

# FCC REPORT (WIFI)

**Applicant:** Neutron Holdings, Inc.

**Address of Applicant:** 85 2nd St, San Francisco, CA 94105 USA

## Equipment Under Test (EUT)

**Product Name:** Central controller

**Model No.:** Lime-4.0-US

**Trade mark:** Lime

**FCC ID:** 2APB2LIME-V4-US

**Applicable standards:** FCC CFR Title 47 Part 15 Subpart C Section 15.247

**Date of sample receipt:** 08 May, 2021

**Date of Test:** 08 May, to 04 Jun., 2021

**Date of report issued:** 04 Jun., 2021

**Test Result:** PASS\*

\* In the configuration tested, the EUT complied with the standards specified above.

Authorized Signature:



Bruce Zhang  
Laboratory Manager

This report details the results of the testing carried out on one sample. The results contained in this test report do not relate to other samples of the same product and does not permit the use of the JYT product certification mark. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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**2 Version**

Version No.	Date	Description
00	04 Jun., 2021	Original

**Tested by:***YT Yang***Test Engineer****Date:***04 Jun., 2021***Reviewed by:***Winner Zhang***Project Engineer****Date:***04 Jun., 2021*

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## 4 Test Summary

Test Items	Section in CFR 47	Test Data	Result
Antenna requirement	15.203 & 15.247 (b)	See Section 6.1	Pass
AC Power Line Conducted Emission	15.207	N/A	N/A
Duty Cycle	ANSI C63.10-2013	Appendix A – 2.4G Wi-Fi	Pass
Conducted Peak Output Power	15.247 (b)(3)	Appendix A – 2.4G Wi-Fi	Pass
6dB Emission Bandwidth 99% Occupied Bandwidth	15.247 (a)(2)	Appendix A – 2.4G Wi-Fi	Pass
Power Spectral Density	15.247 (e)	Appendix A – 2.4G Wi-Fi	Pass
Conducted Band Edge	15.247 (d)	Appendix A – 2.4G Wi-Fi	Pass
Radiated Band Edge		See Section 6.6.2	Pass
Conducted Spurious Emission	15.205 & 15.209	Appendix A – 2.4G Wi-Fi	Pass
Radiated Spurious Emission		See Section 6.7.2	Pass
<b>Remark:</b> 1. Pass: The EUT complies with the essential requirements in the standard. 2. N/A: Not Applicable. 3. The cable insertion loss used by “RF Output Power” and other conduction measurement items is 0.5dB (provided by the customer).			
<b>Test Method:</b>	ANSI C63.10-2013 KDB 558074 D01 15.247 Meas Guidance v05r02		

## 5 General Information

### 5.1 Client Information

Applicant:	Neutron Holdings, Inc.
Address:	85 2nd St, San Francisco, CA 94105 USA
Manufacturer:	Quectel Wireless Solutions Co., Ltd.
Address:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Factory:	MeiG Smart Technology Co., Ltd.
Address:	1/2/3F A, Building A, B, No.5 Lingxia Road, 4th Fenghuang Industrial Park, Fuyong Street, Baoan District, Shenzhen, Guangdong, China

### 5.2 General Description of E.U.T.

Product Name:	Central controller
Model No.:	Lime-4.0-US
Operation Frequency:	2412MHz~2462MHz: 802.11b/802.11g/802.11n(HT20) 2422MHz~2452MHz: 802.11n(HT40)
Channel numbers:	11: 802.11b/802.11g/802.11(HT20) 7: 802.11n(HT40)
Channel separation:	5MHz
Modulation technology: (IEEE 802.11b)	Direct Sequence Spread Spectrum (DSSS)
Modulation technology: (IEEE 802.11g/802.11n)	Orthogonal Frequency Division Multiplexing(OFDM)
Data speed (IEEE 802.11b):	1Mbps, 2Mbps, 5.5Mbps, 11Mbps
Data speed (IEEE 802.11g):	6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps
Data speed (IEEE 802.11n):	Up to 150Mbps
Antenna Type:	Internal Antenna
Antenna gain:	2.0dBi
Test Sample Condition:	The test samples were provided in good working order with no visible defects.

Operation Frequency each of channel for 802.11b/g/n(HT20)							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2412MHz	4	2427MHz	7	2442MHz	10	2457MHz
2	2417MHz	5	2432MHz	8	2447MHz	11	2462MHz
3	2422MHz	6	2437MHz	9	2452MHz		

Note:

- For 802.11n-HT40 mode, the channel number is from 3 to 9;
- Channel 1, 6 & 11 selected for 802.11b/g/n-HT20 as Lowest, Middle and Highest channel. Channel 3, 6 & 9 selected for 802.11n-HT40 as Lowest, Middle and Highest Channel.

### 5.3 Test environment and mode

Operating Environment:	
Temperature:	24.0 °C
Humidity:	54 % RH
Atmospheric Pressure:	1010 mbar
Test mode:	
Transmitting mode	Keep the EUT in continuous transmitting with modulation
<p>Radiated Emission: The sample was placed 0.8m (below 1GHz)/1.5m (above 1GHz) above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y &amp; Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. We have verified the construction and function in typical operation. All the test modes were carried out with the EUT in transmitting operation, which was shown in this test report and defined as follows:</p>	
Per-scan all kind of data rate, the follow list were the worst case.	
Mode	Data rate
802.11b	1Mbps
802.11g	6Mbps
802.11n(HT20)	6.5Mbps
802.11n(HT40)	13.5Mbps

### 5.4 Description of Support Units

The EUT has been tested as an independent unit.

### 5.5 Measurement Uncertainty

Parameters	Expanded Uncertainty
Conducted Emission (9kHz ~ 30MHz)	±1.60 dB (k=2)
Radiated Emission (9kHz ~ 30MHz)	±3.12 dB (k=2)
Radiated Emission (30MHz ~ 1000MHz)	±4.32 dB (k=2)
Radiated Emission (1GHz ~ 18GHz)	±5.16 dB (k=2)
Radiated Emission (18GHz ~ 40GHz)	±3.20 dB (k=2)

### 5.6 Laboratory Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **FCC - Designation No.: CN1211**  
JianYan Testing Group Shenzhen Co., Ltd. has been accredited as a testing laboratory by FCC(Federal Communications Commission). The test firm Registration No. is 727551.
- **ISED – CAB identifier.: CN0021**  
The 3m Semi-anechoic chamber of JianYan Testing Group Shenzhen Co., Ltd. has been Registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 10106A-1.
- **A2LA - Registration No.: 4346.01**  
This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. The test scope can be found as below link: <https://portal.a2la.org/scopepdf/4346-01.pdf>

### 5.7 Laboratory Location

JianYan Testing Group Shenzhen Co., Ltd.  
 Address: No.101, Building 8, Innovation Wisdom Port, No.155 Hongtian Road, Huangpu Community, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, People's Republic of China.  
 Tel: +86-755-23118282, Fax: +86-755-23116366  
 Email: info@ccis-cb.com, Website: <http://www.ccis-cb.com>

### 5.8 Test Instruments list

Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
3m SAC	ETS	9m*6m*6m	966	01-19-2021	01-18-2024
BiConiLog Antenna	SCHWARZBECK	VULB9163	497	03-03-2021	03-02-2022
Biconical Antenna	SCHWARZBECK	VUBA9117	359	06-18-2020	06-17-2021
Horn Antenna	SCHWARZBECK	BBHA9120D	916	03-03-2021	03-02-2022
Horn Antenna	SCHWARZBECK	BBHA9120D	1805	06-18-2020	06-17-2021
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170582	11-18-2020	11-17-2021
EMI Test Software	AUDIX	E3	Version: 6.110919b		
Pre-amplifier	HP	8447D	2944A09358	03-03-2021	03-02-2022
Pre-amplifier	CD	PAP-1G18	11804	03-03-2021	03-02-2022
Spectrum analyzer	Rohde & Schwarz	FSP30	101454	03-03-2021	03-02-2022
Spectrum analyzer	Rohde & Schwarz	FSP40	100363	11-18-2020	11-17-2021
EMI Test Receiver	Rohde & Schwarz	ESRP7	101070	03-03-2021	03-02-2022
Spectrum Analyzer	Agilent	N9020A	MY50510123	11-18-2020	11-17-2021
Signal Generator	Rohde & Schwarz	SMX	835454/016	03-03-2021	03-02-2022
Signal Generator	R&S	SMR20	1008100050	03-03-2021	03-02-2022
RF Switch Unit	MWRFTTEST	MW200	N/A	N/A	N/A
Test Software	MWRFTTEST	MTS8200	Version: 2.0.0.0		
Cable	ZDECL	Z108-NJ-NJ-81	1608458	03-03-2021	03-02-2022
Cable	MICRO-COAX	MFR64639	K10742-5	03-03-2021	03-02-2022
Cable	SUHNER	SUCOFLEX100	58193/4PE	03-03-2021	03-02-2022
DC Power Supply	XinNuoEr	WYK-10020K	1409050110020	09-25-2020	09-24-2021
Temperature Humidity Chamber	HengPu	HPGDS-500	20140828008	11-01-2020	10-31-2021
Simulated Station	Rohde & Schwarz	CMW500	140493	07-22-2020	07-21-2021

Conducted method:					
Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
Spectrum Analyzer	Keysight	N9010B	MY60240202	11-27-2020	11-26-2021
Vector Signal Generator	Keysight	N5182B	MY59101009	11-27-2020	11-26-2021
Analog Signal Generator	Keysight	N5173B	MY59100765	11-27-2020	11-26-2021
Power Detector Box	MWRF-test	MW100-PSB	MW201020JYT	11-27-2020	11-26-2021
Simulated Station	Rohde & Schwarz	CMW270	102335	11-27-2020	11-26-2021
RF Control Box	MWRF-test	MW100-RFCB	MW200927JYT	N/A	N/A
PDU	MWRF-test	XY-G10	N/A	N/A	N/A
Test Software	MWRF-tes	MTS 8310	Version: 2.0.0.0		
DC Power Supply	Keysight	E3642A	MY60296194	11-27-2020	11-26-2021

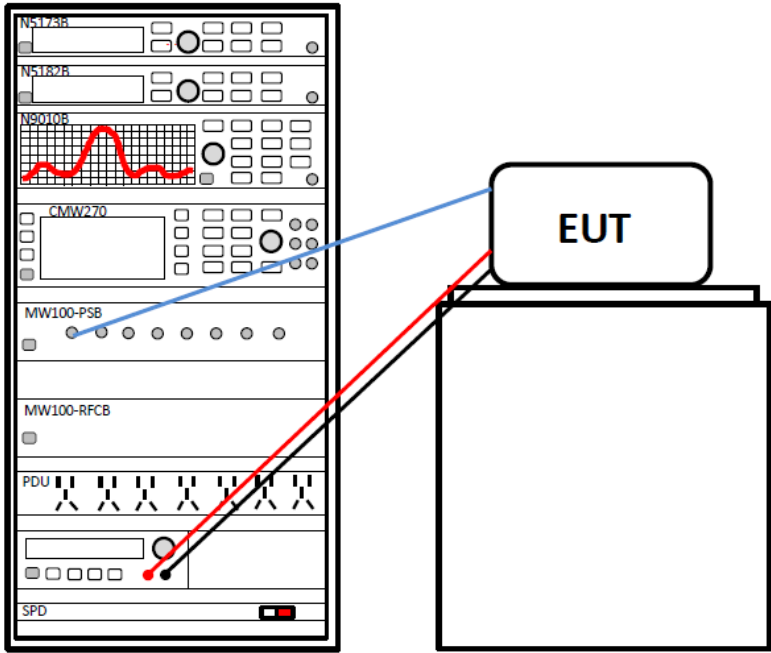
## 6 Test results and Measurement Data

### 6.1 Antenna requirement

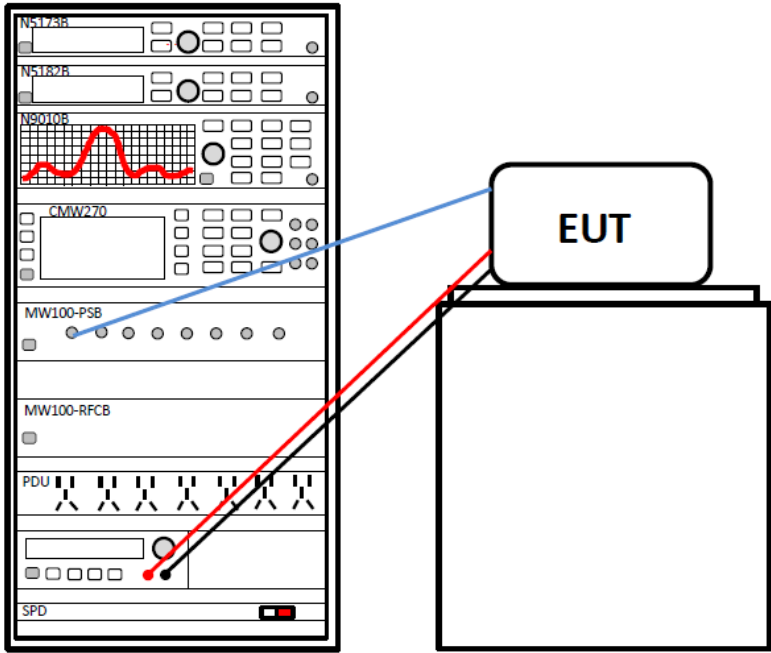
<b>Standard requirement:</b>	FCC Part 15 C Section 15.203 /247(b)
<p>15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.</p> <p>15.247(b) (4) requirement: (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.</p>	
<b>E.U.T Antenna:</b>	
<p>The Wi-Fi antenna is an Internal antenna which cannot replace by end-user, the best case gain of the antenna is 2.0 dBi.</p>	



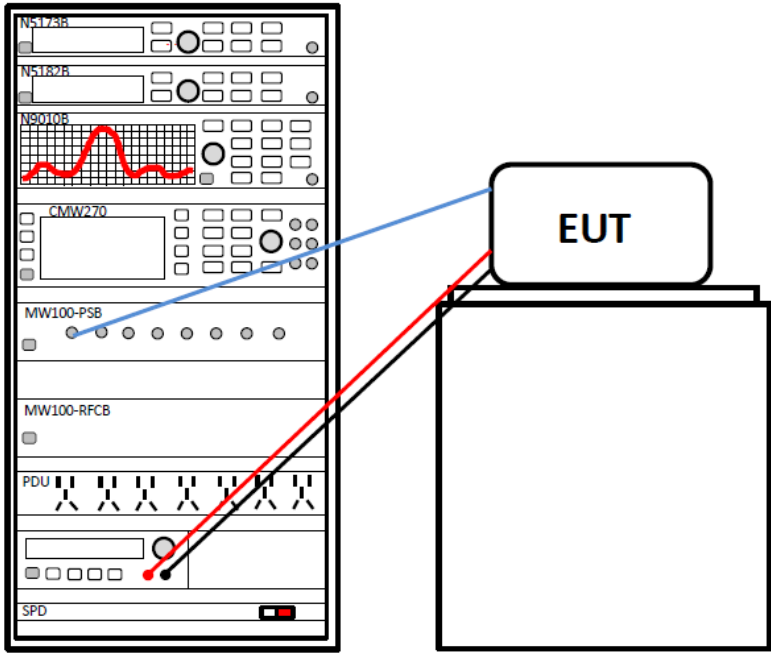
## 6.2 Conducted Output Power

Test Requirement:	FCC Part 15 C Section 15.247 (b)(3)
Limit:	30dBm
Test setup:	
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Measurement Data:	<b>Refer to Appendix A - 2.4G WIFI</b>

### 6.3 Occupy Bandwidth

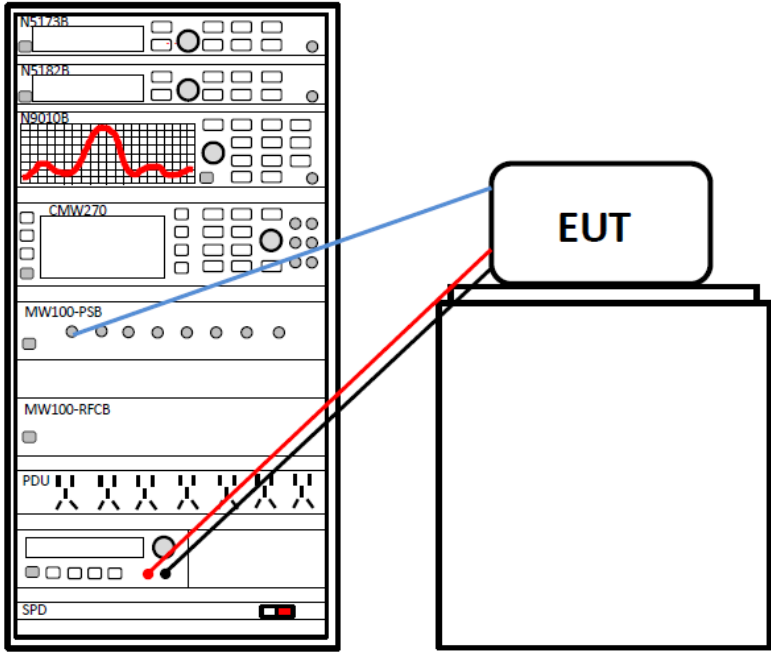
Test Requirement:	FCC Part 15 C Section 15.247 (a)(2)
Limit:	>500kHz
Test setup:	
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Measurement Data:	<b>Refer to Appendix A - 2.4G WIFI</b>

### 6.4 Power Spectral Density

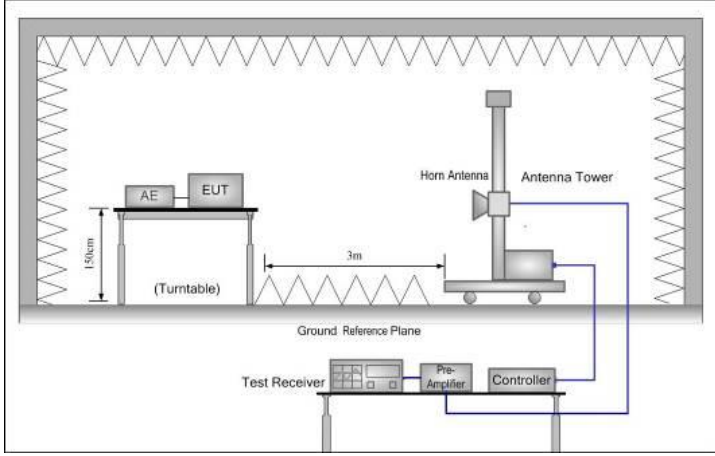
Test Requirement:	FCC Part 15 C Section 15.247 (e)
Limit:	8dBm/3kHz
Test setup:	
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Measurement Data:	<b>Refer to Appendix A - 2.4G WIFI</b>

## 6.5 Band Edge

### 6.5.1 Conducted Emission Method

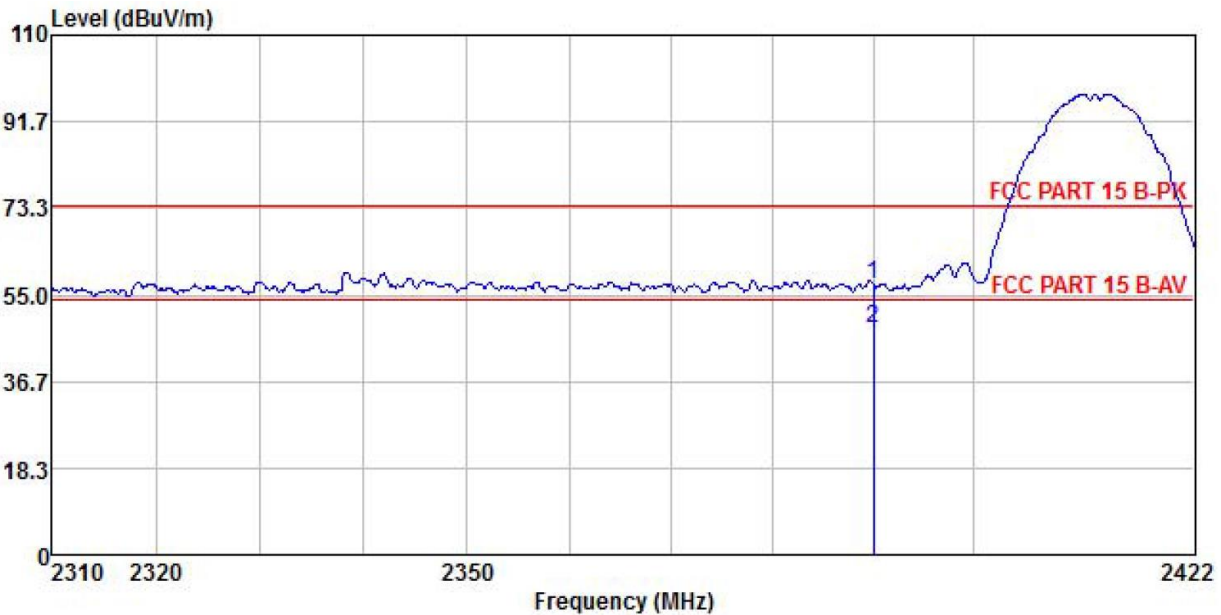
Test Requirement:	FCC Part 15 C Section 15.247 (d)
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
Test setup:	
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Measurement Data:	Refer to Appendix A - 2.4G WIFI

### 6.5.2 Radiated Emission Method

Test Requirement:	FCC Part 15 C Section 15.209 and 15.205				
Test Frequency Range:	2310 MHz to 2390 MHz and 2483.5 MHz to 2500 MHz				
Test Distance:	3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Remark
	Above 1GHz	Peak	1MHz	3MHz	Peak Value
RMS		1MHz	3MHz	Average Value	
Limit:	Frequency	Limit (dBuV/m @3m)		Remark	
	Above 1GHz	54.00		Average Value	
		74.00		Peak Value	
Test Procedure:	<ol style="list-style-type: none"> <li>1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.</li> <li>2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.</li> <li>3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.</li> <li>4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.</li> <li>5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.</li> <li>6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.</li> </ol>				
Test setup:					
Test Instruments:	Refer to section 5.8 for details				
Test mode:	Refer to section 5.3 for details				
Test results:	Passed				

802.11b mode:

Product Name:	Central controller	Product Model:	Lime-4.0-US
Test By:	Mike	Test mode:	802.11b Tx mode
Test Channel:	Lowest channel	Polarization:	Vertical
Test Voltage:	AC 120/60Hz	Environment:	Temp: 24°C Humi: 57%

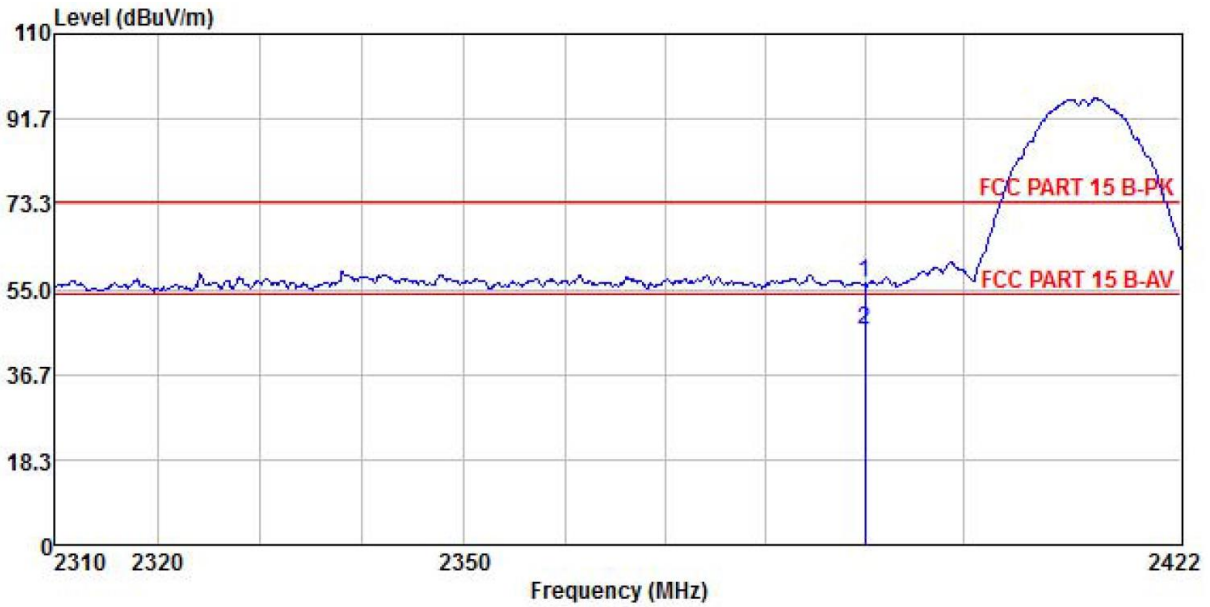


	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.000	21.39	27.03	8.73	0.00	57.15	74.00	-16.85	Peak
2	2390.000	11.94	27.03	8.73	0.00	47.70	54.00	-6.30	Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11b Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

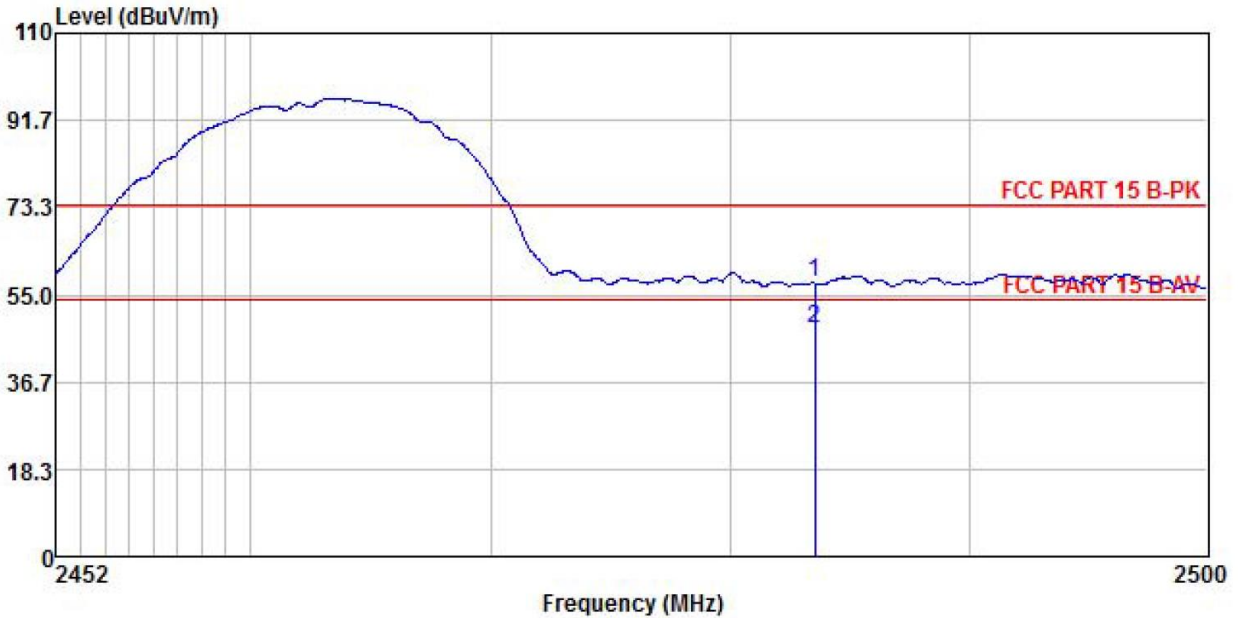


	Read	Antenna	Cable	Preamp	Limit	Over		
Freq	Level	Factor	Loss	Factor	Line	Limit	Remark	
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.000	20.48	27.03	8.73	0.00	56.24	74.00	-17.76 Peak
2	2390.000	10.43	27.03	8.73	0.00	46.19	54.00	-7.81 Average

**Remark:**

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11b Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%



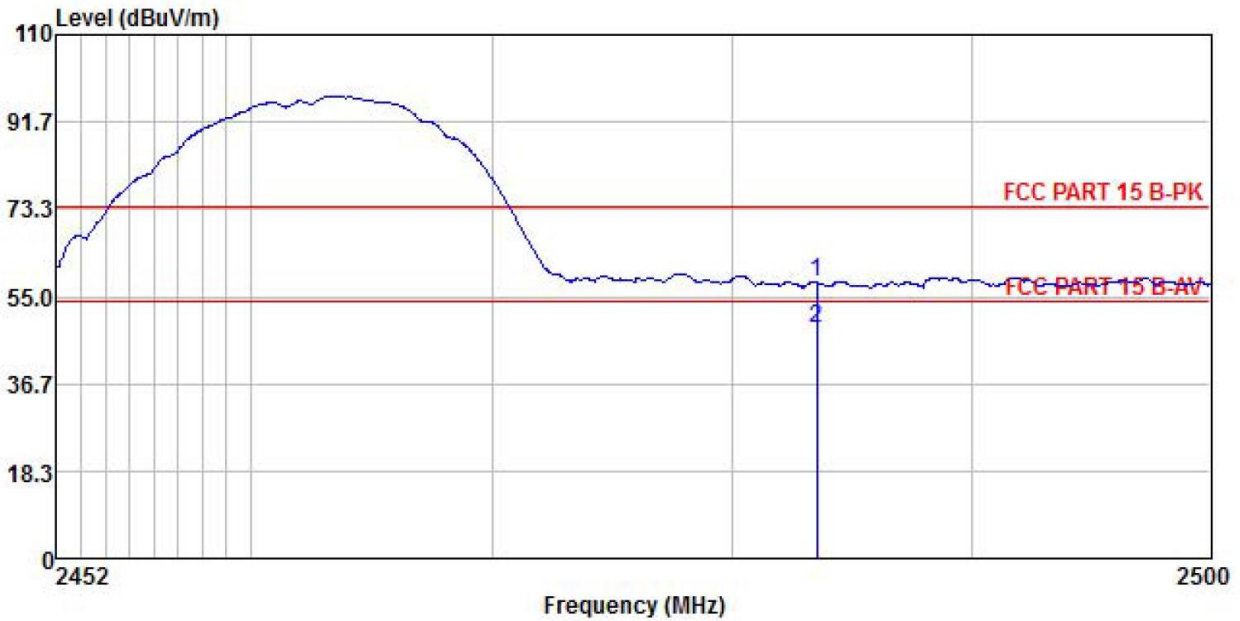
	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2483.500	21.41	27.27	8.82	0.00	57.50	74.00	-16.50	Peak
2	2483.500	11.69	27.27	8.82	0.00	47.78	54.00	-6.22	Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.



<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11b Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%



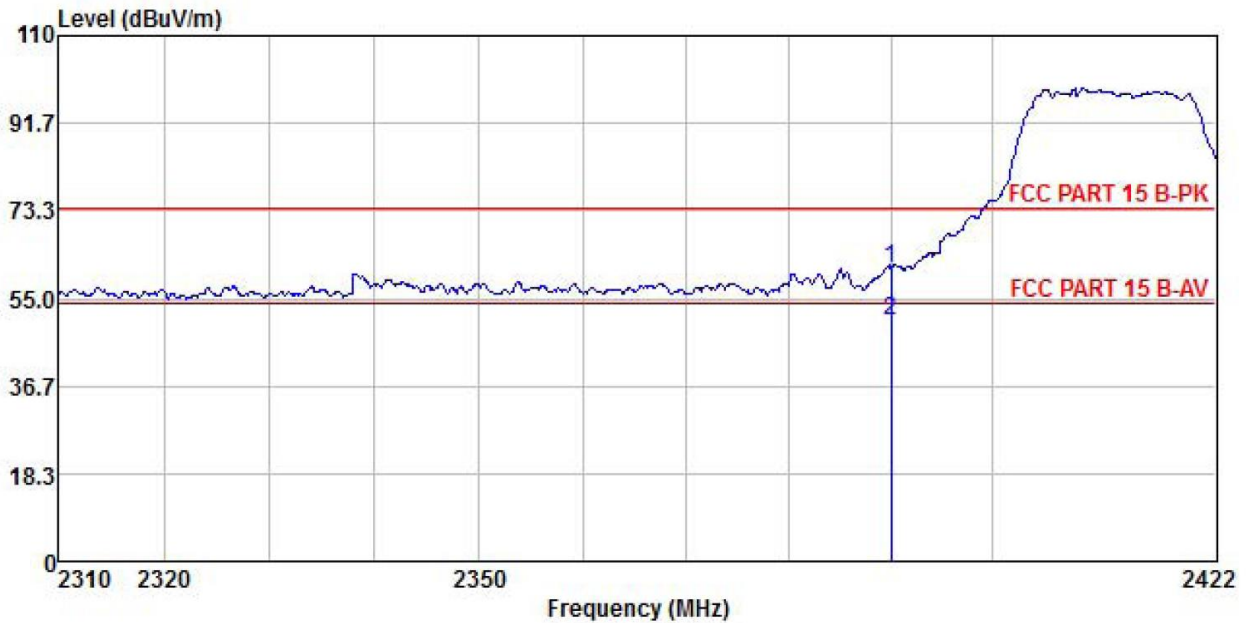
	Read	Antenna	Cable	Preamp	Limit	Over		
Freq	Level	Factor	Loss	Factor	Line	Limit	Remark	
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2483.500	21.99	27.27	8.82	0.00	58.08	74.00	-15.92 Peak
2	2483.500	12.03	27.27	8.82	0.00	48.12	54.00	-5.88 Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

802.11g mode:

Product Name:	Central controller	Product Model:	Lime-4.0-US
Test By:	Mike	Test mode:	802.11g Tx mode
Test Channel:	Lowest channel	Polarization:	Vertical
Test Voltage:	AC 120/60Hz	Environment:	Temp: 24°C Humi: 57%

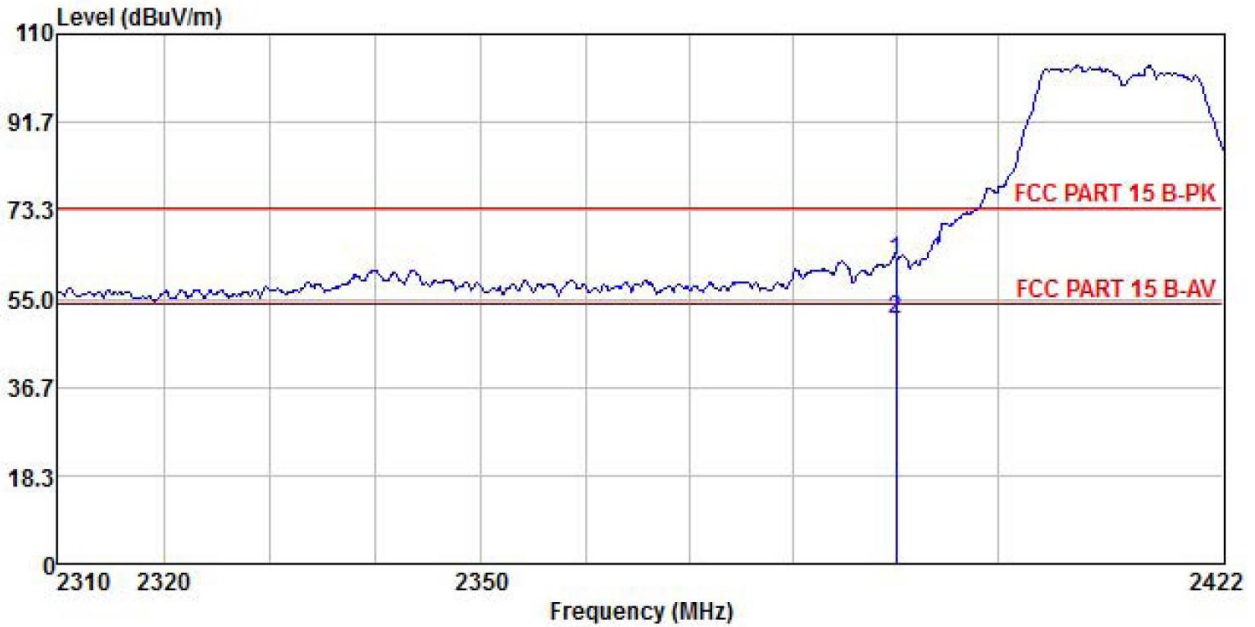


	Read	Antenna	Cable	Preamp	Level	Limit	Over	
-----	Freq	Level	Factor	Loss	Factor	Line	Limit	Remark
-----	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1	2390.000	25.47	27.03	8.73	0.00	61.23	74.00	-12.77 Peak
2	2390.000	14.62	27.03	8.73	0.00	50.38	54.00	-3.62 Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11g Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Huni: 57%

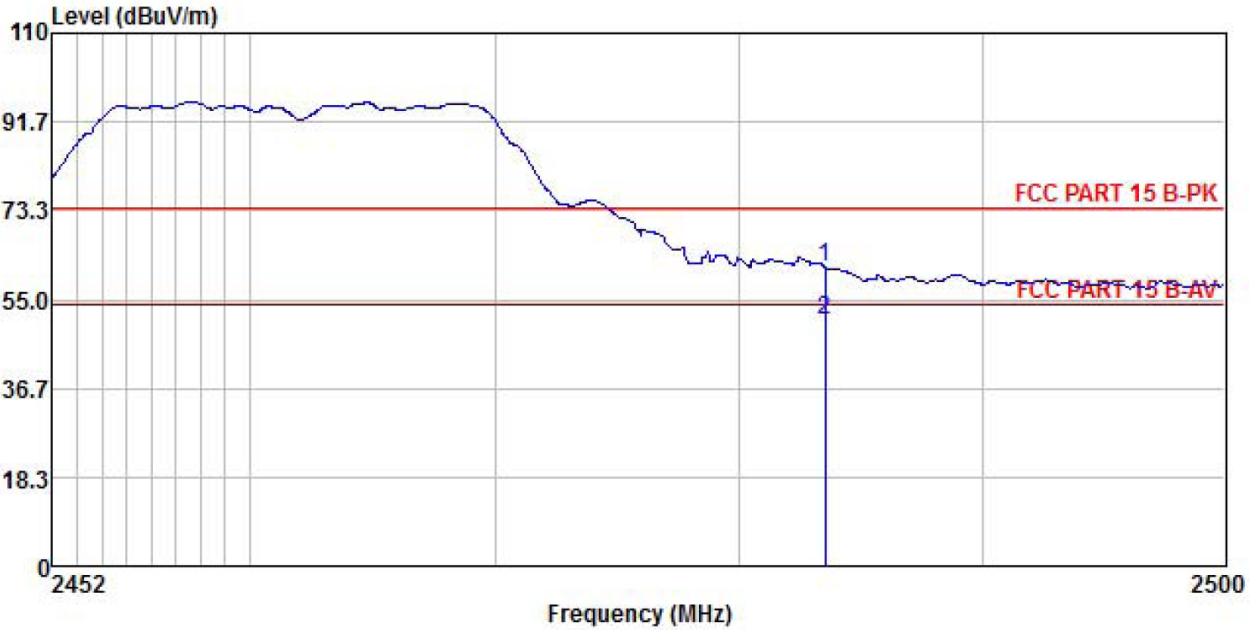


	Read	Antenna	Cable	Preamp	Limit	Over	
Freq	Level	Factor	Loss	Factor	Line	Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1	2390.000	27.00	27.03	8.73	0.00	62.76	74.00 -11.24 Peak
2	2390.000	14.83	27.03	8.73	0.00	50.59	54.00 -3.41 Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11g Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

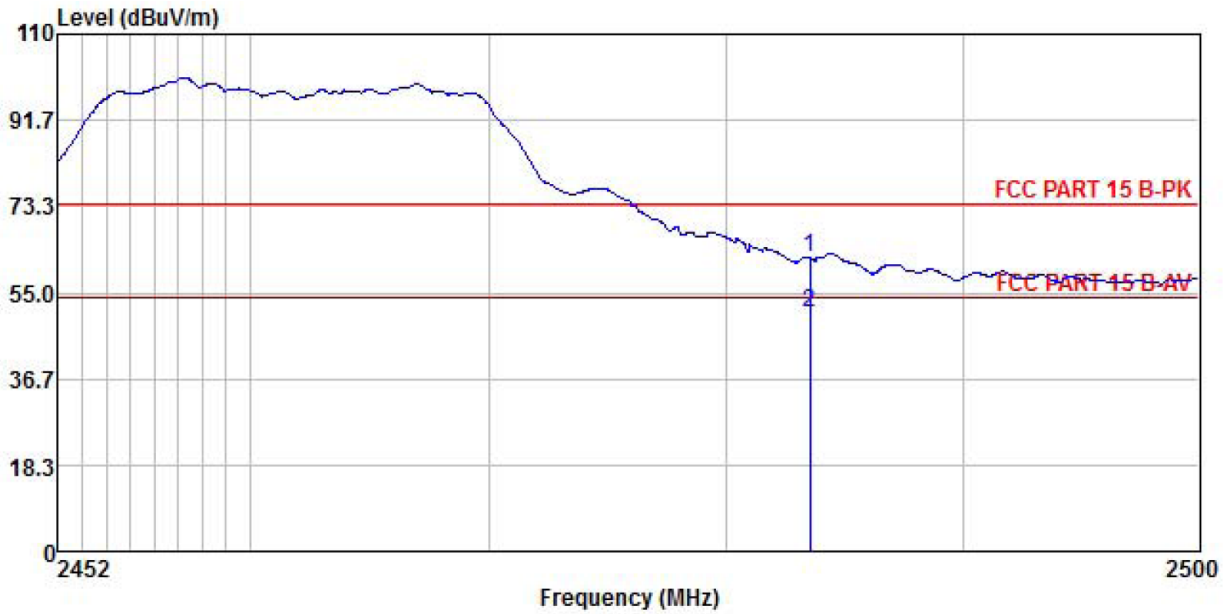


	ReadAntenna	Cable	Preamp	Limit	Over				
Freq	Level	Loss	Factor	Line	Limit	Remark			
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	2483.500	25.68	27.27	8.82	0.00	61.77	74.00	-12.23	Peak
2	2483.500	14.68	27.27	8.82	0.00	50.77	54.00	-3.23	Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11g Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%



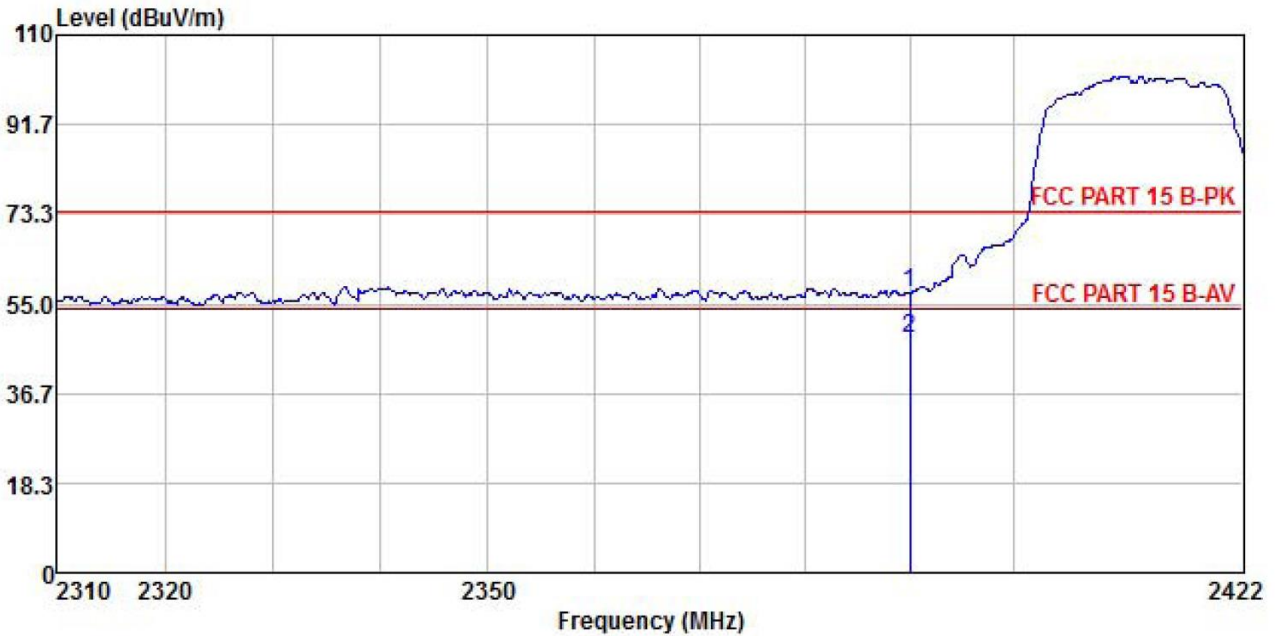
	Read	Antenna	Cable	Preamp	Limit	Over			
Freq	Level	Factor	Loss	Factor	Line	Limit	Remark		
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	2483.500	26.53	27.27	8.82	0.00	62.62	74.00	-11.38	Peak
2	2483.500	14.53	27.27	8.82	0.00	50.62	54.00	-3.38	Average

**Remark:**

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

802.11n(HT20):

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT20) Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

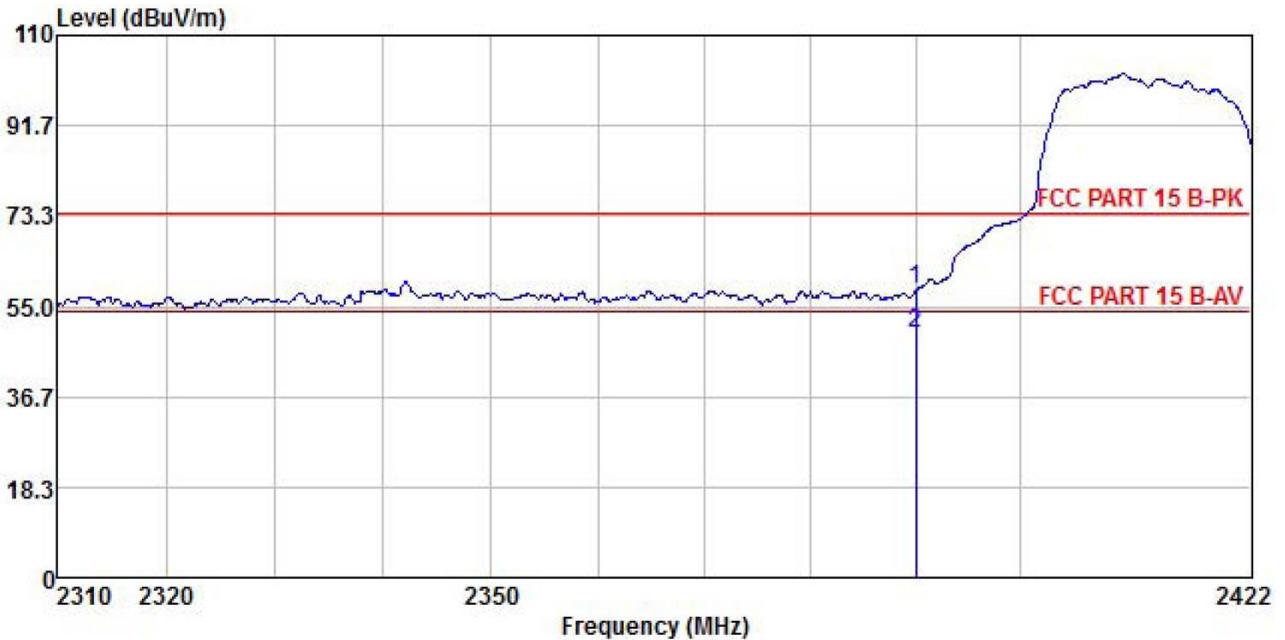


	Freq	ReadAntenna	Cable	Preamp	Limit	Over	Remark		
	MHz	Level	Factor	Loss	Factor	Level	Line	Limit	dB
		dBuV	dB/m	dB	dB	dBuV/m	dBuV/m		
1	2390.000	21.51	27.03	8.73	0.00	57.27	74.00	-16.73	Peak
2	2390.000	12.10	27.03	8.73	0.00	47.86	54.00	-6.14	Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT20) Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

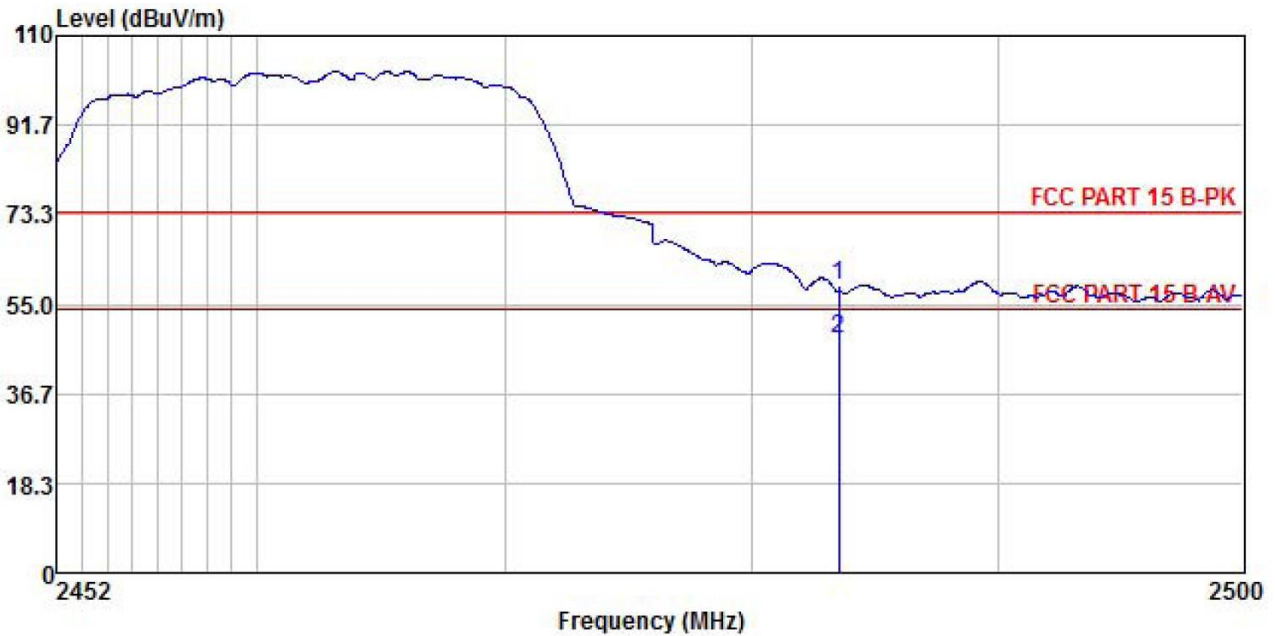


	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.000	22.68	27.03	8.73	0.00	58.44	74.00	-15.56	Peak
2	2390.000	13.81	27.03	8.73	0.00	49.57	54.00	-4.43	Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamp Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT20) Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Huni: 57%



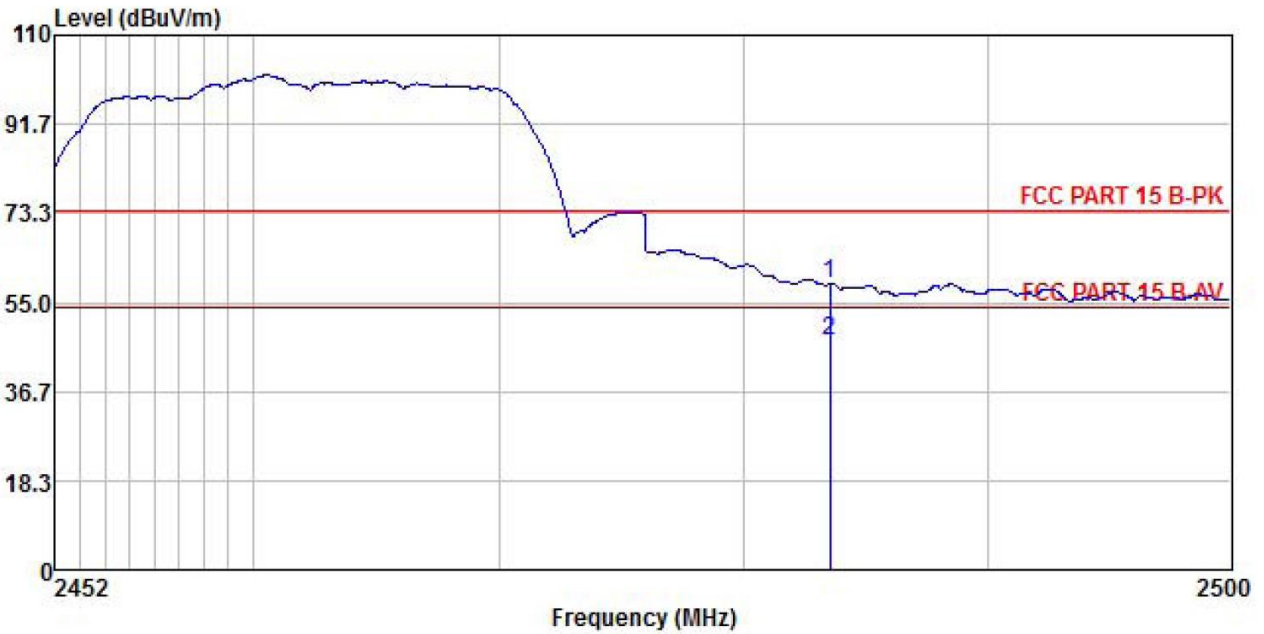
	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2483.500	22.70	27.27	8.82	0.00	58.79	74.00	-15.21	Peak
2	2483.500	11.96	27.27	8.82	0.00	48.05	54.00	-5.95	Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.



<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT20) Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%



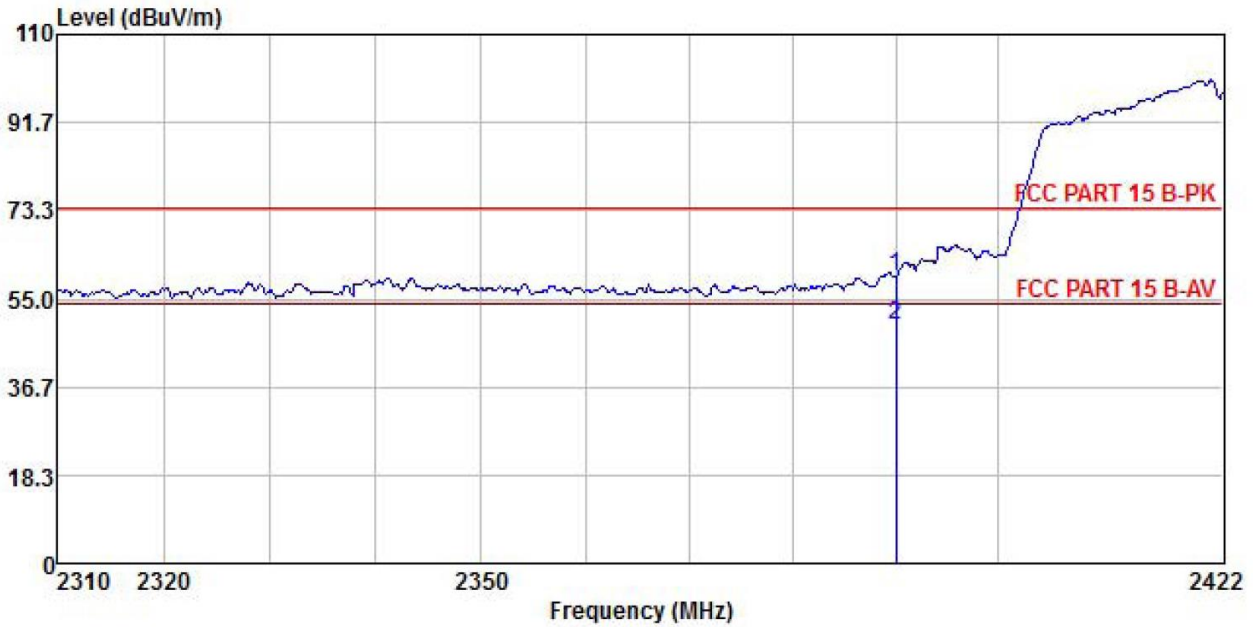
	ReadAntenna	Cable	Preamp	Limit	Over				
Freq	Level	Factor	Loss	Factor	Level	Line			
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m			
1	2483.500	22.62	27.27	8.82	0.00	58.71	74.00	-15.29	Peak
2	2483.500	11.11	27.27	8.82	0.00	47.20	54.00	-6.80	Average

**Remark:**

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

802.11n(HT40):

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT40) Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Huni: 57%

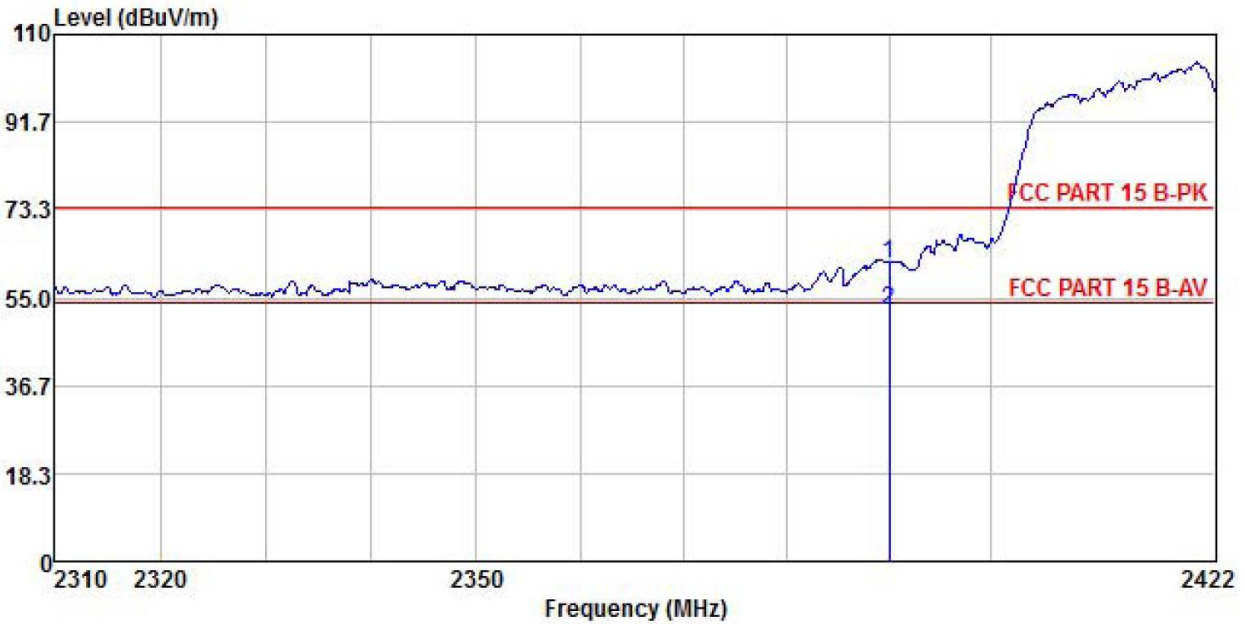


	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Aux Factor	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.000	23.74	27.03	8.73	0.00	0.00	59.50	74.00	-14.50	Peak
2	2390.000	13.82	27.03	8.73	0.00	0.00	49.58	54.00	-4.42	Average

Remark:

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT40) Tx mode
<b>Test Channel:</b>	Lowest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

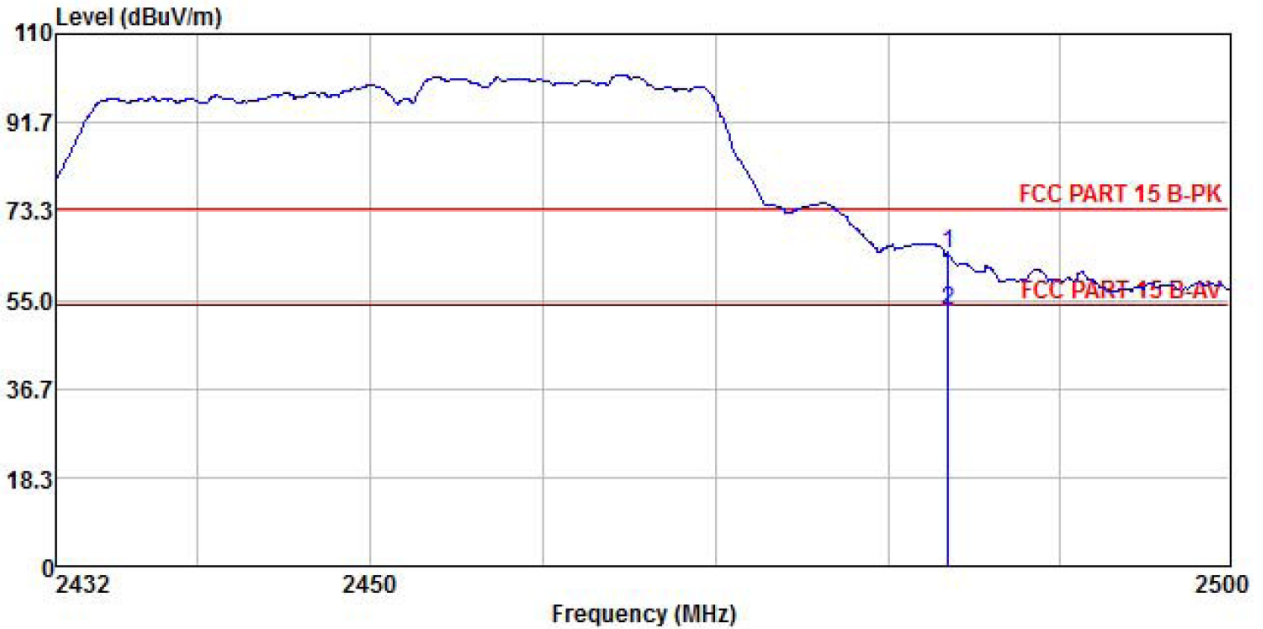


	Read Freq	Antenna Level	Cable Factor	Aux Loss	Preamp Factor	Level	Limit	Over	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.000	26.54	27.03	8.73	0.00	62.30	74.00	-11.70	Peak
2	2390.000	16.42	27.03	8.73	0.00	52.18	54.00	-1.82	Average

**Remark:**

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT40) Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

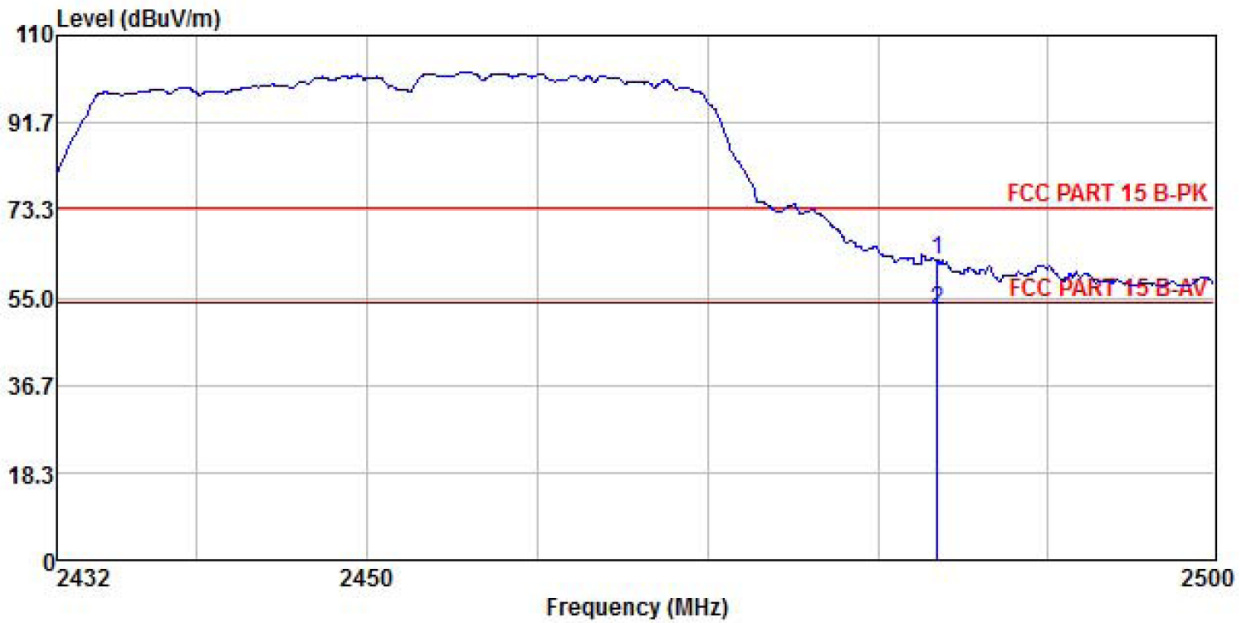


	Freq	Read Level	Antenna Factor	Cable Loss	Aux Factor	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dB	dBuV/m	dBuV/m	dB	
1	2483.500	28.43	27.27	8.82	0.00	0.00	64.52	74.00	-9.48	Peak
2	2483.500	16.75	27.27	8.82	0.00	0.00	52.84	54.00	-1.16	Average

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	802.11n(HT40) Tx mode
<b>Test Channel:</b>	Highest channel	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Huni: 57%



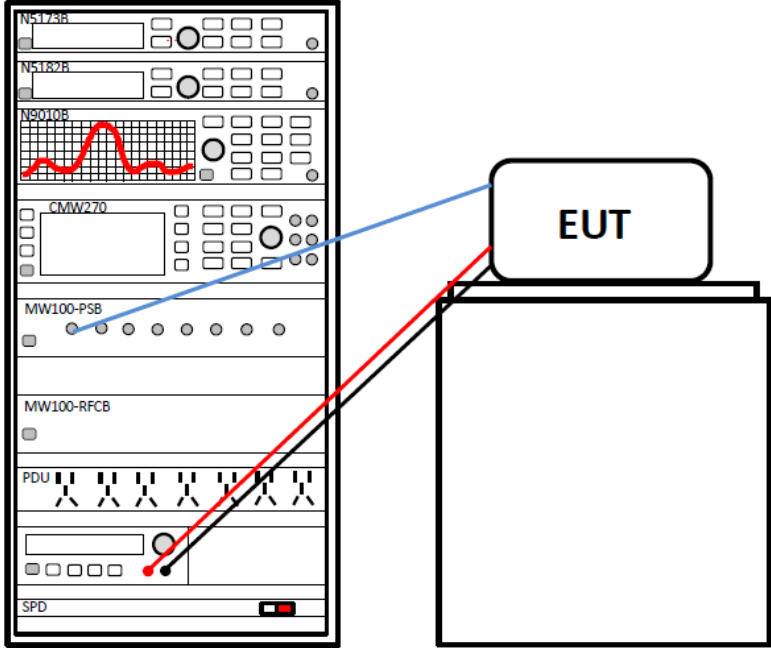
	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Aux Factor	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dB	dBuV/m	dBuV/m	dB	
1	2483.500	26.72	27.27	8.82	0.00	0.00	62.81	74.00	-11.19	Peak
2	2483.500	16.37	27.27	8.82	0.00	0.00	52.46	54.00	-1.54	Average

**Remark:**

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
- The emission levels of other frequencies are lower than the limit 20dB and not show in test report.

## 6.6 Spurious Emission

### 6.6.1 Conducted Emission Method

Test Requirement:	FCC Part 15 C Section 15.247 (d)
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
Test setup:	
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Measurement Data:	Refer to Appendix A - 2.4G WIFI

### 6.6.2 Radiated Emission Method

Test Requirement:	FCC Part 15 C Section 15.209 and 15.205				
Test Frequency Range:	9kHz to 25GHz				
Test Distance:	3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Remark
	30MHz-1GHz	Quasi-peak	120KHz	300KHz	Quasi-peak Value
	Above 1GHz	Peak	1MHz	3MHz	Peak Value
RMS		1MHz	3MHz	Average Value	
Limit:	Frequency	Limit (dBuV/m @3m)		Remark	
	30MHz-88MHz	40.0		Quasi-peak Value	
	88MHz-216MHz	43.5		Quasi-peak Value	
	216MHz-960MHz	46.0		Quasi-peak Value	
	960MHz-1GHz	54.0		Quasi-peak Value	
	Above 1GHz	54.0		Average Value	
		74.0		Peak Value	
Test Procedure:	<ol style="list-style-type: none"> <li>The EUT was placed on the top of a rotating table 0.8m(below 1GHz)/1.5m(above 1GHz) above the ground at a 3 meter chamber. The table was rotated 360 degrees to determine the position of the highest radiation.</li> <li>The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.</li> <li>The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.</li> <li>For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.</li> <li>The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.</li> <li>If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.</li> </ol>				
Test setup:	<p>Below 1GHz</p> <p>Above 1GHz</p>				

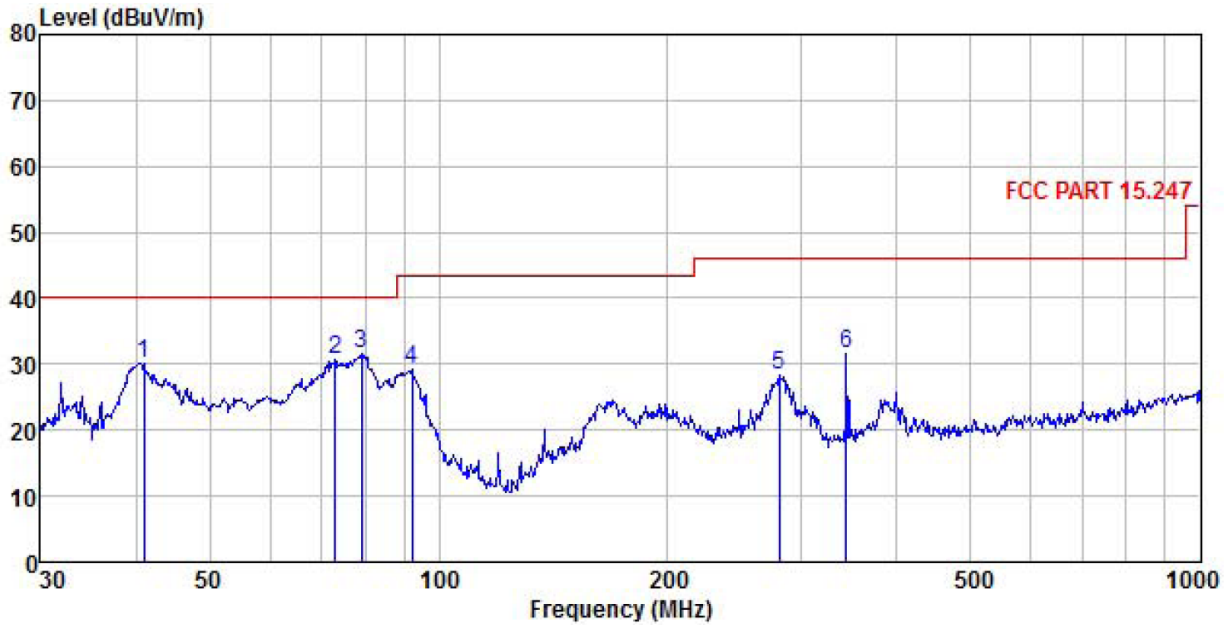
Test Instruments:	Refer to section 5.8 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed
Remark:	<ol style="list-style-type: none"> <li>1. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis is the worst case.</li> <li>2. 9 kHz to 30MHz is lower than the limit 20dB, so only shows the data of above 30MHz in this report.</li> </ol>



**Measurement Data (worst case):**

**Below 1GHz:**

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	Wi-Fi Tx mode
<b>Test Frequency:</b>	30 MHz ~ 1 GHz	<b>Polarization:</b>	Vertical
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%

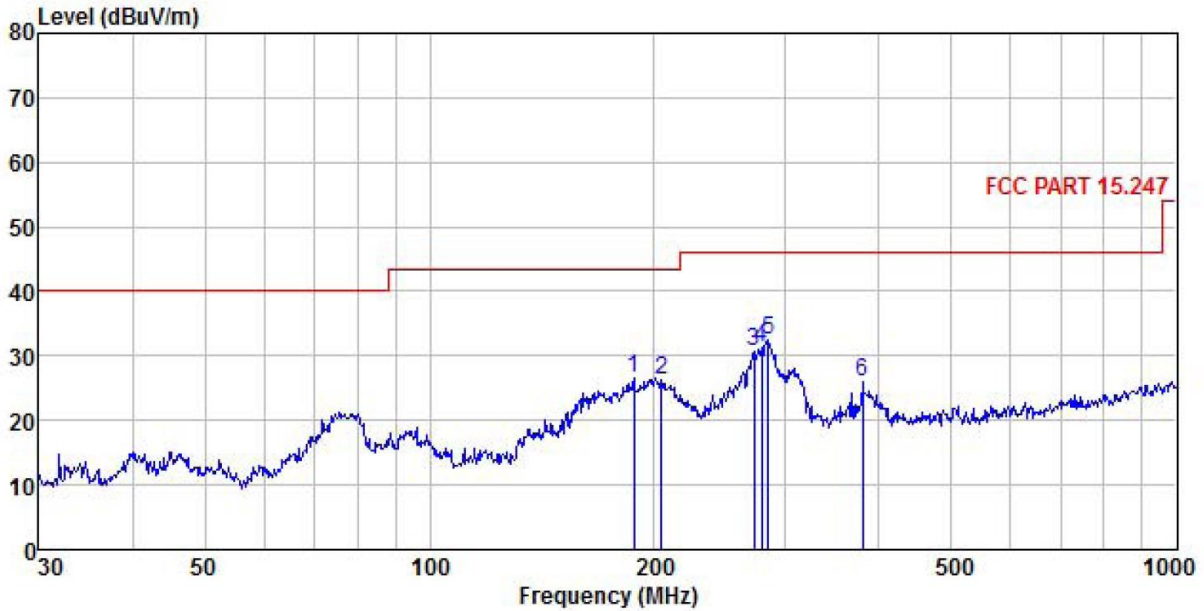


	Read	Antenna	Cable	Aux	Preamp	Limit	Over			
-----	Freq	Level	Factor	Loss	Factor	Factor	Level	Line	Limit	Remark
-----	MHz	dBuV	dB/m	dB	dB	dB	dBuV/m	dBuV/m	dB	
1	40.988	46.96	12.82	0.36	0.00	29.89	30.25	40.00	-9.75	QP
2	73.103	48.94	10.98	0.45	0.00	29.69	30.68	40.00	-9.32	QP
3	79.243	48.05	12.59	0.47	0.00	29.65	31.46	40.00	-8.54	QP
4	92.139	48.90	9.46	0.50	0.00	29.56	29.30	43.50	-14.20	QP
5	280.024	37.30	18.62	0.84	0.00	28.48	28.28	46.00	-17.72	QP
6	343.180	40.44	18.79	0.92	0.00	28.55	31.60	46.00	-14.40	QP

**Remark:**

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Pre-amplifier Factor.
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.
3. The Aux Factor is a notch filter switch box loss, this item is not used.

<b>Product Name:</b>	Central controller	<b>Product Model:</b>	Lime-4.0-US
<b>Test By:</b>	Mike	<b>Test mode:</b>	Wi-Fi Tx mode
<b>Test Frequency:</b>	30 MHz ~ 1 GHz	<b>Polarization:</b>	Horizontal
<b>Test Voltage:</b>	AC 120/60Hz	<b>Environment:</b>	Temp: 24°C Humi: 57%



	ReadAntenna	Cable	Aux	Preamp	Limit	Over			
Freq	Level	Factor	Loss	Factor	Factor	Level	Line	Limit	Remark
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
MHz	dBuV	dB/m	dB	dB	dB	dBuV/m	dBuV/m	dB	
1	187.753	37.54	17.31	0.70	0.00	28.92	26.63	43.50	-16.87 QP
2	204.238	36.05	18.32	0.72	0.00	28.80	26.29	43.50	-17.21 QP
3	272.278	39.86	18.59	0.82	0.00	28.50	30.77	46.00	-15.23 QP
4	278.067	40.46	18.62	0.84	0.00	28.49	31.43	46.00	-14.57 QP
5	283.979	41.46	18.64	0.84	0.00	28.48	32.46	46.00	-13.54 QP
6	379.914	34.82	18.98	0.97	0.00	28.69	26.08	46.00	-19.92 QP

**Remark:**

1. Final Level = Receiver Read level + Factor (Antenna Factor + Cable Loss – Preamplifier Factor).
2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.
3. The Aux Factor is a notch filter switch box loss, this item is not used.

**Above 1GHz**

802.11b						
Test channel: Lowest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	58.16	-10.33	47.83	74.00	26.17	Vertical
4824.00	59.60	-10.33	49.27	74.00	24.73	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	56.61	-10.33	46.28	54.00	7.72	Vertical
4824.00	55.43	-10.33	45.10	54.00	8.90	Horizontal
Test channel: Middle channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	59.15	-10.17	48.98	74.00	25.02	Vertical
4874.00	60.47	-10.17	50.30	74.00	23.70	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	55.95	-10.17	45.78	54.00	8.22	Vertical
4874.00	54.29	-10.17	44.12	54.00	9.88	Horizontal
Test channel: Highest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	59.99	-10.02	49.97	74.00	24.03	Vertical
4924.00	61.37	-10.02	51.35	74.00	22.65	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	55.48	-10.02	45.46	54.00	8.54	Vertical
4924.00	54.73	-10.02	44.71	54.00	9.29	Horizontal
<i>Remark:</i> 1. <i>Final Level = Receiver Read level + Factor.</i> 2. <i>The emission levels of other frequencies are lower than the limit 20dB and not show in test report.</i>						

802.11g						
Test channel: Lowest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	59.86	-10.33	49.53	74.00	24.47	Vertical
4824.00	56.62	-10.33	46.29	74.00	27.71	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	55.52	-10.33	45.19	54.00	8.81	Vertical
4824.00	54.19	-10.33	43.86	54.00	10.14	Horizontal
Test channel: Middle channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	59.35	-10.17	49.18	74.00	24.82	Vertical
4874.00	57.18	-10.17	47.01	74.00	26.99	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	55.56	-10.17	45.39	54.00	8.61	Vertical
4874.00	53.29	-10.17	43.12	54.00	10.88	Horizontal
Test channel: Highest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	60.41	-10.02	50.39	74.00	23.61	Vertical
4924.00	59.83	-10.02	49.81	74.00	24.19	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	54.52	-10.02	44.50	54.00	9.50	Vertical
4924.00	55.20	-10.02	45.18	54.00	8.82	Horizontal
<i>Remark:</i> 1. Final Level = Receiver Read level + Factor. 2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.						

802.11n(HT20)						
Test channel: Lowest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	59.62	-10.33	49.29	74.00	24.71	Vertical
4824.00	56.17	-10.33	45.84	74.00	28.16	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4824.00	55.51	-10.33	45.18	54.00	8.82	Vertical
4824.00	52.29	-10.33	41.96	54.00	12.04	Horizontal
Test channel: Middle channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	58.46	-10.17	48.29	74.00	25.71	Vertical
4874.00	60.11	-10.17	49.94	74.00	24.06	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	57.84	-10.17	47.67	54.00	6.33	Vertical
4874.00	55.39	-10.17	45.22	54.00	8.78	Horizontal
Test channel: Highest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	58.97	-10.02	48.95	74.00	25.05	Vertical
4924.00	60.13	-10.02	50.11	74.00	23.89	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4924.00	56.47	-10.02	46.45	54.00	7.55	Vertical
4924.00	55.09	-10.02	45.07	54.00	8.93	Horizontal
Remark: 1. Final Level = Receiver Read level + Factor. 2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.						

802.11n(HT40)						
Test channel: Lowest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4844.00	58.41	-10.33	48.08	74.00	25.92	Vertical
4844.00	57.23	-10.33	46.90	74.00	27.10	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4844.00	56.69	-10.33	46.36	54.00	7.64	Vertical
4844.00	55.11	-10.33	44.78	54.00	9.22	Horizontal
Test channel: Middle channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	60.52	-10.17	50.35	74.00	23.65	Vertical
4874.00	58.79	-10.17	48.62	74.00	25.38	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4874.00	56.62	-10.17	46.45	54.00	7.55	Vertical
4874.00	55.43	-10.17	45.26	54.00	8.74	Horizontal
Test channel: Highest channel						
Detector: Peak Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4904.00	60.52	-10.02	50.50	74.00	23.50	Vertical
4904.00	58.77	-10.02	48.75	74.00	25.25	Horizontal
Detector: Average Value						
Frequency (MHz)	Read Level (dBuV)	Factor(dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4904.00	56.39	-10.02	46.37	54.00	7.63	Vertical
4904.00	55.52	-10.02	45.50	54.00	8.50	Horizontal
Remark: 1. Final Level = Receiver Read level + Factor. 2. The emission levels of other frequencies are lower than the limit 20dB and not show in test report.						

## 8 EUT Constructional Details

Reference to the test report No.: JYTSZB-R12-2100762

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