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TEST REPORT

For

SHENZHEN TOPFLYtech CO., LIMITED

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FCC ID: 2ASWY2021TLW2BL
IC: 27469-2021TLW2BL

Report Type:	**Product Type:**
Original Report	Hardwired GPS Vehicle GPS Tracker

Report Number:	SZ6210824-52994E-RF
Report Date:	2021-10-26
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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.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Hardwired GPS Vehicle GPS Tracker
Tested Model	TLW2-12BL
Multiple Models	TLW2-6BL,TLW2-2BL
Model Differences	Refer to the DoS letter
HVIN	TLW2-2BL, TLW2-6BL, TLW2-12BL
Frequency Range	BLE: 2402-2480MHz
Data rate	1Mbps & 2Mbps
Maximum Conducted Peak Output Power	BLE: -1.11dBm
Modulation Technique	BLE: GFSK
Antenna Specification*	0.8dBi(It is provided by the applicant)
Voltage Supply	DC 3.7V from battery or DC 7-60V
Sample number	SZ6210824-52994E-RF -S1 (Assigned by BACL, Shenzhen)
Received date	2021-08-24
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada rules.

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.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz- 18GHz	4.98dB
	18GHz- 26.5GHz	5.06dB

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 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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 4297.01

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 5077A-2.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

For BLE, 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.exe" software was used to the EUT tested and power level is 0*. The software and power level was provided by the applicant.

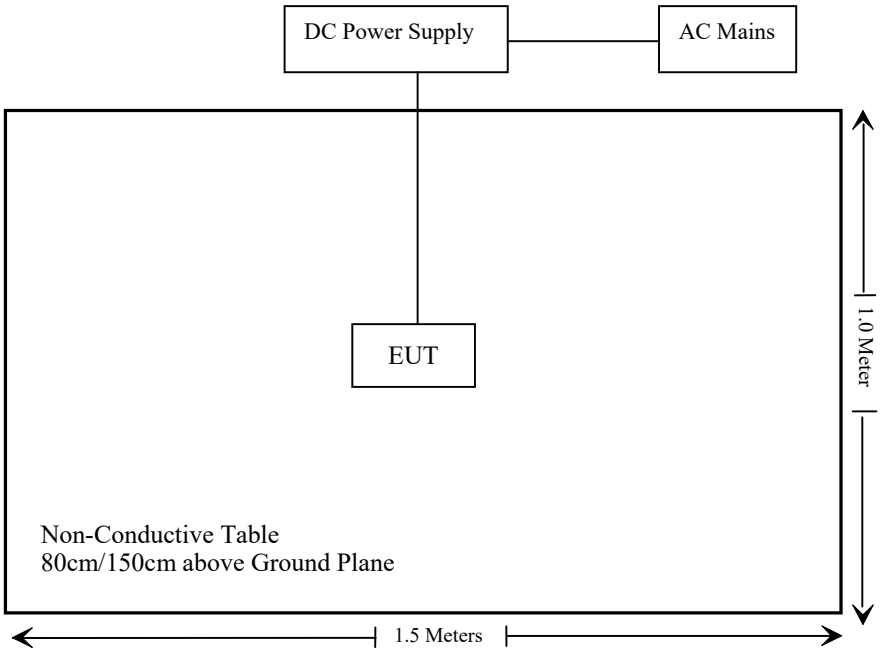
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
UNI-T	DC Power Supply	UTP1306S	2109D0903324

External I/O Cable

Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	ISEDC Rules	Description of Test	Result
§15.247 (i), §2.1091	RSS-102 § 4	Maximum Permissible Exposure (MPE)& RF Exposure Limit	Compliant
§15.203	RSS-Gen §6.8	Antenna Requirement	Compliant
§15.207 (a)	RSS-Gen §8.8	AC Line Conducted Emissions	Not Applicable
§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(d)	RSS-247 § 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	RSS-247 § 5.2 (b)	Power Spectral Density	Compliant

Not Applicable: The EUT is used in vehicle environment condition.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
Rohde& Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2021/07/08	2022/07/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/28	2021/11/27
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2020/12/25	2021/12/24
SCHWARZBECK	LOOP ANTENNA	FMZB1516	1516131	2020/01/05	2023/01/04
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
OREGON SCIENTIFIC	Temperature & Humidity Meter	JB913R	GZ-WS004	2020/01/02	2023/01/01
/	Software	Radiated Emission Test Software: EZ_EMC V 1.1.4.2			
Unknown	RF Coaxial Cable	N-5m	No.3	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-5m	No.4	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.5	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.6	2020/12/25	2021/12/24
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2020/12/25	2021/12/24
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/07/06	2022/07/05

*** 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 §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and 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

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

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		Max Tune Up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BLE	2402-2480	0.8	1.20	-1.00	0.79	20	0.0002	1.00
GSM850	824-849	1.2	1.32	25.97	395.37	20	0.1037	0.55
GSM1900	1850-1910	2.0	1.58	22.97	198.15	20	0.0625	1.00
LTE Band 2	1850-1910	2.0	1.58	22.00	158.49	20	0.0500	1.00
LTE Band 4	1710-1755	1.4	1.38	22.00	158.49	20	0.0435	1.00
LTE Band 5	824-849	1.2	1.32	22.00	158.49	20	0.0416	0.55
LTE Band 12	699-716	0.5	1.12	22.00	158.49	20	0.0354	0.47
LTE Band 13	777-787	1.0	1.26	22.00	158.49	20	0.0397	0.52
LTE Band 14	788-798	1.0	1.26	22.00	158.49	20	0.0397	0.53
LTE Band 25	1850-1915	2.0	1.58	22.00	158.49	20	0.0500	1.00
LTE Band 26	814-849	1.2	1.32	22.00	158.49	20	0.0416	0.54
LTE Band 66	1710-1780	1.5	1.41	22.00	158.49	20	0.0446	1.00
LTE Band 85	698-716	0.5	1.12	22.00	158.49	20	0.0354	0.47
NB-IoT Band 2	1850-1910	2.0	1.58	22.00	158.49	20	0.0500	1.00
NB-IoT Band 4	1710-1755	1.4	1.38	22.00	158.49	20	0.0435	1.00
NB-IoT Band 5	824-849	1.2	1.32	22.00	158.49	20	0.0416	0.55
NB-IoT Band 12	699-716	0.5	1.12	22.00	158.49	20	0.0354	0.47
NB-IoT Band 13	777-787	1.0	1.26	22.00	158.49	20	0.0397	0.52
NB-IoT Band 14	788-798	1.0	1.26	22.00	158.49	20	0.0397	0.53
NB-IoT Band 25	1850-1915	2.0	1.58	22.00	158.49	20	0.0500	1.00
NB-IoT Band 26	814-849	1.2	1.32	22.00	158.49	20	0.0416	0.54
NB-IoT Band 66	1710-1780	1.5	1.41	22.00	158.49	20	0.0446	1.00
NB-IoT Band 71	663-698	0.5	1.12	22.00	158.49	20	0.0354	0.44
NB-IoT Band 85	698-716	0.5	1.12	22.00	158.49	20	0.0354	0.47

Note: 1. the tune up conducted power was declared by the applicant.
2. the BLE function can transmit at the same time with the LTE.
3. please refer to the MPE report of the FCC ID: XMR201910BG95M3 for the LTE output power.

So the worst simultaneous transmitting consideration:

The ratio=MPE_{BLE}/limit + MPE_{GSM850}/limit =0.0002/1.0+0.1037/0.55
=0.189＜1.0

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		Max Tune Up Conducted Power		Evaluation Distance (m)	Power Density (W/m^2)	MPE Limit (W/m^2)
		(dBi)	(numeric)	(dBm)	(W)			
BLE	2402-2480	0.8	1.20	-1.00	0.0008	0.2	0.0019	5.3508
GSM850	824-849	1.2	1.32	25.97	0.3954	0.2	1.0374	2.5756
GSM1900	1850-1910	2.0	1.58	22.97	0.1982	0.2	0.6251	4.4763
LTE Band 2	1850-1910	2.0	1.58	22.00	0.1585	0.2	0.5000	4.4763
LTE Band 4	1710-1755	1.4	1.38	22.00	0.1585	0.2	0.4355	4.2419
LTE Band 5	824-849	1.2	1.32	22.00	0.1585	0.2	0.4159	2.5756
LTE Band 12	699-716	0.5	1.12	22.00	0.1585	0.2	0.3540	2.3017
LTE Band 13	777-787	1.0	1.26	22.00	0.1585	0.2	0.3971	2.4743
LTE Band 25	1850-1915	2.0	1.58	22.00	0.1585	0.2	0.5000	4.4763
LTE Band 26	824-849	1.2	1.32	22.00	0.1585	0.2	0.4159	2.5756
LTE Band 66	1710-1780	1.5	1.41	22.00	0.1585	0.2	0.4456	4.2419
LTE Band 85	698-716	0.5	1.12	22.00	0.1585	0.2	0.3540	2.2995
NB-IoT Band 2	1850-1910	2.0	1.58	22.00	0.1585	0.2	0.5000	4.4763
NB-IoT Band 4	1710-1755	1.4	1.38	22.00	0.1585	0.2	0.4355	4.2419
NB-IoT Band 5	824-849	1.2	1.32	22.00	0.1585	0.2	0.4159	2.5756
NB-IoT Band 12	699-716	0.5	1.12	22.00	0.1585	0.2	0.3540	2.3017
NB-IoT Band 13	777-787	1.0	1.26	22.00	0.1585	0.2	0.3971	2.4743
NB-IoT Band 25	1850-1915	2.0	1.58	22.00	0.1585	0.2	0.5000	4.4763
NB-IoT Band 26	824-849	1.2	1.32	22.00	0.1585	0.2	0.4159	2.5756
NB-IoT Band 66	1710-1780	1.5	1.41	22.00	0.1585	0.2	0.4456	4.2419
NB-IoT Band 71	663-698	0.5	1.12	22.00	0.1585	0.2	0.3540	2.2200
NB-IoT Band 85	698-716	0.5	1.12	22.00	0.1585	0.2	0.3540	2.2995

Note: 1. The antenna gain was provided by the applicant.
2. The BLE function can transmit at the same time with the LTE.
3. Please refer to the MPE report of the IC: 10224A-2019BG95M3 for the LTE output power.

Simultaneous transmitting consideration (worst case):

The ratio=MPE_{BLE}/limit+MPE_{GSM850}/limit=0.0019/5.3508+1.0374/2.5756=0.403＜1.0

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

Result: Pass

§ 15.203 & RSS-Gen §6.8 ANTENNA REQUIREMENT

Applicable Standard

According to § 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 user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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 for BLE which was permanently attached and the gain is 0.8dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Type	Antenna Gain	Impedance
Chip	0.8dBi	50 Ω

Result: Compliant

§15.205, §15.209, §15.247(d) & RSS-GEN § 8.10 & RSS-247 § 5.5 SPURIOUS EMISSIONS

Applicable Standard

FCC §15.247 (d); §15.209; §15.205;

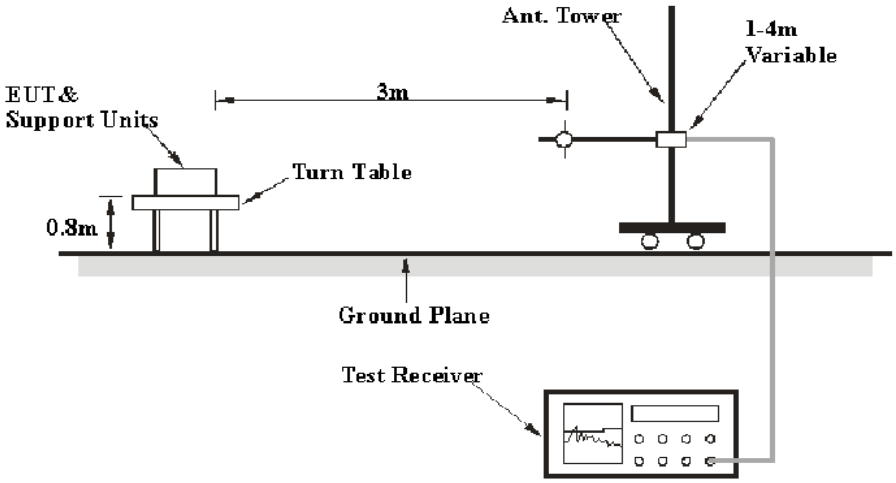
According to RSS-GEN § 8.10 & RSS-247 § 5.5

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

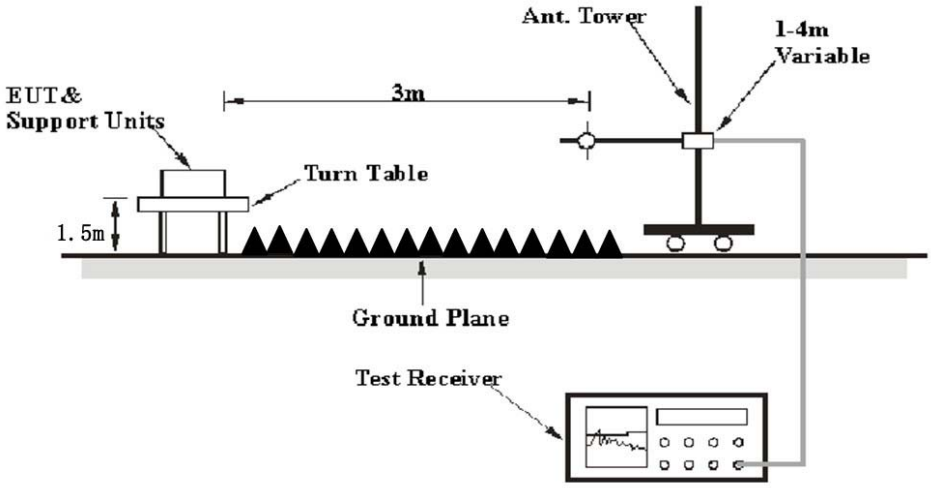
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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.

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013 & RSS-Gen. The specification used was the FCC 15.209, and FCC 15.247 & RSS-Gen 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
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	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.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

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.

Corrected Amplitude & Margin Calculation

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

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

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

Margin = Limit – Corrected Amplitude

Test Data

Environmental Conditions

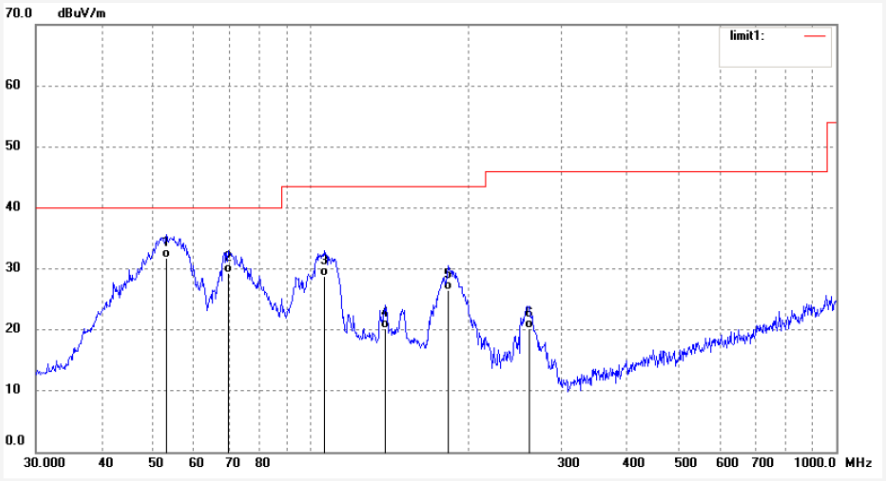
Temperature:	20~28.8 ℃
Relative Humidity:	45~51 %
ATM Pressure:	101.0 kPa

The testing was performed by Caro hu on 2021-09-14 and 2021-10-23.

EUT operation mode: Transmitting

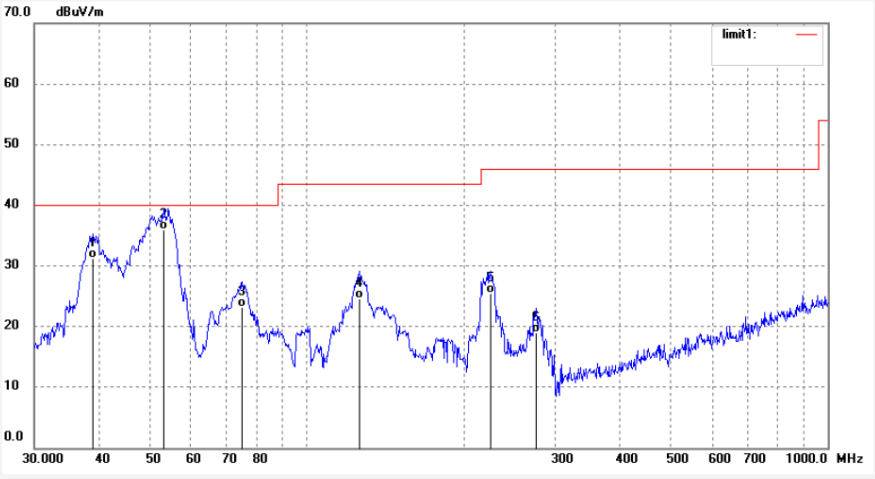
30MHz-1GHz: (Worst case is BLE 1M low channel)

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	53.1313	49.09	-17.29	31.80	40.00	-8.20	QP			
2	69.6004	50.31	-20.98	29.33	40.00	-10.67	QP			
3	106.0126	47.66	-18.90	28.76	43.50	-14.74	QP			
4	138.8735	40.19	-19.90	20.29	43.50	-23.21	QP			
5	182.5592	44.67	-18.17	26.50	43.50	-17.00	QP			
6	260.1444	36.43	-16.29	20.14	46.00	-25.86	QP			

Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	38.8878	47.13	-15.95	31.18	40.00	-8.82	QP			
2	53.1313	53.41	-17.53	35.88	40.00	-4.12	QP			
3	75.1822	44.85	-21.58	23.27	40.00	-16.73	QP			
4	126.3286	43.26	-18.70	24.56	43.50	-18.94	QP			
5	225.3080	42.39	-16.86	25.53	46.00	-20.47	QP			
6	276.1235	34.38	-15.40	18.98	46.00	-27.02	QP			

1 GHz-25 GHz:

BLE_1M

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402MHz)									
2310	67.16	PK	133	1.6	H	-6.84	60.32	74	-13.68
2310	55.71	Ave.	133	1.6	H	-6.84	48.87	54	-5.13
2310	62.3	PK	298	2.3	V	-6.84	55.46	74	-18.54
2310	51.07	Ave.	298	2.3	V	-6.84	44.23	54	-9.77
2390	59.08	PK	7	2.4	H	-6.44	52.64	74	-21.36
2390	56.66	PK	7	2.4	V	-6.44	50.22	74	-23.78
4804	55.51	PK	141	1.8	H	2.81	58.32	74	-15.68
4804	48.31	Ave.	141	1.8	H	2.81	51.12	54	-2.88
4804	50.83	PK	120	2.4	V	2.81	53.64	74	-20.36
4804	45.32	Ave.	120	2.4	V	2.81	48.13	54	-5.87
Middle Channel(2440MHz)									
4880	53.98	PK	236	1.7	H	3.04	57.02	74	-16.98
4880	47.73	Ave.	236	1.7	H	3.04	50.77	54	-3.23
4880	50.6	PK	126	2.4	V	3.04	53.64	74	-20.36
4880	42.97	Ave.	126	2.4	V	3.04	46.01	54	-7.99
High Channel(2480MHz)									
2483.5	68.02	PK	241	1.4	H	-5.96	62.06	74	-11.94
2483.5	55.25	Ave.	241	1.4	H	-5.96	49.29	54	-4.71
2483.5	63	PK	22	2	V	-5.96	57.04	74	-16.96
2483.5	50.97	Ave.	22	2	V	-5.96	45.01	54	-8.99
2500	58.34	PK	317	2	H	-5.88	52.46	74	-21.54
2500	55.71	PK	317	2	V	-5.88	49.83	74	-24.17
4960	52.65	PK	2	1.9	H	3.29	55.94	74	-18.06
4960	46.97	Ave.	2	1.9	H	3.29	50.26	54	-3.74
4960	47.2	PK	291	1.7	V	3.29	50.49	74	-23.51
4960	42.54	Ave.	291	1.7	V	3.29	45.83	54	-8.17

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB below the limit or noise floor was not recorded.

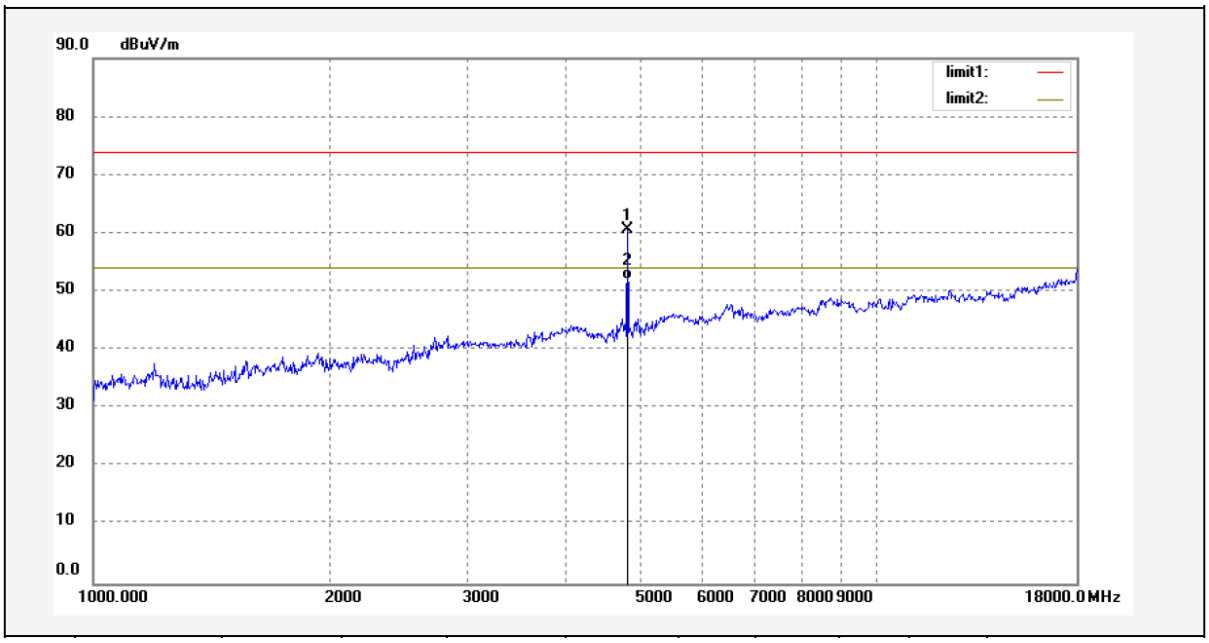
BLE_2M

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402MHz)									
2310	67.12	PK	59	1.9	H	-6.84	60.28	74	-13.72
2310	56.24	Ave.	59	1.9	H	-6.84	49.4	54	-4.6
2310	62.7	PK	324	1.8	V	-6.84	55.86	74	-18.14
2310	50.55	Ave.	324	1.8	V	-6.84	43.71	54	-10.29
2390	58.3	PK	133	2	H	-6.44	51.86	74	-22.14
2390	56.9	PK	124	2	V	-6.44	50.46	74	-23.54
4804	57.79	PK	158	1.8	H	2.81	60.6	74	-13.4
4804	49.17	Ave.	158	1.5	H	2.81	51.98	54	-2.02
4804	52.62	PK	10	1.4	V	2.81	55.43	74	-18.57
4804	44.7	Ave.	10	1.4	V	2.81	47.51	54	-6.49
Middle Channel(2440MHz)									
4880	55.06	PK	164	1.2	H	3.04	58.1	74	-15.9
4880	47.81	Ave.	164	1.2	H	3.04	50.85	54	-3.15
4880	50.5	PK	245	1.4	V	3.04	53.54	74	-20.46
4880	41.51	Ave.	245	1.4	V	3.04	44.55	54	-9.45
High Channel(2480MHz)									
2483.5	66.28	PK	343	1.8	H	-5.96	60.32	74	-13.68
2483.5	56.3	Ave.	343	1.8	H	-5.96	50.34	54	-3.66
2483.5	60.12	PK	12	1.2	V	-5.96	54.16	74	-19.84
2483.5	50.45	Ave.	12	1.2	V	-5.96	44.49	54	-9.51
2500	58.06	PK	27	1.5	H	-5.88	52.18	74	-21.82
2500	56.31	PK	111	1.5	V	-5.88	50.43	74	-23.57
4960	53.61	PK	214	2	H	3.29	56.9	74	-17.1
4960	47.23	Ave.	214	2	H	3.29	50.52	54	-3.48
4960	49.22	PK	198	1.4	V	3.29	52.51	74	-21.49
4960	42.55	Ave.	198	1.4	V	3.29	45.84	54	-8.16

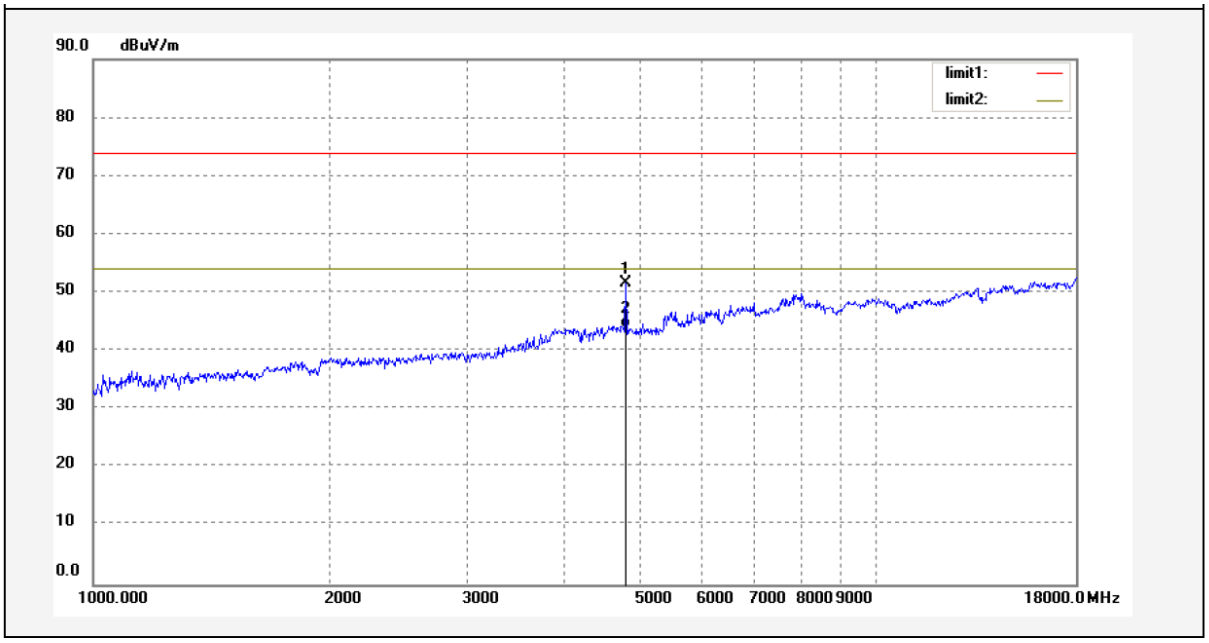
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB below the limit or noise floor was not recorded

1-18 GHz:

Pre-scan for Peak
BLE 2M Low Channel
Horizontal

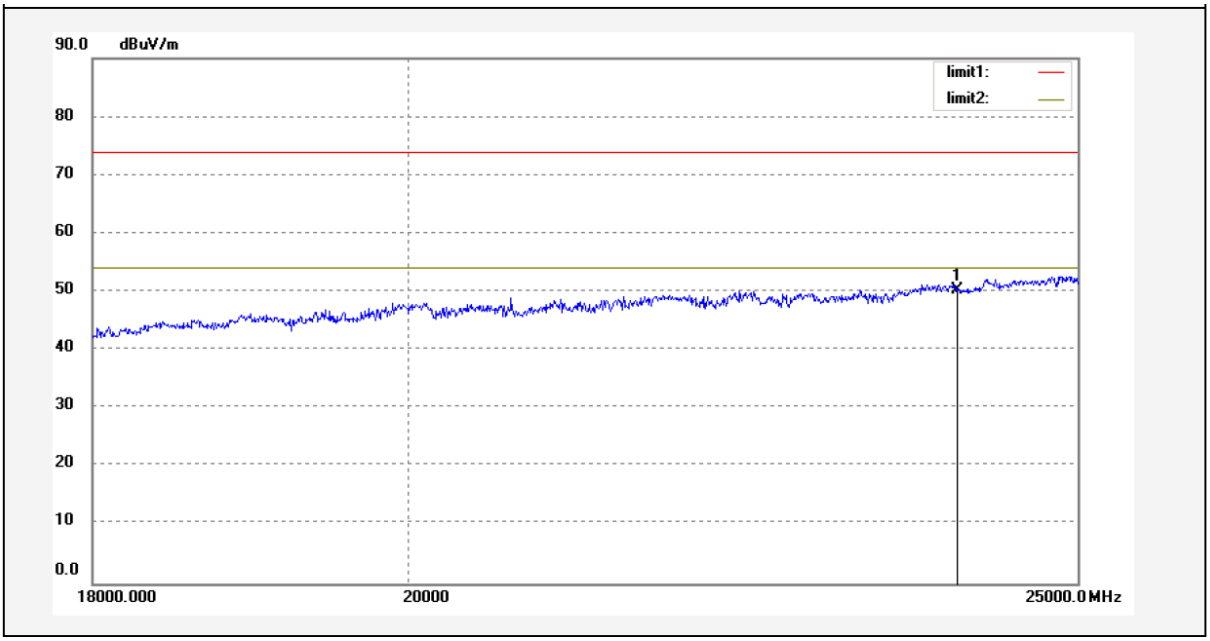


Vertical

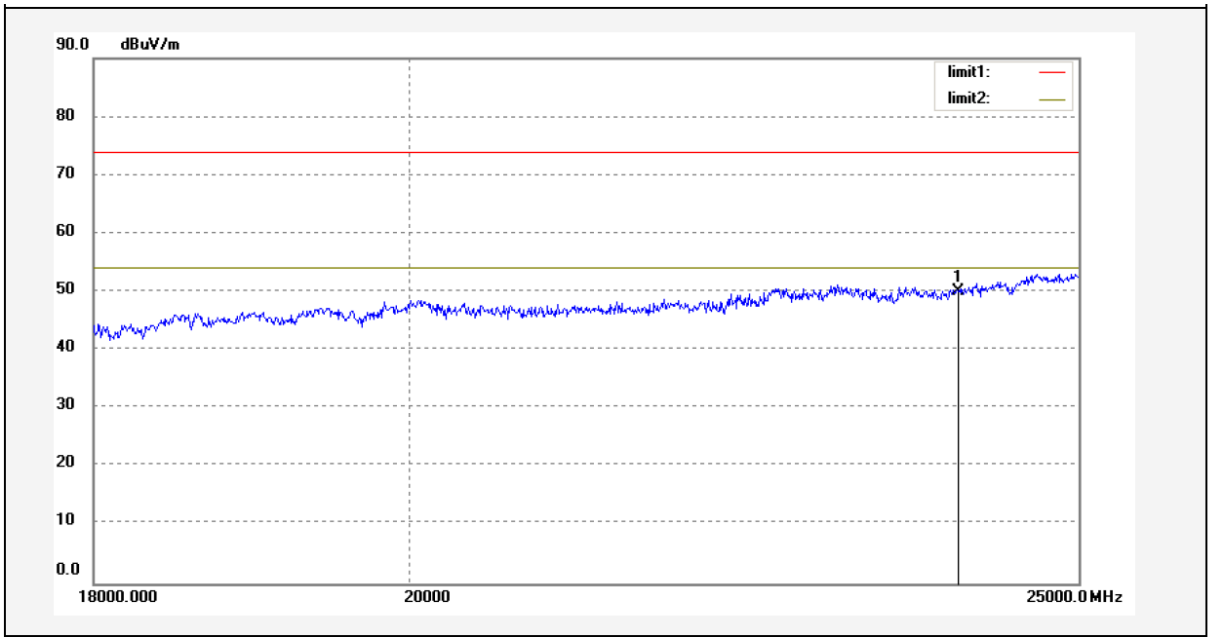


18 -25GHz:

Pre-scan for Peak
BLE 2M Low Channel
Horizontal



Vertical



§15.247 (a)(2) & RSS-Gen§6.7 RSS-247 § 5.2 (a) 99% OCCUPIED BANDWIDTH & 6 dB EMISSION BANDWIDTH

Applicable Standard

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.

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 "6 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 6 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.

Test Procedure

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.

The following conditions shall be observed for measuring the occupied bandwidth and 6 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.

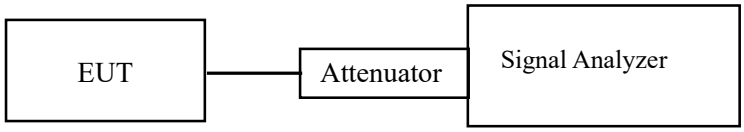
• The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / 6 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 / 6 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 Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	63 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-14.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE.

§15.247(b)(3) & RSS-247 § 5.4(d) MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

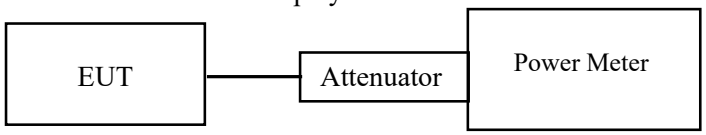
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted 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.

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 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

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

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:	63 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-14.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE.

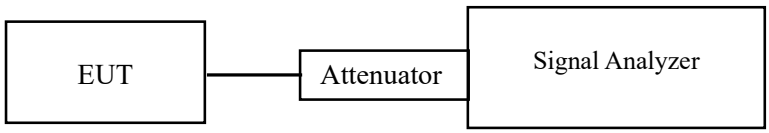
§15.247(d) & RSS-247 § 5.5 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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)).

Test Procedure

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 its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. 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.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	63 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-14.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE.

§15.247(e) & RSS-247 § 5.2 (b) POWER SPECTRAL DENSITY

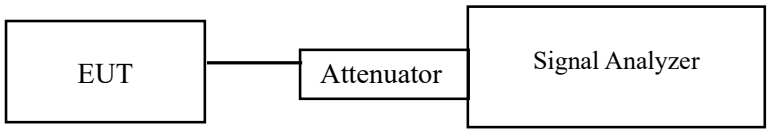
Applicable Standard

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.

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than8 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

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:	63 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-14.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix BLE.

APPENDIX BLE

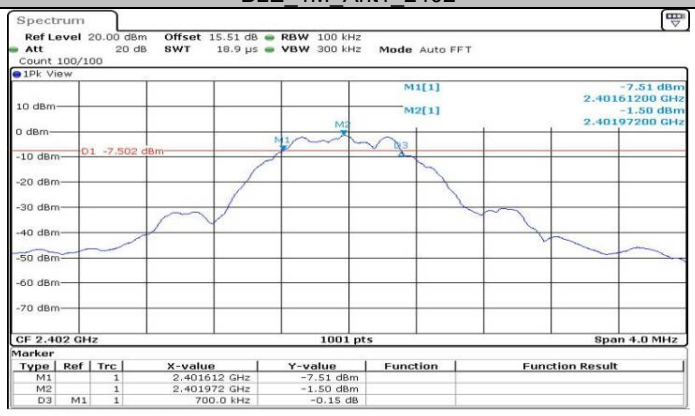
Appendix A: DTS Bandwidth

Test Result

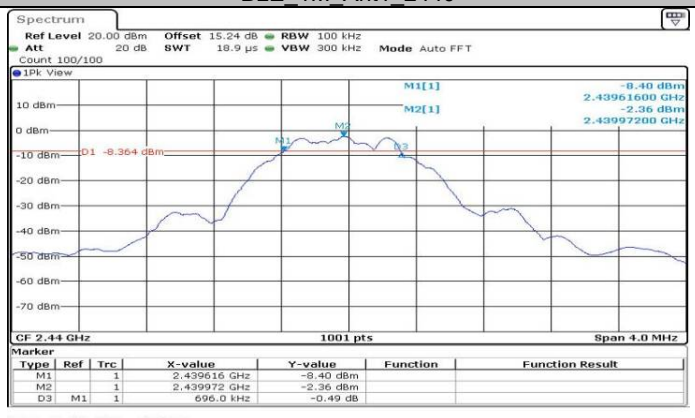
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.700	0.5	PASS
		2440	0.696	0.5	PASS
		2480	0.700	0.5	PASS
BLE_2M	Ant1	2402	1.196	0.5	PASS
		2440	1.200	0.5	PASS
		2480	1.196	0.5	PASS

Test Graphs

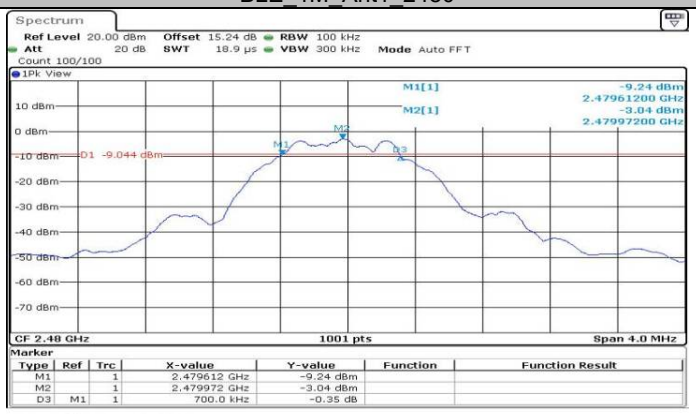
BLE_1M_Ant1_2402



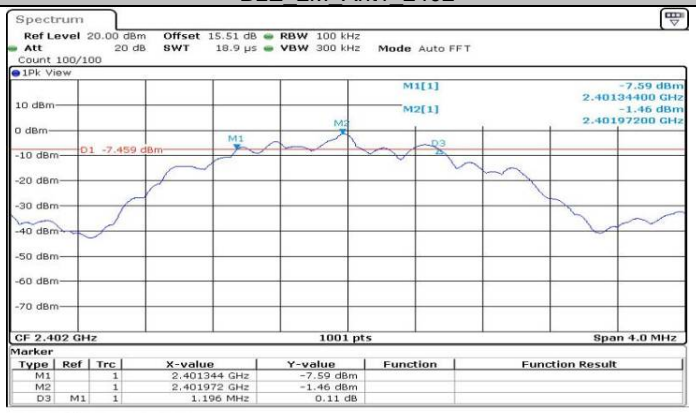
BLE_1M_Ant1_2440



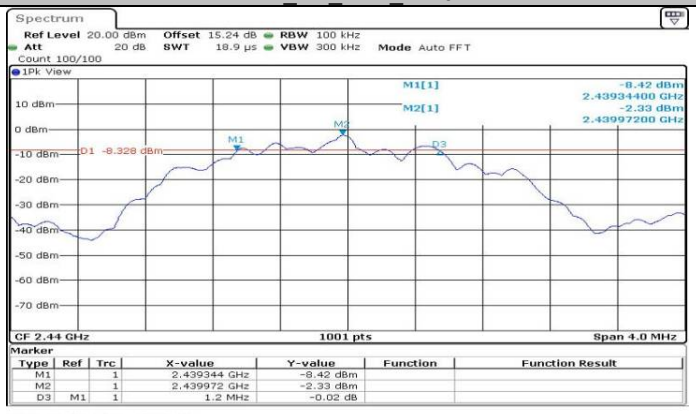
BLE_1M_Ant1_2480



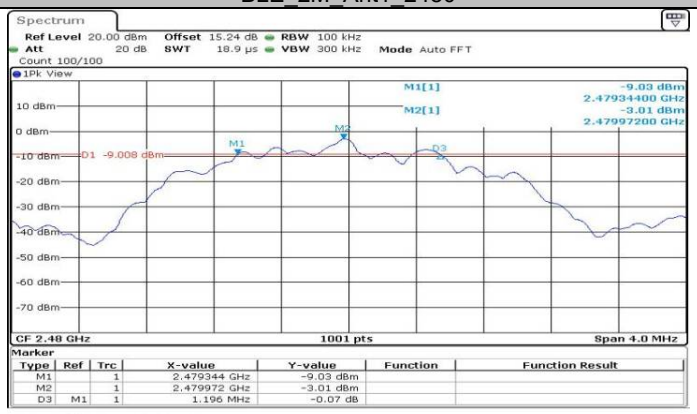
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



Appendix B: Occupied Channel Bandwidth

Test Result

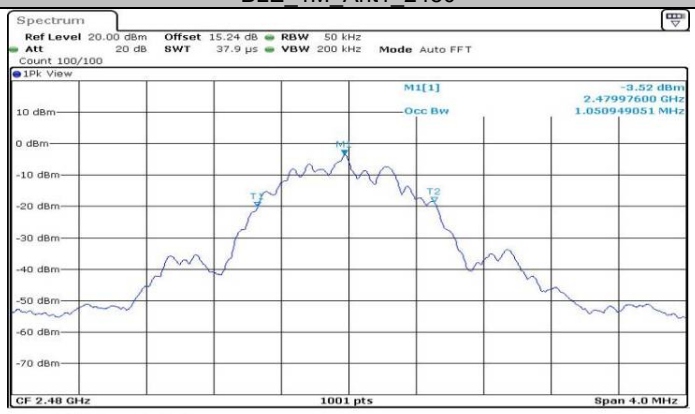
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.047	---	PASS
		2440	1.055	---	PASS
		2480	1.051	---	PASS
BLE_2M	Ant1	2402	2.058	---	PASS
		2440	2.058	---	PASS
		2480	2.062	---	PASS

Test Graphs

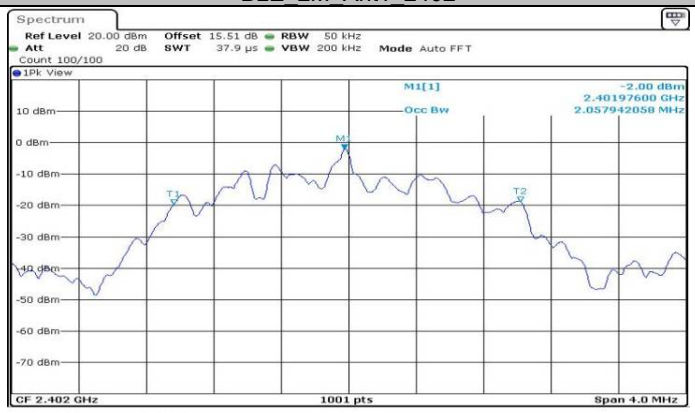
BLE_1M_Ant1_2402

BLE_1M_Ant1_2440

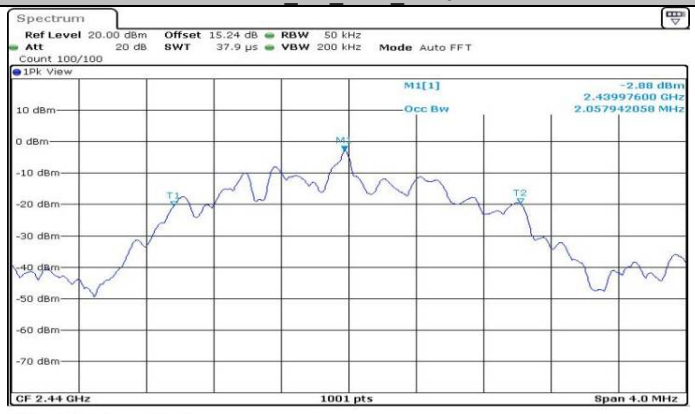
BLE_1M_Ant1_2480



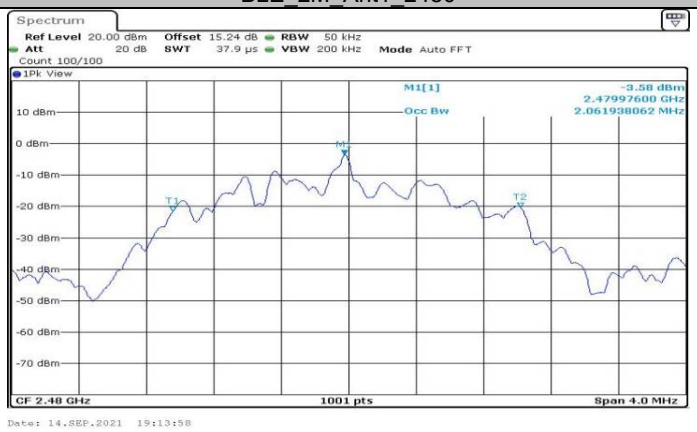
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



Appendix C: Maximum conducted Peak output power

Test Result

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	-1.11	≤30	PASS
		2440	-1.56	≤30	PASS
		2480	-2.09	≤30	PASS
BLE_2M	Ant1	2402	-2.02	≤30	PASS
		2440	-2.26	≤30	PASS
		2480	-2.49	≤30	PASS

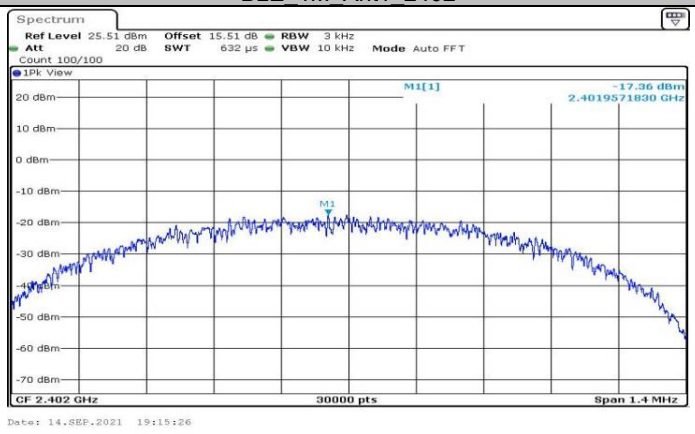
Appendix D: Maximum power spectral density

Test Result

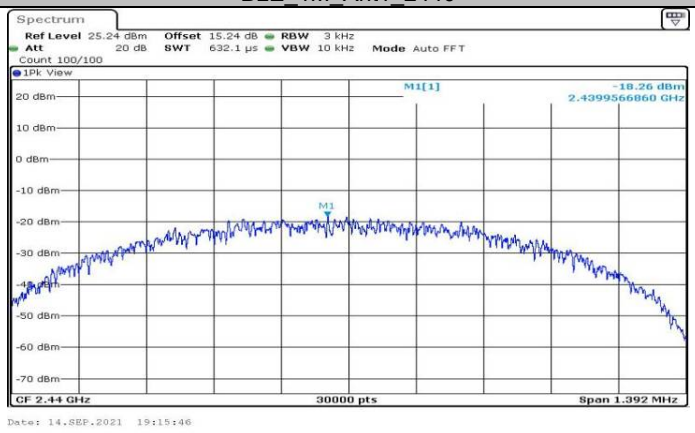
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-17.36	≤8	PASS
		2440	-18.26	≤8	PASS
		2480	-18.97	≤8	PASS
BLE_2M	Ant1	2402	-19.37	≤8	PASS
		2440	-20.24	≤8	PASS
		2480	-20.96	≤8	PASS

Test Graphs

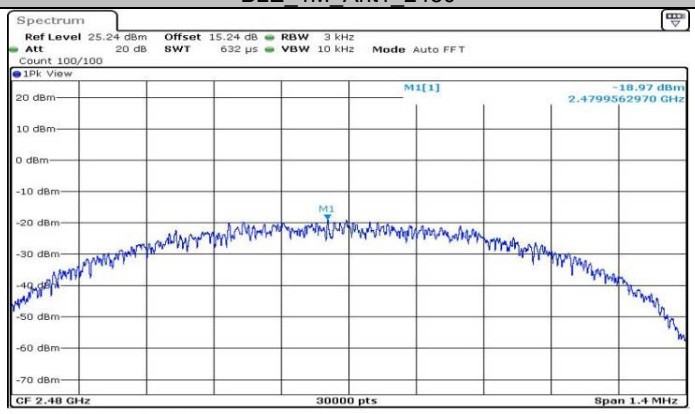
BLE_1M_Ant1_2402



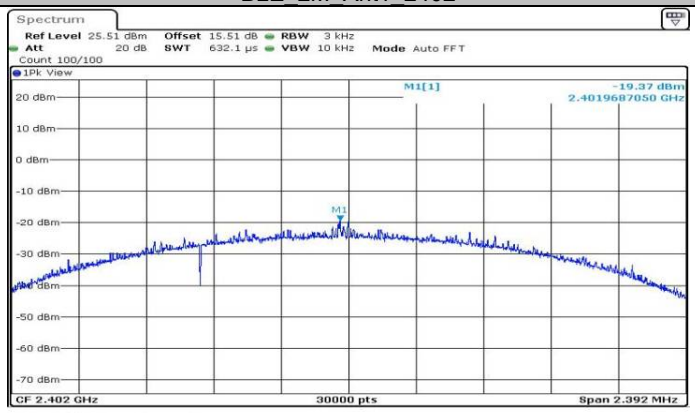
BLE_1M_Ant1_2440



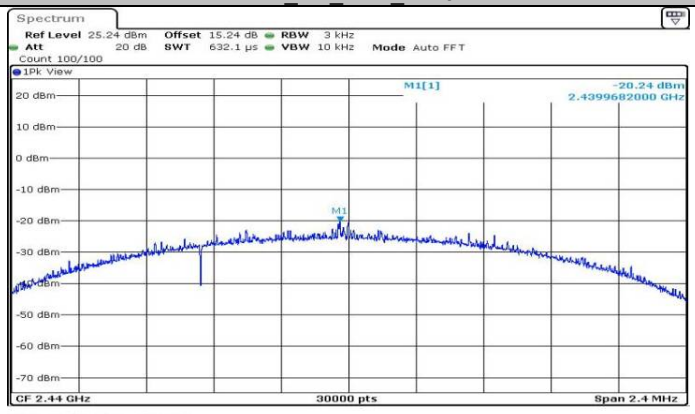
BLE_1M_Ant1_2480



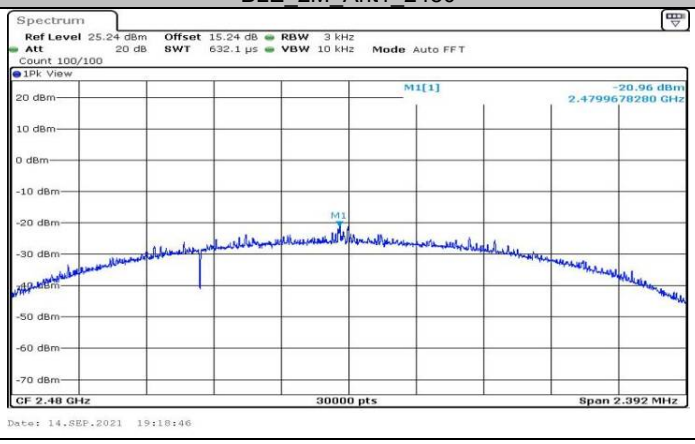
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



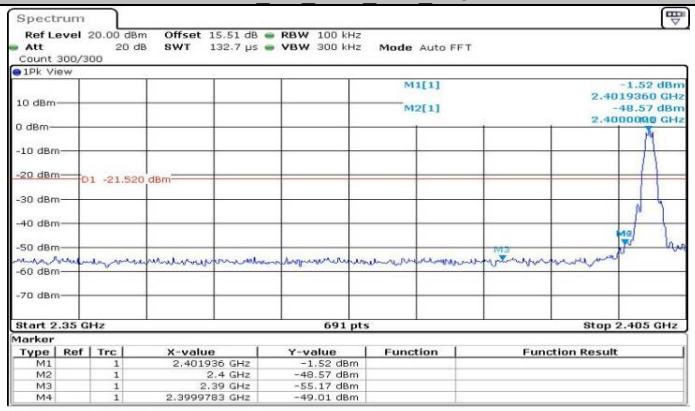
BLE_2M_Ant1_2480



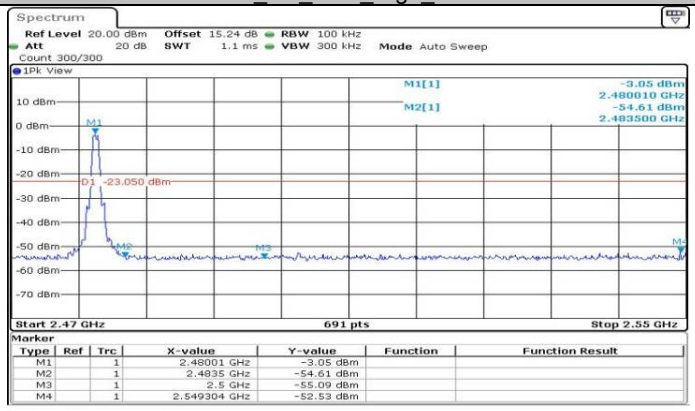
Appendix E: Band edge measurements

Test Graphs

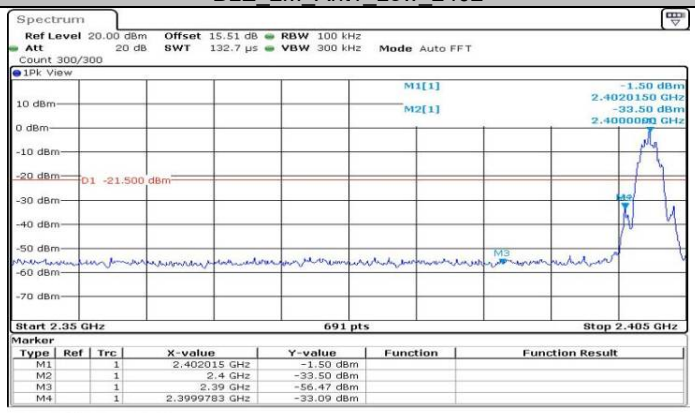
BLE_1M_Ant1_Low_2402



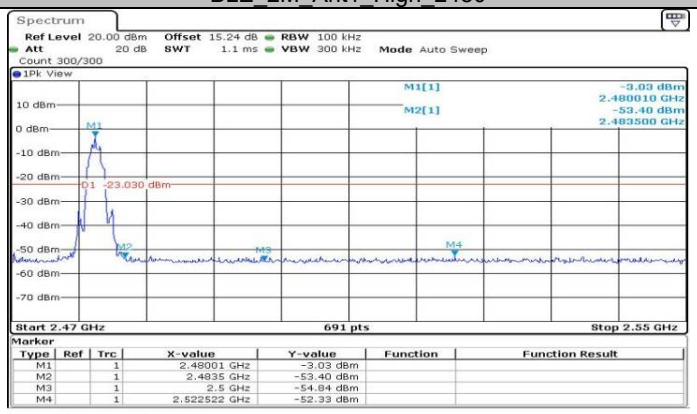
BLE_1M_Ant1_High_2480



BLE_2M_Ant1_Low_2402



BLE_2M_Ant1_High_2480



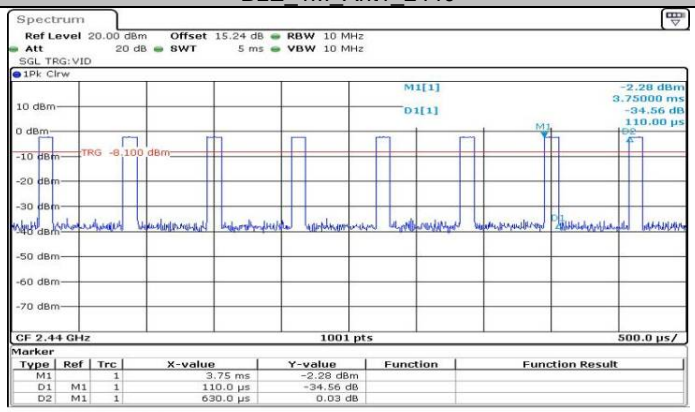
Appendix F: Duty Cycle

Test Result

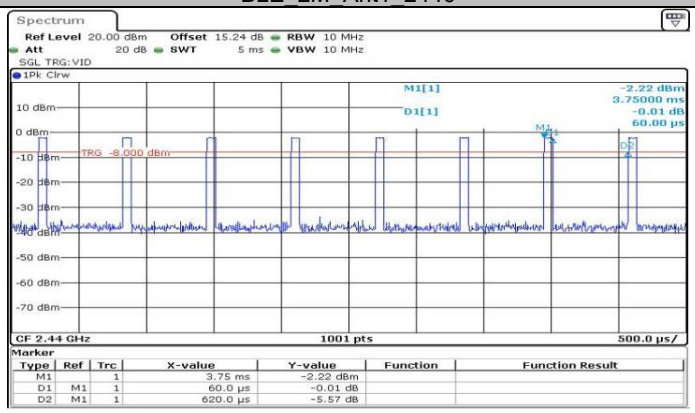
Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	0.11	0.63	17.46
BLE_2M	Ant1	2440	0.06	0.62	9.68

Test Graphs

BLE_1M_Ant1_2440



BLE_2M_Ant1_2440



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