verify No.401014338638

TEST REPORT

KCTL Inc.
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1. Client

- Name : Samsung Electronics Co., Ltd.
- Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
- Date of Receipt : 2020-09-21

2. Use of Report : Certification

3. Name of Product / Model : Wi-Fi/BLE combo module / CCAR210R

4. Manufacturer / Country of Origin : Samsung Electronics Co., Ltd. / Korea

5. FCC ID : A3LCCAR210R

6. IC Certificate No. : 649E-CCAR210R

7. Date of Test : 2020-12-21 to 2021-01-06

8. Location of Test : ■ Permanent Testing Lab ☐ On Site Testing (Address: Address of testing location)

9. Test method used : FCC Part 15 Subpart C, 15.247
RSS-247 Issue 2 February 2017
RSS-Gen Issue 5 March 2019

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

Affirmation	Tested by	Technical Manager
	Name : Hosung Lee (Signature)	Name : Heesu Ahn (Signature)

2021-01-21

KCTL Inc.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

REPORT REVISION HISTORY

Date	Revision	Page No
2021-01-14	Originally issued	-
2021-01-21	Updated	4

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Note. The report No. KR21-SRF0011 is superseded by the report No. KR21-SRF0011-A.

General remarks for test reports

Nothing significant to report.

CONTENTS

1. General information 4
2. Device information 4
2.1. Frequency/channel operations 5
2.3. RF power setting in TEST SW 5
2.3. Duty Cycle Factor 6
3. Antenna requirement 8
4. Summary of tests 9
5. Measurement uncertainty 10
6. Measurement results explanation example 11
7. Test results 12
7.1. Maximum peak output power 12
7.2. Peak Power Spectral Density 16
7.3. 6 dB Bandwidth(DTS Channel Bandwidth) & 99% Bandwidth 23
7.4. Spurious Emission, Band Edge and Restricted bands 35
7.5. Conducted Spurious Emission 93
7.6. AC Conducted emission 102
8. Measurement equipment 105

1. General information

Client	:	Samsung Electronics Co., Ltd.
Address	:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
Manufacturer	:	Samsung Electronics Co., Ltd.
Address	:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. 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-20080, G-20078, C-20059, T-20056 Industry Canada Registration No. : 8035A KOLAS No.: KT231

2. Device information

Equipment under test	:	Wi-Fi/BLE combo module
Model	:	CCAR210R
Frequency range	:	2 402 ㎒ ~ 2 480 ㎒ (Bluetooth(BLE)) 2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n HT20) 2 422 ㎒ ~ 2 452 ㎒ (802.11n HT40)
Modulation technique	:	Bluetooth(BLE)_GFSK WIFI(802.11b/g/n HT20/40)_DSSS, OFDM
Number of channels	:	Bluetooth(BLE)_40 ch 2.4 GHz band: 11 ch (20 ㎒), 7 ch (40 ㎒),
Power source	:	DC 5.0 ㏈, DC 12.0 ㏈
Antenna type	:	Metal Antenna
Antenna gain	:	Bluetooth(BLE) 0.5 ㏈i 2.4 ㎓ band 0.5 ㏈i
Software version	:	v1.0
Hardware version	:	v1.0
Operation temperature	:	-20 ℃ ~ 85 ℃

2.1. Frequency/channel operations

This device contains the following capabilities:
802.11b/g/n HT20/40, Bluetooth Low Energy

Ch.	Frequency (㎒)
01	2 412
. .	. .
06	2 437
. .	. .
11	2 462

Table 2.1.1. 802.11b/g/n_HT20 mode

Ch.	Frequency (㎒)
03	2 422
. .	. .
06	2 437
. .	. .
09	2 452

Table 2.1.2. 802.11n_HT40 mode

2.3. RF power setting in TEST SW

Mode	Frequency(㎒)	RF Power setting value
802.11b	2412	90
	2442	90
	2462	90
802.11g	2412	86
	2442	88
	2462	83
802.11n_HT20	2412	83
	2442	83
	2462	81
802.11n_HT40	2422	83
	2437	86
	2452	81

2.3. Duty Cycle Factor

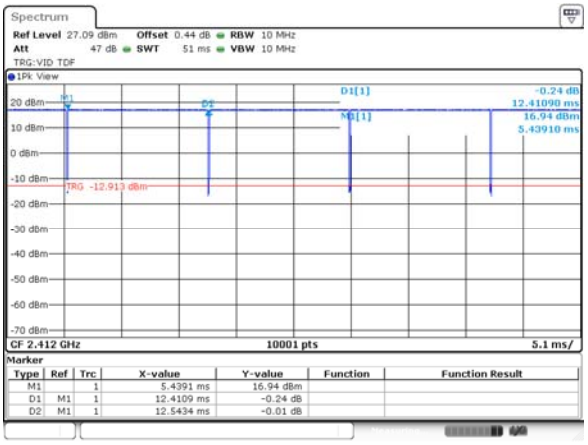
[DC 5 V]

Test mode	Period (ms)	On time (ms)	Duty cycle		Duty Cycle Factor (dB)
			(Linear)	(%)	
802.11b	12.543 4	12.410 9	0.989 4	98.94	0.05
802.11g	2.178 9	2.049 3	0.940 5	94.05	0.27
802.11n_HT20	2.036 7	1.907 1	0.936 4	93.64	0.29
802.11n_HT40	1.074 0	0.943 5	0.878 5	87.85	0.56

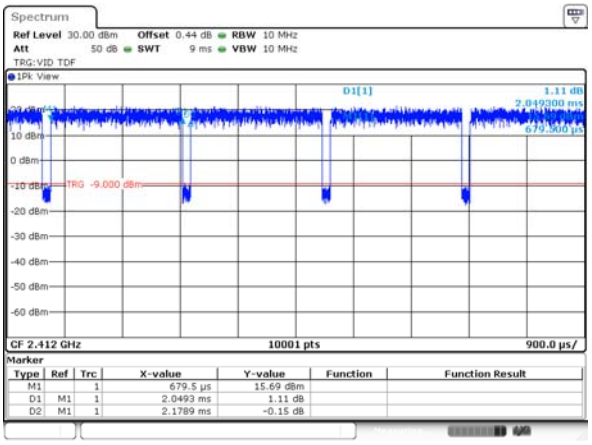
Notes.

1. Duty cycle (Linear) = Ton time / Period
2. DCF(Duty cycle factor) = 10log(1/duty cycle)
3. DCF is not compensated to Average result if duty cycle is more than 98%

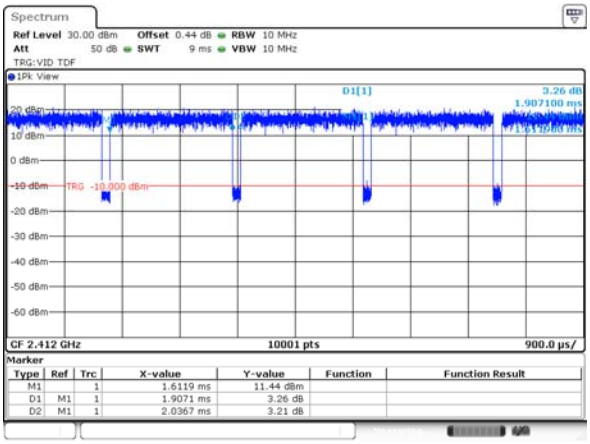
802.11b



802.11g



802.11n_HT20



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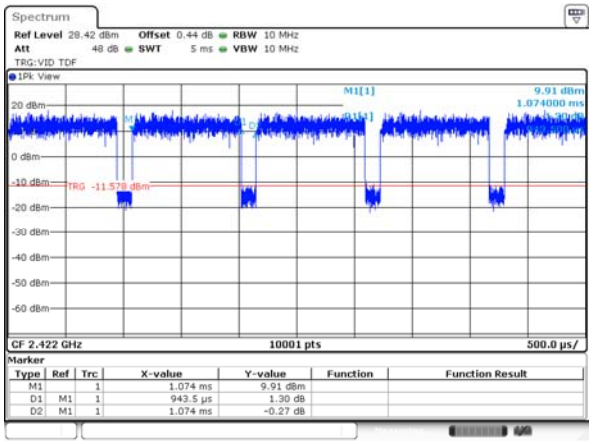


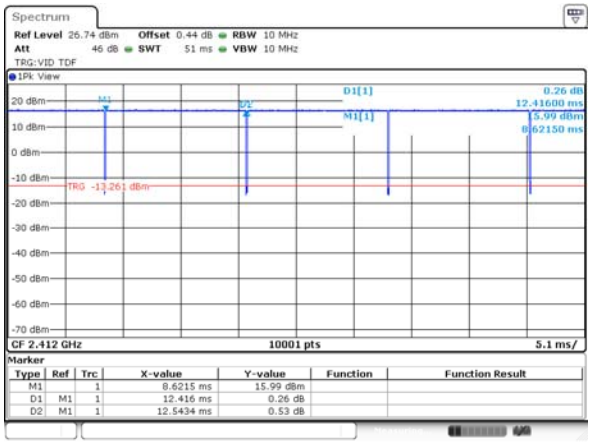
[DC 12 V]

Test mode	Period (ms)	On time (ms)	Duty cycle		Duty Cycle Factor (dB)
			(Linear)	(%)	
802.11b	12.543 4	12.416 0	0.989 8	98.98	0.04
802.11g	2.178 9	2.049 3	0.940 5	94.05	0.27
802.11n_HT20	2.035 8	1.906 2	0.936 3	93.63	0.29
802.11n_HT40	1.074 0	0.944 0	0.879 0	87.90	0.56

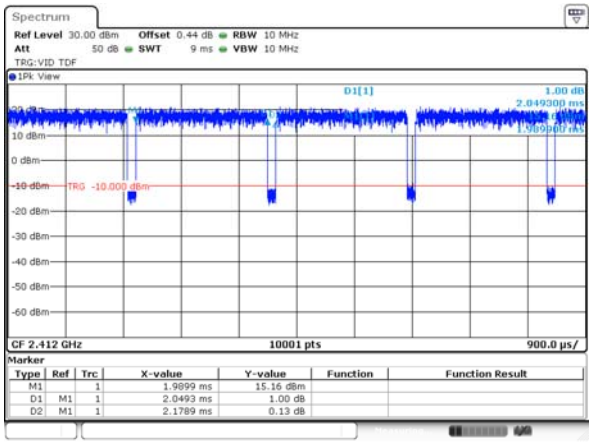
Notes.

1. Duty cycle (Linear) = Ton time / Period
2. DCF(Duty cycle factor) = 10log(1/duty cycle)
3. DCF is not compensated to Average result if duty cycle is more than 98%

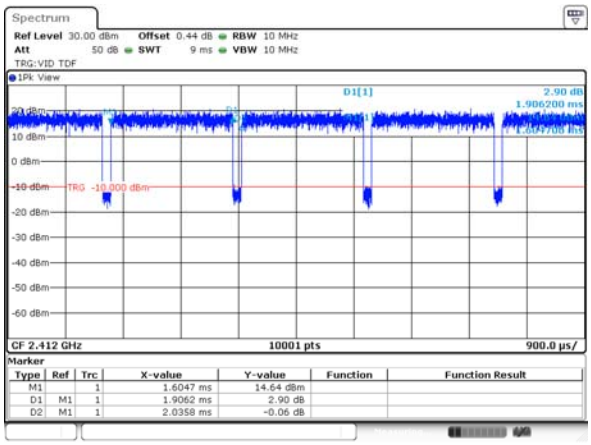
802.11b



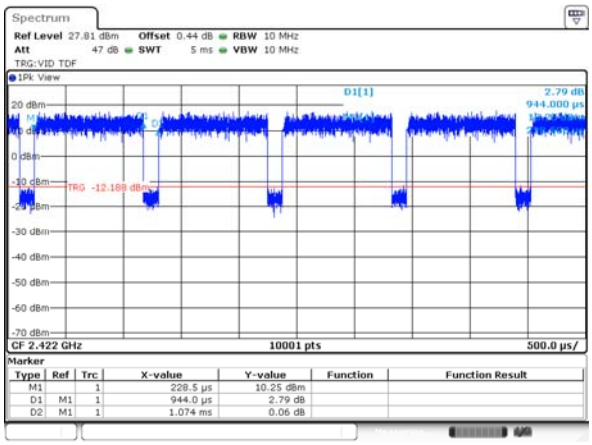
802.11g



802.11n_HT20



802.11n_HT40



3. Antenna requirement

Requirement of FCC part section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Requirement of RSS-Gen Section 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

- The transmitter has permanently attached metal antenna on board.
- The E.U.T Complies with the requirement of §15.203, §15.247.

4. Summary of tests

FCC Part section(s)	IC Rule Reference	Parameter	Test Condition	Test results
15.247(b)(3)	RSS-247 (5.4)(d)	Maximum peak output power	Conducted	Pass
15.247(e)	RSS-247 (5.2)(b)	Peak power spectral density		Pass
15.247(a)(2)	RSS-247 (5.2)(a)	6 dB channel bandwidth		Pass
-	RSS-Gen (6.7)	Occupied Bandwidth		Pass
15.207(a)	RSS-Gen (8.8)	AC Conducted Emissions		Pass
15.247(d)	RSS-247 (5.5)	Conducted Spurious Emissions		Pass
15.205(a), 15.209(a)	RSS-Gen (8.9), (8.10)	Spurious emission	Radiated	Pass
		Band-edge, restricted band		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 558074 D01 V05r02
5. The worst-case data rate were:
   802.11b mode: 1Mbps
   802.11g mode: 6Mbps
   802.11n_HT20 mode: MCS0
   802.11n_HT40 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	1.3 dB	
Conducted spurious emissions	1.3 dB	
Radiated spurious emissions	9 kHz ~ 30 MHz:	2.3 dB
	30 MHz ~ 300 MHz	5.4 dB
	300 MHz ~ 1 000 MHz	5.5 dB
	Above 1 GHz	6.7 dB
Conducted emissions	9 kHz ~ 150 kHz	3.7 dB
	150 kHz ~ 30 MHz	3.3 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.

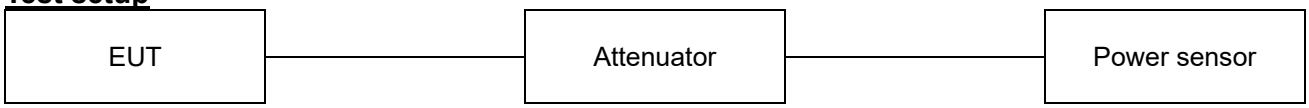
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	9.84	9 000	12.07
50	10.01	10 000	12.18
100	10.07	11 000	12.31
200	10.18	12 000	12.42
300	10.25	13 000	12.44
400	10.32	14 000	12.60
500	10.38	15 000	12.85
600	10.41	16 000	12.85
700	10.48	17 000	13.06
800	10.52	18 000	13.08
900	10.58	19 000	13.19
1 000	10.60	20 000	13.25
2 000	10.92	21 000	13.40
3 000	11.15	22 000	13.58
4 000	11.35	23 000	13.58
5 000	11.60	24 000	13.69
6 000	11.66	25 000	13.79
7 000	11.86	26 000	13.94
8 000	11.99	26 500	13.96

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

7. Test results

7.1. Maximum peak output power

Test setup



Limit

FCC

According to §15.247(b)(3), For systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

IC

According to RSS-247 5.4(d), For DTSs employing digital modulation techniques operating in the bands 902-928 ㎒ and 2400-2483.5 ㎒, the maximum peak conducted output power shall not exceed 1 �W. The e.i.r.p. shall not exceed 4 �W, except as provided in section 5.4(e).

Test procedure

ANSI C63.10 - Section 11.9
Used test method is section 11.9.1.3 and 11.9.2.3.1

Test settings

General
Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth (see ANSI C63.10 for measurement guidance).

When using a spectrum analyzer or EMI receiver to perform these measurements, it shall be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW to set a bin-to-bin spacing of ≤ RBW/2 so that narrowband signals are not lost between frequency bins.

If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level. The intent is to test at 100 % duty cycle; however a small reduction in duty cycle (to no lower than 98 %) is permitted, if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

If continuous transmission (or at least 98 % duty cycle) cannot be achieved due to hardware limitations (e.g., overheating), the EUT shall be operated at its maximum power control level, with the transmit duration as long as possible, and the duty cycle as high as possible during which sweep triggering/signal gating techniques may be used to perform the measurement over the transmission duration.

11.9.1. Maximum peak conducted output power
One of the following procedures may be used to determine the maximum peak conducted output power of a DTS EUT.

11.9.1.1. RBW ≥ DTS bandwidth
The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

11.9.1.3. PKPM1 Peak power meter method
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

11.9.2.3.1. Measurement using a power meter (PM)

Method AVGPM is a measurement using an RF average power meter, as follows:

a) As an alternative to spectrum analyzer or EMI receiver measurements, 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:
   1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
   2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
   3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

b) If the transmitter does not transmit continuously, measure the duty cycle, D, of the transmitter output signal as described in 11.6.

c) Measure the average power of the transmitter. This measurement is an average over both the ON and OFF periods of the transmitter.

d) Adjust the measurement in dBm by adding [10 log(1/D)], where D is the duty cycle

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

[DC 5 V]

Test mode	Frequency (MHz)	Conducted output power (dBm)		Conducted Power Limit (dBm)	Ant. Gain (dBi)	Max. e.i.r.p. (dB m)		Max e.i.r.p. Limit (dBm)
		Peak	Average			Peak	Average	
802.11b	2 412	19.48	16.54	30.00	0.5	19.98	17.04	36.02
	2 437	19.58	16.69			20.08	17.19	
	2 462	19.78	16.89			20.28	17.39	
802.11g	2 412	25.19	15.95			25.69	16.45	
	2 437	25.49	16.53			25.99	17.03	
	2 462	25.09	15.95			25.59	16.45	
802.11n HT20	2 412	24.59	15.30			25.09	15.80	
	2 437	25.19	15.94			25.69	16.44	
	2 462	24.59	15.03			25.09	15.53	
802.11n HT40	2 422	24.19	14.57			24.69	15.07	
	2 437	25.29	15.38			25.79	15.88	
	2 452	25.29	15.40			25.79	15.90	

[DC 12 V]

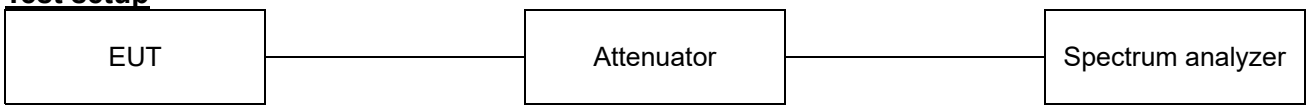
Test mode	Frequency (MHz)	Conducted output power (dBm)		Conducted Power Limit (dBm)	Ant. Gain (dBi)	Max. e.i.r.p. (dB m)		Max e.i.r.p. Limit (dBm)
		Peak	Average			Peak	Average	
802.11b	2 412	19.38	16.49	30.00	0.5	19.88	16.99	36.02
	2 437	19.78	16.94			20.28	17.44	
	2 462	19.78	16.92			20.28	17.42	
802.11g	2 412	25.19	15.68			25.69	16.18	
	2 437	25.59	16.49			26.09	16.99	
	2 462	24.89	15.60			25.39	16.10	
802.11n HT20	2 412	24.59	15.09			25.09	15.59	
	2 437	24.49	15.55			24.99	16.05	
	2 462	24.59	15.03			25.09	15.53	
802.11n HT40	2 422	24.19	14.47			24.69	14.97	
	2 437	25.29	15.74			25.79	16.24	
	2 452	24.19	14.42			24.69	14.92	

Notes:

1. Average result(dB m) = Average Reading (dB m) + DCF(dB)
2. e.i.r.p. Calculation: e.i.r.p. (dBm) = Conducted output power (dBm) + Antenna gain (dBi)

7.2. Peak Power Spectral Density

Test setup



Limit

According to §15.247(e) and RSS-247(5.2), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test procedure

ANSI C63.10 - Section 11.10.2

Test settings

Method PKPSD (peak PSD)

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

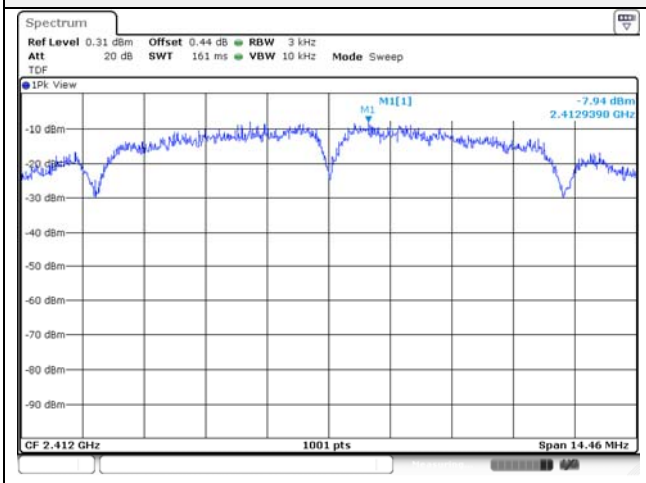
1) Set analyzer center frequency to DTS channel center frequency.
2) Set the span to 1.5 times the DTS bandwidth.
3) Set the RBW to: 3 ㎑ ≤ RBW ≤ 100 ㎑.
4) Set the VBW ≥ 3 x RBW.
5) Detector = peak.
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level within the RBW.
10) If measured value exceeds limit, reduce RBW (no less than 3 ㎑) and repeat.

Test results

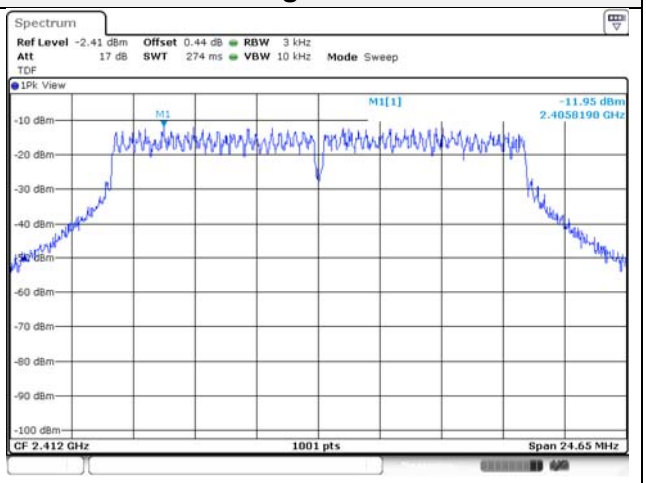
[DC 5 V]

Test mode	Frequency (MHz)	Reading (dBm/ 3kHz)	Limit (dBm/ 3kHz)
802.11b	2 412	-7.94	8.00
	2 437	-6.77	
	2 462	-6.25	
802.11g	2 412	-11.95	
	2 437	-10.79	
	2 462	-10.01	
802.11n HT20	2 412	-11.78	
	2 437	-11.83	
	2 462	-12.36	
802.11n HT40	2 422	-15.78	
	2 437	-14.66	
	2 452	-15.47	

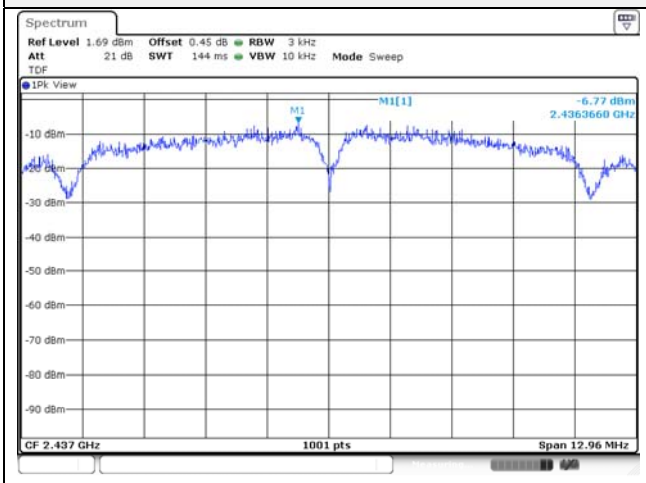
802.11b / 2 412 ㎒



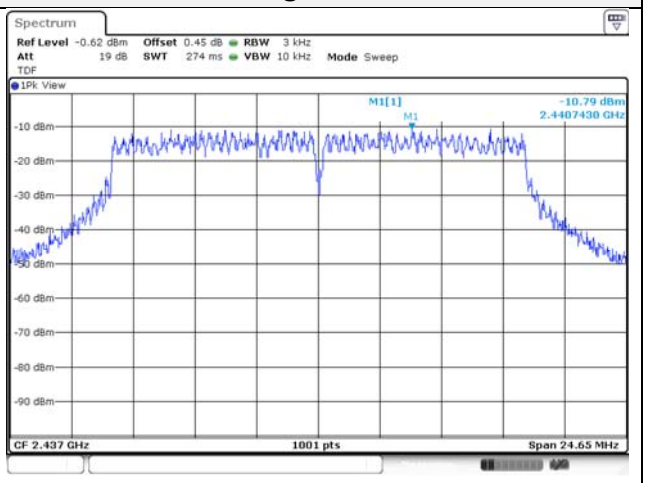
802.11g / 2 412 ㎒



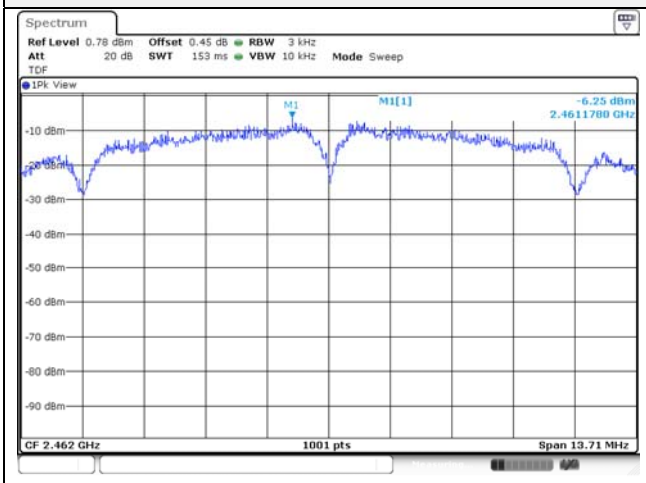
802.11b / 2 437 ㎒



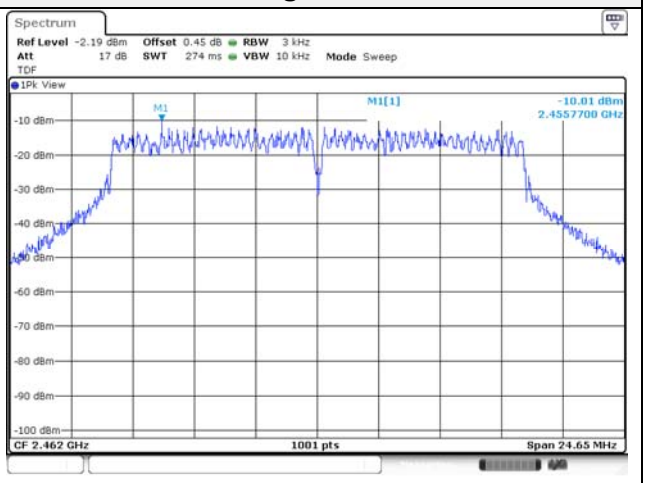
802.11g / 2 437 ㎒



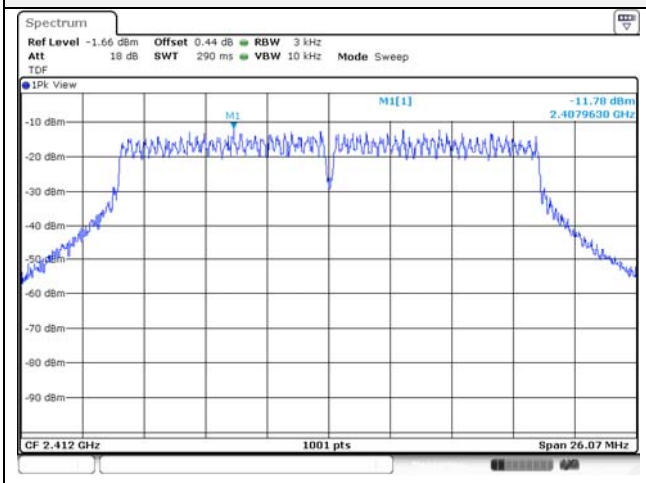
802.11b / 2 462 ㎒



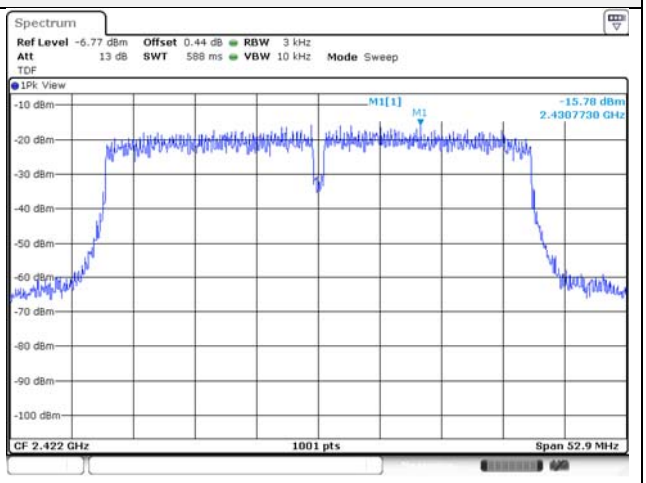
802.11g / 2 462 ㎒



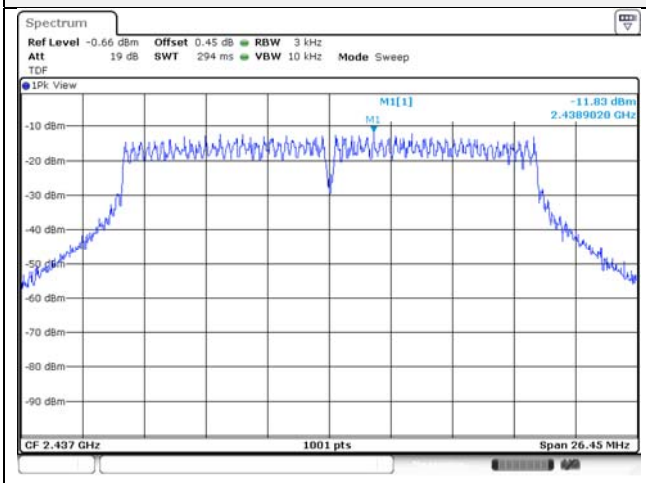
802.11n HT20 / 2 412 ㎒



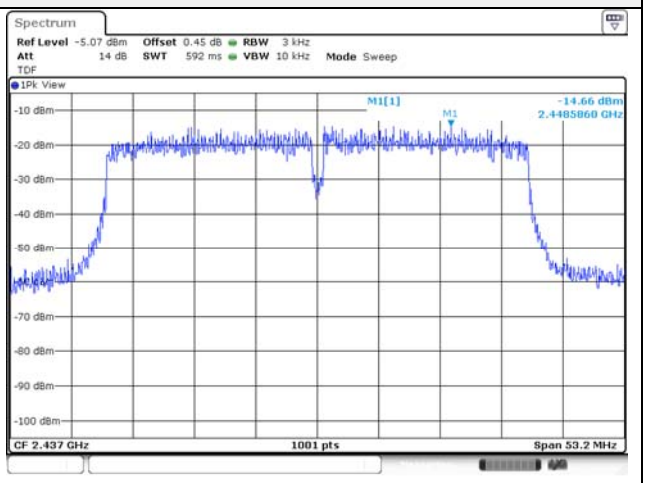
802.11n HT40 / 2 422 ㎒



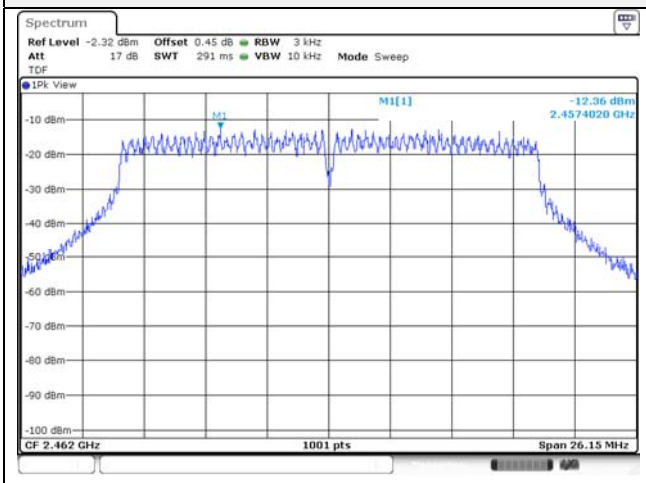
802.11n HT20 / 2 437 ㎒



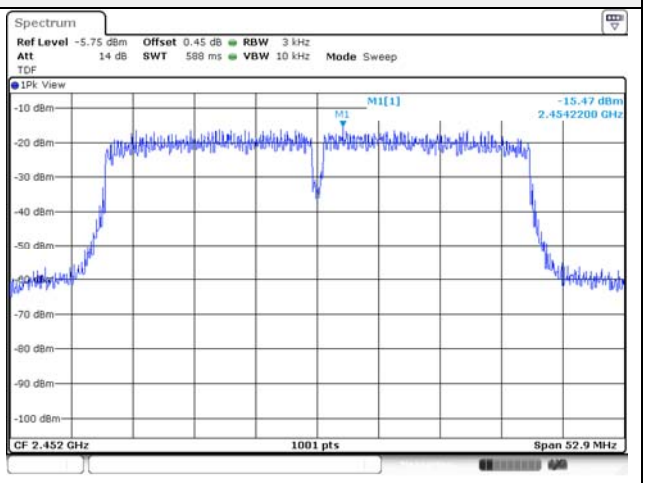
802.11n HT40 / 2 437 ㎒



802.11n HT20 / 2 462 ㎒



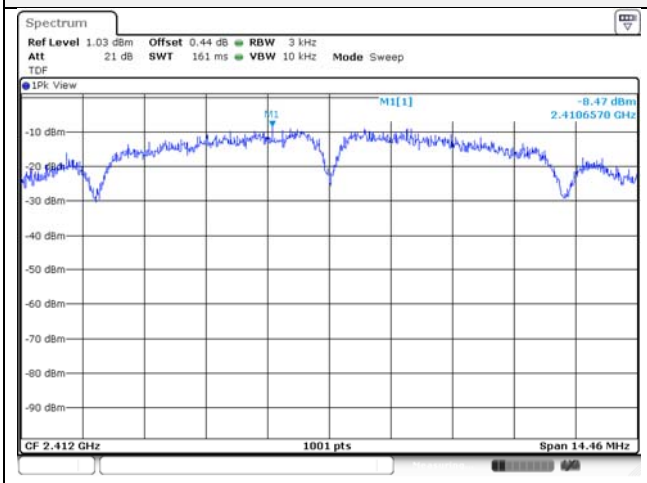
802.11n HT40 / 2 452 ㎒



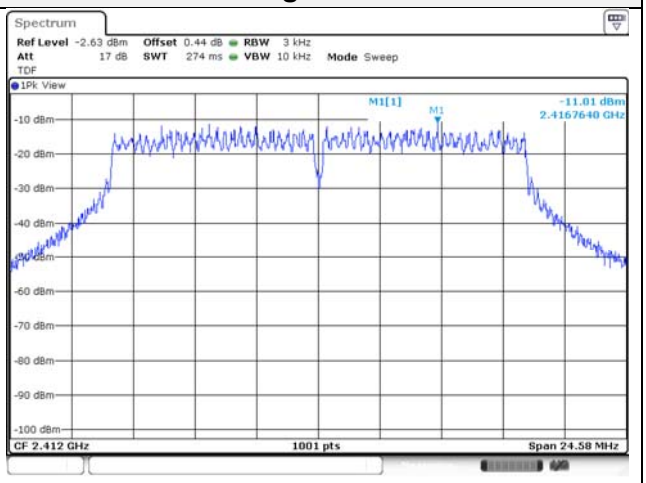
[DC 12 V]

Test mode	Frequency (MHz)	Reading (dBm/ 3kHz)	Limit (dBm/ 3kHz)
802.11b	2 412	-8.47	8.00
	2 437	-7.86	
	2 462	-6.97	
802.11g	2 412	-11.01	
	2 437	-9.81	
	2 462	-11.09	
802.11n HT20	2 412	-12.50	
	2 437	-11.58	
	2 462	-12.45	
802.11n HT40	2 422	-15.14	
	2 437	-14.17	
	2 452	-13.84	

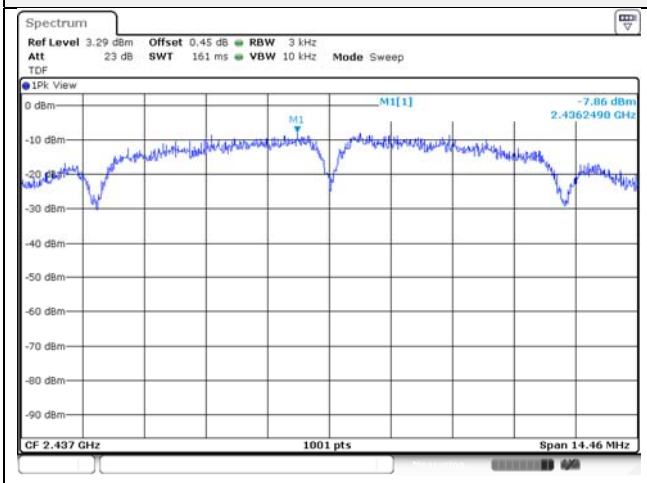
802.11b / 2 412 ㎒



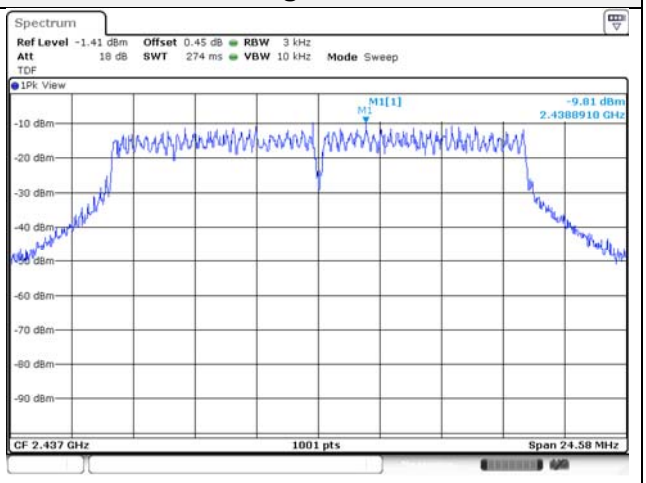
802.11g / 2 412 ㎒



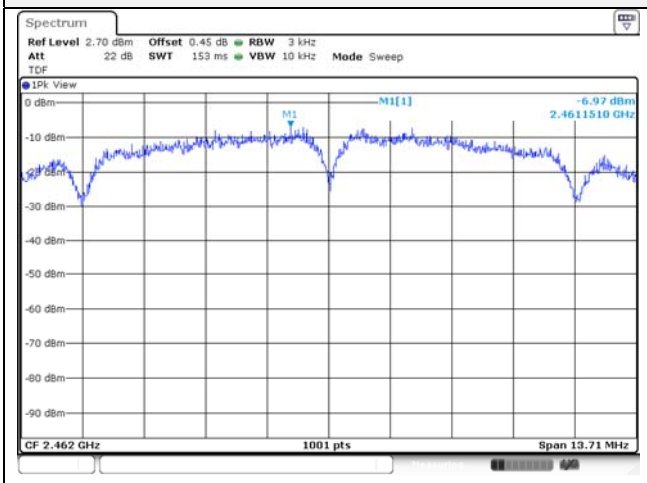
802.11b / 2 437 ㎒



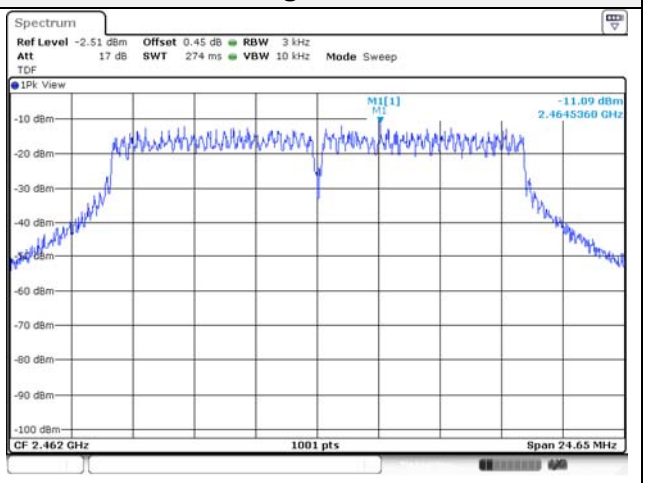
802.11g / 2 437 ㎒



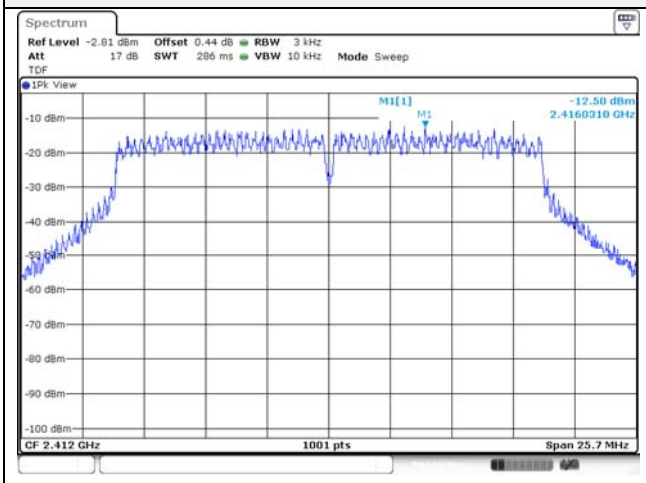
802.11b / 2 462 ㎒



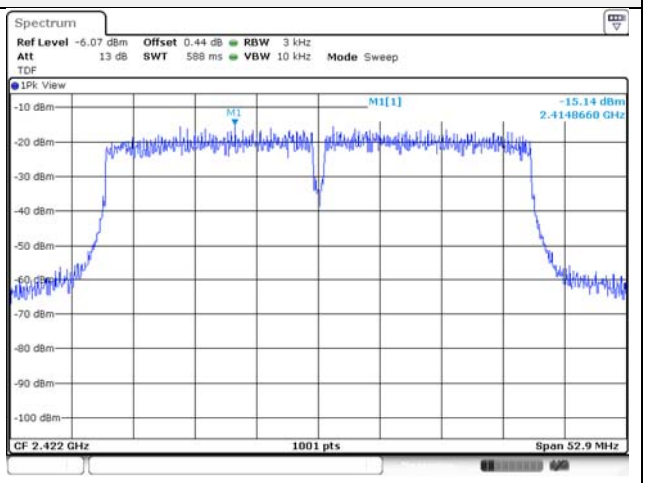
802.11g / 2 462 ㎒



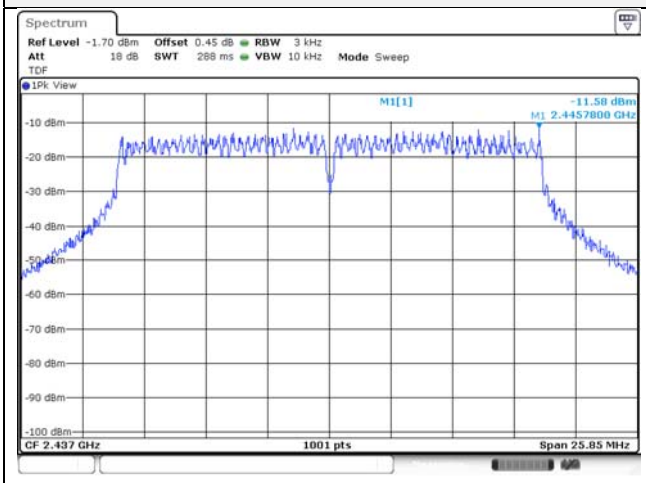
802.11n HT20 / 2 412 ㎒



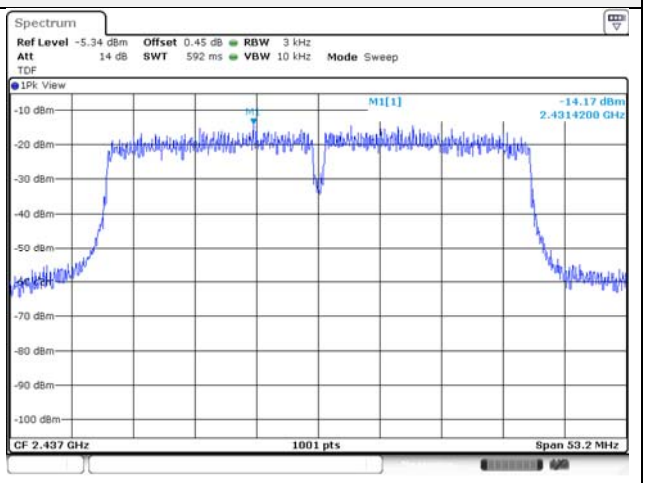
802.11n HT40 / 2 422 ㎒



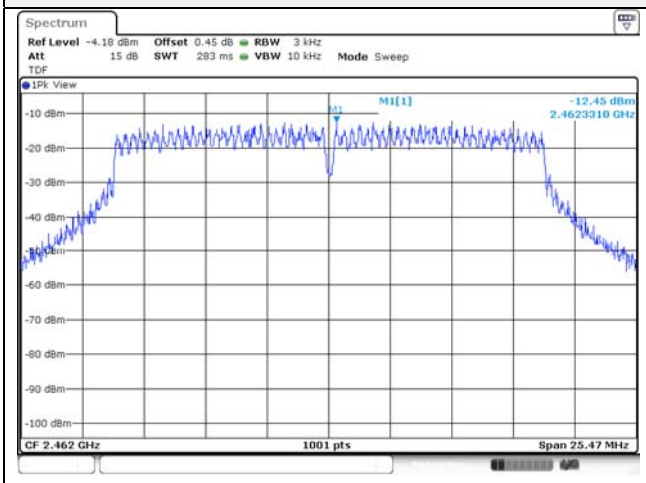
802.11n HT20 / 2 437 ㎒



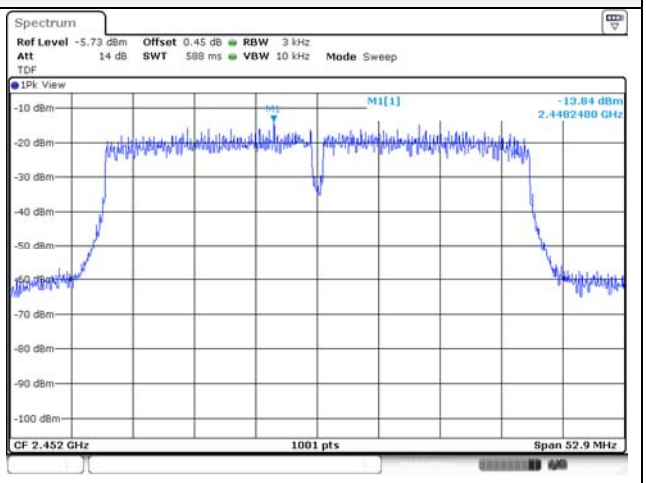
802.11n HT40 / 2 437 ㎒



802.11n HT20 / 2 462 ㎒

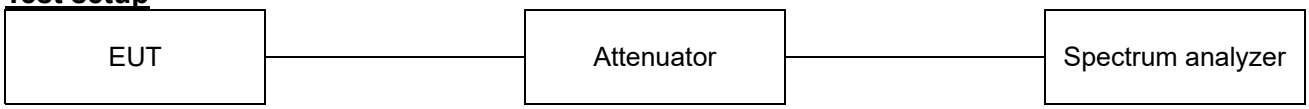


802.11n HT40 / 2 452 ㎒



7.3. 6 dB Bandwidth(DTS Channel Bandwidth) & 99% Bandwidth

Test setup



Limit

According to §15.247(a)(2) and RSS-247(5.2), Systems using digital modulation techniques may operate in the 902–928 ㎒, 2 400–2 483.5 ㎒, and 5 725–5 850 ㎒ bands. The minimum 6 ㏈ bandwidth shall be at least 500 ㎑.

Test procedure

ANSI C63.10 - Section 11.8.2

Test settings

DTS bandwidth

One of the following procedures may be used to determine the modulated DTS bandwidth.

Option 1

1) Set RBW = 100 ㎑.
2) Set the video bandwidth (VBW) ≥ 3 x 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.

Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 ㏈, if the functionality described in 11.8.1 (i.e., RBW = 100 ㎑, VBW ≥ 3 × RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥6 ㏈.

Occupied bandwidth (or 99% emission bandwidth)

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emissions skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted

Notes: it may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms, The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

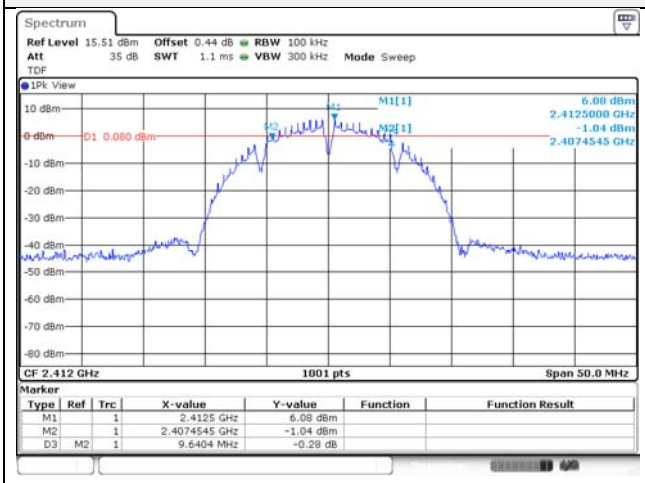
Test results

[DC 5 V]

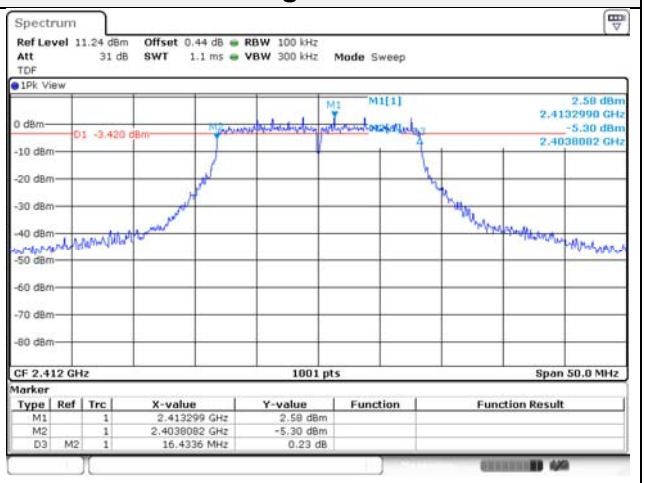
Test mode	Frequency(㎒)	6 ㏈ bandwidth(㎒)	99% bandwidth(㎒)
802.11b	2 412	9.64	14.64
	2 437	8.64	14.64
	2 462	9.14	14.64
802.11g	2 412	16.43	16.58
	2 437	16.43	16.63
	2 462	16.43	16.58
802.11n HT20	2 412	17.38	17.68
	2 437	17.63	17.68
	2 462	17.43	17.68
802.11n HT40	2 422	35.26	35.96
	2 437	35.46	35.86
	2 452	35.26	35.56

6 dB bandwidth

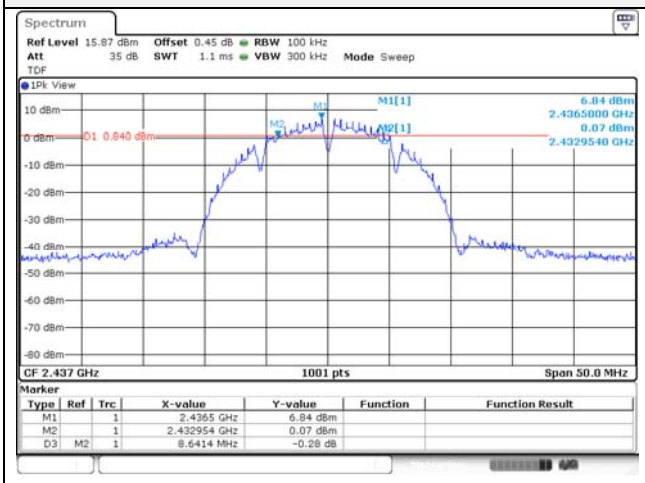
802.11b / 2 412 MHz



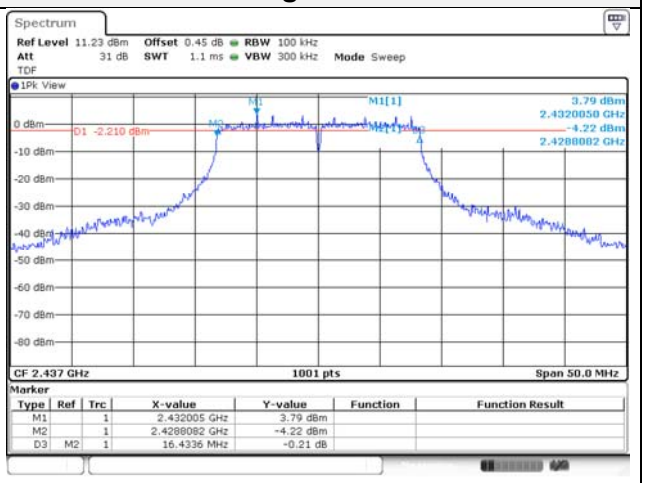
802.11g / 2 412 MHz



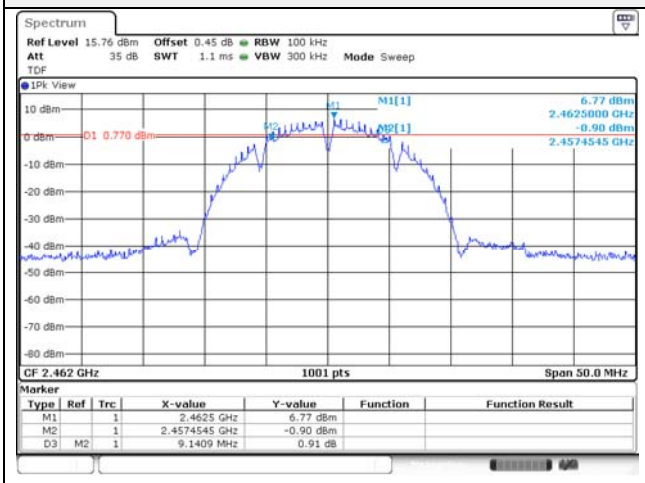
802.11b / 2 437 MHz



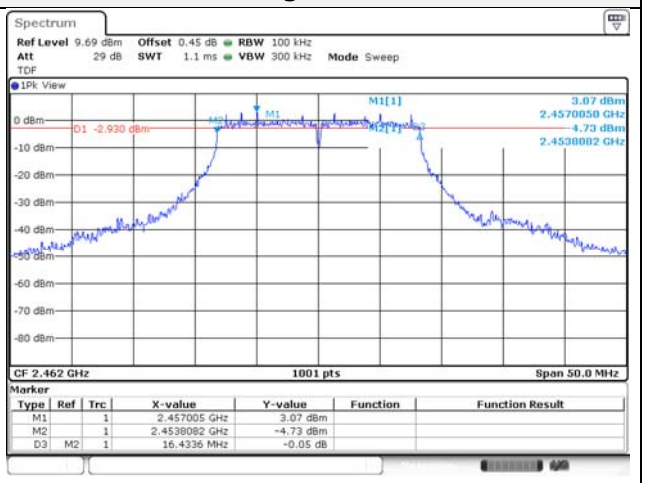
802.11g / 2 437 MHz



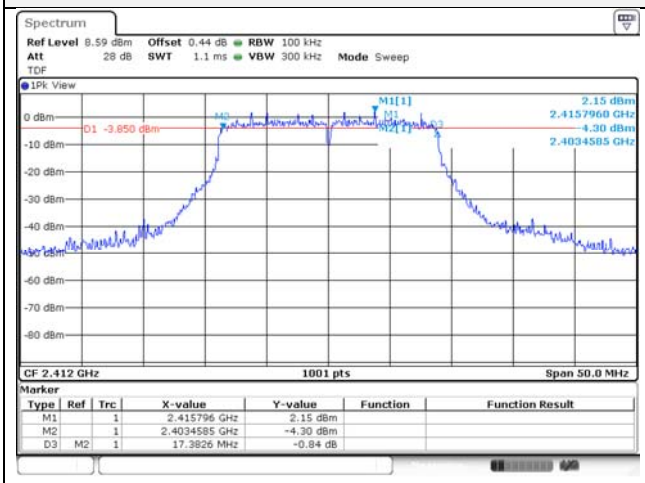
802.11b / 2 462 MHz



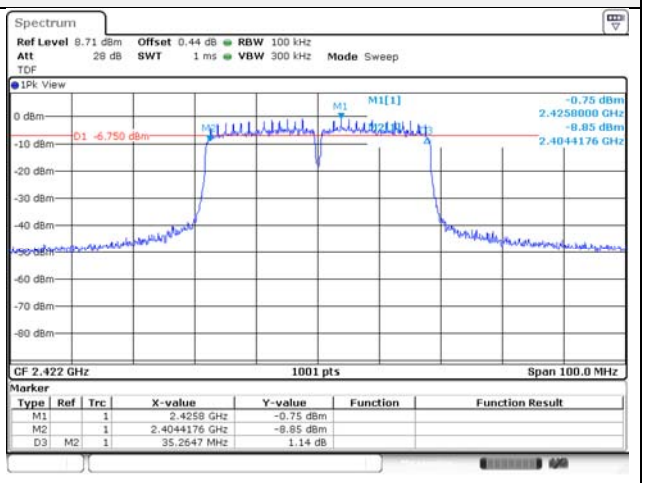
802.11g / 2 462 MHz



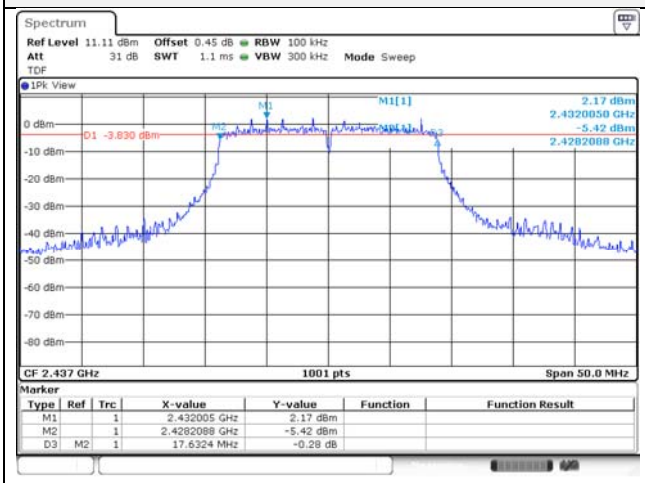
802.11n HT20 / 2 412 ㎒



802.11n HT40 / 2 422 ㎒



802.11n HT20 / 2 437 ㎒



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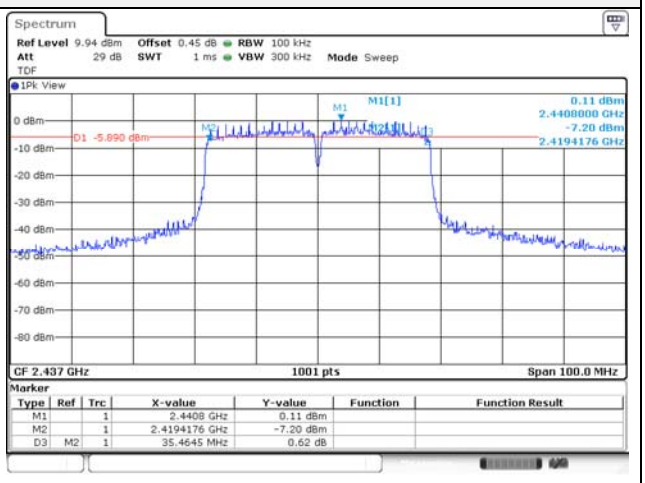
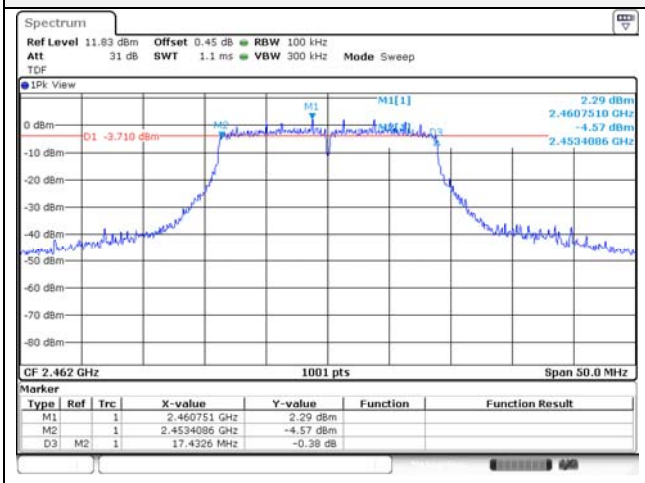
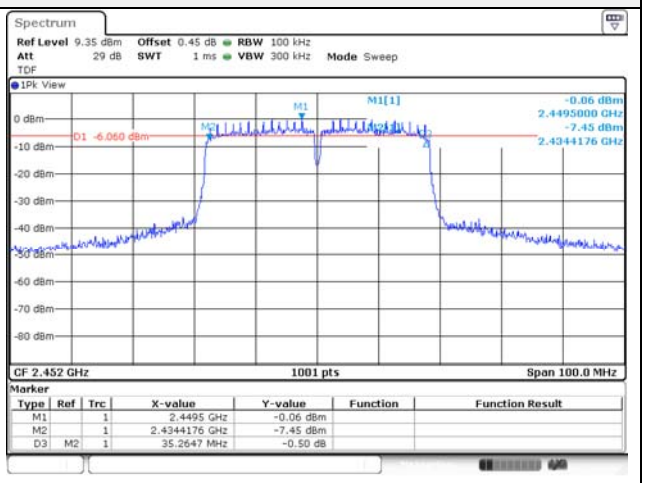


802.11n HT20 / 2 462 ㎒

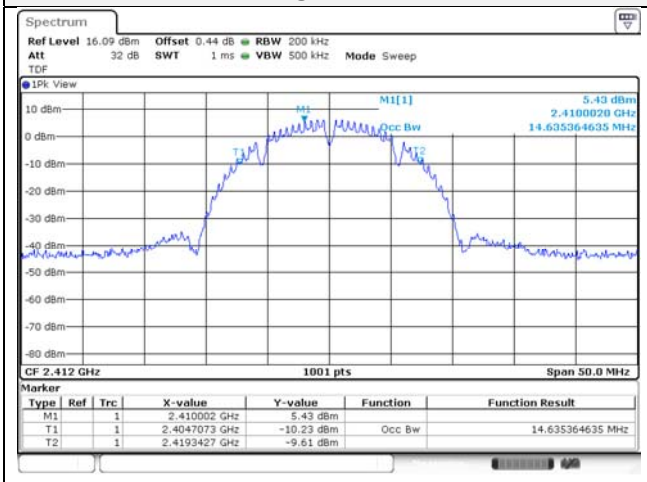


802.11n HT40 / 2 452 ㎒

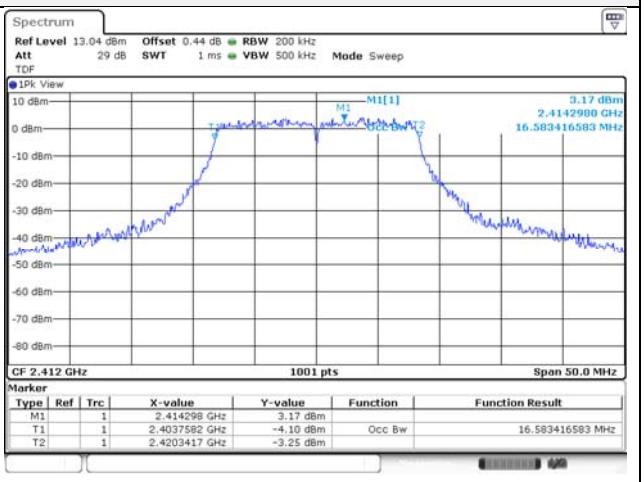


99% bandwidth

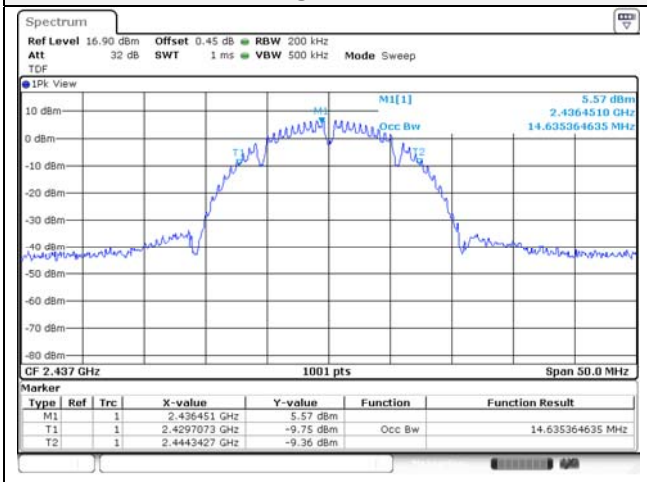
802.11g / 2 412 ㎒



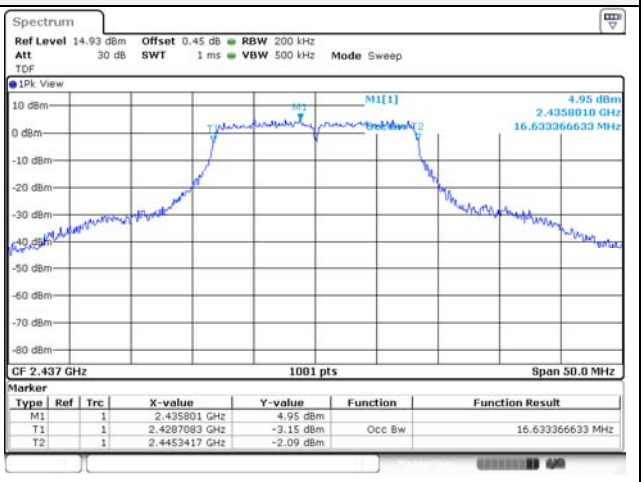
802.11n HT40 / 2 422 ㎒



802.11g / 2 437 ㎒



802.11n HT40 / 2 437 ㎒



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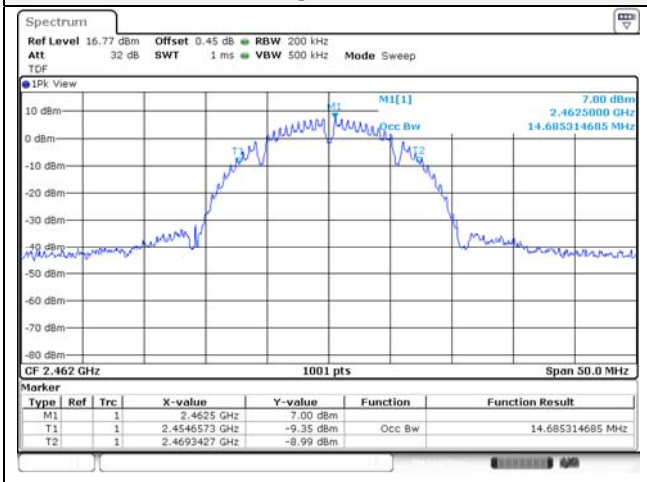

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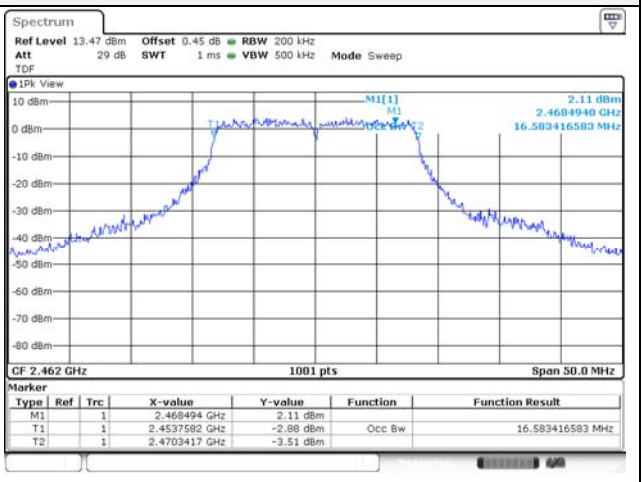

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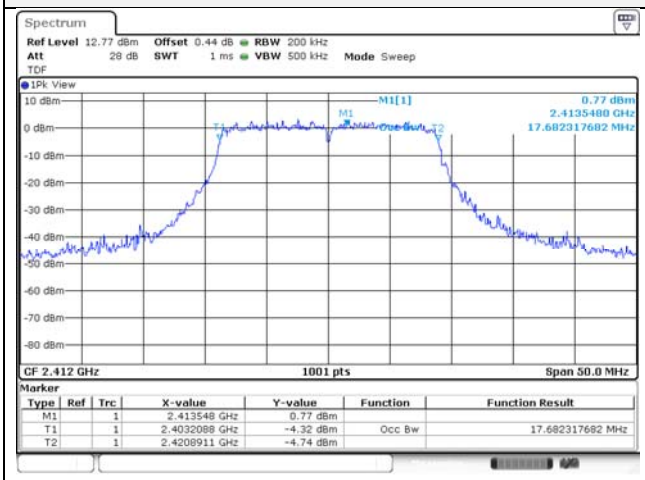

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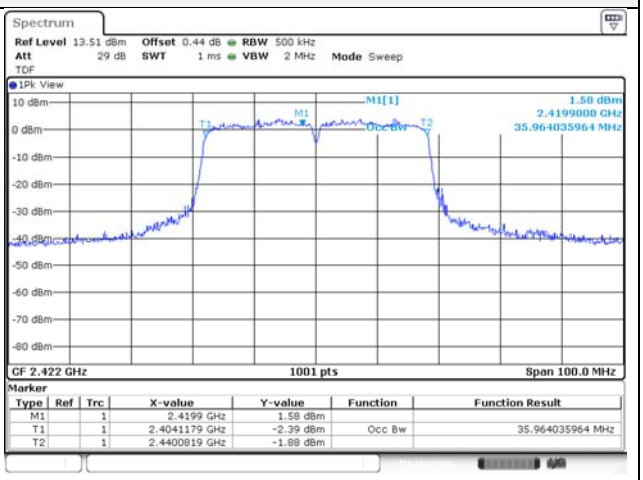
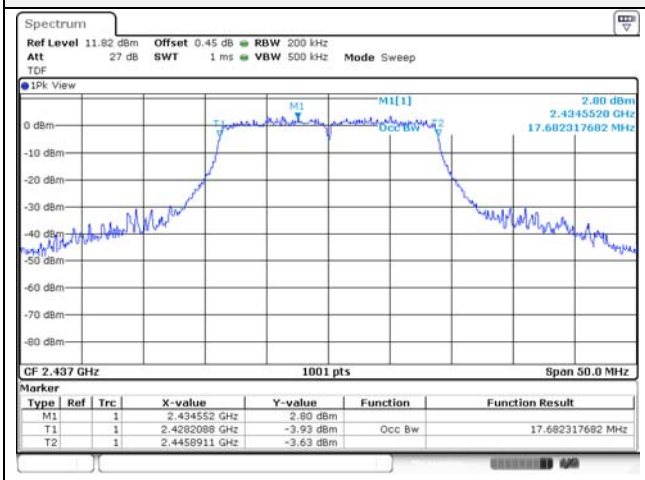
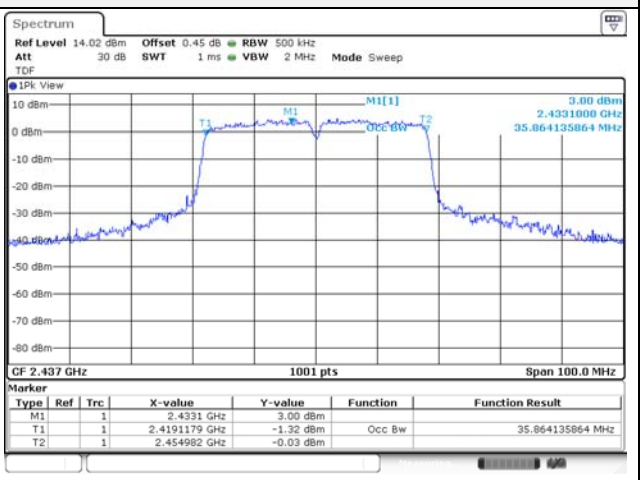


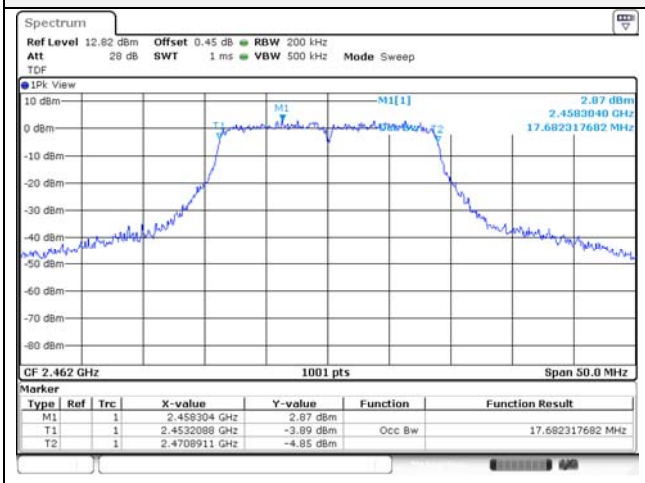
802.11n HT20 / 2 437 ㎒



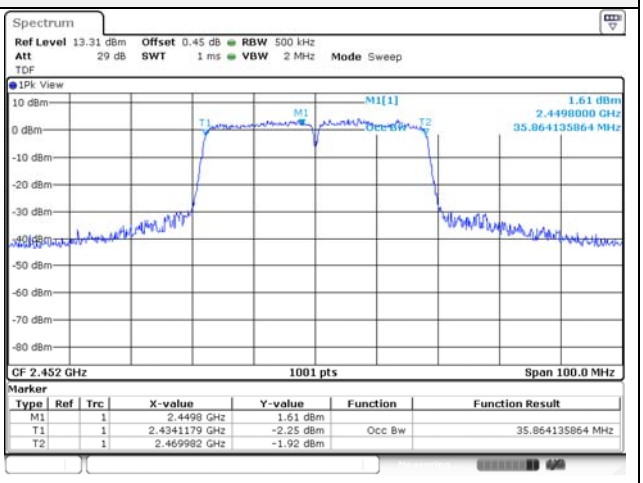
802.11n HT40 / 2 437 ㎒



802.11n HT20 / 2 462 ㎒



802.11n HT40 / 2 452 ㎒

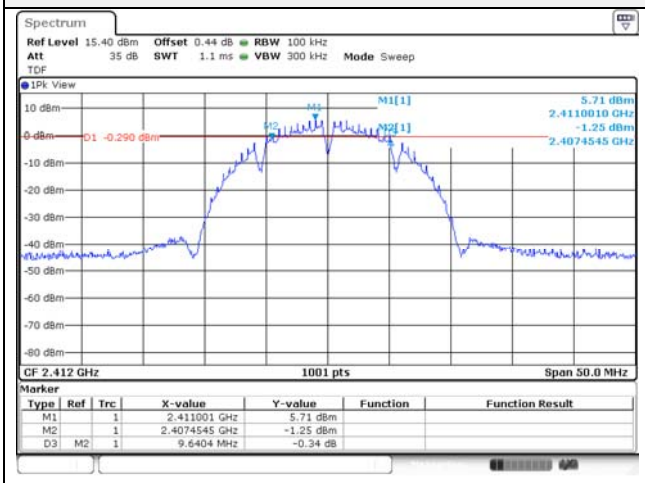


[DC 12 V]

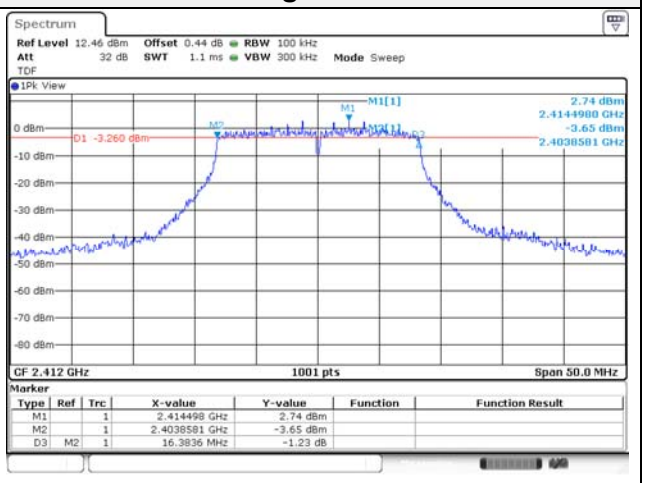
Test mode	Frequency(㎒)	6 ㏈ bandwidth(㎒)	99% bandwidth(㎒)
802.11b	2 412	9.64	14.64
	2 437	9.64	14.64
	2 462	9.14	14.69
802.11g	2 412	16.38	16.58
	2 437	16.38	16.63
	2 462	16.43	16.58
802.11n HT20	2 412	17.13	17.73
	2 437	17.23	17.68
	2 462	16.98	17.68
802.11n HT40	2 422	35.26	35.86
	2 437	35.46	35.86
	2 452	35.26	35.86

6 dB bandwidth

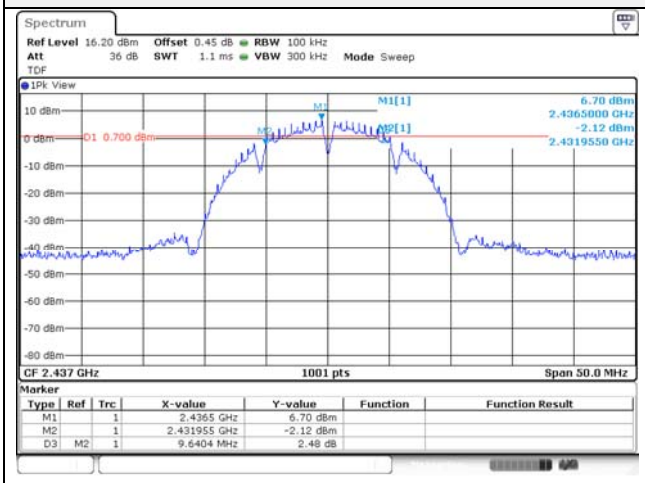
802.11b / 2 412 MHz



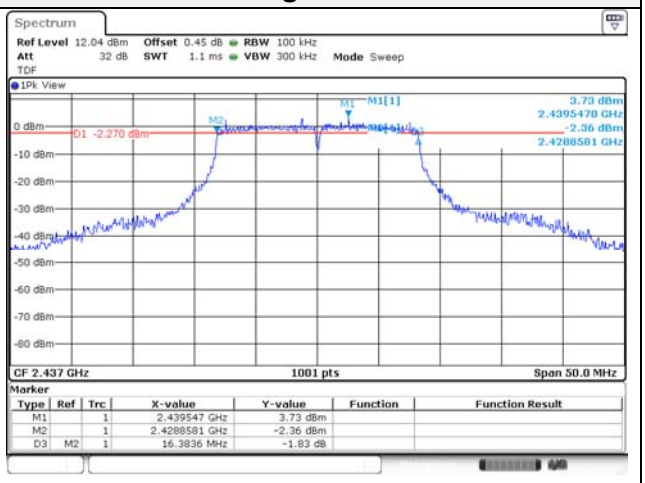
802.11g / 2 412 MHz



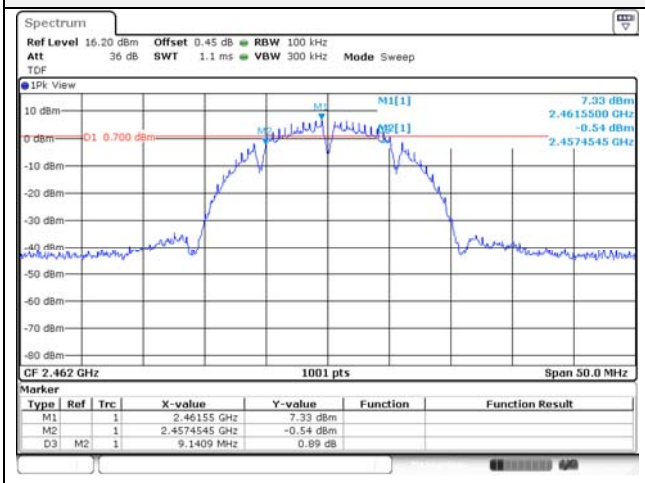
802.11b / 2 437 MHz



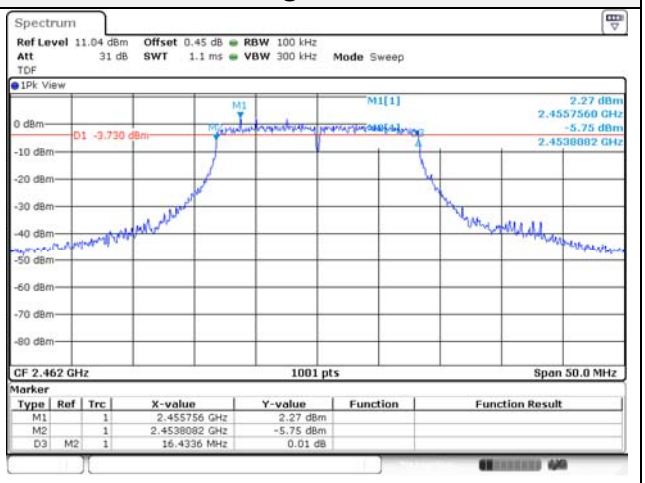
802.11g / 2 437 MHz



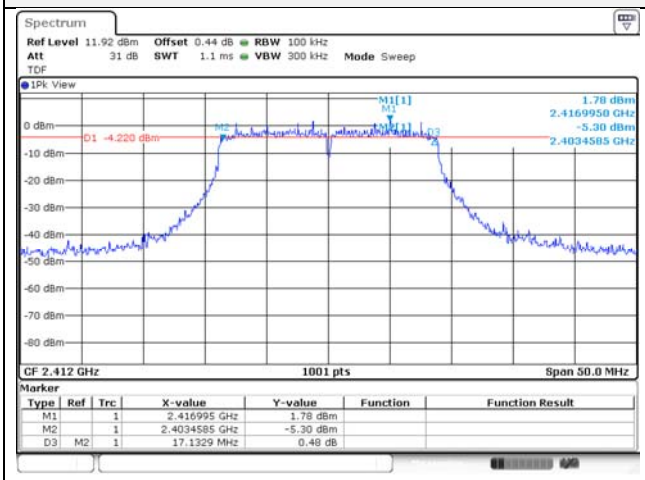
802.11b / 2 462 MHz



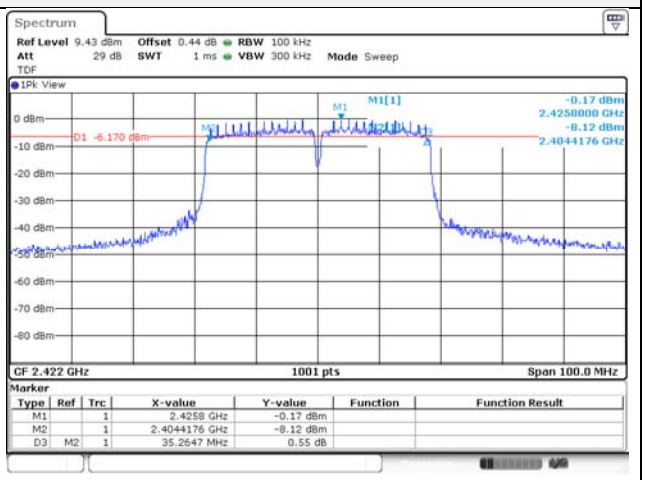
802.11g / 2 462 MHz



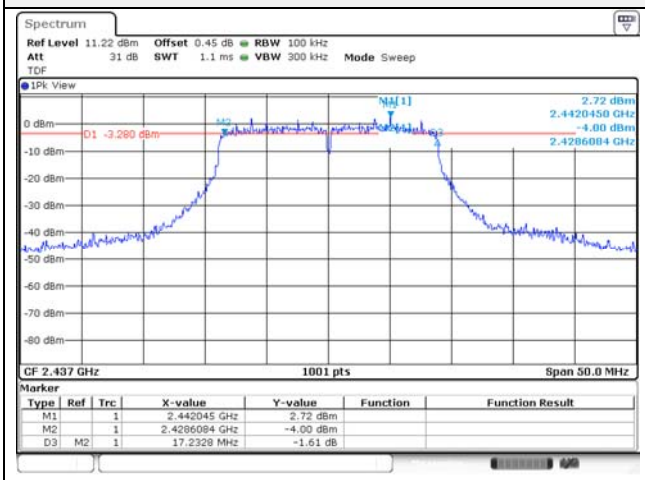
802.11n HT20 / 2 412 ㎒



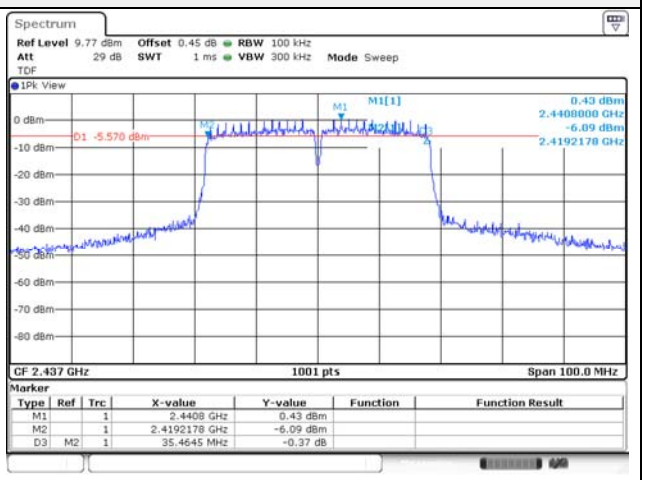
802.11n HT40 / 2 422 ㎒



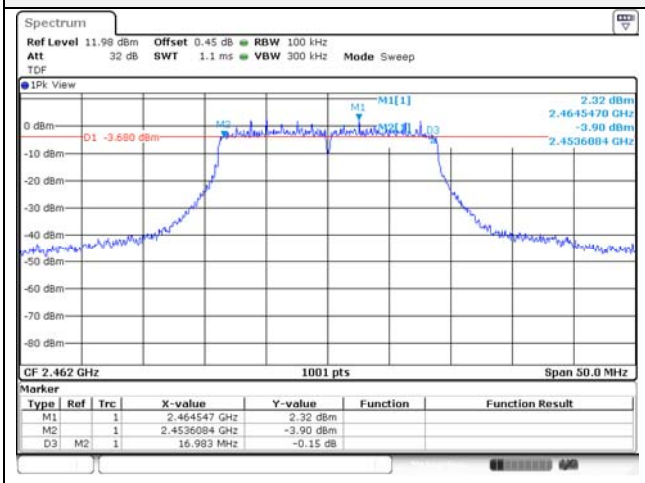
802.11n HT20 / 2 437 ㎒



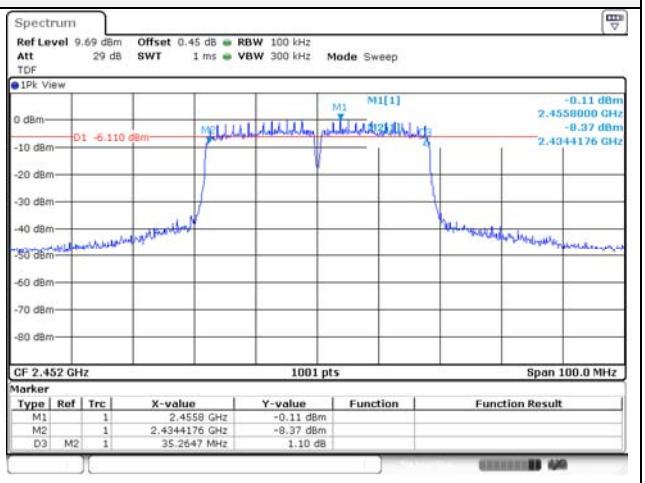
802.11n HT40 / 2 437 ㎒



802.11n HT20 / 2 462 ㎒

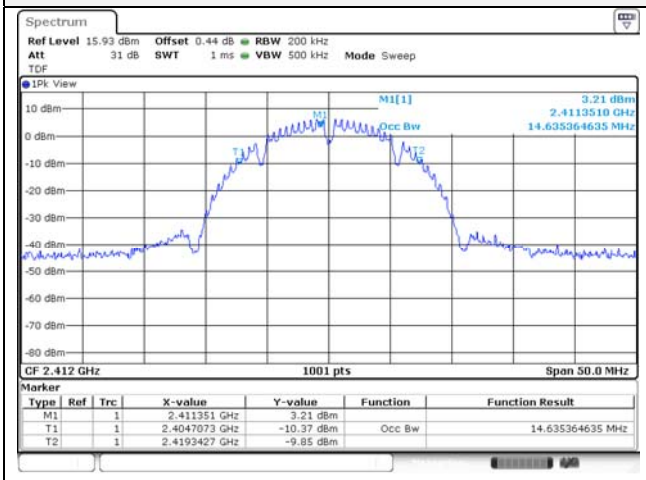


802.11n HT40 / 2 452 ㎒

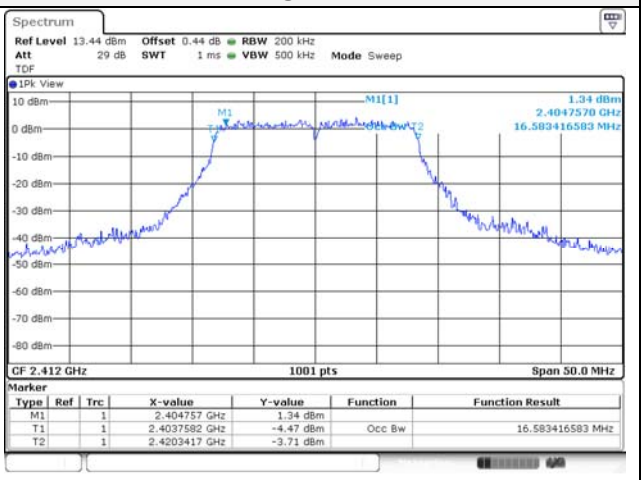


99% bandwidth

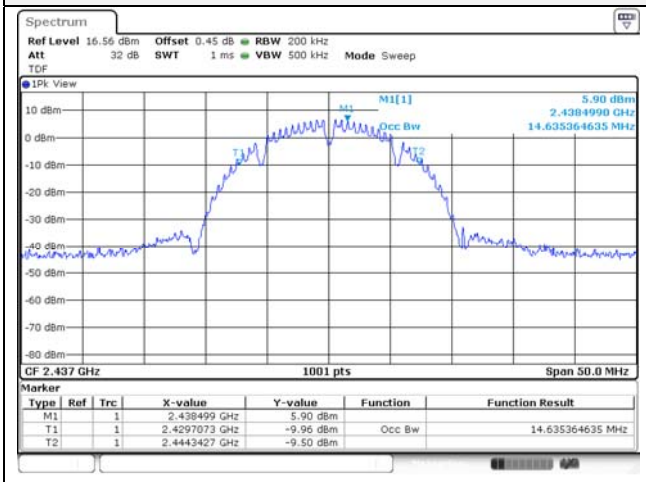
802.11b / 2 412 ㎒



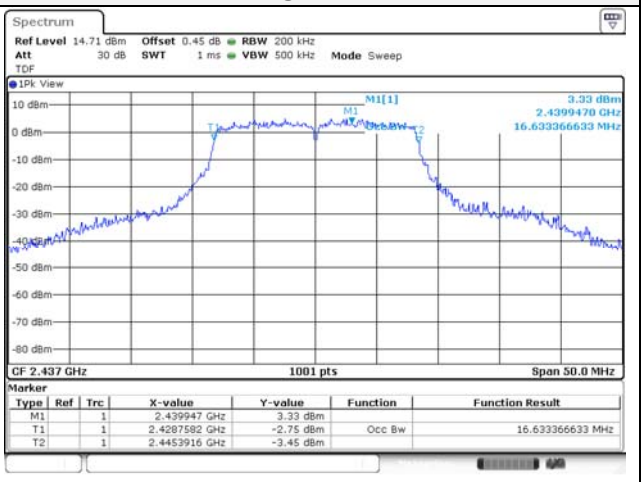
802.11g / 2 412 ㎒



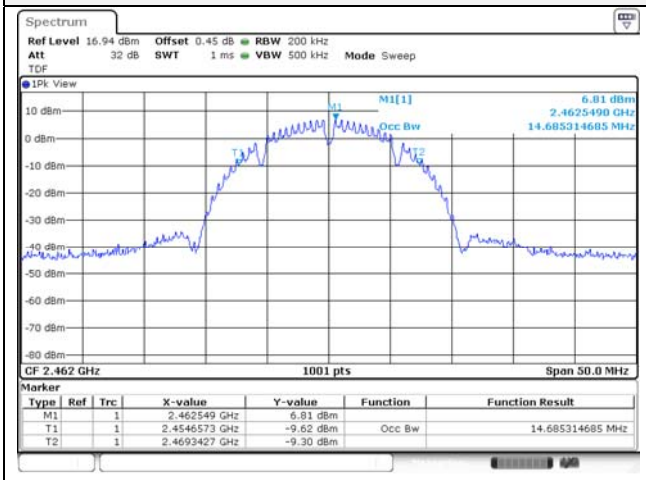
802.11b / 2 437 ㎒



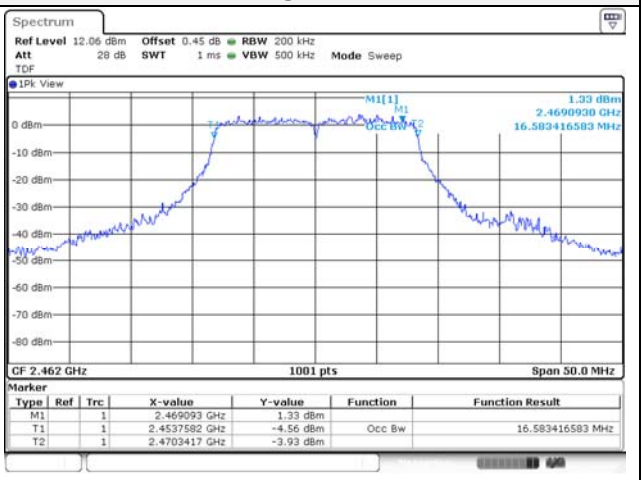
802.11g / 2 437 ㎒



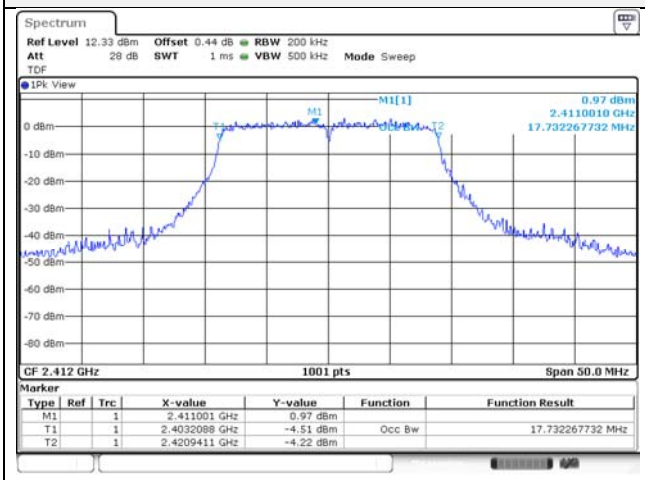
802.11b / 2 462 ㎒



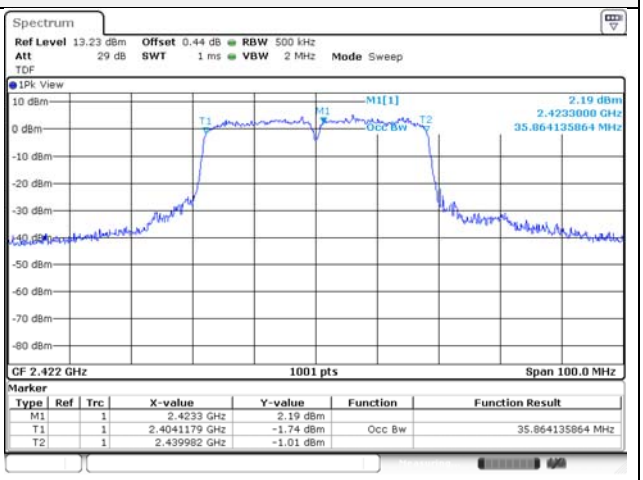
802.11g / 2 462 ㎒



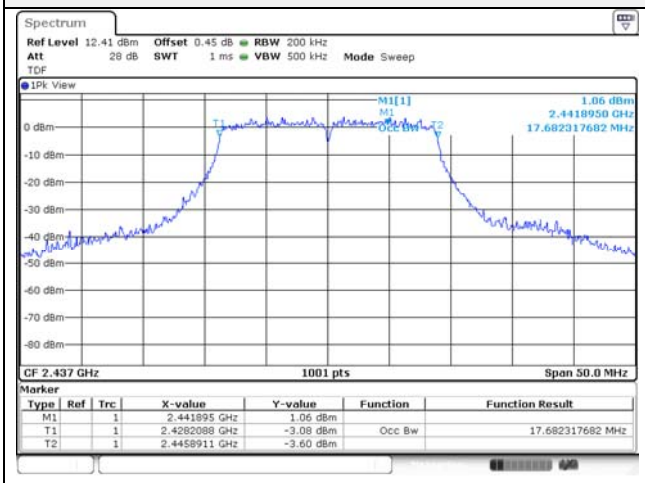
802.11n HT20 / 2 412 ㎒



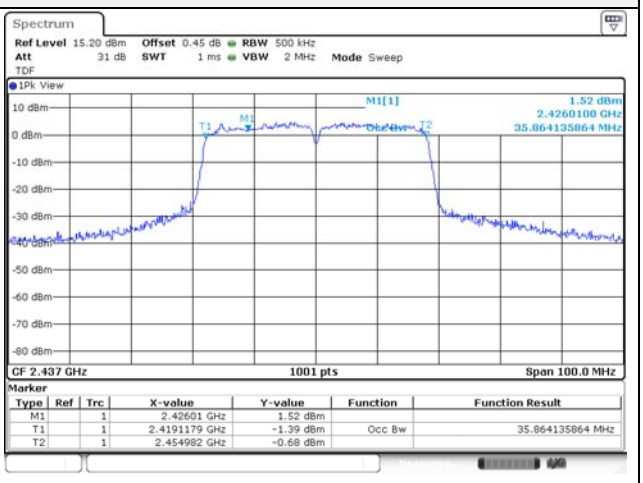
802.11n HT40 / 2 422 ㎒



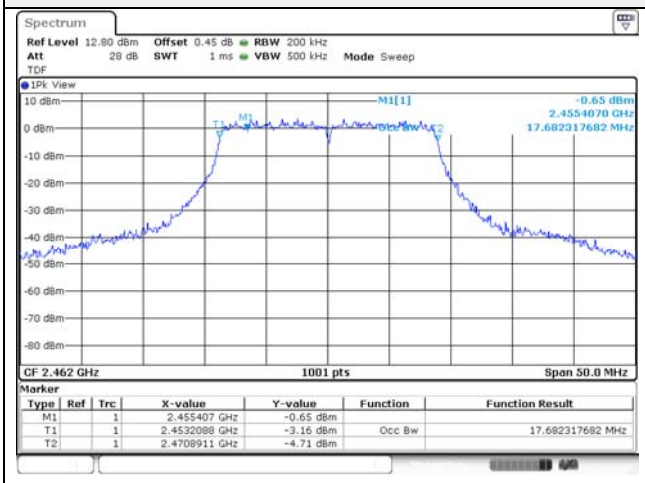
802.11n HT20 / 2 437 ㎒



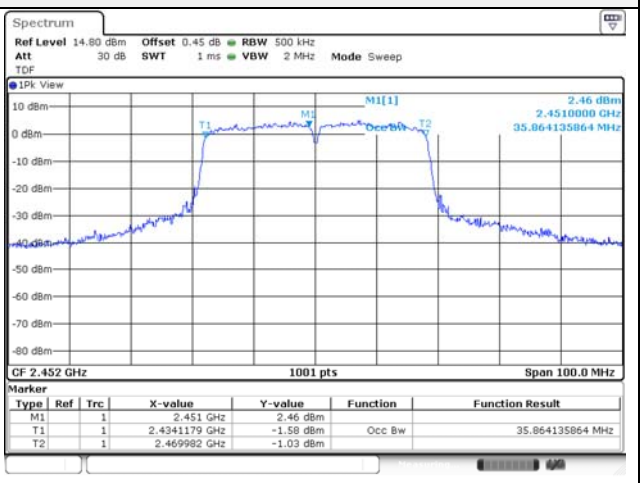
802.11n HT40 / 2 437 ㎒



802.11n HT20 / 2 462 ㎒



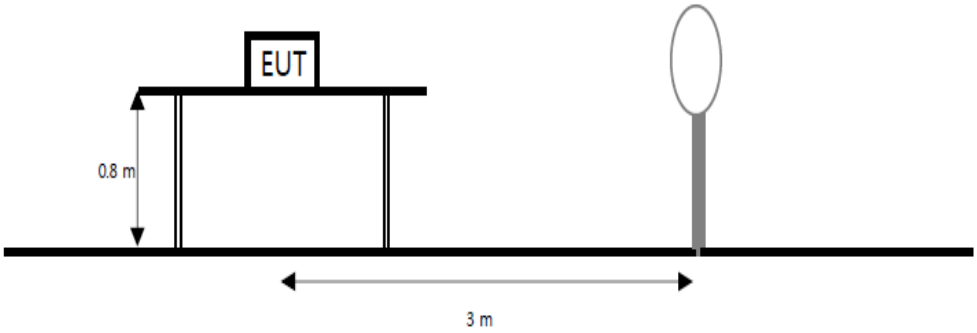
802.11n HT40 / 2 452 ㎒



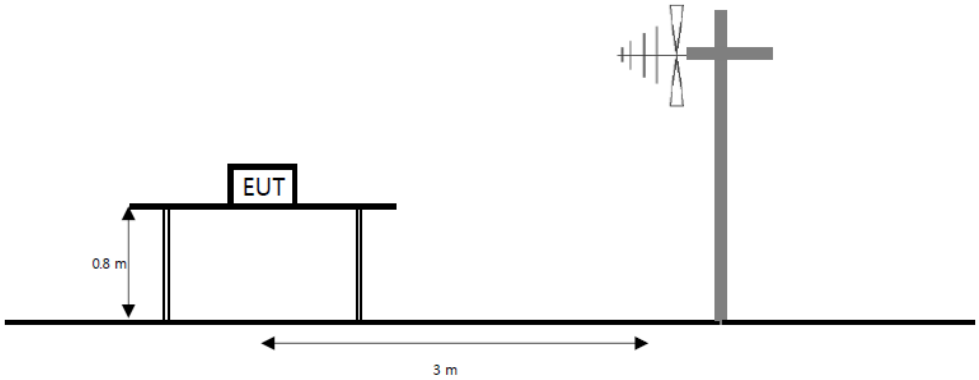
7.4. Spurious Emission, Band Edge and Restricted bands

Test setup

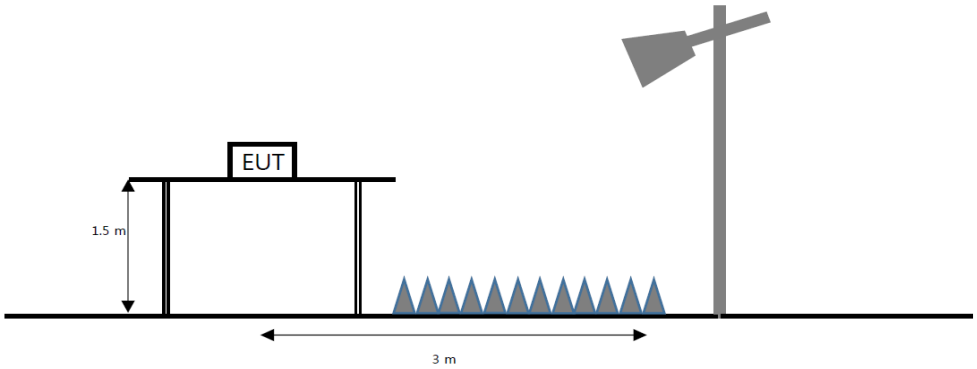
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



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

FCC

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 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75		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.

IC

According to RSS-247(5.5), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

According to RSS-Gen(8.9), Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5- General field strength limits at frequencies above 30 MHz

Frequency(㎒)	Field strength (μV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 6- General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (㎛A/m)	Measurement distance(m)
9 – 490 ㎑ 1)	6.37/F (F in ㎑)	300
490 – 1705 ㎑	63.7/F (F in ㎑)	30
1.705 - 30 ㎒	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

According to RSS-Gen(8.10), Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).
(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.
(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7- Restricted frequency bands*

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Test procedure
ANSI C63.10-2013

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:

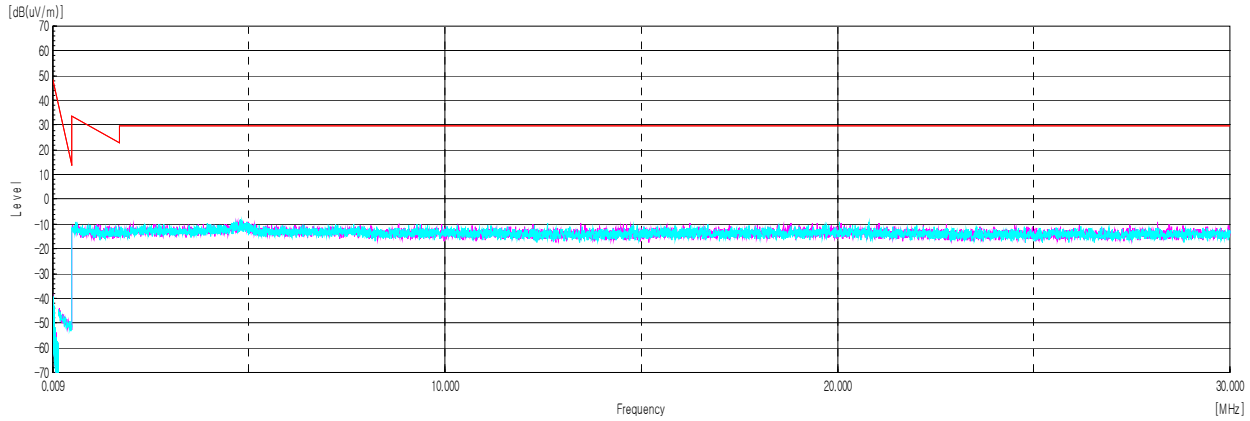
1. *f* <30 MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d= Distance factor in dB
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
2. Factors(dB)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

[DC 5 V]

Test results (Below 30 ㎒) – Worst case: 802.11g mode / 2 437 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. +Cable	Distance Factor	DCF	Result	Limit	Margin
[MHz]	[V/H]	[dB(μV)]	[dB]	[dB]	[dB]	[dB]	[dB(μV/m)]	[dB(μV/m)]	[dB]
No spurious emissions were detected within 20 ㏈ of the limit.									

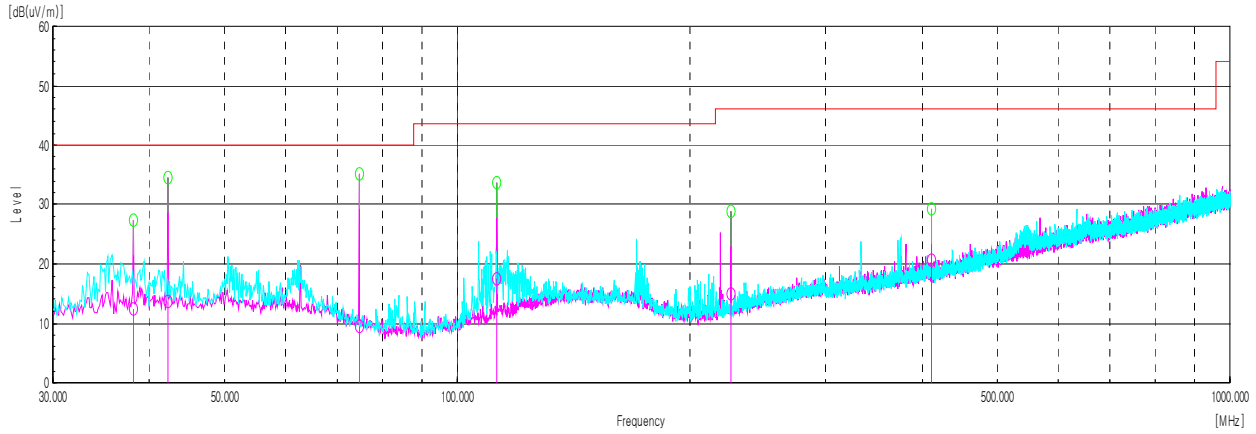
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: 802.11g mode / 2 437 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
38.12[1)]	H	25.4	17.54	-30.56	-	12.38	40.00	27.62
42.25	H	26.2	17.86	-30.44	-	13.62	40.00	26.38
74.74	H	24.1	15.26	-29.84	-	9.52	40.00	30.48
112.69[1)]	H	30.4	16.19	-29.20	-	17.39	43.50	26.11
226.18	H	26.3	16.65	-27.69	-	15.26	46.00	30.74
411.21	H	24.8	21.75	-25.83	-	20.72	46.00	25.28

Horizontal/Vertical

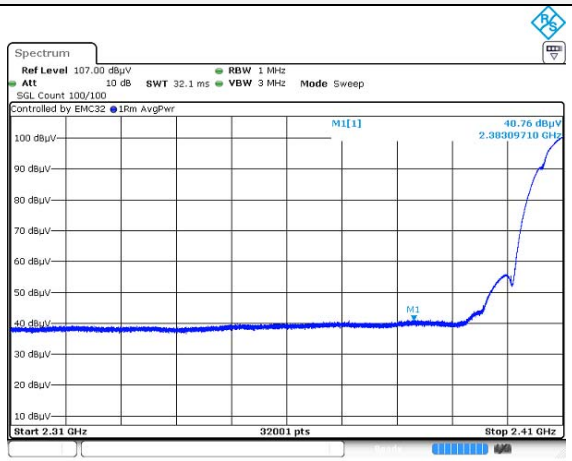


Test results (Above 1 000 ㎒)
802.11b

2 412 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 383.10[1)]	H	56.77	31.99	-27.79	-	60.97	74.00	13.03
3 903.73[1)]	V	69.26	33.02	-54.17	-	48.11	74.00	25.89
4 824.03[1)]	H	68.37	33.79	-52.88	-	49.28	74.00	24.72
7 203.39	V	61.63	35.30	-50.52	-	46.41	74.00	27.59
Average Data								
2 383.10[1)]	H	40.76	31.99	-27.79	-	44.96	54.00	9.04

Average data



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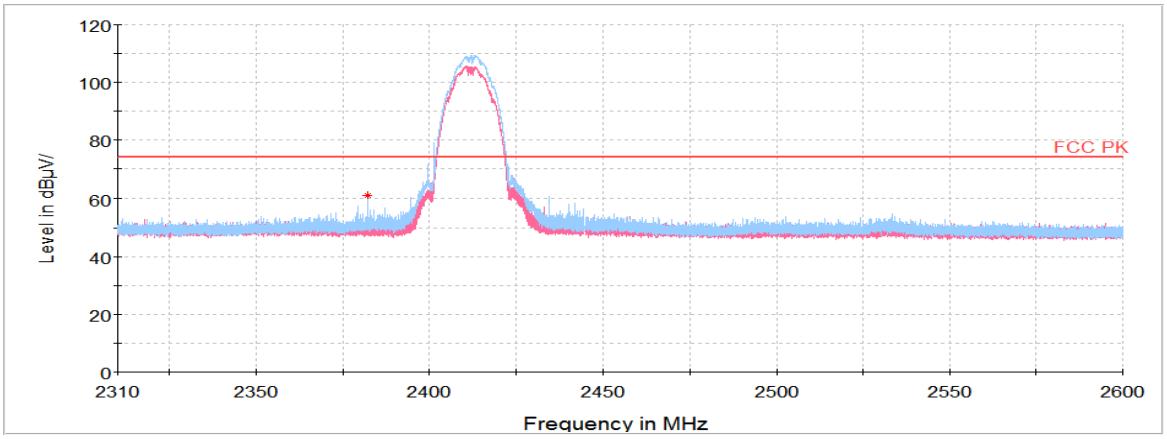
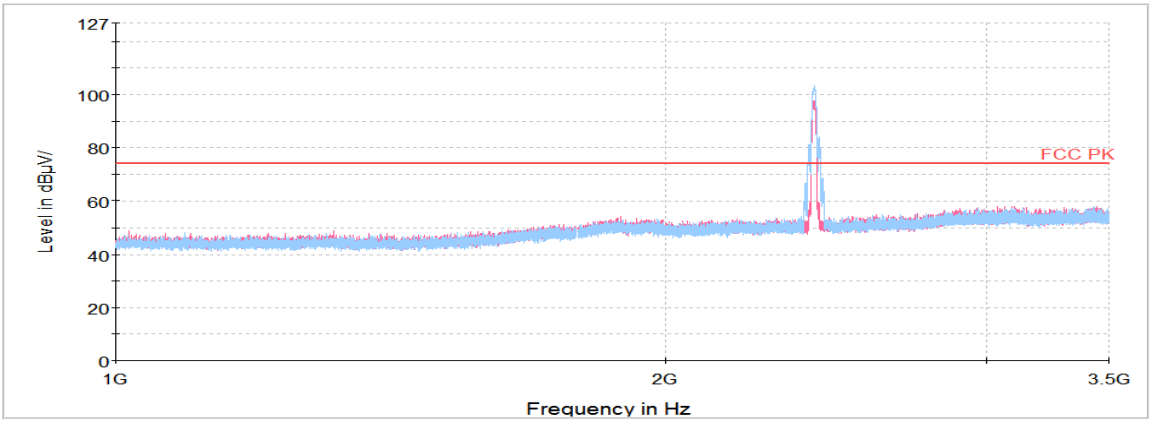
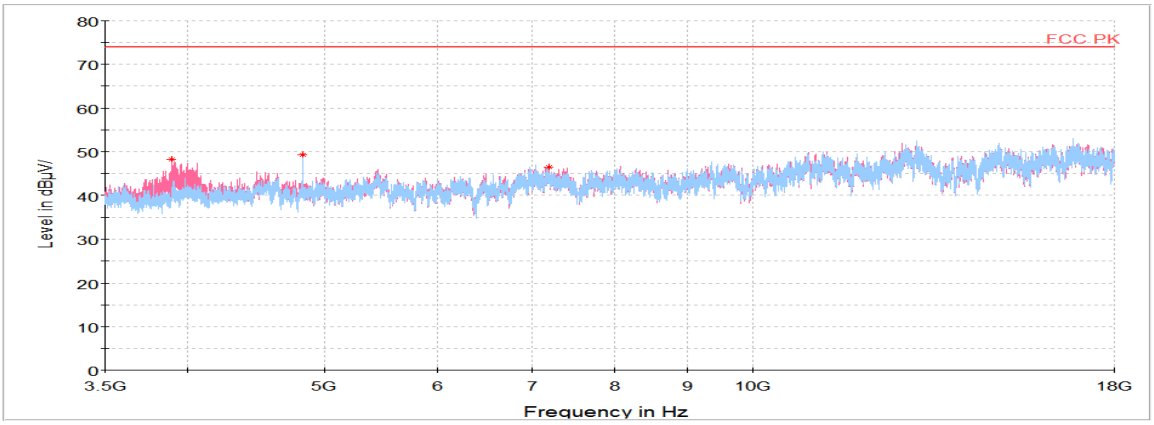
Horizontal/Vertical for Band-edge



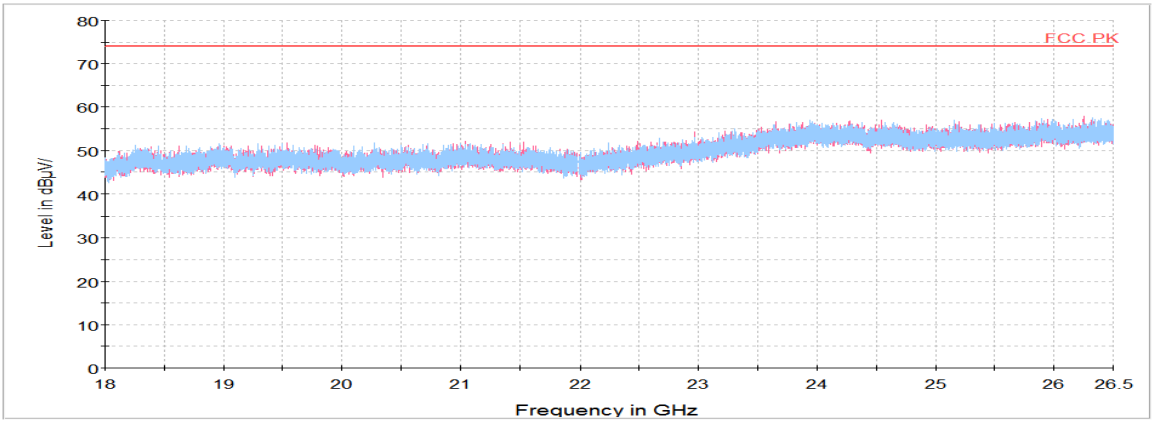
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



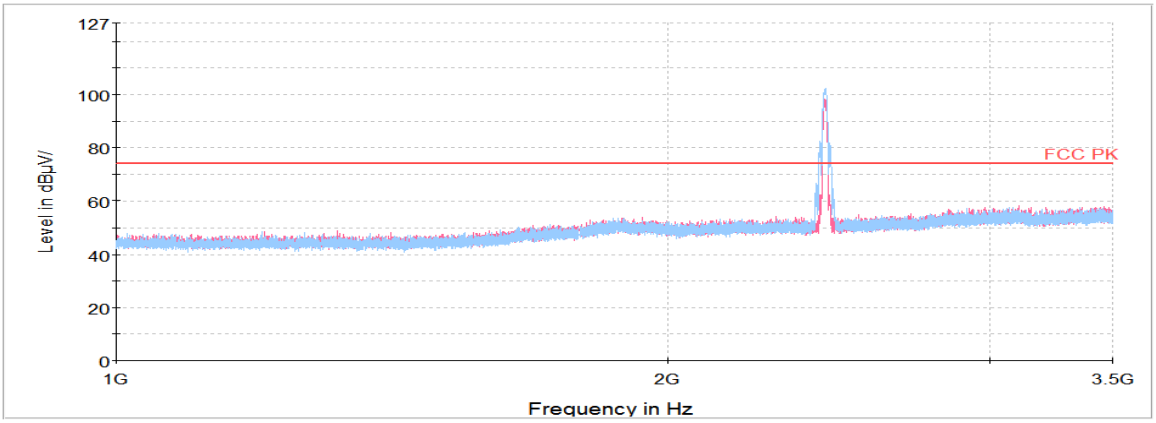
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



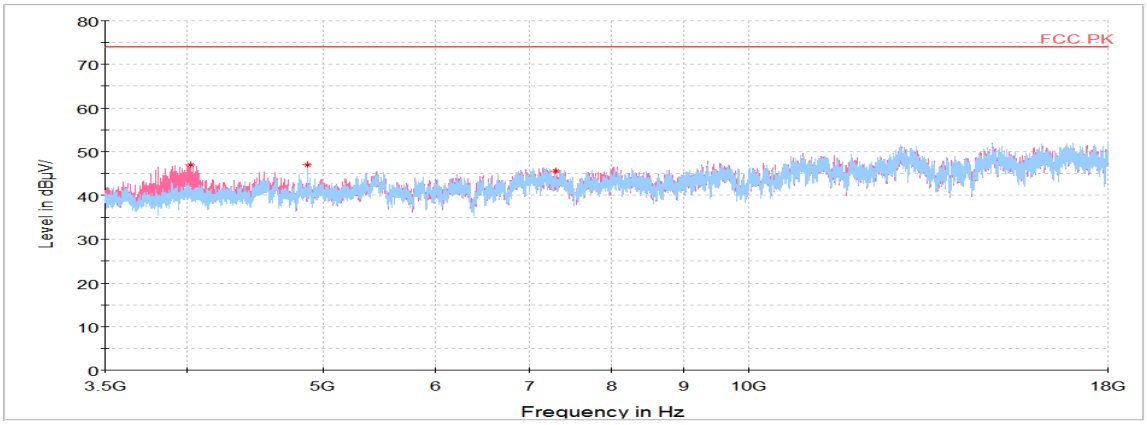
2 437 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
4 022.91[1)]	V	67.47	33.03	-53.59		46.91	74.00	27.09
4 874.33[1)]	H	65.94	33.82	-52.86		46.90	74.00	27.10
7 308.52[1)]	H	61.04	35.30	-50.76		45.58	74.00	28.42
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

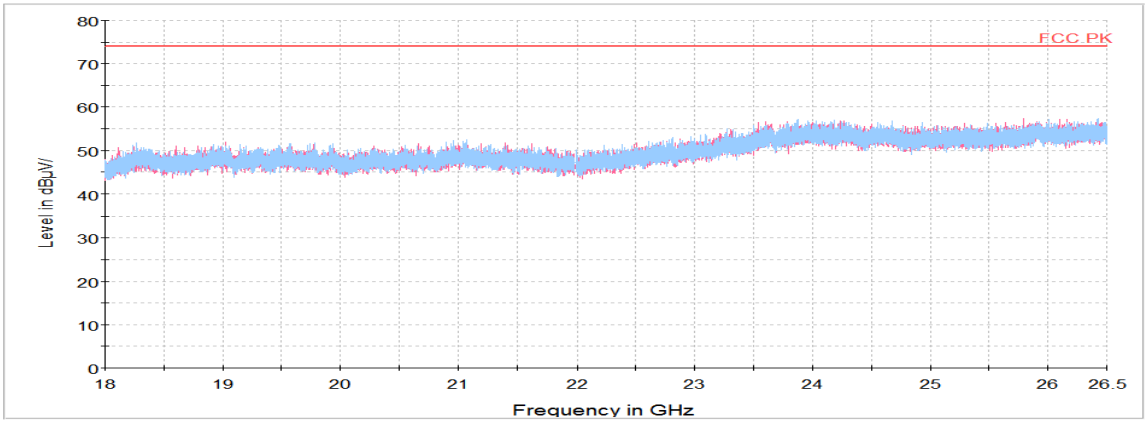
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



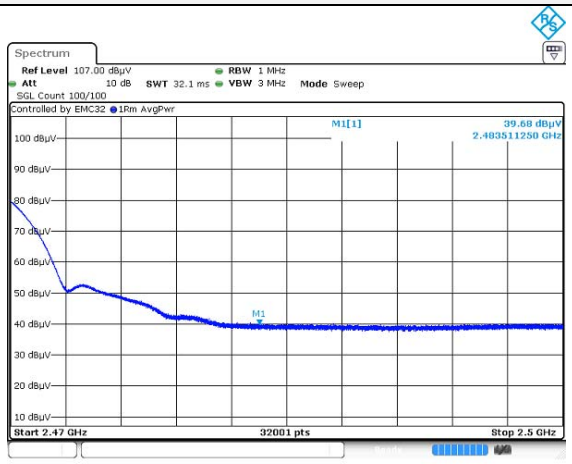
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



2 462 MHz

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 483.51[1)]	H	56.05	32.17	-28.54	-	59.68	74.00	14.32
4 019.73[1)]	V	68.49	33.02	-53.61	-	47.90	74.00	26.10
4 924.17[1)]	H	63.40	33.85	-52.79	-	44.46	74.00	29.54
7 356.55[1)]	V	61.28	35.30	-50.87	-	45.71	74.00	28.29
Average Data								
2 483.51[1)]	H	39.68	32.17	-28.54	-	43.31	54.00	10.69

Average data



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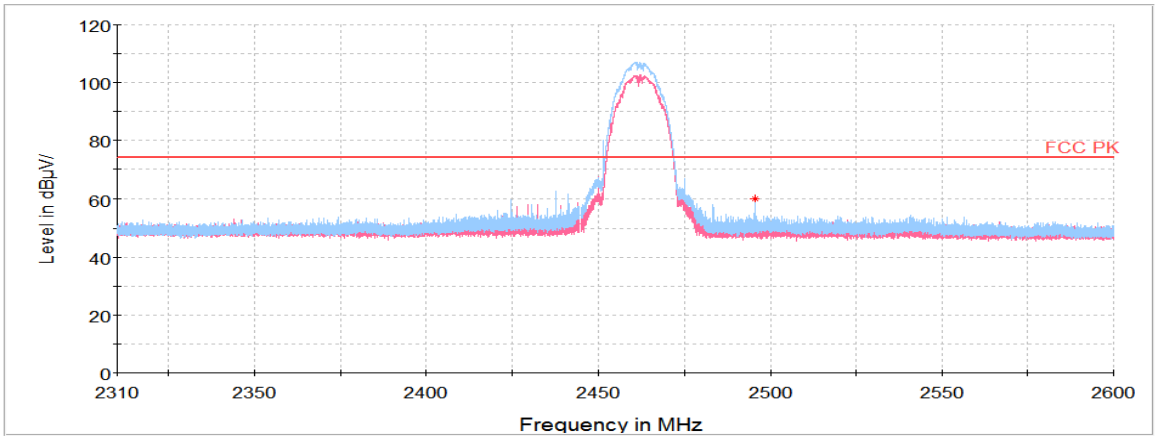
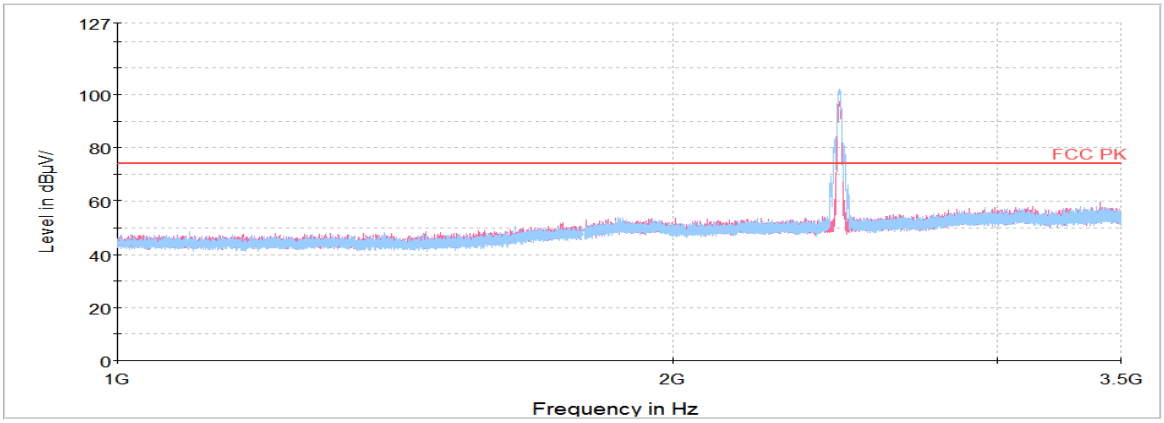
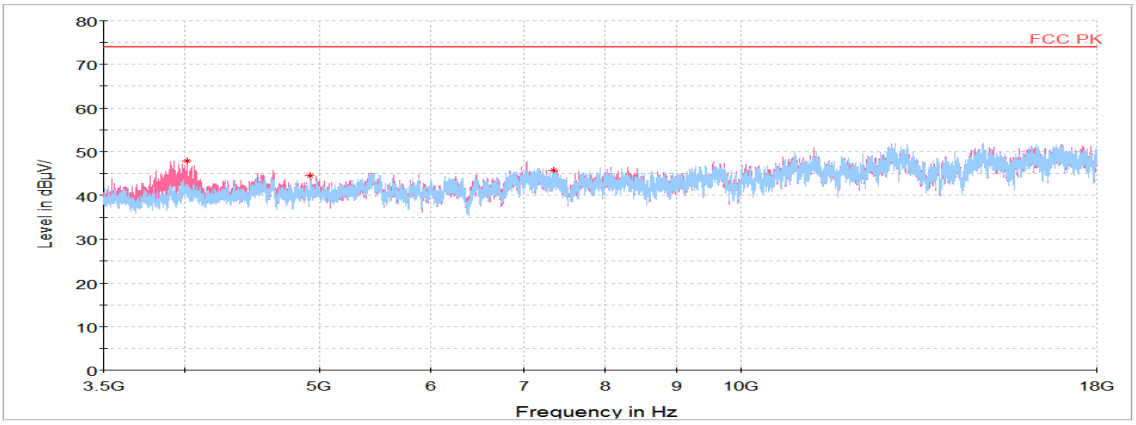
Horizontal/Vertical for Band-edge



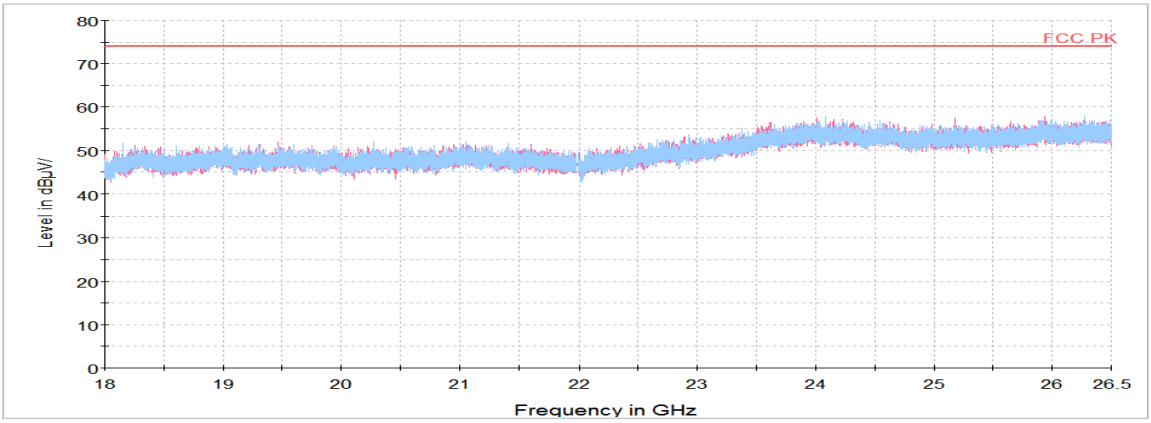
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓

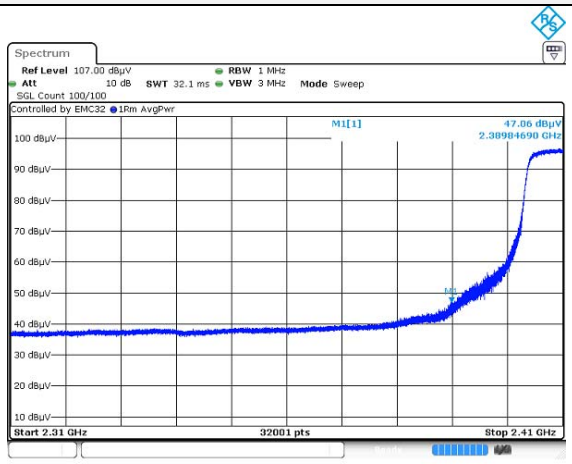


802.11g

2 412 MHz

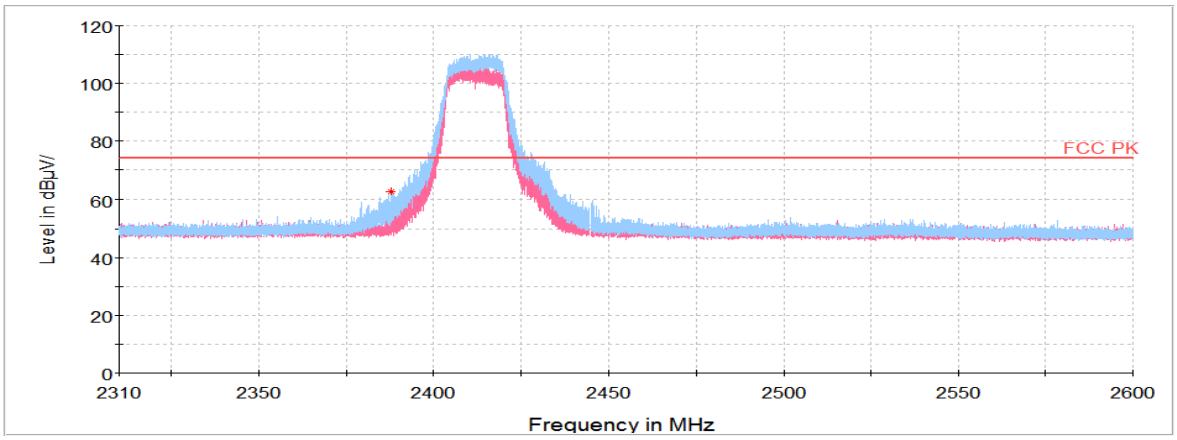
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 389.85[1)]	H	58.31	32.00	-27.79	-	62.52	74.00	11.48
3 907.81[1)]	V	69.62	33.02	-54.15	-	48.49	74.00	25.51
4 820.41[1)]	V	64.26	33.79	-52.88	-	45.17	74.00	28.83
7 241.45	V	61.33	35.30	-50.60	-	46.03	74.00	27.97
Average Data								
2 389.85[1)]	H	47.06	32.00	-27.79	0.27	51.54	54.00	2.46

Average data

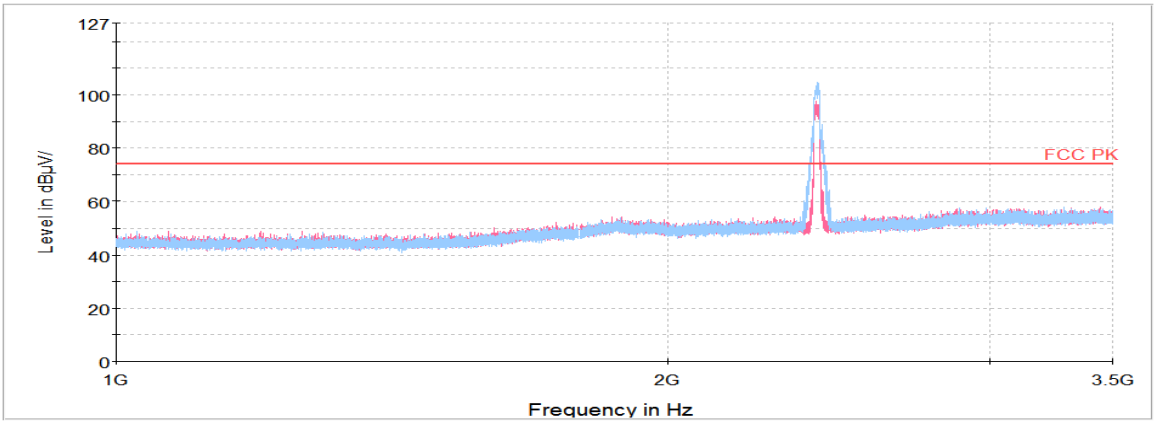


Blank

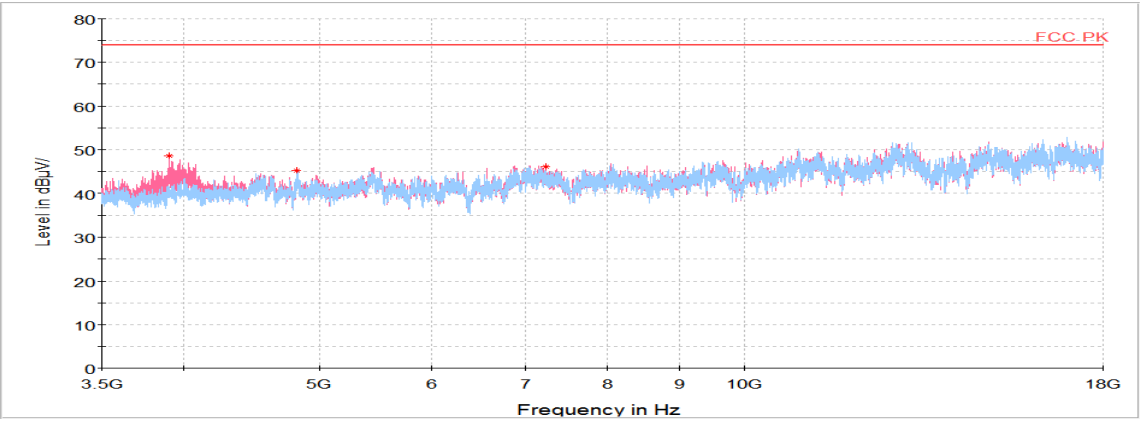
Horizontal/Vertical for Band-edge



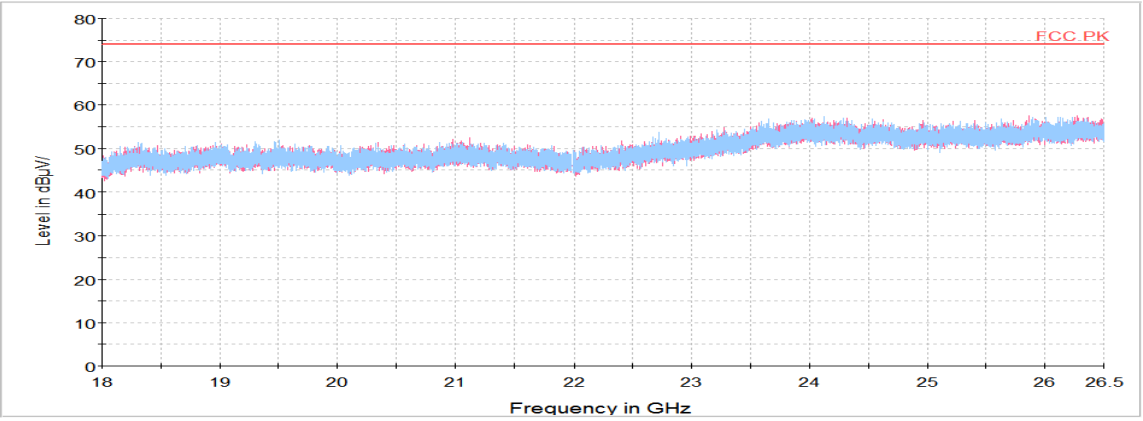
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



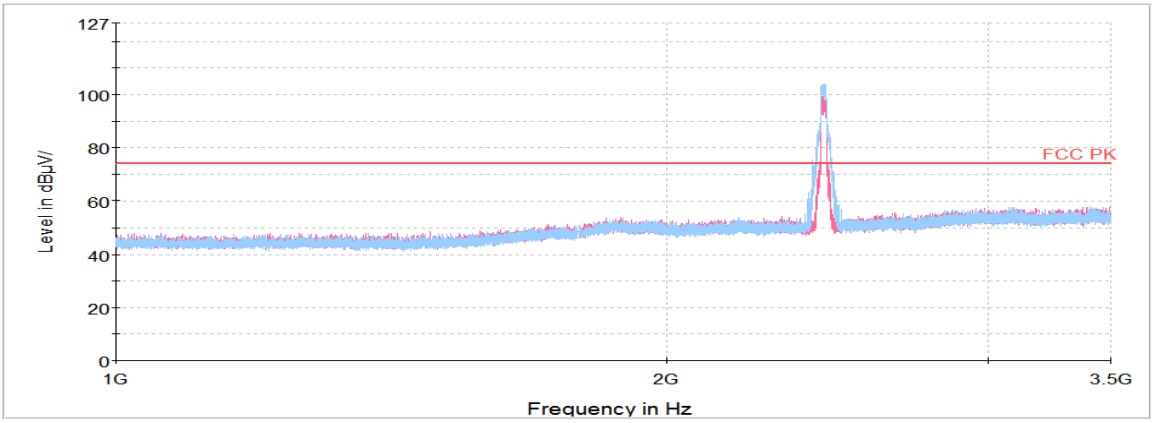
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



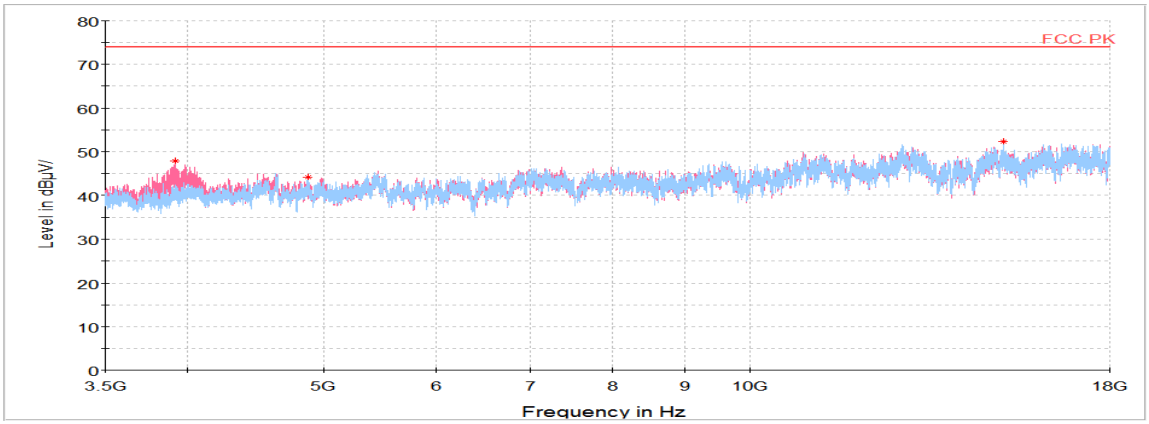
2 437 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
3 920.95[1)]	V	68.89	33.02	-54.09	-	47.82	74.00	26.18
4 871.61[1)]	H	63.06	33.82	-52.87	-	44.01	74.00	29.99
15 125.38	H	57.14	40.17	-44.97	-	52.34	74.00	21.66
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

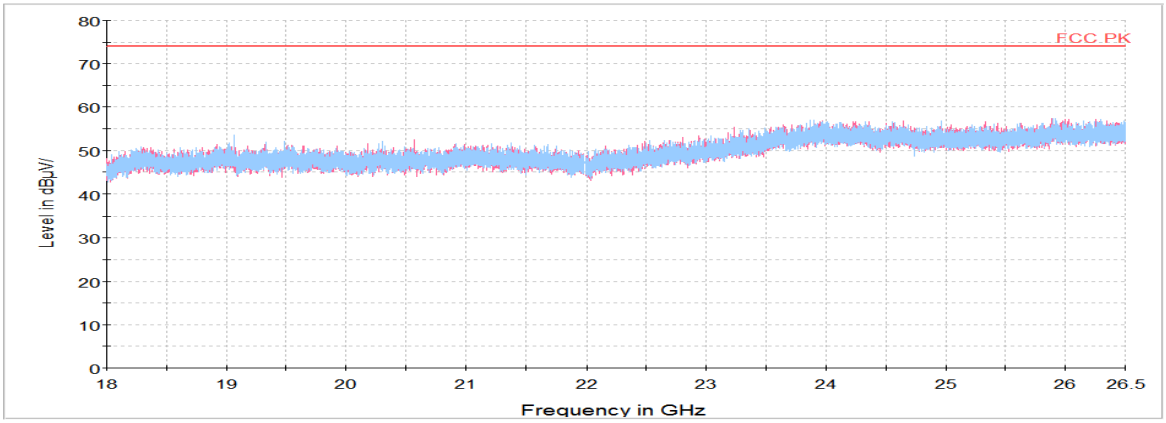
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



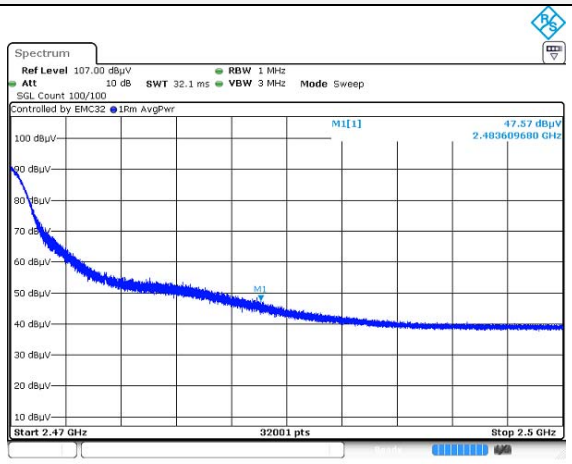
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



2 462 ㎒

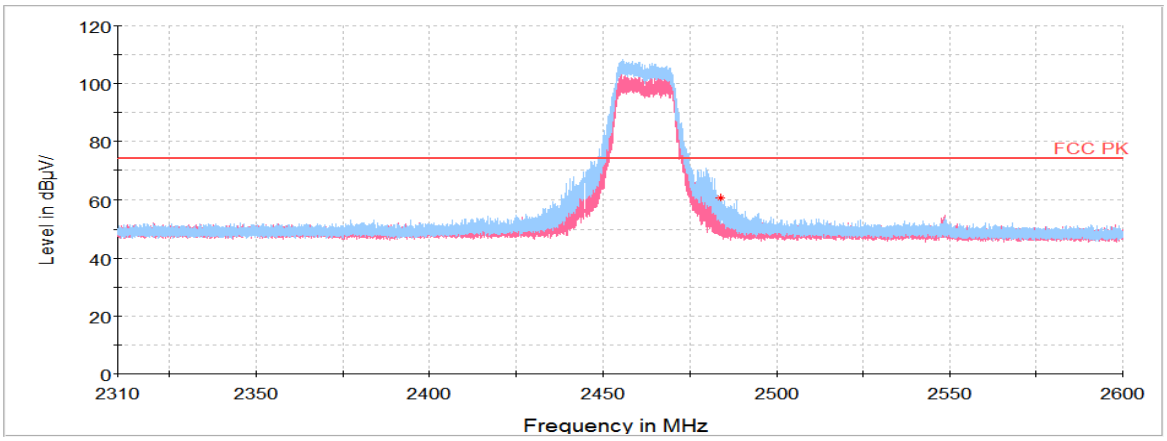
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 483.61[1)]	H	56.97	32.17	-28.54	-	60.60	74.00	13.40
3 913.25[1)]	V	69.50	33.02	-54.12	-	48.40	74.00	25.60
4 961.78[1)]	V	61.88	33.88	-52.68	-	43.08	74.00	30.92
7 367.42[1)]	V	61.15	35.30	-50.90	-	45.55	74.00	28.45
Average Data								
2 483.61[1)]	H	47.57	32.17	-28.54	0.27	51.47	54.00	2.53

Average data

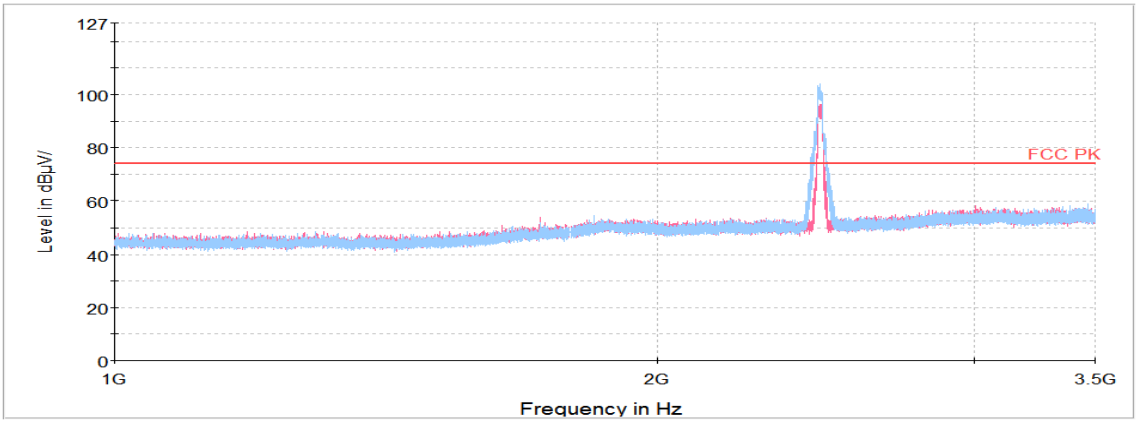


Blank

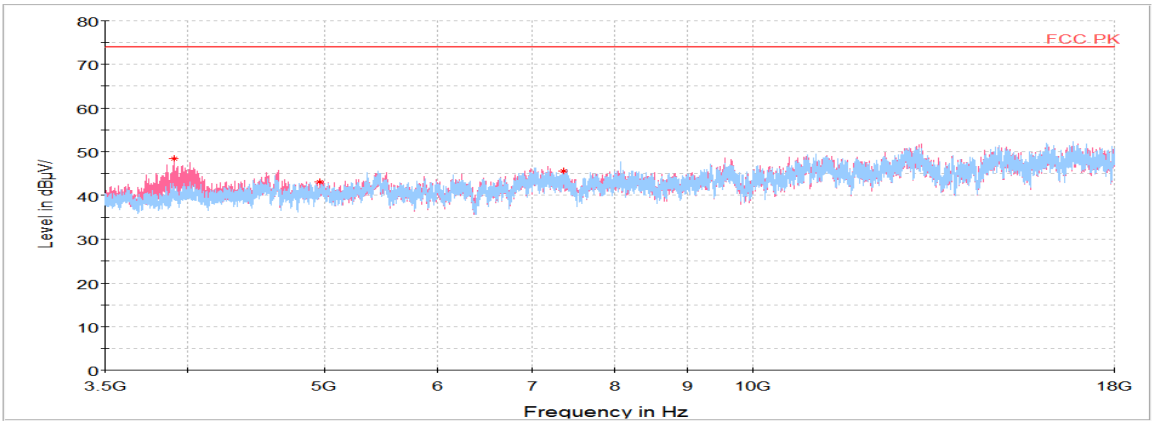
Horizontal/Vertical for Band-edge



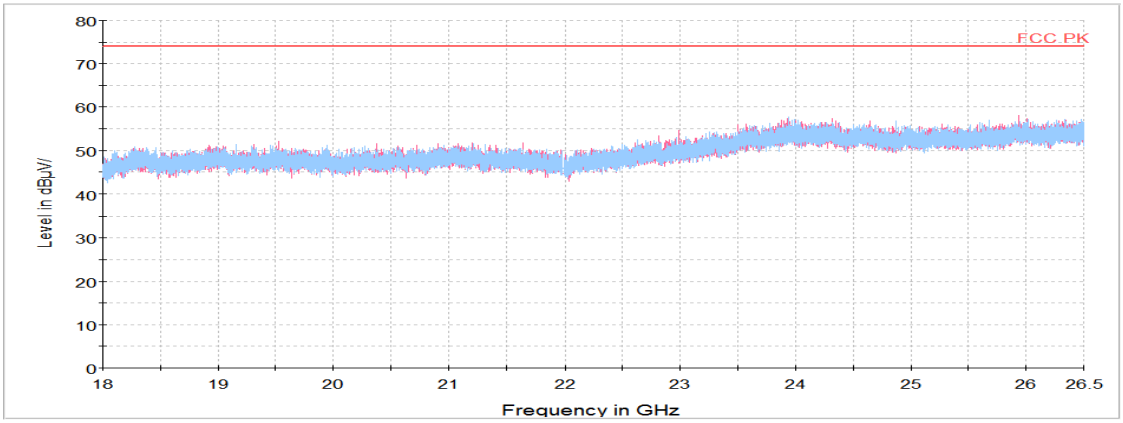
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓

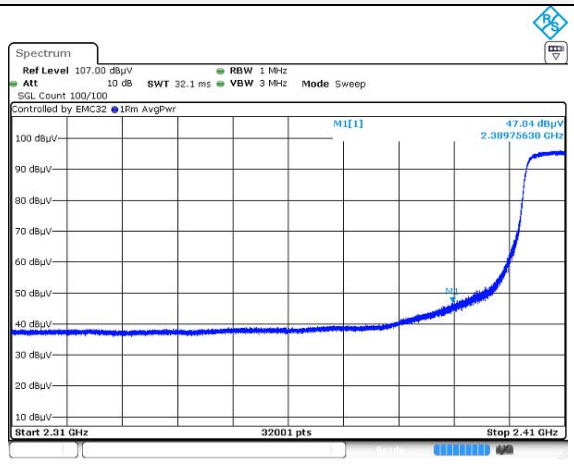


802.11n HT20

2 412 MHz

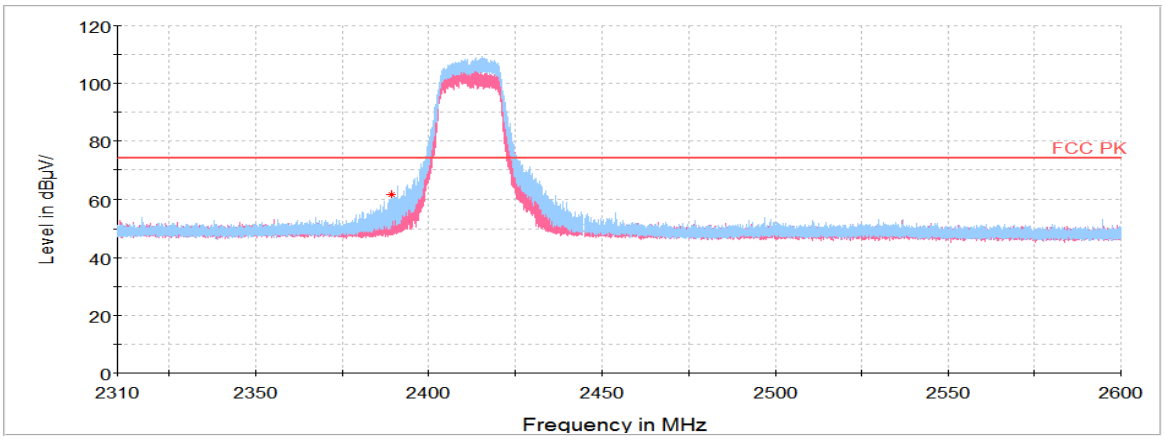
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 389.76[1)]	H	57.27	32.00	-27.79	-	61.48	74.00	12.52
3 990.28[1)]	V	68.28	33.00	-53.76	-	47.52	74.00	26.48
4 822.22[1)]	V	63.50	33.79	-52.88	-	44.41	74.00	29.59
7 252.78[1)]	H	60.74	35.30	-50.63	-	45.41	74.00	28.59
Average Data								
2 389.76[1)]	H	47.04	32.00	-27.79	0.29	51.54	54.00	2.46

Average data

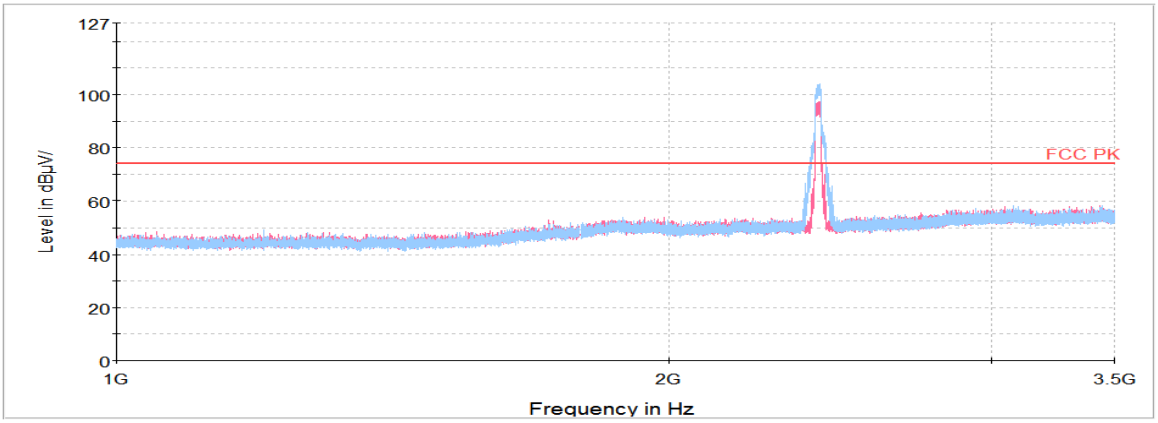


Blank

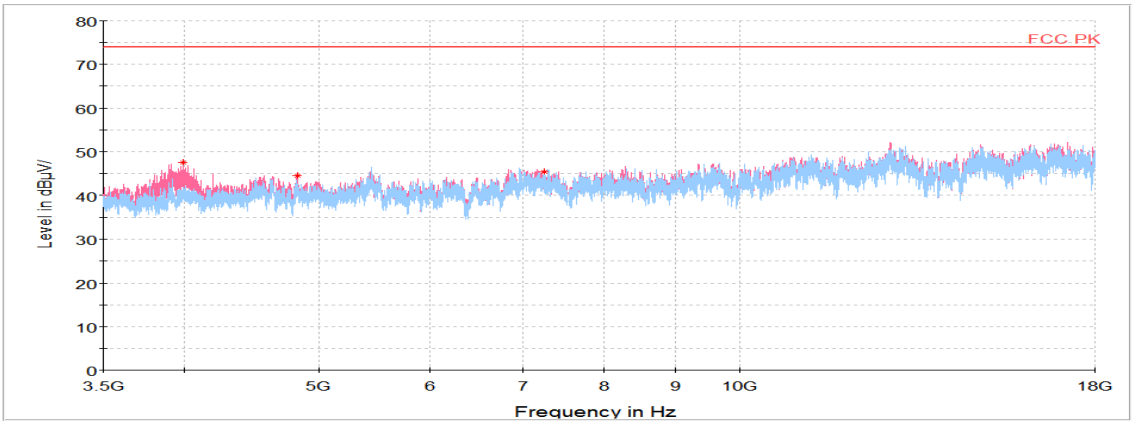
Horizontal/Vertical for Band-edge



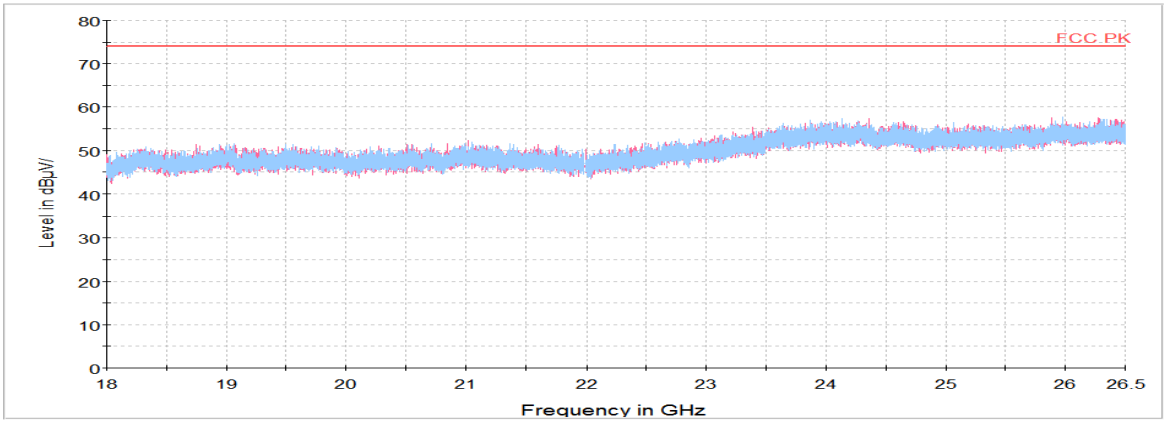
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



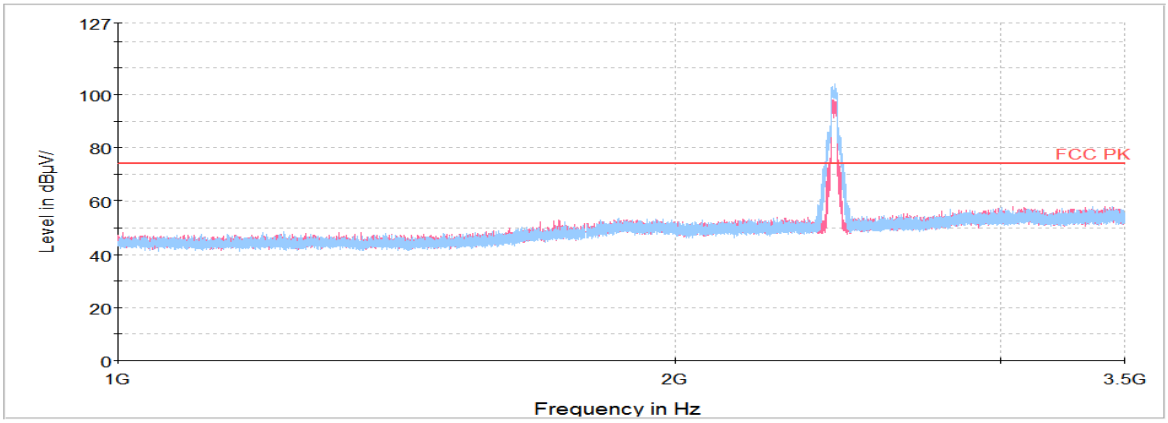
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



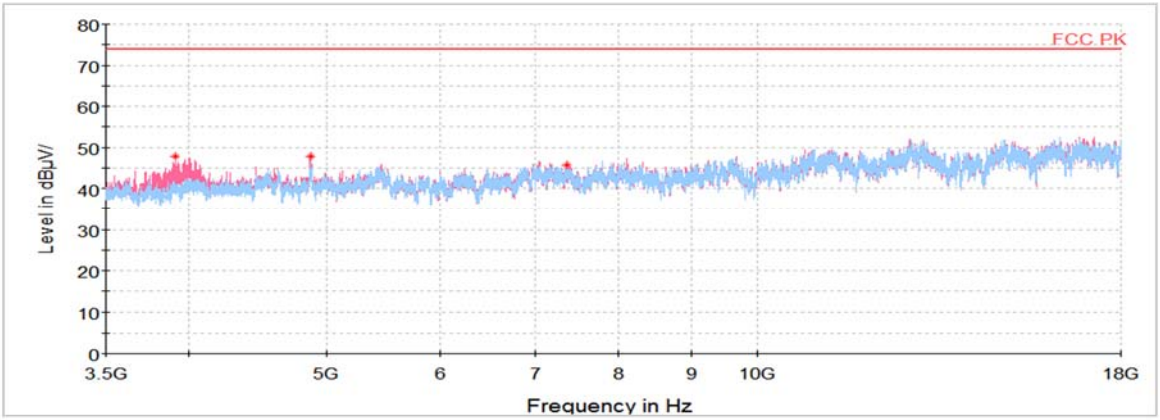
2 437 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
3 912.80[1)]	V	68.87	33.02	-54.13	-	47.76	74.00	26.24
4 874.78[1)]	V	66.82	33.82	-52.86	-	47.78	74.00	26.22
7 374.67[1)]	H	61.34	35.30	-50.92	-	45.72	74.00	28.28
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

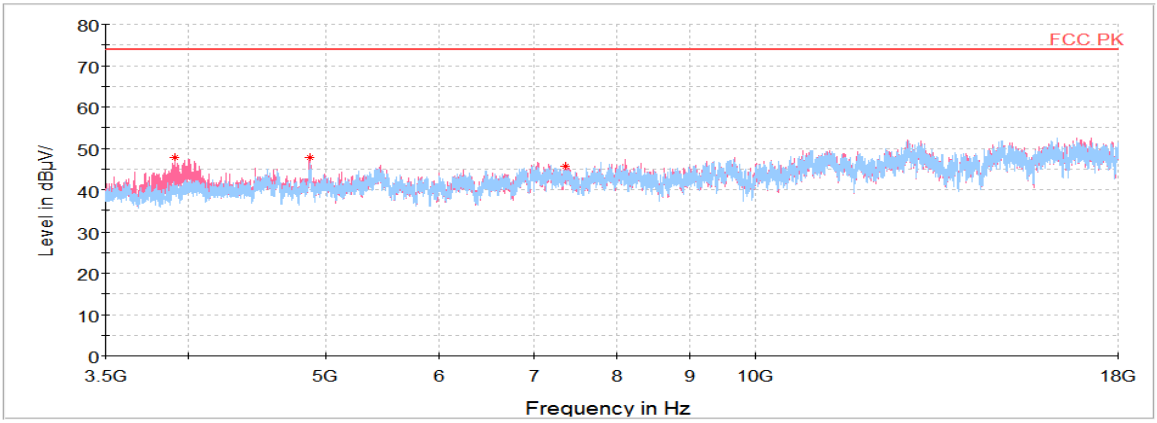
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



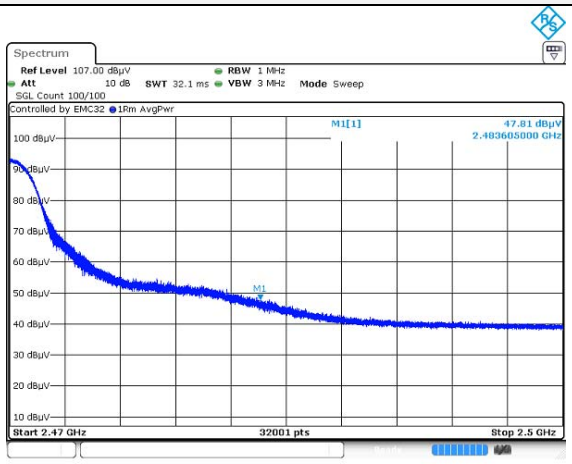
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



2 462 MHz

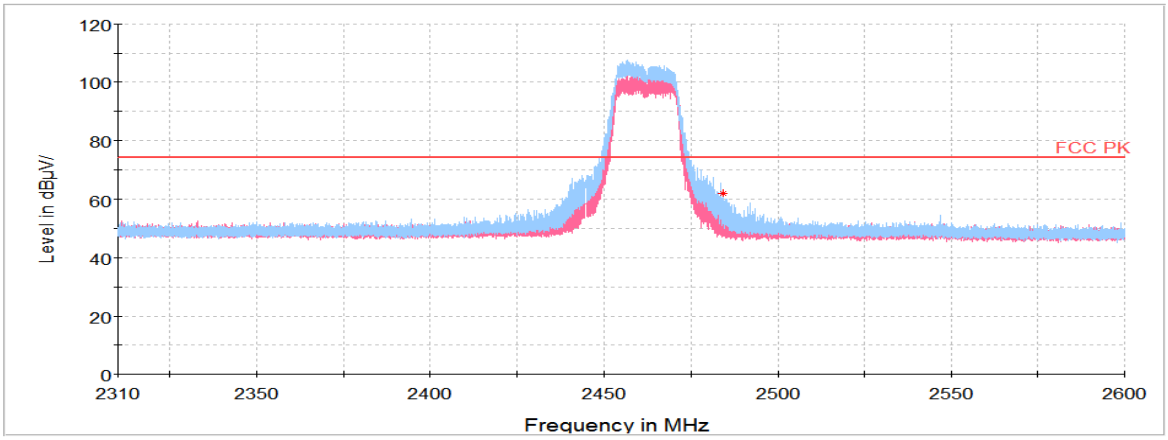
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 483.61[1)]	H	58.23	32.17	-28.54		61.86	74.00	12.14
3 911.44[1)]	V	70.09	33.02	-54.13	-	48.98	74.00	25.02
4 918.73[1)]	V	64.49	33.85	-52.80	-	45.54	74.00	28.46
7 388.72[1)]	H	60.86	35.30	-50.95	-	45.21	74.00	28.79
Average Data								
2 483.61[1)]	H	47.81	32.17	-28.54	0.29	51.73	54.00	2.27

Average data

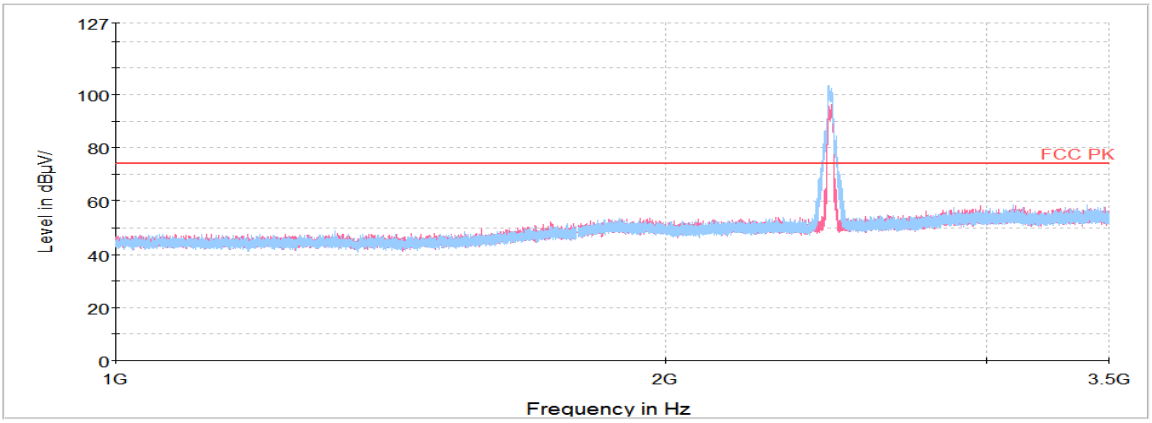


Blank

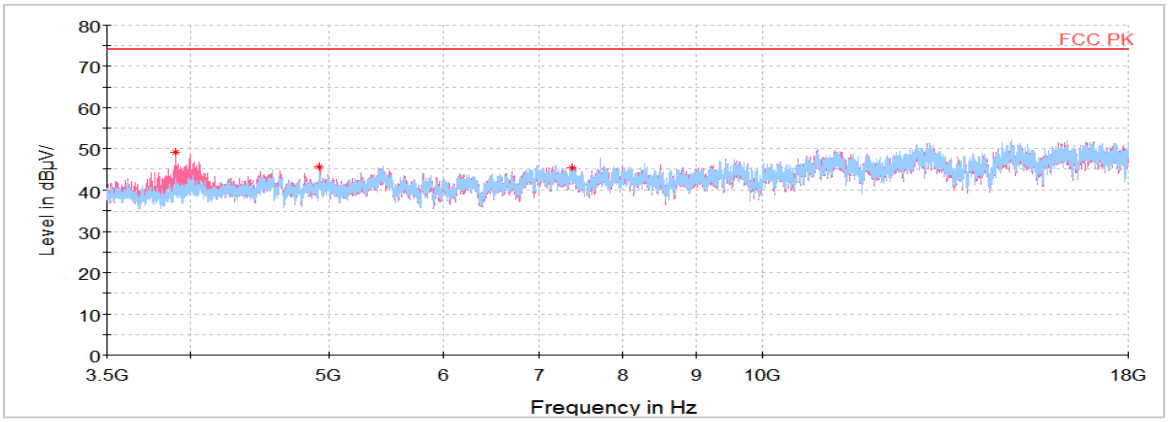
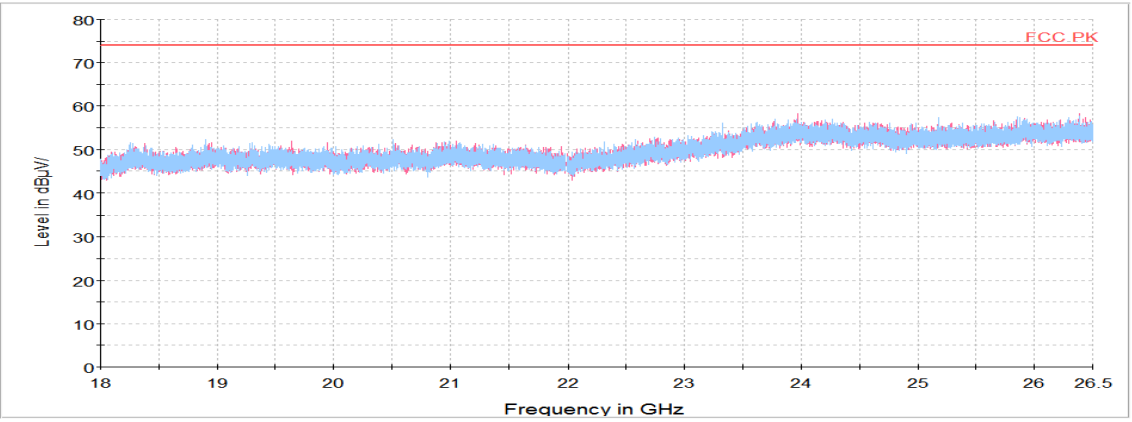
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓