

FCC TEST REPORT  
For  
FN-LINK TECHNOLOGY LIMITED.  
2.4G+5G WIFI+BT Module  
Model No.: 6221C-PUC  
Additional Model No.: N/A

Prepared for : FN-LINK TECHNOLOGY LIMITED.  
Address : No.8 Litong Road, Liuyang Economic Development Zone, Liu yang  
City, Hunan Province, China

Prepared by : Shenzhen LCS Compliance Testing Laboratory Ltd.  
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Date of receipt of test sample : Mar. 12, 2018  
Number of tested samples : 1  
Serial number : Prototype  
Date of Test : Mar. 12, 2018~ Mar. 23, 2018  
Date of Report : Mar. 23, 2018

**FCC TEST REPORT**  
**FCC CFR 47 PART 15 C(15.247)**

**Report Reference No.** ..... : LCS180111037AEB

Date of Issue ..... : Mar. 23, 2018

**Testing Laboratory Name** ..... : Shenzhen LCS Compliance Testing Laboratory Ltd.

Address ..... : 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue,  
Bao'an District, Shenzhen, Guangdong, China

: Full application of Harmonised standards

Testing Location/ Procedure ..... : Partial application of Harmonised standards   
Other standard testing method

**Applicant's Name** ..... : FN-LINK TECHNOLOGY LIMITED.

Address ..... : No.8 Litong Road, Liuyang Economic Development Zone, Liu yang  
City, Hunan Province, China

**Test Specification**

Standard ..... : FCC CFR 47 PART 15 C(15.247)

**Test Report Form No.** ..... : LCSEMC-1.0

TRF Originator ..... : Shenzhen LCS Compliance Testing Laboratory Ltd.

Master TRF ..... : Dated 2011-03

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**EUT Description** ..... : 2.4G+5G WIFI+BT Module

Trade Mark ..... : N/A

Model/ Type reference ..... : 6221C-PUC

Ratings ..... : DC 3.3V  
AC 120V 60Hz(Adapter for DSP)

Result ..... : Positive

Compiled by:



Calvin Weng/ Administrators

Supervised by:



Dick Su/ Technique principal

Approved by:



Gavin Liang/ Manager

## FCC -- TEST REPORT

<b>Test Report No. :</b>	<b>LCS180111037AEB</b>	<u>Mar. 23, 2018</u> Date of issue
EUT.....	: 2.4G+5G WIFI+BT Module	
Type / Model.....	: 6221C-PUC	
<b>Applicant.....</b>	<b>: FN-LINK TECHNOLOGY LIMITED.</b>	
Address.....	: No.8 Litong Road, Liuyang Economic Development Zone, Liu yang City, Hunan Province, China	
Telephone.....	:	
Fax.....	:	
<b>Manufacturer.....</b>	<b>: FN-LINK TECHNOLOGY LIMITED.</b>	
Address.....	: No.8 Litong Road, Liuyang Economic Development Zone, Liu yang City, Hunan Province, China	
Telephone.....	:	
Fax.....	:	
<b>Factory.....</b>	<b>: FN-LINK TECHNOLOGY LIMITED.</b>	
Address.....	: No.8 Litong Road, Liuyang Economic Development Zone, Liu yang City, Hunan Province, China	
Telephone.....	:	
Fax.....	:	

<b>Test Result</b>	<b>Positive</b>
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test result without the written permission of the test laboratory.	

**Revision History**

Revision	Issue Date	Revisions	Revised By
000	Mar. 23, 2018	Initial Issue	Gavin Liang

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## 1. GENERAL INFORMATION

### 1.1. Description of Device (EUT)

Name of EUT	2.4G+5G WIFI+BT Module
Model Number	6221C-PUC
Antenna Gain	0dBi (max.) For BT, 2.4G WLAN & 5G WLAN
Hardware version	V1.0
Software version	V1.0
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11n HT40:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac VHT20:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11ac VHT40:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11ac VHT80:OFDM (64QAM, 16QAM, QPSK,BPSK)
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 IEEE 802.11ac VHT20:5180-5240MHz, 5745-5825MHz IEEE 802.11ac VHT40:5190-5230MHz, 5755-5795MHz IEEE 802.11ac VHT80:5210MHz 5775MHz
Antenna Type	PIFI Antenna for BT/WIFI
BT Modulation Type	GFSK,8-DPSK, $\pi/4$ -DQPSK(BT V4.2)
Extreme temp. Tolerance	-30°C to +85°C
Extreme vol. Limits	3.15VDC to 3.45VDC (nominal: 3.30VDC)

## 1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
Lenovo	ADAPTER for EUT's DSP	Sp-888	---	FCC VoC

## 1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	1	N/A
PCIe	1	N/A

## 1.4. Description of Test Facility

FCC Registration Number is 254912.

Industry Canada Registration Number is 9642A-1.

ESMD Registration Number is ARCB0108.

UL Registration Number is 100571-492.

TUV SUD Registration Number is SCN1081.

TUV RH Registration Number is UA 50296516-001

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 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 LCS 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	±3.10dB	(1)
	30MHz~200MHz	±2.96dB	(1)
	200MHz~1000MHz	±3.10dB	(1)
	1GHz~26GHz	±3.80dB	(1)
	26GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty :	150kHz~30MHz	±1.63dB	(1)
Power disturbance	30MHz~300MHz	±1.60dB	(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 worst case was found when EUT in X position.

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 IEEE 802.11b mode (Low Channel).

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

AC conducted emission pre-test at both at power adapter and power from PC modes, recorded worst case;

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 IEEE 802.11b mode (Low 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.

BT LE: 1Mbps, GFSK.

### 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)
2412~2462MHz	--	--	7	2442
	--	--	8	2447
	3	2422	9	2452
	4	2427	--	--
	5	2432	--	--
	6	2437	--	--

#### Bluetooth V4.0 (DTS)

Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	2402	20	2442
1	2404	---	---
2	2406	---	---
---	---	37	2476
---	---	38	2478
18	2438	39	2480
19	2440		

## 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 LCS Compliance Testing Laboratory 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 KDB558074 D01 DTS Meas. Guidance 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 sample will be controlled by RF test tool to enter RF test mode to control sample change channel, modulation and so on;

#### 3.3. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/unshielded	Notes
1	PC	DELL	L180AS-03	00021778	/	/	DOC
2	Power adapter	Lenovo	SP-888	/	0.5m	unshielded	DOC

#### 3.4 Antenna Information

Ant.	Brand	Model Name	Antenna Type	Connector	Gain(dBi)	Application Range
1	Xingka	XK-W5515A-PC B-2.4-5.8-150	PCB	Ipex	2	2400MHz~2483.5MHz
					2	5150MHz~5250MHz
					2	5745MHz~5850MHz

Note: The EUT has only one type antenna.

#### 3.5. Block Diagram/Schematics

Please refer to the related document

#### 3.6. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

#### 3.7. 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
§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

**Note:** This EUT has two antenna ports, but it's SISO, we test both antennas, but only record worst case on Antenna 1.

## 5. TEST RESULT

### 5.1. On Time and Duty Cycle

#### 5.1.1. Standard Applicable

None; for reporting purpose only.

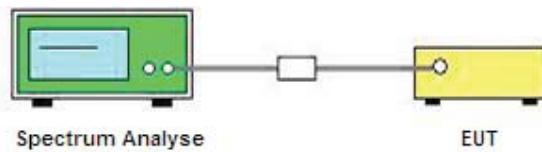
#### 5.1.2. Measuring Instruments and Setting

Please refer to equipment 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=8MHz, VBW=50MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

#### 5.1.4. Test Setup Layout



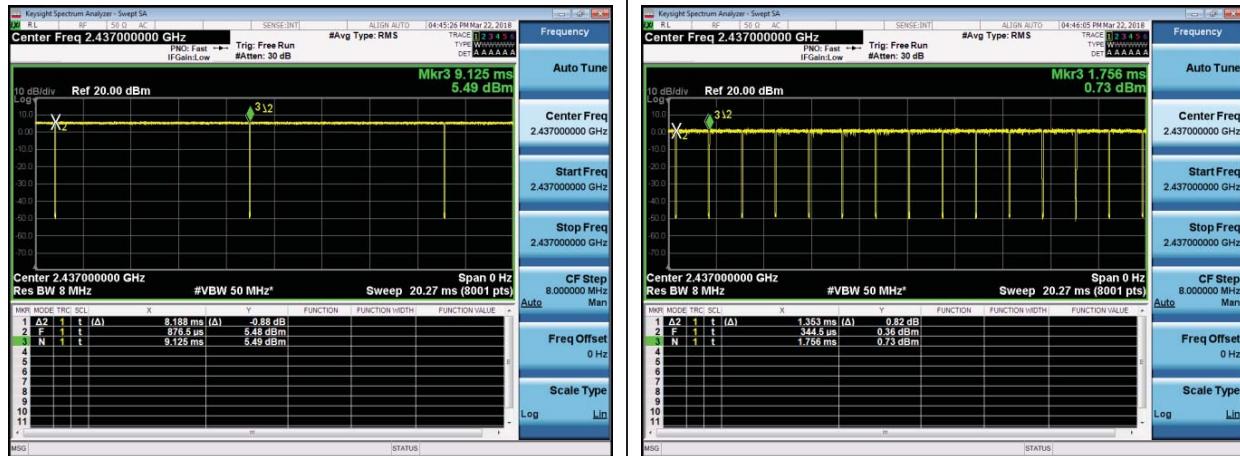
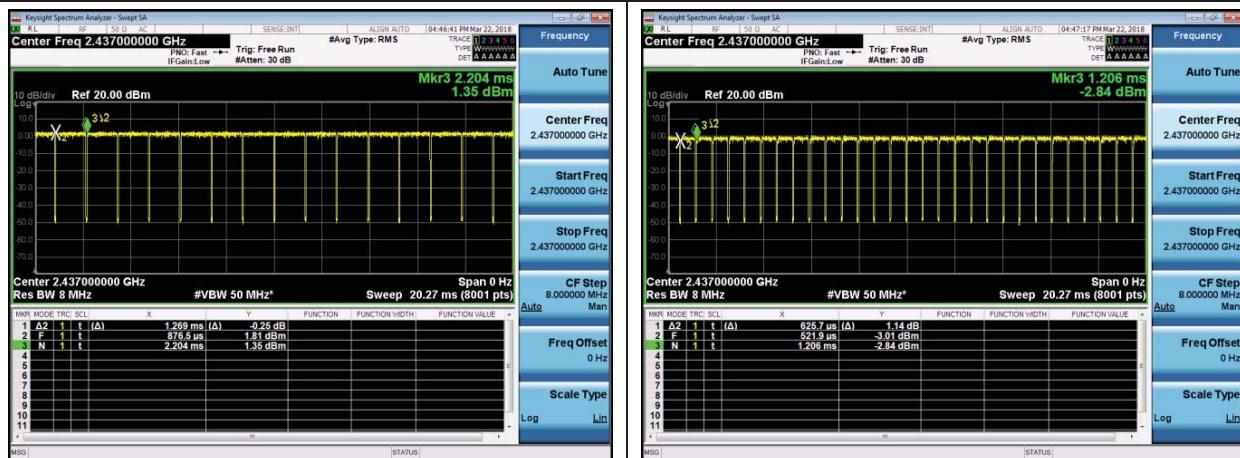
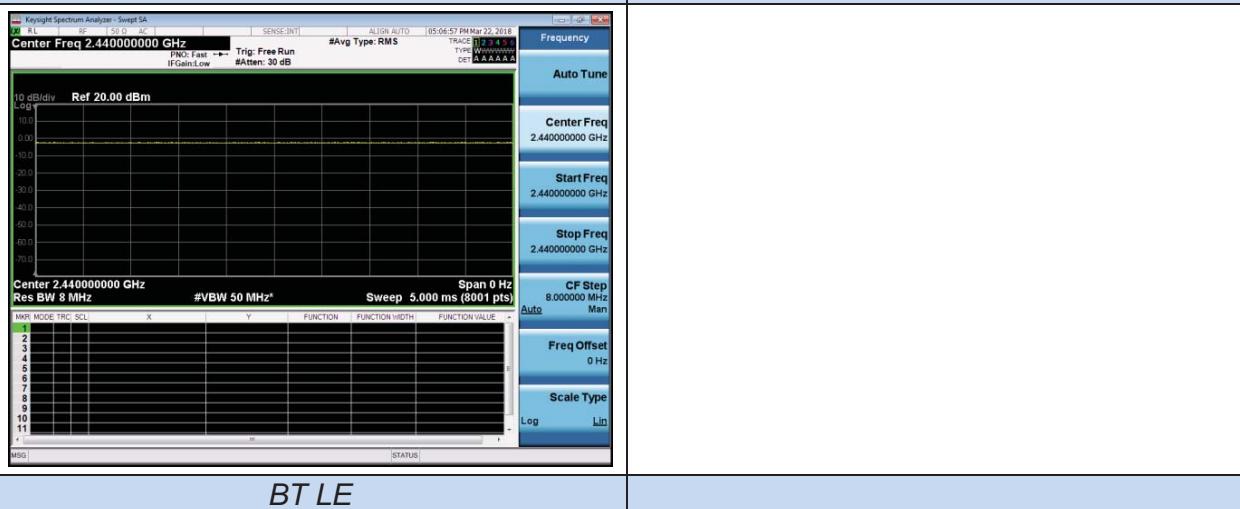
#### 5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

#### 5.1.6. Test result

Mode	On Time B (ms)	Period (ms)	Duty Cycle x (Linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW(KHz)
BT LE	5	5	1	100	0	0.010
IEEE 802.11b	8.188	8.249	0.996	99.6	0.03	0.010
IEEE 802.11g	1.353	1.412	0.959	95.9	0.18	1
IEEE 802.11n HT20	1.269	1.328	0.956	95.6	0.18	1
IEEE 802.11n HT40	0.626	0.684	0.915	91.5	0.39	3

## On Time and Duty Cycle

**IEEE 802.11b****IEEE 802.11g****BT LE**

## 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 limit 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.

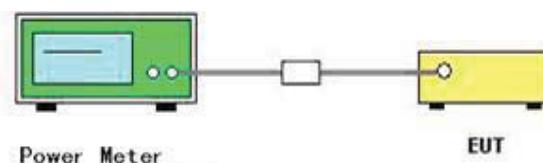
- 1) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.
- 2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
- 3) The integration period of the power meter exceeds the repetition period of the transmitted 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  $10\log(1/x)$ , 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	25°C	Humidity	60%
Test Engineer	Tom Liu	Configurations	IEEE 802.11b/g/n & BT LE

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Limits (dBm)	Verdict
IEEE 802.11b	1	2412	20.19	30	PASS
	6	2437	19.35		
	11	2462	18.76		
IEEE 802.11g	1	2412	22.06	30	PASS
	6	2437	21.83		
	11	2462	21.56		
IEEE 802.11n HT20	1	2412	22.35	30	PASS
	6	2437	21.60		
	11	2462	21.45		
IEEE 802.11n HT40	3	2422	21.76	30	PASS
	6	2437	22.18		
	9	2452	22.21		
BT – LE	0	2402	7.92	30	PASS
	19	2440	6.10		
	39	2480	4.27		

*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;

### 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.

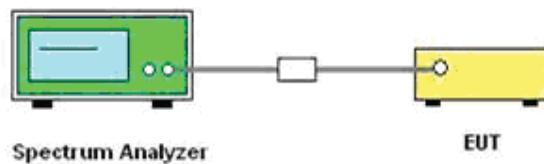
#### 5.3.2. Measuring Instruments and Setting

Please refer to equipment 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  $\geq$  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

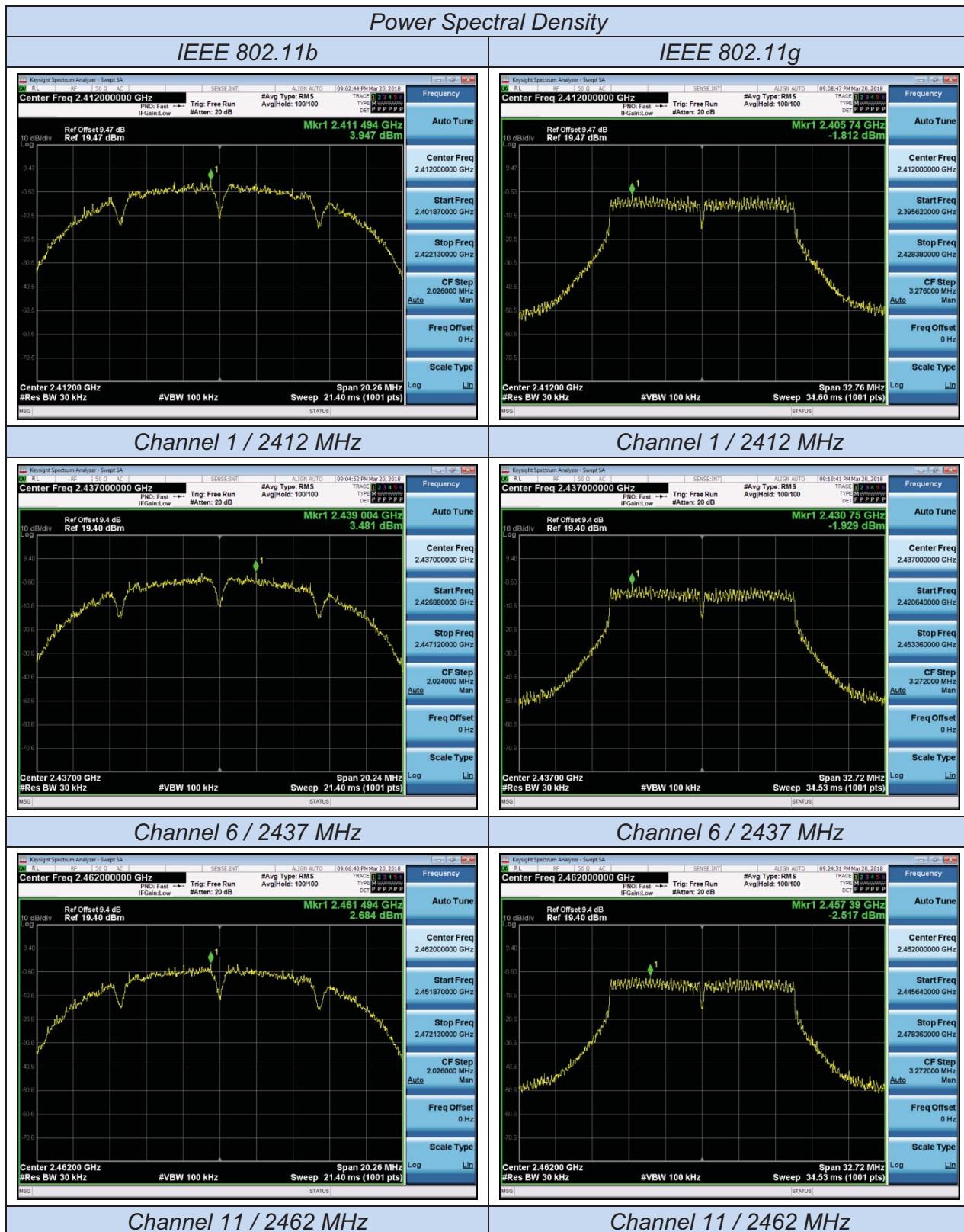
Temperature	25°C	Humidity	60%
Test Engineer	Tom Liu	Configurations	IEEE 802.11b/g/n & BT LE

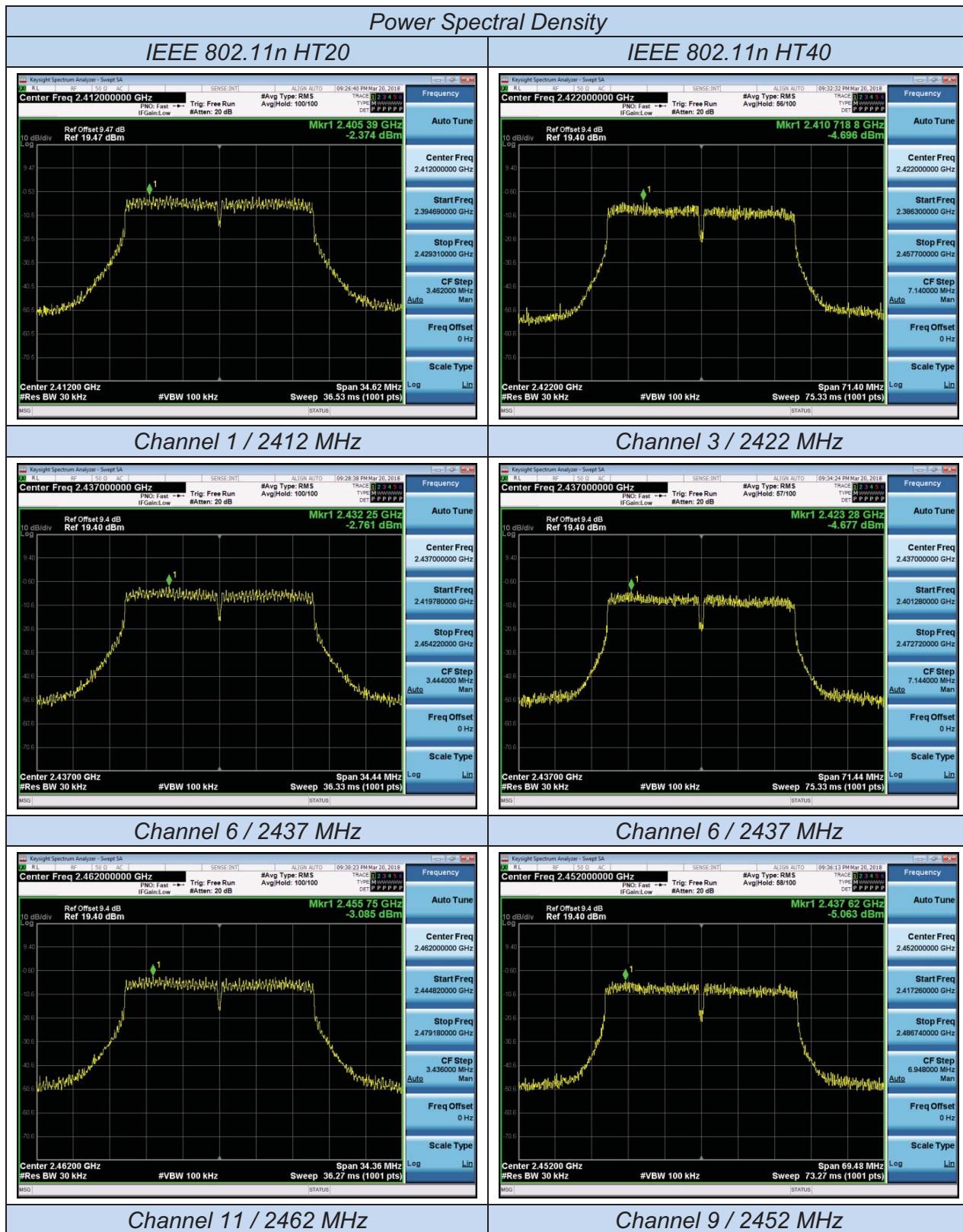
Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectral Density (dBm/30KHz)	Limits (dBm/3KHz)	Verdict
IEEE 802.11b	1	2412	3.947	8	PASS
	6	2437	3.481		
	11	2462	2.684		
IEEE 802.11g	1	2412	-1.812	8	PASS
	6	2437	-1.929		
	11	2462	-2.517		
IEEE 802.11n HT20	1	2412	-2.374	8	PASS
	6	2437	-2.761		
	11	2462	-3.085		
IEEE 802.11n HT40	3	2422	-4.696	8	PASS
	6	2437	-4.677		
	9	2452	-5.063		

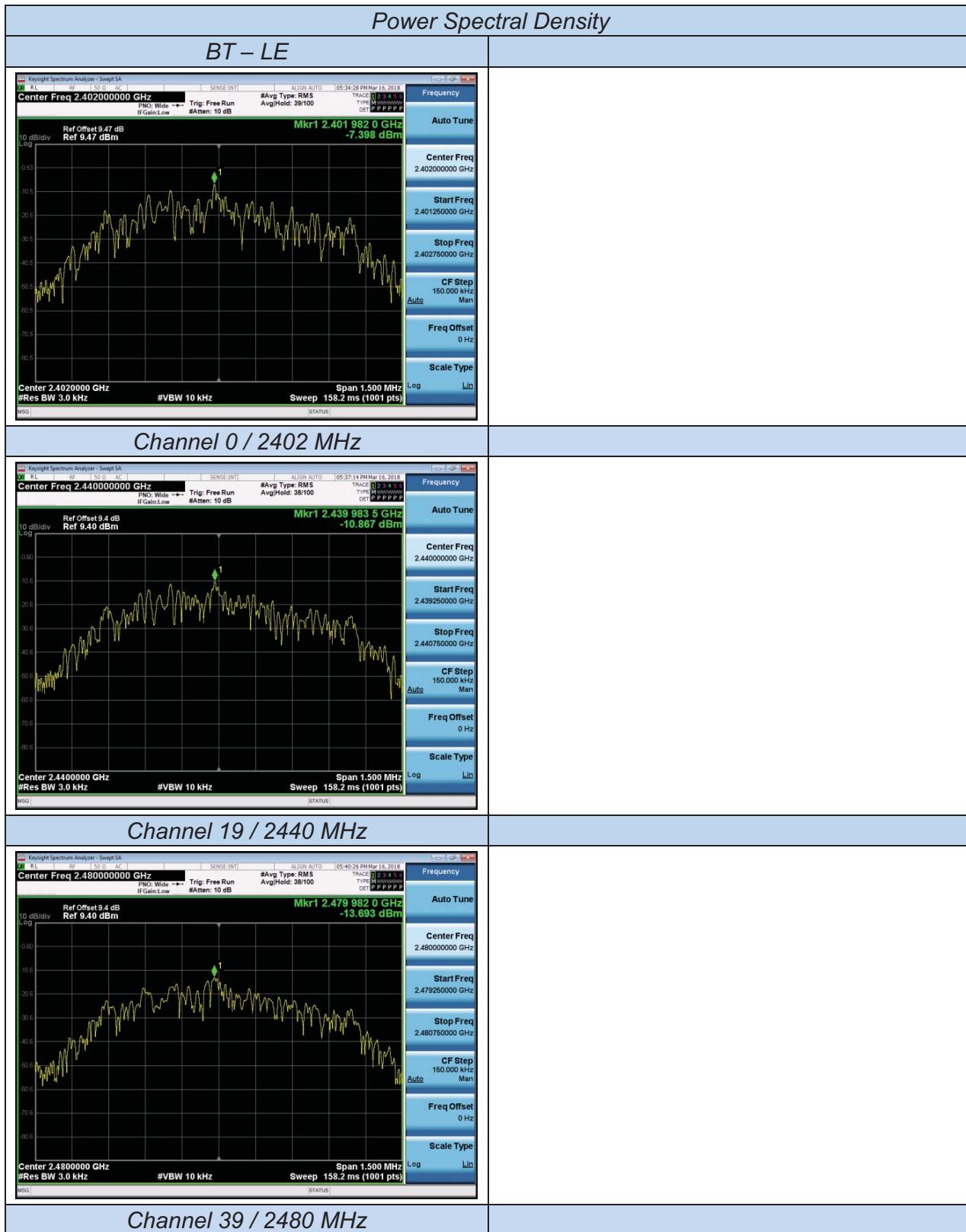
Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectral Density (dBm/30KHz)	Limits (dBm/3KHz)	Verdict
BT – LE	0	2402	-7.398	8	PASS
	19	2440	-10.86		
	39	2480	-13.693		

**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;







## 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

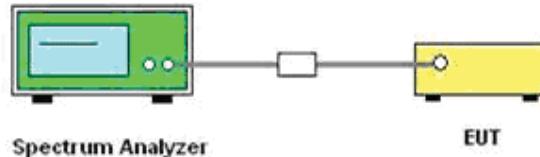
Please refer to equipment's list in this report. The following table is the setting of the Spectrum Analyzer.

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.

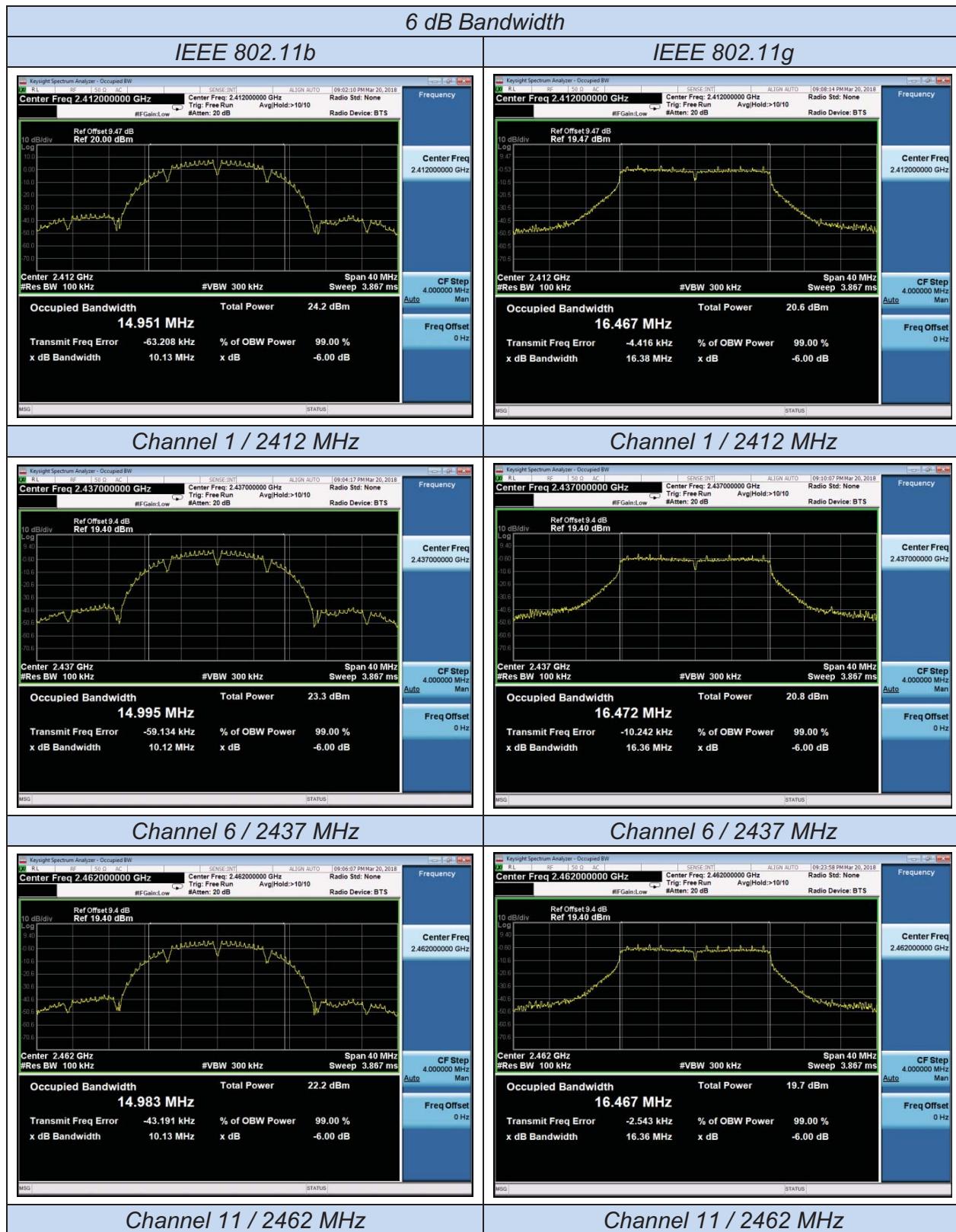
### 5.4.6. Test Result of 6dB Spectrum Bandwidth

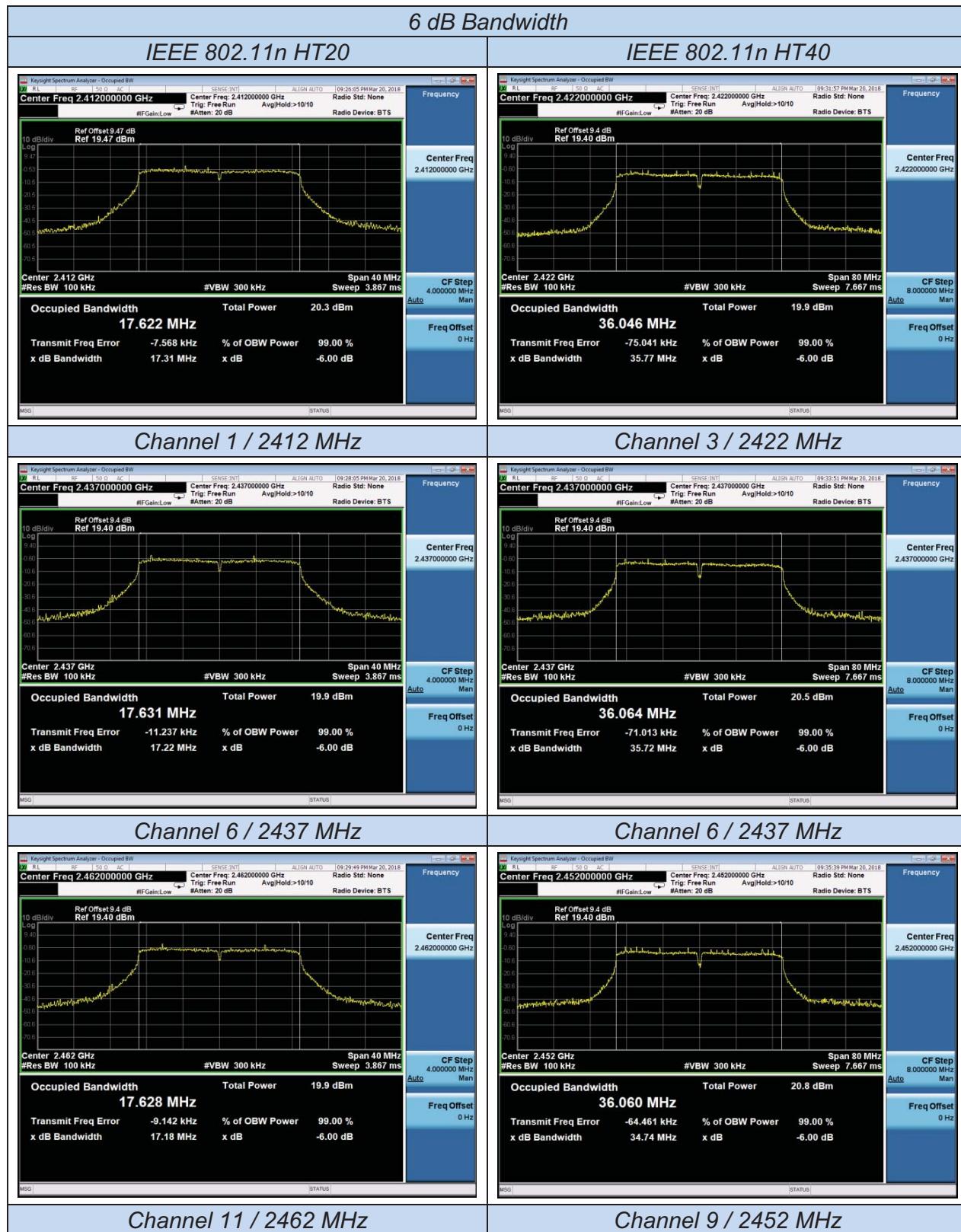
Temperature	25°C	Humidity	60%
Test Engineer	Tom Liu	Configurations	IEEE 802.11b/g/n & BT LE

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limits (MHz)	Verdict
IEEE 802.11b	1	2412	10.13	0.500	PASS
	6	2437	10.12		
	11	2462	10.13		
IEEE 802.11g	1	2412	16.38	0.500	PASS
	6	2437	16.36		
	11	2462	16.36		
IEEE 802.11n HT20	1	2412	17.31	0.500	PASS
	6	2437	17.22		
	11	2462	17.18		
IEEE 802.11n HT40	3	2422	35.77	0.500	PASS
	6	2437	35.72		
	9	2452	34.74		
BT - LE	0	2402	0.64	0.500	PASS
	19	2440	0.627		
	39	2480	0.64		

**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;







## 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	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	10 <sup>th</sup> 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 0.8 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 ( $\pm 45^\circ$ ) 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 ( $\pm 45^\circ$ ) 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.

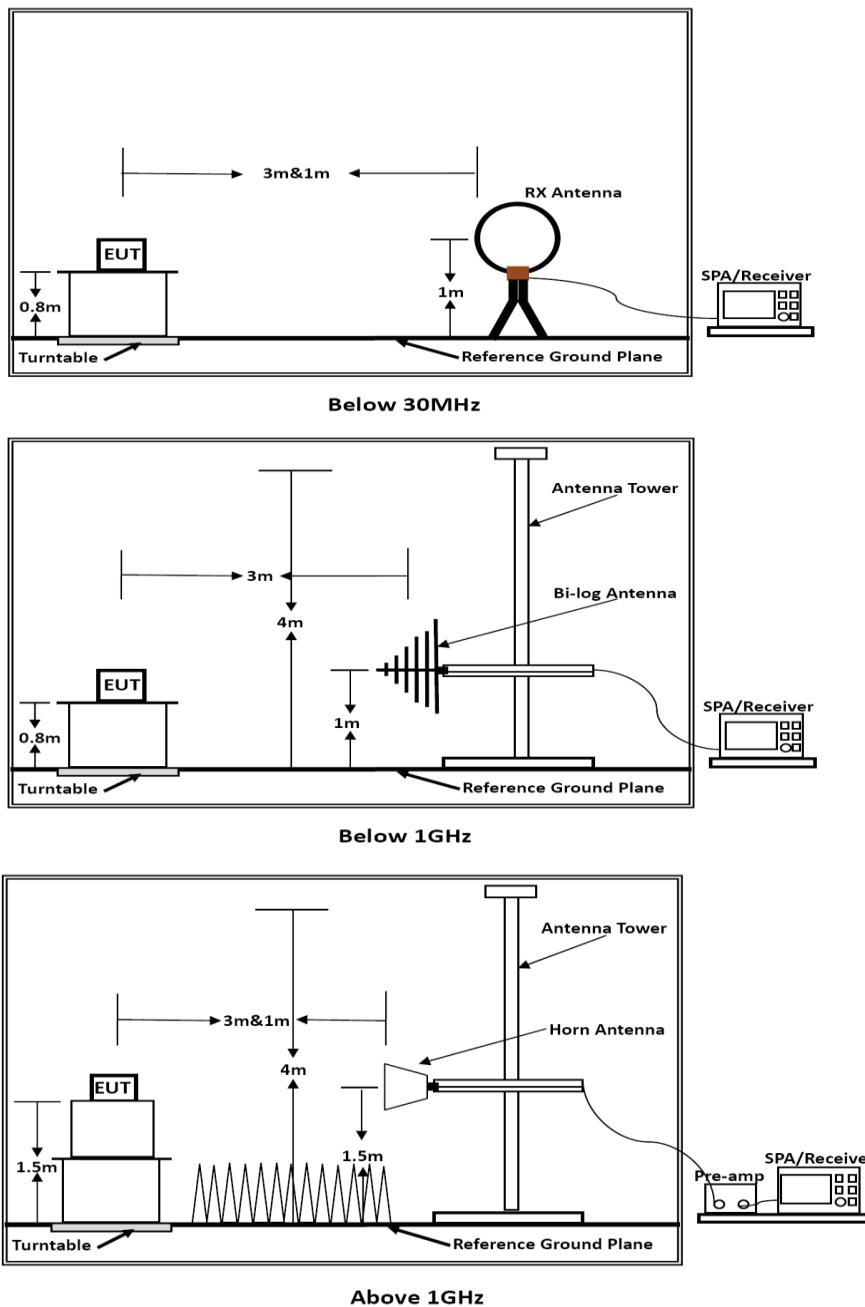
##### **Premeasurement:**

- 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



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

Distance extrapolation factor =  $20 \log (\text{specific distance [3m]} / \text{test distance [1m]})$  (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	25°C	Humidity	60%	
Test Engineer	Tom Liu	Configurations	IEEE 802.11b/g/n & BT LE	
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.

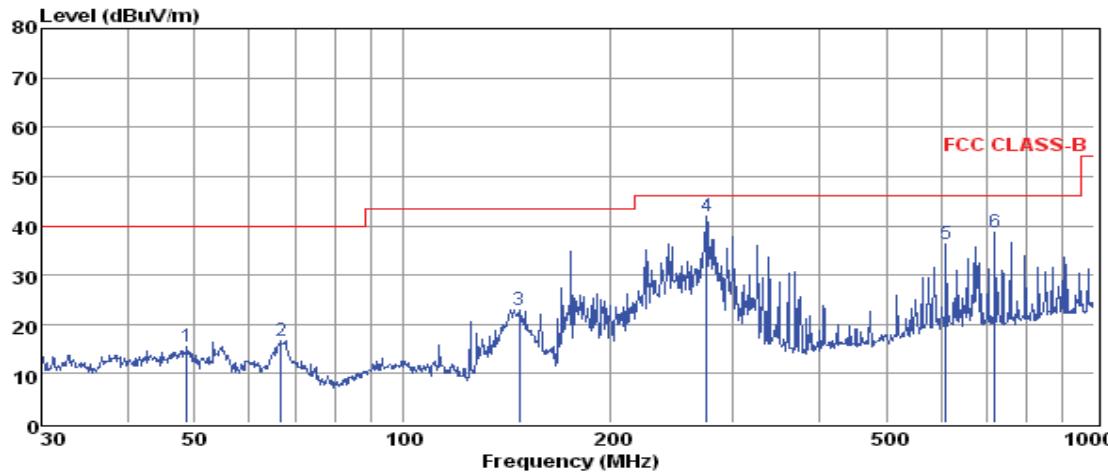
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);  
Limit line = specific limits (dBuV) + distance extrapolation factor.

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

Temperature	25°C	Humidity	60%
Test Engineer	Tom Liu	Configurations	IEEE 802.11b (Low CH)

*Test result for IEEE 802.11b (Low Channel)*

Horizontal:



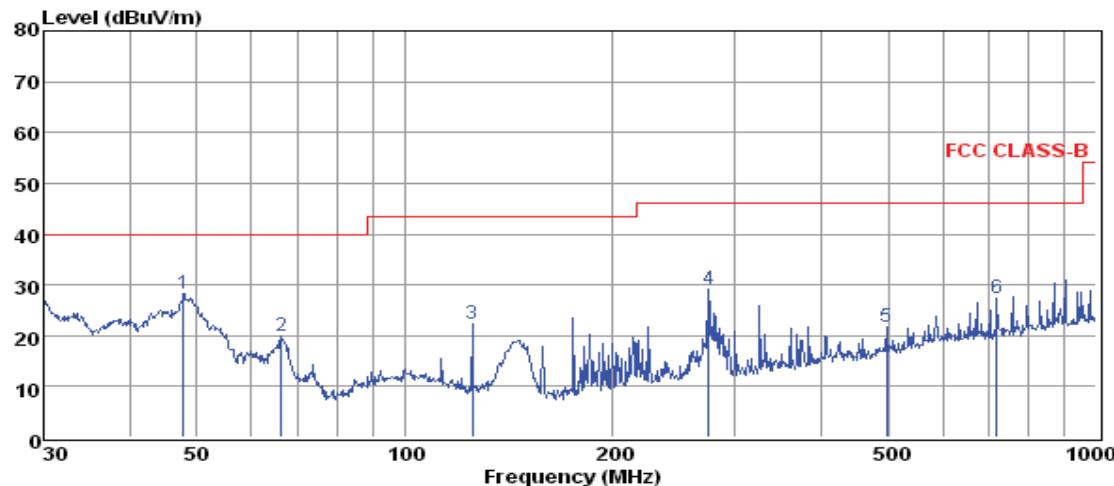
Freq	Reading	CabLoss	Antfac	Measured	Limit	Over	Remark
MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1 48.67	1.88	0.35	13.33	15.56	40.00	-24.44	QP
2 66.73	6.09	0.52	10.00	16.61	40.00	-23.39	QP
3 147.40	13.86	0.86	8.24	22.96	43.50	-20.54	QP
4 275.16	28.50	1.00	12.52	42.02	46.00	-3.98	QP
5 609.92	16.35	1.45	18.49	36.29	46.00	-9.71	QP
6 719.20	17.72	1.75	19.05	38.52	46.00	-7.48	QP

Note: 1. All readings are Quasi-peak values.

2. Measured= Reading + Antenna Factor + Cable Loss

3. The emission that ate 20db blow the official limit are not reported

Vertical:



	Freq MHz	Reading dBuV	CabLos dB	Antfac dB/m	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	47.83	14.40	0.35	13.38	28.13	40.00	-11.87	QP
2	66.27	9.11	0.52	10.19	19.82	40.00	-20.18	QP
3	125.01	11.91	0.71	9.70	22.32	43.50	-21.18	QP
4	275.16	15.50	1.00	12.52	29.02	46.00	-16.98	QP
5	497.68	3.72	1.34	16.52	21.58	46.00	-24.42	QP
6	719.20	6.56	1.75	19.05	27.36	46.00	-18.64	QP

Note: 1. All readings are Quasi-peak values.  
 2. Measured= Reading + Antenna Factor + Cable Loss  
 3. The emission that ate 20db blow the offficial limit are not reported

Note:

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

### 5.5.8. Results for Radiated Emissions (Above 1GHz)

*IEEE 802.11b*

*Channel 1 / 2412MHz*

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	56.44	33.06	35.14	3.98	58.34	74.00	-15.66	Peak	Horizontal
4824.00	39.23	33.06	35.14	3.98	41.13	54.00	-12.87	Average	Horizontal
4824.00	59.66	33.06	35.14	3.98	61.56	74.00	-12.44	Peak	Vertical
4824.00	44.02	33.06	35.14	3.98	45.92	54.00	-8.08	Average	Vertical

*Channel 6 / 2437MHz*

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	56.60	33.16	35.15	3.96	58.57	74.00	-15.43	Peak	Horizontal
4874.00	39.77	33.16	35.15	3.96	41.74	54.00	-12.26	Average	Horizontal
4874.00	60.06	33.16	35.15	3.96	62.03	74.00	-11.97	Peak	Vertical
4874.00	44.05	33.16	35.15	3.96	46.02	54.00	-7.98	Average	Vertical

*Channel 11 / 2462MHz*

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	57.02	33.26	35.14	3.98	59.12	74.00	-14.88	Peak	Horizontal
4924.00	40.05	33.26	35.14	3.98	42.15	54.00	-11.85	Average	Horizontal
4924.00	60.60	33.26	35.14	3.98	62.70	74.00	-11.30	Peak	Vertical
4924.00	44.13	33.26	35.14	3.98	46.23	54.00	-7.77	Average	Vertical

*IEEE 802.11g*

*Channel 1 / 2412MHz*

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	55.99	33.06	35.14	3.98	57.89	74.00	-16.11	Peak	Horizontal
4824.00	40.01	33.06	35.14	3.98	41.91	54.00	-12.09	Average	Horizontal
4824.00	60.67	33.06	35.14	3.98	62.57	74.00	-11.43	Peak	Vertical
4824.00	43.10	33.06	35.14	3.98	45.00	54.00	-9.00	Average	Vertical

## Channel 6 / 2437MHz

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	56.74	33.16	35.15	3.96	58.71	74.00	-15.29	Peak	Horizontal
4874.00	40.60	33.16	35.15	3.96	42.57	54.00	-11.43	Average	Horizontal
4874.00	61.47	33.16	35.15	3.96	63.44	74.00	-10.56	Peak	Vertical
4874.00	43.39	33.16	35.15	3.96	45.36	54.00	-8.64	Average	Vertical

## Channel 11 / 2462MHz

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	56.67	33.26	35.14	3.98	58.77	74.00	-15.23	Peak	Horizontal
4924.00	41.21	33.26	35.14	3.98	43.31	54.00	-10.69	Average	Horizontal
4924.00	62.08	33.26	35.14	3.98	64.18	74.00	-9.82	Peak	Vertical
4924.00	43.70	33.26	35.14	3.98	45.80	54.00	-8.2	Average	Vertical

## IEEE 802.11n HT20

## Channel 1 / 2412MHz

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	50.61	33.06	35.14	3.98	52.51	74.00	-21.49	Peak	Horizontal
4824.00	36.66	33.06	35.14	3.98	38.56	54.00	-15.44	Average	Horizontal
4824.00	54.05	33.06	35.14	3.98	55.95	74.00	-18.05	Peak	Vertical
4824.00	38.11	33.06	35.14	3.98	40.01	54.00	-13.99	Average	Vertical

## Channel 6 / 2437MHz

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	49.85	33.16	35.15	3.96	51.82	74.00	-22.18	Peak	Horizontal
4874.00	35.82	33.16	35.15	3.96	37.79	54.00	-16.21	Average	Horizontal
4874.00	54.11	33.16	35.15	3.96	56.08	74.00	-17.92	Peak	Vertical
4874.00	37.24	33.16	35.15	3.96	39.21	54.00	-14.79	Average	Vertical

## Channel 11 / 2462MHz

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	50.24	33.26	35.14	3.98	52.34	74.00	-21.66	Peak	Horizontal
4924.00	35.93	33.26	35.14	3.98	38.03	54.00	-15.97	Average	Horizontal
4924.00	54.77	33.26	35.14	3.98	56.87	74.00	-17.13	Peak	Vertical
4924.00	37.37	33.26	35.14	3.98	39.47	54.00	-14.53	Average	Vertical

## IEEE 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	50.51	33.06	35.14	3.98	52.41	74.00	-21.59	Peak	Horizontal
4844.00	36.35	33.06	35.14	3.98	38.25	54.00	-15.75	Average	Horizontal
4844.00	55.15	33.06	35.14	3.98	57.05	74.00	-16.95	Peak	Vertical
4844.00	37.58	33.06	35.14	3.98	39.48	54.00	-14.52	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	51.19	33.16	35.15	3.96	53.16	74.00	-20.84	Peak	Horizontal
4874.00	37.21	33.16	35.15	3.96	39.18	54.00	-14.82	Average	Horizontal
4874.00	55.35	33.16	35.15	3.96	57.32	74.00	-16.68	Peak	Vertical
4874.00	37.91	33.16	35.15	3.96	39.88	54.00	-14.12	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	51.82	33.26	35.14	3.98	53.92	74.00	-20.08	Peak	Horizontal
4904.00	37.94	33.26	35.14	3.98	40.04	54.00	-13.96	Average	Horizontal
4904.00	55.83	33.26	35.14	3.98	57.93	74.00	-16.07	Peak	Vertical
4904.00	38.14	33.26	35.14	3.98	40.24	54.00	-13.76	Average	Vertical

## BT LE

## Channel 0 / 2402MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4804.00	48.57	33.06	35.04	3.94	50.53	74.00	-23.47	Peak	Horizontal
4804.00	34.61	33.06	35.04	3.94	36.57	54.00	-17.43	Average	Horizontal
4804.00	50.86	33.06	35.04	3.94	52.82	74.00	-21.18	Peak	Vertical
4804.00	35.47	33.06	35.04	3.94	37.43	54.00	-16.57	Average	Vertical

## Channel 19 / 2440MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4880.00	48.86	33.16	35.15	3.96	50.83	74.00	-23.17	Peak	Horizontal
4880.00	34.83	33.16	35.15	3.96	36.80	54.00	-17.20	Average	Horizontal
4880.00	51.74	33.16	35.15	3.96	53.71	74.00	-20.29	Peak	Vertical
4880.00	35.60	33.16	35.15	3.96	37.57	54.00	-16.43	Average	Vertical

## Channel 39 / 2480MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.00	49.11	33.26	35.14	3.98	51.21	74.00	-22.79	Peak	Horizontal
4960.00	34.72	33.26	35.14	3.98	36.82	54.00	-17.18	Average	Horizontal
4960.00	52.24	33.26	35.14	3.98	54.34	74.00	-19.66	Peak	Vertical
4960.00	36.33	33.26	35.14	3.98	38.43	54.00	-15.57	Average	Vertical

## Notes:

1. Measuring frequencies from 9 KHz~10<sup>th</sup> harmonic or 26GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.
2. Radiated emissions measured in frequency range from 9 KHz~10<sup>th</sup> harmonic or 26GHz (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 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 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 26GHz 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	25°C	Humidity	60%
Test Engineer	Tom Liu	Configurations	IEEE 802.11b/g/n & BT LE

Test Mode	Channel	Frequency (MHz)	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
IEEE 802.11b	1	2412	<-20	-20	PASS
	6	2437	<-20		
	11	2462	<-20		
IEEE 802.11g	1	2412	<-20	-20	PASS
	6	2437	<-20		
	11	2462	<-20		
IEEE 802.11n HT20	1	2412	<-20	-20	PASS
	6	2437	<-20		
	11	2462	<-20		
IEEE 802.11n HT40	3	2412	<-20	-20	PASS
	6	2437	<-20		
	9	2452	<-20		
BT – LE	0	2402	<-20	-20	PASS
	19	2440	<-20		
	39	2480	<-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; “---”means that the fundamental frequency not for 15.209 limits requirement.
4. Please refer to following plots;

