FCC Part 15.247

TEST REPORT

For

Leadtek Research Inc

18F, No. 166, Jian-Yi Rd., Chung Ho Dist.,New Taipei City Taiwan, R.O.C

FCC ID: I2I8Z81

Report Type:	**Product Type:**
Original Report	CaroCare Biomolecular Scanner

Report Producer : Lynette Wen

Report Number : RLK230605008RF01

Report Date : 2023-08-11

Reviewed By: Andy Shih

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RLK230605008	RLK230605008RF01	2023-08-11	Original Report	Lynette Wen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	Leadtek Research Inc
	18F, No. 166, Jian-Yi Rd., Chung Ho Dist.,New Taipei City Taiwan, R.O.C
Manufacturer	Leadtek Research Inc
	18F, No. 166, Jian-Yi Rd., Chung Ho Dist.,New Taipei City Taiwan, R.O.C
Brand(Trade) Name	amor
Product (Equipment)	CaroCare Biomolecular Scanner
Main Model Name	8Z81
Frequency Range	BLE(1M) / BLE(2M) : 2402 ~ 2480 MHz
Peak Conducted Output Power	BLE(1M) Mode : -4.39 dBm BLE(2M) Mode : -4.22 dBm
Modulation Technique	BLE(1M) / BLE(2M) : GFSK
Transmit Data Rate	BLE(1M) : 1 Mbps BLE(2M) : 2 Mbps
Power Operation (Voltage Range)	☐ AC 120V/60Hz ☐ Adapter ☐ By AC Power Cord ☐ PoE
	☒ DC Type ☒ Battery:3.6V ☐ DC Power Supply ☒ External from USB Cable: 5Vdc ☐ External DC Adapter
	☐ Host System
Received Date	2023/6/27
Date of Test	2023/7/25 ~ 2023/7/28

*All measurement and test data in this report was gathered from production sample serial number: RLK230605008-01. Assigned by BACL, Linkou Laboratory.

1.2 Objective

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

1.3 Related Submittal(s)/Grant(s)

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 15.247 Meas Guidance v05r02

1.5 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. (Linkou 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		±3.38 (dB)
RF output power, conducted		±3.74 (dB)
Power Spectral Density, conducted		±0.69 (dBm)
Occupied Bandwidth		±0.09 (%)
Unwanted Emissions, conducted		±1.13 (dB)
Emissions, radiated	30 MHz~1GHz	±5.34 (dB)
	1 GHz~18 GHz	±5.89 (dB)
	18 GHz~40 GHz	±5.52 (dB)
Temperature		±0.44 (%)
Humidity		±0.78 (℃)

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 Data	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2023/7/28	27.5	45	1010	Kevin
Radiation Spurious Emissions	2023/7/26-2023/7/27	23.1-24.7	45-48	1010	Bruce
Conducted Spurious Emissions	2023/7/25	24.8	45	1010	Rory
6 dB Emission Bandwidth	2023/7/25	24.8	45	1010	Rory
Maximum Output Power	2023/7/25	24.8	45	1010	Rory
100 kHz Bandwidth of Frequency Band Edge	2023/7/25	24.8	45	1010	Rory
Power Spectral Density	2023/7/25	24.8	45	1010	Rory

1.8 Test Facility

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

☒ No.6, Wende 2Rd., Guishan Dist., Taoyuan City 33382, Taiwan (R.O.C.).

Bay Area Compliance Laboratories Corp. (Linkou Laboratory) is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3546) and the FCC designation No.TW3546 under the Mutual Recognition Agreement (MRA) in FCC Test.

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 "nrfconnect-setup-4.1.2-x64"

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

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

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number
NB	Dell	E6410
Fixture	waveshare	FT232
Adapter	SUNMI	TPA-23A050200UU01

Note: After EUT transmit TX, remove the fixture.

2.5 External Cable List and Details

Cable Description	Length (m)	From	To
USB to Type-C	1.2	EUT	NB

2.6 Test Mode

Full System (model: 8Z81) test item.

The NB is connected to the fixture, and the EUT is connected to the fixture through internal leads for setup.

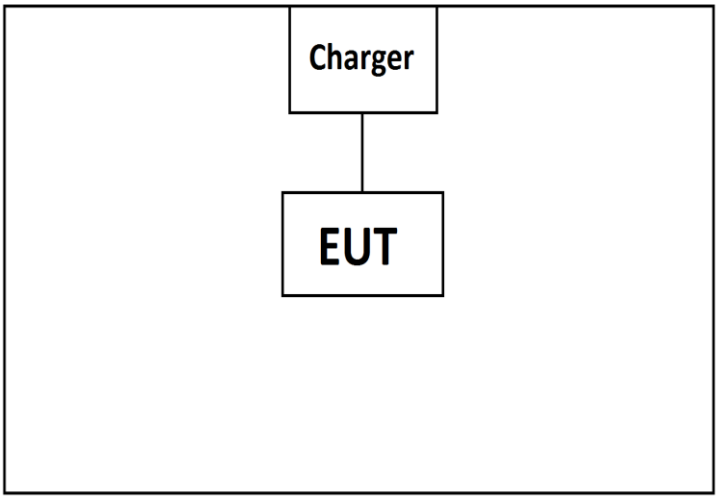
After the EUT continues to transmit TX signals, removing the NB and fixture, then stars test.

2.7 Block Diagram of Test Setup

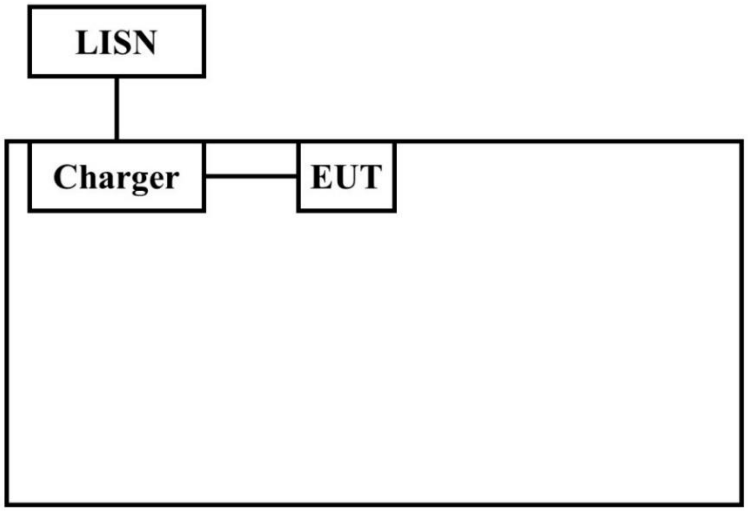
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

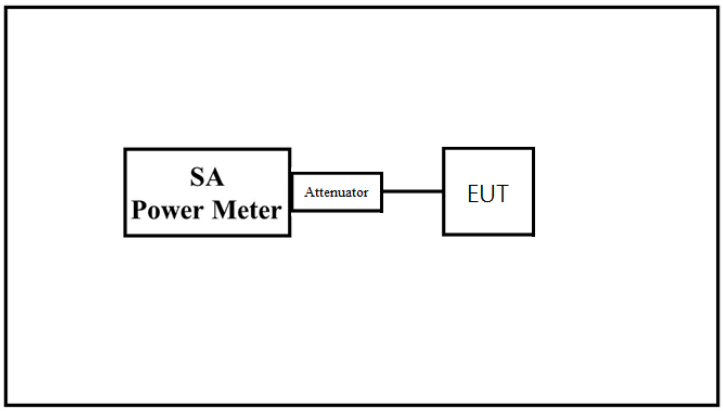
Below 1GHz / Above 1GHz:



Conduction:



Conducted:



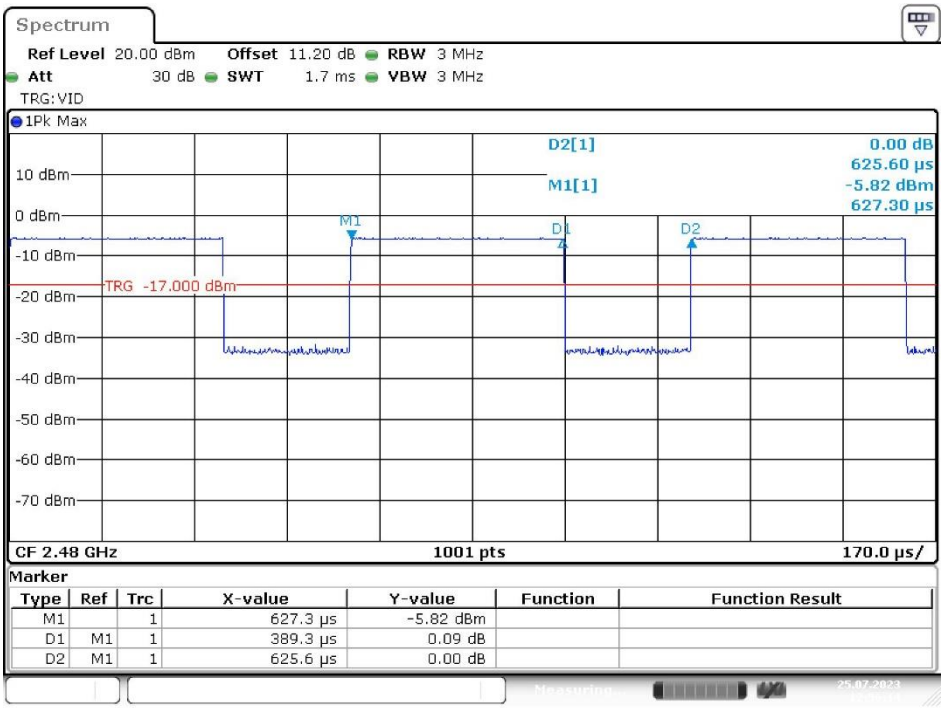
2.8 Duty Cycle

The duty cycle as below:

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	1/T VBW setting (kHz)
BLE(1M)	0.3893	0.6256	62	2.57
BLE(2M)	0.2047	0.6259	33	4.89

Please refer to the following plots.

BLE (1M) Mode



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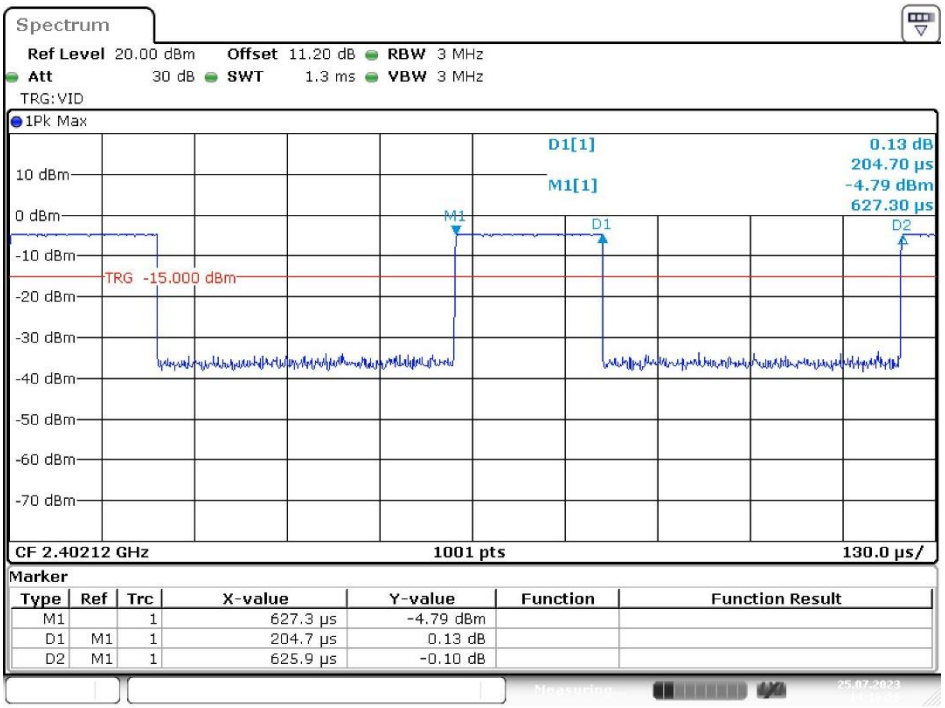
BLE (2M) Mode



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3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1307(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)					
Two-Line-V-Network	Rohde & Schwarz	ENV216	100037	2022/09/13	2023/09/12
EMI Test Receiver	Rohde & Schwarz	ESR3	102430	2022/09/29	2023/09/28
Pulse Limiter	SCHWARZBECK	VTSD 9561-F	00432	2022/08/31	2023/08/30
RF Cable	EMCI	EMCCFD300-BM-BM-3000	221013	2022/10/20	2023/10/19
Software	Audix	e3 v9	E3LK-03	N.C.R	N.C.R
Radiation 3M Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & EMCI	JB3 & N-6-06	A111513 & AT-N0668	2023/4/13	2024/4/11
Horn Antenna	EMCO	3115	2058	2023/03/25	2024/03/23
Double ridged waveguide horn antenna	ETS-Lindgren	3116	00060023	2023/07/07	2024/07/05
Preamplifier	A.H. Systems	PAM-1840VH	174	2023/3/24	2024/3/22
Preamplifier	A.H. Systems	PAM-0118P	479	2022/08/31	2023/08/30
ESR EMI Test Receiver	Rohde & Schwarz	ESR3	102448	2022/9/29	2023/9/28
Spectrum Analyzer	Rohde & Schwarz	FSV40	101457	2022/09/13	2023/09/12
Microflex Cable (0.9m)	UTIFLEX	W6103	LKTE381	2023/06/26	2024/06/24
Microflex Cable (2m)	EMCI	EMC106-SM-SM-2000	180515	2022/8/5	2023/8/4
Microflex Cable (8m)	UTIFLEX	UFA210A-1-3149-300300	MFR 64639 232490-001	2022/8/5	2023/8/4
Software	AUDIX	E3 V9	E3LK-01	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101938	2022/12/7	2023/12/6
Cable	MTJ	MT40S	620620-MT40S-100	2022/12/23	2023/12/22
Power Sensor	KEYSIGHT	U2021XA	SGMY54080007	2022/09/15	2023/09/14
Attenuator	MCL	BW-S10W5+	605	2023/3/22	2024/3/20

***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)	Tune-up Power (dBm)	Ant Gain (dBi)	Distances (mm)	Tune-up Power (mW)	ERP (dBm)	ERP (mW)
BLE	2480	-4	0	5	0.40	-6.15	0.24

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

Band	Freq (MHz)	Result Option A
BLE	2480	exempt

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

Result: The EUT meets exemption requirement.

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
Leadtek Research Inc	2450AT42B100	chip Antenna	0 dBi

Result: Compliance

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

7.1 Applicable Standard

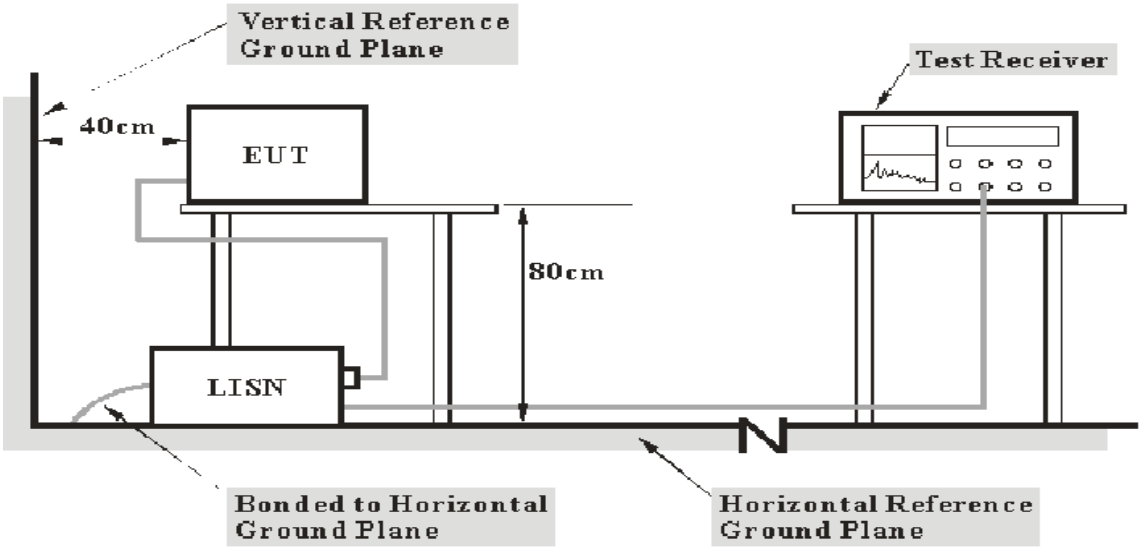
According to §15.207

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

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

Note 1: Decreases with the logarithm of the frequency.

7.2 EUT Setup



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

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

7.3 EMI Test Receiver Setup

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

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

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

7.4 Test Procedure

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

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

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

7.5 Corrected Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Over Limit = Level – Limit Line

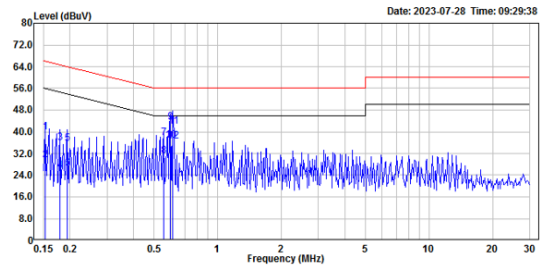
7.6 Test Results

Test Mode: Transmitting

Main: AC120 V, 60 Hz

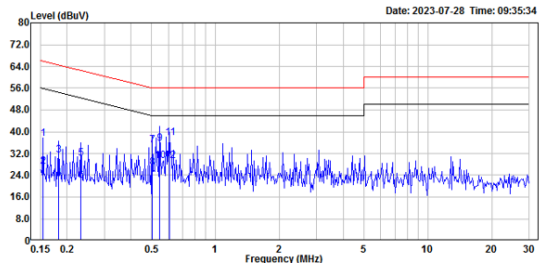
BLE 1M

Line



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.153	20.10	39.76	19.66	65.83	-26.07	QP
2	0.153	10.06	29.72	19.66	55.83	-26.11	Average
3	0.179	16.34	35.99	19.65	64.51	-28.52	QP
4	0.179	6.01	25.66	19.65	54.51	-28.85	Average
5	0.194	16.05	35.69	19.64	63.85	-28.16	QP
6	0.194	7.04	26.68	19.64	53.85	-27.17	Average
7	0.557	18.14	37.82	19.68	56.00	-18.18	QP
8	0.557	11.55	31.23	19.68	46.00	-14.77	Average
9 *	0.597	23.69	43.37	19.68	56.00	-12.63	QP
10 *	0.597	17.25	36.93	19.68	46.00	-9.07	Average
11	0.615	22.29	41.97	19.68	56.00	-14.03	QP
12	0.615	16.70	36.38	19.68	46.00	-9.62	Average

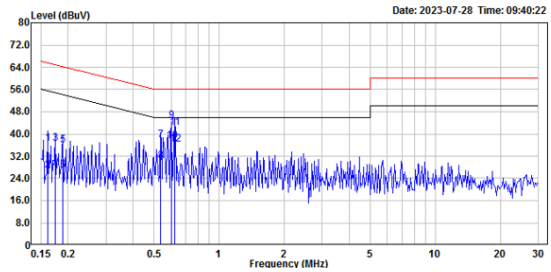
Neutral



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.155	17.67	37.33	19.66	65.75	-28.42	QP
2	0.155	7.54	27.20	19.66	55.75	-28.55	Average
3	0.183	11.81	31.47	19.66	64.35	-32.88	QP
4	0.183	3.38	23.04	19.66	54.35	-31.31	Average
5	0.232	10.58	30.24	19.66	62.37	-32.13	QP
6	0.232	2.52	22.18	19.66	52.37	-30.19	Average
7	0.504	15.23	34.92	19.69	56.00	-21.08	QP
8	0.504	7.05	26.74	19.69	46.00	-19.26	Average
9	0.546	15.81	35.50	19.69	56.00	-20.50	QP
10 *	0.546	9.72	29.41	19.69	46.00	-16.59	Average
11 *	0.609	18.19	37.88	19.69	56.00	-18.12	QP
12	0.609	9.48	29.17	19.69	46.00	-16.83	Average

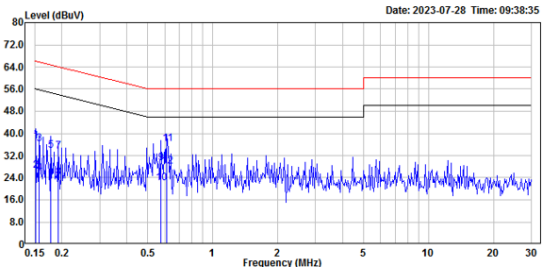
BLE 2M

Line



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.161	16.73	36.38	19.65	65.42	-29.04	QP
2	0.161	7.11	26.76	19.65	55.42	-28.66	Average
3	0.174	17.01	36.66	19.65	64.76	-28.10	QP
4	0.174	7.66	27.31	19.65	54.76	-27.45	Average
5	0.189	16.20	35.84	19.64	64.10	-28.26	QP
6	0.189	7.23	26.87	19.64	54.10	-27.23	Average
7	0.535	18.17	37.85	19.68	56.00	-18.15	QP
8	0.535	10.52	30.20	19.68	46.00	-15.80	Average
9 *	0.603	24.86	44.54	19.68	56.00	-11.46	QP
10 *	0.603	17.62	37.30	19.68	46.00	-8.70	Average
11	0.621	22.70	42.38	19.68	56.00	-13.62	QP
12	0.621	16.49	36.17	19.68	46.00	-9.83	Average

Neutral



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.151	17.42	37.09	19.67	65.92	-28.83	QP
2	0.151	6.96	26.63	19.67	55.92	-29.29	Average
3	0.158	16.53	36.19	19.66	65.59	-29.40	QP
4	0.158	5.91	25.57	19.66	55.59	-30.02	Average
5	0.178	14.09	33.75	19.66	64.60	-30.85	QP
6	0.178	4.13	23.79	19.66	54.60	-30.81	Average
7	0.192	13.77	33.42	19.65	63.94	-30.52	QP
8	0.192	4.54	24.19	19.65	53.94	-29.75	Average
9	0.574	9.50	29.19	19.69	56.00	-26.81	QP
10	0.574	2.21	21.90	19.69	46.00	-24.10	Average
11 *	0.615	16.39	36.08	19.69	56.00	-19.92	QP
12 *	0.615	8.25	27.94	19.69	46.00	-18.06	Average

Note:
Level = Read Level + Factor
Over Limit = Level – Limit Line
Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

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

8.1 Applicable Standard

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

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

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

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

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

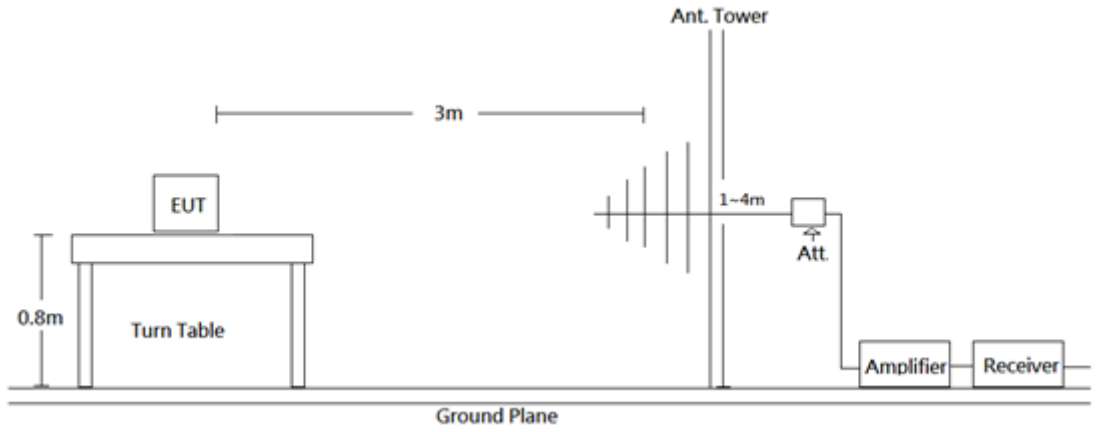
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this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

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

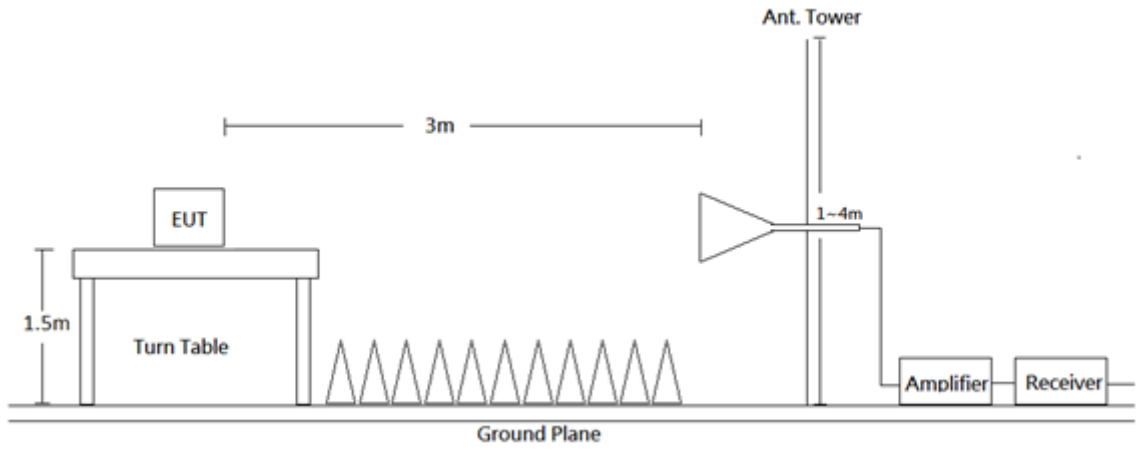
intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the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

8.2 EUT Setup

Below 1 GHz:



Above 1 GHz:



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

8.3 EMI Test Receiver & Spectrum Analyzer Setup

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

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

Note: T is minimum transmission duration

8.4 Test Procedure

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

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

8.5 Corrected Factor & Margin Calculation

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

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

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

Over Limit = Level – Limit

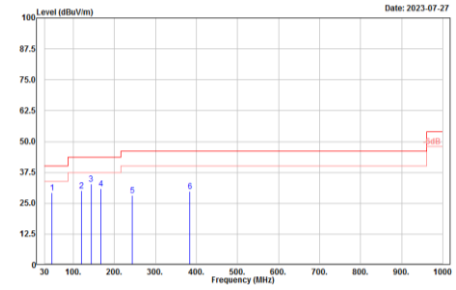
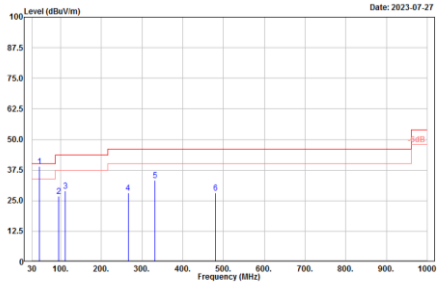
8.6 Test Results

Test Mode: Transmitting

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

(Worst case is BLE 2M mode low channel)

30MHz-1GHz:

Horizontal	Vertical
	

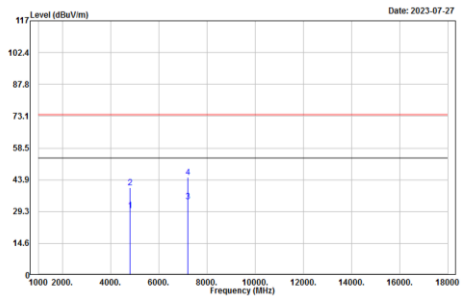
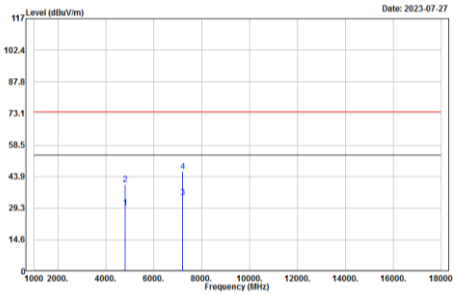
Site : LK-966A
Condition: 3m horizontal
Mode : BLE 2M-TX-2402MHz
Note : Temp/RH:24.7°C/48%
Tester: Bruce

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	47.460	29.26	40.00	-10.74	50.11	-20.85	QP
2	120.210	30.05	43.50	-13.45	48.51	-18.46	QP
3	143.490	32.88	43.50	-10.62	52.37	-19.49	QP
4	167.740	30.96	43.50	-12.54	51.45	-20.49	QP
5	244.370	28.19	46.00	-17.81	49.17	-20.98	QP
6	384.050	29.78	46.00	-16.22	47.61	-17.83	QP

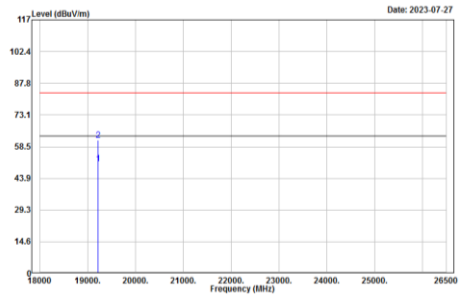
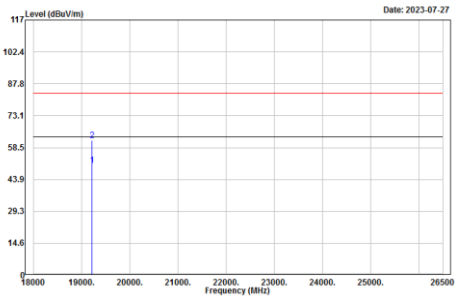
Site : LK-966A
Condition: 3m vertical
Mode : BLE 2M-TX-2402MHz
Note : Temp/RH:24.7°C/48%
Tester: Bruce

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1 !	47.460	38.92	40.00	-1.08	59.77	-20.85	QP
2	94.990	26.91	43.50	-16.59	50.31	-23.40	QP
3	111.480	28.98	43.50	-14.52	48.40	-19.42	QP
4	265.710	28.14	46.00	-17.86	48.33	-20.19	QP
5	331.670	33.38	46.00	-12.62	52.36	-18.98	QP
6	480.080	28.08	46.00	-17.92	43.65	-15.57	QP

1GHz ~ 18GHz

Horizontal	Vertical
	

18GHz ~ 26.5GHz

Horizontal	Vertical
	

Above 1GHz

BLE (1M) Mode

Low channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2389.600	45.26	54.00	-8.74	54.46	-9.20	Average
2	2389.600	50.62	74.00	-23.38	59.82	-9.20	Peak
3	2402.000	86.00	------	------	95.14	-9.14	Average
4	2402.000	86.95	------	------	96.09	-9.14	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4804.000	29.72	54.00	-24.28	32.31	-2.59	Average
2	4804.000	40.76	74.00	-33.24	43.35	-2.59	Peak
3	7206.000	34.61	54.00	-19.39	31.23	3.38	Average
4	7206.000	45.15	74.00	-28.85	41.77	3.38	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2389.600	37.01	54.00	-16.99	46.21	-9.20	Average
2	2389.600	46.43	74.00	-27.57	55.63	-9.20	Peak
3	2402.000	79.14	------	------	88.28	-9.14	Average
4	2402.000	80.15	------	------	89.29	-9.14	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4804.000	30.55	54.00	-23.45	33.14	-2.59	Average
2	4804.000	40.74	74.00	-33.26	43.33	-2.59	Peak
3	7206.000	34.87	54.00	-19.13	31.49	3.38	Average
4	7206.000	45.96	74.00	-28.04	42.58	3.38	Peak

Middle channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2440.000	83.12	------	------	92.09	-8.97	Average
2	2440.000	84.09	------	------	93.06	-8.97	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4880.000	30.53	54.00	-23.47	32.77	-2.24	Average
2	4880.000	41.12	74.00	-32.88	43.36	-2.24	Peak
3	7320.000	35.19	54.00	-18.81	31.36	3.83	Average
4	7320.000	45.71	74.00	-28.29	41.88	3.83	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2440.000	78.10	------	------	87.07	-8.97	Average
2	2440.000	79.12	------	------	88.09	-8.97	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4880.000	30.76	54.00	-23.24	33.00	-2.24	Average
2	4880.000	41.60	74.00	-32.40	43.84	-2.24	Peak
3	7320.000	35.34	54.00	-18.66	31.51	3.83	Average
4	7320.000	45.98	74.00	-28.02	42.15	3.83	Peak

High channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2480.000	80.19	------	------	88.96	-8.77	Average
2	2480.000	81.23	------	------	90.00	-8.77	Peak
3 !	2486.050	50.33	54.00	-3.67	59.07	-8.74	Average
4	2486.050	54.39	74.00	-19.61	63.13	-8.74	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4960.000	30.41	54.00	-23.59	32.27	-1.86	Average
2	4960.000	41.63	74.00	-32.37	43.49	-1.86	Peak
3	7440.000	35.03	54.00	-18.97	30.92	4.11	Average
4	7440.000	46.46	74.00	-27.54	42.35	4.11	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2480.000	76.72	------	------	85.49	-8.77	Average
2	2480.000	77.77	------	------	86.54	-8.77	Peak
3	2486.050	47.16	54.00	-6.84	55.90	-8.74	Average
4	2486.050	51.55	74.00	-22.45	60.29	-8.74	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4960.000	30.49	54.00	-23.51	32.35	-1.86	Average
2	4960.000	42.02	74.00	-31.98	43.88	-1.86	Peak
3	7440.000	34.80	54.00	-19.20	30.69	4.11	Average
4	7440.000	45.44	74.00	-28.56	41.33	4.11	Peak

Level = Reading + Correct Factor
Over Limit = Level – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

BLE (2M) Mode

Low channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2389.900	43.85	54.00	-10.15	53.05	-9.20	Average
2	2389.900	49.67	74.00	-24.33	58.87	-9.20	Peak
3	2402.000	84.82	------	------	93.96	-9.14	Average
4	2402.000	87.00	------	------	96.14	-9.14	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4804.000	29.67	54.00	-24.33	32.26	-2.59	Average
2	4804.000	40.29	74.00	-33.71	42.88	-2.59	Peak
3	7206.000	33.93	54.00	-20.07	30.55	3.38	Average
4	7206.000	44.97	74.00	-29.03	41.59	3.38	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2371.100	33.63	54.00	-20.37	42.92	-9.29	Average
2	2371.100	45.64	74.00	-28.36	54.93	-9.29	Peak
3	2402.000	77.32	------	------	86.46	-9.14	Average
4	2402.000	79.54	------	------	88.68	-9.14	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4804.000	29.33	54.00	-24.67	31.92	-2.59	Average
2	4804.000	40.19	74.00	-33.81	42.78	-2.59	Peak
3	7206.000	34.23	54.00	-19.77	30.85	3.38	Average
4	7206.000	46.33	74.00	-27.67	42.95	3.38	Peak

Middle channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2440.000	81.60	------	------	90.57	-8.97	Average
2	2440.000	83.85	------	------	92.82	-8.97	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4880.000	31.46	54.00	-22.54	33.70	-2.24	Average
2	4880.000	40.83	74.00	-33.17	43.07	-2.24	Peak
3	7320.000	35.35	54.00	-18.65	31.52	3.83	Average
4	7320.000	46.50	74.00	-27.50	42.67	3.83	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2440.000	76.29	------	------	85.26	-8.97	Average
2	2440.000	78.62	------	------	87.59	-8.97	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4880.000	30.64	54.00	-23.36	32.88	-2.24	Average
2	4880.000	41.17	74.00	-32.83	43.41	-2.24	Peak
3	7320.000	35.63	54.00	-18.37	31.80	3.83	Average
4	7320.000	46.17	74.00	-27.83	42.34	3.83	Peak

High channel

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2480.000	78.98	------	------	87.75	-8.77	Average
2	2480.000	81.30	------	------	90.07	-8.77	Peak
3 !	2486.620	48.98	54.00	-5.02	57.72	-8.74	Average
4	2486.620	54.11	74.00	-19.89	62.85	-8.74	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4960.000	30.37	54.00	-23.63	32.23	-1.86	Average
2	4960.000	41.15	74.00	-32.85	43.01	-1.86	Peak
3	7440.000	34.76	54.00	-19.24	30.65	4.11	Average
4	7440.000	45.64	74.00	-28.36	41.53	4.11	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	2480.000	74.84	------	------	83.61	-8.77	Average
2	2480.000	77.34	------	------	86.11	-8.77	Peak
3	2486.740	46.25	54.00	-7.75	54.99	-8.74	Average
4	2486.740	51.63	74.00	-22.37	60.37	-8.74	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	4960.000	30.39	54.00	-23.61	32.25	-1.86	Average
2	4960.000	41.89	74.00	-32.11	43.75	-1.86	Peak
3	7440.000	34.95	54.00	-19.05	30.84	4.11	Average
4	7440.000	46.97	74.00	-27.03	42.86	4.11	Peak

Level = Reading + Correct Factor
Over Limit = Level – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

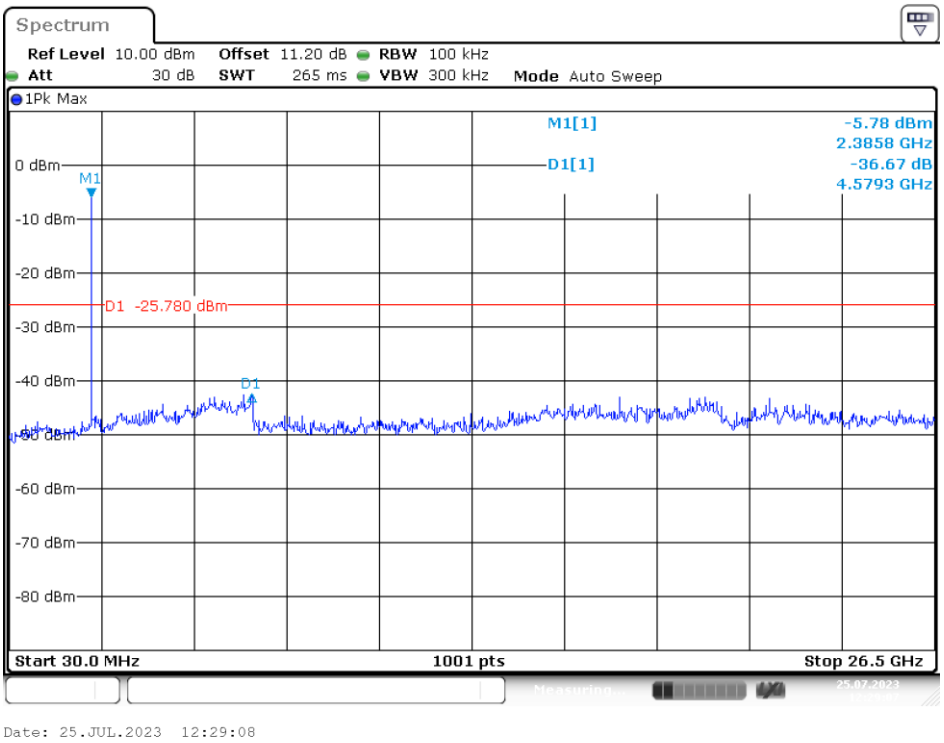
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	36.67	≥ 20	PASS
Mid	2440	35.64	≥ 20	PASS
High	2480	33.50	≥ 20	PASS
BLE(2M) Mode				
Low	2402	37.06	≥ 20	PASS
Mid	2440	35.33	≥ 20	PASS
High	2480	36.35	≥ 20	PASS

Please refer to the following plots

BLE (1M) Mode

Low Channel



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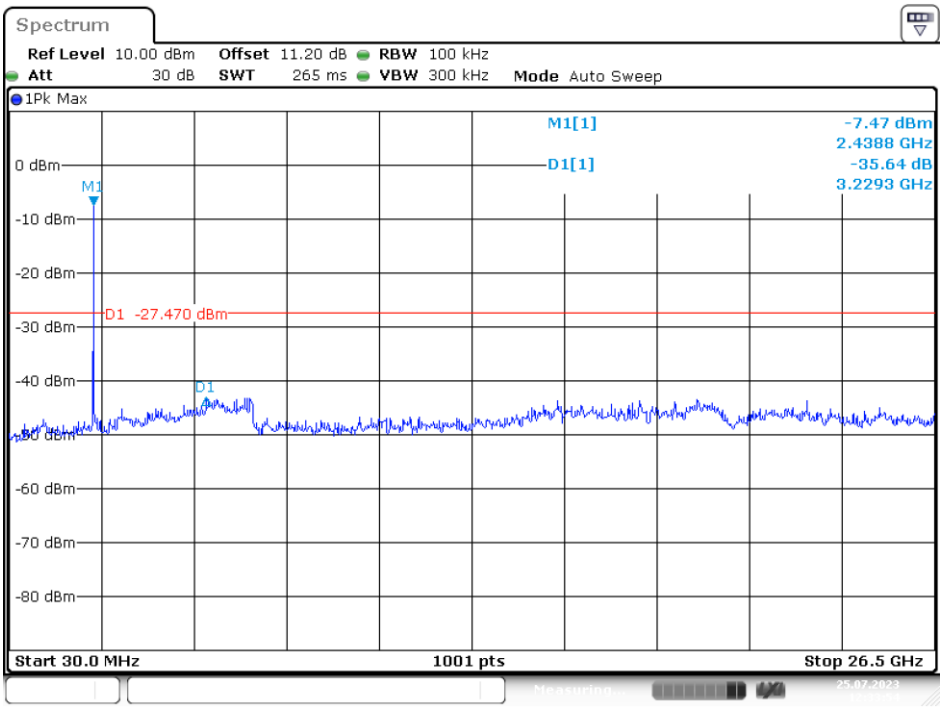
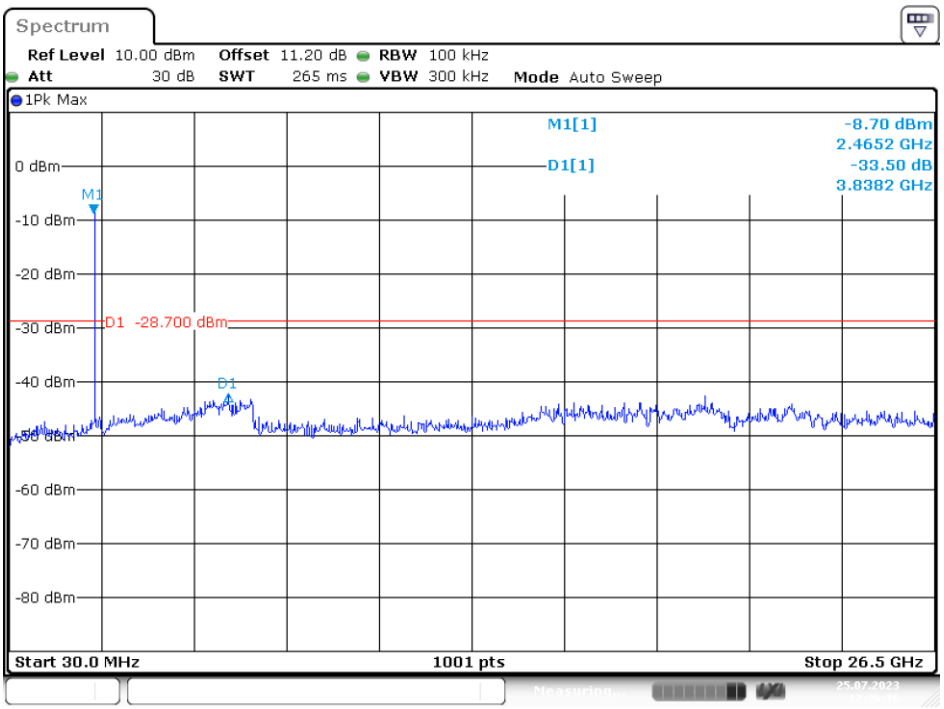
Middle Channel



Date: 25.JUL.2023 12:33:54

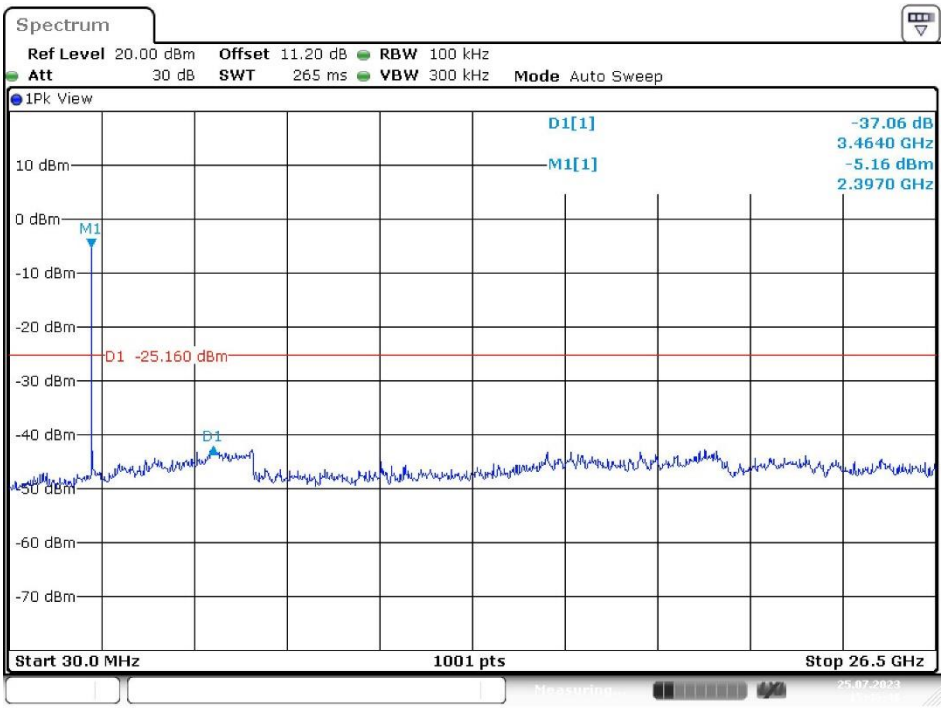
High Channel



Date: 25.JUL.2023 12:36:16

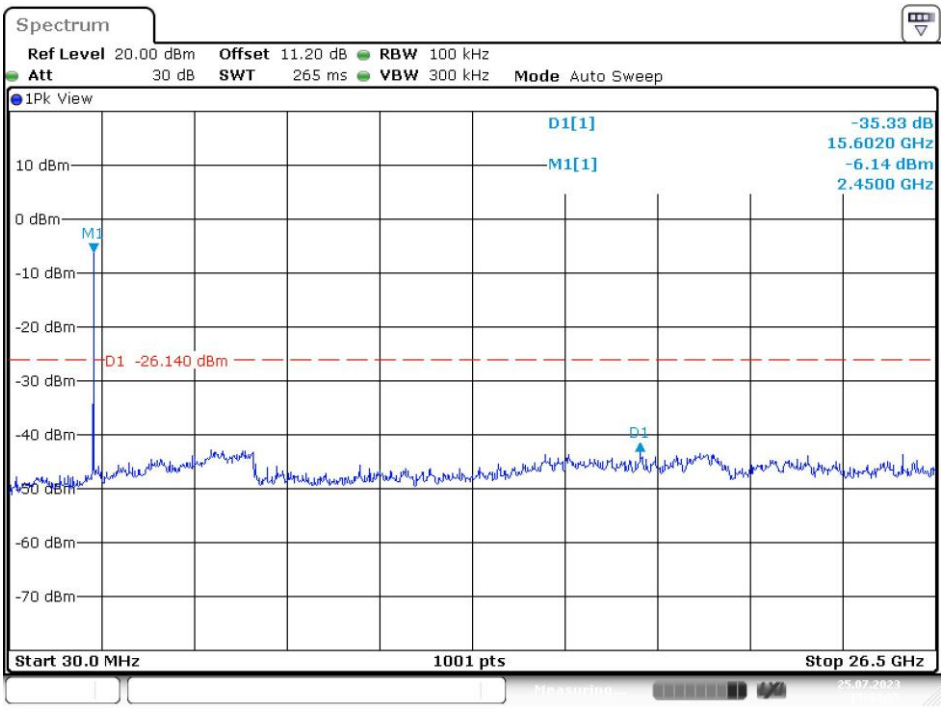
BLE (2M) Mode

Low Channel



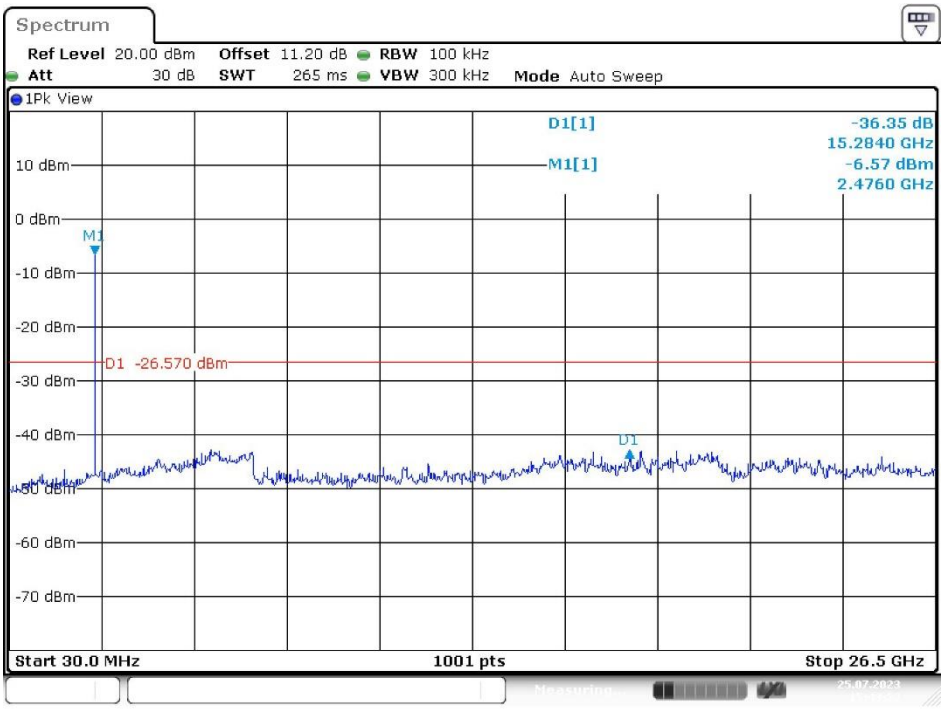
Date: 25.JUL.2023 15:46:48

Middle Channel



Date: 25.JUL.2023 15:44:55

High Channel



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

9.1 Applicable Standard

According to FCC §15.247(a)(2).

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

9.2 Test Procedure

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.

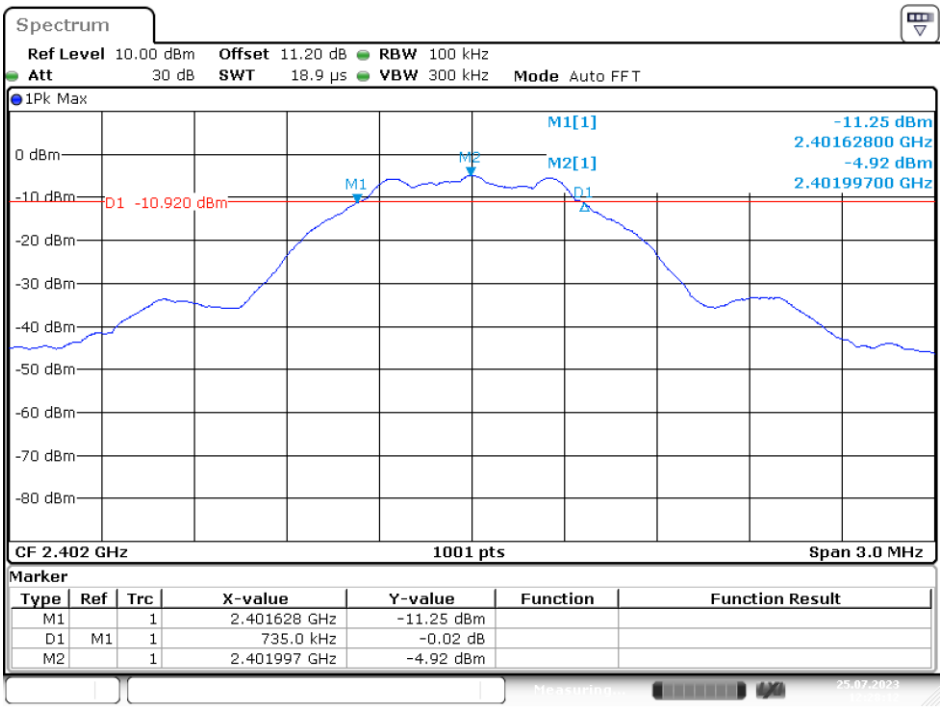
9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)	Result
BLE(1M) Mode				
Low	2402	0.735	> 500	Compliance
Middle	2440	0.735	> 500	Compliance
High	2480	0.738	> 500	Compliance
BLE(2M) Mode				
Low	2402	1.129	> 500	Compliance
Middle	2440	1.138	> 500	Compliance
High	2480	1.133	> 500	Compliance

Please refer to the following plots

BLE (1M) Mode

Low Channel



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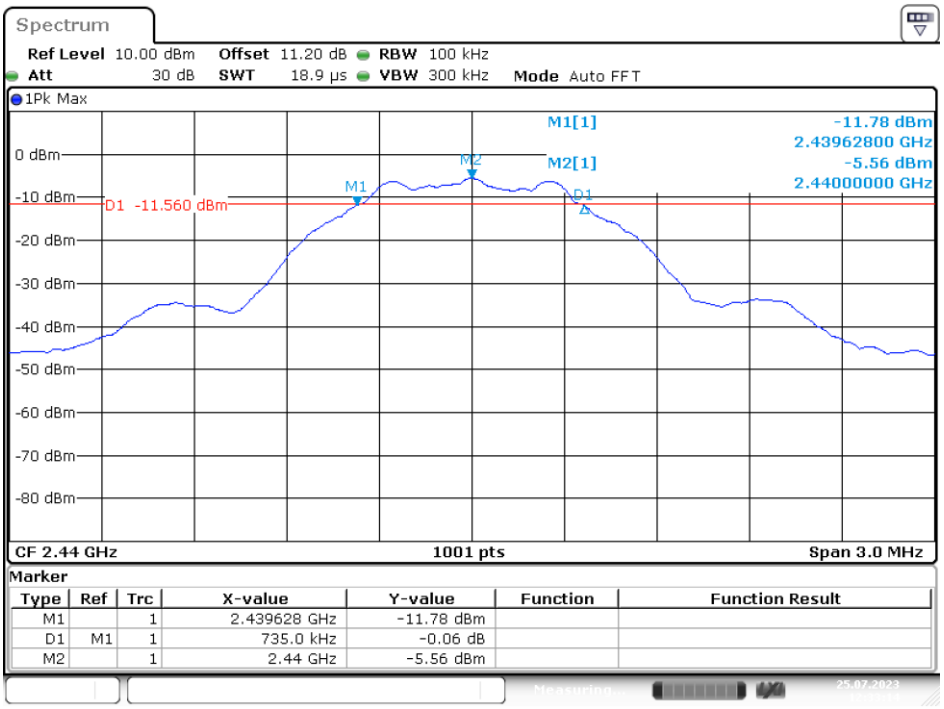
Middle Channel



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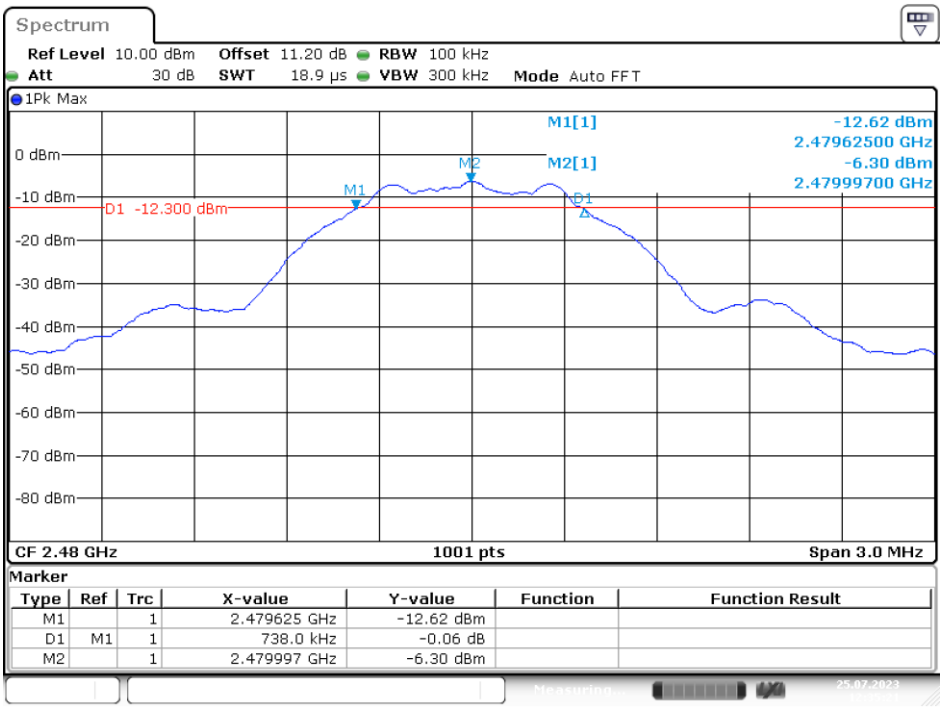
High Channel



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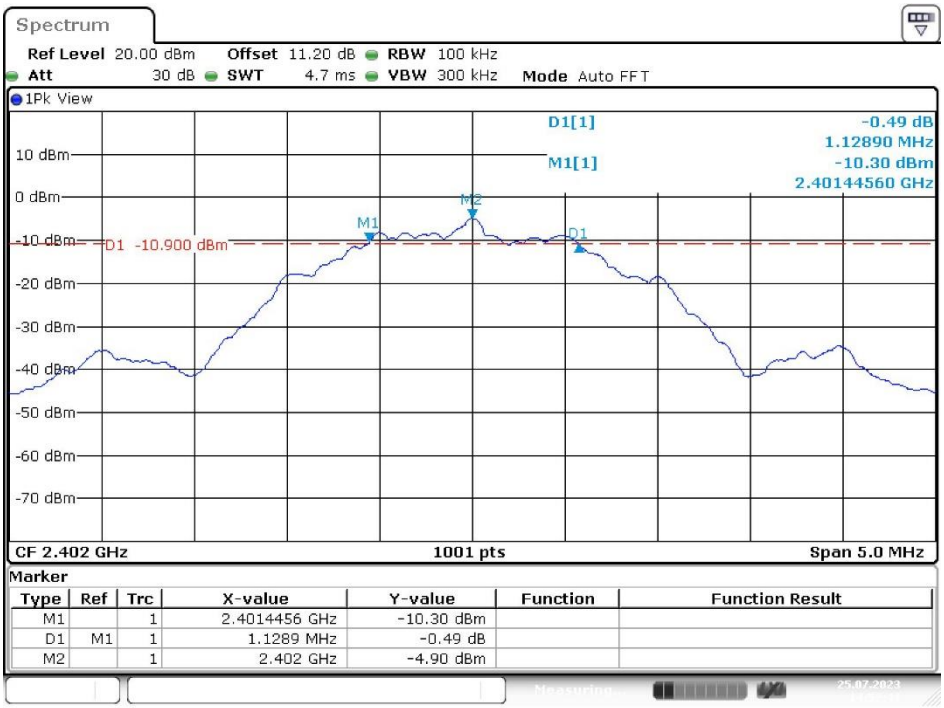
BLE (2M) Mode

Low Channel



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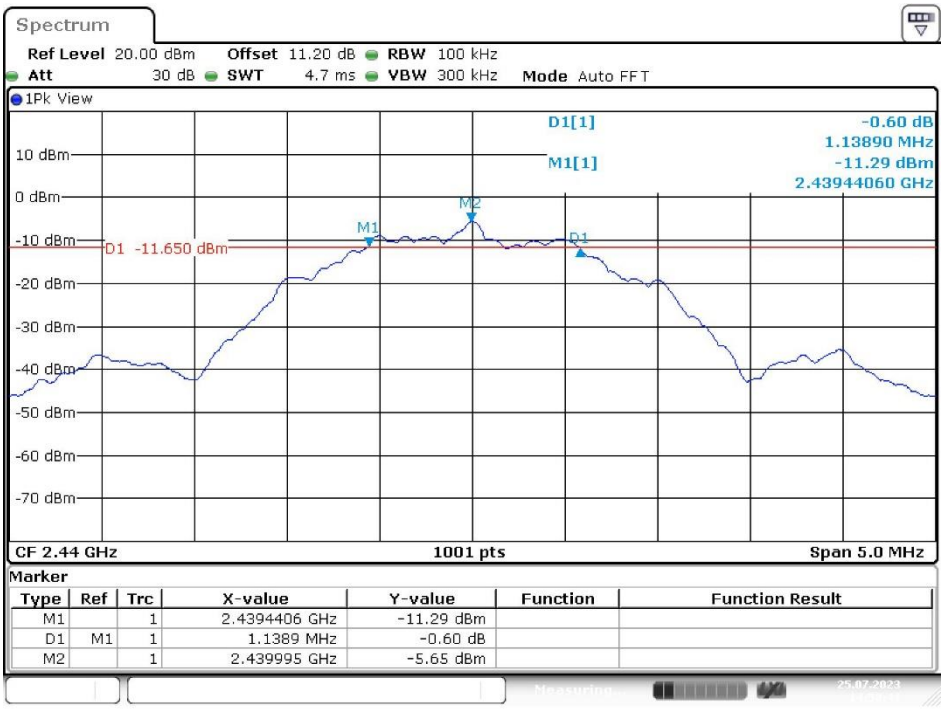
Middle Channel



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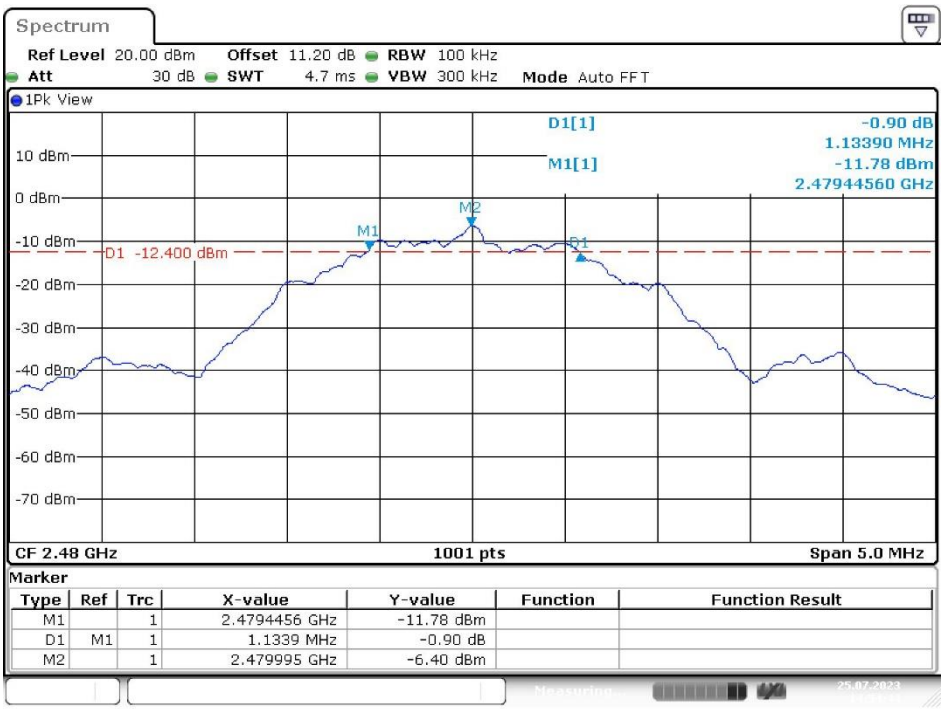
High Channel



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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

Channel	Frequency	Maximum peak Conducted Output Power		Limit	Result
	(MHz)	(dBm)	(W)	(W)	
BLE(1M) Mode					
Low	2402	-4.39	0.0004	1	PASS
Middle	2440	-4.83	0.0003	1	PASS
High	2480	-5.23	0.0003	1	PASS
BLE(2M) Mode					
Low	2402	-4.22	0.0004	1	PASS
Middle	2440	-4.56	0.0003	1	PASS
High	2480	-5.24	0.0003	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. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

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

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

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

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

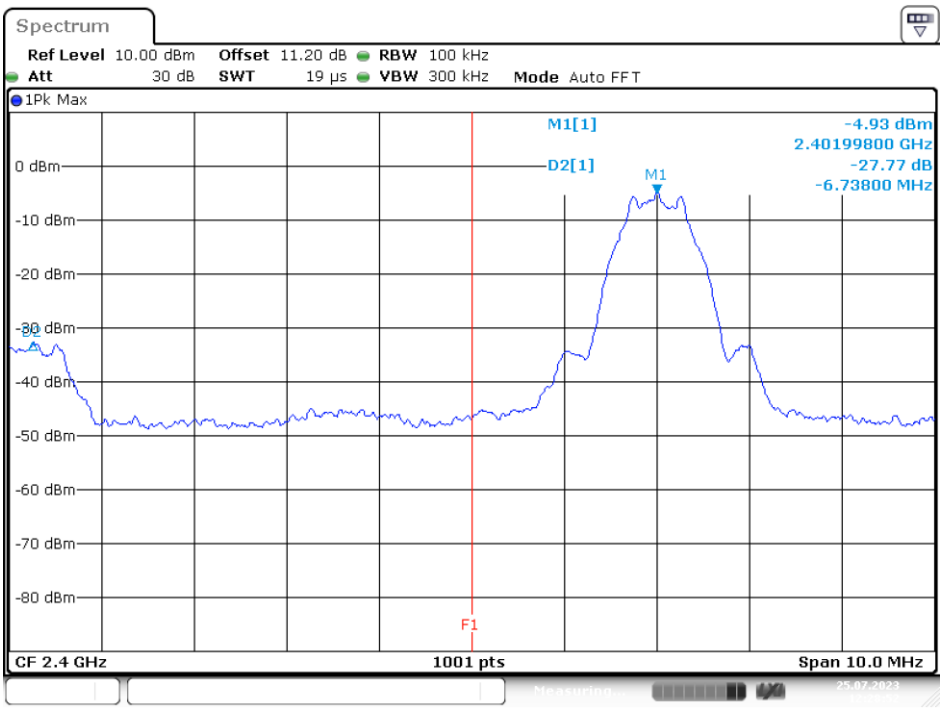
11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	27.77	≥ 20	PASS
High	2480	27.81	≥ 20	PASS
BLE(2M) Mode				
Low	2402	27.41	≥ 20	PASS
High	2480	27.89	≥ 20	PASS

Please refer to the following plots

BLE (1M) Mode

Band Edge, Left Side



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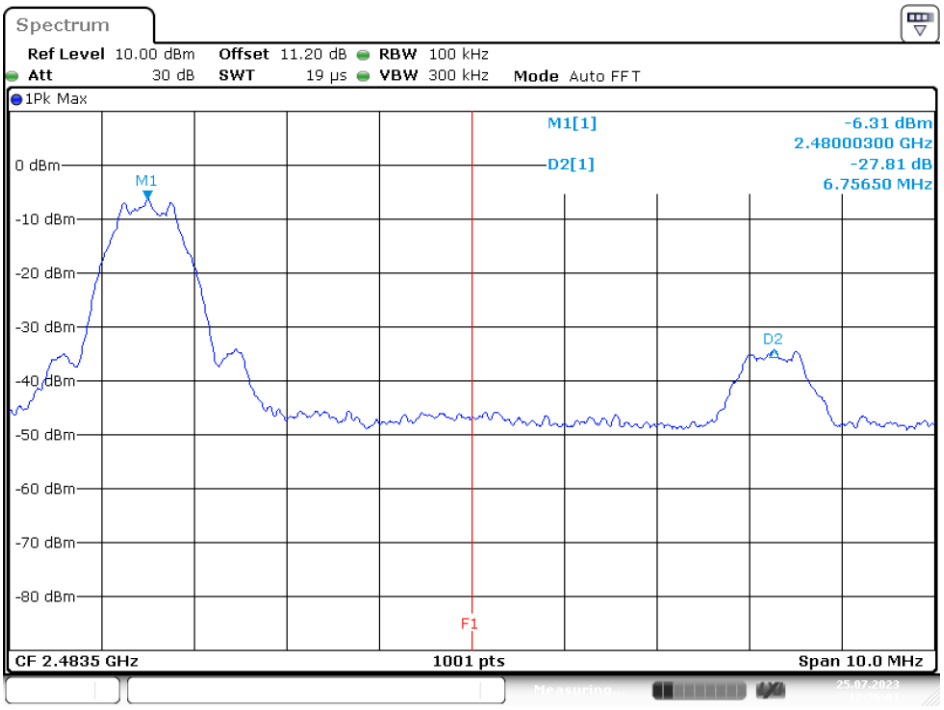
Band Edge, Right Side



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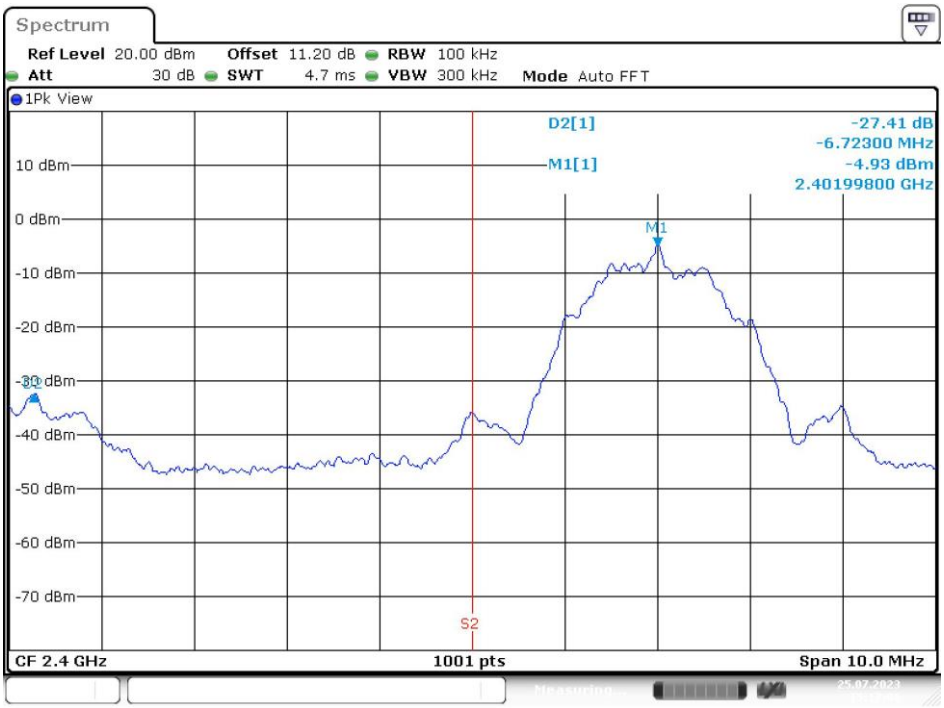
BLE (2M) Mode

Band Edge, Left Side



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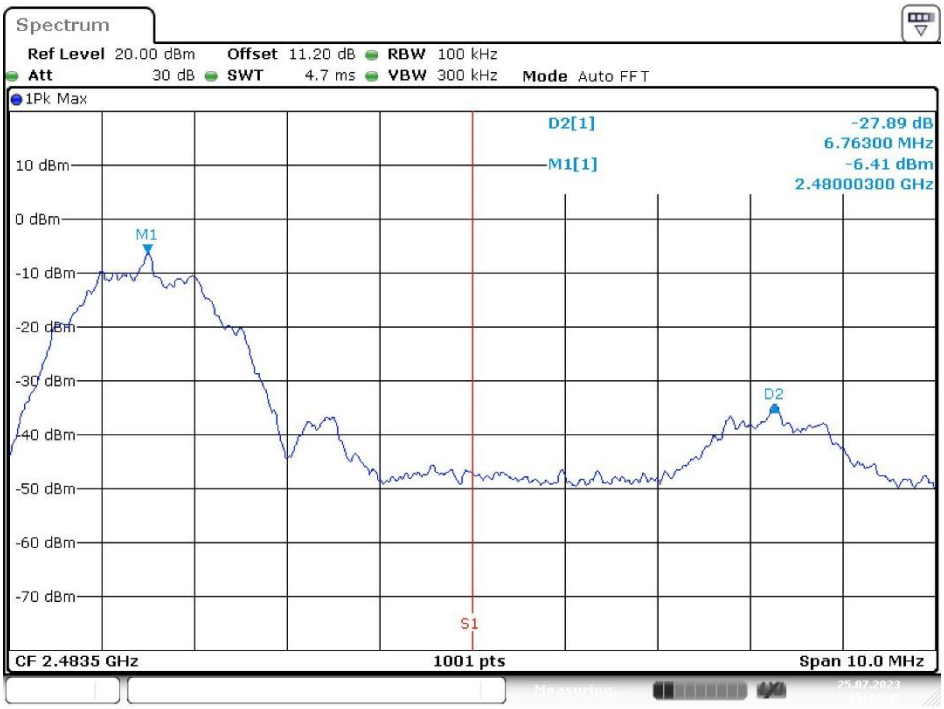
Band Edge, Right Side



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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

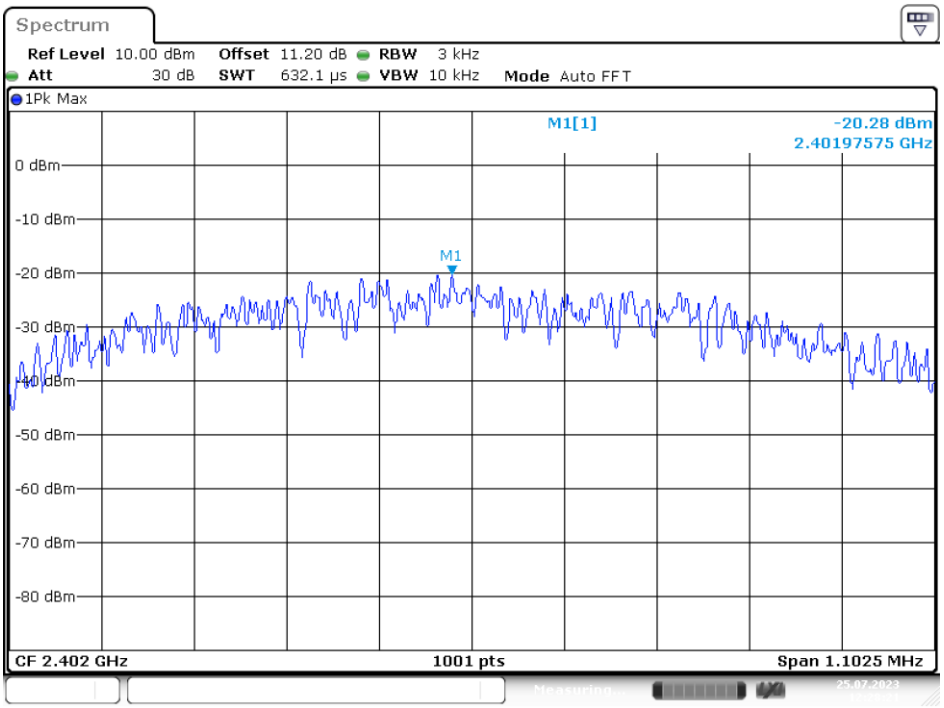
12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE(1M) Mode				
Low	2402	-20.28	8	Compliance
Middle	2440	-20.90	8	Compliance
High	2480	-21.65	8	Compliance
BLE(2M) Mode				
Low	2402	-22.75	8	Compliance
Middle	2440	-23.42	8	Compliance
High	2480	-24.25	8	Compliance

Please refer to the following plots

BLE (1M) Mode

Low Channel



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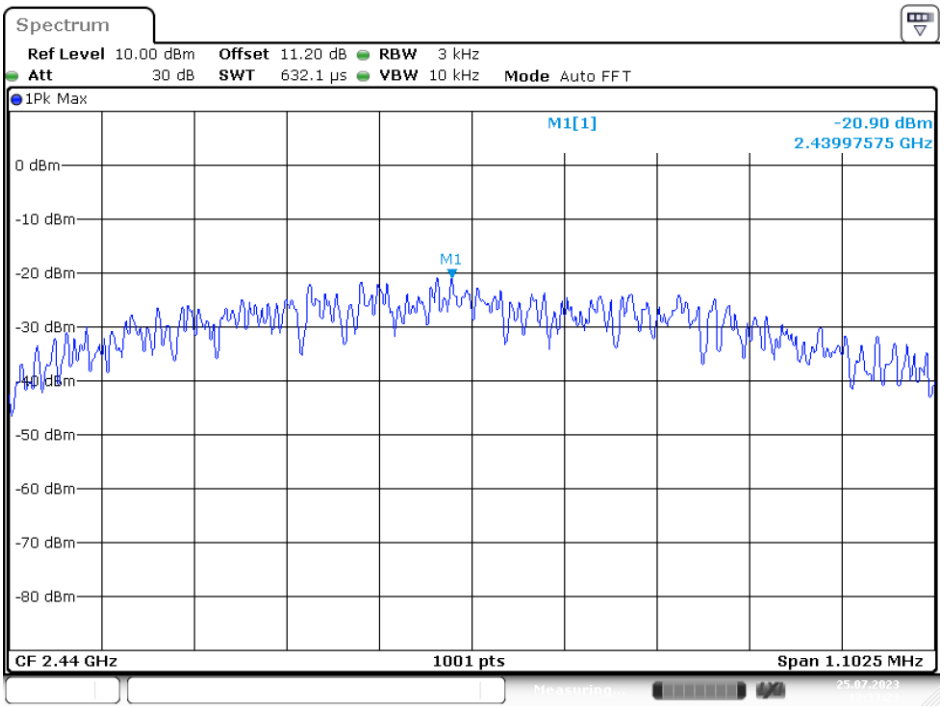
Middle Channel



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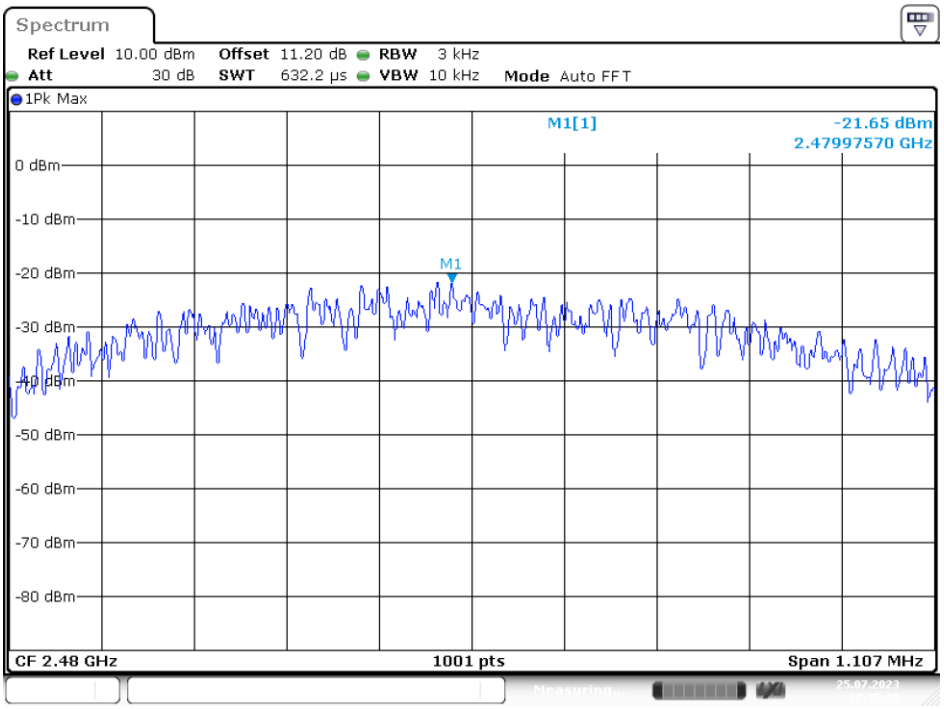
High Channel



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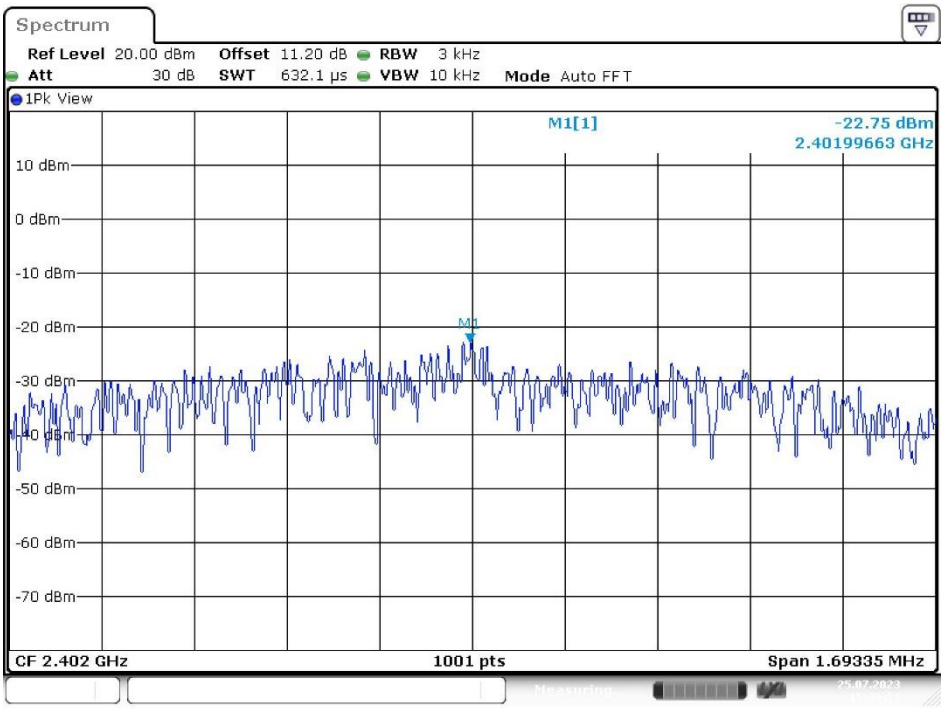
BLE (2M) Mode

Low Channel



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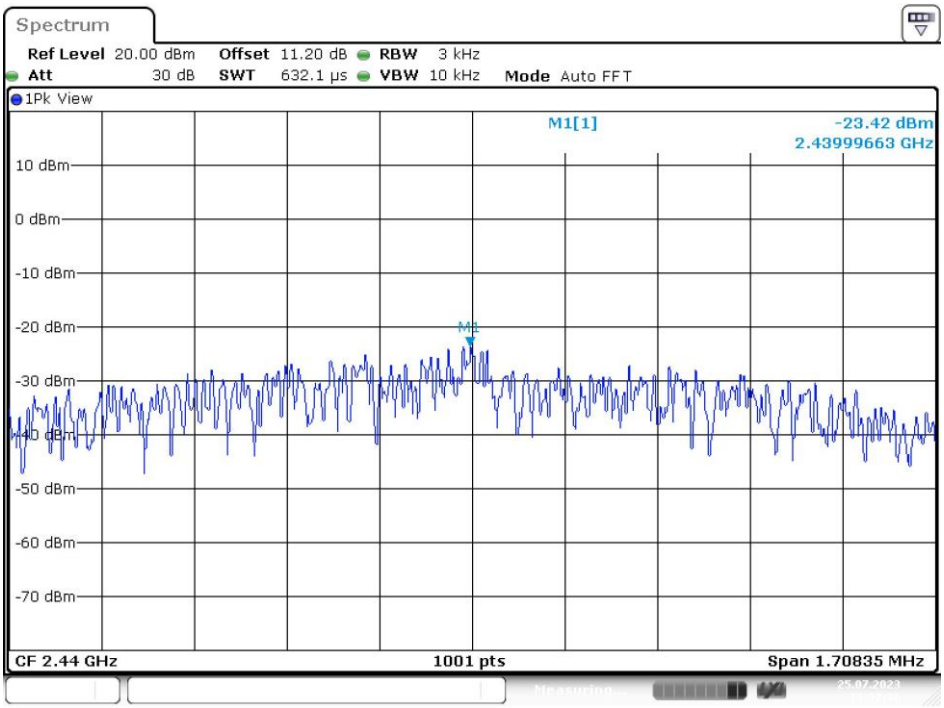
Middle Channel



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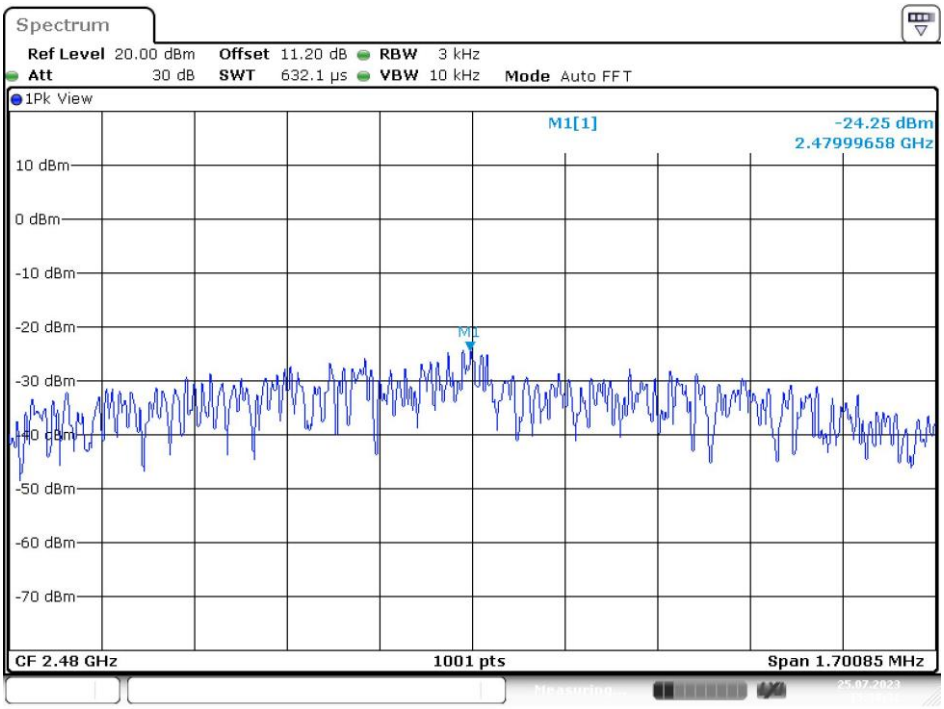
High Channel



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