

TEST REPORT

KCTL Inc.

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Report No.: KCTL16-SFR0022

Page(1) / (44) Pages

KCTL
<http://www.kctl.co.kr>

1. Applicant

Name: HUMAX Co., Ltd
Address: (Yubang-dong)2, Yeongmun-ro, Cheoin-gu Yongin-si,
Gyeonggi-do, Korea

2. Sample Description:

FCC ID: O6ZC41W-500
Type of equipment: Wireless Client
Basic Model: C41W-500



3. Date of Test: April 1 ~ April 2, 2016

4. Test method used: FCC Part 15 Subpart E, 15.407

5. Test Results

Test Item: Refer to page 8
Result: Refer to page 9 ~ page 43
Measurement Uncertainty: Refer to page 8

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

Affirmation	Tested by	Technical Manager
	 Name: BYUNG WOO, AHN	 Name: MIN GI, SON

2016. 04. 05

KCTL Inc. Testing Laboratory

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1. Client information

Applicant: HUMAX Co., Ltd
Address: (Yubang-dong)2, Yeongmun-ro, Cheoin-gu Yongin-si, Gyeonggi-do, Korea
Telephone number: +82-31-776-6368
Facsimile number: +82-31-776-6149
Contact person: CHAN HEON, JEONG / jungch@humaxdigital.com

Manufacturer: HUMAX Co., Ltd
Address: (Yubang-dong)2, Yeongmun-ro, Cheoin-gu Yongin-si, Gyeonggi-do, 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	(Yubang-dong)2, Yeongmun-ro, Cheoin-gu Yongin-si, Gyeonggi-do, Korea
Manufacturer	HUMAX Co., Ltd
Address of Manufacturer	(Yubang-dong)2, Yeongmun-ro, Cheoin-gu Yongin-si, Gyeonggi-do, Korea
Type of equipment	Wireless Client
Basic Model	C41W-500
Serial number	N/A

3.2 General description

Frequency Range	2.4 GHz: 2 425 MHz ~ 2 475 MHz (RF4CE), 5 GHz: 5 190 ~ 5 230 MHz, 5 270 ~ 5 310 MHz, 5 510 ~ 5 670 MHz, 5 755 ~ 5 795 MHz (WiFi 5G)
Type of Modulation	2.4 GHz: O-QPSK (RF4CE), 5 GHz: OFDM (WiFi 5G)
Number of Channels	2.4 GHz: 2 425 MHz ~ 2 475 MHz : 3 ch (RF4CE), 5 GHz: 5 190 ~ 5 230 MHz : 2 (WiFi 5G), 5 270 ~ 5 310 MHz : 2 (WiFi 5G), 5 510 ~ 5 670 MHz : 5 (WiFi 5G), 5 755 ~ 5 795 MHz : 2 (WiFi 5G)
Type of Antenna	Integral Embedded Antenna(Wi-Fi), Integral PCB antenna(RF4CE)
Antenna Gain	2.4 GHz: 2 425 MHz ~ 2 475 MHz : Ant0: 2.89 dBi, Ant1: 2.26 dBi (RF4CE), 5 GHz: 5 190 ~ 5 230 MHz : 1.9 dBi (WiFi 5G), 5 270 ~ 5 310 MHz : 2.5 dBi (WiFi 5G), 5 510 ~ 5 670 MHz : 2.9 dBi (WiFi 5G), 5 755 ~ 5 795 MHz : 3.0 dBi (WiFi 5G)
Transmit Power	23.54 dBm
Power supply	AC 120 V
Product SW/HW version	0x7E6 / V2.1
Radio SW/HW version	V2.1 / v35.2.0.48
Test SW Version	Teraterm
RF power setting in TEST SW	Band 1: 10, Band 4: 15 for low channel, 19 for high channel

Note :

1. The above EUT information was declared by the manufacturer.
2. Since this report is for Class II permissive change(C2PC) regarding 5G Band 1 and Band 4, refer to the original test report (Report #: EMC- FCC- R0108-2, Test Lab: EMC Compliance) for other modes.

3.3 Test frequency

* 802.11n HT40

Frequency	Band 1	Band 4
Low frequency	5 190 MHz	5 755 MHz
Middle frequency	-	-
High frequency	5 230 MHz	5 795 MHz

3.4 Test Voltage

Mode	Voltage
Norminal voltage	AC 120 V

3.5 Duty Factor

Frequency [MHz]	Duty cycle [dB]	Duty cycle factor [dB]
5 190	78.79	1.04
5 230	78.79	1.04
5 755	79.29	1.01
5 795	75.85	1.20

* 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 15.407(a)(1)(2)(3)	-	Antenna Requirement	5.1	C
15.403(i),15.407(e)	RSS-247, 5.1 RSS-GEN, 6.6	Bandwidth Measurement	5.2	C
15.407(a)(1)(2)	RSS-247, 5.4	Maximum Conducted Output Power	5.3	C
15.407(a)(1)(2)(5)	RSS-247, 5.3, (2)	Peak Power Spectral Density	5.4	C
15.205(a), 15.209(a), 15.407(b)(1), 15.407(b)(2), 15.407(b)(3)	RSS-247, 5.5 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/A ₁₎
Note: C = complies NC = Not complies NT = Not tested NA = Not Applicable N/A ₁₎ : Refer to the original test report (Report #: EMC- FCC- R0108-2, Test Lab: EMC Compliance)				

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

4.2 Uncertainty

Measurement Item	Expanded Uncertainty $U = kU_c (k = 2)$	
Conducted RF power	1.44 dB	
Conducted Spurious Emissions	1.52 dB	
Radiated Spurious Emissions	30 MHz ~ 300 MHz:	+ 4.94 dB, - 5.06 dB
		+ 4.93 dB, - 5.05 dB
	300 MHz ~ 1 000 MHz:	+ 4.97 dB, - 5.08 dB
		+ 4.84 dB, - 4.96 dB
Conducted Emissions	1 GHz ~ 25 GHz:	+ 6.03 dB, - 6.05 dB
	9 kHz ~ 150 kHz:	3.75 dB
	150 kHz ~ 30 MHz:	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 PCB antenna and the total directional peak gain of the antenna exceeds 6.0 dBi

	5 150 Mhz Band	5 725 Mhz Band
ANT 1 Gain	1.9 dBi	3.0 dBi
ANT 2 Gain	1.9 dBi	3.0 dBi
ANT 3 Gain	1.9 dBi	3.0 dBi
ANT 4 Gain	1.9 dBi	3.0 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 Mhz for any N_{ANT} ;

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

For power measurements on all other devices:

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

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

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

For 5 150 Mhz Band Total gain = 7.92 dBi (individual gain(1.9 dBi) + Array gain(6.02 dBi))

For 5 725 Mhz Band Total gain = 9.02 dBi (individual gain(3.0 dBi) + Array gain(6.02 dBi))

Maximum conducted output power and maximum power spectral density were reduced by the amount in dB because the directional gain of the antenna exceeds 6 dBi.

5.2 Maximum Conducted Output Power

5.2.1 Regulation

According to §15.407(a) (1) (iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

According to §15.407(a) (3) For the band 5.725-5.85 GHz, 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 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi 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 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

-802.11n HT40 Band 1 ANT 1 + 2 + 3 + 4 MIMO

Frequency [MHz]	Result [dBm] Ant1	Result [dBm] Ant2	Result [dBm] Ant3	Result [dBm] Ant4	D.C.C.F [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 190	9.07	7.10	8.39	7.45	1.04	15.13	30.00	14.87
5 230	8.61	7.14	8.95	7.28	1.04	15.12	30.00	14.88

-802.11n HT40 Band 4 ANT 1 + 2 + 3 + 4 MIMO

Frequency [MHz]	Result [dBm] Ant1	Result [dBm] Ant2	Result [dBm] Ant3	Result [dBm] Ant4	D.C.C.F [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 755	9.58	12.10	12.81	12.51	1.01	18.95	30.00	11.05
5 795	16.45	15.64	16.79	16.30	1.20	23.54	30.00	6.46

Note:

1. D.C.C.F = Duty cycle correction factor

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 dB 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 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

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 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

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

Section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 kHz for the band 5.715-5.85 GHz.

The following procedure shall be used for measuring this bandwidth:

- a) Set RBW = 100 kHz.
- b) Set the video bandwidth (VBW) $\geq 3 \times$ 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 associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB 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

-802.11n_HT40_Band 1

Frequency [MHz]	26 dB Bandwidth	OBW
5 190	44.75	36.35
5 230	44.69	36.35

-802.11n_HT40_Band 4

Frequency [MHz]	6 dB Bandwidth	OBW
5 755	35.60	36.35
5 795	35.36	36.35

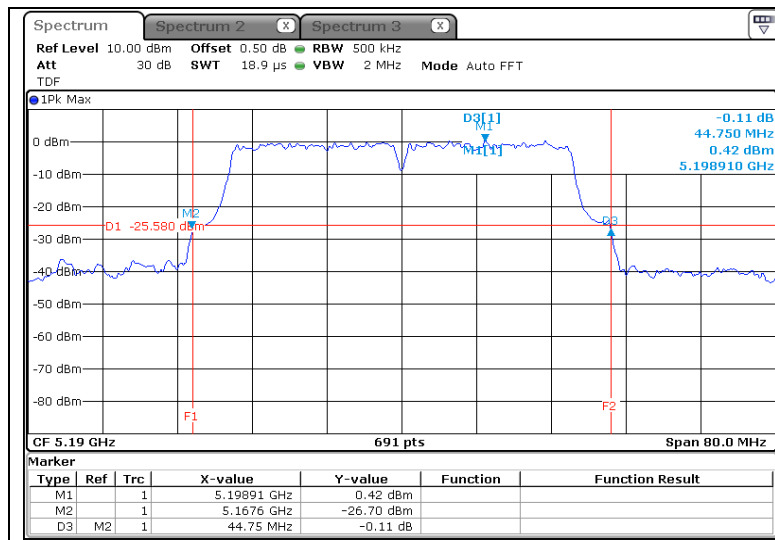
5.3.4 Test Plot

Figure 1. Plot of Bandwidth Measurement

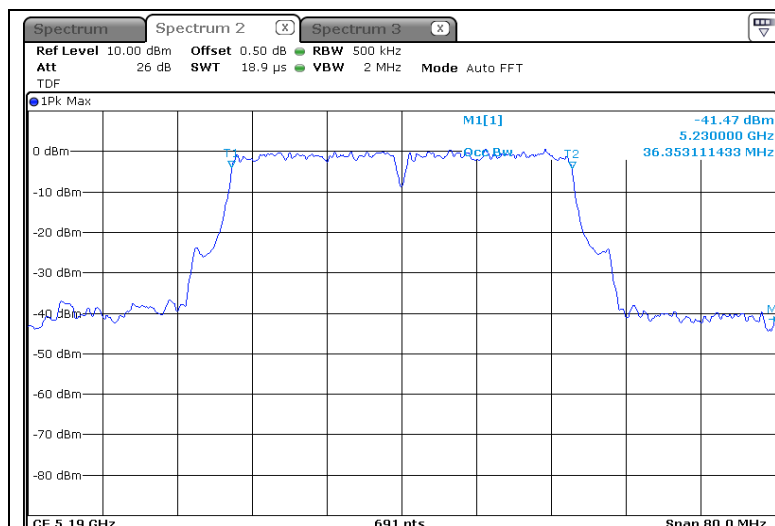
* 802.11n_HT40_Band 1

-5 190 MHz

EBW

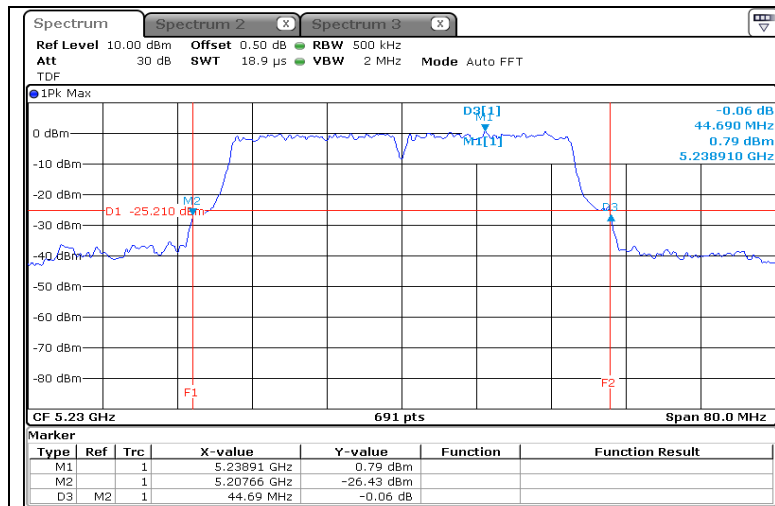


OBW

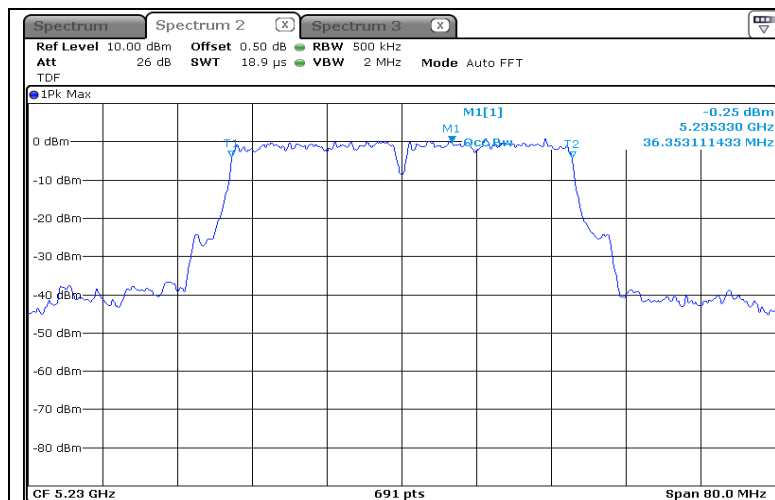


-5 230 MHz

EBW



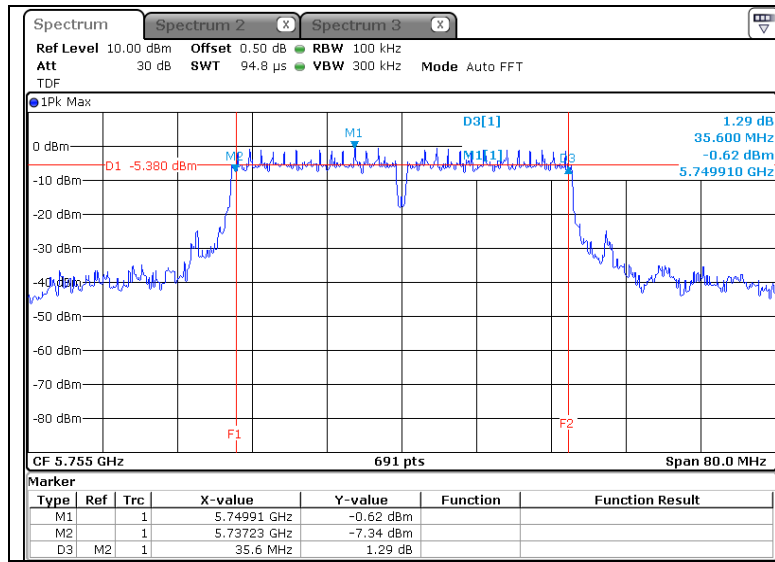
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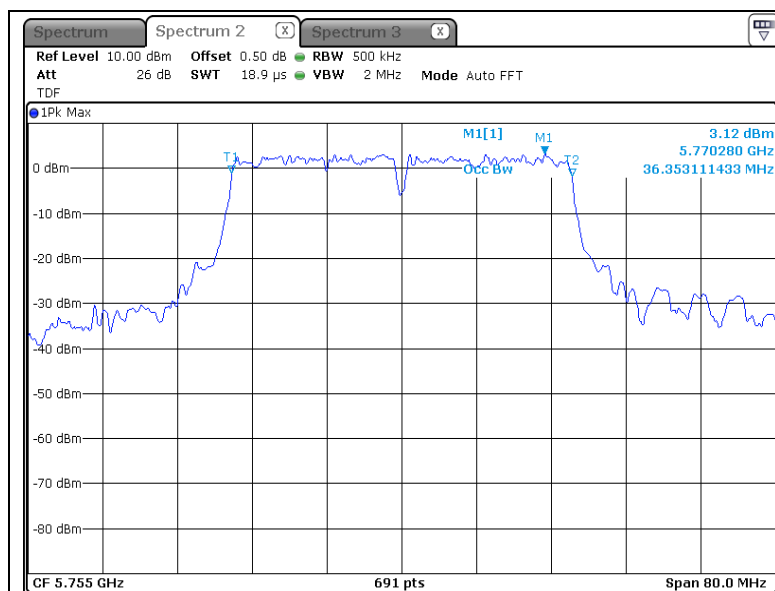
* 802.11n_HT40_Band 4

-5 755 MHz

EBW

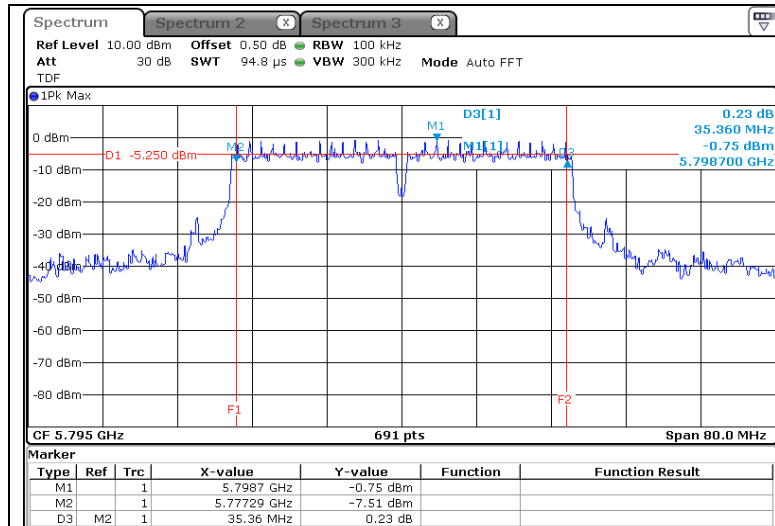


OBW

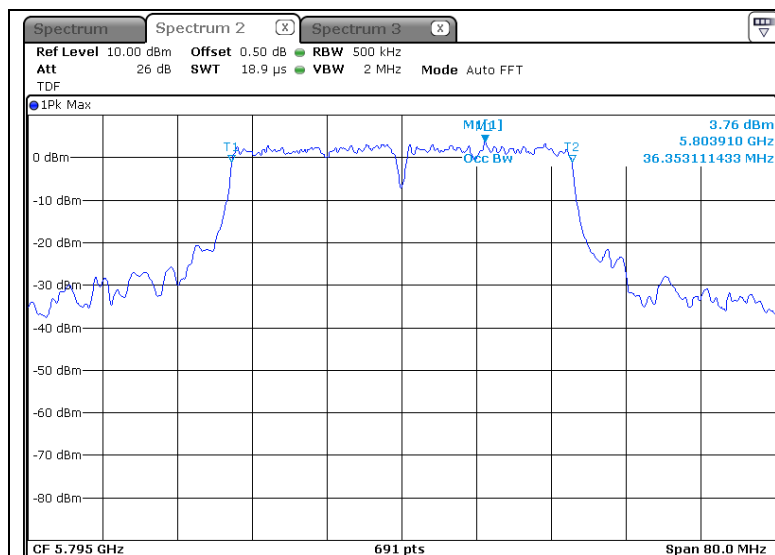


-5 795 MHz

EBW



OBW



5.4 Peak Power Spectral Density

5.4.1 Regulation

According to §15.407(a) (1) (iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

According to §15.407(a) (3) For the band 5.725-5.85 GHz, 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 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi 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 dB to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the Maximum PSD over 1 MHz reference bandwidth.
5. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, "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 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:
 - a) Set $RBW \geq 1/T$, where T is defined in section II.B.1.a).
 - c) Set $VBW \geq 3$ RBW.
 - d) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add $10\log(500\text{kHz}/RBW)$ to the measured result, whereas RBW (< 500 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
 - e) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add $10\log(1\text{MHz}/RBW)$ to the measured result, whereas RBW (< 1 MHz) 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 kHz for the sections 5.c) and 5.d) above, since $RBW=100$ kHz is available on nearly all spectrum analyzers.

5.4.3 Test Result

-Complied

-802.11n_HT40_Band 1_ANT 1 + 2 + 3 + 4_MIMO

Frequency [MHz]	Result [dBm] Ant1	Result [dBm] Ant2	Result [dBm] Ant3	Result [dBm] Ant4	D.C.C.F [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 190	-5.24	-8.08	-5.81	-7.87	1.04	0.48	15.08	14.60
5 230	-5.32	-7.86	-6.82	-6.95	1.04	0.42	15.08	14.66

-802.11n_HT40_Band 4_ANT 1 + 2 + 3 + 4_MIMO

Frequency [MHz]	Result [dBm] Ant1	Result [dBm] Ant2	Result [dBm] Ant3	Result [dBm] Ant4	D.C.C.F [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 755	-5.53	-4.01	-4.83	-5.01	1.01	2.22	13.98	11.76
5 795	-1.93	-2.02	-1.84	-1.54	1.20	5.39	13.98	8.59

NOTE:

1. Since the directional antenna gain exceeds 6.0 dBi (Total Antenna Gain: 7.92 dBi (Band 1), 9.02 dBi (Band 4)), the limit was reduced.
2. D.C.C.F = Duty cycle correction factor

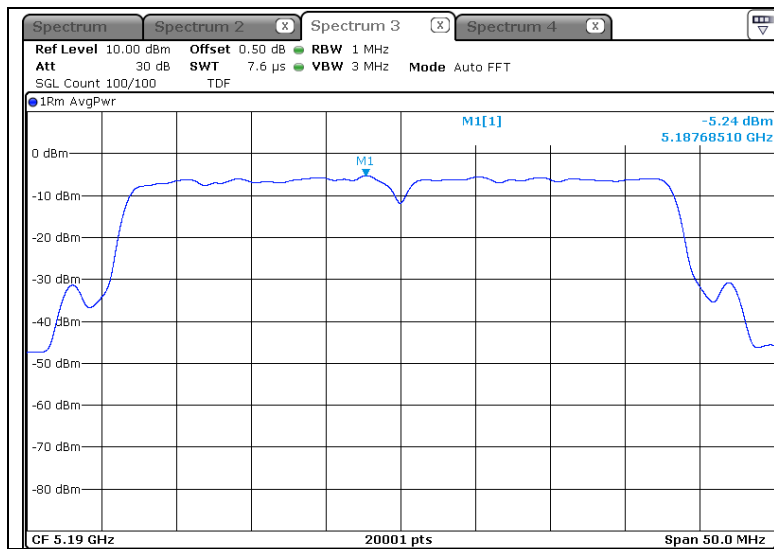
5.4.4 Test Plot

Figure 2. Plot of the Power Spectral Density

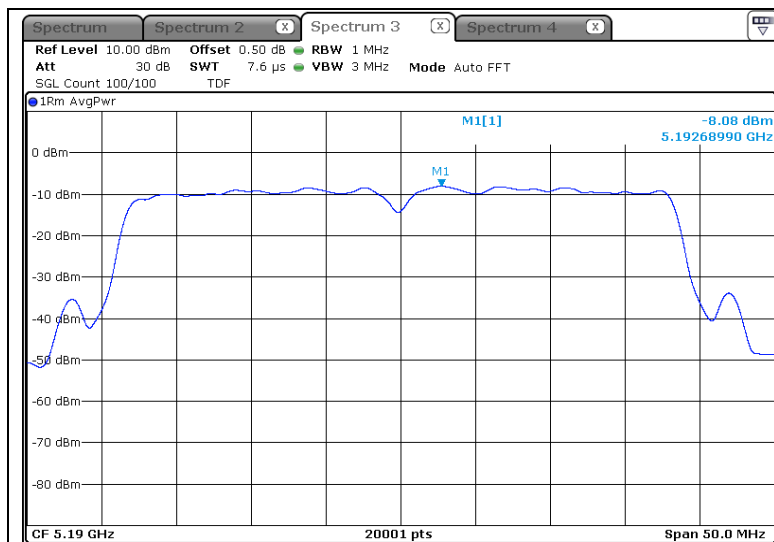
* 802.11n_HT40_Band 1

-5 190 MHz

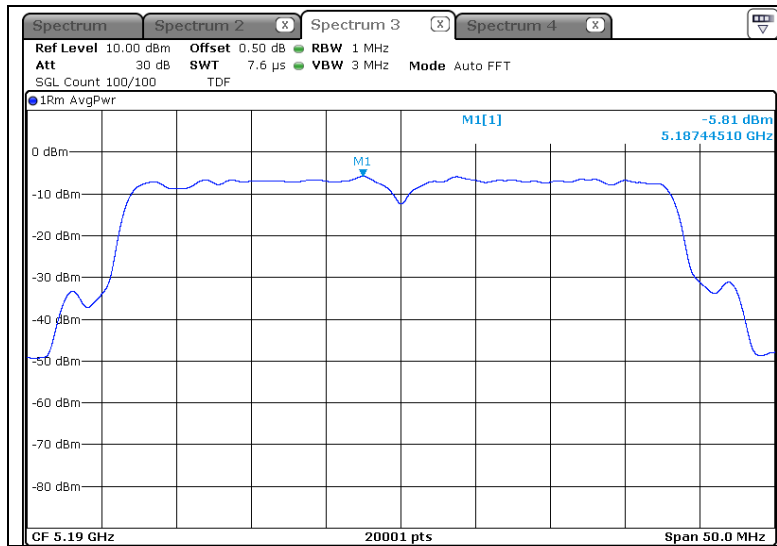
ANT 1



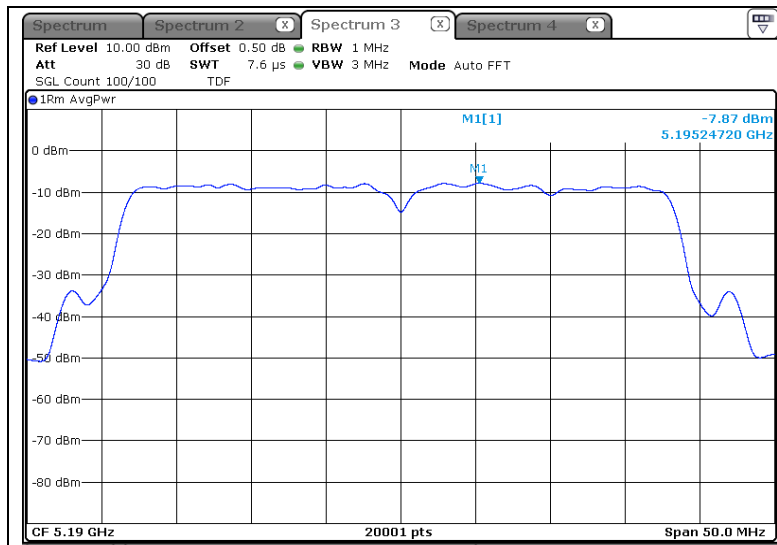
ANT 2



ANT 3

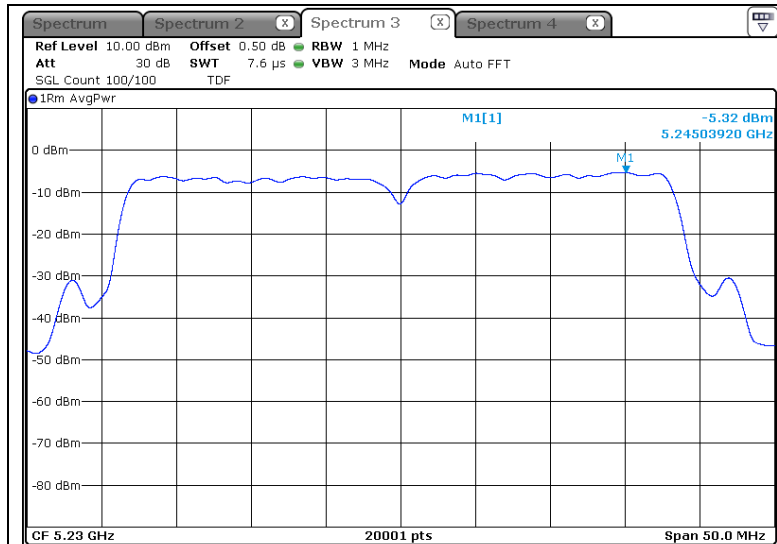


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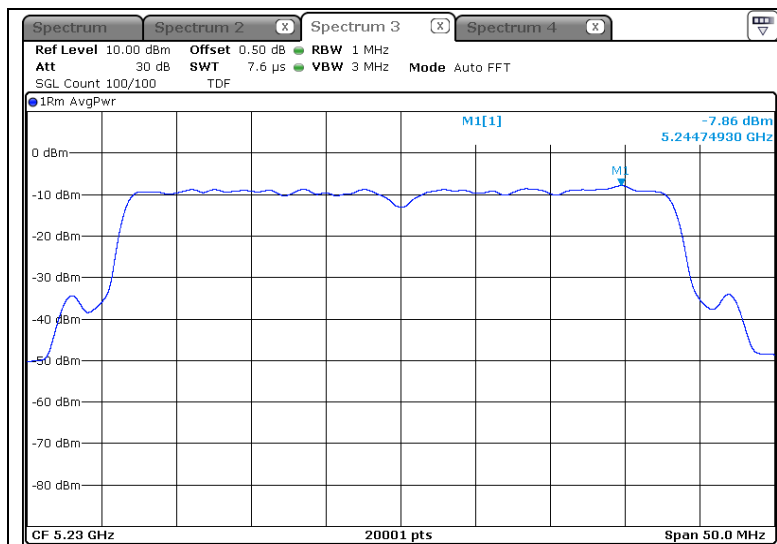


-5 230 MHz

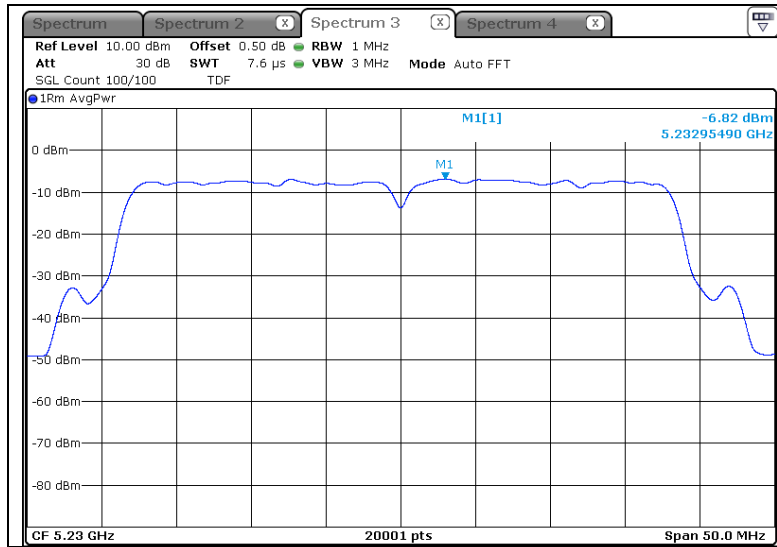
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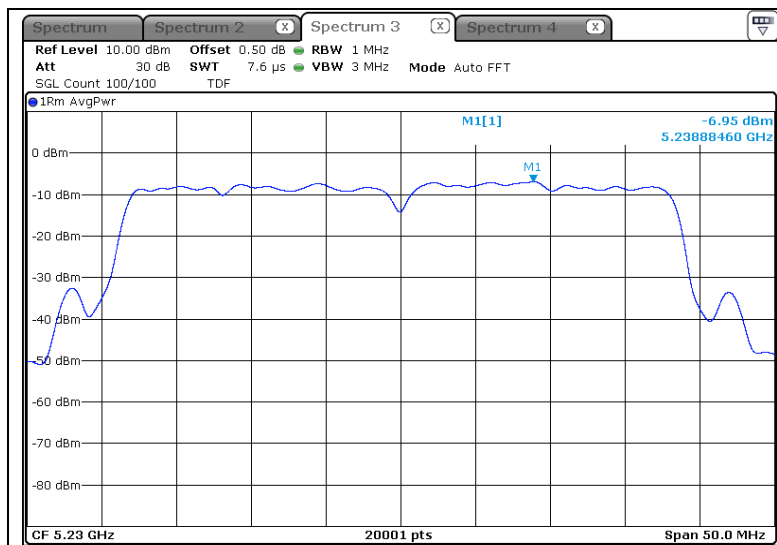
ANT2



ANT 3



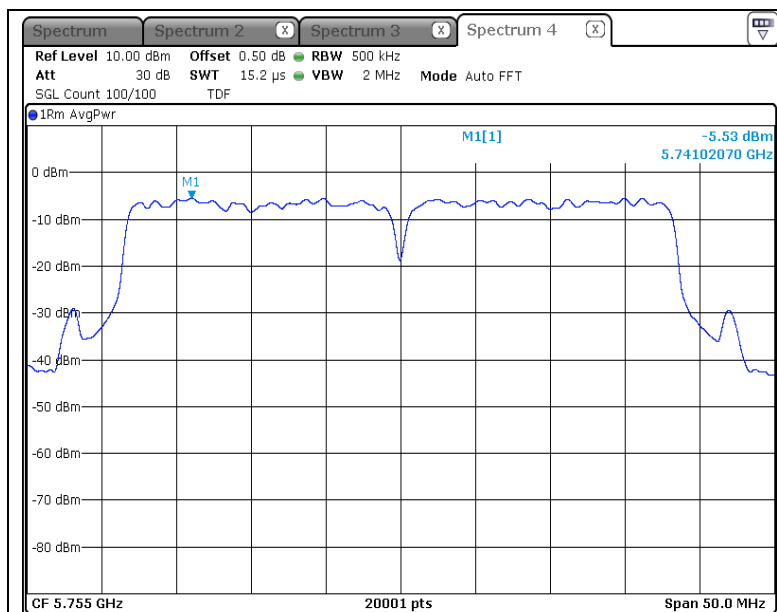
ANT 4



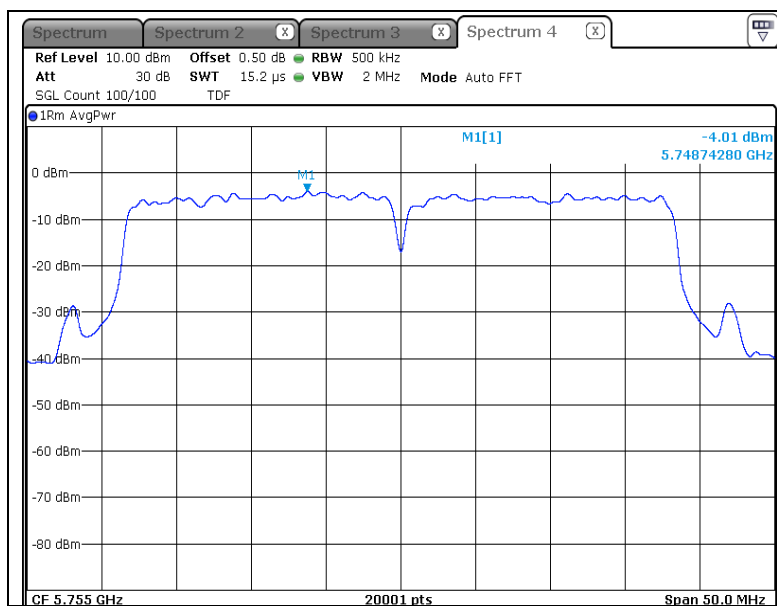
* 802.11n_HT40_Band 4

-5.755GHz

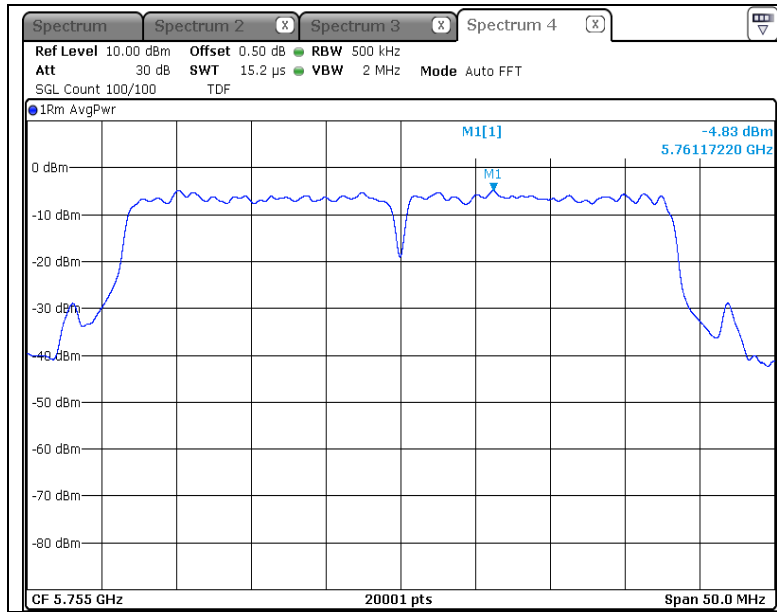
ANT 1



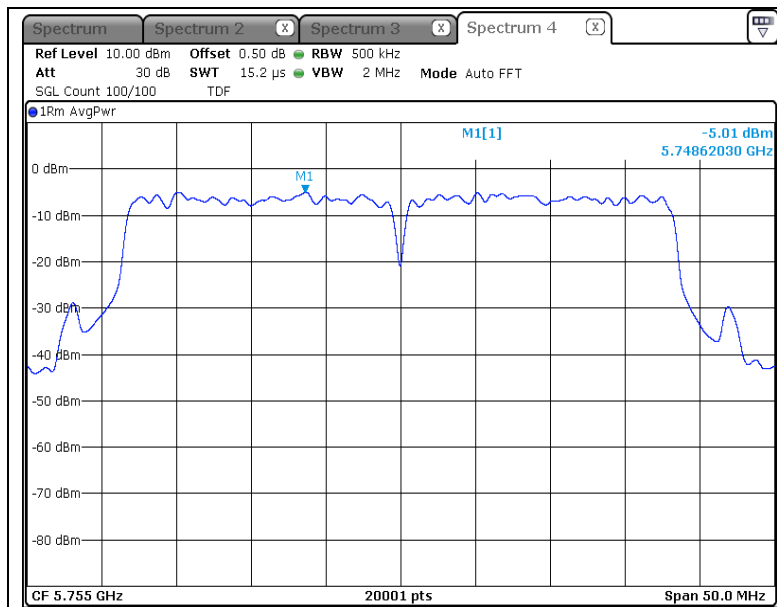
ANT 2



ANT 3

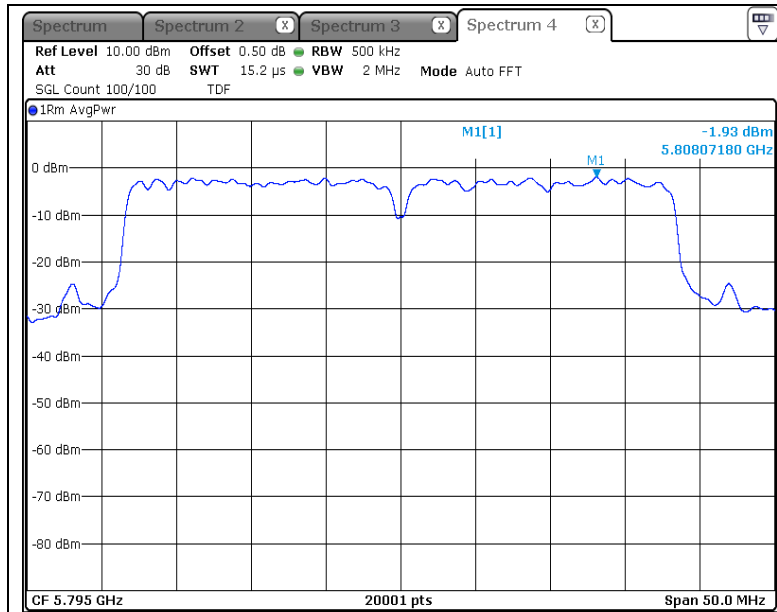


ANT 4

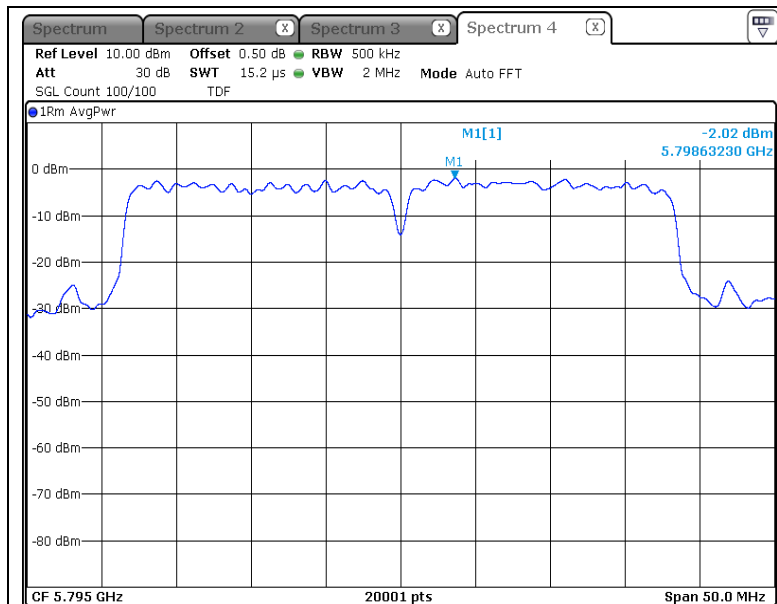


-5.795MHz

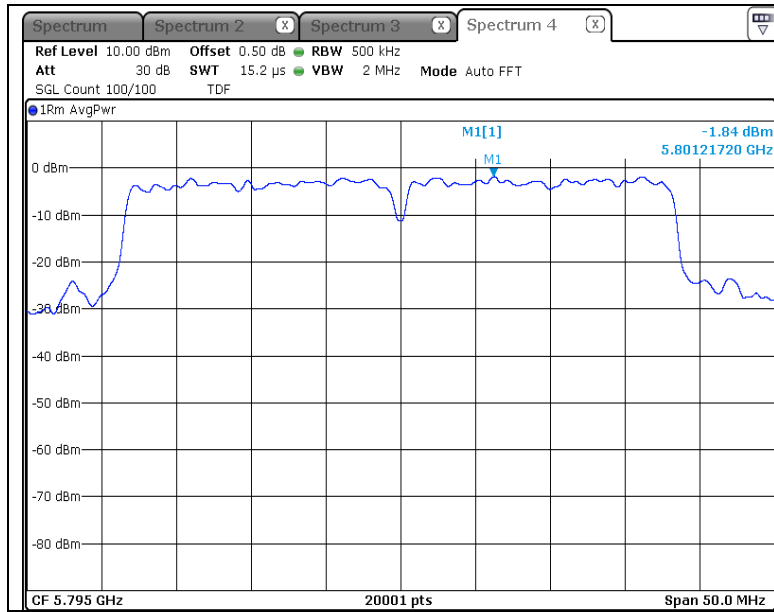
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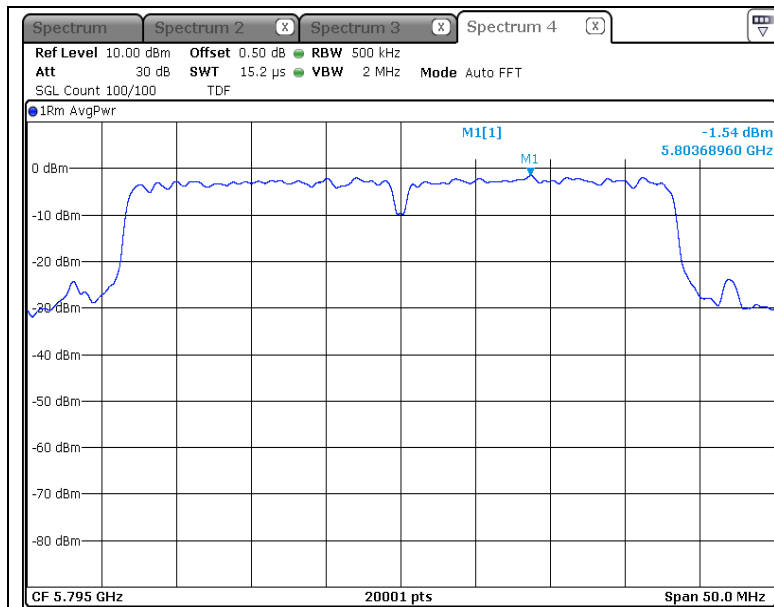
ANT 2



ANT 3



ANT 4



5.5 Spurious Emission, Band Edge And Restricted Bands

5.5.1 Regulation

According to §15.407(b)(1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

According to §15.407(b) (2) For transmitters operating in the 5.25-5.35 GHzband: All emissions outside of the 5.15-5.35 GHzband shall not exceed an e.i.r.p. of -27 dBm/MHz.

According to §15.407(b) For transmitters operating in the 5.47-5.725 GHzband: All emissions outside of the 5.47-5.725 GHzband shall not exceed an e.i.r.p. of -27 dBm/MHz.

According to §15.407(b) (4) For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of -27 dBm/MHz.

According to §15.407(b)(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.

According to §15.209(a), Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength ($\mu\text{V}/\text{m}$)	Measurement distance (m)
0.009 - 0.490	2 400/F(kHz)	300
0.490 -1.705	24 000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

According to §15.407(b)(7) The provisions of §15.205 apply to intentional radiators operating under this section.

(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 - 4 400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

5.5.2 Measurement Procedure

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

For all radiated emissions tests, measurements must correspond to the direction of maximum emission level for each measured emission (see ANSI C63.10 for guidance).

5.5.2.1 Unwanted Emissions in the Restricted Bands & Outside of the Restricted Bands

- (1) For all measurements, follow the requirements in section II.G.3., “General Requirements for Unwanted Emissions Measurements”.
- (2) At frequencies below 1000 MHz, use the procedure described in section II.G.4., “Procedure for Unwanted Emissions Measurements Below 1000 MHz”.
- (3) At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in sections II.G.5. and II.G.6, respectively, must satisfy the respective peak and average limits. If all peak measurements satisfy the average limit, then average measurements are not required.

(4) Unwanted Emissions that fall Outside of the Restricted Bands

As specified in § 15.407(b), emissions above 1000 MHz that are outside of the restricted bands are subject to a maximum emission limit of -27 dBm/MHz (or -17 dBm/MHz as specified in § 15.407(b)(4)).

However, an out-of-band emission that complies with both the peak and average limits of § 15.209 is not required to satisfy the -27 dBm/MHz or -17 dBm/MHz maximum emission limit.

a) If radiated measurements are performed, field strength is then converted to EIRP as follows:

(i) $EIRP = (E \cdot d)^2 / 30$

where: • E is the field strength in V/m; • d is the measurement distance in meters;
• EIRP is the equivalent isotropically radiated power in watts.

(ii) Working in dB units, the above equation is equivalent to:

$$EIRP[dBm] = E[dB\mu V/m] + 20 \log(d[meters]) - 104.77$$

(iii) Or, if d is 3 meters:

$$EIRP[dBm] = E[dB\mu V/m] - 95.2$$

5.5.2.2 Spurious Radiated Emissions:

1. The preliminary and final radiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m anechoic chamber. The EUT was tested at a distance 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1 000 MHz to 40 000 MHz using the horn antenna.
4. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
5. The 0.8m height is measurement for below 1 GHz and 1.5m is for above 1 GHz measurement.

Note

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.

5.5.3 Test Result

-complied

1. Band-edge & Conducted Spurious Emissions was shown in figure 3.
Note: We took the insertion loss of the cable into consideration within the measuring instrument.
2. Measured value of the Field strength of spurious Emissions (Radiated)
3. It tested x,y and z – 3 axis each, mentioned only worst case data at this report.

*** Below 1 GHz data (Worst-case: 5 795 Band)**

802.11a_Middle Channel

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μ V)]	Factor [dB]	Result [dB(μ V/m)]	Limit [dB(μ V/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
5.63	120	H	38.40	-12.40	26.00	69.50	43.50
-	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
301.84	120	H	53.50	-18.10	35.40	46.00	10.60
-	Not Detected	-	-	-	-	-	-

*** Above 1 GHz data_Band 1**

802.11n_HT40 (5 190 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μ V)]	Factor [dB]	Result [dB(μ V/m)]	Limit [dB(μ V/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
* 5 102.31	1 000	V	56.10	-7.50	48.60	74.00	25.40
6 972.94	1 000	V	47.00	-5.70	41.30	74.00	32.70
9 681.19	1 000	V	40.10	-1.90	38.20	74.00	35.80
11 042.50	1 000	V	40.90	-2.40	38.50	74.00	35.50
14 583.06	1 000	H	38.60	0.80	39.40	74.00	34.60
16 893.12	1 000	H	39.40	3.70	43.10	74.00	30.90
17 814.56	1 000	H	39.90	5.00	44.90	74.00	29.10
Above 18 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 102.31	1 000	V	46.90	-7.50	39.40	54.00	14.60
6 972.94	1 000	V	36.50	-5.70	30.80	54.00	23.20
9 681.19	1 000	V	31.30	-1.90	29.40	54.00	24.60
11 042.50	1 000	V	30.90	-2.40	28.50	54.00	25.50
14 583.06	1 000	H	28.70	0.80	29.50	54.00	24.50
16 893.12	1 000	H	29.60	3.70	33.30	54.00	20.70
17 814.56	1 000	H	28.90	5.00	33.90	54.00	20.10
Above 18 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11n_HT40 (5 230 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μ V)]	Factor [dB]	Result [dB(μ V/m)]	Limit [dB(μ V/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
# 5 352.56	1 000	V	54.70	-7.30	47.40	88.20	40.80
6 972.94	1 000	V	47.10	-5.70	41.40	74.00	32.60
9 502.94	1 000	H	41.20	-2.80	38.40	74.00	35.60
10 778.00	1 000	V	41.60	-2.00	39.60	74.00	34.40
13 786.69	1 000	H	38.50	1.50	40.00	74.00	34.00
16 881.62	1 000	H	38.40	3.70	42.10	74.00	31.90
17 837.56	1 000	V	38.10	5.00	43.10	74.00	30.90
Above 18 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
# 5 352.56	1 000	V	43.90	-7.30	36.60	68.20	31.60
6 972.94	1 000	V	35.30	-5.70	29.60	54.00	24.40
9 502.94	1 000	H	30.10	-2.80	27.30	54.00	26.70
10 778.00	1 000	V	30.90	-2.00	28.90	54.00	25.10
13 786.69	1 000	H	29.30	1.50	30.80	54.00	23.20
16 881.62	1 000	H	27.40	3.70	31.10	54.00	22.90
17 837.56	1 000	V	28.60	5.00	33.60	54.00	20.40
Above 18 000.00	Not Detected	-	-	-	-	-	-

This hash means Band Edge.

*** Above 1 GHz data_Band 4**

802.11a (5 755 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μ V)]	Factor [dB]	Result [dB(μ V/m)]	Limit [dB(μ V/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
# 5 708.69	1 000	V	85.70	-7.40	78.30	88.20	9.90
# 5 721.06	1 000	V	91.40	-7.40	84.00	98.20	14.20
6 974.38	1 000	V	45.20	-5.70	39.50	74.00	34.50
9 560.44	1 000	H	40.80	-2.50	38.30	74.00	35.70
11 505.37	1 000	V	43.40	-2.70	40.70	74.00	33.30
14 502.56	1 000	V	38.50	1.00	39.50	74.00	34.50
16 197.37	1 000	H	40.00	2.30	42.30	74.00	31.70
17 849.06	1 000	H	39.30	5.00	44.30	74.00	29.70
Above 18 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
# 5 708.69	1 000	V	71.50	-7.40	64.10	68.20	4.10
# 5 721.06	1 000	V	81.50	-7.40	74.10	78.20	4.10
6 974.38	1 000	V	34.20	-5.70	28.50	54.00	25.50
9 560.44	1 000	H	28.60	-2.50	26.10	54.00	27.90
11 505.37	1 000	V	34.90	-2.70	32.20	54.00	21.80
14 502.56	1 000	V	29.10	1.00	30.10	54.00	23.90
16 197.37	1 000	H	30.70	2.30	33.00	54.00	21.00
17 849.06	1 000	H	29.30	5.00	34.30	54.00	19.70
Above 18 000.00	Not Detected	-	-	-	-	-	-

This hash means Band Edge.

802.11n_HT40 (5 795 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μ V)]	Factor [dB]	Result [dB(μ V/m)]	Limit [dB(μ V/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
# 5 850.31	1 000	V	86.70	-7.40	79.30	98.20	18.90
# 5 862.00	1 000	V	80.50	-7.40	73.10	88.20	15.10
7 756.38	1 000	H	42.60	-5.40	37.20	74.00	36.80
9 566.19	1 000	V	40.50	-2.50	38.00	74.00	36.00
11 590.19	1 000	H	44.90	-2.70	42.20	74.00	31.80
14 137.44	1 000	H	40.60	2.00	42.60	74.00	31.40
16 888.81	1 000	H	39.00	3.70	42.70	74.00	31.30
17 887.87	1 000	V	39.00	5.00	44.00	74.00	30.00
Above 18 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
# 5 850.31	1 000	V	72.30	-7.40	64.90	78.20	13.30
# 5 862.00	1 000	V	65.60	-7.40	58.20	68.20	10.00
7 756.38	1 000	H	31.50	-5.40	26.10	54.00	27.90
9 566.19	1 000	V	29.30	-2.50	26.80	54.00	27.20
11 590.19	1 000	H	38.50	-2.70	35.80	54.00	18.20
14 137.44	1 000	H	28.40	2.00	30.40	54.00	23.60
16 888.81	1 000	H	27.90	3.70	31.60	54.00	22.40
17 887.87	1 000	V	28.20	5.00	33.20	54.00	20.80
Above 18 000.00	Not Detected	-	-	-	-	-	-

This hash means Band Edge.

5.6 Frequency Stability

5.6.1 Regulation

According to §15.407 (g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

5.6.2 Measurement Procedure

The frequency stability of the carrier frequency of the intentional radiator shall be maintained all conditions of normal operation as specified in the users manual. The frequency stability shall be maintained over a temperature variation of specified in the users manual at normal supply voltage, and over a variation in the primary supply voltage of specified in the users manual of the rated supply voltage at a temperature of 20 °C. For equipment that is capable only of operating from a battery, the frequency stability tests shall be performed using a new battery without any further requirement to vary supply voltage.

1. The EUT was placed inside the environmental test chamber.
2. The temperature was incremented by 10 °C intervals from lowest temperature.
3. Each increase step of temperature measured the frequency.
4. The test temperature was set 20°C and the supply voltage was then adjusted on the EUT from 85 % to 115% and the frequency record.

5.6.3 Test Result

-Complied

-5 190 MHz

Voltage [%]	Power [V]	Temp. [°C]	Reading Frequency [Hz]	Frequency Error [Hz]	Frequency Error [%]
100	120	-20	5 190 022 386	-22386	-0.0004
		-10	5 190 024 574	-24574	-0.0005
		0	5 190 022 227	-22227	-0.0004
		10	5 190 005 978	-5978	-0.0001
		20	5 189 997 503	2497	0.0000
		30	5 189 976 432	23568	0.0005
		40	5 189 971 164	28836	0.0006
		50	5 189 970 518	29482	0.0006
85	102	20	5 189 994 186	5814	0.0001
115	138	20	5 190 022 386	-22386	-0.0004

-5 230 MHz

Voltage [%]	Power [V]	Temp. [°C]	Reading Frequency [Hz]	Frequency Error [Hz]	Frequency Error [%]
100	120	-20	5 230 022 717	-22717	-0.0004
		-10	5 230 024 812	-24812	-0.0005
		0	5 230 021 733	-21733	-0.0004
		10	5 230 006 337	-6337	-0.0001
		20	5 229 989 660	10340	0.0002
		30	5 229 976 856	23144	0.0004
		40	5 229 970 406	29594	0.0006
		50	5 229 970 058	29942	0.0006
85	102	20	5 229 992 119	7881	0.0002
115	138	20	5 229 987 756	12244	0.0002

-5 775 MHz

Voltage [%]	Power [V]	Temp. [°C]	Reading Frequency [Hz]	Frequency Error [Hz]	Frequency Error [%]
100	120	-20	5 755 024 937	-24937	-0.0004
		-10	5 755 027 356	-27356	-0.0005
		0	5 755 023 182	-23182	-0.0004
		10	5 755 007 589	-7589	-0.0001
		20	5 754 984 022	15978	0.0003
		30	5 754 975 268	24732	0.0004
		40	5 754 967 013	32987	0.0006
		50	5 754 966 548	33452	0.0006
85	102	20	5 754 982 465	17535	0.0003
115	138	20	5 754 980 958	19042	0.0003

-5 795 MHz

Voltage [%]	Power [V]	Temp. [°C]	Reading Frequency [Hz]	Frequency Error [Hz]	Frequency Error [%]
100	120	-20	5 795 025 147	-25147	-0.0004
		-10	5 795 027 528	-27528	-0.0005
		0	5 795 022 598	-22598	-0.0004
		10	5 795 008 892	-8892	-0.0002
		20	5 794 979 497	20503	0.0004
		30	5 794 975 653	24347	0.0004
		40	5 794 966 075	33925	0.0006
		50	5 794 965 763	34237	0.0006
85	102	20	5 794 978 529	21471	0.0004
115	138	20	5 794 977 700	22300	0.0004

5.7 Conducted Emission

5.7.1 Regulation

According to §15.207(a), 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 μH/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.

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

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

5.7.2 Measurement Procedure

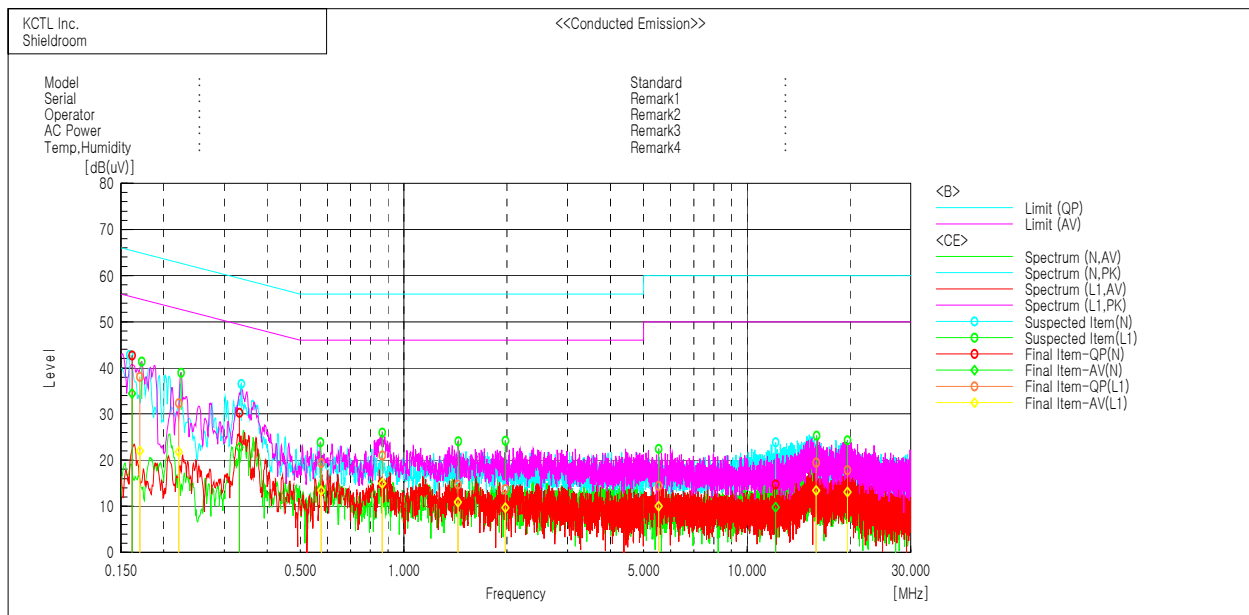
- 1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
- 2) Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
- 3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
- 4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
- 5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

5.7.3 Test Result

- Complied

Figure 4. plot of Conducted Emission

*Conducted worst-case data : 802.11n_HT40_5 795 MHz



Final Result

--- N Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.16182	33.0	24.8	9.7	42.7	34.5	65.4	55.4	22.7	20.9
2	0.33234	20.5	13.0	9.8	30.3	22.8	59.4	49.4	29.1	26.6
3	12.11591	4.9	0.0	9.8	14.7	9.8	60.0	50.0	45.3	40.2

--- L1 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.17031	28.2	12.2	9.8	38.0	22.0	64.9	54.9	26.9	32.9
2	0.22104	22.5	11.9	9.8	32.3	21.7	62.8	52.8	30.5	31.1
3	0.57541	9.5	3.6	9.9	19.4	13.5	56.0	46.0	36.6	32.5
4	0.86503	11.2	5.2	9.8	21.0	15.0	56.0	46.0	35.0	31.0
5	1.43867	5.1	1.2	9.7	14.8	10.9	56.0	46.0	41.2	35.1
6	1.9785	4.1	0.0	9.7	13.8	9.7	56.0	46.0	42.2	36.3
7	5.52677	4.7	0.3	9.7	14.4	10.0	60.0	50.0	45.6	40.0
8	15.92412	9.7	3.7	9.8	19.5	13.5	60.0	50.0	40.5	36.5
9	19.62579	8.0	3.3	9.8	17.8	13.1	60.0	50.0	42.2	36.9

6. Test equipment used for test

	Description	Manufacturer	Model No.	Serial No.	Next Cal Date.
■	Spectrum Analyzer	R & S	FSV30	100808	16.09.02
■	AC Power Supply	KIKUSUI	PCR2000W	GB001619	16.10.12
■	Temp & Humid Chamber	Myeongseong R&P	CTHC-51P-DT	20150824-2	16.10.02
■	Wideband Power Sensor	R & S	NRP-Z81	102398	17.02.11
■	Vector Signal Generator	R & S	SMBV100A	257566	17.01.07
■	Signal Generator	R & S	SMR40	100007	16.06.15
■	Test Receiver	R & S	ESCI	100710	16.09.01
■	TWO-LINE V-NETWORK	R & S	ENV216	101352	16.09.02
■	Test Receiver	R & S	ESR	101078	16.09.02
■	Bi-Log Ant.	SCHWARZBECK	VULB9163	552	16.05.14
■	LOOP Antenna	R & S	HFH2-Z2	100355	18.03.03
■	Amplifier	SONOMA INSTRUMENT	310N	186402	17.01.14
■	3 dB Attenuator	HP	8491B	22981	16.09.01
■	Antenna Mast	Innco Systems	MA4000-EP	303	-
■	Turn Table	Innco Systems	DT2000S-1t	79	-
■	Horn Antenna	ETS-LINDGREN	3117-PA	OO161083	16.11.12