

TEST REPORT

Applicant Name : WIZZILAB SAS
Address : 29 Boulevard Romain Rolland Montrouge 92120 France
Report Number : SZNS211102-56246E-RFA
FCC ID: 2ARZVUM-1
IC: 27701-UM1

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: UWB Module
Model No.: UM-1
Multiple Model(s) No.: N/A
Trade Mark: WIZZILAB
Date Received: 2021/11/02
Date of Test: 2022/01/07~2022/01/12
Report Date: 2022/01/20

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:



Ting Lv
EMC Engineer

Approved By:



Robert Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" .

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TABLE OF CONTENTS

GENERAL INFORMATION	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....	4
OBJECTIVE	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY.....	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
EQUIPMENT MODIFICATIONS	6
DUTY CYCLE	7
SUMMARY OF TEST RESULTS	9
TEST EQUIPMENT LIST	10
FCC§15.247 (I), §1.1307 (B) (1) & §2.1093 – RF EXPOSURE	11
APPLICABLE STANDARD	11
RSS-102 § 2.5.1 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-SAR EVALUATION	12
APPLICABLE STANDARD	12
TEST RESULT:	13
FCC §15.203, RSS-GEN CLAUSE 6.8 - ANTENNA REQUIREMENT	14
RESULT: COMPLIANT	15
FCC §15.207 (A), RSS-GEN §8.8 - AC POWER LINE CONDUCTED EMISSIONS	16
APPLICABLE STANDARD	16
EUT SETUP	16
EMI TEST RECEIVER SETUP.....	16
TEST PROCEDURE	17
TEST RESULTS SUMMARY	17
TRANSD FACTOR & MARGIN CALCULATION.....	17
TEST DATA	17
FCC §15.209, §15.205 & §15.247(D), RSS-GEN § 8.10 & RSS-247 § 5.5 – UNWANTED EMISSION FREQUENCIES AND RESTRICTED BANDS	20
APPLICABLE STANDARD	20
EUT SETUP	20
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	21
TEST PROCEDURE	21
FACTOR & MARGIN CALCULATION	21
TEST RESULTS SUMMARY	21
TEST DATA	22
FCC §15.247(A) (2), RSS-GEN § 6.7 & RSS-247 § 5.2 (A) – 99% OCCUPIED BANDWIDTH & 6 DB EMISSON BANDWIDTH	27
STANDARD APPLICABLE	27
TEST PROCEDURE	28
TEST DATA	28

FCC §15.247(E), RSS-247 §5.2 (B) – POWER SPECTRAL DENSITY29
 APPLICABLE STANDARD29
 TEST PROCEDURE29
 TEST DATA30

FCC §15.247(B) (3), RSS-247 §5.4 (D) - PEAK OUTPUT POWER MEASUREMENT31
 APPLICABLE STANDARD31
 TEST PROCEDURE31
 TEST DATA31

§15.247(D) & RSS-247 § 5.5 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGE.....32
 APPLICABLE STANDARD32
 TEST PROCEDURE32
 TEST DATA32

APPENDIX33
 APPENDIX A: DTS BANDWIDTH33
 APPENDIX B: OCCUPIED CHANNEL BANDWIDTH35
 APPENDIX C: MAXIMUM CONDUCTED PEAK OUTPUT POWER37
 APPENDIX D: MAXIMUM POWER SPECTRAL DENSITY38
 APPENDIX E: BAND EDGE MEASUREMENTS.....40
 APPENDIX F: DUTY CYCLE41

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	UM-1
Frequency Range	BLE: 2402-2480MHz
Maximum Conducted Peak Output Power	2.41dBm
Modulation Technique	BLE: GFSK
Antenna Specification*	Chip Antenna: -4.3dBi(provided by the applicant)
Voltage Range	DC 2.8-3.6V(Typical DC 3.3V)
Sample serial number	SZNS211102-56246E-RF-S1 (CE&RE) SZNS211102-56246E-RF-S2 (RF Conducted) (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
Occupied Channel Bandwidth		5%
RF Frequency		0.082×10^{-7}
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
Temperature		1 °C
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 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.

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

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.

EUT Exercise Software

“rubyinstaller-devkit-2.7.4-1-x64.exe” software was used during test and power level is default*, which provided by manufacturer

Equipment Modifications

No modification was made to the EUT tested.

Duty cycle

Please refer to the Appendix.

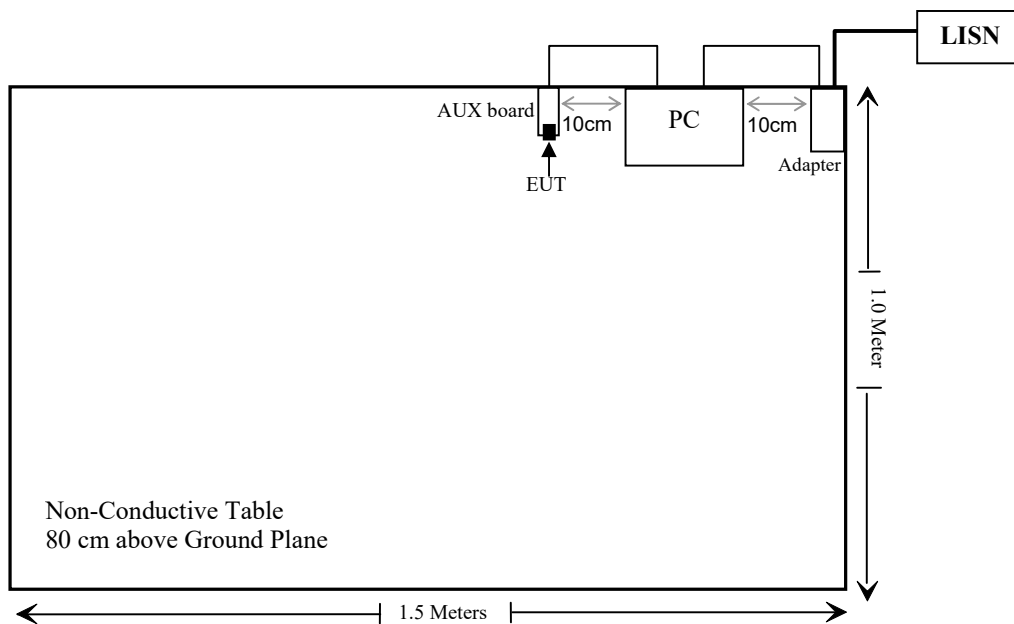
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DELL	PC	Latitude	11429208685
DELL	Adapter	DA130PE1-00	CN-0JU012-68219-18B-JEYY-A04
WIZZILAB SAS	AUX board	Umlab-v1-21.09	Unknown

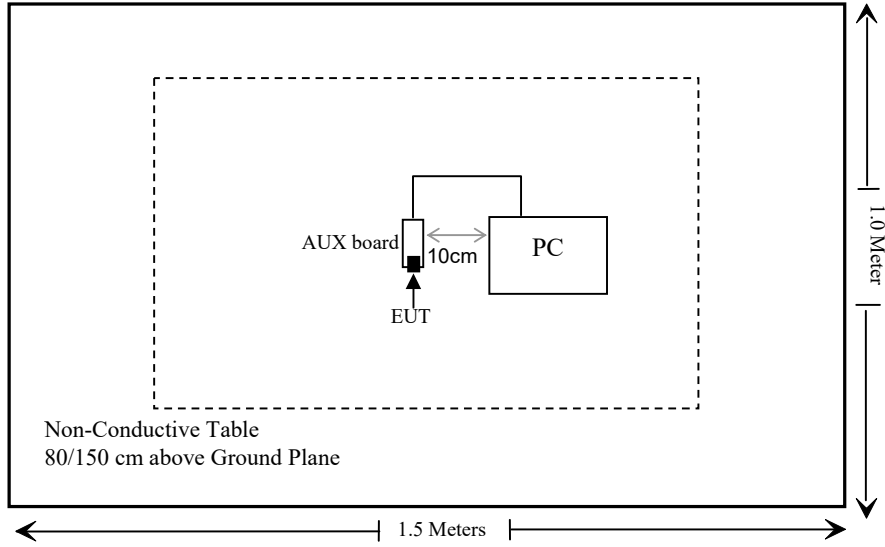
External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable AC Cable	1.5	Adapter	LISN
Un-shielding Detachable DC Cable	1.5	Adapter	PC
Un-shielding Detachable DC Cable	1.3	AUX board	PC

Block Diagram of Test Setup For Conducted Emissions



For Spurious Emissions



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC §15.247 (i) & §2.1093 RSS-102 § 2.5.1	RF EXPOSURE& Exemption Limits for Routine Evaluation – SAR Evaluation	Compliant
FCC §15.203, RSS-GEN Clause 6.8	Antenna Requirement	Compliant
FCC §15.207 (a); RSS-Gen Clause 8.8	AC Line Conducted Emissions	Compliant
FCC §15.205, §15.209, §15.247(d); RSS-247 Clause 5.5 RSS-Gen Clause 8.10	Spurious Emissions	Compliant
FCC §15.247 (a)(2); RSS-247 Clause 5.2 a) RSS-Gen Clause 6.7	6 dB Bandwidth and 99% Occupied Bandwidth	Compliant
FCC §15.247(b)(3); RSS-247 Clause 5.4 d)	Maximum Conducted Output Power	Compliant
FCC §15.247(d); RSS-247 Clause 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) RSS-247 Clause 5.2 b)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/07/06	2022/07/05
Unknown	RF Cable	Unknown	Unknown	Each time	/

* **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), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

- a) According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Measurement Result

For worst case:

Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2402-2480	3.0	2.00	5	0.6	3.0	Yes

Note: the BLE and UWB cannot transmit at same time.

Result: No Standalone SAR test is required

RSS-102 § 2.5.1 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-SAR EVALUATION

Applicable Standard

According to RSS-102 Issue 5 § (2.5.1), SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

4. The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

5. Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

Test Result:

For worst case:

The higher of the conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power:

$$(2480-2450)/(3500-2450) = (4-P)/(4-2)$$

The exemption limit of 2480MHz is $P = 3.94\text{mW}$

The antenna gain is -4.3dBi

The maximum tune-up conducted power is 3.0dBm (2.0mW), which less than $3.94\text{mW}@2480\text{MHz}$ exemption limit

Note: the BLE and UWB cannot transmit at same time.

So the stand-alone SAR test is not required.

FCC §15.203, RSS-GEN CLAUSE 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:

- b. Antenna must be permanently attached to the unit.
- c. 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.

According to RSS-Gen §6.8, 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 permanently attached to the unit, fulfill the requirement of this section. The antenna gain is 2.0 dBi. Please refer to the EUT photos.

Antenna	Type	Antenna Gain	Impedance
	Chip	-4.3dBi	50 Ω

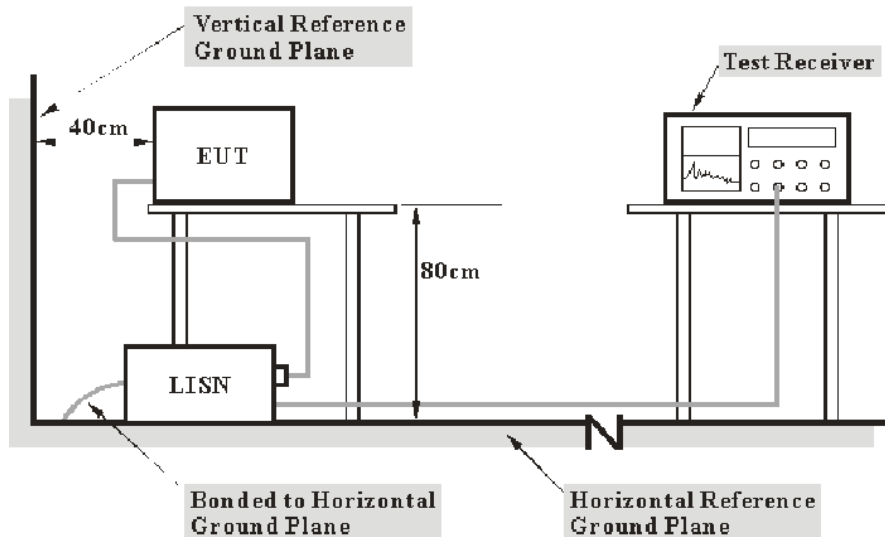
Result: Compliant.

FCC §15.207 (a), RSS-GEN §8.8 - AC Power 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 setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits and 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 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.

Test Results Summary

According to the EUT complied with the FCC 15.207/RSS-Gen.

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:

$$\text{Transd Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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

$$\begin{aligned} \text{Over limit} &= \text{Level} - \text{Limit} \\ \text{Level} &= \text{Reading level} + \text{Transd Factor} \end{aligned}$$

Test Data

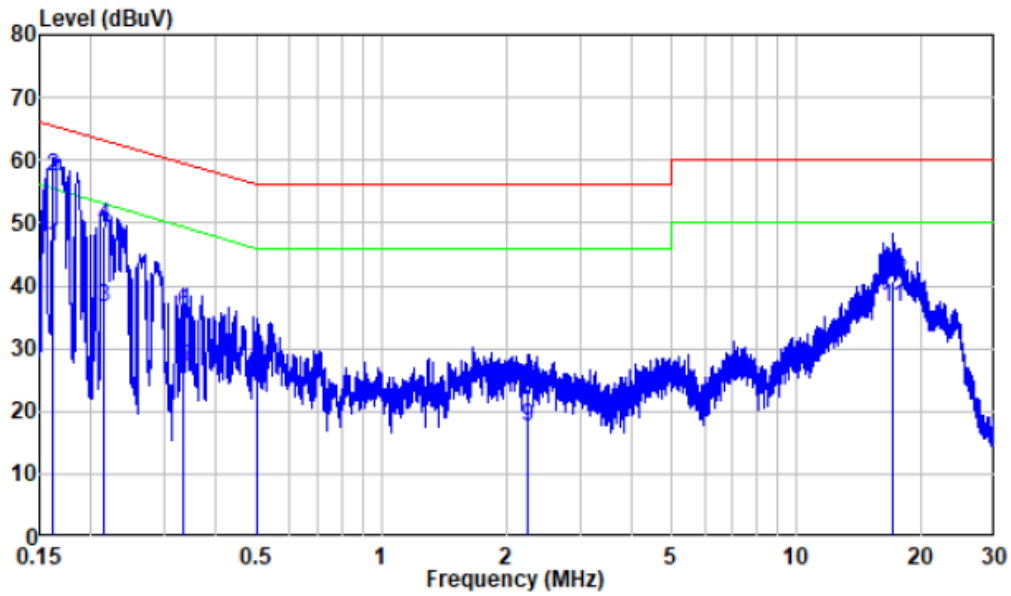
Environmental Conditions

Temperature:	22°C
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Duan on 2022-01-12.

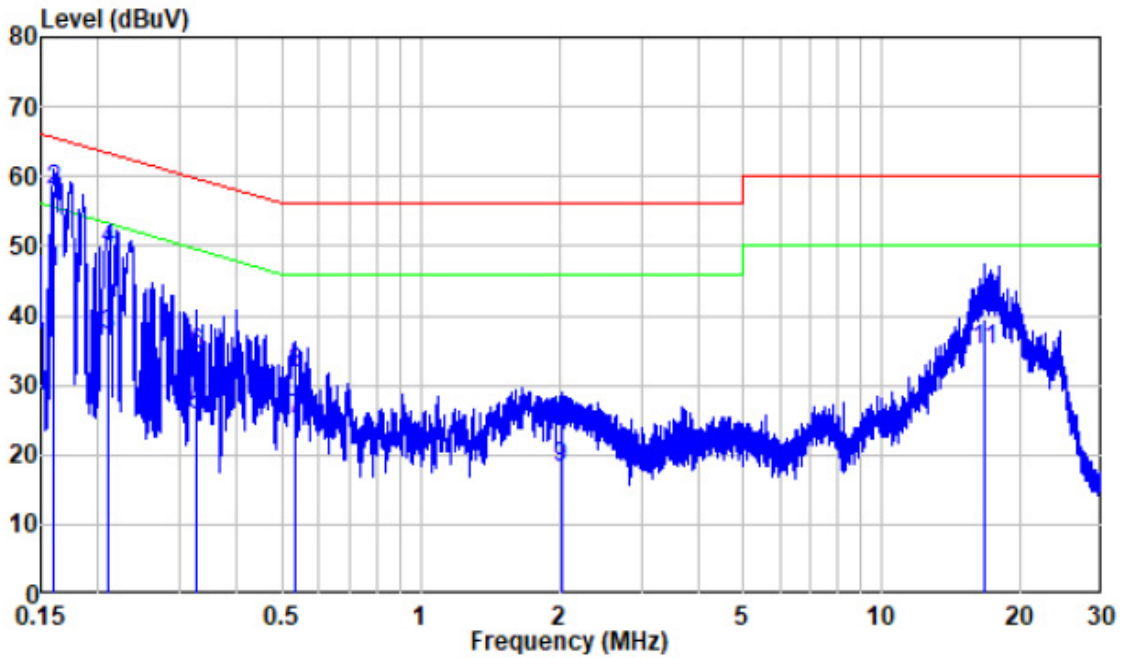
EUT operation mode: Transmitting

AC 120V/60 Hz, Line



	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.162	9.87	36.42	46.29	55.37	-9.08	Average
2	0.162	9.87	47.63	57.50	65.37	-7.87	QP
3	0.213	9.80	26.72	36.52	53.07	-16.55	Average
4	0.213	9.80	39.64	49.44	63.07	-13.63	QP
5	0.332	9.80	17.11	26.91	49.40	-22.49	Average
6	0.332	9.80	25.77	35.57	59.40	-23.83	QP
7	0.500	9.80	14.12	23.92	46.00	-22.08	Average
8	0.500	9.80	18.23	28.03	56.00	-27.97	QP
9	2.250	9.92	7.60	17.52	46.00	-28.48	Average
10	2.250	9.92	13.58	23.50	56.00	-32.50	QP
11	16.984	10.11	26.29	36.40	50.00	-13.60	Average
12	16.984	10.11	30.77	40.88	60.00	-19.12	QP

AC 120V/60 Hz, Neutral



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.160	9.80	36.29	46.09	55.46	-9.37	Average
2	0.160	9.80	48.05	57.85	65.46	-7.61	QP
3	0.211	9.80	27.25	37.05	53.18	-16.13	Average
4	0.211	9.80	39.68	49.48	63.18	-13.70	QP
5	0.325	9.80	15.97	25.77	49.57	-23.80	Average
6	0.325	9.80	24.47	34.27	59.57	-25.30	QP
7	0.532	9.81	15.27	25.08	46.00	-20.92	Average
8	0.532	9.81	21.82	31.63	56.00	-24.37	QP
9	2.013	9.82	8.36	18.18	46.00	-27.82	Average
10	2.013	9.82	14.58	24.40	56.00	-31.60	QP
11	16.606	10.07	24.91	34.98	50.00	-15.02	Average
12	16.606	10.07	29.52	39.59	60.00	-20.41	QP

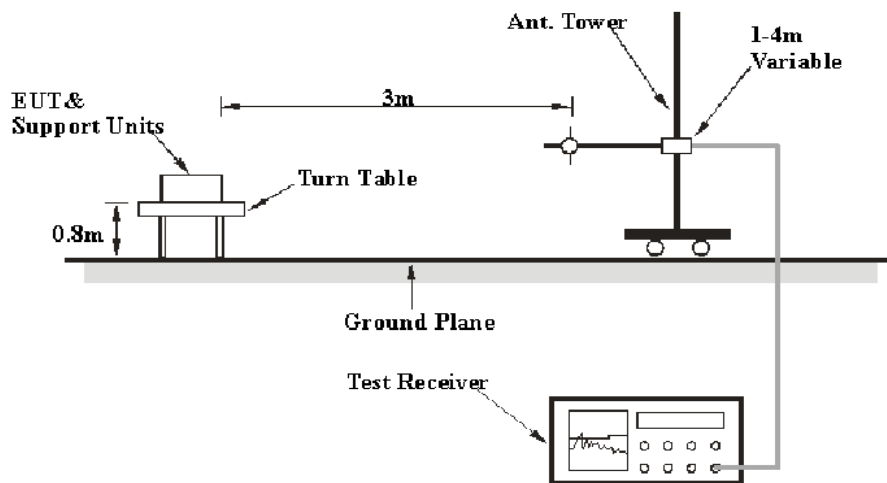
FCC §15.209, §15.205 & §15.247(D), RSS-GEN § 8.10 & RSS-247 § 5.5 – UNWANTED EMISSION FREQUENCIES AND RESTRICTED BANDS

Applicable Standard

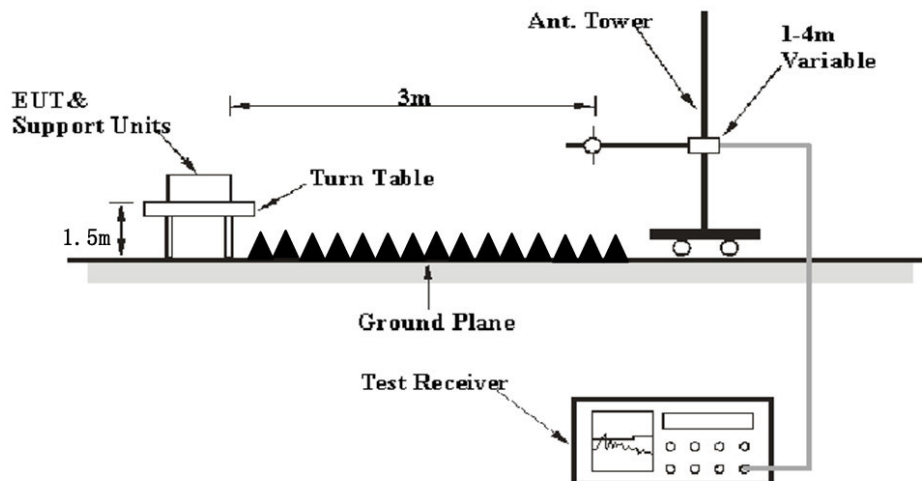
FCC §15.247 (d); §15.209; §15.205; RSS-247 §5.5, RSS-GEN §8.10.

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:

$$\text{Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\begin{aligned} \text{Over Limit/Margin} &= \text{Level} / \text{Corrected Amplitude} - \text{Limit} \\ \text{Level} / \text{Corrected Amplitude} &= \text{Read Level} + \text{Factor} \end{aligned}$$

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:	21 °C
Relative Humidity:	62%
ATM Pressure:	101.0 kPa

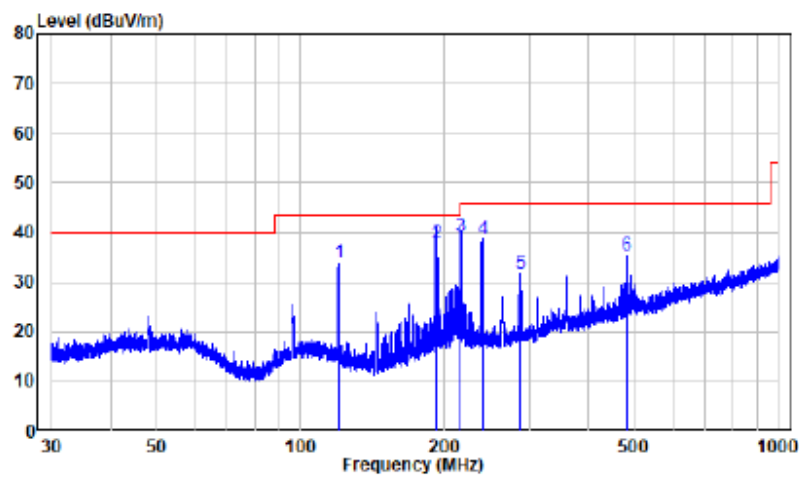
The testing was performed by Bin Deng on 2022-01-12.

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

30 MHz~1 GHz: (the worst case is low channel)

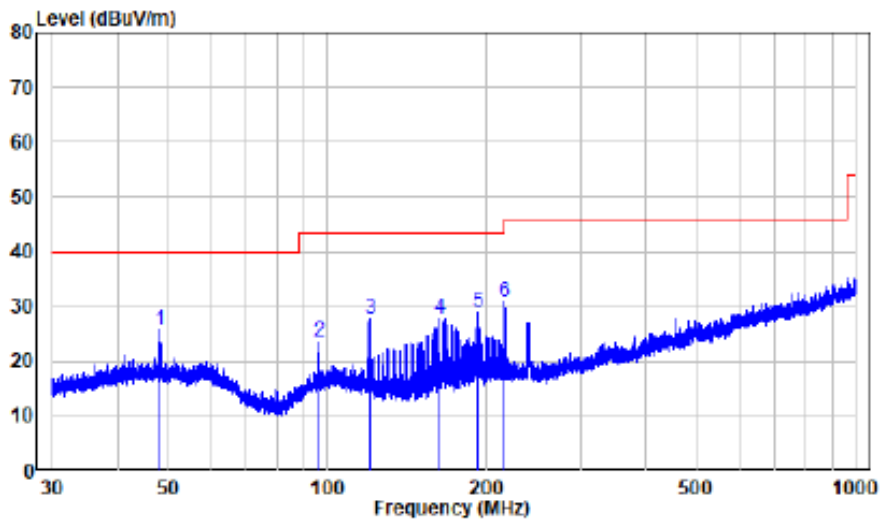
Note: When the test result of peak was less than the limit of QP more than 6dB, just peak value were recorded.

Horizontal



	Freq	Factor	Read Level	Limit Level	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	120.013	-13.53	47.23	33.70	43.50	-9.80 Peak
2	192.250	-11.25	48.99	37.74	43.50	-5.76 QP
3	216.024	-11.63	50.90	39.27	46.00	-6.73 QP
4	240.725	-10.86	49.41	38.55	46.00	-7.45 Peak
5	287.990	-9.36	41.21	31.85	46.00	-14.15 Peak
6	480.107	-5.00	40.24	35.24	46.00	-10.76 Peak

Vertical



	Freq		Read		Limit	Over	Remark
	Factor	Level	Level	Line	Limit		
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	48.163	-9.99	35.75	25.76	40.00	-14.24	Peak
2	96.099	-12.30	35.73	23.43	43.50	-20.07	Peak
3	119.908	-13.51	41.29	27.78	43.50	-15.72	Peak
4	162.896	-14.29	42.03	27.74	43.50	-15.76	Peak
5	192.334	-11.26	40.22	28.96	43.50	-14.54	Peak
6	216.119	-11.62	42.32	30.70	46.00	-15.30	Peak

Above 1GHz:

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 (2402 MHz)									
2310	67.30	PK	56	2.4	H	-7.24	60.06	74	-13.94
2310	54.15	AV	56	2.4	H	-7.24	46.91	54	-7.09
2310	67.16	PK	342	1.1	V	-7.24	59.92	74	-14.08
2310	54.52	AV	342	1.1	V	-7.24	47.28	54	-6.72
2390	67.60	PK	278	1.2	H	-7.22	60.38	74	-13.62
2390	54.75	AV	278	1.2	H	-7.22	47.53	54	-6.47
2390	68.45	PK	294	1.1	V	-7.22	61.23	74	-12.77
2390	54.82	AV	294	1.1	V	-7.22	47.60	54	-6.40
4804	55.75	PK	34	1.6	H	-3.51	52.24	74	-21.76
4804	55.71	PK	302	1.6	V	-3.51	52.20	74	-21.80
7206	56.51	PK	294	2.4	H	2.70	59.21	74	-14.79
7206	47.22	AV	294	2.4	H	2.70	49.92	54	-4.08
7206	54.56	PK	183	1.4	V	2.70	57.26	74	-16.74
7206	44.32	AV	183	1.4	V	2.70	47.02	54	-6.98
Middle Channel (2440 MHz)									
4880	55.99	PK	173	2.5	H	-3.38	52.61	74	-21.39
4880	55.85	PK	178	2.5	V	-3.38	52.47	74	-21.53
7320	56.85	PK	46	1.4	H	3.31	60.16	74	-13.84
7320	47.04	AV	46	1.4	H	3.31	50.35	54	-3.65
7320	54.83	PK	125	1	V	3.31	58.14	74	-15.86
7320	44.37	AV	125	1	V	3.31	47.68	54	-6.32
High Channel (2480 MHz)									
2483.5	69.61	PK	100	2.4	H	-7.20	62.41	74	-11.59
2483.5	55.63	AV	100	2.4	H	-7.20	48.43	54	-5.57
2483.5	68.84	PK	203	1	V	-7.20	61.64	74	-12.36
2483.5	55.57	AV	203	1	V	-7.20	48.37	54	-5.63
2500	68.70	PK	74	2.1	H	-7.18	61.52	74	-12.48
2500	55.61	AV	74	2.1	H	-7.18	48.43	54	-5.57
2500	61.30	PK	56	2.3	V	-7.18	54.12	74	-19.88
2500	51.39	AV	56	2.3	V	-7.18	44.21	54	-9.79
4960	56.65	PK	227	1.7	H	-3.01	53.64	74	-20.36
4960	54.70	PK	334	1.7	V	-3.01	51.69	74	-22.31
7440	56.84	PK	90	1.3	H	3.53	60.37	74	-13.63
7440	45.83	AV	90	1.3	H	3.53	49.36	54	-4.64
7440	56.22	PK	48	2.1	V	3.53	59.75	74	-14.25
7440	46.09	AV	48	2.1	V	3.53	49.62	54	-4.38

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 in the noise floor level was not recorded.

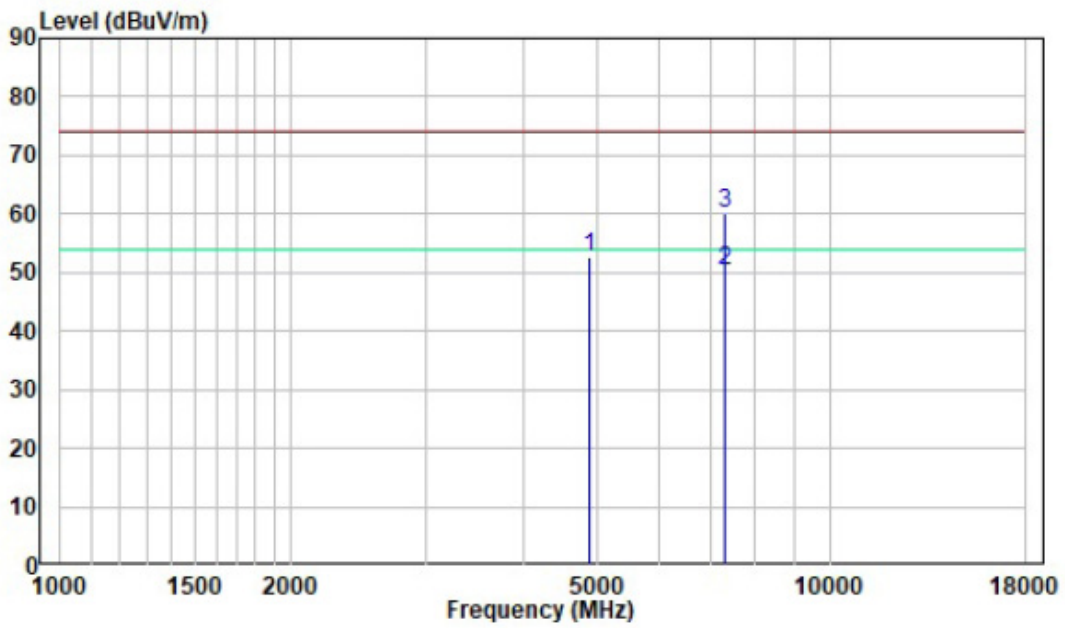
When the test result of peak was less than the limit of average, just peak value were recorded.

1-18GHz

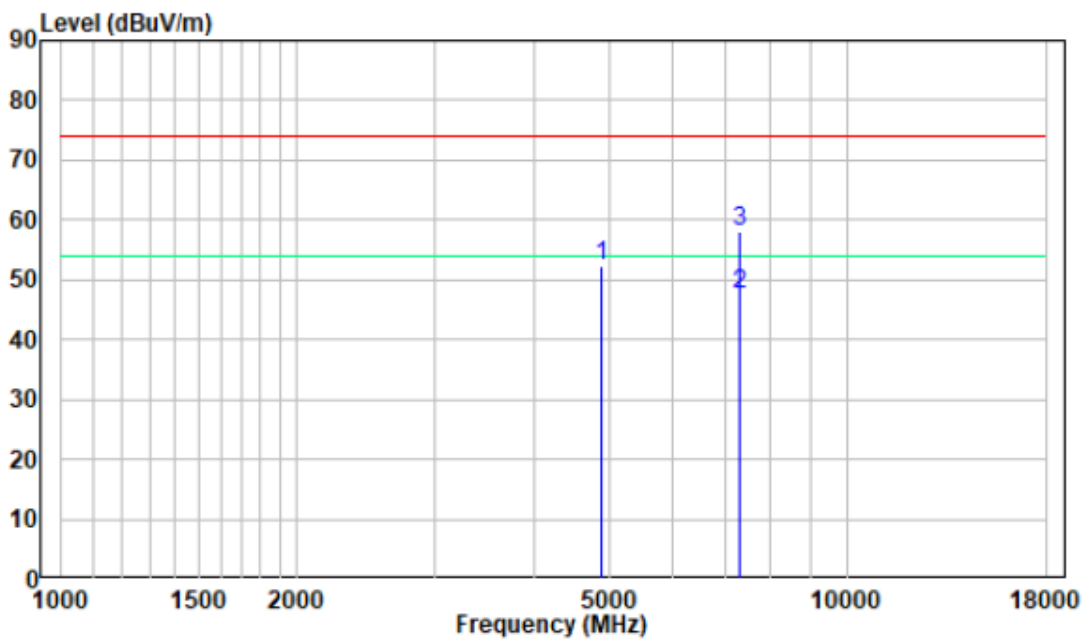
Pre-scan for

Middle Channel

Horizontal:



Vertical:

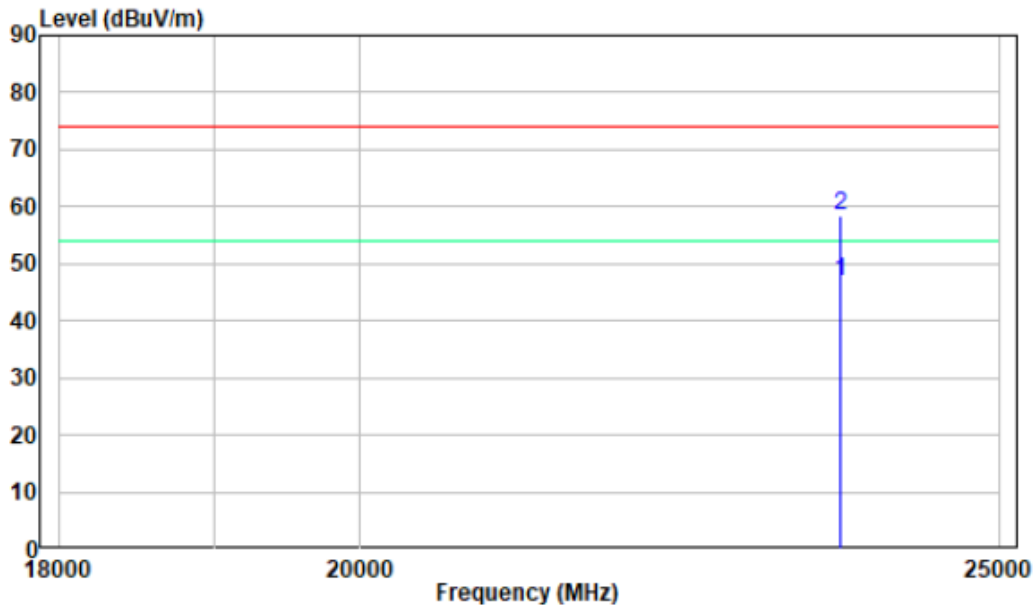


18-25GHz

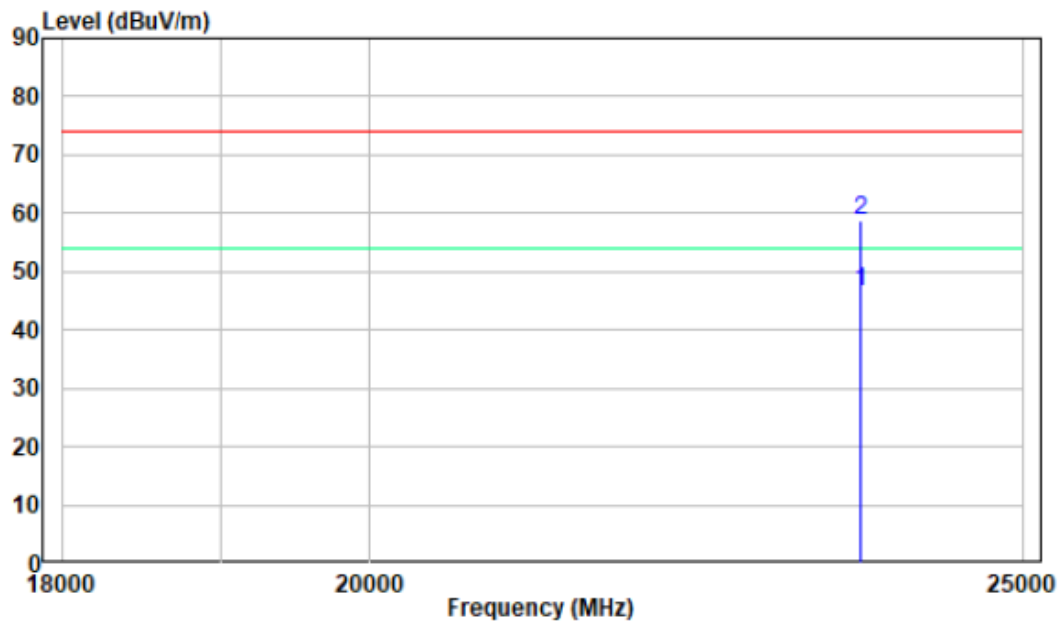
Pre-scan for

Middle Channel

Horizontal:



Vertical:



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

- d. The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- e. 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.
- f. 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.
- g. 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).

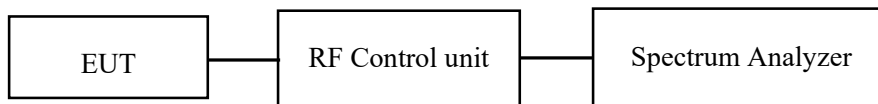
Test Procedure

- h. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- i. 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.
- j. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
- k. 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:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2022-01-07.

Test Mode: Transmitting

Test Result: Pass. 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):

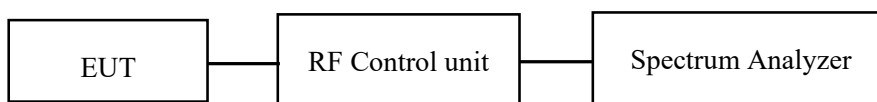
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of 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

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: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
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:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2022-01-07.

Test Mode: Transmitting

Test Result: Pass. Please refer to the Appendix.

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

Applicable Standard

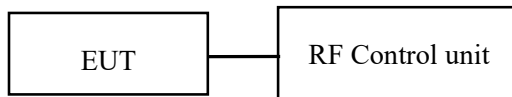
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted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

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.



Note: The RF control unit has a built-in power sensor

Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2022-01-07.

Test Result: Compliant

EUT operation mode: Transmitting

Test Result: Pass. Please refer to the Appendix.

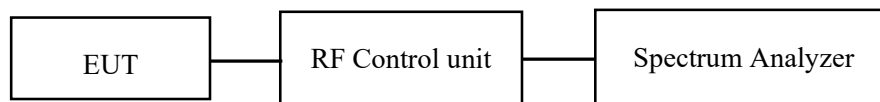
§ 15.247(d) & RSS-247 § 5.5 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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

- l. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- m. 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.
- n. 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.
- o. 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.
- p. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2022-01-07.

EUT operation mode: Transmitting

Test Result: Pass

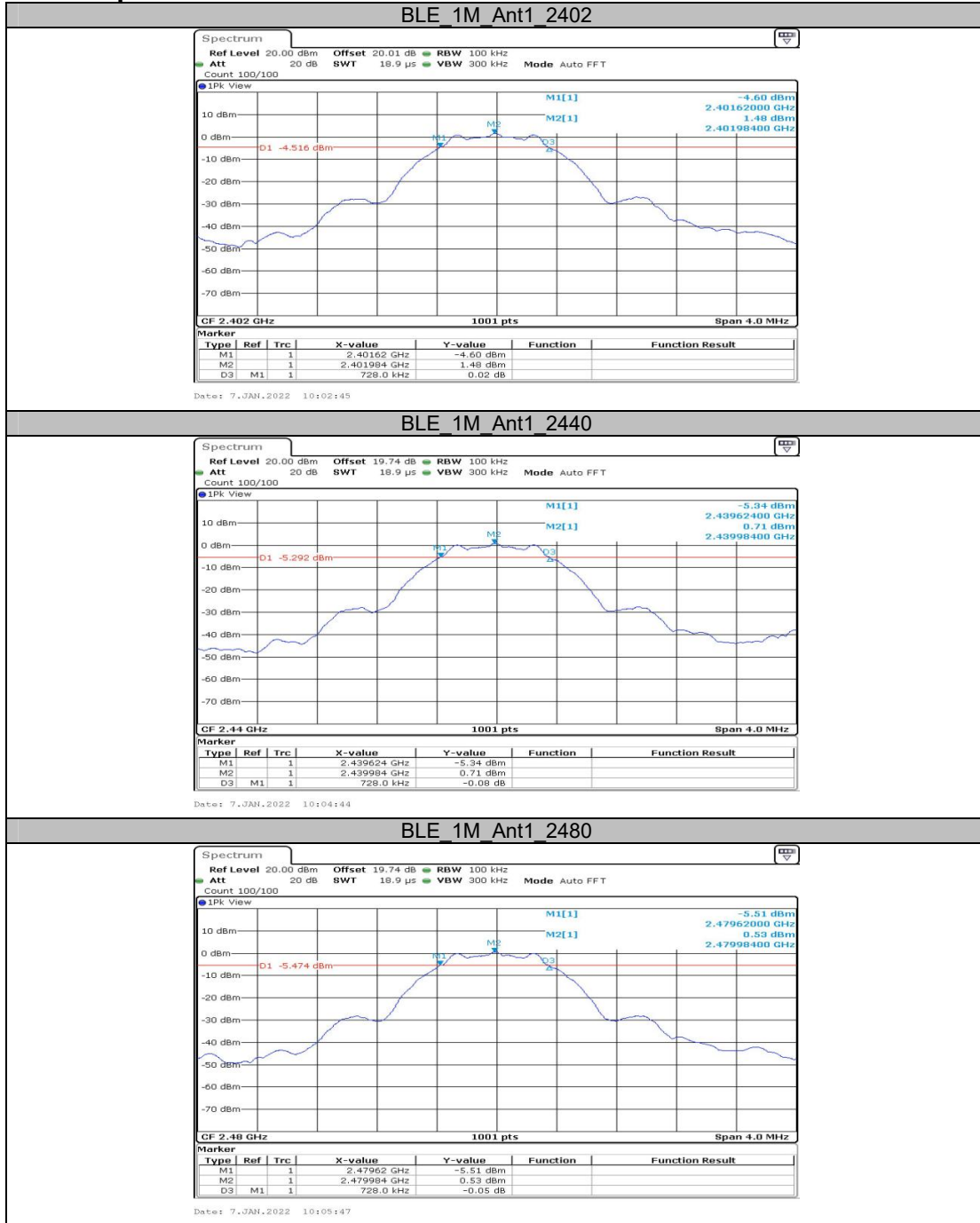
Please refer to the Appendix.

APPENDIX

Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.728	0.5	PASS
		2440	0.728	0.5	PASS
		2480	0.728	0.5	PASS

Test Graphs



**Appendix B: Occupied Channel Bandwidth
Test Result**

Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.063	---	PASS
		2440	1.067	---	PASS
		2480	1.063	---	PASS

Test Graphs



Appendix C: Maximum conducted Peak output power**Test Result**

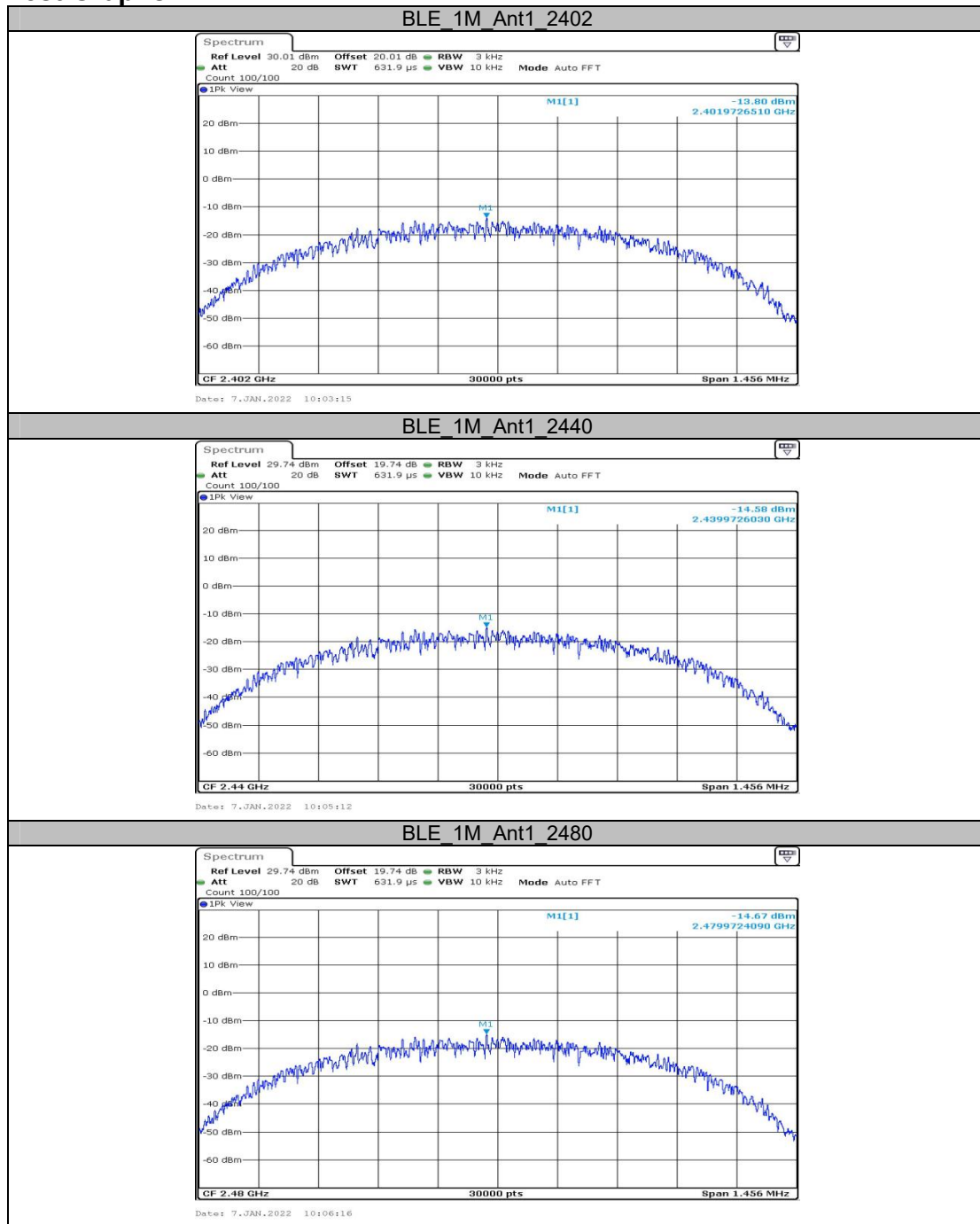
Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	2.41	≤30	PASS
		2440	2.13	≤30	PASS
		2480	1.84	≤30	PASS

Note: the antenna gain is -4.3dBi, the maximum EIRP=2.41dBm-4.3dBi=-1.89dBm<36dBm, so it's compliance with EIRP limit of ISEDC.

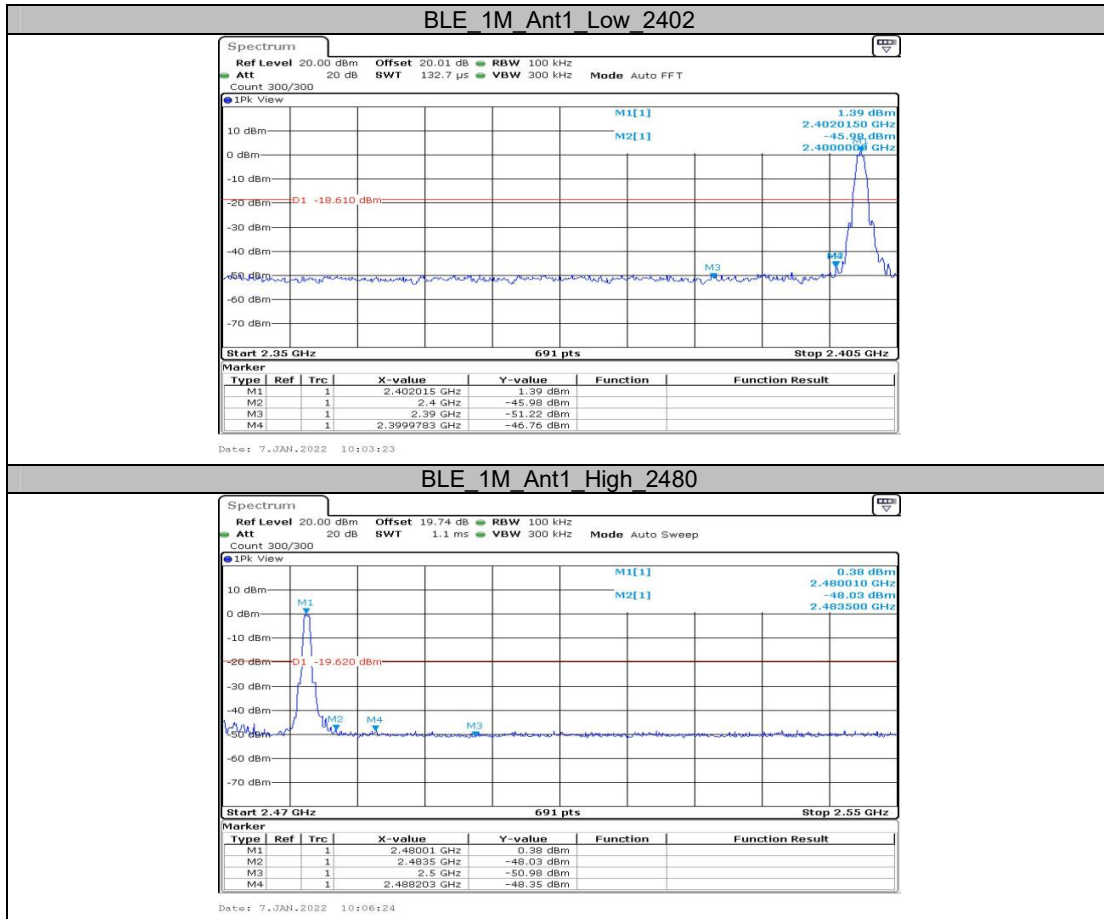
**Appendix D: Maximum power spectral density
Test Result**

Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-13.80	≤8	PASS
		2440	-14.58	≤8	PASS
		2480	-14.67	≤8	PASS

Test Graphs



Appendix E: Band edge measurements Test Graphs

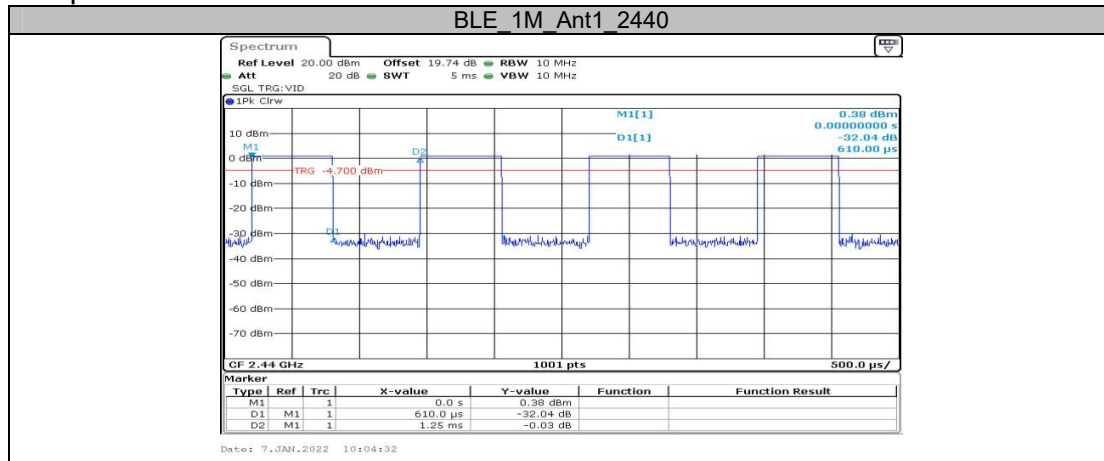


Appendix F: Duty Cycle

Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	0.61	1.25	48.80

Test Graphs



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