

TEST REPORT

KCTL Inc.

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Report No.: KCTL15-FR0075

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

1. Applicant

Name: KOOLi Inc.
Address: 10 Corporate Park, Suite 330 Irvine, California 92606

2. Sample Description:

FCC ID: 2AF8K-W
Type of equipment: WooriKooli
Basic Model: W

3. Date of Test: November 20 ~ November 25, 2015

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

5. Test Results

Test Item: Refer to page 9
Result: Refer to page 8 ~ page 158
Measurement Uncertainty: Refer to page 10

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

Affirmation	Tested by	Technical Manager
	 Name: LEE, GI DONG	 Name: SON, MIN GI

2015. 11. 27

KCTL Inc. Testing Laboratory

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1. Client information

Applicant: KOOLi Inc.
Address: 10 Corporate Park, Suite 330 Irvine, California 92606
Telephone number: +1-70-4032-7800~2
Facsimile number: +1-949-670-6549
Contact person: Changmo Ha / changmoha@kooli.tv

Manufacturer: HUTEK CO., LTD.
Address: #E401-2,Bundang Technopark 151 Yatap-dong,Bundang-gu,Seongnam-si,Gyeonggi-Do,Korea

2. Laboratory information

Address

KCTL Ltd.

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.: 231

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:	KOOLi Inc.
Address of Applicant	10 Corporate Park, Suite 330 Irvine, California 92606
Manufacturer	HUTEK CO., LTD.
Address of Manufacturer	#E401-2,Bundang Technopark 151 Yatap-dong,Bundang-gu,Seongnam-si,Gyeonggi-Do,Korea
Type of equipment	WooriKooli
Basic Model	W

3.2 General description

Frequency Range	2 405 MHz ~ 2 470 MHz (RCU), 2 412 MHz ~ 2 462 MHz (WiFi 2.4G_802.11b/g/n_HT20), 5 180 MHz ~ 5 240 MHz (WiFi 5G_802.11a/n_HT20)
Type of Modulation	GFSK (RCU), DSSS(802.11b), OFDM (802.11a/g/n_HT20)
Number of Channels	3 ch (RCU), 11 ch (WiFi 2.4G), 4 ch (WiFi 5G)
Type of Antenna	Wire Antenna (WiFi), Chip Antenna (RCU)
Antenna Gain	0.5 dBi (RCU), 1.89 dBi (WiFi 2.4G),1.98 dBi (WiFi 5G)
Transmit Power	6.46 dBm
Power supply	DC 5.0 V
Product SW/HW version	1.0 / 1.0
Radio SW/HW version	1.88.45.3
Test SW Version	Android
RF power setting in TEST SW	10

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

3.3 Test frequency

* 802.11a/n HT20

Frequency	Band 1
Low frequency	5 180 MHz
Middle frequency	5 200 MHz
High frequency	5 240 MHz

3.4 Test Voltage

Mode	Voltage
Norminal voltage	DC 5 V

3.5 Duty Factor

Mode	Duty cycle [dB]	Duty cycle factor [dB]
802.11a	97.11	0.13
802.11n HT20	96.92	0.14

* Duty cycle factor=10log(1/Duty cycle)

4. Summary of test results

4.1 Standards & results

FCC Rule	IC Rule (RSS-GEN)	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₎ : This device uses only WiFi 5G Band 1.				

* 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	± 1.30 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 ~ 40 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 wire antenna that antenna gain is 1.98 dBi and it doesn't exceed 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

-802.11a 5 150 Band

Frequency [MHz]	Result [dBm]	Duty Factor [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 180	6.46	0.13	6.59	24.00	17.41
5 200	6.45	0.13	6.58	24.00	17.42
5 240	6.38	0.13	6.51	24.00	17.49

-802.11n HT20 5 150 Band

Frequency [MHz]	Result [dBm]	Duty Factor [dBm]	Total result [dBm]	Limit [dBm]	Margin [dBm]
5 180	5.11	0.14	5.25	24.00	18.75
5 200	5.05	0.14	5.19	24.00	18.81
5 240	5.00	0.14	5.14	24.00	18.86

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

*802.11a 5 150 Band

Frequency	26 dB Bandwidth	OBW
5 180	18.58	16.42
5 200	18.54	16.42
5 240	18.66	16.42

*802.11n HT20 5 150 Band

Frequency	26 dB Bandwidth	OBW
5 180	18.90	17.46
5 200	19.06	17.46
5 240	19.02	17.46

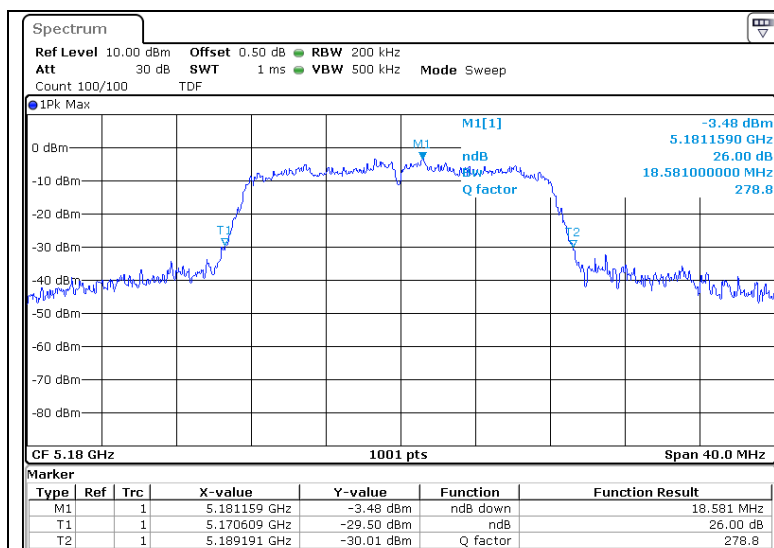
5.3.4 Test Plot

Figure 1. Plot of Bandwidth Measurement

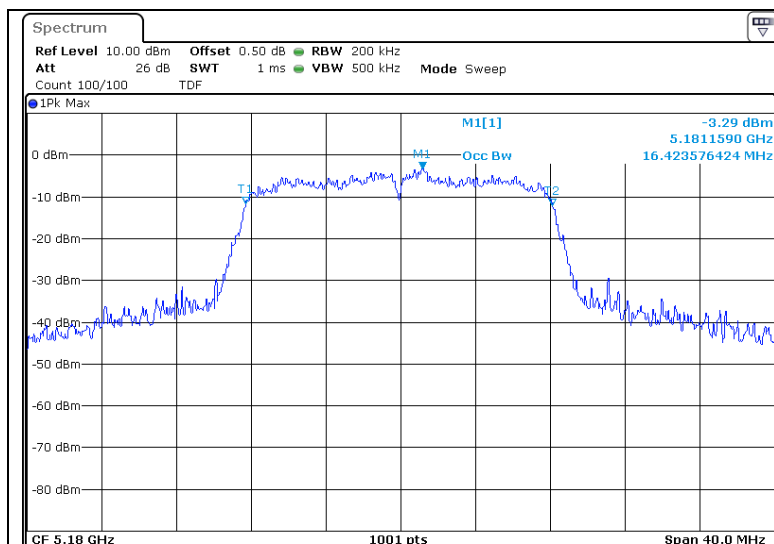
* 802.11a_5 150 Band

-5 180 MHz

EBW

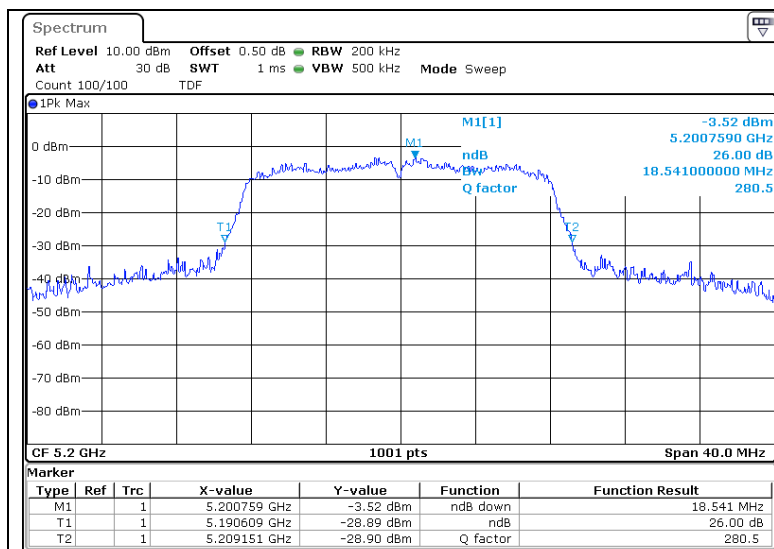


OBW

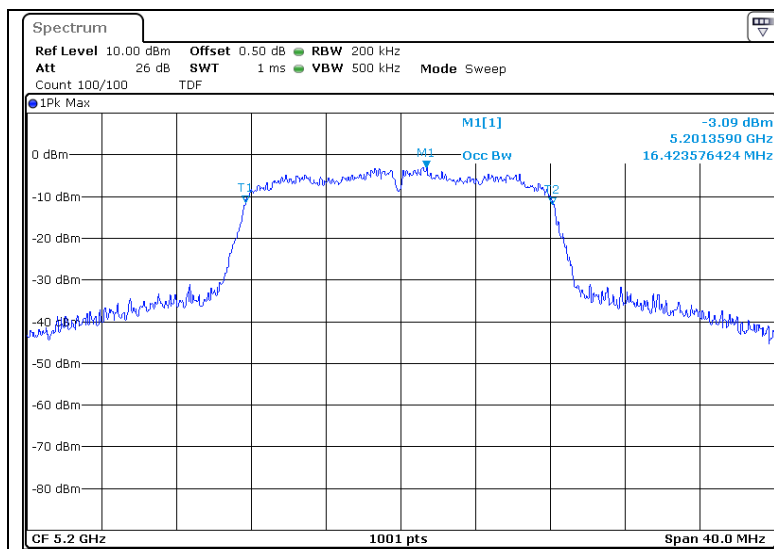


-5 200 MHz

EBW

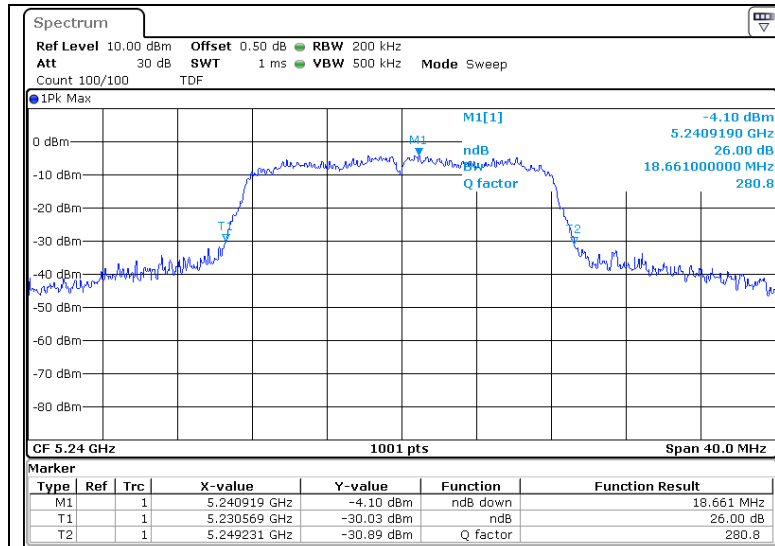


OBW

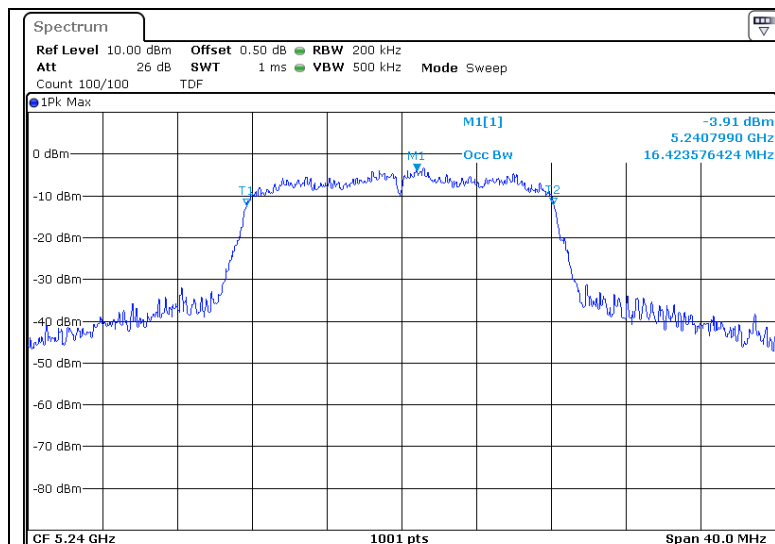


-5 240 MHz

EBW



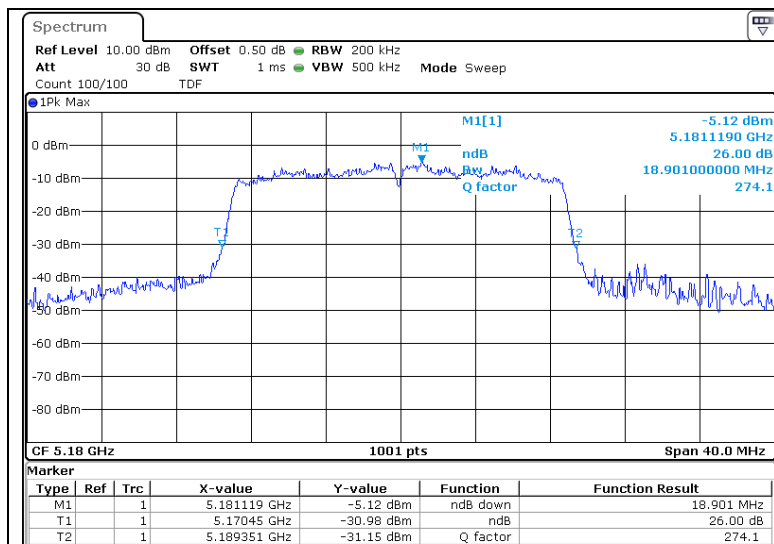
OBW



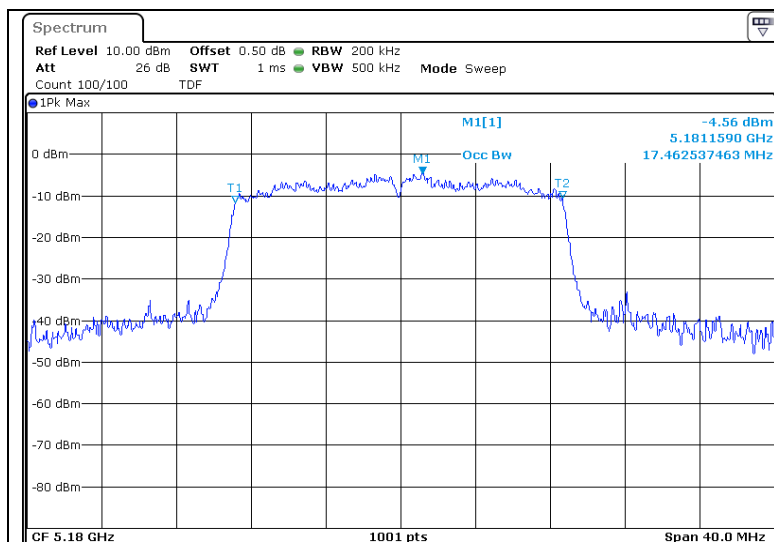
* 802.11n HT20_5 150 Band

-5 180 MHz

EBW

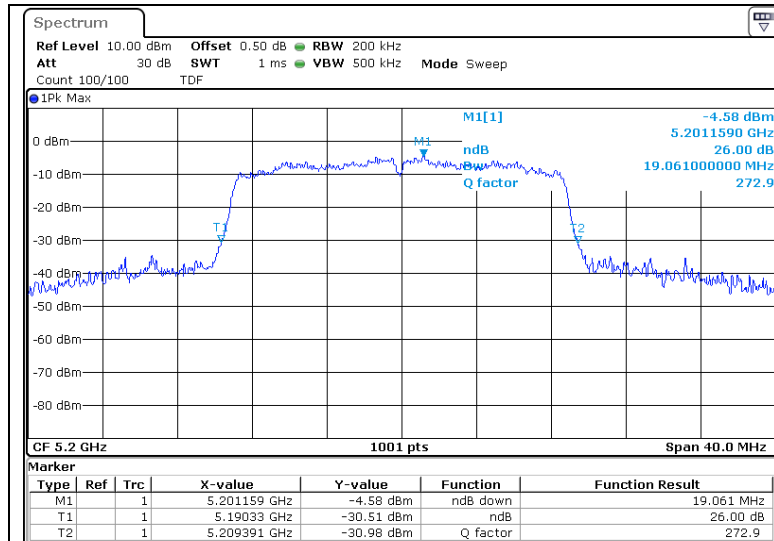


OBW

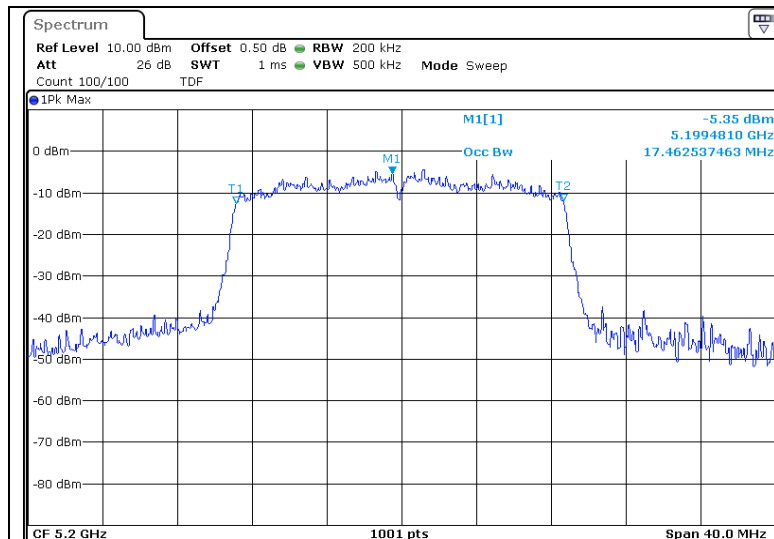


-5 200 MHz

EBW

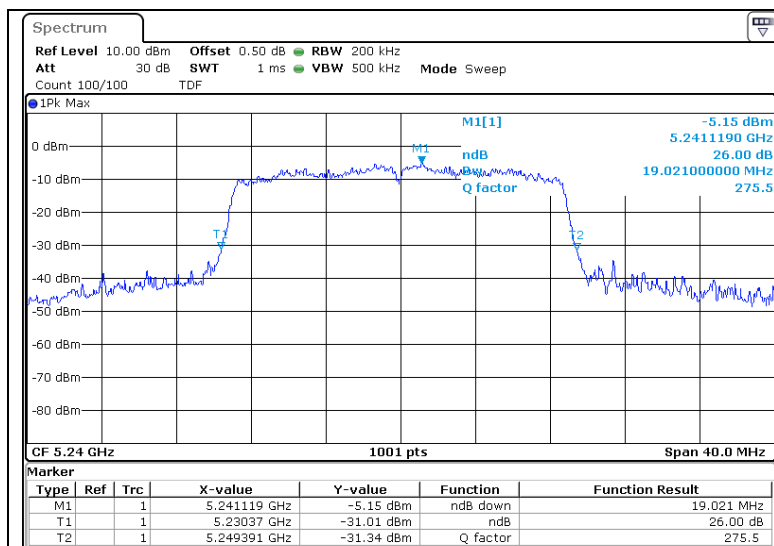


OBW

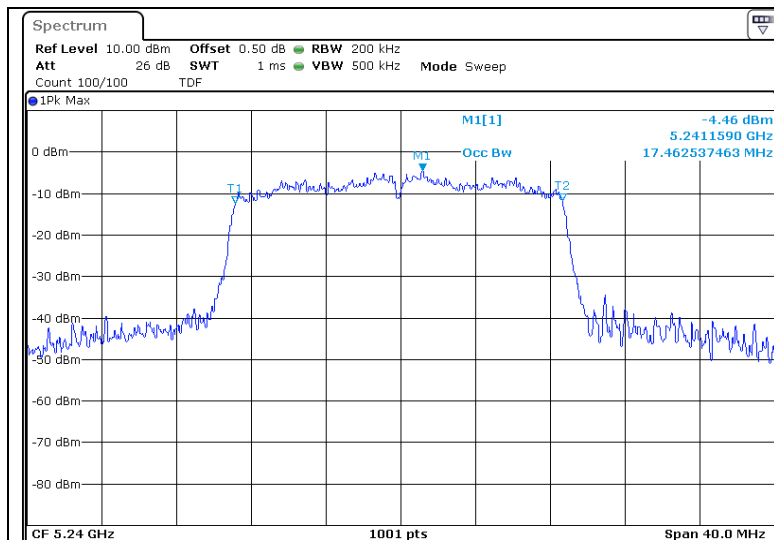


-5 240 MHz

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 $RBW (< 500 \text{ kHz})$ 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 $RBW (< 1 \text{ MHz})$ 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 $RBW=100 \text{ kHz}$ is available on nearly all spectrum analyzers.

5.4.3 Test Result

-Complied

-802.11a_5 150 Band

Frequency [MHz]	Reading [dBm]	Duty Cycle [dB]	Total result [dBm]	Limit [dBm]	Margin [dB]
5 180	-4.24	0.13	-4.11	11.00	15.11
5 200	-3.96	0.13	-3.83	11.00	14.83
5 240	-4.05	0.13	-3.92	11.00	14.92

-802.11n HT20_5 150 Band

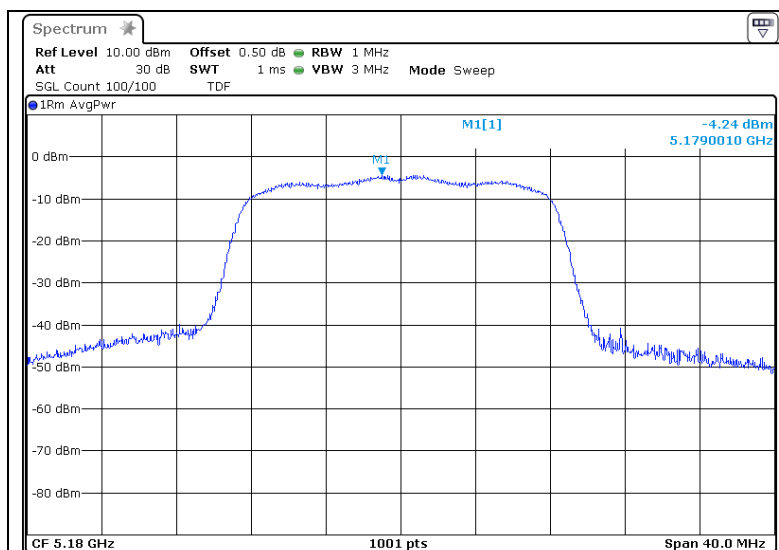
Frequency [MHz]	Reading [dBm]	Duty Cycle [dB]	Total result [dBm]	Limit [dBm]	Margin [dB]
5 180	-5.69	0.14	-5.55	11.00	16.55
5 200	-5.75	0.14	-5.61	11.00	16.61
5 240	-5.65	0.14	-5.51	11.00	16.51

5.4.4 Test Plot

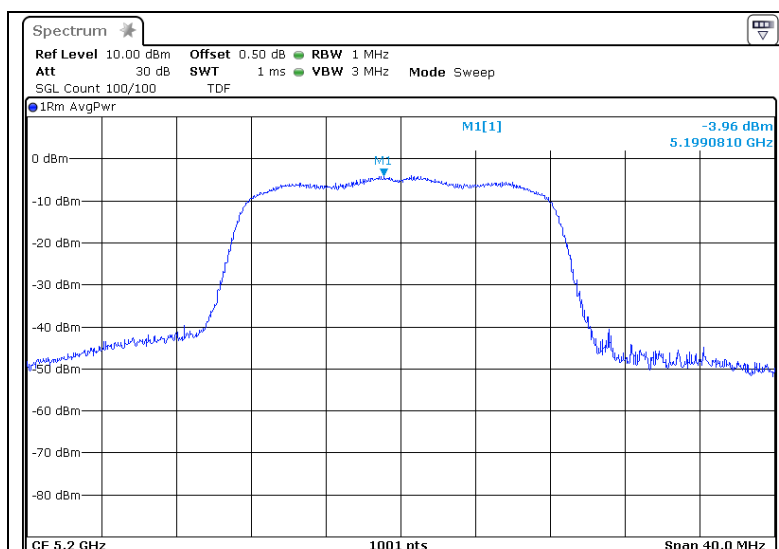
Figure 2. Plot of the Power Spectral Density

* 802.11a_5 150 Band

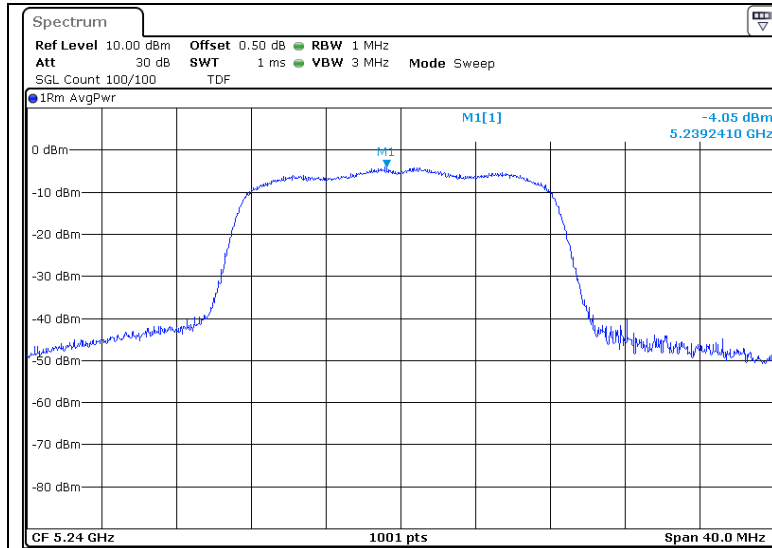
-5 180 MHz



-5 200 MHz

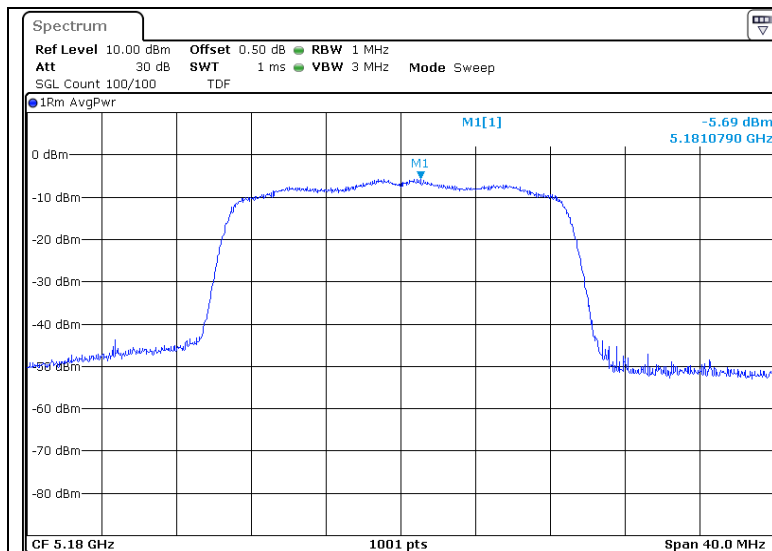


-5 240 MHz

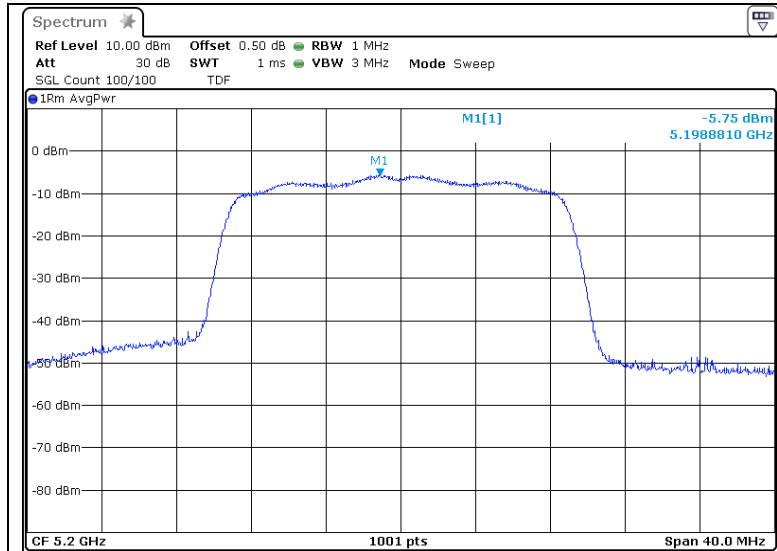


* 802.11n HT20_5 150 Band

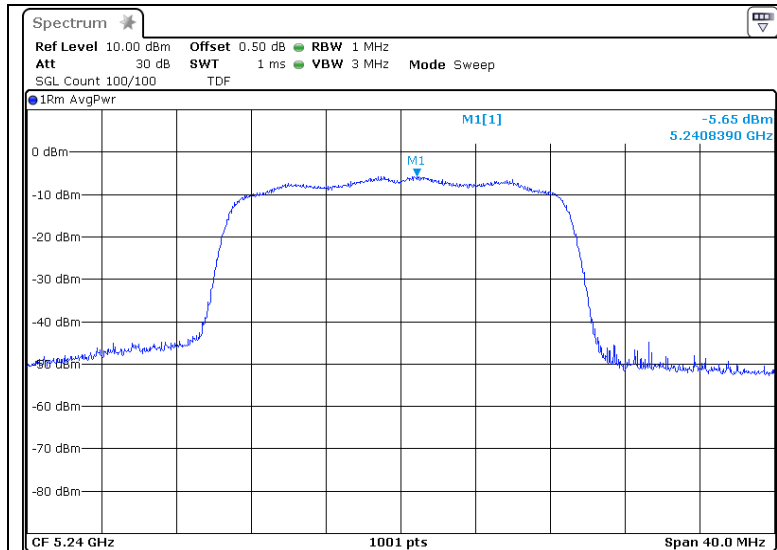
-5 180 MHz



-5 200 MHz



-5 240 MHz



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 (μV/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.

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.
The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz ($\geq 1/T$) for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)

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: 5 250 Band)**

802.11a_Middle Channel

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
below 30.00	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
66.62	120	V	39.00	-18.20	20.80	40.00	19.20
269.95	120	H	32.60	-16.00	16.60	46.00	29.40
377.99	120	H	37.20	-12.60	24.60	46.00	21.40
648.01	120	H	28.60	-5.90	22.70	46.00	23.30
837.65	120	V	37.40	-2.40	35.00	46.00	11.00
960.11	120	H	42.30	0.30	42.60	54.00	11.40
Above 1 000.00	Not Detected	-	-	-	-	-	-

*** Above 1 GHz data_5150 Band**

802.11a (5 180 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							
* 5 026.00	1 000	H	45.30	8.20	53.50	74.00	20.50
* 5 149.75	1 000	H	47.90	8.70	56.60	74.00	17.40
5 340.88	1 000	H	47.30	9.90	57.20	74.00	16.80
Above 6 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 026.00	1 000	H	38.50	8.20	46.70	54.00	7.30
* 5 149.75		H	38.50	8.70	47.20	54.00	6.80
5 340.88		H	38.90	9.90	48.80	54.00	5.20
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11a (5 200 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							
* 5 048.00	1 000	H	45.40	8.30	53.70	74.00	20.30
* 5 360.81	1 000	H	48.90	9.90	58.80	74.00	15.20
Above 6 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 048.00	1 000	H	39.30	8.30	47.60	54.00	6.40
* 5 360.81	1 000	H	40.10	9.90	50.00	54.00	4.00
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11a (5 240 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							
* 5 393.13	1 000	H	47.70	10.20	57.90	74.00	16.10
* 5 086.50	1 000	H	43.70	8.40	52.10	74.00	21.90
Above 6 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 086.50	1 000	H	38.80	8.40	47.20	54.00	6.80
* 5 393.13	1 000	H	39.60	10.20	49.80	54.00	4.20
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11n HT20 (5 180 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							
* 5 026.69	1 000	H	44.80	8.20	53.00	74.00	21.00
5 147.00	1 000	H	48.70	8.70	57.40	74.00	16.60
5 335.38	1 000	H	47.20	9.80	57.00	74.00	17.00
Above 6 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 026.69	1 000	H	38.70	8.20	46.90	54.00	7.10
5 147.00	1 000	H	38.10	8.70	46.80	54.00	7.20
5 335.38	1 000	H	39.00	9.80	48.80	54.00	5.20
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11n HT20 (5 200 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
* 5 044.56	1 000	H	43.30	8.30	51.60	74.00	22.40
* 5 352.56	1 000	H	48.40	9.90	58.30	74.00	15.70
Above 6 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 044.56	1 000	H	39.00	8.30	47.30	54.00	6.70
* 5 352.56	1 000	H	40.70	9.90	50.60	54.00	3.40
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

802.11n HT20 (5 240 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1 GHz							
* 5 088.56	1 000	H	43.50	8.40	51.90	74.00	22.10
* 5 393.13	1 000	H	46.60	10.20	56.80	74.00	17.20
Above 2 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
* 5 088.56	1 000	H	39.90	8.40	48.30	54.00	5.70
* 5 393.13	1 000	H	40.80	10.20	51.00	54.00	3.00
Above 6 000.00	Not Detected	-	-	-	-	-	-

* This Asterisk means restricted band.

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

*802.11a/n_HT20

Voltage [%]	Power [V]	Temp. [°C]	Reading Frequency [Hz]	Frequency Error [Hz]	Frequency Error [%]
100	14.4	0	5 179 896 566	-103 434	-0.002 0
		10	5 179 889 951	-110 049	-0.002 1
		20	5 179 880 288	-119 712	-0.002 3
		30	5 179 870 709	-129 291	-0.002 5
		40	5 179 863 427	-136 573	-0.002 6
		Normal	5 179 863 413	-136 587	-0.002 6
85	4.25	Normal	5 179 863 549	-136 451	-0.002 6
115	5.75	Normal	5 179 863 617	-136 383	-0.002 6

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 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	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

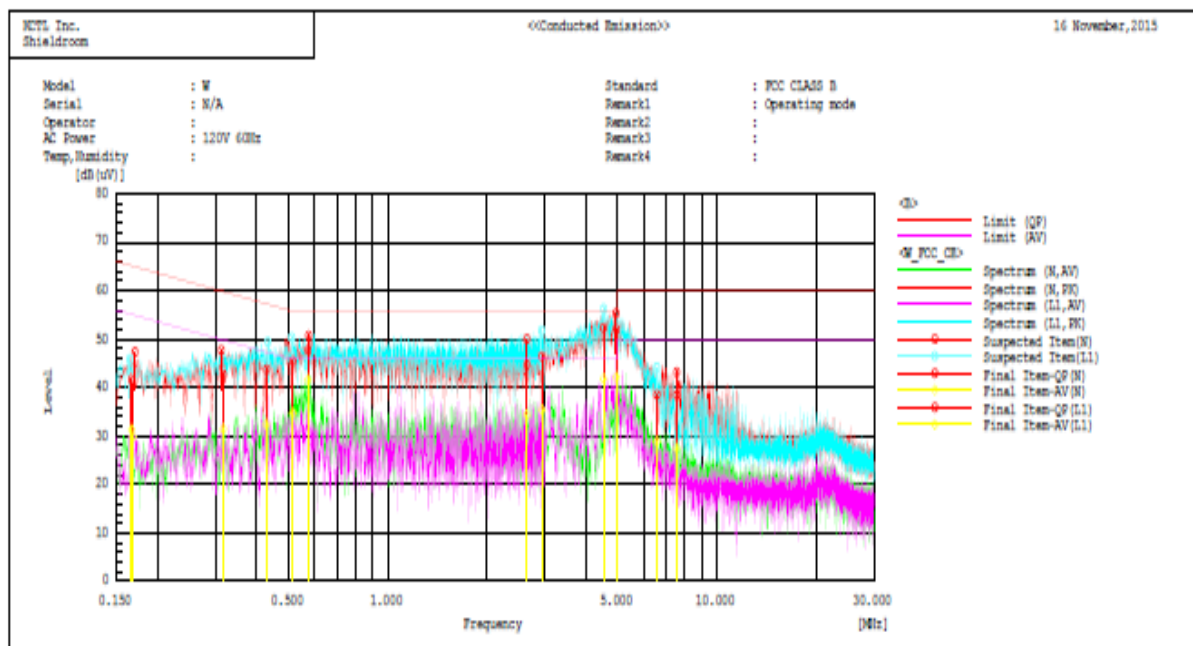
- 1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
- 2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω /50 μ H LISN, 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 : 802.11a_Low Channel (5 180 MHz)



Final Result

--- N Phase ---

No.	Frequency	Reading QP	Reading CAV	c.f	Result QP	Result CAV	Limit QP	Limit AV	Margin QP	Margin CAV
	[MHz]	[dB(uV)]	[dB(uV)]	[dB]	[dB(uV)]	[dB(uV)]	[dB(uV)]	[dB(uV)]	[dB]	[dB]
1	0.16825	30.6	19.7	10.1	40.7	29.8	65.0	55.0	24.3	25.2
2	0.57199	37.7	31.6	10.0	47.7	41.6	56.0	46.0	8.3	4.4
3	4.94808	42.3	32.4	9.7	52.0	42.1	56.0	46.0	4.0	3.9
4	7.55284	28.7	17.8	9.7	38.4	27.5	60.0	50.0	21.6	22.5
5	0.31707	32.8	21.7	9.8	42.6	31.5	59.8	49.8	17.2	18.3
6	2.64791	35.0	24.6	9.7	44.7	34.3	56.0	46.0	11.3	11.7

--- LI Phase ---

No.	Frequency	Reading QP	Reading CAV	c.f	Result QP	Result CAV	Limit QP	Limit AV	Margin QP	Margin CAV
	[MHz]	[dB(uV)]	[dB(uV)]	[dB]	[dB(uV)]	[dB(uV)]	[dB(uV)]	[dB(uV)]	[dB]	[dB]
1	0.16674	31.6	21.2	10.1	41.7	31.3	65.1	55.1	23.4	23.8
2	0.51613	35.5	24.7	10.0	45.5	34.7	56.0	46.0	10.5	11.3
3	2.93923	36.7	25.7	9.7	46.4	35.4	56.0	46.0	9.6	10.6
4	4.52533	42.7	32.2	9.7	52.4	41.9	56.0	46.0	3.6	4.1
5	6.5804	28.8	19.2	9.7	38.5	28.9	60.0	50.0	21.5	21.1
6	0.42864	33.7	22.4	10.0	43.7	32.4	57.3	47.3	13.6	14.9

6. Test equipment used for test

	Description	Manufacturer	Model No.	Serial No.	Next Cal Date.
■	Wideband Power Sensor	R&S	NRP-Z81	100677	16.01.26
■	Attenuator	R&S	DNF Dämpfungsglied 10 dB in N-50 Ohm	0004	16.06.15
■	Spectrum Analyzer	R&S	FSV30	100810	16.09.02
■	DC Power Supply	AGILENT	E3632A	MY400088000	15.12.11
■	Spectrum Analyzer	R&S	FSV30	100807	16.09.02
■	Signal Generator	R&S	SMR40	100007	16.06.15
■	Loop Antenna	R&S	HFH2-Z2	861971/003	17.03.03
■	Bi-Log Antenna	SCHWARZBECK	VULB9163	552	16.06.14
■	Horn Antenna	ETS.lindgren	3115	62589	16.11.12
■	Horn Antenna	ETS.lindgren	3116	00086635	16.04.29
■	Horn Antenna	SCHWARZBECK	3117	155787	16.02.05
■	Broadband Preamplifier	SCHWARZBECK	BBV9721	2	16.05.19
■	Preamplifier	AGILENT	3008A02343	8449B	16.09.02
■	Amplifier	SONOMA INSTRUMENT	310	186280	16.09.01
■	Emi Test Receiver	R&S	ESR	101078	16.02.16
■	Attenuator	AGILENT	8491A	MY52460424	16.07.13
■	Antenna Mast	Innco Systems	MA4000-EP	-	-
■	Turn Table	Innco Systems	DT2000	-	-