FCC TEST REPORT

Test report
On Behalf of
Shenzhen GMK Technology Co., Ltd
For
NucBox2
Model No.: KB2

FCC ID: 2AXUD-KB2

Prepared for : **Shenzhen GMK Technology Co., Ltd**
3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St, Longhua Dist, 518109, Shenzhen, China

Prepared By : **Shenzhen Tongzhou Testing Co.,Ltd**
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Date of Test: **2021/3/17 ~ 2021/3/22**
Date of Report: **2021/3/31**
Report Number: **TZ210302066-E3**

The test report apply only to the specific sample(s) tested under stated test conditions
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TEST RESULT CERTIFICATION

Applicant's name ..... :	**Shenzhen GMK Technology Co., Ltd**
Address ..... :	3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St, Longhua Dist, 518109, Shenzhen, China
Manufacture's Name ..... :	**Shenzhen GMK Technology Co., Ltd**
Address ..... :	3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St, Longhua Dist, 518109, Shenzhen, China
Product description	
Trade Mark .....:	GMK, GMKTEC
Product name .....:	NucBox2
Model and/or type reference :	KB2
Standards..... :	FCC Rules and Regulations Part 15 Subpart C Section 15.247 ANSI C63.10: 2013

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Date of Test ..... :	
Date (s) of performance of tests..... :	2021/3/17 ~ 2021/3/22
Date of Issue ..... :	2021/3/31
Test Result..... :	**Pass**

Testing Engineer : Anna Hu

(Anna Hu)

Technical Manager : Hugo Chen

(Hugo Chen)

Authorized Signatory : Andy Zhang

(Andy Zhang)

Revision History

Revision	Issue Date	Revisions	Revised By
000	2021/3/31	Initial Issue	Andy Zhang

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1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	NucBox2
Model Number	:	KB2
Model Declaration	:	N/A
Test Model	:	KB2
Power Supply	:	DC 19V by adapter
Hardware version	:	IP3_CB1D_MB_V13 2020_11_30A
Software version	:	Windows 10
Sample ID	:	TZ210302066–1#
Bluetooth		
Bluetooth Version	:	V4.2
Channel Number	:	79 Channels for Bluetooth BR/EDR(DSS) 40 Channels for BLE (DTS)
Modulation Technology	:	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth BR/EDR (DSS) GFSK for BLE (DTS)
Data Rates	:	Bluetooth BR/EDR (DSS): 1/2/3Mbps BLE (DTS): 1Mbps
Antenna Type And Gain		Internal Antenna /2.39 dBi(Max.)
WiFi		
WLAN	:	Supported IEEE 802.11a/b/g/n
WLAN FCC Operation Frequency	:	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz / 5180-5240MHz IEEE 802.11n HT40:5190-5230MHz IEEE 802.11a: 5180-5240MHz IEEE 802.11ac VHT20: 5180-5240MHz IEEE 802.11ac VHT40: 5190-5230MHz IEEE 802.11ac VHT80: 5210MHz
WLAN Channel Number	:	11 Channels for 2412-2462MHz(IEEE 802.11b/g/n HT20) 7 Channels for 2422-2452MHz(IEEE 802.11n HT40) 4 Channels for 5180-5240MHz (IEEE 802.11a/ac VHT20/n HT20) 2 Channels for 5190-5230MHz (IEEE 802.11ac VHT40/n HT40) 1 Channels for 5210MHz (IEEE 802.11ac VHT80)
WLAN Modulation Technology	:	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11a: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Type And Gain	:	Internal Antenna Wlan2.4G: 2.39 dBi(Max.) Wlan5G:1.99 dBi(Max.)

Note1: Antenna position refer to EUT Photos.

1.2 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

☑supplied by the lab ☐ supplied by the manufacturer

Manufacturer	Description	Model	Serial Number	Certificate
Shenzhen Jihongda Power Co.,Ltd.	Adapter	JHD-AP030U-120200-AS	N/A	N/A

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	4	N/A
Earphone Port	1	N/A
HDMI Port	2	N/A
Type-c Port	1	N/A
TF Card Port	1	N/A
LAN	1	N/A

1.4. Description of Test Facility

Designation Number: CN1275
Test Firm Registration Number: 167722

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.5. Statement of the Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the HUAK quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.08dB	(1)
		30MHz~1000MHz	±4.42dB	(1)
		1GHz~40GHz	±4.06dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±2.23dB	(1)

(1). This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.7. Description of Test Modes

The EUT has been tested under operating condition.

AC power line conducted emission pre-test at both at AC 120V/60Hz and AC 240V/50Hz modes, recorded worst case.

Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power, that was determined to be 802.11b mode(Middle Channel).

Worst-case mode and channel used for 9 KHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be 802.11b mode(Middle Channel)
Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

IEEE 802.11b Mode: 1 Mbps, DSSS.
IEEE 802.11g Mode: 6 Mbps, OFDM.
IEEE 802.11n Mode HT20: MCS0, OFDM.
IEEE 802.11n Mode HT40: MCS0, OFDM.

Antenna & Bandwidth

Antenna	Antenna 0		Antenna 1		Simultaneously
Bandwidth Mode	20MHz	40MHz	20MHz	40MHz	/
IEEE 802.11b	☑	☐	☐	☐	☐
IEEE 802.11g	☑	☐	☐	☐	☐
IEEE 802.11n	☑	☑	☐	☐	☐

Channel List & Frequency

IEEE 802.11b/g/n HT20

Frequency Band	Channel No.	Frequency(MHz)	Channel No.	Frequency(MHz)
2412~2462MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437	--	--

IEEE 802.11n HT40

Frequency Band	Channel No.	Frequency(MHz)	Channel No.	Frequency(MHz)
2422~2452MHz	1	--	7	2442
	2	--	8	2447
	3	2422	9	2452
	4	2427	10	--
	5	2432	11	--
	6	2437	--	--

2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen Tongzhou Testing Co.,Ltd

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure KDB 558074 D01 DTS Meas Guidance v04 and KDB 662911 D01 Multiple Transmitter Output v02r01 are required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3. General Test Procedures

2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013

2.4. Test Sample

The application provides 1 sample to meet requirement;

Sample ID	Description
TZ210302066 – 1#	Engineer sample – continuous transmit

3. SYSTEM TEST CONFIGURATION

3.1. Justification

The system was configured for testing in a continuous transmits condition.

3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (DRTU)provided by application.

3.3. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/ unshielded	Notes
1	/	/	/	/	/	/	/

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen Tongzhou Testing Co.,Ltd has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

Applied Standard: FCC Part 15 Subpart C			
FCC Rules	Description of Test	Test Sample	Result
/	Duty Cycle	TZ210302066–1#	Compliant
§15.247(b)	Maximum Conducted Output Power	TZ210302066–1#	Compliant
§15.247(e)	Power Spectral Density	TZ210302066–1#	Compliant
§15.247(a)(2)	6dB Bandwidth	TZ210302066–1#	Compliant
§15.247(a)	Occupied Bandwidth	TZ210302066–1#	Compliant
§15.209, §15.247(d)	Radiated and Conducted Spurious Emissions	TZ210302066–1#	Compliant
§15.205	Emissions at Restricted Band	TZ210302066–1#	Compliant
§15.207(a)	Conducted Emissions	TZ210302066–1#	Compliant
§15.203	Antenna Requirements	TZ210302066–1#	Compliant
§15.247(i)§2.1093	RF Exposure	N/A	Compliant

5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

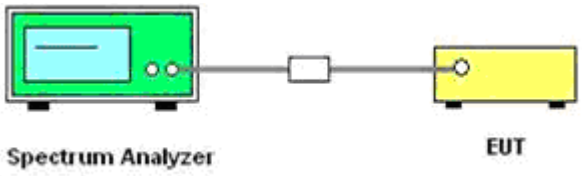
5.1.2. Measuring Instruments and Setting

Please refer to equipment's list in this report. The following table is the setting of the spectrum analyzer.

5.1.3. Test Procedures

1. Set the centre frequency of the spectrum analyzer to the transmitting frequency;
2. Set the span=0MHz, RBW=10MHz, VBW=10MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

5.1.4. Test Setup Layout



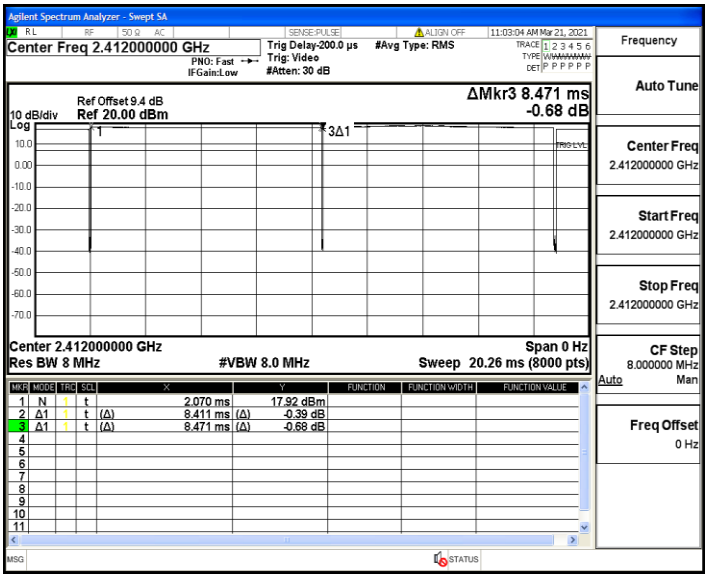
5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

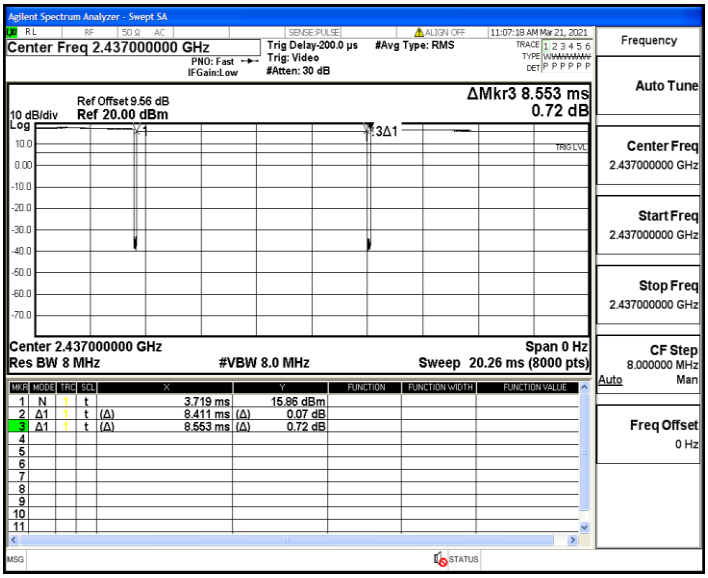
5.1.6. Test result

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2412	8.41	8.47	99.29
		2437	8.41	8.55	98.36
		2462	8.41	8.48	99.17
11G	Ant1	2412	1.39	1.47	94.56
		2437	1.39	1.56	89.10
		2462	1.39	1.49	93.29
11N20SISO	Ant1	2412	1.30	1.36	95.59
		2437	1.31	1.37	95.62
		2462	1.30	1.36	95.59
11N40SISO	Ant1	2422	0.34	0.50	68.00
		2437	0.34	0.46	73.91
		2452	0.34	0.51	66.67

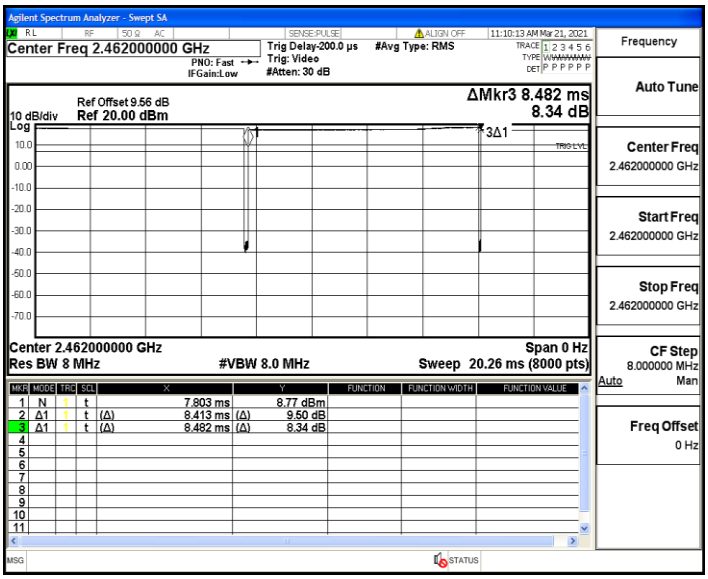
11B_Ant1_2412



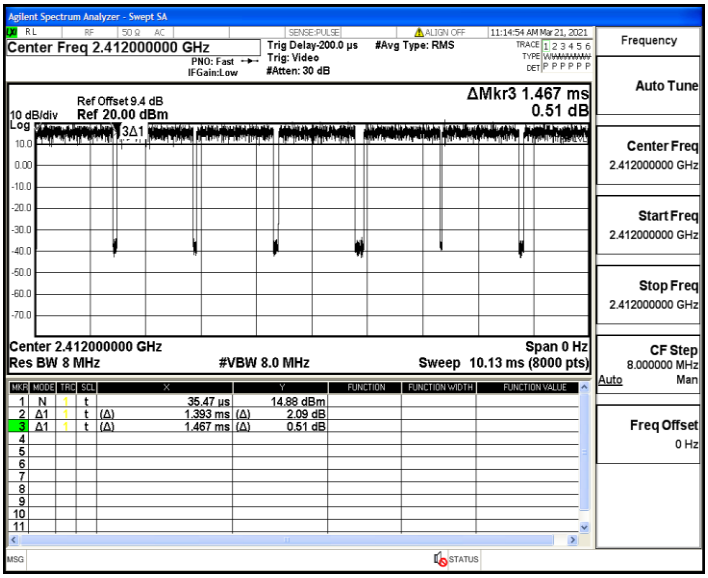
11B_Ant1_2437



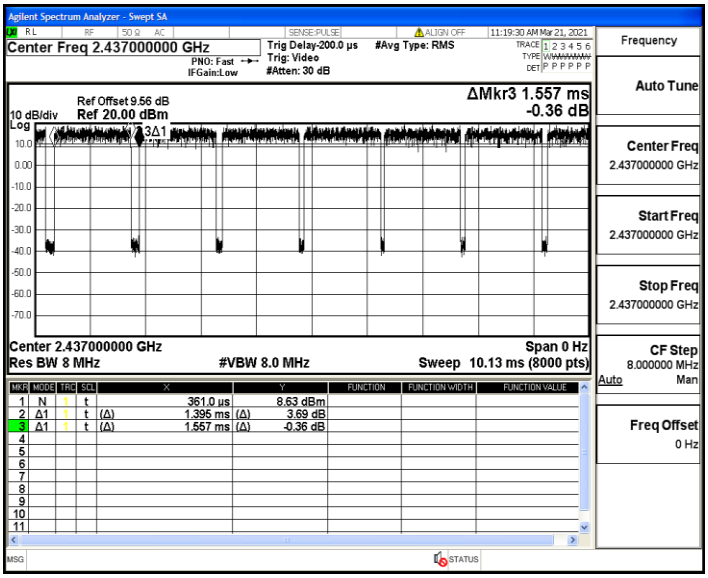
11B_Ant1_2462



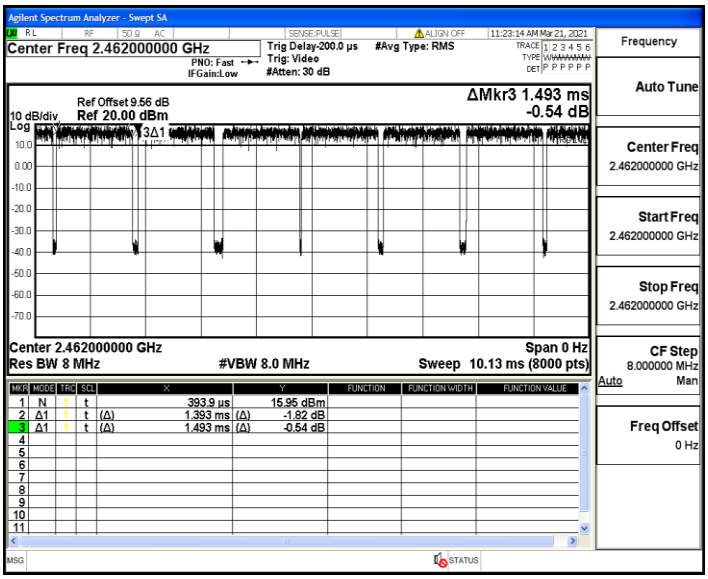
11G_Ant1_2412



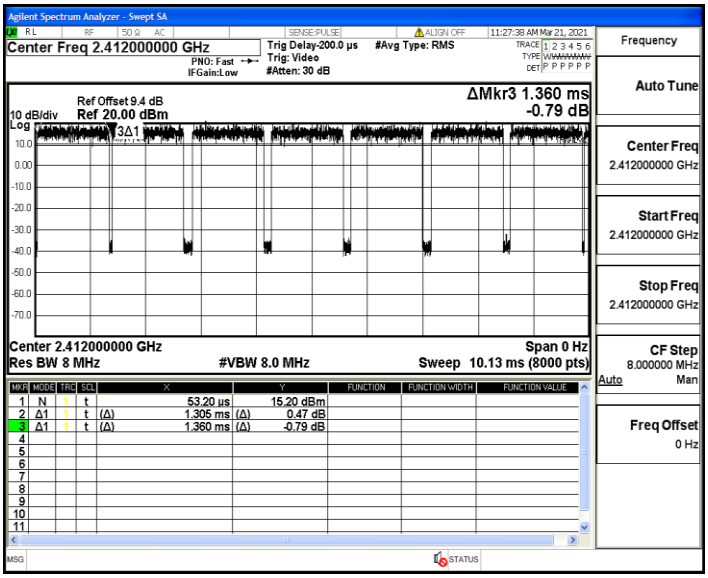
11G_Ant1_2437



11G_Ant1_2462



11N20SISO_Ant1_2412



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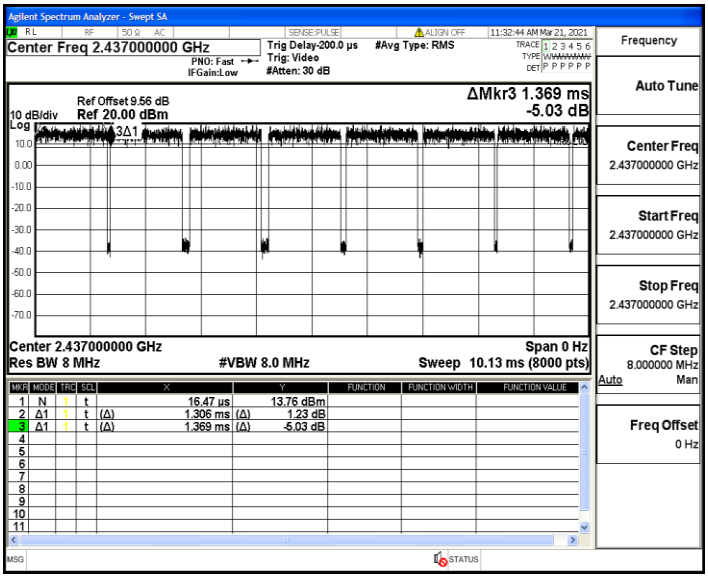

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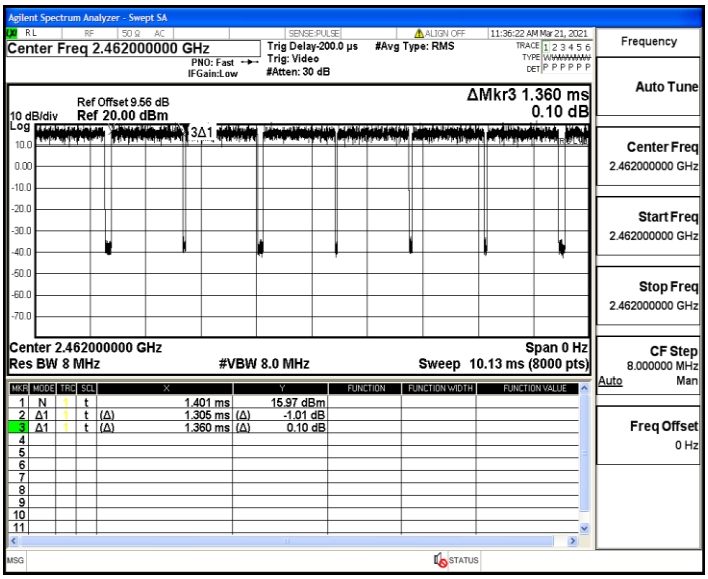

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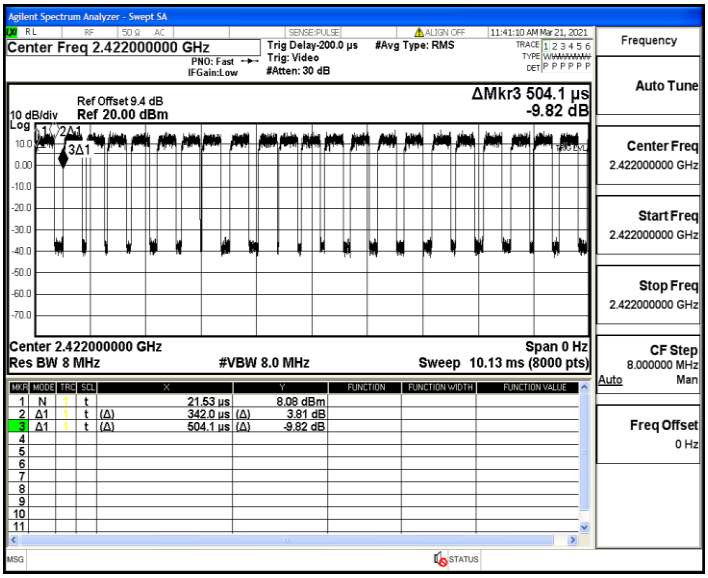
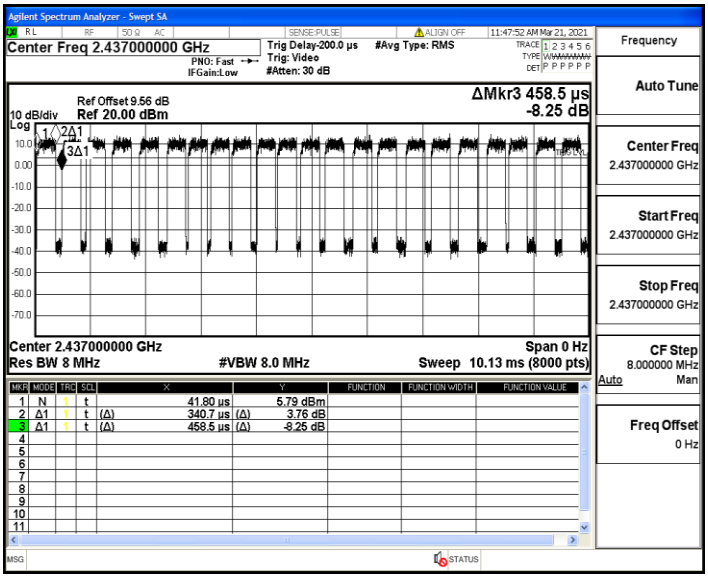
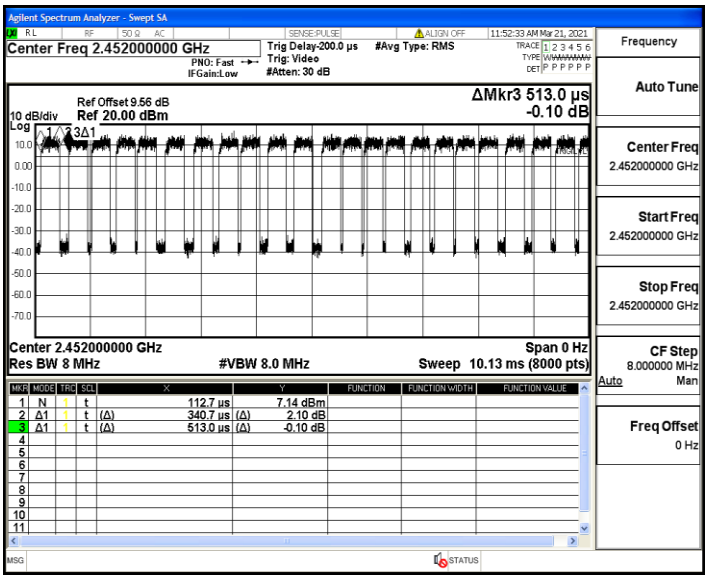


11N40SISO_Ant1_2437



11N40SISO_Ant1_2452



5.2. Maximum Conducted Output Power Measurement

5.2.1. Standard Applicable

According to §15.247(b): For systems using digital modulation in the 2400-2483.5 MHz and 5725-5850 MHz band, the limit for maximum peak conducted output power is 30dBm. The limited has to be reduced by the amount in dB that the gain of the antenna exceeds 6dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi without any corresponding reduction in transmitter peak output power.

5.2.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of the power meter.

5.2.3. Test Procedures

According to KDB558074 D01 DTS Measurement Guidance Section 9.1 Maximum peak conducted output power, 9.1.2 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 utilize a fast-responding diode detector.

According to KDB558074 D01 DTS Measurement Guidance Section 9.2 Maximum average conducted output power, 9.2.3.1 Method AVGPM (Measurement using an RF average power meter)

(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 factor.

2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.

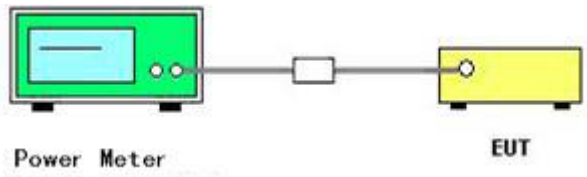
3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(b) If the transmitter does not transmit continuously, measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.

(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 10log (1/x), where x is the duty cycle to the measurement result.

5.2.4. Test Setup Layout



5.2.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.2.6. Test Result of Maximum Conducted Output Power

Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11b/g/n

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	16.28	<=30	PASS
		2437	15.28	<=30	PASS
		2462	16.40	<=30	PASS
11G	Ant1	2412	19.87	<=30	PASS
		2437	19.19	<=30	PASS
		2462	20.28	<=30	PASS
11N20SISO	Ant1	2412	20.30	<=30	PASS
		2437	19.65	<=30	PASS
		2462	20.56	<=30	PASS
11N40SISO	Ant1	2422	18.80	<=30	PASS
		2437	17.51	<=30	PASS
		2452	17.87	<=30	PASS

Remark:

1. *Measured output power at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *Average power is for report only;*

5.3. Power Spectral Density Measurement

5.3.1. Standard Applicable

According to §15.247(e): For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

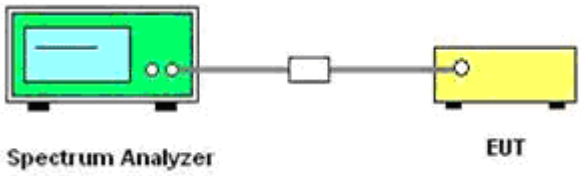
5.3.2. Measuring Instruments and Setting

Please refer to equipment's list in this report. The following table is the setting of Spectrum Analyzer.

5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 3 KHz~100 KHz.
4. Set the VBW ≥ 3*RBW
5. Set the span to 1.5 times the DTS channel bandwidth.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum power level in any 3 kHz band segment within the fundamental EBW.
11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.3.4. Test Setup Layout



5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.3.6. Test Result of Power Spectral Density

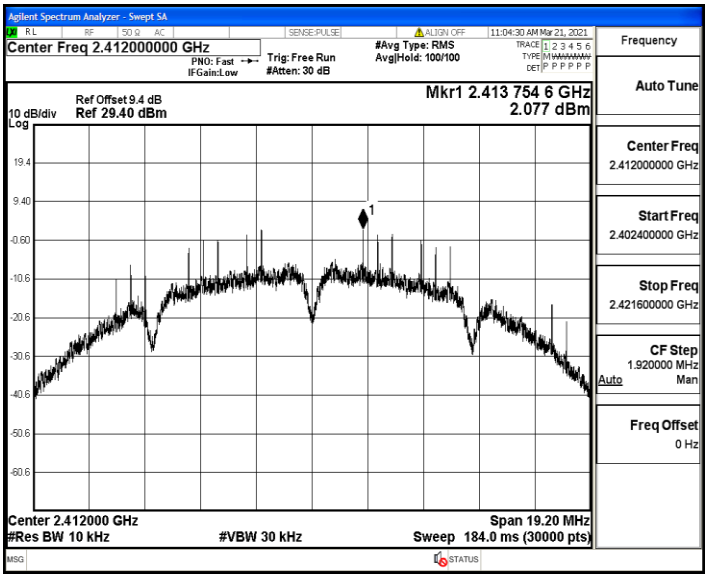
Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11b/g/n

TestMode	Antenna	Channel	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	2.08	<=8	PASS
		2437	1.94	<=8	PASS
		2462	3.18	<=8	PASS
11G	Ant1	2412	-5.79	<=8	PASS
		2437	-8.47	<=8	PASS
		2462	-6.58	<=8	PASS
11N20SISO	Ant1	2412	-6.04	<=8	PASS
		2437	-6.66	<=8	PASS
		2462	-5.1	<=8	PASS
11N40SISO	Ant1	2422	-9.7	<=8	PASS
		2437	-11.48	<=8	PASS
		2452	-10.5	<=8	PASS

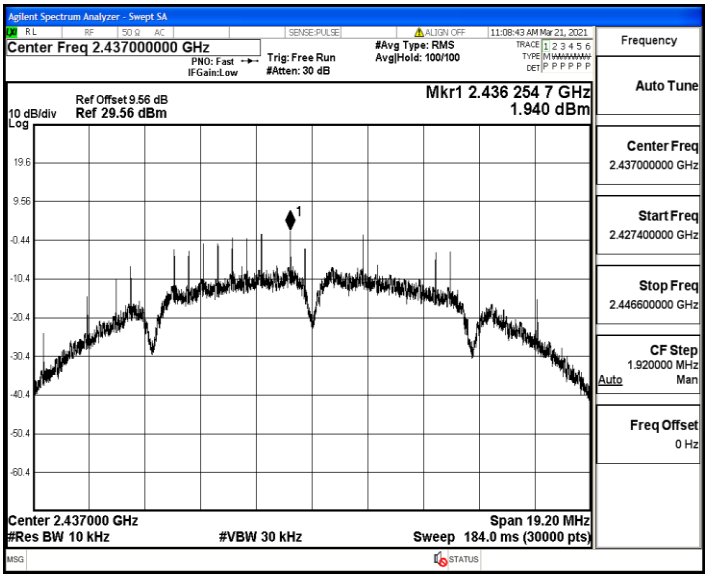
Remark:

1. *Measured peak power spectrum density at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *Please refer to following plots;*

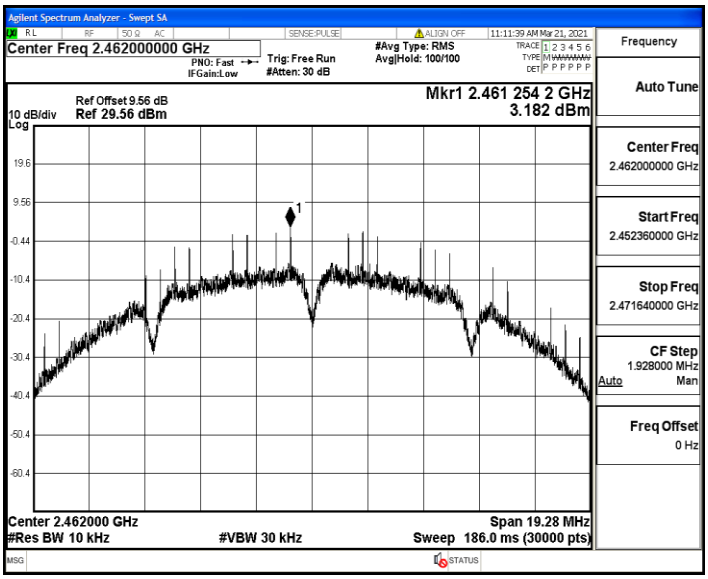
11B_Ant1_2412



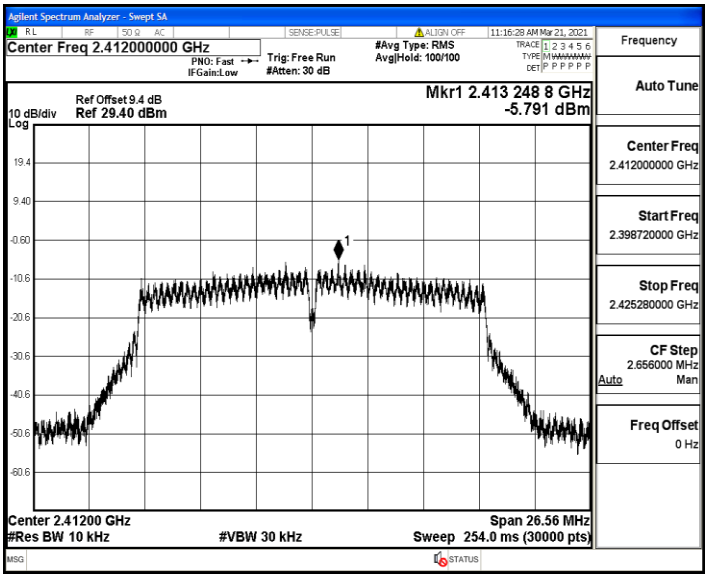
11B_Ant1_2437



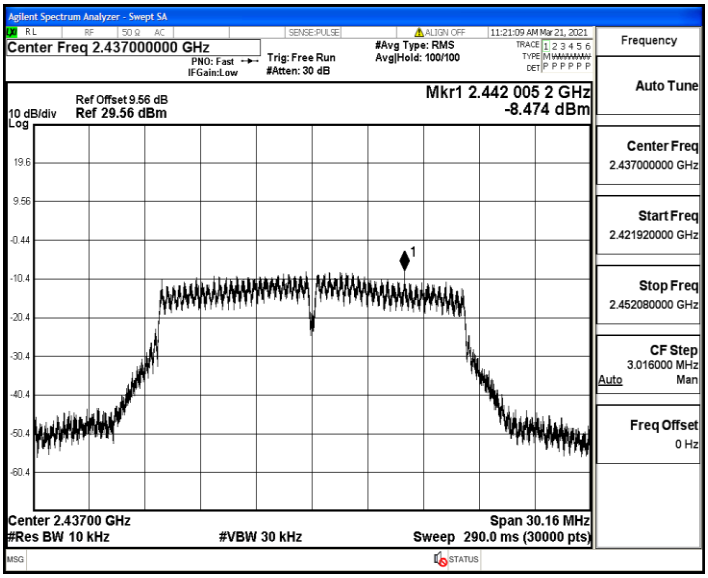
11B_Ant1_2462



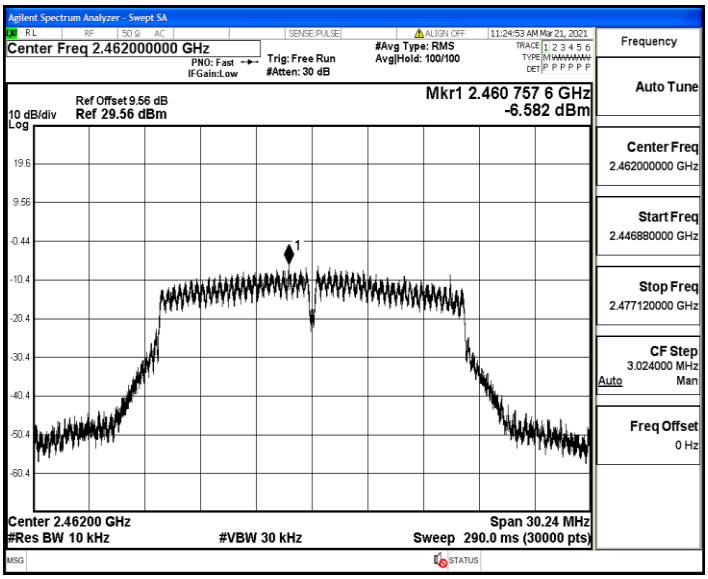
11G_Ant1_2412



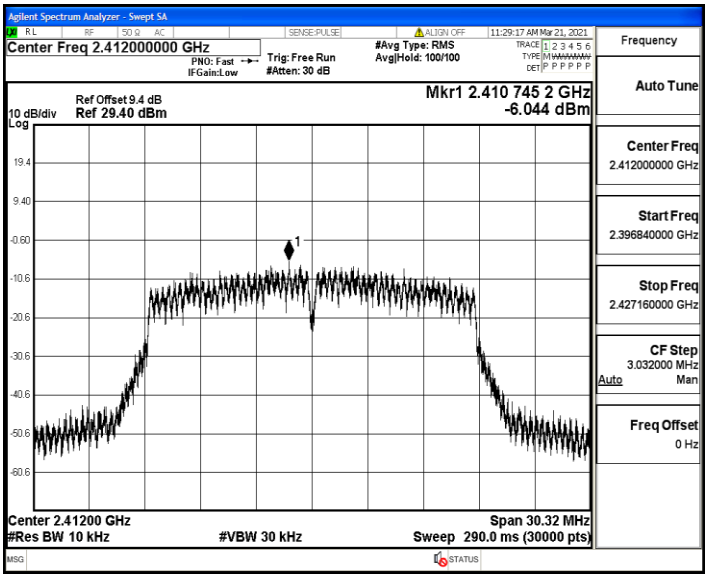
11G_Ant1_2437



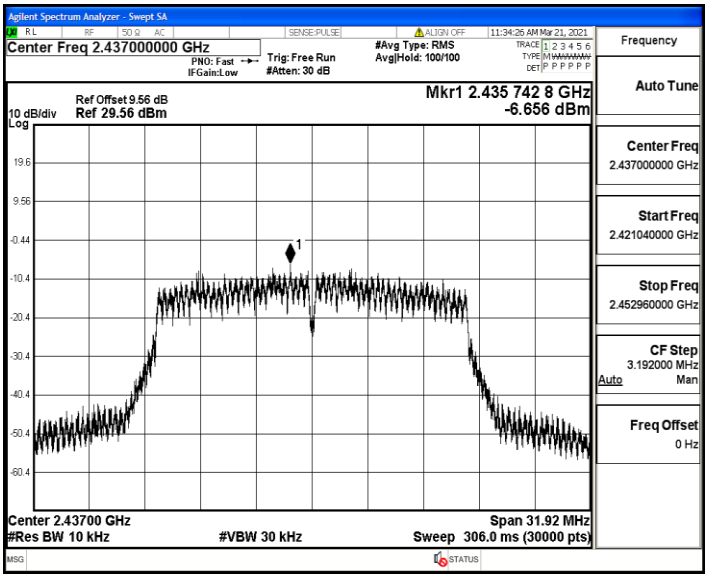
11G_Ant1_2462



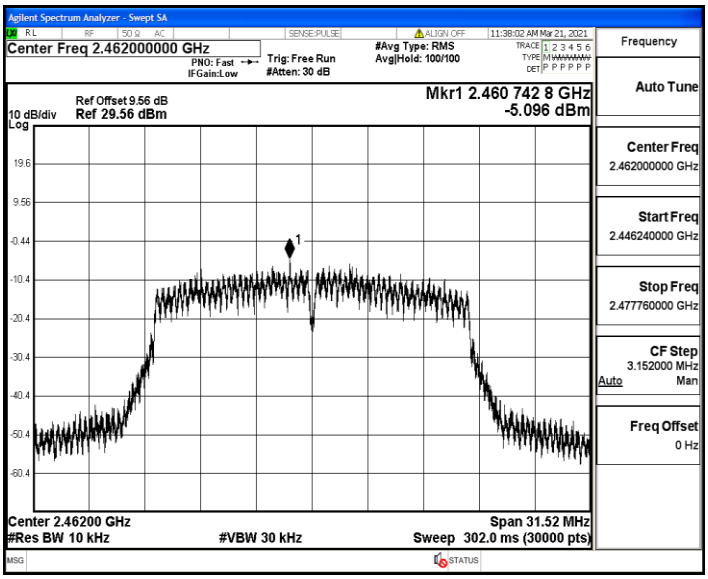
11N20SISO_Ant1_2412



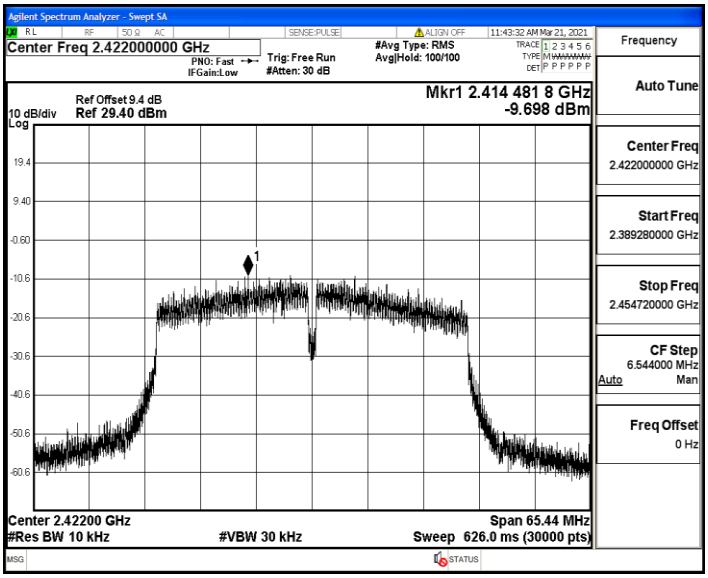
11N20SISO_Ant1_2437



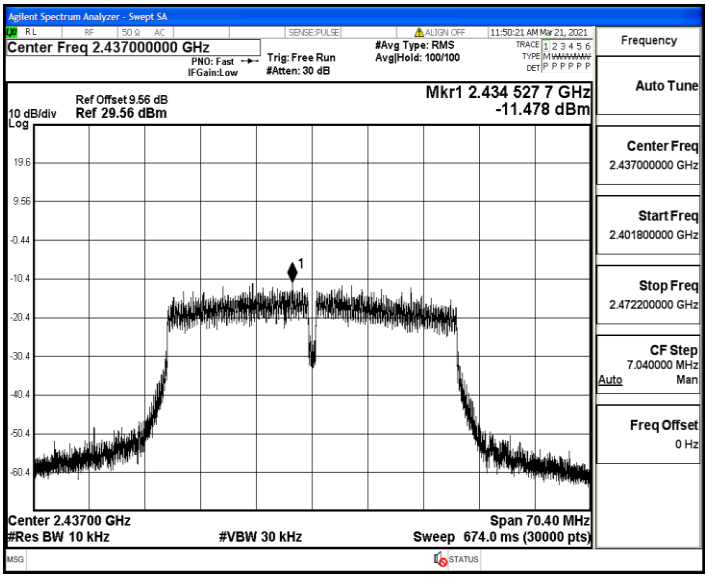
11N20SISO_Ant1_2462



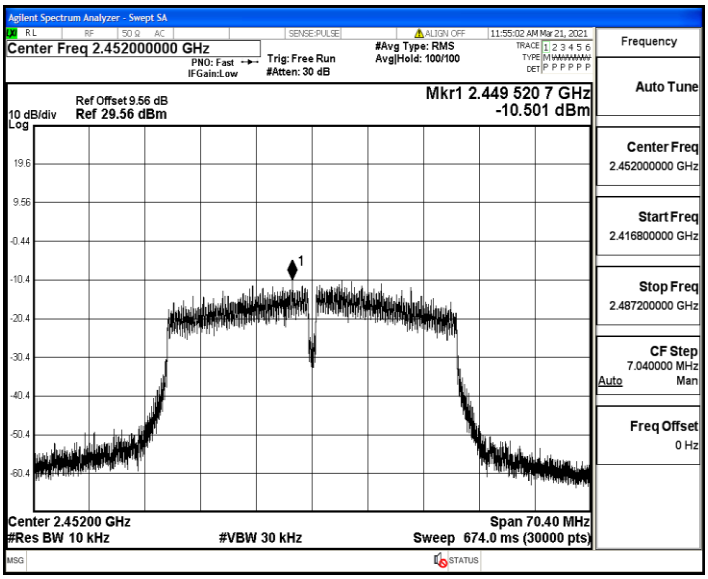
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



11N40SISO_Ant1_2452



5.4. 6 dB Spectrum Bandwidth Measurement

5.4.1. Standard Applicable

According to §15.247(a) (2): For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.4.2. Measuring Instruments and Setting

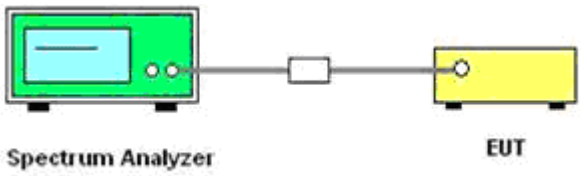
Please refer to equipments list in this report. The following table is the setting of the Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> RBW
Detector	Peak
Trace	Max Hold
Sweep Time	100ms

5.4.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth and the video bandwidth were set according to KDB558074.
3. Measured the spectrum width with power higher than 6dB below carrier.

5.4.4. Test Setup Layout



5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.4.6. Test Result of 6dB Spectrum Bandwidth

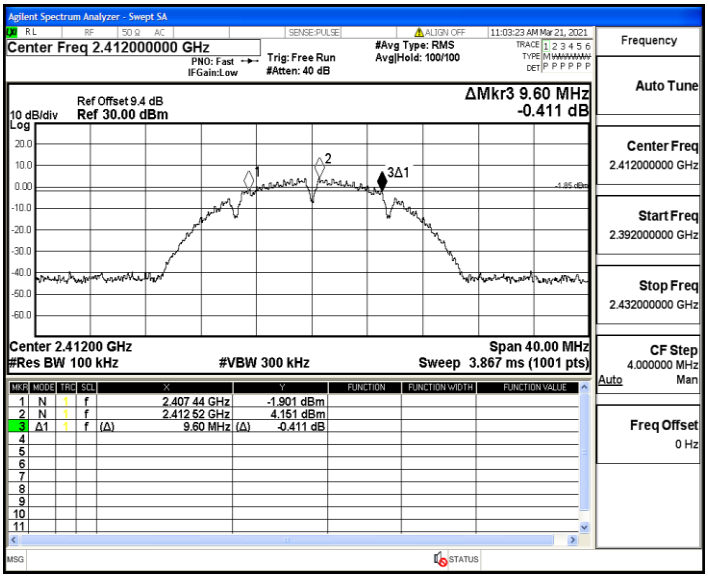
Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11b/g/n

TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	9.600	2407.440	2417.040	0.5	PASS
		2437	9.600	2431.960	2441.560	0.5	PASS
		2462	9.640	2456.960	2466.600	0.5	PASS
11G	Ant1	2412	13.280	2406.320	2419.600	0.5	PASS
		2437	15.080	2429.440	2444.520	0.5	PASS
		2462	15.120	2454.480	2469.600	0.5	PASS
11N20SISO	Ant1	2412	15.160	2404.440	2419.600	0.5	PASS
		2437	15.960	2428.600	2444.560	0.5	PASS
		2462	15.760	2453.840	2469.600	0.5	PASS
11N40SISO	Ant1	2422	32.720	2404.400	2437.120	0.5	PASS
		2437	35.200	2419.400	2454.600	0.5	PASS
		2452	35.200	2434.400	2469.600	0.5	PASS

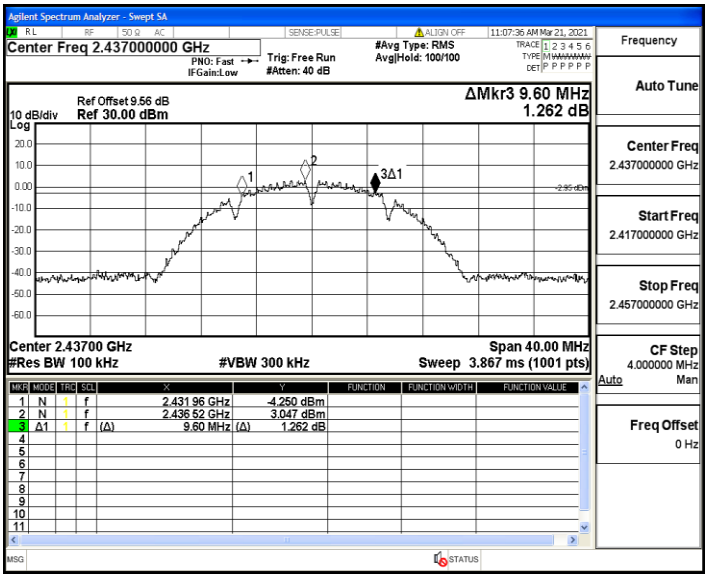
Remark:

1. *Measured 6dB Bandwidth at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *Please refer to following plots;*

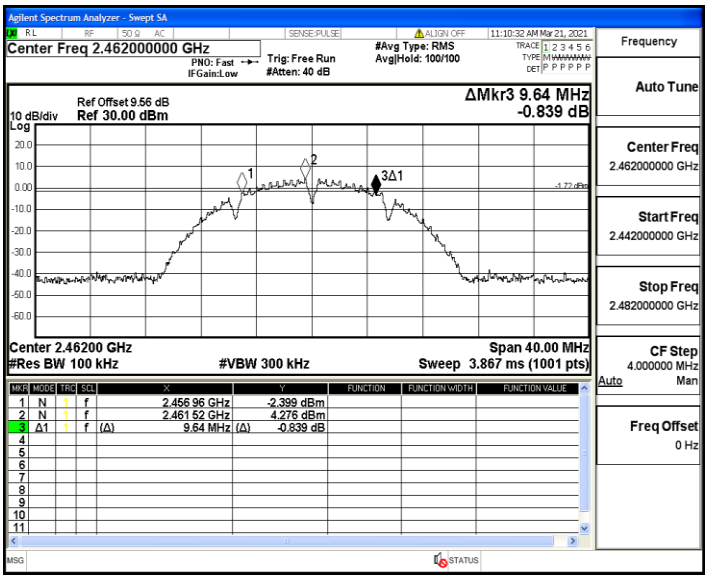
11B_Ant1_2412



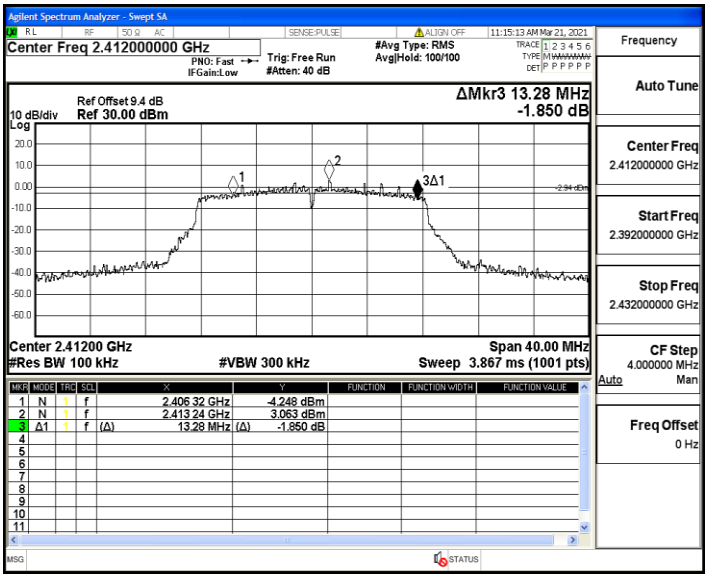
11B_Ant1_2437



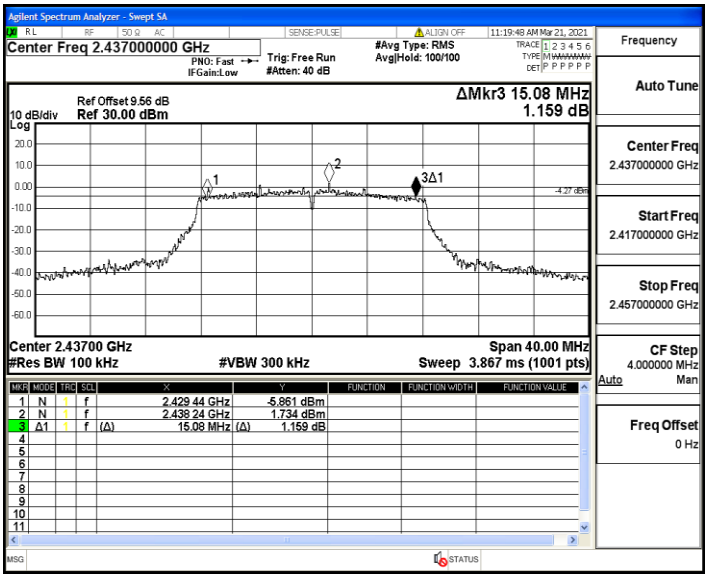
11B_Ant1_2462



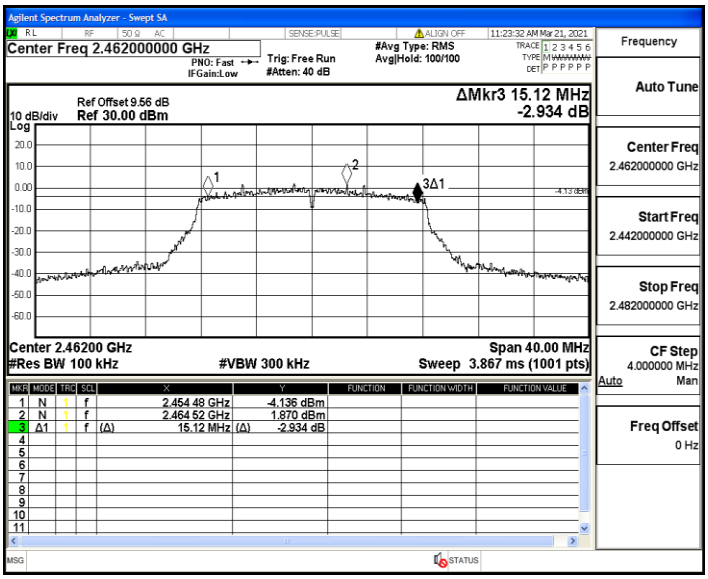
11G_Ant1_2412



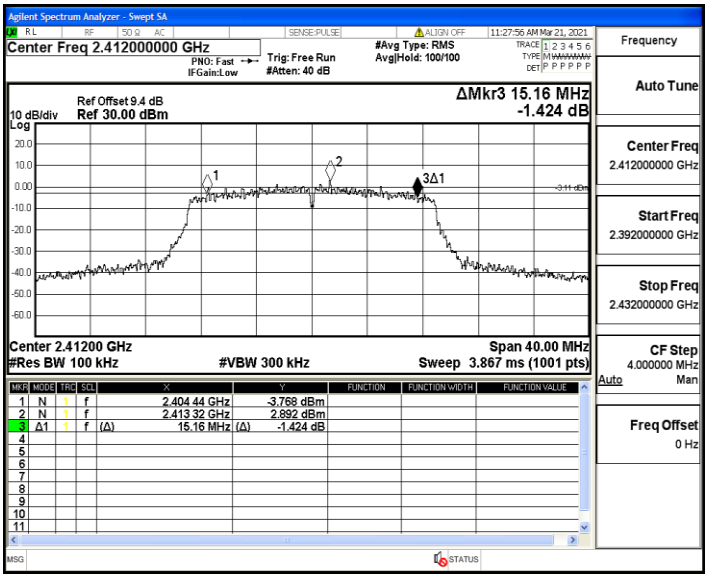
11G_Ant1_2437



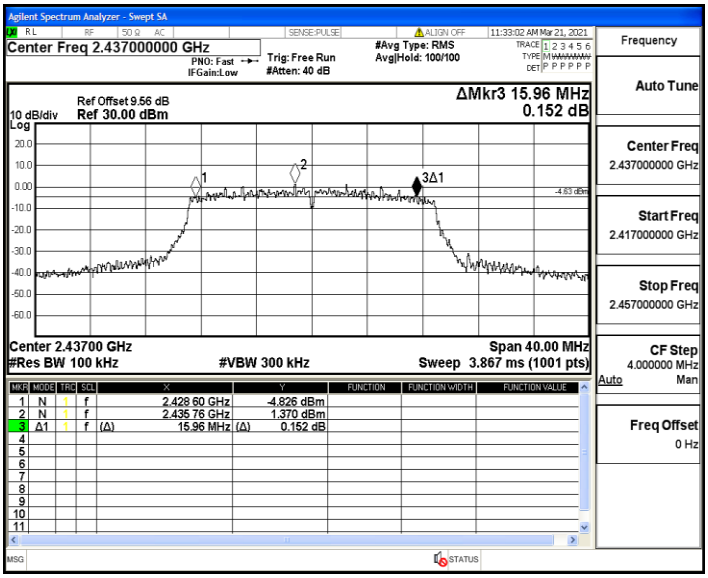
11G_Ant1_2462



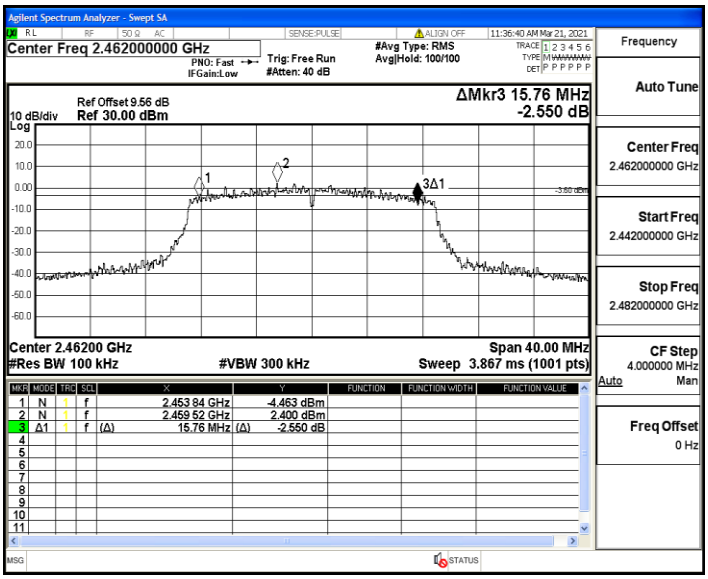
11N20SISO_Ant1_2412



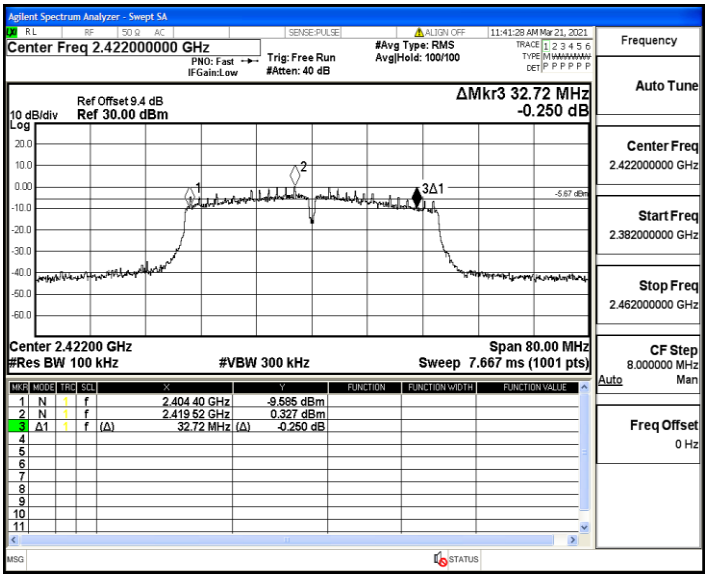
11N20SISO_Ant1_2437



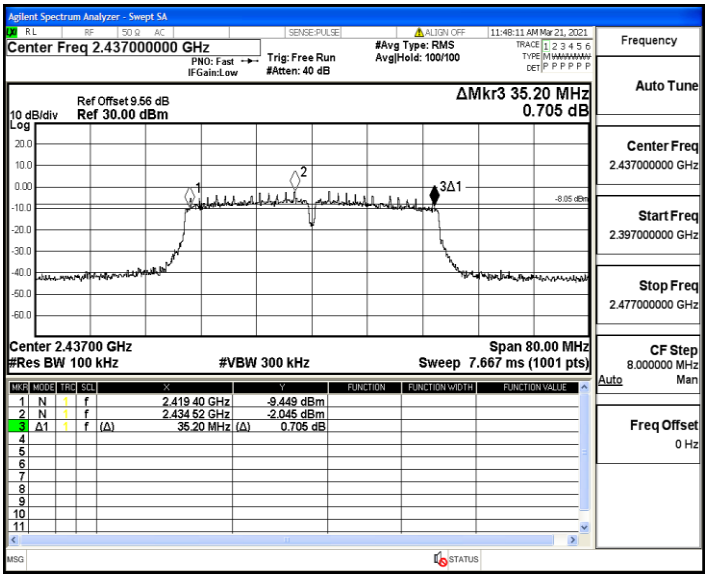
11N20SISO_Ant1_2462



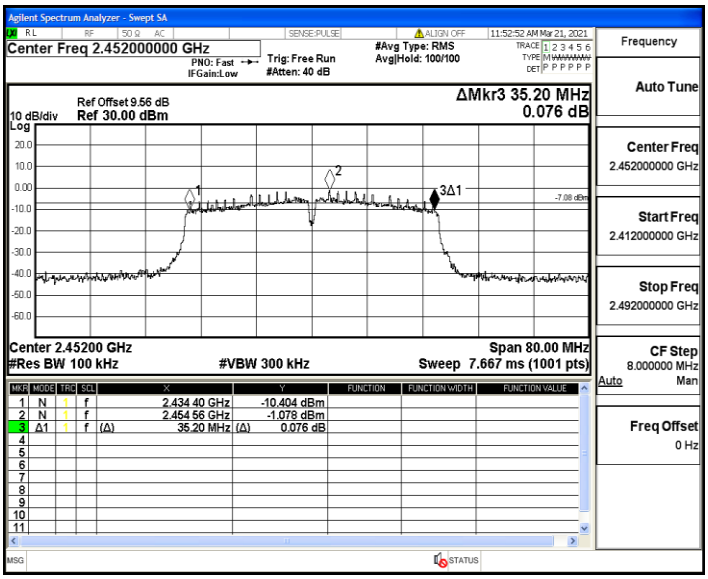
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



11N40SISO_Ant1_2452



5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

5.5.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

5.5.3. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 1.5 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

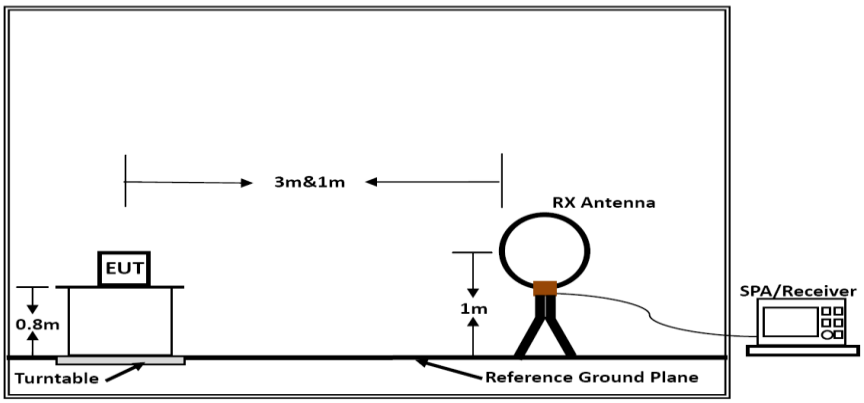
Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

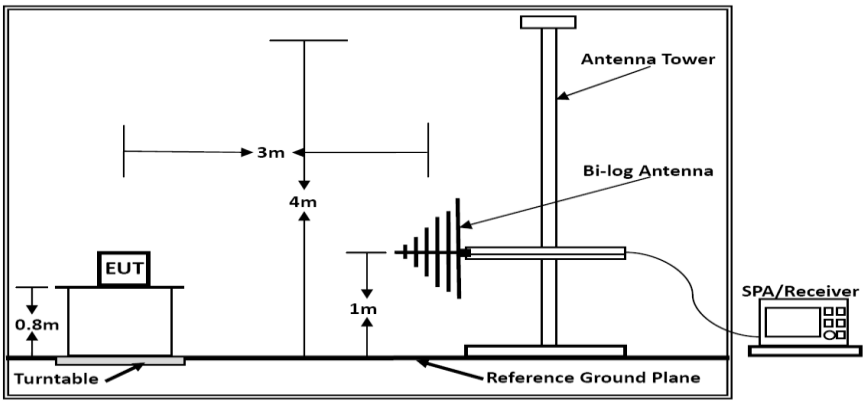
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.4. Test Setup Layout

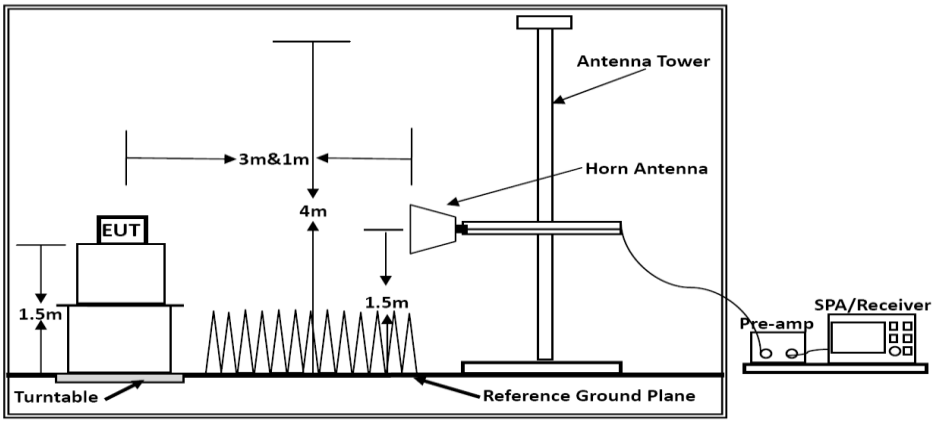
For radiated emissions below 30MHz



Below 30MHz



Below 1GHz



Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1m]) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9 KHz~30MHz)

Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11b/g/n
Test Date	2020/3/6		

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

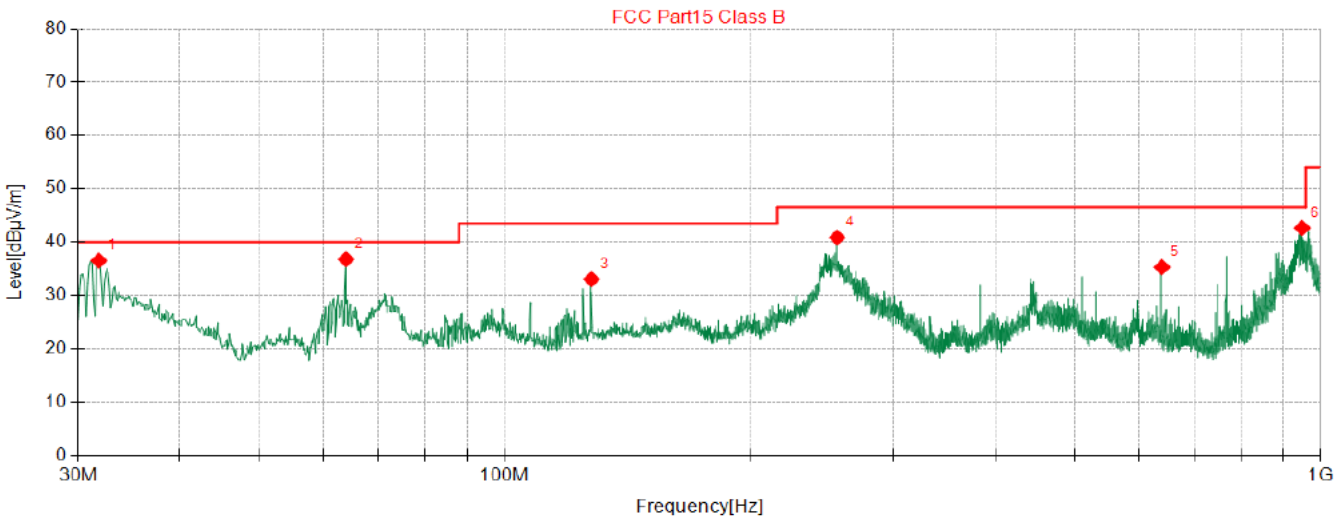
Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	802.11b Low Channel

The Worst Test result for 802.11g Mode(Low Channel)

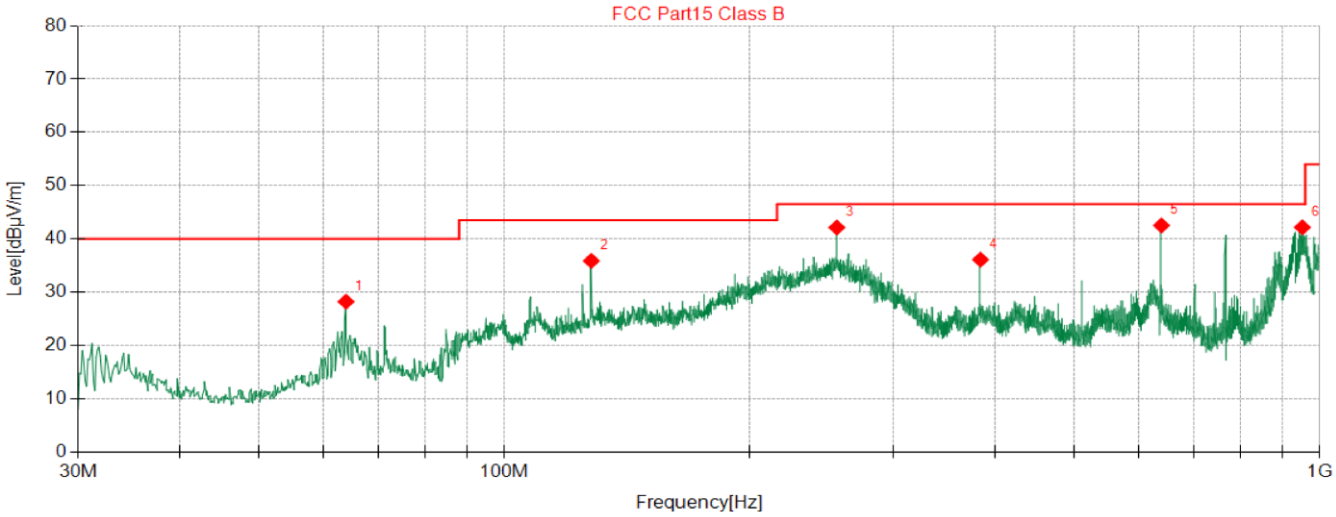
Vertical



◆ QP Detector

Suspected Data List							
NO.	Freq. [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	31.818	36.52	40.00	3.48	100	75	Vertical
2	63.950	36.77	40.00	3.23	100	339	Vertical
3	127.84	33.03	43.50	10.47	100	95	Vertical
4	255.76	40.85	46.50	5.65	100	357	Vertical
5	639.76	35.30	46.50	11.20	100	24	Vertical
6	950.40	42.64	46.50	3.86	100	36	Vertical

Horizontal



◆ QP Detector

Suspected Data List							
NO.	Freq. [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	63.950	28.21	40.00	11.79	100	68	Horizontal
2	127.84	35.87	43.50	7.63	100	26	Horizontal
3	255.76	42.13	46.50	4.37	100	192	Horizontal
4	383.80	36.10	46.50	10.40	100	347	Horizontal
5	639.76	42.52	46.50	3.98	100	31	Horizontal
6	952.47	42.17	46.50	4.33	100	139	Horizontal

Note:
1). Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b Low Channel)
2). Emission level (dBuV/m) = 20 log Emission level (uV/m).
3). Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.
4).Margin(dB) = limit(dBµV/m) – Result Level(dBµV/m)

5.5.8. Results for Radiated Emissions (Above 1GHz)

802.11b

Channel 1 / 2412 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4824.00	59.13	33.06	35.04	3.94	61.09	74.00	12.91	Peak	Horizontal
4824.00	42.37	33.06	35.04	3.94	44.33	54.00	9.67	Average	Horizontal
4824.00	58.08	33.06	35.04	3.94	60.04	74.00	13.96	Peak	Vertical
4824.00	44.44	33.06	35.04	3.94	46.40	54.00	7.60	Average	Vertical

Channel 6 / 2437 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4874.00	59.00	33.16	35.15	3.96	60.97	74.00	13.03	Peak	Horizontal
4874.00	43.83	33.16	35.15	3.96	45.80	54.00	8.20	Average	Horizontal
4874.00	57.32	33.16	35.15	3.96	59.29	74.00	14.71	Peak	Vertical
4874.00	45.73	33.16	35.15	3.96	47.70	54.00	6.30	Average	Vertical

Channel 11 / 2462 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4924.00	59.65	33.26	35.14	3.98	61.75	74.00	12.25	Peak	Horizontal
4924.00	43.31	33.26	35.14	3.98	45.41	54.00	8.59	Average	Horizontal
4924.00	58.32	33.26	35.14	3.98	60.42	74.00	13.58	Peak	Vertical
4924.00	43.59	33.26	35.14	3.98	45.69	54.00	8.31	Average	Vertical

802.11g

Channel 1 / 2412 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4824.00	59.47	33.06	35.04	3.94	61.43	74.00	12.57	Peak	Horizontal
4824.00	43.20	33.06	35.04	3.94	45.16	54.00	8.84	Average	Horizontal
4824.00	57.20	33.06	35.04	3.94	59.16	74.00	14.84	Peak	Vertical
4824.00	42.07	33.06	35.04	3.94	44.03	54.00	9.97	Average	Vertical

Channel 6 / 2437 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4874.00	59.79	33.16	35.15	3.96	61.76	74.00	12.24	Peak	Horizontal
4874.00	41.40	33.16	35.15	3.96	43.37	54.00	10.63	Average	Horizontal
4874.00	56.80	33.16	35.15	3.96	58.77	74.00	15.23	Peak	Vertical
4874.00	45.60	33.16	35.15	3.96	47.57	54.00	6.43	Average	Vertical

Channel 11 / 2462 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4924.00	56.13	33.26	35.14	3.98	58.23	74.00	15.77	Peak	Horizontal
4924.00	45.33	33.26	35.14	3.98	47.43	54.00	6.57	Average	Horizontal
4924.00	59.40	33.26	35.14	3.98	61.50	74.00	12.50	Peak	Vertical
4924.00	45.73	33.26	35.14	3.98	47.83	54.00	6.17	Average	Vertical

802.11n HT20

Channel 1 / 2412 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4824.00	58.35	33.06	35.04	3.94	60.31	74.00	13.69	Peak	Horizontal
4824.00	42.82	33.06	35.04	3.94	44.78	54.00	9.22	Average	Horizontal
4824.00	57.41	33.06	35.04	3.94	59.37	74.00	14.63	Peak	Vertical
4824.00	41.09	33.06	35.04	3.94	43.05	54.00	10.95	Average	Vertical

Channel 6 / 2437 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4874.00	56.49	33.16	35.15	3.96	58.46	74.00	15.54	Peak	Horizontal
4874.00	44.83	33.16	35.15	3.96	46.80	54.00	7.20	Average	Horizontal
4874.00	59.86	33.16	35.15	3.96	61.83	74.00	12.17	Peak	Vertical
4874.00	41.79	33.16	35.15	3.96	43.76	54.00	10.24	Average	Vertical

Channel 11 / 2462 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4924.00	59.87	33.26	35.14	3.98	61.97	74.00	12.03	Peak	Horizontal
4924.00	44.46	33.26	35.14	3.98	46.56	54.00	7.44	Average	Horizontal
4924.00	59.16	33.26	35.14	3.98	61.26	74.00	12.74	Peak	Vertical
4924.00	41.26	33.26	35.14	3.98	43.36	54.00	10.64	Average	Vertical

802.11n HT40

Channel 3 / 2422 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4844.00	56.77	33.06	35.04	3.94	58.73	74.00	15.27	Peak	Horizontal
4844.00	41.21	33.06	35.04	3.94	43.17	54.00	10.83	Average	Horizontal
4844.00	59.05	33.06	35.04	3.94	61.01	74.00	12.99	Peak	Vertical
4844.00	41.57	33.06	35.04	3.94	43.53	54.00	10.47	Average	Vertical

Channel 6 / 2437 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4874.00	57.19	33.16	35.15	3.96	59.16	74.00	14.84	Peak	Horizontal
4874.00	41.02	33.16	35.15	3.96	42.99	54.00	11.01	Average	Horizontal
4874.00	57.72	33.16	35.15	3.96	59.69	74.00	14.31	Peak	Vertical
4874.00	43.17	33.16	35.15	3.96	45.14	54.00	8.86	Average	Vertical

Channel 9 / 2452 MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4904.00	58.45	33.26	35.14	3.98	60.55	74.00	13.45	Peak	Horizontal
4904.00	43.73	33.26	35.14	3.98	45.83	54.00	8.17	Average	Horizontal
4904.00	59.59	33.26	35.14	3.98	61.69	74.00	12.31	Peak	Vertical
4904.00	43.90	33.26	35.14	3.98	46.00	54.00	8.00	Average	Vertical

Notes:

1. *Measuring frequencies from 9 KHz - 10th harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.*
2. *Radiated emissions measured in frequency range from 9 KHz ~10th harmonic or 26.5GHz (which is less) were made with an instrument using Peak detector mode.*
3. *Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*
4. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
5. *Measured[dBμv/m] = Reading[dBμv/m] + Ant. Fac.[dB/m] - Pre. Fac.[dB] + Cab. Loss[dB];*
   Margin[dB] = Limit[dBμV/m] –Measured Level[dBμV/m]

5.6. Conducted Spurious Emissions and Band Edges Test

5.6.1. Standard Applicable

According to §15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

5.6.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Detector	Peak
Attenuation	Auto
RB / VB (Emission in restricted band)	100KHz/300KHz
RB / VB (Emission in non-restricted band)	100KHz/300KHz

5.6.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9 KHz to 26.5GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

5.6.4. Test Setup Layout

This test setup layout is the same as that shown in section 5.4.4.

5.6.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.6.6. Test Results of Conducted Spurious Emissions

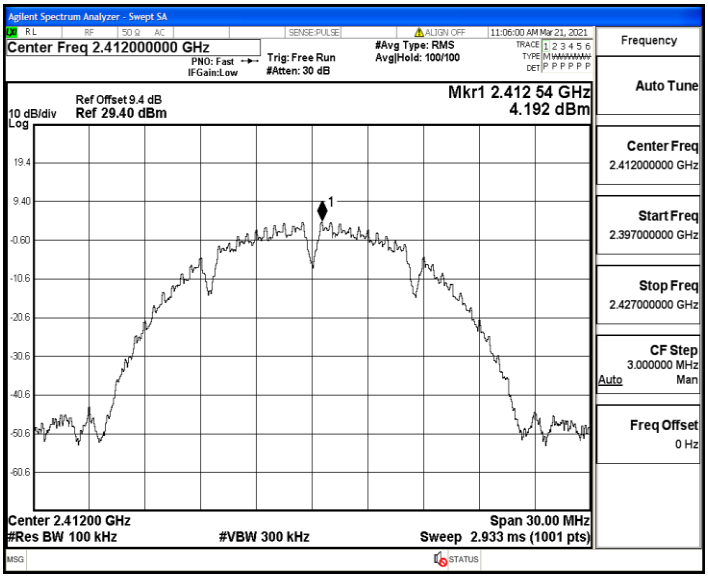
Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11b/g/n

Test Mode	Channel	Frequency (MHz)	Measured Frequency Range	Spurious RF Conducted Emission (dBc)			Limits (dBc)	Verdict
				Antenna 0	Antenna 1	Antenna 2		
IEEE 802.11b	1	2412	9 KHz – 26.5 GHz	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20	<-20	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20	<-20	<-20		
IEEE 802.11g	1	2412	9 KHz – 26.5 GHz	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20	<-20	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20	<-20	<-20		
IEEE 802.11n HT20	1	2412	9 KHz – 26.5 GHz	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20	<-20	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20	<-20	<-20		
IEEE 802.11n HT40	3	2422	9 KHz – 26.5 GHz	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20	<-20	<-20		
	9	2452	9 KHz – 26.5 GHz	<-20	<-20	<-20		

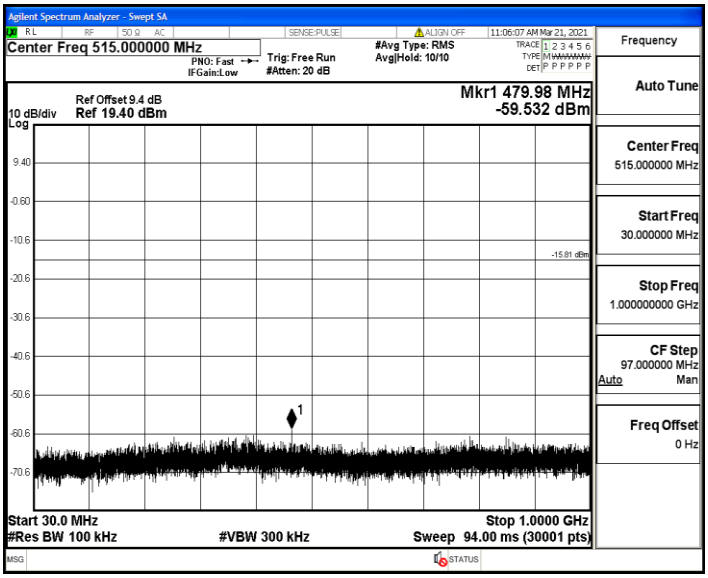
Remark:

1. *Measured RF conducted spurious emission at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *"---"means that the fundamental frequency not for 15.209 limits requirement.*
5. *Not recorded emission values from 9 KHz to 30 MHz as emission level at least 20 dBc lower than limit;*
6. *Please refer to following plots;*

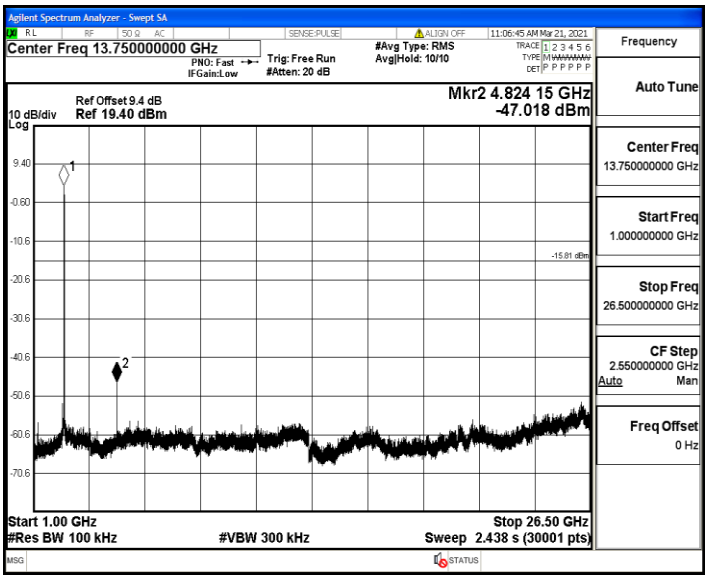
11B_Ant1_2412_0~Reference



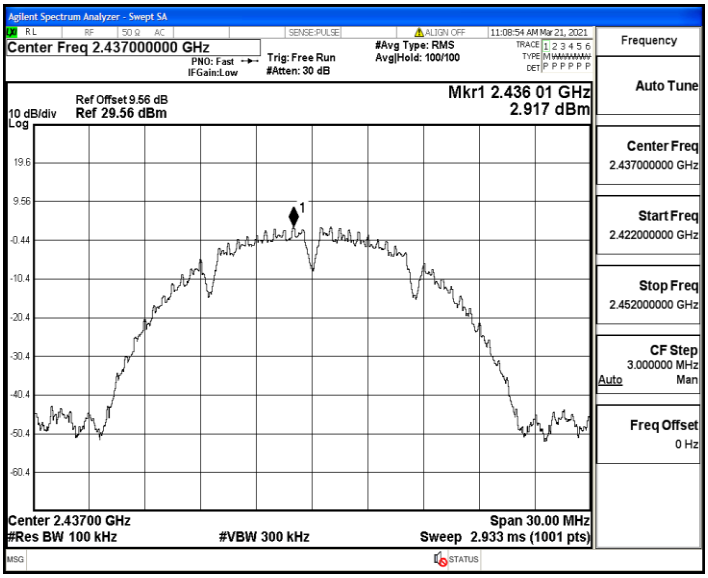
11B_Ant1_2412_30~1000



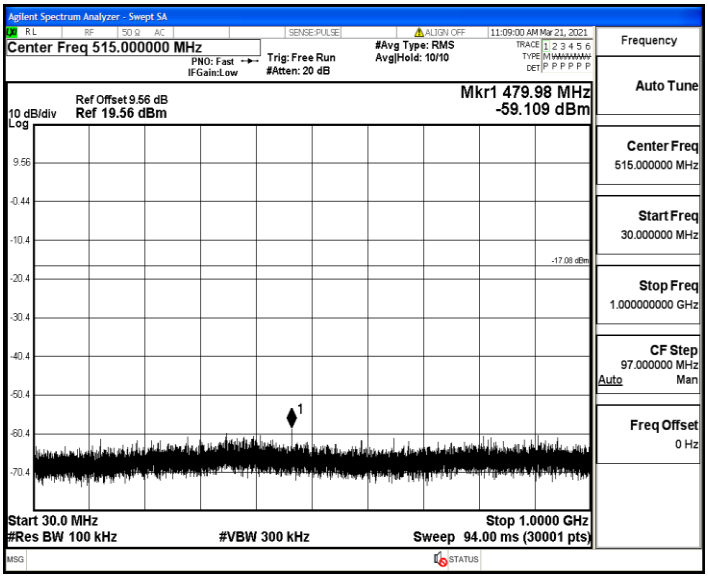
11B_Ant1_2412_1000~26500



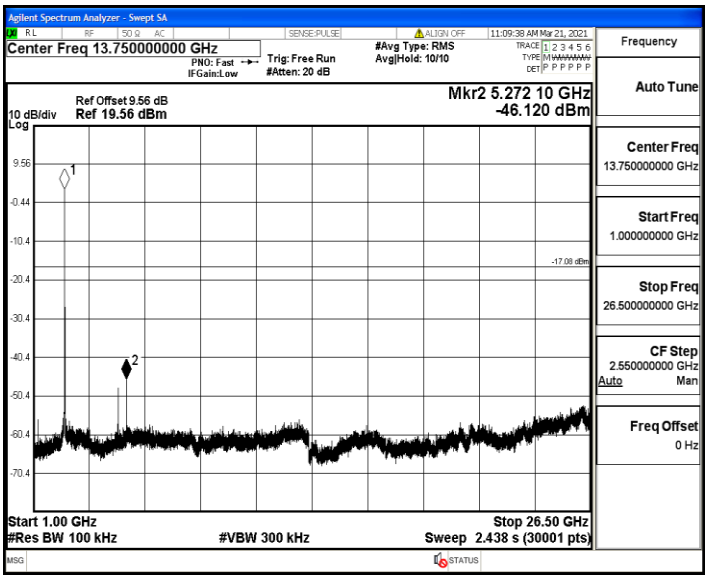
11B_Ant1_2437_0~Reference



11B_Ant1_2437_30~1000



11B_Ant1_2437_1000~26500



11B_Ant1_2462_0~Reference