

FCC Part 15.247

TEST REPORT

For

Toshiba Inspection Solutions Co., Ltd.

8, Shin Sugita-cho, Isogo-ku, Yokohama, Kanagawa Prefecture 235-8523 JAPAN

FCC ID: 2AVHN-TMRCD210RX

Report Type:
Original Report

Product Type:
RF 2.4G USB Dongle

Report Producer : Coco Lin

Report Number : RXZ230705015-01RF02

Report Date : 2024-05-13

Reviewed By: Andy Shih *Andy Shih*

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	RXZ230705015-01	RXZ230705015-01RF02	2024-05-13	Original Report	Coco Lin

TABLE OF CONTENTS

1	General Information	5
1.1	Product Description for Equipment under Test (EUT)	5
1.2	Objective	6
1.3	Test Methodology.....	6
1.4	Statement	6
1.5	Measurement Uncertainty	7
1.6	Environmental Conditions.....	7
1.7	Test Facility	7
2	System Test Configuration.....	8
2.1	Description of Test Configuration.....	8
2.2	Equipment Modifications	8
2.3	EUT Exercise Software	8
2.4	Support Equipment List and Details.....	8
2.5	External Cable List and Details	9
2.6	Test Mode.....	9
2.7	Block Diagram of Test Setup	9
2.8	Duty Cycle.....	11
3	Summary of Test Results.....	12
4	Test Equipment List and Details	13
5	FCC §15.247(i), §1.1307(b)(3)(i) – RF Exposure.....	14
5.1	Applicable Standard	14
5.2	RF Exposure Evaluation Result.....	15
6	FCC §15.203 – Antenna Requirements.....	16
6.1	Applicable Standard	16
6.2	Antenna Information	16
7	FCC §15.207(a) – AC Line Conducted Emissions	17
7.1	Applicable Standard.....	17
7.2	EUT Setup	17
7.3	EMI Test Receiver Setup	18
7.4	Test Procedure.....	18
7.5	Corrected Factor & Margin Calculation	18
7.6	Test Results	19
8	FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions	20
8.1	Applicable Standard.....	20
8.2	EUT Setup	21
8.3	EMI Test Receiver & Spectrum Analyzer Setup.....	22
8.4	Test Procedure	22
8.5	Corrected Factor & Margin Calculation	22
8.6	Test Results	23
9	FCC §15.247(a)(2) – 6 dB Emission Bandwidth.....	29
9.1	Applicable Standard.....	29
9.2	Test Procedure	29
9.3	Test Results	29
10	FCC §15.247(b)(3) – Maximum Output Power.....	32

10.1	Applicable Standard.....	32
10.2	Test Procedure.....	32
10.3	Test Results	32
11	FCC§15.247(d) – 100 kHz Bandwidth of Frequency Band Edge	33
11.1	Applicable Standard.....	33
11.2	Test Procedure.....	33
11.3	Test Results	33
12	FCC §15.247(e) – Power Spectral Density	35
12.1	Applicable Standard.....	35
12.2	Test Procedure.....	35
12.3	Test Results	35

1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	Toshiba Inspection Solutions Co., Ltd.
	8, Shin Sugita-cho, Isogo-ku, Yokohama, Kanagawa Prefecture 235-8523 JAPAN
Manufacturer	King Wins Technology Co., Ltd.
	11F., No.33, Ln. 332, Sec. 2, Zhongshan Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)
Brand(Trade) Name	Toshiba
Product (Equipment)	RF 2.4G USB Dongle
Main Model Name	TMRCD210RX
Frequency Range	2405 ~ 2476 MHz
Conducted Peak Output Power	3.15 dBm
Modulation Technique	GFSK
Power Operation (Voltage Range)	<input type="checkbox"/> AC 120V/60Hz <input type="checkbox"/> Adapter <input type="checkbox"/> By AC Power Core
	<input checked="" type="checkbox"/> DC 5V <input type="checkbox"/> Battery Vdc <input checked="" type="checkbox"/> DC Power Supply <input type="checkbox"/> External from USB Cable <input type="checkbox"/> External DC Adapter
	<input type="checkbox"/> Host System
Received Date	2023/07/19
Date of Test	2023/07/25 ~ 2024/05/09

*All measurement and test data in this report was gathered from production sample serial number: RXZ230705015-1 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

This report is prepared on behalf of *Toshiba Inspection Solutions Co., Ltd.* 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 15.247 Meas Guidance v05r02

1.4 Statement

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

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

Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

The determination of the test results does not require consideration of the uncertainty of the measurement, unless the assessment is required by customer agreement, regulation or standard document specification.

Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) is not responsible for the authenticity of the information provided by the applicant that affects the test results.

1.5 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		±2.53 dB
RF output power, conducted		±3.74 dB
Power Spectral Density, conducted		±0.62 dB
Occupied Bandwidth		±0.09 %
Unwanted Emissions, conducted		±1.15 dB
Emissions, radiated	9 kHz~30 MHz	±3.54 dB
	30 MHz~1GHz	±4.99 dB
	1 GHz~18 GHz	±7.56 dB
	18 GHz~40 GHz	±5.06 dB
Temperature		±0.79 °C
Humidity		±0.44 %

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 (°C)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2023/7/26	27.3	51	1010	Aaron Pan
Radiation Spurious Emissions	2023/7/26~2024/5/9	23.1~23.7	50~65	1010	Aaron Pan
Conducted Spurious Emissions	2023/7/25	26.7	44	1010	Jing Chang
6 dB Emission Bandwidth	2023/7/25	26.7	44	1010	Jing Chang
Maximum Output Power	2023/7/25	26.7	44	1010	Jing Chang
100 kHz Bandwidth of Frequency Band Edge	2023/7/25	26.7	44	1010	Jing Chang
Power Spectral Density	2023/7/25	26.7	44	1010	Jing Chang

1.7 Test Facility

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

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

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

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

2 System Test Configuration

2.1 Description of Test Configuration

For SRD mode, 12 channels are provided to testing:

Channel	Freq. (MHz)
1	2405
2	2407
3	2408
4	2422
5	2423
6	2427
7	2447
8	2451
9	2452
10	2473
11	2474
12	2476

EUT was tested with Channel 1, 7 and 12.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used “Pxi_Link_Emi_Tool v1.0.0.0.exe”

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

Test Frequency	Low	Middle	High
Power Level Setting	6	6	6

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number	S/N
NB	DELL	E6410	8N7PXN1
Adapter	DELL	DA90PE3-00	CN-0WTC0V-48661-076-E013-A00

2.5 External Cable List and Details

N/A.

2.6 Test Mode

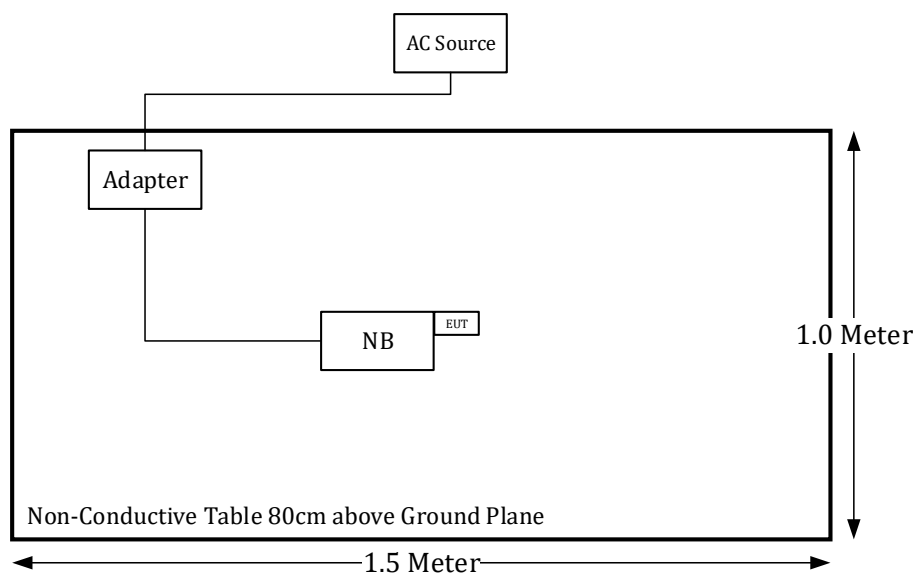
Full System (model: TMRCD210RX) for all test item.

2.7 Block Diagram of Test Setup

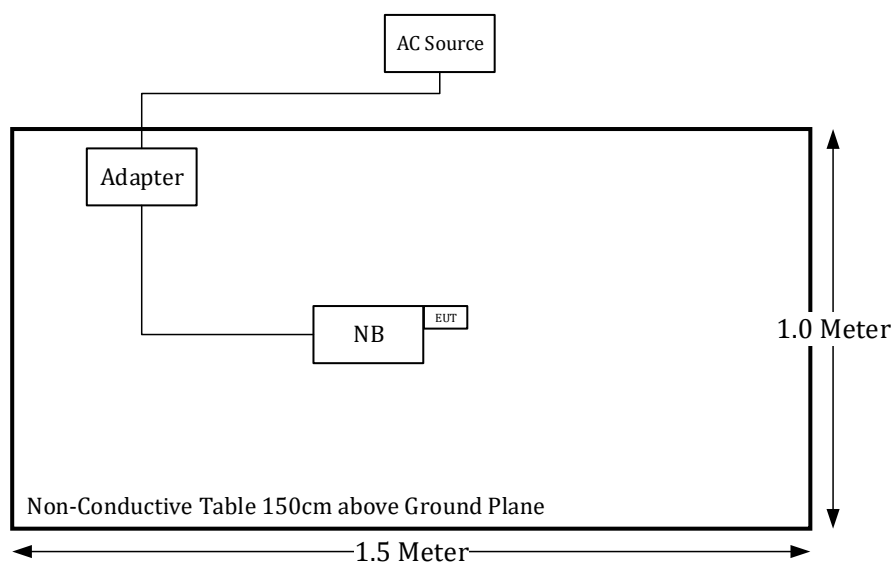
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

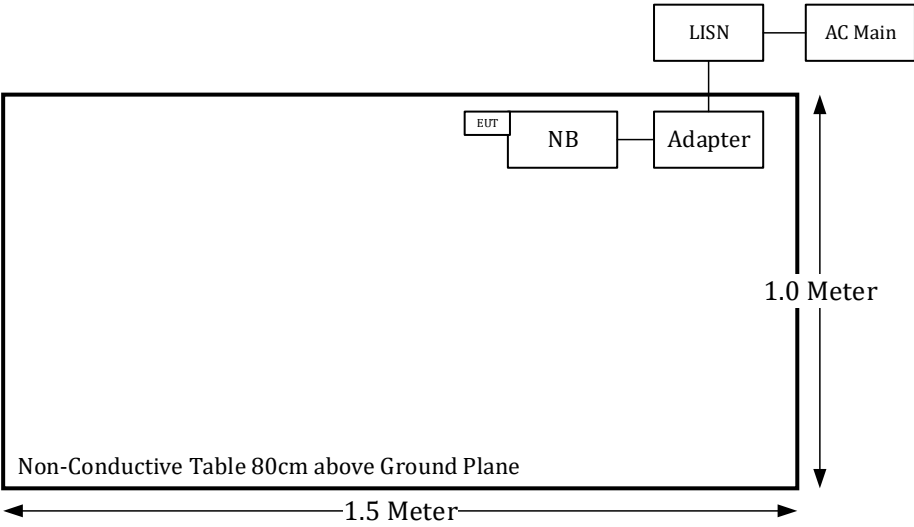
Below 1GHz:



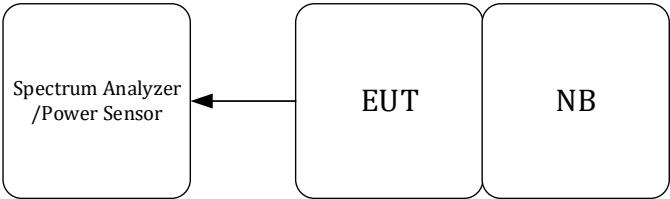
Above 1GHz:



Conduction:



Conducted:



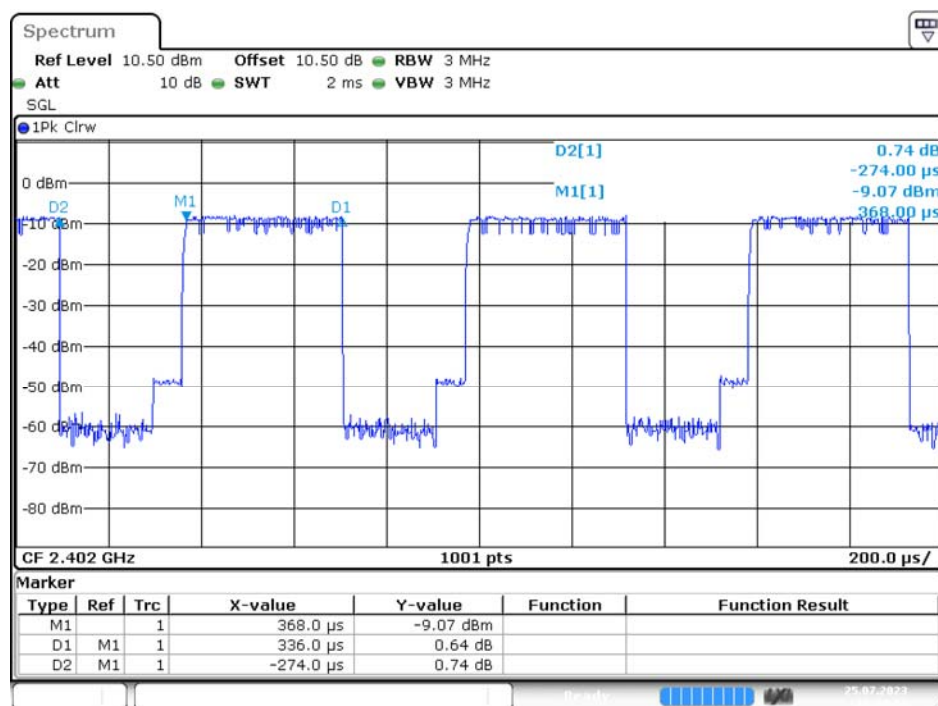
2.8 Duty Cycle

The duty cycle as below:

Radio Mode	On Time (ms)	Off Time (ms)	Duty Cycle (%)	1/T (kHz)	VBW setting (kHz)
SRD	0.336	0.274	55	2.976	3

Please refer to the following plots.

SRD Mode



Date: 25.JUL.2023 16:30:12

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	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	2023/2/2	2024/2/1
EMI Test Receiver	Rohde & Schwarz	ESW8	100947	2023/5/22	2024/5/20
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2023/5/18	2024/5/16
RF Cable	EMEC	EM-CB5D	1	2023/6/6	2024/6/4
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+	A050115/1554_2_01	2023/2/2	2024/2/1
Horn Antenna	EMCO	SAS-571	1020	2023/5/18	2024/5/16
Horn Antenna	ETS-Lindgren	3116	62638	2022/8/18	2023/8/17
Preamplifier	Sonoma	310N	130602	2023/6/16	2024/6/14
Preamplifier	Channel	ERA-100M-18G-01D1748	EC2300051	2023/04/01	2024/03/30
Microwave Preamplifier	EM Electronics Corporation	EM18G40G	60656	2023/1/6	2024/1/5
Spectrum Analyzer	Rohde & Schwarz	FSV40	101939	2023/3/23 2024/3/27	2024/3/22 2025/3/26
EMI Test Receiver	Rohde & Schwarz	ESR3	102099	2023/6/16	2024/6/14
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2023/1/24 2024/1/23	2024/1/23 2025/1/21
Coaxial Cable	COMMATE	PEWC	8Dr	2022/12/24 2023/12/23	2023/12/23 2024/12/21
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2023/1/24 2024/1/23	2024/1/23 2025/1/21
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2022/12/24 2023/12/23	2023/12/23 2024/12/21
Cable	EMC	EMC105-SM-SM-10000	201003	2023/1/24 2024/1/23	2024/1/23 2025/1/21
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2023/1/24	2024/1/23
Coaxial Cable	ROSNOL	K1K50-UP0264-K1K50-50CM	15120-1	2023/2/2	2024/2/1
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
Power Sensor	Boonton	RTP5006	11037	2023/5/23	2024/5/21
Attenuator	MINI-CIRCUITS	BW-S10W5+	1419	2023/2/2	2024/2/1

***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 P_{th} (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). P_{th} is given by:

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

Where

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

and

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

(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	$0.0128 R^2 f$.
1,500-100,000	$19.2 R^2$.

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)
SRD Mode	2476	3.5	1	5	2.24	2.35	1.72

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

§ 1.1307(b)(3)(i)(B)

Band	Freq (MHz)	Pth (mW)	X	ERP 20cm (mW)	Result Option B
SRD Mode	2476	2.72	1.904	3060	exempt

The available maximum time-averaged power or effective radiated power (ERP), whichever is greater.

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).

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
King Wins Technology Co., Ltd	TMRC210RX	PCB Antenna	1 dBi

Result: Compliance

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

7.1 Applicable Standard

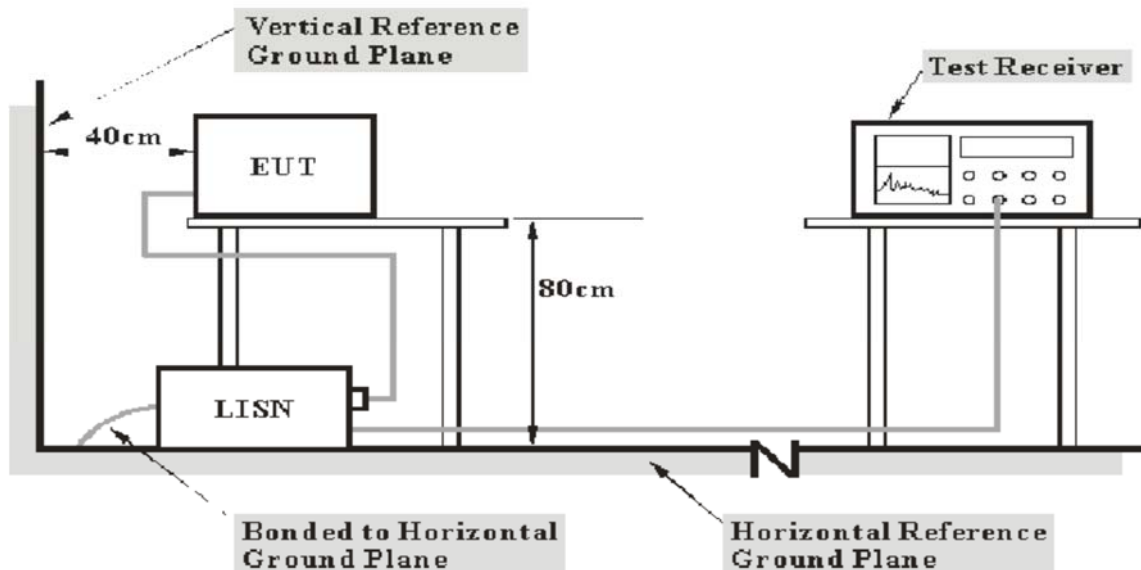
According to §15.207

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 μ H/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:

$$\text{Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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:

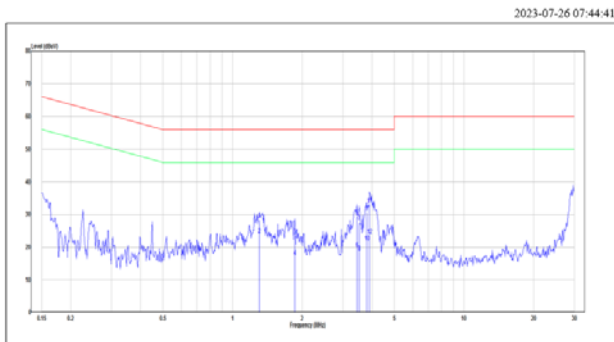
$$\text{Over Limit} = \text{Result} - \text{Limit Line}$$

7.6 Test Results

Test Mode: Transmitting

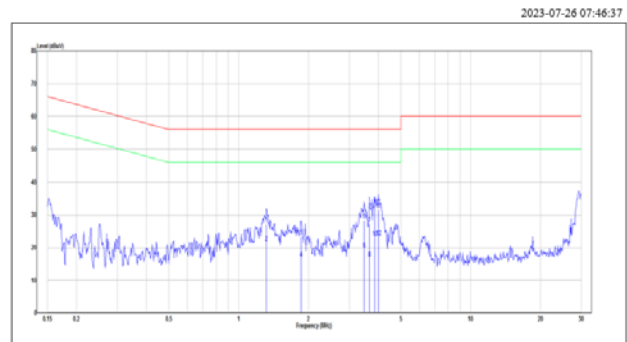
Main: AC120 V, 60 Hz

Line



No.	Frequency (MHz)	Reading dBμV	Correct Factor(dB)	Result dBμV	Limit dBμV	Over limit (dB)	Remark	Phase
1	1.303	8.54	19.93	28.47	56.00	-27.53	QP	Line
2	1.303	3.77	19.93	23.70	46.00	-22.30	Average	Line
3	1.858	3.40	20.04	23.44	56.00	-32.56	QP	Line
4	1.858	-3.04	20.04	17.00	46.00	-29.00	Average	Line
5	3.454	9.13	20.11	29.23	56.00	-26.77	QP	Line
6	3.454	-0.65	20.11	19.46	46.00	-26.54	Average	Line
7	3.528	7.48	20.11	27.59	56.00	-28.41	QP	Line
8	3.528	-1.79	20.11	18.32	46.00	-27.68	Average	Line
9	3.799	10.60	20.12	30.72	56.00	-25.28	QP	Line
10	3.799	1.34	20.12	21.46	46.00	-24.54	Average	Line
11	3.901	12.90	20.12	33.02	56.00	-22.98	QP	Line
12	3.901	3.45	20.12	23.57	46.00	-22.43	Average	Line

Neutral



No.	Frequency (MHz)	Reading dBμV	Correct Factor(dB)	Result dBμV	Limit dBμV	Over limit (dB)	Remark	Phase
1	1.317	7.14	19.93	27.07	56.00	-28.93	QP	Neutral
2	1.317	1.57	19.93	21.51	46.00	-24.49	Average	Neutral
3	1.858	3.22	20.04	23.26	56.00	-32.74	QP	Neutral
4	1.858	-3.29	20.04	16.75	46.00	-29.25	Average	Neutral
5	3.472	8.21	20.12	28.33	56.00	-27.67	QP	Neutral
6	3.472	-0.65	20.12	19.47	46.00	-26.53	Average	Neutral
7	3.661	7.18	20.12	27.31	56.00	-28.69	QP	Neutral
8	3.661	-3.51	20.12	16.61	46.00	-29.39	Average	Neutral
9	3.860	12.76	20.13	32.89	56.00	-23.11	QP	Neutral
10	3.860	2.77	20.13	22.90	46.00	-23.10	Average	Neutral
11	4.006	11.34	20.13	31.47	56.00	-24.53	QP	Neutral
12	4.006	2.94	20.13	23.07	46.00	-22.93	Average	Neutral

Note:

Result = Read Level + 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

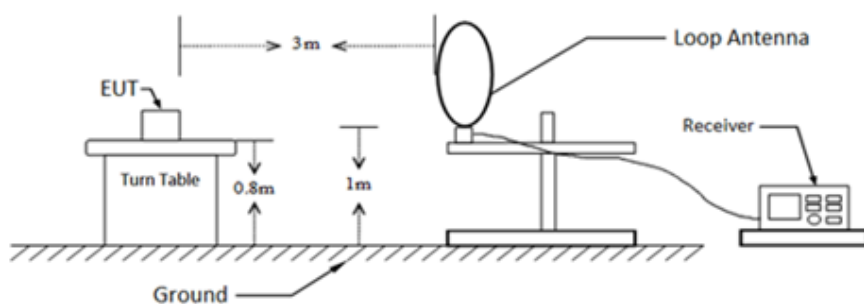
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this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

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

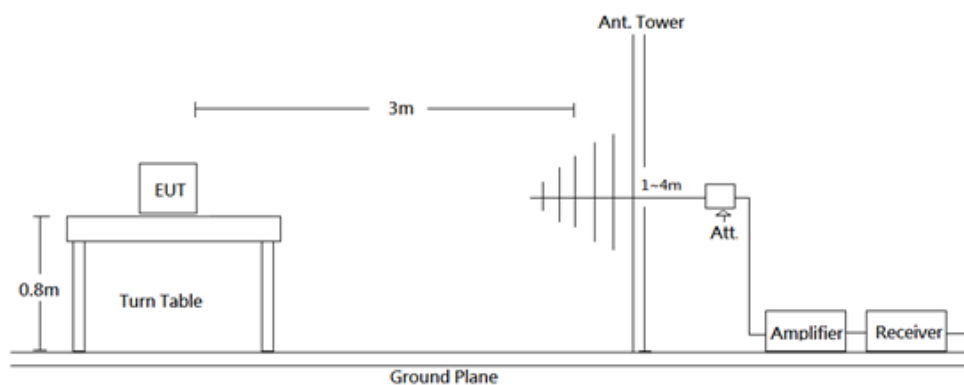
intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the 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

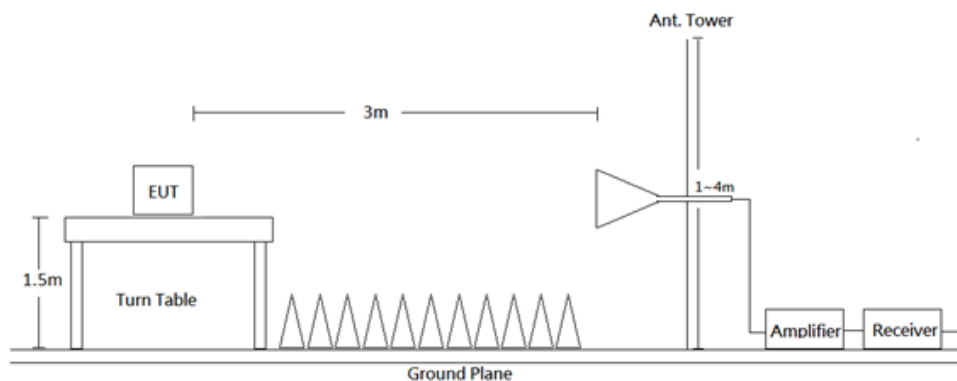
9kHz-30MHz:



30MHz-1GHz:



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
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

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:

$$\text{Correct Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Level} - \text{Limit}$$

8.6 Test Results

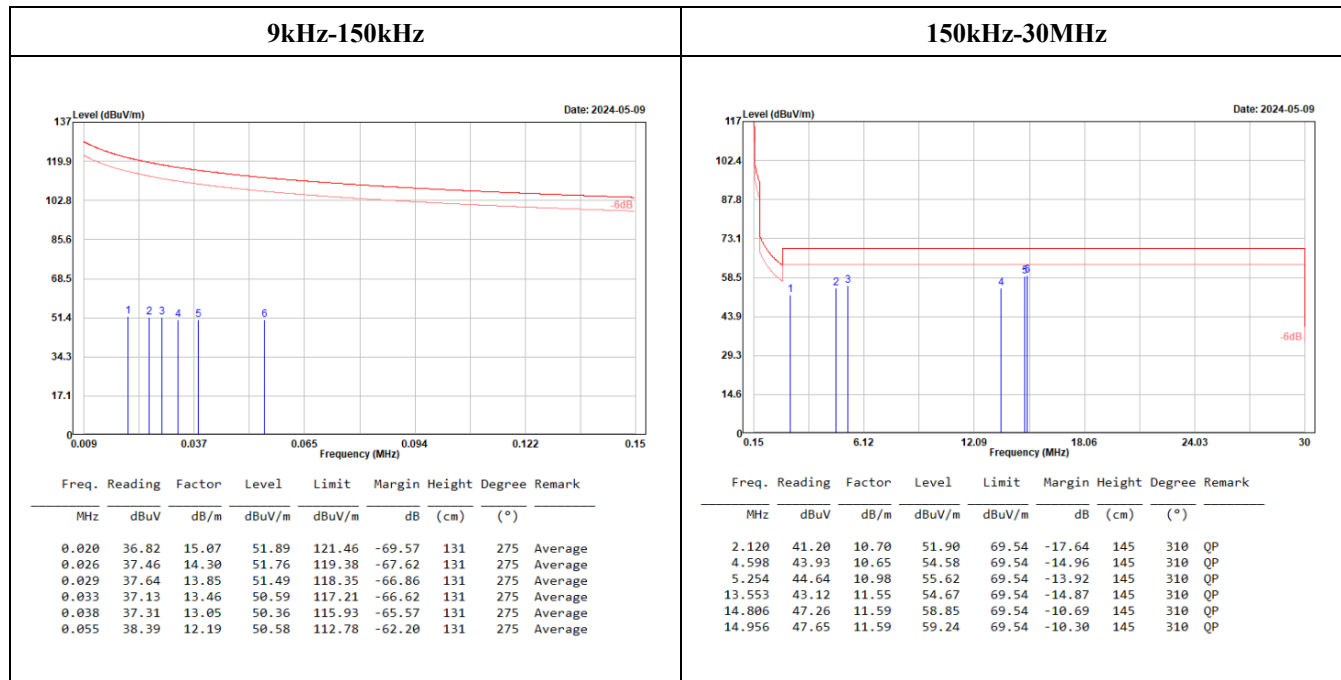
Test Mode: Transmitting

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

9kHz-30MHz:

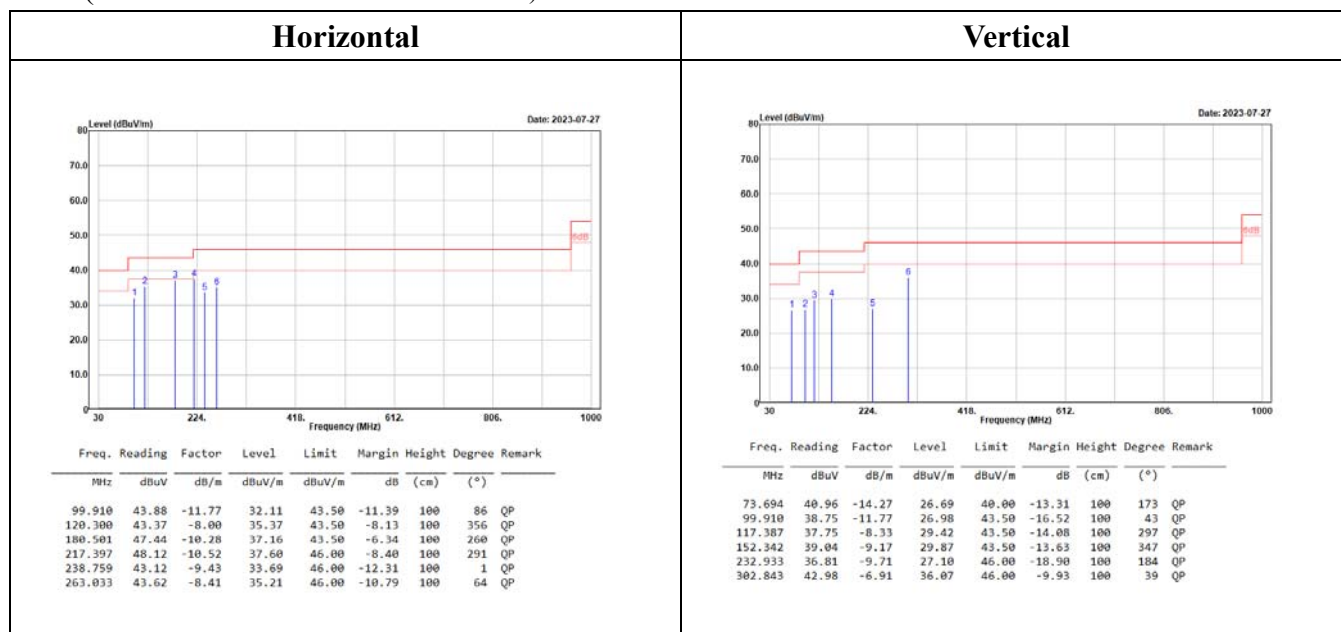
(Worst case is SRD mode middle channel)

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



30MHz-1GHz:

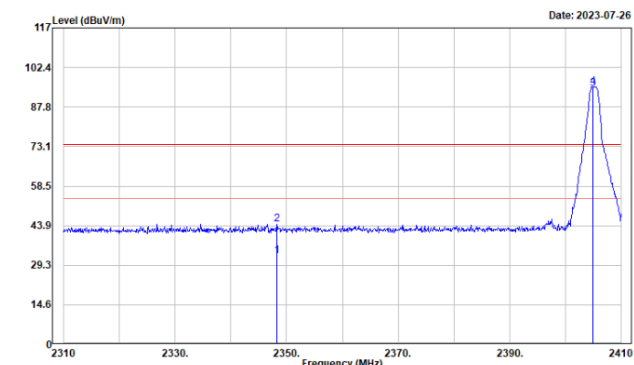
(Worst case is SRD mode middle channel)



Band-Edge:

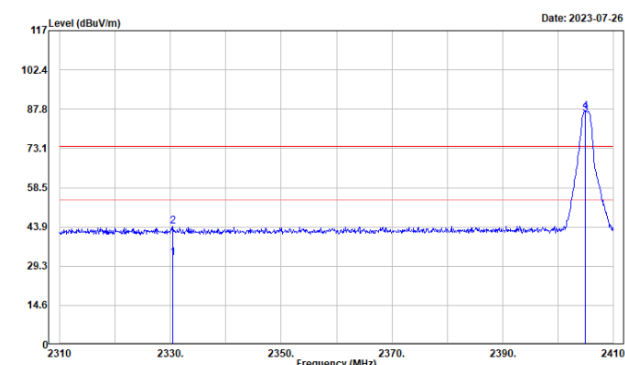
Low channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2348.238	43.91	-11.37	32.54	54.00	-21.46	118	205	Average
2348.238	55.74	-11.37	44.37	74.00	-29.63	118	205	Peak
2405.000	105.50	-11.10	94.40			118	205	Average
2405.000	106.32	-11.10	95.22			118	205	Peak

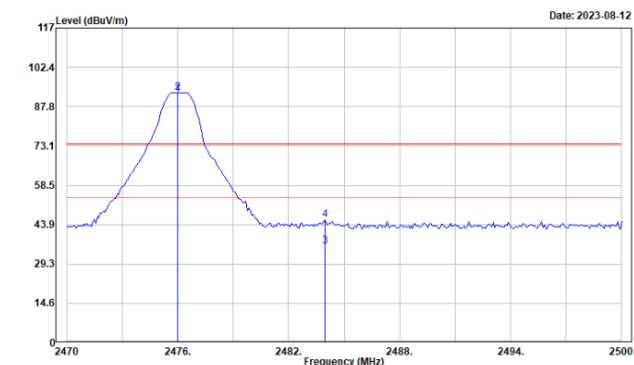
Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2330.420	43.91	-11.50	32.41	54.00	-21.59	189	215	Average
2330.420	55.66	-11.50	44.16	74.00	-29.84	189	215	Peak
2405.000	97.04	-11.10	85.94			189	215	Average
2405.000	97.85	-11.10	86.75			189	215	Peak

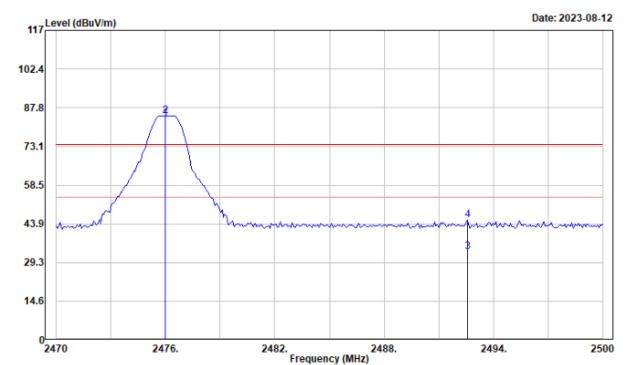
High channel

Horizontal



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2476.000	102.95	-10.70	92.25			125	203	Average
2476.000	103.74	-10.70	93.04			125	203	Peak
2483.954	46.42	-10.59	35.83	54.00	-18.17	125	203	Average
2483.954	56.23	-10.59	45.64	74.00	-28.36	125	203	Peak

Vertical



Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)	
2476.000	94.56	-10.70	83.86			211	234	Average
2476.000	95.41	-10.70	84.71			211	234	Peak
2492.573	43.74	-10.48	33.26	54.00	-20.74	211	234	Average
2492.573	55.83	-10.48	45.35	74.00	-28.65	211	234	Peak

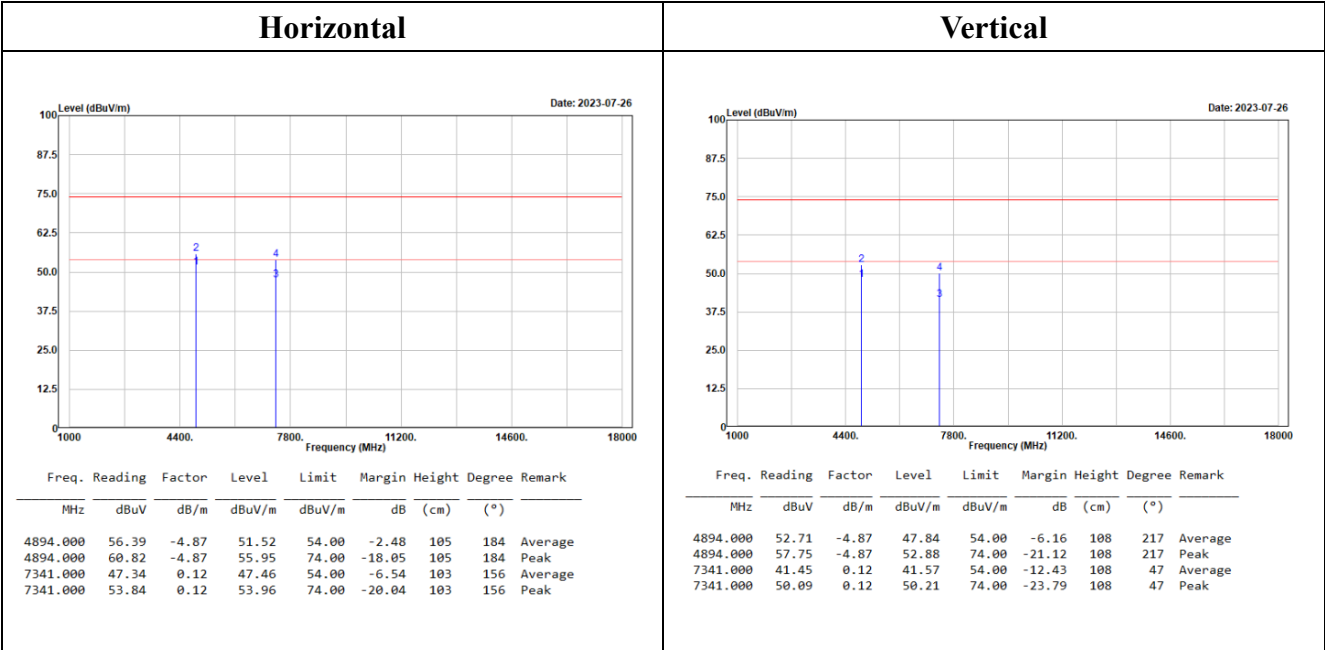
Level = Reading + Factor.

Margin = Level - Limit.

Factor = Antenna Factor + Cable Loss - Amplifier Gain

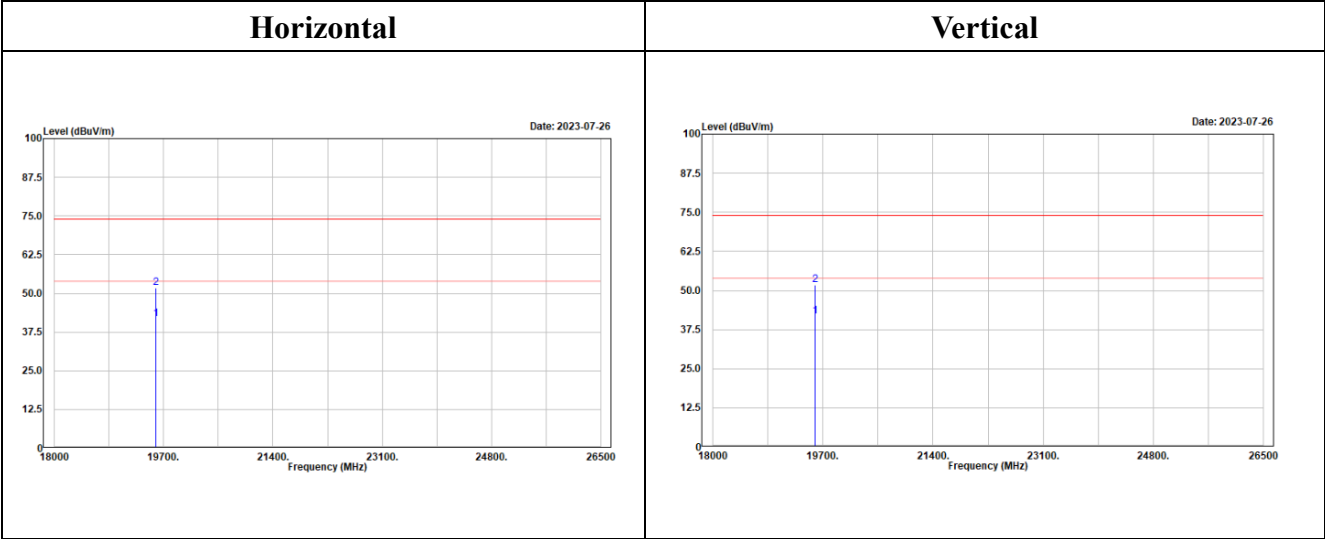
(Worst case is SRD mode middle channel)

1GHz-18GHz:



Level = Reading + Factor.
Margin = Level – Limit.
Factor = Antenna Factor + Cable Loss – Amplifier Gain

18GHz-26.5GHz:



Above 1GHz

Low channel									
Horizontal					Vertical				
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2348.238	43.91	-11.37	32.54	54.00	-21.46	118	205	Average	
2348.238	55.74	-11.37	44.37	74.00	-29.63	118	205	Peak	
2405.000	105.50	-11.10	94.40			118	205	Average	
2405.000	106.32	-11.10	95.22			118	205	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4810.000	56.14	-4.97	51.17	54.00	-2.83	108	184	Average	
4810.000	61.50	-4.97	56.53	74.00	-17.47	108	184	Peak	
7215.000	41.60	0.02	41.62	54.00	-12.38	105	262	Average	
7215.000	50.07	0.02	50.09	74.00	-23.91	105	262	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2330.420	43.91	-11.50	32.41	54.00	-21.59	189	215	Average	
2330.420	55.66	-11.50	44.16	74.00	-29.84	189	215	Peak	
2405.000	97.04	-11.10	85.94			189	215	Average	
2405.000	97.85	-11.10	86.75			189	215	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4810.000	50.99	-4.97	46.02	54.00	-7.98	106	242	Average	
4810.000	57.41	-4.97	52.44	74.00	-21.56	106	242	Peak	
7215.000	39.37	0.02	39.39	54.00	-14.61	110	265	Average	
7215.000	48.92	0.02	48.94	74.00	-25.06	110	265	Peak	

Middle channel									
Horizontal					Vertical				
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2447.000	104.06	-11.05	93.01			115	203	Average	
2447.000	104.91	-11.05	93.86			115	203	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4894.000	56.39	-4.87	51.52	54.00	-2.48	105	184	Average	
4894.000	60.82	-4.87	55.95	74.00	-18.05	105	184	Peak	
7341.000	47.34	0.12	47.46	54.00	-6.54	103	156	Average	
7341.000	53.84	0.12	53.96	74.00	-20.04	103	156	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2447.000	98.23	-11.05	87.18			284	140	Average	
2447.000	99.05	-11.05	88.00			284	140	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4894.000	52.71	-4.87	47.84	54.00	-6.16	108	217	Average	
4894.000	57.75	-4.87	52.88	74.00	-21.12	108	217	Peak	
7341.000	41.45	0.12	41.57	54.00	-12.43	108	47	Average	
7341.000	50.09	0.12	50.21	74.00	-23.79	108	47	Peak	

High channel									
Horizontal					Vertical				
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2476.000	102.95	-10.70	92.25			125	203	Average	
2476.000	103.74	-10.70	93.04			125	203	Peak	
2483.954	46.42	-10.59	35.83	54.00	-18.17	125	203	Average	
2483.954	56.23	-10.59	45.64	74.00	-28.36	125	203	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4952.000	53.85	-4.63	49.22	54.00	-4.78	150	359	Average	
4952.000	58.93	-4.63	54.30	74.00	-19.70	150	359	Peak	
7428.000	48.30	0.37	48.67	54.00	-5.33	108	288	Average	
7428.000	55.35	0.37	55.72	74.00	-18.28	108	288	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
2476.000	94.56	-10.70	83.86			211	234	Average	
2476.000	95.41	-10.70	84.71			211	234	Peak	
2492.573	43.74	-10.48	33.26	54.00	-20.74	211	234	Average	
2492.573	55.83	-10.48	45.35	74.00	-28.65	211	234	Peak	
Freq.	Reading	Factor	Level	Limit	Margin	Height	Degree	Remark	
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	(cm)	(°)		
4952.000	50.20	-4.63	45.57	54.00	-8.43	104	10	Average	
4952.000	55.80	-4.63	51.17	74.00	-22.83	104	10	Peak	
7428.000	40.75	0.37	41.12	54.00	-12.88	253	254	Average	
7428.000	48.93	0.37	49.30	74.00	-24.70	253	254	Peak	

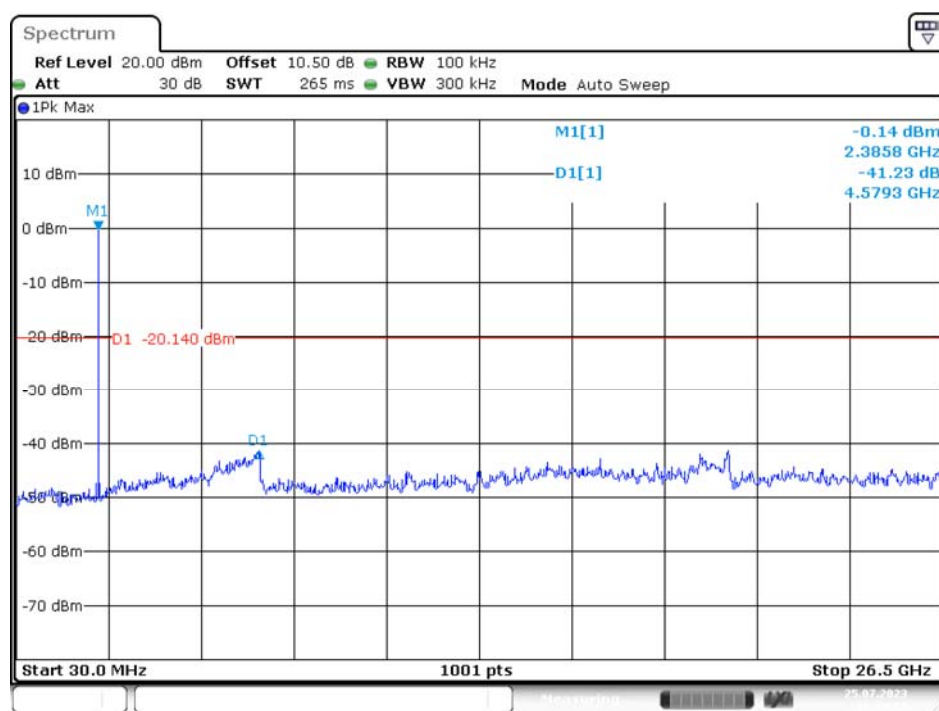
Level = Reading + Factor.

Margin = Level – Limit.

Factor = Antenna Factor + Cable Loss – Amplifier Gain.

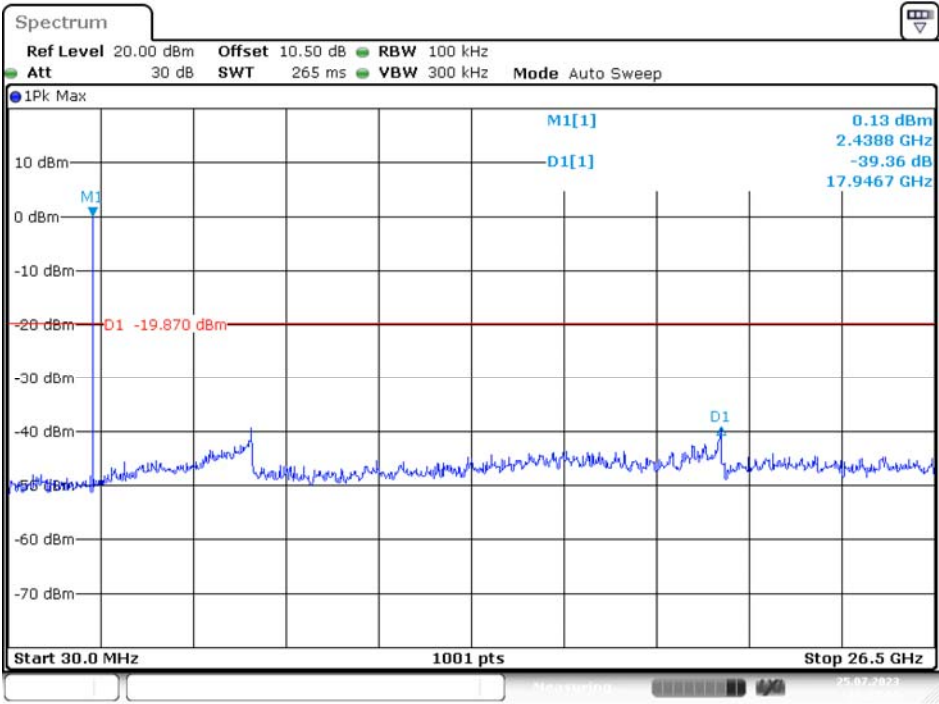
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	2405	41.23	≥ 20	PASS
Mid	2447	39.36	≥ 20	PASS
High	2476	40.72	≥ 20	PASS

Low Channel

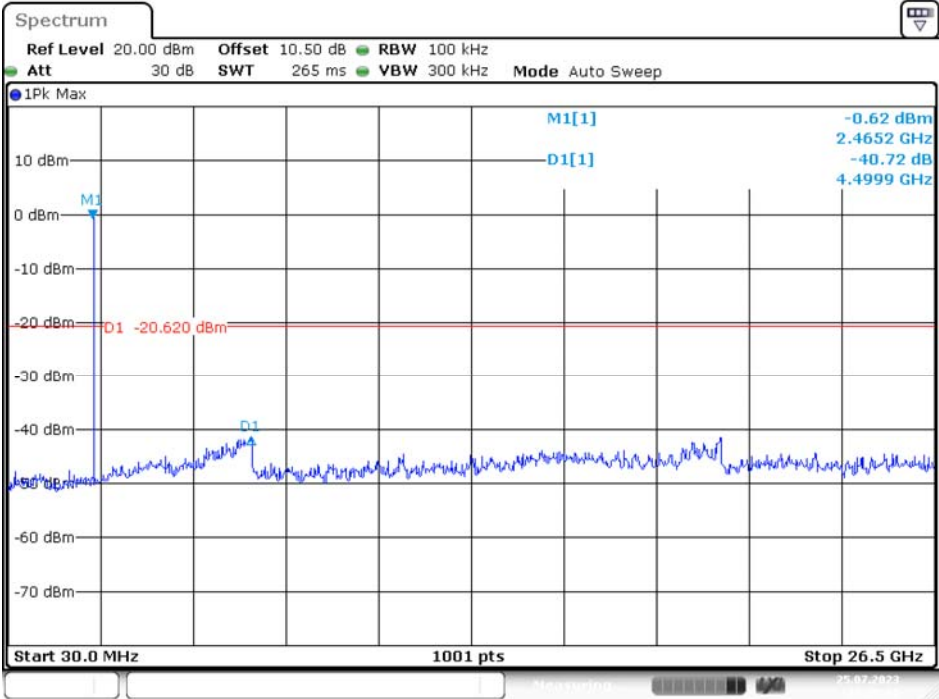
Date: 25 JUL 2023 16:19:51

Middle Channel



Date: 25.JUL.2023 16:22:41

High Channel



Date: 25.JUL.2023 16:26:42

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:

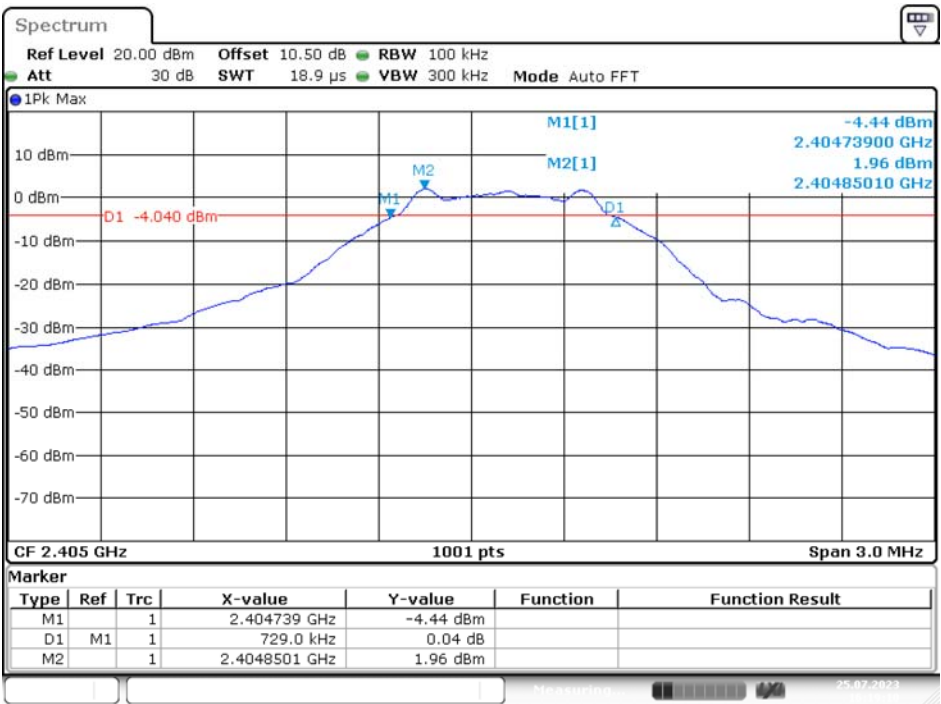
- a) Set RBW = 100 kHz.
- b) Set the VBW $\geq [3 \times \text{RBW}]$.
- c) Detector = peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost 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	2405	0.729	> 500	Compliance
Middle	2447	0.726	> 500	Compliance
High	2476	0.720	> 500	Compliance

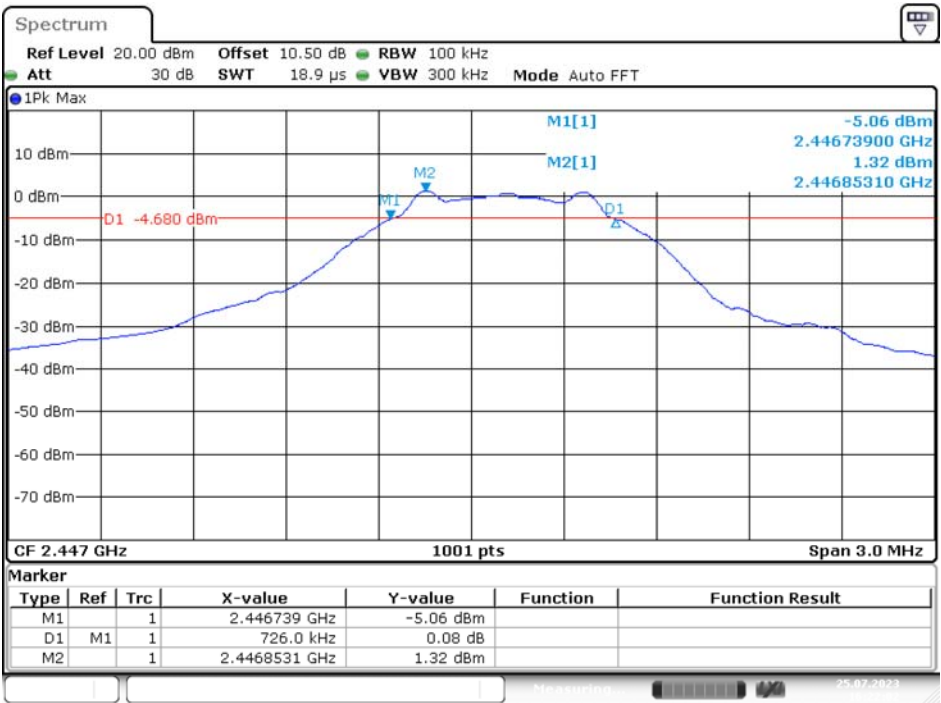
Please refer to the following plots

Low Channel



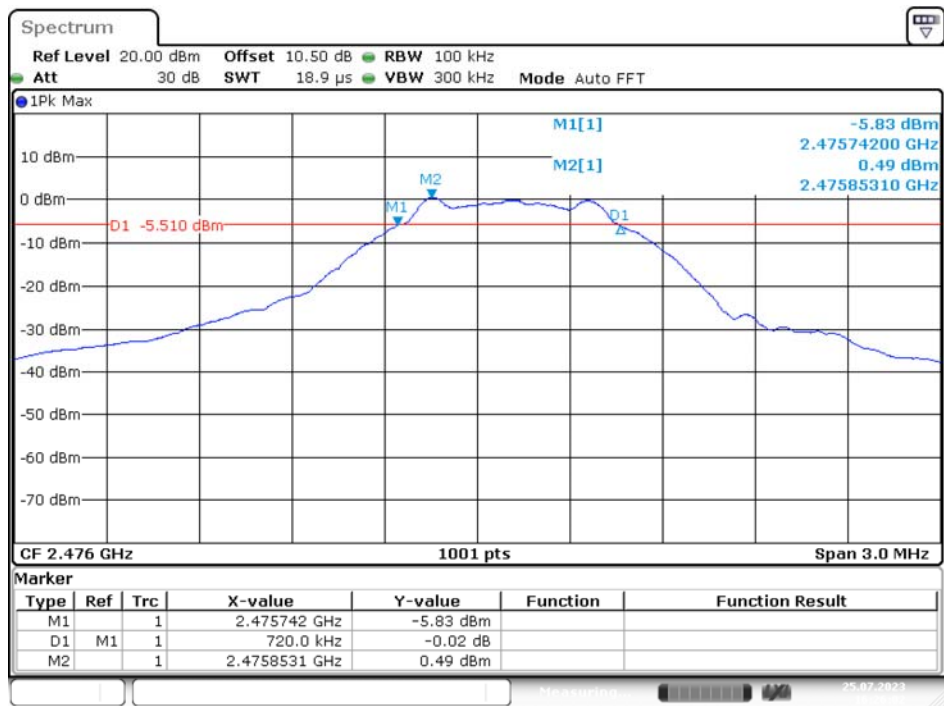
Date: 25.JUL.2023 16:19:11

Middle Channel



Date: 25.JUL.2023 16:22:02

High Channel



Date: 25 JUL 2023 16:26:02

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 (dBm)	Power (W)	Limit (W)	Result
SRD Mode					
Low	2405	3.15	0.002	1	PASS
Middle	2447	2.59	0.002	1	PASS
High	2476	1.88	0.002	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

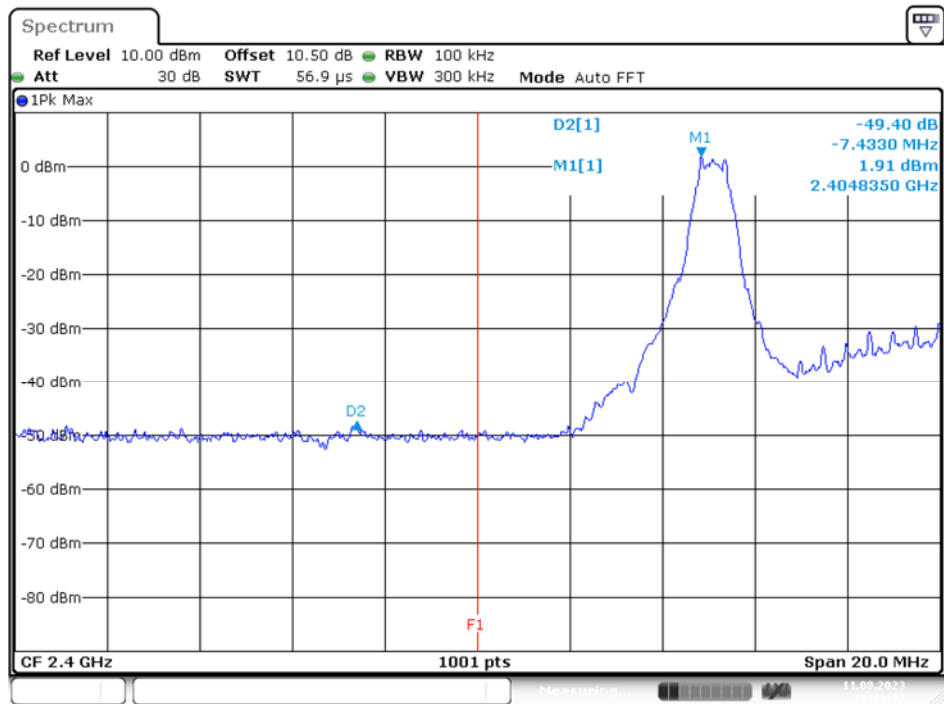
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then 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
Low	2405	49.40	≥ 20	PASS
High	2476	48.84	≥ 20	PASS

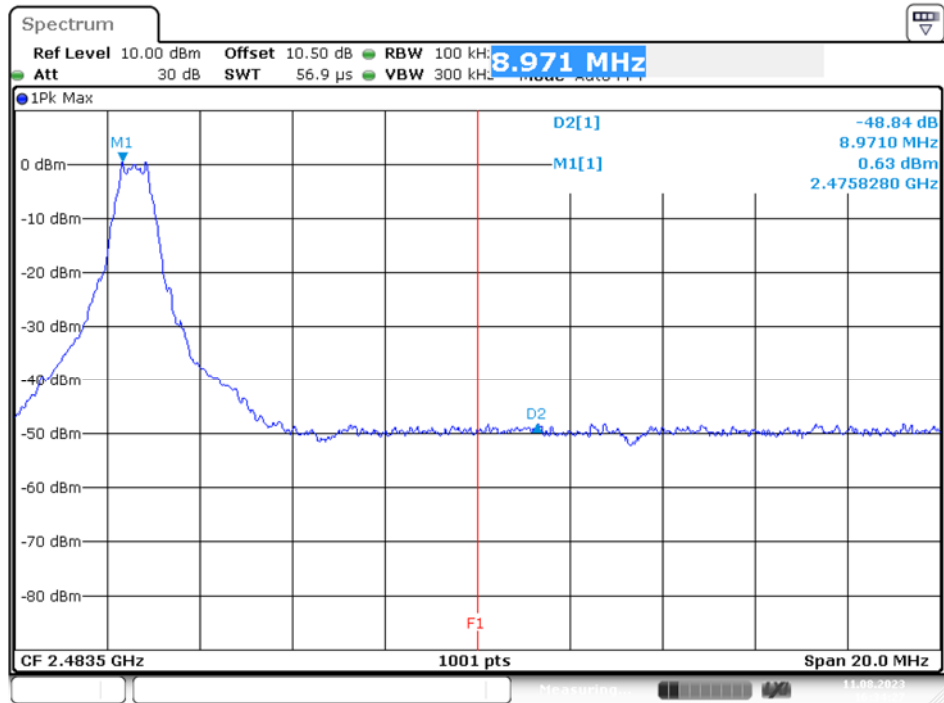
Please refer to the following plots

SRD Mode
Band Edge, Left Side



Date: 25 JUL 2023 16:20:23

Band Edge, Right Side



Date: 25 JUL 2023 16:27:26

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

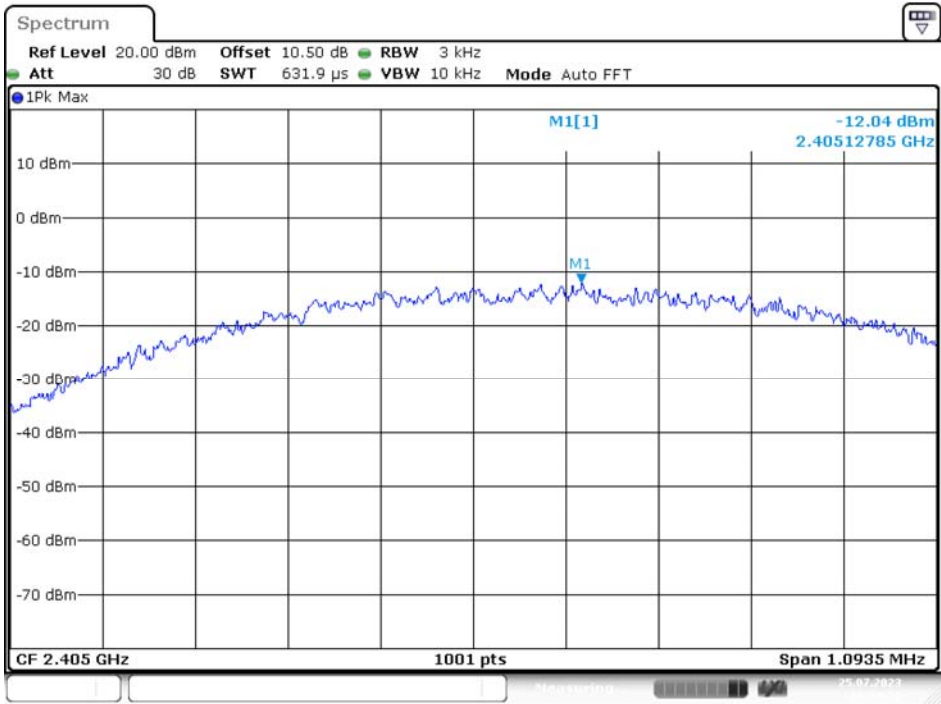
- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d) Set the VBW $\geq [3 \times \text{RBW}]$.
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace 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	2405	-12.04	8	Compliance
Middle	2447	-12.94	8	Compliance
High	2476	-13.78	8	Compliance

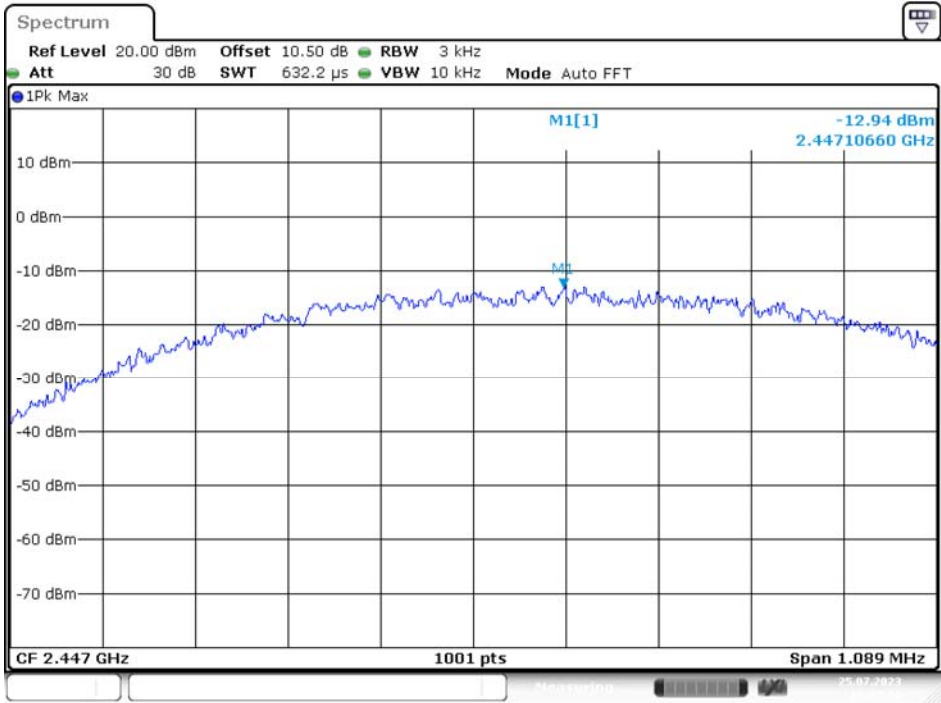
Please refer to the following plots

SRD Mode
Low Channel



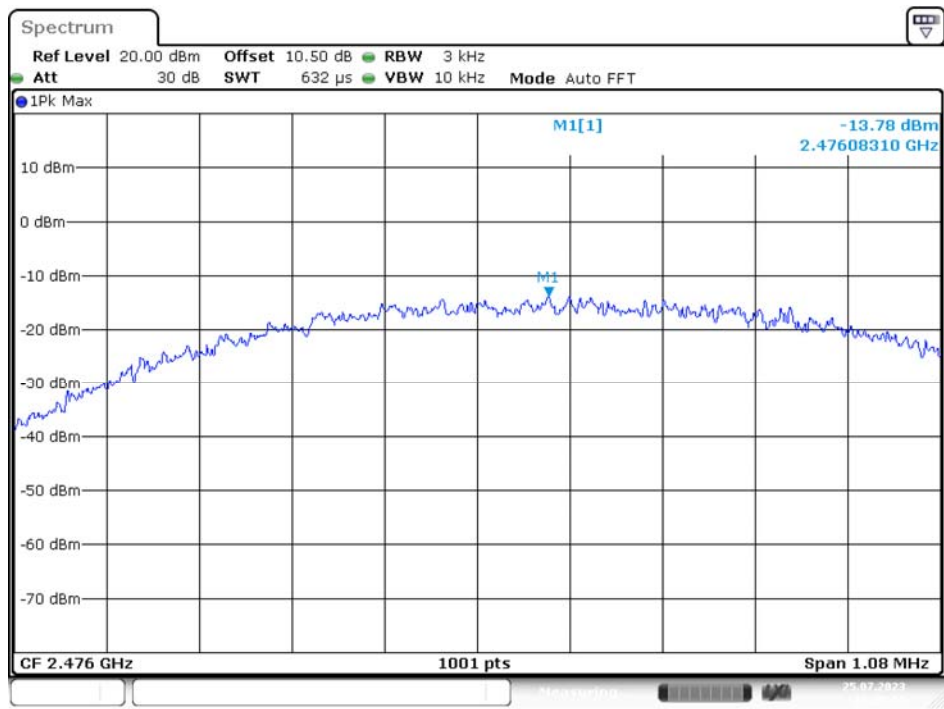
Date: 25 JUL 2023 16:19:20

Middle Channel



Date: 25 JUL 2023 16:22:11

High Channel



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