FCC Part 15.247

TEST REPORT

For

ZHEJIANG EBOY TECHNOLOGY CO., LTD.

No. 568, Huabao street, Qianyuan Town, Deqing County, Huzhou City, Zhejiang Province, China 313200

FCC ID: 2AJ3WEBECZW01-C

Report Type:	**Product Type:**
Original Report	Smart plug

Report Producer : Coco Lin

Report Number : RXZ220121001RF01

Report Date : 2022-03-29

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ220121001	RXZ220121001RF01	2022-03-29	Original Report	Coco Lin

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	ZHEJIANG EBOY TECHNOLOGY CO., LTD.
	No. 568, Huabao street, Qianyuan Town, Deqing County, Huzhou City, Zhejiang Province, China 313200
Manufacturer	ZHEJIANG EBOY TECHNOLOGY CO., LTD.
	No. 568, Huabao street, Qianyuan Town, Deqing County, Huzhou City, Zhejiang Province, China 313200
Brand(Trade) Name	N/A
Product (Equipment)	Smart plug
Main Model Name	EBE-CZW01-C
Series Model Name	EBE-CZW01-B, WW117, WW217, WW317, WW417
Model Discrepancy	The major electrical and mechanical constructions of series models are identical to the basic model, except Market segmentation. The model, EBE-CZW01-C is the testing sample, and the final test data are shown on this test report.
Frequency Range	IEEE 802.11b/g / IEEE 802.11n HT20 Mode: 2412 ~ 2462 MHz
Conducted Peak Output Power	IEEE 802.11b Mode: 21.63 dBm IEEE 802.11g Mode: 24.14 dBm IEEE 802.11n HT20 Mode: 24.18 dBm
Modulation Technique	IEEE 802.11b Mode: DSSS IEEE 802.11g Mode: OFDM IEEE 802.11n HT20 Mode: OFDM
Power Operation (Voltage Range)	☒ AC 120V/60Hz ☐ Adapter I/P: ☒ By AC Power plug ☐ PoE
	☐ DC Type ☐ Battery ☐ DC Power Supply ☐ External from USB Cable ☐ External DC Adapter
	☐ Host System
Received Date	Jan. 24, 2022
Date of Test	Feb. 9, 2022 ~ Feb. 25, 2022

*All measurement and test data in this report was gathered from production sample serial number: RXZ220121001-01 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

This report is prepared on behalf of *ZHEJIANG EBOY TECHNOLOGY CO., LTD.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

1.3 Related Submittal(s)/Grant(s)

N/A.

1.4 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
KDB 558074 D01 15.247 Meas Guidance v05r02

1.5 Statement of Compliance

Decision Rule: No, (The test results do not include MU judgment)

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.
The determination of the test results does not require consideration of the uncertainty of the measurement, unless the assessment is required by customer agreement, regulation or standard document specification.
Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) is not responsible for the authenticity of the information provided by the applicant that affects the test results.

1.6 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		+/- 2.36 dB
RF output power, conducted		+/- 0.93 dB
Power Spectral Density, conducted		+/- 0.93 dBm
Occupied Bandwidth		+/- 0.35 MHz
Unwanted Emissions, conducted		+/- 1.69 dBm
Emissions, radiated	30 MHz~1GHz	+/- 5.22 dB
	1 GHz~18 GHz	+/- 6.12 dB
	18 GHz~40 GHz	+/- 4.99 dB
Temperature		+/- 1.27 °C
Humidity		+/- 3 %

1.7 Environmental Conditions

Test Site	Test Data	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2022/2/25	18.7	69	1010	Boris Kao
Radiation Spurious Emissions	2022/2/9~2022/2/22	17.6~20.2	69~77	1010	Howard Ho
Conducted Spurious Emissions	2022/2/23	25	50	1010	Boris Kao
6 dB Emission Bandwidth	2022/2/23	25	50	1010	Boris Kao
Maximum Output Power	2022/2/23	25	50	1010	Boris Kao
100 kHz Bandwidth of Frequency Band Edge	2022/2/23	25	50	1010	Boris Kao
Power Spectral Density	2022/2/23	25	50	1010	Boris Kao

1.8 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) to collect test data is located on

☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3732) and the FCC designation No.TW3732 under the Mutual Recognition Agreement (MRA) in FCC Test.

2 System Test Configuration

2.1 Description of Test Configuration

For WIFI mode, there are totally 11 channels.

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	/	/

For 802.11 b/g/n20 Modes were tested with channel 1, 6 and 11.

The system was configured for testing in engineering mode, which was provided by manufacturer.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used “Wifi Test Tool v1.6.0 release”

Test Frequency		Low	Mid	High
Power Level Setting	802.11b Mode	10	10	10
	802.11g Mode	15	15	15
	802.11n HT20 Mode	15	15	15

The EUT was configured for testing in an engineering mode which was provided by the manufacturer. The worst-case data rates are determined to be as follows for each mode based upon investigations by measuring the average power and PSD across all data rates and modulations.

802.11b: 1Mbps

802.11g: 6Mbps

802.11n HT20: MCS0

2.4 Test Mode

Full System (model: EBE-CZW01-C) for all test item.

2.5 Support Equipment List and Details

Description	Manufacturer	Model Number	S/N
NB	DELL	E6410	8N7PXN1
NB Adapter	DELL	DA130PE1-00	JU012
Light Bubble	Yousheng Industrial	120V300W	Unknown

2.6 External Cable List and Details

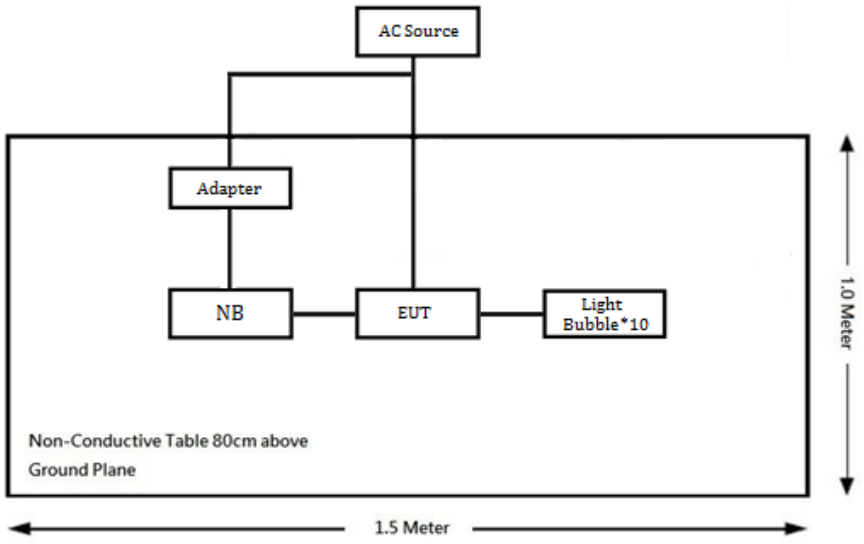
Cable Description	Length (m)	From	To
Power Cable	1.5	Light Bubble	EUT
Power Cable	1.5	NB Adapter	AC Source
Ferrite core cable	1.5	NB Adapter	NB
Fixture Cable	0.15	NB	EUT

2.7 Block Diagram of Test Setup

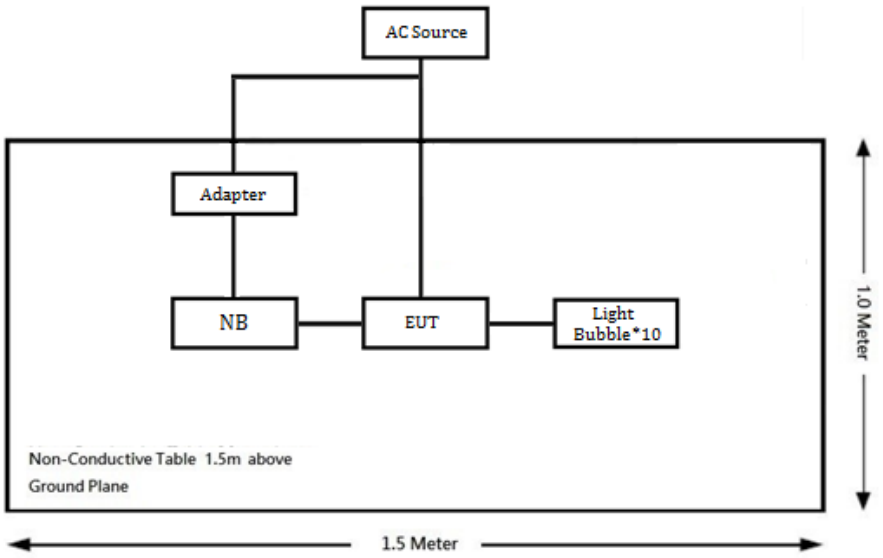
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

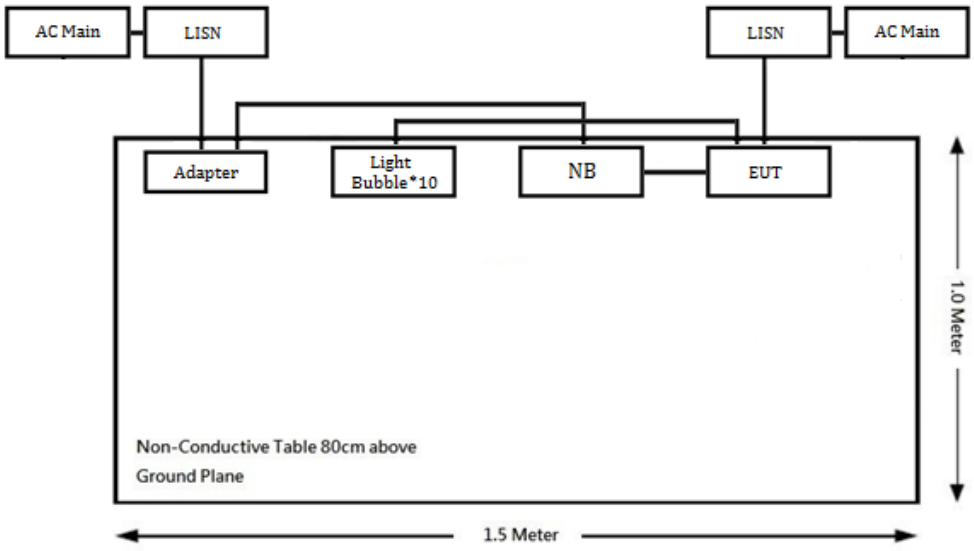
Below 1GHz:



Above 1GHz:



Conduction:



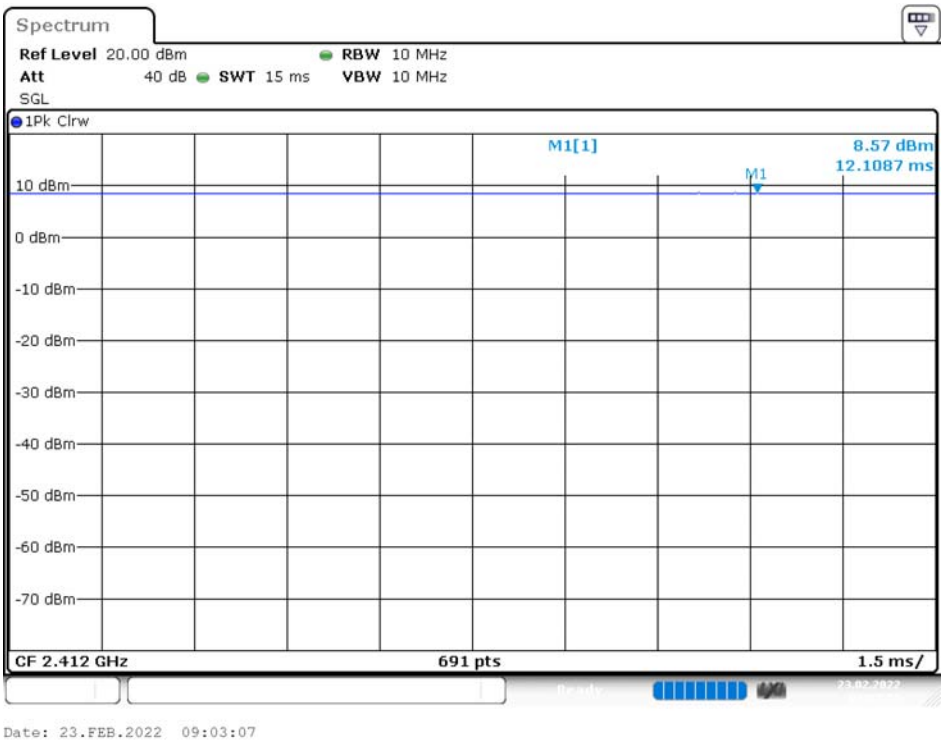
2.8 Duty Cycle

The duty cycle as below:

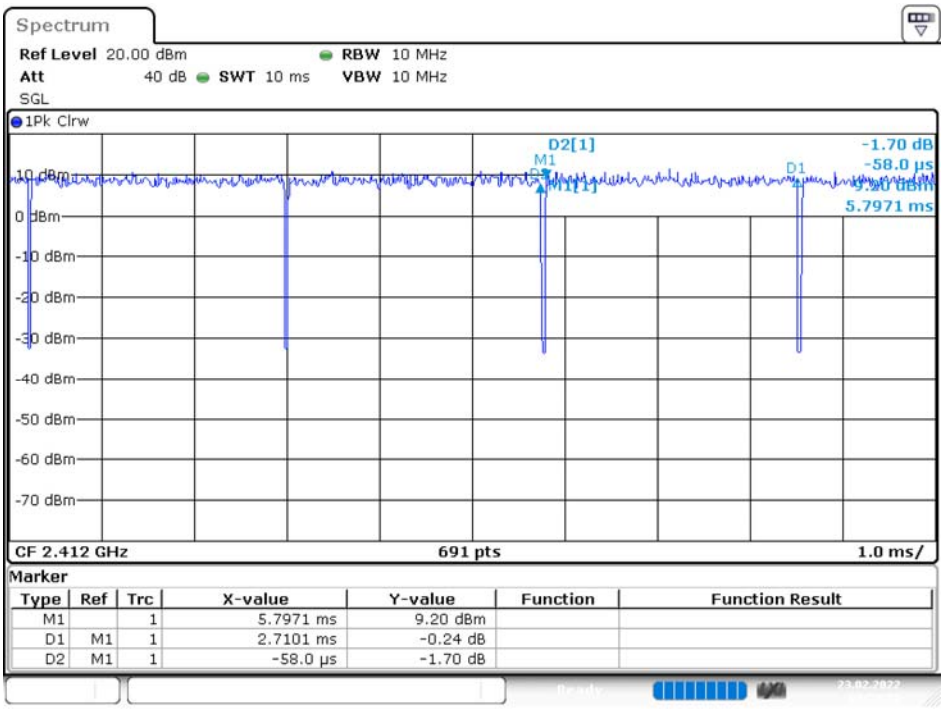
Radio Mode	T_{on} (ms)	$T_{on}+T_{off}$ (ms)	Duty Cycle (%)
802.11b	/	/	100
802.11g	2.71	2.77	98
802.11n20	2.54	2.58	98

Please refer to the following plots.

B Mode

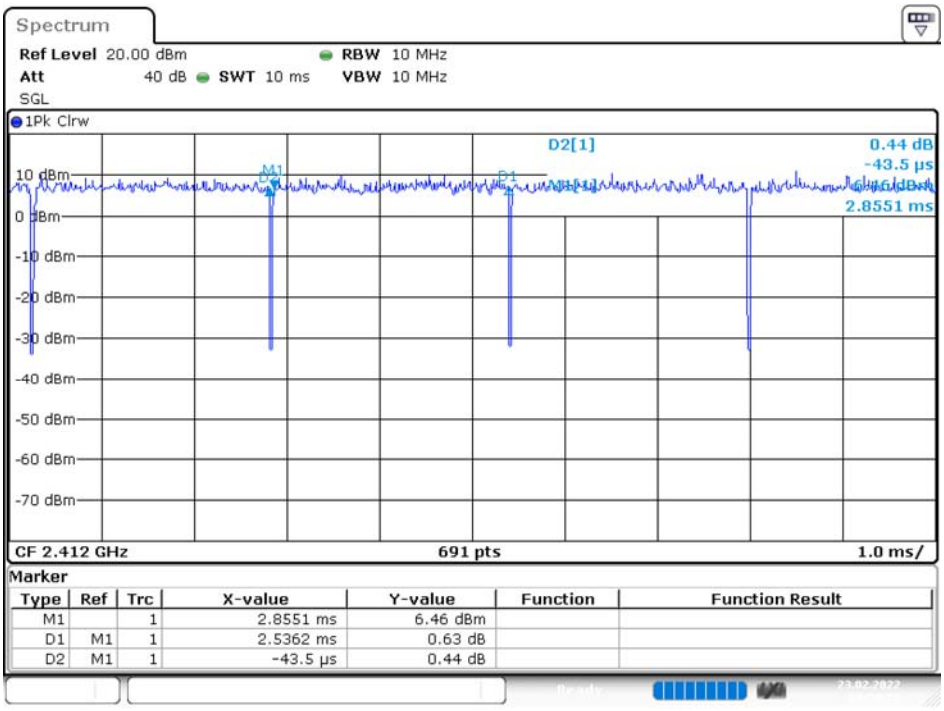


G Mode



Date: 23.FEB.2022 08:58:20

N20 Mode



Date: 23.FEB.2022 08:50:52

3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1310, §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conduction Room (CON-A)					
LISN	Rohde & Schwarz	ENV216	101612	2022/1/10	2023/1/09
LISN	Rohde & Schwarz	ENV216	101248	2021/6/8	2022/6/7
EMI Test Receiver	Rohde & Schwarz	ESW8	100947	2021/7/23	2022/7/22
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2021/7/29	2022/7/28
RF Cable	EMEC	EM-CB5D	1	2021/6/11	2022/6/10
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiated Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & EMEC	JB3 &EM-ATT6000-6-NN	A090816-2&ATT-09-003	2022/1/20	2023/1/19
Horn Antenna	EMCO	SAS-571	1020	2021/4/23	2022/4/22
Horn Antenna	ETS-Lindgren	3116	62638	2021/8/11	2022/8/10
Preamplifier	Sonoma	310N	130602	2021/6/8	2022/6/7
Preamplifier	A.H. system Inc.	PAM-0118P	470	2021/3/15	2022/3/14
Microware Preamplifier	EM Electronics Corporation	EM18G40G	60656	2021/12/27	2022/12/26
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2022/1/13	2023/1/12
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2021/11/9	2022/11/8
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2022/1/24	2023/1/23
Band-stop filter	STI	STI15-9831	STI15-9831-1	2021/3/12	2022/3/11
Coaxial Cable	COMMATE	PEWC	8Dr	2021/12/24	2022/12/23
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2022/1/24	2023/1/23
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2021/12/24	2022/12/23

Cable	EMC	EMC105-SM-SM-10000	201003	2022/1/24	2023/1/23
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2022/1/24	2023/1/23
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-50CM	15120-1	2022/1/18	2023/1/17
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101204	2021/6/10	2022/6/9
Cable	UTIFLEX	UFA210A	9435	2021/10/5	2022/10/4
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2022/1/24	2023/1/23
Attenuator	MCL	BW-S20W5+	1430	2021/6/23	2022/6/22

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements

5 FCC §15.247(i), §1.1310, § 2.1091 - Maximum Permissible Exposure (MPE)

5.1 Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

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

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);

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

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

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

5.2 RF Exposure Evaluation Result

MPE evaluation:

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
WIFI 2.4G	2412-2462	0.00	1.000	24.5	281.838	20	0.056	1

Result: MPE evaluation meets the requirements of the **20cm** standard.

6 FCC §15.203 – Antenna Requirements

6.1 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.

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 does not exceed 6dBi.

6.2 Antenna List and Details

Manufacturer	Model	Antenna Type	Antenna Gain
N/A	N/A	PCB Antenna	0 dBi

Result: Compliance

7 FCC §15.207(a) – AC Line Conducted Emissions

7.1 Applicable Standard

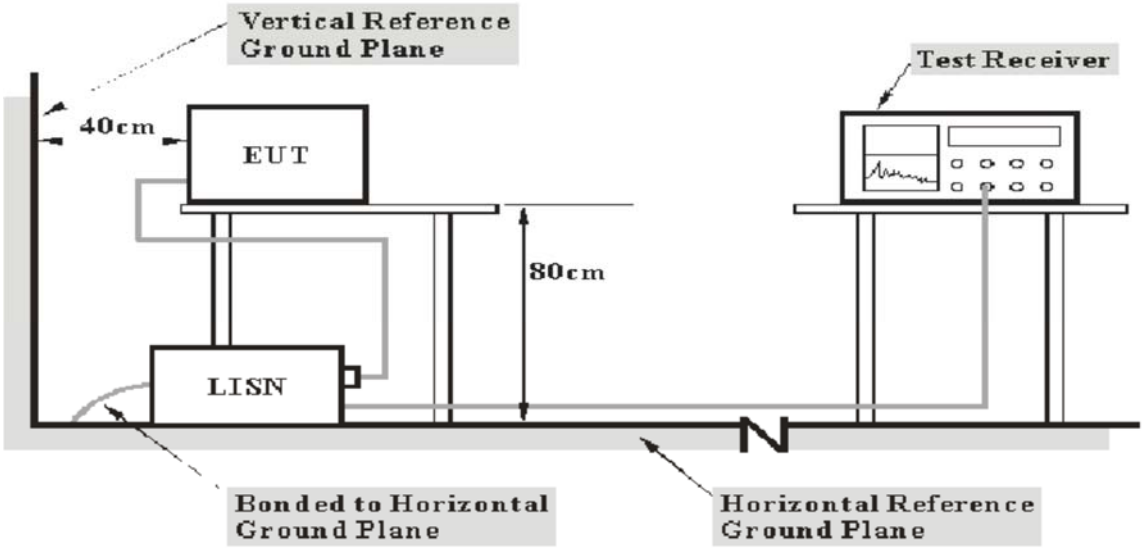
According to §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note	56 to 46 Note
0.5-5	56	46
5-30	60	50

Note: Decreases with the logarithm of the frequency.

7.2 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.

7.3 EMI Test Receiver Setup

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

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

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

7.4 Test Procedure

During the conducted emission test, the EUT is connected to the outlet of the LISN via the power cord.

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

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

7.5 Corrected Factor & Margin Calculation

The factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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 Over Limit calculation is as follows:

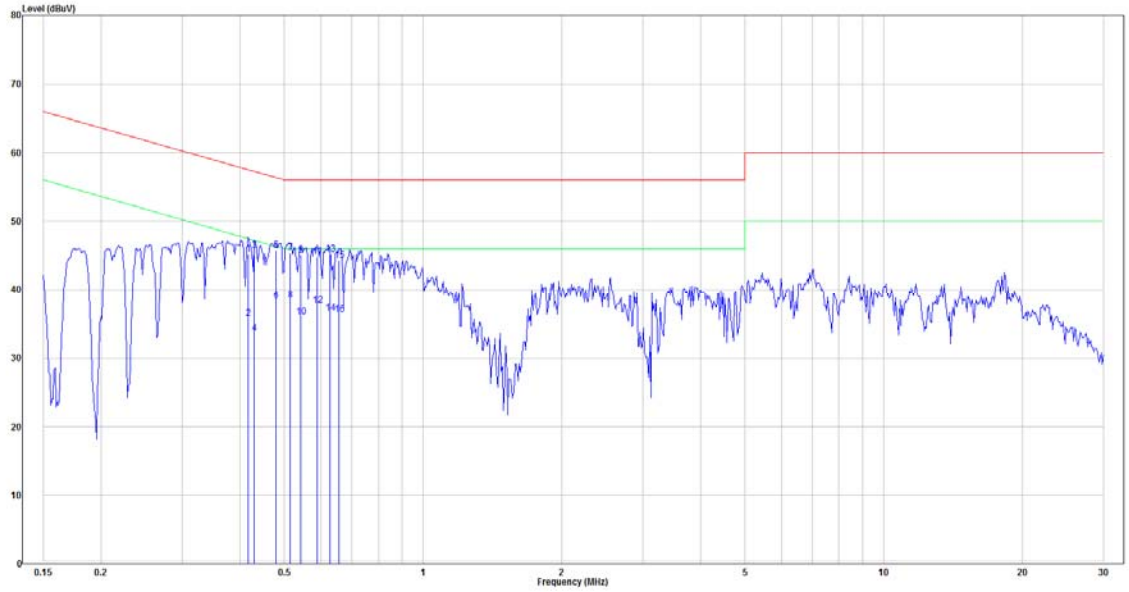
Over Limit = Level – Limit Line

7.6 Test Results

Test Mode: Transmitting

(Worst case is 802.11n HT20 mode, High Channel)

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.417	25.73	19.51	45.24	57.51	-12.27	QP
2	0.417	16.22	19.51	35.73	47.51	-11.78	Average
3	0.431	26.19	19.52	45.71	57.24	-11.53	QP
4	0.431	14.08	19.52	33.60	47.24	-13.64	Average
5	0.479	26.19	19.52	45.71	56.36	-10.65	QP
6	0.479	18.74	19.52	38.26	46.36	-8.10	Average
7	0.516	25.85	19.52	45.37	56.00	-10.63	QP
8	0.516	18.92	19.52	38.44	46.00	-7.56	Average
9	0.544	25.55	19.52	45.07	56.00	-10.93	QP
10	0.544	16.39	19.52	35.91	46.00	-10.09	Average
11	0.589	25.29	19.52	44.81	56.00	-11.19	QP
12	0.589	18.06	19.52	37.58	46.00	-8.42	Average
13	0.627	25.63	19.53	45.16	56.00	-10.84	QP
14	0.627	17.01	19.53	36.54	46.00	-9.46	Average
15	0.658	24.78	19.53	44.31	56.00	-11.69	QP
16	0.658	16.79	19.53	36.32	46.00	-9.68	Average

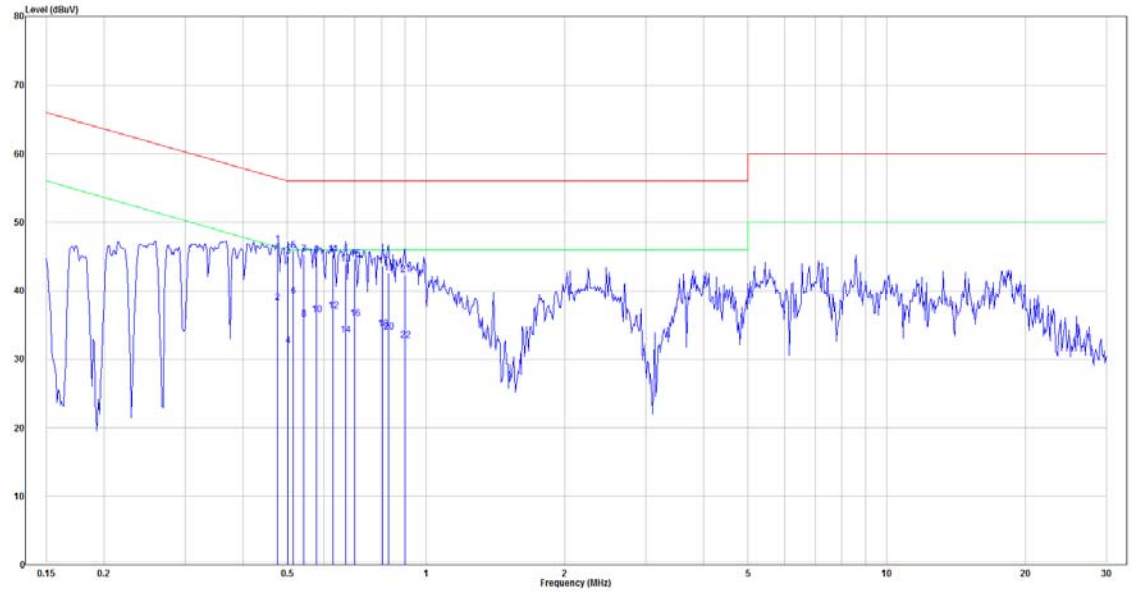
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.476	27.29	19.52	46.81	56.41	-9.60	QP
2	0.476	18.63	19.52	38.15	46.41	-8.26	Average
3	0.502	25.53	19.52	45.05	56.00	-10.95	QP
4	0.502	12.33	19.52	31.85	46.00	-14.15	Average
5	0.516	26.38	19.52	45.90	56.00	-10.10	QP
6	0.516	19.74	19.52	39.26	46.00	-6.74	Average
7	0.544	25.76	19.52	45.28	56.00	-10.72	QP
8	0.544	16.20	19.52	35.72	46.00	-10.28	Average
9	0.579	25.62	19.52	45.14	56.00	-10.86	QP
10	0.579	16.81	19.52	36.33	46.00	-9.67	Average
11	0.627	25.75	19.52	45.27	56.00	-10.73	QP
12	0.627	17.39	19.52	36.91	46.00	-9.09	Average
13	0.668	24.43	19.52	43.95	56.00	-12.05	QP
14	0.668	13.90	19.52	33.42	46.00	-12.58	Average
15	0.701	25.13	19.52	44.65	56.00	-11.35	QP
16	0.701	16.30	19.52	35.82	46.00	-10.18	Average
17	0.804	24.12	19.53	43.65	56.00	-12.35	QP
18	0.804	14.83	19.53	34.36	46.00	-11.64	Average
19	0.830	23.08	19.53	42.61	56.00	-13.39	QP
20	0.830	14.40	19.53	33.93	46.00	-12.07	Average
21	0.899	22.85	19.53	42.38	56.00	-13.62	QP
22	0.899	13.11	19.53	32.64	46.00	-13.36	Average

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

8 FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

8.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	608 – 614	4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	960 – 1240	5. 35 – 5. 46
2.1735 – 2.1905	16.80425 – 16.80475	1300 – 1427	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1435 – 1626.5	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1645.5 – 1646.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1660 – 1710	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1718.8 – 1722.2	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	2200 – 2300	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2310 – 2390	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2483.5 – 2500	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2690 – 2900	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	3260 – 3267	22.01 – 23.12
8.41425 – 8.41475	162.0125 –167.17	3.332 – 3.339	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3 3458 – 3 358	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3.600 – 4.400	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4		Above 38.6
13.36 – 13.41	399.9 – 410		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

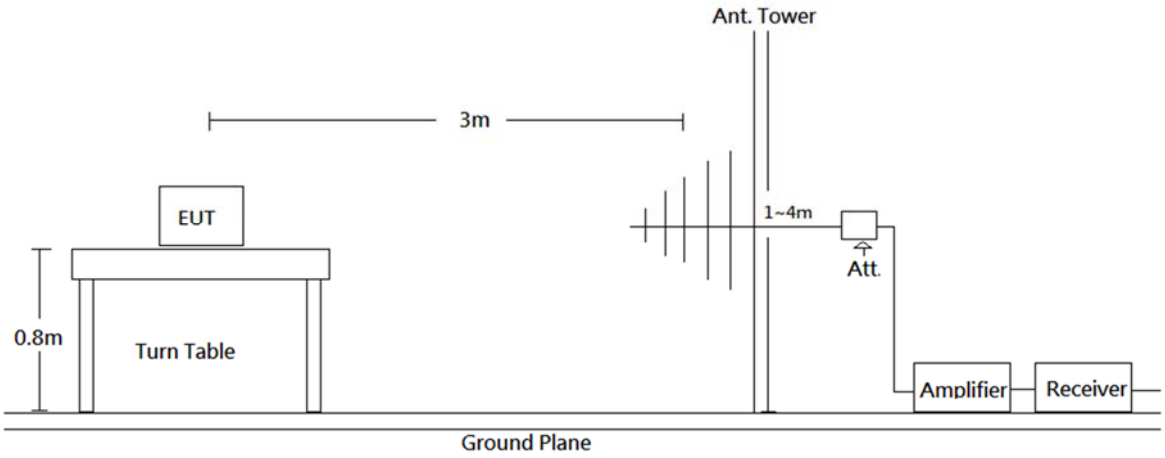
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) 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

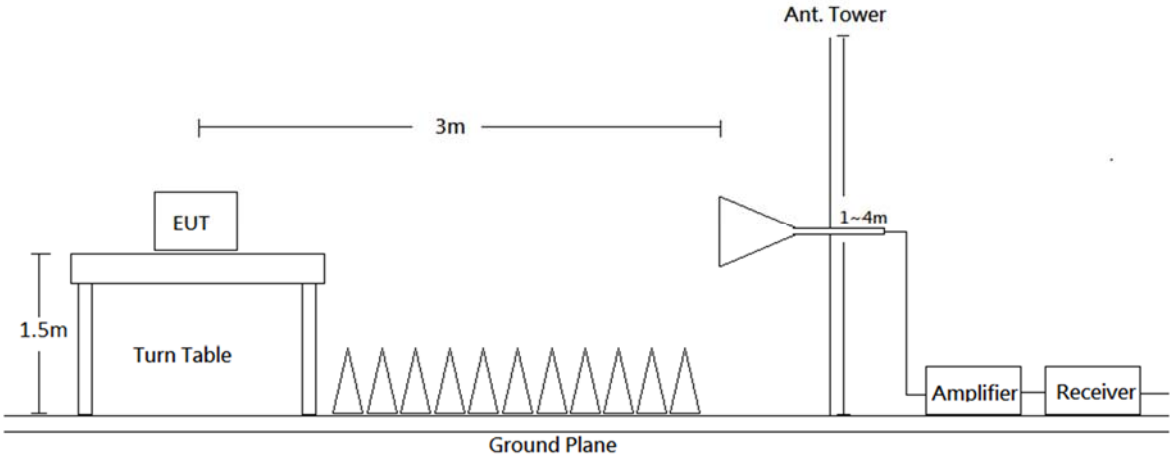
intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the 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).

8.2 EUT Setup

Below 1 GHz:



Above 1 GHz:



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

8.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	/	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	>98%	Ave
	1 MHz	1/T	<98%	Ave

Note: T is minimum transmission duration

8.4 Test Procedure

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

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

8.5 Corrected Factor & Margin Calculation

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

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

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

Margin = Result – Limit

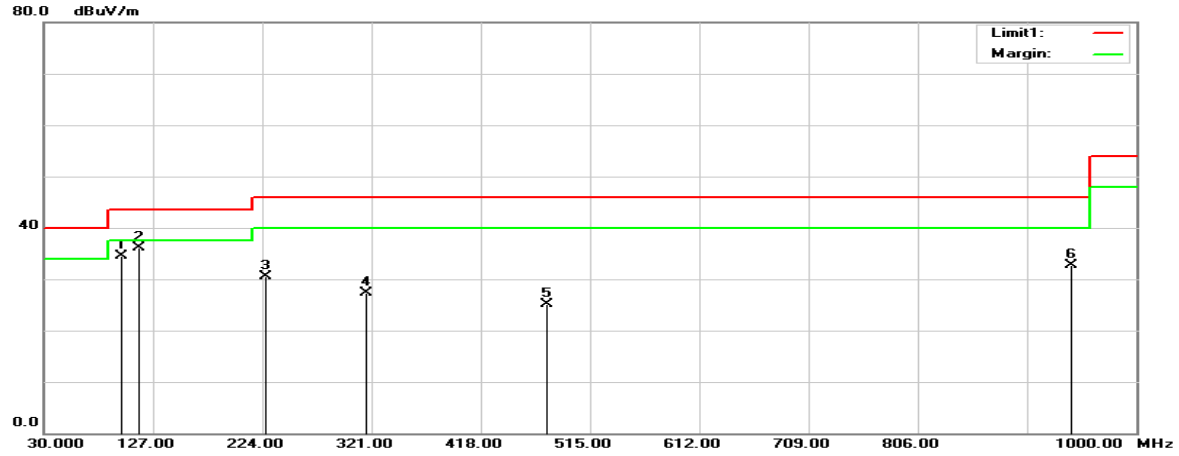
8.6 Test Results

Test Mode: Transmitting

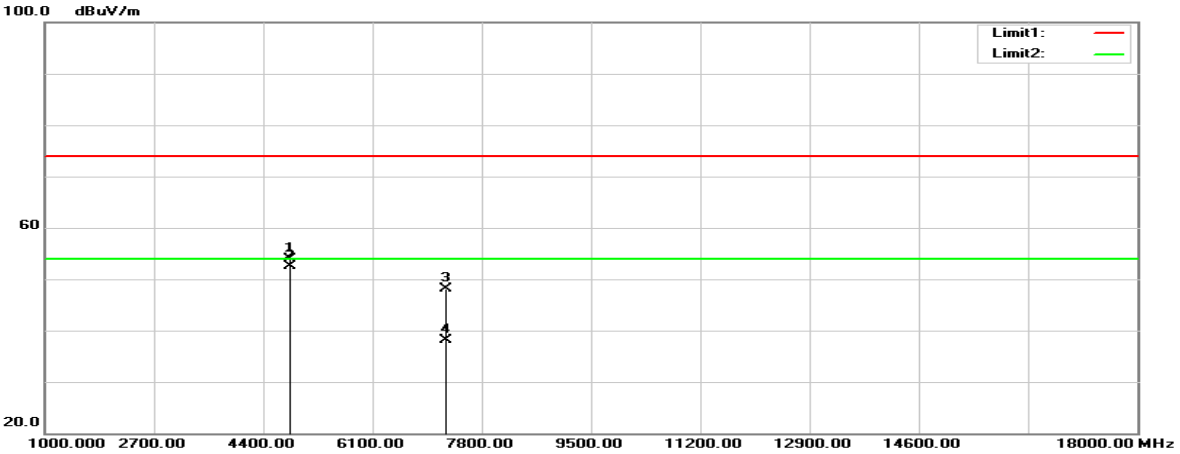
(Pre-scan with three orthogonal axis, and worse case as Z axis.)

Horizontal (worst case is 802.11n HT20 mode, Middle channel)

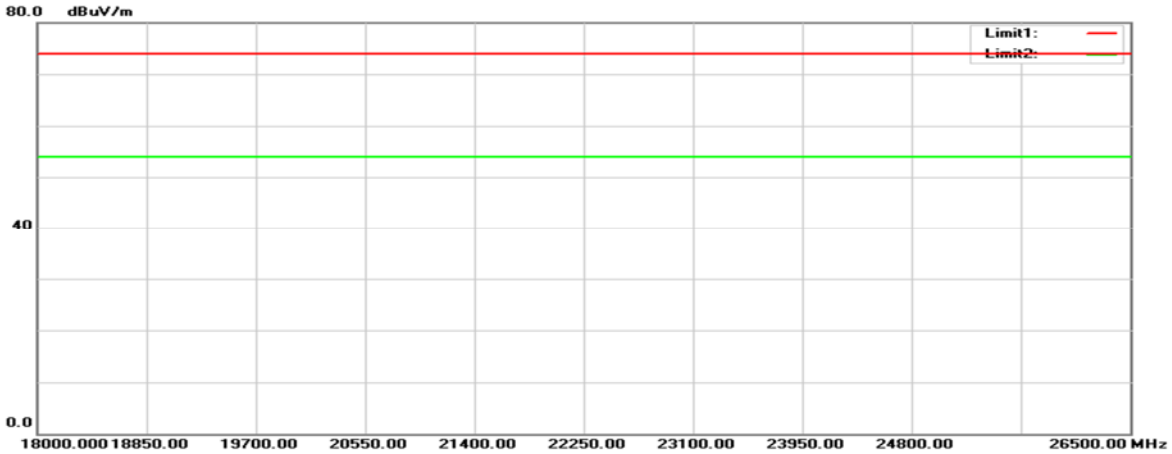
30MHz-1GHz:



1GHz-18GHz:

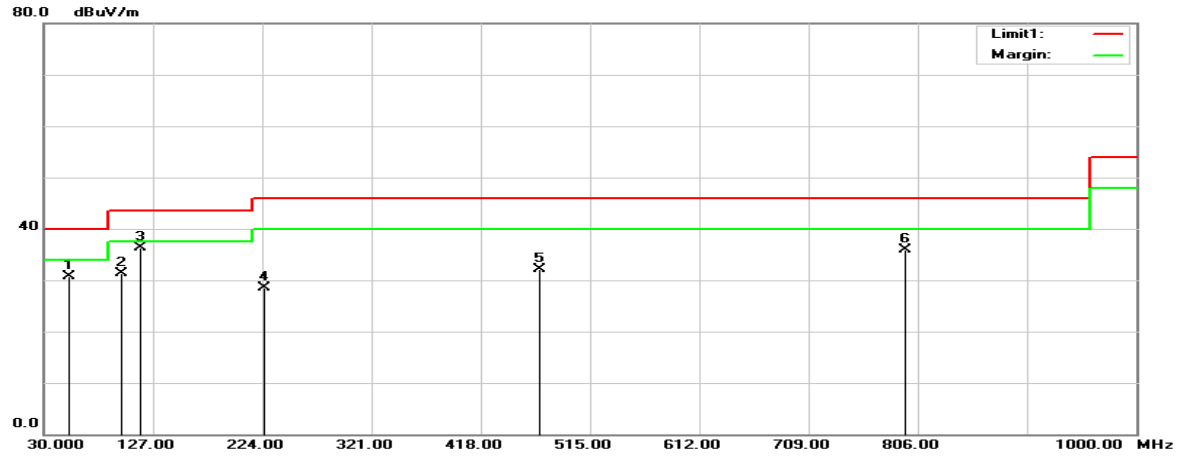


18GHz-26.5GHz:

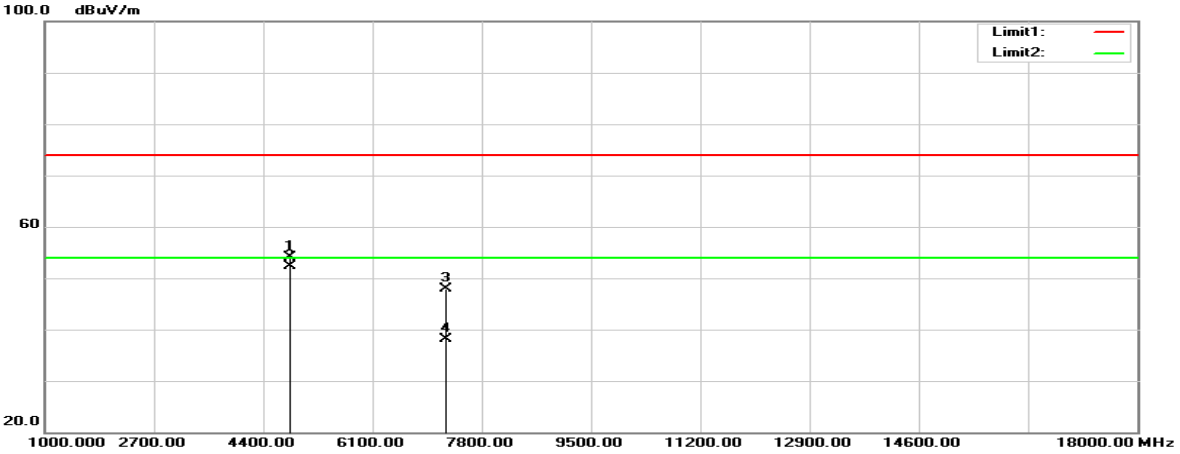


Vertical (worst case is 802.11n HT20 mode, Middle channel)

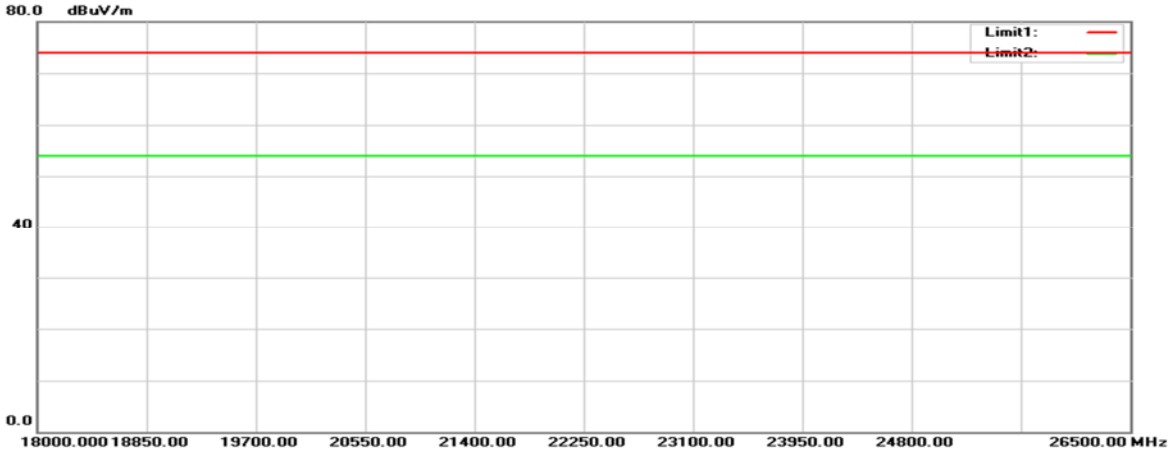
30MHz-1GHz:



1GHz-18GHz:



18GHz-26.5GHz:



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
99.0100	48.98	-14.57	34.41	43.50	-9.09	100	250	peak
114.1200	47.23	-11.10	36.13	43.50	-7.37	100	136	peak
226.8800	43.22	-12.79	30.43	46.00	-15.57	100	258	peak
315.8700	36.98	-9.69	27.29	46.00	-18.71	100	249	peak
477.0100	31.23	-6.11	25.12	46.00	-20.88	100	164	peak
942.5000	30.68	2.08	32.76	46.00	-13.24	100	65	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
52.0100	47.58	-16.80	30.78	40.00	-9.22	100	13	peak
99.2500	45.68	-14.42	31.26	43.50	-12.24	100	225	peak
116.3100	47.22	-10.93	36.29	43.50	-7.21	100	54	peak
225.6800	41.38	-12.84	28.54	46.00	-17.46	100	237	peak
469.9700	38.48	-6.29	32.19	46.00	-13.81	100	241	peak
794.5200	36.97	-1.04	35.93	46.00	-10.07	100	58	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
B Mode, Low channel								
2386.608	59.18	-9.49	49.69	74.00	-24.31	170	103	peak
2386.608	47.08	-9.49	37.59	54.00	-16.41	170	103	AVG
4824.000	56.14	-2.15	53.99	74.00	-20.01	189	62	peak
4824.000	54.59	-2.15	52.44	54.00	-1.56	189	62	AVG
7236.000	43.54	4.55	48.09	74.00	-25.91	166	158	peak
7236.000	33.48	4.55	38.03	54.00	-15.97	166	158	AVG
B Mode, Middle channel								
4874.000	56.59	-1.92	54.67	74.00	-19.33	151	249	peak
4874.000	54.86	-1.92	52.94	54.00	-1.06	151	249	AVG
7311.000	43.46	5.08	48.54	74.00	-25.46	147	133	peak
7311.000	33.67	5.08	38.75	54.00	-15.25	147	133	AVG
B Mode, High channel								
2483.500	56.48	-8.45	48.03	74.00	-25.97	137	110	peak
2483.500	44.55	-8.45	36.10	54.00	-17.90	137	110	AVG
4924.000	56.18	-1.63	54.55	74.00	-19.45	162	269	peak
4924.000	54.22	-1.63	52.59	54.00	-1.41	162	269	AVG
7386.000	41.81	5.20	47.01	74.00	-26.99	153	178	peak
7386.000	31.75	5.20	36.95	54.00	-17.05	153	178	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
B Mode, Low channel								
2382.912	57.36	-9.52	47.84	74.00	-26.16	168	270	peak
2382.912	45.20	-9.52	35.68	54.00	-18.32	168	270	AVG
4824.000	56.25	-2.15	54.10	74.00	-19.90	161	225	peak
4824.000	54.48	-2.15	52.33	54.00	-1.67	161	225	AVG
7236.000	43.34	4.55	47.89	74.00	-26.11	158	134	peak
7236.000	33.57	4.55	38.12	54.00	-15.88	158	134	AVG
B Mode, Middle channel								
4874.000	56.28	-1.92	54.36	74.00	-19.64	161	216	peak
4874.000	54.47	-1.92	52.55	54.00	-1.45	161	216	AVG
7311.000	41.90	5.08	46.98	74.00	-27.02	154	138	peak
7311.000	31.58	5.08	36.66	54.00	-17.34	154	138	AVG
B Mode, High channel								
2483.500	54.71	-8.45	46.26	74.00	-27.74	151	271	peak
2483.500	43.10	-8.45	34.65	54.00	-19.35	151	271	AVG
4924.000	56.49	-1.63	54.86	74.00	-19.14	158	245	peak
4924.000	54.27	-1.63	52.64	54.00	-1.36	158	245	AVG
7386.000	42.02	5.20	47.22	74.00	-26.78	164	187	peak
7386.000	32.55	5.20	37.75	54.00	-16.25	164	187	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
G Mode, Low channel								
2390.000	82.33	-9.46	72.87	74.00	-1.13	172	108	peak
2390.000	62.12	-9.46	52.66	54.00	-1.34	172	108	AVG
4824.000	56.70	-2.15	54.55	74.00	-19.45	163	219	peak
4824.000	54.59	-2.15	52.44	54.00	-1.56	163	219	AVG
7236.000	41.88	4.55	46.43	74.00	-27.57	154	147	peak
7236.000	31.57	4.55	36.12	54.00	-17.88	154	147	AVG
G Mode, Middle channel								
4874.000	56.53	-1.92	54.61	74.00	-19.39	157	258	peak
4874.000	54.74	-1.92	52.82	54.00	-1.18	157	258	AVG
7311.000	41.85	5.08	46.93	74.00	-27.07	162	134	peak
7311.000	31.66	5.08	36.74	54.00	-17.26	162	134	AVG
G Mode, High channel								
2483.500	76.23	-8.45	67.78	74.00	-6.22	205	80	peak
2483.500	54.87	-8.45	46.42	54.00	-7.58	205	80	AVG
4924.000	56.26	-1.63	54.63	74.00	-19.37	153	178	peak
4924.000	54.33	-1.63	52.70	54.00	-1.30	153	178	AVG
7386.000	43.05	5.20	48.25	74.00	-25.75	164	226	peak
7386.000	33.47	5.20	38.67	54.00	-15.33	164	226	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
G Mode, Low channel								
2390.000	75.06	-9.46	65.60	74.00	-8.40	135	275	peak
2390.000	54.16	-9.46	44.70	54.00	-9.30	135	275	AVG
4824.000	56.26	-2.15	54.11	74.00	-19.89	164	225	peak
4824.000	54.33	-2.15	52.18	54.00	-1.82	164	225	AVG
7236.000	41.60	4.55	46.15	74.00	-27.85	158	149	peak
7236.000	31.47	4.55	36.02	54.00	-17.98	158	149	AVG
G Mode, Middle channel								
4874.000	56.34	-1.92	54.42	74.00	-19.58	163	228	peak
4874.000	54.22	-1.92	52.30	54.00	-1.70	163	228	AVG
7311.000	42.99	5.08	48.07	74.00	-25.93	152	145	peak
7311.000	32.58	5.08	37.66	54.00	-16.34	152	145	AVG
G Mode, High channel								
2483.500	66.79	-8.45	58.34	74.00	-15.66	151	271	peak
2483.500	47.35	-8.45	38.90	54.00	-15.10	151	271	AVG
4924.000	56.09	-1.63	54.46	74.00	-19.54	151	254	peak
4924.000	54.28	-1.63	52.65	54.00	-1.35	151	254	AVG
7386.000	41.99	5.20	47.19	74.00	-26.81	168	322	peak
7386.000	31.58	5.20	36.78	54.00	-17.22	168	322	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
N20 Mode, Low channel								
2390.000	80.48	-9.46	71.02	74.00	-2.98	181	154	peak
2390.000	62.32	-9.46	52.86	54.00	-1.14	181	154	AVG
4824.000	56.56	-2.15	54.41	74.00	-19.59	158	218	peak
4824.000	54.88	-2.15	52.73	54.00	-1.27	158	218	AVG
7236.000	42.99	4.55	47.54	74.00	-26.46	163	189	peak
7236.000	32.57	4.55	37.12	54.00	-16.88	163	189	AVG
N20 Mode, Middle channel								
4874.000	56.83	-1.92	54.91	74.00	-19.09	162	219	peak
4874.000	54.91	-1.92	52.99	54.00	-1.01	162	219	AVG
7311.000	42.47	5.08	47.55	74.00	-26.45	155	147	peak
7311.000	32.64	5.08	37.72	54.00	-16.28	155	147	AVG
N20 Mode, High channel								
2483.500	74.84	-8.45	66.39	74.00	-7.61	181	156	peak
2483.500	53.24	-8.45	44.79	54.00	-9.21	181	156	AVG
4924.000	56.18	-1.63	54.55	74.00	-19.45	158	312	peak
4924.000	54.34	-1.63	52.71	54.00	-1.29	158	312	AVG
7386.000	41.41	5.20	46.61	74.00	-27.39	167	239	peak
7386.000	31.54	5.20	36.74	54.00	-17.26	167	239	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
N20 Mode, Low channel								
2390.000	74.90	-9.46	65.44	74.00	-8.56	154	67	peak
2390.000	59.27	-9.46	49.81	54.00	-4.19	154	67	AVG
4824.000	56.91	-2.15	54.76	74.00	-19.24	168	154	peak
4824.000	54.82	-2.15	52.67	54.00	-1.33	168	154	AVG
7236.000	41.74	4.55	46.29	74.00	-27.71	152	192	peak
7236.000	31.45	4.55	36.00	54.00	-18.00	152	192	AVG
N20 Mode, Middle channel								
4874.000	56.26	-1.92	54.34	74.00	-19.66	152	311	peak
4874.000	54.33	-1.92	52.41	54.00	-1.59	152	311	AVG
7311.000	41.73	5.08	46.81	74.00	-27.19	164	227	peak
7311.000	31.65	5.08	36.73	54.00	-17.27	164	227	AVG
N20 Mode, High channel								
2483.500	66.03	-8.45	57.58	74.00	-16.42	150	69	peak
2483.500	49.17	-8.45	40.72	54.00	-13.28	150	69	AVG
4924.000	56.79	-1.63	55.16	74.00	-18.84	158	289	peak
4924.000	54.51	-1.63	52.88	54.00	-1.12	158	289	AVG
7386.000	41.78	5.20	46.98	74.00	-27.02	163	178	peak
7386.000	31.65	5.20	36.85	54.00	-17.15	163	178	AVG

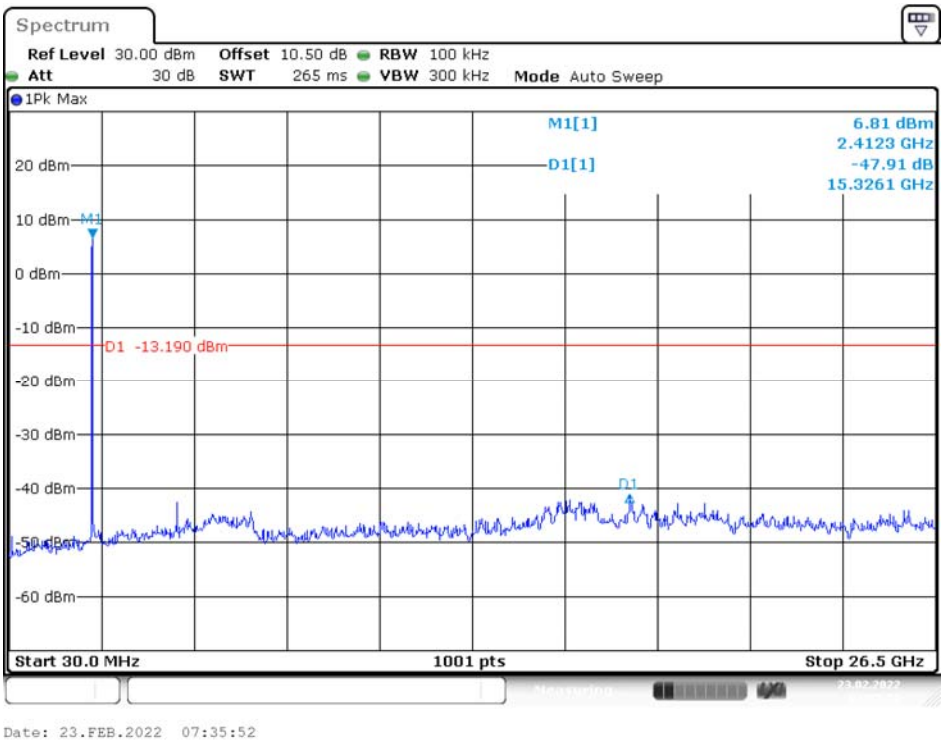
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Conducted Spurious Emissions:

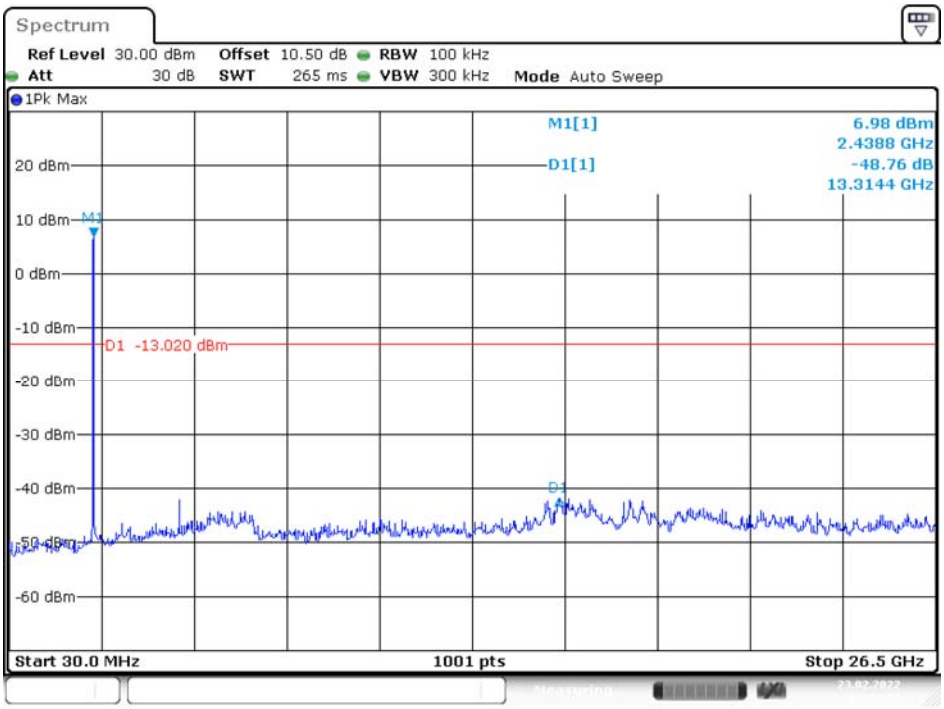
Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	47.91	≥ 20	PASS
Middle	2437	48.76	≥ 20	PASS
High	2462	49.19	≥ 20	PASS
G Mode				
Low	2412	42.03	≥ 20	PASS
Middle	2437	44.21	≥ 20	PASS
High	2462	42.11	≥ 20	PASS
N20 Mode				
Low	2412	39.89	≥ 20	PASS
Middle	2437	40.18	≥ 20	PASS
High	2462	40.87	≥ 20	PASS

B Mode

Low Channel

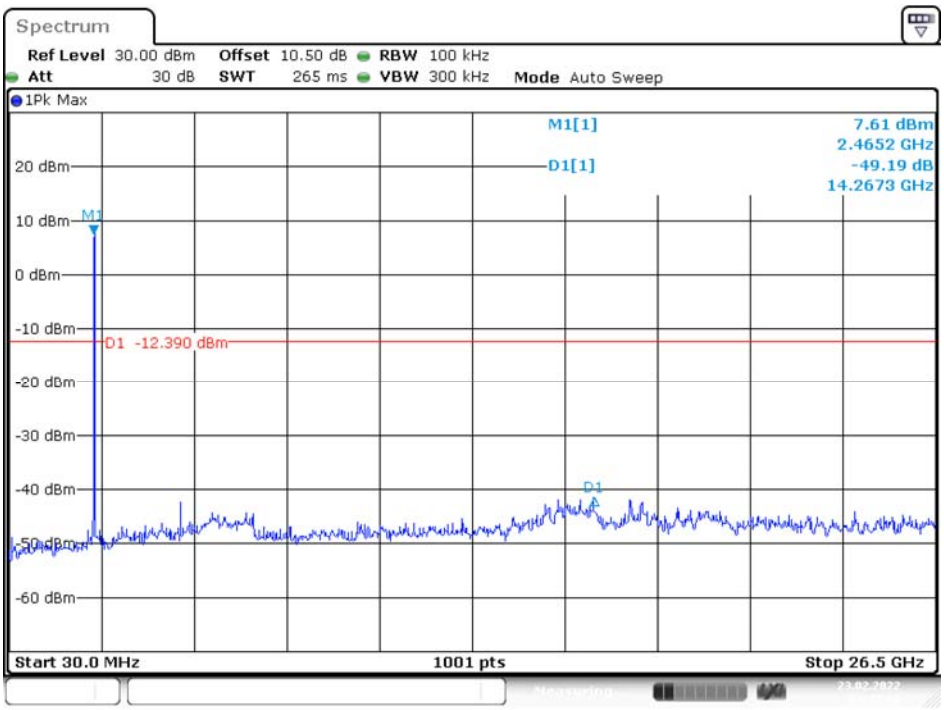


Middle Channel



Date: 23.FEB.2022 07:41:11

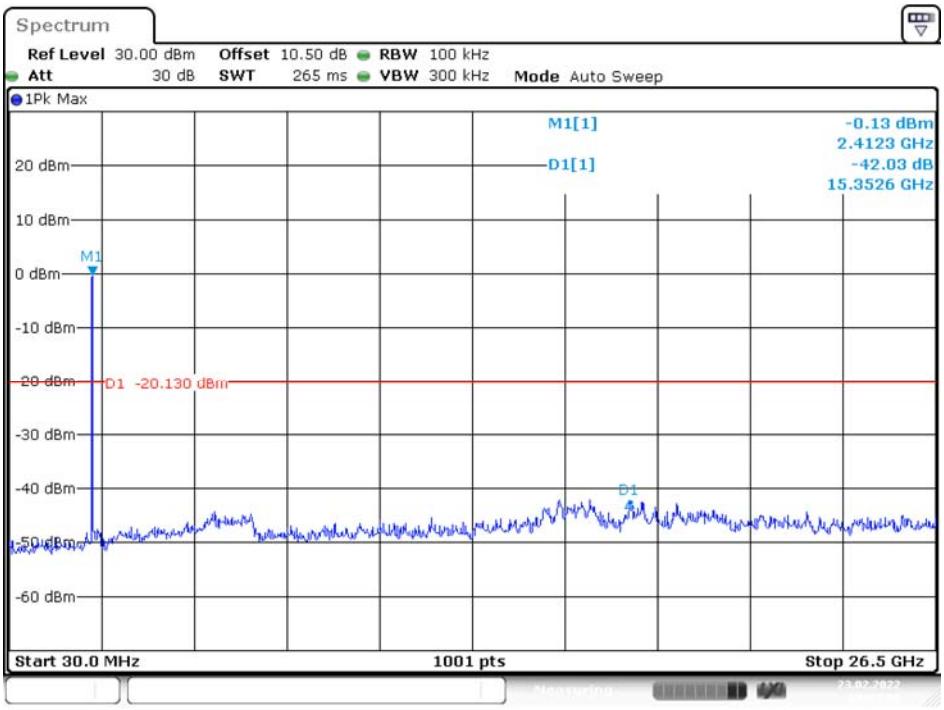
High Channel



Date: 23.FEB.2022 07:43:48

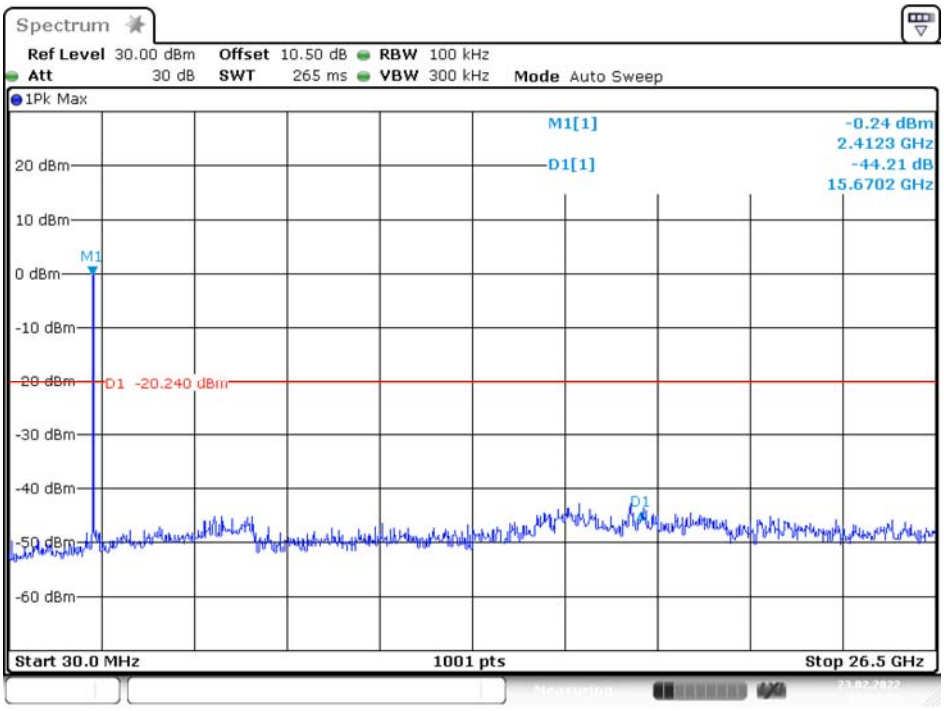
G Mode

Low Channel



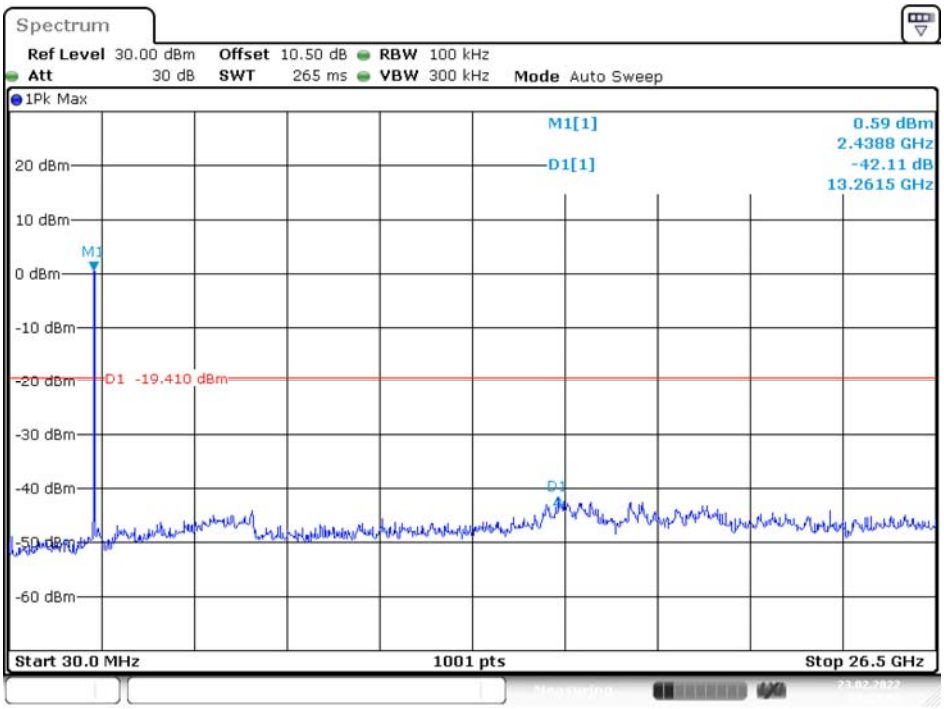
Date: 23.FEB.2022 08:01:00

Middle Channel



Date: 23.FEB.2022 08:04:15

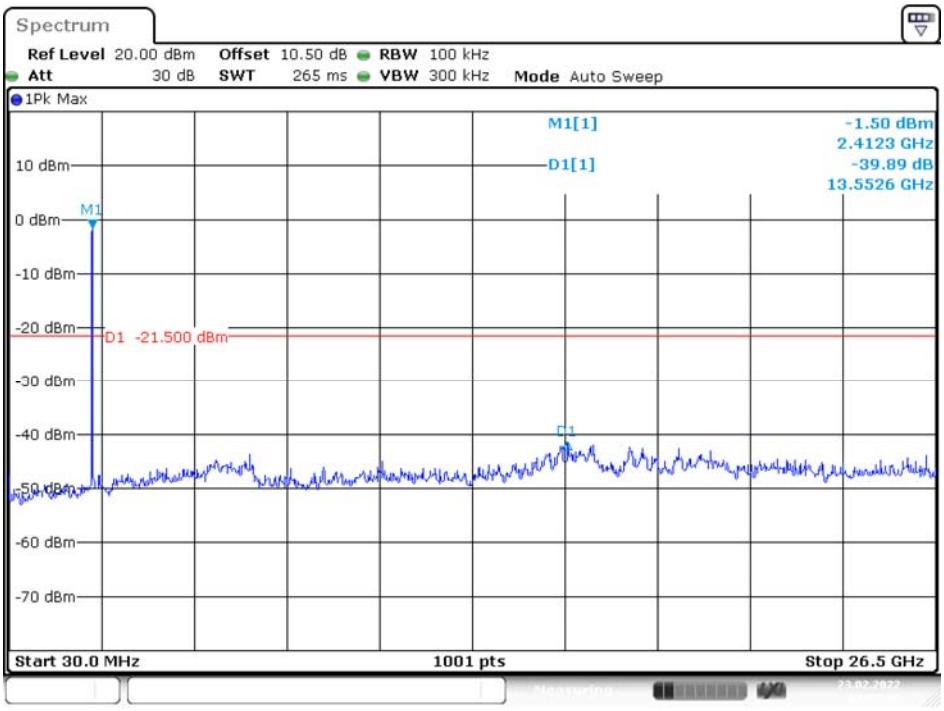
High Channel



Date: 23.FEB.2022 08:23:00

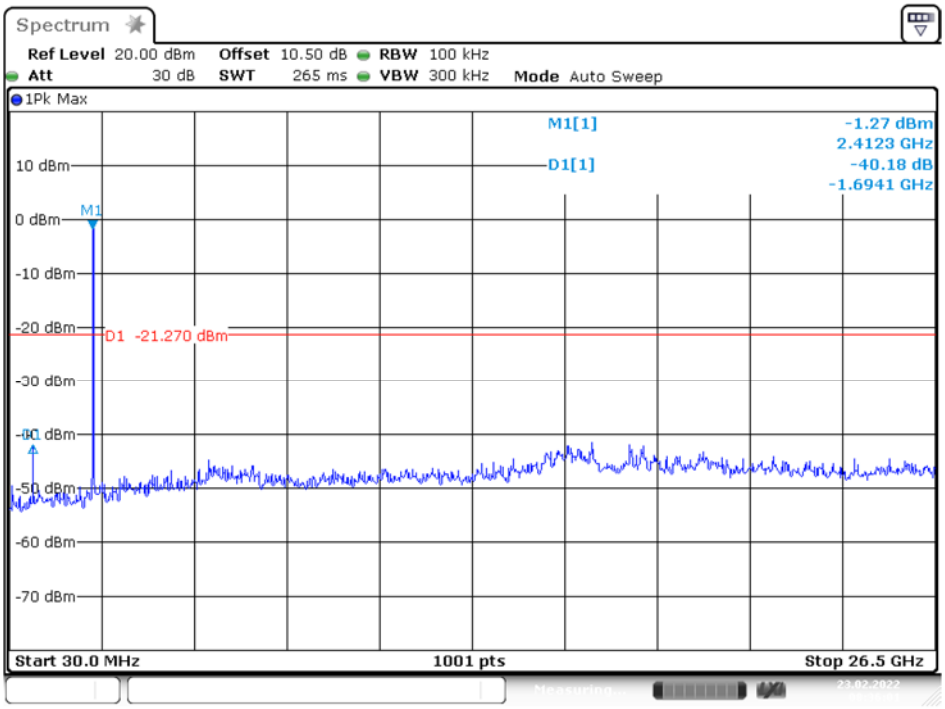
N20 Mode

Low Channel



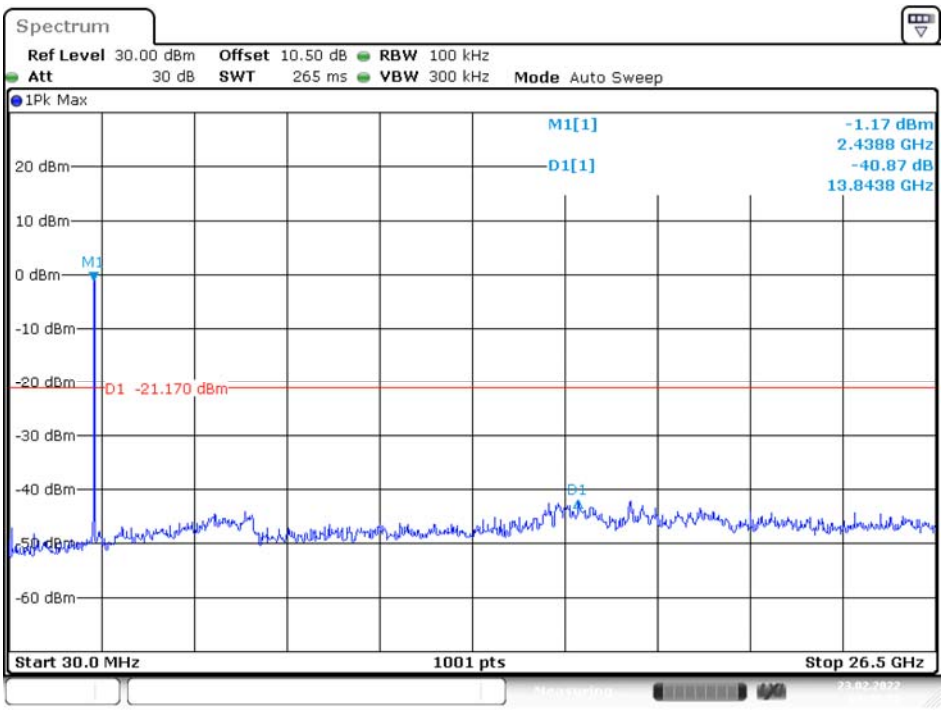
Date: 23.FEB.2022 08:30:45

Middle Channel



Date: 23.FEB.2022 08:36:01

High Channel



Date: 23.FEB.2022 08:40:30

9 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a)(2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the VBW ≥ [3 × RBW].

c) Detector = peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

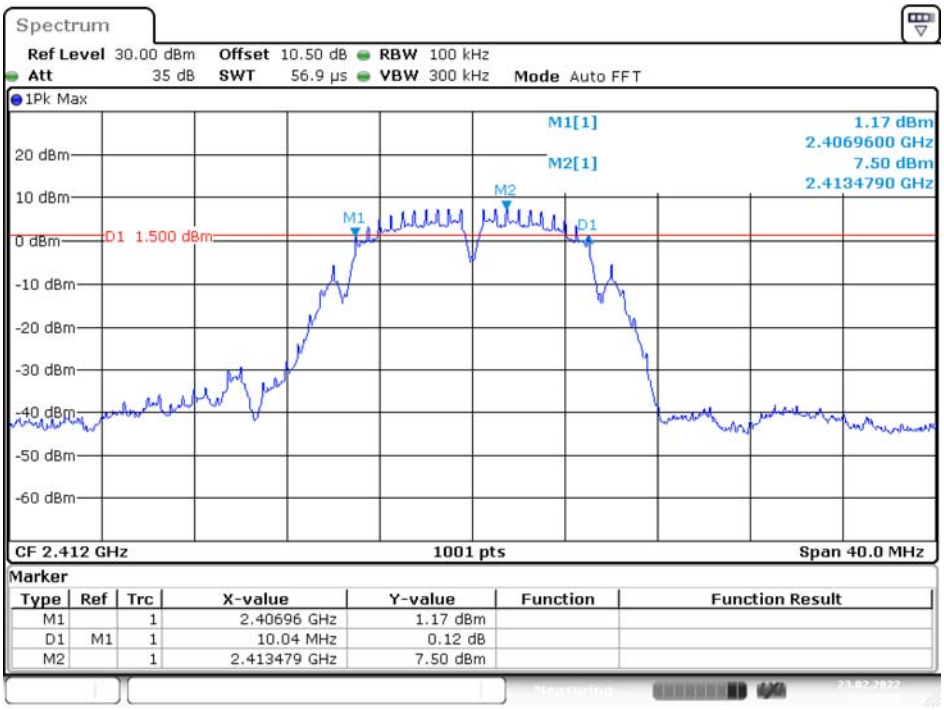
9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)	Result
B Mode				
Low	2412	10.04	> 500	PASS
Middle	2437	10.04	> 500	PASS
High	2462	10.04	> 500	PASS
G Mode				
Low	2412	16.40	> 500	PASS
Middle	2437	16.40	> 500	PASS
High	2462	16.40	> 500	PASS
N20 Mode				
Low	2412	17.60	> 500	PASS
Middle	2437	17.60	> 500	PASS
High	2462	17.60	> 500	PASS

Please refer to the following plots

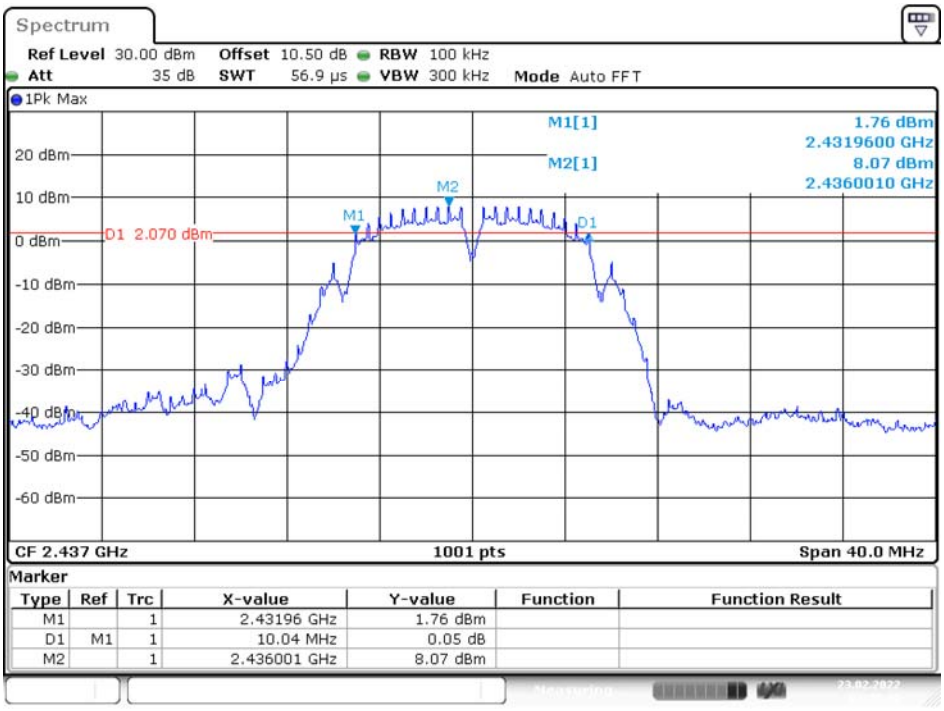
B Mode

Low Channel



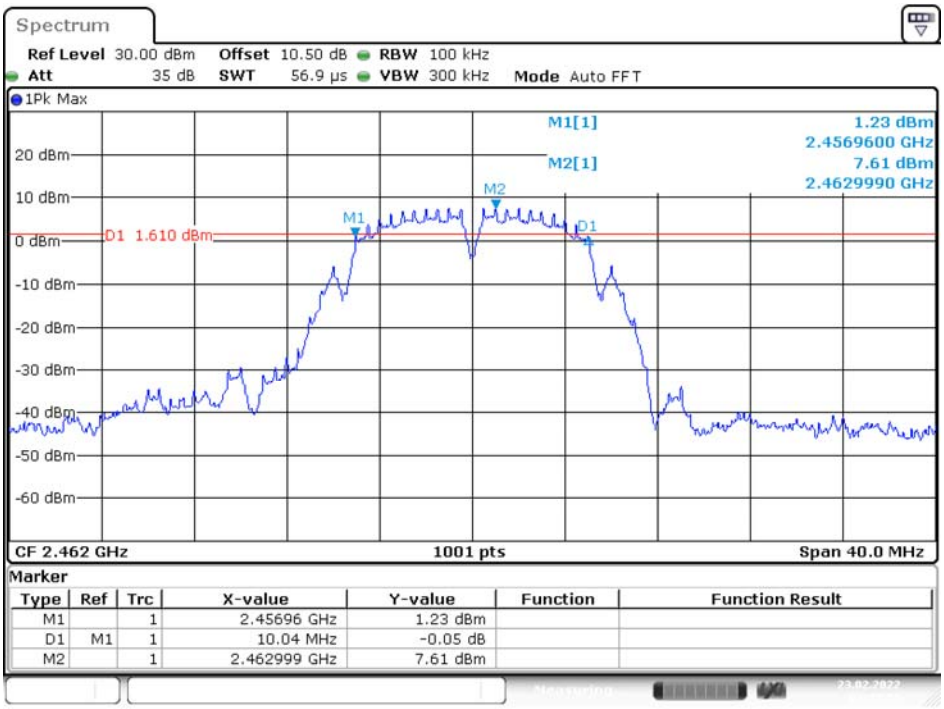
Date: 23.FEB.2022 07:35:12

Middle Channel



Date: 23.FEB.2022 07:40:46

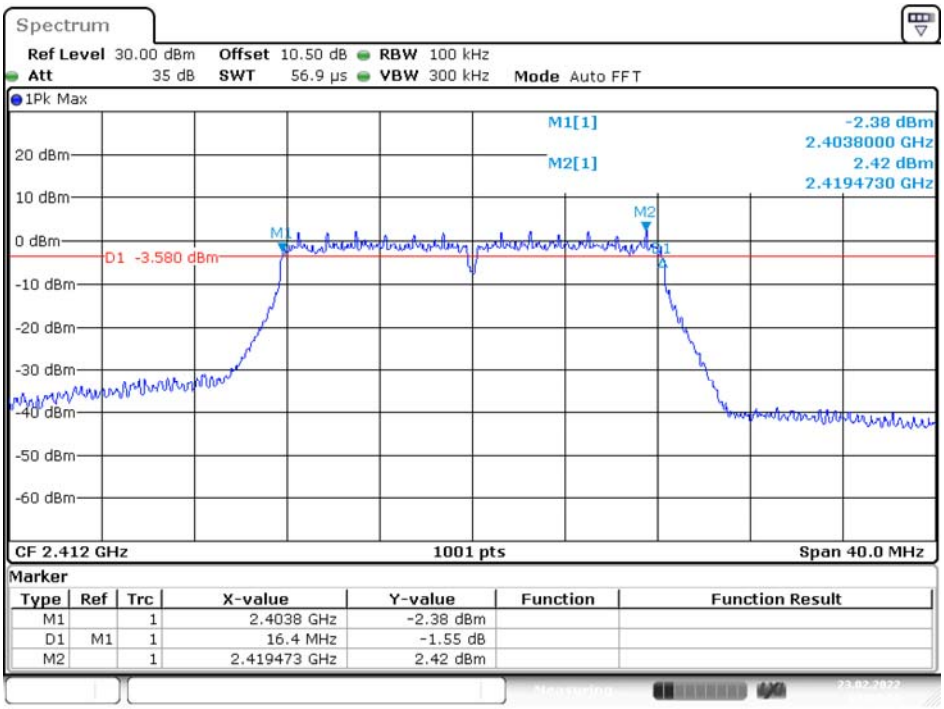
High Channel



Date: 23.FEB.2022 07:43:07

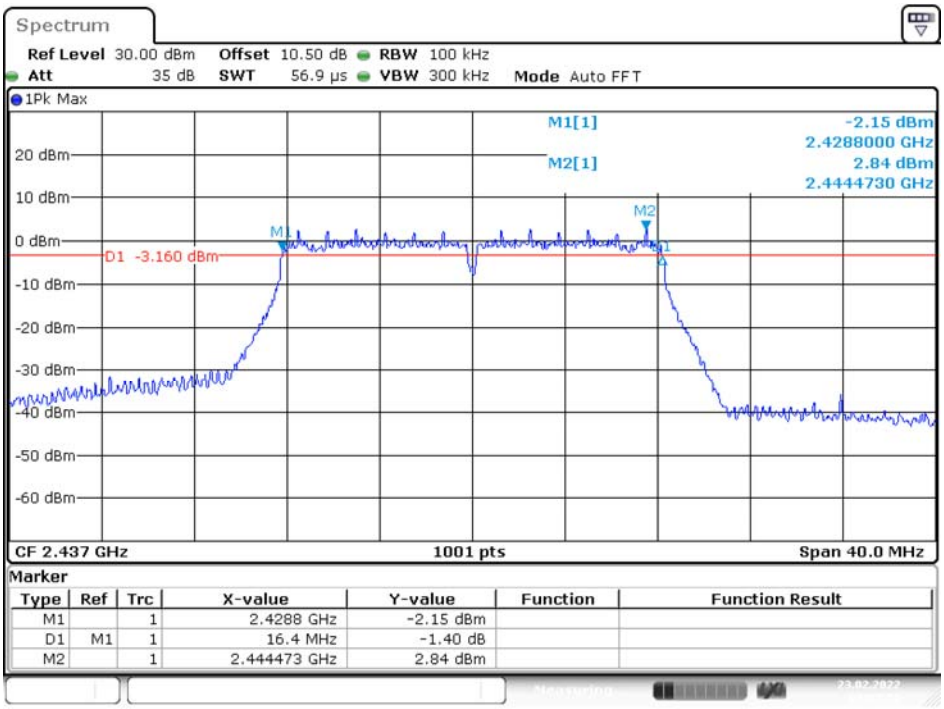
G Mode

Low Channel



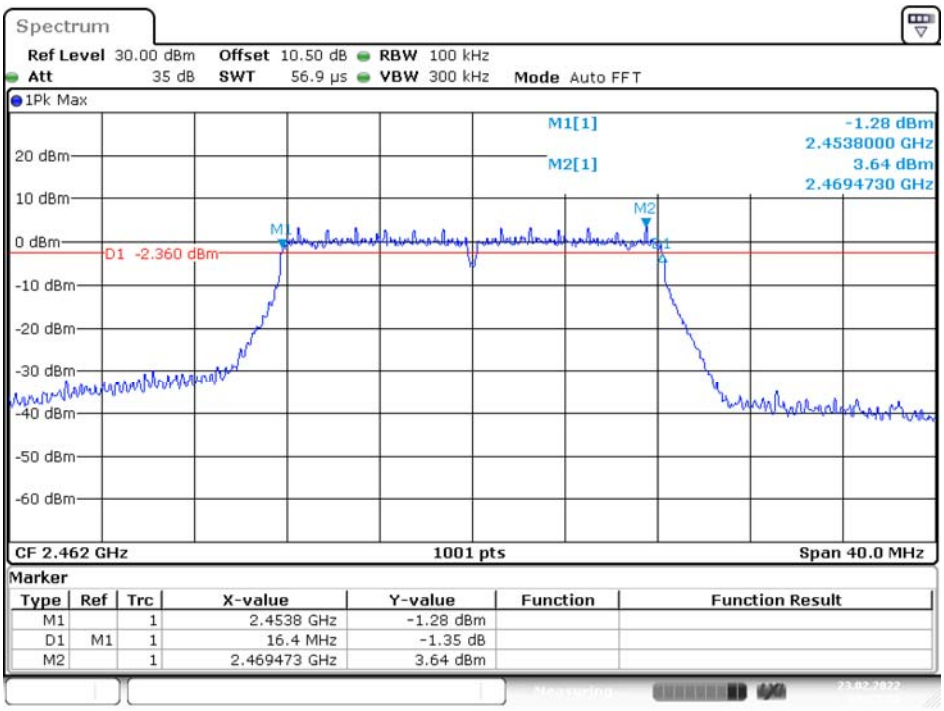
Date: 23.FEB.2022 08:00:19

Middle Channel



Date: 23.FEB.2022 08:03:50

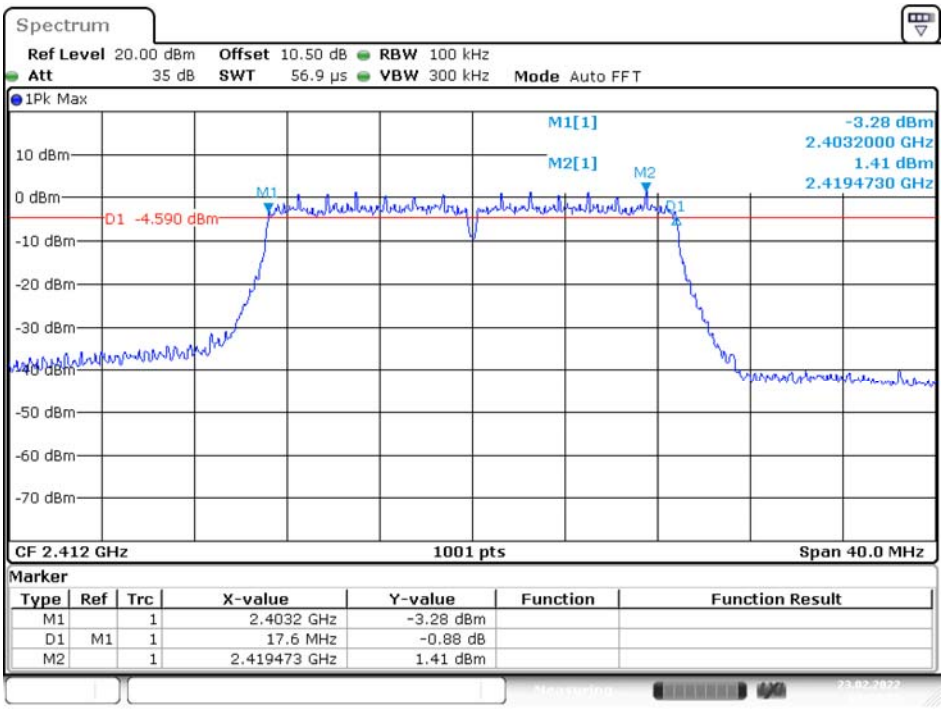
High Channel



Date: 23.FEB.2022 08:22:20

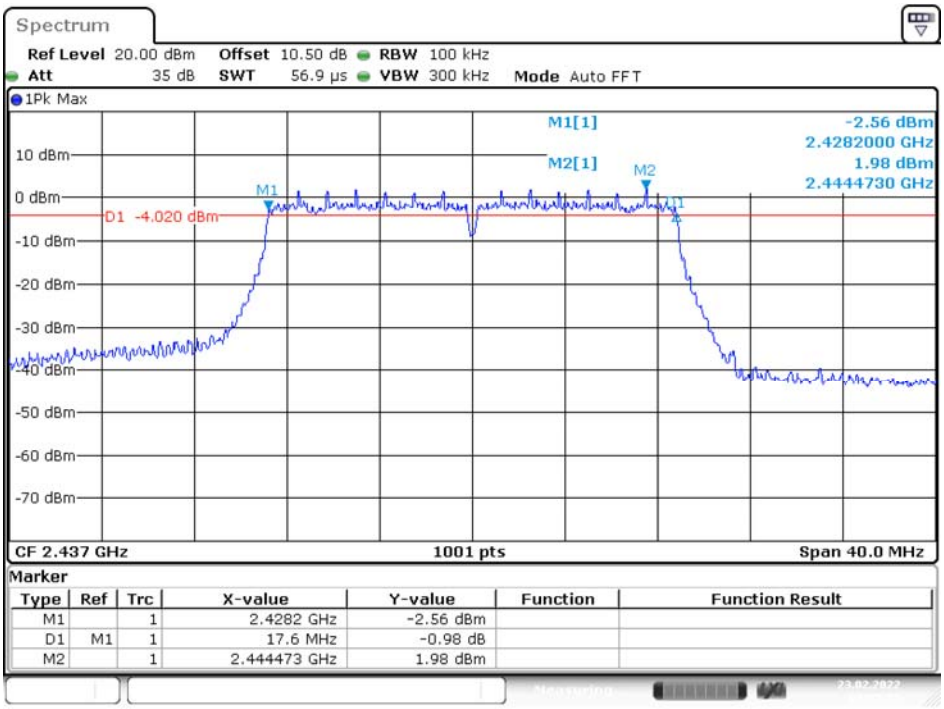
N20 Mode

Low Channel



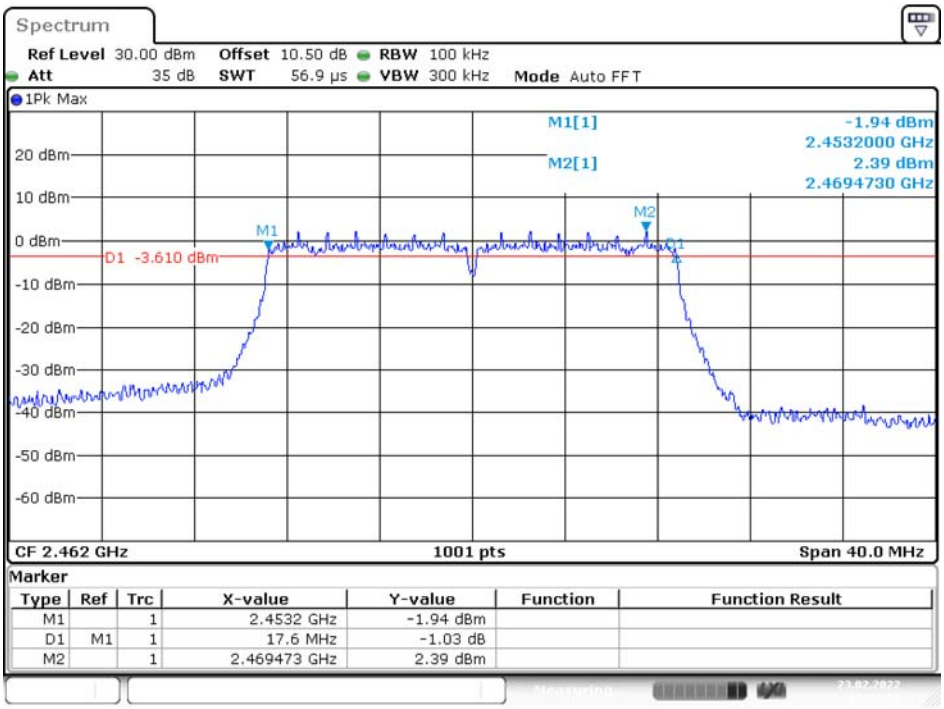
Date: 23.FEB.2022 08:30:05

Middle Channel



Date: 23.FEB.2022 08:35:36

High Channel



10 FCC §15.247(b)(3) – Maximum Peak Output Power

10.1 Applicable Standard

According to FCC §15.247(b) (3).

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.

10.2 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 measuring equipment.

10.3 Test Results

Conducted Peak Output Power

Channel	Frequency (MHz)	Power (dBm)	Power (W)	Limit (W)	Result
802.11b Mode					
Low	2412	20.44	0.111	1	PASS
Middle	2437	21.08	0.128	1	PASS
High	2462	21.63	0.146	1	PASS
802.11g Mode					
Low	2412	23.68	0.233	1	PASS
Middle	2437	24.01	0.252	1	PASS
High	2462	24.14	0.259	1	PASS
802.11n HT20 Mode					
Low	2412	22.67	0.185	1	PASS
Middle	2437	23.14	0.206	1	PASS
High	2462	24.18	0.262	1	PASS

11 FCC§15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

11.1 Applicable Standard

According to FCC §15.247(d).

In any 100kHz 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 20dB below that in the 100kHz 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 30dB instead of 20dB. 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)).

11.2 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.

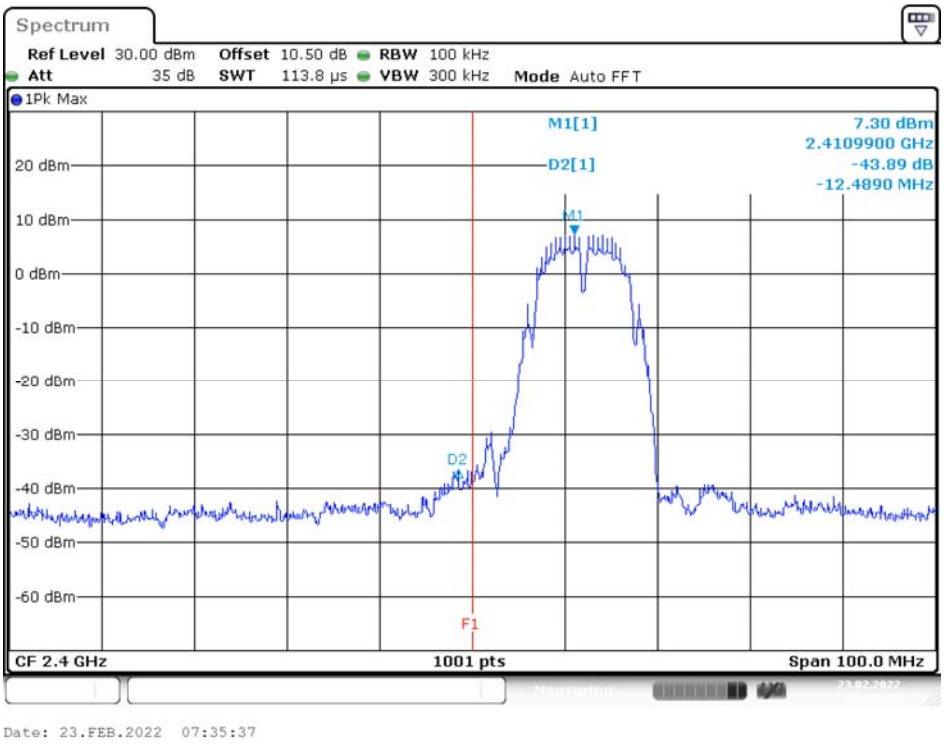
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	43.89	≥ 20	PASS
High	2462	51.47	≥ 20	PASS
G Mode				
Low	2412	34.72	≥ 20	PASS
High	2462	44.71	≥ 20	PASS
N20 Mode				
Low	2412	36.70	≥ 20	PASS
High	2462	47.13	≥ 20	PASS

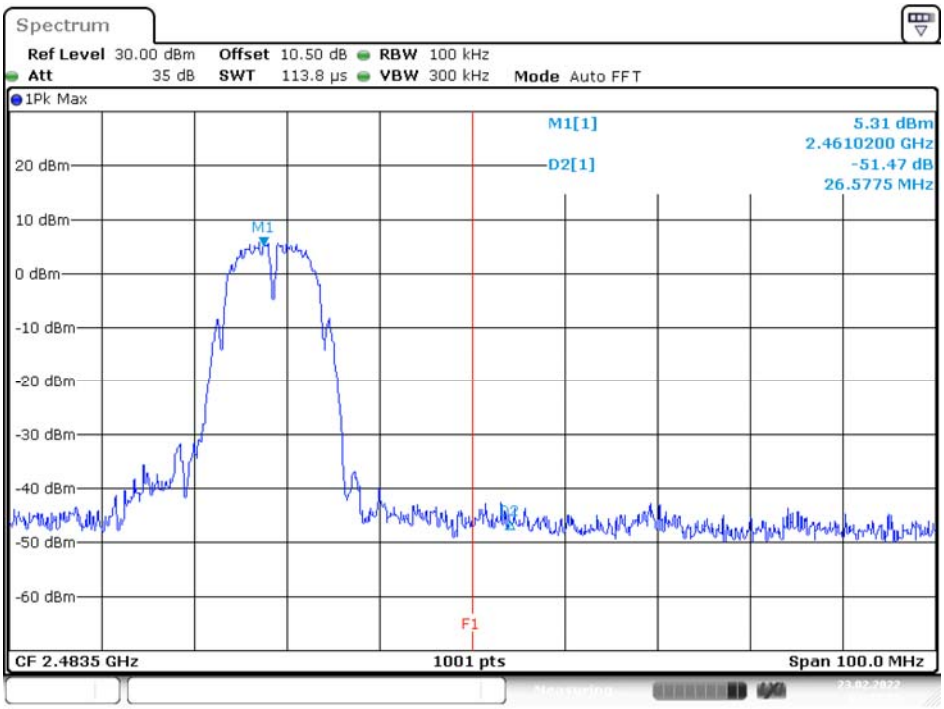
Please refer to the following plots.

B Mode

Band Edge, Left Side



Band Edge, Right Side



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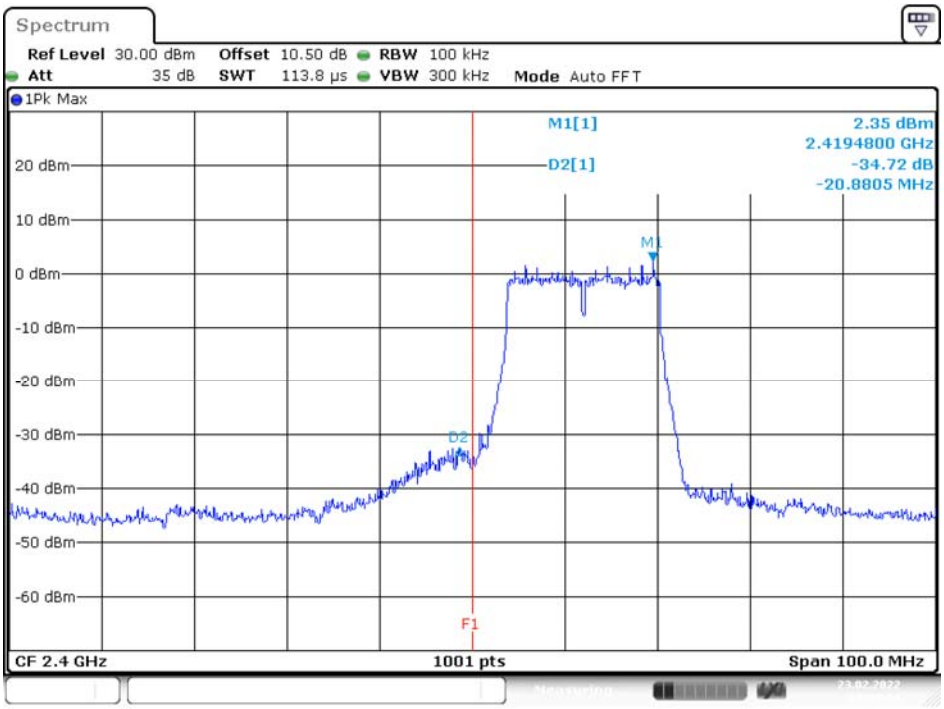
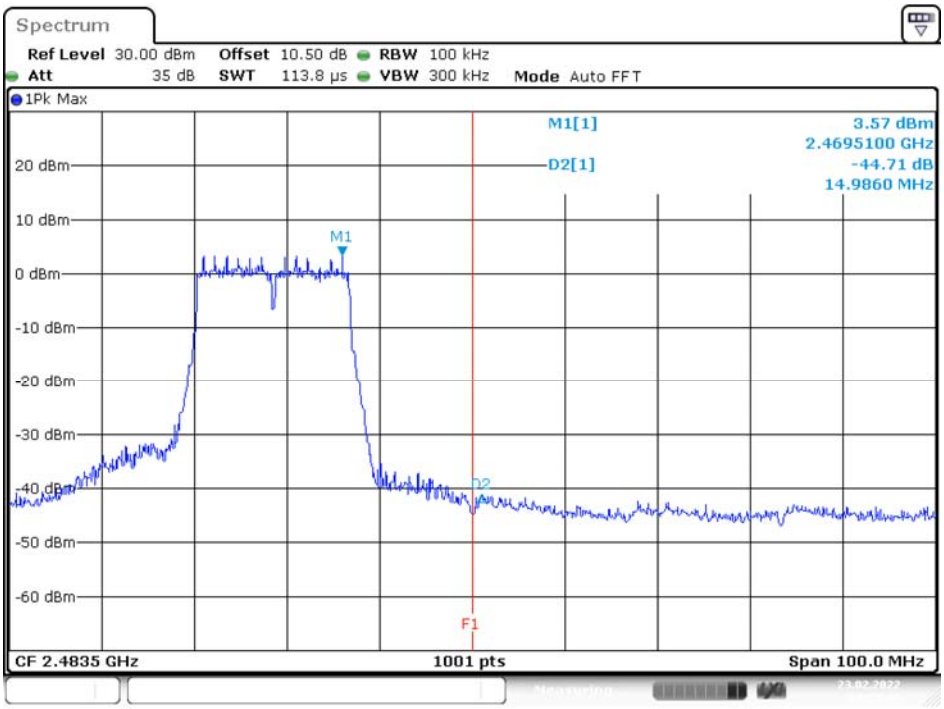
G Mode

Band Edge, Left Side



Date: 23.FEB.2022 08:00:44

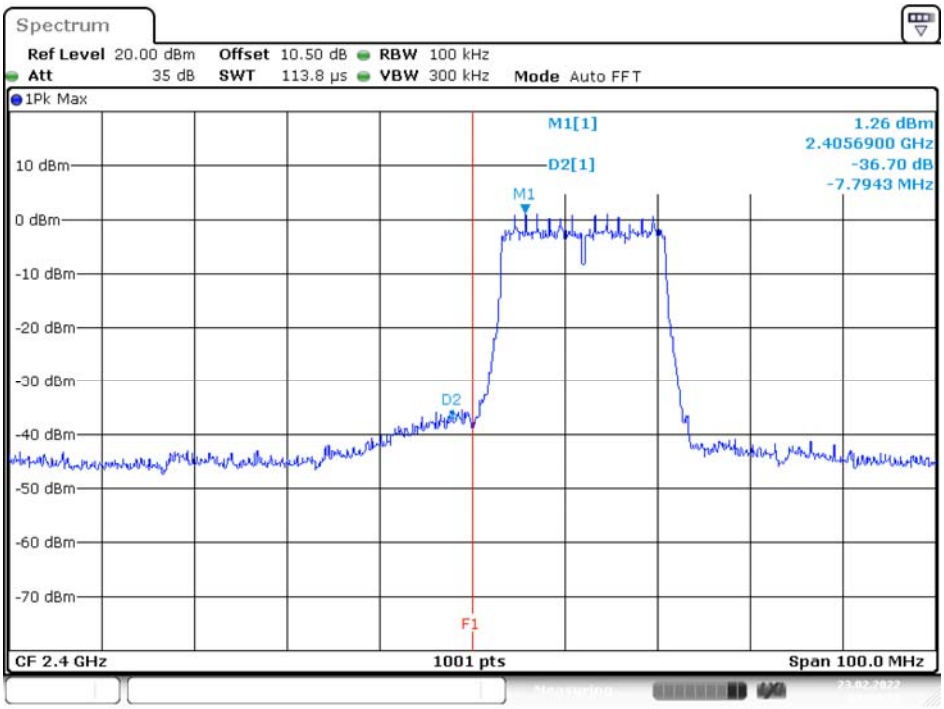
Band Edge, Right Side



Date: 23.FEB.2022 08:22:45

N20 Mode

Band Edge, Left Side



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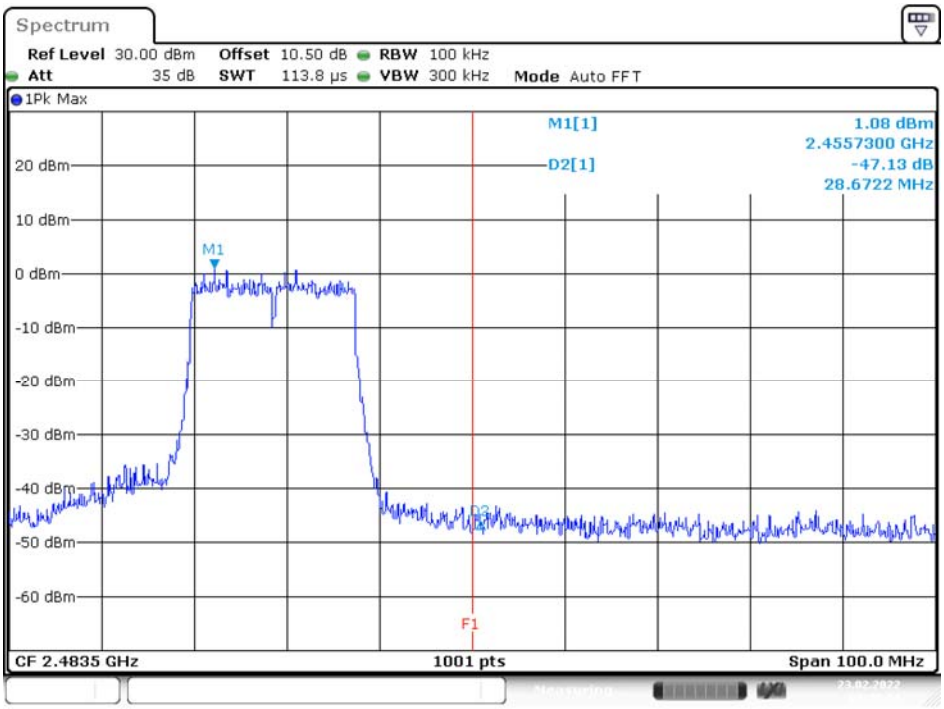
Band Edge, Right Side



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12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

12.2 Test Procedure

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

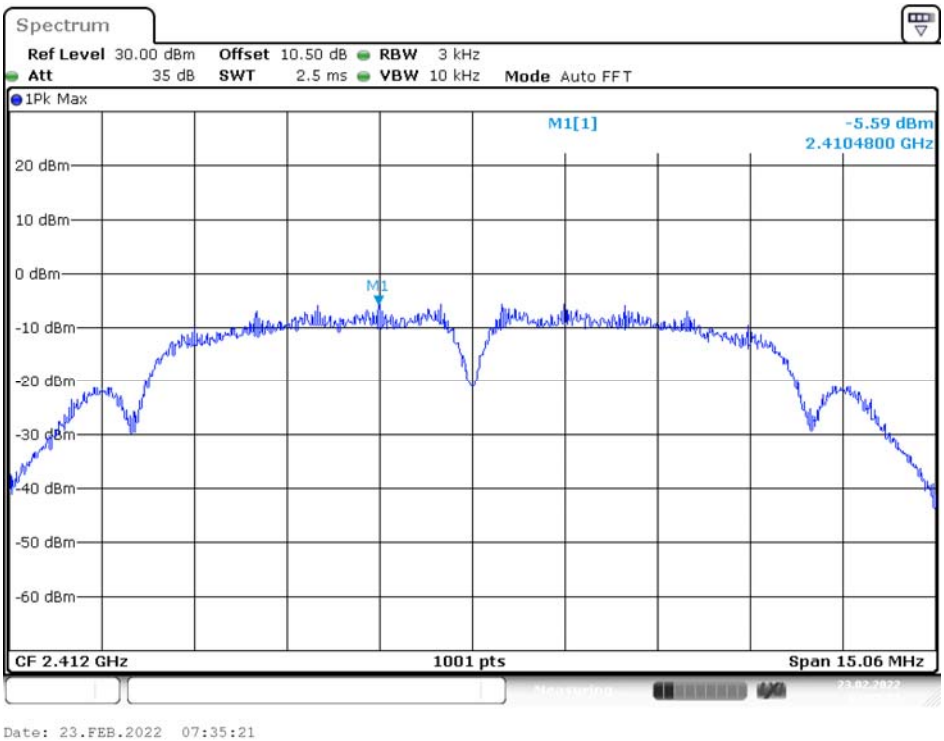
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
B Mode				
Low	2412	-5.59	8	PASS
Middle	2437	-5.00	8	PASS
High	2462	-4.45	8	PASS
G Mode				
Low	2412	-9.20	8	PASS
Middle	2437	-9.39	8	PASS
High	2462	-7.98	8	PASS
N20 Mode				
Low	2412	-9.87	8	PASS
Middle	2437	-11.11	8	PASS
High	2462	-10.16	8	PASS

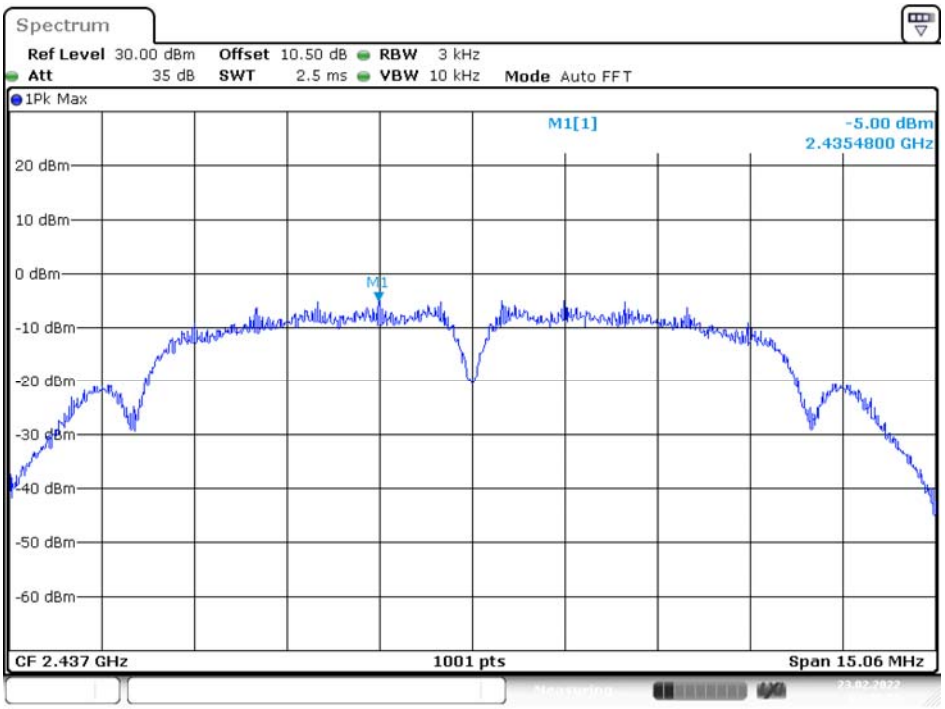
Please refer to the following plots

B Mode

Low Channel

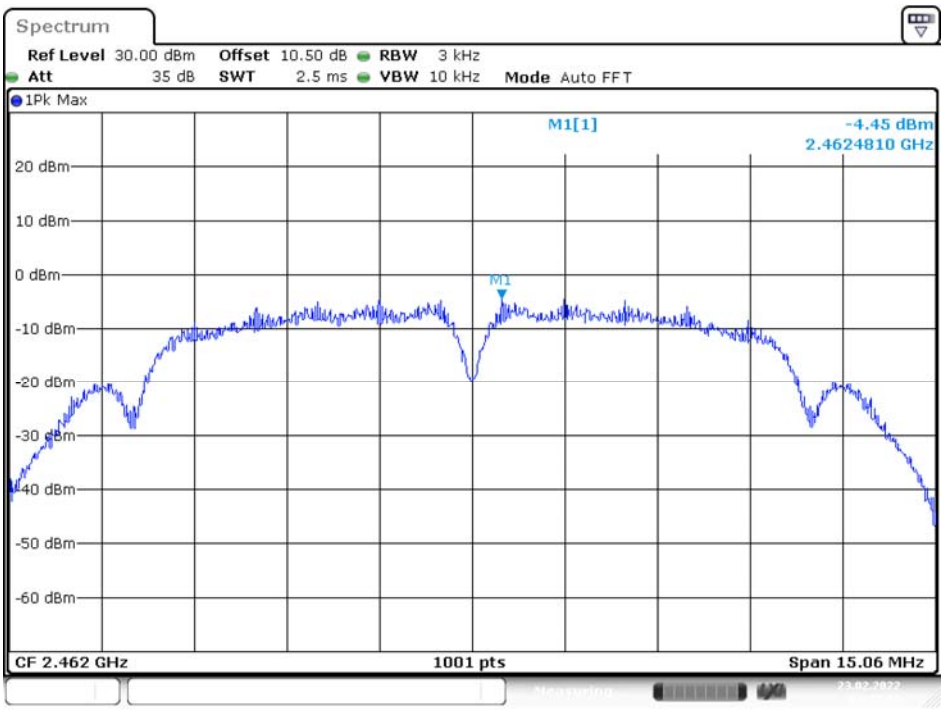


Middle Channel



Date: 23.FEB.2022 07:40:55

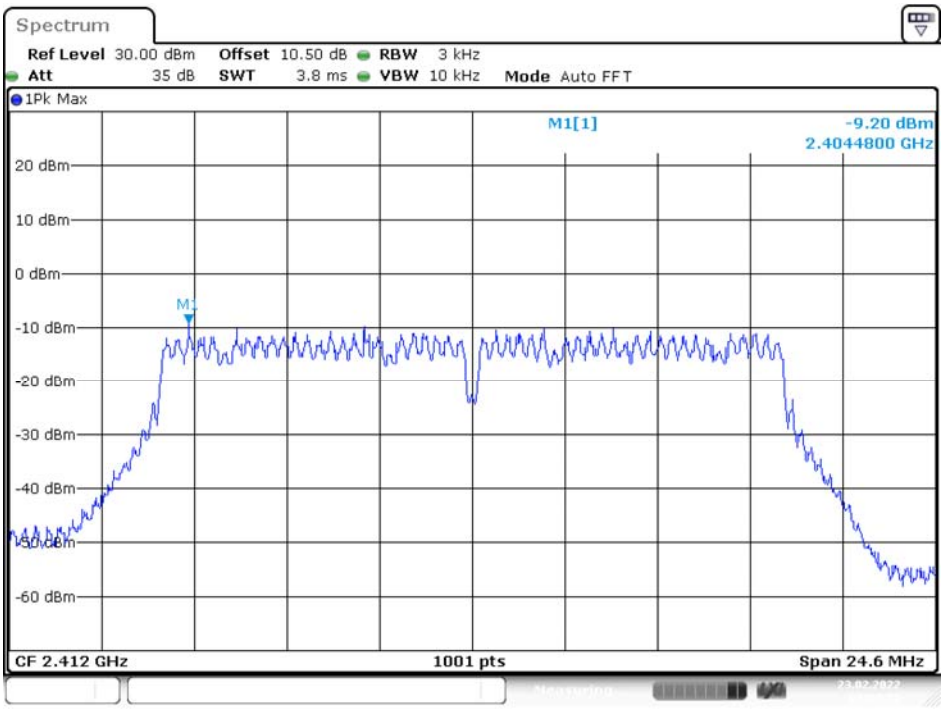
High Channel



Date: 23.FEB.2022 07:43:17

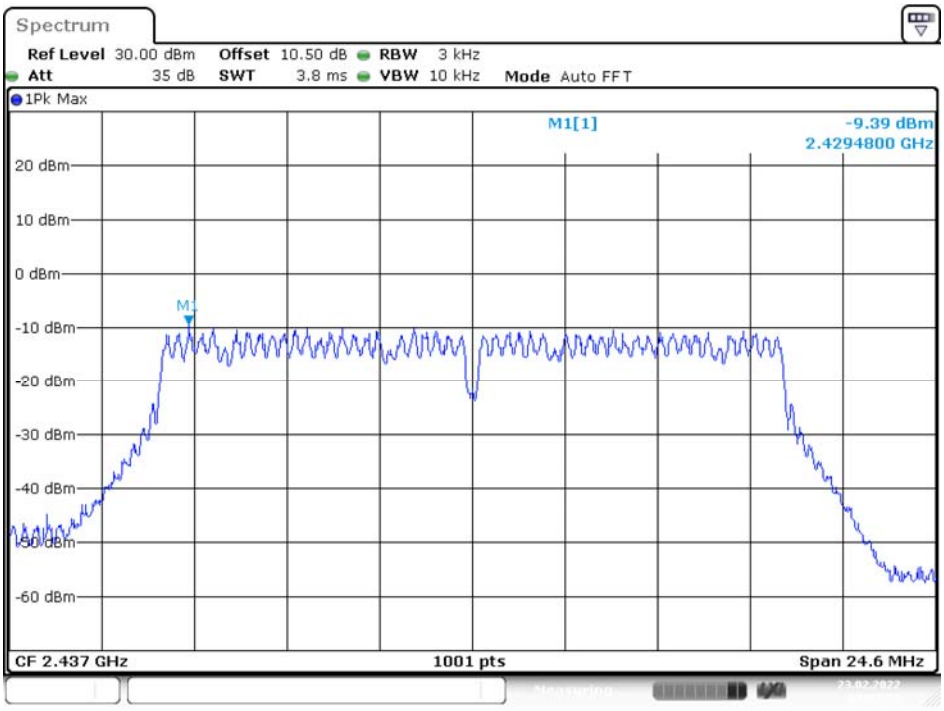
G Mode

Low Channel



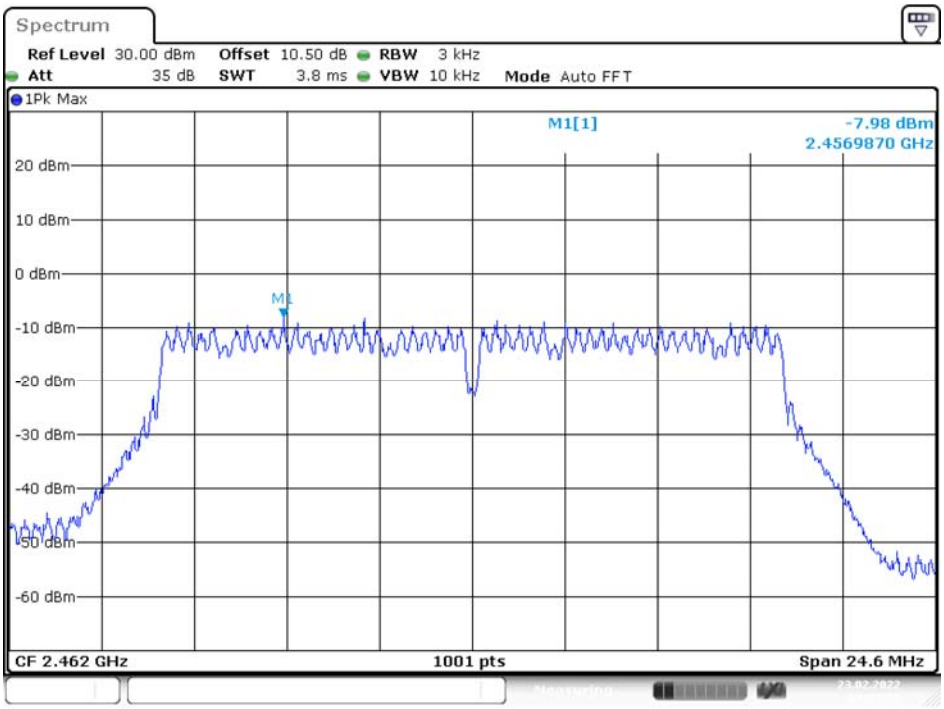
Date: 23.FEB.2022 08:00:28

Middle Channel



Date: 23.FEB.2022 08:03:59

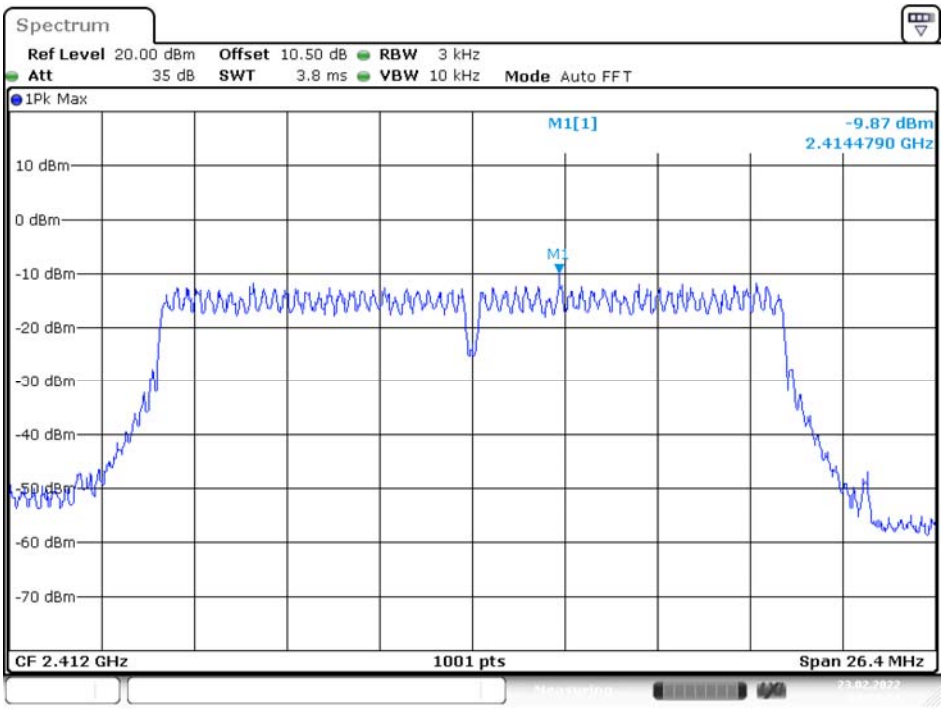
High Channel



Date: 23.FEB.2022 08:22:29

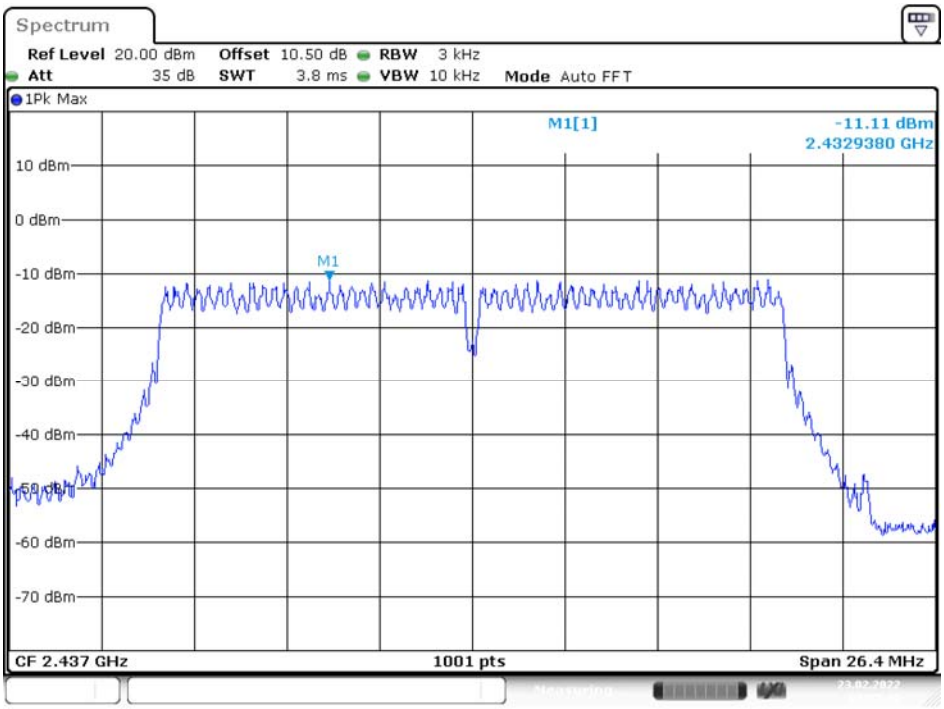
N20 Mode

Low Channel



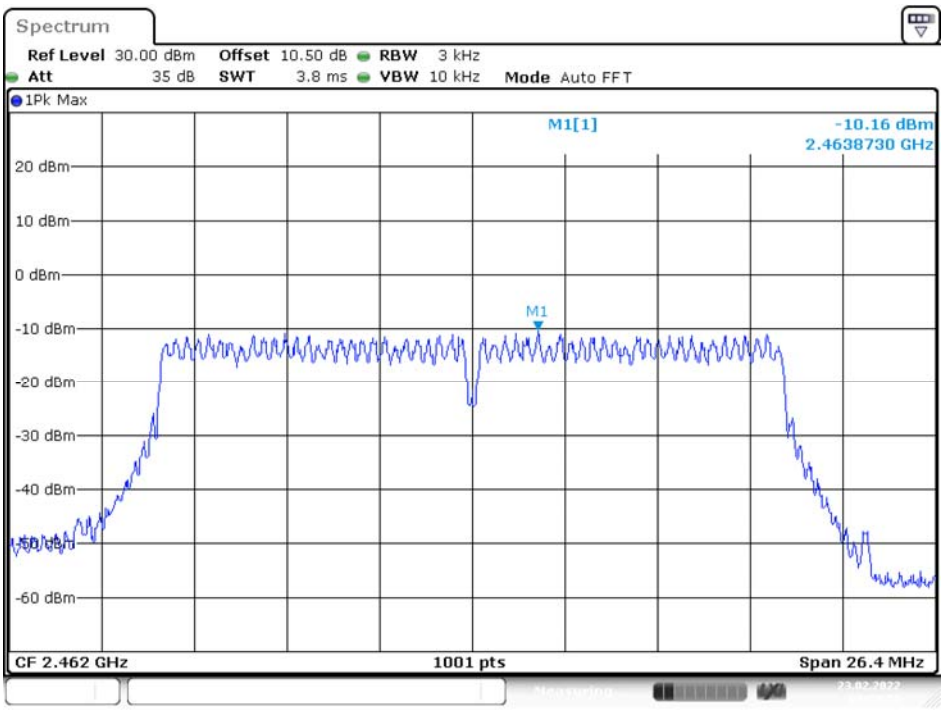
Date: 23.FEB.2022 08:30:14

Middle Channel



Date: 23.FEB.2022 08:35:46

High Channel



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