




REPORT No.: SZ17090079W02A

# FCC RF TEST REPORT

**APPLICANT** : LiFi Labs Inc.

**PRODUCT NAME** : Wifi module

**MODEL NAME** : LCM3C

**TRADE NAME** : 

**BRAND NAME** : LIFX

**FCC ID** : 2AA53-LCM3

**STANDARD(S)** : 47 CFR Part 15 Subpart C

**ISSUE DATE** : 2017-09-22

**SHENZHEN MORLAB COMMUNICATIONS TECHNOLOGY Co., Ltd.**

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Change History		
Issue	Date	Reason for change
1.0	2017-09-22	First edition

**TEST REPORT DECLARATION**

Applicant	LiFi Labs Inc.
Applicant Address	524 Union Street #309 San Francisco, CA 94133 USA
Manufacturer Address	LiFi Labs Inc.
Manufacturer	524 Union Street #309 San Francisco, CA 94133 USA
Product Name	Wifi module
Model Name	LCM3C
Brand Name	LIFX
HW Version	005
SW Version	N/A
Test Standards	47 CFR Part 15 Subpart C
Test Date	2017-09-09 to 2017-09-21
Test Result	PASS

Tested by : Tu Ya'nan  
Tu Ya'nan (Test Engineer)

Approved by : Andy Yeh  
Andy Yeh (Technical Director)




## 1. TECHNICAL INFORMATION

Note: Provide by applicant.

### 1.1 Applicant Information

Company:	LiFi Labs Inc.
Address	524 Union Street #309 San Francisco, CA 94133 USA

### 1.2 Equipment under Test (EUT) Description

Brand Name:	LIFX
Trade Name:	
Model Name:	LCM3C
Frequency Range:	802.11b/g/n-20MHz: 2.412GHz - 2.462GHz
Channel Number:	802.11b/g/n-20MHz: 11
Modulation Type:	DSSS, OFDM
Antenna Type:	Glue stick Antenna
Antenna Gain:	1.84 dBi

#### NOTE:

1. The EUT is a Wifi module. It's operating at 2.4GHz ISM; it supports 802.11b, 802.11g, 802.11n and they are all tested in this report.  
For 802.11b/g/n-20MHz (2.4GHz band), the frequencies allocated is  $F \text{ (MHz)} = 2412 + 5 * (n - 1)$  ( $1 \leq n \leq 11$ ). The lowest, middle, highest channel numbers of the EUT used and tested in this report are separately 1 (2412MHz), 6 (2437MHz) and 11 (2462MHz).
2. The EUT connected to the serial port of the computer with a serial communication cable, we use the dedicated software to control the EUT continuous transmission. And the duty cycle is 100%.
3. For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

#### 1.2.1 Identification of all used EUTs

The EUT identity consists of numerical and letter characters, the letter character indicates the test sample, and the following two numerical characters indicate the software version of the test sample.

EUT Identity	Hardware Version	Software Version
A01	005	N/A



### 1.3 Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 15 Subpart C (Bluetooth, 2.4GHz ISM band radiators) for the EUT FCC ID Certification:

No.	Identity	Document Title
1	47 CFR Part 15 (10-1-15 Edition)	Radio Frequency Devices

Test detailed items/section required by FCC rules and results are as below:

No.	Section	Description	Test Date	Result
1	15.203	Antenna Requirement	N/A	<b><u>PASS</u></b>
2	15.247(b)	Peak Output Power	Sep 09, 2017	<b><u>PASS</u></b>
3	15.247(a)	Bandwidth	Sep 09, 2017	<b><u>PASS</u></b>
4	15.247(d)	Conducted Spurious Emission and Band Edge	Sep 09, 2017	<b><u>PASS</u></b>
5	15.247(d)	Restricted Frequency Bands	Sep 14, 2017	<b><u>PASS</u></b>
6	15.207	Conducted Emission	Sep 21, 2017	<b><u>PASS</u></b>
7	15.209 ,15.247(d)	Radiated Emission	Sep 18, 2017	<b><u>PASS</u></b>
8	15.247(e)	Power spectral density (PSD)	Sep 09, 2017	<b><u>PASS</u></b>

The tests of Conducted Emission and Radiated Emission were performed according to the method of measurements prescribed in ANSI C63.10 2013 and KDB558074 D01 v04 (04/05/2017).

#### 1.3.1 Test Environment Conditions

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 - 35
Relative Humidity (%):	30 -60
Atmospheric Pressure (kPa):	86-106

## 2. 47 CFR PART 15C REQUIREMENTS

### 2.1 Antenna requirement

#### 2.1.1 Applicable Standard

According to FCC 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.

#### 2.1.2 Result: Compliant

The EUT has a permanently and irreplaceable attached antenna. Please refer to the EUT internal photos.

### 2.2 Peak Output Power

#### 2.2.1 Requirement

According to FCC section 15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: The maximum peak conducted output power of the intentional radiator shall not exceed 1 Watt.

#### 2.2.2 Test Description

The measured output power was calculated by the reading of the USB Wideband Power Sensor and calibration.

#### A. Test Setup:



The EUT (Equipment under the test) which is coupled to the USB Wideband Power Sensor; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading, all test result in power meter.

#### B. Equipments List:

Please reference ANNEX A(1.5).



### 2.2.3 Test Result

The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

#### 2.2.3.1 802.11b Test Mode

Channel	Frequency (MHz)	Measured Output Peak Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	18.82	0.07621	30	1	PASS
6	2437	16.83	0.04819			PASS
11	2462	15.75	0.03758			PASS

Channel	Frequency (MHz)	Measured Output Average Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	11.54	0.01426	30	1	PASS
6	2437	10.48	0.01117			PASS
11	2462	9.59	0.00910			PASS

#### 2.2.3.2 802.11g Test mode

Channel	Frequency (MHz)	Measured Output Peak Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	18.48	0.07047	30	1	PASS
6	2437	17.38	0.05470			PASS
11	2462	16.59	0.04560			PASS

Channel	Frequency (MHz)	Measured Output Average Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	11.02	0.01265	30	1	PASS
6	2437	10.22	0.01052			PASS
11	2462	9.02	0.00798			PASS



**2.2.3.3 802.11n-20MHz Test mode**

Channel	Frequency (MHz)	Measured Output Peak Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	18.19	0.06592	30	1	PASS
6	2437	17.33	0.05408			PASS
11	2462	16.37	0.04335			PASS

Channel	Frequency (MHz)	Measured Output Average Power		Limit		Verdict
		dBm	W	dBm	W	
1	2412	9.14	0.00820	30	1	PASS
6	2437	9.86	0.00968			PASS
11	2462	10.97	0.01250			PASS

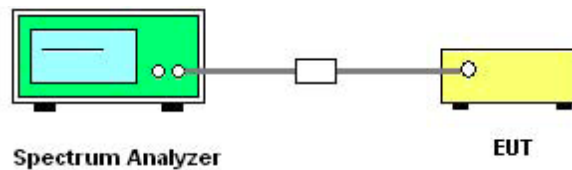
## 2.3 Bandwidth

### 2.3.1 Requirement

According to FCC section 15.247(a) (2), Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 2.3.2 Test Description

#### A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW.

KDB 558074 Section 8.1 Option 1 was used in order to prove compliance.

#### B. Equipments List:

Please reference ANNEX A(1.5).

### 2.3.3 Test Result

The lowest, middle and highest channels are selected to perform testing to record the 6 dB bandwidth of the Module.

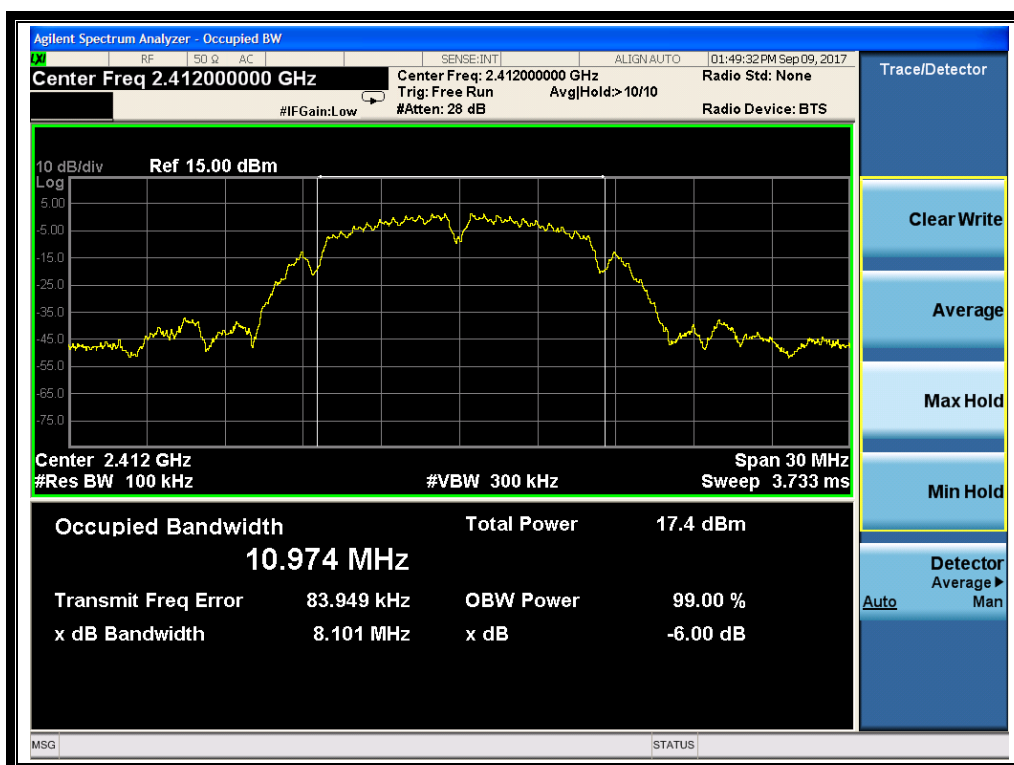


### 2.3.3.1 802.11b Test mode

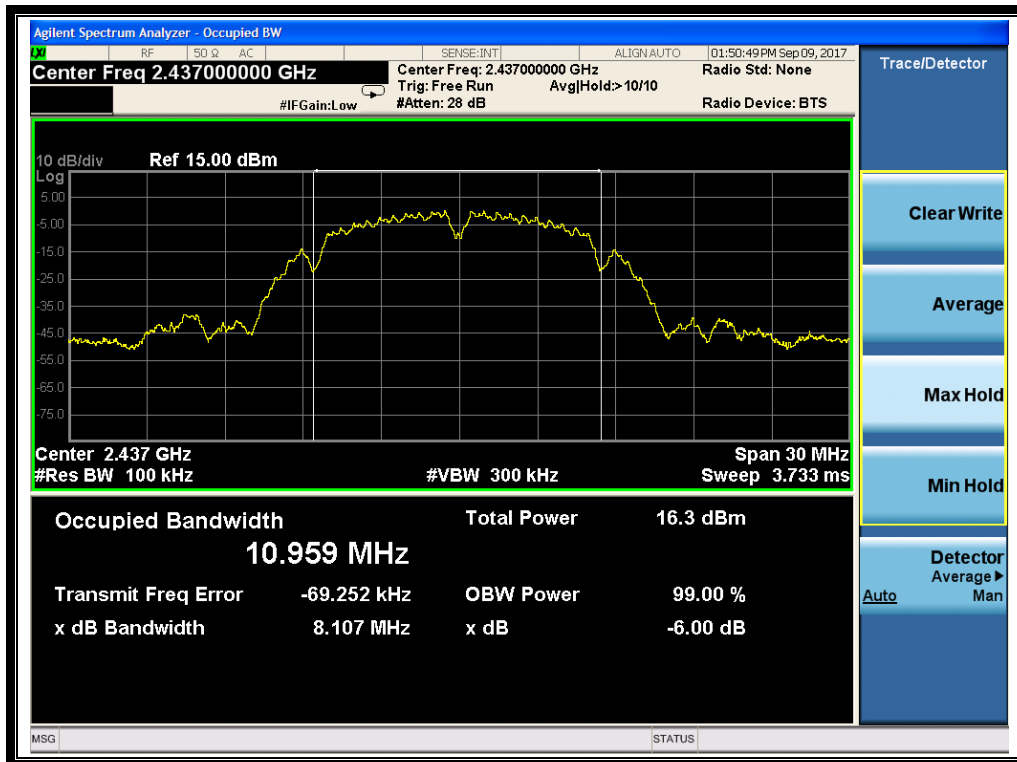
#### A. Test Verdict:

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Limits(kHz)	Result
1	2412	8.101	≥500	PASS
6	2437	8.107	≥500	PASS
11	2462	8.105	≥500	PASS

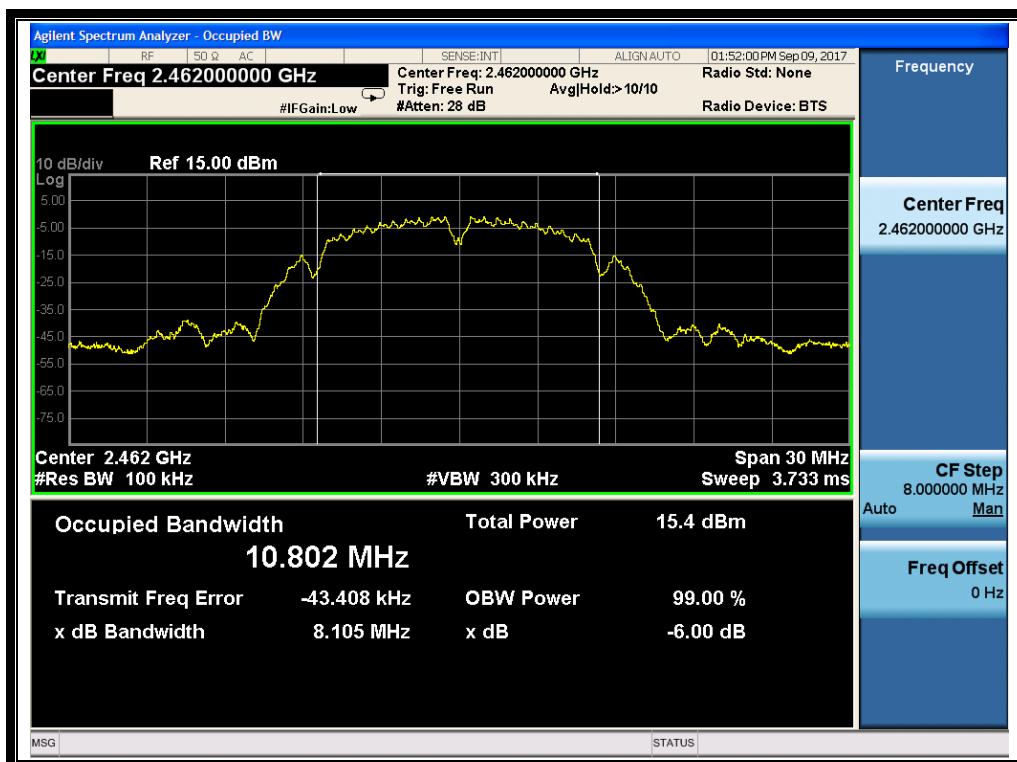
#### B. Test Plots



(Channel 1: 2412MHz @ 802.11b)



(Channel 6: 2437 MHz @ 802.11b)



(Channel 11: 2462MHz @ 802.11b)

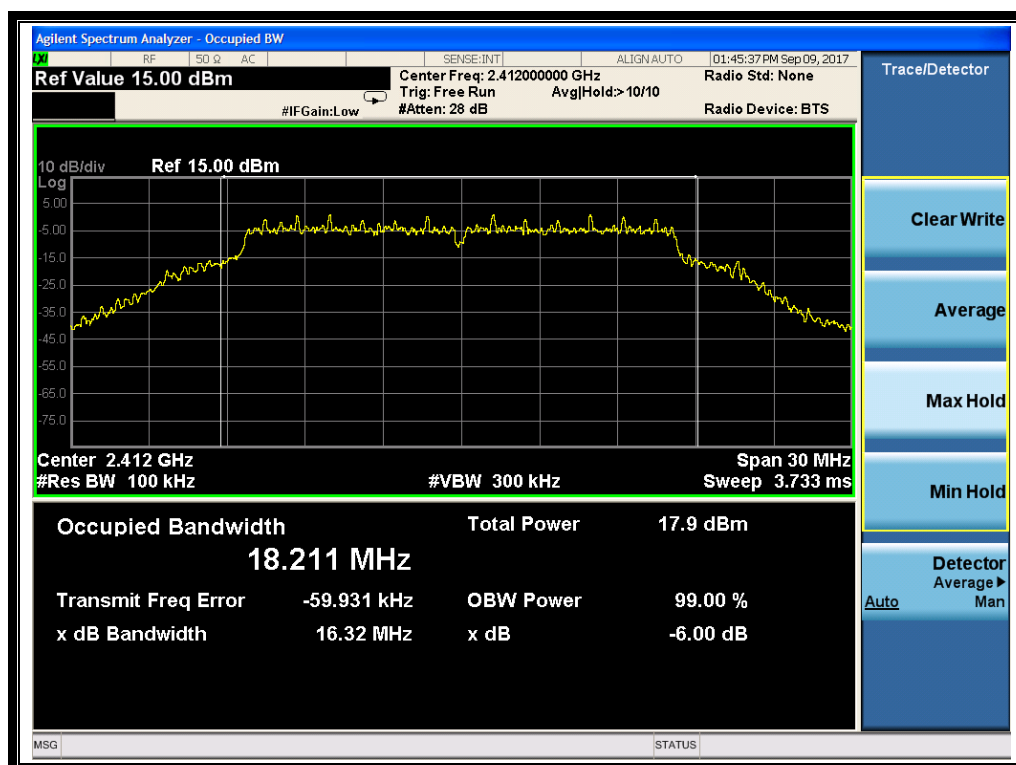


### 2.3.3.2 802.11g Test mode

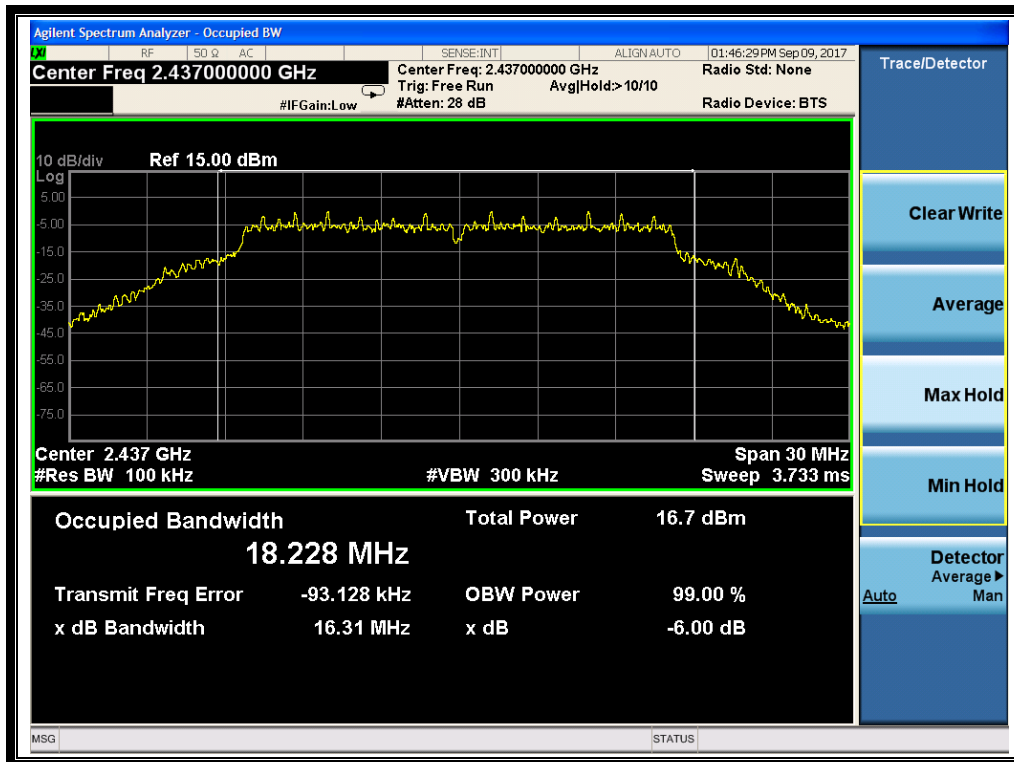
#### A. Test Verdict:

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Limits (kHz)	Result
1	2412	16.32	≥500	PASS
6	2437	16.31	≥500	PASS
11	2462	16.32	≥500	PASS

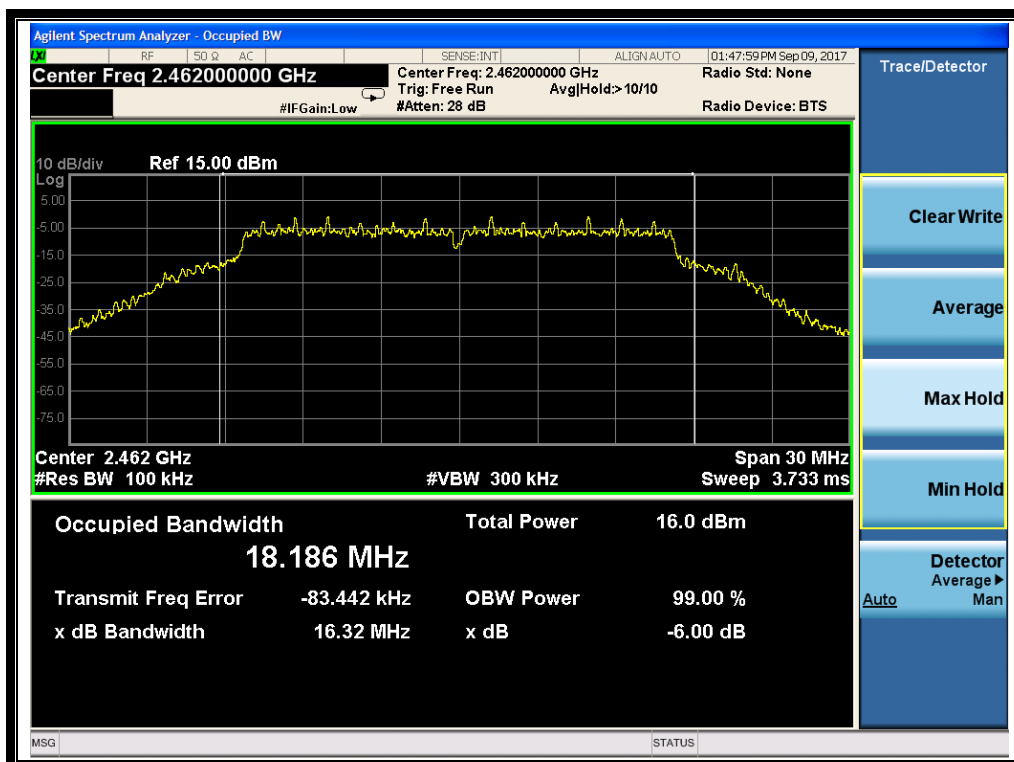
#### B. Test Plots:



(Channel 1: 2412MHz @ 802.11g)



(Channel 6: 2437MHz @ 802.11g)



(Channel 11: 2462MHz @ 802.11g)

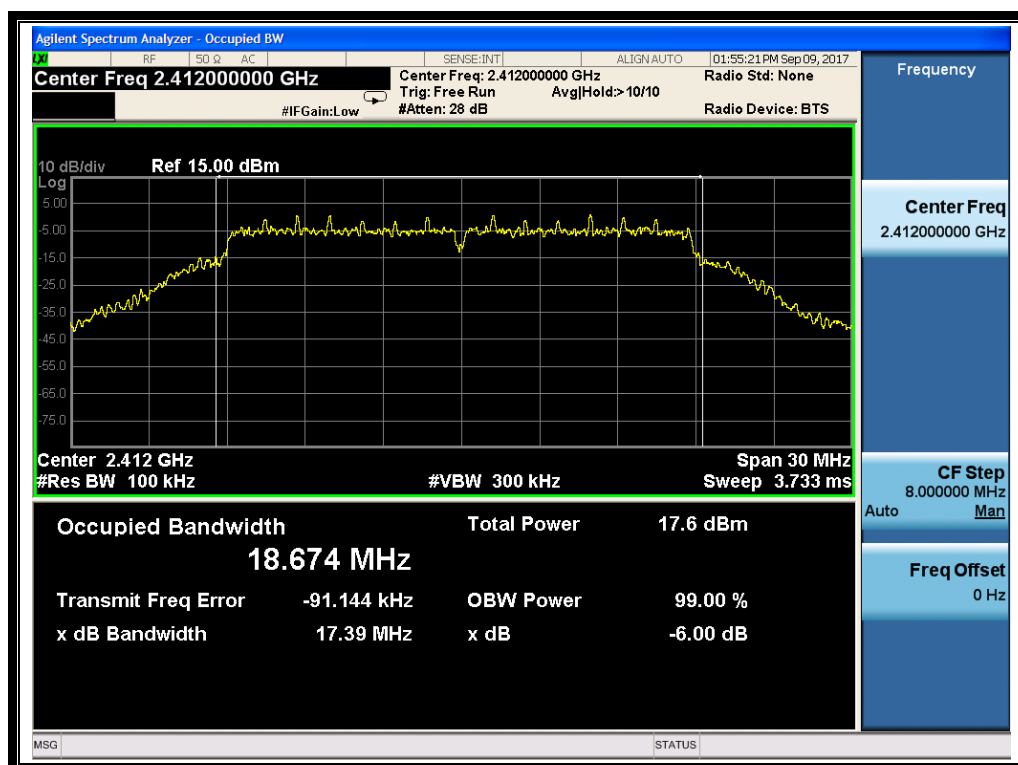


### 2.3.3.3 802.11n-20 Test mode

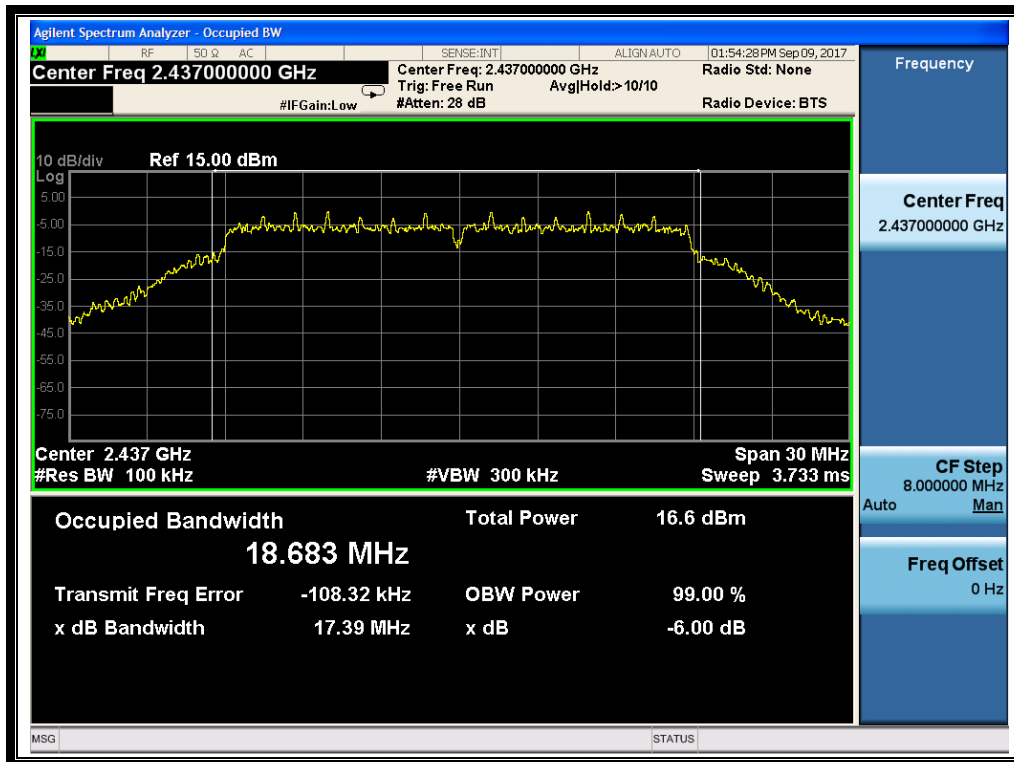
#### A. Test Verdict:

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Limits (kHz)	Result
1	2412	17.39	≥500	PASS
6	2437	17.39	≥500	PASS
11	2462	17.39	≥500	PASS

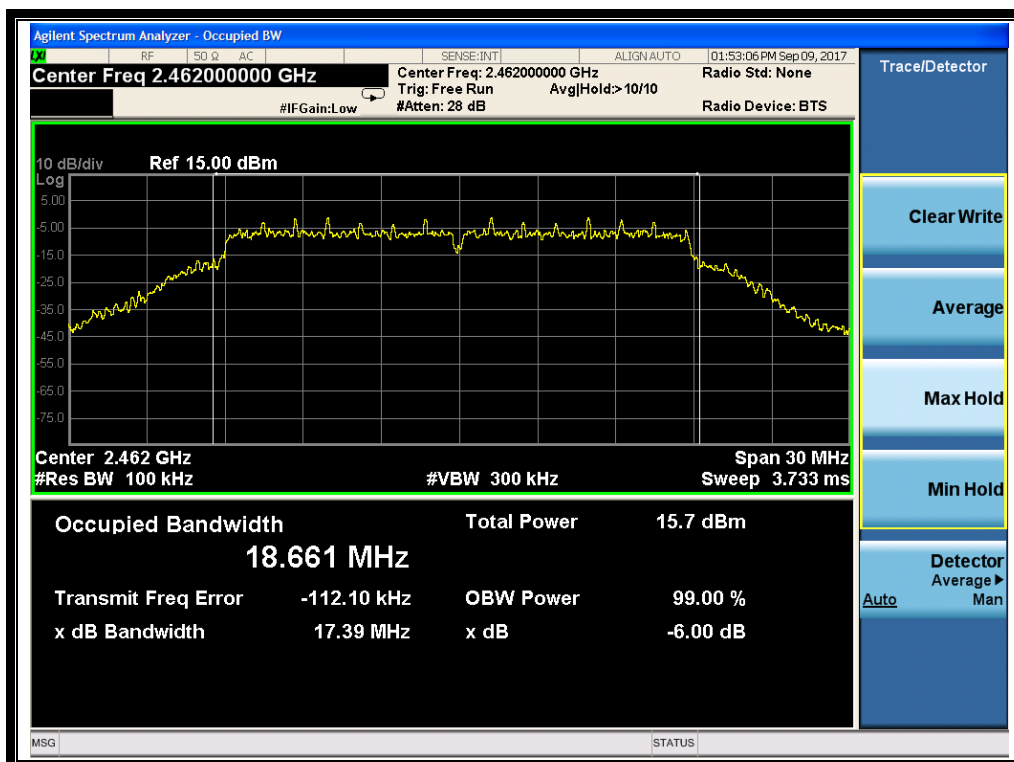
#### B. Test Plots:



(Channel 1: 2412MHz @ 802.11n-20)



(Channel 6: 2437MHz @ 802.11n-20)



(Channel 11: 2462MHz @ 802.11n-20)



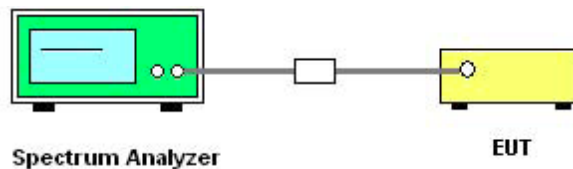
## 2.4 Conducted Spurious Emissions and Band Edge

### 2.4.1 Requirement

According to FCC section 15.247(c), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### 2.4.2 Test Description

#### A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW.

KDB 558074 Section 11.0 was used in order to prove compliance.

#### B. Equipments List:

Please reference ANNEX A(1.5).

### 2.4.3 Test Result

The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions.



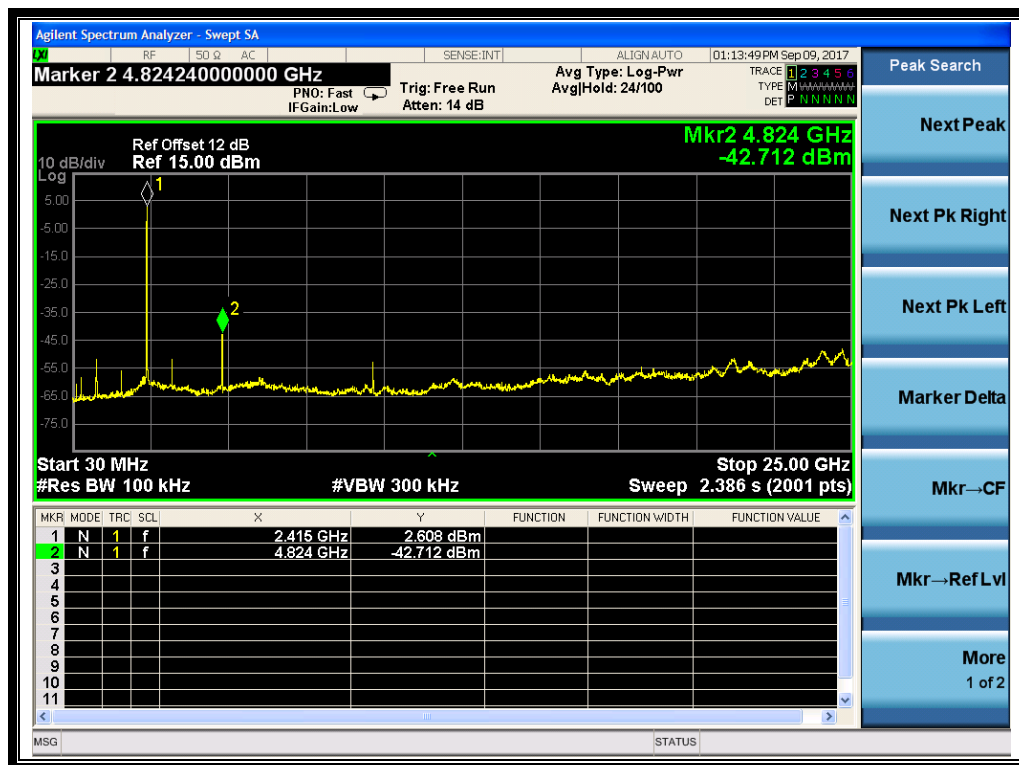
### 2.4.3.1 802.11b Test mode

#### A. Test Verdict:

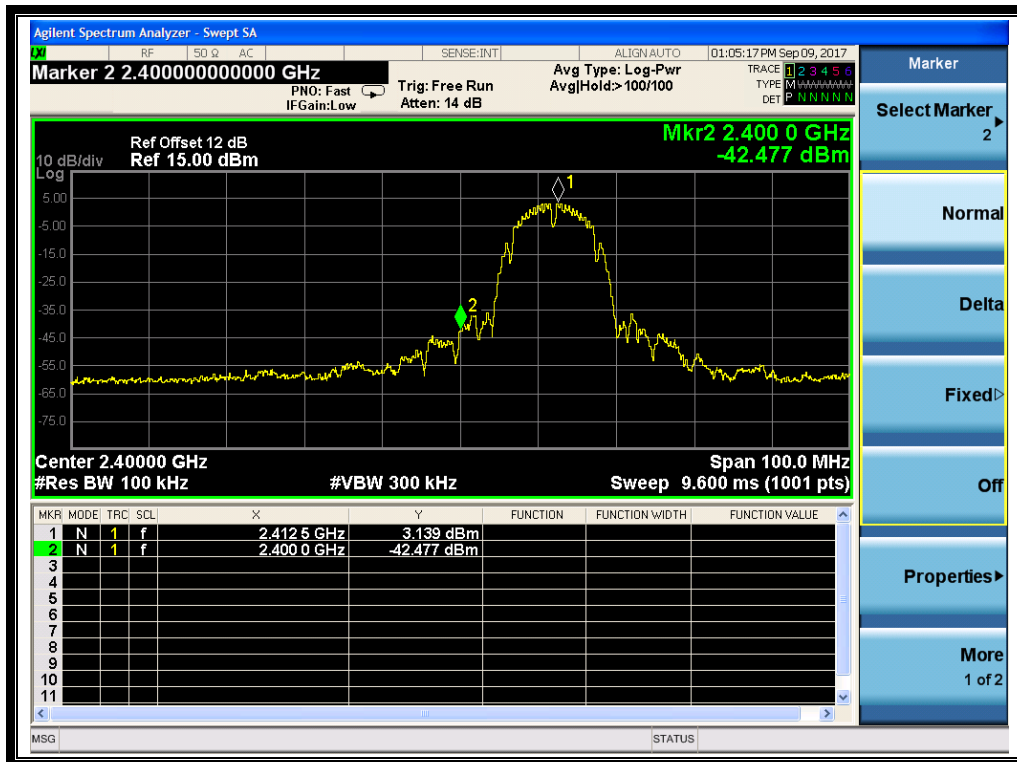
Channel	Frequency (MHz)	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
			Carrier Level	Calculated -20dBc Limit	
1	2412	-42.71	2.61	-17.39	PASS
6	2437	-41.71	1.69	-18.31	PASS
11	2462	-42.59	0.80	-19.20	PASS

#### B. Test Plots:

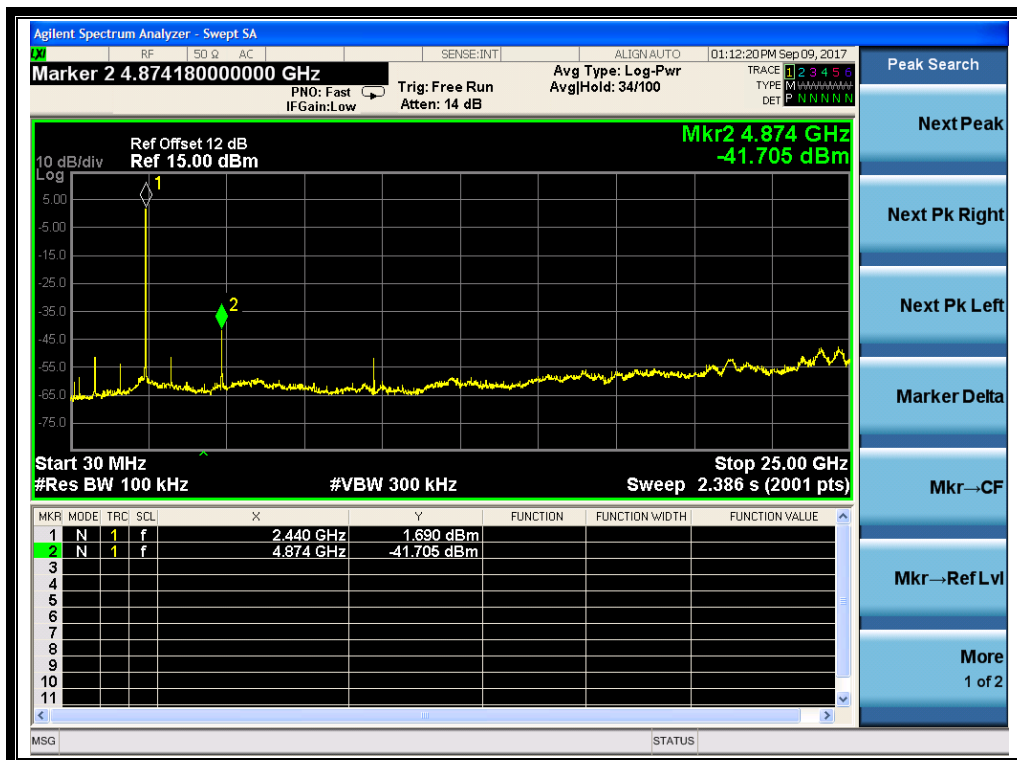
**Note:** the power of the Module transmitting frequency should be ignored.



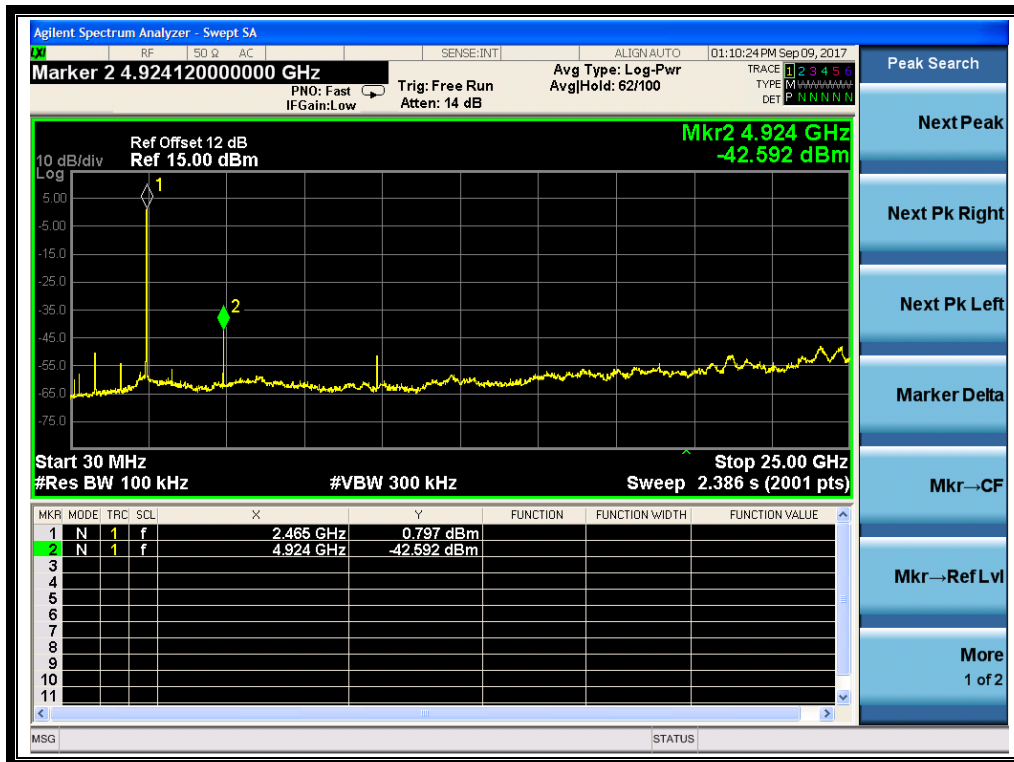
(Channel = 1, 30MHz to 25GHz)



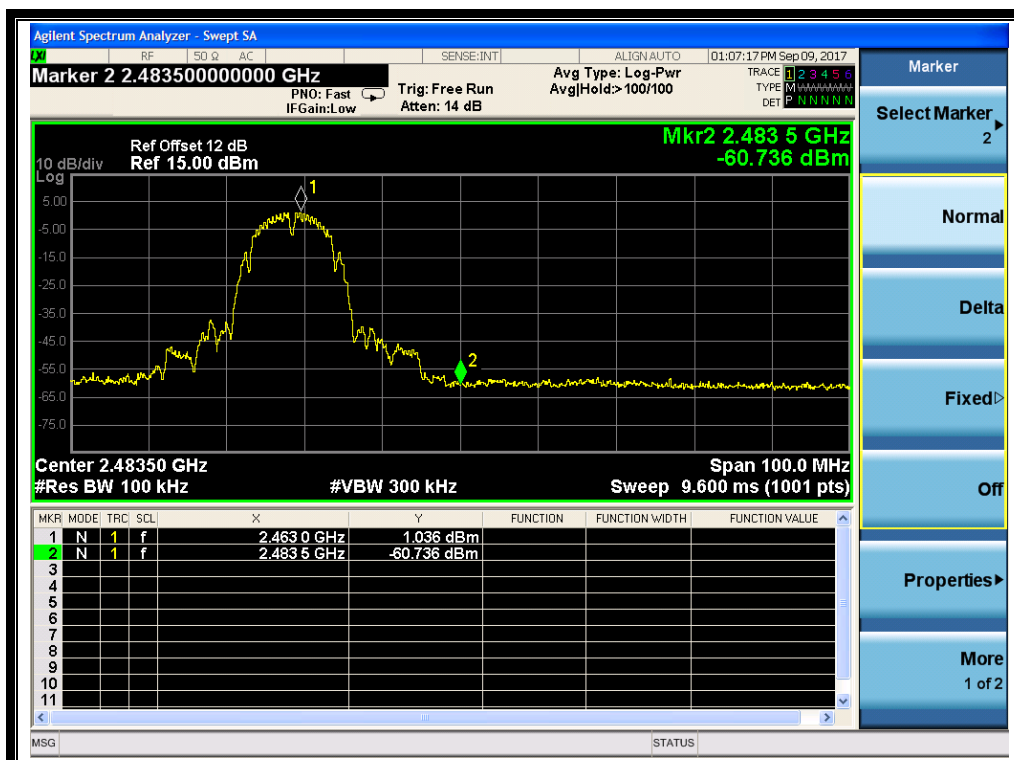
(Band Edge @ Channel = 1)



(Channel = 6, 30MHz to 25GHz)



(Channel = 11, 30MHz to 25GHz)



(Band Edge @ Channel = 11)



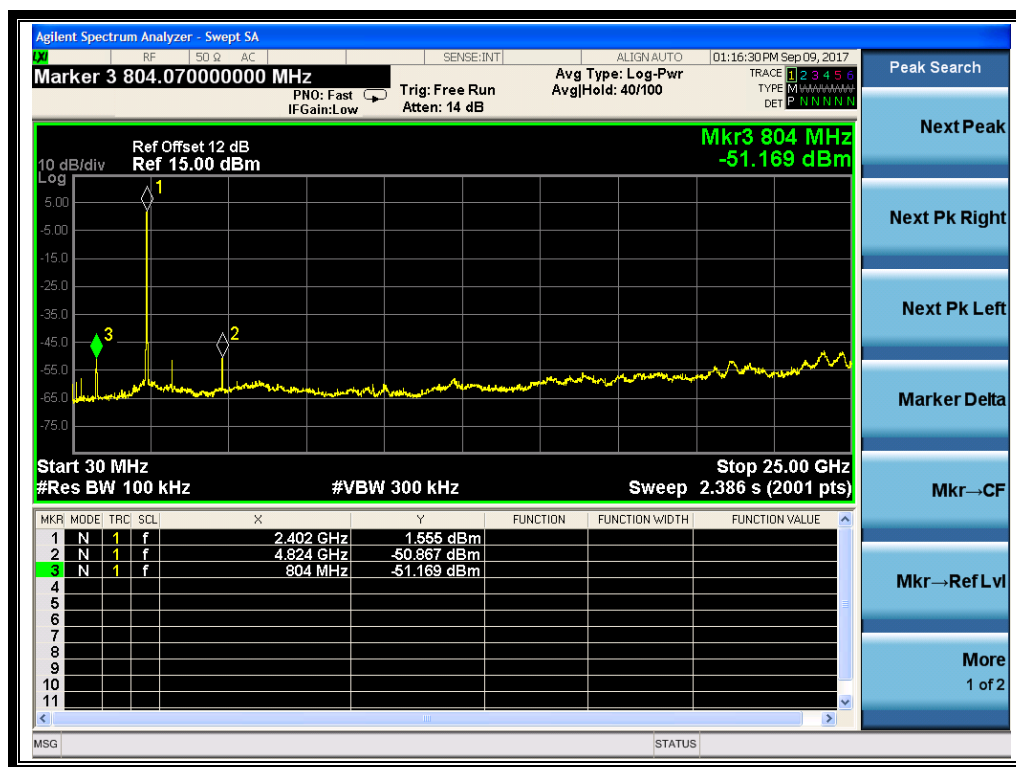
### 2.4.3.2 802.11g Test mode

#### A. Test Verdict:

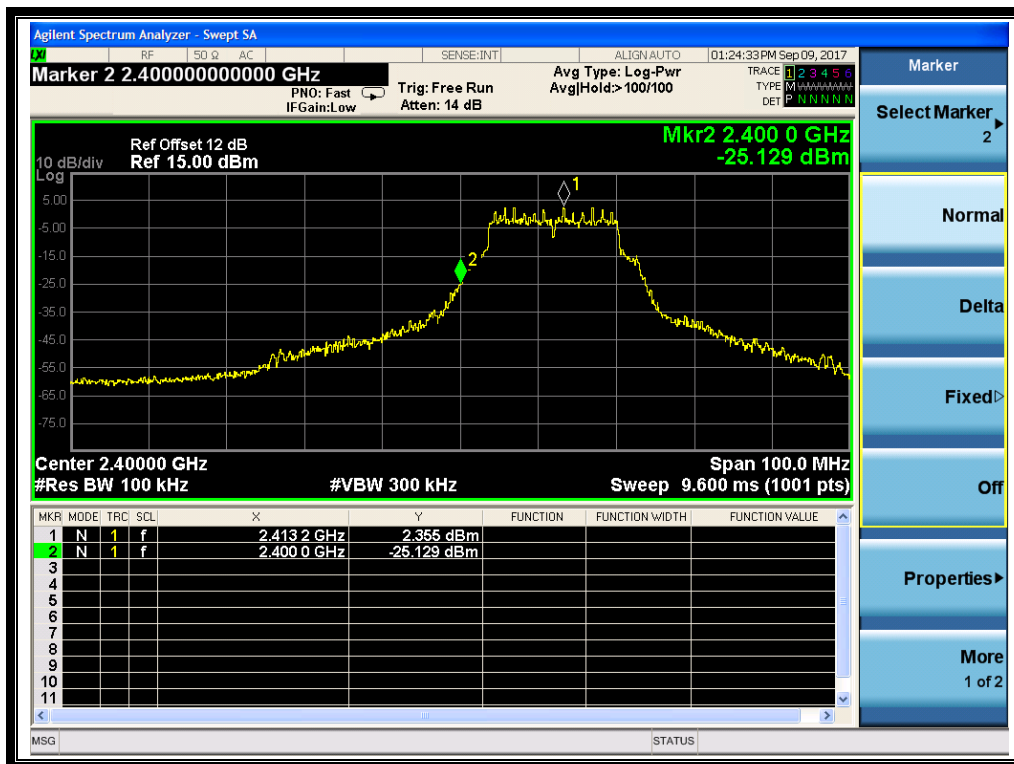
Channel	Frequency (MHz)	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
			Carrier Level	Calculated -20dBc Limit	
1	2412	-50.87	1.56	-18.44	PASS
6	2437	-49.21	0.84	-19.16	PASS
11	2462	-47.04	0.17	-19.83	PASS

#### B. Test Plots:

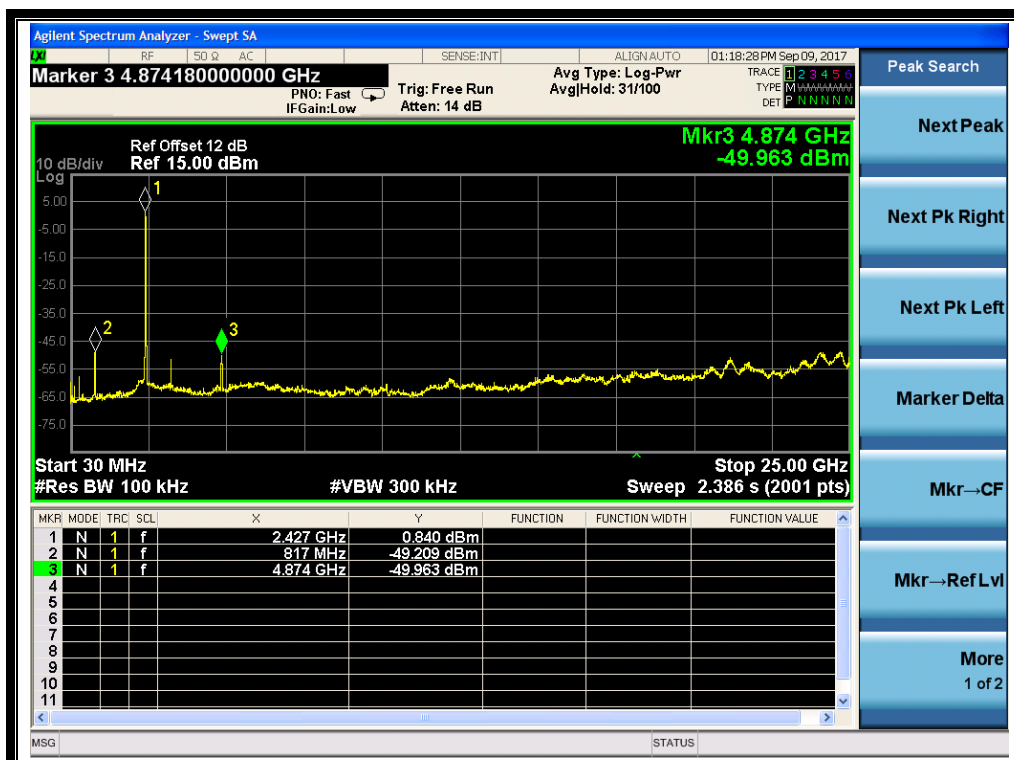
**Note:** the power of the Module transmitting frequency should be ignored.



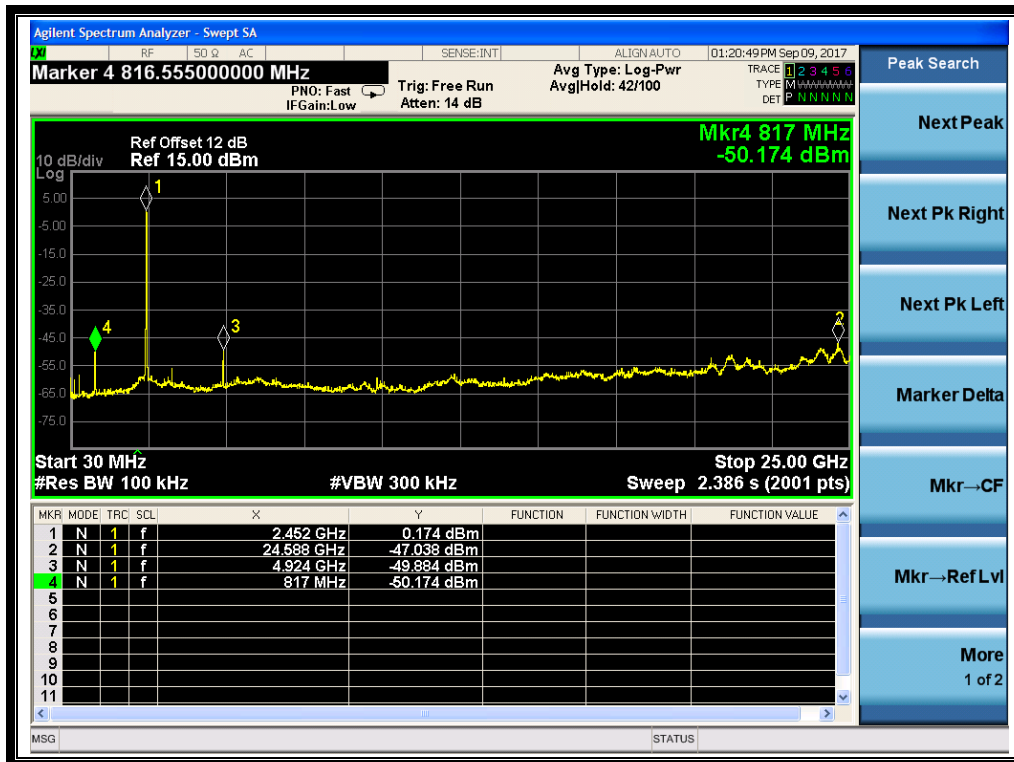
(Channel = 1, 30MHz to 25GHz)



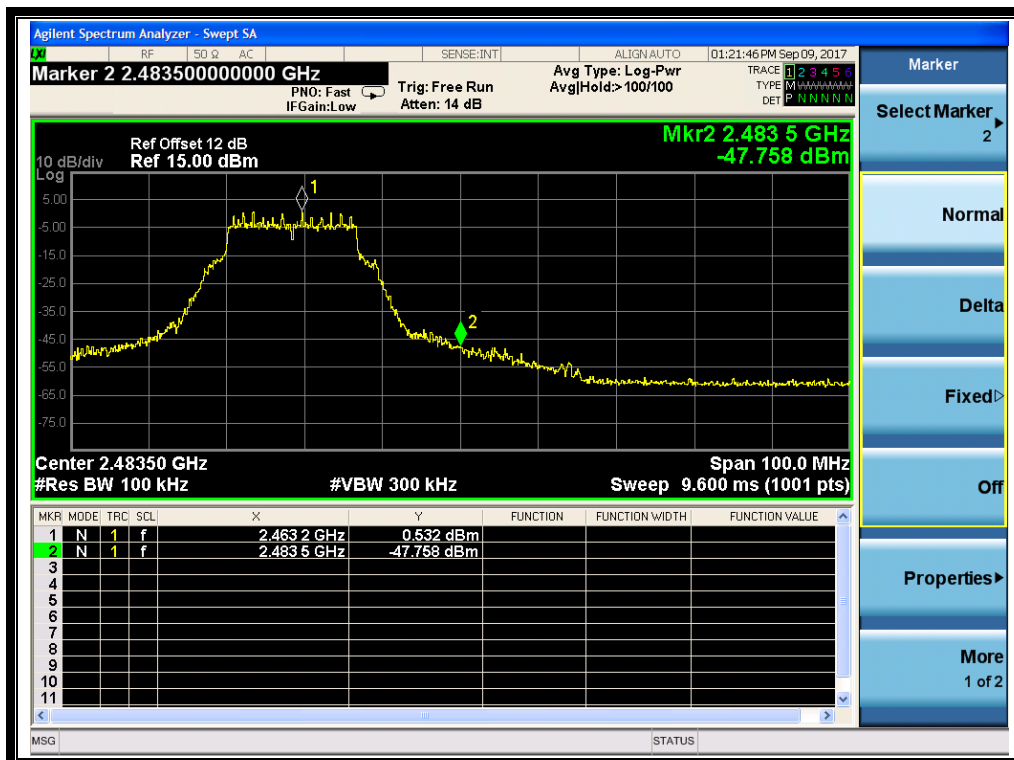
(Band Edge @ Channel = 1)



(Channel = 6, 30MHz to 25GHz)



(Channel = 11, 30MHz to 25GHz)



(Band Edge @ Channel = 11)



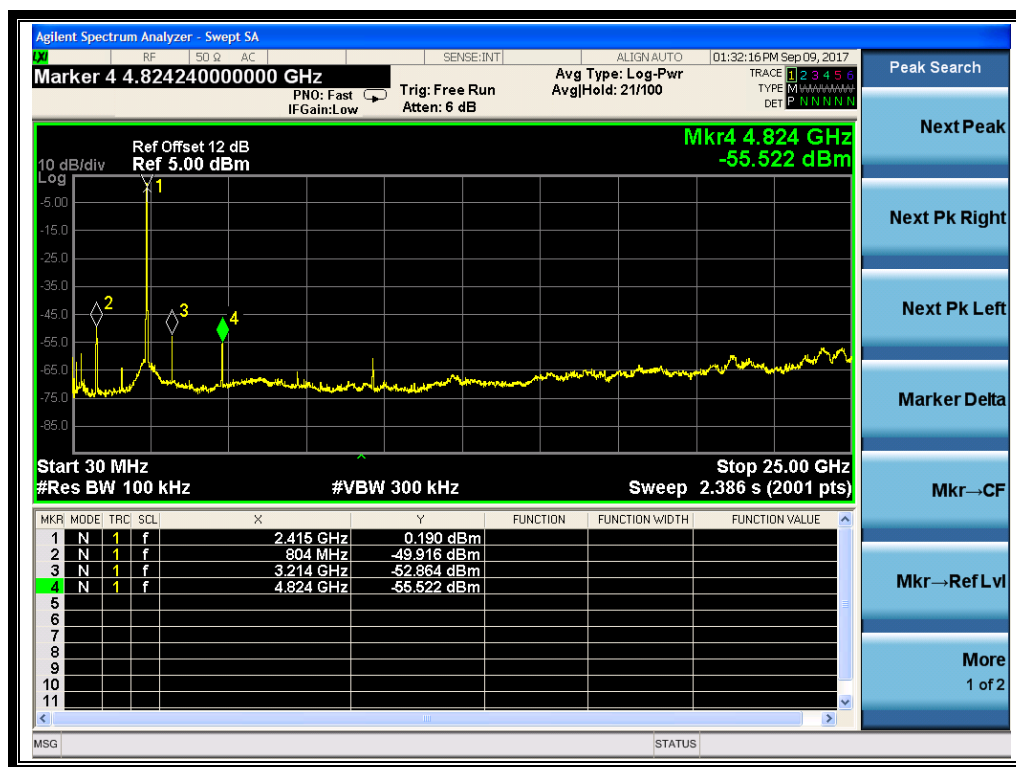
### 2.4.3.3 802.11n -20MHz Test mode

#### A. Test Verdict:

Channel	Frequency (MHz)	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
			Carrier Level	Calculated -20dBc Limit	
1	2412	-49.92	0.19	-19.81	PASS
6	2437	-51.45	-0.07	-20.07	PASS
11	2462	-49.64	-3.25	-23.25	PASS

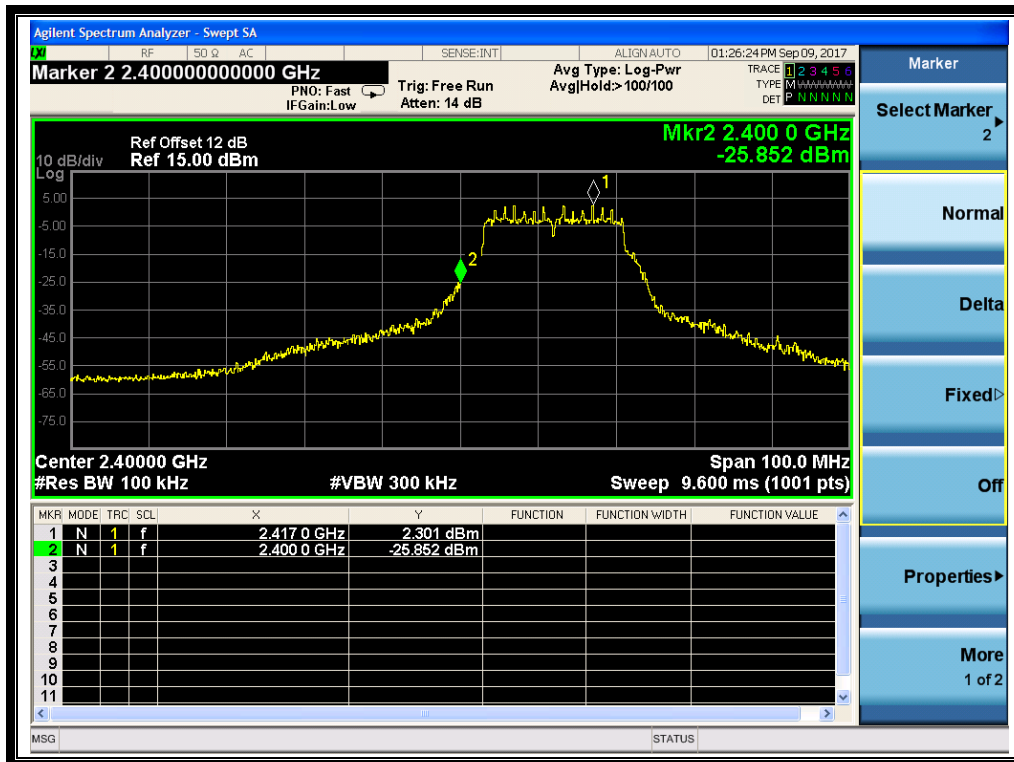
#### B. Test Plots:

**Note:** the power of the Module transmitting frequency should be ignored.

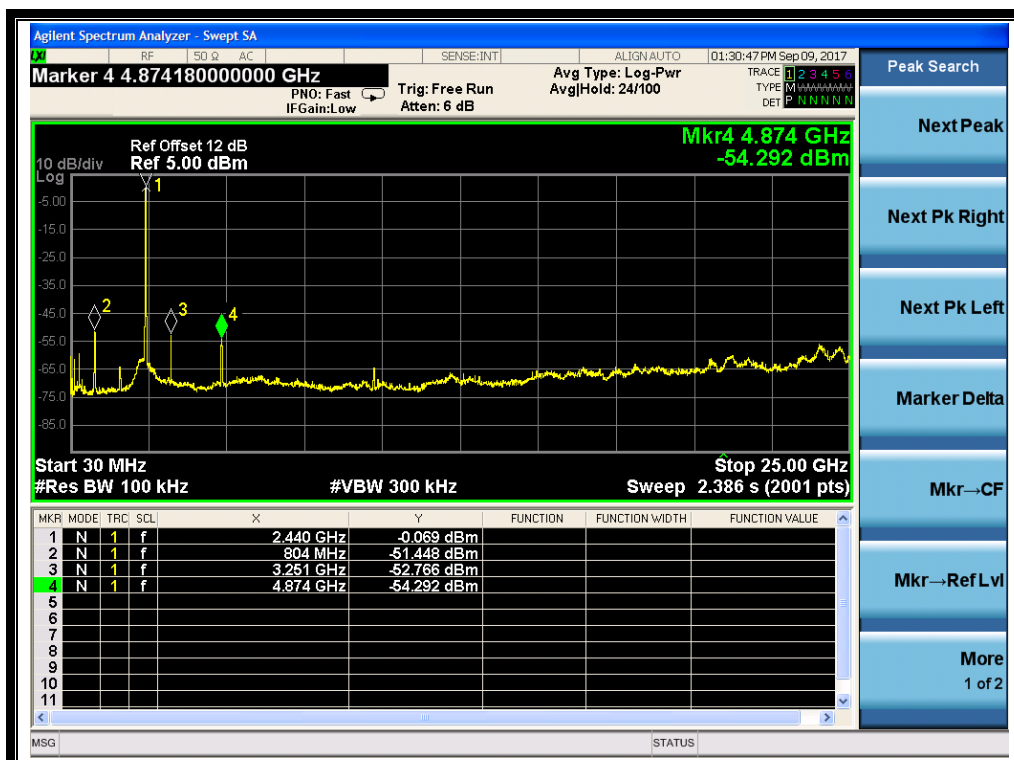


(Channel = 1, 30MHz to 25GHz)

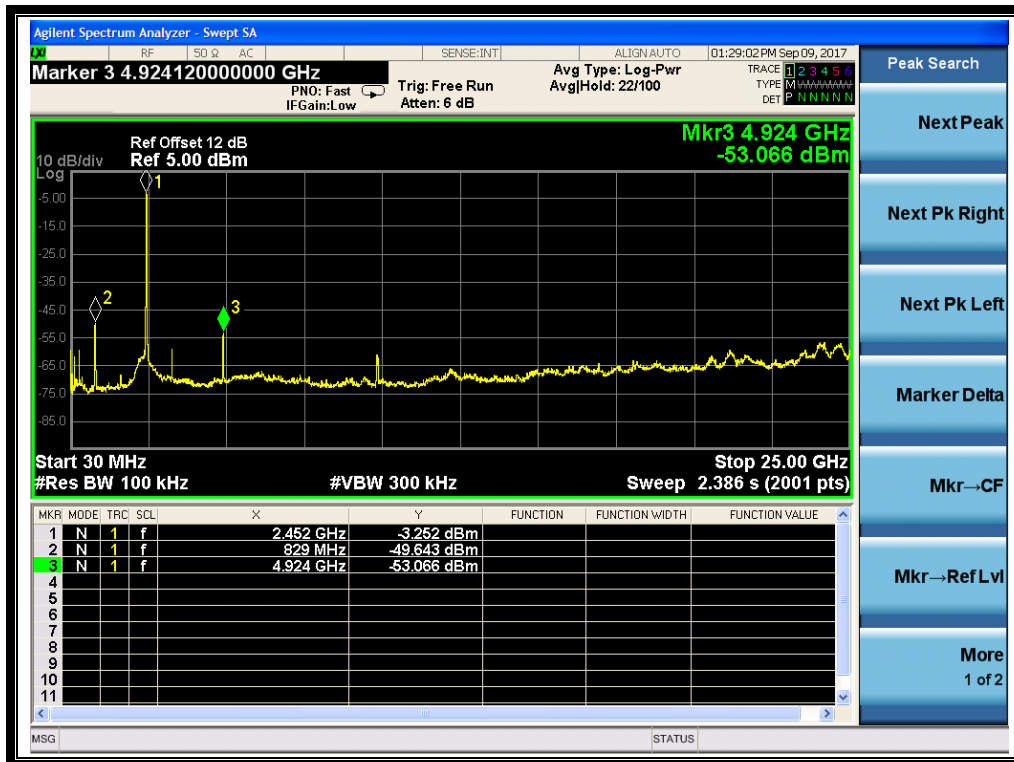




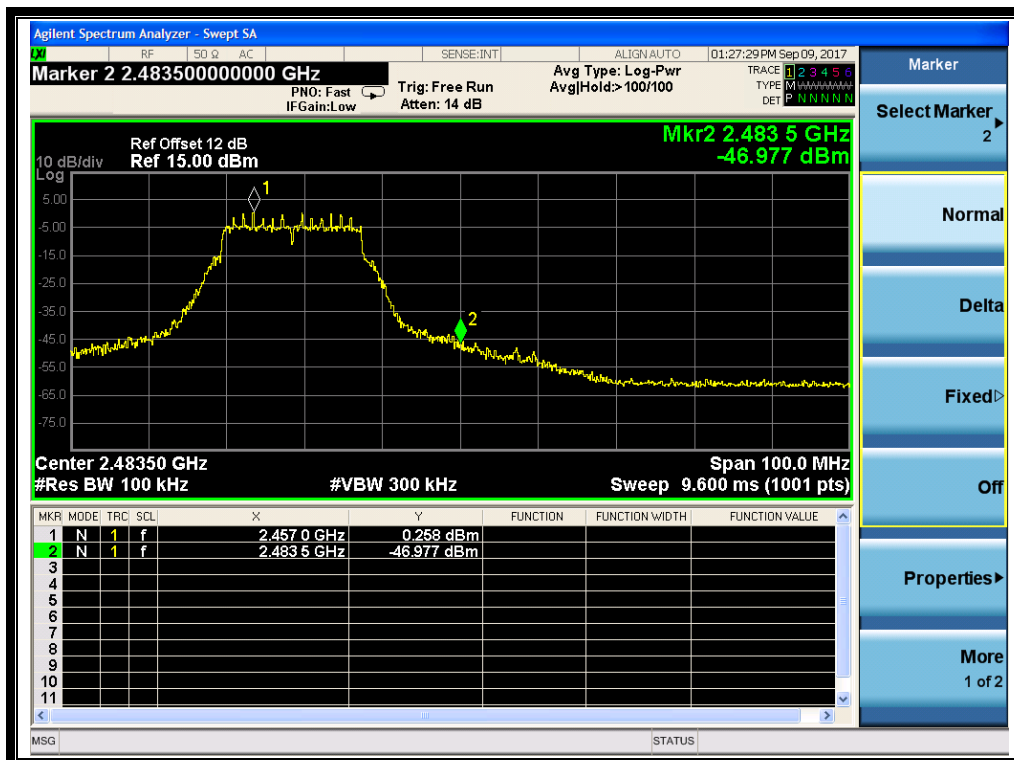
(Band Edge @ Channel = 1)



(Channel = 6, 30MHz to 25GHz)



(Channel = 11, 30MHz to 25GHz)



(Band Edge @ Channel = 11)

## 2.5 Power spectral density (PSD)

### 2.5.1 Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

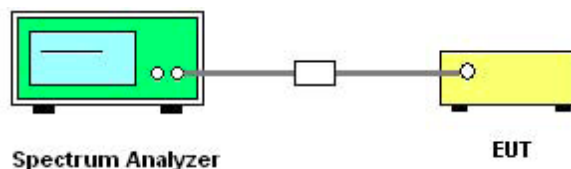
### 2.5.2 Test Description

#### A. Test procedure

The measured power spectral density was calculated by the reading of the spectrum analyzer and calibration. Following is the test procedure for PSD test:

- Set analyzer center frequency to channel center frequency.
- Set the span to 30MHz
- Set the RBW to 3 kHz
- Set the VBW to 10KHz
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.

#### B. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

KDB 558074 Section 10.2 was used in order to prove compliance.

#### C. Equipments List:

Please reference ANNEX A(1.5).



## 2.5.3 Test Result

### 2.5.3.1 802.11b Test mode

#### A. Test Verdict:

Spectral power density (dBm/3kHz)				
Channel	Frequency (MHz)	Measured PSD (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
1	2412	-9.53	8	PASS
6	2437	-10.71	8	PASS
11	2462	-11.78	8	PASS
Measurement uncertainty: $\pm 1.3$ dB				

#### B. Test Plots:



(Channel = 1 @ 802.11b)



(Channel = 6 @ 802.11b)

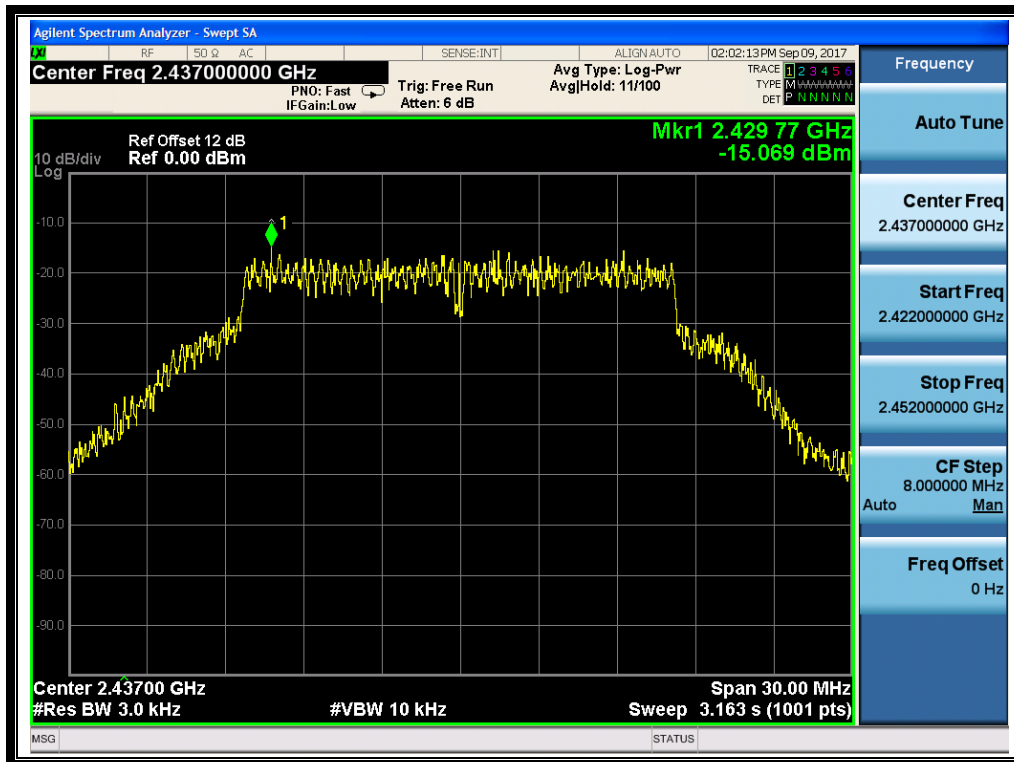


(Channel = 11 @ 802.11b)

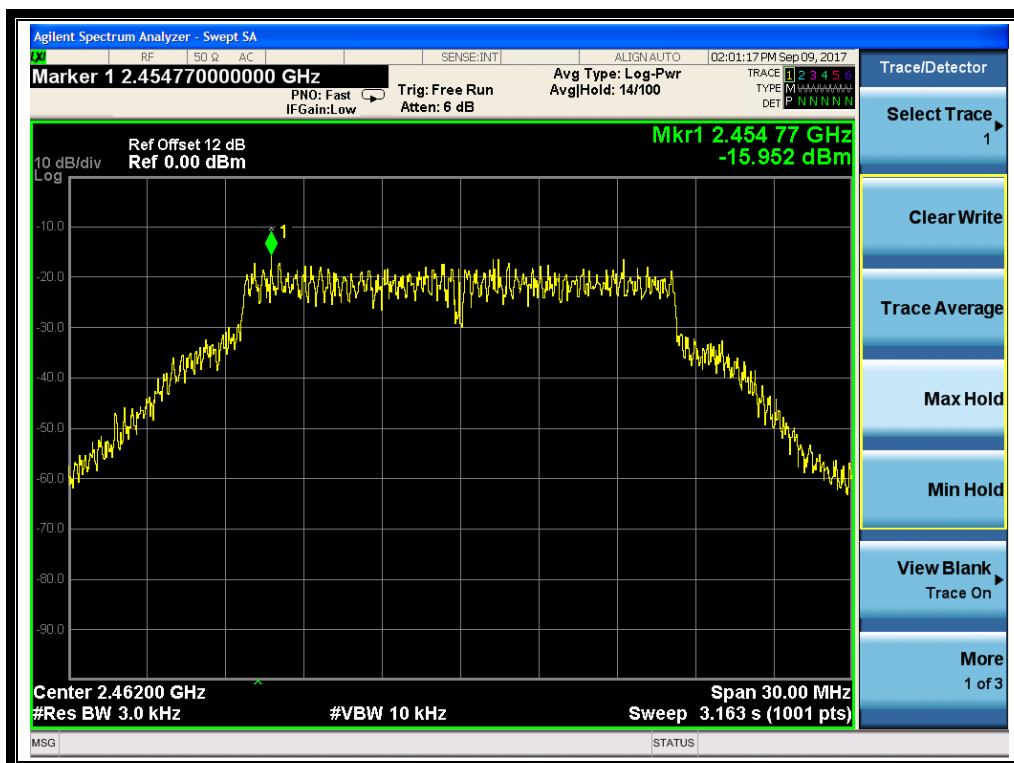




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(Channel = 6 @ 802.11g)



(Channel = 11 @ 802.11g)

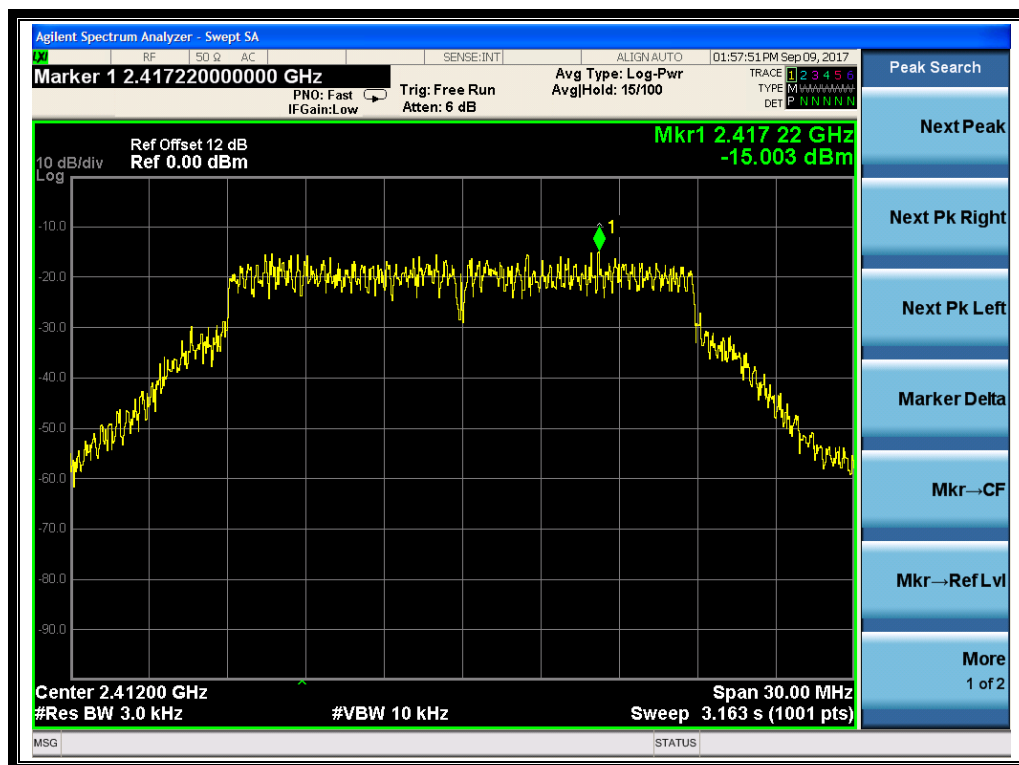


### 2.5.3.3 802.11n-20MHz Test mode

#### A. Test Verdict:

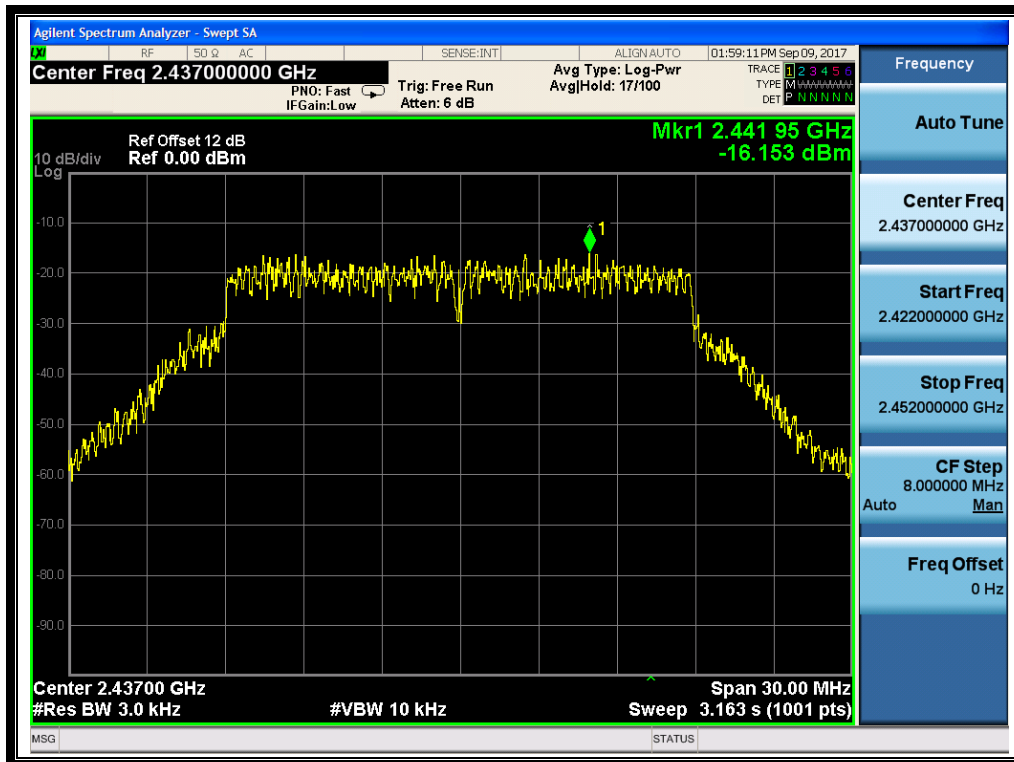
Spectral power density (dBm/3kHz)				
Channel	Frequency (MHz)	Measured PSD (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
1	2412	-15.00	8	PASS
6	2437	-16.15	8	PASS
11	2462	-17.36	8	PASS
Measurement uncertainty: $\pm 1.3$ dB				

#### B. Test Plots:

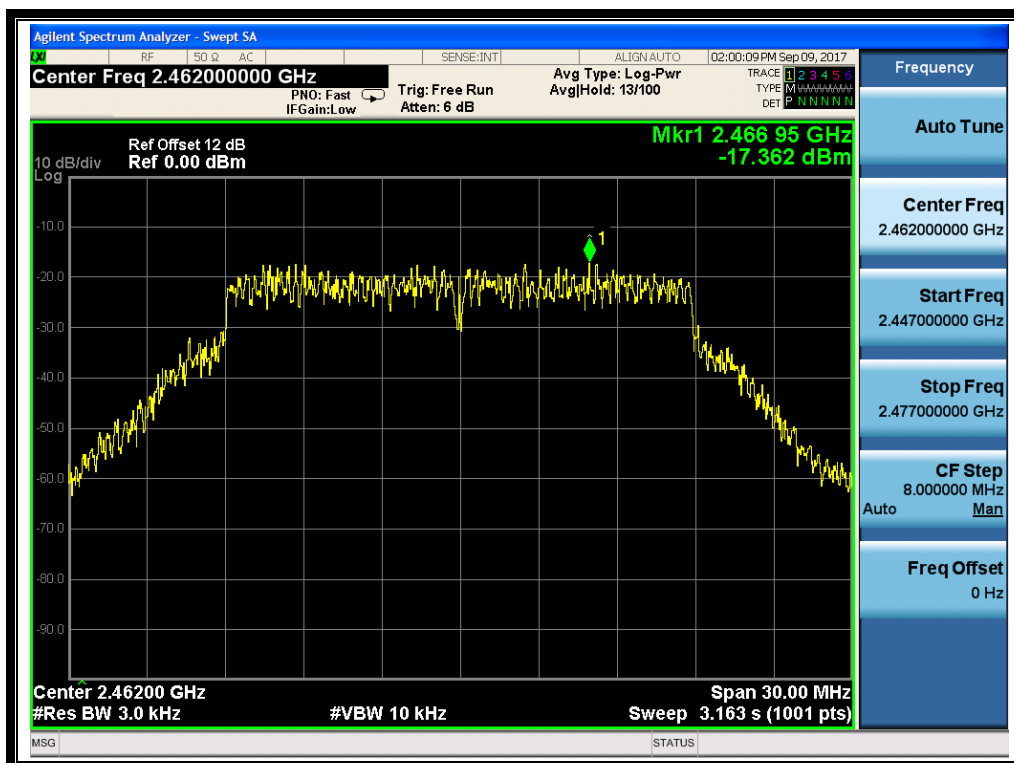


(Channel = 1 @ 802.11n-20MHz)





(Channel = 6 @ 802.11n-20MHz)



(Channel = 11 @ 802.11n-20MHz)

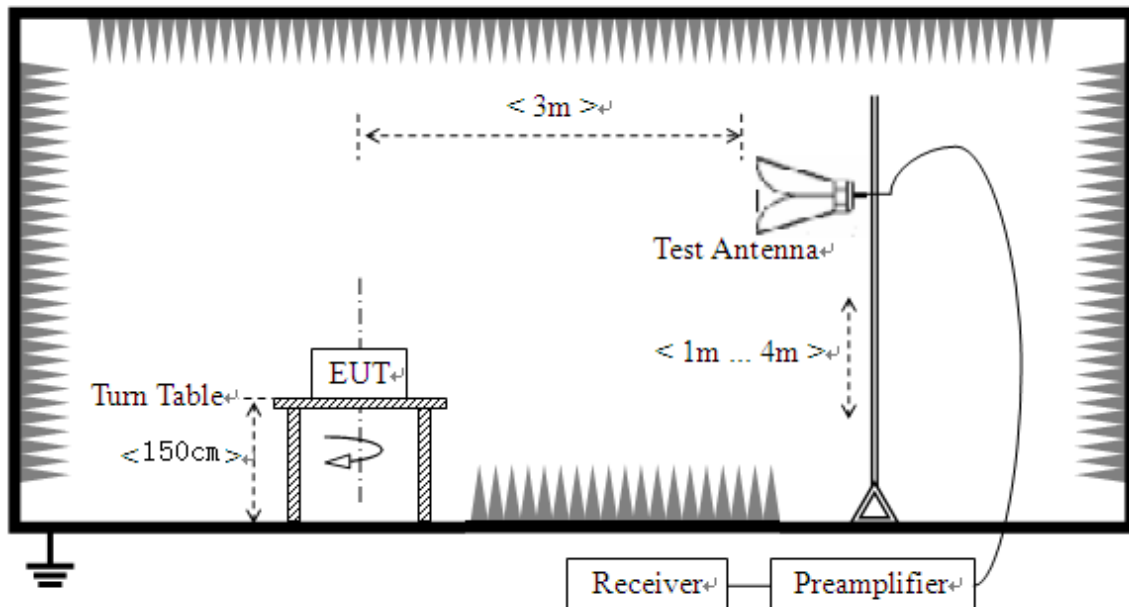
## 2.6 Restricted Frequency Bands

### 2.6.1 Requirement

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. 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).

### 2.6.2 Test Description

#### A. Test Setup



The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading.

For the Test Antenna:

Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the ground to determine the maximum value of the field strength.

KDB 558074 Section 12.1 was used in order to prove compliance.

#### B. Equipments List:

Please reference ANNEX A(1.5).



### 2.6.3 Test Result

The lowest and highest channels are tested to verify Restricted Frequency Bands.

The measurement results are obtained as below:

$$E \text{ [dB}\mu\text{V/m]} = U_R + A_T + A_{\text{Factor}} \text{ [dB]}; A_T = L_{\text{Cable loss}} \text{ [dB]} - G_{\text{preamp}} \text{ [dB]}$$

$A_T$ : Total correction Factor except Antenna

$U_R$ : Receiver Reading

$G_{\text{preamp}}$ : Preamplifier Gain

$A_{\text{Factor}}$ : Antenna Factor at 3m

**Note:** Restricted Frequency Bands were performed when antenna was at vertical and horizontal polarity, and only the worse test condition (vertical) was recorded in this test report.

#### 2.6.3.1 802.11b Test mode

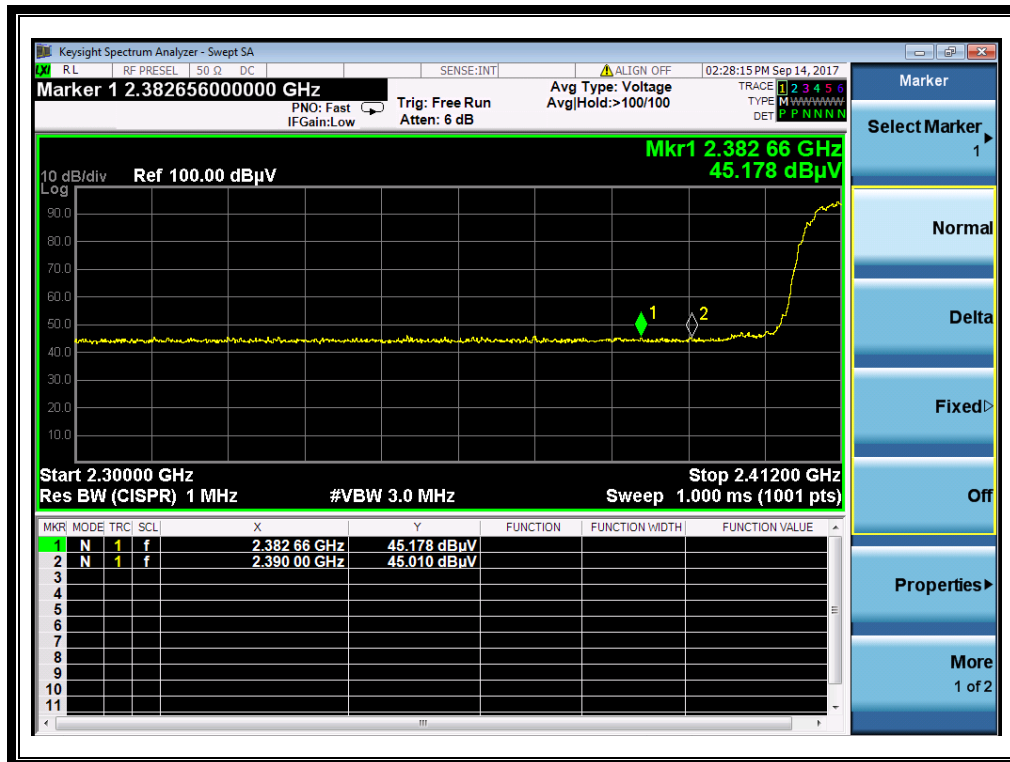
The lowest and highest channels are tested to verify the band edge emissions.

##### A. Test Verdict:

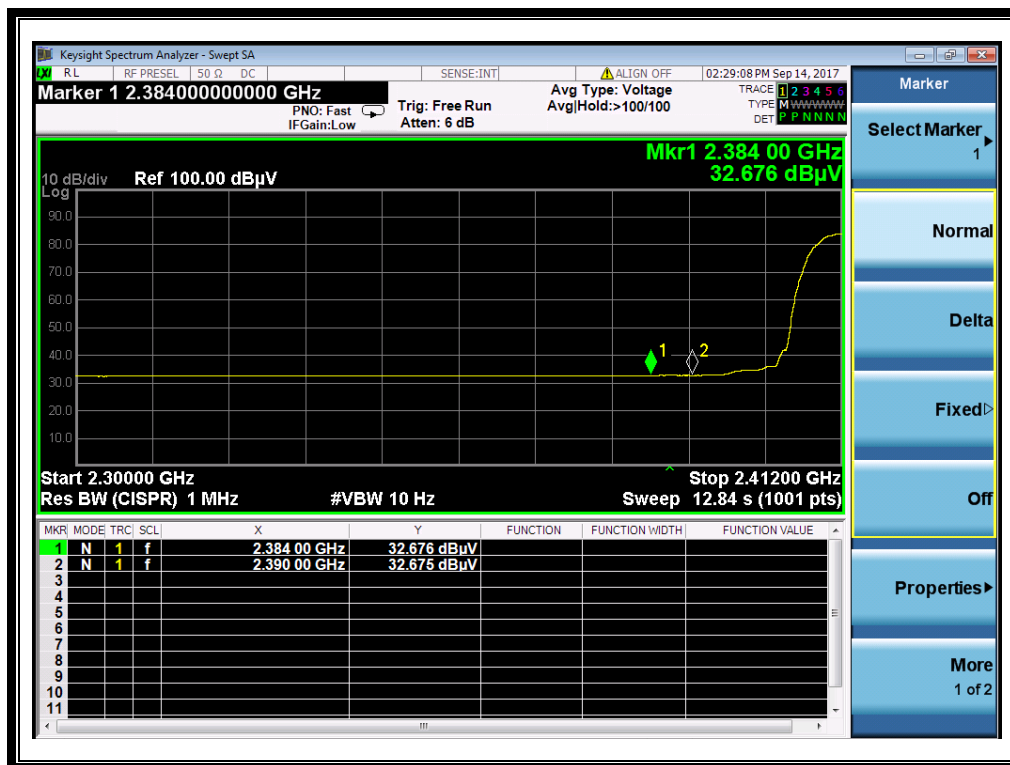
Channel	Frequency (MHz)	Detector	Receiver Reading $U_R$ (dBuV)	$A_T$ (dB)	$A_{\text{Factor}}$ (dB@3m)	Max. Emission E (dBμV/m)	Limit (dBμV/m)	Verdict
		PK/ AV						
1	2382.66	PK	45.18	-33.63	32.56	44.11	74	Pass
1	2384.00	AV	32.68	-33.63	32.56	31.61	54	Pass
11	2489.24	PK	44.40	-33.18	32.5	43.72	74	Pass
11	2486.81	AV	32.44	-33.18	32.5	31.76	54	Pass



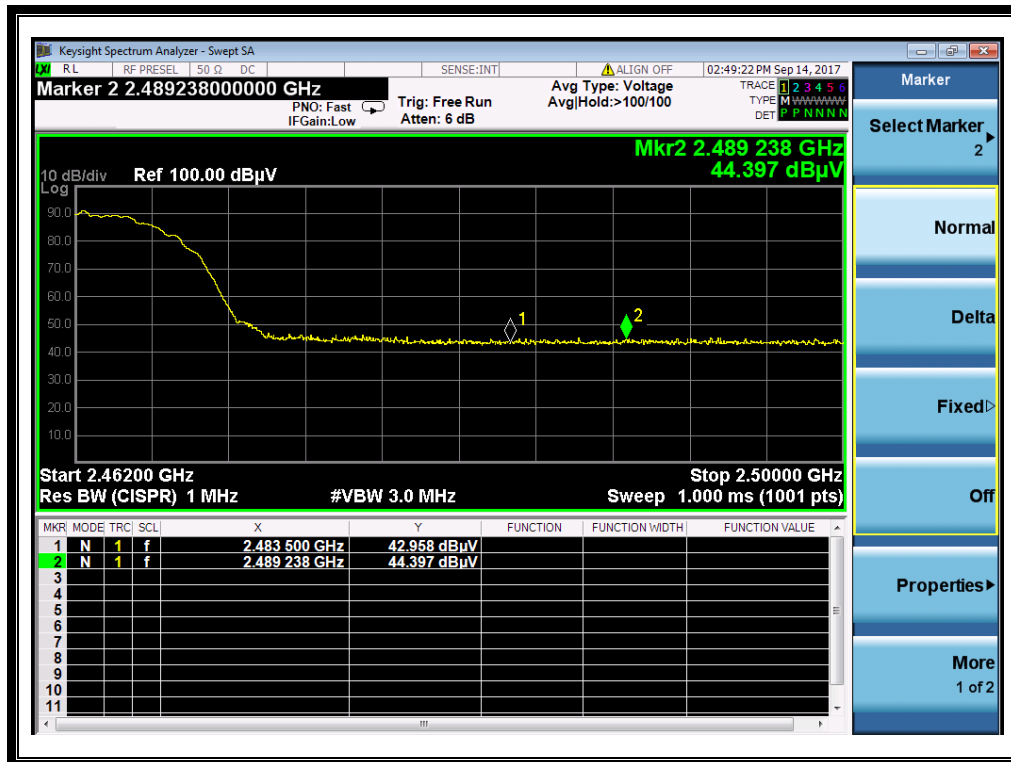
## B. Test Plots:



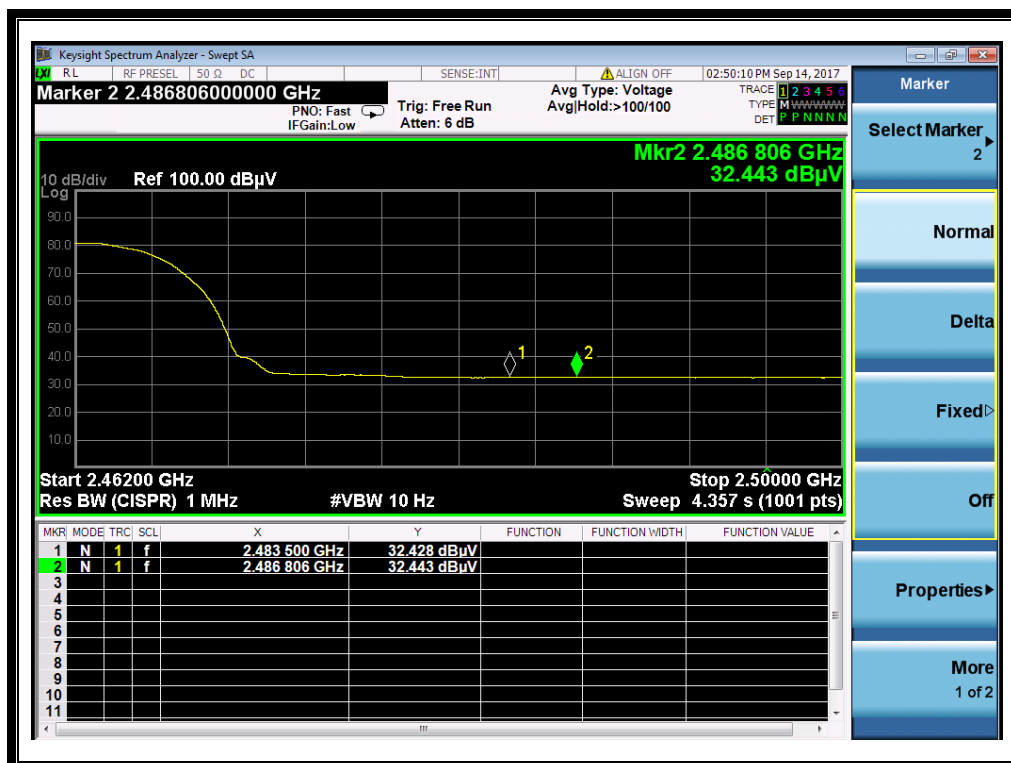
(Plot A1: Channel = 1 PEAK @ 802.11b)



(Plot A2: Channel = 1 AVG @ 802.11b)



(Plot B1: Channel = 11 PEAK @ 802.11b)



(Plot B2: Channel = 11 AVG @ 802.11b)



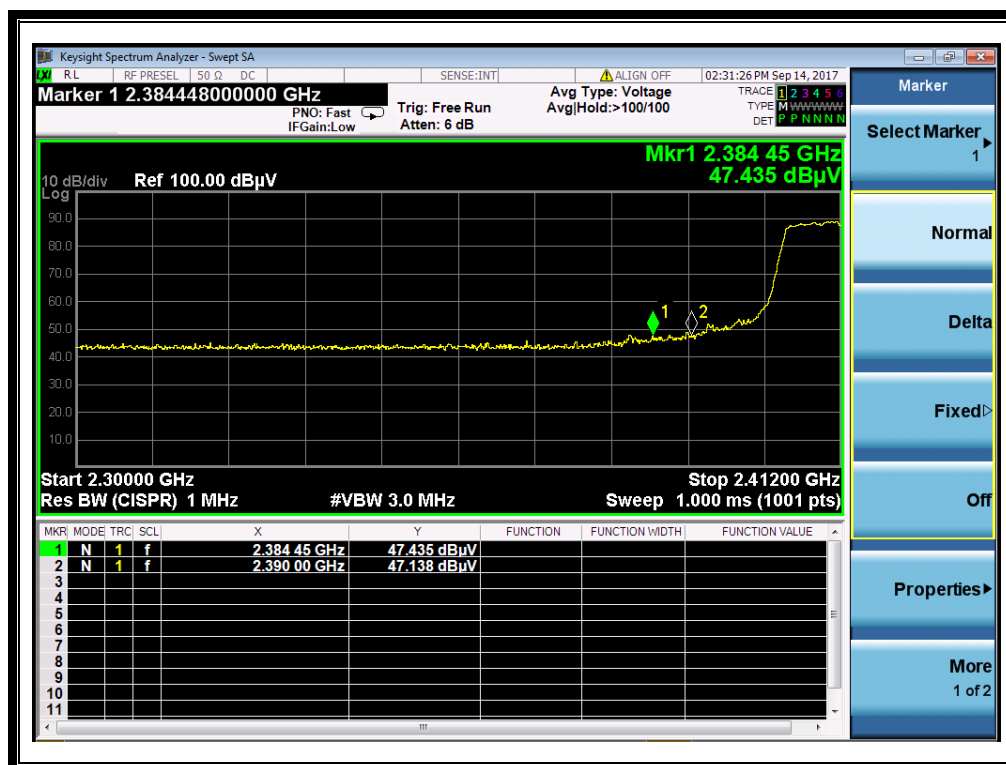
### 2.6.3.2 802.11g Test mode

The lowest and highest channels are tested to verify the band edge emissions.

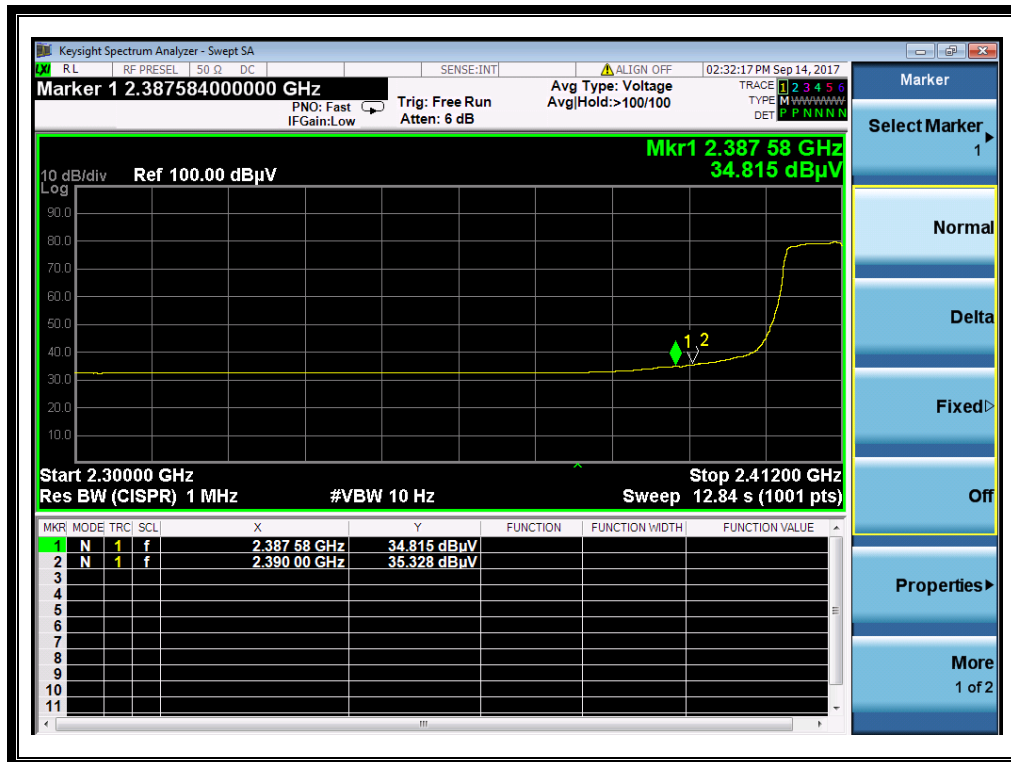
#### A. Test Verdict:

Channel	Frequency (MHz)	Detector	Receiver Reading $U_R$ (dBuV)	$A_T$ (dB)	$A_{Factor}$ (dB@3m)	Max. Emission $E$ (dBuV/m)	Limit (dBuV/m)	Verdict
		PK/ AV						
1	2384.45	PK	47.44	-33.63	32.56	46.37	74	Pass
1	2387.58	AV	34.82	-33.63	32.56	33.75	54	Pass
11	2484.60	PK	46.06	-33.18	32.5	45.38	74	Pass
11	2484.34	AV	33.88	-33.18	32.5	33.20	54	Pass

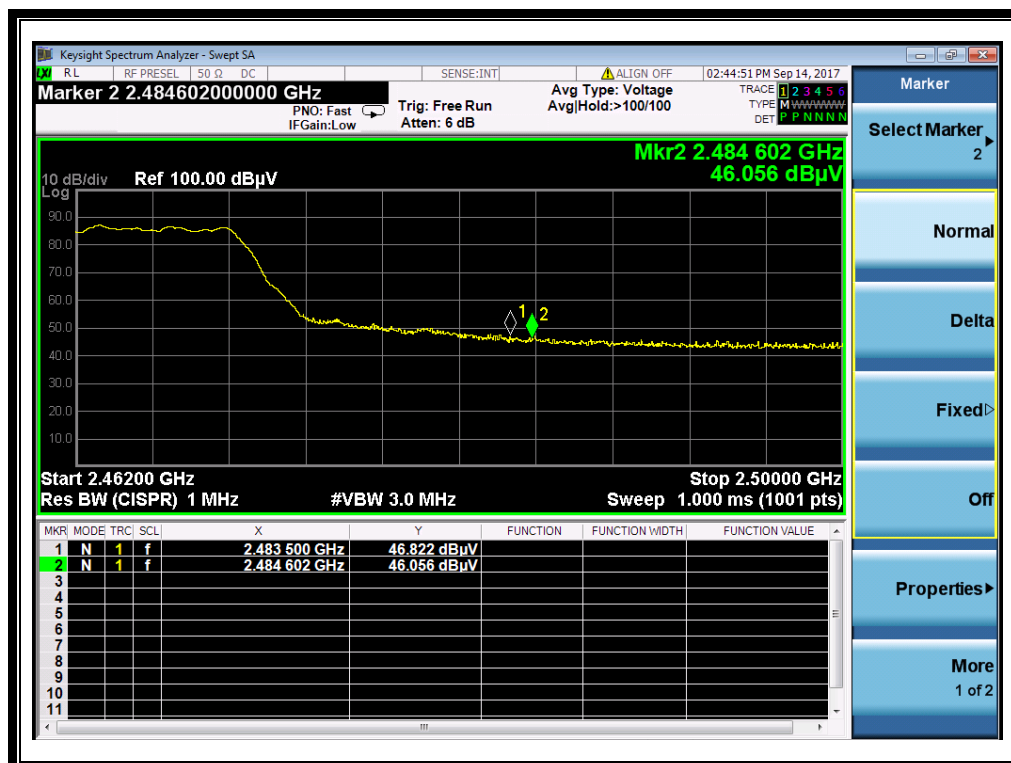
#### B. Test Plots:



(Plot C1: Channel = 1 PEAK @ 802.11g)



(Plot C2: Channel = 1 AVG @ 802.11g)



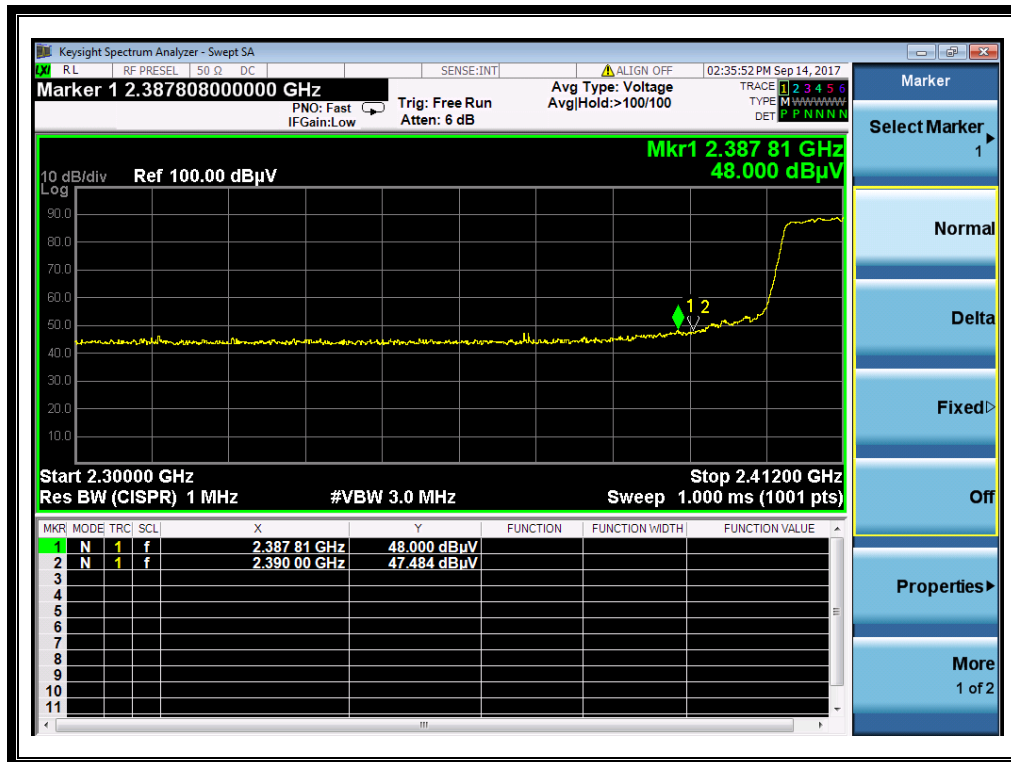
(Plot D1: Channel = 11 PEAK @ 802.11g)



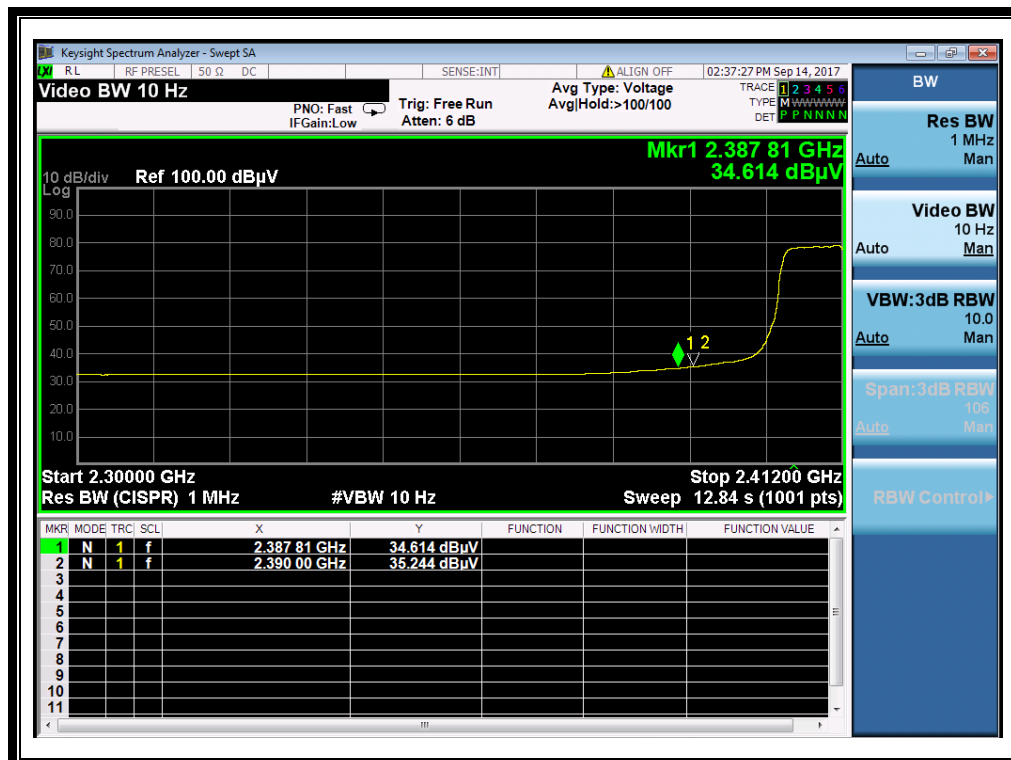




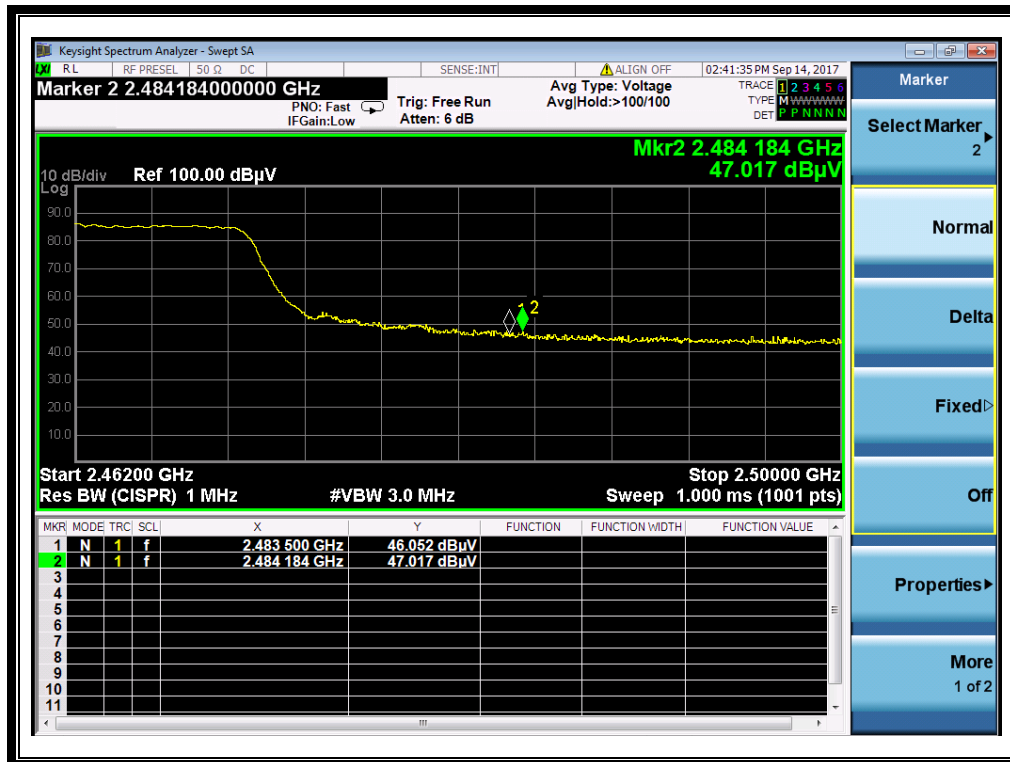
## B. Test Plots:



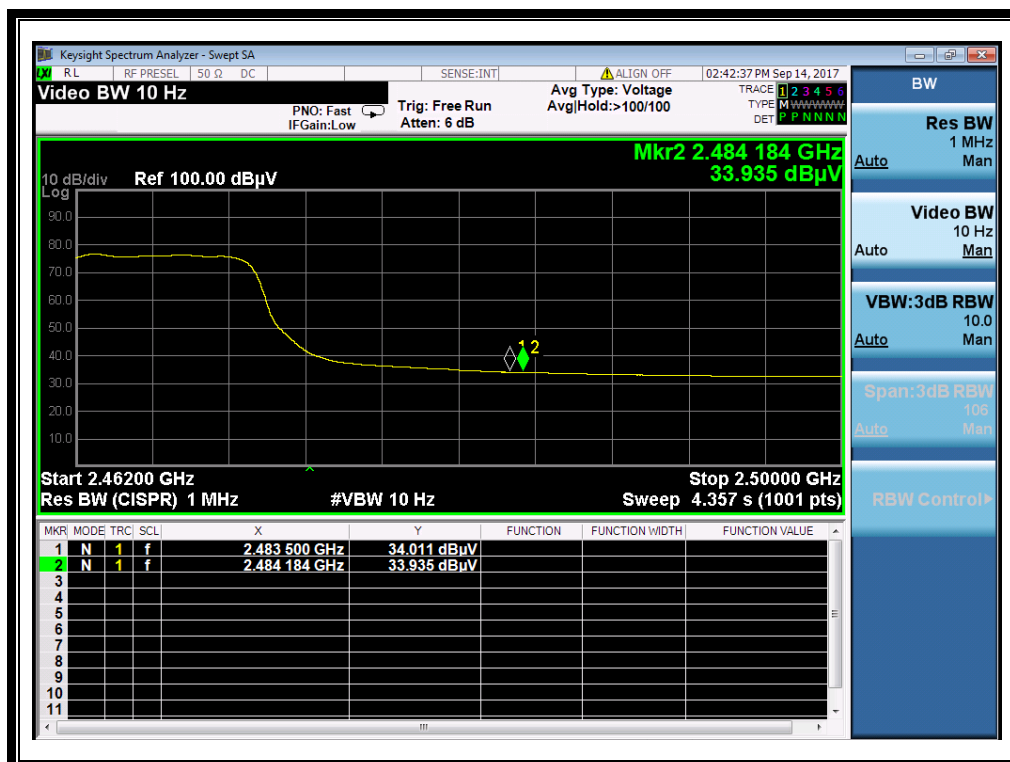
(Plot E1: Channel = 1 PEAK @ 802.11n-20)



(Plot E2: Channel = 1 AVG @ 802.11n-20)



(Plot F1: Channel = 11 PEAK @ 802.11n-20)



(Plot F2: Channel = 11 AVG @ 802.11n-20)

## 2.7 Conducted Emission

### 2.7.1 Requirement

According to FCC section 15.207, for an intentional radiator that 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 within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 $\Omega$  line impedance stabilization network (LISN).

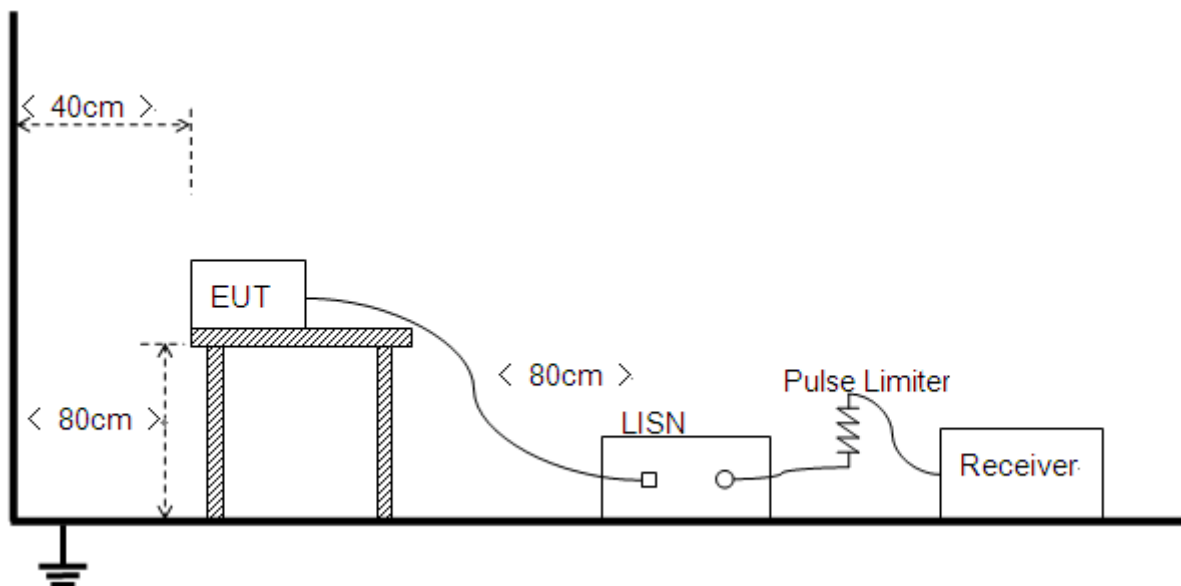
Frequency range (MHz)	Conducted Limit (dB $\mu$ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

#### NOTE:

- The lower limit shall apply at the band edges.
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50MHz.

### 2.7.2 Test Description

#### A. Test Setup:



The Table-top EUT was placed upon a non-metallic table 0.8m above the horizontal metal reference ground plane. EUT was connected to LISN and LISN was connected to reference Ground Plane. EUT was 80cm from LISN. The set-up and test methods were according to ANSI C63.10 2013.

## B. Equipments List:

Please reference ANNEX A(1.5).

### 2.1.1 Test Result

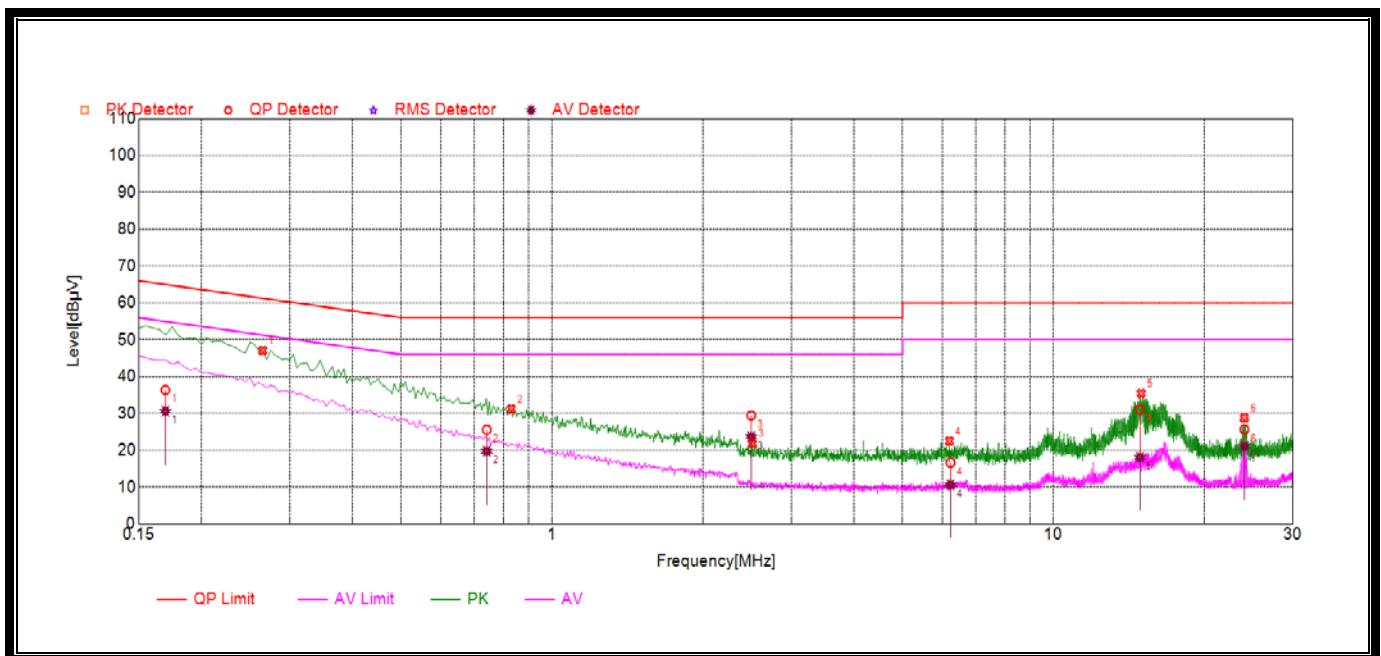
The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

#### A. Test setup:

The EUT configuration of the emission tests is EUT + Link.

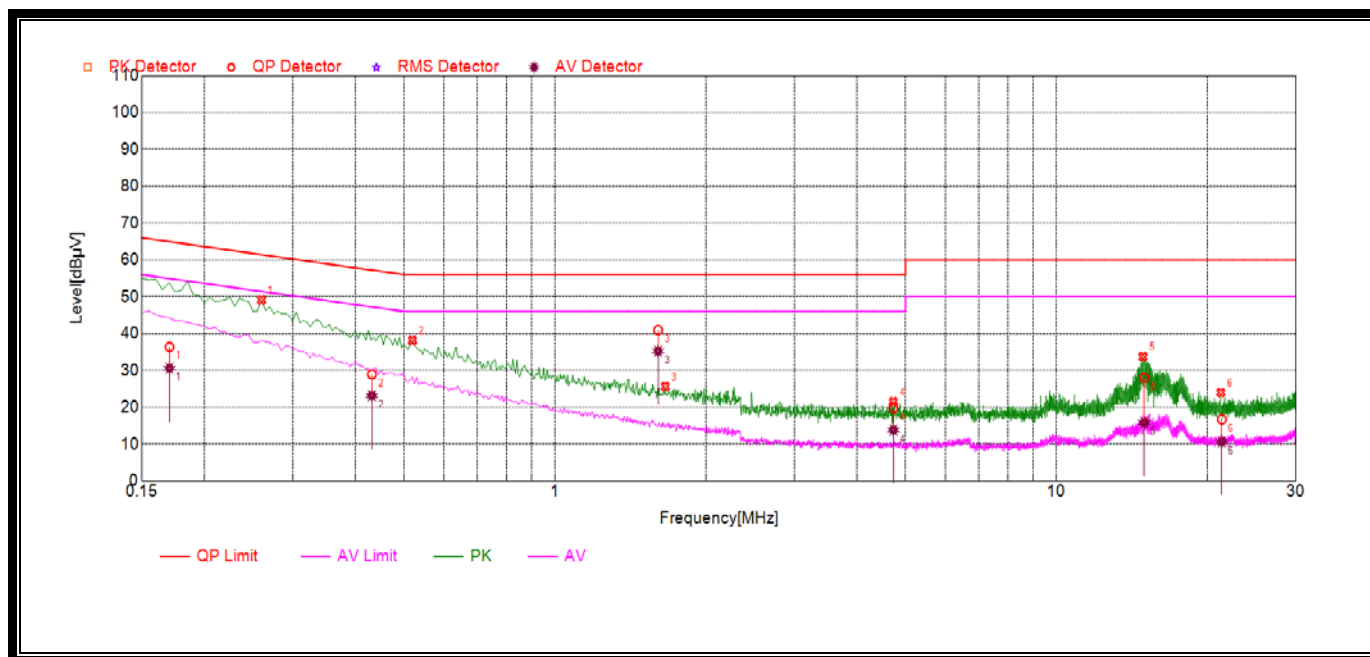
**Note:** The test voltage is AC 120V/60Hz.

#### B. Test Plots:



(Plot A: L Phase)

NO.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1696	36.35	30.57	64.98	54.98	Line	PASS
2	0.7414	25.58	19.76	56.00	46.00		PASS
3	2.4968	29.43	23.69	56.00	46.00		PASS
4	6.2334	16.65	10.62	60.00	50.00		PASS
5	14.877	31.08	18.10	60.00	50.00		PASS
6	24.0358	25.65	21.07	60.00	50.00		PASS



(Plot B: N Phase)

NO.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1704	36.37	30.56	64.94	54.94	Line	PASS
2	0.4316	28.93	23.14	57.22	47.22		PASS
3	1.6058	40.96	35.25	56.00	46.00		PASS
4	4.7326	19.82	13.83	56.00	46.00		PASS
5	14.9698	28.00	15.86	60.00	50.00		PASS
6	21.3744	16.71	10.61	60.00	50.00		PASS



## 2.8 Radiated Emission

### 2.8.1 Requirement

According to FCC section 15.247(d), radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
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

Note:

For Above 1000MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.

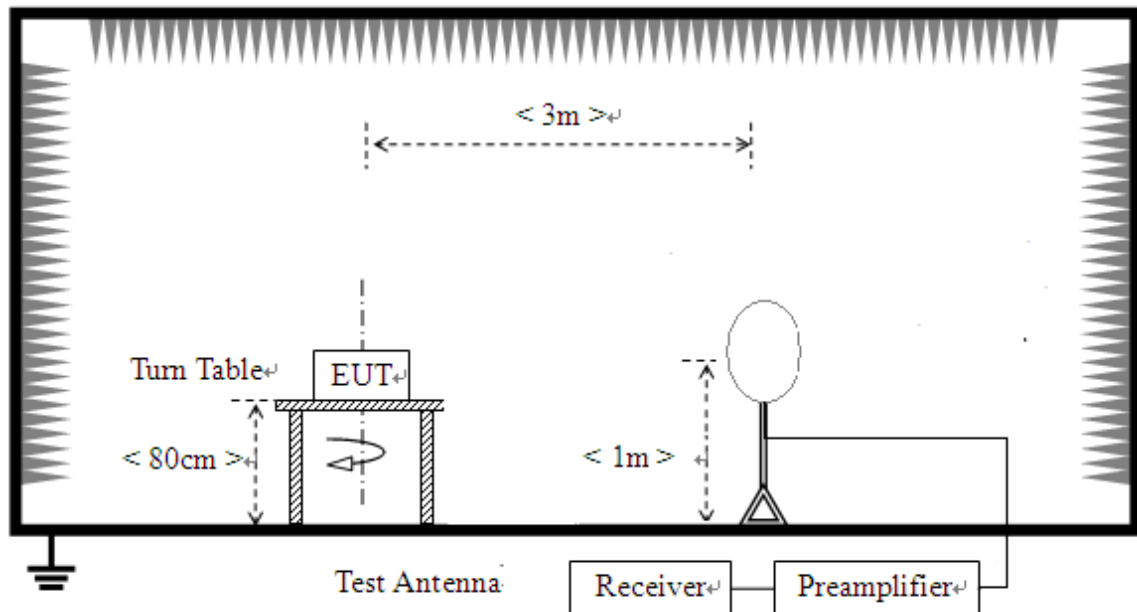
For above 1000MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK)

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), also should comply with the radiated emission limits specified in Section 15.209(a)(above table)

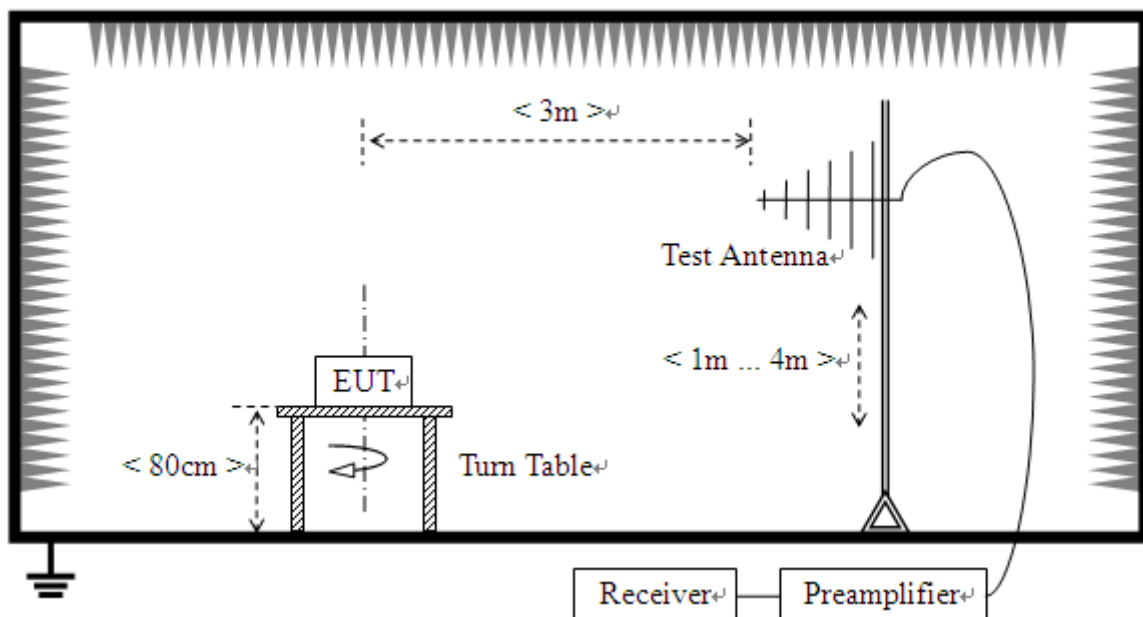
## 2.8.2 Test Description

### A. Test Setup:

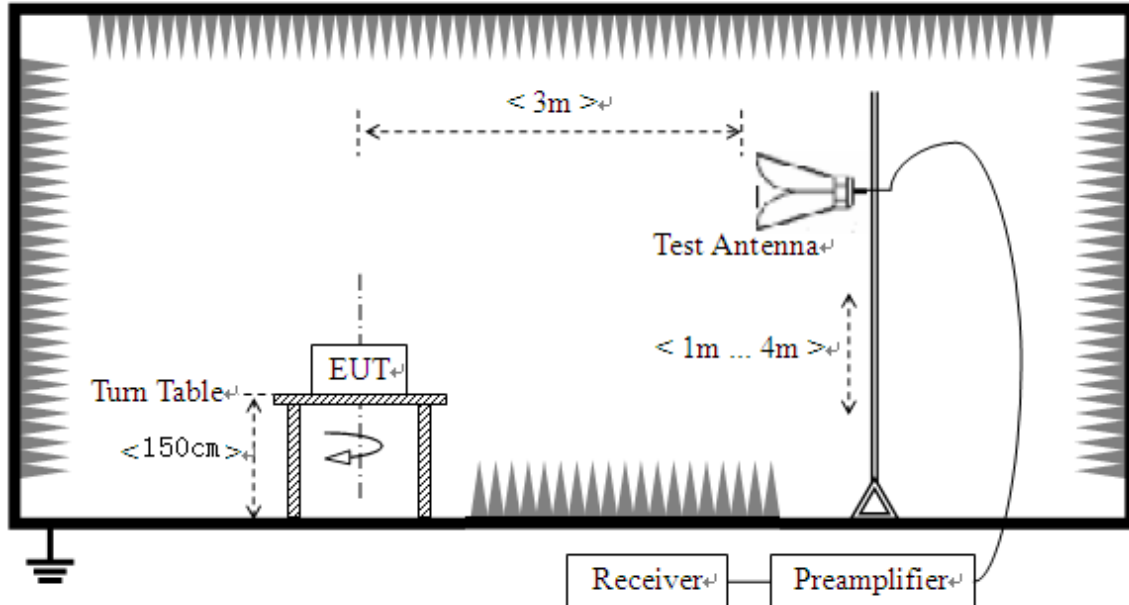
- 1) For radiated emissions from 9kHz to 30MHz



- 2) For radiated emissions from 30MHz to 1GHz



### 3) For radiated emissions above 1GHz



The RF absorbing material used on the reference ground plane and on the turntable have a maximum height (thickness) of 30 cm (12 in) and have a minimum-rated attenuation of 20 dB at all frequencies from 1 GHz to 18 GHz. Test site have a minimum area of the ground plane covered with RF absorbing material as specified in Figure 6 of ANSI C63.4: 2014.

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4dB according to the standards: ANSI C63.10 (2013). For radiated emissions below or equal to 1GHz, The EUT was set-up on insulator 80cm above the Ground Plane, For radiated emissions above 1GHz, The EUT was set-up on insulator 150cm above the Ground Plane. The set-up and test methods were according to ANSI C63.10

For the radiated emission test above 1GHz:

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of





the site as factors are calculated to correct the reading

For the Test Antenna:

(a) In the frequency range of 9kHz to 30MHz, magnetic field is measured with Loop Test Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.

(b) In the frequency range above 30MHz, Bi-Log Test Antenna (30MHz to 1GHz) and Horn Test Antenna (above 1GHz) are used. Place the test antenna at 3m away from area of the EUT, while keeping the test antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The test antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final test antenna elevation shall be that which maximizes the emissions. The test antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. The emission levels at both horizontal and vertical polarizations should be tested.

## B. Equipments List:

Please reference ANNEX A(1.5).

### 2.8.3 Test Result

According to ANSI C63.10, because of peak detection will yield amplitudes equal to or greater than amplitudes measured with the quasi-peak (or average) detector, the measurement data from a spectrum analyzer peak detector will represent the worst-case results, if the peak measured value complies with the quasi-peak limit, it is unnecessary to perform an quasi-peak measurement.

The measurement results are obtained as below:

$$E [\text{dB}\mu\text{V/m}] = U_R + A_T + A_{\text{Factor}} [\text{dB}]; A_T = L_{\text{Cable loss}} [\text{dB}] - G_{\text{preamp}} [\text{dB}]$$

$A_T$ : Total correction Factor except Antenna

$U_R$ : Receiver Reading

$G_{\text{preamp}}$ : Preamplifier Gain

$A_{\text{Factor}}$ : Antenna Factor at 3m

During the test, the total correction Factor  $A_T$  and  $A_{\text{Factor}}$  were built in test software.

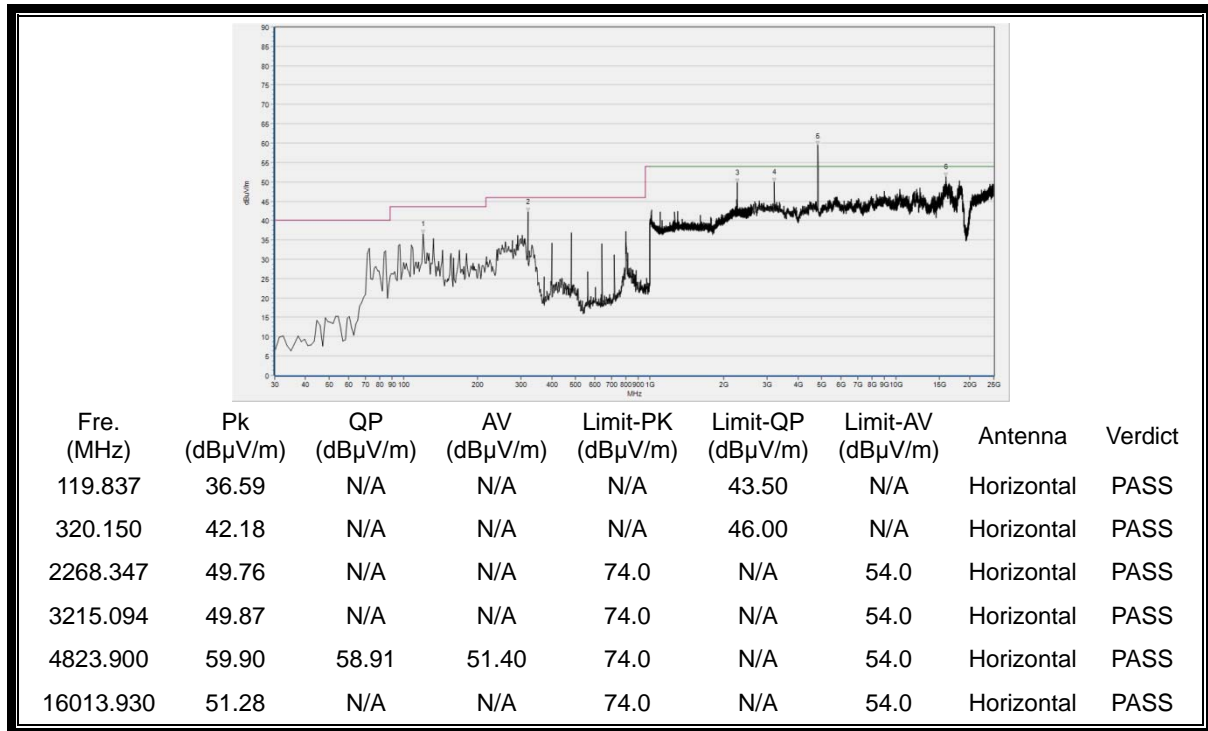
The low frequency, which started from 9KHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.



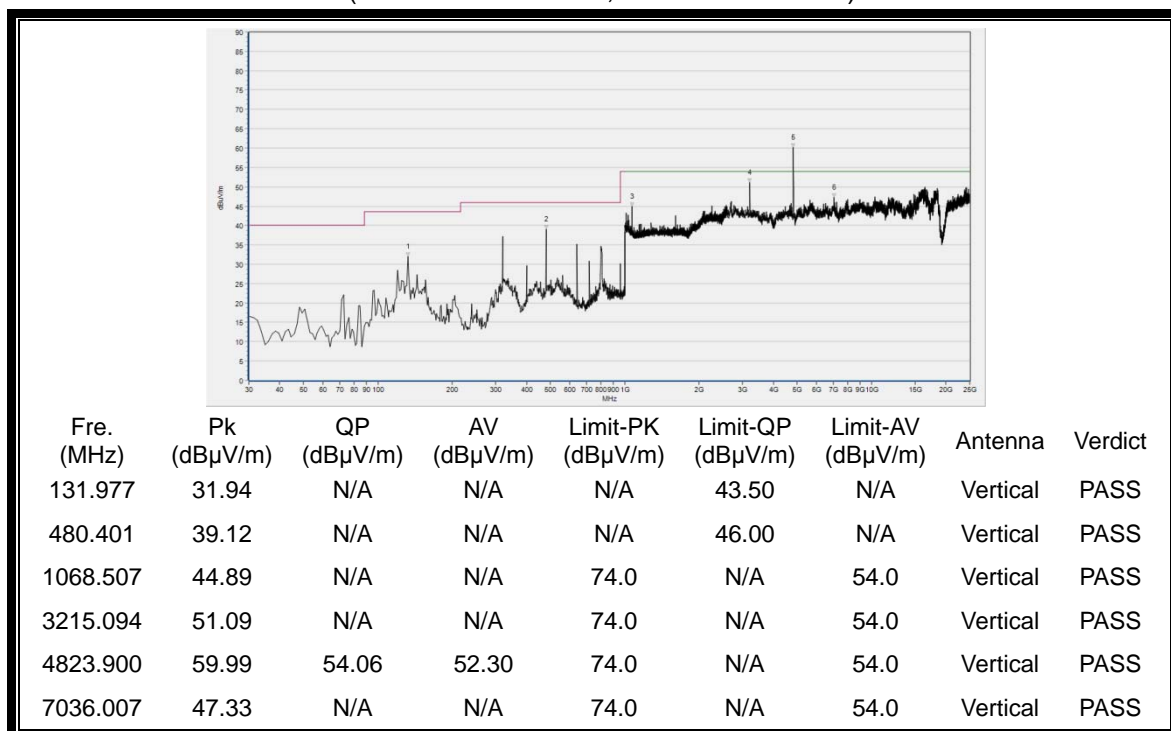
### 2.8.3.1 802.11b Test mode

#### A. Test Plots for the Whole Measurement Frequency Range:

Plots for Channel = 1



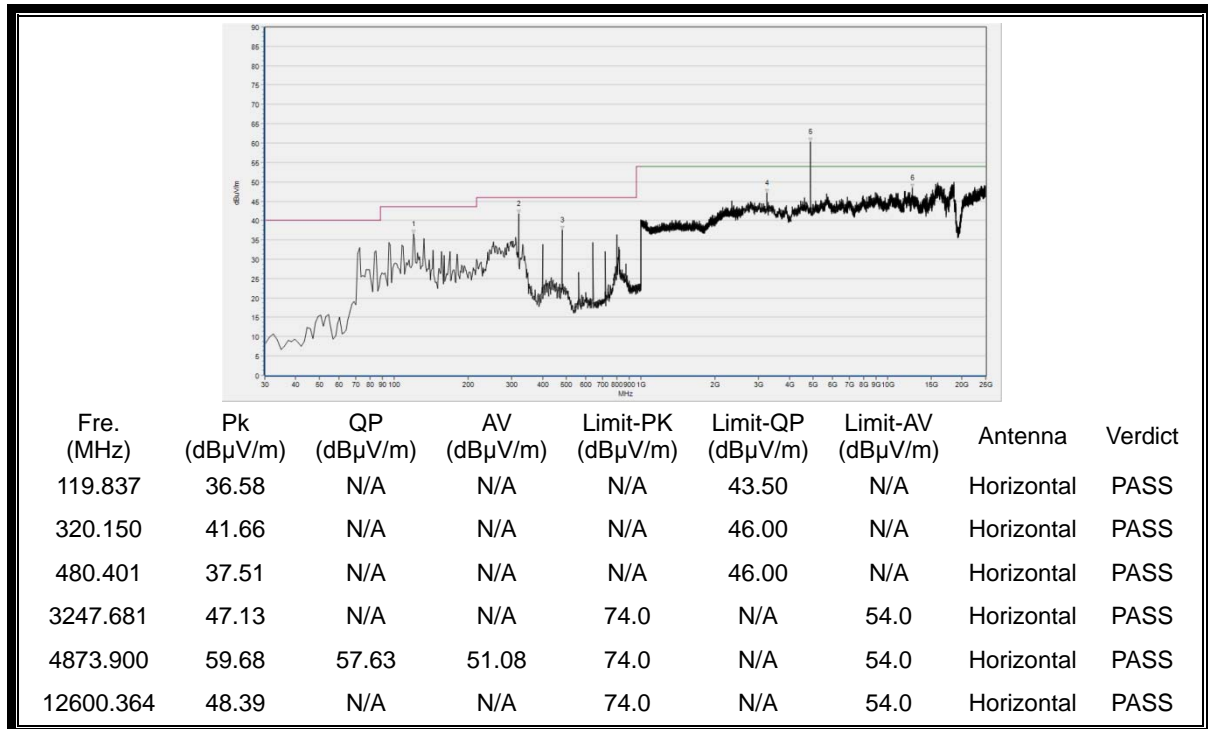
(Antenna Horizontal, 30MHz to 25GHz)



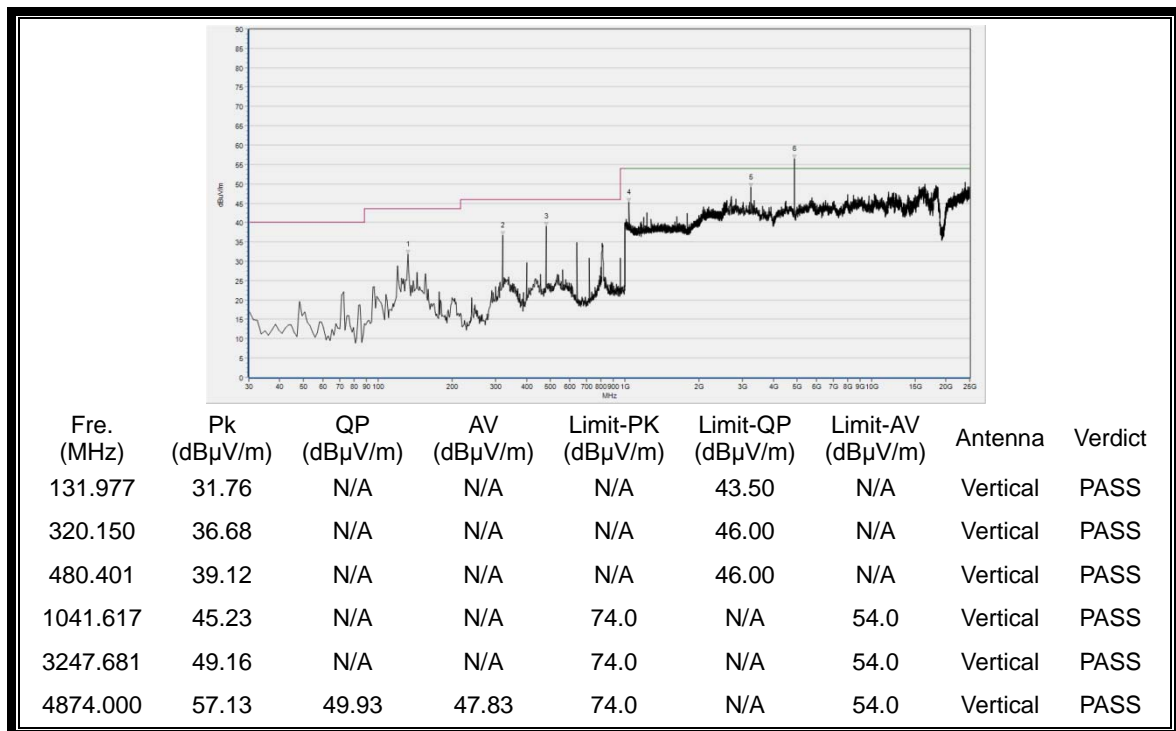
(Antenna Vertical, 30MHz to 25GHz)



Plot for Channel = 6



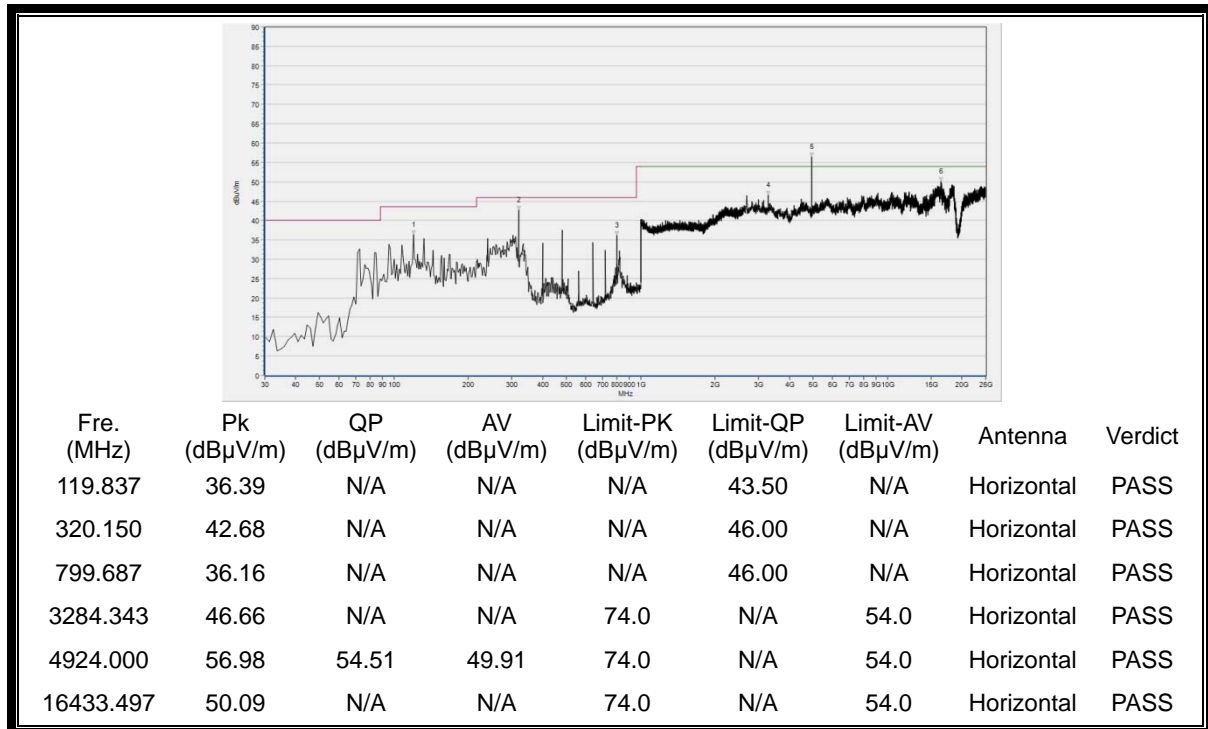
(Antenna Horizontal, 30MHz to 25GHz)



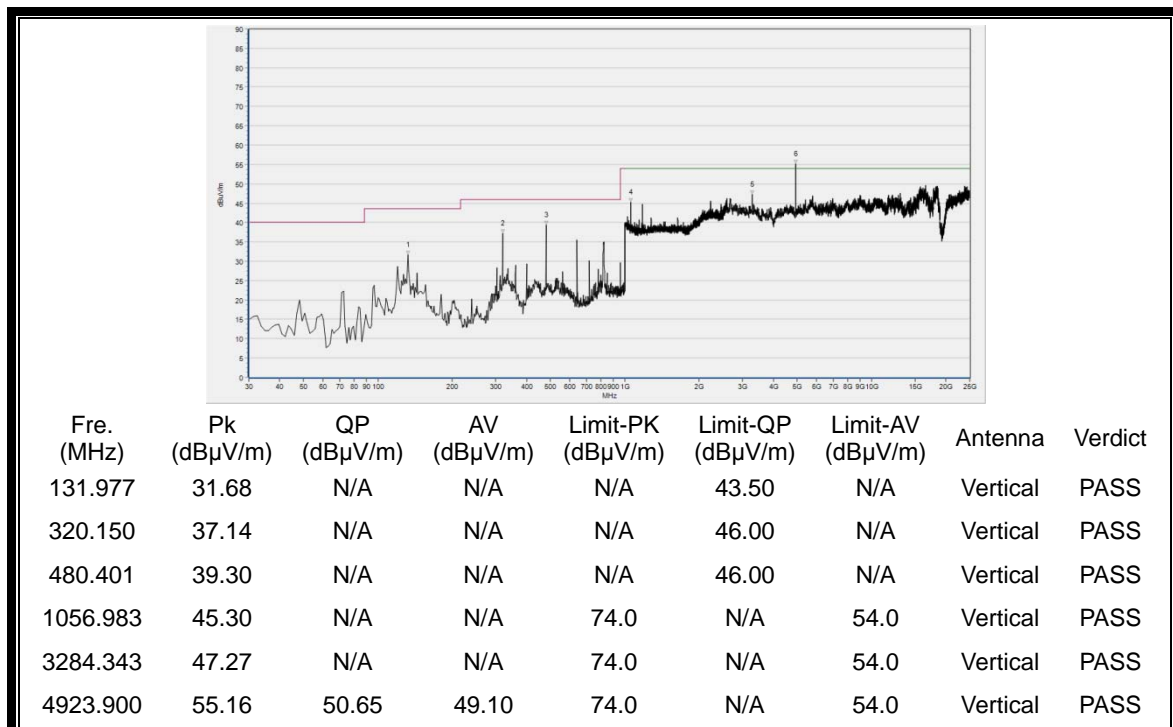
(Antenna Vertical, 30MHz to 25GHz)



Plot for Channel = 11



(Antenna Horizontal, 30MHz to 25GHz)



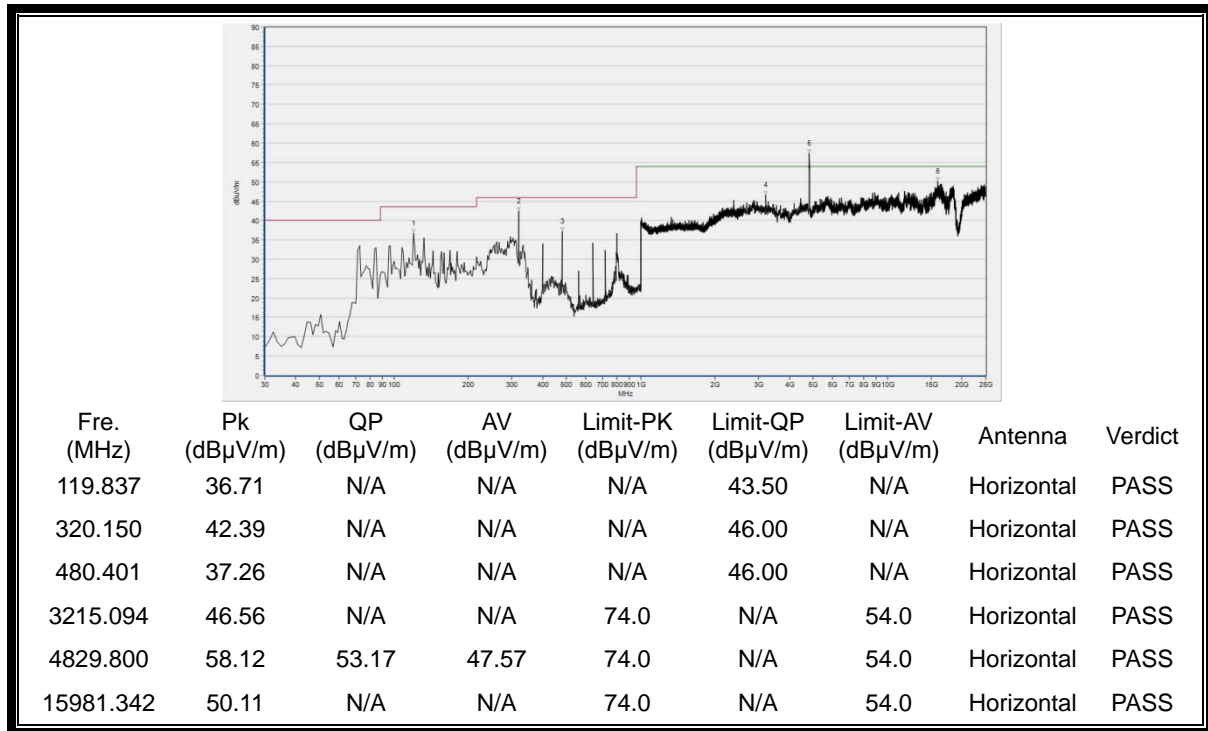
(Antenna Vertical, 30MHz to 25GHz)



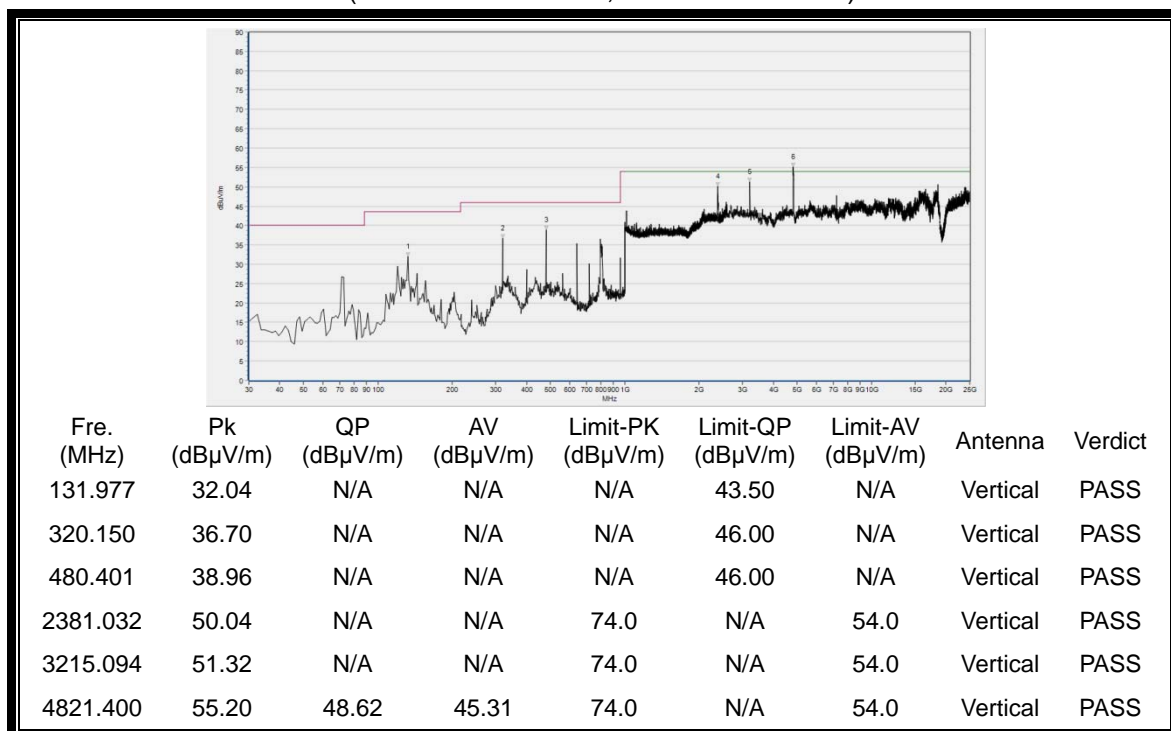
### 2.8.3.2 802.11g Test mode

#### B. Test Plots for the Whole Measurement Frequency Range:

Plots for Channel = 1



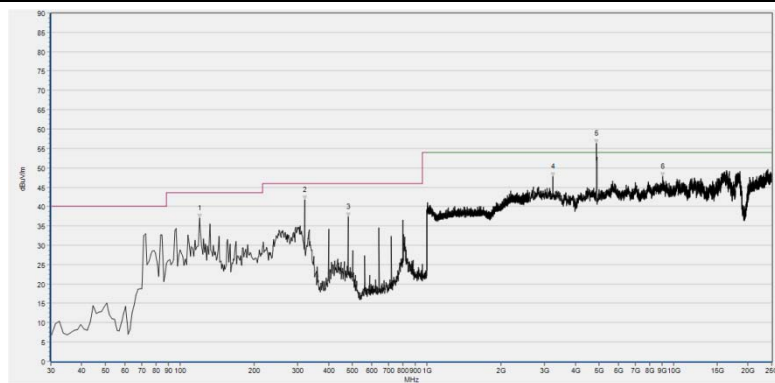
(Antenna Horizontal, 30MHz to 25GHz)



(Antenna Vertical, 30MHz to 25GHz)

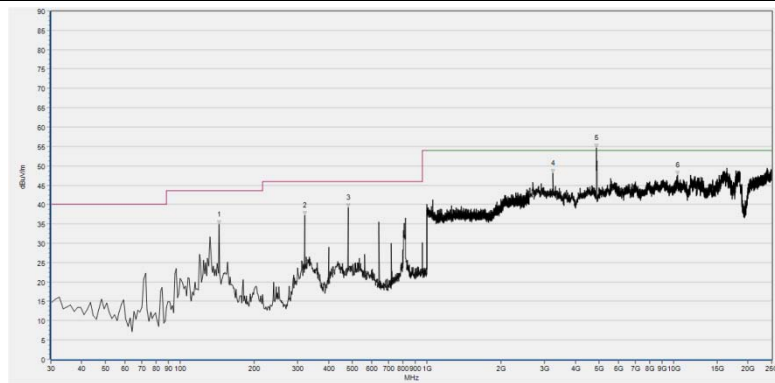


## Plot for Channel = 6



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
119.837	36.99	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
320.150	41.72	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
480.401	37.32	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
3247.681	47.80	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS
4871.500	57.58	50.13	47.65	74.0	N/A	54.0	Horizontal	PASS
9048.300	47.72	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 25GHz)

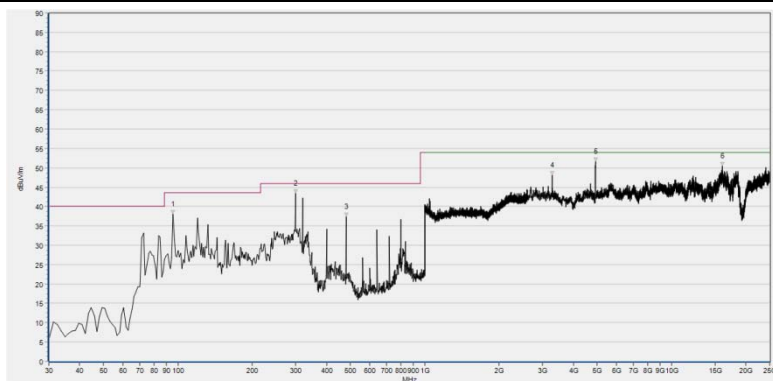


Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
144.118	34.78	N/A	N/A	N/A	43.50	N/A	Vertical	PASS
320.150	37.19	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
480.401	39.19	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
3247.681	48.04	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
4874.200	54.25	49.80	48.55	74.0	N/A	54.0	Vertical	PASS
10372.177	47.61	N/A	N/A	74.0	N/A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 25GHz)

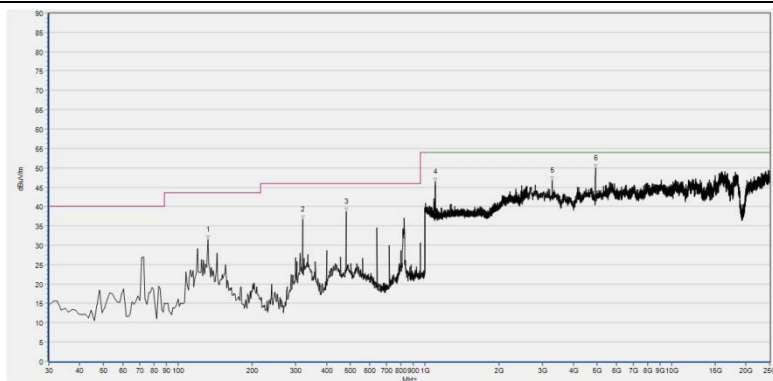


## Plot for Channel = 11



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
95.557	37.96	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
299.512	43.42	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
480.401	37.33	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
3284.343	48.02	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS
4921.200	52.83	47.75	41.90	74.0	N/A	54.0	Horizontal	PASS
16026.150	50.49	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 25GHz)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
131.977	31.56	N/A	N/A	N/A	43.50	N/A	Vertical	PASS
320.150	36.67	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
480.401	38.72	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
1101.160	46.42	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
3284.343	46.79	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
4921.500	50.53	49.77	42.09	74.0	N/A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 25GHz)

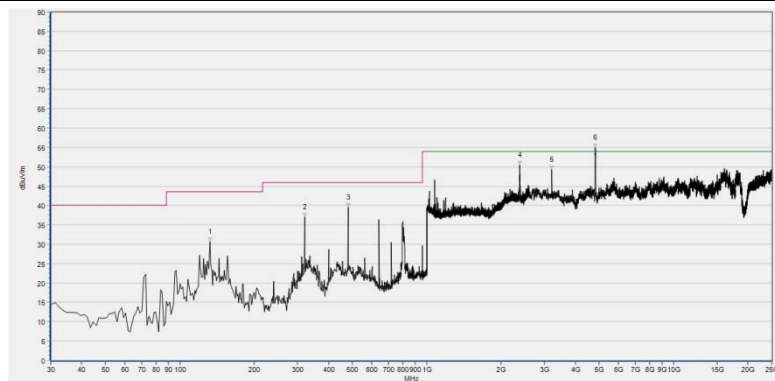
**2.8.3.3 802.11n-20MHz Test mode****C. Test Plots for the Whole Measurement Frequency Range:**

Plots for Channel = 1



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
119.837	36.82	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
320.150	42.55	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
480.401	37.48	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
3215.094	47.36	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS
4818.400	57.97	53.19	45.71	74.0	N/A	54.0	Horizontal	PASS
12197.090	48.11	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 25GHz)



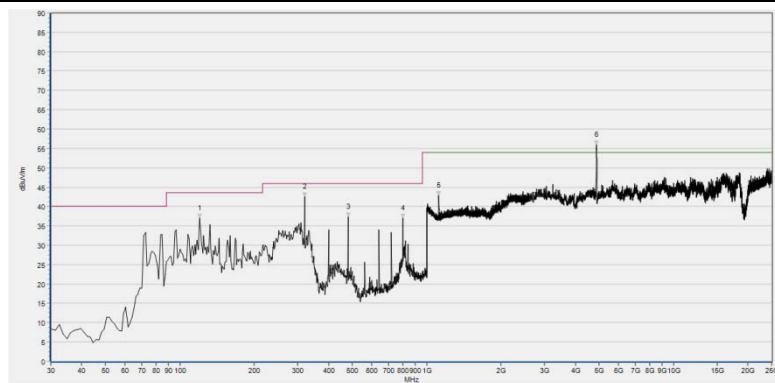
Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
131.977	30.67	N/A	N/A	N/A	43.50	N/A	Vertical	PASS
320.150	36.96	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
480.401	39.52	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
2379.112	50.39	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
3215.094	49.32	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
4823.200	55.12	49.09	48.54	74.0	N/A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 25GHz)



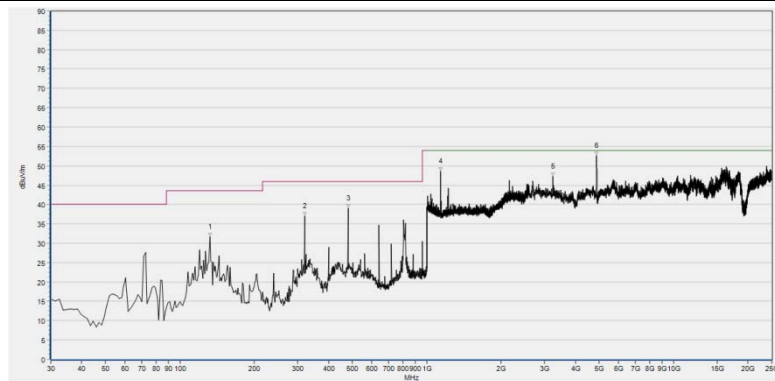


Plot for Channel = 6



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
119.837	37.03	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
320.150	42.57	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
480.401	37.38	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
799.687	37.07	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
1119.728	42.84	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS
4873.100	55.05	48.89	42.51	74.0	N/A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 25GHz)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
131.977	31.64	N/A	N/A	N/A	43.50	N/A	Vertical	PASS
320.150	37.00	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
480.401	39.10	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
1135.734	48.60	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
3247.681	47.27	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
4873.400	53.59	50.70	42.46	74.0	N/A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 25GHz)

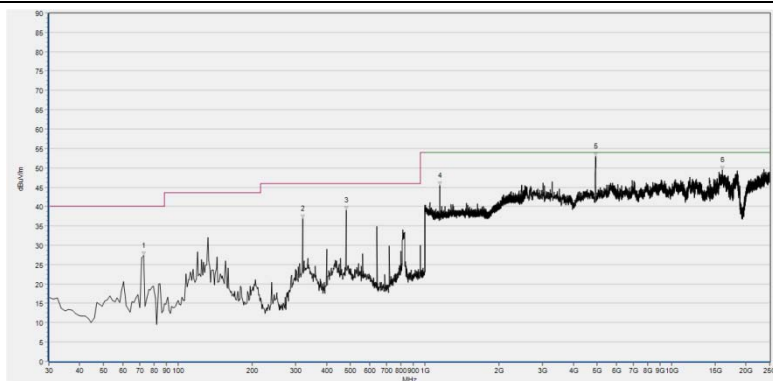


Plot for Channel = 11



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
119.837	36.97	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
320.150	43.12	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
480.401	37.37	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
3284.343	47.54	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS
4923.400	54.61	49.86	47.64	74.0	N/A	54.0	Horizontal	PASS
10302.928	47.53	N/A	N/A	74.0	N/A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 25GHz)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
72.491	27.39	N/A	N/A	N/A	40.00	N/A	Vertical	PASS
320.150	36.79	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
480.401	39.12	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
1152.381	45.37	N/A	N/A	74.0	N/A	54.0	Vertical	PASS
4925.500	53.28	49.49	47.95	74.0	N/A	54.0	Vertical	PASS
16026.150	49.42	N/A	N/A	74.0	N/A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 25GHz)



## ANNEX A GENERAL INFORMATION

### 1.1 Identification of the Responsible Testing Laboratory

Company Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Department:	Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Responsible Test Lab Manager:	Mr. Su Feng
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

### 1.2 Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

### 1.3 Facilities and Accreditations

Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L3572.

All measurement facilities used to collect the measurement data are located at FL.3, Building A, FeiYang Science Park, Block 67, BaoAn District, Shenzhen, 518101 P. R. China. The test site is constructed in conformance with the requirements of ANSI C63.10-2013 and CISPR Publication 22; the FCC designation number is CN1192.

### 1.4 Maximum measurement uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for test performed on the EUT as specified in CISPR 16-1-2:

Test items	Uncertainty
Peak Output Power	$\pm 2.22\text{dB}$
Power spectral density (PSD)	$\pm 2.22\text{dB}$
Bandwidth	$\pm 5\%$
Conducted Spurious Emission	$\pm 2.77\text{ dB}$
Restricted Frequency Bands	$\pm 5\%$
Radiated Emission	$\pm 2.95\text{dB}$
Conducted Emission	$\pm 2.44\text{dB}$



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This uncertainty represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$

## 1.5 Test Equipments Utilized

### 1.5.1 Conducted Test Equipments

Conducted Test Equipment						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
1	Spectrum Analyzer	MY45101810	E4407B	Agilent	2017.05.24	2018.05.23
2	Power Splitter	NW521	1506A	Weinschel	2017.05.24	2018.05.23
3	Attenuator 1	(N/A.)	10dB	Resnet	2017.05.24	2018.05.23
4	Attenuator 2	(N/A.)	3dB	Resnet	2017.05.24	2018.05.23
5	EXA Signal Analyzer	MY53470836	N9010A	Agilent	2016.12.07	2017.12.06
6	RF cable (30MHz-26GHz)	CB01	RF01	Morlab	N/A	N/A
7	Coaxial cable	CB02	RF02	Morlab	N/A	N/A
8	SMA connector	CN01	RF03	HUBER-SUHNER	N/A	N/A

### 1.5.2 Conducted Emission Test Equipments

Conducted Emission Test Equipments						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
1	Receiver	US44210471	E7405A	Agilent	2017.05.24	2018.05.23
2	LISN	812744	NSLK 8127	Schwarzbeck	2017.05.24	2018.05.23
3	Service Supplier	100448	CMU200	R&S	2017.05.24	2018.05.23
4	Pulse Limiter (20dB)	9391	VTSD 9561-D	Schwarzbeck	2017.05.24	2018.05.23
5	Coaxial cable(BNC) (30MHz-26GHz)	CB01	EMC01	Morlab	N/A	N/A

### 1.5.3 Auxiliary Test Equipment

Auxiliary Test Equipment						
No.	Equipment Name	Model No.	Brand Name	Manufacturer	Cal.Date	Cal.Due Date
1	Computer	T430i	Think Pad	Lenovo	N/A	N/A



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**1.5.4 Radiated Test Equipments**

Radiated Test Equipments						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal.Due Date
1	System Simulator	GB45360846	8960-E5515C	Agilent	2017.05.17	2018.05.16
2	Receiver	MY54130016	N9038A	Agilent	2017.05.17	2018.05.16
3	Test Antenna - Bi-Log	N/A	VULB9163	Schwarzbeck	2016.12.09	2017.12.08
4	Test Antenna - Horn	9170C-531	BBHA9170	Schwarzbeck	2017.03.30	2018.03.29
5	Test Antenna - Loop	1519-022	FMZB1519	Schwarzbeck	2017.03.30	2018.03.29
6	Test Antenna - Horn	71688	BBHA 9120D	Schwarzbeck	2017.03.30	2018.03.29
7	Coaxial cable (N male) (9KHz-30MHz)	CB04	EMC04	Morlab	N/A	N/A
8	Coaxial cable (N male) (30MHz-26GHz)	CB02	EMC02	Morlab	N/A	N/A
9	Coaxial cable(N male) (30MHz-26GHz)	CB03	EMC03	Morlab	N/A	N/A
10	1-18GHz pre-Amplifier	MA02	TS-PR18	Rohde& Schwarz	2017.05.17	2018.05.16
11	18-26.5GHz pre-Amplifier	MA03	TS-PR18	Rohde& Schwarz	2017.05.17	2018.05.16

**1.5.5 Climate Chamber**

Climate Chamber						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Climate Chamber	2004012	HL4003T	Yinhe	2017.01.11	2018.01.10

**1.5.6 Vibration Table**

Vibration Table						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Vibration Table	N/A	ACT2000-S015L	CMI-COM	2017.01.11	2018.01.10

**1.5.7 Anechoic Chamber**

Anechoic Chamber						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Anechoic Chamber	N/A	9m*6m*6m	Changning	2017.01.11	2018.01.10

\*\*\*\*\* END OF REPORT \*\*\*\*\*