RF Test Report

For

Shenzhen Hangshi Technology Co.,Ltd

Test Standards:	Part 15C Subpart C §15.247
Product Name:	Bluetooth Keyboard
Tested Model:	HB361-T01
Additional Model No.:	HB361-T02,HB361-T03,HB361-T04
FCC ID:	2AKHJ-HB361
Classification	Digital Spread Spectrum (DSS)
Report No.:	EC2210038RF01
Tested Date:	2022-10-28 to 2023-03-27
Issued Date:	2023-03-27
Prepared By:	Jack Liu / Engineer
Approved By:	Tiny Yang / RF Manager

Testing laboratory:

Hunan Ecloud Testing Technology Co., Ltd.

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Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	2023.03.27	Valid	Original Report

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Summary of Test Result

FCC Rule	Description	Limit	Result	Remark
15.247(a)(1)	20dB Bandwidth	NA	Pass	Test Engineer: Luo Xiang
-	99% Bandwidth	-	Pass	Test Engineer: Luo Xiang
15.247(a)(1)	Hopping Channel Separation	≥ 2/3 of 20dB BW	Pass	Test Engineer: Luo Xiang
15.247(a)(1)	Number of Channels	≥ 15Chs	Pass	Test Engineer: Luo Xiang
15.247(a)(1)	Average Time of Occupancy	≤ 0.4sec in 31.6sec period	Pass	Test Engineer: Luo Xiang
15.247(b)(1)	Peak Output Power	≤ 125 mW	Pass	Test Engineer: Luo Xiang
15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	Test Engineer: Luo Xiang
15.247(d)	Conducted Spurious Emission	≤ 20dBc	Pass	Test Engineer: Luo Xiang
15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.37 dB at 9920 MHz
15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 27.71 dB at 0.672 MHz
15.203 & 15.247(b)	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

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.	HB361-T01
Additional NO.	HB361-T02,HB361-T03,HB361-T04
Difference Description	The difference between HB361-T02,HB361-T03,HB361-T04 and HB361-T01 is only the battery model and the addition of backlight plate, which does not affect any RF parameters.
FCC ID	2AKHJ-HB361
Power Supply	5Vdc (adapter or host equipment) 3.7Vdc (Li-ion, polymer)
Modulation Technology	FHSS
Modulation Type	GFSK
Operating Frequency	2402MHz~2480MHz
Number Of Channel	79
Max. Output Power	Bluetooth BR(1Mbps) : -2.84 dBm (0.0005W)
Antenna Type	PCB Antenna type with 1.87dBi gain
HW Version	v1.1
SW Version	v1.0
Sample no.	2210038R-1/2~2/2
Sample Received Date	2022-10-28, 2023-03-06
I/O Ports	Refer to user's manual
Cable Supplied	Refer to user's manual

NOTE:

1. The above EUT information is declared by manufacturer. The laboratory is not responsible for the information provided by the manufacturer.
2. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
3. 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

Remark:

1. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, 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:

Mode	Channel	Frequency	Bluetooth RF Output Power
GFSK	Ch00	2402MHz	-2.84
	Ch39	2441MHz	-4.02
	Ch78	2480MHz	-5.17

Remark:

1. All the test data for each data rate were verified, but only the worst case was reported.
2. The data rate was set in 1Mbps for all the test items due to the highest RF output power.

3.2 Test Mode

3.2.1 Antenna Port Conducted Measurement

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

3.2.2 Radiated Emission Test (Below 1GHz)

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

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

	Bluetooth BR 1Mbps GFSK
Radiated Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_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 much 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 : Bluetooth Link + USB Cable (Charging from Adapter)

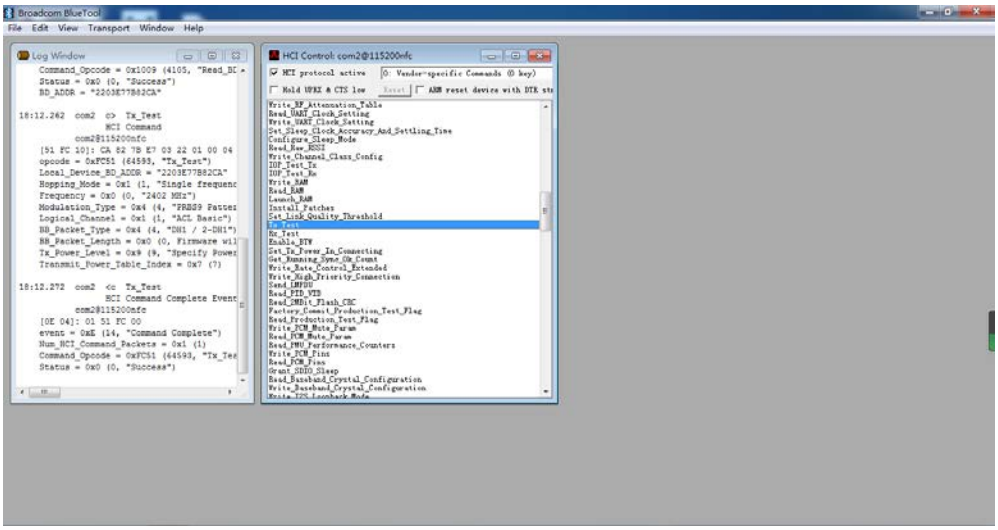
3.3 Support Equipment

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Adapter	HUAWEI	HW-059200CHQ	FCC sDoC	N/A	N/A
2.	MicroUSB Cable	N/A	N/A	N/A	N/A	unshielded 0.8m
3.	Notebook	Lenovo	E470C	FCC sDoC	N/A	shielded cable DC O/P 1.8 m unshielded AC I/P cable1.2 m

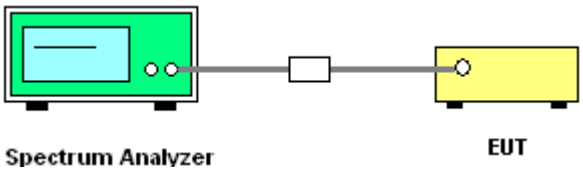
3.4 Test Setup

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

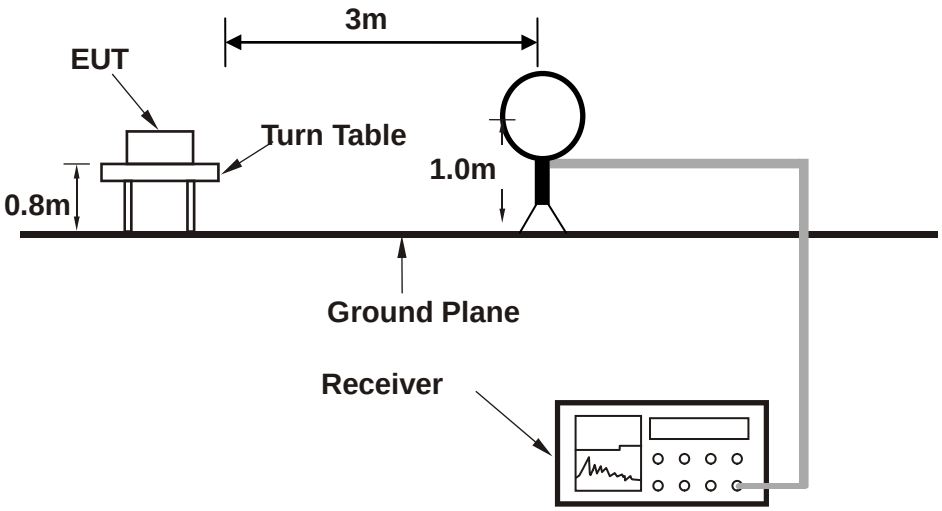
EUT was set in the Hidden menu mode to enable BT communications.



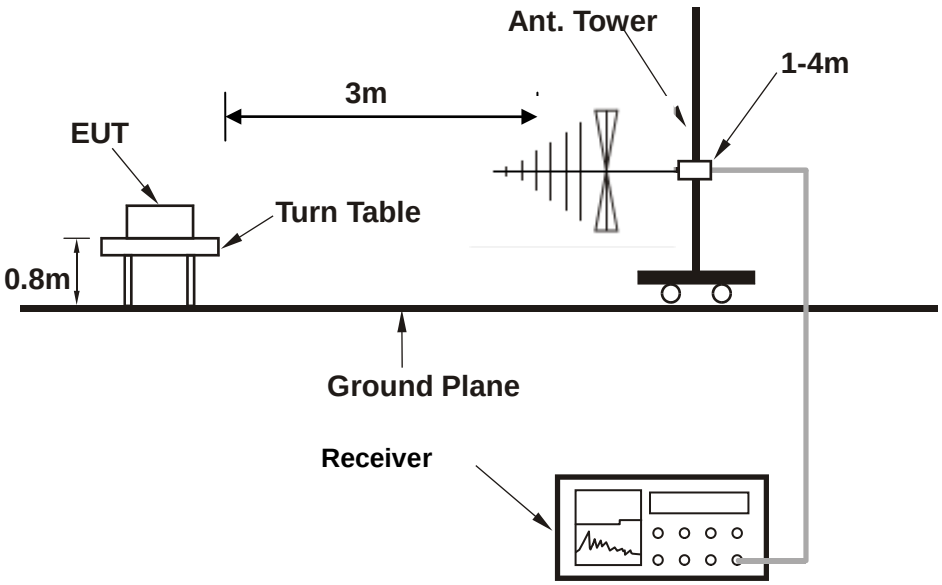
Setup diagram for Conducted Test



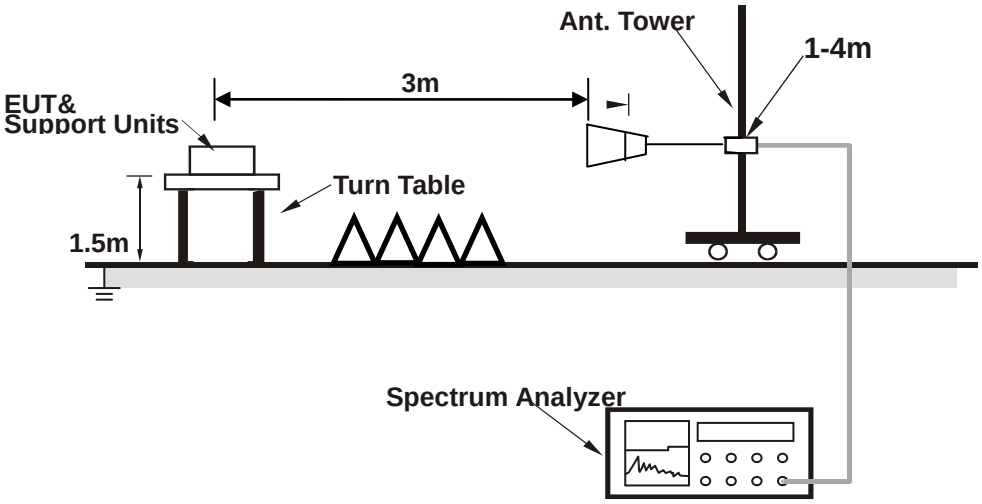
Setup diagram for Radiation(9KHz~30MHz) Test



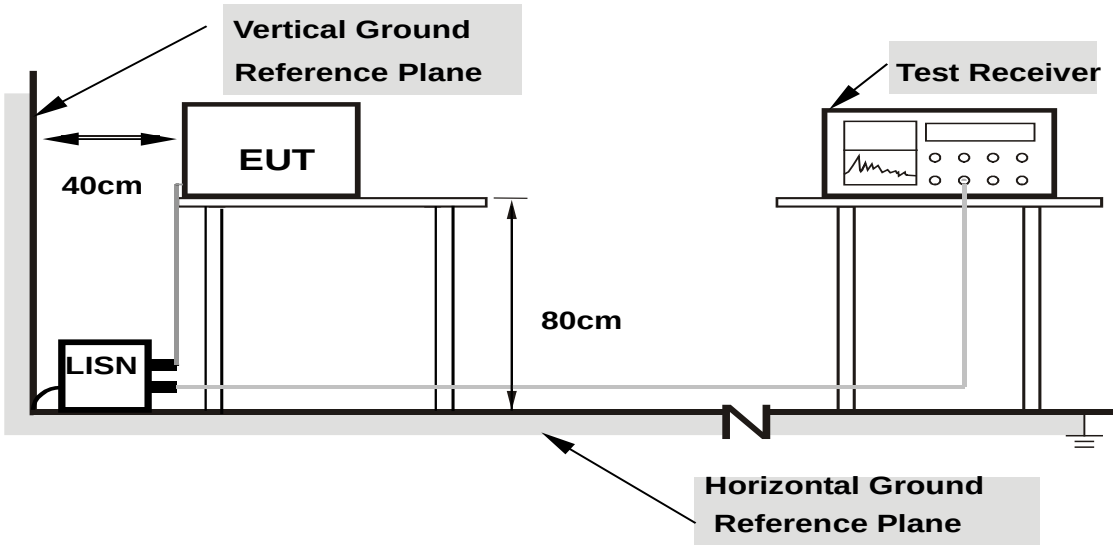
Setup diagram for Radiation(Below 1G) Test



Setup diagram for Radiation(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

Over Limit (dB μ V/m) = Level(dB μ V/m) - Limit Level (dB μ V/m)

4 Test Result

4.1 20dB and 99% Bandwidth Measurement

4.1.1 Limit of 20dB and 99% Bandwidth

None; for reporting purposes only.

4.1.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.

   Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;

   RBW ≥ 1% of the 20 dB bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = peak;

   Trace = max hold.
4. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.

   Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;

   RBW ≥ 1% of the 99% bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = sample;

   Trace = max hold.

4.1.3 Test Result of 20dB Bandwidth

Refer to Appendix A of this test report.

4.1.4 Test Result of 99% Bandwidth

Refer to Appendix B of this test report.

4.2 Peak Output Power Measurement

4.2.1 Limit of Peak Output Power

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

4.2.2 Test Procedures

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

4.2.3 Test Result of Peak Output Power

Refer to Appendix C of this test report.

4.3 Carrier Frequency Separation Measurement

4.3.1 Limit of Hopping Channel Separation

FCC §15.247 (a) (1)

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

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

4.3.2 Test Procedures

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

4.3.3 Test Result of Hopping Channel Separation

Refer to Appendix D of this test report.

4.4 Time of Occupancy Measurement

4.4.1 Limit of Average Time of Occupancy

FCC §15.247 (a) (1) (iii)

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

4.4.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.
4. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

The test period: T= 0.4 Second/Channel x 79 Channel = 31.6 s

Test channel: 2441MHz as below：

DH1 time slot= Burst Width (ms)*(1600/ (2*79))*31.6

DH3 time slot= Burst Width (ms)*(1600/ (4*79))*31.6

DH5 time slot= Burst Width (ms)*(1600/ (6*79))*31.6

4.4.3 Test Result of Dwell Time

Refer to Appendix E of this test report.

4.5 Number of Hopping Channels Measurement

4.5.1 Limits of Number of Hopping Channels

FCC § 15.247(a)(1)(iii)

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

4.5.2 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. The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 100KHz. The analyzer is set to Max Hold.

4.5.3 Test Result of Number of Hopping Channels

Refer to Appendix F of this test report.

4.6 Conducted Band Edges Measurement

4.6.1 Limit of Band Edges

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

4.6.2 Test Procedures

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

4.6.3 Test Result of Conducted Band Edges

Refer to Appendix G of this test report.

4.7 Conducted Spurious Emission Measurement

4.7.1 Limit of Spurious Emission Measurement

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

4.7.2 Test Procedure

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

4.7.3 Test Result of Conducted Spurious Emission

Refer to Appendix H of this test report.

4.8 Radiated Band Edges and Spurious Emission Measurement

4.8.1 Limit of Radiated Band Edges and Spurious Emission

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

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

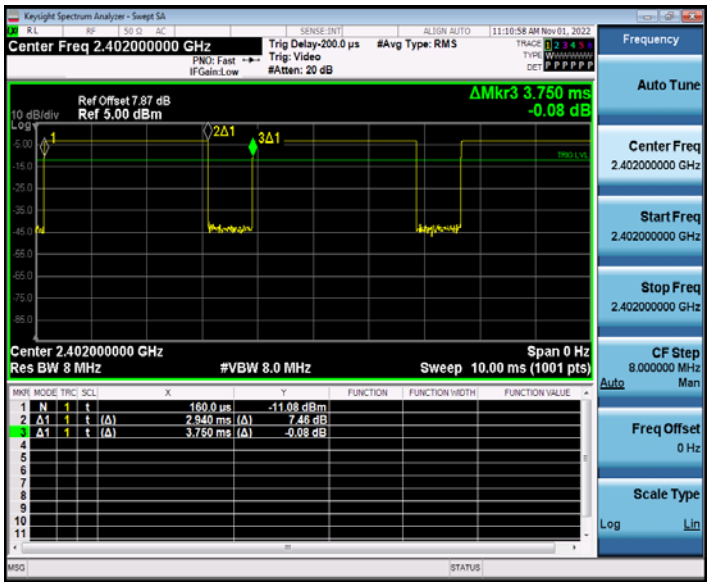
Note: The frequency range from 9KHz to 10th harmonic (25GHz) are checked, and no any emissions were found from 18GHz to 25GHz, So the radiated emissions from 18GHz to 25GHz were not record.

4.8.2 Test Procedures

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) The EUT shall be configured to operate at the maximum achievable duty cycle.
   (2) Measure the duty cycle D of the transmitter output signal as described in 11.6.
   (3) RBW = 1 MHz (unless otherwise specified).
   (4) VBW □[3 × RBW].
   (5) Detector = RMS (power averaging), if span / (# of points in sweep) □(RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
   (6) Averaging type = power (i.e., rms):
      a. As an alternative, the detector and averaging type may be set for linear voltage averaging.
      b. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
   (7) Sweep time = auto.
   (8) Perform a trace average of at least 100 traces.
   (9) A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
      a. If power averaging (rms) mode was used in step f), then the applicable correction factor is [10 log (1 / D)], where D is the duty cycle.
      b. If linear voltage averaging mode was used in step f), then the applicable correction factor is [20 log (1 / D)], where D is the duty cycle.
      c. If a specific emission is demonstrated to be continuous (D □98%) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

(10) Reduction of the measured emission amplitude levels to account for operational duty cycle is not permitted. Determining compliance is based on emission levels occurring during transmission; it is not based on an average across ON and OFF times of the transmitter.

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
1Mbps	78.40	2.94	0.34	1kHz

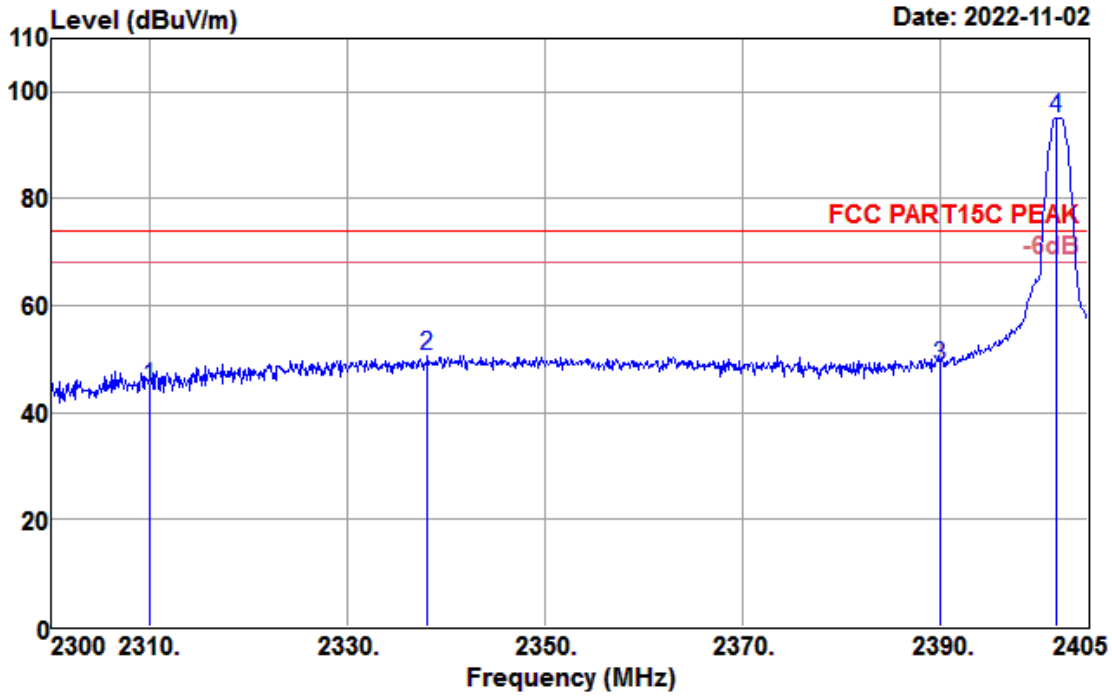


4.8.3 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

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

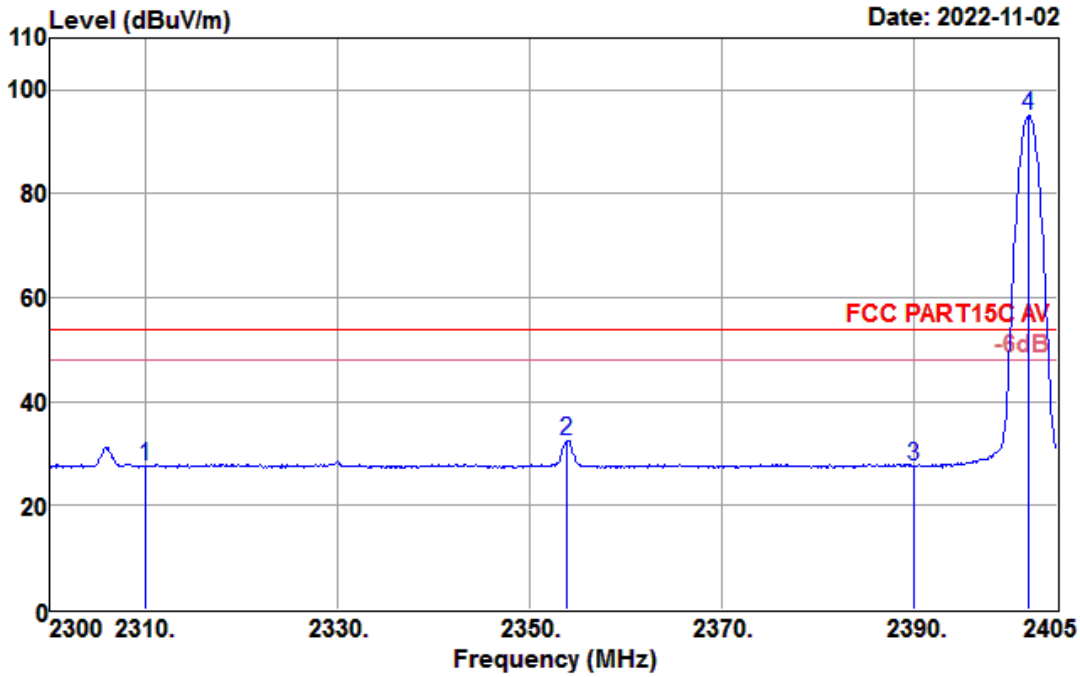
4.8.4 Test Result of Radiated Spurious at Band Edges

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	2.3GHz~2.405GHz	**Polarization :**	Horizontal



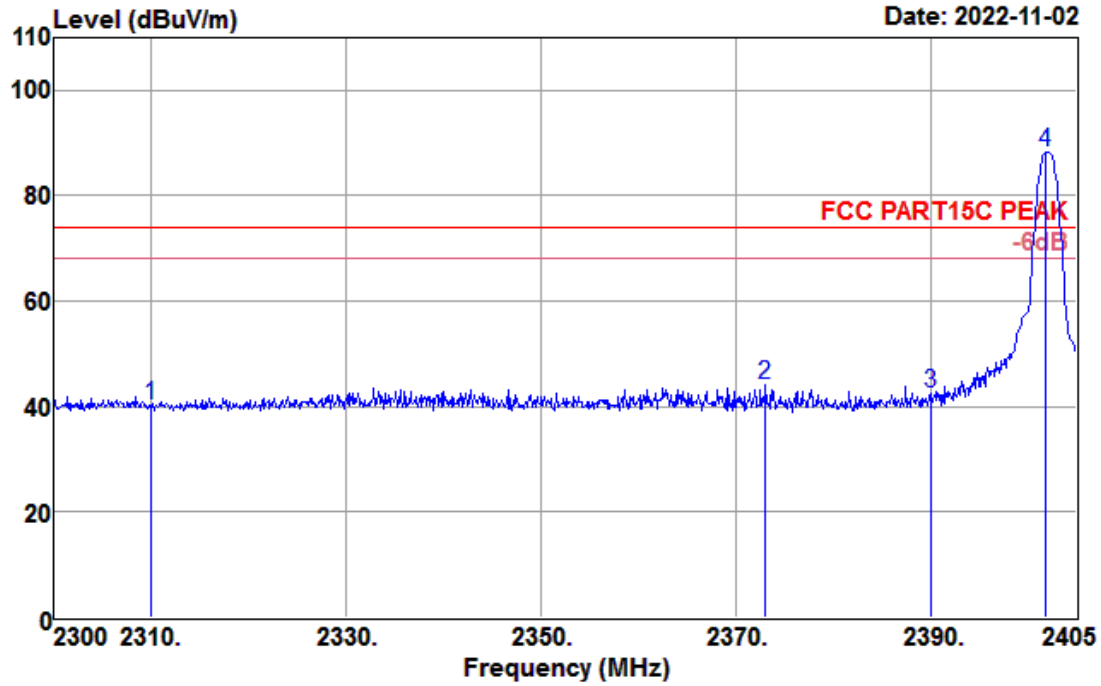
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2310.000	49.15	27.38	4.08	35.71	44.90	74.00	-29.10	Peak
2338.115	54.80	27.44	4.11	35.78	50.57	74.00	-23.43	Peak
2390.000	52.94	27.56	4.16	35.90	48.76	74.00	-25.24	Peak
2401.850	99.40	27.58	4.17	35.92	95.23	74.00	21.23	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Horizontal



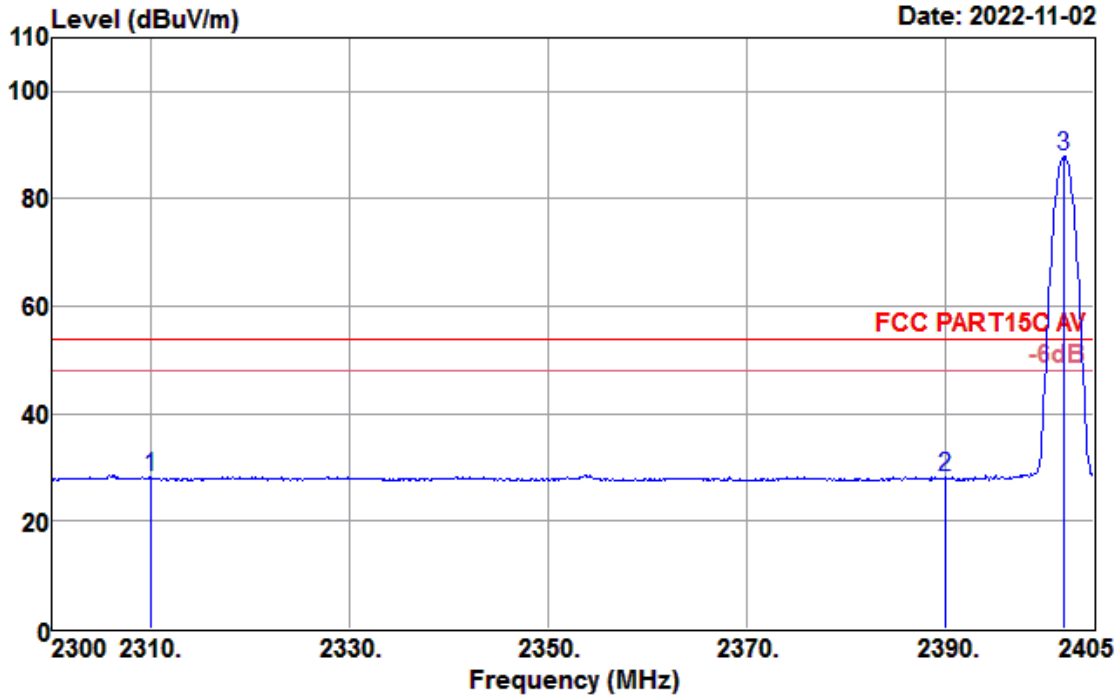
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2310.000	31.81	27.38	4.08	35.71	27.56	54.00	-26.44	Average
2353.970	36.65	27.48	4.12	35.81	32.44	54.00	-21.56	Average
2390.000	31.70	27.56	4.16	35.90	27.52	54.00	-26.48	Average
2402.060	99.22	27.58	4.17	35.92	95.05	54.00	41.05	Average

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical



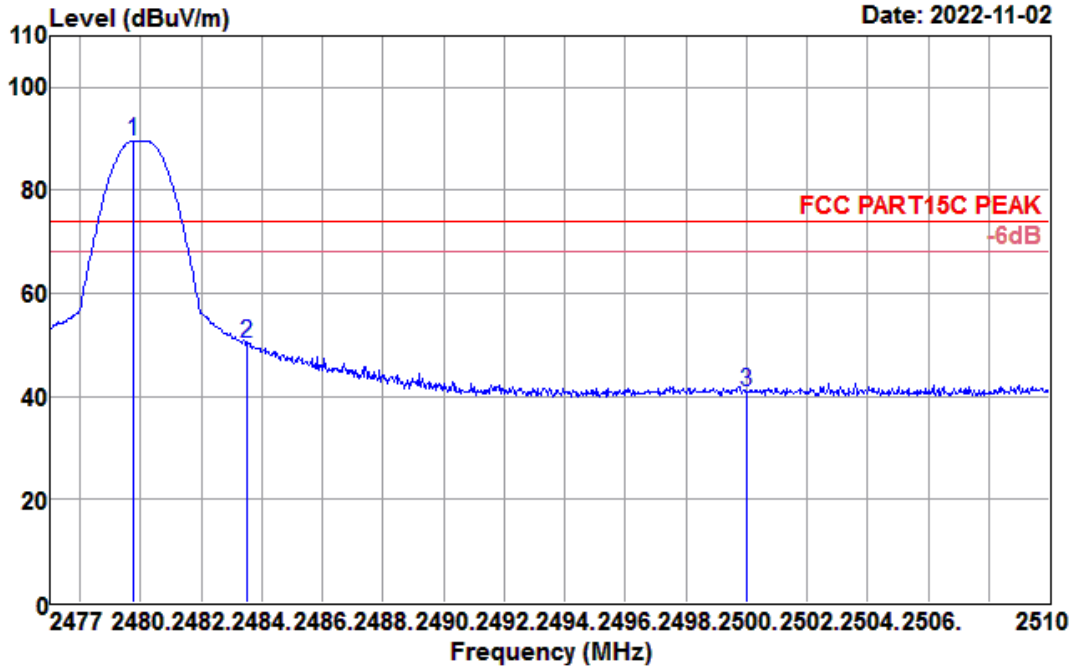
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2310.000	44.44	27.38	4.08	35.71	40.19	74.00	-33.81	Peak
2373.080	48.40	27.52	4.14	35.86	44.20	74.00	-29.80	Peak
2390.000	46.77	27.56	4.16	35.90	42.59	74.00	-31.41	Peak
2401.850	92.39	27.58	4.17	35.92	88.22	74.00	14.22	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical



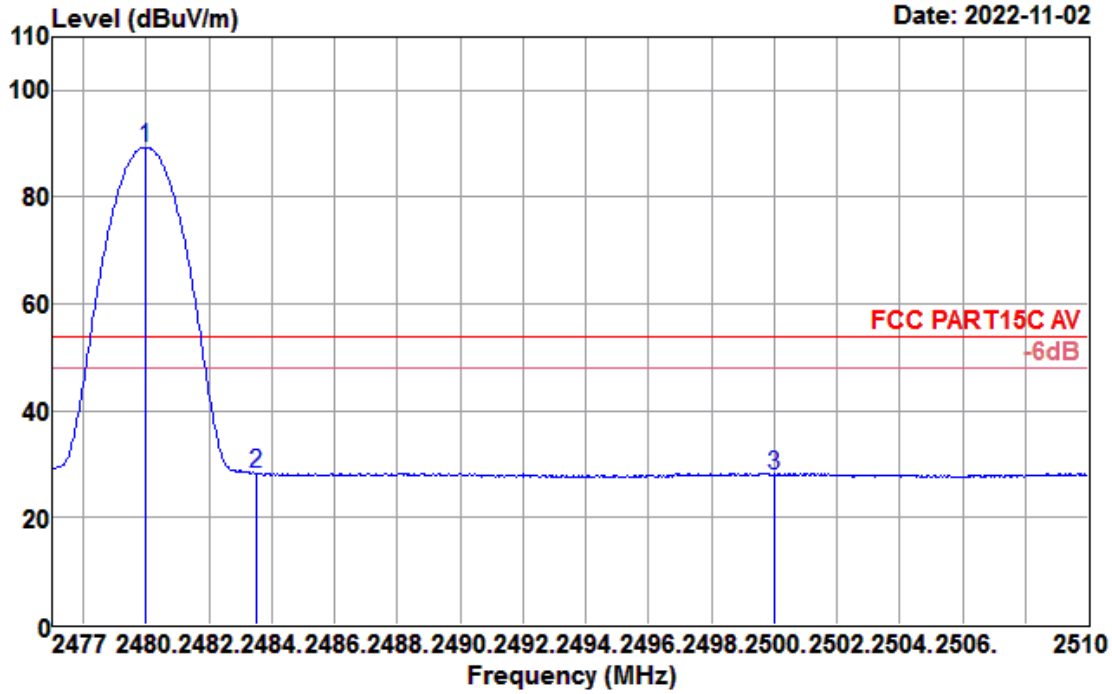
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	32.37	27.38	4.08	35.71	28.12	54.00	-25.88	Average
2390.000	32.47	27.56	4.16	35.90	28.29	54.00	-25.71	Average
2402.060	92.15	27.58	4.17	35.92	87.98	54.00	33.98	Average

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.510GHz	Polarization :	Vertical



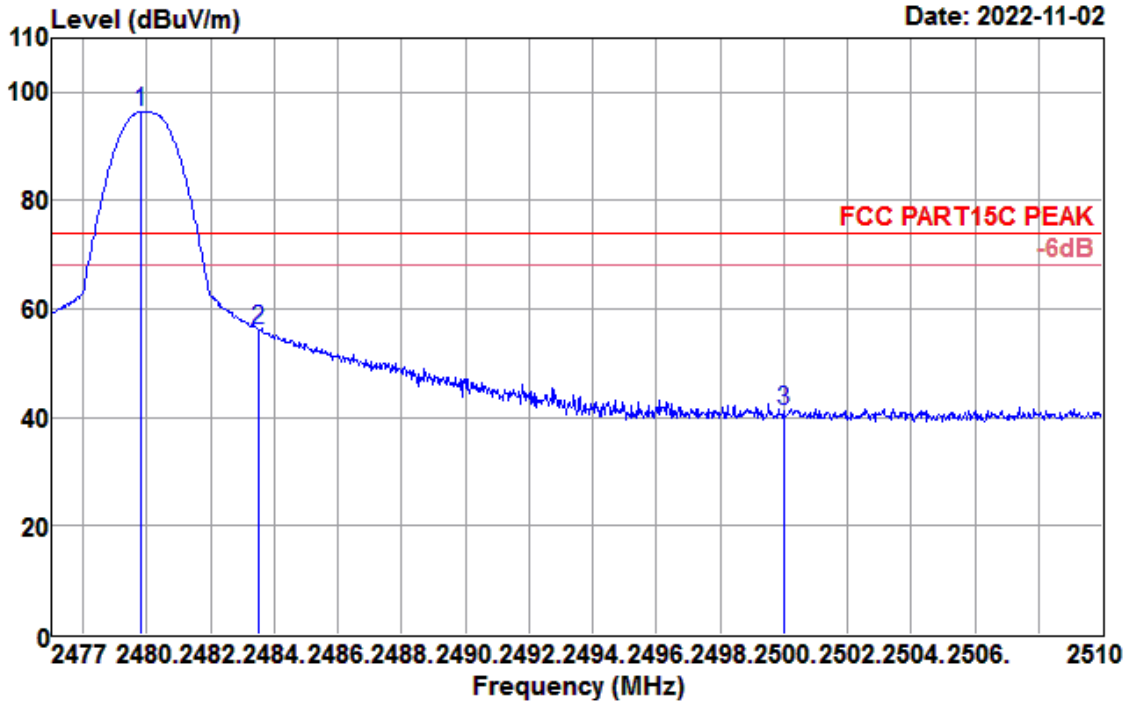
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.772	93.83	27.76	4.19	36.10	89.68	74.00	15.68	Peak
2483.500	54.32	27.76	4.19	36.11	50.16	74.00	-23.84	Peak
2500.000	44.92	27.80	4.19	36.15	40.76	74.00	-33.24	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	2.477GHz~2.510GHz	**Polarization :**	Vertical



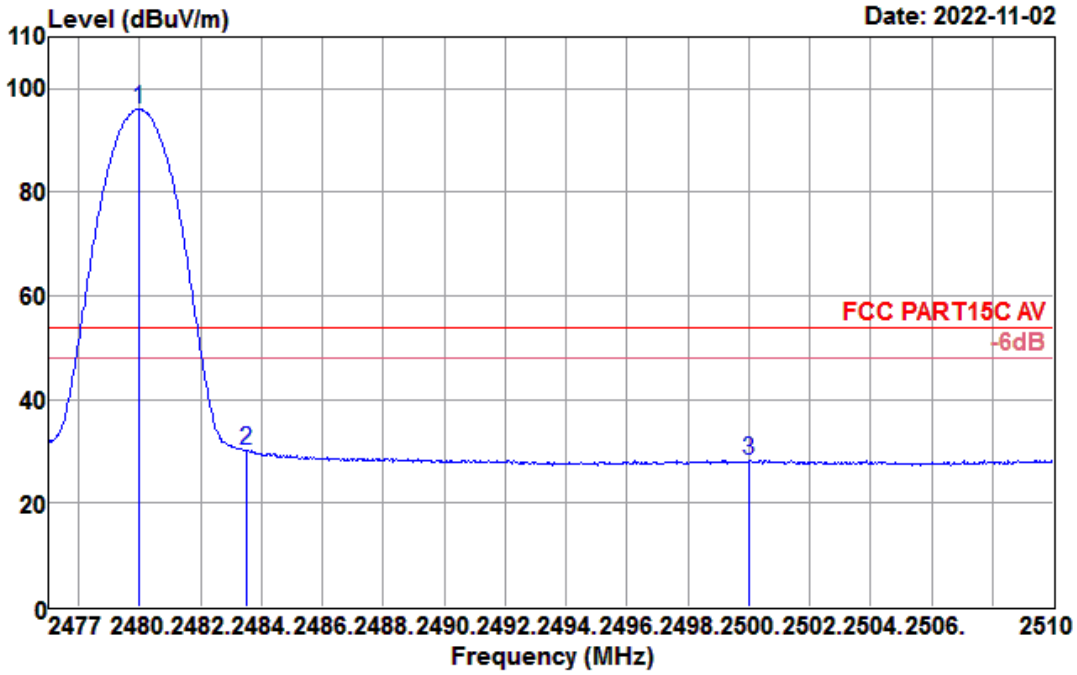
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2480.003	93.53	27.76	4.19	36.10	89.38	54.00	35.38	Average
2483.500	32.41	27.76	4.19	36.11	28.25	54.00	-25.75	Average
2500.000	32.09	27.80	4.19	36.15	27.93	54.00	-26.07	Average

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.510GHz	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	
2479.805	100.43	27.76	4.19	36.10	96.28	74.00	22.28	Peak
2483.500	60.27	27.76	4.19	36.11	56.11	74.00	-17.89	Peak
2500.000	45.34	27.80	4.19	36.15	41.18	74.00	-32.82	Peak

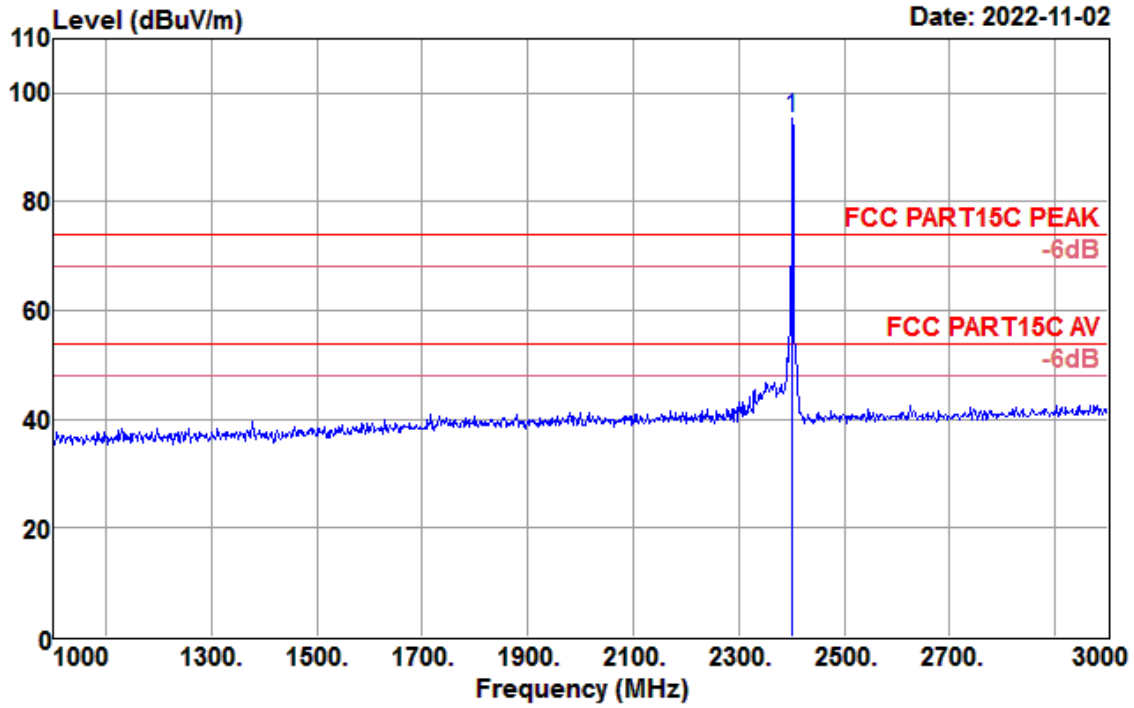
Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.510GHz	Polarization :	Horizontal



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	
2479.970	100.17	27.76	4.19	36.10	96.02	54.00	42.02	Average
2483.500	34.47	27.76	4.19	36.11	30.31	54.00	-23.69	Average
2500.000	32.31	27.80	4.19	36.15	28.15	54.00	-25.85	Average

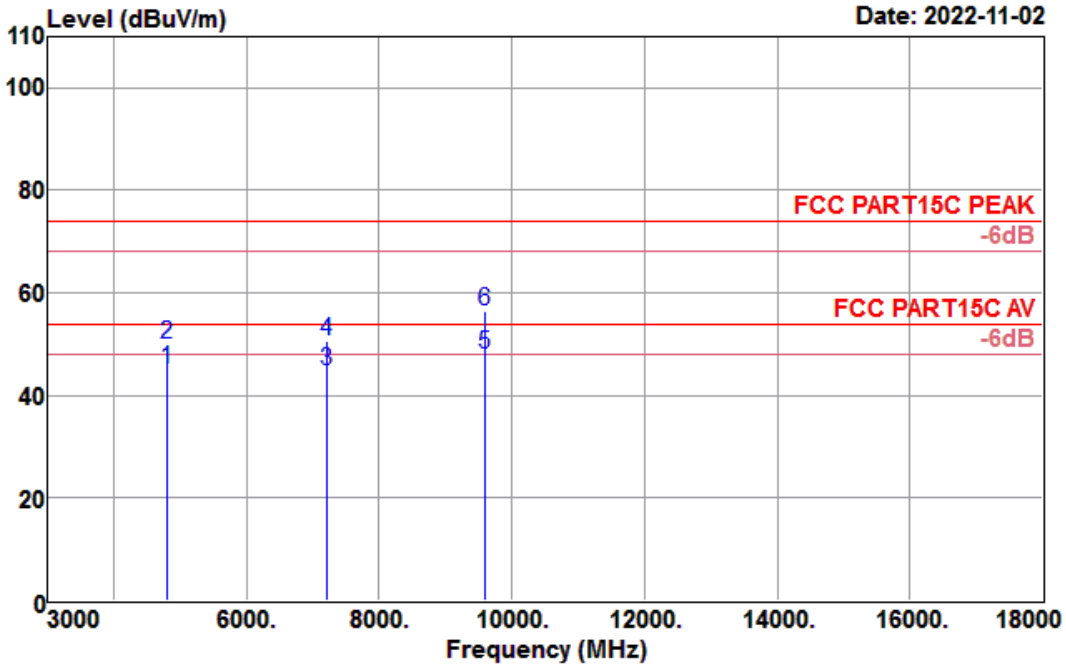
4.8.5 Test Result of Radiated Spurious Emission (1GHz ~ 10th Harmonic)

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



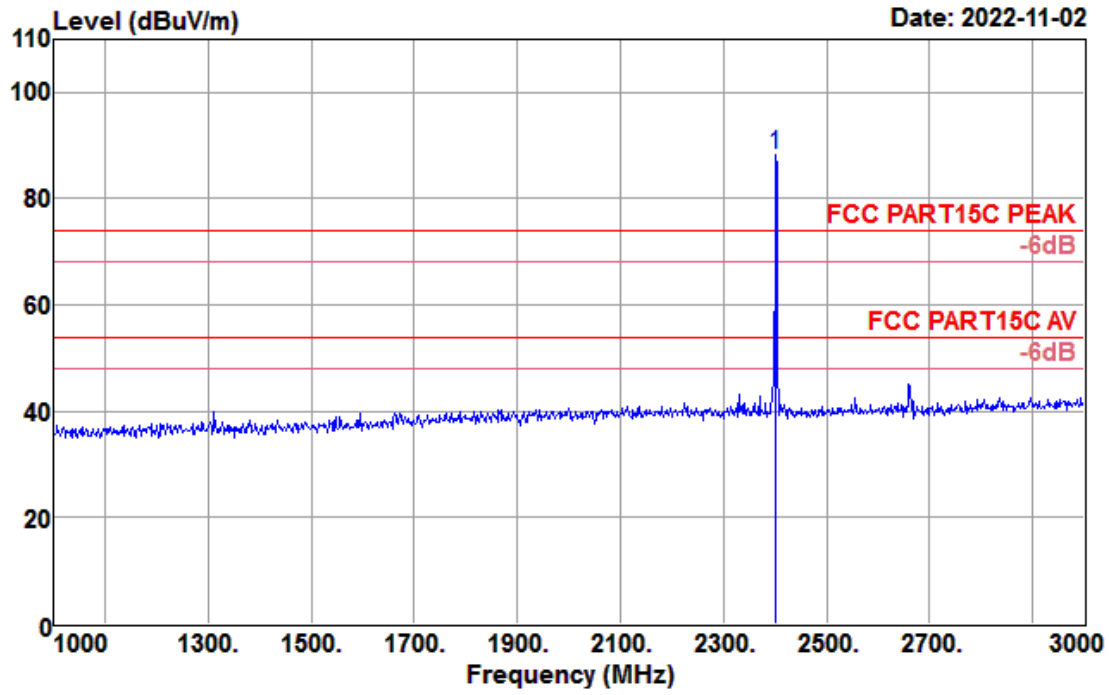
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2402.000	99.44	27.58	4.17	35.92	95.27	74.00	21.27	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal



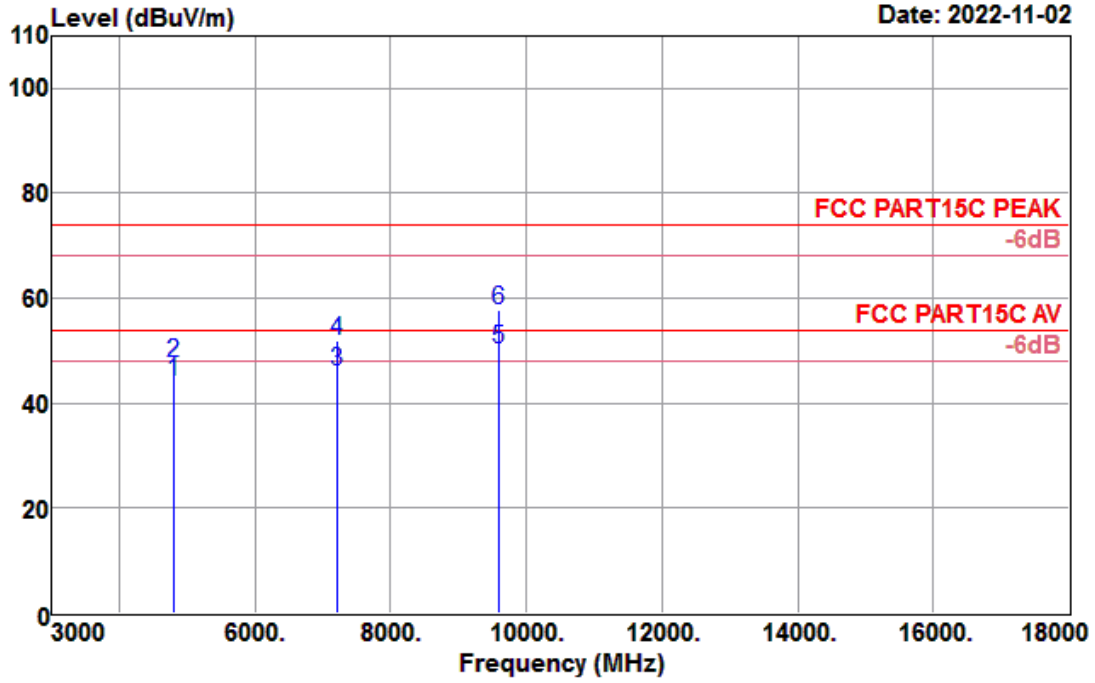
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4804.000	43.61	30.93	6.44	36.02	44.96	54.00	-9.04	Average
4804.000	48.76	30.93	6.44	36.02	50.11	74.00	-23.89	Peak
7206.000	35.01	35.39	8.61	34.31	44.70	54.00	-9.30	Average
7206.000	40.98	35.39	8.61	34.31	50.67	74.00	-23.33	Peak
9608.000	32.13	38.39	11.69	34.24	47.97	54.00	-6.03	Average
9608.000	40.79	38.39	11.69	34.24	56.63	74.00	-17.37	Peak

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



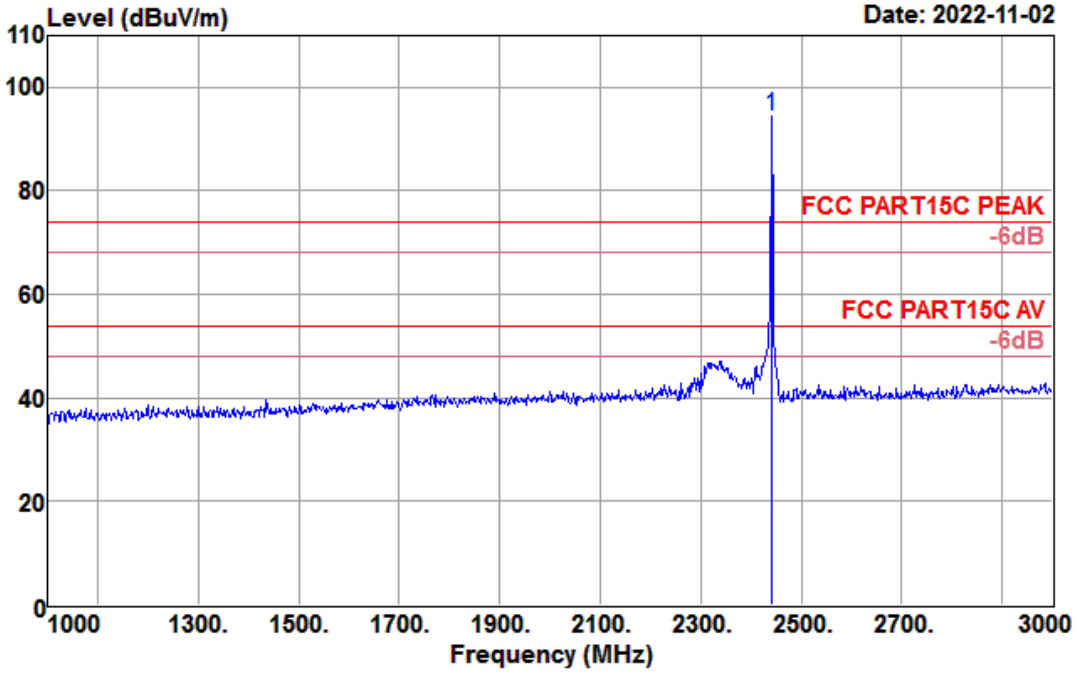
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2402.000	92.41	27.58	4.17	35.92	88.24	74.00	14.24	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical



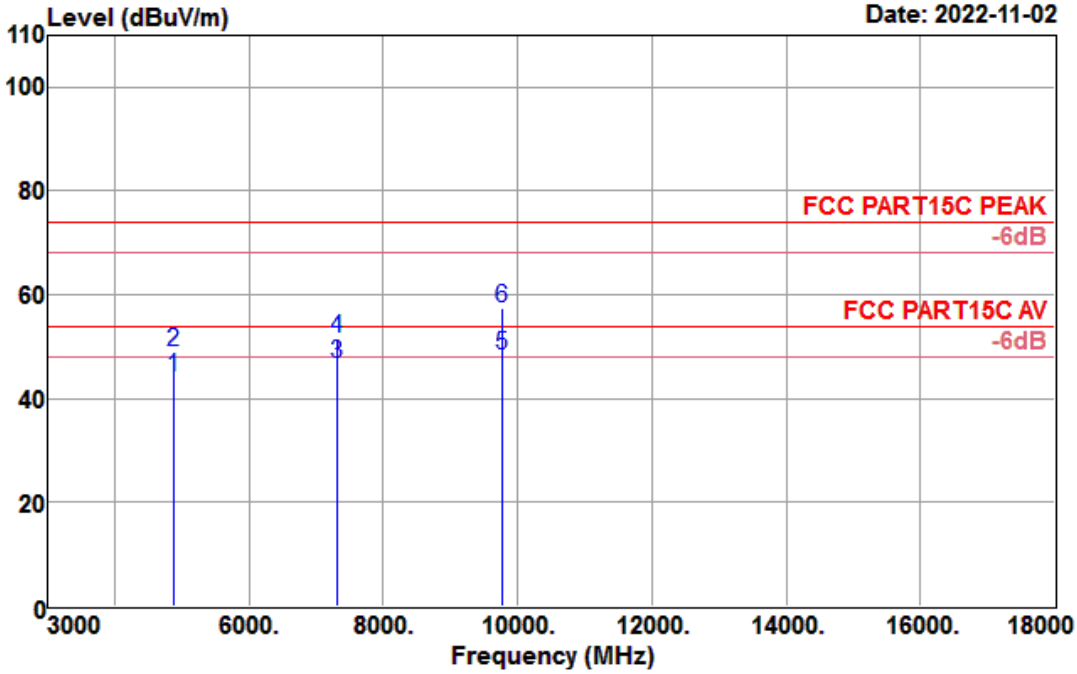
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4804.000	42.85	30.93	6.44	36.02	44.20	54.00	-9.80	Average
4804.000	46.48	30.93	6.44	36.02	47.83	74.00	-26.17	Peak
7206.000	36.35	35.39	8.61	34.31	46.04	54.00	-7.96	Average
7206.000	42.39	35.39	8.61	34.31	52.08	74.00	-21.92	Peak
9608.000	34.47	38.39	11.69	34.24	50.31	54.00	-3.69	Average
9608.000	41.87	38.39	11.69	34.24	57.71	74.00	-16.29	Peak

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal



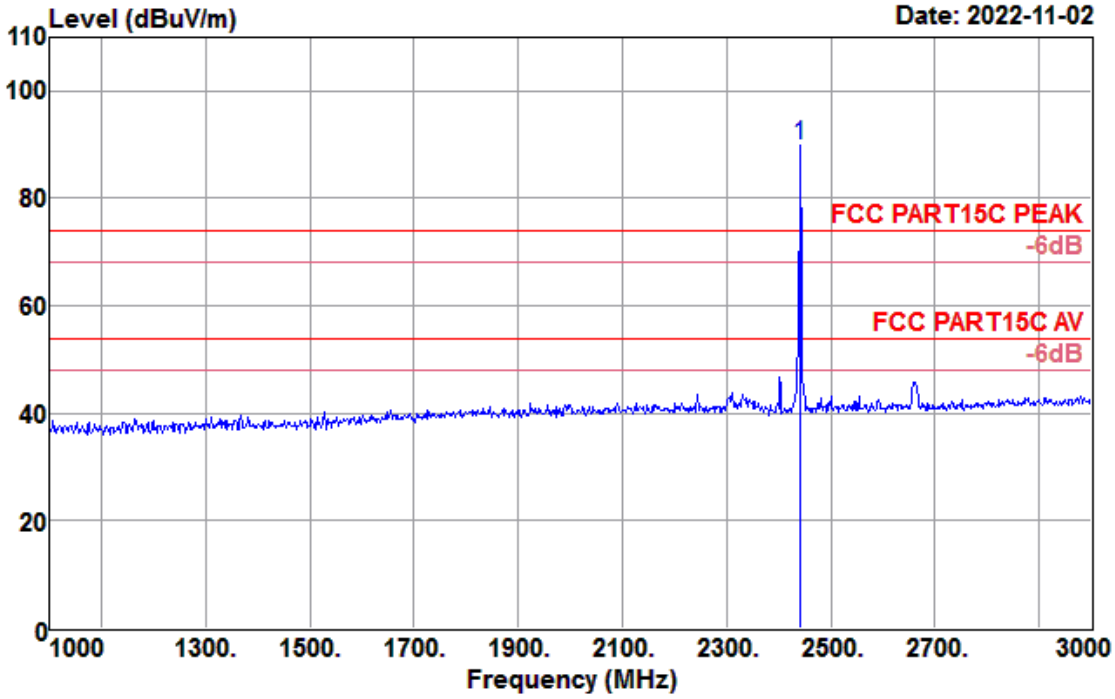
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2441.000	98.50	27.67	4.18	36.01	94.34	74.00	20.34	Peak

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal



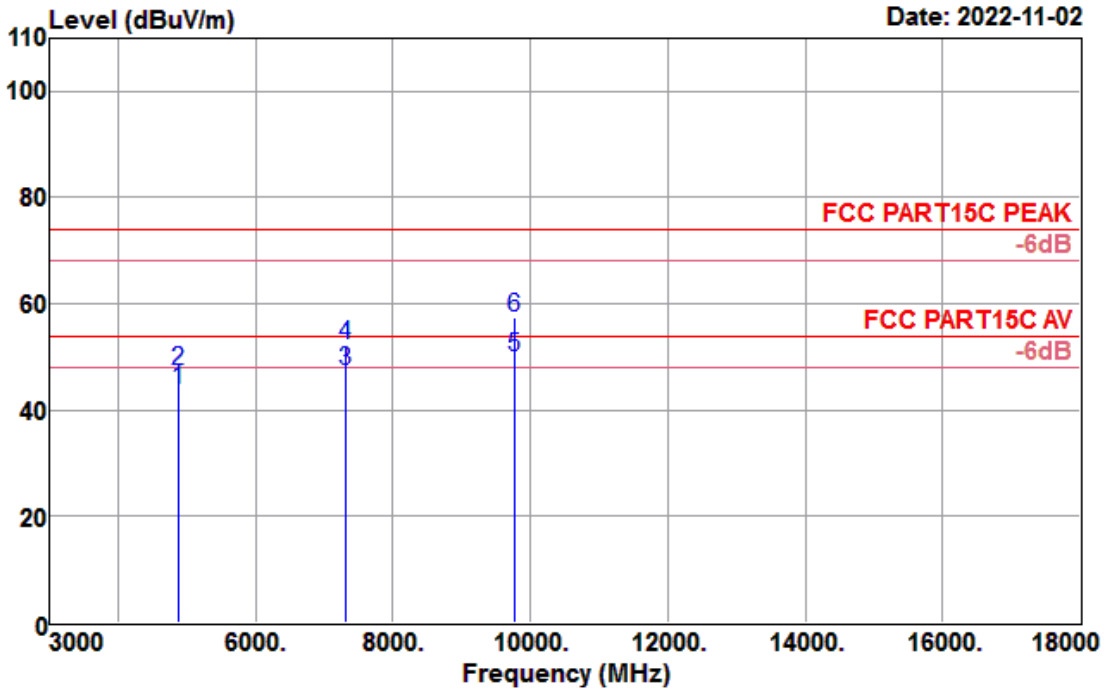
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4882.000	42.13	31.03	7.03	35.97	44.22	54.00	-9.78	Average
4882.000	46.79	31.03	7.03	35.97	48.88	74.00	-25.12	Peak
7323.000	36.39	35.68	8.98	34.42	46.63	54.00	-7.37	Average
7323.000	41.52	35.68	8.98	34.42	51.76	74.00	-22.24	Peak
9764.000	33.03	38.51	11.15	34.31	48.38	54.00	-5.62	Average
9764.000	42.05	38.51	11.15	34.31	57.40	74.00	-16.60	Peak

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	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	
2441.000	93.97	27.67	4.18	36.01	89.81	74.00	15.81	Peak

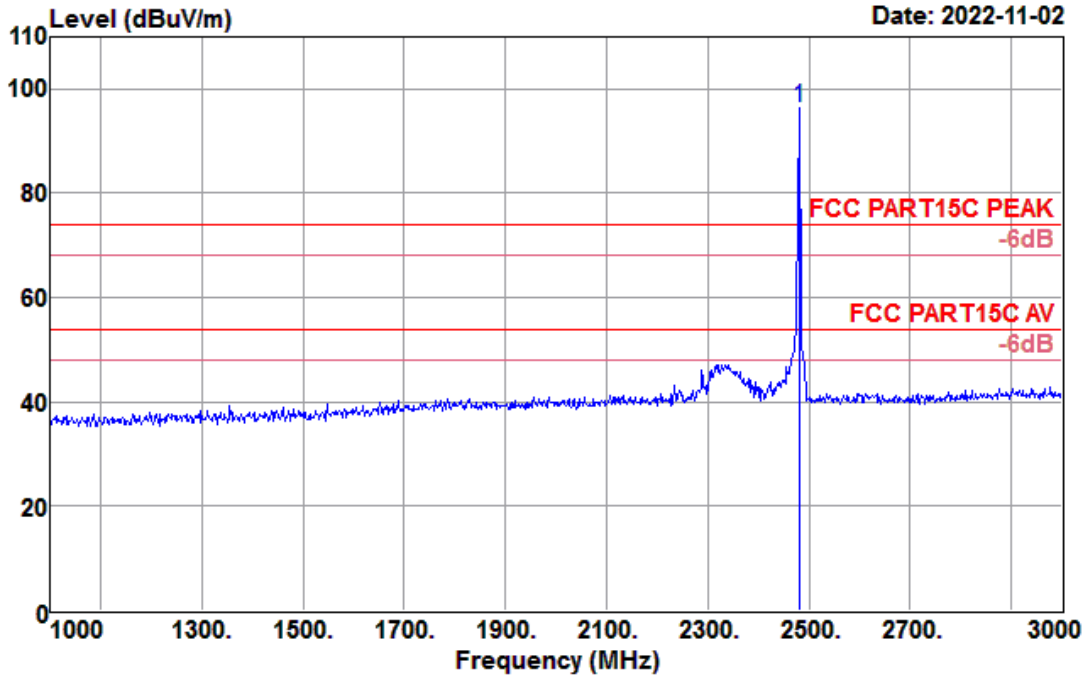
Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical



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
4882.000	41.63	31.03	7.03	35.97	43.72	54.00	-10.28	Average
4882.000	45.38	31.03	7.03	35.97	47.47	74.00	-26.53	Peak
7323.000	37.23	35.68	8.98	34.42	47.47	54.00	-6.53	Average
7323.000	42.08	35.68	8.98	34.42	52.32	74.00	-21.68	Peak
9764.000	34.77	38.51	11.15	34.31	50.12	54.00	-3.88	Average
9764.000	42.19	38.51	11.15	34.31	57.54	74.00	-16.46	Peak

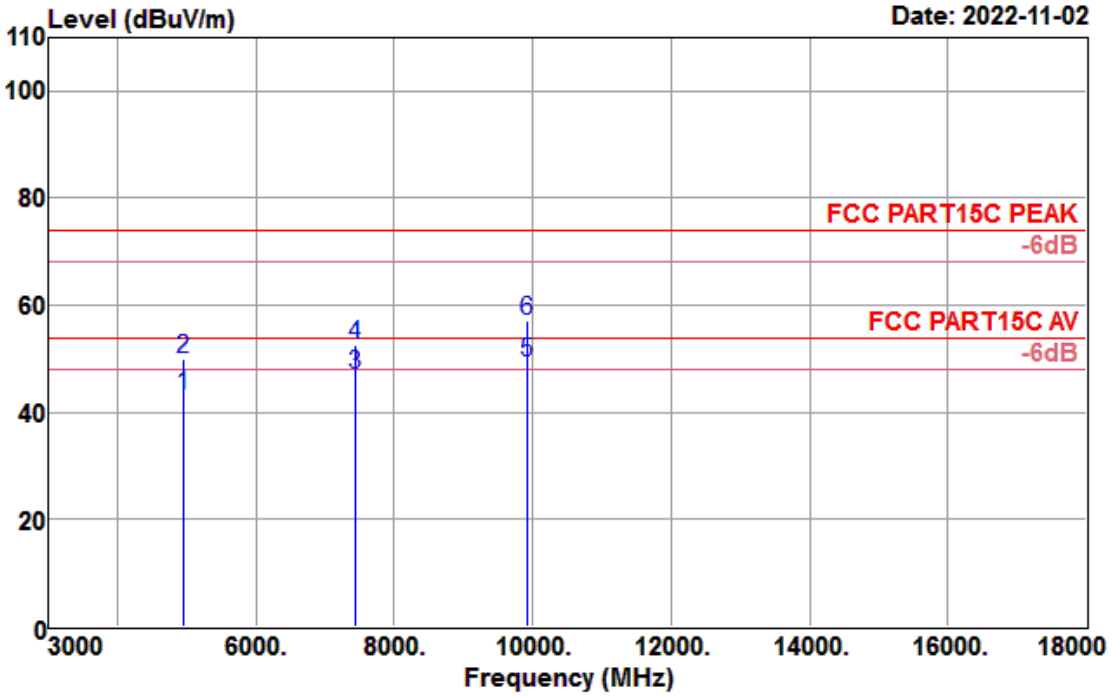
:

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal



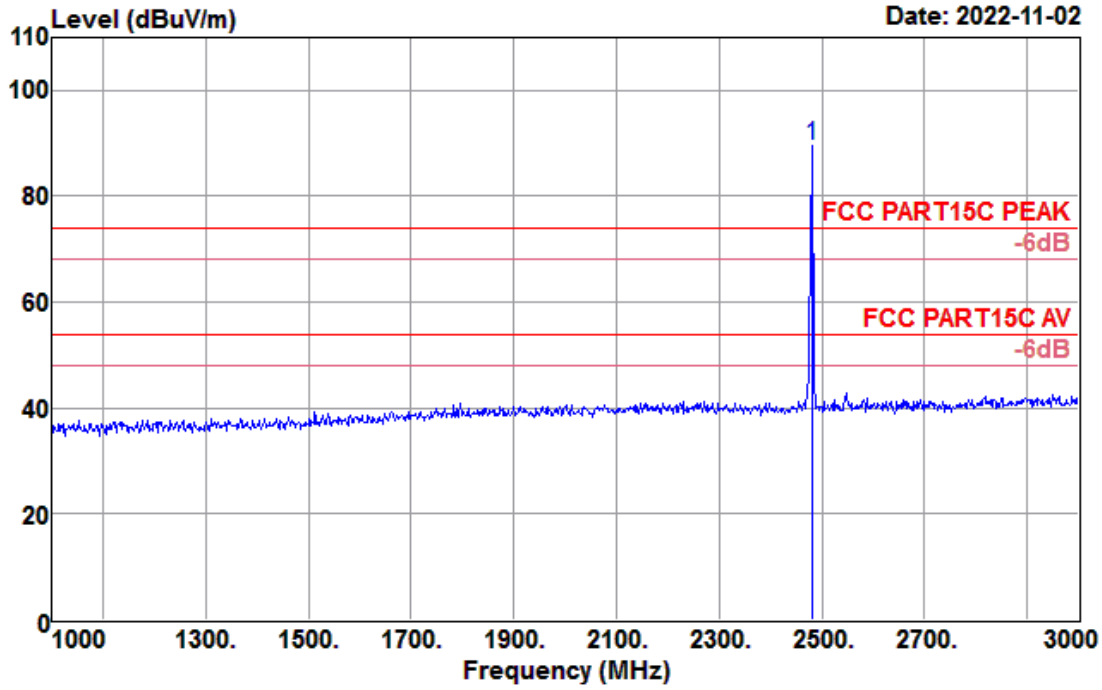
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2480.000	100.44	27.76	4.19	36.10	96.29	74.00	22.29	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal



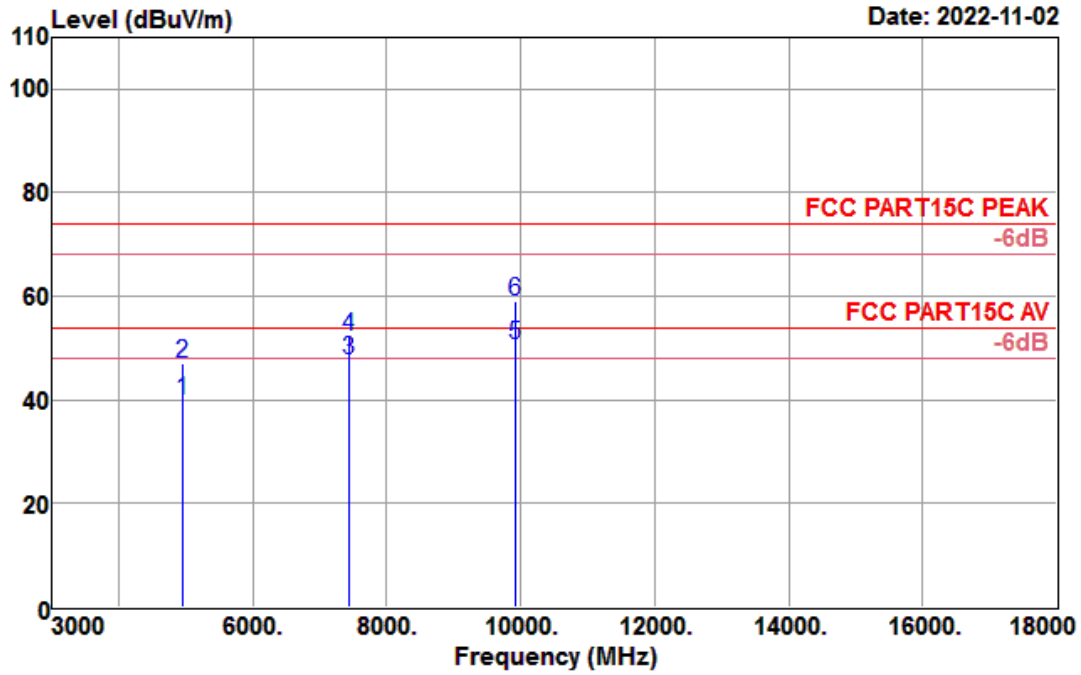
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4960.000	40.43	31.14	7.62	35.92	43.27	54.00	-10.73	Average
4960.000	47.20	31.14	7.62	35.92	50.04	74.00	-23.96	Peak
7440.000	36.61	35.96	9.03	34.54	47.06	54.00	-6.94	Average
7440.000	42.07	35.96	9.03	34.54	52.52	74.00	-21.48	Peak
9920.000	32.97	38.64	12.18	34.37	49.42	54.00	-4.58	Average
9920.000	40.69	38.64	12.18	34.37	57.14	74.00	-16.86	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	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
2480.000	93.80	27.76	4.19	36.10	89.65	74.00	15.65	Peak

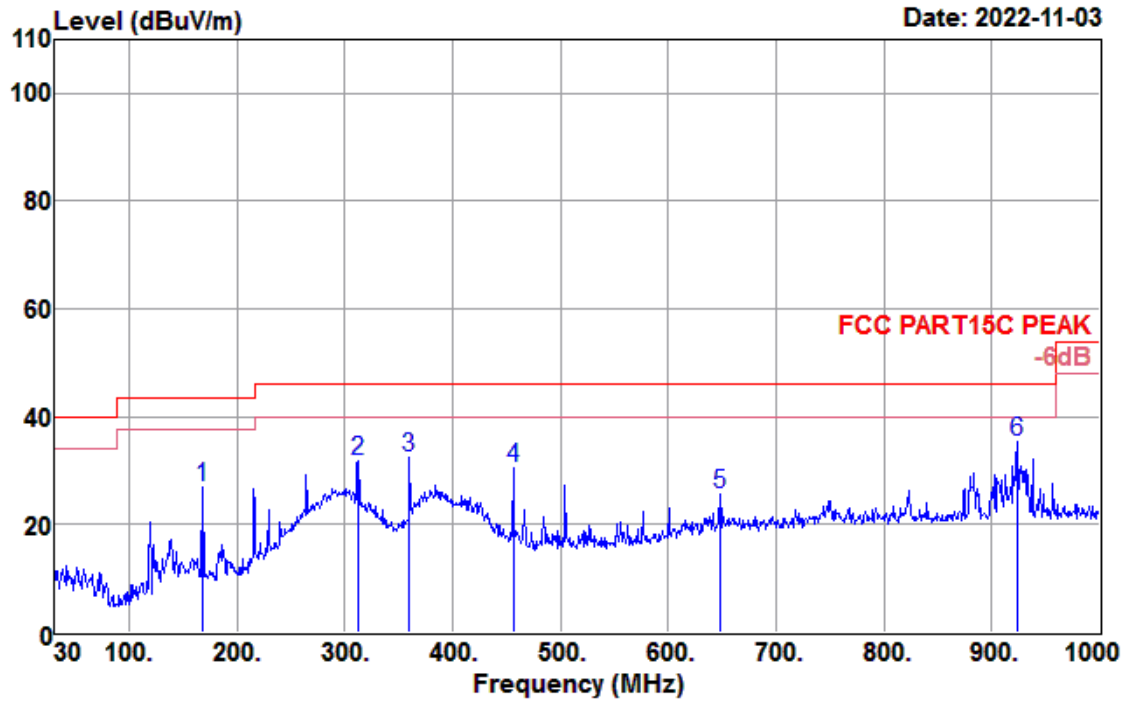
Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical



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	37.23	31.14	7.62	35.92	40.07	54.00	-13.93	Average
4960.000	44.24	31.14	7.62	35.92	47.08	74.00	-26.92	Peak
7440.000	37.28	35.96	9.03	34.54	47.73	54.00	-6.27	Average
7440.000	41.73	35.96	9.03	34.54	52.18	74.00	-21.82	Peak
9920.000	34.18	38.64	12.18	34.37	50.63	54.00	-3.37	Average
9920.000	42.71	38.64	12.18	34.37	59.16	74.00	-14.84	Peak

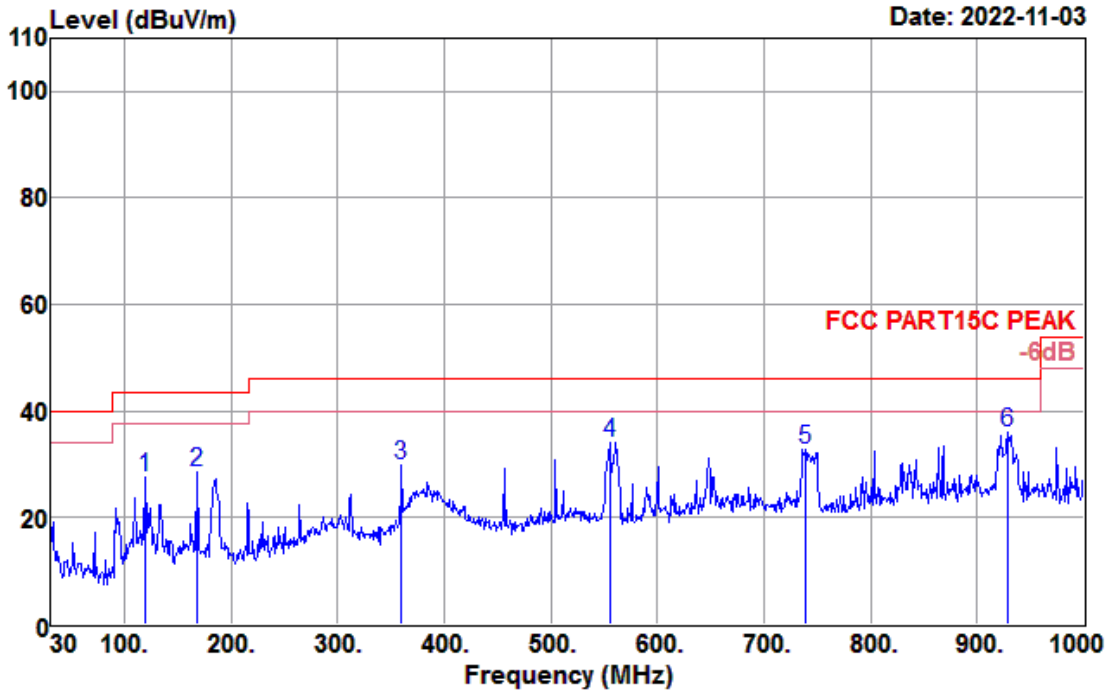
4.8.6 Test Result of Radiated Spurious Emission (30MHz ~ 1GHz)

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	**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
167.740	43.45	13.61	2.50	32.67	26.89	43.50	-16.61	Peak
312.270	47.70	13.42	3.44	32.65	31.91	46.00	-14.09	Peak
359.800	46.98	14.35	3.72	32.70	32.35	46.00	-13.65	Peak
455.830	42.75	16.35	4.24	32.80	30.54	46.00	-15.46	Peak
647.890	33.71	19.30	5.14	32.58	25.57	46.00	-20.43	Peak
923.370	38.73	22.35	6.30	32.06	35.32	46.00	-10.68	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	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
119.240	46.86	11.41	2.03	32.66	27.64	43.50	-15.86	Peak
167.740	45.28	13.61	2.50	32.67	28.72	43.50	-14.78	Peak
359.800	44.42	14.35	3.72	32.70	29.79	46.00	-16.21	Peak
554.770	44.33	17.75	4.73	32.80	34.01	46.00	-11.99	Peak
739.070	38.94	20.72	5.48	32.34	32.80	46.00	-13.20	Peak
929.190	39.53	22.41	6.31	32.06	36.19	46.00	-9.81	Peak

4.9 AC Conducted Emission Measurement

4.9.1 Limit of AC Conducted Emission

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

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

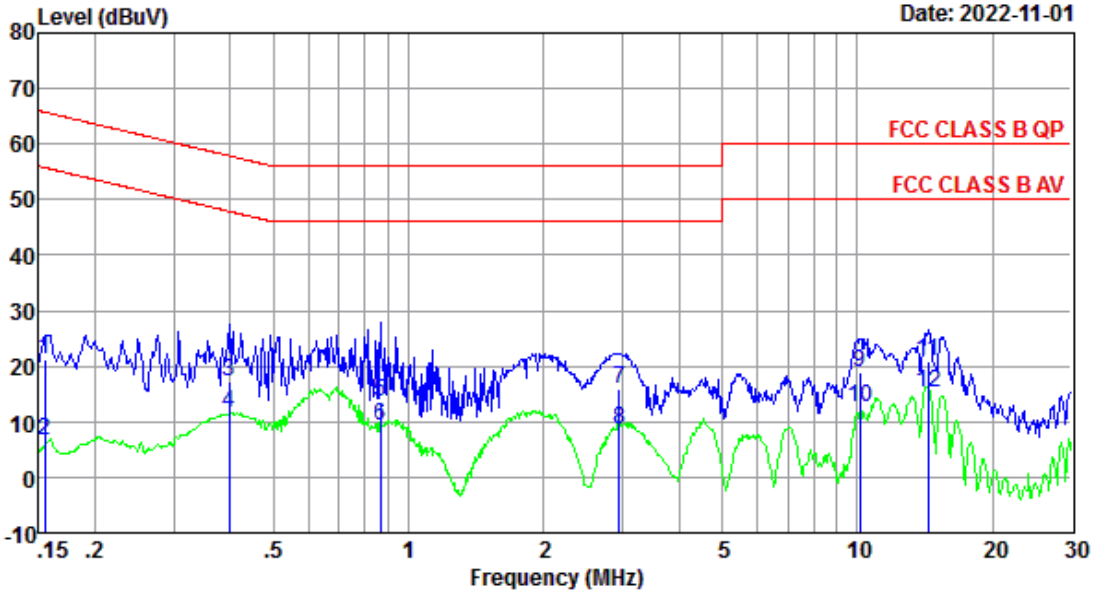
*Decreases with the logarithm of the frequency.

4.9.2 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.

4.9.3 Test Result of AC Conducted Emission

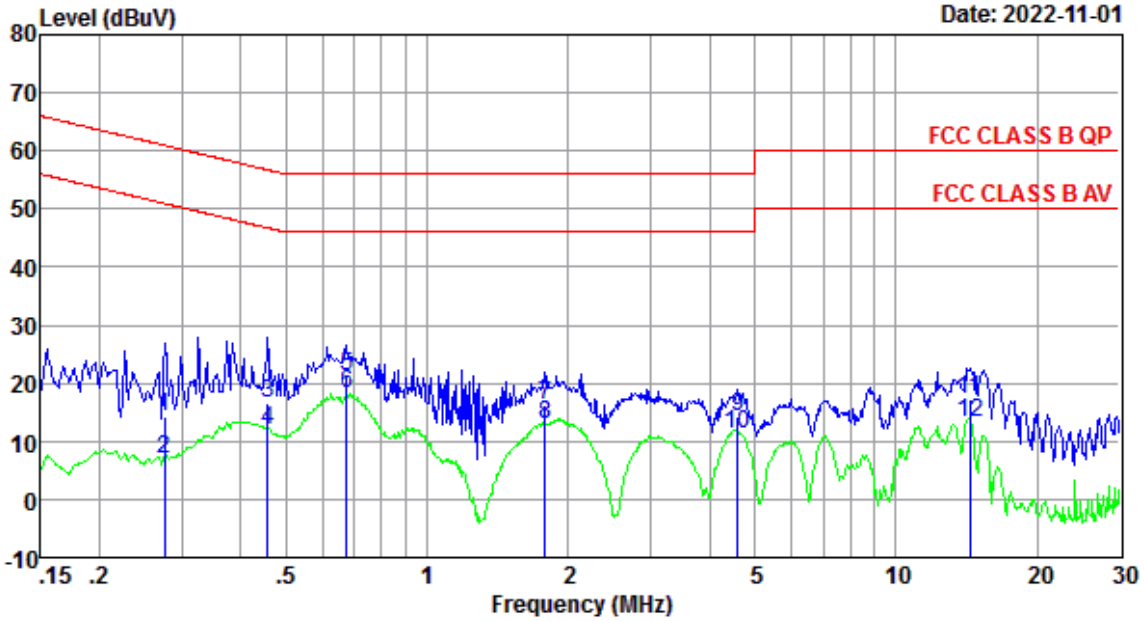
Test Mode :	Mode 1	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	51~53%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Function Type :	Bluetooth Link + USB Cable (Charging from Adapter)		



Freq	Reading level	LISN/ISN factor	Cable loss	Result level	Limit level	Over limit	Remark
MHz	dBuV	dB	dB	dBuV	dBuV	dB	
0.155	11.50	9.54	0.03	21.07	65.74	-44.67	QP
0.155	-2.90	9.54	0.03	6.67	55.74	-49.07	Average
0.398	7.50	9.59	0.03	17.12	57.90	-40.78	QP
0.398	1.90	9.59	0.03	11.52	47.90	-36.38	Average
0.866	3.90	9.65	0.06	13.61	56.00	-42.39	QP
0.866	-0.60	9.65	0.06	9.11	46.00	-36.89	Average
2.946	6.40	9.57	0.07	16.04	56.00	-39.96	QP
2.946	-0.90	9.57	0.07	8.74	46.00	-37.26	Average
10.125	8.90	9.81	0.13	18.84	60.00	-41.16	QP
10.125	2.70	9.81	0.13	12.64	50.00	-37.36	Average
14.364	10.80	9.97	0.13	20.90	60.00	-39.10	QP
14.364	5.20	9.97	0.13	15.30	50.00	-34.70	Average

Result Level= Reading Level + LISN Factor + Cable Loss

Test Mode :	Mode 1	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	51~53%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Function Type :	Bluetooth 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	
0.276	4.60	9.69	0.03	14.32	60.94	-46.62	QP
0.276	-2.80	9.69	0.03	6.92	50.94	-44.02	Average
0.456	6.80	9.66	0.03	16.49	56.76	-40.27	QP
0.456	2.30	9.66	0.03	11.99	46.76	-34.77	Average
0.672	11.50	9.66	0.03	21.19	56.00	-34.81	QP
0.672	8.60	9.66	0.03	18.29	46.00	-27.71	Average
1.781	6.50	9.66	0.06	16.22	56.00	-39.78	QP
1.781	3.20	9.66	0.06	12.92	46.00	-33.08	Average
4.598	4.40	9.68	0.09	14.17	56.00	-41.83	QP
4.598	1.40	9.68	0.09	11.17	46.00	-34.83	Average
14.364	7.10	10.13	0.13	17.36	60.00	-42.64	QP
14.364	2.90	10.13	0.13	13.16	50.00	-36.84	Average

Result Level= Reading Level + LISN Factor + Cable Loss

4.10 Antenna Requirements

4.10.1 Standard Applicable

According to antenna requirement of §15.203.

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

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

4.10.2 Antenna Connected Construction

An PCB antenna design is used.

4.10.3 Antenna Gain

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

5 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	Keysight	N9010A	MY56070788	2021-12-28	2022-12-27	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2021-12-30	2022-12-29	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2021-12-30	2022-12-29	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2021-12-30	2022-12-29	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2021-12-30	2022-12-29	Conducted
Thermal Chamber	Howkin	UHL-34	19111801	2022-04-18	2023-04-17	Conducted
Base Station	R&S	CMW 270	101231	2021-12-28	2022-12-27	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2021-12-28	2022-12-27	Conducted
Signal Generator (Blocker)	Keysight	N5171B	MY56200661	2021-12-28	2022-12-27	Conducted
Spectrum Analyzer	Keysight	N9010A	MY56070788	2022-12-26	2023-12-25	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2022-12-27	2023-12-26	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2022-12-27	2023-12-26	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2022-12-27	2023-12-26	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2022-12-27	2023-12-26	Conducted
Thermal Chamber	Howkin	UHL-34	19111801	2022-12-23	2023-12-22	Conducted
Base Station	R&S	CMW 270	101231	2022-12-26	2023-12-25	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2022-12-26	2023-12-25	Conducted
Signal Generator (Blocker)	Keysight	N5171B	MY56200661	2022-12-26	2023-12-25	Conducted

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV 40	101433	2021-12-29	2022-12-28	Radiation
Amplifier	Sonoma	310	363917	2021-12-29	2022-12-28	Radiation

Amplifier	Schwarzbeck	BBV 9718	327	2021-12-30	2022-12-29	Radiation
Amplifier	Narda	TTA1840-35-HG	2034380	2022-04-27	2023-04-26	Radiation
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-051	2020-02-14	2023-02-13	Radiation
Broadband Antenna	Schwarzbeck	VULB 9168	9168-757	2020-09-27	2023-09-26	Radiation
Horn Antenna	Schwarzbeck	BBHA 9120 D	1677	2020-02-14	2023-02-13	Radiation
Horn Antenna	COM-POWER	AH-1840	101117	2021-06-05	2024-06-04	Radiation
Test Software	Audix	E3	6.111221a	N/A	N/A	Radiation
Filter	Micro-Tronics	BRM 50702	G266	N/A	N/A	Radiation
Spectrum Analyzer	R&S	FSV 30	103728	2022-12-26	2023-12-25	Radiation
Amplifier	Sonoma	310	363917	2022-12-26	2023-12-25	Radiation
Amplifier	Schwarzbeck	BBV 9718	327	2022-12-27	2023-12-26	Radiation
Amplifier	Narda	TTA1840-35-HG	2034380	2020-01-06	2023-01-05	Radiation
Amplifier	Narda	TTA1840-35-HG	2034380	2023-01-04	2024-01-03	Radiation
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-051	2020-02-14	2023-02-13	Radiation
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-051	2023-02-12	2026-02-11	Radiation
Broadband Antenna	Schwarzbeck	VULB 9168	9168-757	2020-09-27	2023-09-26	Radiation
Horn Antenna	Schwarzbeck	BBHA 9120 D	1677	2020-02-14	2023-02-13	Radiation
Horn Antenna	Schwarzbeck	BBHA 9120 D	1677	2023-02-12	2026-02-11	Radiation
Horn Antenna	COM-POWER	AH-1840	101117	2021-06-05	2024-06-04	Radiation
LISN	R&S	ENV216	102125	2023-12-19	2023-12-20	Conducted
LISN	R&S	ENV432	101327	2023-12-19	2023-12-20	Conducted
EMI Test Receiver	R&S	ESR3	102143	2023-12-19	2023-12-20	Conducted

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
LISN	R&S	ENV216	102125	2021-12-29	2022-12-28	Conducted
LISN	R&S	ENV432	101327	2021-12-29	2022-12-28	Conducted
EMI Test Receiver	R&S	ESR3	102143	2021-12-30	2022-12-29	Conducted
EMI Test Software	Audix	E3	N/A	N/A	N/A	Conducted

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	3.29dB
Radiated emission	30MHz ~ 1GHz	5.40dB
	1GHz ~ 18GHz	5.03dB
	18GHz ~ 40GHz	5.21dB

MEASUREMENT	UNCERTAINTY
Occupied Channel Bandwidth	±57.212Hz
RF output power, conducted	±1.04dB
Power density, conducted	±2.31dB
Emissions, conducted	±2.18dB

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

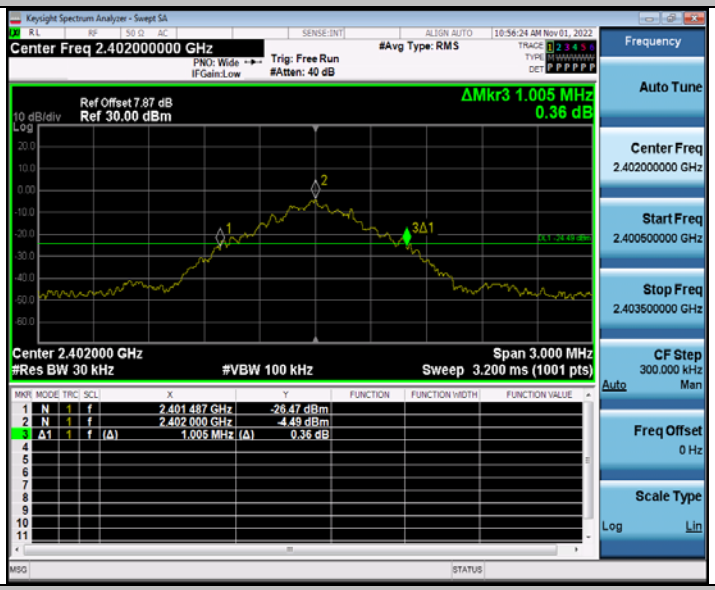
Appendix A: 20dB Emission Bandwidth

Test Result

TestMode	Antenna	Channel	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	1.005	2401.487	2402.492	---	---
		2441	0.999	2440.478	2441.477	---	---
		2480	1.017	2479.484	2480.501	---	---

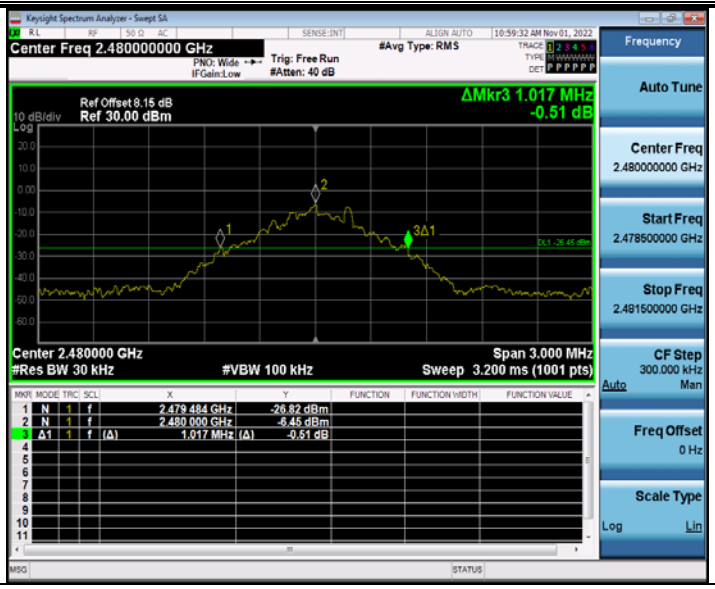
Test Graphs

DH5_Ant1_2402



DH5_Ant1_2441

DH5_Ant1_2480


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
10:59:32 AM Nov 01, 2022
Ref Offset 8.15 dB
10 dB/div
Ref 30.00 dBm
ΔMkr3 1.017 MHz
-0.51 dB
Center 2.480000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.200 ms (1001 pts)
1 N 1 f 2.479 484 GHz -26.82 dBm
2 N 1 f 2.480 000 GHz -6.45 dBm
3 Δ1 1 f (Δ) 1.017 MHz (Δ) -0.51 dB
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.478500000 GHz
Stop Freq
2.481500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

Appendix B: Occupied Channel Bandwidth

Test Result

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.92938	2401.5335	2402.4629	---	---
		2441	0.92158	2440.5415	2441.4631	---	---
		2480	0.92168	2479.5441	2480.4658	---	---

Test Graphs

DH5_Ant1_2402

DH5_Ant1_2441

DH5_Ant1_2480


Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold: 100/100
#Atten: 40 dB
Radio Std: None
Radio Device: BTS
Frequency
Ref Offset 8.15 dB
10 dB/div
Ref 30.00 dBm
Mkr1 2.48 GHz
-7.8472 dBm
Center Freq
2.480000000 GHz
Center 2.48 GHz
#Res BW 20 kHz
#VBW 62 kHz
Span 3 MHz
Sweep 7.2 ms
CF Step
300.000 kHz
Auto
Man
Occupied Bandwidth
921.68 kHz
Total Power
0.82 dBm
Transmit Freq Error
4.916 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.119 MHz
x dB
-26.00 dB
Freq Offset
0 Hz
MSG
STATUS

Appendix C: Maximum conducted output power

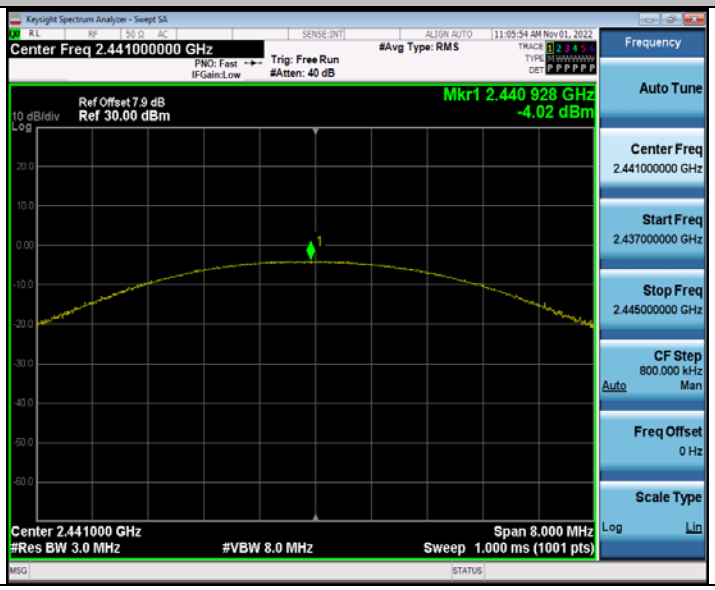
Test Result

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH5	Ant1	2402	-2.84	≤20.97	PASS
		2441	-4.02	≤20.97	PASS
		2480	-5.17	≤20.97	PASS

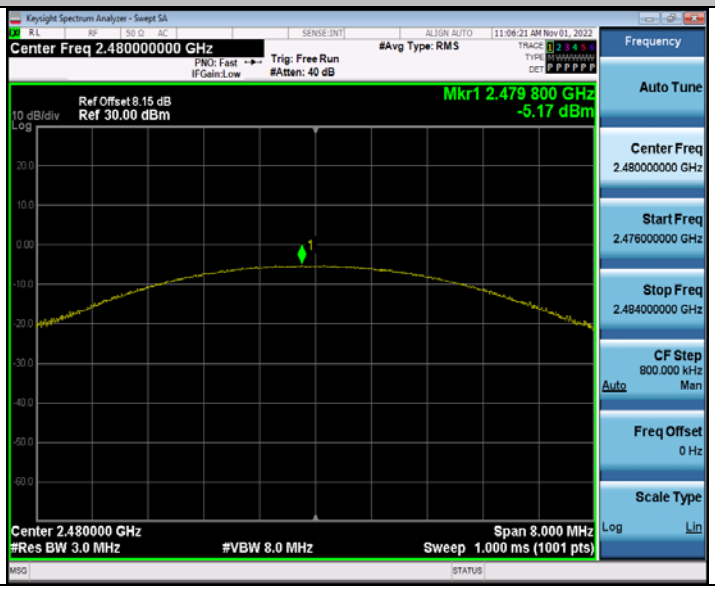
Test Graphs

DH5_Ant1_2402

DH5_Ant1_2441



DH5_Ant1_2480



Appendix D: Carrier frequency separation

Test Result

TestMode	Antenna	Channel	Result[Mhz]	Limit[Mhz]	Verdict
DH5	Ant1	Hop	1.348	≥1.017	PASS

Test Graphs

DH5_Ant1_Hop

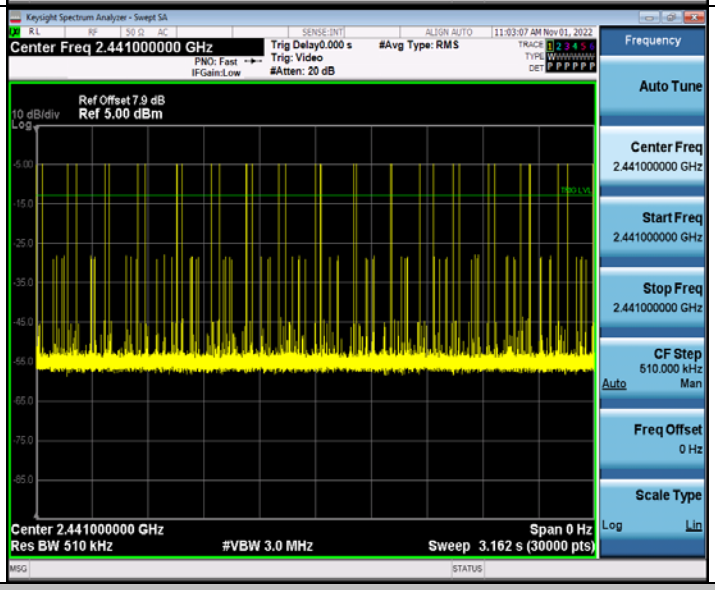

Appendix E: Time of occupancy

Test Result

TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.44	330	0.145	≤0.4	PASS
DH3	Ant1	Hop	1.69	190	0.321	≤0.4	PASS
DH5	Ant1	Hop	2.94	110	0.323	≤0.4	PASS

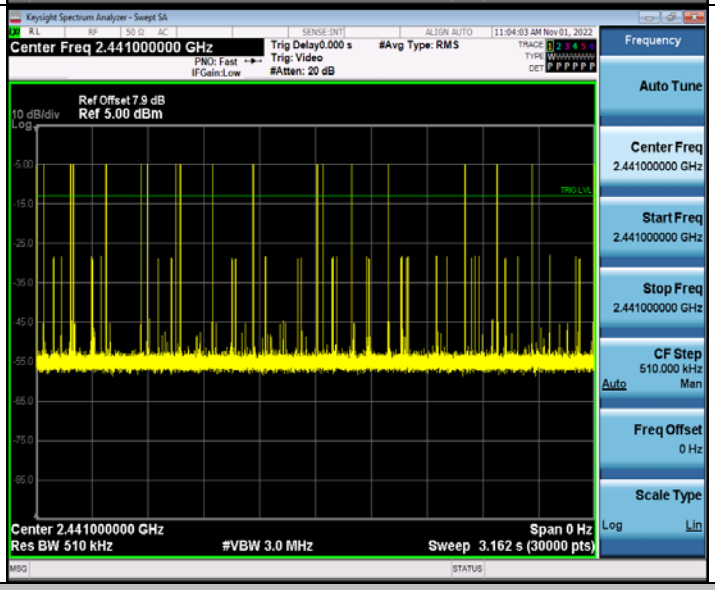
Test Graphs

DH1_Ant1_Hop



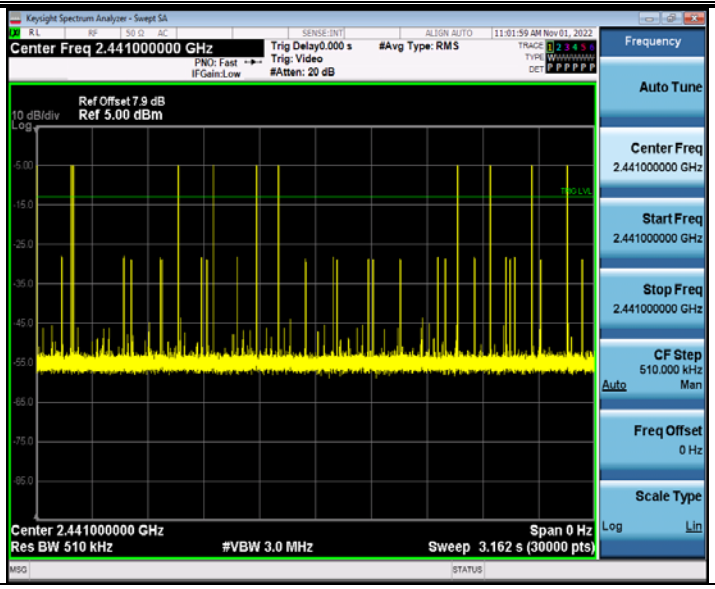
DH3_Ant1_Hop


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Fast
IFGain:Low
Trig Delay-2.000 ms
Trig: Video
#Atten: 20 dB
#Avg Type: RMS
11:03:57 AM Nov 01, 2022
ΔMkr2 1.690 ms
19.60 dB
Ref Offset 7.9 dB
10 dB/div
Ref 5.00 dBm
Center 2.441000000 GHz
Res BW 1.0 MHz
#VBW 3.0 MHz
Span 0 Hz
Sweep 10.13 ms (8000 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
CF Step
1.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Fast
IFGain:Low
Trig Delay0.000 s
Trig: Video
#Atten: 20 dB
#Avg Type: RMS
11:04:03 AM Nov 01, 2022
Ref Offset 7.9 dB
10 dB/div
Ref 5.00 dBm
Center 2.441000000 GHz
Res BW 510 kHz
#VBW 3.0 MHz
Span 0 Hz
Sweep 3.162 s (30000 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
CF Step
510.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

DH5_Ant1_Hop


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Fast
IFGain:Low
Trig Delay-2.000 ms
Trig: Video
#Atten: 20 dB
#Avg Type: RMS
11:01:53 AM Nov 01, 2022
ΔMkr2 2.940 ms
16.74 dB
Ref Offset 7.9 dB
10 dB/div
Ref 5.00 dBm
Center 2.441000000 GHz
Res BW 1.0 MHz
#VBW 3.0 MHz
Span 0 Hz
Sweep 10.13 ms (8000 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
CF Step
1.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Fast
IFGain:Low
Trig Delay0.000 s
Trig: Video
#Atten: 20 dB
#Avg Type: RMS
11:01:59 AM Nov 01, 2022
Ref Offset 7.9 dB
10 dB/div
Ref 5.00 dBm
Log
-5.00
-15.0
-25.0
-35.0
-45.0
-55.0
-65.0
-75.0
-85.0
Center 2.441000000 GHz
Res BW 510 kHz
#VBW 3.0 MHz
Span 0 Hz
Sweep 3.162 s (30000 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
CF Step
510.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
MSG
STATUS

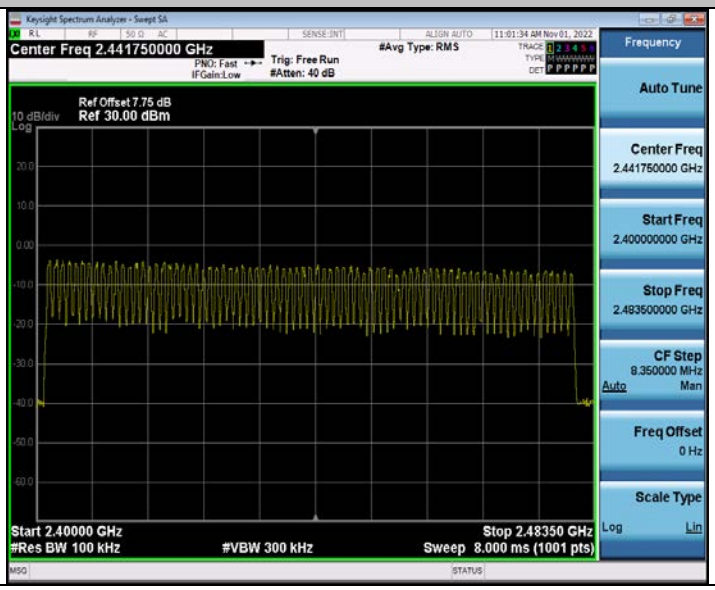
Appendix F: Number of hopping channels

Test Result

TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH5	Ant1	Hop	79	≥15	PASS

Test Graphs

DH5_Ant1_Hop



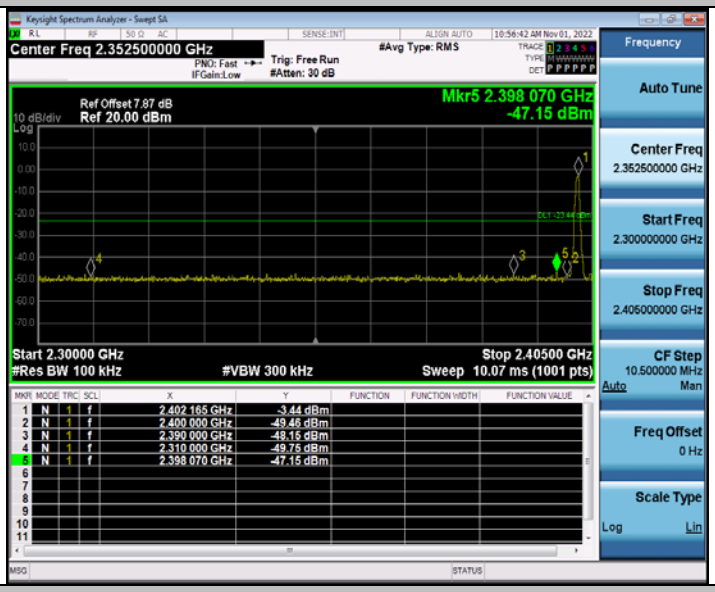
Appendix G: Band edge measurements

Test Result

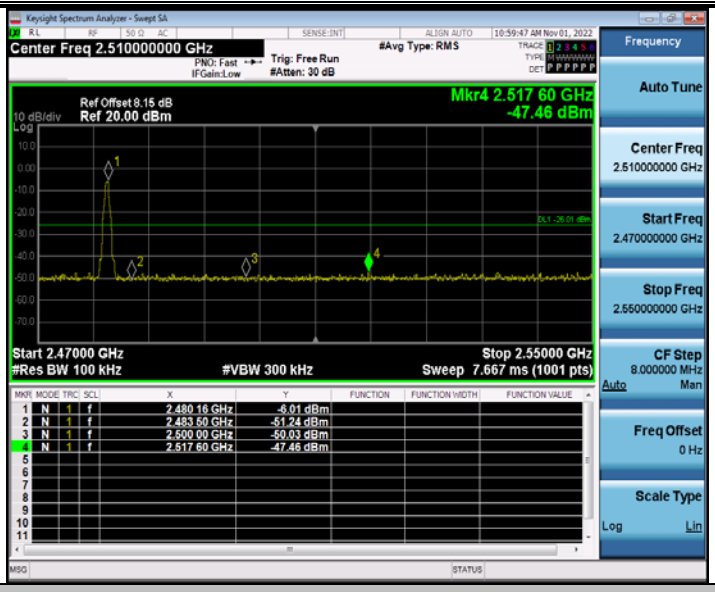
TestMode	Antenna	ChName	Channel	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	Low	2402	-3.44	-47.15	≤-23.44	PASS
		High	2480	-6.01	-47.46	≤-26.01	PASS
		Low	Hop_2402	-3.99	-45.54	≤-23.99	PASS
		High	Hop_2480	-6.23	-48.01	≤-26.23	PASS

Test Graphs

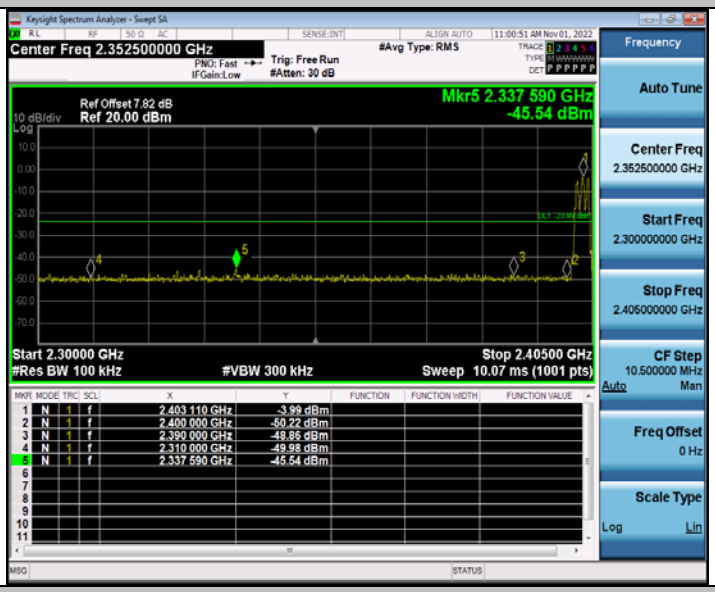
DH5_Ant1_Low_2402



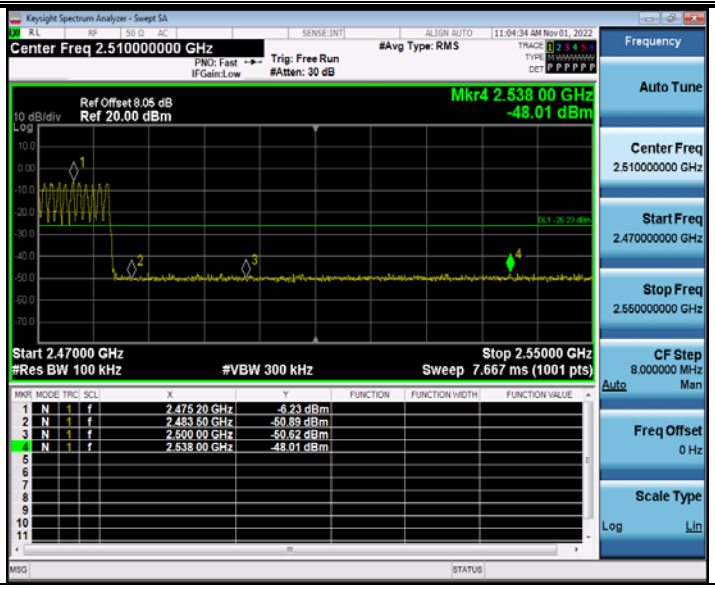
DH5_Ant1_High_2480



DH5_Ant1_Low_Hop_2402



DH5_Ant1_High_Hop_2480


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.510000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
11:04:34 AM Nov 01, 2022
Ref Offset 8.05 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr4 2.538 00 GHz
-48.01 dBm
Start 2.47000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.55000 GHz
Sweep 7.667 ms (1001 pts)
1 N 1 f 2.475 20 GHz -6.23 dBm
2 N 1 f 2.483 50 GHz -50.89 dBm
3 N 1 f 2.500 00 GHz -50.62 dBm
4 N 1 f 2.538 00 GHz -48.01 dBm
Frequency
Auto Tune
Center Freq
2.510000000 GHz
Start Freq
2.470000000 GHz
Stop Freq
2.550000000 GHz
CF Step
8.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
MSG
STATUS

Appendix H: Conducted Spurious Emission

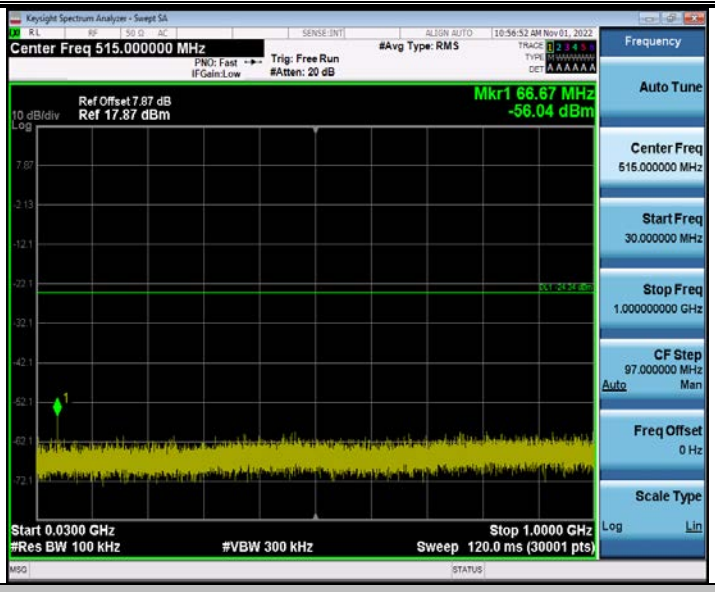
Test Result

TestMode	Antenna	Channel	FreqRange [MHz]	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	2402	Reference	-4.34	-4.34	---	PASS
			30~1000	-4.34	-56.04	≤-24.34	PASS
			1000~26500	-4.34	-38.76	≤-24.34	PASS
		2441	Reference	-4.90	-4.90	---	PASS
			30~1000	-4.90	-56.26	≤-24.9	PASS
			1000~26500	-4.90	-38.17	≤-24.9	PASS
		2480	Reference	-6.99	-6.99	---	PASS
			30~1000	-6.99	-55.44	≤-26.99	PASS
			1000~26500	-6.99	-38.54	≤-26.99	PASS

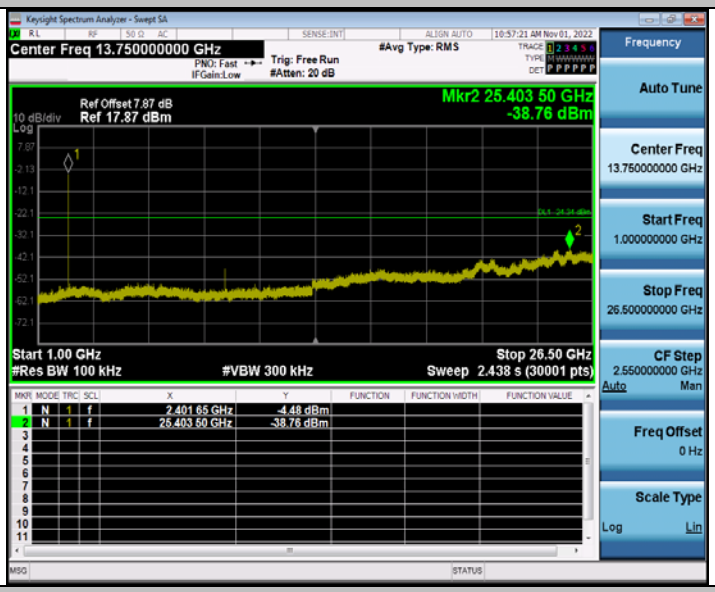
Test Graphs

DH5_Ant1_2402_0~Reference

DH5_Ant1_2402_30~1000

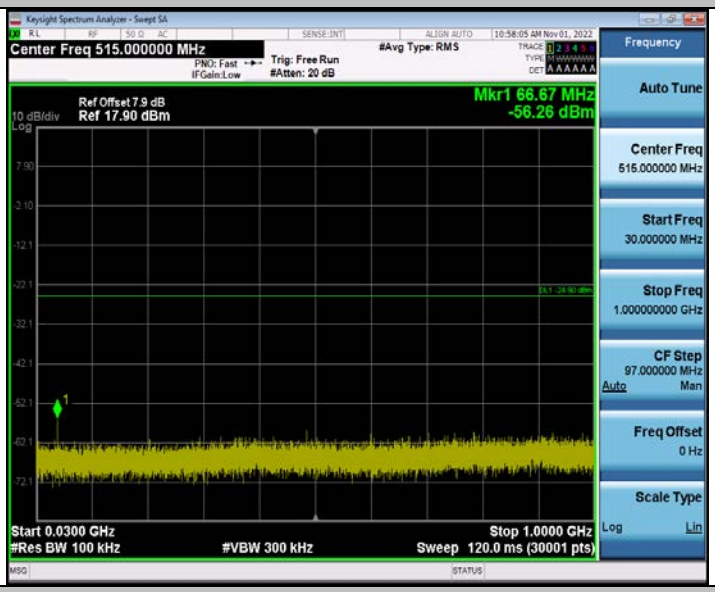


DH5_Ant1_2402_1000~26500

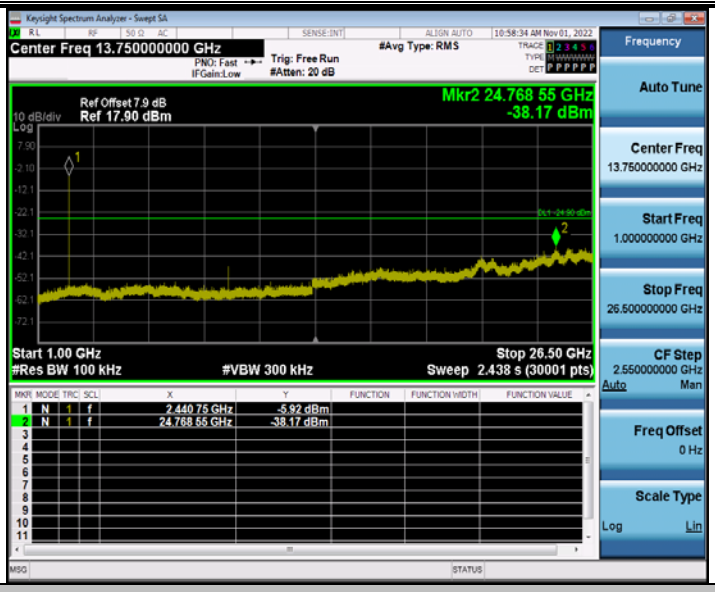


DH5_Ant1_2441_0~Reference

DH5_Ant1_2441_30~1000

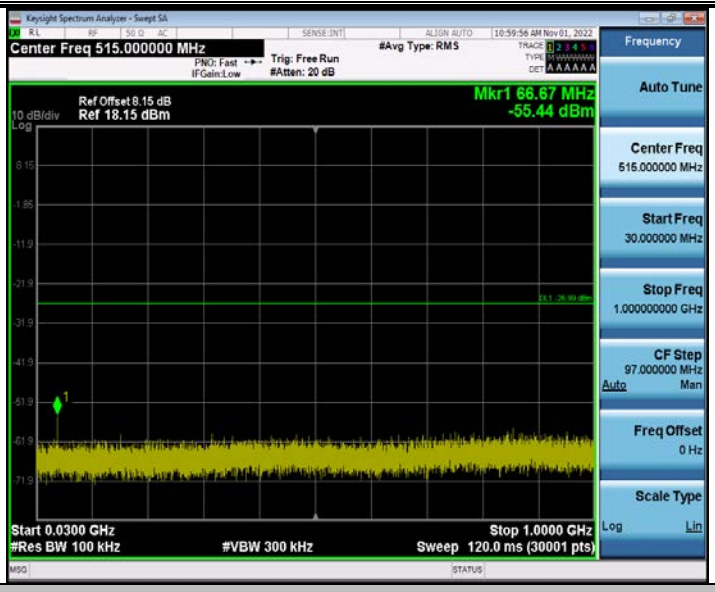


DH5_Ant1_2441_1000~26500

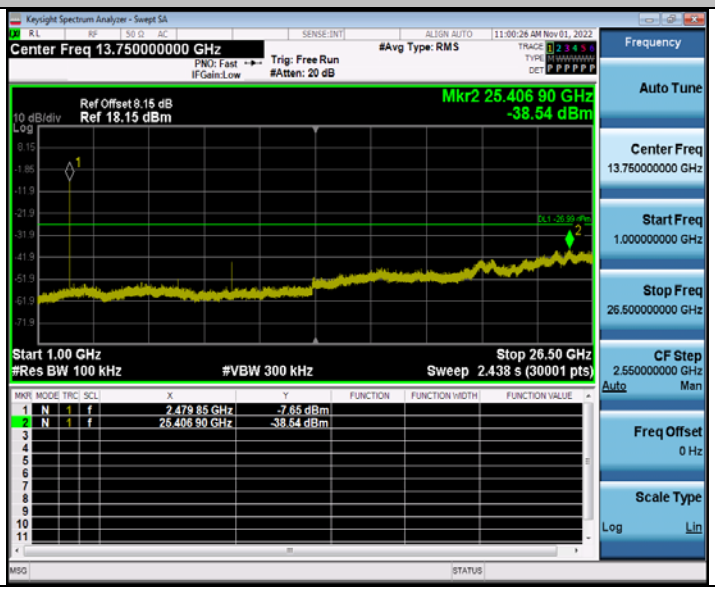


DH5_Ant1_2480_0~Reference

DH5_Ant1_2480_30~1000



DH5_Ant1_2480_1000~26500



Appendix I. Setup Photographs

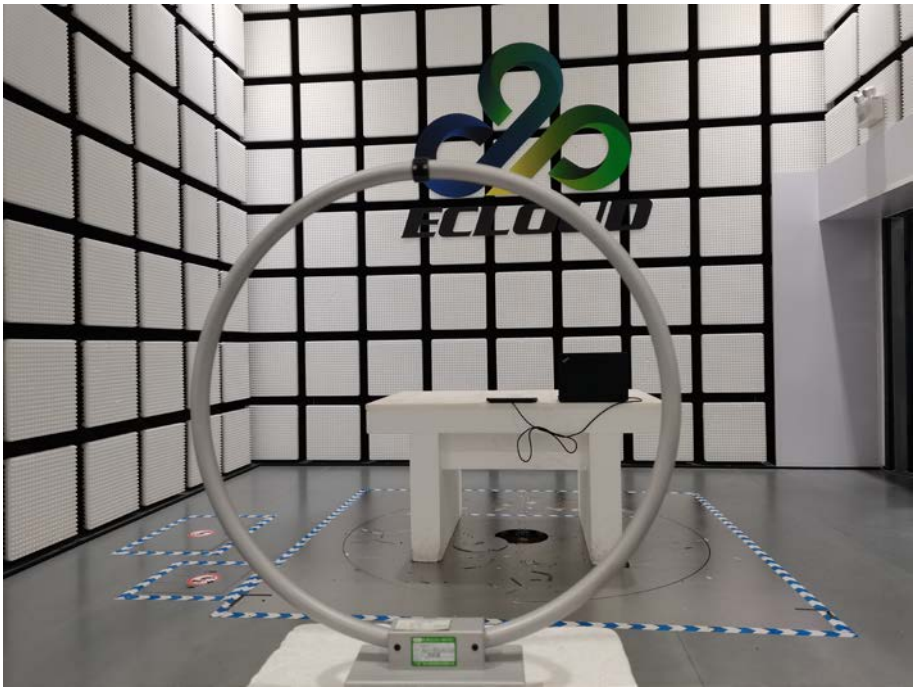


Fig. 1 Radiated emission setup photo(Below 30MHz)

Fig. 2 Radiated emission setup photo(30MHz-1GHz)

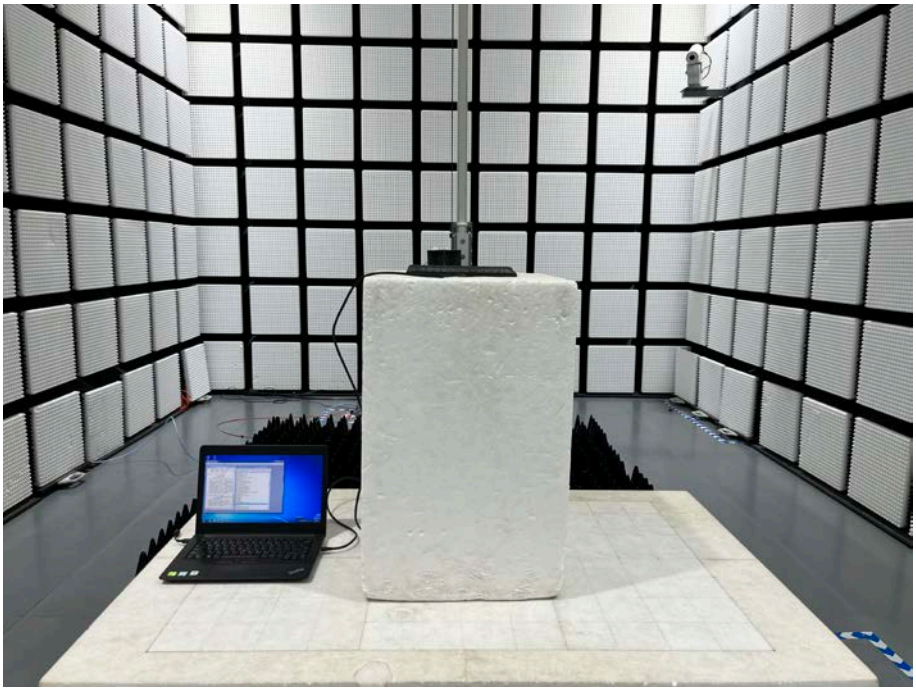


Fig. 3 Radiated emission setup photo(Above 1GHz)

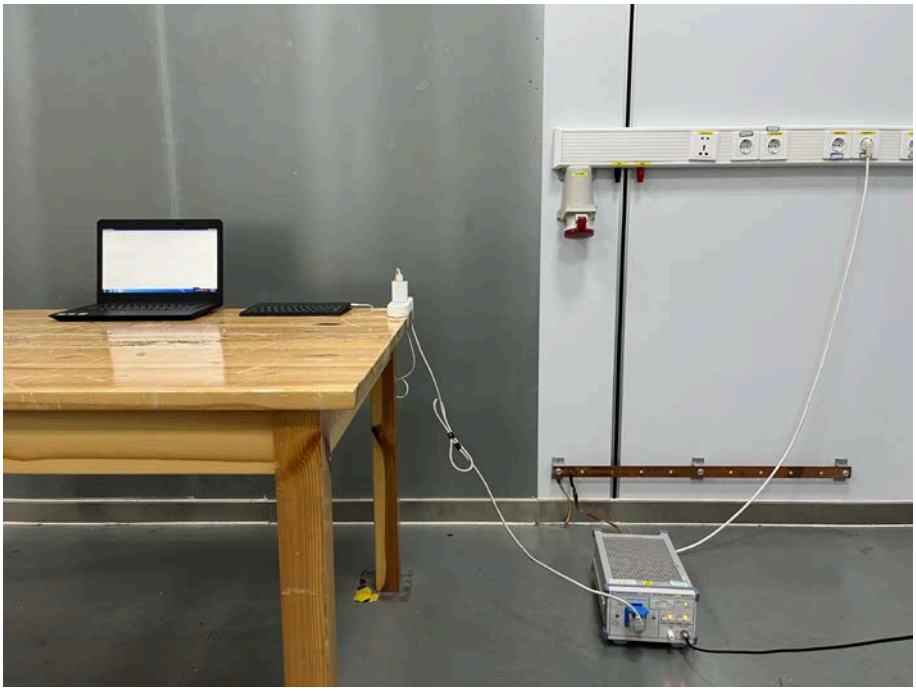


Fig. 4 Power line conducted emission setup photo

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