FCC Test Report

Application No.:	DNT241451R1859-4986
Applicant:	Shenzhen Huitong Botai digital technology Co., LTD.
Address of Applicant:	6F A, Building 7, Rundongsheng Industrial Park, Longzhu Community, Xixiang Street, Baoan District, Shenzhen
EUT Description:	Gamepad
Model No.:	Lenovo S01,Lenovo S02,Lenovo S03,Lenovo S04,Lenovo S05, Lenovo S06,Lenovo S07,Lenovo S08,Lenovo S09,Lenovo S10, Lenovo S01 Pro,Lenovo S02 Pro,Lenovo S03 Pro,Lenovo S04 Pro, Lenovo S05 Pro,Lenovo S06 Pro,Lenovo S07 Pro,Lenovo S08 Pro, Lenovo S09 Pro,Lenovo S10 Pro
FCC ID:	2BHNR-LENOVOS01
Power Supply	DC 3.7V From Battery;DC 5V From Adapter
Trade Mark:	Lenovo
Standards:	47 CFR FCC Part 2, Subpart J 47 CFR Part 15, Subpart C ANSI C63.10: 2020
Date of Receipt:	2024/06/26
Date of Test:	2024/06/26 to 2024/07/09
Date of Issue:	2024/07/10
Test Result:	**PASS**

Prepared By: Wayne.Lin (Testing Engineer)

Reviewed By: Pencils.Chen (Project Engineer)

Approved By: Yeise Chen (Manager)

Dongguan DN Testing Co., Ltd.

Add: No. 1, West Fourth Street, Xingfa South Road, Wusha Community, Chang 'an Town, Dongguan City, Guangdong P.R.China

Web: www.dn-testing.com Tel:+86-769-88087383 E-mail: service@dn-testing.com

Note: If there is any objection to the results in this report, please submit a written inquiry to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp, and is issued by the company in accordance with the requirements of the "Conditions of Issuance of Test Reports" printed in the attached page. Unless otherwise stated, the results presented in this report only apply to the samples tested this time. Partial reproduction of this report is not allowed unless approved by the company in writing.

Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V2.0	/	Jul.10, 2024	Valid	Original Report

1 Test Summary

Test Item	Test Requirement	Test Method	Test Result	Result
Antenna Requirement	15.203/247(b)	--	Clause 3.1	PASS
Duty Cycle	--	--	Clause 3.2	PASS
DTS (6 dB) Bandwidth	15.247 (a)(2)	ANSI C63.10: 2020	Clause 3.3	PASS
Conducted Output Power	15.247 (b)(3)	ANSI C63.10: 2020	Clause 3.4	PASS
Power Spectral Density	15.247 (e)	ANSI C63.10: 2020	Clause 3.5	PASS
Band-edge for RF Conducted Emissions	15.247(d)	ANSI C63.10: 2020	Clause 3.6	PASS
RF Conducted Spurious Emissions	15.247(d)	ANSI C63.10: 2020	Clause 3.7	PASS
Radiated Spurious Emissions	15.247(d);15.205/15.209	ANSI C63.10: 2020	Clause 3.8	PASS
Restricted bands around fundamental frequency (Radiated Emission)	15.247(d);15.205/15.209	ANSI C63.10: 2020	Clause 3.9	PASS
AC Power Line Conducted Emission	15.207	ANSI C63.10: 2020	Clause 3.10	PASS

Note:
1. “N/A” denotes test is not applicable in this test report.

Contents

2 General Information

2.1 Test Location

Company:	Dongguan DN Testing Co., Ltd
Address:	No. 1, West Fourth Street, South Xinfa Road, Wusha Liwu, Chang ' an Town, Dongguan City, Guangdong P.R.China
Test engineer:	Wayne Lin

2.2 General Description of EUT

Manufacturer:	Shenzhen Huitong Botai digital technology Co., LTD.
Address of Manufacturer:	6F A, Building 7, Rundongsheng Industrial Park, Longzhu Community, Xixiang Street, Baoan District, Shenzhen
EUT Description:	Gamepad
Test Model No.:	Lenovo S01
Additional Model(s):	Lenovo S02,Lenovo S03,Lenovo S04,Lenovo S05, Lenovo S06,Lenovo S07,Lenovo S08,Lenovo S09,Lenovo S10, Lenovo S01 Pro,Lenovo S02 Pro,Lenovo S03 Pro,Lenovo S04 Pro, Lenovo S05 Pro,Lenovo S06 Pro,Lenovo S07 Pro,Lenovo S08 Pro, Lenovo S09 Pro,Lenovo S10 Pro
Chip Type:	ZC32RF1M QFN40
Serial Number	PR241451R1859
Power Supply	DC 3.7V From Battery; DC 5V From Adapter
Trade Mark:	Lenovo
Hardware Version:	V1.0
Software Version:	V1.0
Operation Frequency:	2402 MHz to 2480 MHz
Type of Modulation:	GFSK
Sample Type:	☒ Portable Device, ☐ Module, ☐ Mobile Device
Antenna Type:	☐ External, ☒ Integrated
Antenna Ports	☒ Ant 1, ☐ Ant 2, ☐ Ant 3
Antenna Gain*:	☒ Provided by applicant
	-2.3dBi
RF Cable*:	☒ Provided by applicant
	0.5dB(0.6~1GHz); 0.8dB(1.4~2GHz); 1.0dB(2.1~2.7GHz); 1.5dB(3~4GHz); 1.8dB(4.4~6GHz);

Remark:

*All models are just name differences, motherboard, PCB circuit board, chip, electronic components,appearance is all the same.

*Since the above data and/or information is provided by the applicant relevant results or conclusions of this report are only made for these data and/or information , DNT is not responsible for the authenticity, integrity and results of the data and information and/or the validity of the conclusion.

2.3 Channel List

Operation Frequency of each channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	10	2422MHz	20	2442MHz	30	2462MHz
1	2404MHz	11	2424MHz	21	2444MHz	31	2464MHz
2	2406MHz	12	2426MHz	22	2446MHz	32	2466MHz
3	2408MHz	13	2428MHz	23	2448MHz	33	2468MHz
4	2410MHz	14	2430MHz	24	2450MHz	34	2470MHz
5	2412MHz	15	2432MHz	25	2452MHz	35	2472MHz
6	2414MHz	16	2434MHz	26	2454MHz	36	2474MHz
7	2416MHz	17	2436MHz	27	2456MHz	37	2476MHz
8	2418MHz	18	2438MHz	28	2458MHz	38	2478MHz
9	2420MHz	19	2440MHz	29	2460MHz	39	2480MHz

2.4 Test Environment and Mode

Operating Environment:	
Temperature:	20~25.0 ℃
Humidity:	45~56 % RH
Atmospheric Pressure:	101.0~101.30 KPa
Test mode:	
Transmitting mode:	Keep the EUT in transmitting mode with all kind of modulation and all kind of data rate.

2.5 Power Setting of Test Software

Software Name	BT_Tool_v1.1.0		
Frequency(MHz)	2402	2440	2480
BLE 1M Setting	Default	Default	Default

2.6 Description of Support Units

The EUT has been tested independent unit.

2.7 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

Lab A:

• FCC, USA

Designation Number: CN1348

• A2LA (Certificate No. 7050.01)

DONGGUAN DN TESTING CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 7050.01.

• Innovation, Science and Economic Development Canada

DONGGUAN DN TESTING CO., LTD. EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

IC#: 31026.

2.8 Measurement Uncertainty (95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	DTS Bandwidth	±0.0196%
2	Maximum Conducted Output Power	±0.686 dB
3	Maximum Power Spectral Density Level	±0.743 dB
4	Band-edge Compliance	±1.328 dB
5	Unwanted Emissions In Non-restricted Freq Bands	9KHz-1GHz:±0.746dB 1GHz-26GHz: ±1.328dB

No.	Item	Measurement Uncertainty
1	Conduction Emission	± 3.0dB (150kHz to 30MHz)
2	Radiated Emission	± 4.8dB (Below 1GHz)
		± 4.8dB (1GHz to 6GHz)
		± 4.5dB (6GHz to 18GHz)
		± 5.02dB (Above 18GHz)

2.9 Equipment List

For Connect EUT Antenna Terminal Test					
Description	Manufacturer	Model	Serial Number	Cal date	Due date
Signal Generator	Keysight	N5181A-6G	MY48180415	2023-10-25	2024-10-24
Signal Generator	Keysight	N5182B	MY57300617	2023-10-25	2024-10-24
Power supply	Keysight	E3640A	ZB2022656	2023-10-25	2024-10-24
Radio Communication Tester	R&S	CMW500	105082	2023-10-25	2024-10-24
Spectrum Analyzer	Aglient	N9010A	MY52221458	2023-10-25	2024-10-24
BT/WIFI Test Software	Tonscend	JS1120 V3.1.83	NA	NA	NA
RF Control Unit	Tonscend	JS0806-2	22F8060581	NA	NA
Power Sensor	Anritsu	ML2495A	2129005	2023-10-25	2024-10-24
Pulse Power Sensor	Anritsu	MA2411B	1911397	2023-10-25	2024-10-24
temperature and humidity box	SCOTEK	SCD-C40-80PRO	6866682020008	2023-10-25	2024-10-24

Test Equipment for Conducted Emission					
Description	Manufacturer	Model	Serial Number	Cal Date	Due Date
Receiver	R&S	ESCI3	101152	2023-10-24	2024-10-23
LISN	R&S	ENV216	102874	2023-10-24	2024-10-23
ISN	R&S	ENY81-CA6	1309.8590.03	2023-10-24	2024-10-23

Test Equipment for Radiated Emission(30MHz-1000MHz)					
Description	Manufacturer	Model	Serial Number	Cal Date	Due Date
Receiver	R&S	ESR7	102497	2023-10-24	2024-10-23
Test Software	ETS-LINDGREN	TiLE-FULL	NA	NA	NA
RF Cable	ETS-LINDGREN	RFC-NMS-100-NMS-350-IN	NA	2023-10-24	2024-10-23
Log periodic antenna	ETS-LINDGREN	VULB 9168	01475	2023-10-24	2024-10-23
Pre-amplifier	Schwarzbeck	BBV9743B	00423	2023-10-24	2024-10-23

Test Equipment for Radiated Emission(Above 1000MHz)					
Description	Manufacturer	Model	Serial Number	Cal Date	Due Date
Frequency analyser	Keysight	N9010A	MY52221458	2023-10-24	2024-10-23
RF Cable	ETS-LINDGREN	RFC-NMS-100-NMS-350-IN	NA	2023-10-24	2024-10-23
Horn Antenna	ETS-LINDGREN	3117	00252567	2023-10-24	2024-10-23
Double ridged waveguide antenna	ETS-LINDGREN	3116C	00251780	2023-10-24	2024-10-23
Test Software	ETS-LINDGREN	TiLE-FULL	NA	NA	NA
Pre-amplifier	ETS-LINDGREN	3117-PA	252567	2023-10-24	2024-10-23
Pre-amplifier	ETS-LINDGREN	3116C-PA	251780	2023-10-24	2024-10-23

2.10 Assistant equipment used for test

Code	Equipment	Manufacturer	Model No.	Equipment No.
1	Adapter	GaoFanDe	GFDQ3-0502000U	NA
2	Computer	acer	N22C8	EMC notebook01

3 Test results and Measurement Data

3.1 Antenna Requirement

Standard requirement:	47 CFR Part 15C Section 15.203 /247(c)
15.203 requirement: 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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, 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 (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	
The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is -2.3dBi.	

3.2 Duty Cycle

Refer to section : **Appendix A**

Note:

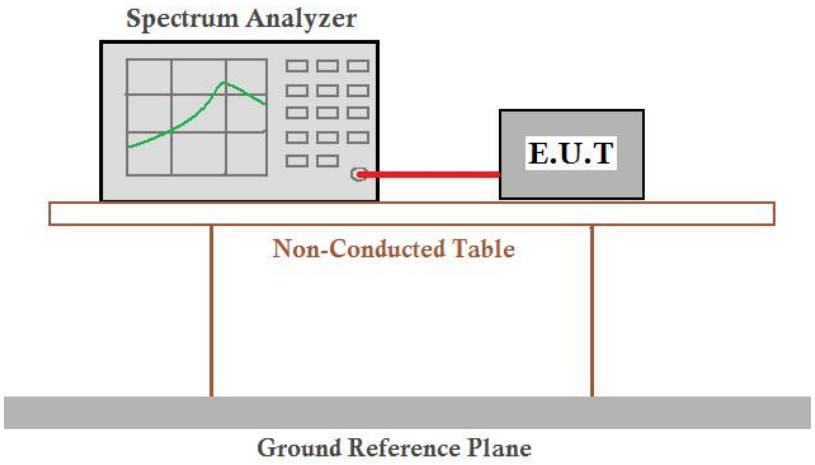
1.If duty cycle <98 %, the conducted average output power and average power spectral density should be add duty factor.

2.If duty cycle≥98 %,the EUT is consider to be transmitting continuously,the conducted average output power and average power spectral density no need to add duty factor(consider to be zero).

3.The conducted peak output power and peak power spectral density no need to consider duty factor.

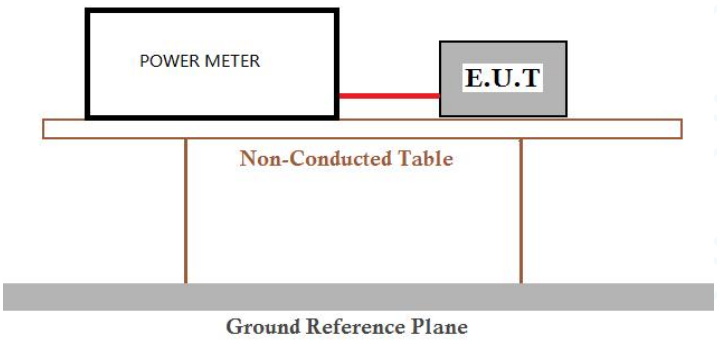
4.The on-time time is transmission duration(T).

3.3 DTS (6 dB) Bandwidth

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(2)
Test Method:	ANSI C63.10: 2020 Section 11.8.1 Option 1
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the the worst case of GFSK
Limit:	≥ 500 kHz
Test Results:	Pass

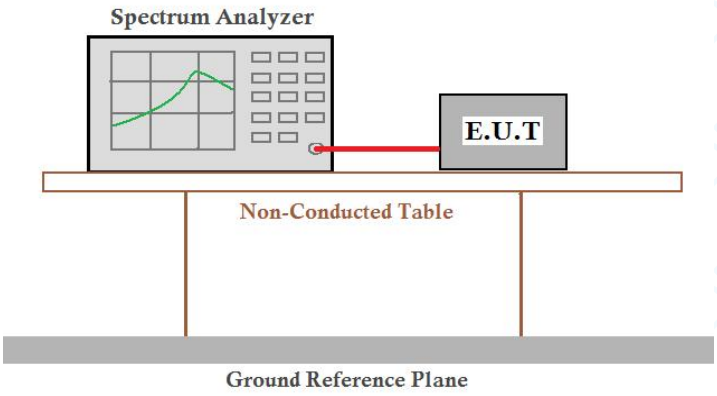
The detailed test data see: **Appendix B**

3.4 Conducted Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(3)
Test Method:	ANSI C63.10: 2020 Section 11.9.1.3
Test Setup:	
Test Instruments:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the the worst case of GFSK
Limit:	30dBm
Test Results:	Pass

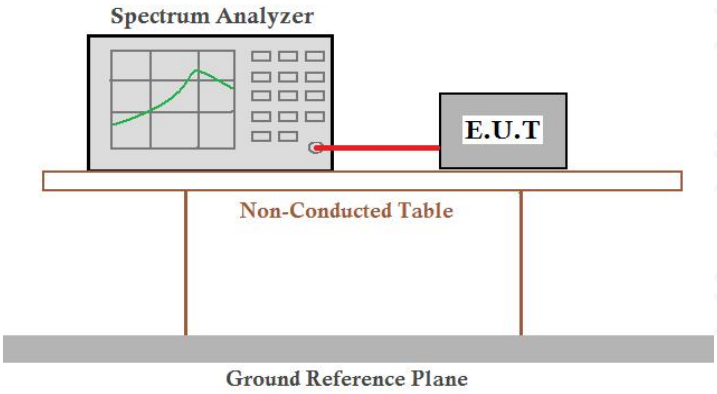
The detailed test data see: **Appendix C**

3.5 Power Spectral Density

Test Requirement:	47 CFR Part 15C Section 15.247 (e)
Test Method:	ANSI C63.10: 2020 Section 11.10.2
Test Setup:	
Test Instruments:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the the worst case of GFSK
Limit:	≤8.00dBm/3kHz
Test Results:	Pass

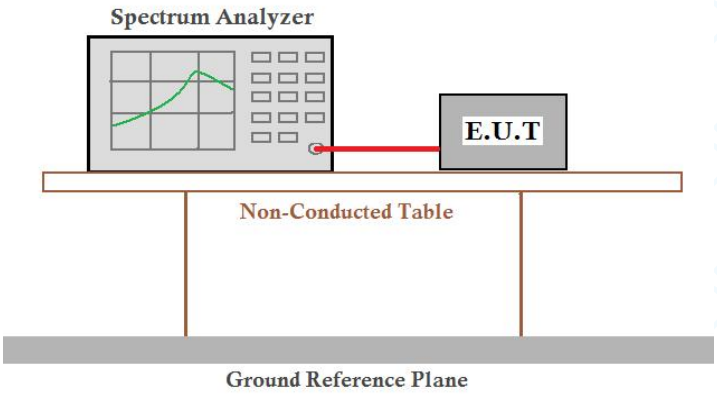
The detailed test data see: **Appendix D**

3.6 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2020 Section 11.13
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the the worst case of GFSK
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass

The detailed test data see: **Appendix E**

3.7 RF Conducted Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2020 Section 11.11
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the worst case of GFSK;
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass

The detailed test data see: **Appendix F**

3.8 Radiated Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10: 2020 Section 11.12				
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	120kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz (DC⩾0.98) ⩾1/T (DC<0.98)	Average
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Remark: 15.35(b),Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				

Test Setup:

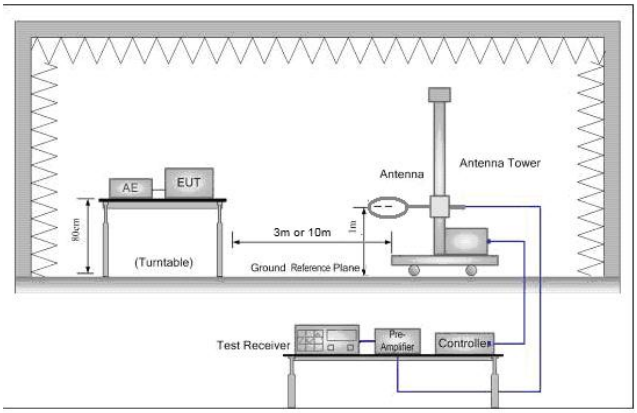


Figure 1. Below 30MHz

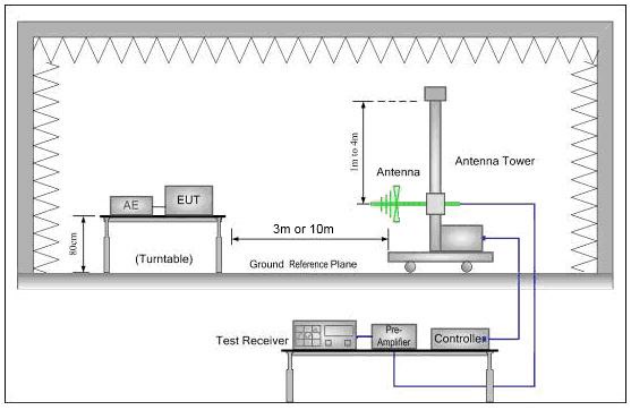


Figure 2. 30MHz to 1GHz

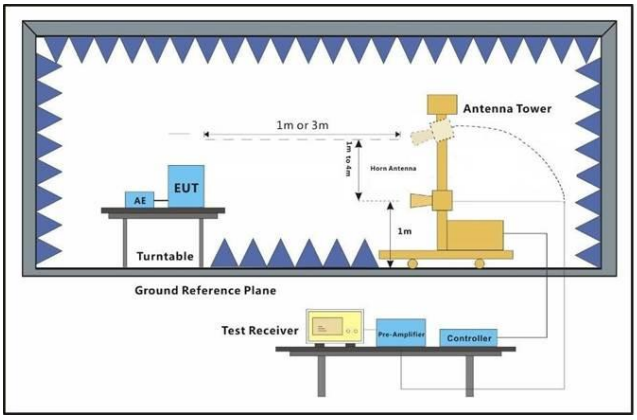


Figure 3. Above 1 GHz

Test Procedure:

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters(for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel ,the Highest channel.

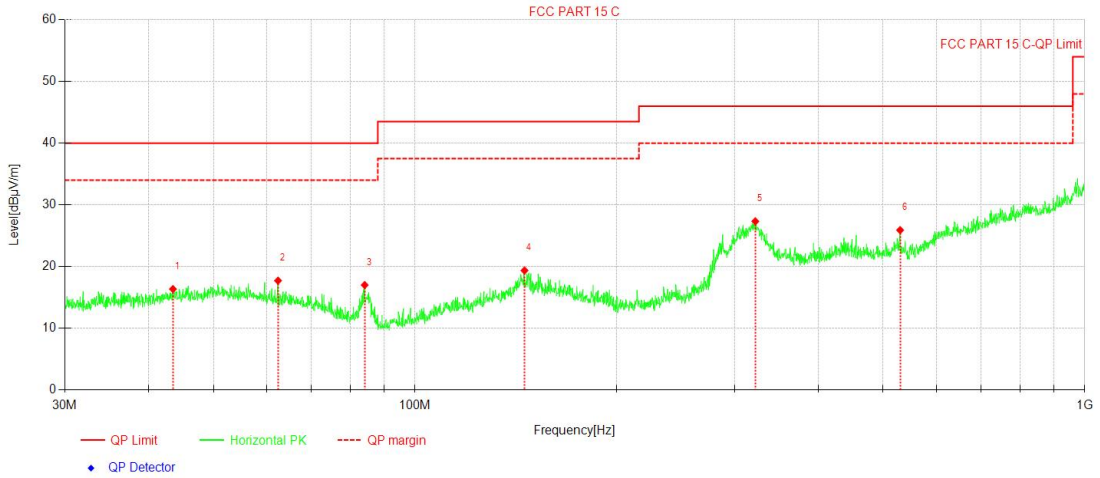
i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, And found the X axis positioning which it is worse case.

j. Repeat above procedures until all frequencies measured was complete.

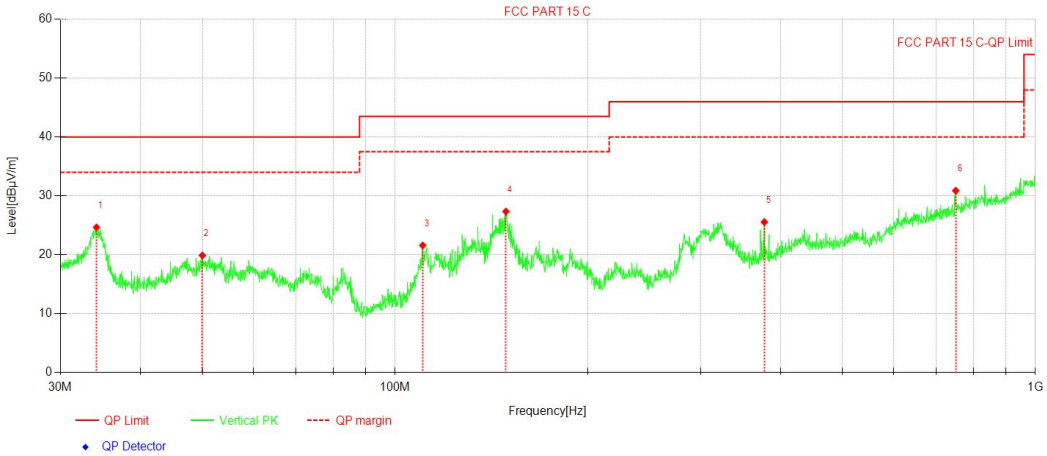
Test Configuration:	Measurements Below 1000MHz • RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 10 Hz, when duty cycle is no less than 98 percent. • VBW ⩾ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Charge + Transmitting mode.
Final Test Mode:	Pretest the EUT at Charging+Transmitting mode. Through Pre-scan, find the worst case of GFSK,Only the worst case is recorded in the report.
Instruments Used:	Refer to section 2.9 for details
Test Results:	Pass

Test data

For 30-1000MHz



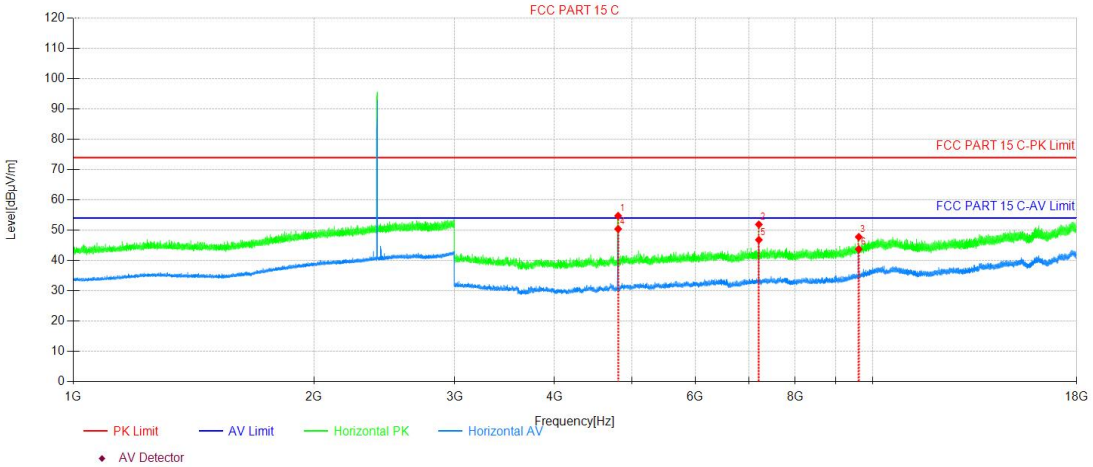
NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	43.50	24.70	-8.36	16.34	40.00	23.66	100	237	QP	Horizontal
2	62.43	26.74	-9.04	17.70	40.00	22.30	200	168	QP	Horizontal
3	84.11	30.46	-13.47	16.99	40.00	23.01	200	2	QP	Horizontal
4	145.69	27.47	-8.12	19.35	43.50	24.15	200	27	QP	Horizontal
5	322.18	33.55	-6.22	27.33	46.00	18.67	100	355	QP	Horizontal
6	530.10	27.06	-1.16	25.90	46.00	20.10	200	355	QP	Horizontal



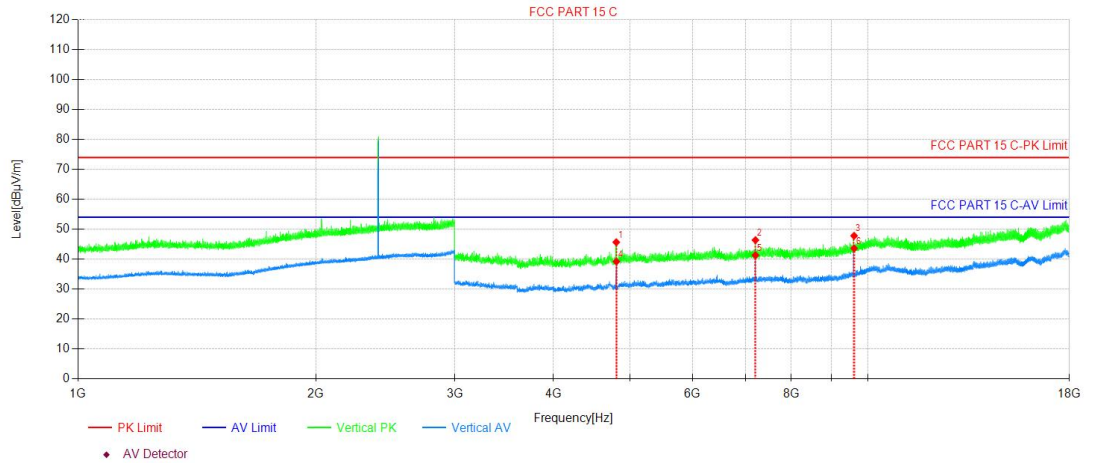
NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	34.15	34.03	-9.39	24.64	40.00	15.36	100	1	QP	Vertical
2	49.99	27.93	-8.07	19.86	40.00	20.14	200	358	QP	Vertical
3	110.43	32.75	-11.17	21.58	43.50	21.92	100	76	QP	Vertical
4	148.96	35.28	-7.94	27.34	43.50	16.16	100	25	QP	Vertical
5	377.25	30.45	-4.90	25.55	46.00	20.45	200	19	QP	Vertical
6	750.98	27.46	3.42	30.88	46.00	15.12	200	92	QP	Vertical

For above 1GHz

BLE 1M 2402MHz

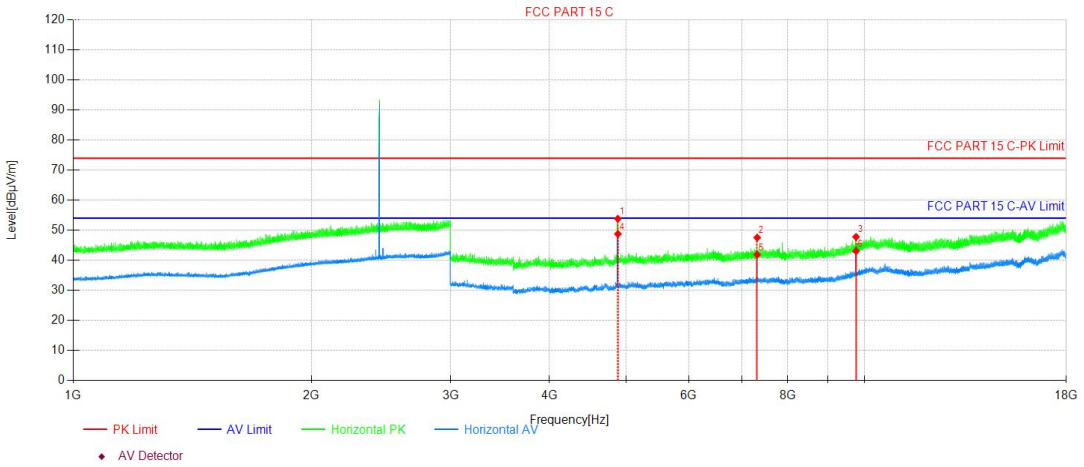


NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	4804.59	59.35	-4.61	54.74	74.00	19.26	150	316	Peak	Horizontal
2	7205.46	53.66	-1.77	51.89	74.00	22.11	150	92	Peak	Horizontal
3	9607.83	46.90	0.87	47.77	74.00	26.23	150	170	Peak	Horizontal
4	4804.59	55.01	-4.61	50.40	54.00	3.60	150	304	AV	Horizontal
5	7206.21	48.58	-1.76	46.82	54.00	7.18	150	92	AV	Horizontal
6	9608.58	42.86	0.88	43.74	54.00	10.26	150	38	AV	Horizontal

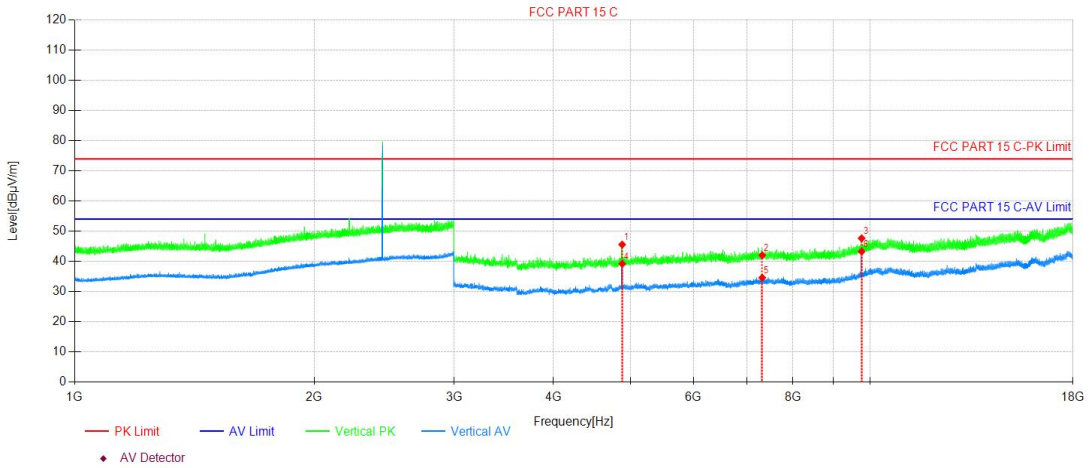


NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	4803.09	50.27	-4.61	45.66	74.00	28.34	150	262	Peak	Vertical
2	7206.96	48.12	-1.76	46.36	74.00	27.64	150	195	Peak	Vertical
3	9607.83	46.94	0.87	47.81	74.00	26.19	150	285	Peak	Vertical
4	4804.59	43.80	-4.61	39.19	54.00	14.81	150	226	AV	Vertical
5	7206.21	43.08	-1.76	41.32	54.00	12.68	150	195	AV	Vertical
6	9608.58	42.74	0.88	43.62	54.00	10.38	150	285	AV	Vertical

BLE 1M 2440MHz



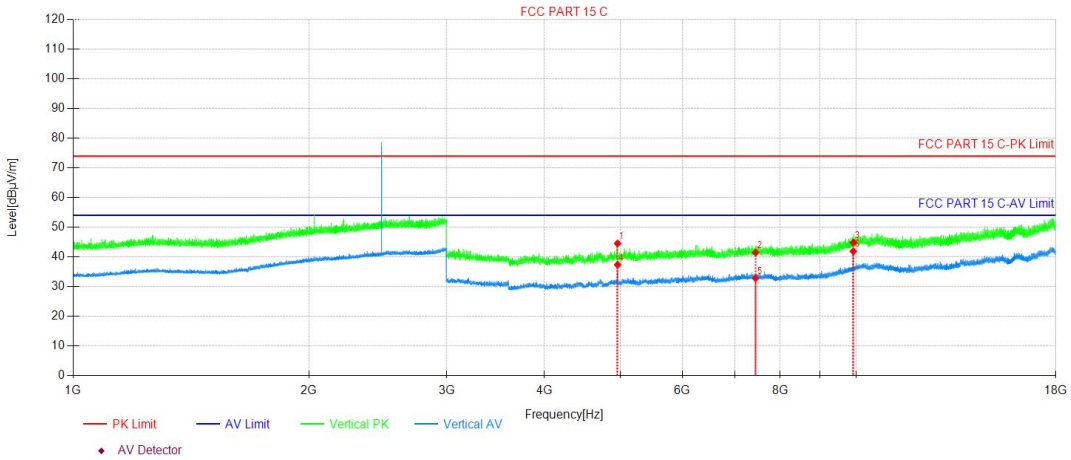
NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	4879.59	58.52	-4.70	53.82	74.00	20.18	150	292	Peak	Horizontal
2	7320.21	49.03	-1.49	47.54	74.00	26.46	150	99	Peak	Horizontal
3	9760.08	46.16	1.62	47.78	74.00	26.22	150	153	Peak	Horizontal
4	4881.09	53.47	-4.71	48.76	54.00	5.24	150	314	AV	Horizontal
5	7320.21	43.34	-1.49	41.85	54.00	12.15	150	99	AV	Horizontal
6	9760.83	41.43	1.63	43.06	54.00	10.94	150	43	AV	Horizontal



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity
1	4879.59	50.27	-4.70	45.57	74.00	28.43	150	270	Peak	Vertical
2	7320.21	43.53	-1.49	42.04	74.00	31.96	150	18	Peak	Vertical
3	9760.08	46.03	1.62	47.65	74.00	26.35	150	281	Peak	Vertical
4	4880.34	43.87	-4.71	39.16	54.00	14.84	150	270	AV	Vertical
5	7320.21	36.08	-1.49	34.59	54.00	19.41	150	171	AV	Vertical
6	9760.83	41.64	1.63	43.27	54.00	10.73	150	281	AV	Vertical

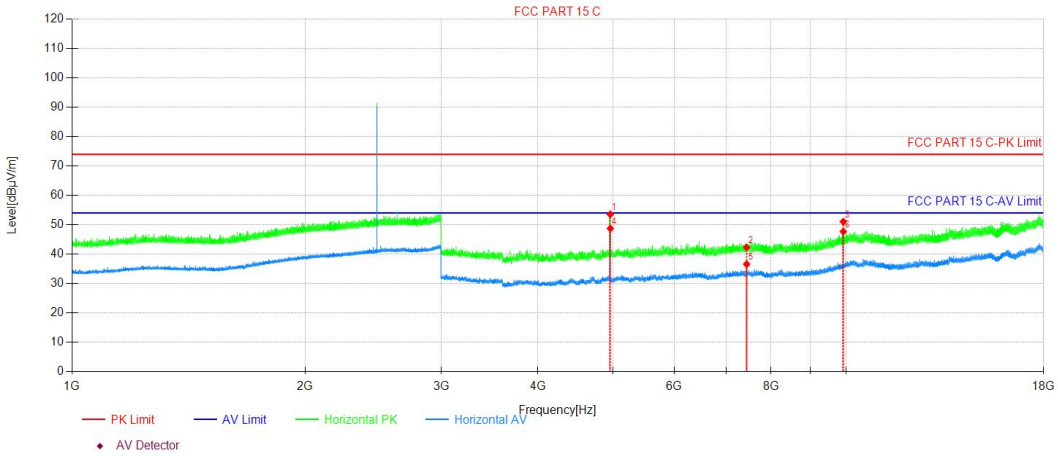
BLE 1M 2480MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	4959.09	49.41	-4.86	44.55	74.00	29.45	150	288	Peak
2	7440.22	42.82	-1.34	41.48	74.00	32.52	150	233	Peak
3	9920.59	42.56	2.27	44.83	74.00	29.17	150	114	Peak
4	4960.59	42.23	-4.86	37.37	54.00	16.63	150	299	AV
5	7440.22	34.15	-1.34	32.81	54.00	21.19	150	0	AV
6	9920.59	39.62	2.27	41.89	54.00	12.11	150	199	AV

Horizontal:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	4959.09	58.43	-4.86	53.57	74.00	20.43	150	295	Peak
2	7440.22	43.63	-1.34	42.29	74.00	31.71	150	295	Peak
3	9919.84	48.81	2.26	51.07	74.00	22.93	150	90	Peak
4	4959.84	53.60	-4.86	48.74	54.00	5.26	150	304	AV
5	7440.97	37.91	-1.34	36.57	54.00	17.43	150	336	AV
6	9920.59	45.41	2.27	47.68	54.00	6.32	150	90	AV

Note:

1. The Measurement (Result Level) is calculated by Reading Level adding the Correct Factor(maybe including Ant.Factor and the Cable Factor etc.), The basic equation is as follows:

Result Level= Reading Level + Correct Factor(including Ant.Factor, Cable Factor etc.)

2. The amplitude of 9KHz to 30MHz spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

3. The amplitude of 18GHz to 25GHz spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be report.

4. All channels had been pre-test,only the worst case was reported.

3.9 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2020 Section 11.12		
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)		
Limit:	Frequency	Limit (dBuV/m)	Remark
	30MHz-88MHz	40.0	Quasi-peak
	88MHz-216MHz	43.5	Quasi-peak
	216MHz-960MHz	46.0	Quasi-peak
	960MHz-1GHz	54.0	Quasi-peak
	Above 1GHz	54.0	Average Value
		74.0	Peak Value
Test Setup:			

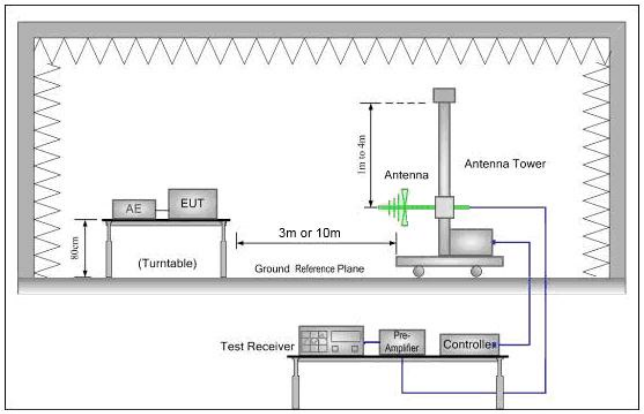


Figure 1. 30MHz to 1GHz

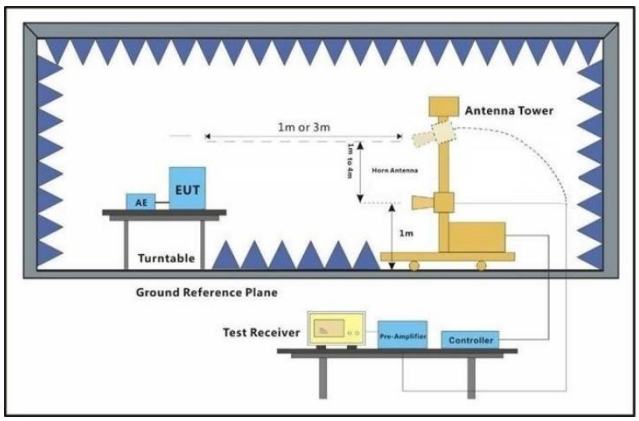


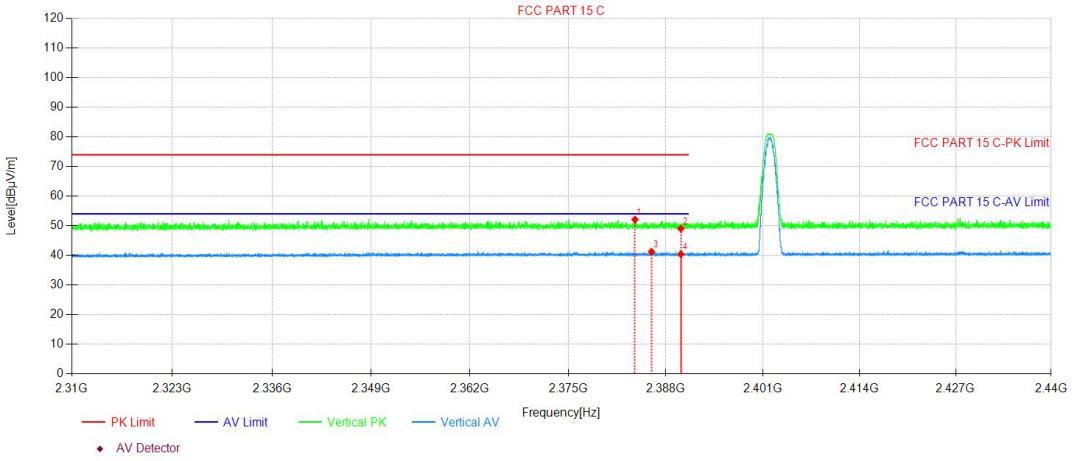
Figure 2. Above 1 GHz

Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel h. Test the EUT in the lowest channel , the Highest channel i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode,And found the X axis positioning which it is worse case. j. Repeat above procedures until all frequencies measured was complete.
Test Configuration:	Measurements Below 1000MHz

	• RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 10 Hz, when duty cycle is no less than 98 percent. • VBW ⩾ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Transmitting mode.
Final Test Mode:	Pretest the EUT at Charge + Transmitting mode. Through Pre-scan, find the worst case of GFSK Only the worst case is recorded in the report.
Instruments Used:	Refer to section 2.9 for details
Test Results:	Pass

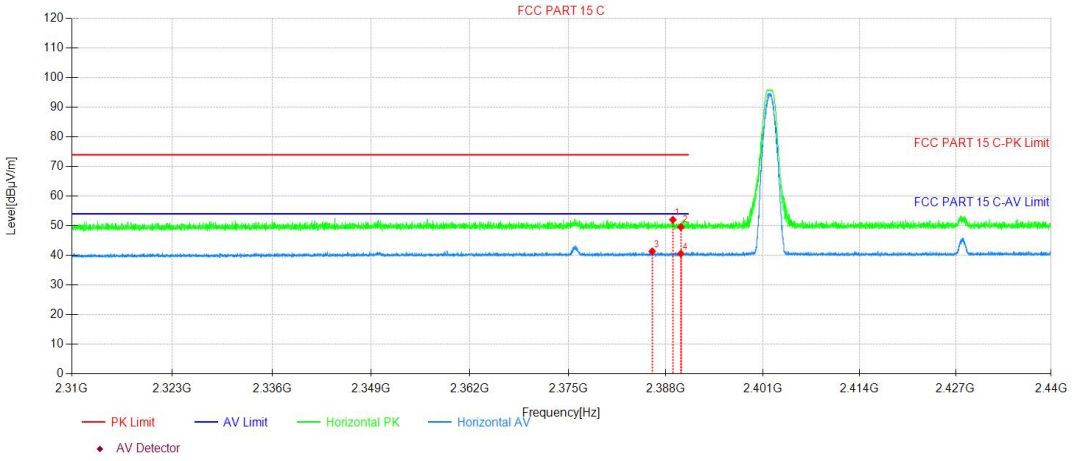
Test Date
BLE 1M 2402MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2383.88	52.92	-0.82	52.10	74.00	21.90	150	186	Peak
2	2390.01	49.84	-0.80	49.04	74.00	24.96	150	271	Peak
3	2386.09	42.04	-0.81	41.23	54.00	12.77	150	347	AV
4	2390.01	41.16	-0.80	40.36	54.00	13.64	150	44	AV

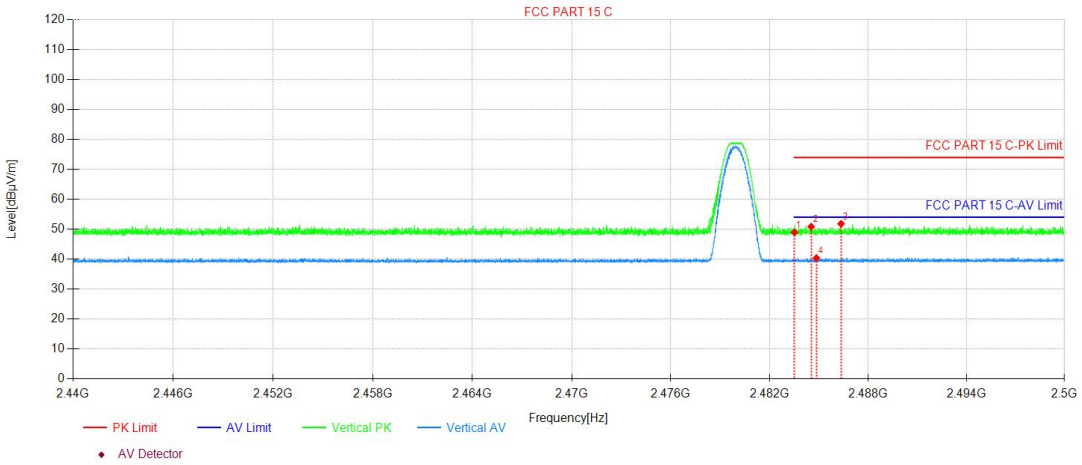
Horizontal:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2388.94	52.82	-0.80	52.02	74.00	21.98	150	174	Peak
2	2390.01	50.37	-0.80	49.57	74.00	24.43	150	356	Peak
3	2386.18	42.16	-0.81	41.35	54.00	12.65	150	215	AV
4	2390.01	41.36	-0.80	40.56	54.00	13.44	150	73	AV

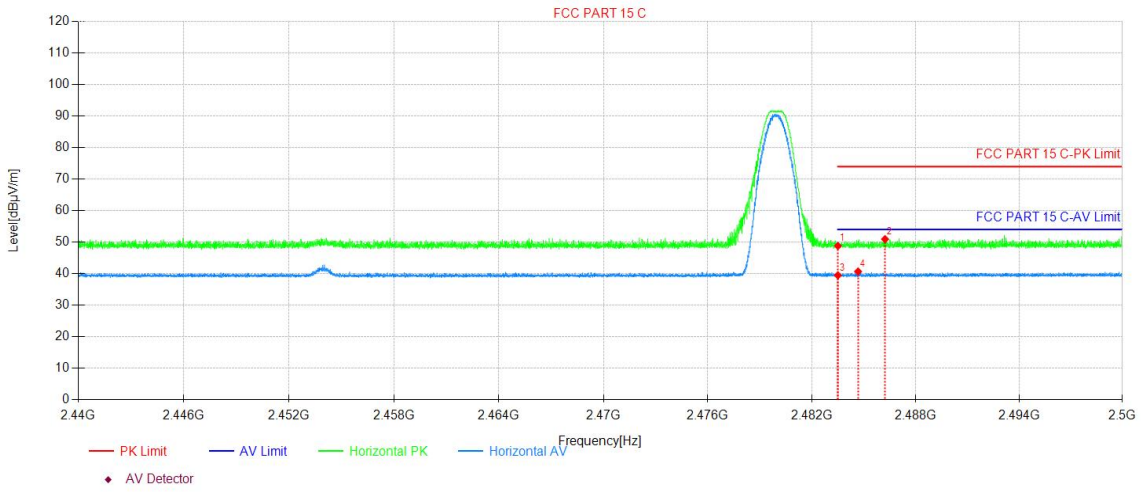
BLE 2480MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2483.51	49.25	-0.29	48.96	74.00	25.04	150	178	Peak
2	2484.53	51.13	-0.28	50.85	74.00	23.15	150	283	Peak
3	2486.35	52.09	-0.26	51.83	74.00	22.17	150	240	AV
4	2484.85	40.62	-0.27	40.35	54.00	13.65	150	349	AV

Horizontal:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	AV Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2483.51	49.09	-0.29	48.80	74.00	25.20	150	254	Peak
2	2486.23	51.21	-0.27	50.94	74.00	23.06	150	148	Peak
3	2483.51	39.75	-0.29	39.46	54.00	14.54	150	299	AV
4	2484.67	40.92	-0.27	40.65	54.00	13.35	150	332	AV

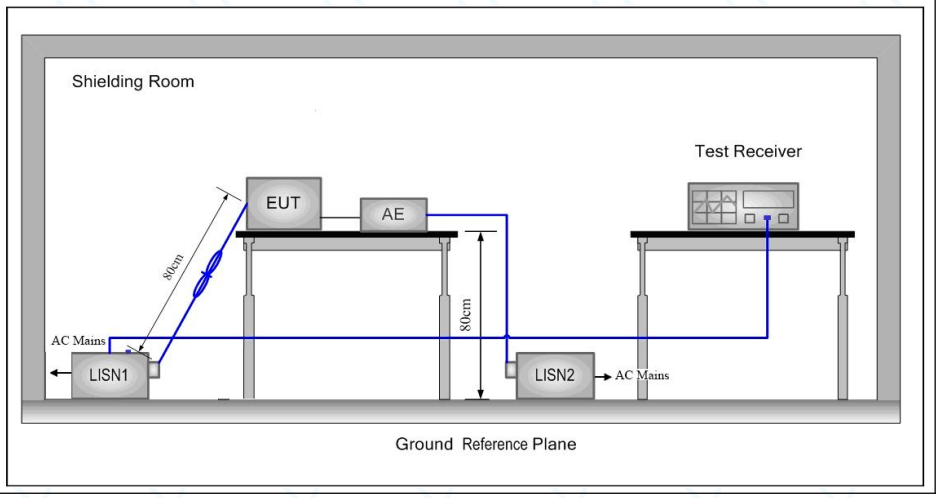
Note:

1. The BLE 1M is the worse case.

2. The Measurement (Result Level) is calculated by Reading Level adding the Correct Factor(maybe including Ant.Factor and the Cable Factor etc.), The basic equation is as follows:

Result Level= Reading Level + Correct Factor(including Ant.Factor ,Cable Factor etc.)

3.10AC Power Line Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2020		
Test Frequency Range:	150kHz to 30MHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		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.		
Test Procedure:	1) The mains terminal disturbance voltage test was conducted in a shielded room. 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded. 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 2013 on conducted measurement.		
Test Setup:			

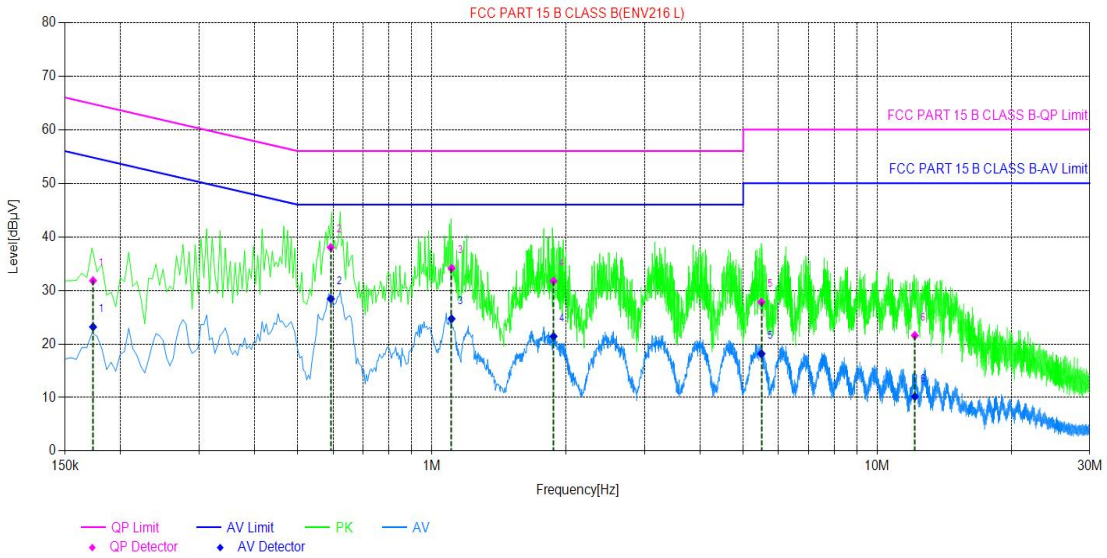
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates at lowest, middle and highest channel.

	Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the the worst case of GFSK
Instruments Used:	Refer to section 2.9 for details
Test Results:	Pass

Measurement Data

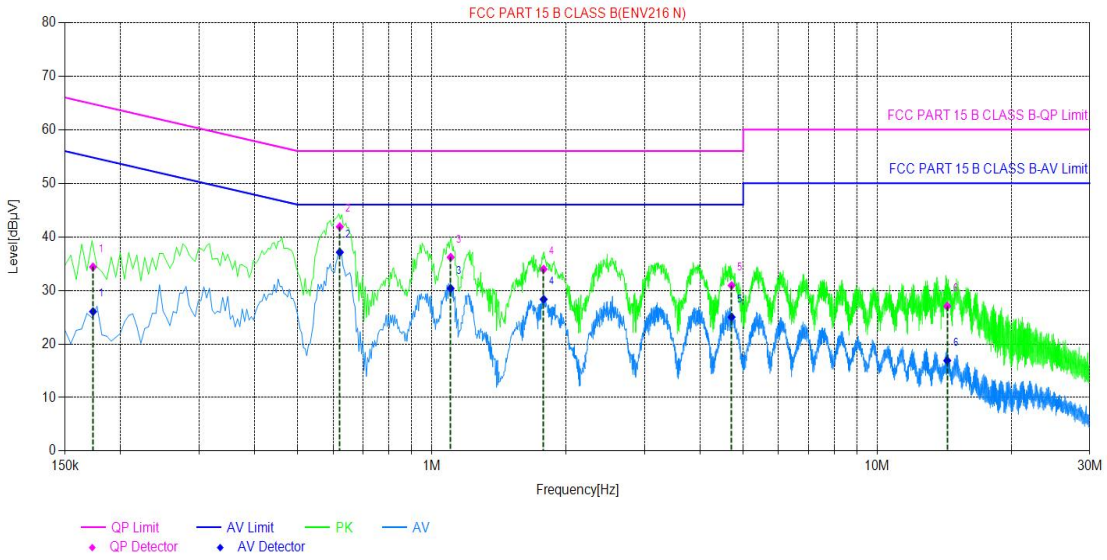
An initial pre-scan was performed on the live and neutral lines with peak detector.
Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Live Line:



NO.	Freq. [MHz]	Correct Factor [dB]	QP Reading Level [dBµV]	QP Result Level [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading Level [dBµV]	AV Result Level [dBµV]	AV Limit [dBµV]	AV Margin [dB]
1	0.1734	9.91	21.89	31.80	64.80	33.00	13.27	23.18	54.80	31.62
2	0.5928	9.82	28.19	38.01	56.00	17.99	18.61	28.43	46.00	17.57
3	1.1071	9.72	24.41	34.13	56.00	21.87	14.98	24.70	46.00	21.30
4	1.8756	9.73	22	31.73	56.00	24.27	11.68	21.41	46.00	24.59
5	5.4950	9.81	17.99	27.80	60.00	32.20	8.37	18.18	50.00	31.82
6	12.146	9.92	11.66	21.58	60.00	38.42	0.25	10.17	50.00	39.83

Neutral Line:



NO.	Freq. [MHz]	Correct Factor [dB]	QP Reading Level [dBµV]	QP Result Level [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading Level [dBµV]	AV Result Level [dBµV]	AV Limit [dBµV]	AV Margin [dB]
1	0.1734	9.82	24.55	34.37	64.80	30.43	16.22	26.04	54.80	28.76
2	0.6211	9.80	32.08	41.88	56.00	14.12	27.31	37.11	46.00	8.89
3	1.1017	9.69	26.49	36.18	56.00	19.82	20.67	30.36	46.00	15.64
4	1.7818	9.75	24.22	33.97	56.00	22.03	18.58	28.33	46.00	17.67
5	4.7093	9.97	20.95	30.92	56.00	25.08	15.04	25.01	46.00	20.99
6	14.358	9.92	17.13	27.05	60.00	32.95	6.98	16.90	50.00	33.10

Remark:

1. The BLE 1M is the worse case.

2. The following Quasi-Peak and Average measurements were performed on the EUT:

3. The Measurement (Result Level) is calculated by Reading Level adding the Correct Factor(maybe including LISN Factor and the Cable Factor etc.), The basic equation is as follows:

Result Level= Reading Level + Correct Factor(including LISN Factor, Cable Factor etc.)

4 Appendix

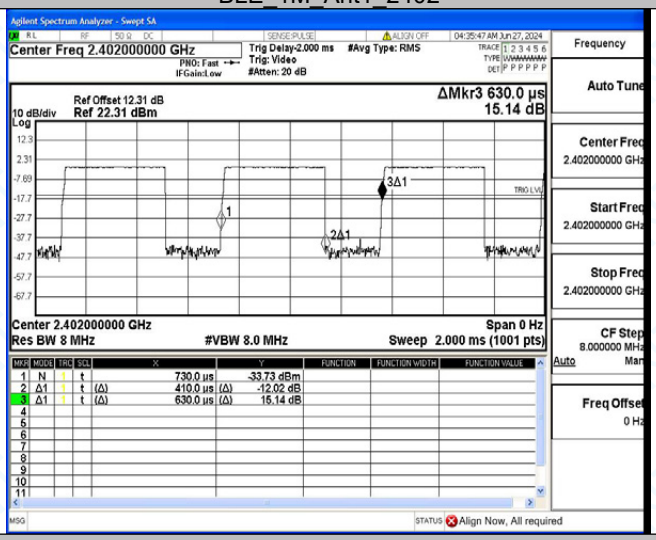
Appendix A: Duty Cycle

Test Result

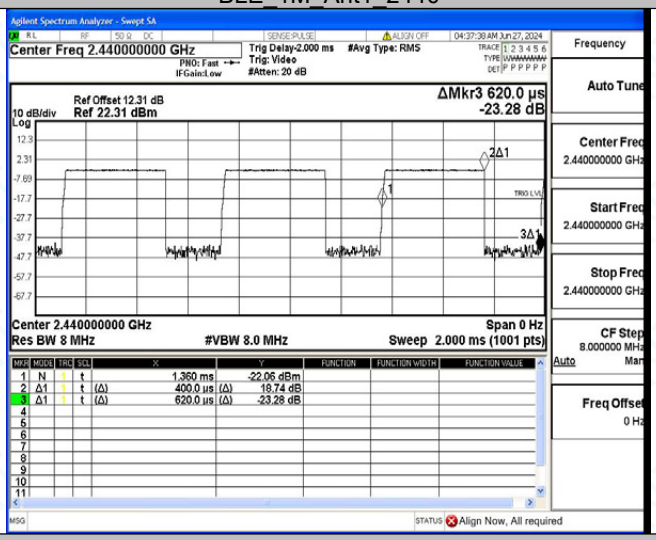
Test Mode	Antenna	Freq(MHz)	ON Time [ms]	Period [ms]	DC [%]
BLE_1M	Ant1	2402	0.41	0.63	65.08
		2440	0.40	0.62	64.52
		2480	0.41	0.63	65.08

Test Graphs

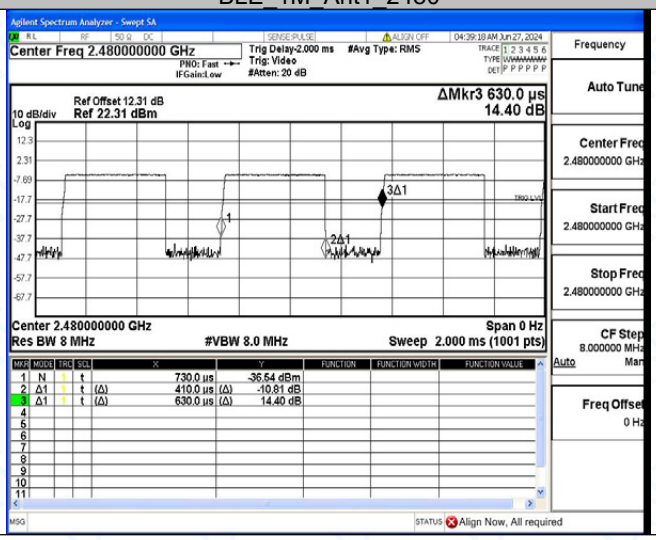
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



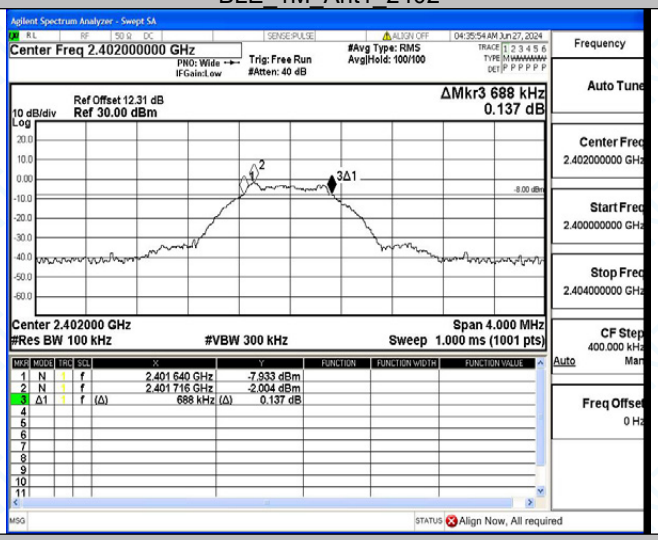
Appendix B: DTS Bandwidth

Test Result

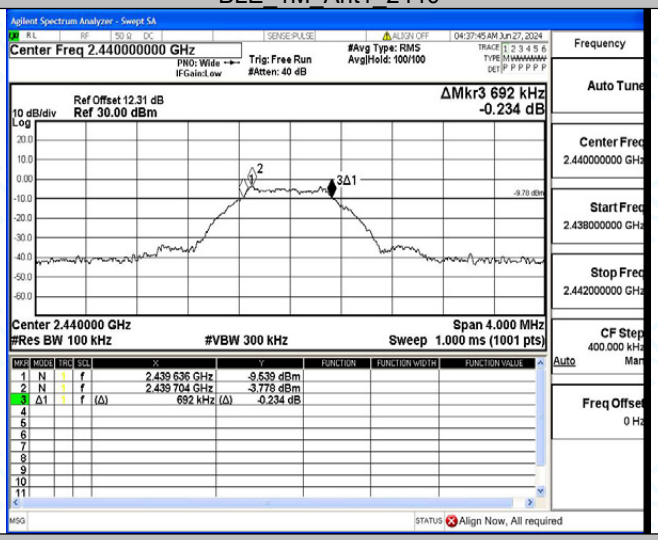
Test Mode	Antenna	Freq(MHz)	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.688	2401.640	2402.328	0.5	PASS
		2440	0.692	2439.636	2440.328	0.5	PASS
		2480	0.688	2479.632	2480.320	0.5	PASS

Test Graphs

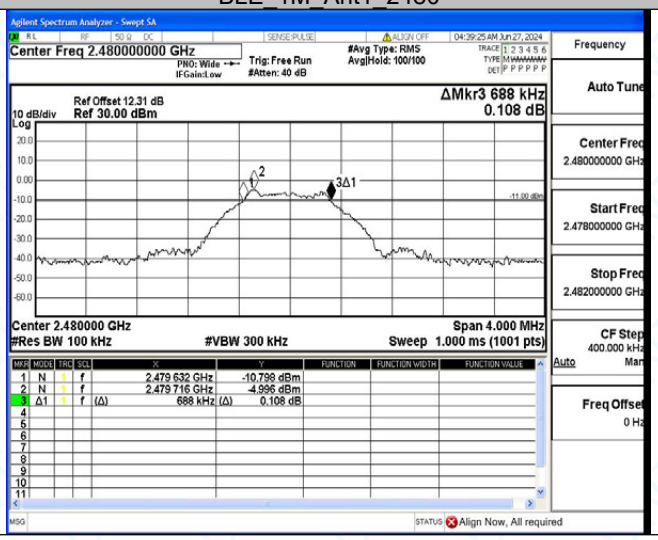
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



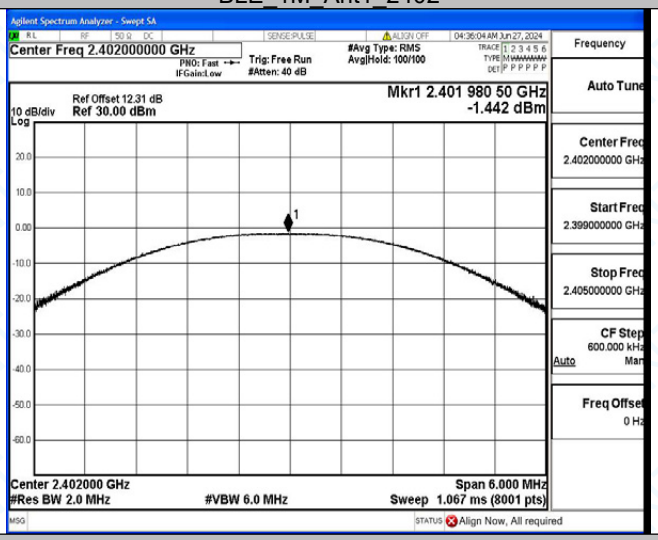
Appendix C: Maximum conducted output power

Test Result

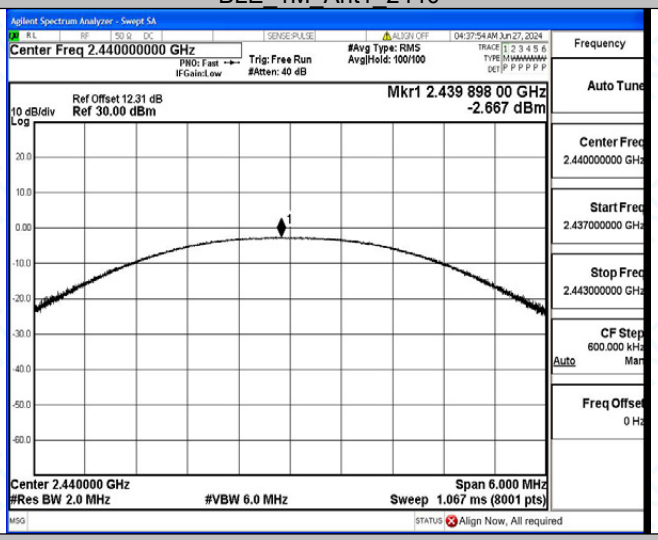
Test Mode	Antenna	Freq(MHz)	Power [dBm]	Limit [dBm]	Verdict
BLE_1M	Ant1	2402	-1.44	≤30	PASS
		2440	-2.67	≤30	PASS
		2480	-4.30	≤30	PASS

Test Graphs

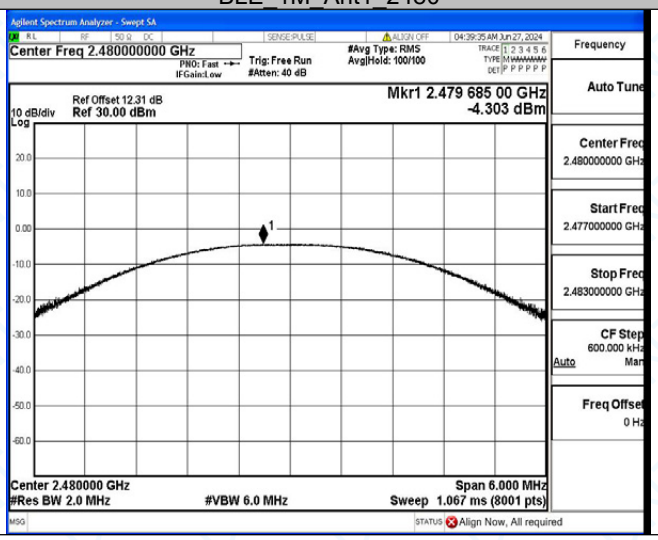
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



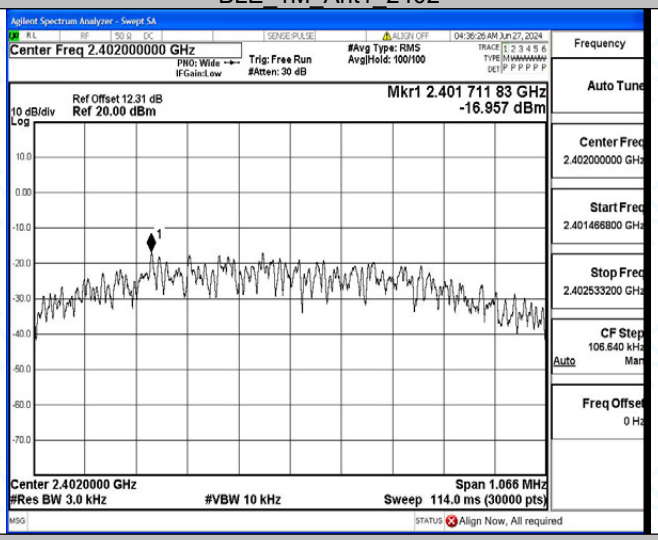
Appendix D: Maximum power spectral density

Test Result

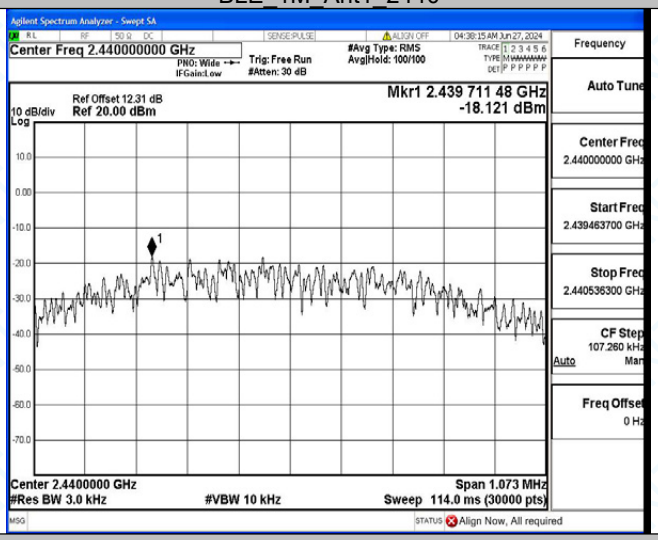
Test Mode	Antenna	Freq(MHz)	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-16.96	≤8.00	PASS
		2440	-18.12	≤8.00	PASS
		2480	-19.88	≤8.00	PASS

Test Graphs

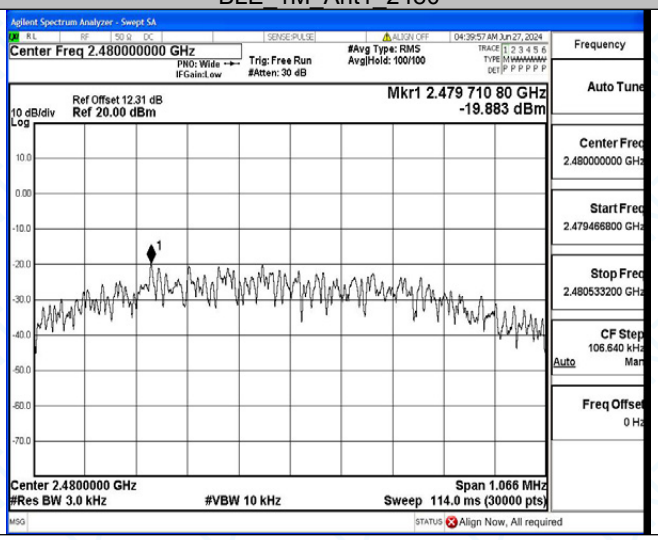
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



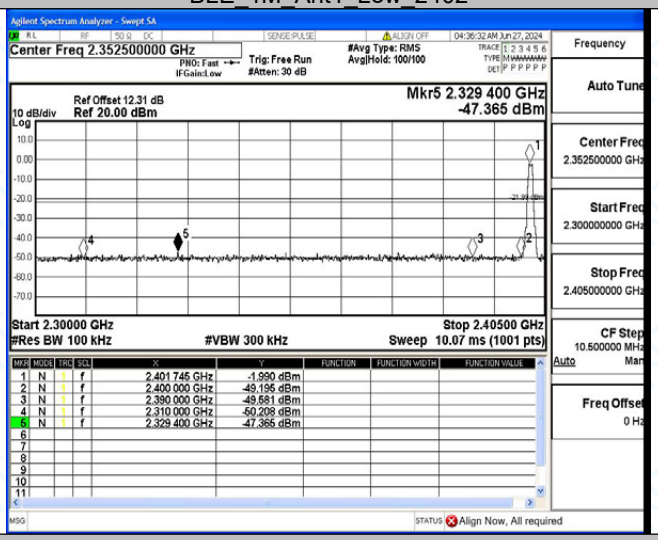
Appendix E: Band edge measurements

Test Result

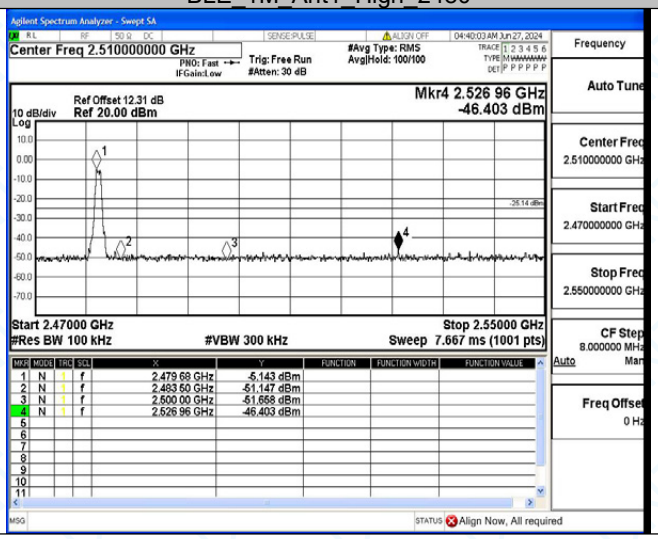
Test Mode	Antenna	Ch Name	Freq (MHz)	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	Low	2402	-1.99	-47.37	≤-21.99	PASS
		High	2480	-5.14	-46.4	≤-25.14	PASS

Test Graphs

BLE_1M_Ant1_Low_2402



BLE_1M_Ant1_High_2480



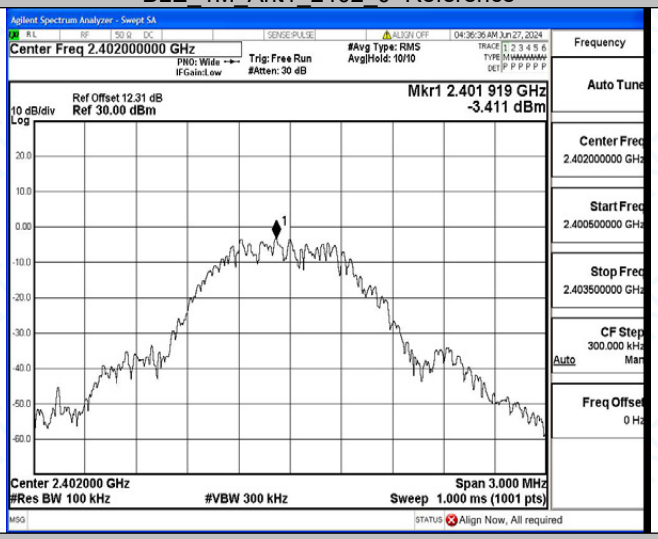
Appendix F: Conducted Spurious Emission

Test Result

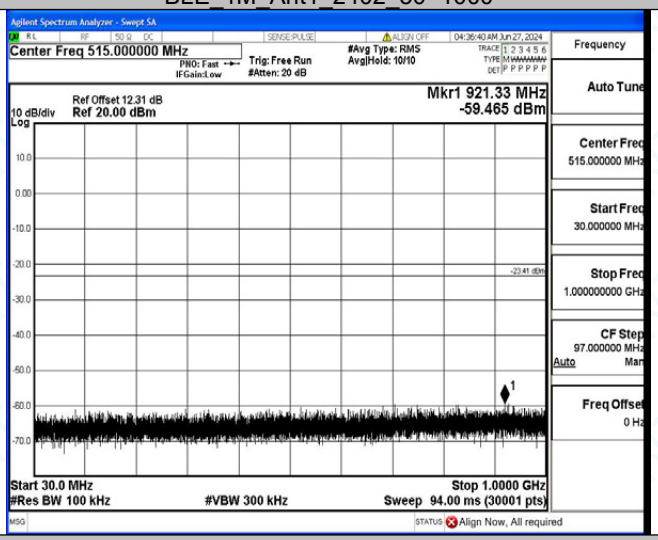
Test Mode	Antenna	Freq(MHz)	Freq Range [Mhz]	Ref Level [dBm]	Result [dBm]	Limit [dBm]	Verdict
BLE_1M	Ant1	2402	Reference	-3.41	-3.41	---	PASS
			30~1000	-3.41	-59.47	≤-23.41	PASS
			1000~26500	-3.41	-43.43	≤-23.41	PASS
		2440	Reference	-3.36	-3.36	---	PASS
			30~1000	-3.36	-58.64	≤-23.36	PASS
			1000~26500	-3.36	-48.81	≤-23.36	PASS
		2480	Reference	-5.04	-5.04	---	PASS
			30~1000	-5.04	-59.72	≤-25.04	PASS
			1000~26500	-5.04	-48.32	≤-25.04	PASS

Test Graphs

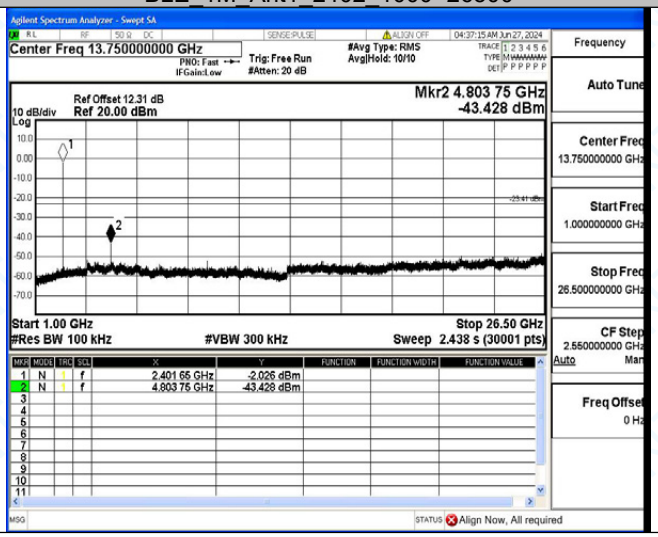
BLE_1M_Ant1_2402_0~Reference



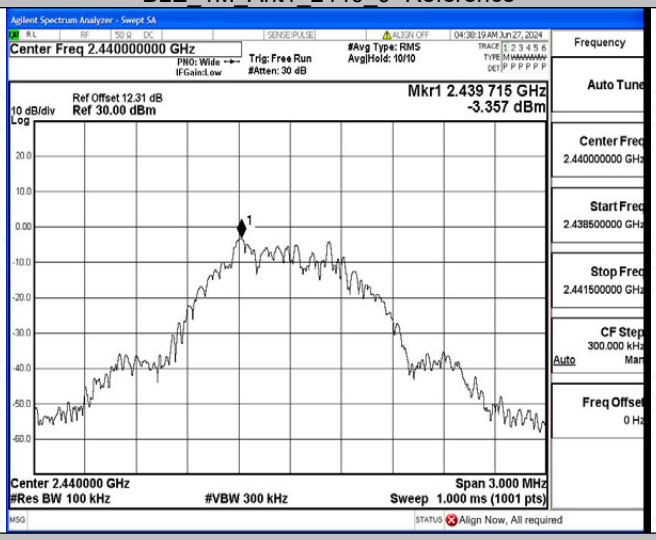
BLE_1M_Ant1_2402_30~1000



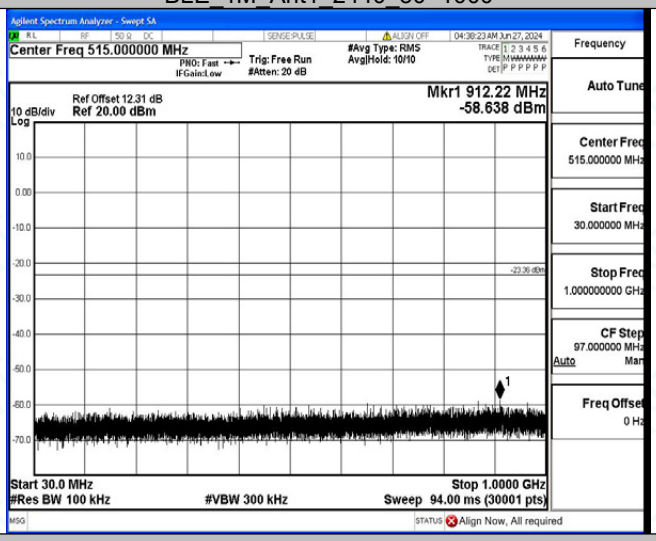
BLE_1M_Ant1_2402_1000~26500



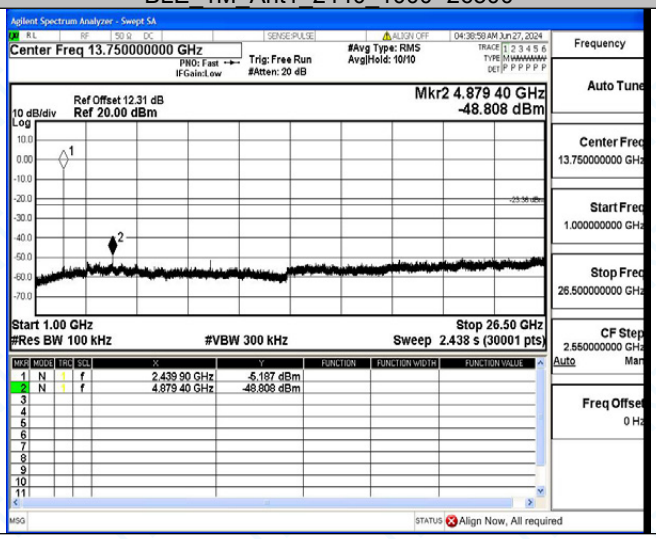
BLE_1M_Ant1_2440_0~Reference



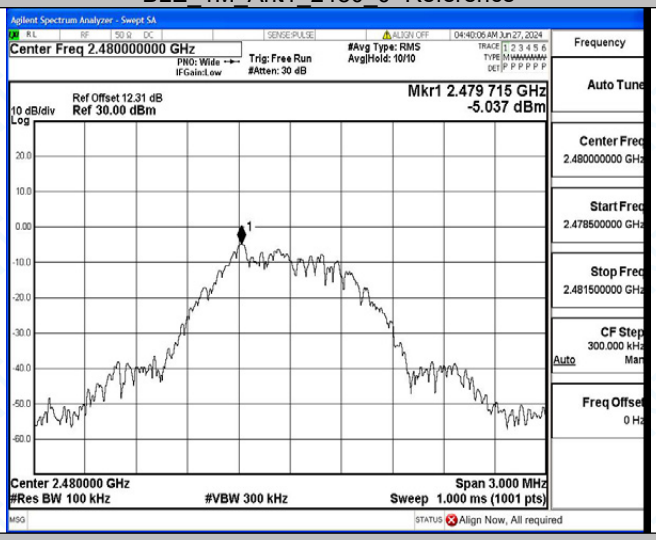
BLE_1M_Ant1_2440_30~1000



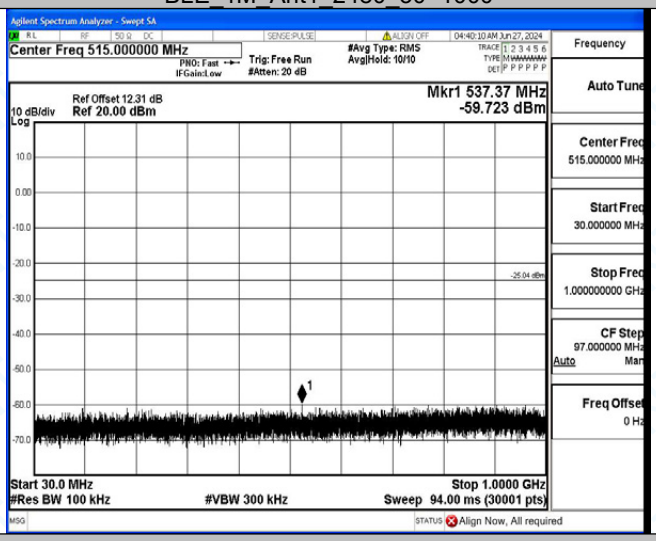
BLE_1M_Ant1_2440_1000~26500



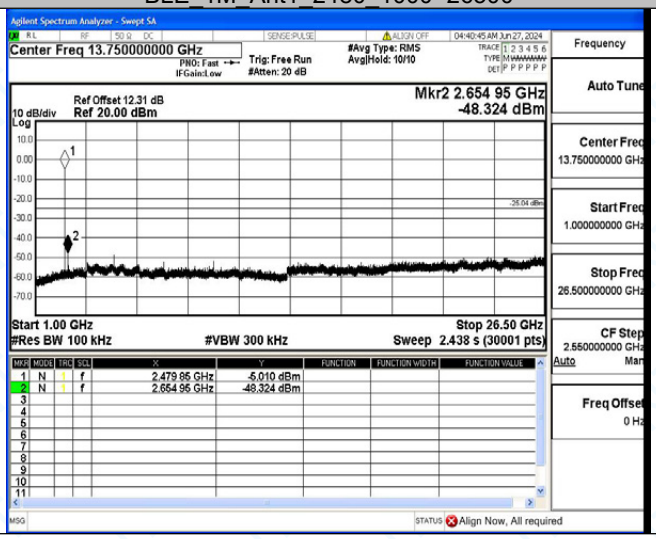
BLE_1M_Ant1_2480_0~Reference



BLE_1M_Ant1_2480_30~1000



BLE_1M_Ant1_2480_1000~26500



The End Report