FCC TEST REPORT

Test report
On Behalf of
Wattbike Ltd.
For
Wattbike Performance Touchscreen
Model No.: 80-000

FCC ID: 2AVJT-80-000

Prepared for : **Wattbike Ltd.**
Unit 13, Nottingham South & Wilford Industrial Estate West Bridgford , Nottingham NG11 7EP, UK

Prepared By : **Shenzhen HUAK Testing Technology Co., Ltd.**
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Date of Test: **Dec 2, 2019~Dec 25, 2019**
Date of Report: **Dec 27, 2019**
Report Number: **HK1912113153-E4**

TEST RESULT CERTIFICATION

Applicant's name ..... :	**Wattbike Ltd.**
Address .... :	Unit 13, Nottingham South & Wilford Industrial Estate West Bridgford, Nottingham NG11 7EP, UK
Manufacture's Name ..... :	**Shenzhen NewMagic Technology Co., Ltd..**
Address .... :	2602A, Block A, World Trade Plaza, Fuhong Road, Futian Dist., Shenzhen, Guangdong, China
Product description	
Trade Mark .....:	WattbikePT1
Product name .....:	Wattbike Performance Touchscreen
Model and/or type reference :	80-000
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..... :	Dec 2, 2019~Dec 25, 2019
Date of Issue .... :	Dec 27, 2019
Test Result..... ..... :	**Pass**

Testing Engineer : Gary Qian

(Gary Qian)

Technical Manager : Eden Hu

(Eden Hu)

Authorized Signatory : Jason Zhou

(Jason Zhou)

Revision History

Revision	Issue Date	Revisions	Revised By
00	Dec 27, 2019	Initial Issue	Jason Zhou

TABLE OF CONTENTS

1. GENERAL INFORMATION **5**
1.1. DESCRIPTION OF DEVICE (EUT) 5
1.2 EUT CONFIGURATION 6
1.3. EXTERNAL I/O CABLE 6
1.4. DESCRIPTION OF TEST FACILITY 6
1.5. STATEMENT OF THE MEASUREMENT UNCERTAINTY 6
1.6. MEASUREMENT UNCERTAINTY 6
1.7. DESCRIPTION OF TEST MODES 7
2. TEST METHODOLOGY **8**
2.1. EUT CONFIGURATION 8
2.2. EUT EXERCISE 8
2.3. GENERAL TEST PROCEDURES 8
3. SYSTEM TEST CONFIGURATION **9**
3.1. JUSTIFICATION 9
3.2. EUT EXERCISE SOFTWARE 9
3.3. SPECIAL ACCESSORIES 9
3.4. BLOCK DIAGRAM/SCHEMATICS 9
3.5. EQUIPMENT MODIFICATIONS 9
3.6. TEST SETUP 9
4. SUMMARY OF TEST RESULTS **10**
5. TEST RESULT **11**
5.1. ON TIME AND DUTY CYCLE 11
5.2. MAXIMUM CONDUCTED OUTPUT POWER MEASUREMENT 13
5.3. POWER SPECTRAL DENSITY MEASUREMENT 15
5.5. RADIATED EMISSIONS MEASUREMENT 23
5.6. CONDUCTED SPURIOUS EMISSIONS AND BAND EDGES TEST 35
5.7. POWER LINE CONDUCTED EMISSIONS 45
5.8. BAND-EDGE MEASUREMENTS FOR RADIATED EMISSIONS 48
5.9. ANTENNA REQUIREMENTS 52
6. LIST OF MEASURING EQUIPMENTS **53**
7. TEST SETUP PHOTOGRAPHS OF EUT **54**
8. EXTERIOR PHOTOGRAPHS OF THE EUT **54**
9. INTERIOR PHOTOGRAPHS OF THE EUT **54**

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	Wattbike Performance Touchscreen
Model Number	:	80-000
Model Declaration	:	/
Test Model	:	80-000
Power Supply	:	DC 3.7V by battery
Hardware version	:	BND-MT8163-MT116-BSF-V1.0
Software version	:	V1.0
Chipset/Module 1	:	MT6625L
Bluetooth Version	:	V5.0+EDR
Channel Number	:	79 Channels for Bluetooth V5.0(DSS) 40 Channels for Bluetooth V5.0(DTS)
Modulation Technology	:	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth V5.0(DSS) GFSK for Bluetooth V5.0(DTS)
Data Rates	:	Bluetooth V5.0(DSS): 1~3Mbps Bluetooth V5.0(DTS): 1Mbps
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 / 5745-5825MHz IEEE 802.11n HT40:2422-2452MHz / 5190-5230MHz / 5755-5795MHz IEEE 802.11a: 5180-5240MHz / 5745-5825MHz
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/n HT20) 2 Channels for 5190-5230MHz (IEEE 802.11n HT40) 5 Channels for 5745-5825MHz(IEEE 802.11a/n HT20) 2 Channels for 5755-5795MHz(IEEE 802.11n HT40)
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)
Antenna Type And Gain	:	Antenna 1 1.56 dBi(Max.), for TX/RX (Bluetooth), 1.56dBi(Max.), for TX/RX (WLAN 2.4G Band), 0.67 dBi(Max.), for TX/RX (WLAN 5.2G Band) 0.53 dBi(Max.), for TX/RX (WLAN 5.8G Band)
Chipset/Module 2	:	nRF52840
Bluetooth Version	:	V4.2 BLE
Frequency Range	:	2402-2480MHz
Channel Number	:	40 Channels
Modulation Technology	:	GFSK

Data Rates : 1Mbps

Antenna Type And Gain : Antenna 2
0.5 dBi(Max.), for TX/RX (Bluetooth only support BLE mode),

Note1: Antenna position refer to EUT Photos.
Note2:This report is for Chipset MT6625L

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
GuaiKaiYuan	Adapter	GKYPG0200050US2	N/A	N/A

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	1	N/A
HDMI Port	1	N/A
DC Port	1	N/A
Earphone Port	1	N/A

1.4. Description of Test Facility

Designation Number: CN1229
Test Firm Registration Number: 616276

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 ca utioned 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 additiona l 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.
This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.

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 802.11g 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 802.11g 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 HUAK Testing Technology 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

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 (MTK NON-SIGNAL) 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 HUAK Testing Technology 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	Result
/	Duty Cycle	Compliant
§15.247(b)	Maximum Conducted Output Power	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(a)(2)	6dB Bandwidth	Compliant
§15.247(a)	Occupied Bandwidth	Compliant
§15.209, §15.247(d)	Radiated and Conducted Spurious Emissions	Compliant
§15.205	Emissions at Restricted Band	Compliant
§15.207(a)	Conducted Emissions	Compliant
§15.203	Antenna Requirements	Compliant
§15.247(i)§2.1093	RF Exposure	Compliant

5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

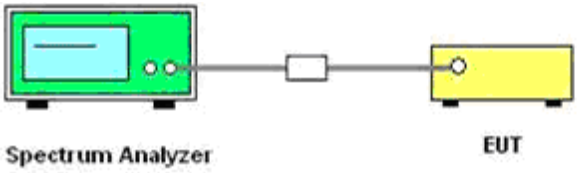
5.1.2. Measuring Instruments and Setting

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



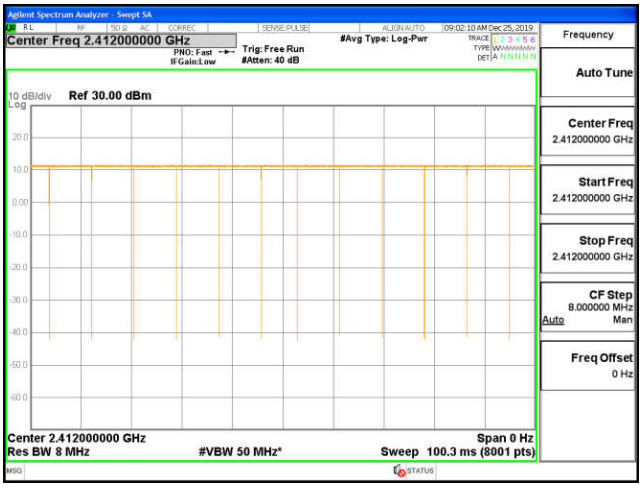
5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

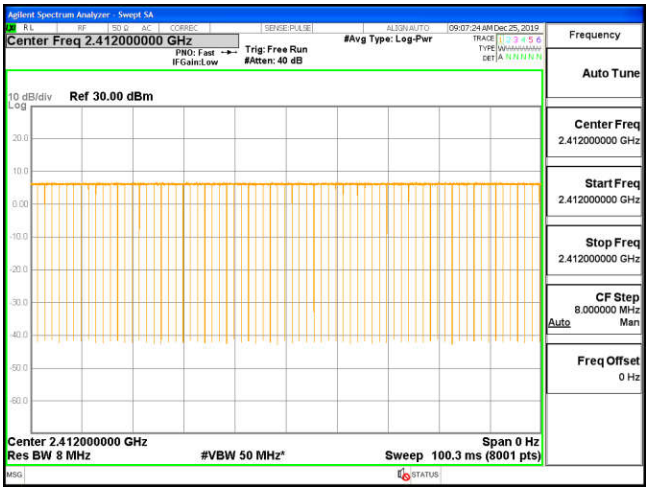
5.1.6. Test result

Mode	On Time Points	Total Sweep points	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (KHz)
IEEE 802.11b	7985	8001	99.80	0.00	0.01
IEEE 802.11g	7984	8001	99.79	0.00	0.01
IEEE 802.11n HT20	7861	8001	98.25	0.08	0.01
IEEE 802.11n HT40	7738	8001	96.71	0.15	0.01

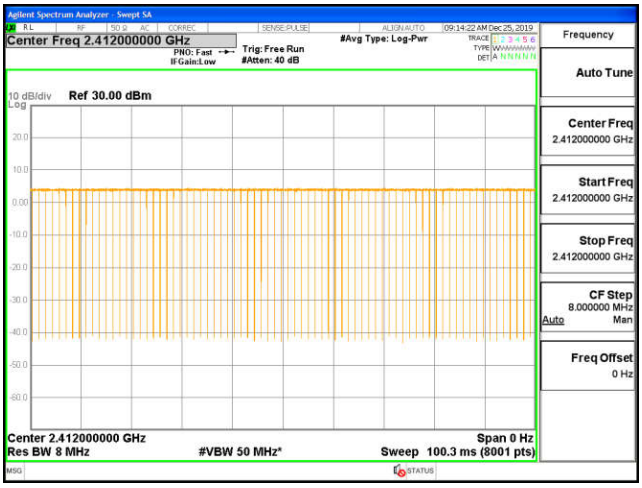
On Time and Duty Cycle



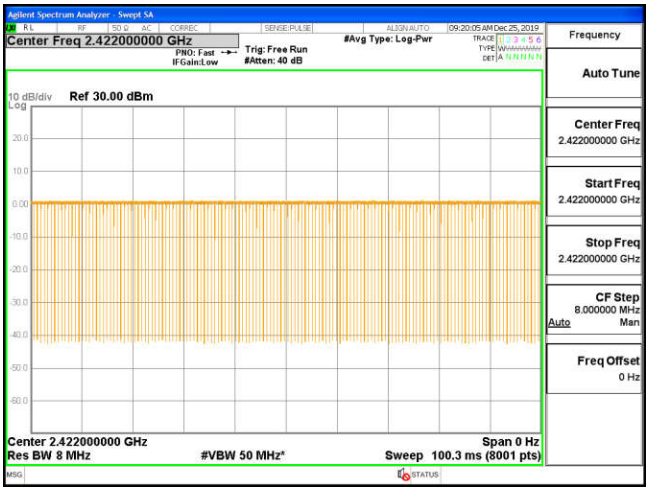
IEEE 802.11b



IEEE 802.11g



IEEE 802.11n HT20



IEEE 802.11n HT40

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.

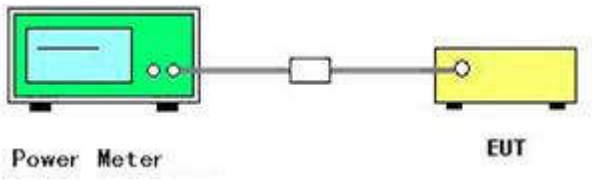
3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(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	Gary Qian	Configurations	IEEE 802.11b/g/n

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Limits (dBm)	Verdict
IEEE 802.11b	1	2412	15.379	30	PASS
	6	2437	14.995		
	11	2462	15.227		
IEEE 802.11g	1	2412	15.086	30	PASS
	6	2437	15.238		
	11	2462	15.952		
IEEE 802.11n HT20	1	2412	15.304	30	PASS
	6	2437	14.972		
	11	2462	14.900		
IEEE 802.11n HT40	3	2422	15.309	30	PASS
	6	2437	15.071		
	9	2452	15.127		

Test Mode	Channel	Frequency (MHz)	Measured Average Output Power (dBm))	Limits (dBm)	Verdict
IEEE 802.11b	1	2412	12.498	30	PASS
	6	2437	12.071		
	11	2462	12.297		
IEEE 802.11g	1	2412	9.861	30	PASS
	6	2437	9.908		
	11	2462	9.711		
IEEE 802.11n HT20	1	2412	7.957	30	PASS
	6	2437	7.634		
	11	2462	7.513		
IEEE 802.11n HT40	3	2422	7.869	30	PASS
	6	2437	7.646		
	9	2452	7.487		

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.

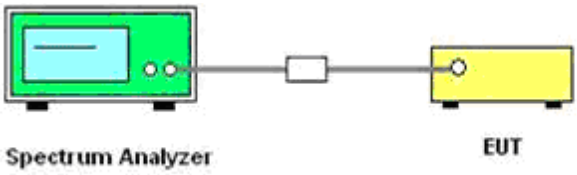
5.3.2. Measuring Instruments and Setting

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	Gary Qian	Configurations	IEEE 802.11b/g/n

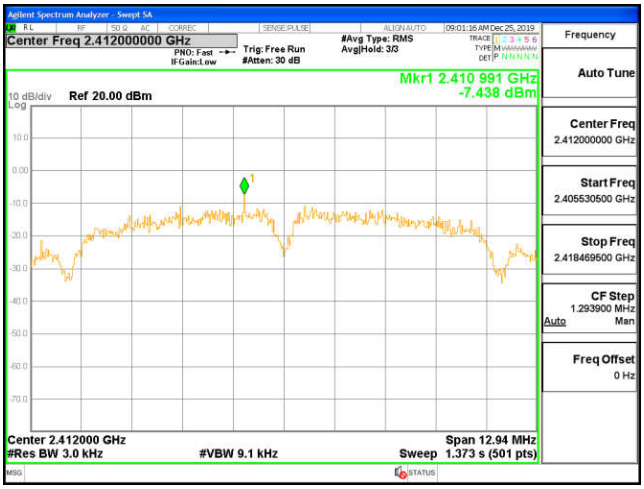
Test Mode	Channel	Frequency (MHz)	Report Peak Power Spectral Density	Limits (dBm/3KHz)	Verdict
IEEE 802.11b	1	2412	-7.44	8.00	PASS
	6	2437	-11.60		
	11	2462	-10.37		
IEEE 802.11g	1	2412	-15.01	8.00	PASS
	6	2437	-15.19		
	11	2462	-15.87		
IEEE 802.11n HT20	1	2412	-18.50	8.00	PASS
	6	2437	-17.88		
	11	2462	-18.01		
IEEE 802.11n HT40	3	2422	-20.39	8.00	PASS
	6	2437	-20.90		
	9	2452	-20.24		

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;*

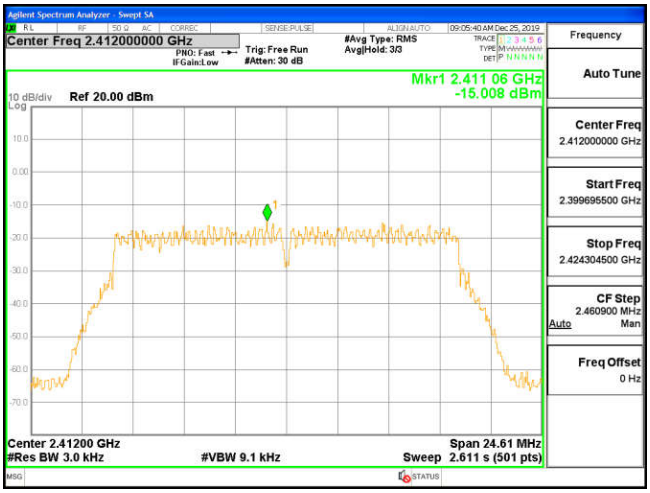
Power Spectral Density

IEEE 802.11b

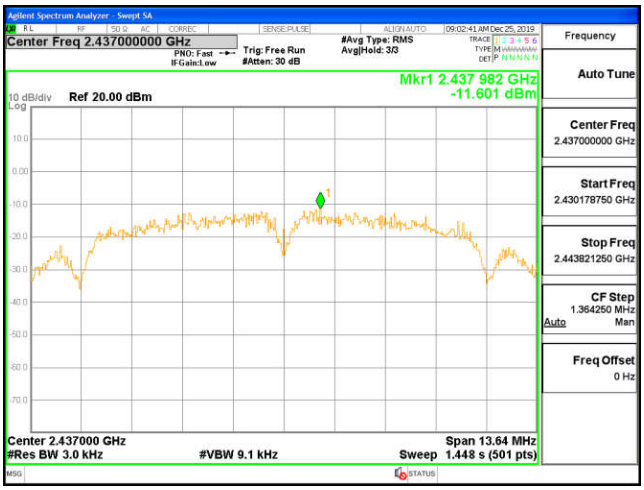


Channel 1 / 2412 MHz

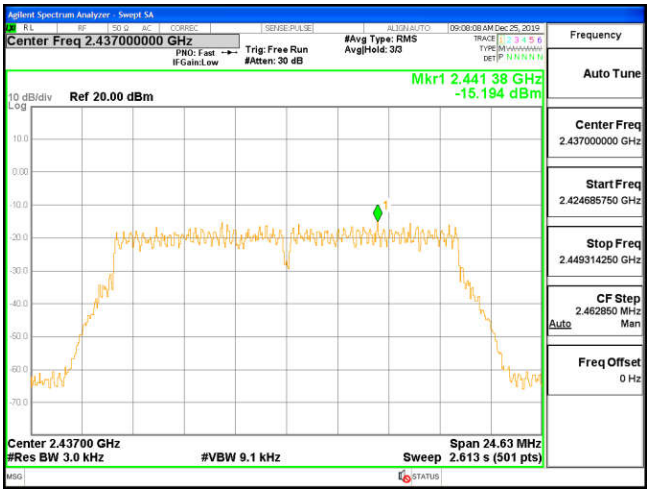
IEEE 802.11g



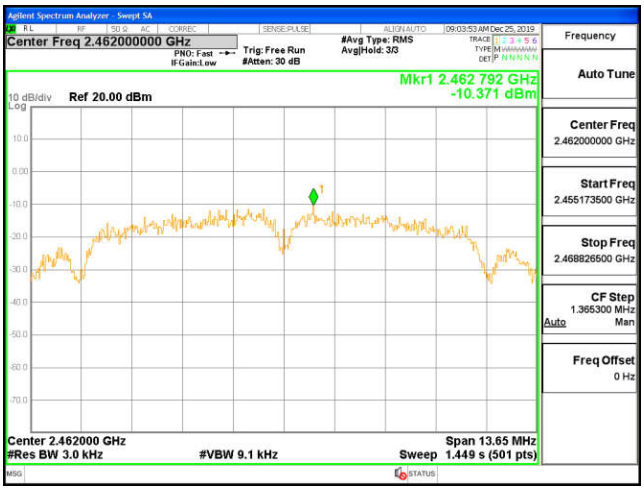
Channel 1 / 2412 MHz



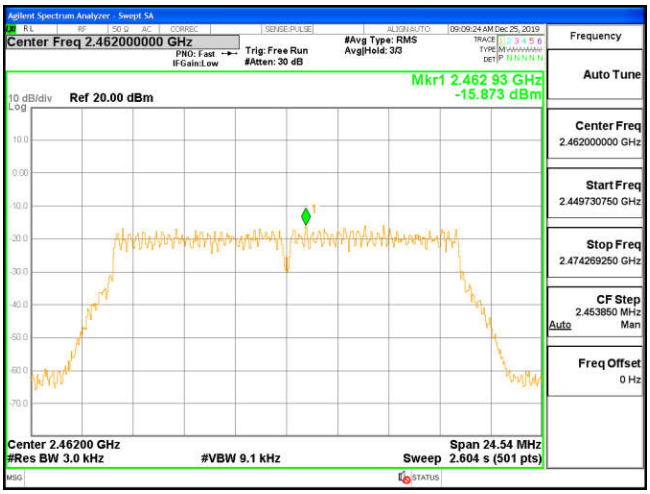
Channel 6 / 2437 MHz



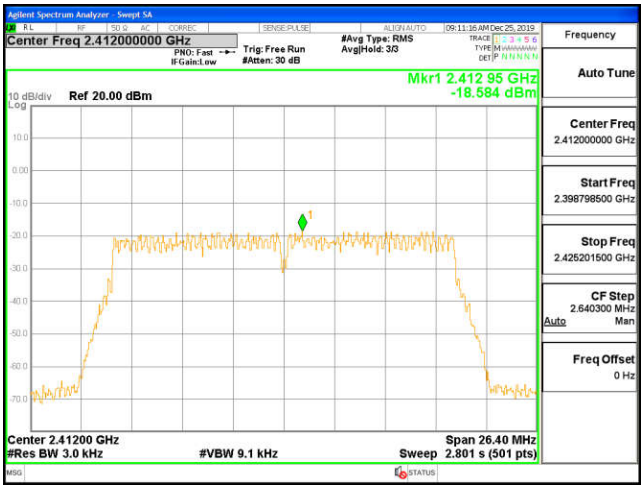
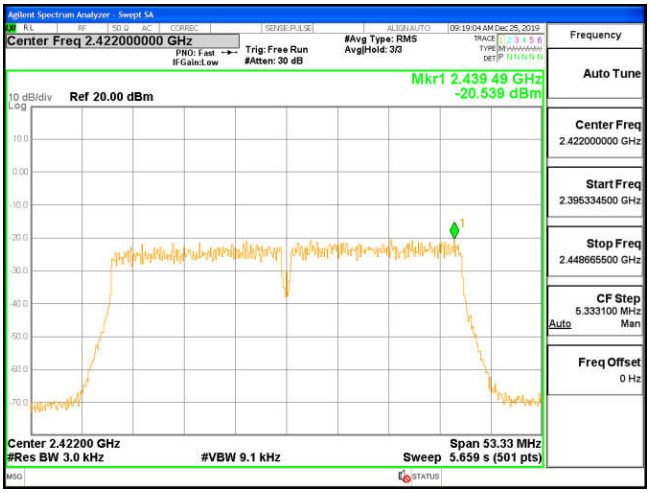
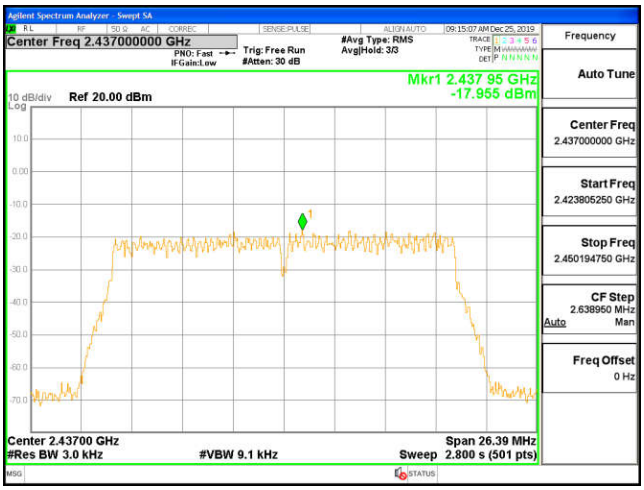
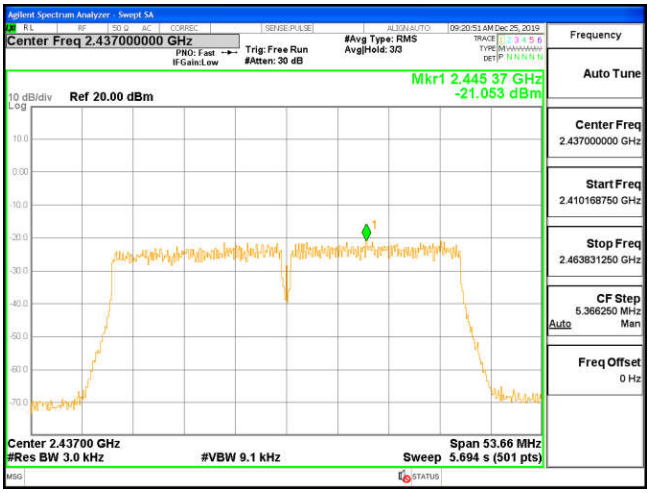
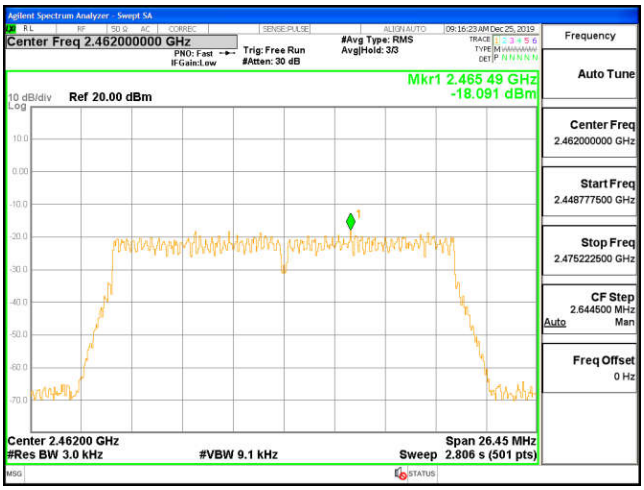
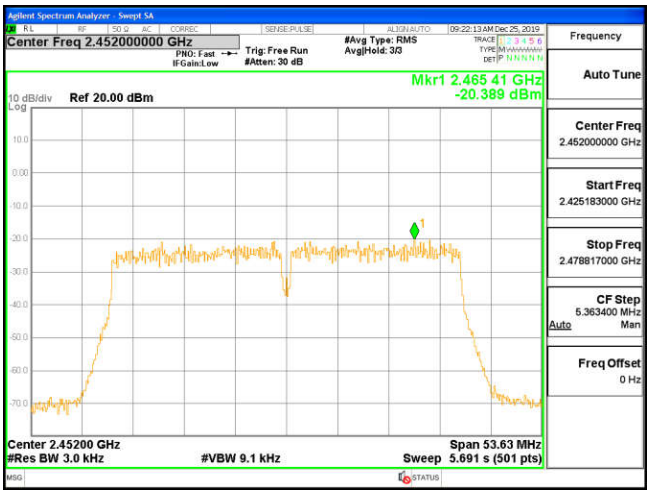
Channel 6 / 2437 MHz



Channel 11 / 2462 MHz



Channel 11 / 2462 MHz

Power Spectral Density	
IEEE 802.11n HT20	IEEE 802.11n HT40
	
Channel 1 / 2412 MHz	Channel 3 / 2422 MHz
	
Channel 6 / 2437 MHz	Channel 6 / 2437 MHz
	
Channel 11 / 2462 MHz	Channel 9 / 2452 MHz

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

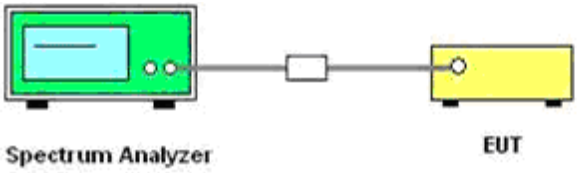
Please refer to equipments list in this report. The following table is the sett ing of the Spectrum Analyzer.

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	Gary Qian	Configurations	IEEE 802.11b/g/n

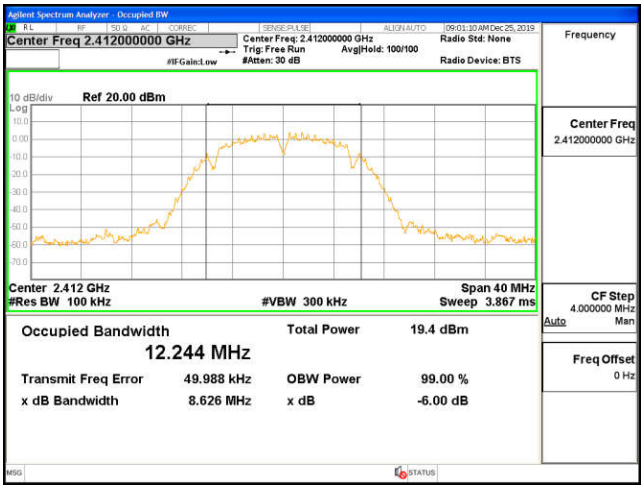
Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limits (MHz)	Verdict
IEEE 802.11b	1	2412	8.626	0.500	PASS
	6	2437	9.095		
	11	2462	9.102		
IEEE 802.11g	1	2412	16.41	0.500	PASS
	6	2437	16.42		
	11	2462	16.36		
IEEE 802.11n HT20	1	2412	17.60	0.500	PASS
	6	2437	17.59		
	11	2462	17.63		
IEEE 802.11n HT40	3	2422	35.55	0.500	PASS
	6	2437	35.77		
	9	2452	35.76		

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;*

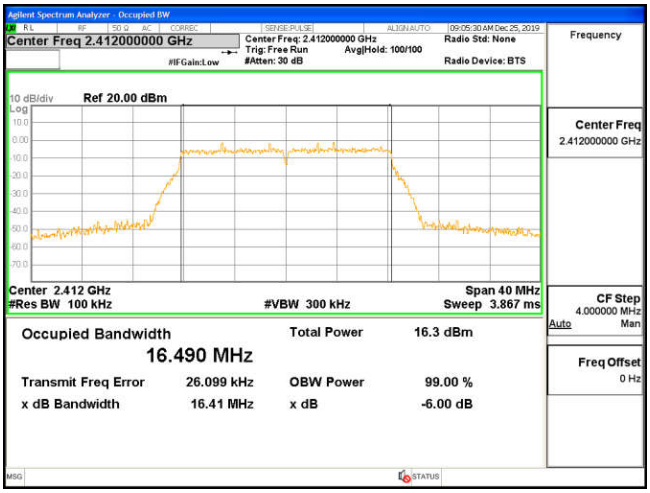
6 dB Bandwidth

IEEE 802.11b

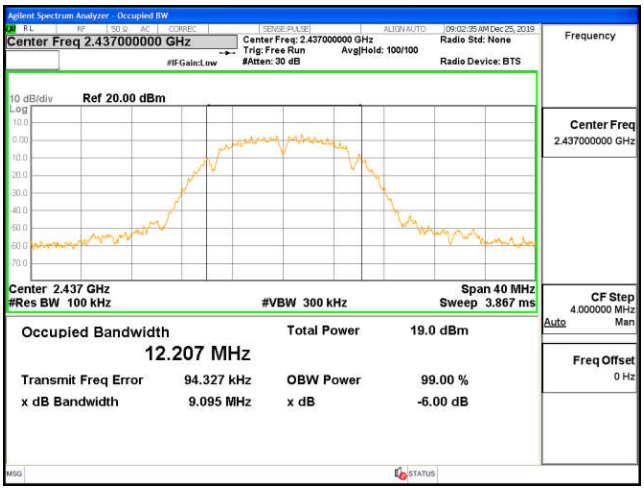


Channel 1 / 2412 MHz

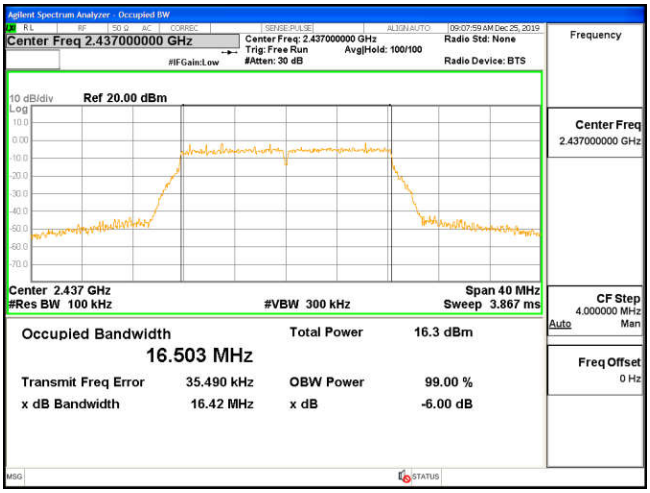
IEEE 802.11g



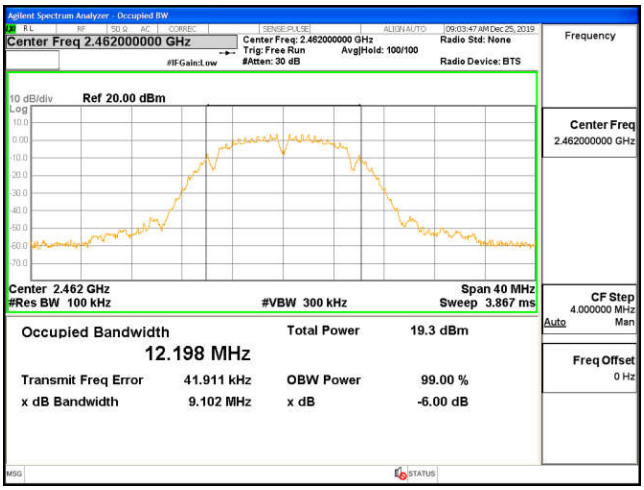
Channel 1 / 2412 MHz



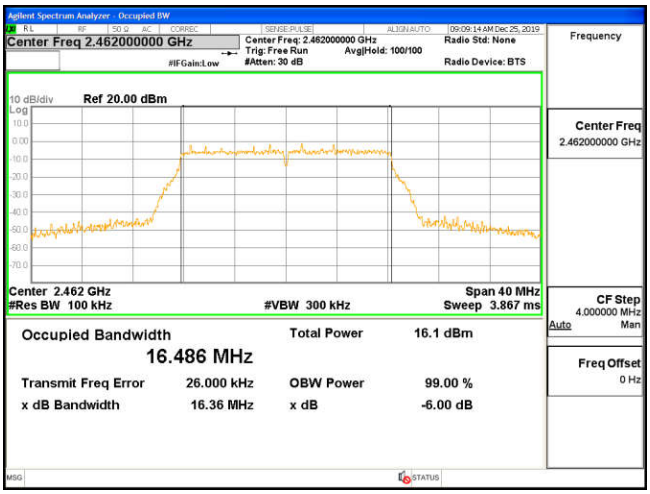
Channel 6 / 2437 MHz



Channel 6 / 2437 MHz



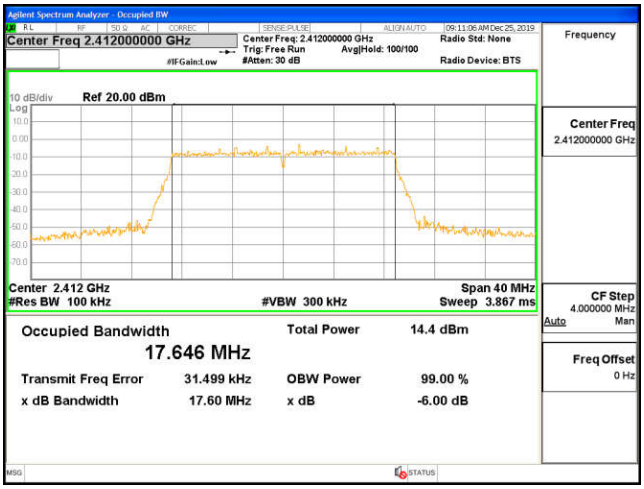
Channel 11 / 2462 MHz



Channel 11 / 2462 MHz

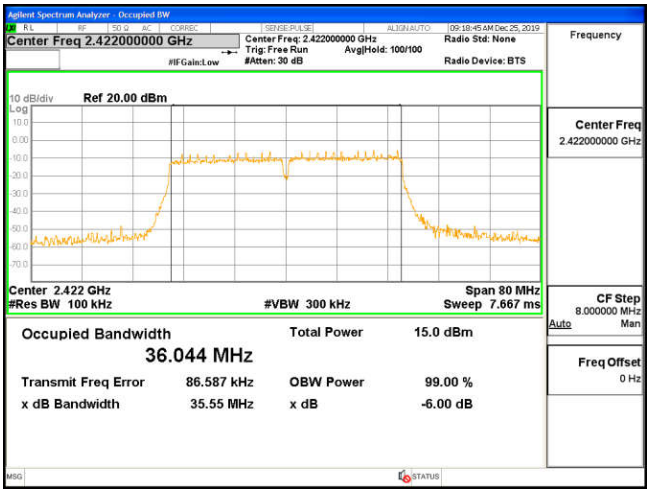
6 dB Bandwidth

IEEE 802.11n HT20

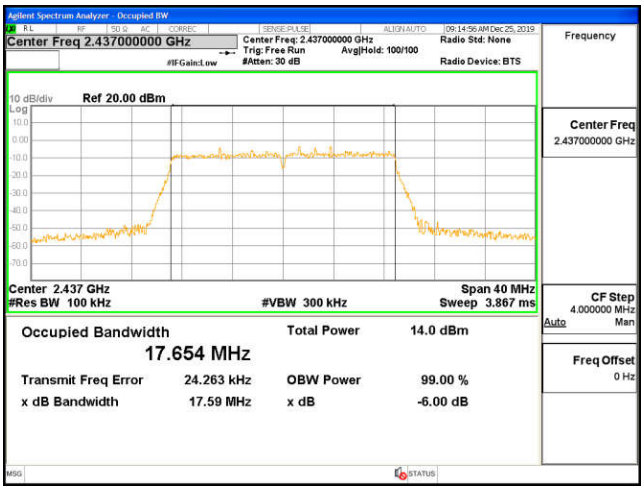


Channel 1 / 2412 MHz

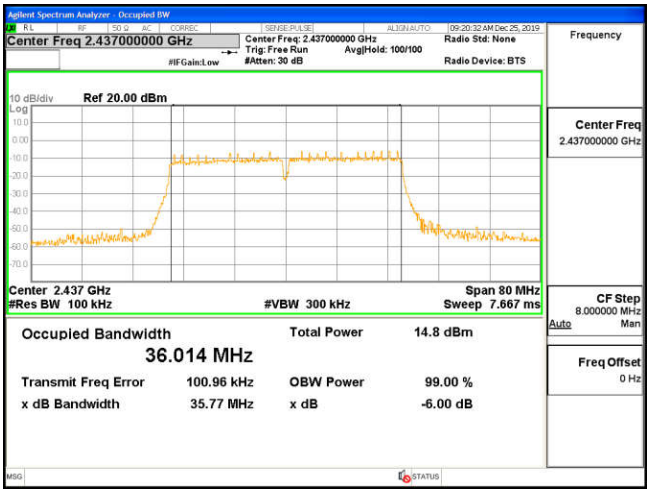
IEEE 802.11n HT40



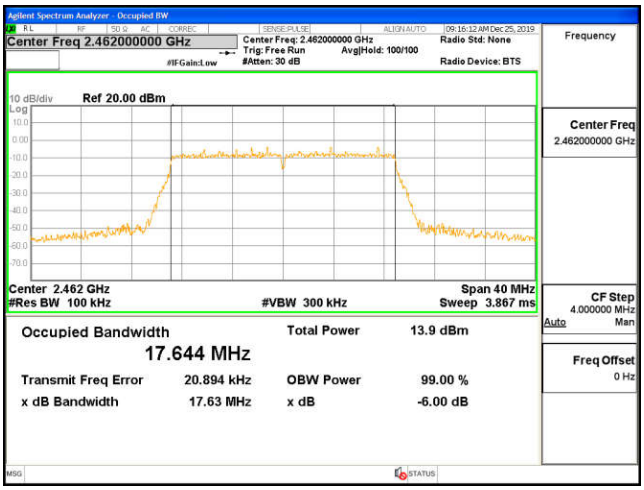
Channel 3 / 2422 MHz



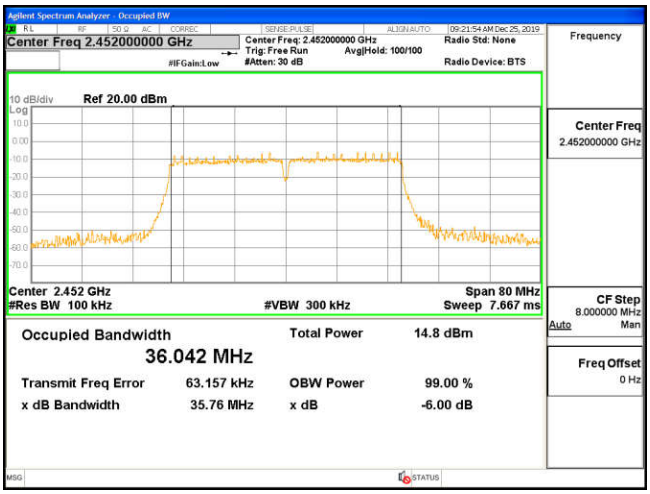
Channel 6 / 2437 MHz



Channel 6 / 2437 MHz



Channel 11 / 2462 MHz



Channel 9 / 2452 MHz

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 t urntable.

--- 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 operatio n 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.

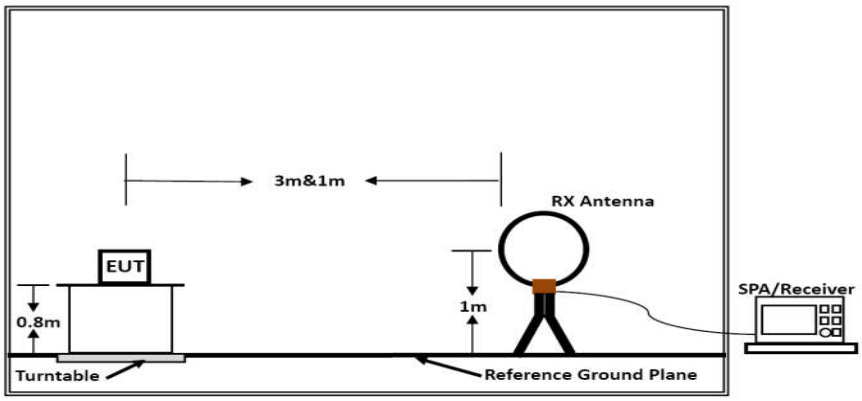
Final measurement:

--- 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.

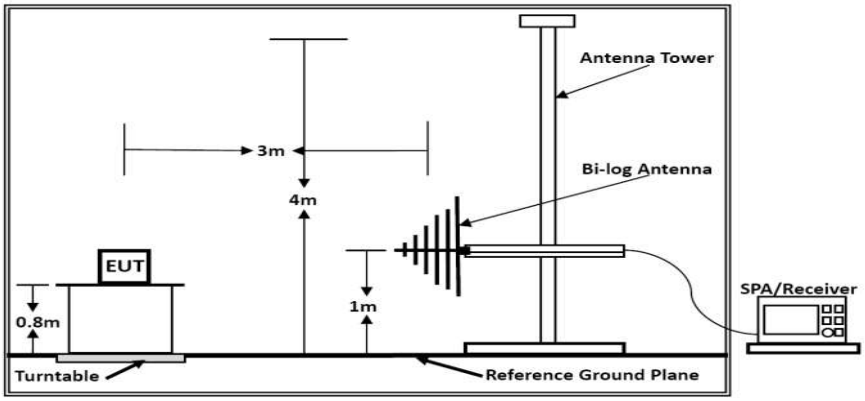
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.4. Test Setup Layout

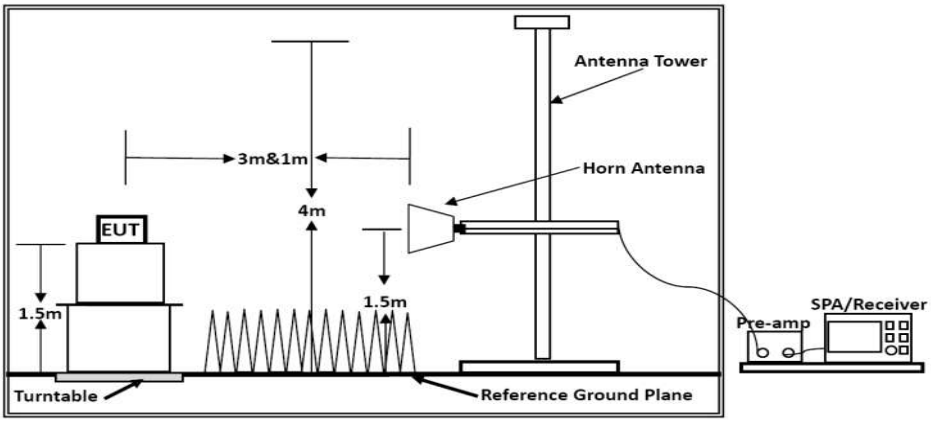
For radiated emissions below 30MHz



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	22.5℃	Humidity	56%
Test Engineer	Gary Qian	Configurations	IEEE 802.11b/g/n
Test Date	Dec 16, 2019		

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);

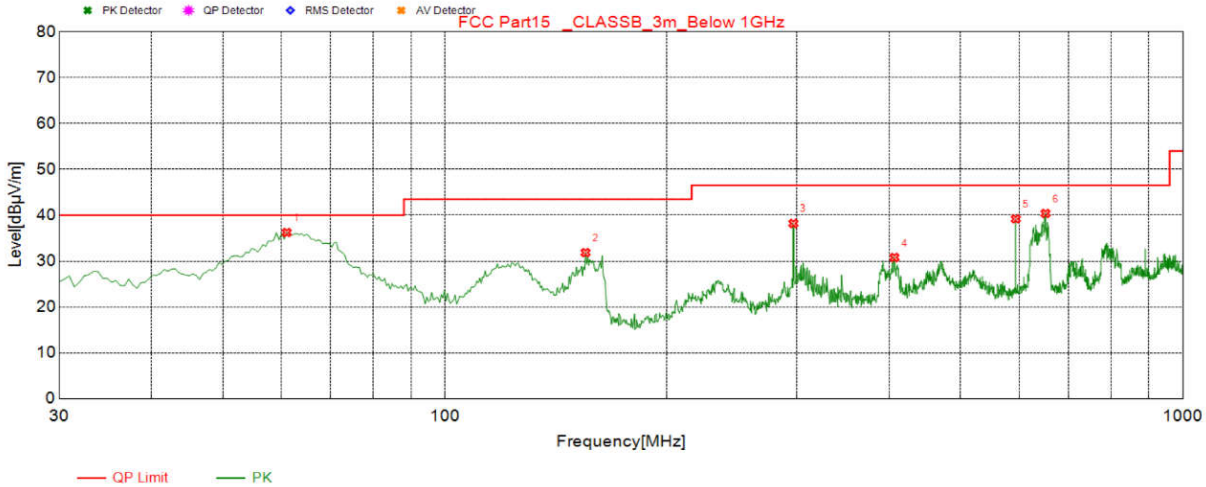
Limit line = specific limits (dBuV) + distance extrapolation factor.

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

Temperature	22.5℃	Humidity	56%
Test Engineer	Gary Qian	Configurations	802.11g Middle Channel
Test Date	Dec 16, 2019		

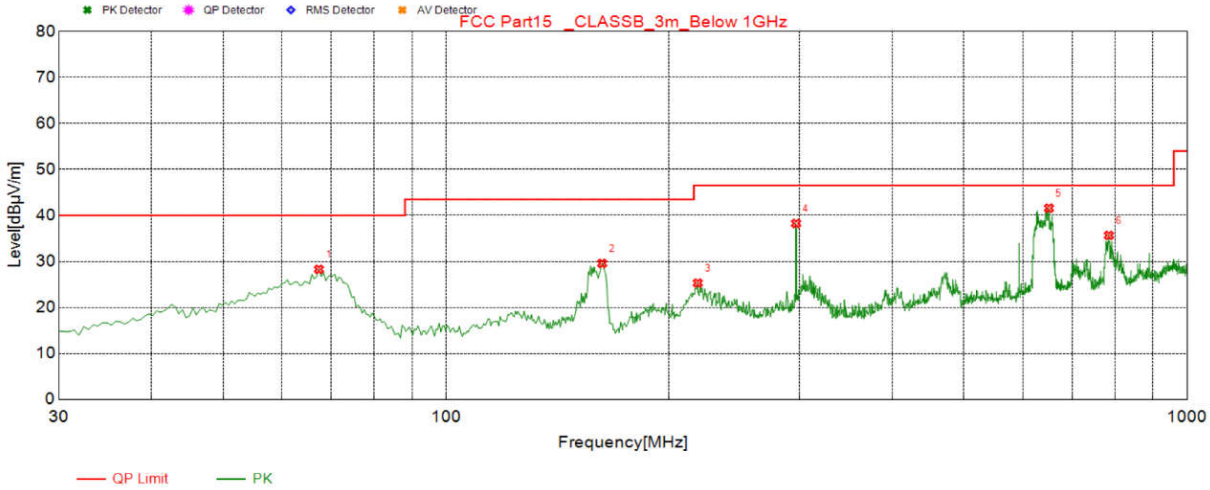
The Worst Test result for 802.11g mode(Middle Channel)

Vertical



Suspected List								
NO.	Freq. [MHz]	Result Level [dBµV/m]	Factor [dB/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle[°]	Polarity
1	61.040	36.23	-15.92	40.00	3.77	100	189	Vertical
2	155.130	31.84	-18.88	43.50	11.66	100	337	Vertical
3	296.750	38.2	-12.88	46.50	8.30	200	8	Vertical
4	406.845	30.78	-9.90	46.50	15.72	100	343	Vertical
5	594.055	39.2	-5.74	46.50	7.30	100	32	Vertical
6	651.770	40.39	-4.95	46.50	6.11	100	50	Vertical

Horizontal



Suspected List								
NO.	Freq. [MHz]	Result Level [dBµV/m]	Factor [dB/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle[°]	Polarity
1	67.345	28.28	-17.53	40.00	11.72	300	76	Horizontal
2	162.405	29.57	-18.54	43.50	13.93	100	355	Horizontal
3	218.665	25.3	-14.85	46.50	21.20	100	183	Horizontal
4	296.750	38.26	-12.88	46.50	8.24	100	94	Horizontal
5	651.285	41.58	-4.95	46.50	4.92	100	359	Horizontal
6	784.660	35.66	-3.12	46.50	10.84	100	273	Horizontal

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

5.5.8. Results for Radiated Emissions (Above 1GHz)

IEEEE 802.11b

Antenna 0

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	59.28	33.06	35.04	3.94	61.24	74.00	12.76	Peak	Horizontal
4824.00	45.20	33.06	35.04	3.94	47.16	54.00	6.84	Average	Horizontal
4824.00	56.89	33.06	35.04	3.94	58.85	74.00	15.15	Peak	Vertical
4824.00	45.10	33.06	35.04	3.94	47.06	54.00	6.94	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	57.30	33.16	35.15	3.96	59.27	74.00	14.73	Peak	Horizontal
4874.00	42.59	33.16	35.15	3.96	44.56	54.00	9.44	Average	Horizontal
4874.00	56.93	33.16	35.15	3.96	58.90	74.00	15.10	Peak	Vertical
4874.00	42.56	33.16	35.15	3.96	44.53	54.00	9.47	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	57.48	33.26	35.14	3.98	59.58	74.00	14.42	Peak	Horizontal
4924.00	43.32	33.26	35.14	3.98	45.42	54.00	8.58	Average	Horizontal
4924.00	58.48	33.26	35.14	3.98	60.58	74.00	13.42	Peak	Vertical
4924.00	44.19	33.26	35.14	3.98	46.29	54.00	7.71	Average	Vertical

IEEEE 802.11g

Antenna 0

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	57.69	33.06	35.04	3.94	59.65	74.00	14.35	Peak	Horizontal
4824.00	45.80	33.06	35.04	3.94	47.76	54.00	6.24	Average	Horizontal
4824.00	58.21	33.06	35.04	3.94	60.17	74.00	13.83	Peak	Vertical
4824.00	42.25	33.06	35.04	3.94	44.21	54.00	9.79	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	58.08	33.16	35.15	3.96	60.05	74.00	13.95	Peak	Horizontal
4874.00	45.93	33.16	35.15	3.96	47.90	54.00	6.10	Average	Horizontal
4874.00	57.22	33.16	35.15	3.96	59.19	74.00	14.81	Peak	Vertical
4874.00	43.99	33.16	35.15	3.96	45.96	54.00	8.04	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	59.39	33.26	35.14	3.98	61.49	74.00	12.51	Peak	Horizontal
4924.00	42.70	33.26	35.14	3.98	44.80	54.00	9.20	Average	Horizontal
4924.00	57.77	33.26	35.14	3.98	59.87	74.00	14.13	Peak	Vertical
4924.00	42.92	33.26	35.14	3.98	45.02	54.00	8.98	Average	Vertical

IEEE 802.11n HT20

Combined Antenna 0, Antenna 1 and Antenna 2

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	56.45	33.06	35.04	3.94	58.41	74.00	15.59	Peak	Horizontal
4824.00	40.07	33.06	35.04	3.94	42.03	54.00	11.97	Average	Horizontal
4824.00	58.62	33.06	35.04	3.94	60.58	74.00	13.42	Peak	Vertical
4824.00	44.33	33.06	35.04	3.94	46.29	54.00	7.71	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	57.99	33.16	35.15	3.96	59.96	74.00	14.04	Peak	Horizontal
4874.00	41.23	33.16	35.15	3.96	43.20	54.00	10.80	Average	Horizontal
4874.00	58.23	33.16	35.15	3.96	60.20	74.00	13.80	Peak	Vertical
4874.00	45.34	33.16	35.15	3.96	47.31	54.00	6.69	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	57.21	33.26	35.14	3.98	59.31	74.00	14.69	Peak	Horizontal
4924.00	43.99	33.26	35.14	3.98	46.09	54.00	7.91	Average	Horizontal
4924.00	56.54	33.26	35.14	3.98	58.64	74.00	15.36	Peak	Vertical
4924.00	43.40	33.26	35.14	3.98	45.50	54.00	8.50	Average	Vertical

IEEE 802.11n HT40

Combined Antenna 0, Antenna 1 and Antenna 2

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	57.32	33.06	35.04	3.94	59.28	74.00	14.72	Peak	Horizontal
4844.00	45.72	33.06	35.04	3.94	47.68	54.00	6.32	Average	Horizontal
4844.00	59.02	33.06	35.04	3.94	60.98	74.00	13.02	Peak	Vertical
4844.00	40.05	33.06	35.04	3.94	42.01	54.00	11.99	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	57.81	33.16	35.15	3.96	59.78	74.00	14.22	Peak	Horizontal
4874.00	45.94	33.16	35.15	3.96	47.91	54.00	6.09	Average	Horizontal
4874.00	58.86	33.16	35.15	3.96	60.83	74.00	13.17	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	57.90	33.26	35.14	3.98	60.00	74.00	14.00	Peak	Horizontal
4904.00	43.64	33.26	35.14	3.98	45.74	54.00	8.26	Average	Horizontal
4904.00	58.59	33.26	35.14	3.98	60.69	74.00	13.31	Peak	Vertical
4904.00	44.27	33.26	35.14	3.98	46.37	54.00	7.63	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;*

5.6. 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 spe cified 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.

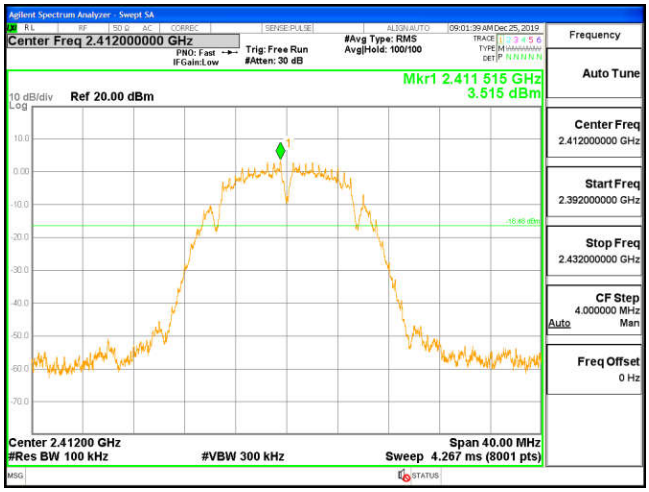
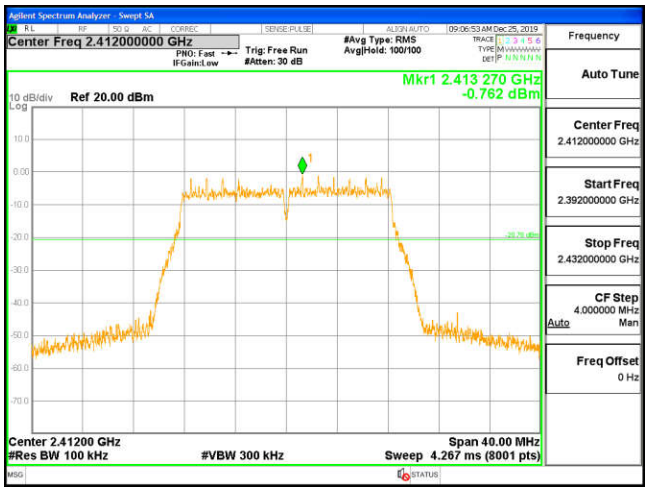
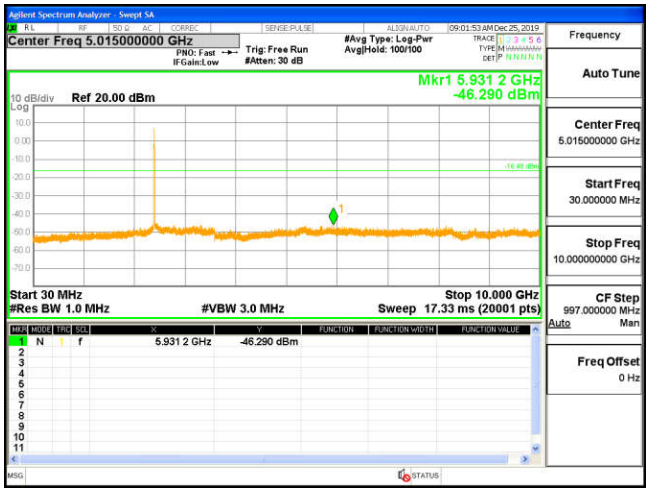
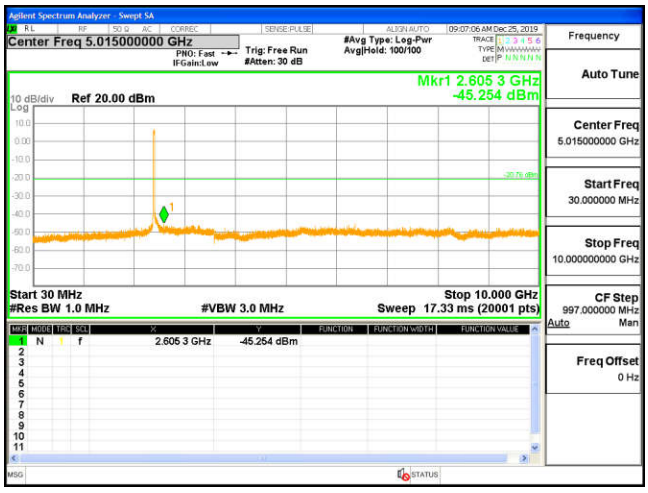
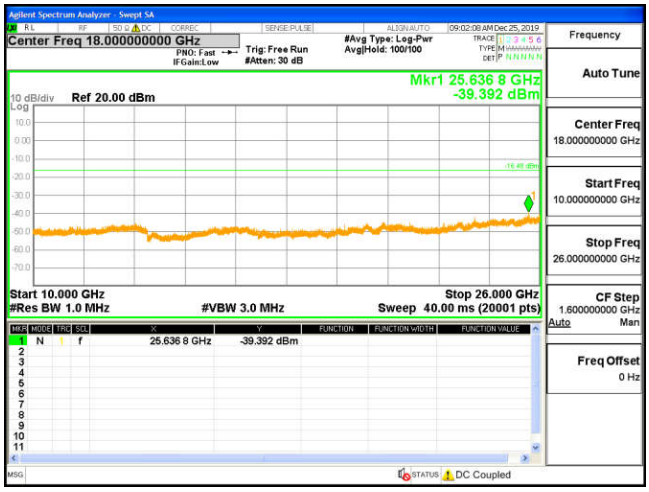
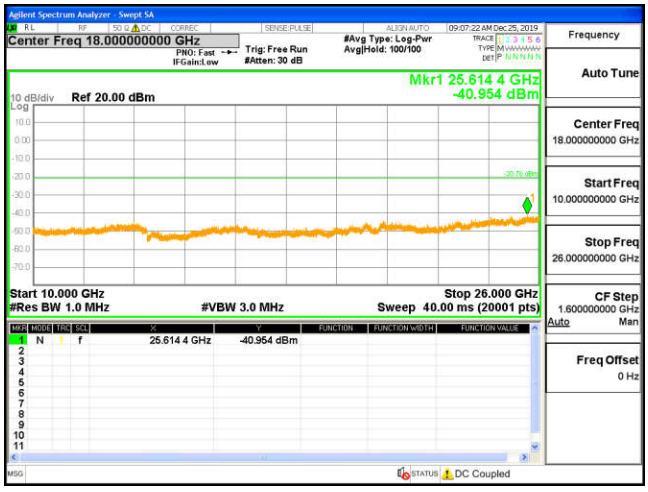
5.6.6. Test Results of Conducted Spurious Emissions

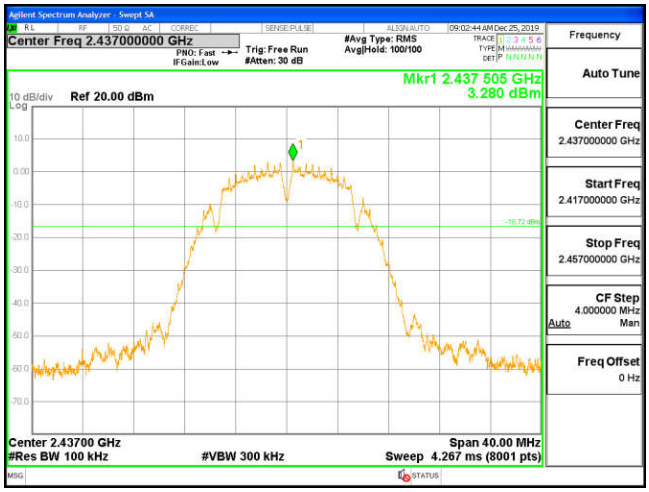
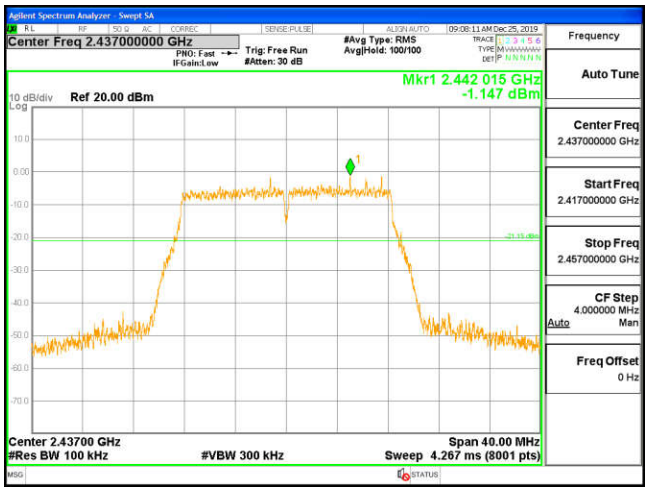
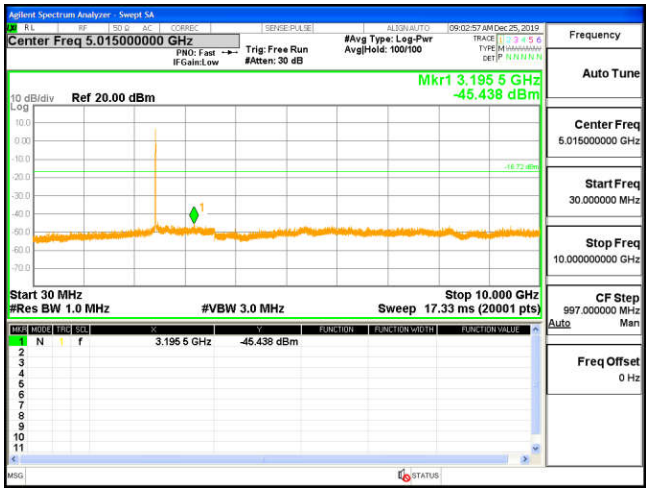
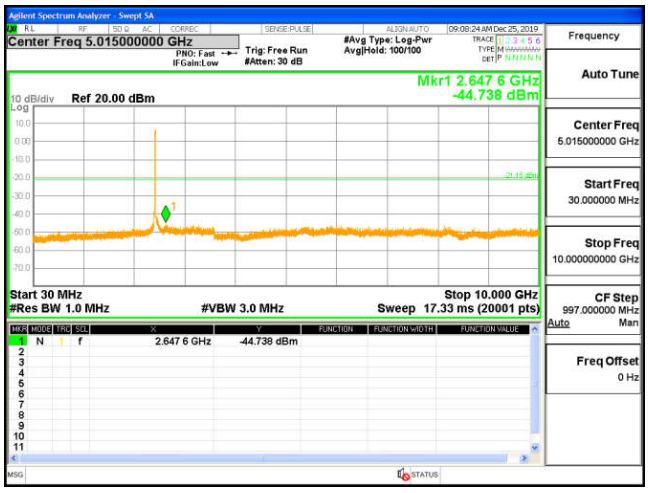
Temperature	22.5℃	Humidity	56%
Test Engineer	Gary Qian	Configurations	IEEE 802.11b/g/n

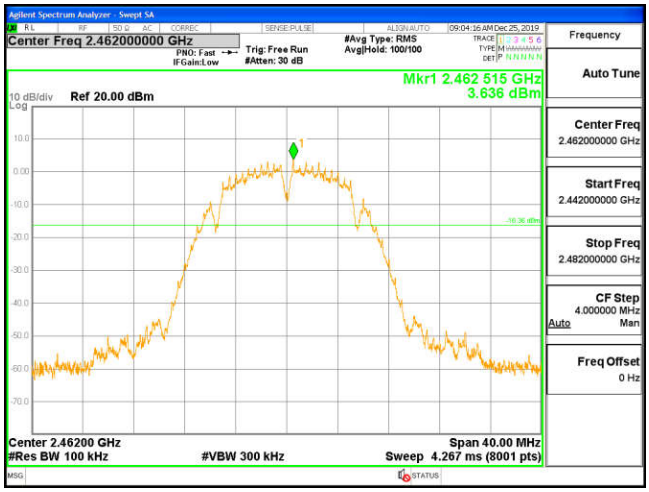
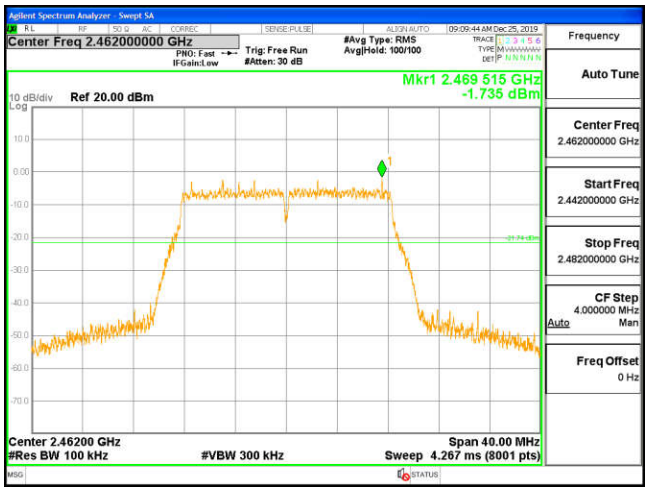
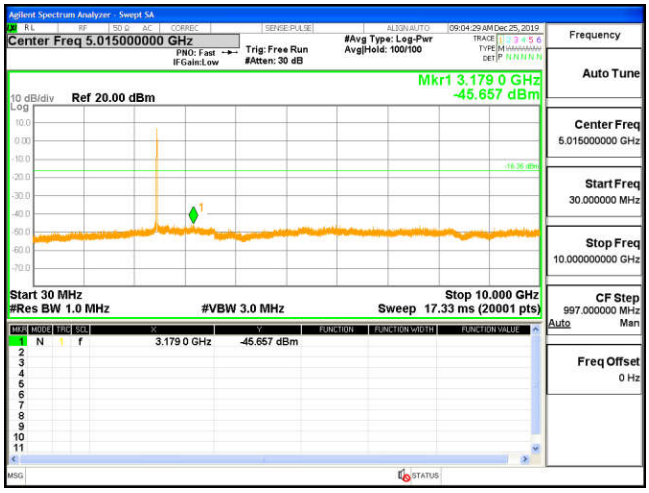
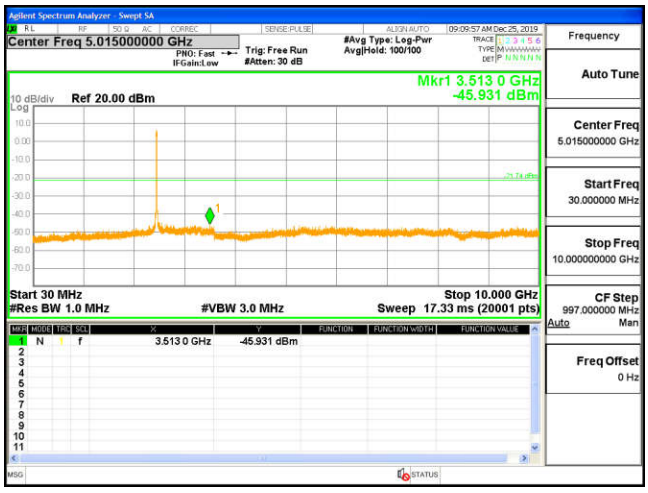
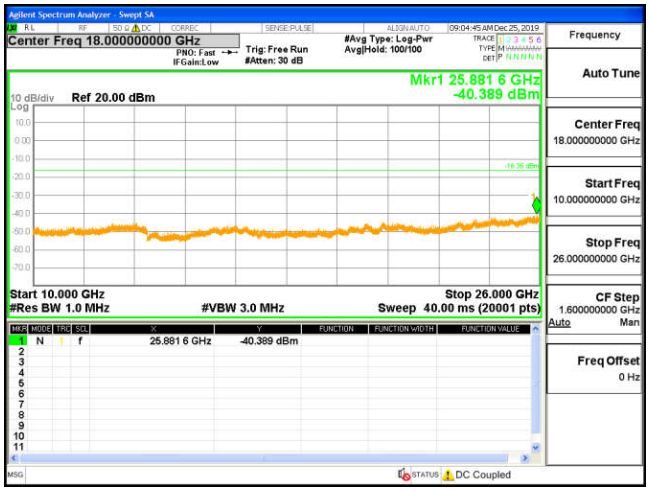
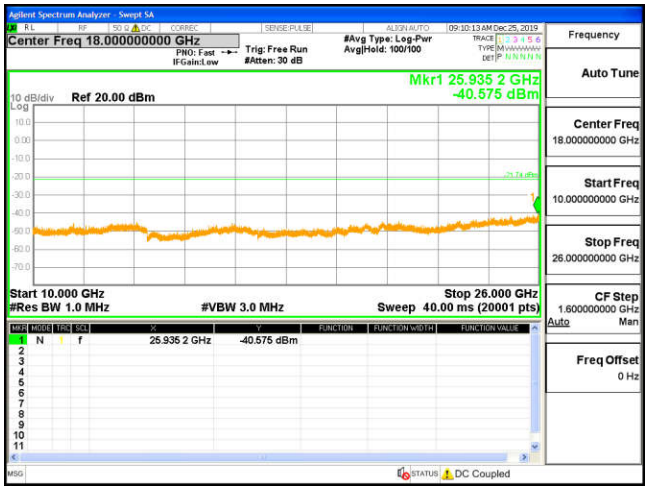
Test Mode	Channel	Frequency (MHz)	Measured Frequency Range	Spurious RF Conducted Emission (dBc)			Limits (dBc)	Verdict
				Antenna 0	Antenna 1	Antenna 2		
IEEE 802.11b	1	2412	9 KHz – 26.5 GHz	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20	<-20	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20	<-20	<-20		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

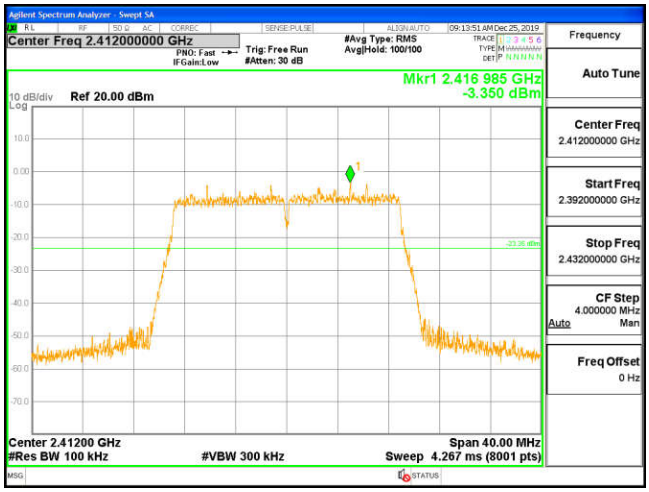
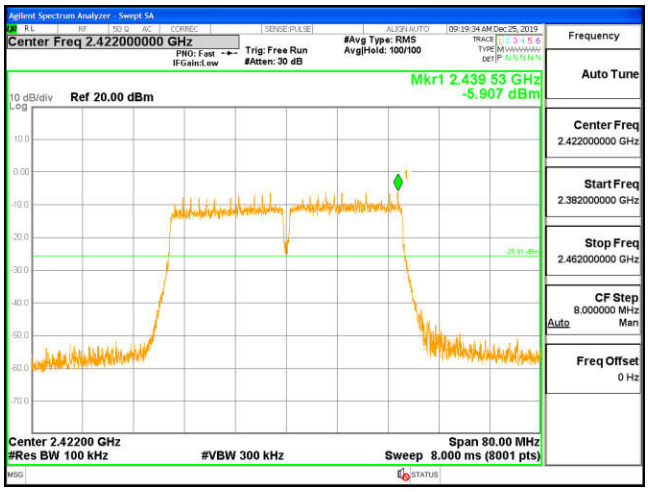
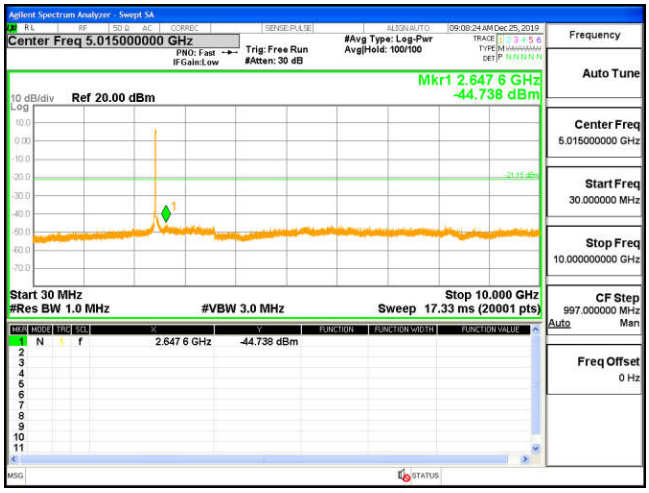
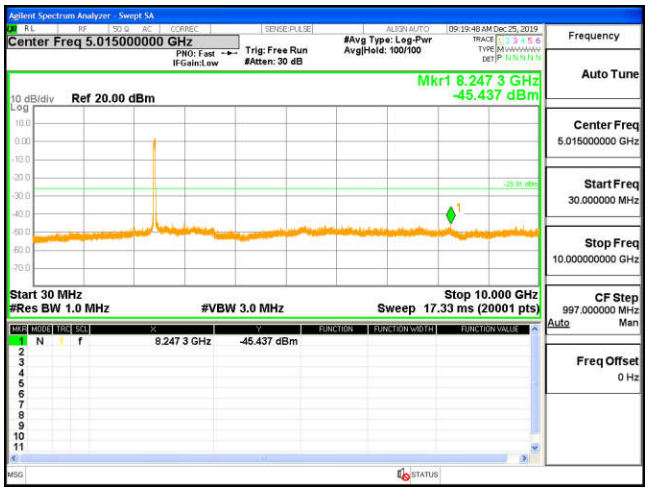
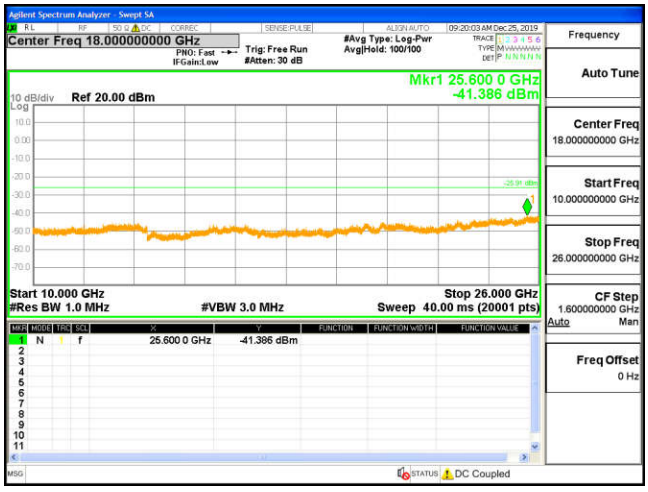
Remark:

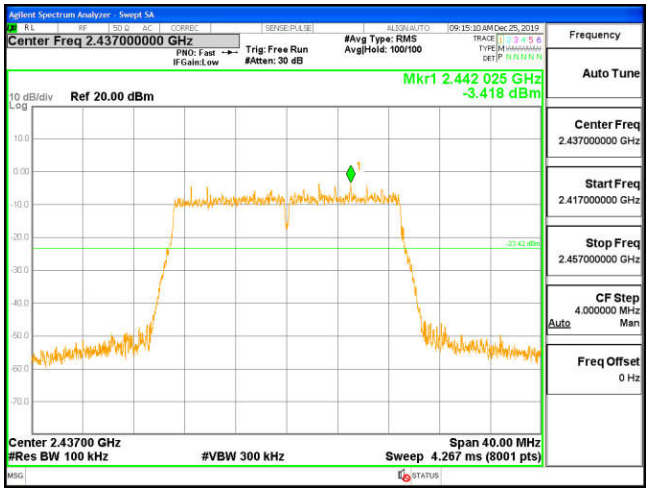
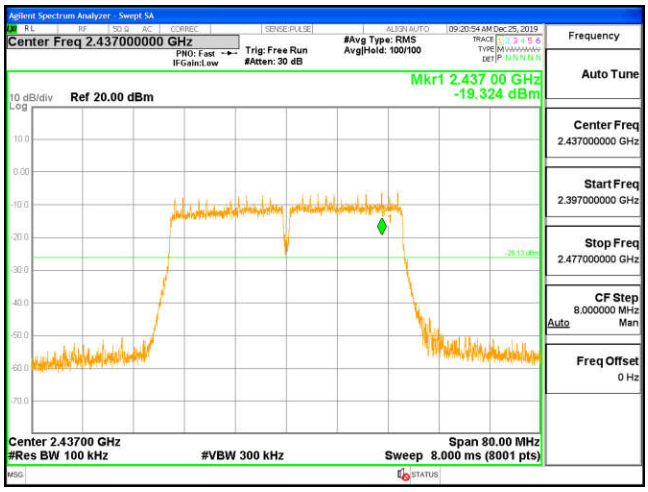
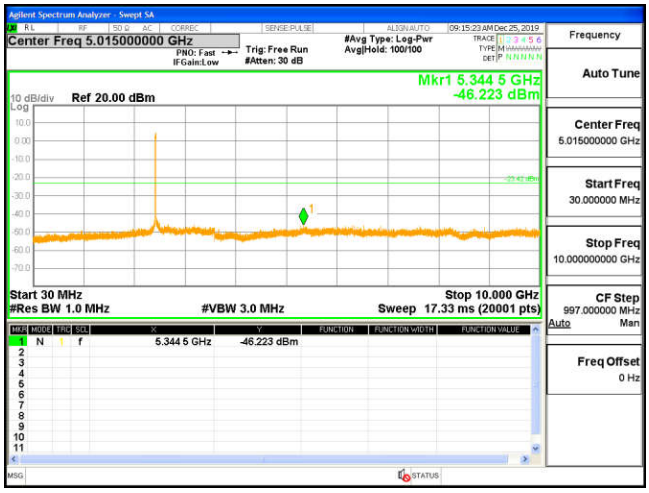
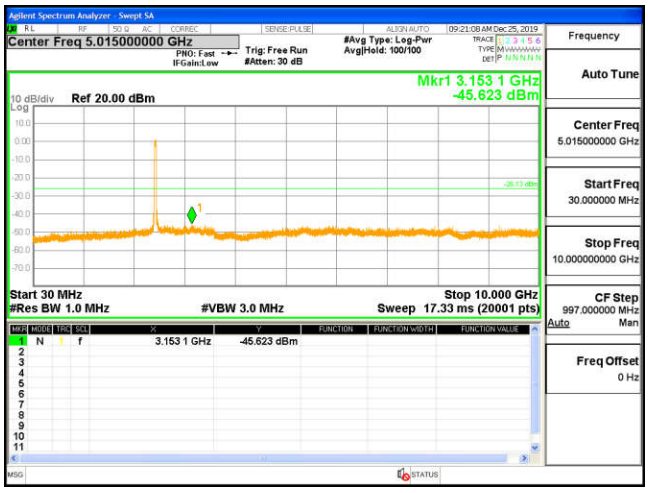
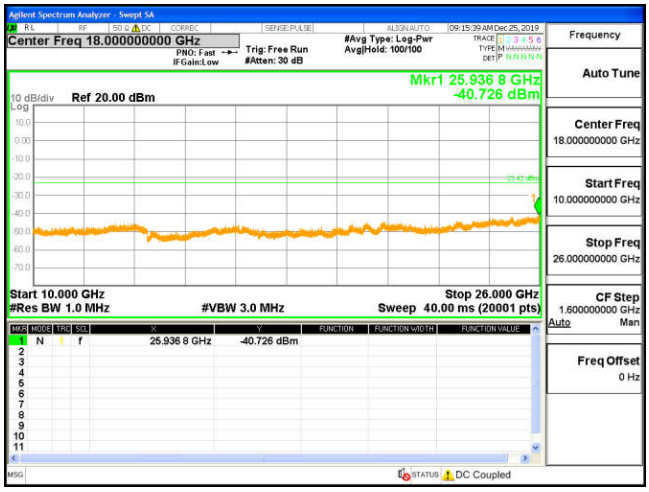
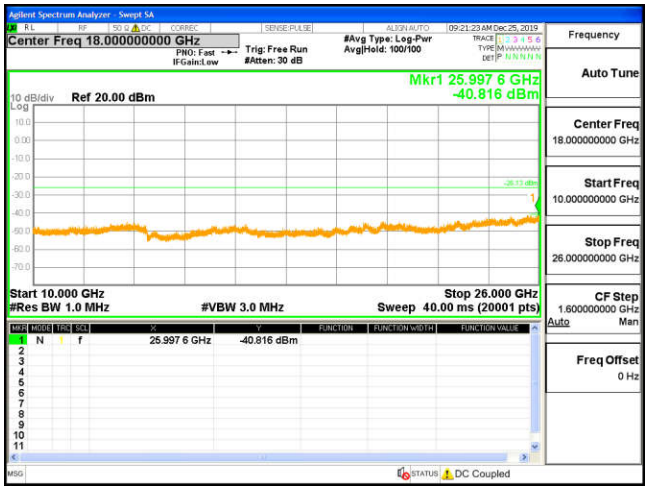
1. *Measured RF conducted spurious emission at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *"---"means 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;*

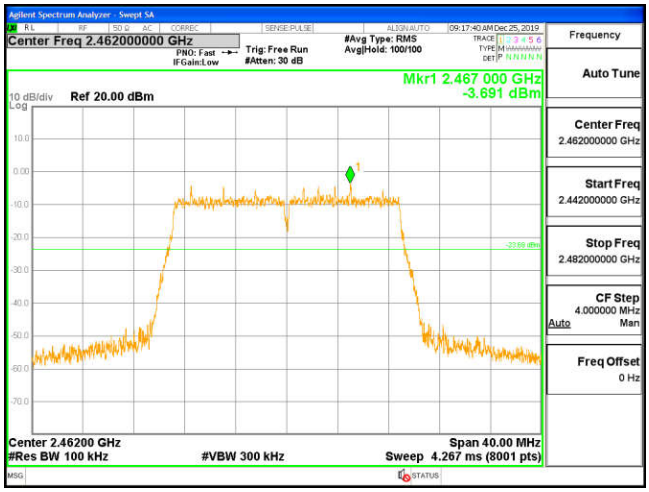
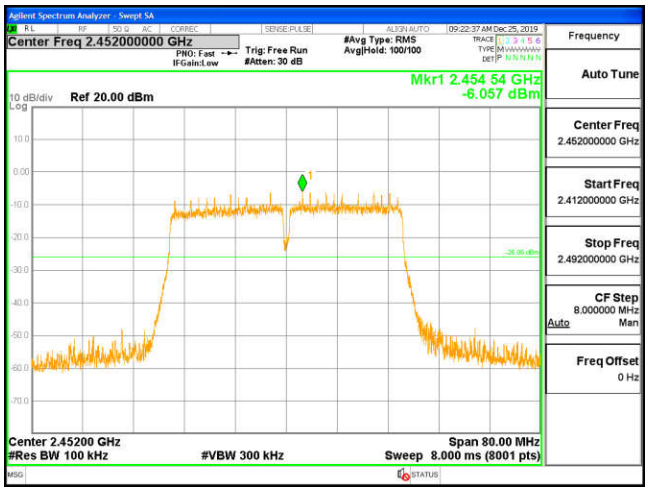
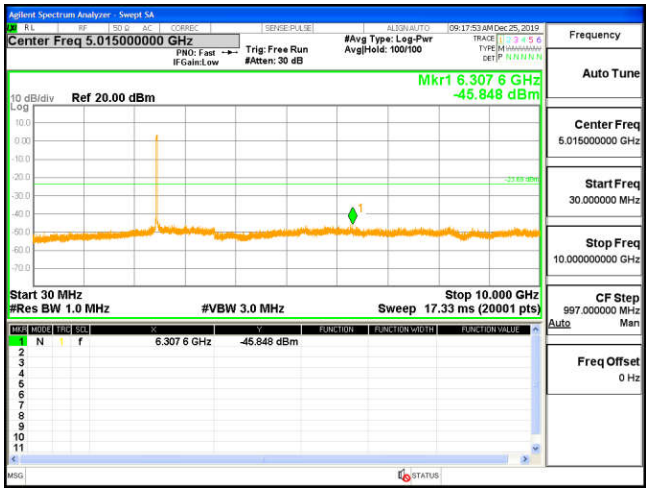
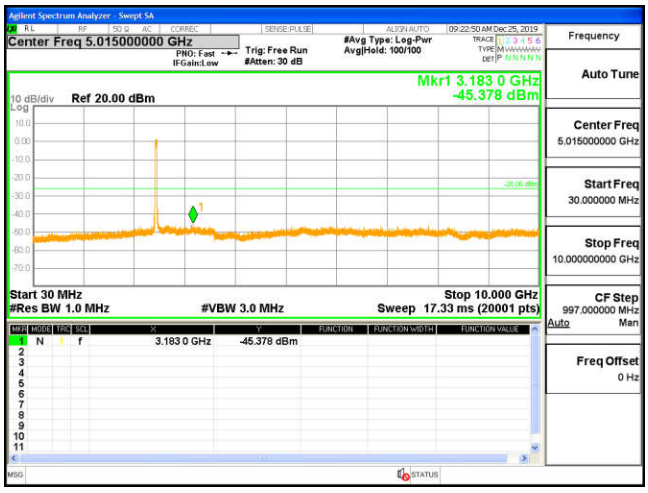
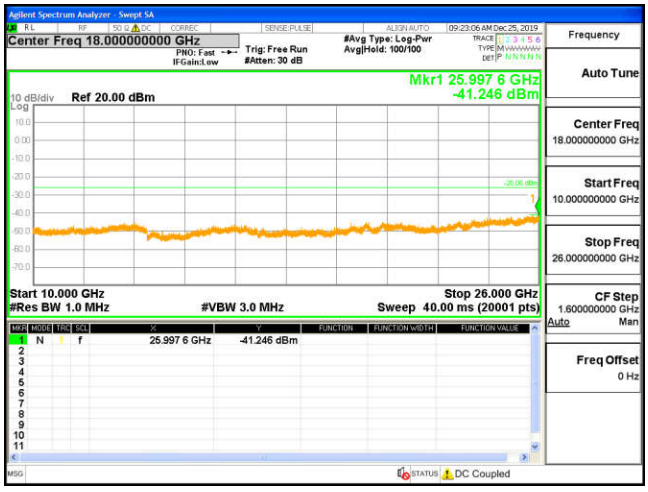
RF Conducted Spurious Emissions	
IEEE 802.11b	IEEE 802.11g
Channel 1 / 2412 MHz	Channel 1 / 2412 MHz
	
2392 MHz – 2432 MHz	2392 MHz – 2432 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
	
10 GHz – 26 GHz	10 GHz – 26 GHz

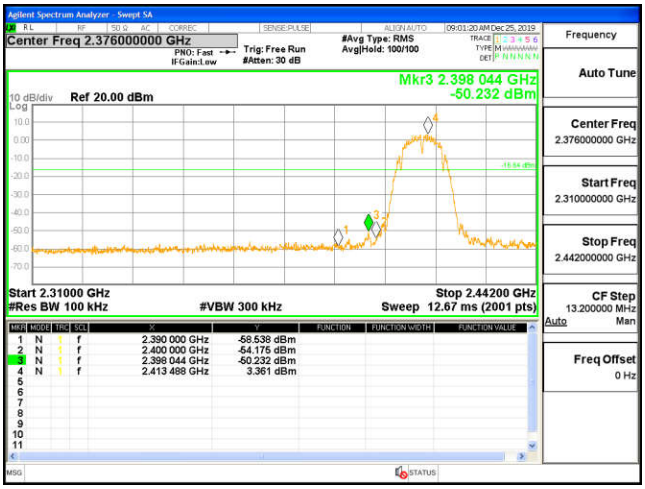
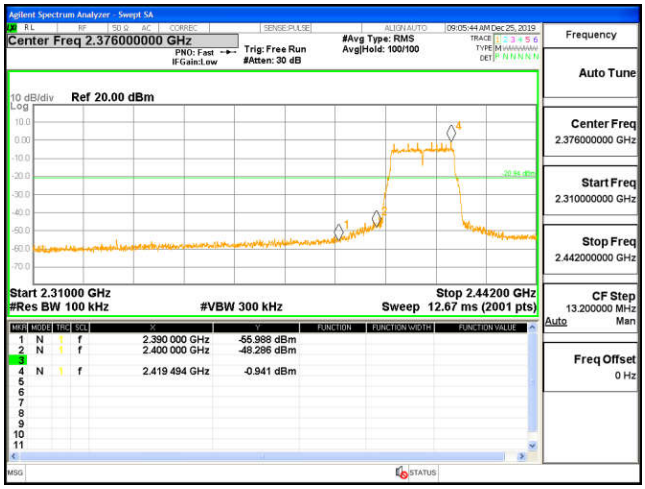
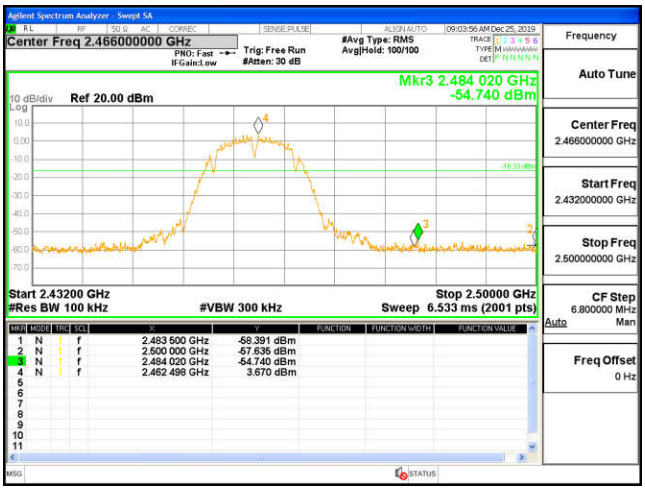
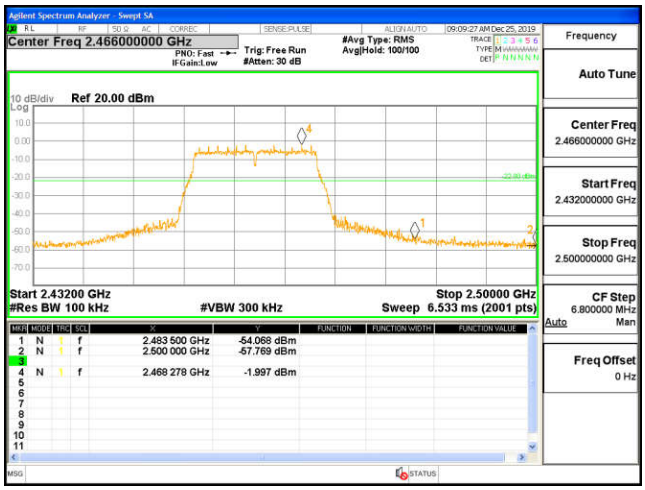
RF Conducted Spurious Emissions	
IEEE 802.11b	IEEE 802.11g
Channel 6 / 2437 MHz	Channel 6 / 2437 MHz
	
2417 MHz – 2457 MHz	2417 MHz – 2457 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
10 GHz – 26 GHz	10 GHz – 26 GHz

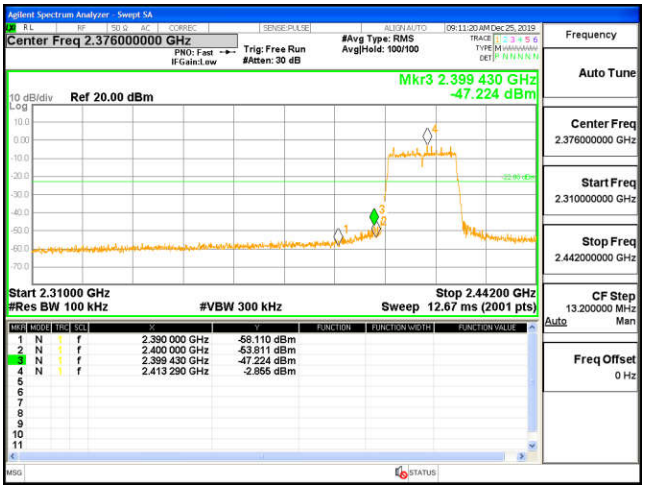
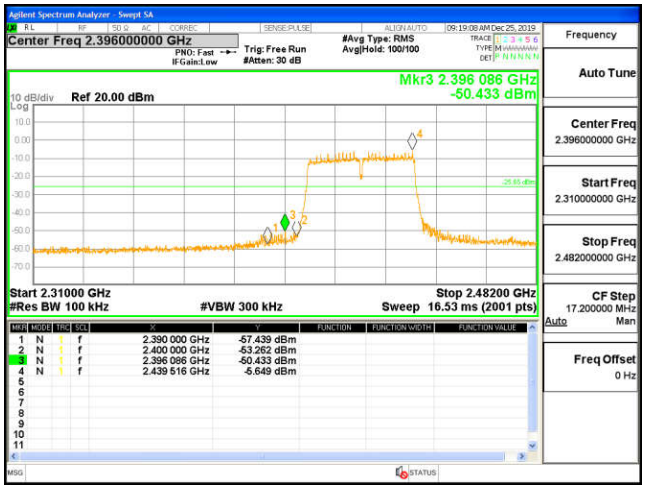
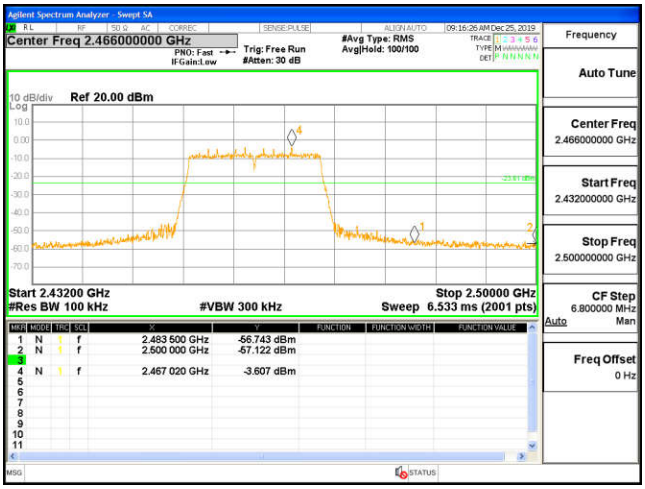
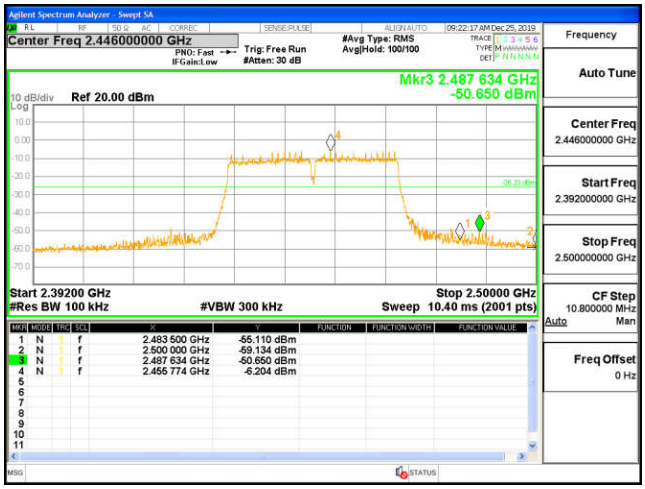
RF Conducted Spurious Emissions	
IEEE 802.11b	IEEE 802.11g
Channel 11 / 2462 MHz	Channel 11 / 2462 MHz
	
2442 MHz – 2482 MHz	2442 MHz – 2482 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
	
10 GHz – 26 GHz	10 GHz – 26 GHz

RF Conducted Spurious Emissions	
IEEE 802.11n HT20	IEEE 802.11n HT40
Channel 1 / 2412 MHz	Channel 3 / 2422 MHz
	
2392 MHz – 2432 MHz	2382 MHz – 2462 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
	
10 GHz – 26 GHz	10 GHz – 26 GHz

RF Conducted Spurious Emissions	
IEEE 802.11n HT20	IEEE 802.11n HT40
Channel 6 / 2437 MHz	Channel 6 / 2437 MHz
	
2417 MHz – 2457 MHz	2397 MHz – 2477 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
	
10 GHz – 26 GHz	10 GHz – 26 GHz

RF Conducted Spurious Emissions	
IEEE 802.11n HT20	IEEE 802.11n HT40
Channel 11 / 2462 MHz	Channel 9 / 2452 MHz
	
2442 MHz – 2482 MHz	2412 MHz – 2492 MHz
	
30 MHz – 10 GHz	30 MHz – 10 GHz
	
10 GHz – 26 GHz	10 GHz – 26 GHz

Band-edge Measurements for Conducted Emissions	
IEEE 802.11b	IEEE 802.11g
	
Channel 1 / 2412 MHz	Channel 1 / 2412 MHz
	
Channel 11 / 2462 MHz	Channel 11 / 2462 MHz

Band-edge Measurements for Conducted Emissions	
IEEE 802.11n20	IEEE 802.11n40
	
Channel 1 / 2412 MHz	Channel 1 / 2412 MHz
	
Channel 11 / 2462 MHz	Channel 11 / 2462 MHz

5.7. Power line conducted emissions

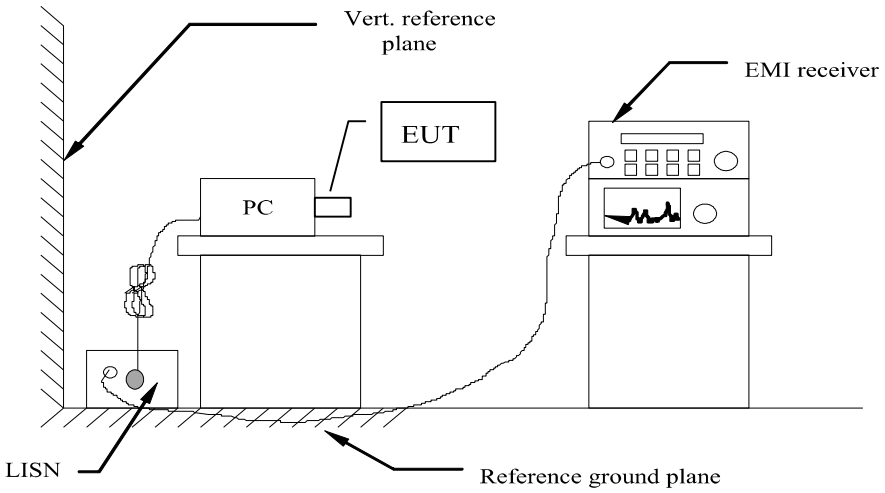
5.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



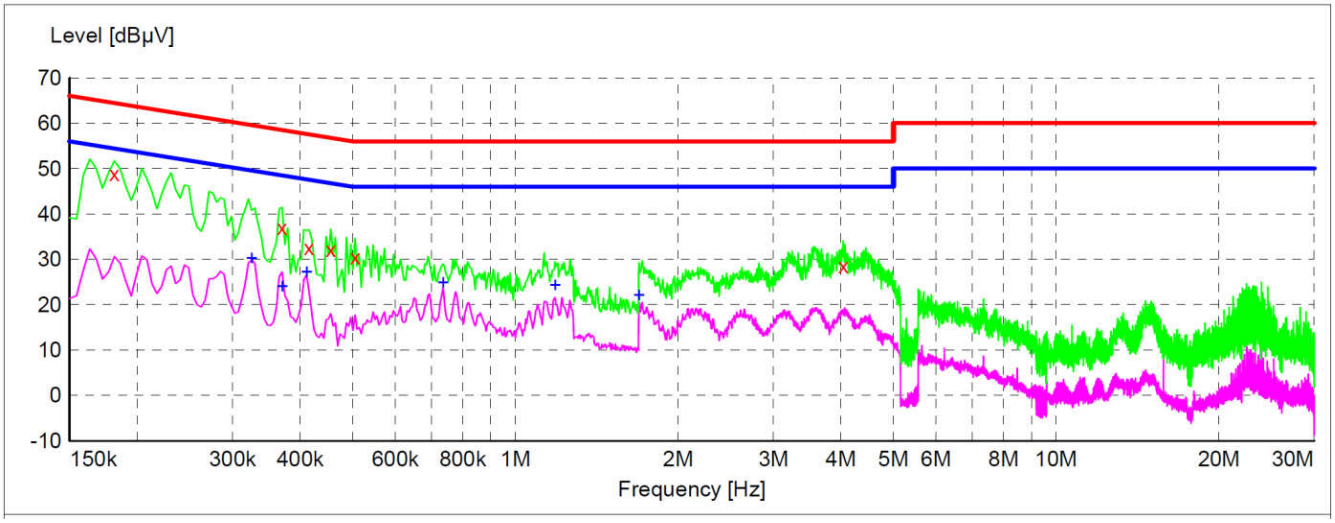
5.7.3 Test Results

Temperature	22.5℃	Humidity	56.2%
Test Engineer	Gary Qian	Configurations	802.11g (Middle Channel)
Test Date	Sept 6, 2019		

The Worst Test result for 802.11g (Middle Channel)

AC Conducted Emission of power adapter @ AC 120V/60Hz @ IEEE 802.11g Middle Channel (worst case)

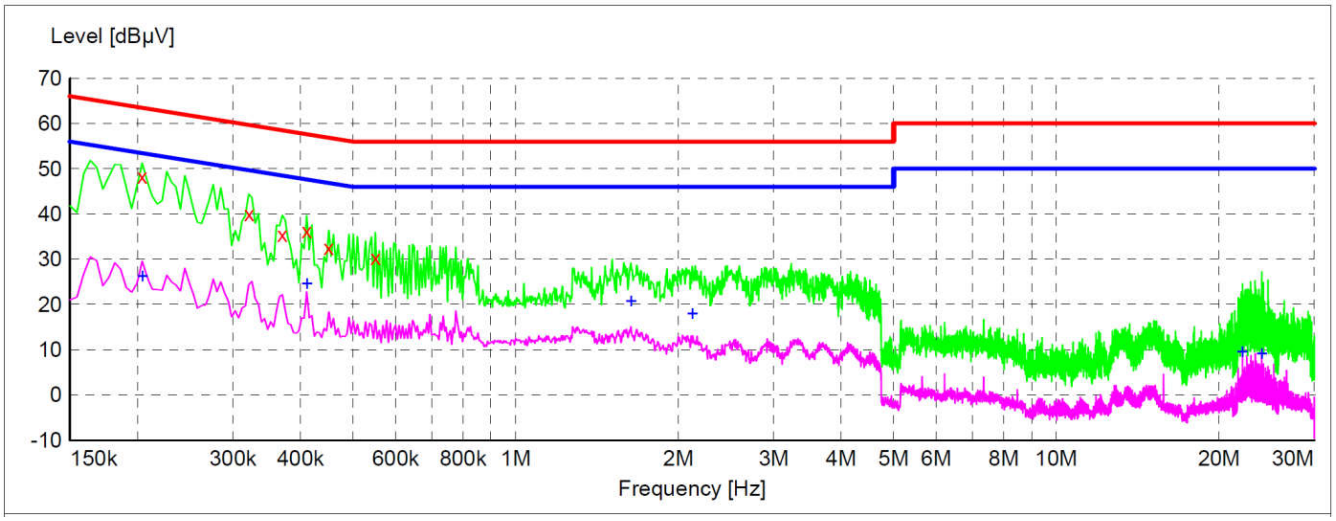
Line



Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.181500	48.80	10.3	64	15.6	QP	L1	GND
0.370500	37.00	10.1	59	21.5	QP	L1	GND
0.415500	32.50	10.0	58	25.0	QP	L1	GND
0.456000	32.20	10.0	57	24.6	QP	L1	GND
0.505500	30.50	9.9	56	25.5	QP	L1	GND
4.038000	28.60	9.7	56	27.4	QP	L1	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.325500	30.20	10.1	50	19.4	AV	L1	GND
0.370500	24.00	10.1	49	24.5	AV	L1	GND
0.411000	27.10	10.0	48	20.5	AV	L1	GND
0.735000	24.80	9.9	46	21.2	AV	L1	GND
1.185000	24.20	9.8	46	21.8	AV	L1	GND
1.693500	22.00	9.7	46	24.0	AV	L1	GND

Neutral



Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.204000	48.30	10.6	63	15.1	QP	N	GND
0.321000	40.00	10.2	60	19.7	QP	N	GND
0.370500	35.50	10.1	59	23.0	QP	N	GND
0.411000	36.30	10.0	58	21.3	QP	N	GND
0.451500	32.60	10.0	57	24.2	QP	N	GND
0.550500	30.30	9.9	56	25.7	QP	N	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.204000	26.20	10.6	53	27.2	AV	N	GND
0.411000	24.60	10.0	48	23.0	AV	N	GND
1.635000	20.60	9.7	46	25.4	AV	N	GND
2.125500	17.90	9.7	46	28.1	AV	N	GND
22.101000	9.50	10.2	50	40.5	AV	N	GND
23.986500	9.00	10.1	50	41.0	AV	N	GND

****Note: Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11g Middle Channel).*

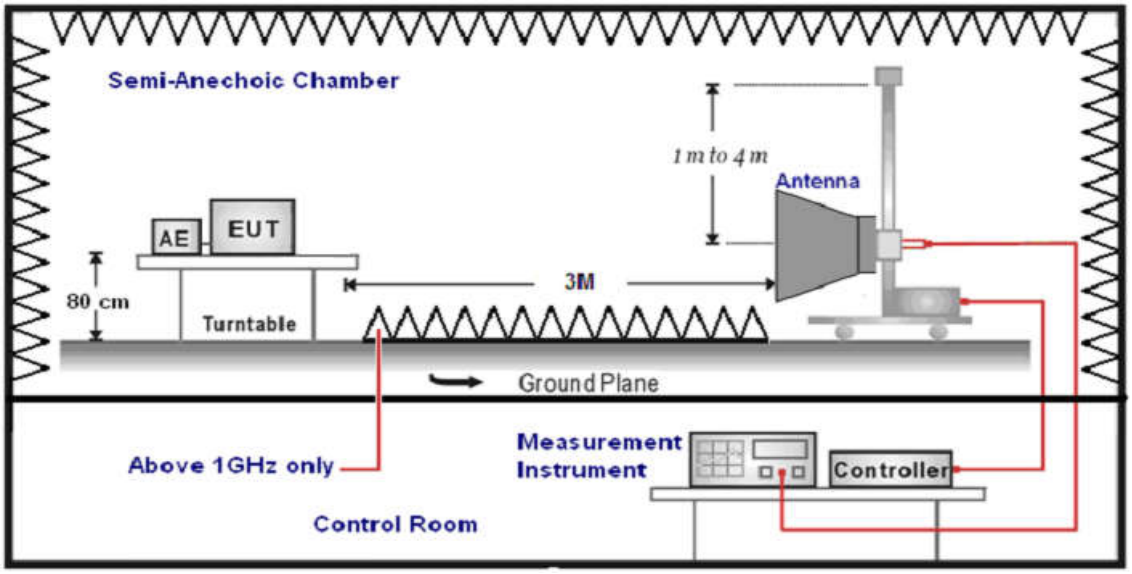
5.8. Band-edge measurements for radiated emissions

5.8.1 Standard Applicable

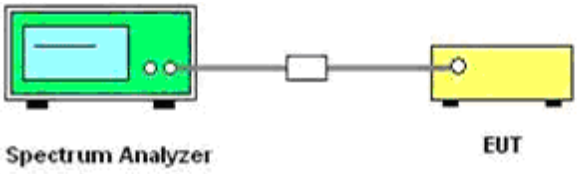
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidt h within the band that contains 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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 §15.205(c)).

5.8.2 Test Setup Layout

☒**For Radiated**



☐**For Conducted**



5.8.3. Measuring Instruments and Setting

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

5.8.4. Test Procedures

☒**Radiated Method:**

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.

3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed..
5. The distance between test antenna and EUT was 3 meter:
6. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

☐Conducted Method:

According to KDB 558074 D01 for Antenna-port conducted measurement. Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=1/B for AV detector.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 12.2.2, 12.2.3, and 12.2.4 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10. Convert the result ant EIRP level to an equivalent electric field strength using the following relationship:

    $E = EIRP - 20\log D + 104.77 = EIRP + 95.23$

    Where:
    E = electric field strength in dBμV/m,
    EIRP = equivalent isotropic radiated power in dBm
    D = specified measurement distance in meters.
11. Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
12. Per KDB662911 D01 section b) In cases where a combination of conducted measurements and cabinet radiated measurements are permitted to demonstrate compliance with absolute radiated out-of-band and spurious limits (e.g., KDB Publications 558074 for DTS and 789033 for U-NII), the conducted measurements must be combined with directional gain to compute the radiated levels of the out-of-band and spurious emissions as described in this section.
13. Compare the resultant electric field strength level to the applicable regulatory limit.
14. Perform radiated spurious emission test duress until all measured frequencies were complete.

5.8.5 Test Results

IEEE 802.11b										
Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	57.61	29.99	30.21	8.35	65.74	74	-8.26	Peak	Horizontal
1	2390.00	36.75	29.99	30.21	8.35	44.88	54	-9.12	AV[1]	Horizontal
2	2390.00	56.11	29.99	30.21	8.35	64.24	74	-9.76	Peak	Vertical
2	2390.00	40.68	29.99	30.21	8.35	48.81	54	-5.19	AV[1]	Vertical
3	2483.50	57.76	30.25	30.25	8.5	66.26	74	-7.74	Peak	Horizontal
3	2483.50	27.57	30.25	30.25	8.5	36.07	54	-17.93	AV[1]	Horizontal
4	2483.50	51.87	30.25	30.25	8.5	60.37	74	-13.63	Peak	Vertical
4	2483.50	24.75	30.25	30.25	8.5	33.25	54	-20.75	AV[1]	Vertical
5	2485.62	54.32	30.25	30.25	8.5	62.82	74	-11.18	Peak	Horizontal
5	2483.16	35.14	30.25	30.25	8.5	43.64	54	-10.36	AV[1]	Horizontal
6	2495.52	50.45	30.25	30.25	8.5	58.95	74	-15.05	Peak	Vertical
6	2499.67	36.19	30.25	30.25	8.5	44.69	54	-9.31	AV[1]	Vertical

IEEE 802.11g										
Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	54.76	29.99	30.21	8.35	62.89	74	-11.11	Peak	Horizontal
1	2390.00	38.51	29.99	30.21	8.35	46.64	54	-7.36	AV[1]	Horizontal
2	2390.00	56.56	29.99	30.21	8.35	64.69	74	-9.31	Peak	Vertical
2	2390.00	40.18	29.99	30.21	8.35	48.31	54	-5.69	AV[1]	Vertical
3	2483.50	55.79	30.25	30.25	8.5	64.29	74	-9.71	Peak	Horizontal
3	2483.50	26.39	30.25	30.25	8.5	34.89	54	-19.11	AV[1]	Horizontal
4	2483.50	52.35	30.25	30.25	8.5	60.85	74	-13.15	Peak	Vertical
4	2483.50	24.79	30.25	30.25	8.5	33.29	54	-20.71	AV[1]	Vertical
5	2484.71	56.01	30.25	30.25	8.5	64.51	74	-9.49	Peak	Horizontal
5	2486.18	36.08	30.25	30.25	8.5	44.58	54	-9.42	AV[1]	Horizontal
6	2497.09	48.16	30.25	30.25	8.5	56.66	74	-17.34	Peak	Vertical
6	2497.11	39.27	30.25	30.25	8.5	47.77	54	-6.23	AV[1]	Vertical

IEEE 802.11n HT20										
Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	53.55	29.99	30.21	8.35	61.68	74	-12.32	Peak	Horizontal
1	2390.00	37.17	29.99	30.21	8.35	45.30	54	-8.70	AV[1]	Horizontal
2	2390.00	55.96	29.99	30.21	8.35	64.09	74	-9.91	Peak	Vertical
2	2390.00	37.94	29.99	30.21	8.35	46.07	54	-7.93	AV[1]	Vertical
3	2483.50	53.82	30.25	30.25	8.5	62.32	74	-11.68	Peak	Horizontal
3	2483.50	25.01	30.25	30.25	8.5	33.51	54	-20.49	AV[1]	Horizontal
4	2483.50	52.05	30.25	30.25	8.5	60.55	74	-13.45	Peak	Vertical
4	2483.50	27.60	30.25	30.25	8.5	36.10	54	-17.90	AV[1]	Vertical
5	2486.45	55.47	30.25	30.25	8.5	63.97	74	-10.03	Peak	Horizontal
5	2489.30	38.34	30.25	30.25	8.5	46.84	54	-7.16	AV[1]	Horizontal
6	2495.95	48.08	30.25	30.25	8.5	56.58	74	-17.42	Peak	Vertical
6	2499.37	36.57	30.25	30.25	8.5	45.07	54	-8.93	AV[1]	Vertical

IEEE 802.11n HT40										
Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	55.99	29.99	30.21	8.35	64.12	74	-9.88	Peak	Horizontal
1	2390.00	37.33	29.99	30.21	8.35	45.46	54	-8.54	AV[1]	Horizontal
2	2390.00	57.02	29.99	30.21	8.35	65.15	74	-8.85	Peak	Vertical
2	2390.00	39.09	29.99	30.21	8.35	47.22	54	-6.78	AV[1]	Vertical
3	2483.50	53.27	30.25	30.25	8.5	61.77	74	-12.23	Peak	Horizontal
3	2483.50	27.66	30.25	30.25	8.5	36.16	54	-17.84	AV[1]	Horizontal
4	2483.50	53.03	30.25	30.25	8.5	61.53	74	-12.47	Peak	Vertical
4	2483.50	26.06	30.25	30.25	8.5	34.56	54	-19.44	AV[1]	Vertical
5	2484.75	58.07	30.25	30.25	8.5	66.57	74	-7.43	Peak	Horizontal
5	2486.70	38.48	30.25	30.25	8.5	46.98	54	-7.02	AV[1]	Horizontal
6	2496.21	49.42	30.25	30.25	8.5	57.92	74	-16.08	Peak	Vertical
6	2497.30	37.62	30.25	30.25	8.5	46.12	54	-7.88	AV[1]	Vertical

REMARKS:
1. Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.
2. The other emission levels were very low against the limit.
3. Over Limit=Emission Level - Limit.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;

5.9. Antenna Requirements

5.9.1. Standard Applicable

According to antenna requirement of §15.203.

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

5.9.2. Antenna Connected Construction

5.9.2.1. Standard Applicable

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

5.9.2.2. Antenna Connector Construction

The directional gains of antenna refer to section 1.1, and the antenna is a Internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

5.9.2.3. Results: Compliance.

6. LIST OF MEASURING EQUIPMENTS

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	L.I.S.N. Artificial Mains Network	R&S	ENV216	HKE-002	Dec. 27, 2018	1 Year
2.	Receiver	R&S	ESCI 7	HKE-010	Dec. 27, 2018	1 Year
3.	RF automatic control unit	Tonscend	JS0806-2	HKE-060	Dec. 27, 2018	1 Year
4.	Spectrum analyzer	R&S	FSP40	HKE-025	Dec. 27, 2018	1 Year
5.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 27, 2018	1 Year
6.	Preamplifier	Schwarzbeck	BBV 9743	HKE-006	Dec. 27, 2018	1 Year
7.	EMI Test Receiver	Rohde & Schwarz	ESCI 7	HKE-010	Dec. 27, 2018	1 Year
8.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	HKE-012	Dec. 27, 2018	1 Year
9.	Loop Antenna	Schwarzbeck	FMZB 1519 B	HKE-014	Dec. 27, 2018	1 Year
10.	Horn Antenna	Schewarzbeck	9120D	HKE-013	Dec. 27, 2018	1 Year
11.	Broadband Horn Antenna	Schewarzbeck	BBHA 9170	HKE-017	Dec. 27, 2018	1 Year
12.	Pre-amplifier	EMCI	EMC051845 SE	HKE-015	Dec. 27, 2018	1 Year
13.	Pre-amplifier	Agilent	83051A	HKE-016	Dec. 27, 2018	1 Year
14.	EMI Test Software EZ-EMC	Tonscend	JS1120-B	HKE-083	Dec. 27, 2018	N/A
15.	Power Sensor	Agilent	E9300A	HKE-086	Dec. 27, 2018	1 Year
16.	Signal generator	Agilent	N5182A	HKE-029	Dec. 27, 2018	1 Year
17.	Signal Generator	Agilent	83630A	HKE-028	Dec. 27, 2018	1 Year
18.	Shielded room	Shiel Hong	4*3*3	HKE-039	Dec. 27, 2018	3 Year
19.	Horn Antenna	ETS	3117	HKE-040	Dec. 27, 2018	1 Year
20.	RF Cable(below 1GHz)	HUBER+SUHNER	RG214	HKE-055	Dec. 27, 2018	1 Year
21.	RF Cable(above 1GHz)	HUBER+SUHNER	RG214	HKE-056	Dec. 27, 2018	1 Year

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

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