TEST REPORT

Applicant Name :	SHENZHEN TOPFLYtech CO., LIMITED
Address :	Rm409 Scientific Research Building Tsinghua, Hi-tech Park Hi-tech Industrial Nanshan District, shenzhen, China
Report Number :	RA230621-35652E-RF
FCC ID:	2ASWYSOLARGUARDX200
IC:	27469-GUARDX200

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2; RSS-247, ISSUE 2, FEBRUARY 2017

Sample Description

Product Type:	SolarGuardX 200
Model No.:	SolarGuardX 200
Multiple Model(s) No.:	N/A
Trade Mark:	TOPFLYtech
Date Received:	2023/06/21
Report Date:	2023/07/10
Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Roger Liang
EMC Engineer

Approved By:

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230621-35652E-RF	Original Report	2023/07/10

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	V1.0
FVIN	V2.1
Frequency Range	BLE 1M/2M: 2402-2480MHz
Maximum Conducted Peak Output Power	BLE:8.57dBm
Modulation Technique	BLE: GFSK
Antenna Specification*	1.1dBi (provided by the applicant)
Voltage Range	DC 3.6V from battery or 120V AC/5V DC adaptor or charging from solar panel
Sample serial number	RE&CE: 276B-1 RF: 276B-1 (Assigned by ATC)
Sample/EUT Status	Good condition

Objective

This report is in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209, 15.247 rules and RSS-GEN Issue 5, February 2021 Amendment 2 and RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada rules.

Test Methodology

All tests and measurements indicated in this document were performed in accordance ANSI C63.10-2013, RSS-GEN Issue 5, February 2021 Amendment 2 and RSS-247, Issue 2, February 2017.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Harmonic Current		0.512%, k=2
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.71dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions	9k-30MHz	2.74dB, k=2
	150kHz-30MHz	2.92dB, k=2
Audio Frequency Response		0.1dB
Low Pass Filter Response		1.2dB
Modulation Limiting		1%
Emissions, Radiated	9kHz - 30MHz	2.06dB
	30MHz - 1GHz	5.08dB
	1GHz - 18GHz	4.96dB
	18GHz - 26.5GHz	5.16dB
	26.5GHz - 40GHz	4.64dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 30241.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For BLE mode, 40 channels are provided to testing:

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

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“nRF_DTM * software was used to test and power level as below:

Mode	Data rate	Power Level*		
		Low Channel	Middle Channel	High Channel
BLE	1Mbps	8	8	8
BLE	2Mbps	8	8	8

The software and power level was provided by the applicant.

Duty cycle

Test Result: Compliant. Please refer to the Appendix

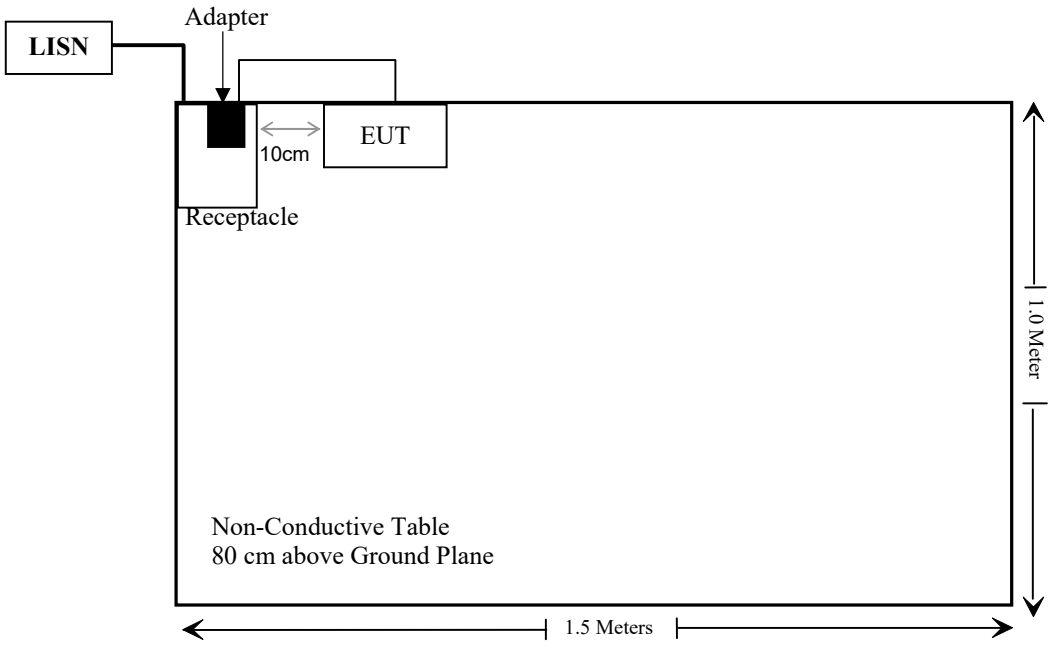
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
TIANYIN	Adapter	TPA-10S260UU01	E326703

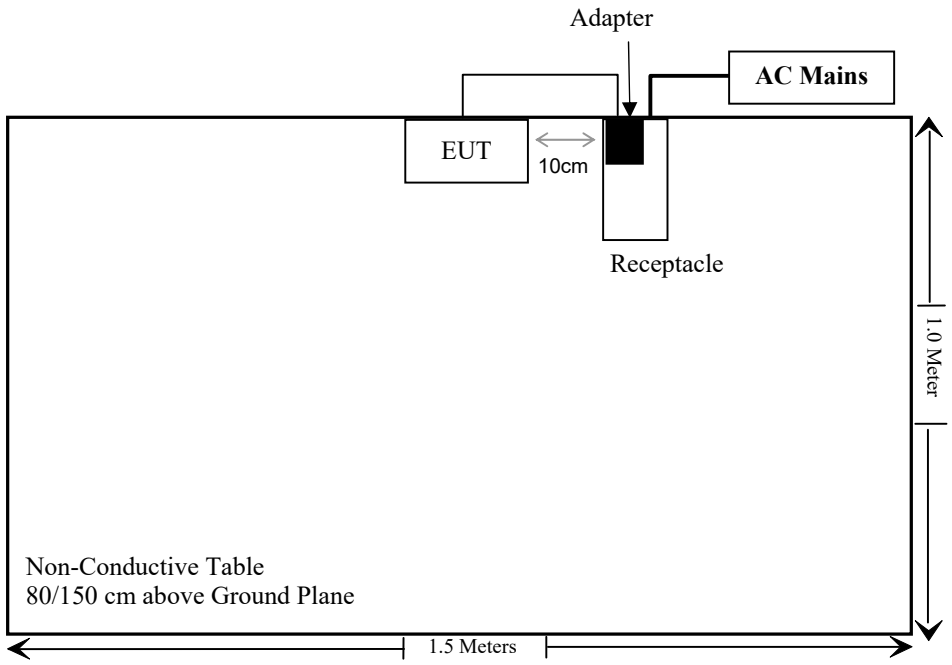
External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable DC Cable	0.5	EUT	Adapter

Block Diagram of Test Setup
For conducted emission



For Radiated Emissions:



Note: the support table edge was flush with the center of turntable

SUMMARY OF TEST RESULTS

FCC Rules	RSS Rules	Description of Test	Result
§2.1091	RSS-102 § 4	MAXIMUM PERMISSIBLE EXPOSURE (MPE) & EXPOSURE LIMITS	Compliant
§15.203	RSS-Gen §6.8	Antenna Requirement	Compliant
§15.207 (a)	RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	RSS-GEN § 8.10 & RSS-247 § 5.5	Spurious Emissions	Compliant
§15.247 (a)(2)	RSS- Gen§6.7 RSS-247 § 5.2 (a)	99% Occupied Bandwidth & 6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	RSS-247 § 5.4(d)	Maximum Conducted Output Power	Compliant
§15.247(e)	RSS-247 § 5.2 (b)	Power Spectral Density	Compliant
§15.247(d)	RSS-247 § 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted emission test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2022/11/25	2023/11/24
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2022/11/25	2023/11/24
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2022/12/07	2023/12/06
Unknown	RF Coaxial Cable	No.17	N0350	2022/11/25	2023/11/24
Conducted Emission Test Software: e3 191218 (V9)					
Radiated emission test					
Rohde& Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	837	2023/02/22	2026/02/21
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2022/12/26	2025/12/25
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.15	N600	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.16	N650	2022/11/25	2023/11/24
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2022/11/25	2023/11/24
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/11/25	2023/11/24
Tonscend	RF Control Unit	JS0806-2	19G8060182	2022/10/24	2023/10/23
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (Minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Mode	Frequency (MHz)	Antenna Gain		Tune up output power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BLE	2402-2480	1.1	1.29	9.0	7.94	20	0.002	1.0
LTE B2	1850-1910	1.5	1.41	24	251.19	20	0.070	1.0
LTE B4	1710-1755	1.5	1.41	24	251.19	20	0.070	1.0
LTE B5	824-849	1.0	1.26	26	398.11	20	0.100	0.549
LTE B12	699-716	0.8	1.20	25	316.23	20	0.076	0.466
LTE B13	777-787	0.8	1.20	23	199.53	20	0.048	0.518
LTE B25	1850-1915	1.5	1.41	24	251.19	20	0.070	1.0
LTE B26	814-849	1.0	1.26	25	316.23	20	0.079	0.543
LTE B41	2496-2690	1.5	1.41	24	251.19	20	0.070	1.0
LTE B66	1710-1780	1.5	1.41	24	251.19	20	0.070	1.0
NFC	13.56	/	/	/	0.295	20	0.00006	0.98

Note: 1. The device contains a certified WWAN Module, FCC ID: 2AJYU-8PYA007, the output power was refer to the module report.
2. The antenna gain was provided by applicant
3. For NFC, the maximum E-field strength is 59.93dBuV/m@3m=0.992mV/m@3m
EIRP=(E*r)^2/30=(0.975*3)^2/30=0.295mW

Simultaneously transmitting consideration:

The ratio=MPE_{BLE}/Limit+MPE_{WWAN}/Limit+MPE_{NFC}/Limit =0.002/1+0.100/0.549+0.00006/0.98=0.184<1

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

RSS-102 § 4 –EXPOSURE LIMITS

Applicable Standard

According to RSS-102 §4:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \le 1$$

Mode	Frequency (MHz)	Antenna Gain		Tune up output power		Evaluation Distance (m)	Power Density (W/m^2)	MPE Limit (W/m^2)
		(dBi)	(numeric)	(dBm)	(W)			
BLE	2402-2480	1.1	1.29	9.0	0.010	0.2	0.026	5.35
LTE B2	1850-1910	1.5	1.41	24	0.250	0.2	0.702	4.48
LTE B4	1710-1755	1.5	1.41	24	0.250	0.2	0.702	4.24
LTE B5	824-849	1.0	1.26	26	0.400	0.2	1.003	2.58
LTE B12	699-716	0.8	1.20	25	0.320	0.2	0.764	2.30
LTE B13	777-787	0.8	1.20	23	0.200	0.2	0.478	2.47
LTE B25	1850-1915	1.5	1.41	24	0.250	0.2	0.702	4.48
LTE B26	824-849	1.0	1.26	25	0.320	0.2	0.803	2.58
LTE B41	2570-2620	1.5	1.41	24	0.250	0.2	0.702	5.60
LTE B66	1710-1780	1.5	1.41	24	0.250	0.2	0.702	4.24
NFC	13.56	/	/	/	0.000295	0.2	0.001	2.0

Note: 1. The device contains a certified WWAN Module, IC: 23761-8PYA008, the output power was refer to the module report.
2. The antenna gain was provided by applicant
3. For NFC, the maximum E-field strength is 59.93dBuV/m@3m=0.992mV/m@3m
EIRP=(E*r)^2/30=(0.975*3)^2/30=0.295mW

Simultaneous transmitting consideration (worst case):

The ratio=MPE_{BLE}/limit+MPE_{WWAN}/limit+MPE_{NFC}/Limit =0.026/5.35+1.003/2.58+0.001/2.0=0.394＜1.0, so simultaneous exposure is compliant.

To maintain compliance with the ISEDC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

FCC §15.203 & RSS-GEN §6.8 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

According to FCC § 15.203, the applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.
Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has one internal antenna arrangement which was permanently attached and the maximum antenna gain is 1.1dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain	Impedance	Frequency Range
PCB	1.1dBi	50 Ω	2.4~2.5GHz

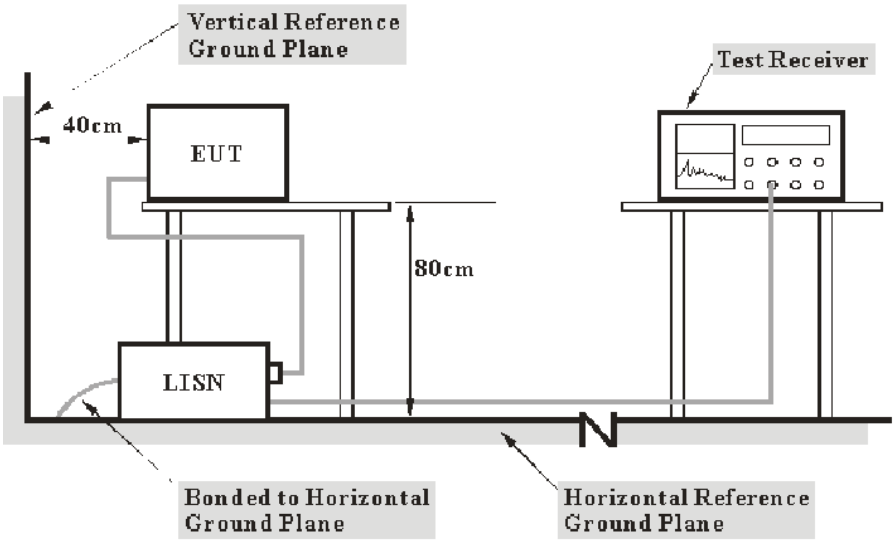
Result: Compliance

FCC §15.207 (a) & RSS-GEN § 8.8 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a), RSS-GEN § 8.8

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207 & RSS-Gen.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Transd Factor & Margin Calculation

The Transd factor is calculated by adding LISN VDF (Voltage Division Factor) and Cable Loss. The basic equation is as follows:

Transd Factor = LISN VDF + Cable Loss

The "**Over limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over limit of -7 dB means the emission is 7 dB below the limit. The equation for calculation is as follows:

Over Limit = Level – Limit
Level = Read Level + Factor

Test Data

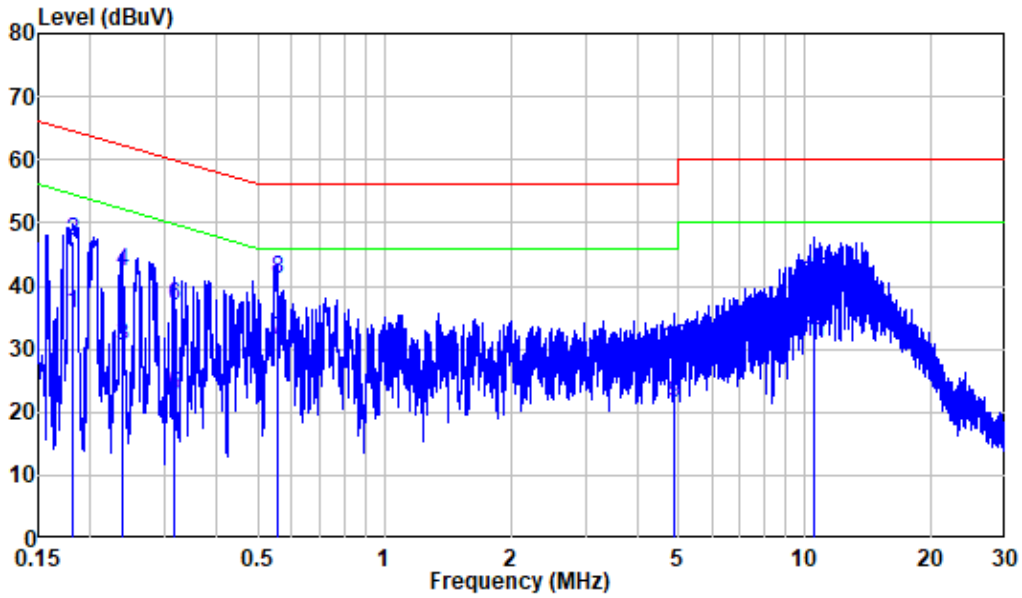
Environmental Conditions

Temperature:	24℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Jerry Wu on 2023-06-28.

EUT operation mode: Transmitting (BLE 1M, Low channel)

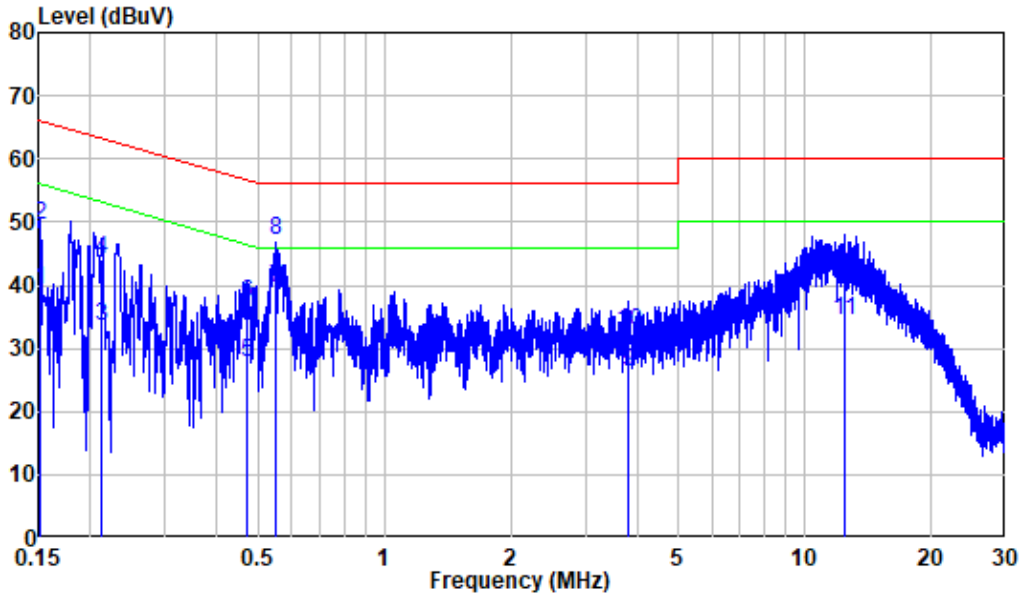
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Job No. : RA230621-35652E-RF
Mode : BLE Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.182	10.31	25.18	35.49	54.41	-18.92	Average
2	0.182	10.31	36.65	46.96	64.41	-17.45	QP
3	0.237	10.34	20.28	30.62	52.19	-21.57	Average
4	0.237	10.34	31.91	42.25	62.19	-19.94	QP
5	0.315	10.42	12.20	22.62	49.85	-27.23	Average
6	0.315	10.42	26.38	36.80	59.85	-23.05	QP
7	0.556	10.60	20.67	31.27	46.00	-14.73	Average
8	0.556	10.60	30.32	40.92	56.00	-15.08	QP
9	4.871	10.55	10.98	21.53	46.00	-24.47	Average
10	4.871	10.55	19.58	30.13	56.00	-25.87	QP
11	10.487	10.57	20.66	31.23	50.00	-18.77	Average
12	10.487	10.57	30.10	40.67	60.00	-19.33	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Job No. : RA230621-35652E-RF
Mode : BLE Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.152	10.27	28.83	39.10	55.90	-16.80	Average
2	0.152	10.27	39.22	49.49	65.90	-16.41	QP
3	0.213	10.30	23.22	33.52	53.10	-19.58	Average
4	0.213	10.30	33.83	44.13	63.10	-18.97	QP
5	0.473	10.45	17.43	27.88	46.47	-18.59	Average
6	0.473	10.45	26.63	37.08	56.47	-19.39	QP
7	0.553	10.47	29.11	39.58	46.00	-6.42	Average
8	0.553	10.47	36.61	47.08	56.00	-8.92	QP
9	3.789	10.54	15.73	26.27	46.00	-19.73	Average
10	3.789	10.54	22.14	32.68	56.00	-23.32	QP
11	12.384	10.43	23.97	34.40	50.00	-15.60	Average
12	12.384	10.43	31.74	42.17	60.00	-17.83	QP

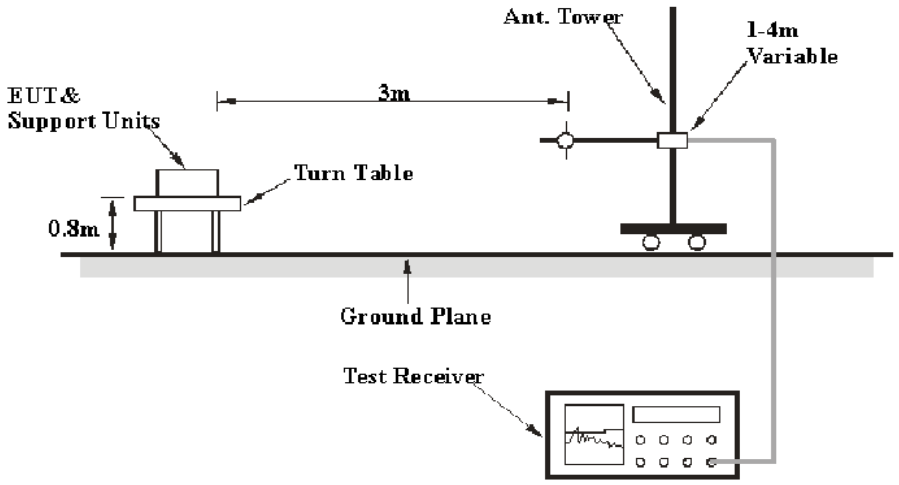
FCC §15.209, §15.205 & §15.247(D), RSS-GEN § 8.10 & RSS-247 § 5.5 – UNWANTED EMISSION FREQUENCIES AND RESTRICTED BANDS

Applicable Standard

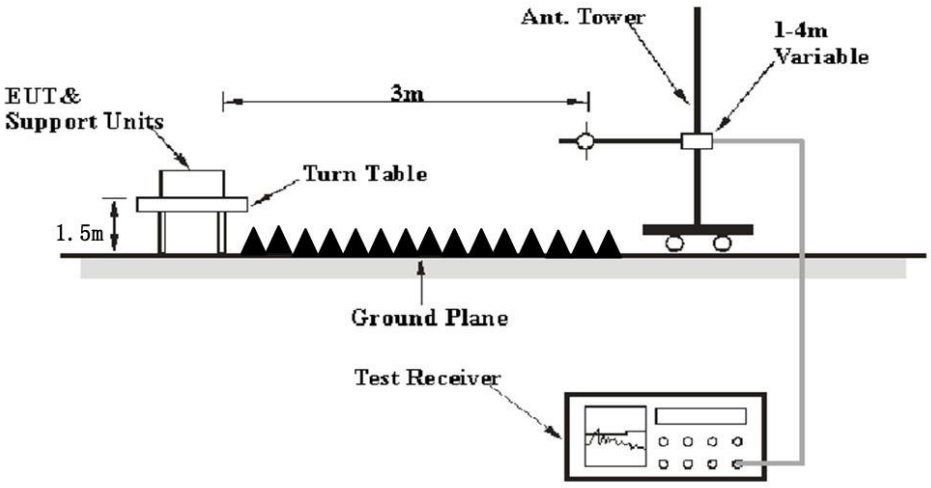
FCC §15.247 (d); §15.209; §15.205; RSS-247 §5.5, RSS-GEN §8.10.

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.205, FCC 15.209, FCC 15.247, RSS-Gen and RSS-247 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30MHz – 1000 MHz	100 kHz	300 kHz	120kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz Note 1	/	Average
	1MHz	＞1/T Note 2	/	Average

Note 1: when duty cycle is no less than 98%
Note 2: when duty cycle is less than 98%

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.

Repeat above procedures until all measured frequencies were complete.

Factor & Margin Calculation

The Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain. The basic equation is as follows:

Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "**Over Limit/Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit/margin of -7dB means the emission is 7dB below the limit. The equation for calculation is as follows:

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Results Summary

According to the data in the following table, the EUT complied with the FCC 15.205, FCC 15.209, FCC 15.247, RSS-Gen and RSS-247.

Test Data

Environmental Conditions

Temperature:	22~25℃
Relative Humidity:	49~60%
ATM Pressure:	101.0 kPa

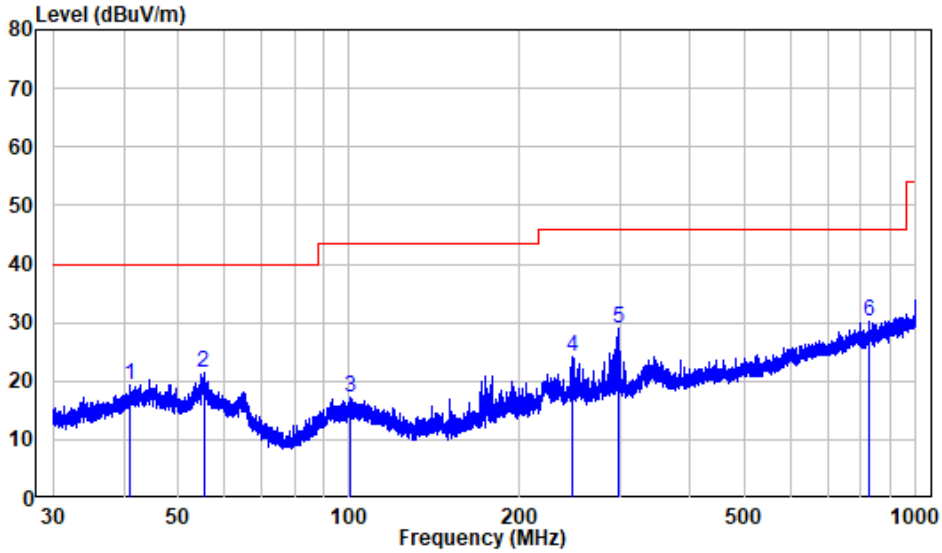
The testing was performed by Jason Liu on 2023-06-28 for below 1GHz and Jimi Zheng on 2023-06-27 for above 1GHz.

EUT operation mode: Transmitting (Pre-scan in the X, Y and Z axes of orientation, the worst case X-axes of orientation were recorded)

30MHz-1GHz: *(BLE 1M, Low channel)*

Note: When the test result of peak was less than the limit of QP more than 6dB, just peak value were recorded.

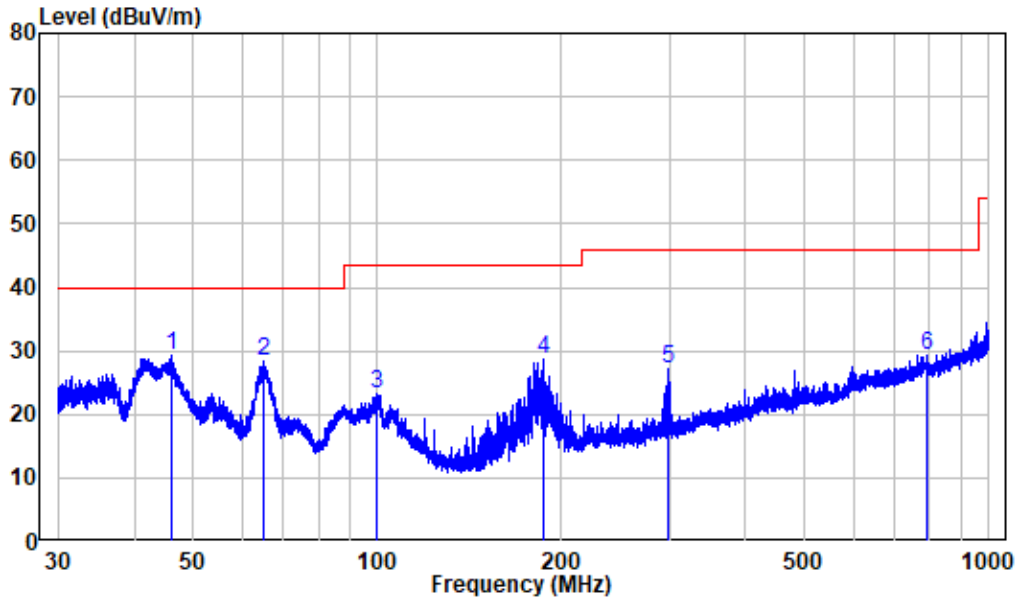
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230621-35652E-RF
Test Mode: BLE Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.952	-10.19	29.50	19.31	40.00	-20.69	Peak
2	55.342	-10.25	31.64	21.39	40.00	-18.61	Peak
3	100.669	-11.72	29.02	17.30	43.50	-26.20	Peak
4	247.682	-10.67	34.68	24.01	46.00	-21.99	Peak
5	299.710	-9.23	38.18	28.95	46.00	-17.05	Peak
6	827.856	0.05	30.03	30.08	46.00	-15.92	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230621-35652E-RF
Test Mode: BLE Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	46.138	-9.99	39.25	29.26	40.00	-10.74	Peak
2	65.057	-12.53	40.82	28.29	40.00	-11.71	Peak
3	99.878	-11.83	34.95	23.12	43.50	-20.38	Peak
4	186.278	-12.02	40.61	28.59	43.50	-14.91	Peak
5	299.841	-9.23	36.43	27.20	46.00	-18.80	Peak
6	789.580	-0.13	29.43	29.30	46.00	-16.70	Peak

1-25 GHz:

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
BLE 1M									
Low Channel(2402MHz)									
2384.9	67.67	PK	67	1.4	H	-10.63	57.04	74	-16.96
2384.9	54.77	AV	67	1.4	H	-10.63	44.14	54	-9.86
2385.25	66.89	PK	135	1.8	V	-10.63	56.26	74	-17.74
2385.25	54.45	AV	135	1.8	V	-10.63	43.82	54	-10.18
2390	65.28	PK	292	1.7	H	-10.62	54.66	74	-19.34
2390	53.78	AV	292	1.7	H	-10.62	43.16	54	-10.84
2390	64.43	PK	235	2.1	V	-10.62	53.81	74	-20.19
2390	53.02	AV	235	2.1	V	-10.62	42.40	54	-11.60
4804	58.10	PK	189	1.6	H	-5.57	52.53	74	-21.47
4804	45.20	AV	189	1.6	H	-5.57	39.63	54	-14.37
4804	56.59	PK	36	1	V	-5.57	51.02	74	-22.98
4804	45.75	AV	36	1	V	-5.57	40.18	54	-13.82
Middle Channel(2440MHz)									
4880	59.13	PK	20	2.1	H	-5.24	53.89	74	-20.11
4880	47.10	AV	20	2.1	H	-5.24	41.86	54	-12.14
4880	58.46	PK	94	1.7	V	-5.24	53.22	74	-20.78
4880	46.64	AV	94	1.7	V	-5.24	41.4	54	-12.60
High Channel(2480 MHz)									
2483.5	70.84	PK	76	1.6	H	-10.46	60.38	74	-13.62
2483.5	55.67	AV	76	1.6	H	-10.46	45.21	54	-8.79
2483.5	69.73	PK	186	2.2	V	-10.46	59.27	74	-14.73
2483.5	54.27	AV	186	2.2	V	-10.46	43.81	54	-10.19
2483.71	72.43	PK	101	1.4	H	-10.46	61.97	74	-12.03
2483.71	55.56	AV	101	1.4	H	-10.46	45.1	54	-8.90
2483.75	71.16	PK	307	1.5	V	-10.46	60.7	74	-13.30
2483.75	54.03	AV	307	1.5	V	-10.46	43.57	54	-10.43
4960	58.12	PK	50	1.2	H	-4.90	53.22	74	-20.78
4960	46.09	AV	50	1.2	H	-4.90	41.19	54	-12.81
4960	57.45	PK	174	1.8	V	-4.90	52.55	74	-21.45
4960	45.63	AV	174	1.8	V	-4.90	40.73	54	-13.27

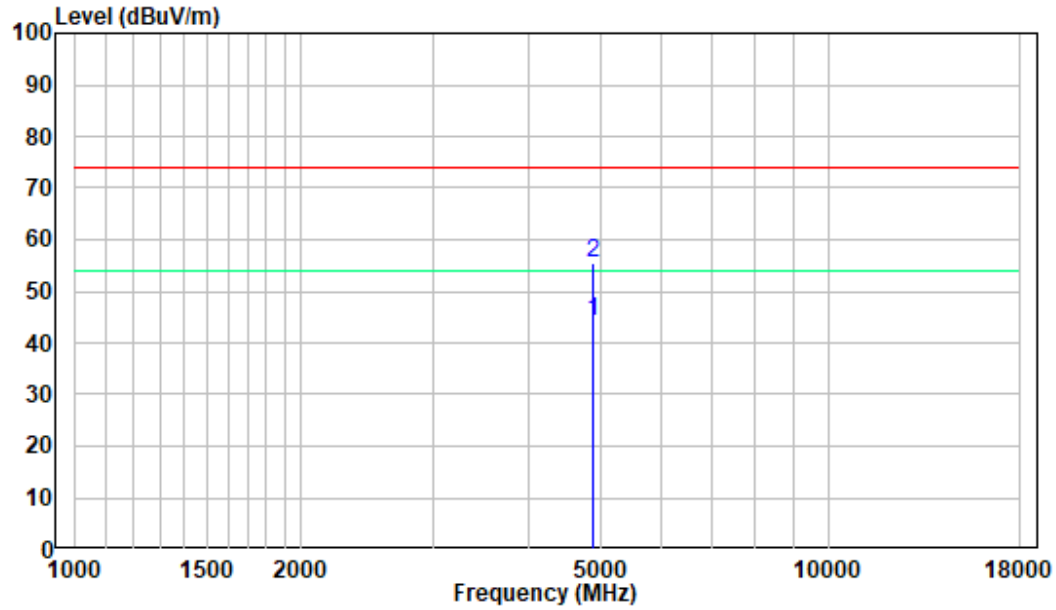
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
BLE 2M									
Low Channel(2402MHz)									
2370.3	66.97	PK	200	1.2	H	-10.69	56.28	74	-17.72
2370.3	55.90	AV	200	1.2	H	-10.69	45.21	54	-8.79
2370.56	65.90	PK	133	1.5	V	-10.69	55.21	74	-18.79
2370.56	54.99	AV	133	1.5	V	-10.69	44.30	54	-9.70
2390	66.42	PK	181	1.1	H	-10.62	55.80	74	-18.20
2390	55.61	AV	181	1.1	H	-10.62	44.99	54	-9.01
2390	65.44	PK	176	2.3	V	-10.62	54.82	74	-19.18
2390	54.34	AV	176	2.3	V	-10.62	43.72	54	-10.28
4804	59.96	PK	167	1.8	H	-5.57	54.39	74	-19.61
4804	48.44	AV	167	1.8	H	-5.57	42.87	54	-11.13
4804	58.59	PK	16	1.9	V	-5.57	53.02	74	-20.98
4804	47.78	AV	16	1.9	V	-5.57	42.21	54	-11.79
Middle Channel(2440MHz)									
4880	60.73	PK	223	1.1	H	-5.24	55.49	74	-18.51
4880	49.21	AV	223	1.1	H	-5.24	43.97	54	-10.03
4880	59.36	PK	209	2.1	V	-5.24	54.12	74	-19.88
4880	48.55	AV	209	2.1	V	-5.24	43.31	54	-10.69
High Channel(2480 MHz)									
2483.5	72.27	PK	58	1.7	H	-10.46	61.81	74	-12.19
2483.5	59.25	AV	58	1.7	H	-10.46	48.79	54	-5.21
2483.5	71.14	PK	74	1.1	V	-10.46	60.68	74	-13.32
2483.5	58.07	AV	74	1.1	V	-10.46	47.61	54	-6.39
2483.71	71.96	PK	181	2.3	H	-10.46	61.5	74	-12.50
2483.71	58.98	AV	181	2.3	H	-10.46	48.52	54	-5.48
2483.78	71.15	PK	260	1.3	V	-10.46	60.69	74	-13.31
2483.78	58.39	AV	260	1.3	V	-10.46	47.93	54	-6.07
4960	57.89	PK	320	1.1	H	-4.90	52.99	74	-21.01
4960	45.46	AV	320	1.1	H	-4.90	40.56	54	-13.44
4960	56.35	PK	245	1.4	V	-4.90	51.45	74	-22.55
4960	44.78	AV	245	1.4	V	-4.90	39.88	54	-14.12

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is in the noise floor level was not recorded.

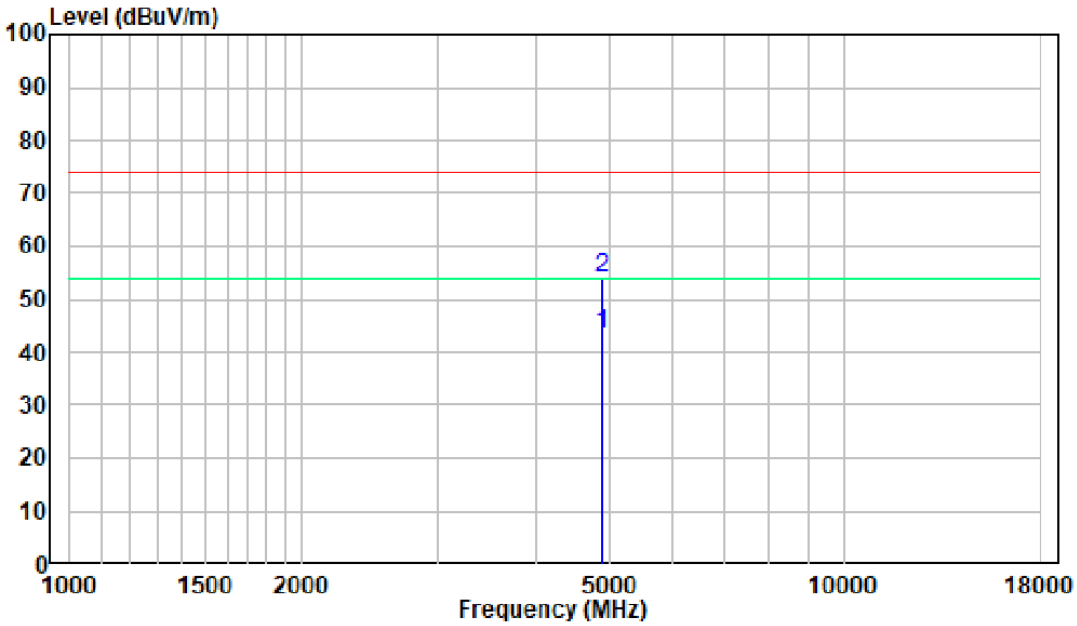
1-18 GHz:

Pre-scan for BLE 2M Middle Channel

Horizontal



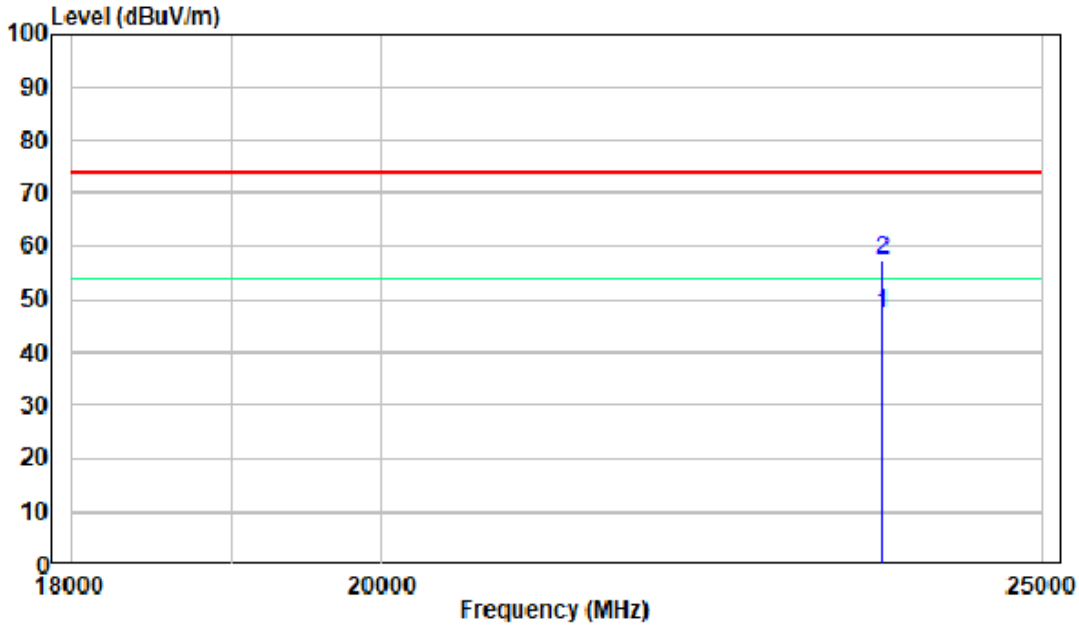
Vertical



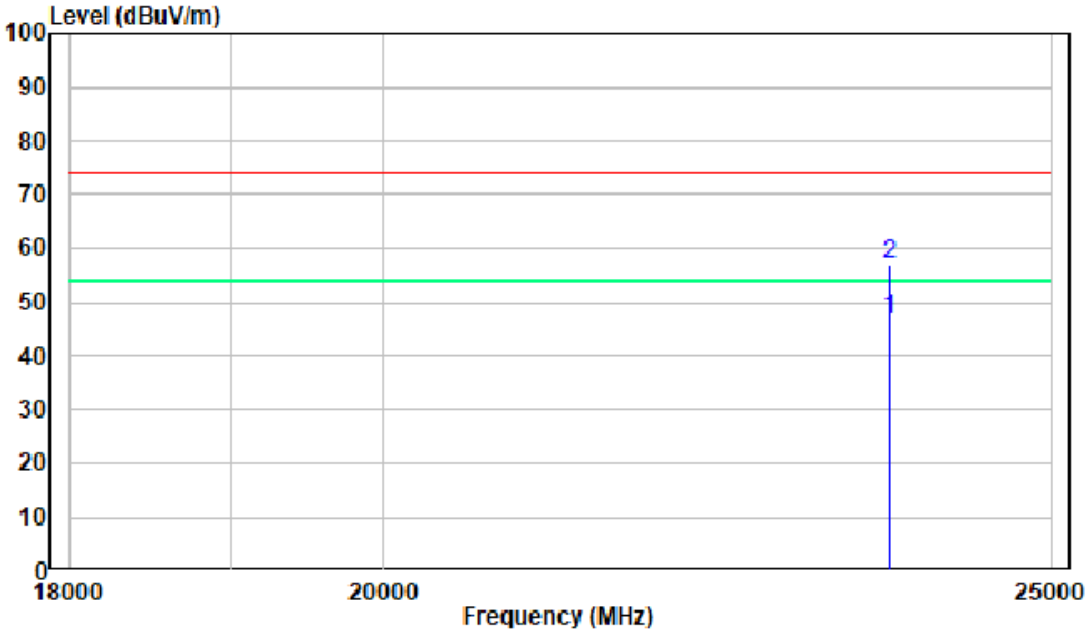
18 -25GHz:

Pre-scan for BLE 2M Middle Channel

Horizontal



Vertical



FCC §15.247(a) (2), RSS-GEN § 6.7 & RSS-247 § 5.2 (a) – 99% OCCUPIED BANDWIDTH & 6 dB EMISSON BANDWIDTH

Standard Applicable

According to FCC §15.247(a) (2)
Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

According to RSS-247 §5.2 a)
The minimum 6 dB bandwidth shall be 500 kHz.

According to RSS-Gen §6.7
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.
In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.
The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

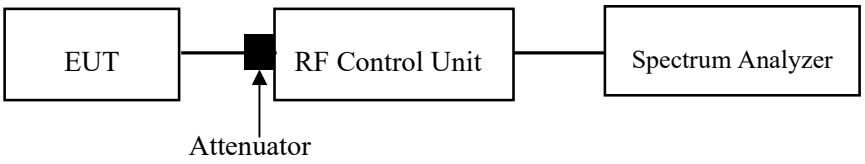
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.8.1 & Clause 6.9.3

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

99% Occupied bandwidth test:
Use Occupied bandwidth test function, measure the 99% Occupied bandwidth.
Repeat above procedures until all frequencies measured were complete.



Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	45 %
ATM Pressure:	101.0 kPa

The testing was performed by Amanda Wei on 2023-06-27.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(b) (3), RSS-247 §5.4 (d) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

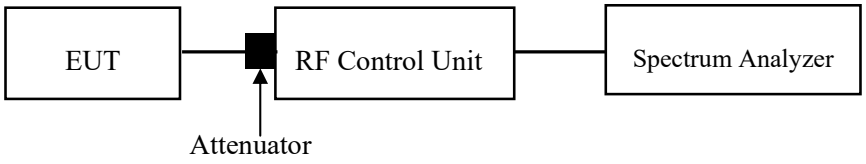
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to RSS-247§5.4 d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(e), the e.i.r.p. shall not exceed 4 W.
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.9.1.1

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	45 %
ATM Pressure:	101.0 kPa

The testing was performed by Amanda Wei on 2023-06-27.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(e), RSS-247 §5.2 (b) – POWER SPECTRAL DENSITY

Applicable Standard

According to FCC §15.247(e):
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

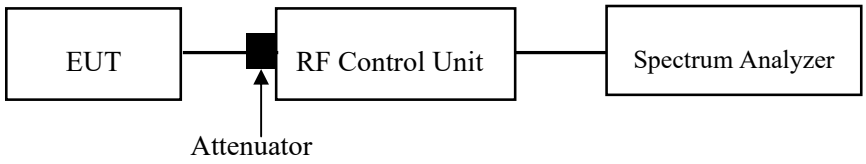
According to RSS-247 §5.2 b):

b) The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: 3kHz≤ RBW≤100 kHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	45 %
ATM Pressure:	101.0 kPa

The testing was performed by Amanda Wei on 2023-07-07.

Test Mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(d) & RSS-247 §5.5 – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

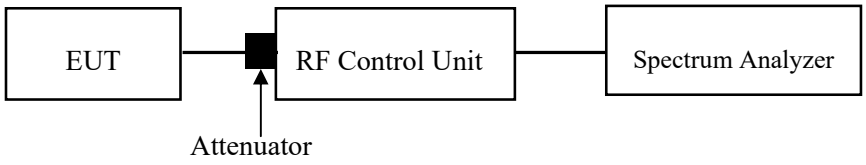
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.11

1. Set the RBW =100 kHz.
2. Set the VBW ≥ 3×RBW.
3. Detector = peak
4. Sweep time = auto couple.
5. Trace mode=max hold
6. All trace to fully stabilize
7. Use the peak marker function to determine the maximum amplitude level.
   Ensure that amplitude of all unwanted emissions outside of the authorized frequency band(excluding restricted frequency bands) is attenuated by at least the minimum requirement specified in 11.11.
   Report the three highest emissions relative to the limit.



Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	45 %
ATM Pressure:	101.0 kPa

The testing was performed by Amanda Wei on 2023-06-27.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

APPENDIX

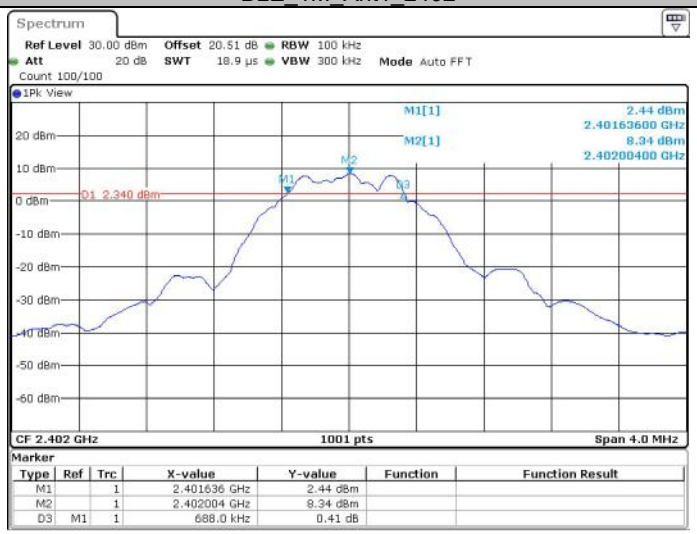
Appendix A: DTS Bandwidth

Test Result

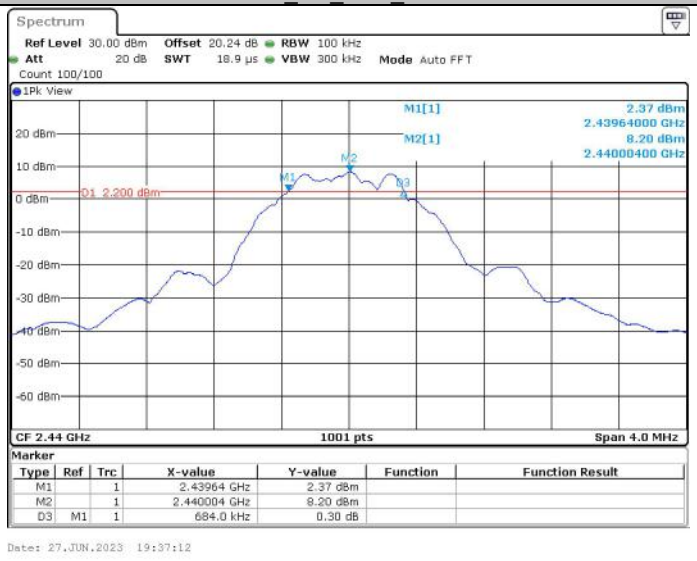
Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.69	2401.64	2402.32	0.5	PASS
		2440	0.68	2439.64	2440.32	0.5	PASS
		2480	0.68	2479.64	2480.32	0.5	PASS
BLE_2M	Ant1	2402	1.19	2401.37	2402.56	0.5	PASS
		2440	1.19	2439.37	2440.56	0.5	PASS
		2480	1.18	2479.37	2480.56	0.5	PASS

Test Graphs

BLE_1M_Ant1_2402

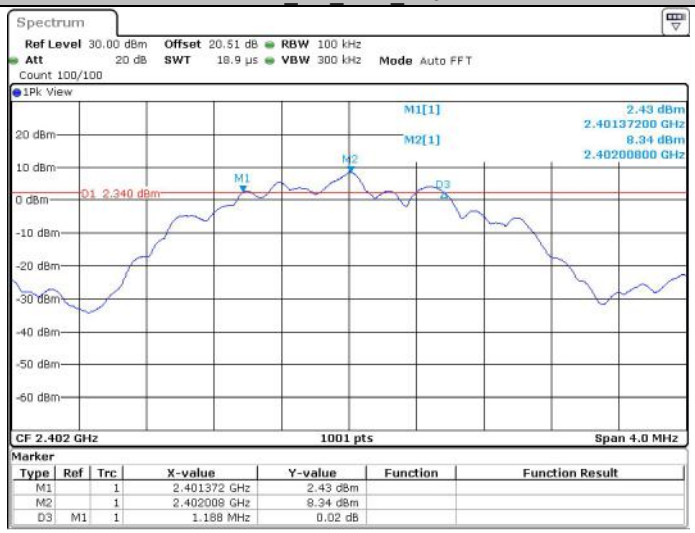


BLE_1M_Ant1_2440

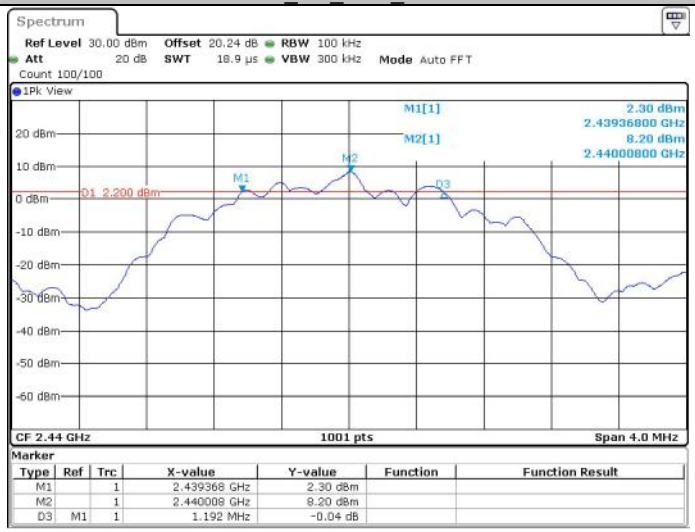


BLE_1M_Ant1_2480

BLE_2M_Ant1_2402

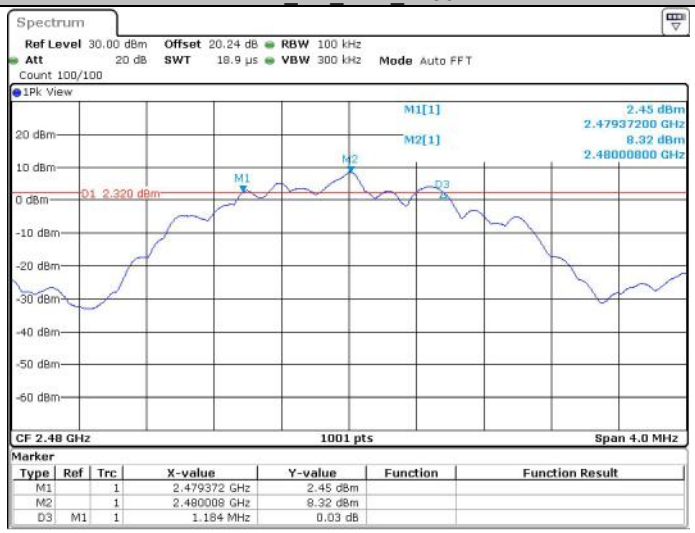


BLE_2M_Ant1_2440



Date: 27.JUN.2023 19:42:02

BLE_2M_Ant1_2480



Date: 27.JUN.2023 19:43:03

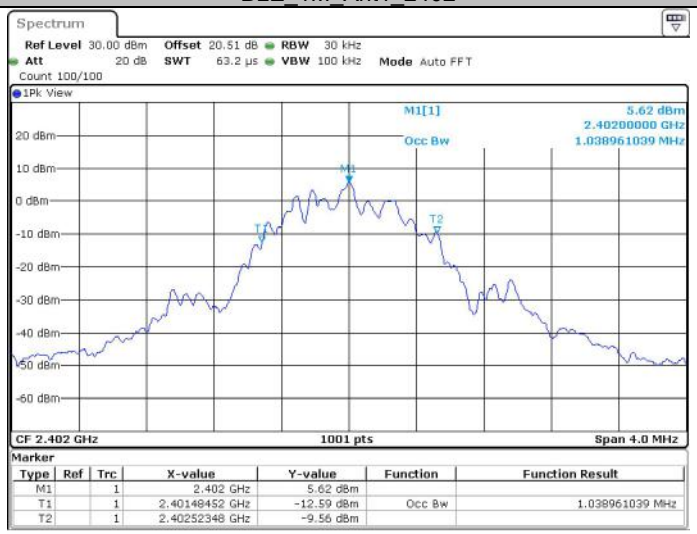
Appendix B: Occupied Channel Bandwidth

Test Result

Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.039	2401.485	2402.523	---	---
		2440	1.043	2439.481	2440.523	---	---
		2480	1.043	2479.481	2480.523	---	---
BLE_2M	Ant1	2402	2.038	2400.993	2403.031	---	---
		2440	2.042	2438.993	2441.035	---	---
		2480	2.046	2478.989	2481.035	---	---

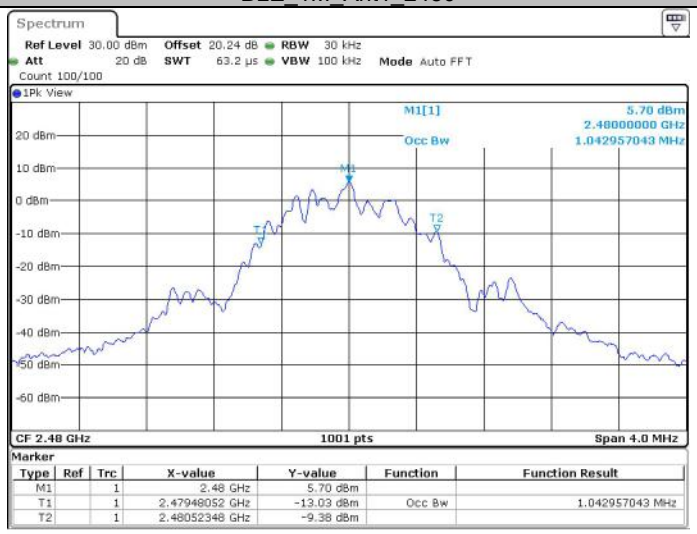
Test Graphs

BLE_1M_Ant1_2402

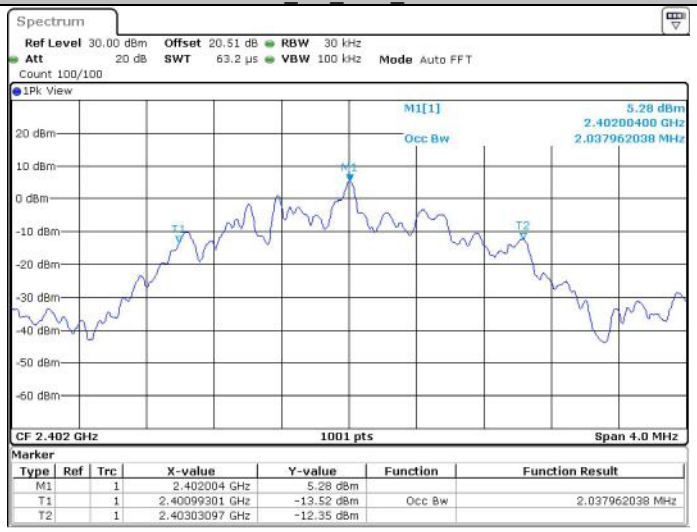


BLE_1M_Ant1_2440

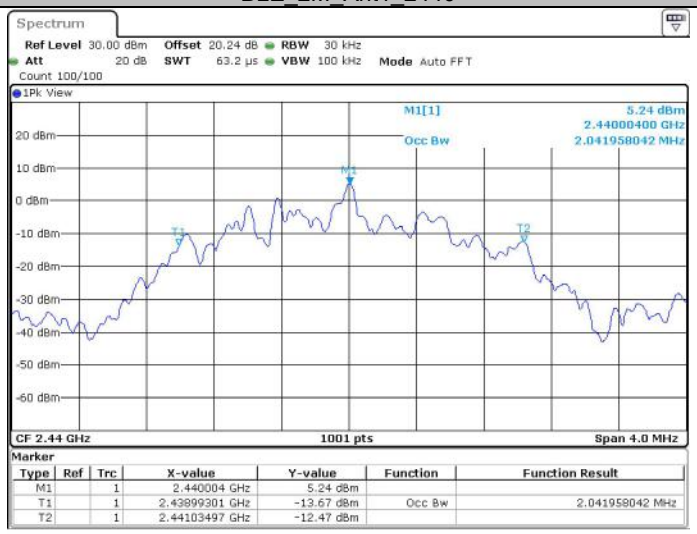
BLE_1M_Ant1_2480



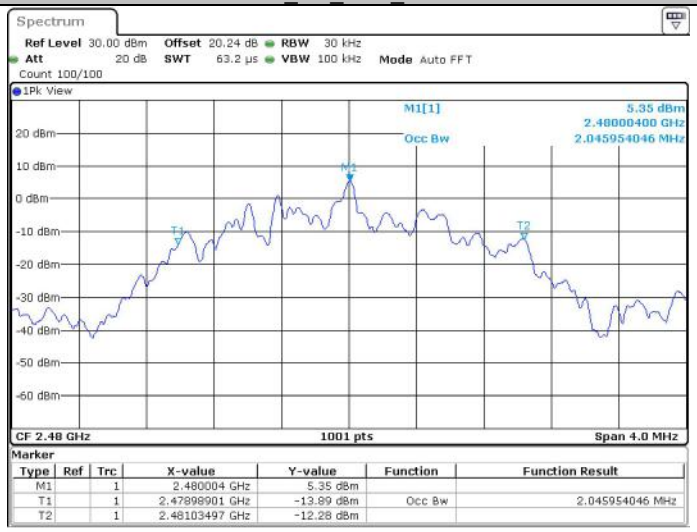
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



Appendix C: Maximum conducted output power

Test Result Peak

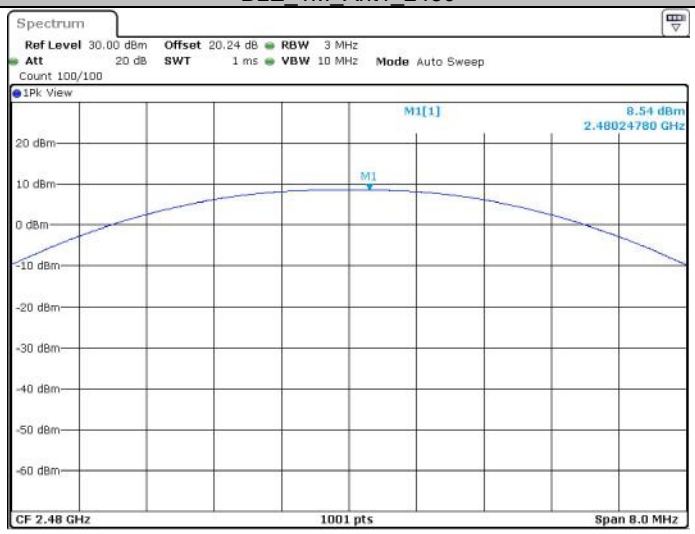
Test Mode	Antenna	Frequency[MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	Verdict
BLE_1M	Ant1	2402	**8.57**	≤30	PASS
		2440	8.44	≤30	PASS
		2480	8.54	≤30	PASS
BLE_2M	Ant1	2402	8.52	≤30	PASS
		2440	8.44	≤30	PASS
		2480	8.54	≤30	PASS
Note: the antenna gain is 1.1dBi, the maximum EIRP=9.67dBm<36dBm					

Test Graphs Peak

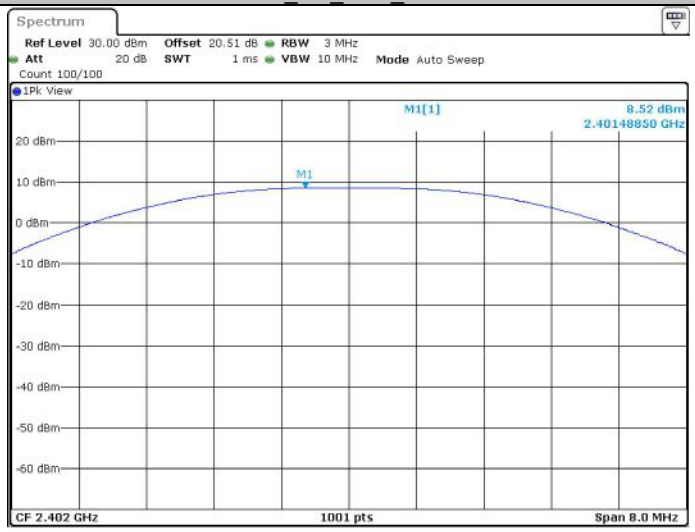
BLE_1M_Ant1_2402

BLE_1M_Ant1_2440

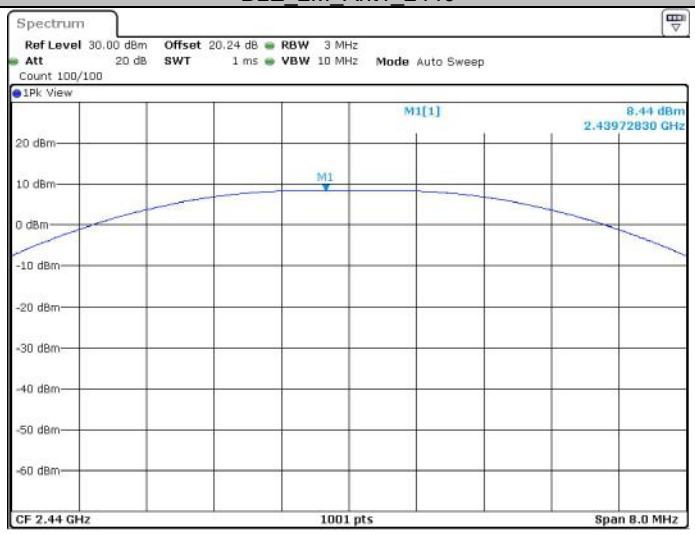
BLE_1M_Ant1_2480



BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480

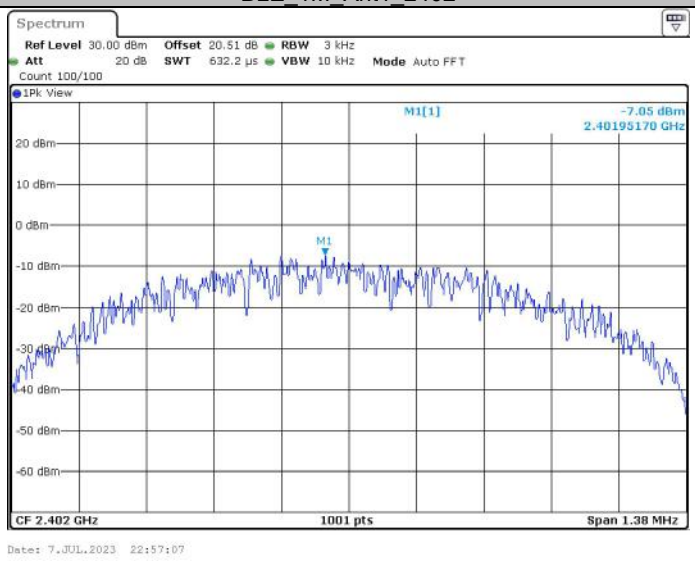
Appendix D: Maximum power spectral density

Test Result

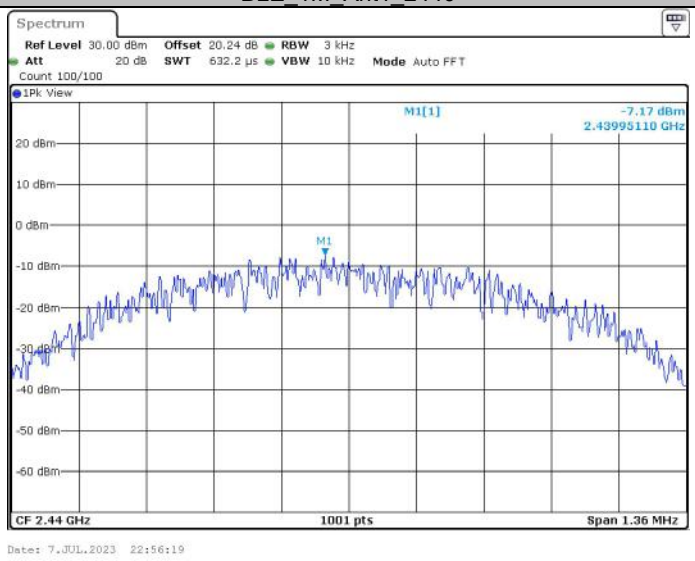
Test Mode	Antenna	Frequency[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-7.05	≤8.00	PASS
		2440	-7.17	≤8.00	PASS
		2480	-7.05	≤8.00	PASS
BLE_2M	Ant1	2402	-9.55	≤8.00	PASS
		2440	-9.71	≤8.00	PASS
		2480	-9.66	≤8.00	PASS

Test Graphs

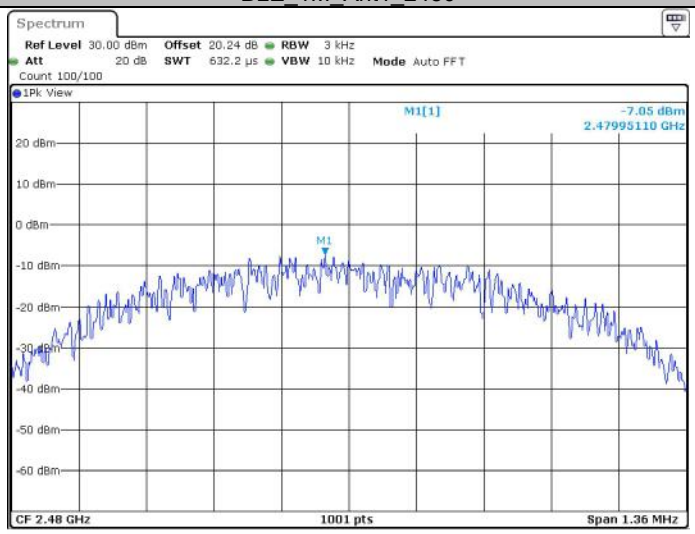
BLE_1M_Ant1_2402



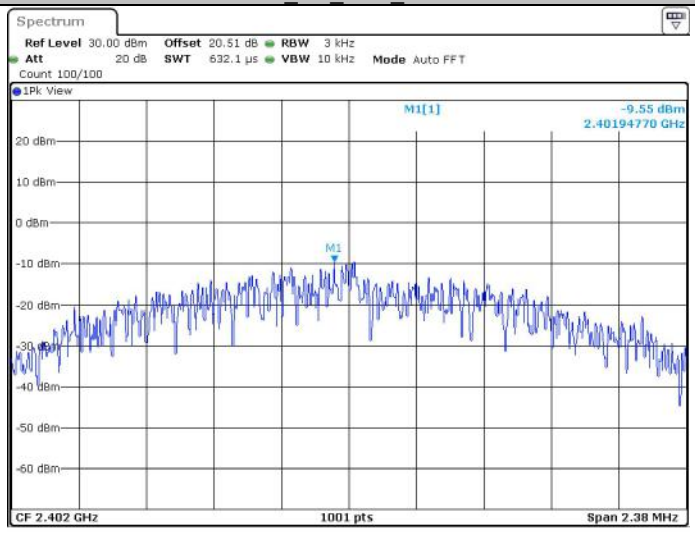
BLE_1M_Ant1_2440



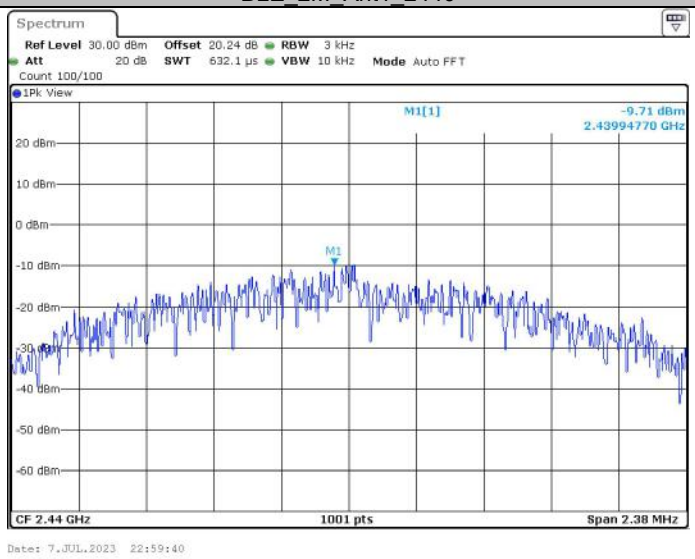
BLE_1M_Ant1_2480



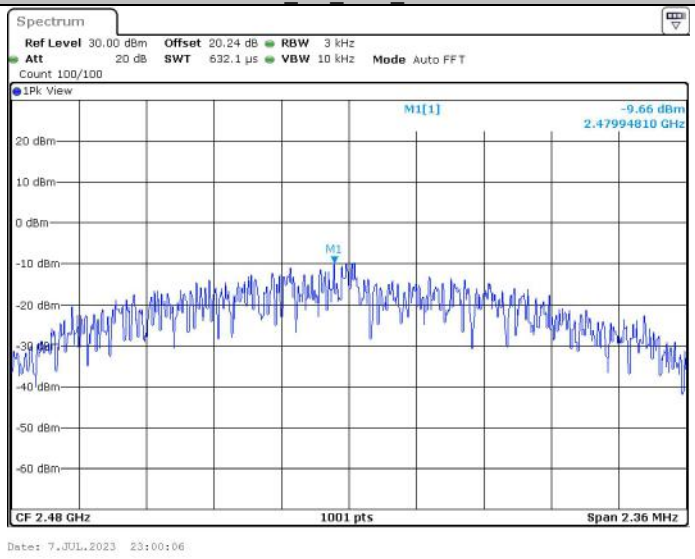
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



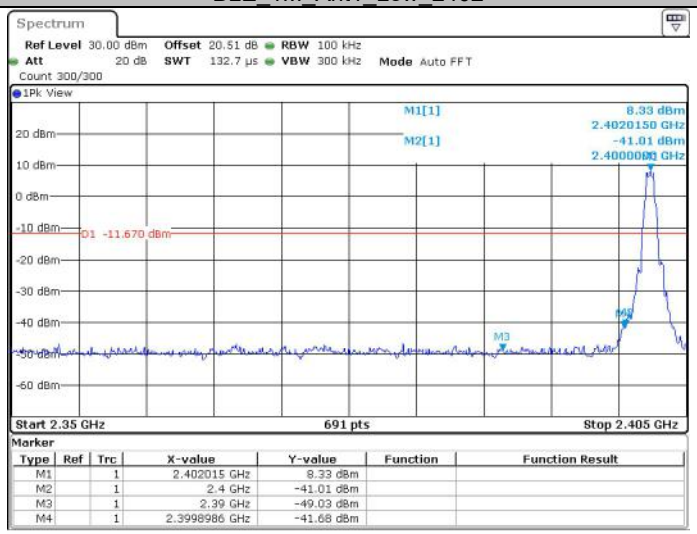
BLE_2M_Ant1_2480



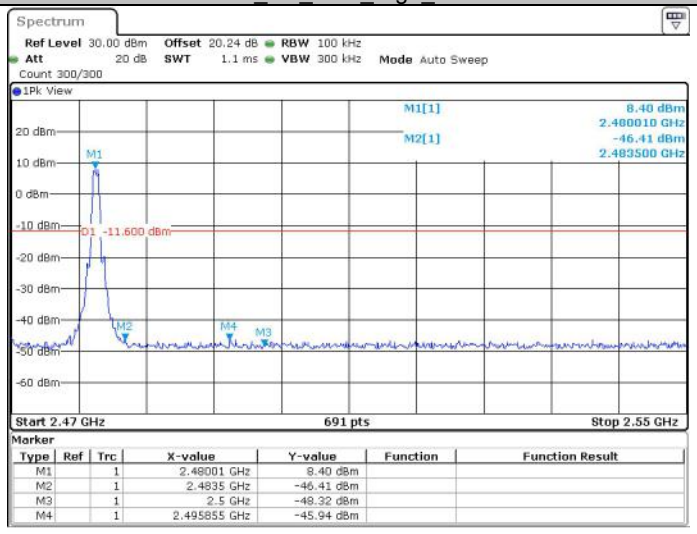
Appendix E: Band edge measurements

Test Graphs

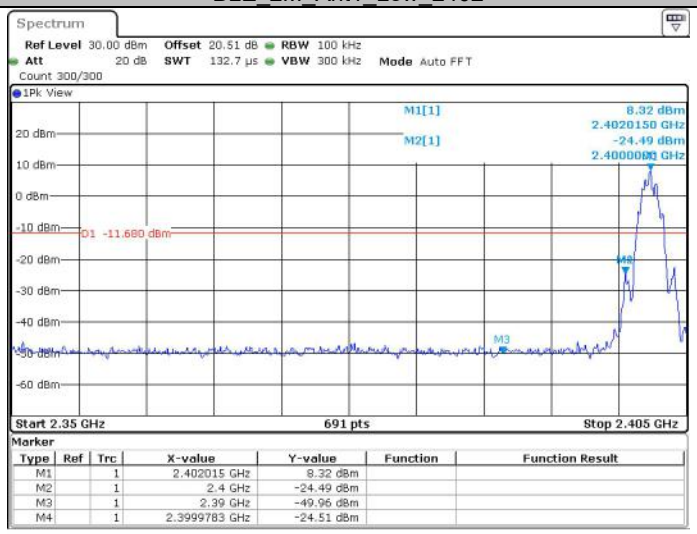
BLE_1M_Ant1_Low_2402



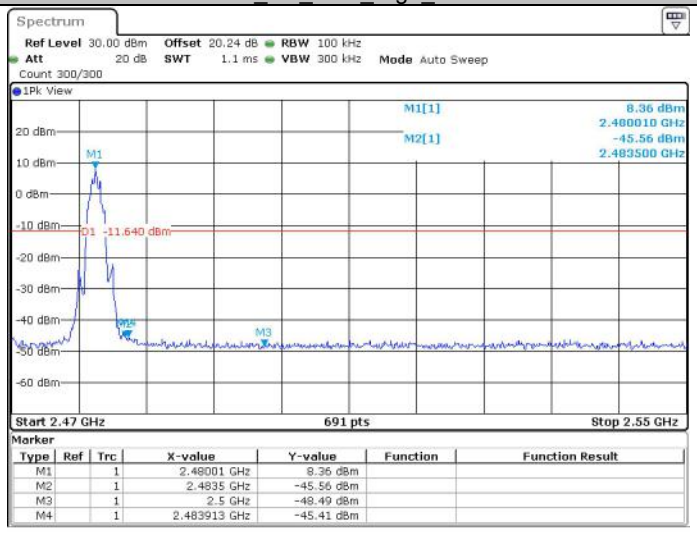
BLE_1M_Ant1_High_2480



BLE_2M_Ant1_Low_2402



BLE_2M_Ant1_High_2480



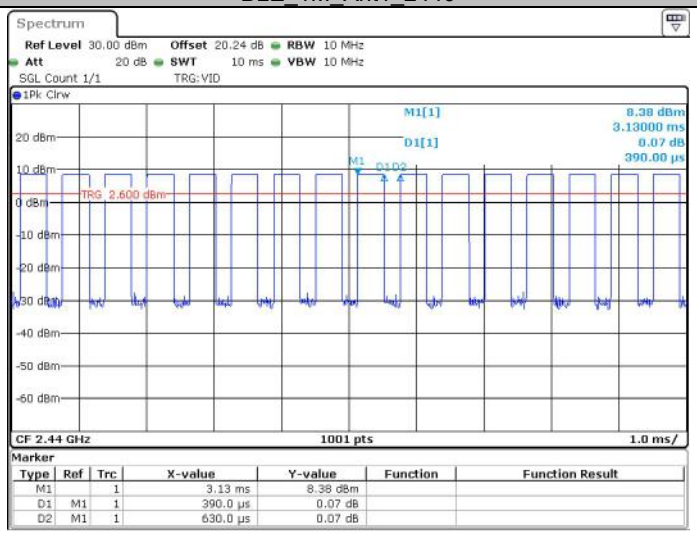
Appendix F: Duty Cycle

Test Result

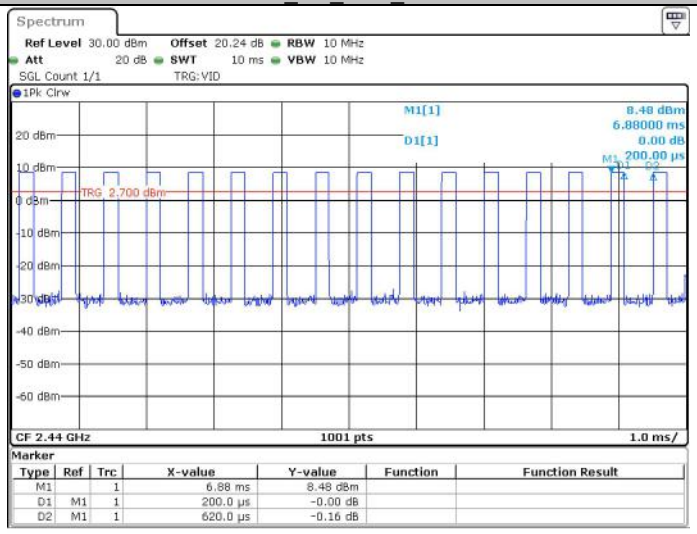
Test Mode	Antenna	Frequency[MHz]	ON Time [ms]	Period [ms]	Duty Cycle [%]	1/T Minimum VBW (kHz)
BLE_1M	Ant1	2440	0.39	0.63	61.90	2.56
BLE_2M	Ant1	2440	0.20	0.62	32.26	5.00

Test Graphs

BLE_1M_Ant1_2440



BLE_2M_Ant1_2440



******* END OF REPORT *******