FCC Part 15.247

TEST REPORT

For

MOBILETRON ELECTRONICS CO., LTD.

85, Sec.4, Chung-Ching Rd., Ta-Ya District, Taichung, Taiwan

FCC ID: ULZ-TXB001

Report Type:	**Product Type:**
Original Report	TPMS

Report Producer : Lynette Wen

Report Number : RXZ221219002RF01

Report Date : 2023-03-15

Reviewed By: David Hsu David.Hsu

Prepared By: Bay Area Compliance Laboratories Corp.
(New Taipei Laboratory)
70, Lane 169, Sec. 2, Datong Road, Xizhi Dist.,
New Taipei City 22183, Taiwan, R.O.C.
Tel: +886 (2) 2647 6898
Fax: +886 (2) 2647 6895
www.bacl.com.tw

Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ221219002	RXZ221219002RF01	2023-03-15	Original Report	Lynette Wen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

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<tr><td rowspan="2">Applicant</td><td>MOBILETRON ELECTRONICS CO., LTD.</td></tr>
<tr><td>85, Sec.4, Chung-Ching Rd., Ta-Ya District, Taichung, Taiwan</td></tr>
<tr><td rowspan="2">Manufacturer</td><td>MOBILETRON ELECTRONICS CO., LTD.</td></tr>
<tr><td>85, Sec.4, Chung-Ching Rd., Ta-Ya District, Taichung, Taiwan</td></tr>
<tr><td>Brand(Trade) Name</td><td>MORE SENSOR</td></tr>
<tr><td>Product (Equipment)</td><td>TPMS</td></tr>
<tr><td>Main Model Name</td><td>TX-B001</td></tr>
<tr><td>Series Model Name</td><td>TX-B001-1、TX-B001-2</td></tr>
<tr><td>Model Discrepancy</td><td>Difference of Serial Model
<table><tr><td>Model Name</td><td>TX-B001</td><td>TX-B001-1</td><td>TX-B001-2</td></tr><tr><td>Difference</td><td>Aluminum color valve</td><td>Glossy black valve</td><td>Matte black valve</td></tr></table>Note: The difference of above model is color of valve and market segmentation.</td></tr>
<tr><td>Frequency Range</td><td>BLE Mode: 2402 ~ 2480 MHz</td></tr>
<tr><td>Transmit Power</td><td>BLE Mode: 1.40 dBm (0.00138W)</td></tr>
<tr><td>Modulation Technique</td><td>BLE Mode: GFSK</td></tr>
<tr><td rowspan="3">Power Operation (Voltage Range)</td><td>☐ AC Type
☐ Adapter
☐ By AC Power Cord
☐ PoE</td></tr>
<tr><td>☒ DC Type
☒ Battery:3Vdc
☐ DC Power Supply
☐ External from USB Cable
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<tr><td>☐ Host System</td></tr>
<tr><td>Received Date</td><td>2022/12/19</td></tr>
<tr><td>Date of Test</td><td>2023/2/18~2023/3/1</td></tr>
</table>

*All measurement and test data in this report was gathered from production sample serial number: RXZ221219002-01 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

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

1.3 Related Submittal(s)/Grant(s)

N/A.

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
KDB 558074 D01 Meas Guidance v05r02

1.5 Statement of Compliance

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

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

1.6 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		±2.36 (dB)
RF output power, conducted		±0.93 (dB)
Power Spectral Density, conducted		±0.92 (dBm/kHz)
Occupied Bandwidth		±0.09%
Unwanted Emissions, conducted		±1.69 (dB)
Emissions, radiated	30 MHz~1GHz	±5.22(dB)
	1 GHz~6 GHz	±6.12(dB)
	6 GHz~18 GHz	±6.12(dB)
	18 GHz~40 GHz	±4.99(dB)
Temperature		+/- 1.27 ℃
Humidity		+/- 3 %

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

1.7 Environmental Conditions

Test Site	Test Date	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
Radiation Spurious Emissions	2023/2/18~2023/2/23	19.2~22.5	61~66	1010	Aaron
Conducted Spurious Emissions	2023/3/1	24	61~66	1010	Aaron
6 dB Emission Bandwidth	2023/3/1	24	47	1010	Andy
Maximum Output Power	2023/3/1	24	47	1010	Andy
100 kHz Bandwidth of Frequency Band Edge	2023/3/1	24	47	1010	Andy
Power Spectral Density	2023/3/1	24	47	1010	Andy

1.8 Test Facility

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

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

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

2 System Test Configuration

2.1 Description of Test Configuration

For BLE mode, there are totally 40 channels.

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

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

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

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used "SmartRF Flash Programmer 2"

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

2.4 Support Equipment List and Details

Not Applicable

2.5 External Cable List and Details

N/A

2.6 Test Mode

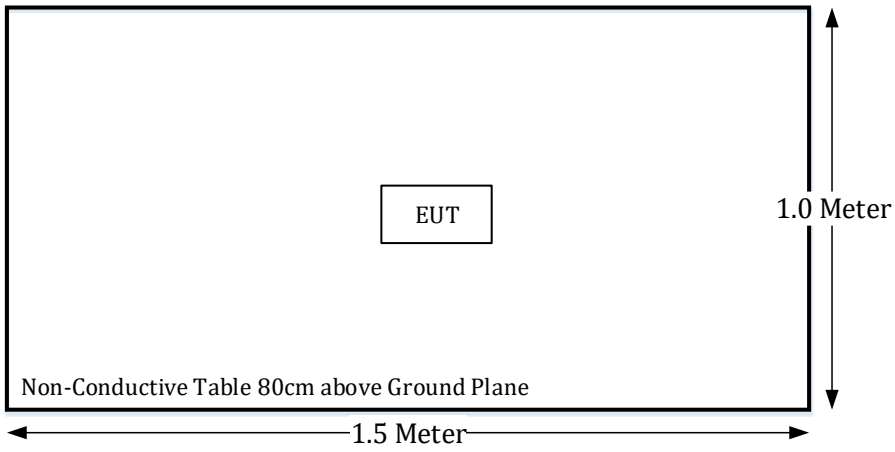
Full System (model: TX-B001) for all test item.

2.7 Block Diagram of Test Setup

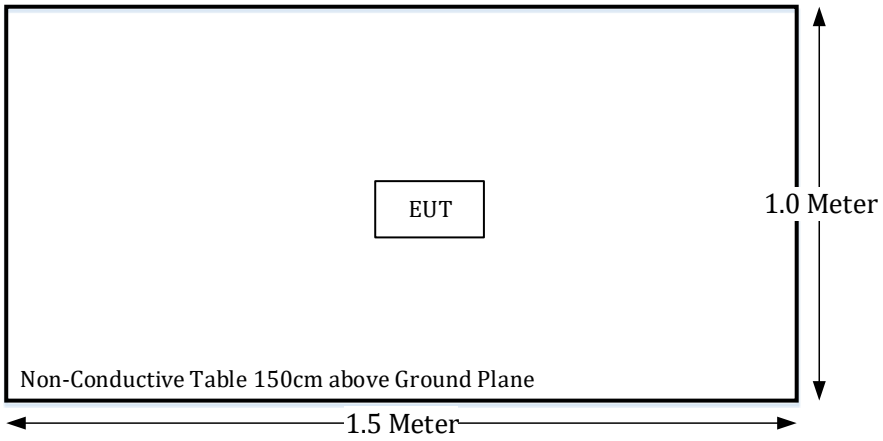
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

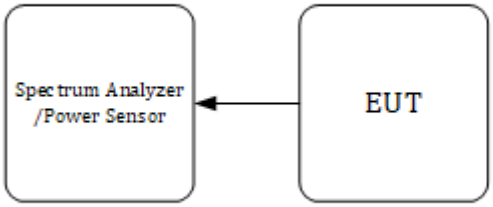
Below 1GHz:



Above 1GHz:



Conducted:



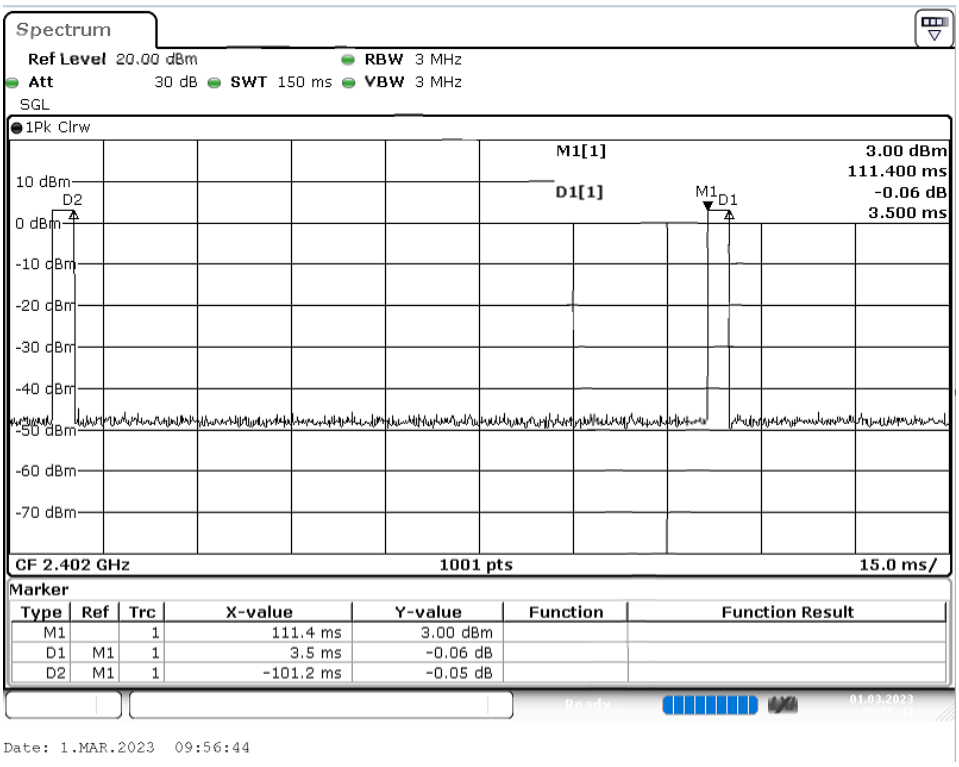
2.8 Duty Cycle

The duty cycle as below:

Radio Mode	T_{on} (ms)	$T_{on}+T_{off}$ (ms)	Duty Cycle (%)
BLE	3.5	104.7	0.03

Please refer to the following plots.

BLE Mode



3 Summary of Test Results

FCC Rules	Description of Test	Results
FCC §15.247(i), §1.1307(b)(3)(i)	RF EXPOSURE	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Not applicable
§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

Not applicable: Device only supports battery.

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation 3M Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2023/2/2	2024/2/1
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
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2023/2/1	2024/1/31
Coaxial Cable	COMMATE	PEWC	8Dr	2022/12/24	2023/12/23
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2022/12/24	2023/12/23
Preamplifier	A.H. system Inc.	PAM-0118P	470	2022/3/28	2023/3/27
Software	AUDIX	E3	18621a	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101140	2023/2/10	2024/2/9
Cable	UTIFLEX	UFA210A	9435	2022/10/3	2023/10/2
Attenuator	MINI-CIRCUITS	BW-S10W5+	1419	2023/2/2	2024/2/1
Power Sensor	KEYSIGHT	U2021XA	MY58140006	2022/11/2	2023/11/1

***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)(i) – RF EXPOSURE

5.1 Applicable Standard

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

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 $\lambda/2\pi$, 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 $\lambda/4$ 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)	Turn-up (dBm)	Ant Gain (dBi)	Distances (mm)	Turn-up (mW)	ERP (dBm)	ERP (mW)
BLE	2480	1.5	-10	200	1.41	-10.65	0.09

Option A The available maximum time-averaged power is more than 1 mW

Band	Freq (MHz)	Result Option A
BLE	2480	not exempt

Option C

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

Band	Freq (MHz)	$\lambda/2\pi$ (mm)	Distances applies	ERP Limit (mW)	Result Option C
BLE	2480	19.25	apply	768.00	exempt

6 FCC §15.203 – Antenna Requirements

6.1 Applicable Standard

According to § 15.203,

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6dBi.

6.2 Antenna Information

Manufacturer	Model	Type	Antenna Gain
MOBILETRON	20011208	Monopole Antenna	-10 dBi

Result: Compliance

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

7.1 Applicable Standard

According to §15.207

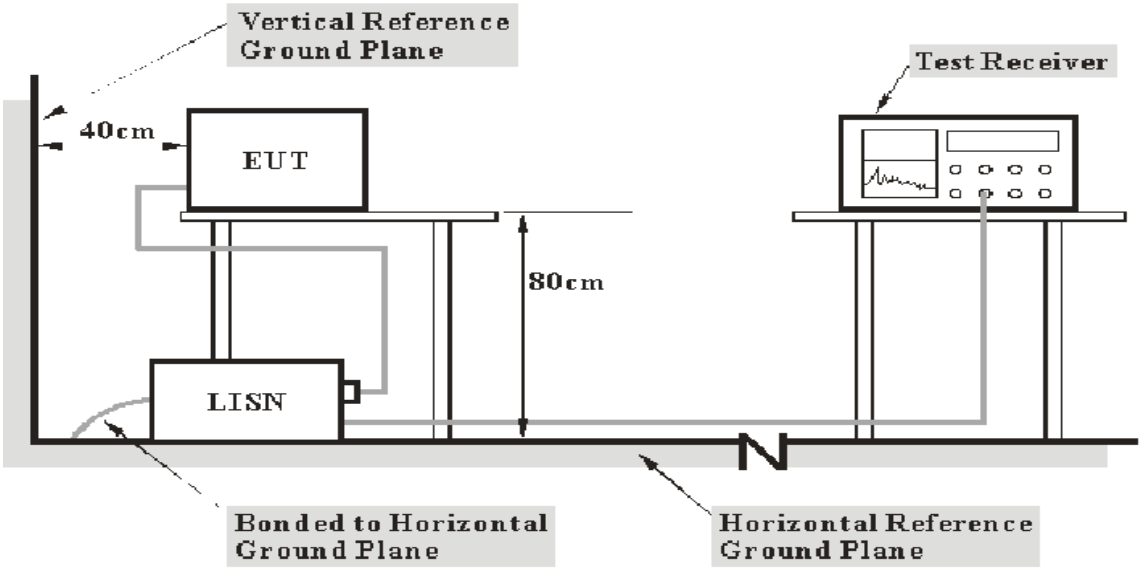
For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured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

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

Note 2: A linear average detector is required

7.2 EUT Setup



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

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

7.3 EMI Test Receiver Setup

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

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

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

7.4 Test Procedure

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

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

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

7.5 Corrected Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Over Limit = Level – Limit Line

7.6 Test Results

Test Mode: Transmitting

Not Applicable

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

8.1 Applicable Standard

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

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

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

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

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

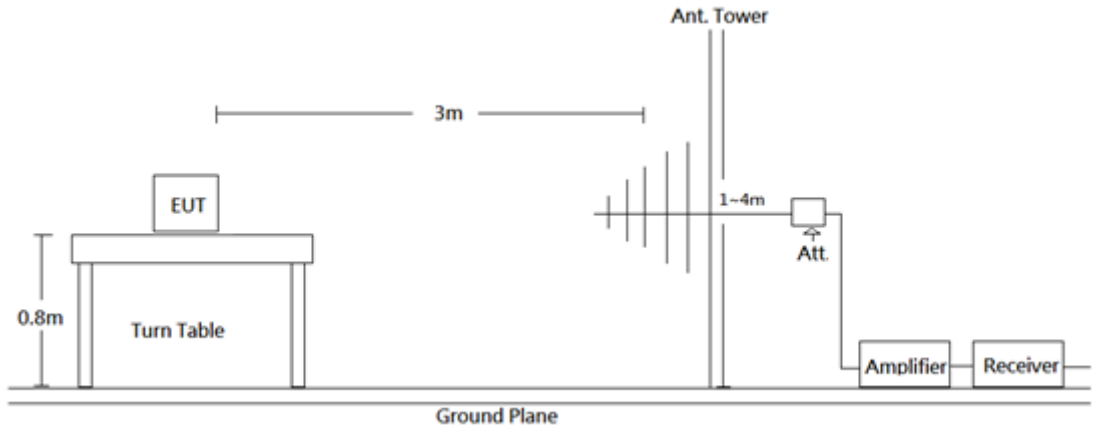
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this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

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

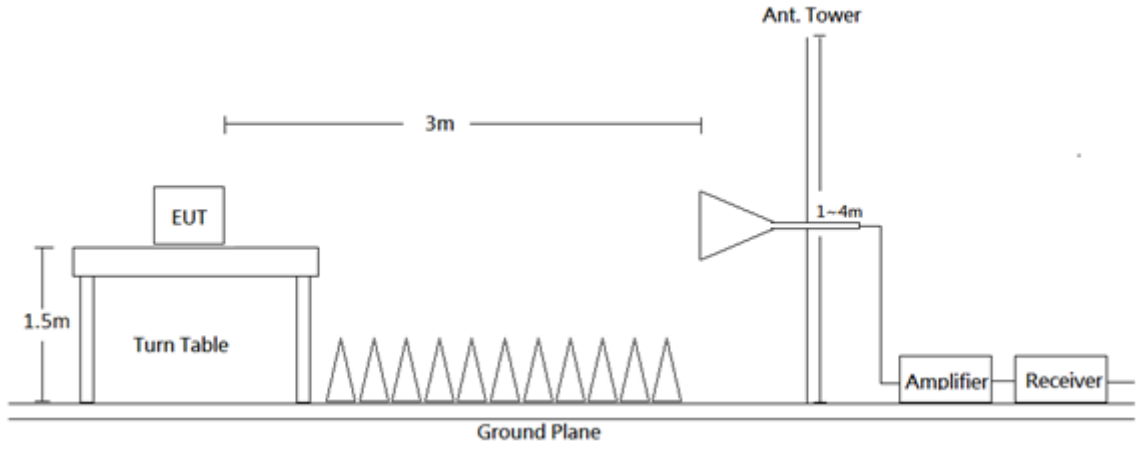
intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

8.2 EUT Setup

Below 1 GHz:



Above 1 GHz:



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

8.3 EMI Test Receiver & Spectrum Analyzer Setup

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

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

1/T= 1/3.5ms=0.285 =0.3k so RBW/VBW= 1M/300Hz

8.4 Test Procedure

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

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

8.5 Corrected Factor & Margin Calculation

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

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

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

Margin = Result – Limit

8.6 Test Results

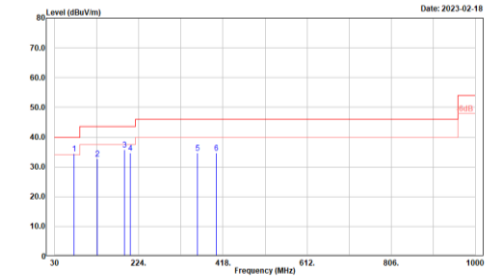
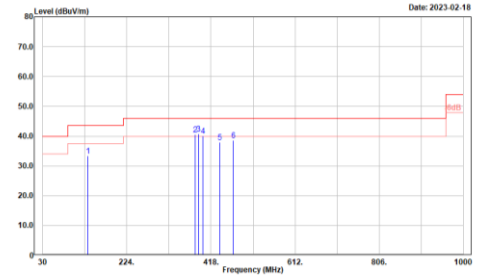
Test Mode: Transmitting

BLE Mode

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

(Worst case for BLE mode is low channel)

30MHz-1GHz:

Horizontal	Vertical
	

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
74.665	48.55	-14.16	34.39	40.00	-5.61	100	358	QP
128.068	40.50	-7.75	32.75	43.50	-10.75	100	326	QP
191.181	45.70	-9.91	35.79	43.50	-7.71	100	237	QP
203.804	44.57	-9.96	34.61	43.50	-8.89	100	253	QP
359.159	40.06	-5.48	34.58	46.00	-11.42	100	98	QP
402.853	38.88	-4.26	34.62	46.00	-11.38	100	268	QP

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
134.865	41.47	-8.10	33.37	43.50	-10.13	100	187	QP
381.492	45.70	-5.16	40.54	46.00	-5.46	100	202	QP
389.259	45.70	-4.89	40.81	46.00	-5.19	100	213	QP
399.940	44.49	-4.39	40.10	46.00	-5.90	100	210	QP
438.779	41.03	-3.18	37.85	46.00	-8.15	100	225	QP
468.879	40.95	-2.43	38.52	46.00	-7.48	100	213	QP

Level = Reading + Factor.

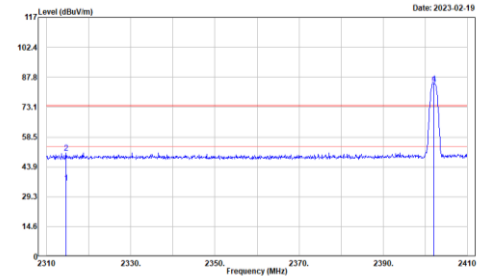
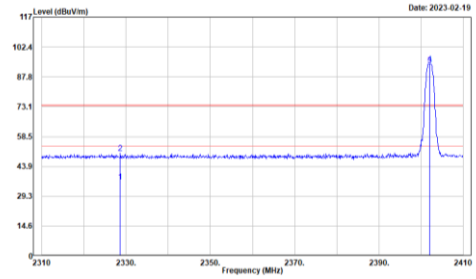
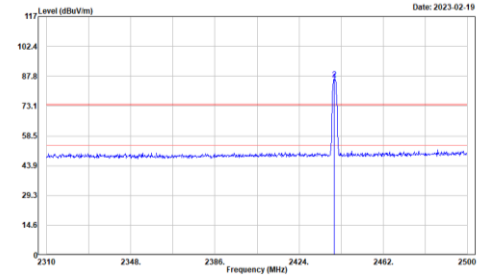
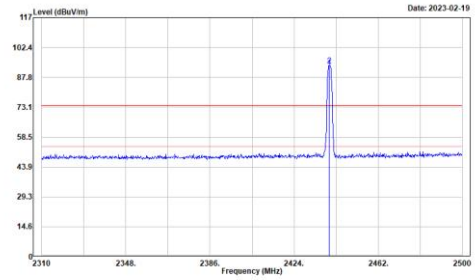
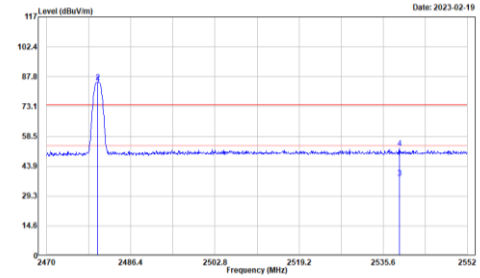
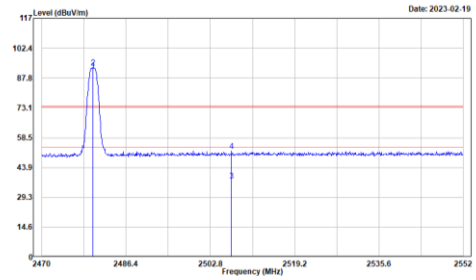
Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

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

Fundamental:

BLE MODE

Low Channel / Horizontal	Low Channel / Vertical
	
Middle Channel / Horizontal	Middle Channel / Vertical
	
High Channel / Horizontal	High Channel / Vertical
	

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2314.604	41.20	-5.01	36.19	54.00	-17.81	149	89	Average
2314.604	55.71	-5.01	50.70	74.00	-23.30	149	89	Peak
2402.000	88.43	-4.48	83.95			149	89	Average
2402.000	89.28	-4.48	84.80			149	89	Peak

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2328.619	41.33	-4.98	36.35	54.00	-17.65	146	230	Average
2328.619	55.28	-4.98	50.30	74.00	-23.70	146	230	Peak
2402.000	98.16	-4.48	93.68			146	230	Average
2402.000	98.74	-4.48	94.26			146	230	Peak

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2440.000	89.41	-4.20	85.21			145	323	Average
2440.000	90.32	-4.20	86.12			145	323	Peak

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2440.000	96.75	-4.20	92.55			150	245	Average
2440.000	97.64	-4.20	93.44			150	245	Peak

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	87.80	-3.73	84.07			113	305	Average
2480.000	88.72	-3.73	84.99			113	305	Peak
2538.785	41.01	-3.12	37.89	54.00	-16.11	113	305	Average
2538.785	55.72	-3.12	52.60	74.00	-21.40	113	305	Peak

Level (dBuV/m) Date: 2023-02-19

Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2480.000	95.37	-3.73	91.64			102	239	Average
2480.000	96.48	-3.73	92.75			102	239	Peak
2506.937	40.88	-3.39	37.49	54.00	-16.51	102	239	Average
2506.937	55.42	-3.39	52.03	74.00	-21.97	102	239	Peak

Level = Reading + Factor.

Margin = Level – Limit.

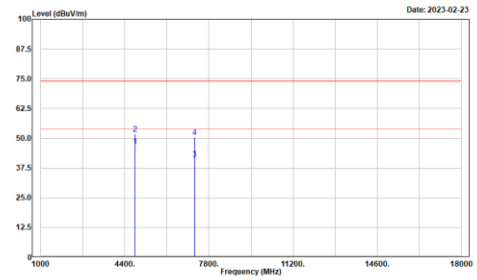
Factor = Antenna Factor + Cable Loss – Amplifier Gain.

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

1GHz-18GHz:

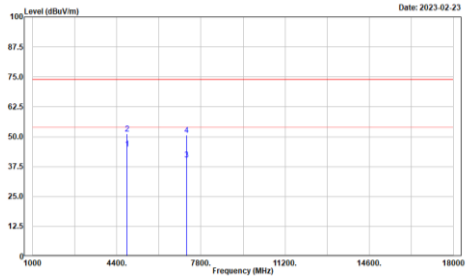
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	43.14	3.45	46.59	54.00	-7.41	151	342	Average
4804.000	48.27	3.45	51.72	74.00	-22.28	151	342	Peak
7206.000	32.28	9.05	41.33	54.00	-12.67	106	311	Average
7206.000	41.41	9.05	50.46	74.00	-23.54	106	311	Peak

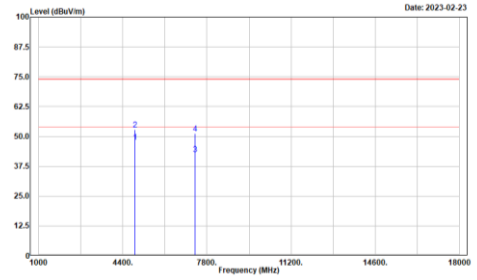
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4804.000	41.53	3.45	44.98	54.00	-9.02	149	260	Average
4804.000	47.80	3.45	51.25	74.00	-22.75	149	260	Peak
7206.000	31.28	9.05	40.33	54.00	-13.67	119	271	Average
7206.000	41.56	9.05	50.61	74.00	-23.39	119	271	Peak

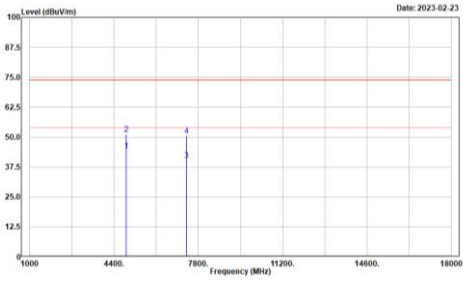
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	44.11	3.57	47.68	54.00	-6.32	109	46	Average
4880.000	49.16	3.57	52.73	74.00	-21.27	109	46	Peak
7320.000	33.28	9.25	42.53	54.00	-11.47	100	31	Average
7320.000	41.90	9.25	51.15	74.00	-22.85	100	31	Peak

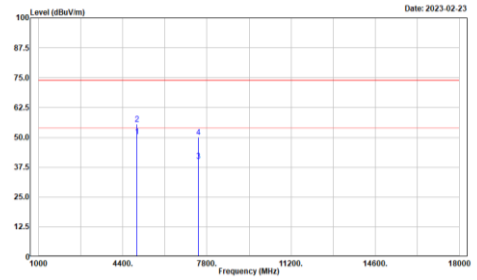
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4880.000	41.01	3.57	44.58	54.00	-9.42	151	249	Average
4880.000	47.56	3.57	51.13	74.00	-22.87	151	249	Peak
7320.000	31.18	9.25	40.43	54.00	-13.57	109	274	Average
7320.000	41.46	9.25	50.71	74.00	-23.29	109	274	Peak

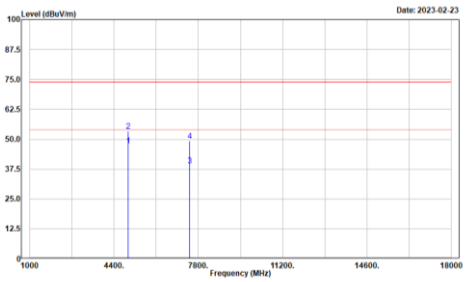
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	46.55	3.92	50.47	54.00	-3.53	109	310	Average
4960.000	51.66	3.92	55.58	74.00	-18.42	109	310	Peak
7440.000	30.60	9.42	40.02	54.00	-13.98	100	42	Average
7440.000	40.74	9.42	50.16	74.00	-23.84	100	42	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
4960.000	43.59	3.92	47.51	54.00	-6.49	151	276	Average
4960.000	49.51	3.92	53.43	74.00	-20.57	151	276	Peak
7440.000	29.58	9.42	39.00	54.00	-15.00	246	291	Average
7440.000	39.81	9.42	49.23	74.00	-24.77	246	291	Peak

Level = Reading + Factor.

Margin = Level – Limit.

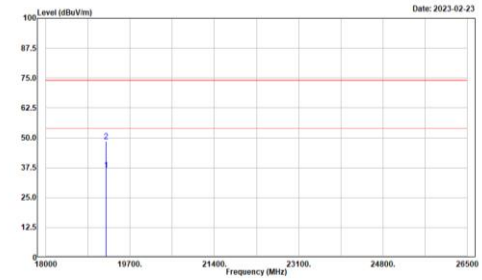
Factor = Antenna Factor + Cable Loss – Amplifier Gain.

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

18GHz-26.5GHz:

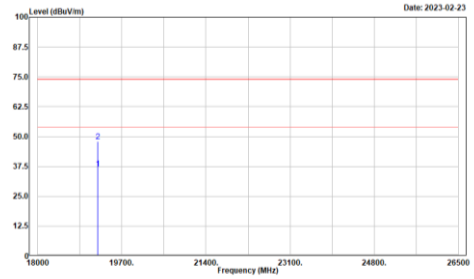
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	37.13	-0.57	36.56	54.00	-17.44	150	234	Average
19216.000	49.19	-0.57	48.62	74.00	-25.38	150	234	Peak

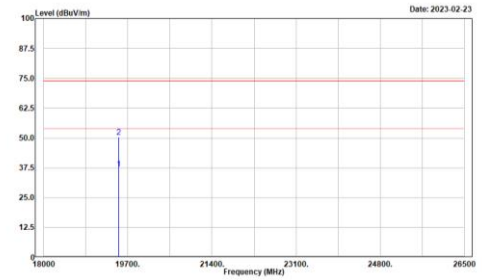
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19216.000	37.20	-0.57	36.63	54.00	-17.37	150	21	Average
19216.000	48.66	-0.57	48.09	74.00	-25.91	150	21	Peak

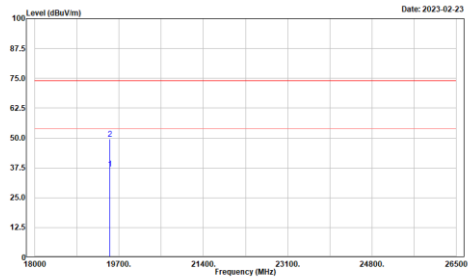
Middle channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19520.000	36.85	0.34	37.19	54.00	-16.81	150	272	Average
19520.000	49.96	0.34	50.30	74.00	-23.70	150	272	Peak

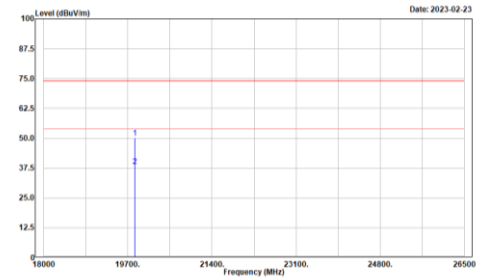
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19520.000	36.81	0.34	37.15	54.00	-16.85	150	360	Average
19520.000	49.22	0.34	49.56	74.00	-24.44	150	360	Peak

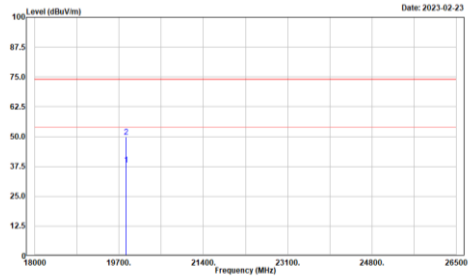
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19840.000	48.80	1.22	50.02	74.00	-23.98	150	336	Peak
19840.000	37.09	1.22	38.31	74.00	-35.69	150	336	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
19840.000	37.08	1.22	38.30	54.00	-15.70	150	95	Average
19840.000	48.65	1.22	49.87	74.00	-24.13	150	95	Peak

Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

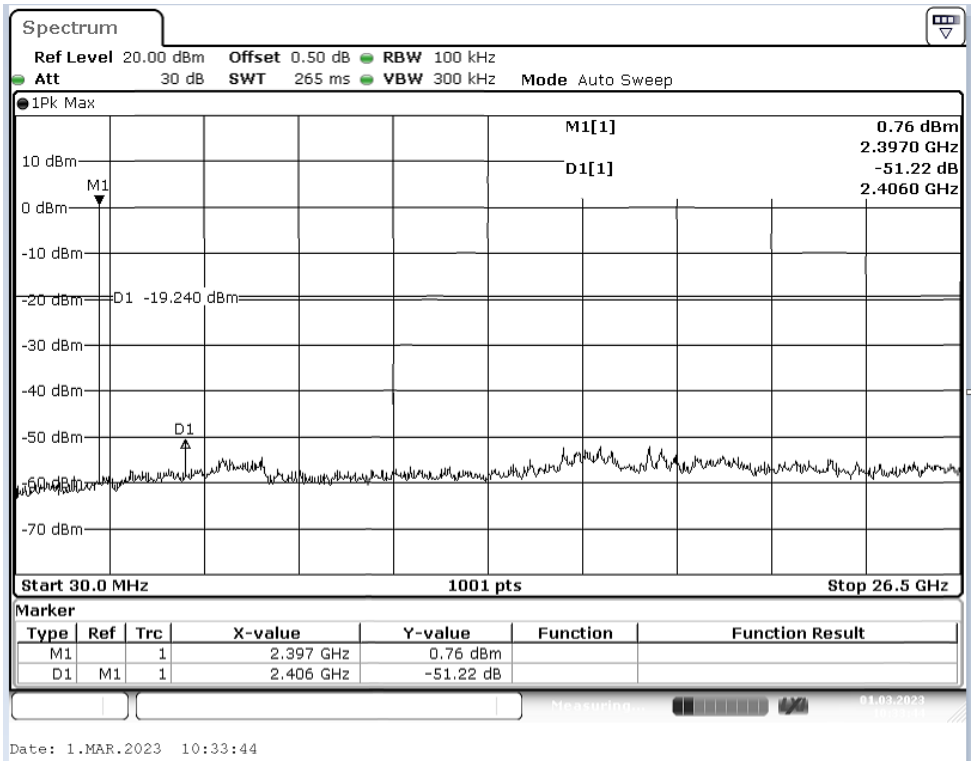
Spurious emissions more than 20 dB below the limit were not reported.

Conducted Spurious Emissions:

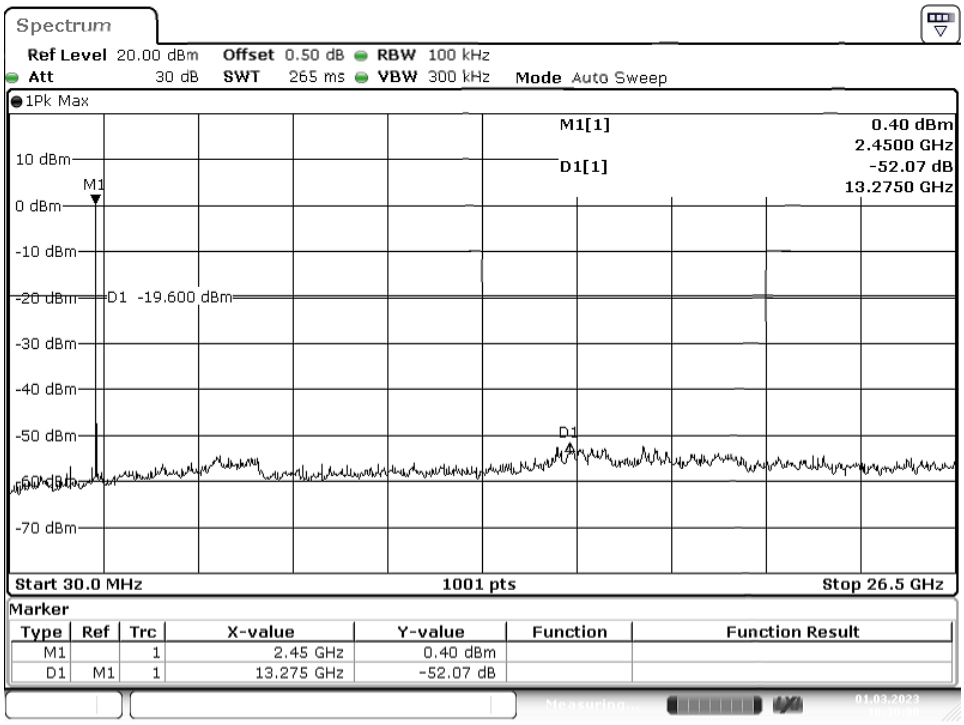
Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	2402	51.22	≥ 20	PASS
Mid	2440	52.07	≥ 20	PASS
High	2480	52.66	≥ 20	PASS

BLE Mode

Low Channel

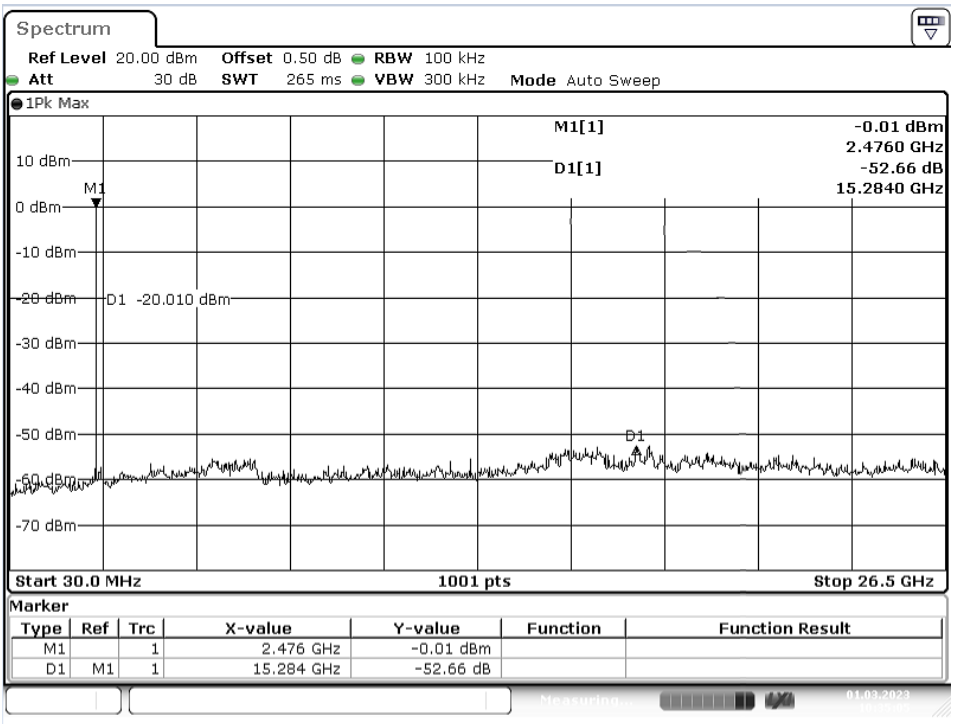


Middle Channel



Date: 1.MAR.2023 10:30:00

High Channel



Date: 1.MAR.2023 10:35:05

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

9.1 Applicable Standard

According to FCC §15.247(a)(2).

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

9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the VBW ≥ [3 × RBW].

c) Detector = peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

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

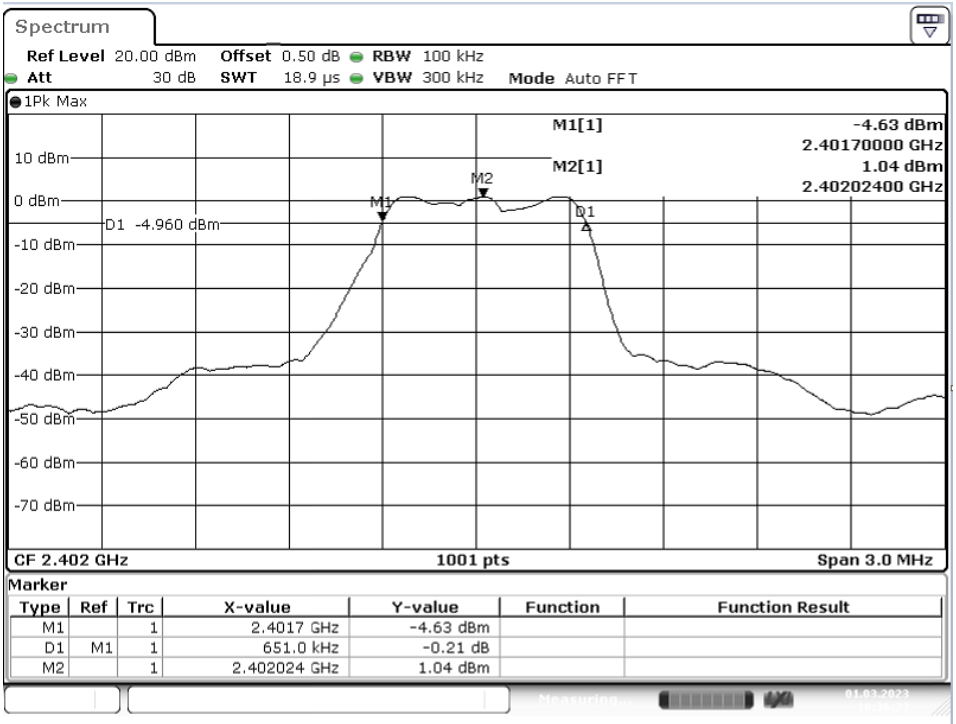
9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)	Result
Low	2402	0.65	> 500	Compliance
Middle	2440	0.65	> 500	Compliance
High	2480	0.65	> 500	Compliance

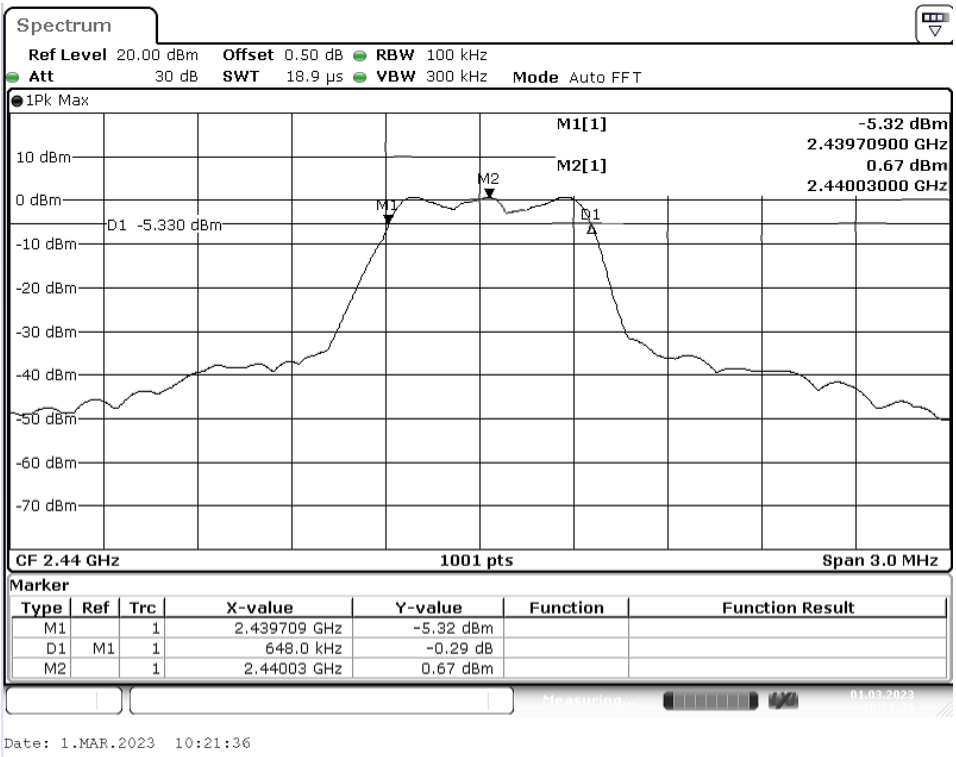
Please refer to the following plots

BLE Mode

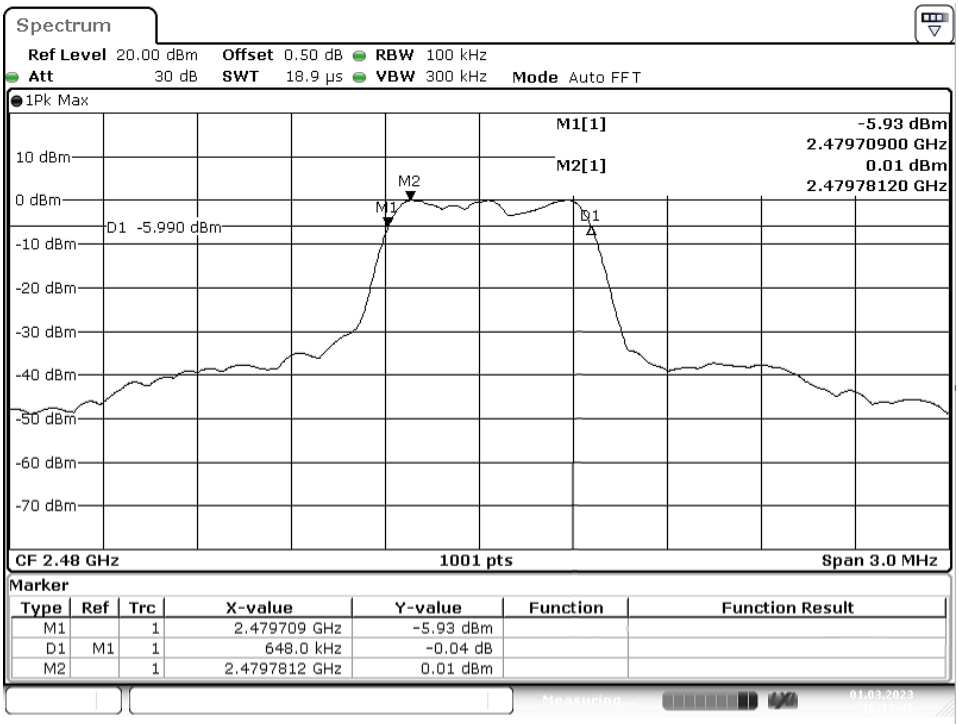
Low Channel



Middle Channel



High Channel



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

10.1 Applicable Standard

According to FCC §15.247(b) (3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

10.2 Test Procedure

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

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

10.3 Test Results

Conducted Peak Output Power

Channel	Frequency (MHz)	Power (dBm)	Power (W)	Limit (W)	Result
BLE Mode					
Low	2402	1.40	0.00138	1	PASS
Middle	2440	1.20	0.00132	1	PASS
High	2480	0.95	0.00124	1	PASS

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

11.1 Applicable Standard

According to FCC §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

11.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.

3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.

4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.

5. Repeat above procedures until all measured frequencies were complete.

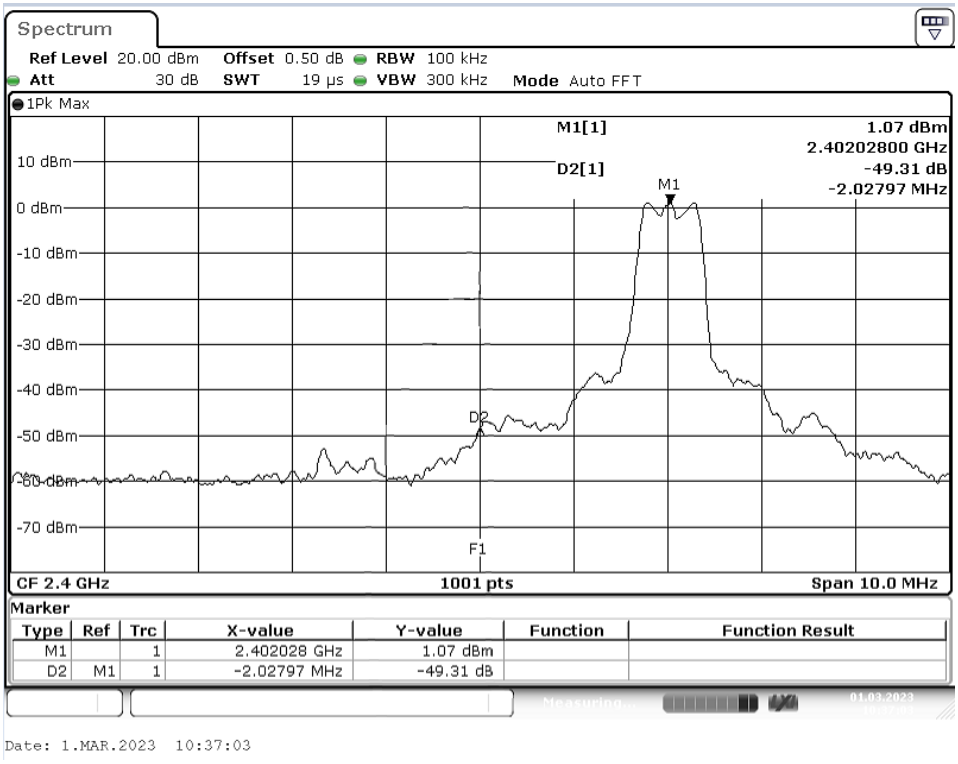
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	2402	49.31	≥ 20	PASS
High	2480	58.47	≥ 20	PASS

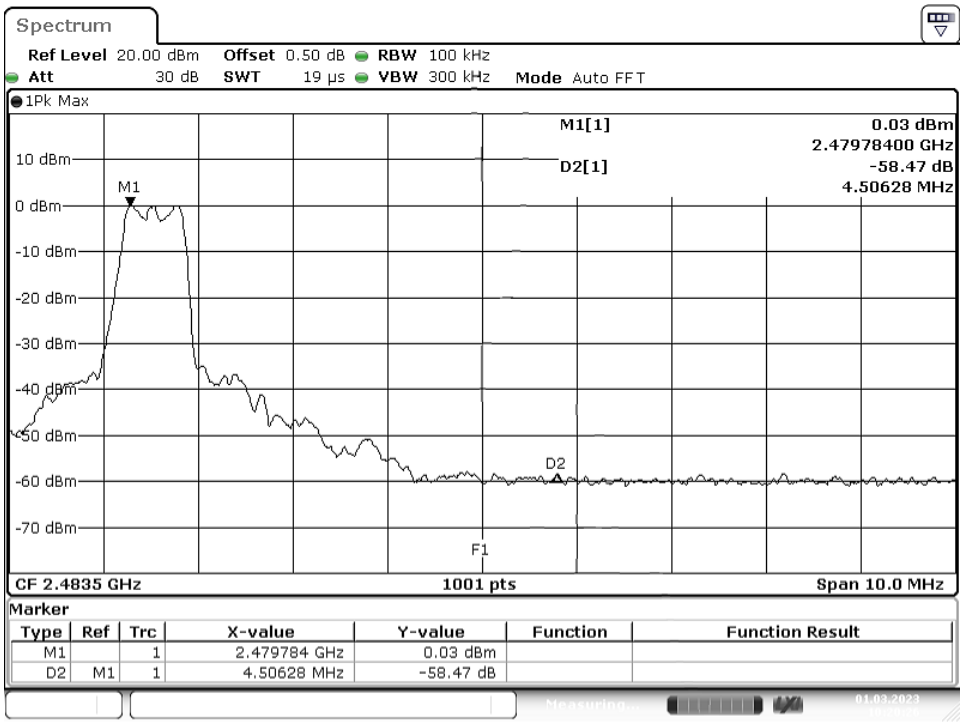
Please refer to the following plots

BLE Mode

Band Edge, Left Side



Band Edge, Right Side



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12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

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

12.2 Test Procedure

According to ANSI C63.10-2013

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

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

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

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

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

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

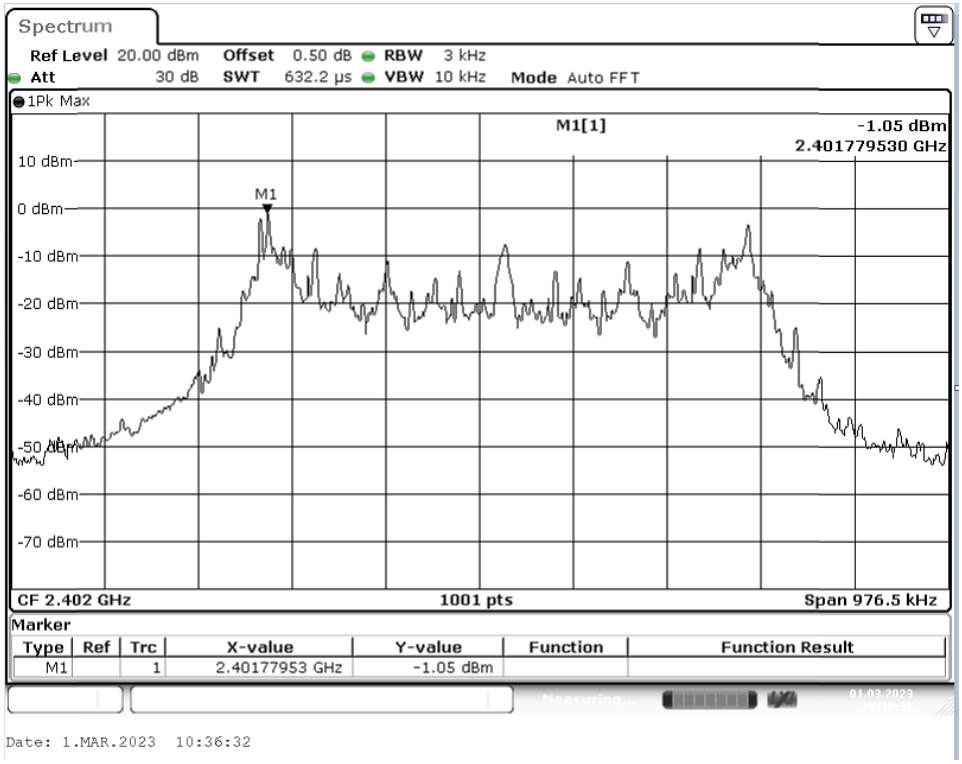
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
Low	2402	-1.05	8	Compliance
Middle	2440	-1.56	8	Compliance
High	2480	-2.04	8	Compliance

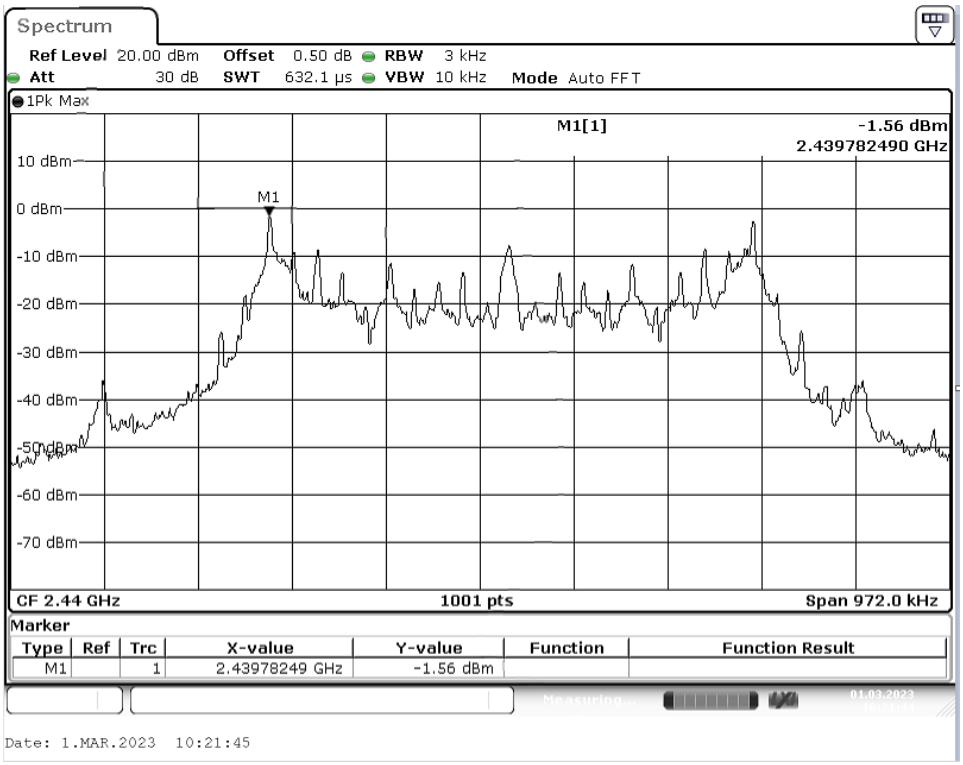
Please refer to the following plots

BLE Mode

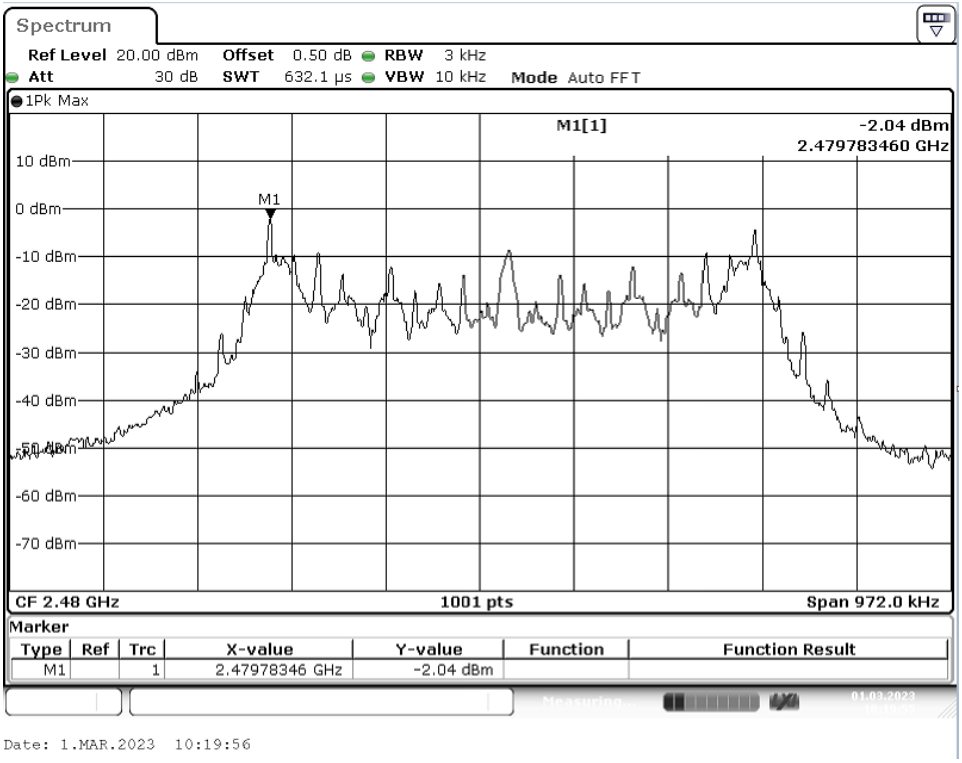
Low Channel



Middle Channel



High Channel



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