RF Test Report

For

HUNAN FN-LINK TECHNOLOGY LIMITED

Test Standards:	Part 15C Subpart C §15.247
Product Description:	2.4G Wi-Fi+Bluetooth V5.0 Module
Tested Model:	6220N-IS
Brand Name	FN-LINK
FCC ID:	2AATL-6220N-IS
IC:	24844-6220NIS
Classification	(DTS) Digital Transmission System
Report No.:	EC1909021RF02
Tested Date:	2019-09-24 to 2019-11-12
Issued Date:	2019-11-12
Prepared By:	Victorique Gao /Engineer
Approved By:	Bacon Wu / RF Manager

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Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	2019.11.12	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 8.7 dB at 359.8 MHz
15.207	RSS-GEN 8.8	AC Conducted Emission	15.207(a)	Pass	Under limit 8.37 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, ISED# :24347)

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 Number: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

HUNAN FN-LINK TECHNOLOGY LIMITED
No. 8, Litong Road, Liuyang Economic Development Zone, Liuyang City, Hunan Province, China

2.2 Manufacturer

HUNAN FN-LINK TECHNOLOGY LIMITED
No. 8, Litong Road, Liuyang Economic Development Zone, Liuyang City, Hunan Province, China

2.3 General Description Of EUT

Product	2.4G Wi-Fi+Bluetooth V5.0 Module
Model No.	6220N-IS
Brand Name	FN-LINK
FCC ID	2AATL-6220N-IS
IC	24844-6220NIS
Power Supply	3.3Vdc
Modulation Technology	BLE
Modulation Type	GFSK
Operating Frequency	2402MHz~2480MHz
Number Of Channel	40
Max. Output Power	3.68 dBm (2.33 mW)
Antenna Type	PCB Antenna type with 2dBi gain
I/O Ports	Refer to user's manual
Cable Supplied	N/A

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 v05r02
- IC RSS-247 Issue 2
- IC RSS-Gen Issue 5

Remark:

1. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, and ICES-003 recorded in a separate test report.

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	3.68
Ch19	2440MHz	GFSK	3.27
Ch39	2480MHz	GFSK	3.3

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.

3.2 Test Mode

3.2.1 Antenna Port Conducted Measurement

Summary table of Test Cases		
Test Item	Data Rate / Modulation	
	Bluetooth 5.0 – LE GFSK (1Mbps)	Bluetooth 5.0 – LE GFSK (2Mbps)
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_2480 MHz	Mode 4: CH00_2402 MHz Mode 5: CH19_2440 MHz Mode 6: CH39_2480 MHz

3.2.2 Radiated Emission Test (Below 1GHz)

Radiated Test Cases	Bluetooth LE 2Mbps GFSK
	Mode 1: CH00_2402 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. X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

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

3.2.3 Radiated Emission Test (Above 1GHz)

Radiated Test Cases	Bluetooth LE 2Mbps GFSK
	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_2480 MHz

Note : 1. 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.

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

3. For frequency above 18GHz, the measured value is 20dB lower than the limit, therefore, it is not reflected in the report.

3.2.4 Power Line Conducted Emission Test:

AC Conducted Emission	Mode 1 : BLE Idle+ Power supply(From Notebook)

3.3 Support Equipment

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	Lenovo	E540	FCC DoC	N/A	shielded cable DC O/P 1.8 m unshielded AC I/P cable1.2 m
2.	USB Cable	N/A	N/A	N/A	N/A	unshielded 0.8m

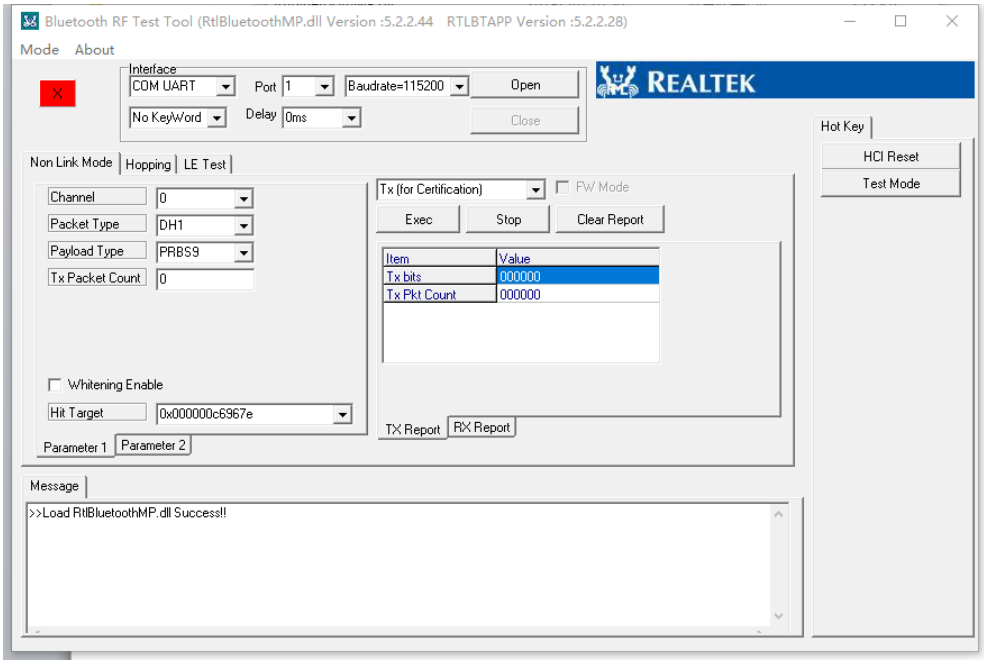
3.4 Test Setup

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

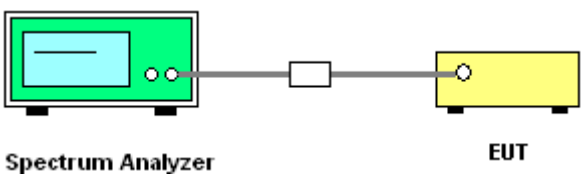
EUT was set in the Hidden menu mode to enable BT communications.

The following picture is a screenshot of the test software

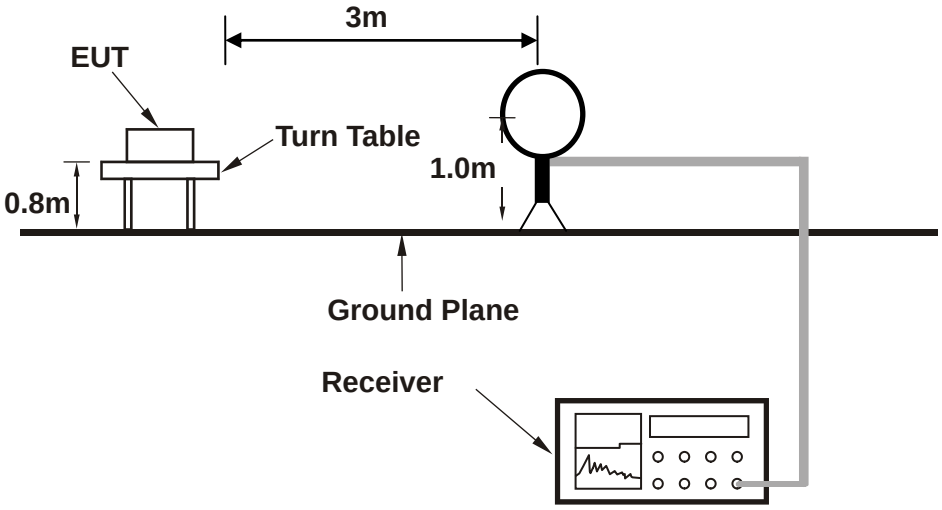
BLE:



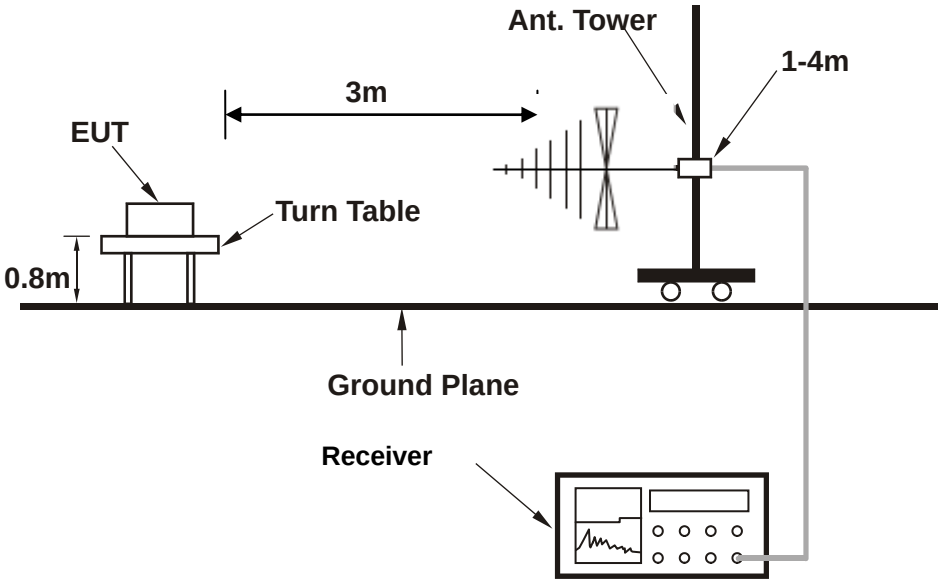
Setup diagram for Conducted Test



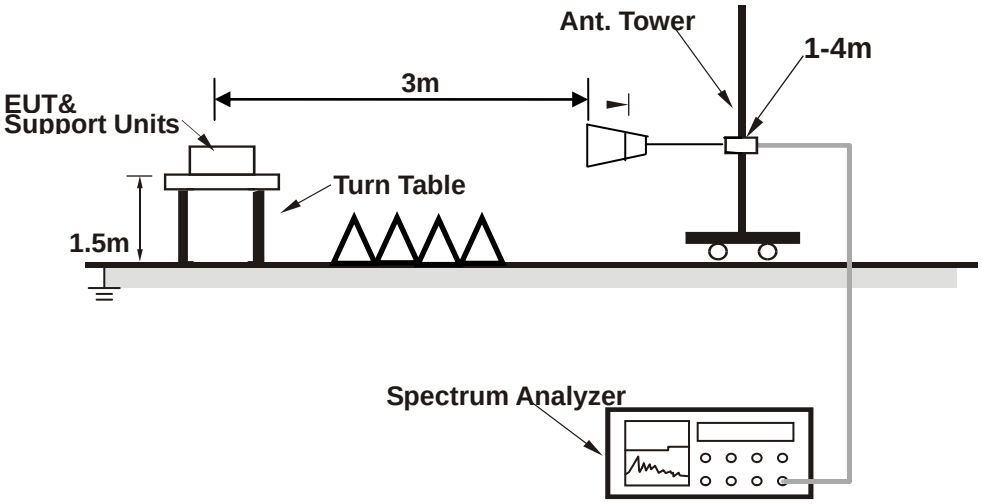
Setup diagram for Raidation(9KHz~30MHz) Test



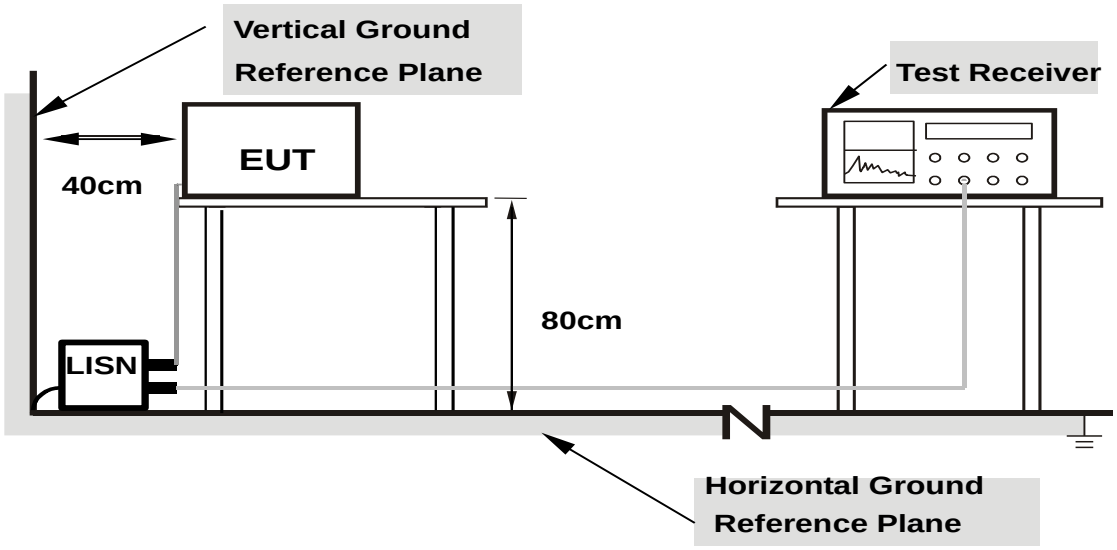
Setup diagram for Raidation(Below 1G) Test



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)

For all radiated test items:

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

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.

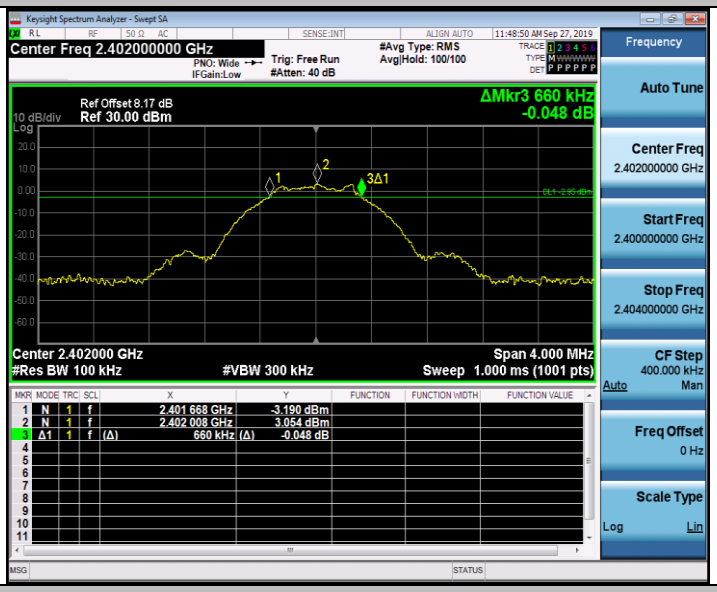
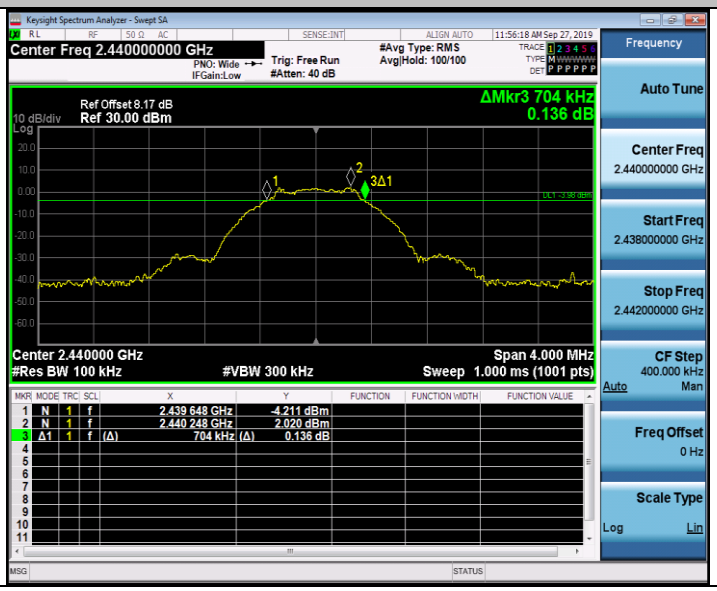
4.1.3 Test Result of 6dB and 99% Bandwidth

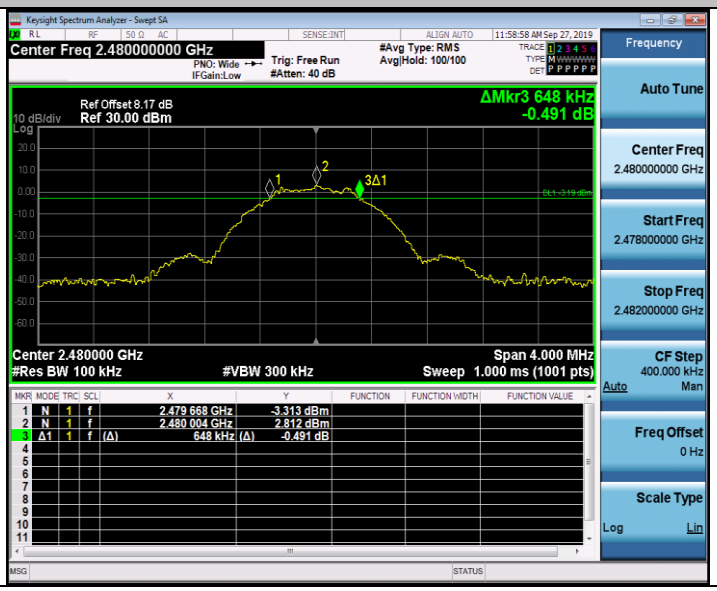
Test Mode :	BLE,	**Temperature :**	24~26℃
Test Engineer :	Victorique Gao	**Relative Humidity :**	50~53%

Mode	Rate	Channel	6dB Bandwidth [MHz]	99% OBW[MHz]	Verdict
BLE	1M	LCH	0.660	1.0306	PASS
		MCH	0.704	1.0426	PASS
		HCH	0.648	1.0418	PASS
	2M	LCH	1.128	2.0835	PASS
		MCH	1.108	2.0818	PASS
		HCH	1.080	2.0842	PASS

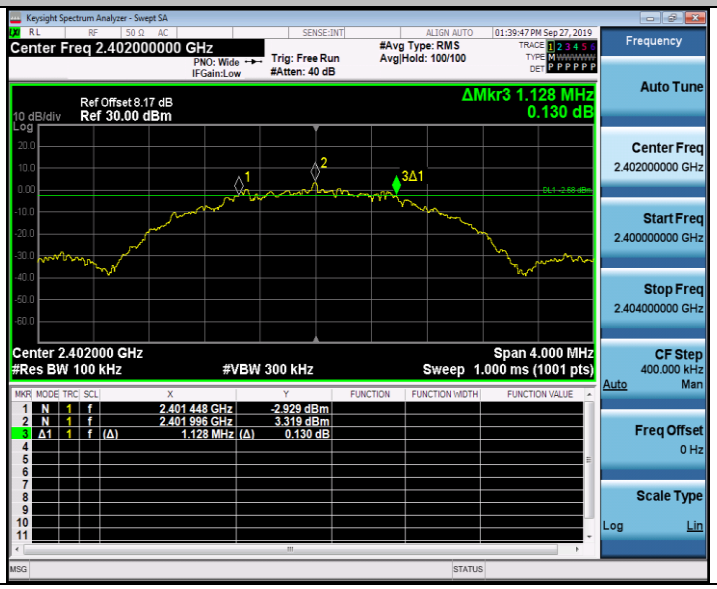
6dB Bandwidth Plot

1M

BLE_ Ant1_2402

BLE_ Ant1_2440


BLE_ Ant1_2480


2M

BLE_ Ant1_2402


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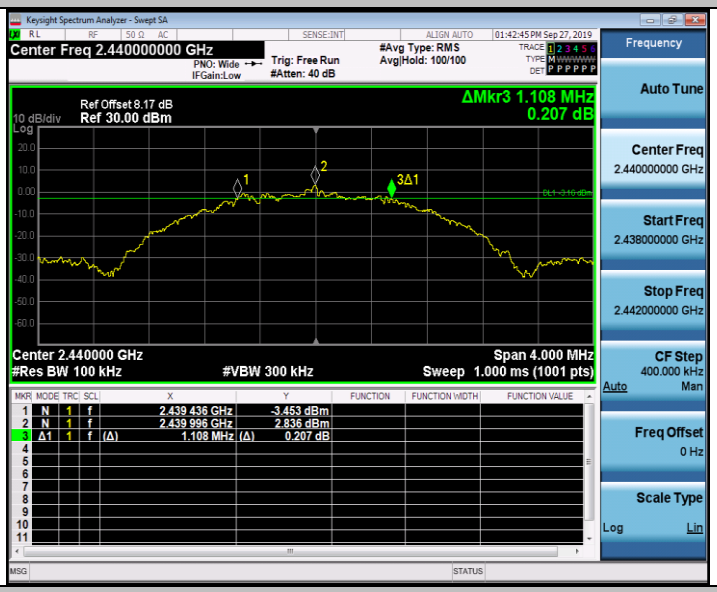
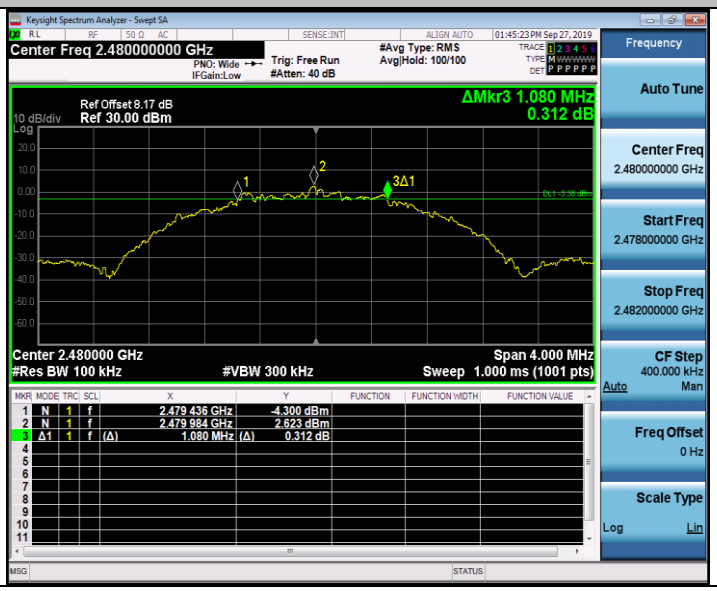

BLE_ Ant1_2480


99% Bandwidth Plot

1M

BLE_ Ant1_2402

BLE_ Ant1_2440


BLE_ Ant1_2480


2M

BLE_ Ant1_2402


BLE_ Ant1_2440

BLE_ Ant1_2480


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

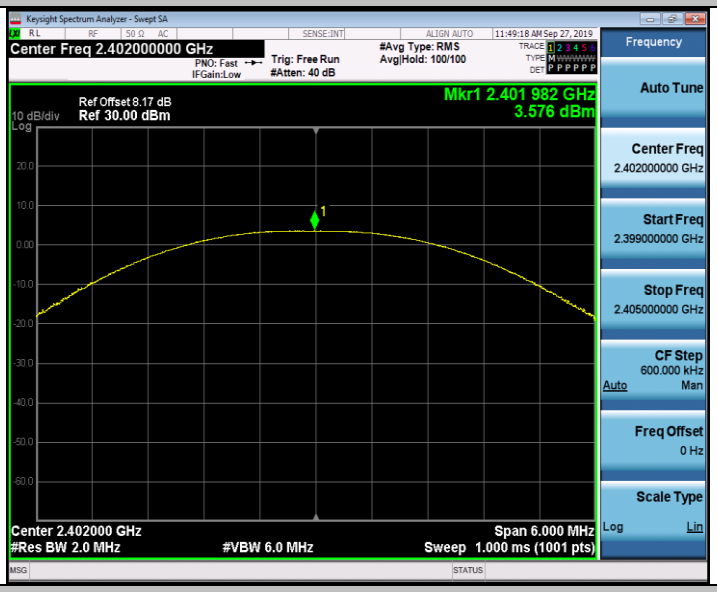
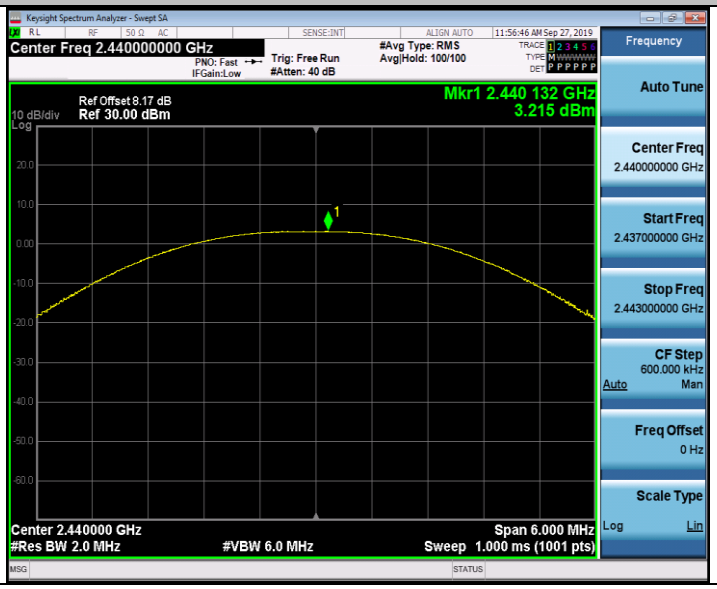
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to spectrum analyzer.
3. Set to the maximum power setting and enable the EUT transmit continuously
4. Set the RBW=DTS Bandwidth,VBW≥3*RBW,Span≥1.5*DTS 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

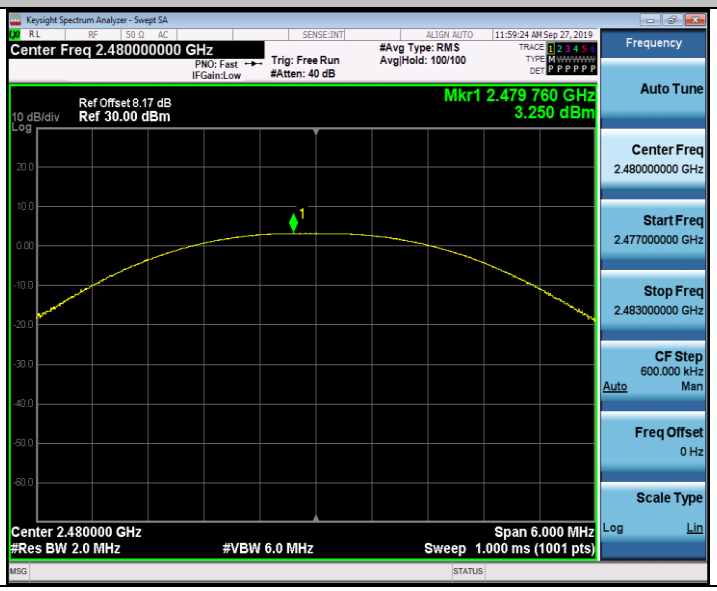
4.2.3 Test Result of Peak Output Power

Test Mode :	BLE		**Temperature :**	24~26℃
Test Engineer :	Victorique Gao		**Relative Humidity :**	50~53%
Mode	**Rate**	**Channel**	**Conduct Peak Power[dBm]**	Verdict
BLE	1M	LCH	3.58	PASS
		MCH	3.22	PASS
		HCH	3.25	PASS
	2M	LCH	3.68	PASS
		MCH	3.27	PASS
		HCH	3.3	PASS

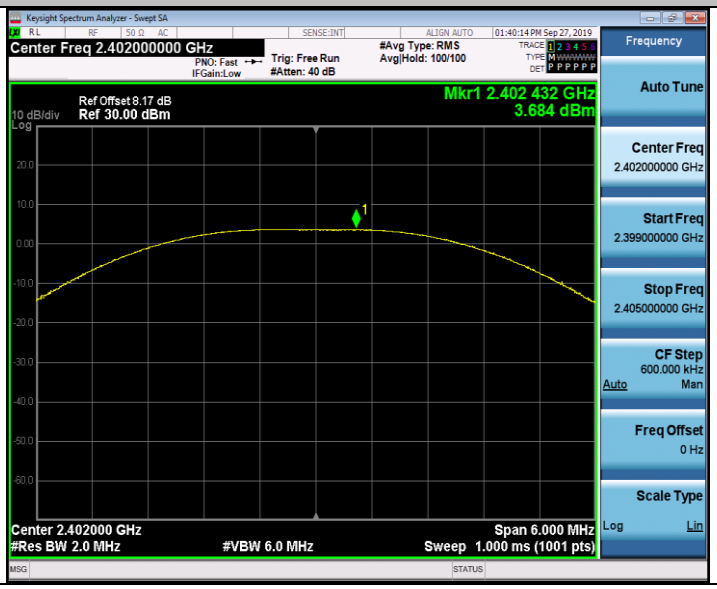
Peak Output Power Plot

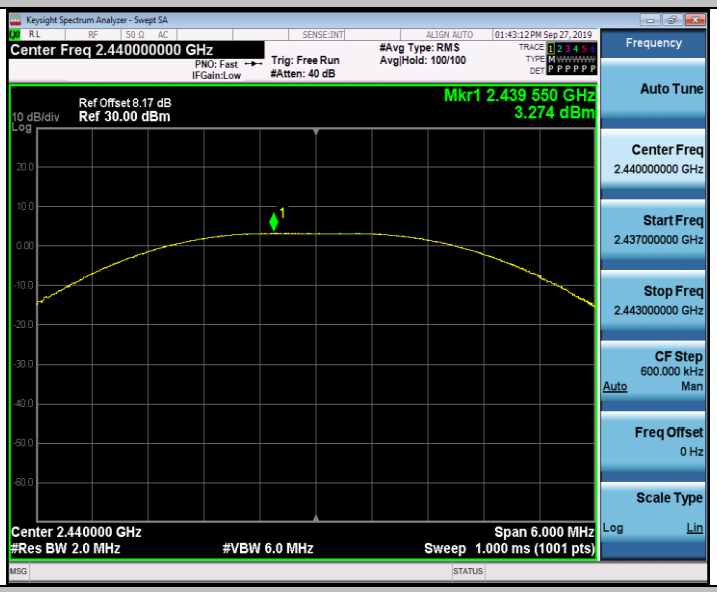
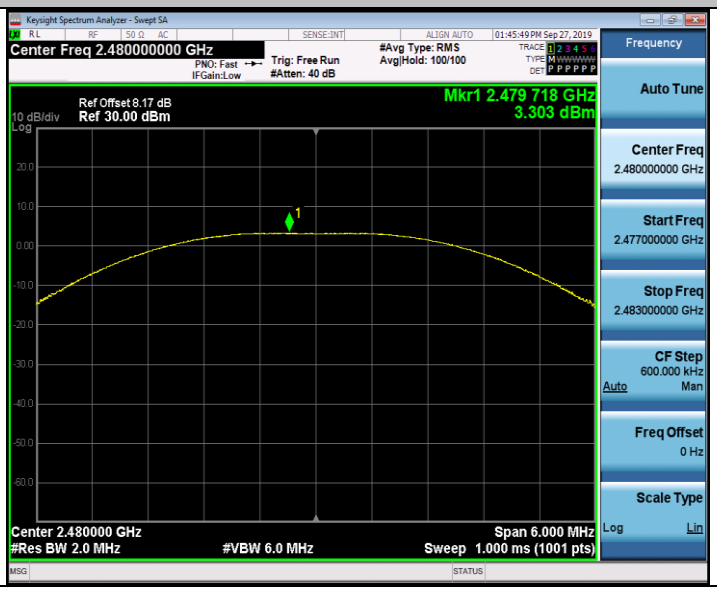
1M

BLE_ Ant1_2402

BLE_ Ant1_2440


BLE_ Ant1_2480


2M

BLE_ Ant1_2402


BLE_ Ant1_2440

BLE_ Ant1_2480


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

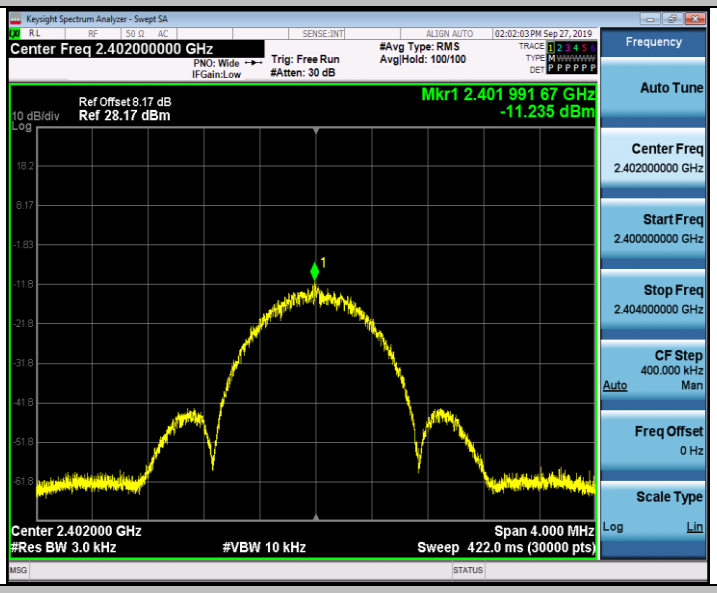
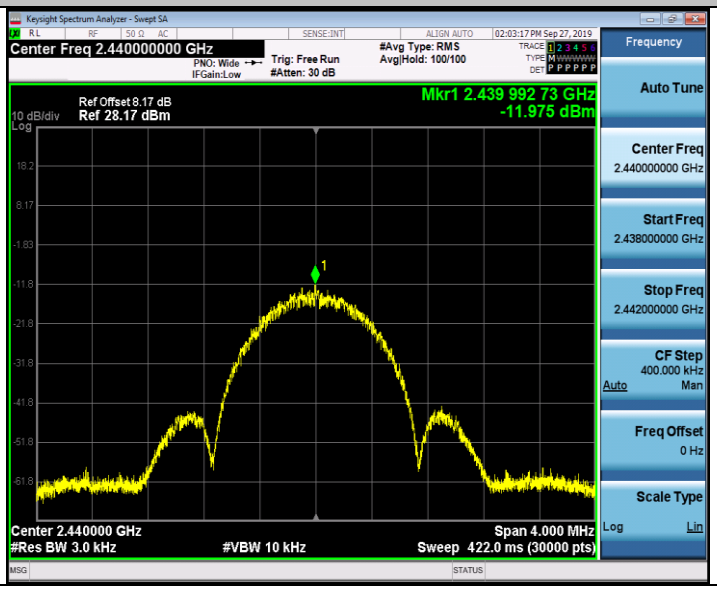
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth 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.

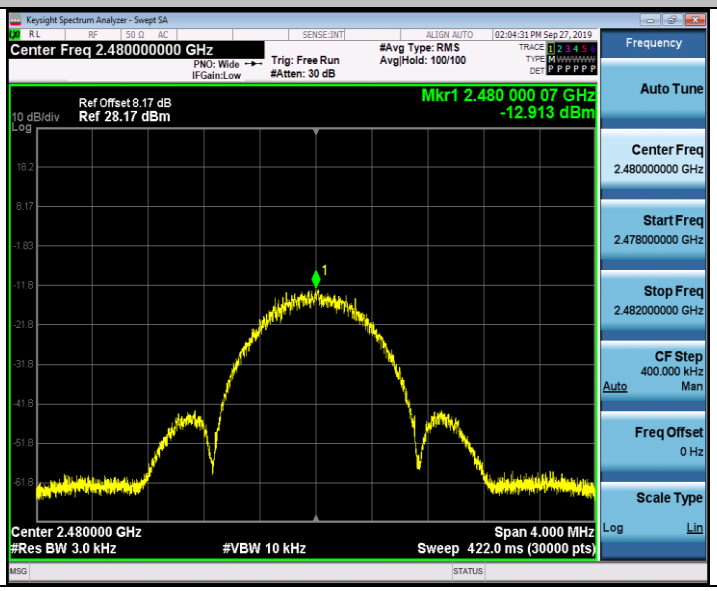
4.3.3 Test Result of Power Spectral Density

Test Mode :	BLE		**Temperature :**	24~26℃
Test Engineer :	Victorique Gao		**Relative Humidity :**	50~53%
Mode	**Rate**	Channel	**PSD [dBm]**	Verdict
BLE	1M	LCH	-11.24	PASS
		MCH	-11.98	PASS
		HCH	-12.91	PASS
	2M	LCH	-14.01	PASS
		MCH	-14.6	PASS
		HCH	-13.85	PASS

Power Spectral Density Plot

1M

BLE_ Ant1_2402

BLE_ Ant1_2440


BLE_ Ant1_2480


2M

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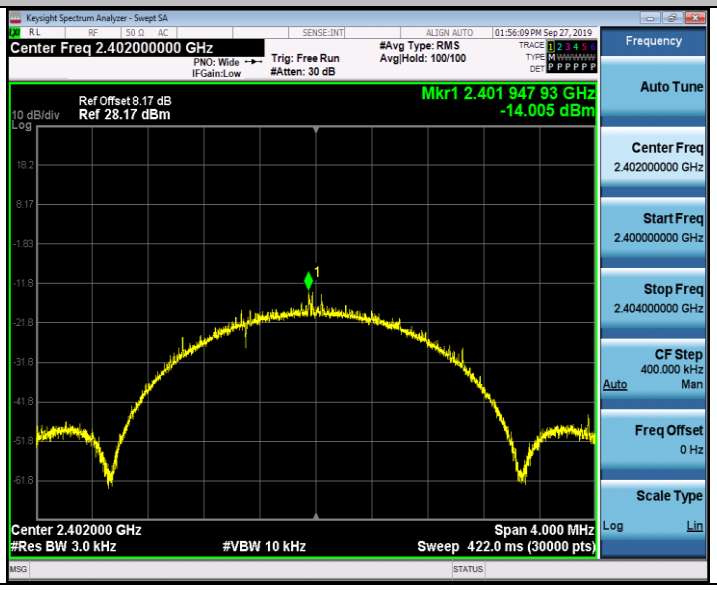
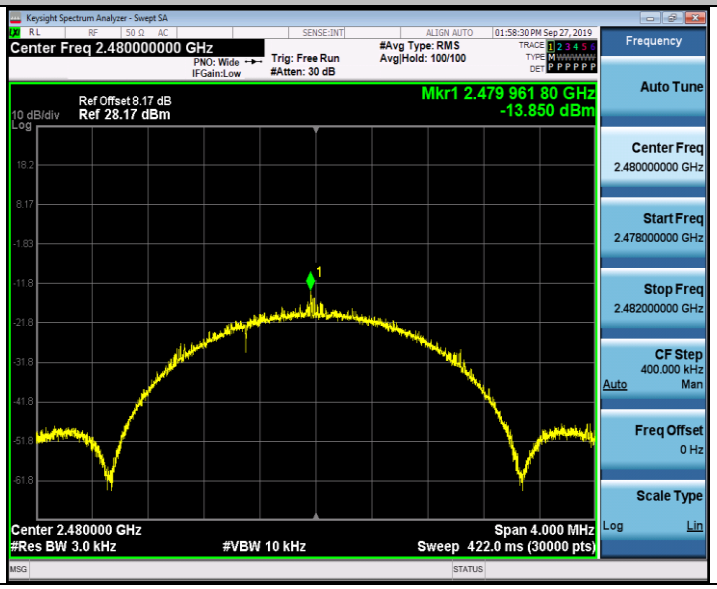


BLE_ Ant1_2440

BLE_ Ant1_2480


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

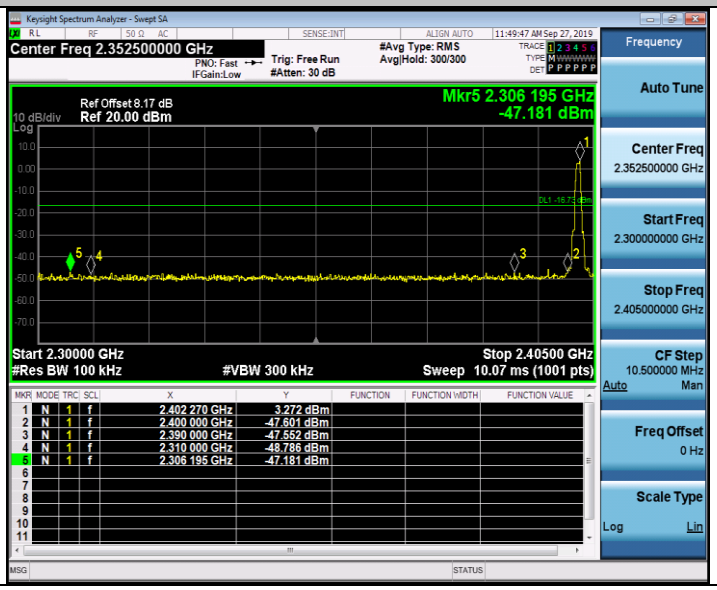
Test Mode :	BLE	Temperature :	24~26℃
Test Engineer :	Victorique Gao	Relative Humidity :	50~53%

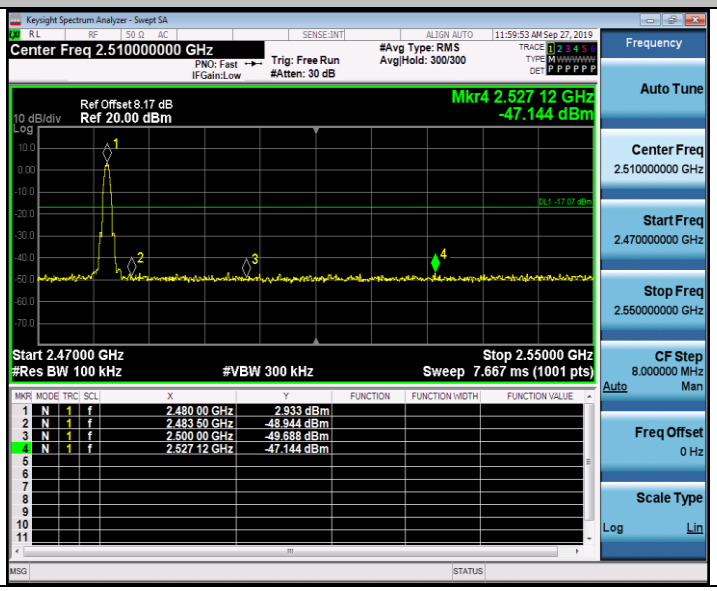
Mode	Rate	Channel	Carrier Power[dBm]	Max.Spurious Level [dBm]	Limit [dBm]	Verdict
BLE	1M	LCH	3.27	-47.18	<=-16.73	PASS
		HCH	2.93	-47.14	<=-17.07	PASS
	2M	LCH	3.41	-47.54	<=-16.59	PASS
		HCH	2.34	-47.53	<=-17.66	PASS

Conducted Band Edges Plot

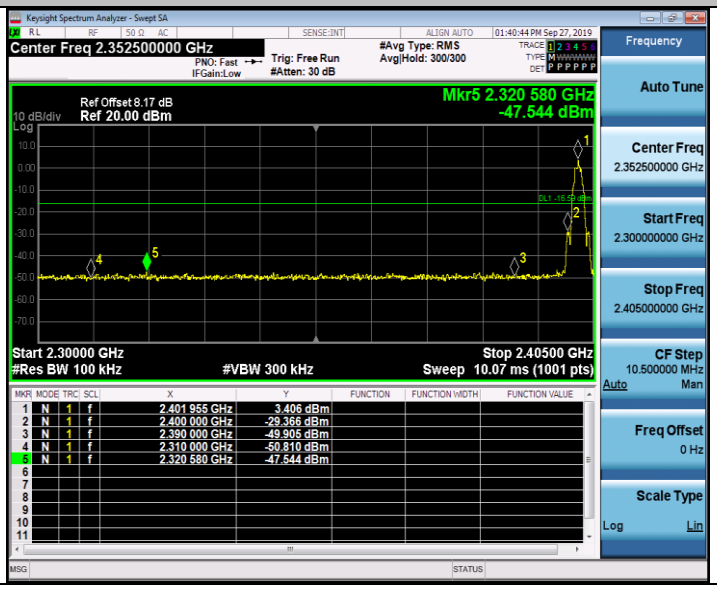
1M

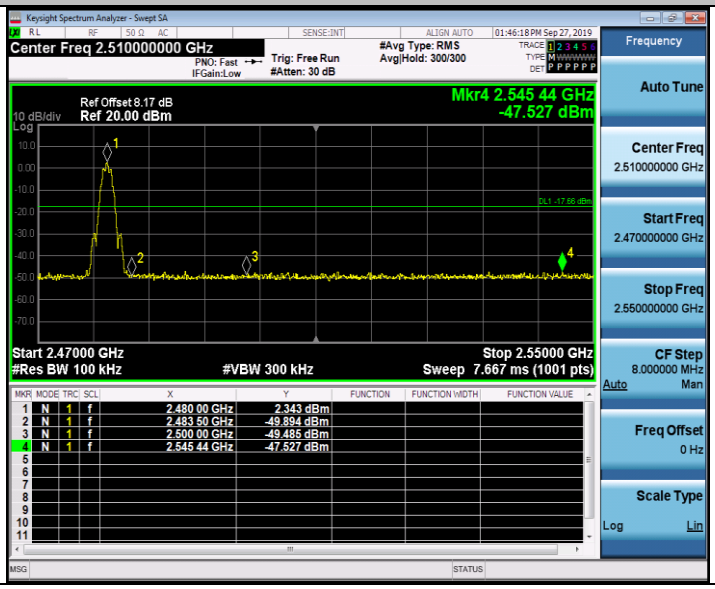
BLE_ Ant1_Low_2402



BLE_ Ant1_High_2480


2M

BLE_ Ant1_Low_2402


BLE_ Ant1_High_2480


4.4.4 Test Result of Conducted Spurious Emission

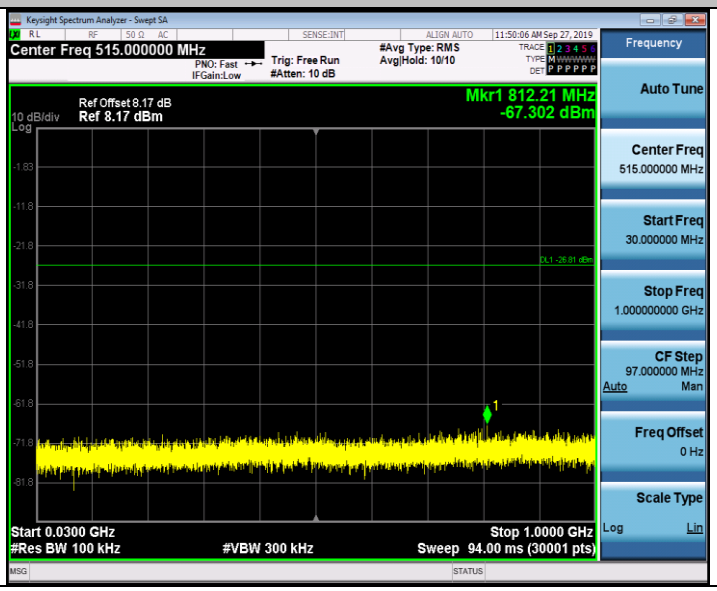
Test Mode :	BLE		**Temperature :**		24~26℃		
Test Engineer :	Victorique Gao		**Relative Humidity :**		50~53%		
TestMode		Channel	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE	1M	LCH	Reference	3.19	3.19	---	PASS
			30~1000	30~1000	-67.302	<=-26.809	PASS
			1000~26500	1000~26500	-47.056	<=-26.809	PASS
		MCH	Reference	1.99	1.99	---	PASS
			30~1000	30~1000	-67.881	<=-28.009	PASS
			1000~26500	1000~26500	-48.578	<=-28.009	PASS
		HCH	Reference	2.09	2.09	---	PASS
			30~1000	30~1000	-68.17	<=-27.913	PASS
			1000~26500	1000~26500	-47.913	<=-27.913	PASS
BLE	2M	LCH	Reference	3.28	3.28	---	PASS
			30~1000	30~1000	-66.882	<=-26.724	PASS
			1000~26500	1000~26500	-47.701	<=-26.724	PASS
		MCH	Reference	2.83	2.83	---	PASS
			30~1000	30~1000	-67.009	<=-27.174	PASS
			1000~26500	1000~26500	-48.407	<=-27.174	PASS
		HCH	Reference	2.87	2.87	---	PASS
			30~1000	30~1000	-67.379	<=-27.132	PASS
			1000~26500	1000~26500	-48.819	<=-27.132	PASS

Conducted Spurious Emission Plot

1M

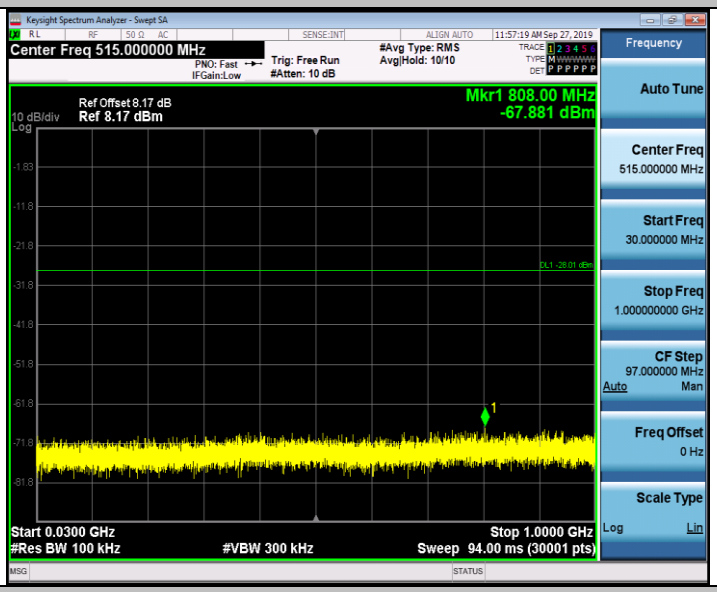
BLE_ Ant1_2402_0~Reference

BLE_ Ant1_2402_30~1000

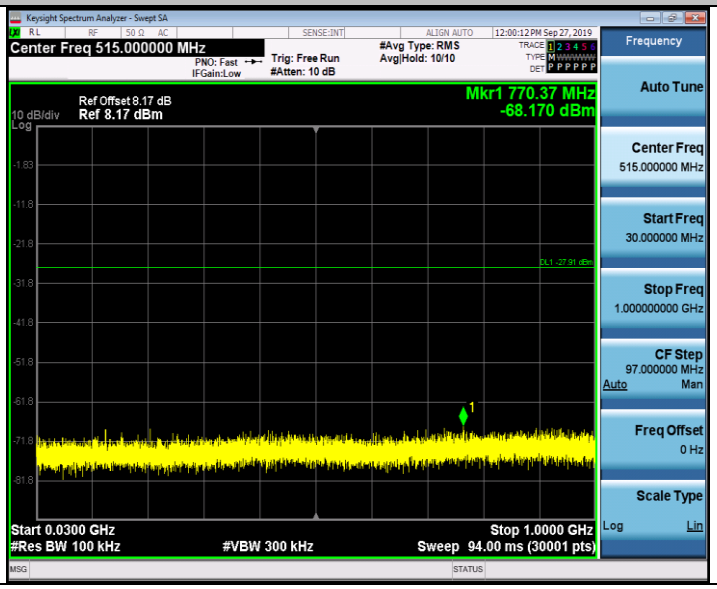


BLE_ Ant1_2402_1000~26500

BLE_ Ant1_2440_0~Reference


BLE_ Ant1_2440_30~1000

BLE_ Ant1_2440_1000~26500

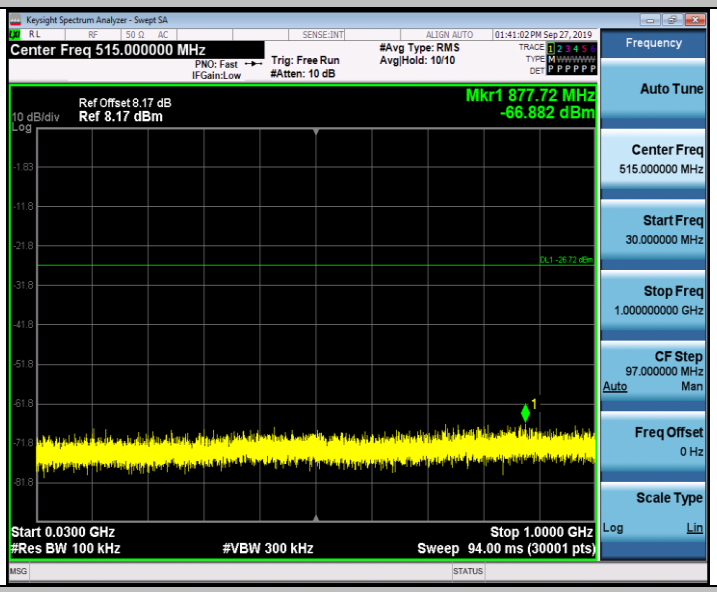

BLE_ Ant1_2480_0~Reference

BLE_ Ant1_2480_30~1000


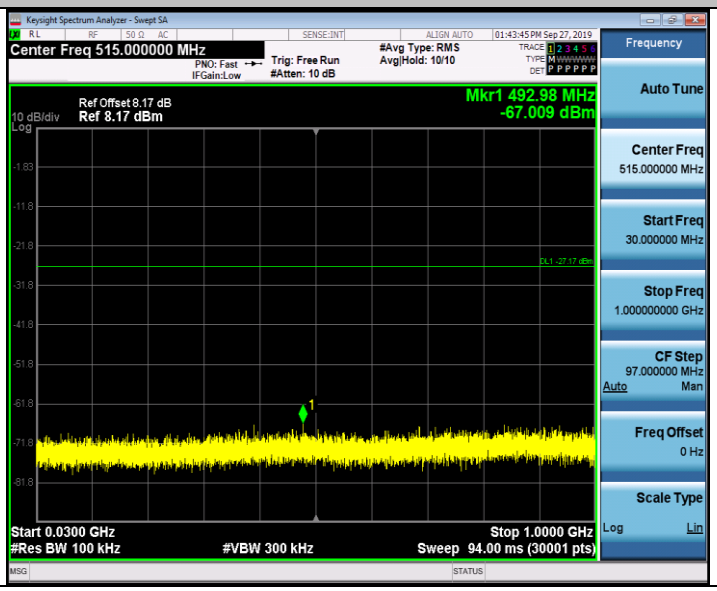
BLE_ Ant1_2480_1000~26500


2M

BLE_ Ant1_2402_0~Reference

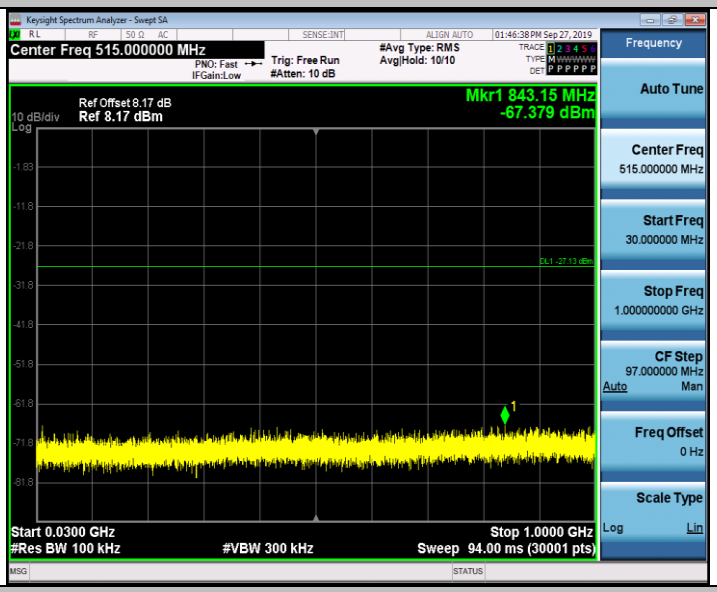

BLE_ Ant1_2402_30~1000

BLE_ Ant1_2402_1000~26500


BLE_ Ant1_2440_0~Reference

BLE_ Ant1_2440_30~1000


BLE_ Ant1_2440_1000~26500

BLE_ Ant1_2480_0~Reference


BLE_ Ant1_2480_30~1000

BLE_ Ant1_2480_1000~26500


4.5 Radiated Band Edges and Spurious Emission Measurement

4.5.1 Limit of Radiated Band Edges and Spurious Emission

FCC §15.247 (d)

IC RSS-247 5.5

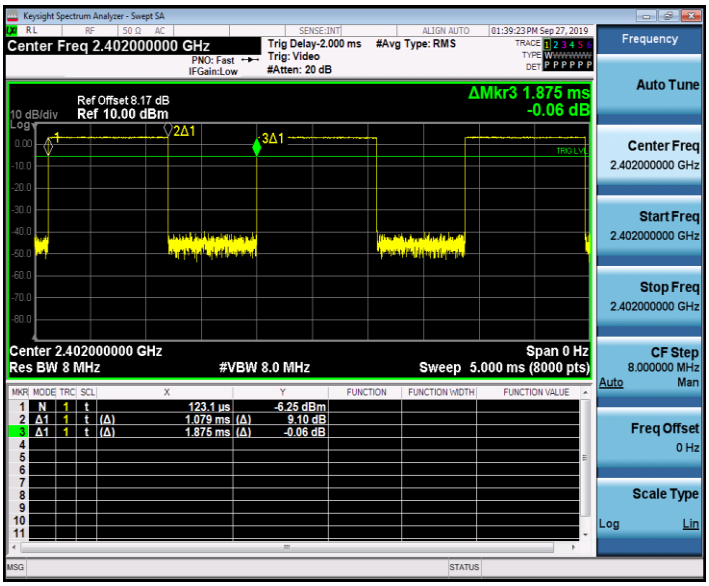
In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as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

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
BLE 2M	57.53	1.08	0.926	1KHz



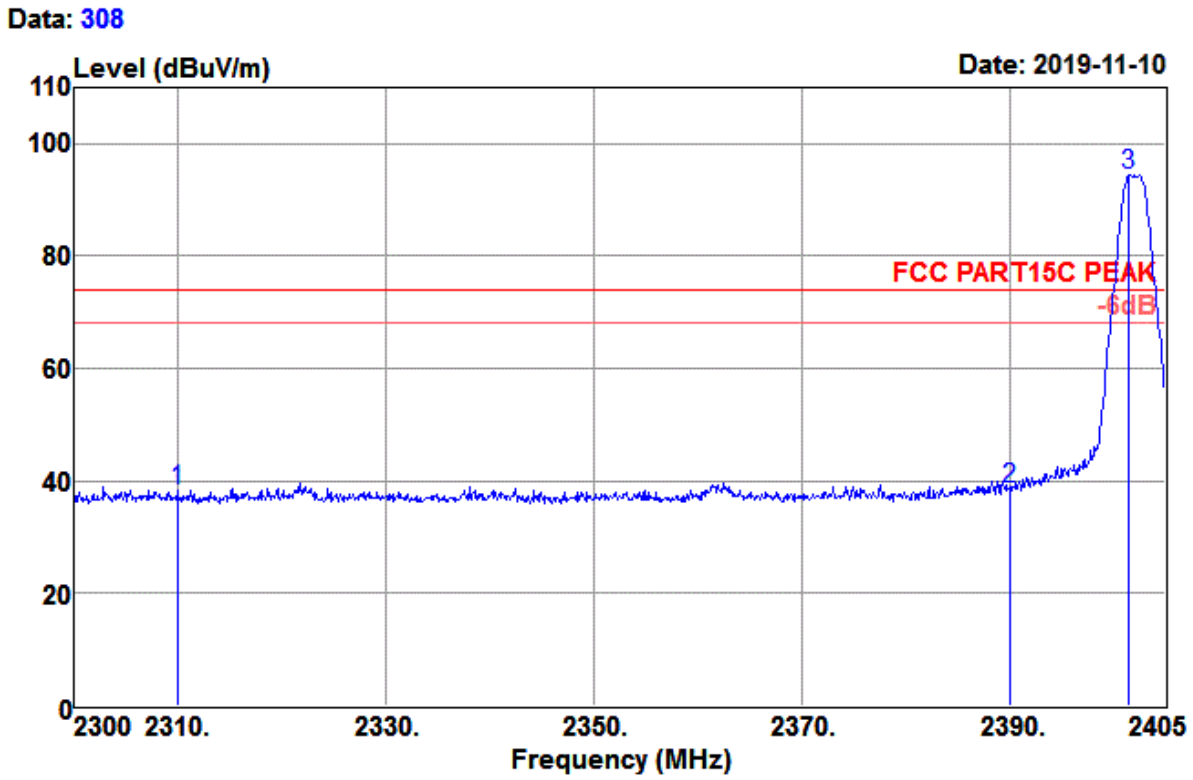
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

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.

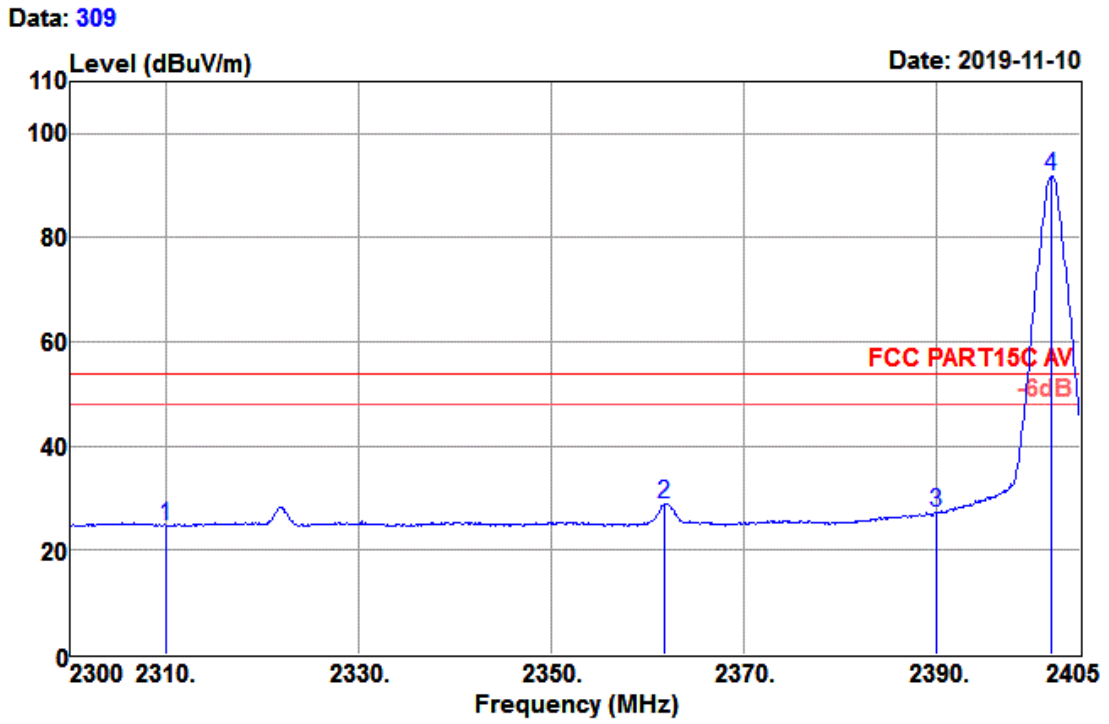
4.5.4 Test Result of Radiated Spurious at Band Edges

Test Mode :	BLE CH00 (2402 MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	2.3GHz~2.405GHz	**Polarization :**	Horizontal



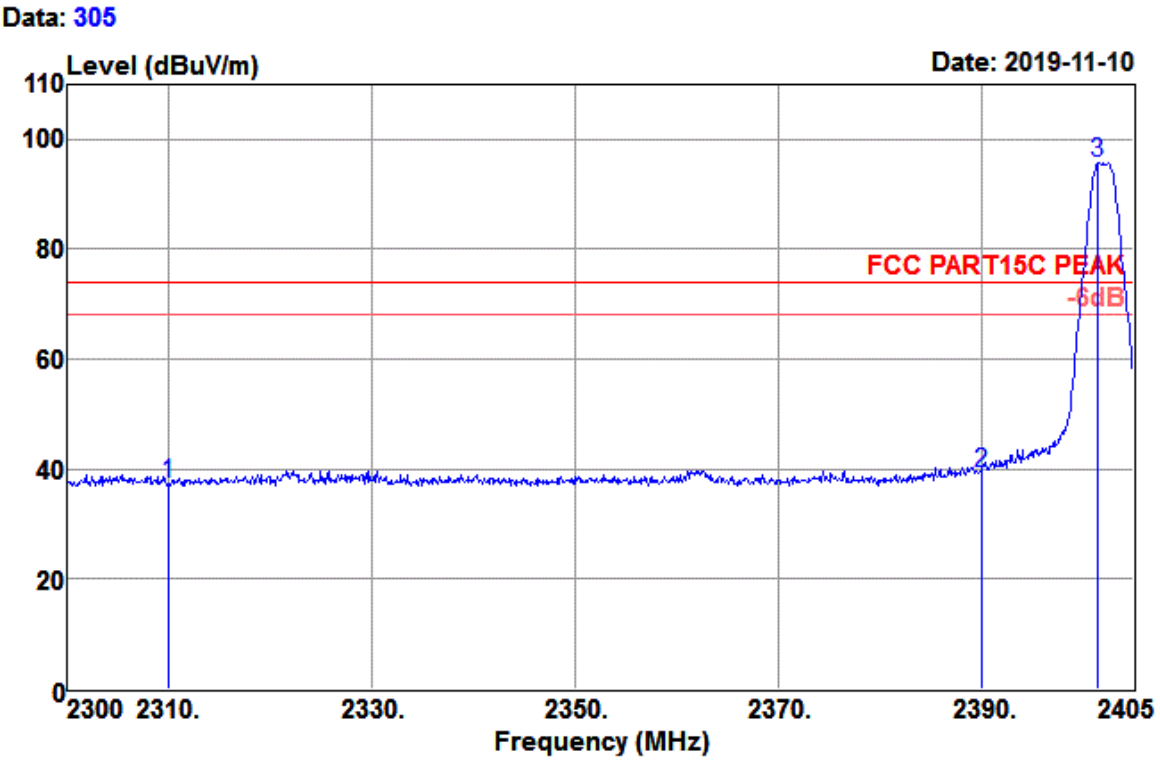
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	43.40	26.91	3.48	35.43	38.36	74.00	-35.64	Peak
2390.000	43.59	27.11	3.53	35.55	38.68	74.00	-35.32	Peak
2401.535	99.22	27.14	3.54	35.56	94.34	74.00	20.34	Peak

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Horizontal



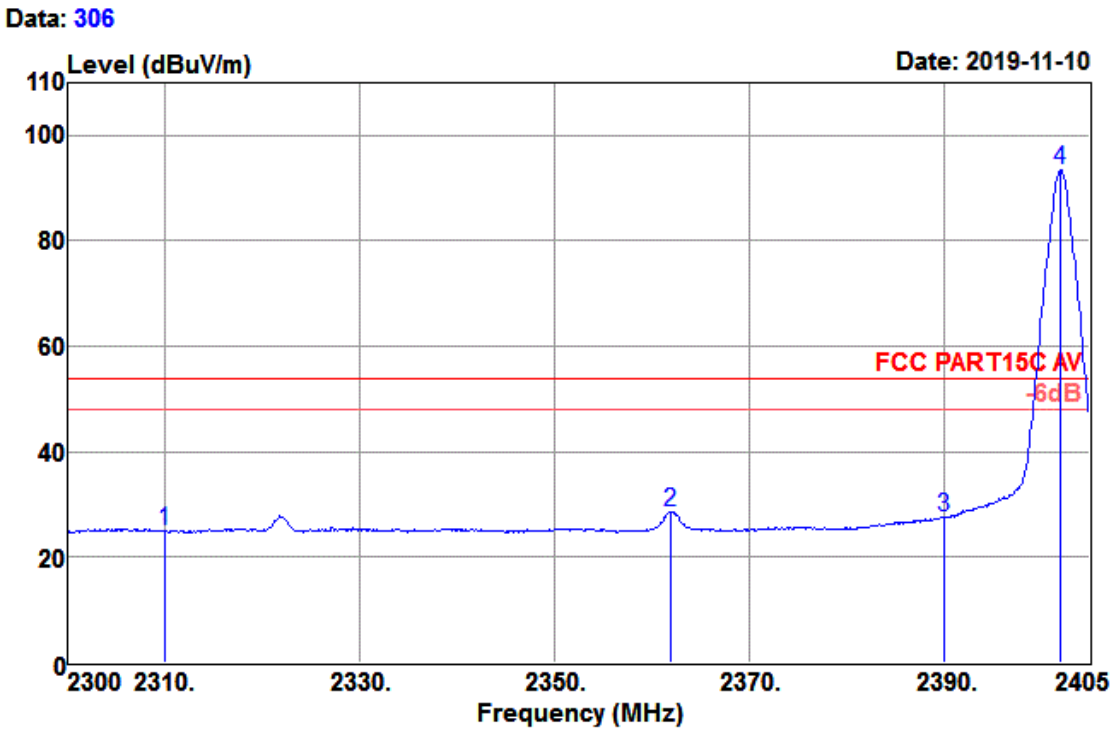
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	29.80	26.91	3.48	35.43	24.76	54.00	-29.24	Average
2361.845	33.86	27.04	3.51	35.51	28.90	54.00	-25.10	Average
2390.000	32.18	27.11	3.53	35.55	27.27	54.00	-26.73	Average
2402.060	96.72	27.15	3.54	35.56	91.85	54.00	37.85	Average

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical



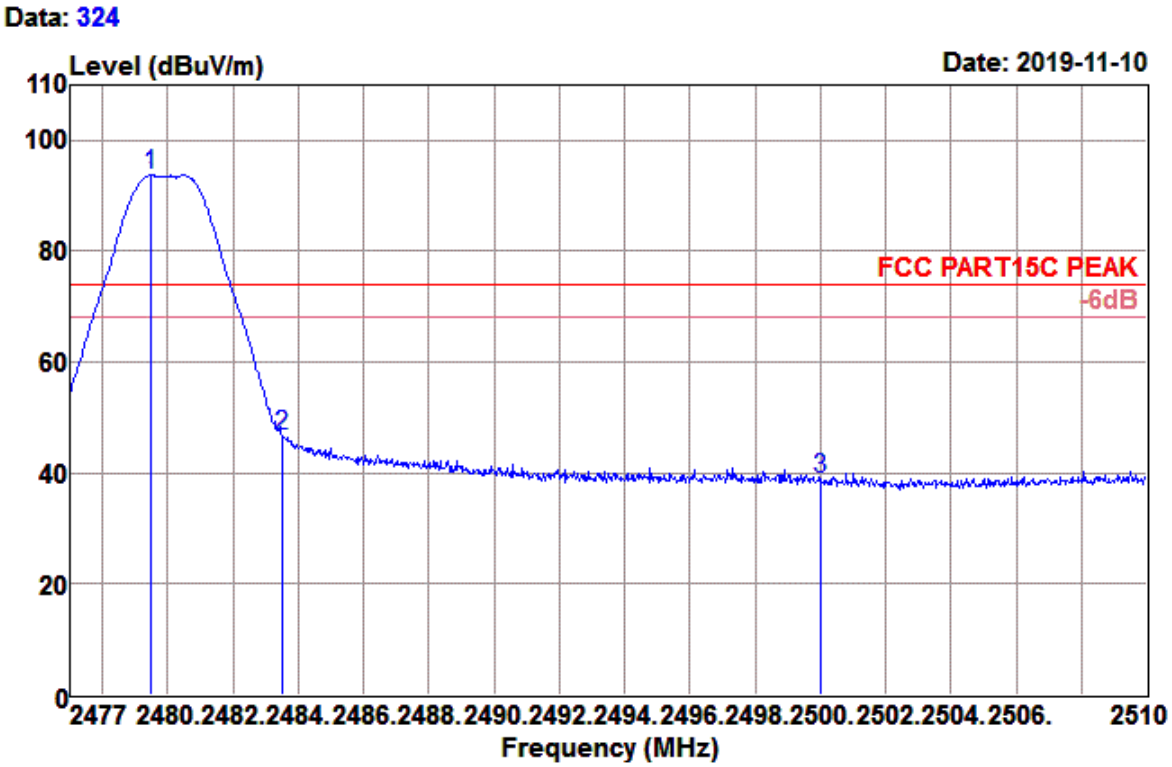
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	42.42	26.91	3.48	35.43	37.38	74.00	-36.62	Peak
2390.000	44.20	27.11	3.53	35.55	39.29	74.00	-34.71	Peak
2401.535	100.52	27.14	3.54	35.56	95.64	74.00	21.64	Peak

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical



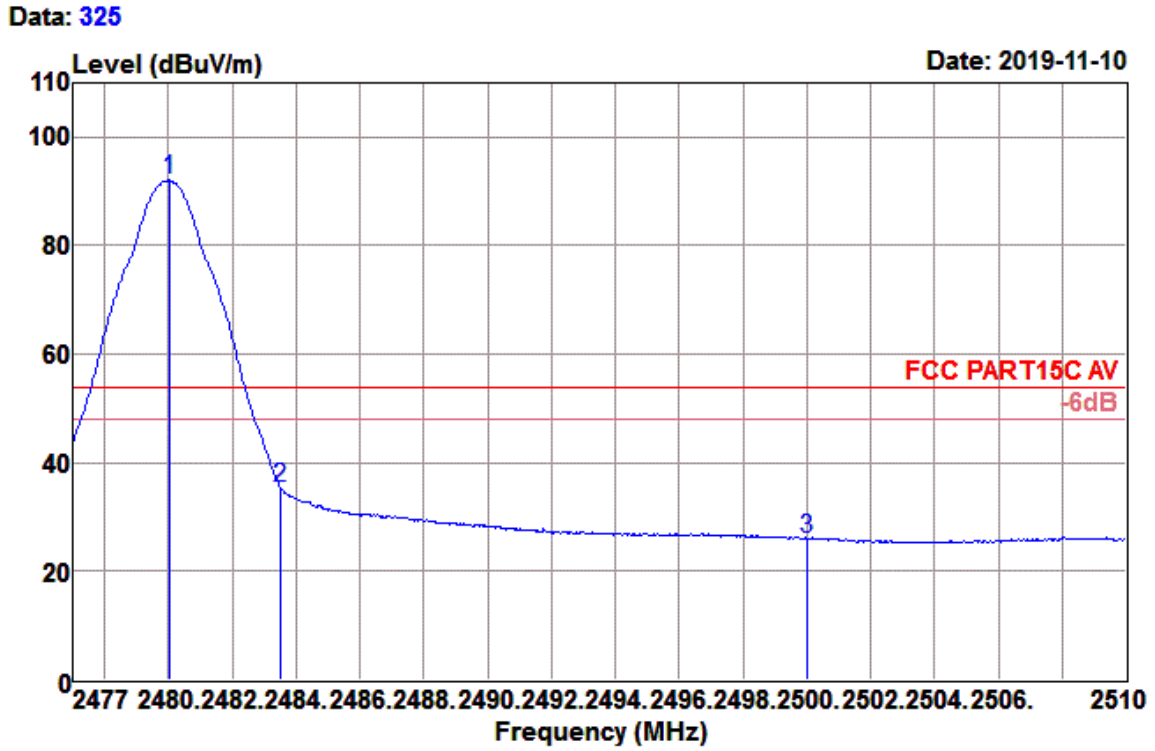
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	30.04	26.91	3.48	35.43	25.00	54.00	-29.00	Average
2362.055	33.62	27.04	3.51	35.51	28.66	54.00	-25.34	Average
2390.000	32.36	27.11	3.53	35.55	27.45	54.00	-26.55	Average
2402.060	98.33	27.15	3.54	35.56	93.46	54.00	39.46	Average

Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Horizontal



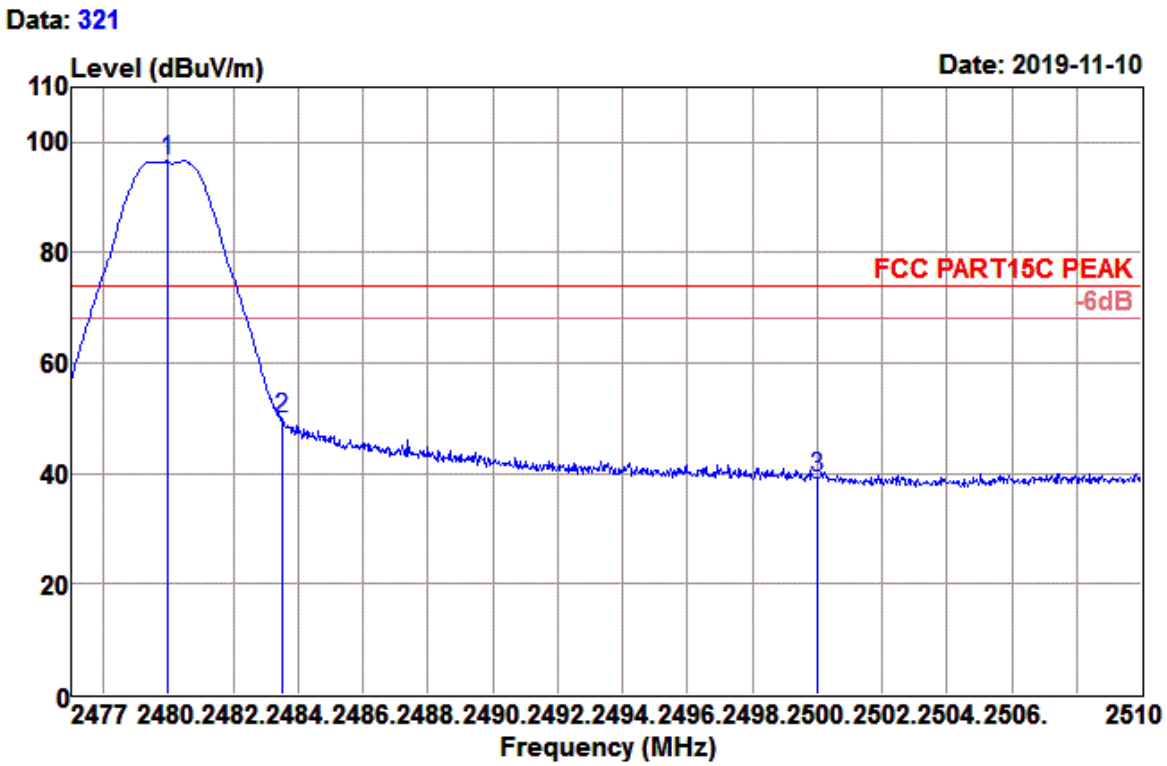
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.475	98.47	27.35	3.59	35.67	93.74	74.00	19.74	Peak
2483.500	51.56	27.36	3.59	35.68	46.83	74.00	-27.17	Peak
2500.000	43.61	27.40	3.60	35.70	38.91	74.00	-35.09	Peak

Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Horizontal



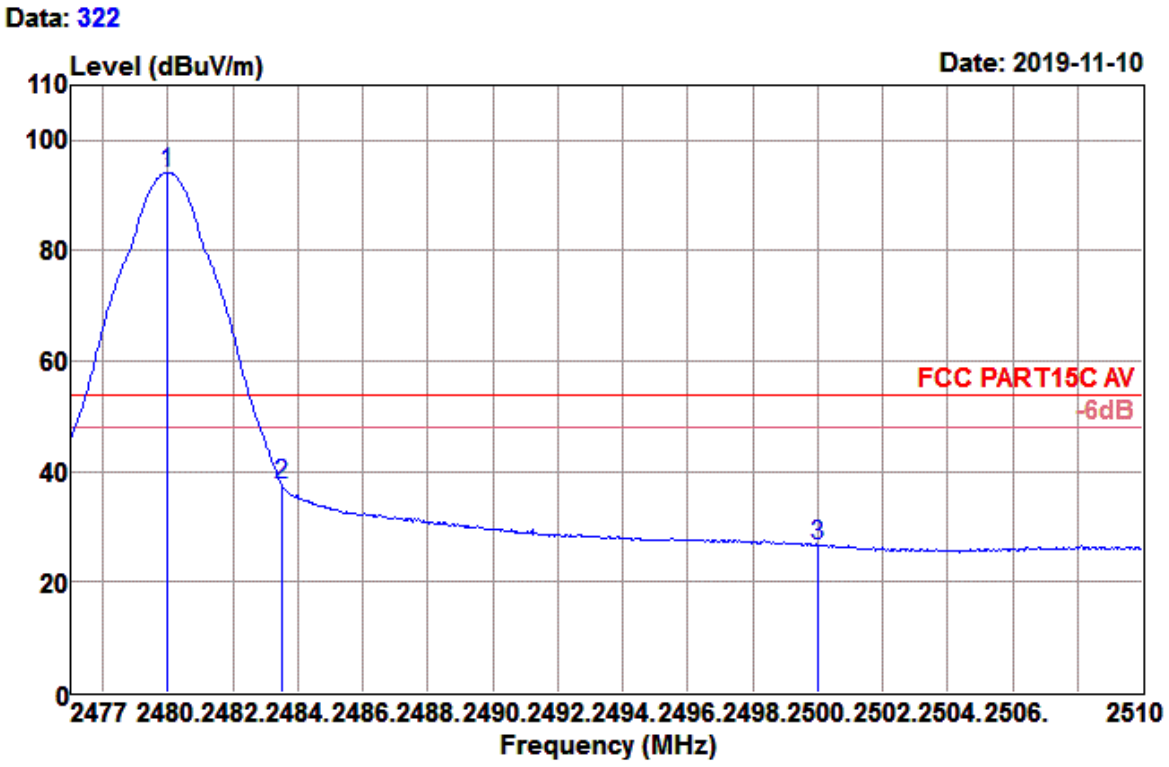
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2480.036	96.76	27.35	3.59	35.67	92.03	54.00	38.03	Average
2483.500	40.20	27.36	3.59	35.68	35.47	54.00	-18.53	Average
2500.000	30.70	27.40	3.60	35.70	26.00	54.00	-28.00	Average

Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Vertical



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.970	101.38	27.35	3.59	35.67	96.65	74.00	22.65	Peak
2483.500	54.85	27.36	3.59	35.68	50.12	74.00	-23.88	Peak
2500.000	43.93	27.40	3.60	35.70	39.23	74.00	-34.77	Peak

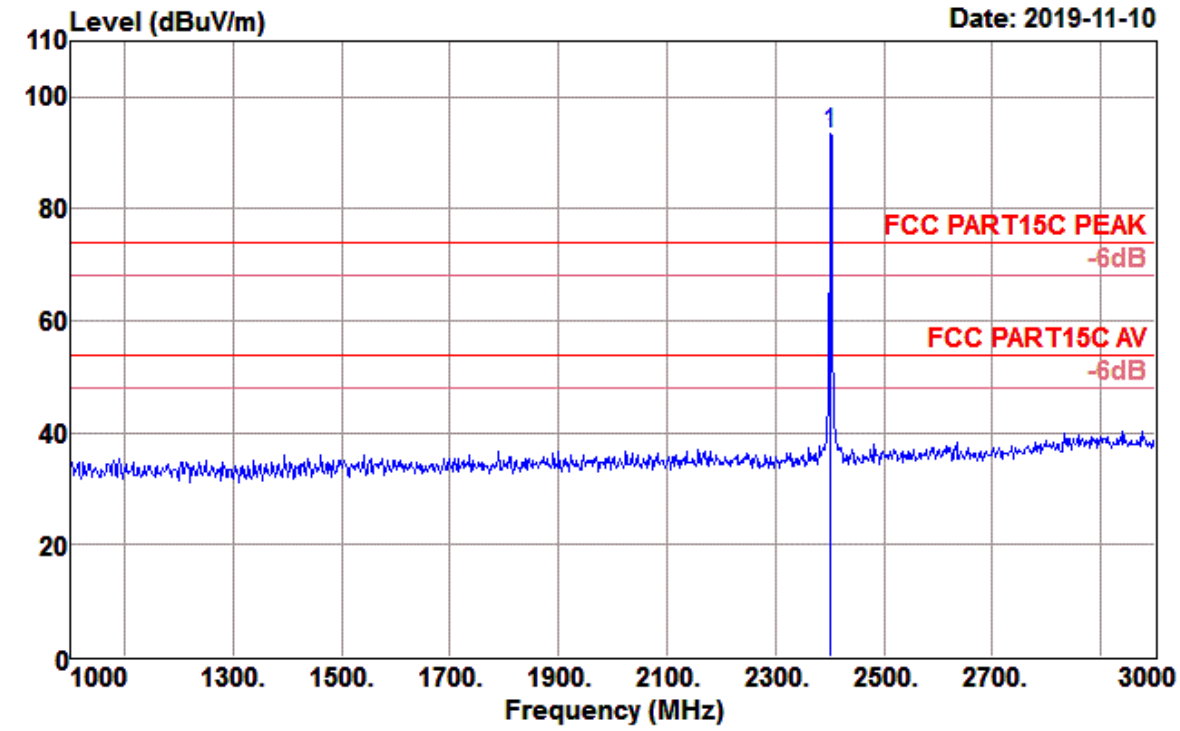
Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Vertical



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2480.003	98.88	27.35	3.59	35.67	94.15	54.00	40.15	Average
2483.500	42.34	27.36	3.59	35.68	37.61	54.00	-16.39	Average
2500.000	31.31	27.40	3.60	35.70	26.61	54.00	-27.39	Average

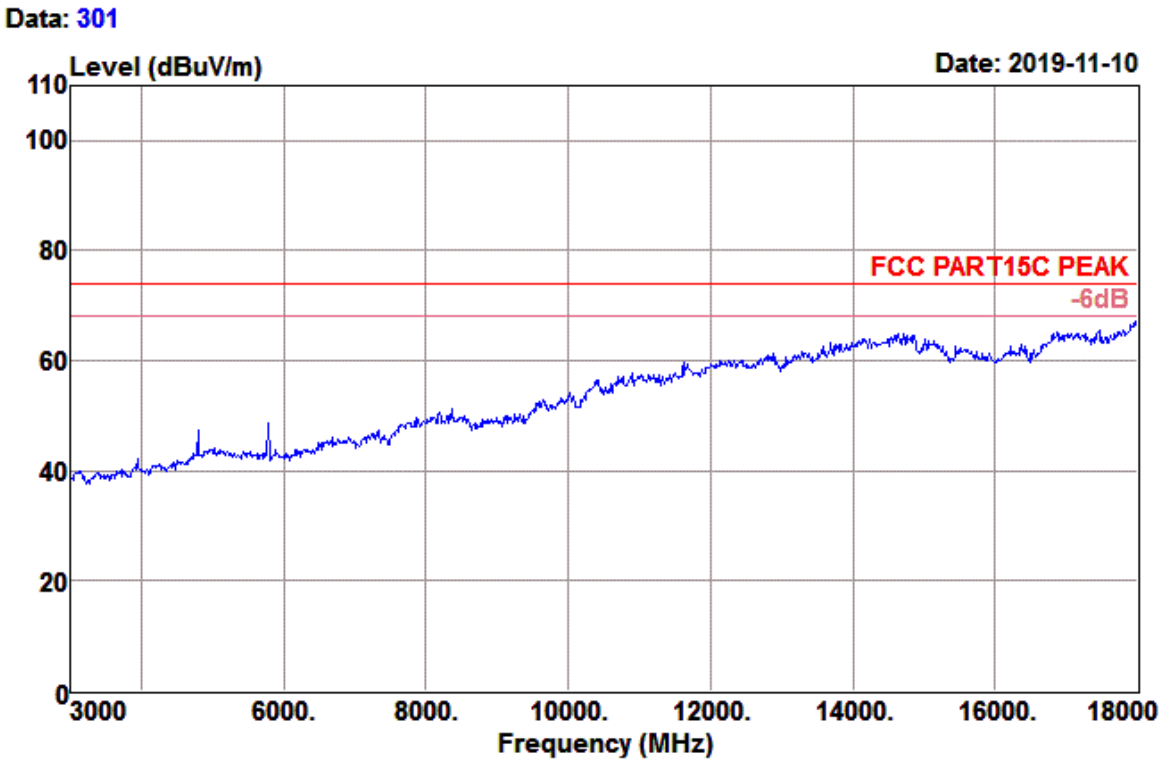
4.5.5 Test Result of Radiated Spurious Emission (1GHz ~ 10th Harmonic)

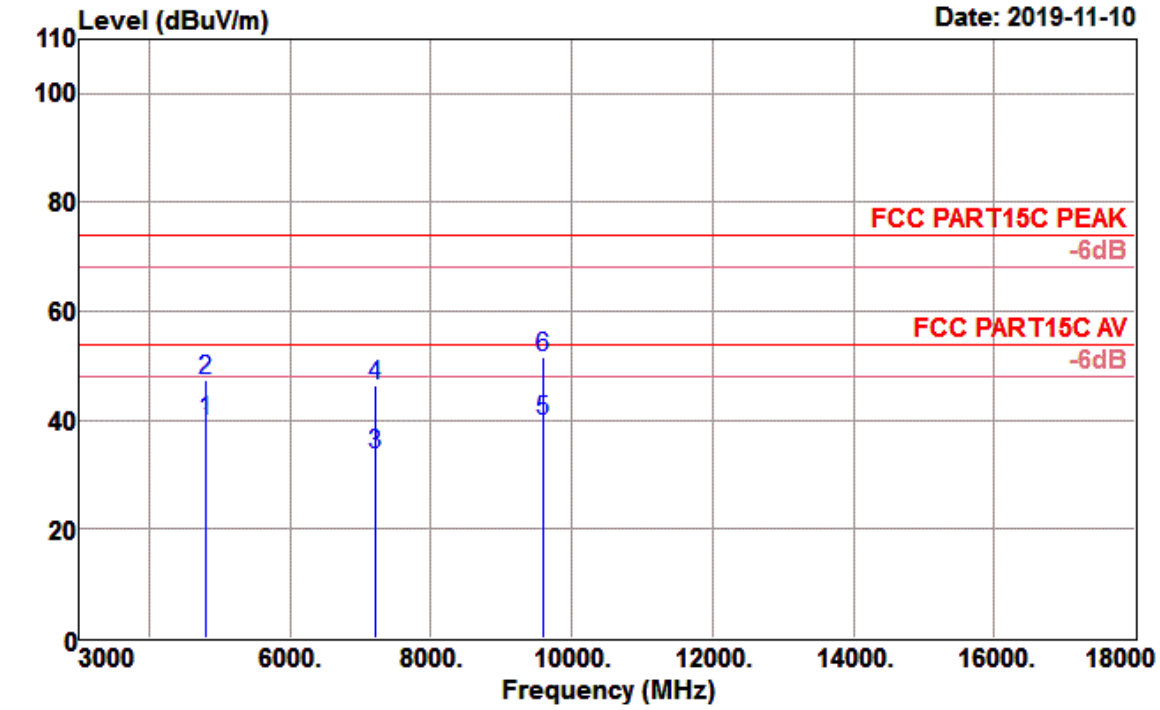
Test Mode :	BLE CH00 (2402 MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	1GHz~3GHz	**Polarization :**	Horizontal



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2402.000	98.35	27.15	3.54	35.56	93.48	74.00	19.48	Peak

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal

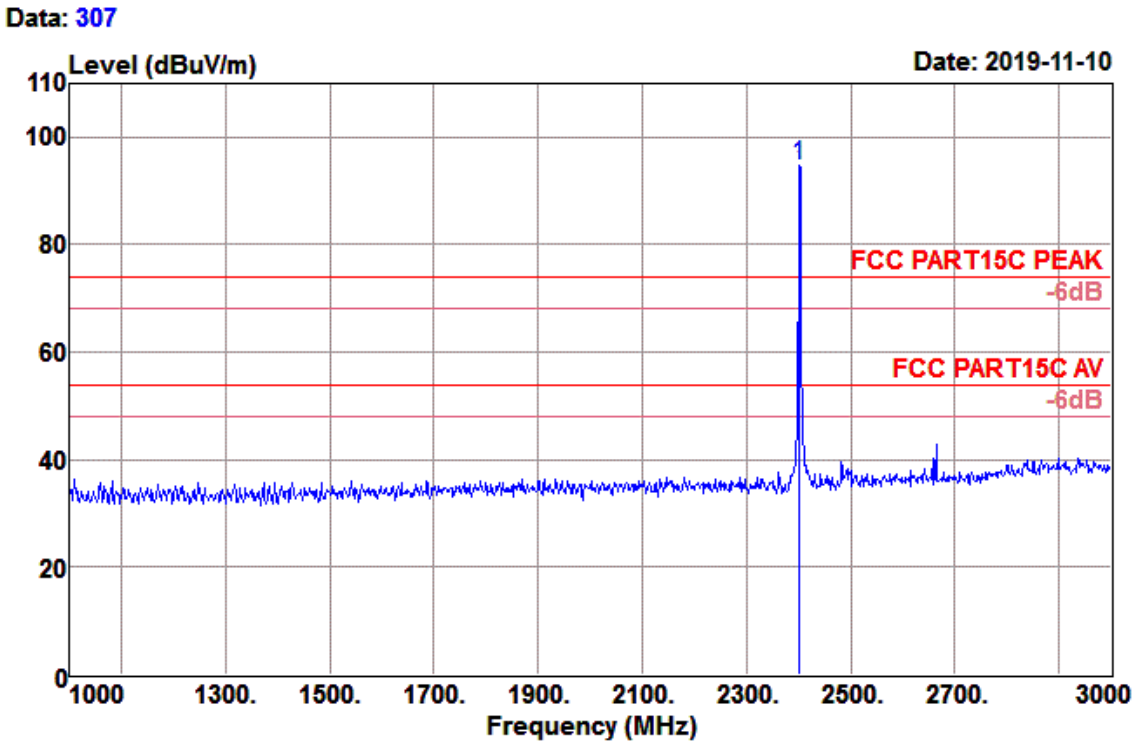




Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
4804.000	38.08	31.23	5.57	34.86	40.02	54.00	-13.98	Average
4804.000	45.46	31.23	5.57	34.86	47.40	74.00	-26.60	Peak
7206.000	26.75	35.87	7.63	36.40	33.85	54.00	-20.15	Average
7206.000	39.40	35.87	7.63	36.40	46.50	74.00	-27.50	Peak
9608.000	28.09	37.79	10.29	36.40	39.77	54.00	-14.23	Average
9608.000	40.05	37.79	10.29	36.40	51.73	74.00	-22.27	Peak

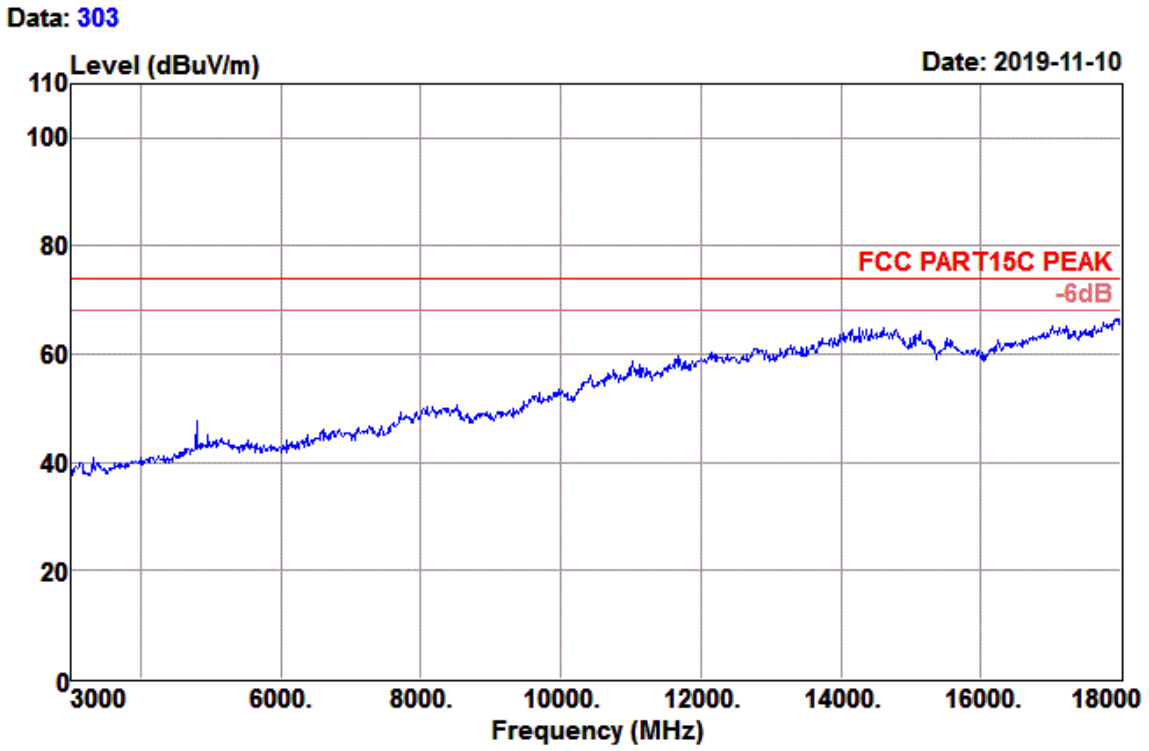
Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

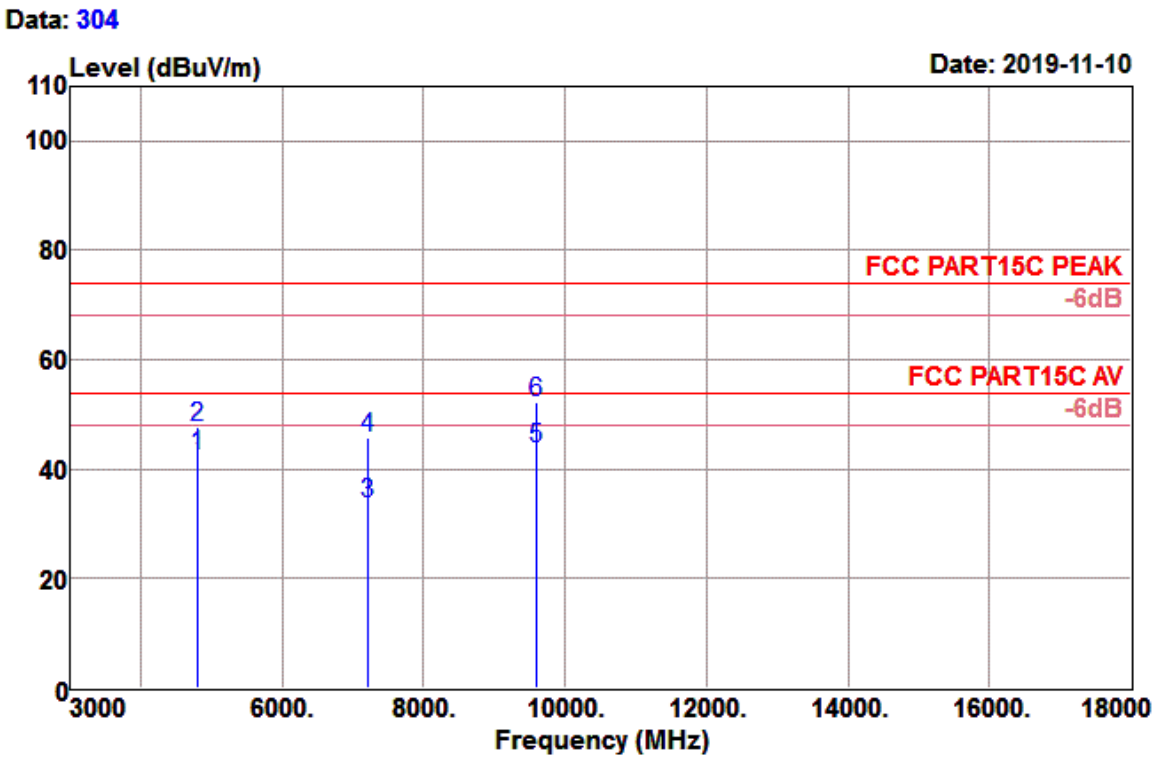
Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2402.000	99.50	27.15	3.54	35.56	94.63	74.00	20.63	Peak

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical

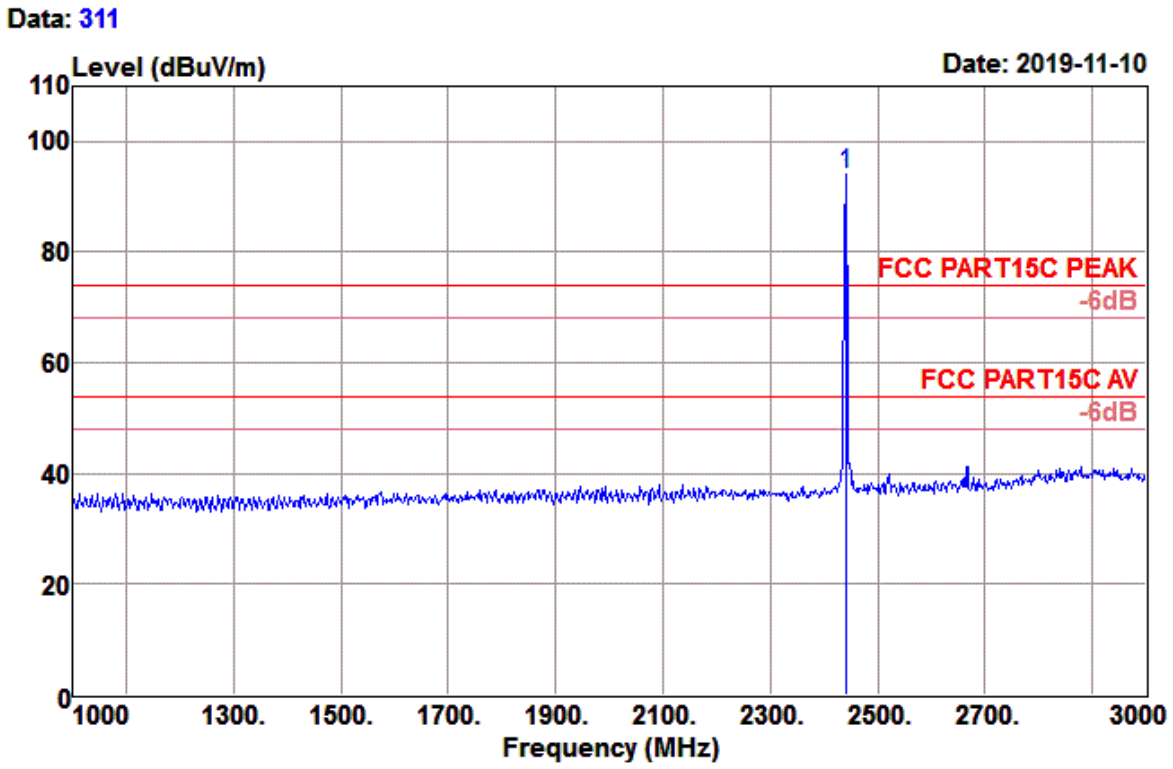




Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
4804.000	40.43	31.23	5.57	34.86	42.37	54.00	-11.63	Average
4804.000	45.72	31.23	5.57	34.86	47.66	74.00	-26.34	Peak
7206.000	26.57	35.87	7.63	36.40	33.67	54.00	-20.33	Average
7206.000	38.81	35.87	7.63	36.40	45.91	74.00	-28.09	Peak
9608.000	32.13	37.79	10.29	36.40	43.81	54.00	-10.19	Average
9608.000	40.50	37.79	10.29	36.40	52.18	74.00	-21.82	Peak

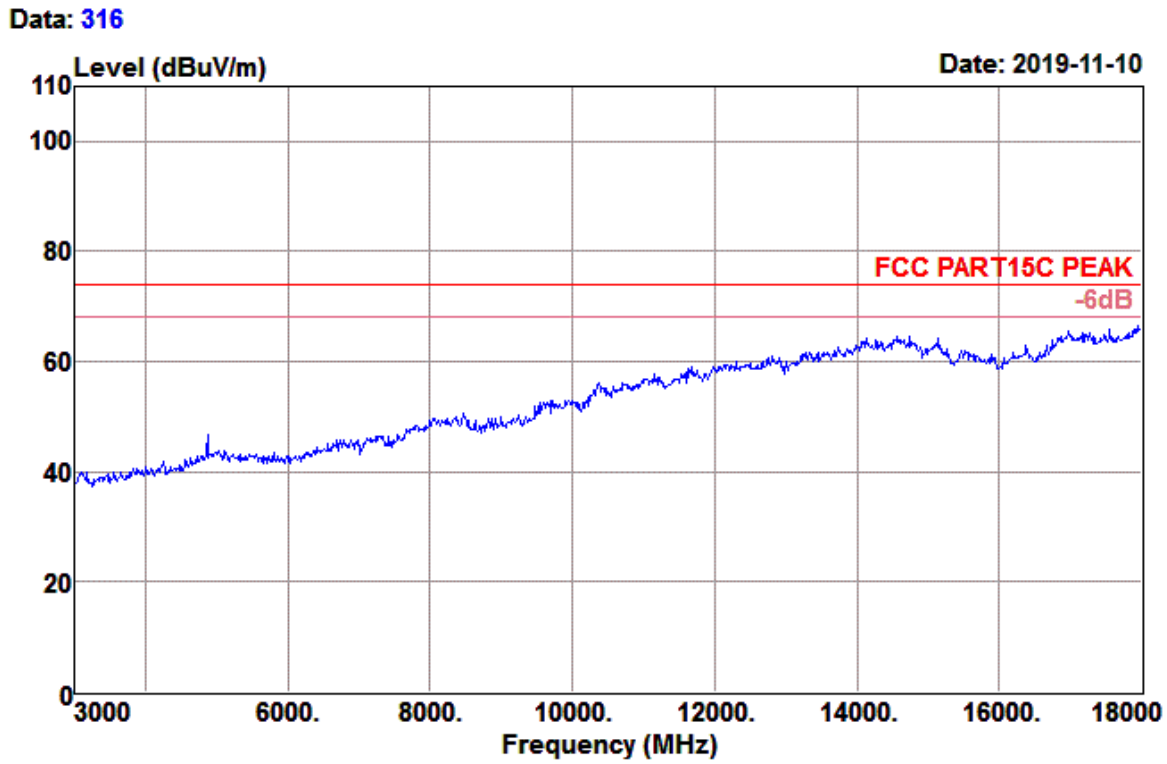
Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

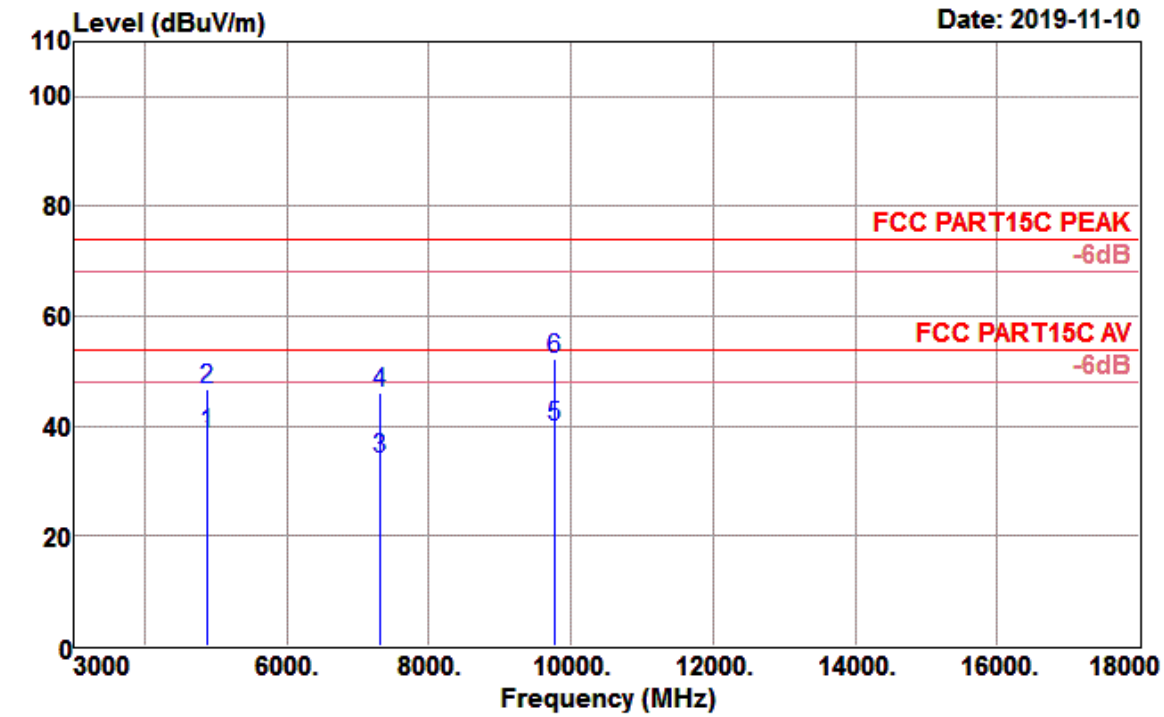
Test Mode :	BLE CH19 (2440 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2440.000	98.78	27.24	3.56	35.62	93.96	74.00	19.96	Peak

Test Mode :	BLE CH19 (2440 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal

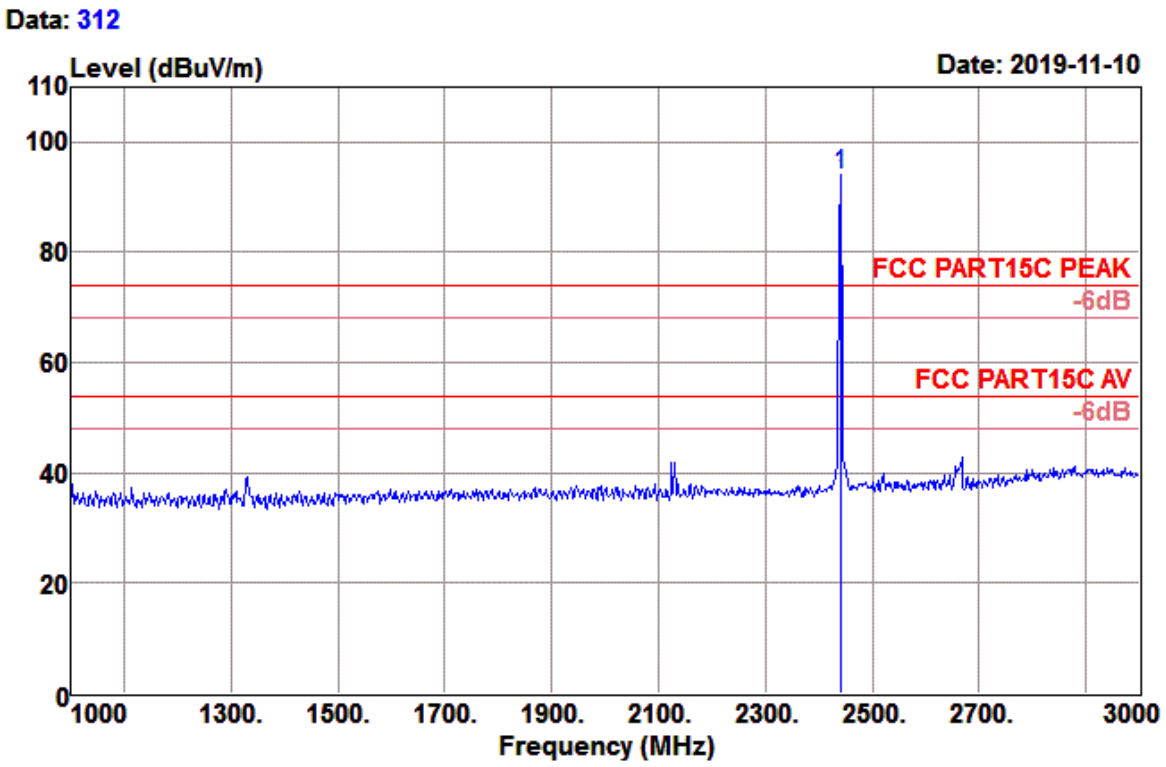




Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4880.000	36.40	31.41	5.55	34.80	38.56	54.00	-15.44	Average
4880.000	44.44	31.41	5.55	34.80	46.60	74.00	-27.40	Peak
7320.000	26.91	36.14	7.53	36.40	34.18	54.00	-19.82	Average
7320.000	38.71	36.14	7.53	36.40	45.98	74.00	-28.02	Peak
9760.000	27.68	38.07	10.73	36.40	40.08	54.00	-13.92	Average
9760.000	40.01	38.07	10.73	36.40	52.41	74.00	-21.59	Peak

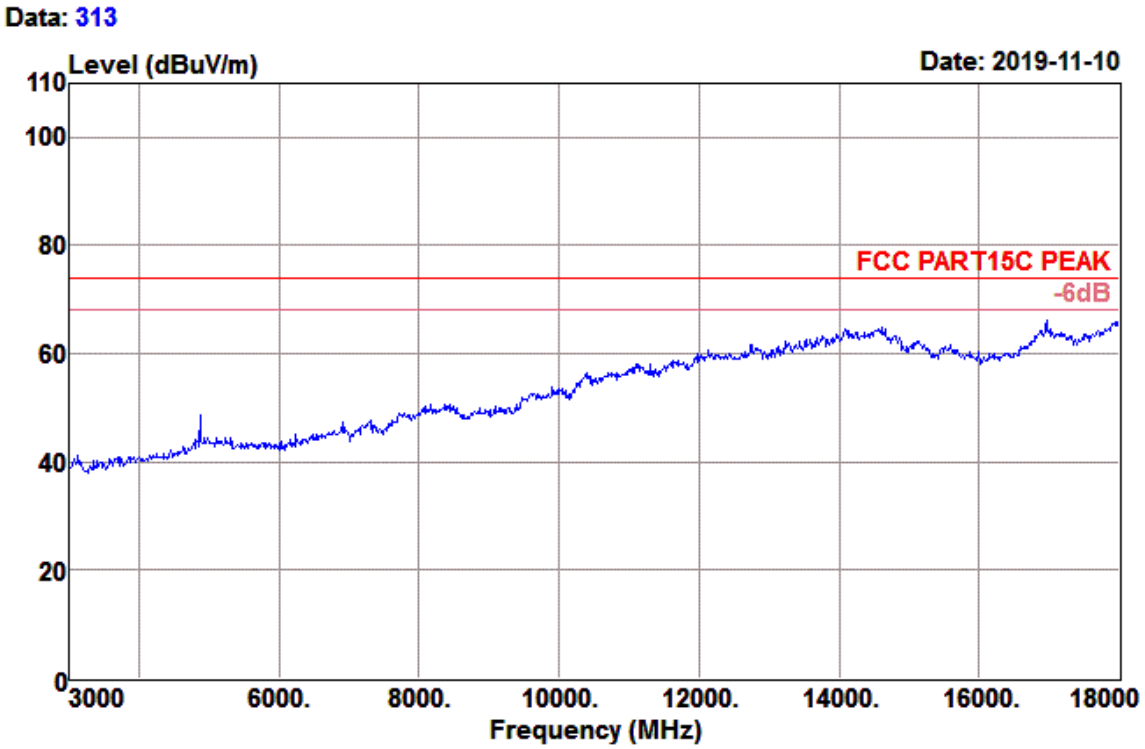
Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

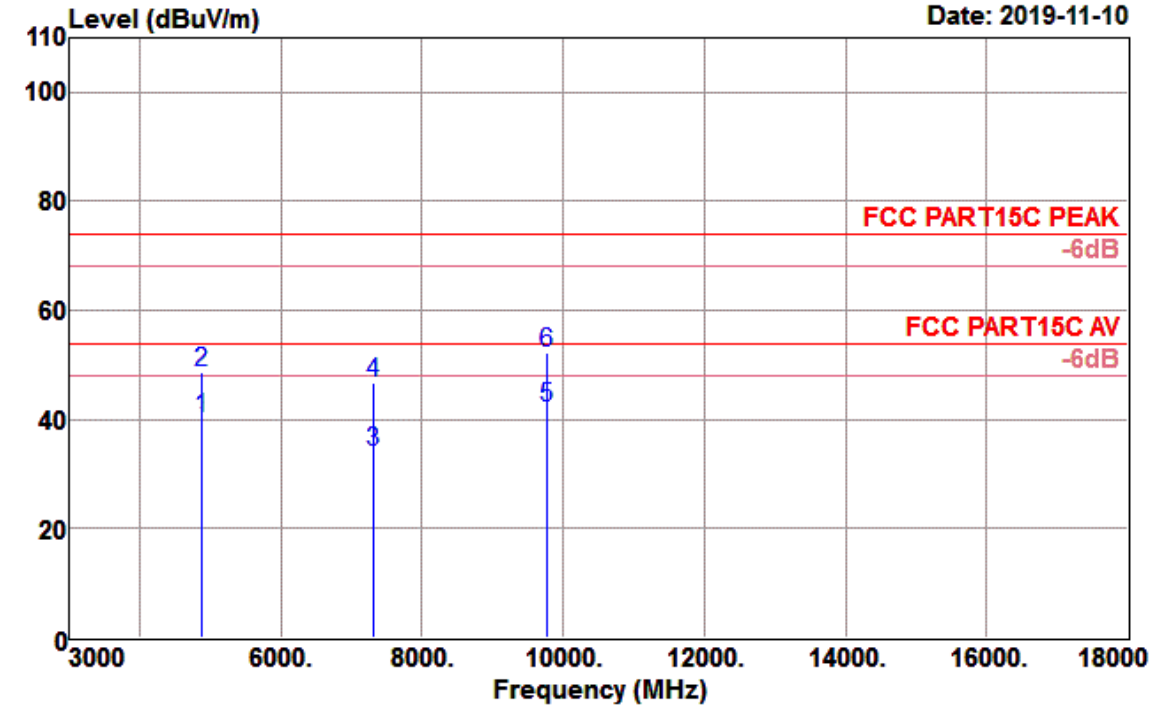
Test Mode :	BLE CH19 (2440 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2440.000	98.78	27.24	3.56	35.62	93.96	74.00	19.96	Peak

Test Mode :	BLE CH19 (2440 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical

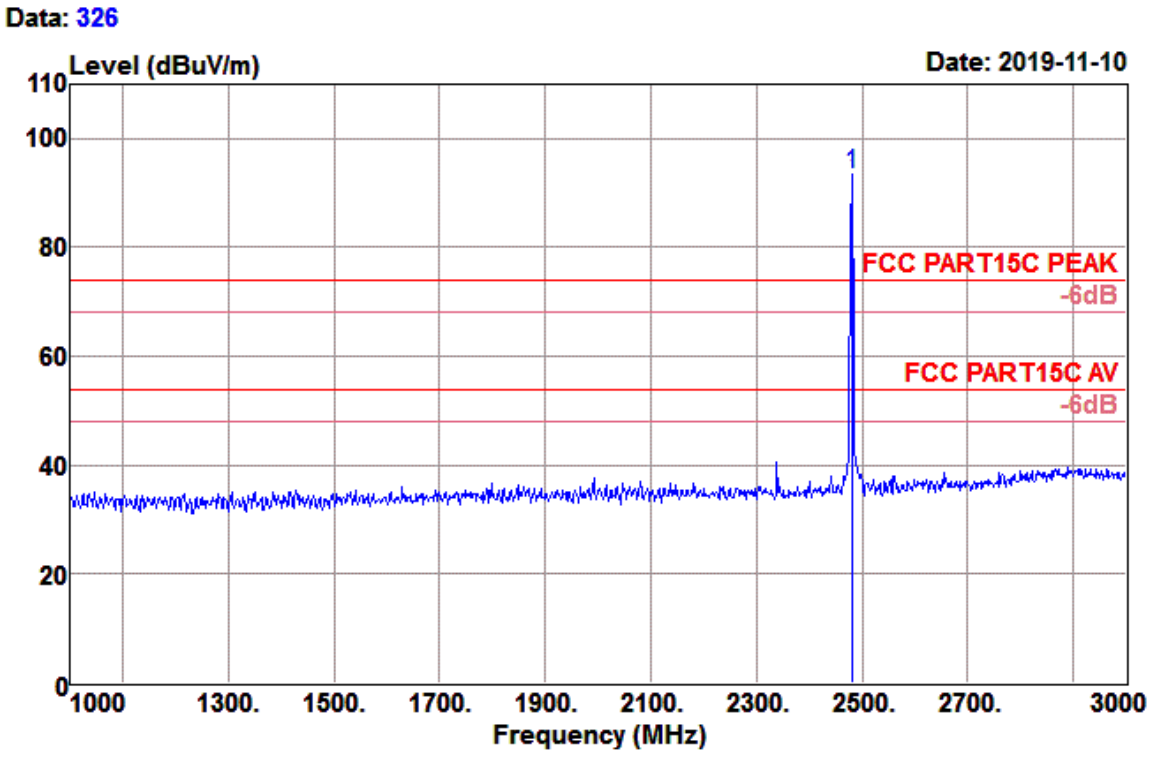




Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
4880.000	38.05	31.41	5.55	34.80	40.21	54.00	-13.79	Average
4880.000	46.57	31.41	5.55	34.80	48.73	74.00	-25.27	Peak
7320.000	26.70	36.14	7.53	36.40	33.97	54.00	-20.03	Average
7320.000	39.57	36.14	7.53	36.40	46.84	74.00	-27.16	Peak
9760.000	29.81	38.07	10.73	36.40	42.21	54.00	-11.79	Average
9760.000	39.91	38.07	10.73	36.40	52.31	74.00	-21.69	Peak

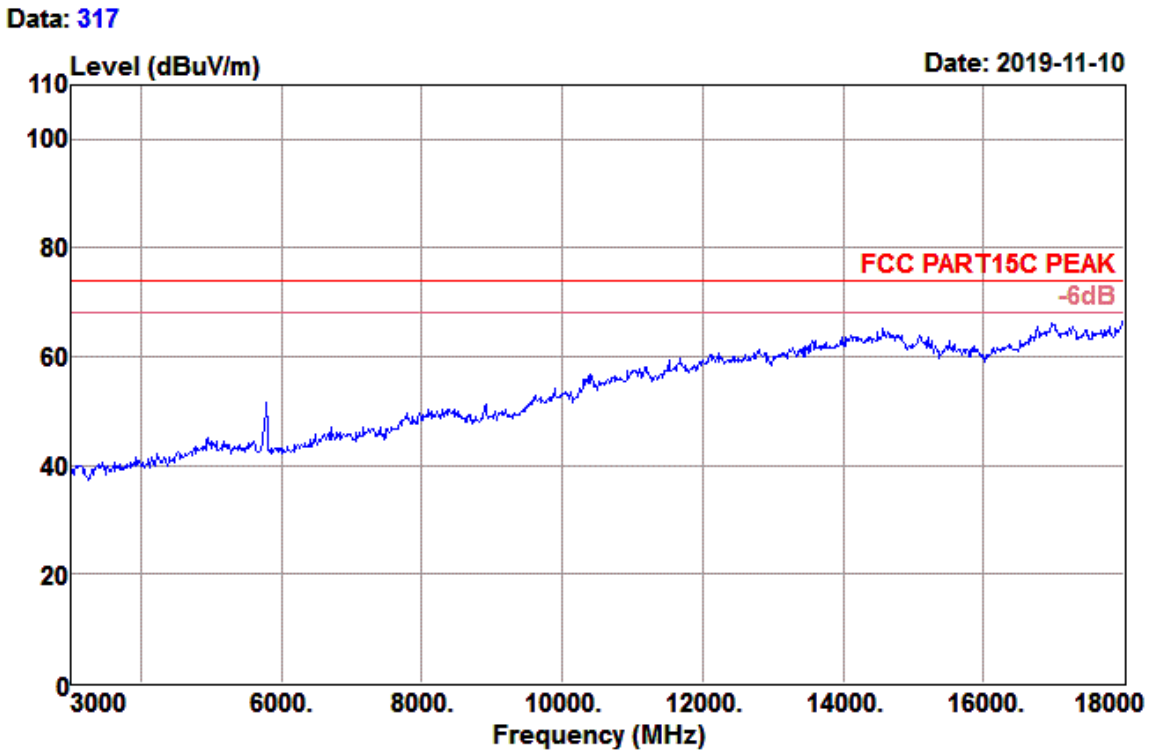
Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

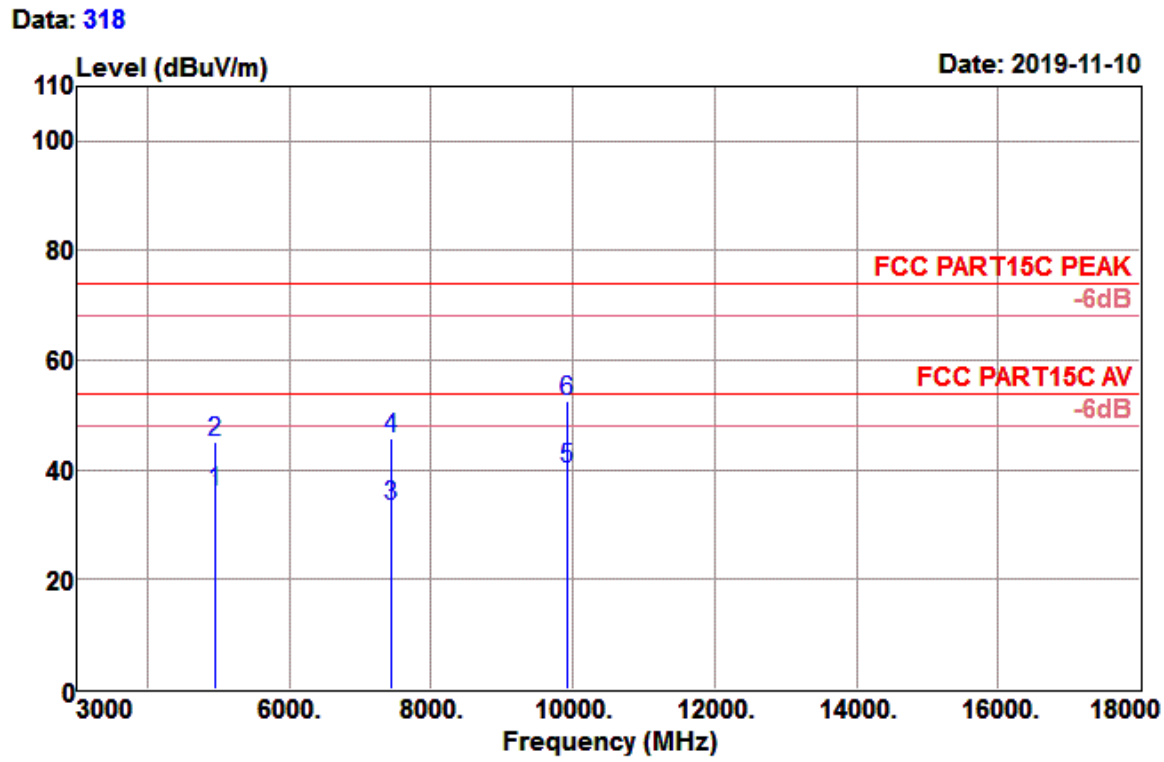
Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2480.000	98.33	27.35	3.59	35.67	93.60	74.00	19.60	Peak

Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal

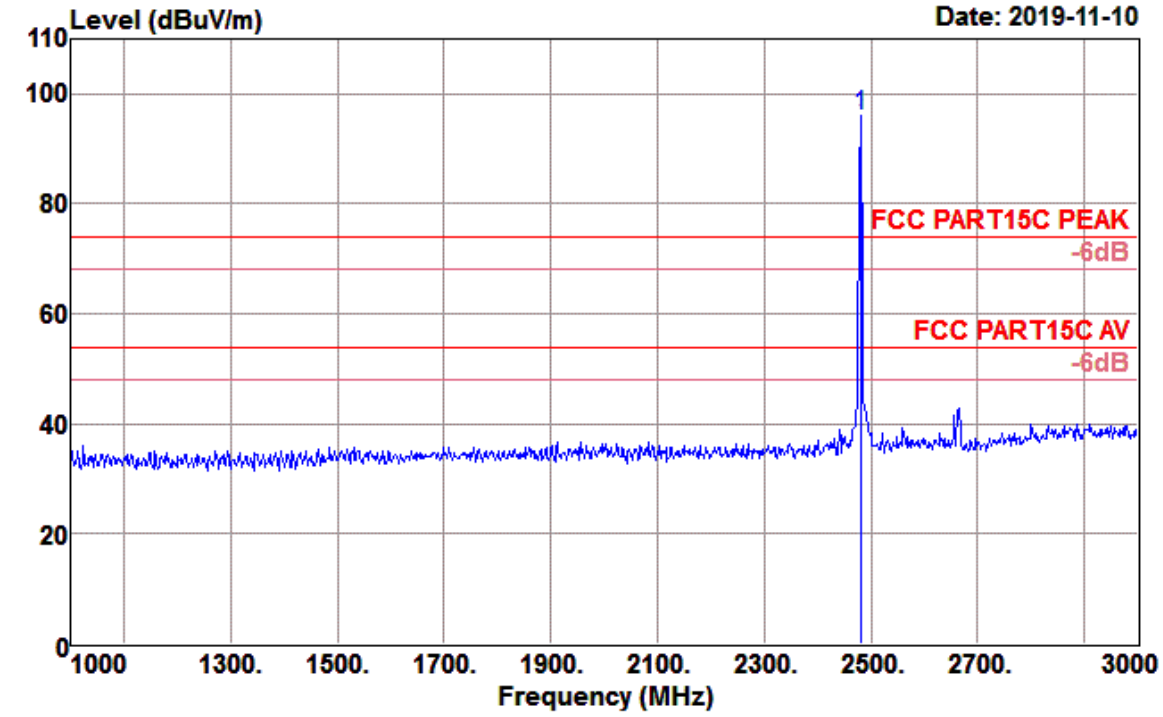




Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4960.000	33.54	31.60	5.52	34.73	35.93	54.00	-18.07	Average
4960.000	42.57	31.60	5.52	34.73	44.96	74.00	-29.04	Peak
7440.000	25.79	36.41	7.56	36.40	33.36	54.00	-20.64	Average
7440.000	38.21	36.41	7.56	36.40	45.78	74.00	-28.22	Peak
9920.000	27.10	38.36	11.17	36.40	40.23	54.00	-13.77	Average
9920.000	39.49	38.36	11.17	36.40	52.62	74.00	-21.38	Peak

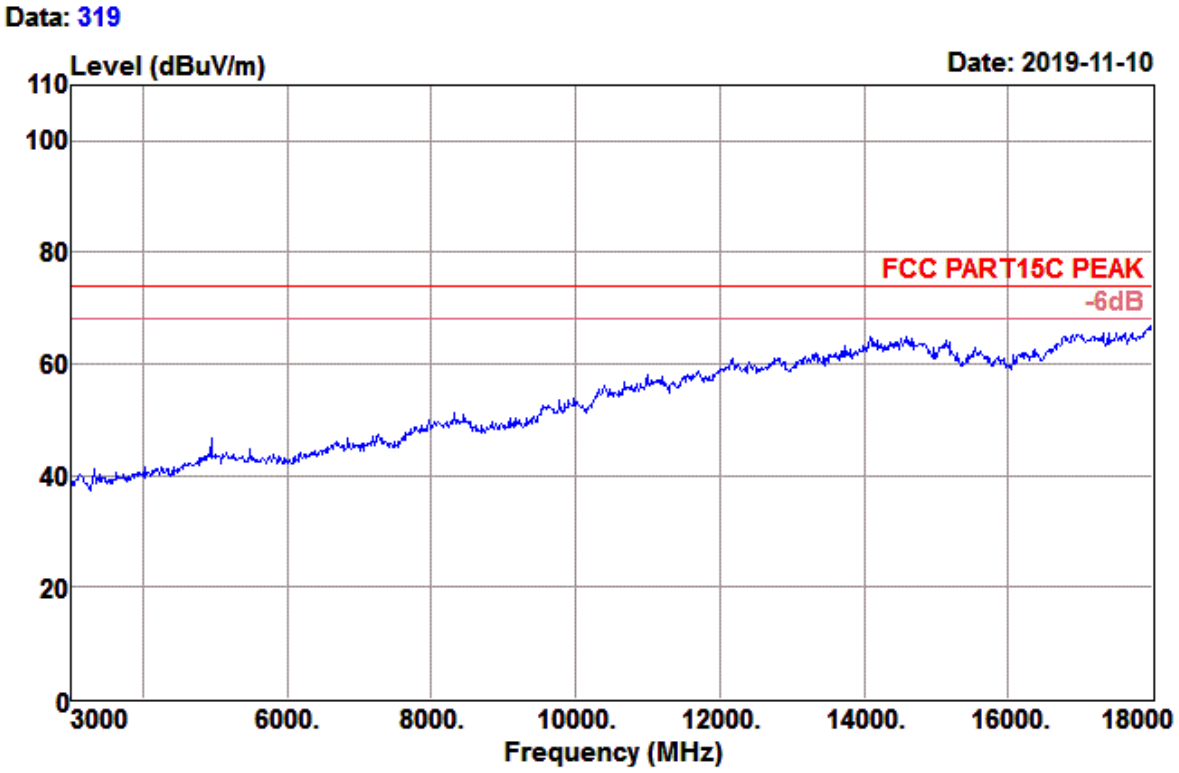
Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

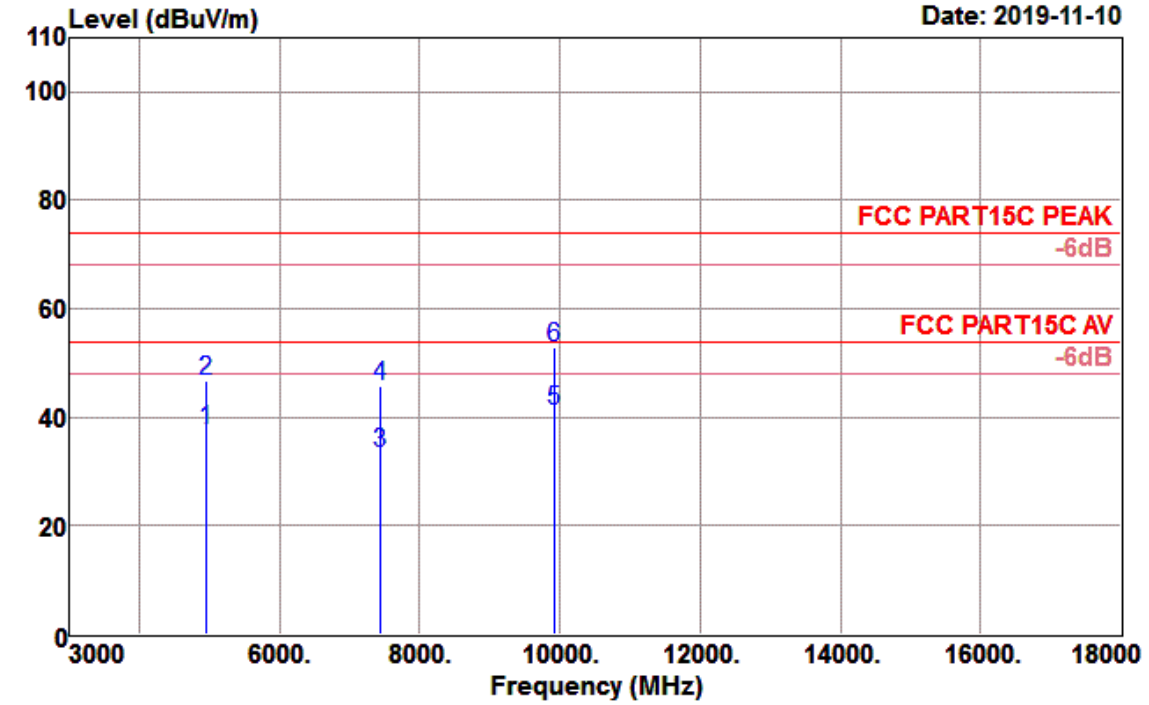
Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2480.000	100.63	27.35	3.59	35.67	95.90	74.00	21.90	Peak

Test Mode :	BLE CH39 (2480 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical



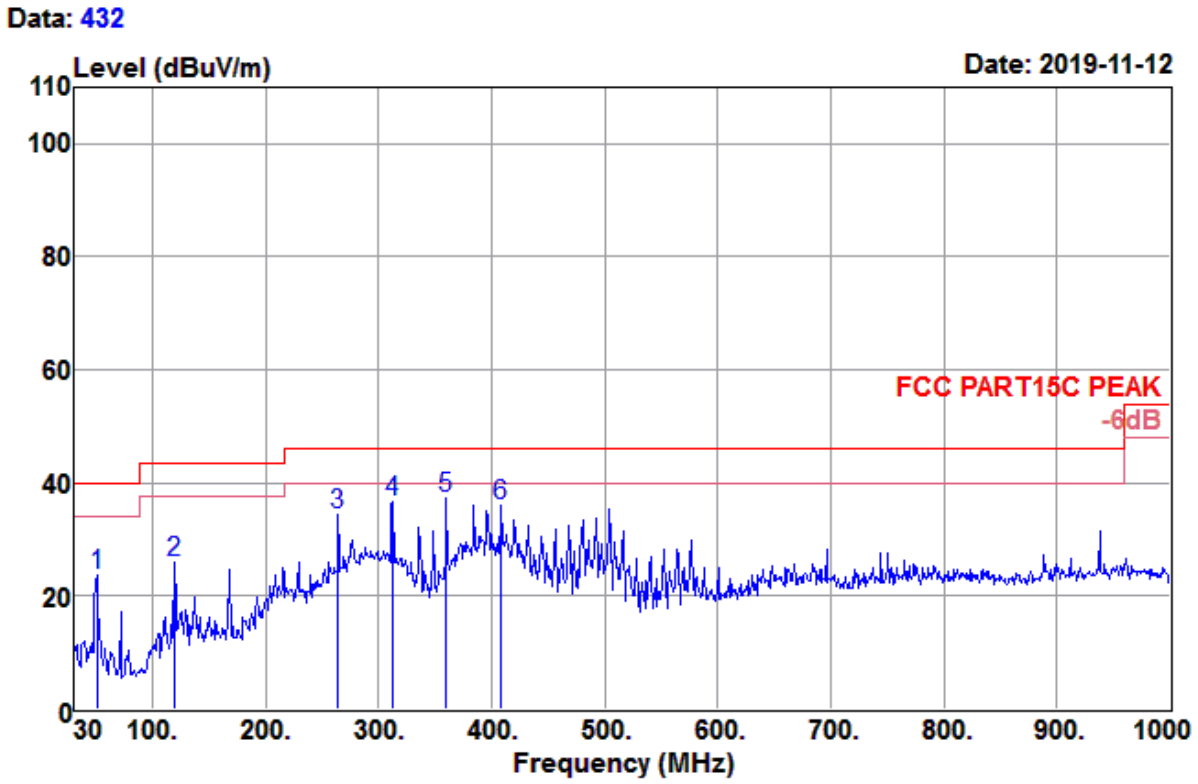


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4960.000	35.38	31.60	5.52	34.73	37.77	54.00	-16.23	Average
4960.000	44.46	31.60	5.52	34.73	46.85	74.00	-27.15	Peak
7440.000	25.73	36.41	7.56	36.40	33.30	54.00	-20.70	Average
7440.000	38.13	36.41	7.56	36.40	45.70	74.00	-28.30	Peak
9920.000	28.02	38.36	11.17	36.40	41.15	54.00	-12.85	Average
9920.000	39.66	38.36	11.17	36.40	52.79	74.00	-21.21	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

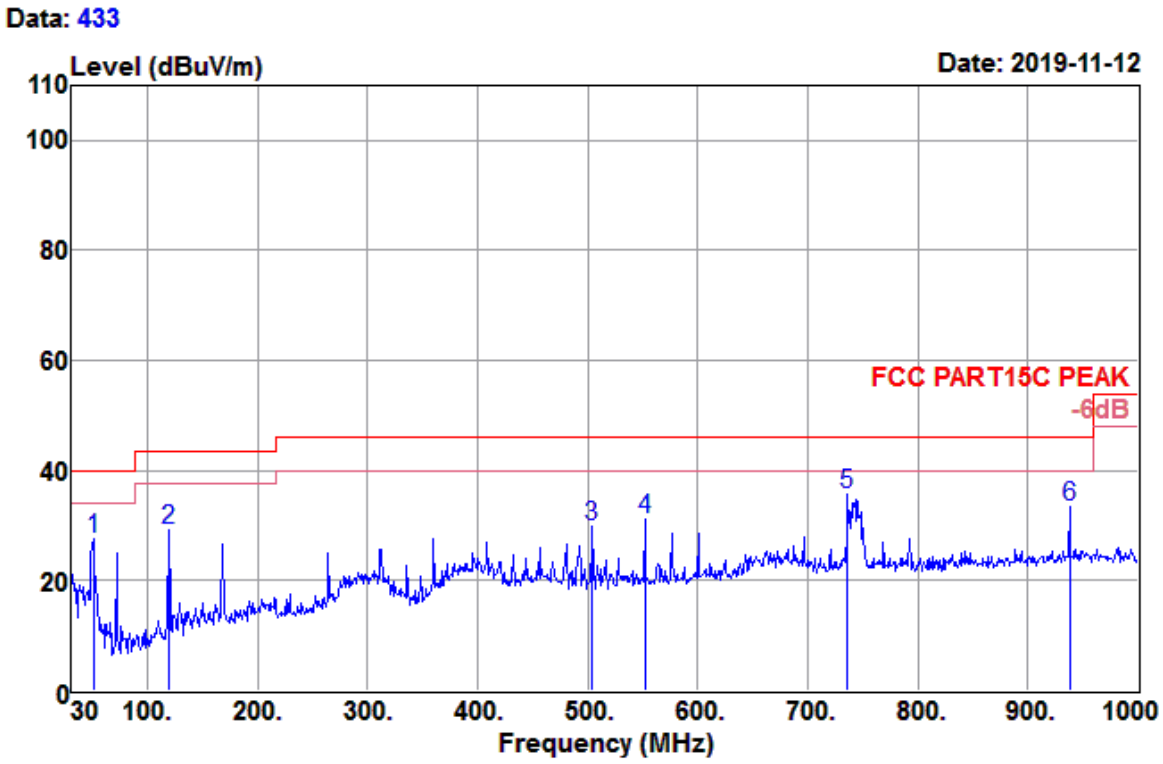
4.5.6 Test Result of Radiated Spurious Emission (30MHz ~ 1GHz)

Test Mode :	BLE CH00 (2402 MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	30MHz~1GHz	**Polarization :**	Horizontal



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
50.370	41.84	12.65	1.66	32.50	23.65	40.00	-16.35	Peak
119.240	45.61	10.92	2.04	32.61	25.96	43.50	-17.54	Peak
263.770	51.04	13.40	2.62	32.68	34.38	46.00	-11.62	Peak
312.270	52.19	14.35	2.82	32.71	36.65	46.00	-9.35	Peak
359.800	51.97	15.00	3.09	32.76	37.30	46.00	-8.70	Peak
408.300	49.67	16.05	3.26	32.81	36.17	46.00	-9.83	Peak

Test Mode :	BLE CH00 (2402 MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	30MHz~1GHz	Polarization :	Vertical



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
50.370	45.77	12.65	1.66	32.50	27.58	40.00	-12.42	Peak
119.240	48.91	10.92	2.04	32.61	29.26	43.50	-14.24	Peak
504.330	40.99	18.00	3.65	32.89	29.75	46.00	-16.25	Peak
551.860	40.98	19.13	3.79	32.74	31.16	46.00	-14.84	Peak
736.160	41.47	21.92	4.45	32.19	35.65	46.00	-10.35	Peak
937.920	35.88	24.18	5.11	31.79	33.38	46.00	-12.62	Peak

4.6 AC Conducted Emission Measurement

4.6.1 Limit of AC Conducted Emission

FCC §15.207

IC RSS-GEN 8.8

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

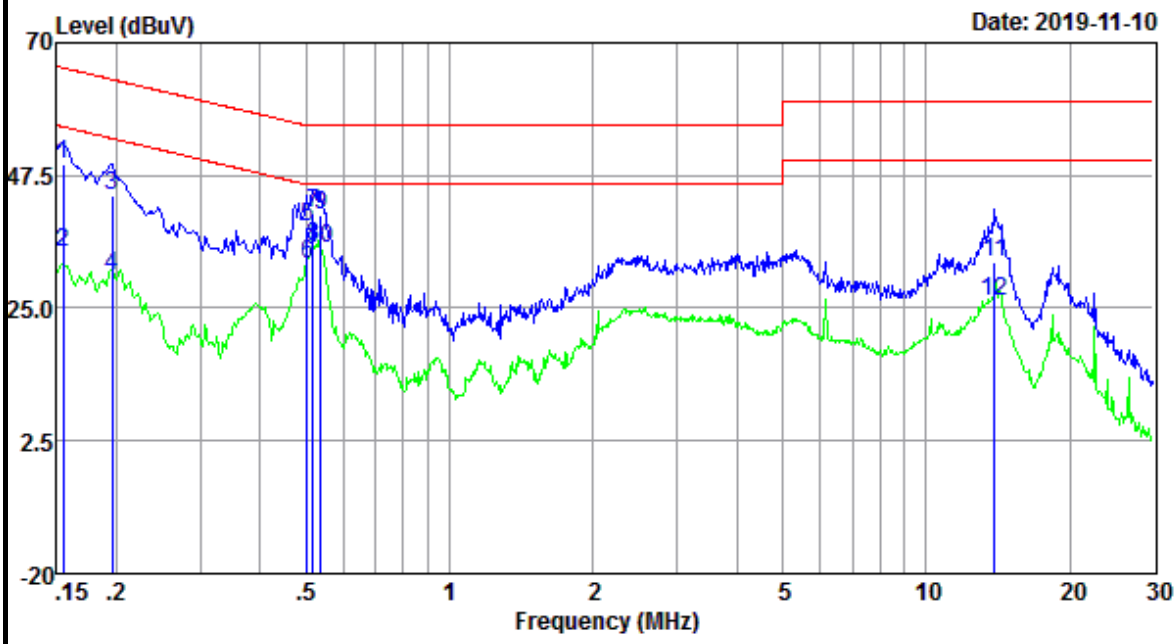
*Decreases with the logarithm of the frequency.

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 :	Jerry Wang	**Relative Humidity :**	41~43%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Function Type :	BLE Link + USB Cable (Charging from Adapter)		

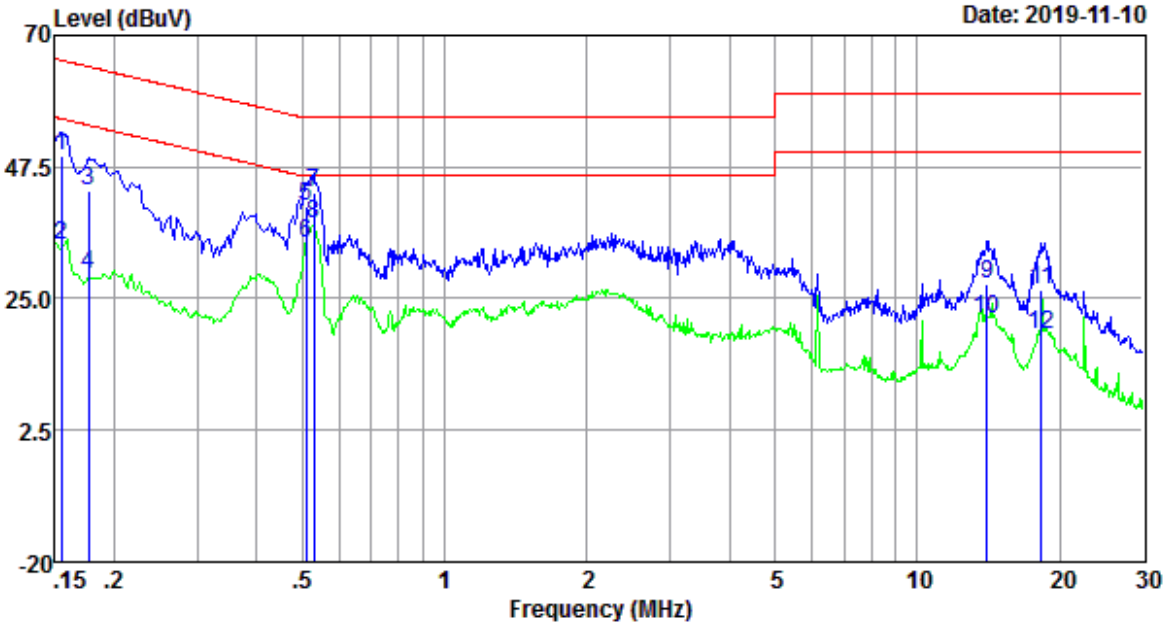


Freq	Reading level	LISN/ISN factor	Cable loss	Result level	Limit level	Over limit	Remark
MHz	dBuV	dB	dB	dBuV	dBuV	dB	
0.155	39.67	9.63	0.04	49.34	65.74	-16.40	QP
0.155	24.87	9.63	0.04	34.54	55.74	-21.20	Average
0.195	34.32	9.65	0.04	44.01	63.80	-19.79	QP
0.195	20.73	9.65	0.04	30.42	53.80	-23.38	Average
0.502	28.87	9.72	0.04	38.63	56.00	-17.37	QP
0.502	22.86	9.72	0.04	32.62	46.00	-13.38	Average
0.516	31.18	9.72	0.04	40.94	56.00	-15.06	QP
0.516	25.67	9.72	0.04	35.43	46.00	-10.57	Average
0.538	30.95	9.73	0.04	40.72	56.00	-15.28	QP
0.538	25.30	9.73	0.04	35.07	46.00	-10.93	Average
13.915	22.75	10.01	0.12	32.88	60.00	-27.12	QP
13.915	16.07	10.01	0.12	26.20	50.00	-23.80	Average

Result Level= Reading Level + LISN Factor + Cable Loss

Over Limit (margin) = Result Level – Limit Level

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



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	Result level dBuV	Limit level dBuV	Over limit dB	Remark
0.155	39.92	9.59	0.04	49.55	65.74	-16.19	QP
0.155	24.61	9.59	0.04	34.24	55.74	-21.50	Average
0.177	33.77	9.60	0.04	43.41	64.64	-21.23	QP
0.177	19.56	9.60	0.04	29.20	54.64	-25.44	Average
0.510	31.20	9.64	0.04	40.88	56.00	-15.12	QP
0.510	24.71	9.64	0.04	34.39	46.00	-11.61	Average
0.529	33.51	9.65	0.04	43.20	56.00	-12.80	QP
0.529	27.94	9.65	0.04	37.63	46.00	-8.37	Average
14.063	17.54	9.89	0.12	27.55	60.00	-32.45	QP
14.063	11.59	9.89	0.12	21.60	50.00	-28.40	Average
18.328	16.43	9.96	0.14	26.53	60.00	-33.47	QP
18.328	8.61	9.96	0.14	18.71	50.00	-31.29	Average

Result Level= Reading Level + LISN Factor + Cable Loss

Over Limit (margin) = Result Level – Limit Level

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 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	2019-01-23	2020-01-22	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2019-01-23	2020-01-22	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2019-01-23	2020-01-22	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2019-01-23	2020-01-22	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2019-01-23	2020-01-22	Conducted
Thermal Chamber	Sanmtest	SMC-408-CD	2435	2019-05-09	2020-05-08	Conducted
Base Station	R&S	CMW 270	101231	2019-01-23	2020-01-22	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2019-04-10	2020-04-09	Conducted
Signal Generator (Blocker)	Keysight	N5171B	MY56200661	2019-01-23	2020-01-22	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	2019-07-18	2020-07-17	Radiation
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-051	2017-03-03	2020-03-02	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	Audix	E3	6.111221a	N/A	N/A	Radiation
Filter	Micro-Tronics	BRM 50702	G266	N/A	N/A	Radiation

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
LISN	R&S	ENV216	102125	2019-01-22	2020-01-21	LISN
LISN	R&S	ENV432	101327	2019-01-22	2020-01-21	LISN
EMI Test Receiver	R&S	ESR3	102143	2019-01-23	2020-01-22	EMI Test Receiver
EMI Test Software	Audix	E3	N/A	N/A	N/A	EMI Test Software

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	2.60dB
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.