



Certificate No.: 3745.01



China

FCC - TEST REPORT

Report Number : **709502102915-00** Date of Issue: March 30, 2021

Model : CBU-IPEX

Product Type : Wi-Fi and Bluetooth module

Applicant : Hangzhou Tuya Information Technology Co.,Ltd

Address : Room701,Building3,More Center,No.87 GuDun Road, Hangzhou, Zhejiang China

Manufacturer : Hangzhou Tuya Information Technology Co.,Ltd

Address : Room701,Building3,More Center,No.87 GuDun Road, Hangzhou, Zhejiang China

Test Result : **Positive** **Negative**

Total pages including Appendices : 55

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1 Table of Contents

1	Table of Contents	2
2	Details about the Test Laboratory	3
3	Description of the Equipment under Test.....	4
4	Summary of Test Standards	5
5	Summary of Test Results	6
6	General Remarks	7
7	Test Setups	8
8	Systems test configuration	11
9	Technical Requirement.....	12
9.1	Conducted Emission.....	12
9.2	Conducted peak output power	15
9.3	6dB bandwidth	16
9.4	Power spectral density.....	21
9.5	Spurious RF conducted emissions	26
9.6	Band edge	39
9.7	Spurious radiated emissions for transmitter.....	44
10	Test Equipment List.....	52
11	System Measurement Uncertainty	53
12	Photographs of Test Set-ups.....	54
13	Photographs of EUT	55



2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
No.16 Lane, 1951 Du Hui Road,
Shanghai 201108,
P.R. China

Test Firm FCC
Registration
Number: 820234

Test Firm IC
Registration
Number: 25988

Telephone: +86 21 6141 0123
Fax: +86 21 6140 8600



3 Description of the Equipment under Test

Description of the Equipment Under Test

Product:	Wi-Fi and Bluetooth module
Model no.:	CBU-IPEX
FCC ID:	2ANDL-CBU-IPEX
Options and accessories:	NA
Rating:	DC 3.0-3.6V
RF Transmission Frequency:	For 802.11b/g/n-HT20: 2412~2462 MHz For 802.11n-HT40: 2422~2452 MHz For 802.15.1:2402~2480 MHz
No. of Operated Channel:	2.4GHz WIFI: 11 for 802.11b/802.11g/802.11n(H20) 7 for 802.11n(H40) 2.4GHz BLE: 40
Modulation:	For 2.4GHz WIFI: Direct Sequence Spread Spectrum (DSSS) for 802.11b Orthogonal Frequency Division Multiplexing (OFDM) for 802.11g/n For 2.4GHz BLE: GFSK
Antenna Type:	FPC antenna
Antenna Gain:	3.3 dBi
Description of the EUT:	The Equipment Under Test (EUT) is a low-power embedded Wi-Fi and Bluetooth module (5.1). We tested it and listed the worst data in this report.
Test sample no.:	SHA-557632-1

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.



4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2014 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).

5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition	Pages	Test Site	Test Result			
			Pass	Fail	N/A	
§15.207	Conducted emission AC power port	12-14	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247 (b) (3)	Conducted peak output power	15	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)	20dB bandwidth	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)	Carrier frequency separation	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)(iii)	Dwell Time	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(2)	6dB bandwidth and 99% Occupied Bandwidth	16-20	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(e)	Power spectral density	21-25	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Spurious RF conducted emissions	26-38	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Band edge	39-43	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	44-51	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.203	Antenna requirement	See note 1		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses an FPC antenna, which gain is 3.3dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.



6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2ANDL-CBU-IPEX, complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

This report is only for the 2.4GHz Wi-Fi test report, for the 2.4GHz BLE test report please refer to 709502102919-00.

According to the client's declaration, the "ILAC – A2LA Accredited" symbol is added to the report.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: March 9, 2021

Testing Start Date: March 14, 2021

Testing End Date: March 19, 2021

-TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:

Prepared by:

Tested by:



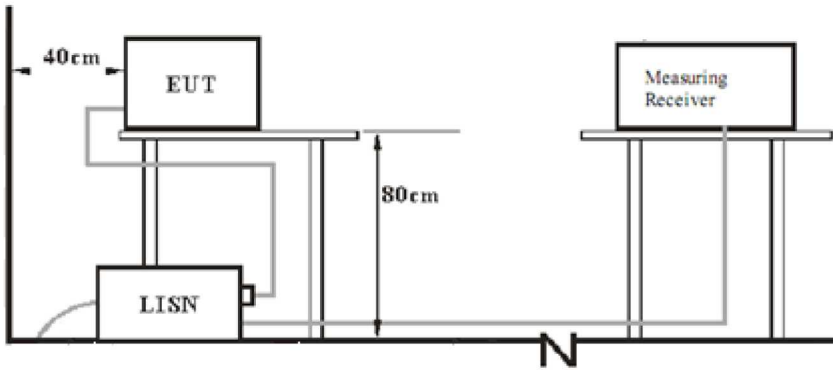
Hui TONG
EMC Section Manager

Wenqiang LU
EMC Project Engineer

Jiayi XU
EMC Test Engineer

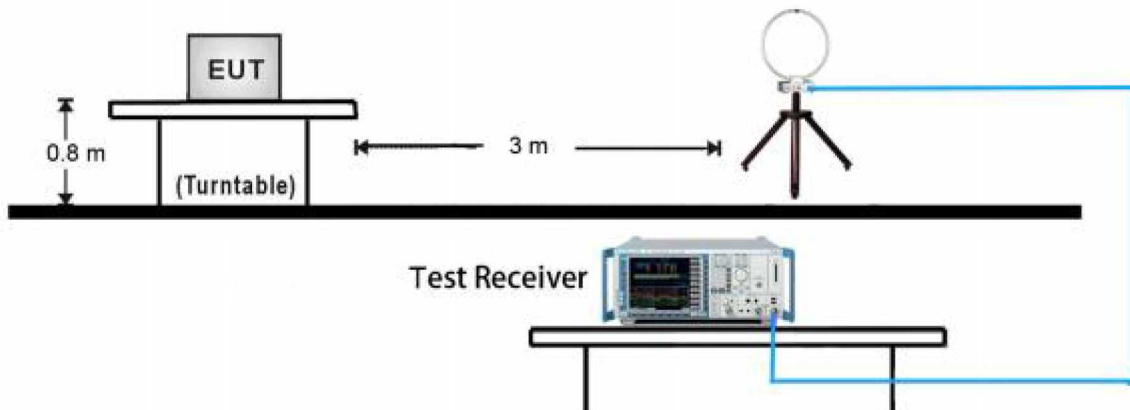
7 Test Setups

7.1 AC Power Line Conducted Emission test setups

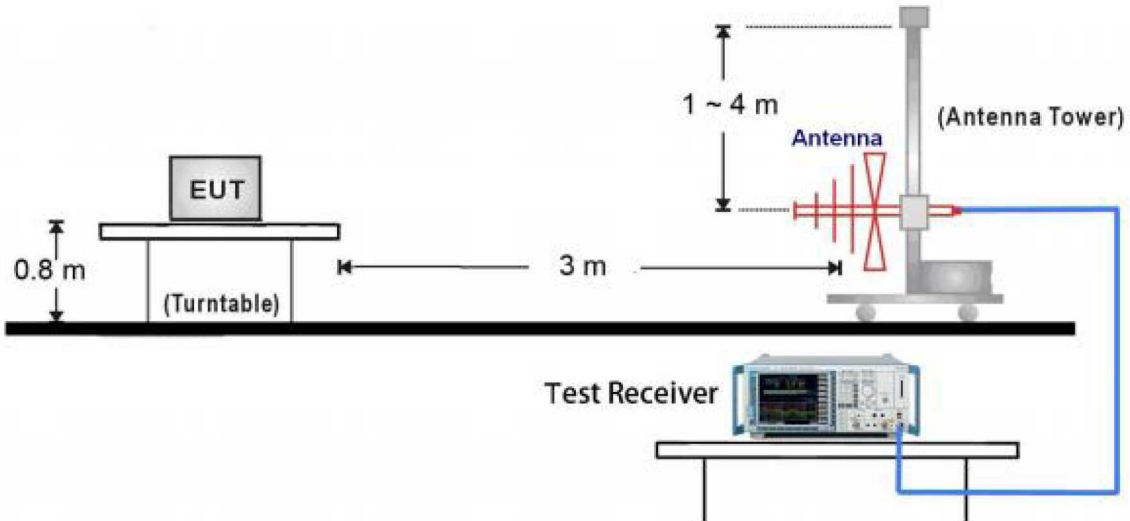


7.2 Radiated test setups

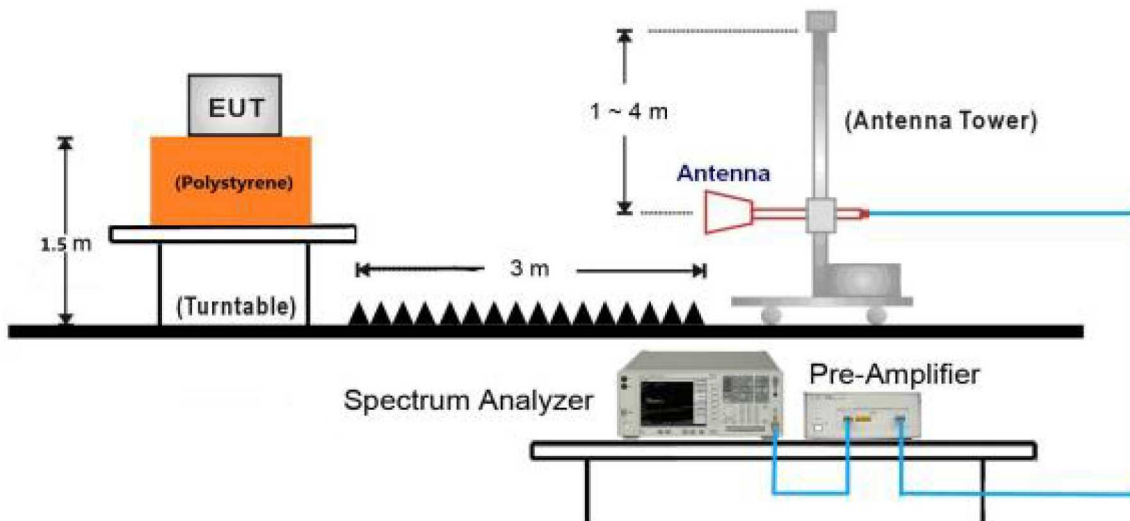
9kHz ~ 30MHz Test Setup:



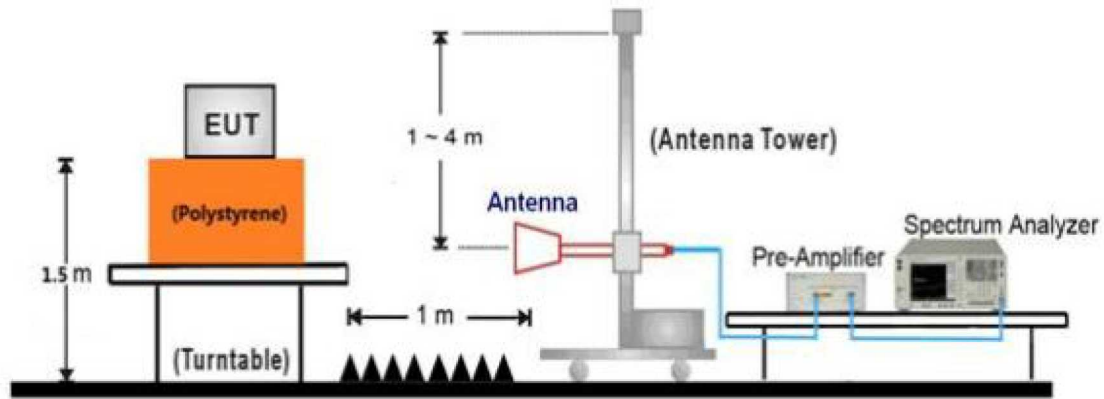
30MHz ~ 1GHz Test Setup:



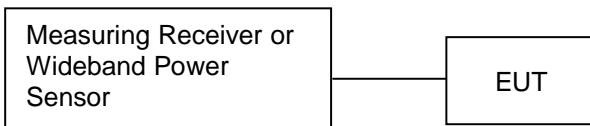
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenove	X240	Notebook

Test software: Wi-Fi test tool V1.4.2

The system was configured to channel 1(2412MHz), 6(2437MHz), and 11(2462MHz) for 802.11 b/g/n HT20 test and channel 3(2422MHz), 6(2437MHz), 9(2452MHz) for 802.11n HT40.

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through an Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. An EMI test receiver is used to test the emissions from both sides of AC line

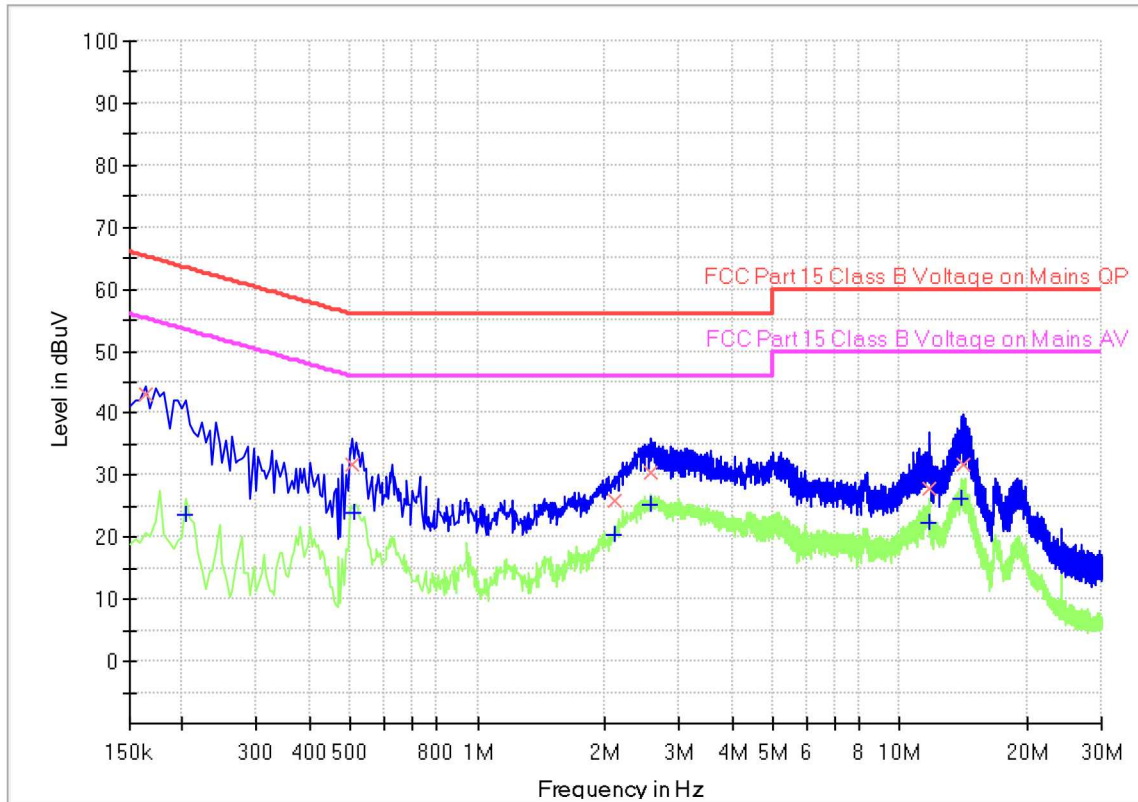
Limit

According to §15.207, conducted emissions limit as below:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

Product Type : Wi-Fi and Bluetooth module
 M/N : CBU-IPEX
 Operating Condition : Mode 1: Tx_2462MHz for 802.11n HT20 (worst case)
 Test Specification : L-line
 Comment : AC 120V/60Hz (powered by notebook)



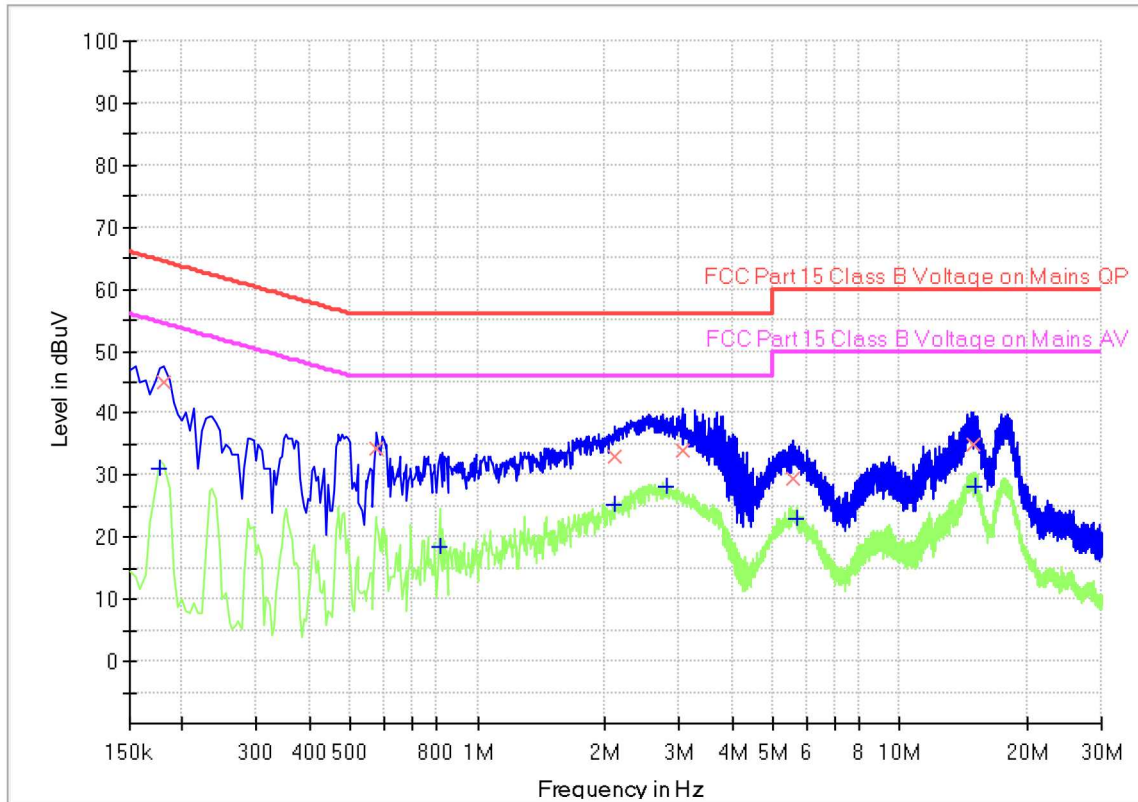
Final Result

Frequency (MHz)	Quasi Peak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.163500	43.03	---	65.28	22.25	1000.0	9.000	L1	19.5
0.204000	---	23.70	53.45	29.75	1000.0	9.000	L1	19.5
0.505500	31.87	---	56.00	24.13	1000.0	9.000	L1	19.5
0.510000	---	24.00	46.00	22.00	1000.0	9.000	L1	19.5
2.098500	---	20.30	46.00	25.70	1000.0	9.000	L1	19.5
2.098500	26.00	---	56.00	30.00	1000.0	9.000	L1	19.5
2.566500	30.56	---	56.00	25.44	1000.0	9.000	L1	19.5
2.566500	---	25.30	46.00	20.70	1000.0	9.000	L1	19.5
11.710500	27.95	---	60.00	32.05	1000.0	9.000	L1	19.7
11.719500	---	22.40	50.00	27.60	1000.0	9.000	L1	19.7
14.037000	---	26.16	50.00	23.84	1000.0	9.000	L1	19.7
14.118000	31.82	---	60.00	28.18	1000.0	9.000	L1	19.7

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator



Product Type : Wi-Fi and Bluetooth module
 M/N : CBU-IPEX
 Operating Condition : Mode 1: Tx_2462MHz for 802.11n HT20 (worst case)
 Test Specification : N-line
 Comment : AC 120V/60Hz (powered by notebook)



Final Result

Frequency (MHz)	Quasi Peak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.177000	---	31.11	54.63	23.52	1000.0	9.000	N	19.5
0.181500	44.93	---	64.42	19.49	1000.0	9.000	N	19.5
0.577500	34.19	---	56.00	21.81	1000.0	9.000	N	19.5
0.811500	---	18.54	46.00	27.46	1000.0	9.000	N	19.5
2.112000	33.02	---	56.00	22.98	1000.0	9.000	N	19.5
2.112000	---	25.26	46.00	20.74	1000.0	9.000	N	19.5
2.800500	---	28.19	46.00	17.81	1000.0	9.000	N	19.6
3.043500	34.10	---	56.00	21.90	1000.0	9.000	N	19.6
5.581500	29.48	---	60.00	30.52	1000.0	9.000	N	19.6
5.685000	---	22.99	50.00	27.01	1000.0	9.000	N	19.6
14.860500	34.95	---	60.00	25.05	1000.0	9.000	N	19.8
15.117000	---	28.31	50.00	21.69	1000.0	9.000	N	19.8

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
RBW > the 6 dB bandwidth of the emission being measured, VBW \geq 3RBW, Span \geq 3RBW
Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Use a power meter to measure the conducted peak output power.

Limits

According to §15.247 (b) (3), conducted peak output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤ 1	≤ 30

Test result as below table

802.11B

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2412MHz	18.61	Pass
Middle channel 2437MHz	18.78	Pass
High channel 2462MHz	19.56	Pass

802.11G

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2412MHz	22.21	Pass
Middle channel 2437MHz	22.11	Pass
High channel 2462MHz	22.70	Pass

802.11N20

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2412MHz	22.09	Pass
Middle channel 2437MHz	22.21	Pass
High channel 2462MHz	22.94	Pass

802.11N40

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2422MHz	22.15	Pass
Middle channel 2437MHz	21.68	Pass
High channel 2452MHz	22.08	Pass

9.3 6dB bandwidth

Test Method

1. Use the following spectrum analyzer settings:
RBW=100K, VBW \geq 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be \geq 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]

—————
 \geq 500

Test result
802.11B

Frequency MHz	6dB bandwidth MHz	Result
Low channel 2412MHz	12.069	Pass
Middle channel 2437MHz	12.068	Pass
High channel 2462MHz	12.055	Pass

802.11G

Frequency MHz	6dB bandwidth MHz	Result
Low channel 2412MHz	15.112	Pass
Middle channel 2437MHz	15.127	Pass
High channel 2462MHz	15.117	Pass

802.11N20

Frequency MHz	6dB bandwidth MHz	Result
Low channel 2412MHz	15.100	Pass
Middle channel 2437MHz	15.099	Pass
High channel 2462MHz	15.100	Pass

802.11N40

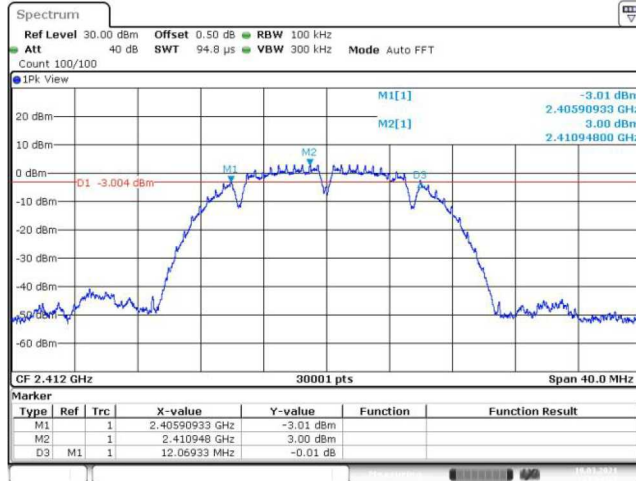
Frequency MHz	6dB bandwidth MHz	Result
Low channel 2422MHz	35.049	Pass
Middle channel 2437MHz	35.047	Pass
High channel 2452MHz	35.039	Pass



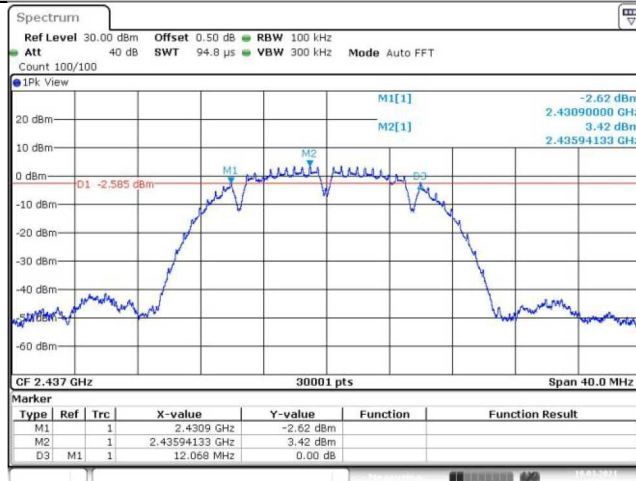
6 dB Bandwidth

802.11B

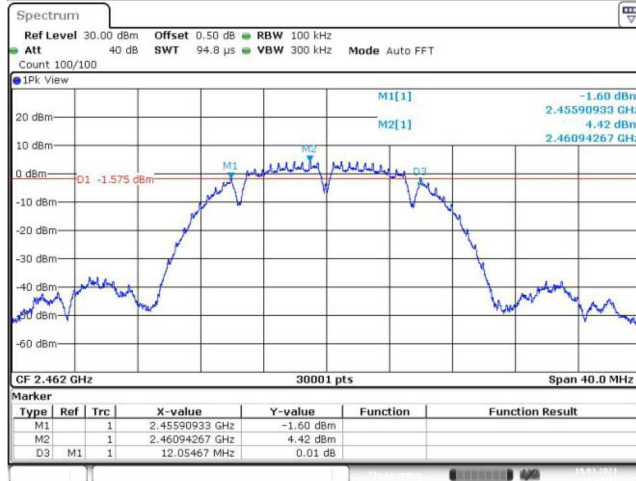
2412



2437



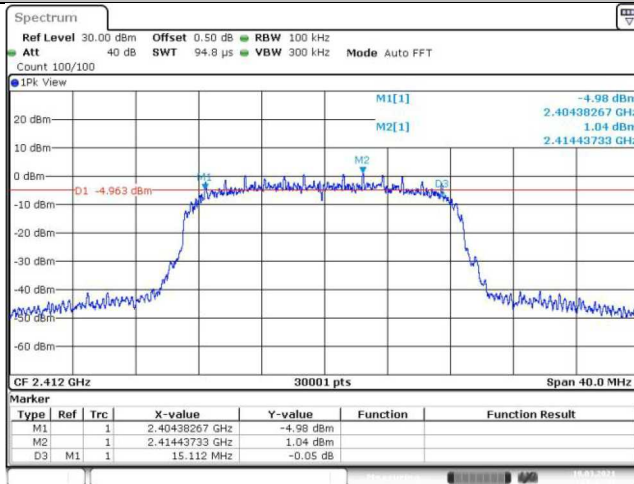
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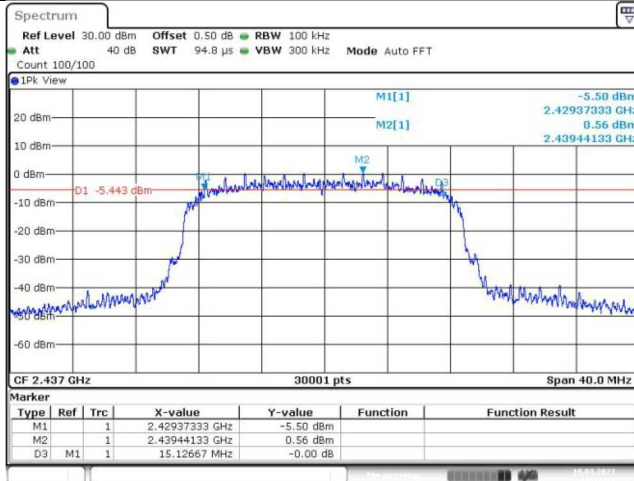
802.11G

2412



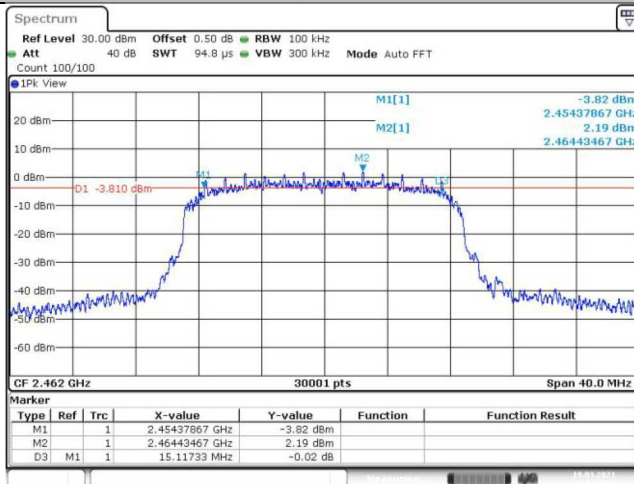
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2437



Date: 19 MAR 2021 11:15:53

2462

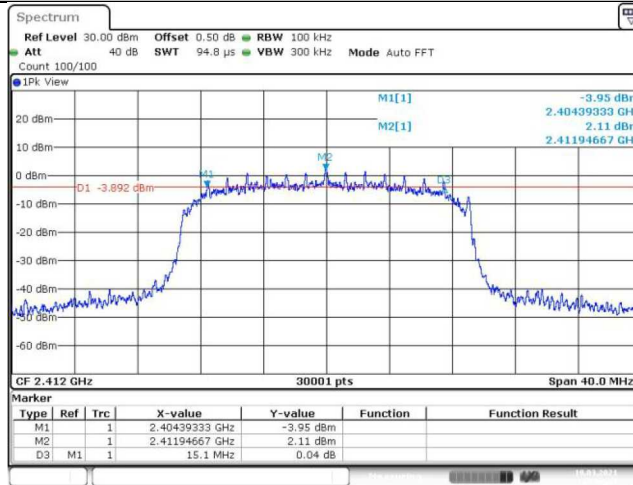


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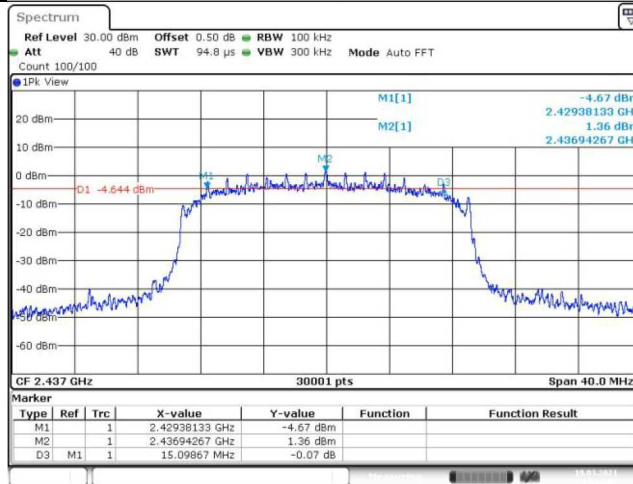
802.11N20

2412



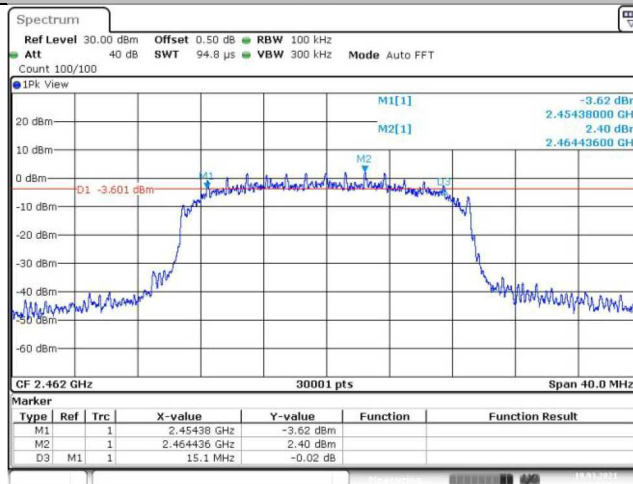
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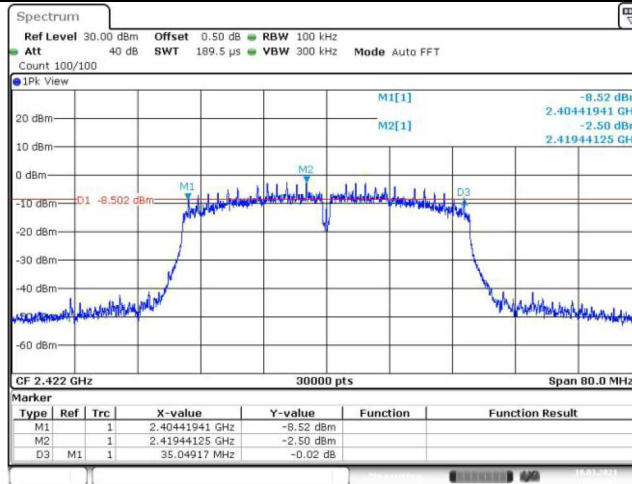


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802.11N40

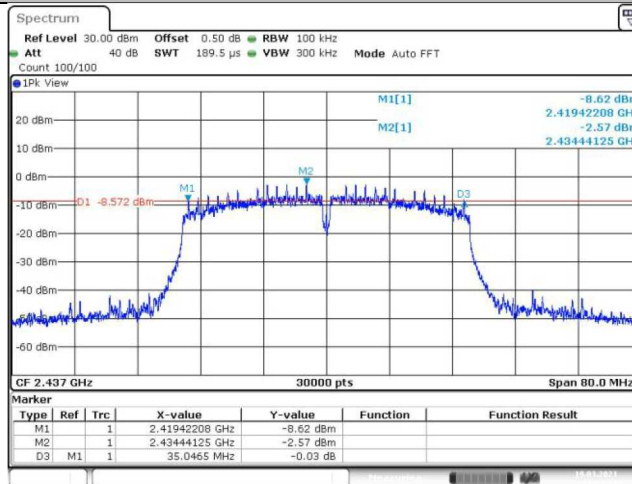
2422

China



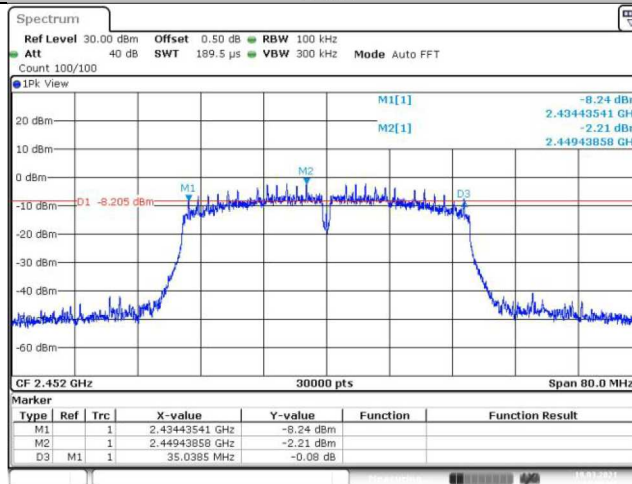
Date: 19 MAR 2021 12:16:44

2437



Date: 19 MAR 2021 12:19:54

2452



Date: 19 MAR 2021 12:21:48

9.4 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW \geq 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3kHz]

≤ 8

Test result
802.11 B

Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-9.83	Pass
Middle channel 2437MHz	-9.44	Pass
High channel 2462MHz	-8.45	Pass

802.11 G

Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-12.76	Pass
Middle channel 2437MHz	-12.65	Pass
High channel 2462MHz	-11.44	Pass

802.11 N20

Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-13.04	Pass
Middle channel 2437MHz	-13.46	Pass
High channel 2462MHz	-12.66	Pass

802.11 N40

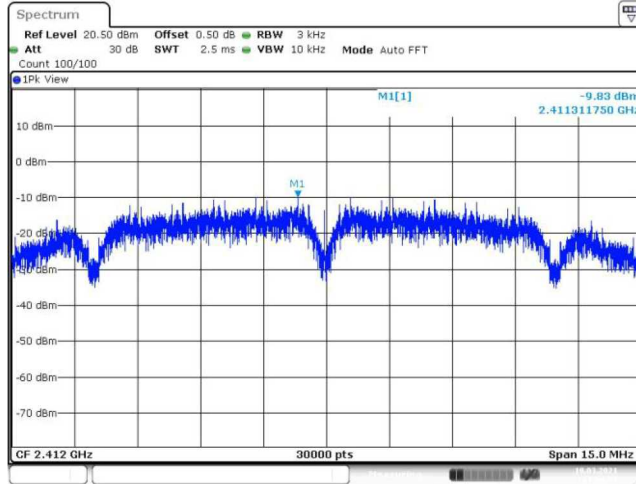
Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2422MHz	-15.3	Pass
Middle channel 2437MHz	-15.54	Pass
High channel 2452MHz	-15.99	Pass



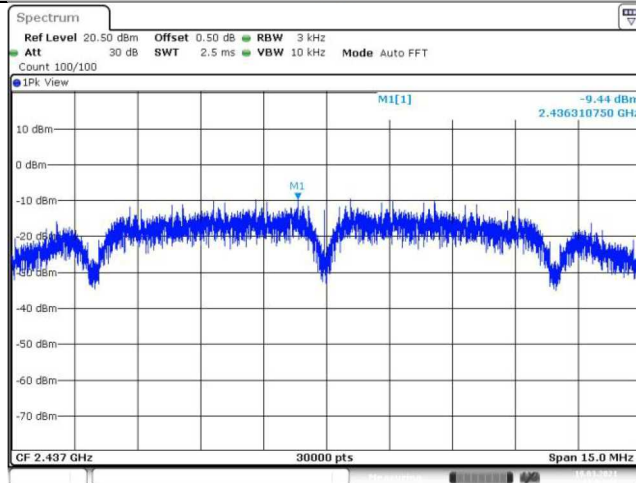
Power spectral density

802.11B

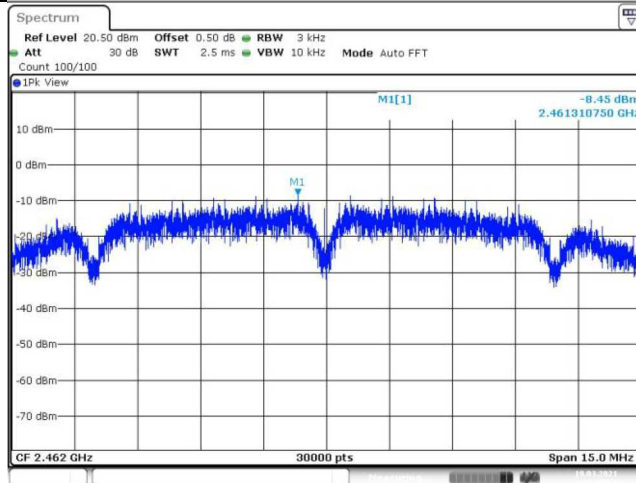
2412



2437



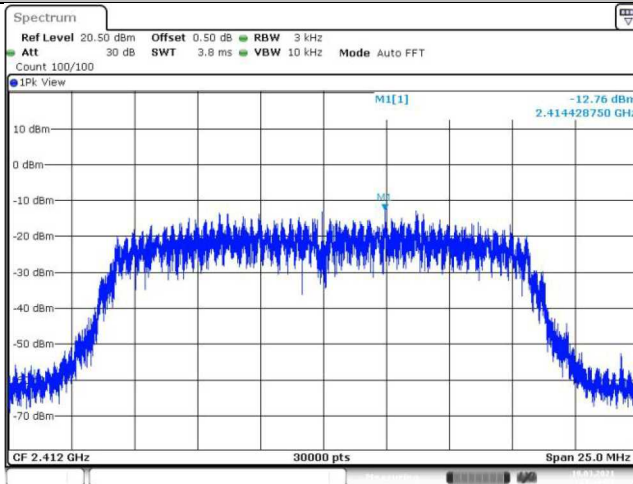
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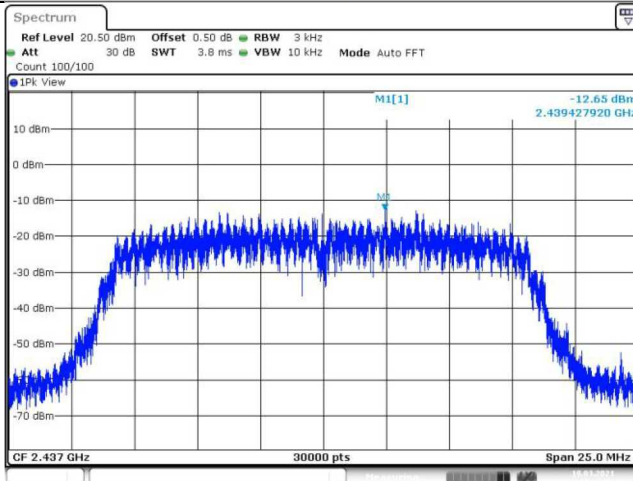
802.11G

2412



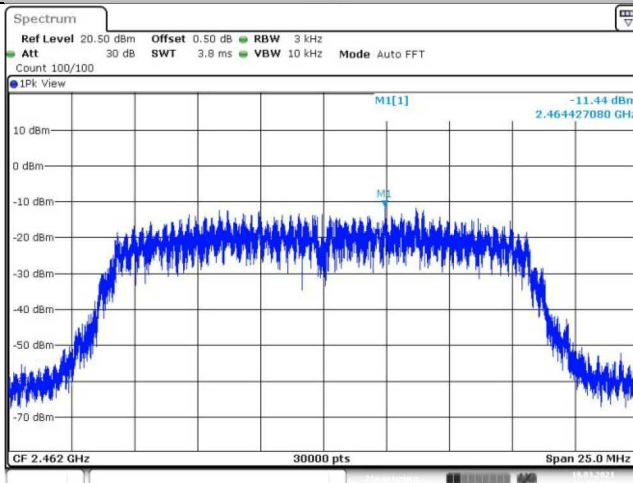
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2437



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2462

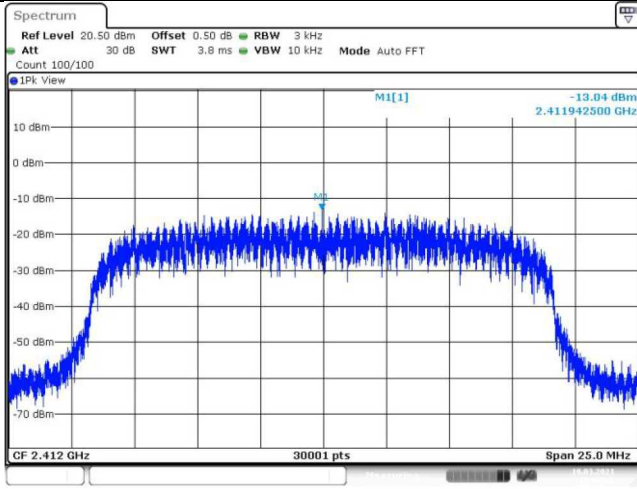


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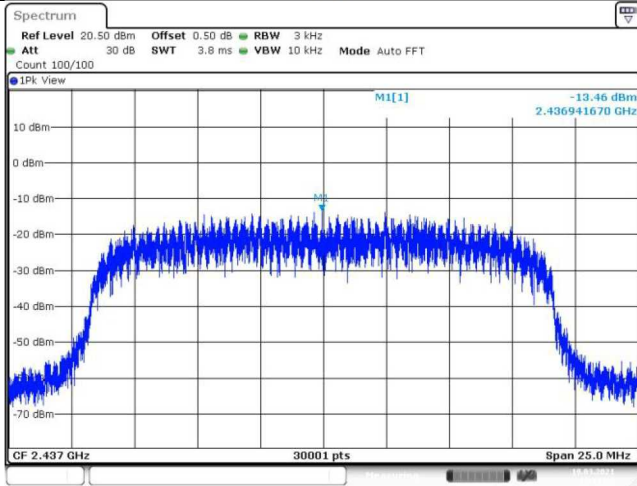
802.11N20

2412



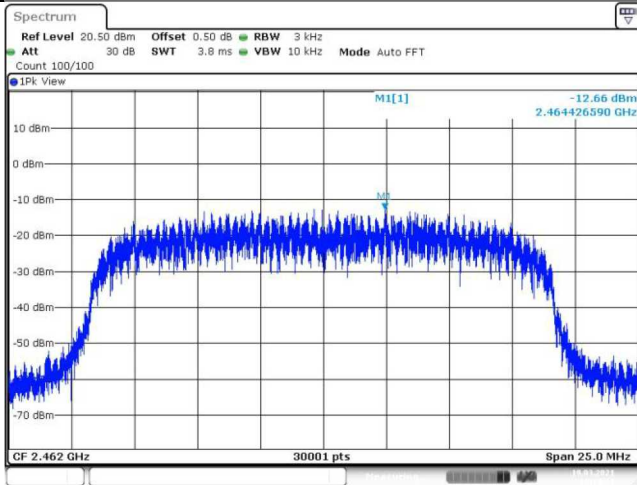
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2462

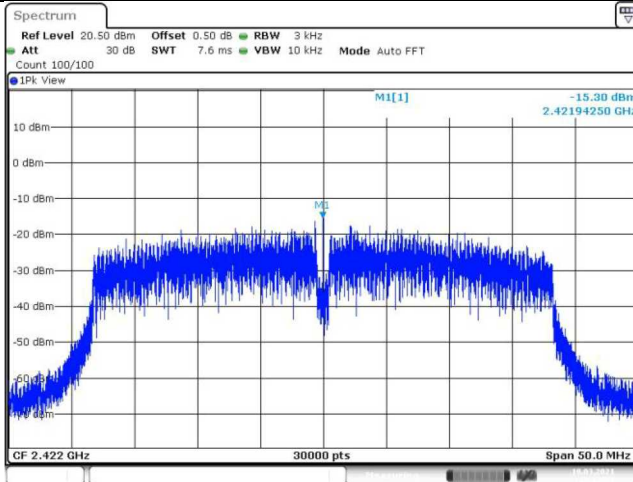


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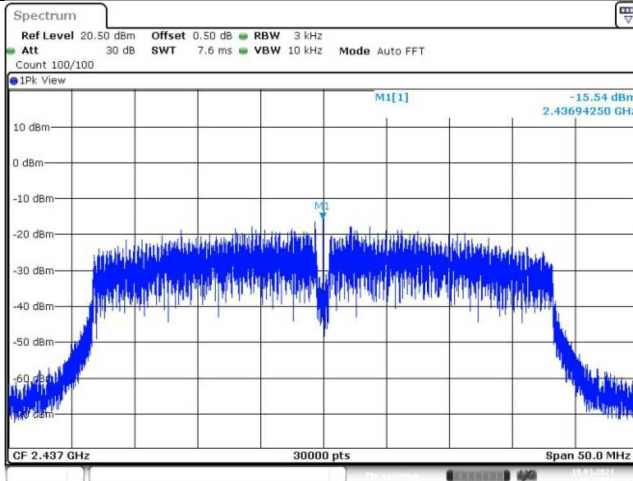
802.11N40

2422



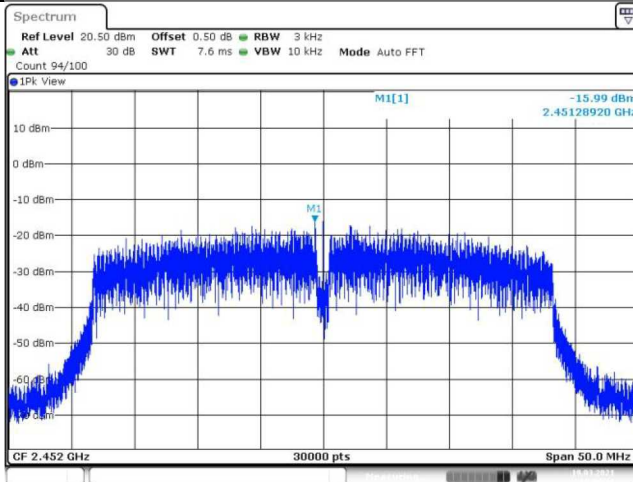
Date: 19 MAR 2021 12:17:05

2437



Date: 19 MAR 2021 12:20:23

2452



Date: 19 MAR 2021 12:22:17



9.5 Spurious RF conducted emissions

Test Method

1. Establish a reference level by using the following procedure:
 - a. Set RBW=100 kHz. VBW \geq 3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
 - b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
 - a. Set the center frequency and span to encompass frequency range to be measured.
 - b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Frequency Range MHz	Limit (dBc)
30-25000	-20

Spurious RF conducted emissions

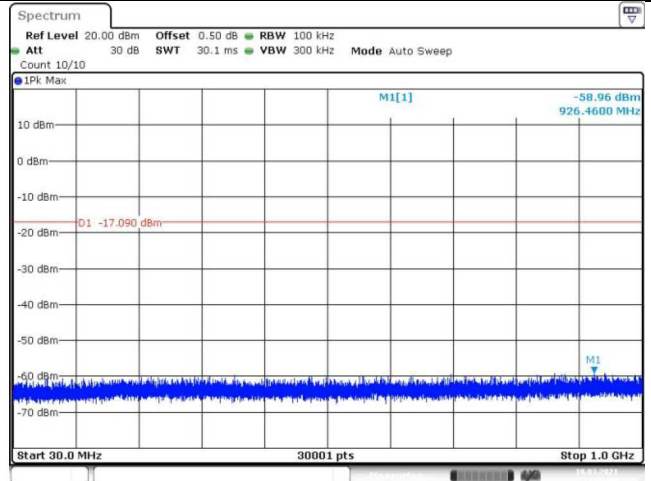
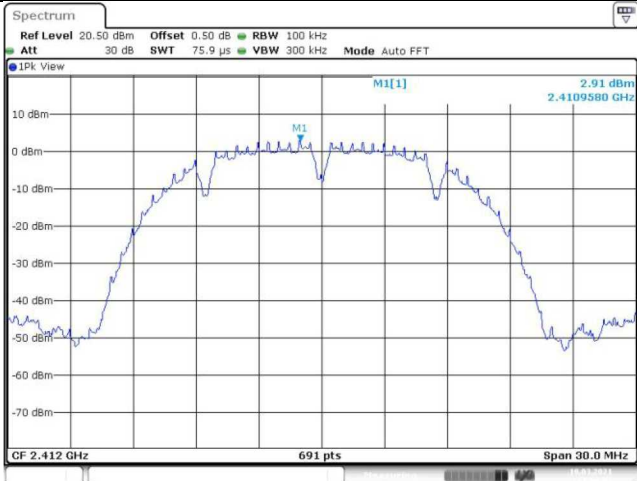
802.11 B

Out-of-Band Emissions

Channel 1 (2412MHz)

Reference point

Spurious Emission (30MHz – 1GHz)

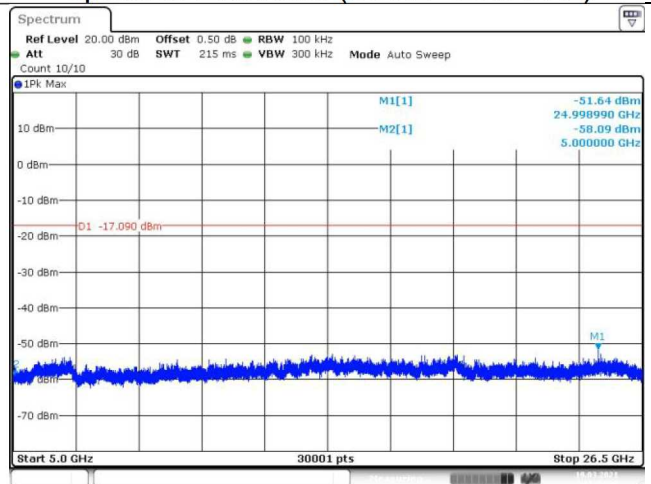
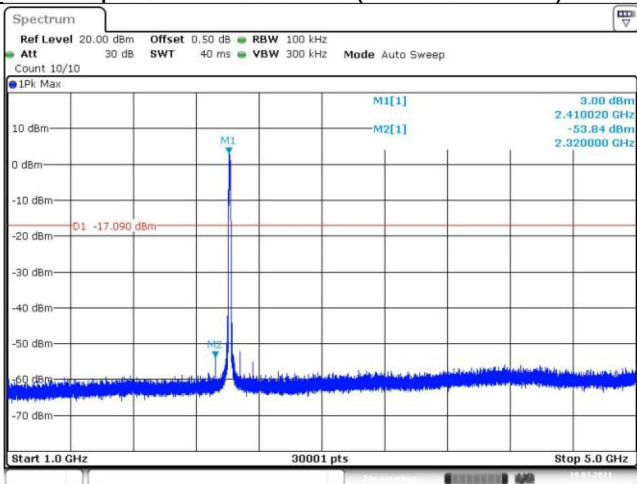


Date: 19 MAR 2021 11:01:49

Date: 19 MAR 2021 11:01:54

Spurious Emission (1GHz – 5GHz)

Spurious Emission (5GHz – 26.5GHz)



Date: 19 MAR 2021 11:02:06

Date: 19 MAR 2021 11:02:37

Note: The emission which exceed the limit is the fundamental.

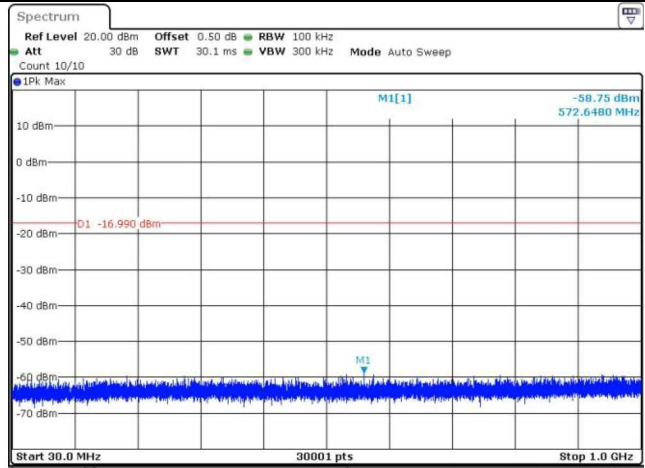
Out-of-Band Emissions
Channel 6 (2437MHz)

Reference point



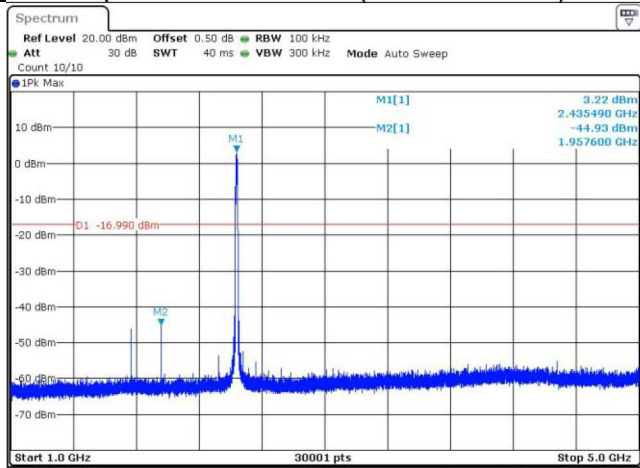
Date: 19 MAR 2021 11:03:50

Spurious Emission (30MHz – 1GHz)



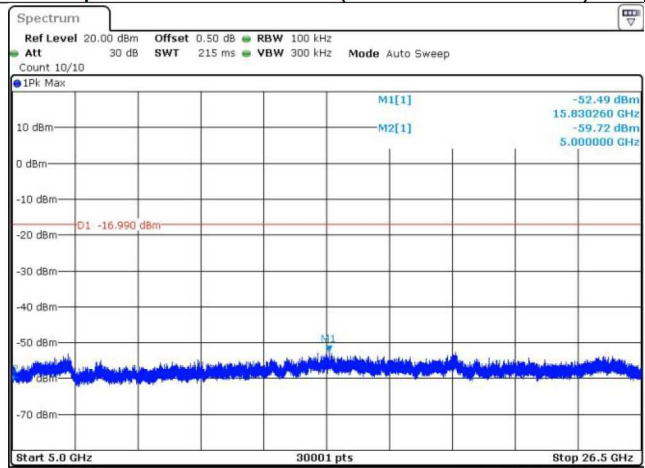
Date: 19 MAR 2021 11:03:54

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 11:04:07

Spurious Emission (5GHz –26.5GHz)



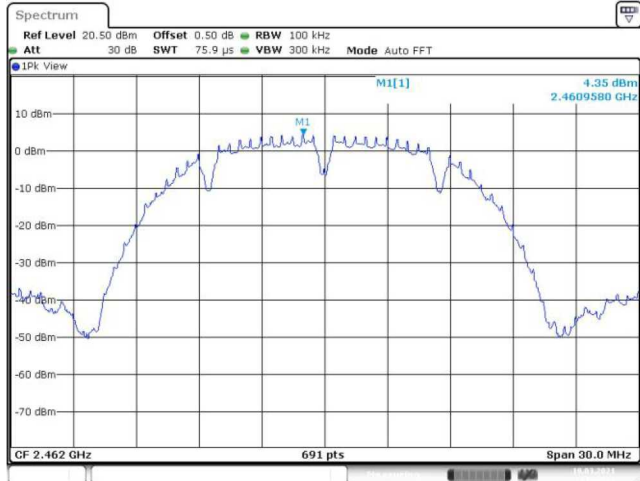
Date: 19 MAR 2021 11:04:38

Note: The emission which exceed the limit is the fundamental.



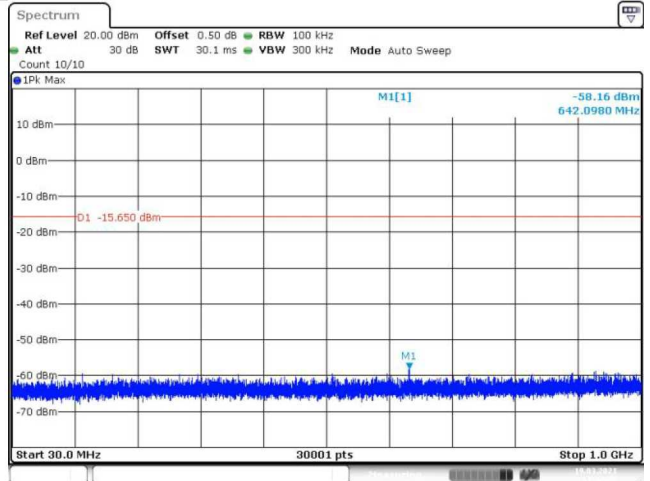
Out-of-Band Emissions
Channel 11 (2462MHz)

Reference point



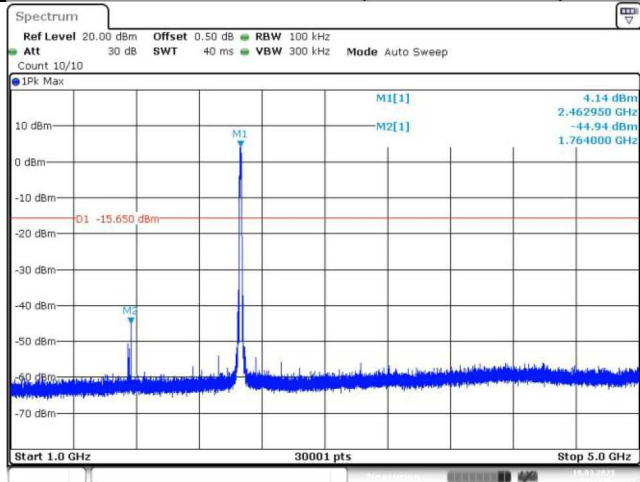
Date: 19 MAR 2021 11:10:54

Spurious Emission (30MHz – 1GHz)



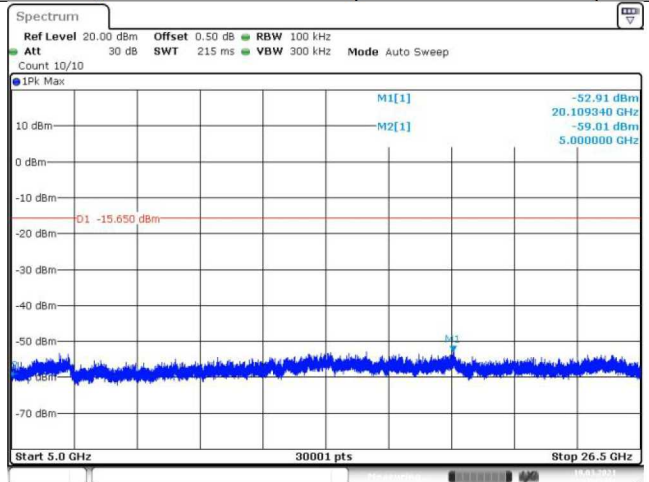
Date: 19 MAR 2021 11:10:58

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 11:11:10

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 11:11:41

Note: The emission which exceed the limit is the fundamental.

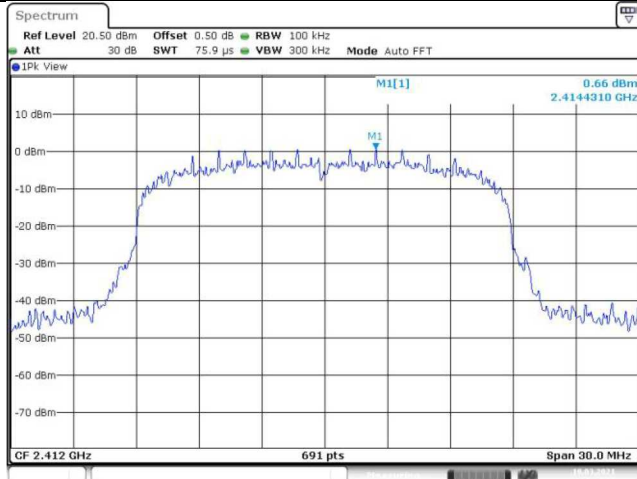


802.11 G

Out-of-Band Emissions

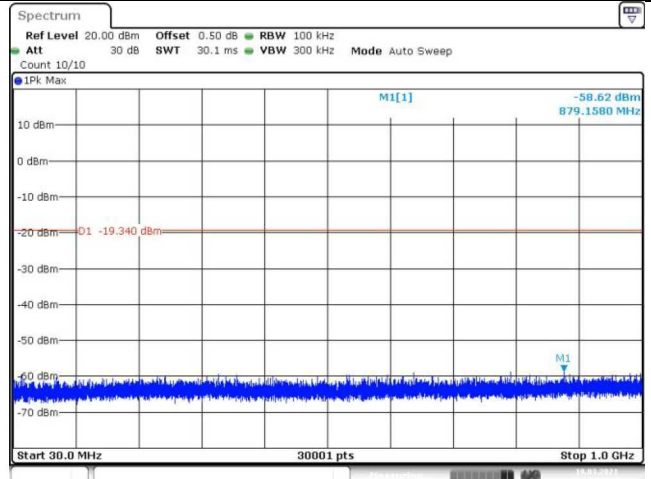
Channel 1 (2412MHz)

Reference point



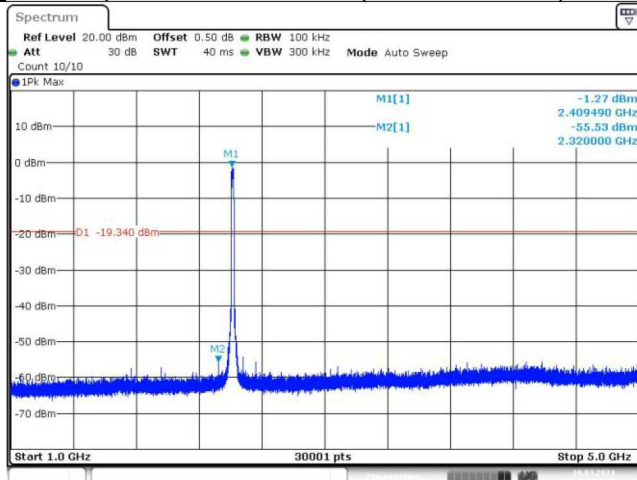
Date: 19 MAR 2021 11:13:20

Spurious Emission (30MHz – 1GHz)



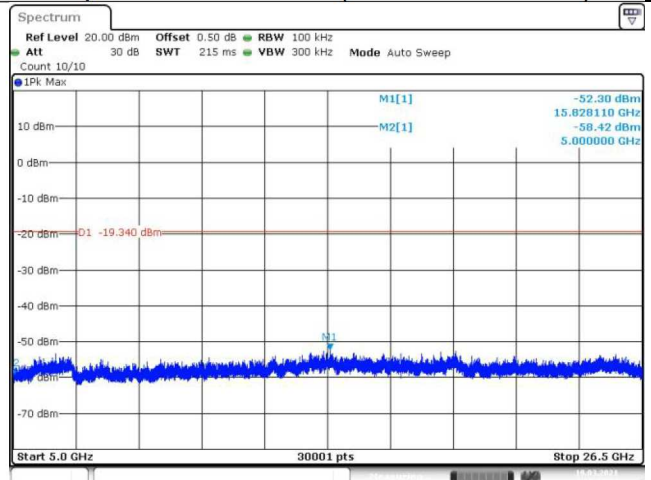
Date: 19 MAR 2021 11:13:24

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 11:13:36

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 11:14:08

Note: The emission which exceed the limit is the fundamental.



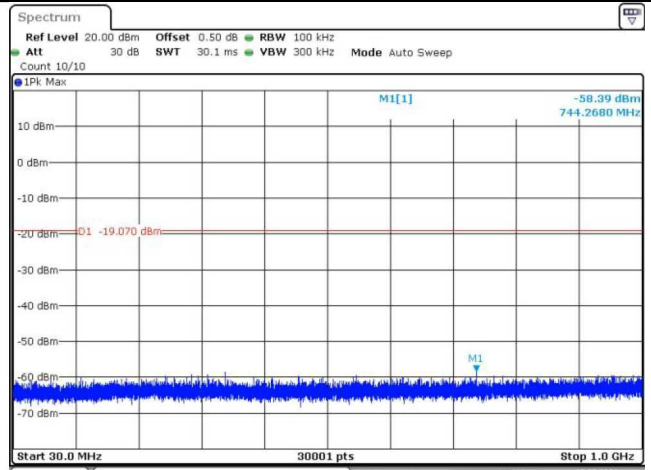
Out-of-Band Emissions
Channel 6 (2437MHz)

Reference point



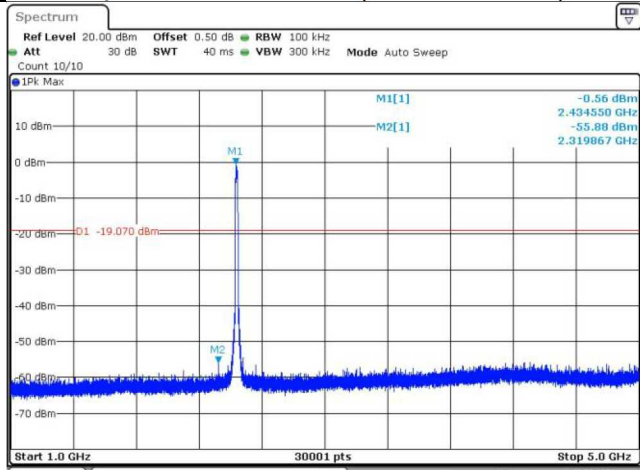
Date: 19 MAR 2021 11:16:27

Spurious Emission (30MHz – 1GHz)



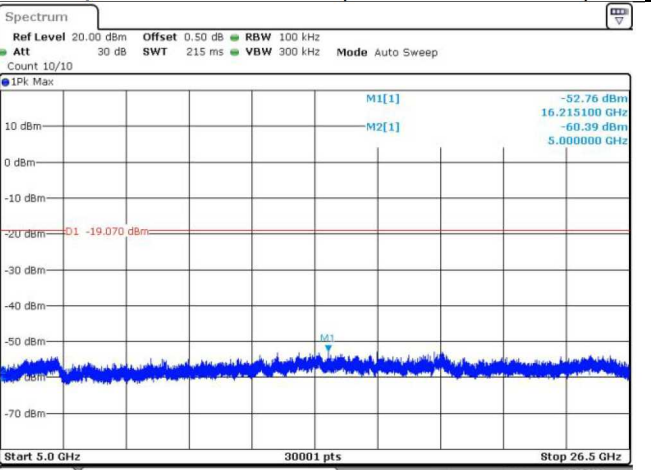
Date: 19 MAR 2021 11:16:31

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 11:16:43

Spurious Emission (5GHz –26.5GHz)



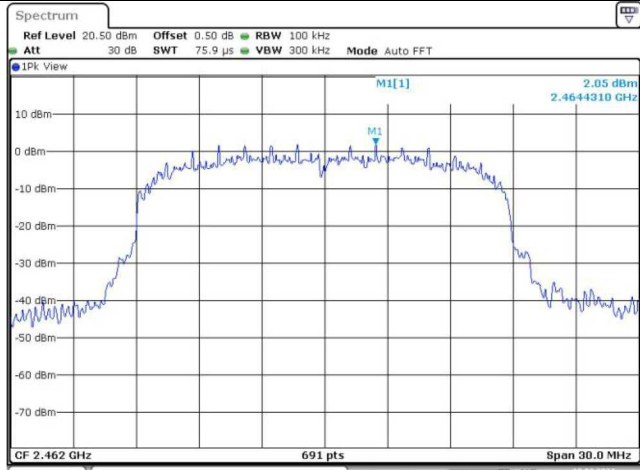
Date: 19 MAR 2021 11:17:15

Note: The emission which exceed the limit is the fundamental.



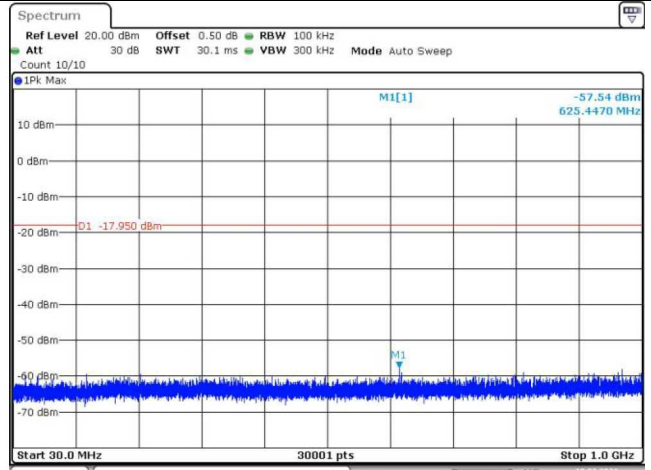
Out-of-Band Emissions
Channel 11 (2462MHz)

Reference point



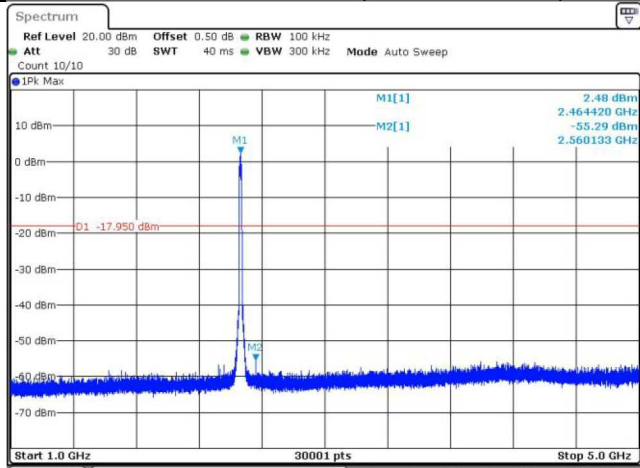
Date: 19 MAR 2021 11:18:31

Spurious Emission (30MHz – 1GHz)



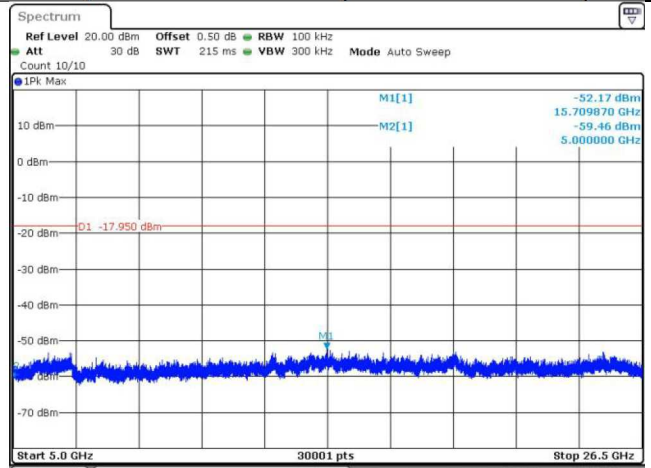
Date: 19 MAR 2021 11:18:36

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 11:18:48

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 11:19:19

Note: The emission which exceed the limit is the fundamental.

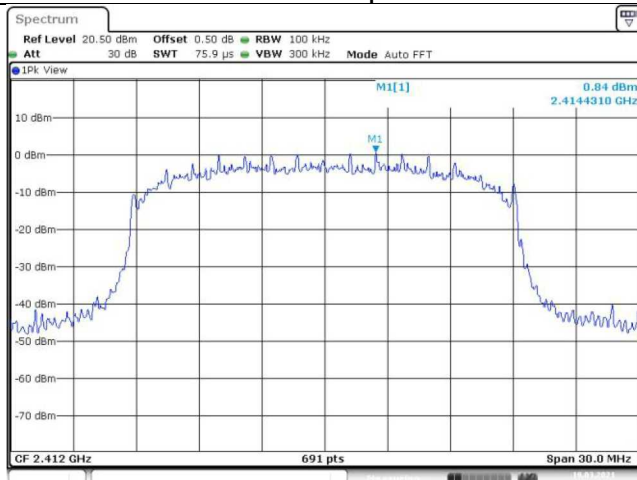


802.11 N20

Out-of-Band Emissions

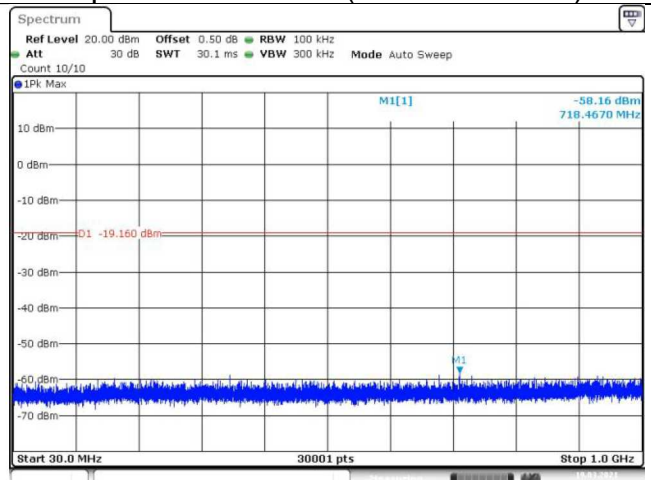
Channel 1 (2412MHz)

Reference point



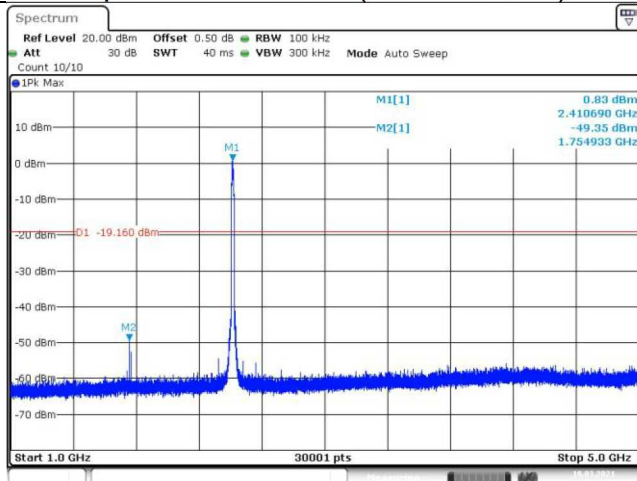
Date: 19 MAR 2021 12:10:02

Spurious Emission (30MHz – 1GHz)



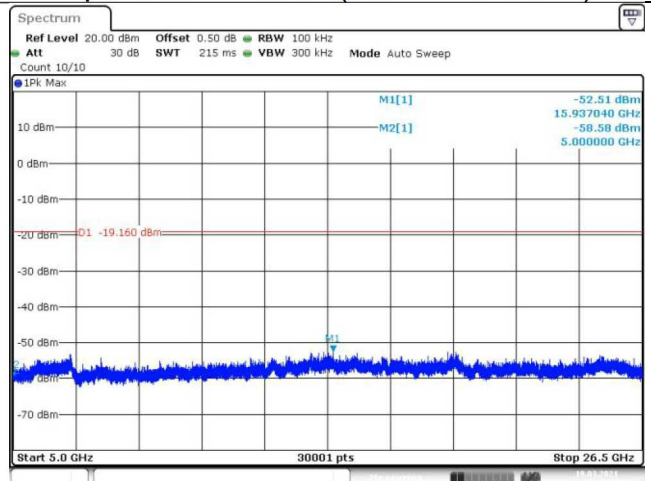
Date: 19 MAR 2021 12:10:06

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 12:10:18

Spurious Emission (5GHz –26.5GHz)

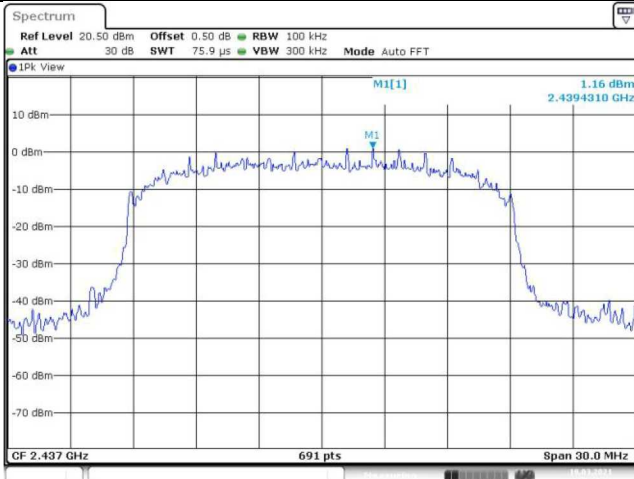


Date: 19 MAR 2021 12:10:50

Note: The emission which exceed the limit is the fundamental.

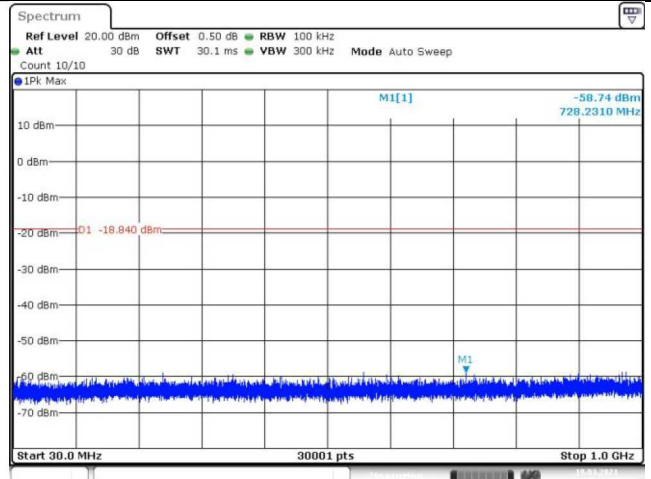
Out-of-Band Emissions
Channel 6 (2437MHz)

Reference point



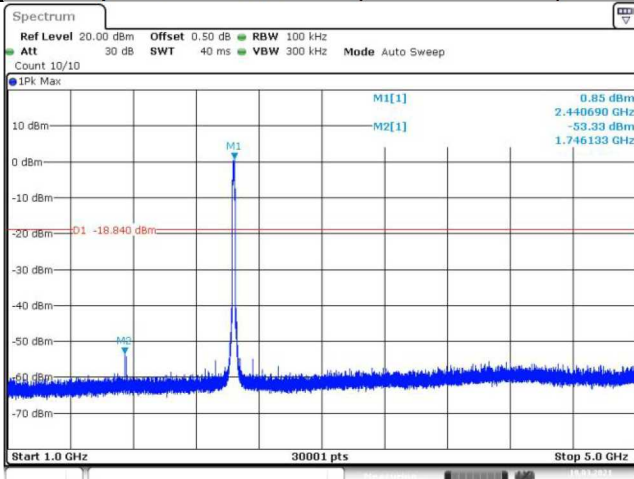
Date: 19 MAR 2021 12:11:53

Spurious Emission (30MHz – 1GHz)



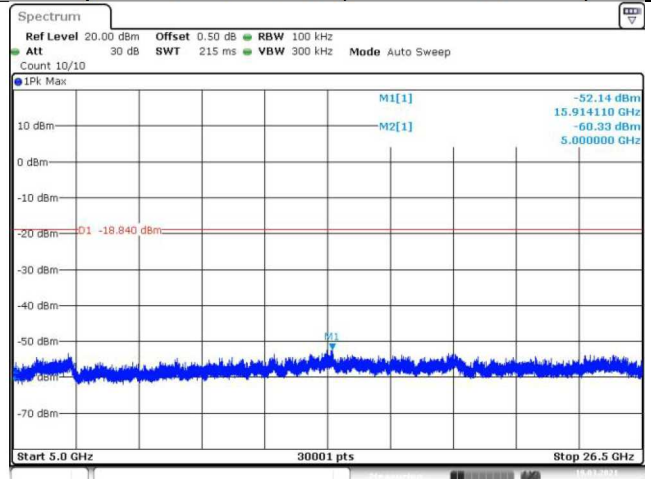
Date: 19 MAR 2021 12:11:58

Spurious Emission (1GHz – 5GHz)



Date: 19 MAR 2021 12:12:10

Spurious Emission (5GHz – 26.5GHz)



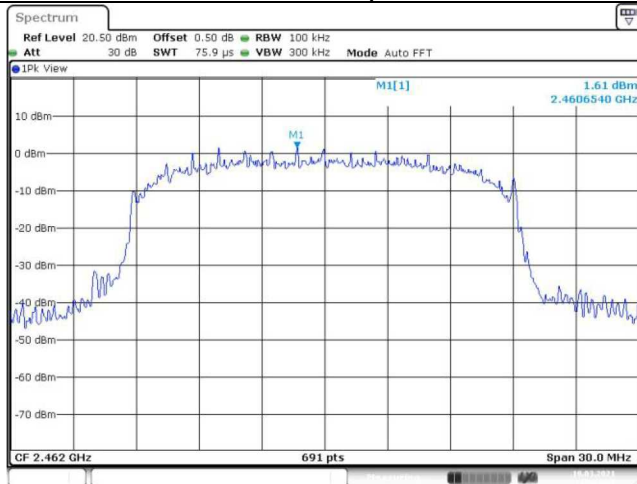
Date: 19 MAR 2021 12:12:41

Note: The emission which exceed the limit is the fundamental.



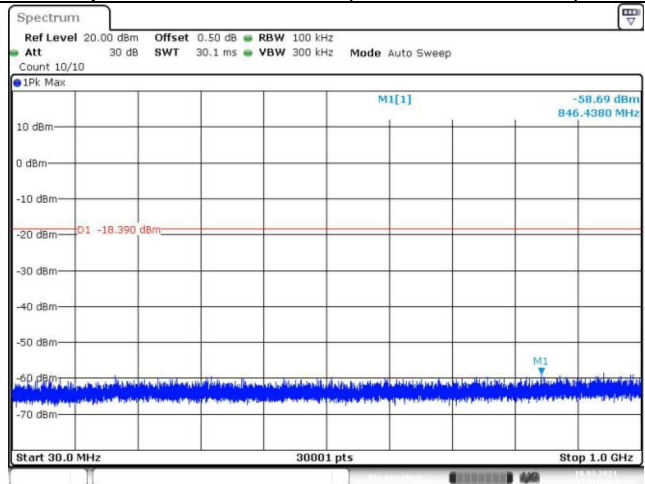
Out-of-Band Emissions
Channel 11 (2462MHz)

Reference point



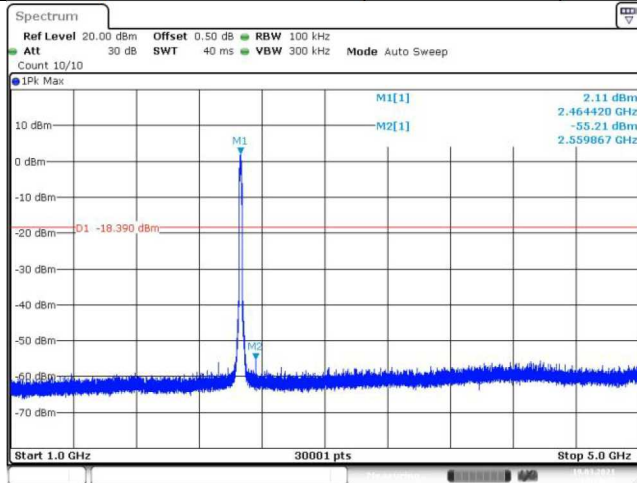
Date: 19 MAR 2021 12:14:29

Spurious Emission (30MHz – 1GHz)



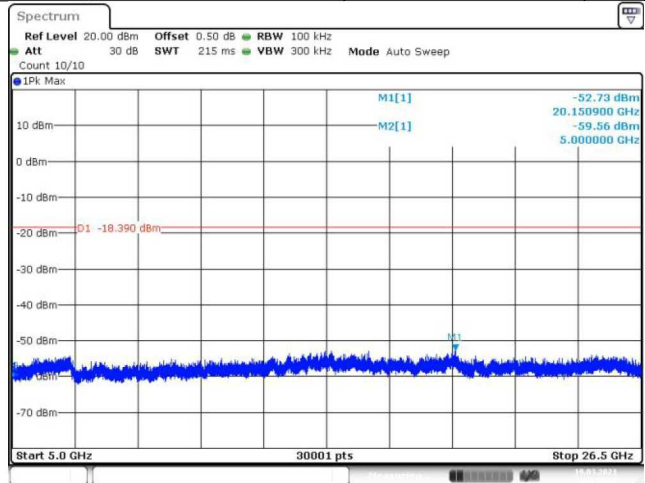
Date: 19 MAR 2021 12:14:33

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 12:14:46

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 12:15:17

Note: The emission which exceed the limit is the fundamental.

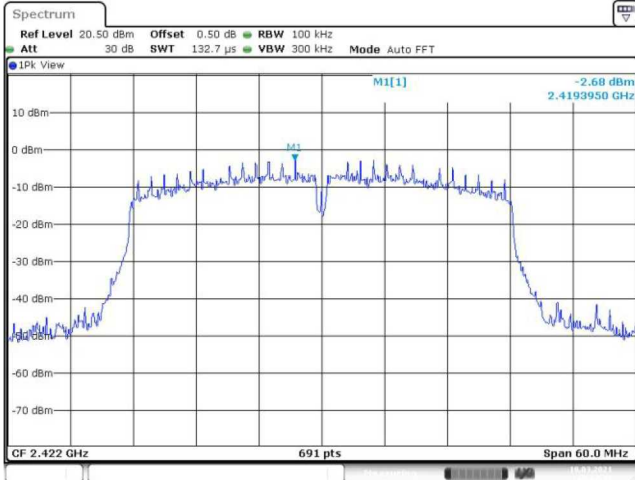
802.11 N40

Out-of-Band Emissions

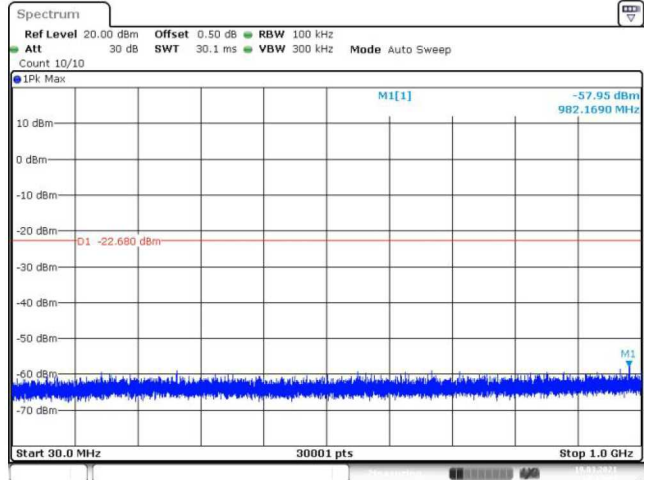
Channel 1 (2422MHz)

Reference point

Spurious Emission (30MHz – 1GHz)



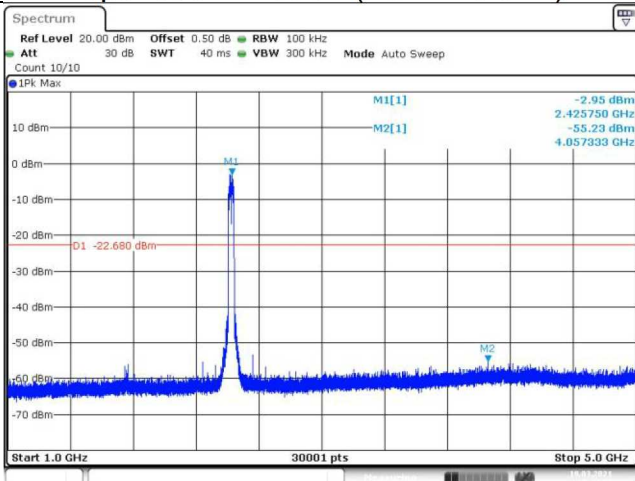
Date: 19 MAR 2021 12:17:20



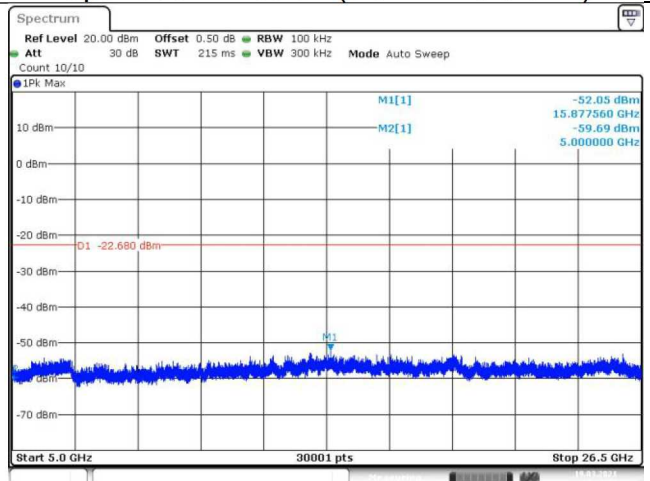
Date: 19 MAR 2021 12:17:24

Spurious Emission (1GHz –5GHz)

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 12:17:36



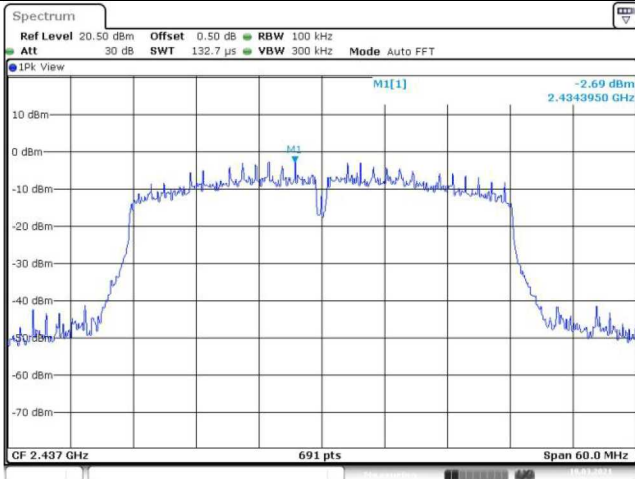
Date: 19 MAR 2021 12:18:08

Note: The emission which exceed the limit is the fundamental.

Out-of-Band Emissions

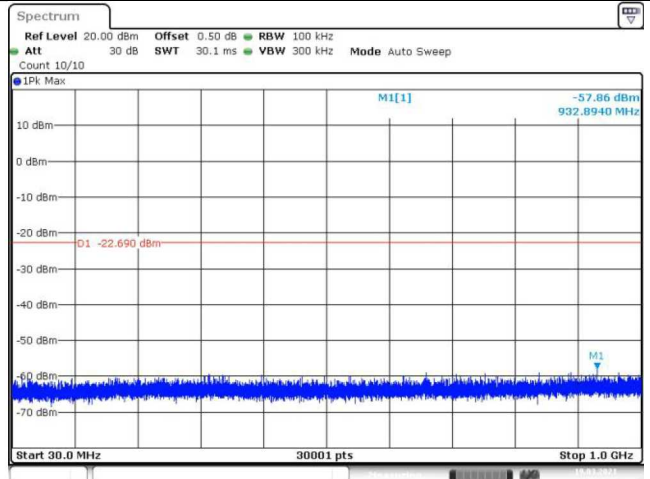
Channel 6 (2437MHz)

Reference point



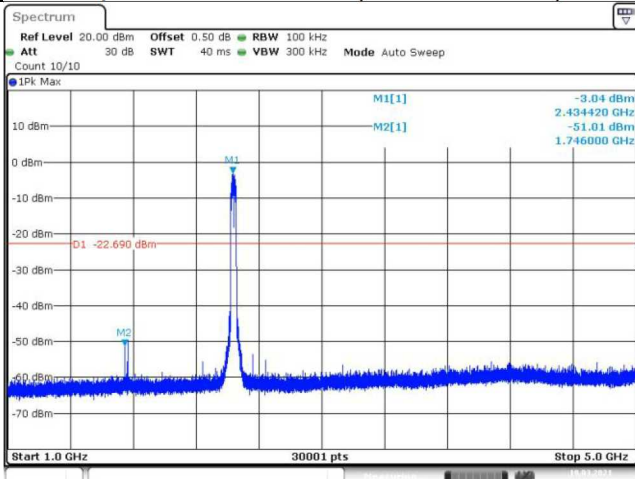
Date: 19 MAR 2021 12:20:28

Spurious Emission (30MHz – 1GHz)



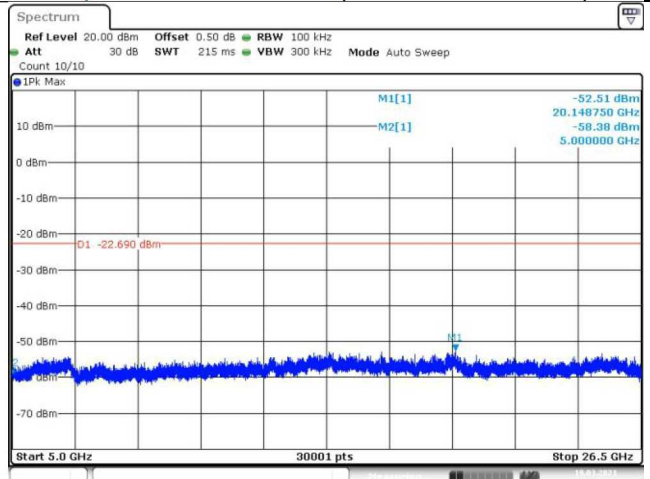
Date: 19 MAR 2021 12:20:32

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 12:20:44

Spurious Emission (5GHz –26.5GHz)

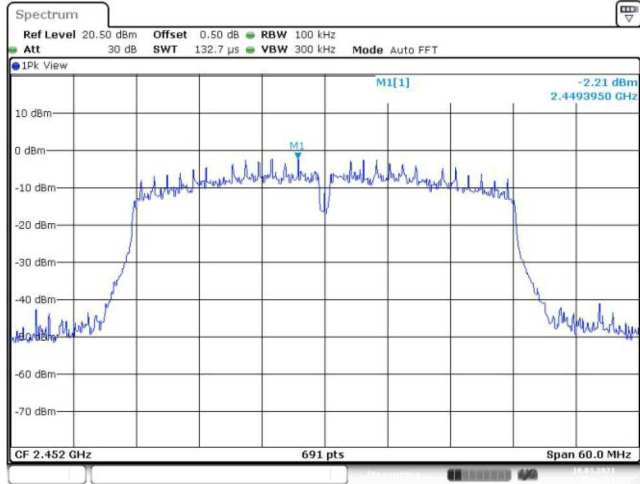


Date: 19 MAR 2021 12:21:16

Note: The emission which exceed the limit is the fundamental.

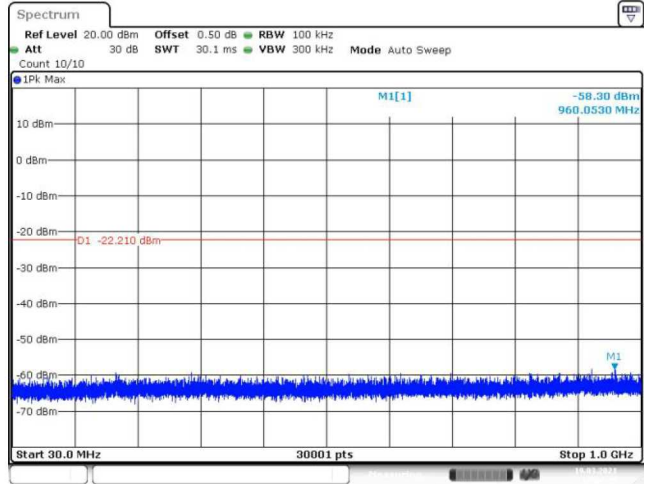
Out-of-Band Emissions
Channel 11 (2452MHz)

Reference point



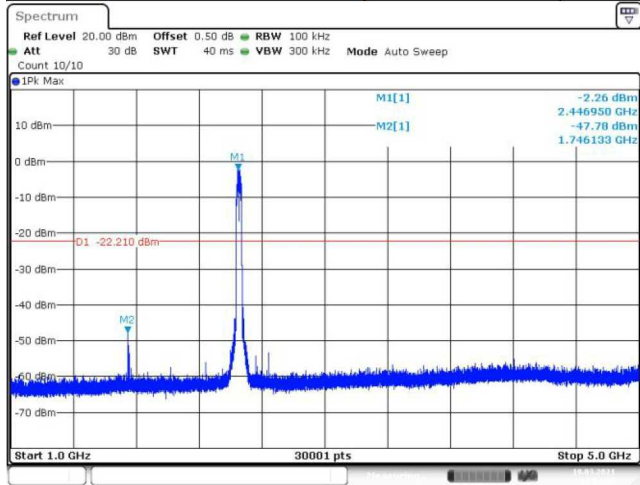
Date: 19 MAR 2021 12:22:31

Spurious Emission (30MHz – 1GHz)



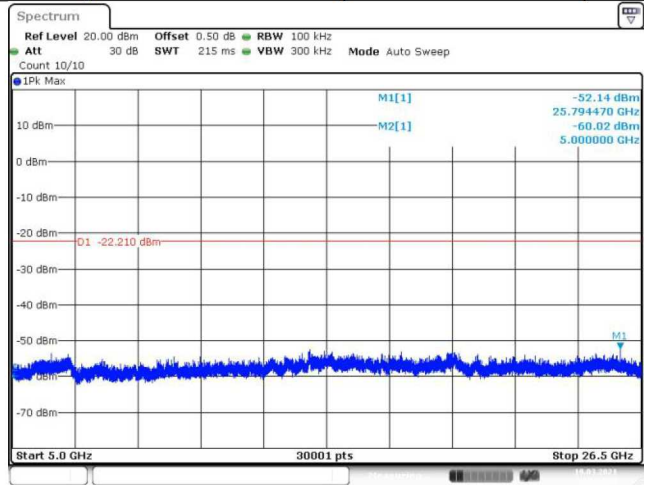
Date: 19 MAR 2021 12:22:35

Spurious Emission (1GHz –5GHz)



Date: 19 MAR 2021 12:22:47

Spurious Emission (5GHz –26.5GHz)



Date: 19 MAR 2021 12:23:19

Note: The emission which exceed the limit is the fundamental.



9.6 Band edge

Test Method

- 1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section.

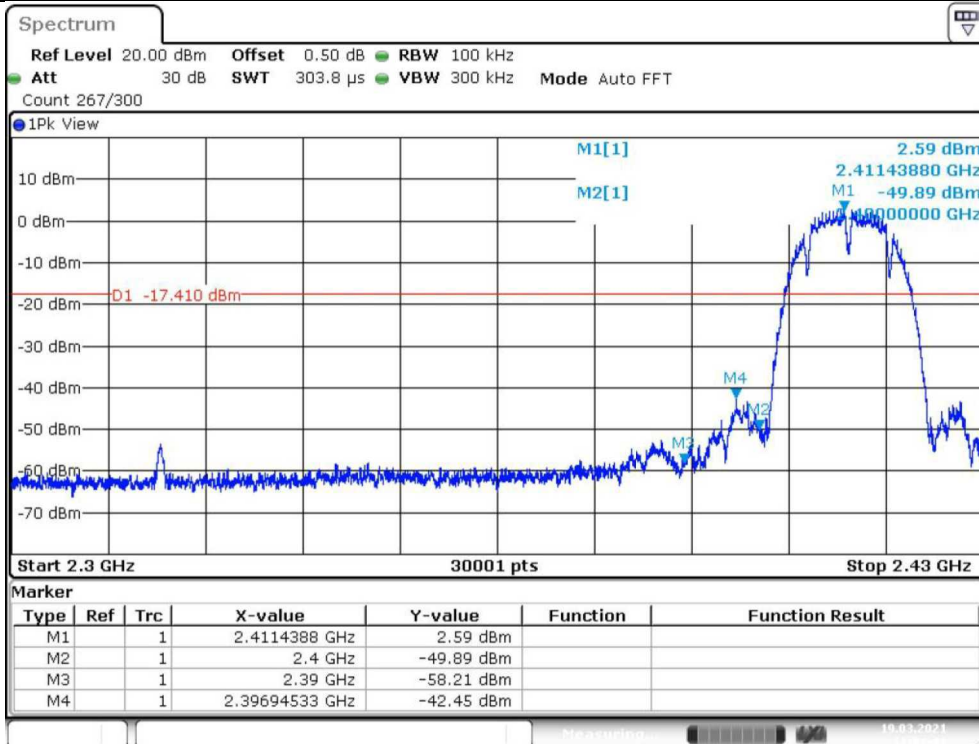
Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

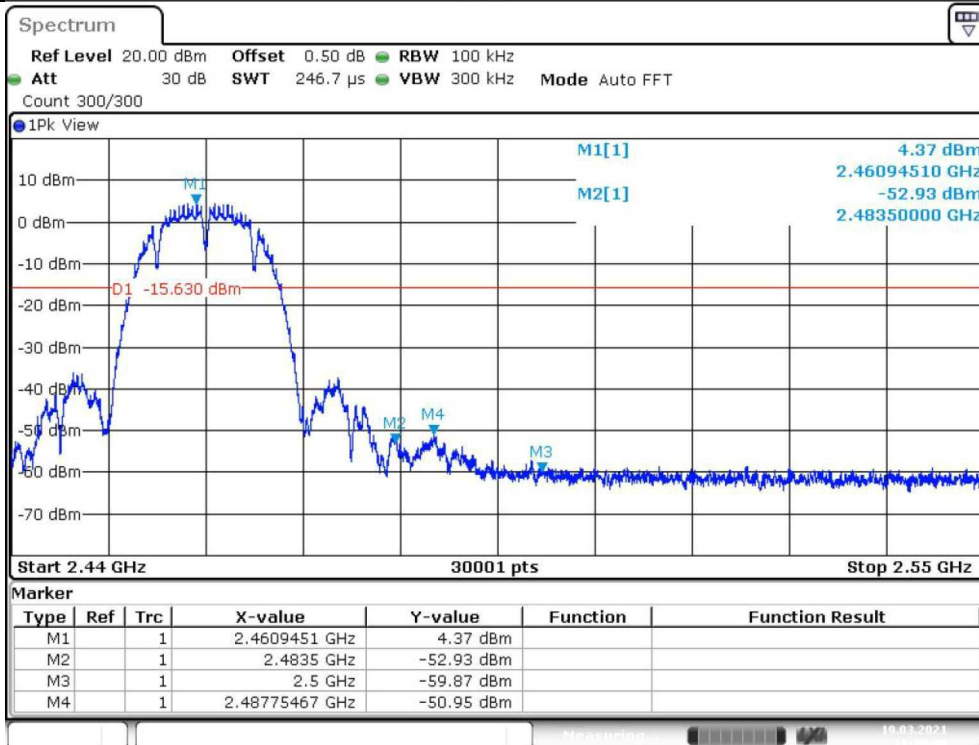
Test result

802.11 B

Low_2412



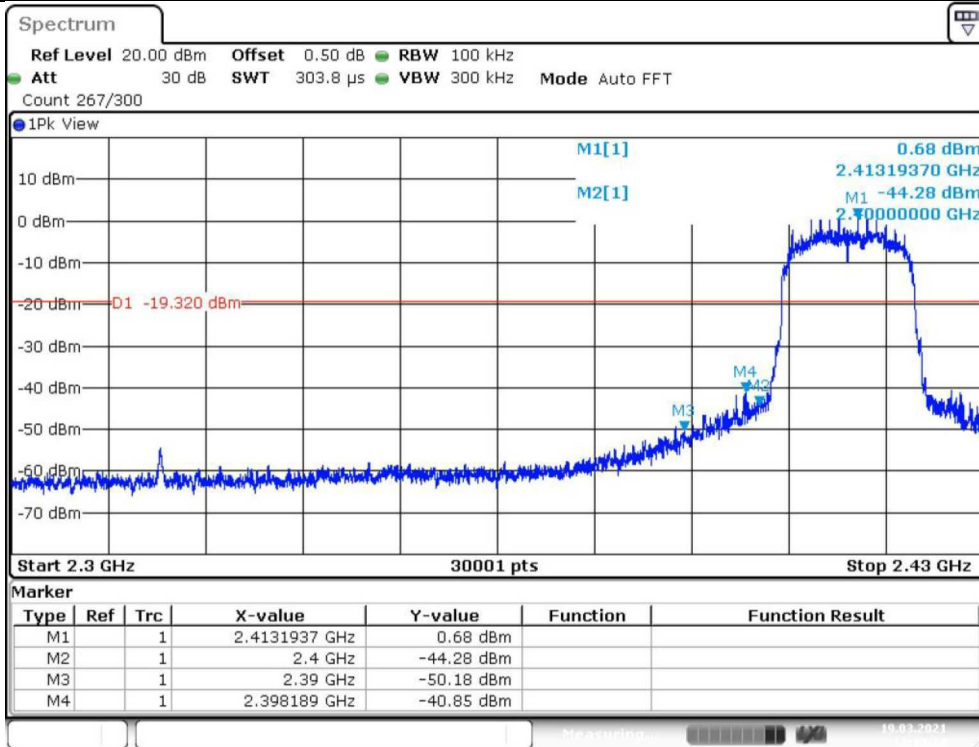
High_2462



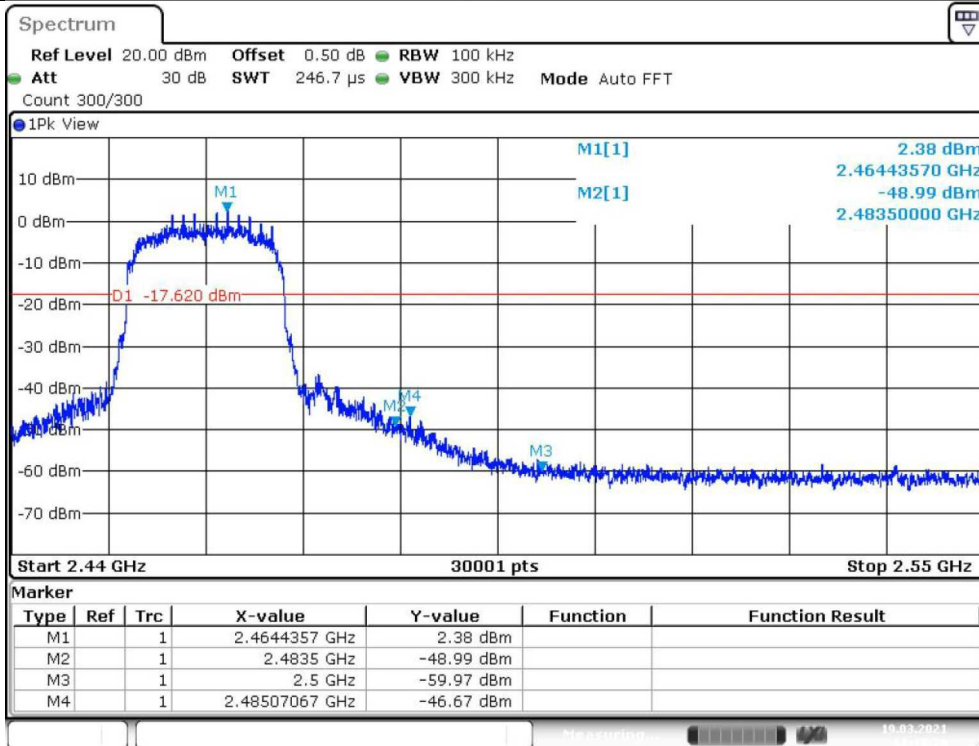


802.11 G

Low_2412



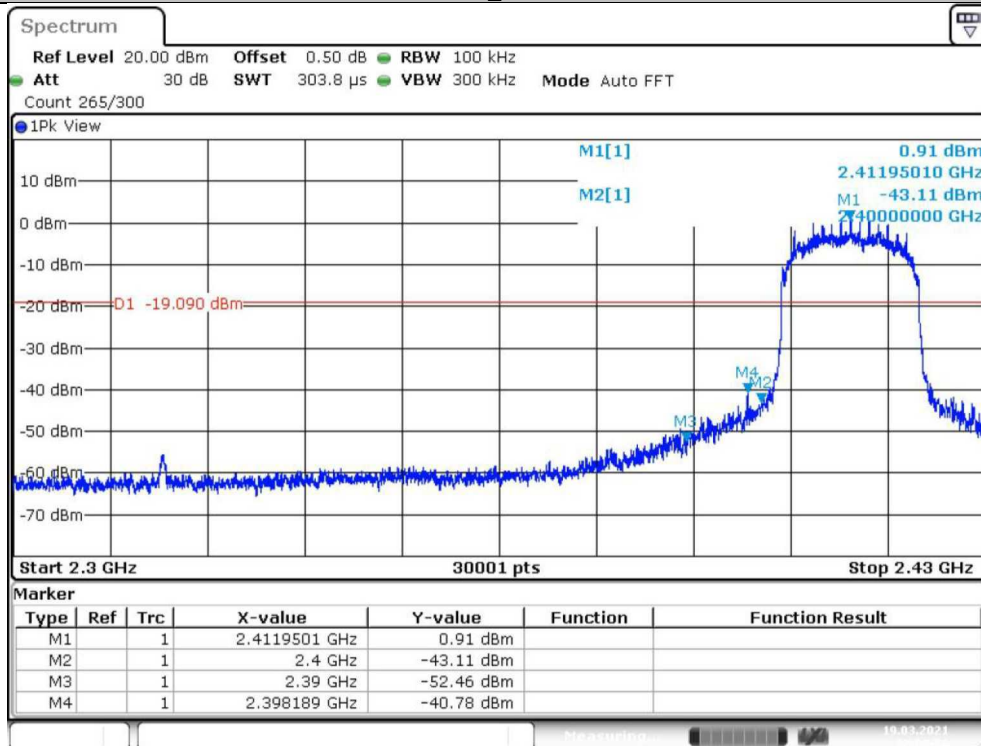
High_2462





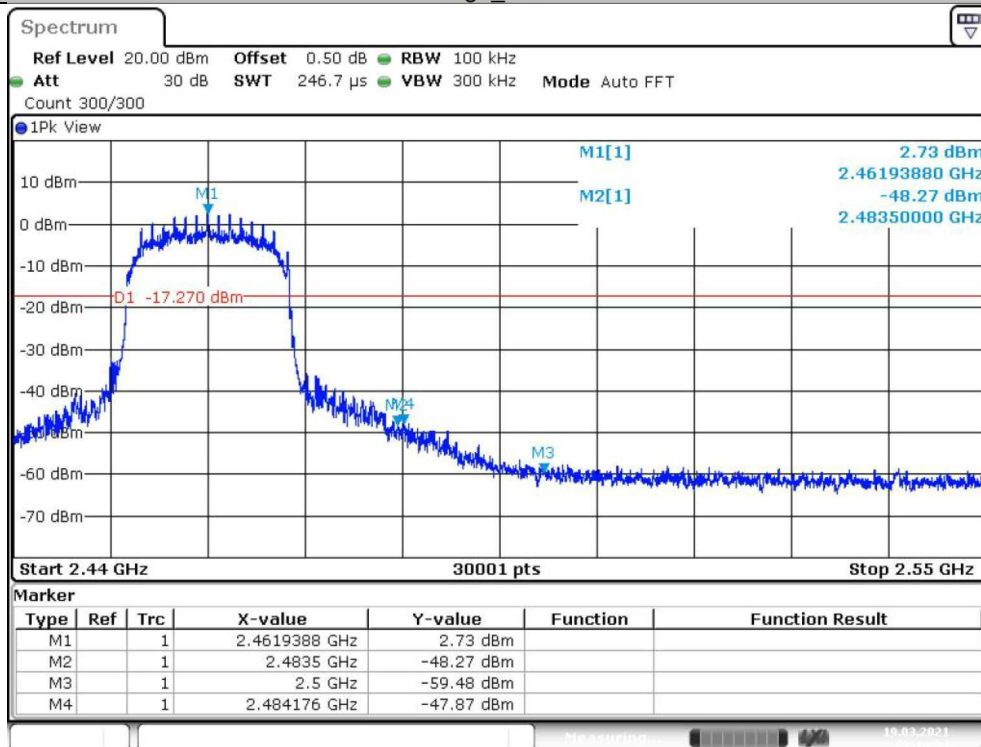
802.11 N20

Low_2412



Date: 19.MAR.2021 12:09:57

High_2462

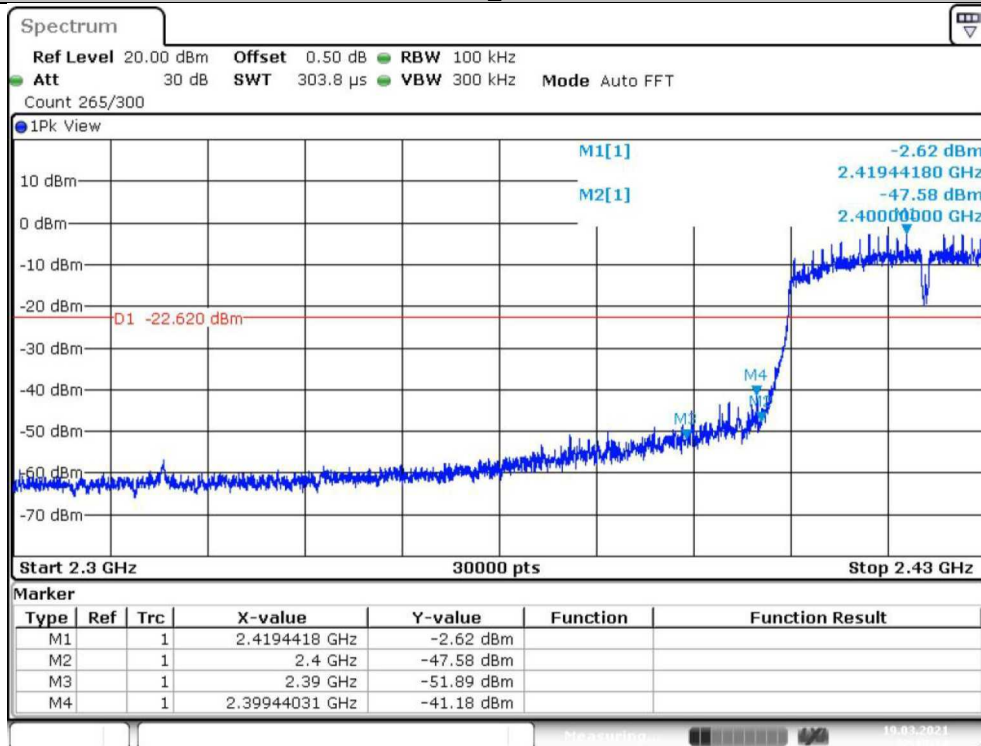


Date: 19.MAR.2021 12:14:24

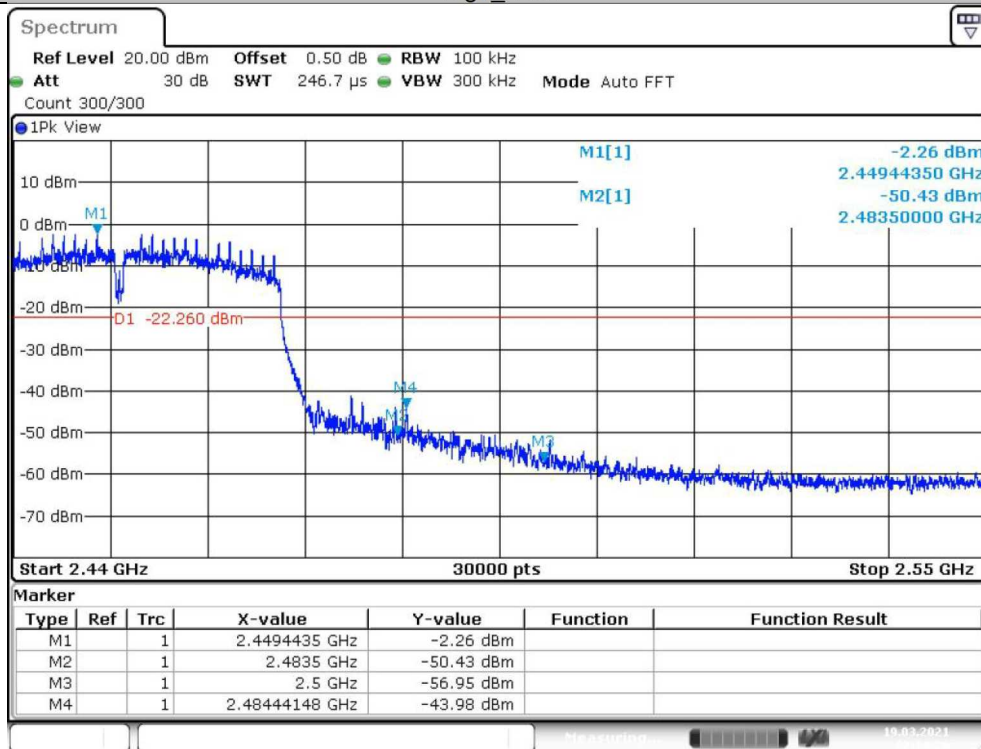


802.11 N40

Low_2422



High_2452



9.7 Spurious radiated emissions for transmitter

Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10:

For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious
 RBW = 100 kHz to 120 kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious
 RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1000 MHz

- a) RBW = 1MHz.
- b) VBW ≥ [3 × RBW].
- c) Detector = RMS (power averaging), if $[\text{span} / (\# \text{ of points in sweep})] \leq \text{RBW} / 2$. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
- e) Sweep time = auto.
- f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
- g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then 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 the preceding step e), then the correction

factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.

2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205 must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Measured Distance Meters
0.009~0.490	2400/F (kHz)	300
0.490~1.705	24000/F (kHz)	30
1.705~30	30	30

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

The only worse case (which is subject to the maximum EIRP, 802.11n HT20 mode) test result is listed in the report.

Transmitting spurious emission test result as below:

Test mode: 802.11B					
Channel 1 (2412MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2385.9	54.2	74.0	19.8	Peak	Horizontal
2385.9	50.1	54.0	3.9	Average	Horizontal
4823.9	47.1	74.0	26.9	Peak	Horizontal
2385.9	49.4	74.0	24.6	Peak	Vertical
4818.8	43.6	74.0	30.4	Peak	Vertical

Test mode: 802.11B					
Channel 6 (2437MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4873.7	44.3	74.0	29.7	Peak	Horizontal
5939.6	46.1	74.0	27.9	Peak	Vertical

Test mode: 802.11B					
Channel 11 (2462MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2487.8	51.4	74.0	22.6	Peak	Horizontal
5849.0	46.5	74.0	27.5	Peak	Horizontal
2483.6	48.7	74.0	25.3	Peak	Vertical
9847.9	49.0	74.0	25	Peak	Vertical

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

Test mode: 802.11G					
Channel 1 (2412MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2389.4	57.8	74.0	16.2	Peak	Horizontal
2389.4	46.9	54.0	7.1	Average	Horizontal
4993.3	45.0	74.0	29	Peak	Horizontal
2389.3	55.6	74.0	18.4	Peak	Vertical
2389.3	44.4	54.0	9.6	Average	Vertical
8252.8	49.7	74.0	24.3	Peak	Vertical

Test mode: 802.11G					
Channel 6 (2437MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
5896.0	45.7	74.0	28.3	Peak	Horizontal
9747.6	49.3	74.0	24.7	Peak	Vertical

Test mode: 802.11G					
Channel 11 (2462MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.5	55.6	74.0	18.4	Peak	Horizontal
2483.5	44.8	54.0	9.2	Average	Horizontal
6234.9	45.9	74.0	28.1	Peak	Horizontal
2483.6	54.2	74.0	19.8	Peak	Vertical
2483.6	45.4	54.0	8.6	Average	Vertical
9847.9	50.2	74.0	23.8	Peak	Vertical

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

Test mode: 802.11N20					
Channel 1 (2412MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2389.9	59.7	74.0	14.3	Peak	Horizontal
2389.9	49.2	54.0	4.8	Average	Horizontal
9647.9	50.7	74.0	23.3	Peak	Horizontal
2390.0	53.1	74.0	20.9	Peak	Vertical
2390.0	43.7	54.0	10.3	Average	Vertical
8280.5	49.4	74.0	24.6	Peak	Vertical

Test mode: 802.11N20					
Channel 6 (2437MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
9747.6	51.2	74.0	22.8	Peak	Horizontal
9762.4	48.9	74.0	25.1	Peak	Vertical

Test mode: 802.11N20					
Channel 11 (2462MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.6	56.1	74.0	17.9	Peak	Horizontal
2483.6	43.1	54.0	10.9	Average	Horizontal
9847.9	51.0	74.0	23	Peak	Horizontal
2483.6	53.2	74.0	20.8	Peak	Vertical
2483.6	42.5	54.0	11.5	Average	Vertical
9847.9	49.1	74.0	24.9	Peak	Vertical

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading



Test mode: 802.11N40					
Channel 1 (2422MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2389.9	57.1	74.0	16.9	Peak	Horizontal
2389.9	48.2	54.0	5.8	Average	Horizontal
9688.1	51.3	74.0	22.7	Peak	Horizontal
2389.9	52.7	74.0	21.3	Peak	Vertical
2388.9	45.1	54.0	8.9	Average	Vertical
1056.4	51.0	74.0	23	Peak	Vertical

Test mode: 802.11N40					
Channel 6 (2437MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
8280.5	50.4	74.0	23.6	Peak	Horizontal
9747.6	49.0	74.0	25	Peak	Vertical

Test mode: 802.11N40					
Channel 11 (2452MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.8	53.3	74.0	20.7	Peak	Horizontal
2483.8	43.2	54.0	10.8	Average	Horizontal
9807.7	51.6	74.0	22.4	Peak	Horizontal
2483.7	59.7	74.0	14.3	Peak	Vertical
2483.7	43.3	54.0	10.7	Average	Vertical
9846.2	48.5	74.0	25.5	Peak	Vertical

Remark:

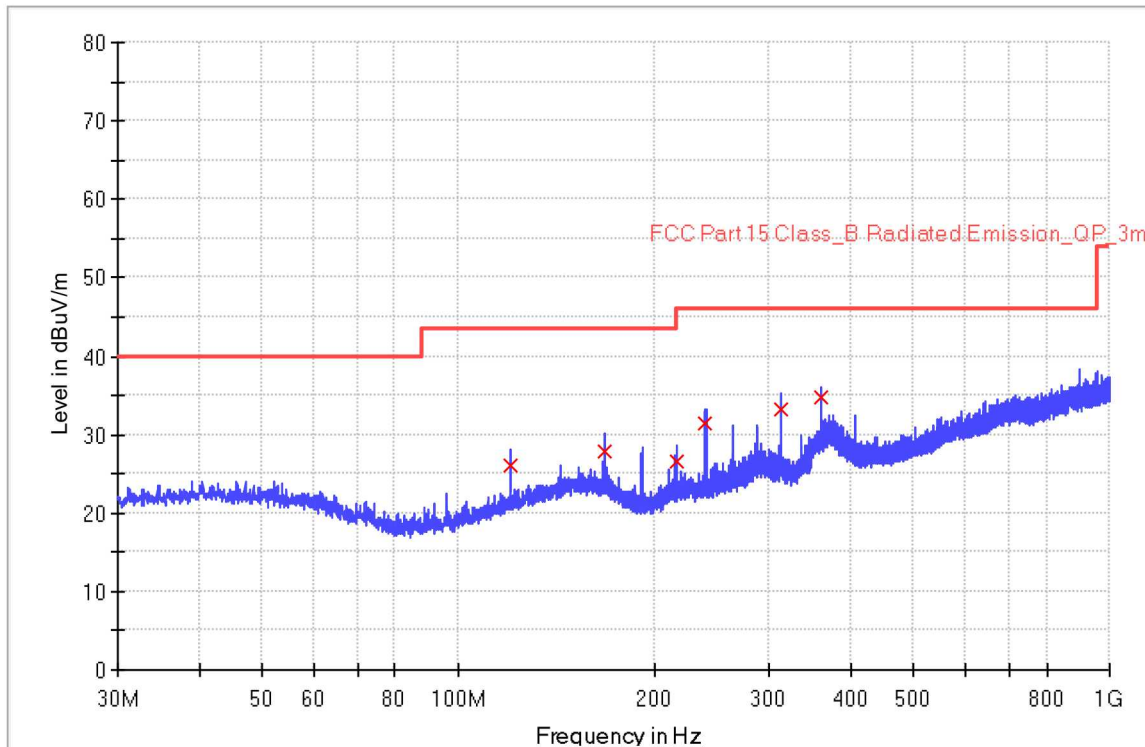
- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading



The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2021/03/14 - 10:51
Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)	Engineer: Wenqiang LU
Probe: VULB9168	Polarity: Horizontal
UT: Wi-Fi and Bluetooth module, Model no: CBU-IPEX	Power: 120VAC, 60Hz
Note: Transmit by at channel 2462MHz 802.11n HT20 (worst case).	
Note: Pre-scan with three orthogonal axis and worst case as X axis.	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
120.000000	26.2	1000.0	120.000	100.0	H	158.0	13.5	17.4	43.5
167.920000	27.9	1000.0	120.000	100.0	H	263.0	14.9	15.7	43.5
216.000000	26.6	1000.0	120.000	100.0	H	18.0	12.3	19.4	46.0
238.840000	31.3	1000.0	120.000	100.0	H	205.0	13.4	14.7	46.0
311.920000	33.1	1000.0	120.000	100.0	H	114.0	15.3	12.9	46.0
360.040000	34.7	1000.0	120.000	100.0	H	52.0	16.5	11.3	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

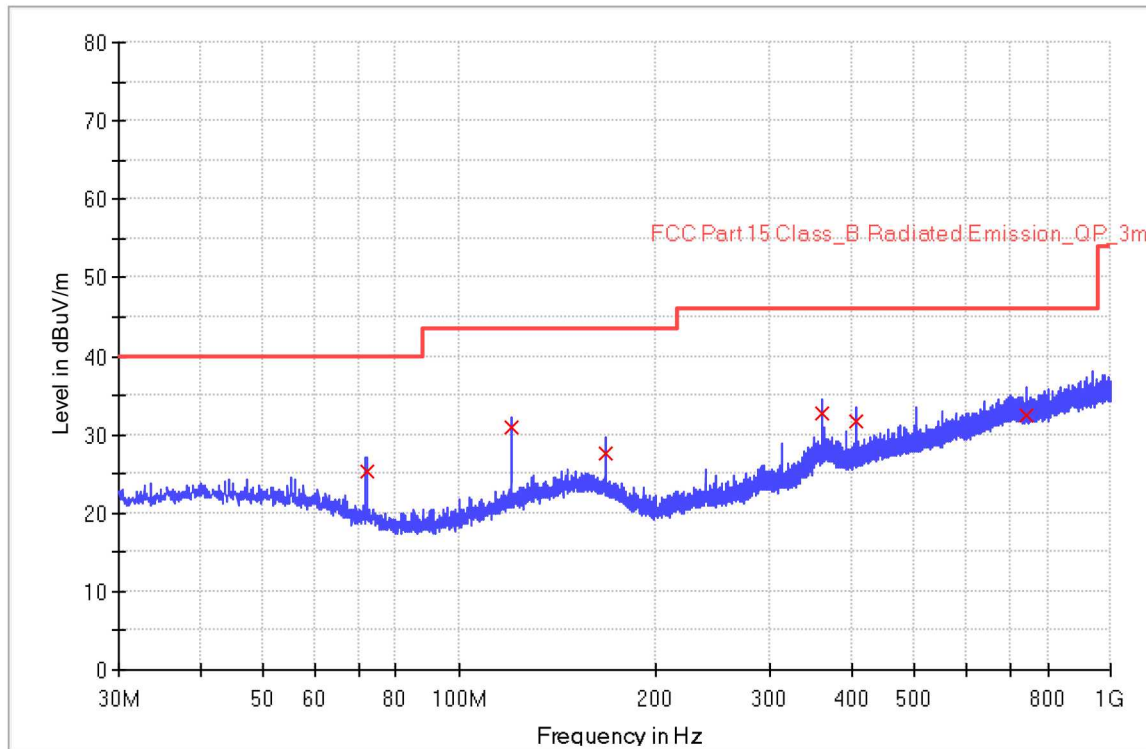
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.



Site: 3 meter chamber	Time: 2021/03/14 - 15:52
Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)	Engineer: Wenqiang LU
Probe: VULB9168	Polarity: Vertical
UT: Wi-Fi and Bluetooth module, Model no: CBU-IPEX	Power: 120VAC, 60Hz
Note: Transmit by at channel 2462MHz 802.11n HT20 (worst case).	
Note: Pre-scan with three orthogonal axis and worst case as X axis.	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
71.960000	25.2	1000.0	120.000	100.0	V	162.0	11.5	14.8	40.0
120.000000	31.0	1000.0	120.000	100.0	V	84.0	13.5	12.5	43.5
168.040000	27.7	1000.0	120.000	100.0	V	205.0	14.9	15.8	43.5
359.960000	32.6	1000.0	120.000	100.0	V	162.0	16.5	13.4	46.0
407.960000	31.7	1000.0	120.000	100.0	V	84.0	17.5	14.3	46.0
743.960000	32.4	1000.0	120.000	100.0	V	114.0	23.9	13.6	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

10 Test Equipment List

List of Test Instruments Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
	Wideband power sensor	Rohde & Schwarz	NRP-Z81	104782	2020-12-23	2021-12-22
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2020-8-4	2021-8-3
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2019-3-16	2022-3-15
	Horn Antenna	Rohde & Schwarz	HF907	102393	2018-6-11	2021-4-1
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2020-8-4	2021-8-3
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2020-6-28	2021-6-27
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2020-9-23	2021-9-22
	3m Semi-anechoic chamber	TDK	9X6X6	----	2018-5-11	2021-5-10
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2020-8-4	2021-8-3
	LISN	Rohde & Schwarz	ENV216	101924	2020-8-4	2021-8-3
Measurement Software Information						
Test Item	Software	Manufacturer	Version			
C	Power Viewer	Rohde & Schwarz	V 11.0			
C	Bluetooth and WiFi Test System	Shenzhen JS tonscond co.,ltd	2.6.77.0518			
RE	EMC 32	Rohde & Schwarz	V9.15.00			
CE	EMC 32	Rohde & Schwarz	V9.15.03			

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Band edge

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, ± 3.16 dB
Radiated Disturbance	30MHz to 1GHz, ± 5.03 dB (Horizontal) ± 5.12 dB (Vertical) 1GHz to 18GHz, ± 5.49 dB 18GHz to 40GHz, ± 5.63 dB
Carrier power conducted measurement	50MHz~18GHz, ± 1.238 dB
Spurious Emission Conducted Measurement	9kHz ~40GHz, ± 1.224 dB



12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



13 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

THE END