FCC Part 15.247
RSS-GEN, ISSUE 5, February 2021 Amendment 2
RSS-247, ISSUE 2, February 2017
TEST REPORT

For

Tractive GmbH

Poststrasse 4 ,Pasching, 4061 Austria

FCC ID: 2AVE6TG5
IC: 25970-TG5

Report Type:	**Product Type:**
Original Report	Tractive CAT mini

Report Producer : Jojo Lu

Report Number : RXZ230110032RF02

Report Date : 2023-04-11

Reviewed By: David Hsu David.Hsu

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ230110032	RXZ230110032RF02	2023-04-11	Original Report	Jojo Lu

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	Tractive GmbH
	Poststrasse 4 ,Pasching, 4061Austria
Manufacturer	Tractive GmbH
	Poststrasse 4 ,Pasching, 4061 Austria
Brand(Trade) Name	N/A
Product (Equipment)	Tractive CAT mini
Main Model Name (HVIN)	TG5
Frequency Range	IEEE 802.11b Mode: 2412 ~ 2462 MHz BLE (1M) Mode: 2402 ~ 2480 MHz
Transmit Power	IEEE 802.11b Mode: 8.56 dBm BLE (1M) Mode: -5.83 dBm
Modulation Technique	IEEE 802.11b Mode: DSSS BLE (1M) Mode: GFSK
Power Operation (Voltage Range)	☒ AC ☒ Adapter ☐ By AC Power Cord ☐ PoE
	☒ DC Type ☒ Battery 3.8Vdc Brand Name: Tractive GmbH Model: HI9213380677 ☐ DC Power Supply ☒ External from USB Cable ☐ External DC Adapter
	☐ Host System
Received Date	2023/01/10
Date of Test	2023/01/10~2023/01/13

*All measurement and test data in this report was gathered from production sample serial number: RXZ230110032 Assigned by BACL, New Taipei Laboratory.

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1.2 Objective

This report is prepared on behalf of ***Tractive GmbH*** in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules and RSS-247, Issue 2, February 2017, RSS Gen, Issue 5, February 2021 Amendment 2 of the Innovation, Science and Economic Development Canada.

1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and KDB 558074 D01 15.247 Meas Guidance v05r02. And RSS-247, Issue 2, February 2017, RSSGen, Issue 5, February 2021 Amendment 2 of the Innovation, Science and Economic Development Canada.

1.4 Statement

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

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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.

1.5 Measurement Uncertainty

Parameter		Uncertainty
RF output power, conducted		+/- 0.9 dBm
Frequency stability		+/- 0.02 MHz
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 ℃
Humidity		+/- 3 %

1.6 Environmental Conditions

Test Site	Test Data	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2023/01/12	24.3	69	1010	Andy Cheng
Radiation Spurious Emissions	2023/01/10~2023/01/13	22.3~23.6	65~75	1010	Jim Chen
Conducted Spurious Emissions	2023/01/11~2023/01/13	23.8~24.6	45~59	1010	Andy Cheng
6 dB Emission Bandwidth	2023/01/11~2023/01/13	23.8~24.6	45~59	1010	Andy Cheng
Maximum Output Power	2023/01/11~2023/01/13	23.8~24.6	45~59	1010	Andy Cheng
100 kHz Bandwidth of Frequency Band Edge	2023/01/11~2023/01/13	23.8~24.6	45~59	1010	Andy Cheng
Power Spectral Density	2023/01/11~2023/01/13	23.8~24.6	45~59	1010	Andy Cheng

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1.7 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: 3546) and the FCC designation No.TW3546 under the Mutual Recognition Agreement (MRA) in FCC Test.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: TW3732.

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2 System Test Configuration

2.1 Description of Test Configuration

For WIFI mode, there are totally 11 channels.

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

For 802.11 b Modes were tested with channel 1, 6 and 11. (data rate:1M)

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. (data rate:1Mbps)

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 2.4G WiFi test software uses "teraterm-4.106", BLE does not use test software.

Test Frequency		Low	Mid	High
Power Level Setting	B Mode	default	default	default
	BLE Mode	default	default	default

2.4 Support Equipment List and Details

NO.	Description	Manufacturer	Model Number
1	Charging Dock	Tractive	N/A
2	Adapter	Opro9	FMP205

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2.5 External Cable List and Details

NO.	Cable Description	Length	From	To
A	USB Cable	0.8	Charging dock	Adapter

2.6 Test Mode

Full System (model: TG5) test item.

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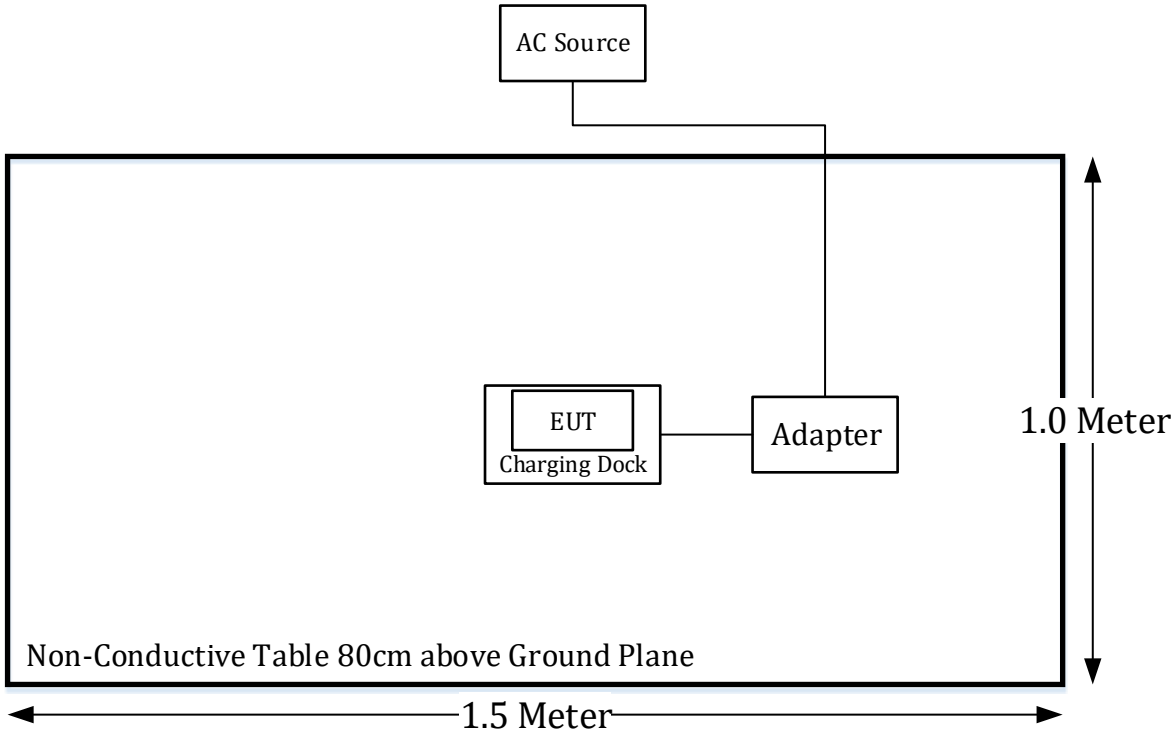
2.7 Block Diagram of Test Setup

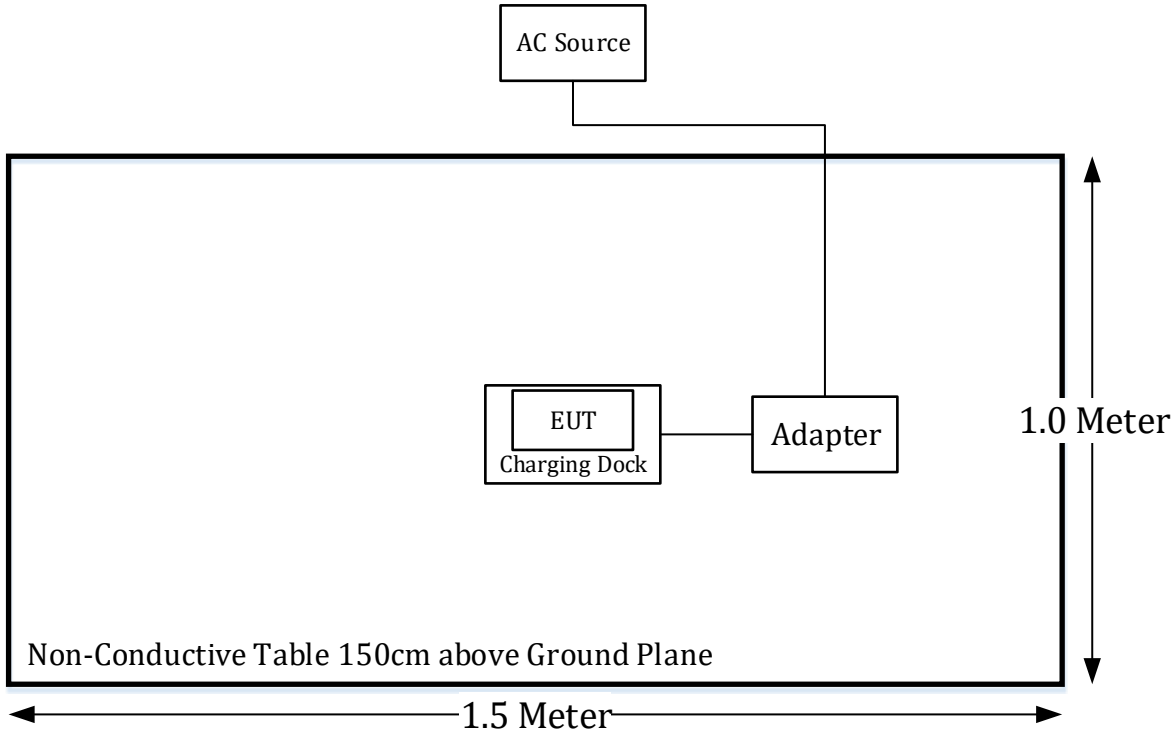
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

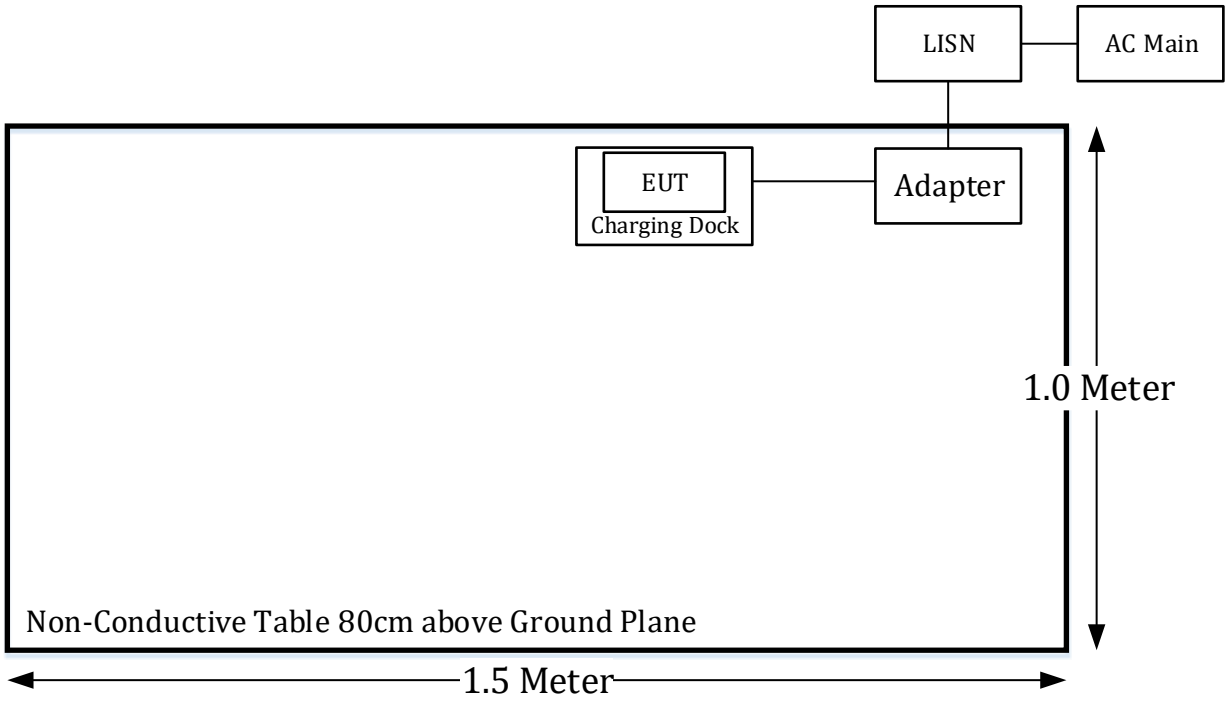
Below 1GHz:



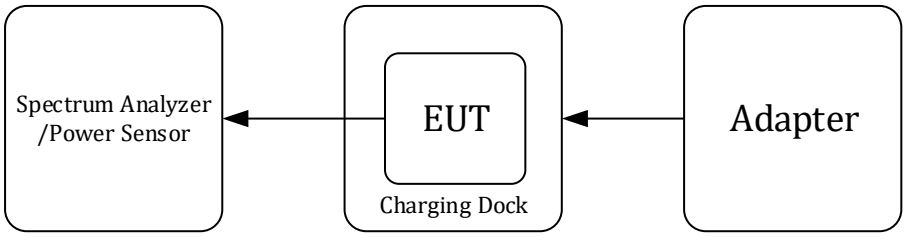
Above 1GHz:



Conduction:



Conducted:



2.8 Duty Cycle

The duty cycle as below:

Radio Mode	On Time (ms)	Off Time (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	8.4058	0.087	0.99	0.04
BLE (1M)	0.178	0.447	0.28	5.53

B MODE: 1/T=1/8.4058=0.1189 VBW=200Hz

BLE MODE: 1/T=1/0.178= 5.617 VBW=10KHz

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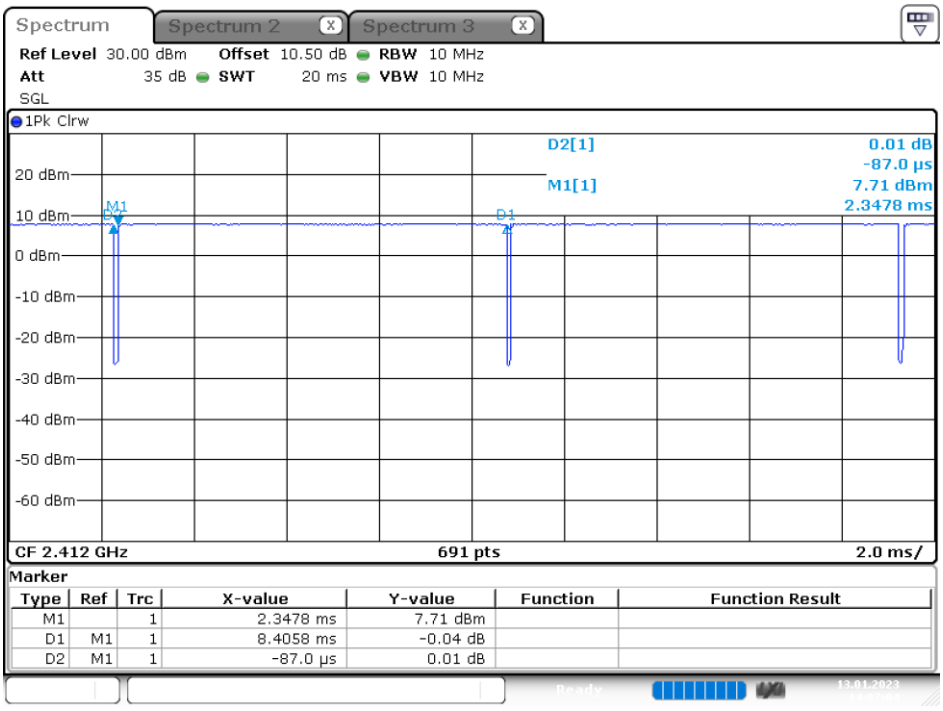
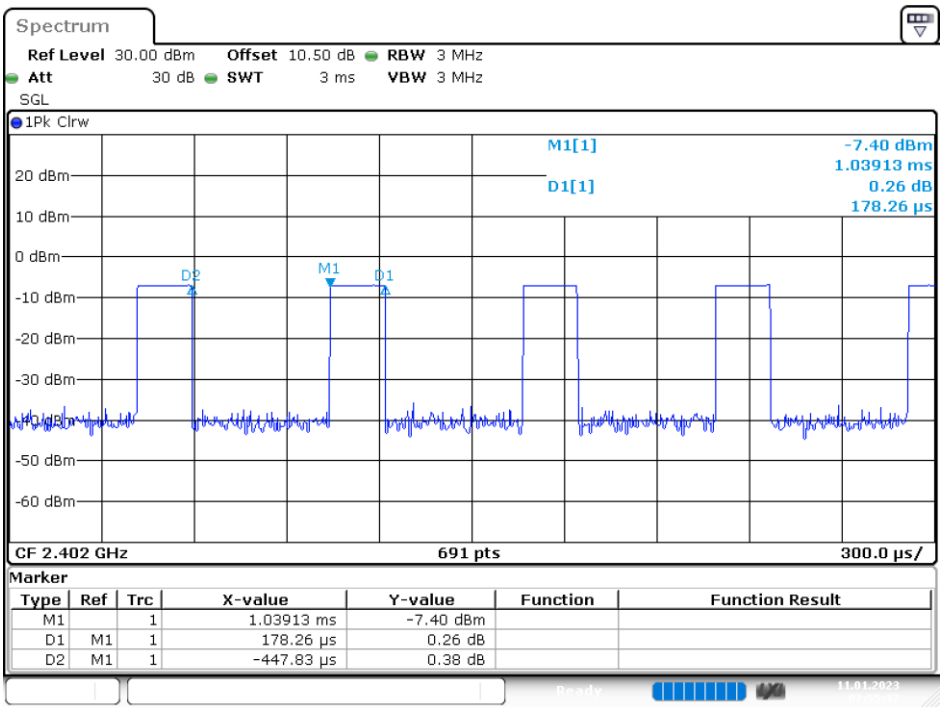
Please refer to the following plots.

B Mode



Date: 13.JAN.2023 14:07:05

BLE Mode



Date: 11.JAN.2023 07:55:17

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3 Summary of Test Results

Rules	Description of Test	Results
FCC §15.247(i), §1.1307(b)(3)(i)	RF Exposure	Compliance
RSS-102 §2.5.1	Exemption Limits from Routine Evaluation – SAR Evaluation	Compliance
FCC §15.203 RSS-Gen §6.8	Antenna Requirements	Compliance
FCC §15.207(a) RSS-Gen §8.8	AC Line Conducted Emissions	Compliance
FCC §15.209, §15.205, §15.247(d) & RSS-GEN §8.9, §8.10	Spurious Emissions	Compliance
FCC §15.247(a)(2) RSS-247 §5.2 (a) RSS-Gen §6.7	6 dB Emission Bandwidth & Occupied Bandwidth	Compliance
FCC §15.247(b)(3) RSS-247 §5.4 (d)	Maximum Output Power	Compliance
FCC §15.247(d) RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliance
FCC §15.247(e) RSS-247 §5.2 (b)	Power Spectral Density	Compliance

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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	2022/6/22	2023/6/21
EMI Test Receiver	Rohde & Schwarz	ESR3	102099	2022/6/16	2023/6/15
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2022/7/19	2023/7/18
RF Cable	EMEC	EM-CB5D	1	2022/6/7	2023/6/6
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiation 3M Room (966-A)					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2023/1/6	2024/1/13
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2022/2/14	2023/2/13
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2022/11/2	2023/11/1
Horn Antenna	EMCO	SAS-571	1020	2022/5/25	2023/5/24
Horn Antenna	ETS-Lindgren	3116	62638	2022/8/18	2023/8/17
Preamplifier	Sonoma	310N	130602	2022/6/16	2023/6/15
Microware Preamplifier	EM Electronics Corporation	EM18G40G	60656	2023/1/6	2024/1/5
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2022/1/24	2023/1/23
Coaxial Cable	COMMATE	PEWC	8Dr	2022/12/24	2023/12/23
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	2022/12/24	2023/12/23
Cable	EMC	EMC105-SM-SM-10000	201003	2022/1/24	2023/1/23
Preamplifier	A.H. system Inc.	PAM-0118P	470	2022/3/28	2023/3/27
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101140	2022/2/18	2023/2/17
Cable	UTIFLEX	UFA210A	9435	2022/10/3	2023/10/2

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Power Sensor	KEYSIGHT	U2021XA	MY54080018	2022/1/24	2023/1/23
Attenuator	MINI-CIRCUITS	BW-S10W5+	1419	2022/2/11	2023/2/10

***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.

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5 FCC §15.247(i), §1.1307(b)(3)(i) - RF Exposure

5.1 Applicable Standard

According to subpart 15.247(i) and subpart §1.1307(b)(3)(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

The sequence to apply for single portable RF sources includes the following steps:

1) determination of 1 mW blanket exemption under § 1.1307(b)(3)(i)(A)

2) determination of exemption under the MPE-based § 1.1307(b)(3)(i)(C) if 1) is not met

3) determination of exemption under the SAR-based § 1.1307(b)(3)(i)(B) if both 1) and 2) are not met

5.2 RF Exposure Evaluation Result

Project info

Band	Freq (MHz)	Turn-up Average Power (dBm)	Ant Gain (dBi)	Distances (mm)	Turn-up (mW)	ERP (dBm)	ERP (mW)
BLE	2480	-5.5	2.29	5	0.28	-5.36	0.29

§ 1.1307(b)(3)(i)(A) method is applicable.

Option A The available maximum time-averaged power is no more than 1 mW

Band	Freq (MHz)	Result Option A
BLE	2480	exempt

Result: The EUT meets exemption requirement for BLE

RF Exposure Evaluation Result for WIF

Please refer to the SAR report, report No.: RXZ230110032SA01

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6 RSS-102 § 2.5.1 – EXEMPTION LIMITS FROM ROUTINE EVALUATION – SAR EVALUATION

6.1 Applicable Standard

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW
Frequency (MHz)	**Exemption Limits (mW)**				
	At separation distance of 30 mm	**At separation distance of 35 mm**	**At separation distance of 40 mm**	**At separation distance of 45 mm**	**At separation distance of ≥50 mm**
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5.

If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required. For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

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6.2 RF Exposure Evaluation Result

BLE

Tune-up power = -5.5dBm

EIRP = -3.21 dBm = 0.478 mW

Exemption from Routine Evaluation Limit is:

$1.31 \times 10^{-2} f^{0.6834} = 1.31 \times 10^{-2} 2402^{0.6834} = 2.68W > 0.478mW$

Result: The device meets the exemption requirement for BLE

RF Exposure Evaluation Result for WIF

Please refer to the SAR report, report No.: RXZ230110032SA02

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7 FCC §15.203 & RSS-GEN §6.8– Antenna Requirements

7.1 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.

According to RSS-Gen 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type

7.2 Antenna Information

Manufacturer	Type	Antenna Gain	Impedance
ZHEJIANG JIAKANG ELETRONICS	Chip Antenna	2.29 dBi	50Ω

Result: Compliance

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8 FCC §15.207(a) & RSS-GEN §8.8– AC Line Conducted Emissions

8.1 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.

According to RSS-GEN §8.8

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

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.

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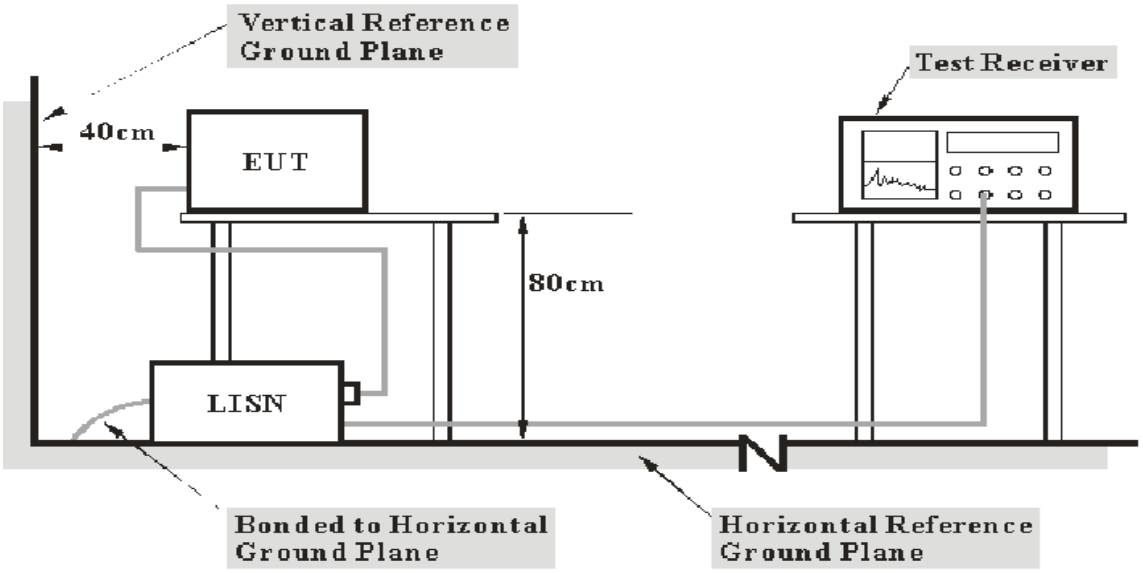
8.2 EUT Setup



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 and RSS-GEN limits.

8.3 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

8.4 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.

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8.5 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

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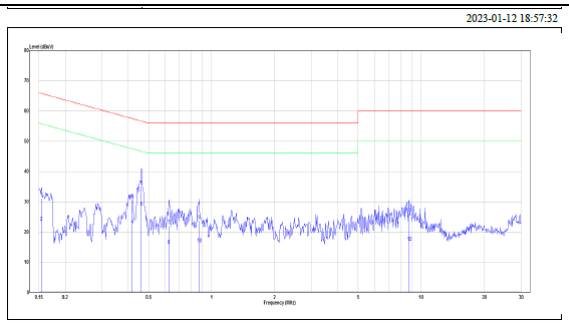
8.6 Test Results

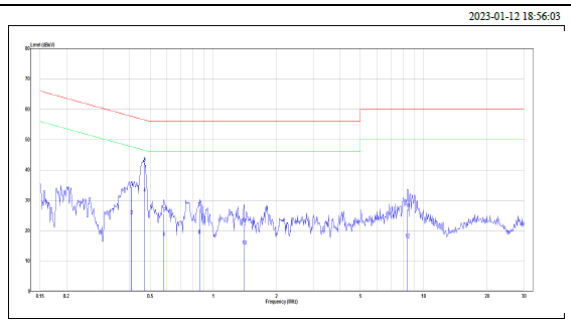
Main: AC120 V, 60 Hz,

2.4G WiFi

Neutral	Line



No.	Frequency (MHz)	Reading dBuV	Correct Factor(dB)	Result dBuV	Limit dBuV	Over limit (dB)	Remark	Phase
1	0.154	11.66	19.49	31.15	65.78	-34.63	QP	Neutral
2	0.154	3.72	19.49	23.21	55.78	-32.57	Average	Neutral
3	0.417	11.24	19.50	30.74	57.51	-26.77	QP	Neutral
4	0.417	2.95	19.50	22.45	47.51	-25.06	Average	Neutral
5	0.461	15.62	19.50	35.12	56.67	-21.55	QP	Neutral
6	0.461	8.78	19.50	28.28	46.67	-18.39	Average	Neutral
7	0.624	2.62	19.51	22.13	56.00	-33.87	QP	Neutral
8	0.624	-3.93	19.51	15.57	46.00	-30.43	Average	Neutral
9	0.871	4.26	19.52	23.77	56.00	-32.23	QP	Neutral
10	0.871	-3.27	19.52	16.24	46.00	-29.76	Average	Neutral
11	8.776	6.38	19.72	26.10	60.00	-33.90	QP	Neutral
12	8.776	-3.05	19.72	16.67	50.00	-33.33	Average	Neutral



No.	Frequency (MHz)	Reading dBuV	Correct Factor(dB)	Result dBuV	Limit dBuV	Over limit (dB)	Remark	Phase
1	0.408	14.97	19.49	34.46	57.68	-23.22	QP	Line
2	0.408	5.42	19.49	24.90	47.68	-22.78	Average	Line
3	0.471	22.92	19.49	42.41	56.49	-14.08	QP	Line
4	0.471	12.87	19.49	32.36	46.49	-14.14	Average	Line
5	0.582	6.19	19.49	25.68	56.00	-30.32	QP	Line
6	0.582	-1.65	19.49	17.85	46.00	-28.15	Average	Line
7	0.857	7.80	19.50	27.30	56.00	-28.70	QP	Line
8	0.857	-0.93	19.50	18.57	46.00	-27.43	Average	Line
9	1.403	2.90	19.52	22.43	56.00	-33.57	QP	Line
10	1.403	-4.50	19.52	15.03	46.00	-30.97	Average	Line
11	8.367	7.53	19.69	27.22	60.00	-32.78	QP	Line
12	8.367	-2.48	19.69	17.21	50.00	-32.79	Average	Line

Note:

Level = Read Level + Factor

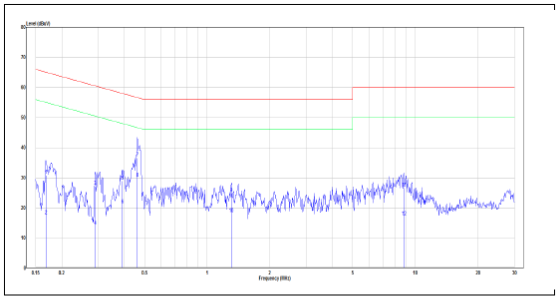
Over Limit = Level – Limit Line

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

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

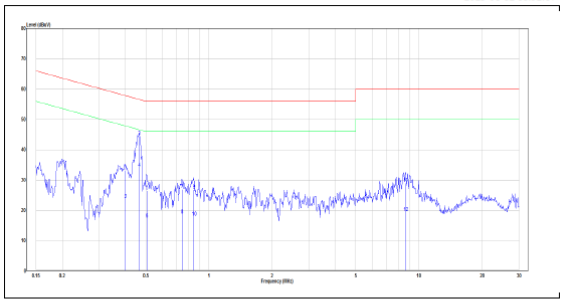
BLE

Neutral



No.	Frequency (MHz)	Reading dBuV	Correct Factor(dB)	Result dBuV	Limit dBuV	Over limit (dB)	Remark	Phase
1	0.168	11.36	19.49	30.85	65.08	-34.23	QP	Neutral
2	0.168	-2.05	19.49	17.44	55.08	-37.64	Average	Neutral
3	0.289	7.69	19.49	27.18	60.54	-33.36	QP	Neutral
4	0.289	-5.56	19.49	13.93	50.54	-36.61	Average	Neutral
5	0.391	9.47	19.50	28.96	58.03	-29.07	QP	Neutral
6	0.391	1.61	19.50	21.10	48.03	-26.93	Average	Neutral
7	0.461	17.13	19.50	36.63	56.67	-20.04	QP	Neutral
8	0.461	10.34	19.50	29.84	46.67	-16.83	Average	Neutral
9	1.303	5.36	19.53	24.89	56.00	-31.11	QP	Neutral
10	1.303	-1.41	19.53	18.12	46.00	-27.88	Average	Neutral
11	8.822	6.97	19.72	26.69	60.00	-33.31	QP	Neutral
12	8.822	-2.61	19.72	17.11	50.00	-32.89	Average	Neutral

Line



No.	Frequency (MHz)	Reading dBuV	Correct Factor(dB)	Result dBuV	Limit dBuV	Over limit (dB)	Remark	Phase
1	0.400	13.65	19.49	33.14	57.86	-24.72	QP	Line
2	0.400	4.01	19.49	23.49	47.86	-24.37	Average	Line
3	0.466	24.90	19.49	44.39	56.58	-12.19	QP	Line
4	0.466	14.52	19.49	34.01	46.58	-12.58	Average	Line
5	0.505	7.04	19.49	26.53	56.00	-29.47	QP	Line
6	0.505	-2.27	19.49	17.22	46.00	-28.78	Average	Line
7	0.743	7.35	19.50	26.85	56.00	-29.15	QP	Line
8	0.743	-0.97	19.50	18.53	46.00	-27.47	Average	Line
9	0.848	7.32	19.50	26.82	56.00	-29.18	QP	Line
10	0.848	-1.75	19.50	17.76	46.00	-28.24	Average	Line
11	8.637	9.35	19.70	29.04	60.00	-30.96	QP	Line
12	8.637	-0.38	19.70	19.31	50.00	-30.69	Average	Line

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

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

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

9 FCC §15.209, §15.205, §15.247(d) & RSS-GEN §8.9, §8.10 – Spurious Emissions

9.1 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 RSS-Gen 8.10,

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

(a)The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).

(b)Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c)Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

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) and RSS-GEN §8.9: 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:

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

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.

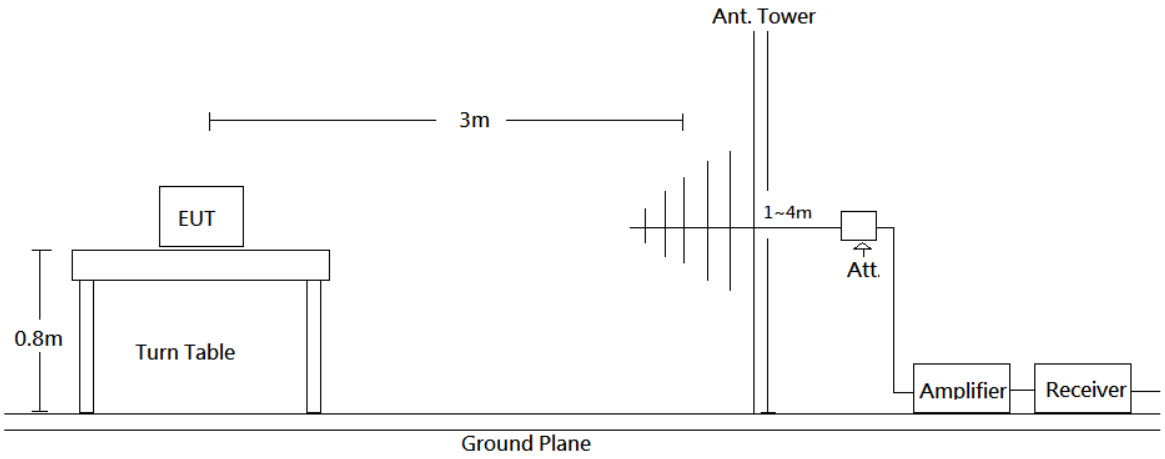
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the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

As per RSS-247 5.5,
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

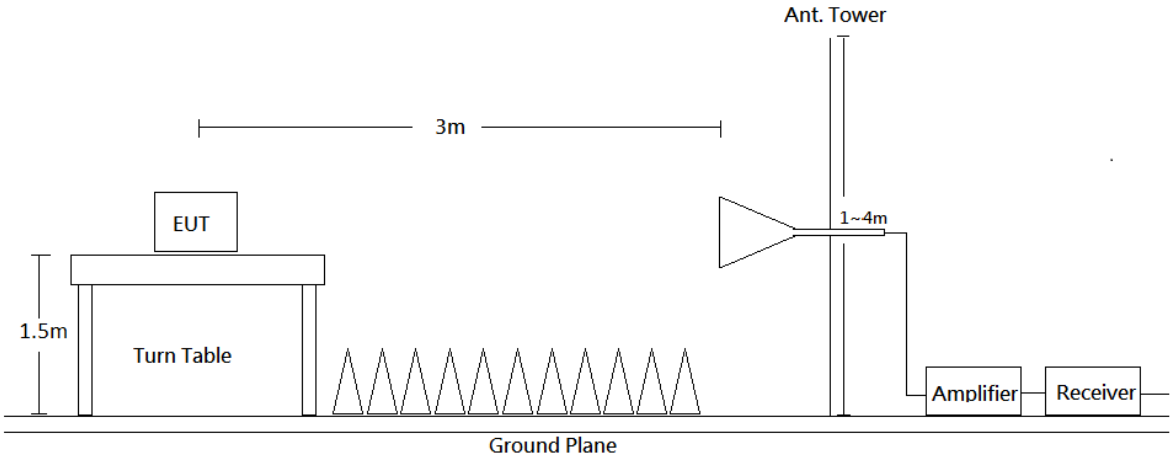
Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

9.2 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, FCC 15.247 and RSS-Gen, RSS-247 Limits.

9.3 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

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

9.4 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.

9.5 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

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

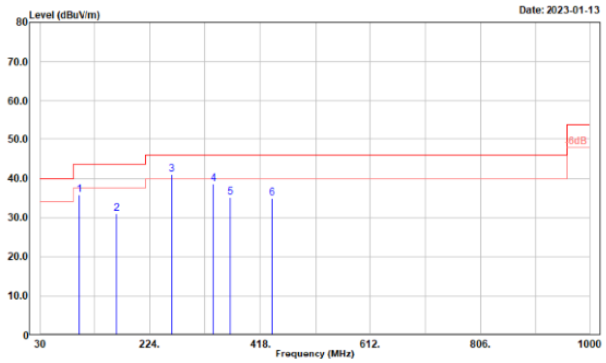
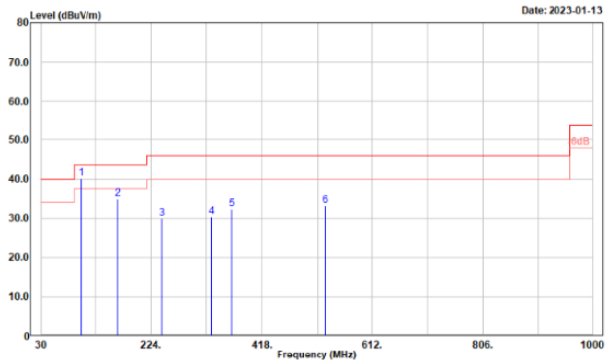
9.6 Test Results

Test Mode: Transmitting

Power: AC120/60Hz

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

30MHz-1GHz:

Horizontal	Vertical
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
98.939	47.88	-12.07	35.81	43.50	-7.69	100	332	QP
165.936	40.61	-9.53	31.08	43.50	-12.42	100	290	QP
263.033	49.42	-8.41	41.01	46.00	-4.99	100	254	QP
335.856	44.76	-6.24	38.52	46.00	-7.48	100	313	QP
364.985	40.44	-5.34	35.10	46.00	-10.90	100	324	QP
437.808	38.17	-3.22	34.95	46.00	-11.05	100	23	QP

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
99.910	51.79	-11.77	40.02	43.50	-3.48	100	41	QP
165.936	44.36	-9.53	34.83	43.50	-8.67	100	1	QP
243.614	39.29	-9.29	30.00	46.00	-16.00	100	359	QP
329.059	36.70	-6.39	30.31	46.00	-15.69	100	156	QP
365.956	37.58	-5.33	32.25	46.00	-13.75	100	300	QP
531.021	34.76	-1.54	33.22	46.00	-12.78	100	359	QP

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

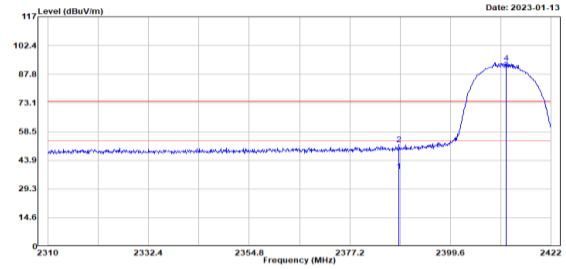
Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

Fundamental:

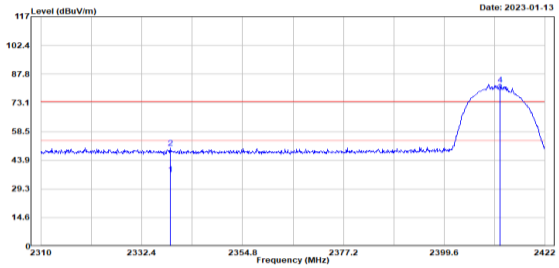
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2388.142	43.06	-4.60	38.46	54.00	-15.54	101	136	Average
2388.142	56.56	-4.60	51.96	74.00	-22.04	101	136	Peak
2412.000	94.58	-4.42	90.16			101	136	Average
2412.000	98.03	-4.42	93.61			101	136	Peak

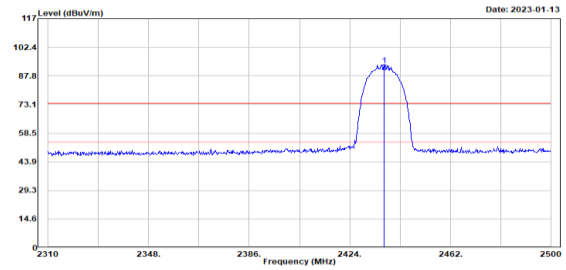
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2338.813	41.82	-4.97	36.85	54.00	-17.15	150	193	Average
2338.813	55.07	-4.97	50.10	74.00	-23.90	150	193	Peak
2412.000	83.20	-4.42	78.78			150	193	Average
2412.000	86.72	-4.42	82.30			150	193	Peak

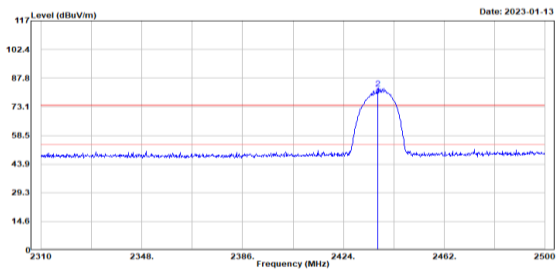
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2437.000	97.56	-4.22	93.34			103	300	Average
2437.000	94.05	-4.24	89.81			103	300	Average

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2437.000	83.25	-4.20	79.05			150	177	Average
2437.000	86.55	-4.20	82.35			152	177	Peak

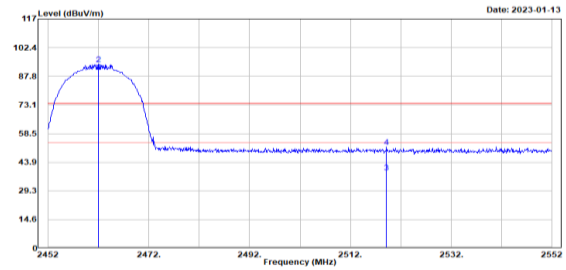
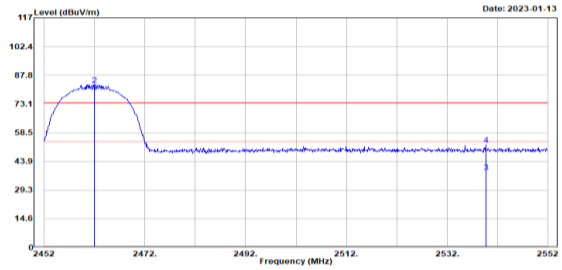
Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

High channel	
Horizontal	**Vertical**
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2462.000	93.93	-3.97	89.96			105	297	Average
2462.000	97.70	-3.97	93.73			105	297	Peak
2519.167	41.84	-3.29	38.55	54.00	-15.45	105	297	Average
2519.167	55.13	-3.29	51.84	74.00	-22.16	105	297	Peak

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2462.000	83.34	-3.98	79.36			154	198	Average
2462.000	86.86	-3.98	82.88			154	198	Peak
2539.688	41.38	-3.10	38.28	54.00	-15.72	150	198	Average
2539.688	55.29	-3.10	52.19	74.00	-21.81	150	198	Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

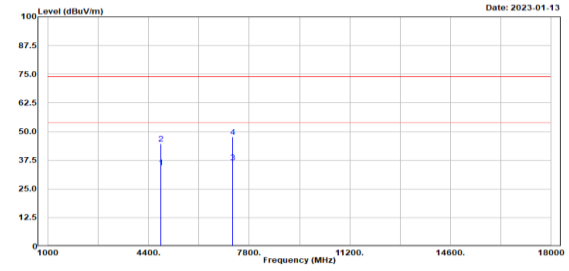
Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

1GHz~18GHz

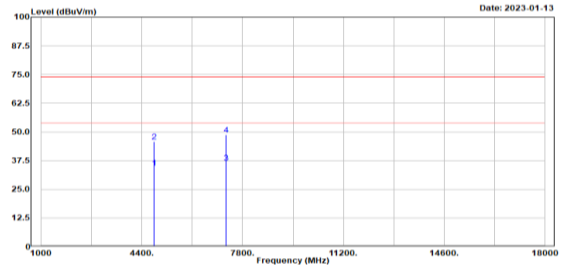
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4824.000	31.10	3.43	34.53	54.00	-19.47	156	241	Average
4824.000	41.29	3.43	44.72	74.00	-29.28	156	241	Peak
7236.000	27.51	9.21	36.72	54.00	-17.28	153	349	Average
7236.000	38.46	9.21	47.67	74.00	-26.33	153	349	Peak

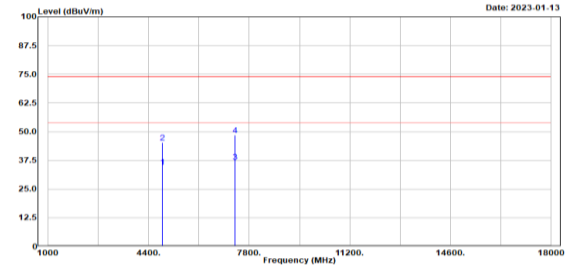
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4824.000	30.98	3.43	34.41	54.00	-19.59	155	196	Average
4824.000	42.40	3.43	45.83	74.00	-28.17	155	196	Peak
7236.000	27.36	9.21	36.57	54.00	-17.43	147	88	Average
7236.000	39.66	9.21	48.87	74.00	-25.13	147	88	Peak

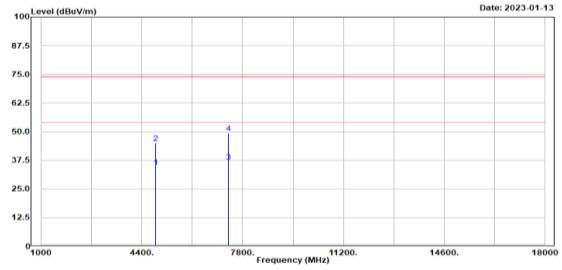
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4874.000	31.10	3.54	34.64	54.00	-19.36	156	350	Average
4874.000	41.61	3.54	45.15	74.00	-28.85	156	350	Peak
7311.000	27.69	9.25	36.94	54.00	-17.06	154	213	Average
7311.000	39.31	9.25	48.56	74.00	-25.44	154	213	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4874.000	30.87	3.54	34.41	54.00	-19.59	148	2	Average
4874.000	41.32	3.54	44.86	74.00	-29.14	148	2	Peak
7311.000	27.67	9.25	36.92	54.00	-17.08	145	317	Average
7311.000	40.21	9.25	49.46	74.00	-24.54	145	317	Peak

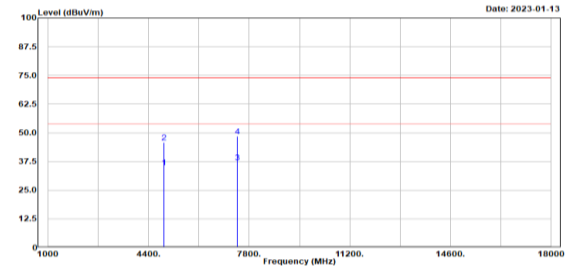
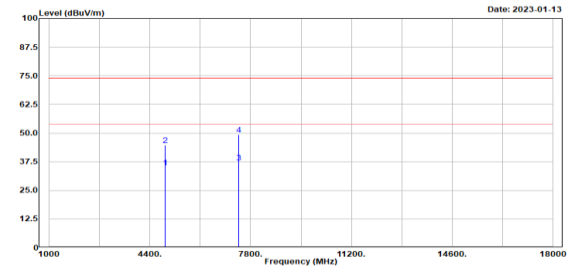
Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

High channel	
Horizontal	**Vertical**
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4924.000	31.15	3.77	34.92	54.00	-19.08	152	0	Average
4924.000	41.94	3.77	45.71	74.00	-28.29	152	0	Peak
7386.000	27.91	9.23	37.14	54.00	-16.86	144	186	Average
7386.000	39.22	9.23	48.45	74.00	-25.55	144	186	Peak

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4924.000	31.18	3.77	34.95	54.00	-19.05	146	321	Average
4924.000	41.07	3.77	44.84	74.00	-29.16	146	321	Peak
7386.000	27.85	9.23	37.08	54.00	-16.92	153	223	Average
7386.000	40.16	9.23	49.39	74.00	-24.61	153	223	Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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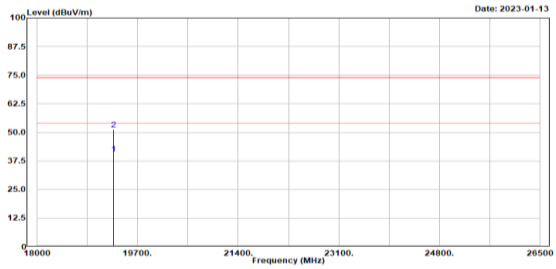
18GHz~26.5GHz

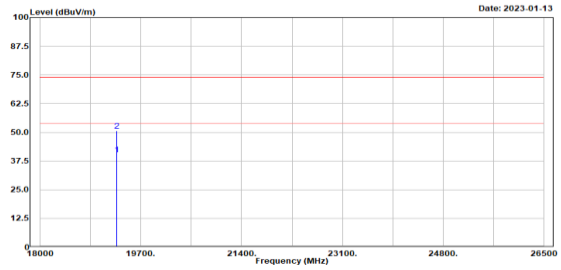
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19296.000	40.79	-0.24	40.55	54.00	-13.45	150	303	Average
19296.000	51.43	-0.24	51.19	74.00	-22.81	150	303	Peak

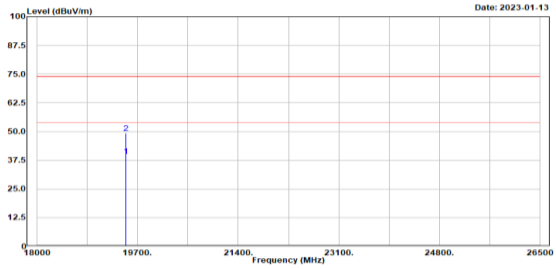
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19296.000	40.66	-0.24	40.42	54.00	-13.58	150	217	Average
19296.000	51.00	-0.24	50.76	74.00	-23.24	150	217	Peak

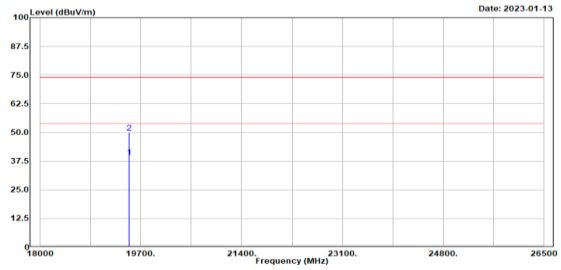
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19496.000	39.07	0.25	39.32	54.00	-14.68	150	154	Average
19496.000	49.15	0.25	49.40	74.00	-24.60	150	154	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19496.000	39.03	0.25	39.28	54.00	-14.72	150	64	Average
19496.000	49.51	0.25	49.76	74.00	-24.24	150	64	Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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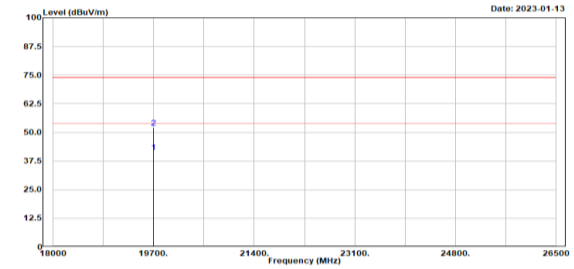
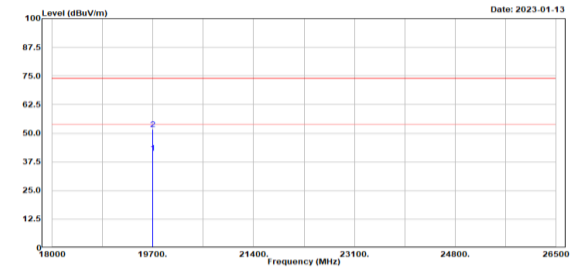
High channel	
Horizontal	**Vertical**
	
Freq. Reading Factor Level Limit Margin Height Degree Remark MHz dBuV dB/m dBuV/m dBuV/m dB (cm) (°) 19696.000 40.38 0.98 41.36 54.00 -12.64 150 131 Average 19696.000 50.97 0.98 51.95 74.00 -22.05 150 131 Peak	Freq. Reading Factor Level Limit Margin Height Degree Remark MHz dBuV dB/m dBuV/m dBuV/m dB (cm) (°) 19696.000 40.41 0.98 41.39 54.00 -12.61 150 205 Average 19696.000 50.83 0.98 51.81 74.00 -22.19 150 205 Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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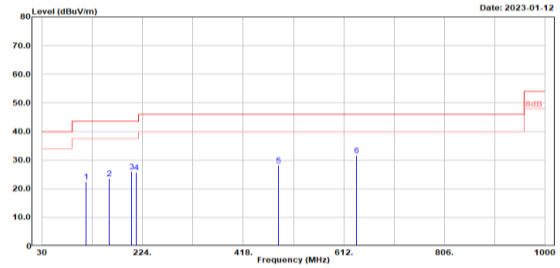
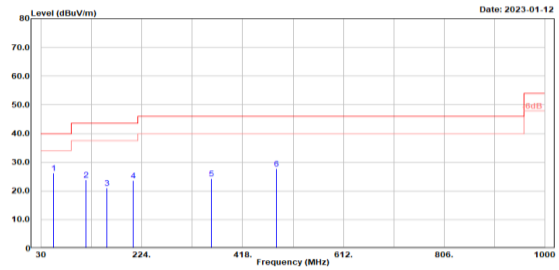
BLE Mode (Pre-scan with three orthogonal axis, and worse case as Y axis.)

30MHz-1GHz:

Horizontal	Vertical
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
115.445	31.22	-8.59	22.63	43.50	-20.87	100	252	QP
159.139	32.82	-9.10	23.72	43.50	-19.78	100	22	QP
202.833	35.65	-9.65	26.00	43.50	-17.50	100	76	QP
211.572	36.77	-10.89	25.88	43.50	-17.62	100	76	QP
485.385	30.18	-2.06	28.12	46.00	-17.88	100	118	QP
636.857	30.95	0.72	31.67	46.00	-14.33	100	0	QP

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
53.303	41.38	-15.06	26.32	40.00	-13.68	100	13	QP
116.416	32.37	-8.50	23.87	43.50	-19.63	100	40	QP
157.197	30.06	-9.11	20.95	43.50	-22.55	100	179	QP
207.688	34.40	-10.68	23.72	43.50	-19.78	100	108	QP
358.188	29.88	-5.50	24.38	46.00	-21.62	100	357	QP
482.473	29.91	-2.07	27.84	46.00	-18.16	100	175	QP

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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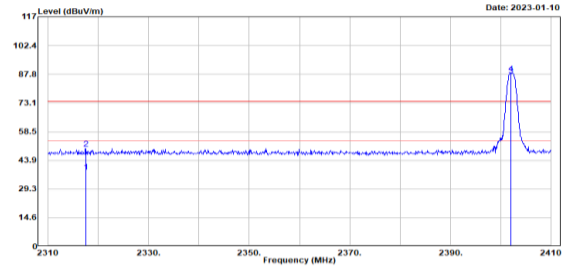
Fundamental:

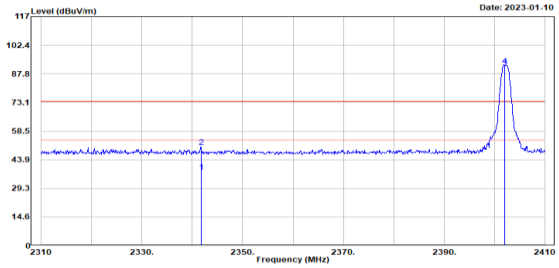
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2317.508	43.08	-5.00	38.08	54.00	-15.92	132	16	Average
2317.508	54.90	-5.00	49.90	74.00	-24.10	132	16	Peak
2402.000	91.64	-4.48	87.16			132	16	Average
2402.000	92.77	-4.48	88.29			132	16	Peak

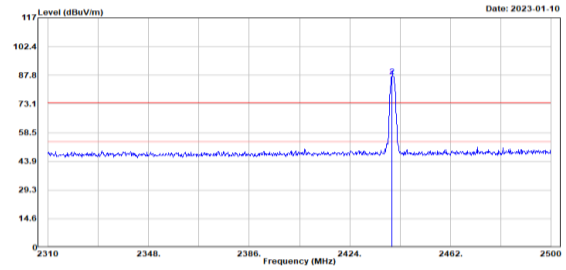
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2341.732	42.85	-4.97	37.88	54.00	-16.12	147	360	Average
2341.732	55.52	-4.97	50.55	74.00	-23.45	147	360	Peak
2402.000	95.46	-4.48	90.98			147	360	Average
2402.000	96.58	-4.48	92.10			147	360	Peak

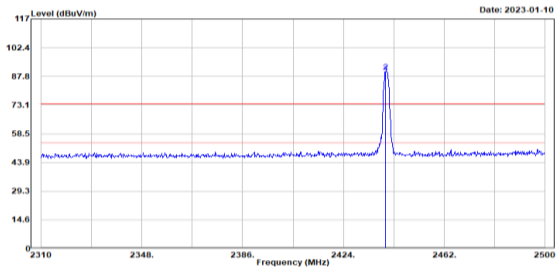
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2440.000	90.34	-4.20	86.14			137	360	Average
2440.000	91.48	-4.20	87.28			137	360	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2440.000	93.21	-4.20	89.01			147	340	Average
2440.000	94.40	-4.20	90.20			147	340	Peak

Level (Result) = Reading + Factor.

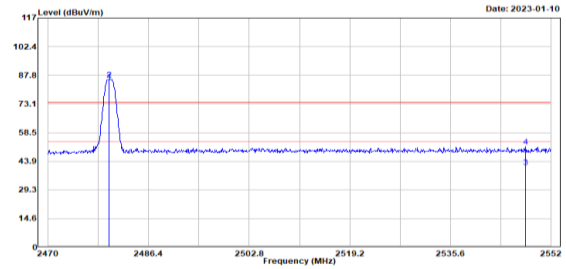
Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

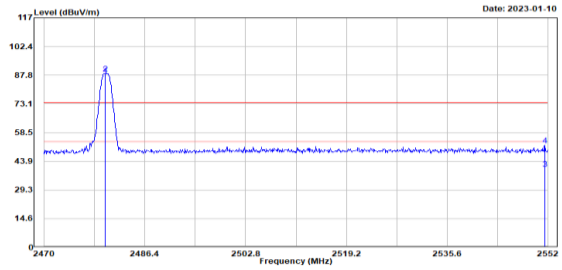
Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

High channel	
Horizontal	**Vertical**



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	88.31	-3.73	84.58			117	276	Average
2480.000	89.45	-3.73	85.72			117	276	Peak
2547.896	43.85	-3.04	40.81	54.00	-13.19	117	276	Average
2547.896	54.27	-3.04	51.23	74.00	-22.77	117	276	Peak



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	91.13	-3.73	87.40			113	360	Average
2480.000	92.28	-3.73	88.55			113	360	Peak
2551.508	42.92	-3.01	39.91	54.00	-14.09	113	360	Average
2551.508	55.11	-3.01	52.10	74.00	-21.90	113	360	Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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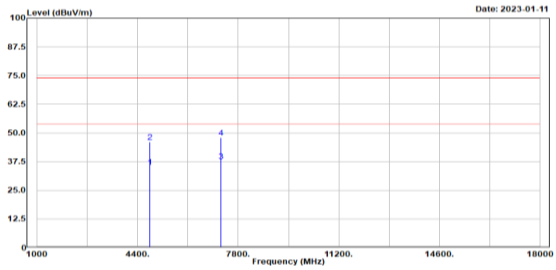
1GHz-18GHz:

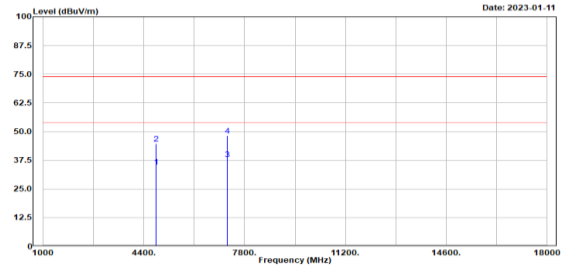
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	31.65	3.45	35.10	54.00	-18.90	153	223	Average
4804.000	42.62	3.45	46.07	74.00	-27.93	153	223	Peak
7206.000	28.71	9.05	37.76	54.00	-16.24	151	91	Average
7206.000	38.86	9.05	47.91	74.00	-26.09	151	91	Peak

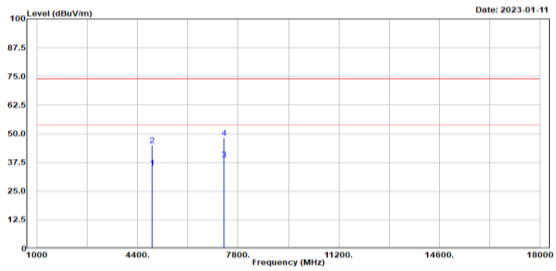
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	31.28	3.45	34.73	54.00	-19.27	154	338	Average
4804.000	41.15	3.45	44.60	74.00	-29.40	154	338	Peak
7206.000	28.87	9.05	37.92	54.00	-16.08	147	29	Average
7206.000	39.21	9.05	48.26	74.00	-25.74	147	29	Peak

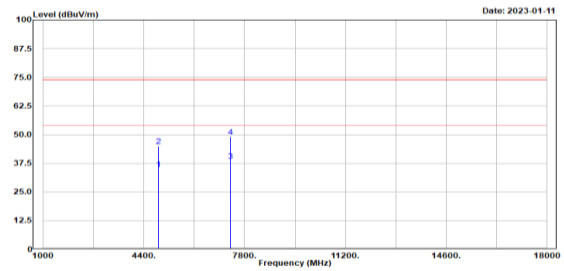
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	31.72	3.57	35.29	54.00	-18.71	153	211	Average
4880.000	41.51	3.57	45.08	74.00	-28.92	153	211	Peak
7320.000	29.38	9.25	38.63	54.00	-15.37	152	10	Average
7320.000	39.12	9.25	48.37	74.00	-25.63	152	10	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	31.49	3.57	35.06	54.00	-18.94	155	157	Average
4880.000	41.47	3.57	45.04	74.00	-28.96	155	157	Peak
7320.000	29.36	9.25	38.61	54.00	-15.39	152	331	Average
7320.000	39.78	9.25	49.03	74.00	-24.97	152	331	Peak

Level (Result) = Reading + Factor.

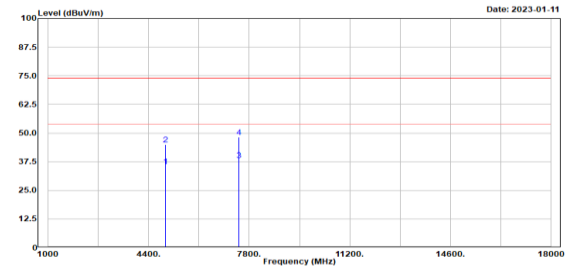
Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

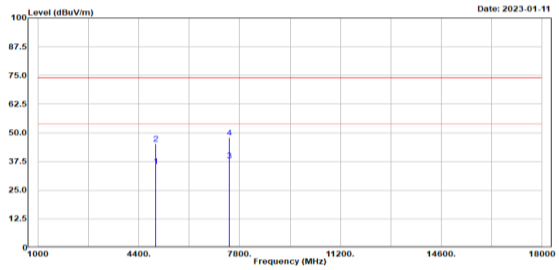
Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

High channel	
Horizontal	**Vertical**



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	31.45	3.92	35.37	54.00	-18.63	154	300	Average
4960.000	40.99	3.92	44.91	74.00	-29.09	154	300	Peak
7440.000	28.74	9.42	38.16	54.00	-15.84	152	188	Average
7440.000	38.74	9.42	48.16	74.00	-25.84	152	188	Peak



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	31.51	3.92	35.43	54.00	-18.57	156	0	Average
4960.000	41.41	3.92	45.33	74.00	-28.67	156	0	Peak
7440.000	28.63	9.42	38.05	54.00	-15.95	147	333	Average
7440.000	38.67	9.42	48.09	74.00	-25.91	147	333	Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

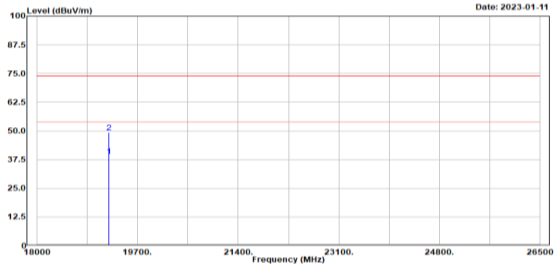
Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

18GHz-26.5GHz:

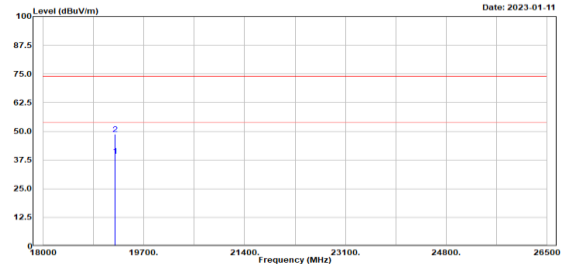
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	39.68	-0.57	39.11	54.00	-14.89	150	75	Average
19216.000	49.85	-0.57	49.28	74.00	-24.72	150	75	Peak

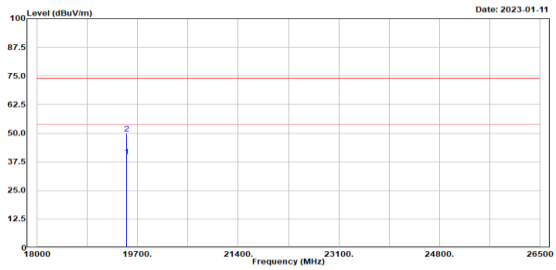
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	39.88	-0.57	39.31	54.00	-14.69	150	127	Average
19216.000	49.39	-0.57	48.82	74.00	-25.18	150	127	Peak

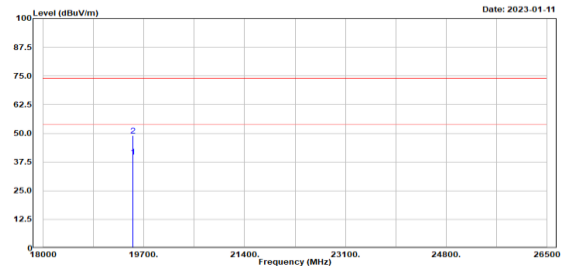
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19520.000	39.42	0.34	39.76	54.00	-14.24	150	270	Average
19520.000	49.45	0.34	49.79	74.00	-24.21	150	270	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19520.000	39.47	0.34	39.81	54.00	-14.19	150	96	Average
19520.000	48.77	0.34	49.11	74.00	-24.89	150	96	Peak

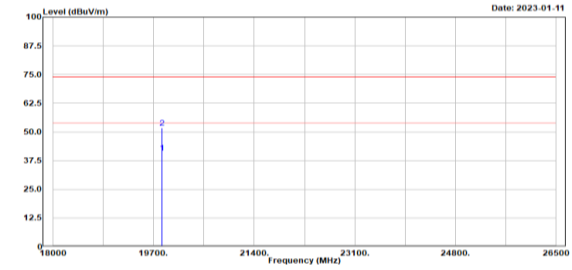
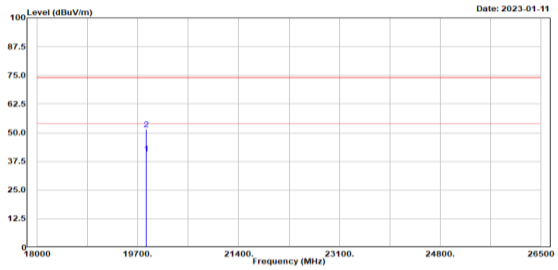
Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

Note: It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (New Taipei Laboratory)

High channel	
Horizontal	**Vertical**
 Freq. Reading Factor Level Limit Margin Height Degree Remark MHz dBuV dB/m dBuV/m dBuV/m dB (cm) (°) 19840.000 39.74 1.22 40.96 54.00 -13.04 150 3 Average 19840.000 50.53 1.22 51.75 74.00 -22.25 150 3 Peak	 Freq. Reading Factor Level Limit Margin Height Degree Remark MHz dBuV dB/m dBuV/m dBuV/m dB (cm) (°) 19840.000 39.62 1.22 40.84 54.00 -13.16 150 135 Average 19840.000 50.19 1.22 51.41 74.00 -22.59 150 135 Peak

Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

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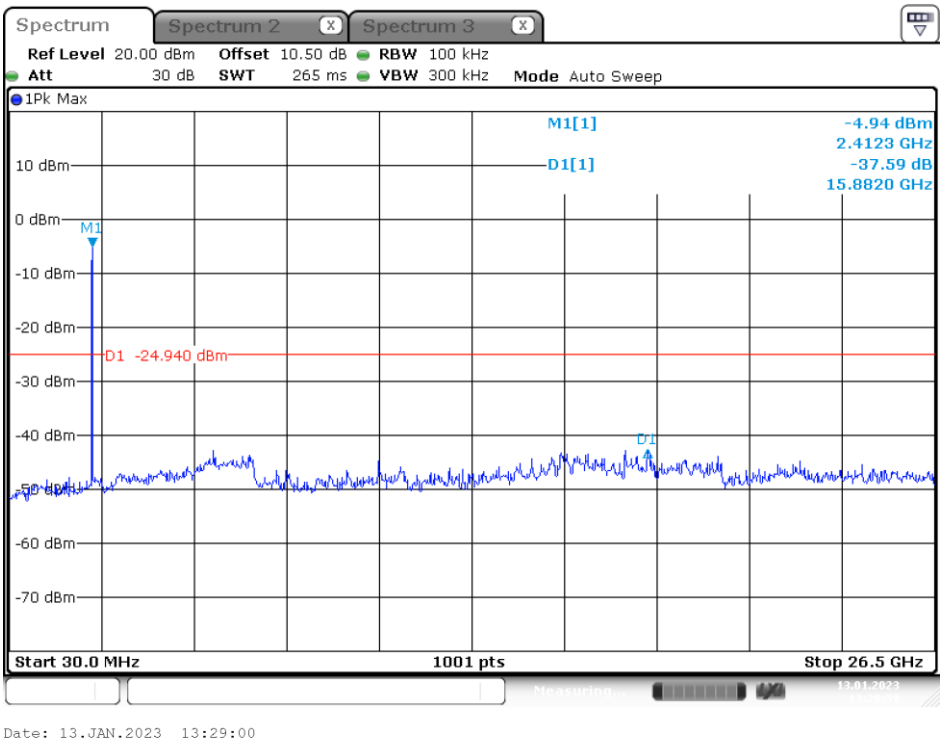
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	37.59	≥ 20	PASS
Middle	2437	37.66	≥ 20	PASS
High	2462	38.59	≥ 20	PASS
BLE Mode				
Low	2402	31.05	≥ 20	PASS
Mid	2440	30.91	≥ 20	PASS
High	2480	31.23	≥ 20	PASS

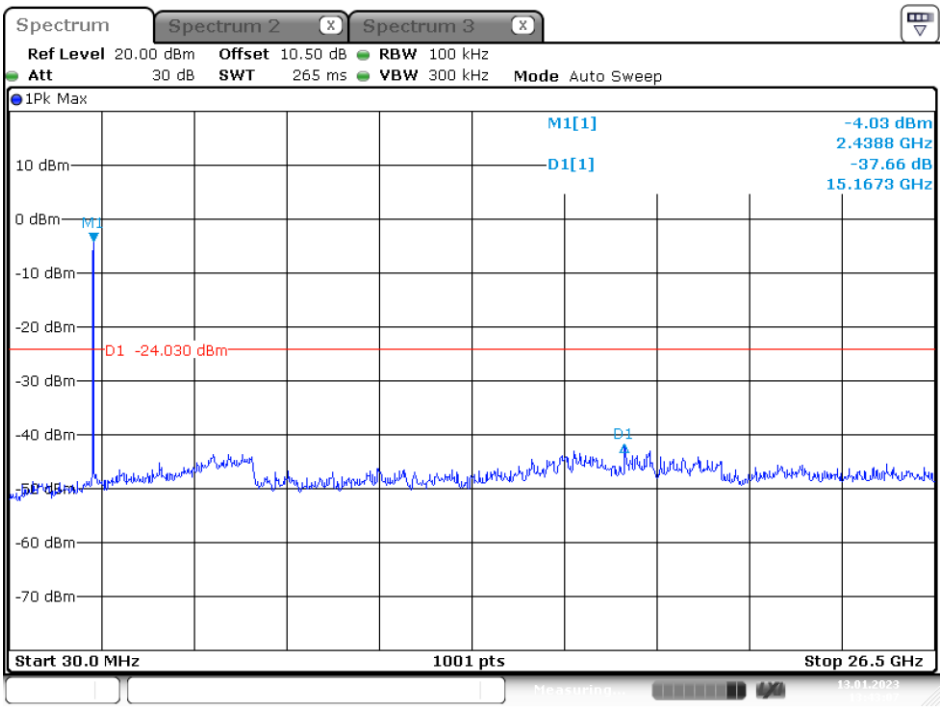
B Mode

Low Channel



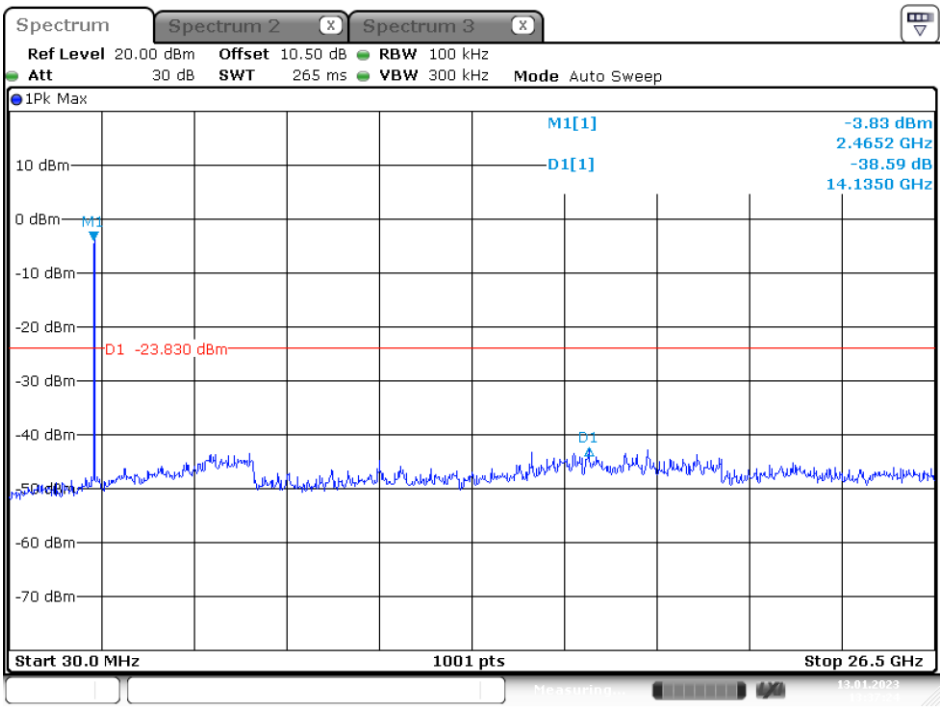
Date: 13.JAN.2023 13:29:00

Middle Channel



Date: 13.JAN.2023 13:43:08

High Channel



Date: 13.JAN.2023 13:37:24

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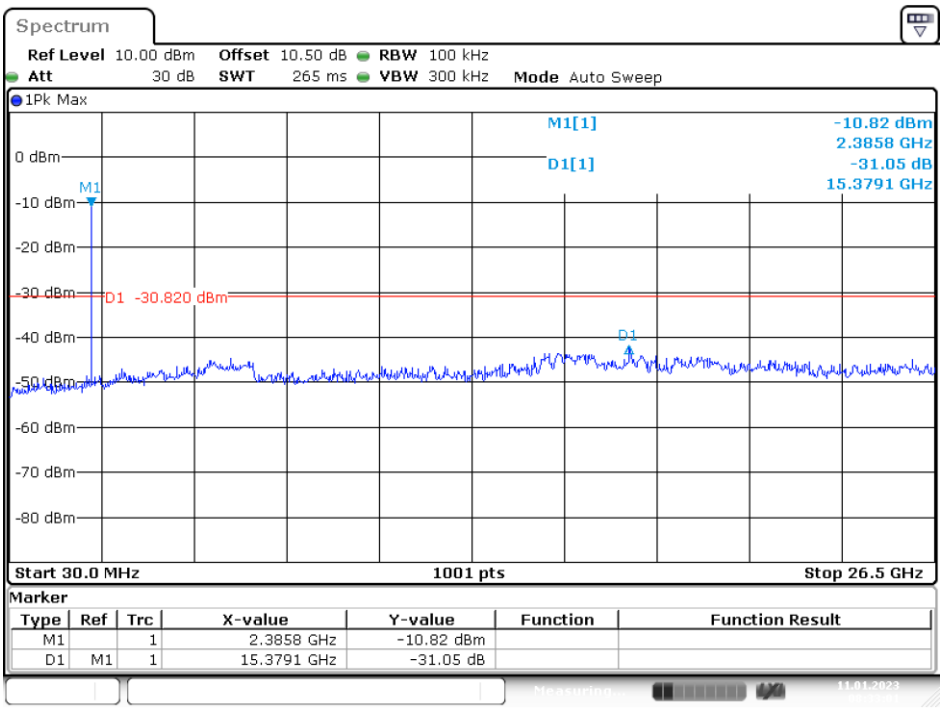
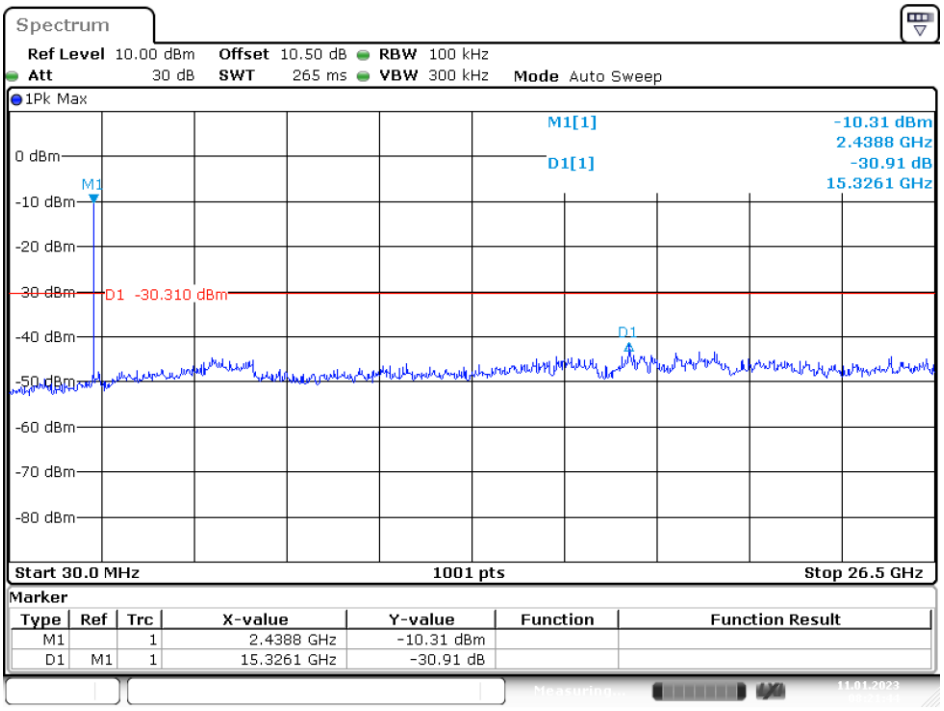
BLE Mode

Low Channel



Date: 11.JAN.2023 08:33:01

Middle Channel



Date: 11.JAN.2023 08:21:44

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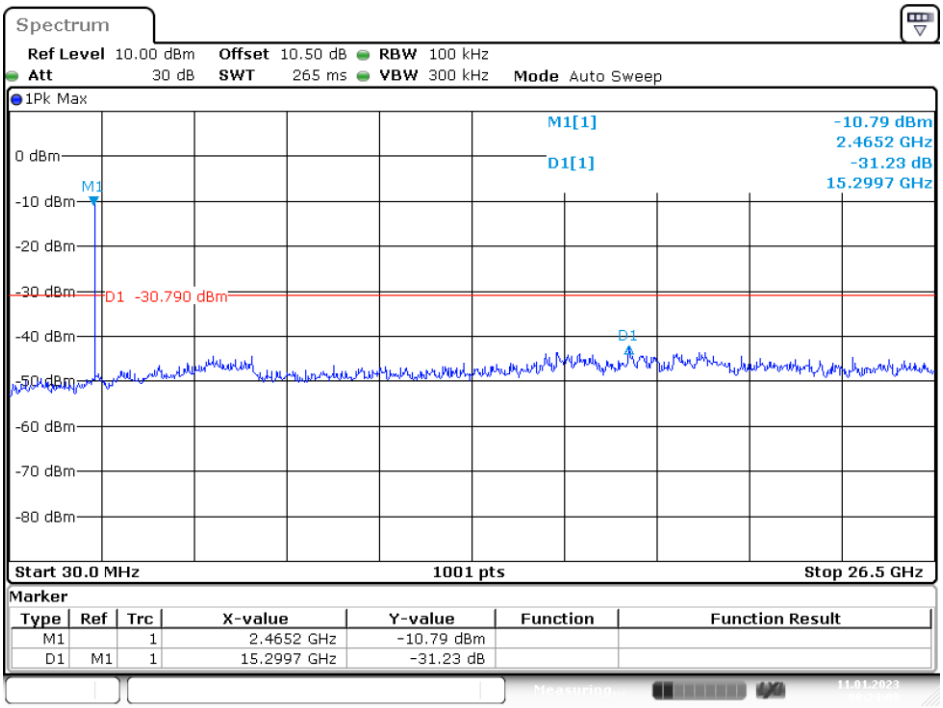
High Channel



Date: 11.JAN.2023 08:24:01

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10 FCC §15.247(a)(2) & RSS-247 §5.2(a), RSS-GEN §6.7 – 6 dB Emission Bandwidth & Occupied Bandwidth

10.1 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.

According to RSS-247 §5.2 (a)

The minimum 6 dB bandwidth shall be 500 kHz.

According to RSS-GEN §6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

10.2 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.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

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10.3 Test Results

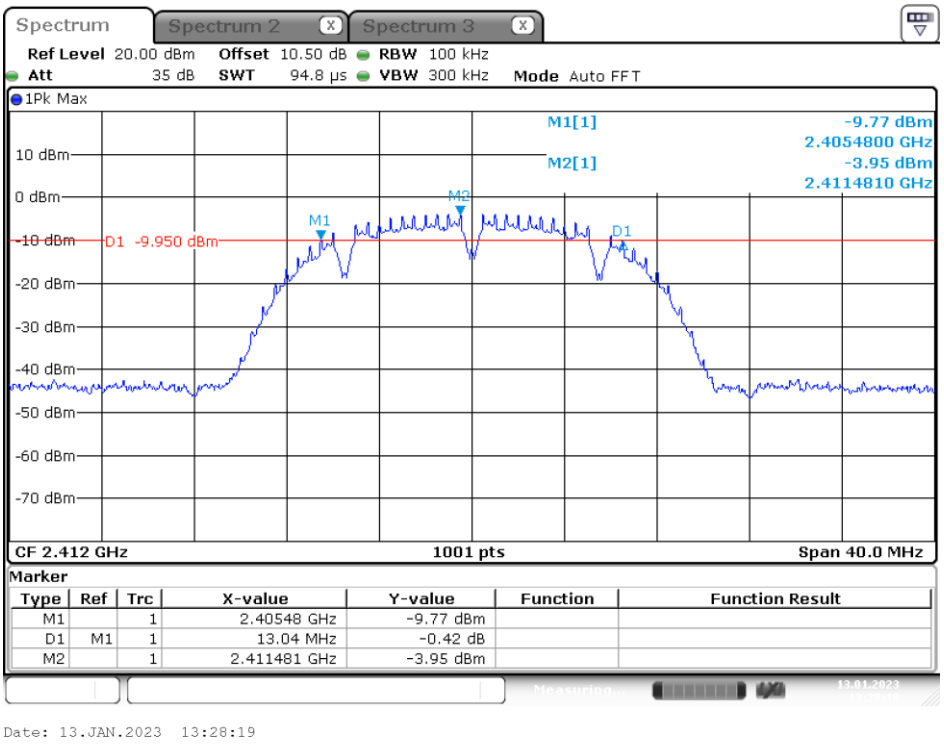
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% Bandwidth (MHz)	Limit (kHz)	Result
B Mode					
Low	2412	13.04	15.34	> 500	PASS
Middle	2437	13.04	15.34	> 500	PASS
High	2462	13.04	15.38	> 500	PASS
BLE Mode					
Low	2402	0.723	1.04	≥500	PASS
Mid	2440	0.723	1.05	≥500	PASS
High	2480	0.726	1.05	≥500	PASS

Please refer to the following plots

B Mode

6 dB Emission Bandwidth

Low Channel



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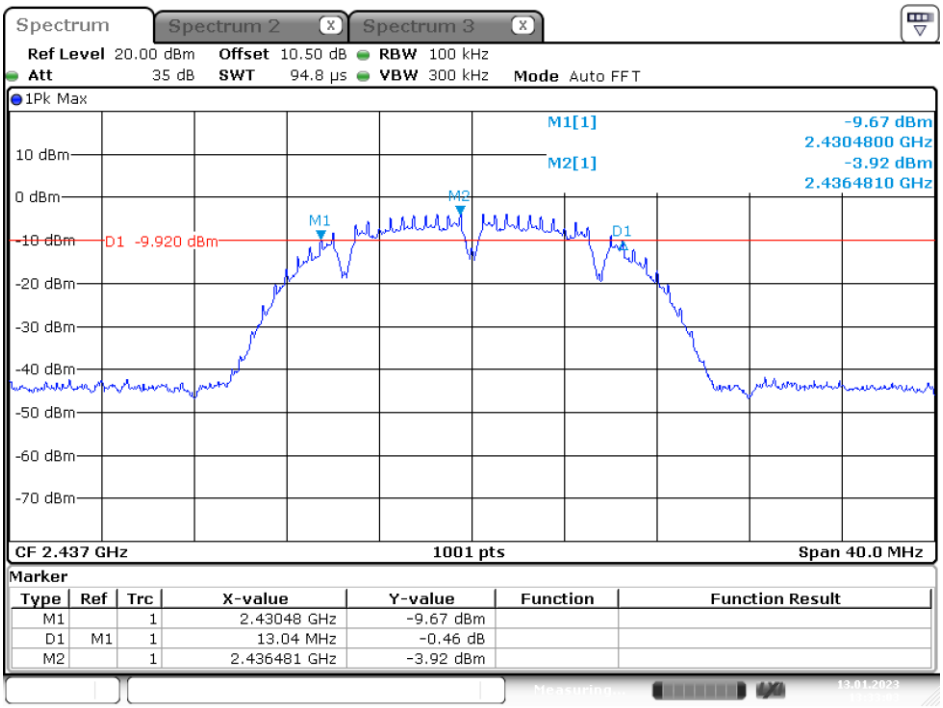
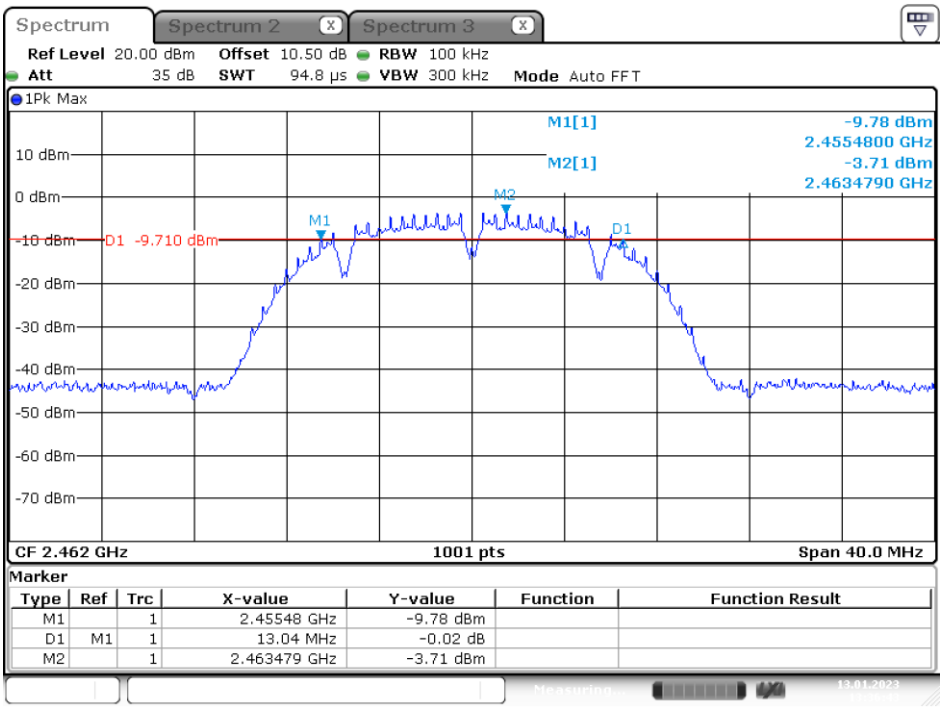
Middle Channel



Date: 13.JAN.2023 13:33:03

High Channel



Date: 13.JAN.2023 13:36:44

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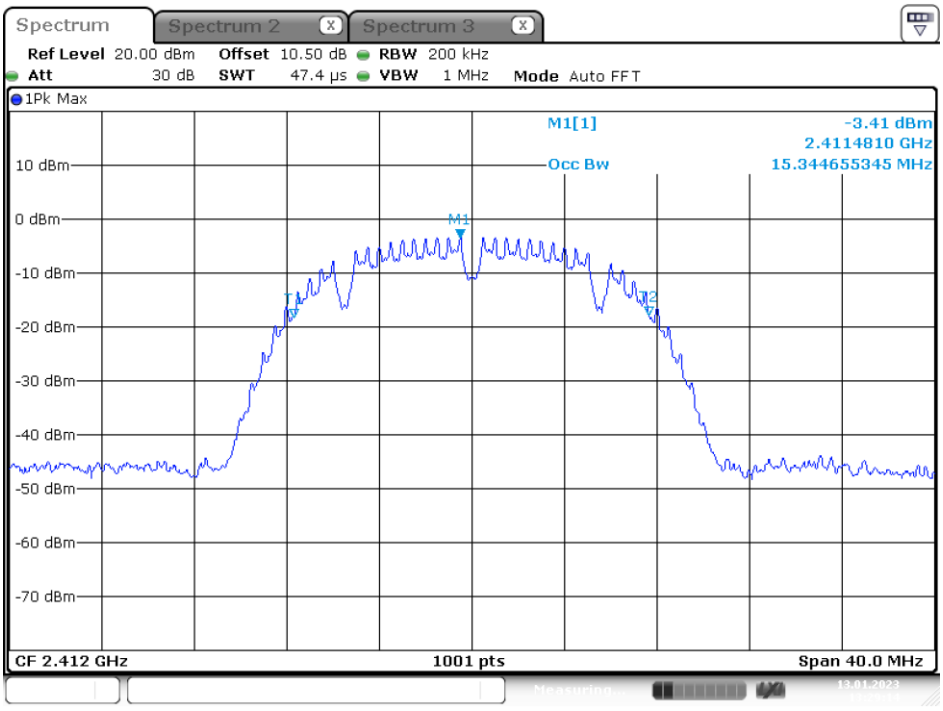
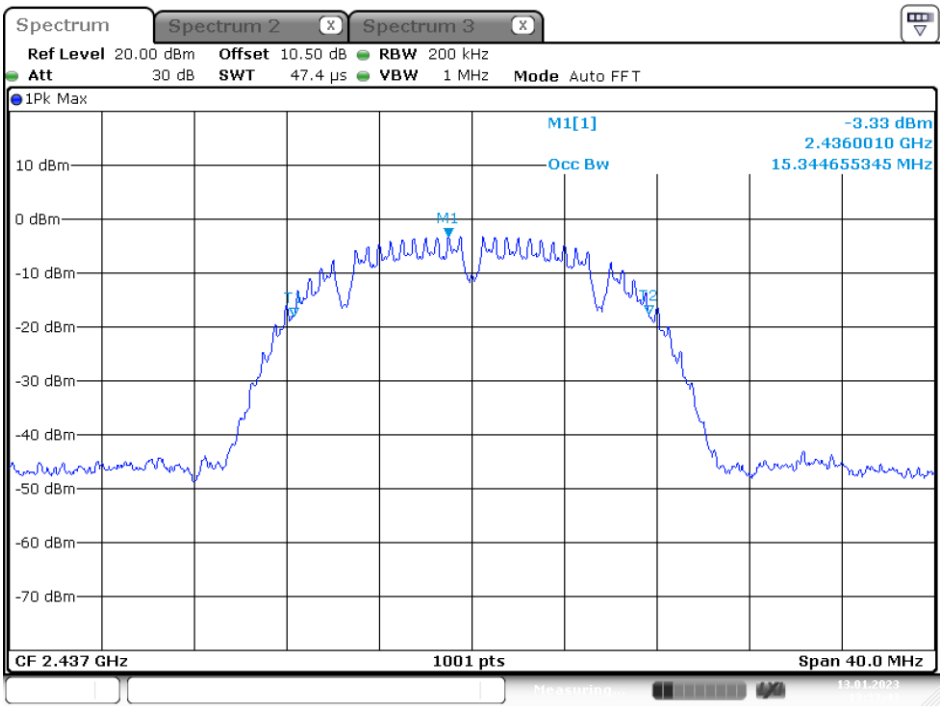
99% Bandwidth

Low Channel



Date: 13.JAN.2023 13:29:15

Middle Channel



Date: 13.JAN.2023 13:33:43

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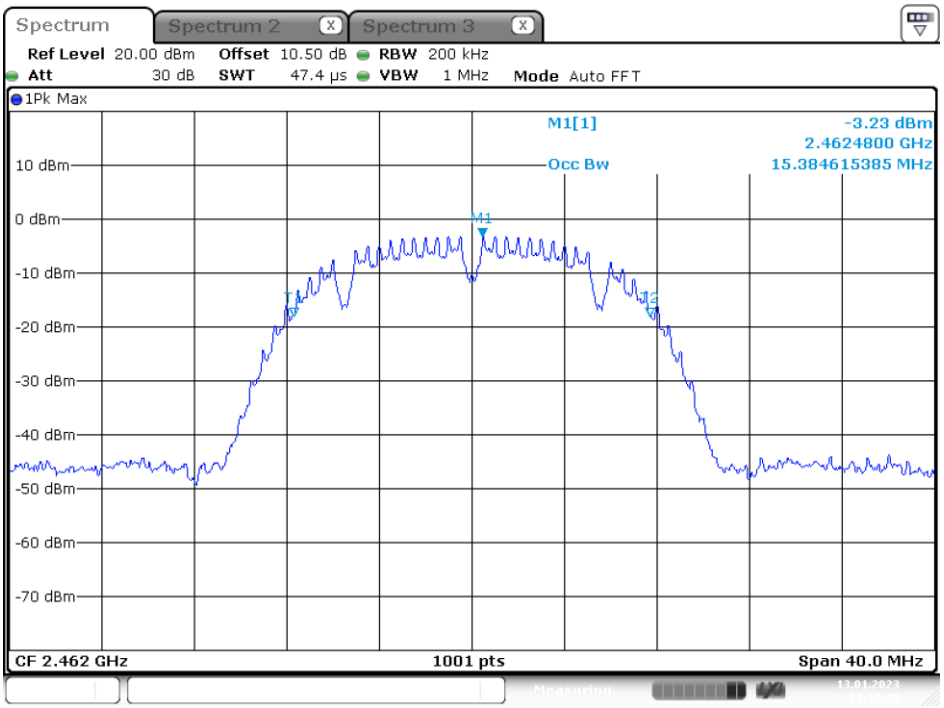
High Channel



Date: 13.JAN.2023 13:37:39

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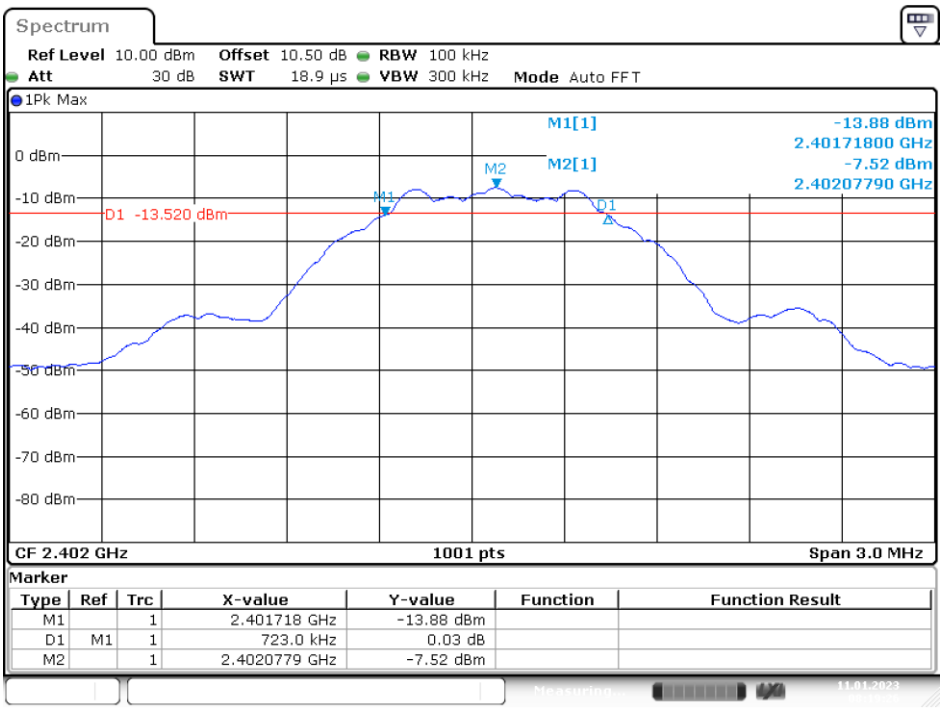
BLE

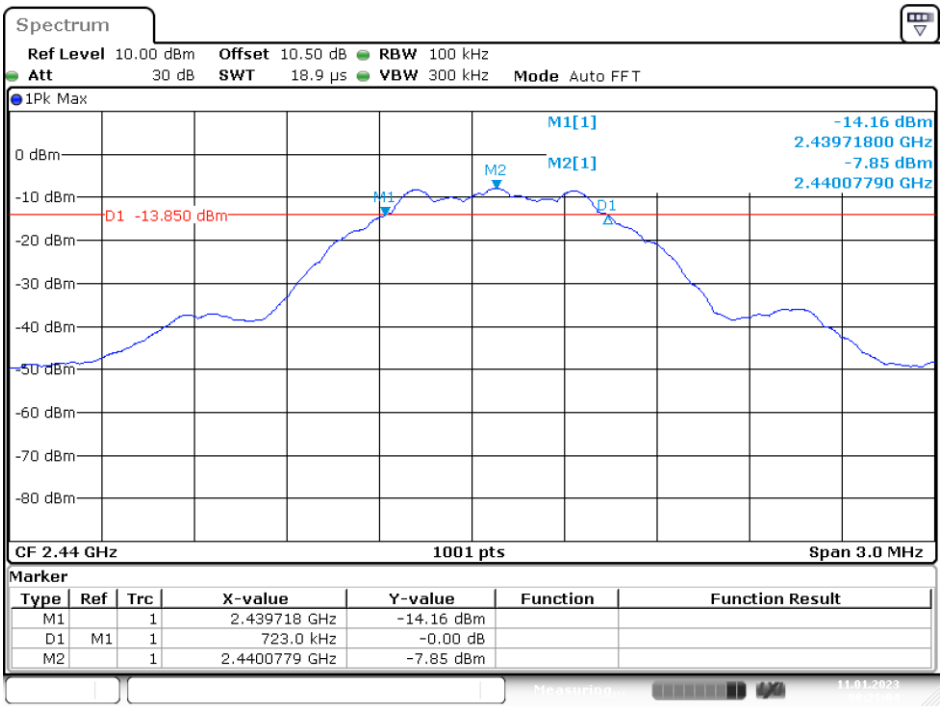
6 dB Emission Bandwidth

Low Channel



Date: 11.JAN.2023 08:19:27

Middle Channel



Date: 11.JAN.2023 08:21:04

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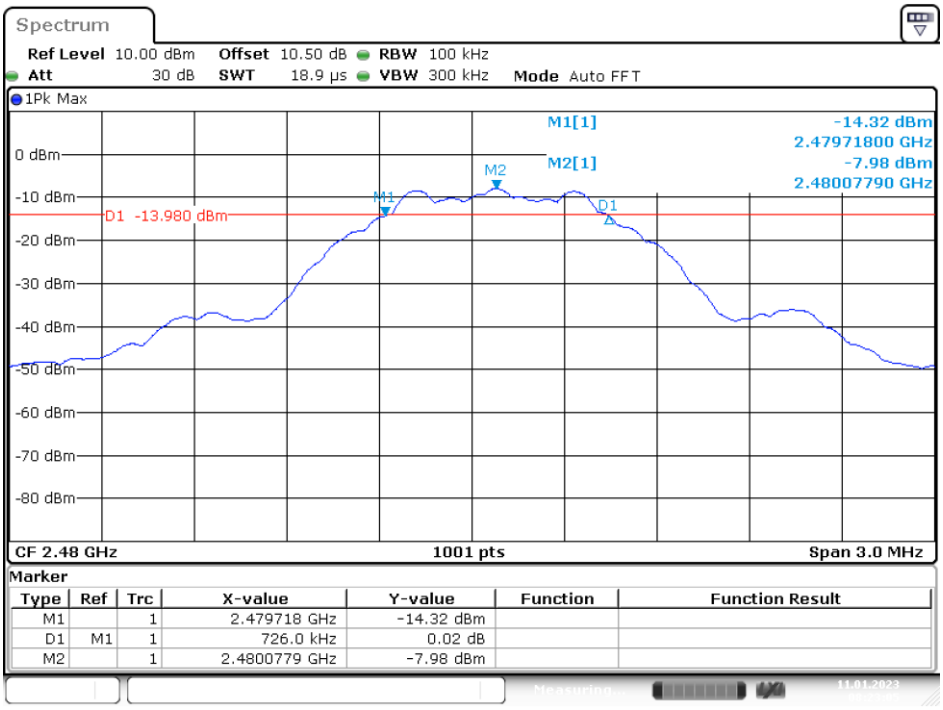
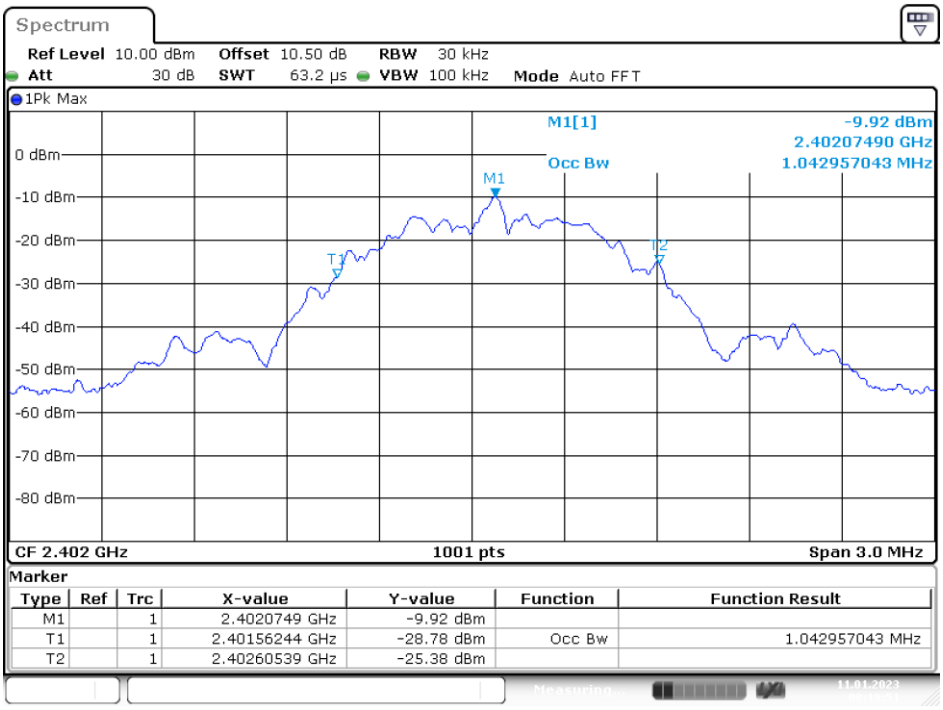
High Channel



Date: 11.JAN.2023 08:23:05

99% Bandwidth

Low Channel



Date: 11.JAN.2023 08:19:51

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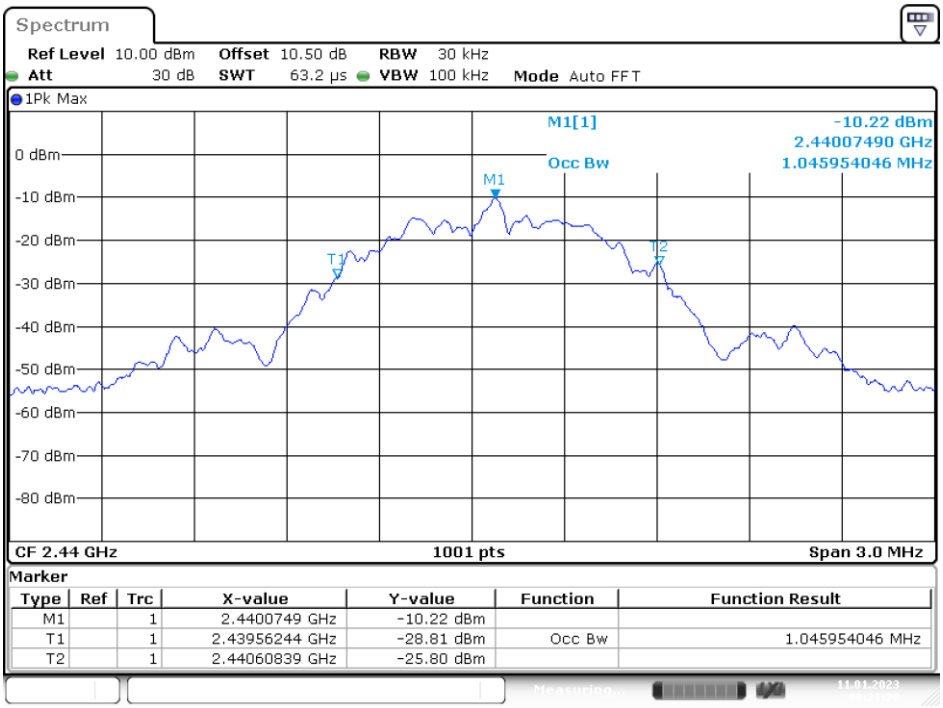
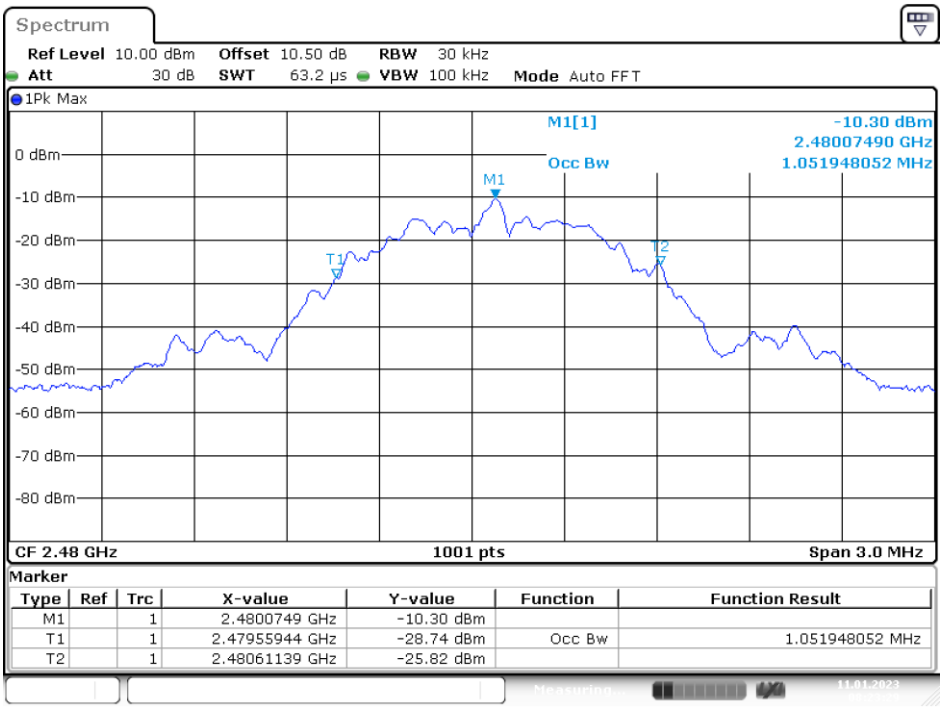
Middle Channel



Date: 11.JAN.2023 08:21:29

High Channel



Date: 11.JAN.2023 08:23:29

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11 FCC §15.247(b)(3) & RSS-247 §5.4(d) – Maximum Output Power

11.1 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.

According to RSS-247 §5.4(d).

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

11.2 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.

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11.3 Test Results

Conducted Peak Output Power

Channel	Frequency (MHz)	Power (dBm)	Limit (dBm)	Antenna Gain (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)
B Mode						
Low	2412	8.36	30	2.29	10.650	36
Middle	2437	8.48	30	2.29	10.770	36
High	2462	8.56	30	2.29	10.850	36
BLE Mode						
Low	2402	-5.83	30	2.29	-3.540	36
Mid	2440	-5.91	30	2.29	-3.620	36
High	2480	-6.12	30	2.29	-3.830	36

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12 FCC §15.247(d) & RSS-247 §5.5 – 100 kHz Bandwidth of Frequency Band Edge

12.1 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)).

According to RSS-247 §5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

12.2 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.

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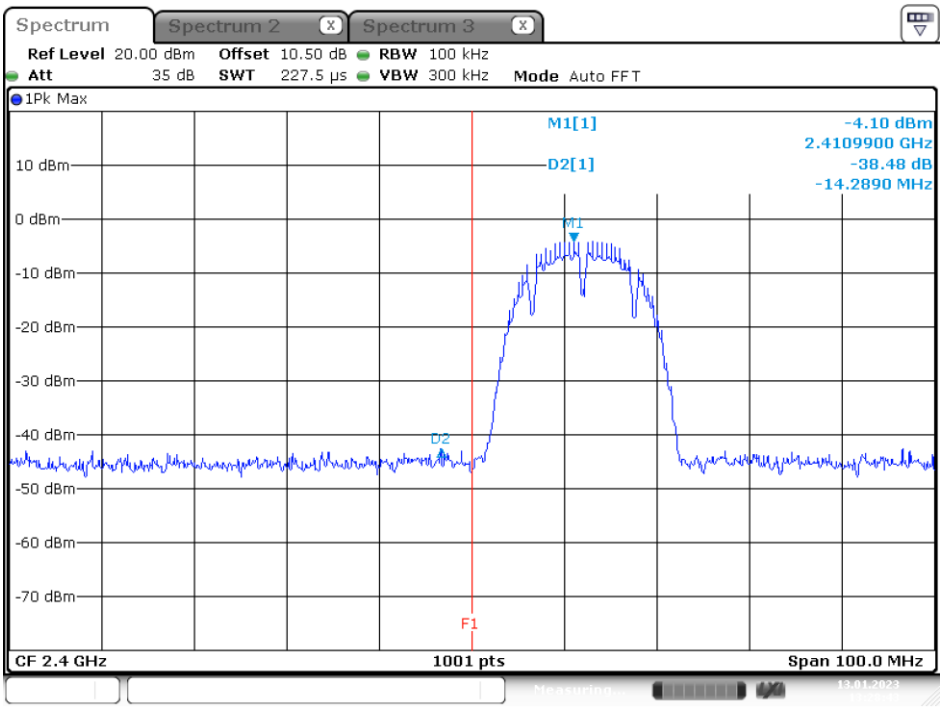
12.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
B Mode				
Low	2412	38.48	≥ 20	PASS
High	2462	38.68	≥ 20	PASS
BLE				
Low	2402	40.62	≥ 20	PASS
High	2480	39.78	≥ 20	PASS

Please refer to the following plots

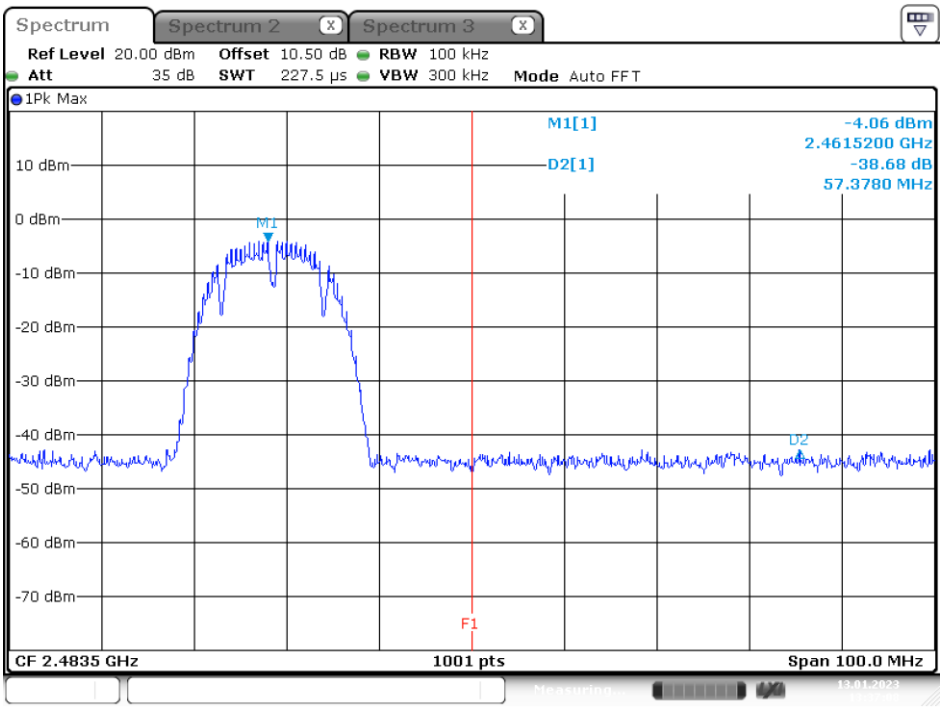
B Mode

Band Edge, Left Side



Date: 13.JAN.2023 13:28:44

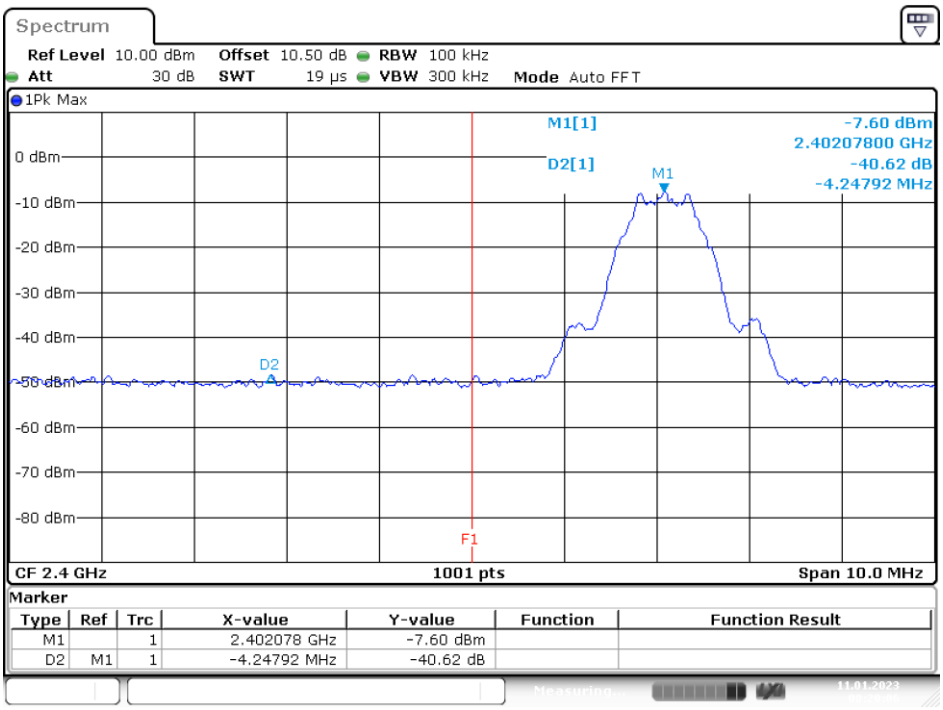
Band Edge, Right Side



Date: 13.JAN.2023 13:37:09

BLE Mode

Band Edge, Left Side



Date: 11.JAN.2023 08:20:07

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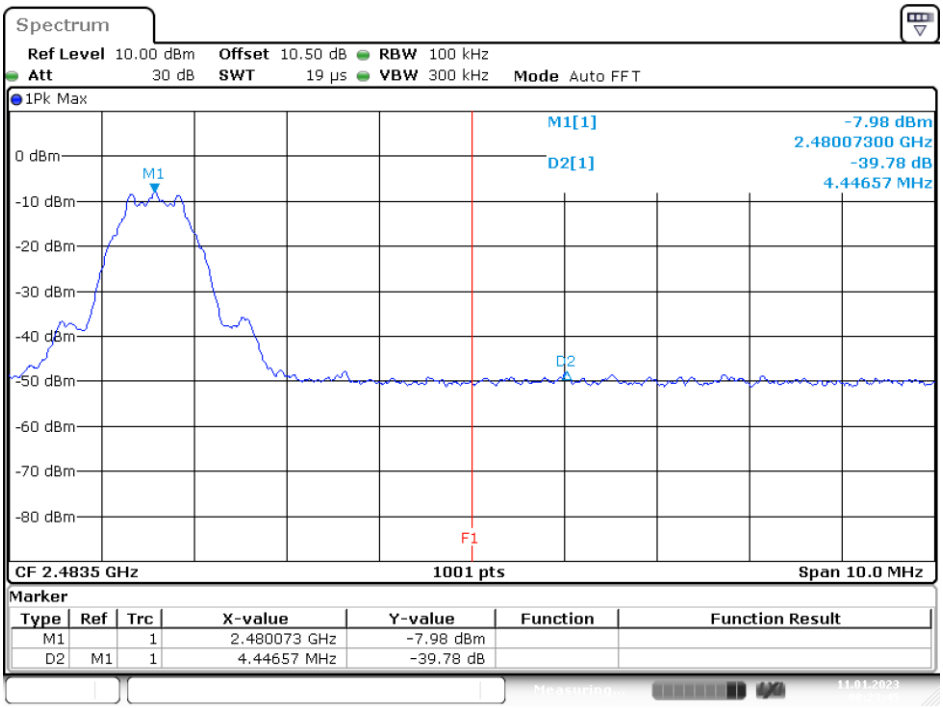
Band Edge, Right Side



Date: 11.JAN.2023 08:23:45

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13 FCC §15.247(e) & RSS-247 §5.2(b) – Power Spectral Density

13.1Applicable 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.

According to RSS-247 §5.2(b).

The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

13.2Test 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

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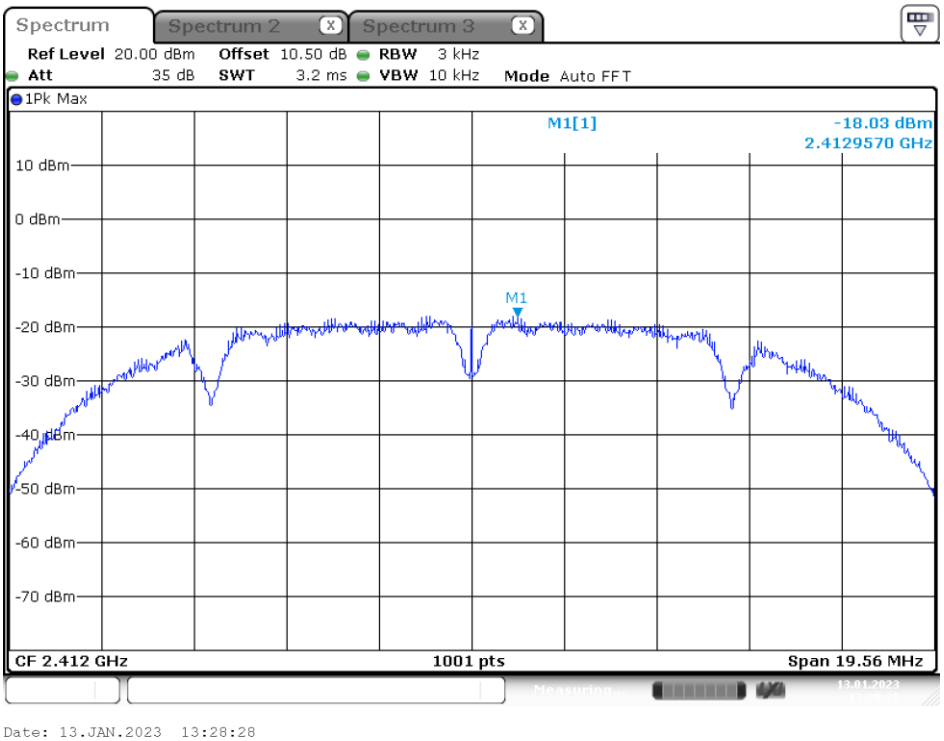
13.3Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
B Mode				
Low	2412	-18.03	8	PASS
Mid	2437	-17.97	8	PASS
High	2462	-17.76	8	PASS
BLE Mode				
Low	2402	-24.76	8	PASS
Mid	2440	-25.04	8	PASS
High	2480	-25.22	8	PASS

Please refer to the following plots

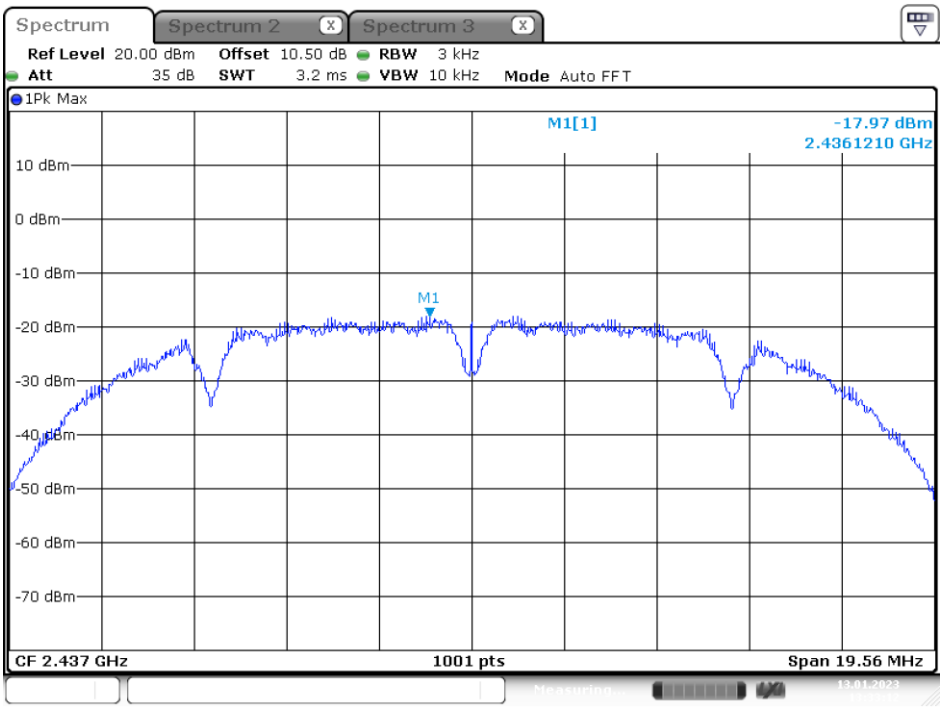
B Mode

Low Channel



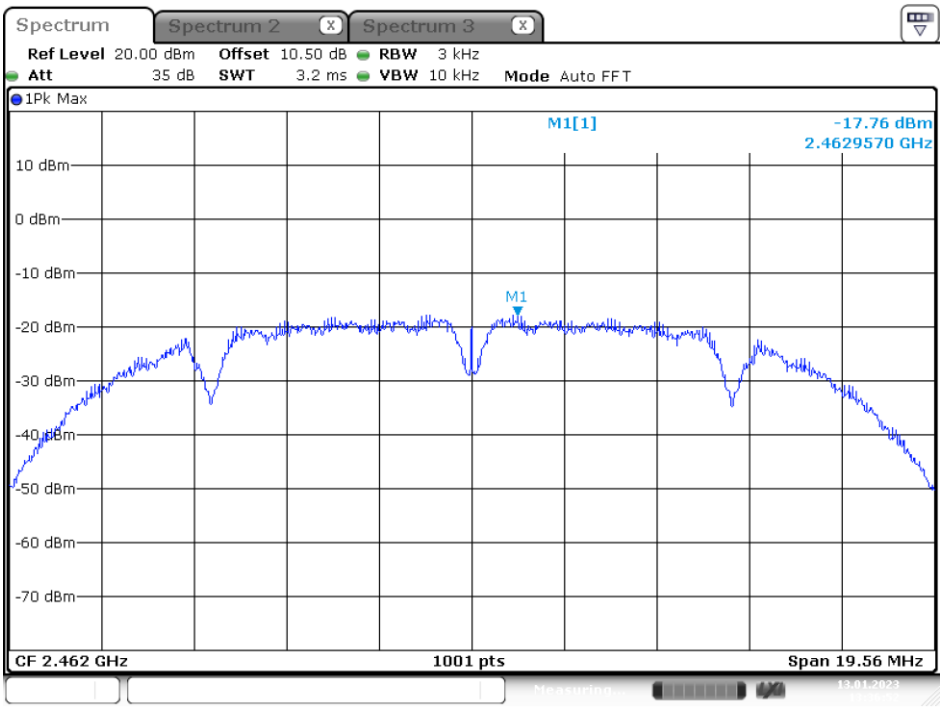
Date: 13.JAN.2023 13:28:28

Middle Channel



Date: 13.JAN.2023 13:33:12

High Channel



Date: 13.JAN.2023 13:36:53

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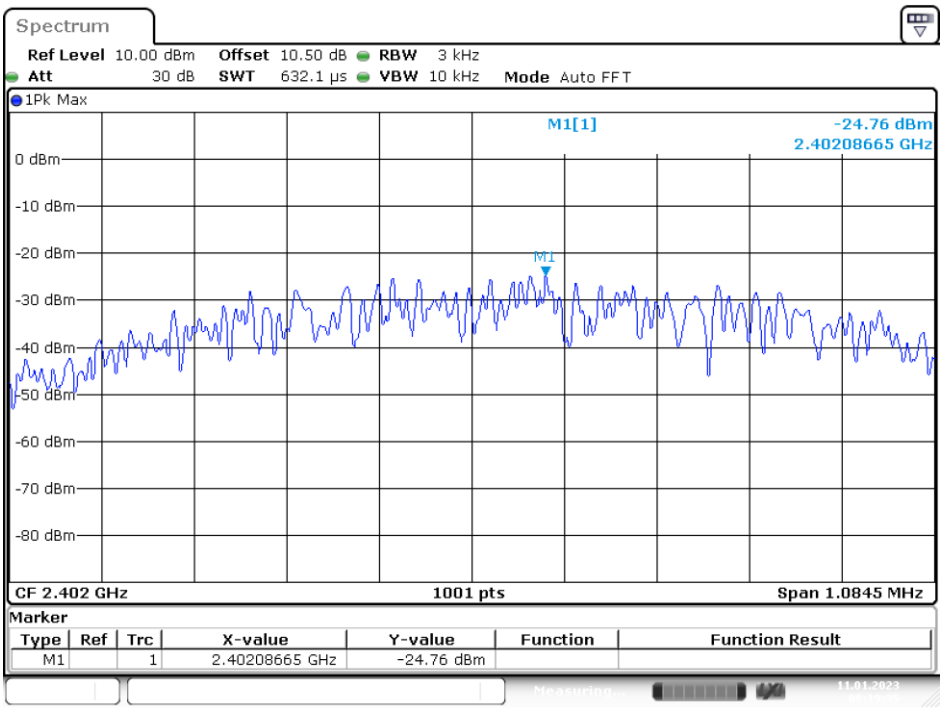
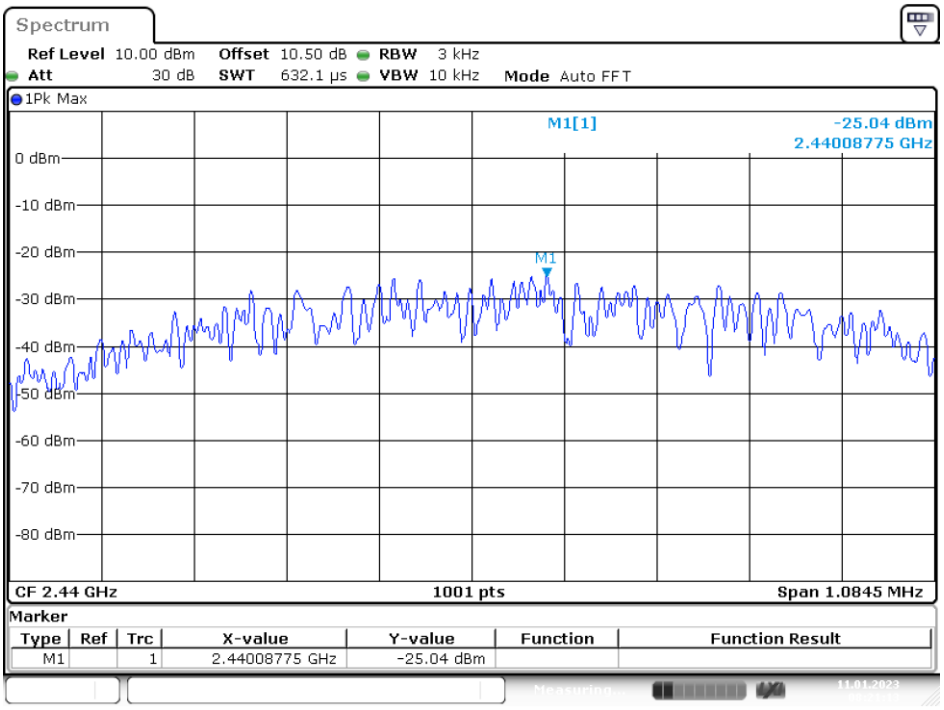
BLE Mode

Low Channel



Date: 11.JAN.2023 08:19:36

Middle Channel



Date: 11.JAN.2023 08:21:13

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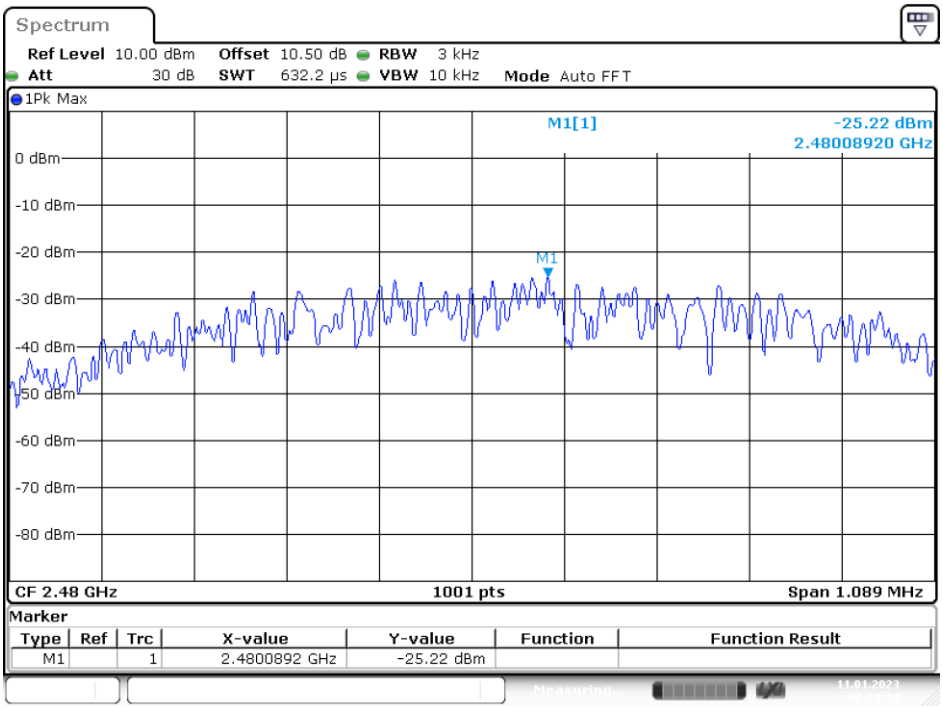
High Channel



Date: 11.JAN.2023 08:23:14

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