FCC Part 15.247

TEST REPORT

For

M5Stack Technology Co., Ltd

106,1st Floor,Building 1,Bright Technology Park 88 Zhuguang North Road,XiliTaoyuan Street,Nanshan District,Shenzhen,Guangdong,China

FCC ID: 2AN3WM5ATOMU

Report Type:	**Product Type:**
Original Report	M5AtomU

Report Producer : Jane Chen

Report Number : RXZ211213004RF02

Report Date : 2022-02-22

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ211213004	RXZ211213004RF02	2022-02-22	Original Report	Jane Chen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	M5Stack Technology Co., Ltd
	106,1st Floor, Building 1, Bright Technology Park 88 Zhuguang North Road, XiliTaoyuan Street, Nanshan District, Shenzhen, Guangdong, China
Manufacturer	M5Stack Technology Co., Ltd
	106,1st Floor, Building 1,Bright Technology Park 88 Zhuguang North Road, XiliTaoyuan Street, Nanshan District, Shenzhen, Guangdong, China
Brand(Trade) Name	M5Stack
Product (Equipment)	M5AtomU
Main Model Name	AtomU
Series Model Name	BoksLINK
Model Discrepancy	The major electrical and mechanical constructions of series models are identical to the basic model, except interfaces. The model, AtomU 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 IEEE 802.11n HT40 Mode: 2422 ~ 2452 MHz BLE(1M): 2402 ~ 2480 MHz
Transmit Power	IEEE 802.11b Mode: 9.47 dBm IEEE 802.11g Mode: 9.42 dBm IEEE 802.11n HT20 Mode: 9.31 dBm IEEE 802.11n HT40 Mode: 9.48 dBm BLE(1M) Mode : 9.24 dBm
Modulation Technique	IEEE 802.11b Mode: DSSS IEEE 802.11g/ n HT20/ n HT40 Mode: OFDM BLE(1M) Mode: GFSK
Power Operation (Voltage Range)	☐ AC Type ☐ Adapter ☐ By AC Power Cord ☐ PoE
	☒ DC 5V ☐ Battery ☐ DC Power Supply ☒ External from USB Port ☐ External DC Adapter
	☐ Host System
Received Date	Dec. 14, 2021
Date of Test	Dec. 26, 2021 ~ Feb. 8, 2022

*All measurement and test data in this report was gathered from production sample serial number: RXZ211213004-01 (Assigned by BACL (New Taipei Laboratory).

1.2 Objective

This report is prepared on behalf of *M5Stack 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)

FCC Part 15.247 DSS submissions with FCC ID: 2AN3WM5ATOMU

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	2022/1/10	19.6	53	1010	David
Radiation Spurious Emissions	2022/1/7~2022/2/8	19.2~21.9	60~68	1010	Aaron
Conducted Spurious Emissions	2021/12/26~2021/12/27	22.1~22.3	44~47	1010	Howard
6 dB Emission Bandwidth	2021/12/26~2021/12/27	22.1~22.3	44~47	1010	Howard
Maximum Output Power	2021/12/26~2021/12/27	22.1~22.3	44~47	1010	Howard
100 kHz Bandwidth of Frequency Band Edge	2021/12/26~2021/12/27	22.1~22.3	44~47	1010	Howard
Power Spectral Density	2021/12/26~2021/12/27	22.1~22.3	44~47	1010	Howard

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) 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 2.4G 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.

For 802.11n40 Mode were tested with channel 3, 6 and 9.

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	--	--
2	2406	--	--
3	2408	37	2476
--	--	38	2478
19	2440	39	2480

For BLE Modes were tested with channel 0, 19 and 39.

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 "QATol_Dbg v1.0"

Test Frequency		Low	Mid	High
Power Level Setting	B Mode	64	64	64
	G Mode	60	60	60
	N20 Mode	60	60	60
	N40 Mode	60	60	60
	BLE 1M	8	8	8

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 bandwidths, and modulations.

802.11b: 1Mbps

802.11g: 6Mbps

802.11n HT20: MCS0

802.11n HT40: MCS0

BLE 1M : 1 Mbps

2.4 Test Mode

Model: AtomU for all test item.

2.5 Support Equipment List and Details

Description	Manufacturer	Model Number	S/N
NB	DELL	E6410	8N7PXN1

2.6 External Cable List and Details

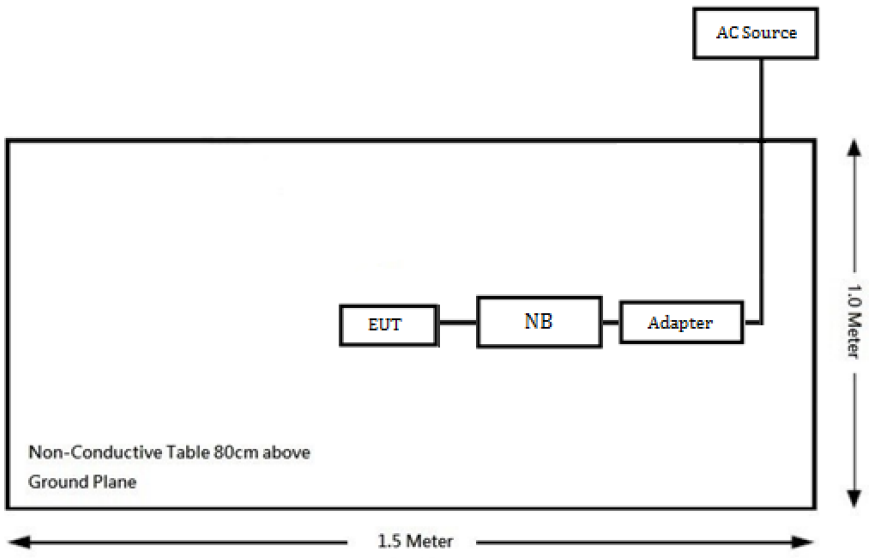
Cable Description	Length (m)	From	To
USB extension cable	1.5	EUT	NB

2.7 Block Diagram of Test Setup

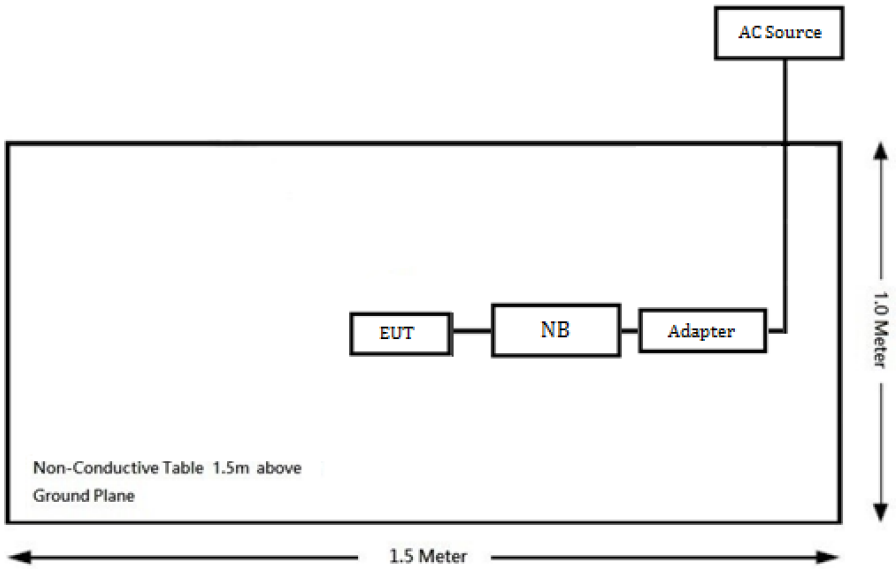
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

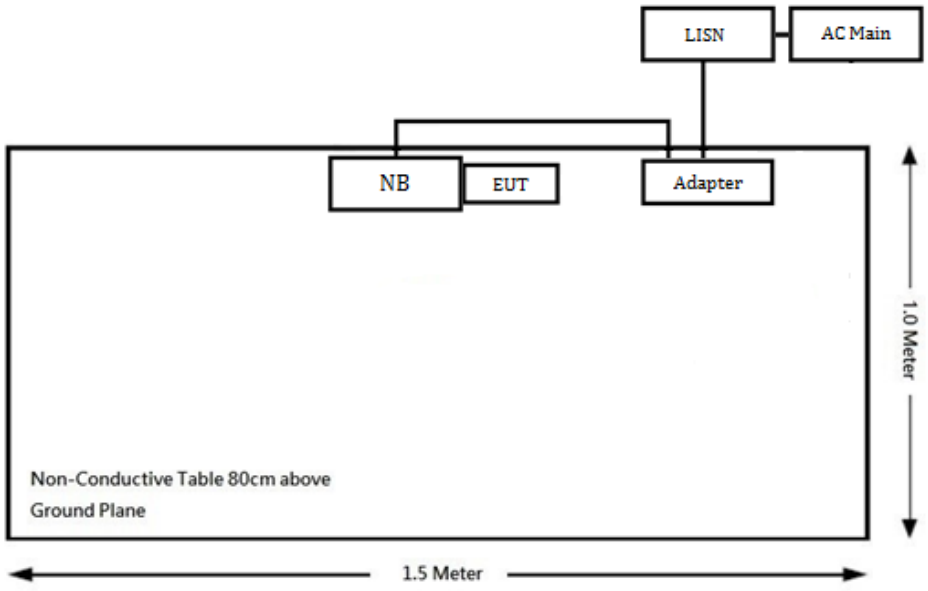
Below 1GHz:



Above 1GHz:



Conduction:



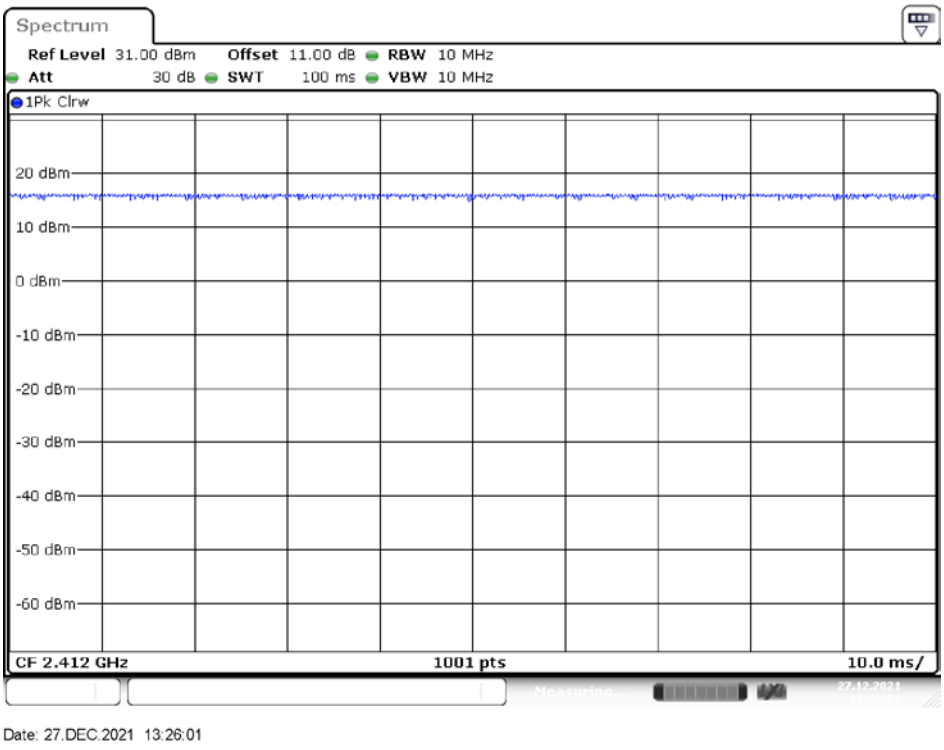
2.8 Duty Cycle

The duty cycle as below:

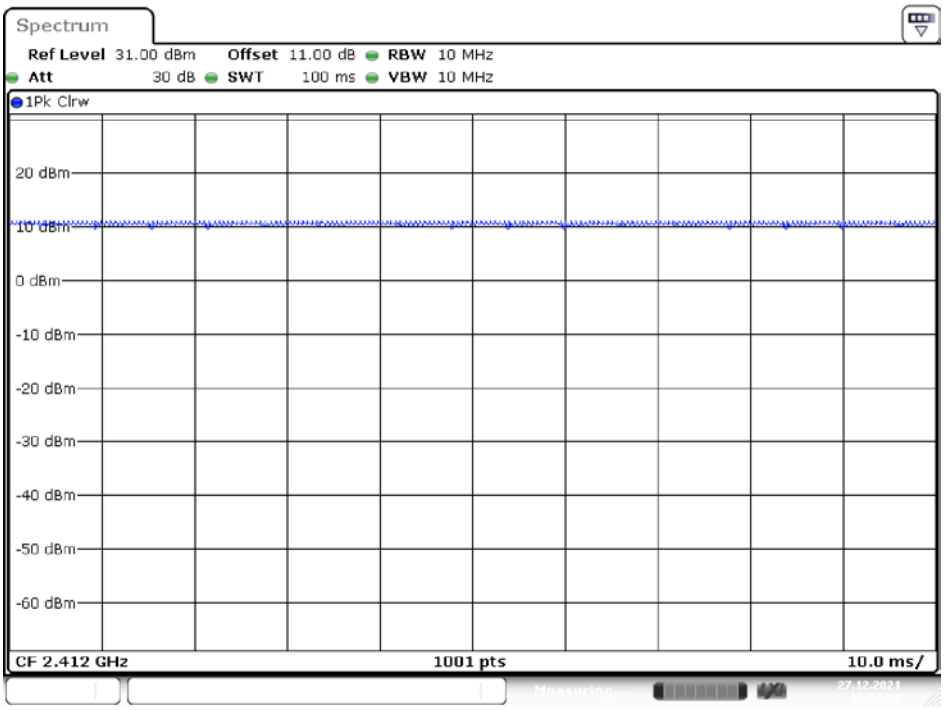
Radio Mode	T_{on} (ms)	$T_{on}+T_{off}$ (ms)	Duty Cycle (%)
802.11b	/	/	100
802.11g	/	/	100
802.11n20	/	/	100
802.11n40	/	/	100
BLE(1M)	2.09	2.5	84

Please refer to the following plots.

B Mode



G Mode



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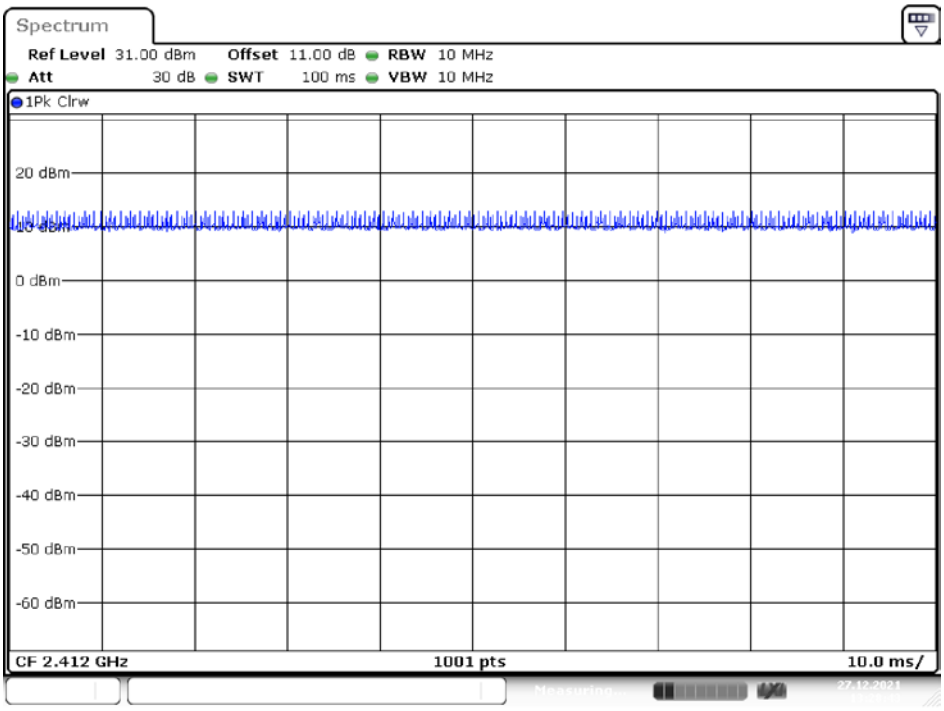
N20 Mode



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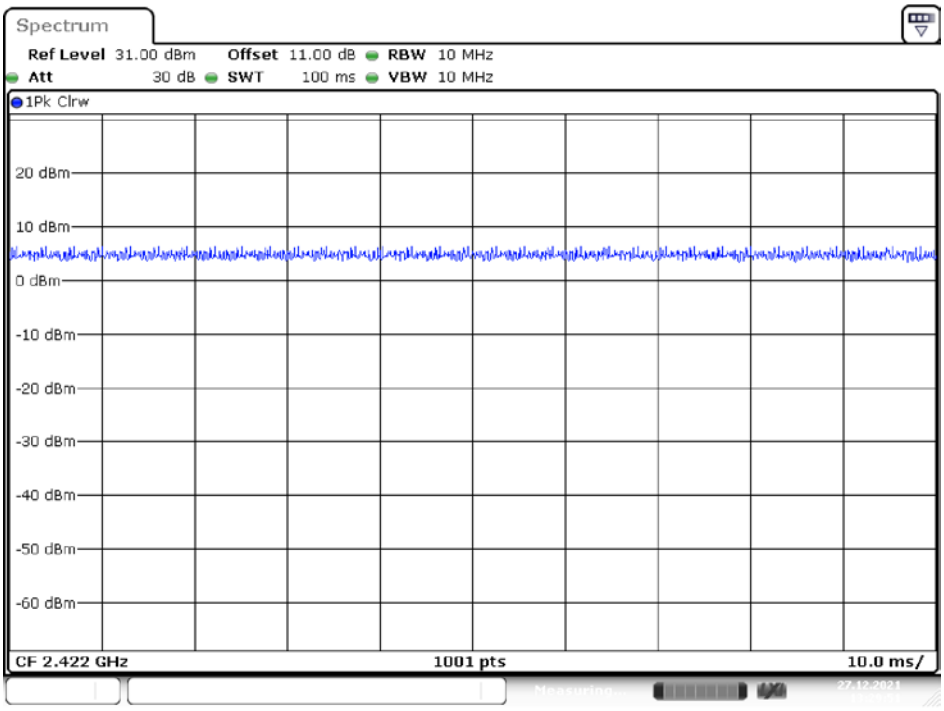
N40 Mode



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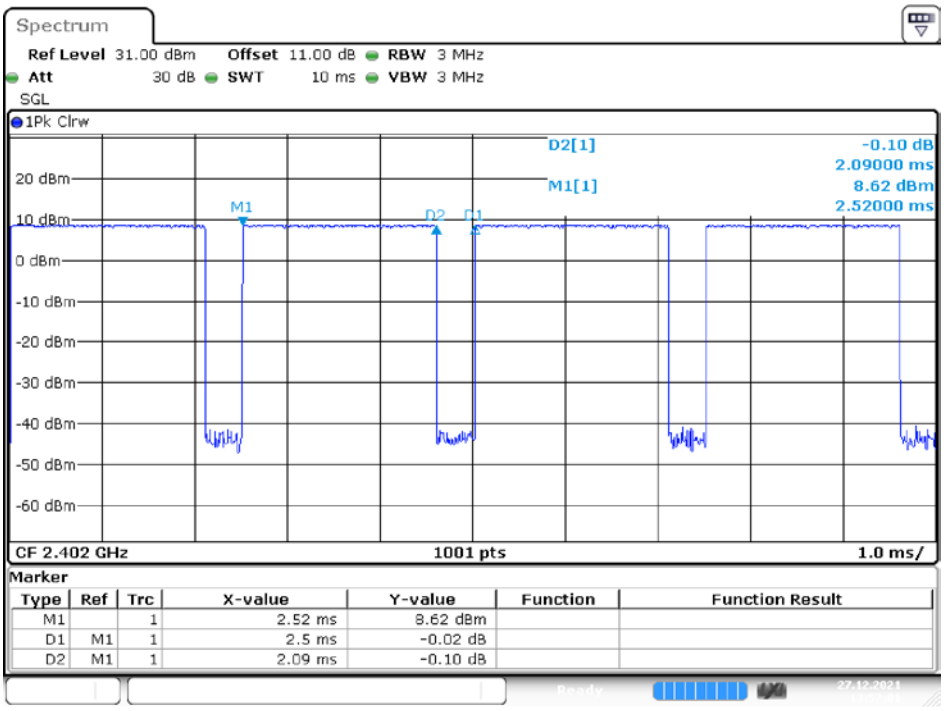
BLE(1M) Mode



Date: 27.DEC.2021 13:57:01

3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1310, §2.1093	RF Exposure	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	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 & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2021/1/19	2022/1/18
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2021/11/9	2022/11/8
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
Microware Preamplifier	EM Electronics Corporation	EM18G40G	60656	2021/12/22	2022/12/21
Preamplifier	A.H. system Inc.	PAM-0118P	470	2021/3/15	2022/3/14
Spectrum Analyzer	Rohde & Schwarz	FSV40	101204	2021/06/10	2022/06/09
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2021/2/1	2022/1/31
Coaxial Cable	COMMATE	PEWC	8Dr	2021/12/19	2022/12/18
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2021/2/1	2022/1/31
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2021/12/19	2022/12/18
Cable	EMC	EMC105-SM-SM-10000	201003	2021/2/3	2022/2/2
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2021/2/1	2022/1/31
				2022/1/24	2023/1/23

Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-50CM	15120-1	2021/1/28	2022/1/27
				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	101140	2021/1/7	2022/1/6
Cable	UTIFLEX	UFA210A	9435	2021/10/5	2022/10/4
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2021/1/28	2022/1/27
Attenuator	MINI-CIRCUITS	BW-S10W5+	1419	2021/1/28	2022/1/27

***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, § 2.1093 – RF Exposure

5.1 Applicable Standard

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

According to KDB 447498 D01 General RF Exposure Guidance v06

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

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·

[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

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

5.2 RF Exposure Evaluation Result

RF Exposure evaluation:

Mode	Frequency Range (MHz)	Tunp-up Power		Evaluation Distance (mm)	Calculated Value	Threshold	SAR Test Exclusion
		(dBm)	(mW)			(1-g SAR)	
WIFI 2.4G	2412-2462	9.5	8.913	5	2.8	3	Yes
BLE	2402-2480	9.5	8.913	5	2.8	3	Yes
BT	2402-2480	9.5	8.913	5	2.8	3	Yes

Result: SAR test is exempted.

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	Type	Antenna Gain
PROANT	PRO-OB-440	PIFA Antenna	2 dBi

Result: Compliance

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

7.1 Applicable Standard

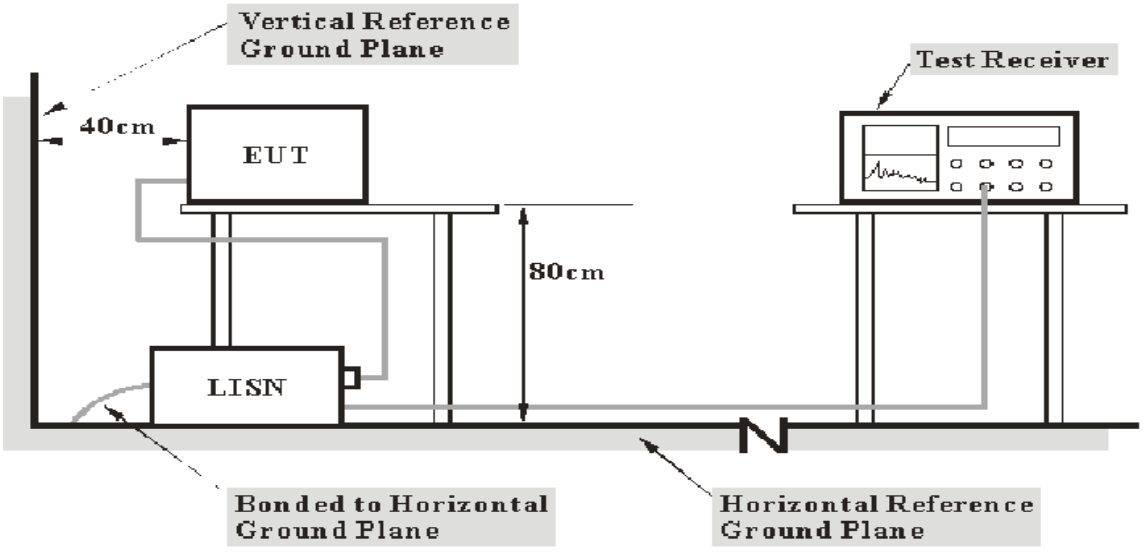
According to §15.207

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 1)	56 to 46 (Note 1)
0.5-5	56	46
5-30	60	50

Note 1: 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 adapter was connected to the outlet of the LISN.

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:

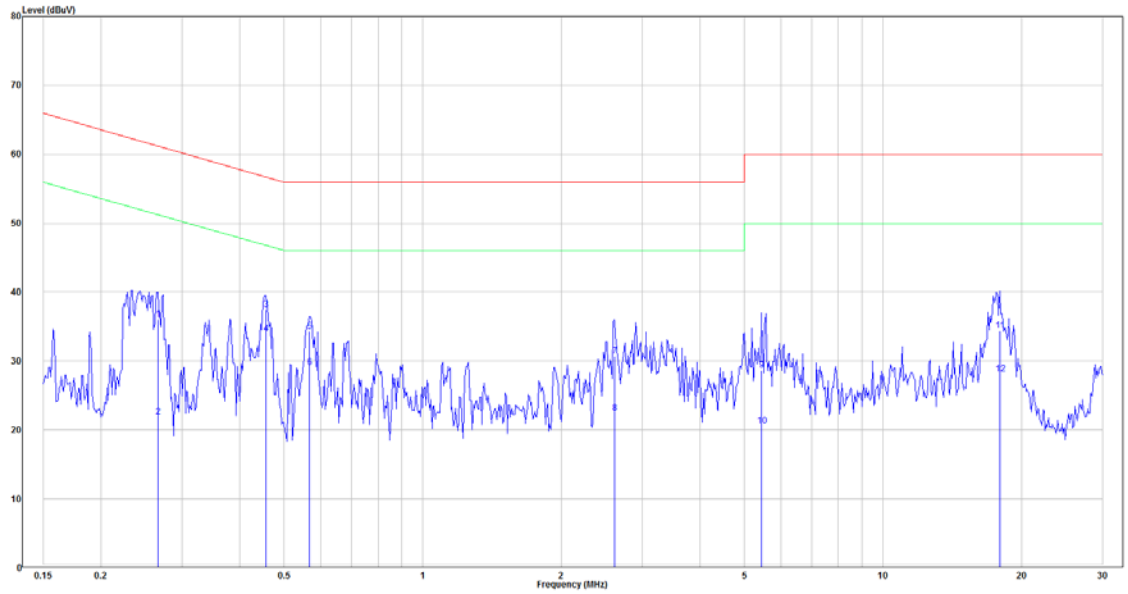
Over Limit = Level – Limit Line

7.6 Test Results

Test Mode: Transmitting

WIFI Mode (Worst case is 802.11n HT20 mode, Middle Channel)

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.266	16.44	19.58	36.02	61.25	-25.23	QP
2	0.266	2.28	19.58	21.86	51.25	-29.39	Average
3	0.456	17.86	19.59	37.45	56.76	-19.31	QP
4	0.456	14.42	19.59	34.01	46.76	-12.75	Average
5	0.567	14.72	19.59	34.31	56.00	-21.69	QP
6	0.567	9.44	19.59	29.03	46.00	-16.97	Average
7	2.608	11.02	19.66	30.68	56.00	-25.32	QP
8	2.608	2.82	19.66	22.48	46.00	-23.52	Average
9	5.447	8.95	19.73	28.68	60.00	-31.32	QP
10	5.447	0.83	19.73	20.56	50.00	-29.44	Average
11	17.944	14.52	19.85	34.37	60.00	-25.63	QP
12	17.944	8.27	19.85	28.12	50.00	-21.88	Average

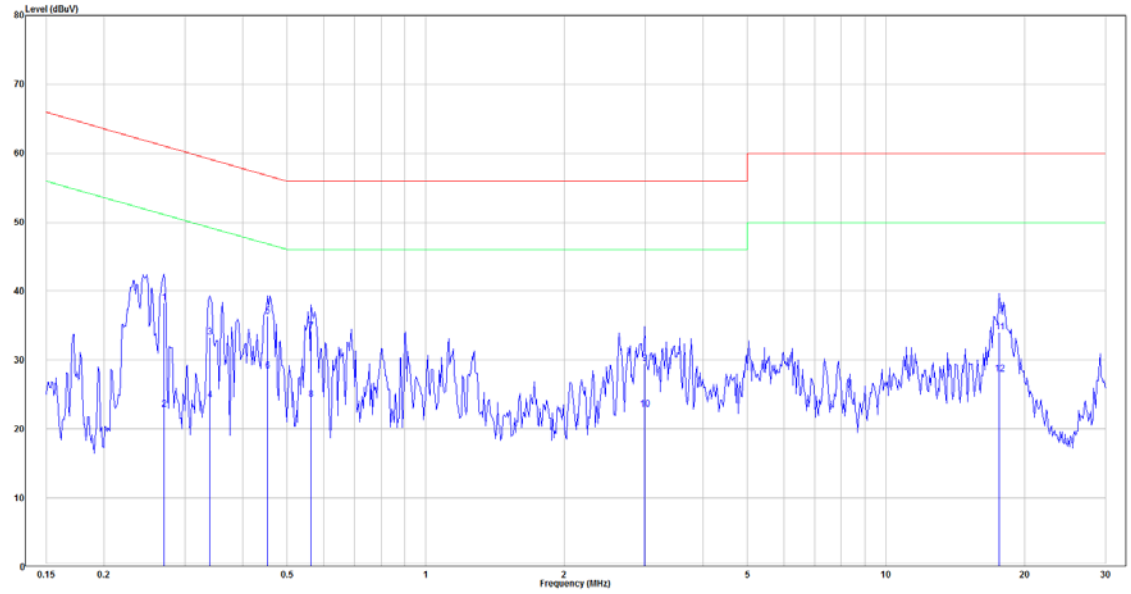
Note:

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	0.270	18.73	19.57	38.30	61.12	-22.82	QP
2	0.270	3.30	19.57	22.87	51.12	-28.25	Average
3	0.339	13.70	19.57	33.27	59.22	-25.95	QP
4	0.339	4.55	19.57	24.12	49.22	-25.10	Average
5	0.454	16.78	19.58	36.36	56.80	-20.44	QP
6	0.454	8.80	19.58	28.38	46.80	-18.42	Average
7	0.564	14.56	19.58	34.14	56.00	-21.86	QP
8	0.564	4.73	19.58	24.31	46.00	-21.69	Average
9	2.993	9.80	19.66	29.46	56.00	-26.54	QP
10	2.993	3.21	19.66	22.87	46.00	-23.13	Average
11	17.661	14.18	19.91	34.09	60.00	-25.91	QP
12	17.661	8.10	19.91	28.01	50.00	-21.99	Average

Note:

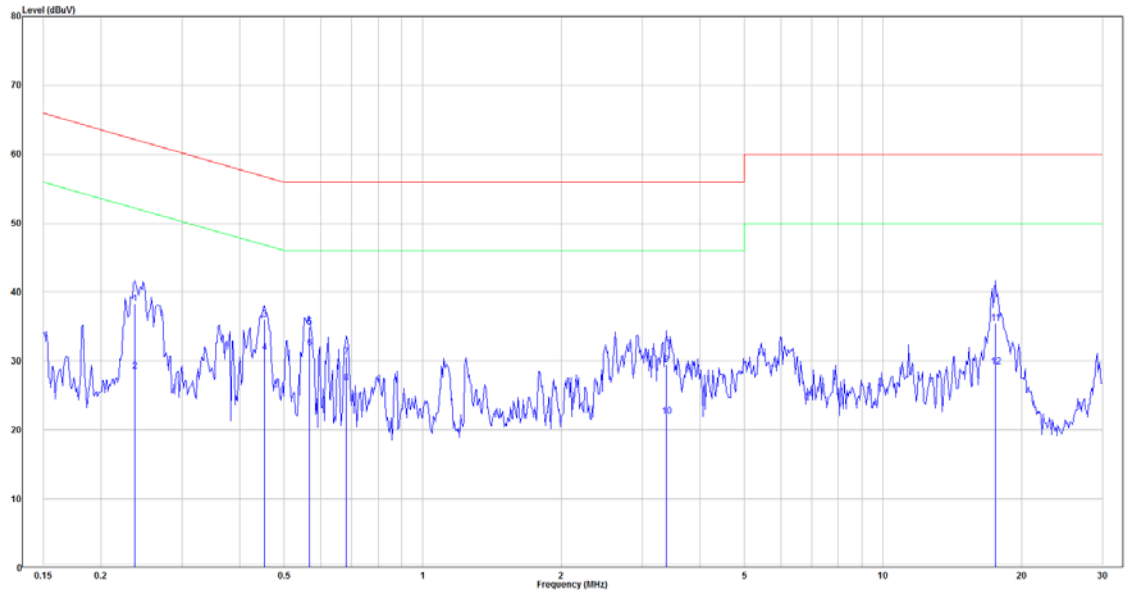
Level = Read Level + Factor

Over Limit = Level – Limit Line

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

BLE Mode (Worst case is BLE mode, Middle Channel)

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.237	18.69	19.58	38.27	62.22	-23.95	QP
2	0.237	8.93	19.58	28.51	52.22	-23.71	Average
3	0.454	16.44	19.59	36.03	56.80	-20.77	QP
4	0.454	11.66	19.59	31.25	46.80	-15.55	Average
5	0.567	15.32	19.59	34.91	56.00	-21.09	QP
6	0.567	12.31	19.59	31.90	46.00	-14.10	Average
7	0.683	10.98	19.59	30.57	56.00	-25.43	QP
8	0.683	7.23	19.59	26.82	46.00	-19.18	Average
9	3.381	9.79	19.67	29.46	56.00	-26.54	QP
10	3.381	2.32	19.67	21.99	46.00	-24.01	Average
11	17.568	15.61	19.85	35.46	60.00	-24.54	QP
12	17.568	9.35	19.85	29.20	50.00	-20.80	Average

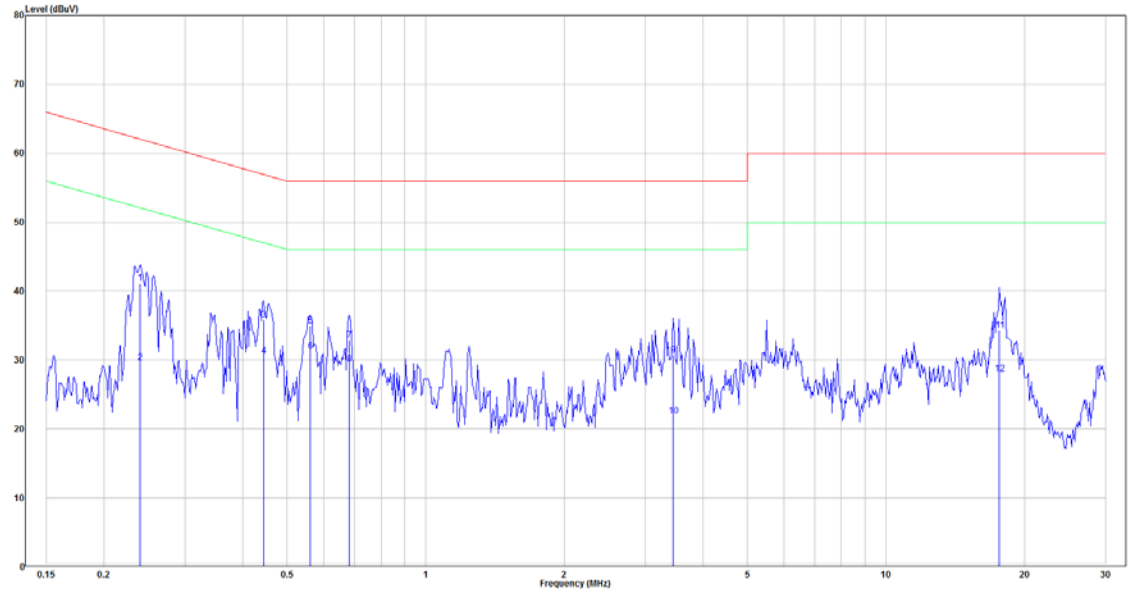
Note:

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	0.239	21.53	19.57	41.10	62.13	-21.03	QP
2	0.239	10.07	19.57	29.64	52.13	-22.49	Average
3	0.444	16.25	19.58	35.83	56.98	-21.15	QP
4	0.444	11.01	19.58	30.59	46.98	-16.39	Average
5	0.561	15.41	19.58	34.99	56.00	-21.01	QP
6	0.561	11.61	19.58	31.19	46.00	-14.81	Average
7	0.683	13.26	19.59	32.85	56.00	-23.15	QP
8	0.683	9.85	19.59	29.44	46.00	-16.56	Average
9	3.454	11.02	19.68	30.70	56.00	-25.30	QP
10	3.454	2.21	19.68	21.89	46.00	-24.11	Average
11	17.661	14.41	19.91	34.32	60.00	-25.68	QP
12	17.661	8.04	19.91	27.95	50.00	-22.05	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:

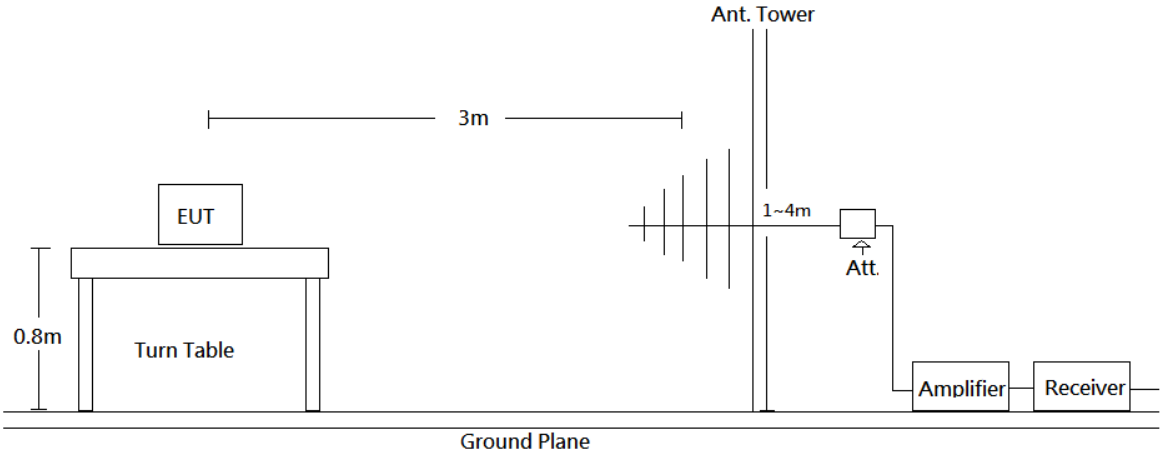
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** 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.

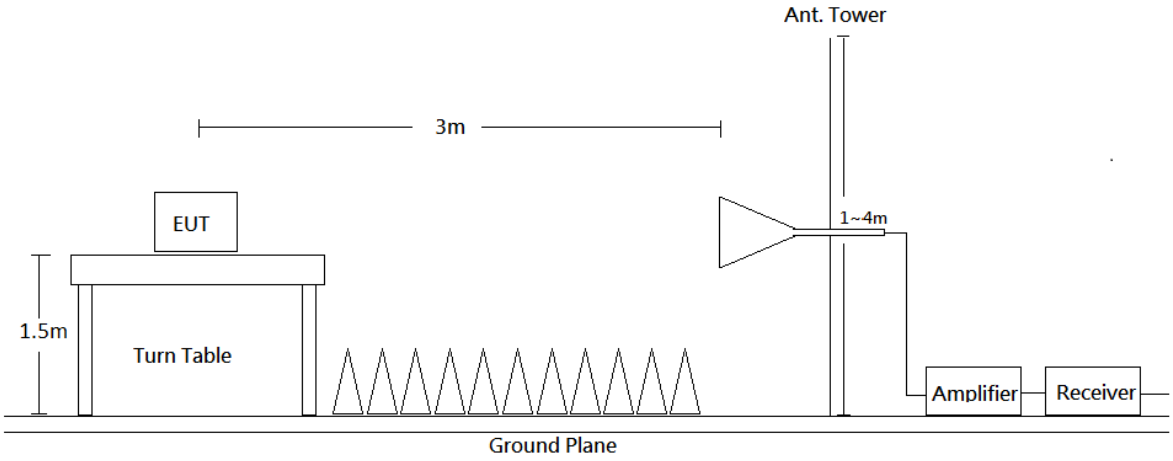
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the 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

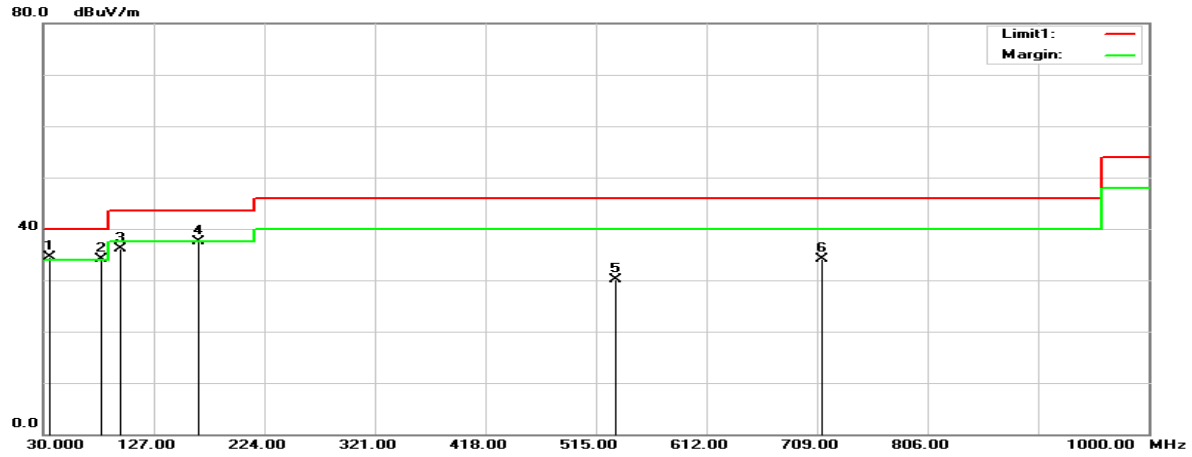
8.6 Test Results

Test Mode: Transmitting

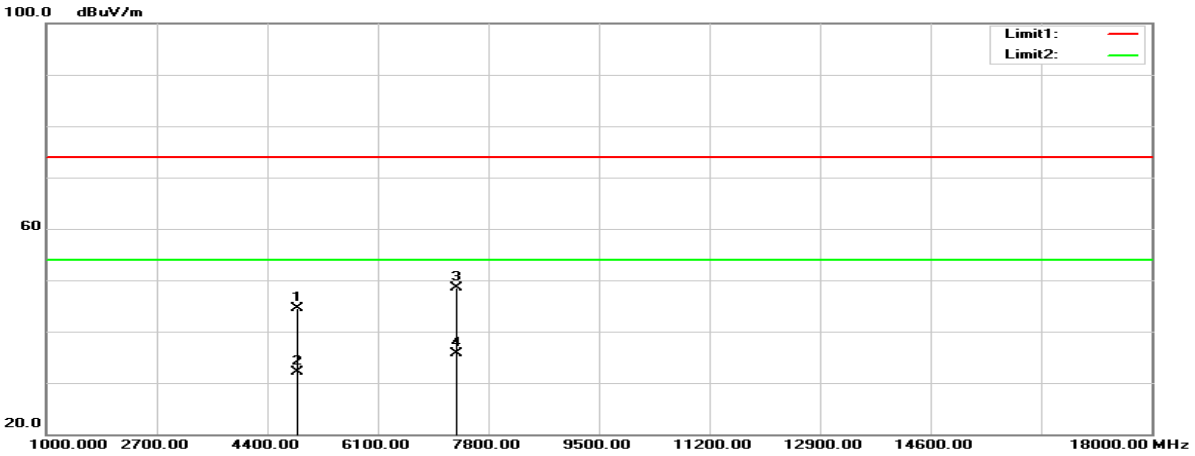
WIFI Mode (Pre-scan with three orthogonal axis, and worse case as X axis.)

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

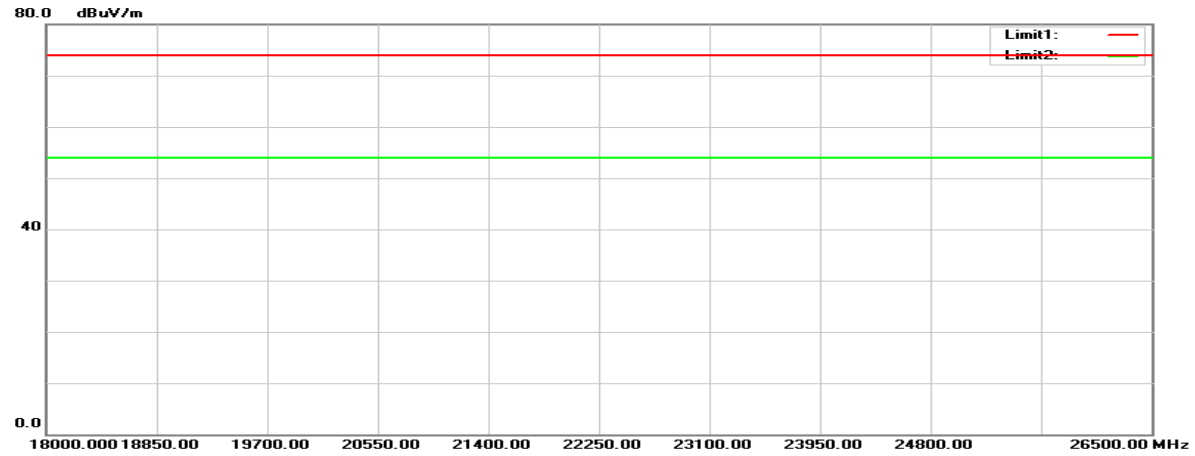
30MHz-1GHz:



1GHz-18GHz:

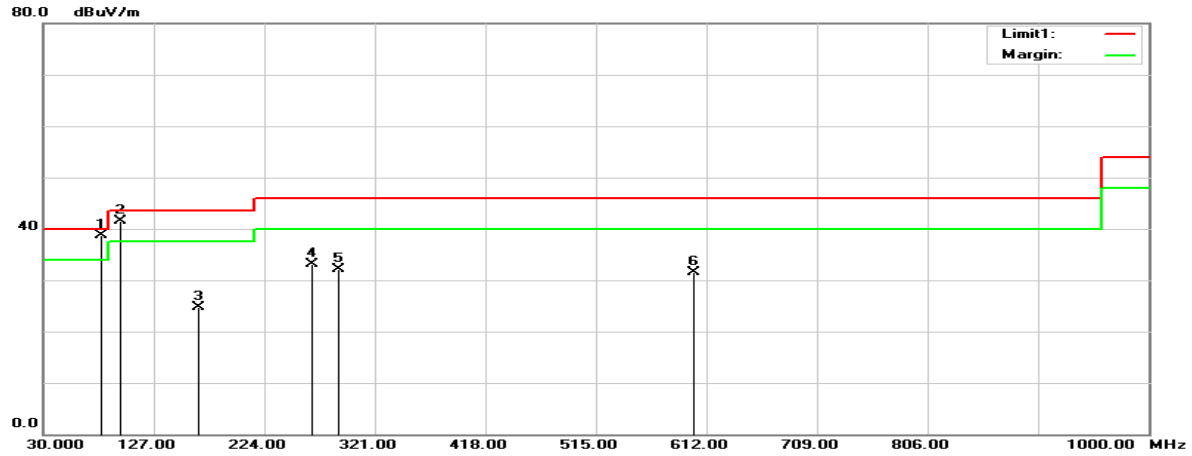


18GHz-26.5GHz:

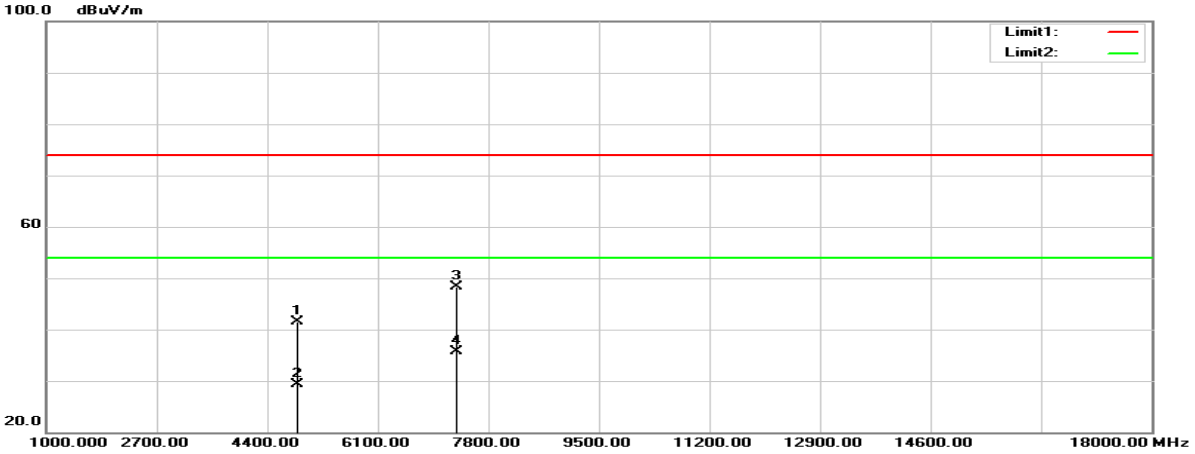


Vertical (worst case is 802.11n HT20 mode Middle channel)

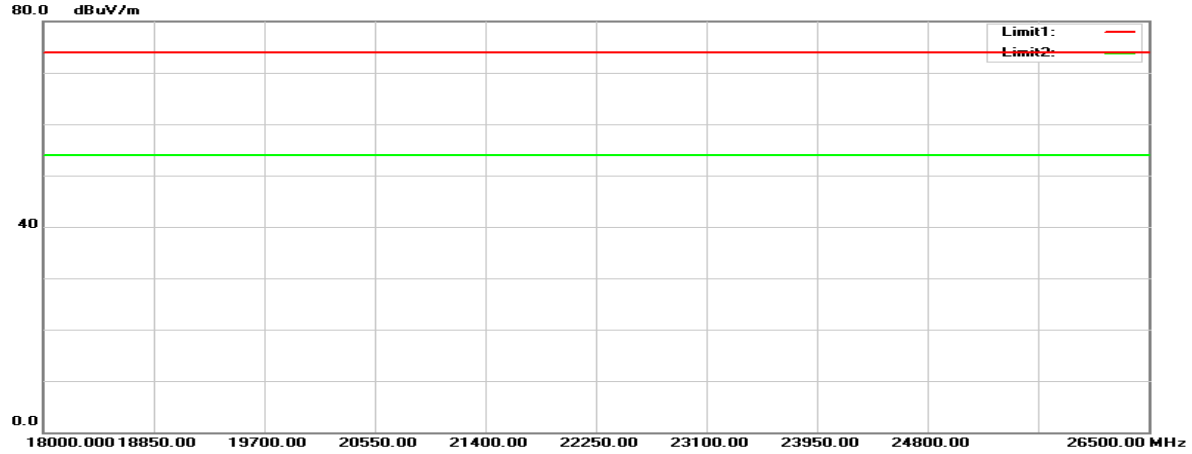
30MHz-1GHz:



1GHz-18GHz:



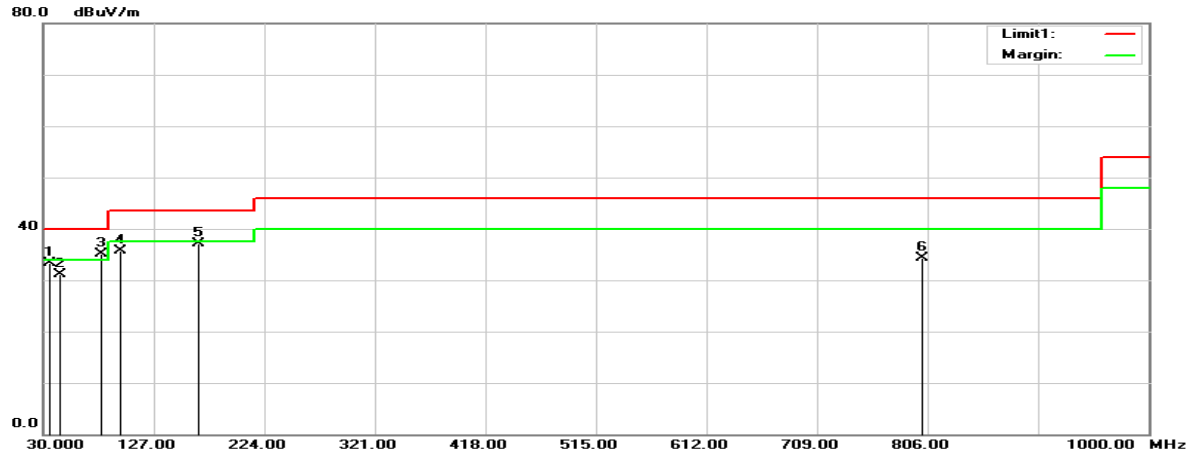
18GHz-26.5GHz:



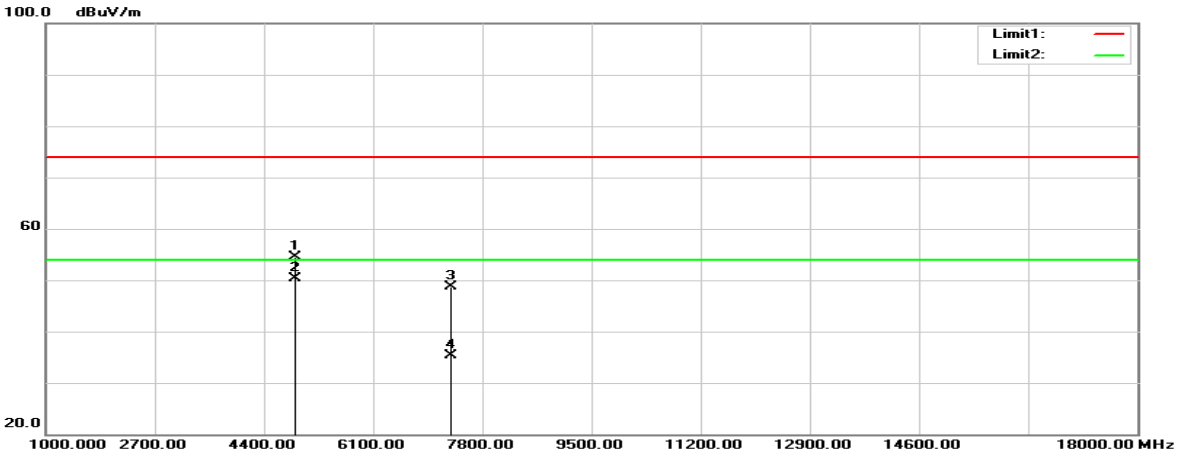
BLE(1M) Mode (Pre-scan with three orthogonal axis, and worse case as X axis.)

Horizontal (worst case is BLE (1M) mode Middle channel)

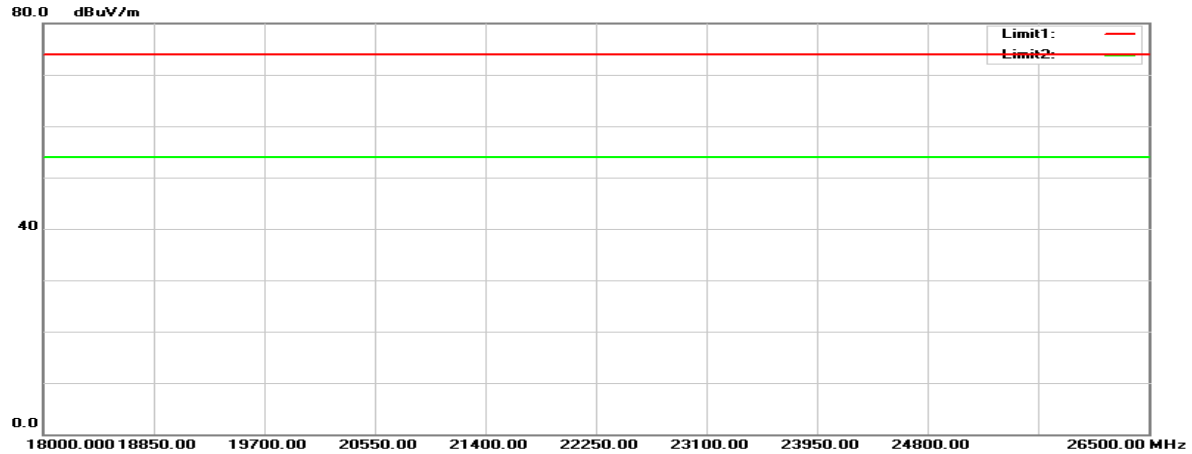
30MHz-1GHz



1GHz-18GHz

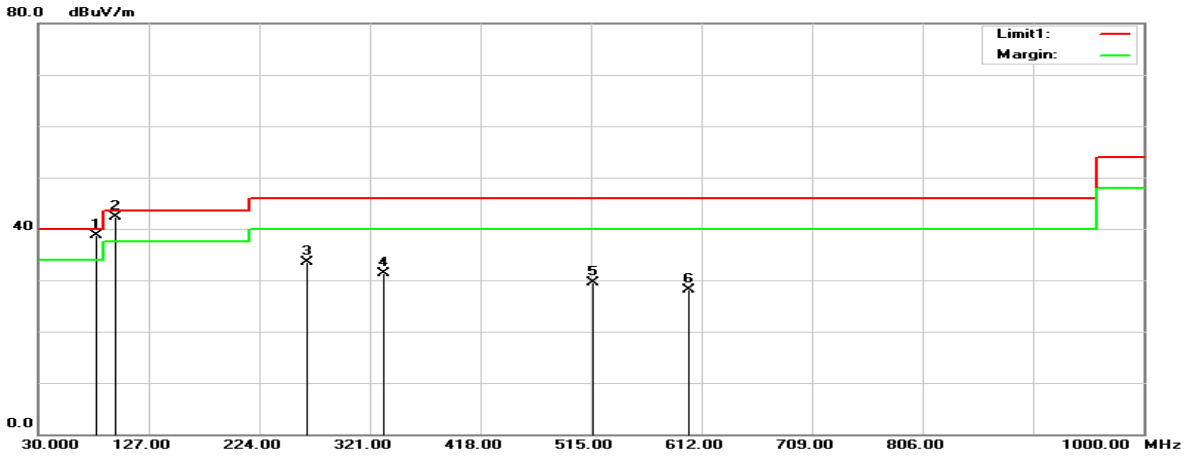


18GHz-26.5GHz:

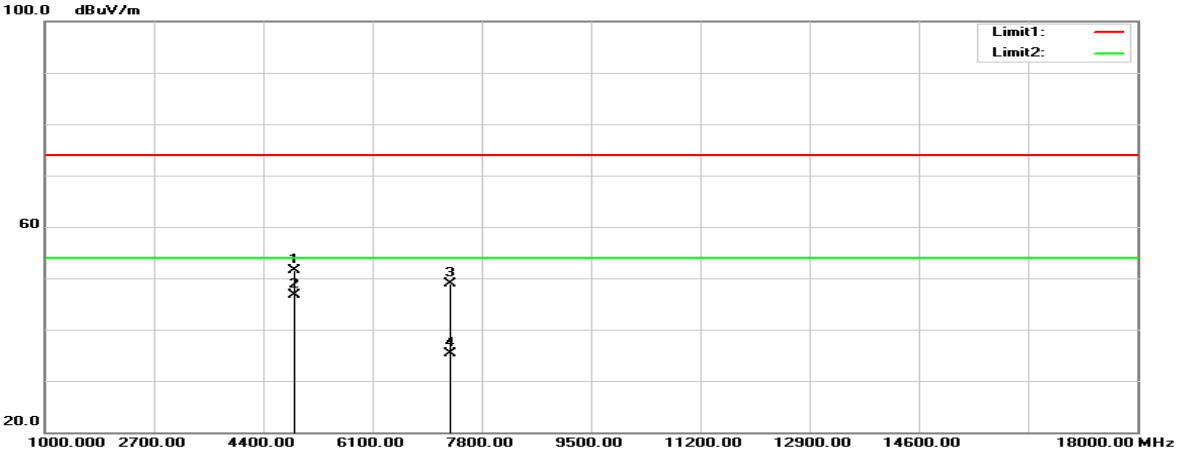


Vertical (worst case is BLE (1M) mode Middle channel)

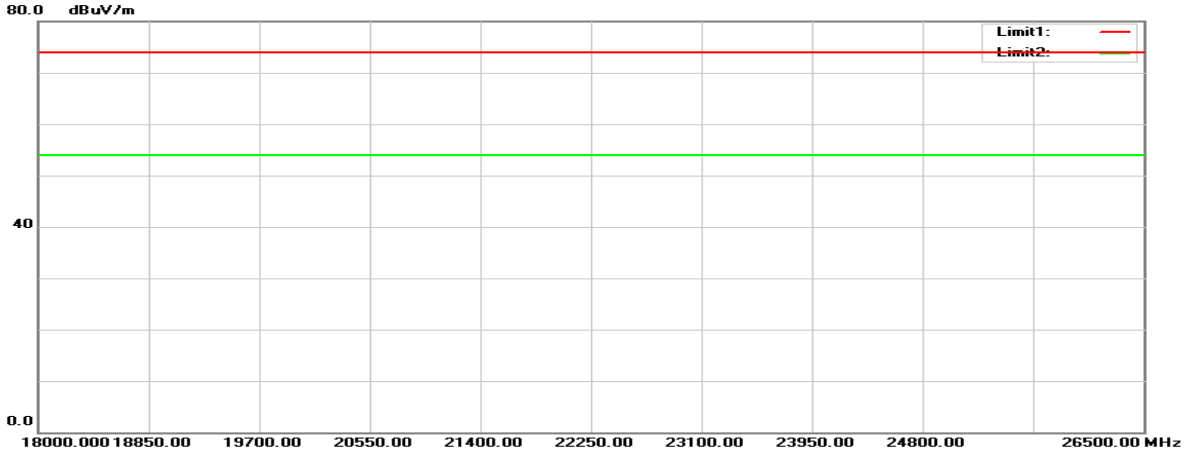
30MHz-1GHz



1GHz-18GHz



18GHz-26.5GHz:



Below 1GHz

WIFI Mode

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
35.8200	42.46	-7.87	34.59	40.00	-5.41	100	165	peak
81.4100	50.64	-16.62	34.02	40.00	-5.98	100	177	peak
97.9000	50.72	-14.71	36.01	43.50	-7.49	100	15	peak
165.8000	49.18	-11.71	37.47	43.50	-6.03	100	125	peak
532.4600	35.72	-5.64	30.08	46.00	-15.92	100	21	peak
713.8500	36.65	-2.64	34.01	46.00	-11.99	100	198	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
81.4100	55.30	-16.62	38.68	40.00	-1.32	100	158	peak
97.9000	56.27	-14.71	41.56	43.50	-1.94	100	144	peak
165.8000	36.48	-11.71	24.77	43.50	-18.73	100	11	peak
265.7100	43.99	-10.80	33.19	46.00	-12.81	100	204	peak
288.9900	42.12	-10.00	32.12	46.00	-13.88	100	195	peak
600.3600	36.58	-5.13	31.45	46.00	-14.55	100	11	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.

BLE(1M) Mode

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
35.8200	41.11	-7.87	33.24	40.00	-6.76	100	324	peak
44.5500	44.72	-13.59	31.13	40.00	-8.87	100	145	peak
81.4100	51.65	-16.62	35.03	40.00	-4.97	100	65	peak
97.9000	50.51	-14.71	35.80	43.50	-7.70	100	95	peak
165.8000	48.74	-11.71	37.03	43.50	-6.47	100	147	peak
801.1500	35.22	-1.01	34.21	46.00	-11.79	100	111	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
81.4100	55.26	-16.62	38.64	40.00	-1.36	100	247	peak
97.9000	56.98	-14.71	42.27	43.50	-1.23	100	95	peak
265.7100	44.39	-10.80	33.59	46.00	-12.41	100	165	peak
332.6400	40.76	-9.46	31.30	46.00	-14.70	100	115	peak
516.9400	35.18	-5.71	29.47	46.00	-16.53	100	14	peak
600.3600	33.28	-5.13	28.15	46.00	-17.85	100	95	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								
2359.840	59.12	-9.71	49.41	74.00	-24.59	151	210	peak
2359.840	44.88	-9.71	35.17	54.00	-18.83	151	210	AVG
4824.000	44.46	-2.15	42.31	74.00	-31.69	151	157	peak
4824.000	31.41	-2.15	29.26	54.00	-24.74	151	157	AVG
7236.000	43.25	4.55	47.80	74.00	-26.20	148	181	peak
7236.000	30.52	4.55	35.07	54.00	-18.93	148	181	AVG
B Mode, Middle channel								
4874.000	46.49	-1.92	44.57	74.00	-29.43	113	315	peak
4874.000	34.11	-1.92	32.19	54.00	-21.81	113	315	AVG
7311.000	43.37	5.08	48.45	74.00	-25.55	144	48	peak
7311.000	30.64	5.08	35.72	54.00	-18.28	144	48	AVG
B Mode, High channel								
2497.408	57.99	-8.25	49.74	74.00	-24.26	125	212	peak
2497.408	44.38	-8.25	36.13	54.00	-17.87	125	212	AVG
4924.000	47.65	-1.63	46.02	74.00	-27.98	110	325	peak
4924.000	35.29	-1.63	33.66	54.00	-20.34	110	325	AVG
7386.000	43.87	5.20	49.07	74.00	-24.93	152	46	peak
7386.000	30.45	5.20	35.65	54.00	-18.35	152	46	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								
2375.072	58.93	-9.58	49.35	74.00	-24.65	190	124	peak
2375.072	44.67	-9.58	35.09	54.00	-18.91	190	124	AVG
4824.000	43.60	-2.15	41.45	74.00	-32.55	142	200	peak
4824.000	31.23	-2.15	29.08	54.00	-24.92	142	200	AVG
7236.000	43.01	4.55	47.56	74.00	-26.44	149	360	peak
7236.000	30.56	4.55	35.11	54.00	-18.89	149	360	AVG
B Mode, Middle channel								
4874.000	43.46	-1.92	41.54	74.00	-32.46	149	1	peak
4874.000	31.20	-1.92	29.28	54.00	-24.72	149	1	AVG
7311.000	43.28	5.08	48.36	74.00	-25.64	147	137	peak
7311.000	30.62	5.08	35.70	54.00	-18.30	147	137	AVG
B Mode, High channel								
2488.528	58.41	-8.38	50.03	74.00	-23.97	184	123	peak
2488.528	44.70	-8.38	36.32	54.00	-17.68	184	123	AVG
4924.000	47.86	-1.63	46.23	74.00	-27.77	105	229	peak
4924.000	33.89	-1.63	32.26	54.00	-21.74	105	229	AVG
7386.000	42.17	5.20	47.37	74.00	-26.63	154	70	peak
7386.000	30.50	5.20	35.70	54.00	-18.30	154	70	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								
2367.568	58.99	-9.64	49.35	74.00	-24.65	151	211	Peak
2367.568	44.85	-9.64	35.21	54.00	-18.79	151	211	AVG
4824.000	44.57	-2.15	42.42	74.00	-31.58	151	202	peak
4824.000	31.29	-2.15	29.14	54.00	-24.86	151	202	AVG
7236.000	42.91	4.55	47.46	74.00	-26.54	147	150	peak
7236.000	30.55	4.55	35.10	54.00	-18.90	147	150	AVG
G Mode, Middle channel								
4874.000	43.76	-1.92	41.84	74.00	-32.16	148	322	peak
4874.000	31.58	-1.92	29.66	54.00	-24.34	148	322	AVG
7311.000	43.37	5.08	48.45	74.00	-25.55	145	1	peak
7311.000	30.64	5.08	35.72	54.00	-18.28	145	1	AVG
G Mode, High channel								
2490.448	58.71	-8.34	50.37	74.00	-23.63	125	210	peak
2490.448	44.76	-8.34	36.42	54.00	-17.58	125	210	AVG
4924.000	47.04	-1.63	45.41	74.00	-28.59	104	0	peak
4924.000	33.11	-1.63	31.48	54.00	-22.52	104	0	AVG
7386.000	43.81	5.20	49.01	74.00	-24.99	141	273	peak
7386.000	30.56	5.20	35.76	54.00	-18.24	141	273	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								
2386.048	58.07	-9.49	48.58	74.00	-25.42	194	125	peak
2386.048	44.50	-9.49	35.01	54.00	-18.99	194	125	AVG
4824.000	44.13	-2.15	41.98	74.00	-32.02	152	143	peak
4824.000	31.35	-2.15	29.20	54.00	-24.80	152	143	AVG
7236.000	43.19	4.55	47.74	74.00	-26.26	147	96	peak
7236.000	30.55	4.55	35.10	54.00	-18.90	147	96	AVG
G Mode, Middle channel								
4874.000	43.67	-1.92	41.75	74.00	-32.25	152	167	peak
4874.000	31.20	-1.92	29.28	54.00	-24.72	152	167	AVG
7311.000	43.58	5.08	48.66	74.00	-25.34	151	240	peak
7311.000	30.65	5.08	35.73	54.00	-18.27	151	240	AVG
G Mode, High channel								
2496.352	59.41	-8.26	51.15	74.00	-22.85	208	129	peak
2496.352	45.03	-8.26	36.77	54.00	-17.23	208	129	AVG
4924.000	46.42	-1.63	44.79	74.00	-29.21	150	130	peak
4924.000	31.96	-1.63	30.33	54.00	-23.67	150	130	AVG
7386.000	42.51	5.20	47.71	74.00	-26.29	152	71	peak
7386.000	30.51	5.20	35.71	54.00	-18.29	152	71	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								
2350.320	58.21	-9.79	48.42	74.00	-25.58	127	214	peak
2350.320	45.02	-9.79	35.23	54.00	-18.77	127	214	AVG
4824.000	43.52	-2.15	41.37	74.00	-32.63	148	72	peak
4824.000	31.32	-2.15	29.17	54.00	-24.83	148	72	AVG
7236.000	42.80	4.55	47.35	74.00	-26.65	153	299	peak
7236.000	30.59	4.55	35.14	54.00	-18.86	153	299	AVG
N20 Mode, Middle channel								
4874.000	43.69	-1.92	41.77	74.00	-32.23	150	60	peak
4874.000	31.50	-1.92	29.58	54.00	-24.42	150	60	AVG
7311.000	43.68	5.08	48.76	74.00	-25.24	152	307	peak
7311.000	30.69	5.08	35.77	54.00	-18.23	152	307	AVG
N20 Mode, High channel								
2485.600	58.58	-8.42	50.16	74.00	-23.84	125	217	peak
2485.600	44.85	-8.42	36.43	54.00	-17.57	125	217	AVG
4924.000	45.63	-1.63	44.00	74.00	-30.00	151	3	peak
4924.000	32.23	-1.63	30.60	54.00	-23.40	151	3	AVG
7386.000	43.37	5.20	48.57	74.00	-25.43	153	256	peak
7386.000	30.54	5.20	35.74	54.00	-18.26	153	256	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								
2389.072	58.36	-9.47	48.89	74.00	-25.11	209	127	peak
2389.072	44.83	-9.47	35.36	54.00	-18.64	209	127	AVG
4824.000	43.65	-2.15	41.50	74.00	-32.50	152	183	peak
4824.000	31.33	-2.15	29.18	54.00	-24.82	152	183	AVG
7236.000	43.10	4.55	47.65	74.00	-26.35	149	176	peak
7236.000	30.61	4.55	35.16	54.00	-18.84	149	176	AVG
N20 Mode, Middle channel								
4874.000	43.54	-1.92	41.62	74.00	-32.38	152	55	peak
4874.000	31.28	-1.92	29.36	54.00	-24.64	152	55	AVG
7311.000	43.62	5.08	48.70	74.00	-25.30	146	157	peak
7311.000	30.71	5.08	35.79	54.00	-18.21	146	157	AVG
N20 Mode, High channel								
2493.136	59.13	-8.31	50.82	74.00	-23.18	210	129	peak
2493.136	44.96	-8.31	36.65	54.00	-17.35	210	129	AVG
4924.000	44.22	-1.63	42.59	74.00	-31.41	148	107	peak
4924.000	31.35	-1.63	29.72	54.00	-24.28	148	107	AVG
7386.000	42.60	5.20	47.80	74.00	-26.20	151	183	peak
7386.000	30.55	5.20	35.75	54.00	-18.25	151	183	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
N40 Mode, Low channel								
2389.596	58.72	-9.46	49.26	74.00	-24.74	123	220	peak
2389.596	45.53	-9.46	36.07	54.00	-17.93	123	220	AVG
4844.000	43.52	-2.11	41.41	74.00	-32.59	147	19	peak
4844.000	31.36	-2.11	29.25	54.00	-24.75	147	19	AVG
7266.000	42.50	4.83	47.33	74.00	-26.67	142	7	peak
7266.000	30.55	4.83	35.38	54.00	-18.62	142	7	AVG
N40 Mode, Middle channel								
4874.000	44.85	-1.92	42.93	74.00	-31.07	152	280	peak
4874.000	31.44	-1.92	29.52	54.00	-24.48	152	280	AVG
7311.000	42.87	5.08	47.95	74.00	-26.05	147	214	peak
7311.000	30.70	5.08	35.78	54.00	-18.22	147	214	AVG
N40 Mode, High channel								
2484.564	60.75	-8.44	52.31	74.00	-21.69	124	220	peak
2484.564	46.70	-8.44	38.26	54.00	-15.74	124	220	AVG
4904.000	43.77	-1.71	42.06	74.00	-31.94	145	293	peak
4904.000	31.71	-1.71	30.00	54.00	-24.00	145	293	AVG
7356.000	43.02	5.18	48.20	74.00	-25.80	152	155	peak
7356.000	30.72	5.18	35.90	54.00	-18.10	152	155	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
N40 Mode, Low channel								
2384.712	57.44	-9.50	47.94	74.00	-26.06	206	111	peak
2384.712	44.71	-9.50	35.21	54.00	-18.79	206	111	AVG
4844.000	43.56	-2.11	41.45	74.00	-32.55	155	142	peak
4844.000	31.29	-2.11	29.18	54.00	-24.82	155	142	AVG
7266.000	42.99	4.83	47.82	74.00	-26.18	146	136	peak
7266.000	30.60	4.83	35.43	54.00	-18.57	146	136	AVG
N40 Mode, Middle channel								
4874.000	44.27	-1.92	42.35	74.00	-31.65	153	226	peak
4874.000	31.21	-1.92	29.29	54.00	-24.71	153	226	AVG
7311.000	43.81	5.08	48.89	74.00	-25.11	146	86	peak
7311.000	30.73	5.08	35.81	54.00	-18.19	146	86	AVG
N40 Mode, High channel								
2483.952	59.88	-8.44	51.44	74.00	-22.56	207	109	peak
2483.952	46.27	-8.44	37.83	54.00	-16.17	207	109	AVG
4904.000	43.85	-1.71	42.14	74.00	-31.86	158	210	peak
4904.000	31.28	-1.71	29.57	54.00	-24.43	158	210	AVG
7356.000	42.77	5.18	47.95	74.00	-26.05	146	321	peak
7356.000	30.70	5.18	35.88	54.00	-18.12	146	321	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
BLE(1M) Mode, Low channel								
2390.000	59.71	-9.46	50.25	74.00	-23.75	145	33	peak
2390.000	48.07	-9.46	38.61	54.00	-15.39	145	33	AVG
4804.000	56.02	-2.17	53.85	74.00	-20.15	105	148	peak
4804.000	51.25	-2.17	49.08	54.00	-4.92	105	148	AVG
7206.000	43.64	4.18	47.82	74.00	-26.18	158	72	peak
7206.000	29.36	4.18	33.54	54.00	-20.46	158	72	AVG
BLE(1M) Mode, Middle channel								
4880.000	56.41	-1.88	54.53	74.00	-19.47	108	168	peak
4880.000	52.14	-1.88	50.26	54.00	-3.74	108	168	AVG
7320.000	43.53	5.10	48.63	74.00	-25.37	152	75	peak
7320.000	30.28	5.10	35.38	54.00	-18.62	152	75	AVG
BLE(1M) Mode, High channel								
2488.420	66.49	-8.38	58.11	74.00	-15.89	143	60	peak
2488.420	52.09	-8.38	43.71	54.00	-10.29	143	60	AVG
4960.000	56.77	-1.49	55.28	74.00	-18.72	101	175	peak
4960.000	53.20	-1.49	51.71	54.00	-2.29	101	175	AVG
7440.000	43.03	5.23	48.26	74.00	-25.74	150	36	peak
7440.000	29.54	5.23	34.77	54.00	-19.23	150	36	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
BLE(1M) Mode, Low channel								
2374.700	56.87	-9.58	47.29	74.00	-26.71	180	94	peak
2374.700	44.31	-9.58	34.73	54.00	-19.27	180	94	AVG
4804.000	53.49	-2.17	51.32	74.00	-22.68	146	122	peak
4804.000	48.30	-2.17	46.13	54.00	-7.87	146	122	AVG
7206.000	43.41	4.18	47.59	74.00	-26.41	150	285	peak
7206.000	29.75	4.18	33.93	54.00	-20.07	150	285	AVG
BLE(1M) Mode, Middle channel								
4880.000	53.46	-1.88	51.58	74.00	-22.42	145	131	peak
4880.000	48.63	-1.88	46.75	54.00	-7.25	145	131	AVG
7320.000	43.80	5.10	48.90	74.00	-25.10	157	36	peak
7320.000	30.15	5.10	35.25	54.00	-18.75	157	36	AVG
BLE(1M) Mode, High channel								
2488.750	59.60	-8.38	51.22	74.00	-22.78	180	165	peak
2488.750	45.91	-8.38	37.53	54.00	-16.47	180	165	AVG
4960.000	54.39	-1.49	52.90	74.00	-21.10	145	100	peak
4960.000	49.86	-1.49	48.37	54.00	-5.63	145	100	AVG
7440.000	42.60	5.23	47.83	74.00	-26.17	152	75	peak
7440.000	29.71	5.23	34.94	54.00	-19.06	152	75	AVG

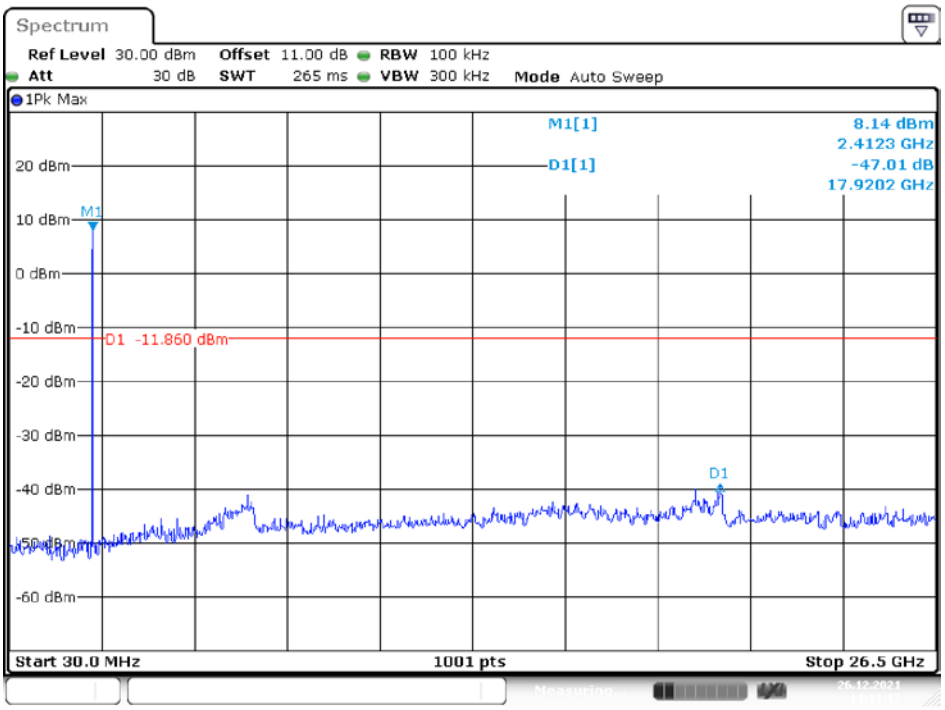
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	47.01	≥ 20	PASS
Middle	2437	45.96	≥ 20	PASS
High	2462	47.34	≥ 20	PASS
G Mode				
Low	2412	41.64	≥ 20	PASS
Middle	2437	41.67	≥ 20	PASS
High	2462	41.77	≥ 20	PASS
N20 Mode				
Low	2412	42.78	≥ 20	PASS
Middle	2437	42.46	≥ 20	PASS
High	2462	41.83	≥ 20	PASS
N40 Mode				
Low	2422	39.40	≥ 20	PASS
Middle	2437	40.36	≥ 20	PASS
High	2452	36.30	≥ 20	PASS
BLE(1M) Mode				
Low	2402	44.41	≥ 20	PASS
Middle	2440	48.10	≥ 20	PASS
High	2480	46.25	≥ 20	PASS

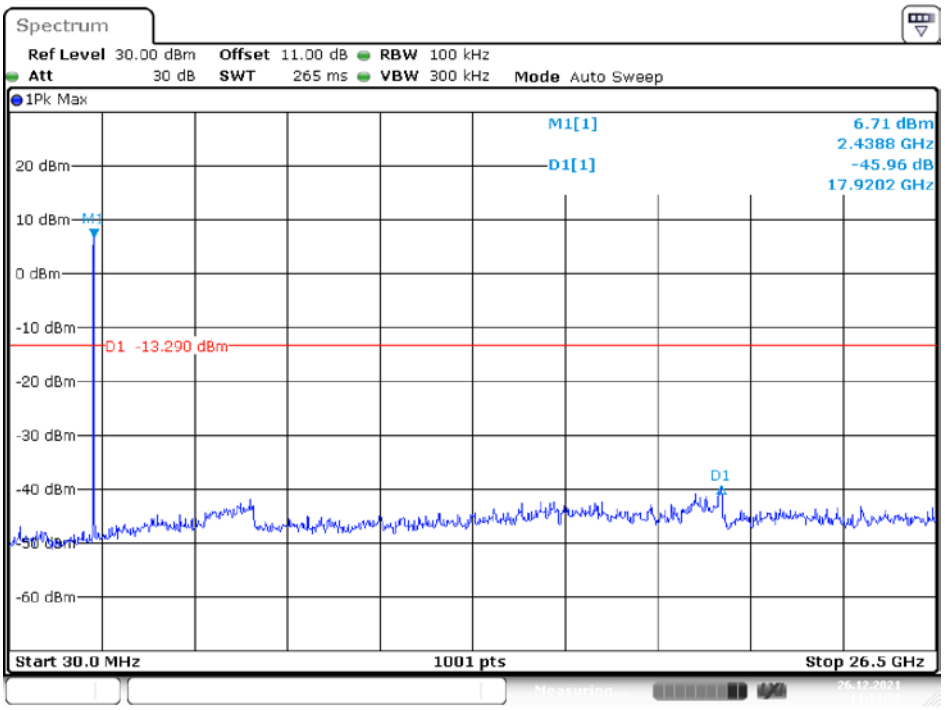
B Mode

Low Channel



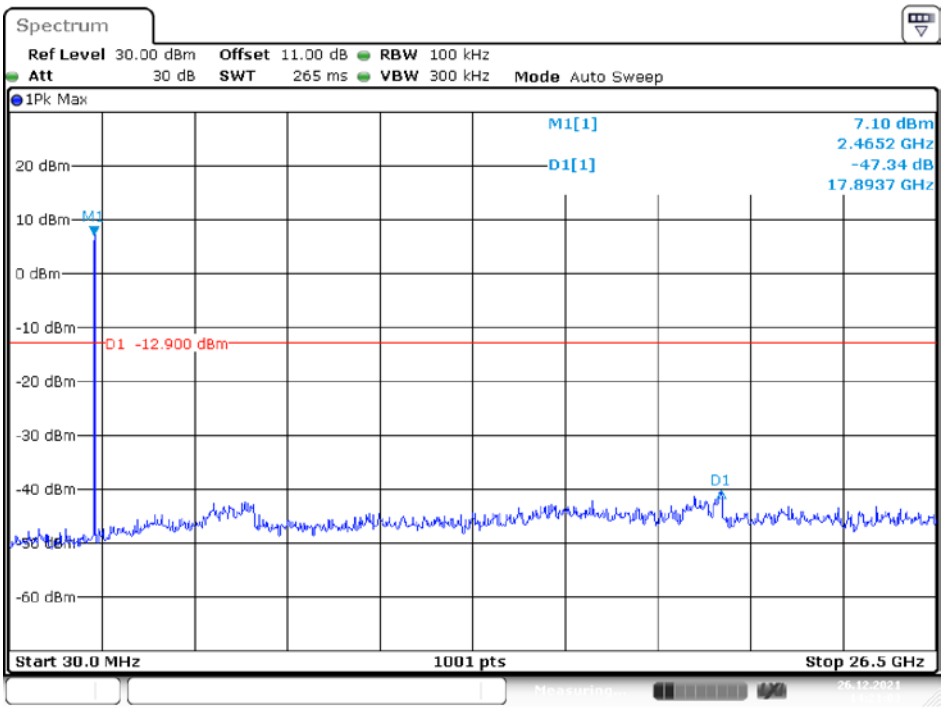
Date: 26.DEC.2021 14:11:18

Middle Channel



Date: 26.DEC.2021 14:14:59

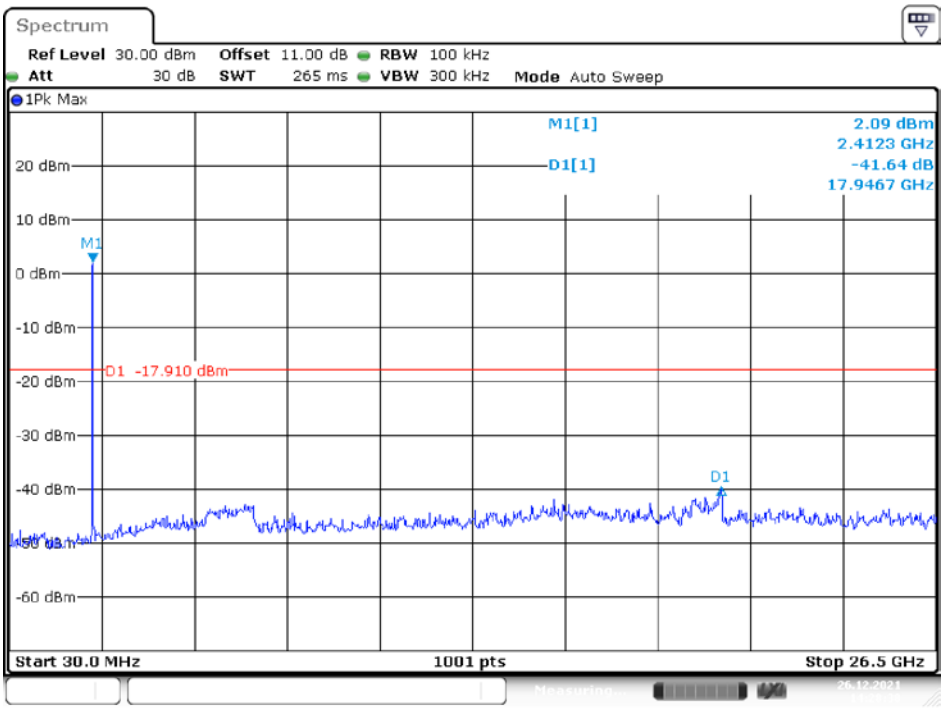
High Channel



Date: 26.DEC.2021 14:21:03

G Mode

Low Channel



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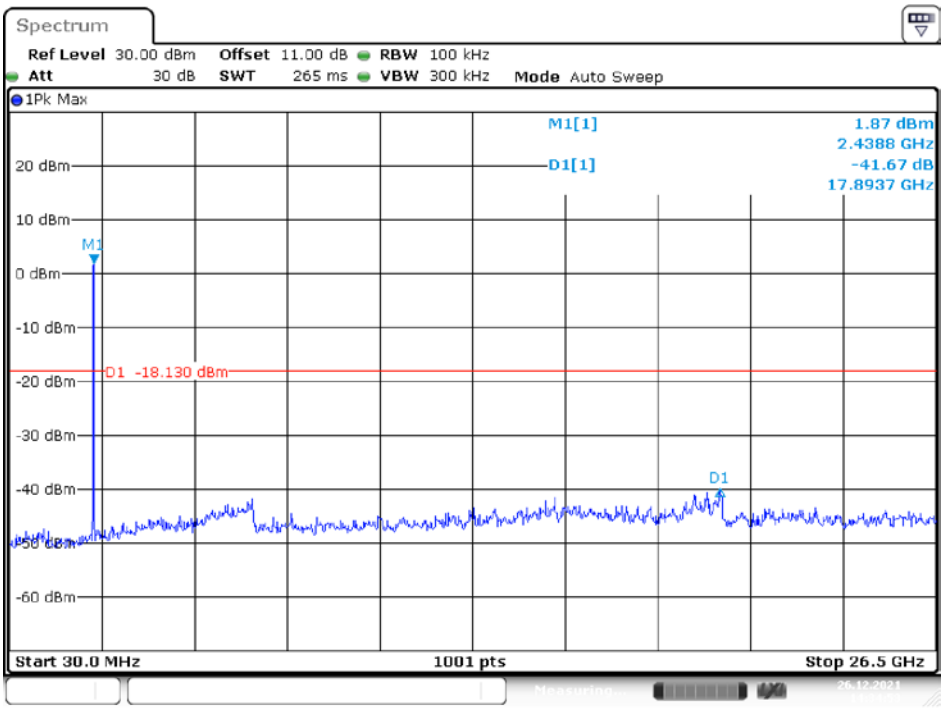
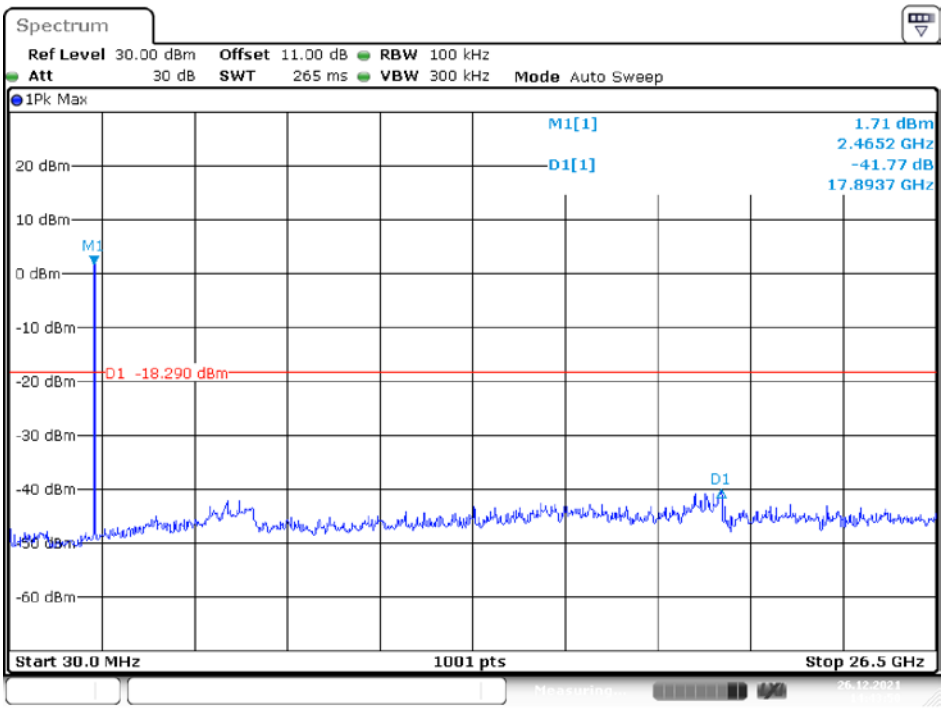
Middle Channel



Date: 26.DEC.2021 14:34:53

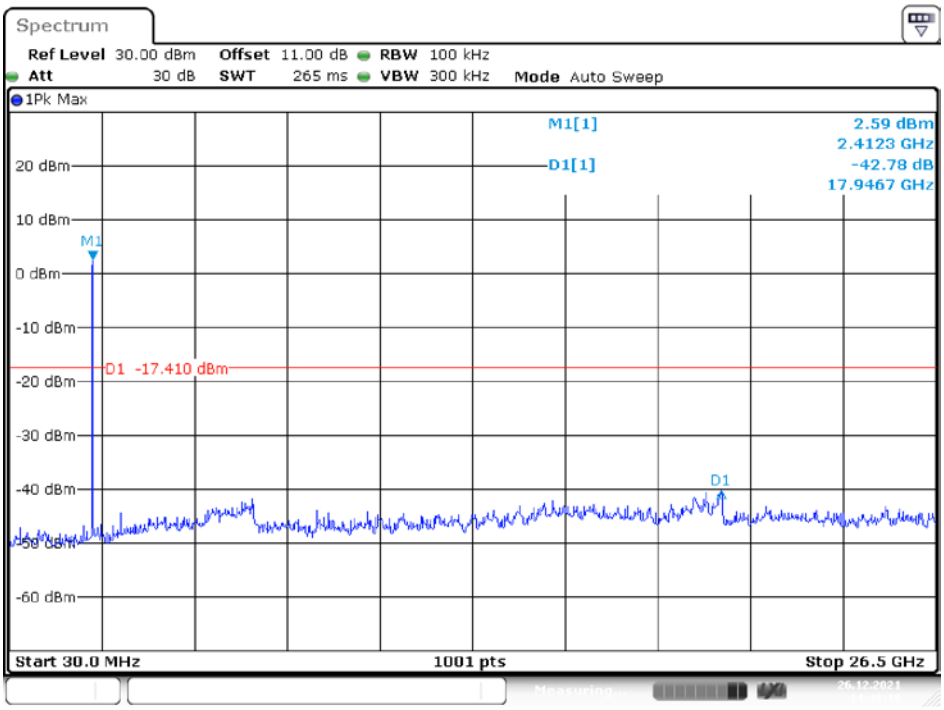
High Channel



Date: 26.DEC.2021 14:43:51

N20 Mode

Low Channel



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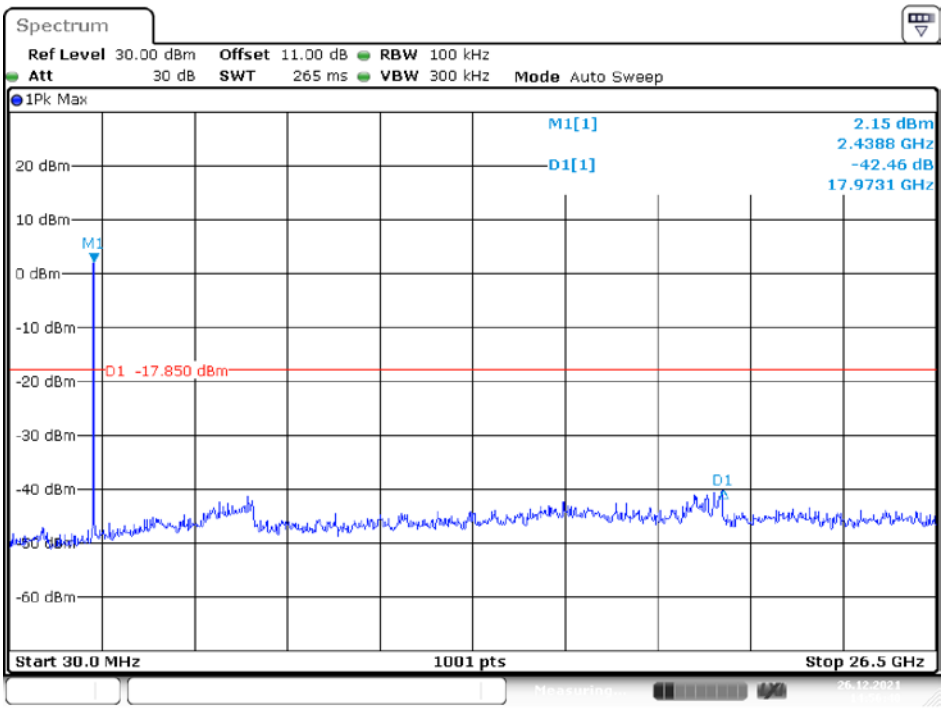
Middle Channel



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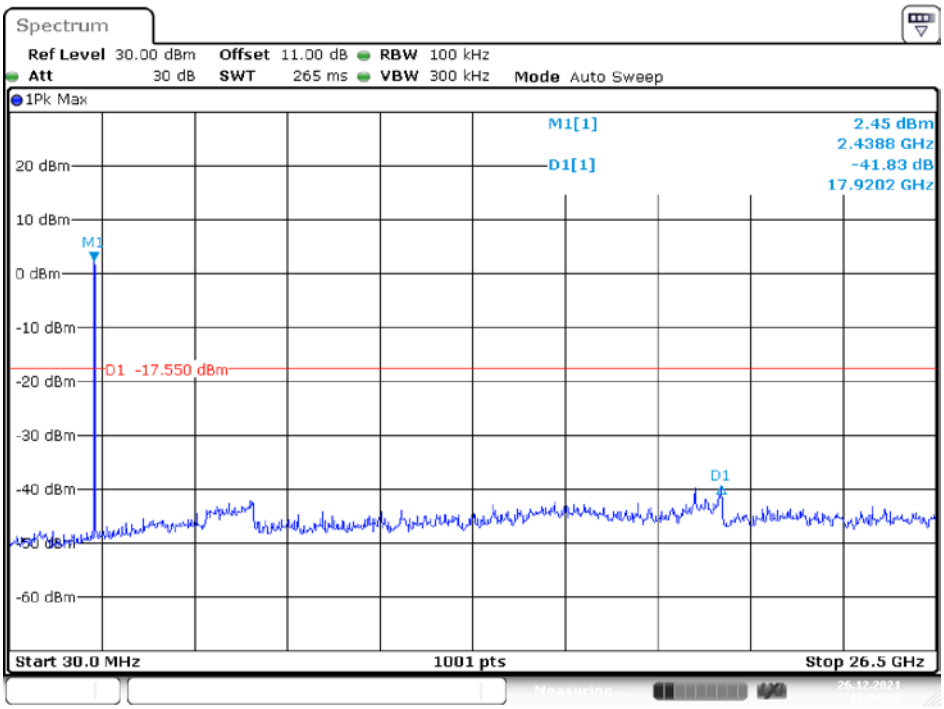
High Channel



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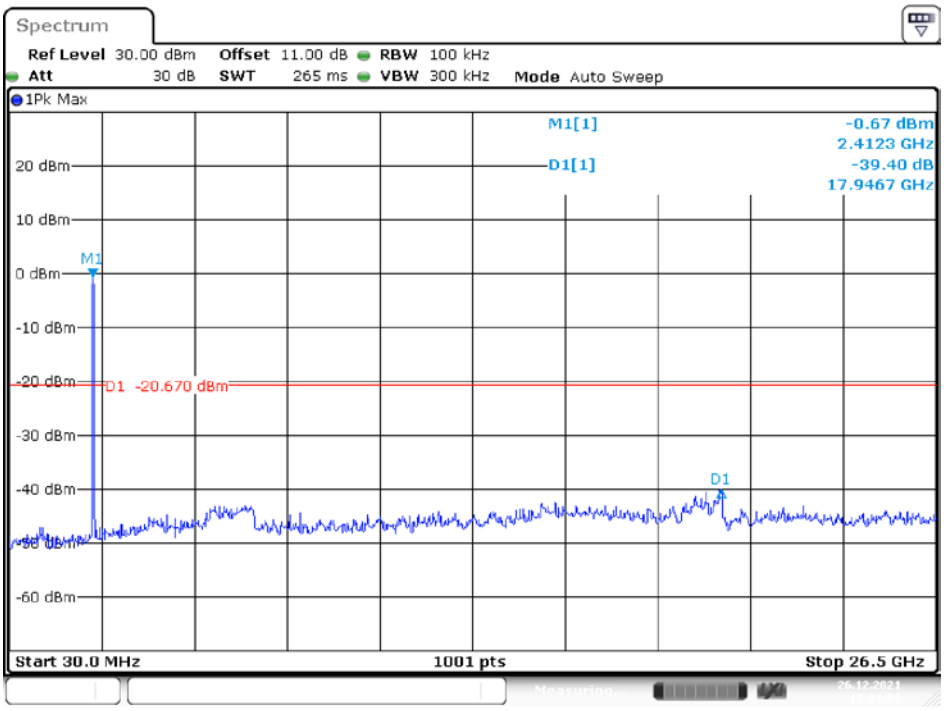
N40 Mode

Low Channel



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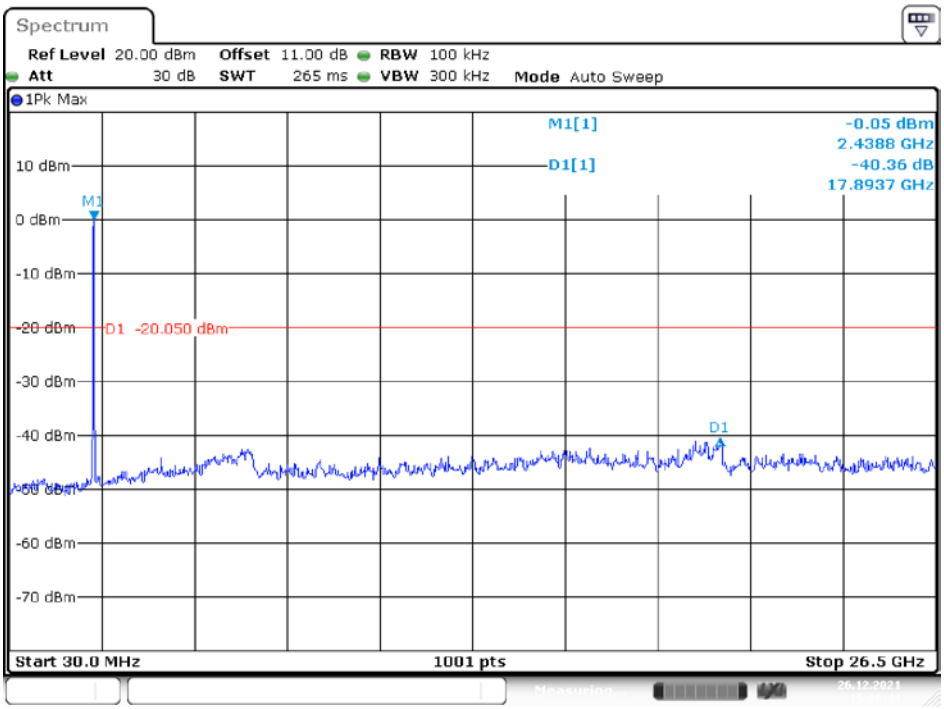
Middle Channel



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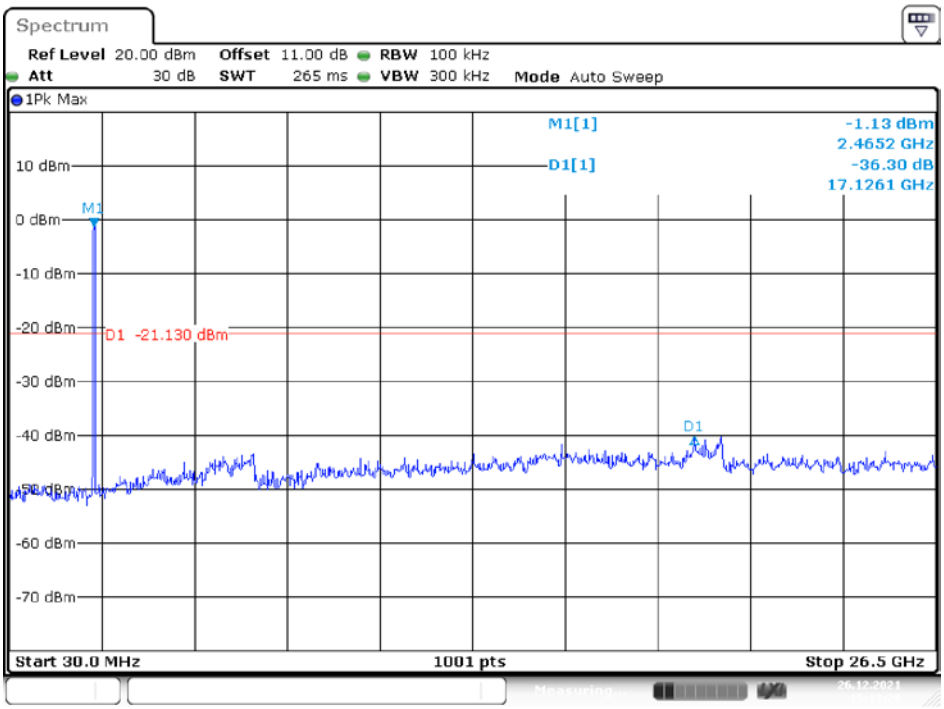
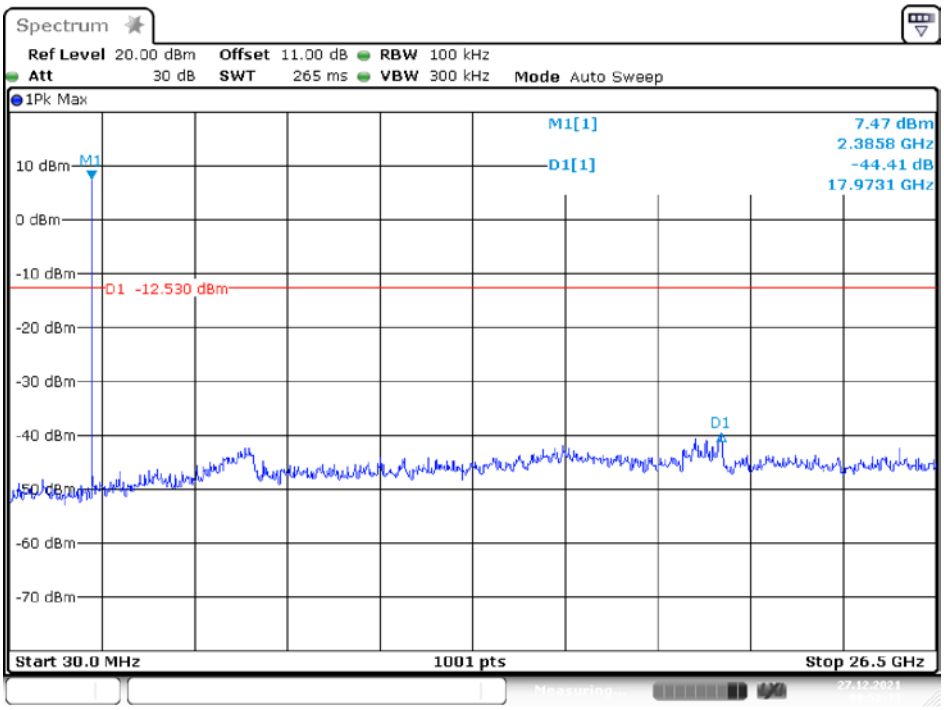
High Channel



Date: 26.DEC.2021 15:13:28

BLE(1M) Mode

Low Channel



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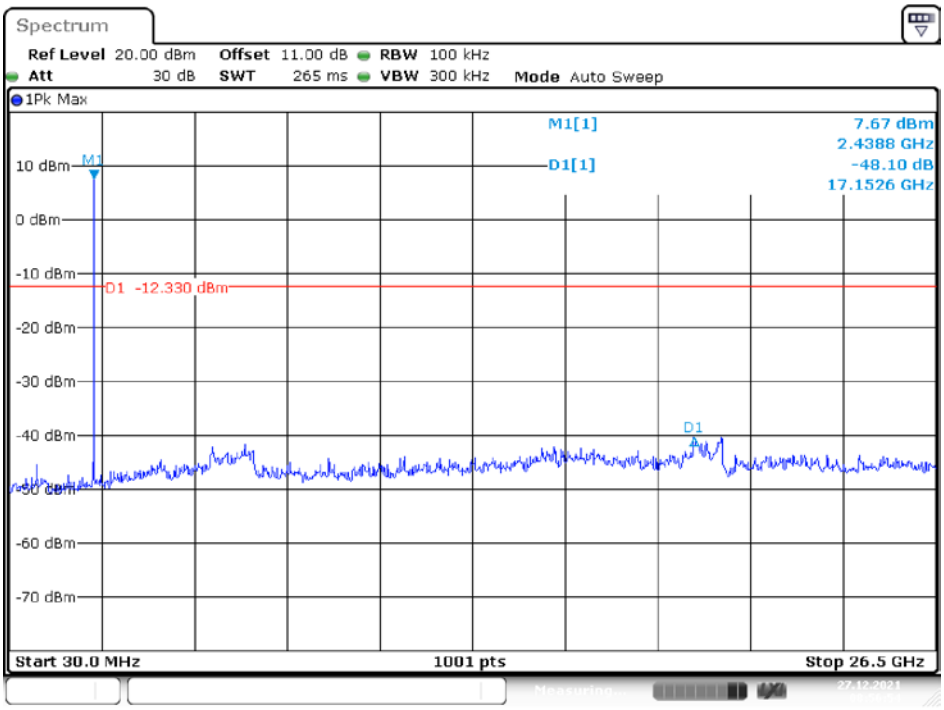
Middle Channel



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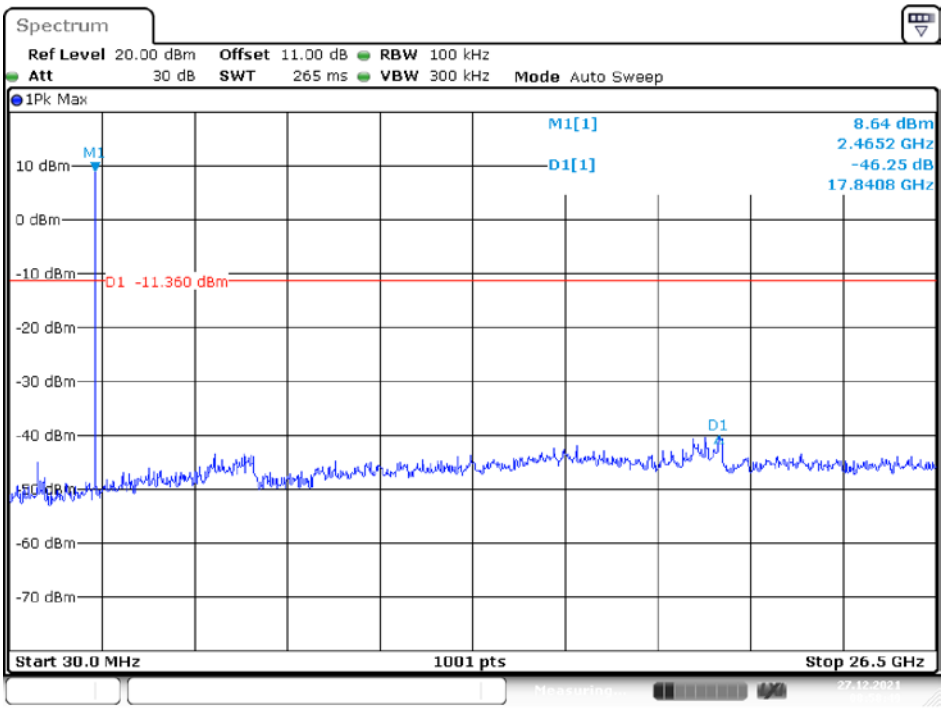
High Channel



Date: 27.DEC.2021 08:58:49

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.

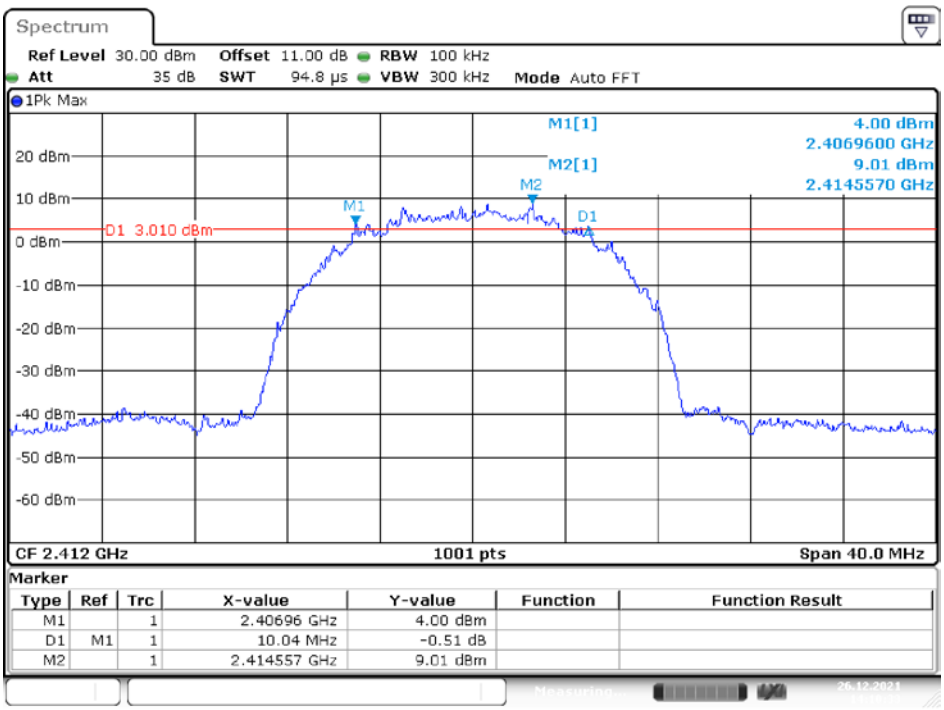
9.3 Test Results

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	16.44	> 500	PASS
Middle	2437	16.44	> 500	PASS
High	2462	16.44	> 500	PASS
N20 Mode				
Low	2412	17.60	> 500	PASS
Middle	2437	17.60	> 500	PASS
High	2462	17.60	> 500	PASS
N40 Mode				
Low	2422	36.40	> 500	PASS
Middle	2437	36.40	> 500	PASS
High	2452	36.40	> 500	PASS
BLE(1M) Mode				
Low	2402	0.65	> 500	PASS
Middle	2440	0.65	> 500	PASS
High	2480	0.65	> 500	PASS

Please refer to the following plots

B Mode

Low Channel



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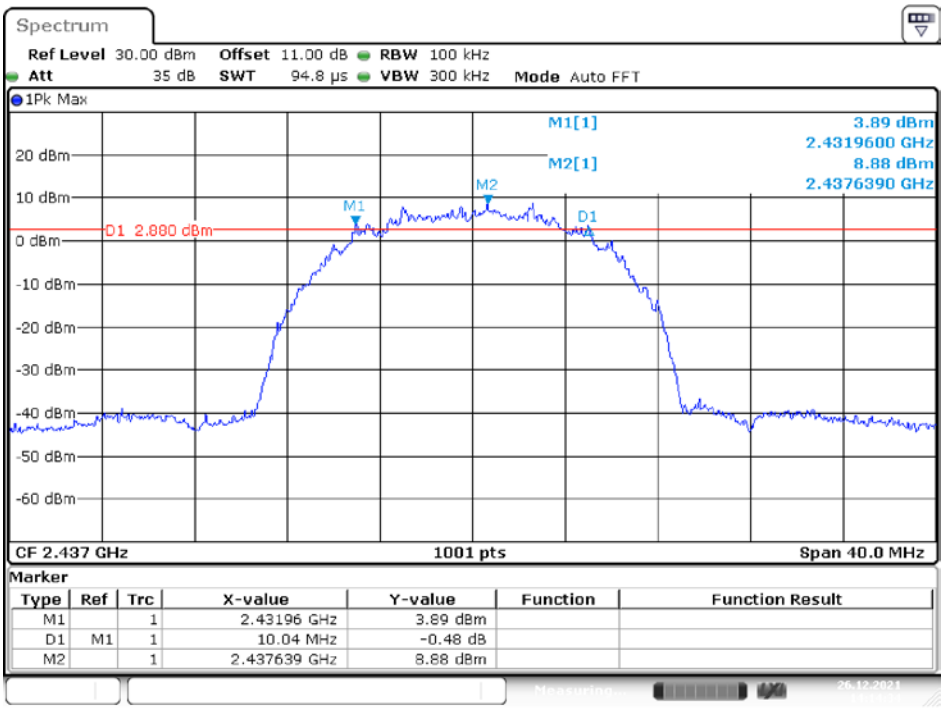
Middle Channel



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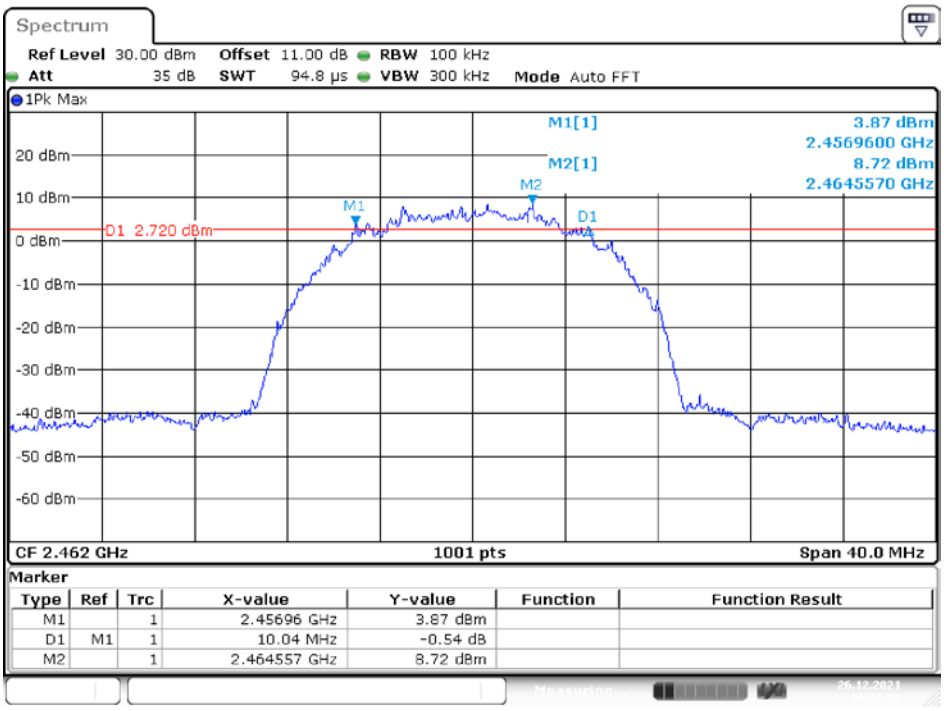
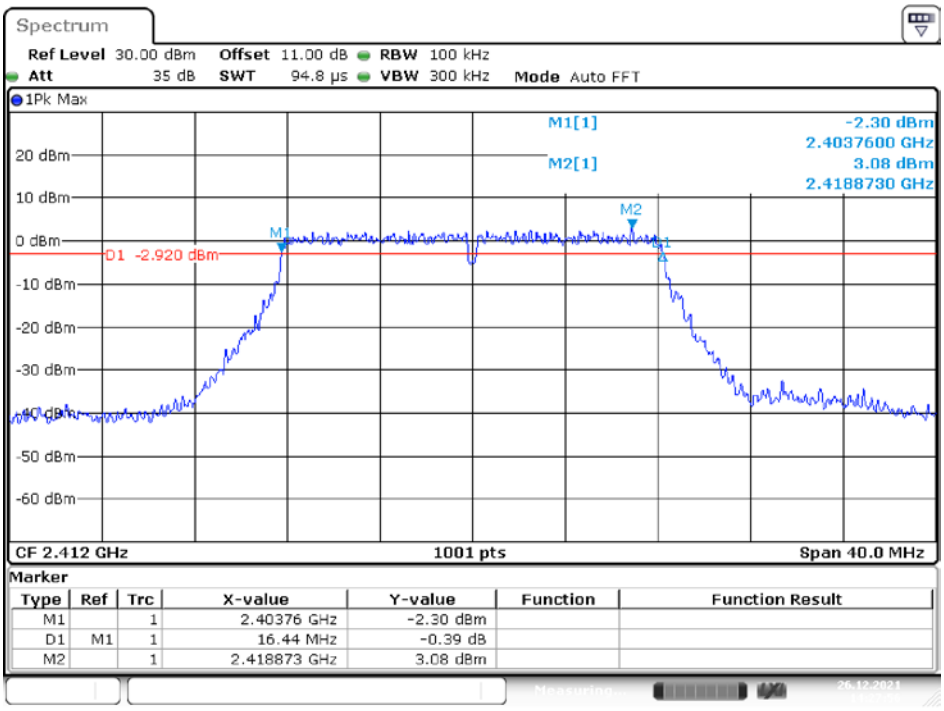
High Channel



Date: 26.DEC.2021 14:20:22

G Mode

Low Channel



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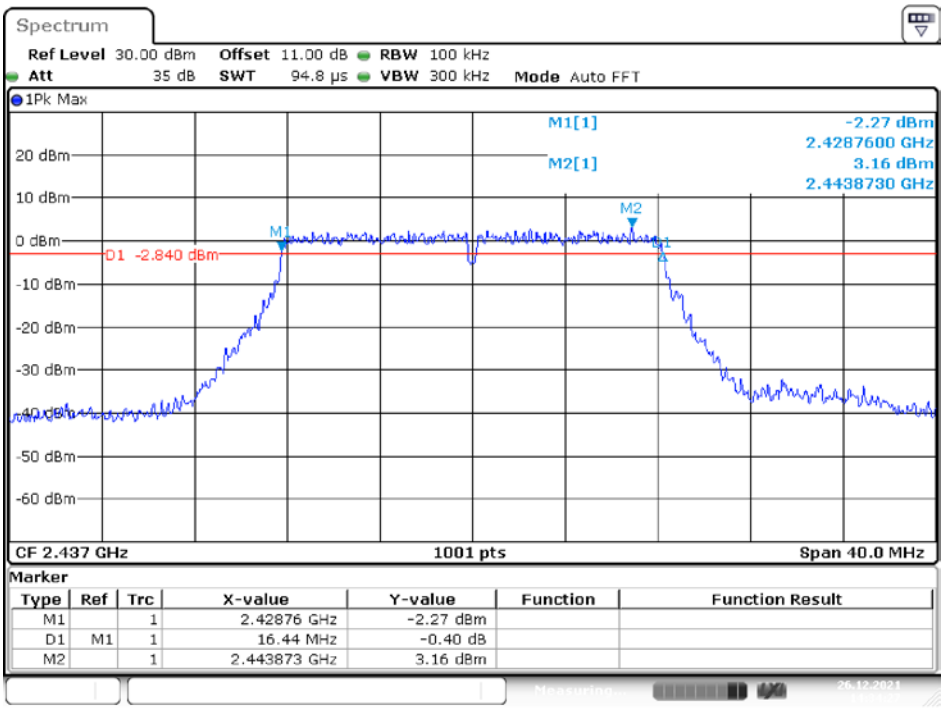
Middle Channel



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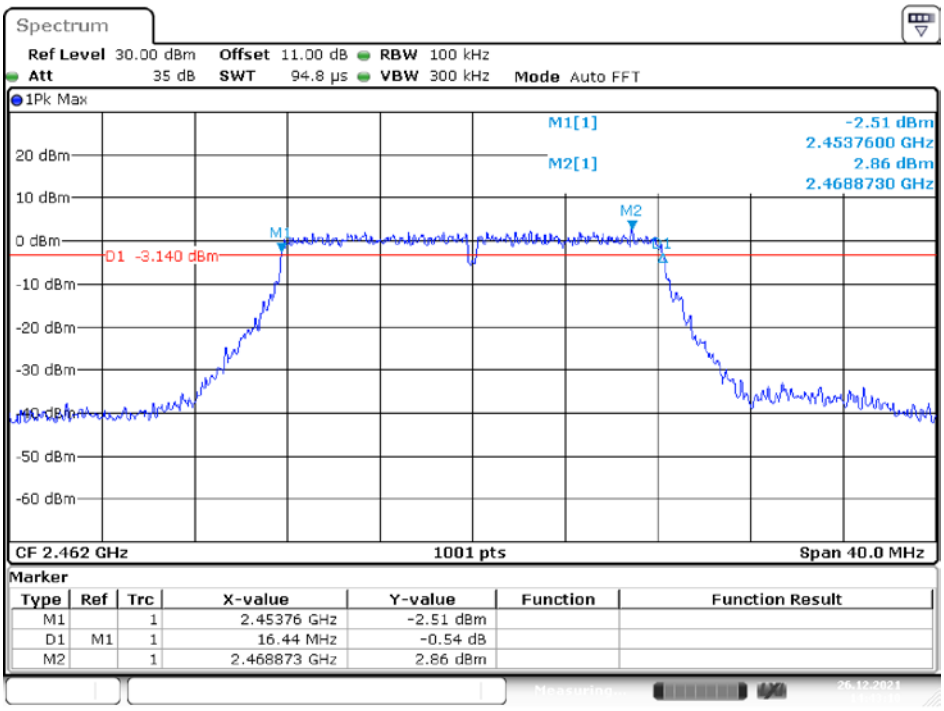
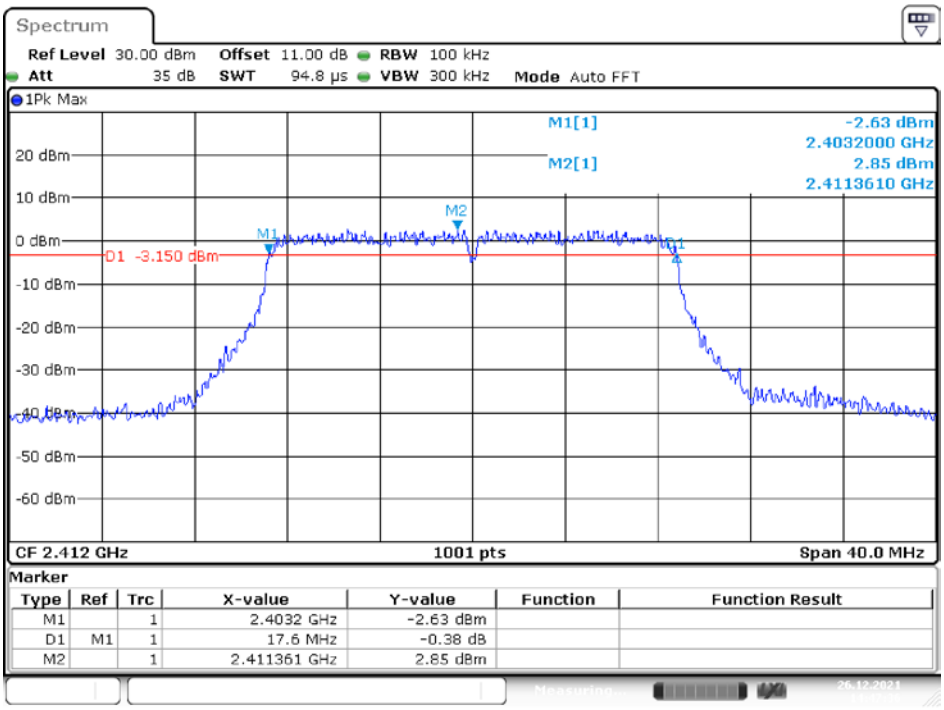
High Channel



Date: 26.DEC.2021 14:43:10

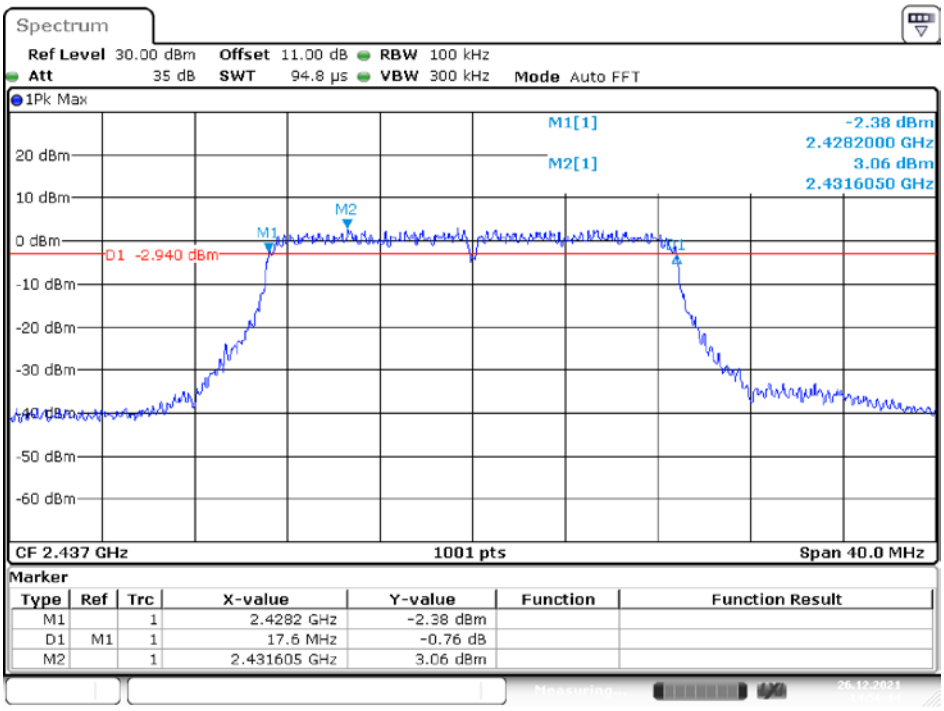
N20 Mode

Low Channel



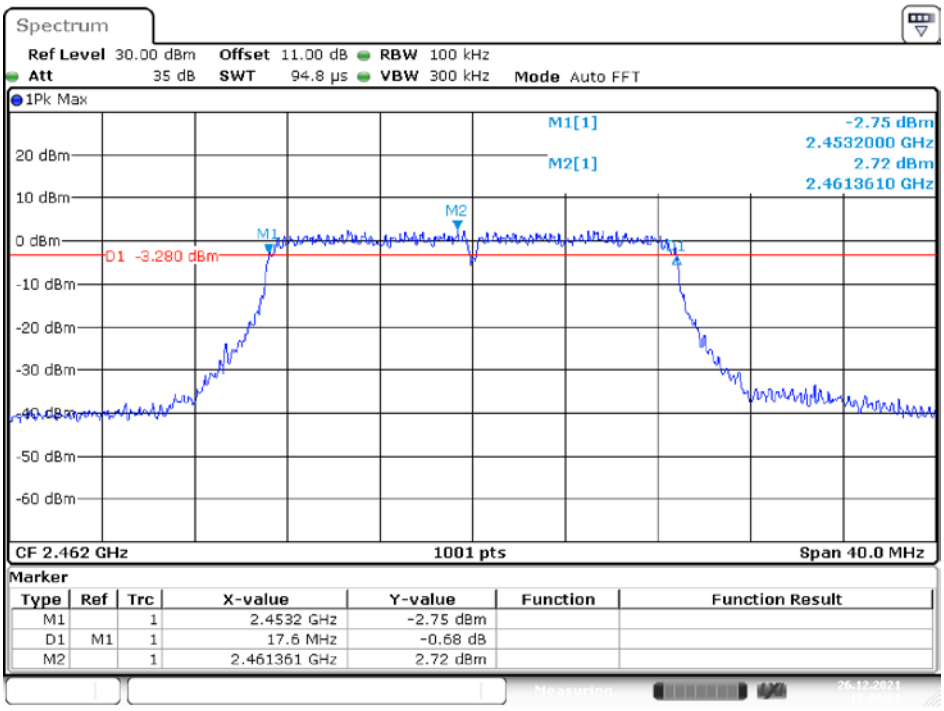
Date: 26.DEC.2021 14:47:37

Middle Channel



Date: 26.DEC.2021 14:56:14

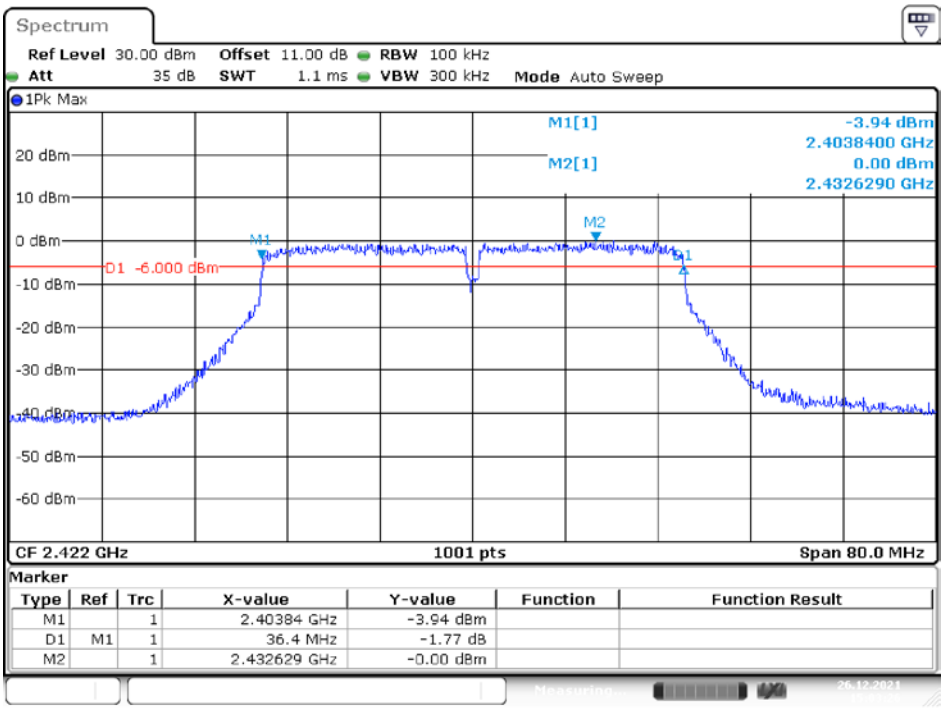
High Channel



Date: 26.DEC.2021 15:00:01

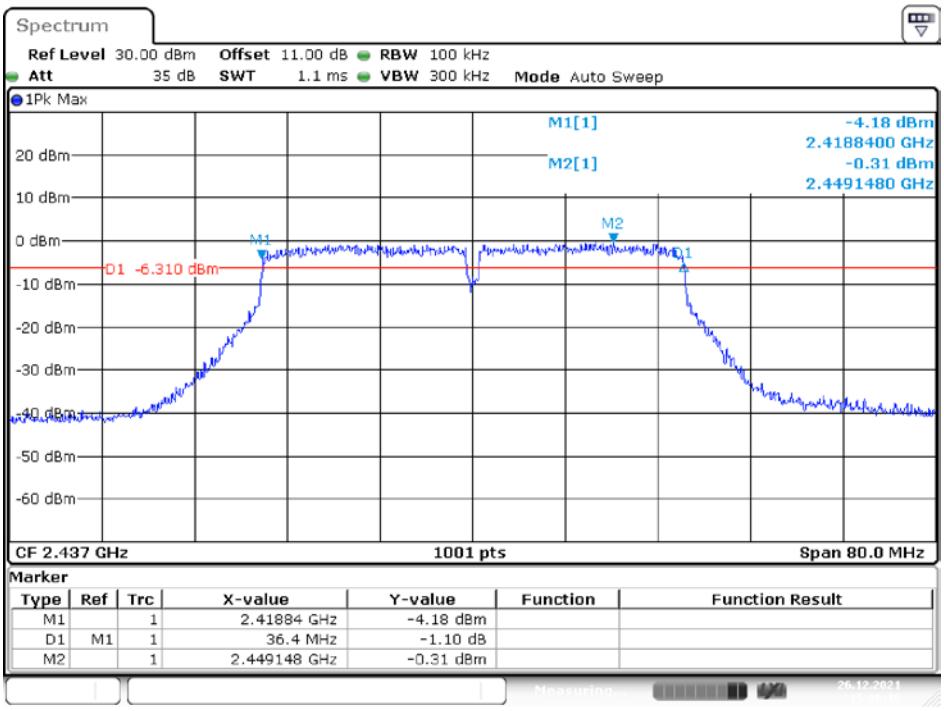
N40 Mode

Low Channel



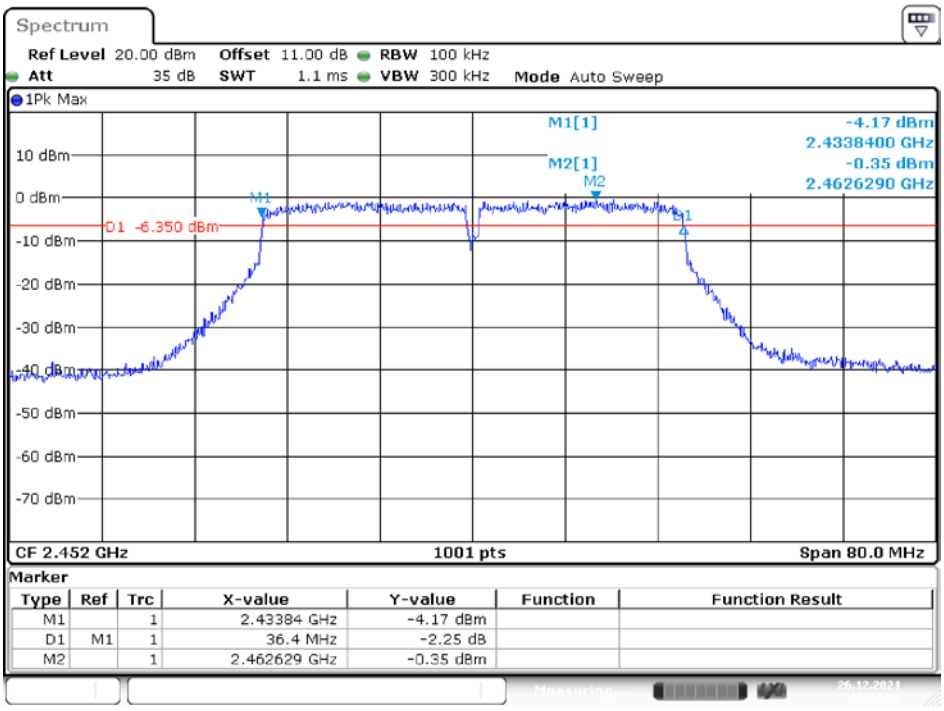
Date: 26.DEC.2021 15:03:27

Middle Channel



Date: 26.DEC.2021 15:06:16

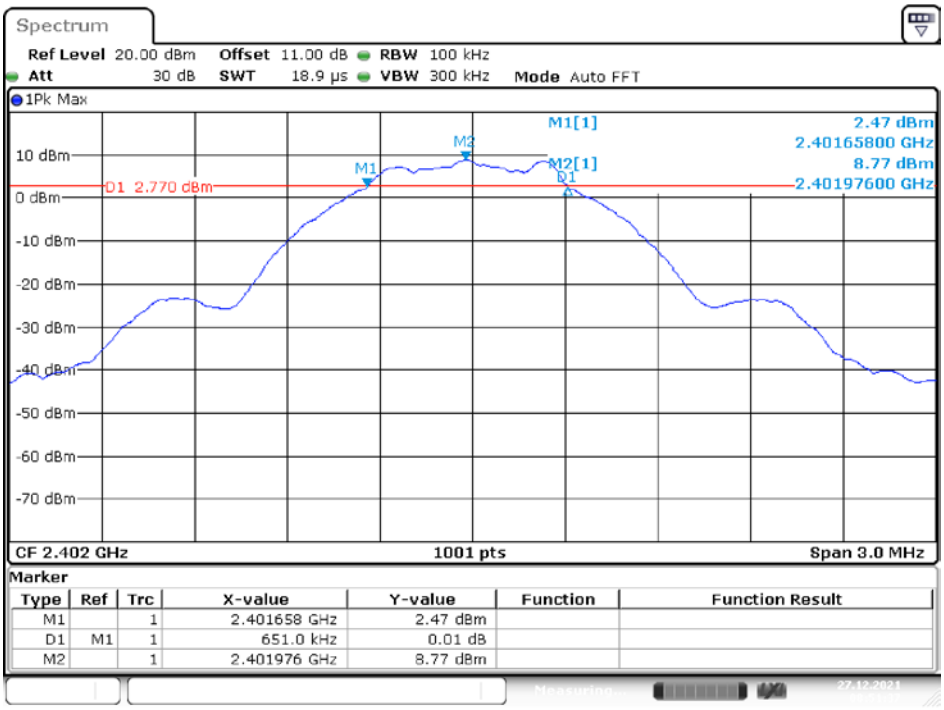
High Channel



Date: 26.DEC.2021 15:12:47

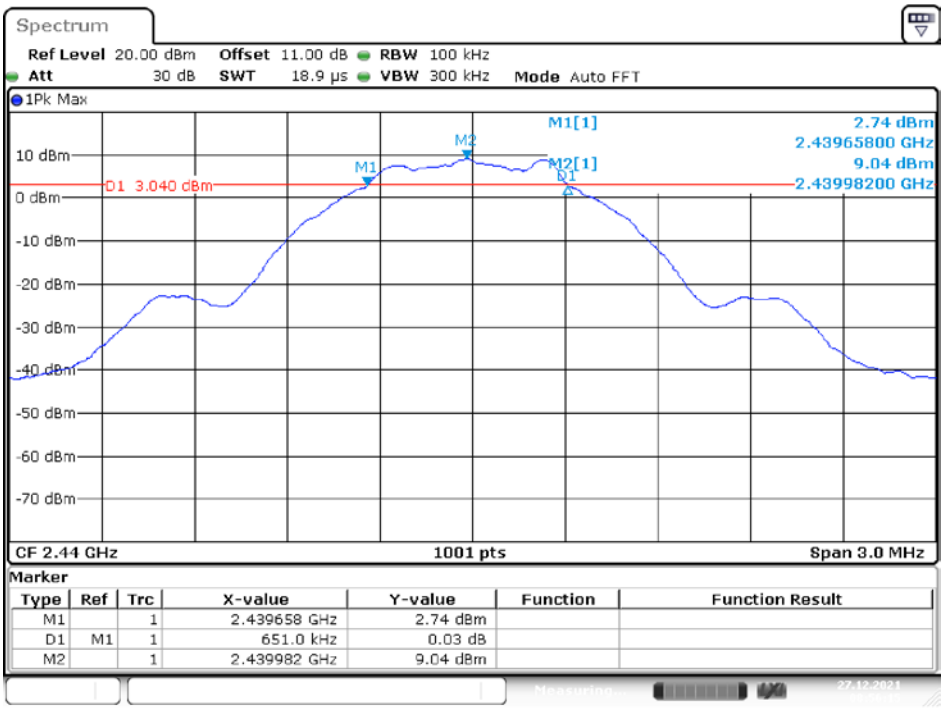
BLE(1M) Mode

Low Channel



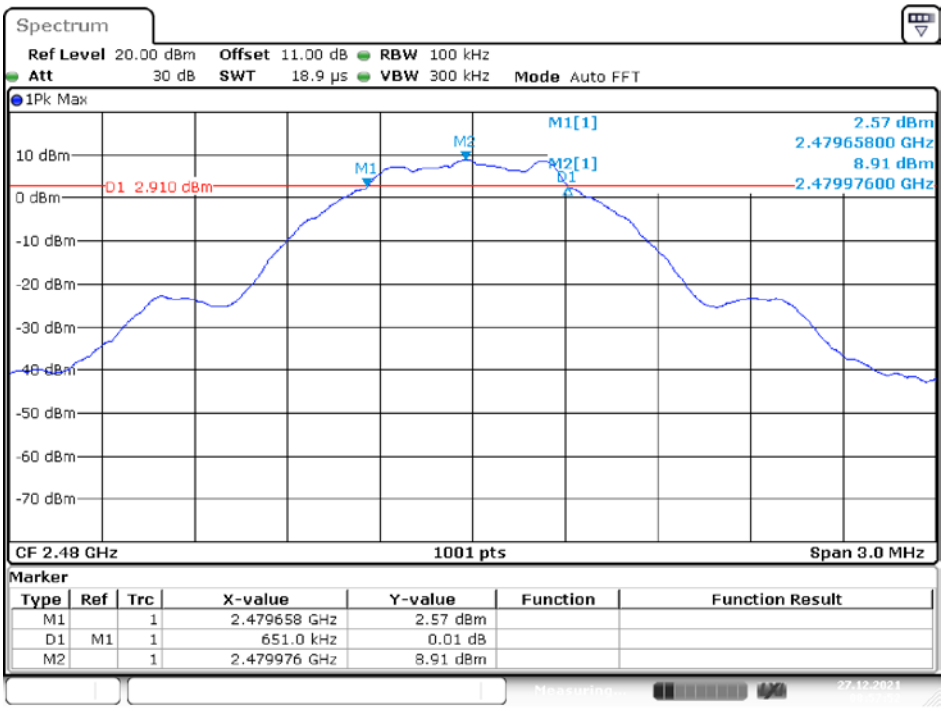
Date: 27.DEC.2021 08:51:37

Middle Channel



Date: 27.DEC.2021 08:56:14

High Channel



Date: 27.DEC.2021 08:57:52

10 FCC §15.247(b)(3) – Maximum 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	9.38	0.009	1	PASS
Middle	2437	9.41	0.009	1	PASS
High	2462	9.47	0.009	1	PASS
802.11g Mode					
Low	2412	9.41	0.009	1	PASS
Middle	2437	9.42	0.009	1	PASS
High	2462	9.35	0.009	1	PASS
802.11n HT20 Mode					
Low	2412	9.27	0.008	1	PASS
Middle	2437	9.21	0.008	1	PASS
High	2462	9.31	0.009	1	PASS
802.11n HT40 Mode					
Low	2422	9.48	0.009	1	PASS
Middle	2437	9.12	0.008	1	PASS
High	2452	9.46	0.009	1	PASS
BLE(1M) Mode					
Low	2402	9.01	0.008	1	PASS
Middle	2440	9.24	0.008	1	PASS
High	2480	9.11	0.008	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.

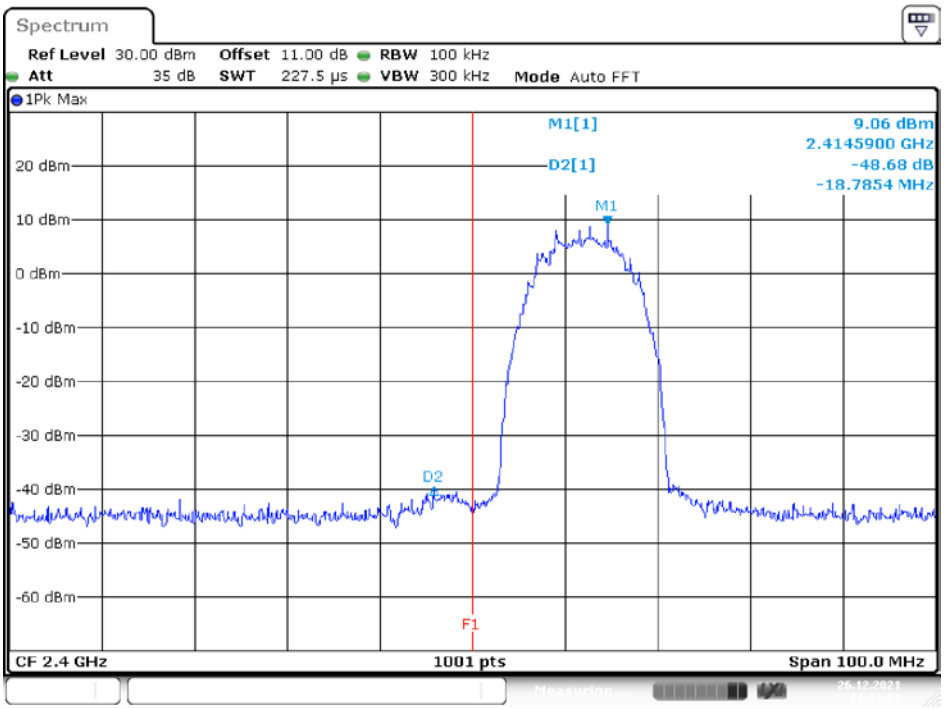
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	48.68	≥ 20	PASS
High	2462	49.12	≥ 20	PASS
G Mode				
Low	2412	39.98	≥ 20	PASS
High	2462	43.08	≥ 20	PASS
N20 Mode				
Low	2412	38.49	≥ 20	PASS
High	2462	43.37	≥ 20	PASS
N40 Mode				
Low	2422	27.63	≥ 20	PASS
High	2452	37.22	≥ 20	PASS
BLE(1M) Mode				
Low	2402	50.23	≥ 20	PASS
High	2480	51.39	≥ 20	PASS

Please refer to the following plots.

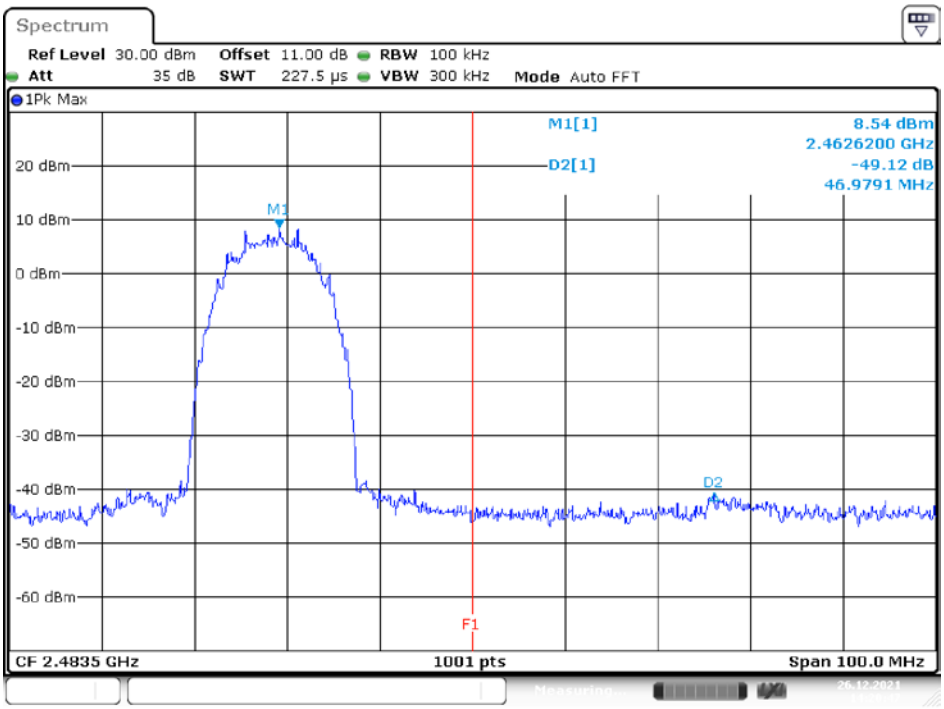
B Mode

Band Edge, Left Side



Date: 26.DEC.2021 14:11:02

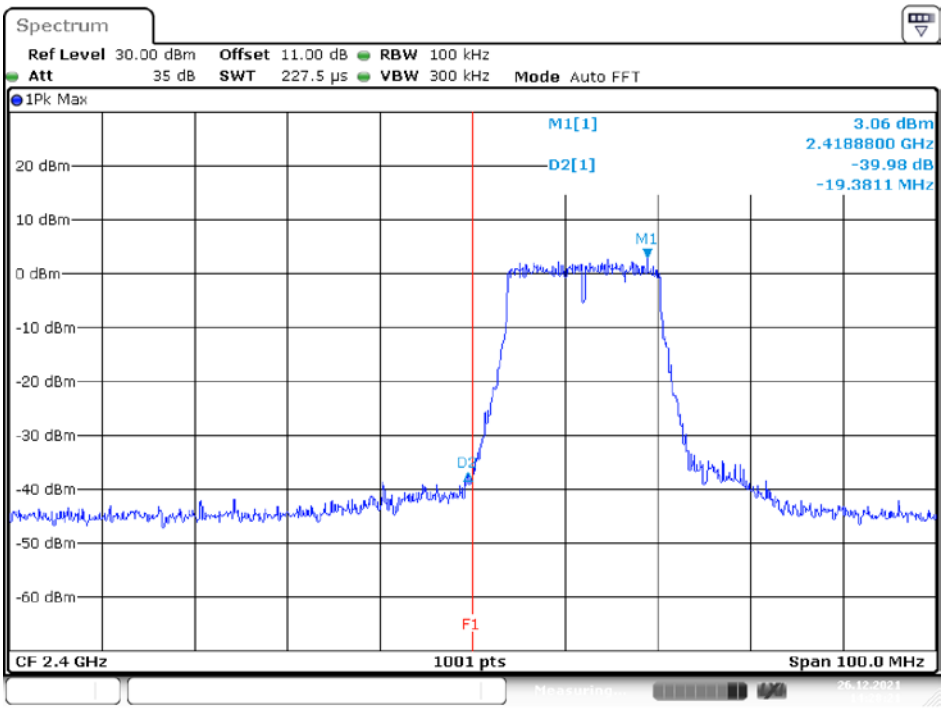
Band Edge, Right Side



Date: 26.DEC.2021 14:20:48

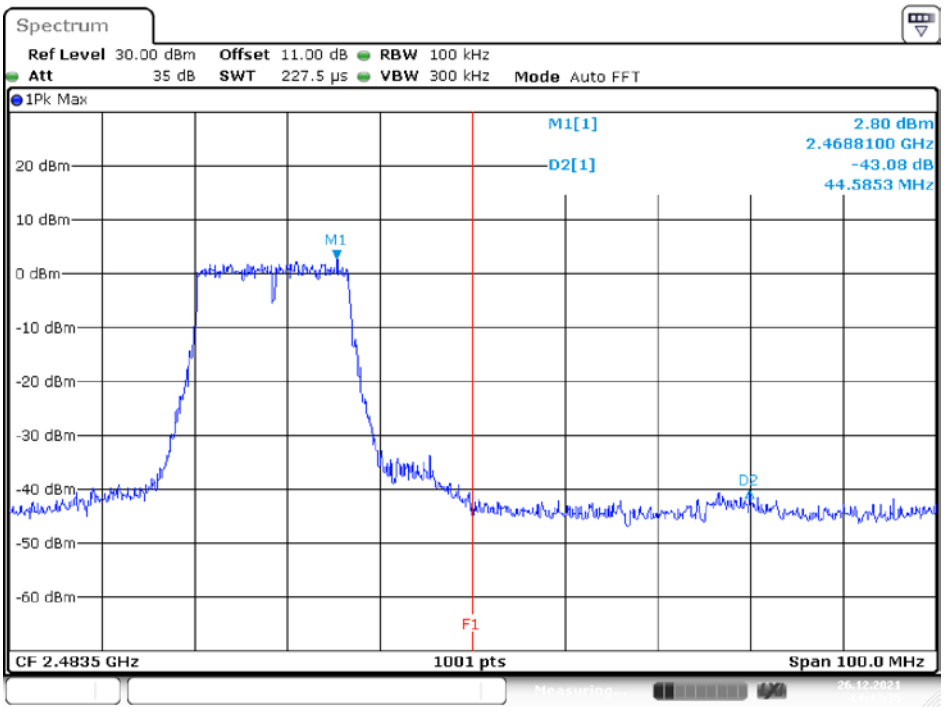
G Mode

Band Edge, Left Side



Date: 26.DEC.2021 14:28:22

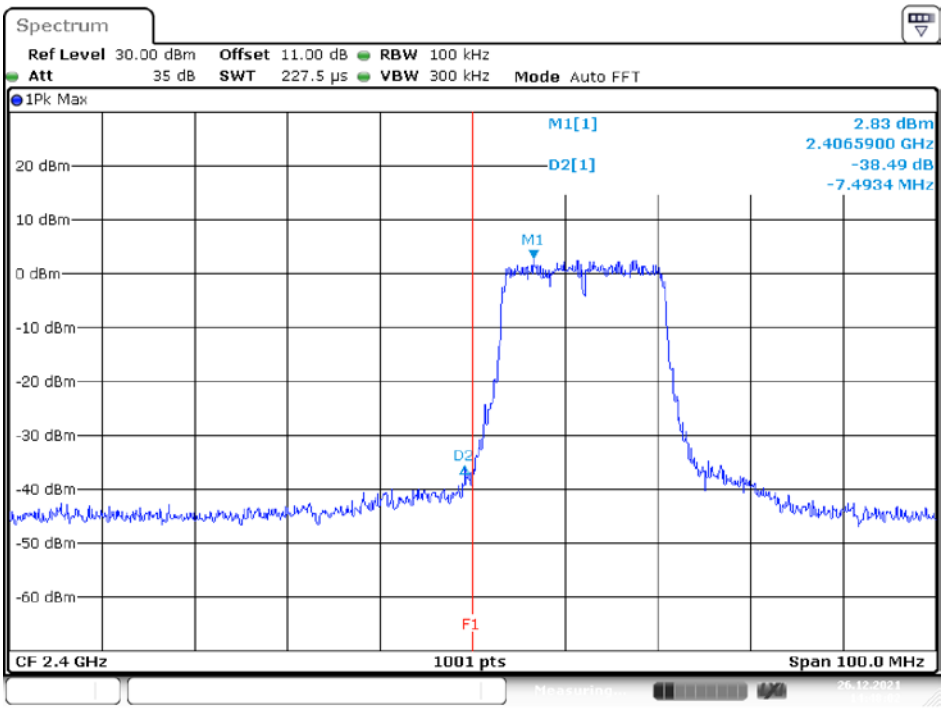
Band Edge, Right Side



Date: 26.DEC.2021 14:43:35

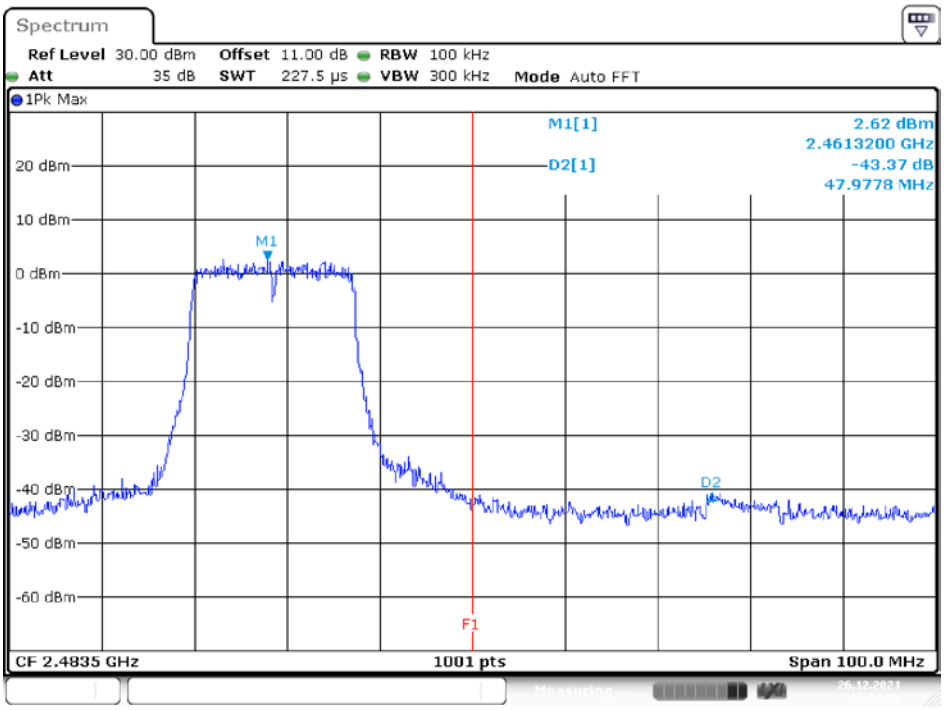
N20 Mode

Band Edge, Left Side



Date: 26.DEC.2021 14:48:02

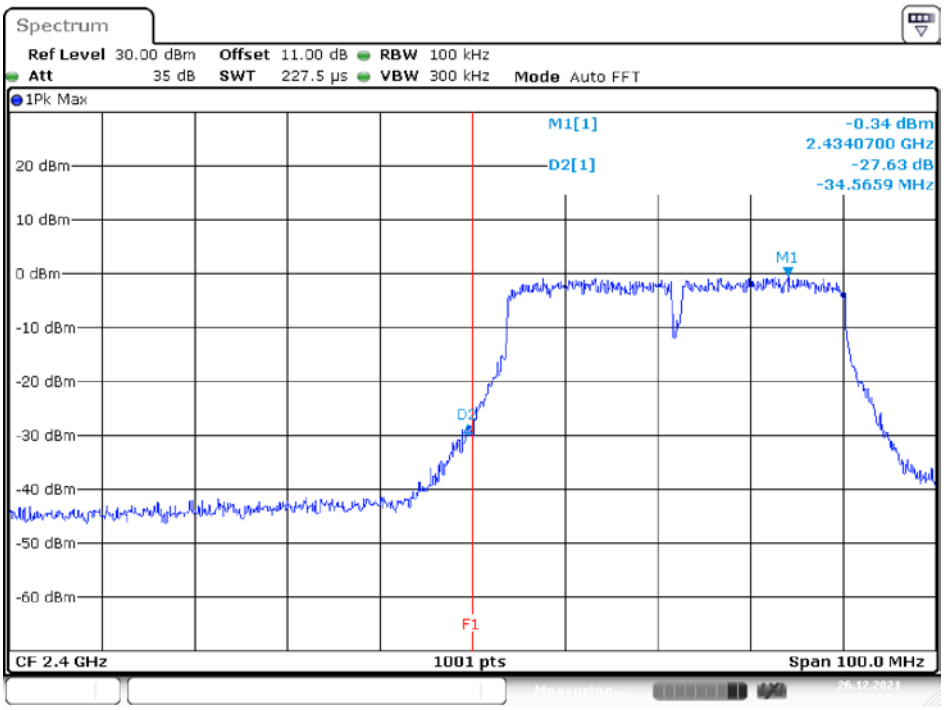
Band Edge, Right Side



Date: 26.DEC.2021 15:00:27

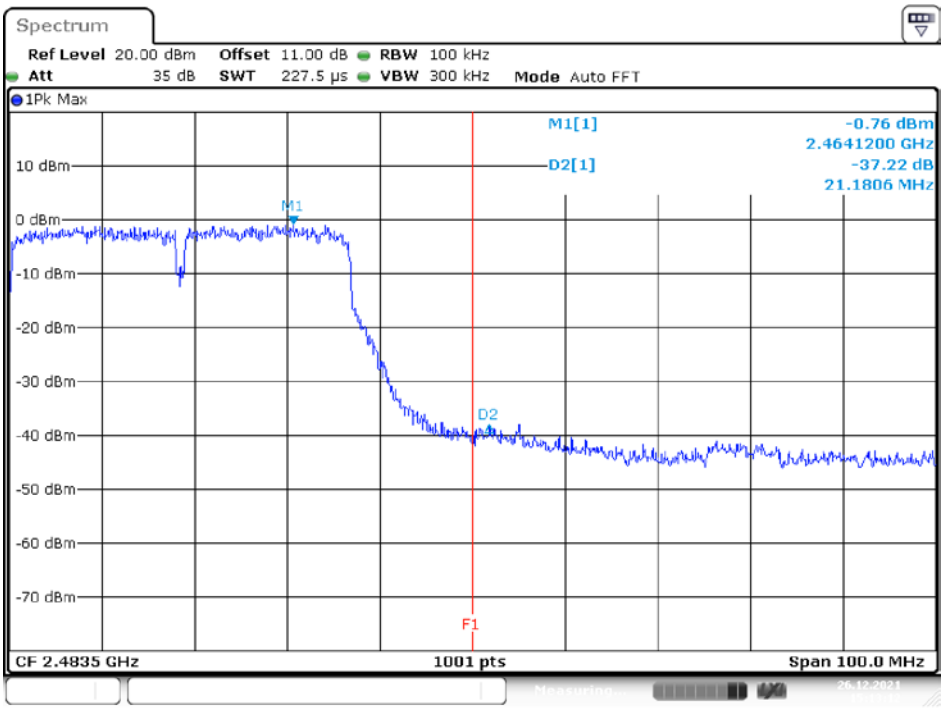
N40 Mode

Band Edge, Left Side



Date: 26.DEC.2021 15:03:52

Band Edge, Right Side



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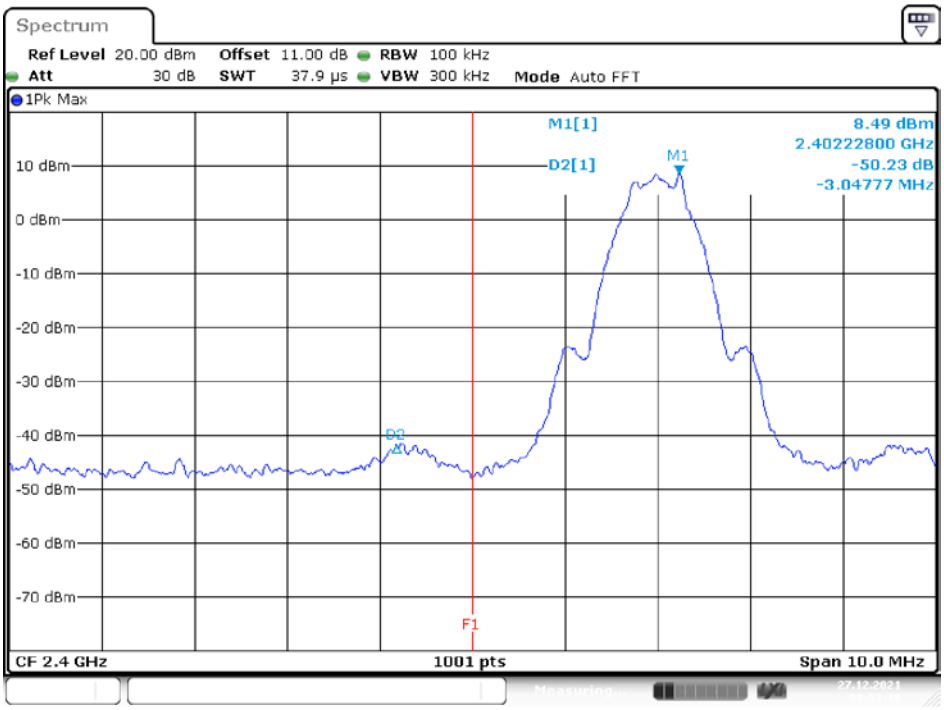
BLE(1M) Mode

Band Edge, Low Channel



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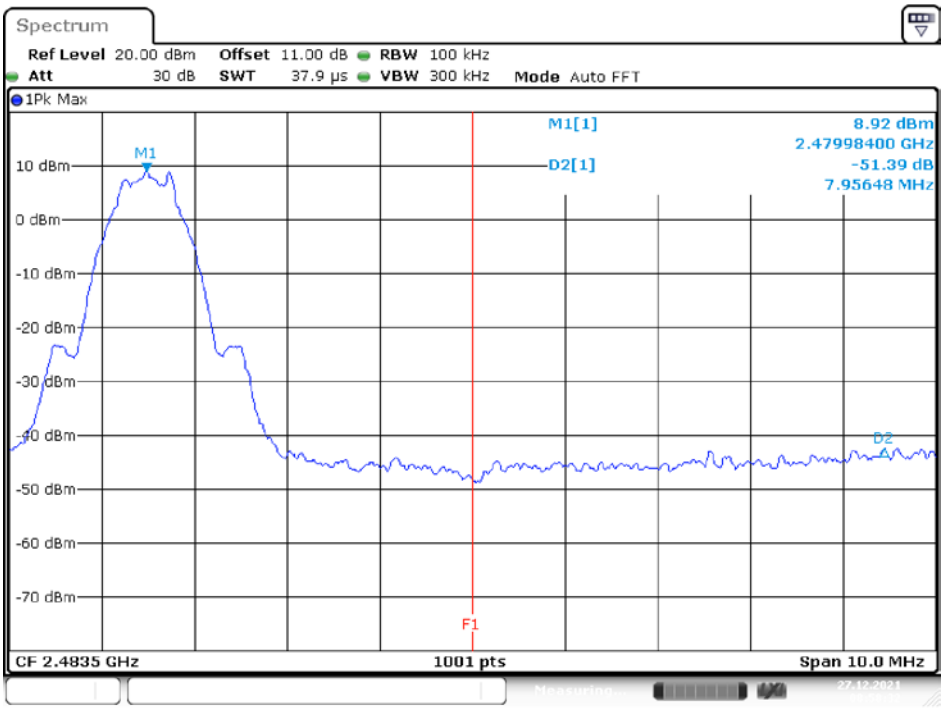
Band Edge, High Channel



Date: 27.DEC.2021 08:58:33

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

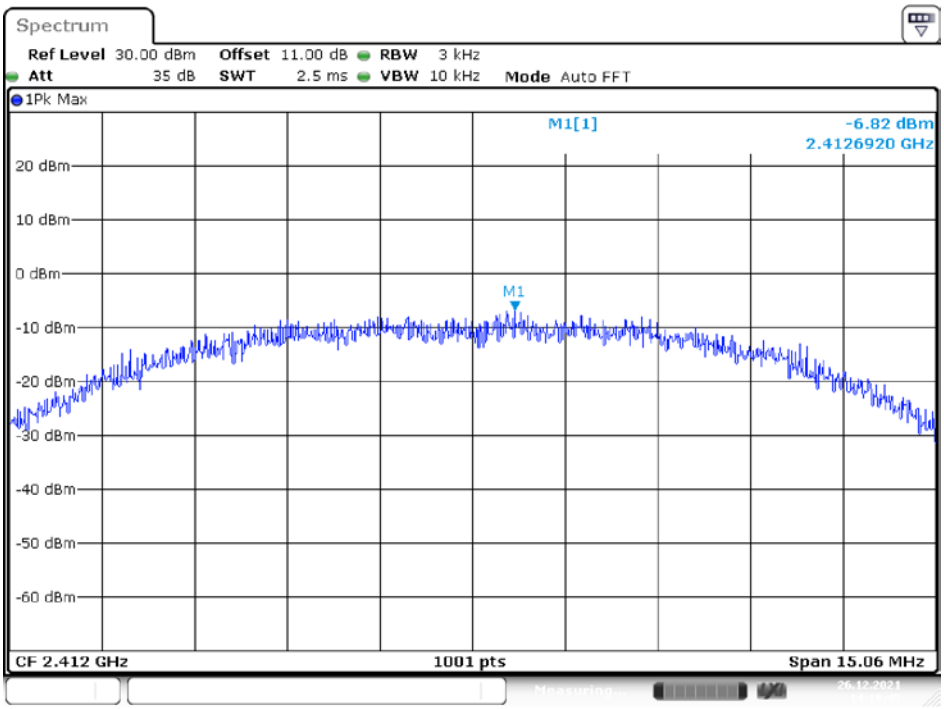
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
B Mode				
Low	2412	-6.82	8	PASS
Middle	2437	-6.88	8	PASS
High	2462	-6.95	8	PASS
G Mode				
Low	2412	-12.31	8	PASS
Middle	2437	-12.35	8	PASS
High	2462	-12.55	8	PASS
N20 Mode				
Low	2412	-11.64	8	PASS
Middle	2437	-11.67	8	PASS
High	2462	-11.82	8	PASS
N40 Mode				
Low	2422	-12.97	8	PASS
Middle	2437	-13.37	8	PASS
High	2452	-13.39	8	PASS
BLE(1M) Mode				
Low	2402	-6.93	8	PASS
Middle	2440	-6.40	8	PASS
High	2480	-6.45	8	PASS

Please refer to the following plots

B Mode

Low Channel



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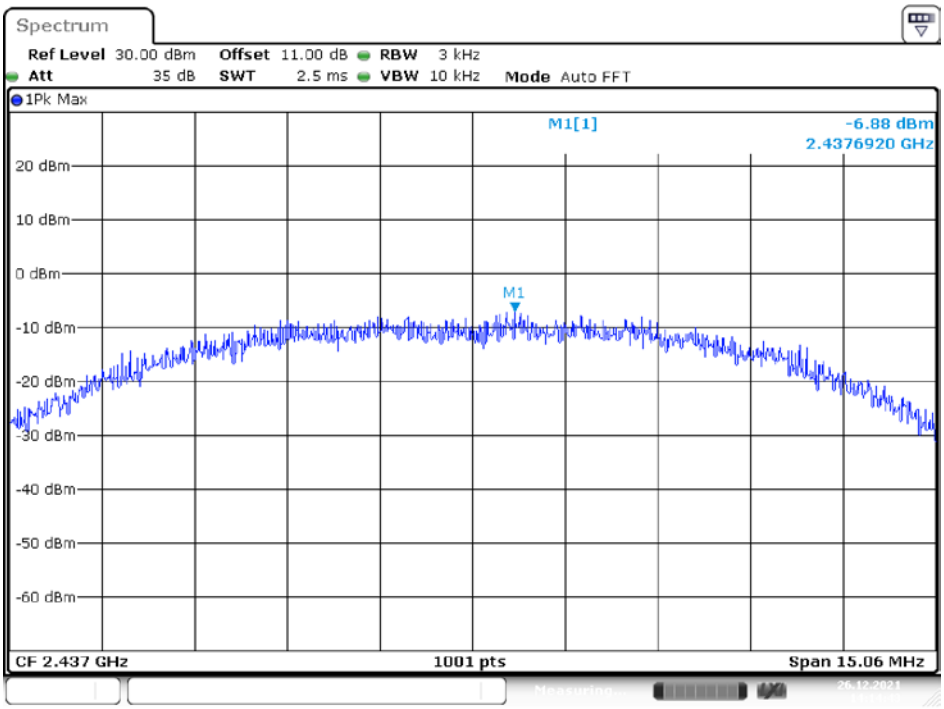
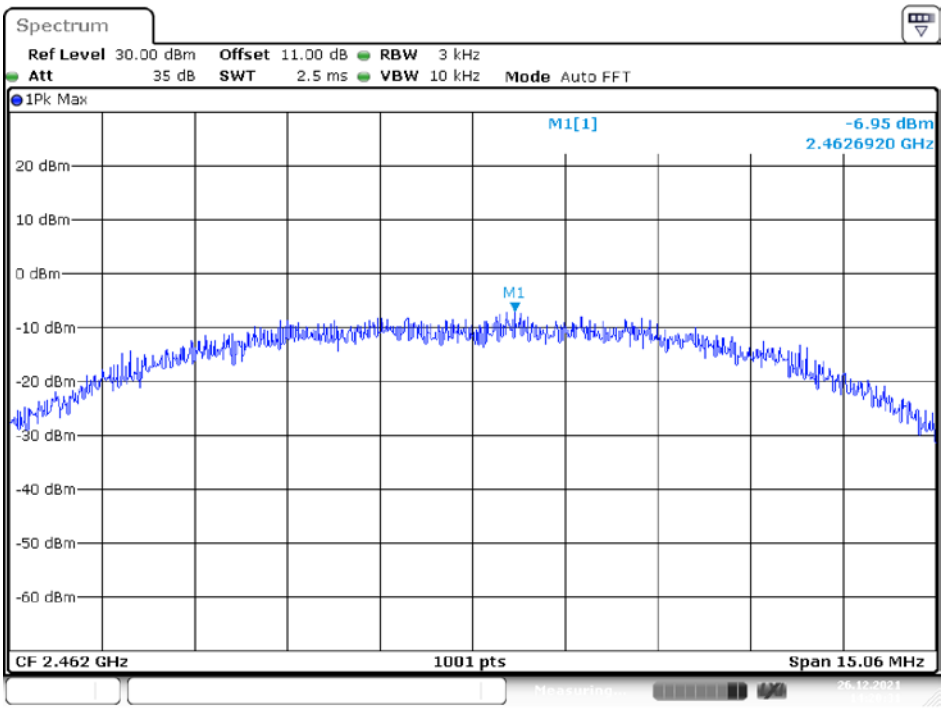
Middle Channel



Date: 26.DEC.2021 14:14:43

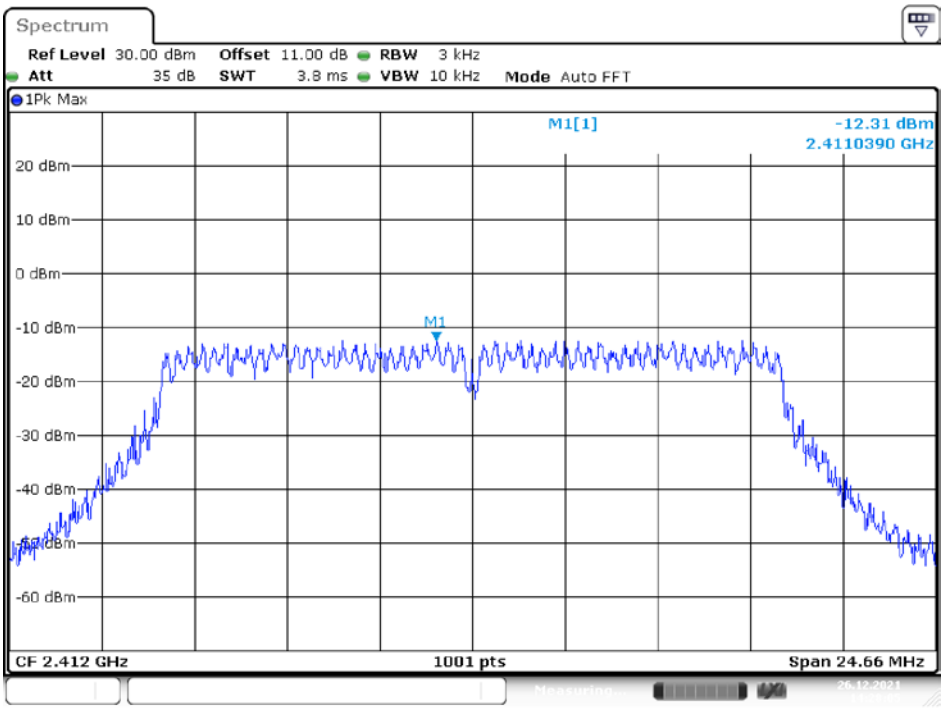
High Channel



Date: 26.DEC.2021 14:20:31

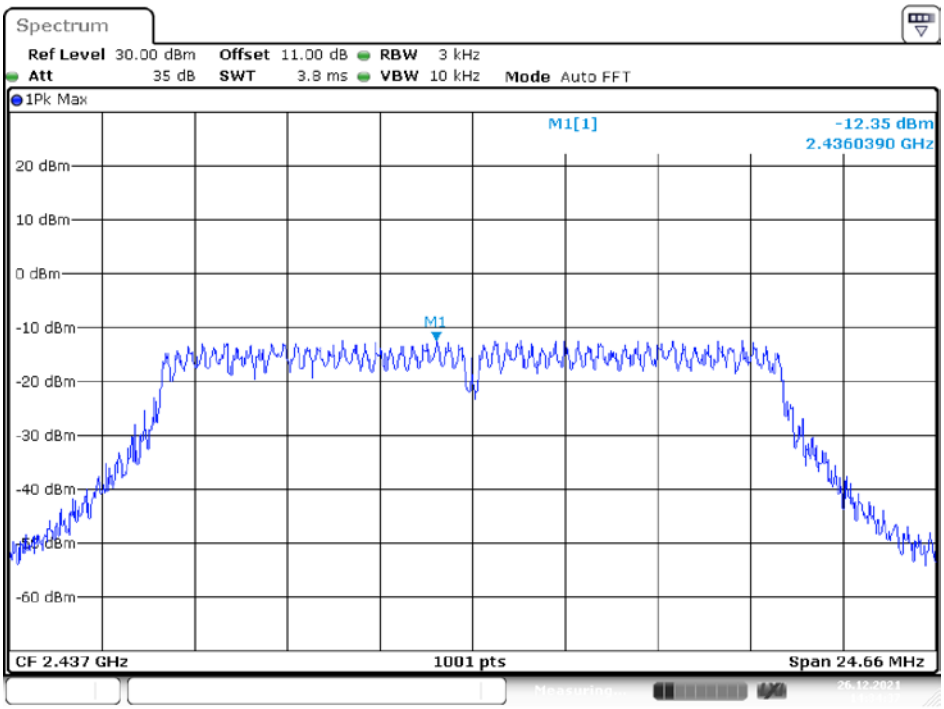
G Mode

Low Channel



Date: 26.DEC.2021 14:28:06

Middle Channel



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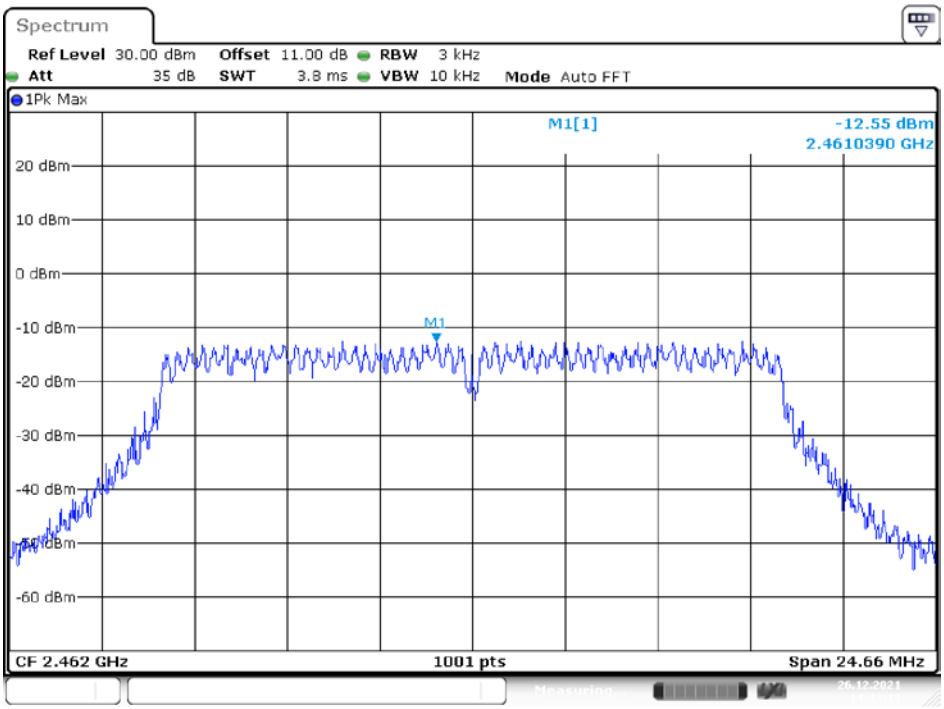
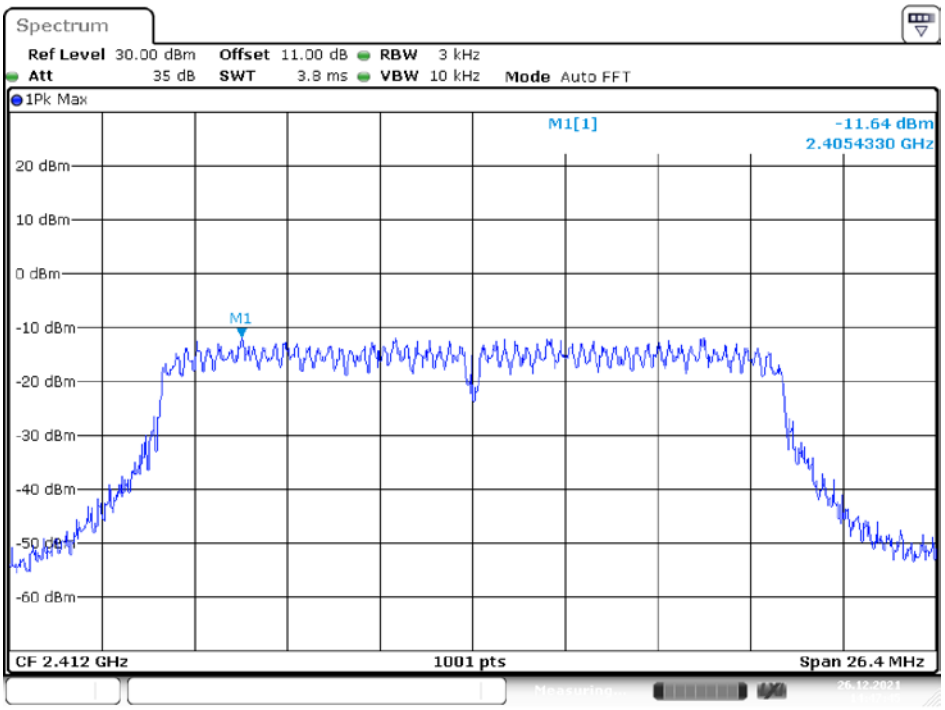
High Channel



Date: 26.DEC.2021 14:43:19

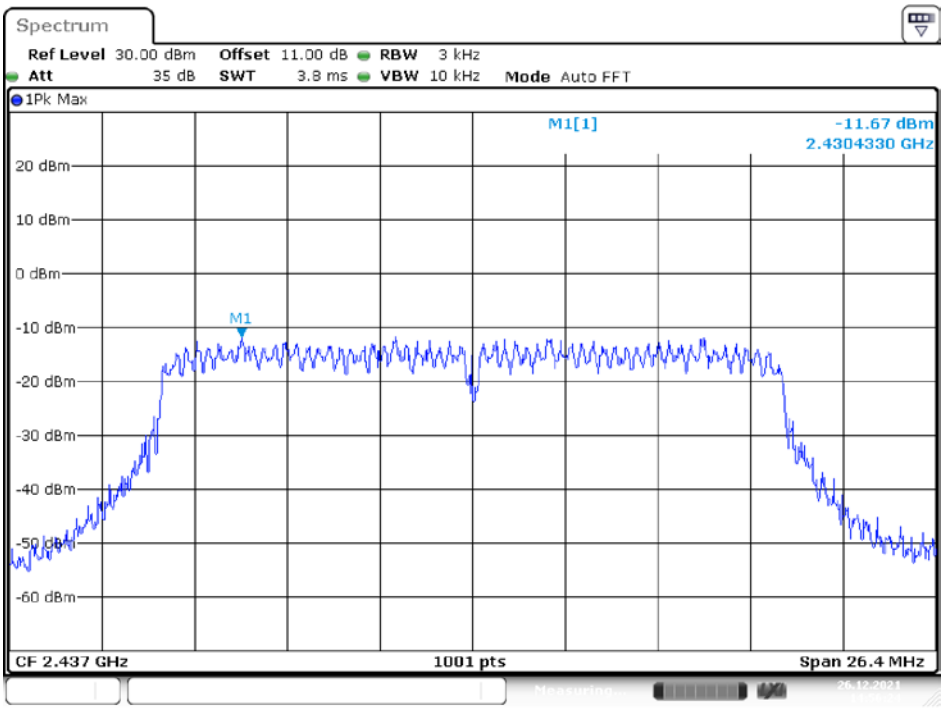
N20 Mode

Low Channel



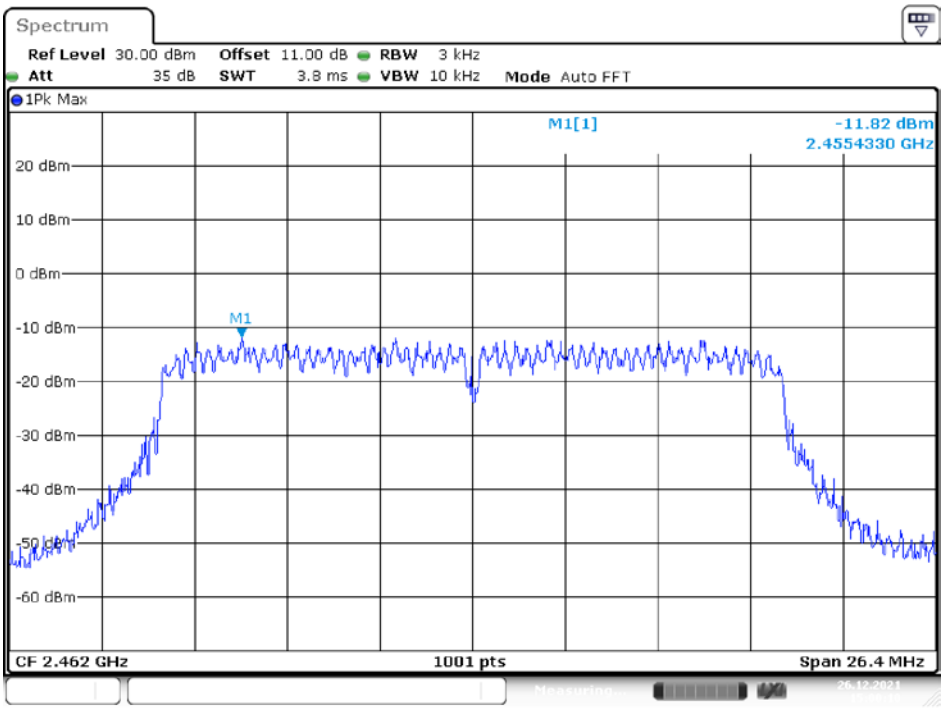
Date: 26.DEC.2021 14:47:46

Middle Channel



Date: 26.DEC.2021 14:56:24

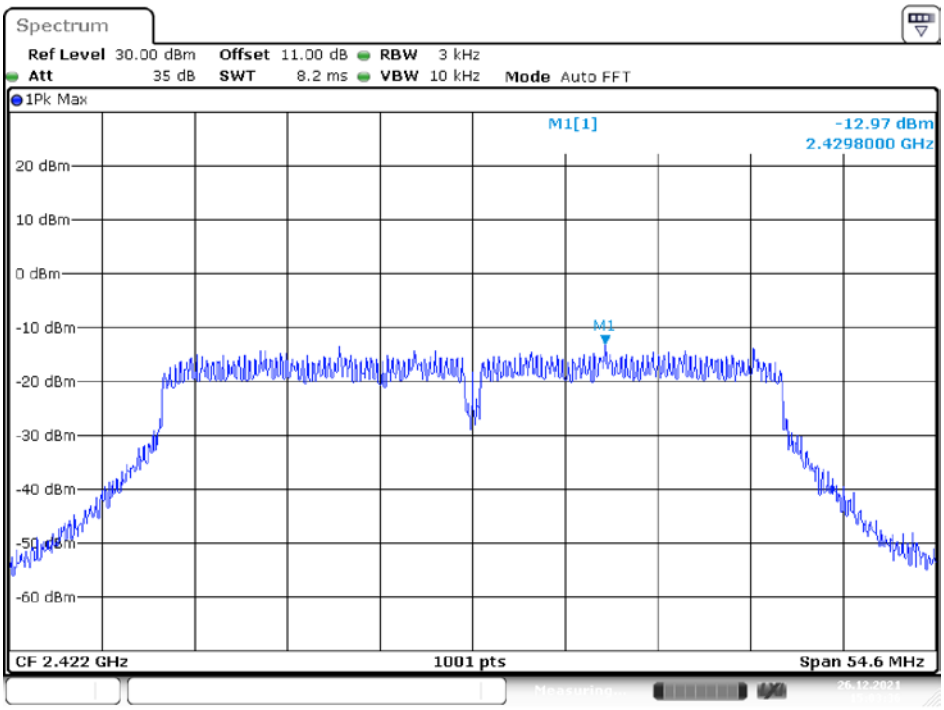
High Channel



Date: 26.DEC.2021 15:00:11

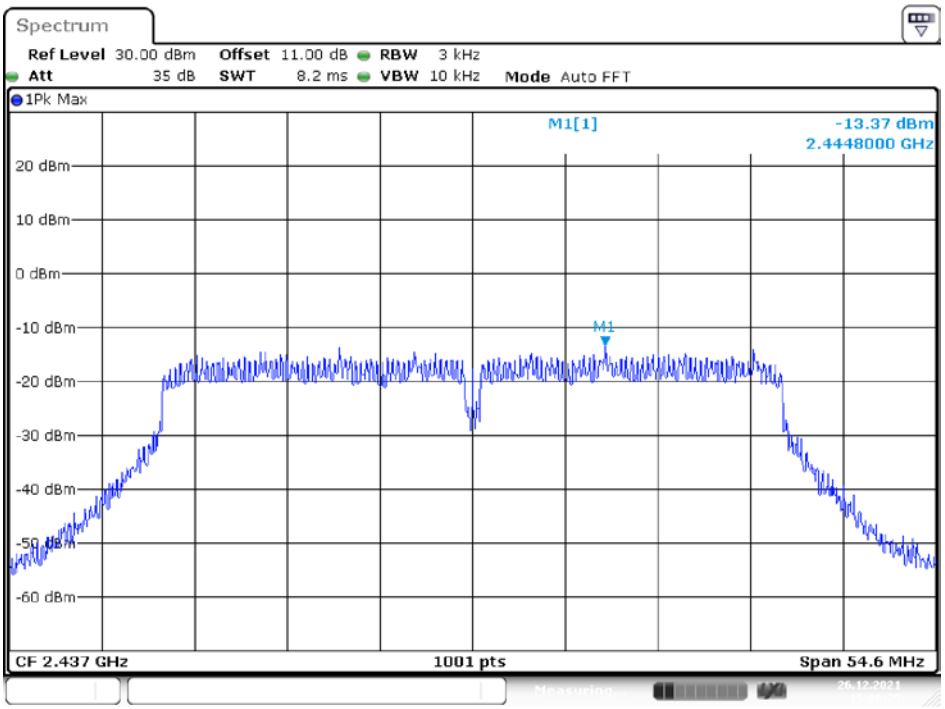
N40 Mode

Low Channel



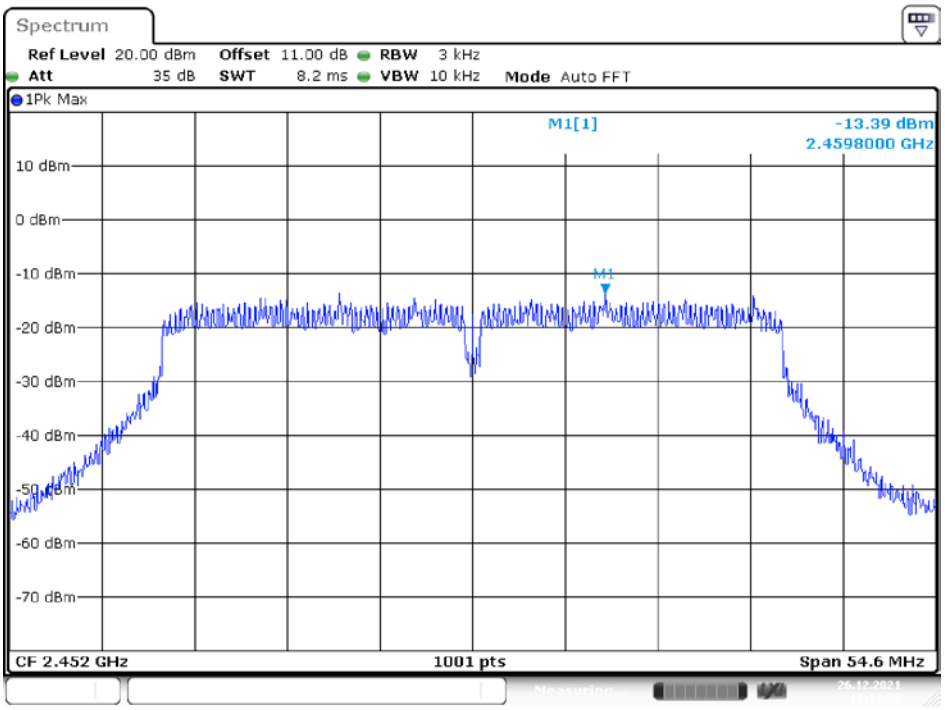
Date: 26.DEC.2021 15:03:36

Middle Channel



Date: 26.DEC.2021 15:06:25

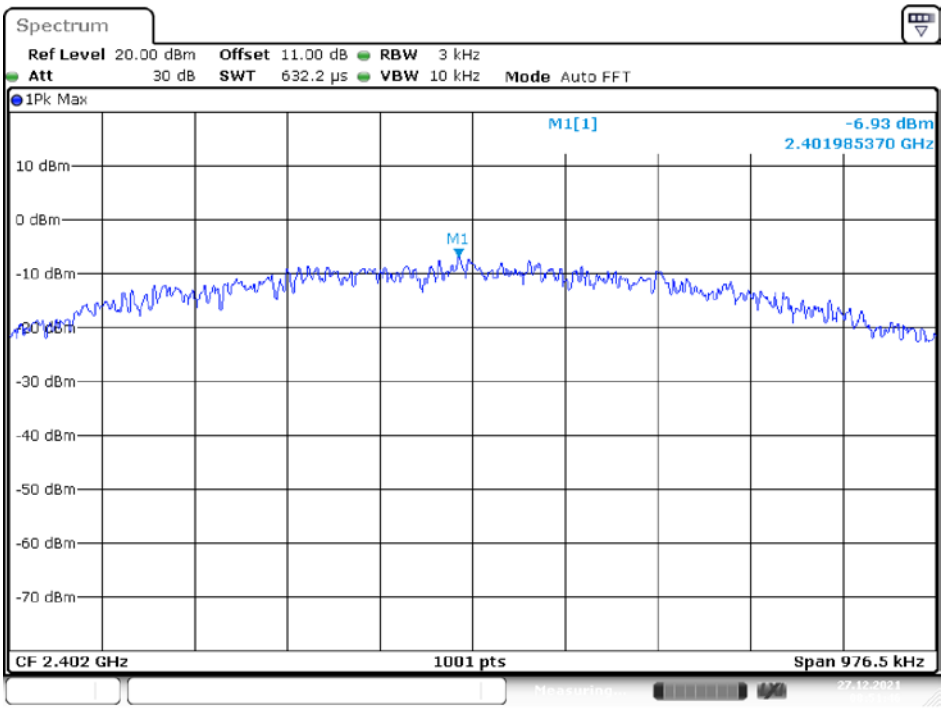
High Channel



Date: 26.DEC.2021 15:12:56

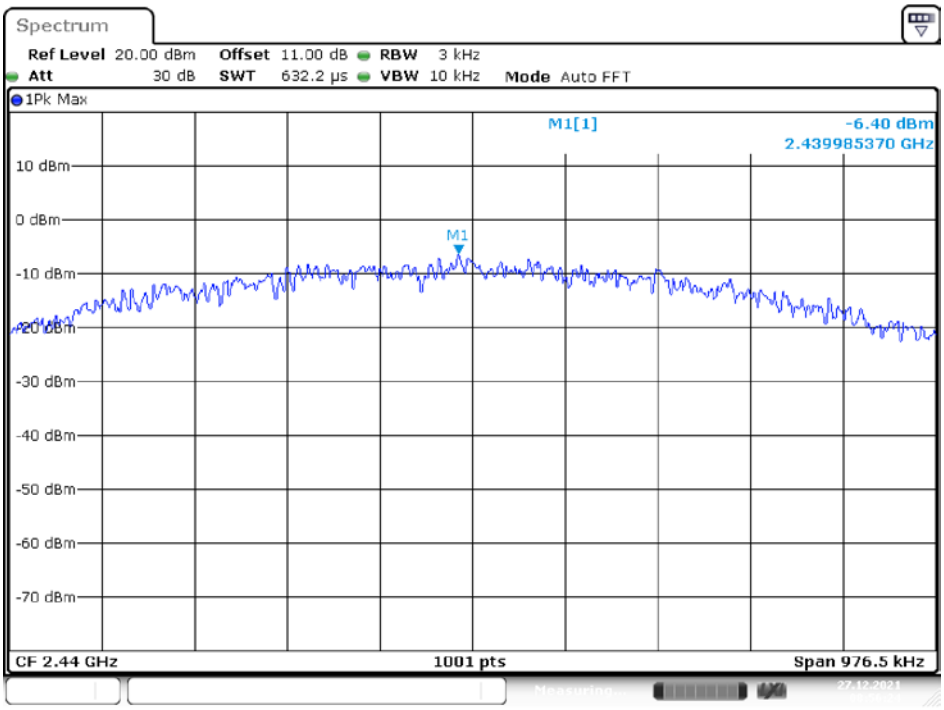
BLE(1M) Mode

Low Channel



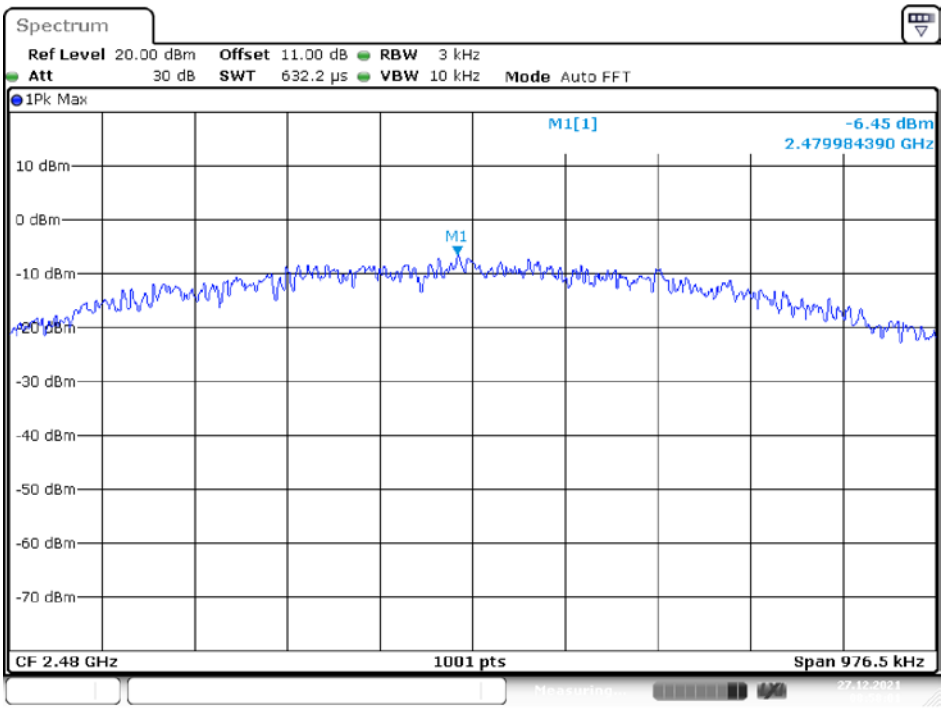
Date: 27.DEC.2021 08:51:47

Middle Channel



Date: 27.DEC.2021 08:56:23

High Channel



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