TESTREPORT

Applicant Name :	Altobeam(China) Inc.
Address :	No. A1 A2 D 8F Building 2 1# Yard Wangzhuang Road Haidian District Beijing China
Report Number:	BJ220706-30561E-RF
FCC ID:	2AOXXATBM601X

Test Standard (s)

FCC Part 15.247

Sample Description

Product:	Wi-Fi Module
Tested Model:	ATBM601X
Trade Name:	AltoBeam
Date Received:	2022-07-06
Date of Test:	2022-07-28 to 2022-11-15
Report Date:	2022-11-17

Test Result:	Pass*

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

Prepared and Checked By:

Roger.Ling

Roger.Ling
EMC Engineer

Approved By:

Candy. Li

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 testresults are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Wi-Fi Module
Tested Model	ATBM601X
Frequency Range	Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	Wi-Fi: 15.48dBm(802.11b), 16.83dBm(802.11g), 16.56dBm(802.11n20)
Modulation Technique	Wi-Fi: DSSS, OFDM
Antenna Specification*	Dipole Antenna: 2.25dBi(provided by the applicant)
Voltage Range	DC 3.3V
Sample serial number	BJ220706-30561E-RF-S1(Assigned by ATC, Shenzhen)
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 Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz- 18GHz	4.98dB
	18GHz- 26.5GHz	5.06dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

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

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189.

Accredited by American Association for Laboratory Accreditation (A2LA). The Certificate Number is 4297.01

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 802.11b, 802.11g, 802.11n-HT20, 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 Channel1, 6 and 11.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

Software “test-gui-litepoint.exe”* was used during testing and power level as below:

Mode	Data Rate (Mbps)	Power Level*
802.11 b	1	Default
802.11 g	6	Default
802.11 n20	MCS0	Default

The worse-case data rates are determined to be as above for each mode based upon investigations by measuring the output power and PSD across all data rates, bandwidths and modulations.

Duty cycle

Test Result: Compliant. Please refer to the Appendix F

Support Equipment List and Details

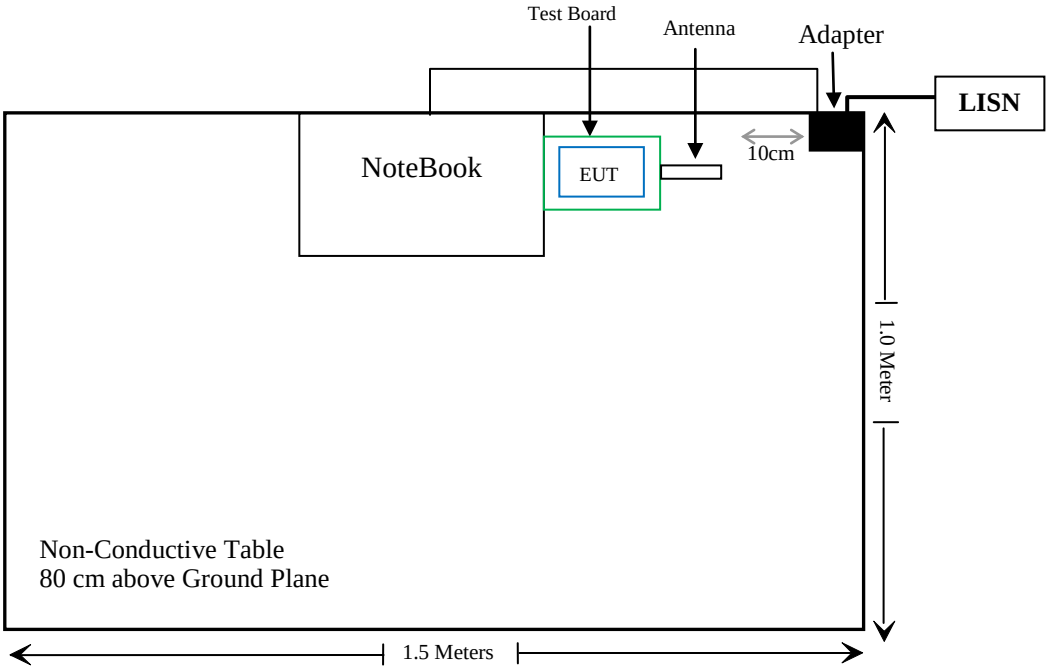
Manufacturer	Description	Model	Serial Number
Lenovo	NoteBook	T430	23447YC
Lenovo	Adapter	ADLX65NLC3A	11S45N0257Z1ZX1773ND2K
AltoBeam Inc.	Test Board	ATBM601X USB Mother Board	20211130V1.2

External I/O Cable

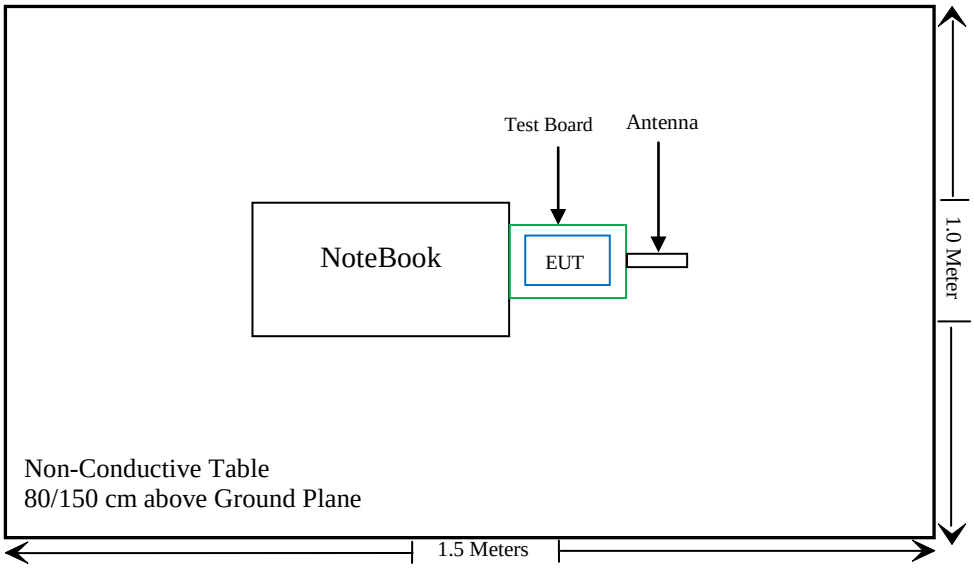
Cable Description	Length (m)	From Port	To
Un-shielding Detachable AC Cable	1.2	LISN	Adapter
Un-shielding Un-Detachable DC Cable	1.5	Adapter	NoteBook

Block Diagram of Test Setup

For Conducted Emission



For Radiated Emission



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i) & §1.1307(b)	RF Exposure	Compliant
§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)	100kHz 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 Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde & Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde & Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2021/12/14	2022/12/13
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
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
Rohde & Schwarz	Open Switch and ControlUnit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.33	RF-03	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 §1.1307(b) – RF EXPOSURE

Applicable Standard

According to KDB 447498 D04 Interim General RF Exposure Guidance v01, clause 2.1.4–MPE-Based Exemption:

An alternative to the SAR-based exemption is provided in § 1.1307(b)(3)(i)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the product of the maximum antenna gain and the delivered maximum time-averaged power. For this case, a RF source is an RF exempt device if its ERP (watts) is no more than a frequency-dependent value, as detailed tabular form in Appendix B. These limits have been derived based on the basic specifications on Maximum Permissible Exposure (MPE) considered for the FCC rules in § 1.1310(e)(1).

Table to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.

f = frequency in MHz;
R = minimum separation distance from the body of a nearby person (appropriate units, e.g., m);

Test Result

For worst case:

Mode	Frequency Range (MHz)	Tune-up Output Power		Antenna Gain		ERP		Evaluation Distance (cm)	MPE-Based Exemption Limit (mW)
		(dBm)	(mW)	(dBi)	(dBd)	(dBm)	(mW)		
2.4G Wi-Fi	2412-2462	17.0	50.12	2.25	0.1	17.1	51.29	20	768

Note 1: The tune-up power was declared by the applicant.
Note 2: 0dBd=2.15dBi.

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 Dipole Antenna arrangement for 2.4G Wi-Fi, which used a unique coupling attached to the EUT and the antenna gain is 2.25dBi, fulfill the requirement of this section. Please refer to the EUT photos.

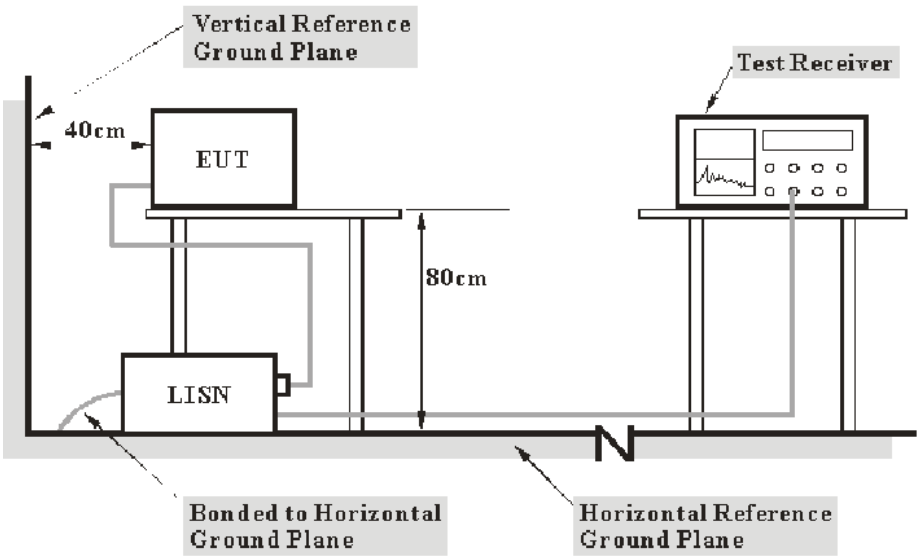
Result: Compliant.

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 30MHz.

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

FrequencyRange	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter 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.

Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss

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

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

Test Data

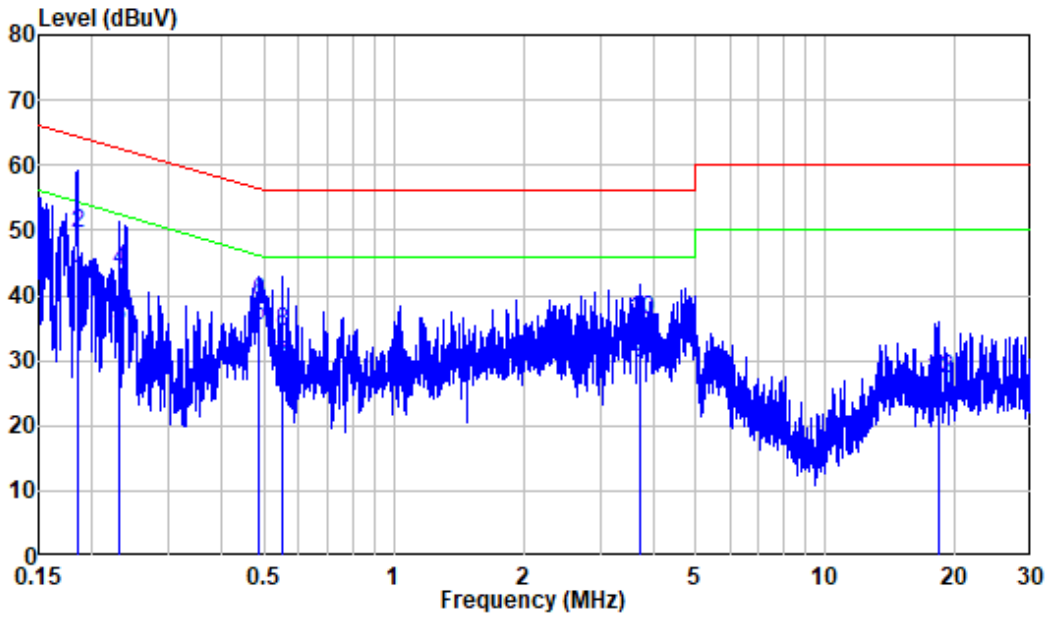
Environmental Conditions

Temperature:	24 °C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

The testing was performed by Jason Liu on 2022-11-15.

EUT operation mode: 2.4G Wi-Fi Transmitting (Worst case for 802.11B Middle channel as below)

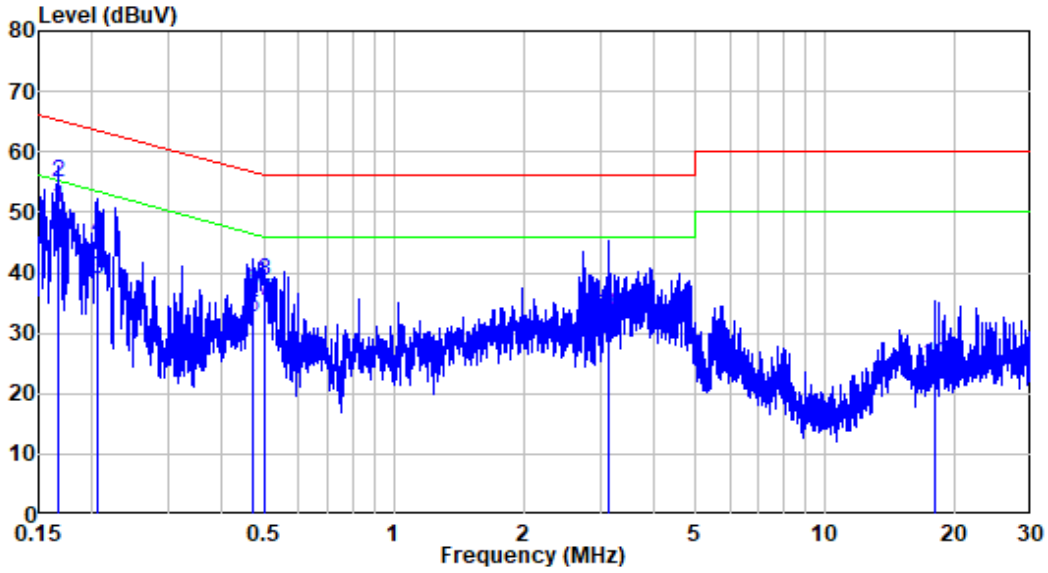
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Job No. : BJ220706-30561E-RF
Mode : 2.4G WIFI
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.184	9.80	32.39	42.19	54.29	-12.10	Average
2	0.184	9.80	39.77	49.57	64.29	-14.72	QP
3	0.231	9.80	25.48	35.28	52.42	-17.14	Average
4	0.231	9.80	33.98	43.78	62.42	-18.64	QP
5	0.488	9.80	25.56	35.36	46.20	-10.84	Average
6	0.488	9.80	29.11	38.91	56.20	-17.29	QP
7	0.553	9.81	19.36	29.17	46.00	-16.83	Average
8	0.553	9.81	24.72	34.53	56.00	-21.47	QP
9	3.710	9.84	19.65	29.49	46.00	-16.51	Average
10	3.710	9.84	26.32	36.16	56.00	-19.84	QP
11	18.268	9.98	15.77	25.75	50.00	-24.25	Average
12	18.268	9.98	17.06	27.04	60.00	-32.96	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Job No. : BJ220706-30561E-RF
Mode : 2.4G WIFI
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.166	9.80	40.81	50.61	55.15	-4.54	Average
2	0.166	9.80	45.27	55.07	65.15	-10.08	QP
3	0.205	9.80	29.05	38.85	53.40	-14.55	Average
4	0.205	9.80	35.72	45.52	63.40	-17.88	QP
5	0.471	9.80	22.91	32.71	46.49	-13.78	Average
6	0.471	9.80	27.14	36.94	56.49	-19.55	QP
7	0.500	9.80	25.54	35.34	46.00	-10.66	Average
8	0.500	9.80	28.98	38.78	56.00	-17.22	QP
9	3.156	9.83	20.82	30.65	46.00	-15.35	Average
10	3.156	9.83	23.37	33.20	56.00	-22.80	QP
11	17.944	10.08	12.17	22.25	50.00	-27.75	Average
12	17.944	10.08	14.74	24.82	60.00	-35.18	QP

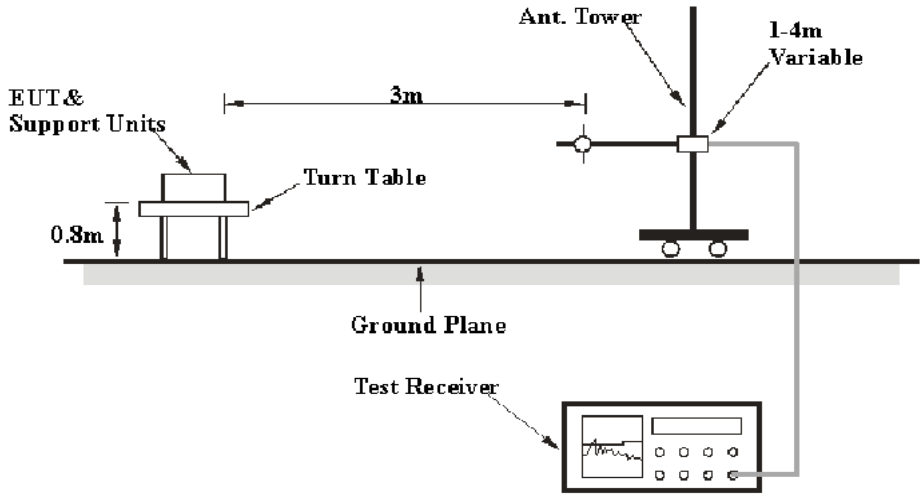
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

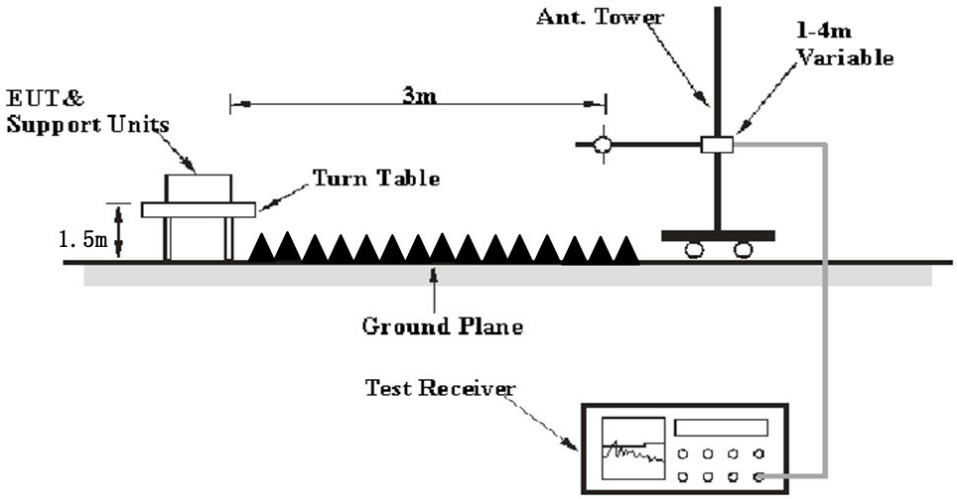
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3meters 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
30MHz – 1000 MHz	100 kHz	300 kHz	120kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz Note 1	/	Average
	1MHz	＞1/T Note 2	/	Average

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

If the maximized peak measured value complies with the limit, then it is unnecessary to perform QP/Average measurement.

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:

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

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

Test Data

Environmental Conditions

Temperature:	23℃
Relative Humidity:	62 %
ATM Pressure:	101.0 kPa

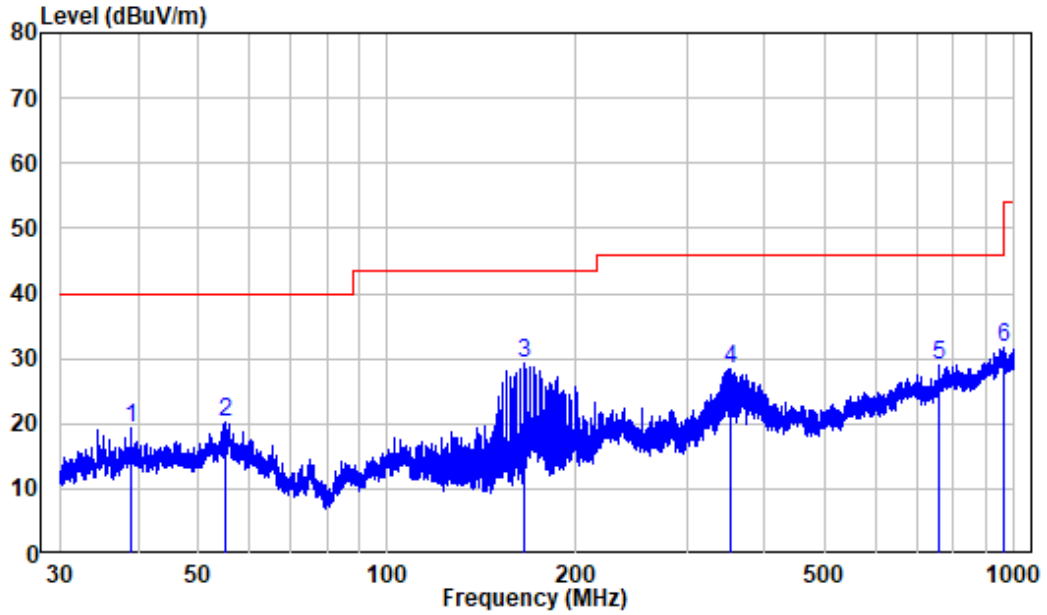
The testing was performed by Level Li on 2022-11-15.

EUT operation mode: 2.4G Wi-Fi Transmitting (Pre-scan all modes, the worst case was recorded)

30MHz-1GHz: (Worst case)

Wi-Fi: 802.11B mode, Middle Channel

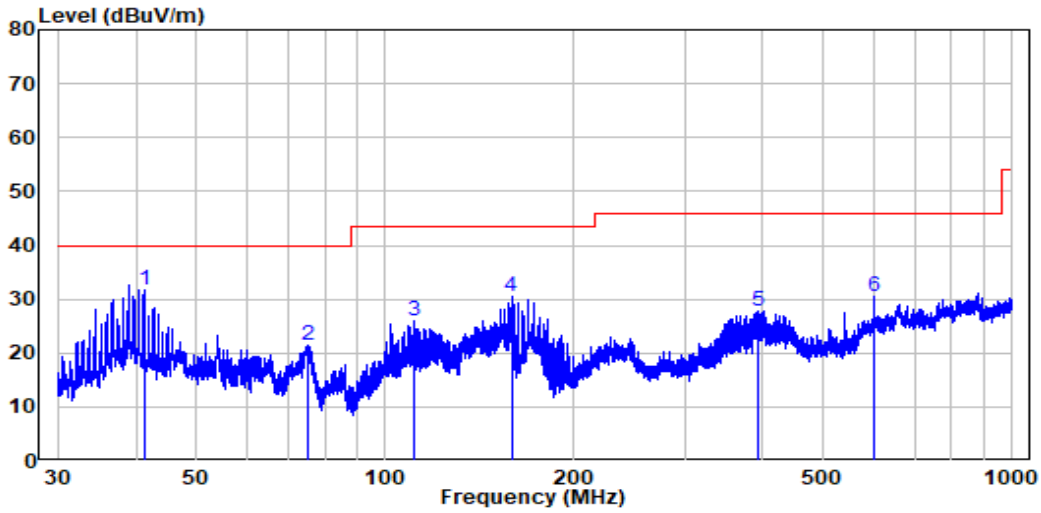
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : BJ220706-30561E-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	38.939	-10.60	29.91	19.31	40.00	-20.69	Peak
2	55.293	-10.26	30.38	20.12	40.00	-19.88	Peak
3	164.908	-14.15	43.30	29.15	43.50	-14.35	Peak
4	351.862	-7.37	35.72	28.35	46.00	-17.65	Peak
5	760.037	-0.55	29.55	29.00	46.00	-17.00	Peak
6	965.542	2.43	29.33	31.76	54.00	-22.24	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : BJ220706-30561E-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	41.186	-10.15	41.81	31.66	40.00	-8.34	Peak
2	75.347	-16.30	37.88	21.58	40.00	-18.42	Peak
3	110.763	-12.06	37.98	25.92	43.50	-17.58	Peak
4	158.877	-14.37	44.79	30.42	43.50	-13.08	Peak
5	393.818	-6.82	34.56	27.74	46.00	-18.26	Peak
6	600.110	-2.43	32.92	30.49	46.00	-15.51	Peak

1-25 GHz:

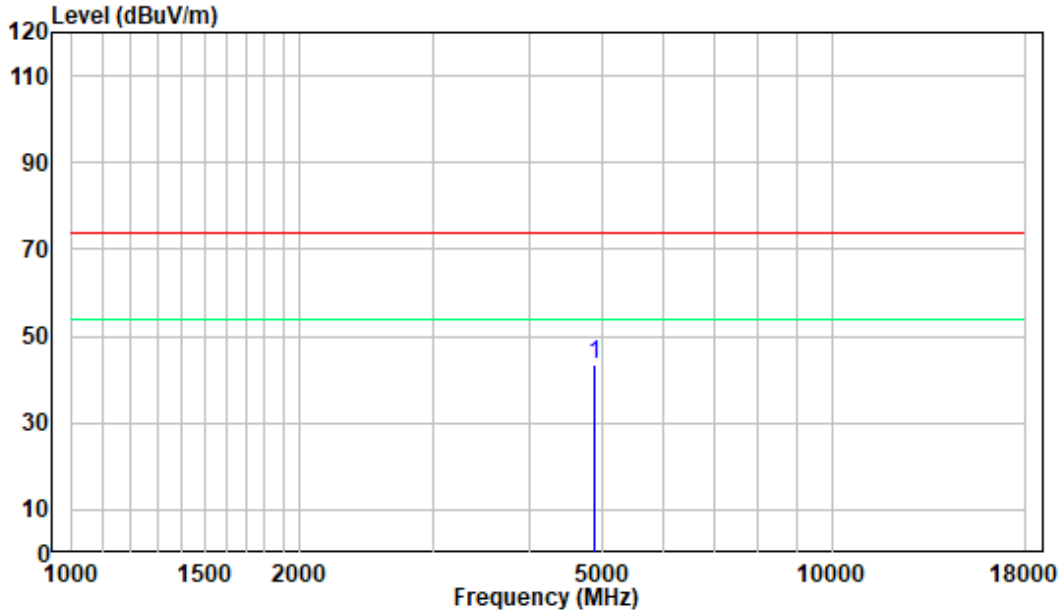
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV		Height (m)	Polar (H/V)				
802.11B, Low Channel									
2310	53.10	PK	203	1.7	H	-7.23	45.87	74	-28.13
2310	52.07	PK	260	1.7	V	-7.23	44.84	74	-29.16
2390	58.83	PK	148	1.6	H	-7.21	51.62	74	-22.38
2390	56.38	PK	256	2.1	V	-7.21	49.17	74	-24.83
4824	46.51	PK	264	1.1	H	-3.53	42.98	74	-31.02
4824	48.80	PK	188	1.8	V	-3.53	45.27	74	-28.73
802.11B, Middle Channel									
4874	47.02	PK	53	1.0	H	-3.42	43.60	74	-30.4
4874	49.77	PK	97	1.4	V	-3.42	46.35	74	-27.65
802.11B, High Channel									
2483.5	57.47	PK	13	2	H	-7.2	50.27	74	-23.73
2483.5	61.87	PK	110	1.5	V	-7.2	54.67	74	-19.33
2483.5	42.81	AV	110	1.5	V	-7.2	35.61	54	-18.39
2500	54.86	PK	228	1.2	H	-7.18	47.68	74	-26.32
2500	56.66	PK	235	1.7	V	-7.18	49.48	74	-24.52
4924	46.65	PK	256	1.6	H	-3.16	43.49	74	-30.51
4924	48.59	PK	31	2.1	V	-3.16	45.43	74	-28.57
802.11G, Low Channel									
2310	54.14	PK	287	1.3	H	-7.23	46.91	74	-27.09
2310	57.31	PK	153	2.2	V	-7.23	50.08	74	-23.92
2390	67.67	PK	344	2.1	H	-7.21	60.46	74	-13.54
2390	48.24	AV	344	2.1	H	-7.21	41.03	54	-12.97
2390	76.44	PK	78	1.2	V	-7.21	69.23	74	-4.77
2390	57.50	AV	78	1.2	V	-7.21	50.29	54	-3.71
4824	46.34	PK	121	2.2	H	-3.53	42.81	74	-31.19
4824	46.82	PK	187	2.2	V	-3.53	43.29	74	-30.71
802.11G, Middle Channel									
4874	46.47	PK	178	1.0	H	-3.42	43.05	74	-30.95
4874	48.84	PK	333	1.8	V	-3.42	45.42	74	-28.58
802.11G, High Channel									
2483.5	62.7	PK	57	1.8	H	-7.2	55.5	74	-18.5
2483.5	44.63	AV	57	1.8	H	-7.2	37.43	54	-16.57
2483.5	76.32	PK	204	1.8	V	-7.2	69.12	74	-4.88
2483.5	57.23	AV	204	1.8	V	-7.2	50.03	54	-3.97
2500	56.62	PK	177	2	H	-7.18	49.44	74	-24.56
2500	58.46	PK	245	1.5	V	-7.18	51.28	74	-22.72
4924	45.21	PK	137	2	H	-3.16	42.05	74	-31.95
4924	49.03	PK	287	1.2	V	-3.16	45.87	74	-28.13

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV		Height (m)	Polar (H/V)				
802.11N20, Low Channel									
2310	54.96	PK	3	1.3	H	-7.23	47.73	74	-26.27
2310	56.19	PK	192	2.2	V	-7.23	48.96	74	-25.04
2390	68.66	PK	281	2.3	H	-7.21	61.45	74	-12.55
2390	51.68	AV	281	2.3	H	-7.21	44.47	54	-9.53
2390	77.04	PK	296	1.7	V	-7.21	69.83	74	-4.17
2390	57.55	AV	296	1.7	V	-7.21	50.34	54	-3.66
4824	45.52	PK	45	2.0	H	-3.53	41.99	74	-32.01
4824	46.78	PK	56	1.5	V	-3.53	43.25	74	-30.75
802.11N20, Middle Channel									
4874	45.60	PK	184	1.1	H	-3.42	42.18	74	-31.82
4874	49.41	PK	203	2.1	V	-3.42	45.99	74	-28.01
802.11N20, High Channel									
2483.5	62.65	PK	281	1.3	H	-7.2	55.45	74	-18.55
2483.5	46.01	AV	281	1.3	H	-7.2	38.81	54	-15.19
2483.5	72.97	PK	5	2.1	V	-7.2	65.77	74	-8.23
2483.5	55.79	AV	5	2.1	V	-7.2	48.59	54	-5.41
2500	54.03	PK	136	1.6	H	-7.18	46.85	74	-27.15
2500	58.66	PK	163	2.1	V	-7.18	51.48	74	-22.52
4924	46.75	PK	164	2.0	H	-3.16	43.59	74	-30.41
4924	49.28	PK	210	1.5	V	-3.16	46.12	74	-27.88

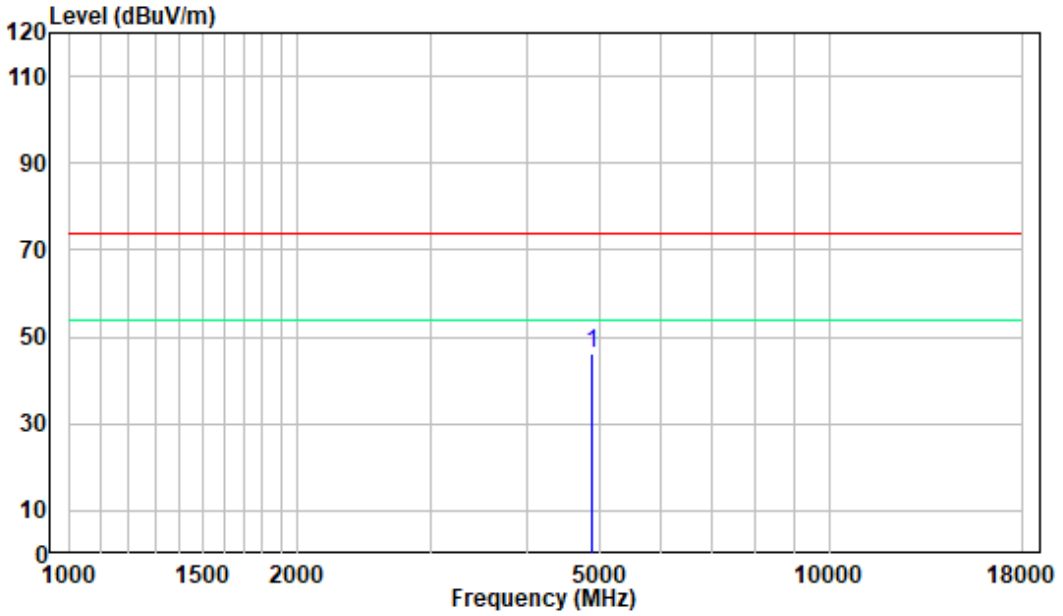
Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level (Corrected Amplitude) –Limit
The other spurious emission which is in the noise floor level was not recorded.
For above 1GHz, the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, so just peak value was recorded.

1-18 GHz: (Worst case)

Pre-scan plots
802.11 b Middle Channel
Horizontal

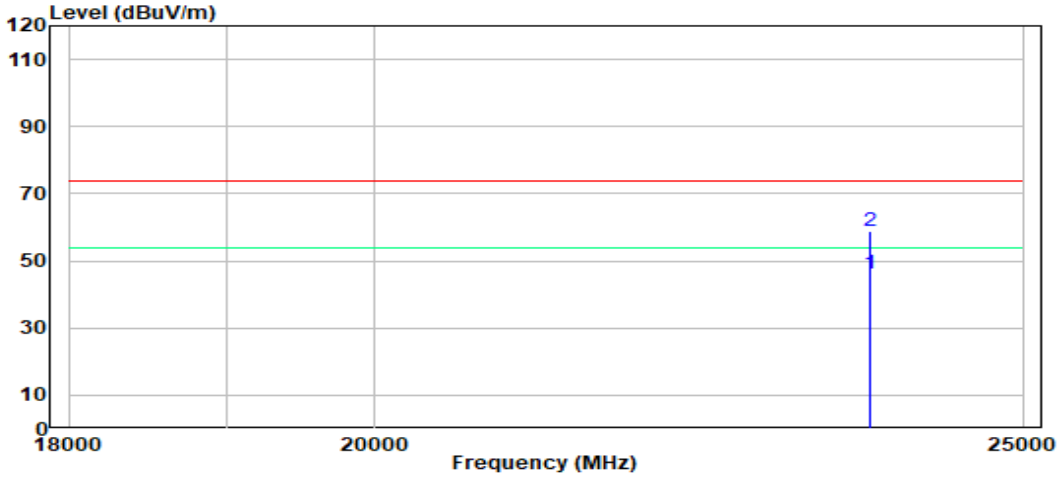


Vertical

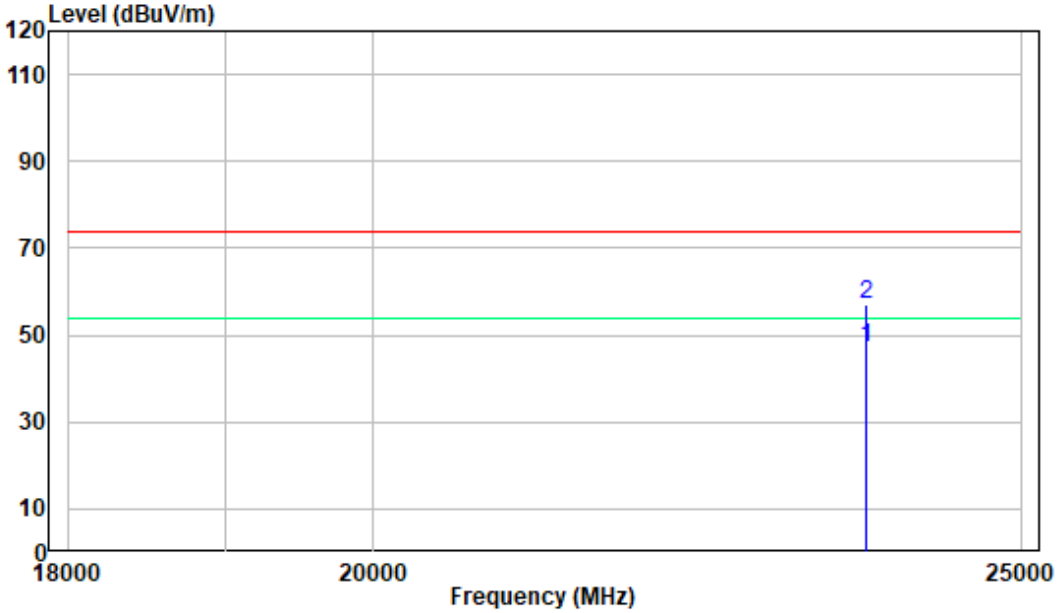


18 -25GHz: (Worst case)

Pre-scan plots
802.11 b Middle Channel
Horizontal



Vertical



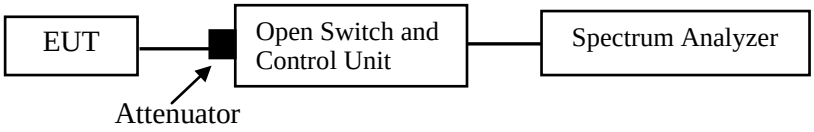
FCC §15.247(A) (2) – 6 DB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Glenn Jiang on 2022-07-28.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix A and Appendix B.

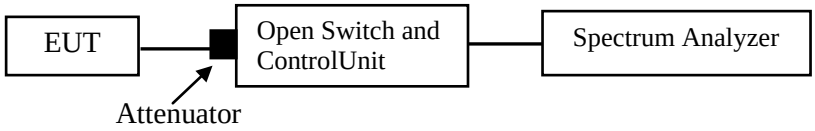
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

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

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



Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Glenn Jiang on 2022-07-28.

EUT operation mode: Transmitting

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

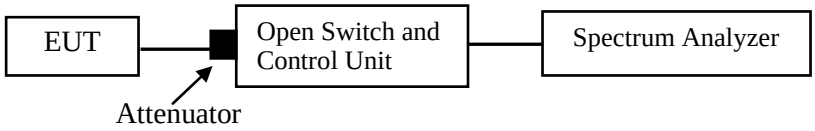
FCC §15.247(d) – 100kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Glenn Jiang on 2022-07-28.

EUT operation mode: Transmitting

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

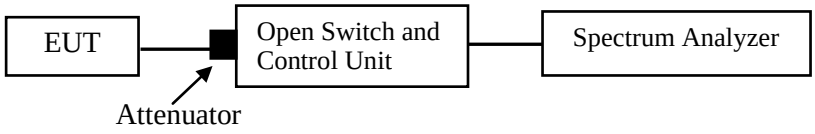
FCC §15.247(e)- POWER SPECTRAL DENSITY

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

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



Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Glenn Jiang on 2022-07-28.

EUT operation mode: Transmitting

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

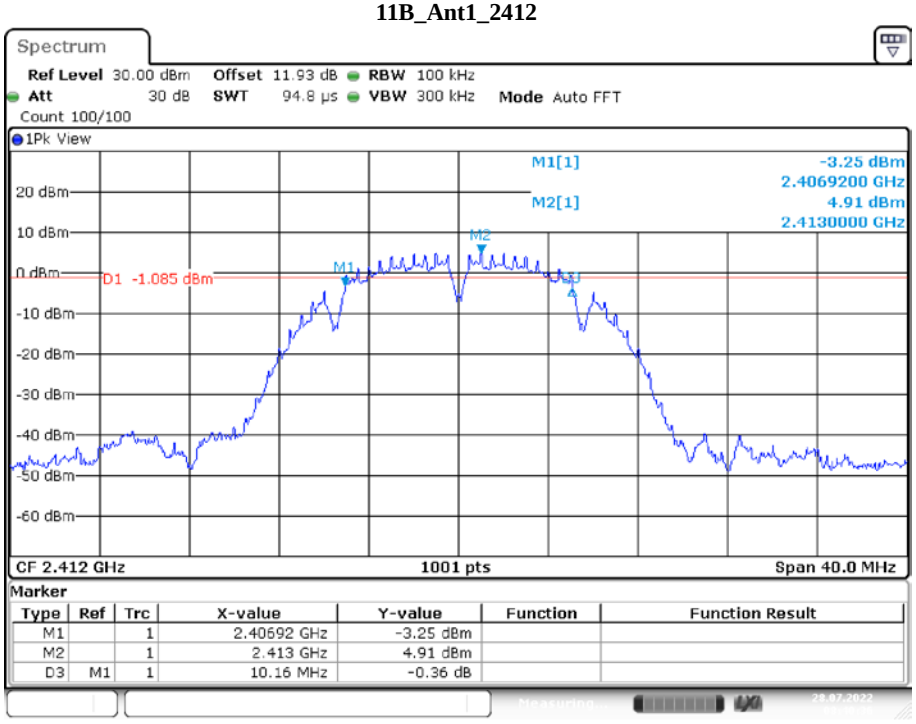
APPENDIX A: 6dB Emission Bandwidth

Test Result

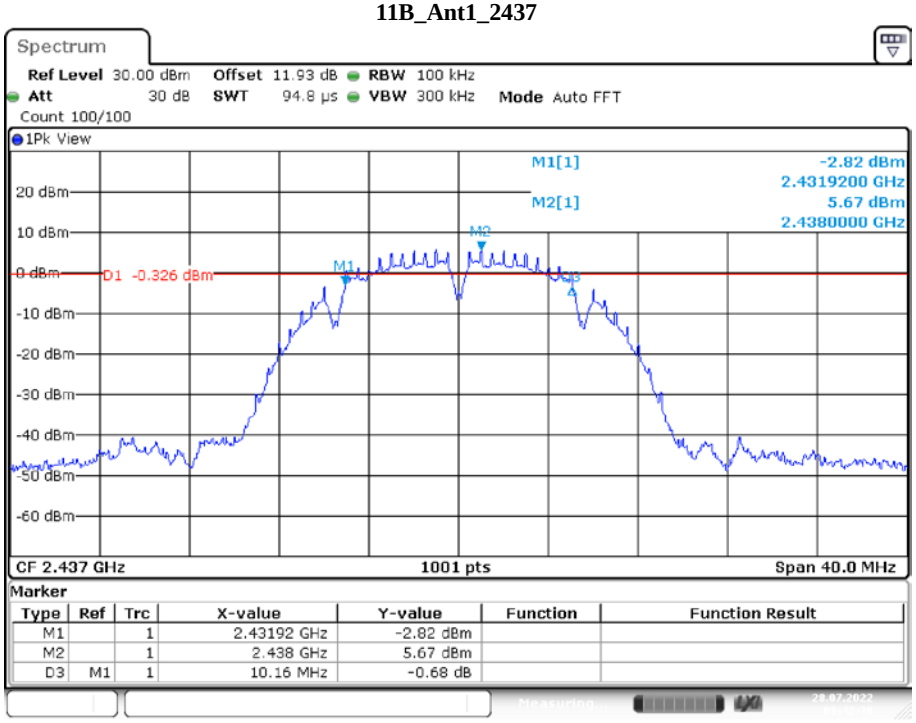
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	10.160	0.5	PASS
		2437	10.160	0.5	PASS
		2462	10.120	0.5	PASS
11G	Ant1	2412	16.400	0.5	PASS
		2437	16.400	0.5	PASS
		2462	16.400	0.5	PASS
11N20 SISO	Ant1	2412	17.200	0.5	PASS
		2437	17.120	0.5	PASS
		2462	17.120	0.5	PASS

Test Graphs

11B_Ant1_2412

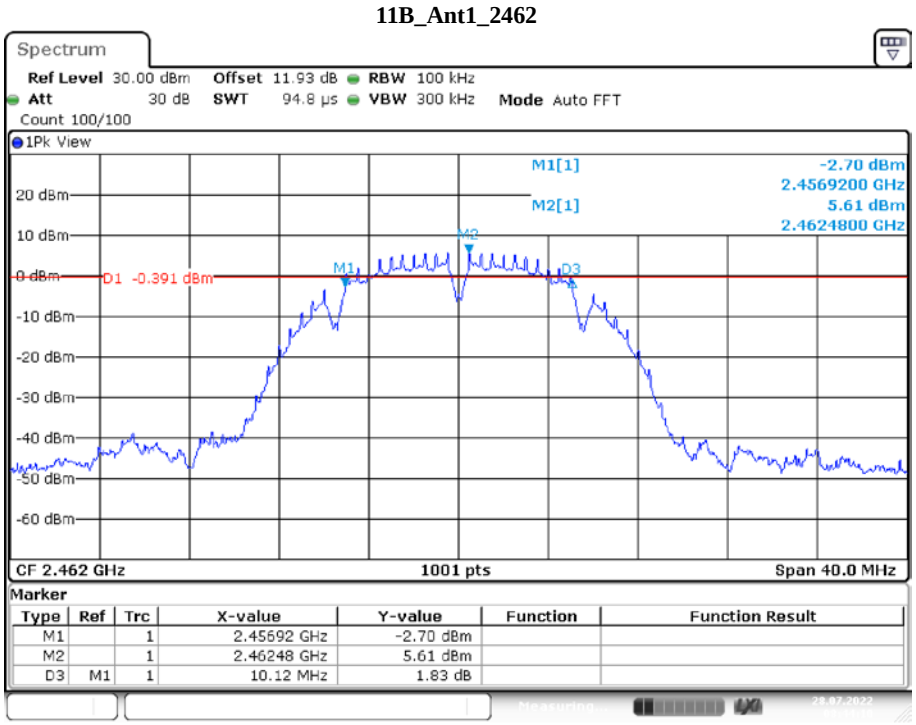


11B_Ant1_2437



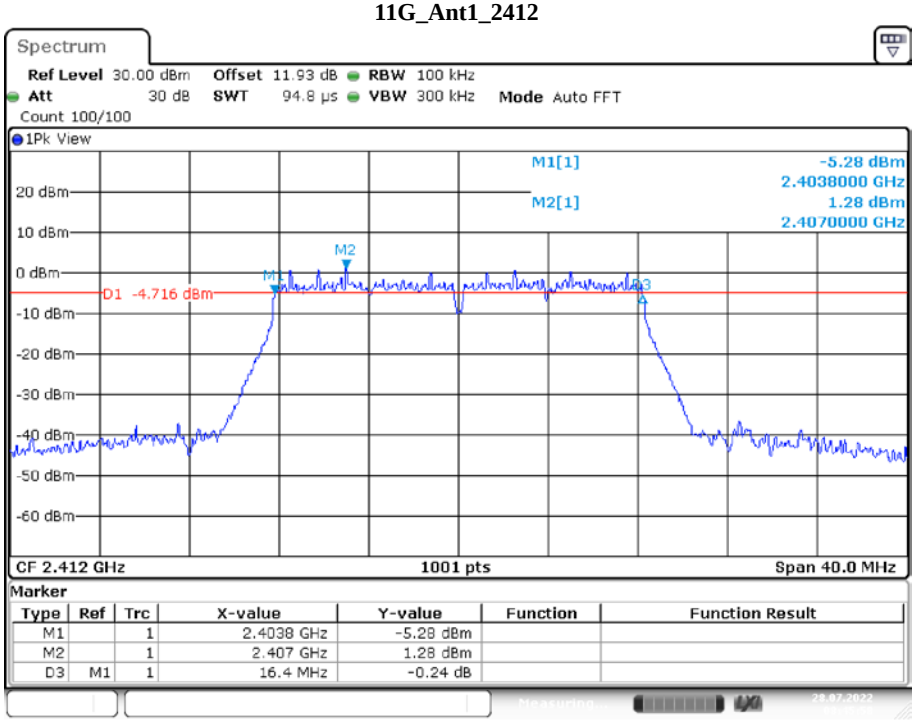
Date: 28.JUL.2022 08:42:30

11B_Ant1_2462



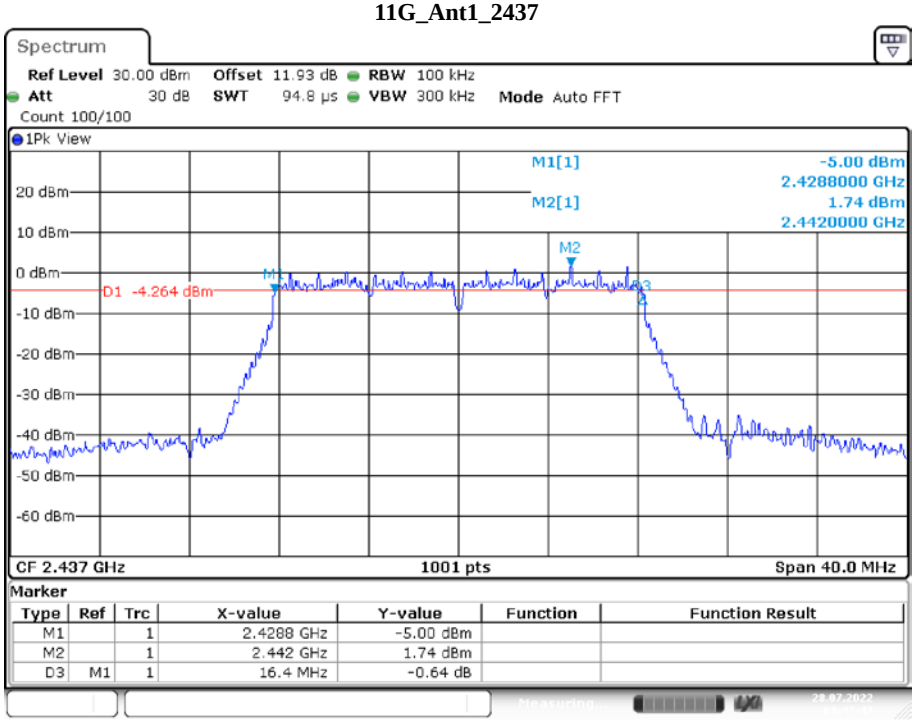
Date: 28.JUL.2022 08:44:10

11G_Ant1_2412



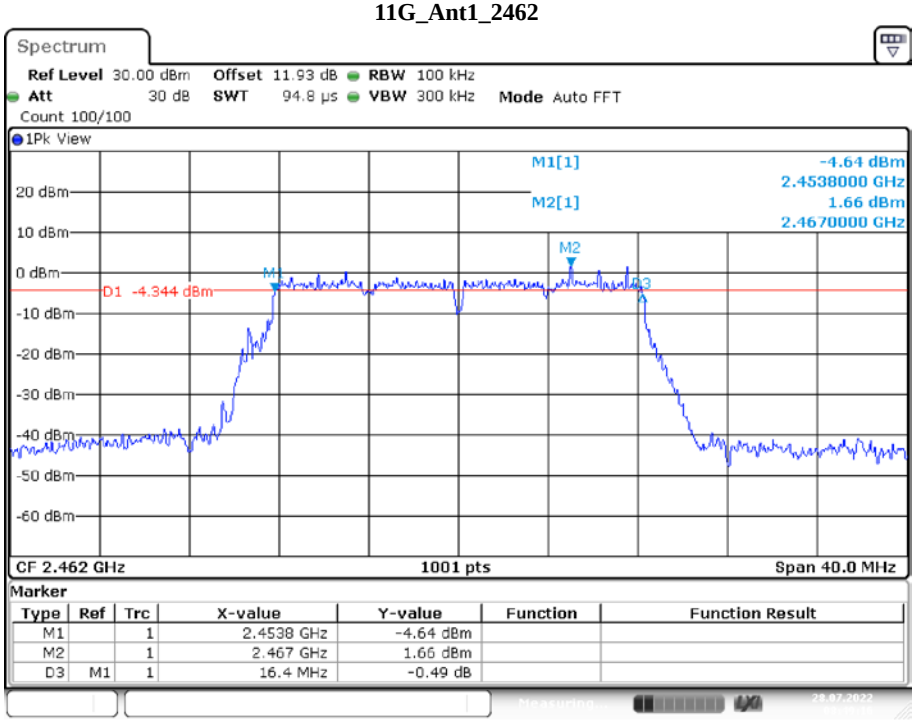
Date: 28.JUL.2022 08:45:58

11G_Ant1_2437



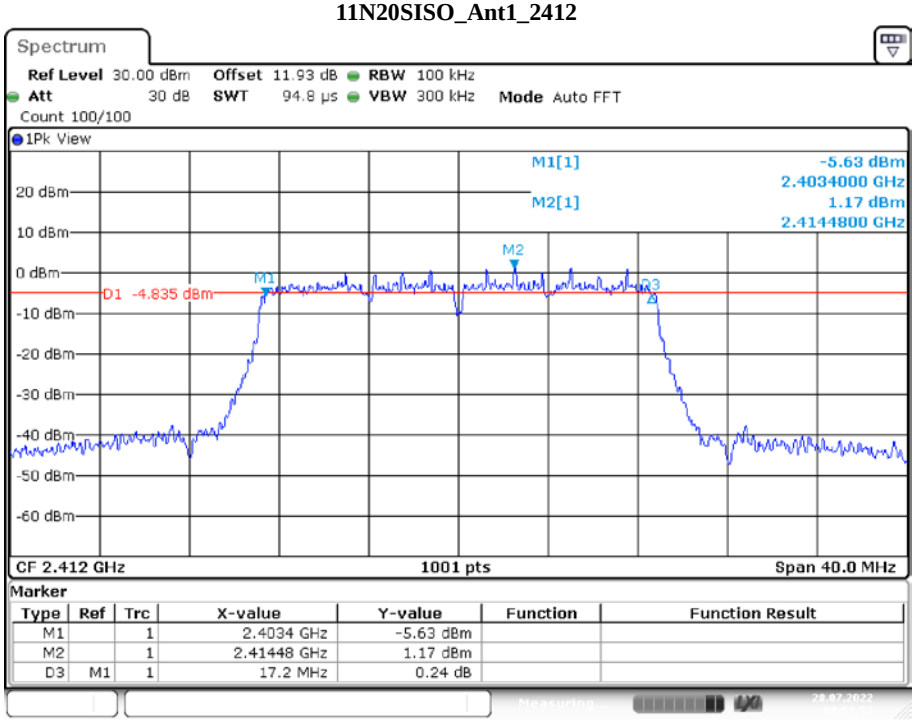
Date: 28.JUL.2022 08:47:47

11G_Ant1_2462



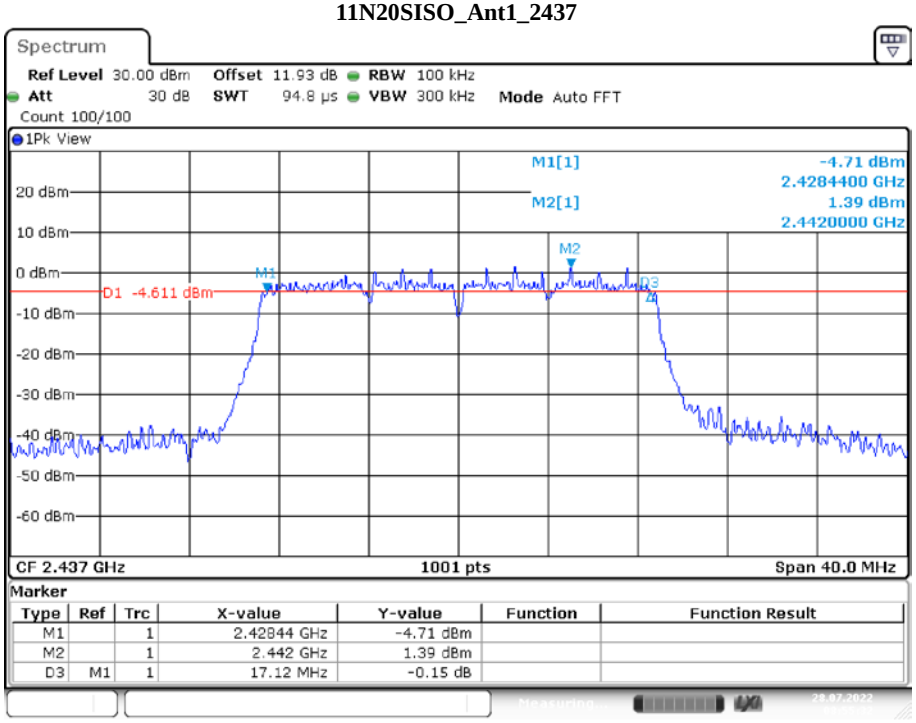
Date: 28.JUL.2022 08:49:16

11N20SISO_Ant1_2412



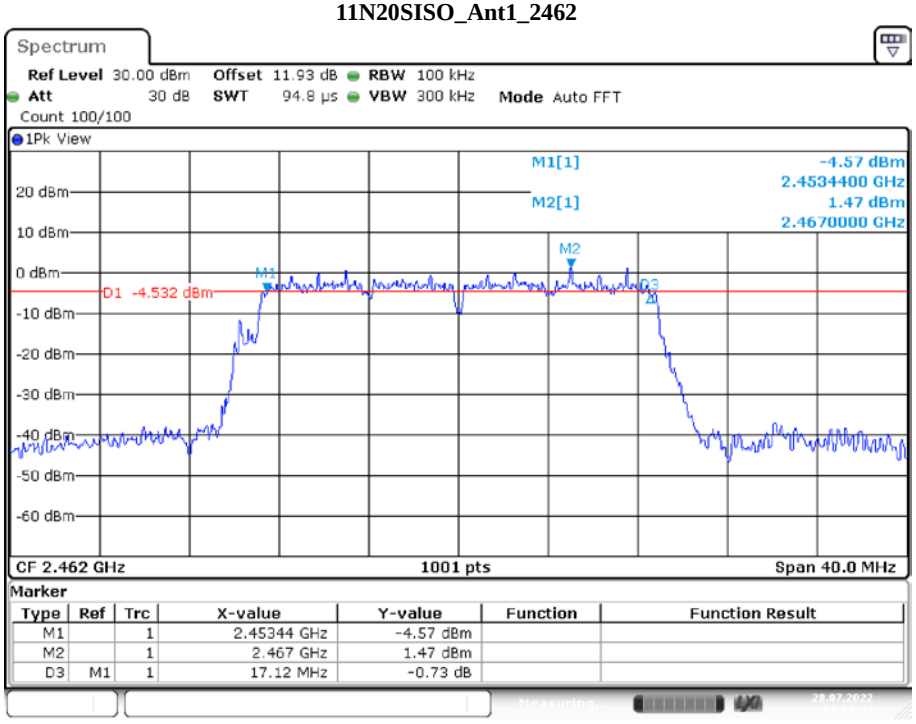
Date: 28.JUL.2022 08:53:53

11N20SISO_Ant1_2437



Date: 28.JUL.2022 08:55:33

11N20SISO_Ant1_2462



Date: 28.JUL.2022 08:58:43

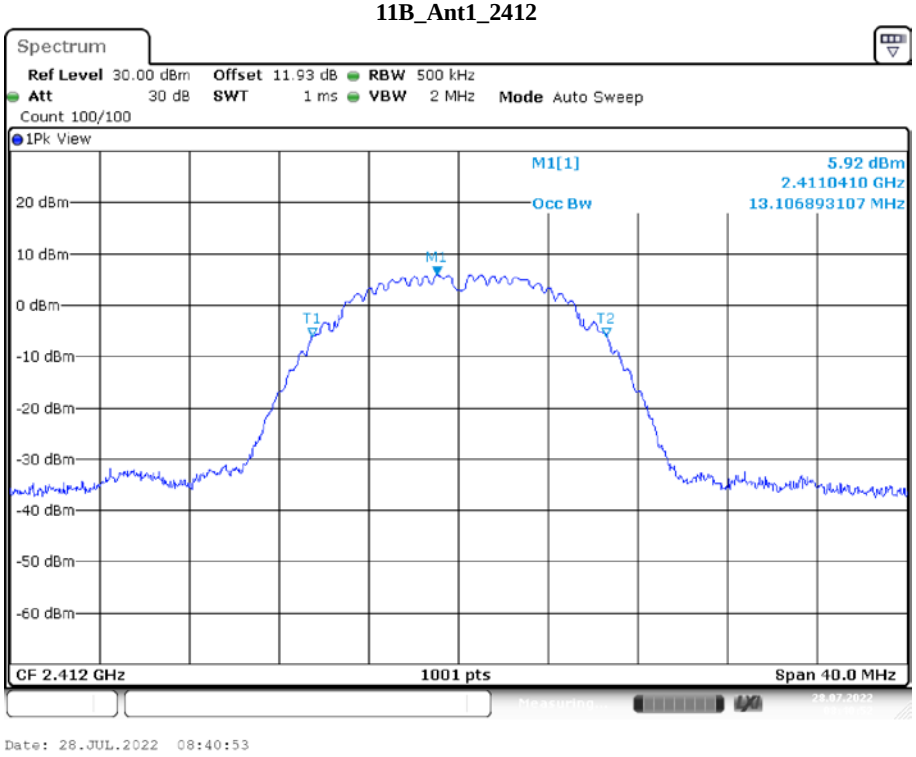
APPENDIX B: Occupied Channel Bandwidth

Test Result:

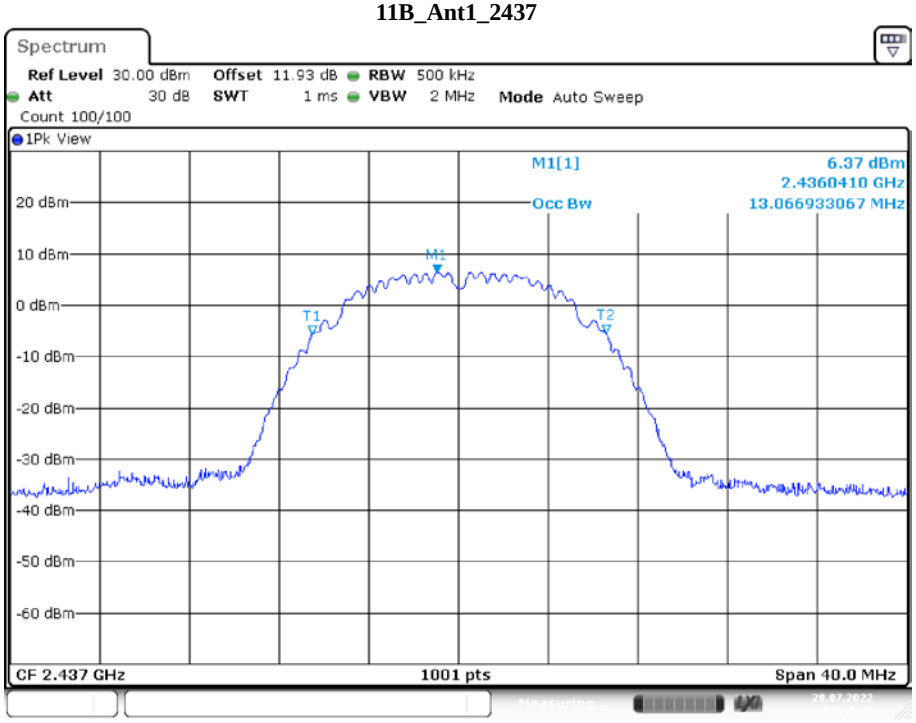
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	13.107	---	PASS
		2437	13.067	---	PASS
		2462	13.107	---	PASS
11G	Ant1	2412	17.183	---	PASS
		2437	17.183	---	PASS
		2462	17.183	---	PASS
11N20 SISO	Ant1	2412	17.822	---	PASS
		2437	17.902	---	PASS
		2462	17.862	---	PASS

Test Graphs:

11B_Ant1_2412

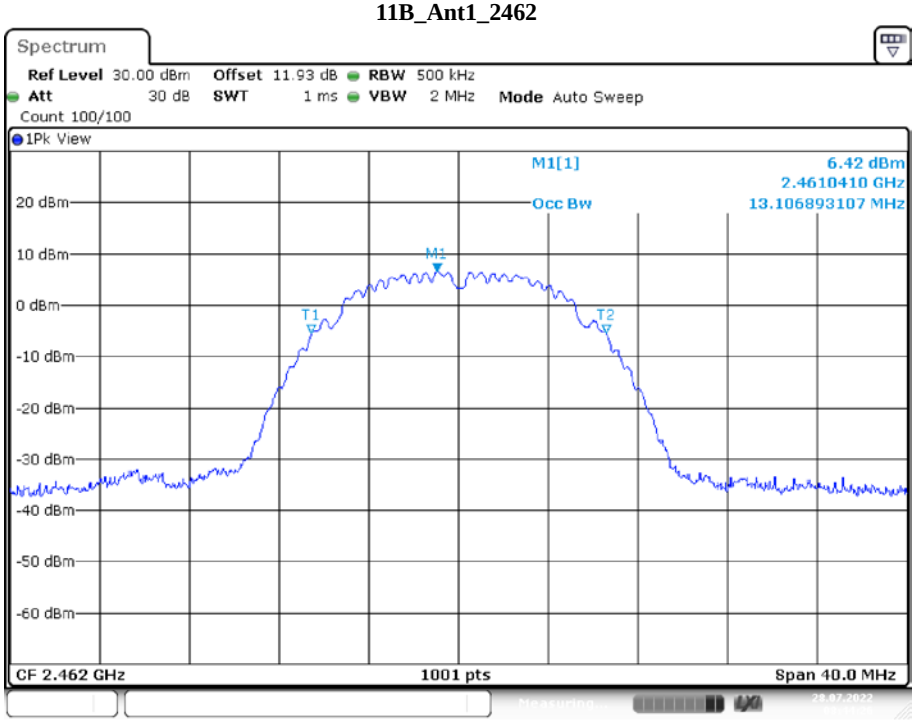


11B_Ant1_2437



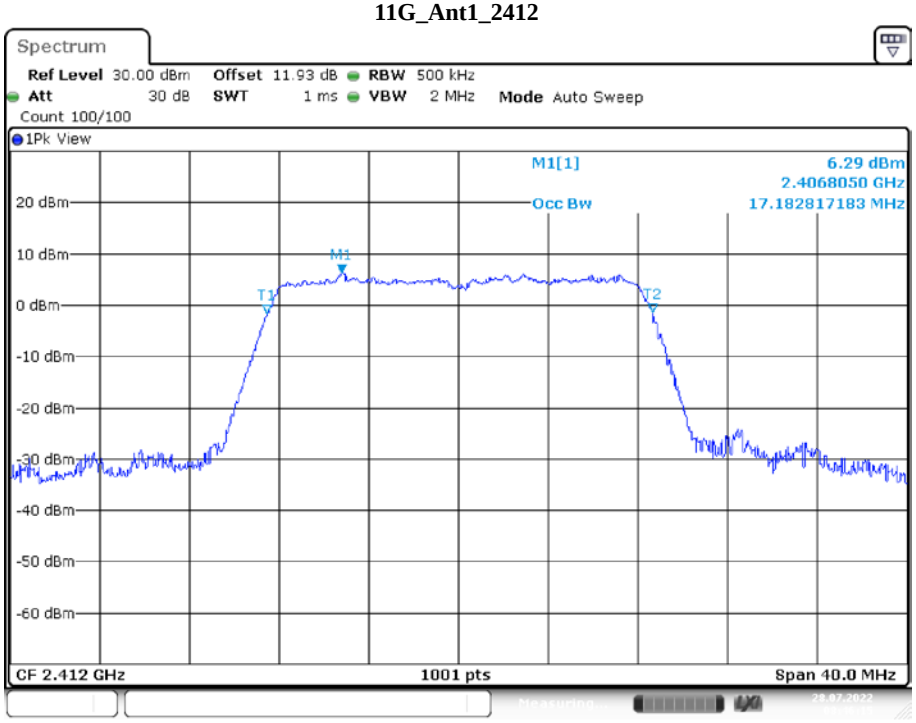
Date: 28.JUL.2022 08:42:47

11B_Ant1_2462



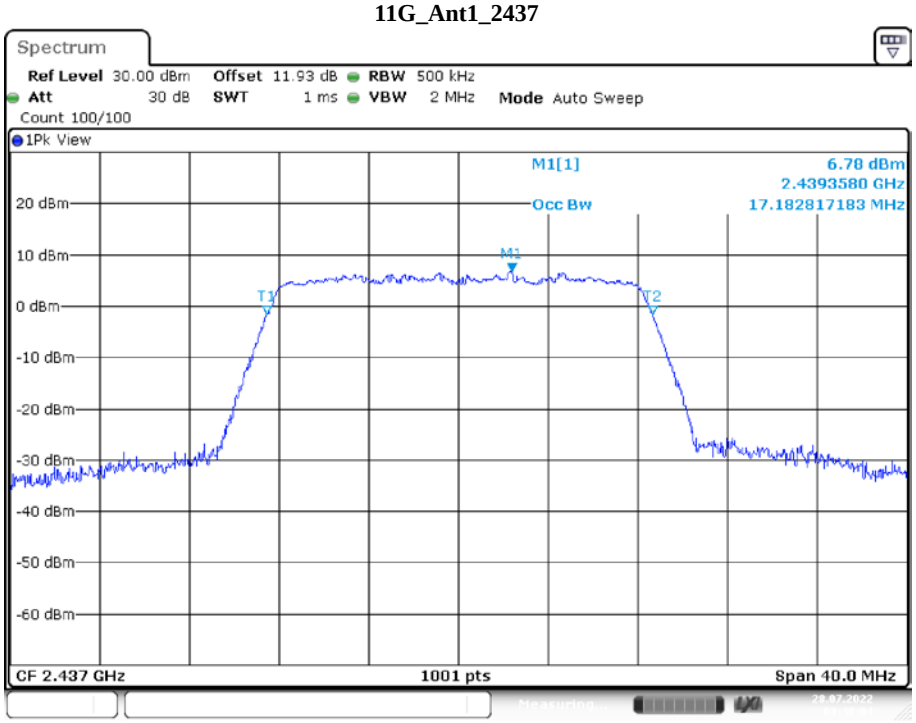
Date: 28.JUL.2022 08:44:27

11G_Ant1_2412



Date: 28.JUL.2022 08:46:15

11G_Ant1_2437



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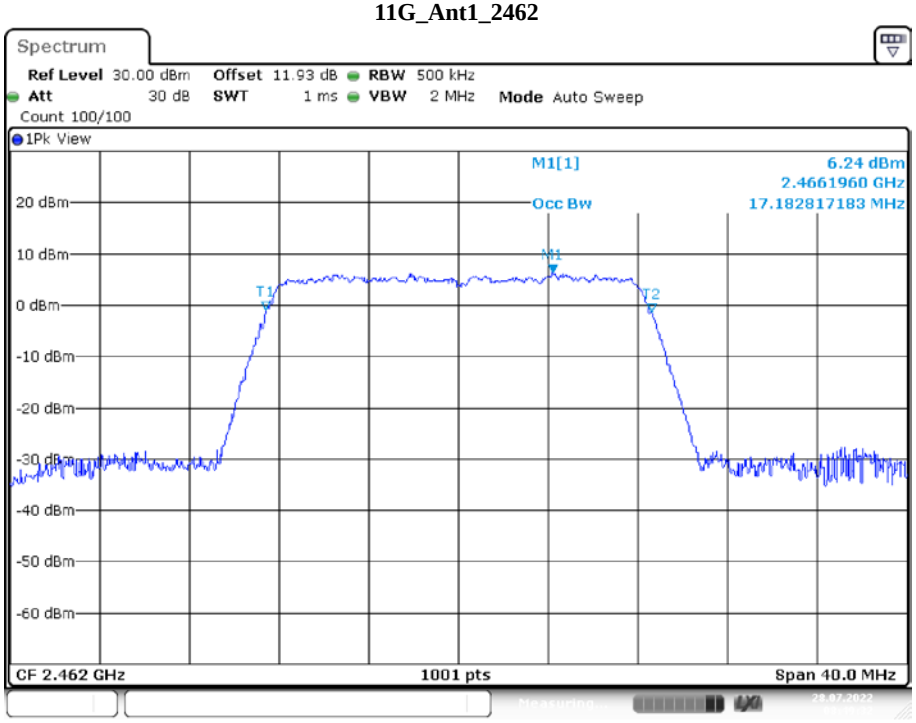
11G_Ant1_2462



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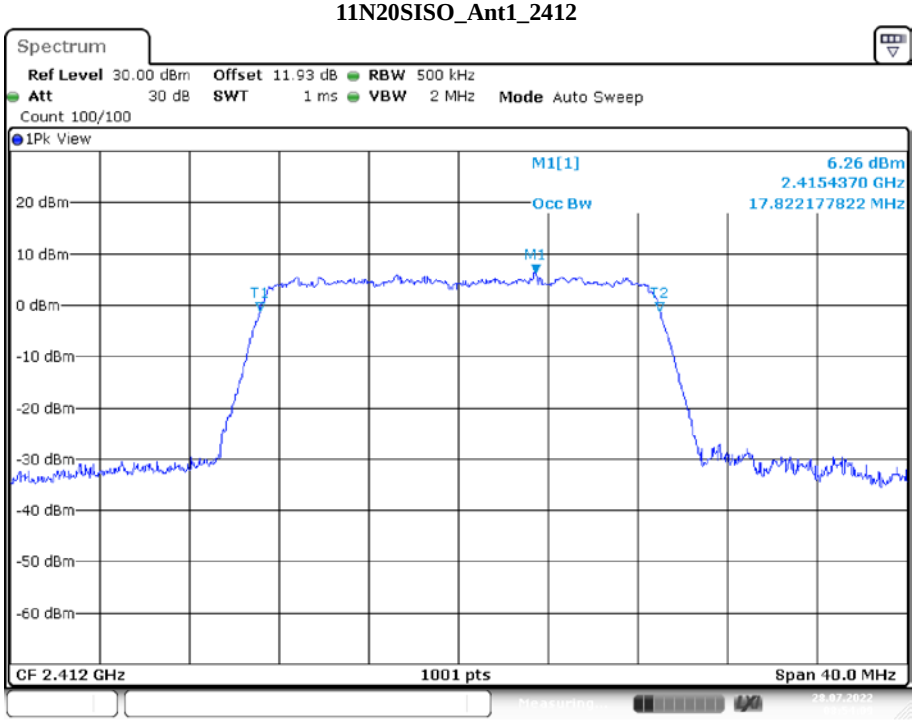
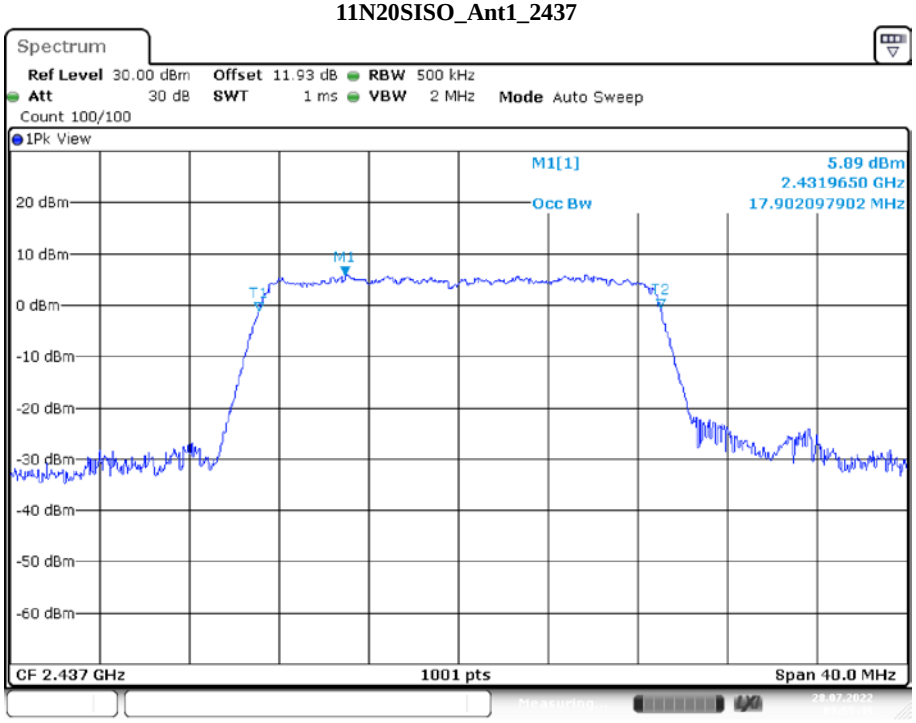


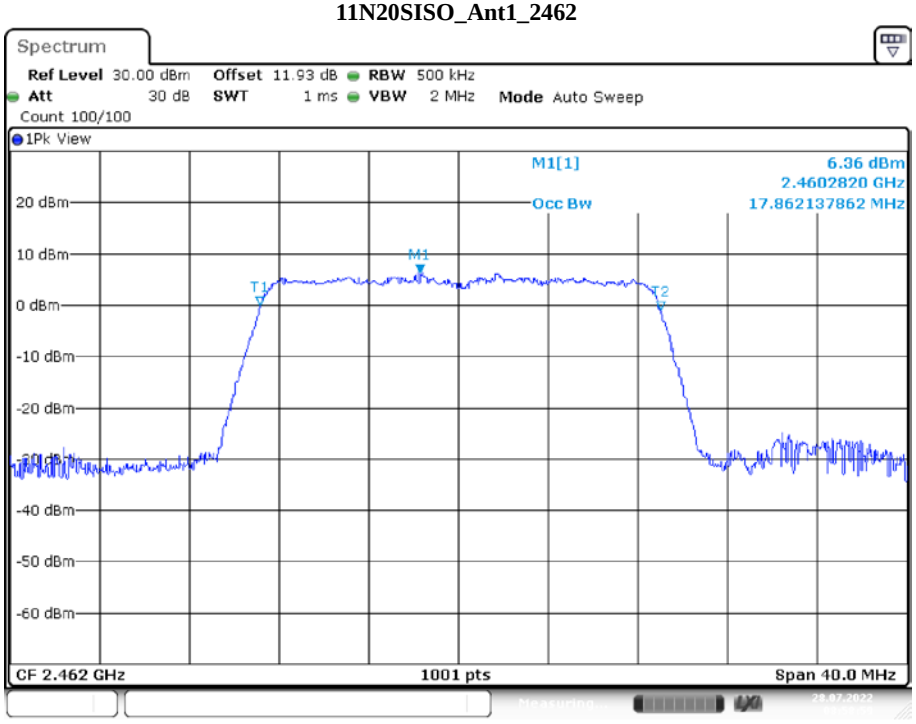
Date: 28.JUL.2022 08:54:09

11N20SISO_Ant1_2437



Date: 28.JUL.2022 08:55:50

11N20SISO_Ant1_2462



Date: 28.JUL.2022 08:59:00

APPENDIX C: Maximum conducted output power

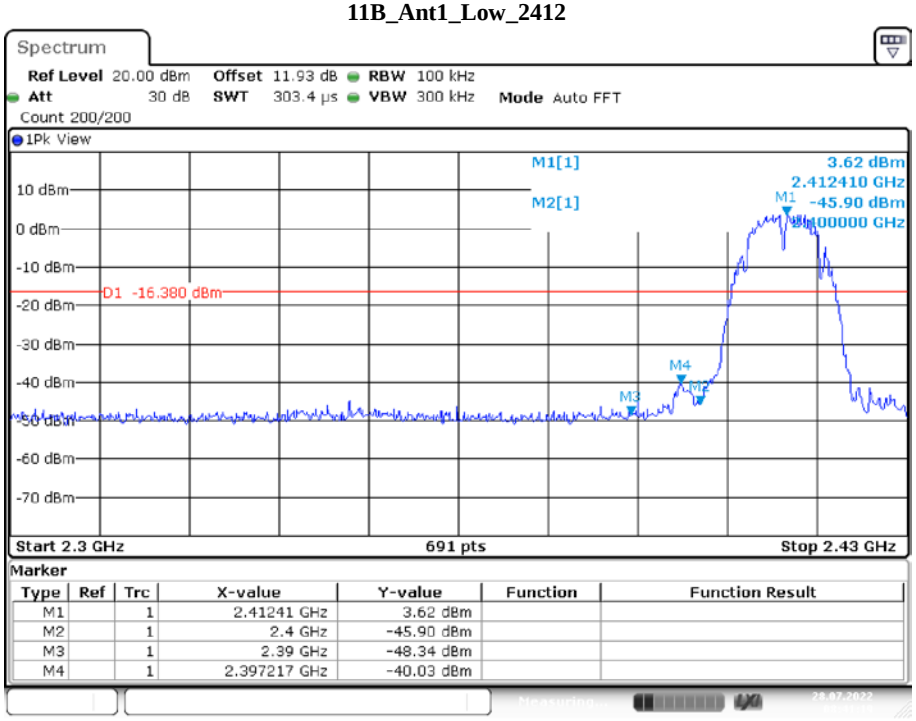
Test Result

Test Mode	Antenna	Channel	Peak Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	15.16	<=30	PASS
		2437	14.98	<=30	PASS
		2462	**15.48**	<=30	PASS
11G	Ant1	2412	**16.83**	<=30	PASS
		2437	16.45	<=30	PASS
		2462	16.66	<=30	PASS
11N20 SISO	Ant1	2412	16.44	<=30	PASS
		2437	16.56	<=30	PASS
		2462	**16.56**	<=30	PASS

APPENDIX D: Band edge measurements

Test Graphs

11B_Ant1_Low_2412



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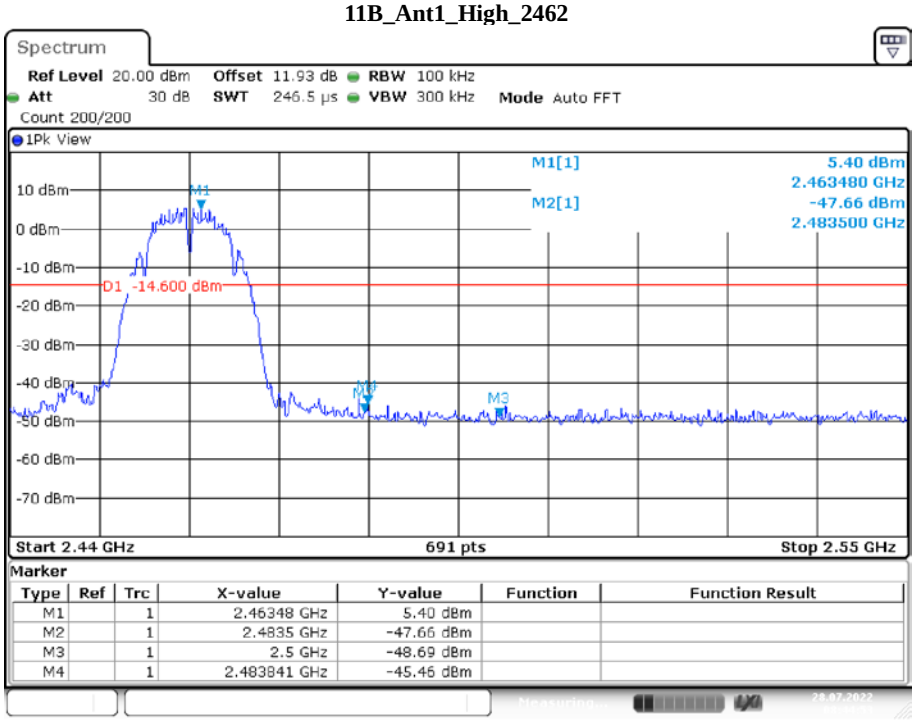
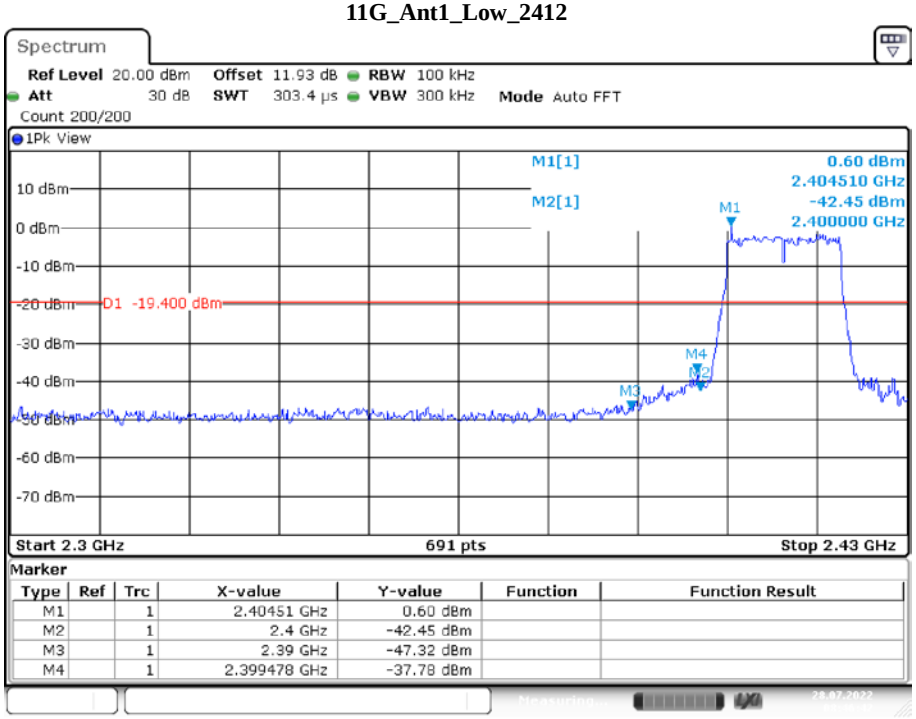
11B_Ant1_High_2462



Date: 28.JUL.2022 08:44:54

11G_Ant1_Low_2412

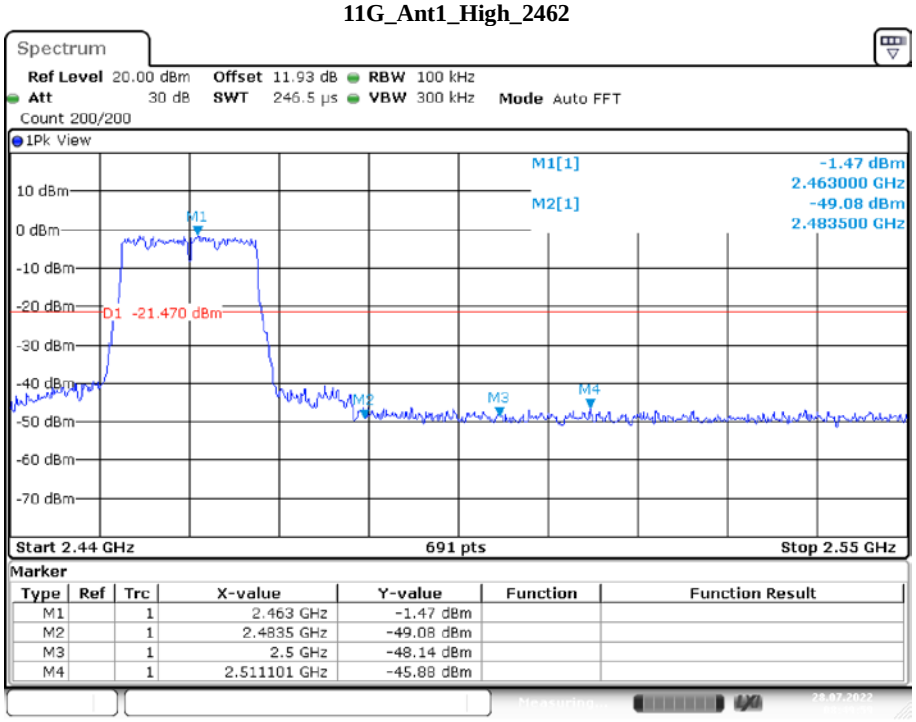


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40451 GHz	0.60 dBm		
M2		1	2.4 GHz	-42.45 dBm		
M3		1	2.39 GHz	-47.32 dBm		
M4		1	2.399478 GHz	-37.78 dBm		

Date: 28.JUL.2022 08:46:42

11G_Ant1_High_2462



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.463 GHz	-1.47 dBm		
M2		1	2.4835 GHz	-49.08 dBm		
M3		1	2.5 GHz	-48.14 dBm		
M4		1	2.511101 GHz	-45.88 dBm		

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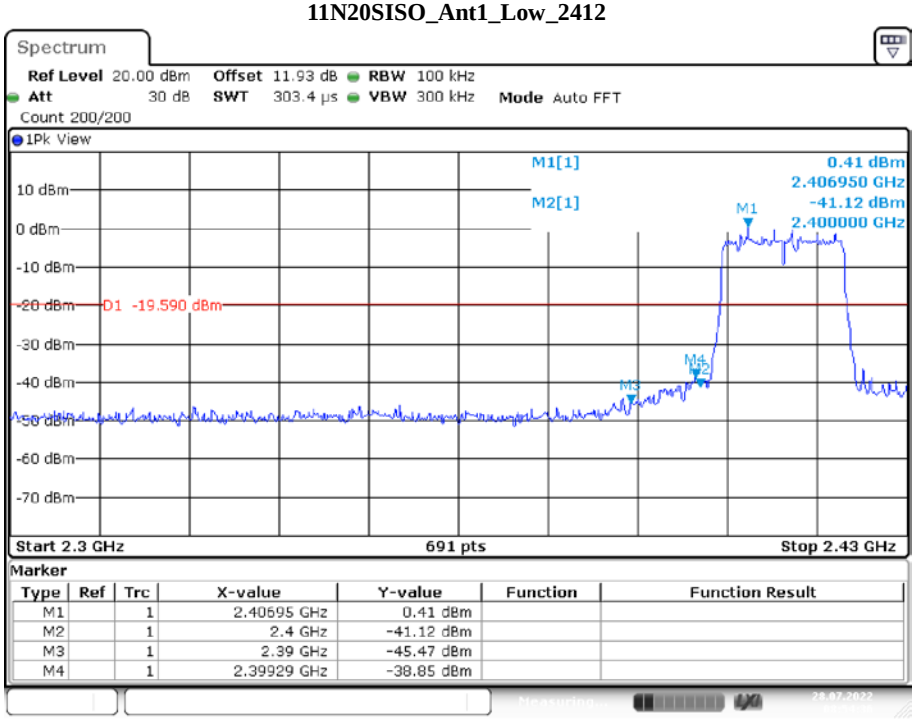
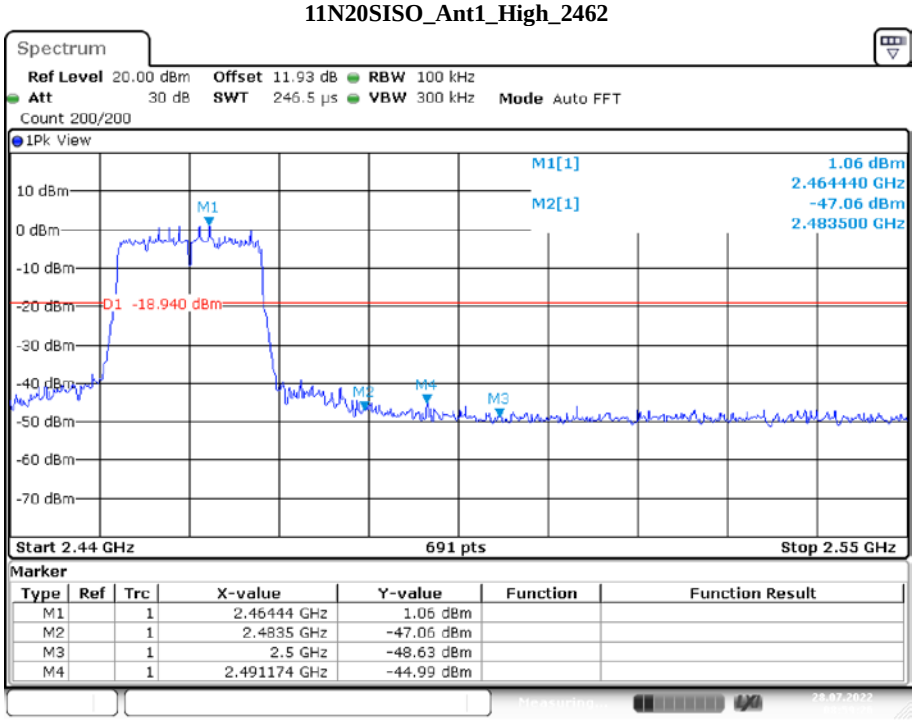
11N20SISO_Ant1_Low_2412



Date: 28.JUL.2022 08:54:36

11N20SISO_Ant1_High_2462



Date: 28.JUL.2022 08:59:27

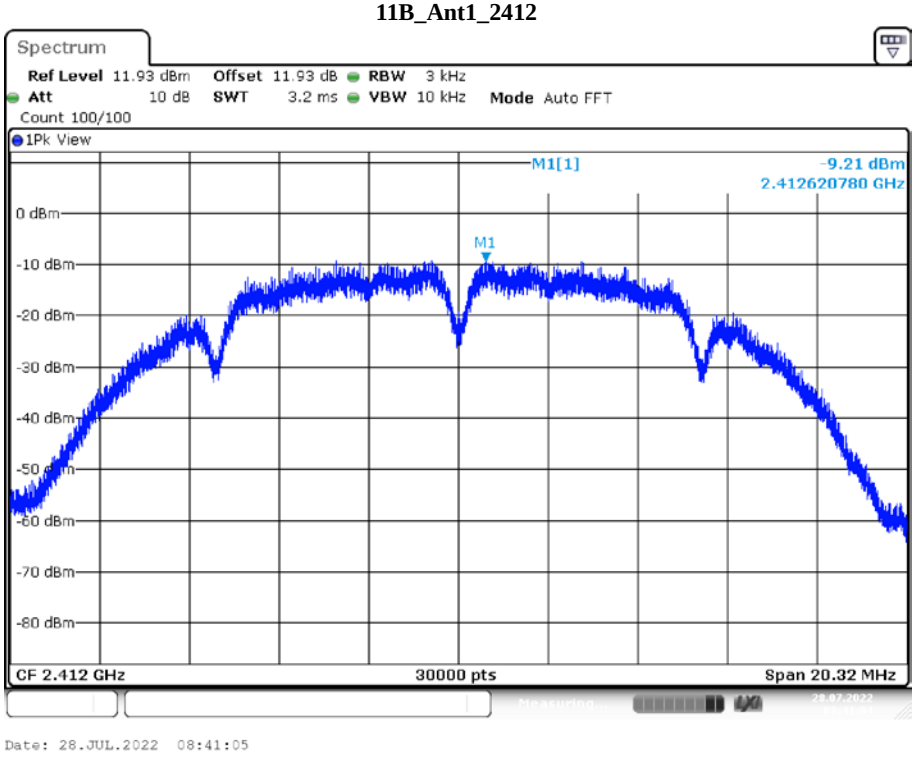
APPENDIX E: Maximum power spectral density

Test Result

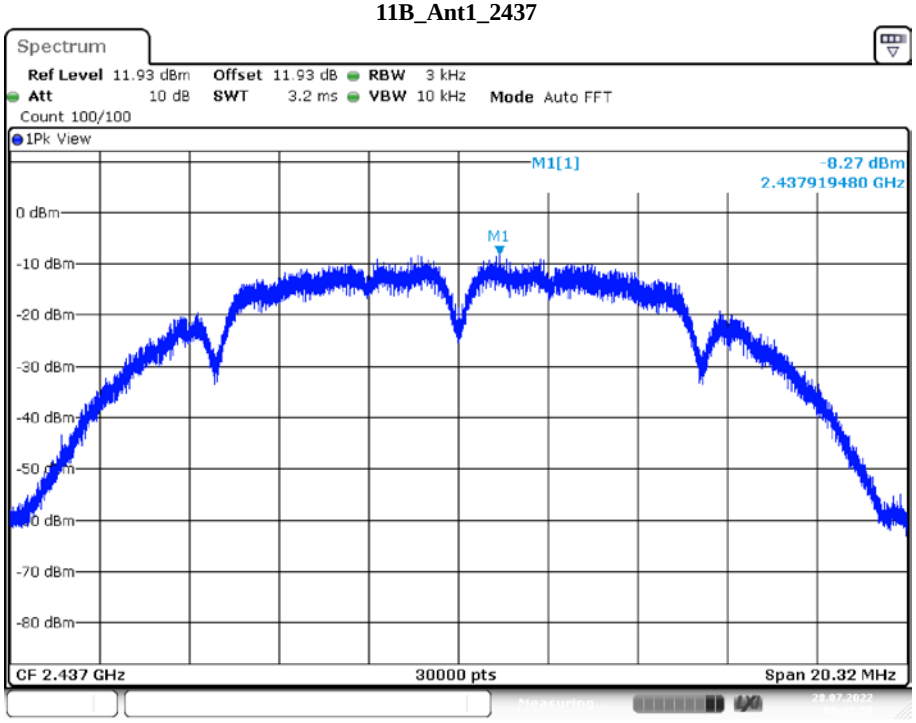
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-9.21	<=8	PASS
		2437	-8.27	<=8	PASS
		2462	-8.38	<=8	PASS
11G	Ant1	2412	-13.09	<=8	PASS
		2437	-11.83	<=8	PASS
		2462	-13.5	<=8	PASS
11N20 SISO	Ant1	2412	-12.13	<=8	PASS
		2437	-13.54	<=8	PASS
		2462	-11.83	<=8	PASS

Test Graphs

11B_Ant1_2412



11B_Ant1_2437



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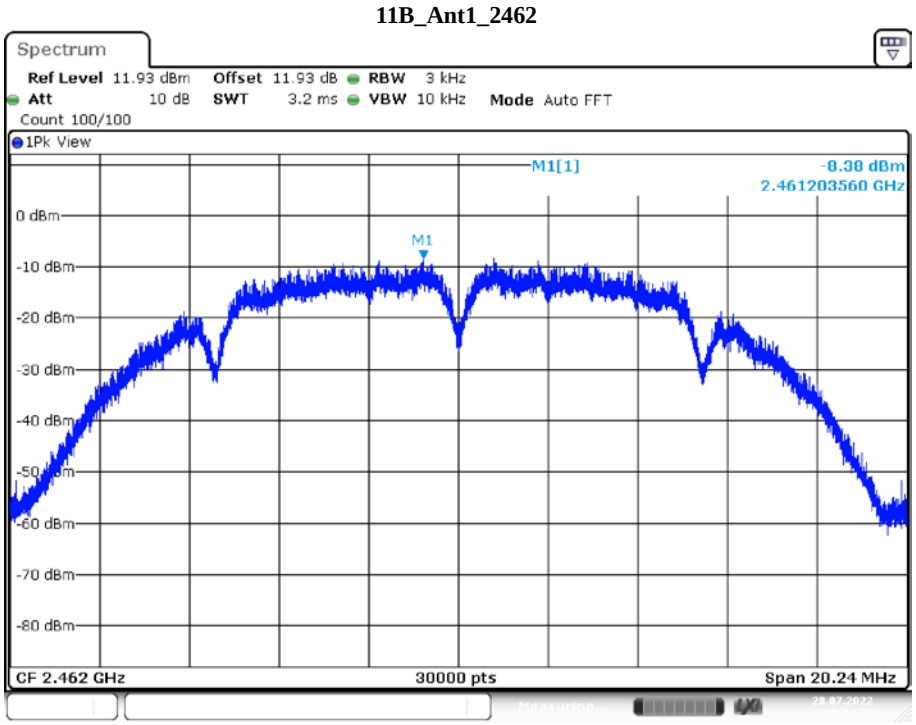
11B_Ant1_2462



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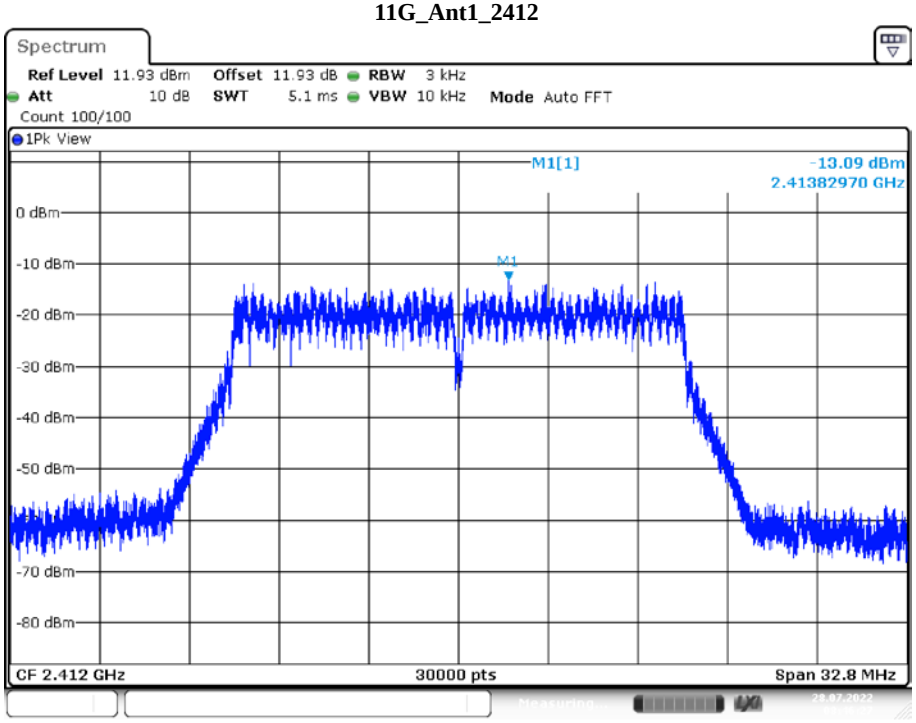
11G_Ant1_2412



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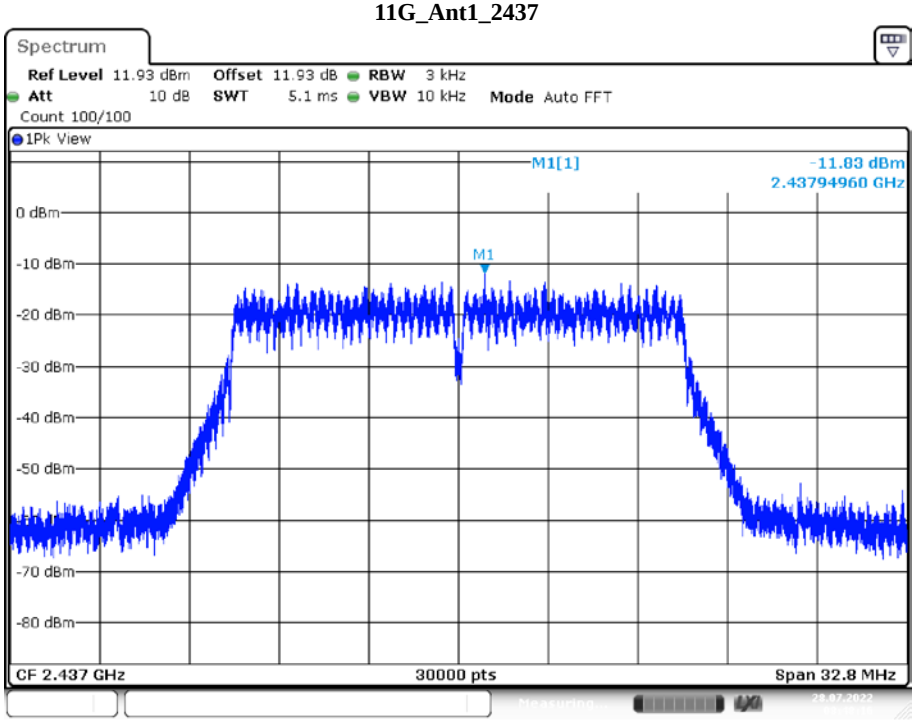
11G_Ant1_2437



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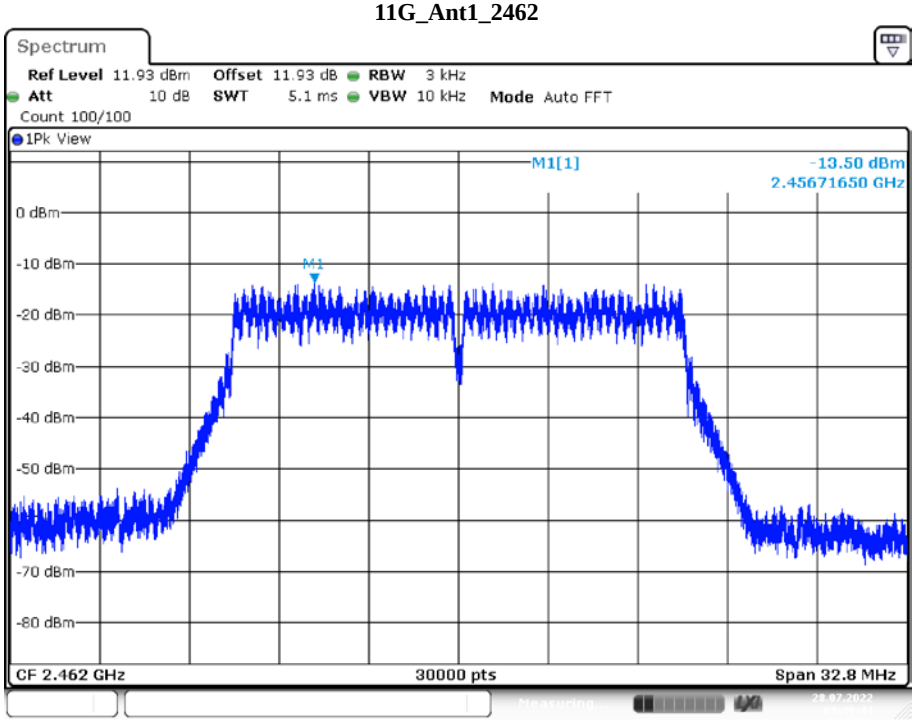
11G_Ant1_2462



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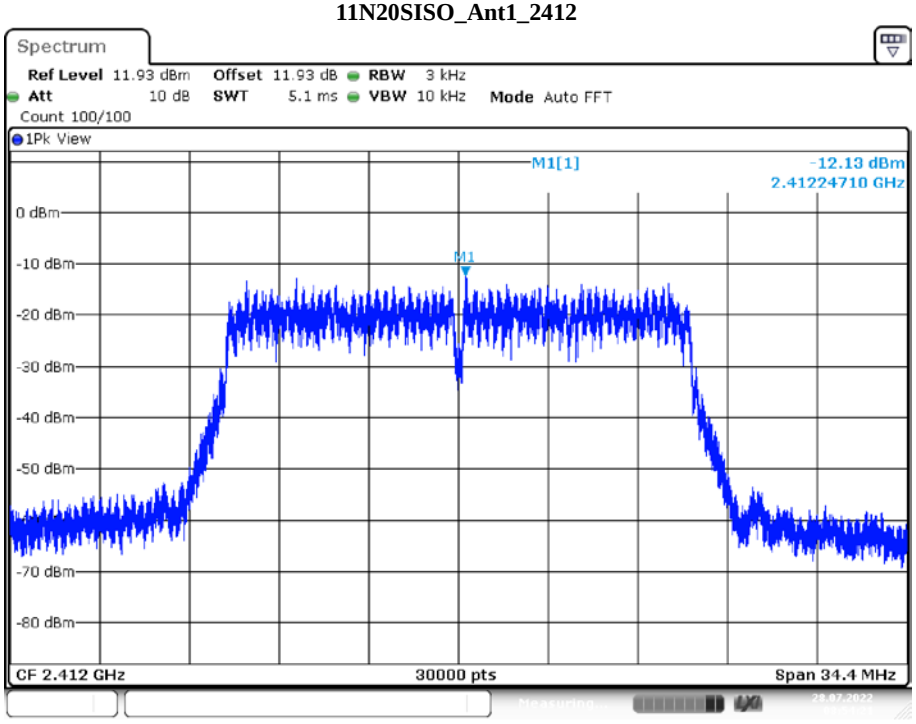
11N20SISO_Ant1_2412



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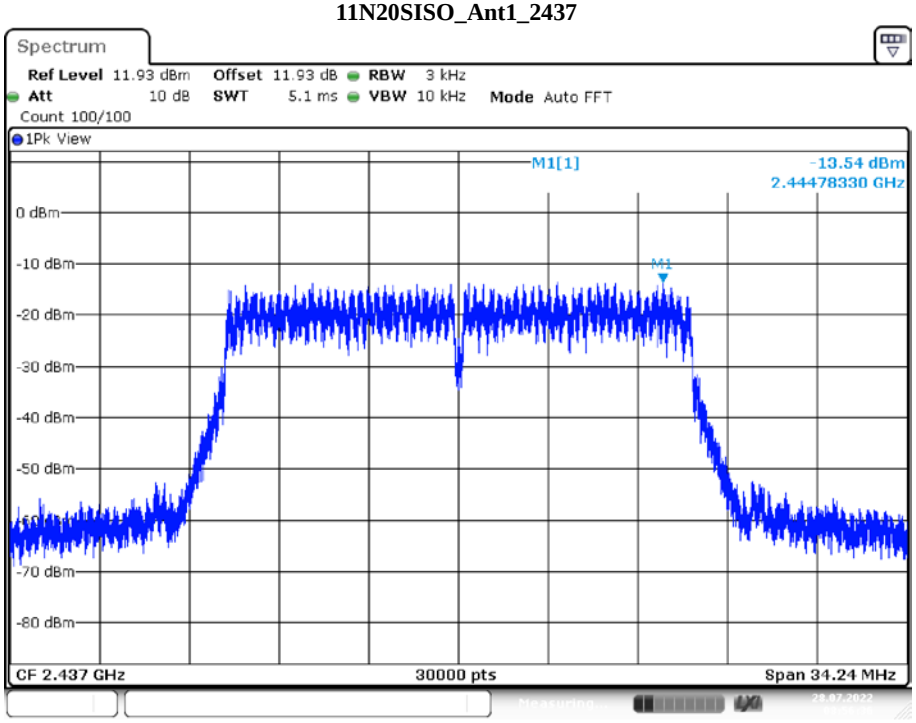
11N20SISO_Ant1_2437



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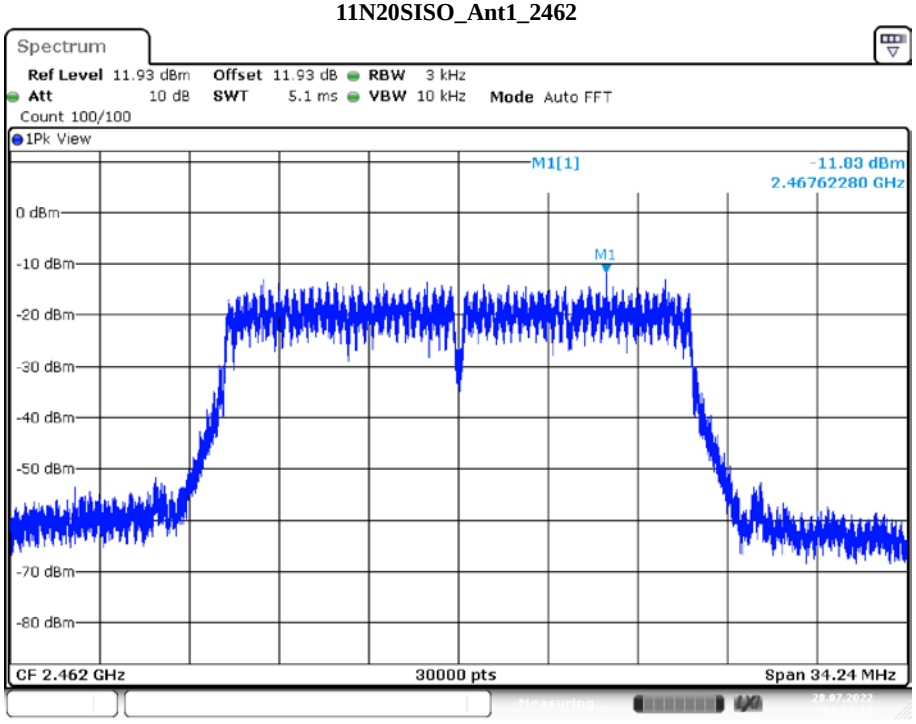


Date: 28.JUL.2022 08:59:12

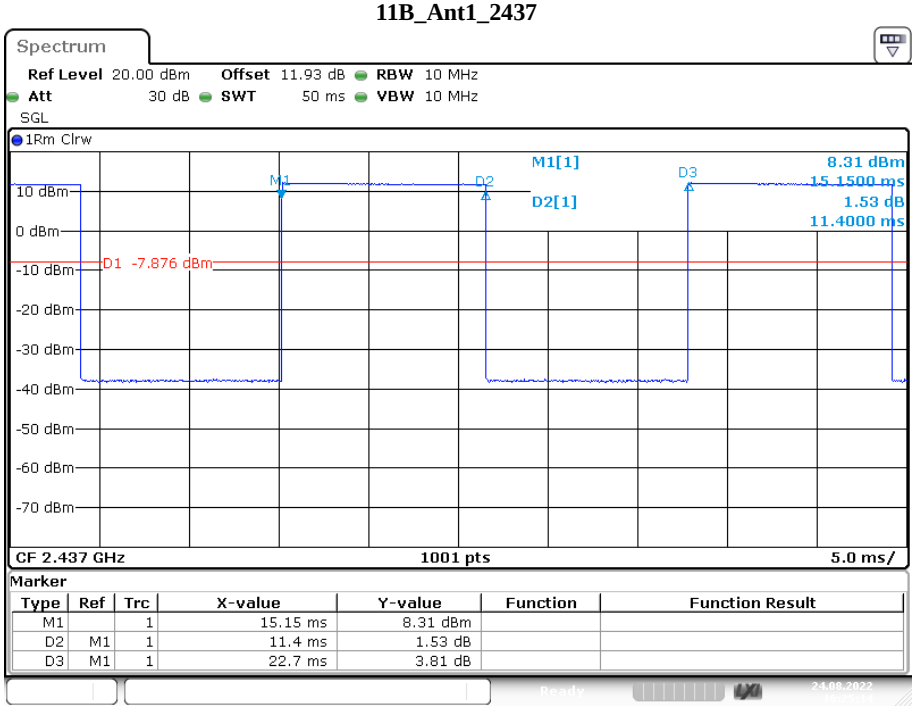
APPENDIX F: Duty Cycle

Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2437	11.4	22.7	50.22
11G	Ant1	2437	1.87	3.77	49.60
11N20 SISO	Ant1	2437	1.75	3.51	49.86

Test Graphs

11B_Ant1_2437



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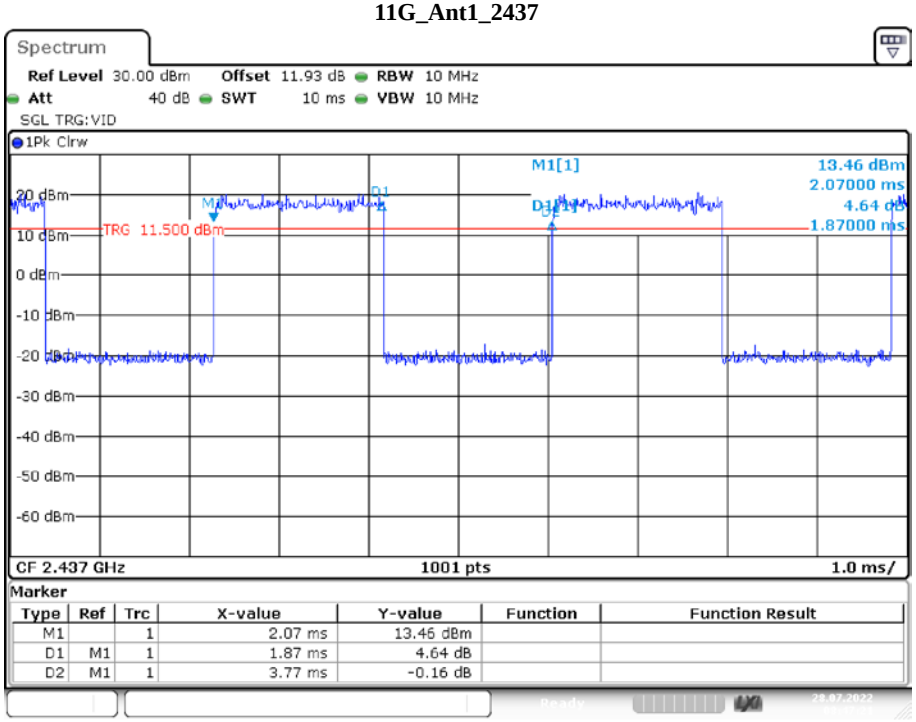
11G_Ant1_2437



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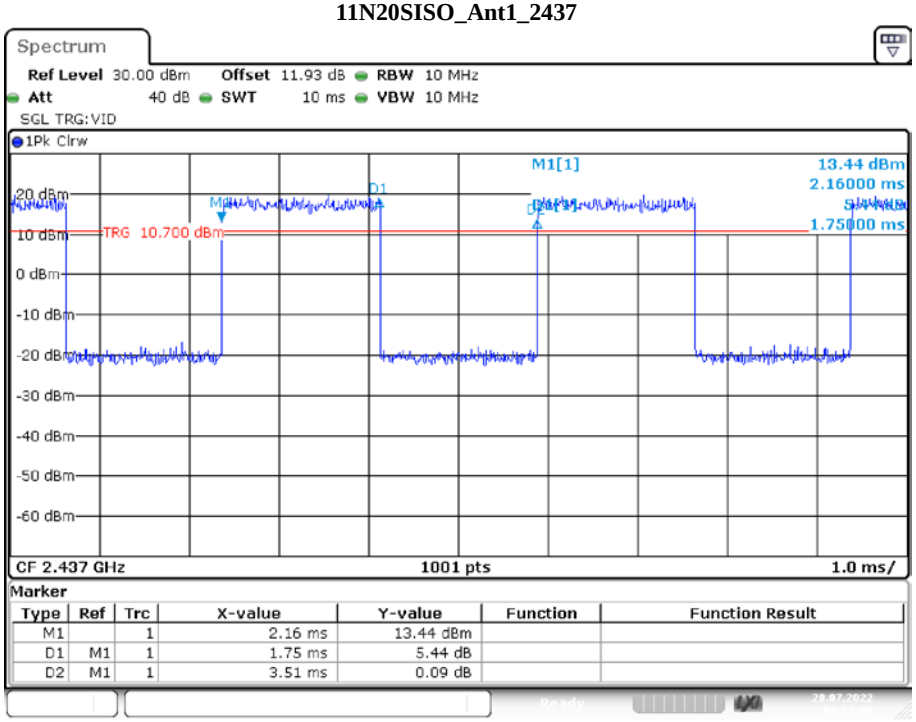

Date: 28.JUL.2022 08:55:07

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