FCC RF Test Report

For

Shenzhen Hangshi Technology Co.,Ltd.

Test Standards:	Part 15C Subpart C §15.247
Product Description:	Bluetooth Keyboard
Tested Model:	HB066C
Additional Model No.:	N/A
Brand Name:	N/A
FCC ID:	2AKHJHB066C
Classification	(DTS) Digital Transmission System
Report No.:	EC1811011F01
Tested Date:	2018-11-22 to 2018-11-28
Issued Date:	2018-11-28
Prepared By:	Tiny Yang/ Engineer
Approved By:	Bacon Wu / RF Manager

Hunan Ecloud Testing Technology Co., Ltd.

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Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	2018.11.28	Valid	Original Report

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Summary of Test RESULT

FCC Rule	IC Rule	Description	Limit	Result	Remark
15.247(a)(2)	RSS-247 5.2(1)	6dB Bandwidth	≥ 0.5MHz	Pass	-
-	RSS-Gen 6.6	99% Bandwidth	-	Pass	-
15.247(b)(1)	RSS-247 A5.4(4)	Peak Output Power	≤ 30dBm	Pass	-
15.247(e)	RSS-247 5.2(2)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
15.247(d)	RSS-247 5.5	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass	-
15.247(d)	RSS-247 5.5	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit -1.57 dB at 4003 MHz
15.207	RSS-GEN 8.8	AC Conducted Emission	15.207(a)	Pass	Under limit -12.49 dB at 0.518 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.

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

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

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

Product	Bluetooth Keyboard
Model No.	HB066C
Additional No.	N/A
Difference Description	N/A
FCC ID	2AKHJHB066C
IC ID	N/A
Power Supply	5Vdc (adapter or host equipment) 3.7Vdc (Li-ion)
Modulation Technology	BLE
Modulation Type	GFSK
Operating Frequency	2402MHz~2480MHz
Number Of Channel	40
Max. Output Power	-3.964 dBm (0.4014 mW)
Antenna Type	PCB Antenna type with 1.5dBi gain
I/O Ports	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
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05

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	-3.964
Ch19	2440MHz	GFSK	-4.932
Ch39	2480MHz	GFSK	-7.817

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 X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

3.2 Test Mode

3.2.1 Antenna Port Conducted Measurement

Summary table of Test Cases	
Test Item	Data Rate / Modulation
	Bluetooth 4.2 – LE GFSK
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_2480 MHz

3.2.2 Radiated Emission Test (Below 1GHz)

	Bluetooth 4.2 - LE	
Radiated Test Cases	Transmitting+Charging	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_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)

	Bluetooth 4.2 - LE	
Radiated Test Cases	Transmitting+Charging	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_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)

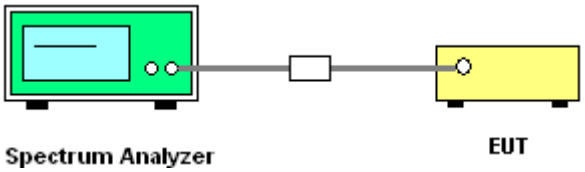
3.3 Support Equipment

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Adapter	HTC	TC E250	N/A	N/A	N/A
2.	Micro-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 cable1.2 m

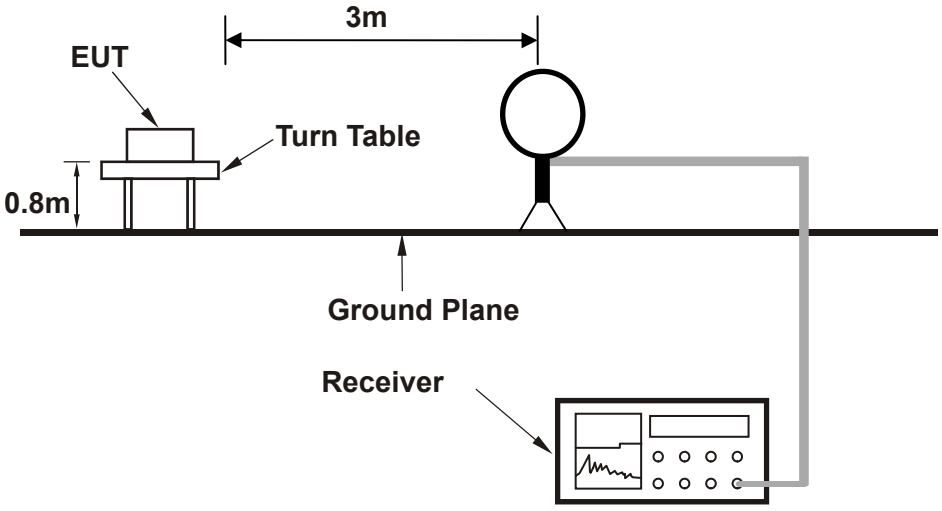
3.4 Test Setup

The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.

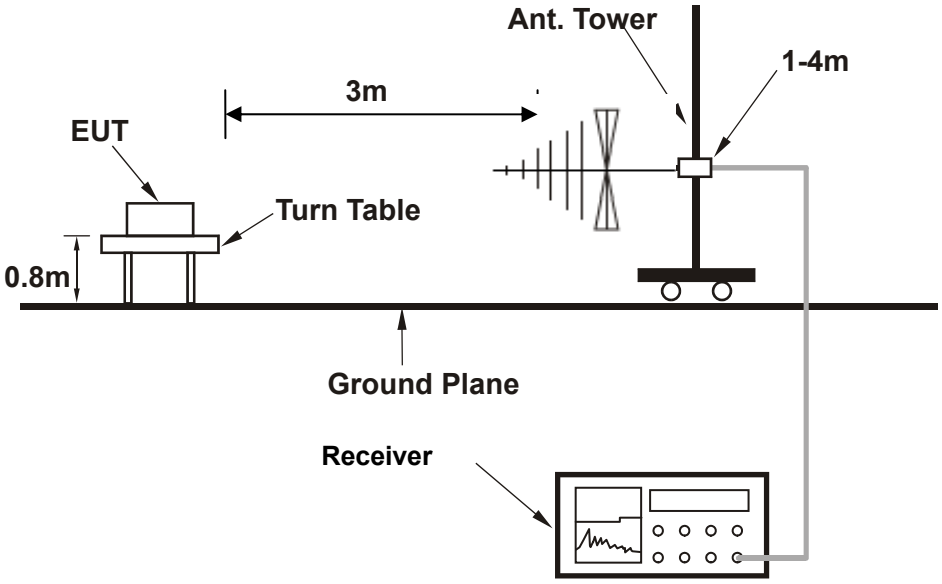
Setup diagram for Conducted Test



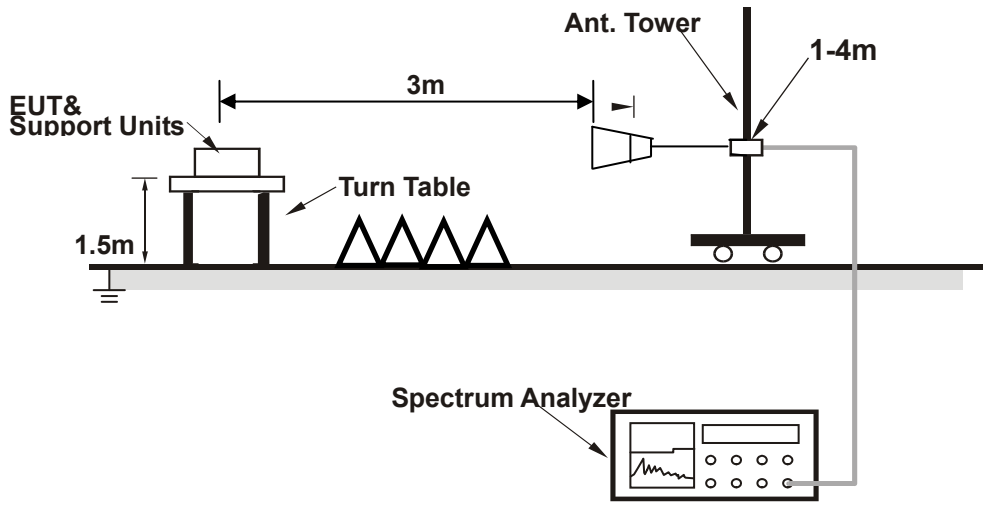
Setup diagram for Raidation(9KHz~30MHz) Test



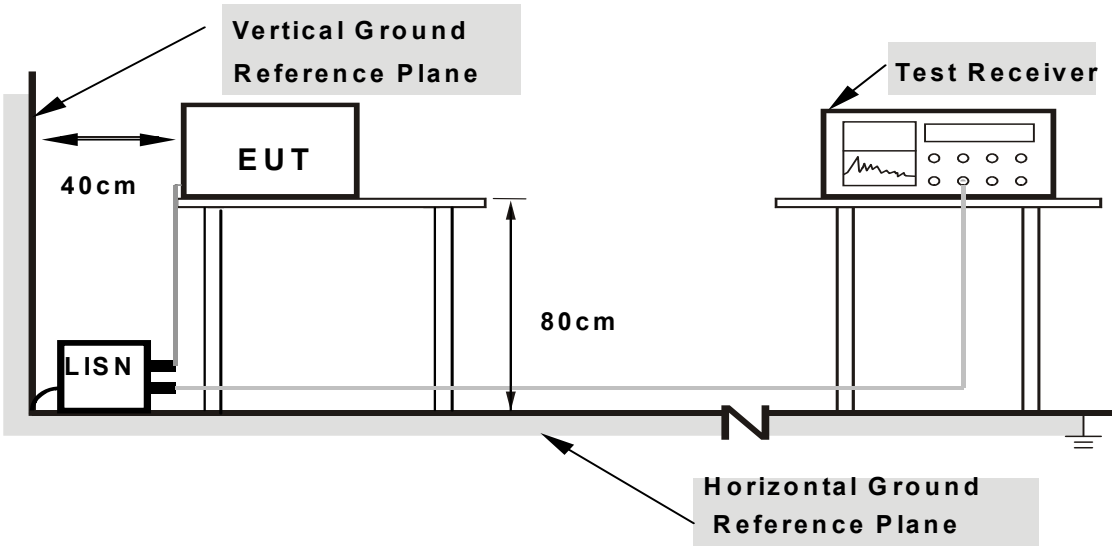
Setup diagram for Raidation(Below 1G) Test



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.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 5 + 10 = 15 (dB)

4. Test Result

4.1 6dB and 99% Bandwidth Measurement

4.1.1 Limit of 6dB and 99% Bandwidth

FCC §15.247 (a) (2)

The minimum 6 dB bandwidth shall be at least 500 kHz.

4.1.2 Test Procedures

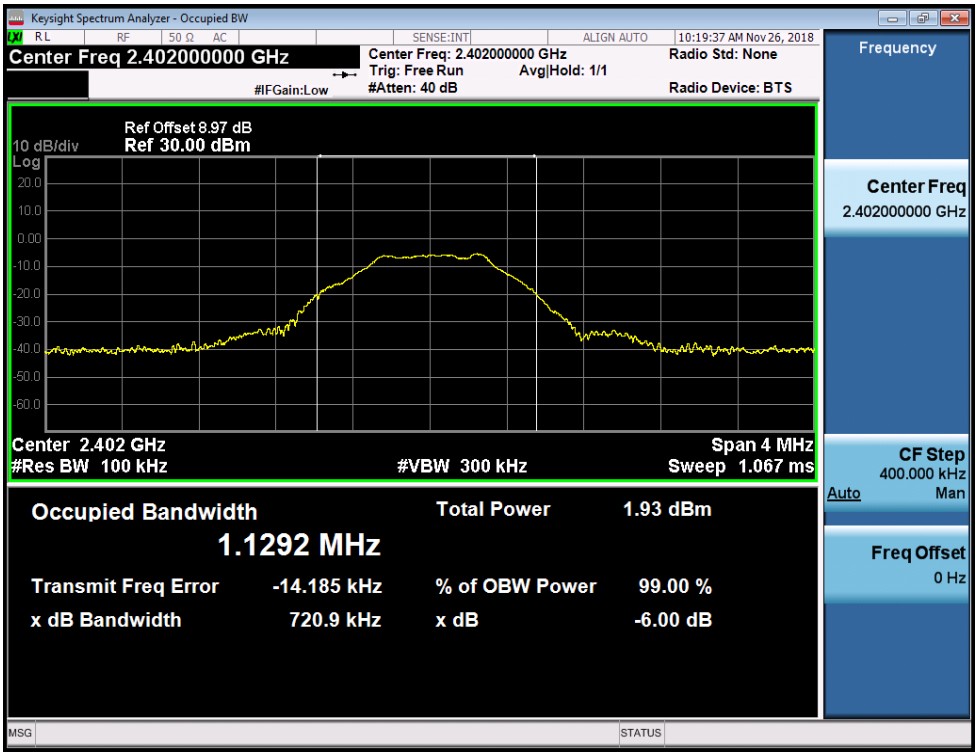
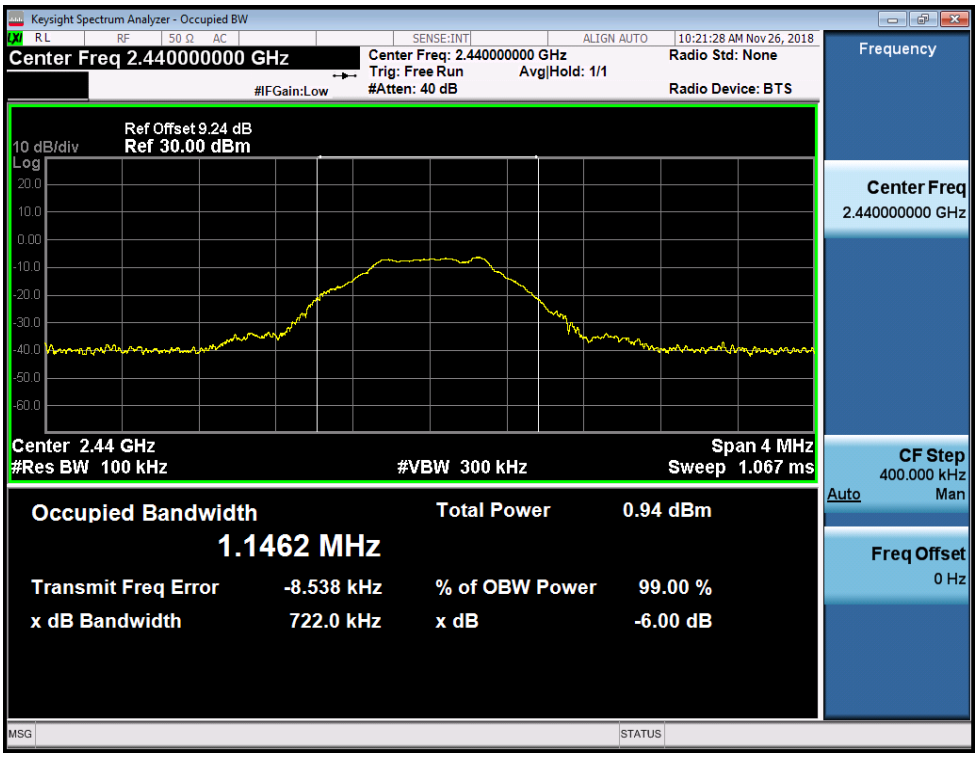
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set to the maximum power setting and enable the EUT transmit continuously
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.

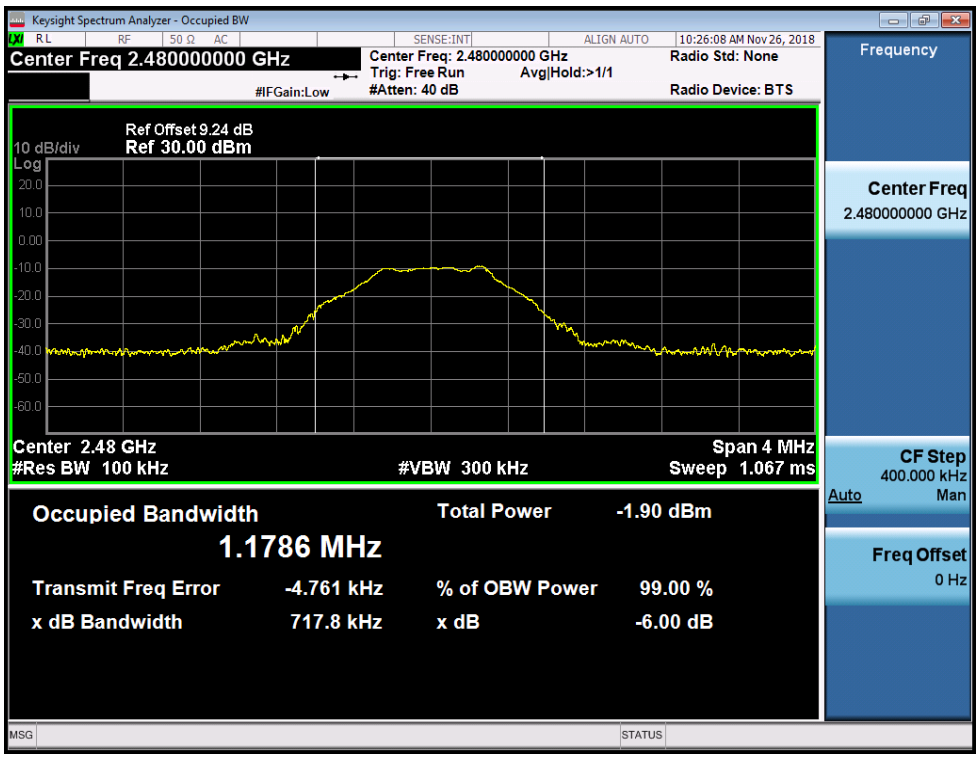
4.1.3 Test Result of 6dB and 99% Bandwidth

Test Mode :	Transmitting	**Temperature :**	24~26℃
Test Engineer :	Damon Zhang	**Relative Humidity :**	50~53%

Data Rate	Modulation	Channel	6dB Bandwidth [MHz]	99% OBW[MHz]	Verdict
1Mbps	GFSK	LCH	0.7209	1.1292	PASS
1Mbps	GFSK	MCH	0.7220	1.1462	PASS
1Mbps	GFSK	HCH	0.7178	1.1786	PASS

6dB and 99% Bandwidth Plot

Graphs	
LCH	
MCH	

HCH	

Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω
AC
SENSE:INT
ALIGN AUTO
10:26:08 AM Nov 26, 2018
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>1/1
#IFGain:Low
#Atten: 40 dB
Radio Std: None
Radio Device: BTS
Frequency
Ref Offset 9.24 dB
10 dB/div
Ref 30.00 dBm
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Center Freq
2.480000000 GHz
Center 2.48 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 4 MHz
Sweep 1.067 ms
CF Step
400.000 kHz
Auto
Man
Occupied Bandwidth
1.1786 MHz
Total Power
-1.90 dBm
Transmit Freq Error
-4.761 kHz
% of OBW Power
99.00 %
x dB Bandwidth
717.8 kHz
x dB
-6.00 dB
Freq Offset
0 Hz
MSG
STATUS

4.2 Peak Output Power Measurement

4.2.1 Limit of Peak Output Power

FCC §15.247 (b)(3)

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. 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.

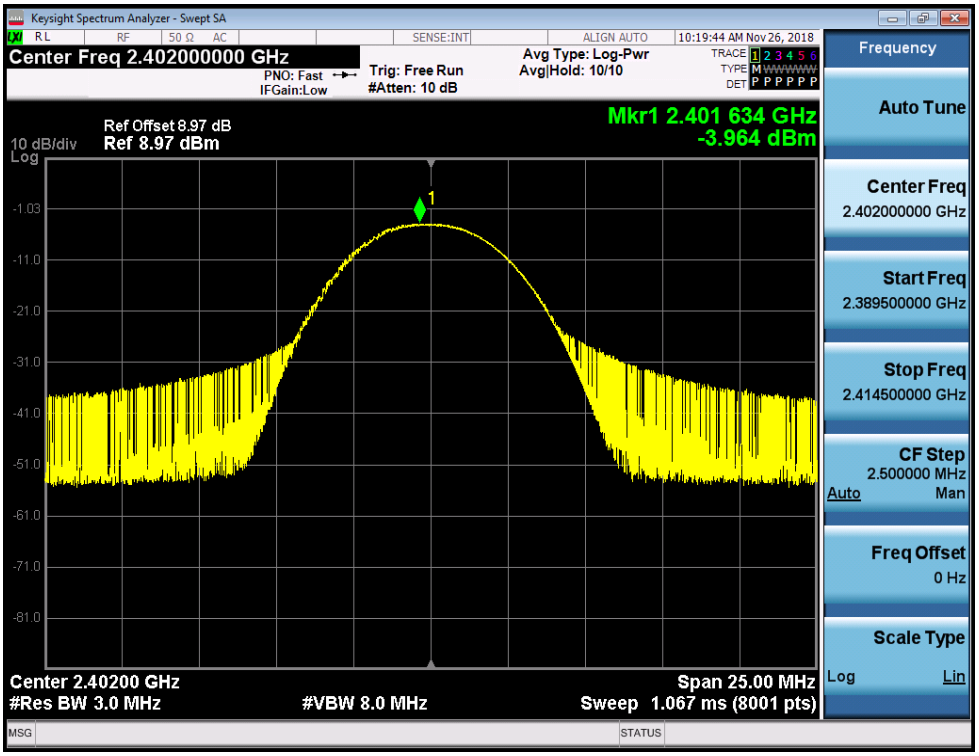
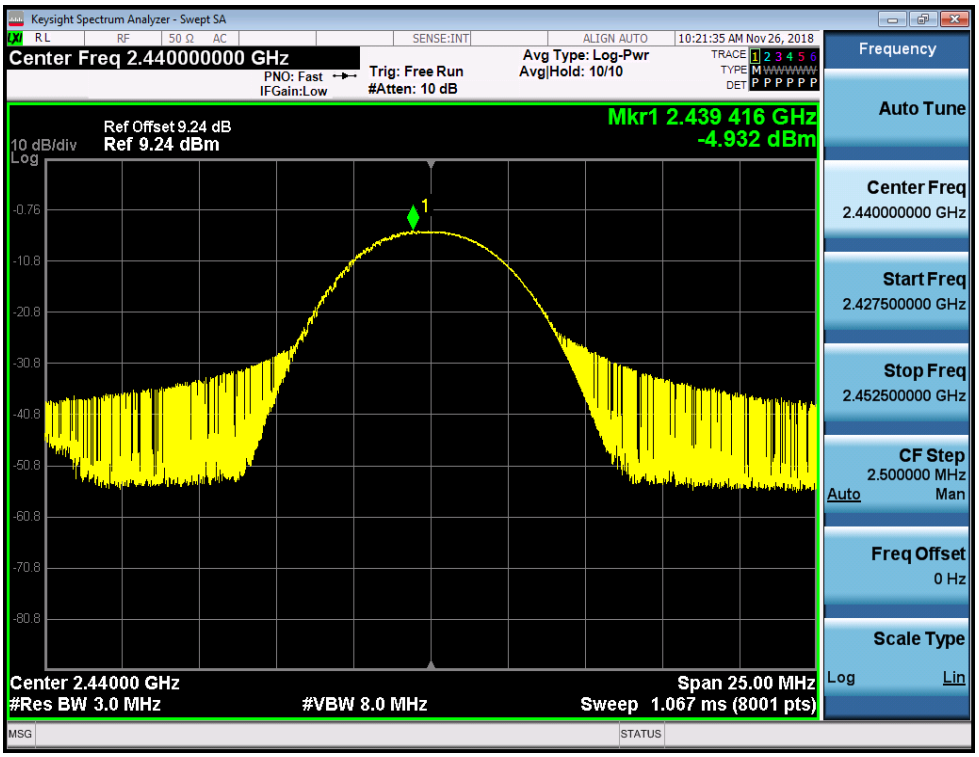
4.2.2 Test Procedures

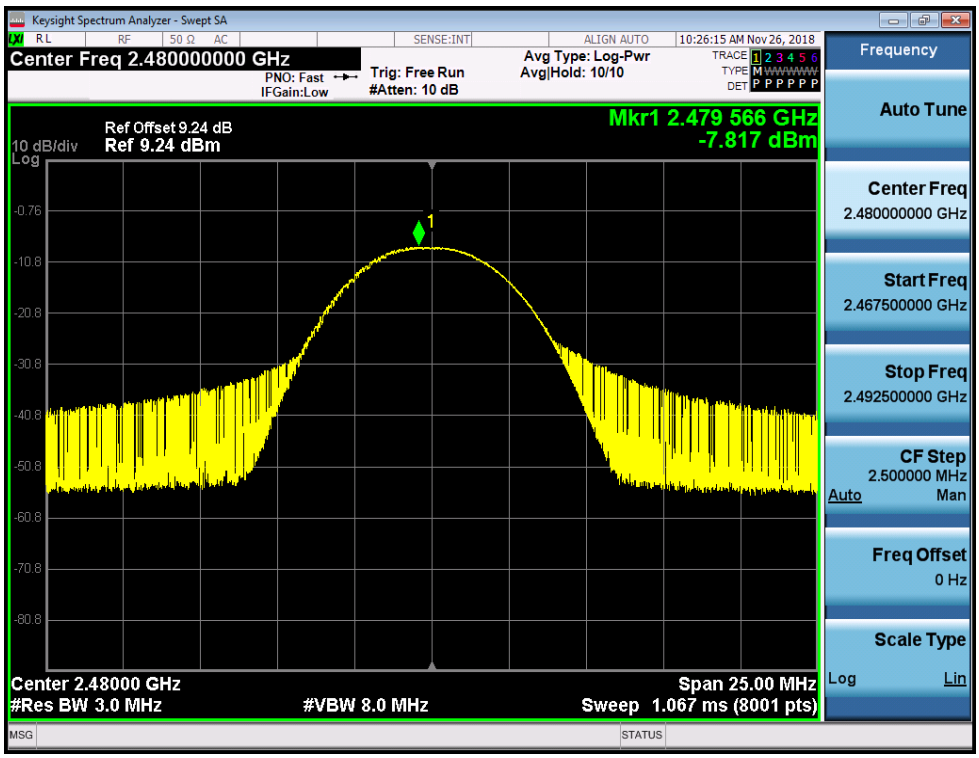
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to spectrum analyzer.
3. Set to the maximum power setting and enable the EUT transmit continuously
4. Set the RBW=DTS Bandwidth,VBW ≥ 3*RBW,Span ≥ 1.5*DTS Bandwidth,Detector=Peak,Sweep time=auto couple,Trace mode=max holde.
5. Allow trace to fully stabilize, Use peak marker function to determine the peak amplitude level.
6. Measure the conducted output power

4.2.3 Test Result of Peak Output Power

Test Mode :		Transmitting	**Temperature :**	24~26℃
Test Engineer :		Damon Zhang	**Relative Humidity :**	50~53%
Data Rate	**Modulation**	Channel	**Conduct Peak Power[dBm]**	Verdict
1Mbps	GFSK	LCH	**-3.964**	PASS
1Mbps	GFSK	MCH	**-4.932**	PASS
1Mbps	GFSK	HCH	**-7.817**	PASS

Peak Output Power Plot

Graphs	
LCH	
MCH	

HCH	

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold: 10/10
10:26:15 AM Nov 26, 2018
Ref Offset 9.24 dB
10 dB/div
Log
Ref 9.24 dBm
Mkr1 2.479 566 GHz
-7.817 dBm
-0.76
-10.8
-20.8
-30.8
-40.8
-50.8
-60.8
-70.8
-80.8
Center 2.48000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 25.00 MHz
Sweep 1.067 ms (8001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.467500000 GHz
Stop Freq
2.492500000 GHz
CF Step
2.500000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
MSG
STATUS

4.3 Power Spectral Density Measurement

4.3.1 Limits of Power Spectral Density

FCC § 15.247(e)

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

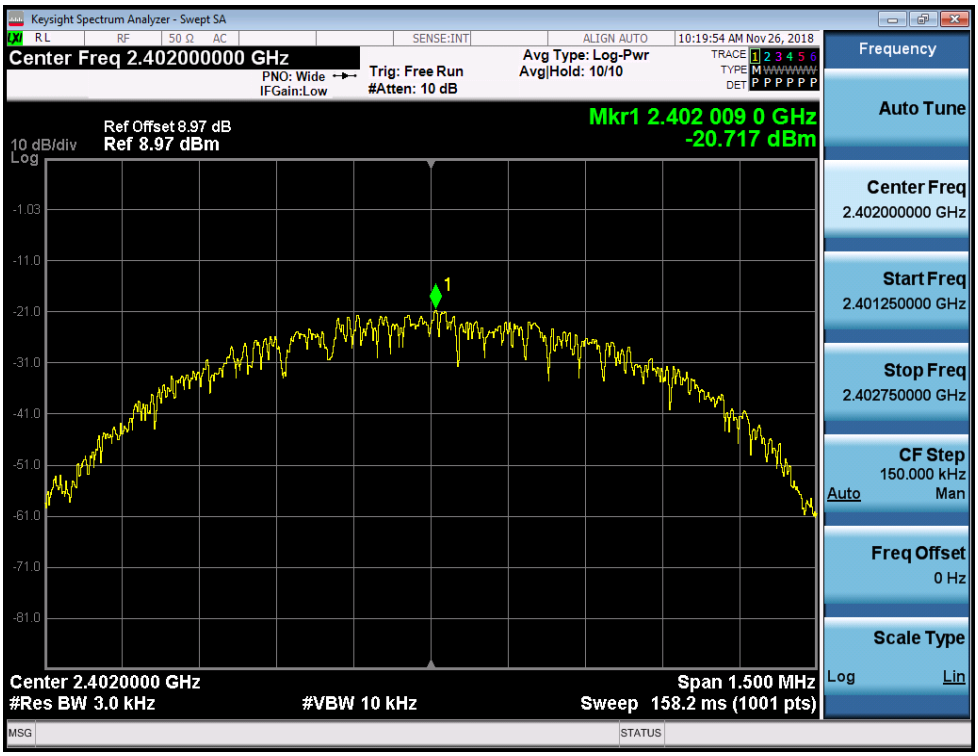
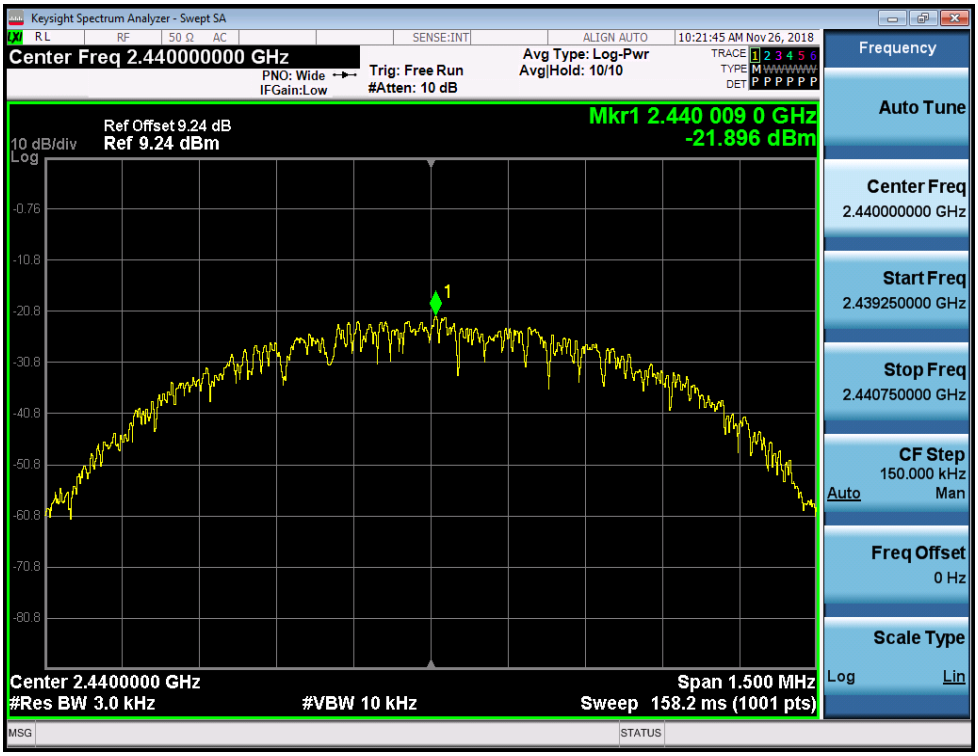
4.3.2 Test Procedure

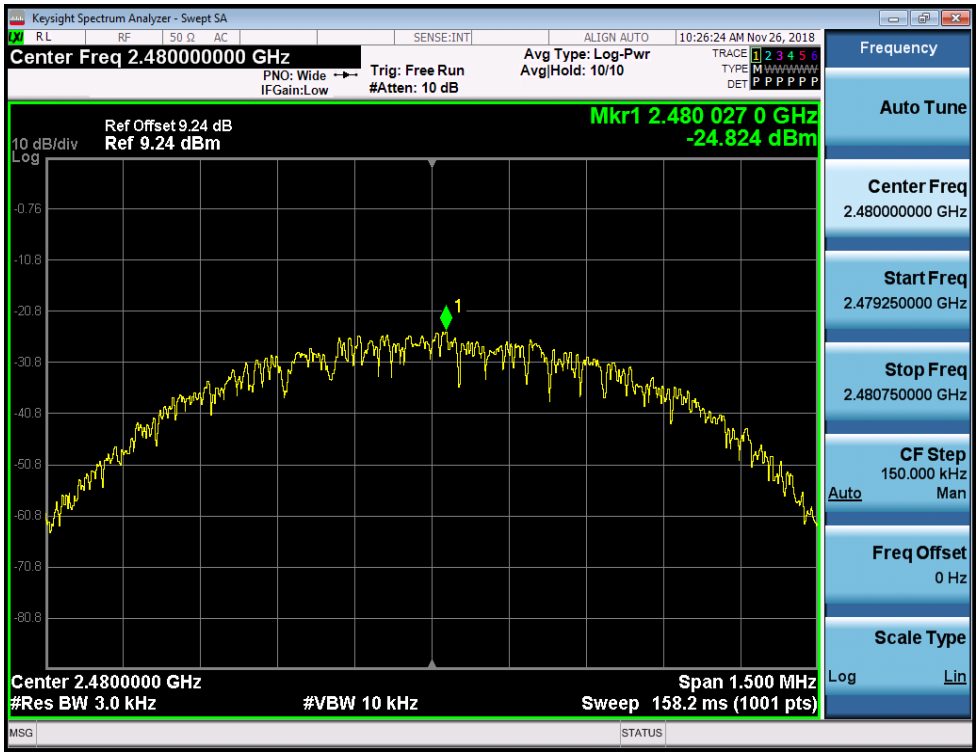
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
4. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
5. Measure and record the results in the test report.
6. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

4.3.3 Test Result of Power Spectral Density

Test Mode :		Transmitting	**Temperature :**	24~26℃
Test Engineer :		Damon Zhang	**Relative Humidity :**	50~53%
Data Rate	**Modulation**	Channel	**PSD [dBm]**	Verdict
1Mbps	GFSK	LCH	**-20.717**	PASS
1Mbps	GFSK	MCH	**-21.896**	PASS
1Mbps	GFSK	HCH	**-24.824**	PASS

Power Spectral Density Plot

Graphs	
LCH	
MCH	

HCH	

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold: 10/10
10:26:24 AM Nov 26, 2018
Ref Offset 9.24 dB
10 dB/div
Log
Ref 9.24 dBm
Mkr1 2.480 027 0 GHz
-24.824 dBm
Center 2.4800000 GHz
#Res BW 3.0 kHz
#VBW 10 kHz
Span 1.500 MHz
Sweep 158.2 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.479250000 GHz
Stop Freq
2.480750000 GHz
CF Step
150.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

4.4 Conducted Band Edges and Spurious Emission Measurement

4.4.1 Limit of Conducted Band Edges and Spurious Emission

FCC §15.247 (d)

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

4.4.2 Test Procedures

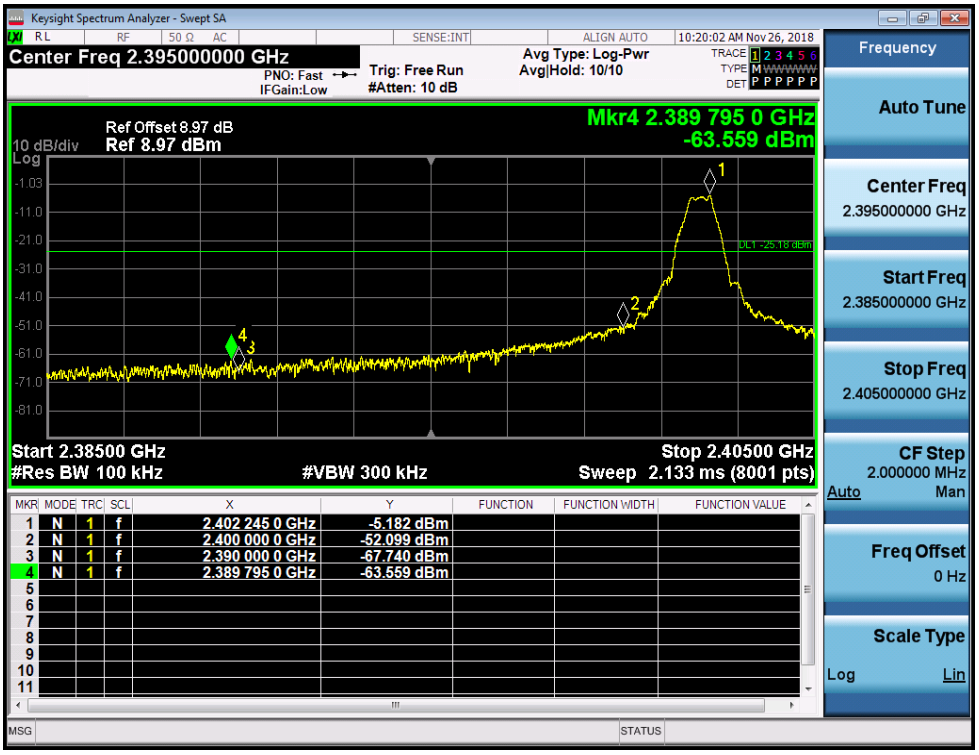
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

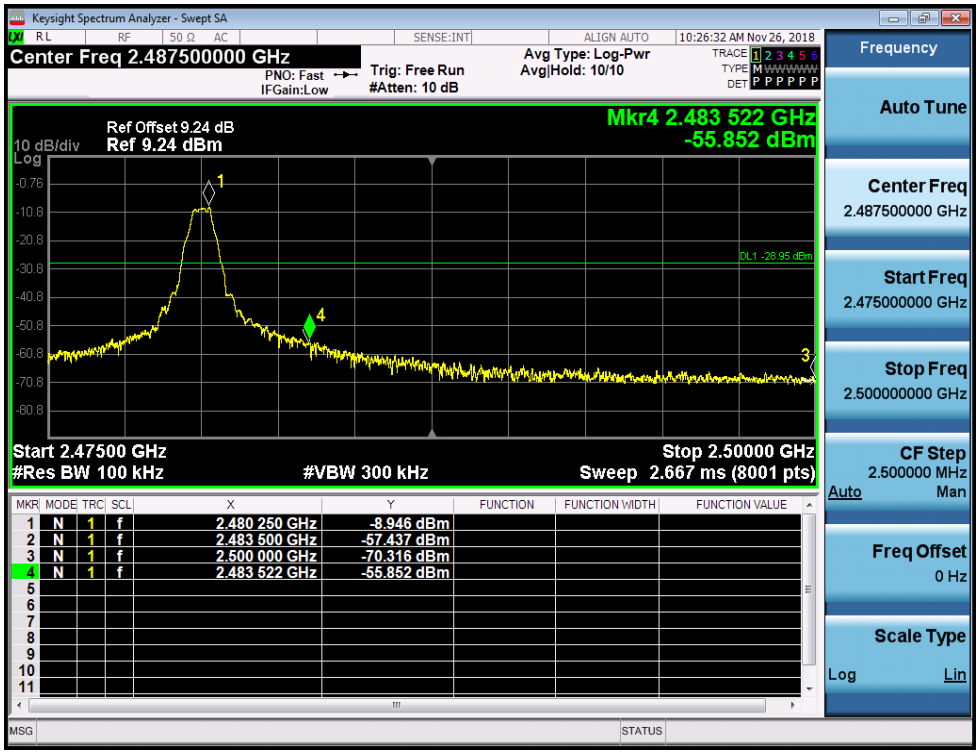
4.4.3 Test Result of Conducted Band Edges

Test Mode :	Transmitting	Temperature :	24~26℃
Test Engineer :	Damon Zhang	Relative Humidity :	50~53%

Data Rate	Modulation	Channel	Carrier Power[dBm]	Max.Spurious Level [dBm]	Limit [dBm]	Verdict
1Mbps	GFSK	LCH	-5.182	-52.099	-25.18	PASS
1Mbps	GFSK	HCH	-8.946	-55.852	-28.95	PASS

Conducted Band Edges Plot

Graphs	
LCH	

HCH	

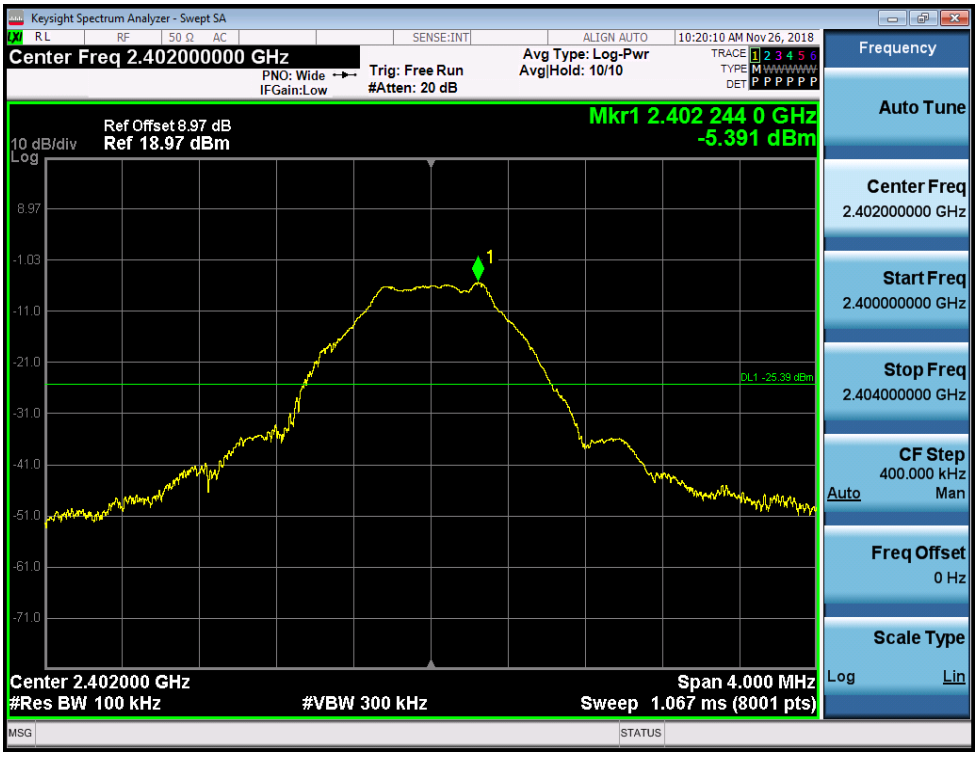
Keysight Spectrum Analyzer - Swept SA
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold: 10/10
10:26:32 AM Nov 26, 2018
Ref Offset 9.24 dB
10 dB/div
Log
Ref 9.24 dBm
Mkr4 2.483 522 GHz
-55.852 dBm
DL1 -28.95 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.667 ms (8001 pts)
1 N 1 f 2.480 250 GHz -8.946 dBm
2 N 1 f 2.483 500 GHz -57.437 dBm
3 N 1 f 2.500 000 GHz -70.316 dBm
4 N 1 f 2.483 522 GHz -55.852 dBm
Frequency
Auto Tune
Center Freq
2.487500000 GHz
Start Freq
2.475000000 GHz
Stop Freq
2.500000000 GHz
CF Step
2.500000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

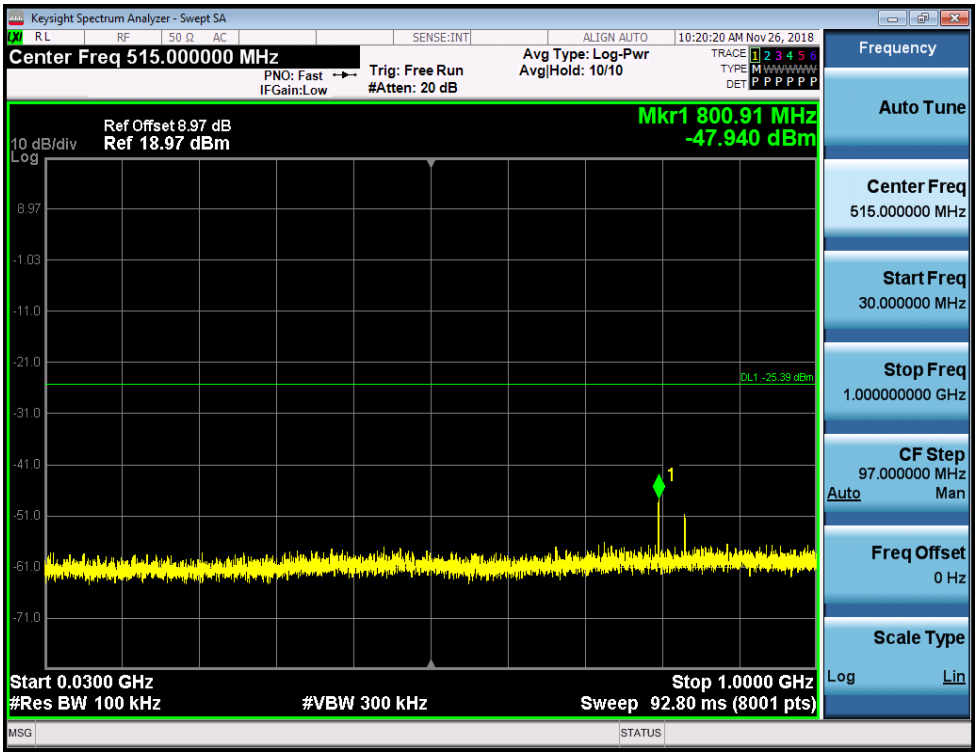
4.4.4 Test Result of Conducted Spurious Emission

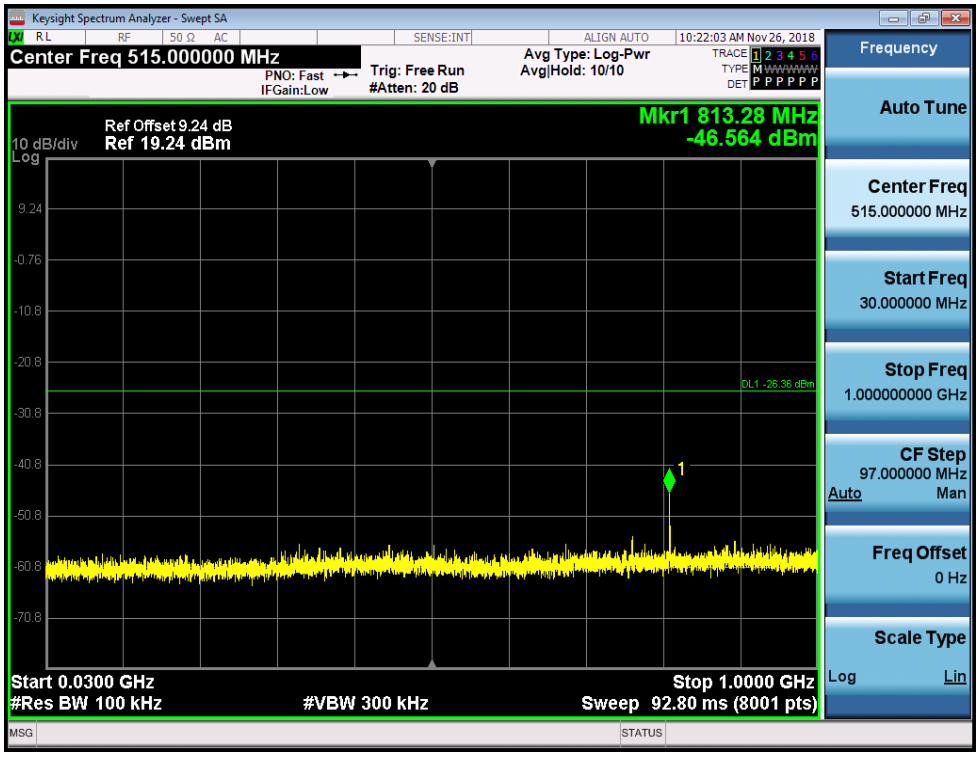
Test Mode :	Transmitting	Temperature :	24~26℃
Test Engineer :	Damon Zhang	Relative Humidity :	50~53%

Data Rate	Modulation	Channel	Pref [dBm]	Puw[dBm]	Verdict
1Mbps	GFSK	LCH	-5.391	<Limit	PASS
1Mbps	GFSK	MCH	-6.356	<Limit	PASS
1Mbps	GFSK	HCH	-9.197	<Limit	PASS

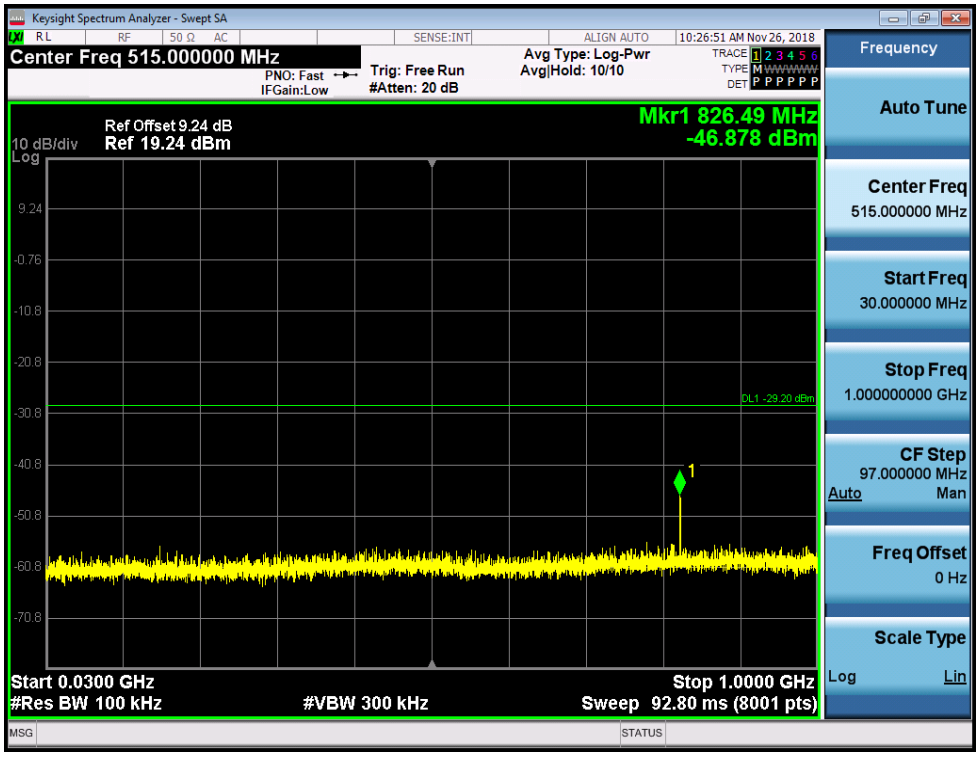
Conducted Band Edges and Spurious Emission Plot

BLE_LCH_Graphs	
Pref/BLE/LCH	

Puw/BLE/LCH	 

BLE_MCH_Graphs	
Pref/BLE/MCH	
Puw/BLE/MCH	


Keysight Spectrum Analyzer - Swept SA
RL
RF
50 Ω
AC
SENSE:INT
ALIGN AUTO
10:22:21 AM Nov 26, 2018
Center Freq 13.000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold: 5/10
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P P P P
Ref Offset 9.24 dB
10 dB/div
Log
Ref 19.24 dBm
Mkr2 24.775 GHz
-37.077 dBm
9.24
-0.76
-10.8
-20.8
-30.8
-40.8
-50.8
-60.8
-70.8
DL1 -26.36 dBm
Start 1.00 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.294 s (8001 pts)
MSG
STATUS
Frequency
Auto Tune
Center Freq
13.000000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
25.000000000 GHz
CF Step
2.400000000 GHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

BLE_HCH_Graphs	
Pref/BLE/HCH	
Puw/BLE/HCH	


Keysight Spectrum Analyzer - Swept SA
Center Freq 13.000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold: 5/10
10:27:08 AM Nov 26, 2018
Ref Offset 9.24 dB
10 dB/div
Log
Ref 19.24 dBm
Mkr2 4.132 GHz
-38.737 dBm
DL1 -29.20 dBm
Start 1.00 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.294 s (8001 pts)
Frequency
Auto Tune
Center Freq
13.000000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
25.000000000 GHz
CF Step
2.400000000 GHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

4.5 Radiated Band Edges and Spurious Emission Measurement

4.5.1 Limit of Radiated Band Edges and Spurious Emission

FCC §15.247 (d)

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.

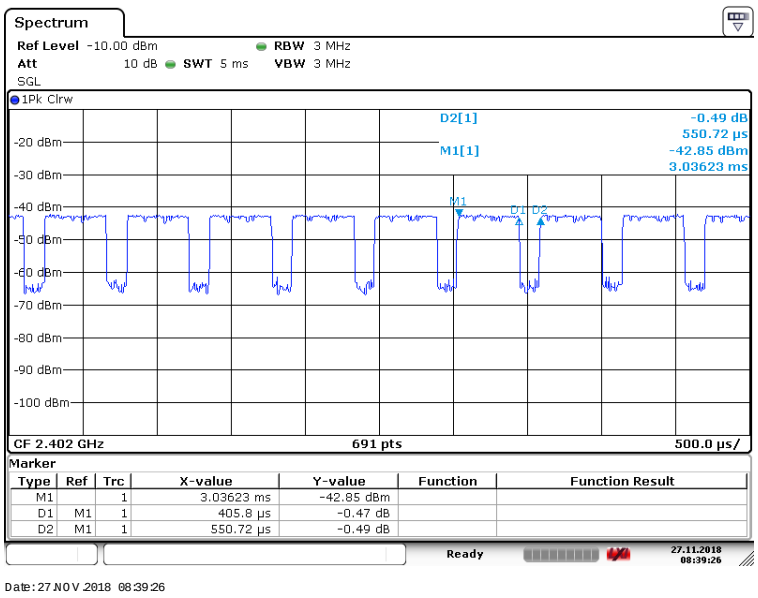
Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

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.

4.5.2 Test Procedures

1. 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.
2. The measurement distance is 3 meter.
3. 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.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. 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>1GHz ; VBW ≥ 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 ≥ 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.

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
Bluetooth 4.2 - LE	73.7	0.4058	2.46	3KHz



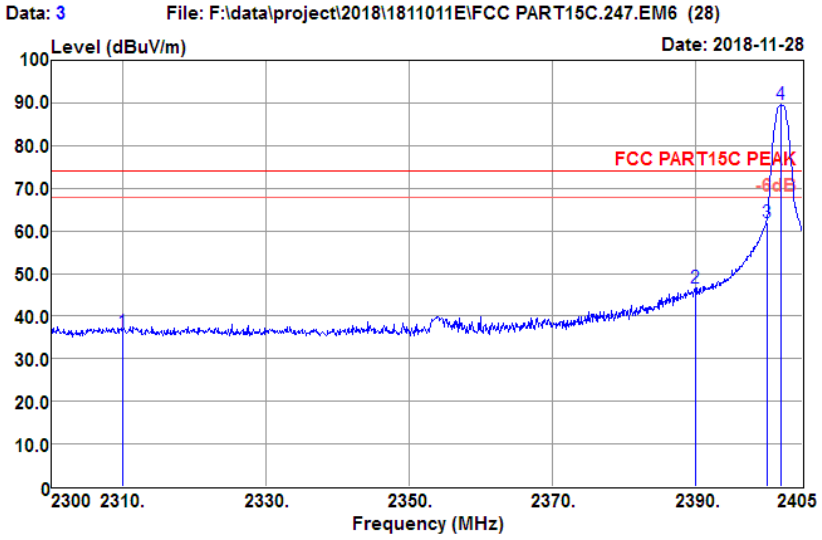
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

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

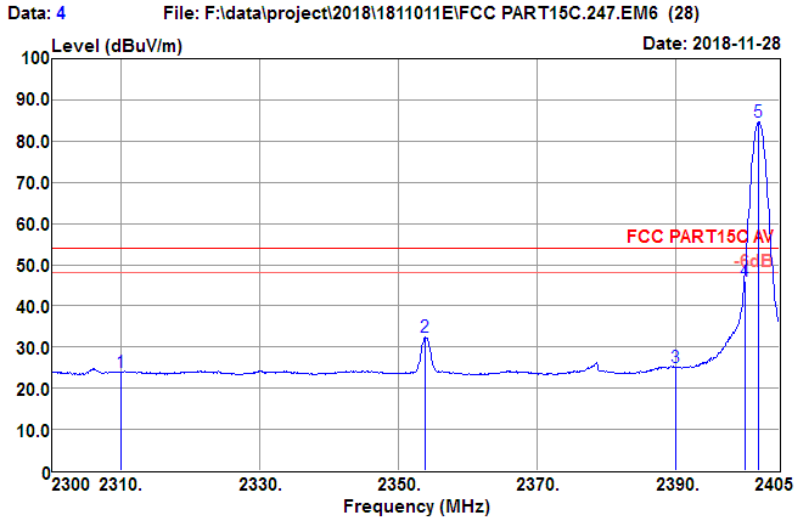
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

4.5.4 Test Result of Radiated Spurious at Band Edges

Low Channel Horizontal:

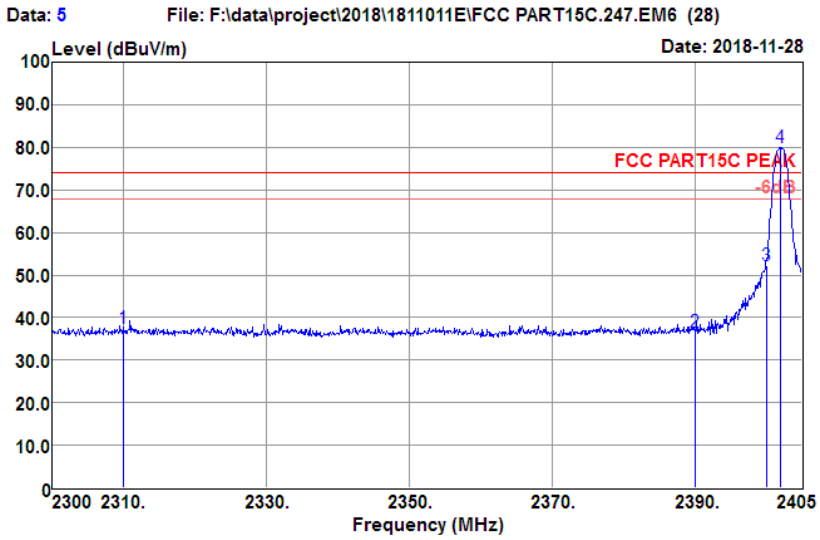


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2310.000	41.67	26.91	3.56	35.87	36.27	74.00	-37.73	Peak
2390.000	51.95	27.11	3.64	36.08	46.62	74.00	-27.38	Peak
2400.000	67.34	27.14	3.65	36.11	62.02	74.00	-11.98	Peak
2401.955	94.86	27.15	3.65	36.11	89.55	74.00	15.55	Peak

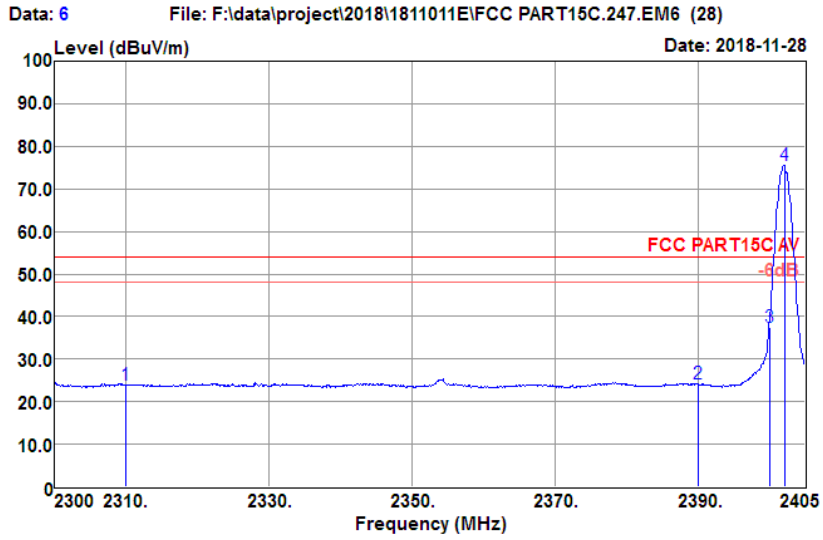


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2310.000	29.40	26.91	3.56	35.87	24.00	54.00	-30.00	Average
2353.970	37.81	27.02	3.60	35.98	32.45	54.00	-21.55	Average
2390.000	30.35	27.11	3.64	36.08	25.02	54.00	-28.98	Average
2400.000	51.40	27.14	3.65	36.11	46.08	54.00	-7.92	Average
2401.955	90.08	27.15	3.65	36.11	84.77	54.00	30.77	Average

Low Channel Vertical:

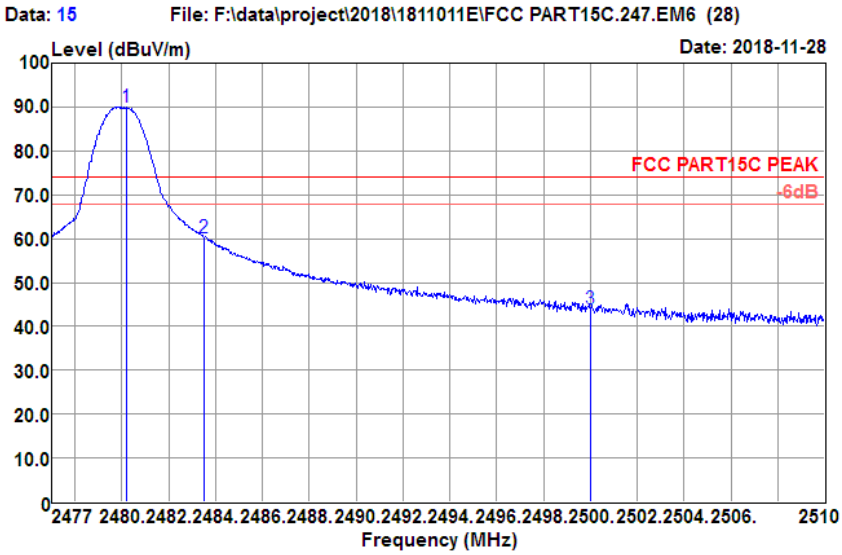


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2310.000	42.89	26.91	3.56	35.87	37.49	74.00	-36.51	Peak
2390.000	41.93	27.11	3.64	36.08	36.60	74.00	-37.40	Peak
2400.000	57.68	27.14	3.65	36.11	52.36	74.00	-21.64	Peak
2402.060	85.27	27.15	3.65	36.11	79.96	74.00	5.96	Peak

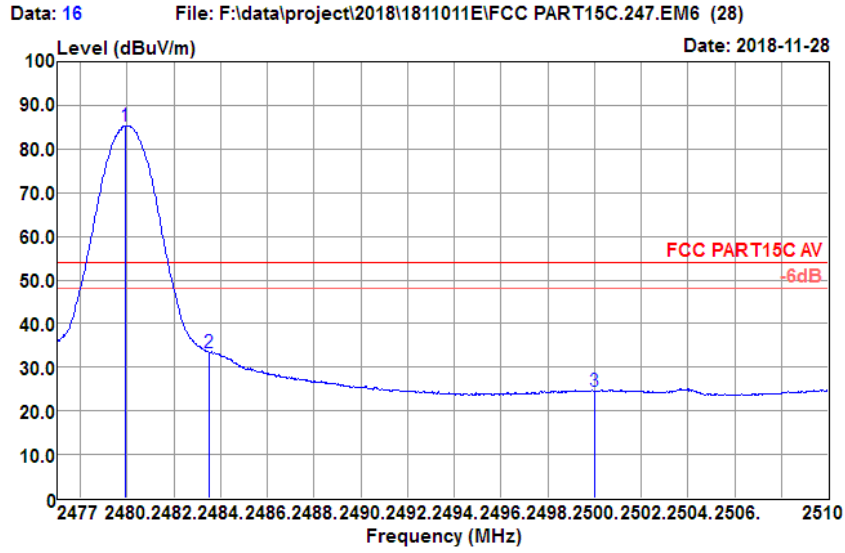


Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2310.000	29.36	26.91	3.56	35.87	23.96	54.00	-30.04	Average
2390.000	29.42	27.11	3.64	36.08	24.09	54.00	-29.91	Average
2400.000	42.92	27.14	3.65	36.11	37.60	54.00	-16.40	Average
2402.165	80.94	27.15	3.65	36.11	75.63	54.00	21.63	Average

High Channel Horizontal:

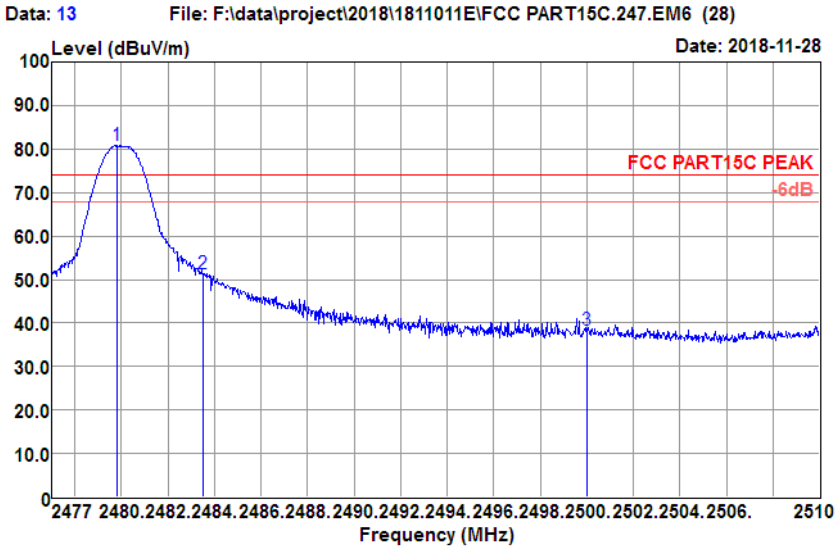


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2480.201	95.22	27.35	3.68	36.32	89.93	74.00	15.93	Peak
2483.500	65.35	27.36	3.68	36.33	60.06	74.00	-13.94	Peak
2500.000	49.20	27.40	3.68	36.37	43.91	74.00	-30.09	Peak

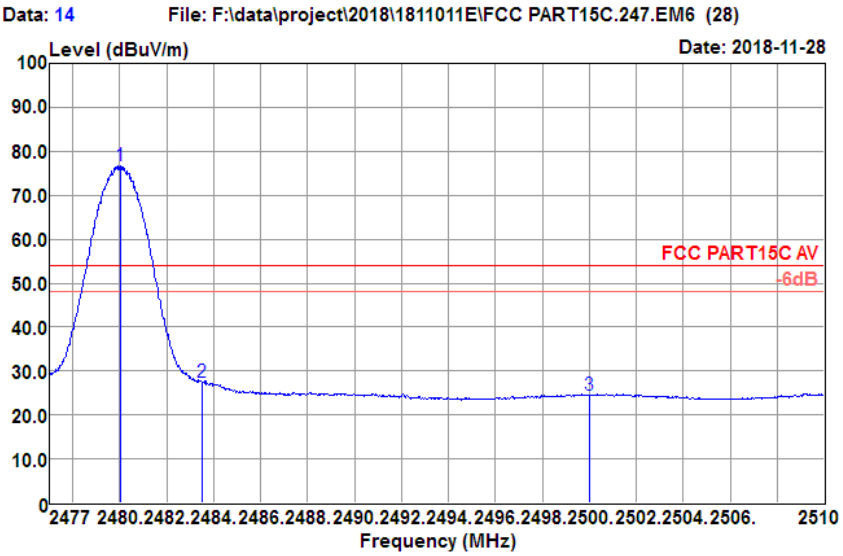


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2479.937	90.66	27.35	3.68	36.32	85.37	54.00	31.37	Average
2483.500	38.65	27.36	3.68	36.33	33.36	54.00	-20.64	Average
2500.000	29.76	27.40	3.68	36.37	24.47	54.00	-29.53	Average

High Channel Vertical:



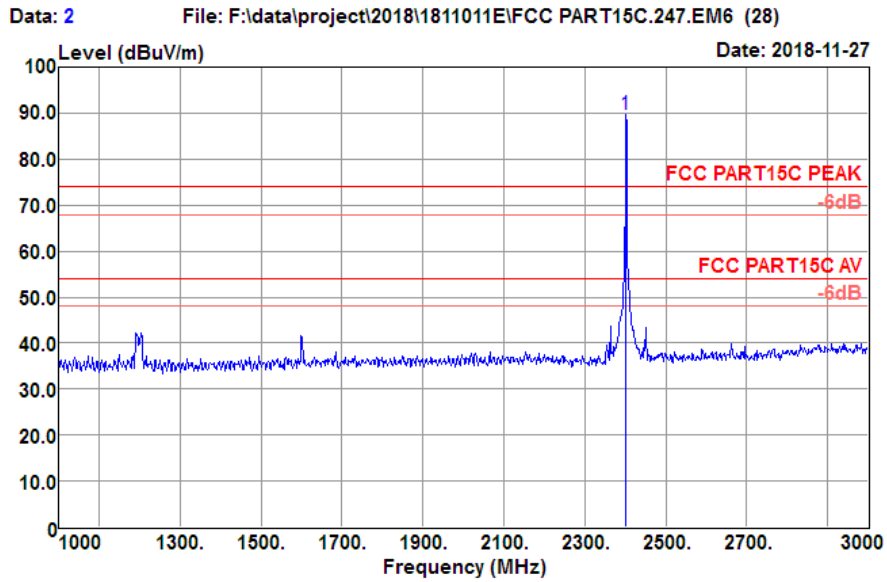
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2479.838	86.11	27.35	3.68	36.32	80.82	74.00	6.82	Peak
2483.500	56.70	27.36	3.68	36.33	51.41	74.00	-22.59	Peak
2500.000	43.62	27.40	3.68	36.37	38.33	74.00	-35.67	Peak



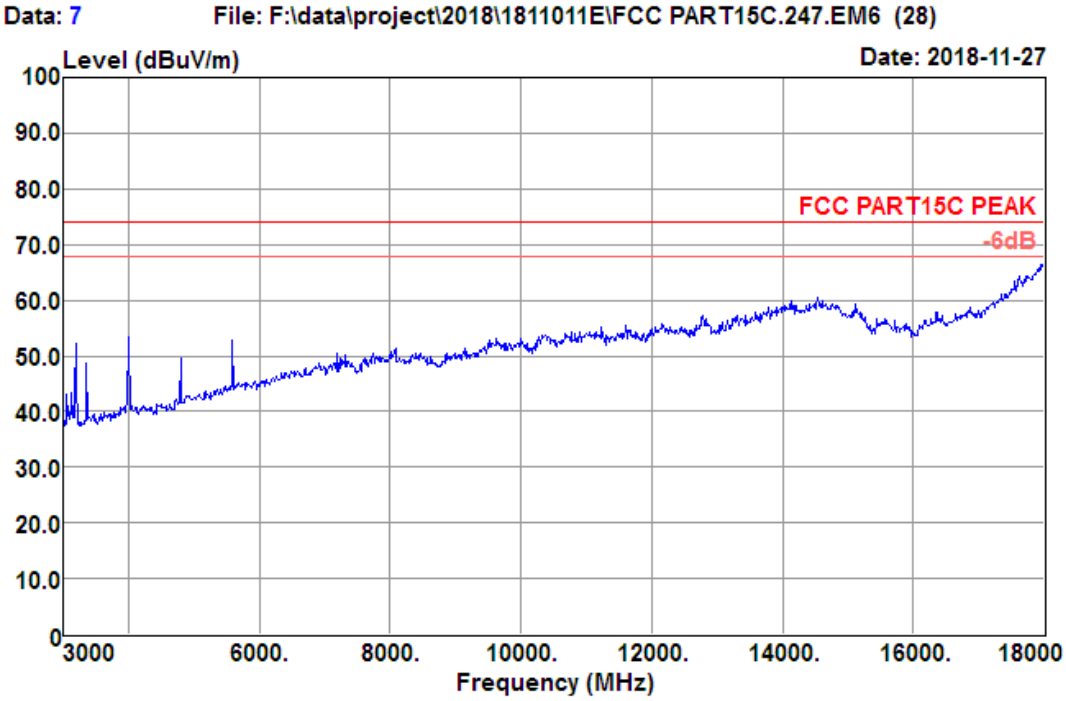
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2480.036	81.93	27.35	3.68	36.32	76.64	54.00	22.64	Average
2483.500	32.59	27.36	3.68	36.33	27.30	54.00	-26.70	Average
2500.000	29.76	27.40	3.68	36.37	24.47	54.00	-29.53	Average

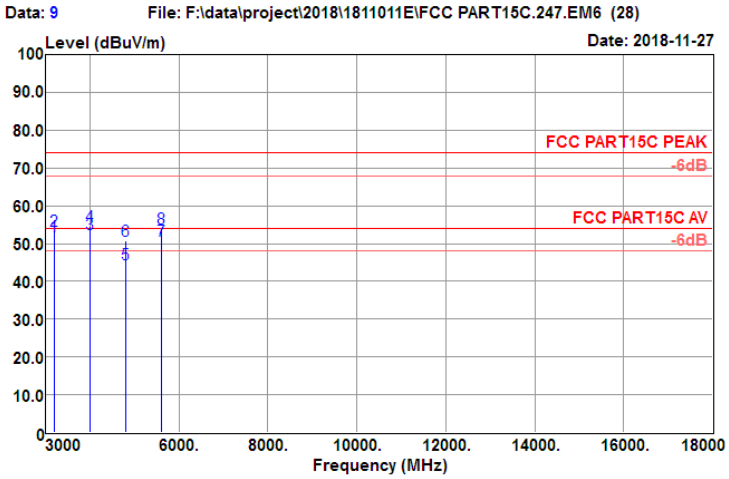
4.5.5 Test Result of Radiated Spurious Emission (1GHz ~ 10th Harmonic)

Low Channel Horizontal:



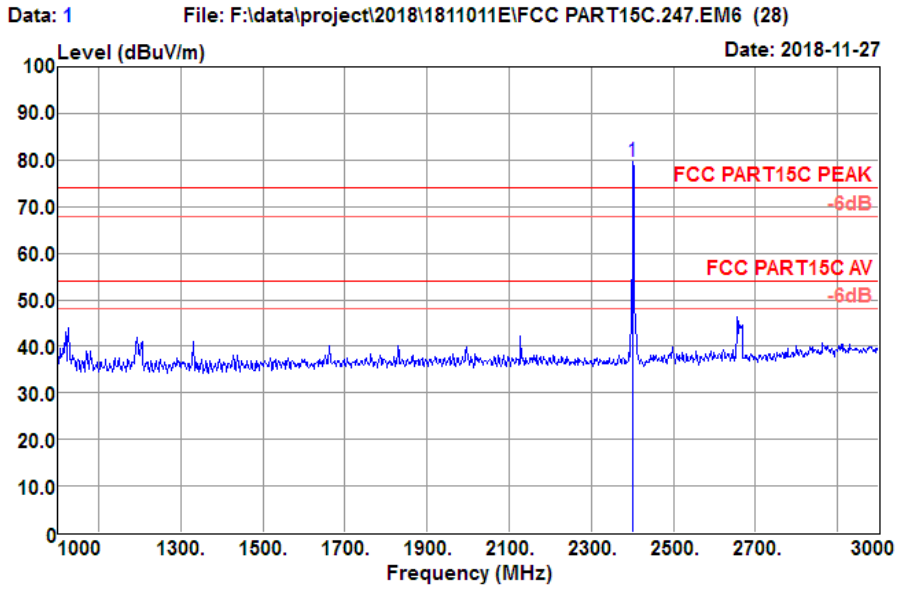
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2402.000	94.87	27.15	3.65	36.11	89.56	74.00	15.56	Peak



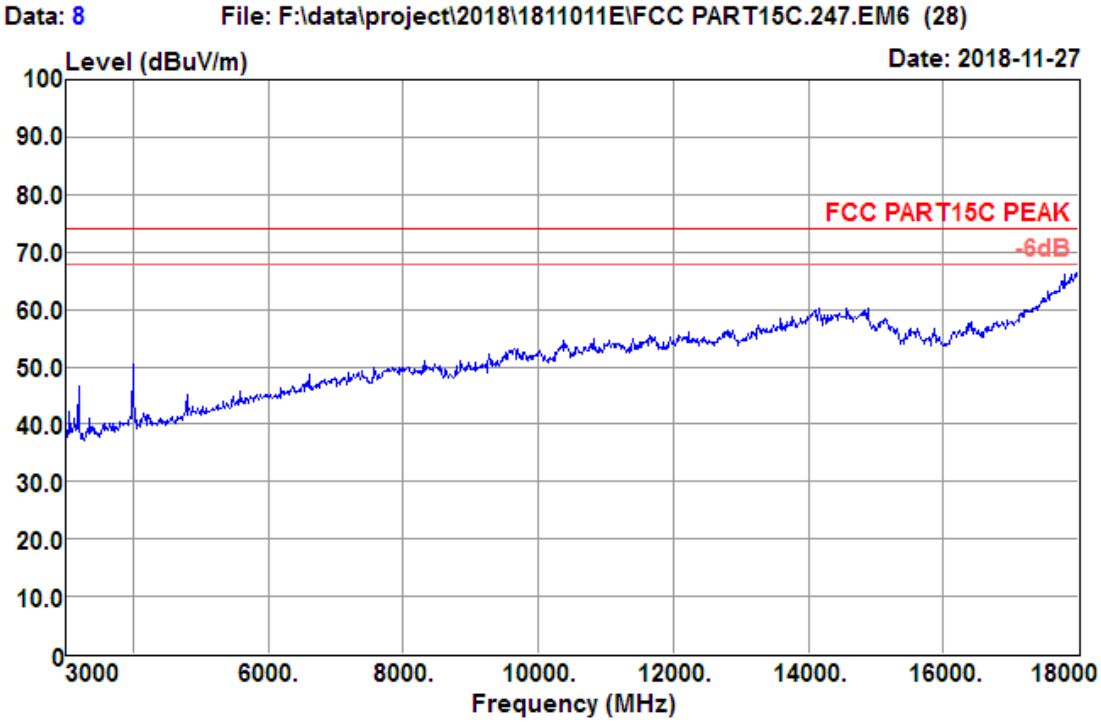


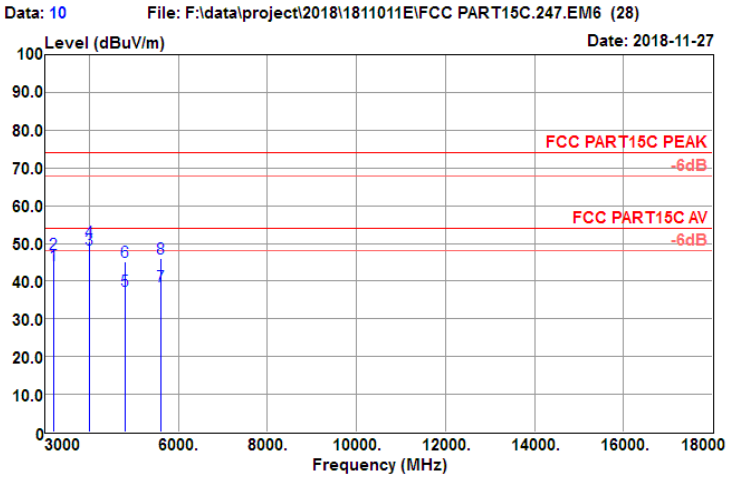
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
3202.000	56.39	28.82	4.27	37.46	52.02	54.00	-1.98	Average
3202.000	57.67	28.82	4.27	37.46	53.30	74.00	-20.70	Peak
4003.000	54.33	29.31	5.34	36.55	52.43	54.00	-1.57	Average
4003.000	56.57	29.31	5.34	36.55	54.67	74.00	-19.33	Peak
4804.000	44.00	31.23	5.45	36.27	44.41	54.00	-9.59	Average
4804.000	50.40	31.23	5.45	36.27	50.81	74.00	-23.19	Peak
5605.000	47.74	32.18	6.25	35.30	50.87	54.00	-3.13	Average
5605.000	50.85	32.18	6.25	35.30	53.98	74.00	-20.02	Peak

Low Channel Vertical:



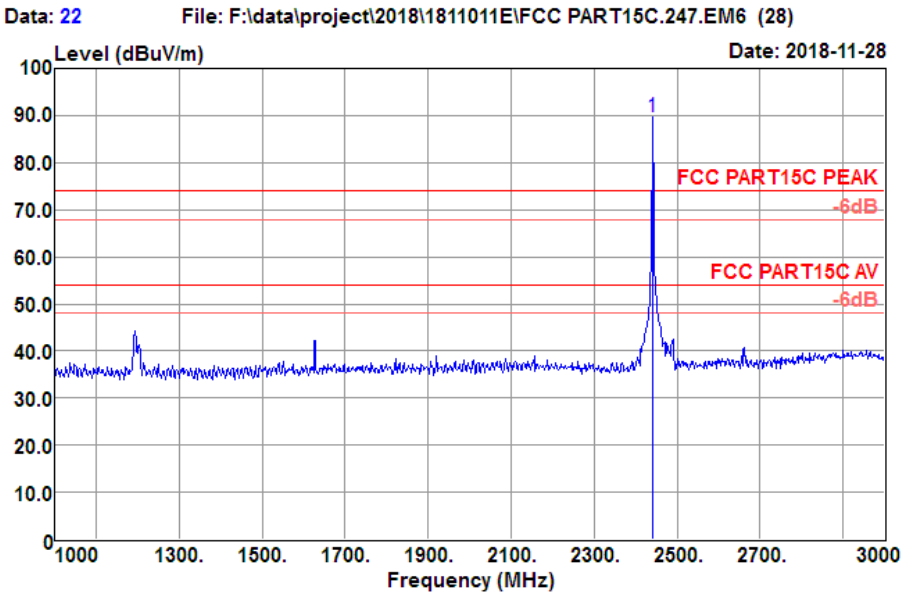
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2402.000	85.11	27.15	3.65	36.11	79.80	74.00	5.80	Peak



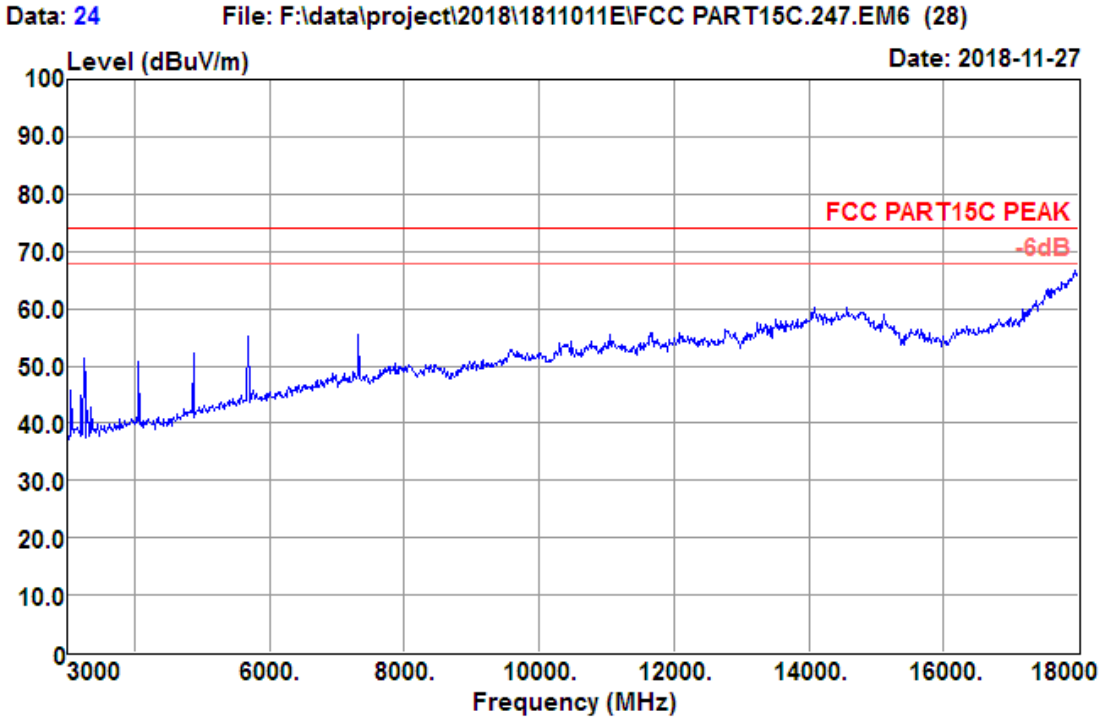


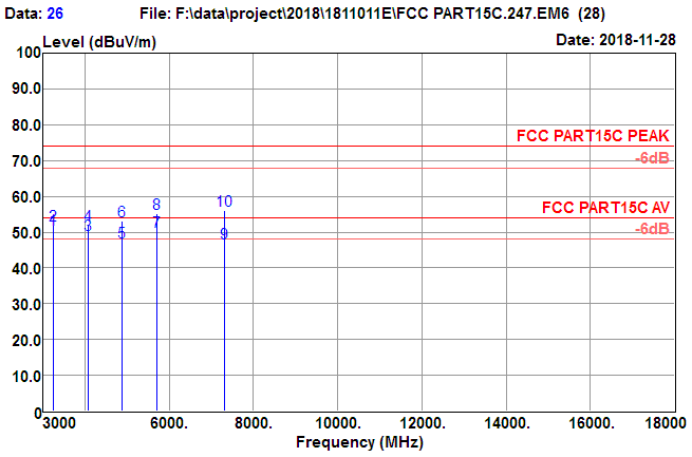
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
3202.000	48.56	28.82	4.27	37.46	44.19	54.00	-9.81	Average
3202.000	51.67	28.82	4.27	37.46	47.30	74.00	-26.70	Peak
4003.000	50.33	29.31	5.34	36.55	48.43	54.00	-5.57	Average
4003.000	52.38	29.31	5.34	36.55	50.48	74.00	-23.52	Peak
4804.000	37.12	31.23	5.45	36.27	37.53	54.00	-16.47	Average
4804.000	44.60	31.23	5.45	36.27	45.01	74.00	-28.99	Peak
5605.000	35.55	32.18	6.25	35.30	38.68	54.00	-15.32	Average
5605.000	42.78	32.18	6.25	35.30	45.91	74.00	-28.09	Peak

Middle Channel Horizontal:



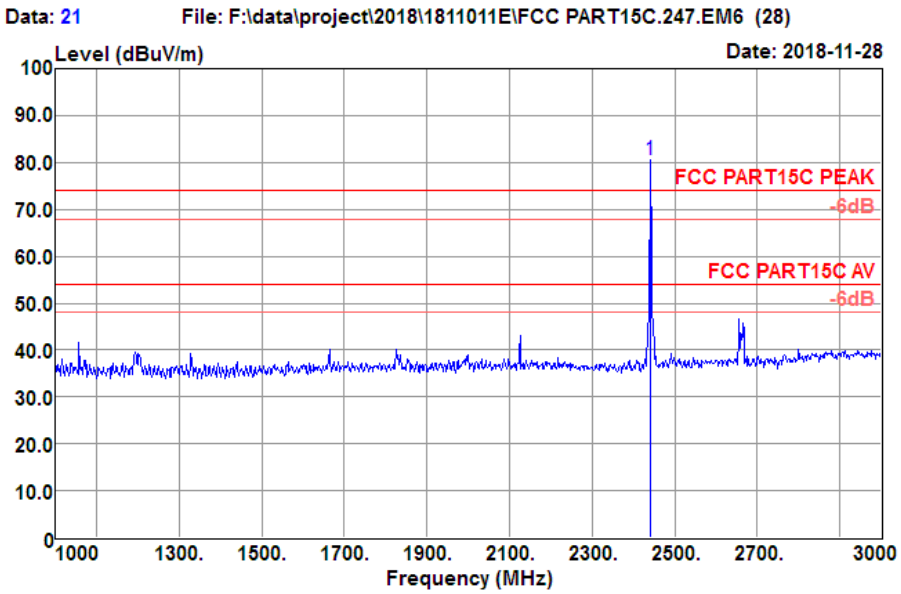
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2440.000	94.97	27.24	3.66	36.21	89.66	74.00	15.66	Peak



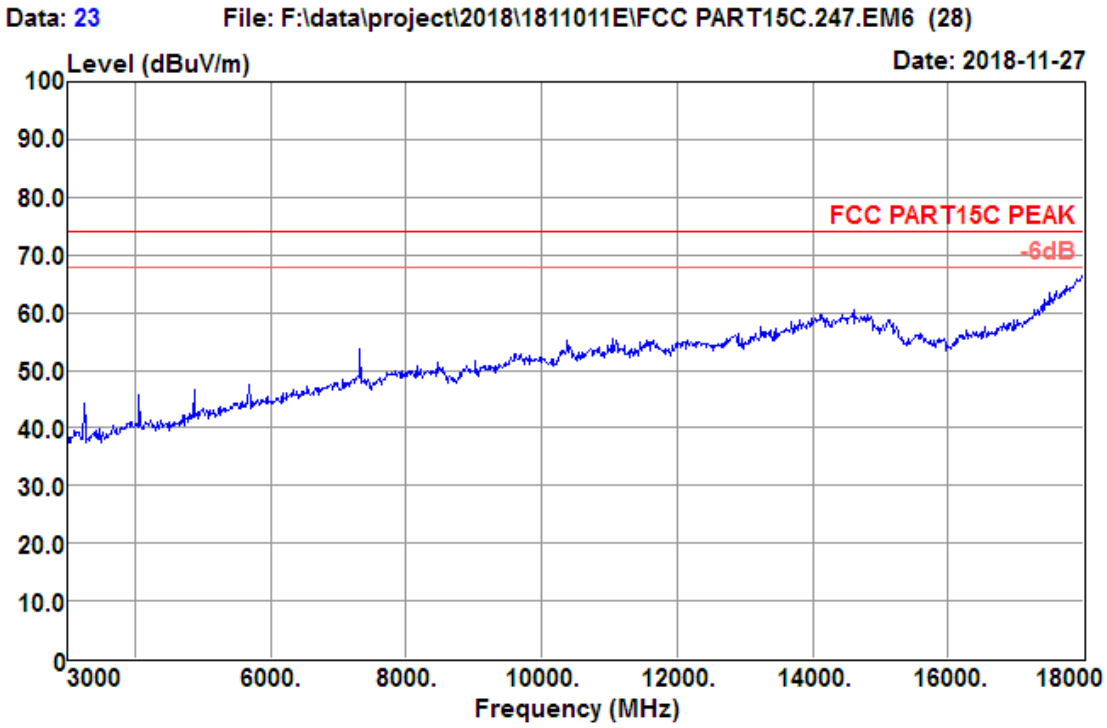


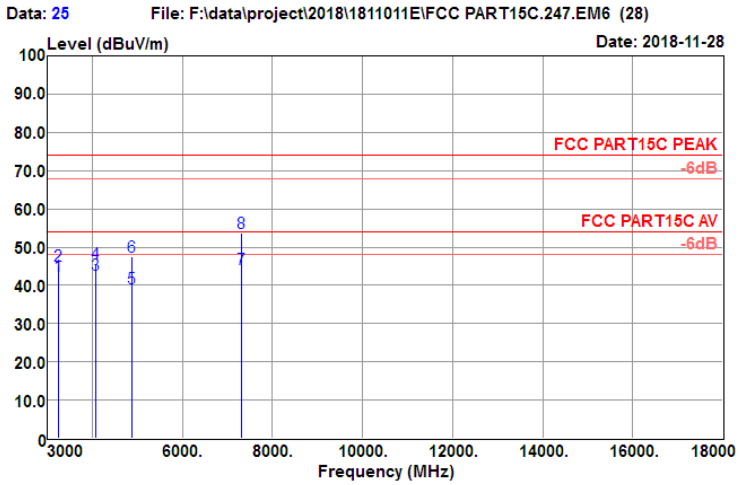
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
3254.000	55.05	28.85	4.32	37.40	50.82	54.00	-3.18	Average
3254.000	56.21	28.85	4.32	37.40	51.98	74.00	-22.02	Peak
4068.000	51.10	29.46	5.35	36.53	49.38	54.00	-4.62	Average
4068.000	53.65	29.46	5.35	36.53	51.93	74.00	-22.07	Peak
4880.000	46.78	31.41	5.41	36.24	47.36	54.00	-6.64	Average
4880.000	52.56	31.41	5.41	36.24	53.14	74.00	-20.86	Peak
5696.000	46.76	32.26	6.38	35.17	50.23	54.00	-3.77	Average
5696.000	51.65	32.26	6.38	35.17	55.12	74.00	-18.88	Peak
7320.000	37.71	36.14	7.27	34.35	46.77	54.00	-7.23	Average
7320.000	46.94	36.14	7.27	34.35	56.00	74.00	-18.00	Peak

Middle Channel Vertical:



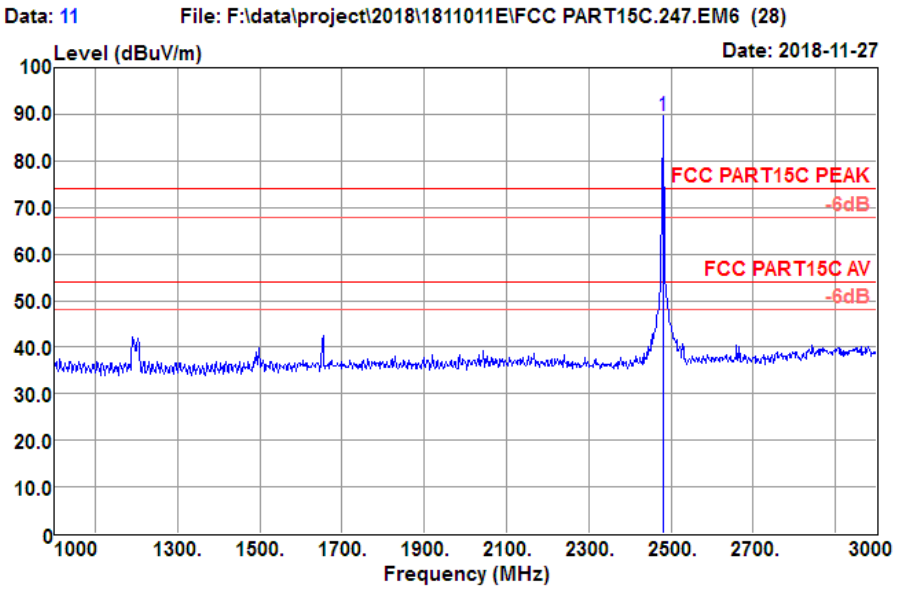
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
2440.000	85.96	27.24	3.66	36.21	80.65	74.00	6.65	Peak



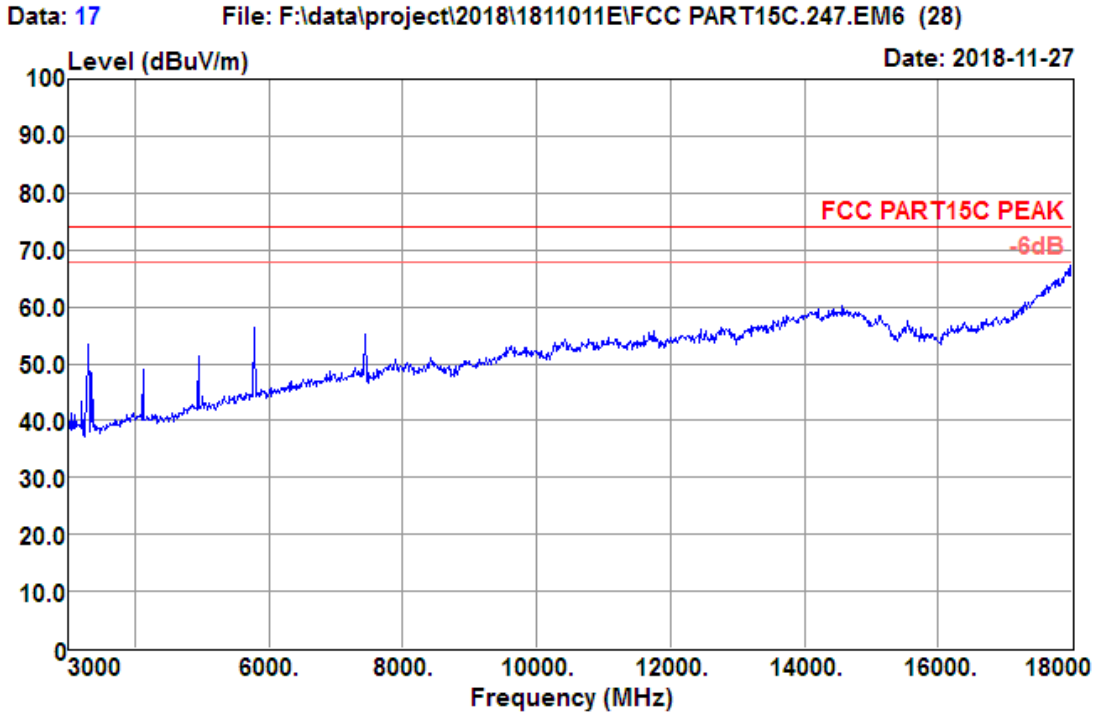


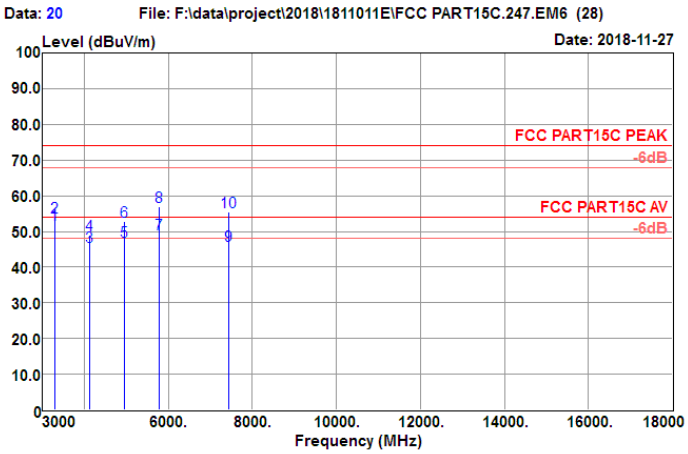
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
3254.000	46.65	28.85	4.32	37.40	42.42	54.00	-11.58	Average
3254.000	49.51	28.85	4.32	37.40	45.28	74.00	-28.72	Peak
4068.000	44.64	29.46	5.35	36.53	42.92	54.00	-11.08	Average
4068.000	47.32	29.46	5.35	36.53	45.60	74.00	-28.40	Peak
4880.000	38.79	31.41	5.41	36.24	39.37	54.00	-14.63	Average
4880.000	46.80	31.41	5.41	36.24	47.38	74.00	-26.62	Peak
7320.000	35.27	36.14	7.27	34.35	44.33	54.00	-9.67	Average
7320.000	44.61	36.14	7.27	34.35	53.67	74.00	-20.33	Peak

High Channel Horizontal:



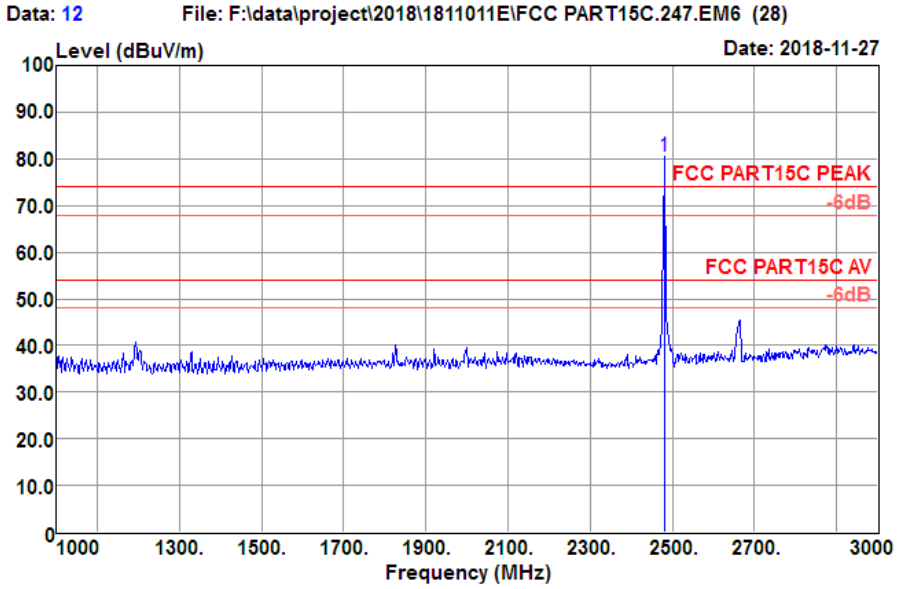
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2480.000	95.09	27.35	3.68	36.32	89.80	74.00	15.80	Peak



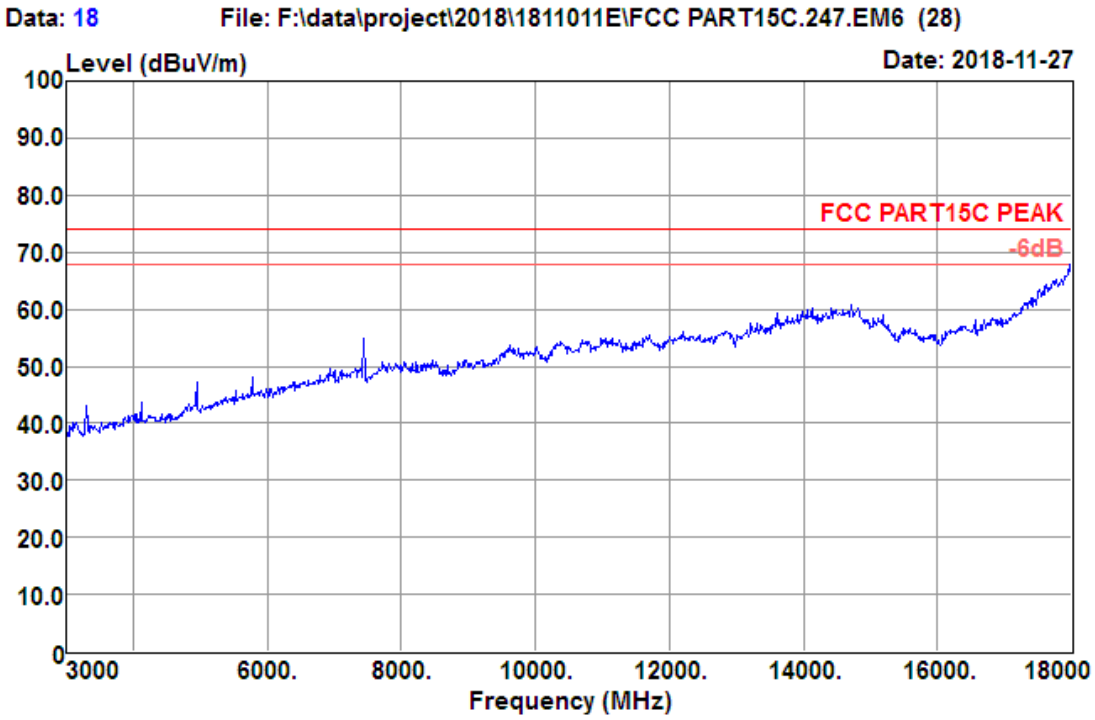


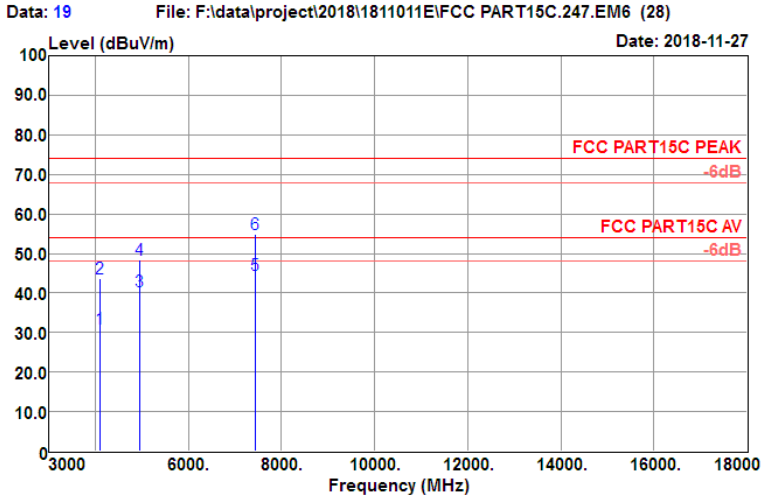
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV	Limit level dBuV/m	Over limit dB	Remark
3306.000	56.04	28.88	4.37	37.34	51.95	54.00	-2.05	Average
3306.000	58.02	28.88	4.37	37.34	53.93	74.00	-20.07	Peak
4133.000	47.22	29.62	5.36	36.50	45.70	54.00	-8.30	Average
4133.000	50.60	29.62	5.36	36.50	49.08	74.00	-24.92	Peak
4960.000	46.32	31.60	5.36	36.21	47.07	54.00	-6.93	Average
4960.000	51.95	31.60	5.36	36.21	52.70	74.00	-21.30	Peak
5787.000	45.34	32.33	6.51	35.04	49.14	54.00	-4.86	Average
5787.000	53.17	32.33	6.51	35.04	56.97	74.00	-17.03	Peak
7440.000	36.53	36.41	7.44	34.47	45.91	54.00	-8.09	Average
7440.000	45.96	36.41	7.44	34.47	55.34	74.00	-18.66	Peak

High Channel Vertical:



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
2480.000	85.86	27.35	3.68	36.32	80.57	74.00	6.57	Peak

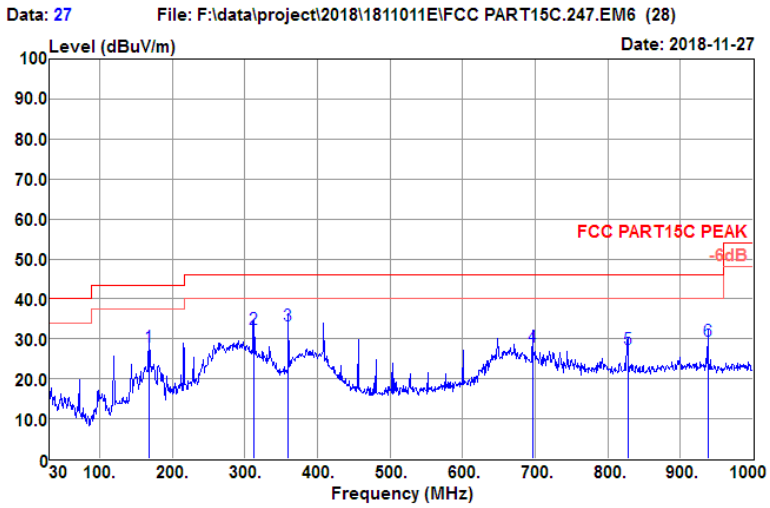




Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV	dBuV/m	dB	
4113.000	32.50	29.57	5.36	36.51	30.92	54.00	-23.08	Average
4113.000	45.18	29.57	5.36	36.51	43.60	74.00	-30.40	Peak
4960.000	39.69	31.60	5.36	36.21	40.44	54.00	-13.56	Average
4960.000	47.60	31.60	5.36	36.21	48.35	74.00	-25.65	Peak
7440.000	35.19	36.41	7.44	34.47	44.57	54.00	-9.43	Average
7440.000	45.63	36.41	7.44	34.47	55.01	74.00	-18.99	Peak

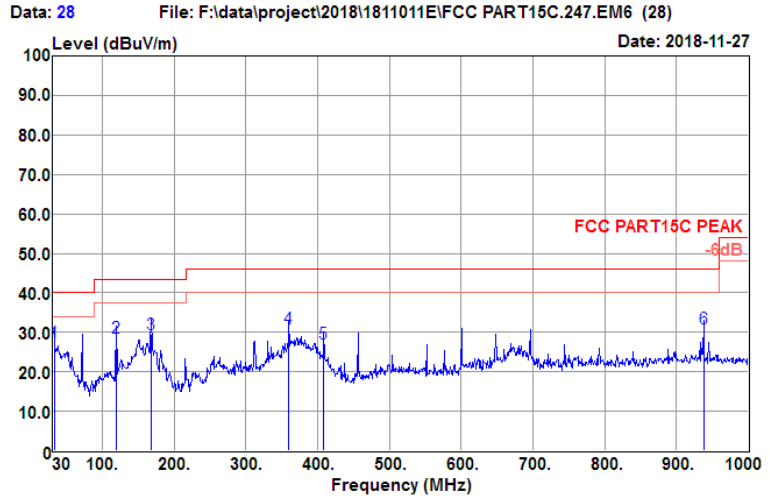
4.5.6 Test Result of Radiated Spurious Emission (30MHz ~ 1GHz)

Horizontal:



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
167.740	44.73	13.43	2.53	32.52	28.17	43.50	-15.33	QP
312.270	48.25	13.13	3.52	32.51	32.39	46.00	-13.61	QP
359.800	47.87	14.04	3.86	32.49	33.28	46.00	-12.72	QP
696.390	35.69	19.65	5.55	32.78	28.11	46.00	-17.89	QP
827.340	32.75	21.05	6.04	32.49	27.35	46.00	-18.65	QP
937.920	33.23	21.93	6.43	32.06	29.53	46.00	-16.47	QP

Vertical:



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
32.910	45.52	13.32	1.04	32.53	27.35	40.00	-12.65	QP
119.240	46.78	12.12	2.11	32.47	28.54	43.50	-14.96	QP
167.740	45.96	13.43	2.53	32.52	29.40	43.50	-14.10	QP
359.800	45.59	14.04	3.86	32.49	31.00	46.00	-15.00	QP
408.300	40.75	14.94	4.04	32.48	27.25	46.00	-18.75	QP
937.920	34.67	21.93	6.43	32.06	30.97	46.00	-15.03	QP

4.6 AC Conducted Emission Measurement

4.6.1 Limit of AC Conducted Emission

FCC §15.207

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 (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

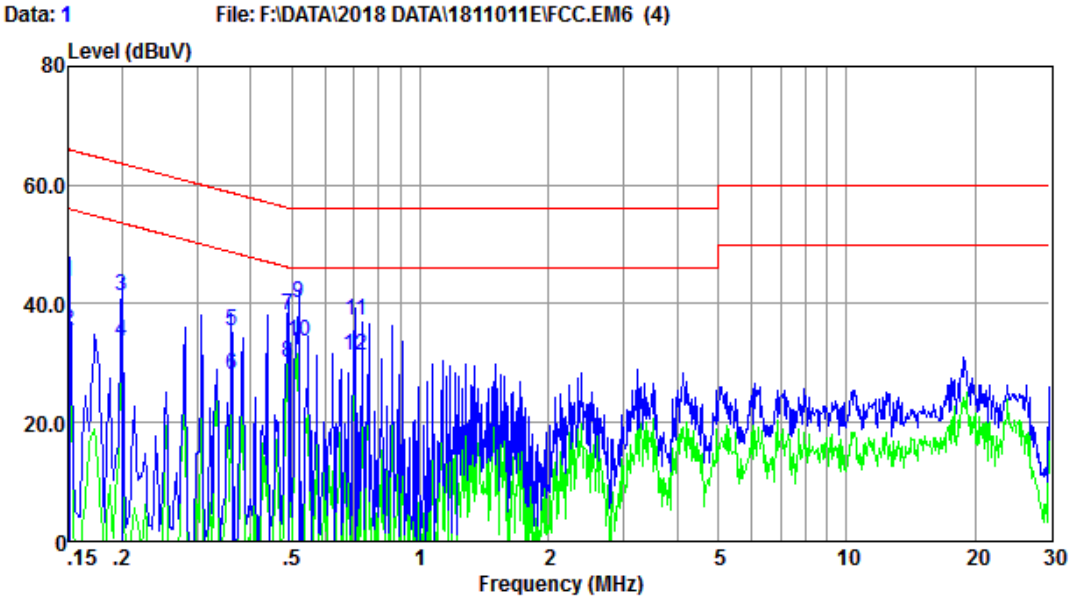
*Decreases with the logarithm of the frequency.

4.6.2 Test Procedures

1. 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.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. 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.

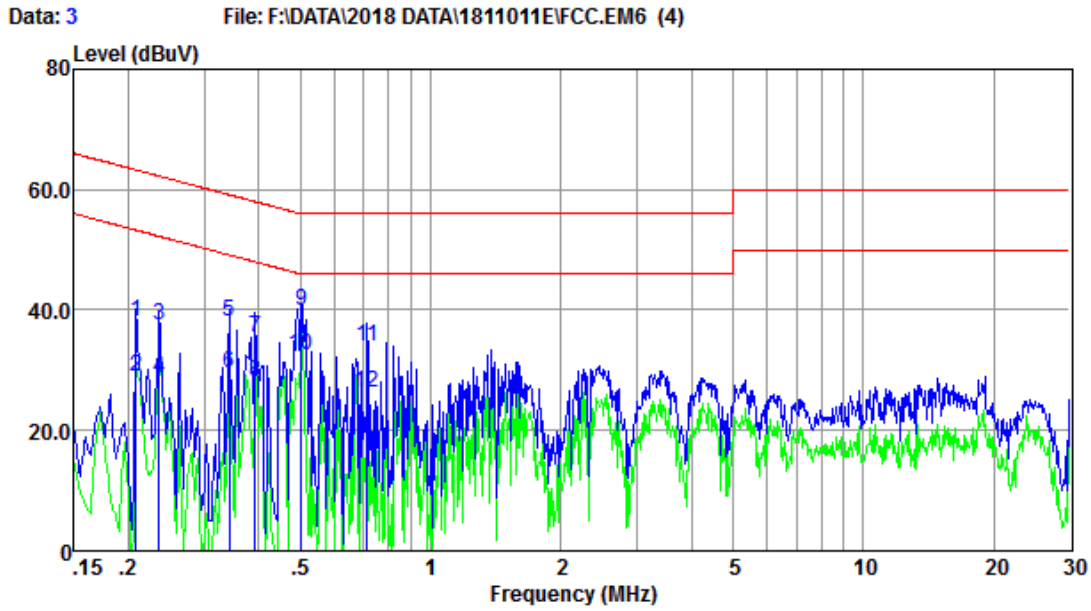
4.6.3 Test Result of AC Conducted Emission

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



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	level dBuV	Limit level dBuV	Over limit dB	Remark
0.150	34.13	9.54	0.07	43.74	66.00	-22.26	QP
0.150	25.94	9.54	0.07	35.55	56.00	-20.45	Average
0.200	31.61	9.56	0.01	41.18	63.62	-22.44	QP
0.200	24.18	9.56	0.01	33.75	53.62	-19.87	Average
0.361	25.71	9.58	0.02	35.31	58.69	-23.38	QP
0.361	18.47	9.58	0.02	28.07	48.69	-20.62	Average
0.491	28.46	9.58	0.02	38.06	56.14	-18.08	QP
0.491	20.46	9.58	0.02	30.06	46.14	-16.08	Average
0.518	30.66	9.58	0.02	40.26	56.00	-15.74	QP
0.518	23.91	9.58	0.02	33.51	46.00	-12.49	Average
0.705	27.54	9.59	0.03	37.16	56.00	-18.84	QP
0.705	21.81	9.59	0.03	31.43	46.00	-14.57	Average

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



Freq	Reading level	LISN/ISN factor	Cable loss		Limit level	Over limit	Remark
MHz	dBuV	dB	dB	level dBuV	dBuV	dB	
0.208	28.40	9.57	0.01	37.98	63.27	-25.29	QP
0.208	19.26	9.57	0.01	28.84	53.27	-24.43	Average
0.235	27.88	9.59	0.01	37.48	62.26	-24.78	QP
0.235	18.93	9.59	0.01	28.53	52.26	-23.73	Average
0.343	28.52	9.61	0.02	38.15	59.13	-20.98	QP
0.343	19.97	9.61	0.02	29.60	49.13	-19.53	Average
0.393	25.85	9.62	0.02	35.49	57.99	-22.50	QP
0.393	18.55	9.62	0.02	28.19	47.99	-19.80	Average
0.502	30.22	9.63	0.02	39.87	56.00	-16.13	QP
0.502	22.82	9.63	0.02	32.47	46.00	-13.53	Average
0.712	24.17	9.64	0.03	33.84	56.00	-22.16	QP
0.712	16.70	9.64	0.03	26.37	46.00	-19.63	Average

4.7 Antenna Requirements

4.7.1 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.

4.7.2 Antenna Connected Construction

An embedded-in antenna design is used.

4.7.3 Antenna Gain

The antenna peak gain of EUT is 1.5dBi 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	2018-03-02	2019-03-01	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2018-03-02	2019-03-01	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2018-03-02	2019-03-01	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2018-03-02	2019-03-01	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2018-03-02	2019-03-01	Conducted
Thermal Chamber	Sanmtest	SMC-408-CD	2435	2018-07-05	2019-07-04	Conducted
Base Station	R&S	CMW 270	101231	2018-03-17	2019-03-16	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2018-04-10	2019-04-09	Conducted
Signal Generator (Blocker)	Keysight	N5171B	MY56200661	2018-03-15	2019-03-14	Conducted

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV 40	101433	2018-03-14	2019-03-13	Radiation
Amplifier	Sonoma	310	363917	2018-03-06	2019-03-05	Radiation
Amplifier	Schwarzbeck	BBV 9718	327	2018-03-14	2019-03-13	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.