TEST REPORT

KCTL Inc.
65, Sinwon-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16677, Korea
TEL: 82-31-285-0894 FAX: 82-505-299-8311
www.kctl.co.kr

1. Client

- Name : WONDERFUL PLATFORM CO.,LTD
- Address : F 5. F6, 175, Nonhyeon-ro, Seocho-gu, Seoul, Republic of Korea
- Date of Receipt : 2019-03-18

2. Use of Report : -

3. Name of Product and Model : AI LASER BEAM PROJECTOR / UO+

4. Manufacturer and Country of Origin : CHUNGO TECH CO., LTD. / Korea

5. FCC ID : 2AST7-UOPLUS

6. Date of Test : 2019-04-26 to 2019-05-01

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 : Kidong Lee (Signature)	Technical Manager Name : Seungyong Kim (Signature)

2019-05-08

KCTL Inc.

Report revision history

Date	Revision	Page No
2019-05-02	Initial report	-
2019-05-08	Revised the conducted emission test date Revised Measurement equipment calibration date	43, 44

CONTENTS

1. General information 4
2. Device information 4
2.1. Accessory information 5
2.2. Frequency/channel operations 5
2.3. Duty Cycle Correction Factor 6
3. Antenna requirement 7
4. Summary of tests 7
5. Measurement uncertainty 8
6. Measurement results explanation example 9
7. Test results 10
7.1. Maximum conducted output power 10
7.2. Maximum Power Spectral Density 13
7.3. 26 dB Bandwidth & 99% Occupied Bandwidth 17
7.4. Frequency Stability 21
7.5. Spurious Emission, Band Edge and Restricted bands 23
7.6. AC Conducted emission 42
8. Measurement equipment 44

1. General information

Client	:	WONDERFUL PLATFORM CO.,LTD
Address	:	F 5. F6, 175, Nonhyeon-ro, Seocho-gu, Seoul, Republic of Korea
Manufacturer	:	CHUNGO TECH CO., LTD.
Address	:	303-604, BUCHEON TECHNO PARK SSANGYONG 3CHA, 397, Seokcheon-ro, Bucheon-si, Gyeonggi-do, 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-2
		KOLAS No.: KT231

2. Device information

Equipment under test	:	AI LASER BEAM PROJECTOR
Model	:	UO+
Frequency range	:	Bluetooth(BDR/EDR) _2 402 ㎒ ~ 2 480 ㎒
		WIFI(802.11b/g/n20)_2 412 ㎒ ~ 2 462 ㎒
		WIFI(802.11a/n20)_5 180 ㎒ ~ 5 240 ㎒ (UNII-1)
Modulation technique	:	Bluetooth(BDR/EDR)_GFSK, π/4DQPSK, 8DPSK
		WIFI(802.11a/b/g/n20)_DSSS, OFDM
Number of channels	:	Bluetooth(BDR/EDR)_79ch
		WIFI(802.11b/g/n20)_11ch (2.4 ㎓)
		WIFI(802.11a/n20)_4ch (UNII-1)
Power source	:	DC 3.7 V
Antenna specification	:	Chip Antenna
Antenna gain	:	1.88 ㏈i (Bluetooth, WIFI 2.4 ㎓), 3.60 ㏈i (WIFI 5 ㎓)
Software version	:	1.0.0
Hardware version	:	1.0
Test device serial No.	:	N/A
Operation temperature	:	23 ℃

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Battery	Fello Tech Co., Ltd.	FT845554P 1S2P	-	3.7V/6400mAh
AC Adaptor	ShenZhen Cenwell Technology Co.,Ltd.	CW0504000RE	-	100-240V~50/60Hz 0.8A

2.2. Frequency/channel operations

This device contains the following capabilities:
Bluetooth(BDR/EDR), WIFI(802.11a/b/g/n20)

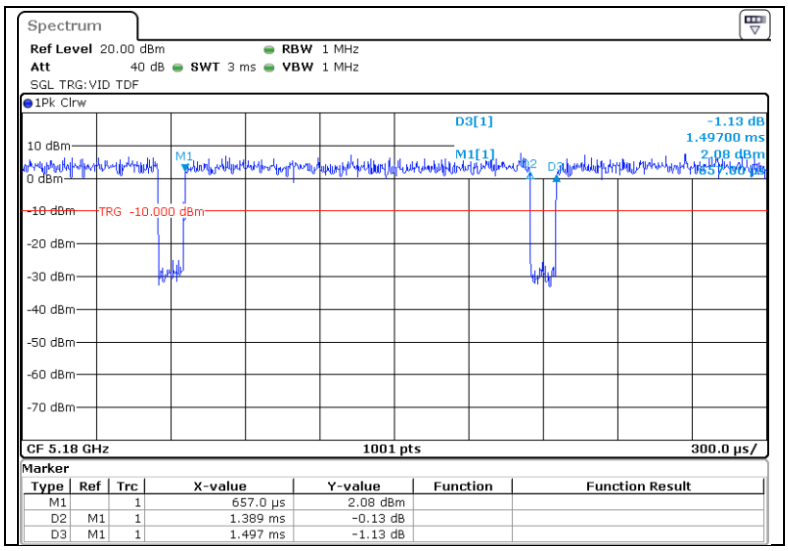
UNII-1

Ch.	Frequency (㎒)
36	5 180
. .	. .
40	5 200
. .	. .
48	5 240

Table 2.2.1. 802.11a/n(HT20) mode

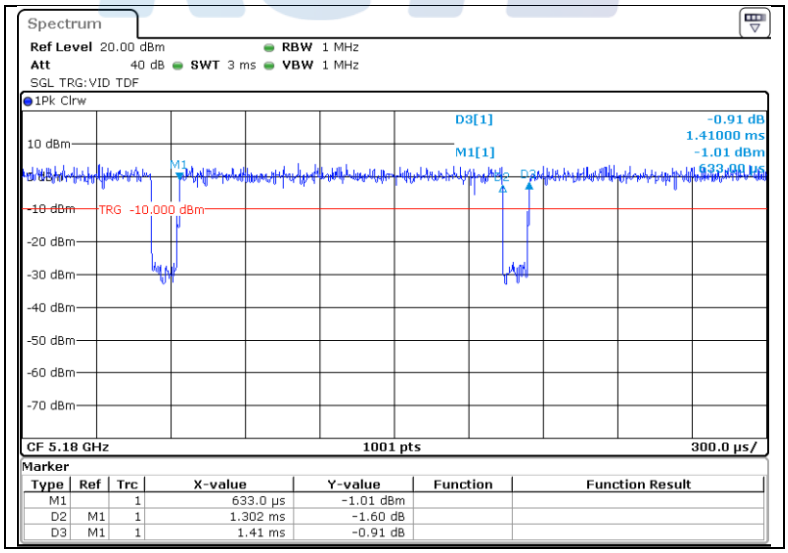
2.3. Duty Cycle Correction Factor

- 802.11a



Note1) : period : 1.50 ㎳, On time : 1.39 ㎳
Note2) : DCCF = 10 log(1 / x) = 10 log(1/0.928) = 0.325 ㏈, x = 1.39/1.50 = 0.928
Note3) : 802.11a is a continuous transmission (duty cycle <= 95 %)

- 802.11n HT20



Note1) : period : 1.41 ㎳, On time : 1.30 ㎳
Note2) : DCCF = 10 log(1 / x) = 10 log(1/0.923) = 0.346 ㏈, x = 1.30/1.41 = 0.923
Note3) : 802.11n HT20 is a continuous transmission (duty cycle <= 95 %)

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 Chip Antenna (internal 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 ㏈ bandwidth & 99% Occupied 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 X orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in X orientation
4. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
   - KDB 662911 D01 v02r01
   - KDB 789033 D02 v02r01

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.

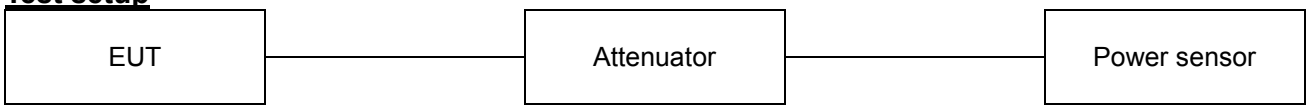
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	10.53	17 000	13.78
100	10.80	18 000	13.78
200	10.91	19 000	13.82
300	11.06	20 000	13.94
400	11.11	21 000	14.16
500	11.17	22 000	14.39
600	11.30	23 000	14.00
700	11.17	24 000	13.94
800	11.19	25 000	14.04
900	11.42	26 000	14.10
1 000	11.37	26 500	14.40
2 000	11.62	27 000	13.98
3 000	11.75	28 000	15.14
4 000	12.09	29 000	15.54
5 000	12.38	30 000	15.52
6 000	12.44	31 000	15.71
7 000	12.77	32 000	15.86
8 000	12.74	33 000	15.93
9 000	12.62	34 000	15.89
10 000	12.85	35 000	15.97
11 000	12.89	36 000	15.84
12 000	13.34	37 000	15.82
13 000	13.34	38 000	16.21
14 000	13.49	39 000	16.28
15 000	13.45	40 000	16.39
16 000	13.95		

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

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 (24 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)
KDB 662911 D01 v02r01 – Section E).1)

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.

◆ KDB 662911 D01 v02r01

Section E).1)
In-Band Power Measurements
The measure-and-sum technique shall be used for measuring in-band transmit power of a device. Total power is the sum of the conducted power levels measured at the various output ports

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

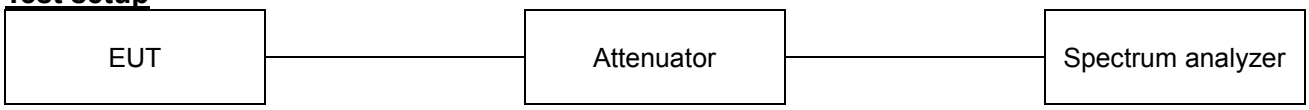
Ant1

Test mode	Band	Frequency(㎒)	Measured output power			Limit(㏈m)
			Reading(㏈m)	Duty Factor(㏈)	Result(㏈m)	
802.11a	UNII-1	5 180	6.51	0.33	6.84	24.00
		5 200	6.62	0.33	6.95	
		5 240	6.72	0.33	7.05	
802.11n HT20	UNII-1	5 180	6.43	0.35	6.78	24.00
		5 200	6.45	0.35	6.80	
		5 240	6.62	0.35	6.97	

Note.
1. Result(㏈ m) = Reading(㏈ m) + Duty Factor(㏈)

7.2. Maximum Power Spectral Density

Test setup



Limit

According to §15.407(a)

Band	EUT category		Limit
UNII-1		Outdoor access point	17dBm/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 bereduced by the amount in dB that the directional gain if the antenna exceed 6 dBi.

Test procedure

KDB 789033 D02 v02r01 - Section F
KDB 662911 D01 v02r01 - Section E). 2)
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. serch 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 1MHz 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 MHz RBW to satisfy directly the 1 MHz reference

bandwidth specified in Section 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 RBWs less than 1MHz, 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≥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 kHz, add 10 log (500 kHz /RBW) to the measured result, whereas RBW (<500 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10 log (1MHz/RBW) to the measured result, whereas RBW (< 1 MHz) 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.

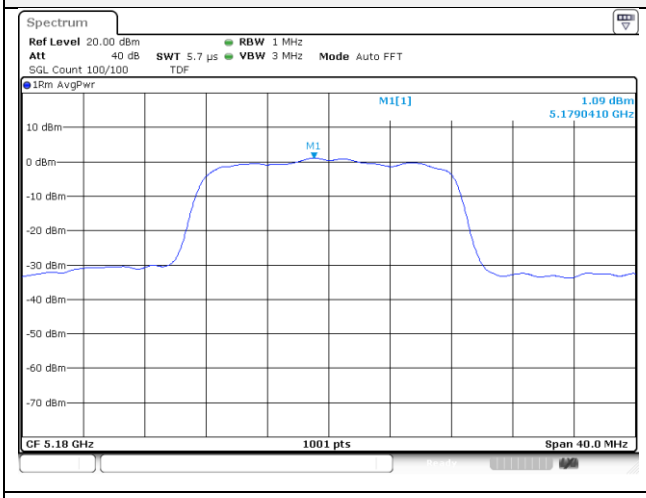
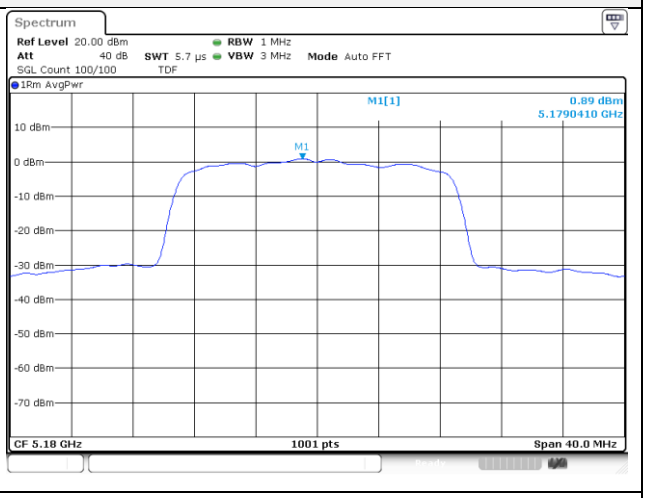
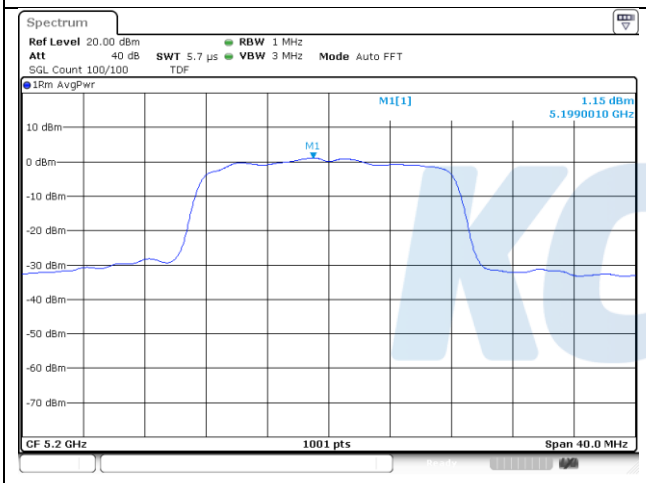
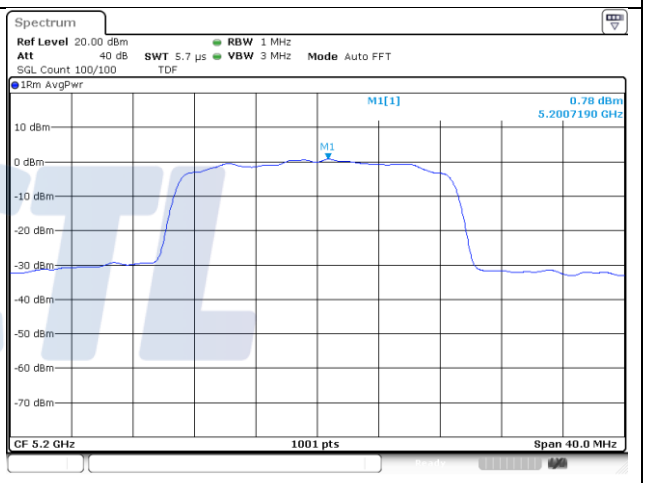
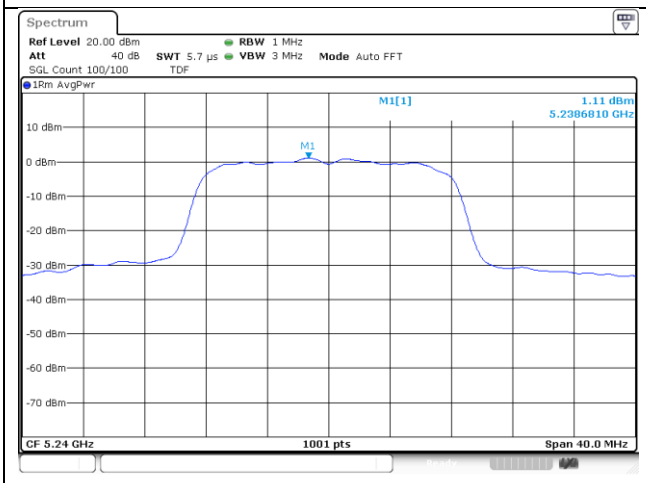
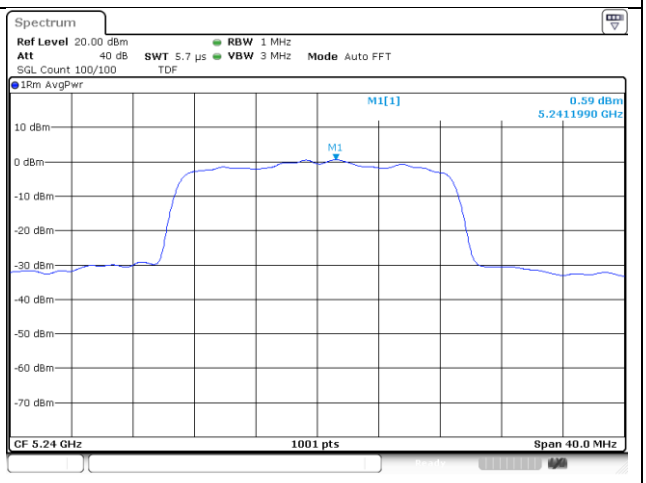
Note: As a practical matter, it is recommended to use reduced RBW of 100 kHz for the II.F.5.c) and II.F.5.d), since RBW=100 kHz is available on nearly all spectrum analyzers.

Test results

Test mode	Band	Frequency(㎒)	Peak Power Spectral Density			Limit(㏈m)
			Reading(㏈m)	Duty Factor (㏈)	Result [1] (㏈m)	
802.11a	UNII-1	5 180	1.09	0.33	1.42	11.00
		5 200	1.15	0.33	1.48	
		5 240	1.11	0.33	1.44	
802.11n HT20	UNII-1	5 180	0.89	0.35	1.24	11.00
		5 200	0.78	0.35	1.13	
		5 240	0.59	0.35	0.94	

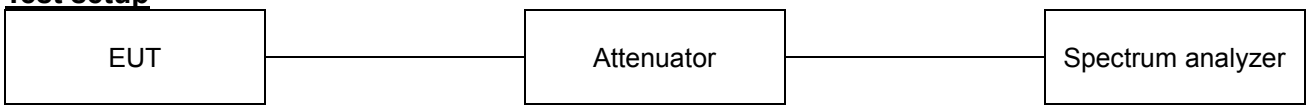
Note.

1. Result(㏈ m) = Reading(㏈ m) + Duty Factor(㏈)

802.11a	802.11n HT20
	
5 180 ㎒	5 180 ㎒
	
5 200 ㎒	5 200 ㎒
	
5 740 ㎒	5 740 ㎒

7.3. 26 dB Bandwidth & 99% Occupied Bandwidth

Test setup



Limit

N/A

Test procedure

26dB bandwidth

KDB 789033 D02 v02r01 - Section C.1

99% bandwidth

KDB 789033 D02 v02r01 - Section D

Test settings

1. 26dB 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%.

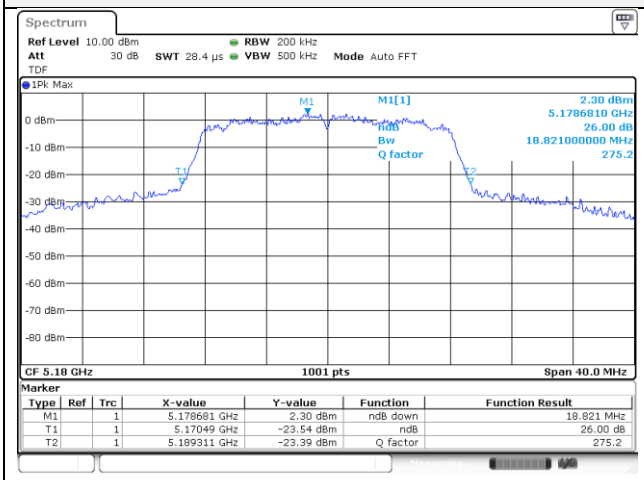
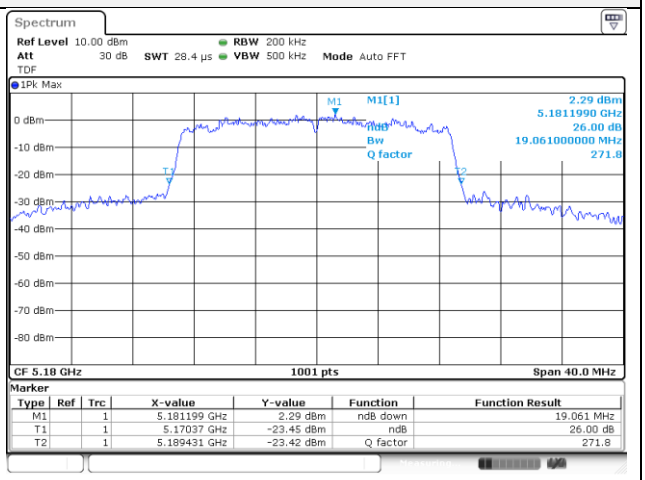
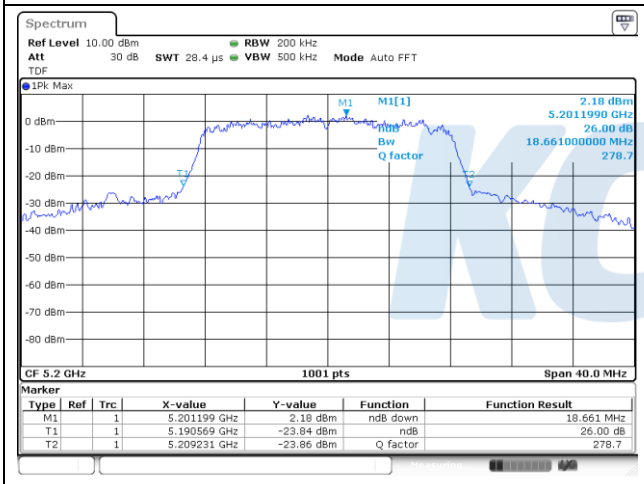
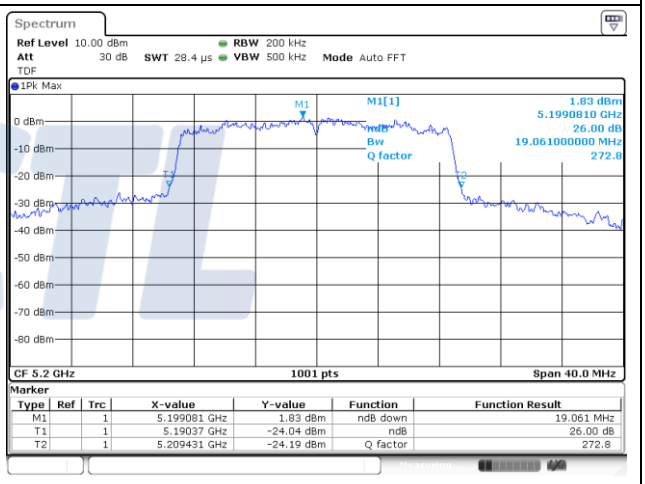
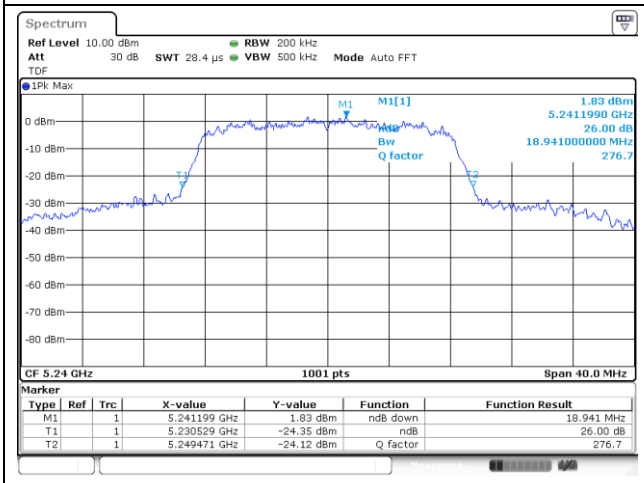
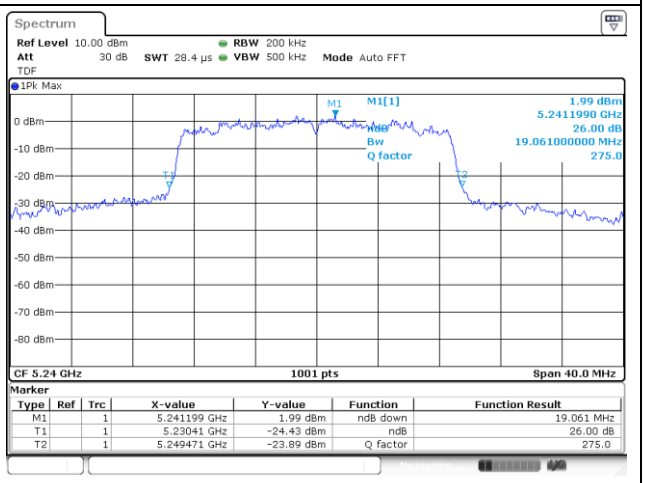
2. 99% Occupied Bandwidth

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.

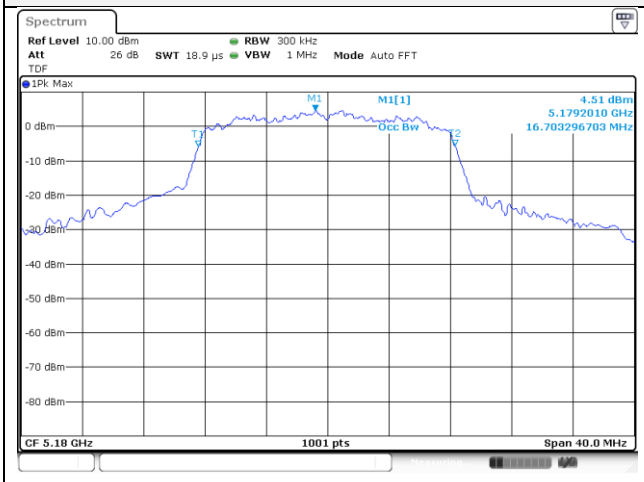
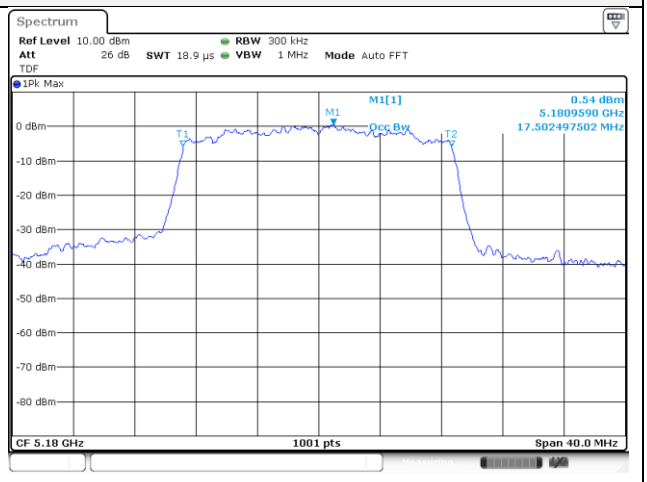
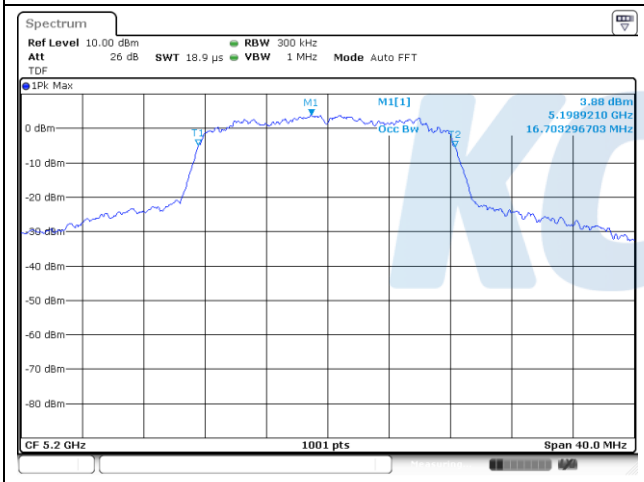
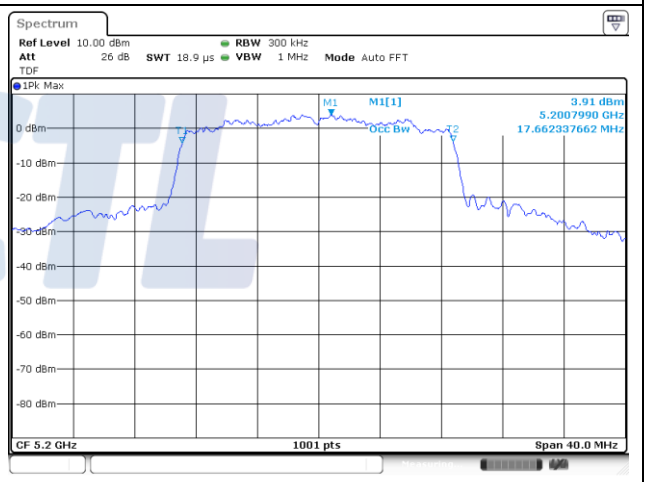
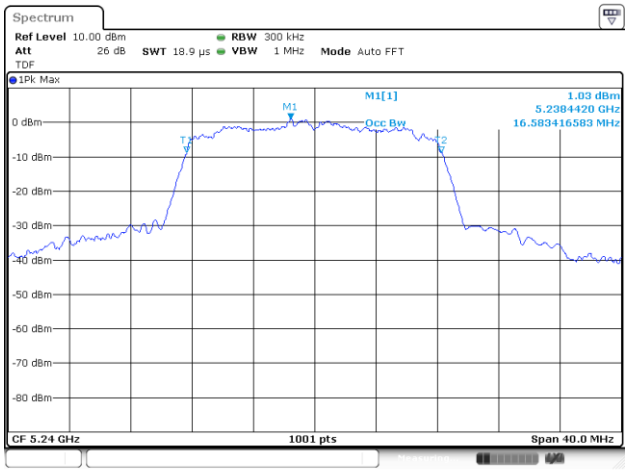
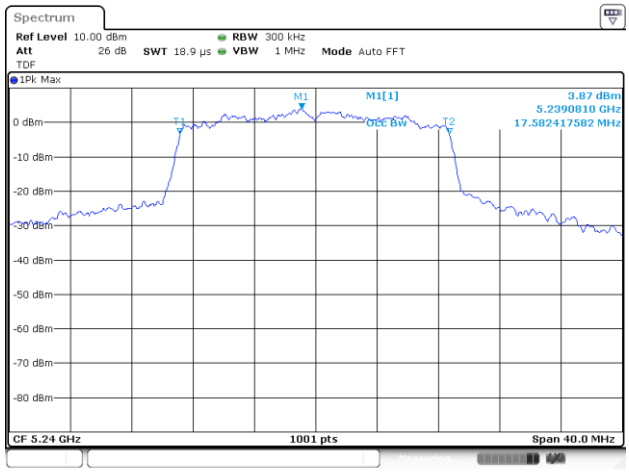
Test results

Test mode	Frequency(㎒)	26 ㏈ bandwidth(㎒)	99 % bandwidth(㎒)
802.11a	5 180	18.82	16.70
	5 200	18.66	16.70
	5 240	18.94	16.58
802.11n HT20	5 180	19.06	17.50
	5 200	19.06	17.66
	5 240	19.06	17.58

26 dB bandwidth(㎒)

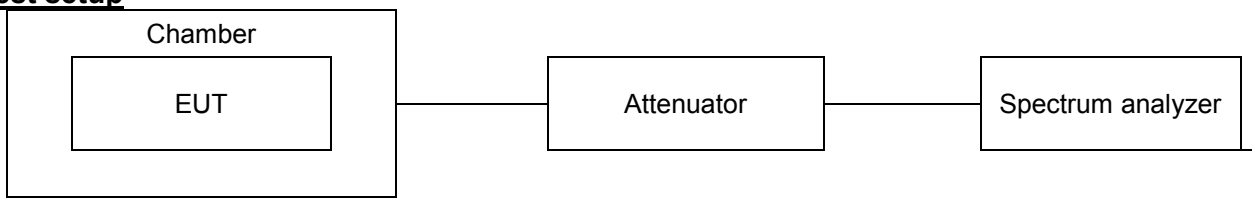
802.11a	802.11n HT20
	
5 180 ㎒	5 180 ㎒
	
5 200 ㎒	5 200 ㎒
	
5 240 ㎒	5 240 ㎒

99 % bandwidth(㎒)

802.11a	802.11n HT20
	
5 180 ㎒	5 180 ㎒
	
5 200 ㎒	5 200 ㎒
	
5 240 ㎒	5 240 ㎒

7.4. 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 °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.

Test results

Test mode : UNII-1

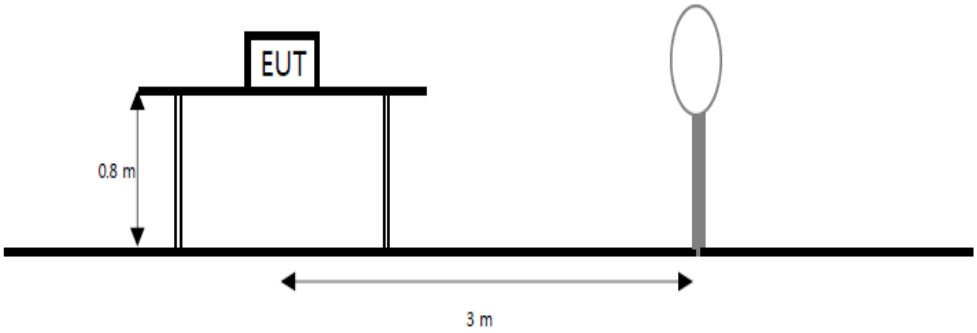
Frequency(㎐) : 5 180 000 000

Voltage [%]	Voltage [V]	TEMP [℃]	Maintaining time	Measure frequency [㎐]	Frequency deviation [㎐]	Deviation [%]
100	3.70	20	Startup	5179 934 170	-658 30.00	-0.001 27
			2 minutes	5179 934 170	-658 30.00	-0.001 27
			5 minutes	5179 934 170	-658 30.00	-0.001 27
			10 minutes	5179 934 170	-658 30.00	-0.001 27
		-20	Startup	5179 944 860	-551 40.00	-0.001 06
			2 minutes	5179 945 110	-548 90.00	-0.001 06
			5 minutes	5179 945 360	-546 40.00	-0.001 05
			10 minutes	5179 945 460	-545 40.00	-0.001 05
		-10	Startup	5179 942 363	-576 37.00	-0.001 11
			2 minutes	5179 942 063	-579 37.00	-0.001 12
			5 minutes	5179 941 913	-580 87.00	-0.001 12
			10 minutes	5179 941 813	-581 87.00	-0.001 12
		0	Startup	5179 935 369	-646 31.00	-0.001 25
			2 minutes	5179 934 820	-651 80.00	-0.001 26
			5 minutes	5179 934 320	-656 80.00	-0.001 27
			10 minutes	5179 934 170	-658 30.00	-0.001 27
		10	Startup	5179 932 621	-673 79.00	-0.001 30
			2 minutes	5179 932 471	-675 29.00	-0.001 30
			5 minutes	5179 932 471	-675 29.00	-0.001 30
			10 minutes	5179 932 321	-676 79.00	-0.001 31
		25	Startup	5179 931 322	-686 78.00	-0.001 33
			2 minutes	5179 931 322	-686 78.00	-0.001 33
			5 minutes	5179 931 422	-685 78.00	-0.001 32
			10 minutes	5179 931 472	-685 28.00	-0.001 32
		30	Startup	5179 934 570	-654 30.00	-0.001 26
			2 minutes	5179 934 470	-655 30.00	-0.001 27
			5 minutes	5179 934 420	-655 80.00	-0.001 27
			10 minutes	5179 934 370	-656 30.00	-0.001 27
		40	Startup	5179 934 170	-658 30.00	-0.001 27
			2 minutes	5179 934 170	-658 30.00	-0.001 27
			5 minutes	5179 934 120	-658 80.00	-0.001 27
			10 minutes	5179 934 120	-658 80.00	-0.001 27
		50	Startup	5179 934 170	-658 30.00	-0.001 27
			2 minutes	5179 934 170	-658 30.00	-0.001 27
			5 minutes	5179 934 170	-658 30.00	-0.001 27
			10 minutes	5179 934 170	-658 30.00	-0.001 27
85	3.15	20	Startup	5179 944 860	-551 40.00	-0.001 06
			2 minutes	5179 945 110	-548 90.00	-0.001 06
			5 minutes	5179 945 360	-546 40.00	-0.001 05
			10 minutes	5179 945 460	-545 40.00	-0.001 05
115	4.26	20	Startup	5179 942 363	-576 37.00	-0.001 11
			2 minutes	5179 942 063	-579 37.00	-0.001 12
			5 minutes	5179 941 913	-580 87.00	-0.001 12
			10 minutes	5179 941 813	-581 87.00	-0.001 12

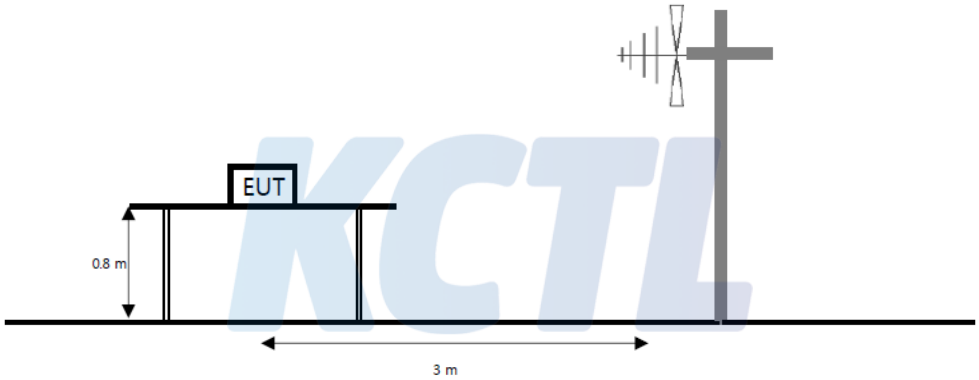
7.5. Spurious Emission, Band Edge and Restricted bands

Test setup

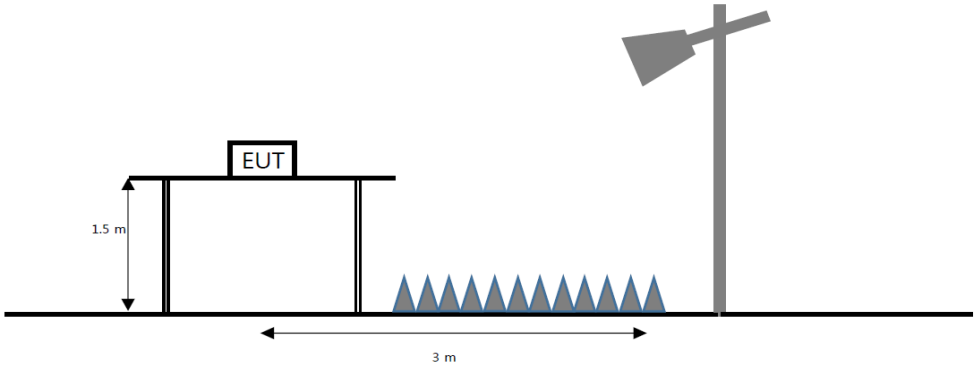
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



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
KDB 789033 D2 v02r01 – Section G

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.

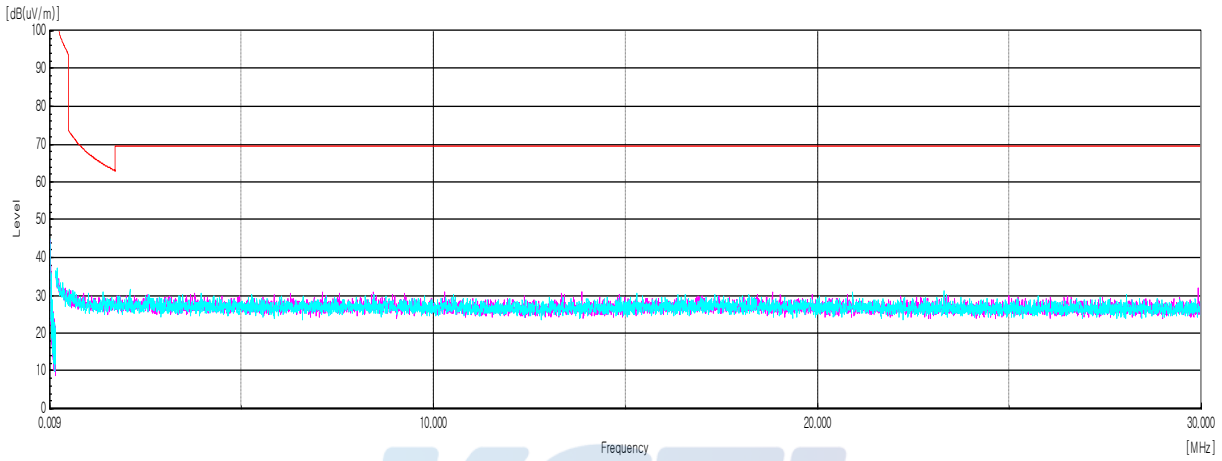
Notes:

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 dB/decade of distance. F_d = 40log(D_m/Ds)
   f ≥30 ㎒, extrapolation factor of 20 dB/decade of distance. F_d = 20log(D_m/Ds)
   Where:
   F_d= Distance factor in dB
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
3. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d(dB)
4. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. 1) mean is 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.

Test results (Below 30 ㎒) – Worst case: 802.11a_UNII-1 Highest 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.									

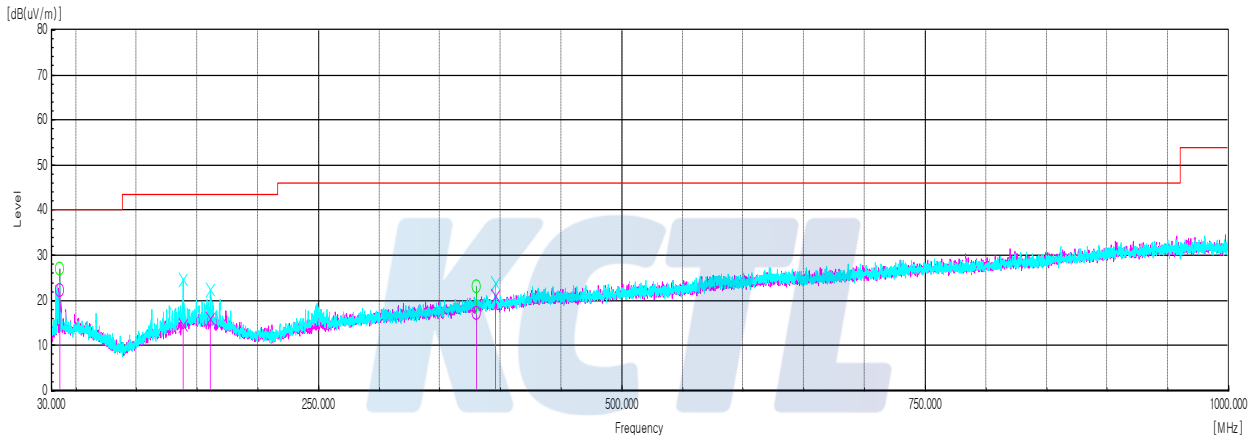
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: 802.11a_UNII-1 Highest 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)
Quasi peak data									
36.67	H	35.30	1.21	-27.08	12.67	-	22.10	40.00	17.90
138.40	V	25.40	2.55	-26.01	12.56	-	14.50	43.50	29.00
160.83	V	26.50	2.78	-26.31	13.13	-	16.10	43.50	27.40
380.17	H	23.60	4.43	-26.09	15.26	-	17.20	46.00	28.80
395.93	V	27.00	4.54	-26.05	15.61	-	21.10	46.00	24.90

Horizontal/Vertical

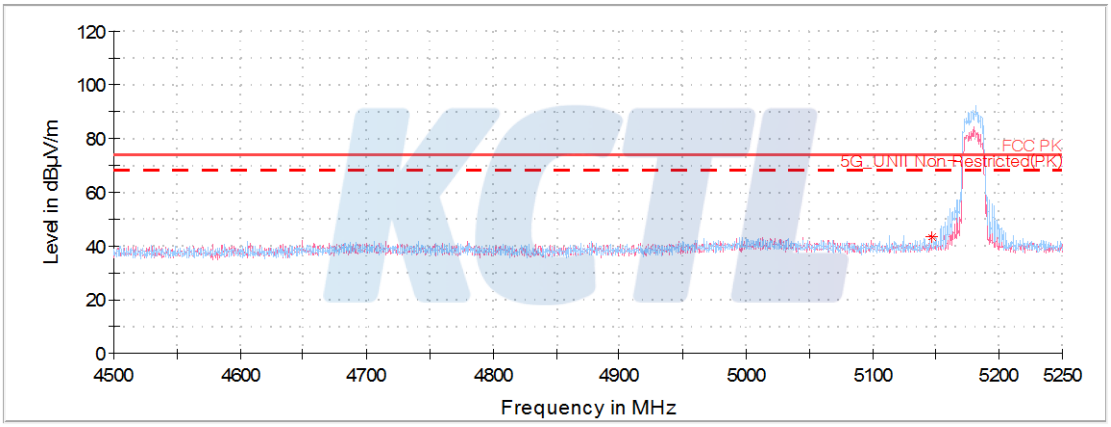


Test results (Above 1 000 ㎒)
802.11a_UNII-1

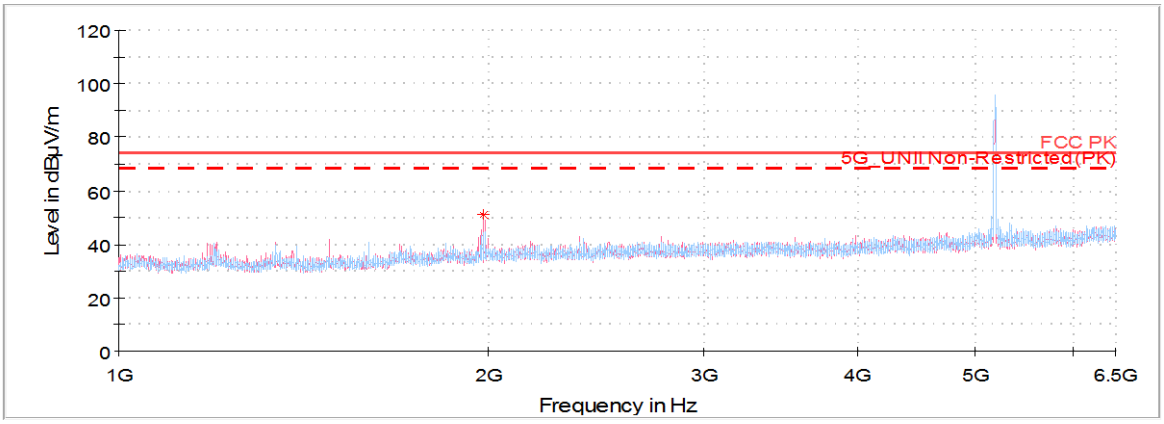
Lowest Channel (5 180 ㎒)

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)
Peak data									
1 980.20	V	56.14	3.41	-36.19	27.72	-	51.08	68.20	17.12
5 146.31[1)]	H	43.25	5.56	-38.38	33.12	-	43.55	74.00	30.45
16 774.53	V	51.75	11.94	-60.44	41.26	-	44.51	68.20	23.69
Average Data									
No spurious emissions were detected within 20 ㏈ of the limit.									

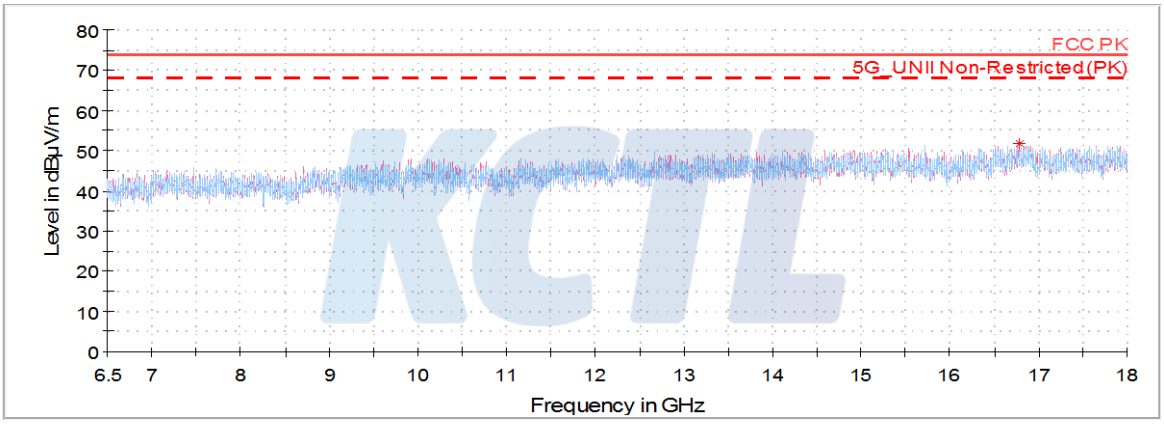
Horizontal/Vertical for Band-edge



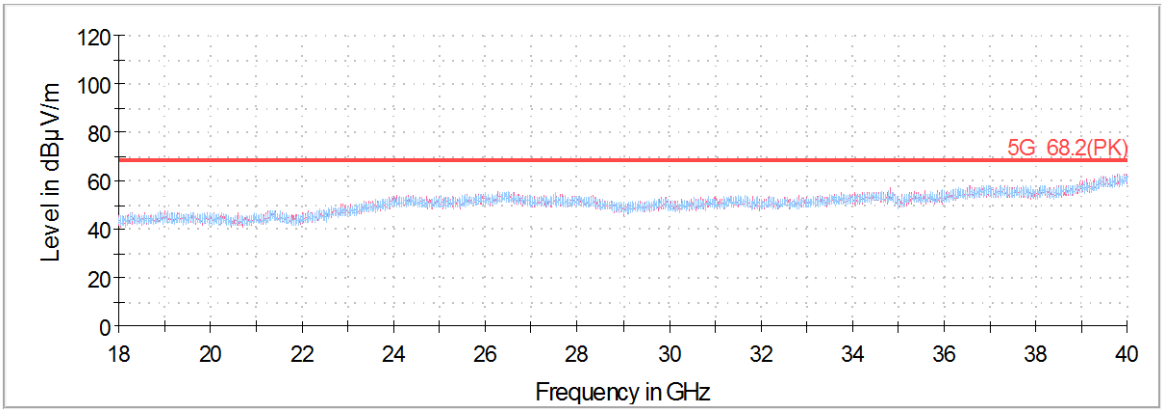
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓

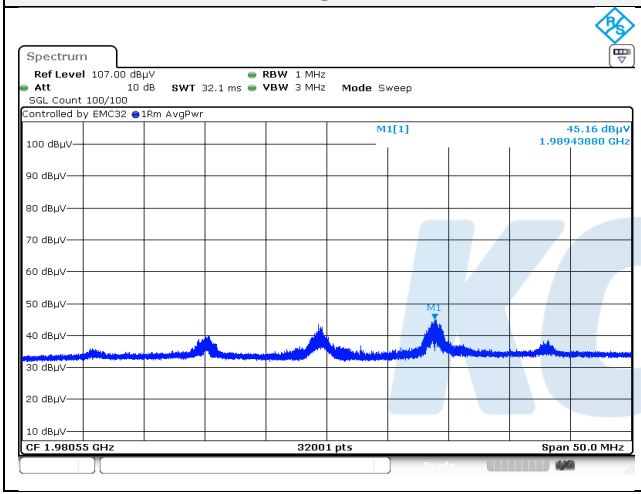


Horizontal/Vertical for 18 ㎓ ~ 40 ㎓

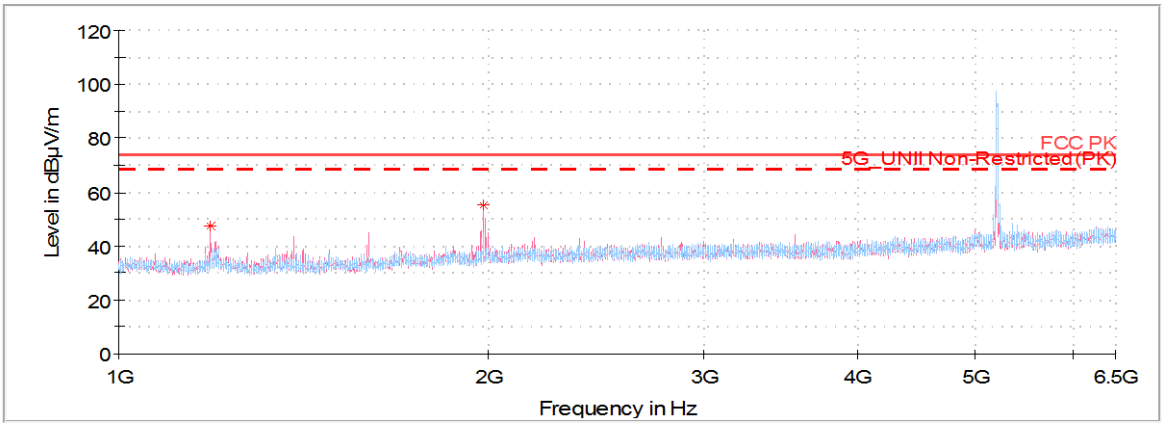


Middle Channel (5 200 ㎒)

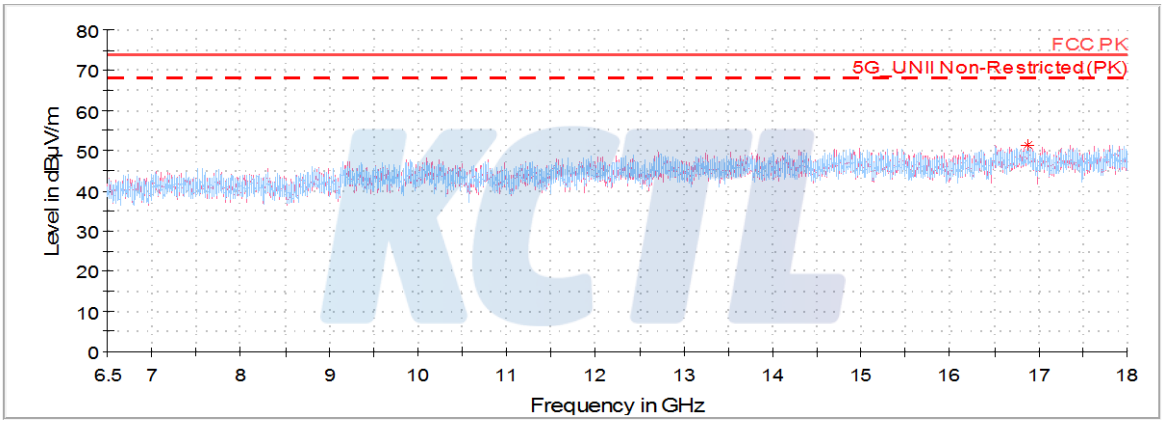
Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 188.03[1)]	V	56.56	2.65	-36.04	24.55	-	47.72	74.00	26.28
1 989.44	V	60.02	3.42	-36.24	27.76	-	54.96	68.20	13.24
16 875.16	H	51.57	11.92	-60.38	41.38	-	44.49	68.20	23.71
Average Data									
1 989.44	V	45.16	3.42	-36.24	27.76	0.33	40.43	54.00	13.58

Average data	Average data
	Blank

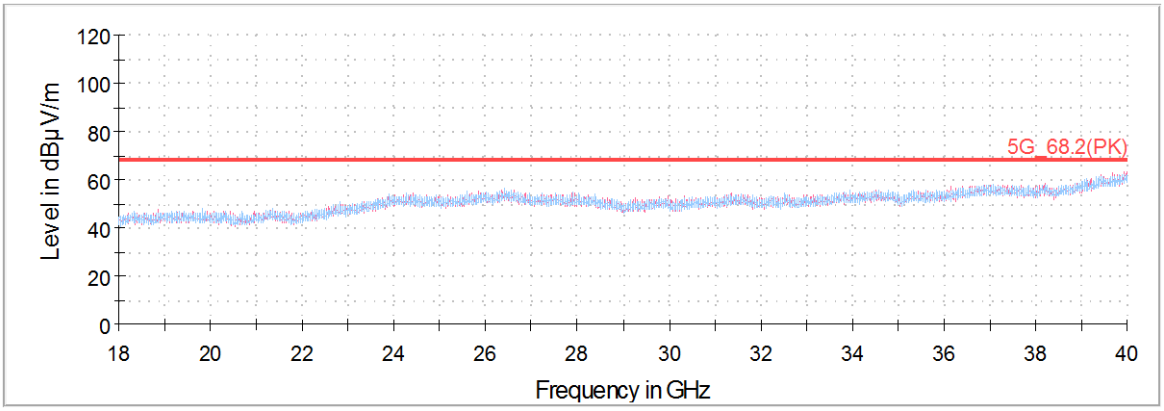
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



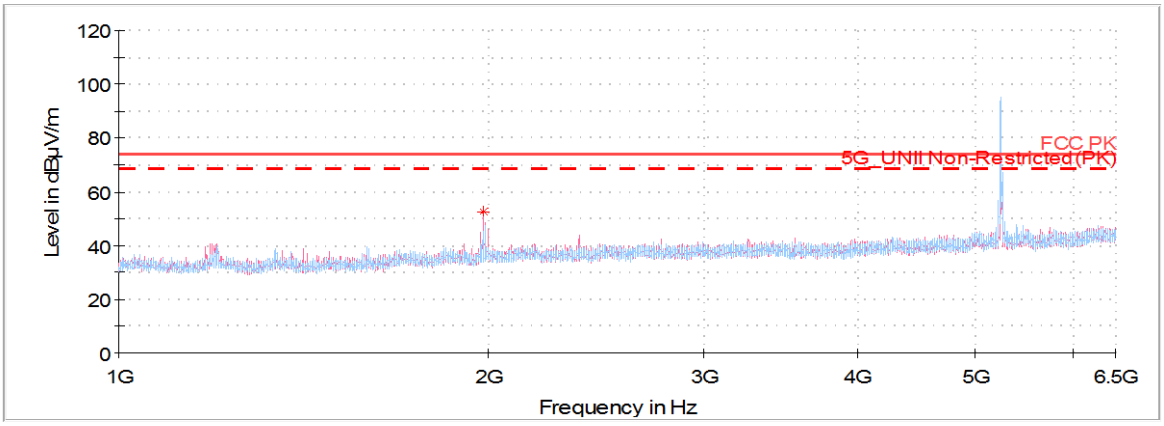
Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



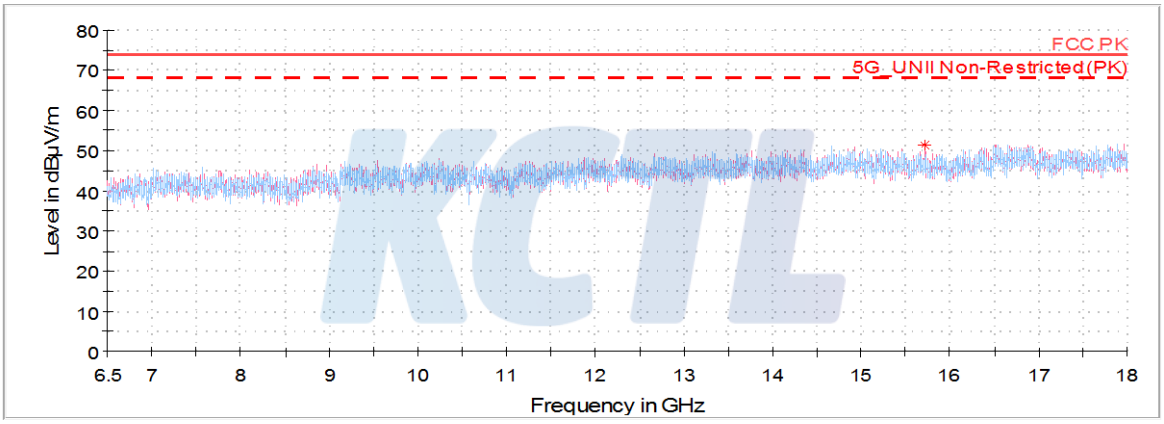
Highest Channel (5 240 ㎒)

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)
Peak data									
1 979.69	V	57.85	3.41	- 36.19	27.72	-	52.79	68.20	15.41
15 722.64[1)]	V	51.38	11.57	- 60.52	40.18	-	42.61	74.00	31.39
Average Data									
No spurious emissions were detected within 20 ㏈ of the limit.									

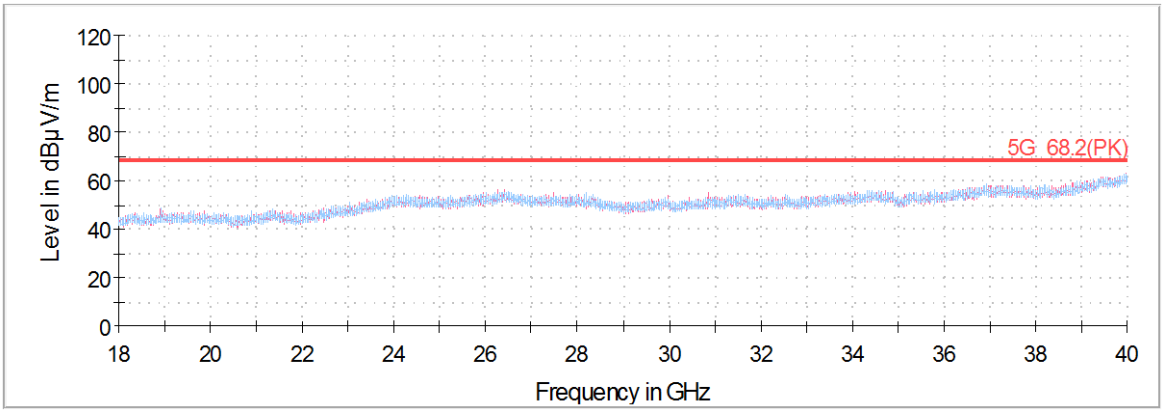
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 40 ㎓

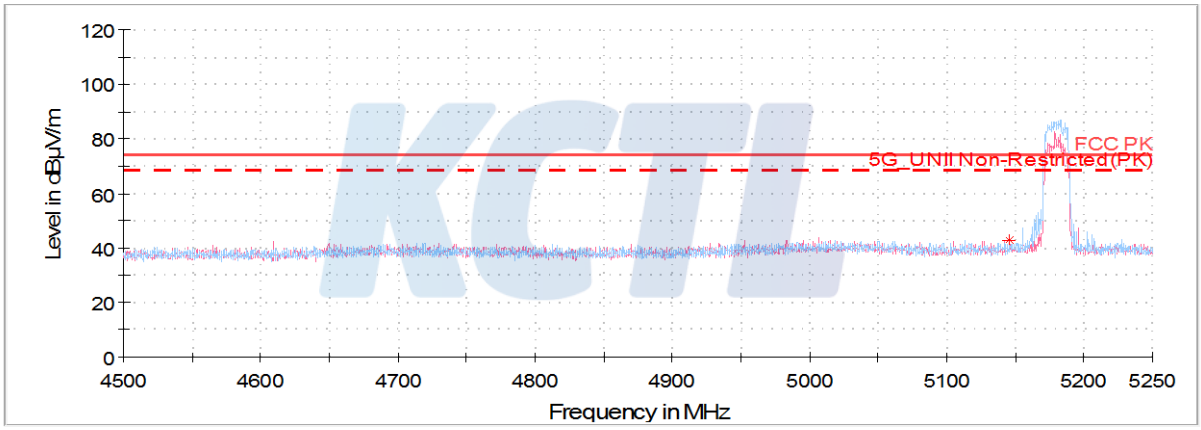


802.11n HT20 UNII-1

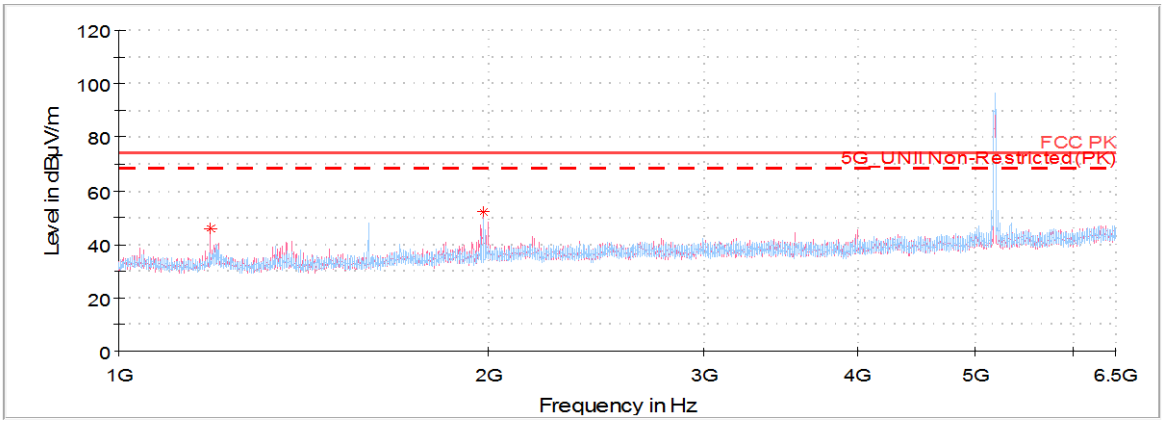
Lowest Channel (5 180 ㎒)

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)
Peak data									
1 592.97[1)]	H	53.18	3.04	-37.42	26.17	-	44.97	74.00	29.03
1 979.00	H	52.23	3.41	-36.20	27.72	-	47.16	68.20	21.04
5 145.97[1)]	V	42.55	5.56	-38.37	33.12	-	42.86	74.00	31.14
16 877.31	V	52.22	11.92	-60.39	41.39	-	45.14	68.20	23.06
Average Data									
No spurious emissions were detected within 20 ㏈ of the limit.									

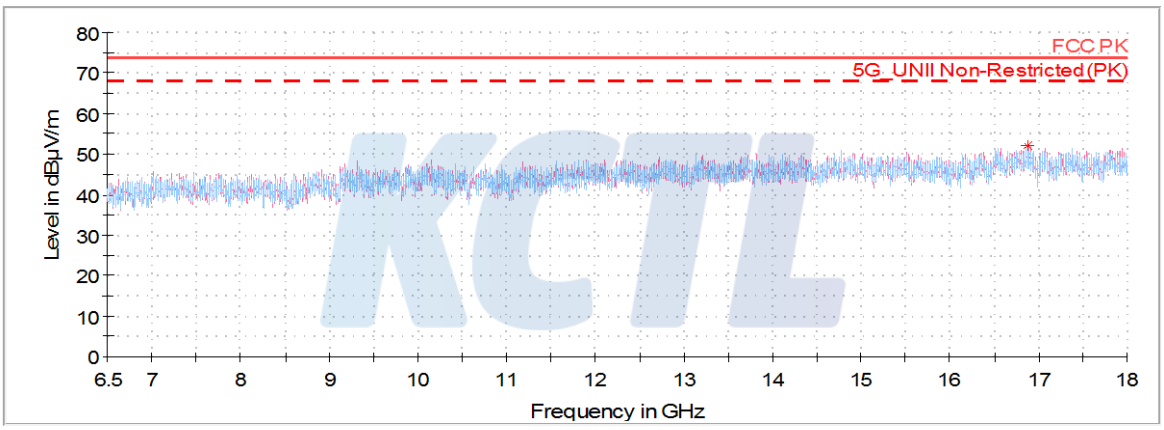
Horizontal/Vertical for Band-edge



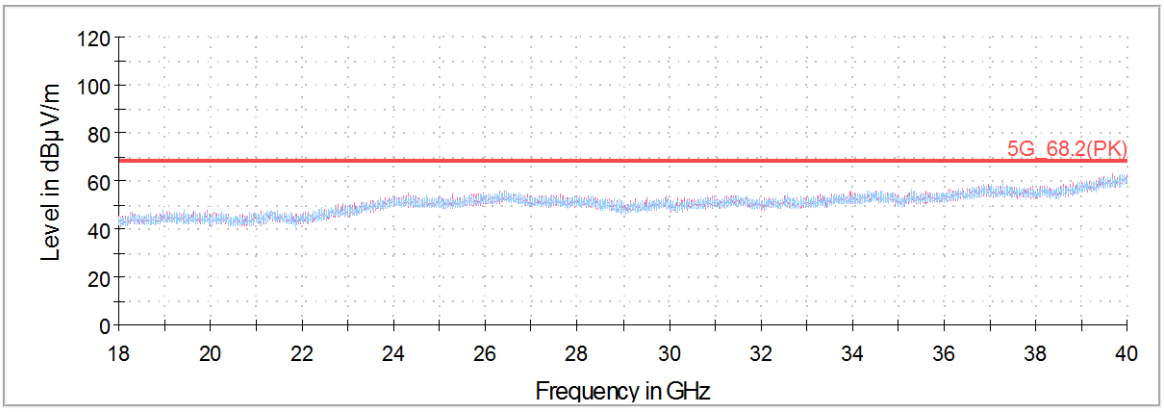
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



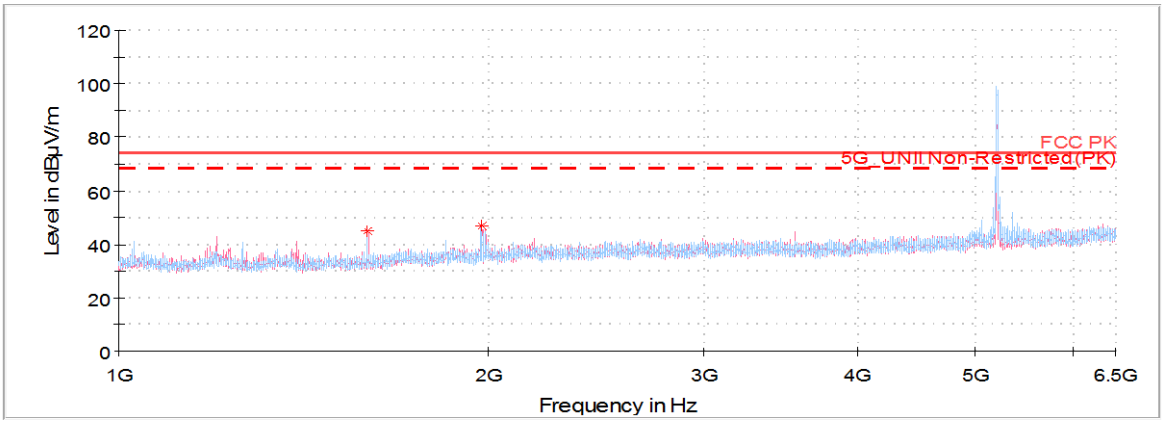
Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



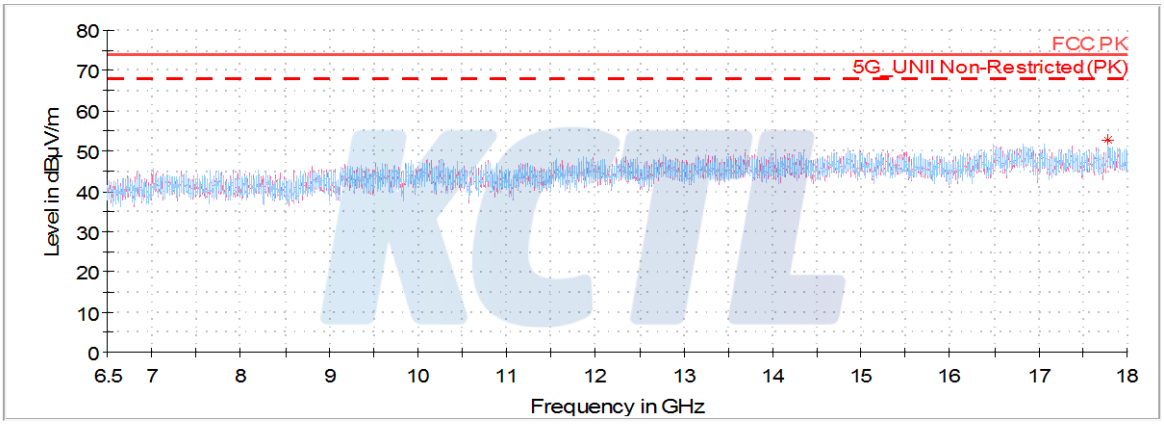
Middle Channel (5 200 ㎒)

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 592.97[1)]	H	53.18	3.04	-37.42	26.17	-	44.97	74.00	29.03
1 979.00	H	52.23	3.41	-36.20	27.72	-	47.16	68.20	21.04
17 787.97[1)]	H	52.63	12.02	-60.75	41.55	-	45.45	74.00	28.55
Average Data									
No spurious emissions were detected within 20 ㏈ of the limit.									

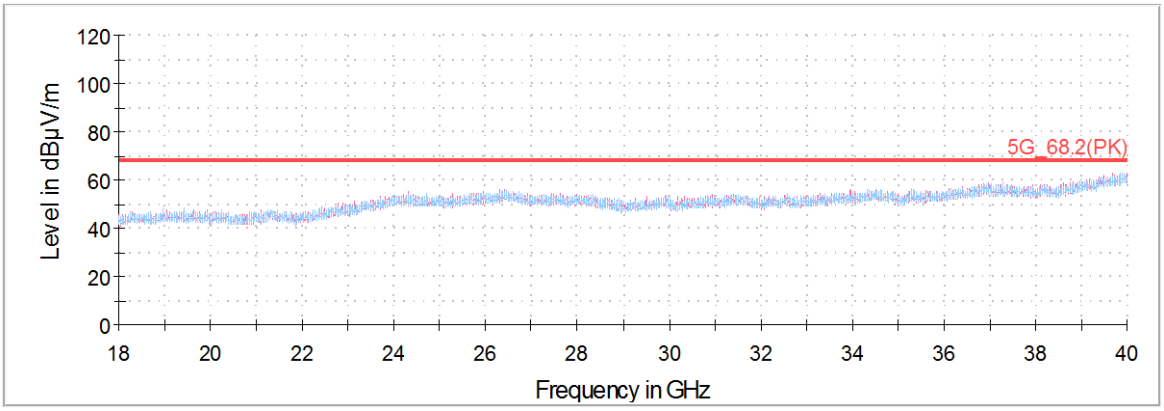
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓



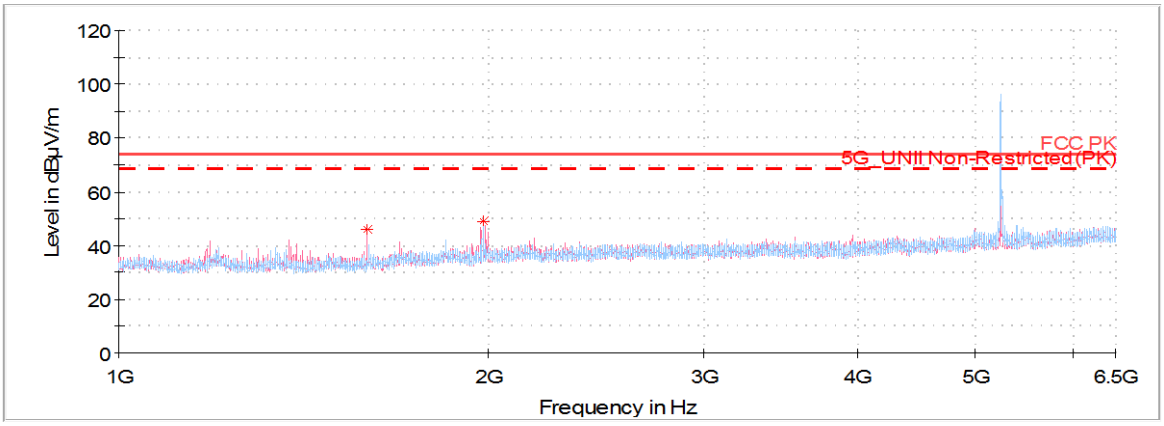
Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



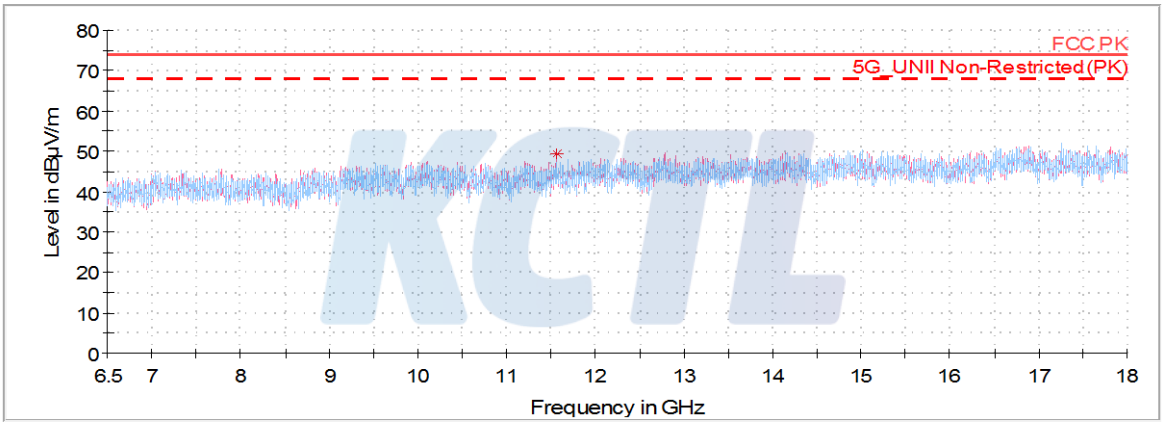
Highest Channel (5 240 ㎒)

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 595.55[1)]	V	53.98	3.04	-37.42	26.18	-	45.78	74.00	28.22
1 980.03	V	53.98	3.41	-36.19	27.72	-	48.92	68.20	19.28
11 575.09[1)]	V	49.29	8.44	-59.90	38.33	-	36.16	74.00	37.84
Average Data									
No spurious emissions were detected within 20 ㏈ of the limit.									

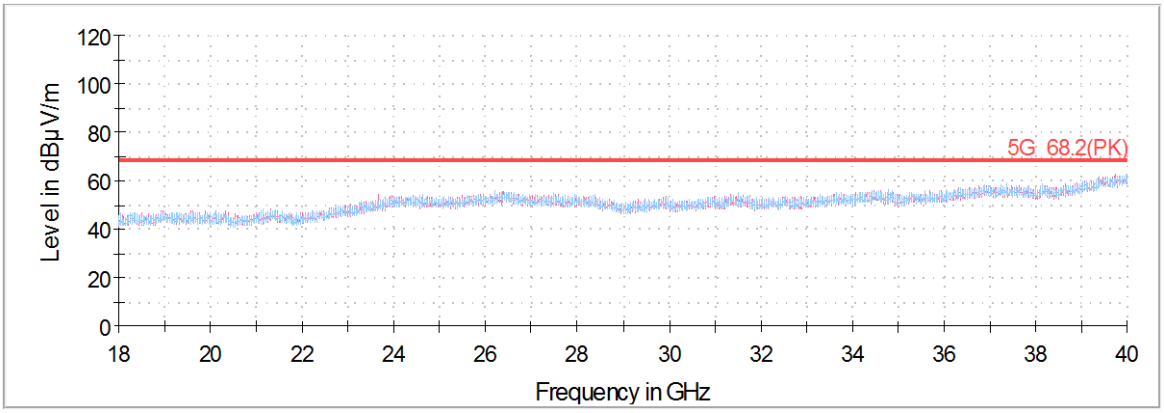
Horizontal/Vertical for 1 ㎓ ~ 6.5 ㎓



Horizontal/Vertical for 6.5 ㎓ ~ 18 ㎓

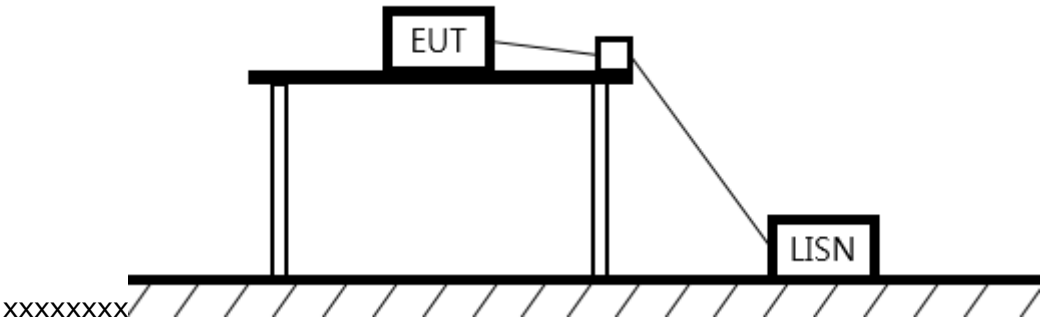


Horizontal/Vertical for 18 ㎓ ~ 40 ㎓



7.6. AC Conducted emission

Test setup



Limit

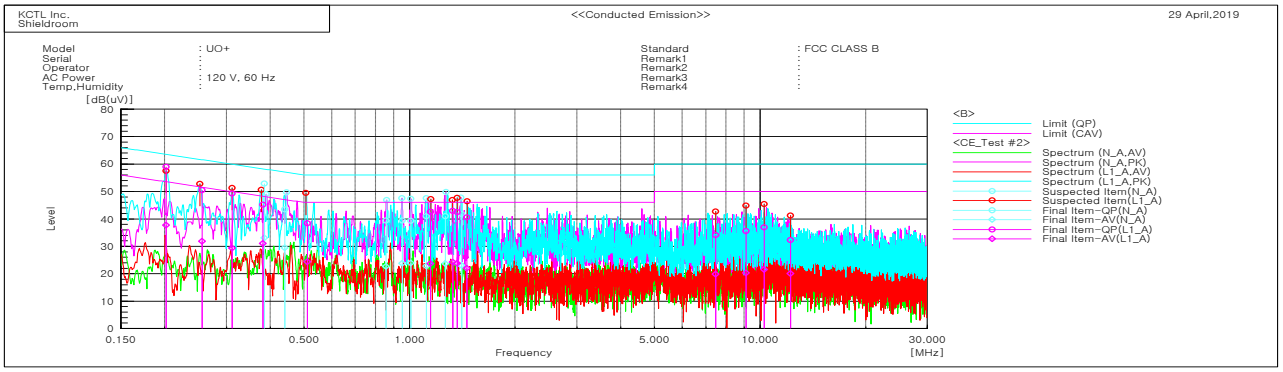
According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Measurement procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ 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 ㅡ 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 ㎒ to 30 ㎒.
5. The measurements were made with the detector set to peak amplitude within a bandwidth of 10 ㎑ or to quasi-peak and average within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

Test results



Final Result

--- N_A 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	0.38544	42.9	23.1	9.9	52.8	33.0	58.2	48.2	5.4	15.2
2	0.4407	33.5	19.5	9.9	43.4	29.4	57.0	47.0	13.6	17.6
3	0.85588	29.5	12.9	9.8	39.3	22.7	56.0	46.0	16.7	23.3
4	0.95324	29.6	14.0	9.8	39.4	23.8	56.0	46.0	16.6	22.2
5	1.00872	29.5	14.1	9.8	39.3	23.9	56.0	46.0	16.7	22.1
6	1.11763	31.1	12.9	9.8	40.9	22.7	56.0	46.0	15.1	23.3
7	1.26504	31.2	13.9	9.8	41.0	23.7	56.0	46.0	15.0	22.3
8	1.40591	32.0	13.2	9.8	41.8	23.0	56.0	46.0	14.2	23.0

--- L1_A 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	0.20203	49.1	27.8	9.9	59.0	37.7	63.5	53.5	4.5	15.8
2	0.25548	40.8	22.1	9.7	50.5	31.8	61.6	51.6	11.1	19.8
3	0.31148	39.5	19.6	9.8	49.3	29.4	59.9	49.9	10.6	20.5
4	0.38141	35.2	21.1	9.9	45.1	31.0	58.2	48.2	13.1	17.2
5	0.51048	28.5	14.4	9.9	38.4	24.3	56.0	46.0	17.6	21.7
6	1.14547	32.8	13.8	9.8	42.6	23.6	56.0	46.0	13.4	22.4
7	1.32689	33.1	14.4	9.8	42.9	24.2	56.0	46.0	13.1	21.8

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R & S	FSV30	100806	19.08.01
Spectrum Analyzer	R & S	FSV40	100989	20.01.04
Wideband Power Sensor	R & S	NRP-Z81	102398	20.01.25
Temp & Humid Chamber	Myeongseong R&P	CTHC-50P-DT	20150824-2	19.08.01
ATTENUATOR	R & S	DNF Dämpfungsglied 10 dB in N-50 Ohm	31212	19.05.14
EMI TEST RECEIVER	R & S	ESCI	100732	19.08.23
Bi-Log Antenna	SCHWARZBECK	VULB 9168	583	20.05.04
Amplifier	SONOMA INSTRUMENT	310N	284608	19.08.23
COAXIAL FIXED ATTENUATOR	Agilent	8491B-003	2708A18758	20.05.04
Horn antenna	ETS.lindgren	3116	00086635	19.05.10
Horn antenna	ETS.lindgren	3117	161225	19.05.18
AMPLIFIER	L-3 Narda-MITEQ	AMF-7D-01001800 -22-10P	2003683	19.05.15
AMPLIFIER	L-3 Narda-MITEQ	JS44-18004000-33 -8P	2000997	19.08.02
LOOP Antenna	R & S	HFH2-Z2	100355	20.08.24
Antenna Mast	Innco Systems	MA4640-XP-ET	-	-
Turn Table	Innco Systems	DT2000	79	-
Antenna Mast	Innco Systems	MA4000-EP	303	-
Turn Table	Innco Systems	DT2000	79	-
TWO-LINE V - NETWORK	R&S	ENV216	101584	20.04.05
EMI TEST RECEIVER	R & S	ESCI	101408	19.08.23
High Pass Filter	WT	WT-A1699-HS	WT160411002	19.05.14
Vector Signal Generator	R & S	SMBV100A	257566	20.01.04
Signal Generator	R & S	SMR40	100007	19.05.15
Cable Assembly	RadiAll	2301761768000PJ	1724.659	-
Cable Assembly	gigalane	RG-400	-	-
Cable Assembly	HUER+SUHNER	SUCOFLEX 104	MY4342/4	-

End of test report