TEST REPORT

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1. Client

- Name : DREAMUS COMPANY
- Address : 5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
- Date of Receipt : 2019-04-11

2. Use of Report : -

3. Name of Product and Model : SP2000 / PPF33

4. Manufacturer and Country of Origin : DREAMUS COMPANY / Korea

5. FCC ID : QDMPPF33

6. Date of Test : 2019-05-01 to 2019-05-30

7. Test Standards : FCC Part 15 Subpart E, 15.407

8. Test Results : Refer to the test result in the test report

Affirmation	Tested by Name : Taeyoung Kim (Signature)	Technical Manager Name : Jaehyong Lee (Signature)

2019-05-30

KCTL Inc.

Report revision history

Date	Revision	Page No
2019-05-30	Initial report	-

CONTENTS

1. General information

Client	:	DREAMUS COMPANY
Address	:	5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
Manufacturer	:	DREAMUS COMPANY
Address	:	5, Bangbae-ro 18gil, Seocho-gu, Seoul, Republic of Korea
Laboratory	:	KCTL Inc.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
Accreditations	:	FCC Site Designation No: KR0040, FCC Site Registration No: 687132 VCCI Registration No. : R-3327, G-198, C-3706, T-1849 Industry Canada Registration No. : 8035A KOLAS No.: KT231

2. Device information

Equipment under test	:	SP2000
Model	:	PPF33
Frequency range	:	2 402 ㎒ ~ 2 480 ㎒ (Bluetooth(BDR/EDR)) 2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n HT20) 2 422 ㎒ ~ 2 452 ㎒ (802.11n HT40) 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n HT20) 5 190 ㎒ ~ 5 230 ㎒ (802.11n HT40) 5 210 ㎒ (802.11ac VHT80) 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n HT20) 5 755 ㎒ ~ 5 795 ㎒ (802.11n HT40) 5 775 ㎒ (802.11ac VHT80)
Modulation technique	:	GFSK, π/4DQPSK, 8DPSK (Bluetooth(BDR/EDR)) DSSS, OFDM (802.11a/b/g/n(HT20/40)/ac(VHT80))
Number of channels	:	2.4 ㎓: 11 ch (802.11b/g/n HT20), 7 ch (802.11n HT40) 79 ch (Bluetooth(BDR/EDR)) 5 ㎓ (UNII 1): 4 ch (802.11a/n HT20) 2 ch (802.11n HT40) 1 ch (802.11ac VHT80) 5.8 ㎓ (UNII 3): 5 ch (802.11a/n HT20) 2 ch (802.11n HT40) 1 ch (802.11ac VHT80)
Power source	:	DC 3.8 V
Antenna specification	:	Carrier LPS Antenna
Antenna gain	:	-2.059 ㏈i (Bluetooth, WIFI 2.4 ㎓), 2.054 ㏈i (WIFI 5 ㎓) 0.004 ㏈i (WIFI 5.8 ㎓)
Software version	:	1.0

Hardware version : ES
Test device serial No. : N/A
Operation temperature : 23 ℃

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Battery	HYPERPOWER BATTERIES INC.	PR-596073G	-	DC 3.8 V, 3 700 ㎃ /24 ㎒

2.2. Frequency/channel operations

This device contains the following capabilities:
WIFI(802.11a/b/g/n(HT20/HT40)/ac(VHT80) , Bluetooth(BDR, EDR)

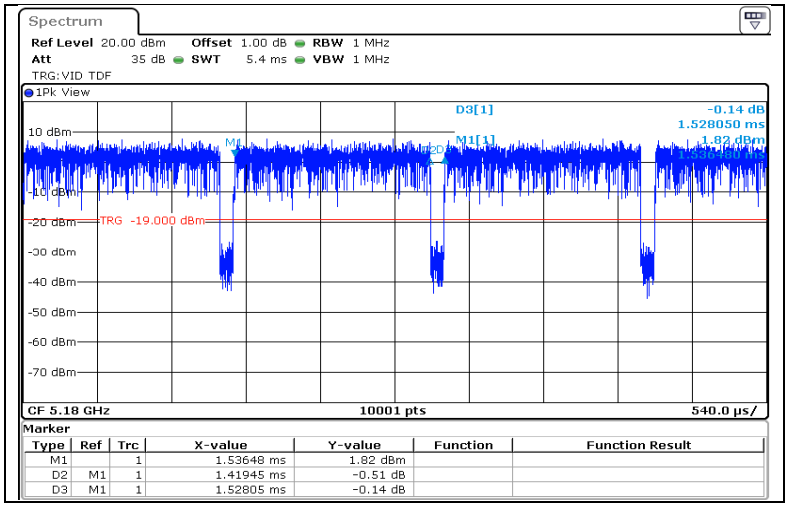
UNII-1 (5 150 ㎒ – 5 250 ㎒)			
Mode	Lowest frequency	Middle frequency	Highest frequency
802.11a/n HT20	5 180 ㎒	5 200 ㎒	5 240 ㎒
802.11n HT40	5 190 ㎒	-	5 230 ㎒
802.11ac VHT80	5 210 ㎒		
UNII-3 (5 725 ㎒ – 5 850 ㎒)			
802.11a/n HT20	5 745 ㎒	5 785 ㎒	5 825 ㎒
802.11n HT40	5 755 ㎒	-	5 795 ㎒
802.11ac VHT80	-	5 775 ㎒	-

Table 2.2.1. WIFI(802.11a/n(HT20/HT40)/ac(VHT80) mode

2.3. Duty Cycle Correction Factor

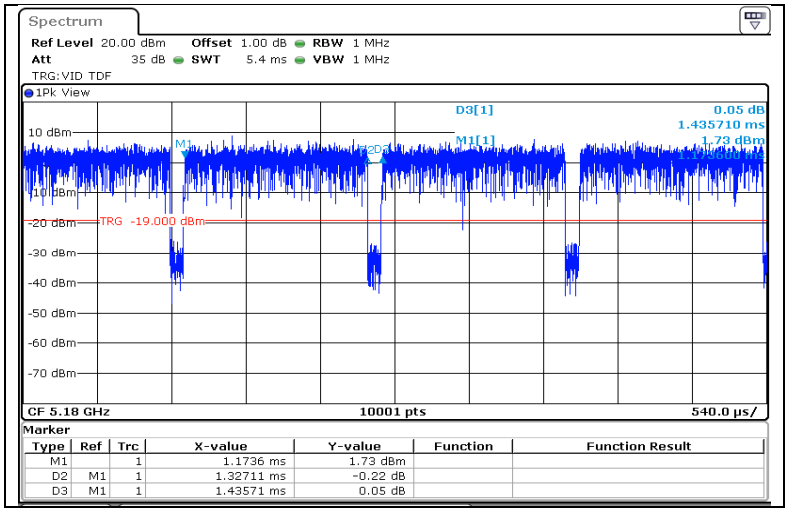
- **UNII-1**

- 802.11a



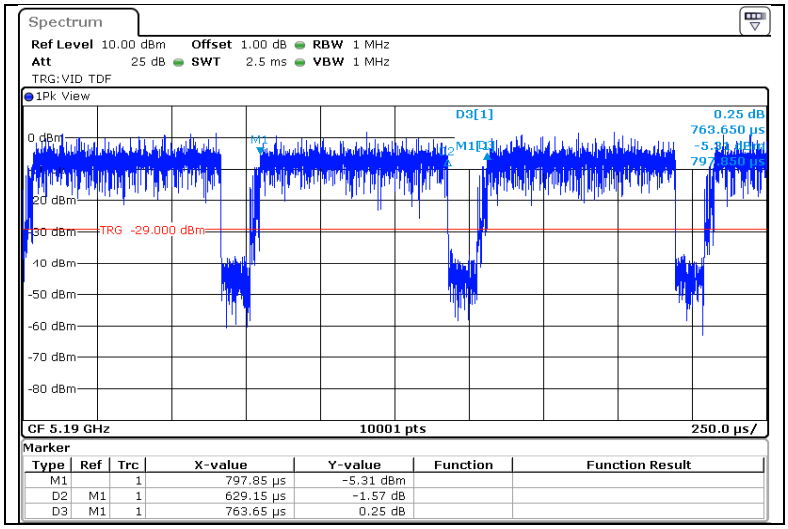
Note1): period: 1.528 ㎳, On time: 1.419 ㎳
Note2): DCCF = 10 log(1 / x) = 10 log(1/0.929) = 0.32 ㏈, x = 1.419/1.528 = 0.929 (92.9%)
Note3): 802.11a is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT20



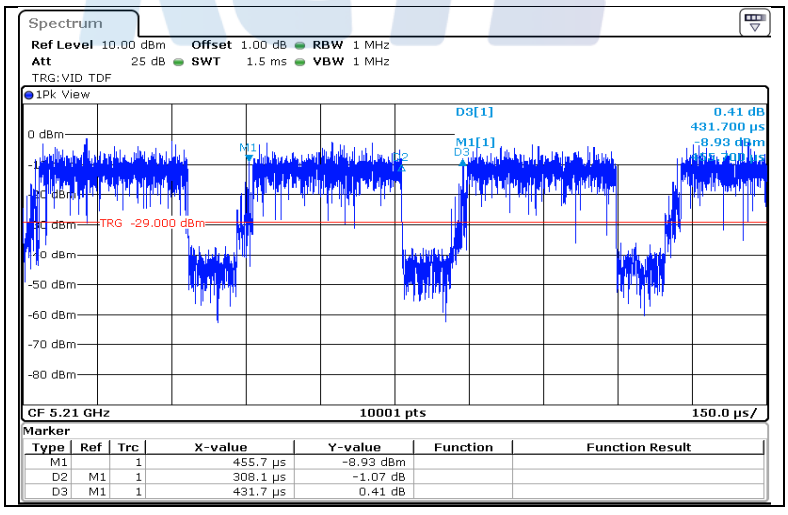
Note1): period: 1.44 ㎳, On time: 1.33 ㎳
Note2): DCCF = 10 log(1 / x) = 10 log(1/0.924) = 0.34 ㏈, x = 1.33/1.44 = 0.924 (92.4%)
Note3): 802.11n HT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT40



Note1): period: 0.76 ㎳, On time: 0.63 ㎳
Note2): DCCF = 10 log(1 / x) = 10 log(1/0.824) = 0.84 ㏈, x = 0.63/0.76 = 0.824 (82.4%)
Note3): 802.11n HT40 is a non-continuous transmission (duty cycle < 98%)

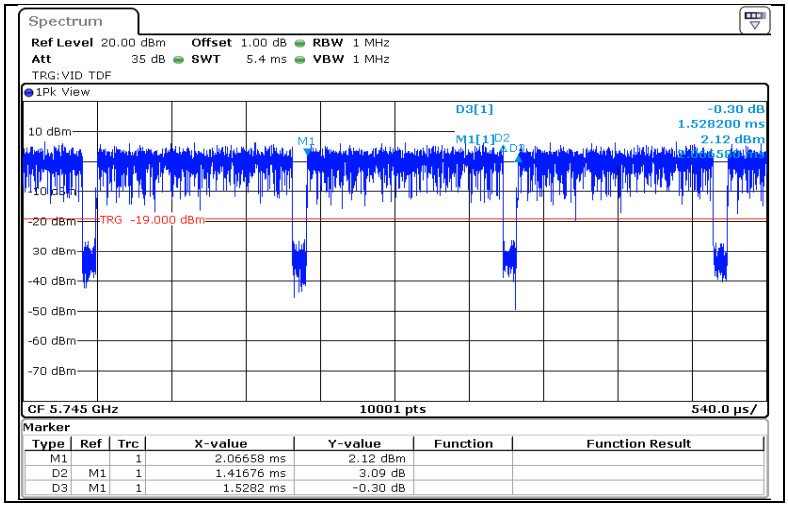
- 802.11ac VHT80



Note1): period: 0.43 ㎳, On time: 0.31 ㎳
Note2): DCCF = 10 log(1 / x) = 10 log(1/0.714) = 1.46 ㏈, x = 0.31/0.43 = 0.714 (71.4%)
Note3): 802.11acVHT80 is a non-continuous transmission (duty cycle < 98%)

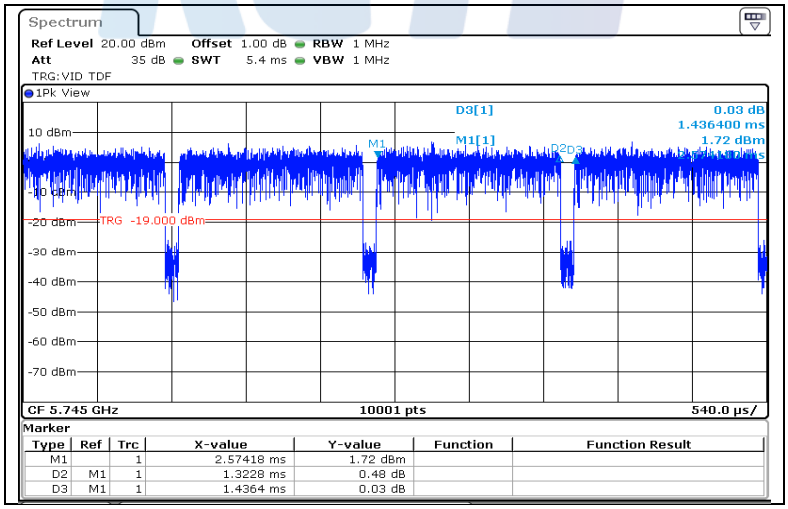
- UNII-3

- 802.11a



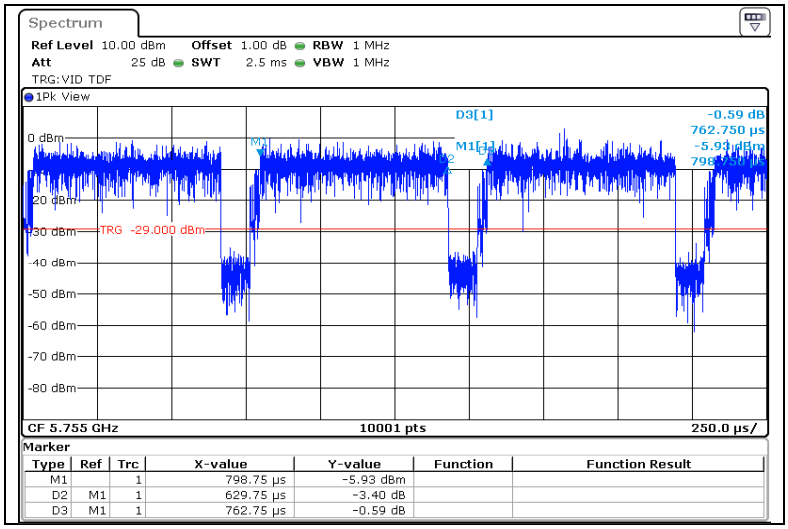
Note$_{1)}$: period: 1.53 ㎳, On time: 1.42 ㎳
Note$_{2)}$: DCCF = 10 log(1 / x) = 10 log(1/0.927) = 0.33 ㏈, x = 1.42/1.53 = 0.927 (92.7%)
Note$_{3)}$: 802.11a is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT20



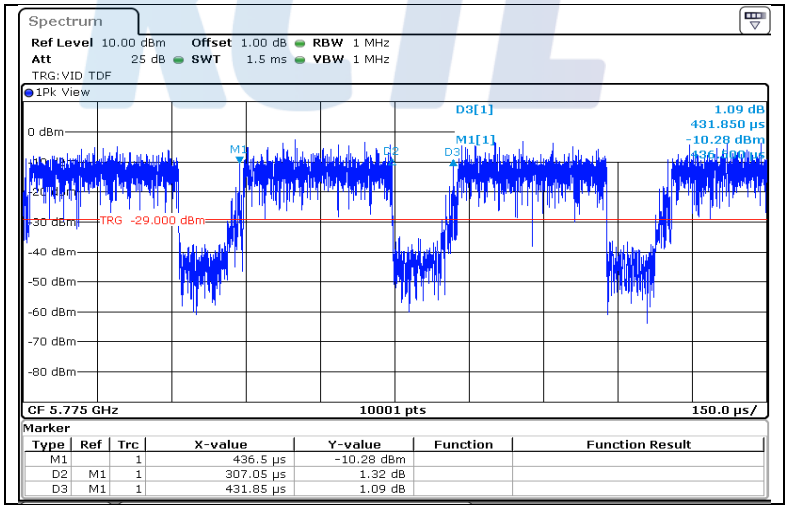
Note$_{1)}$: period: 1.44 ㎳, On time: 1.32 ㎳
Note$_{2)}$: DCCF = 10 log(1 / x) = 10 log(1/0.921) = 0.36 ㏈, x = 1.32/1.44 = 0.921 (92.1%)
Note$_{3)}$: 802.11n HT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT40



Note$_{1)}$: period: 0.76 ㎳, On time: 0.63 ㎳
Note$_{2)}$: DCCF = 10 log(1 / x) = 10 log(1/0.826) = 0.83 ㏈, x = 0.63/0.76 = 0.826 (82.6%)
Note$_{3)}$: 802.11n HT40 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT80



Note$_{1)}$: period: 0.43 ㎳, On time: 0.31 ㎳
Note$_{2)}$: DCCF = 10 log(1 / x) = 10 log(1/0.711) = 1.48 ㏈, x = 0.31/0.43 = 0.711 (71.1%)
Note$_{3)}$: 802.11ac VHT80 is a non-continuous transmission (duty cycle < 98%)

3. Antenna requirement

According to §15.203, §15.407

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 transmitter has permanently attached Carrier LPS Antenna on board.
- The E.U.T Complies with the requirement of §15.203, §15.407

4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.407(a)	Maximum conducted output power	Pass
15.407(a)	Maximum power spectral density	Pass
15.407(a)	26 dB bandwidth & 99% Occupied bandwidth	Pass
15.407(e)	6 dB bandwidth	Pass
15.407(g)	Frequency stability	Pass
15.407(d), 15.205(a), 15.209(a)	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted emissions	Pass

Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
3. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that Z orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in Z orientation
4. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
   - KDB 789033 D02 v02r01
5. The EUT does not operate simultaneously.
6. The worst-case data rates were:
   802.11a mode : 6 Mbps
   802.11n HT20 mode : MCS0
   802.11n HT40 mode : MCS0
   802.11ac VHT80 mode : MCS0

5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k=2 to indicated a 95 % level of confidence. The measurement data shown herein meets of exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty	
Conducted RF power	1.76 dB	
Conducted spurious emissions	4.03 dB	
Radiated spurious emissions	9 kHz ~ 30 MHz:	2.28 dB
	30 MHz ~ 300 MHz	4.98 dB
	300 MHz ~ 1 000 MHz	5.14 dB
	1 GHz ~ 6 GHz	6.70 dB
	Above 6 GHz	6.60 dB
Conducted emissions	9 kHz ~ 150 kHz	3.66 dB
	150 kHz ~ 30 MHz	3.26 dB

6. Measurement results explanation example

The offset level is set in the spectrum analyzer to compensate the RF cable loss factor between EUT conducted output port and spectrum analyzer.
With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

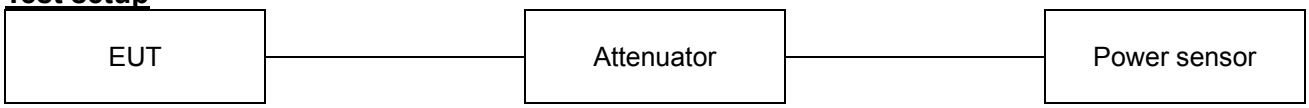
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	10.02	16 000	11.56
100	10.04	17 000	11.58
200	10.05	18 000	11.56
300	10.07	19 000	11.63
400	10.07	20 000	11.72
500	10.08	21 000	11.74
600	10.09	22 000	11.74
700	10.09	23 000	11.92
800	10.09	24 000	11.79
900	10.09	25 000	11.88
1 000	10.09	26 000	11.99
2 000	10.52	27 000	12.05
3 000	10.68	28 000	12.16
4 000	10.81	29 000	12.27
5 000	10.90	30 000	12.09
6 000	10.96	31 000	12.27
7 000	11.03	32 000	12.26
8 000	11.10	33 000	12.30
9 000	11.17	34 000	12.30
10 000	11.21	35 000	12.33
11 000	11.24	36 000	12.43
12 000	11.32	37 000	12.58
13 000	11.36	38 000	12.67
14 000	11.35	39 000	12.71
15 000	11.54	40 000	12.70

Note.
Offset(㏈) = RF cable loss(㏈) + Attenuator(㏈)

7. Test results

7.1. Maximum conducted output power

Test setup



Limit

According to §15.407(a)

Band	EUT category		Limit
UNII-1		Outdoor access point	1 W (30 dBm)
		Indoor access point	
		Fixed point-to-point access point	
	√	Client device	250 mW (23.98 dBm)
UNII-2A	-		250 mW or 11 dBm + 10logB*
UNII-2C	-		250 mW or 11 dBm + 10logB*
UNII-3	√		1 W (30 dBm)

Notes:

*FCC Limit B is the 26 dB emission bandwidth.

Test procedure

ANSI C63.10-2013-Section 12.3.3.2 and 14.2
KDB 789033 D02 v02r01 - Section E.3.a) or b)

Test settings

◆ **KDB 789033 D02 v02r01**

Section E.3.a)
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 II

(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%).

Section E.3.b)
Method PM-G (Measurement using a gated RF average power meter):
Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

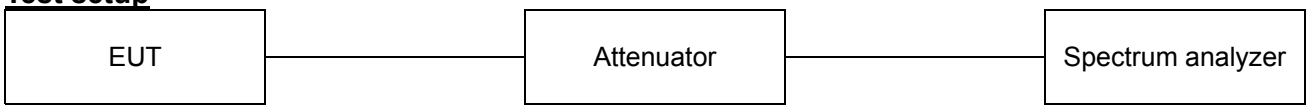
Notes:
A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

Test results

Test mode	Band	Frequency (㎒)	Measured output power			Limit (dBm)
			Reading (dBm)	Duty Factor (dB)	Result (dBm)	
11a	UNII 1	5 180	13.91	0.32	14.23	23.98
		5 200	13.97	0.32	14.29	
		5 240	13.70	0.32	14.02	
	UNII 3	5 745	12.34	0.33	12.67	30
		5 785	12.39	0.33	12.72	
		5 825	12.42	0.33	12.75	
11n HT20	UNII 1	5 180	13.57	0.34	13.91	23.98
		5 200	13.57	0.34	13.91	
		5 240	13.55	0.34	13.89	
	UNII 3	5 745	11.32	0.36	11.68	30
		5 785	11.46	0.36	11.82	
		5 825	11.44	0.36	11.80	
11n HT40	UNII 1	5 190	12.68	0.84	13.52	23.98
		5 230	12.91	0.84	13.75	
	UNII 3	5 755	10.43	0.83	11.26	30
		5 795	10.42	0.83	11.25	
11ac VHT80	UNII 1	5190	12.45	1.46	13.91	23.98
	UNII 3	5 775	10.43	1.48	11.91	30

7.2. Maximum Power Spectral Density

Test setup



Limit

According to §15.407(a)

Band	EUT category		Limit
UNII-1		Outdoor access point	17 dBm/MHz
		Indoor access point	
		Fixed point-to-point access point	
	√	Client device	11 dBm/MHz
UNII-2A	-		11 dBm/MHz
UNII-2C	-		11 dBm/MHz
UNII-3	√		30 dBm/500 kHz

Notes:

1. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain if the antenna exceed 6 dBi.

Test procedure

KDB 789033 D02 v02r01 - Section F
ANSI C63.10-2013

Test settings

Section F

The rules requires “maximum power spectral density” measurements where the intent is to measure the maximum value of the time average of the power spectral density measured during a period of continuous transmission. Refer to III.A for additional guidance for devices that use channel aggregation.

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in 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. Search function on the instrument to find the peak of the spectrum and record its value.
3. 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 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

preceding procedures make use of 1 ㎒ RBW to satisfy directly the 1 ㎒ reference bandwidth specified in Section 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 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 II.B.I.a).
b) Set VBW≥3 RBW.
c) If measurement bandwidth of Maximum PSD is specified in 500 ㎑, add 10 log (500 ㎑ /RBW) to the measured result, whereas RBW (<500 ㎑) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
d) If measurement bandwidth of Maximum PSD is specified in 1 ㎒, add 10 log (1㎒/RBW) to the measured result, whereas RBW (< 1 ㎒) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

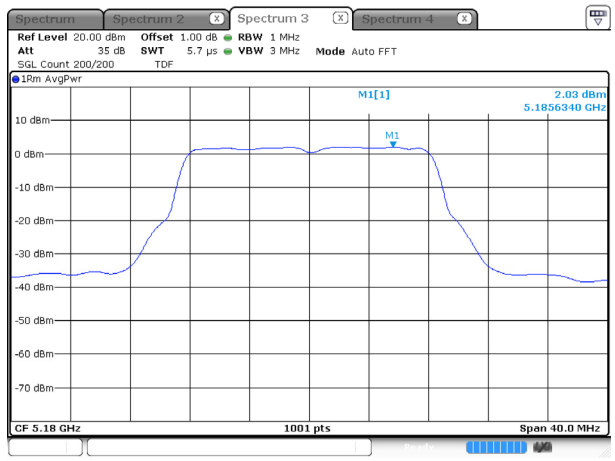
Note: As a practical matter, it is recommended to use reduced RBW of 100 ㎑ for the II.F.5.c) and II.F.5.d), since RBW=100 ㎑ is available on nearly all spectrum analyzers.

Test results

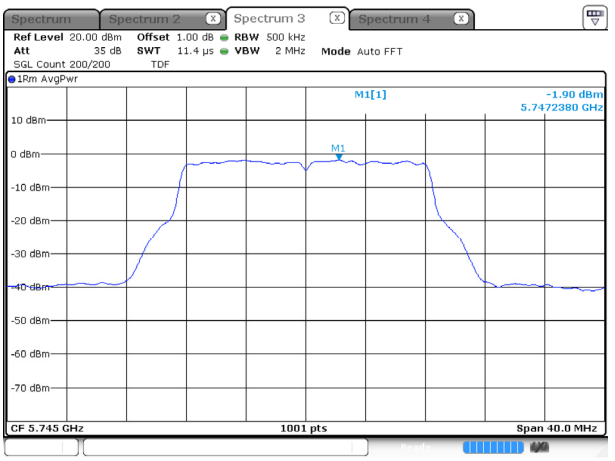
Test mode	Band	Frequency (㎒)	Measured output power			Limit (dBm/㎒)
			Reading (dBm)	Duty Factor (dB)	Result (dBm)	
11a	UNII 1	5 180	2.03	0.32	2.35	11
		5 200	2.40	0.32	2.72	
		5 240	2.20	0.32	2.52	
11n HT20	UNII 1	5 180	-1.99	0.84	-1.15	11
		5 200	-1.42	0.84	-0.58	
		5 240	-4.38	1.46	-2.92	
11n HT40	UNII 1	5 190	-3.54	0.36	-3.18	11
		5 230	-4.25	0.36	-3.89	
11ac VHT80	UNII 1	5190	-7.25	0.83	-6.42	11

Test mode	Band	Frequency (㎒)	Measured output power			Limit (dBm/㎒)
			Reading (dBm)	Duty Factor (dB)	Result (dBm)	
11a	UNII 3	5 745	2.12	0.34	2.46	30
		5 785	1.94	0.34	2.28	
		5 825	1.70	0.34	2.04	
11n HT20	UNII 3	5 745	-1.90	0.33	-1.57	30
		5 785	-2.55	0.33	-2.22	
		5 825	-1.58	0.33	-1.25	
11n HT40	UNII 3	5 755	-2.99	0.36	-2.63	30
		5 795	-7.07	0.83	-6.24	
11ac VHT80	UNII 3	5 775	-10.14	1.48	-8.66	30

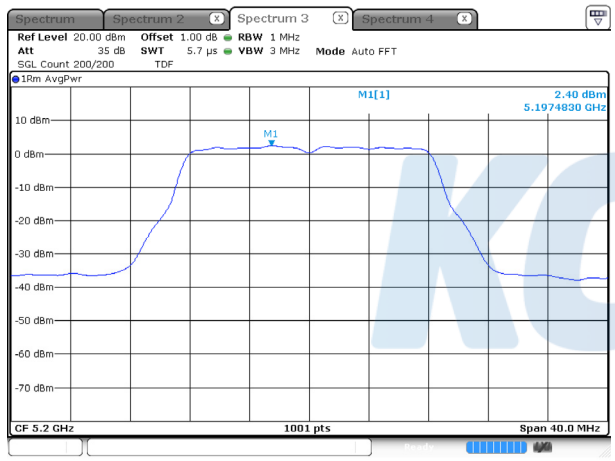
UNII-1 / 802.11a / Low ch.



UNII-3 / 802.11a / Low ch.

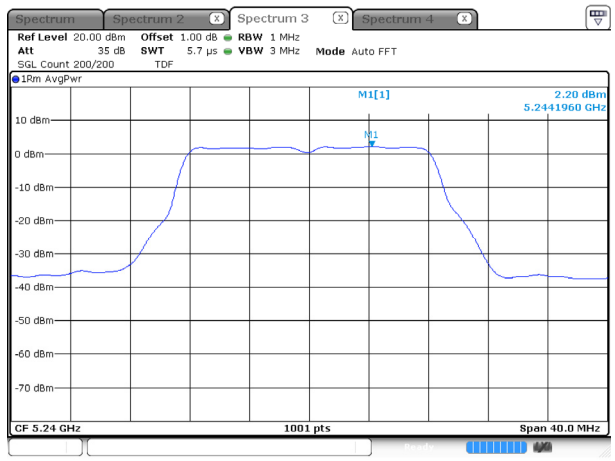


UNII-1 / 802.11a / Mid ch.

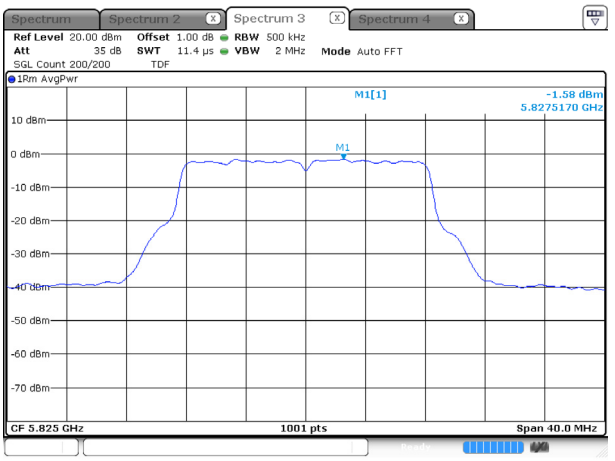


UNII-3 / 802.11a / Mid ch.

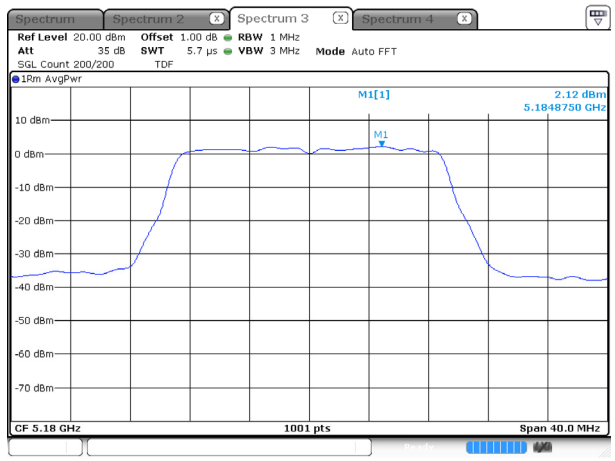
UNII-1 / 802.11a / High ch.



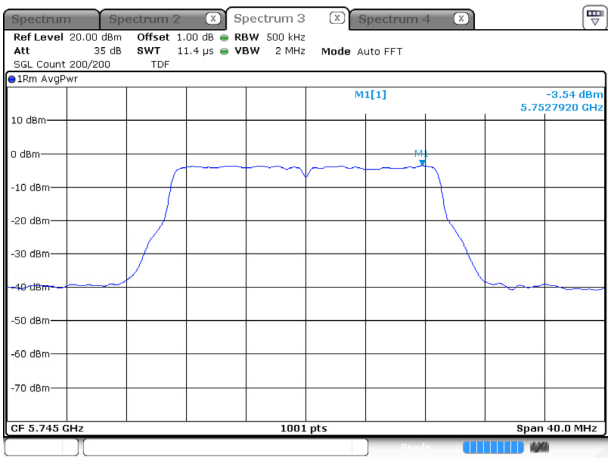
UNII-3 / 802.11a / High ch.



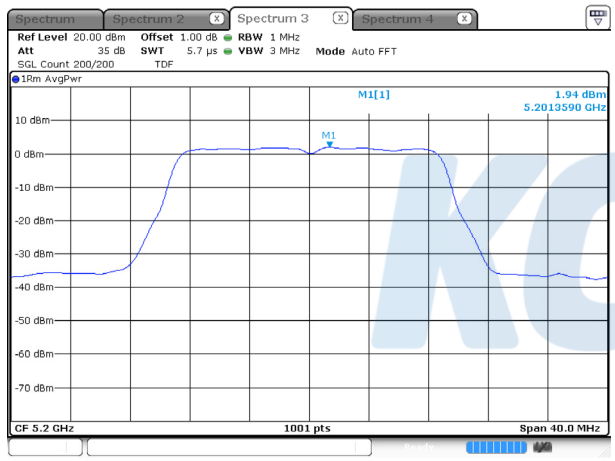
UNII-1 / 802.11n HT20 / Low ch.



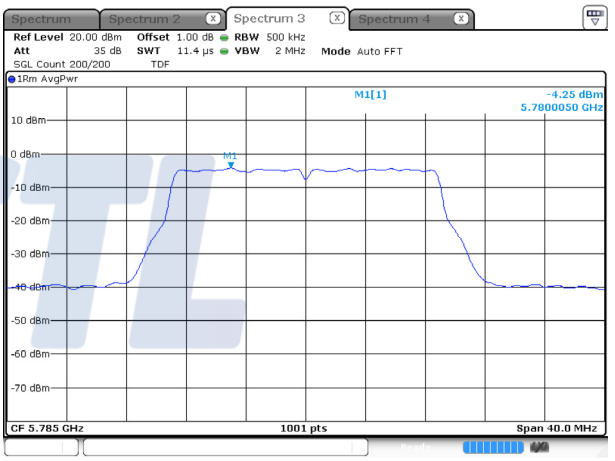
UNII-3 / 802. 11n HT20 / Low ch.



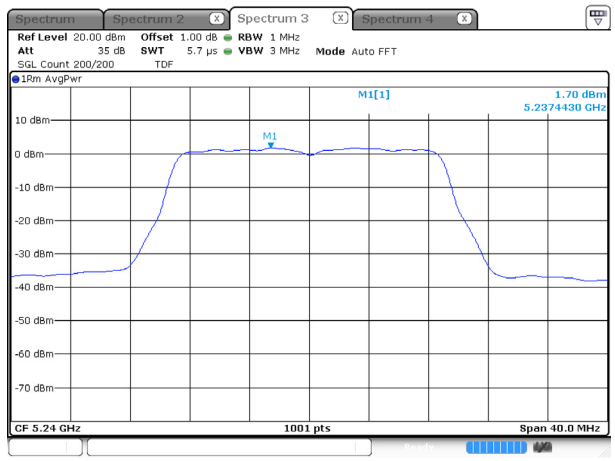
UNII-1 / 802.11n HT20 / Mid ch.



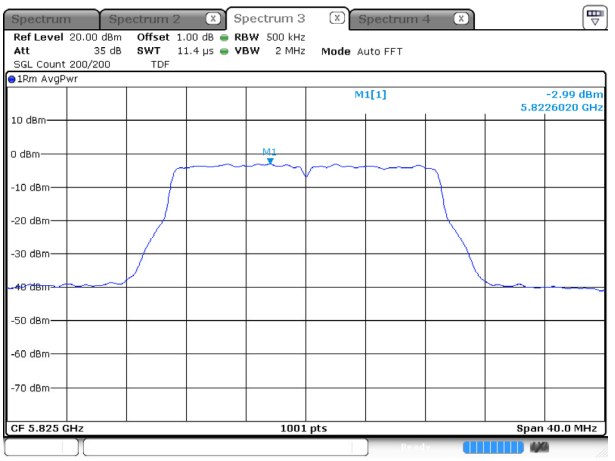
UNII-3 / 802.11n HT20 / Mid ch.



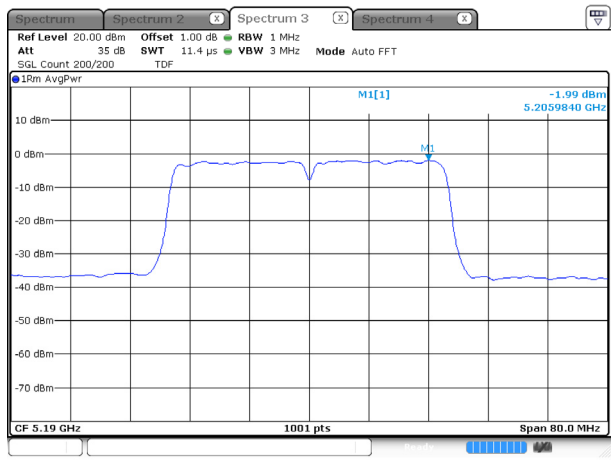
UNII-1 / 802.11n HT20 / High ch.



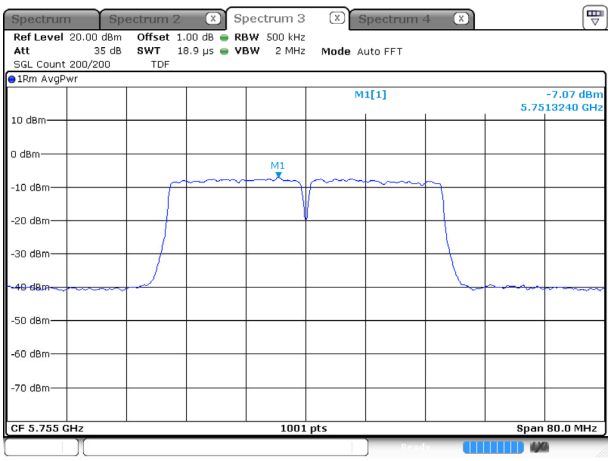
UNII-3 / 802.11n HT20 / High ch.



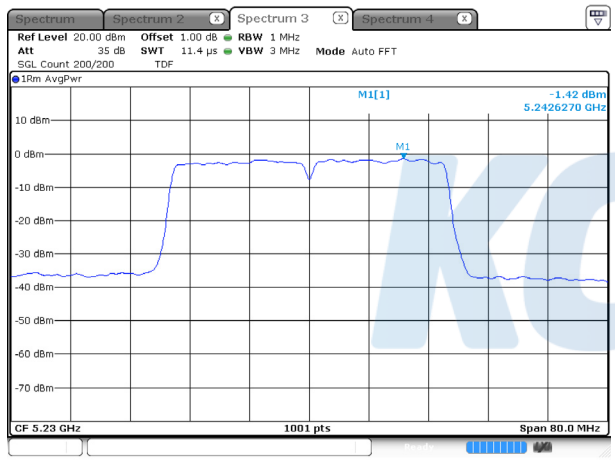
UNII-1 / 802.11n HT40 / Low ch.



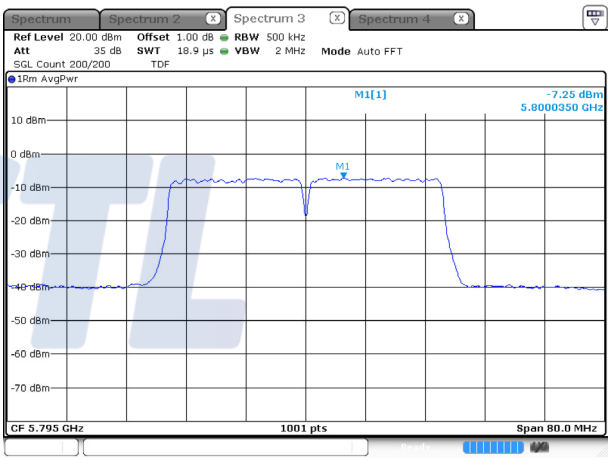
UNII-3 / 802. 11n HT40 / Low ch.



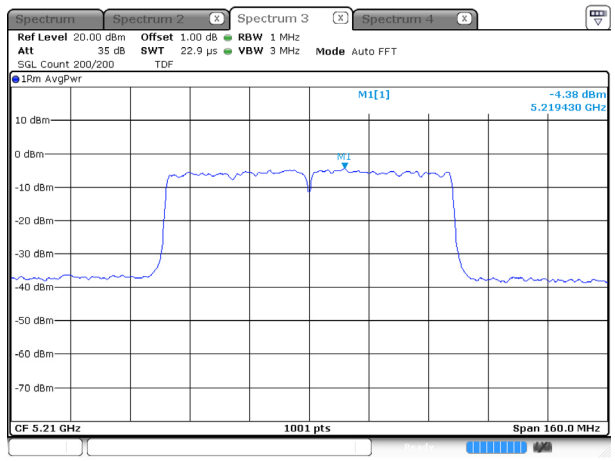
UNII-1 / 802.11n HT40 / High ch.



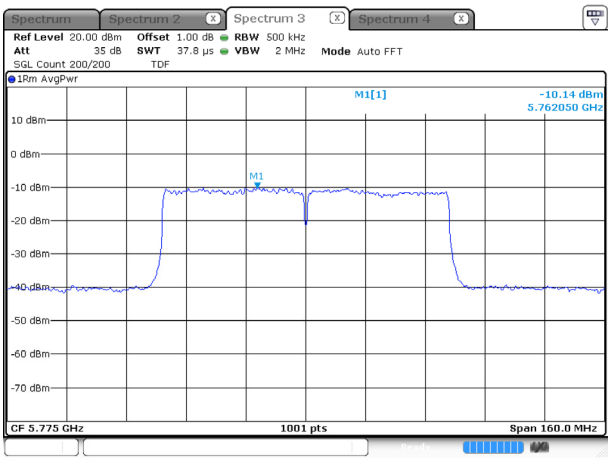
UNII-2A / 802.11n HT40 / High ch.



UNII-1 / 802.11ac VHT80 / Mid ch.

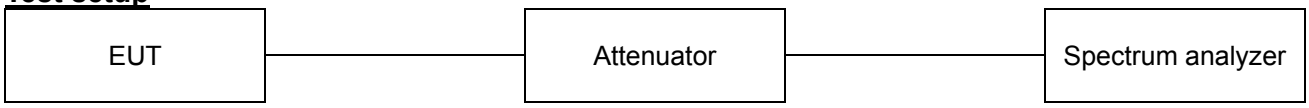


UNII-3 / 802.11ac VHT80 / Mid ch.



7.3. 26 dB Bandwidth & 99% Occupied Bandwidth

Test setup



Limit

N/A

Test procedure

26dBbandwidth

KDB 789033 D02 v02r01 - Section C.1

99% bandwidth

KDB 789033 D02 v02r01 - Section D

Test settings

26 dB Bandwidth

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. 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. 99% Occupied Bandwidth

1. Set center frequency to the nominal EUT channel center frequency.
2. Set span = 1.5 times to 5.0 times the OBW.
3. Set RBW = 1% to 5% of the OBW
4. Set VBW ≥ 3 x RBW
5. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
6. Use the 99% power bandwidth function of the instrument (if available).
7. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test results

26 dB bandwidth

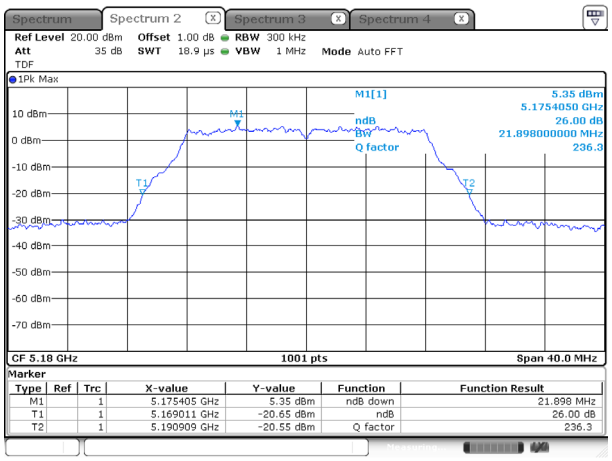
Test mode	Band	Frequency(㎒)	Measured Bandwidth (㎒)
11a	UNII-1	5 180	21.90
		5 200	21.86
		5 240	21.94
11n HT20		5 180	22.02
		5 200	22.14
		5 240	21.98
11n HT40		5 190	40.60
		5 230	40.44
11ac VHT80		5 210	82.80

99% bandwidth

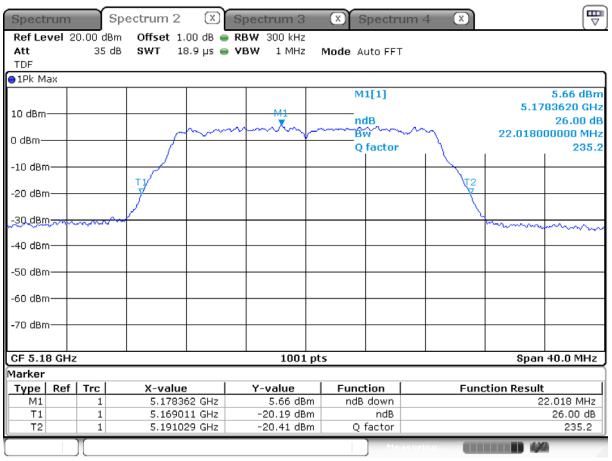
Test mode	Frequency(㎒)	Occupied Bandwidth (99% BW) (㎒)
UNII-1_11a	5 240	17.34
UNII-1_11n HT20	5 240	18.26
UNII-1_11n HT40	5 230	36.52
UNII-1_11ac VHT80	5 210	76.08

26 dB bandwidth

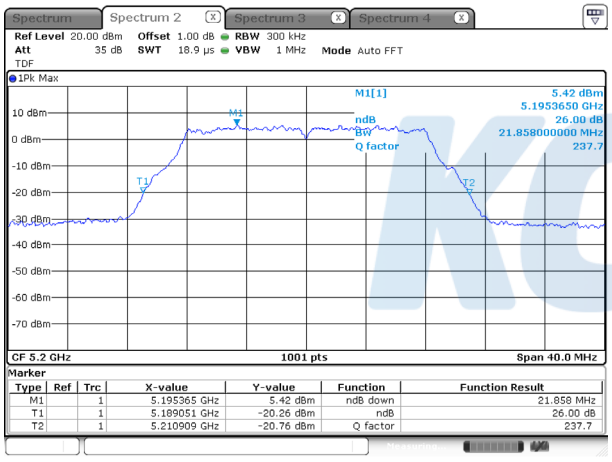
UNII-1 / 802.11a / Low ch.



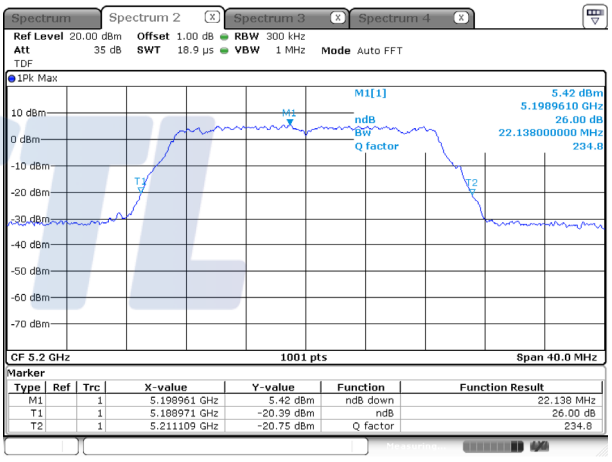
UNII-1 / 802.11n HT20 / Low ch.



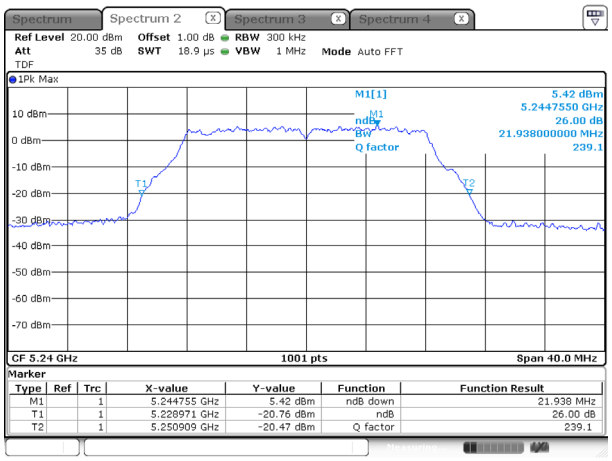
UNII-1 / 802.11a / Mid ch.



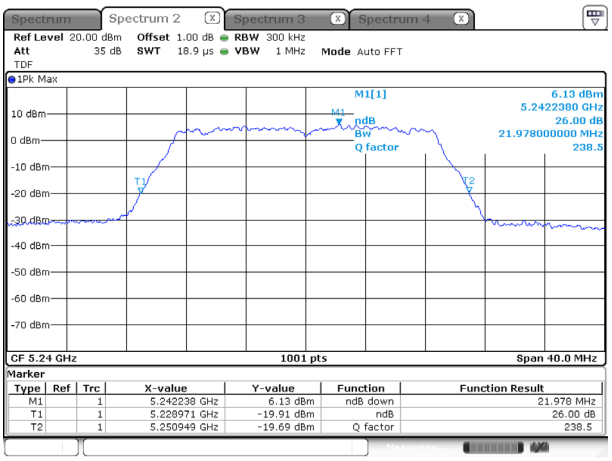
UNII-1 / 802.11n HT20 / Mid ch.



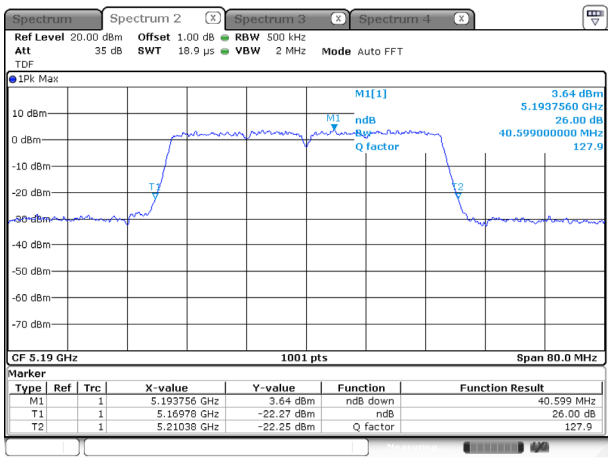
UNII-1 / 802.11a / High ch.



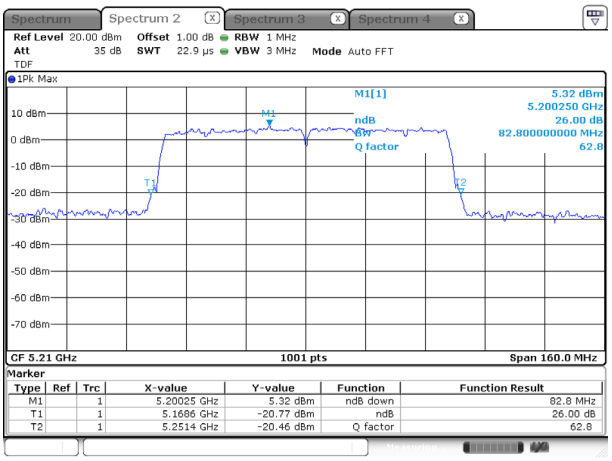
UNII-1 / 802.11n HT20 / High ch.



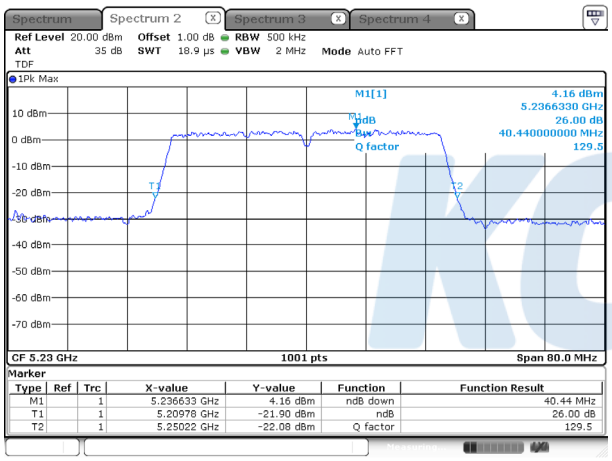
UNII-1 / 802.11n HT40 / Low ch.



UNII-1 / 802. 11ac VHT80 / Mid ch.



UNII-1 / 802.11n HT40 / High ch.



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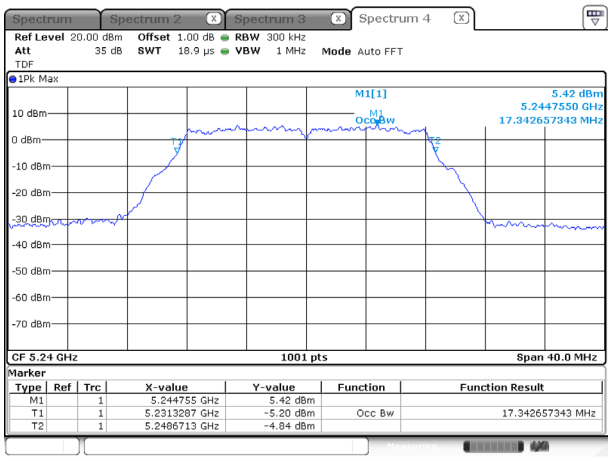
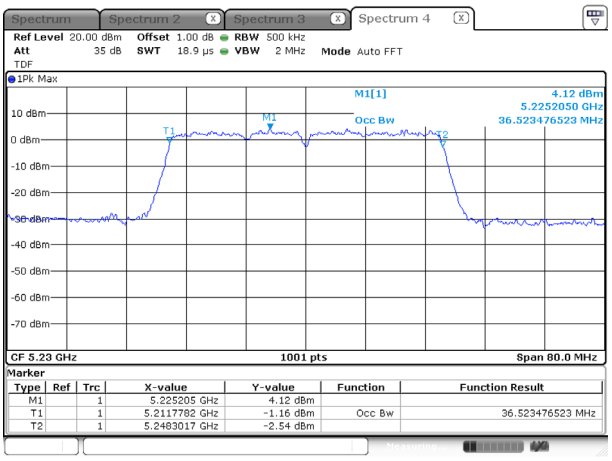
99% bandwidth

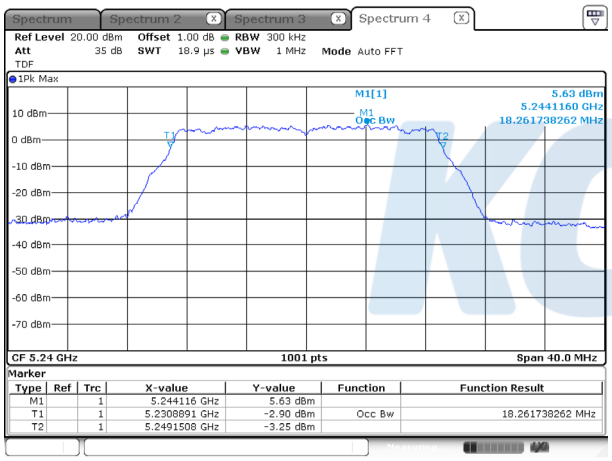
UNII-1 / 802.11a



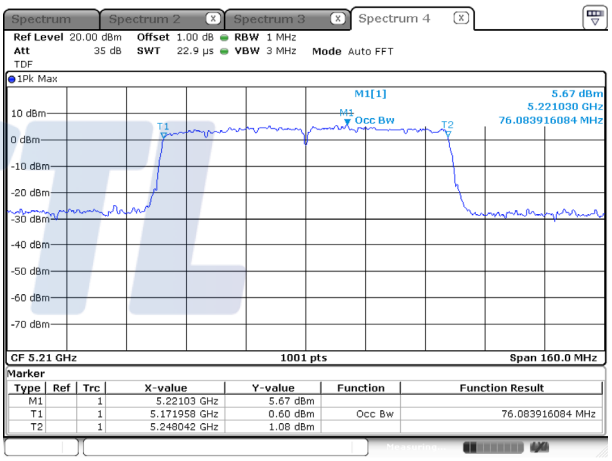
UNII-1 / 802.11n HT40



UNII-1 / 802.11n HT20

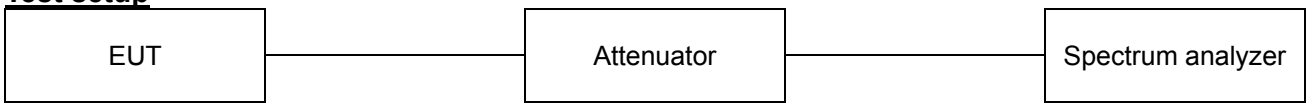


UNII-1 / 802.11ac VHT80



7.4. 6 dB Bandwidth

Test setup



Limit

Within the 5.725-585 ㎓ band, the minimum 6 ㏈ bandwidth if U-NII devices shall be at least 500㎑

Test procedure

KDB 789033 D02 v02r01 - Section C.2

Test settings

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 the band 5.725−5.85 ㎓. The following procedure shall be used for measuring this bandwidth:

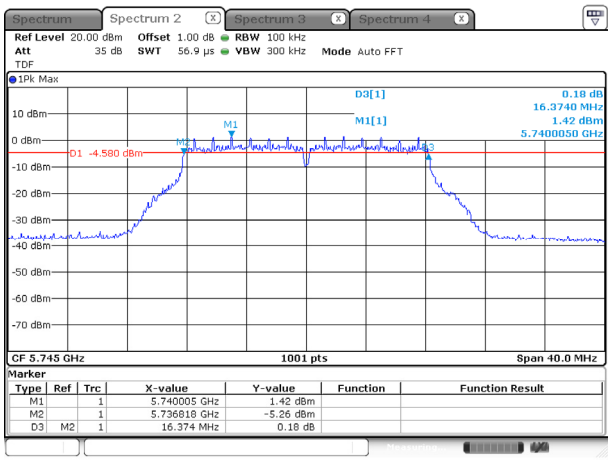
1. Set RBW = 100 ㎑.
2. Set the video bandwidth (VBW) ≥ 3 RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 ㏈ relative to the maximum level measured in the fundamental emission.

Test results

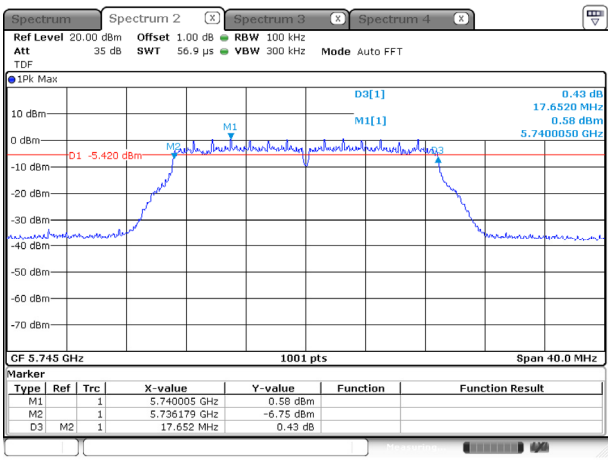
Test mode	Band	Frequency(㎒)	Measured Bandwidth (㎒)
11a	UNII-3	5 745	16.37
		5 785	16.38
		5 825	16.38
11n HT20		5 745	17.65
		5 785	17.66
		5 825	17.66
11n HT40		5 755	36.44
		5 795	36.42
11ac VHT80		5 775	76.70

6 dB bandwidth

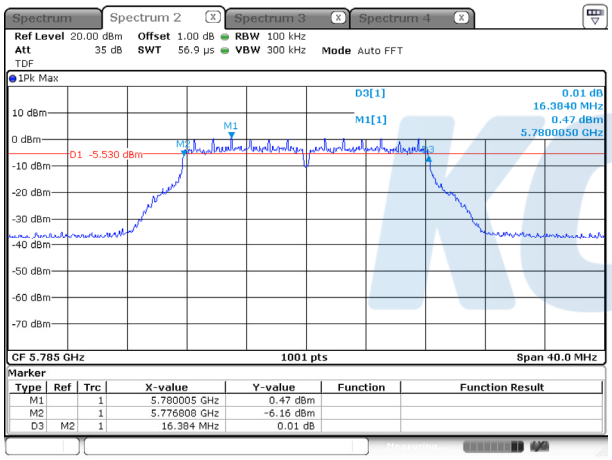
UNII-3 / 802.11a / Low ch.



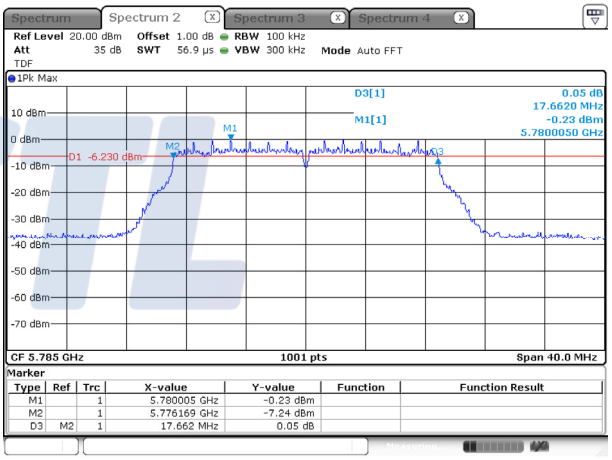
UNII-3 / 802.11n HT20 / Low ch.



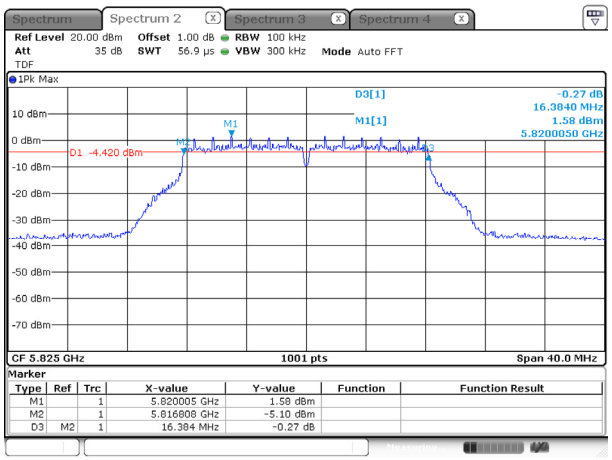
UNII-3 / 802.11a / Mid ch.



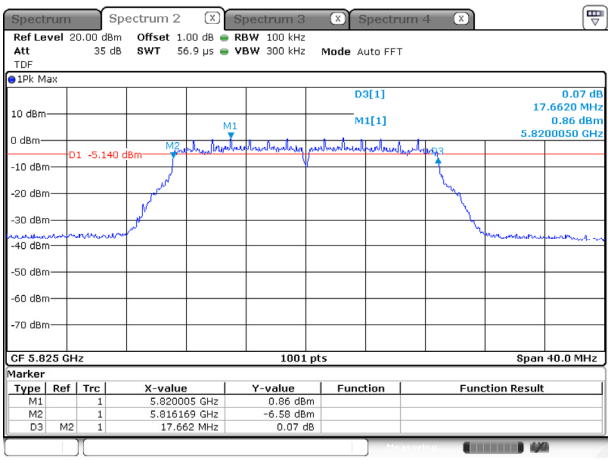
UNII-3 / 802.11n HT20 / Mid ch.



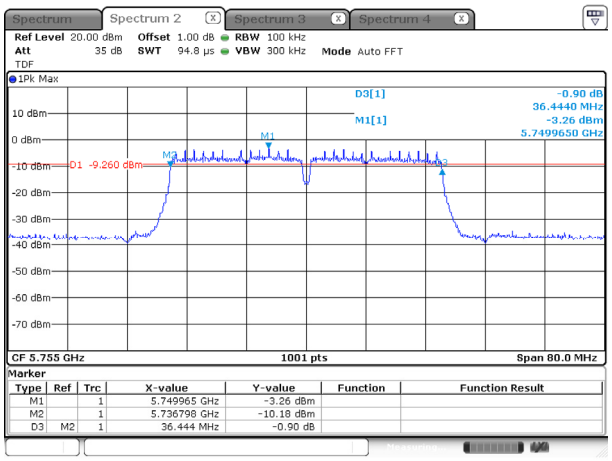
UNII-3 / 802.11a / High ch.



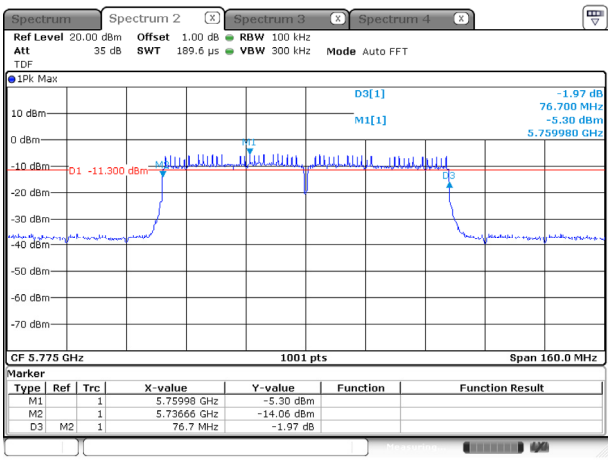
UNII-3 / 802.11n HT20 / High ch.



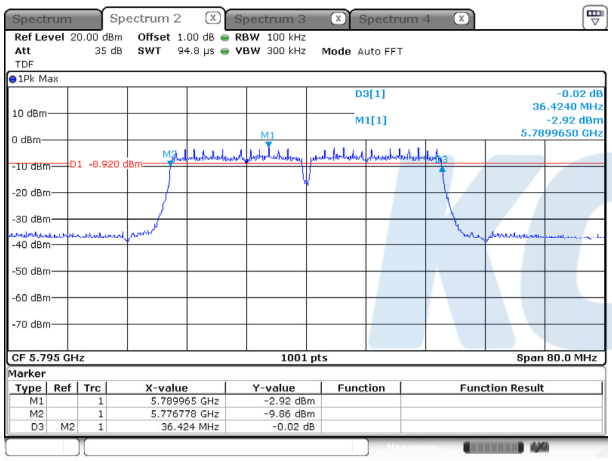
UNII-3 / 802.11n HT40 / Low ch.



UNII-3 / 802. 11ac VHT80 / Mid ch.



UNII-3 / 802.11n HT40 / High ch.



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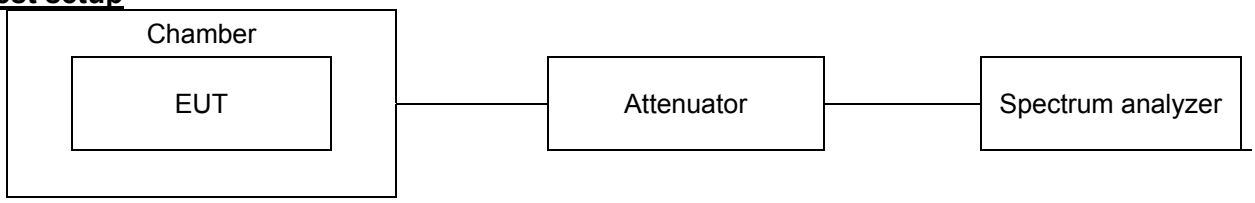
7.5. Frequency Stability

Test setup



Limit

N/A

Test procedure

ANSI C63.10-2013, clause 6.8.1

Test settings

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 ℃. 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 ℃ intervals from lowest temperature.
3. Each increase step of temperature measured the frequency.
4. The test temperature was set 20 ℃ and the supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
5. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

Test results

Test mode : UNII 1

Frequency (㎐) : 5 180 000 000

Voltage	Voltage	TEMP	Maintaining time	Measure frequency	Frequency deviation	Deviation
[%]	[V]	[℃]		[㎐]	[ppm]	[%]
100	3.8	+20(Ref)	Startup	5 179 996 653	- 0.65	-0.000 06
			2 minutes	5 179 994 406	- 1.08	-0.000 11
			5 minutes	5 179 994 256	- 1.11	-0.000 11
			10 minutes	5 179 994 106	- 1.14	-0.000 11
		-10	Startup	5 180 036 416	7.03	0.000 70
			2 minutes	5 180 031 920	6.16	0.000 62
			5 minutes	5 180 031 621	6.10	0.000 61
			10 minutes	5 180 031 171	6.02	0.000 60
		0	Startup	5 180 035 567	6.87	0.000 69
			2 minutes	5 180 030 322	5.85	0.000 59
			5 minutes	5 180 028 524	5.51	0.000 55
			10 minutes	5 180 027 325	5.28	0.000 53
		10	Startup	5 180 024 288	4.69	0.000 47
			2 minutes	5 180 019 643	3.79	0.000 38
			5 minutes	5 180 018 144	3.50	0.000 35
			10 minutes	5 180 017 545	3.39	0.000 34
		25	Startup	5 180 006 006	1.16	0.000 12
			2 minutes	5 180 000 612	0.12	0.000 01
			5 minutes	5 179 998 963	- 0.20	-0.000 02
			10 minutes	5 179 998 364	- 0.32	-0.000 03
		30	Startup	5 179 993 716	- 1.21	-0.000 12
			2 minutes	5 179 993 416	- 1.27	-0.000 13
			5 minutes	5 179 993 416	- 1.27	-0.000 13
			10 minutes	5 179 993 566	- 1.24	-0.000 12
		40	Startup	5 180 004 817	0.93	0.000 09
			2 minutes	5 180 009 612	1.86	0.000 19
			5 minutes	5 180 010 062	1.94	0.000 19
			10 minutes	5 180 010 511	2.03	0.000 20
85	3.23	20	Startup	5 179 995 554	- 0.86	-0.000 09
			2 minutes	5 179 995 105	- 0.95	-0.000 09
			5 minutes	5 179 994 955	- 0.97	-0.000 10
			10 minutes	5 179 994 805	- 1.00	-0.000 10
115	4.37	20	Startup	5 179 995 105	- 0.95	-0.000 09
			2 minutes	5 179 993 756	- 1.21	-0.000 12
			5 minutes	5 179 994 056	- 1.15	-0.000 11
			10 minutes	5 179 994 356	- 1.09	-0.000 11

Test mode : UNII 3

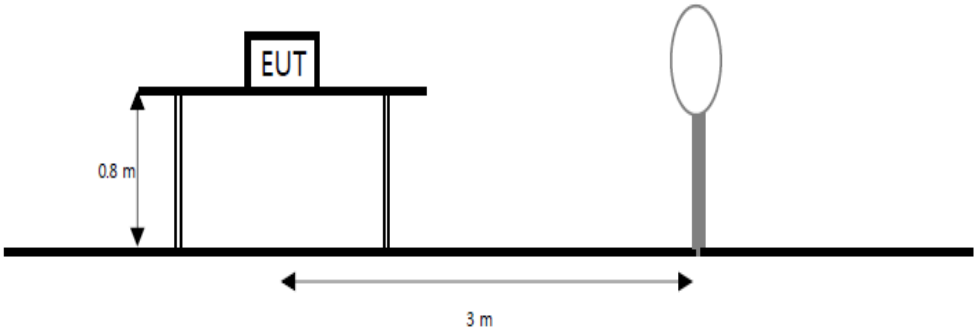
Frequency (㎐) : 5 745 000 000

Voltage	Voltage	TEMP	Maintaining time	Measure frequency	Frequency deviation	Deviation
[%]	[V]	[℃]		[㎐]	[ppm]	[%]
100	3.8	+20(Ref)	Startup	5 744 993 507	- 1.13	-0.000 11
			2 minutes	5 744 992 308	- 1.34	-0.000 13
			5 minutes	5 744 992 008	- 1.39	-0.000 14
			10 minutes	5 744 992 158	- 1.37	-0.000 14
		-10	Startup	5 745 030 569	5.32	0.000 53
			2 minutes	5 745 029 371	5.11	0.000 51
			5 minutes	5 745 029 221	5.09	0.000 51
			10 minutes	5 745 029 071	5.06	0.000 51
		0	Startup	5 745 036 511	6.36	0.000 64
			2 minutes	5 745 033 065	5.76	0.000 58
			5 minutes	5 745 031 716	5.52	0.000 55
			10 minutes	5 745 031 117	5.42	0.000 54
		10	Startup	5 745 017 580	3.06	0.000 31
			2 minutes	5 745 016 232	2.83	0.000 28
			5 minutes	5 745 014 733	2.56	0.000 26
			10 minutes	5 745 013 984	2.43	0.000 24
		25	Startup	5 744 999 848	- 0.03	-0.000 01
			2 minutes	5 744 997 450	- 0.44	-0.000 04
			5 minutes	5 744 996 402	- 0.63	-0.000 06
			10 minutes	5 744 995 802	- 0.73	-0.000 07
		30	Startup	5 744 999 149	- 0.15	-0.000 01
			2 minutes	5 744 998 849	- 0.20	-0.000 02
			5 minutes	5 744 998 549	- 0.25	-0.000 03
			10 minutes	5 744 998 100	- 0.33	-0.000 03
		40	Startup	5 744 992 233	- 1.35	-0.000 14
			2 minutes	5 744 992 083	- 1.38	-0.000 14
			5 minutes	5 744 992 383	- 1.33	-0.000 13
			10 minutes	5 744 992 683	- 1.27	-0.000 13
		50	Startup	5 744 996 664	- 0.58	-0.000 06
			2 minutes	5 744 999 361	- 0.11	-0.000 01
			5 minutes	5 745 001 310	0.23	0.000 02
			10 minutes	5 745 002 808	0.49	0.000 05
85	3.23	20	Startup	5 744 992 058	- 1.38	-0.000 14
			2 minutes	5 744 992 657	- 1.28	-0.000 13
			5 minutes	5 744 992 957	- 1.23	-0.000 12
			10 minutes	5 744 993 257	- 1.17	-0.000 12
115	4.37	20	Startup	5 744 992 108	- 1.37	-0.000 14
			2 minutes	5 744 992 557	- 1.30	-0.000 13
			5 minutes	5 744 993 157	- 1.19	-0.000 12
			10 minutes	5 744 993 307	- 1.17	-0.000 12

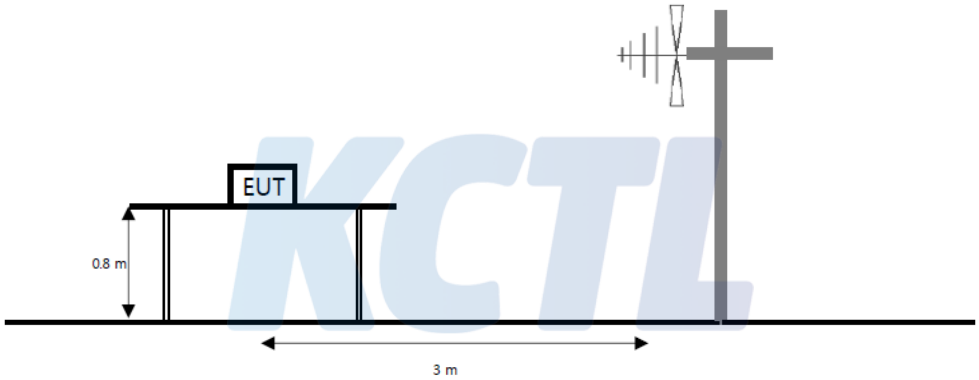
7.6. Spurious Emission, Band Edge and Restricted bands

Test setup

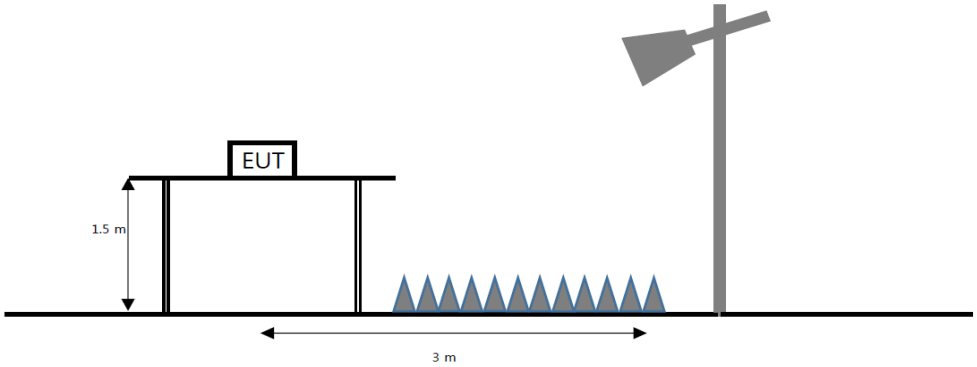
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Limit

According to section 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

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section15.231 and 15.241.

According to section 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	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75	25	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	156.7 - 156.9	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	162.012 5 - 167.17	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	167.72 - 173.2	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	240 - 285	3 600 – 4 400	Above 38.6
13.36 - 13.41	322 - 335.4		

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

According to section 15.407(b), undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

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 e.i.r.p. of −27 dBm/MHz

For transmitters operating in the 5.25-5.35 ㎓ band: All emissions outside of the 5.15-5.35 ㎓ band shall not exceed an e.i.r.p. of −27 ㏈m/㎒.

For transmitters operating in the 5.725-5.85 ㎓ band: All emissions shall be limited to a level of -27 ㏈m/㎒ at 75 ㎒ or more above or below the band edge increasing linearly to 10 ㏈m/㎒ at 25 ㎒ above or below the band edge, and form 25 ㎒ above or below the band edge increasing linearly to a level of 15.6 ㏈m/㎒ at 5 ㎒ above or below the band edge, and from 5 ㎒ above or below the band edge increasing linearly to a level of 27 ㏈m/㎒ at the band edge.

Test procedure

ANSI C63.10-2013 Section 6.4.6
KDB 558074 D01 V05r02

Test settings

Peak field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW ≥ (3×RBW)
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

Table. RBW as a function of frequency

Frequency	RBW
9 ㎑ to 150 ㎑	200 ㎐ to 300 ㎐
0.15 ㎒ to 30 ㎒	9 ㎑ to 10 ㎑
30 ㎒ to 1 000 ㎒	100 ㎑ to 120 ㎑
> 1 000 ㎒	1 ㎒

Average field strength measurements

Trace averaging with continuous EUT transmission at full power

If the EUT can be configured or modified to transmit continuously (D ≥ 98%), then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

1. RBW = 1 ㎒ (unless otherwise specified).
2. VBW ≥ (3×RBW).
3. Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ (RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
4. Averaging type = power (i.e., rms):
   1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
   2) Some instruments require linear display mode to use linear voltage averaging. Log or ㏈ averaging shall not be used.
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.

Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

1. The EUT shall be configured to operate at the maximum achievable duty cycle.
2. Measure the duty cycle D of the transmitter output signal as described in 11.6.
3. RBW = 1 ㎒ (unless otherwise specified).
4. VBW ≥ [3 × RBW].
5. Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ (RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this

condition cannot be satisfied, then the detector mode shall be set to peak.

6. Averaging type = power (i.e., rms):
   1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
   2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
7. Sweep time = auto.
8. Perform a trace average of at least 100 traces.
9. A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
   1) If power averaging (rms) mode was used in step f), then the applicable correction factor is [10 log (1 / D)], where D is the duty cycle.
   2) If linear voltage averaging mode was used in step f), then the applicable correction factor is [20 log (1 / D)], where D is the duty cycle.
   3) If a specific emission is demonstrated to be continuous (D ≥ 98%) rather than turning ON and OFF with with the transmit cycle, then no duty cycle correction is required for that emission.

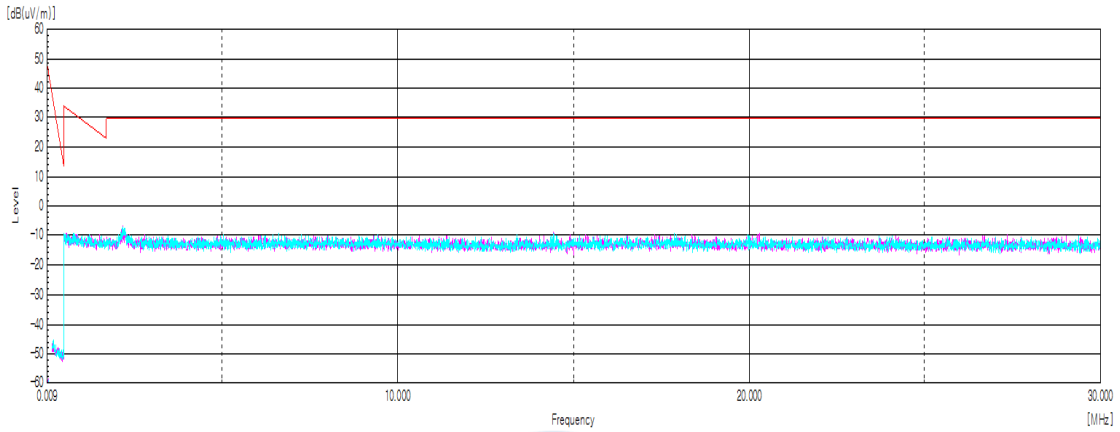
Notes:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 1 ㎑(≥1/T) for Average detection (AV) at frequency above 1 ㎓. (where T = pulse width)
2. *f* <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. F_d = 40log(D_m/Ds)
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. F_d = 20log(D_m/Ds)
   Where:
   F_d= Distance factor in ㏈
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
3. Factors(㏈) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
4. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. 1) means restricted band.
7. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.
8. Below 30 ㎒ frequency range, In order to search for the worst result, all orientations about parallel, perpendicular, and ground-parallel were investigated then reported. when the emission level was higher than 20 ㏈ of the limit, then the following statement shall be made: “No spurious emissions were detected within 20 ㏈ of the limit.”

Test results (Below 30 ㎒) – Worst case: 802.11a_UNII 1 Middle frequency

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
No spurious emissions were detected within 20 ㏈ of the limit.									

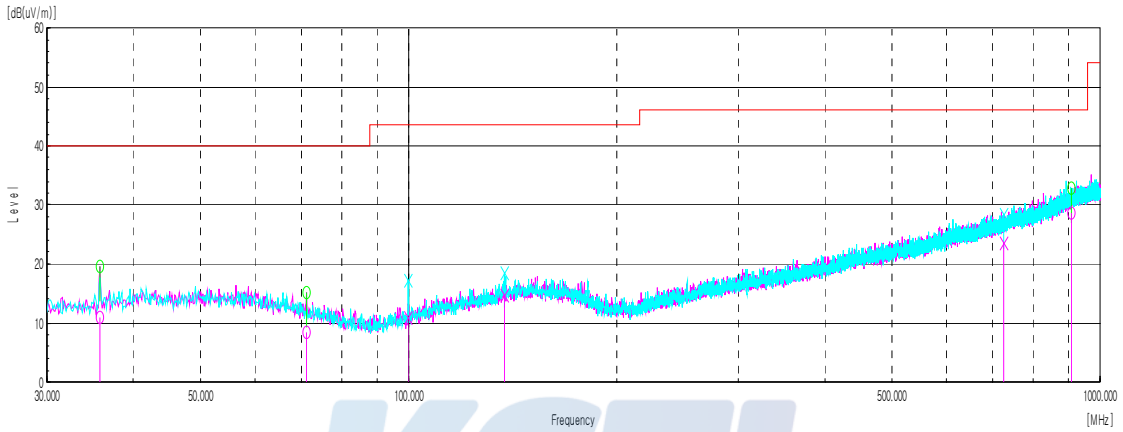
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: 802.11a_UNII 1 Middle frequency

Frequency	Pol.	Reading	Amp. + Cable	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
908.34	H	23.40	-24.38	29.55	-	28.57	46.00	17.43

Horizontal/Vertical



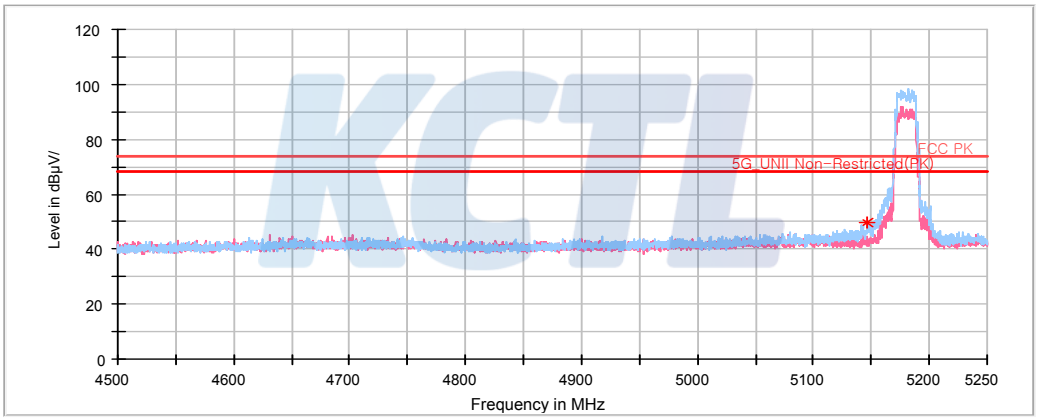
Test results (Above 1 000 ㎒)

802.11a_UNII 1

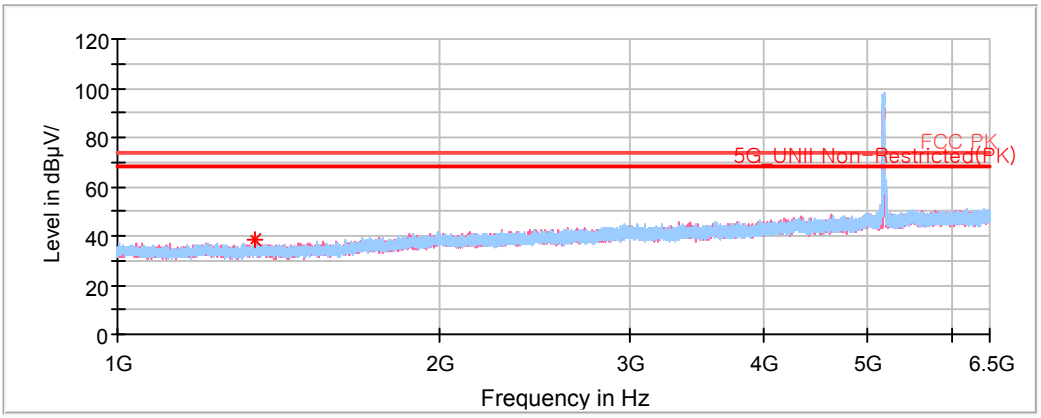
Lowest Channel (5 180 ㎒)

Frequency	Pol.	Reading	Amp. + Cable	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
5 146.31[1)]	H	43.63	-28.09	34.08	-	49.62	74.00	24.38
10 348.91	H	64.78	-52.48	37.31	-	49.61	68.20	18.59
15 547.63[1)]	H	60.65	-48.83	40.02	-	51.84	74.00	22.16
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit								

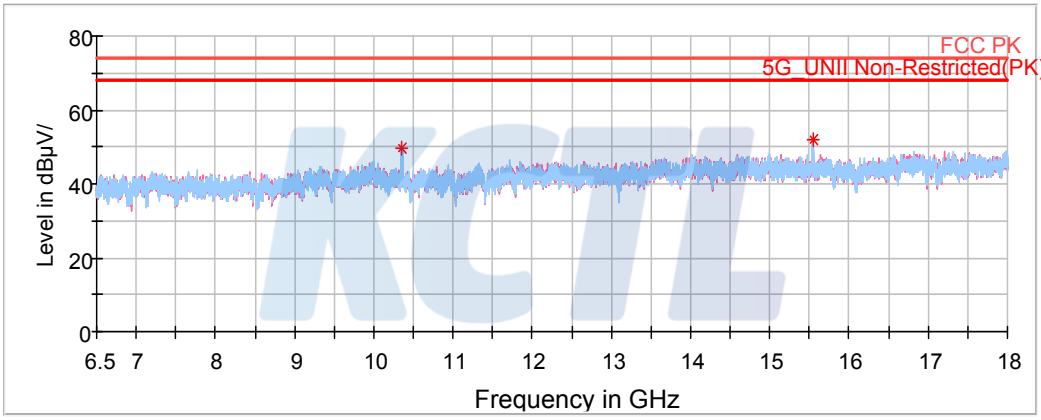
Horizontal/Vertical for Band-edge



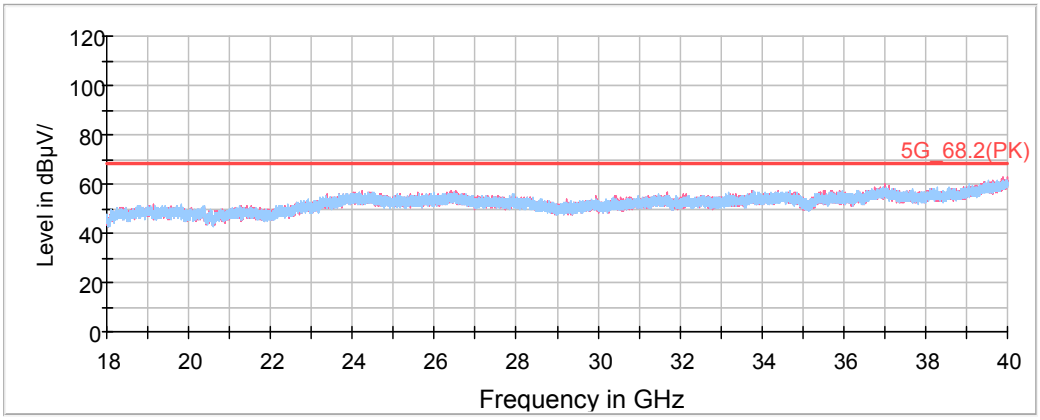
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



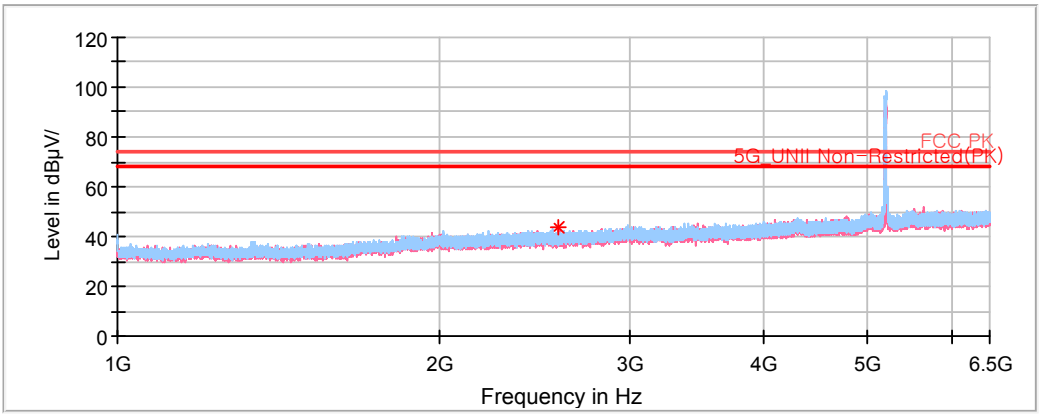
Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



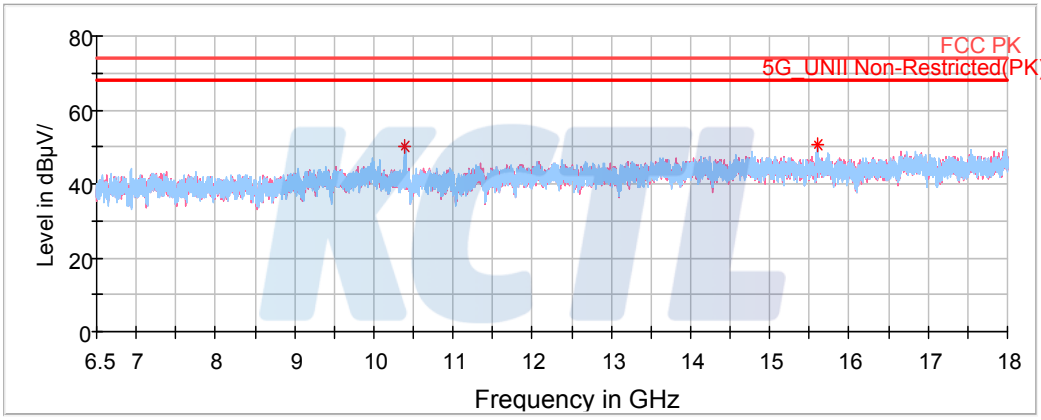
Middle Channel (5 200 ㎒)

Frequency	Pol.	Reading	Amp. + Cable	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
10 396.34	H	65.14	-52.56	37.34	-	49.92	68.20	18.28
15 595.78[1)]	H	59.47	-48.91	40.04	-	50.60	74.00	23.40
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit								

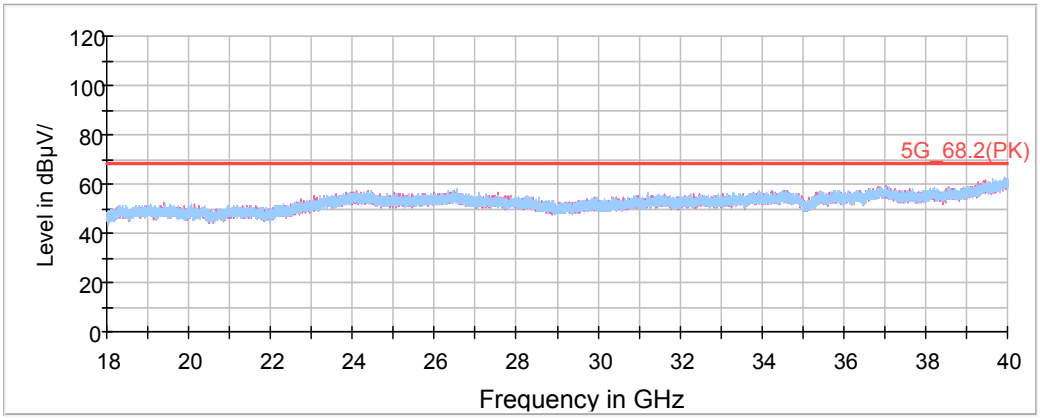
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



Highest Channel (5 240 ㎒)

Frequency	Pol.	Reading	Amp. + Cable	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 716.20	V	61.39	-36.23	29.60	-	54.76	68.20	13.44
10 479.72	H	62.97	-52.69	37.39	-	47.67	68.20	20.53
15 733.06[1)]	H	60.53	-49.15	40.09	-	51.47	74.00	22.53
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit								