

# FCC RF Test Report

**For**

**CEED LTD**

<b>Test Standards:</b>	<u>Part 15C Subpart C §15.247</u>
<b>Product Description:</b>	<u>Pi-Top 4</u>
<b>Tested Model:</b>	<u>4.0 keyboard</u>
<b>Additional Model No.:</b>	<u>N/A</u>
<b>Brand Name:</b>	<u>PI-TOP</u>
<b>FCC ID:</b>	2AF9IMK42
<b>Classification</b>	Digital Spread Spectrum (DSS)
<b>Report No.:</b>	<u>EC1902016F01</u>
<b>Tested Date:</b>	<u>2019-02-25 to 2019-03-06</u>
<b>Issued Date:</b>	<u>2019-03-06</u>
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Note: The test results in this report apply exclusively to the tested model / sample. Without written approval of

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## Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	2019.03.06	Valid	Original Report

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## Summary of Test Result

FCC Rule	IC Rule	Description	Limit	Result	Remark
15.247(a)(1)	RSS-247 5.1(1)	20dB Bandwidth	NA	Pass	-
-	RSS-Gen 6.6	99% Bandwidth	-	Pass	-
15.247(a)(1)	RSS-247 5.1(2)	Hopping Channel Separation	$\geq 2/3$ of 20dB BW	Pass	-
15.247(a)(1)	RSS-247 5.1(4)	Number of Channels	$\geq 15$ Chs	Pass	-
15.247(a)(1)	RSS-247 5.1(4)	Average Time of Occupancy	$\leq 0.4$ sec in 31.6sec period	Pass	-
15.247(b)(1)	RSS-247 5.4(2)	Peak Output Power	$\leq 125$ mW	Pass	-
15.247(d)	RSS-247 5.5	Conducted Band Edges	$\leq 20$ dBc	Pass	-
15.247(d)	RSS-247 5.5	Conducted Spurious Emission	$\leq 20$ dBc	Pass	-
15.247(d)	RSS-247 5.5	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 6.97 dB at 191.990 MHz
15.207	RSS-Gen 8.8	AC Conducted Emission	15.207(a)	Pass	Under limit 12.00 dB at 0.529 MHz
15.203 & 15.247(b)	N/A	Antenna Requirement	N/A	Pass	-

## **1 Test Laboratory**

### **1.1 Test facility**

#### **CNAS ( accreditation number: L11138 )**

Hunan Ecloud Testing Technology Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

#### **FCC (Designation number: CN1244 , Test Firm Registration Number: 793308 )**

Hunan Ecloud Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

#### **ISED(CAB identifier: CN0012)**

Hunan Ecloud Testing Technology Co., Ltd. has been listed on the Wireless Device Testing Laboratories list of innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.

#### **A2LA (Certificate Code : 4895.01 )**

Hunan Ecloud Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

## 2 General Description

### 2.1 Applicant

**CEED LTD**

8 Mill Street London SE1 2BA

### 2.2 Manufacturer

**Shenzhen Hangshi Technology Co.,Ltd.**

Hangshi Technology Park, Democracy West Industry Area, Shajing Town, Bao'an District, Shenzhen, China.

### 2.3 General Description Of EUT

<b>Product</b>	Pi-Top 4
<b>Model No.</b>	4.0_keyboard
<b>Additional No.</b>	N/A
<b>Difference Description</b>	N/A
<b>FCC ID</b>	2AF9IMK42
<b>IC ID</b>	N/A
<b>Power Supply</b>	5Vdc (adapter or host equipment) 3.7Vdc (Li-ion battery)
<b>Modulation Technology</b>	FHSS
<b>Modulation Type</b>	GFSK
<b>Operating Frequency</b>	2402MHz~2480MHz
<b>Number Of Channel</b>	79
<b>Max. Output Power</b>	Bluetooth BR(1Mbps) : -3.96 dBm (0.0004 W)
<b>Antenna Type</b>	FPC Antenna with 1.87dBi gain
<b>I/O Ports</b>	Refer to user's manual

**NOTE:**

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
2. For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.

## 2.4 Modification of EUT

No modifications are made to the EUT during all test items.

## 2.5 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ ANSI C63.10-2013
- ♦ KDB 558074 D01 15.247 Meas Guidance v05r01

### 3 Test Configuration of Equipment Under Test

#### 3.1 Descriptions of Test Mode

The transmitter has a maximum peak conducted output power as follows:

Channel	Frequency	Mode	Bluetooth RF Output Power
Ch00	2402MHz	GFSK	-3.957
Ch39	2441MHz	GFSK	-5.779
Ch78	2480MHz	GFSK	-7.070

**Remark:**

1. All the test data for each data rate were verified, but only the worst case was reported.
2. The data rate was set in 1Mbps for all the test items due to the highest RF output power.
  - a. Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.
  - b. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z it was determined that Z orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Z orientation.



## 3.2 Test Mode

### 3.2.1 Antenna Port Conducted Measurement

Summary table of Test Cases	
Test Item	Data Rate / Modulation
	Bluetooth BR 1Mbps GFSK
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz

### 3.2.2 Radiated Emission Test (Below 1GHz)

Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz

Note : 1. Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, XYZ axis, antenna ports (if EUT with antenna diversity architecture) and packet type.

2. All above modes were tested, but only the worst case test mode 2 was reported.

### 3.2.3 Radiated Emission Test (Above 1GHz)

Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz

Note : 1. Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, XYZ axis, antenna ports (if EUT with antenna diversity architecture) and packet type.

2. Following channel(s) was (were) selected for the final test as listed above

### 3.2.4 Power Line Conducted Emission Test:

AC Conducted Emission	Mode 1 : Bluetooth Link + USB Cable (Charging from Adapter)
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### 3.3 Support Equipment

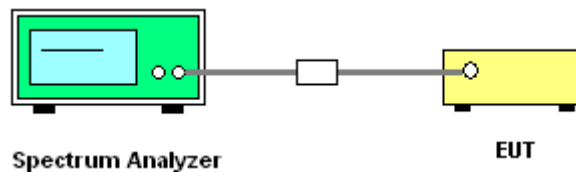
Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Adapter	HTC	TC E250	N/A	N/A	N/A
2.	USB Cable	HTC	N/A	N/A	N/A	unshielded 1.2m
3.	Notebook	Lenovo	E470C	FCC DoC	N/A	shielded cable DC O/P 1.8 m unshielded AC I/P cable 1.2 m

### 3.4 Test Setup

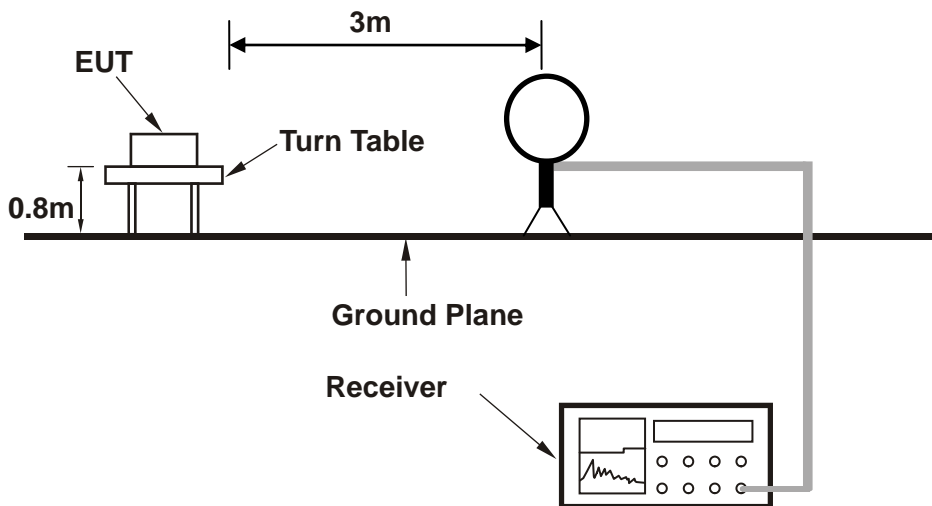
The EUT is continuously communicating to the Bluetooth tester during the tests.

EUT was set in the Hidden menu mode to enable BT communications.

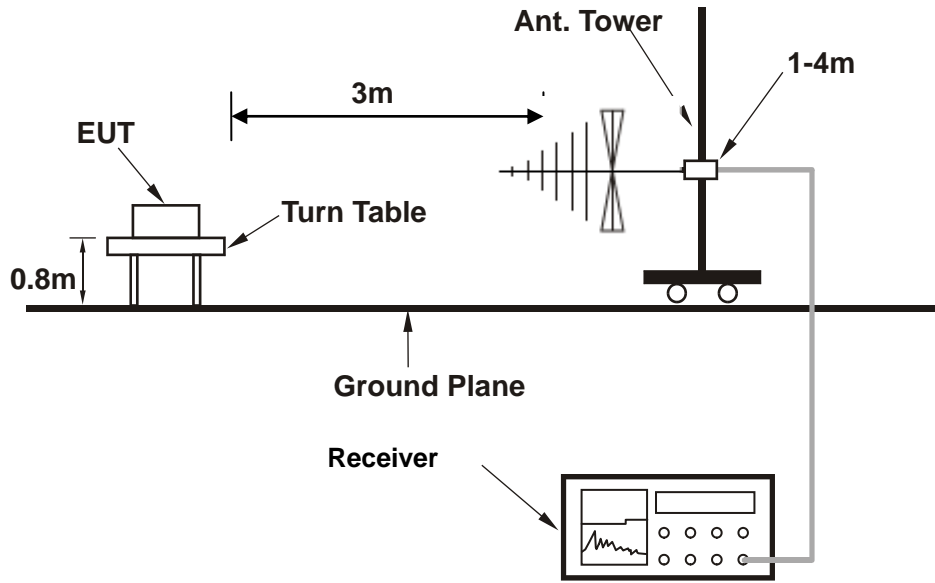
#### Setup diagram for Conducted Test



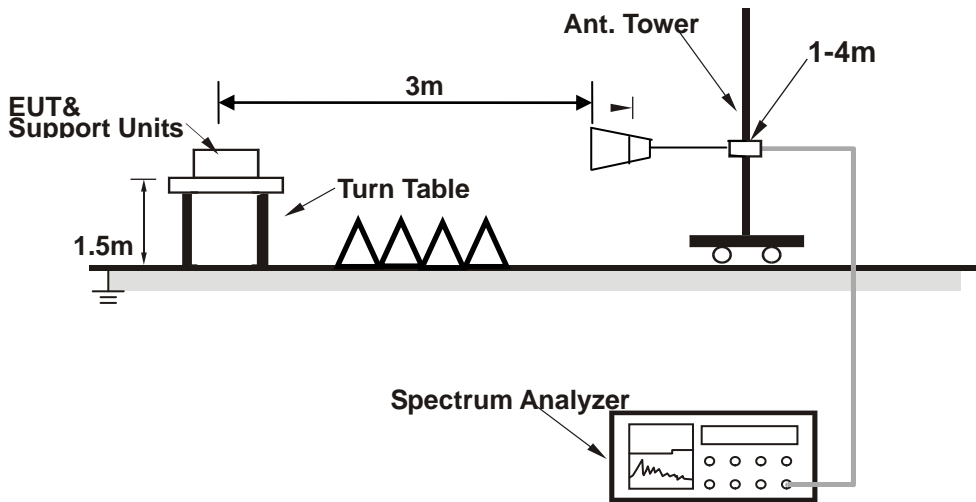
#### Setup diagram for Raidation(9KHz~30MHz) Test

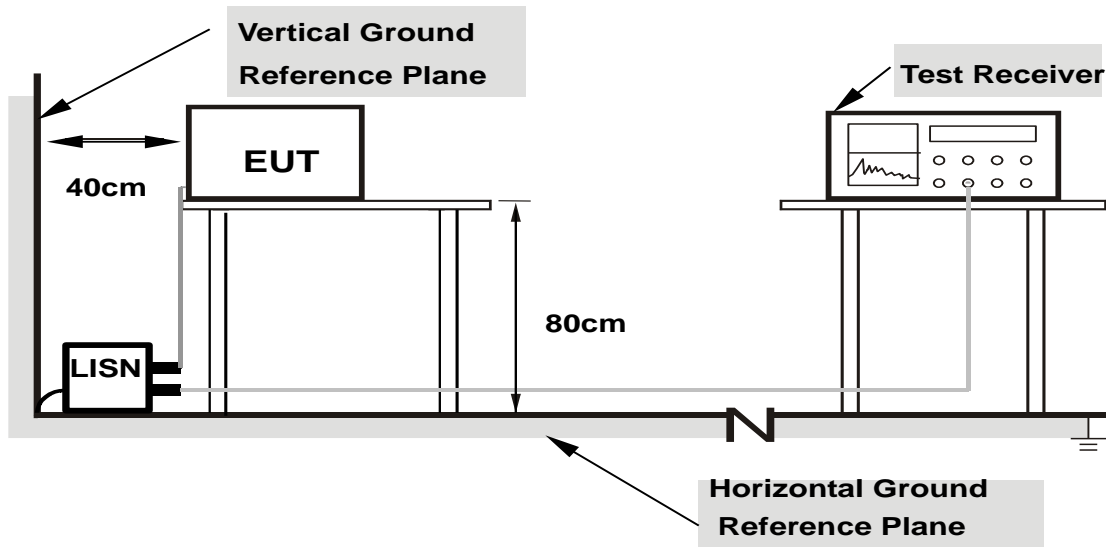


#### Setup diagram for Raidation(Below 1G) Test



Setup diagram for Raidation(Above1G) Test



**Setup diagram for AC Conducted Emission Test**


- Note: 1.Support units were connected to second LISN.**  
**2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes**

### 3.5 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

*Offset = RF cable loss + attenuator factor.*

Following shows an offset computation example with cable loss 5 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 5 + 10 = 15 \text{ (dB)} \end{aligned}$$

## 4 Test Result

### 4.1 20dB and 99% Bandwidth Measurement

#### 4.1.1 Limit of 20dB and 99% Bandwidth

None; for reporting purposes only.

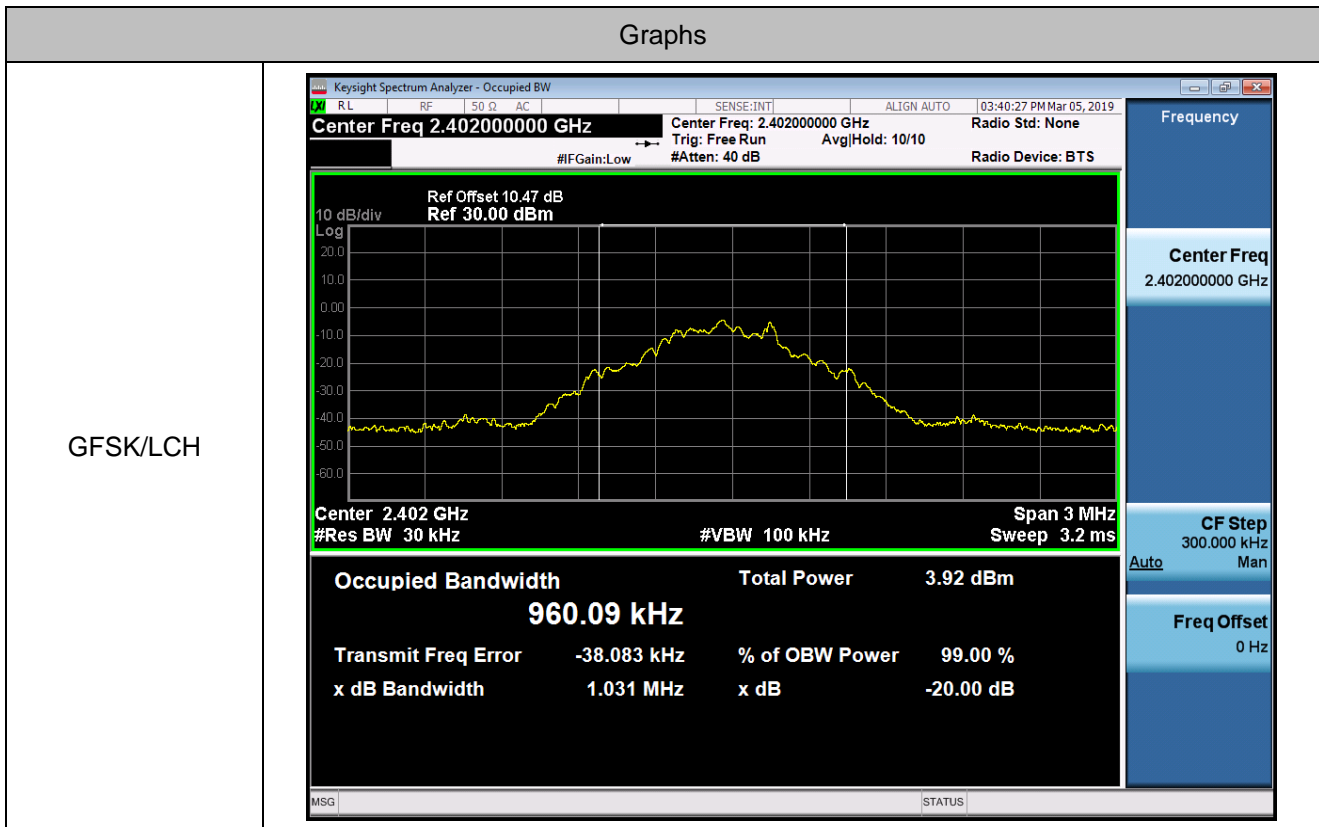
#### 4.1.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.
  - Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;
  - RBW = 1% to 5% of the 20 dB bandwidth; VBW = approximately 3 times RBW; Sweep = auto;
  - Detector function = peak; Trace = max hold.
4. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.
  - Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
  - RBW = 1% to 5% of the 99% bandwidth; VBW = approximately 3 times RBW; Sweep = auto;
  - Detector function = peak; Trace = max hold.

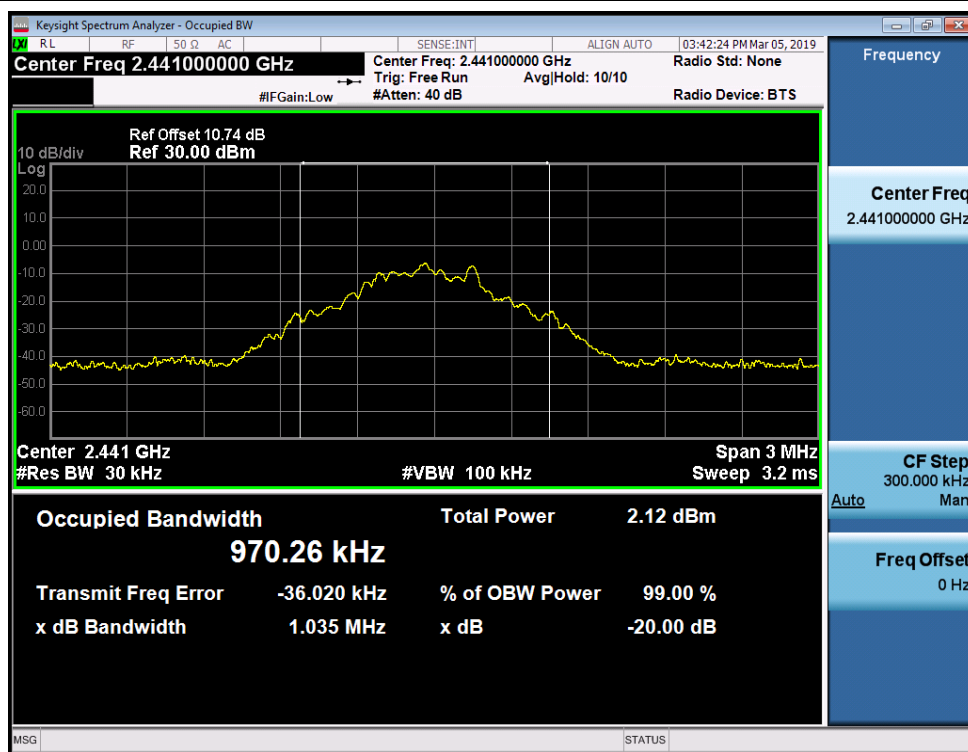
### 4.1.3 Test Result of 20dB Bandwidth and 99% Bandwidth

Test Mode :		Transmitting		Temperature :		24~26°C	
Test Engineer :		Damon Zhang		Relative Humidity :		50~53%	
Data Rate	Modulation	Channel	20dB Bandwidth [MHz]	99% OBW [MHz]	Verdict		
1Mbps	GFSK	LCH	1.031	0.96009	PASS		
1Mbps	GFSK	MCH	1.035	0.97026	PASS		
1Mbps	GFSK	HCH	1.026	0.97107	PASS		

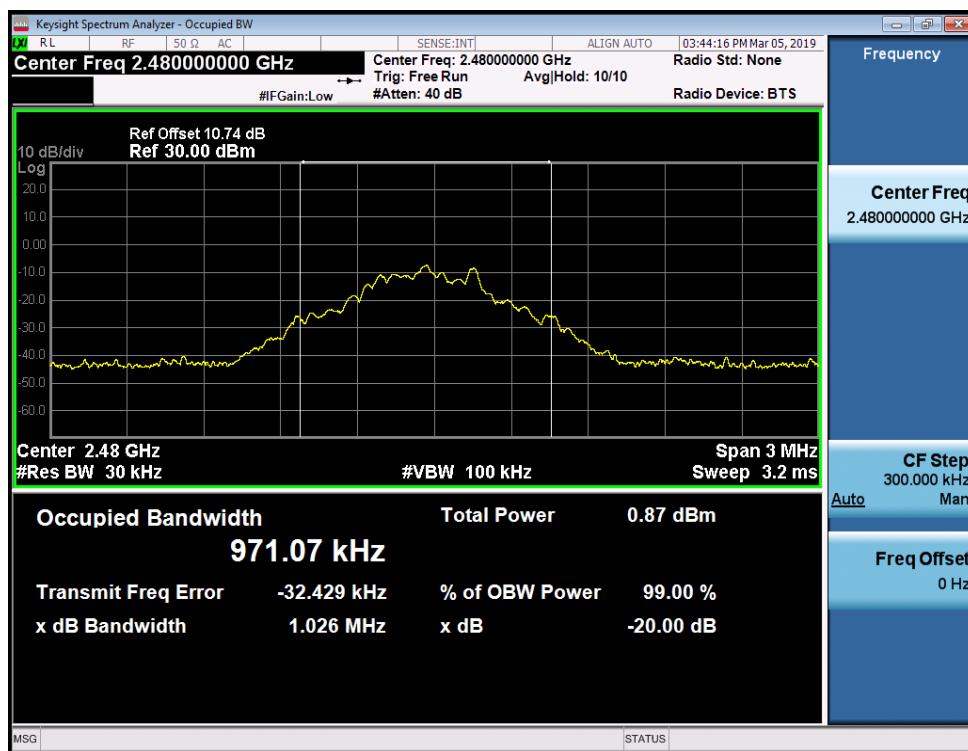
#### 20dB and 99% Plot



GFSK/MCH



GFSK/HCH



## 4.2 Hopping Channel Separation Measurement

### 4.2.1 Limit of Hopping Channel Separation

FCC §15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### 4.2.2 Test Procedures

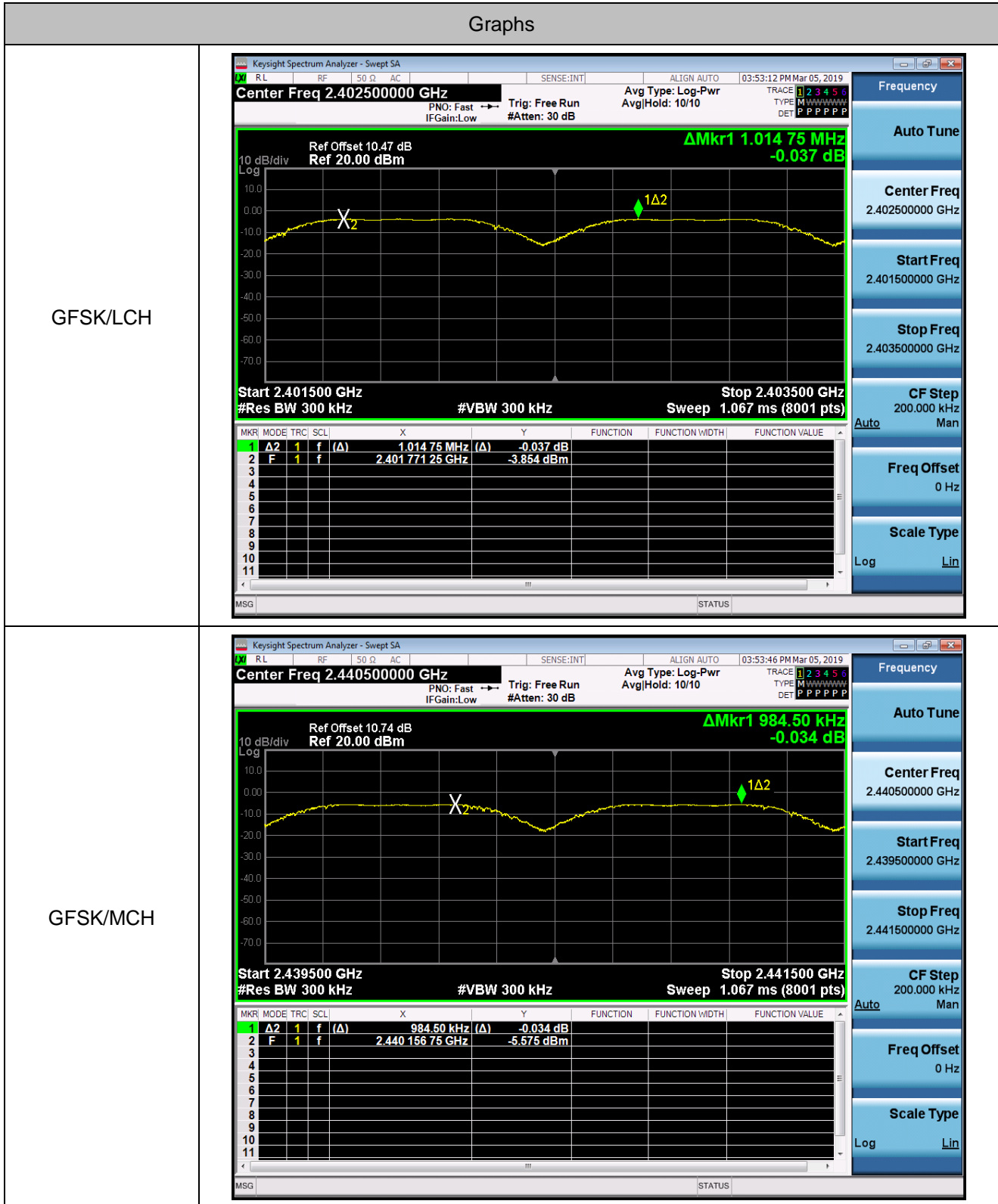
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

### 4.2.3 Test Result of Hopping Channel Separation

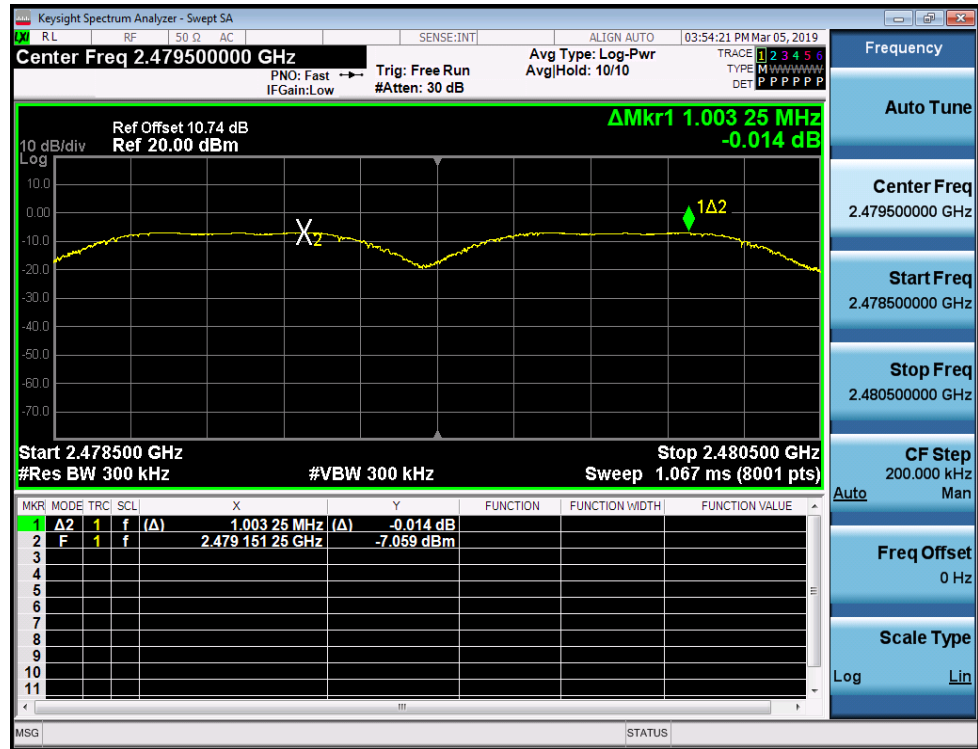
<b>Test Mode :</b>		Transmitting		<b>Temperature :</b>	24~26°C
<b>Test Engineer :</b>		Damon Zhang		<b>Relative Humidity :</b>	50~53%
Data Rate	Modulation	Channel	Carrier Frequency Separation [MHz]	Verdict	
1Mbps	GFSK	LCH	1.015	PASS	
1Mbps	GFSK	MCH	0.985	PASS	
1Mbps	GFSK	HCH	1.003	PASS	



## Hopping Frequency Separation Plot



GFSK/HCH



## 4.3 Number of Channel Measurement

### 4.3.1 Limits of Number of Hopping Frequency

FCC § 15.247(a)(1)(iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

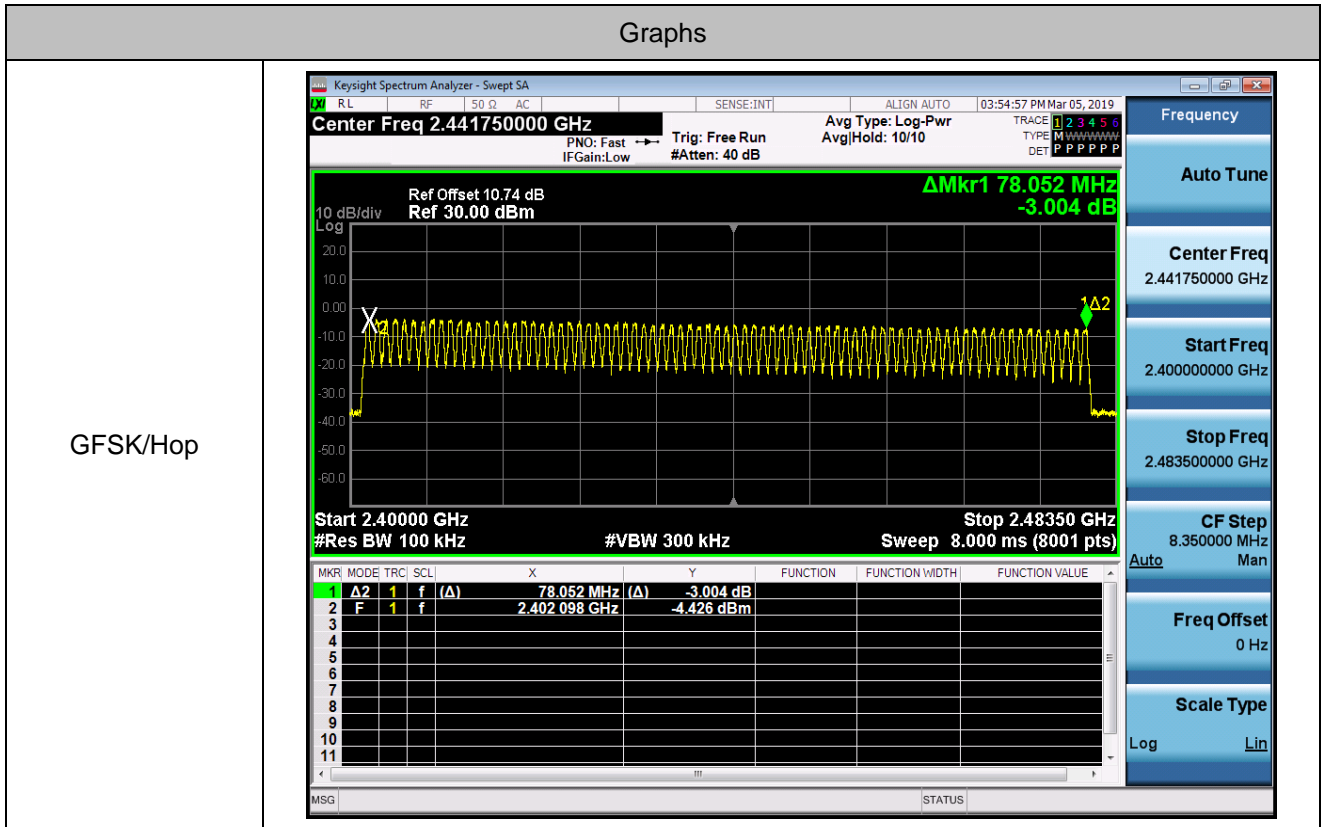
### 4.3.2 Test Procedure

4. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
5. Turn on the EUT and connect it to measurement instrument.
6. The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple continuous sweeps. The RBW is set to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.. The analyzer is set to Max Hold.

### 4.3.3 Test Result of Number of Hopping Frequency

<b>Test Mode :</b>		Transmitting		<b>Temperature :</b>	24~26°C
<b>Test Engineer :</b>		Damon Zhang		<b>Relative Humidity :</b>	50~53%
Data Rate	Modulation	Channel.	Number of Hopping Channel		Verdict
1Mbps	GFSK	Hop	79		PASS

**Number of Hopping Channels**



## 4.4 Average Time of Occupancy Measurement

### 4.4.1 Limit of Average Time of Occupancy

FCC §15.247 (a) (1) (iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

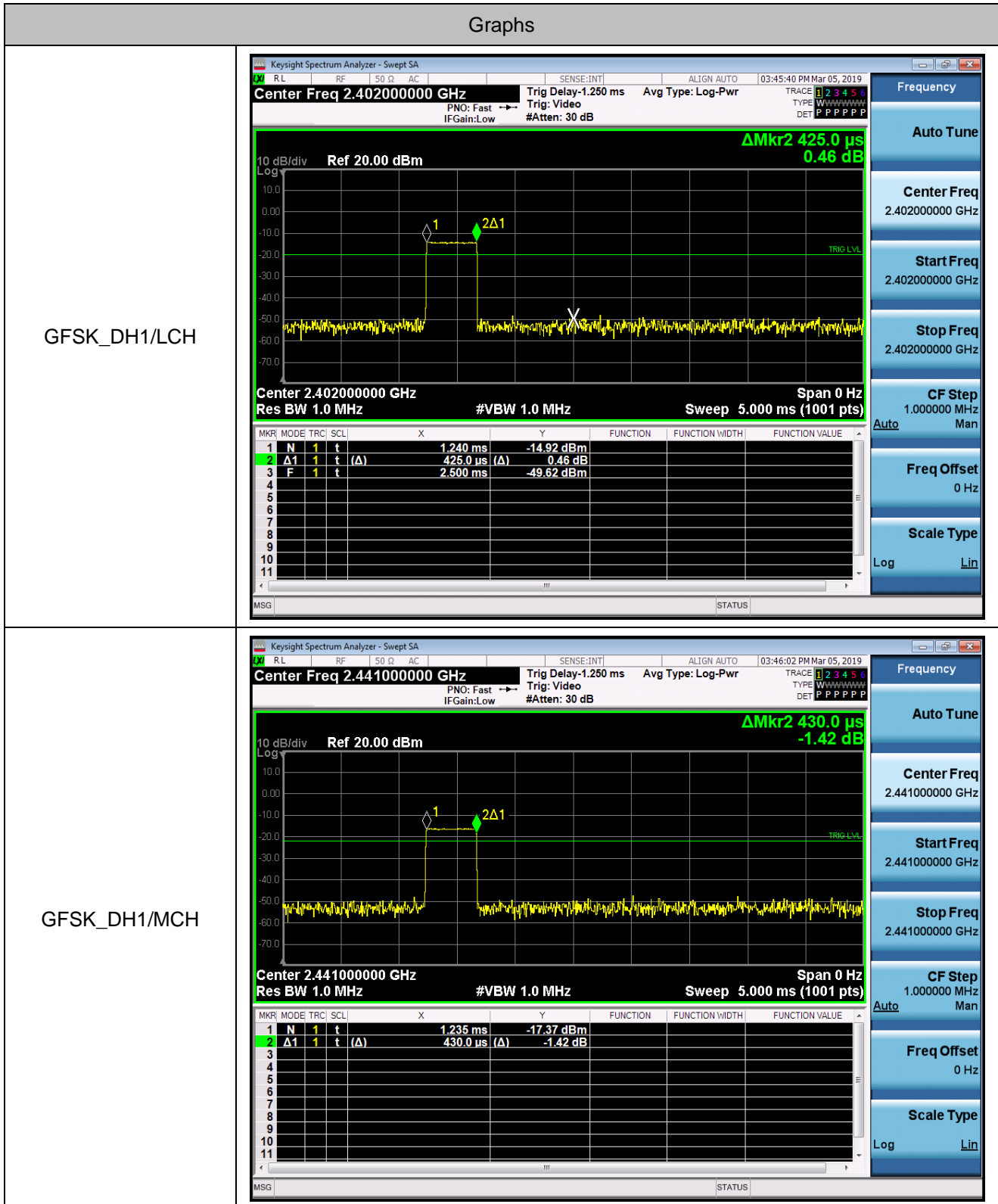
### 4.4.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.
4. The average time of occupancy in the specified 31.6 second period (79 channels \* 0.4 s) is equal to  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$ .
5. The test period:  $T = 0.4 \text{ Second/Channel} \times 79 \text{ Channel} = 31.6 \text{ s}$ 
  - DH1 time slot =  $0.43(\text{ms}) * (1600 / (2 * 79)) * 31.6 = 137.63 \text{ms}$
  - DH3 time slot =  $1.68(\text{ms}) * (1600 / (4 * 79)) * 31.6 = 268.80 \text{ms}$
  - DH5 time slot =  $2.91(\text{ms}) * (1600 / (6 * 79)) * 31.6 = 310.40 \text{ms}$

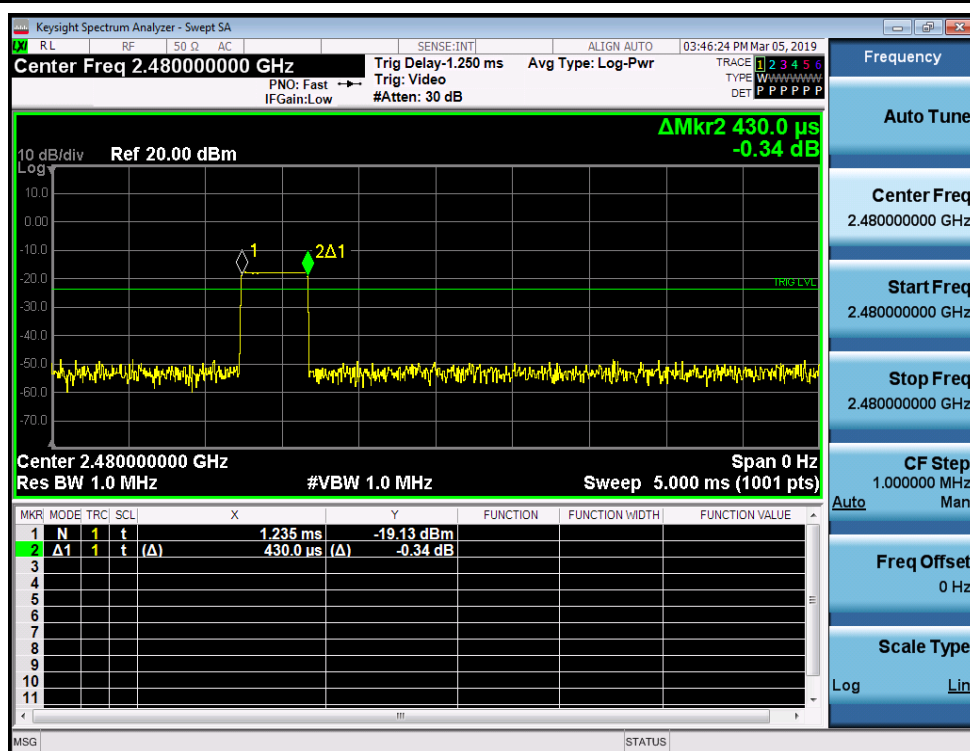
### 4.4.3 Test Result of Dwell Time

Test Mode :		Transmitting		Temperature :		24~26℃	
Test Engineer :		Damon Zhang		Relative Humidity :		50~53%	
Data Rate	Modulation	Packet	Channel	Burst Width [ms/hop/ch]	Total Hops[hop*ch]	Dwell Time[s]	Verdict
1Mbps	GFSK	DH1	LCH	0.43	320	0.138	PASS
1Mbps	GFSK	DH1	MCH	0.43	320	0.138	PASS
1Mbps	GFSK	DH1	HCH	0.43	320	0.138	PASS
1Mbps	GFSK	DH3	LCH	1.68	160	0.269	PASS
1Mbps	GFSK	DH3	MCH	1.67	160	0.267	PASS
1Mbps	GFSK	DH3	HCH	1.68	160	0.269	PASS
1Mbps	GFSK	DH5	LCH	2.91	106.7	0.31	PASS
1Mbps	GFSK	DH5	MCH	2.91	106.7	0.31	PASS
1Mbps	GFSK	DH5	HCH	2.91	106.7	0.31	PASS

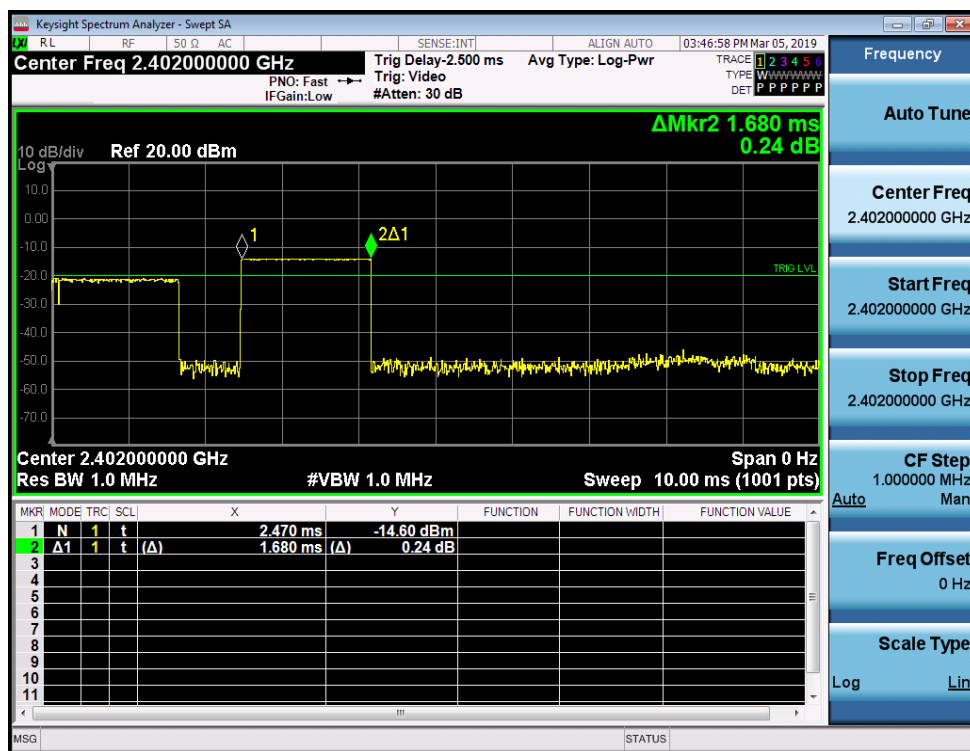
## The Average Time of Occupancy Plot



GFSK\_DH1/HCH

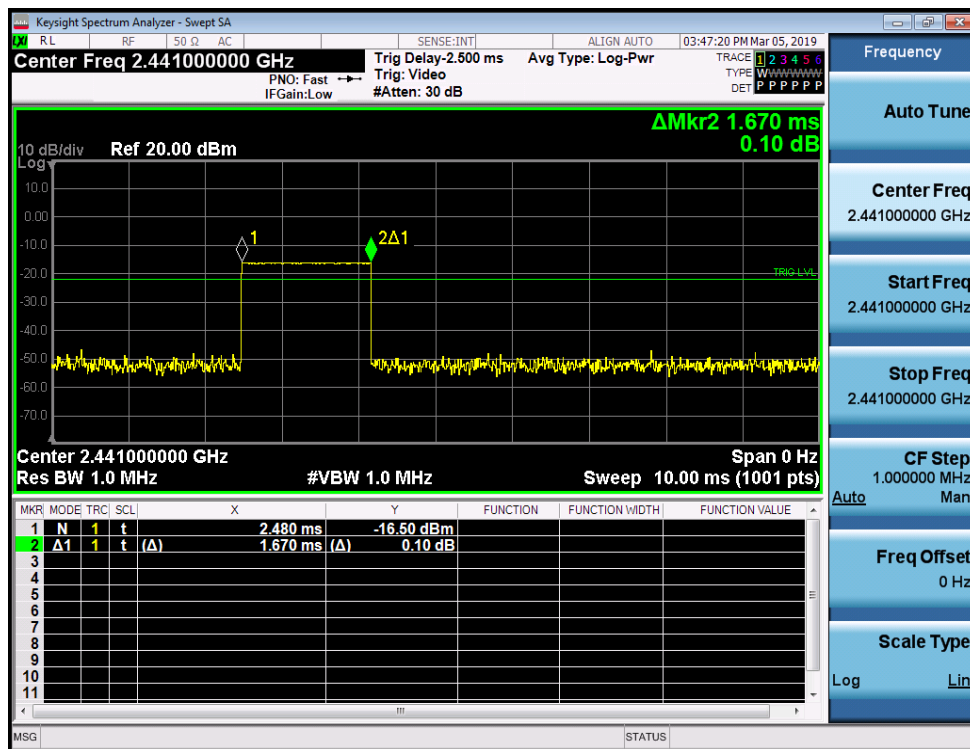


GFSK\_DH3/LCH

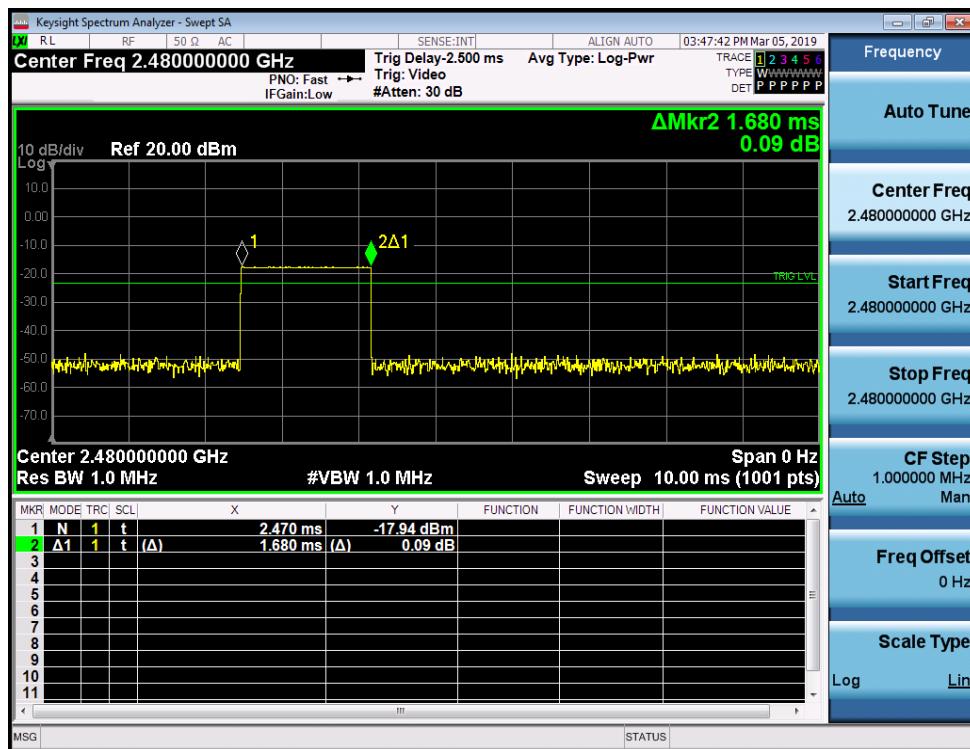




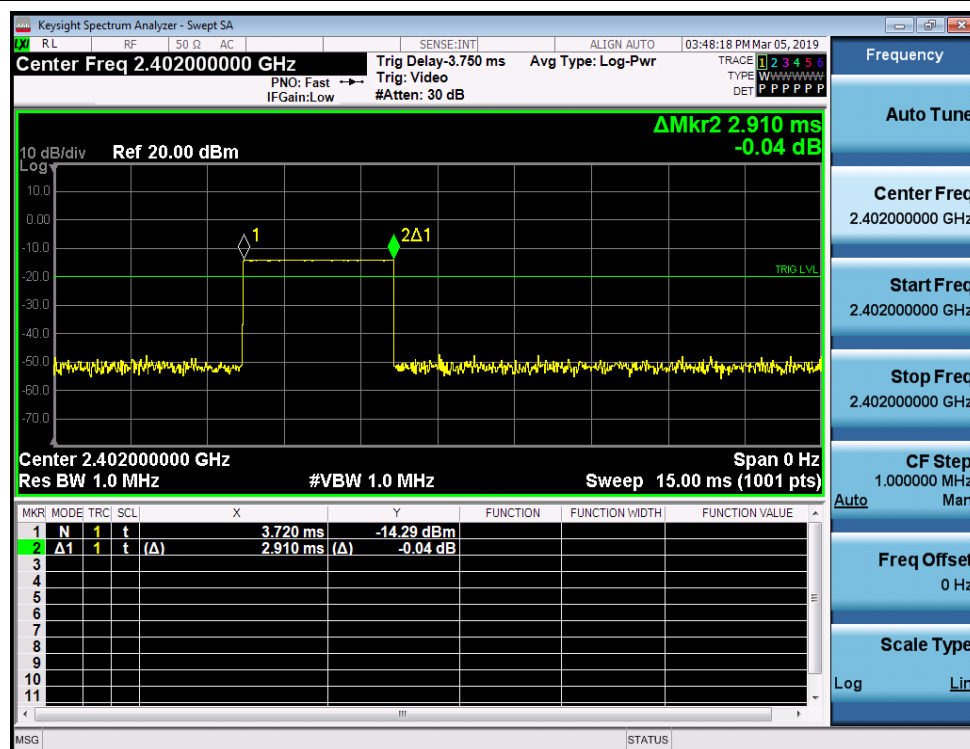
GFSK\_DH3/MCH



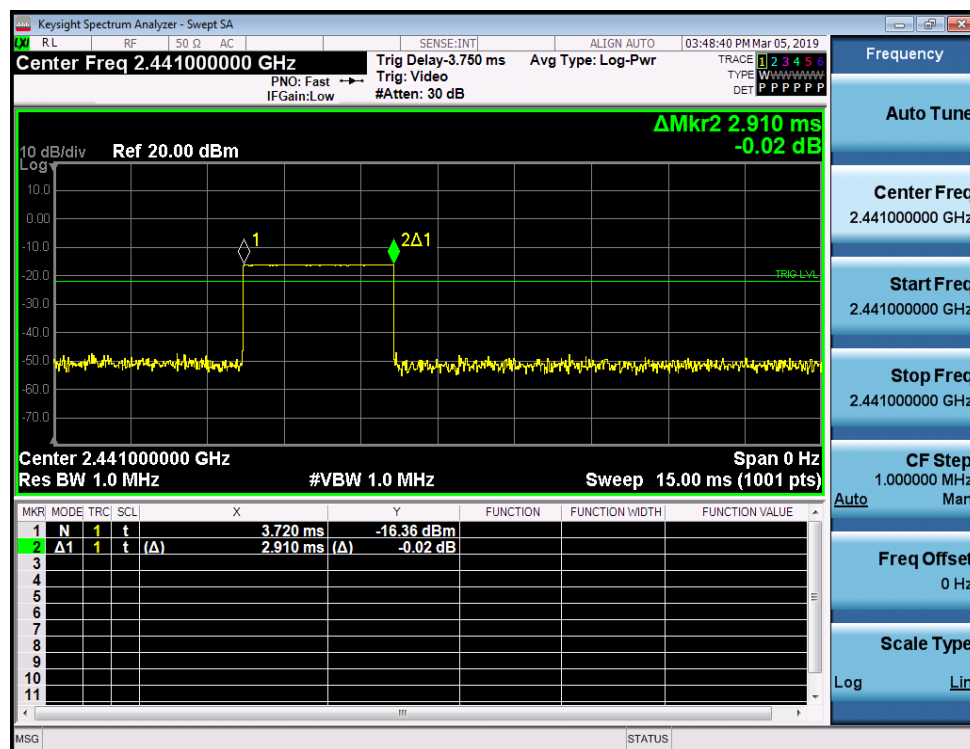
GFSK\_DH3/HCH



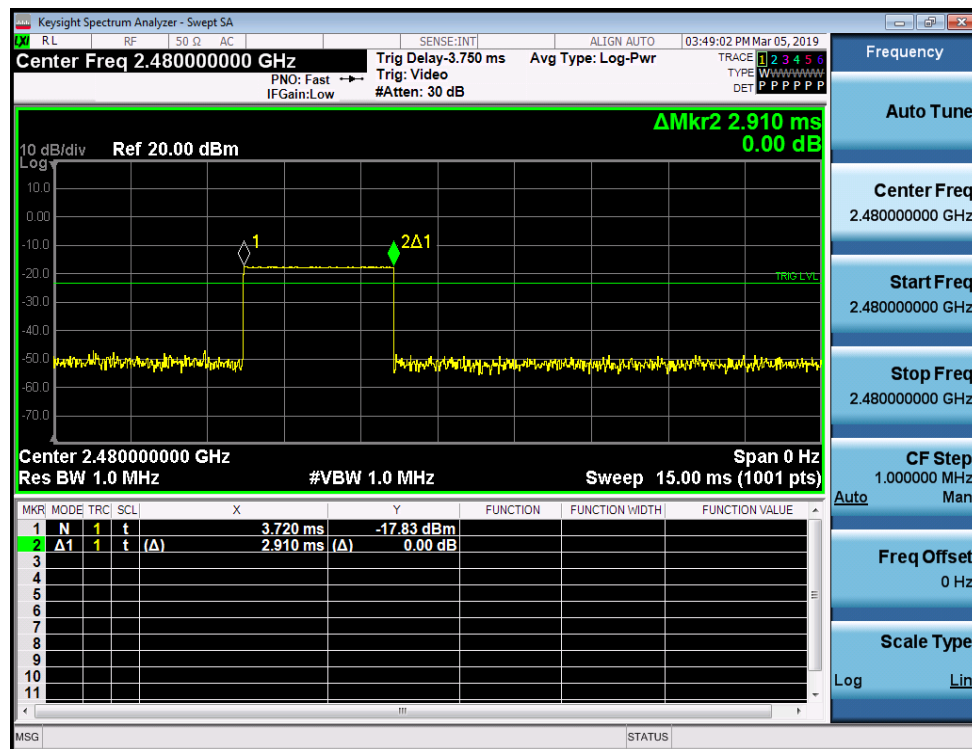
GFSK\_DH5/LCH



GFSK\_DH5/MCH



GFSK\_DH5/HCH



## 4.5 Peak Output Power Measurement

### 4.5.1 Limit of Peak Output Power

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.

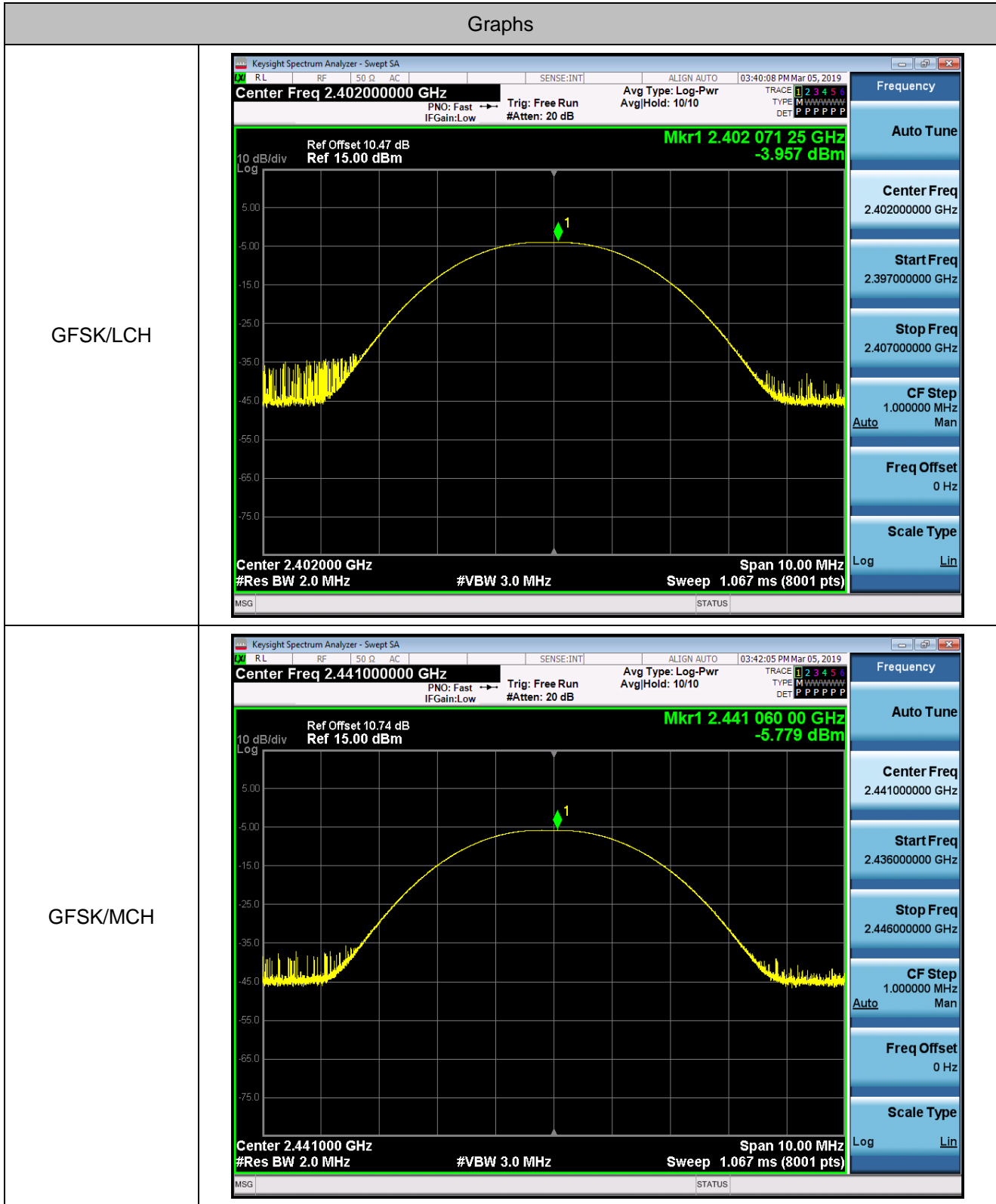
### 4.5.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

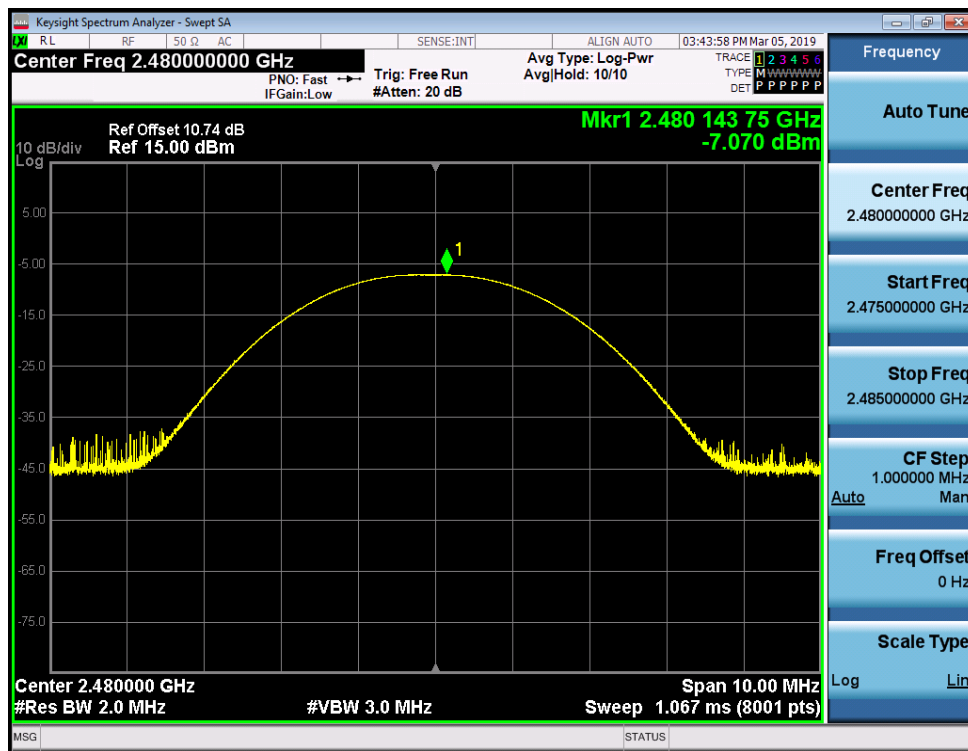
### 4.5.3 Test Result of Peak Output Power

<b>Test Mode :</b>		Transmitting		<b>Temperature :</b>	24~26°C	
<b>Test Engineer :</b>		Damon Zhang		<b>Relative Humidity :</b>	50~53%	
Data Rate	Modulation	Channel	Maximum Peak Output Power [dBm]	Limit[dBm]	Verdict	
1Mbps	GFSK	LCH	-3.957	21	PASS	
1Mbps	GFSK	MCH	-5.779	21	PASS	
1Mbps	GFSK	HCH	-7.070	21	PASS	

Peak Output Power Polt



GFSK/HCH



## 4.6 Conducted Band Edges Measurement

### 4.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

### 4.6.2 Test Procedures

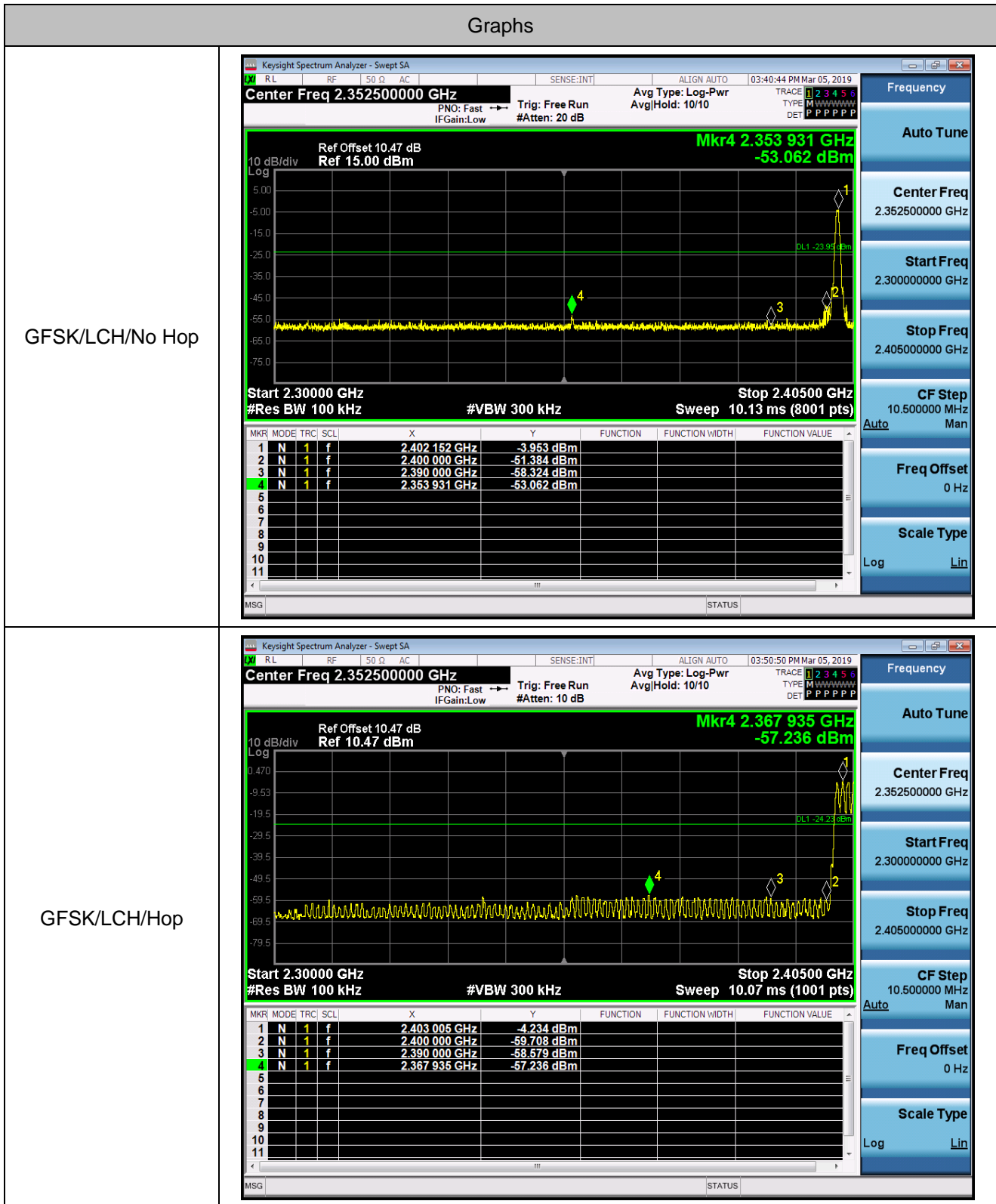
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set RBW = 100kHz, VBW = 300kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 1~3.

### 4.6.3 Test Result of Conducted Band Edges

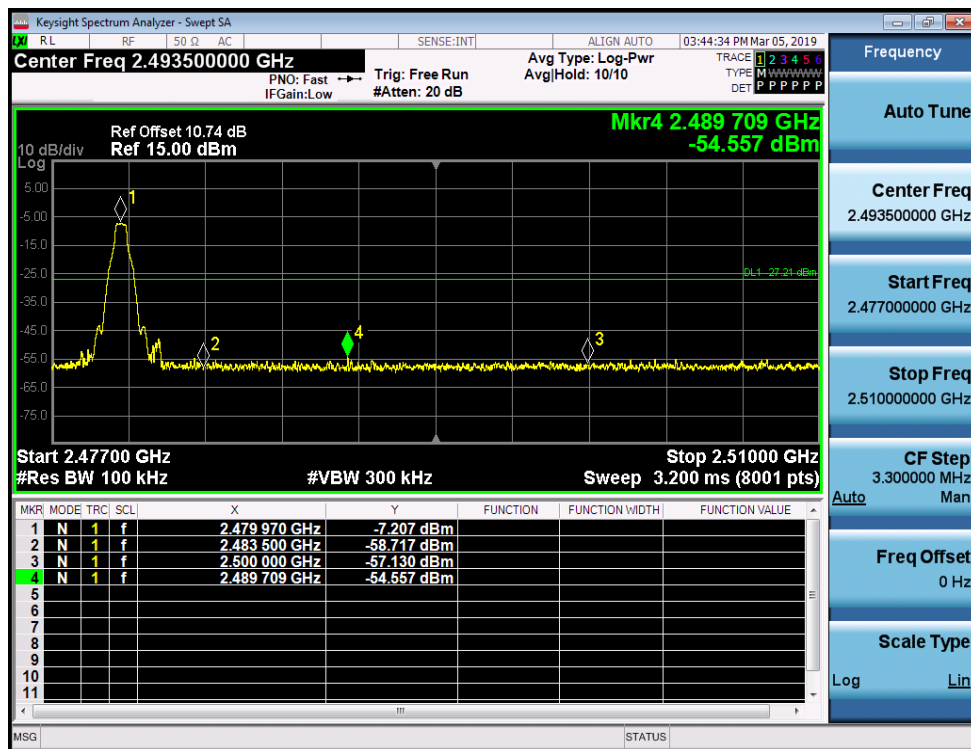
Test Mode :		Transmitting			Temperature :		24~26℃	
Test Engineer :		Damon Zhang			Relative Humidity :		50~53%	
Data Rate	Modulation	Channel	Carrier Frequency [MHz]	Carrier Power [dBm]	Frequency Hopping	Max Spurious Level [dBm]	Limit [dBm]	Verdict
1Mbps	GFSK	LCH	2402	-3.953	Off	-51.384	-23.95	PASS
				-4.234	On	-57.236	-24.23	PASS
1Mbps	GFSK	HCH	2480	-7.207	Off	-54.557	-27.21	PASS
				-7.542	On	-61.067	-27.54	PASS



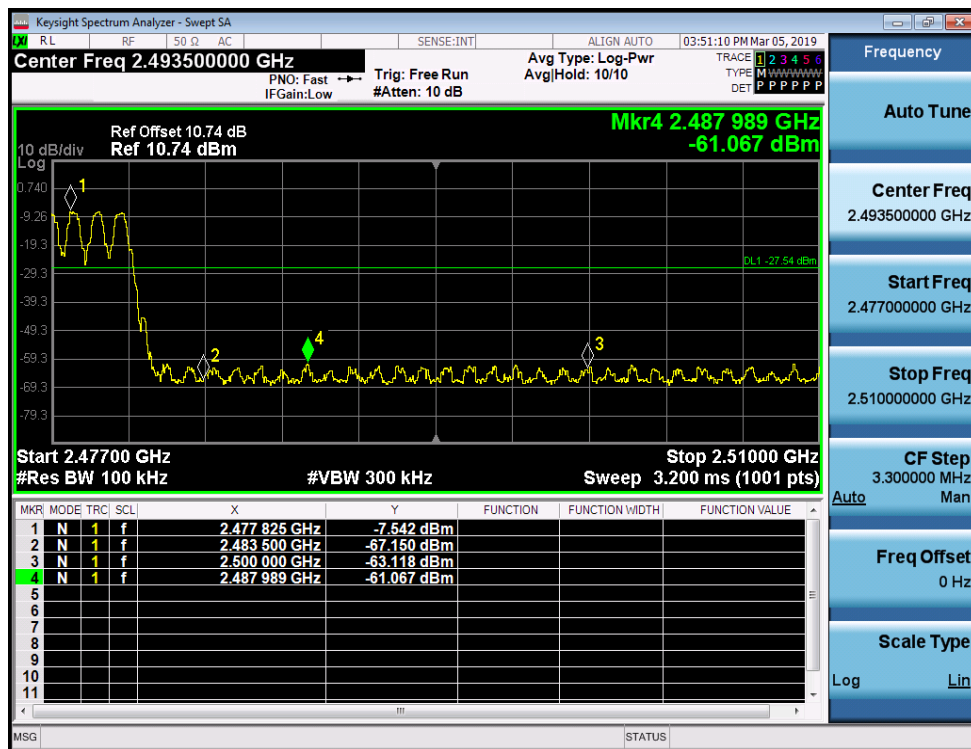
Conducted Band Edge Polt



GFSK/HCH/No Hop



GFSK/HCH/Hop



## 4.7 Conducted Spurious Emission Measurement

### 4.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

### 4.7.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

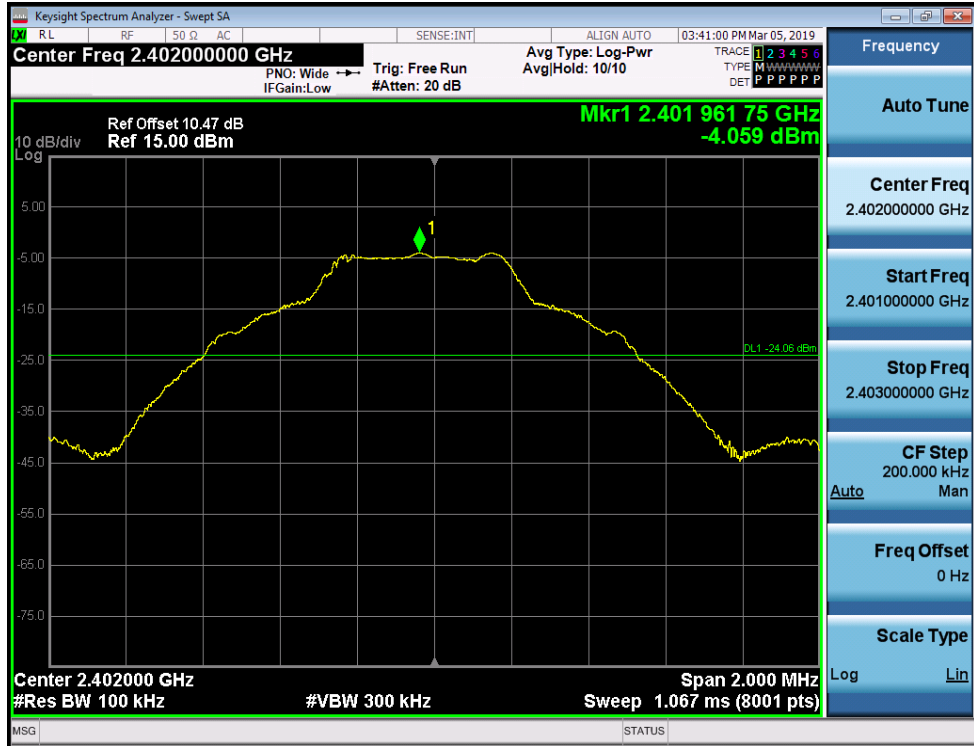
### 4.7.3 Test Result of Conducted Spurious Emission

<b>Test Mode :</b>		Transmitting		<b>Temperature :</b> 24~26°C	
<b>Test Engineer :</b>		Damon Zhang		<b>Relative Humidity :</b> 50~53%	
Data Rate	Modulation	Channel	Pref [dBm]	Puw[dBm]	Verdict
1Mbps	GFSK	LCH	-4.059	<Limit	PASS
1Mbps	GFSK	MCH	-5.934	<Limit	PASS
1Mbps	GFSK	HCH	-7.214	<Limit	PASS

## Conducted Spurious Emission Polt

## GFSK\_LCH\_Graphs

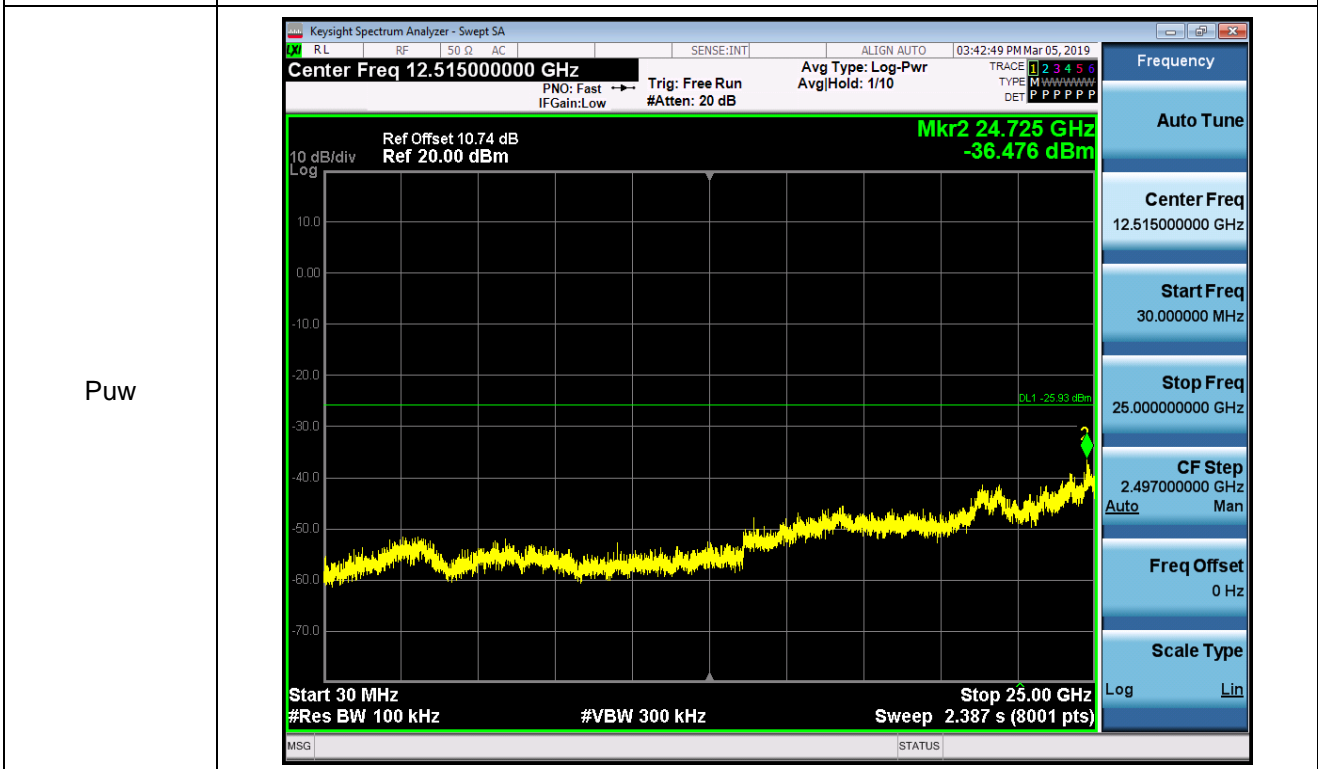
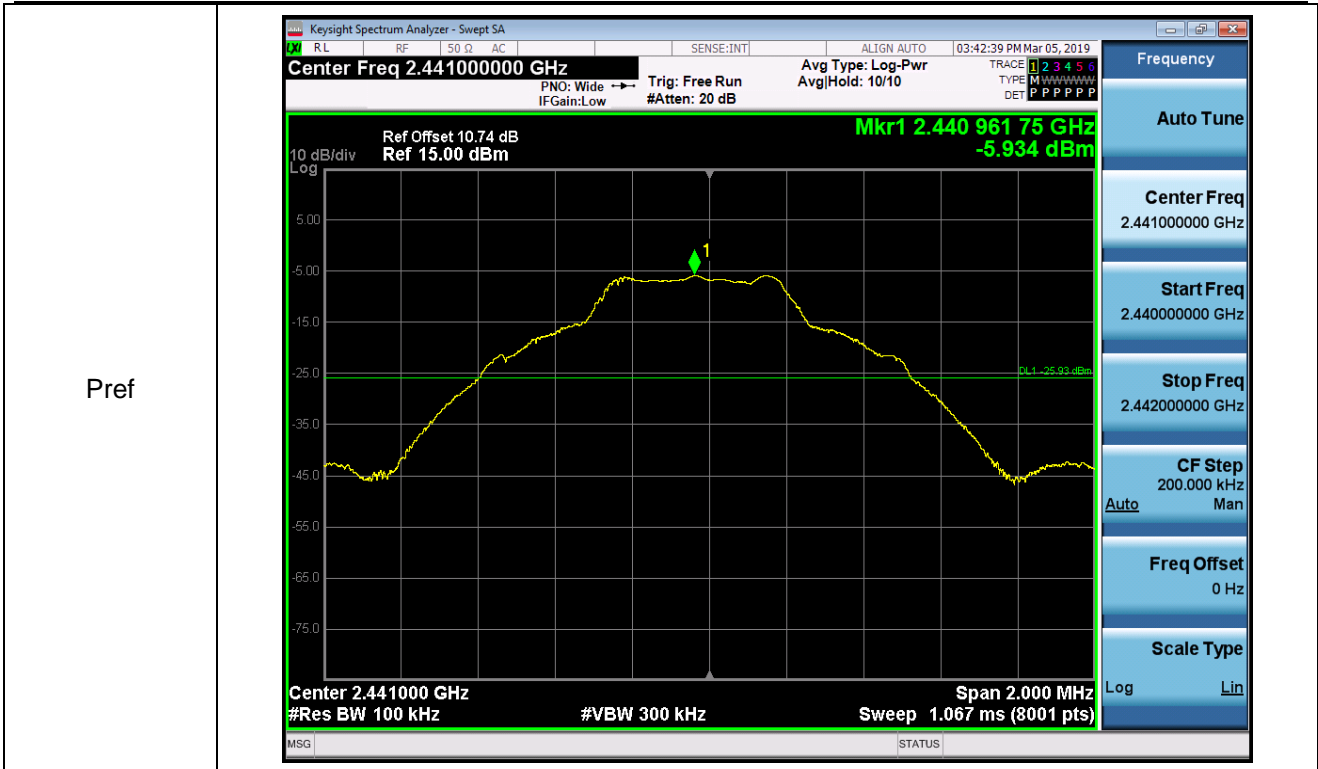
Pref



Puw



## GFSK\_MCH\_Graphs



GFSK\_HCH\_Graphs

Pref



Puw



## 4.8 Radiated Band Edges and Spurious Emission Measurement

### 4.8.1 Limit of Radiated Band Edges and Spurious Emission

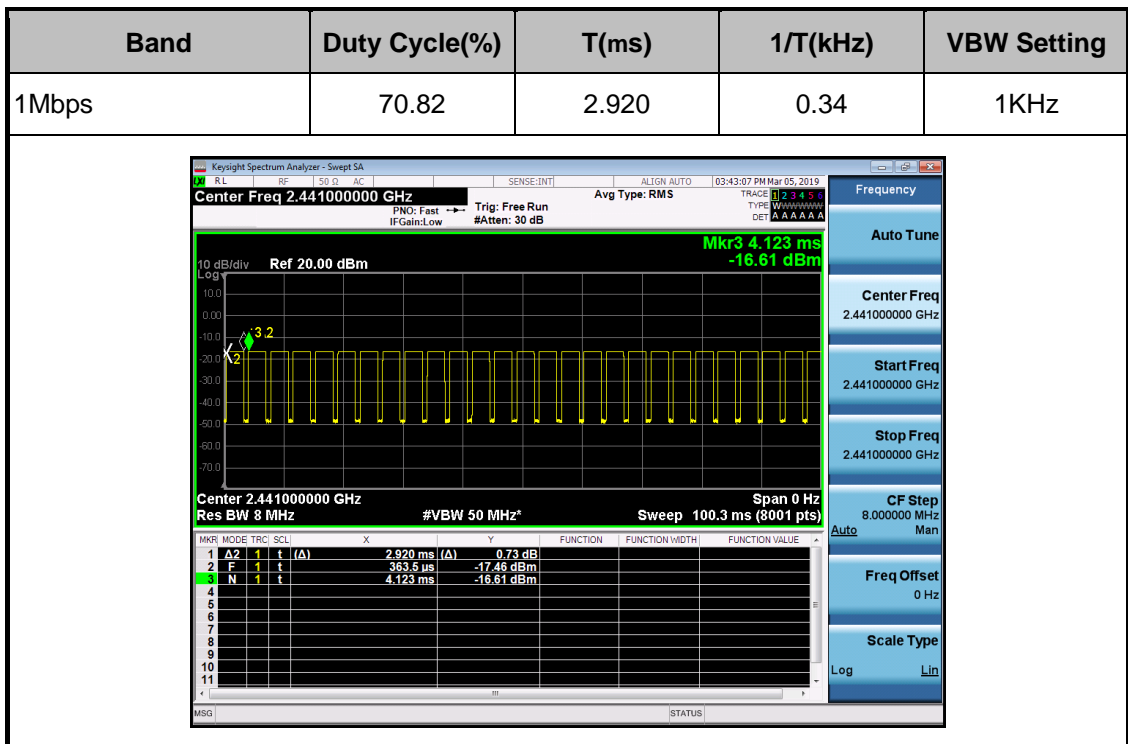
In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

Frequency (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

Note: The frequency range from 9KHz to 10th harmonic (25GHz) are checked, and no any emissions were found from 18GHz to 25GHz, So the radiated emissions from 18GHz to 25GHz were not record.

### 4.8.2 Test Procedures

6. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
7. The measurement distance is 3 meter.
8. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
9. Set to the maximum power setting and enable the EUT transmit continuously.
10. Use the following spectrum analyzer settings:
  - (1) Span shall wide enough to fully capture the emission being measured;
  - (2) Set RBW=100 kHz for  $f < 1$  GHz, RBW=1MHz for  $f > 1$ GHz ; VBW  $\geq$  RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
  - (3) For average measurement:  
 VBW = 10 Hz, when duty cycle is no less than 98 percent.  
 VBW  $\geq 1/T$ , when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.



11. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level



### 4.8.3 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

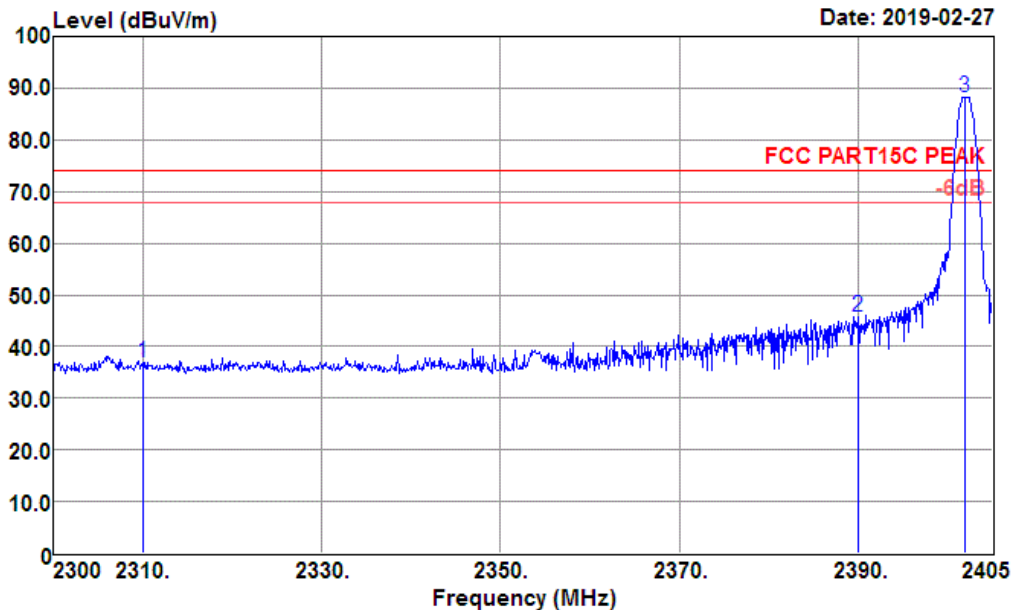
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

### 4.8.4 Test Result of Radiated Spurious at Band Edges

Low Channel Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2402MHz TX Mode		
-----			

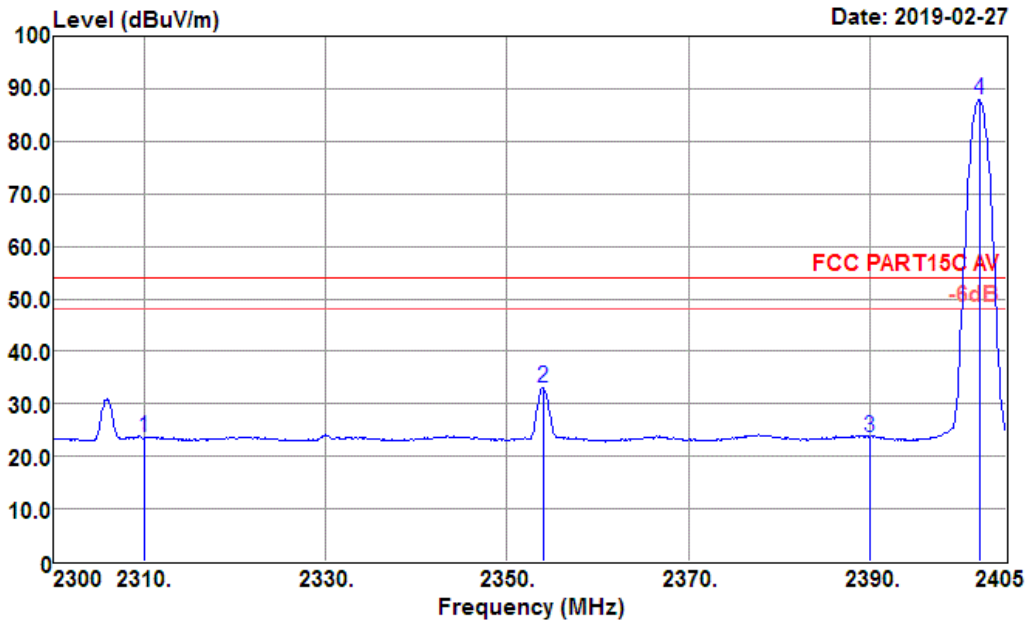
Data: 1 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2309.975	42.40	26.91	3.56	35.87	37.00	74.00	-37.00	Peak	**	**
2390.000	51.13	27.11	3.64	36.08	45.80	74.00	-28.20	Peak	**	**
2401.850	93.68	27.14	3.65	36.11	88.36	74.00	14.36	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

Data: 2 File: F:\data\project\2019\2月\1902015\1902015F\CC PART 15C.247.EM6 (29)

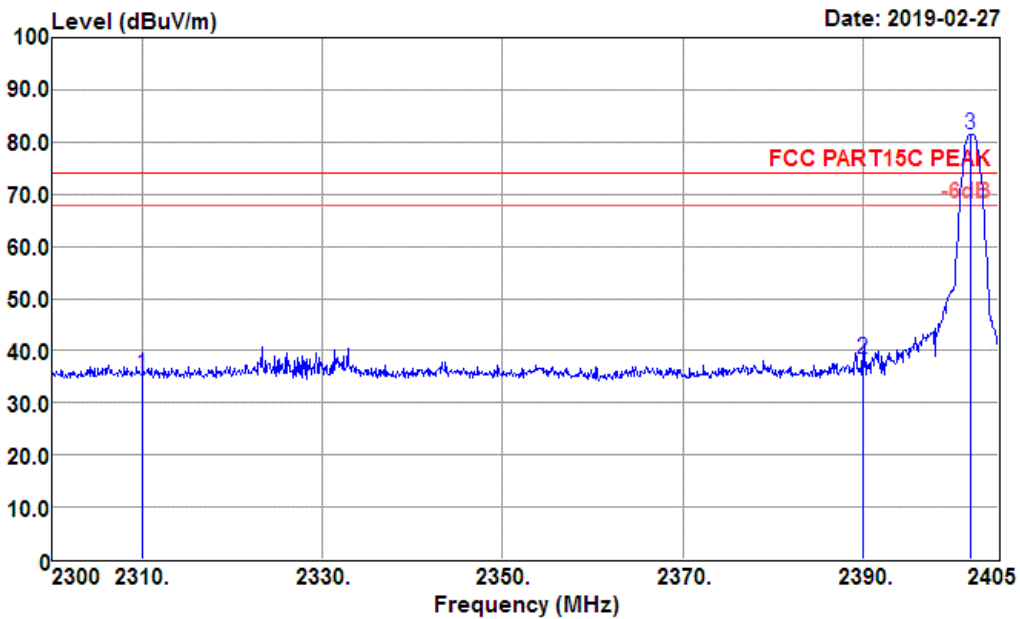


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2310.000	28.87	26.91	3.56	35.87	23.47	54.00	-30.53	Average	150	30
2353.970	38.39	27.02	3.60	35.98	33.03	54.00	-20.97	Average	150	30
2390.000	28.99	27.11	3.64	36.08	23.66	54.00	-30.34	Average	150	30
2402.060	93.19	27.15	3.65	36.11	87.88	54.00	33.88	Average	150	30

Low Channel Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

Data: 20 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)

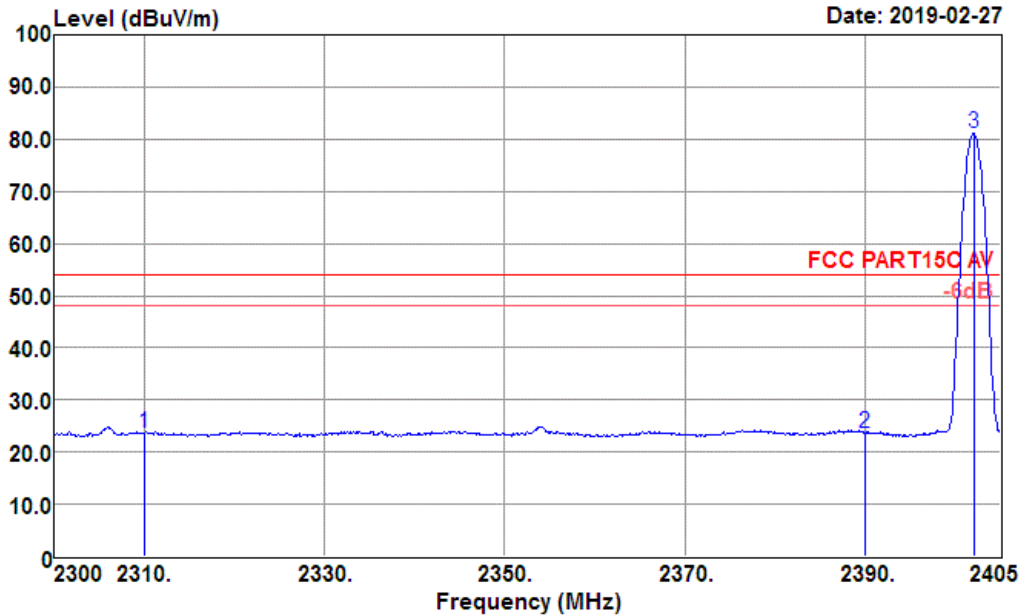


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2310.000	40.72	26.91	3.56	35.87	35.32	74.00	-38.68	Peak	**	**
2390.000	43.69	27.11	3.64	36.08	38.36	74.00	-35.64	Peak	**	**
2401.850	86.77	27.14	3.65	36.11	81.45	74.00	7.45	Peak	**	**

High Channel Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

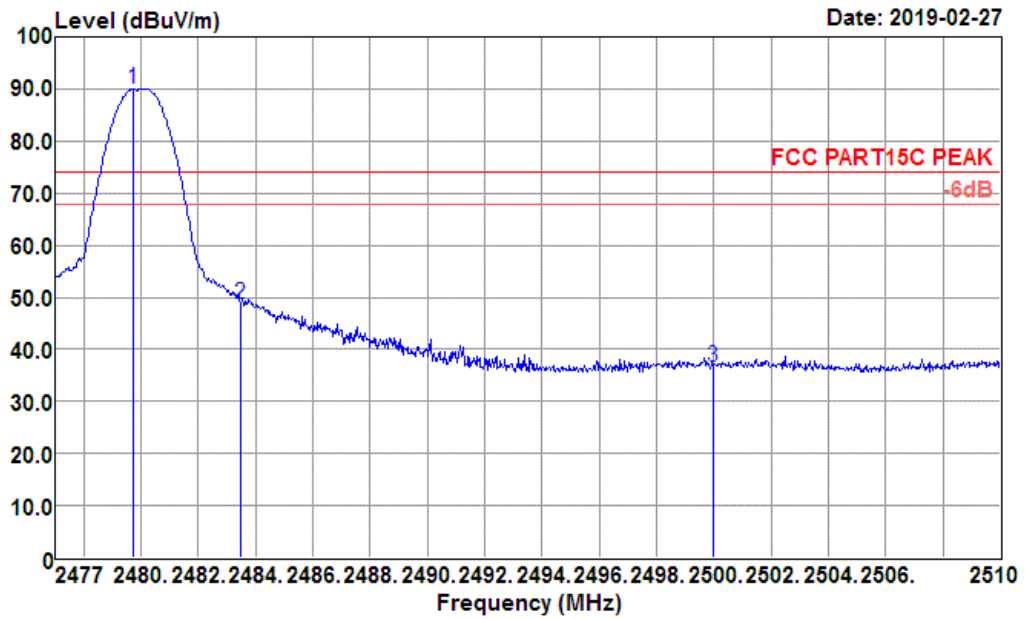
Data: 21 File: F:\data\project\2019\2月\1902015\1902015\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2310.000	29.03	26.91	3.56	35.87	23.63	54.00	-30.37	Average	400	242
2390.000	29.09	27.11	3.64	36.08	23.76	54.00	-30.24	Average	400	242
2402.060	86.41	27.15	3.65	36.11	81.10	54.00	27.10	Average	400	242

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

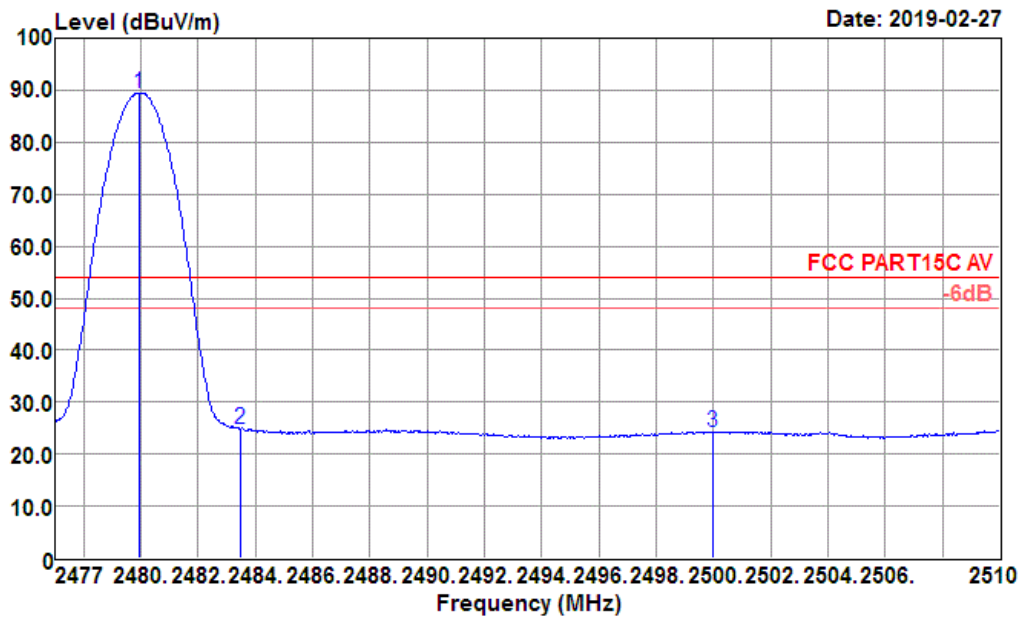
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Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2479.739	95.30	27.35	3.68	36.32	90.01	74.00	16.01	Peak	**	**
2483.501	53.86	27.36	3.68	36.33	48.57	74.00	-25.43	Peak	**	**
2500.000	41.99	27.40	3.68	36.37	36.70	74.00	-37.30	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

Data: 5 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)

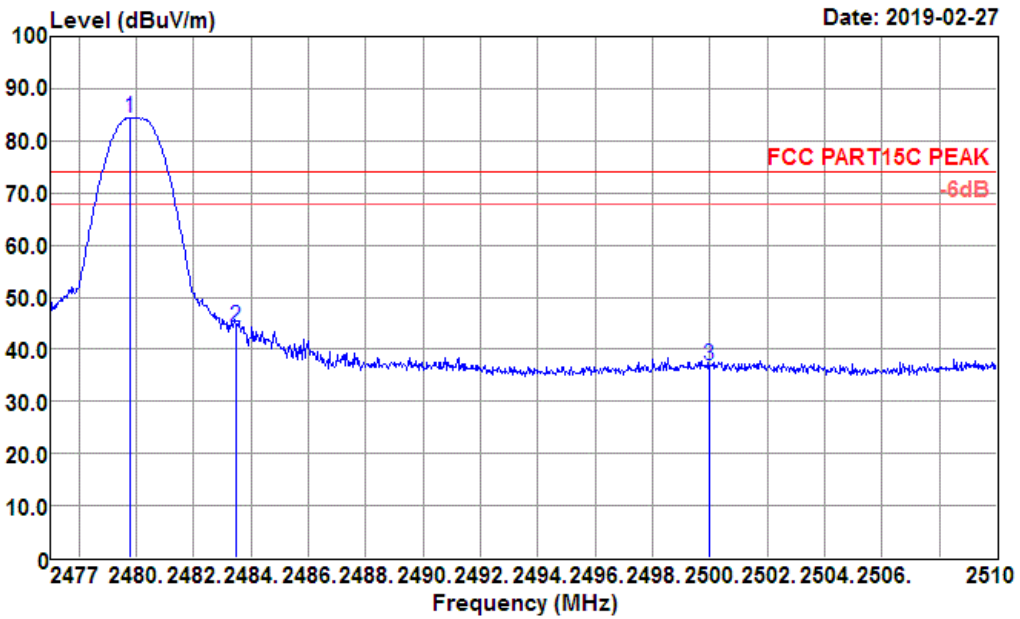


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2479.970	94.80	27.35	3.68	36.32	89.51	54.00	35.51	Average	200	49
2483.501	30.09	27.36	3.68	36.33	24.80	54.00	-29.20	Average	200	49
2500.000	29.44	27.40	3.68	36.37	24.15	54.00	-29.85	Average	200	49

High Channel Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

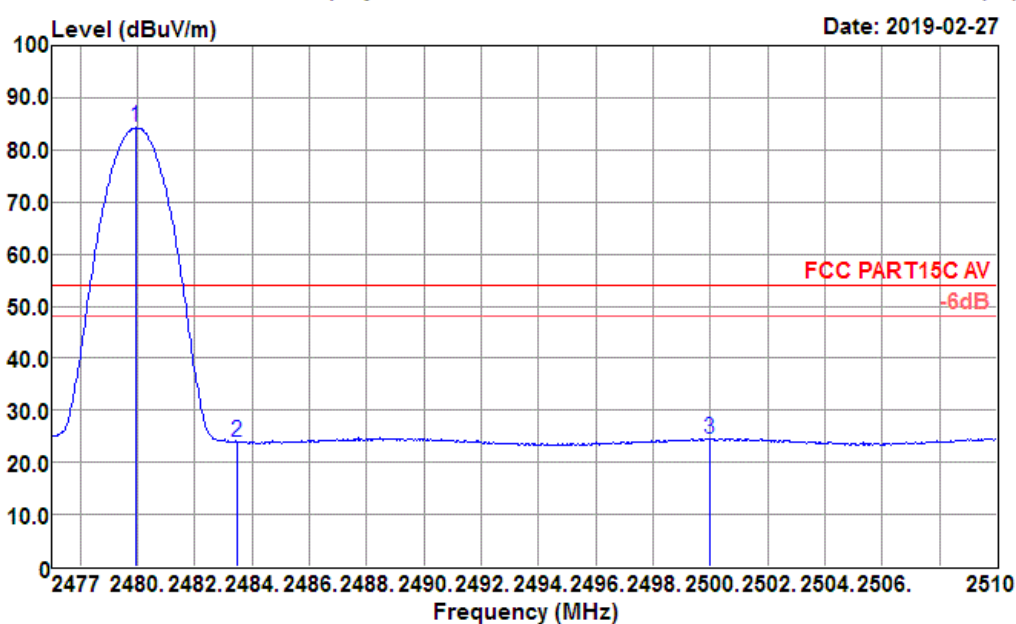
Data: 24 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2479.772	89.79	27.35	3.68	36.32	84.50	74.00	10.50	Peak	**	**
2483.500	49.61	27.36	3.68	36.33	44.32	74.00	-29.68	Peak	**	**
2500.000	42.17	27.40	3.68	36.37	36.88	74.00	-37.12	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

Data: 25 File: F:\data\project\2019\2月\1902015\1902015F\CC PART 15C.247.EM6 (29)



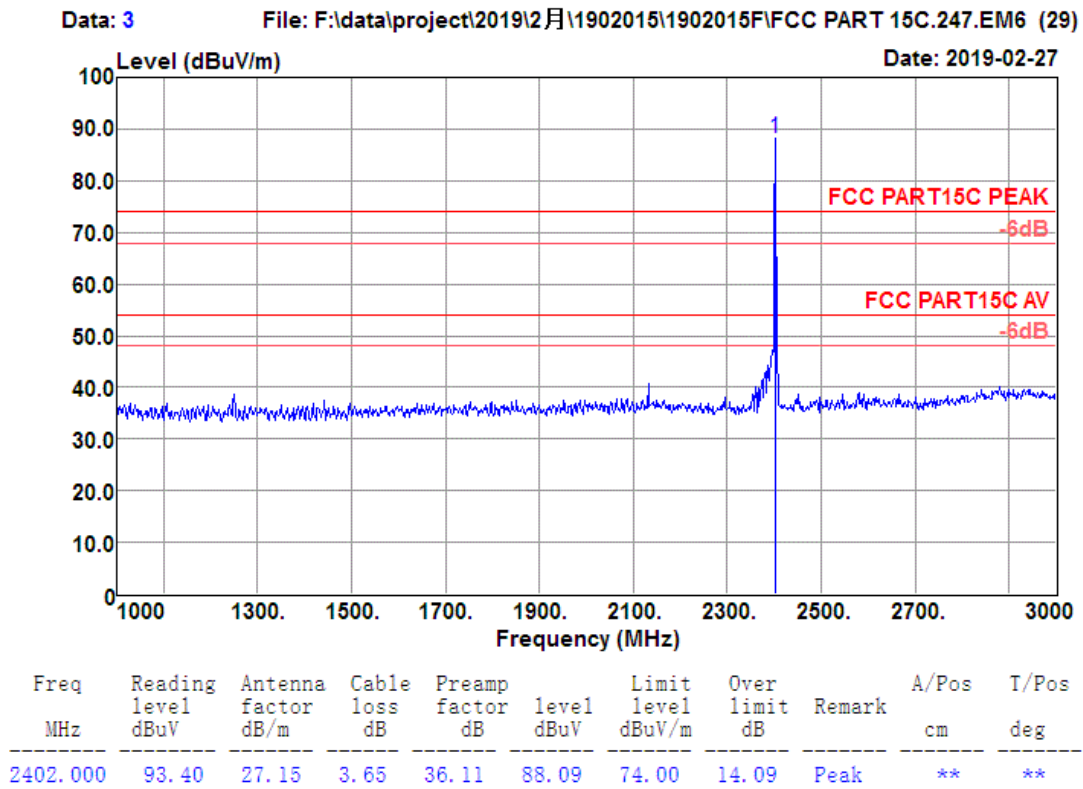
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2479.970	89.53	27.35	3.68	36.32	84.24	54.00	30.24	Average	366	338
2483.501	29.18	27.36	3.68	36.33	23.89	54.00	-30.11	Average	366	338
2500.000	29.79	27.40	3.68	36.37	24.50	54.00	-29.50	Average	366	338



### 4.8.5 Test Result of Radiated Spurious Emission (1GHz ~ 10<sup>th</sup> Harmonic)

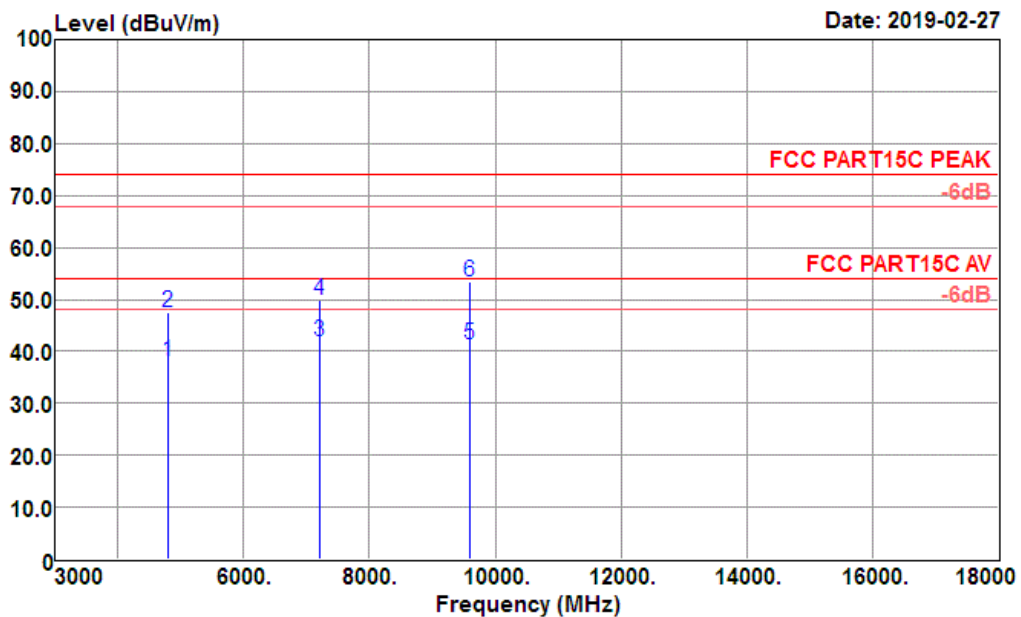
Low Channel Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		



Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

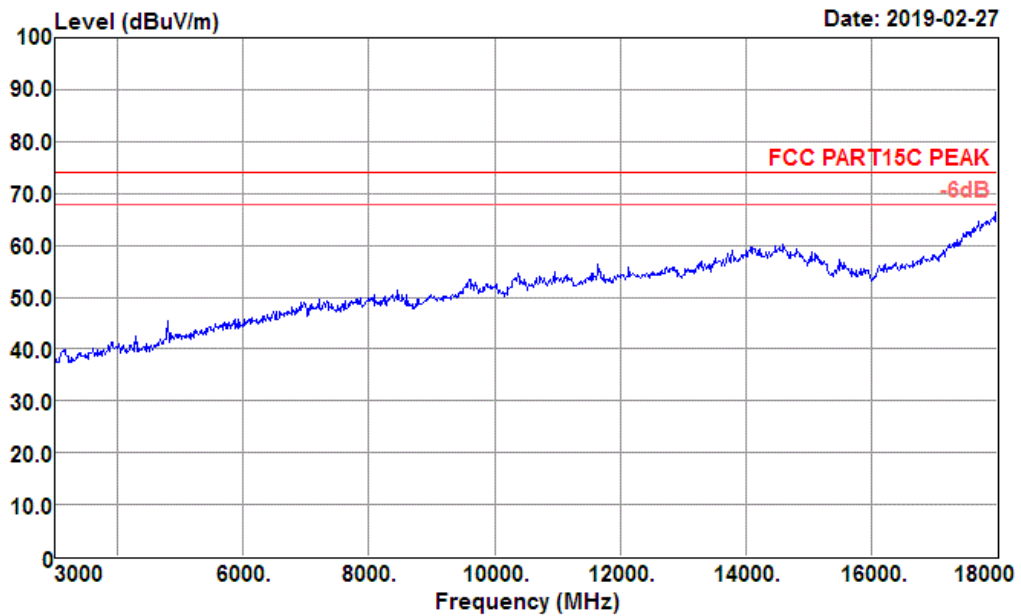
Data: 16 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
4804.000	37.54	31.23	5.45	36.27	37.95	54.00	-16.05	Average	150	355
4804.000	47.00	31.23	5.45	36.27	47.41	74.00	-26.59	Peak	150	355
7206.000	33.23	35.87	6.94	34.25	41.79	54.00	-12.21	Average	285	310
7206.000	41.23	35.87	6.94	34.25	49.79	74.00	-24.21	Peak	285	310
9608.000	30.02	37.79	7.77	34.13	41.45	54.00	-12.55	Average	289	225
9608.000	41.97	37.79	7.77	34.13	53.40	74.00	-20.60	Peak	289	225

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

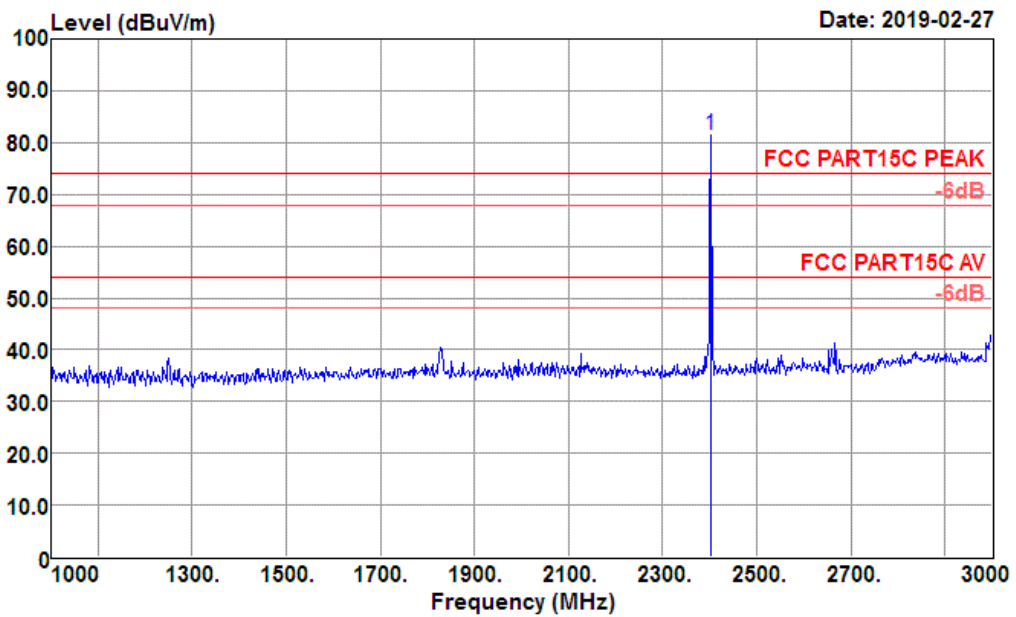
Data: 10 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Low Channel Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

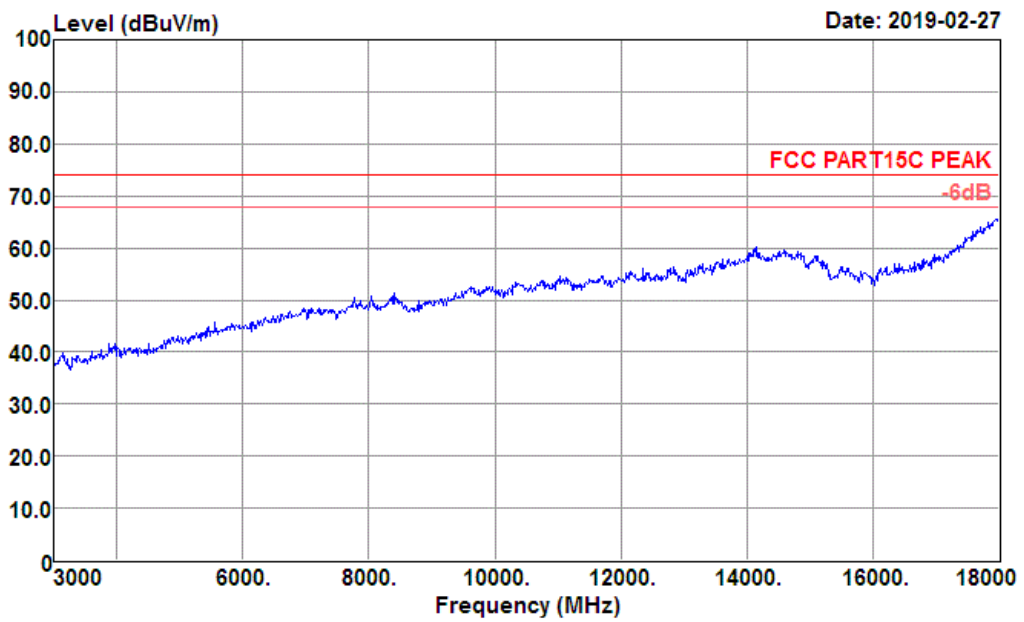
Data: 22 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2402.000	86.75	27.15	3.65	36.11	81.44	74.00	7.44	Peak	**	**

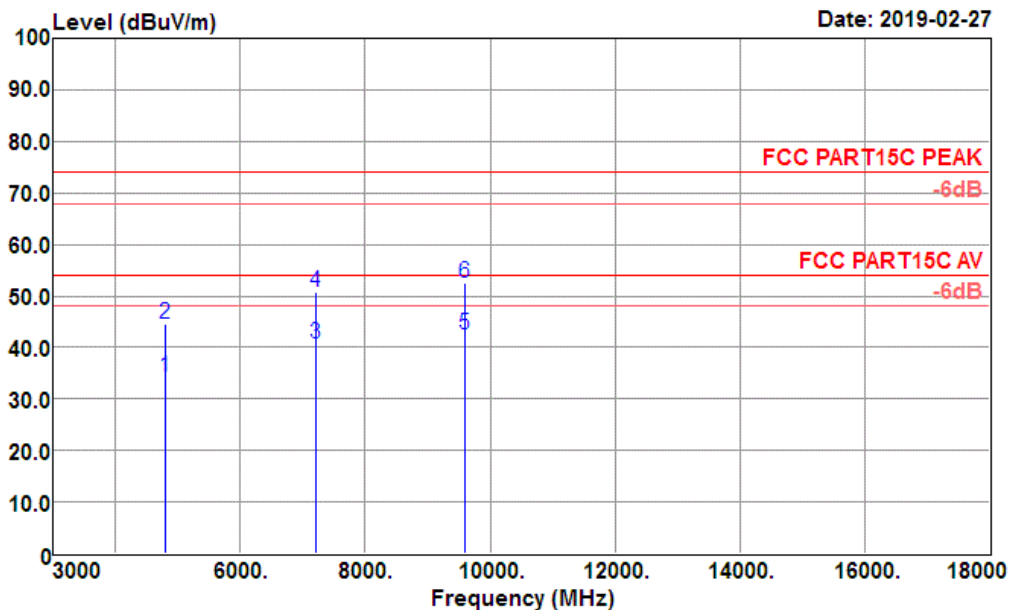
Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2402MHz TX Mode		

Data: 11 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2402MHz TX Mode		
-----			

Data: 17 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



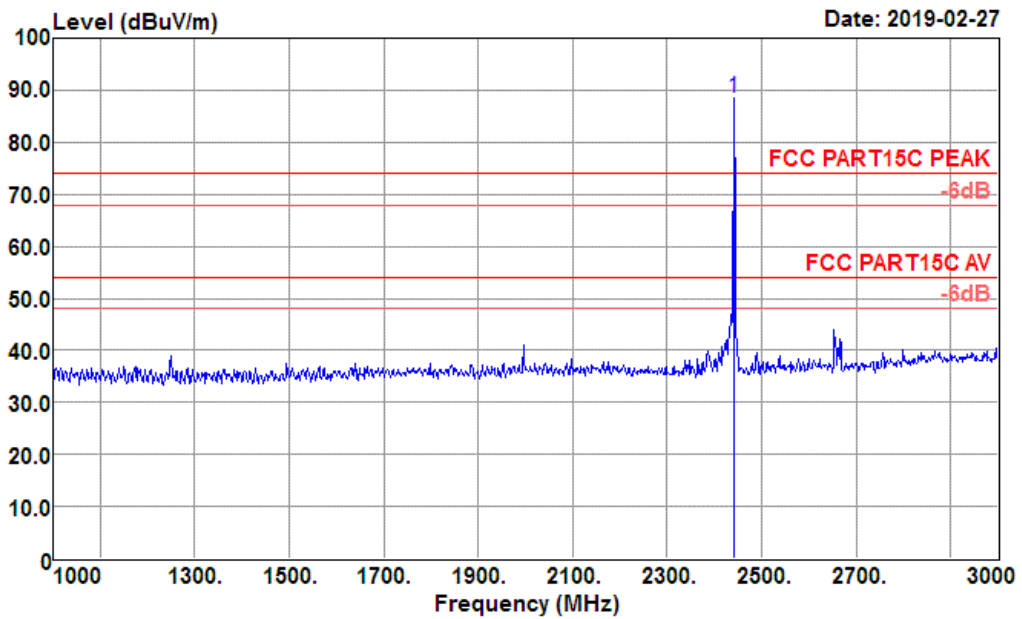
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
4804.000	33.85	31.23	5.45	36.27	34.26	54.00	-19.74	Average	150	123
4804.000	44.20	31.23	5.45	36.27	44.61	74.00	-29.39	Peak	150	123
7206.000	32.10	35.87	6.94	34.25	40.66	54.00	-13.34	Average	229	207
7206.000	42.31	35.87	6.94	34.25	50.87	74.00	-23.13	Peak	229	207
9608.000	30.98	37.79	7.77	34.13	42.41	54.00	-11.59	Average	201	260
9608.000	41.12	37.79	7.77	34.13	52.55	74.00	-21.45	Peak	201	260

r

Middle Channel Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

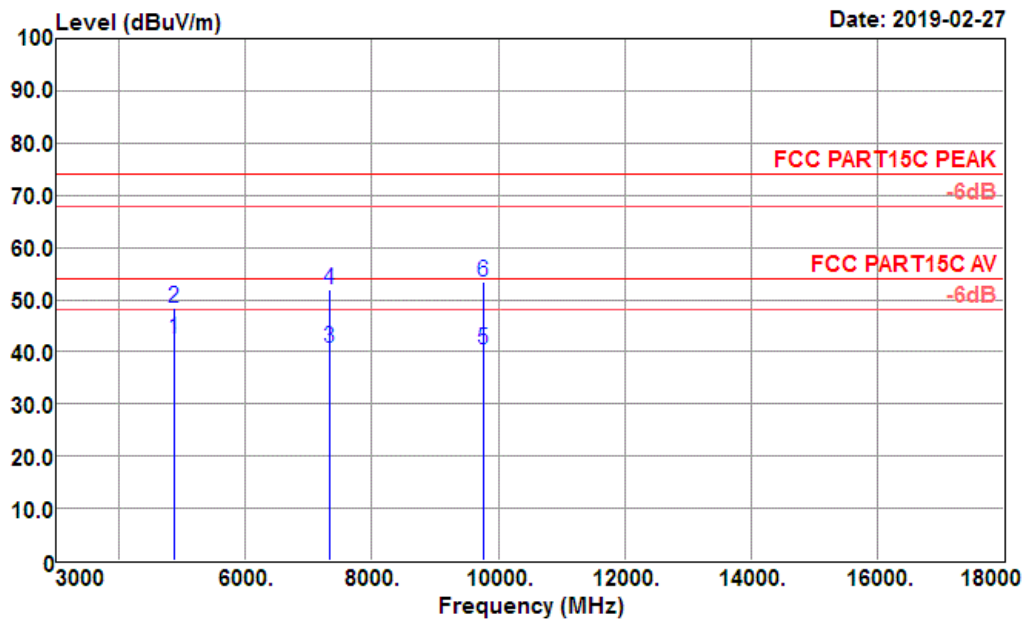
Data: 7 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2442.000	93.95	27.25	3.66	36.22	88.64	74.00	14.64	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2441MHz TX Mode		
-----			

Data: 14 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)

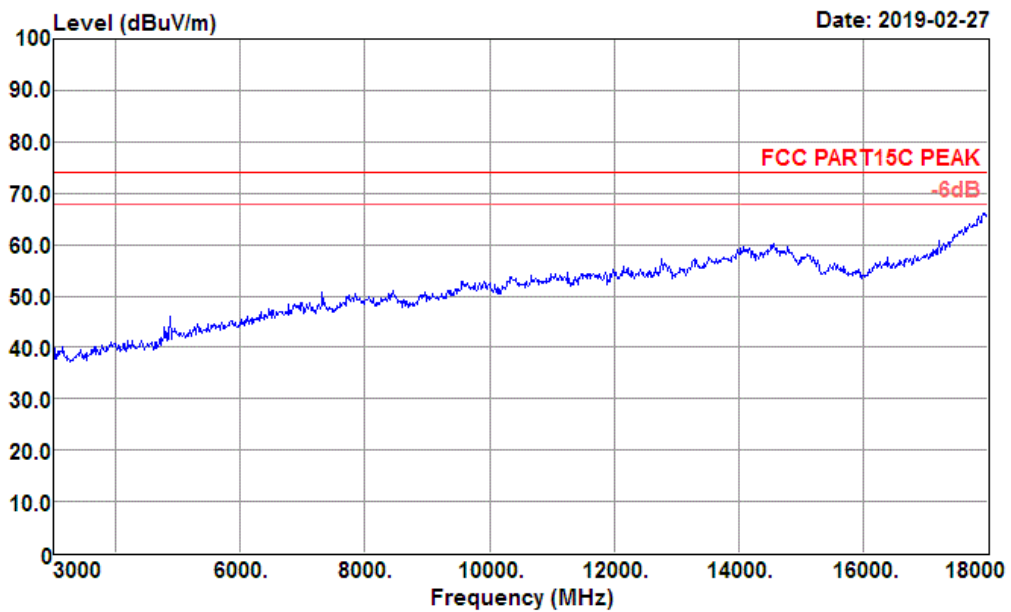


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
4882.000	41.80	31.42	5.40	36.24	42.38	54.00	-11.62	Average	224	201
4882.000	47.70	31.42	5.40	36.24	48.28	74.00	-25.72	Peak	224	201
7323.000	31.80	36.14	7.28	34.36	40.86	54.00	-13.14	Average	226	241
7323.000	42.83	36.14	7.28	34.36	51.89	74.00	-22.11	Peak	226	241
9764.000	28.69	38.08	7.98	34.20	40.55	54.00	-13.45	Average	150	285
9764.000	41.68	38.08	7.98	34.20	53.54	74.00	-20.46	Peak	150	285



Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

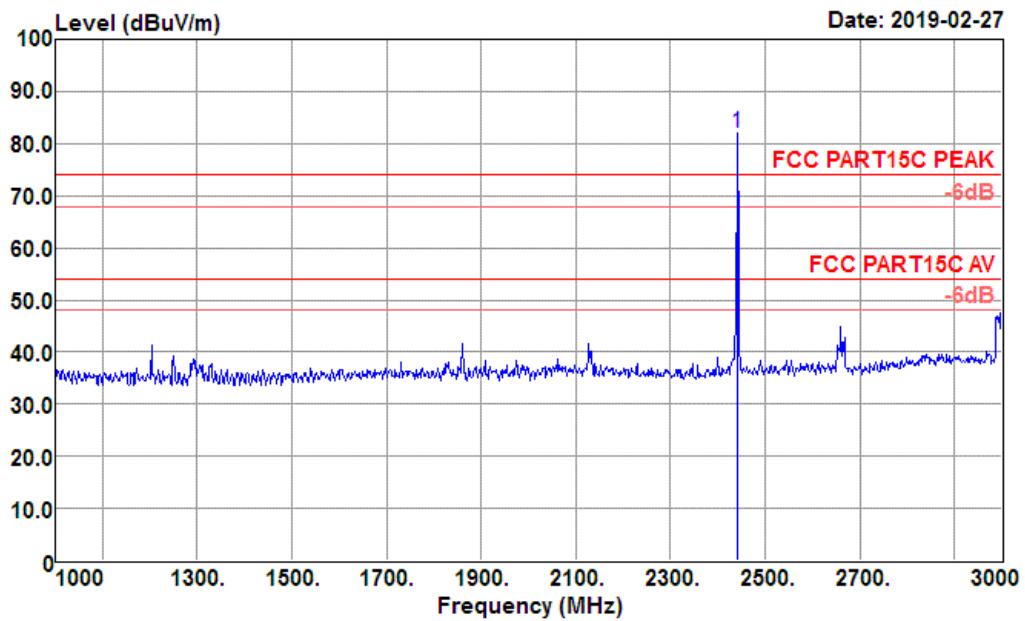
Data: 8 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Middle Channel Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

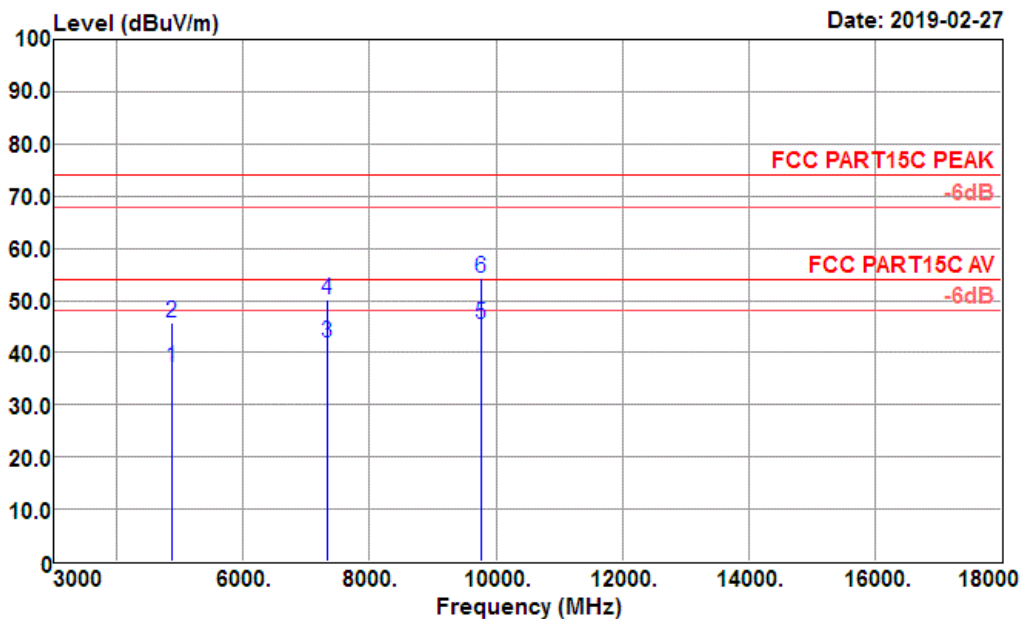
Data: 26 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2442.000	87.25	27.25	3.66	36.22	81.94	74.00	7.94	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2441MHz TX Mode		
-----			

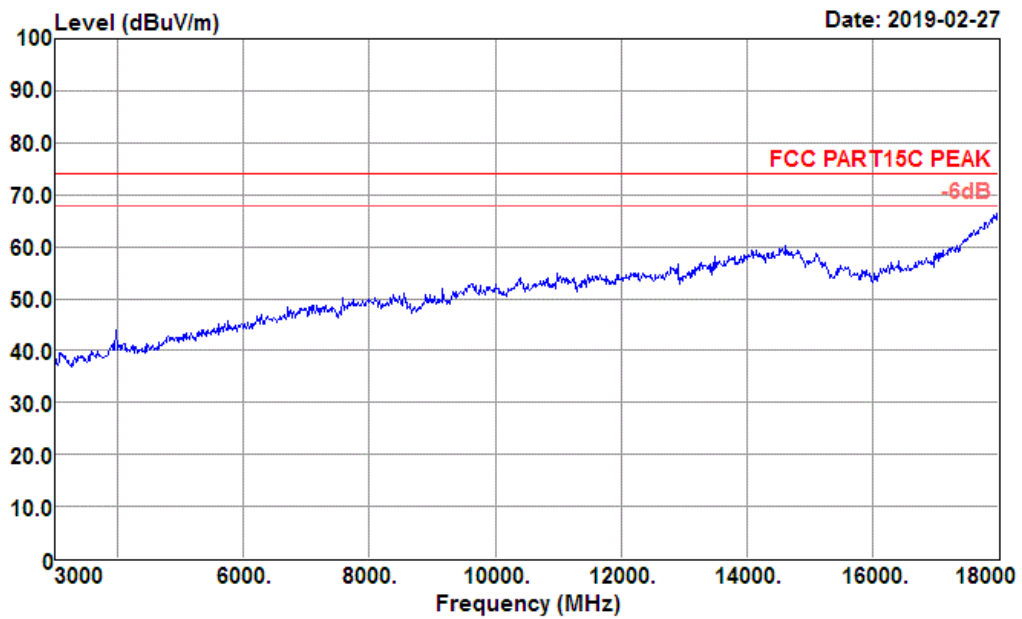
Data: 15 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	I/Pos deg
4882.000	36.60	31.42	5.40	36.24	37.18	54.00	-16.82	Average	277	96
4882.000	45.07	31.42	5.40	36.24	45.65	74.00	-28.35	Peak	277	96
7323.000	32.83	36.14	7.28	34.36	41.89	54.00	-12.11	Average	300	30
7323.000	41.12	36.14	7.28	34.36	50.18	74.00	-23.82	Peak	300	30
9764.000	33.55	38.08	7.98	34.20	45.41	54.00	-8.59	Average	298	91
9764.000	42.46	38.08	7.98	34.20	54.32	74.00	-19.68	Peak	277	126

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

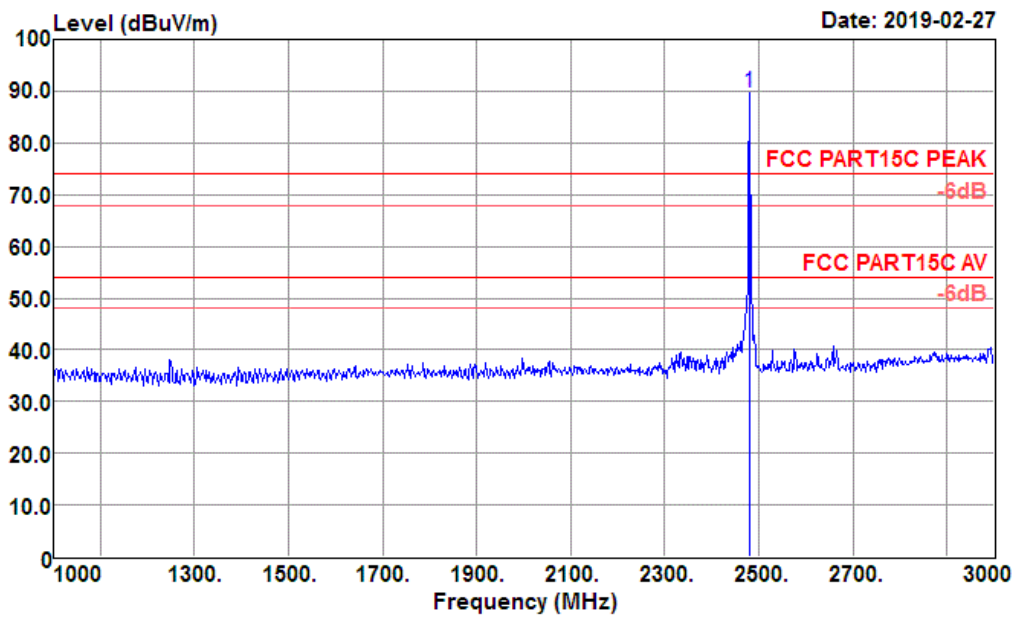
Data: 9 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



## High Channel Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

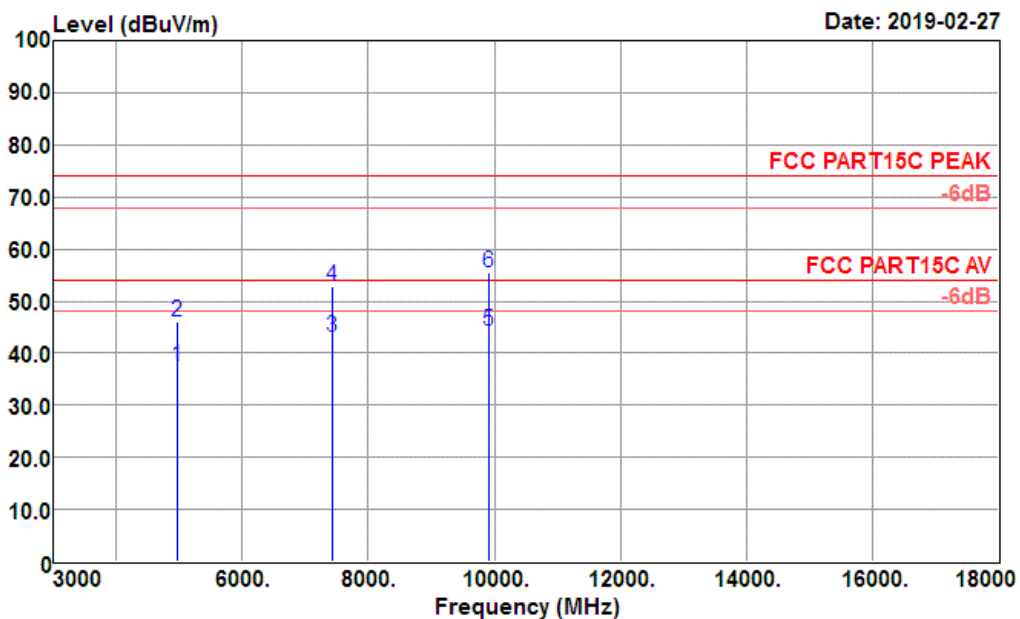
Data: 6 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2480.000	95.07	27.35	3.68	36.32	89.78	74.00	15.78	Peak	**	**

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

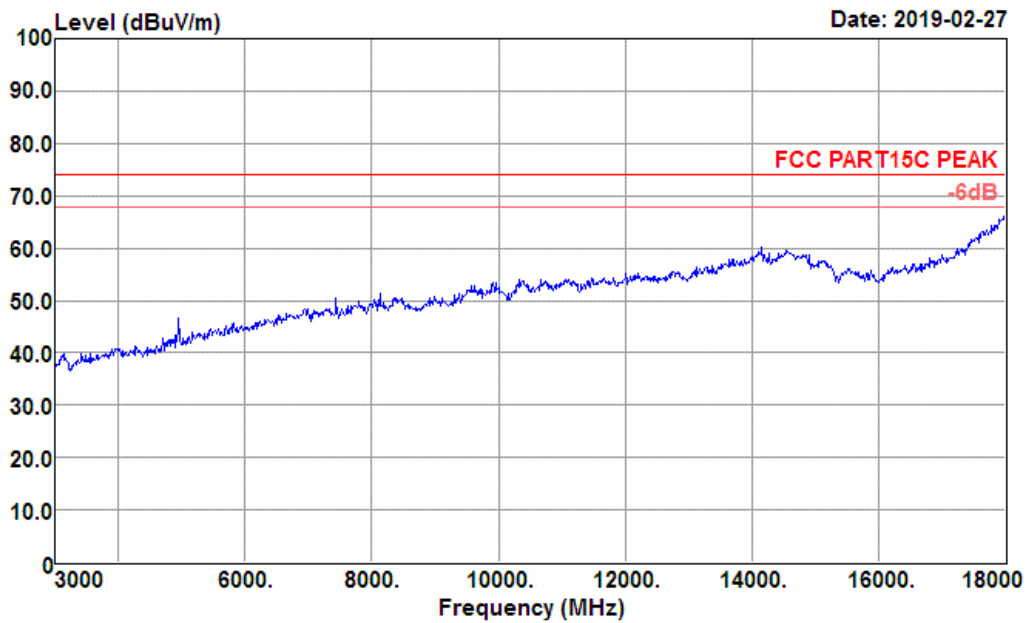
Data: 19 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
4960.000	36.87	31.60	5.36	36.21	37.62	54.00	-16.38	Average	168	115
4960.000	45.31	31.60	5.36	36.21	46.06	74.00	-27.94	Peak	168	115
7440.000	33.76	36.41	7.44	34.47	43.14	54.00	-10.86	Average	168	130
7440.000	43.40	36.41	7.44	34.47	52.78	74.00	-21.22	Peak	168	130
9920.000	32.21	38.36	8.05	34.26	44.36	54.00	-9.64	Average	172	168
9920.000	43.27	38.36	8.05	34.26	55.42	74.00	-18.58	Peak	172	168

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

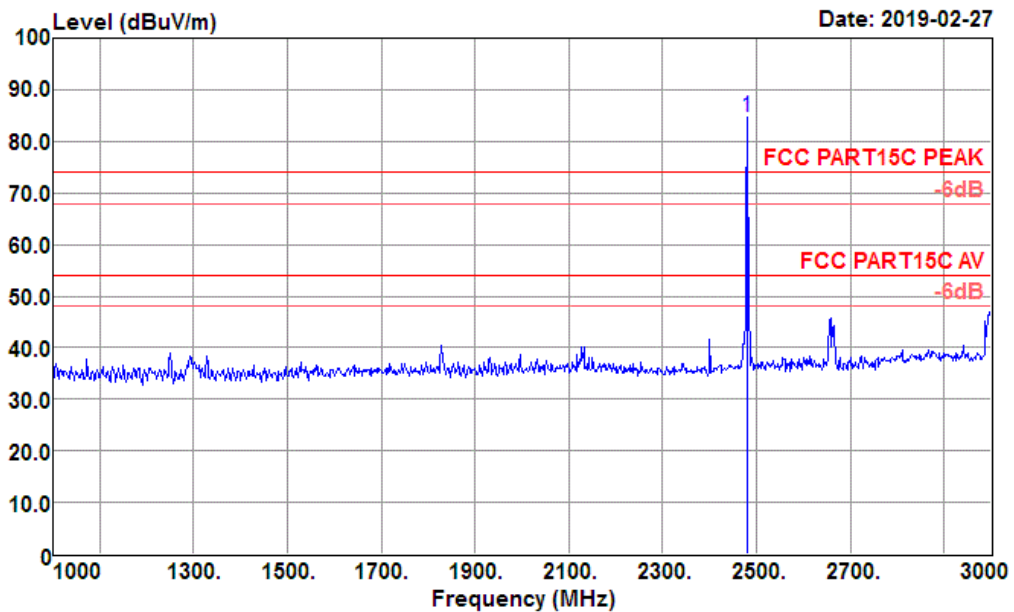
Data: 13 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



## High Channel Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2480MHz TX Mode		
-----			

Data: 23 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)

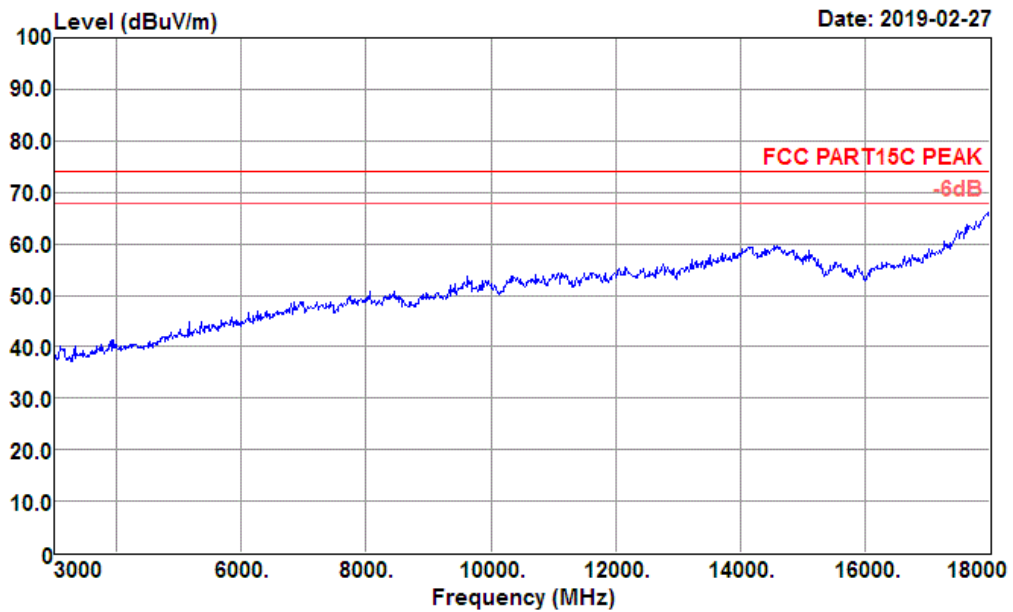


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
2480.000	89.82	27.35	3.68	36.32	84.53	74.00	10.53	Peak	**	**



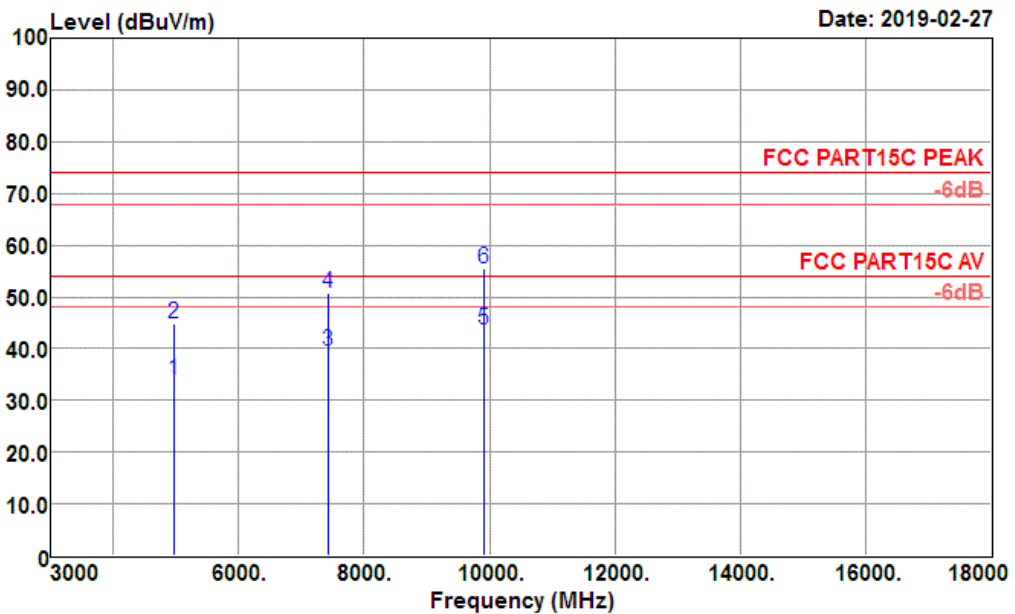
Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2480MHz TX Mode		

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Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
-----			
Tested by	: Damon	Power rating:	DC3.7V
-----			
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
-----			
EUT	: Pi-Top 4		
-----			
Test Mode	: 2480MHz TX Mode		
-----			

Data: 18 File: F:\data\project\2019\2月\1902015\1902015F\FCC PART 15C.247.EM6 (29)



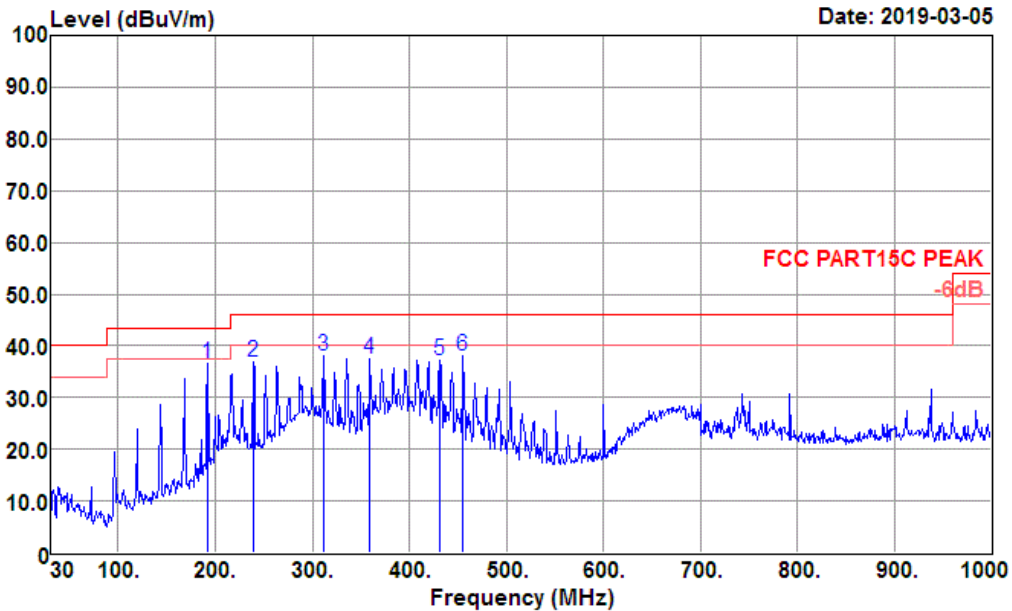
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
4960.000	33.25	31.60	5.36	36.21	34.00	54.00	-20.00	Average	226	256
4960.000	44.24	31.60	5.36	36.21	44.99	74.00	-29.01	Peak	226	256
7440.000	30.28	36.41	7.44	34.47	39.66	54.00	-14.34	Average	229	365
7440.000	41.28	36.41	7.44	34.47	50.66	74.00	-23.34	Peak	229	365
9920.000	31.44	38.36	8.05	34.26	43.59	54.00	-10.41	Average	226	265
9920.000	43.19	38.36	8.05	34.26	55.34	74.00	-18.66	Peak	226	265

#### 4.8.6 Test Result of Radiated Spurious Emission (30MHz ~ 1GHz)

Horizontal:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: HORIZONTAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

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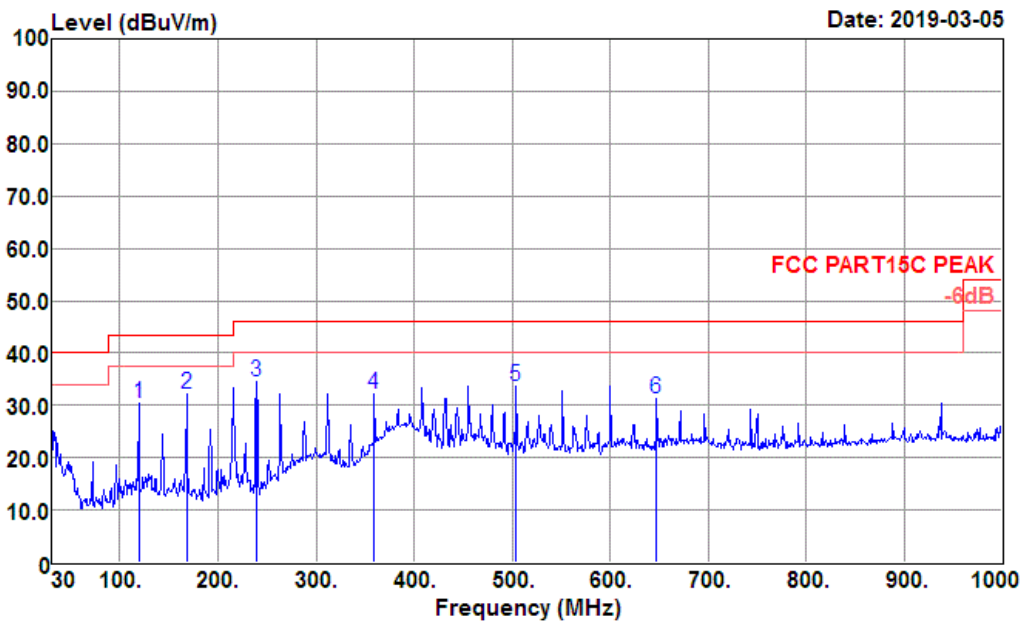


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	T/Pos deg
191.990	55.91	10.38	2.78	32.54	36.53	43.50	-6.97	Peak	**	**
239.520	55.29	11.09	3.08	32.54	36.92	46.00	-9.08	Peak	**	**
311.300	53.92	13.11	3.52	32.51	38.04	46.00	-7.96	Peak	**	**
359.800	52.19	14.04	3.86	32.49	37.60	46.00	-8.40	Peak	**	**
431.580	50.11	15.34	4.19	32.50	37.14	46.00	-8.86	Peak	**	**
455.830	50.63	15.75	4.34	32.52	38.20	46.00	-7.80	Peak	**	**

Vertical:

Test Site	: 3m Chamber	Temp/Humi	: 17°C/56%
Tested by	: Damon	Power rating:	DC3.7V
Model No.	: P18-04KEYB-010	Pol/Phase	: VERTICAL
EUT	: Pi-Top 4		
Test Mode	: 2441MHz TX Mode		

Data: 27 File: F:\data\project\2019\2月\1902015\1902015\FCC PART 15C.247.EM6 (29)



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark	A/Pos cm	I/Pos deg
119.240	48.54	12.12	2.11	32.47	30.30	43.50	-13.20	Peak	**	**
167.740	48.67	13.43	2.53	32.52	32.11	43.50	-11.39	Peak	**	**
239.520	52.76	11.09	3.08	32.54	34.39	46.00	-11.61	Peak	**	**
359.800	46.86	14.04	3.86	32.49	32.27	46.00	-13.73	Peak	**	**
504.330	45.24	16.58	4.51	32.56	33.77	46.00	-12.23	Peak	**	**
647.890	39.89	19.02	5.17	32.73	31.35	46.00	-14.65	Peak	**	**

## 4.9 AC Conducted Emission Measurement

### 4.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\*Decreases with the logarithm of the frequency.

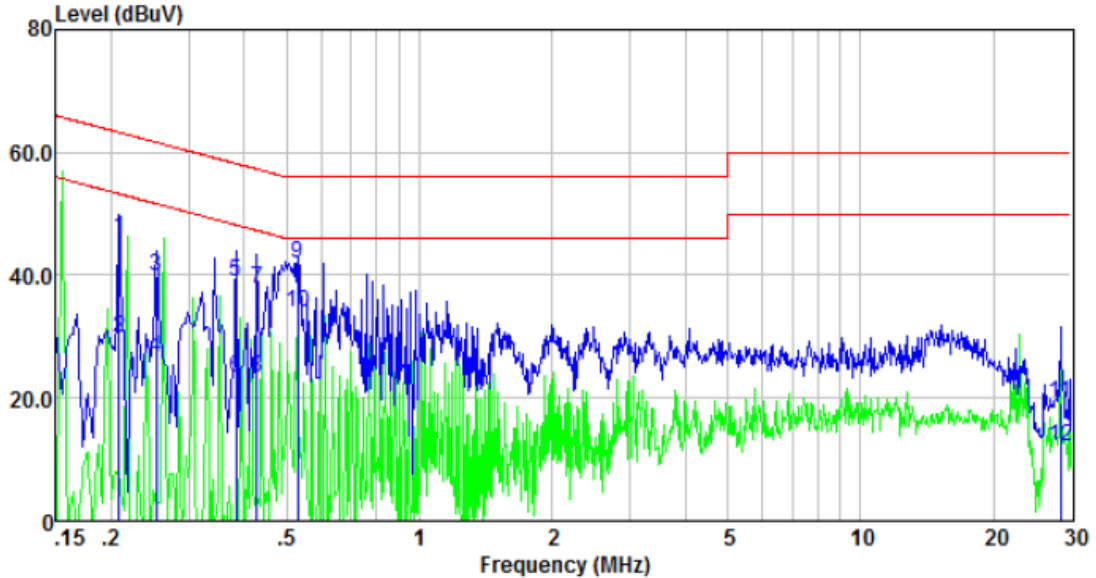
### 4.9.2 Test Procedures

12. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
13. Connect EUT to the power mains through a line impedance stabilization network (LISN).
14. All the support units are connecting to the other LISN.
15. The LISN provides 50 ohm coupling impedance for the measuring instrument.
16. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
17. Both sides of AC line were checked for maximum conducted interference.
18. The frequency range from 150 kHz to 30 MHz was searched.
19. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

### 4.9.3 Test Result of AC Conducted Emission

<b>Test Mode :</b>	Mode 1	<b>Temperature :</b>	21~23°C
<b>Test Engineer :</b>	Damon Zhang	<b>Relative Humidity :</b>	41~43%
<b>Test Voltage :</b>	120Vac / 60Hz	<b>Phase :</b>	Line
<b>Function Type :</b>	Bluetooth Link + USB Cable (Charging from Adapter)		

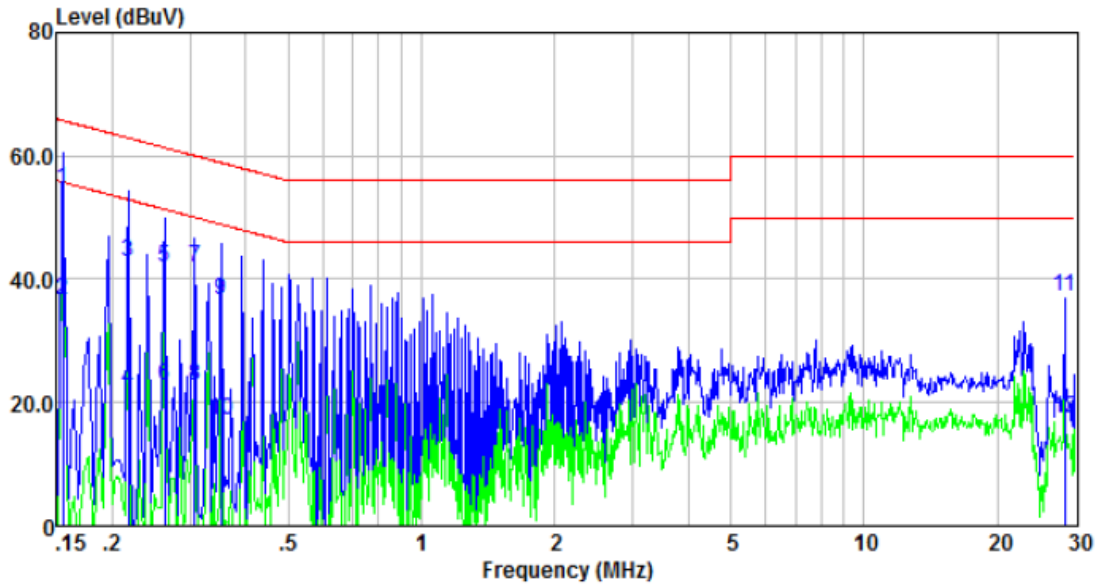
Data: 3 File: F:\DATA\2019 DATA\1902015\FCC.EM6 (4)



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	level dBuV	Limit level dBuV	Over limit dB	Remark
0.208	36.40	9.56	0.01	45.97	63.27	-17.30	QP
0.208	20.30	9.56	0.01	29.87	53.27	-23.40	Average
0.253	30.40	9.57	0.01	39.98	61.64	-21.66	QP
0.253	17.00	9.57	0.01	26.58	51.64	-25.06	Average
0.383	29.30	9.58	0.02	38.90	58.21	-19.31	QP
0.383	13.70	9.58	0.02	23.30	48.21	-24.91	Average
0.428	28.20	9.58	0.02	37.80	57.29	-19.49	QP
0.428	13.80	9.58	0.02	23.40	47.29	-23.89	Average
0.529	32.40	9.58	0.02	42.00	56.00	-14.00	QP
0.529	24.40	9.58	0.02	34.00	46.00	-12.00	Average
28.452	9.20	9.84	0.05	19.09	60.00	-40.91	QP
28.452	2.10	9.84	0.05	11.99	50.00	-38.01	Average

<b>Test Mode :</b>	Mode 1	<b>Temperature :</b>	21~23°C
<b>Test Engineer :</b>	Damon Zhang	<b>Relative Humidity :</b>	41~43%
<b>Test Voltage :</b>	120Vac / 60Hz	<b>Phase :</b>	Neutral
<b>Function Type :</b>	Bluetooth Link + USB Cable (Charging from Adapter)		

Data: 1 File: F:\DATA\2019 DATA\1902015\FCC.EM6 (4)



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	level dBuV	Limit level dBuV	Over limit dB	Remark
0.155	44.91	9.54	0.06	54.51	65.74	-11.23	QP
0.155	27.01	9.54	0.06	36.61	55.74	-19.13	Average
0.217	33.10	9.56	0.01	42.67	62.92	-20.25	QP
0.217	12.70	9.56	0.01	22.27	52.92	-30.65	Average
0.263	32.30	9.57	0.01	41.88	61.34	-19.46	QP
0.263	13.10	9.57	0.01	22.68	51.34	-28.66	Average
0.307	32.31	9.57	0.01	41.89	60.06	-18.17	QP
0.307	13.11	9.57	0.01	22.69	50.06	-27.37	Average
0.352	27.09	9.58	0.02	36.69	58.91	-22.22	QP
0.352	7.39	9.58	0.02	16.99	48.91	-31.92	Average
28.452	27.40	9.84	0.05	37.29	60.00	-22.71	QP
28.452	7.40	9.84	0.05	17.29	50.00	-32.71	Average

## 4.10 Antenna Requirements

### 4.10.1 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.

### 4.10.2 Antenna Connected Construction

An embedded-in antenna design is used.

### 4.10.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



## 5 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	Keysight	N9010A	MY56070788	2019/1/23	2020/1/22	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2019/1/23	2020/1/22	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2019/1/23	2020/1/22	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2019/1/23	2020/1/22	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2019/1/23	2020/1/22	Conducted
Thermal Chamber	Sanmtest	SMC-408-CD	2435	2018-07-05	2019-07-04	Conducted
Base Station	R&S	CMW 270	101231	2019/1/23	2020-01-22	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2019/1/23	2020/1/22	Conducted
Signal Generator (Blocker)	Keysight	N5171B	MY56200661	2019/1/23	2020/1/22	Conducted

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV 40	101433	2019-02-18	2020-02-17	Radiation
Amplifier	Sonoma	310	363917	2019/01/22	2020/01/21	Radiation
Amplifier	Schwarzbeck	BBV 9718	327	2019/01/22	2020/01/21	Radiation
Amplifier	Narda	TTA1840-35-HG	2034380	2018-07-18	2019-07-17	Radiation
Broadband Antenna	Schwarzbeck	VULB 9168	9168-757	2017-03-03	2020-03-02	Radiation
Horn Antenna	Schwarzbeck	BBHA 9120 D	1677	2017-03-03	2020-03-02	Radiation
Horn Antenna	COM-POWER	AH-1840	101117	2018-06-20	2021-06-19	Radiation
Test Software	Auidx	E3	6.111221a	N/A	N/A	Radiation
Filter	Micro-Tronics	BRM 50702	G266	N/A	N/A	Radiation

N/A: No Calibration Required

## 6 Uncertainty of Evaluation

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	FREQUENCY	UNCERTAINTY
Conducted emissions	9kHz~30MHz	2.64dB
Radiated emission	30MHz ~ 1GMHz	5.05dB
	1GHz ~ 18GHz	5.06 dB
	18GHz ~ 40GHz	3.65dB

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

-----End of the report-----