



RF MEASUREMENT REPORT

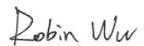
FCC ID: 2A846-MA325
Applicant: MS Electronics, LLC
Product: Amplifier
Model No.: MA325
Brand Name: MSE
FCC Classification: Digital Transmission System (DTS)
FCC Rule Part(s): Part 15 Subpart C (Section 15.247)
Result: Complies
Received Date: 2022-11-02
Test Date: 2023-01-13 ~ 2023-01-17

Reviewed By:



Kevin Guo

Approved By:



Robin Wu



The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

The test report shall not be reproduced except in full without the written approval of MRT Technology (Suzhou) Co., Ltd.

Revision History

Report No.	Version	Description	Issue Date	Note
2211RSU002-U2	V01	Initial Report	2023-02-17	Valid

CONTENTS

Description	Page
1. General Information	5
1.1. Applicant	5
1.2. Manufacturer	5
1.3. Testing Facility	5
1.4. Product Information	6
1.5. Radio Specification under Test	6
1.6. Working Frequencies	6
2. Test Configuration	7
2.1. Test System Connection Diagram	7
2.2. Test Software	7
2.3. Applied Standards	8
2.4. Test Environment Condition	8
3. Antenna Requirements	9
4. Measuring Instrument	10
5. Decision Rules and Measurement Uncertainty	11
5.1. Decision Rules	11
5.2. Measurement Uncertainty	11
6. Test Result	12
6.1. Summary	12
6.2. 6dB Bandwidth Measurement	13
6.2.1. Test Limit	13
6.2.2. Test Procedure	13
6.2.3. Test Setting	13
6.2.4. Test Setup	13
6.2.5. Test Result	13
6.3. Output Power Measurement	14
6.3.1. Test Limit	14
6.3.2. Test Procedure	14
6.3.3. Test Setting	14
6.3.4. Test Setup	14
6.3.5. Test Result	14
6.4. Power Spectral Density Measurement	15
6.4.1. Test Limit	15
6.4.2. Test Procedure	15
6.4.3. Test Setting	15

6.4.4.	Test Setup	15
6.4.5.	Test Result	15
6.5.	Conducted Band Edge and Out-of-Band Emissions Measurement	16
6.5.1.	Test Limit	16
6.5.2.	Test Procedure	16
6.5.3.	Test Settling	16
6.5.4.	Test Setup	16
6.5.5.	Test Result	17
6.6.	Radiated Spurious Emission Measurement.....	18
6.6.1.	Test Limit	18
6.6.2.	Test Procedure	18
6.6.3.	Test Setting	18
6.6.4.	Test Setup	20
6.6.5.	Test Result	21
6.7.	Radiated Restricted Band Edge Measurement	22
6.7.1.	Test Limit	22
6.7.2.	Test Procedure	23
6.7.3.	Test Setting	23
6.7.4.	Test Setup	24
6.7.5.	Test Result	24
6.8.	AC Conducted Emissions Measurement	25
6.8.1.	Test Limit	25
6.8.2.	Test Setup	25
6.8.3.	Test Result	25
Appendix A - Test Result.....		26
A.1	Duty Cycle Test Result.....	26
A.2	6dB Bandwidth Test Result	27
A.3	Output Power Test Result	28
A.4	Power Spectral Density Test Result.....	29
A.5	Conducted Band Edge and Out-of-Band Emissions Test Result.....	30
A.6	Radiated Spurious Emission Test Result.....	32
A.7	Radiated Restricted Band Edge Test Result.....	35
A.8	AC Conducted Emissions Test Result	43
Appendix B - Test Setup Photograph		45
Appendix C - EUT Photograph		46

1. General Information

1.1. Applicant

MS Electronics, LLC

13720 W 109th St, Lenexa, KS 66215

1.2. Manufacturer

MS Electronics, LLC

13720 W 109th St, Lenexa, KS 66215

1.3. Testing Facility

☒	Test Site – MRT Suzhou Laboratory
	Laboratory Location (Suzhou - Wuzhong) D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China
	Laboratory Location (Suzhou - SIP) 4b Building, Liando U Valley, No.200 Xingpu Rd., Shengpu Town, Suzhou Industrial Park, China
	Laboratory Accreditations
	A2LA: 3628.01 FCC: CN1166 VCCI: ☐ R-20025 ☐ G-20034 ☐ C-20020 ☐ T-20020 ☐ R-20141 ☐ G-20134 ☐ C-20103 ☐ T-20104
	CNAS: L10551 ISED: CN0001
☐	Test Site – MRT Shenzhen Laboratory
	Laboratory Location (Shenzhen) 1G, Building A, Junxiangda Building, Zhongshanyuan Road West, Nanshan District, Shenzhen, China
	Laboratory Accreditations
	A2LA: 3628.02 FCC: CN1284
	CNAS: L10551 ISED: CN0105
☐	Test Site – MRT Taiwan Laboratory
	Laboratory Location (Taiwan) No. 38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)
	Laboratory Accreditations
	TAF: L3261-190725 FCC: 291082, TW3261 ISED: TW3261

1.4. Product Information

Product Name	Amplifier
Model No.	MA325
Bluetooth Specification	V5.0 Bluetooth-LE only
EUT Serial No.	H22XMSESUBBP0001(for Radiated), H22XMSESUBBP0002(for Conducted)
Operating Temperature	0~40°C
Power Supply	100-120VAC / 220-240VAC 50/60Hz 320W
Note: The information of EUT was provided by the manufacturer, and the accuracy of the information shall be the responsibility of the manufacturer.	

1.5. Radio Specification under Test

Bluetooth Frequency	2402 ~ 2480MHz
Channel Number	40
Type of modulation	GFSK
Data Rate	1Mbps
Antenna Type	PCB Antenna
Antenna Gain	1.13

1.6. Working Frequencies

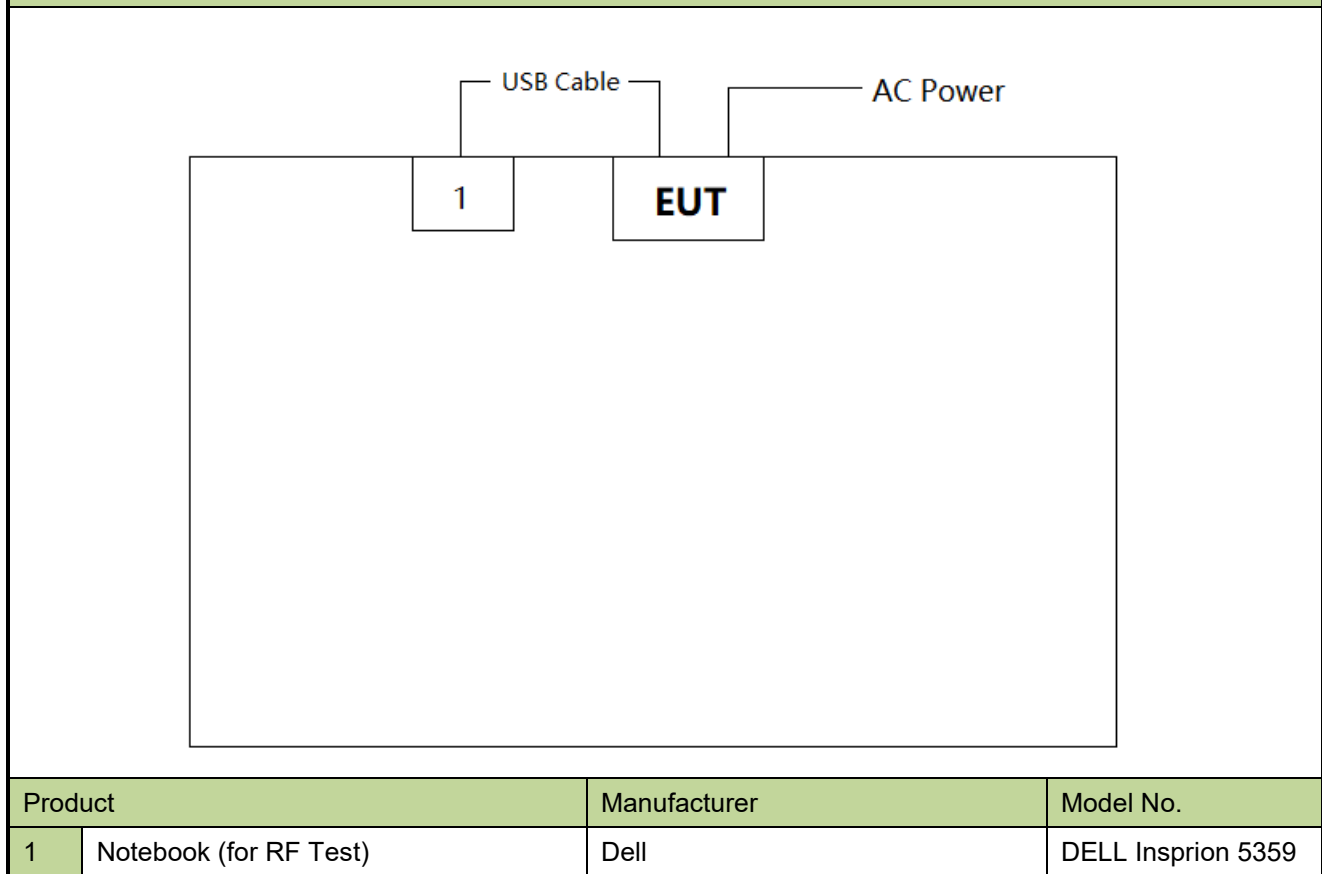
Channel	Frequency	Channel	Frequency	Channel	Frequency
00	2402 MHz	01	2404 MHz	02	2406 MHz
03	2408 MHz	04	2410 MHz	05	2412 MHz
06	2414 MHz	07	2416 MHz	08	2418 MHz
09	2420 MHz	10	2422 MHz	11	2424 MHz
12	2426 MHz	13	2428 MHz	14	2430 MHz
15	2432 MHz	16	2434 MHz	17	2436 MHz
18	2438 MHz	19	2440 MHz	20	2442 MHz
21	2444 MHz	22	2446 MHz	23	2448 MHz
24	2450 MHz	25	2452 MHz	26	2454 MHz
27	2456 MHz	28	2458 MHz	29	2460 MHz
30	2462 MHz	31	2464 MHz	32	2466 MHz
33	2468 MHz	34	2470 MHz	35	2472 MHz
36	2474 MHz	37	2476 MHz	38	2478 MHz
39	2480 MHz	--	--	--	--

2. Test Configuration

2.1. Test System Connection Diagram

The device was tested per the guidance ANSI C63.10: 2013 was used to reference the appropriate EUT setup for radiated emissions testing and AC line conducted testing.

Connection Diagram – Radiated Emission testing & AC Conducted Emissions



2.2. Test Software

The test utility software used during testing was “LeKit”, and the version was v2.5.1a.

2.3. Applied Standards

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

- FCC Part 15.247
- KDB 558074 D01v05r02
- ANSI C63.10-2013

2.4. Test Environment Condition

Ambient Temperature	15 ~ 35°C
Relative Humidity	20 ~75%RH

3. Antenna Requirements

Excerpt from §15.203 of the FCC Rules/Regulations:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antenna of the device is **permanently attached**.
- There are no provisions for connection to an external antenna.

Conclusion:

The unit complies with the requirement of §15.203.

4. Measuring Instrument

Instrument	Manufacturer	Model No.	Asset No.	Cali. Interval	Cali. Due Date	Test Site
EMI Test Receiver	R&S	ESR7	MRTSUE06001	1 year	2023-12-28	WZ-AC1
Horn Antenna	Schwarzbeck	BBHA 9120D	MRTSUE06023	1 year	2023-08-22	WZ-AC1
Preamplifier	Agilent	83017A	MRTSUE06076	1 year	2023-05-08	WZ-AC1
TRILOG Antenna	Schwarzbeck	VULB 9168	MRTSUE06172	1 year	2023-06-21	WZ-AC1
Anechoic Chamber	TDK	WZ-AC1	MRTSUE06212	1 year	2023-04-21	WZ-AC1
Thermohygrometer	testo	608-H1	MRTSUE06403	1 year	2023-06-06	WZ-AC1
Signal Analyzer	Keysight	N9010B	MRTSUE06607	1 year	2023-12-28	WZ-AC1
Thermohygrometer	testo	608-H1	MRTSUE11039	1 year	2023-11-01	WZ-AC1
Loop Antenna	Schwarzbeck	FMZB 1519	MRTSUE06025	1 year	2023-09-29	WZ-AC1
Two-Line V-Network	R&S	ENV216	MRTSUE06002	1 year	2023-06-04	WZ-SR2
Symmetrical Attenuator	Schwarzbeck	SYMAT 40	MRTSUE06117	1 year	2023-04-10	WZ-SR2
Passive Voltage Probe	R&S	ESH2-Z3	MRTSUE06189	1 year	2023-04-06	WZ-SR2
Shielding Room	MIX-BEP	WZ-SR2	MRTSUE06215	5 years	2026-12-20	WZ-SR2
Thermohygrometer	testo	608-H1	MRTSUE06404	1 year	2023-06-06	WZ-SR2
Four-Line V-Network	R&S	ENV432	MRTSUE06615	1 year	2023-10-08	WZ-SR2
EMI Test Receiver	R&S	ESR3	MRTSUE06909	1 year	2023-10-27	WZ-SR2
USB Power Sensor	Keysight	U2021XA	MRTSUE06446	1 year	2023-06-04	WZ-TR3
Temperature Chamber	BAOYT	BYH-150CL	MRTSUE06051	1 year	2023-10-08	WZ-TR3
Thermohygrometer	testo	608-H1	MRTSUE06401	1 year	2023-06-06	WZ-TR3
Attenuator	MVE	MVE2213	MRTSUE11078	1 year	2023-06-09	WZ
Attenuator	MVE	MVE2213	MRTSUE11091	1 year	2023-06-09	WZ
Signal Analyzer	Keysight	N9010B	MRTSUE07027	1 year	2023-11-25	WZ-TR3
Signal Analyzer	Keysight	N9010B	MRTSUE06457	1 year	2023-06-04	WZ-TR3

Software	Version	Function
EMI Software	V3.0.0	EMI Test Software
Controller_MF 7802	2.03C	RE Antenna & Turntable
Agilent Power Analyzer/Agilent Power Panel	V R03.09.00	Power

5. Decision Rules and Measurement Uncertainty

5.1. Decision Rules

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4: 2012 Clause 8.2.

(Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.2. Measurement Uncertainty

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k = 2$.

AC Conducted Emission Measurement	
Measurement Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
9kHz~150kHz:	3.58dB
150kHz~30MHz:	3.20dB
Radiated Disturbance	
Measurement Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
Coaxial:	9kHz~30MHz: 2.59dB
Coplanar:	9kHz~30MHz: 2.60dB
Horizontal:	30MHz~200MHz: 3.85dB
	200MHz~1GHz: 4.36dB
	1GHz~40GHz: 4.98dB
Vertical:	30MHz~200MHz: 4.06dB
	200MHz~1GHz: 5.28dB
	1GHz~40GHz: 4.91dB
Spurious Emissions, Conducted	
Measuring Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
	2.3dB
Output Power	
Measuring Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
	1.5dB
Power Spectrum Density	
Measuring Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
	2.3dB
Occupied Bandwidth	
Measuring Uncertainty for a Level of Confidence of 95% ($U=2U_c(y)$):	
	3.2%

6. Test Result

6.1. Summary

FCC Section(s)	Test Description	Test Condition	Verdict
15.247(a)(2)	6dB Bandwidth	Conducted	Pass
15.247(b)(3)	Output Power		Pass
15.247(e)	Power Spectral Density		Pass
15.247(d)	Band Edge / Out-of-Band Emissions		Pass
15.205 15.209	General Field Strength (Restricted Bands and Radiated Emission)	Radiated	Pass
15.207	AC Conducted Emissions 150kHz - 30MHz	Line Conducted	Pass

Notes:

1. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
2. For radiated emission test, every axis (X, Y, Z) was also verified. The test results shown in the following sections represent the worst-case emissions.

6.2. 6dB Bandwidth Measurement

6.2.1. Test Limit

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

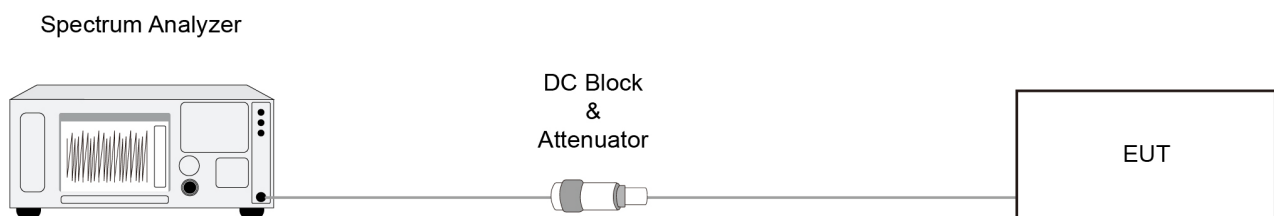
6.2.2. Test Procedure

ANSI C63.10 - 2013 - Section 11.8

6.2.3. Test Setting

1. The Spectrum's automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to $X = 6$. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. Set RBW = 100 kHz
3. $VBW \geq 3 \times RBW$
4. Detector = Peak
5. Trace mode = Max hold
6. Sweep = Auto couple
7. Allow the trace to stabilize

6.2.4. Test Setup



6.2.5. Test Result

Refer to Appendix A.2.

6.3. Output Power Measurement

6.3.1. Test Limit

The maximum output power shall be less 1 Watt (30dBm).

The conducted output power limit specified in paragraph FCC Part 15.247(b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs FCC Part 15.247(b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.3.2. Test Procedure

ANSI C63.10 - 2013 - Section 11.9.1.3

ANSI C63.10 - 2013 - Section 11.9.2.3.2

6.3.3. Test Setting

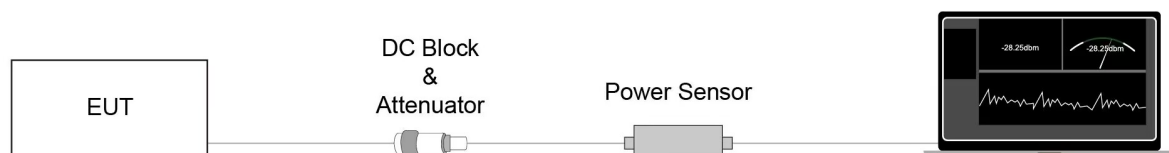
Method PKPM1 (Peak Power Measurement of Signals with DTS BW $\leq$ 50MHz)

Peak power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The pulse sensor employs a VBW = 50MHz so this method was only used for signals whose DTS bandwidth was less than or equal to 50MHz.

Average Power Measurement

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter.

6.3.4. Test Setup



6.3.5. Test Result

Refer to Appendix A.3.

6.4. Power Spectral Density Measurement

6.4.1. Test Limit

The maximum permissible power spectral density is 8dBm in any 3 kHz band.

The same method of determining the conducted output power shall be used to determine the power spectral density.

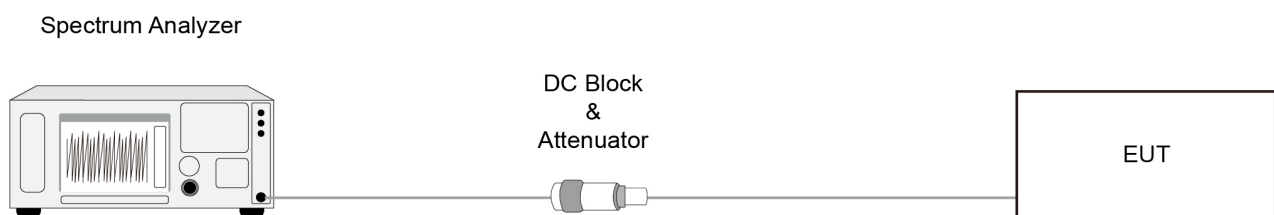
6.4.2. Test Procedure

ANSI C63.10-2013 Section 11.10.2

6.4.3. Test Setting

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3 kHz
4. VBW $\geq 3 \times$ RBW
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

6.4.4. Test Setup



6.4.5. Test Result

Refer to Appendix A.4.

6.5. Conducted Band Edge and Out-of-Band Emissions Measurement

6.5.1. Test Limit

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100 kHz bandwidth per the PSD procedure.

6.5.2. Test Procedure

ANSI C63.10-2013 - Section 11.11

6.5.3. Test Settling

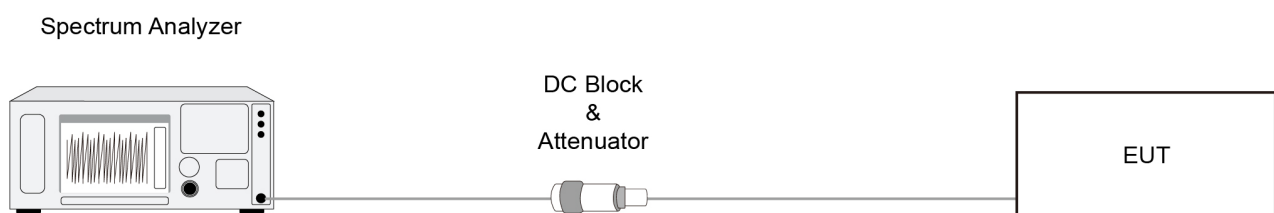
Reference level measurement

1. Set instrument center frequency to DTS channel center frequency
2. Set the span to ≥ 1.5 times the DTS bandwidth
3. Set the RBW = 100 kHz
4. Set the VBW $\geq 3 \times$ RBW
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Allow trace to fully stabilize

Emission level measurement

1. Set the center frequency and span to encompass frequency range to be measured
2. RBW = 100kHz
3. VBW $\geq 3 \times$ RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

6.5.4. Test Setup



6.5.5. Test Result

Refer to Appendix A.5.

6.6. Radiated Spurious Emission Measurement

6.6.1. Test Limit

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table per Section 15.209.

FCC Part 15 Subpart C Paragraph 15.209		
Frequency [MHz]	Field Strength [uV/m]	Measured Distance [Meters]
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

6.6.2. Test Procedure

ANSI C63.10 - 2013 - Section 11.11 & 11.12

ANSI C63.10 - 2013 - Section 6.3 (General Requirements)

ANSI C63.10 - 2013 - Section 6.4 (Standard test method below 30MHz)

ANSI C63.10 - 2013 - Section 6.5 (Standard test method above 30MHz to 1GHz)

ANSI C63.10 - 2013 - Section 6.6 (Standard test method above 1GHz)

6.6.3. Test Setting

Table 1 - RBW as a function of frequency

Frequency	RBW
9 ~ 150 kHz	200 ~ 300 Hz
0.15 ~ 30 MHz	9 ~ 10 kHz
30 ~ 1000 MHz	100 ~ 120 kHz
> 1000MHz	1MHz

Quasi-Peak Measurements below 1GHz

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Span was set greater than 1MHz
3. RBW = as specified in Table 1
4. Detector = CISPR quasi-peak
5. Sweep time = auto couple
6. Trace was allowed to stabilize

Peak Measurements above 1GHz

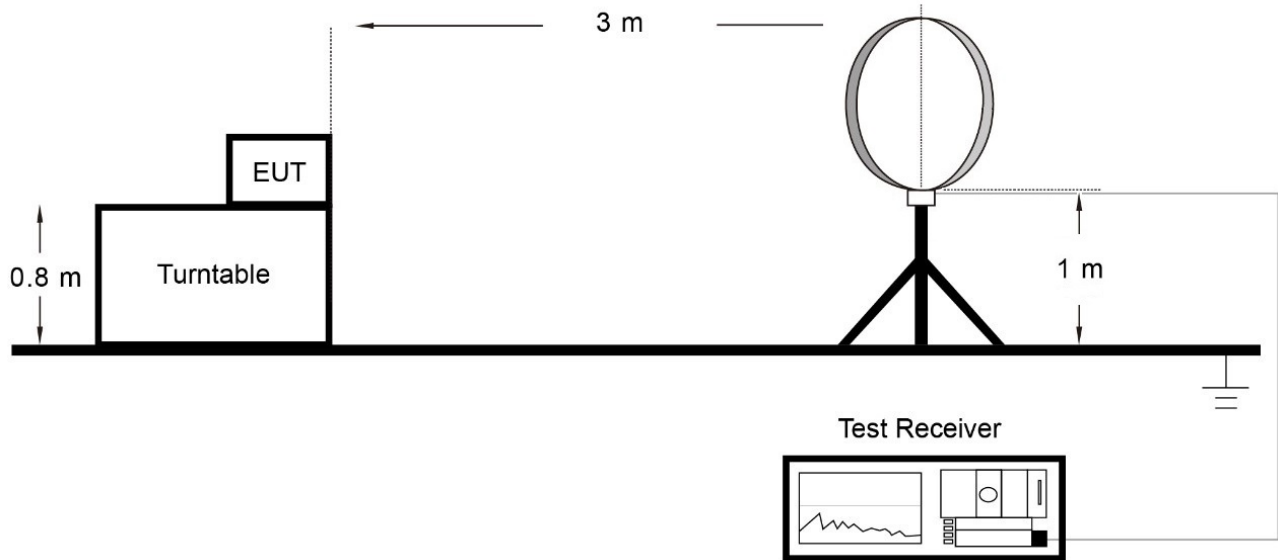
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Average Measurements above 1GHz (Method VB)

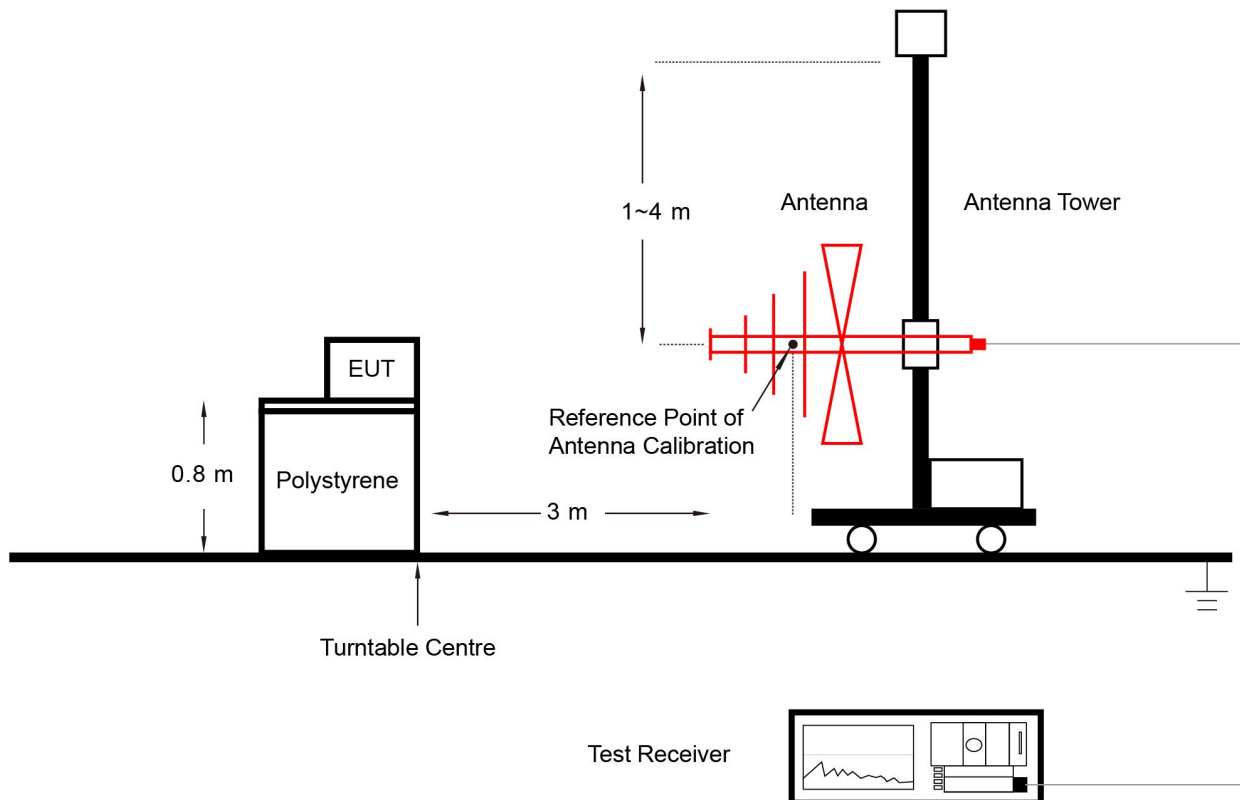
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW; If the EUT is configured to transmit with duty cycle $\geq 98\%$, set VBW = 10 Hz.
If the EUT duty cycle is $< 98\%$, set $\text{VBW} \geq 1/T$. T is the minimum transmission duration.
4. Detector = Peak
5. Sweep time = auto
6. Trace mode = max hold
7. Trace was allowed to stabilize

6.6.4. Test Setup

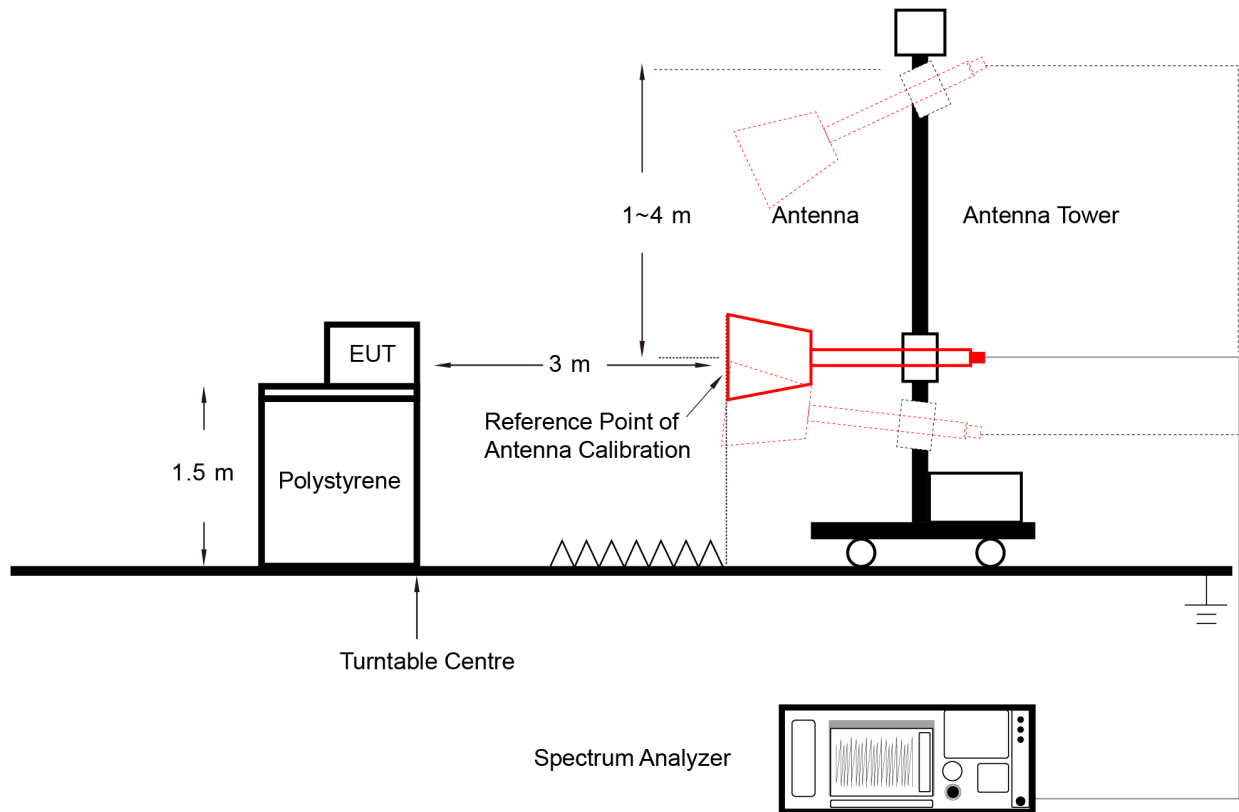
Below 30MHz Test Setup:



Below 1GHz Test Setup:



Above 1GHz Test Setup:



6.6.5. Test Result

Refer to Appendix A.6.

6.7. Radiated Restricted Band Edge Measurement

6.7.1. Test Limit

For 15.205 requirement:

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) of FCC part 15, must also comply with the radiated emission limits specified in Section 15.209(a).

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

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47CFR must not exceed the limits shown in Table per Section 15.209.

FCC Part 15 Subpart C Paragraph 15.209		
Frequency [MHz]	Field Strength [uV/m]	Measured Distance [Meters]
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

6.7.2. Test Procedure

ANSI C63.10-2013 Section 6.3 & 6.6 & 11.13

6.7.3. Test Setting

Peak Field Strength Measurements

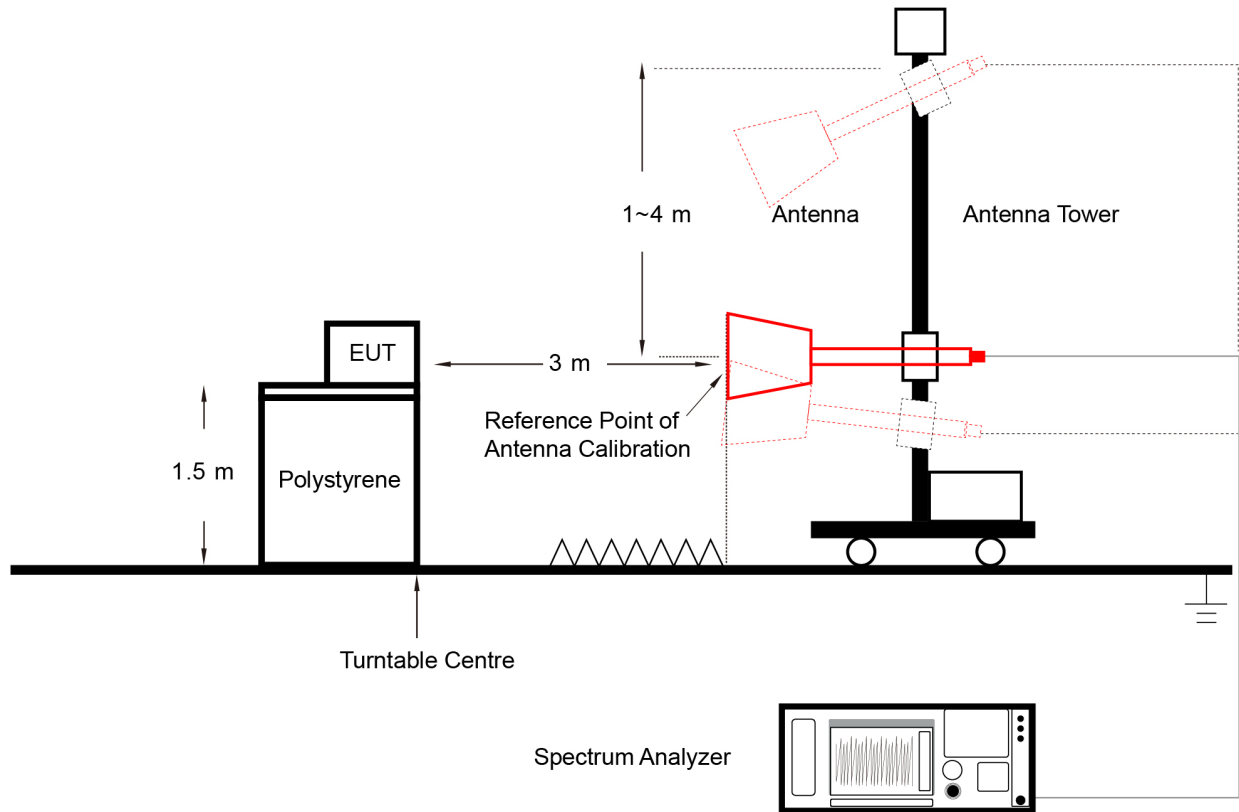
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW $\geq 1/T$
4. As an alternative, the instrument may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some instruments require linear display mode in order to accomplish this. Others have a setting for Average-VBW Type, which can be set to "Voltage" regardless of the display mode
5. Detector = Peak

6. Sweep time = auto
7. Trace mode = max hold
8. Allow max hold to run for at least 50 times (1/duty cycle) traces

6.7.4. Test Setup



6.7.5. Test Result

Refer to Appendix A.7.

6.8. AC Conducted Emissions Measurement

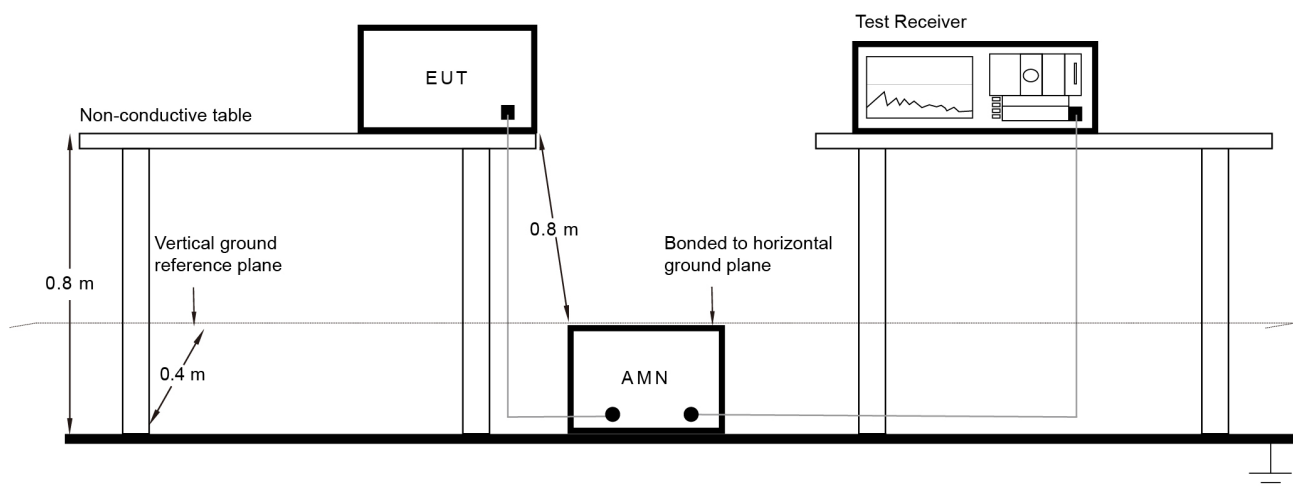
6.8.1. Test Limit

FCC Part 15 Subpart C Paragraph 15.207 Limits		
Frequency (MHz)	QP (dBuV)	AV (dBuV)
0.15 - 0.50	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

Note 1: The lower limit shall apply at the transition frequencies.

Note 2: The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

6.8.2. Test Setup



6.8.3. Test Result

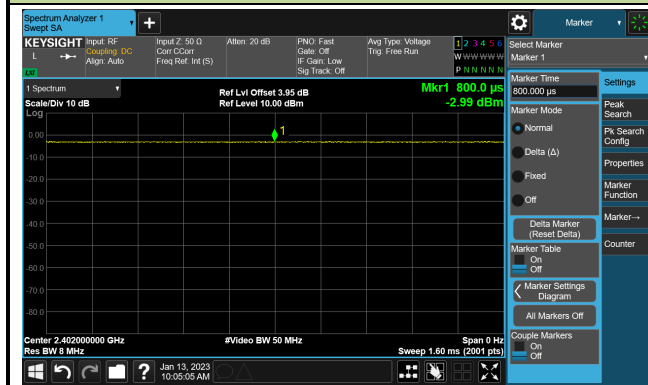
Refer to Appendix A.8.

Appendix A - Test Result

A.1 Duty Cycle Test Result

Test Site	WZ-TR3	Test Engineer	Lynn Yang
Test Date	2023-01-13		

Test Mode	Duty Cycle
BLE-1Mbps	100.0%
Duty Cycle (T = Transmission Duration)	
BLE-1Mbps	



A.2 6dB Bandwidth Test Result

Test Site	WZ-TR3	Test Engineer	Lynn Yang
Test Date	2023-01-13		

Test Mode	Data Rate	Channel No.	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)
BLE	1Mbps	00	2402	0.7467	≥ 0.5
BLE	1Mbps	19	2440	0.7646	≥ 0.5
BLE	1Mbps	39	2480	0.7701	≥ 0.5



A.3 Output Power Test Result

Test Site	WZ-TR3	Test Engineer	Lynn Yang
Test Date	2023-01-13		

Test Result of Peak Output Power

Test Mode	Data Rate	Channel No.	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Result
BLE	1Mbps	00	2402	0.14	≤ 30.00	Pass
BLE	1Mbps	19	2440	-0.03	≤ 30.00	Pass
BLE	1Mbps	39	2480	-0.04	≤ 30.00	Pass

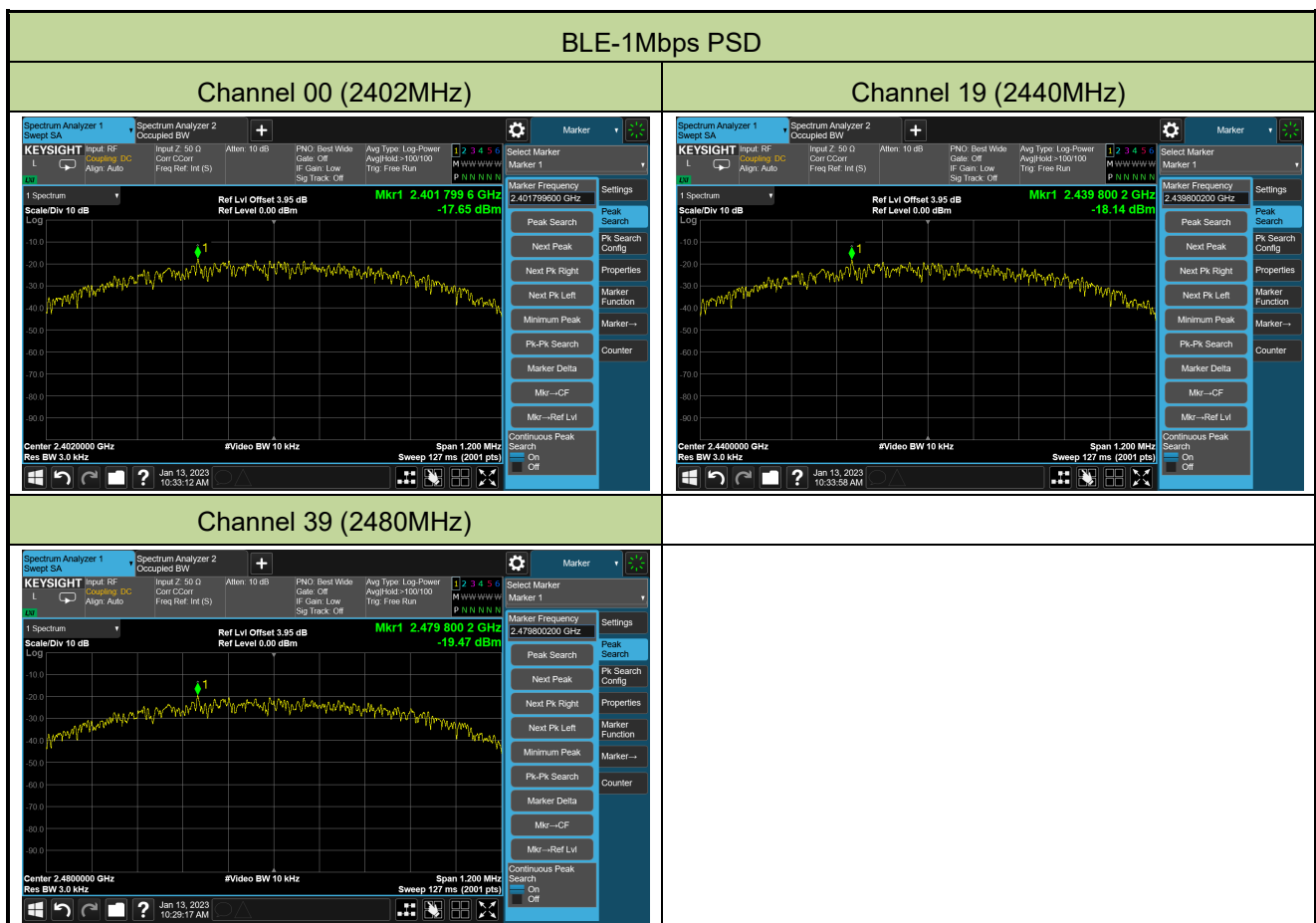
Test Result of Average Output Power (Reporting Only)

Test Mode	Data Rate	Channel No.	Frequency (MHz)	Average Power (dBm)	Limit (dBm)	Result
BLE	1Mbps	00	2402	-0.06	≤ 30.00	Pass
BLE	1Mbps	19	2440	-0.17	≤ 30.00	Pass
BLE	1Mbps	39	2480	-0.15	≤ 30.00	Pass

A.4 Power Spectral Density Test Result

Test Site	WZ-TR3	Test Engineer	Lynn Yang
Test Date	2023-01-13		

Test Mode	Data Rate	Channel No.	Frequency (MHz)	PSD Result (dBm / 3kHz)	Limit (dBm / 3kHz)	Result
BLE	1Mbps	00	2402	-17.65	≤ 8.00	Pass
BLE	1Mbps	19	2440	-18.14	≤ 8.00	Pass
BLE	1Mbps	39	2480	-19.47	≤ 8.00	Pass



A.5 Conducted Band Edge and Out-of-Band Emissions Test Result

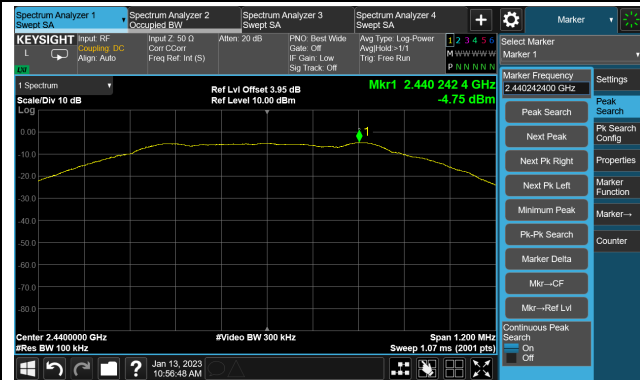
Test Site	WZ-TR3	Test Engineer	Lynn Yang
Test Date	2023-01-13		

Test Mode	Data Rate / Mbps	Channel No.	Frequency (MHz)	Limit (dBc)	Result
BLE	1	00	2402	20	Pass
BLE	1	19	2440	20	Pass
BLE	1	39	2480	20	Pass

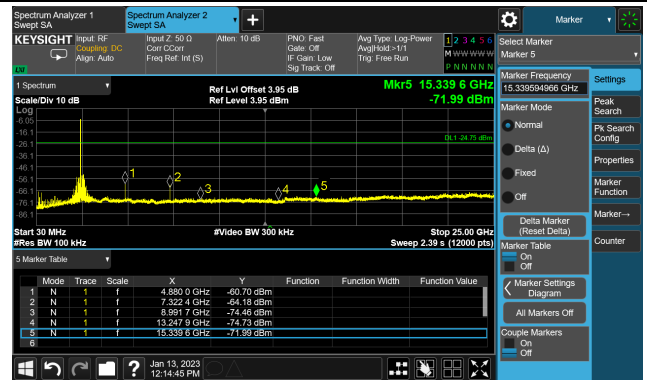


Channel 19 (2440MHz)

100kHz PSD Reference Level

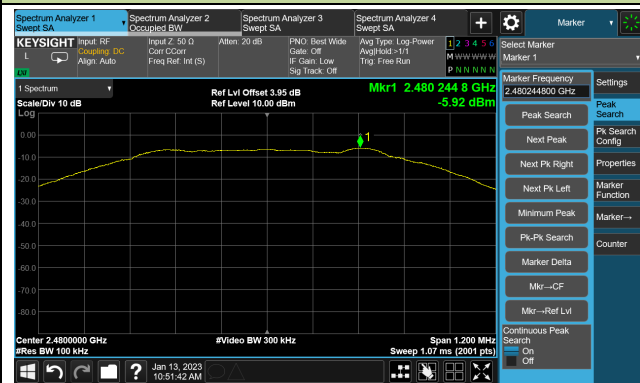


Spurious Emission 30MHz ~ 25GHz

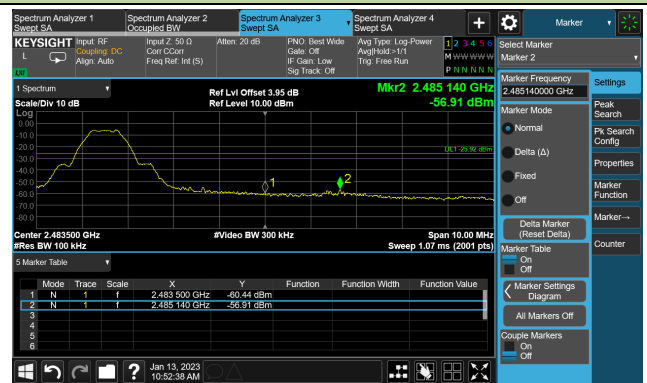


Channel 39 (2480MHz)

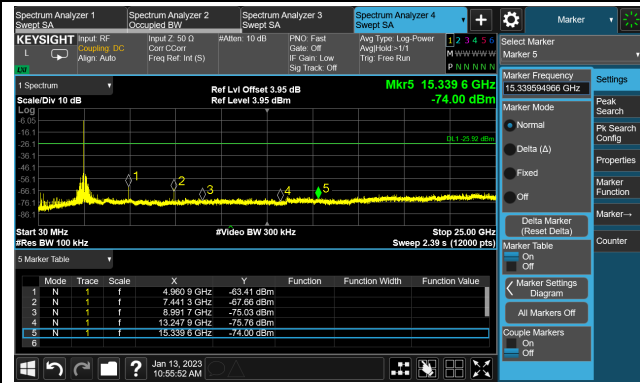
100kHz PSD Reference Level



High Band Edge



Spurious Emission 30MHz ~ 25GHz



A.6 Radiated Spurious Emission Test Result

Test Site	WZ-AC1	Test Engineer	Carl Jiang
Test Date	2023-01-16	Test Mode:	BLE-1Mbps
Remark:	1. Average measurement was not performed if peak level lower than average limit. 2. Other frequency was 20dB below limit line within 1-18GHz, there is not show in the report.		

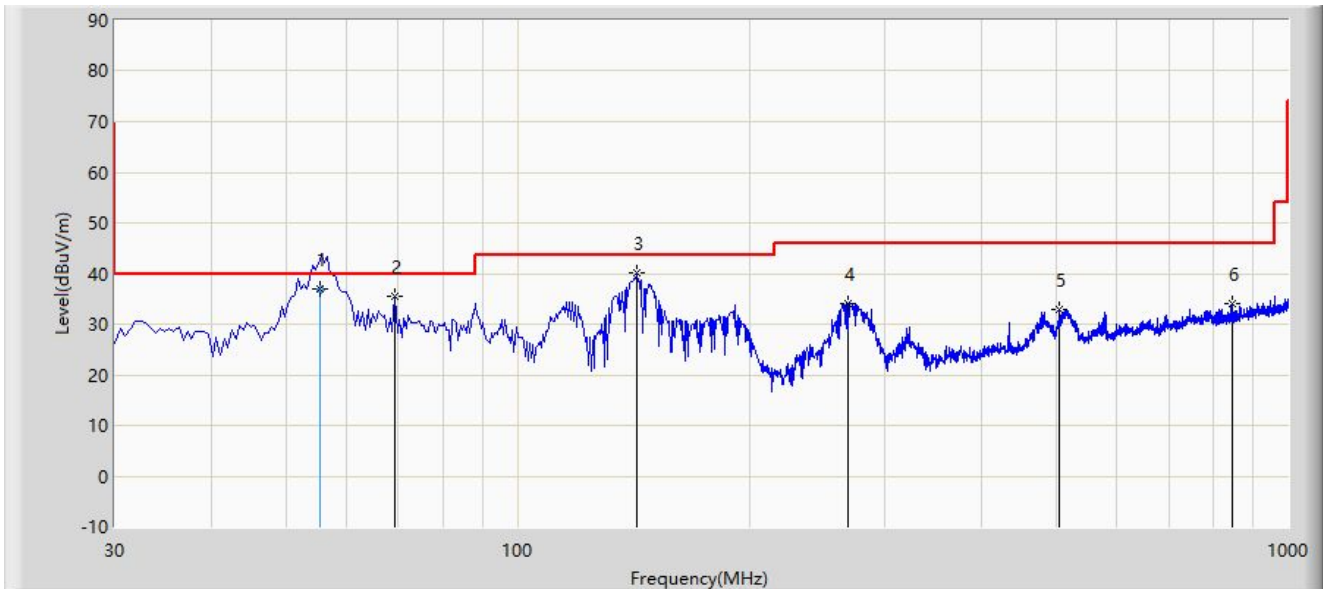
Test Channel	Frequency (MHz)	Reading Level (dBμV)	Factor (dB/m)	Measure Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Polarization
00	4808.0	53.2	2.8	56.0	74.0	-18.0	Peak	Horizontal
	4808.0	50.1	2.8	52.9	54.0	-1.1	Average	Horizontal
	10826.0	35.9	13.3	49.2	74.0	-24.8	Peak	Horizontal
	11939.5	36.8	12.1	48.9	74.0	-25.1	Peak	Horizontal
	4799.5	50.6	2.9	53.5	74.0	-20.5	Peak	Vertical
	4799.5	47.6	2.9	50.5	54.0	-3.5	Average	Vertical
	11064.0	35.6	13.3	48.9	74.0	-25.1	Peak	Vertical
	12177.5	36.1	12.1	48.2	74.0	-25.8	Peak	Vertical
19	4884.5	51.6	2.9	54.5	74.0	-19.5	Peak	Horizontal
	4884.5	47.9	2.9	50.8	54.0	-3.2	Average	Horizontal
	11038.5	36.2	13.6	49.8	74.0	-24.2	Peak	Horizontal
	12364.5	36.7	12.0	48.7	74.0	-25.3	Peak	Horizontal
	4876.0	50.0	2.8	52.8	74.0	-21.2	Peak	Vertical
	4876.0	47.3	2.8	50.1	54.0	-3.9	Average	Vertical
	10809.0	35.6	13.3	48.9	74.0	-25.1	Peak	Vertical
	11616.5	36.0	12.6	48.6	74.0	-25.4	Peak	Vertical
39	4961.0	47.6	3.1	50.7	74.0	-23.3	Peak	Horizontal
	10741.0	36.6	13.6	50.2	74.0	-23.8	Peak	Horizontal
	11854.5	36.8	12.4	49.2	74.0	-24.8	Peak	Horizontal
	4961.0	52.6	3.1	55.7	74.0	-18.3	Peak	Vertical
	4961.0	48.8	3.1	51.9	54.0	-2.1	Average	Vertical
	11004.5	36.7	13.5	50.2	74.0	-23.8	Peak	Vertical
	12381.5	35.0	11.8	46.8	74.0	-27.2	Peak	Vertical

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m)

Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m) - Pre_Amplifier Gain (dB)

The Result of Radiated Emission below 1GHz:

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_Part15.209_RSE(3m)	Engineer: Carl Jiang
Probe: VULB 9168_25-2000MHz	Polarity: Vertical
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE-1M at channel 2440MHz	



No	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Margin (dB)	Limit (dBuV/m)	Factor (dB/m)	Type
1	*	55.405	36.836	18.970	-3.164	40.000	17.866	QP
2		69.285	35.570	19.283	-4.430	40.000	16.286	PK
3		143.005	40.223	22.554	-3.277	43.500	17.670	PK
4		268.135	33.986	16.643	-12.014	46.000	17.343	PK
5		505.785	32.958	9.739	-13.042	46.000	23.219	PK
6		844.800	33.944	5.221	-12.056	46.000	28.723	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Note 4: Quasi-Peak measurement was not performed when peak measure level was lower than the quasi-peak limit.

Note 5: The amplitude of radiated emissions (frequency range from 9kHz to 30MHz and 18GHz to 25GHz) is that proximity to ambient noise, which also are attenuated more than 20 dB below the permissible value.

Therefore, the data is not presented in the report.

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_Part15.209_RSE(3m)	Engineer: Carl Jiang
Probe: VULB 9168_25-2000MHz	Polarity: Horizontal
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE-1M at channel 2440MHz	



No	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Margin (dB)	Limit (dBuV/m)	Factor (dB/m)	Type
1		57.160	29.604	11.889	-10.396	40.000	17.715	PK
2	*	144.460	39.184	21.443	-4.316	43.500	17.741	PK
3		186.655	34.569	18.780	-8.931	43.500	15.788	PK
4		278.805	37.121	19.184	-8.879	46.000	17.937	PK
5		319.545	37.500	18.425	-8.500	46.000	19.075	PK
6		514.030	31.090	7.590	-14.910	46.000	23.500	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

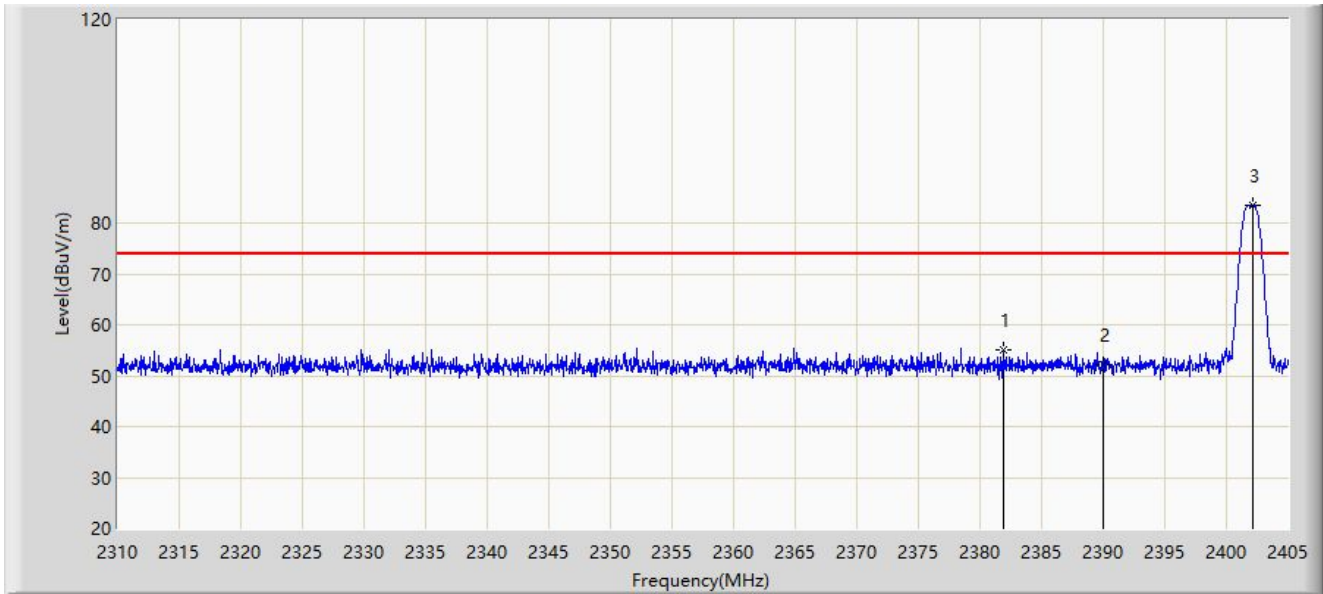
Note 4: Quasi-Peak measurement was not performed when peak measure level was lower than the quasi-peak limit.

Note 5: The amplitude of radiated emissions (frequency range from 9kHz to 30MHz and 18GHz to 25GHz) is that proximity to ambient noise, which also are attenuated more than 20 dB below the permissible value.

Therefore, the data is not presented in the report.

A.7 Radiated Restricted Band Edge Test Result

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Horizontal
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2402MHz	



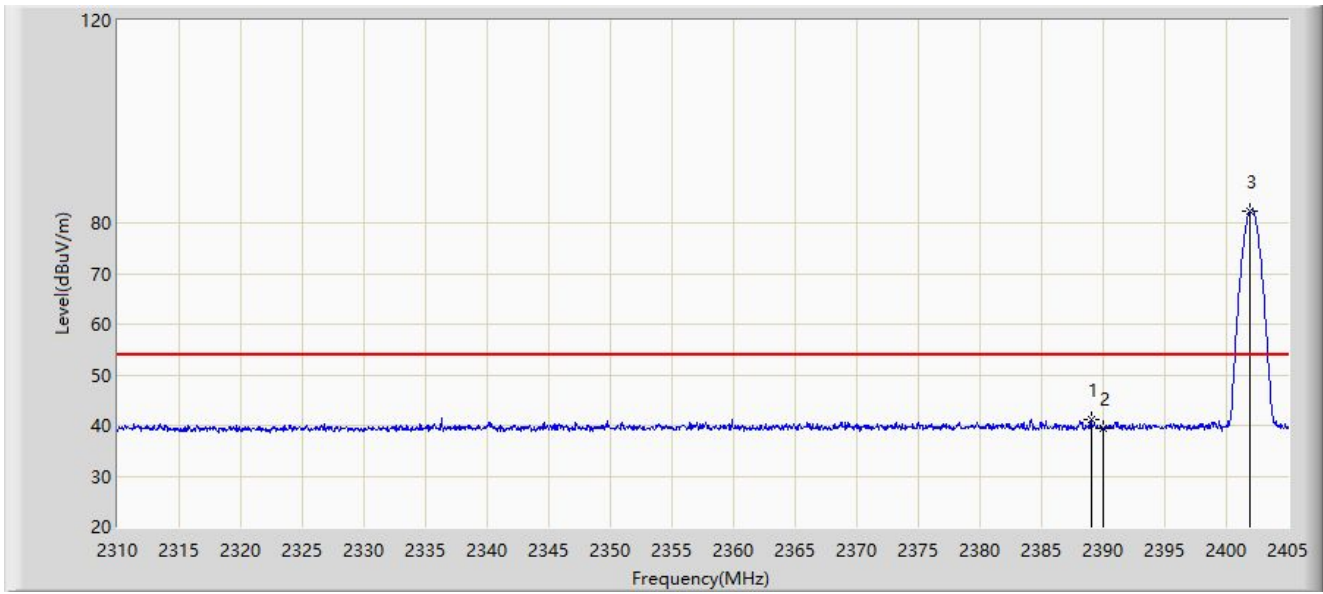
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1	*	2381.962	55.031	24.027	-18.969	74.000	31.004	PK
2		2390.000	52.295	21.303	-21.705	74.000	30.992	PK
3		2402.198	83.537	52.549	N/A	N/A	30.988	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Horizontal
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2402MHz	



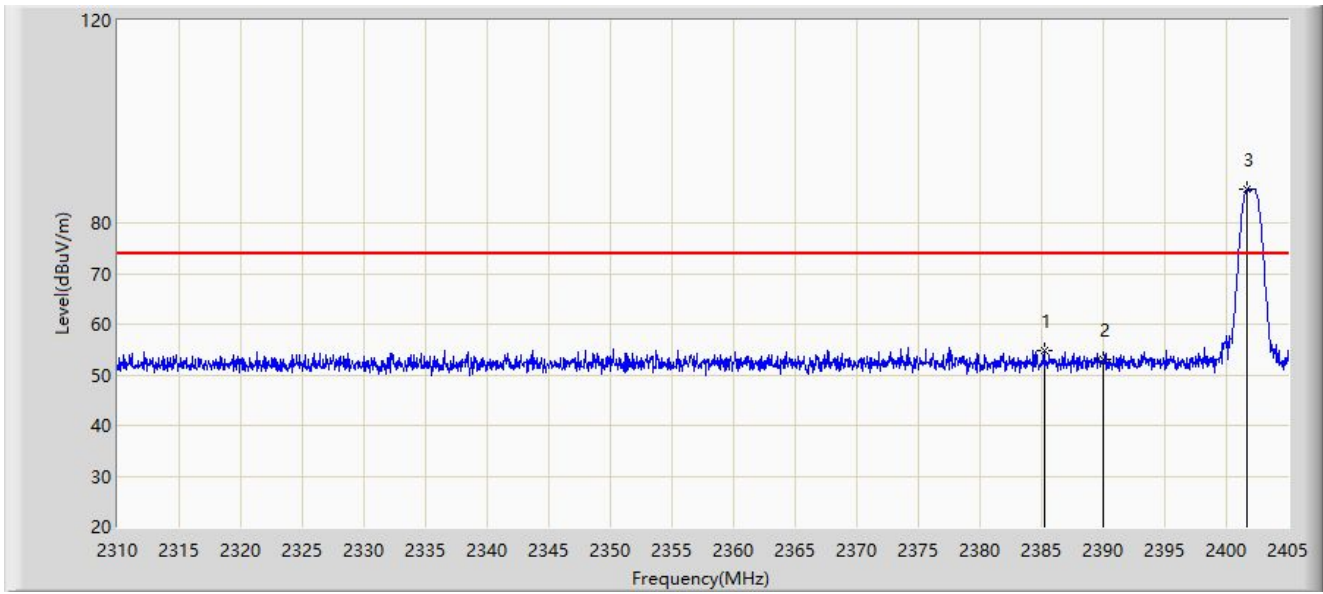
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1	*	2388.992	41.030	10.037	-12.970	54.000	30.993	AV
2		2390.000	39.499	8.507	-14.501	54.000	30.992	AV
3		2401.913	82.277	51.288	N/A	N/A	30.989	AV

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Vertical
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2402MHz	



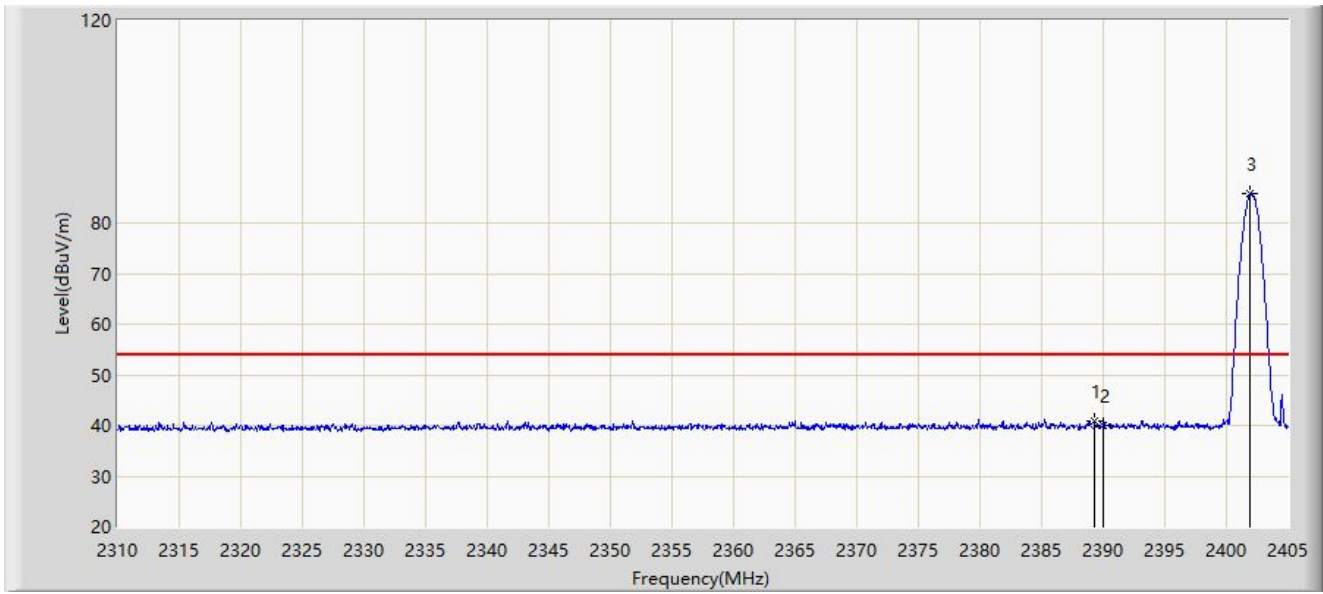
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1	*	2385.192	54.682	23.688	-19.318	74.000	30.994	PK
2		2390.000	52.938	21.946	-21.062	74.000	30.992	PK
3		2401.722	86.705	55.716	N/A	N/A	30.989	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Vertical
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2402MHz	



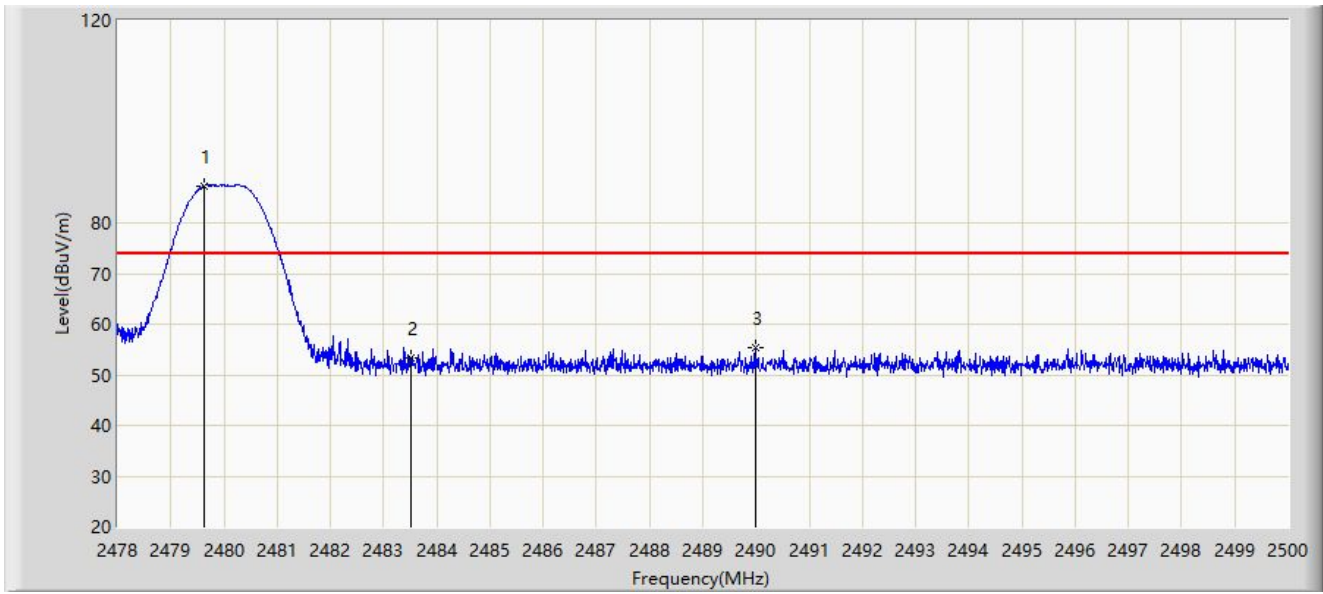
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1	*	2389.278	40.883	9.890	-13.117	54.000	30.992	AV
2		2390.000	40.007	9.015	-13.993	54.000	30.992	AV
3		2401.960	85.707	54.718	N/A	N/A	30.989	AV

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Horizontal
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2480MHz	



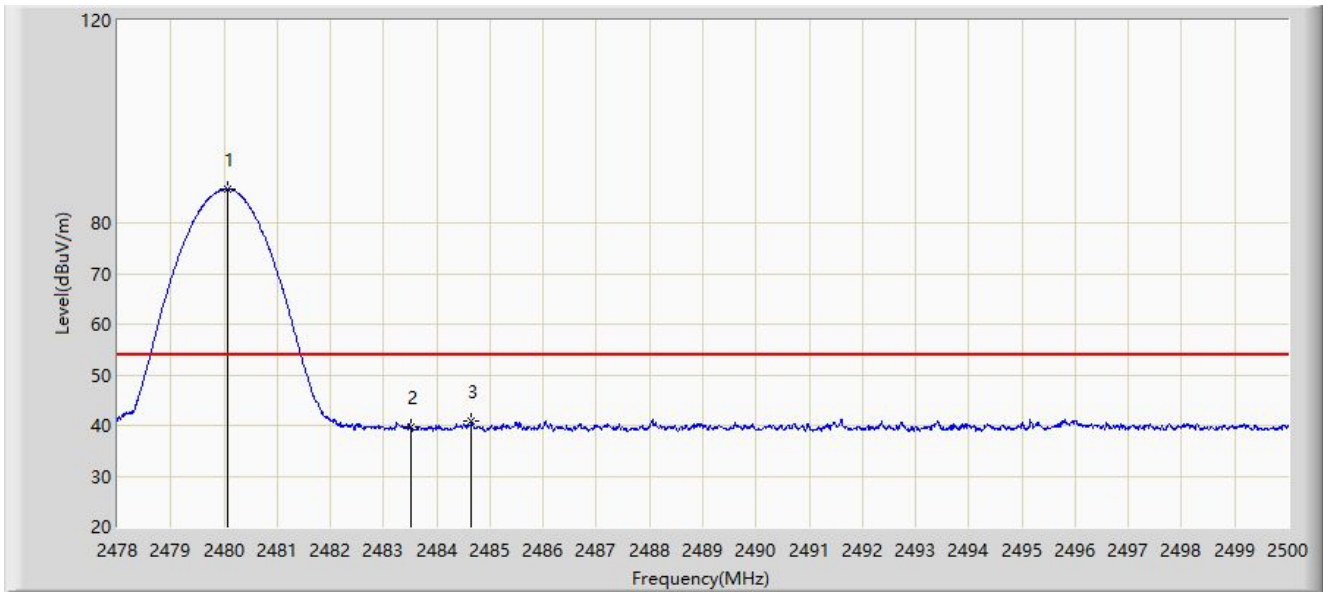
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1		2479.617	87.271	56.373	N/A	N/A	30.898	PK
2		2483.500	53.425	22.534	-20.575	74.000	30.892	PK
3	*	2489.979	55.395	24.514	-18.605	74.000	30.881	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Horizontal
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2480MHz	



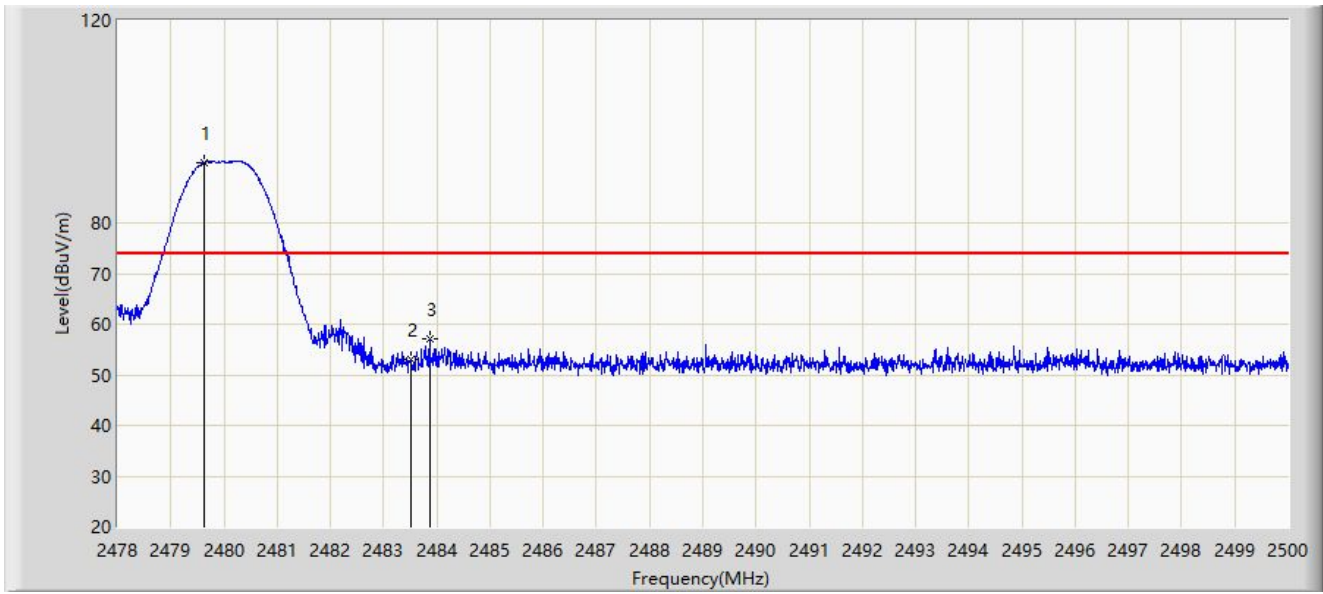
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1		2480.057	86.617	55.720	N/A	N/A	30.897	AV
2		2483.500	39.659	8.768	-14.341	54.000	30.892	AV
3	*	2484.655	40.858	9.968	-13.142	54.000	30.890	AV

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Vertical
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2480MHz	



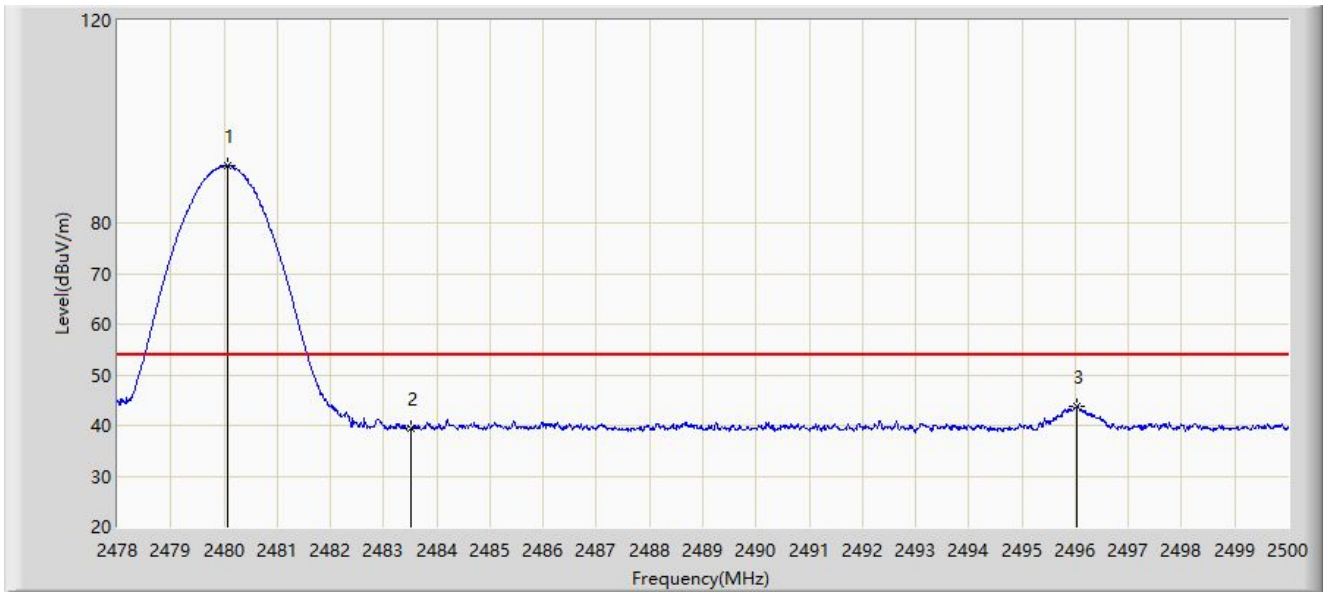
No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1		2479.617	91.947	61.049	N/A	N/A	30.898	PK
2		2483.500	52.964	22.073	-21.036	74.000	30.892	PK
3	*	2483.863	57.174	26.283	-16.826	74.000	30.891	PK

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: WZ-AC1	Test Date: 2023-01-16
Limit: FCC_2.4G_RE(3m)	Engineer: Carl Jiang
Probe: BBHA9120D_1167_1-18GHz	Polarity: Vertical
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE 1M at 2480MHz	



No	Mark	Frequency (MHz)	Measure Level (dBμV/m)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV/m)	Factor (dB/m)	Type
1		2480.057	91.276	60.379	N/A	N/A	30.897	AV
2		2483.500	39.420	8.529	-14.580	54.000	30.892	AV
3	*	2496.029	43.813	12.925	-10.187	54.000	30.888	AV

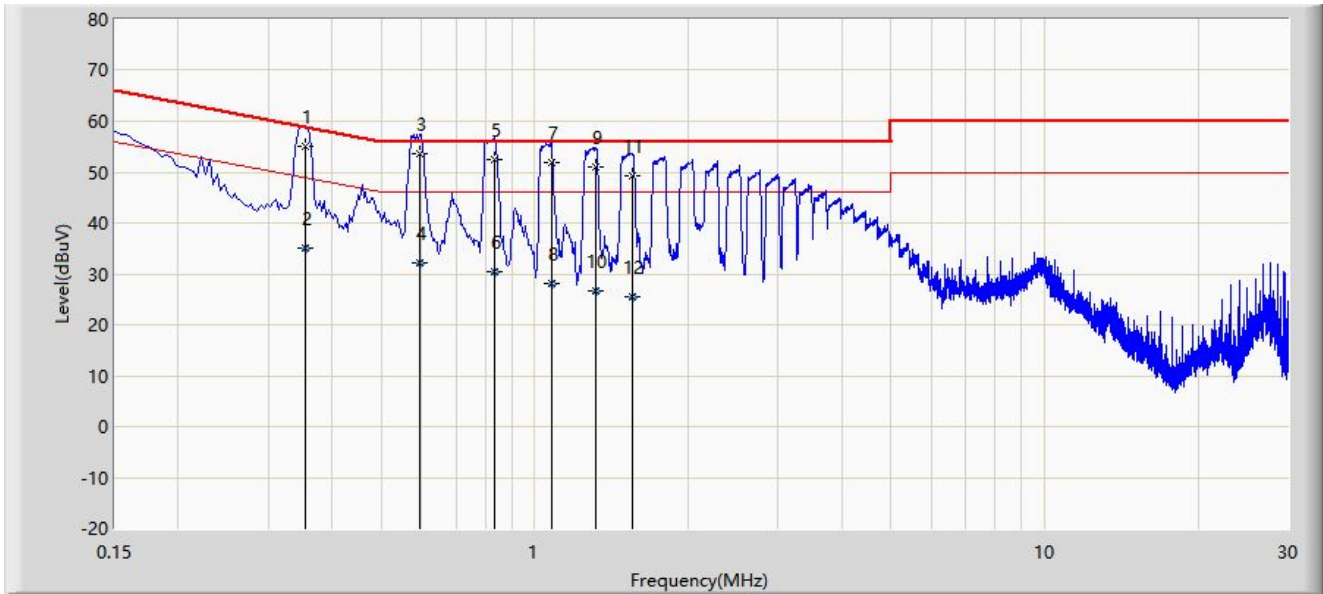
Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m).

Note 3: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m).

A.8 AC Conducted Emissions Test Result

Site: WZ-SR2	Test Date: 2023-01-17
Limit: FCC_Part15.207_CE_AC Power	Engineer: Helen Han
Probe: ENV216_101683_Filter Off_C	Polarity: Line
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE-1M at channel 2440MHz	



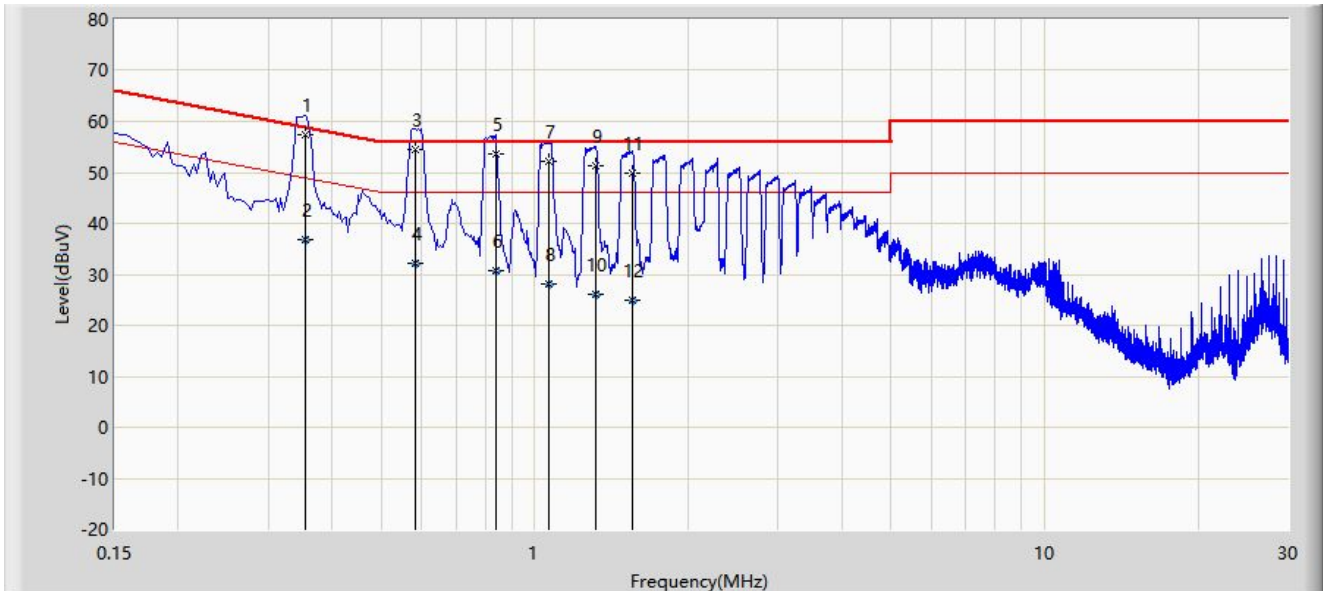
No	Mark	Frequency (MHz)	Measure Level (dBμV)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV)	Factor (dB)	Type
1		0.354	55.211	45.450	-3.657	58.868	9.761	QP
2		0.354	35.075	25.314	-13.793	48.868	9.761	AV
3	*	0.594	53.743	43.926	-2.257	56.000	9.818	QP
4		0.594	32.046	22.229	-13.954	46.000	9.818	AV
5		0.834	52.586	42.737	-3.414	56.000	9.849	QP
6		0.834	30.402	20.553	-15.598	46.000	9.849	AV
7		1.078	51.863	42.014	-4.137	56.000	9.849	QP
8		1.078	28.225	18.376	-17.775	46.000	9.849	AV
9		1.318	50.986	41.139	-5.014	56.000	9.847	QP
10		1.318	26.551	16.704	-19.449	46.000	9.847	AV
11		1.554	49.335	39.490	-6.665	56.000	9.844	QP
12		1.554	25.552	15.707	-20.448	46.000	9.844	AV

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV) = Reading Level (dBμV) + Factor (dB).

Note 3: Factor (dB) = Cable Loss (dB) + LISN Factor (dB).

Site: WZ-SR2	Test Date: 2023-01-17
Limit: FCC_Part15.207_CE_AC Power	Engineer: Helen Han
Probe: ENV216_101683_Filter Off_C	Polarity: Neutral
EUT: Amplifier	Power: AC 120V/60Hz
Test Mode: Transmit by BLE-1M at channel 2440MHz	



No	Mark	Frequency (MHz)	Measure Level (dBμV)	Reading Level (dBμV)	Margin (dB)	Limit (dBμV)	Factor (dB)	Type
1		0.354	57.264	47.463	-1.604	58.868	9.801	QP
2		0.354	36.788	26.987	-12.080	48.868	9.801	AV
3	*	0.582	54.505	44.668	-1.495	56.000	9.837	QP
4		0.582	32.104	22.266	-13.896	46.000	9.837	AV
5		0.838	53.550	43.710	-2.450	56.000	9.840	QP
6		0.838	30.778	20.938	-15.222	46.000	9.840	AV
7		1.066	52.118	42.286	-3.882	56.000	9.832	QP
8		1.066	27.994	18.162	-18.006	46.000	9.832	AV
9		1.318	51.315	41.475	-4.685	56.000	9.840	QP
10		1.318	26.067	16.228	-19.933	46.000	9.840	AV
11		1.554	49.713	39.867	-6.287	56.000	9.847	QP
12		1.554	24.885	15.038	-21.115	46.000	9.847	AV

Note 1: " * ", means this data is the worst emission level.

Note 2: Measure Level (dBμV) = Reading Level (dBμV) + Factor (dB).

Note 3: Factor (dB) = Cable Loss (dB) + LISN Factor (dB).

Appendix B - Test Setup Photograph

Refer to “2211RSU002-UT” file.

Appendix C - EUT Photograph

Refer to “2211RSU002-UE” file.

The End
