

**ATC**

# TEST REPORT

Applicant Name : Vuzix Corporation  
Address : FCC: 25 Hendrix Rd, West Henrietta, New York, United States 14586  
ISEDC: 25 Hendrix Road West Henrietta NY 14586 United States Of America (Excluding The States Of Alaska  
Report Number : SZNS220425-16463E-RF-RFB  
FCC ID: 2AA9D-514  
IC: 11503A-514

## 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: Blade 2  
Model No.: Model 514  
Multiple Model(s) No.: N/A  
Trade Mark: Vuzix  
Date Received: 2022/04/25  
Report Date: 2022/07/12

Test Result:	Pass*
--------------	-------

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

**Prepared and Checked By:**

**Approved By:**

Andy Yu  
EMC Engineer

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.

## Shenzhen Accurate Technology Co., Ltd.

1F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China  
Tel: +86 755-26503290 Fax: +86 755-26503396 Web: [www.atc-lab.com](http://www.atc-lab.com)

## **TABLE OF CONTENTS**

<b>GENERAL INFORMATION.....</b>	<b>4</b>
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....	4
OBJECTIVE .....	4
TEST METHODOLOGY .....	4
MEASUREMENT UNCERTAINTY .....	5
<b>SYSTEM TEST CONFIGURATION.....</b>	<b>6</b>
DESCRIPTION OF TEST CONFIGURATION .....	6
EQUIPMENT MODIFICATIONS .....	7
EUT EXERCISE SOFTWARE .....	7
SUPPORT EQUIPMENT LIST AND DETAILS .....	7
EXTERNAL I/O CABLE.....	7
BLOCK DIAGRAM OF TEST SETUP .....	8
<b>SUMMARY OF TEST RESULTS .....</b>	<b>9</b>
<b>TEST EQUIPMENT LIST .....</b>	<b>10</b>
<b>FCC§15.247 (I), §1.1307 (B) (3) &amp;§2.1093 – RF EXPOSURE .....</b>	<b>11</b>
APPLICABLE STANDARD .....	11
<b>RSS-102 § 2.5.1 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-SAR EVALUATION.....</b>	<b>13</b>
APPLICABLE STANDARD .....	13
TEST RESULT: .....	14
<b>§15.203 &amp; RSS-GEN §6.8 ANTENNA REQUIREMENT.....</b>	<b>15</b>
APPLICABLE STANDARD .....	15
ANTENNA CONNECTOR CONSTRUCTION .....	16
<b>§15.207 (A) &amp; RSS-GEN §8.8 AC LINE CONDUCTED EMISSIONS.....</b>	<b>17</b>
APPLICABLE STANDARD .....	17
EUT SETUP.....	18
EMI TEST RECEIVER SETUP.....	18
TEST PROCEDURE .....	18
CORRECTED FACTOR & MARGIN CALCULATION .....	19
TEST DATA .....	19
<b>§15.205, §15.209, §15.247(D) &amp; RSS-GEN § 8.10 &amp; RSS-247 § 5.5 SPURIOUS EMISSIONS.....</b>	<b>22</b>
APPLICABLE STANDARD .....	22
EUT SETUP .....	22
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....	23
TEST PROCEDURE .....	24
FACTOR & MARGIN CALCULATION .....	24
TEST DATA .....	24
<b>§15.247 (A)(2) &amp; RSS-GEN§6.7 RSS-247 § 5.2 (A) 99% OCCUPIED BANDWIDTH &amp; 6 DB EMISSION BANDWIDTH.....</b>	<b>34</b>
APPLICABLE STANDARD .....	34
TEST PROCEDURE .....	34
TEST DATA .....	35

<b>§15.247(B)(3) &amp; RSS-247 § 5.4(D) MAXIMUM CONDUCTED OUTPUT POWER .....</b>	<b>36</b>
APPLICABLE STANDARD .....	36
TEST PROCEDURE .....	36
TEST DATA .....	37
<b>§15.247(D) &amp; RSS-247 § 5.5 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGE.....</b>	<b>38</b>
APPLICABLE STANDARD .....	38
TEST PROCEDURE .....	38
TEST DATA .....	38
<b>§15.247(E) &amp; RSS-247 § 5.2 (B) POWER SPECTRAL DENSITY.....</b>	<b>39</b>
APPLICABLE STANDARD .....	39
TEST PROCEDURE .....	39
TEST DATA .....	40
<b>APPENDIX WI-FI.....</b>	<b>41</b>
APPENDIX A: DTS BANDWIDTH .....	41
APPENDIX B: OCCUPIED CHANNEL BANDWIDTH .....	46
APPENDIX C: MAXIMUM CONDUCTED OUTPUT POWER .....	51
APPENDIX D: MAXIMUM POWER SPECTRAL DENSITY.....	52
APPENDIX E: BAND EDGE MEASUREMENTS.....	57
APPENDIX F: DUTY CYCLE .....	60
<b>APPENDIX BLE.....</b>	<b>63</b>
APPENDIX A: DTS BANDWIDTH .....	63
APPENDIX B: OCCUPIED CHANNEL BANDWIDTH .....	65
APPENDIX C: MAXIMUM CONDUCTED OUTPUT POWER .....	67
APPENDIX D: MAXIMUM POWER SPECTRAL DENSITY.....	69
APPENDIX E: BAND EDGE MEASUREMENTS.....	71
APPENDIX F: DUTY CYCLE .....	72

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

HVIN	514
FVIN	514
Frequency Range	BLE 1M: 2402-2480MHz Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	BLE 1M: 1.26dBm Wi-Fi: 15.24dBm(802.11b), 15.79dBm(802.11g) 15.74dBm(802.11n-HT20), 15.51dBm(802.11n-HT40)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	2.1dBi (It is provided by the applicant)
Voltage Range	DC3.7V from battery
Sample serial number	SZNS220425-16463E-RF-S1 for Conducted and Radiated Emissions SZNS220425-16463E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition

### Objective

This report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's 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.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliant Testing of Unlicensed Wireless Devices and 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.

Each test item follows test standards and with no deviation.

## 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. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISED), the Registration Number is 5077A.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

For Wi-Fi mode, total 13 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

For 802.11b, 802.11g, 802.11n-HT20, EUT was tested with Channel 1, 6 and 11.

For 802.11n-HT40, EUT was tested with Channel 3, 6 and 9.

For BLE 1M 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

“QRCT” \* Exercise Software was used.

The device was tested with the worst case was performed as below:

Mode	Data rate	Power Level*		
		Low Channel	Middle Channel	High Channel
BLE	1Mbps	default	default	default
802.11b	1Mbps	16	16	16
802.11g	6Mbps	12	12	12
802.11n-HT20	MCS0	12	12	12
802.11n-HT40	MCS0	10	10	10

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PSD across all data rates, bandwidths and modulations.

The power level was provided by the applicant.

## Support Equipment List and Details

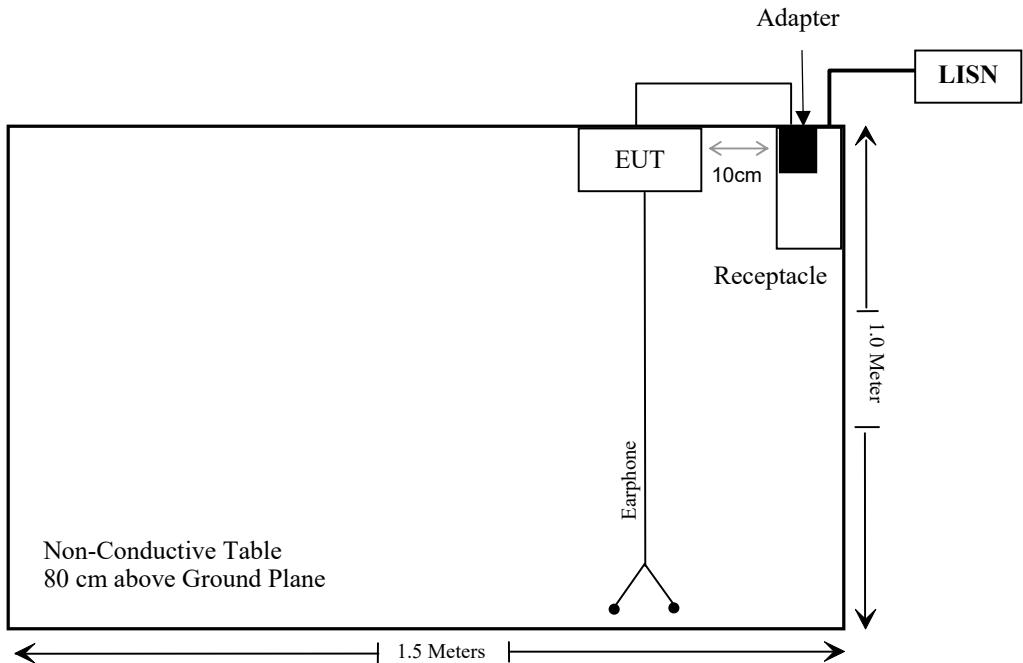
Manufacturer	Description	Model	Serial Number
Chillax Care Limited	Adapter	S005CAU0500100	Unknown

## External I/O Cable

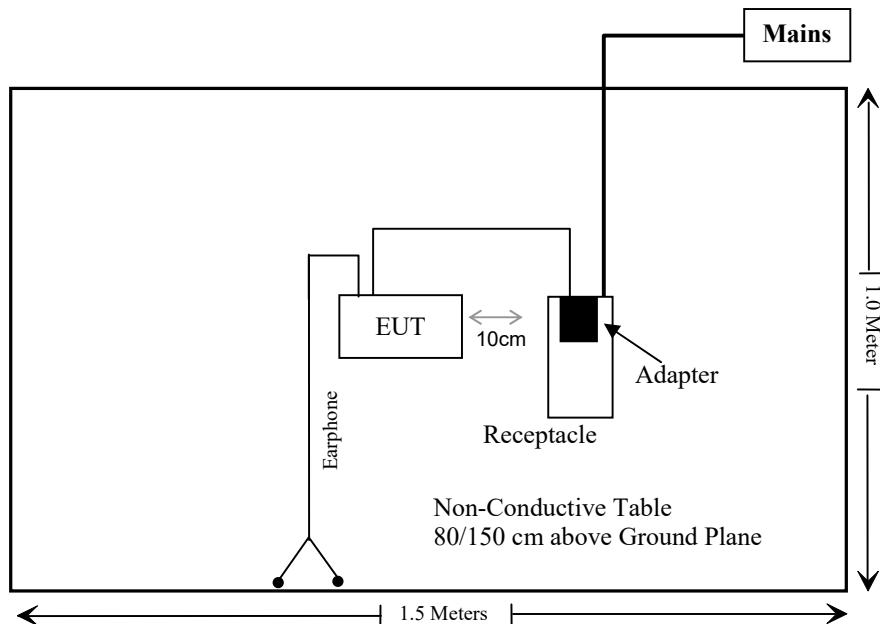
Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	1.0	EUT	Adapter

## Block Diagram of Test Setup

For conducted emission:



For radiated emission:



## SUMMARY OF TEST RESULTS

FCC Rules	RSS Rules	Description of Test	Result
§15.247 (i), §2.1093	RSS-102	RF EXPOSURE	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(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

## 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
NARDA	Magnetic field tester	2300/90.10	B-0137	2021/12/22	2022/12/21
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
Radiated Emission Test Software: e3 19821b (V9)					
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
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/01/19	2023/01/18
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/10/26	2022/10/25
Unknown	RF Coaxial Cable	No.31	RF-01	Each time	
Unknown	RF Cable	Unknown	1	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) (3) &§2.1093 – RF EXPOSURE****Applicable Standard**

According to FCC §2.1093 and §1.1307(b) (3), 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.

According to KDB 447498 D04 Interim General RF Exposure Guidance

**SAR-Based Exemption:**

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum timeaveraged power or maximum time-averaged ERP, whichever is greater.

Per § 1.1307(b)(3)(i)(B), for single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold  $P_{th}$  (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive).  $P_{th}$  is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left( \frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

*d = the separation distance (cm);*

**For worst case:**

**For BLE mode:**

Exemption limit:

For  $f=2.48\text{GHz}$ ,  $d=0.5\text{cm}$ , the  $P_{th}=2.72\text{mW}$

The higher of the available maximum time-averaged power or effective radiated power (ERP):

The antenna gain is  $2.1\text{dBi}(-0.05\text{dBd})$ ,  $0\text{dBd}=2.15\text{dBi}$

The maximum tune-up conducted power is  $1.5\text{dBm}$  ( $1.41\text{ mW}$ ), which less than  $2.72\text{ mW}@2480\text{MHz}$  exemption limit

**So the stand-alone SAR evaluation can be exempted.**

For **Wi-Fi mode**, please refer to the SAR report: SZNS220425-16463E-20.

## 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<sup>4,5</sup>**

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:

#### **BLE mode:**

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 2.1Bi, the maximum tune-up conducted power is 1.5dBm

The maximum EIRP is 3.6dBm (2.29mW), which less than 3.94 mW@2480MHz exemption limit

**So the stand-alone SAR test is not required.**

For **Wi-Fi mode**, please refer to the SAR report: SZNS220425-16463E-20.

## § 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 use 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 an internal antenna arrangement which was permanently attached for BLE and Wi-Fi, the antenna gain is 2.1dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Type	Antenna Gain	Impedance
Integral	2.1dBi	50 Ω

**Result: Compliant**

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

### Applicable Standard

FCC § 15.207 (a) & RSS-GEN §8.8

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50  $\mu$ H / 50  $\Omega$  line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

**Table 4 - AC Power Lines Conducted Emission Limits**

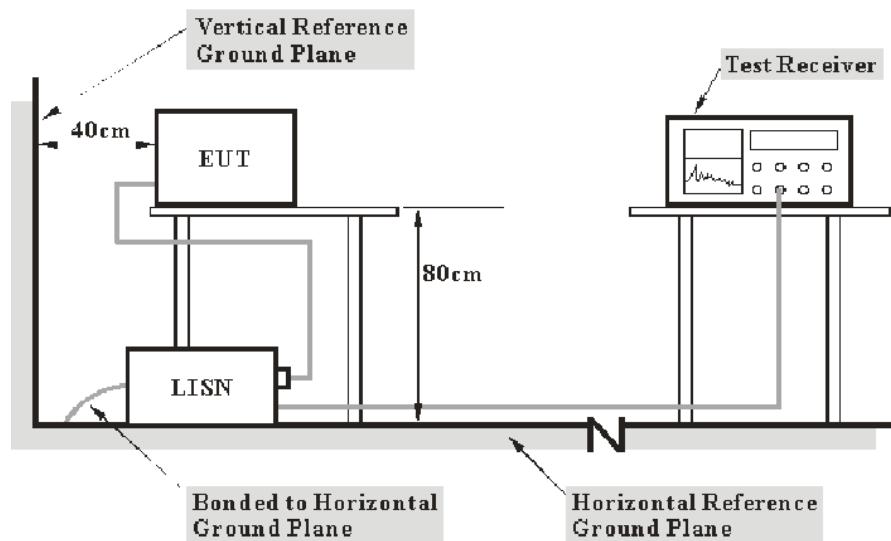
Frequency range (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56 <sup>1</sup>	56 to 46 <sup>1</sup>
0.5 – 5	56	46
5 – 30	60	50

**Note 1:** The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

- (a) Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.
- (b) Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

## 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 & RSS-247/RSS-Gen limits.

The spacing between the peripherals was 10 cm.

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.

## Corrected 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, an Over limit of -7 dB means the emission is 7 dB below the limit. The equation for calculation is as follows:

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

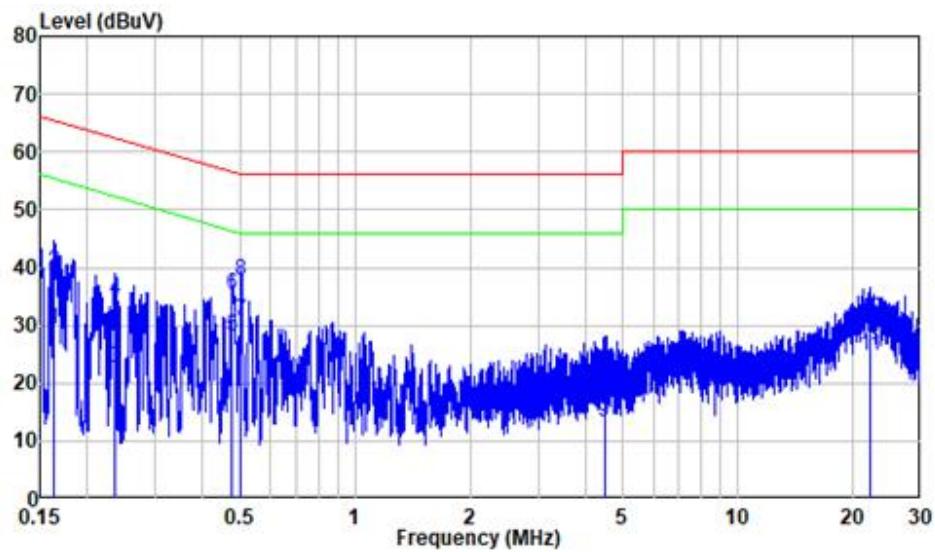
## Test Data

### Environmental Conditions

<b>Temperature:</b>	23°C
<b>Relative Humidity:</b>	55%
<b>ATM Pressure:</b>	101.0 kPa

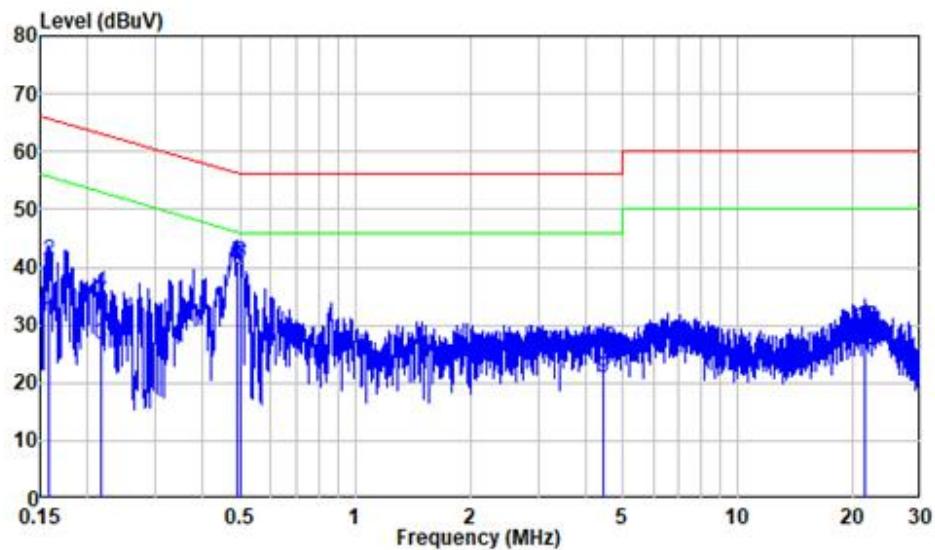
*The testing was performed by Jason Liu on 2022-06-14.*

*EUT operation mode: Transmitting (the worst case is 802.11g mode, low channel)*

**AC 120V/60 Hz, Line**

Site : Shielding Room  
Condition: Line  
Mode : 2.4G WIFI  
Model : Model 514  
Power : AC 120V 60Hz

Freq	Factor	Read		Limit		Over Limit	Remark
		MHz	dB	dBuV	dBuV		
1	0.163	9.80	19.60	29.40	55.30	-25.90	Average
2	0.163	9.80	29.47	39.27	65.30	-26.03	QP
3	0.235	9.80	12.74	22.54	52.26	-29.72	Average
4	0.235	9.80	24.70	34.50	62.26	-27.76	QP
5	0.476	9.80	18.15	27.95	46.40	-18.45	Average
6	0.476	9.80	25.59	35.39	56.40	-21.01	QP
7	0.501	9.80	20.94	30.74	46.00	-15.26	Average
8	0.501	9.80	27.95	37.75	56.00	-18.25	QP
9	4.469	9.84	3.43	13.27	46.00	-32.73	Average
10	4.469	9.84	12.17	22.01	56.00	-33.99	QP
11	22.077	10.02	14.79	24.81	50.00	-25.19	Average
12	22.077	10.02	20.99	31.01	60.00	-28.99	QP

**AC 120V/60 Hz, Neutral**

Site : Shielding Room  
Condition: Neutral  
Mode : 2.4G WIFI  
Model : Model 514  
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Limit Level	Over Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.158	9.80	21.05	30.85	55.57	-24.72	Average
2	0.158	9.80	31.30	41.10	65.57	-24.47	QP
3	0.217	9.80	16.83	26.63	52.92	-26.29	Average
4	0.217	9.80	25.70	35.50	62.92	-27.42	QP
5	0.489	9.80	31.00	40.80	46.19	-5.39	Average
6	0.489	9.80	29.73	39.53	56.19	-16.66	QP
7	0.503	9.80	30.30	40.10	46.00	-5.90	Average
8	0.503	9.80	30.86	40.66	56.00	-15.34	QP
9	4.460	9.86	10.90	20.76	46.00	-25.24	Average
10	4.460	9.86	16.11	25.97	56.00	-30.03	QP
11	21.401	10.11	13.37	23.48	50.00	-26.52	Average
12	21.401	10.11	19.45	29.56	60.00	-30.44	QP

## §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;

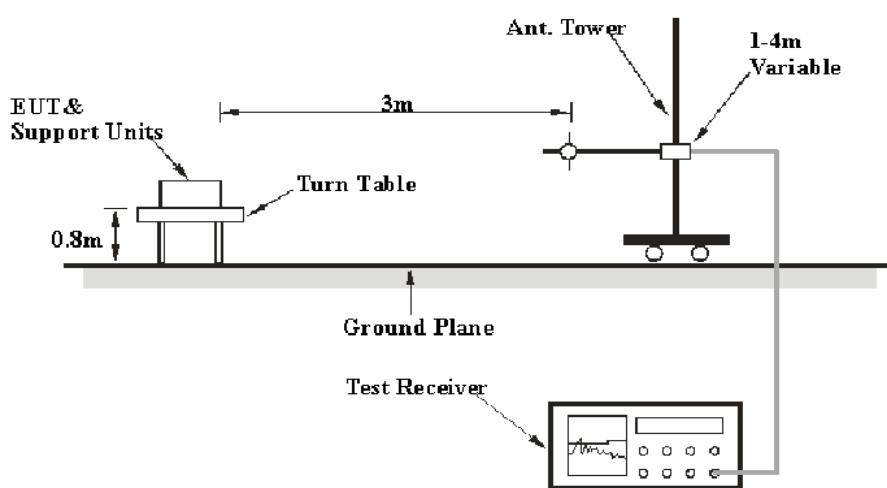
According to RSS-GEN § 8.10 & RSS-247 § 5.5

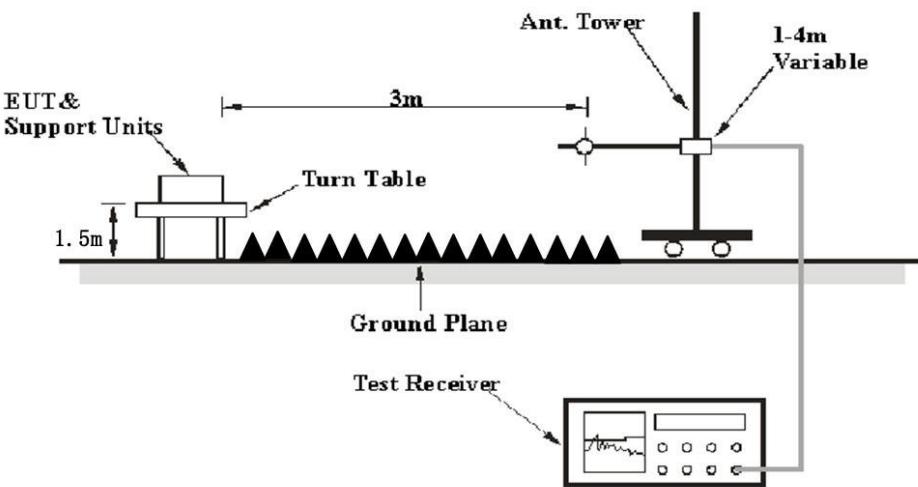
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to 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 <sup>Note 1</sup>	/	Average
	1MHz	>1/T <sup>Note 2</sup>	/	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.

## 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 Data

### Environmental Conditions

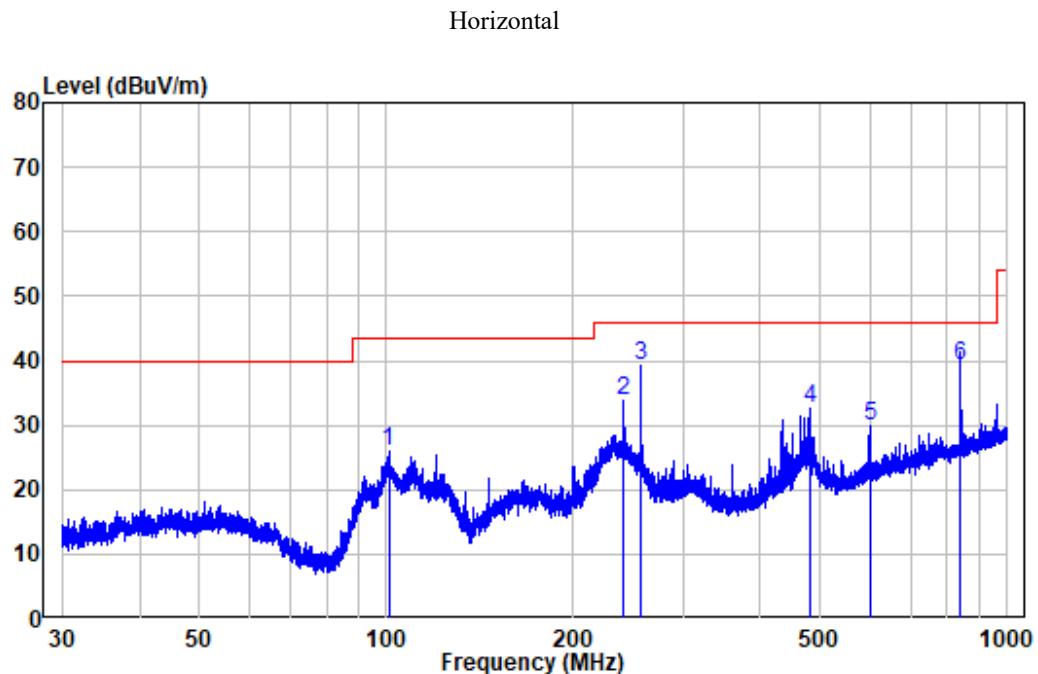
<b>Temperature:</b>	25~28 °C
<b>Relative Humidity:</b>	55~61%
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Level Li on 2022-06-17 for below 1GHz, Zeki Ma on 2022-07-06 for above 1GHz.*

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

**30 MHz~1 GHz:** (worst case is 802.11g mode, low channel)

*Note: When the test result of Peak was more than 6dB below the limit of QP, just the Peak value was recorded.*



Site : chamber

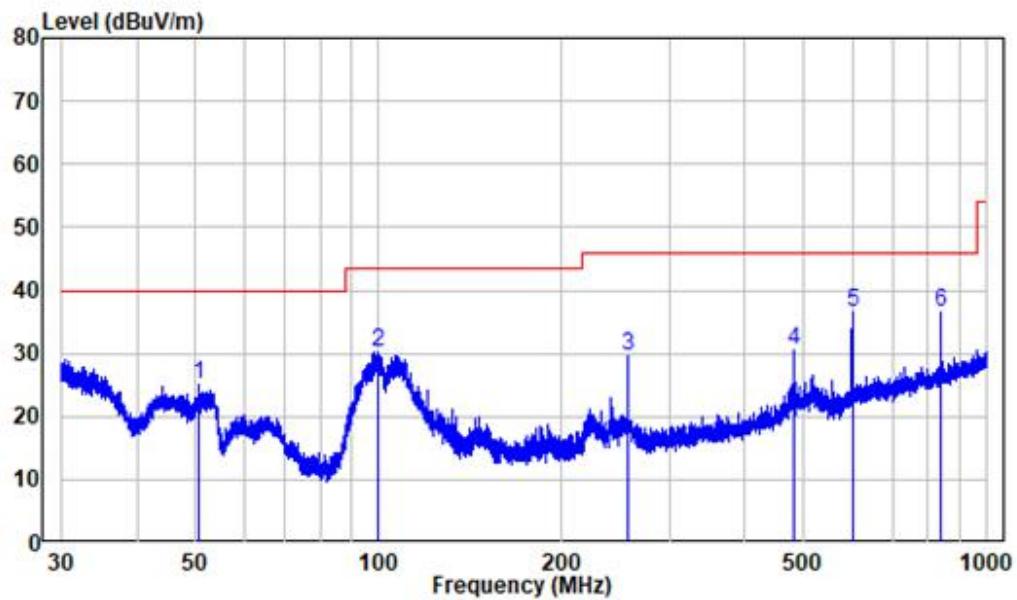
Condition: 3m HORIZONTAL

Job No. : SZNS220425-16463E-RF

Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	100.801	-11.71	37.52	25.81	43.50	-17.69	Peak
2	241.253	-10.82	44.66	33.84	46.00	-12.16	Peak
3	256.409	-10.60	49.92	39.32	46.00	-6.68	Peak
4	479.686	-5.03	37.56	32.53	46.00	-13.47	Peak
5	600.110	-2.43	32.26	29.83	46.00	-16.17	Peak
6	840.654	0.28	39.11	39.39	46.00	-6.61	QP

Vertical



Site : chamber

Condition: 3m VERTICAL

Job No. : SZNS220425-16463E-RF

Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Limit Level	Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	50.431	-9.92	35.01	25.09	40.00	-14.91	Peak
2	100.009	-11.80	42.00	30.20	43.50	-13.30	Peak
3	256.971	-10.60	40.04	29.44	46.00	-16.56	Peak
4	480.107	-5.00	35.56	30.56	46.00	-15.44	Peak
5	600.110	-2.43	39.06	36.63	46.00	-9.37	Peak
6	839.918	0.27	36.17	36.44	46.00	-9.56	Peak

**1 GHz-25 GHz:****Wi-Fi:**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)					
	Reading (dB $\mu$ V)	PK/QP/AV		Height (m)	Polar (H/V)									
<b>802.11b Mode</b>														
Low Channel (2412 MHz)														
2310	68.42	PK	266	1.6	H	-7.24	61.18	74	-12.82					
2310	53.73	AV	266	1.6	H	-7.24	46.49	54	-7.51					
2310	68.31	PK	76	1.8	V	-7.24	61.07	74	-12.93					
2310	53.64	AV	76	1.8	V	-7.24	46.40	54	-7.60					
2390	69.45	PK	6	1.4	H	-7.22	62.23	74	-11.77					
2390	54.48	AV	6	1.4	H	-7.22	47.26	54	-6.74					
2390	69.33	PK	252	1.1	V	-7.22	62.11	74	-11.89					
2390	54.40	AV	252	1.1	V	-7.22	47.18	54	-6.82					
4824	54.67	PK	96	1.2	H	-3.53	51.14	74	-22.86					
4824	54.85	PK	298	1	V	-3.53	51.32	74	-22.68					
Middle Channel (2437MHz)														
4874	54.71	PK	140	1.8	H	-3.41	51.3	74	-22.70					
4874	54.89	PK	251	2.1	V	-3.41	51.48	74	-22.52					
High Channel (2462 MHz)														
2483.5	69.87	PK	256	1.4	H	-7.2	62.67	74	-11.33					
2483.5	55.21	AV	256	1.4	H	-7.2	48.01	54	-5.99					
2483.5	69.76	PK	83	1.4	V	-7.2	62.56	74	-11.44					
2483.5	55.09	AV	83	1.4	V	-7.2	47.89	54	-6.11					
2500	69.03	PK	63	2	H	-7.18	61.85	74	-12.15					
2500	54.98	AV	63	2	H	-7.18	47.8	54	-6.2					
2500	68.90	PK	46	1.7	V	-7.18	61.72	74	-12.28					
2500	54.89	AV	46	1.7	V	-7.18	47.71	54	-6.29					
4924	54.61	PK	296	1	H	-3.16	51.45	74	-22.55					
4924	55.17	PK	188	1.4	V	-3.16	52.01	74	-21.99					

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)					
	Reading (dB $\mu$ V)	PK/QP/AV		Height (m)	Polar (H/V)									
<b>802.11g Mode</b>														
Low Channel (2412 MHz)														
2310	69.85	PK	314	1.2	H	-7.24	62.61	74	-11.39					
2310	54.11	AV	314	1.2	H	-7.24	46.87	54	-7.13					
2310	69.66	PK	315	1	V	-7.24	62.42	74	-11.58					
2310	54.02	AV	315	1	V	-7.24	46.78	54	-7.22					
2390	73.95	PK	0	1.2	H	-7.22	66.73	74	-7.27					
2390	57.24	AV	0	1.2	H	-7.22	50.02	54	-3.98					
2390	71.48	PK	235	1.5	V	-7.22	64.26	74	-9.74					
2390	56.17	AV	235	1.5	V	-7.22	48.95	54	-5.05					
4824	54.93	PK	75	1.1	H	-3.53	51.40	74	-22.60					
4824	55.16	PK	260	2.5	V	-3.53	51.63	74	-22.37					
Middle Channel (2437 MHz)														
4874	54.79	PK	164	1.8	H	-3.41	51.38	74	-22.62					
4874	55.03	PK	251	2.2	V	-3.41	51.62	74	-22.38					
High Channel (2462 MHz)														
2483.5	76.02	PK	235	1.6	H	-7.2	68.82	74	-5.18					
2483.5	58.26	AV	235	1.6	H	-7.2	51.06	54	-2.94					
2483.5	73.51	PK	227	2.4	V	-7.2	66.31	74	-7.69					
2483.5	57.60	AV	227	2.4	V	-7.2	50.4	54	-3.6					
2500	70.67	PK	171	1.9	H	-7.18	63.49	74	-10.51					
2500	55.43	AV	171	1.9	H	-7.18	48.25	54	-5.75					
2500	70.56	PK	243	1.1	V	-7.18	63.38	74	-10.62					
2500	55.38	AV	243	1.1	V	-7.18	48.2	54	-5.8					
4924	54.20	PK	197	1.1	H	-3.16	51.04	74	-22.96					
4924	54.41	PK	205	2.2	V	-3.16	51.25	74	-22.75					

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)					
	Reading (dB $\mu$ V)	PK/QP/AV		Height (m)	Polar (H/V)									
<b>802.11n20 Mode</b>														
Low Channel (2412 MHz)														
2310	70.00	PK	244	2.4	H	-7.24	62.76	74	-11.24					
2310	54.24	AV	244	2.4	H	-7.24	47.00	54	-7.00					
2310	69.86	PK	206	2.4	V	-7.24	62.62	74	-11.38					
2310	54.13	AV	206	2.4	V	-7.24	46.89	54	-7.11					
2390	74.40	PK	179	2.1	H	-7.22	67.18	74	-6.82					
2390	57.48	AV	179	2.1	H	-7.22	50.26	54	-3.74					
2390	72.56	PK	40	1.3	V	-7.22	65.34	74	-8.66					
2390	56.52	AV	40	1.3	V	-7.22	49.30	54	-4.70					
4824	55.06	PK	203	1.9	H	-3.53	51.53	74	-22.47					
4824	55.35	PK	165	2.5	V	-3.53	51.82	74	-22.18					
Middle Channel (2437MHz)														
4874	55.06	PK	130	2.2	H	-3.41	51.65	74	-22.35					
4874	55.22	PK	335	2.4	V	-3.41	51.81	74	-22.19					
High Channel (2462 MHz)														
2483.5	76.38	PK	297	2	H	-7.2	69.18	74	-4.82					
2483.5	58.44	AV	297	2	H	-7.2	51.24	54	-2.76					
2483.5	73.69	PK	21	1.1	V	-7.2	66.49	74	-7.51					
2483.5	57.75	AV	21	1.1	V	-7.2	50.55	54	-3.45					
2500	70.76	PK	270	2.1	H	-7.18	63.58	74	-10.42					
2500	55.50	AV	270	2.1	H	-7.18	48.32	54	-5.68					
2500	70.64	PK	336	1.9	V	-7.18	63.46	74	-10.54					
2500	55.39	AV	336	1.9	V	-7.18	48.21	54	-5.79					
4924	54.49	PK	161	2.1	H	-3.16	51.33	74	-22.67					
4924	54.75	PK	21	2	V	-3.16	51.59	74	-22.41					

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)					
	Reading (dB $\mu$ V)	PK/QP/AV		Height (m)	Polar (H/V)									
<b>802.11n40 Mode</b>														
Low Channel (2422 MHz)														
2310	70.15	PK	171	1.1	H	-7.24	62.91	74	-11.09					
2310	54.56	AV	171	1.1	H	-7.24	47.32	54	-6.68					
2310	70.02	PK	262	1.9	V	-7.24	62.78	74	-11.22					
2310	54.43	AV	262	1.9	V	-7.24	47.19	54	-6.81					
2390	77.41	PK	128	2	H	-7.22	70.19	74	-3.81					
2390	59.25	AV	128	2	H	-7.22	52.03	54	-1.97					
2390	75.35	PK	270	2	V	-7.22	68.13	74	-5.87					
2390	58.22	AV	270	2	V	-7.22	51.00	54	-3.00					
4844	54.71	PK	32	2	H	-3.54	51.17	74	-22.83					
4844	54.94	PK	240	1.1	V	-3.54	51.40	74	-22.60					
Middle Channel (2437MHz)														
4874	55.13	PK	180	1.6	H	-3.41	51.72	74	-22.28					
4874	55.36	PK	39	1.6	V	-3.41	51.95	74	-22.05					
High Channel (2452 MHz)														
2483.5	76.48	PK	59	1.5	H	-7.2	69.28	74	-4.72					
2483.5	59.85	AV	59	1.5	H	-7.2	52.65	54	-1.35					
2483.5	74.64	PK	62	1.4	V	-7.2	67.44	74	-6.56					
2483.5	58.56	AV	62	1.4	V	-7.2	51.36	54	-2.64					
2500	70.79	PK	161	1.6	H	-7.18	63.61	74	-10.39					
2500	55.85	AV	161	1.6	H	-7.18	48.67	54	-5.33					
2500	70.67	PK	263	1.6	V	-7.18	63.49	74	-10.51					
2500	55.76	AV	263	1.6	V	-7.18	48.58	54	-5.42					
4904	55.07	PK	231	1.1	H	-3.26	51.81	74	-22.19					
4904	55.29	PK	125	1.2	V	-3.26	52.03	74	-21.97					

**BLE 1M**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
	Reading (dB $\mu$ V)	PK/QP/AV		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2310	67.94	PK	126	1	H	-7.24	60.70	74	-13.30
2310	54.51	AV	126	1	H	-7.24	47.27	54	-6.73
2310	67.78	PK	264	2.5	V	-7.24	60.54	74	-13.46
2310	54.64	AV	264	2.5	V	-7.24	47.40	54	-6.60
2390	69.96	PK	154	2.2	H	-7.22	62.74	74	-11.26
2390	55.51	AV	154	2.2	H	-7.22	48.29	54	-5.71
2390	69.10	PK	106	1.3	V	-7.22	61.88	74	-12.12
2390	55.52	AV	106	1.3	V	-7.22	48.30	54	-5.70
4804	54.30	PK	250	2.4	H	-3.51	50.79	74	-23.21
4804	54.68	PK	5	2.1	V	-3.51	51.17	74	-22.83
Middle Channel (2440 MHz)									
4880	54.77	PK	280	2.5	H	-3.37	51.4	74	-22.60
4880	54.88	PK	38	2.4	V	-3.37	51.51	74	-22.49
High Channel(2480 MHz)									
2483.5	70.06	PK	226	2.3	H	-7.2	62.86	74	-11.14
2483.5	56.12	AV	226	2.3	H	-7.2	48.92	54	-5.08
2483.5	69.35	PK	15	1.9	V	-7.2	62.15	74	-11.85
2483.5	56.10	AV	15	1.9	V	-7.2	48.9	54	-5.1
2500	68.43	PK	303	2.5	H	-7.18	61.25	74	-12.75
2500	55.94	AV	303	2.5	H	-7.18	48.76	54	-5.24
2500	69.18	PK	12	1.6	V	-7.18	62	74	-12
2500	56.04	AV	12	1.6	V	-7.18	48.86	54	-5.14
4960	54.68	PK	214	2.3	H	-3.01	51.67	74	-22.33
4960	54.41	PK	94	2.3	V	-3.01	51.4	74	-22.6

**Note:**

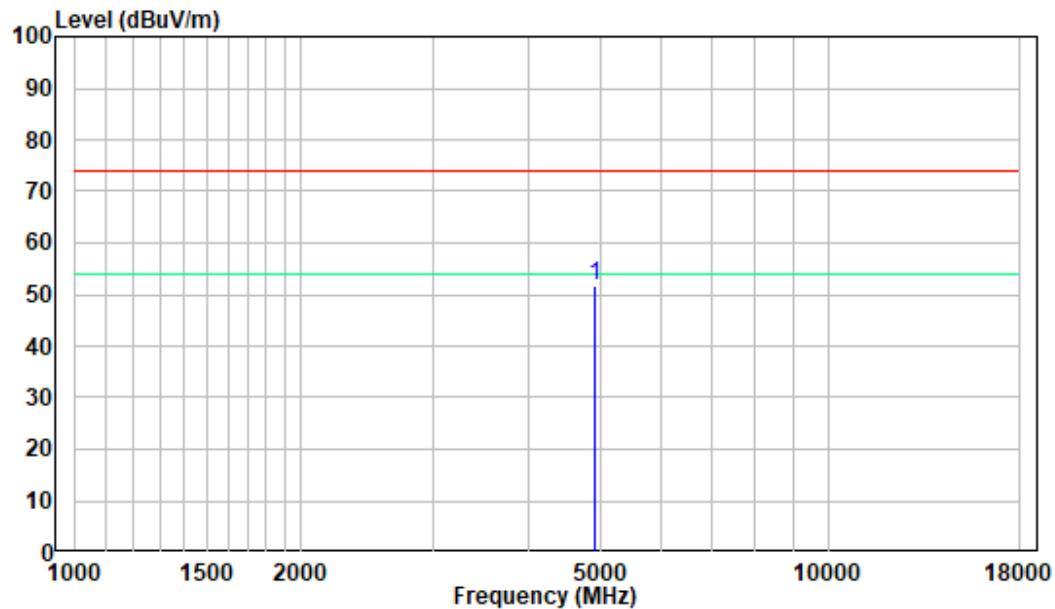
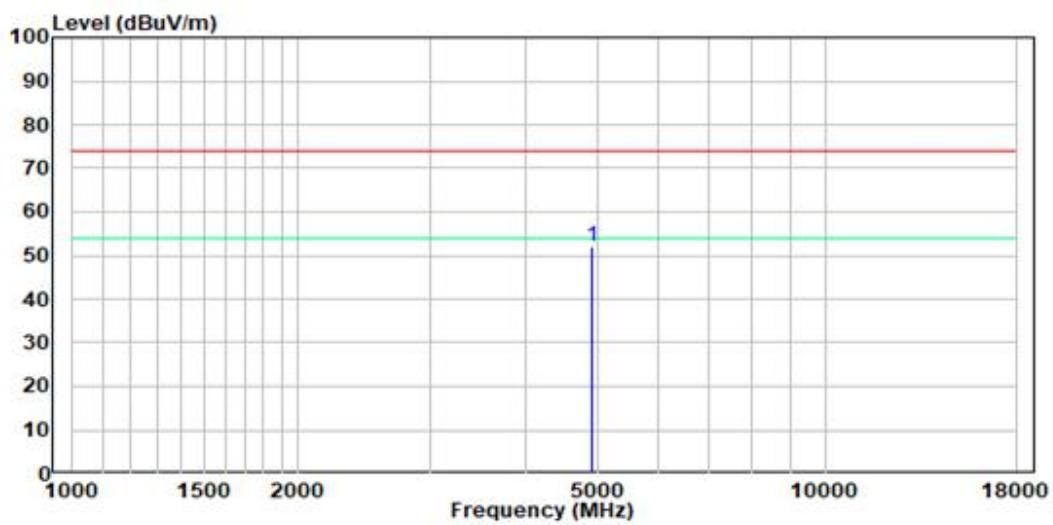
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

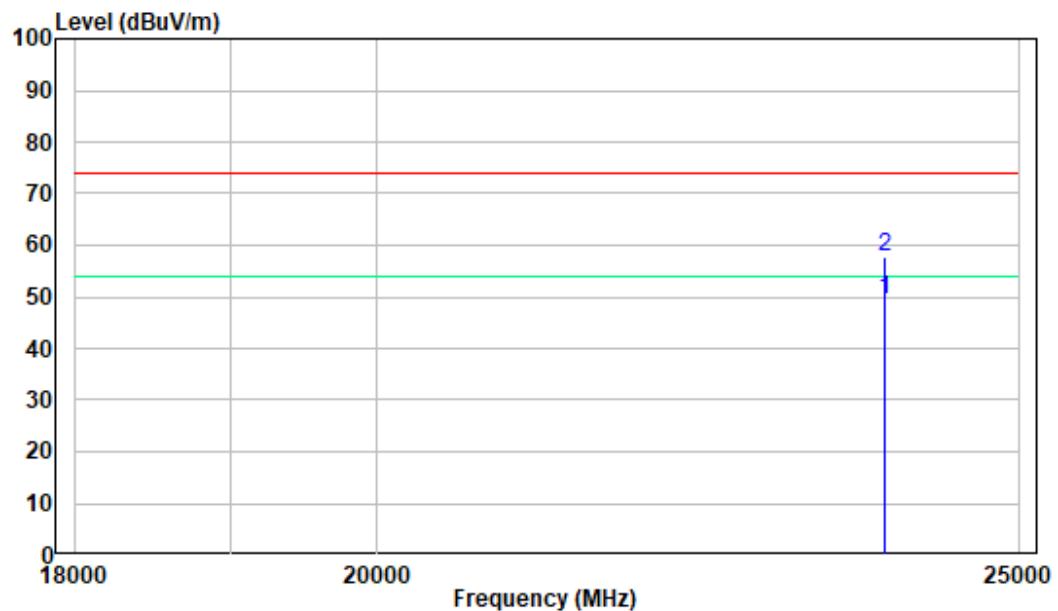
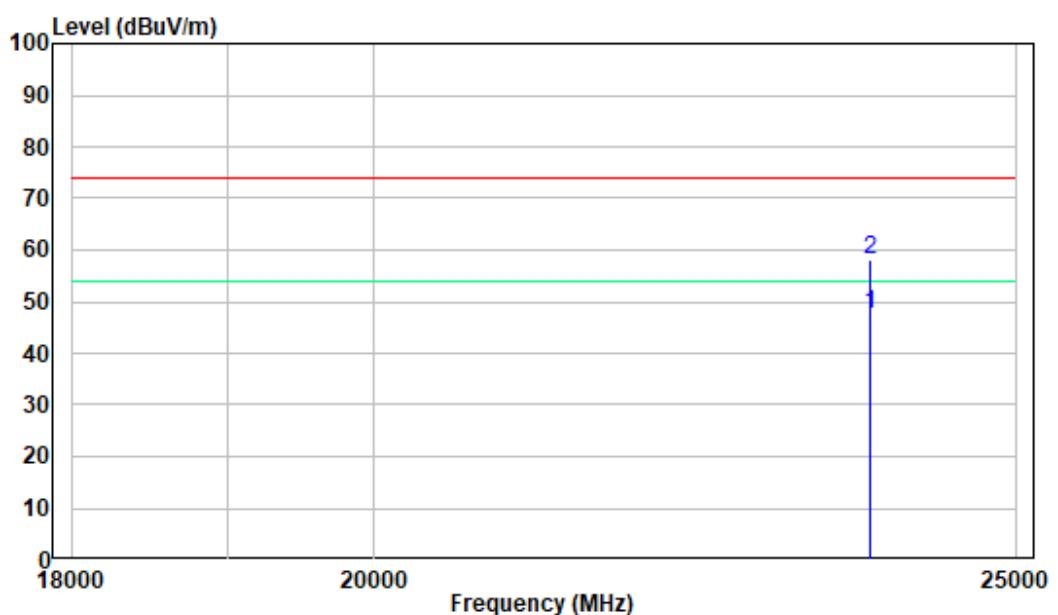
Corrected Amplitude = Corrected Factor + Reading

Margin = Corrected. Amplitude - Limit

The other spurious emission which is 20dB to the limit or in noise floor level was not recorded.

The test result of peak was less than the limit of average, so just the peak value was recorded.

**1-18 GHz:****Pre-scan for 802.11B High Channel****Horizontal****Vertical**

**18 -25GHz:****Pre-scan for 802.11B High 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:	26 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

*The testing was performed by Roger Ling on 2022-05-19.*

*EUT operation mode: Transmitting*

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

## §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.

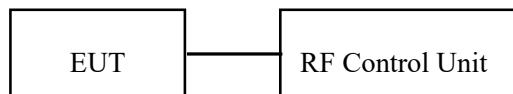
For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

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

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

For wifi mode:



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

For BLE mode:



## Test Data

### Environmental Conditions

<b>Temperature:</b>	26 °C
<b>Relative Humidity:</b>	60 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Roger Ling on 2022-05-19.*

*EUT operation mode: Transmitting*

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

## § 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

- f. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- g. 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.
- h. 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.
- i. 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.
- j. Repeat above procedures until all measured frequencies were complete.



### Test Data

#### Environmental Conditions

Temperature:	26 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

*The testing was performed by Roger Ling on 2022-05-19.*

*EUT operation mode: Transmitting*

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

## §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 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

- k. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
- l. Set the RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
- m. Set the VBW  $\geq 3 \times \text{RBW}$ .
- n. Set the span to 1.5 times the DTS bandwidth.
- o. Detector = peak.
- p. Sweep time = auto couple.
- q. Trace mode = max hold.
- r. Allow trace to fully stabilize.
- s. Use the peak marker function to determine the maximum amplitude level within the RBW.
- t. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



## Test Data

### Environmental Conditions

<b>Temperature:</b>	26 °C
<b>Relative Humidity:</b>	60 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Roger Ling on 2022-05-19.*

*EUT operation mode: Transmitting*

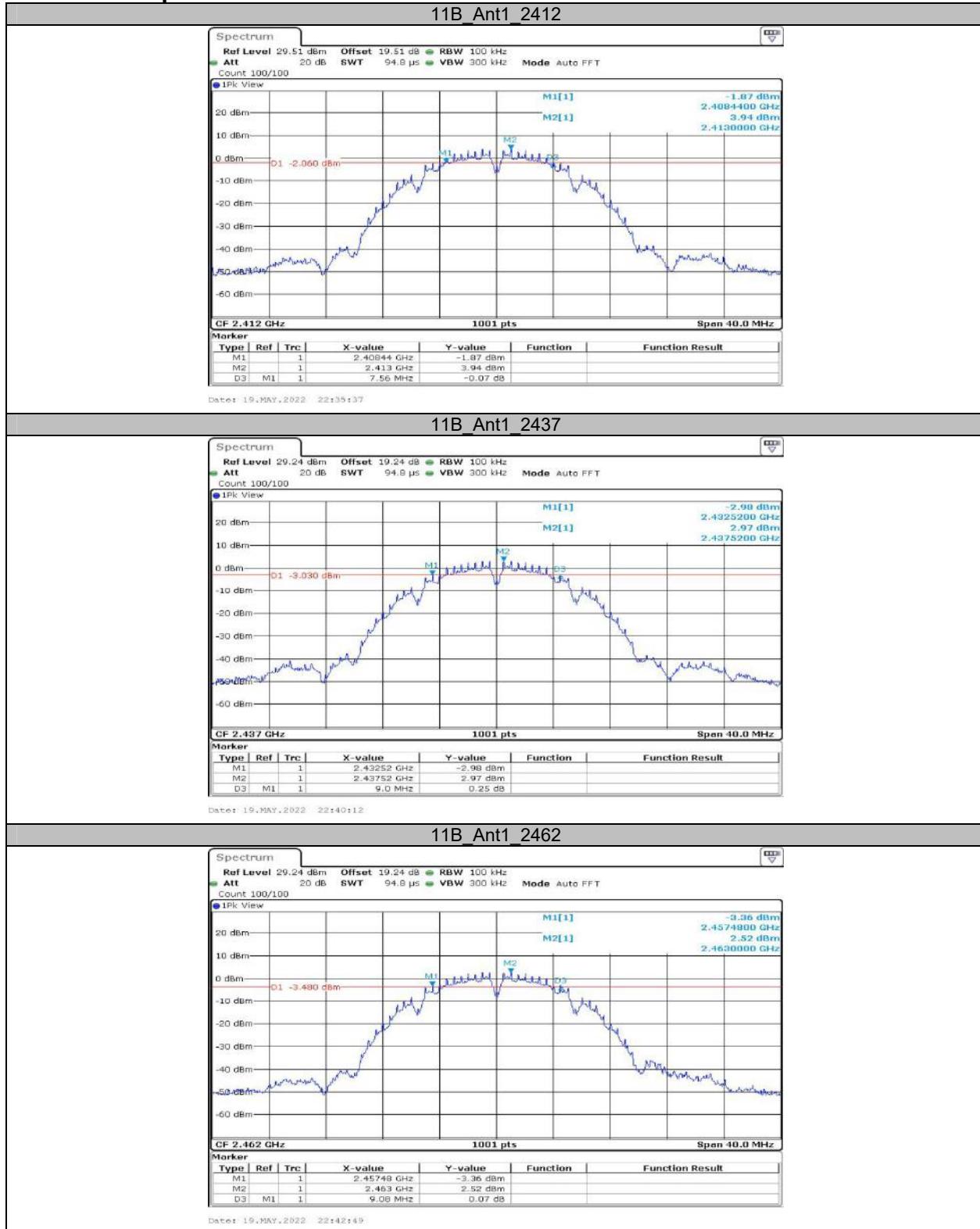
Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

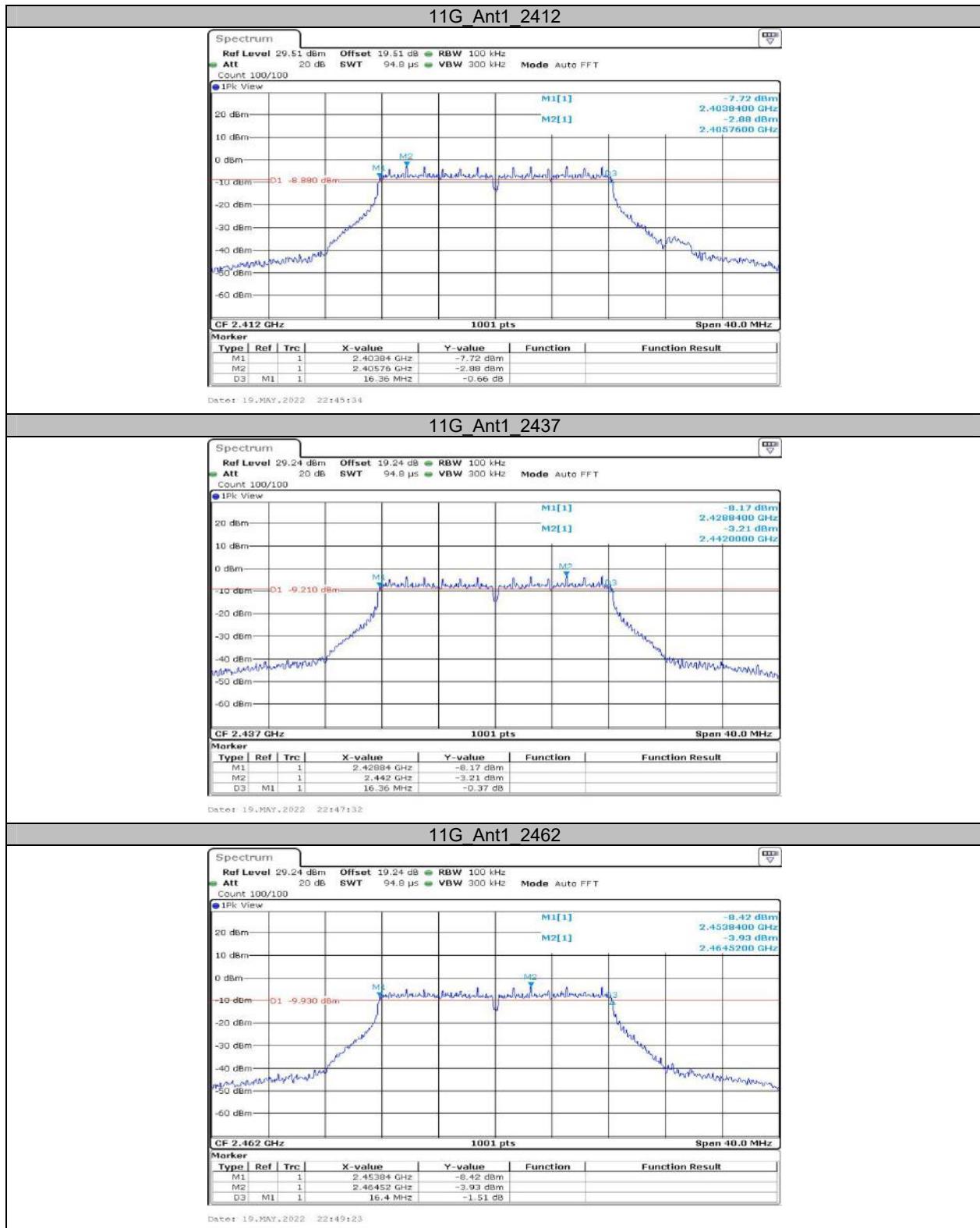
## APPENDIX Wi-Fi

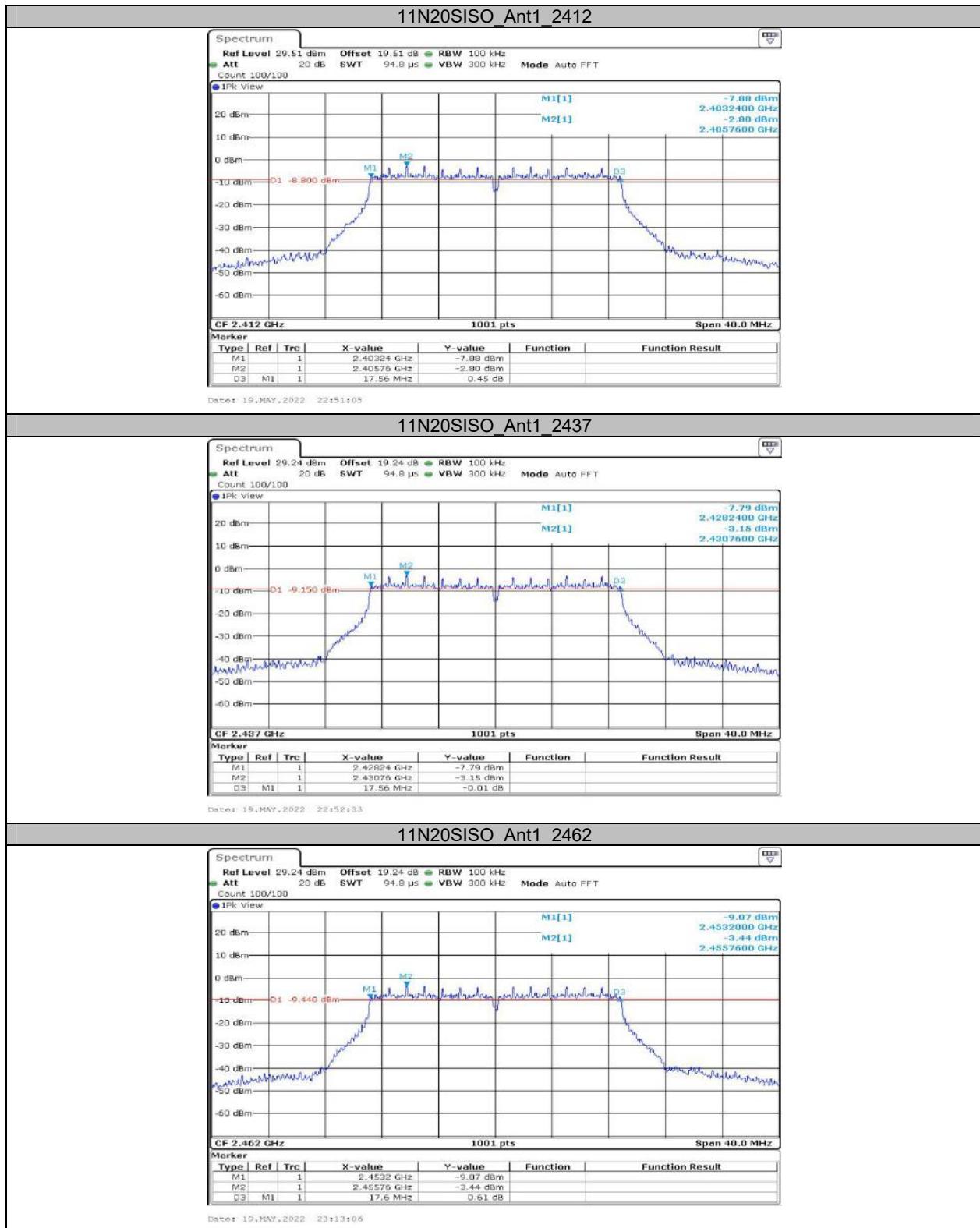
### Appendix A: DTS Bandwidth Test Result

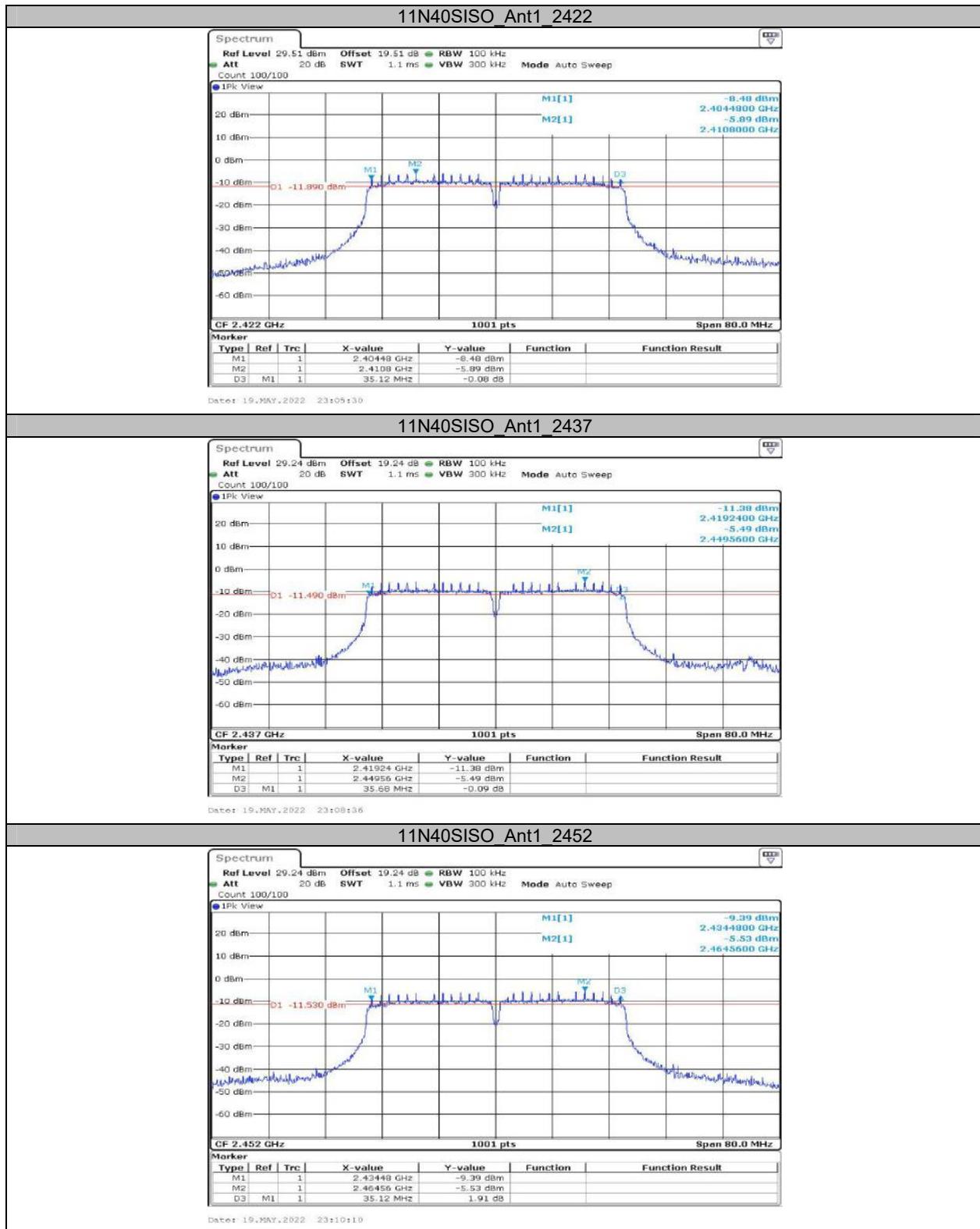
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	7.56	0.5	PASS
		2437	9.00	0.5	PASS
		2462	9.08	0.5	PASS
11G	Ant1	2412	16.36	0.5	PASS
		2437	16.36	0.5	PASS
		2462	16.40	0.5	PASS
11N20SISO	Ant1	2412	17.56	0.5	PASS
		2437	17.56	0.5	PASS
		2462	17.60	0.5	PASS
11N40SISO	Ant1	2422	35.12	0.5	PASS
		2437	35.68	0.5	PASS
		2452	35.12	0.5	PASS

## Test Graphs





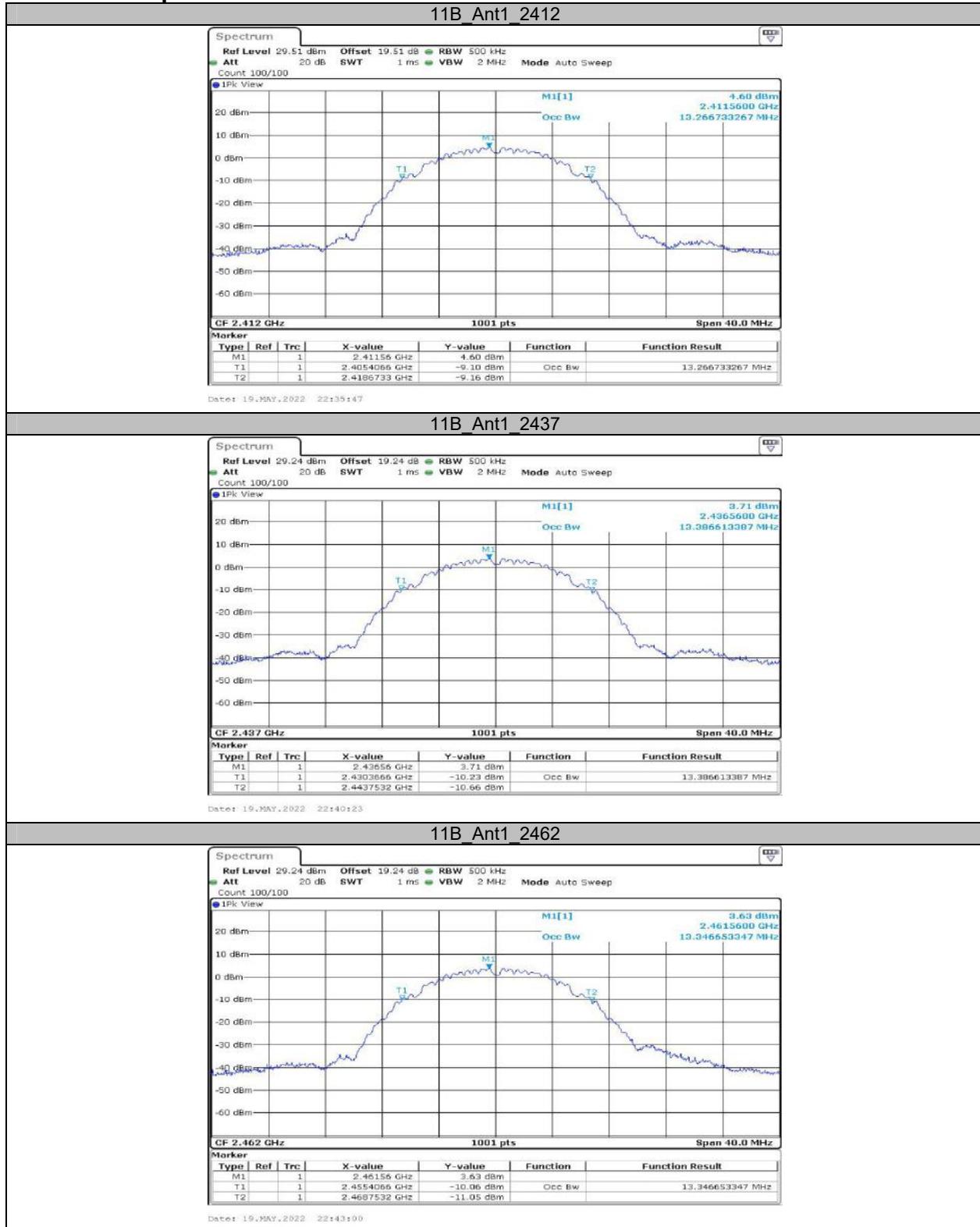


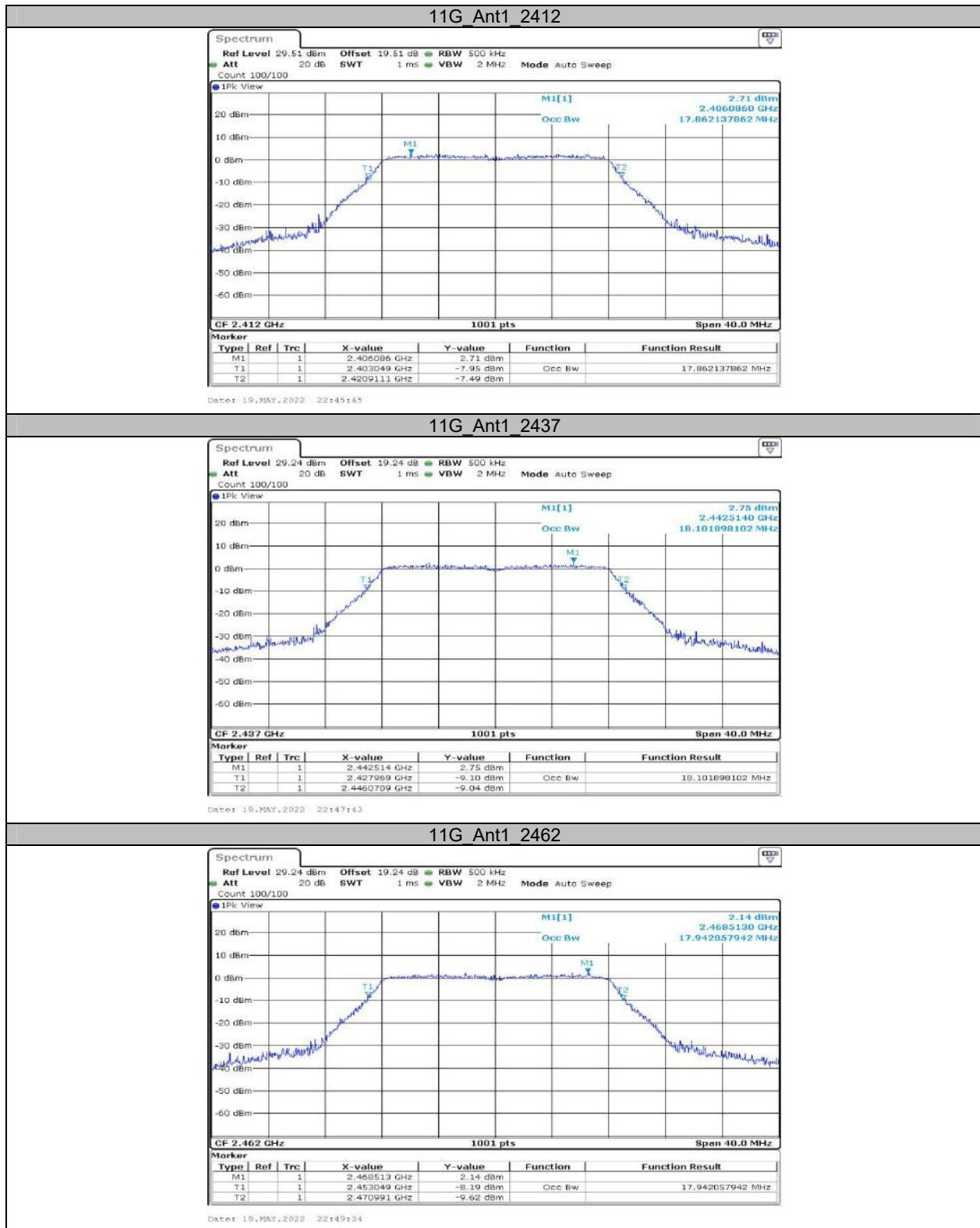


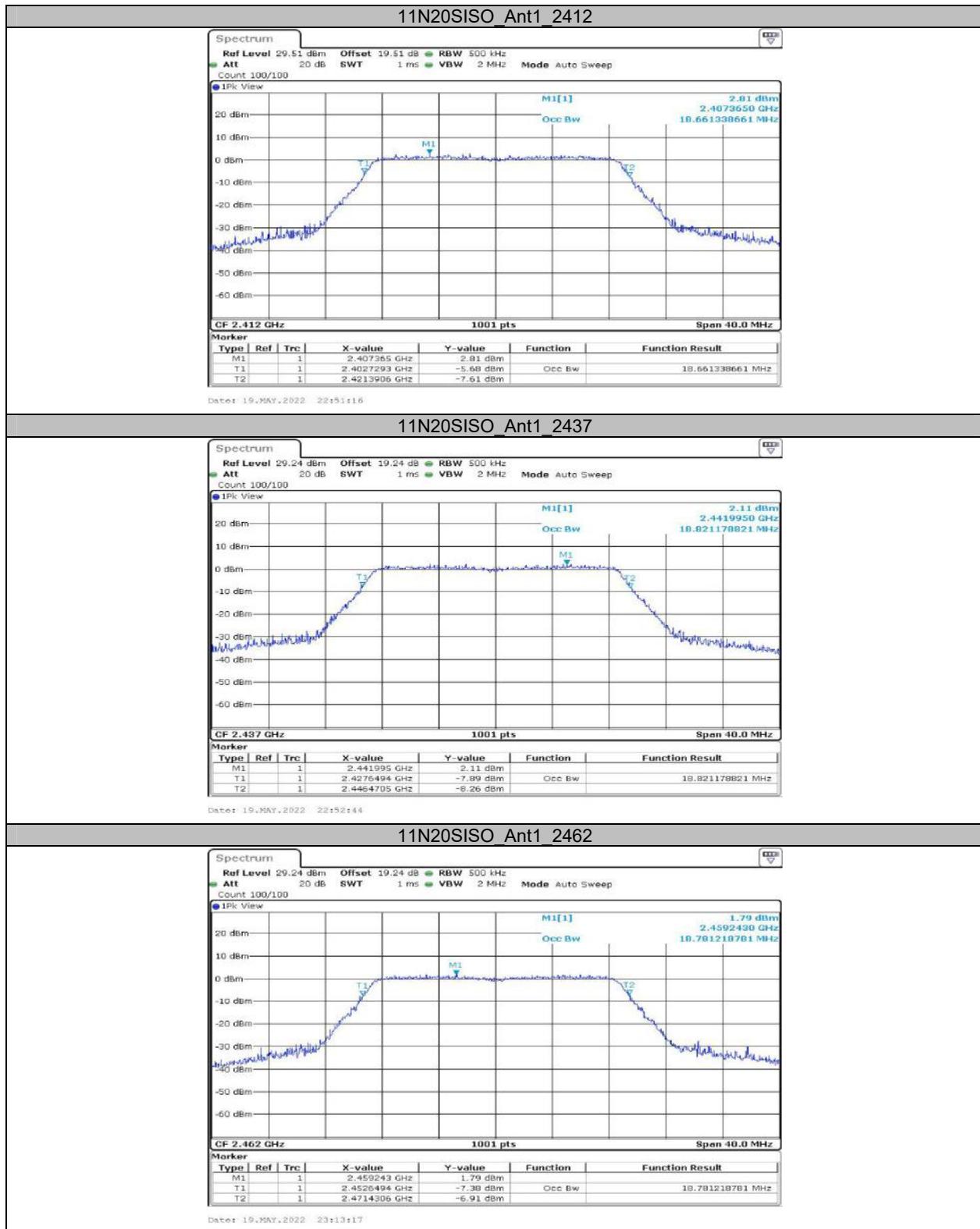
**Appendix B: Occupied Channel Bandwidth  
Test Result**

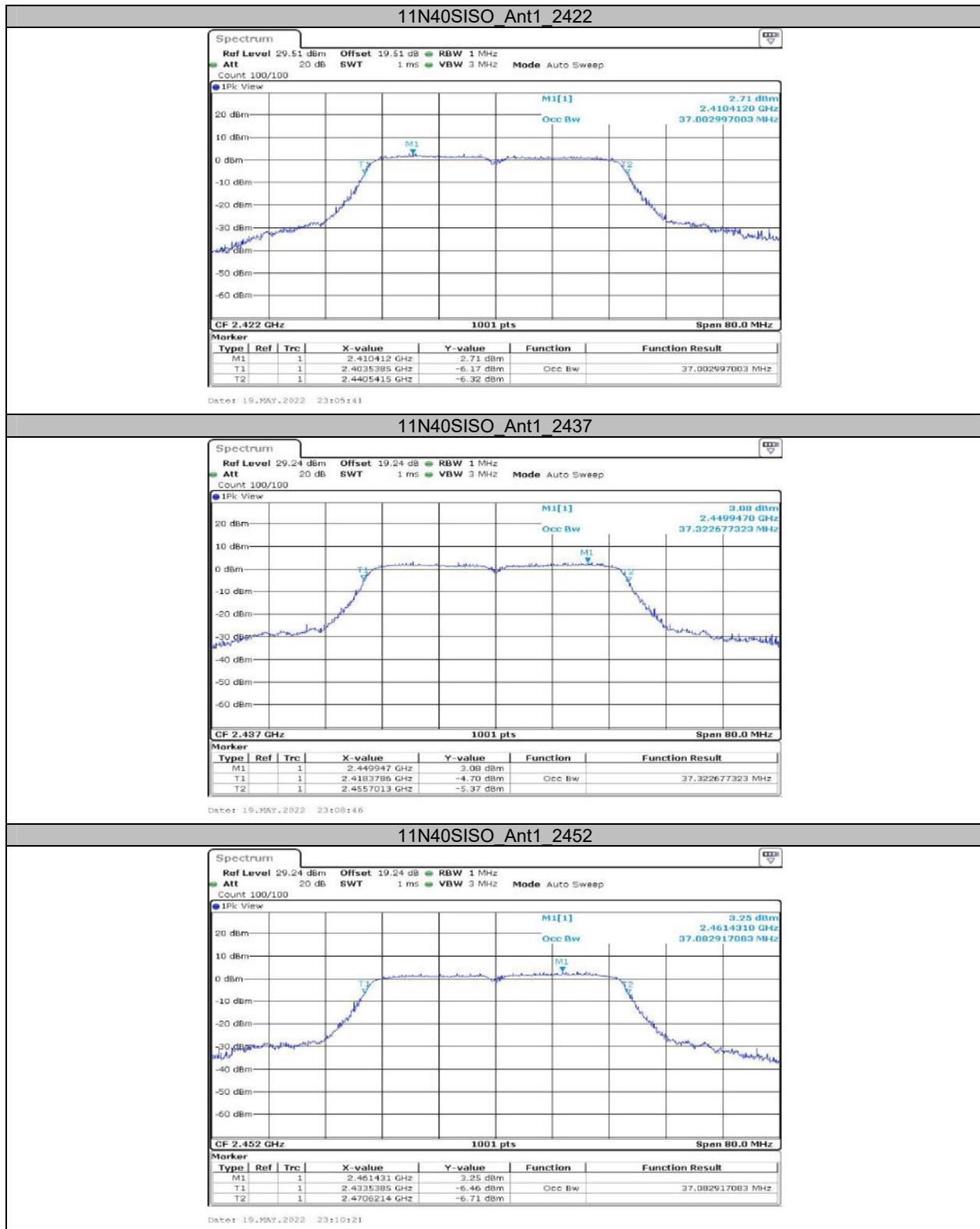
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	13.267	---	---
		2437	13.387	---	---
		2462	13.347	---	---
11G	Ant1	2412	17.862	---	---
		2437	18.102	---	---
		2462	17.942	---	---
11N20SISO	Ant1	2412	18.661	---	---
		2437	18.821	---	---
		2462	18.781	---	---
11N40SISO	Ant1	2422	37.003	---	---
		2437	37.323	---	---
		2452	37.083	---	---

## Test Graphs









## Appendix C: Maximum conducted output power

### Test Result----pk

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	15.24	≤30.00	PASS
		2437	14.61	≤30.00	PASS
		2462	14.53	≤30.00	PASS
11G	Ant1	2412	15.70	≤30.00	PASS
		2437	15.79	≤30.00	PASS
		2462	15.06	≤30.00	PASS
11N20SISO	Ant1	2412	15.74	≤30.00	PASS
		2437	15.31	≤30.00	PASS
		2462	15.19	≤30.00	PASS
11N40SISO	Ant1	2422	15.02	≤30.00	PASS
		2437	15.36	≤30.00	PASS
		2452	15.51	≤30.00	PASS

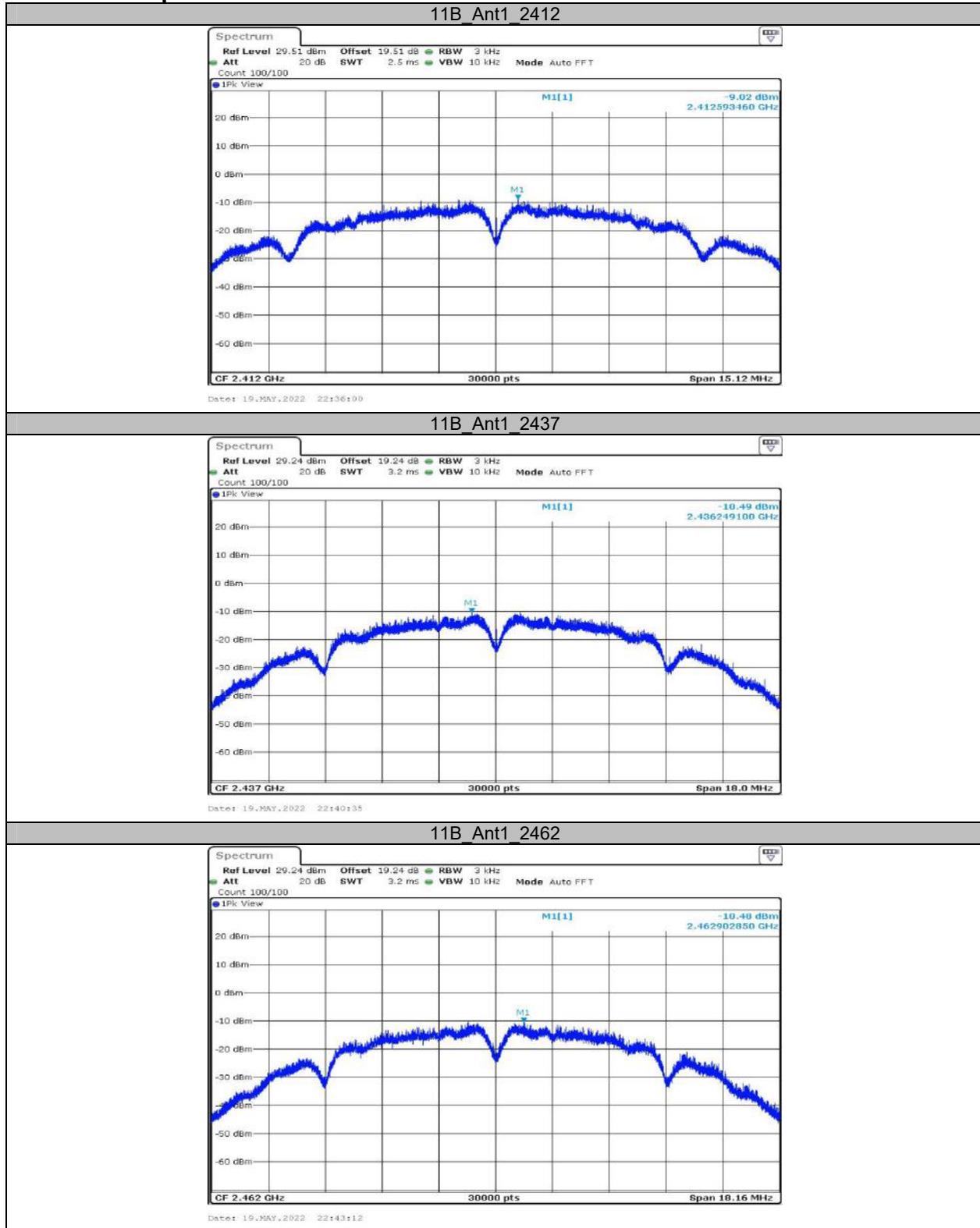
### Test Result----AV

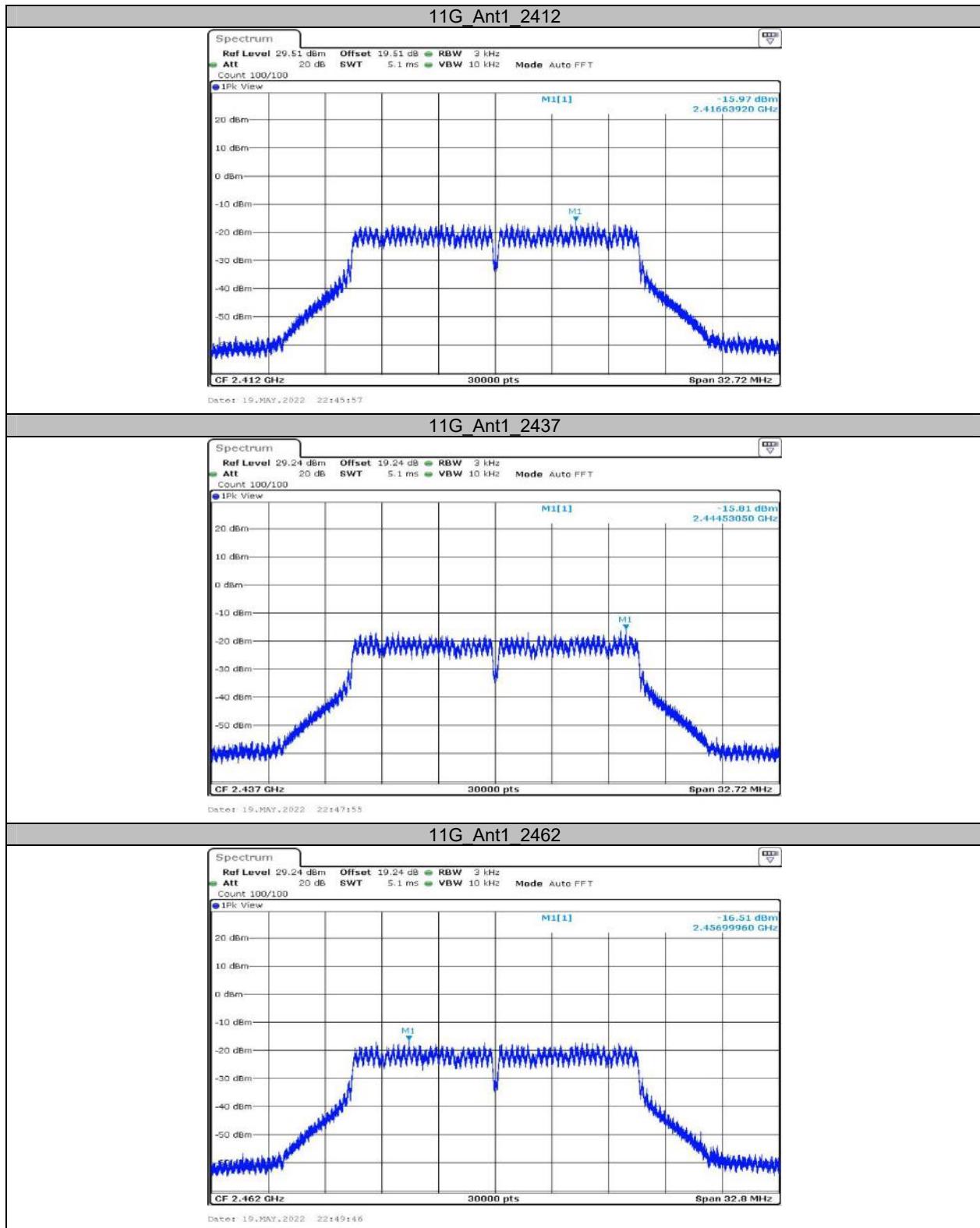
Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	12.46	≤30.00	PASS
		2437	11.91	≤30.00	PASS
		2462	12.03	≤30.00	PASS
11G	Ant1	2412	8.68	≤30.00	PASS
		2437	8.76	≤30.00	PASS
		2462	8.01	≤30.00	PASS
11N20SISO	Ant1	2412	8.69	≤30.00	PASS
		2437	8.35	≤30.00	PASS
		2462	8.22	≤30.00	PASS
11N40SISO	Ant1	2422	8.06	≤30.00	PASS
		2437	8.35	≤30.00	PASS
		2452	8.56	≤30.00	PASS

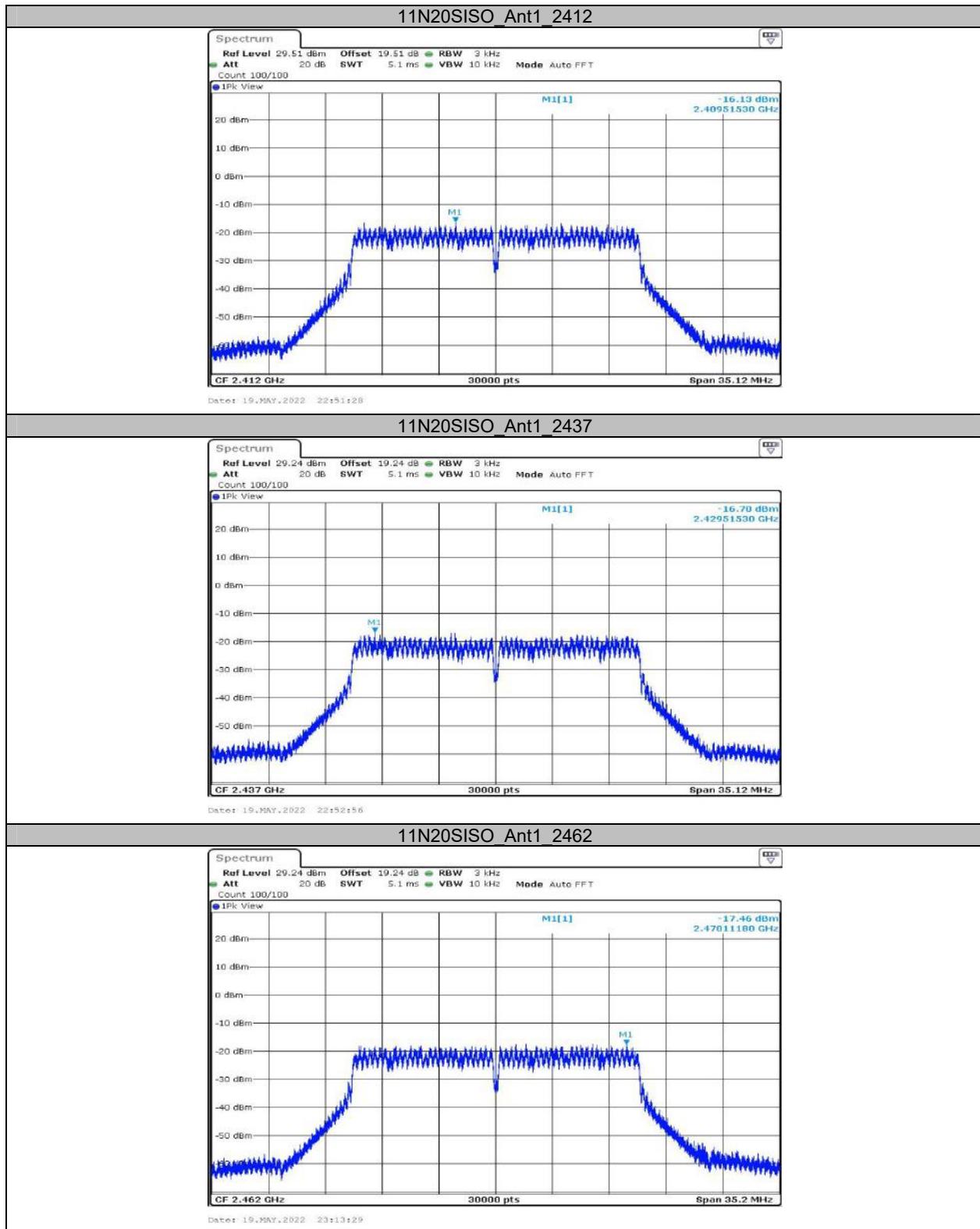
**Appendix D: Maximum power spectral density  
Test Result**

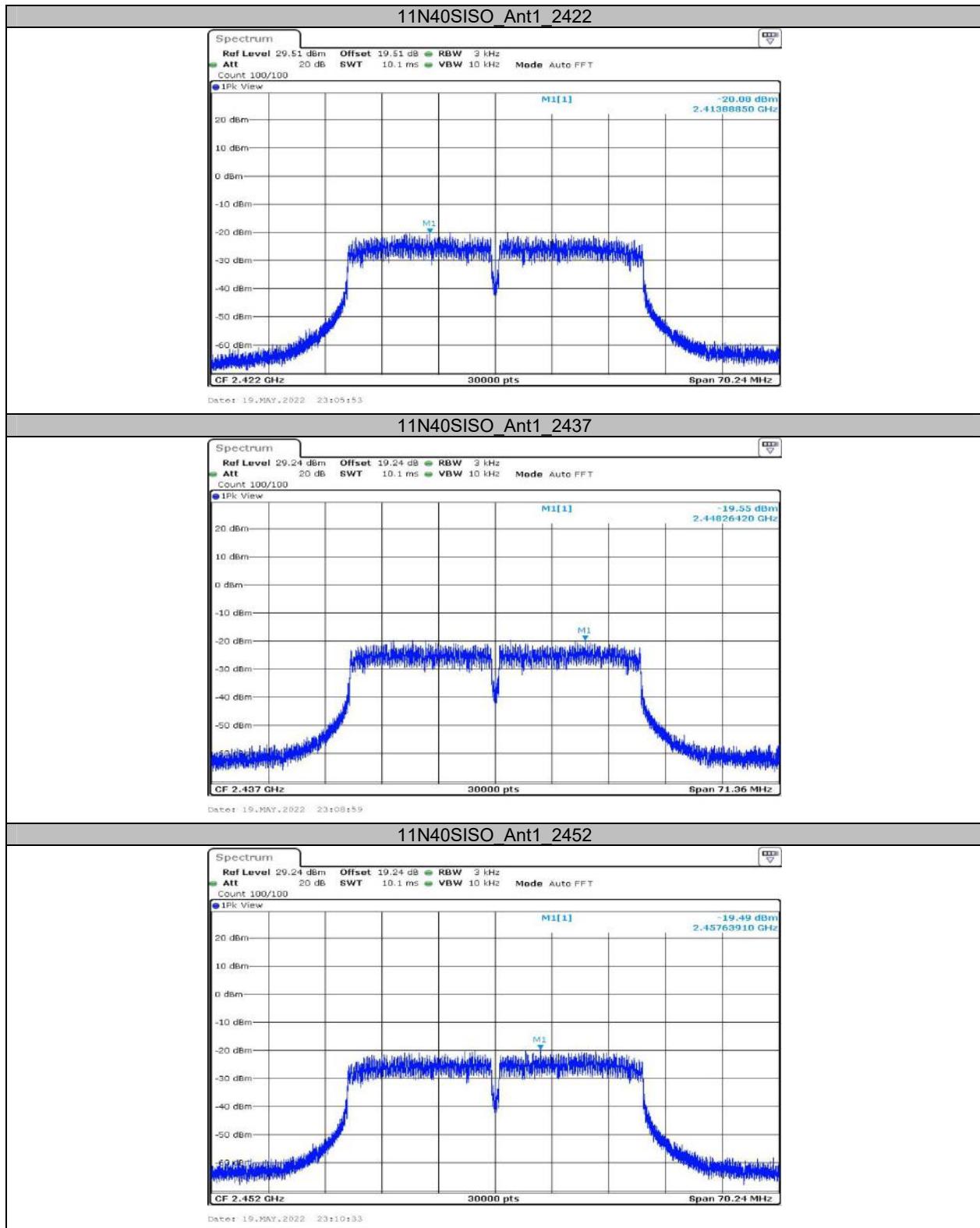
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-9.02	≤8.00	PASS
		2437	-10.49	≤8.00	PASS
		2462	-10.48	≤8.00	PASS
11G	Ant1	2412	-15.97	≤8.00	PASS
		2437	-15.81	≤8.00	PASS
		2462	-16.51	≤8.00	PASS
11N20SISO	Ant1	2412	-16.13	≤8.00	PASS
		2437	-16.7	≤8.00	PASS
		2462	-17.46	≤8.00	PASS
11N40SISO	Ant1	2422	-20.08	≤8.00	PASS
		2437	-19.55	≤8.00	PASS
		2452	-19.49	≤8.00	PASS

## Test Graphs



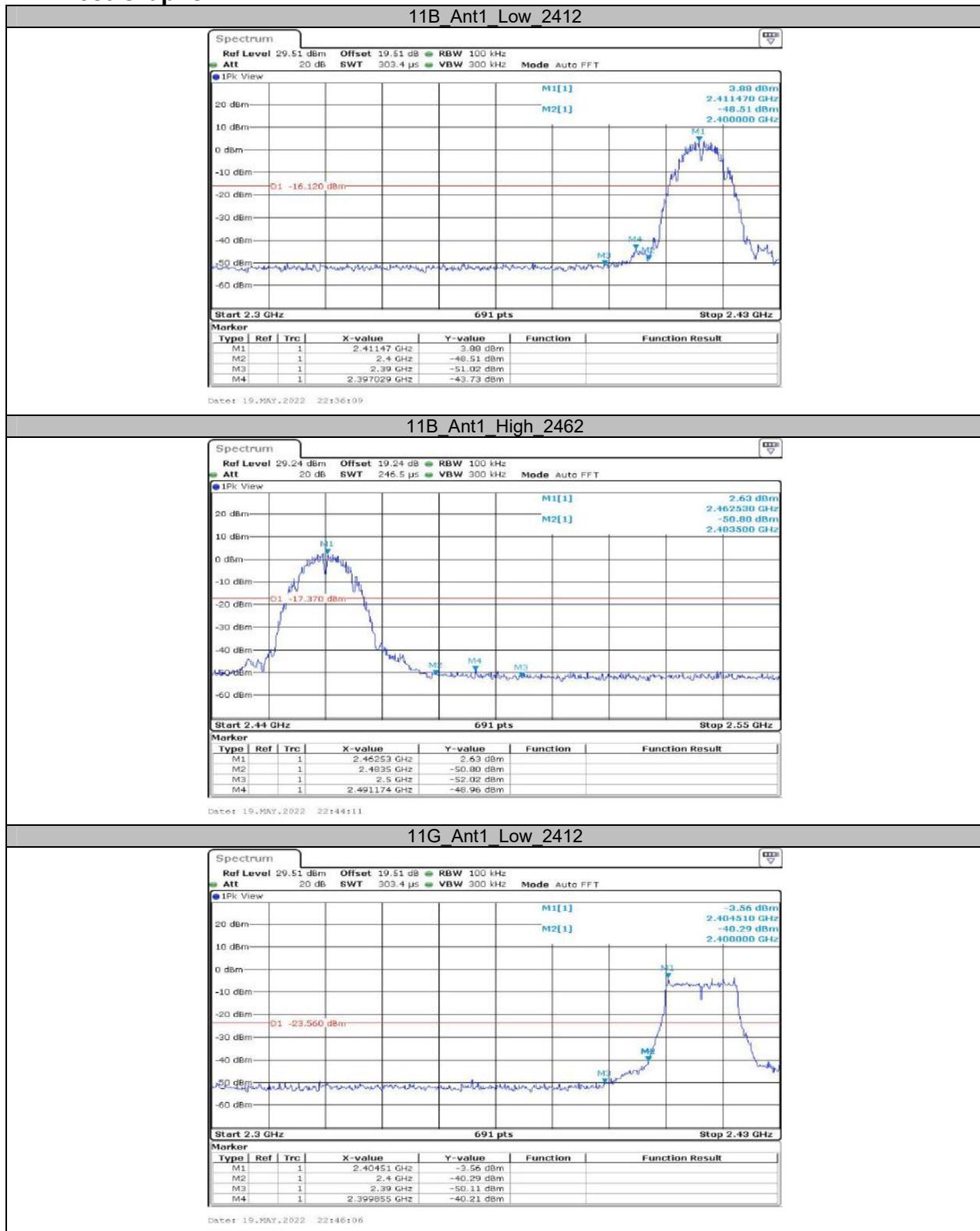


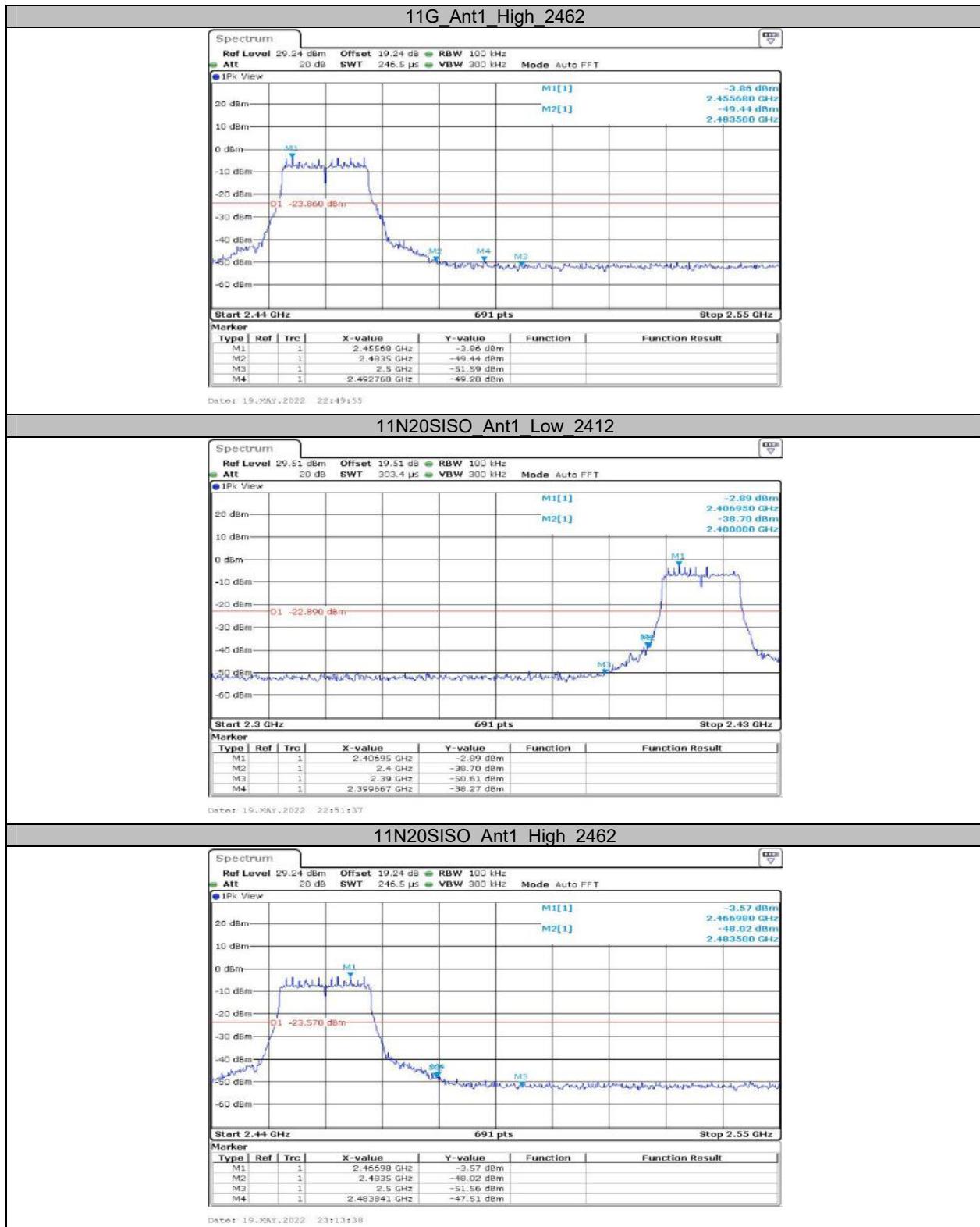


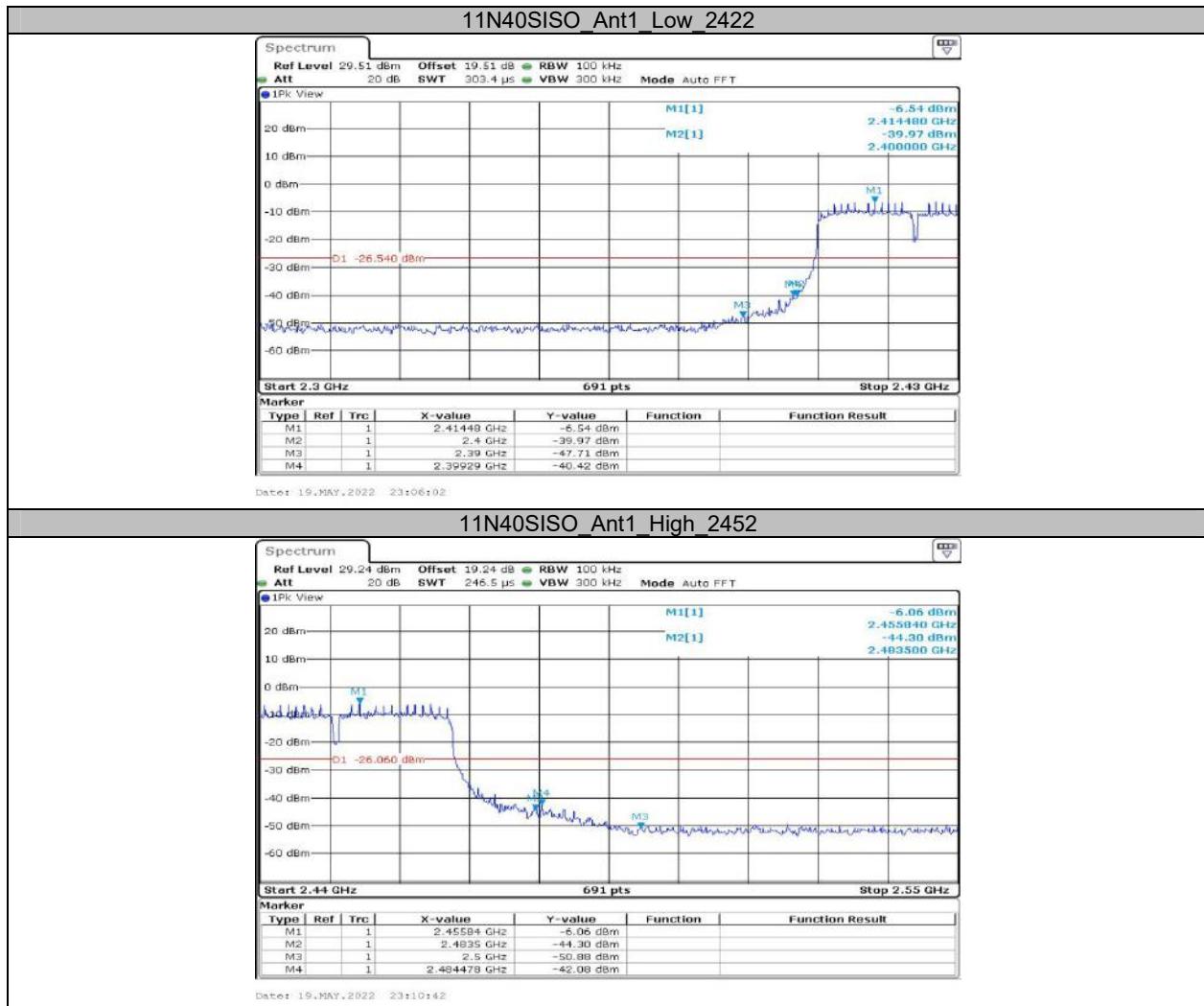


## Appendix E: Band edge measurements

### Test Graphs



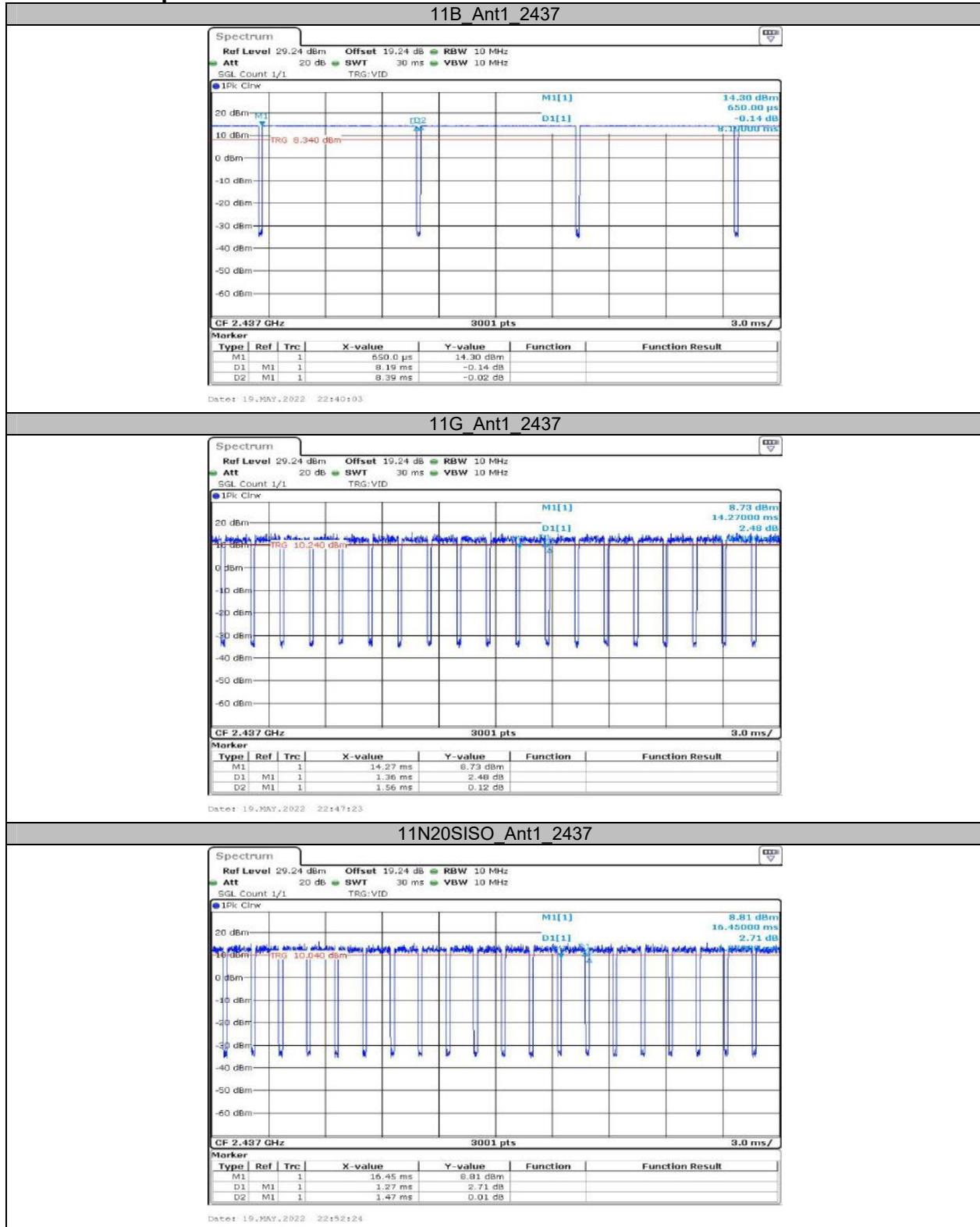


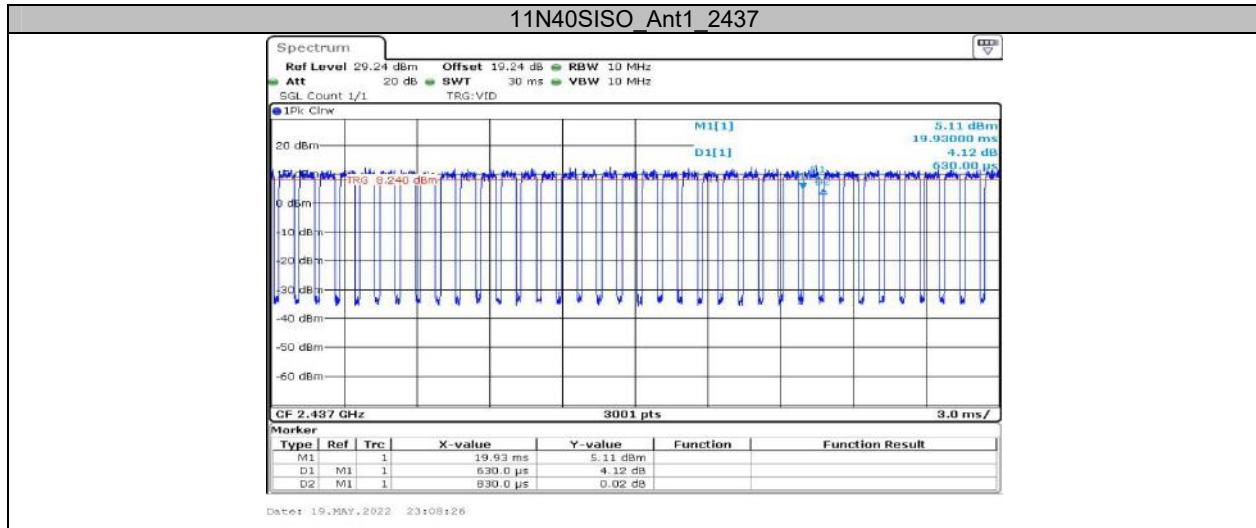


**Appendix F: Duty Cycle  
Test Result**

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2437	8.19	8.39	97.62
11G	Ant1	2437	1.36	1.56	87.18
11N20SISO	Ant1	2437	1.27	1.47	86.39
11N40SISO	Ant1	2437	0.63	0.83	75.90

## Test Graphs



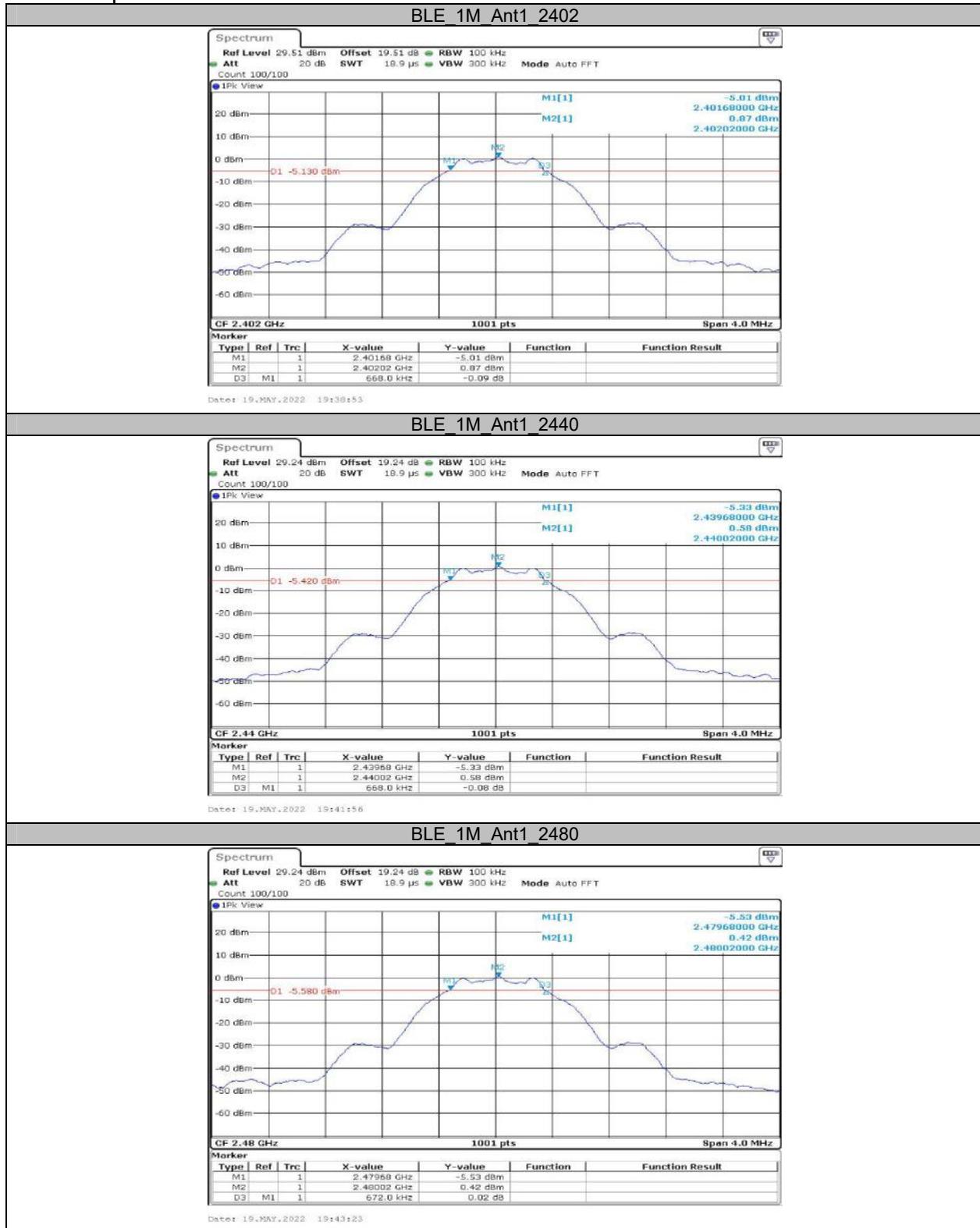


## APPENDIX BLE

### Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.67	0.5	PASS
		2440	0.67	0.5	PASS
		2480	0.67	0.5	PASS

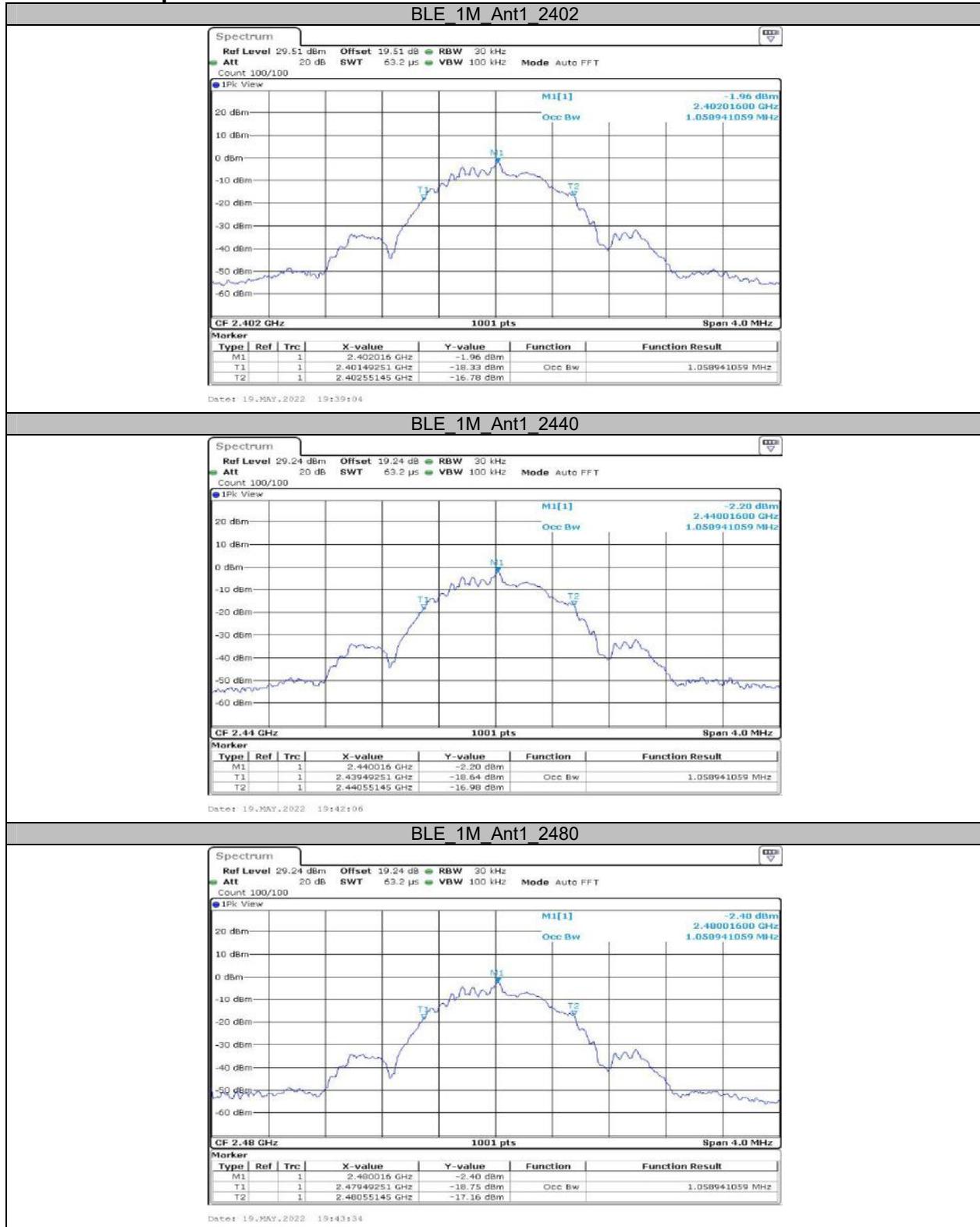
## Test Graphs



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

Test Mode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.059	2401.493	2402.551	---	---
		2440	1.059	2439.493	2440.551	---	---
		2480	1.059	2479.493	2480.551	---	---

## Test Graphs

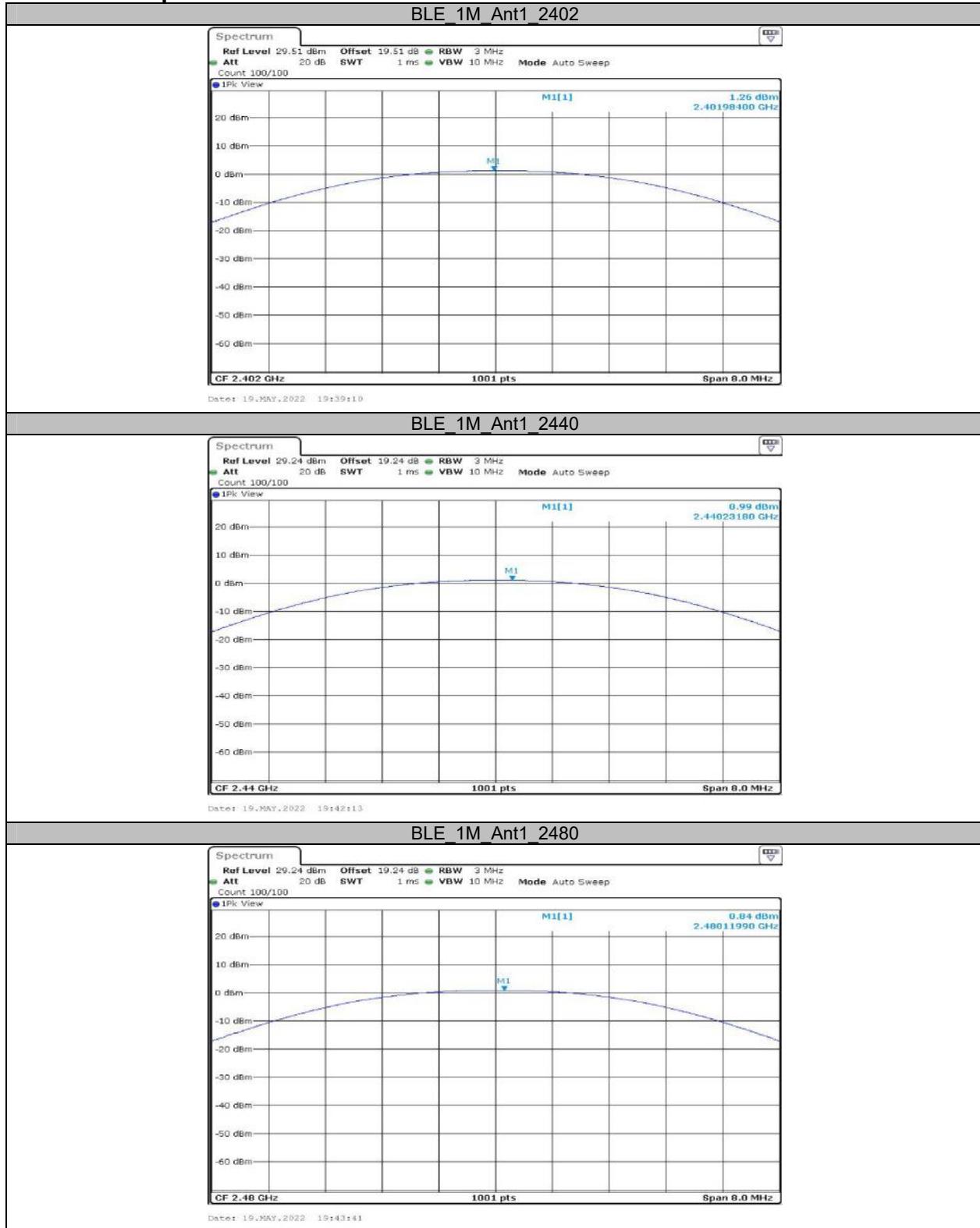


**Appendix C: Maximum conducted output power  
Test Result**

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	1.26	≤30	PASS
		2440	0.99	≤30	PASS
		2480	0.84	≤30	PASS

Note: the antenna gain is 2.1dBi, the maximum EIRP=3.36dBm<36dBm

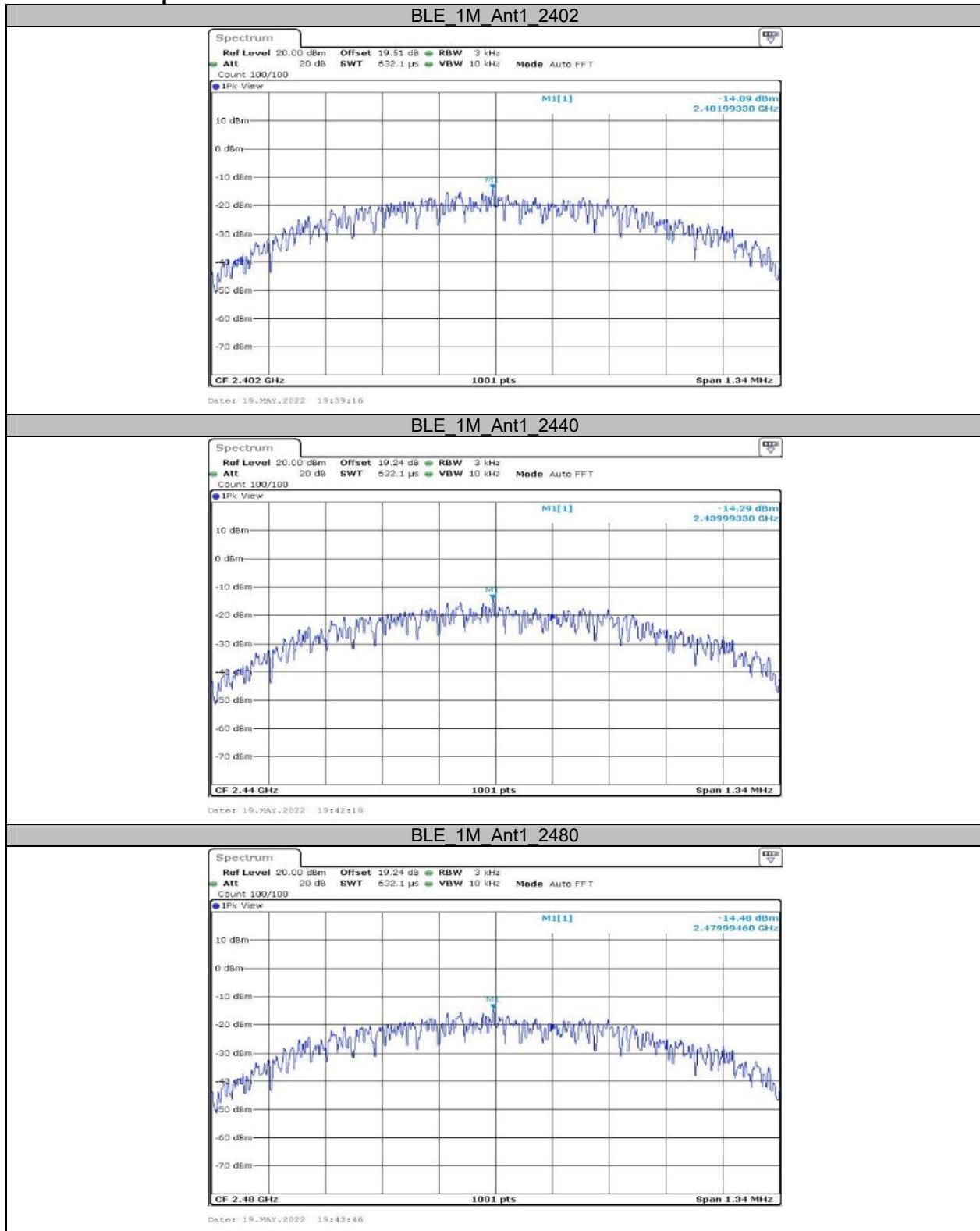
## Test Graphs



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

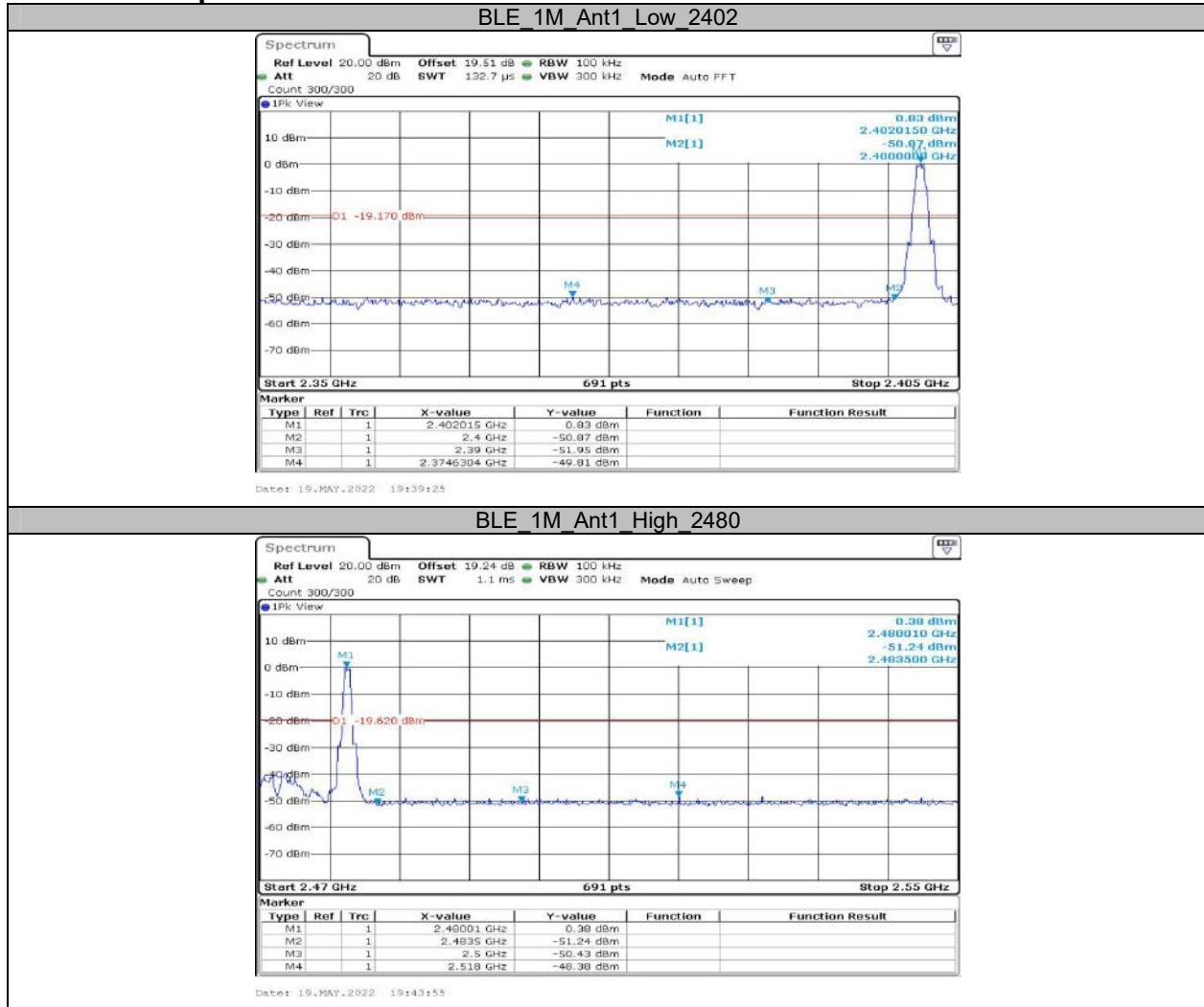
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-14.09	≤8.00	PASS
		2440	-14.29	≤8.00	PASS
		2480	-14.48	≤8.00	PASS

## Test Graphs



## Appendix E: Band edge measurements

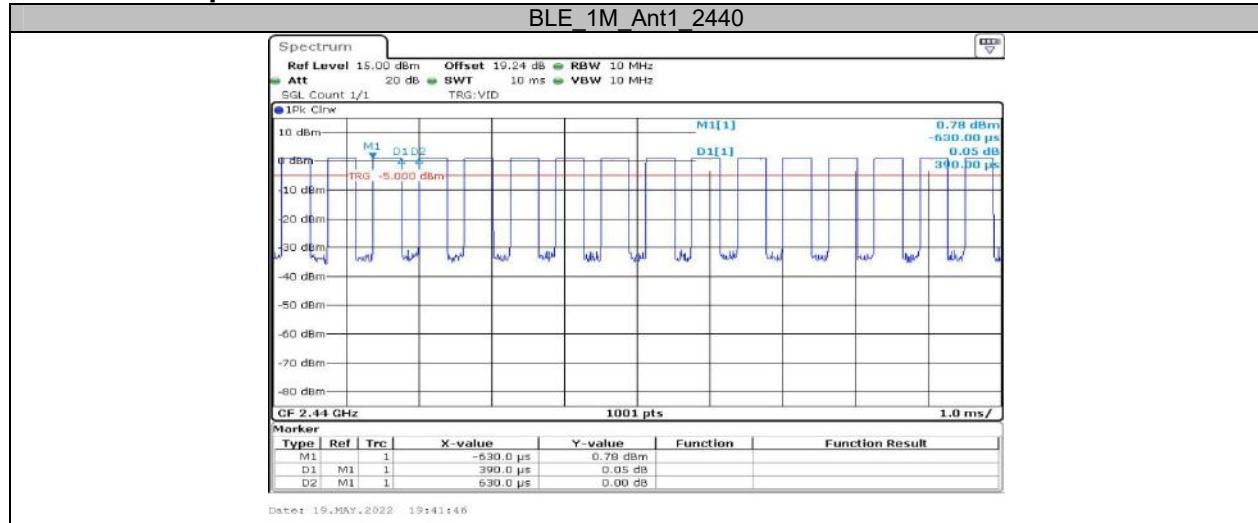
### Test Graphs



## Appendix F: Duty Cycle Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	0.39	0.63	61.90

### Test Graphs



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