



TEST REPORT

Applicant Name : Astera LED-Technology GmbH
Address : Stahlgruberring 36, Munich, 81829 Germany
Report Number : SZ4210812-52663E-RF-00B
FCC ID: X55AX9

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type: PowerPAR
Model No.: AX9
Multiple Model(s) No.: N/A
Trade Mark: ASTERA
Date Received: 2021/08/12
Date of Test: 2021/11/23~2022/01/12
Report Date: 2022/01/19

Test Result:

Pass*

* 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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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	BLE: 2402-2480MHz Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	BLE : 8.78dBm Wi-Fi: 17.12dBm(802.11b), 16.88dBm(802.11g) 17.06dBm(802.11n20), 15.67dBm(802.11n40)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	-1.03 dBi (provided by the applicant)
Voltage Range	DC18V From Battery or AC 100-240V
Sample serial number	SZ4210812-52663E-RF-S2(for conduct test) SZ4210812-52663E-RF-S1(for CE&RE test) (Assigned by ATC)
Sample/EUT Status	Good condition

Objective

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

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 output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Line Conducted emission		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz- 18GHz	4.98dB
	18GHz- 26.5GHz	5.06dB
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 11 channels are provided to testing:

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

802.11b, 802.11g and 802.11n-HT20 mode was tested with Channel 1, 6 and 11.
802.11n-HT40 mode was tested with Channel 3, 6 and 9.

For BLE mode, 40 channels are provided to testing:

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

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“EspRFTesTool_v2.6_Manual*” software was used to test.

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

Item	Mode	Data rate	Power Level*		
			Low Channel	Middle Channel	High Channel
Wi-Fi	802.11b	1Mbps	10	10	10
	802.11g	6Mbps	10	10	10
	802.11n-HT20	MCS0	10	10	10
	802.11n-HT40	MCS0	10	10	10
BLE	BLE 1M	1Mbps	8		

Duty cycle

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

Support Equipment List and Details

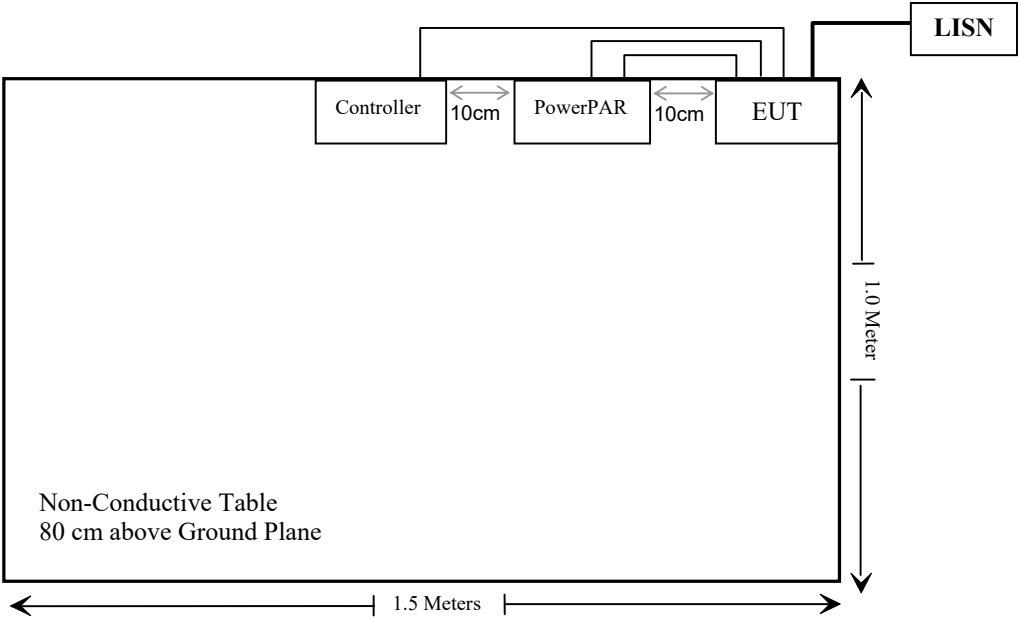
Manufacturer	Description	Model	Serial Number
Astera LED-Technology GmbH	PowerPAR	AX9	Unknown
Astera LED-Technology GmbH	Controller	DMX-100	Unknown

External I/O Cable

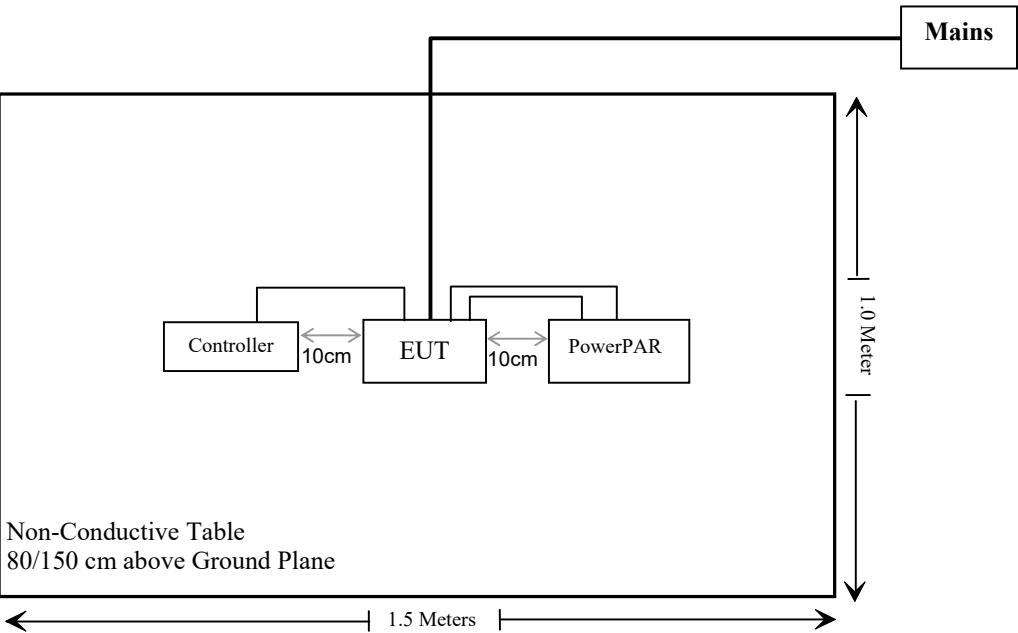
Cable Description	Length (m)	From Port	To
Un-Shielding Detachable AC Cable	1.0	EUT	LISN
Un-Shielding Detachable AC Cable	0.6	EUT	PowerPAR
Un-Dhielding Detachable DMX Cable	0.6	EUT	PowerPAR
Un-Dhielding Detachable DMX Cable	0.6	EUT	Controller

Block Diagram of Test Setup

For Conducted emission:



For radiated Emissions:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1) & §2.1091	MAXIMUM PERMISSIBLE EXPOSURE (MPE)	Compliance
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth & Occupied Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted emission 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 emission 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	531	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)					

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF conducted test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/07/06	2022/07/05
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) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm²)	Averaging Time (Minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

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

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

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

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

Mode	Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
UHF	917~922.2	2.0	1.58	9.5	8.91	20	0.0028	0.61
BT	2402-2480	-1.03	0.79	8.0	6.31	20	0.0010	1
BLE	2402-2480	-1.03	0.79	9.0	7.94	20	0.0012	1
Wi-Fi	2412-2462	-1.03	0.79	17.5	56.23	20	0.0088	1

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.

2. The UHF and BT/BLE/Wi-Fi can transmit at the same time, while the BT, BLE and Wi-Fi cannot transmitting simultaneously.

Simultaneous transmitting consideration:

The ratio= $MPE_{Wi-Fi}/limit + MPE_{UHF}/limit = 0.0088/1 + 0.0028/0.61 = 0.0134 < 1.0$

So simultaneous exposure comply with the limit.

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

Result: Compliant.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

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

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has one internal antenna which was permanently attached, and the maximum antenna gain is -1.03dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

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.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

During the conducted emission test, the device was connected to the outlet of the LISN.

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

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

Transd Factor & Margin Calculation

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

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

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

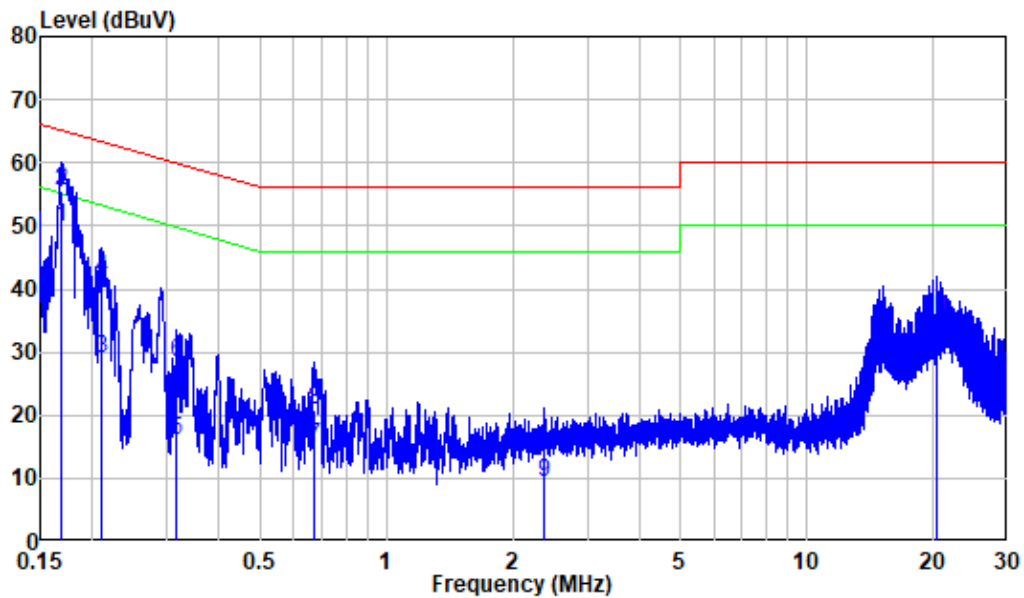
Environmental Conditions

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

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

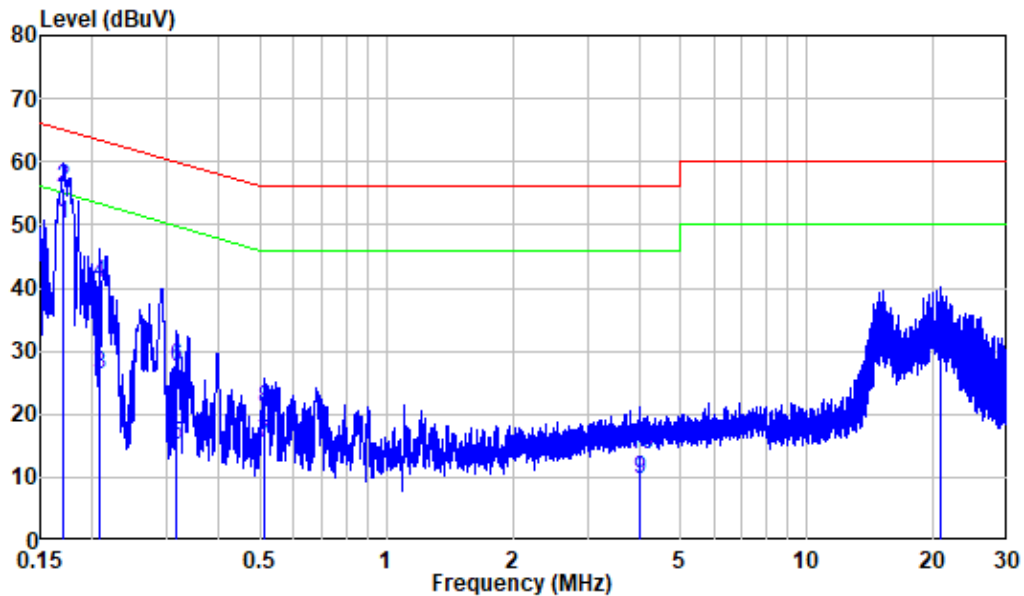
EUT operation mode: Transmitting (pre-scan BLE/Wi-Fi all modes, the worst case is 802.11b, low channel)

AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Mode : 2.4G WIFI
Model : AX9
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.168	9.86	40.04	49.90	55.07	-5.17	Average
2	0.168	9.86	45.57	55.43	65.07	-9.64	QP
3	0.209	9.80	19.30	29.10	53.24	-24.14	Average
4	0.209	9.80	31.86	41.66	63.24	-21.58	QP
5	0.315	9.80	6.18	15.98	49.83	-33.85	Average
6	0.315	9.80	18.49	28.29	59.83	-31.54	QP
7	0.670	9.81	5.39	15.20	46.00	-30.80	Average
8	0.670	9.81	11.14	20.95	56.00	-35.05	QP
9	2.374	9.92	-0.63	9.29	46.00	-36.71	Average
10	2.374	9.92	3.54	13.46	56.00	-42.54	QP
11	20.256	10.21	25.12	35.33	50.00	-14.67	Average
12	20.256	10.21	23.65	33.86	60.00	-26.14	QP

AC 120V/60 Hz, Neutral

Site : Shielding Room
 Condition: Neutral
 Mode : 2.4G WIFI
 Model : AX9
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.171	9.94	40.02	49.96	54.93	-4.97	Average
2	0.171	9.94	45.97	55.91	64.93	-9.02	QP
3	0.208	10.00	16.28	26.28	53.29	-27.01	Average
4	0.208	10.00	30.65	40.65	63.29	-22.64	QP
5	0.317	9.95	5.07	15.02	49.79	-34.77	Average
6	0.317	9.95	17.64	27.59	59.79	-32.20	QP
7	0.513	9.91	5.53	15.44	46.00	-30.56	Average
8	0.513	9.91	10.97	20.88	56.00	-35.12	QP
9	3.990	10.04	-0.36	9.68	46.00	-36.32	Average
10	3.990	10.04	3.43	13.47	56.00	-42.53	QP
11	20.717	10.22	21.04	31.26	50.00	-18.74	Average
12	20.717	10.22	20.38	30.60	60.00	-29.40	QP

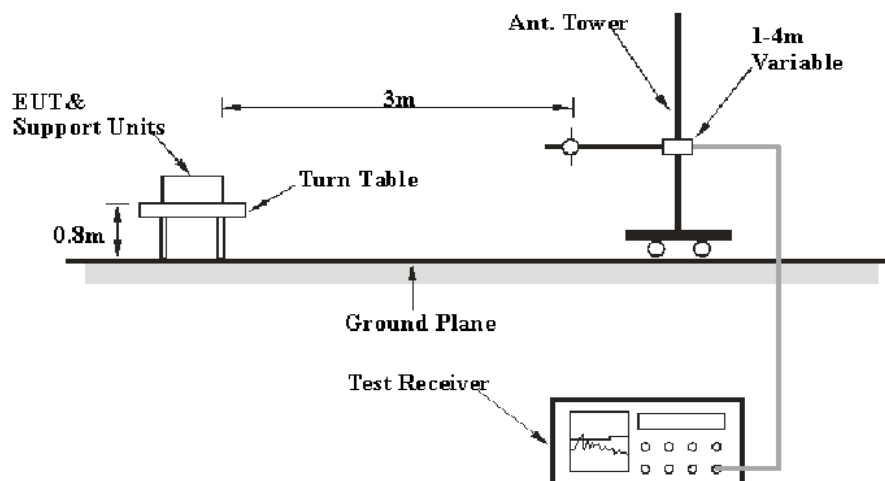
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

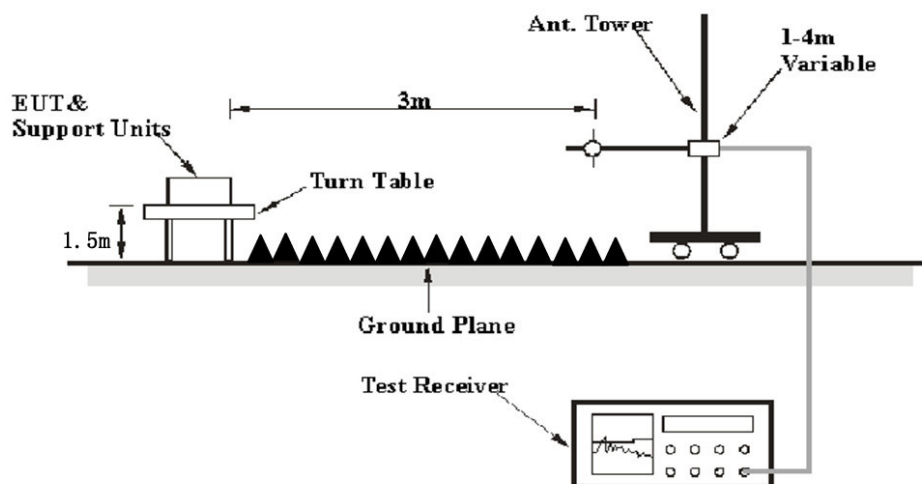
FCC §15.247 (d); §15.209; §15.205;

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. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

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

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

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

Note 2: when duty cycle is less than 98%

Test Procedure

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

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

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

Temperature:	21~26.2 °C
Relative Humidity:	53~62 %
ATM Pressure:	101.2 kPa

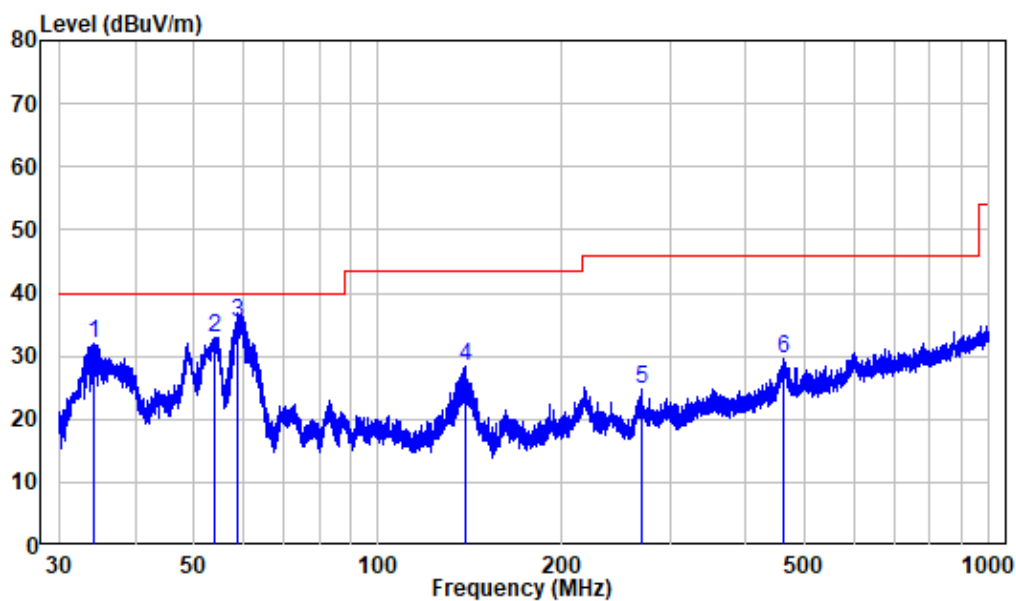
The testing was performed by Biu Deng 2022-01-12 for below 1GHz and Bin Deng on 2022-01-12 for above 1GHz.

EUT operation mode: Transmitting

30MHz-1GHz: (pre-scan BLE/Wi-Fi all modes, the worst case is 802.11b, low channel)

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

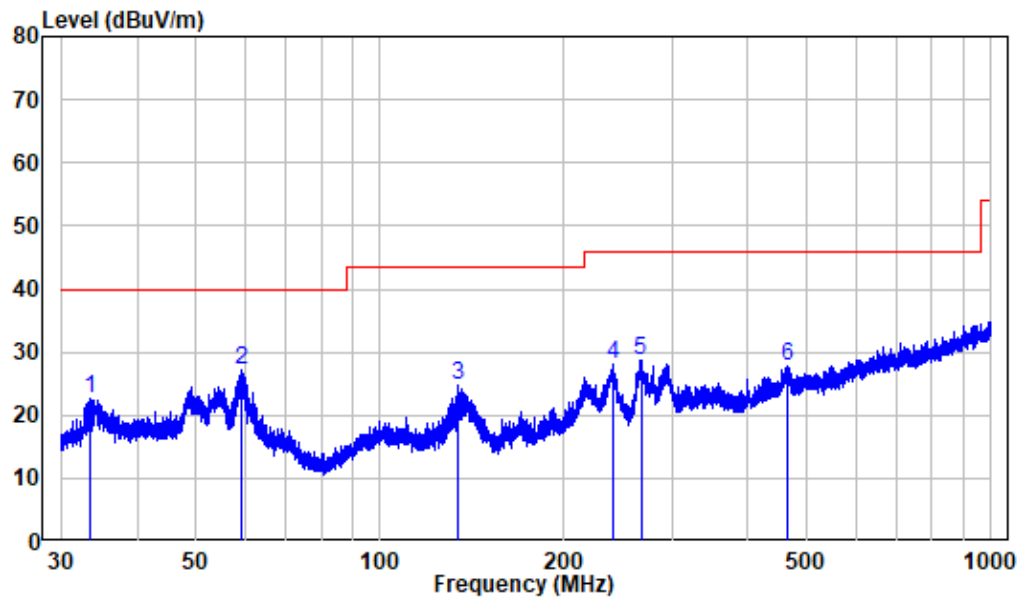
Horizontal:



Site : chamber
Condition: 3m VERTICAL
Job No. : SZ4210812-52663E-RF
Test Mode: 2.4G WIFI

	Freq Factor		Read	Limit	Over	Remark
	MHz	dB/m	Level	Line	Limit	
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	34.231	-11.78	43.74	31.96	40.00	-8.04 Peak
2	53.787	-10.31	43.23	32.92	40.00	-7.08 Peak
3	59.051	-10.28	45.60	35.32	40.00	-4.68 QP
4	139.056	-15.40	43.66	28.26	43.50	-15.24 Peak
5	269.547	-10.25	34.96	24.71	46.00	-21.29 Peak
6	461.536	-5.43	35.11	29.68	46.00	-16.32 Peak

Vertical



Site : chamber
 Condition: 3m HORIZONTAL
 Job No. : SZ4210812-52663E-RF
 Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	33.474	-11.94	34.57	22.63	40.00	-17.37	Peak
2	59.181	-10.32	37.63	27.31	40.00	-12.69	Peak
3	134.382	-14.99	39.70	24.71	43.50	-18.79	Peak
4	241.042	-10.84	38.82	27.98	46.00	-18.02	Peak
5	267.194	-10.35	39.17	28.82	46.00	-17.18	Peak
6	465.191	-5.49	33.31	27.82	46.00	-18.18	Peak

1-25 GHz:**BLE:**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
BLE, Low Channel									
2310	68.00	PK	141	2	H	-7.24	60.76	74	-13.24
2310	53.93	AV	141	2	H	-7.24	46.69	54	-7.31
2310	68.29	PK	277	1.2	V	-7.24	61.05	74	-12.95
2310	54.94	AV	277	1.2	V	-7.24	47.70	54	-6.30
2390	67.94	PK	325	1.3	H	-7.22	60.72	74	-13.28
2390	53.93	AV	325	1.3	H	-7.22	46.71	54	-7.29
2390	68.16	PK	77	1.1	V	-7.22	60.94	74	-13.06
2390	54.96	AV	77	1.1	V	-7.22	47.74	54	-6.26
4804	54.83	PK	34	2.1	H	-3.51	51.32	74	-22.68
4804	55.59	PK	231	2.1	V	-3.51	52.08	74	-21.92
BLE, Middle Channel									
4880	54.75	PK	157	1.8	H	-3.38	51.37	74	-22.63
4880	55.56	PK	103	1.8	V	-3.38	52.18	74	-21.82
BLE, High Channel									
2483.5	69.10	PK	317	2.5	H	-7.20	61.9	74	-12.10
2483.5	55.26	AV	317	2.5	H	-7.20	48.06	54	-5.94
2483.5	68.27	PK	289	1.7	V	-7.20	61.07	74	-12.93
2483.5	55.11	AV	289	1.7	V	-7.20	47.91	54	-6.09
2500	68.54	PK	330	2.5	H	-7.18	61.36	74	-12.64
2500	55.17	AV	330	2.5	H	-7.18	47.99	54	-6.01
2500	68.54	PK	158	2.3	V	-7.18	61.36	74	-12.64
2500	55.16	AV	158	2.3	V	-7.18	47.98	54	-6.02
4960	54.34	PK	136	1.7	H	-3.01	51.33	74	-22.67
4960	55.17	PK	189	1.7	V	-3.01	52.16	74	-21.84

Note:

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

Corrected Amplitude = Corrected Factor + Reading

Margin = Corrected. Amplitude - Limit

The other spurious emission which is in the noise floor level was not recorded.

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

Wi-Fi:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11B, Low Channel									
2310	68.01	PK	272	2	H	-7.24	60.77	74	-13.23
2310	53.61	AV	272	2	H	-7.24	46.37	54	-7.63
2310	68.32	PK	53	2.2	V	-7.24	61.08	74	-12.92
2310	54.19	AV	53	2.2	V	-7.24	46.95	54	-7.05
2390	67.79	PK	193	1.6	H	-7.22	60.57	74	-13.43
2390	53.80	AV	193	1.6	H	-7.22	46.58	54	-7.42
2390	68.09	PK	338	1.5	V	-7.22	60.87	74	-13.13
2390	54.29	AV	338	1.5	V	-7.22	47.07	54	-6.93
4824	57.11	PK	165	1.6	H	-3.53	53.58	74	-20.42
4824	60.27	PK	47	1.3	V	-3.53	56.75	74	-17.25
4824	54.37	AV	47	1.3	V	-3.53	50.85	54	-3.15
802.11B, Middle Channel									
4874	56.47	PK	151	1.1	H	-3.42	53.05	74	-20.95
4874	59.01	PK	55	2.2	V	-3.42	55.59	74	-18.41
4874	53.39	AV	55	2.2	V	-3.42	49.97	54	-4.03
802.11B, High Channel									
2483.5	68.90	PK	245	1.8	H	-7.20	61.7	74	-12.30
2483.5	55.99	AV	245	1.8	H	-7.20	48.79	54	-5.21
2483.5	67.78	PK	286	1.9	V	-7.20	60.58	74	-13.42
2483.5	55.13	AV	286	1.9	V	-7.20	47.93	54	-6.07
2500	68.93	PK	195	1.1	H	-7.18	61.75	74	-12.25
2500	56.19	AV	195	1.1	H	-7.18	49.01	54	-4.99
2500	68.77	PK	222	1	V	-7.18	61.59	74	-12.41
2500	55.05	AV	222	1	V	-7.18	47.87	54	-6.13
4924	56.05	PK	73	1.6	H	-3.16	52.89	74	-21.11
4924	58.64	PK	308	1.1	V	-3.16	55.48	74	-18.52
4924	52.78	AV	308	1.1	V	-3.16	49.62	54	-4.38

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11G, Low Channel									
2310	68.71	PK	345	1.9	H	-7.24	61.47	74	-12.53
2310	53.85	AV	345	1.9	H	-7.24	46.61	54	-7.39
2310	68.38	PK	79	1.9	V	-7.24	61.14	74	-12.86
2310	54.70	AV	79	1.9	V	-7.24	47.46	54	-6.54
2390	68.31	PK	39	2	H	-7.22	61.09	74	-12.91
2390	53.70	AV	39	2	H	-7.22	46.48	54	-7.52
2390	68.97	PK	18	2.4	V	-7.22	61.75	74	-12.25
2390	54.59	AV	18	2.4	V	-7.22	47.37	54	-6.63
4824	54.07	PK	264	2.2	H	-3.53	50.54	74	-23.46
4824	58.44	PK	111	2.2	V	-3.53	54.91	74	-19.09
802.11G, Middle Channel									
4874	54.52	PK	28	1.3	H	-3.42	51.10	74	-22.90
4874	56.11	PK	298	1.3	V	-3.42	52.69	74	-21.31
802.11G, High Channel									
2483.5	70.95	PK	123	1.4	H	-7.20	63.75	74	-10.25
2483.5	58.08	AV	123	1.4	H	-7.20	50.88	54	-3.12
2483.5	68.44	PK	178	2	V	-7.20	61.24	74	-12.76
2483.5	55.01	AV	178	2	V	-7.20	47.81	54	-6.19
2500	71.77	PK	290	1.9	H	-7.18	64.59	74	-9.41
2500	58.12	AV	290	1.9	H	-7.18	50.94	54	-3.06
2500	68.70	PK	60	1.6	V	-7.18	61.52	74	-12.48
2500	55.04	AV	60	1.6	V	-7.18	47.86	54	-6.14
4924	54.14	PK	39	1.7	H	-3.16	50.98	74	-23.02
4924	55.44	PK	308	1.7	V	-3.16	52.28	74	-21.72

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11N20, Low Channel									
2310	67.81	PK	192	1	H	-7.24	60.57	74	-13.43
2310	53.63	AV	192	1	H	-7.24	46.39	54	-7.61
2310	69.22	PK	289	2.1	V	-7.24	61.98	74	-12.02
2310	54.65	AV	289	2.1	V	-7.24	47.41	54	-6.59
2390	68.51	PK	47	2.3	H	-7.22	61.29	74	-12.71
2390	53.62	AV	47	2.3	H	-7.22	46.40	54	-7.60
2390	70.01	PK	280	1.8	V	-7.22	62.79	74	-11.21
2390	54.65	AV	280	1.8	V	-7.22	47.43	54	-6.57
4824	54.29	PK	102	1.4	H	-3.53	50.76	74	-23.24
4824	55.51	PK	105	1.4	V	-3.53	51.98	74	-22.02
802.11 N20, Middle Channel									
4874	54.60	PK	171	1.5	H	-3.42	51.18	74	-22.82
4874	55.61	PK	25	1.5	V	-3.42	52.19	74	-21.81
802.11 N20, High Channel									
2483.5	71.73	PK	37	1.6	H	-7.20	64.53	74	-9.47
2483.5	57.42	AV	37	1.6	H	-7.20	50.22	54	-3.78
2483.5	68.10	PK	124	1	V	-7.20	60.9	74	-13.10
2483.5	55.22	AV	124	1	V	-7.20	48.02	54	-5.98
2500	72.49	PK	196	2.1	H	-7.18	65.31	74	-8.69
2500	58.15	AV	196	2.1	H	-7.18	50.97	54	-3.03
2500	67.70	PK	302	1.4	V	-7.18	60.52	74	-13.48
2500	55.07	AV	302	1.4	V	-7.18	47.89	54	-6.11
4924	53.98	PK	245	1.7	H	-3.16	50.82	74	-23.18
4924	55.16	PK	90	1.7	V	-3.16	52.01	74	-21.99

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11N40, Low Channel									
2310	68.56	PK	233	2.2	H	-7.24	61.32	74	-12.68
2310	53.59	AV	233	2.2	H	-7.24	46.35	54	-7.65
2310	69.61	PK	339	1.2	V	-7.24	62.37	74	-11.63
2310	54.84	AV	339	1.2	V	-7.24	47.60	54	-6.40
2390	67.88	PK	330	1	H	-7.22	60.66	74	-13.34
2390	53.73	AV	330	1	H	-7.22	46.51	54	-7.49
2390	70.08	PK	89	1.6	V	-7.22	62.86	74	-11.14
2390	54.86	AV	89	1.6	V	-7.22	47.64	54	-6.36
4844	53.83	PK	76	1.3	H	-3.54	50.29	74	-23.71
4844	55.07	PK	86	1.3	V	-3.54	51.53	74	-22.47
802.11N40, Middle Channel									
4874	54.48	PK	122	2.2	H	-3.42	51.06	74	-22.94
4874	55.37	PK	205	2.2	V	-3.42	51.95	74	-22.05
802.11 N40, High Channel									
2483.5	71.94	PK	305	2.4	H	-7.20	64.74	74	-9.26
2483.5	57.51	AV	305	2.4	H	-7.20	50.31	54	-3.69
2483.5	68.28	PK	75	1.5	V	-7.20	61.08	74	-12.92
2483.5	55.23	AV	75	1.5	V	-7.20	48.03	54	-5.97
2500	71.43	PK	299	2.5	H	-7.18	64.25	74	-9.75
2500	58.04	AV	299	2.5	H	-7.18	50.86	54	-3.14
2500	68.08	PK	32	1.9	V	-7.18	60.9	74	-13.10
2500	55.05	AV	32	1.9	V	-7.18	47.87	54	-6.13
4904	54.51	PK	341	1.7	H	-3.26	51.25	74	-22.75
4904	55.36	PK	286	1.7	V	-3.26	52.10	74	-21.90

Note:

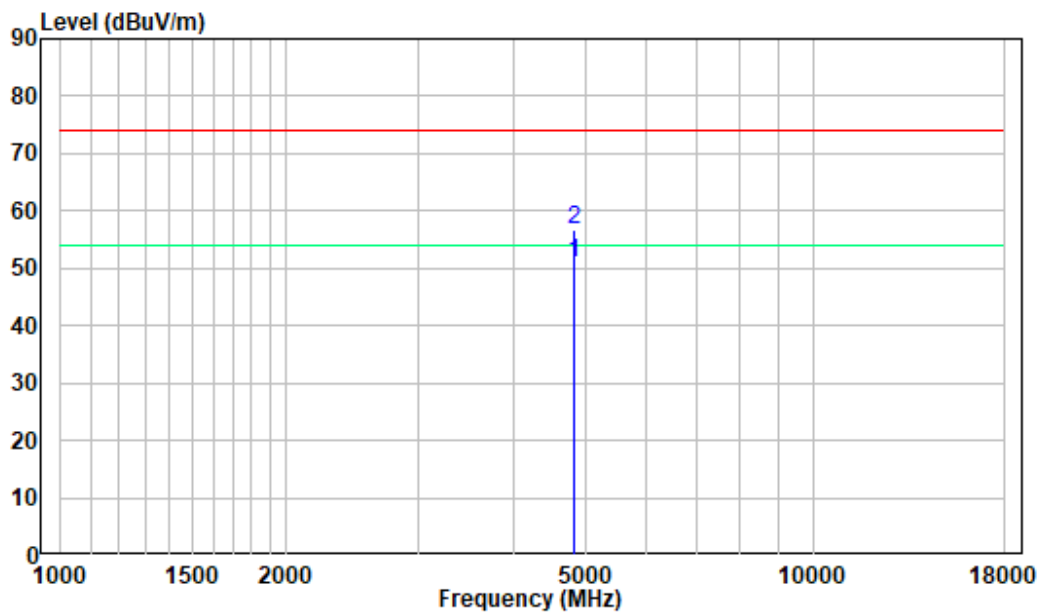
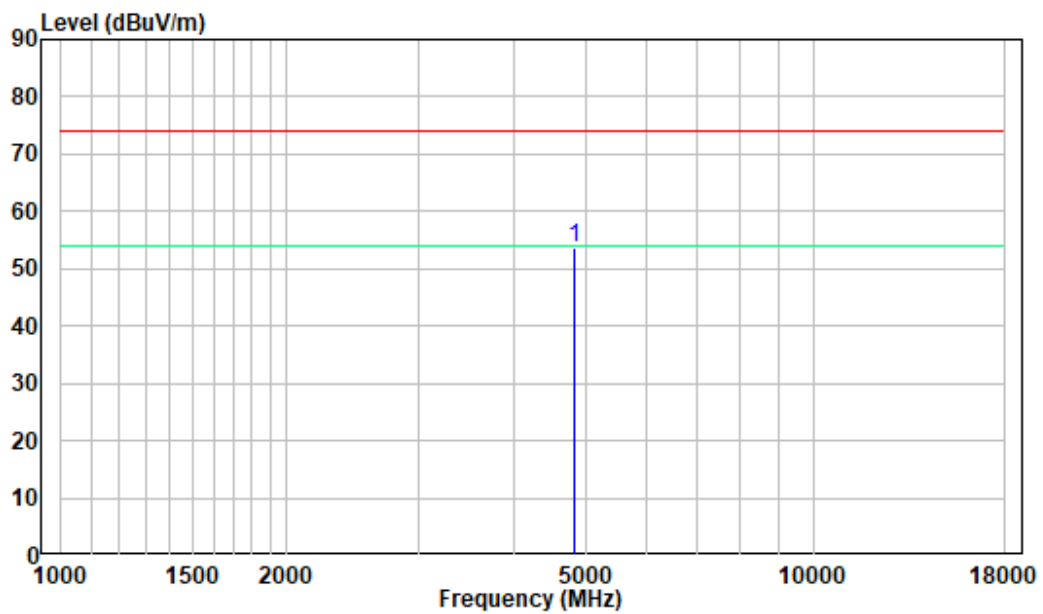
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Corrected. Amplitude - Limit

The other spurious emission which is in the noise floor level was not recorded.

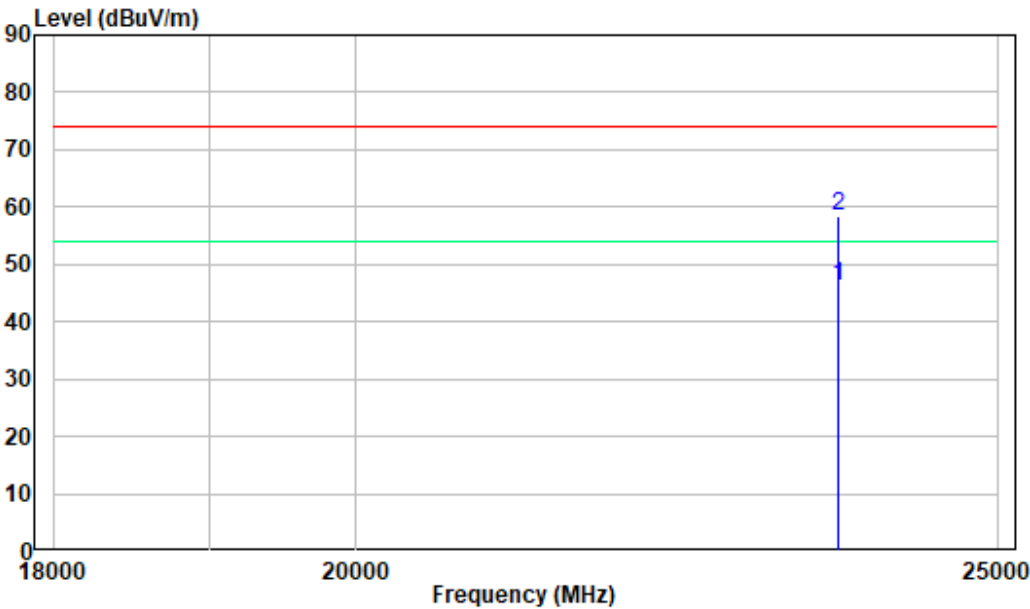
The test result of peak was less than the limit of average, so just peak value were recorded.

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

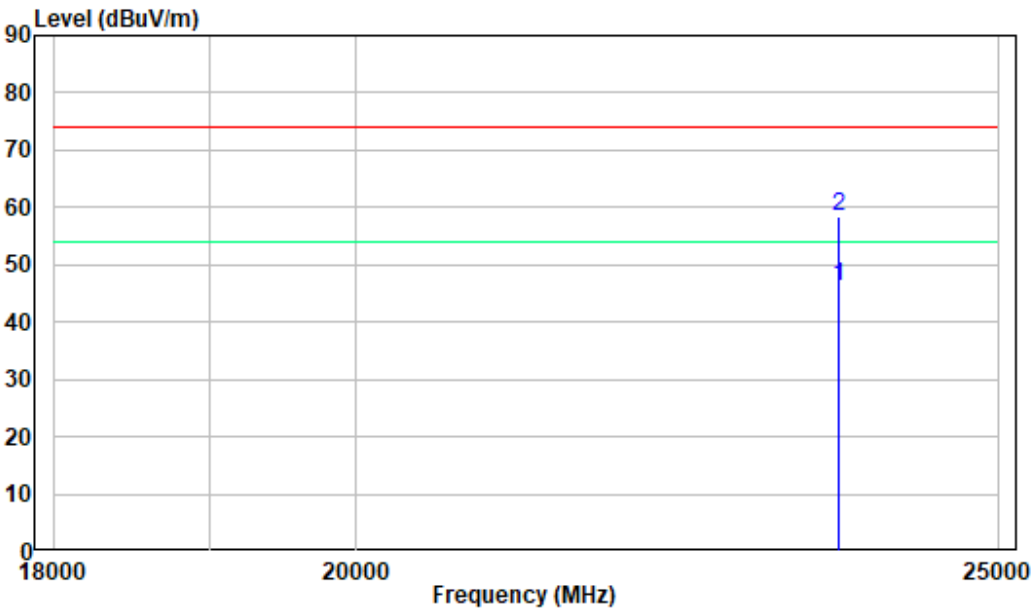
18 -25GHz:

Pre-scan for 802.11B, Low Channel

Horizontal



Vertical



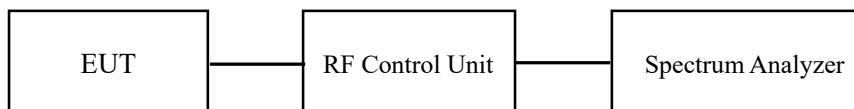
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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.

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.



Test Data

Environmental Conditions

Temperature:	24 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-11-23.

EUT operation mode: Transmitting

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

FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

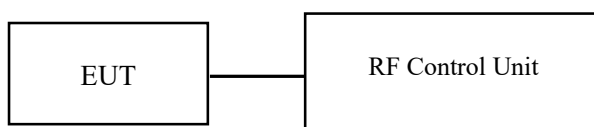
Applicable Standard

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.

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.



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

Test Data

Environmental Conditions

Temperature:	24 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-11-23.

EUT operation mode: Transmitting

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

FCC §15.247(d) – 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:	24 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-11-23.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

Please refer to the Appendix Wi-Fi and Appendix BLE.

FCC §15.247(e) - 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.

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

Temperature:	24 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-11-23.

EUT operation mode: Transmitting

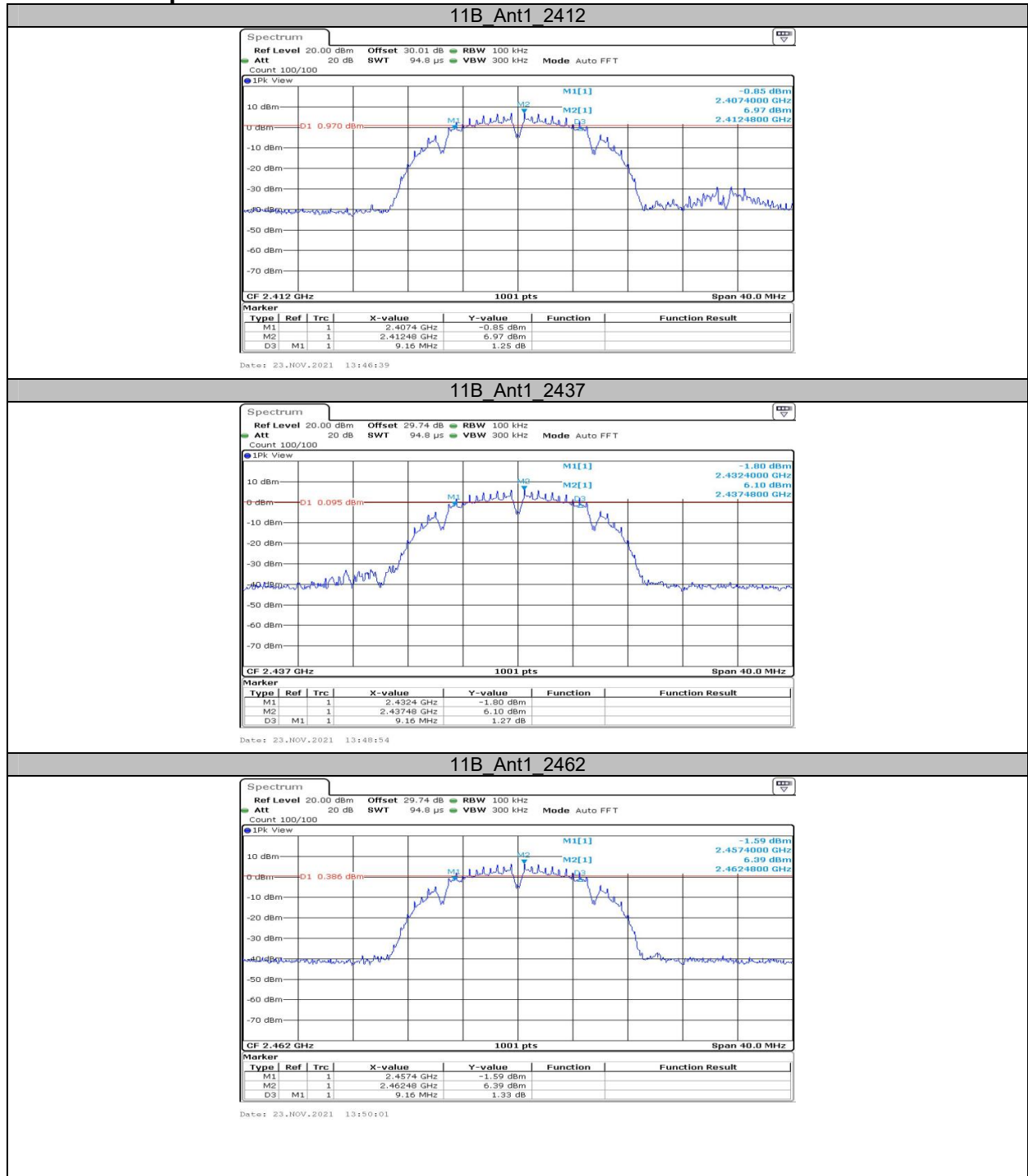
Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

APPENDIX Wi-Fi

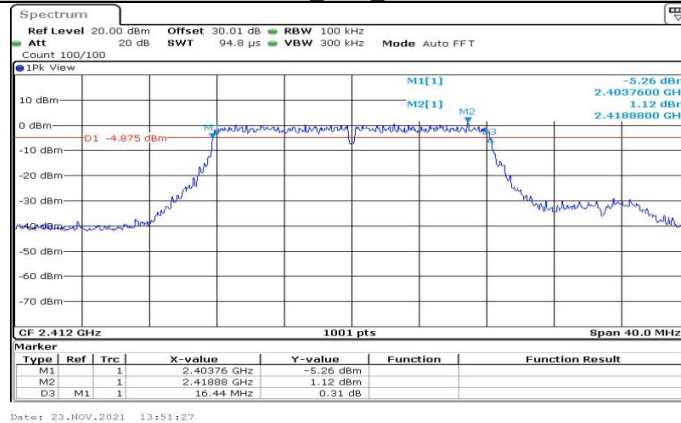
Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	9.160	0.5	PASS
		2437	9.160	0.5	PASS
		2462	9.160	0.5	PASS
11G	Ant1	2412	16.440	0.5	PASS
		2437	16.440	0.5	PASS
		2462	16.440	0.5	PASS
11N20SISO	Ant1	2412	17.400	0.5	PASS
		2437	17.400	0.5	PASS
		2462	17.400	0.5	PASS
11N40SISO	Ant1	2422	33.120	0.5	PASS
		2437	33.040	0.5	PASS
		2452	33.040	0.5	PASS

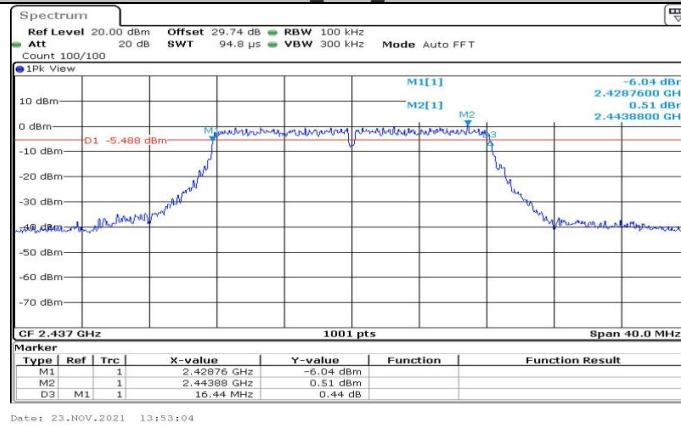
Test Graphs



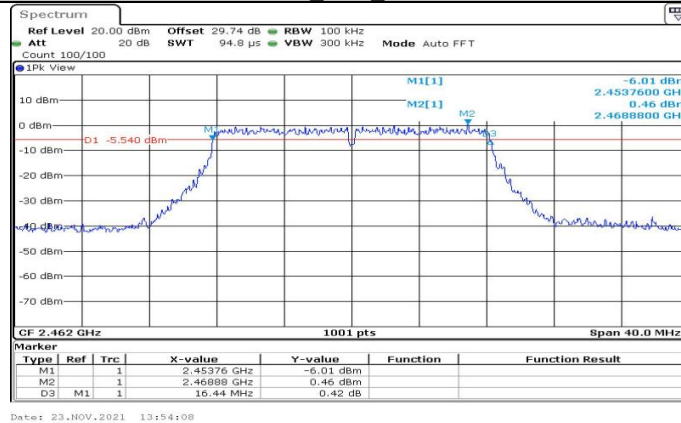
11G Ant1_2412



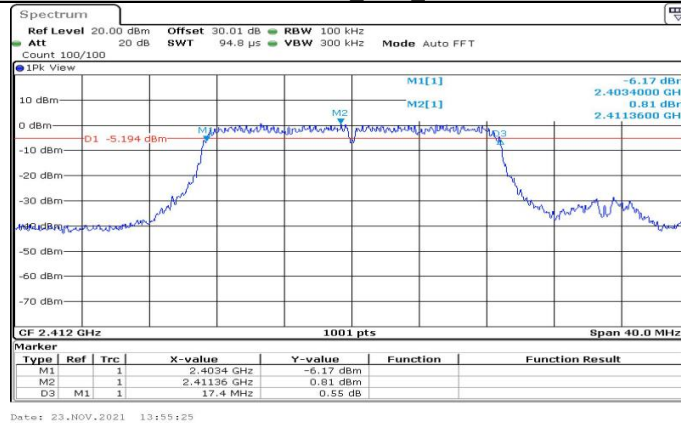
11G Ant1_2437



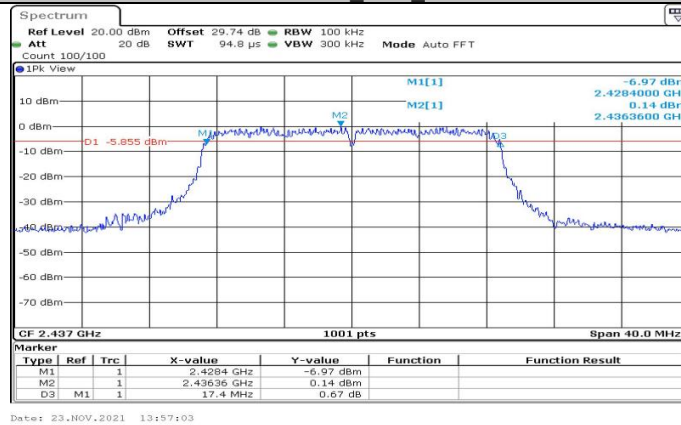
11G Ant1_2462



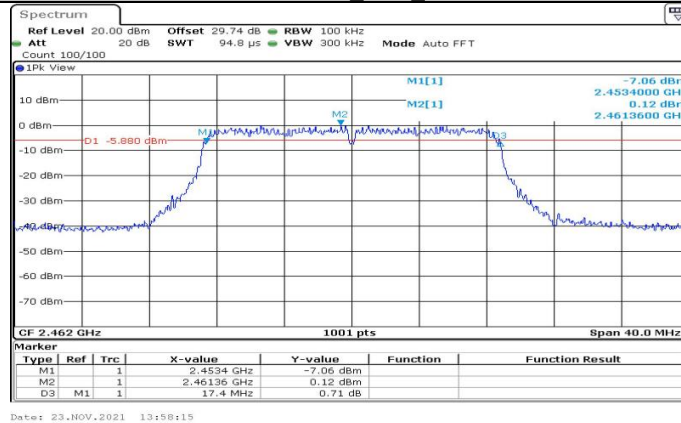
11N20SISO_Ant1_2412



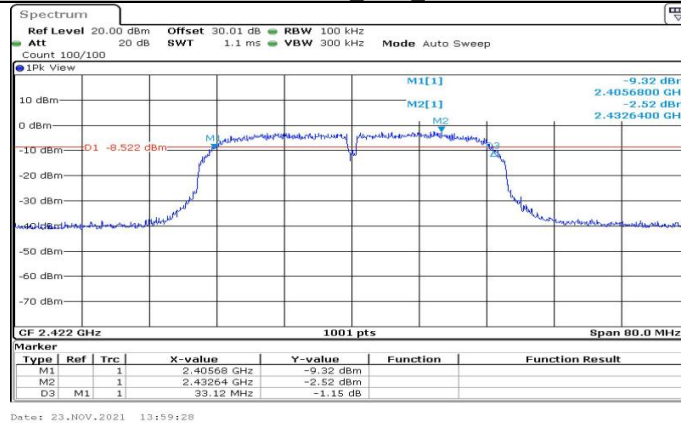
11N20SISO_Ant1_2437



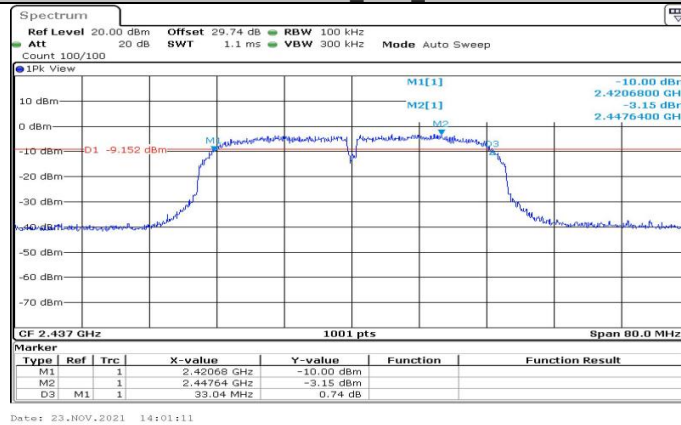
11N20SISO_Ant1_2462



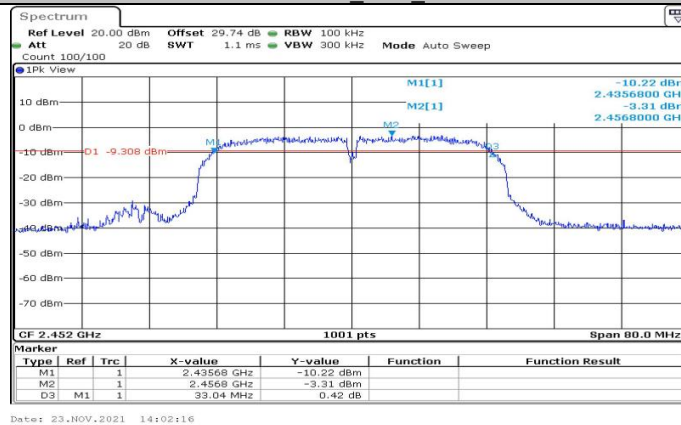
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



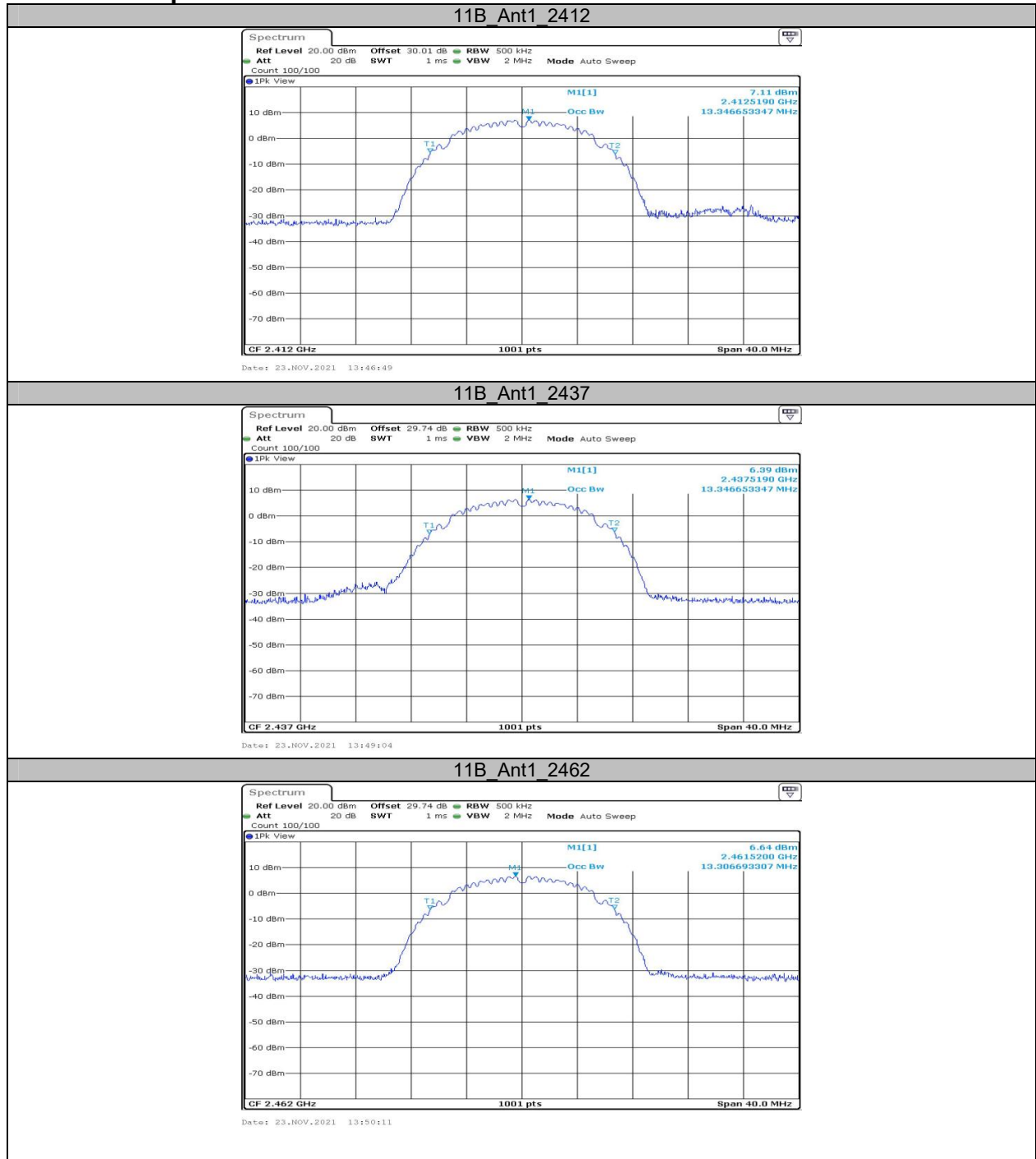
11N40SISO_Ant1_2452



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

Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	13.347	---	PASS
		2437	13.347	---	PASS
		2462	13.307	---	PASS
11G	Ant1	2412	16.743	---	PASS
		2437	16.743	---	PASS
		2462	16.743	---	PASS
11N20SISO	Ant1	2412	17.463	---	PASS
		2437	17.463	---	PASS
		2462	17.423	---	PASS
11N40SISO	Ant1	2422	34.605	---	PASS
		2437	34.605	---	PASS
		2452	34.685	---	PASS

Test Graphs



11G_Ant1_2412



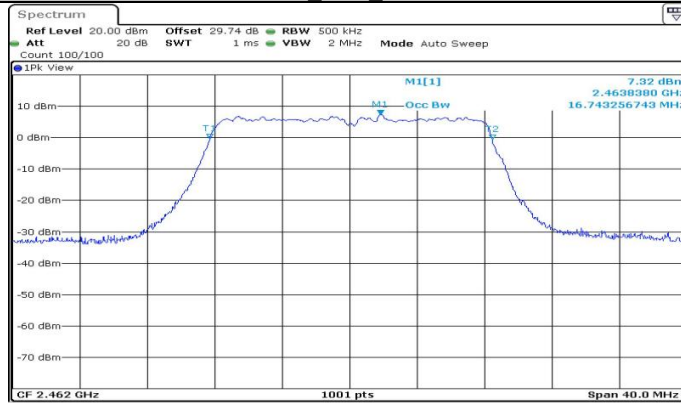
Date: 23.NOV.2021 13:51:37

11G_Ant1_2437

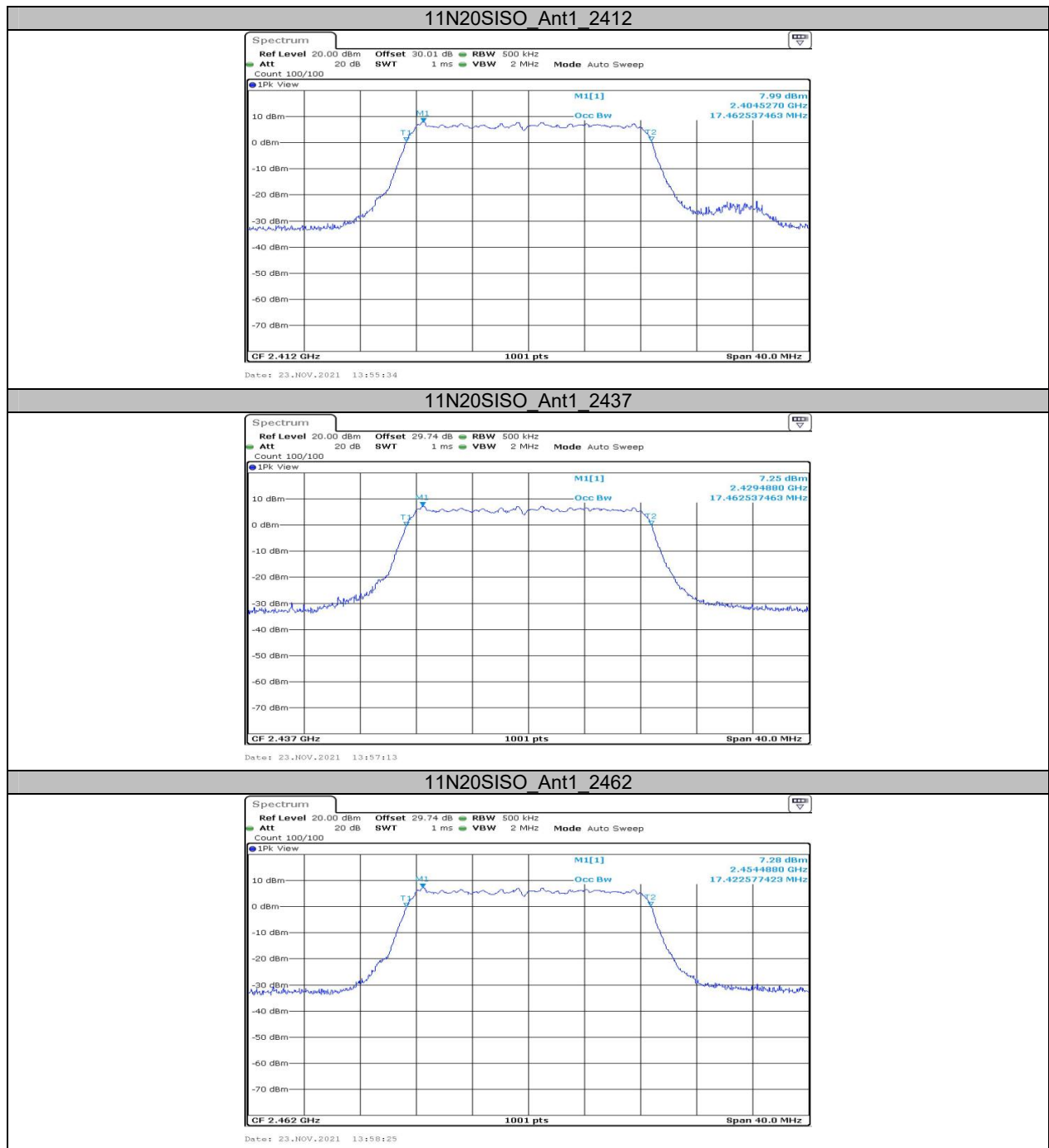


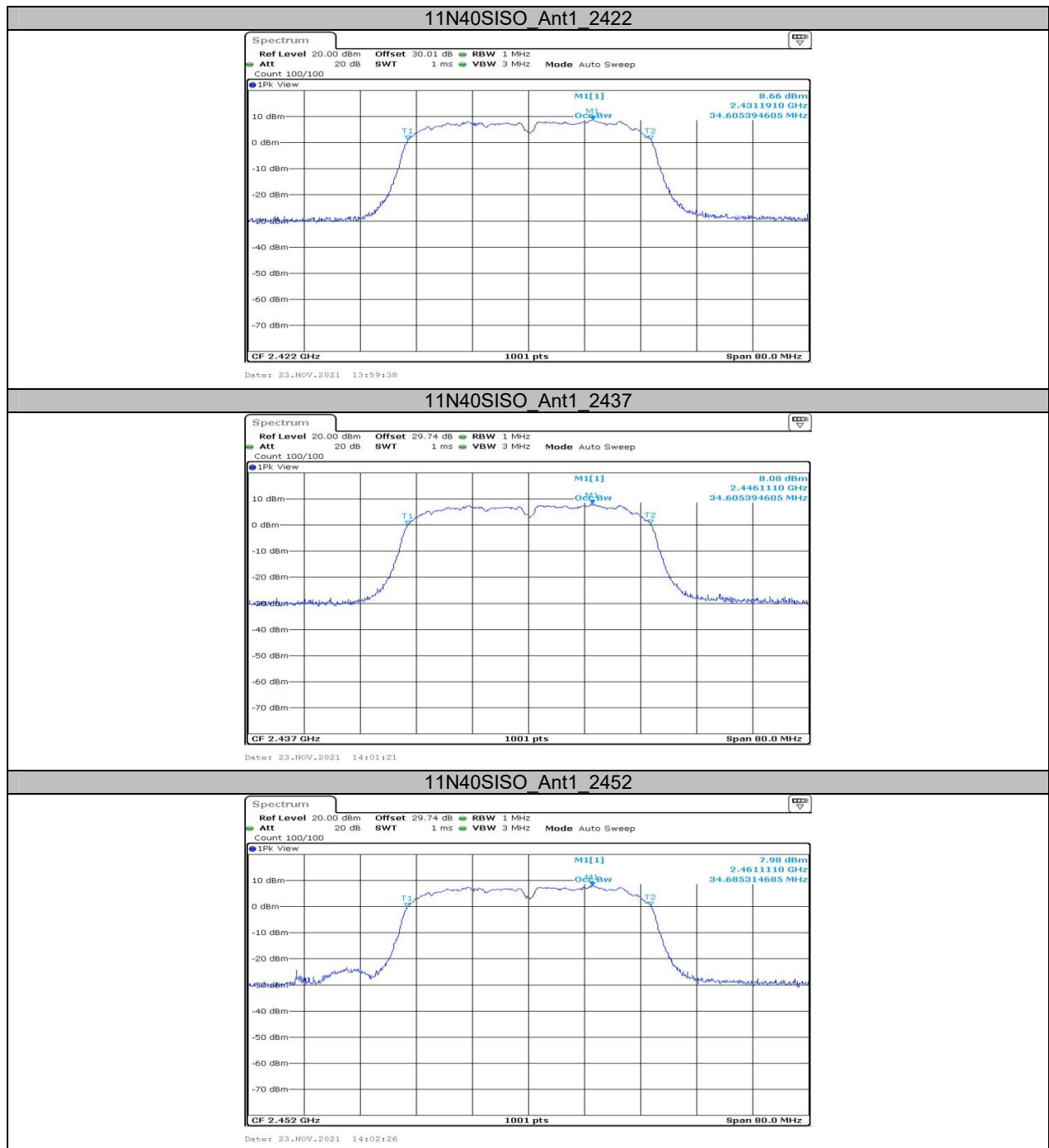
Date: 23.NOV.2021 13:53:14

11G_Ant1_2462



Date: 23.NOV.2021 13:54:18





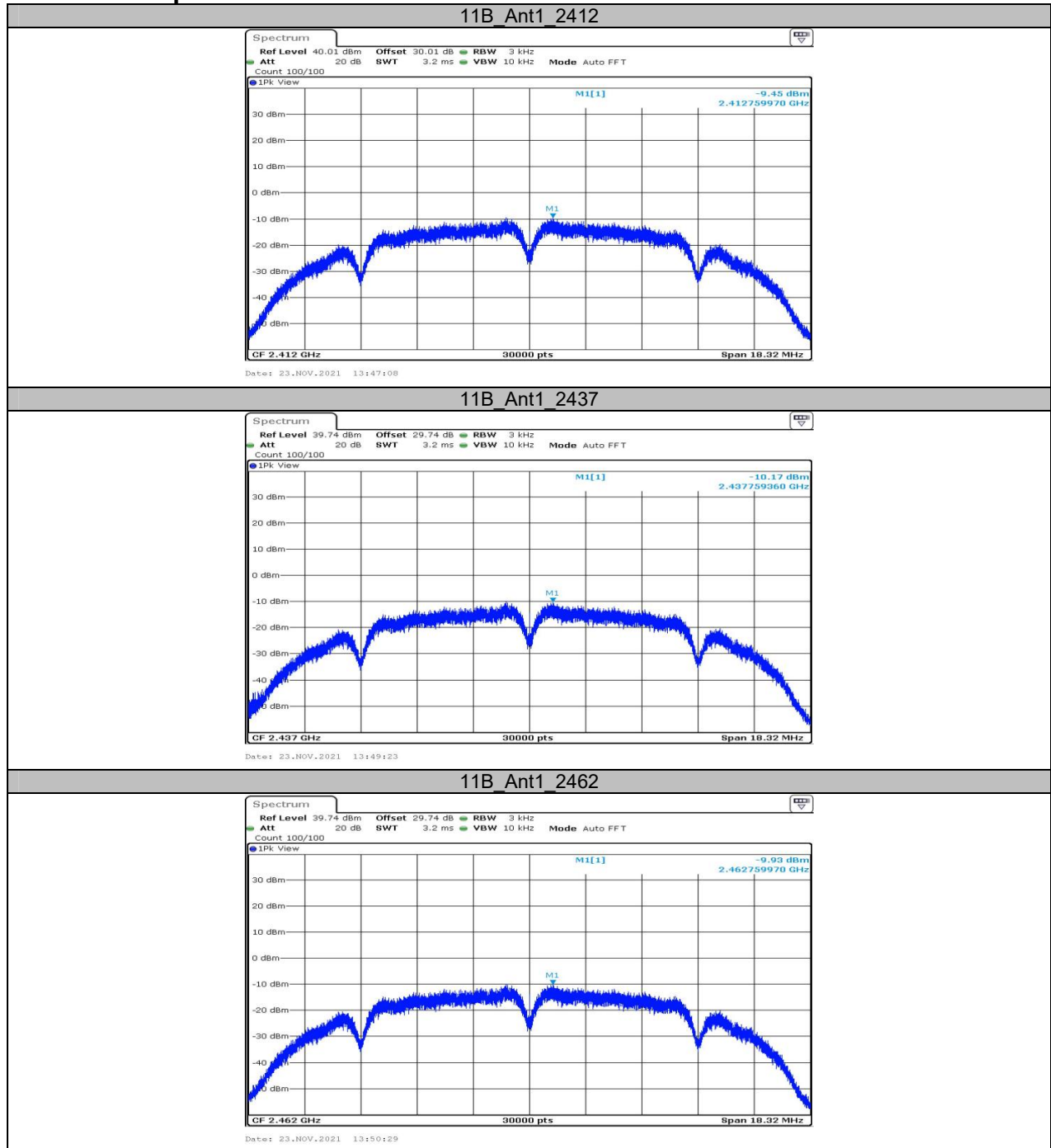
**Appendix C: Maximum conducted output power
Test Result**

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	17.12	≤30	PASS
		2437	16.64	≤30	PASS
		2462	16.88	≤30	PASS
11G	Ant1	2412	16.88	≤30	PASS
		2437	16.38	≤30	PASS
		2462	16.31	≤30	PASS
11N20SISO	Ant1	2412	17.06	≤30	PASS
		2437	16.88	≤30	PASS
		2462	16.82	≤30	PASS
11N40SISO	Ant1	2422	15.67	≤30	PASS
		2437	15.28	≤30	PASS
		2452	15.12	≤30	PASS

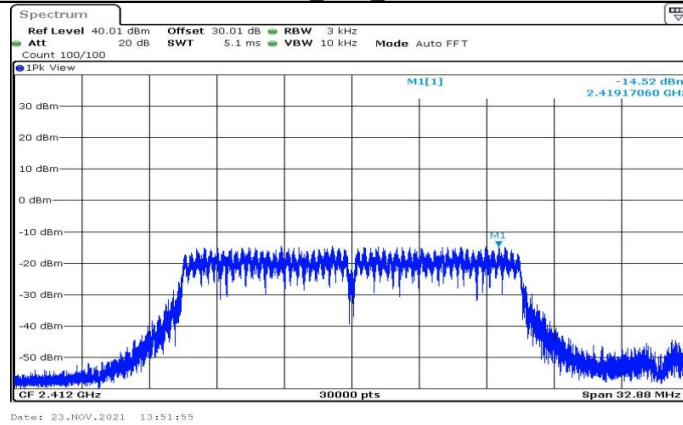
**Appendix D: Maximum power spectral density
Test Result**

Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-9.45	≤8	PASS
		2437	-10.17	≤8	PASS
		2462	-9.93	≤8	PASS
11G	Ant1	2412	-14.52	≤8	PASS
		2437	-15.16	≤8	PASS
		2462	-15.28	≤8	PASS
11N20SISO	Ant1	2412	-13.85	≤8	PASS
		2437	-14.57	≤8	PASS
		2462	-14.59	≤8	PASS
11N40SISO	Ant1	2422	-15.44	≤8	PASS
		2437	-15.83	≤8	PASS
		2452	-15.92	≤8	PASS

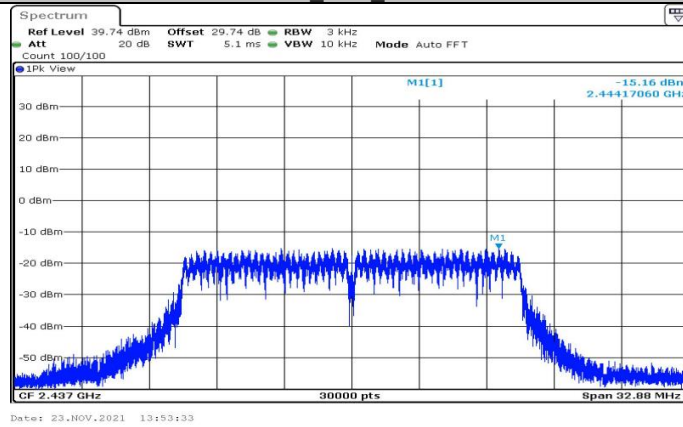
Test Graphs



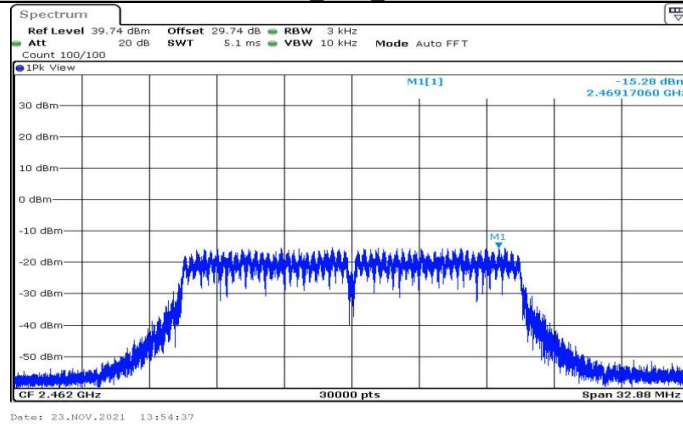
11G_Ant1_2412

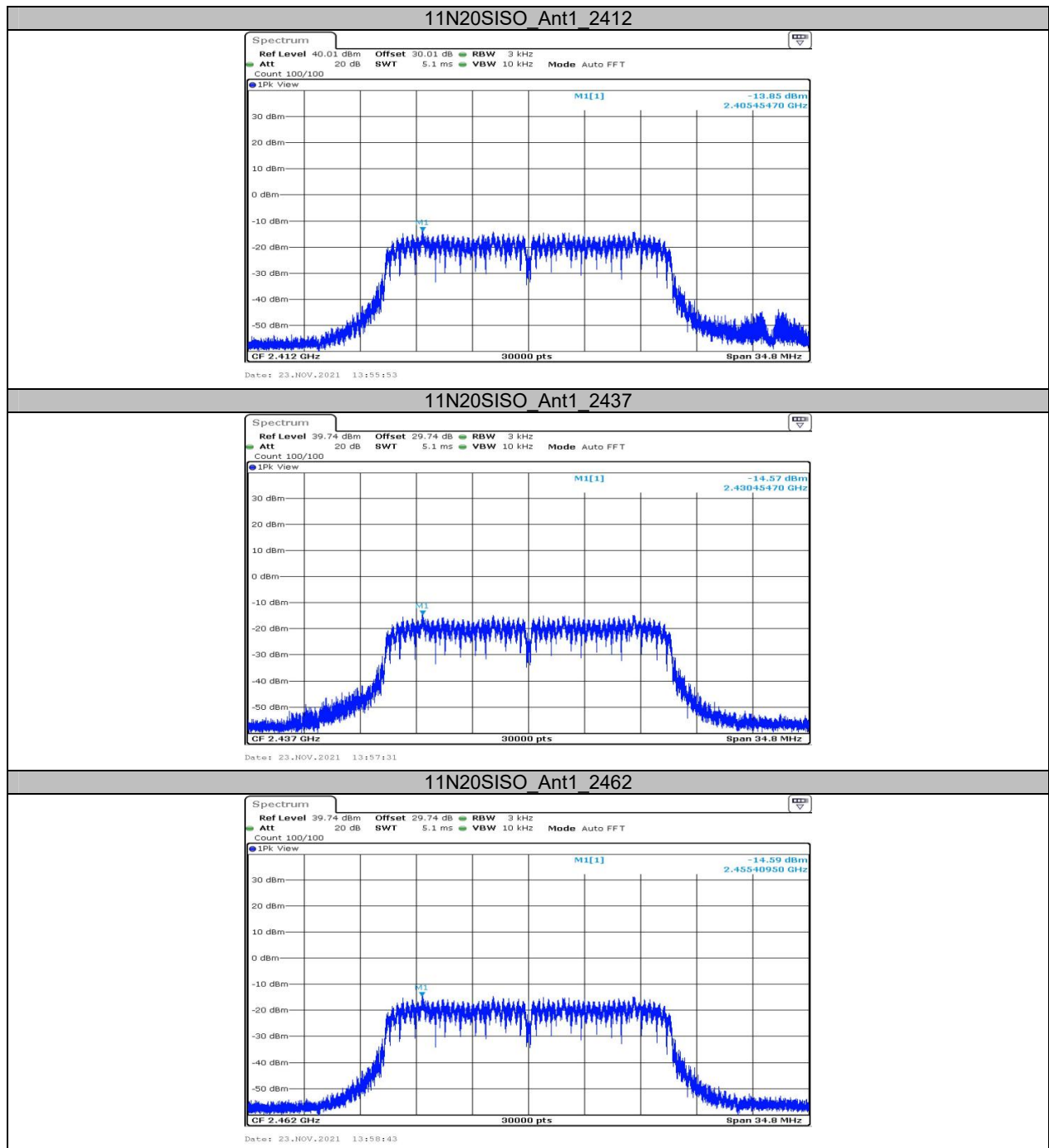


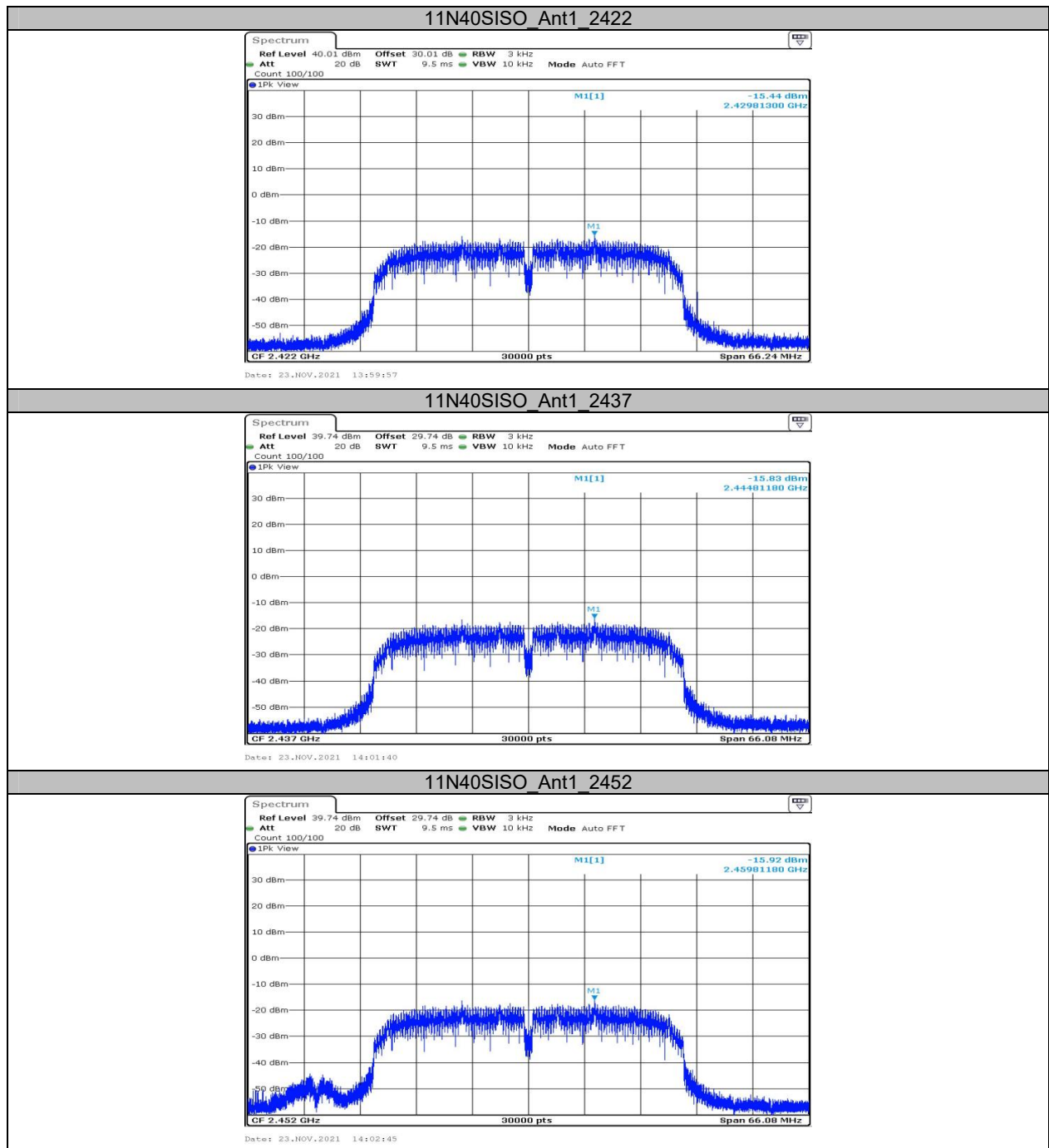
11G_Ant1_2437



11G_Ant1_2462



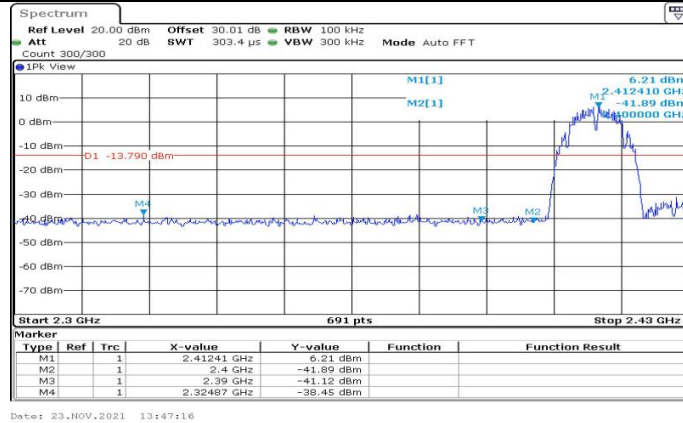




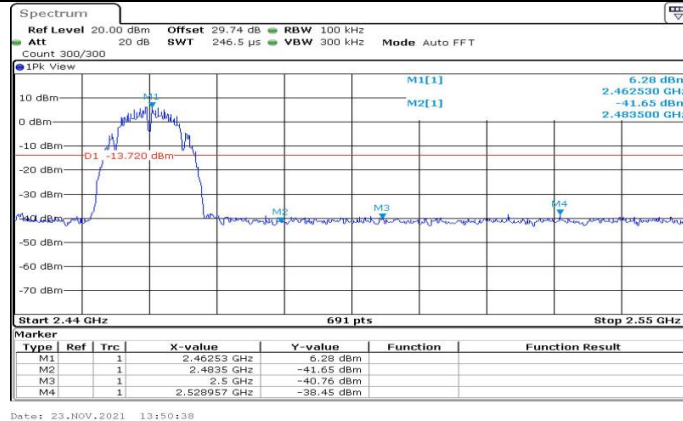
Appendix E: Band edge measurements

Test Graphs

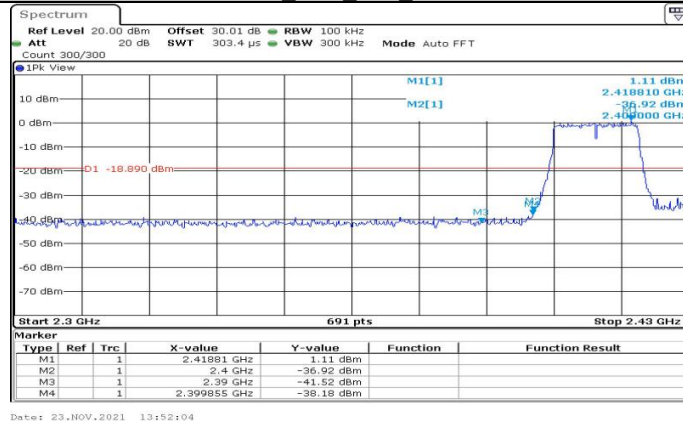
11B Ant1 Low 2412



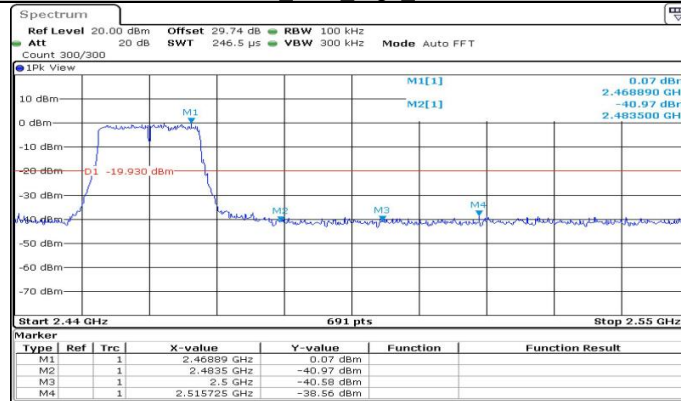
11B Ant1 High 2462



11G Ant1 Low 2412

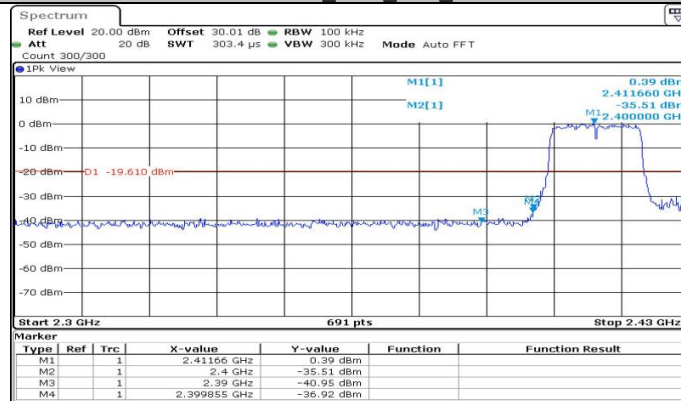


11G Ant1_High_2462



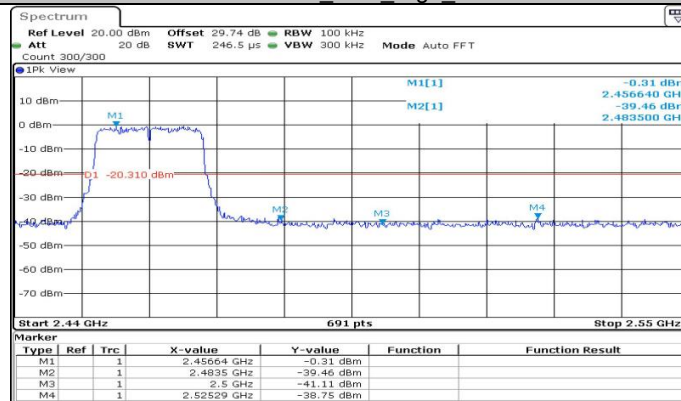
Date: 23.NOV.2021 13:54:45

11N20SISO Ant1_Low_2412

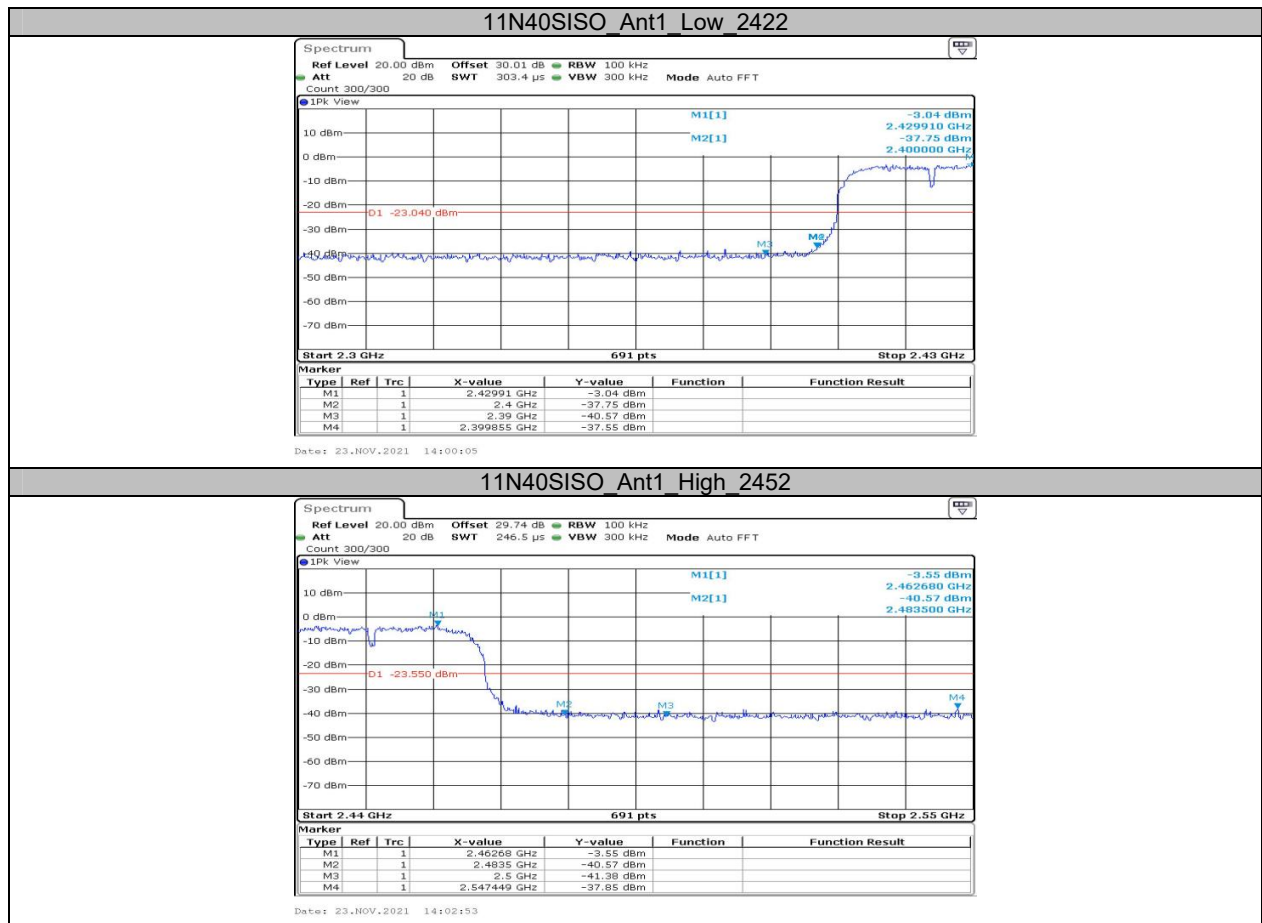


Date: 23.NOV.2021 13:56:02

11N20SISO Ant1_High_2462



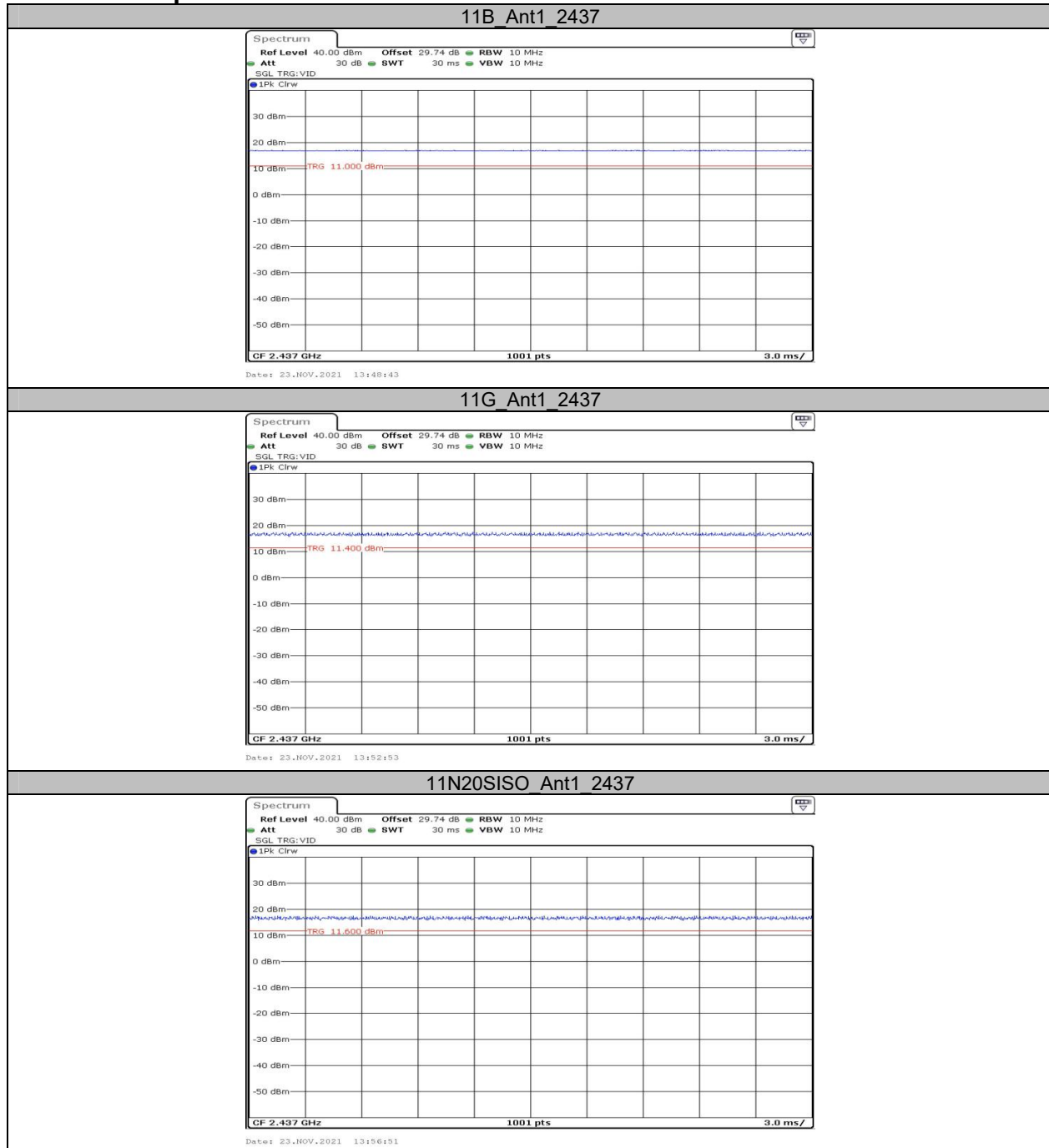
Date: 23.NOV.2021 13:58:52

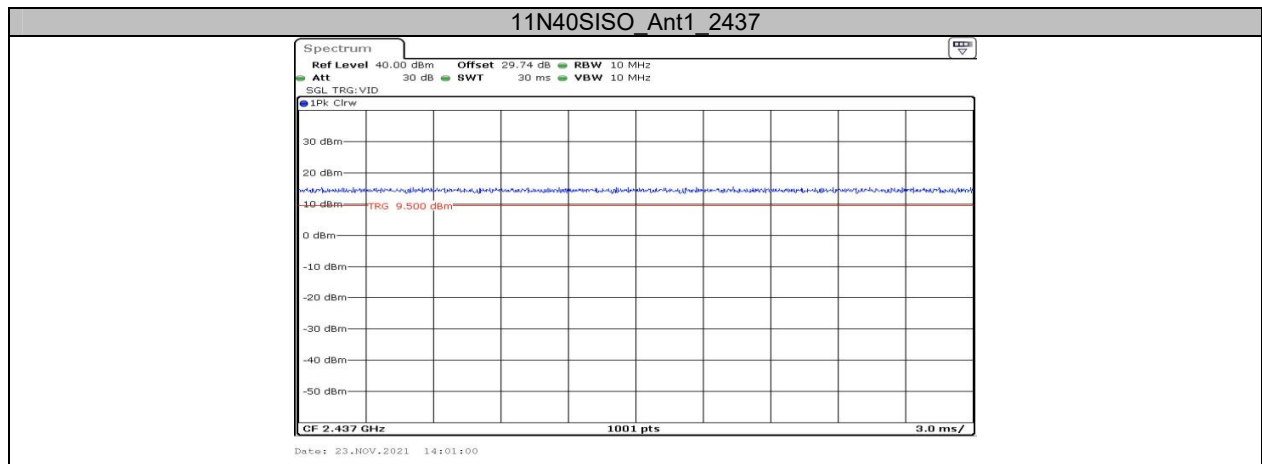


Appendix F: Duty Cycle Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2437	30.00	30.00	100.00
11G	Ant1	2437	30.00	30.00	100.00
11N20SISO	Ant1	2437	30.00	30.00	100.00
11N40SISO	Ant1	2437	30.00	30.00	100.00

Test Graphs





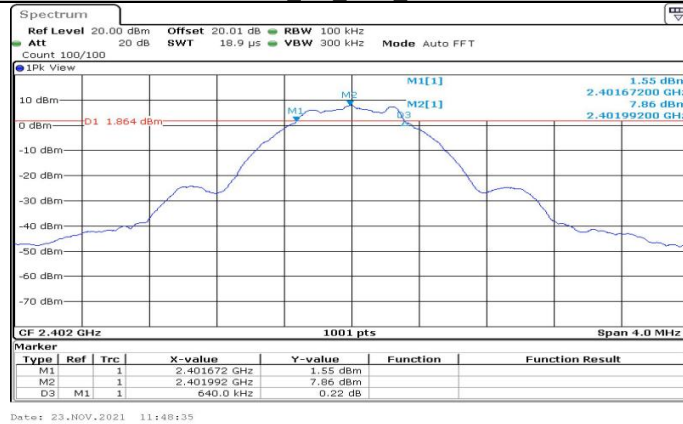
APPENDIX BLE

Appendix A: DTS Bandwidth Test Result

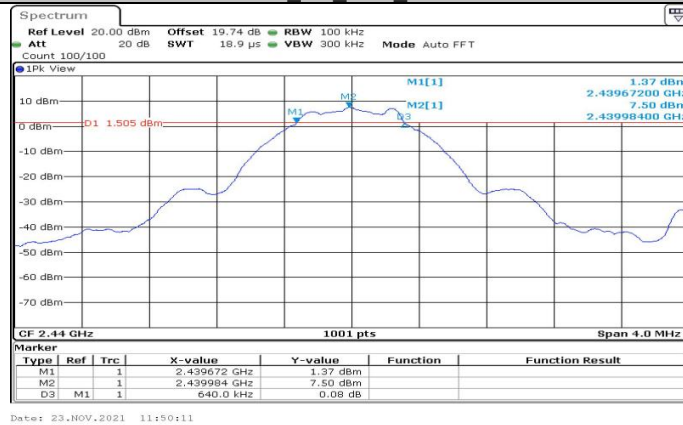
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.640	0.5	PASS
		2440	0.640	0.5	PASS
		2480	0.640	0.5	PASS

Test Graphs

BLE 1M Ant1 2402



BLE 1M Ant1 2440



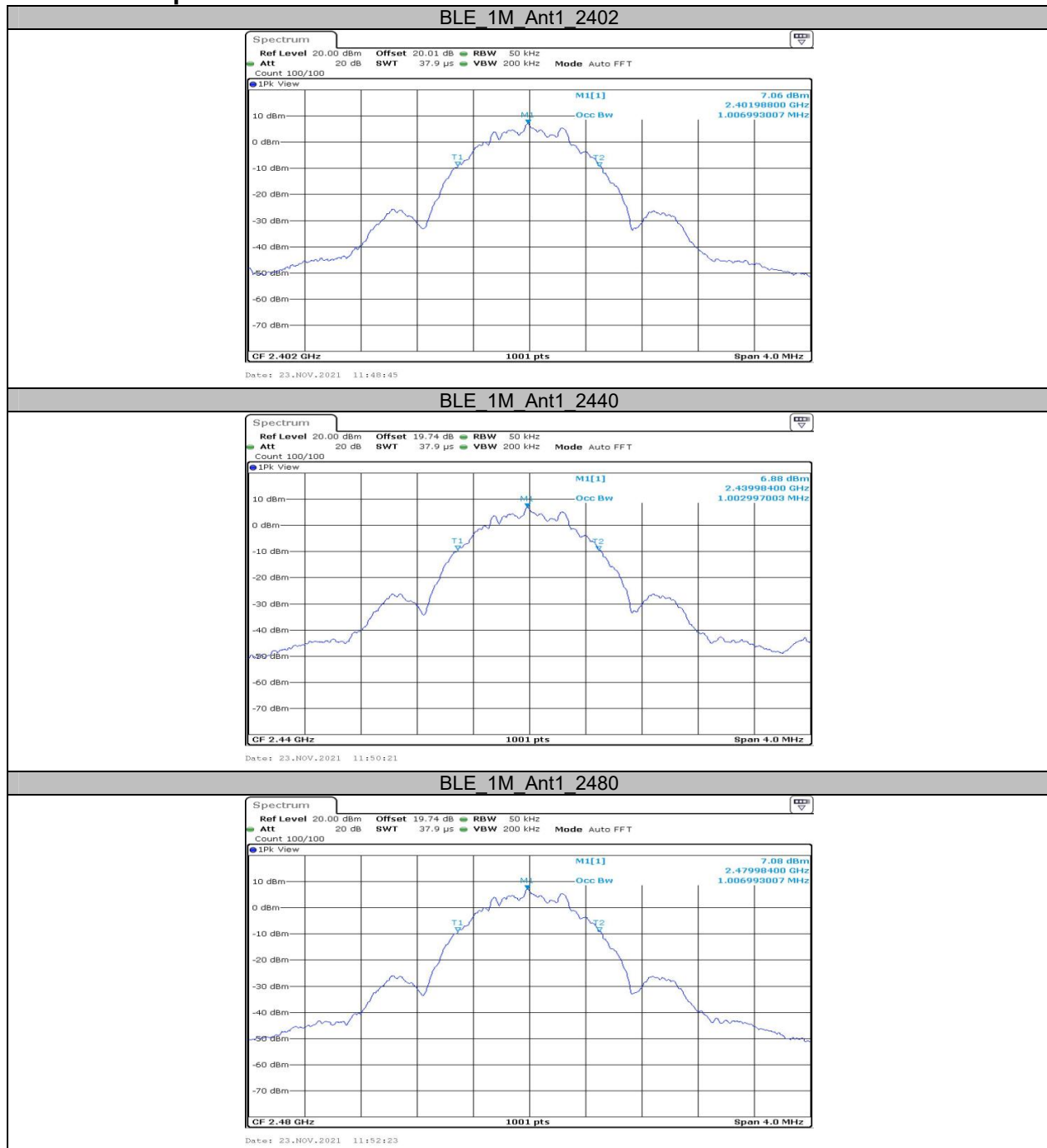
BLE 1M Ant1 2480



Appendix B: Occupied Channel Bandwidth Test Result

Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.007	---	PASS
		2440	1.003	---	PASS
		2480	1.007	---	PASS

Test Graphs



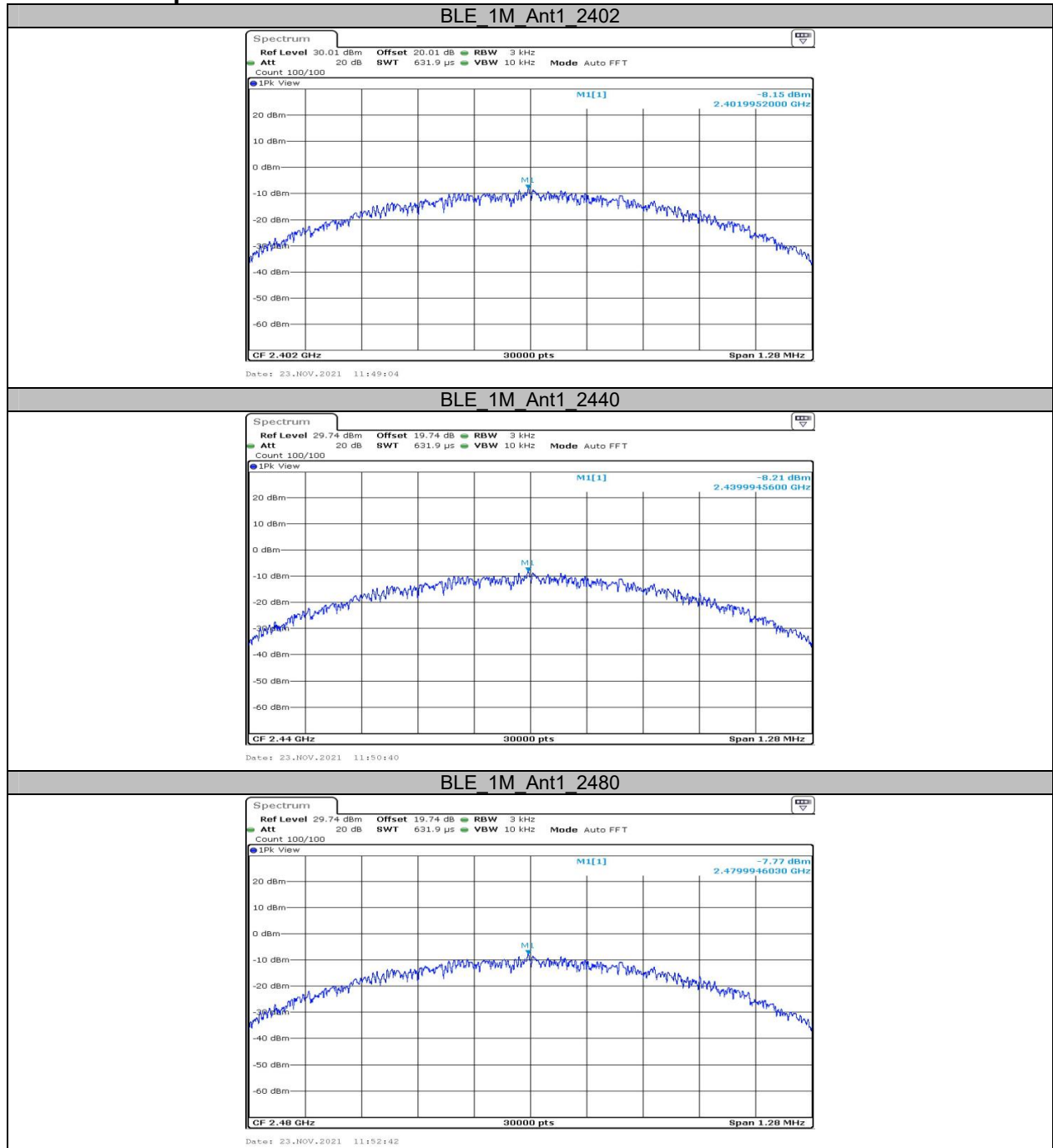
**Appendix C: Maximum conducted Peak output power
Test Result**

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	8.38	≤30	PASS
		2440	8.51	≤30	PASS
		2480	8.78	≤30	PASS

Appendix D: Maximum power spectral density Test Result

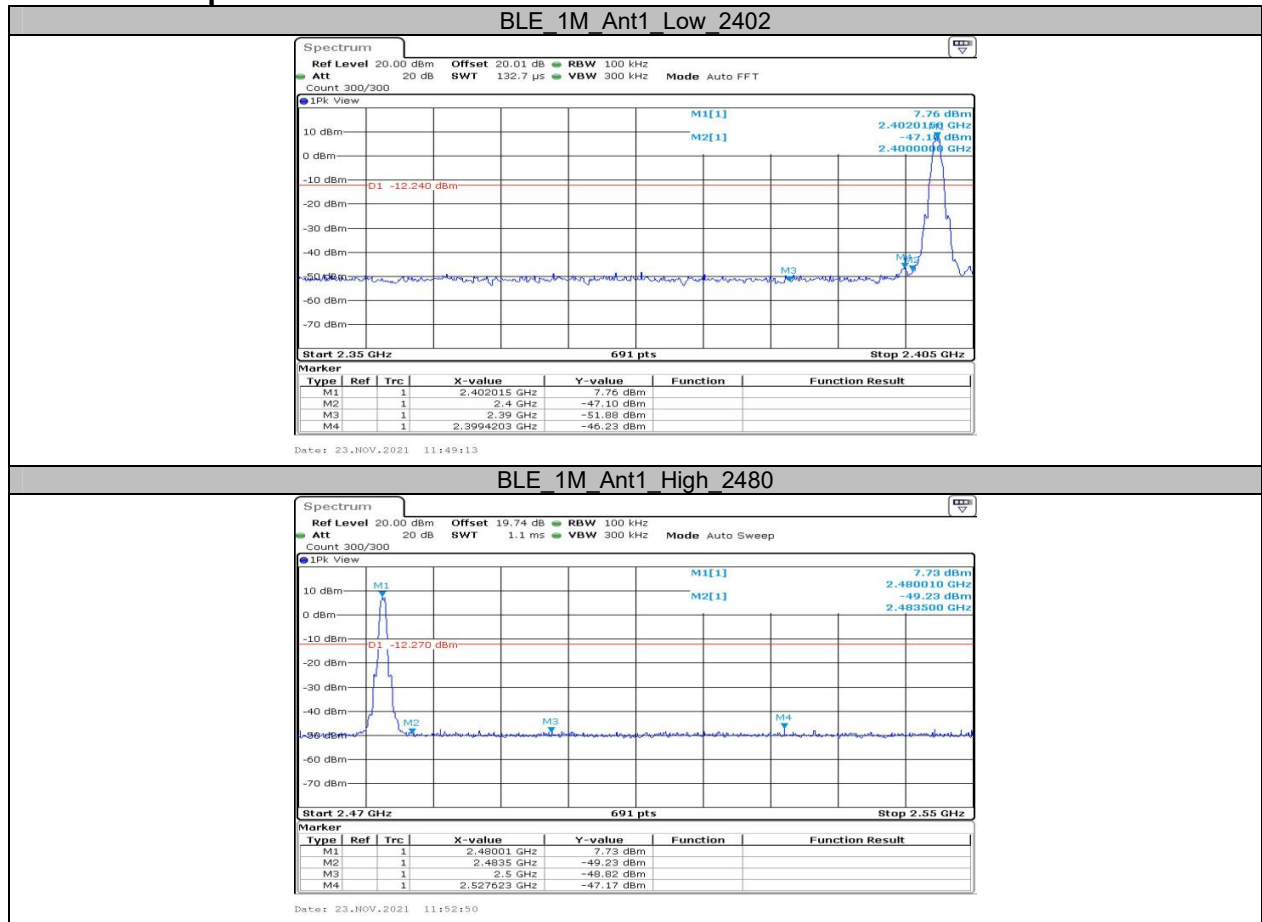
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-8.15	≤8	PASS
		2440	-8.21	≤8	PASS
		2480	-7.77	≤8	PASS

Test Graphs



Appendix E: Band edge measurements

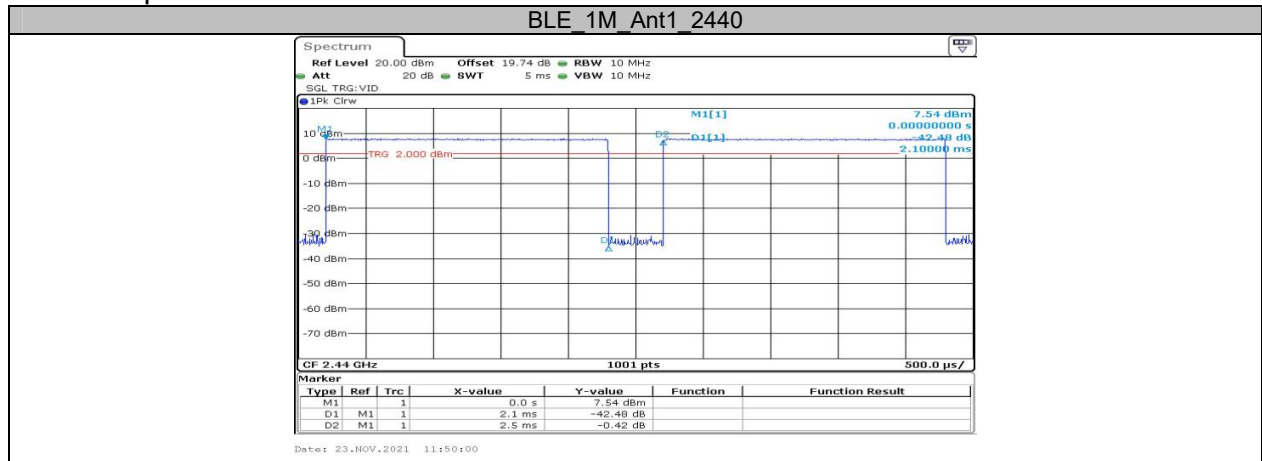
Test Graphs



Appendix F: Duty Cycle Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	2.10	2.50	84.00

Test Graphs



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