FCC Part 15.247

TEST REPORT

For

IOTTECH CORPORATION

No. 10-1, Shijian Rd., Hukou Township, Hsinchu County 303, Taiwan (R.O.C.)

FCC ID: 2AWP5WM8420

Report Type:	**Product Type:**
Original Report	2.4GHz BLE Module

Report Producer : Coco Lin

Report Number : RXZ240711038RF02

Report Date : 2024-08-29

Reviewed By: Andy Shih

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ240711038	RXZ240711038RF02	2024-08-29	Original Report	Coco Lin

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	IOTTECH CORPORATION
	No. 10-1, Shijian Rd., Hukou Township, Hsinchu County 303, Taiwan (R.O.C.)
Brand(Trade) Name	IOTTECH Corp.
Product (Equipment)	2.4GHz BLE Module
Main Model Name	ITM-8420
Series Model Name	N/A
Frequency Range	2402 ~ 2480 MHz
Maximum Conducted Peak Output Power	BLE(1M) Mode : 13.82 dBm BLE(2M) Mode : 13.83 dBm BLE(125k) Mode : 7.64 dBm BLE(500k) Mode : 7.72 dBm
Modulation Technique	GFSK
Transmit Data Rate	125kbps, 500kbps, 1Mbps, 2Mbps
Power Operation (Voltage Range)	☐ AC ☐ Adapter I/P: ☐ By AC Power Cord ☐ PoE
	☒ DC Type 3V ☐ Battery ☐ DC Power Supply ☐ External DC Adapter
	☐ Host System
Received Date	2024/07/11
Date of Test	2024/07/15 ~ 2024/08/27

*All measurement and test data in this report was gathered from production sample serial number: RXZ240711038-1 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

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

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.
KDB 558074 D01 Meas Guidance v05r02

1.4 Statement

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

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

1.5 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		+/- 3.02 dB
RF output power, conducted		+/- 0.57 dB
Power Spectral Density, conducted		+/- 0.60 dB
Occupied Bandwidth		+/- 0.09 %
Unwanted Emissions, conducted		+/- 1.09 dB
Emissions, radiated	9 kHz~30 MHz	+/- 3.20 dB
	30 MHz~1 GHz	+/- 3.30 dB
	1 GHz~18 GHz	+/- 5.14 dB
	18 GHz~40 GHz	+/- 4.75 dB
Temperature		+/- 0.76 °C
Humidity		+/- 0.41 %

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

1.6 Environmental Conditions

Test Site	Test Date	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2024/7/15	26.6	40	1010	Wayne Pan
Radiation Spurious Emissions	2024/7/16~2024/7/17	23.9~25.1	58~67	1010	Aaron Pan
Duty Cycle	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan
Conducted Spurious Emissions	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan
6 dB Emission Bandwidth	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan
Maximum Output Power	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan
100 kHz Bandwidth of Frequency Band Edge	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan
Power Spectral Density	2024/7/15~2024/8/27	25.3~25.4	45~49	1010	Wayne Pan

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 221, Taiwan, R.O.C.

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

2 System Test Configuration

2.1 Description of Test Configuration

For 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.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used "Tera v4.7.1"

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

Test Frequency		Low	Middle	High
Power Level Setting	BLE 1M	4	4	4
	BLE 2M	4	4	4
	BLE 125k	default	default	default
	BLE 500k	default	default	default

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number
NB	DELL	E6410
NB Adapter	DELL	DA130PE1-00
Bottom Layer PCB	iotTech	IOTTECH-EVB-8420
Fixture	Waveshare	FT232

2.5 External Cable List and Details

Description	Manufacturer	Cable length
USBA to Micro USB	BACL	1m

2.6 Test Mode

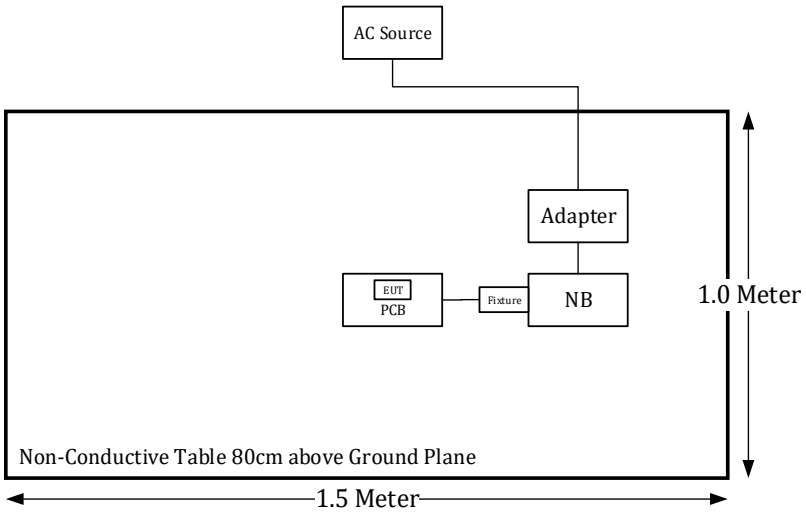
Full System (model: ITM-8420) for all test item.

2.7 Block Diagram of Test Setup

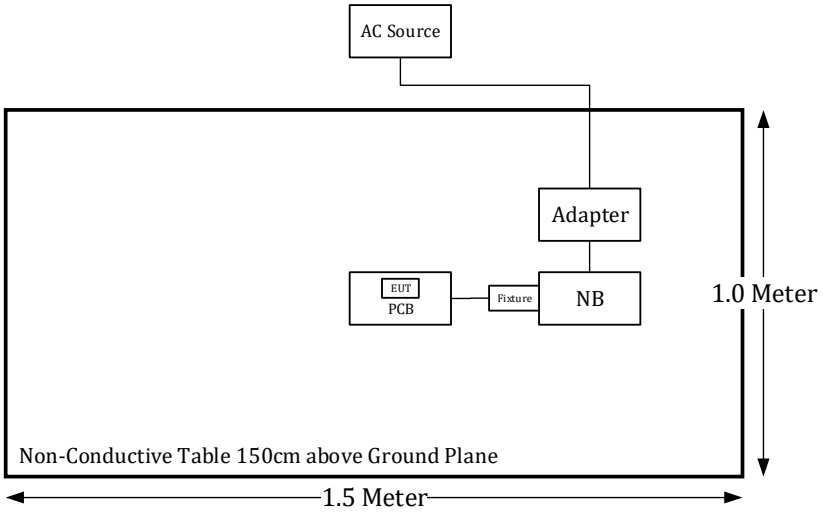
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

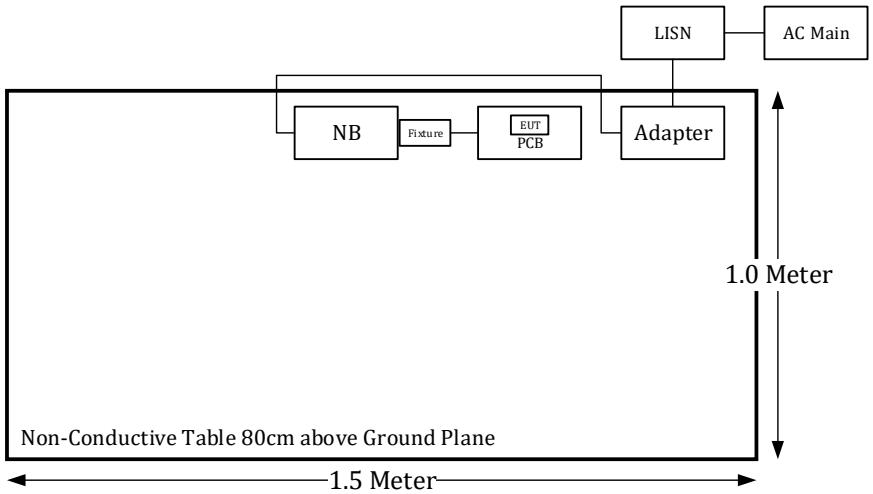
Below 1GHz:



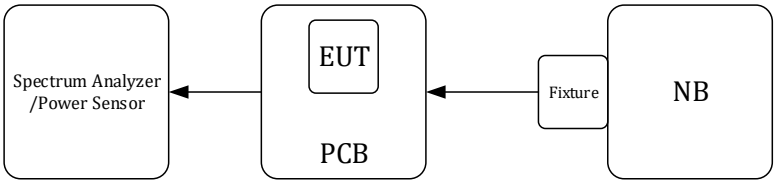
Above 1GHz:



Conduction:



Conducted:



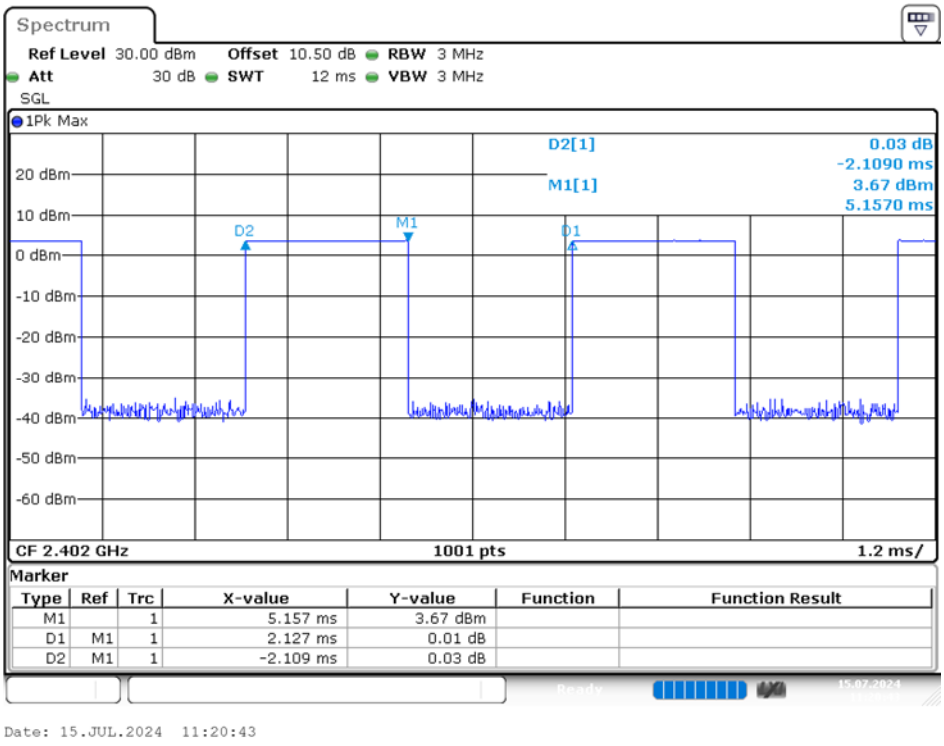
2.8 Duty Cycle

The duty cycle as below:

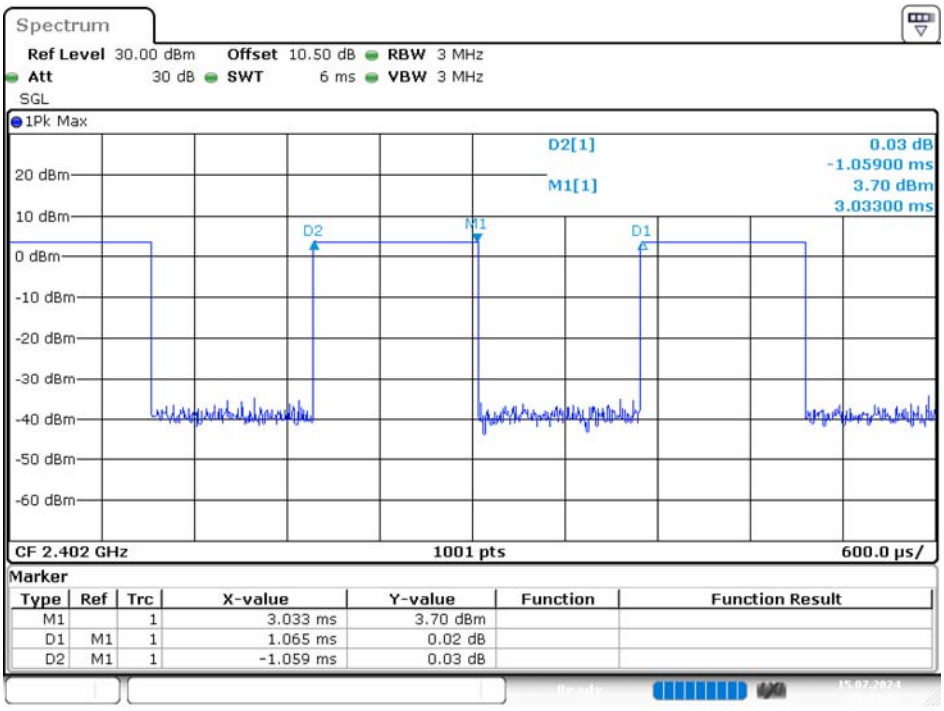
Radio Mode	T_{on} (ms)	$T_{on}+T_{off}$ (ms)	Duty Cycle (%)	1/T (kHz)	1/T VBW setting (kHz)
BLE 1M	2.109	4.236	50	0.47	0.5
BLE 2M	1.059	2.124	50	0.94	1
BLE 500k	2.505	4.245	59	0.40	0.5
BLE 125k	8.8	16.95	52	0.11	0.2

Please refer to the following plots.

BLE(1M) Mode



BLE(2M) Mode



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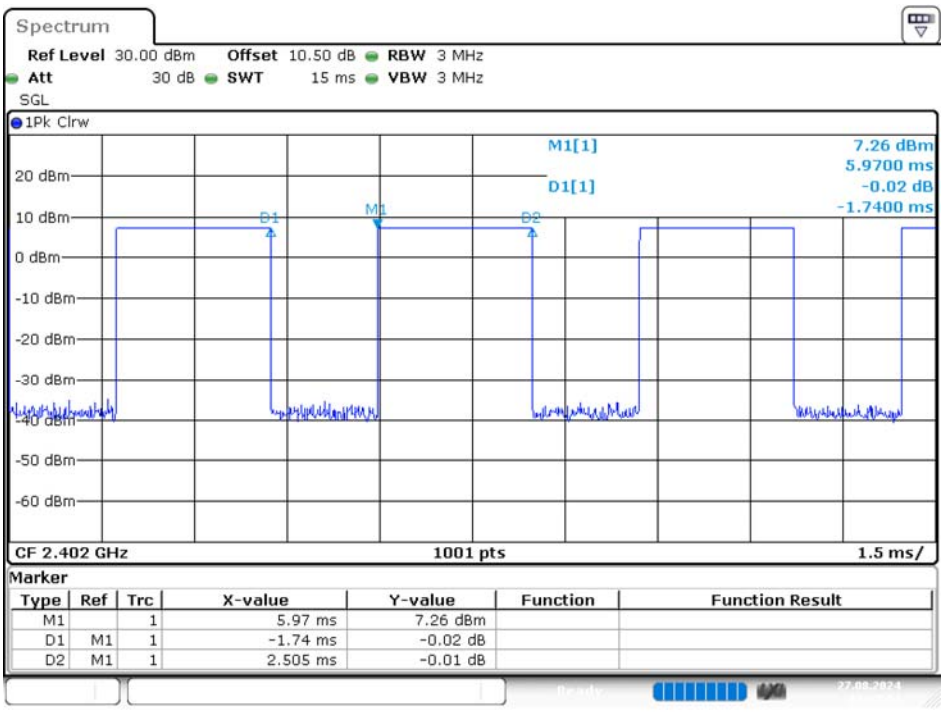
BLE(500k) Mode



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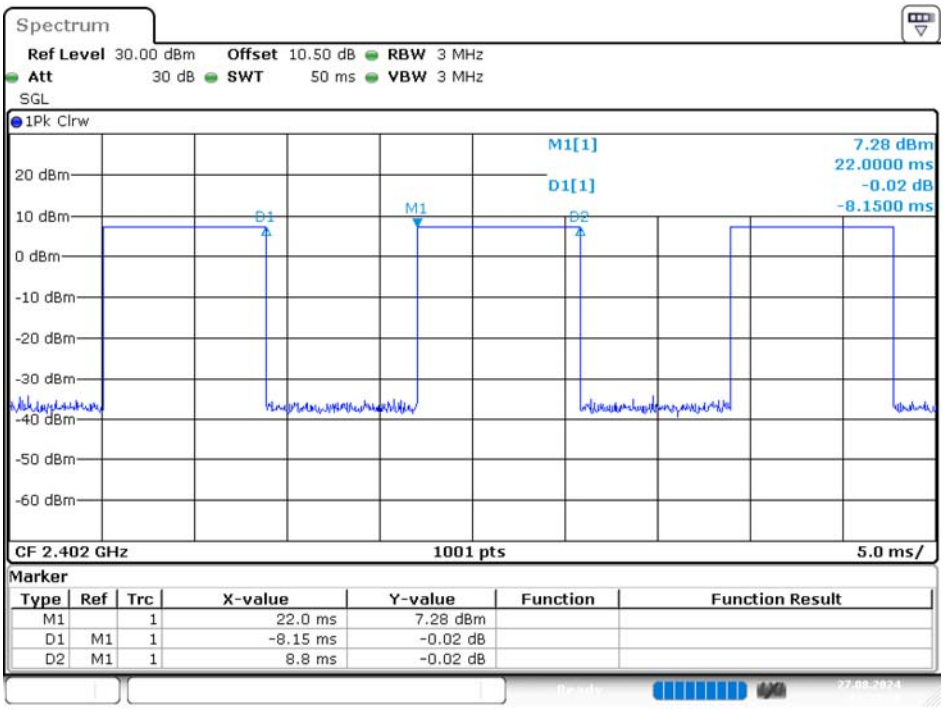
BLE(125k) Mode



3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1307(b)(3)(i)	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	2024/2/16	2025/2/15
EMI Test Receiver	Rohde & Schwarz	ESW8	100947	2024/5/24	2025/5/23
RF Cable	EMEC	EM-CB5D	1	2024/6/5	2025/6/4
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiation 3M Room (966-A)					
Active Loop Antenna	ETS-Lindgren	6502	35796	2024/3/27	2025/3/26
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2024/1/19	2025/1/18
Horn Antenna	A.H. system	SAS-571	1020	2024/5/21	2025/5/20
Horn Antenna	ETS-Lindgren	3116	62638	2023/8/25	2024/8/24
Preamplifier	Sonoma	310N	130601	2024/1/29	2025/1/28
Preamplifier	Channel	ERA-100M-18G-01D1748	EC2300051	2024/3/29	2025/3/28
Microware Preamplifier	EM Electronics Corporation	EM18G40G	60656	2024/1/8	2025/1/7
EMI Test Receiver	Rohde & Schwarz	ESR3	102099	2024/6/24	2025/6/23
Spectrum Analyzer	Rohde & Schwarz	FSV40	101939	2024/3/27	2025/3/26
Microflex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2024/1/23	2025/1/22
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2024/1/23	2025/1/22
Coaxial Cable	COMMATE	PEWC	8Dr	2023/12/23	2024/12/22
Cable	EMC	EMC105-SM-SM-10000	201003	2024/1/23	2025/1/22
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2023/12/23	2024/12/22
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2024/1/23	2025/1/22
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2024/1/23	2025/1/22
Band-stop filter	Woken	STI15-9831	STI15-9831-1	2023/10/20	2024/10/19
High-pass filter	XINGBOKEJI	XBLBQ-GTA54	200108-3-2	2023/10/20	2024/10/19
Software	AUDIX	E3	18621a	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz(R&S)	FSV40	101204	2024/5/30	2025/5/29
Cable	UTIFLEX	UFA210A	9435	2023/10/2	2024/10/1
Power Sensor	Boonton	RTP5006	11037	2024/5/21	2025/5/20
Attenuator	MCL	BW-S10W5+	1419	2024/2/23	2025/2/22

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

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

5.1 Applicable Standard

According to subpart 15.247(i) and subpart §1.1307(b)(3), 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);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

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

5.2 RF Exposure Evaluation Result

Project info

Band	Freq (MHz)	Tune-up Power (dBm)	Ant Gain (dBi)	Distances (mm)	Tune-up Power (mW)	ERP (dBm)	ERP (mW)
BLE	2402	13.9	3.53	200	24.55	15.28	33.73

§ 1.1307(b)(3)(i)(A) method is not applicable.

§ 1.1307(b)(3)(i)(C)

Band	Freq (MHz)	λ/2π (mm)	Distances applies	ERP Limit (mW)	Result Option C
BLE	**2402**	**19.88**	**apply**	**768.00**	**exempt**

The minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates
ERP (watts) is no more than the calculated value prescribed for that frequency
R must be at least $\lambda/2\pi$
λ is the free-space operating wavelength in meters

Note: The Tune-up output power was declared by the Applicant.

Result: The device compliant the MPE-Based Exemption at 20cm distances.

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.

6.2 Antenna Information

Manufacturer	Model	Type	Antenna Gain	Impedance
UDE	WCA1-ZZ-0601	Chip Antenna	3.53 dBi	50Ω

The antenna is permanently attached to the device.

Result: Compliance

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

7.1 Applicable Standard

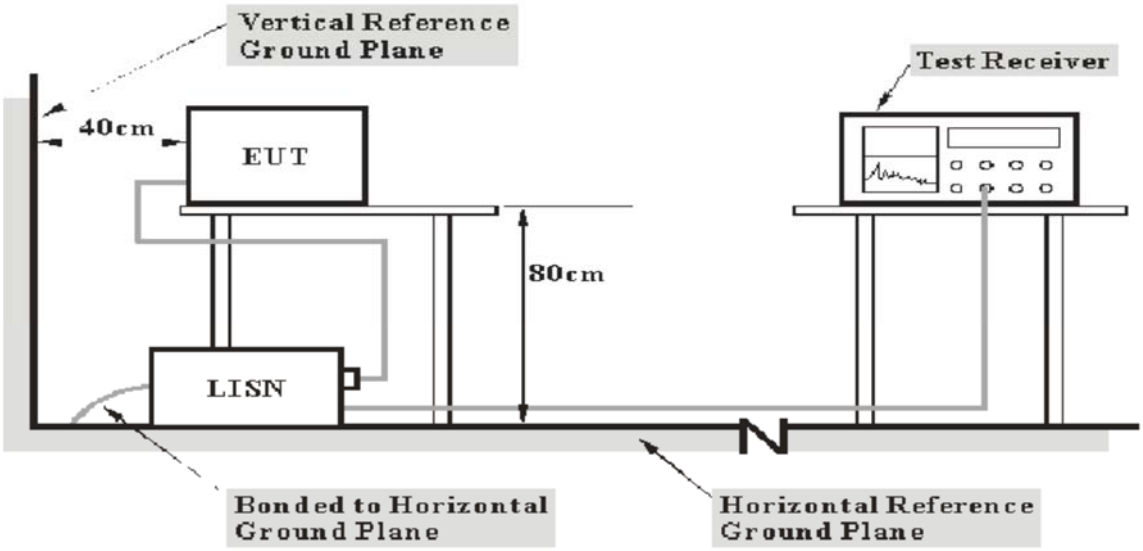
According to §15.207

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

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 1
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

7.2 EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

7.3 EMI Test Receiver Setup

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

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

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

7.4 Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

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

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

7.5 Corrected Factor & Over Limit 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 = Result – Limit Line

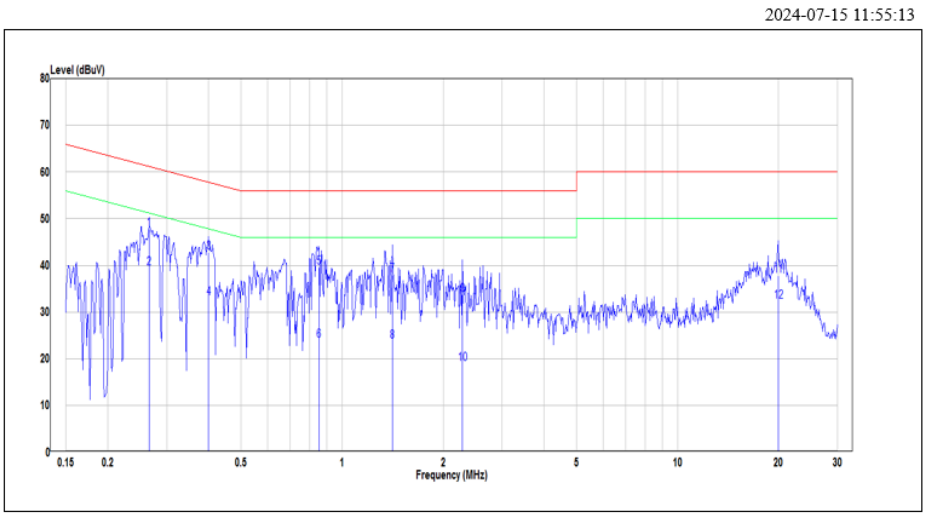
7.6 Test Results

Test Mode: Transmitting

Main: AC120 V, 60 Hz

Worst case is BLE(1M) mode, low channel

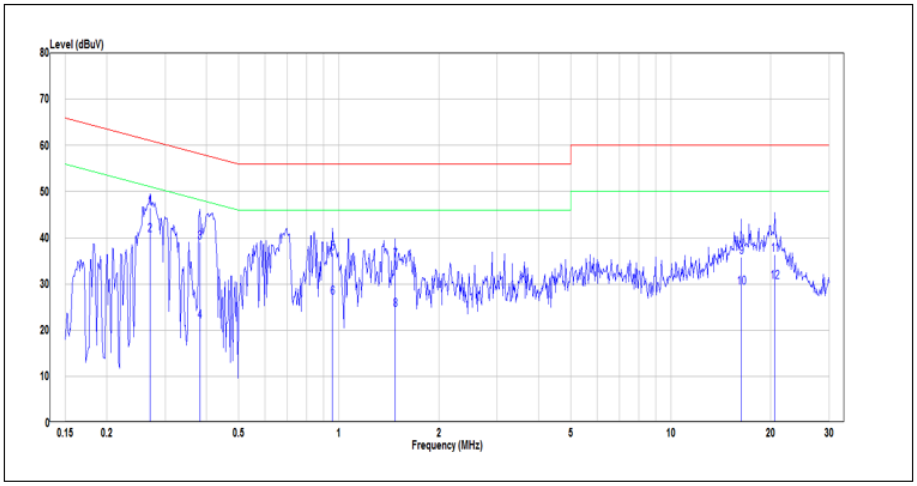
Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark	Phase
	(MHz)	dBuV	Factor(dB)	dBuV	dBuV	(dB)		
1	0.266	37.73	10.08	47.81	61.25	-13.44	QP	Line
2	0.266	29.34	10.08	39.42	51.25	-11.83	Average	Line
3	0.400	32.57	10.18	42.76	57.86	-15.10	QP	Line
4	0.400	22.80	10.18	32.98	47.86	-14.88	Average	Line
5	0.853	29.20	10.32	39.51	56.00	-16.49	QP	Line
6	0.853	13.49	10.32	23.81	46.00	-22.19	Average	Line
7	1.411	27.69	10.34	38.03	56.00	-17.97	QP	Line
8	1.411	13.34	10.34	23.68	46.00	-22.32	Average	Line
9	2.285	23.40	10.35	33.75	56.00	-22.25	QP	Line
10	2.285	8.52	10.35	18.86	46.00	-27.14	Average	Line
11	19.950	27.18	10.61	37.79	60.00	-22.21	QP	Line
12	19.950	21.58	10.61	32.19	50.00	-17.81	Average	Line

Neutral

2024-07-15 12:03:14



No.	Frequency (MHz)	Reading dBuV	Correct Factor(dB)	Result dBuV	Limit dBuV	Over limit (dB)	Remark	Phase
1	0.270	36.38	10.09	46.48	61.12	-14.64	QP	Neutral
2	0.270	30.45	10.09	40.55	51.12	-10.57	Average	Neutral
3	0.381	28.86	10.18	39.04	58.25	-19.21	QP	Neutral
4	0.381	11.76	10.18	21.94	48.25	-26.31	Average	Neutral
5	0.958	26.37	10.34	36.71	56.00	-19.29	QP	Neutral
6	0.958	16.79	10.34	27.13	46.00	-18.87	Average	Neutral
7	1.480	24.71	10.35	35.06	56.00	-20.94	QP	Neutral
8	1.480	14.03	10.35	24.38	46.00	-21.62	Average	Neutral
9	16.312	25.25	10.63	35.89	60.00	-24.11	QP	Neutral
10	16.312	18.62	10.63	29.25	50.00	-20.75	Average	Neutral
11	20.594	25.74	10.67	36.42	60.00	-23.58	QP	Neutral
12	20.594	19.75	10.67	30.42	50.00	-19.58	Average	Neutral

Note:

Result = Reading + Factor

Over Limit = Result – 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.

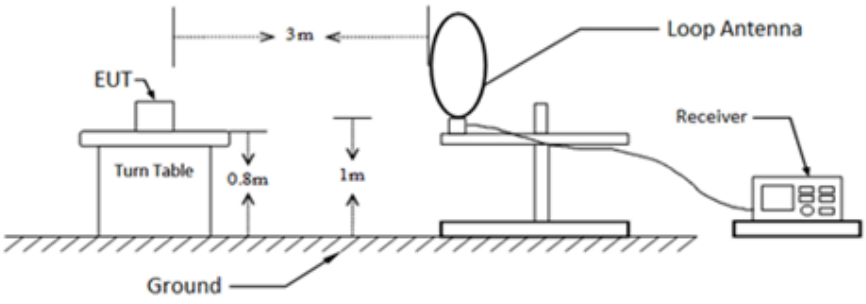
According to ANSI C63.10-2013, section 5.3.3

Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field, and the emissions to be measured can be detected by the measurement equipment (see 4.3.4). Measurements shall not be performed at a distance greater than 30 m for frequencies above 30 MHz, unless it can be further demonstrated that measurements at a distance of 30 m or less are impractical. Measurements from 18 GHz to 40 GHz are typically made at distances significantly less than 3 m from the EUT. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade of distance (inverse of linear distance for field-strength measurements or inverse of linear distance-squared for power-density measurements).

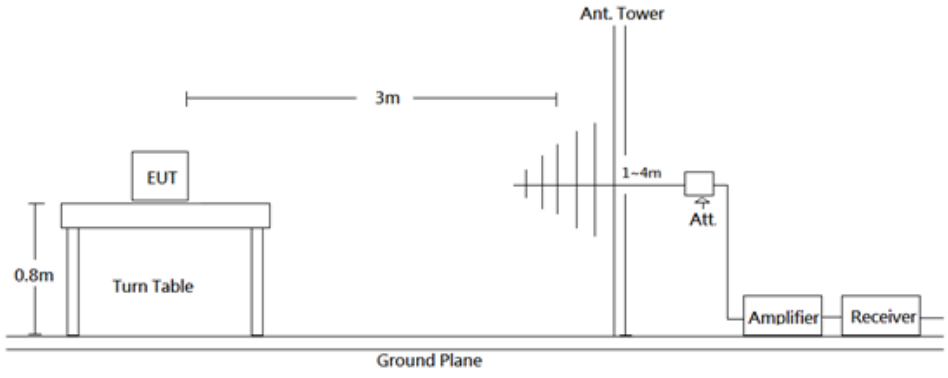
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the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

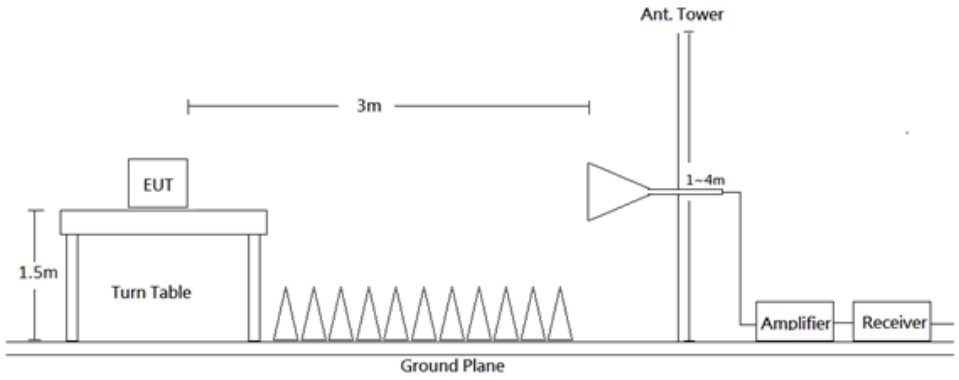
9kHz-30MHz:



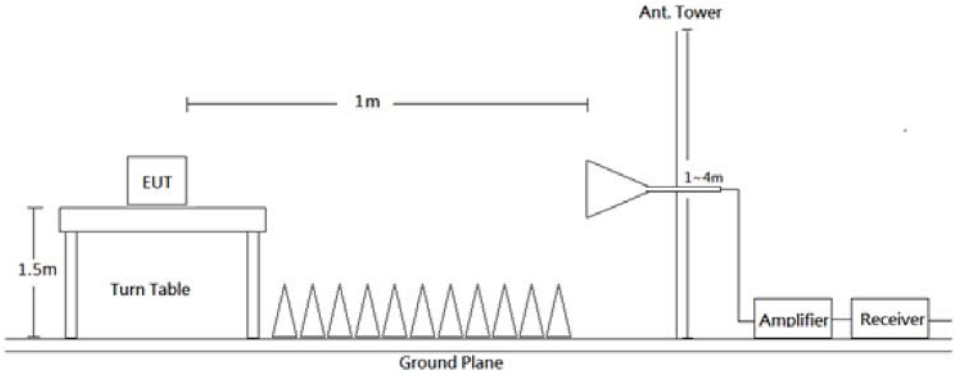
30MHz-1GHz:



1-18 GHz:



18-26.5 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 9 kHz 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
9 kHz - 150 kHz	200 Hz/300 Hz	1 kHz	/	QP/AV
150 kHz - 30 MHz	9 kHz/10 kHz	30 kHz	/	QP/AV
30-1000 MHz	120 kHz	300 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

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

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 Quasi-peak and average detector mode from 9 kHz to 30 MHz, 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 = Level – Limit

8.6 Test Results

Test Mode: Transmitting

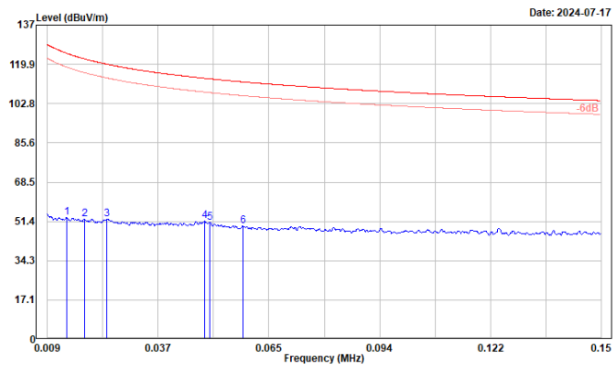
(Pre-scan with three orthogonal axis, and worse case as X axis.)

9kHz-30MHz:

(Worst case is BLE(1M) mode, low channel)

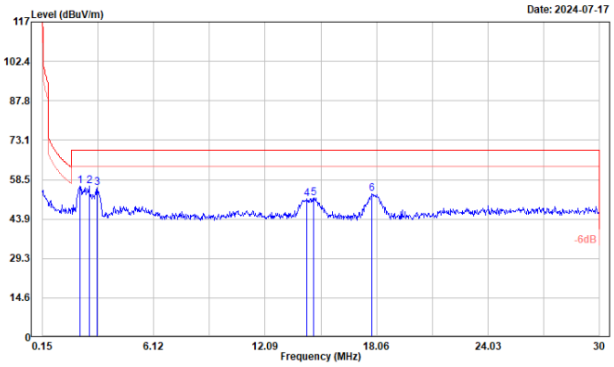
(Pre-scan using three directional polarities, worst case as parallel.)

9kHz-150kHz



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
0.014	37.29	15.78	53.07	124.72	-71.65	100	110	Average
0.018	37.17	15.28	52.45	122.28	-69.83	100	89	Average
0.024	37.85	14.52	52.37	119.92	-67.55	100	315	Average
0.049	38.79	12.64	51.43	113.79	-62.36	100	227	Average
0.050	38.38	12.59	50.97	113.57	-62.60	100	156	Average
0.059	37.66	11.89	49.55	112.22	-62.67	100	111	Average

150kHz-30MHz



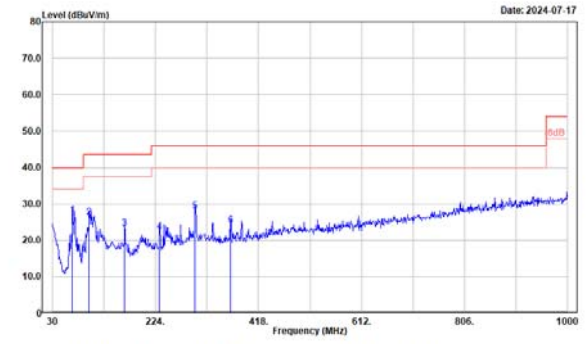
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2.180	45.53	10.69	56.22	69.54	-13.32	100	220	QP
2.657	45.70	10.55	56.25	69.54	-13.29	100	159	QP
3.105	45.05	10.47	55.52	69.54	-14.02	100	100	QP
14.329	39.78	11.57	51.35	69.54	-18.19	100	360	QP
14.687	40.09	11.58	51.67	69.54	-17.87	100	227	QP
17.821	41.62	11.64	53.26	69.54	-16.28	100	85	QP

30MHz-1GHz:

(Worst case is BLE(1M) mode)

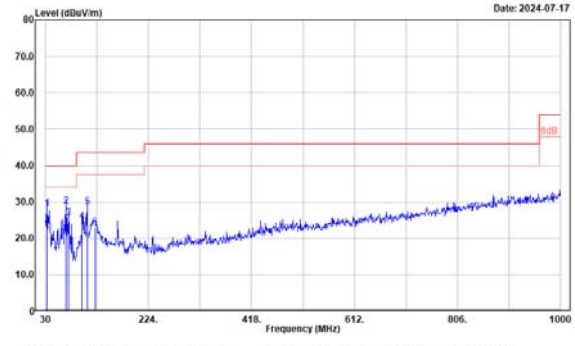
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
67.830	41.98	-15.07	26.91	40.00	-13.09	100	102	QP
98.870	39.57	-13.36	26.21	43.50	-17.29	100	87	QP
165.800	33.89	-10.70	23.19	43.50	-20.31	100	251	QP
231.760	33.68	-11.42	22.26	46.00	-23.74	100	178	QP
298.690	36.73	-8.80	27.93	46.00	-18.07	100	144	QP
364.650	31.83	-7.80	24.03	46.00	-21.97	100	292	QP

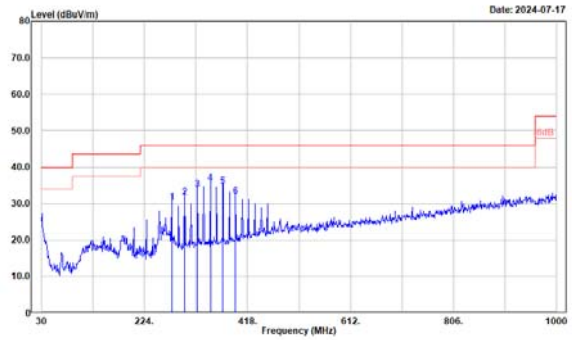
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
32.910	33.05	-4.91	28.14	40.00	-11.86	100	197	QP
68.800	44.03	-15.27	28.76	40.00	-11.24	100	24	QP
73.650	40.78	-15.26	25.52	40.00	-14.48	100	116	QP
98.870	37.99	-13.36	24.63	43.50	-18.87	100	308	QP
108.570	39.57	-11.06	28.51	43.50	-14.99	100	5	QP
123.120	32.21	-9.26	22.95	43.50	-20.55	100	97	QP

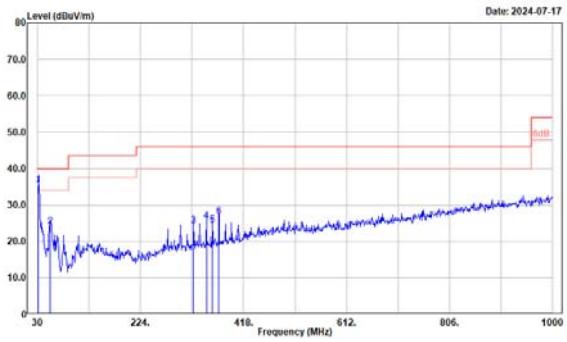
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
275.410	39.52	-9.17	30.35	46.00	-15.65	100	301	QP
299.660	40.47	-8.80	31.67	46.00	-14.33	100	203	QP
323.910	42.35	-8.46	33.89	46.00	-12.11	100	332	QP
348.160	43.71	-8.13	35.58	46.00	-10.42	100	188	QP
371.440	42.34	-7.63	34.71	46.00	-11.29	100	346	QP
395.690	38.61	-6.77	31.84	46.00	-14.16	100	0	QP

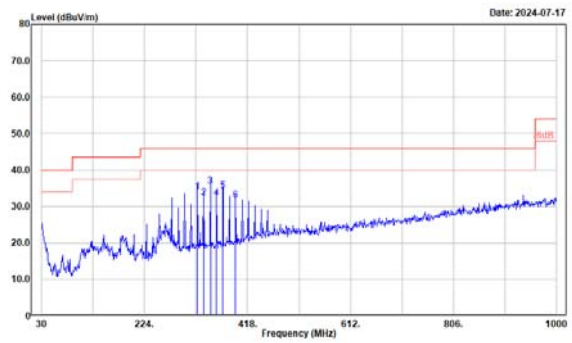
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
31.940	39.58	-3.95	35.63	40.00	-4.37	100	108	QP
54.250	39.84	-15.81	24.03	40.00	-15.97	100	28	QP
323.910	32.84	-8.46	24.38	46.00	-21.62	100	306	QP
348.160	33.79	-8.13	25.66	46.00	-20.34	100	325	QP
359.800	32.42	-7.88	24.54	46.00	-21.46	100	329	QP
371.440	34.42	-7.63	26.79	46.00	-19.21	100	329	QP

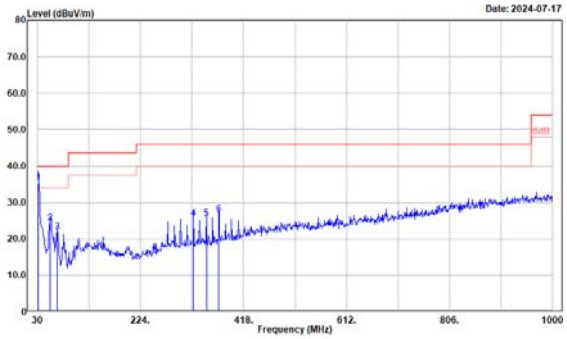
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
323.910	42.43	-8.46	33.97	46.00	-12.03	100	335	QP
335.550	40.38	-8.17	32.21	46.00	-13.79	100	339	QP
348.160	43.77	-8.13	35.64	46.00	-10.36	100	178	QP
359.800	40.13	-7.88	32.25	46.00	-13.75	100	343	QP
371.440	41.96	-7.63	34.33	46.00	-11.67	100	359	QP
395.690	38.40	-6.77	31.63	46.00	-14.37	100	360	QP

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
31.940	39.36	-3.95	35.41	40.00	-4.59	100	132	QP
54.250	40.04	-15.81	24.23	40.00	-15.77	100	60	QP
67.830	36.87	-15.07	21.80	40.00	-18.20	100	101	QP
323.910	34.11	-8.46	25.65	46.00	-20.35	100	297	QP
348.160	33.63	-8.13	25.50	46.00	-20.50	100	309	QP
371.440	34.29	-7.63	26.66	46.00	-19.34	100	316	QP

Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

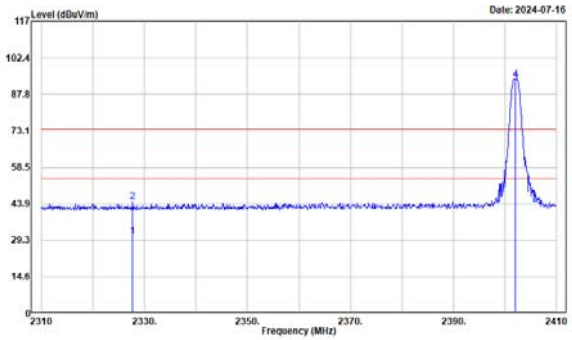
Band-Edge:

(Worst case is BLE(1M) and BLE(2M) mode)

BLE(1M) Mode

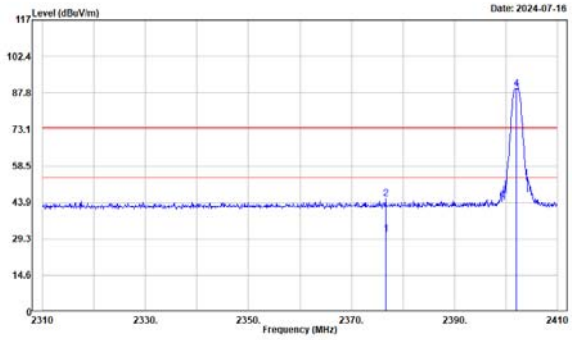
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2327.700	42.20	-11.56	30.64	54.00	-23.36	121	314	Average
2327.700	56.32	-11.56	44.76	74.00	-29.24	121	314	Peak
2402.000	103.51	-11.02	92.49			121	314	Average
2402.000	104.62	-11.02	93.60			121	314	Peak

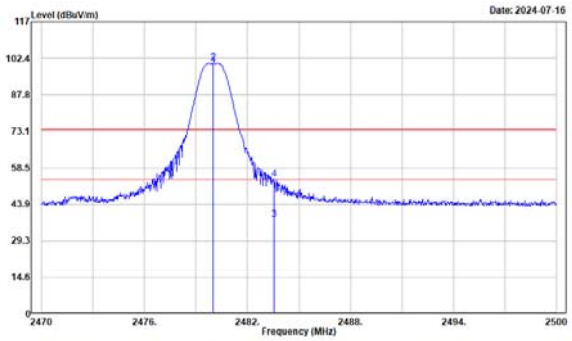
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2376.600	42.13	-11.20	30.93	54.00	-23.07	346	10	Average
2376.600	56.45	-11.20	45.25	74.00	-28.75	346	10	Peak
2402.000	99.21	-11.02	88.19			346	10	Average
2402.000	100.32	-11.02	89.30			346	10	Peak

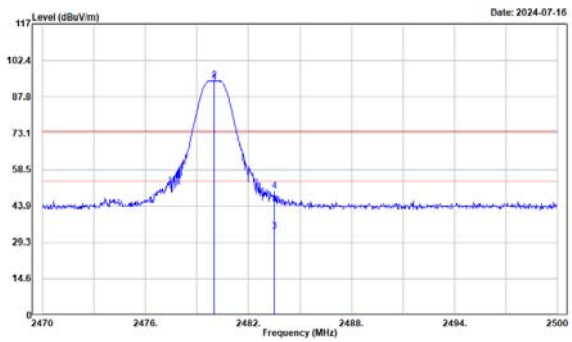
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	109.94	-10.66	99.28			138	321	Average
2480.000	111.04	-10.66	100.38			138	321	Peak
2483.560	48.25	-10.61	37.64	54.00	-16.36	138	321	Average
2483.560	64.44	-10.61	53.83	74.00	-20.17	138	321	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	103.75	-10.66	93.09			356	11	Average
2480.000	104.85	-10.66	94.19			356	11	Peak
2483.500	44.28	-10.61	33.67	54.00	-20.33	356	11	Average
2483.500	60.27	-10.61	49.66	74.00	-24.34	356	11	Peak

Level = Reading + Factor.

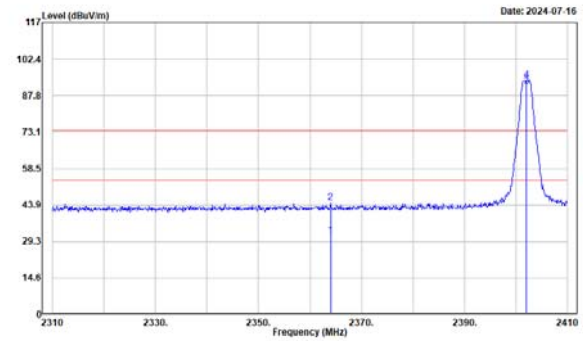
Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

BLE(2M) Mode

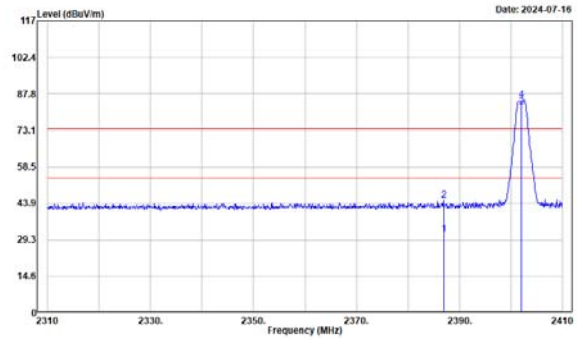
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2364.000	42.71	-11.29	31.42	54.00	-22.58	123	317	Average
2364.000	55.87	-11.29	44.58	74.00	-29.42	123	317	Peak
2402.000	102.25	-11.02	91.23			123	317	Average
2402.000	104.91	-11.02	93.89			123	317	Peak

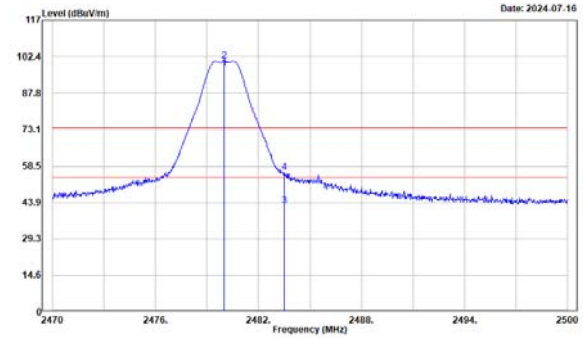
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2386.900	42.40	-11.12	31.28	54.00	-22.72	238	12	Average
2386.900	56.27	-11.12	45.15	74.00	-28.85	238	12	Peak
2402.000	93.49	-11.02	82.47			238	12	Average
2402.000	96.16	-11.02	85.14			238	12	Peak

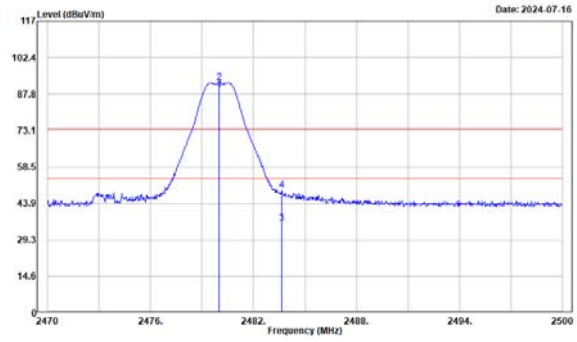
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	108.40	-10.66	97.74			140	318	Average
2480.000	111.20	-10.66	100.54			140	318	Peak
2483.500	53.04	-10.61	42.43	54.00	-11.57	140	318	Average
2483.500	66.51	-10.61	55.90	74.00	-18.10	140	318	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	100.13	-10.66	89.47			288	12	Average
2480.000	102.97	-10.66	92.31			288	12	Peak
2483.620	46.59	-10.61	35.98	54.00	-18.02	288	12	Average
2483.620	59.63	-10.61	49.02	74.00	-24.98	288	12	Peak

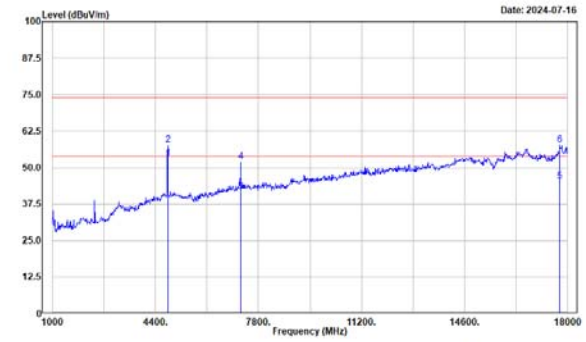
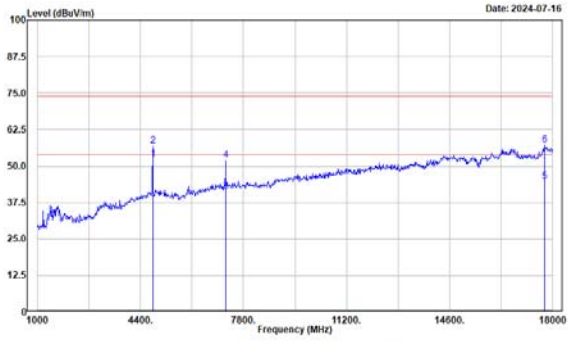
Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

1GHz-18GHz:

(worst case is BLE(1M) Mode low channel)

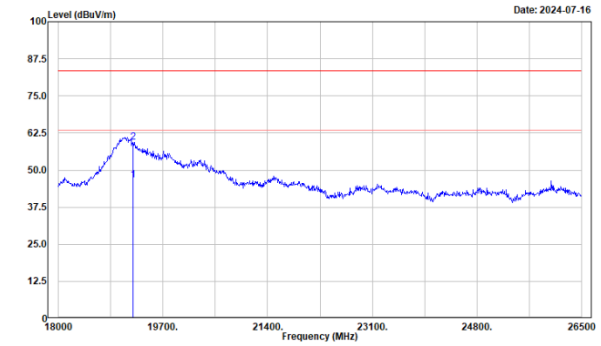
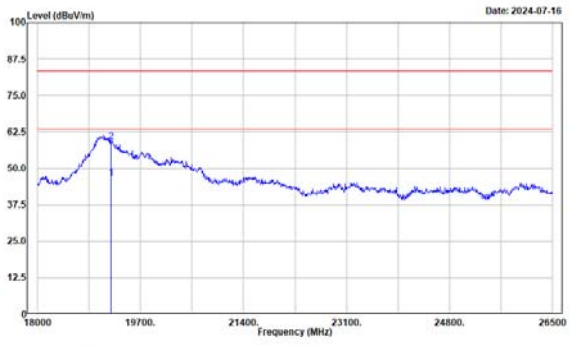
Horizontal	Vertical
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	57.34	-4.09	53.25	54.00	-0.75	119	227	Average
4804.000	61.88	-4.09	57.79	74.00	-16.21	119	227	Peak
7206.000	41.26	0.43	41.69	54.00	-12.31	103	1	Average
7206.000	51.51	0.43	51.94	74.00	-22.06	103	1	Peak
17745.000	32.55	12.78	45.33	54.00	-8.67	150	1	Average
17745.000	45.02	12.78	57.80	74.00	-16.20	150	1	Peak

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	56.29	-4.09	52.20	54.00	-1.80	102	112	Average
4804.000	60.97	-4.09	56.88	74.00	-17.12	102	112	Peak
7206.000	40.76	0.43	41.19	54.00	-12.81	138	303	Average
7206.000	51.61	0.43	52.04	74.00	-21.96	138	303	Peak
17728.000	31.89	12.76	44.65	54.00	-9.35	150	82	Average
17728.000	44.35	12.76	57.11	74.00	-16.89	150	82	Peak

18GHz-26.5GHz:

(worst case is BLE(1M) Mode low channel)

Horizontal	Vertical
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	30.39	16.33	46.72	63.50	-16.78	156	182	Average
19216.000	42.93	16.33	59.26	83.50	-24.24	156	182	Peak

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	30.34	16.33	46.67	63.50	-16.83	150	112	Average
19216.000	42.76	16.33	59.09	83.50	-24.41	150	112	Peak

Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

For 18-26.5GHz Convert the test distance limit of 3 meters to a limit of 1 meter:

Conversion factor = 20 log (1m/3m) = 9.5 dB,

Average Limit = 54+9.5 = 63.50 dBuV/m , Peak Limit = 63.50+20 = 83.50 dBuV/m @ 1m

Above 1GHz

(Worst case is BLE(1M) and BLE(2M) mode)

BLE(1M) Mode

Low channel

Horizontal

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	57.34	-4.09	53.25	54.00	-0.75	119	227	Average
4804.000	61.88	-4.09	57.79	74.00	-16.21	119	227	Peak
7206.000	41.26	0.43	41.69	54.00	-12.31	103	1	Average
7206.000	51.51	0.43	51.94	74.00	-22.06	103	1	Peak
17745.000	32.55	12.78	45.33	54.00	-8.67	150	1	Average
17745.000	45.02	12.78	57.80	74.00	-16.20	150	1	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	56.29	-4.09	52.20	54.00	-1.80	102	112	Average
4804.000	60.97	-4.09	56.88	74.00	-17.12	102	112	Peak
7206.000	40.76	0.43	41.19	54.00	-12.81	138	303	Average
7206.000	51.61	0.43	52.04	74.00	-21.96	138	303	Peak
17728.000	31.89	12.76	44.65	54.00	-9.35	150	82	Average
17728.000	44.35	12.76	57.11	74.00	-16.89	150	82	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	54.26	-3.54	50.72	54.00	-3.28	115	258	Average
4880.000	59.35	-3.54	55.81	74.00	-18.19	115	258	Peak
7320.000	42.67	0.53	43.20	54.00	-10.80	101	3	Average
7320.000	52.94	0.53	53.47	74.00	-20.53	101	3	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	54.66	-3.54	51.12	54.00	-2.88	286	80	Average
4880.000	59.78	-3.54	56.24	74.00	-17.76	286	80	Peak
7320.000	44.31	0.53	44.84	54.00	-9.16	104	298	Average
7320.000	54.40	0.53	54.93	74.00	-19.07	104	298	Peak

High channel

Horizontal

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	54.46	-3.67	50.79	54.00	-3.21	114	297	Average
4960.000	59.83	-3.67	56.16	74.00	-17.84	114	297	Peak
7440.000	40.64	0.28	40.92	54.00	-13.08	122	104	Average
7440.000	51.23	0.28	51.51	74.00	-22.49	122	104	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	51.71	-3.67	48.04	54.00	-5.96	102	109	Average
4960.000	57.36	-3.67	53.69	74.00	-20.31	102	109	Peak
7440.000	40.73	0.28	41.01	54.00	-12.99	130	310	Average
7440.000	51.33	0.28	51.61	74.00	-22.39	130	310	Peak

Note:

Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

BLE(2M) Mode

Low channel

Horizontal

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	52.95	-4.09	48.86	54.00	-5.14	117	236	Average
4804.000	62.05	-4.09	57.96	74.00	-16.04	117	236	Peak
7206.000	41.58	0.43	42.01	54.00	-11.99	122	3	Average
7206.000	51.70	0.43	52.13	74.00	-21.87	122	3	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	50.95	-4.09	46.86	54.00	-7.14	101	98	Average
4804.000	60.34	-4.09	56.25	74.00	-17.75	101	98	Peak
7206.000	41.36	0.43	41.79	54.00	-12.21	252	293	Average
7206.000	51.78	0.43	52.21	74.00	-21.79	252	293	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	50.05	-3.54	46.51	54.00	-7.49	124	229	Average
4880.000	59.42	-3.54	55.88	74.00	-18.12	124	229	Peak
7320.000	42.62	0.53	43.15	54.00	-10.85	103	10	Average
7320.000	52.68	0.53	53.21	74.00	-20.79	103	10	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	49.93	-3.54	46.39	54.00	-7.61	286	81	Average
4880.000	59.38	-3.54	55.84	74.00	-18.16	286	81	Peak
7320.000	44.20	0.53	44.73	54.00	-9.27	117	300	Average
7320.000	54.05	0.53	54.58	74.00	-19.42	117	300	Peak

High channel

Horizontal

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	49.42	-3.67	45.75	54.00	-8.25	112	314	Average
4960.000	59.32	-3.67	55.65	74.00	-18.35	112	314	Peak
7440.000	40.35	0.28	40.63	54.00	-13.37	102	333	Average
7440.000	50.69	0.28	50.97	74.00	-23.03	102	333	Peak

Vertical

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	48.46	-3.67	44.79	54.00	-9.21	262	91	Average
4960.000	58.13	-3.67	54.46	74.00	-19.54	262	91	Peak
7440.000	40.50	0.28	40.78	54.00	-13.22	139	236	Average
7440.000	51.54	0.28	51.82	74.00	-22.18	139	236	Peak

Note:

Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

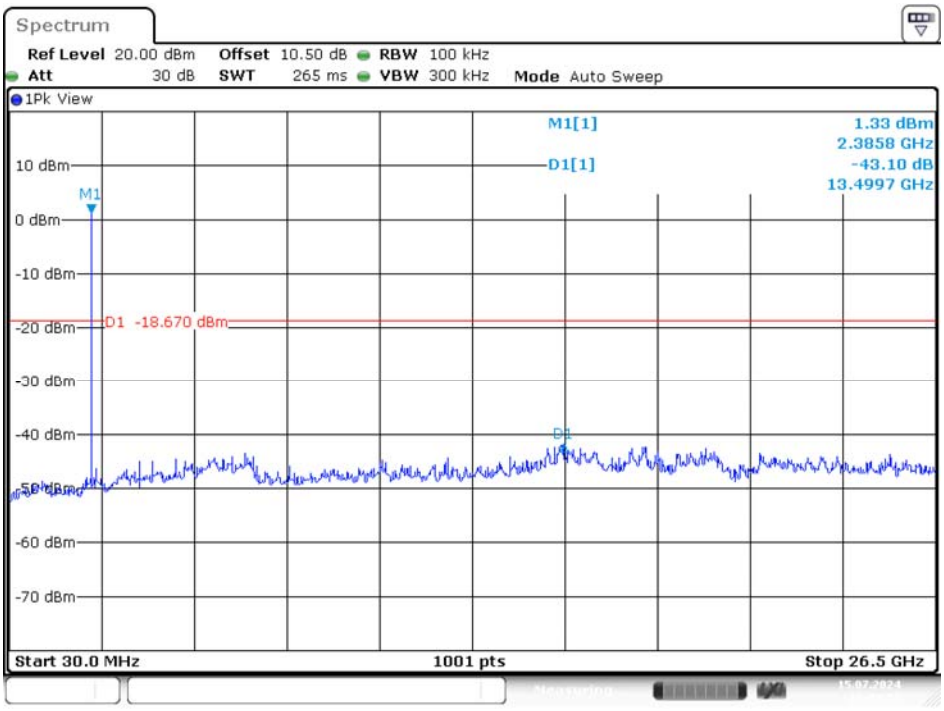
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	43.10	≥ 20	PASS
Middle	2440	42.28	≥ 20	PASS
High	2480	43.51	≥ 20	PASS
BLE(2M) Mode				
Low	2402	41.39	≥ 20	PASS
Middle	2440	42.14	≥ 20	PASS
High	2480	42.19	≥ 20	PASS
BLE(125k) Mode				
Low	2402	43.43	≥ 20	PASS
Middle	2440	43.88	≥ 20	PASS
High	2480	44.32	≥ 20	PASS
BLE(500k) Mode				
Low	2402	42.99	≥ 20	PASS
Middle	2440	45.22	≥ 20	PASS
High	2480	44.28	≥ 20	PASS

Please refer to the following plots

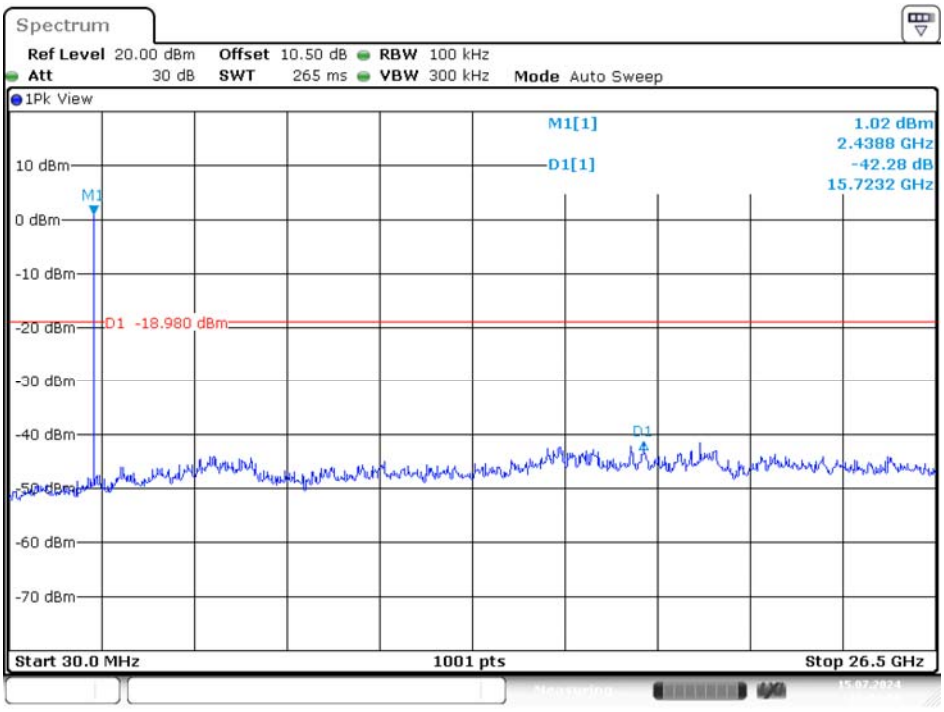
BLE(1M) Mode

Low Channel



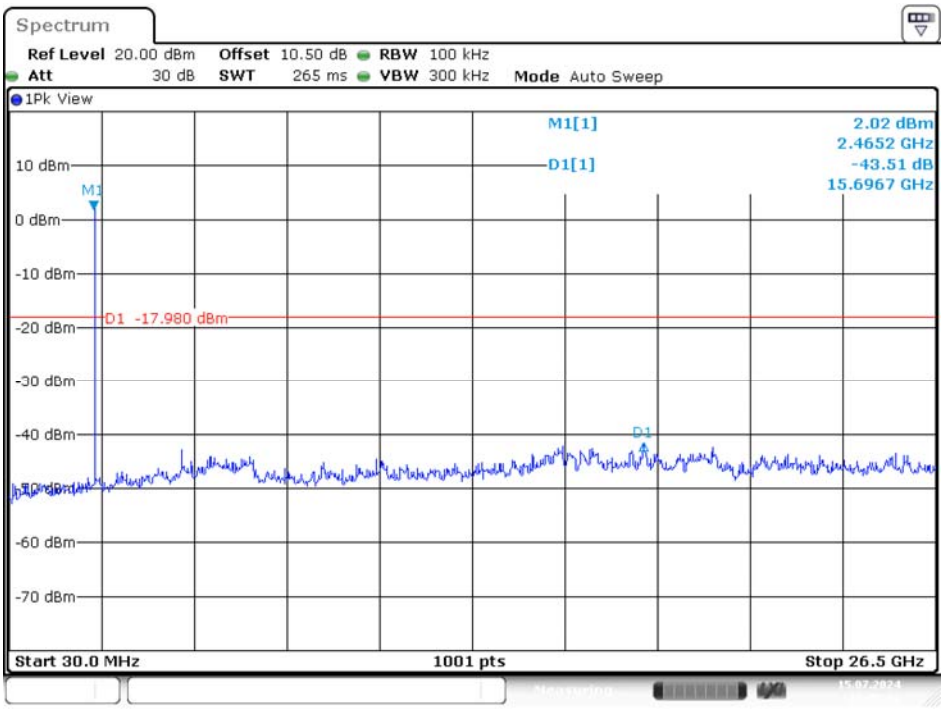
Date: 15.JUL.2024 10:41:55

Middle Channel



Date: 15.JUL.2024 10:44:09

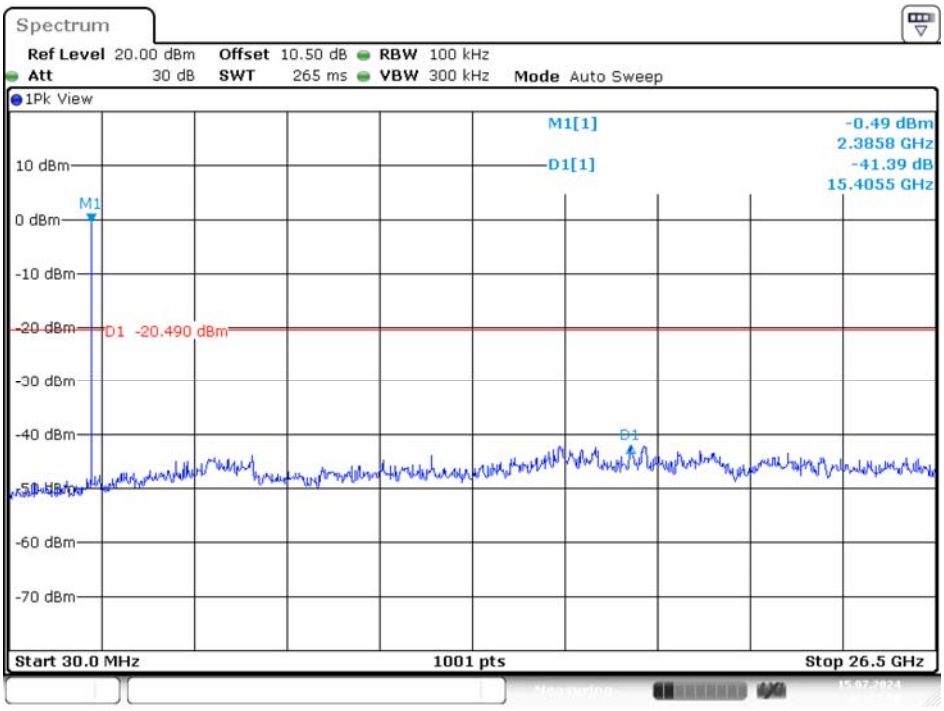
High Channel



Date: 15.JUL.2024 10:46:42

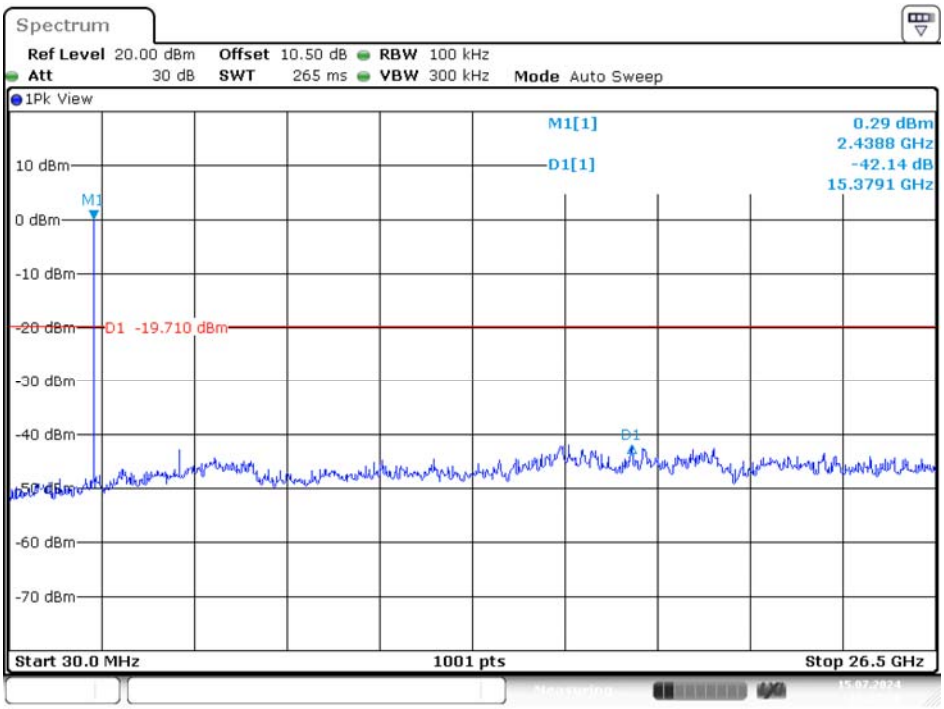
BLE(2M) Mode

Low Channel



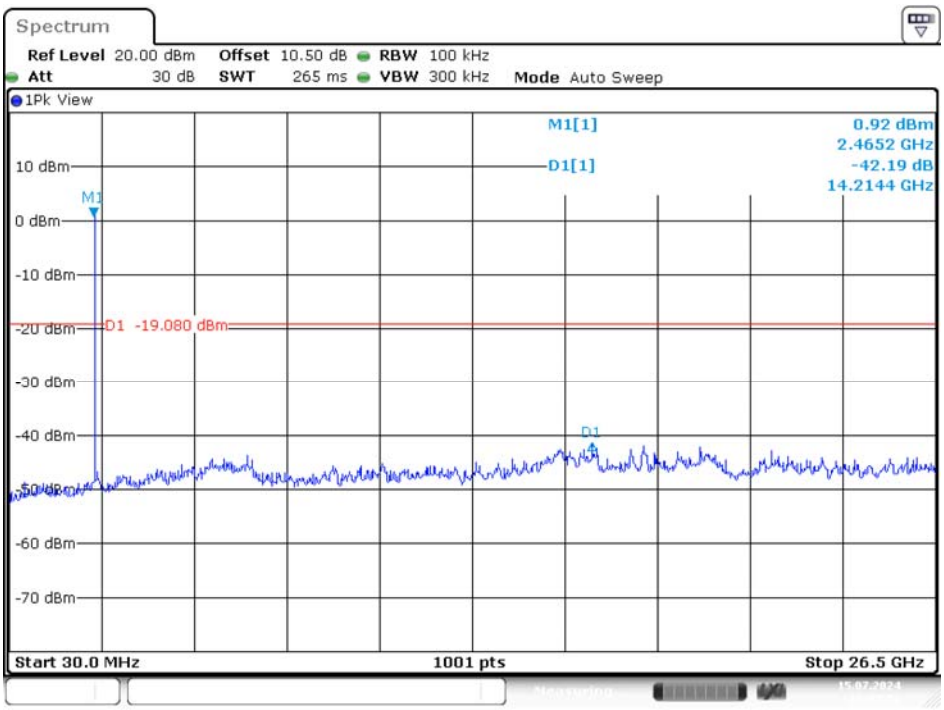
Date: 15.JUL.2024 10:25:10

Middle Channel



Date: 15.JUL.2024 10:27:36

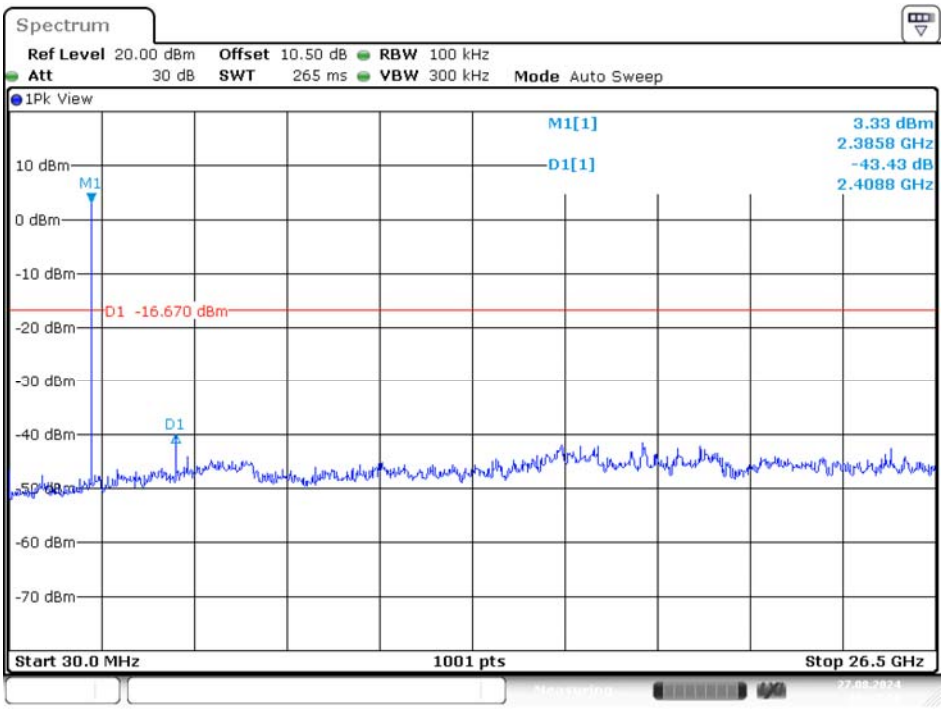
High Channel



Date: 15.JUL.2024 10:33:52

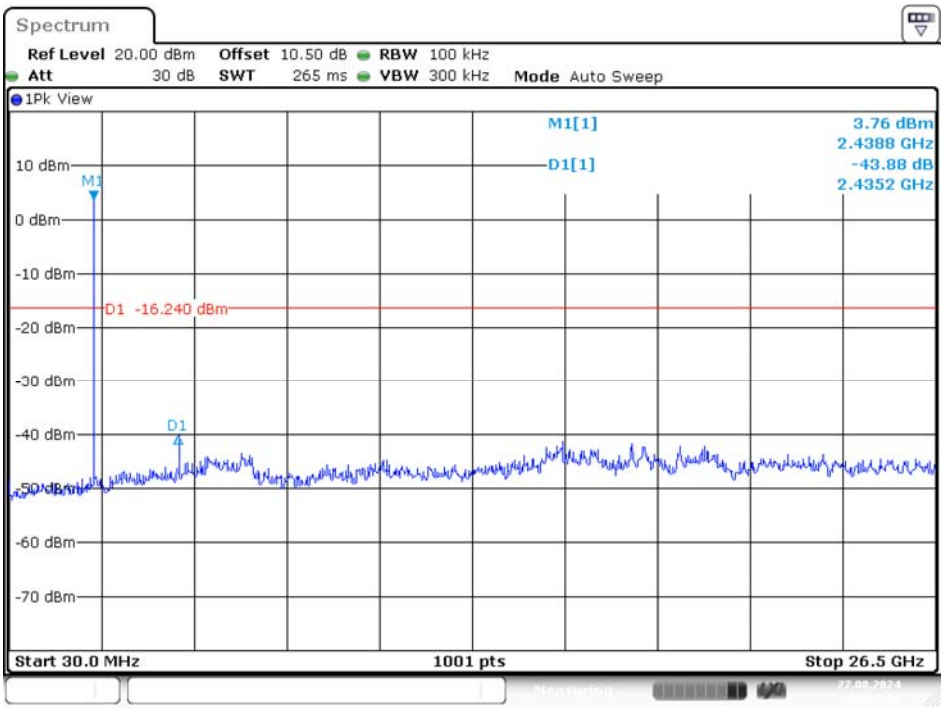
BLE(125k) Mode

Low Channel



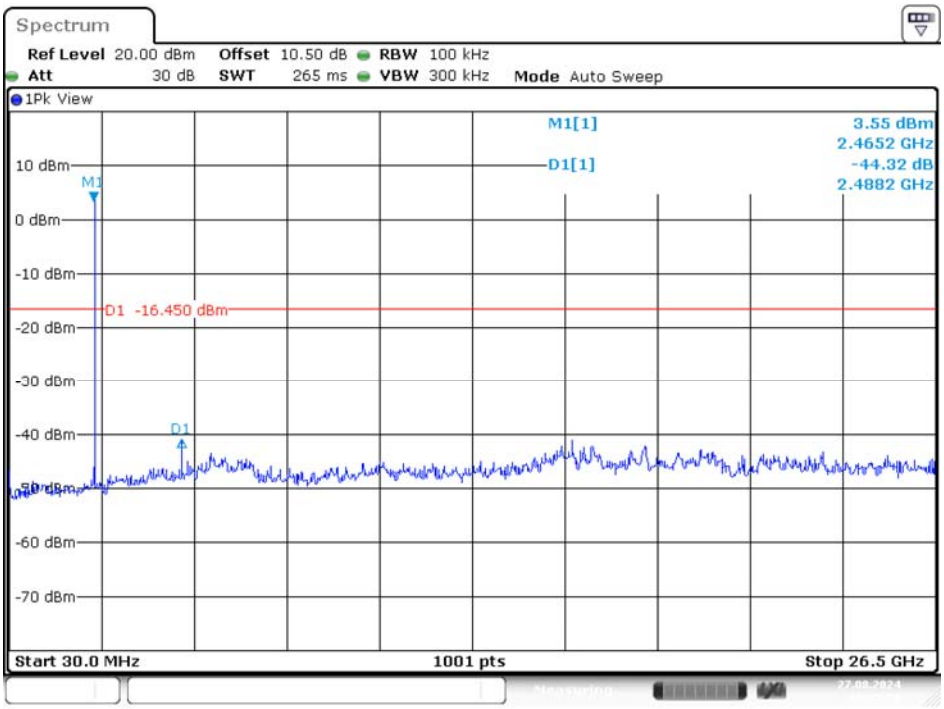
Date: 27.AUG.2024 10:02:16

Middle Channel



Date: 27.AUG.2024 10:08:08

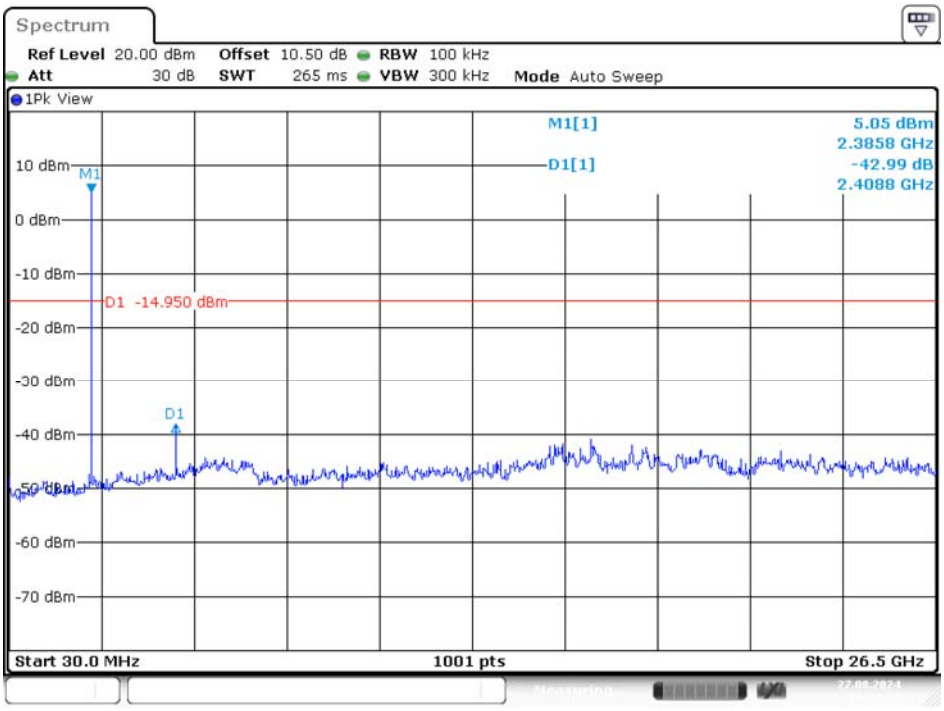
High Channel



Date: 27.AUG.2024 10:15:50

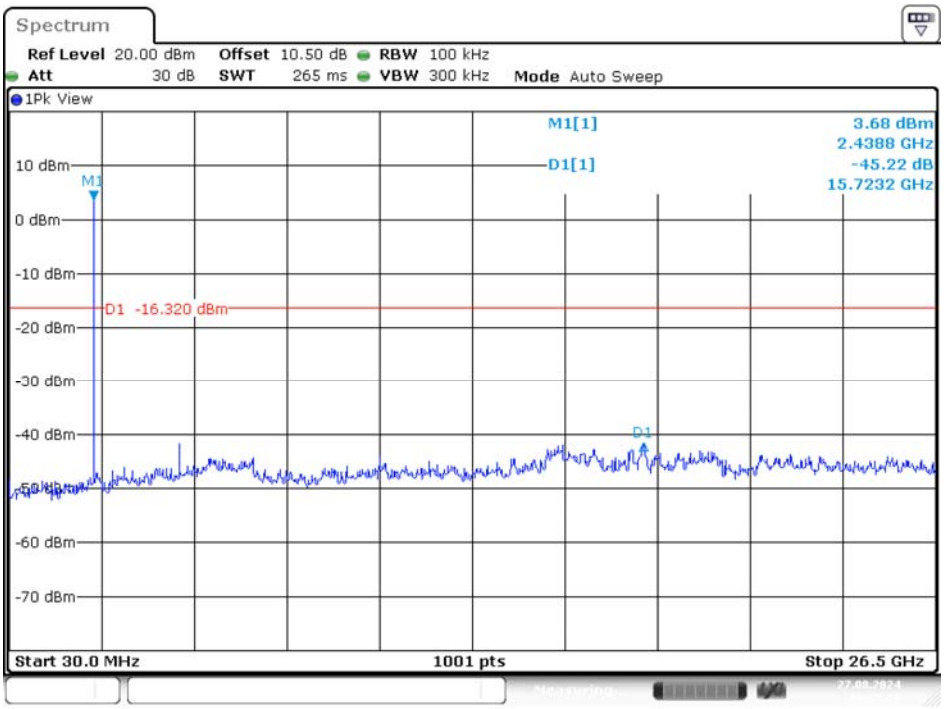
BLE(500k) Mode

Low Channel



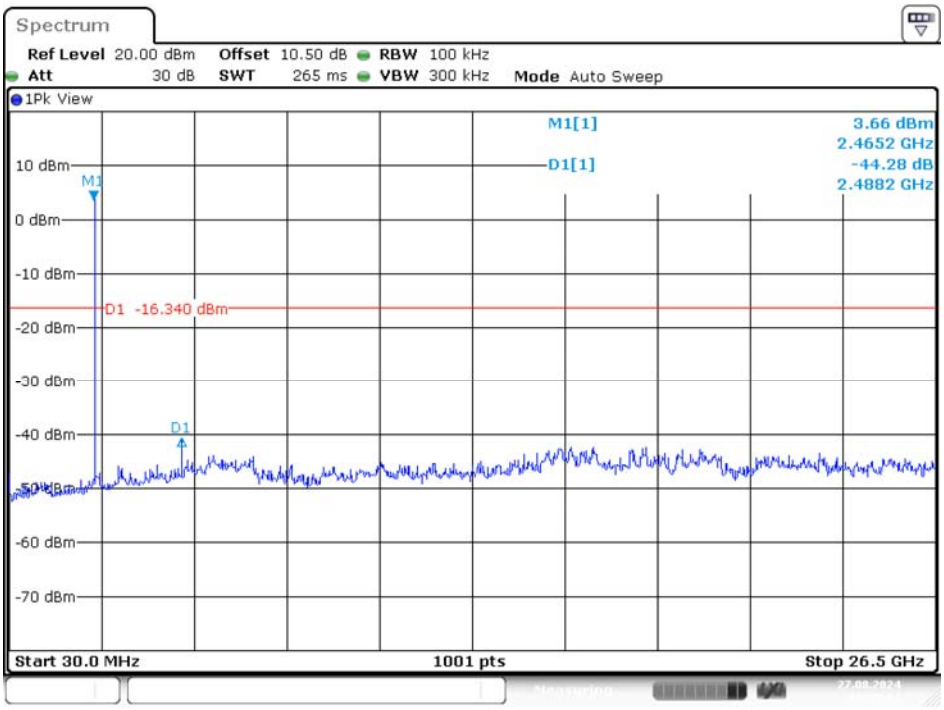
Date: 27.AUG.2024 10:20:45

Middle Channel



Date: 27.AUG.2024 10:23:18

High Channel



Date: 27.AUG.2024 10:25:44

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

According to ANSI C63.10-2013, section 11.8

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.

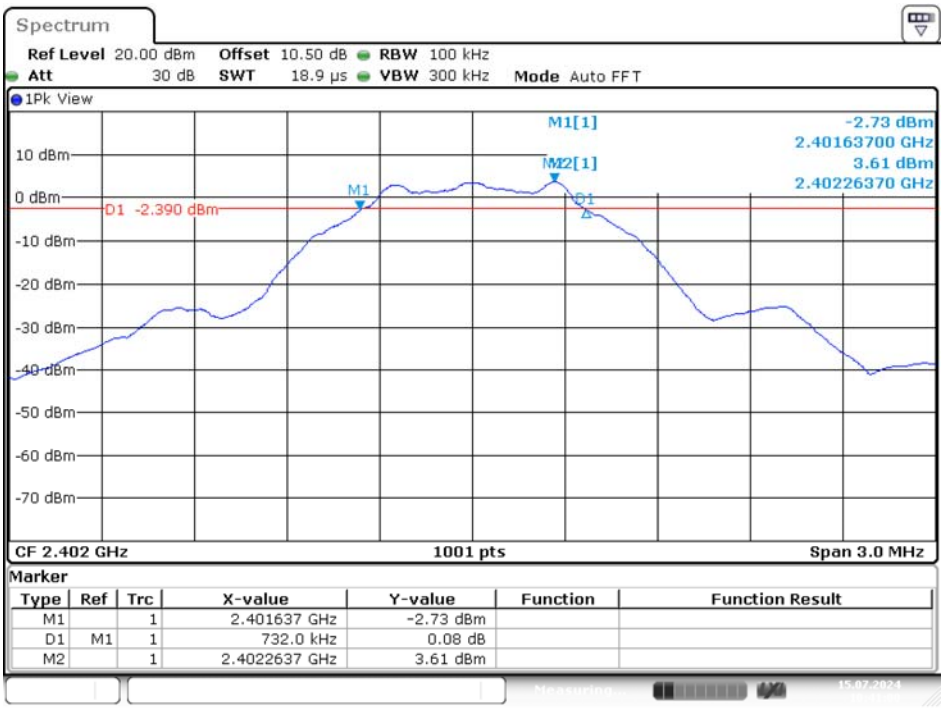
9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	Limit (kHz)	Result
BLE(1M) Mode				
Low	2402	732	> 500	Compliance
Middle	2440	732	> 500	Compliance
High	2480	738	> 500	Compliance
BLE(2M) Mode				
Low	2402	1260	> 500	Compliance
Middle	2440	1131	> 500	Compliance
High	2480	1224	> 500	Compliance
BLE(125k) Mode				
Low	2402	621	> 500	Compliance
Middle	2440	618	> 500	Compliance
High	2480	618	> 500	Compliance
BLE(500k) Mode				
Low	2402	729	> 500	Compliance
Middle	2440	732	> 500	Compliance
High	2480	735	> 500	Compliance

Please refer to the following plots

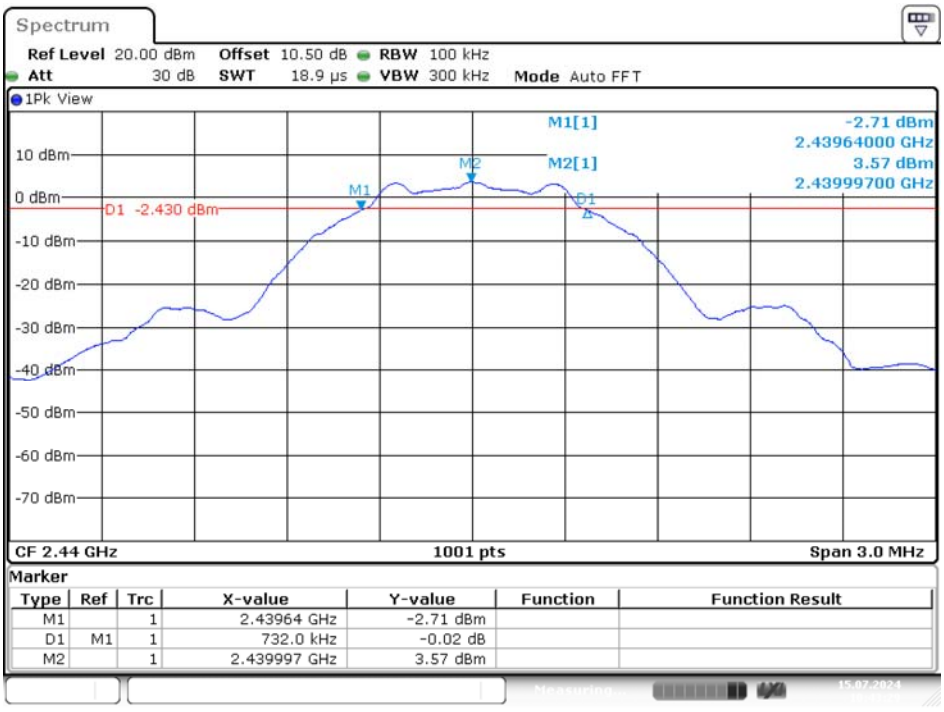
BLE(1M) Mode

Low Channel



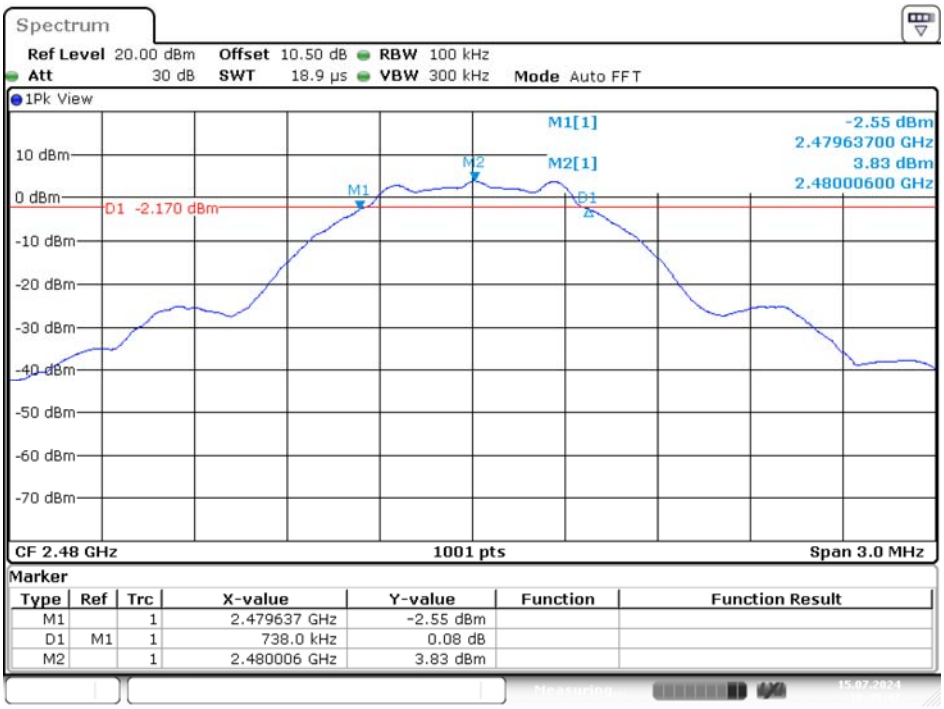
Date: 15.JUL.2024 10:40:59

Middle Channel



Date: 15.JUL.2024 10:43:29

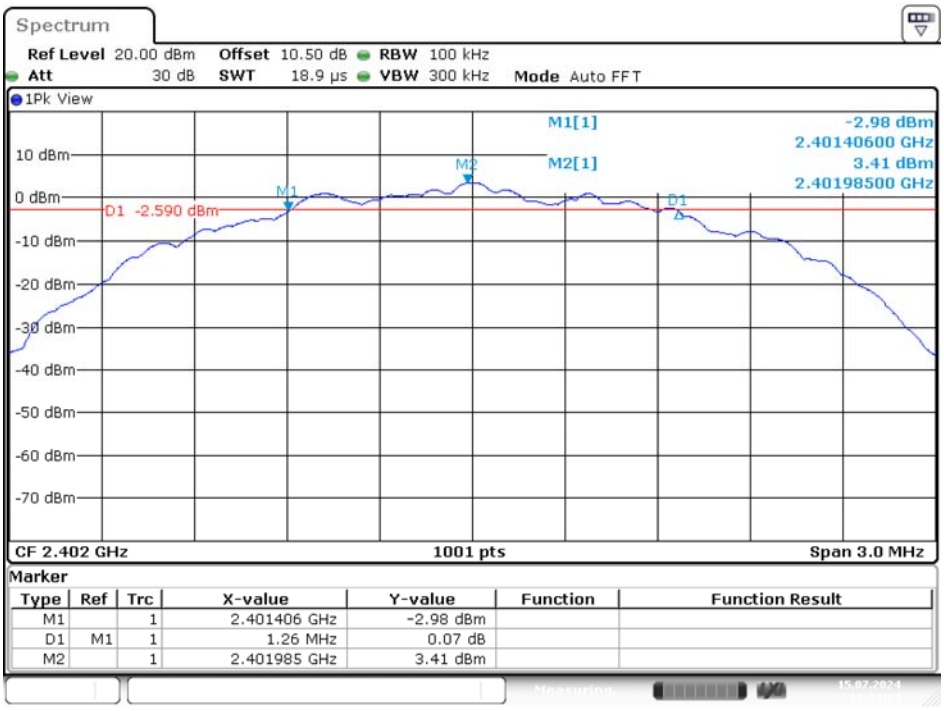
High Channel



Date: 15.JUL.2024 10:45:47

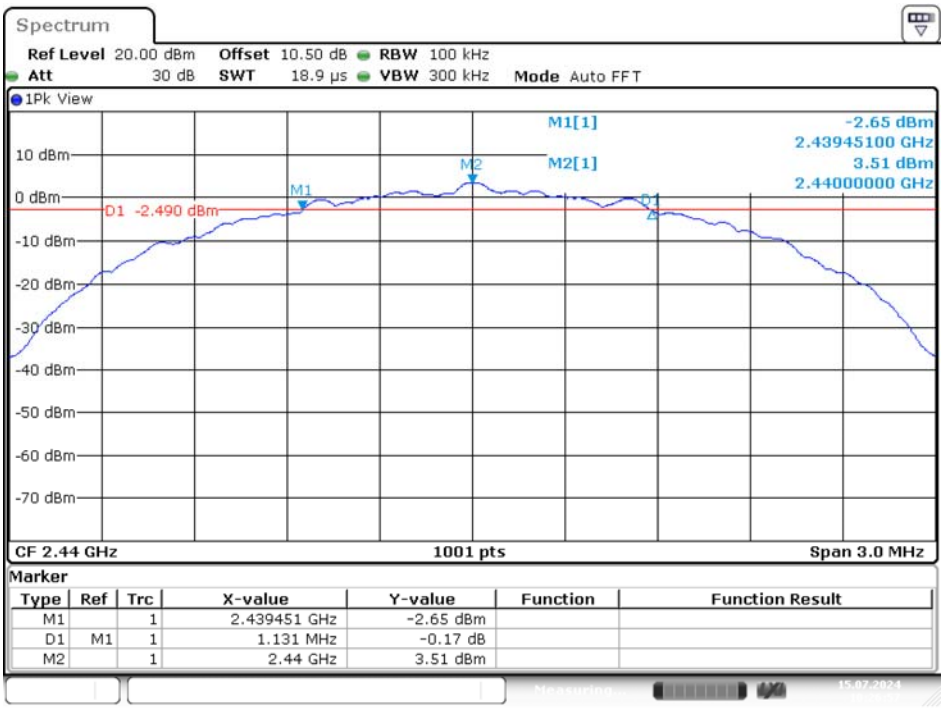
BLE(2M) Mode

Low Channel



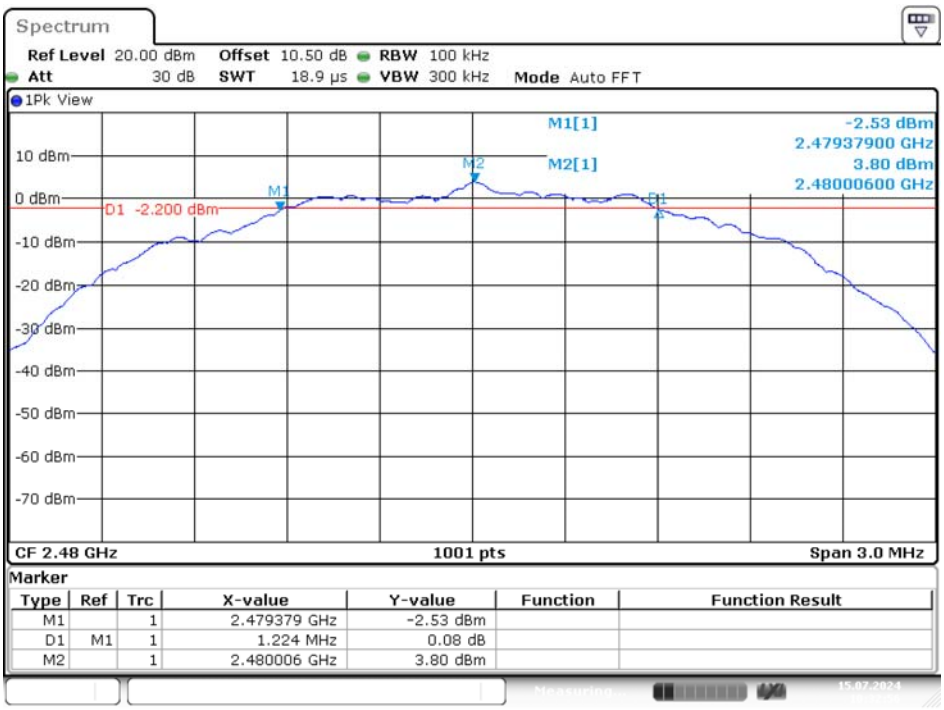
Date: 15.JUL.2024 10:24:14

Middle Channel



Date: 15.JUL.2024 10:26:57

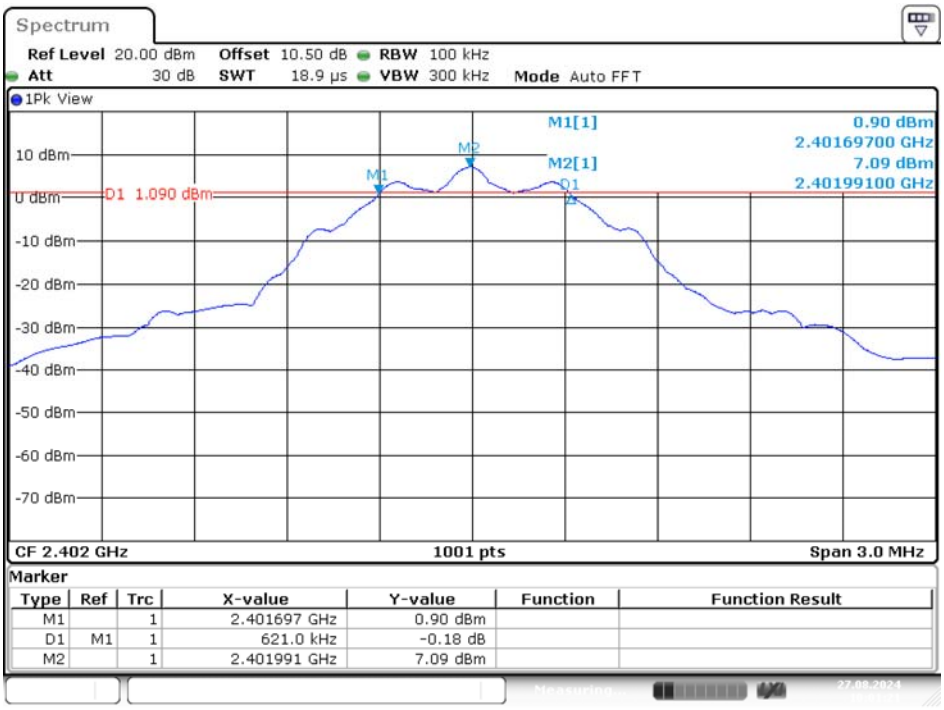
High Channel



Date: 15.JUL.2024 10:32:56

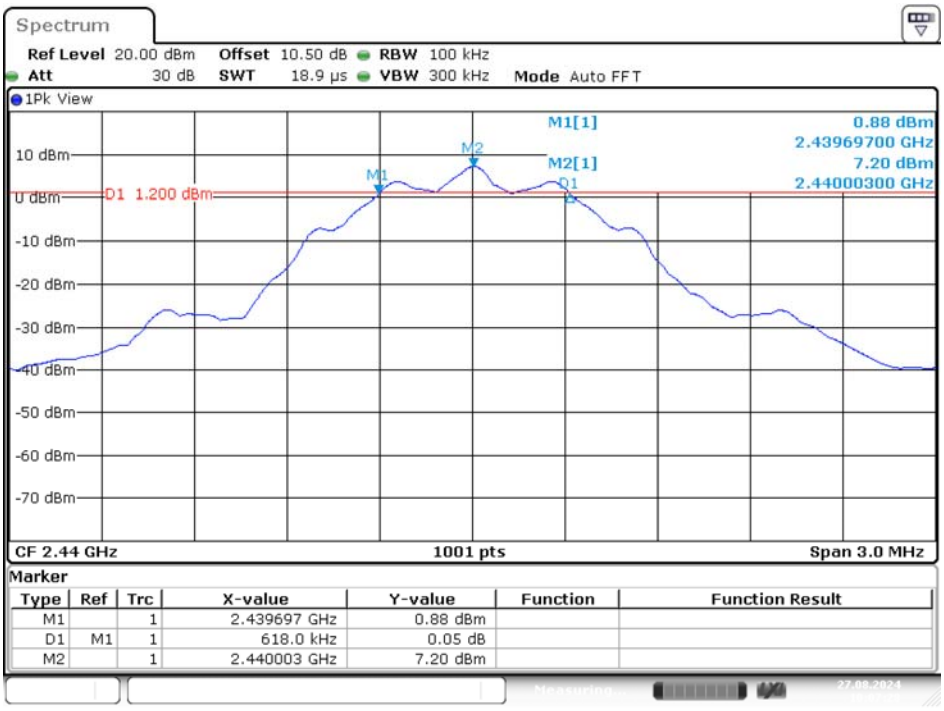
BLE(125k) Mode

Low Channel



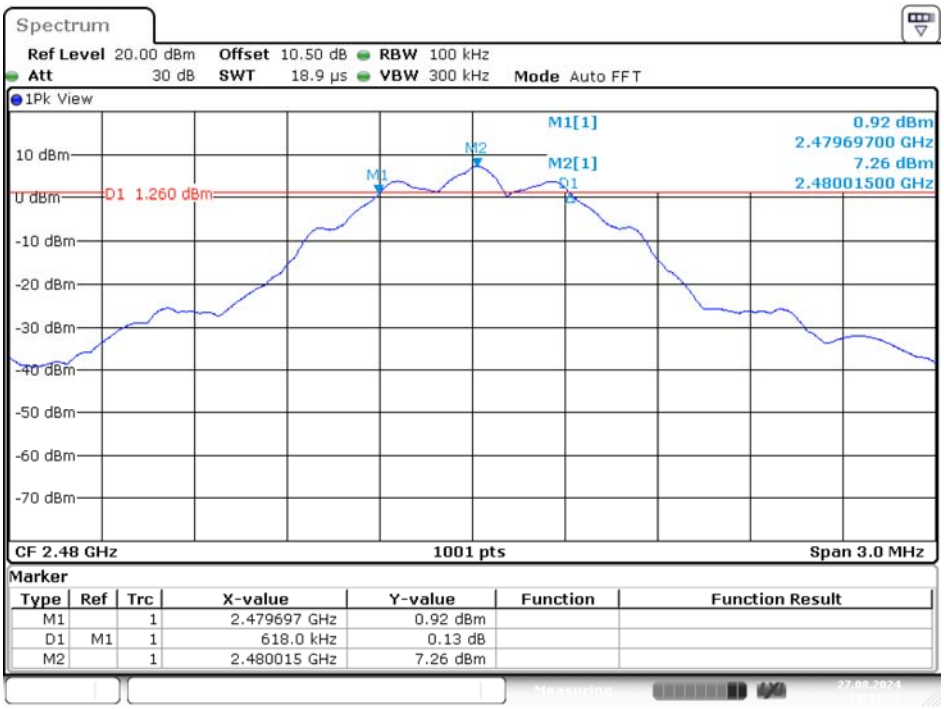
Date: 27.AUG.2024 10:01:21

Middle Channel



Date: 27.AUG.2024 10:07:28

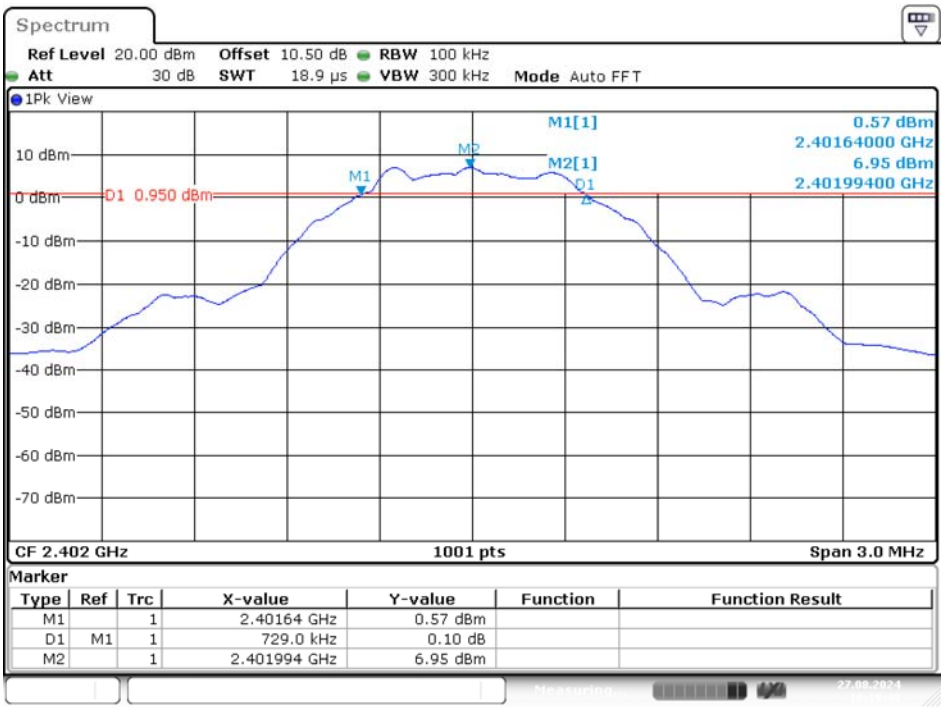
High Channel



Date: 27.AUG.2024 10:14:55

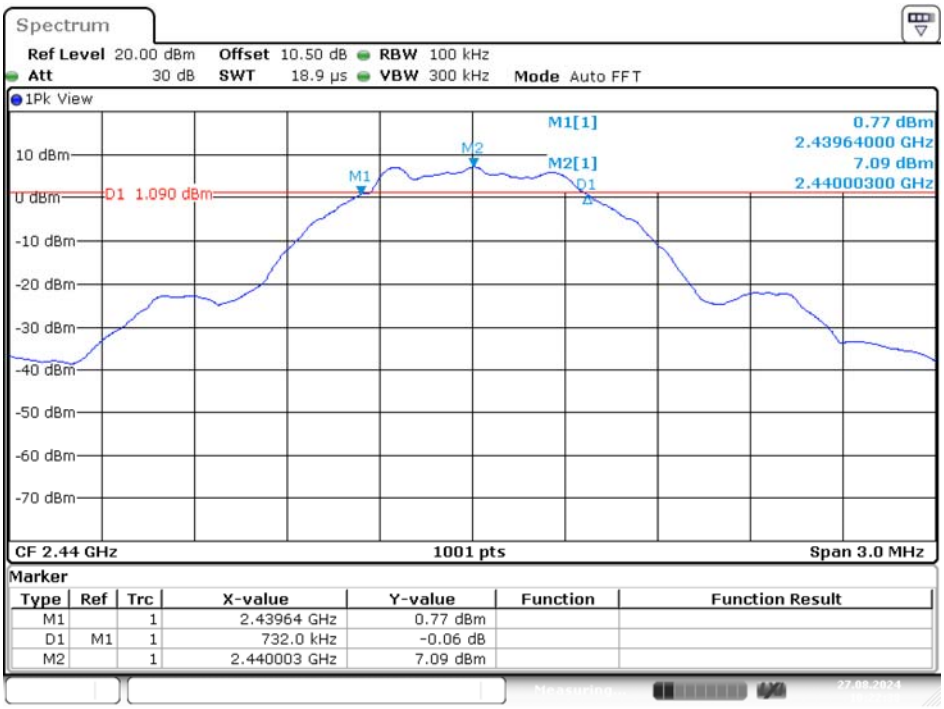
BLE(500k) Mode

Low Channel



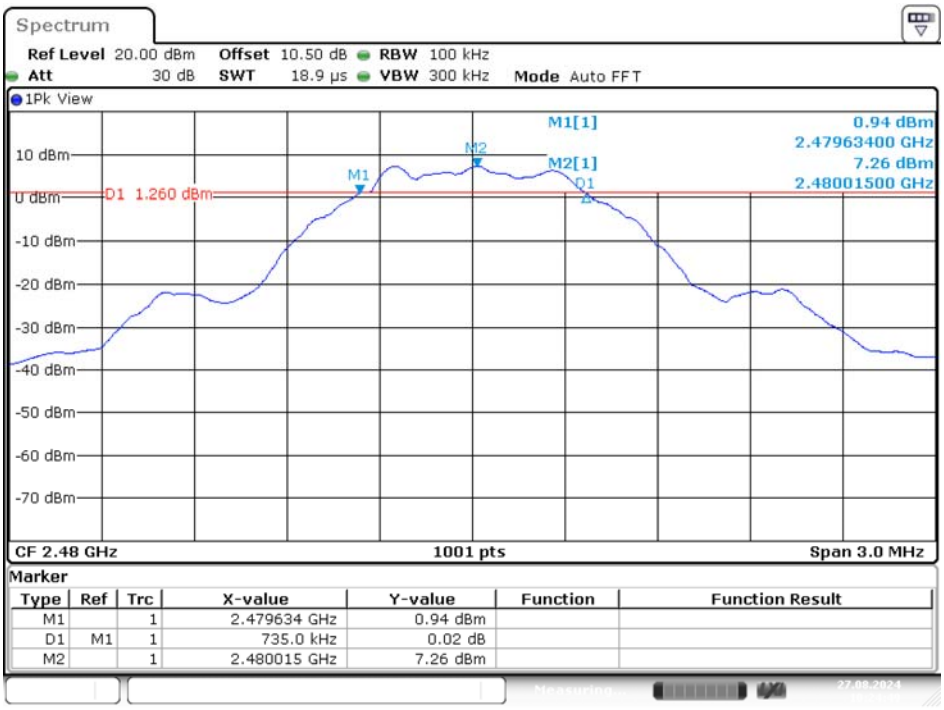
Date: 27.AUG.2024 10:19:49

Middle Channel



Date: 27.AUG.2024 10:22:38

High Channel



Date: 27.AUG.2024 10:24:48

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

According to ANSI C63.10-2013, section 11.9.1.3

1. Place the EUT on a bench and set it in transmitting mode.

2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

10.3 Test Results

Conducted Peak Output Power

Channel	Frequency (MHz)	Conducted Peak Output Power		Limit (W)	Result
		(dBm)	(W)		
BLE(1M) Mode					
Low	2402	13.59	0.023	1	PASS
Middle	2440	13.69	0.023	1	PASS
High	2480	13.82	0.024	1	PASS
BLE(2M) Mode					
Low	2402	13.58	0.023	1	PASS
Middle	2440	13.68	0.023	1	PASS
High	2480	13.83	0.024	1	PASS
BLE(125k) Mode					
Low	2402	7.42	0.006	1	PASS
Middle	2440	7.52	0.006	1	PASS
High	2480	7.64	0.006	1	PASS
BLE(500k) Mode					
Low	2402	7.60	0.006	1	PASS
Middle	2440	7.62	0.006	1	PASS
High	2480	7.72	0.006	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

According to ANSI C63.10-2013 Section 11.11

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.
3. Set the VBW ≥ [3 × RBW].
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

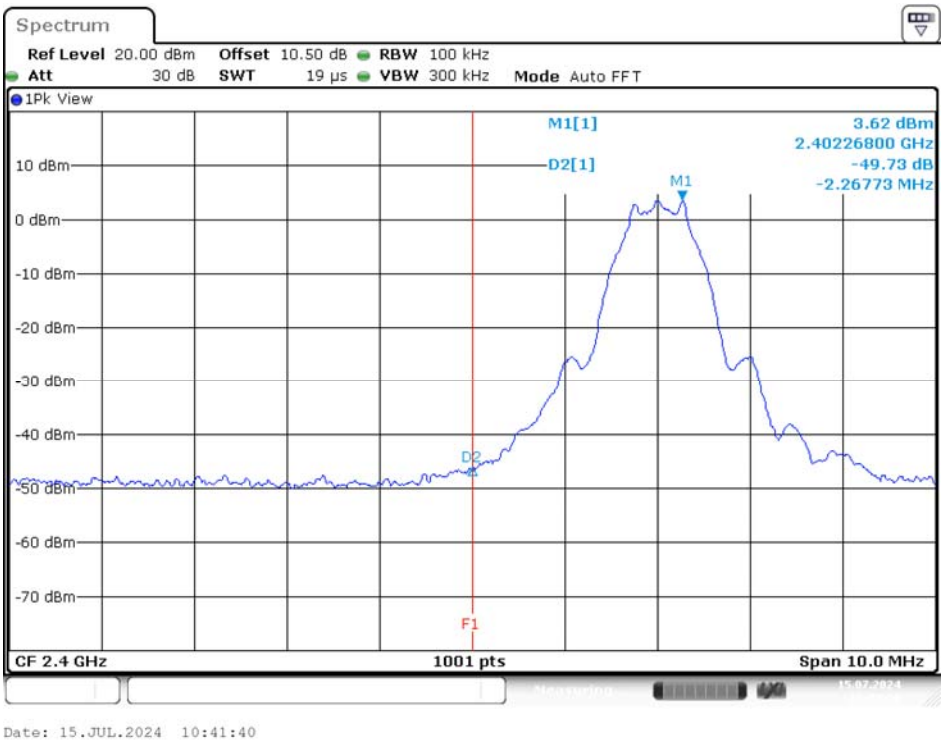
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	49.73	≥ 20	PASS
High	2480	51.83	≥ 20	PASS
BLE(2M) Mode				
Low	2402	32.00	≥ 20	PASS
High	2480	50.31	≥ 20	PASS
BLE(125k) Mode				
Low	2402	50.99	≥ 20	PASS
High	2480	54.29	≥ 20	PASS
BLE(500k) Mode				
Low	2402	51.62	≥ 20	PASS
High	2480	53.61	≥ 20	PASS

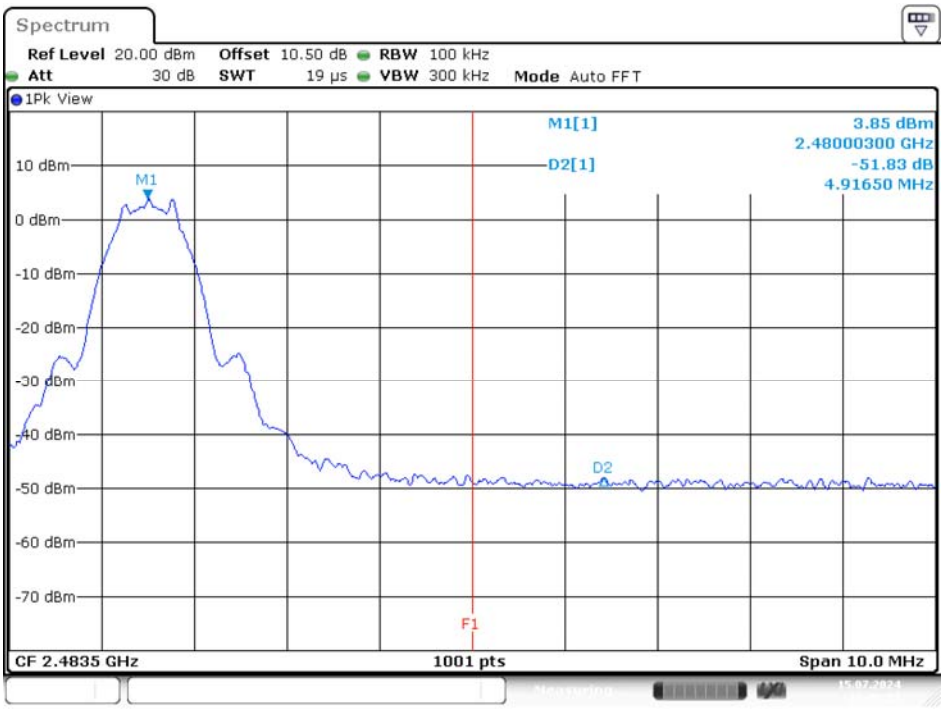
Please refer to the following plots

BLE(1M) Mode

Band Edge, Left Side



Band Edge, Right Side



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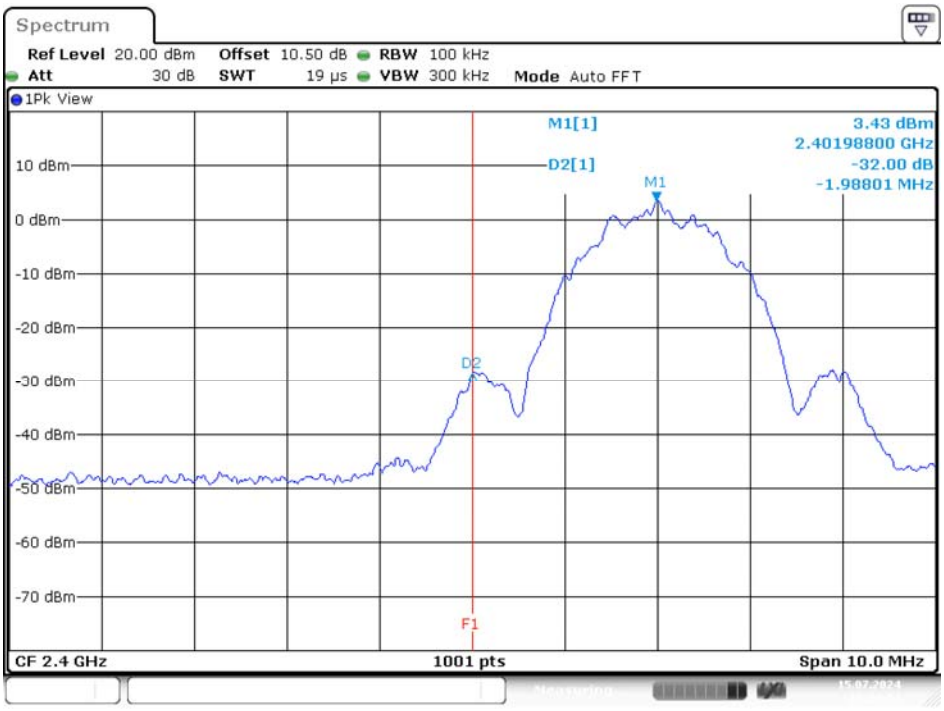
BLE(2M) Mode

Band Edge, Left Side



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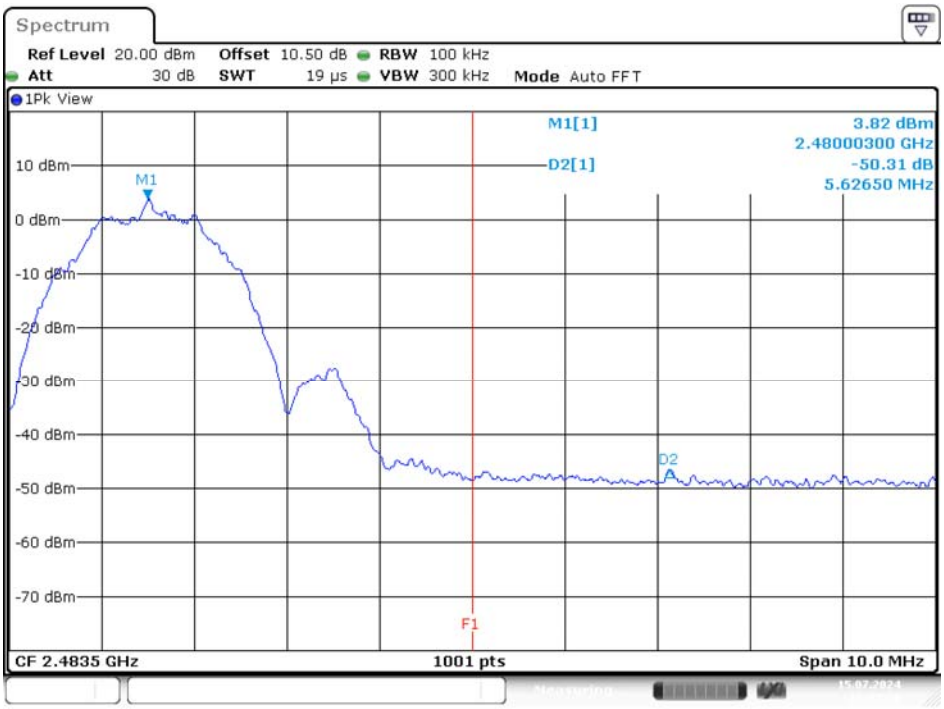
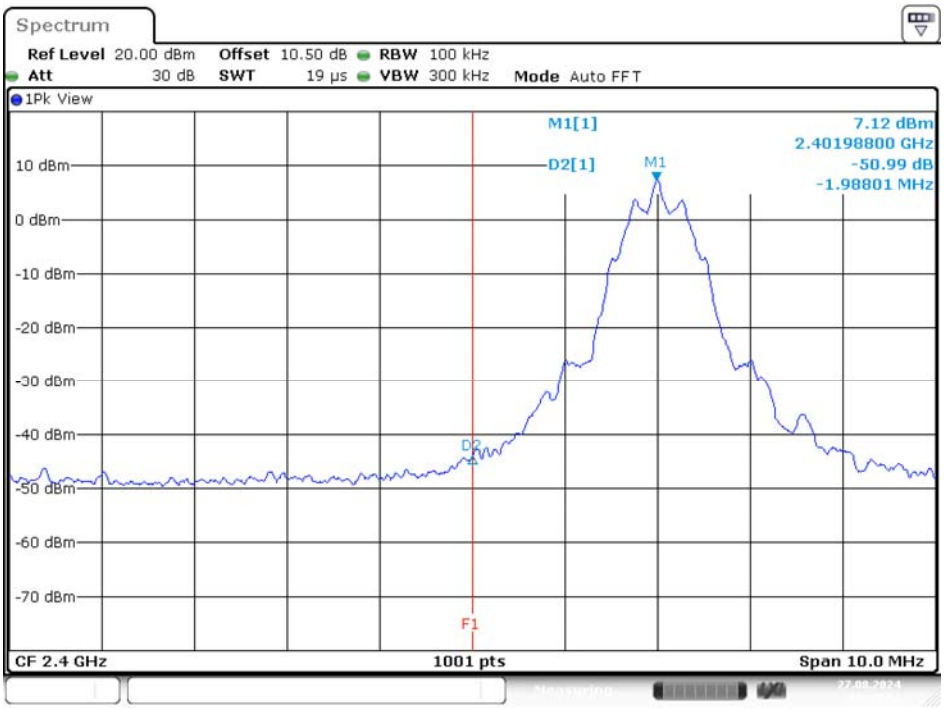
Band Edge, Right Side



Date: 15.JUL.2024 10:33:36

BLE(125k) Mode

Band Edge, Left Side



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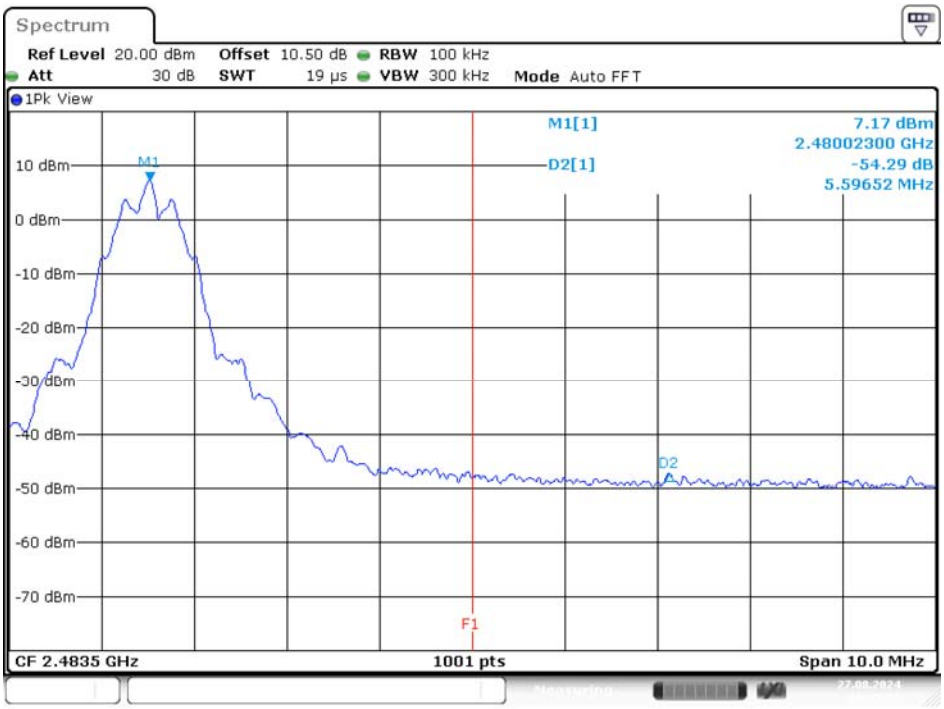
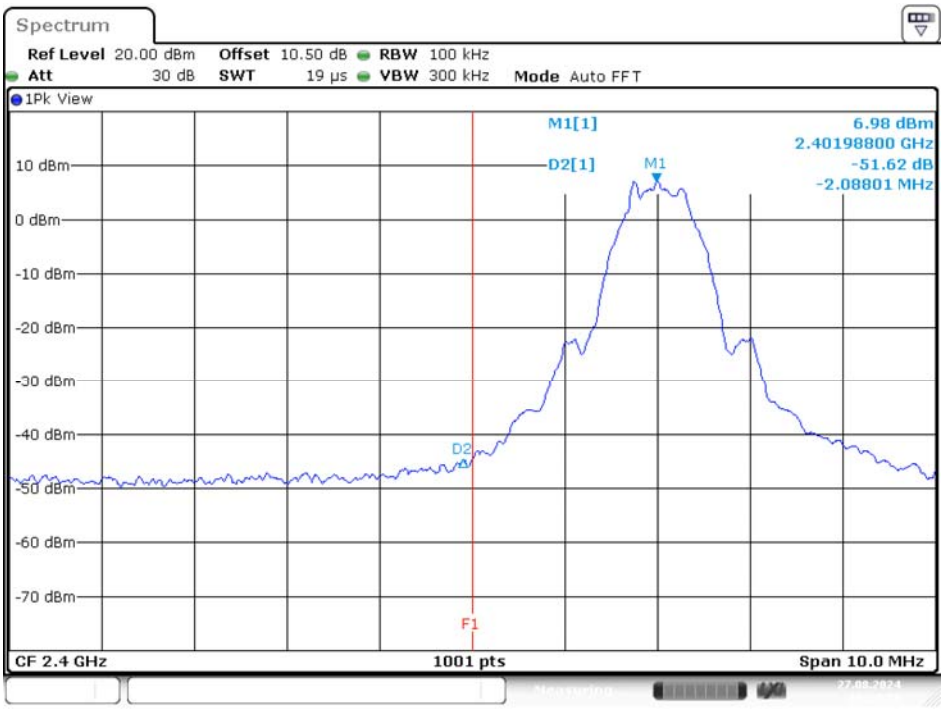
Band Edge, Right Side



Date: 27.AUG.2024 10:15:35

BLE(500k) Mode

Band Edge, Left Side



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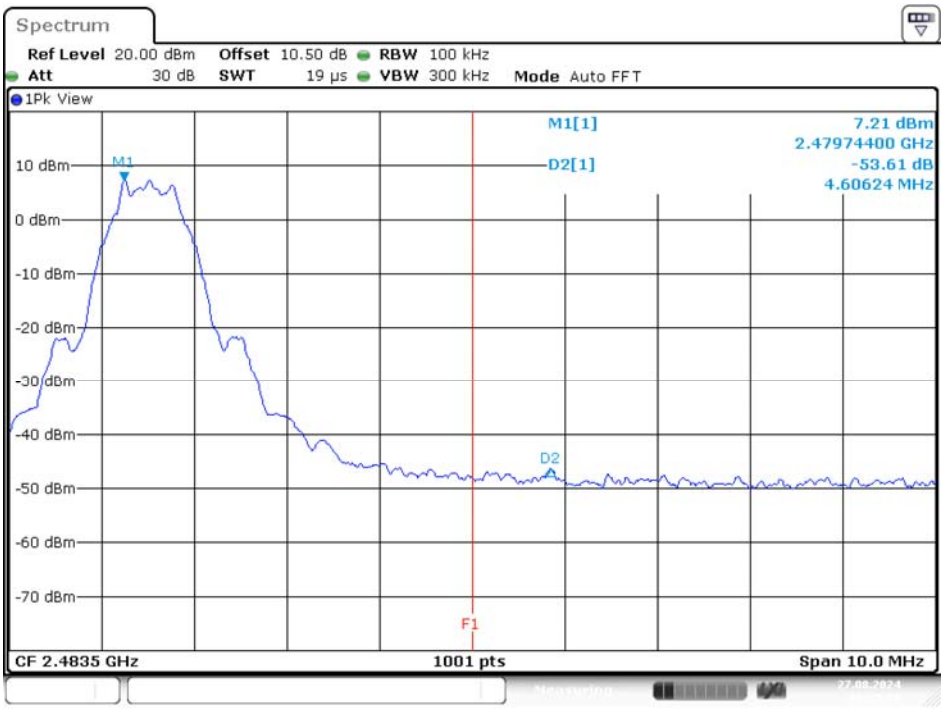
Band Edge, Right Side



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12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

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

12.2 Test Procedure

According to ANSI C63.10-2013, section 11.10.2

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

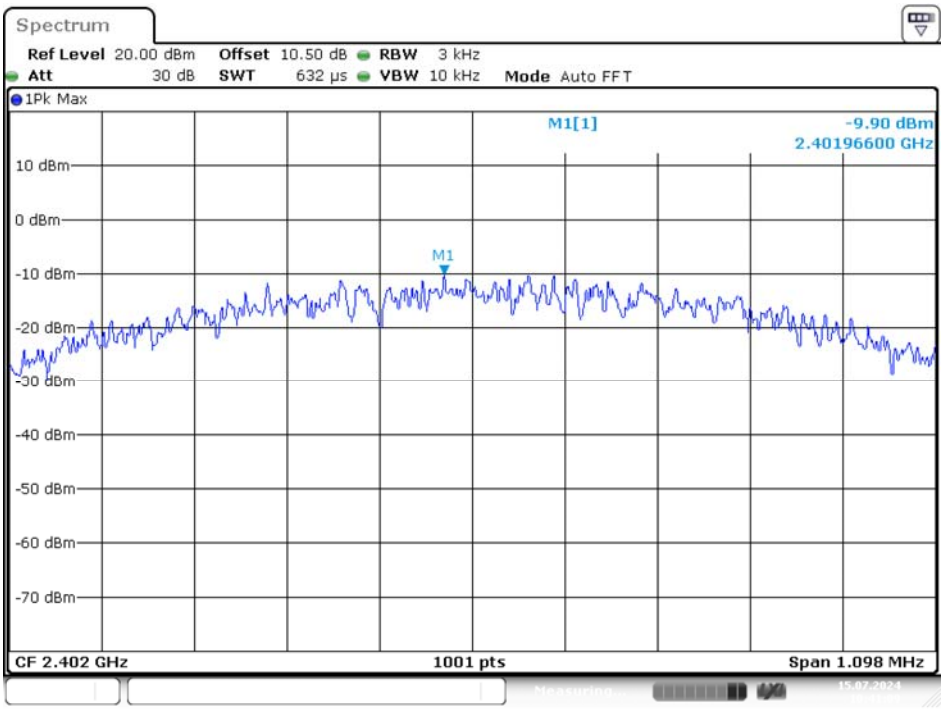
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE(1M) Mode				
Low	2402	-9.90	8	Compliance
Middle	2440	-9.66	8	Compliance
High	2480	-9.34	8	Compliance
BLE(2M) Mode				
Low	2402	-12.37	8	Compliance
Middle	2440	-11.72	8	Compliance
High	2480	-12.28	8	Compliance
BLE(125k) Mode				
Low	2402	1.16	8	Compliance
Middle	2440	1.33	8	Compliance
High	2480	1.38	8	Compliance
BLE(500k) Mode				
Low	2402	0.79	8	Compliance
Middle	2440	0.97	8	Compliance
High	2480	1.13	8	Compliance

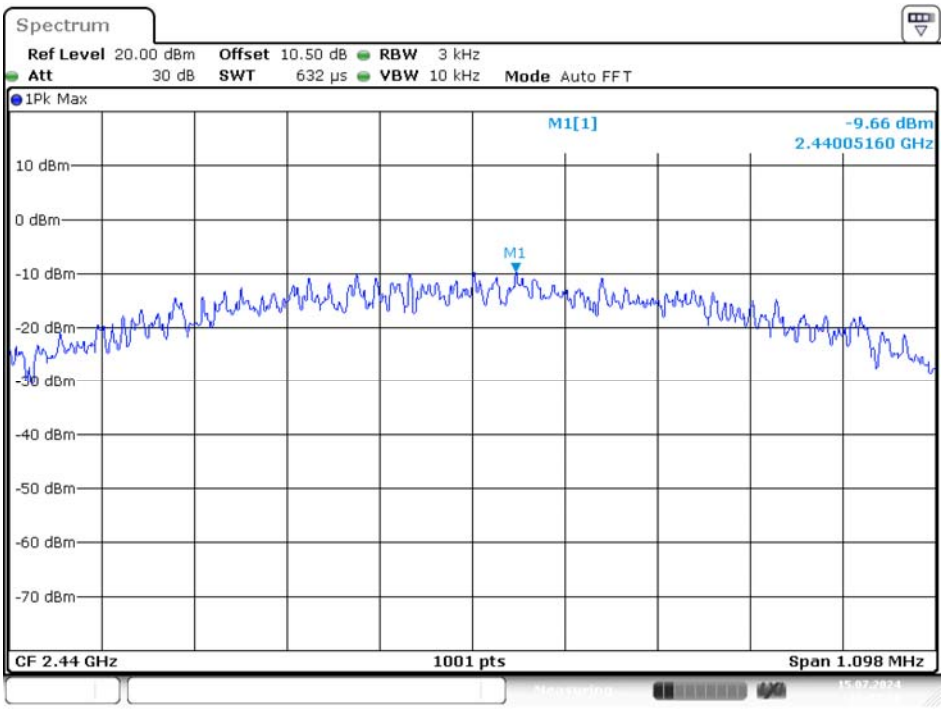
Please refer to the following plots

BLE(1M) Mode

Low Channel



Middle Channel



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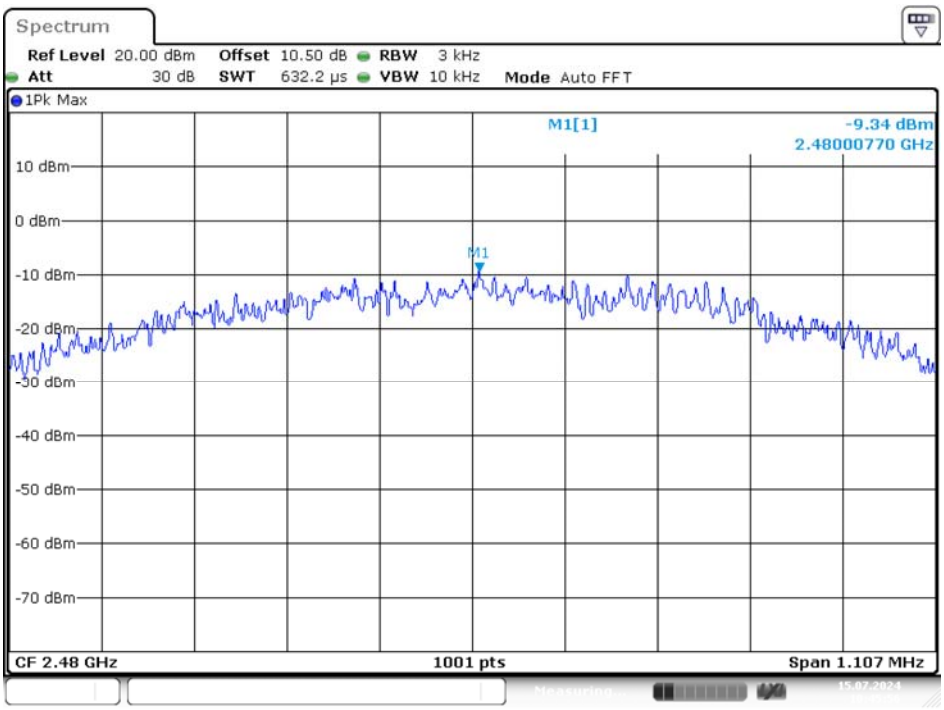
High Channel



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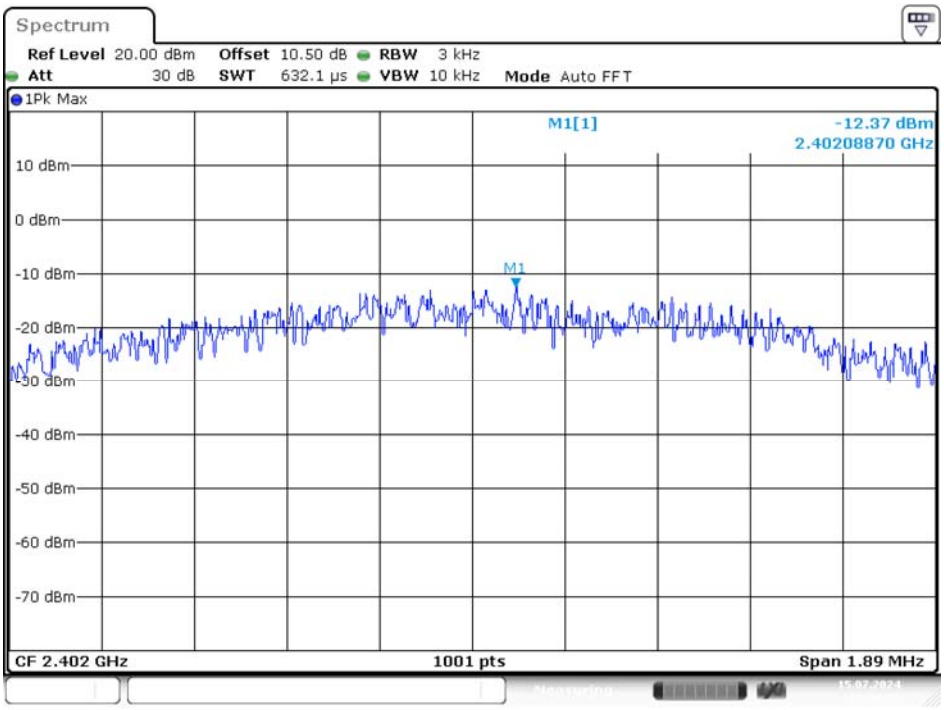
BLE(2M) Mode

Low Channel



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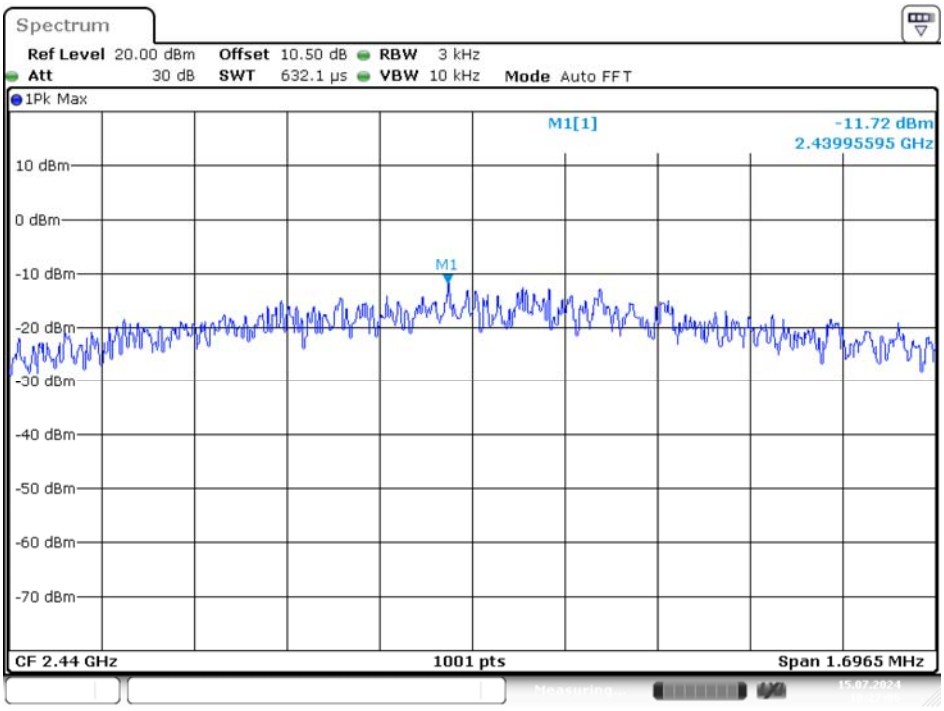
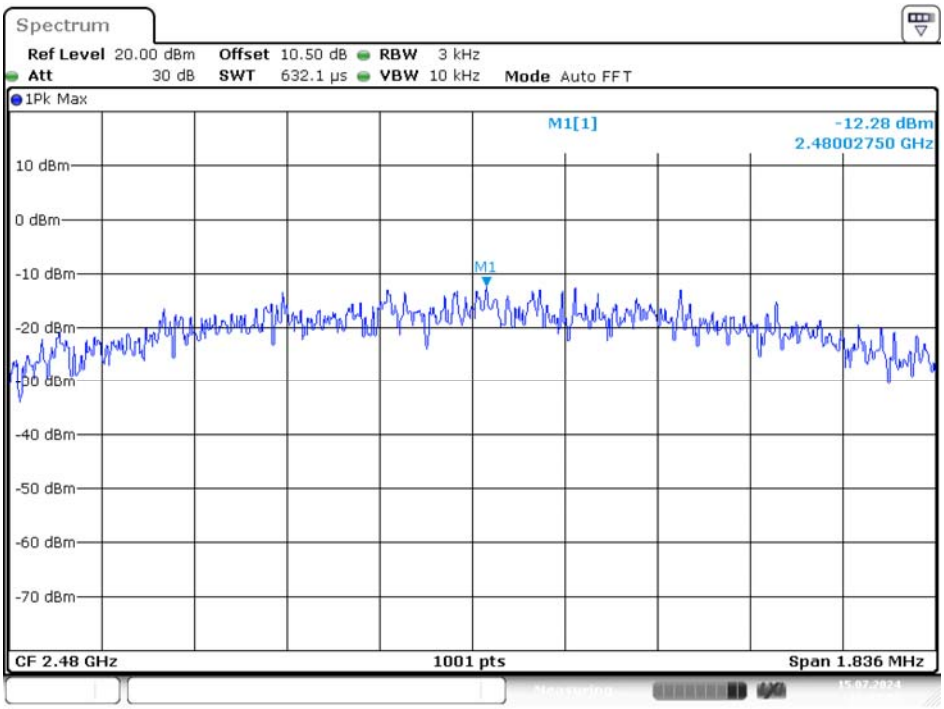
Middle Channel



Date: 15.JUL.2024 10:27:06

High Channel



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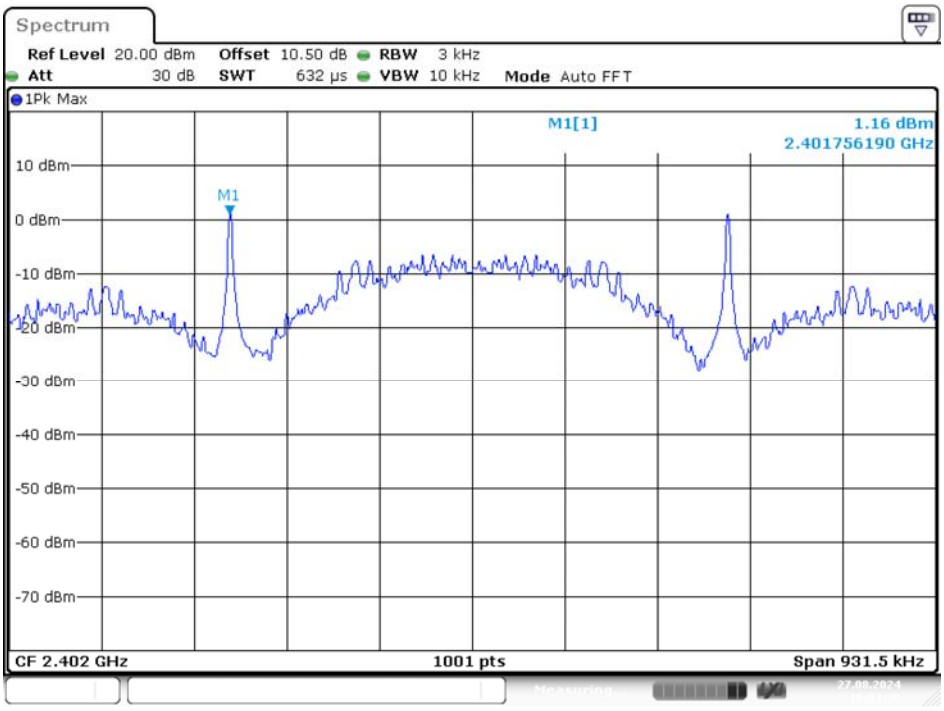
BLE(125k) Mode

Low Channel



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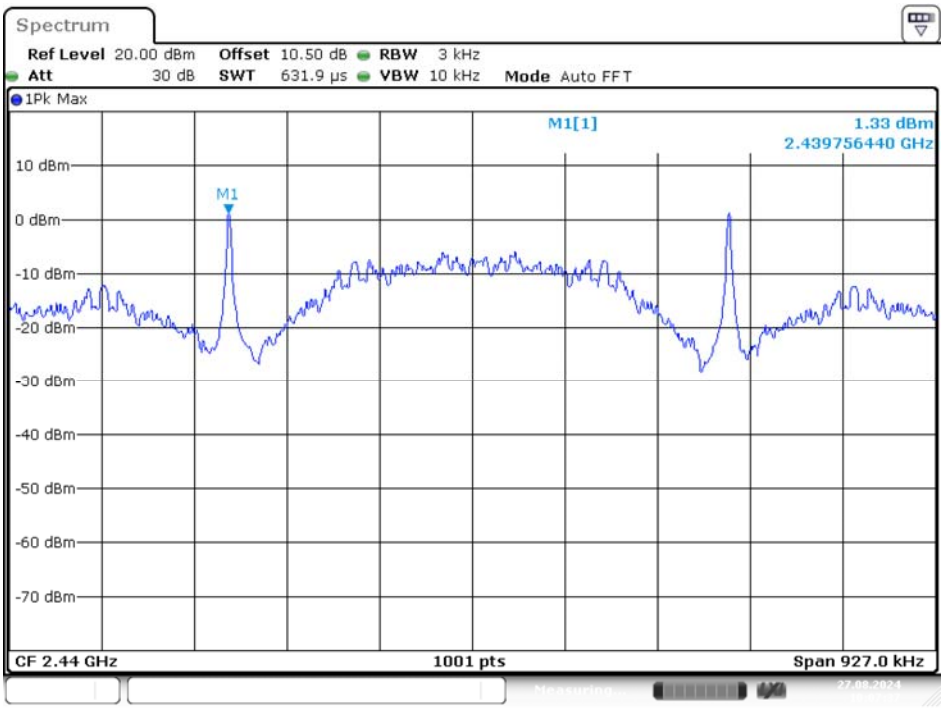
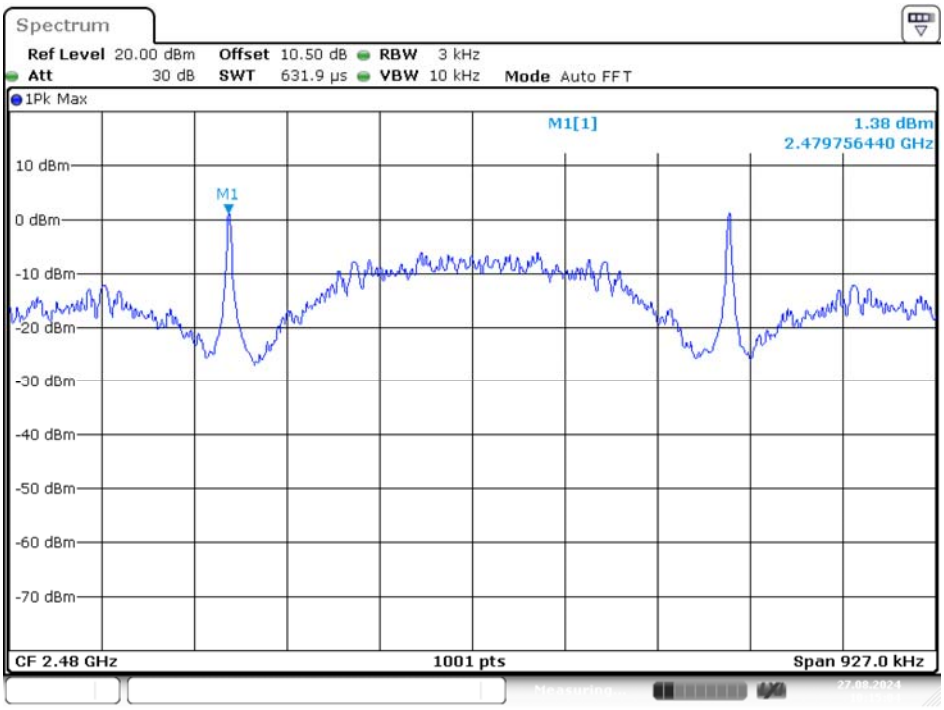
Middle Channel



Date: 27.AUG.2024 10:07:37

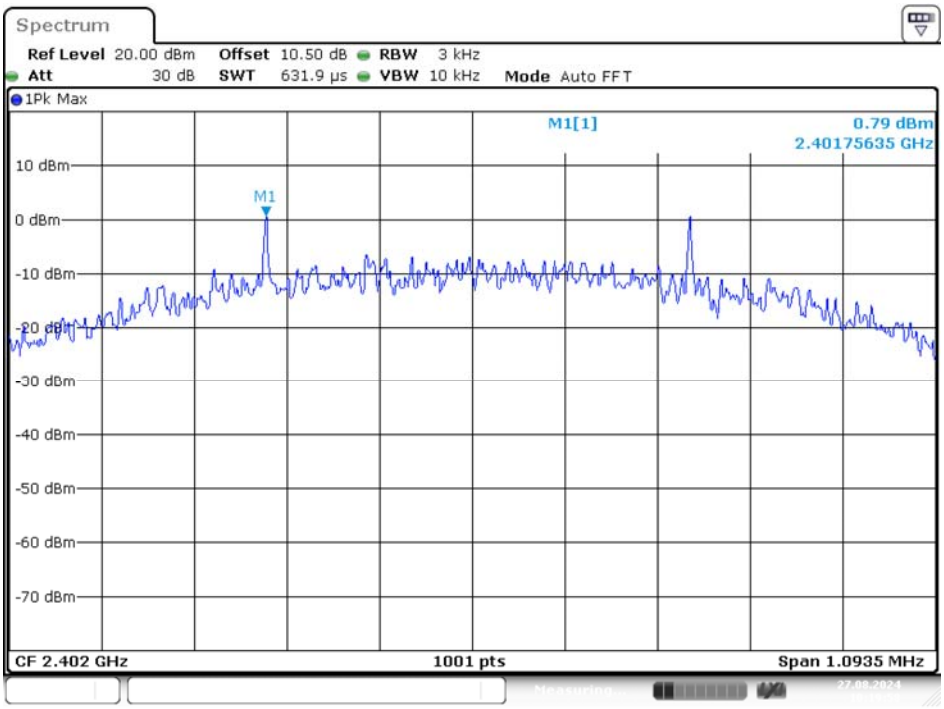
High Channel



Date: 27.AUG.2024 10:15:04

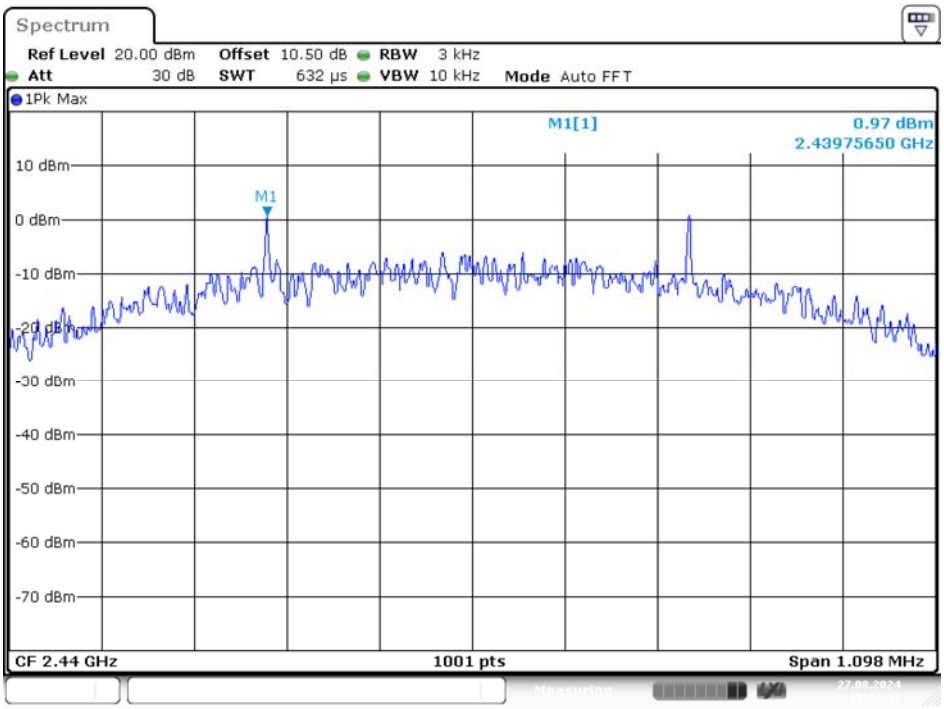
BLE(500k) Mode

Low Channel



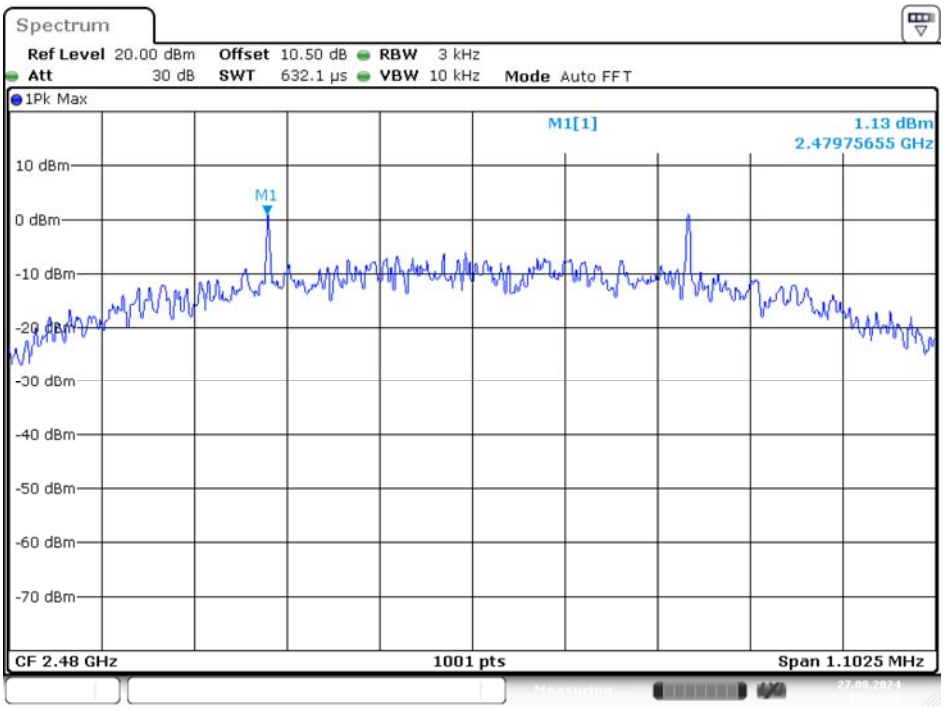
Date: 27.AUG.2024 10:19:58

Middle Channel



Date: 27.AUG.2024 10:22:47

High Channel



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