae-dong, Bundang-gu,<br>Seongnam city, Gyeonggi-do, South Korea |
| Type of equipment | OTT BOX |
| Basic Model | H3 |
| Basic Model[1)] | L3 |
| Serial number | N/A |

[1)] : This variant model will be sold in Canada..

## 3.2 General description

| | |
|---|---|
| Frequency Range | 2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20),<br>2 402 ㎒ ~ 2 480 ㎒ (Bluetooth, Bluetooth Low Energy)<br>5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20)<br>5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40)<br>5 745 ㎒ ~ 5 825 ㎒ (802.11a/n_HT20),<br>5 755 ㎒ ~ 5 795 ㎒ (802.11n_HT40) |
| Type of Modulation | 802.11b: DSSS, 802.11a/g/n: OFDM,<br>Bluetooth: GFSK, π/4DQPSK, 8DPSK<br>Bluetooth Low Energy: GFSK |
| Number of Channels | 2.4 ㎓: 11 ch (802.11b/g/n_HT20), 79 ch (Bluetooth),<br>40 ch (Bluetooth Low Energy)<br>5 ㎓: 5 150 ㎒ Band: 4 (802.11a/n_HT20),<br>5 150 ㎒ Band: 2 (802.11n_HT40),<br>5 725 ㎒ Band: 5 (802.11a/n_HT20),<br>5 725 ㎒ Band: 2 (802.11n_HT40), |
| Type of Antenna | Chip Antenna |
| Antenna Gain | 2.4 ㎓: 2.28 ㏈i (2 400 ㎒ ~ 2 483.5 ㎒)<br>5 ㎓: 2.54 ㏈i (5 150 ㎒ ~ 5 725 ㎒)<br>3.22 ㏈i (5 725 ㎒ ~ 5 850 ㎒) |
| Transmit Power | 13.44 ㏈m |
| Power supply | DC 12 Ⅴ |
| Product SW/HW version | version 6.10.197.114 (r447587) FWID 01-8dde6027 / 1.0 |
| Radio SW/HW version | version 6.10.197.114 (r447587) FWID 01-8dde6027 / 1.0 |
| Test SW Version | rf test tool |
| RF power setting in TEST SW | 5 150 ㎒ Band: a: 8, n HT20: 8, n HT40: 8<br>5 725 ㎒ Band: a: 10, n HT20: 8, n HT40: 8 |

Note ： The above EUT information was declared by the manufacturer.

## 3.3 Test frequency

- 802.11a/n_HT20

| Frequency | Band 1 | Band 4 |
|---|---|---|
| Lowest frequency | 5 180 ㎒ | 5 745 ㎒ |
| Middle frequency | 5 200 ㎒ | 5 785 ㎒ |
| Highest frequency | 5 240 ㎒ | 5 825 ㎒ |

- 802.11n_HT40

| Frequency | Band 1 | Band 4 |
|---|---|---|
| Lowest frequency | 5 190 ㎒ | 5 755 ㎒ |
| Middle frequency | - | - |
| Highest frequency | 5 230 ㎒ | 5 795 ㎒ |

## 3.4 Test Voltage

| Mode | Voltage |
|---|---|
| Norminal voltage | DC 12 V |

## 3.5 Duty Factor

| Mode | Duty cycle [%] | Duty cycle factor [dB] |
|---|---|---|
| 802.11a_ANT 1, 2 | 96.72 | 0.15 |
| 802.11n HT20_ANT 1, 2 | 96.48 | 0.16 |
| 802.11n HT40_ANT 1, 2 | 93.13 | 0.31 |
| 802.11n HT20_MIMO (ANT 1+2) | 93.33 | 0.30 |
| 802.11n HT40_MIMO (ANT 1+2) | 87.69 | 0.57 |

Note: Duty cycle factor=10log(1/Duty cycle)

# 4. Summary of test results

## 4.1 Standards & results

| FCC Rule | IC Rule | Parameter | Report Section | Test Result |
|---|---|---|---|---|
| 15.203<br>15.407(a)(1)(2)(3) | - | Antenna Requirement | 5.1 | C |
| 15.407(a)(1)(2) | RSS-247, 5.4 | Maximum Conducted Output Power | 5.2 | C |
| 15.403(i),15.407(e) | RSS-247, 5.1<br>RSS-GEN, 6.6 | Bandwidth Measurement | 5.3 | C |
| 15.407(a)(1)(2)(5) | RSS-247, 5.3, (2) | Peak Power Spectral Density | 5.4 | C |
| 15.205(a),<br>15.209(a),<br>15.407(b)(1),<br>15.407(b)(2),<br>15.407(b)(3) | RSS-247, 5.5<br>RSS-GEN, 8.9, 10 | Spurious Emission, Band Edge and Restricted bands | 5.5 | C |
| 15.407(g) | RSS-GEN, 6.11 | Frequency Stability | 5.6 | C |
| 15.207(a) | RSS-GEN, 8.8 | Conducted Emissions | 5.7 | C |
| 15.407(h) | RSS-247, 6.3 | Dynamic Frequency Selection | - | N/A1) |
| Note: C = complies<br>NC = Not complies<br>NT = Not tested<br>NA = Not Applicable | | | | |

Note: The general test methods used to test this device is ANSI C63.10:2013

## 4.2 Uncertainty

| Measurement Item | Expanded Uncertainty<br>U = *k*Uc (*k* = 2) | |
|---|---|---|
| Conducted RF power | 1.44 dB | |
| Conducted Spurious Emissions | 1.52 dB | |
| Radiated Spurious Emissions | 30 ㎒ ~ 300 ㎒: | + 4.94 dB, - 5.06 dB |
| | | + 4.93 dB, - 5.05 dB |
| | 300 ㎒ ~ 1 000 ㎒: | + 4.97 dB, - 5.08 dB |
| | | + 4.84 dB, - 4.96 dB |
| | 1 ㎓ ~ 25 ㎓: | + 6.03 dB, - 6.05 dB |
| Conducted Emissions | 9 ㎑ ~ 150 ㎑: | 3.75 dB |
| | 150 ㎑ ~ 30 ㎒: | 3.36 dB |

# 5. Test results

## 5.1 Antenna Requirement

### 5.1.1 Regulation

According to §15.203, 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.

And according to §15.407(a)(1)(2)(3), If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

## 5.1.2 Result

-Complied

The transmitter has an integral Chip antenna and the total directional peak gain of the antenna exceeds 6.0 dBi

| | 5 150 ㎒ Band | 5 725 ㎒ Band |
|---|---|---|
| ANT 1 Gain | 2.54 dBi | 3.22 dBi |
| ANT 2 Gain | 2.54 dBi | 3.22 dBi |

According to KDB 662911 D01 Multiple Transmitter Output v02r01
- Directional gain = $G_{ANT}$ + Array Gain, where Array Gain is as follows.

For power measurements on IEEE 802.11 devices

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;

Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 ㎒ for any $N_{ANT}$;

Array Gain = 5 log($N_{ANT}/N_{SS}$) dB or 3 dB, whichever is less, for 20-㎒ channel widths with $N_{ANT} \geq 5$.

For power measurements on all other devices:

Array Gain = 10 log($N_{ANT}/N_{SS}$) dB.

For 5 150 ㎒ Band Total gain = 2.54 dBi (individual gain(2.54 dBi) + Array gain(0 dBi))

For 5 725 ㎒ Band Total gain = 3.22 dBi (individual gain(3.22 dBi) + Array gain(0 dBi))

For power spectral density (PSD) measurements on all devices,

Array Gain = 10 log($N_{ANT}/N_{SS}$) dB.

For 5 150 ㎒ Band Total gain = 5.55 dBi (individual gain(2.54 dBi) + Array gain(3.01 dBi))

For 5 725 ㎒ Band Total gain = 6.23 dBi (individual gain(3.22 dBi) + Array gain(3.01 dBi))

## 5.2 Maximum Conducted Output Power

### 5.2.1 Regulation

According to §15.407(a) (1) (ii) For an indoor access point operating in the band 5.15-5.25 ㎓, the maximumConducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 ㏈i. In addition, the maximum power spectral density shall not exceed 17 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

According to §15.407(a) (2) For the 5.25-5.35 ㎓ and 5.47-5.725 ㎓ bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 ㎽ or 11 ㏈m + 10 log B, where B is the 26 ㏈ emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈that the directional gain of the antenna exceeds 6 ㏈i.

According to §15.407(a) (3) For the band 5.725-5.85 ㎓, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 ㏈m in any 500-㎑ band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 ㏈i without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information.

The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

## 5.2.2 Measurement Procedure

These test measurement settings are specified in section C of 789033 D02 General UNII Test Procedures.

### 5.2.2.1 Method SA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction).

(i) Measure the duty cycle, x, of the transmitter output signal as described in section II.B.

(ii) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.

(iii) Set RBW = 1 MHz.

(iv) Set VBW ≥ 3 MHz.

(v) Number of points in sweep ≥ 2 × span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)

(vi) Sweep time = auto.

(vii) Detector = power averaging (rms), if available. Otherwise, use sample detector mode.

(viii) Do not use sweep triggering. Allow the sweep to "free run."

(ix) Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

(x) Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.

(xi) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25 %.

5.2.2.2 Method PM (Measurement using an RF average power meter):

(i) Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

• The EUT is configured to transmit continuously or to transmit with a constant duty cycle.

• At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.

• The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(ii) If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.

(iii) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

(iv) Adjust the measurement in dBm by adding 10 log(1/x) where x is the duty cycle (e.g., 10 log(1/0.25) if the duty cycle is 25 percent).

## 5.2.4 Test Result

## -Complied

- 5 150 Band

- Ant 1

-802.11a

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | 9.50 | 0.15 | 9.65 | 30.00 | 20.35 |
| 5 200 | 9.71 | 0.15 | 9.86 | 30.00 | 20.14 |
| 5 240 | 10.24 | 0.15 | 10.39 | 30.00 | 19.61 |

-802.11n HT20

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | 8.99 | 0.16 | 9.15 | 30.00 | 20.85 |
| 5 200 | 9.42 | 0.16 | 9.58 | 30.00 | 20.42 |
| 5 240 | 10.27 | 0.16 | 10.43 | 30.00 | 19.57 |

-802.11n_HT40

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 190 | 6.16 | 0.31 | 6.47 | 30.00 | 23.53 |
| 5 230 | 7.04 | 0.31 | 7.35 | 30.00 | 22.65 |

- Ant 2

-802.11a

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | 8.74 | 0.15 | 8.89 | 30.00 | 21.11 |
| 5 200 | 8.58 | 0.15 | 8.73 | 30.00 | 21.27 |
| 5 240 | 8.90 | 0.15 | 9.05 | 30.00 | 20.95 |

-802.11n HT20

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | 7.53 | 0.16 | 7.69 | 30.00 | 22.31 |
| 5 200 | 7.65 | 0.16 | 7.81 | 30.00 | 22.19 |
| 5 240 | 8.10 | 0.16 | 8.26 | 30.00 | 21.74 |

-802.11n_HT40

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 190 | 6.18 | 0.31 | 6.49 | 30.00 | 23.51 |
| 5 230 | 5.59 | 0.31 | 5.90 | 30.00 | 24.10 |

- MIMO (ANT 1+2)

-802.11n HT20

| Frequency [㎒] | Average power _ANT 1 [dBm] | Average power _ANT 2 [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|
| 5 180 | 9.44 | 8.45 | 0.30 | 12.28 | 30.00 | 17.72 |
| 5 200 | 9.91 | 8.65 | 0.30 | 12.64 | 30.00 | 17.36 |
| 5 240 | 10.73 | 8.92 | 0.30 | 13.23 | 30.00 | 16.77 |

-802.11n_HT40

| Frequency [㎒] | Average power _ANT 1 [dBm] | Average power _ANT 2 [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|
| 5 190 | 6.40 | 5.02 | 0.57 | 9.35 | 30.00 | 20.65 |
| 5 230 | 6.94 | 4.71 | 0.57 | 9.55 | 30.00 | 20.45 |

- 5 725 Band

- ANT 1

-802.11a

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 745 | 11.83 | 0.15 | 11.98 | 30.00 | 18.02 |
| 5 785 | 11.24 | 0.15 | 11.39 | 30.00 | 18.61 |
| 5 825 | 10.71 | 0.15 | 10.86 | 30.00 | 19.14 |

-802.11n HT20

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 745 | 9.28 | 0.16 | 9.44 | 30.00 | 20.56 |
| 5 785 | 8.55 | 0.16 | 8.71 | 30.00 | 21.29 |
| 5 825 | 7.89 | 0.16 | 8.05 | 30.00 | 21.95 |

-802.11n_HT40

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 755 | 7.33 | 0.31 | 7.64 | 30.00 | 22.36 |
| 5 795 | 7.28 | 0.31 | 7.59 | 30.00 | 22.41 |

- ANT 2

-802.11a

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 745 | 13.29 | 0.15 | 13.44 | 30.00 | 16.56 |
| 5 785 | 12.90 | 0.15 | 13.05 | 30.00 | 16.95 |
| 5 825 | 12.71 | 0.15 | 12.86 | 30.00 | 17.14 |

-802.11n HT20

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 745 | 9.74 | 0.16 | 9.90 | 30.00 | 20.10 |
| 5 785 | 9.62 | 0.16 | 9.78 | 30.00 | 20.22 |
| 5 825 | 9.48 | 0.16 | 9.64 | 30.00 | 20.36 |

-802.11n_HT40

| Frequency [㎒] | Average power [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 755 | 8.92 | 0.31 | 9.23 | 30.00 | 20.77 |
| 5 795 | 8.13 | 0.31 | 8.44 | 30.00 | 21.56 |

- MIMO (ANT 1+2)

-802.11n HT20

| Frequency [㎒] | Average power _ANT 1 [dBm] | Average power _ANT 2 [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|
| 5 745 | 5.51 | 5.40 | 0.30 | 8.77 | 30.00 | 21.23 |
| 5 785 | 4.64 | 5.40 | 0.30 | 8.35 | 30.00 | 21.65 |
| 5 825 | 4.08 | 5.32 | 0.30 | 8.05 | 30.00 | 21.95 |

-802.11n_HT40

| Frequency [㎒] | Average power _ANT 1 [dBm] | Average power _ANT 2 [dBm] | D.C.C.F [dB] | Result [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|
| 5 755 | 3.50 | 4.20 | 0.57 | 7.45 | 30.00 | 22.55 |
| 5 795 | 3.42 | 3.41 | 0.57 | 7.00 | 30.00 | 23.00 |

1. D.C.C.F = Duty cycle correction factor = 10log(1/Duty Cycle)

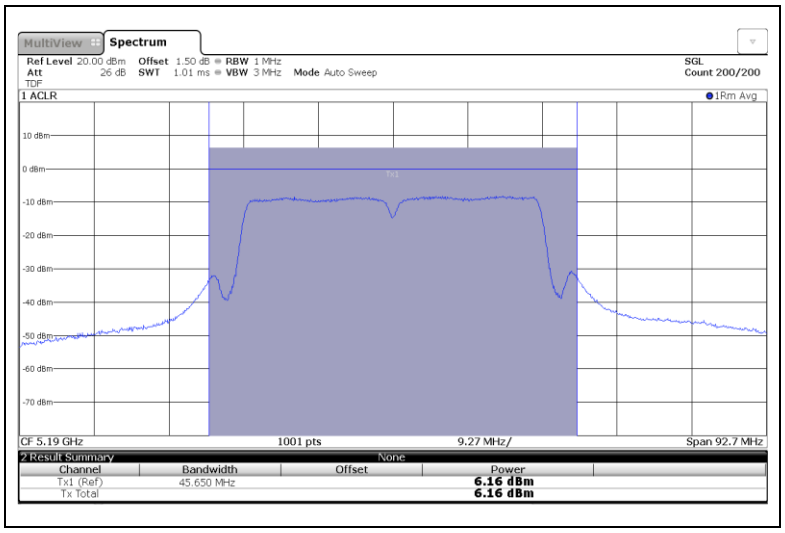
## 5.2.4 Test Plot

Figure 1. Conducted Output Power

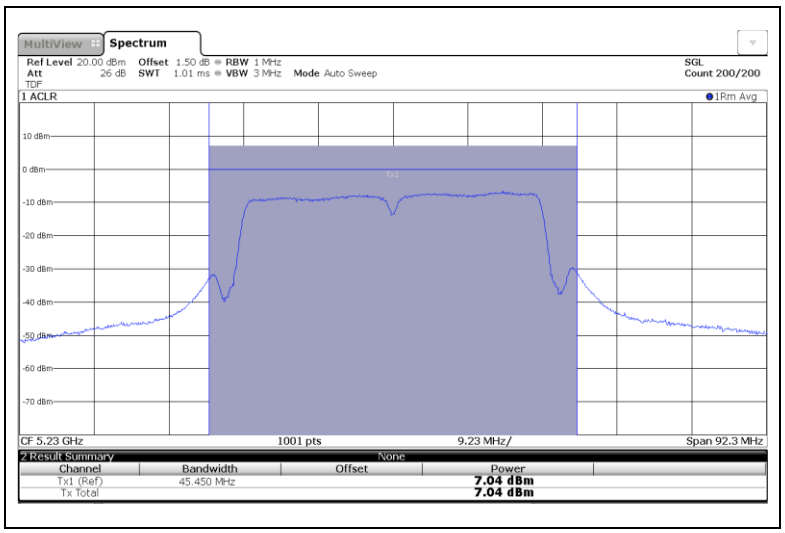
- 5 150 Band

- ANT 1

Lowest Channel (5 190 ㎒)

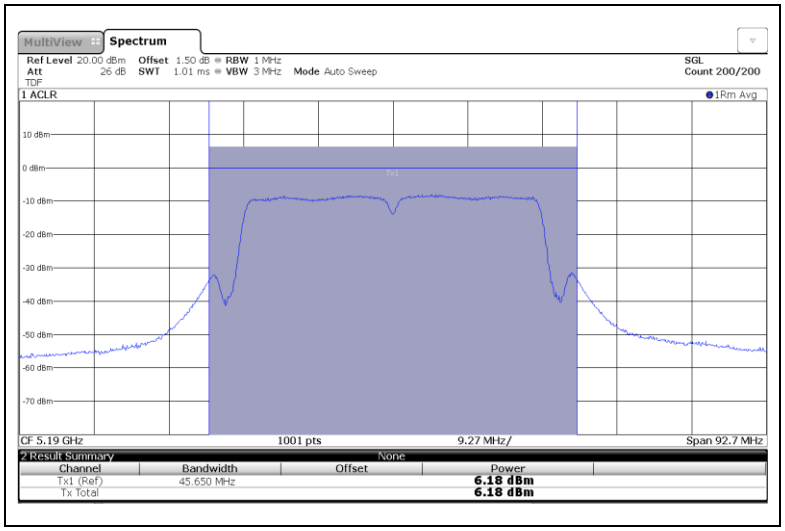



Highest Channel (5 230 ㎒)

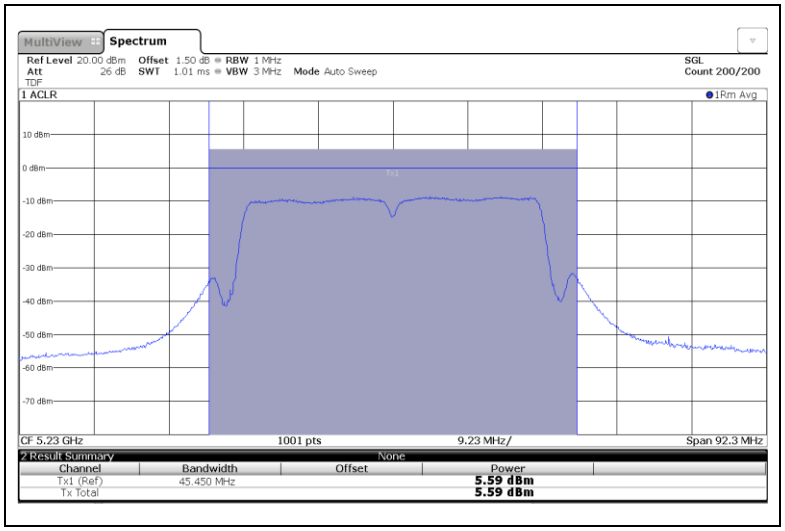


- ANT 2

Lowest Channel (5 190 ㎒)

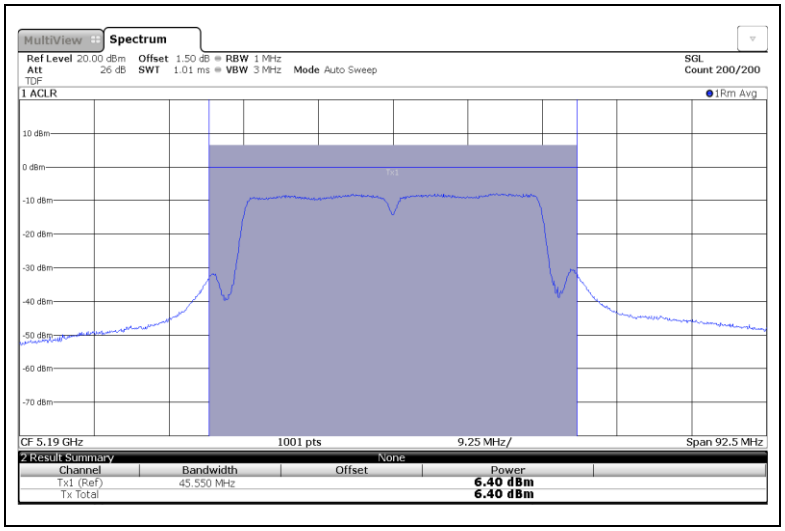



Highest Channel (5 230 ㎒)

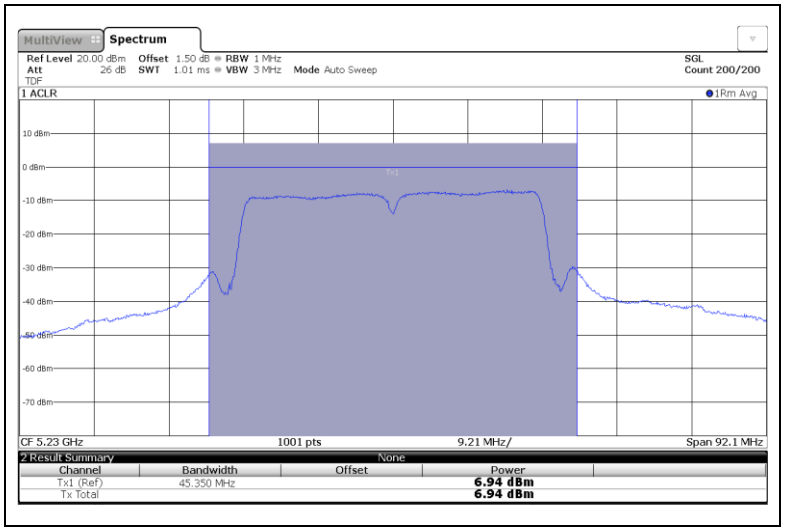


- MIMO (ANT 1)

Lowest Channel (5 190 ㎒)

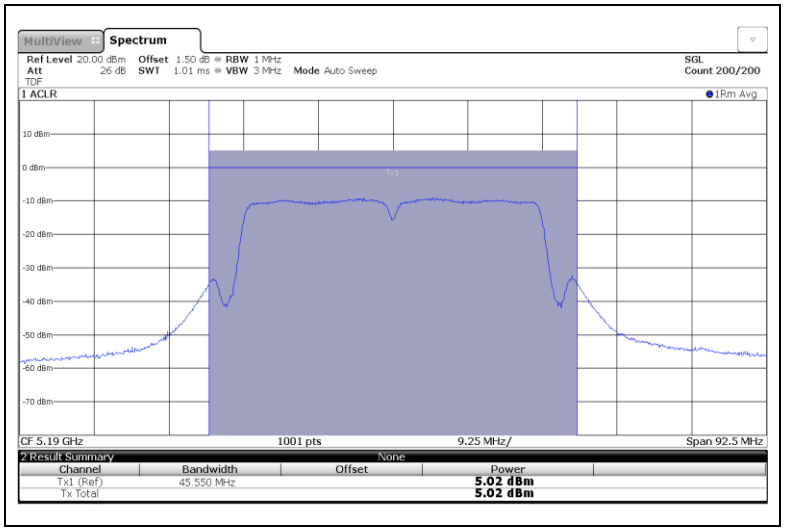



Highest Channel (5 230 ㎒)

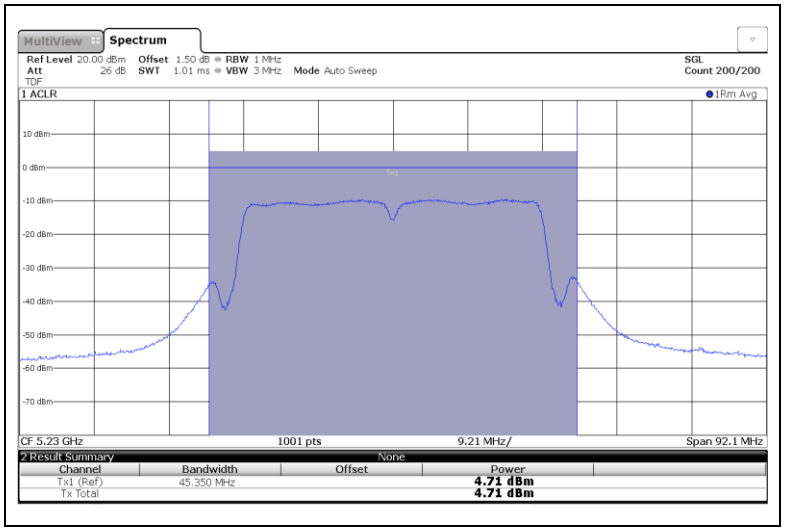


- MIMO (ANT 2)

Lowest Channel (5 190 ㎒)



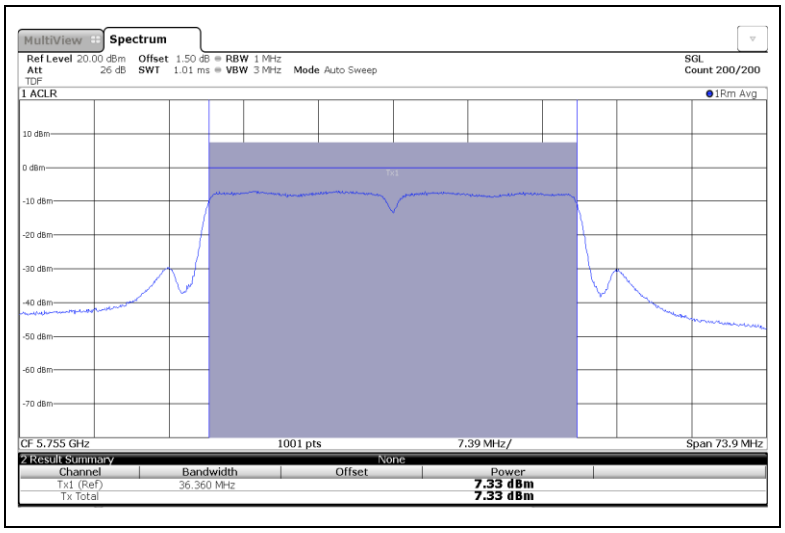

Highest Channel (5 230 ㎒)



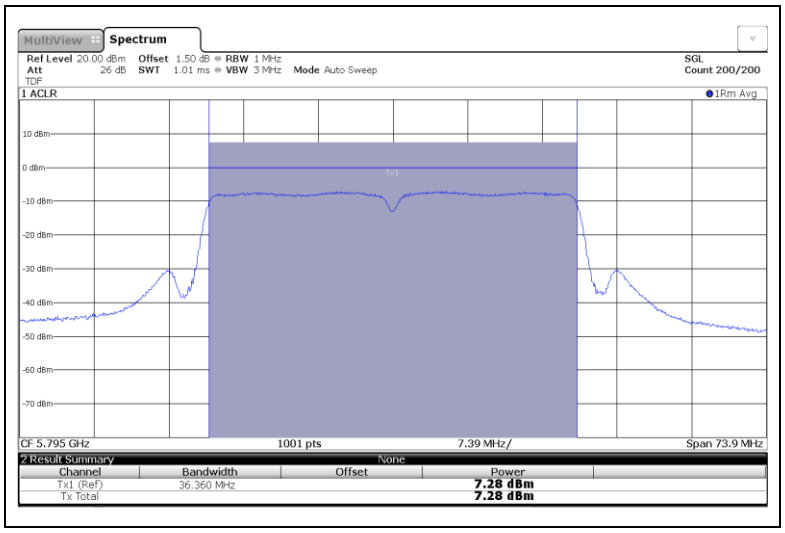
- 5 725 Band

- ANT 1

Lowest Channel (5 755 ㎒)

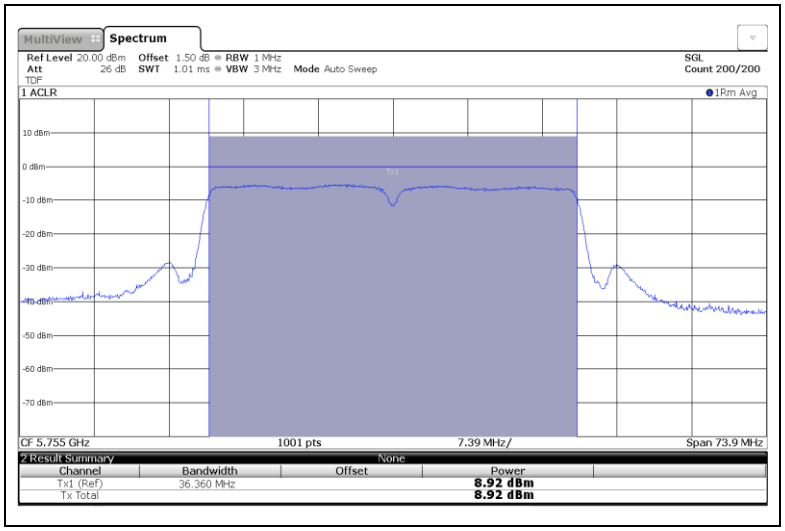



Highest Channel (5 795 ㎒)

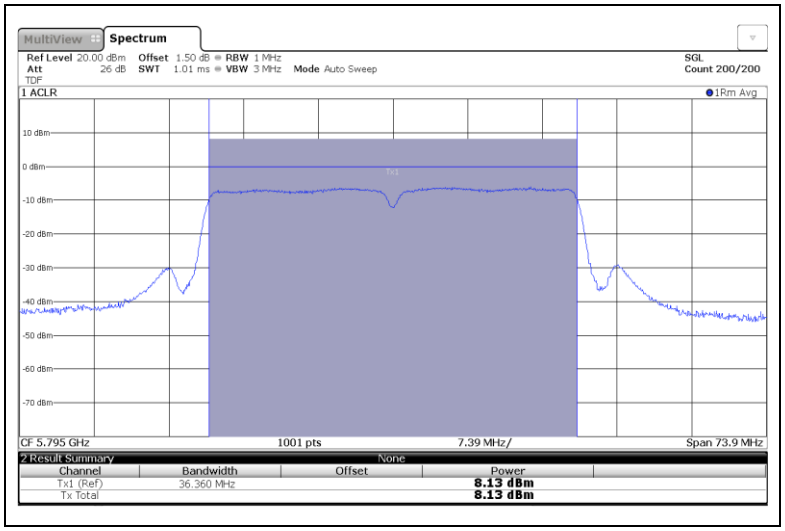


- ANT 2

Lowest Channel (5 755 ㎒)

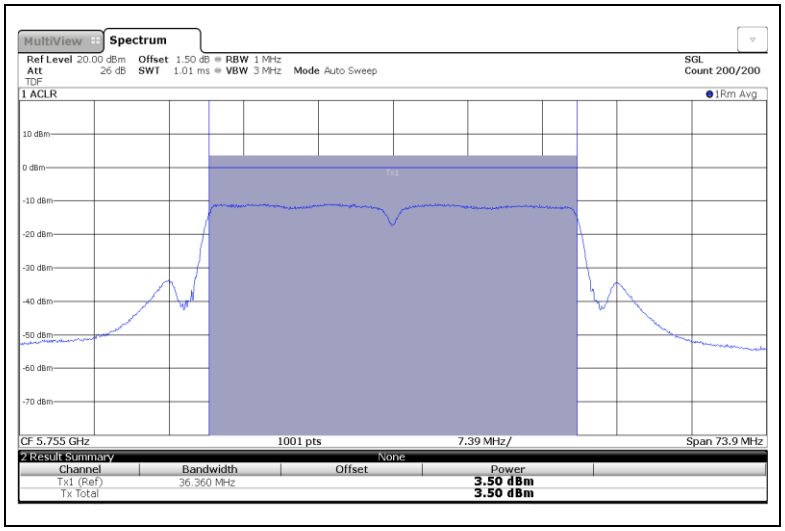



Highest Channel (5 795 ㎒)

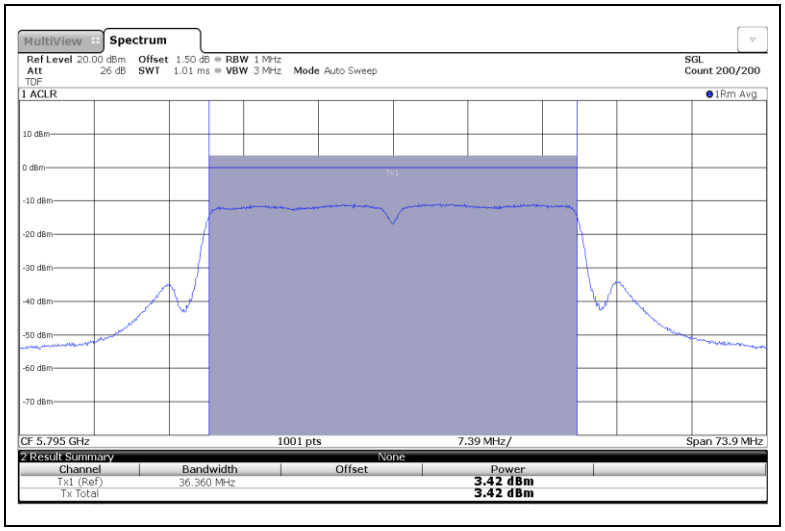


- MIMO (ANT 1)

Lowest Channel (5 755 ㎒)

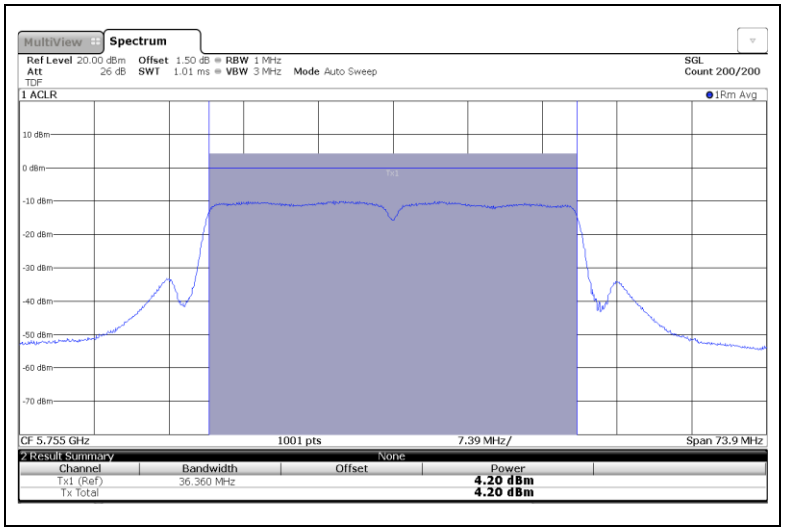



Highest Channel (5 795 ㎒)



- MIMO (ANT 2)

Lowest Channel (5 755 ㎒)




Highest Channel (5 795 ㎒)

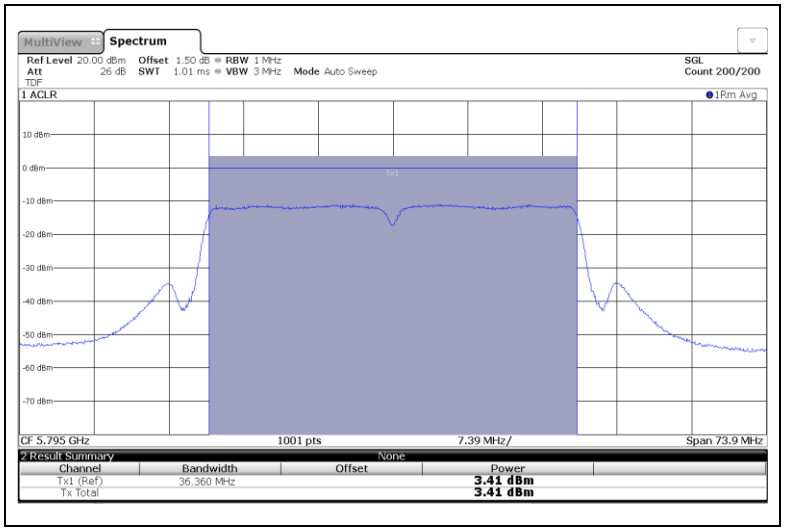
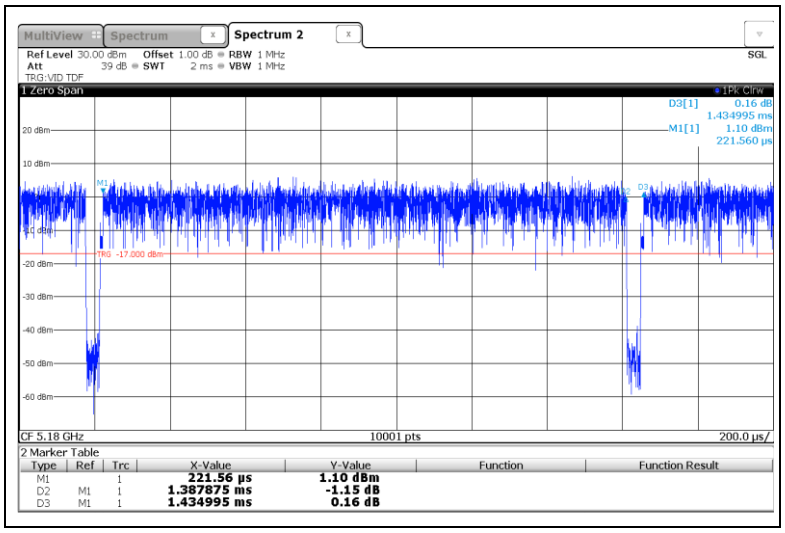


Figure 2. Duty Cycle

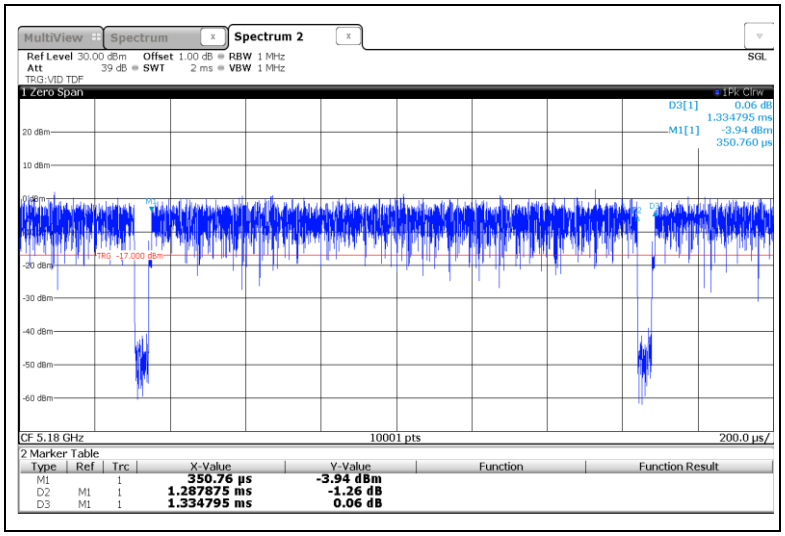
- ANT 1, 2

- 802.11a



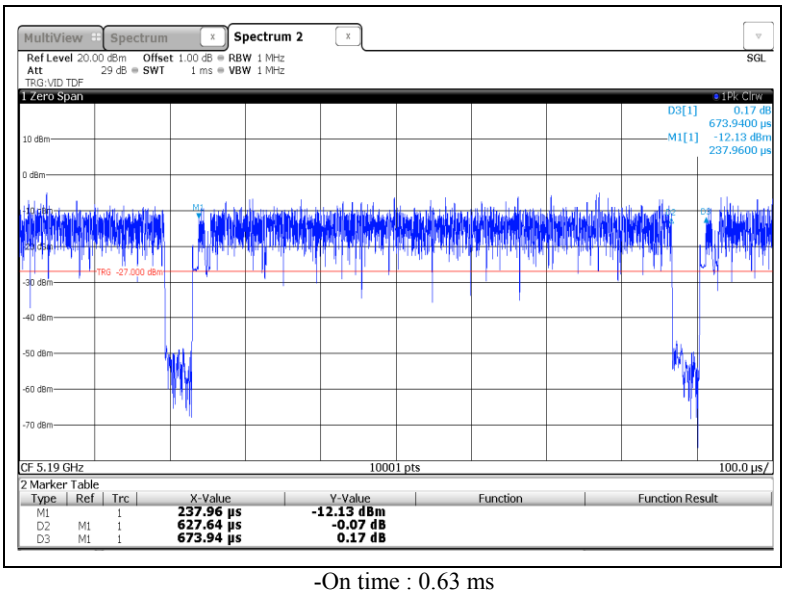

-On time : 1.39 ms
-Period : 1.43 ms
-Duty Cycle : 0.967 2
-D.C.C.F : 0.15 dB

- 802.11n HT20




-On time : 1.29 ms
-Period : 1.33 ms
-Duty Cycle : 0.964 8
-D.C.C.F : 0.16 dB

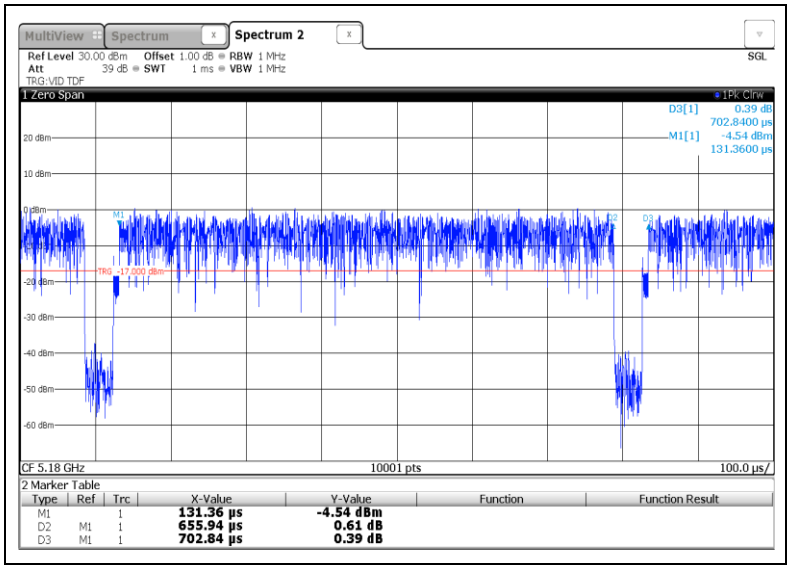
- 802.11n HT40




-On time : 0.63 ms
-Period : 0.67 ms
-Duty Cycle : 0.931 3
-D.C.C.F : 0.31 dB

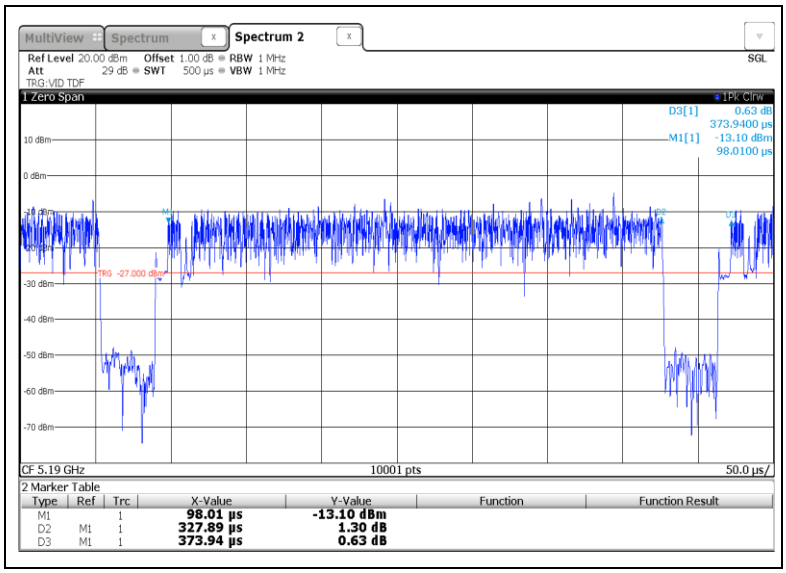
- MIMO (ANT 1+2)

- 802.11n HT20




-On time : 0.66 ms
-Period : 0.70 ms
-Duty Cycle : 0.933 3
-D.C.C.F : 0.30 dB

- 802.11n HT40




-On time : 0.33 ms
-Period : 0.37 ms
-Duty Cycle : 0.876 9
-D.C.C.F : 0.57 dB

## 5.3 Bandwidth Measurement

### 5.3.1 Regulation

According to §15.403,(i) Emission bandwidth. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 ㏈ down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

According to §15.407,(e) Within the 5.725-5.85 ㎓ band, the minimum 6 ㏈ bandwidth of U-NII devices shall be at least 500 ㎑.

### 5.3.2 Measurement Procedure

1.Emission Bandwidth (EBW)

a)Set RBW = approximately 1% of the emission bandwidth.
b)Set the VBW > RBW.
c)Detector = Peak.
d)Trace mode = max hold.
e)Measure the maximum width of the emission that is 26 ㏈ down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeatmeasurement as needed until the RBW/EBW ratio is approximately 1%.

2.Minimum Emission Bandwidth for the band 5.725 - 5.85 ㎓

Section 15.407(e) specifies the minimum 6 ㏈ emission bandwidth of at least 500 ㎑ for theband 5.715-5.85 ㎓. The following procedure shall be used for measuring this bandwidth:

a) Set RBW = 100 ㎑.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associatedwith the two outermost amplitude points (upper and lower frequencies) that are attenuated by6 ㏈ relative to the maximum level measured in the fundamental emission.

Note: The automatic bandwidth measurement capability of a spectrum analyzer or EMI receiver may be employed if it implements the functionality described above.

## 5.3.3 Test Result

-Complied

- 5 150 Band

- Ant 1

- 802.11a

| Frequency [㎒] | 26 dB Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 180 | 19.78 | 16.53 |
| 5 200 | 19.83 | 16.58 |
| 5 240 | 19.58 | 16.53 |

- 802.11n HT20

| Frequency [㎒] | 26 dB Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 180 | 20.03 | 17.53 |
| 5 200 | 20.23 | 17.48 |
| 5 240 | 20.18 | 17.48 |

- 802.11n HT40

| Frequency [㎒] | 26 dB Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 190 | 45.65 | 36.56 |
| 5 230 | 45.45 | 36.56 |

- MIMO (ANT 1+2)

- 802.11n HT20

| Frequency [㎒] | 26 dB Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 180 | 20.18 | 17.58 |
| 5 200 | 19.93 | 17.58 |
| 5 240 | 19.98 | 17.53 |

- 802.11n HT40

| Frequency [㎒] | 26 dB Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 190 | 45.55 | 36.56 |
| 5 230 | 45.35 | 36.56 |

- 5 725 Band

- Ant 1

- 802.11a

| Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 745 | 15.83 | 16.73 |
| 5 785 | 15.78 | 16.73 |
| 5 825 | 15.73 | 16.68 |

- 802.11n HT20

| Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 745 | 16.63 | 17.48 |
| 5 785 | 16.48 | 17.48 |
| 5 825 | 16.63 | 17.48 |

- 802.11n HT40

| Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 755 | 36.36 | 36.56 |
| 5 795 | 36.36 | 36.46 |

- MIMO (ANT 1+2)

- 802.11n HT20

| Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 745 | 16.28 | 17.48 |
| 5 785 | 16.48 | 17.48 |
| 5 825 | 16.48 | 17.48 |

- 802.11n HT40

| Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | OBW [㎒] |
|---|---|---|
| 5 755 | 36.36 | 36.56 |
| 5 795 | 36.36 | 36.56 |

## 5.3.4 Test Plot

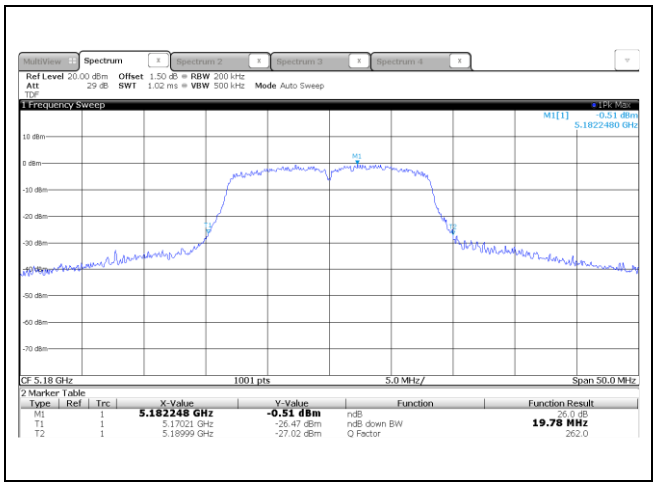
Figure 1. Plot of Bandwidth Measurement

- 5 150 Band

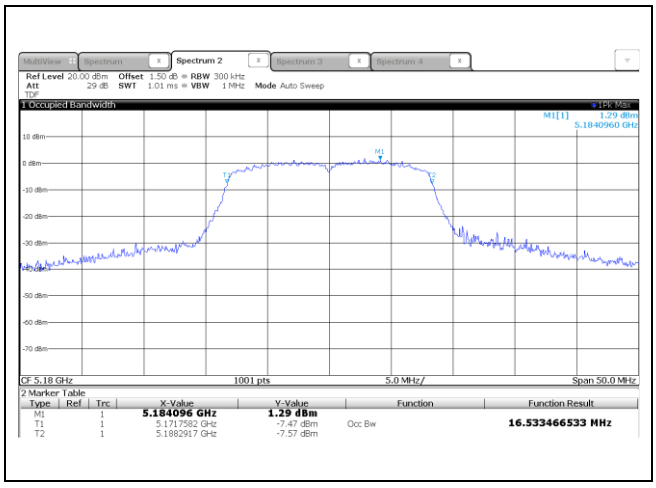
- 802.11a_Ant 1

- 5 180 MHz

EBW

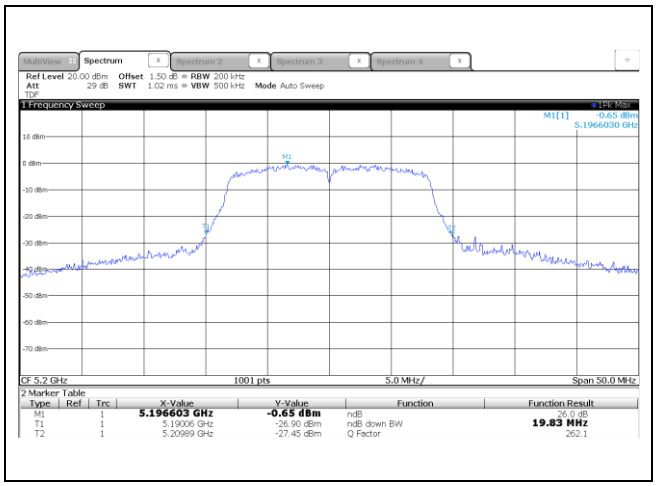



OBW

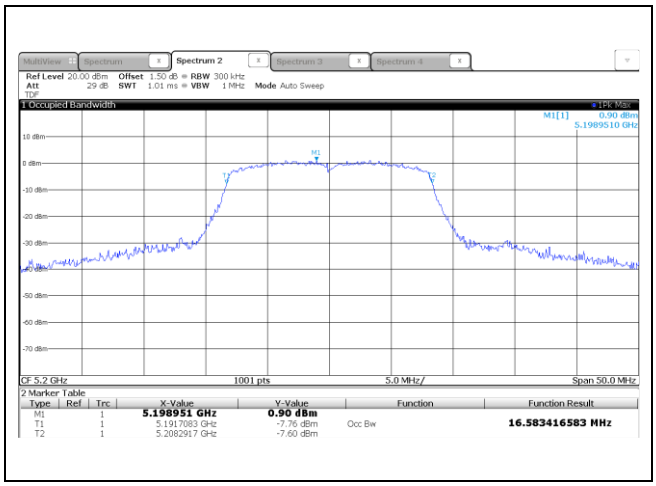


- 5 200 ㎒

EBW

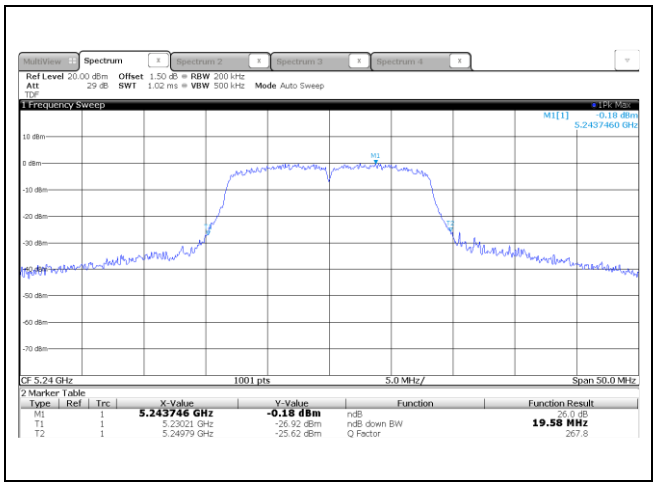



OBW

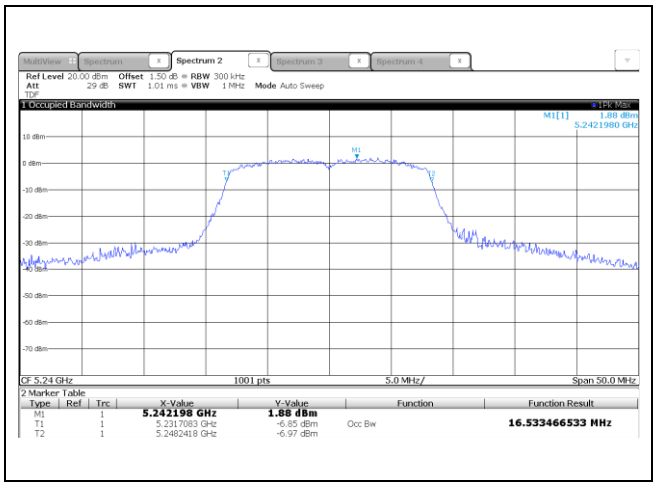


- 5 240 ㎒

EBW



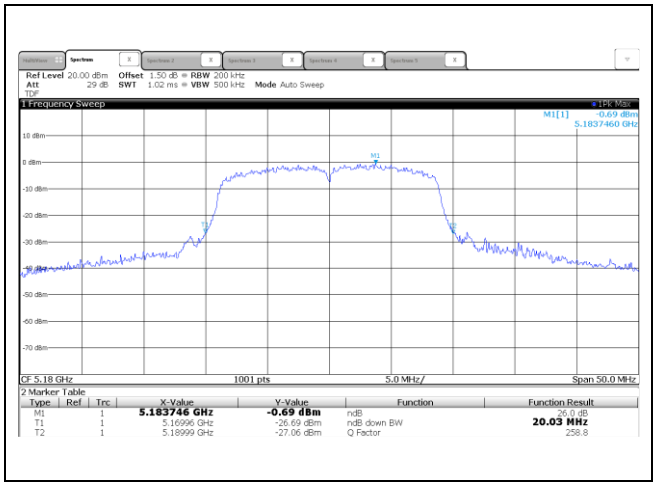

OBW



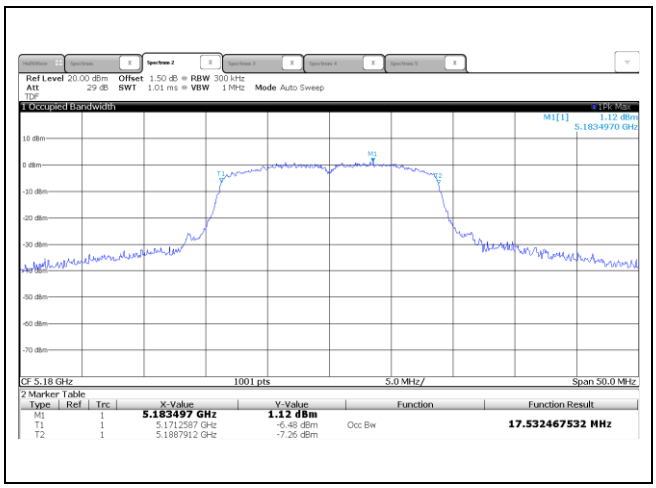
- 802.11n HT20

- 5 180 ㎒

EBW

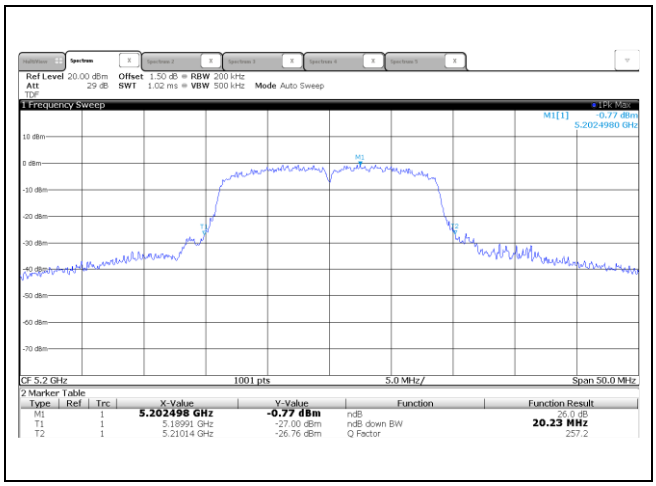



OBW

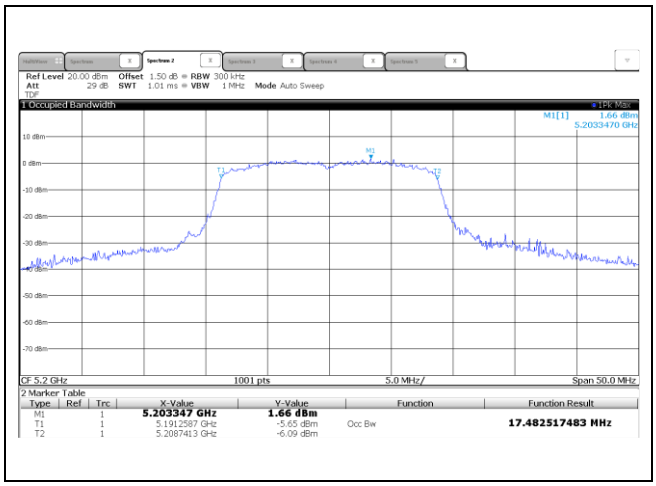


- 5 200 ㎒

EBW

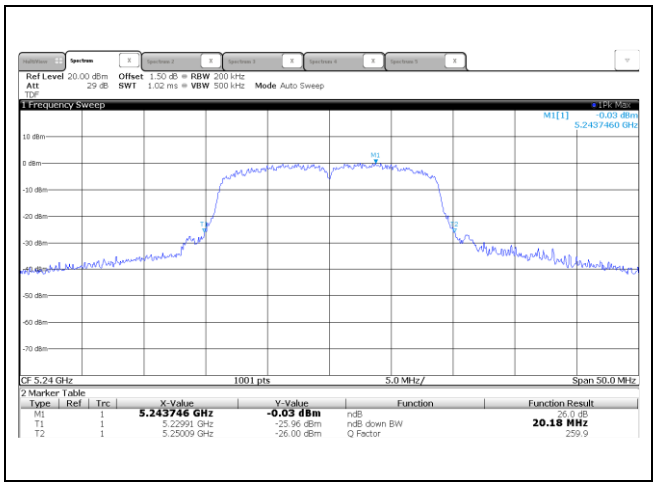



OBW

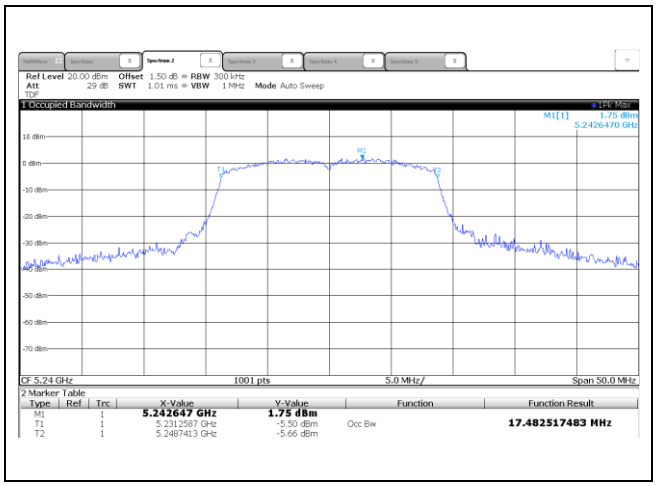


- 5 240 ㎒

EBW



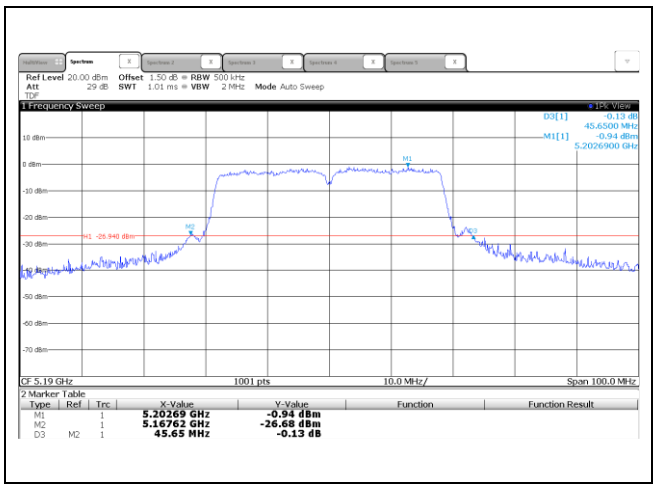

OBW



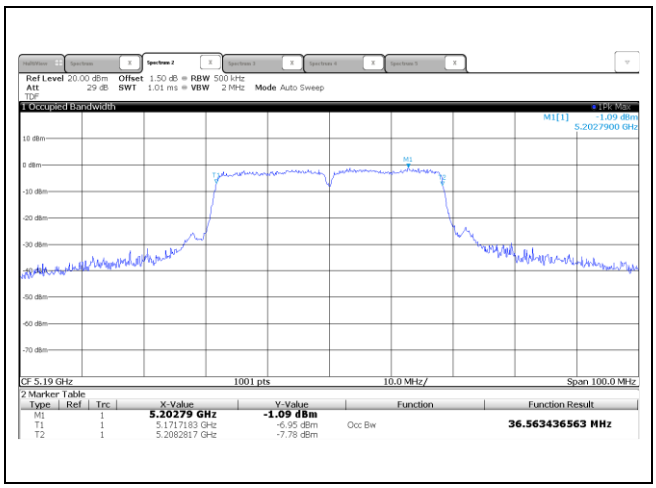
- 802.11n HT40

- 5 190 ㎒

EBW

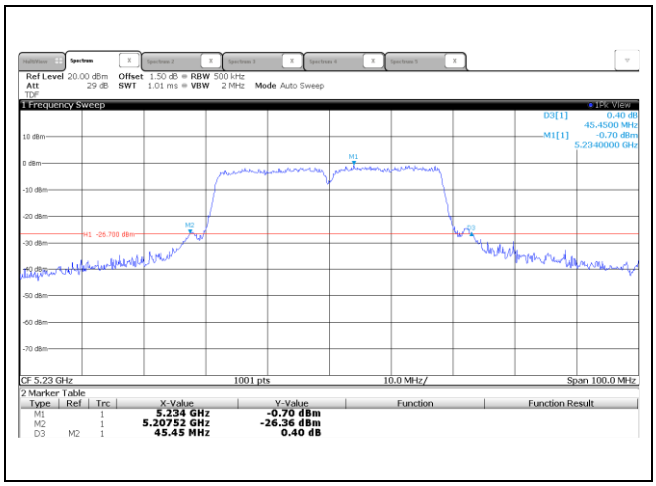



OBW

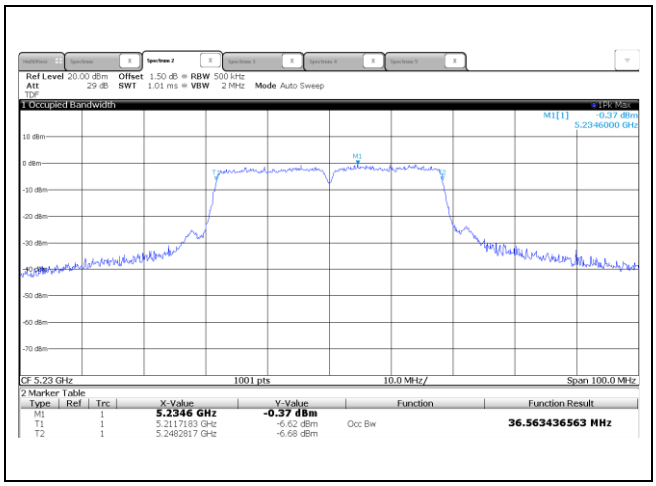


- 5 230 ㎒

EBW



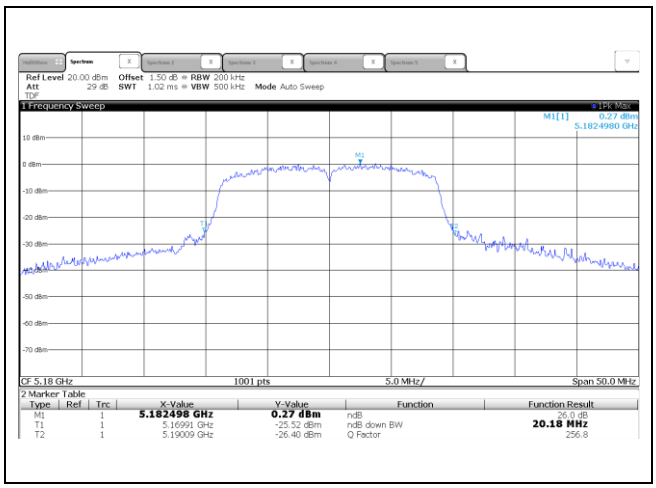

OBW



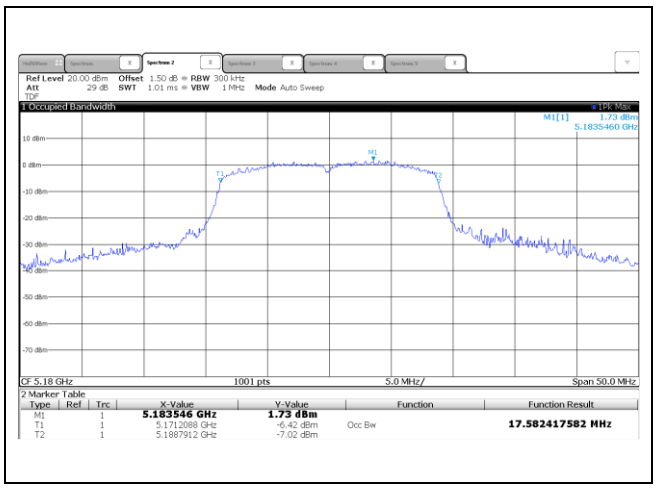
- 802.11n HT20_MIMO (Ant 1)

- 5 180 ㎒

EBW

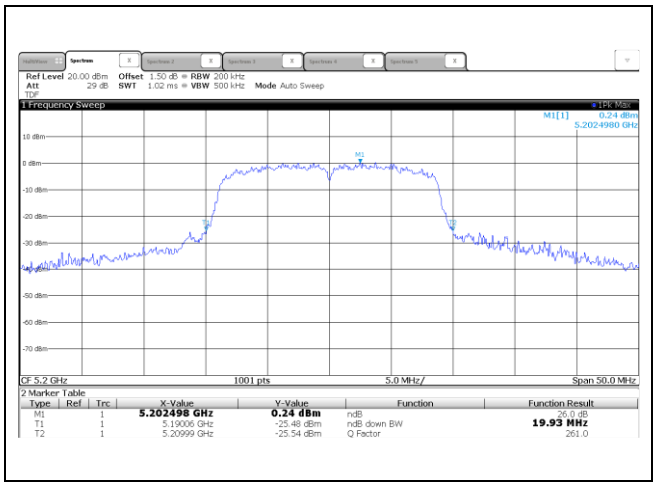



OBW

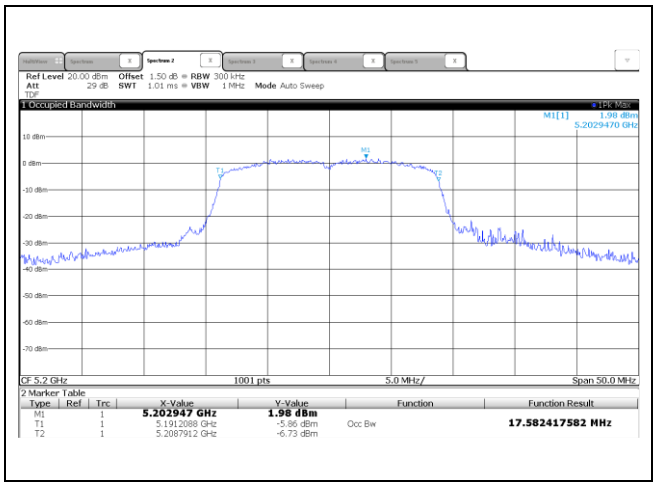


- 5 200 ㎒

EBW

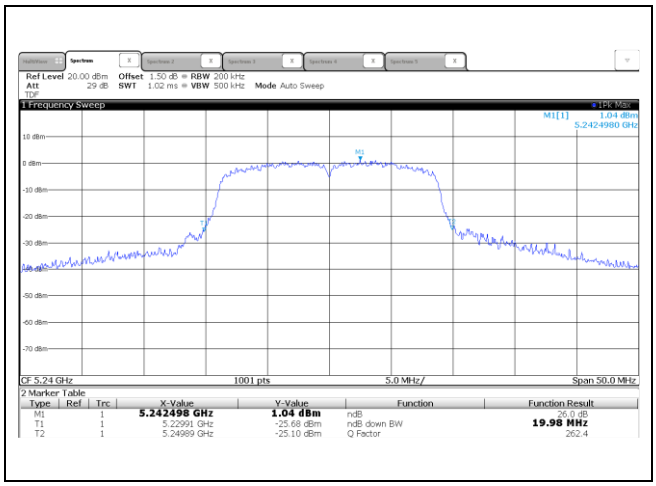



OBW



- 5 240 ㎒

EBW

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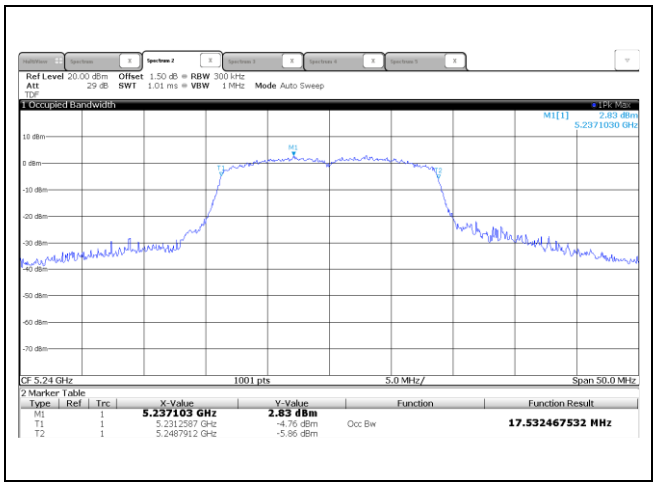
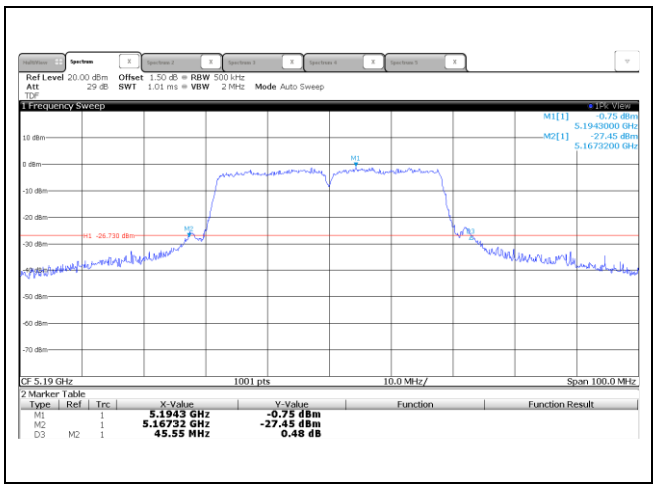


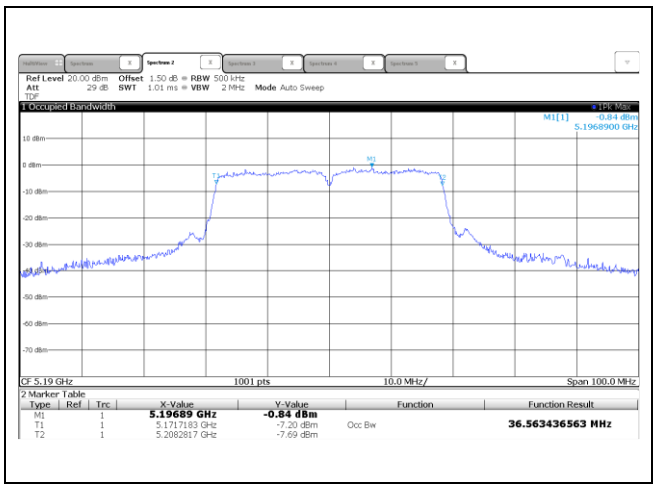
- 802.11n HT40_MIMO (Ant 1)

- 5 190 ㎒

EBW

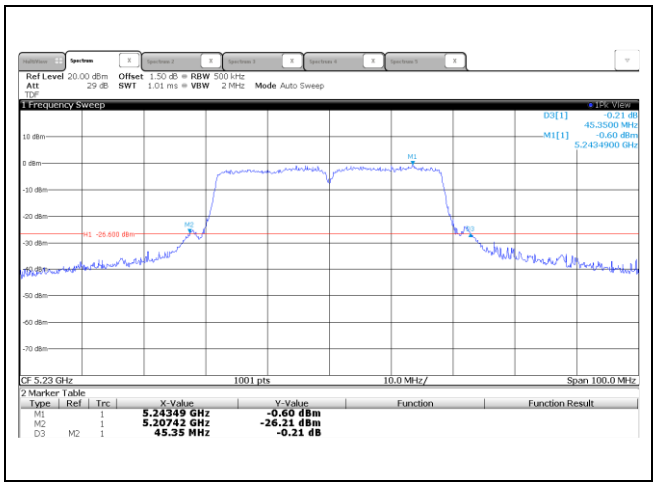



OBW

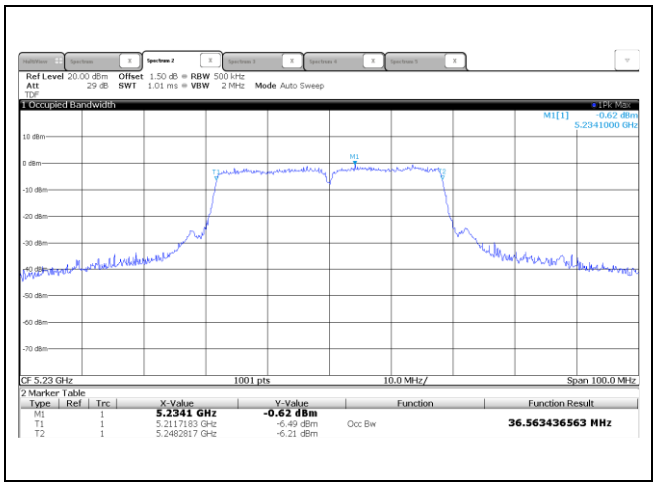


- 5 230 ㎒

EBW




OBW

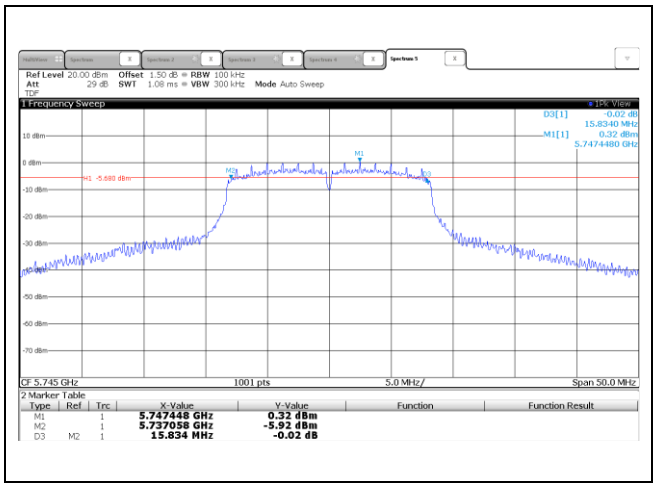


- 5 725 Band

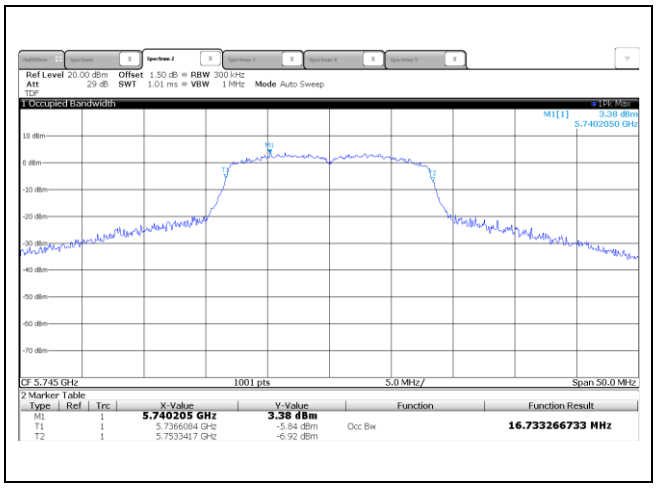
- 802.11a_Ant 1

- 5 745 ㎒

EBW

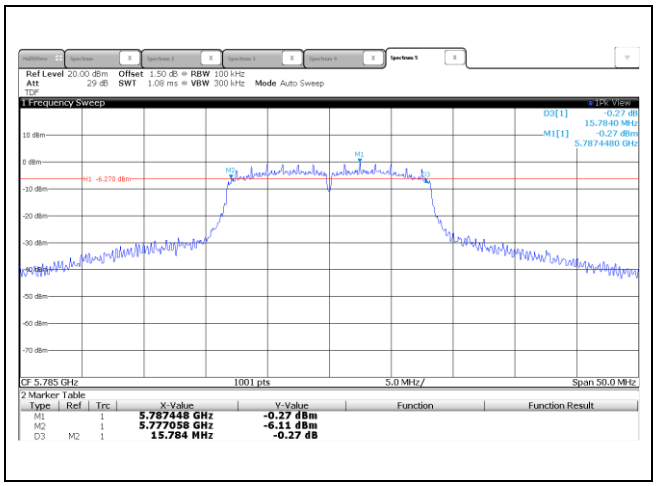



OBW

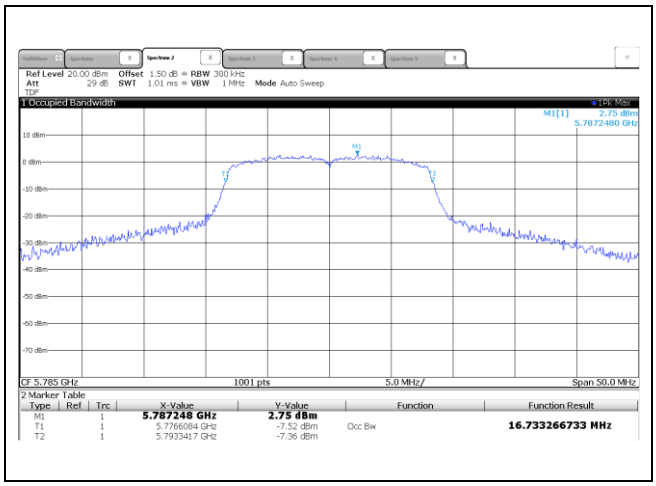


- 5 785 ㎒

EBW

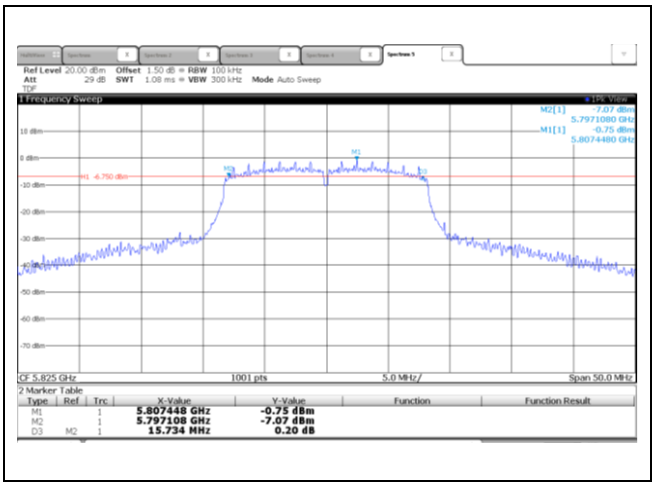



OBW

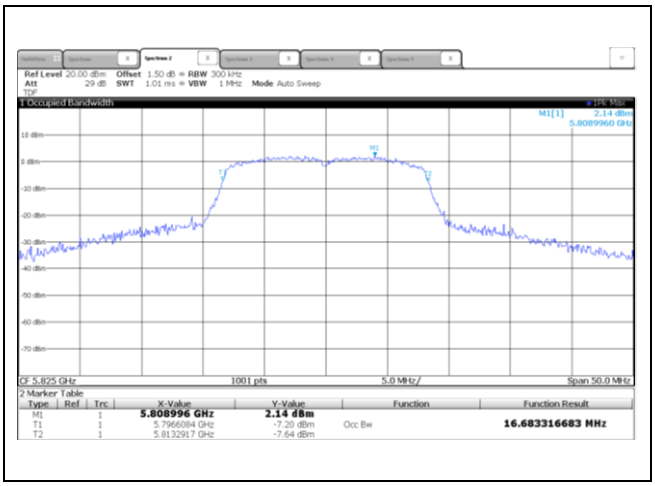


- 5 825 ㎒

EBW



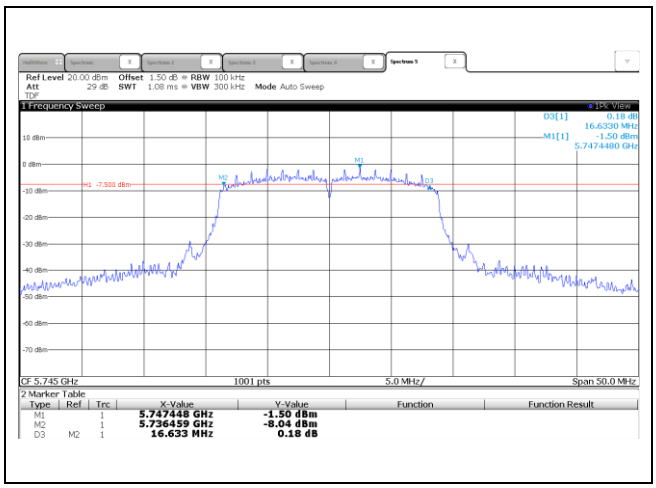

OBW



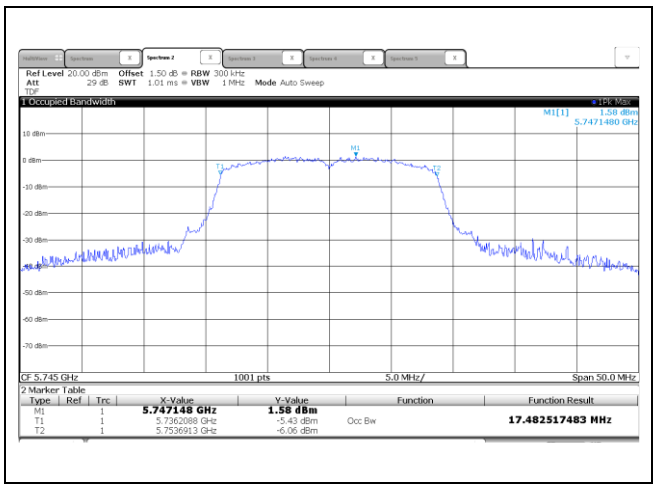
- 802.11n HT20

- 5 745 ㎒

EBW

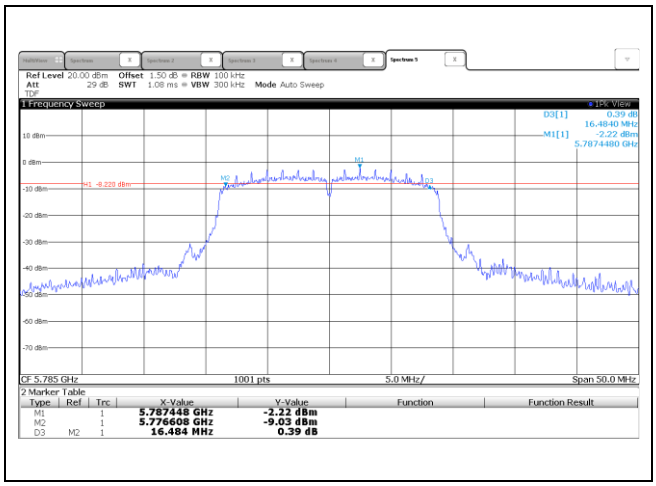



OBW



- 5 785 ㎒

EBW

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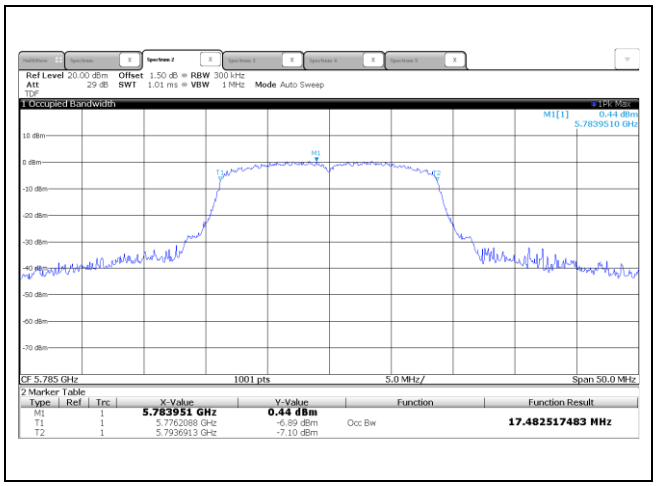
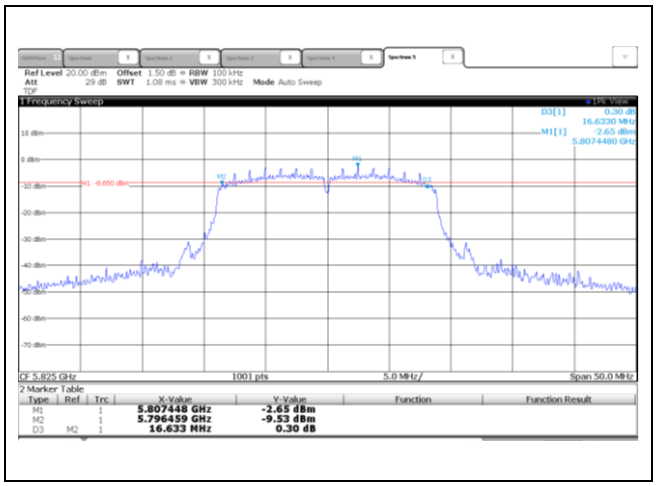


- 5 825 ㎒

EBW

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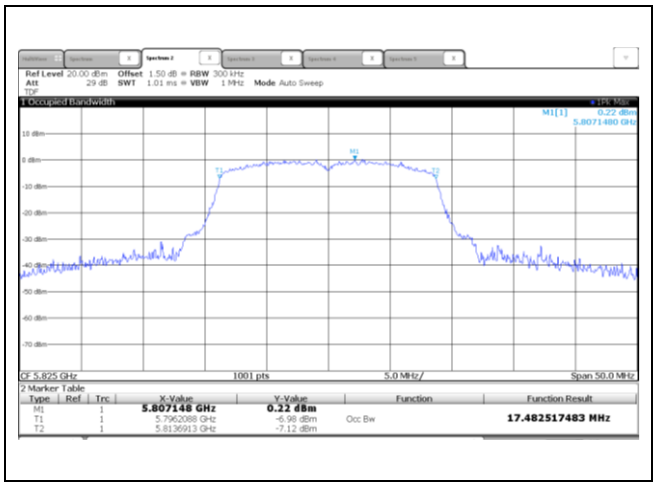
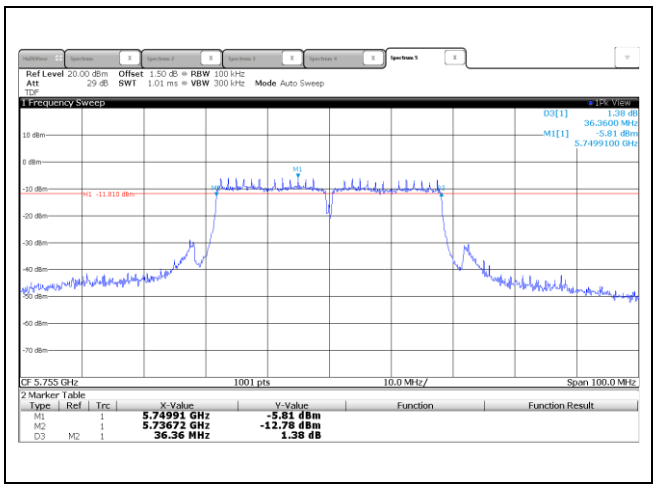


- 802.11n HT40

- 5 755 ㎒

EBW

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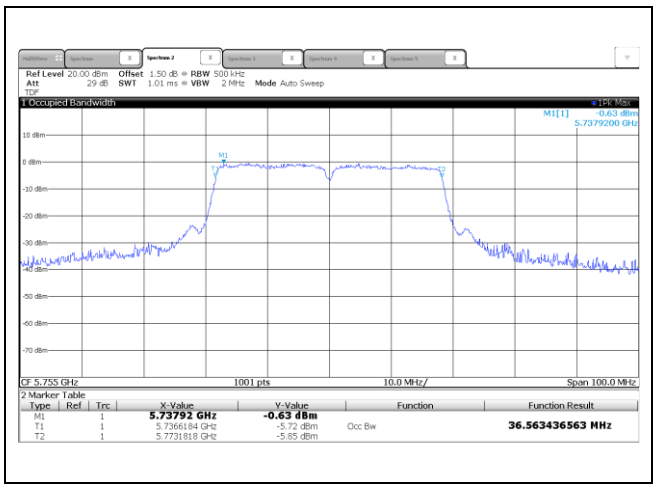

- 5 795 ㎒

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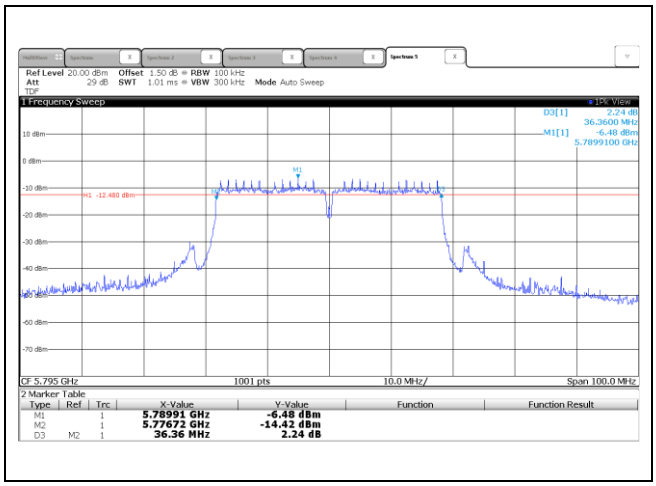
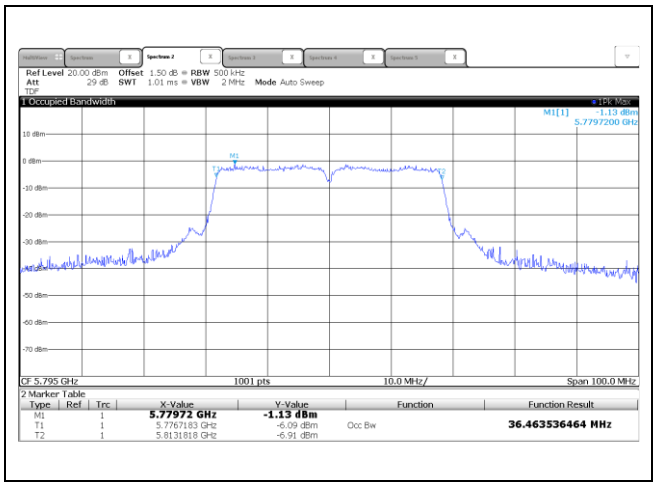


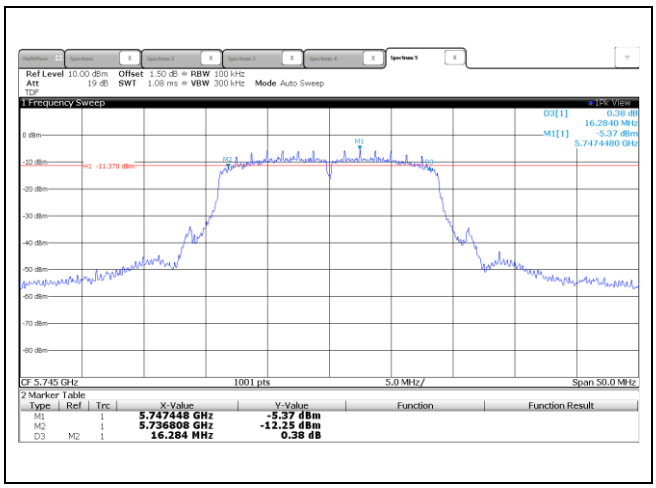

OBW



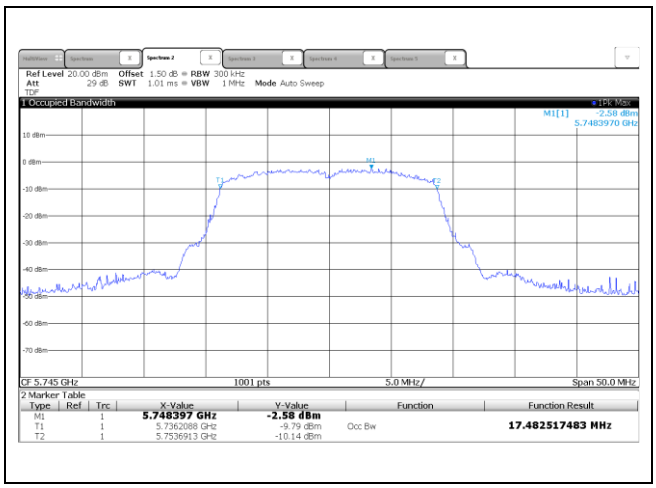
- 802.11n HT20_MIMO (Ant 1)

- 5 745 ㎒

EBW

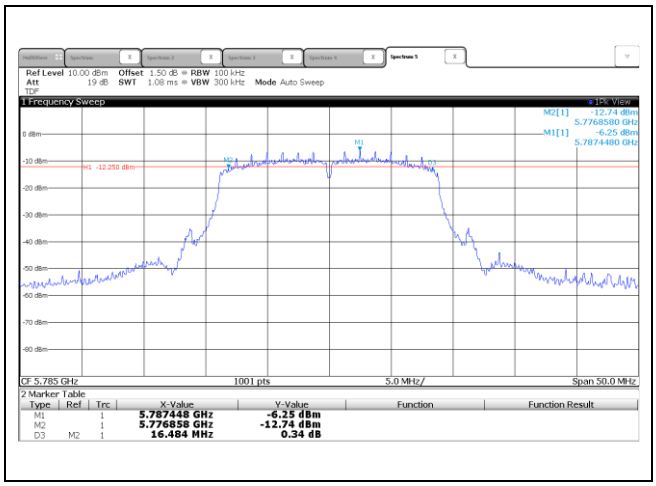



OBW

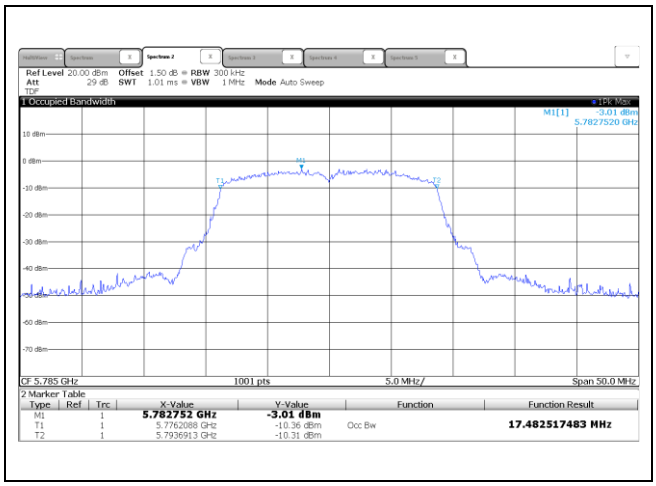


- 5 785 ㎒

EBW

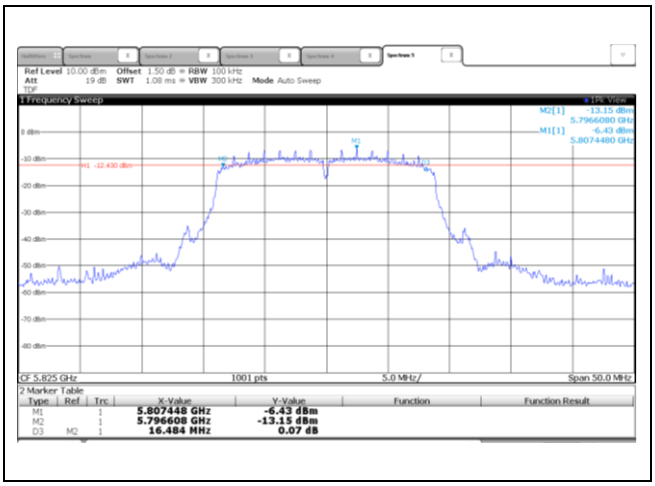



OBW

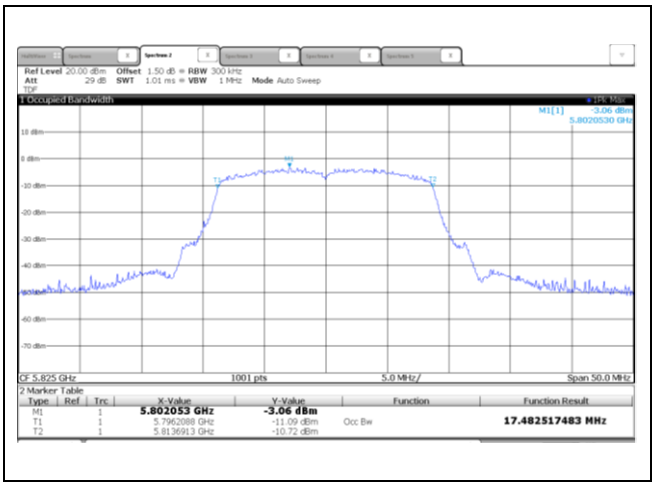


- 5 825 ㎒

EBW



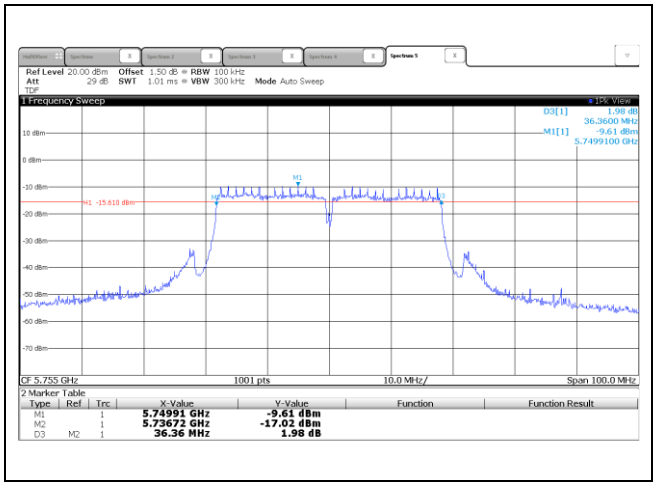

OBW



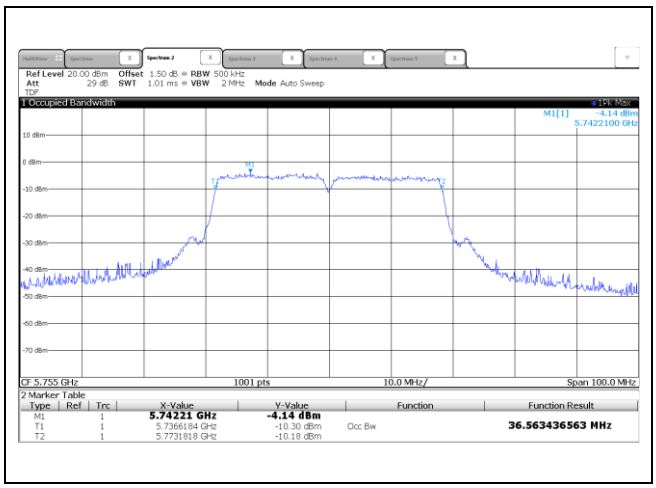
- 802.11n HT40_MIMO (Ant 1)

- 5 755 ㎒

EBW




OBW



- 5 795 ㎒

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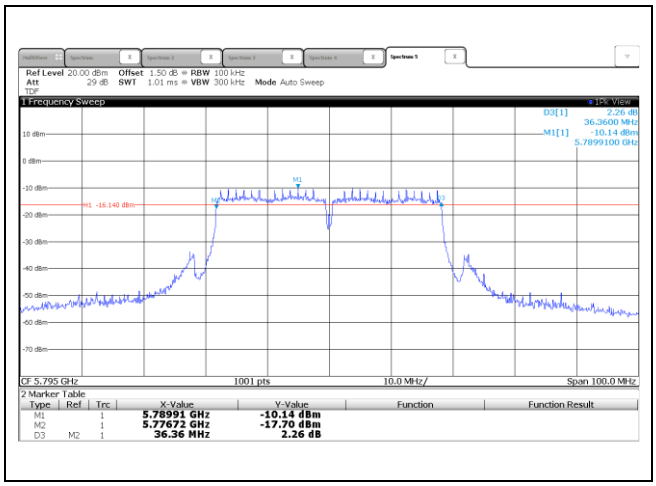


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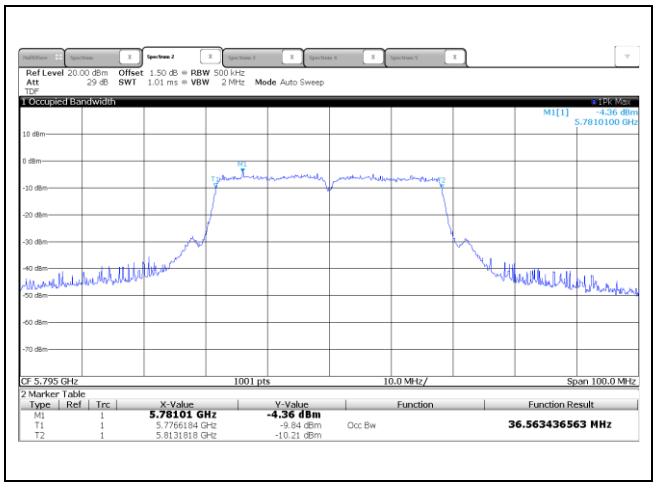

## 5.4 Peak Power Spectral Density

### 5.4.1 Regulation

According to §15.407(a) (1) (ii) For an indoor access point operating in the band 5.15-5.25 ㎓, the maximumConducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 ㏈i. In addition, the maximum power spectral density shall not exceed 17 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

According to §15.407(a) (2) For the 5.25-5.35 ㎓ and 5.47-5.725 ㎓ bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 ㎽ or 11 ㏈m + 10 log B, where B is the 26 ㏈ emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈that the directional gain of the antenna exceeds 6 ㏈i.

According to §15.407(a) (3) For the band 5.725-5.85 ㎓, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 ㏈m in any 500-㎑ band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 ㏈i without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information.

The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

## 5.4.2 Measurement Procedure

These test measurement settings are specified in section F of 789033 D02 General UNII Test Procedures New Rules v01.

### 5.4.2.1 Maximum power spectral density (PSD)

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, "Compute power…". (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)

2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.

3. Make the following adjustments to the peak value of the spectrum, if applicable:
a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.
b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 ㏈ to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the Maximum PSD over 1 ㎒ reference bandwidth.

5. For devices operating in the bands 5.15-5.25 ㎓, 5.25-5.35 ㎓, and 5.47-5.725 ㎓, the above procedures make use of 1 ㎒ RBW to satisfy directly the 1 ㎒ reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 ㎓, the rules specify a measurement bandwidth of 500 ㎑. Many spectrum analyzers do not have 500 ㎑ RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 ㎒, or 500 ㎑, "provided that the measured power is integrated over the full reference bandwidth" to show the total power over the specified measurement bandwidth (i.e., 1 ㎒, or 500 ㎑). If measurements are performed using a reduced resolution bandwidth (< 1 ㎒, or < 500 ㎑) and integrated over 1 ㎒, or 500 ㎑ bandwidth, the following adjustments to the procedures apply: a) Set RBW ≥ 1/T, where T is defined in section II.B.l.a).
c) Set VBW ≥ 3 RBW.
d) If measurement bandwidth of Maximum PSD is specified in 500 ㎑, add 10log(500㎑/RBW) to the measured result, whereas RBW (< 500 ㎑) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
e) If measurement bandwidth of Maximum PSD is specified in 1 ㎒, add 10log(1㎒/RBW) to the measured result, whereas RBW (< 1 ㎒) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
f) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

Note: As a practical matter, it is recommended to use reduced RBW of 100 ㎑ for the sections 5.c) and 5.d) above, since RBW=100 ㎑ is available on nearly all spectrum analyzers.

## 5.4.3 Test Result

## -Complied

- 5 150 Band

- Ant 1

- 802.11a

| Frequency [㎒] | Result [dBm/㎒] | D.C.C.F [dB] | Total result [dBm/㎒] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | -1.66 | 0.15 | -1.51 | 17.00 | 18.51 |
| 5 200 | -1.35 | 0.15 | -1.20 | 17.00 | 18.20 |
| 5 240 | -0.74 | 0.15 | -0.59 | 17.00 | 17.59 |

- 802.11n HT20

| Frequency [㎒] | Result [dBm/㎒] | D.C.C.F [dB] | Total result [dBm/㎒] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | -1.32 | 0.16 | -1.16 | 17.00 | 18.16 |
| 5 200 | -1.39 | 0.16 | -1.23 | 17.00 | 18.23 |
| 5 240 | -1.00 | 0.16 | -0.84 | 17.00 | 17.84 |

- 802.11n HT40

| Frequency [㎒] | Result [dBm/㎒] | D.C.C.F [dB] | Total result [dBm/㎒] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | -6.42 | 0.31 | -6.11 | 17.00 | 23.11 |
| 5 240 | -6.13 | 0.31 | -5.82 | 17.00 | 22.82 |

- Ant 2

- 802.11a

| Frequency [㎒] | Result [dBm/㎒] | D.C.C.F [dB] | Total result [dBm/㎒] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|
| 5 180 | -2.17 | 0.15 | -2.02 | 17.00 | 19.02 |
| 5 200 | -1.83 | 0.15 | -1.68 | 17.00 | 18.68 |
| 5 240 | -2.13 | 0.15 | -1.98 | 17.00 | 18.98 |