FCC Part 15.247

TEST REPORT

For

ATEN Technology, Inc., dba IOGEAR

15365 Barranca Parkway Irvine, CA 92618, USA

FCC ID: QLEGBU621

Report Type: Original Report	**Product Type:** Micro USB Bluetooth 5.1 Transmitter

Report Producer : Eva Kao

Report Number : RXZ211207001RF01

Report Date : 2022-04-19

Reviewed By: David Hsu David.Hsu

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ211207001	RXZ211207001RF01	2022-04-19	Original Report	Eva Kao

TABLE OF CONTENTS

1 General Information

1.1 Product Description for Equipment under Test (EUT)

Manufacturer	ATEN Technology, Inc., dba IOGEAR
	15365 Barranca Parkway Irvine, CA 92618, USA
Brand(Trade) Name	IOGEAR
Product (Equipment)	Micro USB Bluetooth 5.1 Transmitter
Main Model Name	GBU621
Series model	GBU621W6, GBU621X, GBU621B, GBU621W3
Model Discrepancy	The major electrical and mechanical constructions of series models are identical to the basic model, the difference is Market Segmentation. The model, GBU621 is the testing sample, and the final test data are shown on this test report.
Frequency Range	2402 ~ 2480 MHz
Transmit Power	BLE(1M) Mode : 5.91 dBm BLE(2M) Mode : 5.71dBm
Modulation Technique	BLE(1M) / BLE(2M) : GFSK
Channel Separation	BLE(1M) / BLE(2M) : 2 MHz
Power Operation (Voltage Range)	DC 5V from USB Port
Received Date	Jan. 28, 2022
Date of Test	Feb. 10, 2022 ~ Feb. 25, 2022

*All measurement and test data in this report was gathered from production sample serial number: RXZ211207001-01 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

This report is prepared on behalf of ***ATEN Technology, Inc., dba IOGEAR*** in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.
The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS Submittal with FCC ID: QLEGBU621

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.
558074 D01 15.247 Meas Guidance v05r02

1.5 Statement

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

It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory).
Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.
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 Date	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2022/2/25	18.7	69	1010	Aaron
Radiation Spurious Emissions	2022/2/18~2022/2/25	17.2-20.2	71-77	1010	David Lee
Conducted Spurious Emissions	2022/2/10	21	56	1010	Aaron
6 dB Emission Bandwidth	2022/2/10	21	56	1010	Aaron
Maximum Output Power	2022/2/10	21	56	1010	Aaron
100 kHz Bandwidth of Frequency Band Edge	2022/2/10	21	56	1010	Aaron
Power Spectral Density	2022/2/10	21	56	1010	Aaron

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. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10.

2 System Test Configuration

2.1 Description of Test Configuration

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 "RTLBTAPP V5.2.2.54 "

Test Frequency		Low	Mid	High
Power Level Setting	BLE 1M	Default	Default	Default
	BLE 2M	Default	Default	Default

2.4 Support Equipment List and Details

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

2.5 External Cable List and Details

Cable Description	Length (m)	From	To
N/A	N/A	N/A	N/A

2.6 Test Mode

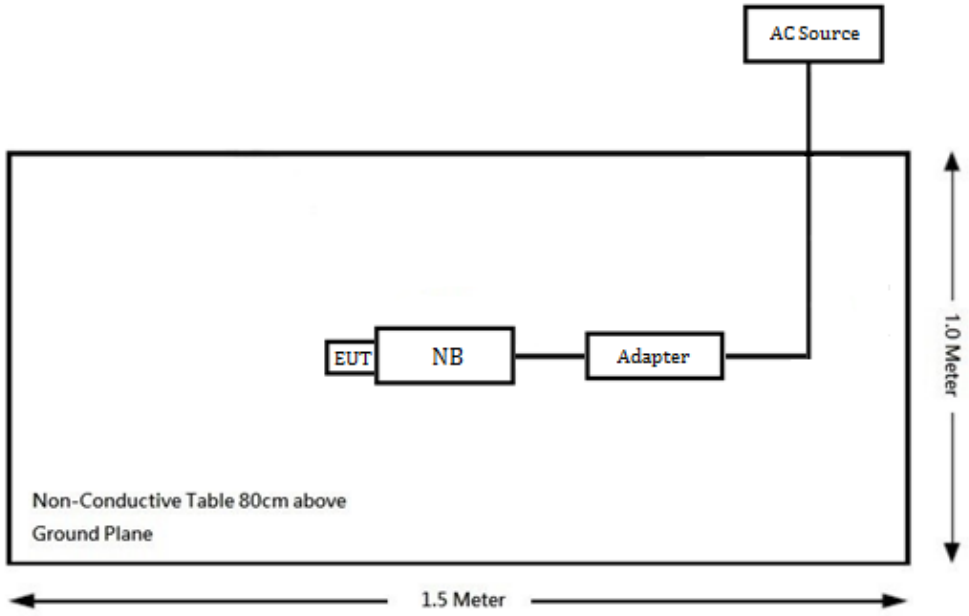
Full System (model: GBU621) for all test item.

2.7 Block Diagram of Test Setup

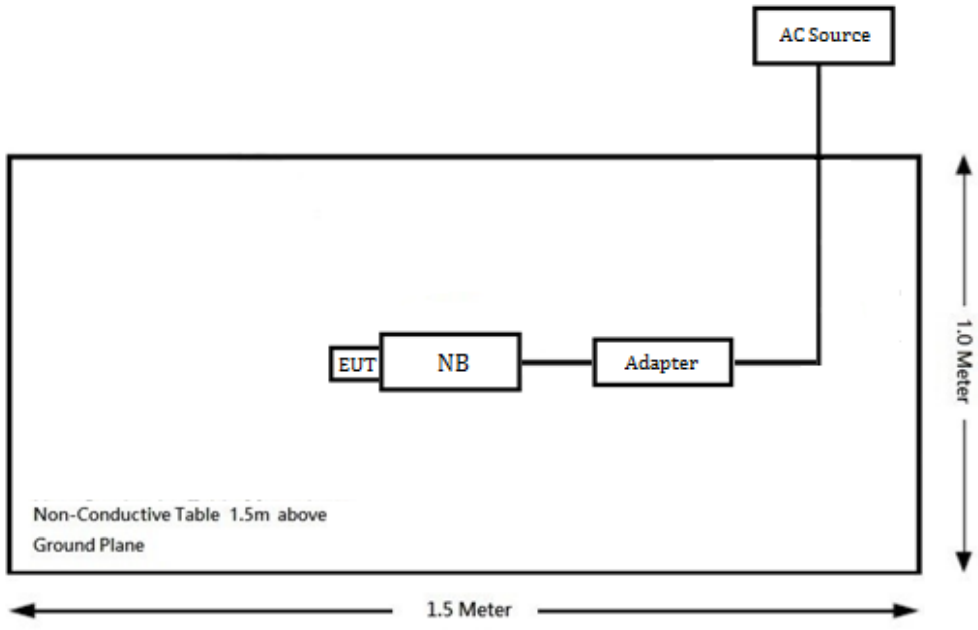
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

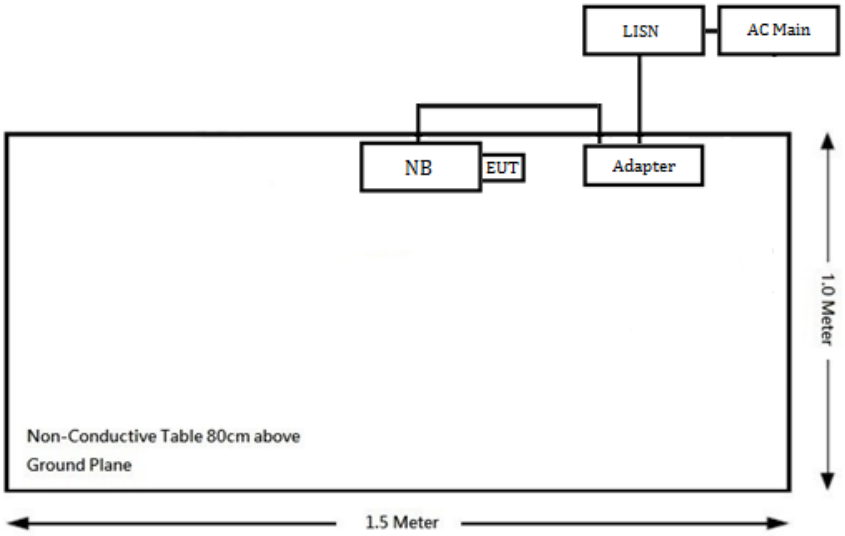
Below 1GHz:



Above 1GHz:



Conduction:



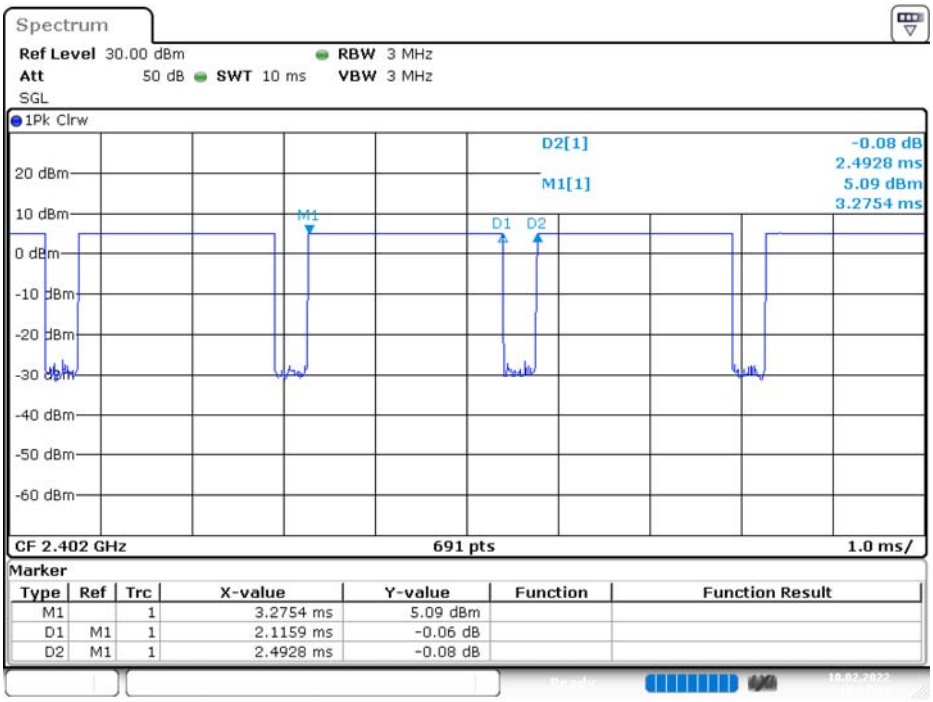
2.8 Duty Cycle

The duty cycle as below:

Radio Mode	T_{on} (ms)	$T_{on}+T_{off}$ (ms)	Duty Cycle (%)
BLE 1M	2.1159	2.4928	0.85
BLE 2M	1.0725	1.8696	0.57

Please refer to the following plots.

BLE(1M) Mode



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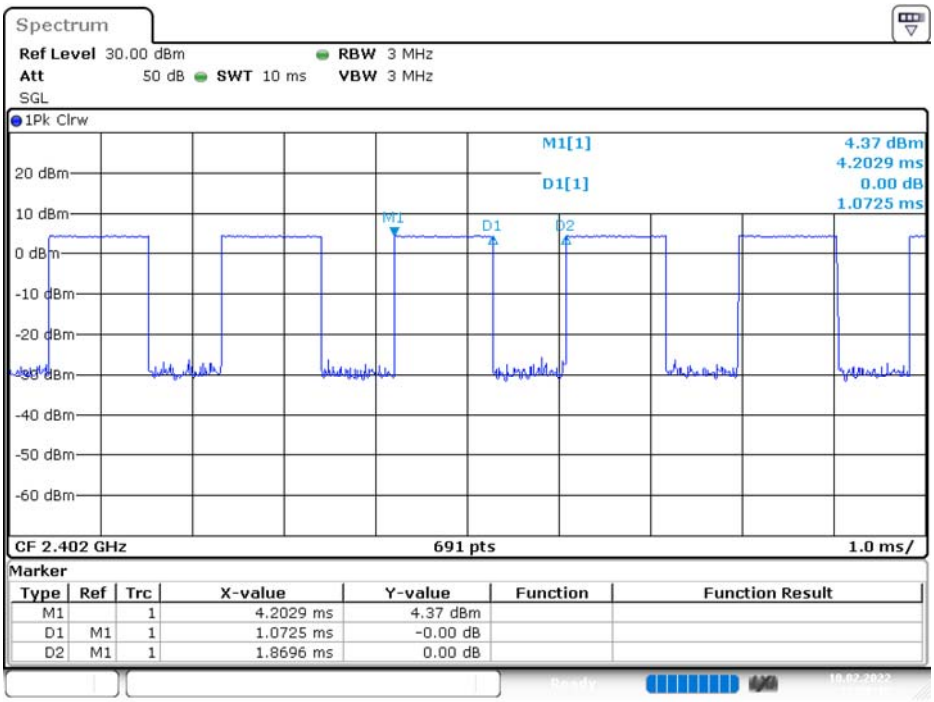
BLE(2M) Mode



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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	101612	2022/1/10	2023/1/09
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
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

***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)] •

[$\sqrt{}$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	Tunp-up Power		Evaluation Distrance	Calculated Value	Threshold	SAR Test Exclusion
	(MHz)	(dBm)	(mW)	(mm)		(1-g SAR)	
BT	2402-2480	9.5	8.9	5	2.8	3	Yes
BLE	2402-2480	6	4.0	5	1.3	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 Information

Manufacturer	Model	Type	Antenna Gain
CC&C Technologies, Inc.	BT-330S-V2	Printed Antenna	-4.10 dBi

Result: Compliance

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

7.1 Applicable Standard

According to §15.207

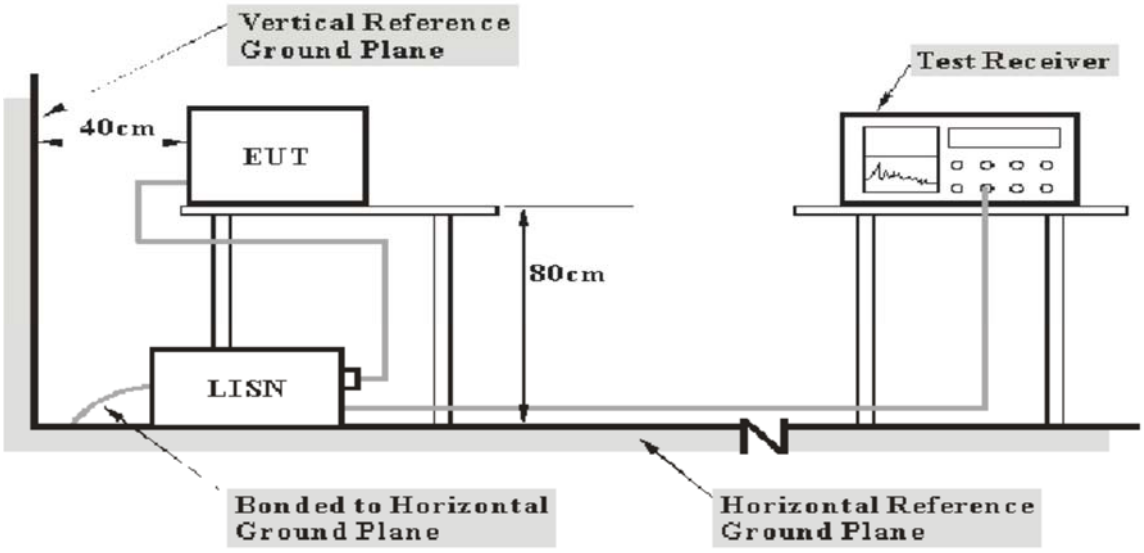
For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured 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 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

Note 2: A linear average detector is required

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

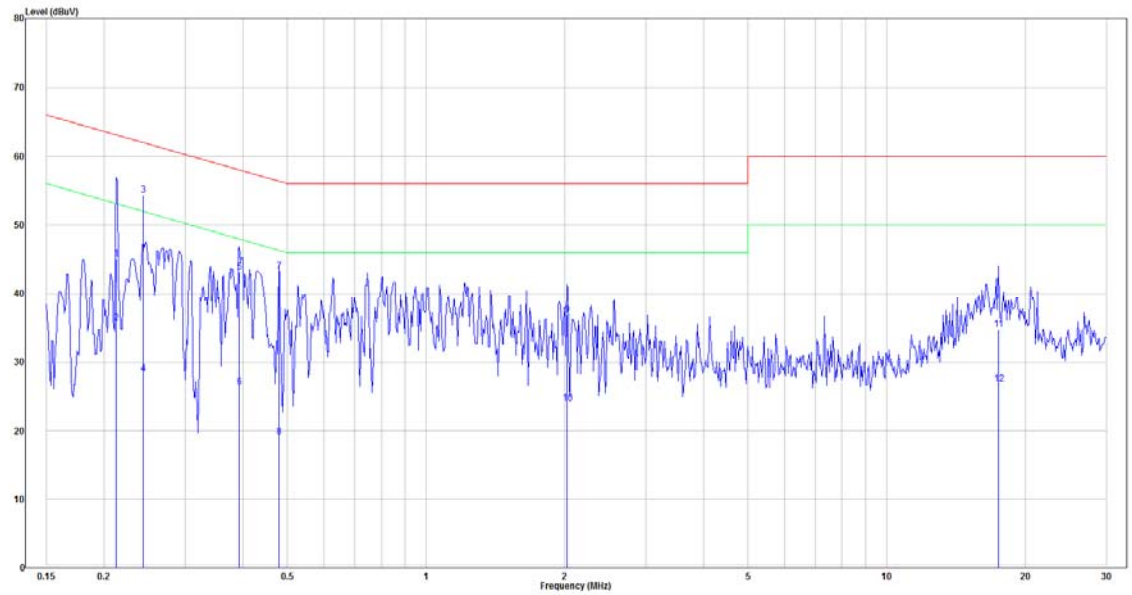
The “Over Limit” column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

Over Limit = Level – Limit Line

7.6 Test Results

Test Mode: Transmitting

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark	Phase
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)		
1	0.213	25.56	19.50	45.06	63.10	-18.04	QP	Line
2	0.213	16.06	19.50	35.56	53.10	-17.54	Average	Line
3	0.243	34.81	19.50	54.32	62.00	-7.68	QP	Line
4	0.243	8.74	19.50	28.24	52.00	-23.75	Average	Line
5	0.393	23.67	19.51	43.19	57.99	-14.80	QP	Line
6	0.393	6.82	19.51	26.34	47.99	-21.65	Average	Line
7	0.479	23.76	19.52	43.28	56.36	-13.08	QP	Line
8	0.479	-0.46	19.52	19.06	46.36	-27.30	Average	Line
9	2.023	17.24	19.58	36.82	56.00	-19.18	QP	Line
10	2.023	4.39	19.58	23.97	46.00	-22.03	Average	Line
11	17.475	14.83	19.80	34.64	60.00	-25.36	QP	Line
12	17.475	6.98	19.80	26.79	50.00	-23.21	Average	Line

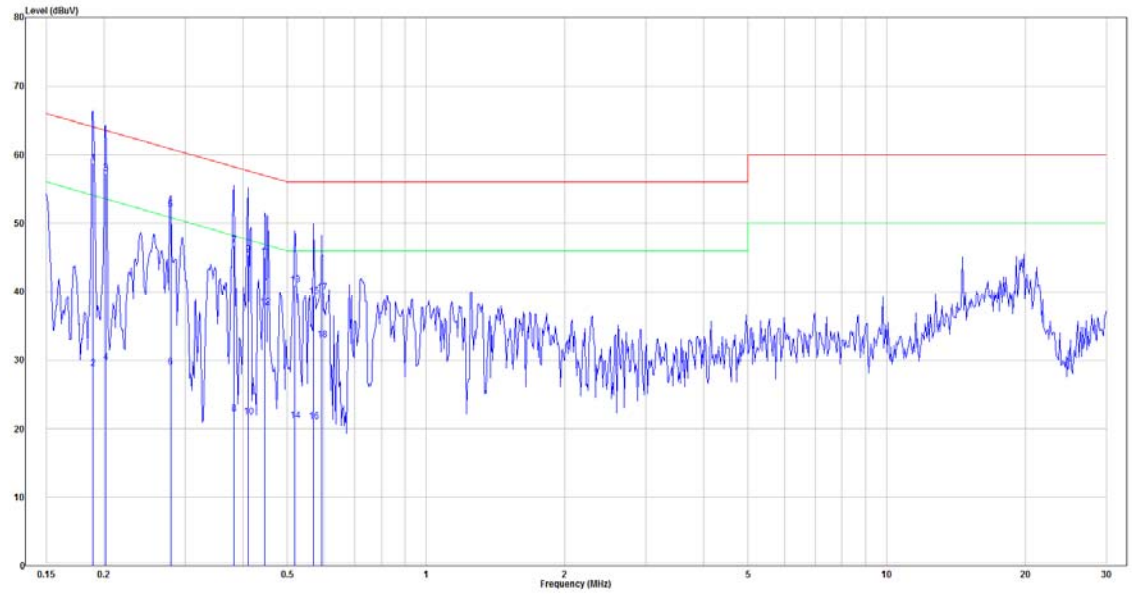
Note:

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	Phase
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)		
1	0.189	39.29	19.49	58.78	64.06	-5.28	QP	Neutral
2	0.189	9.20	19.49	28.69	54.06	-25.37	Average	Neutral
3	0.202	37.77	19.49	57.26	63.54	-6.28	QP	Neutral
4	0.202	10.07	19.49	29.56	53.54	-23.98	Average	Neutral
5	0.279	32.51	19.50	52.01	60.85	-8.84	QP	Neutral
6	0.279	9.46	19.50	28.96	50.85	-21.89	Average	Neutral
7	0.383	27.28	19.51	46.79	58.21	-11.42	QP	Neutral
8	0.383	2.63	19.51	22.14	48.21	-26.07	Average	Neutral
9	0.410	25.96	19.51	45.47	57.64	-12.17	QP	Neutral
10	0.410	2.20	19.51	21.71	47.64	-25.93	Average	Neutral
11	0.447	25.57	19.52	45.08	56.93	-11.85	QP	Neutral
12	0.447	18.14	19.52	37.65	46.93	-9.28	Average	Neutral
13	0.518	21.50	19.52	41.02	56.00	-14.98	QP	Neutral
14	0.518	1.57	19.52	21.09	46.00	-24.91	Average	Neutral
15	0.570	19.82	19.52	39.35	56.00	-16.65	QP	Neutral
16	0.570	1.50	19.52	21.02	46.00	-24.98	Average	Neutral
17	0.595	20.37	19.52	39.89	56.00	-16.11	QP	Neutral
18	0.595	13.33	19.52	32.86	46.00	-13.14	Average	Neutral

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:

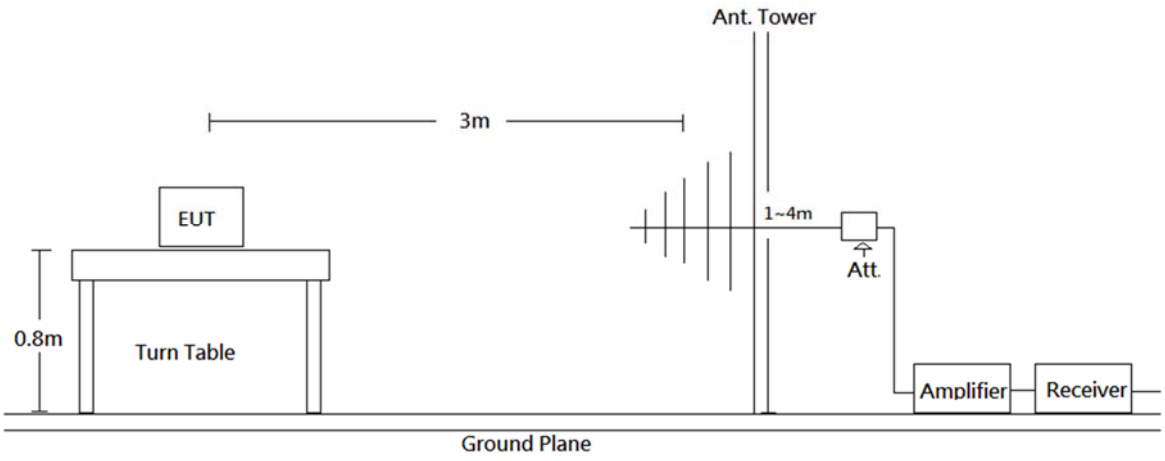
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** 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.

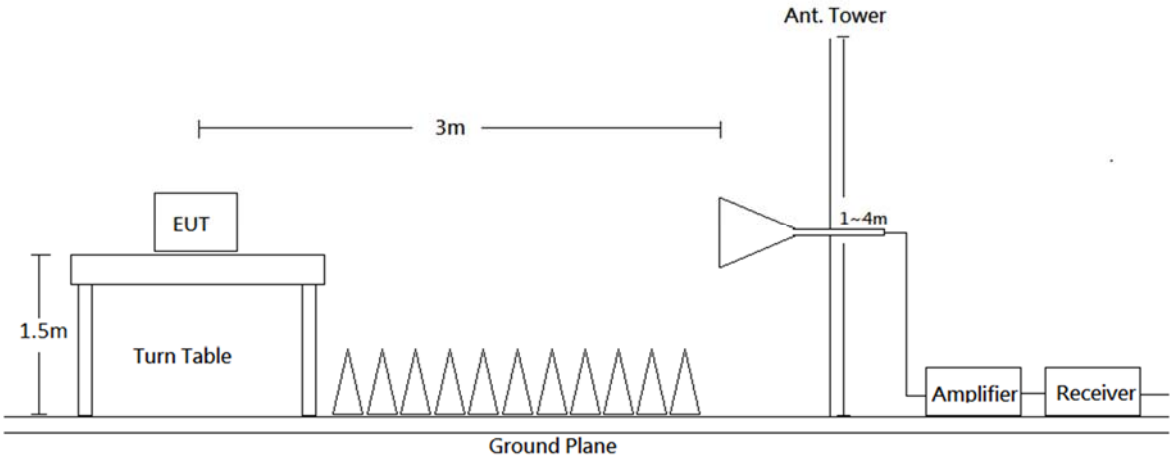
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the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

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:

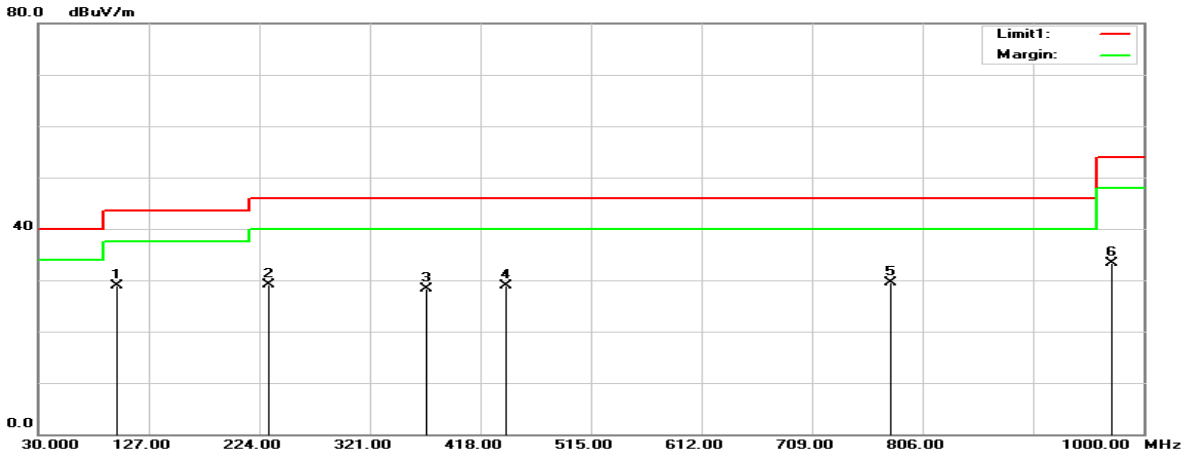
Margin = Result – Limit

8.6 Test Results

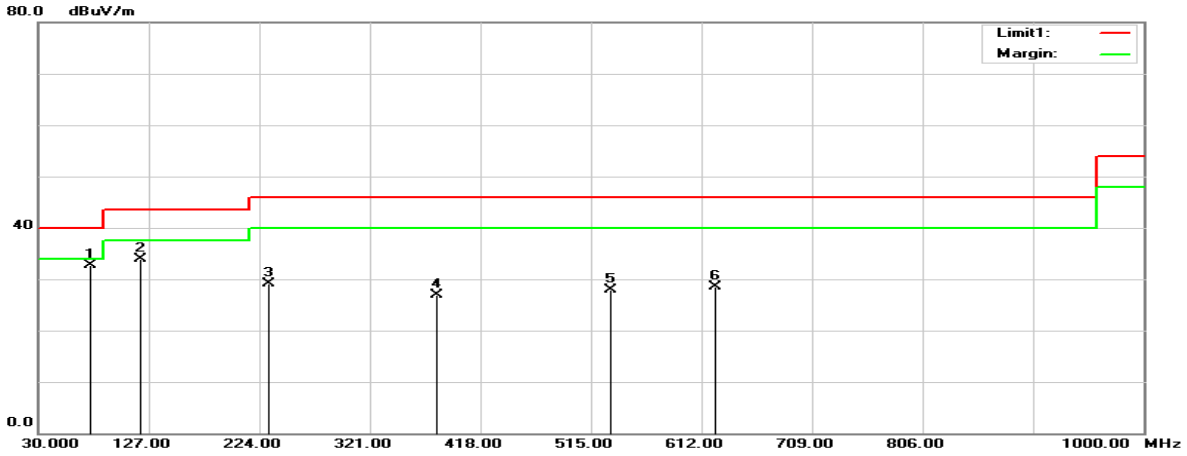
Test Mode: Transmitting (Pre-scan with three orthogonal axis, and worse case as X axis.)

30MHz-1GHz: (worst case is BLE 1M mode)

Horizontal



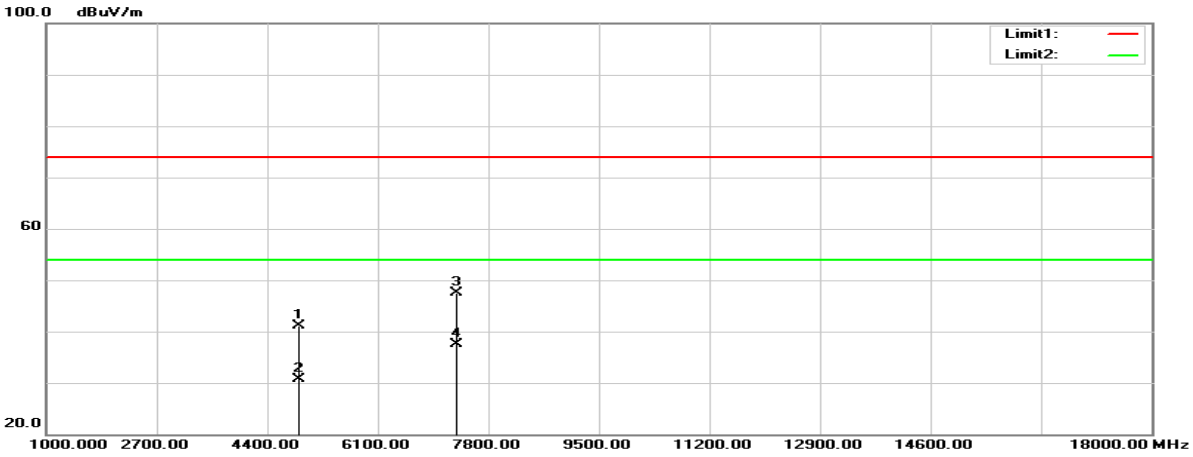
Vertical



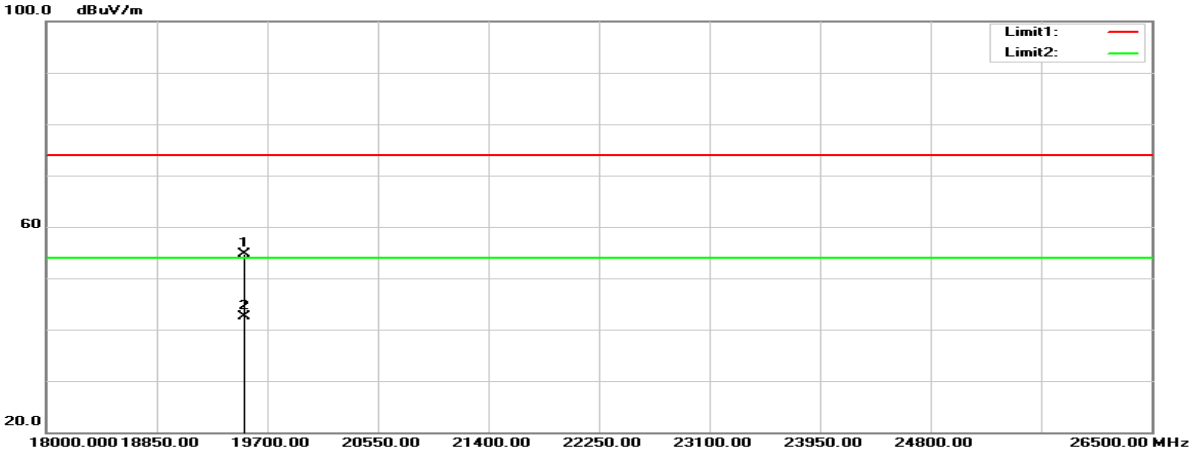
BLE (1M) Mode (Pre-scan with three orthogonal axis, and worse case as X axis.)

Horizontal (worst case is Middle channel)

1GHz-18GHz:

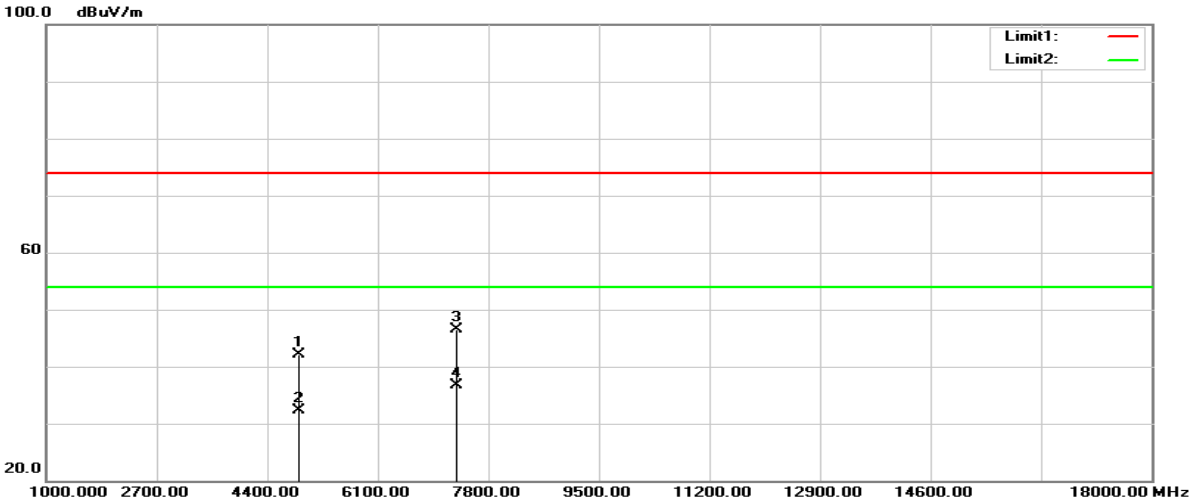


18GHz-26.5GHz:

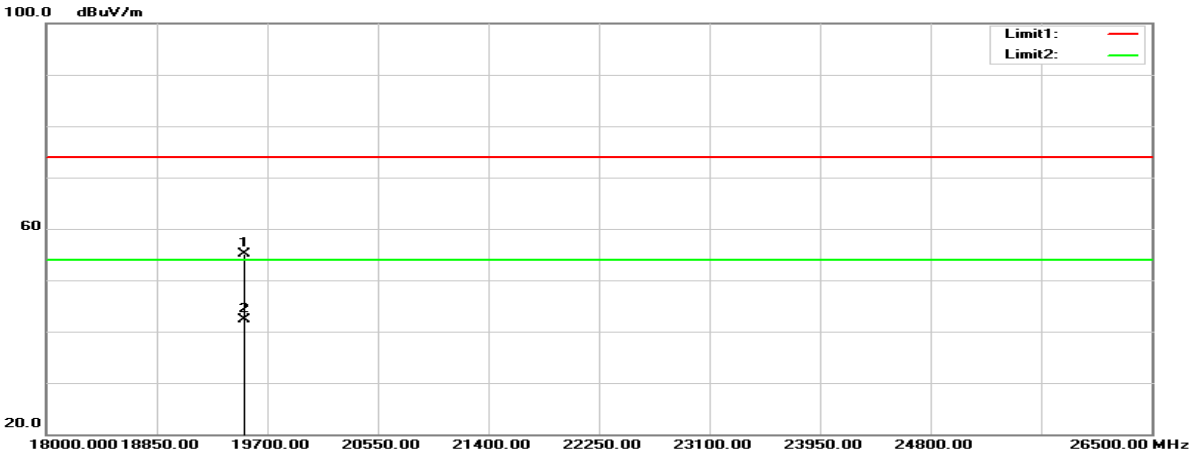


Vertical

1GHz-18GHz:



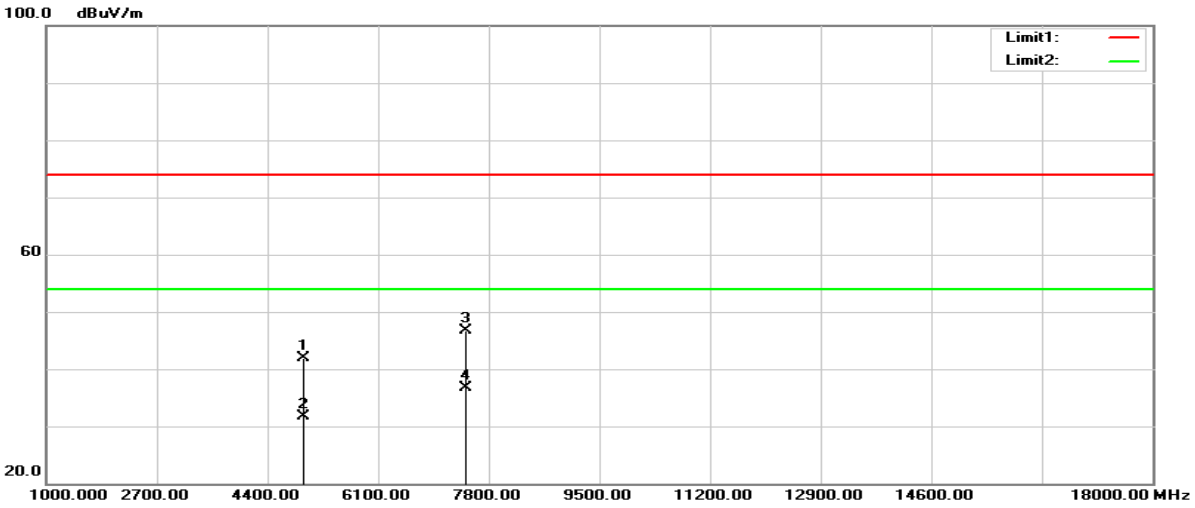
18GHz-26.5GHz:



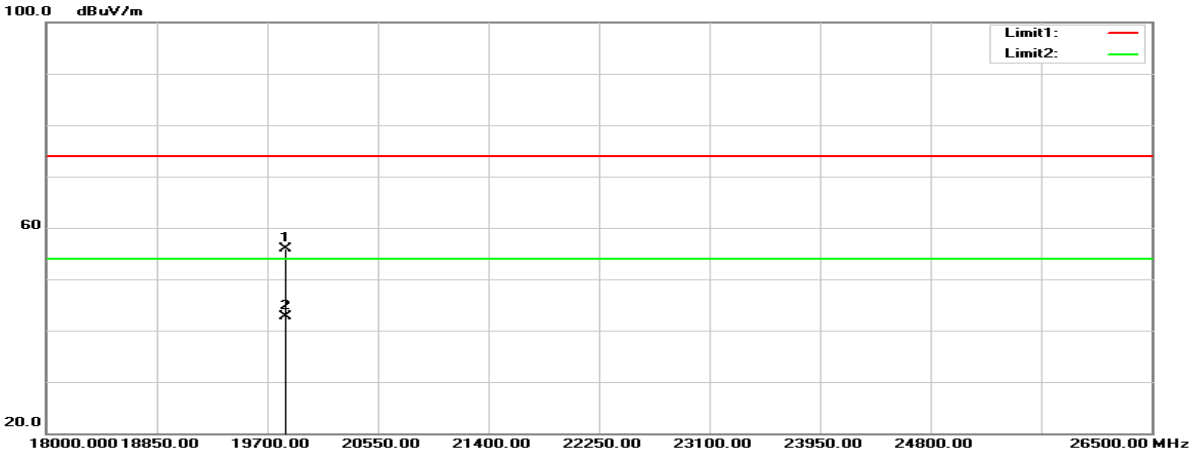
BLE (2M) Mode (Pre-scan with three orthogonal axis, and worse case as X axis.)

Horizontal (worst case is high channel)

1GHz-18GHz:

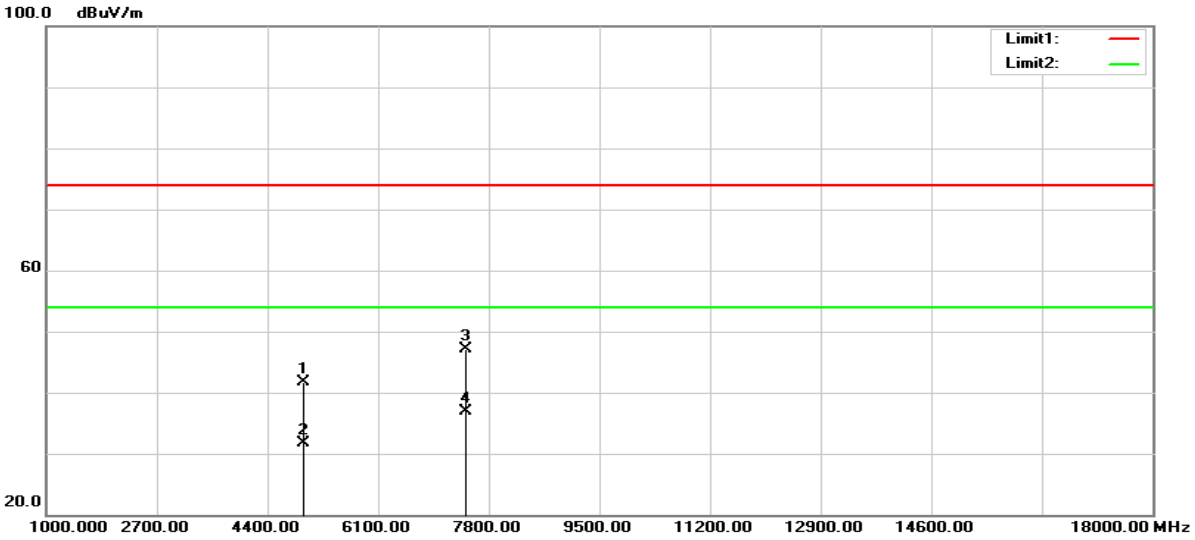


18GHz-26.5GHz:

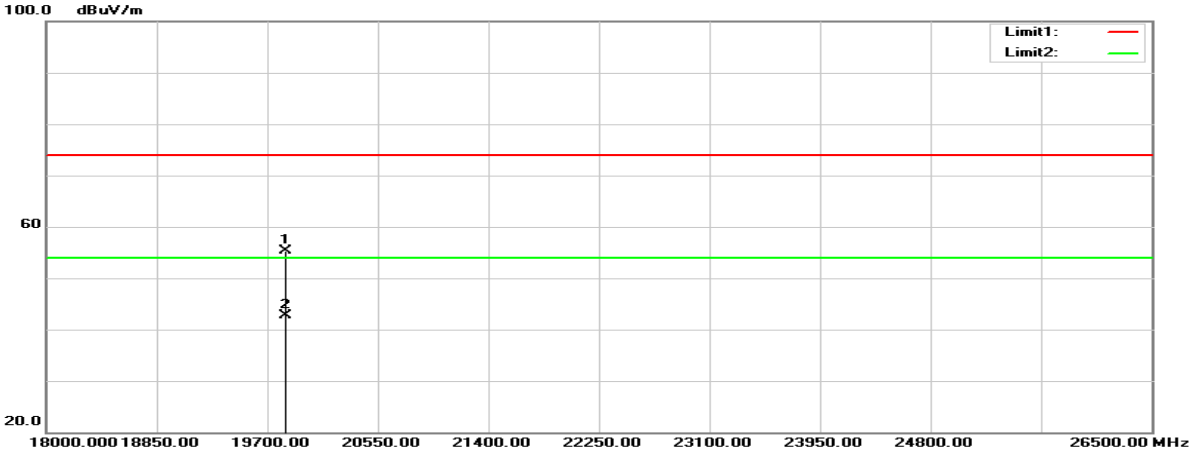


Vertical

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
98.8700	43.42	-14.59	28.83	43.50	-14.67	100	268	peak
232.7300	41.58	-12.54	29.04	46.00	-16.96	100	190	peak
370.4700	36.95	-8.63	28.32	46.00	-17.68	100	359	peak
440.3100	35.53	-6.63	28.90	46.00	-17.10	100	312	peak
777.8700	31.06	-1.56	29.50	46.00	-16.50	100	57	peak
971.8700	30.66	2.61	33.27	54.00	-20.73	100	42	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
75.5900	48.87	-16.21	32.66	40.00	-7.34	100	14	peak
119.2400	44.37	-10.54	33.83	43.50	-9.67	100	20	peak
232.7300	41.58	-12.54	29.04	46.00	-16.96	100	95	peak
379.2000	35.30	-8.46	26.84	46.00	-19.16	100	320	peak
532.4600	33.46	-5.64	27.82	46.00	-18.18	100	44	peak
623.6400	33.40	-4.81	28.59	46.00	-17.41	100	251	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

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2377.400	56.58	-9.56	47.02	74.00	-26.98	116	281	peak
2377.400	42.75	-9.56	33.19	54.00	-20.81	116	281	AVG
4804.000	42.41	-2.17	40.24	74.00	-33.76	142	134	peak
4804.000	32.58	-2.17	30.41	54.00	-23.59	142	134	AVG
7206.000	41.11	4.18	45.29	74.00	-28.71	156	328	peak
7206.000	31.64	4.18	35.82	54.00	-18.18	156	328	AVG
Middle channel								
4880.000	42.91	-1.88	41.03	74.00	-32.97	145	167	peak
4880.000	32.58	-1.88	30.70	54.00	-23.30	145	167	AVG
7320.000	42.40	5.10	47.50	74.00	-26.50	158	325	peak
7320.000	32.46	5.10	37.56	54.00	-16.44	158	325	AVG
High channel								
2495.710	56.14	-8.27	47.87	74.00	-26.13	151	30	peak
2495.710	42.96	-8.27	34.69	54.00	-19.31	151	30	AVG
4960.000	44.57	-1.49	43.08	74.00	-30.92	145	196	peak
4960.000	34.51	-1.49	33.02	54.00	-20.98	145	196	AVG
7440.000	41.13	5.23	46.36	74.00	-27.64	161	218	peak
7440.000	31.28	5.23	36.51	54.00	-17.49	161	218	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
Low channel								
2376.400	56.20	-9.57	46.63	74.00	-27.37	133	354	peak
2376.400	42.83	-9.57	33.26	54.00	-20.74	133	354	AVG
4804.000	43.40	-2.17	41.23	74.00	-32.77	166	225	peak
4804.000	33.45	-2.17	31.28	54.00	-22.72	166	225	AVG
7206.000	42.17	4.18	46.35	74.00	-27.65	153	149	peak
7206.000	32.28	4.18	36.46	54.00	-17.54	153	149	AVG
Middle channel								
4880.000	44.02	-1.88	42.14	74.00	-31.86	152	258	peak
4880.000	34.28	-1.88	32.40	54.00	-21.60	152	258	AVG
7320.000	41.31	5.10	46.41	74.00	-27.59	146	322	peak
7320.000	31.66	5.10	36.76	54.00	-17.24	146	322	AVG
High channel								
2492.920	55.68	-8.31	47.37	74.00	-26.63	134	302	peak
2492.920	42.39	-8.31	34.08	54.00	-19.92	134	302	AVG
4960.000	42.87	-1.49	41.38	74.00	-32.62	163	147	peak
4960.000	32.56	-1.49	31.07	54.00	-22.93	163	147	AVG
7440.000	41.50	5.23	46.73	74.00	-27.27	155	238	peak
7440.000	31.52	5.23	36.75	54.00	-17.25	155	238	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.

BLE (2M) Mode

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2378.500	56.68	-9.55	47.13	74.00	-26.87	150	9	peak
2378.500	42.84	-9.55	33.29	54.00	-20.71	150	9	AVG
4804.000	43.65	-2.17	41.48	74.00	-32.52	147	149	peak
4804.000	33.54	-2.17	31.37	54.00	-22.63	147	149	AVG
7206.000	42.21	4.18	46.39	74.00	-27.61	153	231	peak
7206.000	32.19	4.18	36.37	54.00	-17.63	153	231	AVG
Middle channel								
4880.000	42.59	-1.88	40.71	74.00	-33.29	153	168	peak
4880.000	32.66	-1.88	30.78	54.00	-23.22	153	168	AVG
7320.000	41.94	5.10	47.04	74.00	-26.96	147	235	peak
7320.000	31.48	5.10	36.58	54.00	-17.42	147	235	AVG
High channel								
2488.780	55.74	-8.37	47.37	74.00	-26.63	143	156	peak
2488.780	44.00	-8.37	35.63	54.00	-18.37	143	156	AVG
4960.000	43.30	-1.49	41.81	74.00	-32.19	153	165	peak
4960.000	33.28	-1.49	31.79	54.00	-22.21	153	165	AVG
7440.000	41.57	5.23	46.80	74.00	-27.20	144	218	peak
7440.000	31.45	5.23	36.68	54.00	-17.32	144	218	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
Low channel								
2316.100	56.87	-9.80	47.07	74.00	-26.93	130	104	peak
2316.100	42.82	-9.80	33.02	54.00	-20.98	130	104	AVG
4804.000	42.27	-2.17	40.10	74.00	-33.90	156	174	peak
4804.000	32.33	-2.17	30.16	54.00	-23.84	156	174	AVG
7206.000	42.11	4.18	46.29	74.00	-27.71	143	216	peak
7206.000	32.28	4.18	36.46	54.00	-17.54	143	216	AVG
Middle channel								
4880.000	43.59	-1.88	41.71	74.00	-32.29	145	138	peak
4880.000	33.45	-1.88	31.57	54.00	-22.43	145	138	AVG
7320.000	41.73	5.10	46.83	74.00	-27.17	153	211	peak
7320.000	31.29	5.10	36.39	54.00	-17.61	153	211	AVG
High channel								
2498.620	56.05	-8.23	47.82	74.00	-26.18	205	248	peak
2498.620	43.88	-8.23	35.65	54.00	-18.35	205	248	AVG
4960.000	43.18	-1.49	41.69	74.00	-32.31	148	328	peak
4960.000	33.25	-1.49	31.76	54.00	-22.24	148	328	AVG
7440.000	41.82	5.23	47.05	74.00	-26.95	153	224	peak
7440.000	31.67	5.23	36.90	54.00	-17.10	153	224	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.

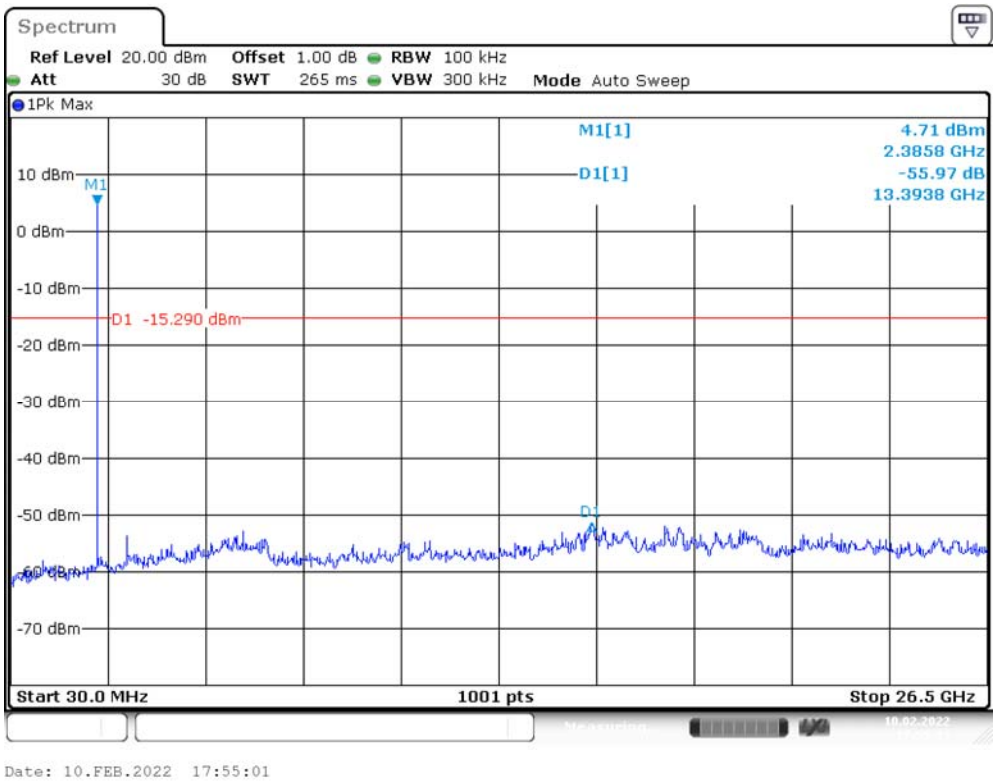
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	55.97	≥ 20	PASS
Mid	2441	53.85	≥ 20	PASS
High	2480	54.41	≥ 20	PASS
BLE(2M) Mode				
Low	2402	53.01	≥ 20	PASS
Mid	2441	51.57	≥ 20	PASS
High	2480	51.47	≥ 20	PASS

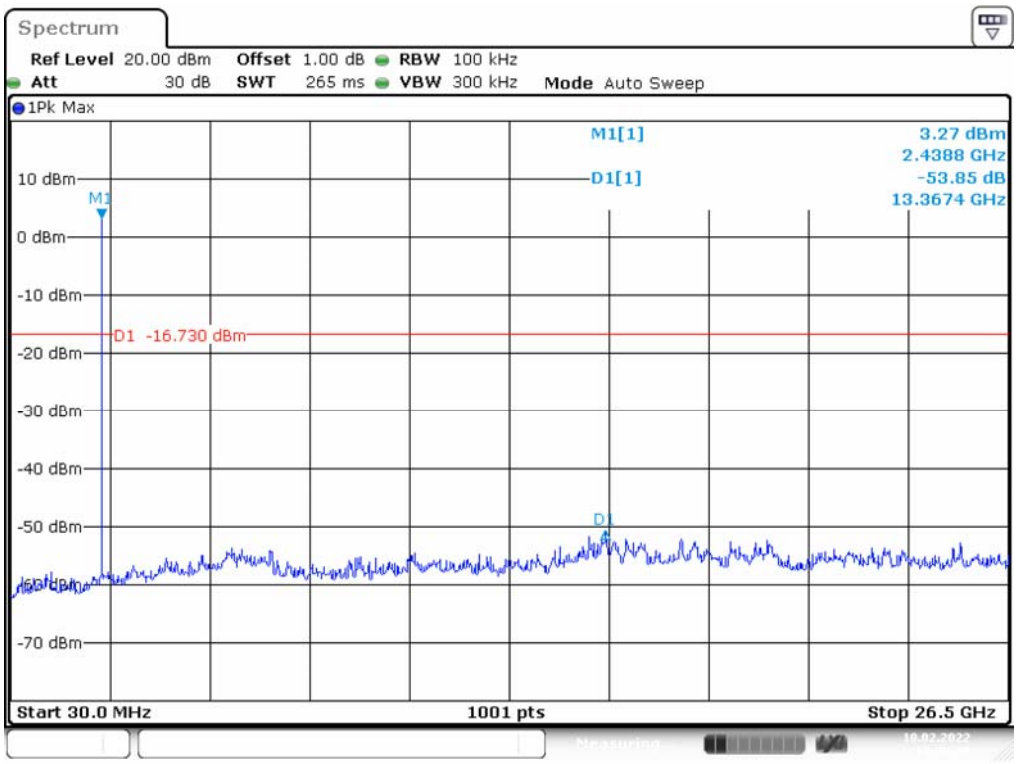
Please refer to the following plots

BLE (1M) Mode

Low Channel

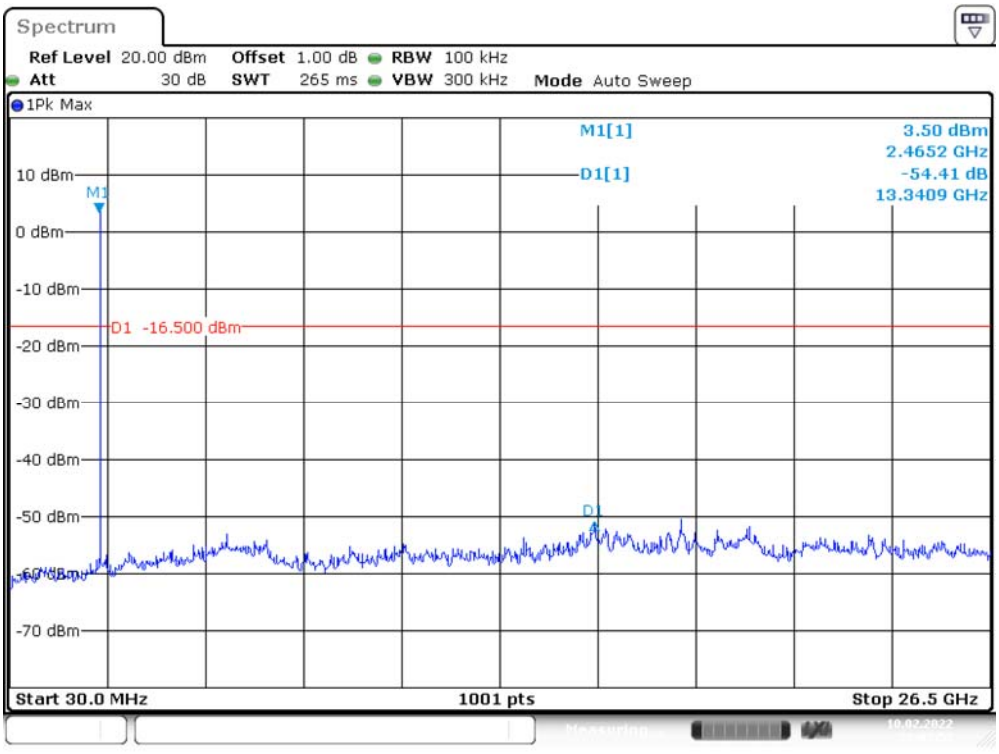


Middle Channel



Date: 10.FEB.2022 18:00:41

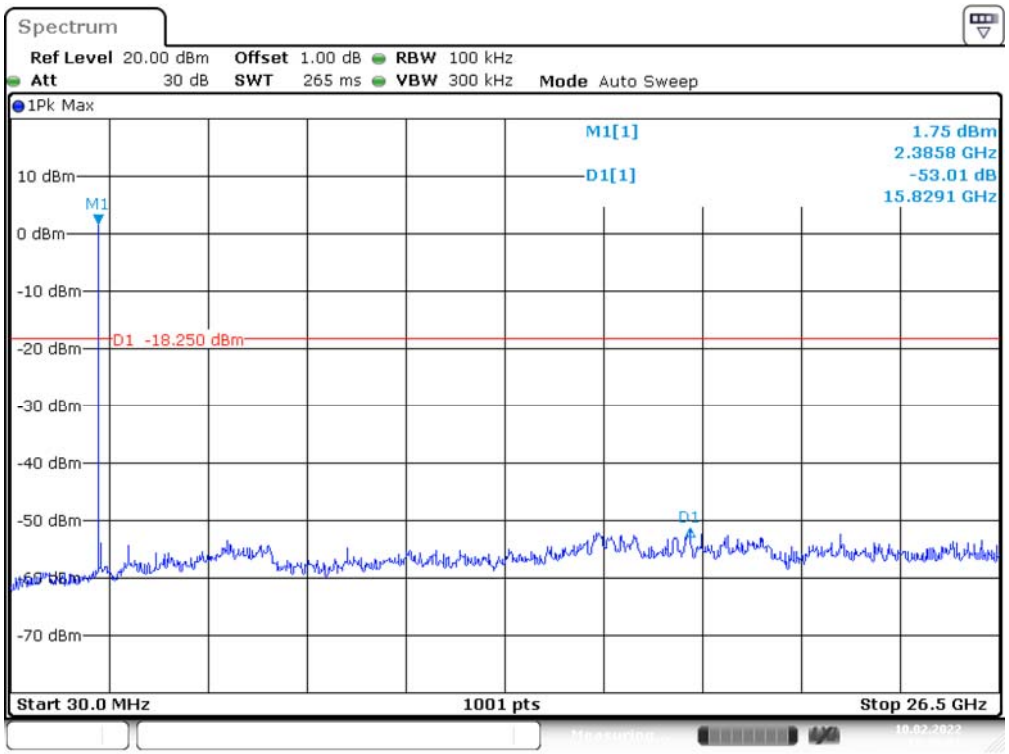
High Channel



Date: 10.FEB.2022 18:03:54

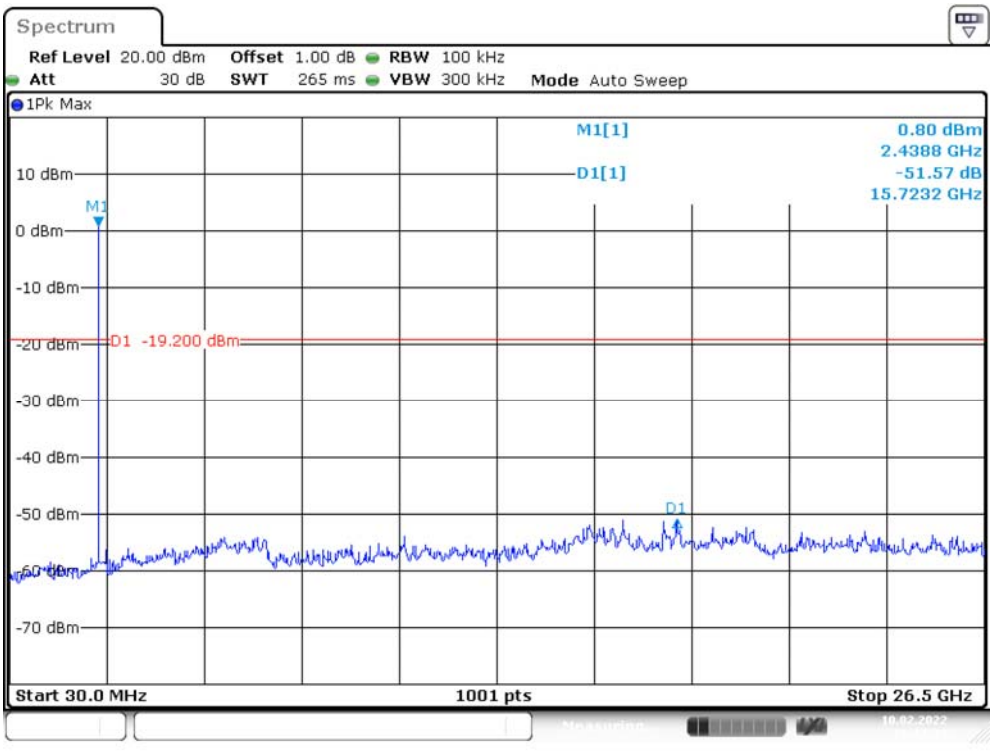
BLE (2M) Mode

Low Channel



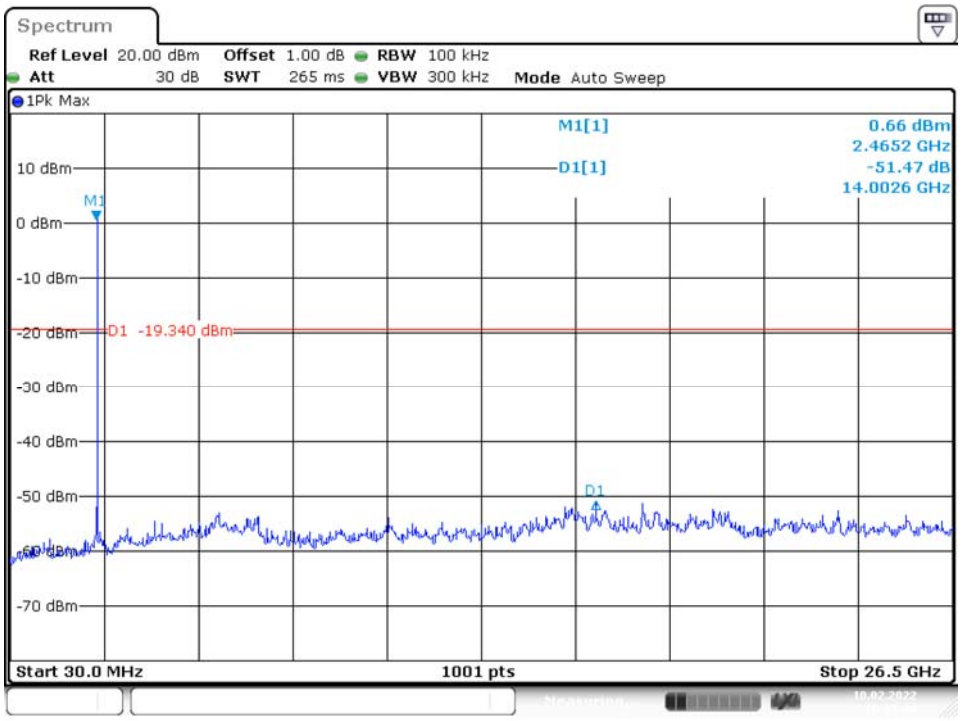
Date: 10.FEB.2022 18:15:01

Middle Channel



Date: 10.FEB.2022 18:17:23

High Channel



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.

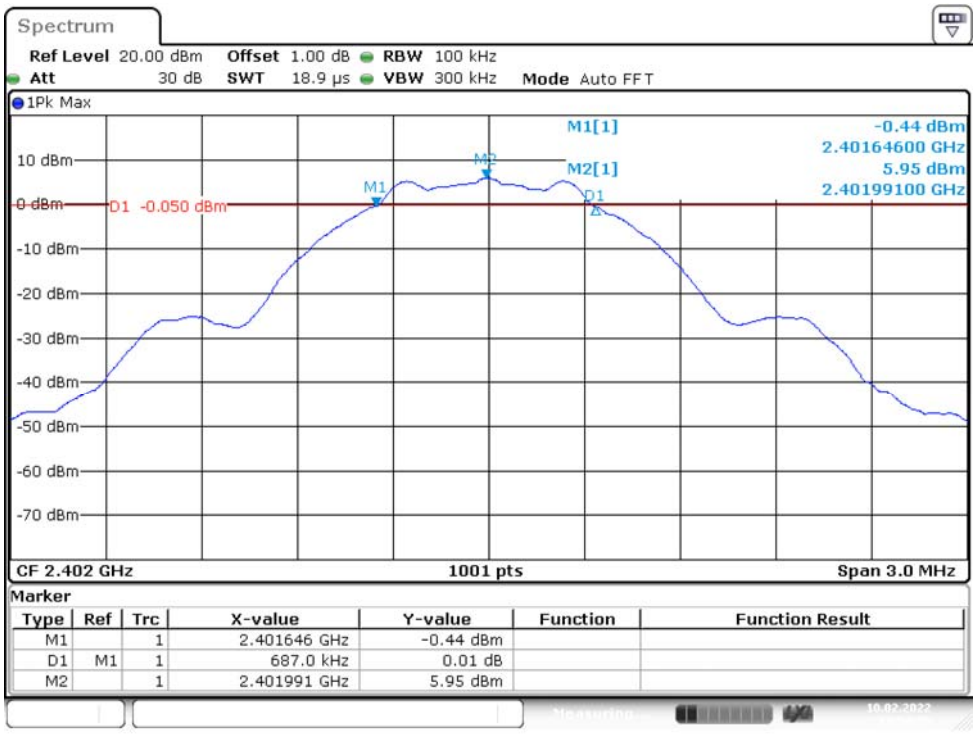
9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)	Result
BLE (1M) Mode				
Low	2402	0.687	> 500	Compliance
Middle	2440	0.690	> 500	Compliance
High	2480	0.684	> 500	Compliance
BLE (2M) Mode				
Low	2402	1.158	> 500	Compliance
Middle	2440	1.155	> 500	Compliance
High	2480	1.155	> 500	Compliance

Please refer to the following plots

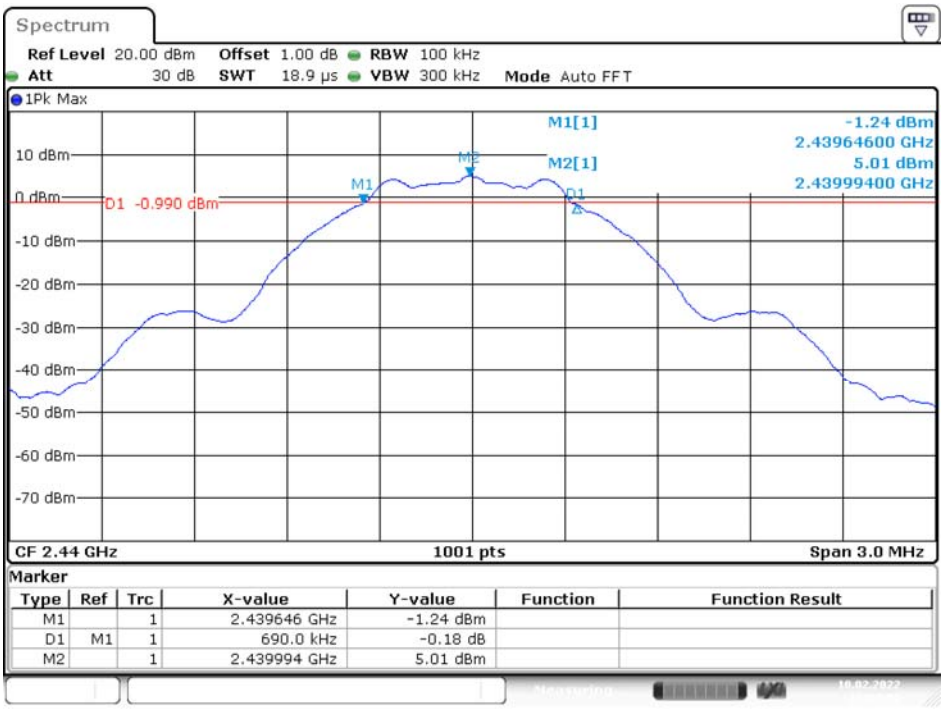
BLE (1M) Mode

Low Channel



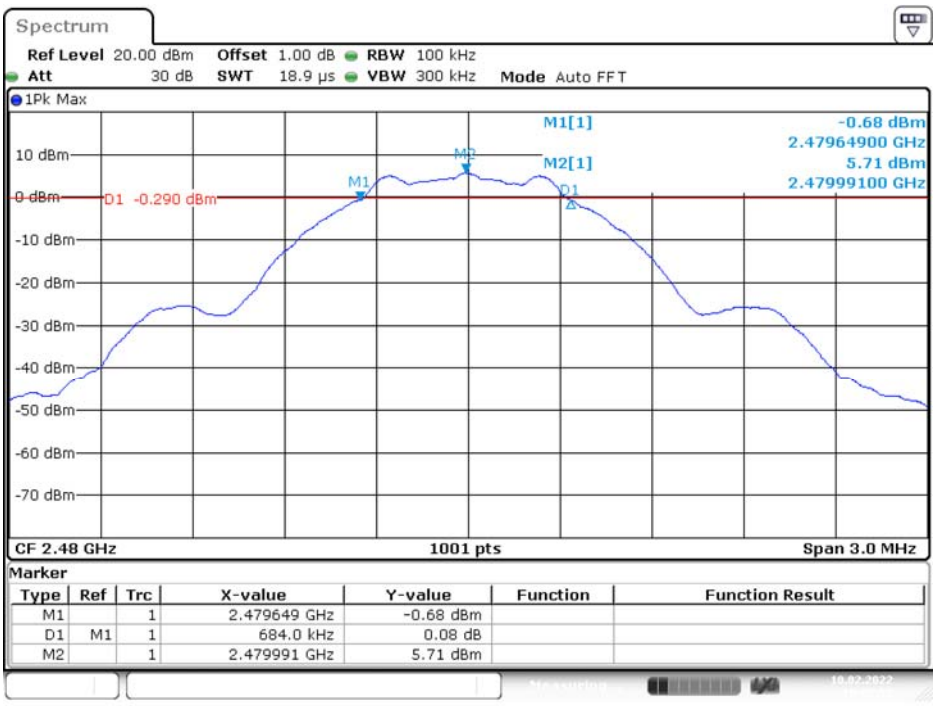
Date: 10.FEB.2022 17:54:05

Middle Channel



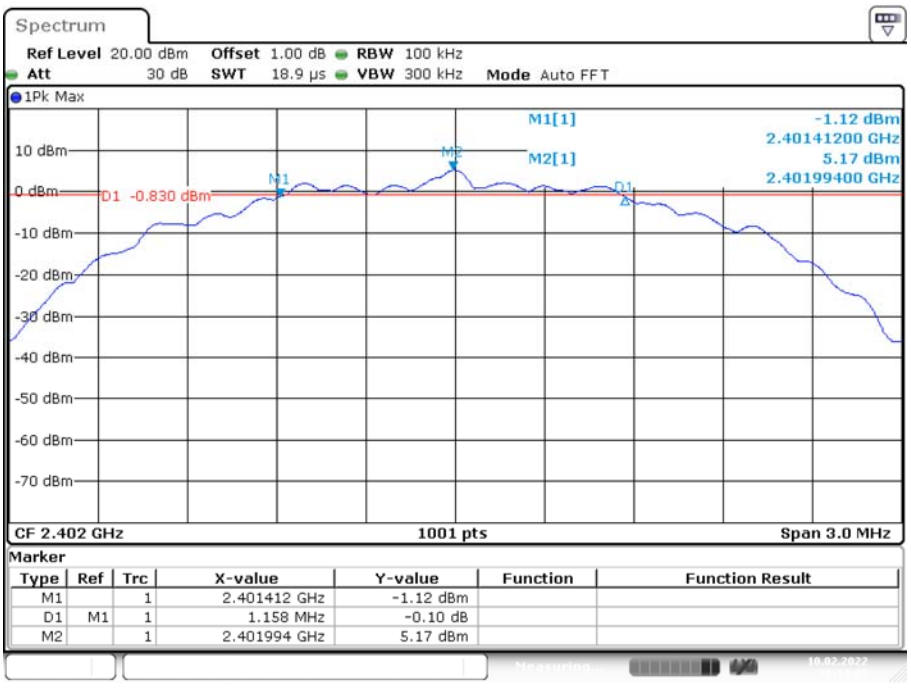
Date: 10.FEB.2022 18:00:01

High Channel

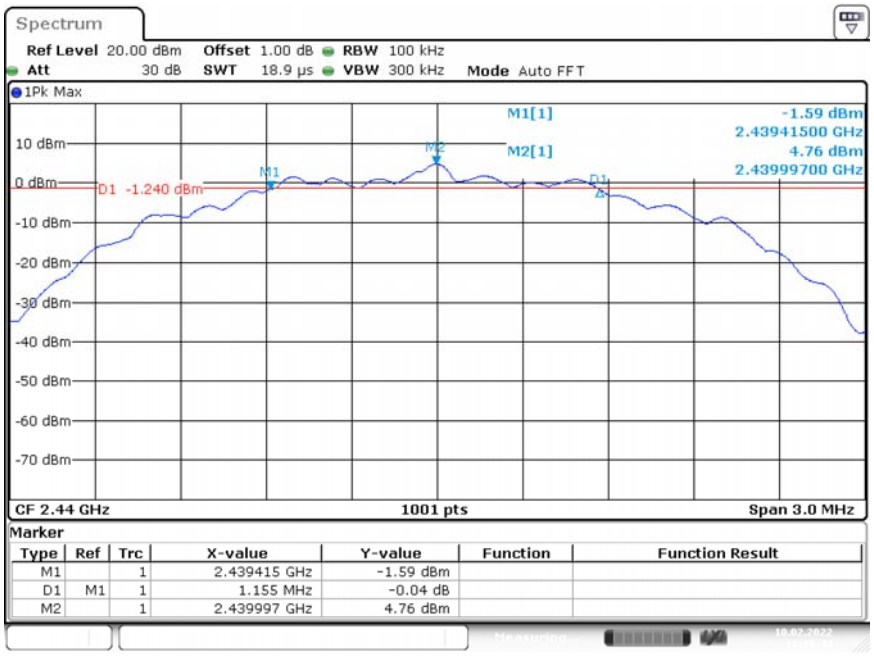


BLE (2M) Mode

Low Channel

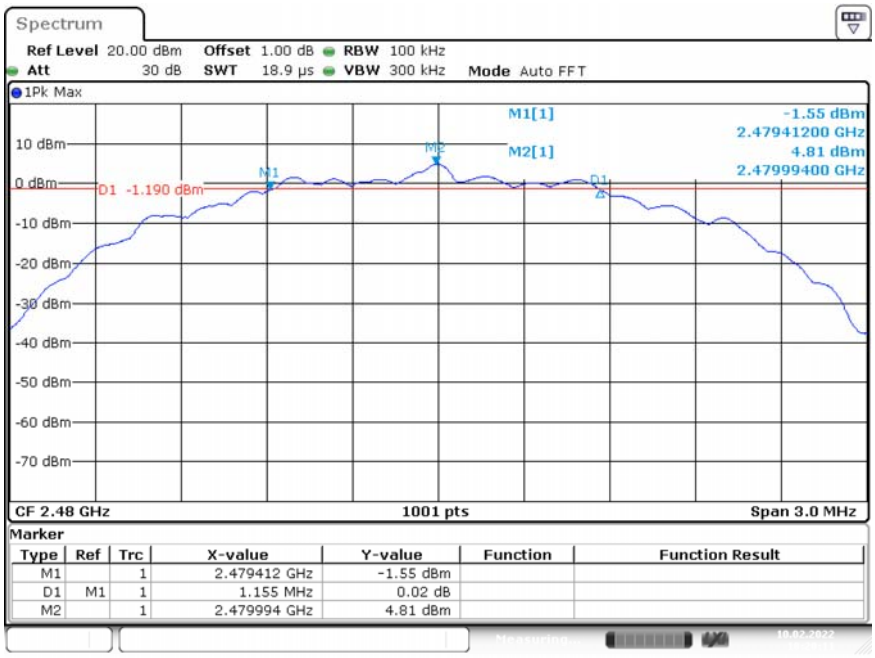


Middle Channel



Date: 10.FEB.2022 18:16:44

High Channel



Date: 10.FEB.2022 18:20:11

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

Channel	Frequency	Maximum peak Conducted Output Power		Limit	Result
	(MHz)	(dBm)	(W)	(W)	
BLE (1M) Mode					
Low	2402	5.91	0.00390	1	PASS
Middle	2440	5.28	0.00337	1	PASS
High	2480	5.19	0.00330	1	PASS
BLE (2M) Mode					
Low	2402	5.71	0.00372	1	PASS
Middle	2440	5.48	0.00353	1	PASS
High	2480	5.36	0.00344	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 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)).

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.

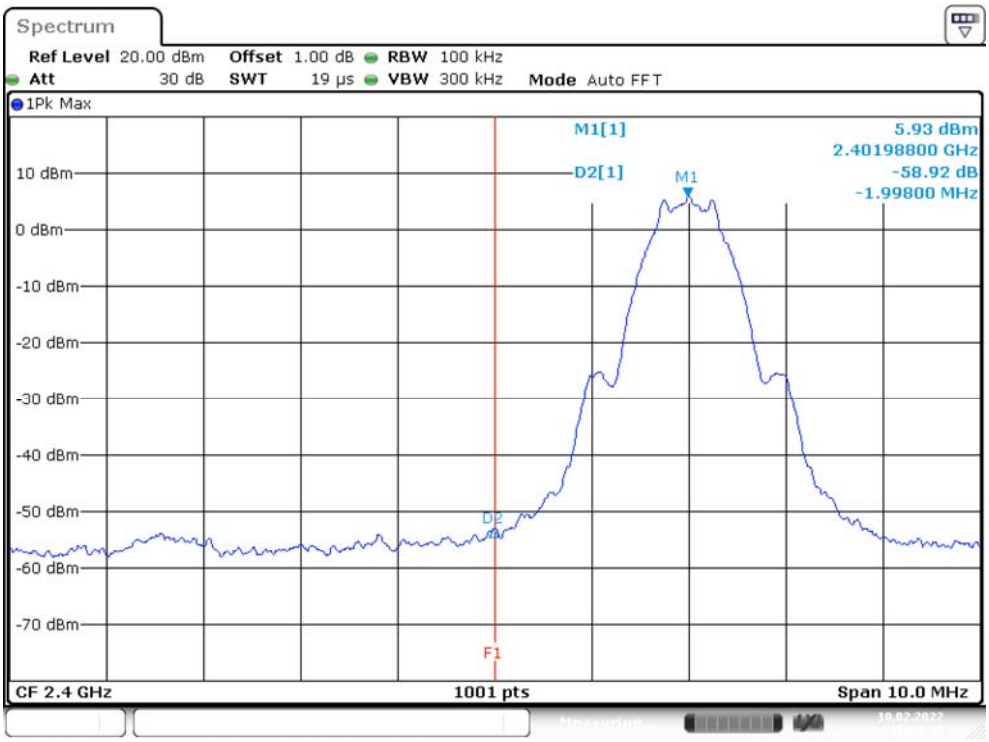
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	58.92	≥ 20	PASS
High	2480	61.78	≥ 20	PASS
BLE(2M) Mode				
Low	2402	31.81	≥ 20	PASS
High	2480	59.59	≥ 20	PASS

Please refer to the following plots

BLE (1M) Mode

Band Edge, Left Side



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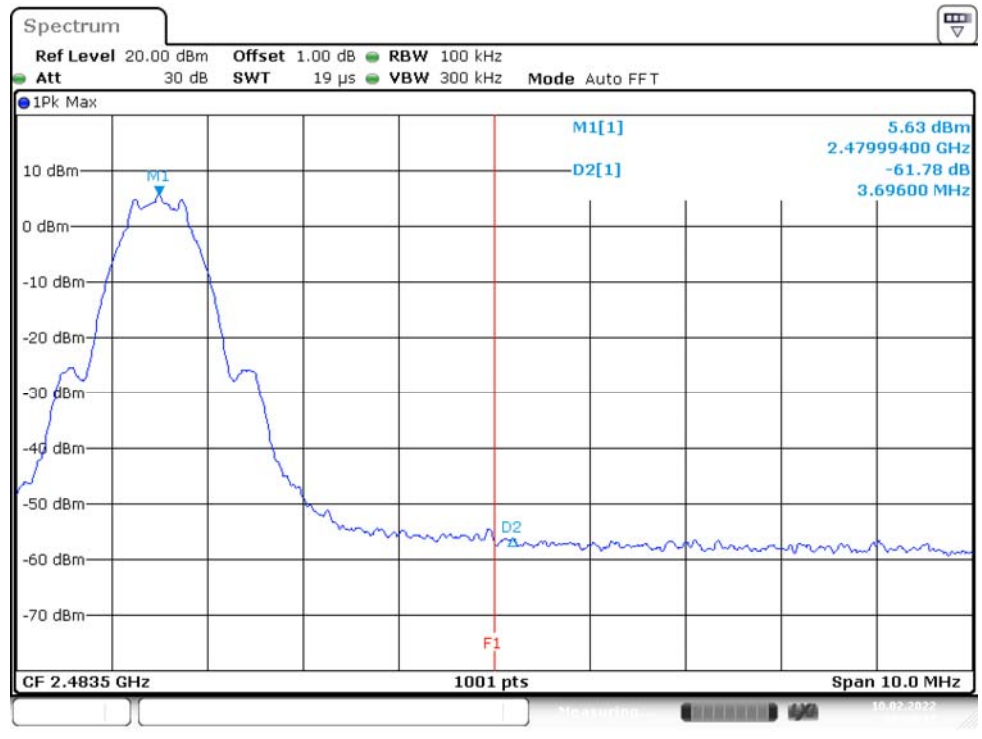
Band Edge, Right Side



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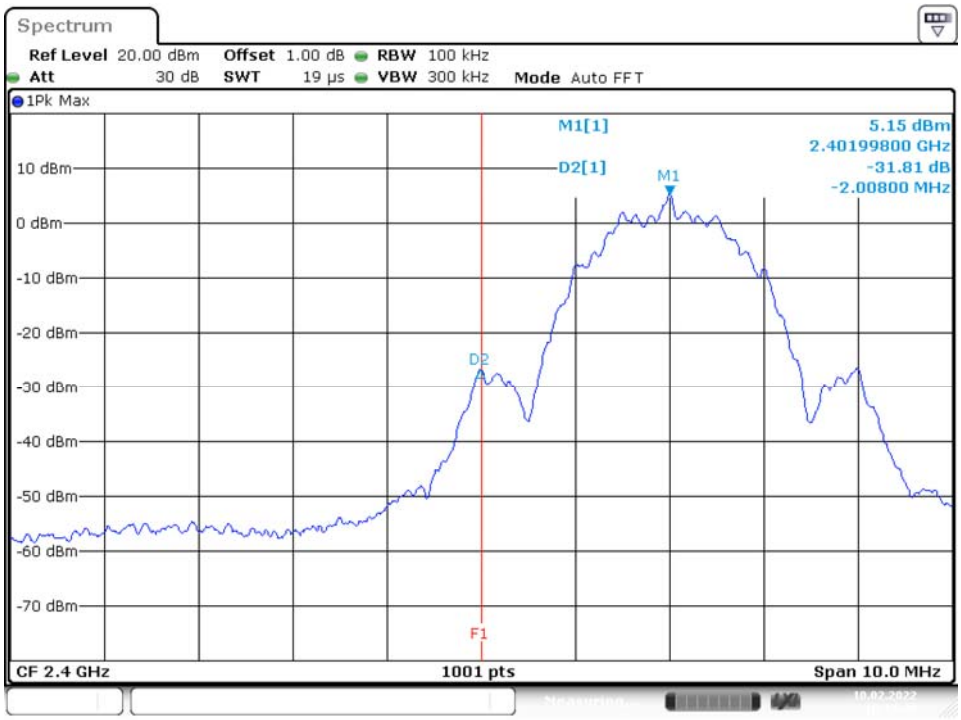
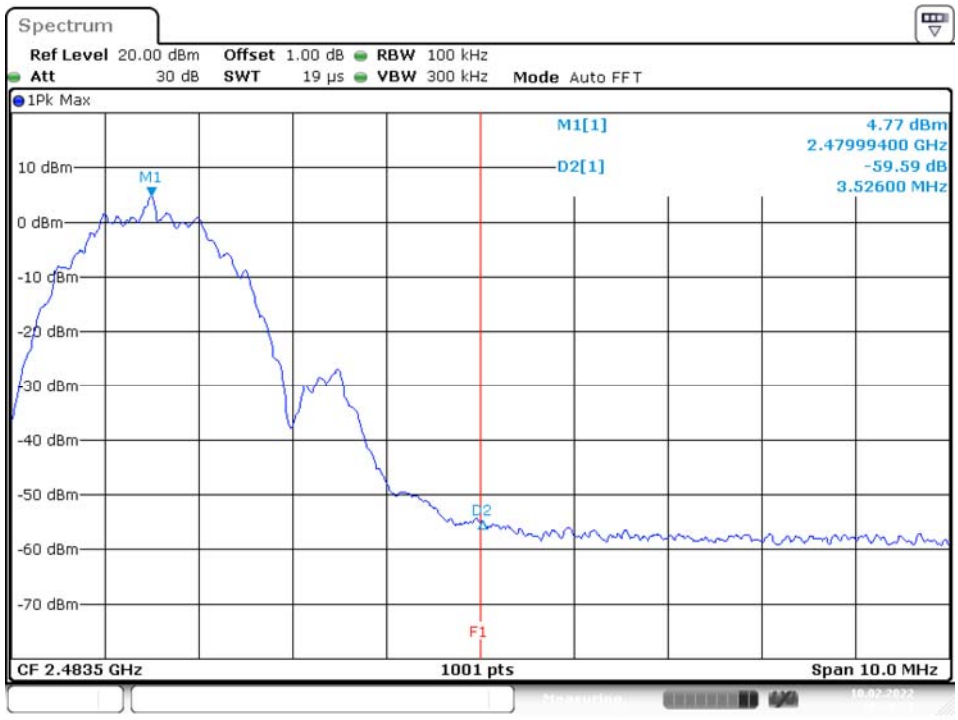
BLE (2M) Mode

Band Edge, Left Side



Date: 10.FEB.2022 18:14:45

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

According to ANSI C63.10-2013

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

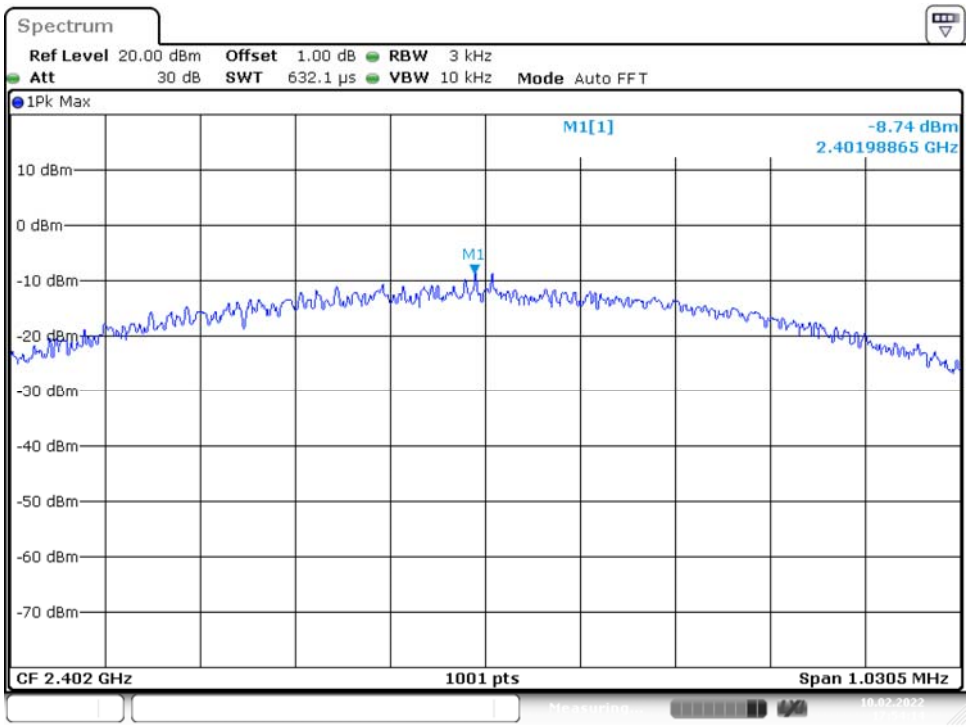
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE(1M) Mode				
Low	2402	-8.74	8	Compliance
Middle	2440	-10.63	8	Compliance
High	2480	-9.96	8	Compliance
BLE(2M) Mode				
Low	2402	-12.85	8	Compliance
Middle	2440	-13.35	8	Compliance
High	2480	-13.02	8	Compliance

Please refer to the following plots

BLE(1M) Mode

Low Channel



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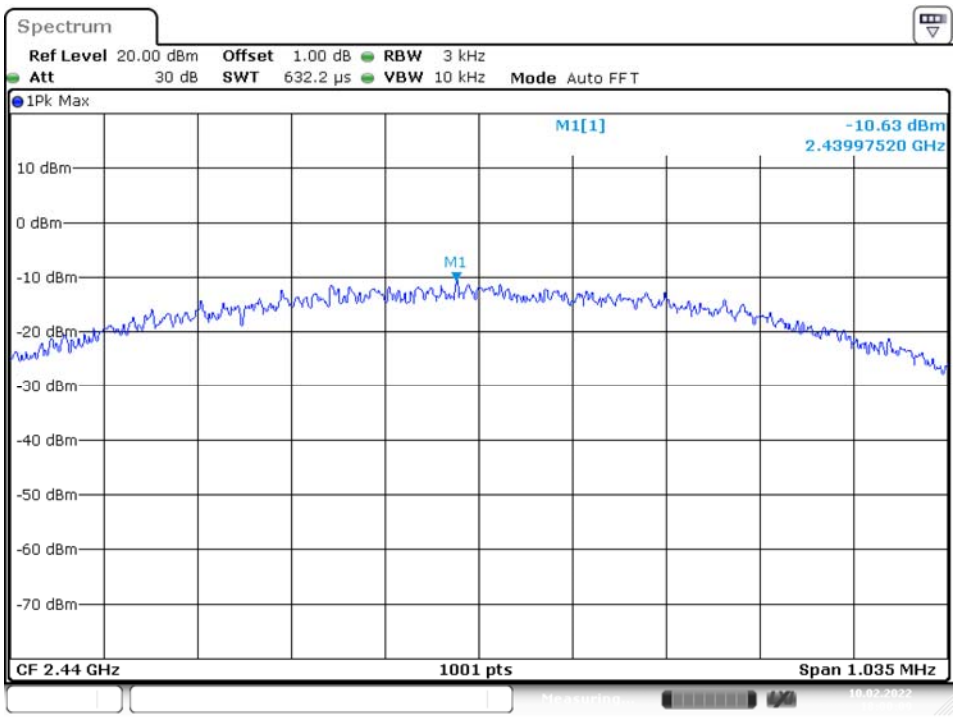
Middle Channel



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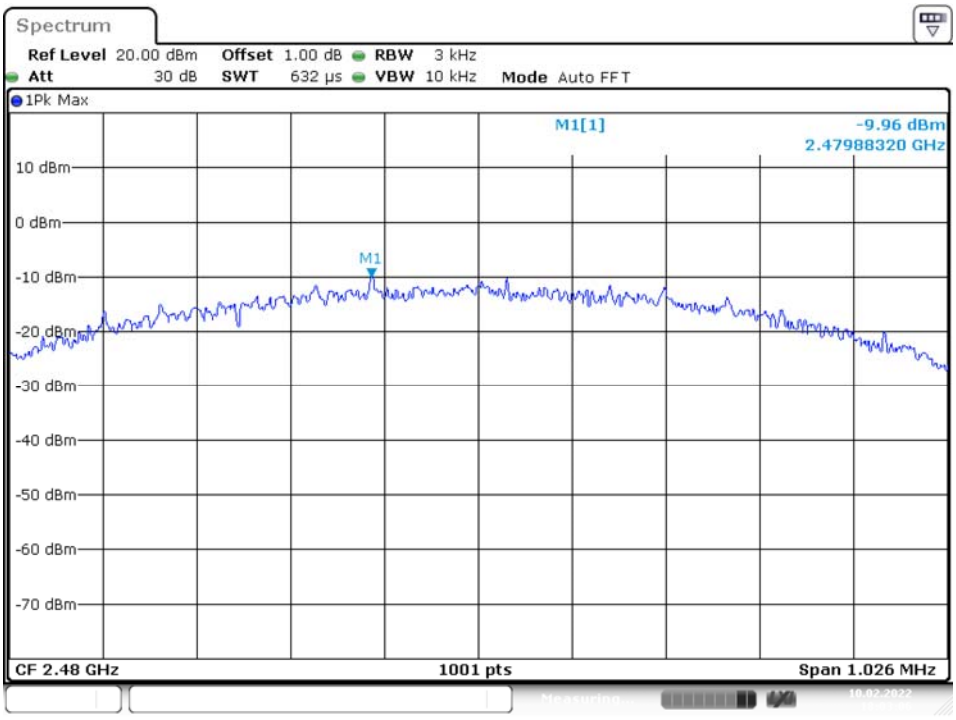
High Channel



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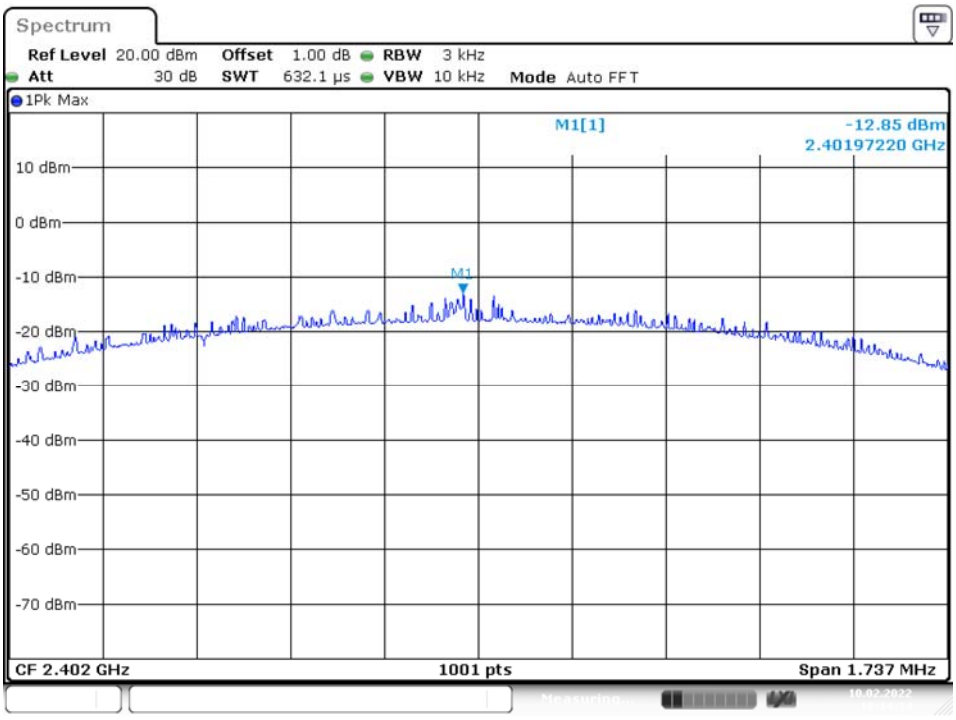
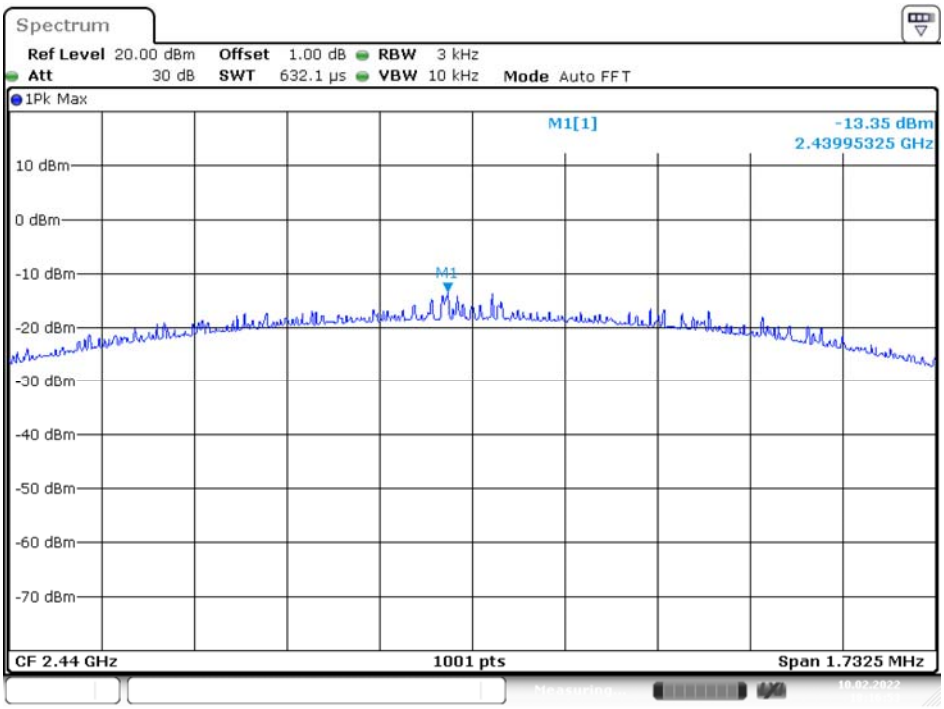
BLE(2M) Mode

Low Channel



Date: 10.FEB.2022 18:14:14

Middle Channel



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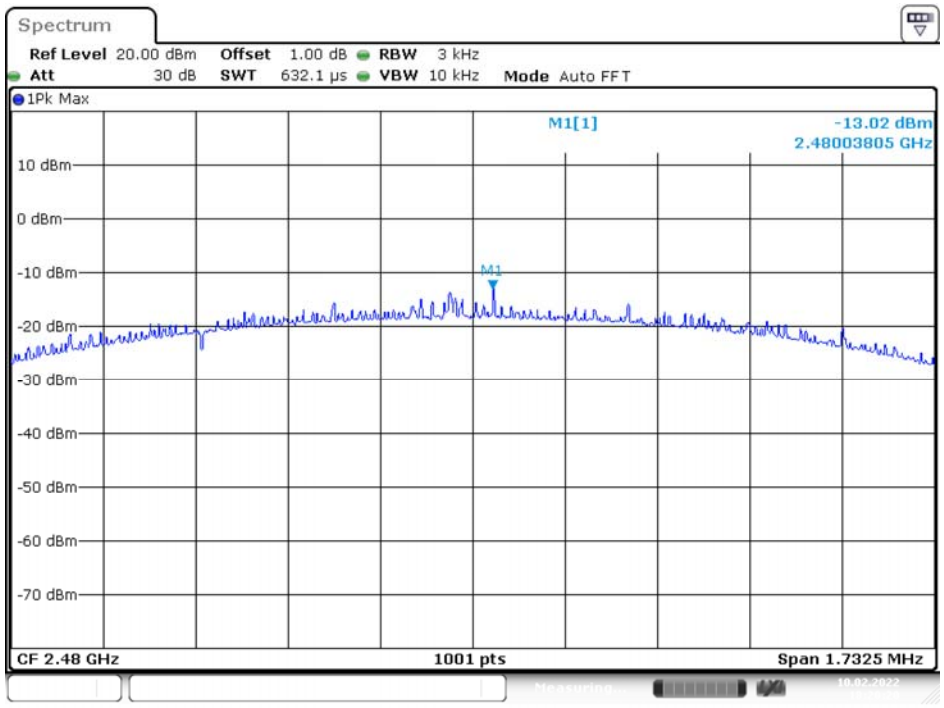
High Channel



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