

RF TEST REPORT  
For  
EcoTech Marine  
Bluetooth LE and 802.15.4 module

Model No.: 900-00088

FCC ID: VKB271831

IC: 7349A-271831

Prepared for	:	EcoTech Marine
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Date of receipt of test sample	:	December 23, 2016
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	December 23, 2016~January 06, 2017
Date of Report	:	January 06, 2017

**FCC TEST REPORT****FCC CFR 47 PART 15 C(15.247): 2015 & RSS-247: Issue 1****Report Reference No.** ..... : **LCS1612233362E**

Date of Issue ..... : January 06, 2017

**Testing Laboratory Name** ..... : **Shenzhen LCS Compliance Testing Laboratory Ltd.**Address ..... : 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue,  
Bao'an District, Shenzhen, Guangdong, ChinaTesting Location/ Procedure ..... : Full application of Harmonised standards ■  
Partial application of Harmonised standards □  
Other standard testing method □**Applicant's Name** ..... : **EcoTech Marine**

Address ..... : 999 Postal Road, Suite 100, Allentown PA 18109, USA

**Test Specification**

Standard ..... : FCC CFR 47 PART 15 C(15.247): 2015 &amp; RSS-247: Issue 1

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

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

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

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**EUT Description.** ..... : **Bluetooth LE and 802.15.4 module**

Trade Mark ..... : EcoTech Marine

Model/ Type reference ..... : 900-00088

Ratings ..... : DC4.5-5.5V, 1A

Result ..... : **Positive****Compiled by:**

Jacky Li/ File administrators

**Supervised by:**

Glin Lu/ Technique principal

**Approved by:**

Gavin Liang/ Manager

## FCC -- TEST REPORT

Test Report No. : LCS1612233362E	January 06, 2017 Date of issue
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EUT.....	: Bluetooth LE and 802.15.4 module
Type / Model.....	: 900-00088
<b>Applicant</b> .....	: <b>EcoTech Marine</b>
Address.....	: 999 Postal Road, Suite 100, Allentown PA 18109, USA
Telephone.....	: 800-785-0338
Fax.....	: 484-229-0578
<b>Manufacturer</b> .....	: <b>EcoTech Marine</b>
Address.....	: 999 Postal Road, Suite 100, Allentown PA 18109, USA
Telephone.....	: 800-785-0338
Fax.....	: 484-229-0578
<b>Factory</b> .....	: <b>EcoTech Marine</b>
Address.....	: 999 Postal Road, Suite 100, Allentown PA 18109, USA
Telephone.....	: 800-785-0338
Fax.....	: 484-229-0578

Test Result	Positive
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The test report merely corresponds to the test sample.

It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

**Revision History**

Revision	Issue Date	Revisions	Revised By
00	2017-01-06	Initial Issue	Gavin Liang

## TABLE OF CONTENTS

<b>1. GENERAL INFORMATION .....</b>	<b>6</b>
1.1. DESCRIPTION OF DEVICE (EUT).....	6
1.2. HOST SYSTEM CONFIGURATION LIST AND DETAILS.....	6
1.3. EXTERNAL I/O CABLE.....	6
1.4. DESCRIPTION OF TEST FACILITY.....	6
1.5. STATEMENT OF THE MEASUREMENT UNCERTAINTY.....	7
1.6. MEASUREMENT UNCERTAINTY.....	7
1.7. DESCRIPTION OF TEST MODES .....	7
<b>2. TEST METHODOLOGY.....</b>	<b>8</b>
2.1. EUT CONFIGURATION.....	8
2.2. EUT EXERCISE.....	8
2.3. GENERAL TEST PROCEDURES .....	8
<b>3. SYSTEM TEST CONFIGURATION .....</b>	<b>9</b>
3.1. JUSTIFICATION .....	9
3.2. EUT EXERCISE SOFTWARE .....	9
3.3. SPECIAL ACCESSORIES.....	9
3.4. BLOCK DIAGRAM/SCHEMATICS .....	9
3.5. EQUIPMENT MODIFICATIONS.....	9
3.6. TEST SETUP .....	9
<b>4. SUMMARY OF TEST RESULTS .....</b>	<b>10</b>
<b>5. TEST RESULT .....</b>	<b>11</b>
5.1. ON TIME AND DUTY CYCLE.....	11
5.2. MAXIMUM CONDUCTED OUTPUT POWER MEASUREMENT .....	13
5.3. POWER SPECTRAL DENSITY MEASUREMENT .....	14
5.4. 6 dB AND 99% SPECTRUM BANDWIDTH MEASUREMENT .....	17
5.5. RADIATED EMISSIONS MEASUREMENT .....	21
5.6. CONDUCTED SPURIOUS EMISSIONS AND BAND EDGES TEST .....	42
5.7. POWER LINE CONDUCTED EMISSIONS.....	48
5.8. ANTENNA REQUIREMENTS .....	51
<b>6. LIST OF MEASURING EQUIPMENTS .....</b>	<b>52</b>
<b>7. TEST SETUP PHOTOGRAPHS OF EUT .....</b>	<b>53</b>
<b>8. EXTERIOR PHOTOGRAPHS OF THE EUT .....</b>	<b>53</b>
<b>9. INTERIOR PHOTOGRAPHS OF THE EUT.....</b>	<b>53</b>

## 1. GENERAL INFORMATION

### 1.1. Description of Device (EUT)

EUT : Bluetooth LE and 802.15.4 module  
 Model Number : 900-00088  
 Power Supply : DC4.5-5.5V, 1A  
 Frequency Range : 2402.00~2480.00MHz for Bluetooth LE;  
 2405.00~2480.00MHz for Zigbee;  
 Channel Number : 40 Channels for Bluetooth LE;  
 16 Channels for Zigbee;  
 Modulation Technology : GFSK for Bluetooth LE;  
 OQPSK for Zigbee;  
 Data Rates : 1Mbps for Bluetooth LE;  
 250kbps for Zigbee;  
 Antenna Type And Gain : PCB antenna, 3.72 dBi(Max.)  
 SW version : V1.0  
 HW version : KW41\_RF\_Module  
 Test Software : KW41 FCC Tester(Power class: Default)

### 1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
EcoTech Marine	RF Module Tester	Threshold Tester	--	--

### 1.3. External I/O Cable

I/O Port Description	Quantity	Cable
--	--	--

### 1.4. Description of Test Facility

CNAS Registration Number. is L4595.  
 FCC Registration Number. is 899208.  
 Industry Canada Registration Number. is 9642A-1.  
 VCCI Registration Number. is C-4260 and R-3804.  
 ESMD Registration Number. is ARCB0108.  
 UL Registration Number. is 100571-492.  
 TUV SUD Registration Number. is SCN1081.  
 TUV RH Registration Number. is UA 50296516-001

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10:2013 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

### 1.5. Statement of The Measurement Uncertainty

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

### 1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.10dB	(1)
		30MHz~200MHz	±2.96dB	(1)
		200MHz~1000MHz	±3.10dB	(1)
		1GHz~26.5GHz	±3.80dB	(1)
		26.5GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±1.63dB	(1)
Power disturbance	:	30MHz~300MHz	±1.60dB	(1)

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

### 1.7. Description Of Test Modes

The EUT has been tested under operating condition.

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

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

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be Zigbee (High Channel).

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case datarates used during the testing are as follows:

Bluetooth LE Mode: 1 Mbps, GFSK.

Zigbee Mode: 250 kbps, OQPSK.

## 2. TEST METHODOLOGY

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

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

### 2.1. EUT Configuration

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

### 2.2. EUT Exercise

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

According to FCC's request, Test Procedure KDB558074 D01 DTS Meas. Guidance v03r05 is required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209, 15.247 under the FCC Rules Part 15 Subpart C and RSS-247.

### 2.3. General Test Procedures

#### 2.3.1 Conducted Emissions

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

#### 2.3.2 Radiated Emissions

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



### 3. SYSTEM TEST CONFIGURATION

#### 3.1. Justification

The system was configured for testing in a continuous transmit condition. The duty cycle is 100% and the average correction factor is 0.

#### 3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (KW41 FCC Tester App) provided by application.

#### 3.3. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/ unshielded	Notes
1	PC	Lenovo	Ideapad	A131101550	/	/	DOC
2	Power adapter	Lenovo	CPA-A090	36200414	1.00m	unshielded	DOC

#### 3.4. Block Diagram/Schematics

Please refer to the related document

#### 3.5. Equipment Modifications

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

#### 3.6. Test Setup

Please refer to the test setup photo.

#### 4. SUMMARY OF TEST RESULTS

Applied Standard: FCC Part 15.247 & RSS-247		
FCC Rules	Description of Test	Result
§15.247(b) & RSS-247§5.4 (4)	Maximum Conducted Output Power	Compliant
§15.247(e) & RSS-247§5.4 (2)	Power Spectral Density	Compliant
§15.247(a)(2) & RSS-247§5.4 (1)	6dB Bandwidth	Compliant
RSS-GEN	99% Occupied Bandwidth	Compliant
§15.209, §15.247(d) & RSS-247§5.5, RSS-Gen	Radiated Spurious Emissions	Compliant
§15.205 & RSS-Gen	Emissions at Restricted Band	Compliant
§15.207(a) & RSS-GEN	Conducted Emissions	Compliant
§15.203 & RSS-GEN	Antenna Requirements	Compliant
§15.247(i)§2.1093 & RSS-102	RF Exposure	Compliant

Note: "N/A" is not applicable.

## 5. TEST RESULT

### 5.1. On Time and Duty Cycle

#### 5.1.1. Standard Applicable

None; for reporting purpose only.

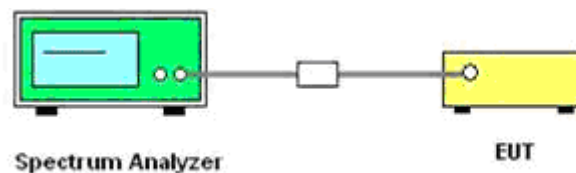
#### 5.1.2. Measuring Instruments and Setting

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

#### 5.1.3. Test Procedures

1. Set the centre frequency of the spectrum analyse to the transmitting frequency;
2. Set the span=0MHz, RBW=8MHz, VBW=50MHz, Sweep time=10ms;
3. Detector = peak;
4. Trace mode = Single hold.

#### 5.1.4. Test Setup Layout



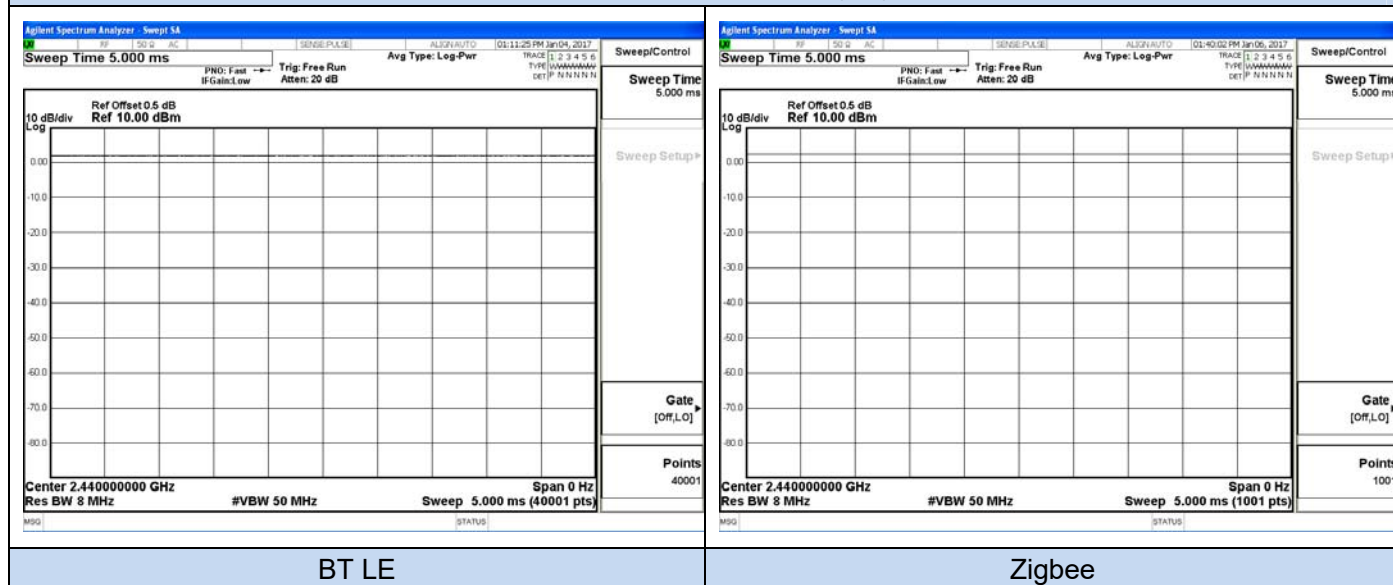
#### 5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

#### 5.1.6. Test result

Mode	On Time B (ms)	Period (ms)	Duty Cycle x (Linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW(KHz)
BT LE	5	5	1	100	0	0.010
Zigbee	5	5	1	100	0	0.010

## Test plot of On Time and Duty Cycle



## 5.2. Maximum Conducted Output Power Measurement

### 5.2.1. Standard Applicable

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

According to RSS-247§5.4(4): For DTSS employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.

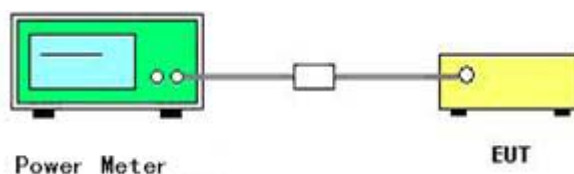
### 5.2.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of the power meter.

### 5.2.3. Test Procedures

The transmitter output (antenna port) was connected to the power meter.

### 5.2.4. Test Setup Layout



### 5.2.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

### 5.2.6. Test Result of Maximum Conducted Output Power

Temperature	25°C	Humidity	60%
Test Engineer	Jacky	Configurations	BT LE & Zigbee

Mode	Channel	Frequency (MHz)	Conducted Power ( Peak, dBm)	Max. Limit (dBm)	Result
BT LE	1	2402	2.106	30	Complies
	19	2440	1.984	30	Complies
	40	2480	2.130	30	Complies
Zigbee	1	2405	8.304	30	Complies
	8	2440	8.187	30	Complies
	16	2480	8.341	30	Complies

### 5.3. Power Spectral Density Measurement

#### 5.3.1. Standard Applicable

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

According to RSS-247§5.2(2): The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm 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 Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

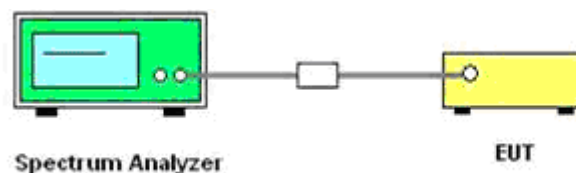
#### 5.3.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of Spectrum Analyzer.

#### 5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer through a directional couple.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 3 kHz~100kHz.
4. Set the VBW  $\geq 3 \times$  RBW
5. Set the span to 1.5 times the DTS channel bandwidth.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum power level in any 3 kHz band segment within the fundamental EBW.

#### 5.3.4. Test Setup Layout



#### 5.3.5. EUT Operation during Test

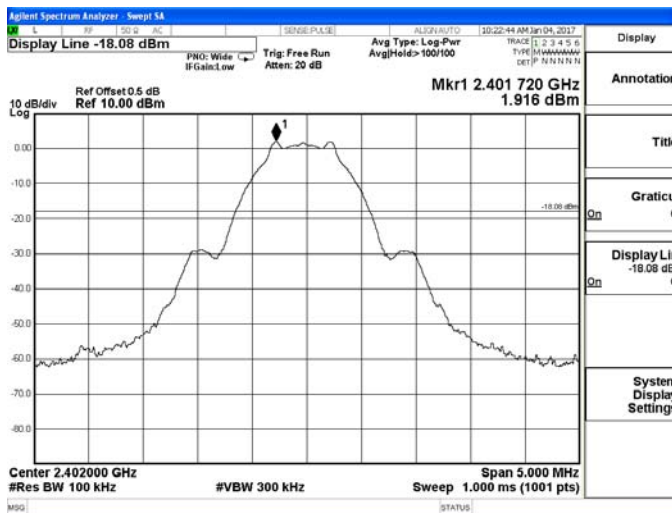
The EUT was programmed to be in continuously transmitting mode.

## 5.3.6. Test Result of Power Spectral Density

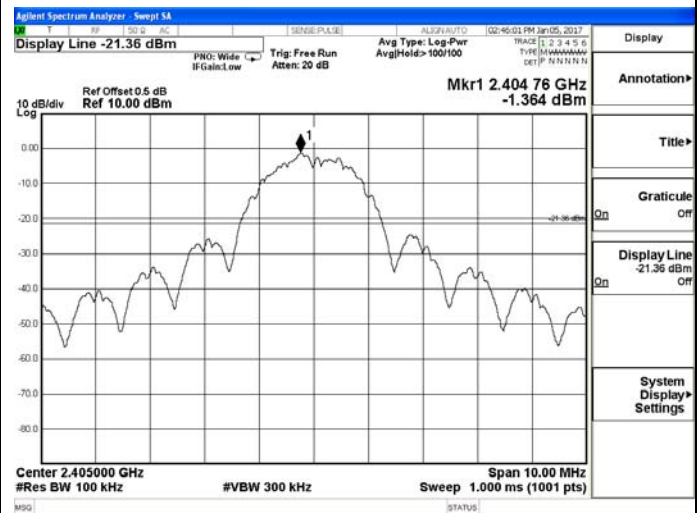
Temperature	25℃	Humidity	60%
Test Engineer	Jakcy	Configurations	BT LE & Zigbee

Mode	Channel	Frequency (MHz)	Mearsured Power Density (dBm/100KHz)	Max. Limit (dBm/3KHz)	Result
BT LE	1	2402	1.916	8	Complies
	19	2440	1.829	8	Complies
	40	2480	1.931	8	Complies
Zigbee	1	2405	-1.364	8	Complies
	8	2440	-1.521	8	Complies
	16	2480	-1.377	8	Complies

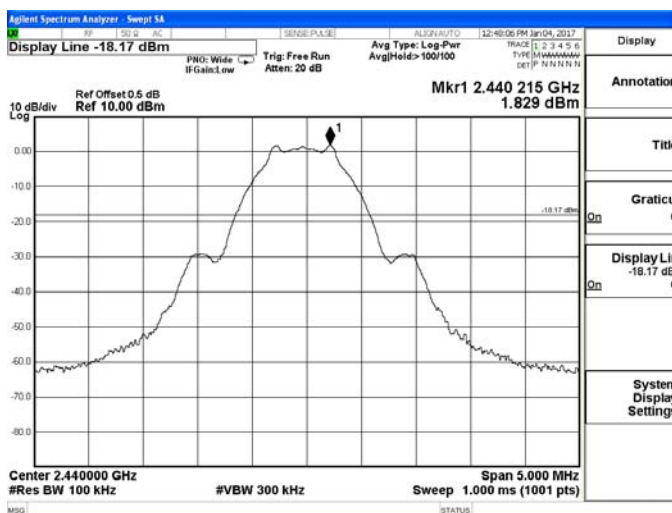
## Test plot of Power Spectral Density



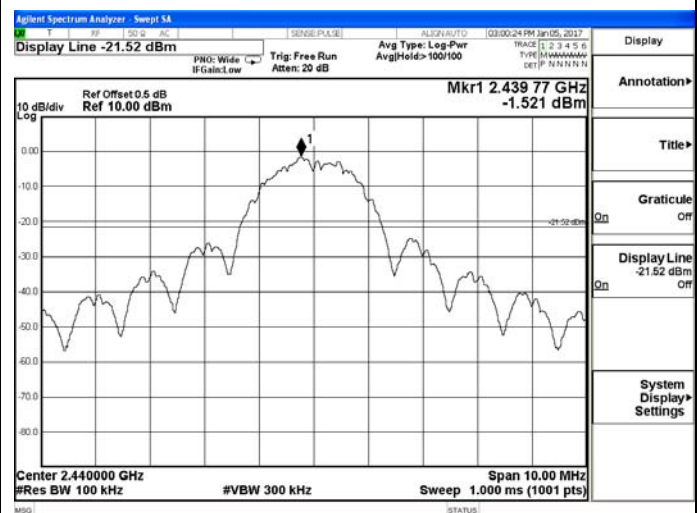
BT LE-Low channel



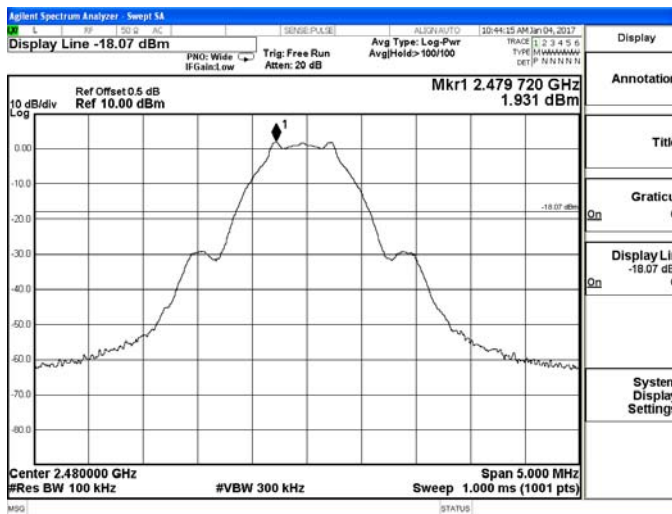
Zigbee-Low channel



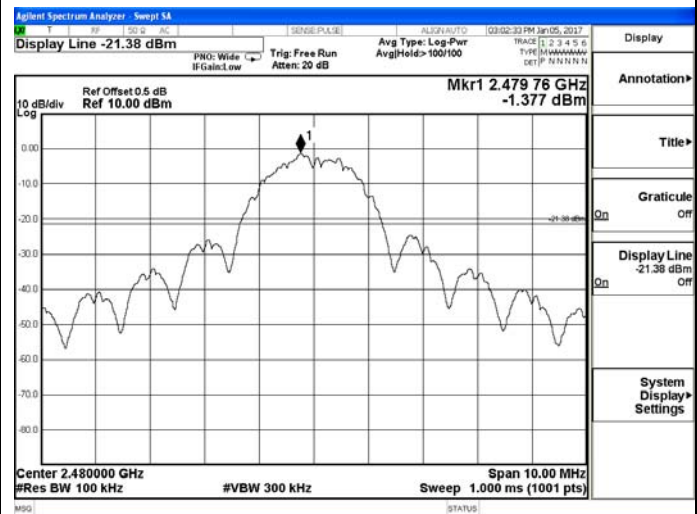
BT LE-Middle channel



Zigbee-Middle channel



BT LE-High channel



Zigbee-High channel



## 5.4. 6 dB and 99% Spectrum Bandwidth Measurement

### 5.4.1. Standard Applicable

According to §15.247(a)(2) and RSS-247§5.2(1): For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.4.2. Measuring Instruments and Setting

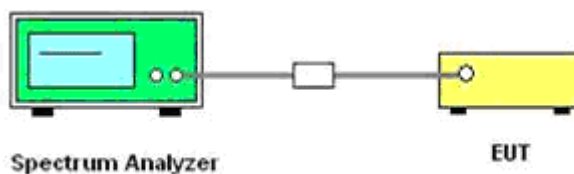
Please refer to section 6 of equipments list in this report. The following table is the setting of the Spectrum Analyzer.

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

### 5.4.3. Test Procedures

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

### 5.4.4. Test Setup Layout



### 5.4.5. EUT Operation during Test

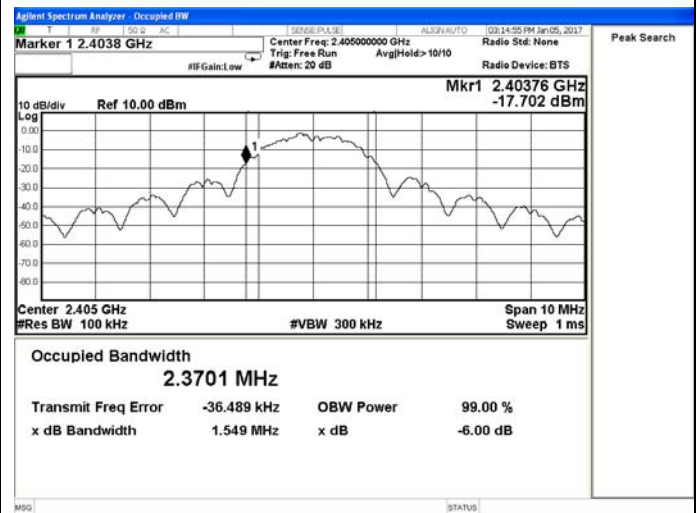
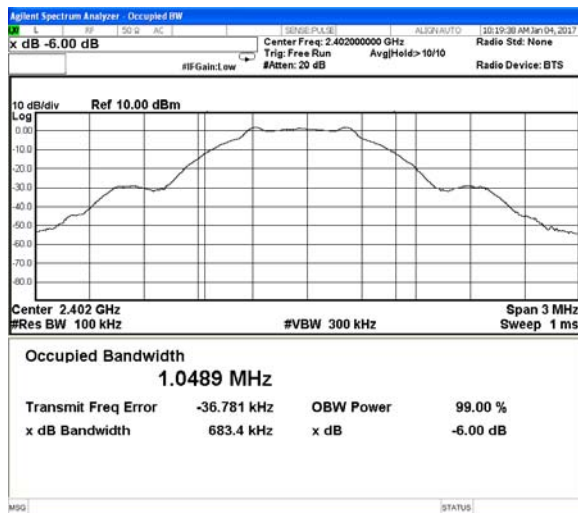
The EUT was programmed to be in continuously transmitting mode.

## 5.4.6. Test Result of 6dB Spectrum Bandwidth

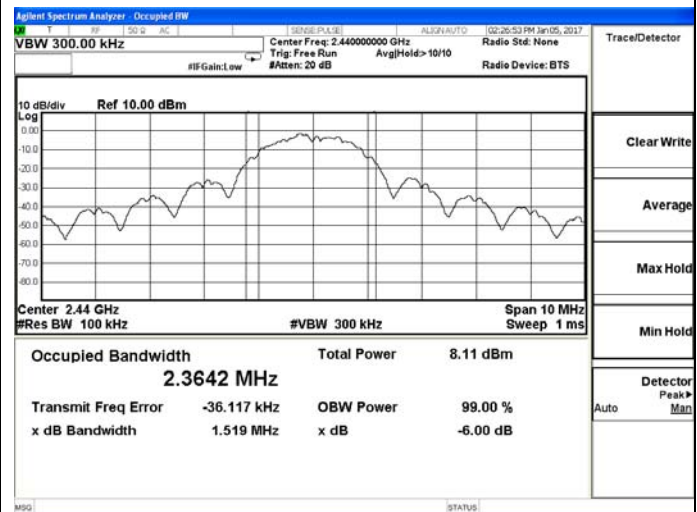
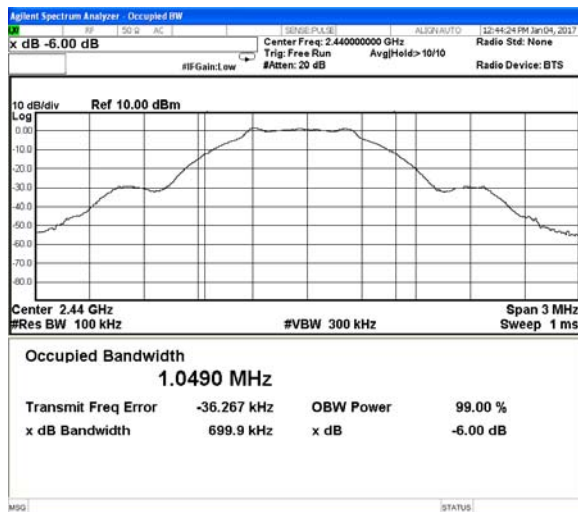
Temperature	25°C	Humidity	60%
Test Engineer	Jacky	Configurations	BT LE & Zigbee

Mode	Channel	Frequency	6dB Bandwidth (kHz)	Min. Limit (kHz)	Result	99%dB Bandwidth (MHz) (Only for IC)
BT LE	1	2402	683.4	500	Complies	1.0357
	19	2440	699.9	500	Complies	1.0366
	40	2480	686.8	500	Complies	1.0256
Zigbee	1	2405	1549.0	500	Complies	2.3016 (F <sub>L</sub> :2403.99)
	8	2440	1519.0	500	Complies	2.2960
	16	2480	1533.0	500	Complies	2.2983 (F <sub>H</sub> :2481.00)

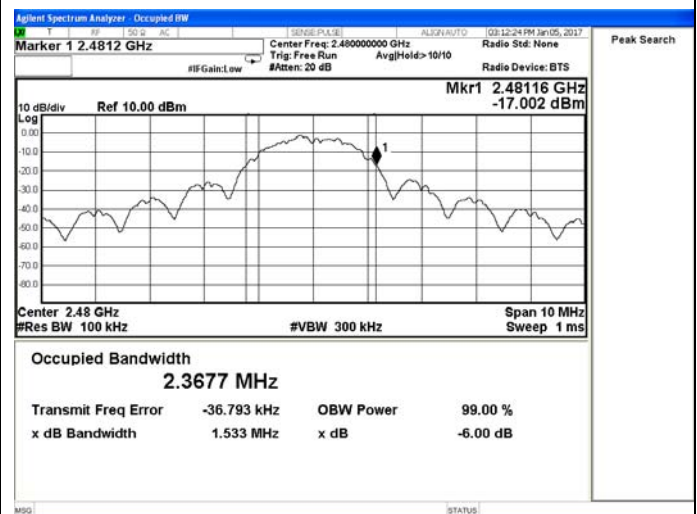
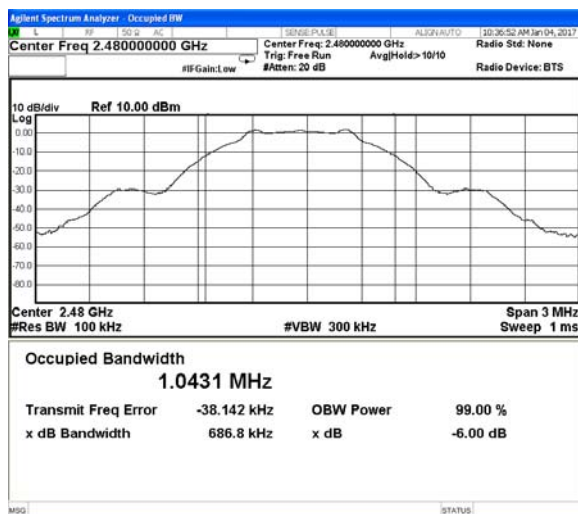
## Test plot of 6 dB Bandwidth



## BT LE-Low channel



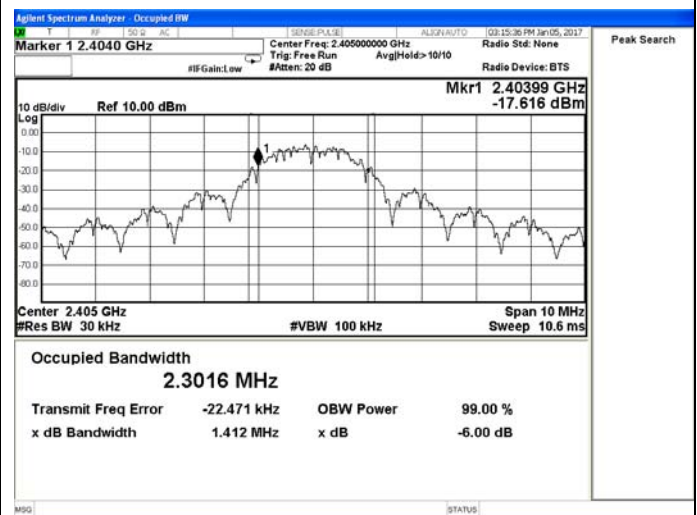
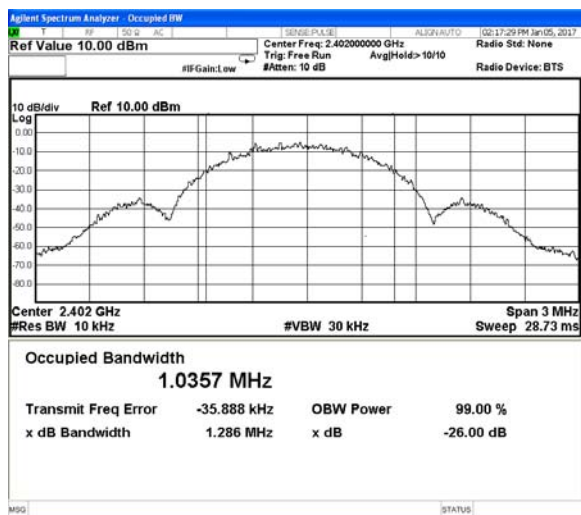
## BT LE-Middle channel



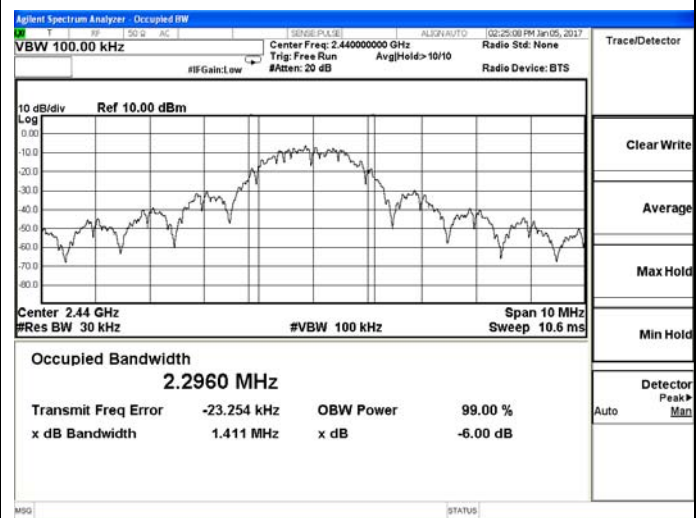
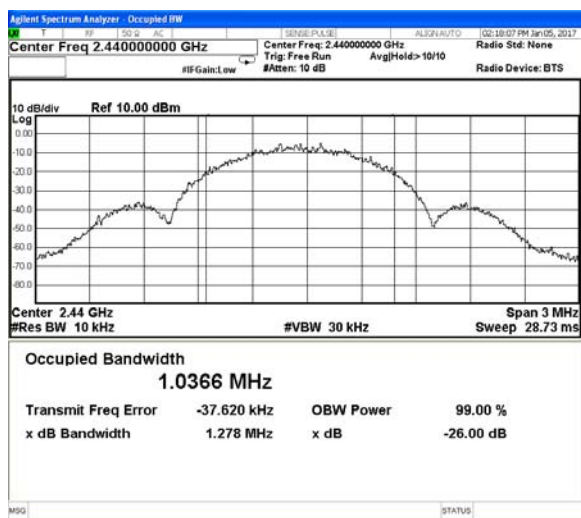
## BT LE-High channel

## Zigbee-High channel

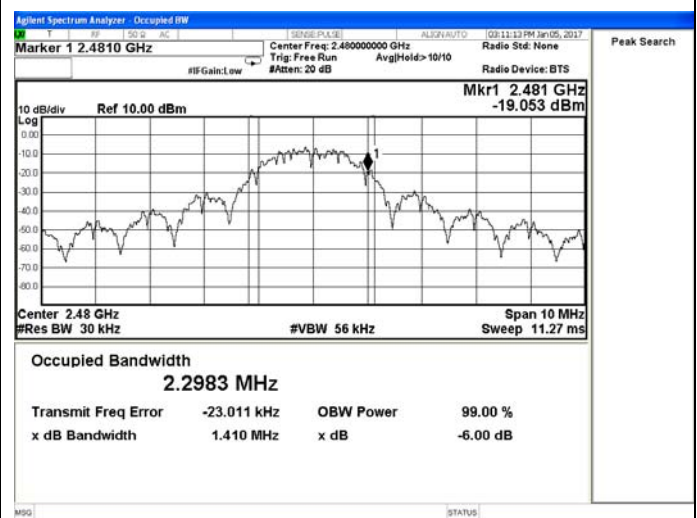
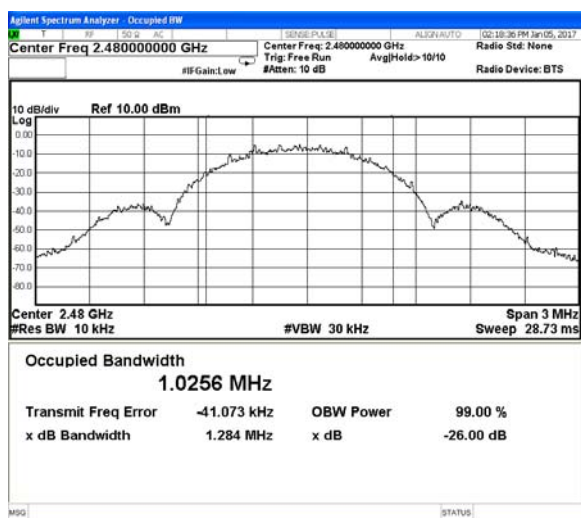
## Test plot of 99% dB Bandwidth



## BT LE-Low channel



## BT LE-Middle channel



## BT LE-High channel

## Zigbee-High channel

## 5.5. Radiated Emissions Measurement

### 5.5.1. Standard Applicable

#### For FCC:

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

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

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

\2\ Above 38.6

#### For IC RSS-GEN §8.10:

Restricted bands, identified in Table 6, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:

(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 6 except for apparatus complying under RSS-287;

(b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and

(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

MHz	MHz	MHz	GHz
0.090-0.110	12.51975-12.52025	399.9-410	5.35-5.46
2.1735-2.1905	12.57675-12.57725	608-614	7.25-7.75
3.020-3.026	13.36-13.41	960-1427	8.025-8.5
4.125-4.128	16.42-16.423	1435-1626.5	9.0-9.2
4.17725-4.17775	16.69475-16.69525	1645.5-1646.5	9.3-9.5
4.20725-4.20775	16.80425-16.80475	1660-1710	10.6-12.7
5.677-5.683	25.5-25.67	1718.8-1722.2	13.25-13.4
6.215-6.218	37.5-38.25	2200-2300	14.47-14.5
6.26775-6.26825	73-74.6	2310-2390	15.35-16.2
6.31175-6.31225	74.8-75.2	2690-2900	17.7-21.4
8.291-8.294	108-138	3260-3267	22.01-23.12
8.362-8.366	156.52475-156.52525	3332-3339	23.6-24.0
8.37625-8.38675	156.7-156.9	3345.8-3358	31.2-31.8
8.41425-8.41475	240-285	3500-4400	36.43-36.5
12.29-12.293.	322-335.4	4500~5150	Above 38.6

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

According to RSS-GEN§8.9: Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in the Table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

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

According to RSS-GEN§7.1.2: Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 5x the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

## 5.5.2. Measuring Instruments and Setting

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

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

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB 100kHz for QP

### 5.5.3. Test Procedures

#### 1) Sequence of testing 9 kHz to 30 MHz

##### **Setup:**

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.
- If the EUT is a floor standing device, it is placed on the ground.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

##### **Premeasurement:**

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 0.8 meter.
- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

##### **Final measurement:**

- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).
- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.
- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.



## 2) Sequence of testing 30 MHz to 1 GHz

### Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

### Premeasurement:

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 to 3 meter.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

### Final measurement:

- The final measurement will be performed with minimum the six highest peaks.
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ( $\pm 45^\circ$ ) and antenna movement between 1 and 4 meter.
- The final measurement will be done with QP detector with an EMI receiver.
- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

### 3) Sequence of testing 1 GHz to 18 GHz

#### Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

#### Premeasurement:

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height scan range is 1 meter to 2.5 meter.
- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

#### Final measurement:

- The final measurement will be performed with minimum the six highest peaks.
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ( $\pm 45^\circ$ ) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.
- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

#### 4) Sequence of testing above 18 GHz

**Setup:**

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 1 meter.
- The EUT was set into operation.

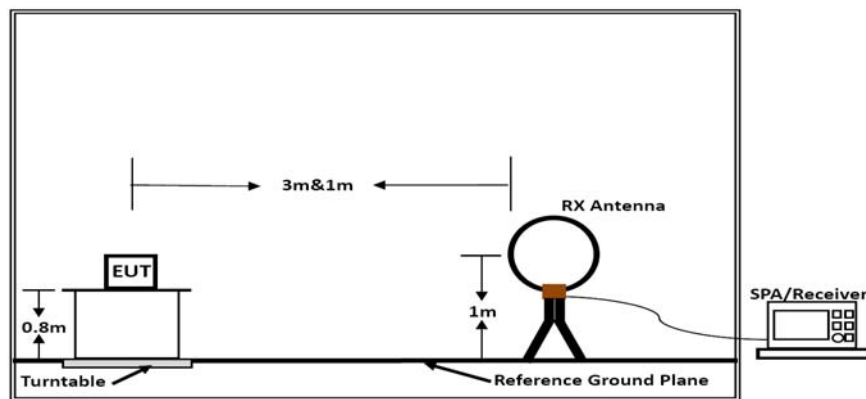
**Premeasurement:**

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

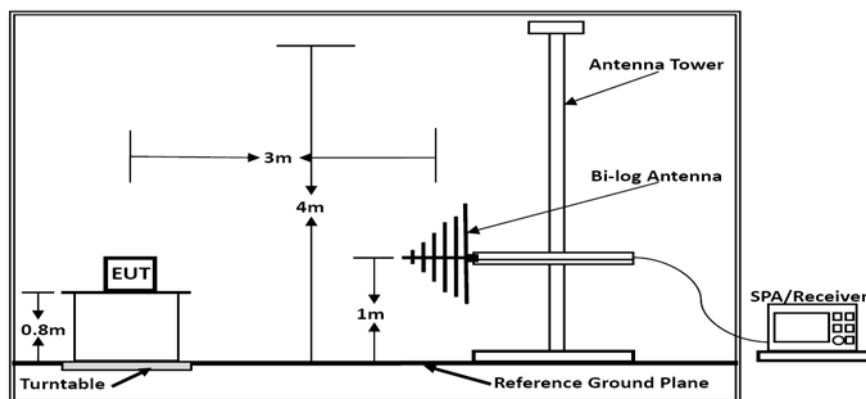
**Final measurement:**

- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

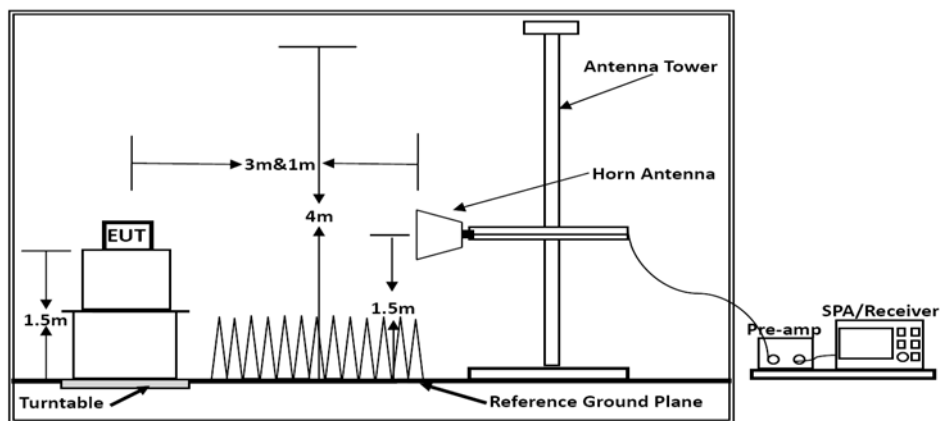
## 5.5.4. Test Setup Layout



Below 30MHz



Below 1GHz



Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from 3m to 1.5m.

Distance extrapolation factor =  $20 \log (\text{specific distance [3m]} / \text{test distance [1.5m]})$  (dB);  
 Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

## 5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

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

Temperature	25°C	Humidity	60%
Test Engineer	Jacky	Configurations	BT LE & Zigbee

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

## Note:

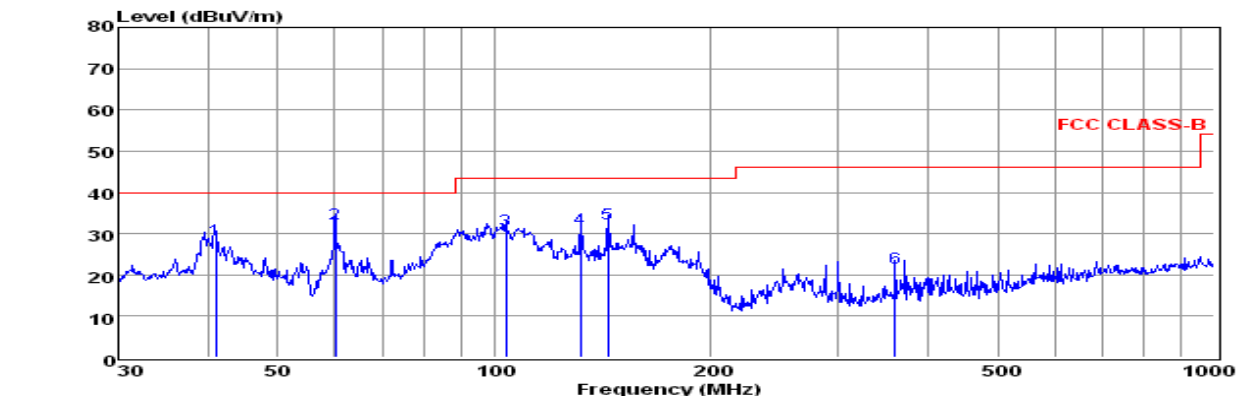
The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor =  $40 \log (\text{specific distance} / \text{test distance})$  (dB);

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

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

Temperature	25℃	Humidity	60%
Test Engineer	Jacky	Configurations	Zigbee (High CH)



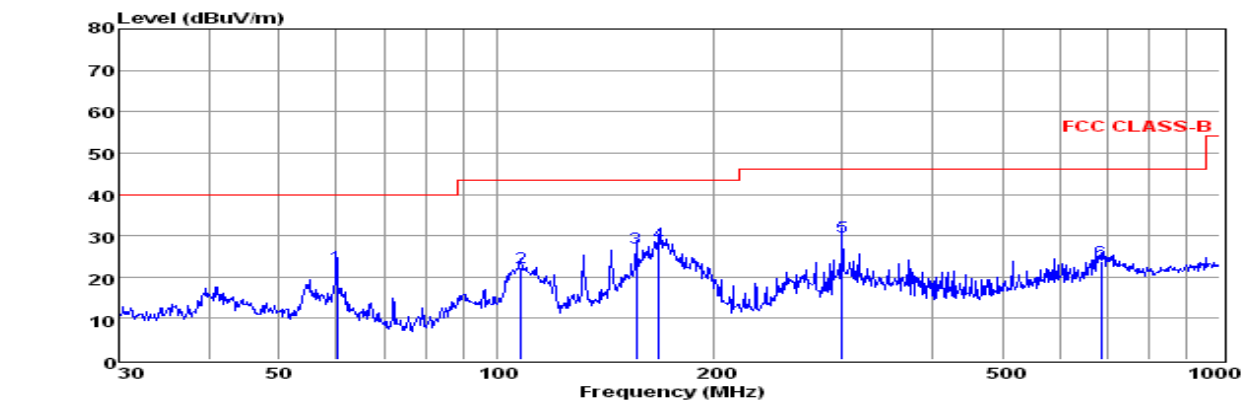
Env./Ins: 24℃/56%  
pol: VERTICAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	40.99	14.47	0.50	13.57	28.54	40.00	-11.46	QP
2	60.07	19.18	0.49	12.66	32.33	40.00	-7.67	QP
3	103.81	17.57	0.61	12.81	30.99	43.50	-12.51	QP
4	131.76	21.77	0.76	8.80	31.33	43.50	-12.17	QP
5	143.83	23.50	0.71	8.22	32.43	43.50	-11.07	QP
6	360.45	6.02	1.18	14.43	21.63	46.00	-24.37	QP

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

2. Measured= Reading + Antenna Factor + Cable Loss

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



Env./Ins: 24℃/56%  
pol: HORIZONTAL

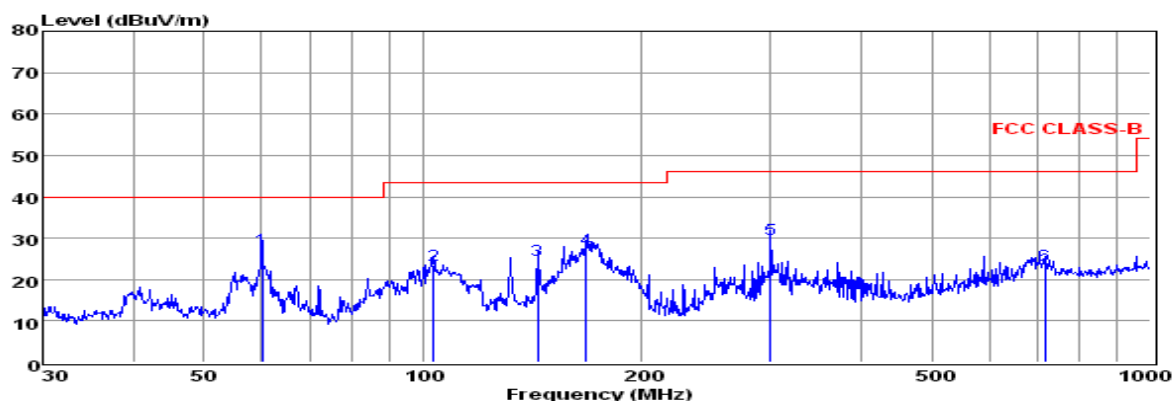
	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	60.07	9.47	0.49	12.66	22.62	40.00	-17.38	QP
2	107.89	9.17	0.68	12.44	22.29	43.50	-21.21	QP
3	155.91	17.73	0.76	8.50	26.99	43.50	-16.51	QP
4	167.82	18.52	0.77	8.90	28.19	43.50	-15.31	QP
5	300.37	15.66	1.13	13.06	29.85	46.00	-16.15	QP
6	684.75	3.52	1.60	18.76	23.88	46.00	-22.12	QP

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

2. Measured= Reading + Antenna Factor + Cable Loss

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

Temperature	25°C	Humidity	60%
Test Engineer	Jacky	Configurations	Zigbee RX Mode(Only for IC)



Env./Ins: 24°C/56%  
 pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	60.07	14.29	0.49	12.66	27.44	40.00	-12.56	QP
2	103.44	10.02	0.61	12.85	23.48	43.50	-20.02	QP
3	143.83	15.77	0.71	8.22	24.70	43.50	-18.80	QP
4	167.82	17.69	0.77	8.90	27.36	43.50	-16.14	QP
5	300.37	15.50	1.13	13.06	29.69	46.00	-16.31	QP
6	716.68	2.87	1.69	19.02	23.58	46.00	-22.42	QP

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

#### Note:

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

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

## Transmit Spurious Emissions(TX Mode)

## BT LE Channel 1

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4804.00	51.80	33.06	35.04	3.94	53.76	74	-20.24	Peak	Horizontal
4804.00	36.07	33.06	35.04	3.94	38.03	54	-15.97	Average	Horizontal
4804.00	52.19	33.06	35.04	3.94	54.15	74	-19.85	Peak	Vertical
4804.00	38.49	33.06	35.04	3.94	40.45	54	-13.55	Average	Vertical

## BT LE Channel 19

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4880.00	52.75	33.16	35.15	3.96	54.72	74	-19.28	Peak	Horizontal
4880.00	37.49	33.16	35.15	3.96	39.46	54	-14.54	Average	Horizontal
4880.00	53.86	33.16	35.15	3.96	55.83	74	-18.17	Peak	Vertical
4880.00	38.19	33.16	35.15	3.96	40.16	54	-13.84	Average	Vertical

## BT LE Channel 40

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.00	50.92	33.26	35.14	3.98	53.02	74	-20.98	Peak	Horizontal
4960.00	35.16	33.26	35.14	3.98	37.26	54	-16.74	Average	Horizontal
4960.00	53.31	33.26	35.14	3.98	55.41	74	-18.59	Peak	Vertical
4960.00	39.65	33.26	35.14	3.98	41.75	54	-12.25	Average	Vertical

## BT LE Receiver Spurious Emissions(RX Mode, Only for IC)

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
2402.45	48.38	32.66	33.18	3.16	51.02	74	-22.98	Peak	Horizontal
2402.45	33.77	32.66	33.18	3.16	36.41	54	-17.59	Average	Horizontal
4804.62	48.93	33.06	35.04	3.94	50.89	74	-23.11	Peak	Horizontal
4804.62	32.71	33.06	35.04	3.94	34.67	54	-19.33	Average	Horizontal
2402.45	50.61	32.66	33.18	3.16	53.25	74	-20.75	Peak	Vertical
2402.45	34.39	32.66	33.18	3.16	37.03	54	-16.97	Average	Vertical
4804.62	48.45	33.06	35.04	3.94	50.41	74	-23.59	Peak	Vertical
4804.62	33.29	33.06	35.04	3.94	35.25	54	-18.75	Average	Vertical



## Transmit Spurious Emissions(TX Mode)

## Zigbee Channel 1

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4810.00	53.83	33.09	35.08	3.94	55.78	74	-18.22	Peak	Horizontal
4810.00	38.20	33.09	35.08	3.94	40.15	54	-13.85	Average	Horizontal
4810.00	56.27	33.09	35.08	3.94	58.22	74	-15.78	Peak	Vertical
4810.00	40.58	33.09	35.08	3.94	42.53	54	-11.47	Average	Vertical

## Zigbee Channel 8

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4880.00	52.72	33.16	35.15	3.96	54.69	74	-19.31	Peak	Horizontal
4880.00	37.05	33.16	35.15	3.96	39.02	54	-14.98	Average	Horizontal
4880.00	55.44	33.16	35.15	3.96	57.41	74	-16.59	Peak	Vertical
4880.00	39.41	33.16	35.15	3.96	41.38	54	-12.62	Average	Vertical

## Zigbee Channel 16

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.00	52.28	33.26	35.14	3.98	54.38	74	-19.62	Peak	Horizontal
4960.00	37.98	33.26	35.14	3.98	40.08	54	-13.92	Average	Horizontal
4960.00	54.91	33.26	35.14	3.98	57.01	74	-16.99	Peak	Vertical
4960.00	40.77	33.26	35.14	3.98	42.87	54	-11.13	Average	Vertical

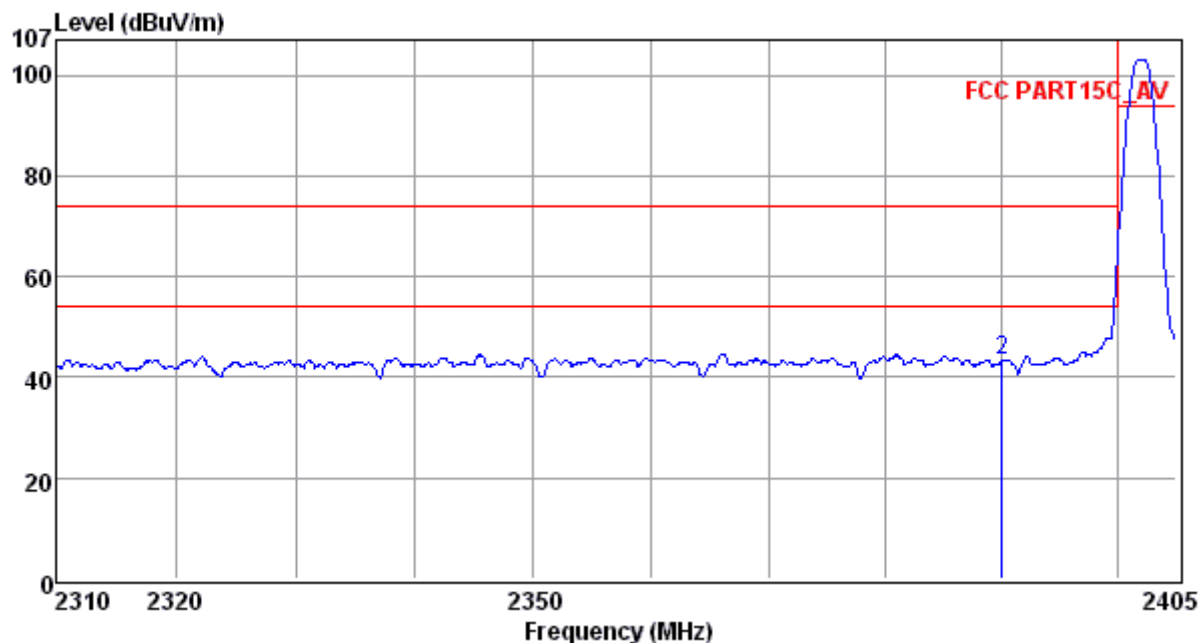
## Zigbee Receiver Spurious Emissions(RX Mode, Only for IC)

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
2405.14	48.50	32.67	33.16	3.15	51.16	74	-22.84	Peak	Horizontal
2405.14	33.78	32.67	33.16	3.15	36.44	54	-17.56	Average	Horizontal
4810.46	48.32	33.05	35.07	3.95	50.25	74	-23.75	Peak	Horizontal
4810.46	33.10	33.05	35.07	3.95	35.03	54	-18.97	Average	Horizontal
2405.14	51.12	32.67	33.16	3.15	53.78	74	-20.22	Peak	Vertical
2405.14	34.49	32.67	33.16	3.15	37.15	54	-16.85	Average	Vertical
4810.46	49.59	33.05	35.07	3.95	51.52	74	-22.48	Peak	Vertical
4810.46	34.76	33.05	35.07	3.95	36.69	54	-17.31	Average	Vertical

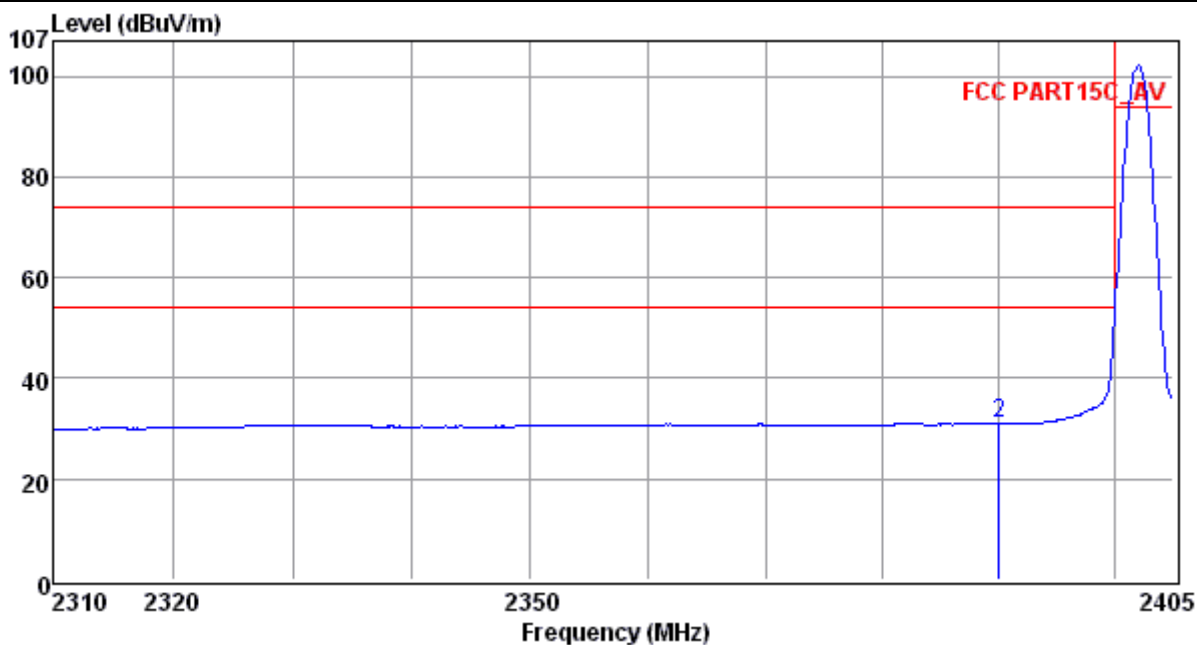
## Notes:

- 1). Measuring frequencies from 9k~10th harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.
- 2). Radiated emissions measured in frequency range from 9k~10th harmonic or 26.5GHz (which is less) were made with an instrument using Peak detector mode.
- 3). Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

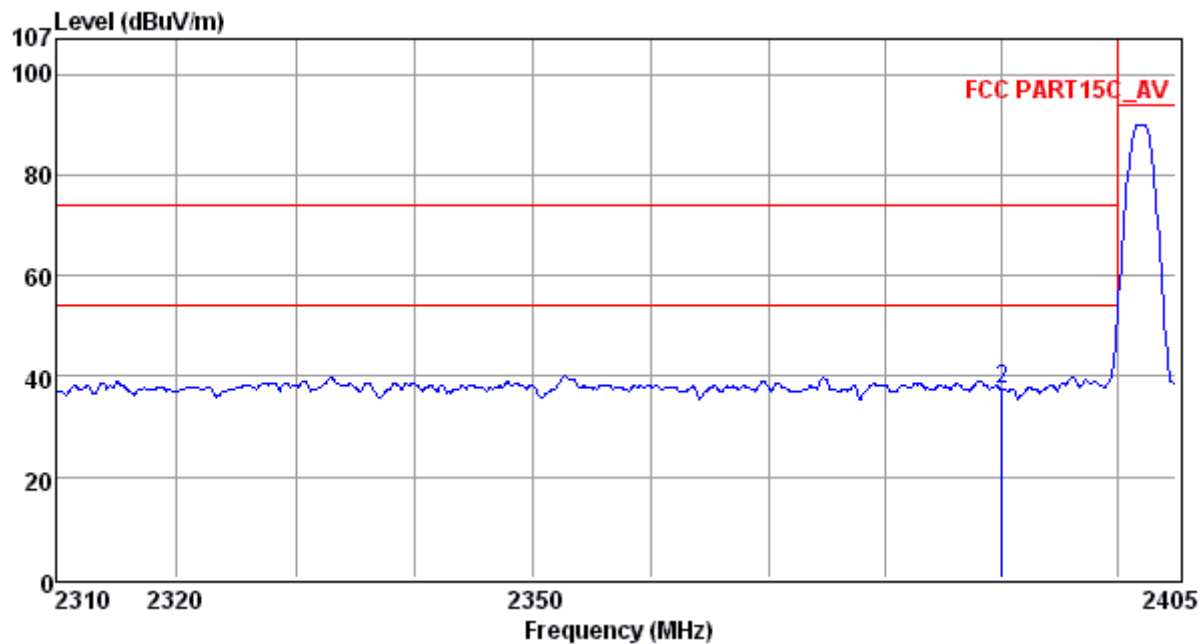
## 5.5.9. Results of Restricted Bands Test

**Test plot of Restricted Bands-Bluetooth LE Low channel(Horizontal)**

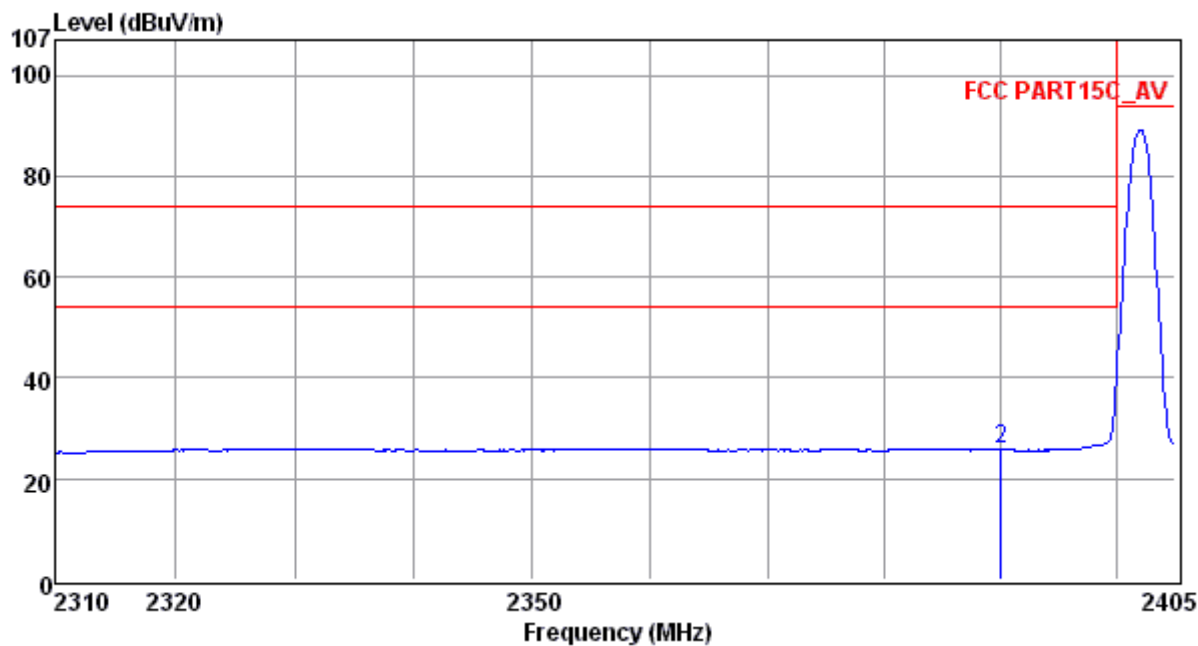
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	42.06	74.00	-31.94	Peak	Pass
2390.00	43.30	74.00	-30.70	Peak	Pass



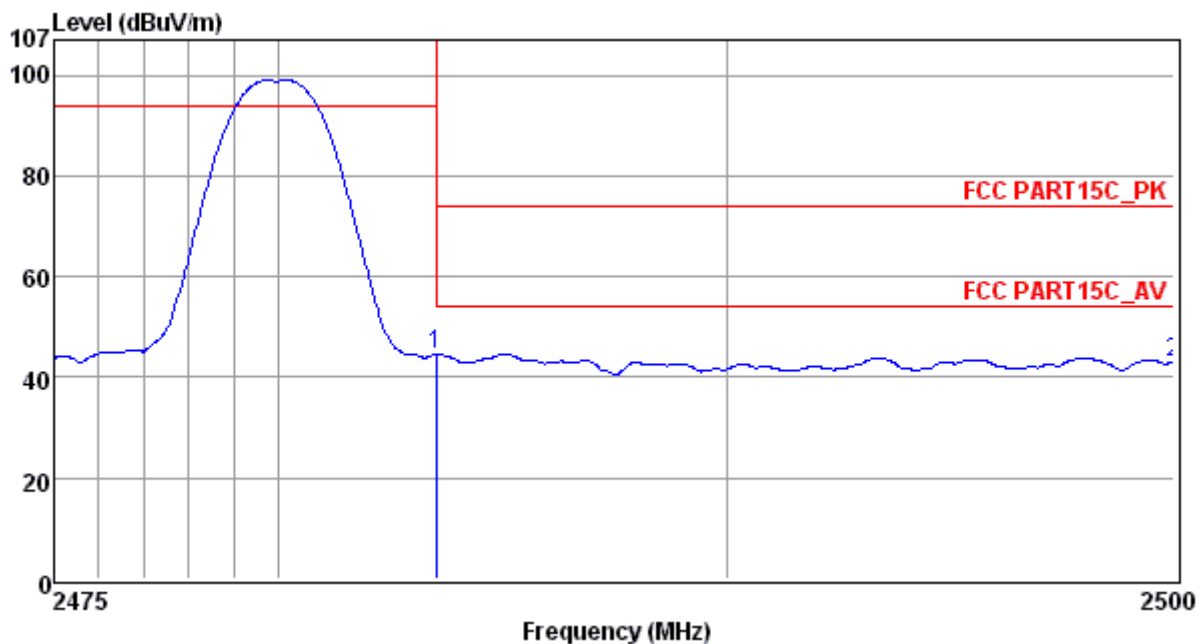
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	29.80	54.00	-24.20	Average	Pass
2390.00	30.97	54.00	-23.03	Average	Pass

**Test plot of Restricted Bands-Bluetooth LE Low channel(Vertical)**

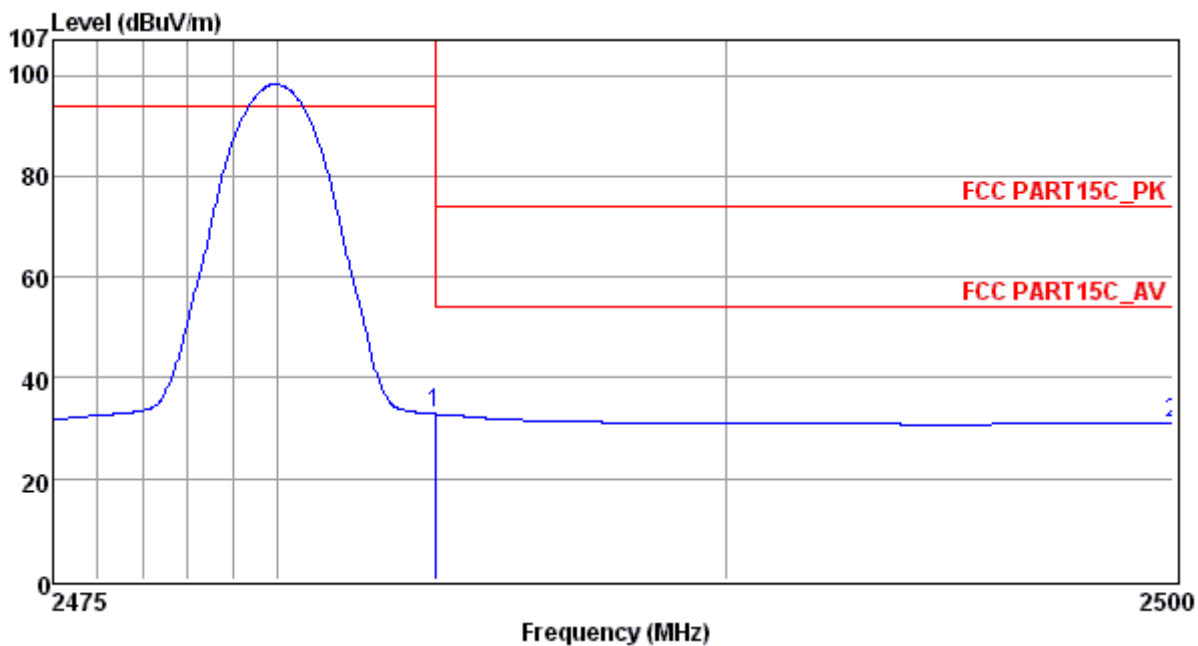
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	37.28	74.00	-36.72	Peak	Pass
2390.00	37.37	74.00	-36.63	Peak	Pass



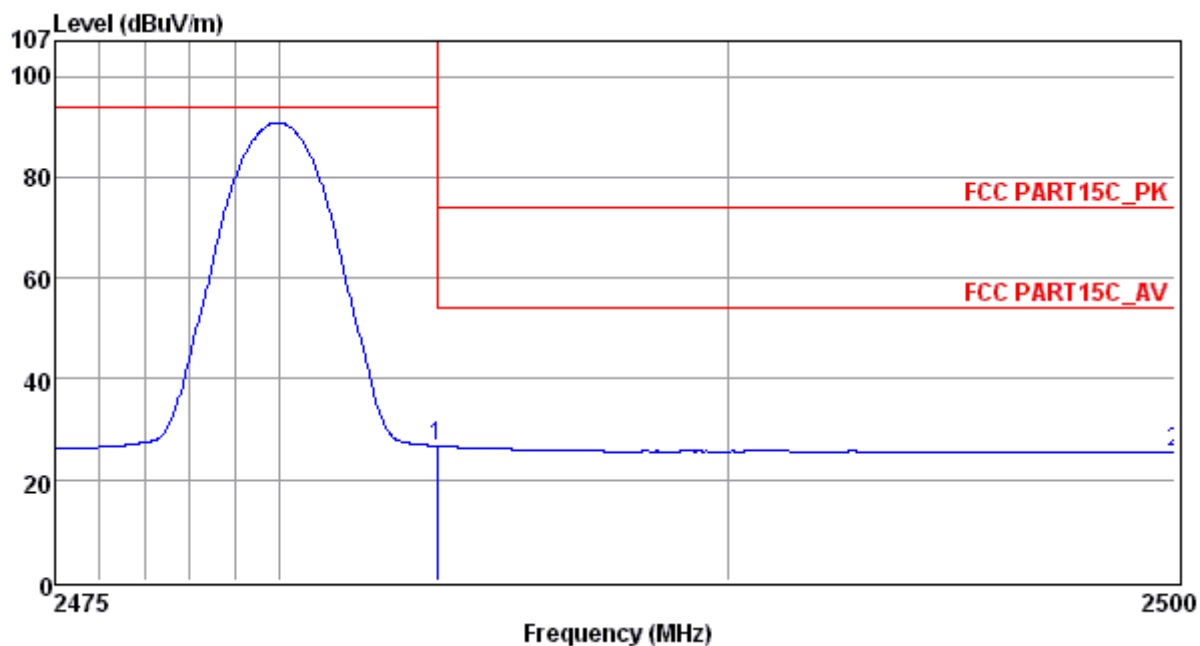
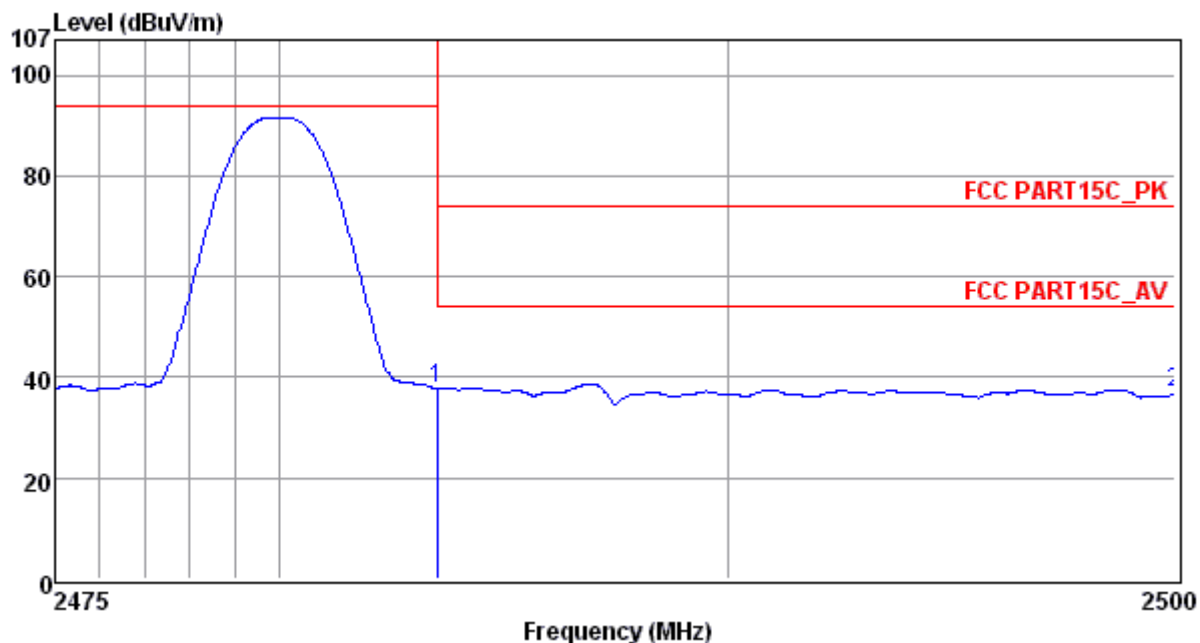
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	25.23	54.00	-28.77	Average	Pass
2390.00	25.86	54.00	-28.14	Average	Pass

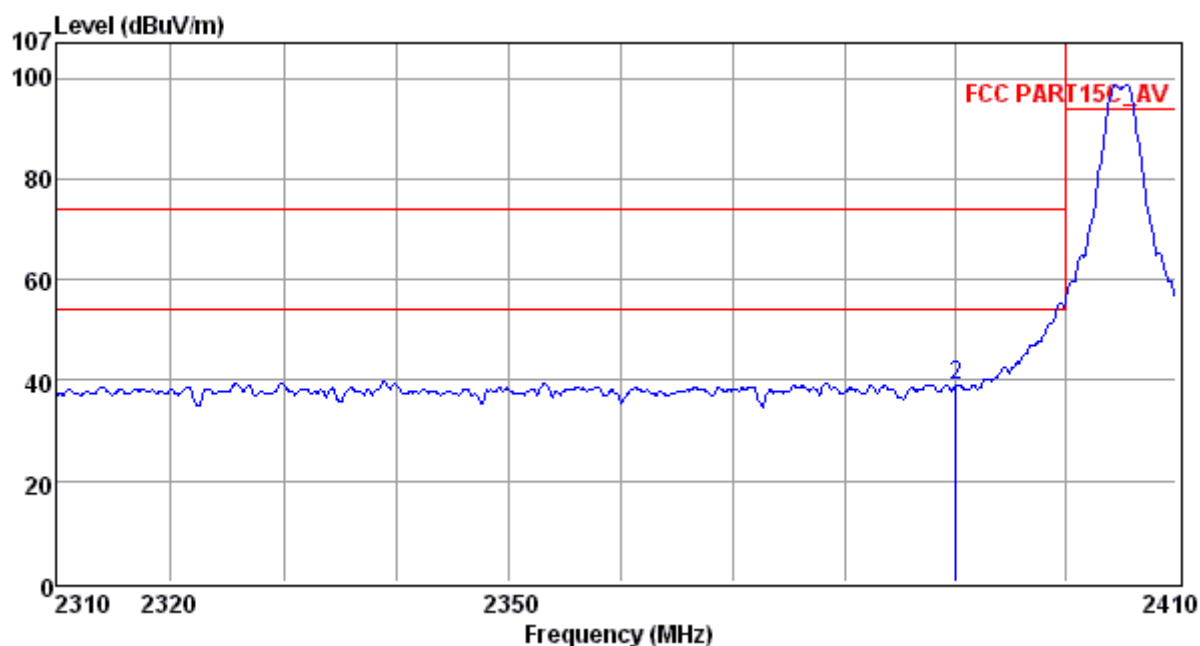
**Test plot of Restricted Bands-Bluetooth LE High channel(Horizontal)**

Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2483.50	44.49	74.00	-29.51	Peak	Pass
2500.00	43.05	74.00	-30.95	Peak	Pass

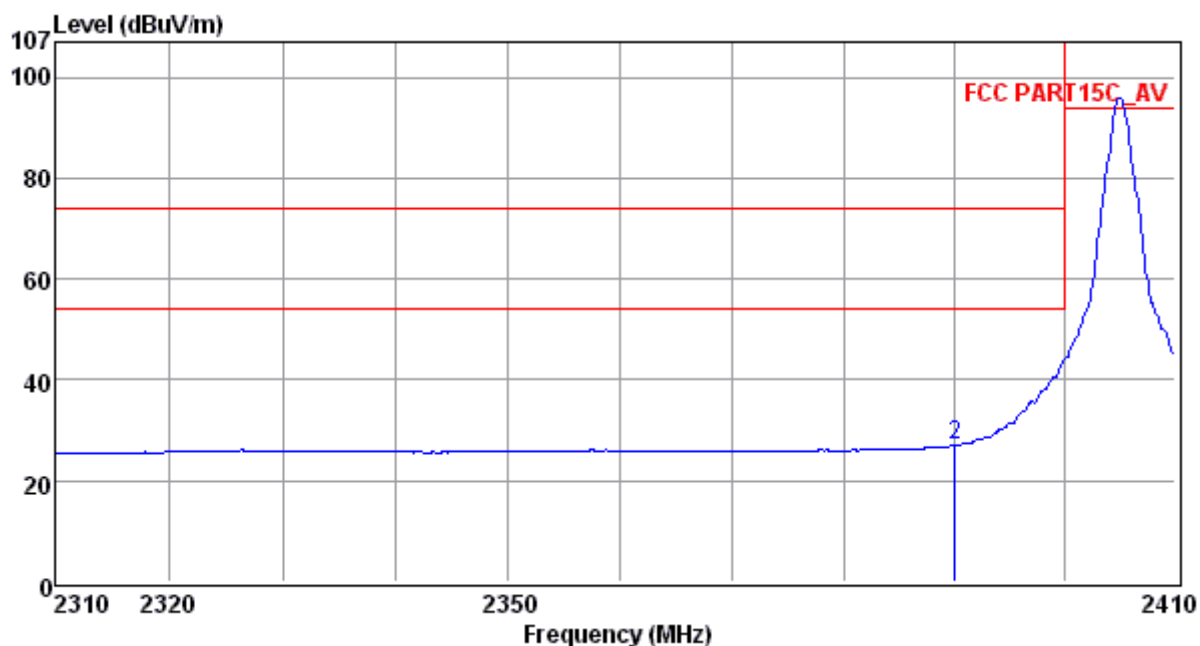


Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2483.50	32.84	54.00	-21.16	Average	Pass
2500.00	30.92	54.00	-23.08	Average	Pass

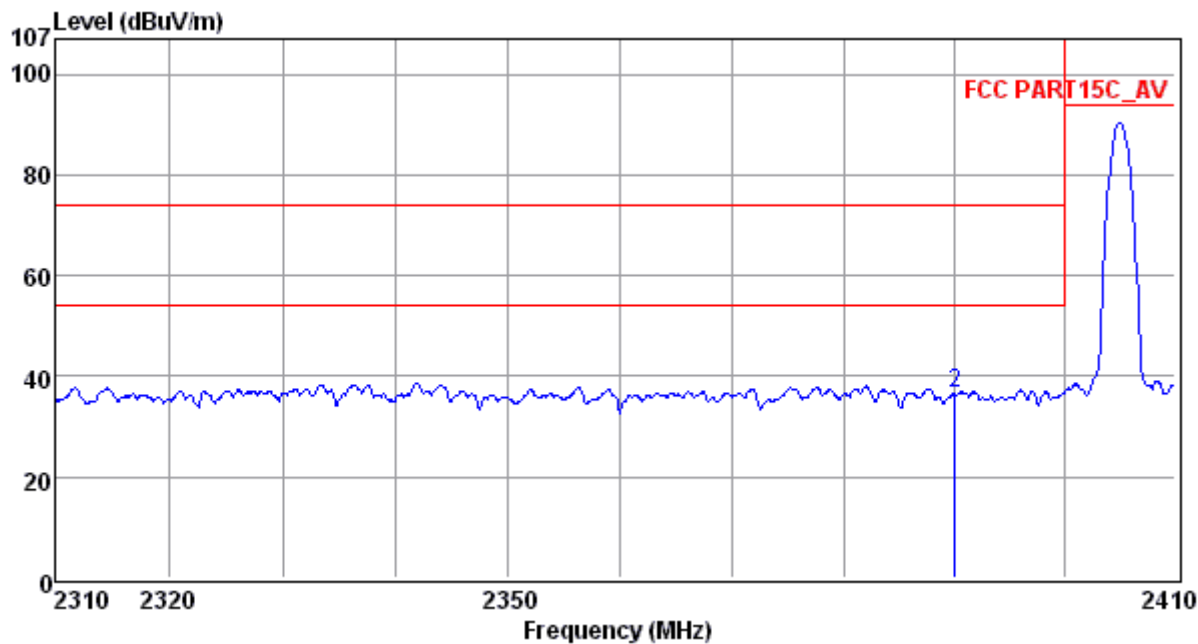
**Test plot of Restricted Bands-Bluetooth LE High channel(Vertical)**

**Test plot of Restricted Bands-Zigbee Low channel(Horizontal)**

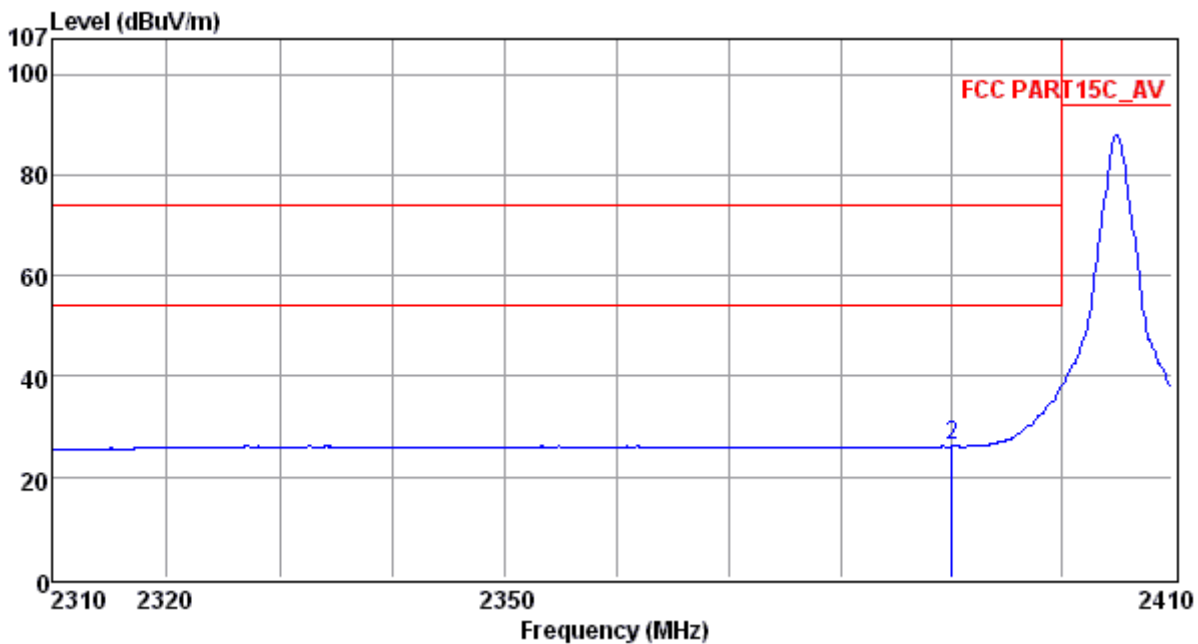
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	37.08	74.00	-36.92	Peak	Pass
2390.00	39.09	74.00	-34.91	Peak	Pass



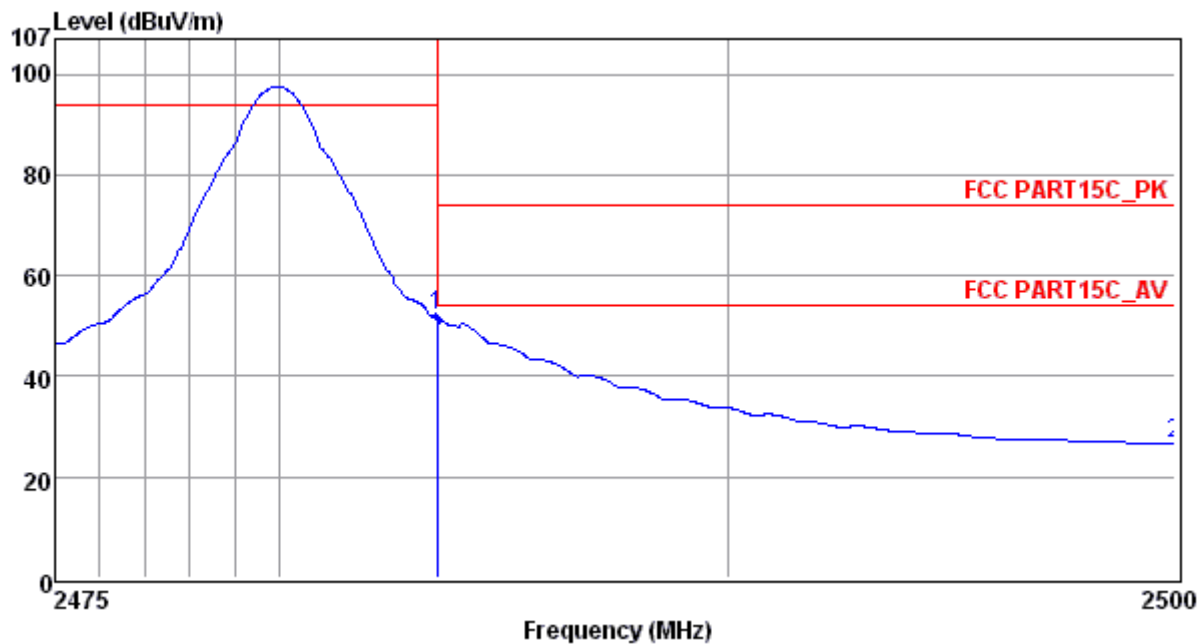
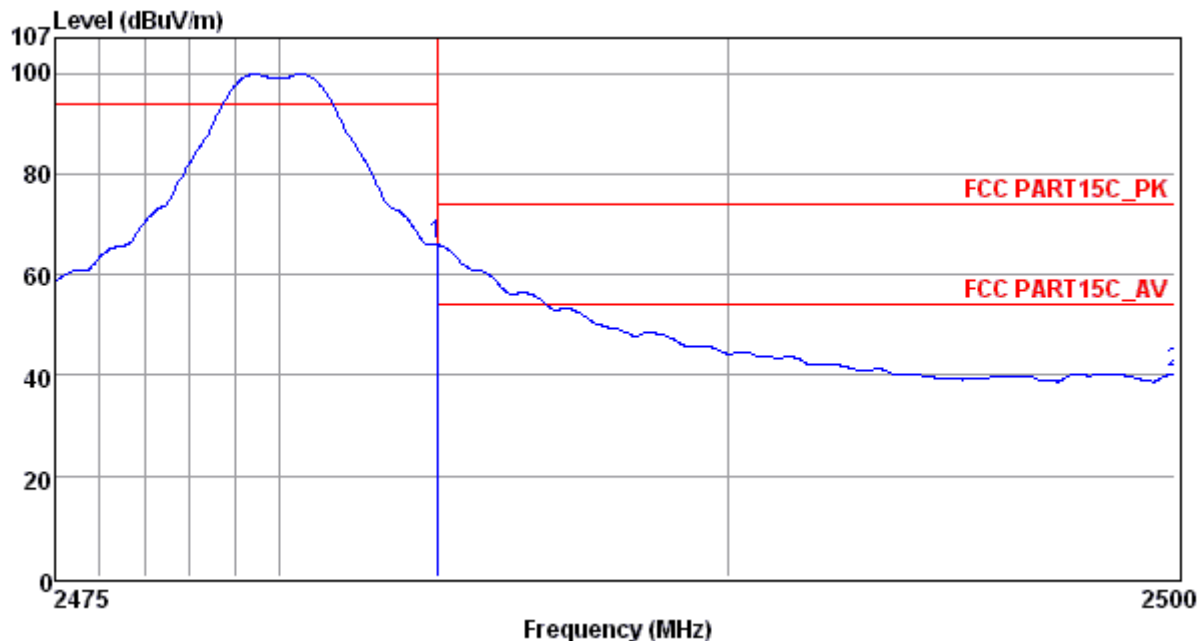
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	25.32	54.00	-28.68	Average	Pass
2390.00	27.15	54.00	-26.85	Average	Pass

**Test plot of Restricted Bands-Zigbee Low channel(Vertical)**

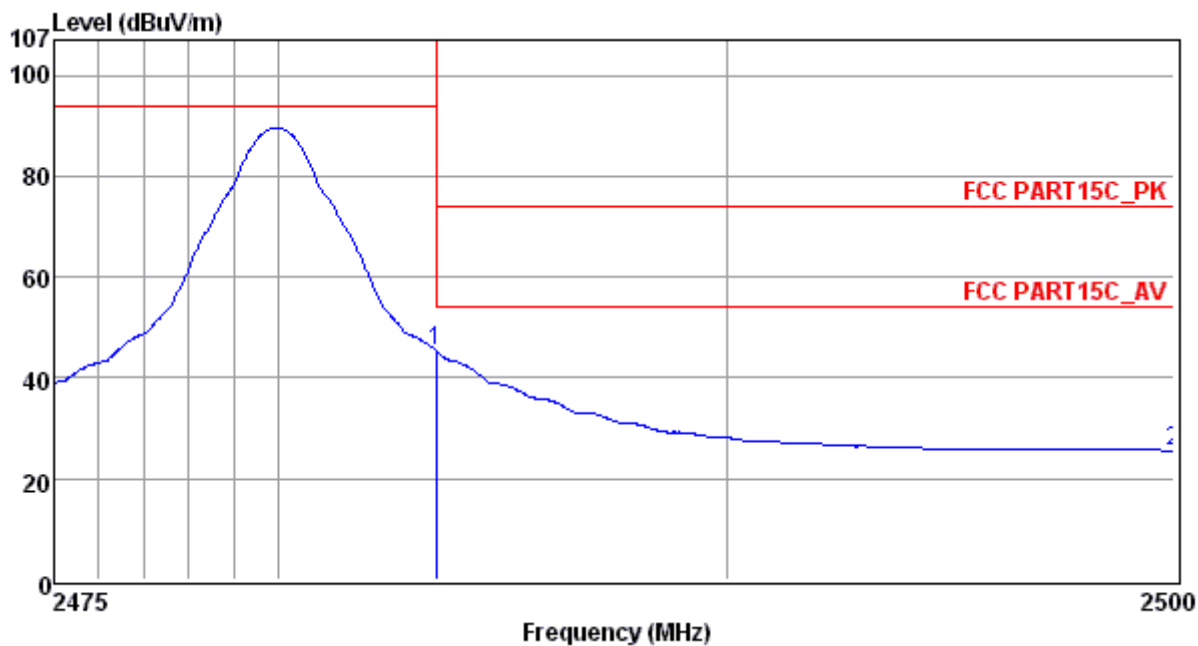
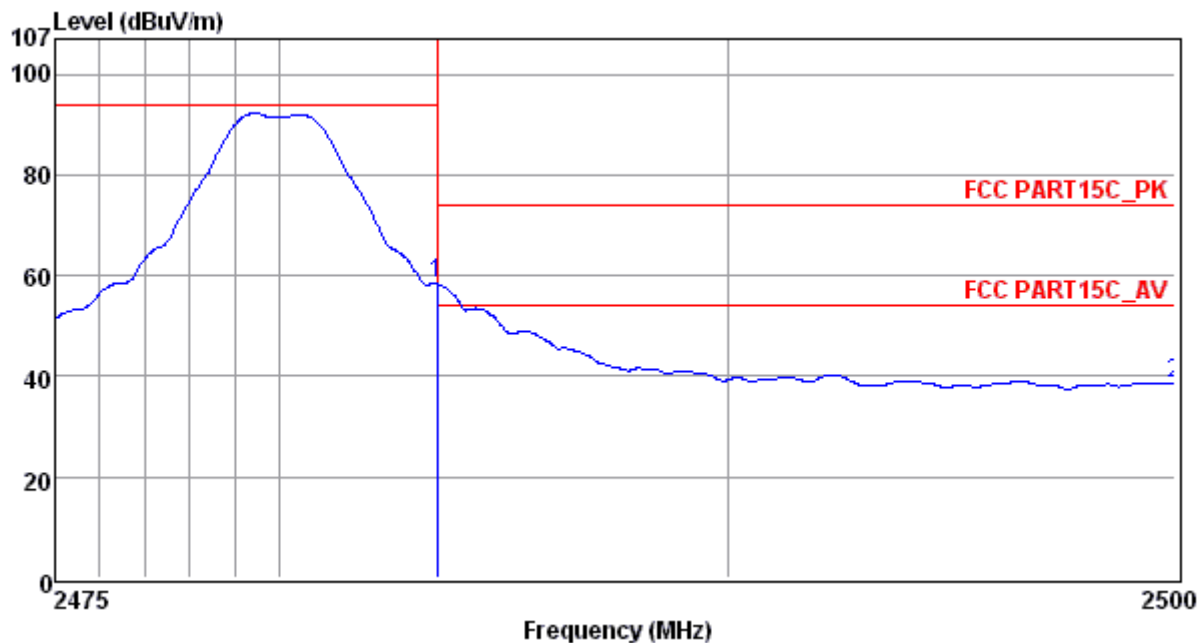
Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	35.70	74.00	-38.30	Peak	Pass
2390.00	36.44	74.00	-37.56	Peak	Pass



Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Result
2310.00	25.39	54.00	-28.61	Average	Pass
2390.00	26.07	54.00	-27.93	Average	Pass

**Test plot of Restricted Bands-Zigbee High channel(Horizontal)**



**Test plot of Restricted Bands-Zigbee High channel(Vertical)**

## 5.6. Conducted Spurious Emissions and Band Edges Test

### 5.6.1. Standard Applicable

According to §15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to RSS-247§5.5: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

### 5.6.2. Measuring Instruments and Setting

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

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

### 5.6.3. Test Procedures

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

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

### 5.6.4. Test Setup Layout

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

### 5.6.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

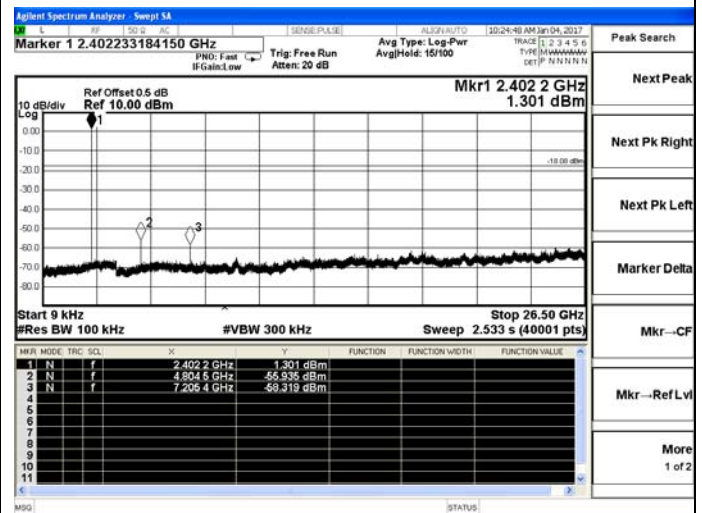
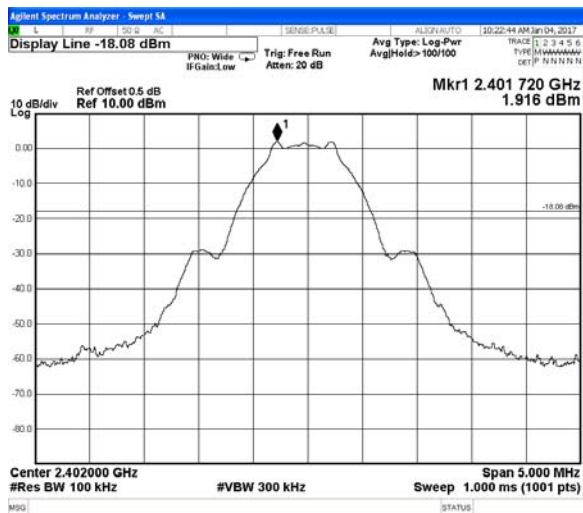
## 5.6.6. Test Results of Conducted Spurious Emissions

Test Mode	Channel	Frequency (MHz)	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
BT LE	1	2402	<-20	-20	PASS
	19	2440	<-20		
	40	2480	<-20		
Zigbee	1	2405	<-20	-20	PASS
	8	2440	<-20		
	16	2480	<-20		

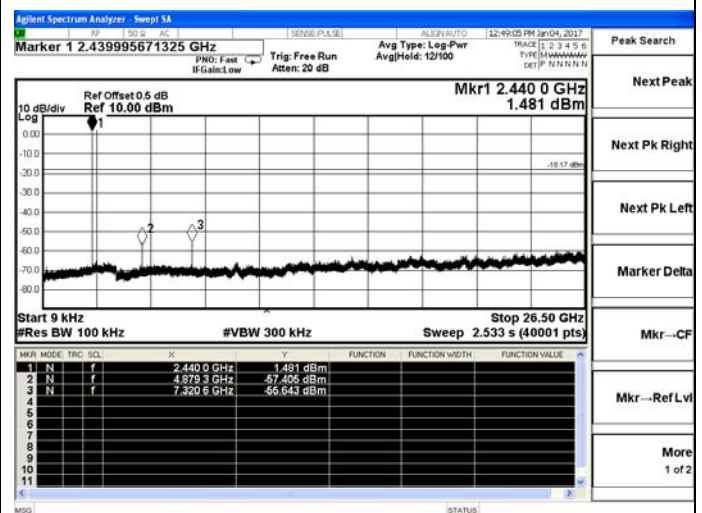
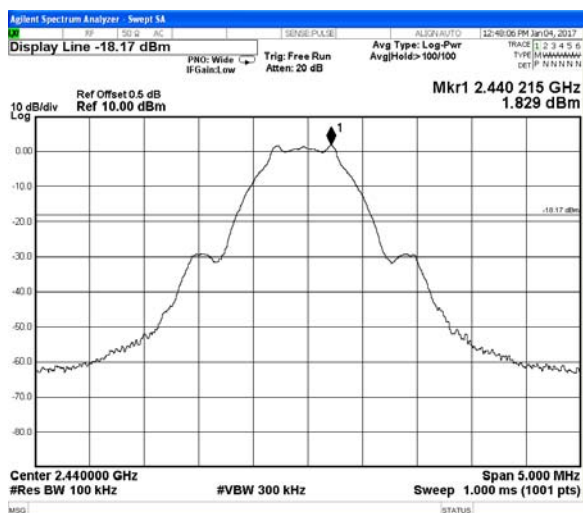
## Remark:

1. Measured output power at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 1Mbps at BT LE; 250 kbps at Zigbee;
4. Please refer to following plots;

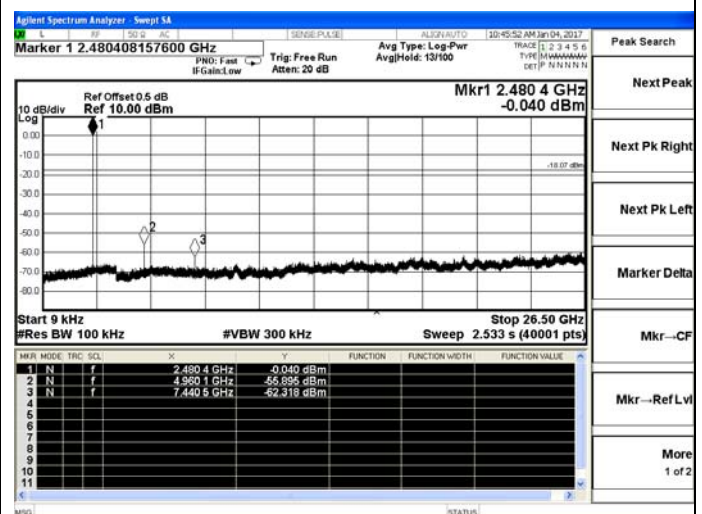
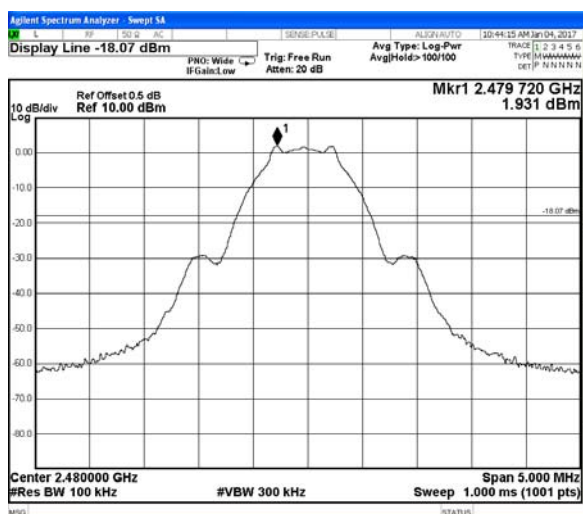
## Test plot of Conducted Spurious Emission



## BT LE-Low channel Reference



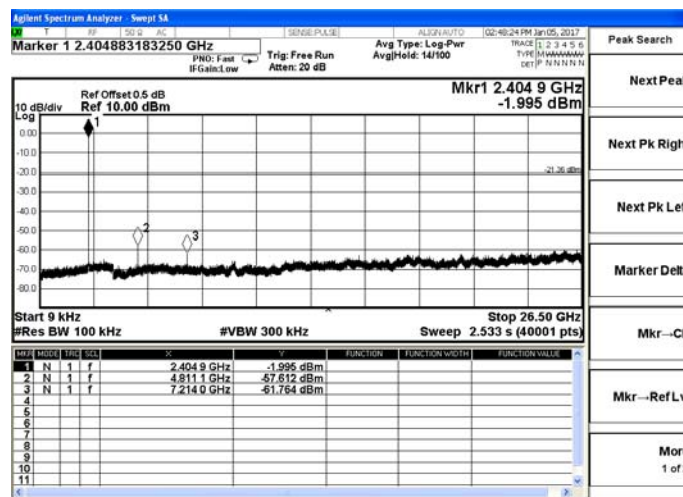
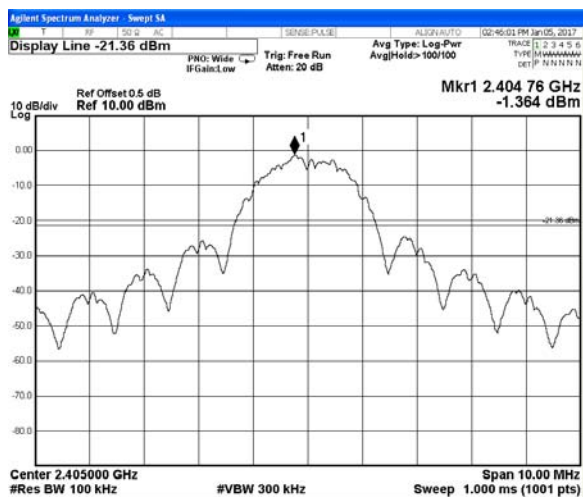
## BT LE-Middle channel Reference



## BT LE-High channel Reference

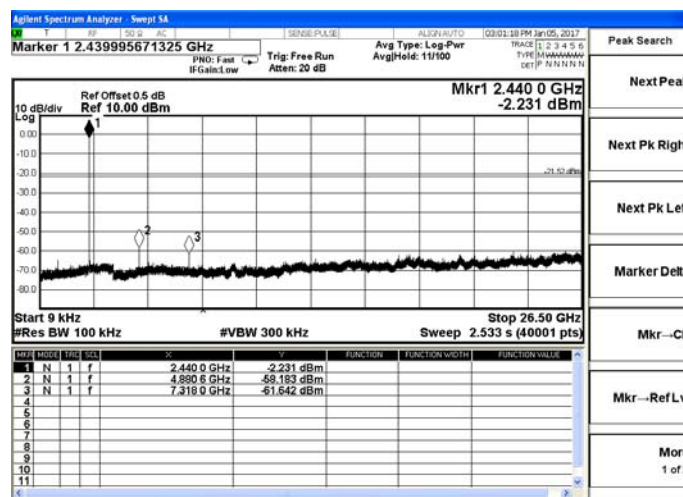
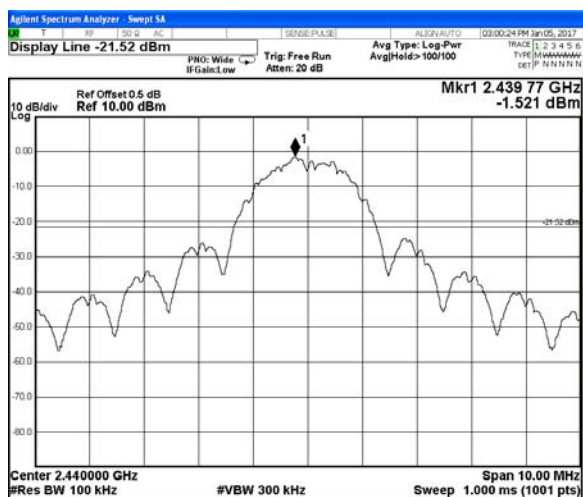
## BT LE-High channel

## Test plot of Conducted Spurious Emission



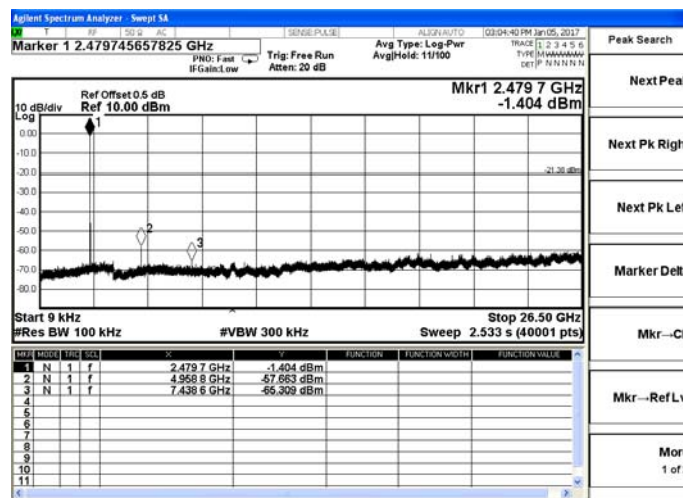
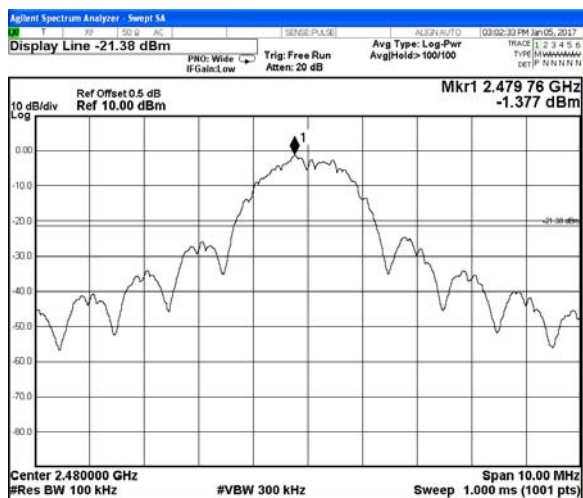
## Zigbee-Low channel Reference

## Zigbee-Low channel



## Zigbee-Middle channel Reference

## Zigbee-Middle channel



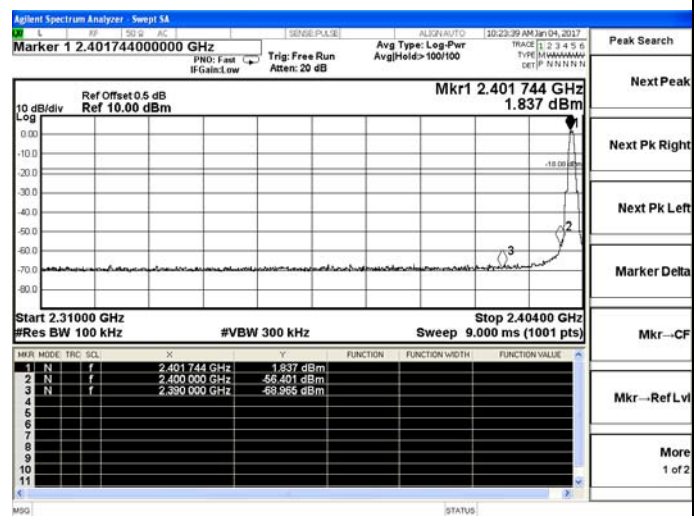
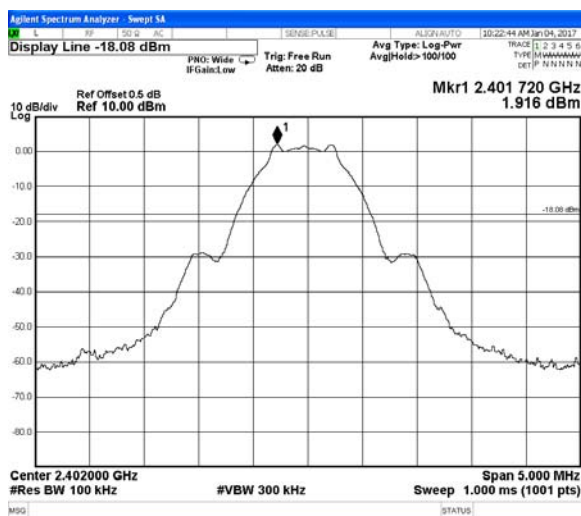
## Zigbee-High channel Reference

## Zigbee-High channel



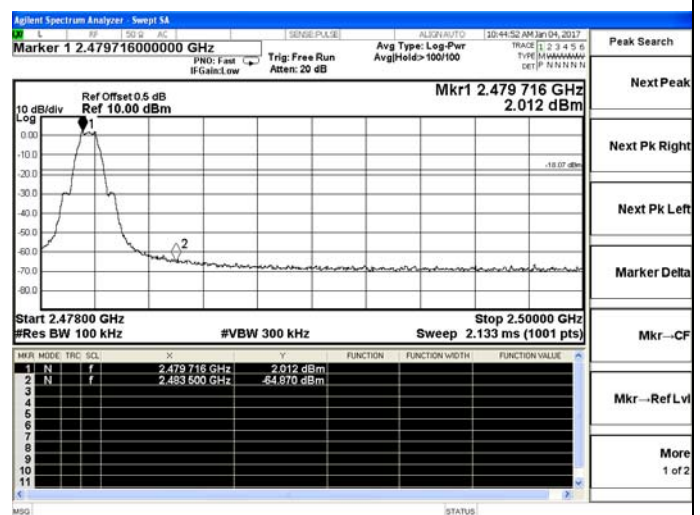
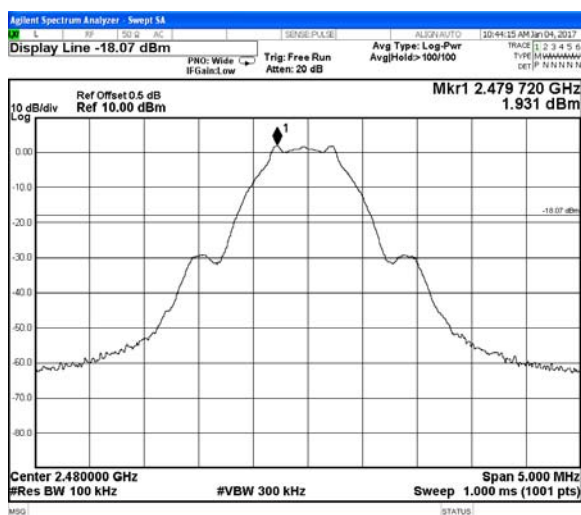
## 5.6.7. Test Results of Band Edges Test

Test plot of Band Edges Test



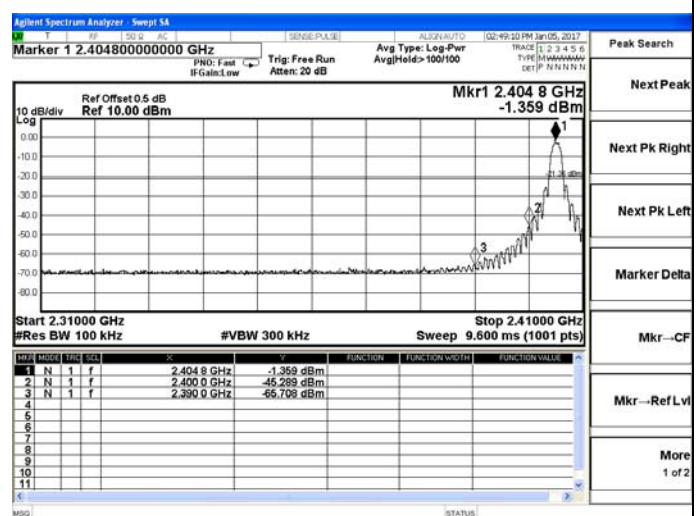
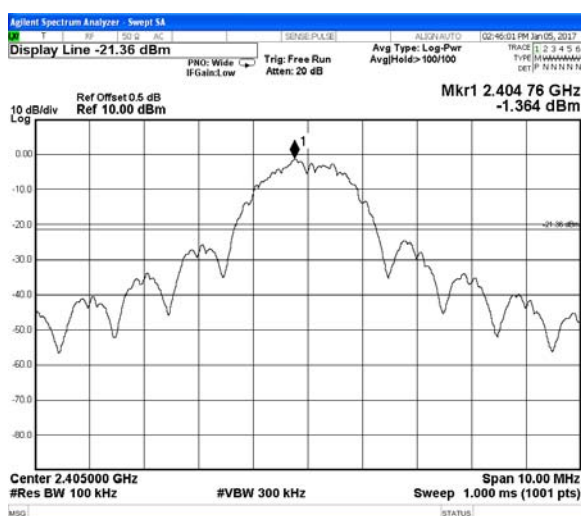
BT LE-Low channel Reference

BT LE-Low channel



BT LE-High channel Reference

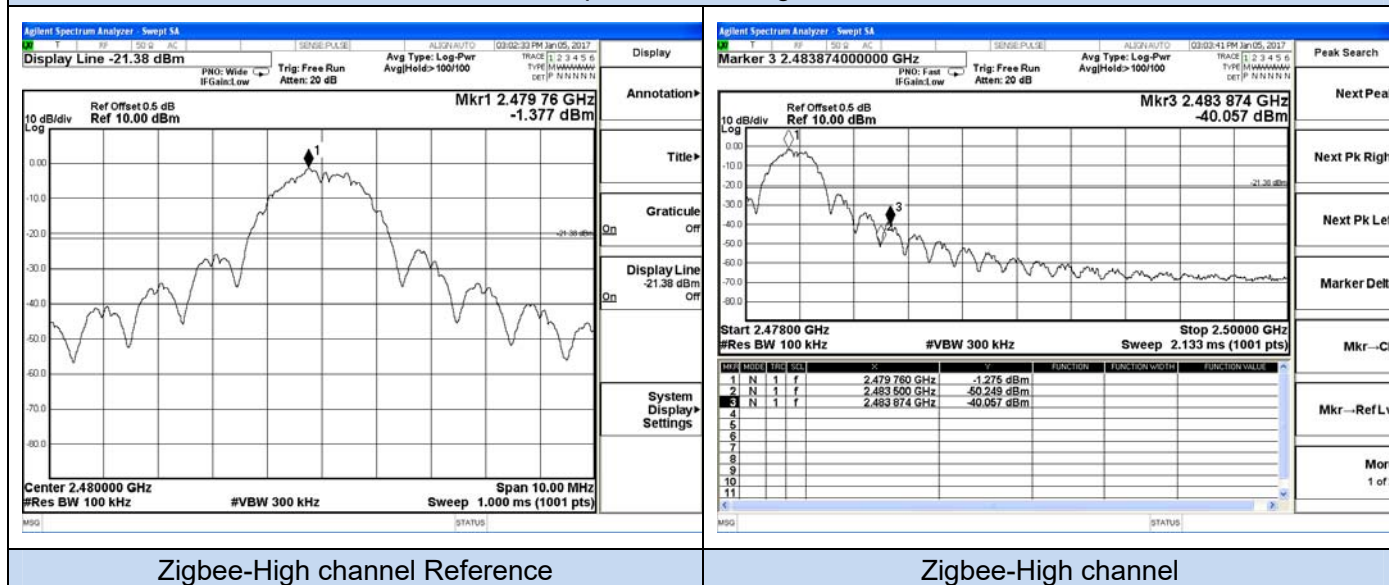
BT LE-High channel



Zigbee-Low channel Reference

Zigbee-Low channel

## Test plot of Band Edges Test



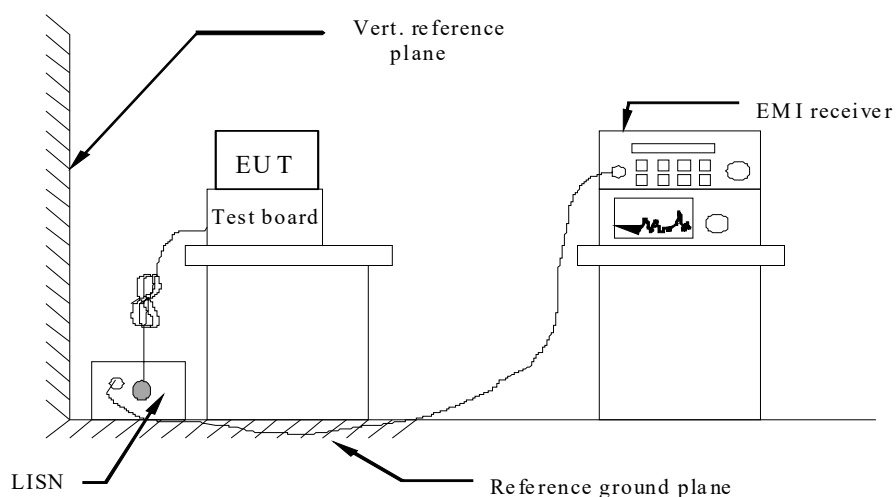
## 5.7. Power line conducted emissions

### 5.7.1 Standard Applicable

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

Frequency Range (MHz)	Limits (dB $\mu$ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

### 5.7.2 Block Diagram of Test Setup



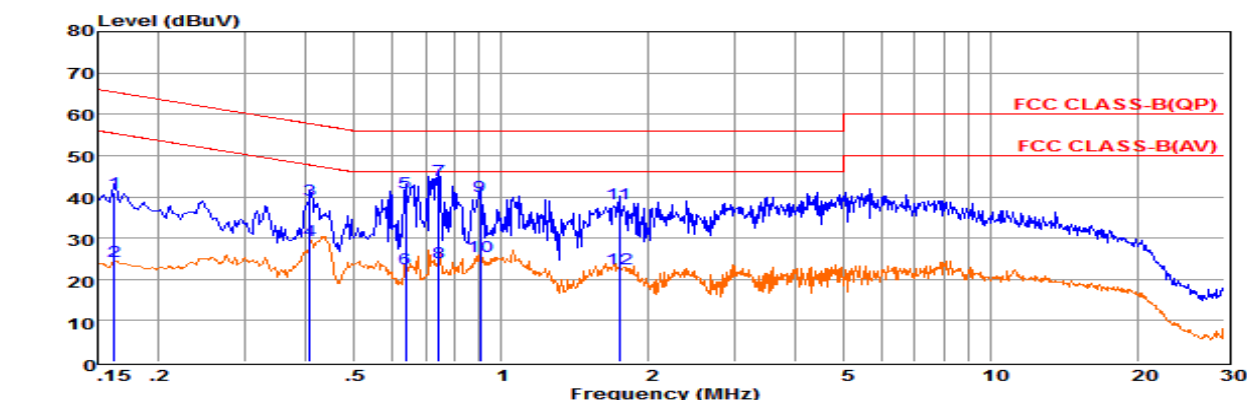
### 5.7.3 Test Results

**PASS.**

The test data please refer to following page.



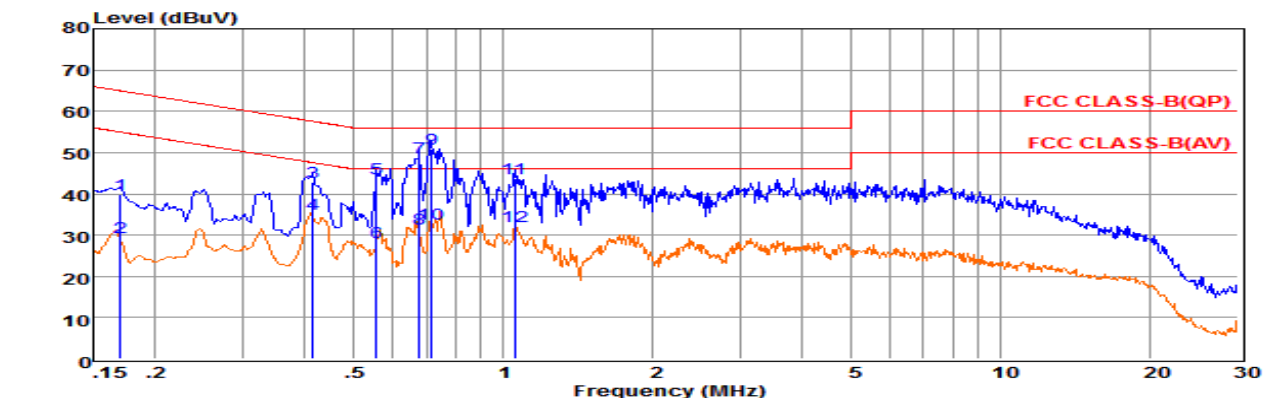
## Test result for Zigbee-AC 120V



Env. Ins: 24\*/56%  
 Pol: LINE

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	21.52	9.59	0.02	10.00	41.13	65.34	-24.21	QP
2	0.16	4.67	9.59	0.02	10.00	24.28	55.33	-31.05	Average
3	0.41	19.74	9.62	0.04	10.00	39.40	57.73	-18.33	QP
4	0.41	9.73	9.62	0.04	10.00	29.39	47.72	-18.33	Average
5	0.64	21.46	9.63	0.04	10.00	41.13	56.00	-14.87	QP
6	0.64	3.07	9.63	0.04	10.00	22.74	46.00	-23.26	Average
7	0.75	24.33	9.64	0.04	10.00	44.01	56.00	-11.99	QP
8	0.75	4.50	9.64	0.04	10.00	24.18	46.00	-21.82	Average
9	0.90	20.44	9.63	0.05	10.00	40.12	56.00	-15.88	QP
10	0.90	5.81	9.63	0.05	10.00	25.49	46.00	-20.51	Average
11	1.74	18.58	9.64	0.05	10.00	38.27	56.00	-17.73	QP
12	1.74	2.83	9.64	0.05	10.00	22.52	46.00	-23.48	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.  
 2. The emission levels that are 20dB below the official limit are not reported.

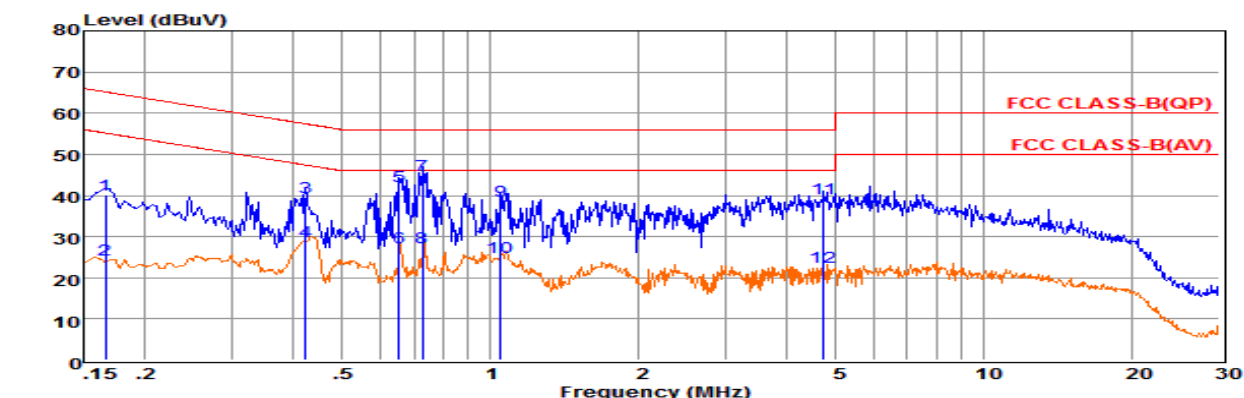


Env. Ins: 24\*/56%  
 Pol: NEUTRAL

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.17	20.09	9.65	0.02	10.00	39.76	64.94	-25.18	QP
2	0.17	9.72	9.65	0.02	10.00	29.39	54.94	-25.55	Average
3	0.41	23.13	9.61	0.04	10.00	42.78	57.55	-14.77	QP
4	0.41	15.40	9.61	0.04	10.00	35.05	47.55	-12.50	Average
5	0.56	24.04	9.62	0.04	10.00	43.70	56.00	-12.30	QP
6	0.56	8.71	9.62	0.04	10.00	28.37	46.00	-17.63	Average
7	0.68	29.04	9.63	0.04	10.00	48.71	56.00	-7.29	QP
8	0.68	11.92	9.63	0.04	10.00	31.59	46.00	-14.41	Average
9	0.72	31.08	9.63	0.04	10.00	50.75	56.00	-5.25	QP
10	0.72	13.11	9.63	0.04	10.00	32.78	46.00	-13.22	Average
11	1.05	24.09	9.63	0.05	10.00	43.77	56.00	-12.23	QP
12	1.06	12.53	9.63	0.05	10.00	32.21	46.00	-13.79	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.  
 2. The emission levels that are 20dB below the official limit are not reported.

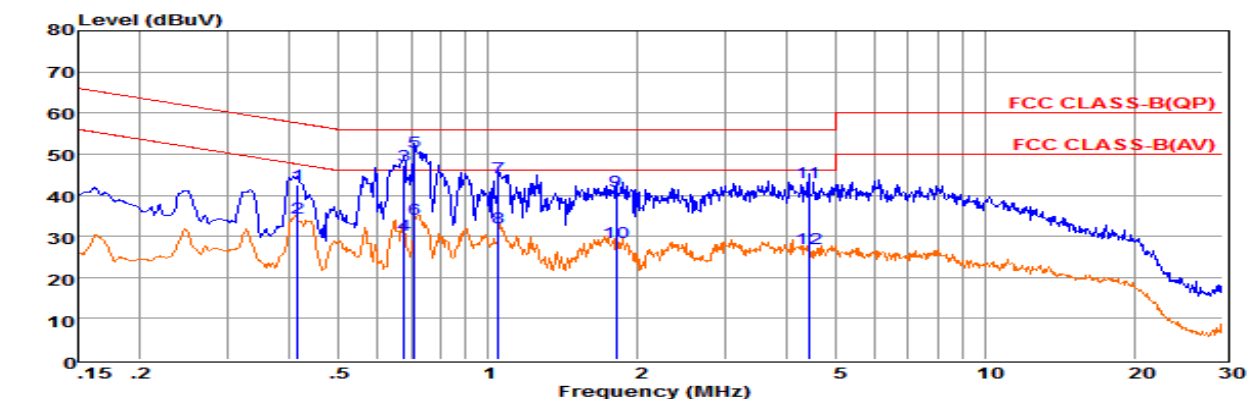
## Test result for Zigbee-AC 240V



Env. Ins: 24\*/56%  
 Pol: LINE

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.17	20.42	9.59	0.02	10.00	40.03	65.16	-25.13	QP
2	0.17	4.92	9.59	0.02	10.00	24.53	55.16	-30.63	Average
3	0.42	20.00	9.62	0.04	10.00	39.66	57.42	-17.76	QP
4	0.42	9.15	9.62	0.04	10.00	28.81	47.42	-18.61	Average
5	0.65	22.59	9.64	0.04	10.00	42.27	56.00	-13.73	QP
6	0.65	7.63	9.64	0.04	10.00	27.31	46.00	-18.69	Average
7	0.73	25.37	9.64	0.04	10.00	45.05	56.00	-10.95	QP
8	0.73	7.72	9.64	0.04	10.00	27.40	46.00	-18.60	Average
9	1.05	18.92	9.63	0.05	10.00	38.60	56.00	-17.40	QP
10	1.05	5.27	9.63	0.05	10.00	24.95	46.00	-21.05	Average
11	4.75	19.40	9.65	0.06	10.00	39.11	56.00	-16.89	QP
12	4.75	2.96	9.65	0.06	10.00	22.67	46.00	-23.33	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.  
 2. The emission levels that are 20dB below the official limit are not reported.



Env. Ins: 24\*/56%  
 Pol: NEUTRAL

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.41	22.95	9.61	0.04	10.00	42.60	57.55	-14.95	QP
2	0.41	14.90	9.61	0.04	10.00	34.55	47.55	-13.00	Average
3	0.68	27.70	9.63	0.04	10.00	47.37	56.00	-8.63	QP
4	0.68	10.62	9.63	0.04	10.00	30.29	46.00	-15.71	Average
5	0.71	30.93	9.63	0.04	10.00	50.60	56.00	-5.40	QP
6	0.71	14.45	9.63	0.04	10.00	34.12	46.00	-11.88	Average
7	1.05	24.51	9.63	0.05	10.00	44.19	56.00	-11.81	QP
8	1.05	12.45	9.63	0.05	10.00	32.13	46.00	-13.87	Average
9	1.81	21.49	9.63	0.05	10.00	41.17	56.00	-14.83	QP
10	1.81	8.98	9.63	0.05	10.00	28.66	46.00	-17.34	Average
11	4.41	23.37	9.66	0.06	10.00	43.09	56.00	-12.91	QP
12	4.41	7.25	9.66	0.06	10.00	26.97	46.00	-19.03	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.  
 2. The emission levels that are 20dB below the official limit are not reported.

## 5.8. Antenna Requirements

### 5.8.1 Standard Applicable

#### **According to antenna requirement of §15.203**

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

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

#### **According to RSS-Gen**

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.<sup>9</sup> When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

### 5.8.2 Antenna Connected Construction

#### 5.8.2.1. Standard Applicable

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

#### 5.8.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 3.72dBi, and the antenna is an PCB antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

#### 5.8.2.3. Results: Compliance.

## 6. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	June 18, 2016	June 17, 2017
Signal analyzer	Agilent	N9020A	MY5051014 0	9kHz~26.5GHz	October 27, 2015	October 27, 2016
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	June 18, 2016	June 17, 2017
LISN (Support Unit)	EMCO	3819/2NM	9703-1839	9KHz-30MHz	June 18, 2016	June 17, 2017
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	June 18, 2016	June 17, 2017
ISN	SCHAFFNER	ISN ST08	21653	9KHz-30MHz	June 18, 2016	June 17, 2017
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-18GHz 3m	June 18, 2016	June 17, 2017
Amplifier	SCHAFFNER	COA9231A	18667	9kHz-2GHz	June 18, 2016	June 17, 2017
Amplifier	Agilent	8449B	3008A02120	1GHz-26.5GHz	July 16, 2016	July 15, 2017
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	July 16, 2016	July 15, 2017
Loop Antenna	R&S	HFH2-Z2	860004/001	9k-30MHz	June 18, 2016	June 17, 2017
By-log Antenna	SCHWARZBECK	VULB9163	9163-470	30MHz-1GHz	June 10, 2016	June 09, 2017
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	June 10, 2016	June 09, 2017
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA91701 54	15GHz-40GHz	June 10, 2016	June 09, 2017
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	June 18, 2016	June 17, 2017
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz-40GHz	June 18, 2016	June 17, 2017
Power Meter	R&S	NRVS	100444	DC-40GHz	June 18, 2016	June 17, 2017
Power Sensor	R&S	NRV-Z51	100458	DC-30GHz	June 18, 2016	June 17, 2017
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	June 18, 2016	June 17, 2017
AC Power Source	HPC	HPA-500E	HPA-910002 4	AC 0~300V	June 18, 2016	June 17, 2017
DC power Source	GW	GPC-6030D	C671845	DC 1V-60V	June 18, 2016	June 17, 2017
Temp. and Humidigy Chamber	Giant Force	GTH-225-20-S	MAB0103-00	N/A	June 18, 2016	June 17, 2017
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	June 18, 2016	June 17, 2017
RF CABLE-2m	JYE Bao	RG142	CB)35-2m	20MHz-1GHz	June 18, 2016	June 17, 2017

Note: All equipment through GRGT EST calibration

## **7. TEST SETUP PHOTOGRAPHS OF EUT**

Please refer to test setup photographs of eut

## **8. EXTERIOR PHOTOGRAPHS OF THE EUT**

Please refer to test setup photographs of eut

## **9. INTERIOR PHOTOGRAPHS OF THE EUT**

Please refer to test setup photographs of eut

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