TEST REPORT

Applicant Name:	Shenzhen Jiayz photo industrial ., Ltd
Address:	A16 Building, Intelligent Terminal Industrial Park of Silicon Valley Power, Guanlan,Longhua District, Shenzhen, China
Report Number:	2401X65578E-RF-00
FCC ID:	2ARN3-121911TX

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	Wireless Microphone
Model No.:	BOYA mini-TX
Multiple Model(s) No.:	N/A
Trade Mark:	BOYA
Date Received:	2024/09/11
Issue Date:	2024/11/05

Test Result:	Pass▲

▲ In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Kungfumaster Liang
RF Engineer

Approved By:

Nancy Wang
RF Supervisor

Note: The information marked # is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report. Customer model name, addresses, names, trademarks etc. are included.

This report may contain data that are not covered by the NVLAP accreditation and are marked with an asterisk "▼".

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	2401X65578E-RF-00	Original Report	2024/11/05

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Wireless Microphone
Tested Model	BOYA mini-TX
Multiple Model(s)	N/A
Frequency Range	2402-2480MHz
Maximum conducted peak output power	4.68dBm
Modulation Technique	GFSK
Antenna Specification#	-0.63dBi (provided by the applicant)
Voltage Range	DC 3.8V from Battery or DC 5V from Charging Contacts
Sample serial number	2RL7-2 for RF Conducted Test 2RL7-1 for Radiated Emissions (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	N/A

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.209 and 15.247 rules.

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.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Frequency		213.55 Hz(k=2, 95% level of confidence)
RF output power, conducted		0.72 dB(k=2, 95% level of confidence)
Unwanted Emission, conducted		1.75 dB(k=2, 95% level of confidence)
AC Power Lines Conducted Emissions	9 kHz~150 KHz	3.94dB(k=2, 95% level of confidence)
	150 kHz ~30MHz	3.84dB(k=2, 95% level of confidence)
Radiated Emissions	9kHz - 30MHz	3.30dB(k=2, 95% level of confidence)
	30MHz~200MHz (Horizontal)	4.48dB(k=2, 95% level of confidence)
	30MHz~200MHz (Vertical)	4.55dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Horizontal)	4.85dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Vertical)	5.05dB(k=2, 95% level of confidence)
	1GHz - 6GHz	5.35dB(k=2, 95% level of confidence)
	6GHz - 18GHz	5.44dB(k=2, 95% level of confidence)
	18GHz - 40GHz	5.16dB(k=2, 95% level of confidence)
Temperature		±1℃
Humidity		±1%
Supply voltages		±0.4%

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.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 715558, the FCC Designation No. : CN5045.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

Channel list[#]

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	40	2442
1	2403	41	2443
2	2404	42	2444
…	…	…	…
…	…	…	…
36	2438	75	2477
37	2439	76	2478
38	2440	77	2479
39	2441	78	2480

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

"FCC_assist 1.0.4"[#] exercise software was used and the power level is 10[#]. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

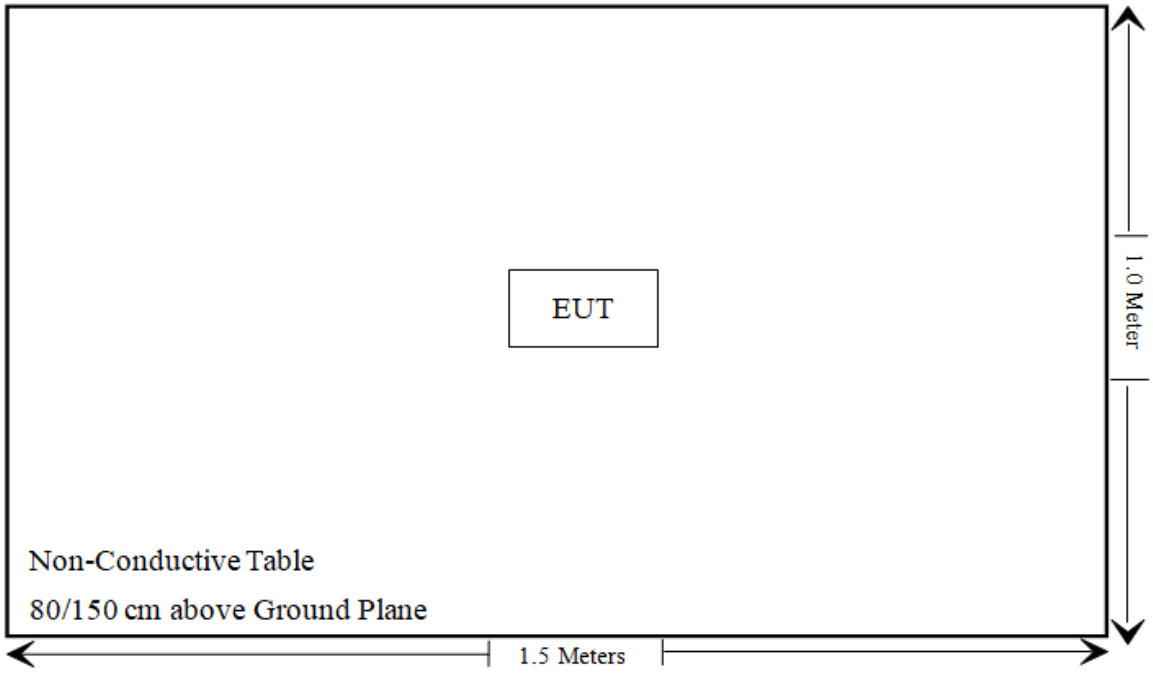
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From/Port	To
/	/	/	/

Block Diagram of Test Setup

For Radiated Emissions:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC§15.247 (i), §1.1307 (b) (1) &§2.1093	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Not Applicable
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	20dBEmission Bandwidth&99% Occupied Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
§15.247(b)(1)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

Not Applicable, the device was powered by battery when operating.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESR3	102455	2024/01/16	2025/01/15
Sonoma instrument	Pre-amplifier	310 N	186238	2024/05/21	2025/05/20
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2023/07/20	2026/07/19
Unknown	Cable	Chamber A Cable 1	N/A	2024/06/18	2025/06/17
Unknown	Cable	XH500C	J-10M-A	2024/06/18	2025/06/17
BACL	Active Loop Antenna	1313-1A	4031911	2024/05/14	2027/05/13
Unknown	Cable	2Y194	0735	2024/05/21	2025/05/20
Unknown	Cable	PNG214	1354	2024/05/21	2025/05/20
Audix	EMI Test software	E3	19821b(V9)	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40	101605	2024/03/27	2025/03/26
COM-POWER	Pre-amplifier	PA-122	181919	2024/06/18	2025/06/17
Schwarzbeck	Horn Antenna	BBHA9120D (1201)	1143	2023/07/26	2026/07/25
Unknown	RF Cable	KMSE	735	2024/06/18	2025/06/17
Unknown	RF Cable	UFA147	219661	2024/06/18	2025/06/17
Unknown	RF Cable	XH750A-N	J-10M	2024/06/18	2025/06/17
JD	Multiplex Switch Test Control Set	DT7220FSU	DQ77926	2024/06/18	2025/06/17
A.H.System	Pre-amplifier	PAM-1840VH	190	2024/06/18	2025/06/17
Electro-Mechanics Co	Horn Antenna	3116	2026	2023/09/18	2026/09/17
UTIFLEX	RF Cable	NO. 13	232308-001	2024/06/18	2025/06/17
Audix	EMI Test software	E3	191218(V9)	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200982	2023/12/18	2024/12/17
MARCONI	10dB Attenuator	6534/3	2942	2024/06/27	2025/06/26

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i)&§1.1307 (b) &§2.1093 - RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Measurement Result

Mode	Frequency (MHz)	Max tune-up conducted power# (dBm)	Max tune-up conducted power# (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
GFSK	2402-2480	5.0	3.16	5	1.0	3.0	**Yes**

Result: Compliant

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 use of a standard antenna jack or electrical connector is prohibited.

Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Antenna Connector Construction

The EUT has a FPC antenna arrangement which was permanently attached and the antenna gain[#] is -0.63dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant

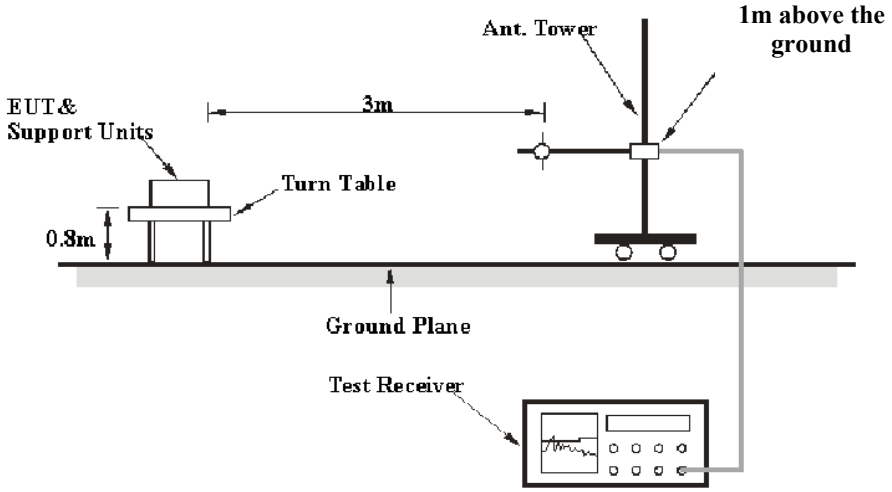
FCC §15.205, §15.209&§15.247(d) – RADIATED EMISSIONS

Applicable Standard

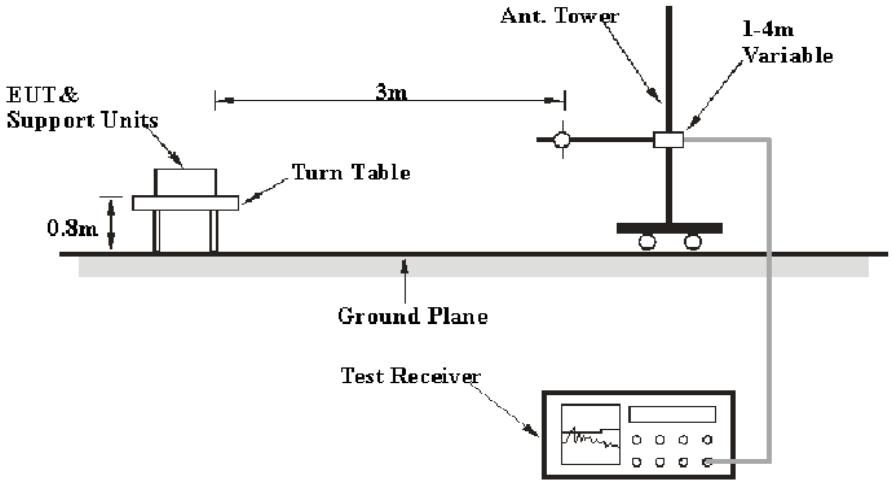
FCC §15.205; §15.209; §15.247(d)

EUT Setup

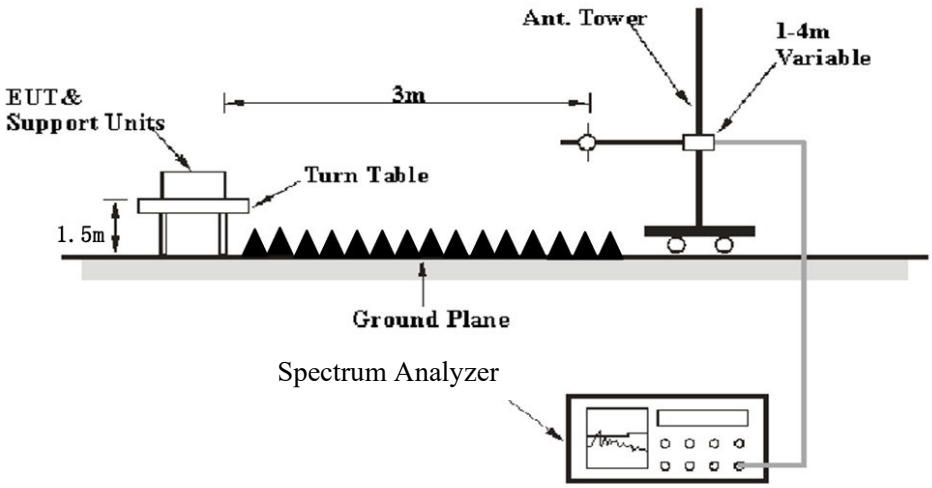
9 kHz-30MHz:



30MHz-1GHz:



Above 1GHz:



The radiated emission tests were performed in the 3meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver &Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
9 kHz – 150 kHz	/	/	200 Hz	QP
	300 Hz	1 kHz	/	PK
150 kHz – 30 MHz	/	/	9 kHz	QP
	10 kHz	30 kHz	/	PK
30 MHz – 1000 MHz	/	/	120 kHz	QP
	100 kHz	300 kHz	/	PK
Above 1 GHz	Harmonics & Band Edge			
	1MHz	3 MHz	/	PK
	Average Emission Level=Peak Emission Level+20*log(Duty cycle)			
	Other Emissions			
	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Average

For Duty cycle measurement:

Use the duty cycle factor correction factor method per 15.35(c).
Duty cycle=On time/100milliseconds, On time=N1*L1+N2*L2+…Nn-1*Ln-1+Nn*Ln,
Where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc.

Test Procedure

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

All final data was recorded in Quasi-peak detection mode except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz, average detection modes for frequency bands 9–90 kHz and 110–490 kHz, peak and average detection modes for frequencies above 1 GHz.

For 9 kHz-30MHz, the report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB.

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

All emissions under the average limit and under the noise floor have not recorded in the report.

Factor & Over Limit/Margin Calculation

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

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Margin/Over Limit = Corrected Amplitude/Level-Limit
Corrected Amplitude/Level = Reading + Factor

Test Data

Environmental Conditions

Temperature:	22~25 ℃
Relative Humidity:	50~54 %
ATM Pressure:	101.0 kPa

The testing was performed by Anson Su on 2024-09-26 for below 1GHz and Zenos Qiao and Dylan Yang from 2024-09-27 to 2024-10-29 for above 1GHz.

EUT operation mode: Transmitting

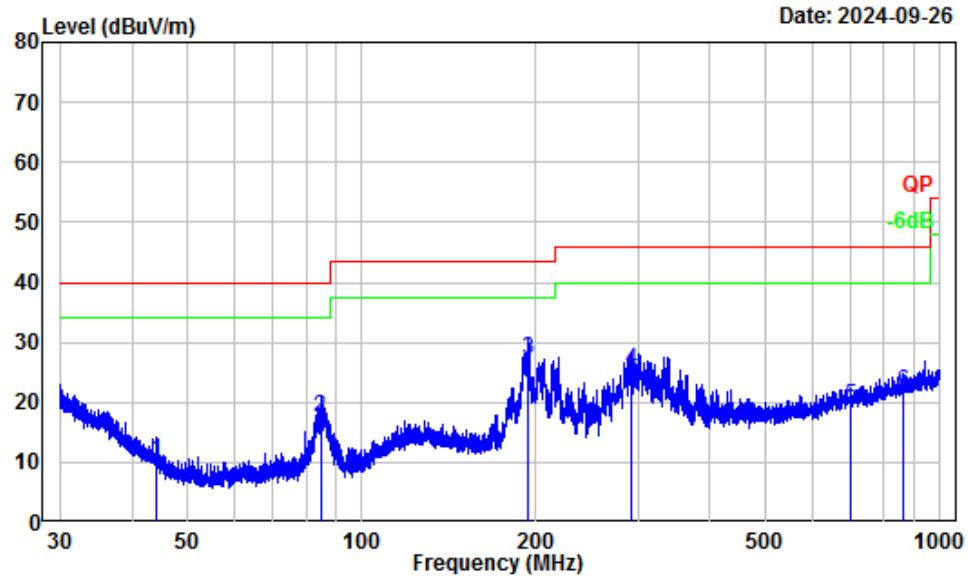
Note: Pre-scan in the X, Y and Z axes of orientation, the worst case Z-axis of orientation was recorded.

9 kHz-30MHz: *(Maximum output power mode, High channel)*

The amplitude of spurious emissions attenuated more than 20 dB below the limit was not recorded.

30MHz-1GHz: *(Maximum output power mode, High channel)*

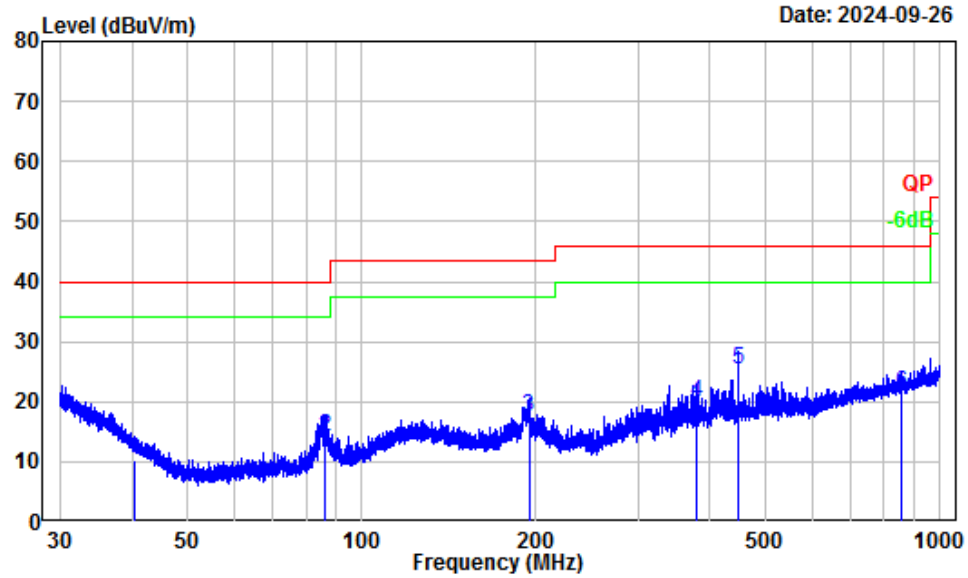
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401X65578E-RF
Test Mode : Transmitting
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	44.24	-16.20	26.50	10.30	40.00	-29.70	QP
2	84.74	-18.76	36.15	17.39	40.00	-22.61	QP
3	194.11	-12.87	40.11	27.24	43.50	-16.26	QP
4	291.67	-12.93	38.19	25.26	46.00	-20.74	QP
5	699.61	-6.61	25.94	19.33	46.00	-26.67	QP
6	861.92	-4.00	25.81	21.81	46.00	-24.19	QP

Vertical



Site : Chamber A
Condition : 3m Vertical
Project Number: 2401X65578E-RF
Test Mode : Transmitting
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.36	-13.45	23.70	10.25	40.00	-29.75	QP
2	86.12	-18.76	33.04	14.28	40.00	-25.72	QP
3	194.45	-12.83	30.28	17.45	43.50	-26.05	QP
4	378.92	-11.48	31.33	19.85	46.00	-26.15	QP
5	447.20	-9.82	35.29	25.47	46.00	-20.53	QP
6	860.41	-4.00	25.58	21.58	46.00	-24.42	QP

Above 1GHz:

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/AV					
Low Channel(2402MHz)							
2381.30	59.06	PK	H	-3.19	55.87	74	-18.13
2381.05	55.30	PK	V	-3.19	52.11	74	-21.89
4804.00	49.47	PK	H	2.42	51.89	74	-22.11
4804.00	48.66	PK	V	2.42	51.08	74	-22.92
Middle Channel(2441MHz)							
4882.00	48.78	PK	H	2.58	51.36	74	-22.64
4882.00	48.35	PK	V	2.58	50.93	74	-23.07
High Channel(2480MHz)							
2483.61	61.79	PK	H	-3.17	58.62	74	-15.38
2483.50	58.42	PK	V	-3.17	55.25	74	-18.75
4960.00	49.26	PK	H	2.68	51.94	74	-22.06
4960.00	48.75	PK	V	2.68	51.43	74	-22.57

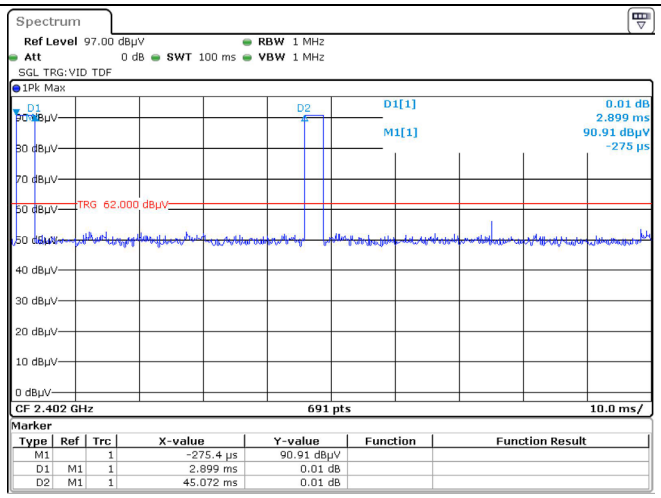
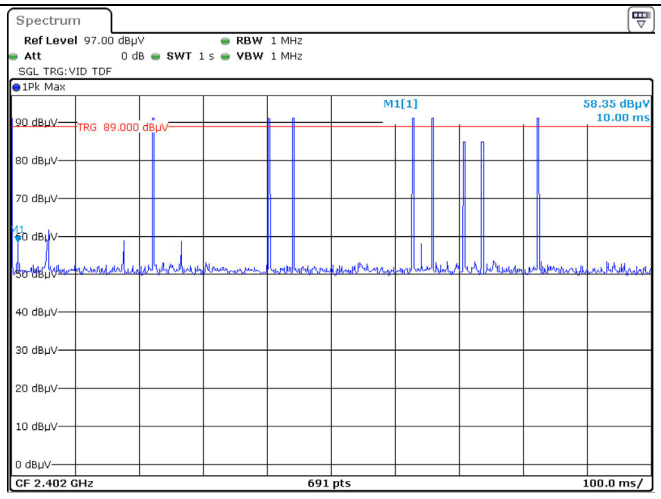
Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude/Level = Corrected Factor + Reading
Margin = Corrected Amplitude/Level - Limit
Other emissions which were more than 20dB below limit or on noise floor level was not recorded.

Field Strength of Average							
Frequency (MHz)	**Peak Measurement @3m (dBµV/m)**	**Polar (H/V)**	**Duty Cycle Corrected Factor (dB)**	**Average Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Comment**
Low Channel 2402MHz							
2381.30	55.87	H	-24.73	31.14	54	-22.86	Bandedge
2381.05	52.11	V	-24.73	27.38	54	-26.62	Bandedge
4804.00	51.89	H	-24.73	27.16	54	-26.84	Harmonic
4804.00	51.08	V	-24.73	26.35	54	-27.65	Harmonic
Middle Channel 2441MHz							
4882.00	51.36	H	-24.73	26.63	54	-27.37	Harmonic
4882.00	50.93	V	-24.73	26.20	54	-27.80	Harmonic
High Channel 2480MHz							
2483.61	58.62	H	-24.73	33.89	54	-20.11	Bandedge
2483.50	55.25	V	-24.73	30.52	54	-23.48	Bandedge
4960.00	51.94	H	-24.73	27.21	54	-26.79	Harmonic
4960.00	51.43	V	-24.73	26.70	54	-27.30	Harmonic

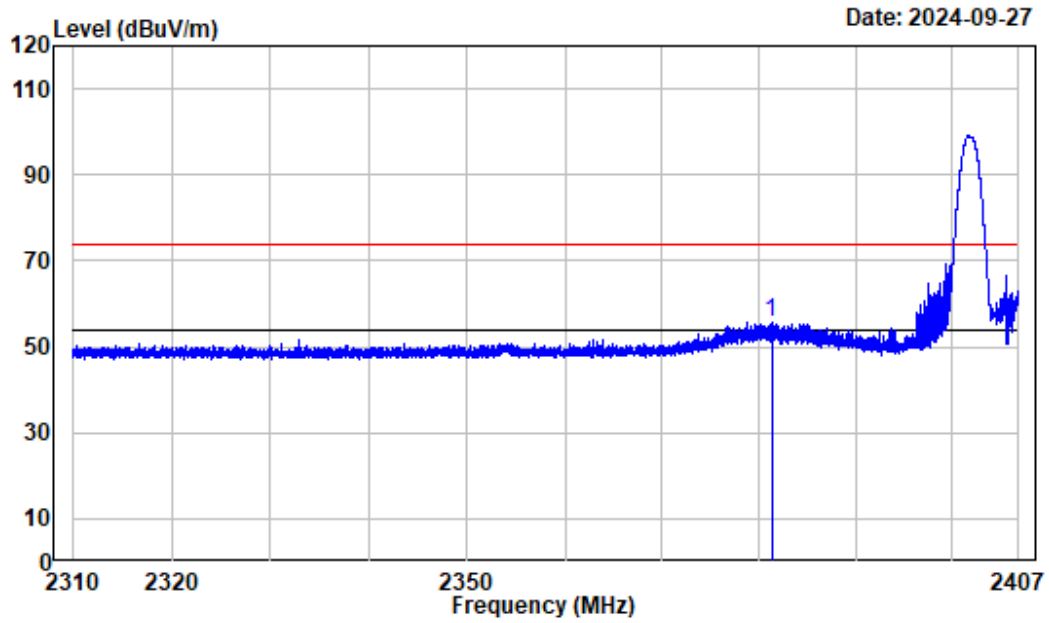
Note: Average level= Peak level+ Duty Cycle Corrected Factor
Margin = Average level- Limit

Worst case duty cycle:
Duty Cycle = Ton/100ms = 2.899*2/100=0.05798
Duty Cycle Corrected Factor = 20lg (Duty Cycle) = 20lg0.05798 = -24.73

Duty Cycle (100ms)	
Duty Cycle (1s)	

Test plots for Band Edge Measurements (Radiated):

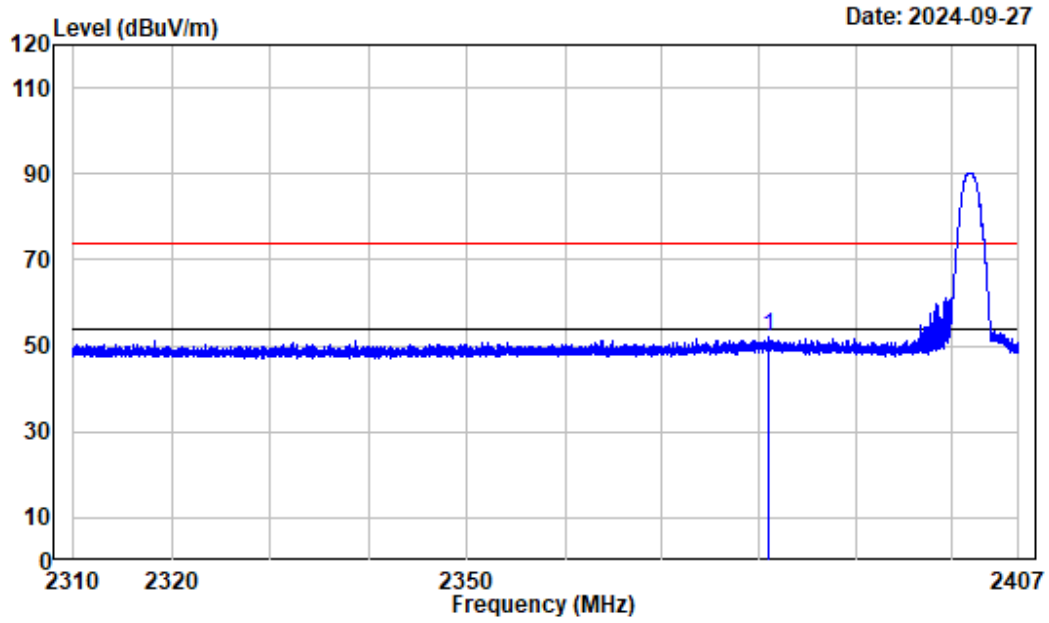
Test Channel:	2402MHz	Ant. Polar. :	Horizontal



Condition : Horizontal
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2402

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2381.295	-3.19	59.06	55.87	74.00	-18.13	Peak

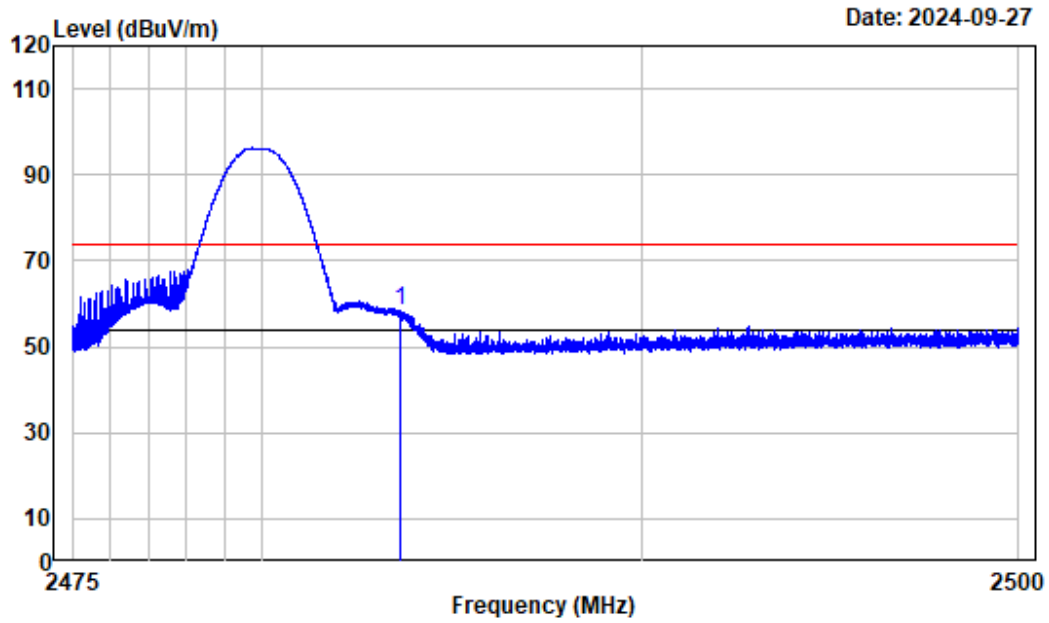
Test Channel:	2402MHz	Ant. Polar. :	Vertical



Condition : Vertical
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2402

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2381.052	-3.19	55.30	52.11	74.00	-21.89	Peak

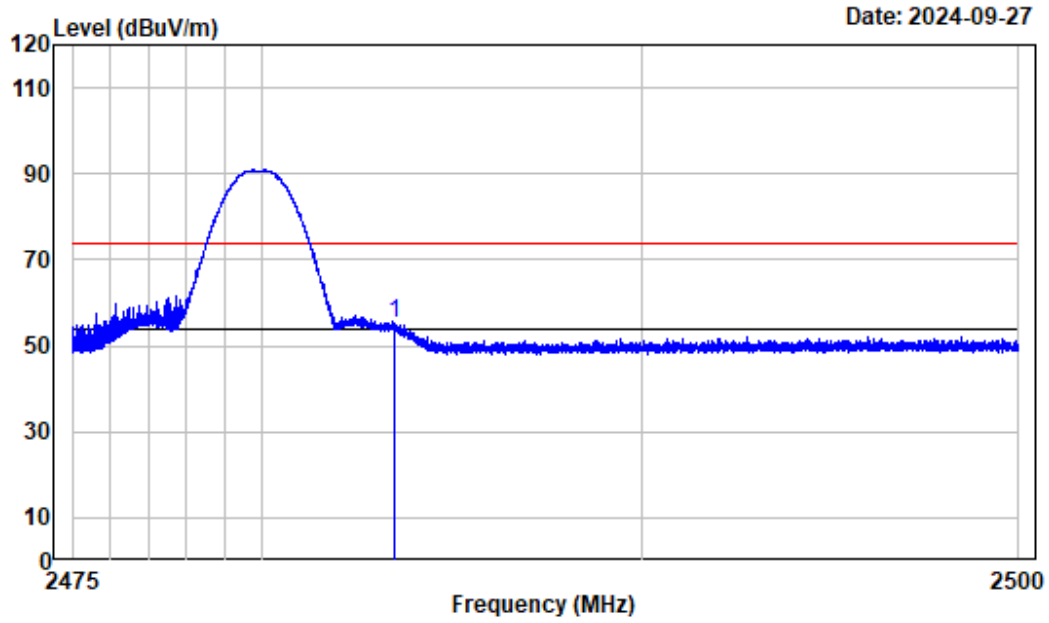
Test Channel:	2480MHz	Ant. Polar. :	Horizontal



Condition : Horizontal
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2483.613	-3.17	61.79	58.62	74.00	-15.38	Peak

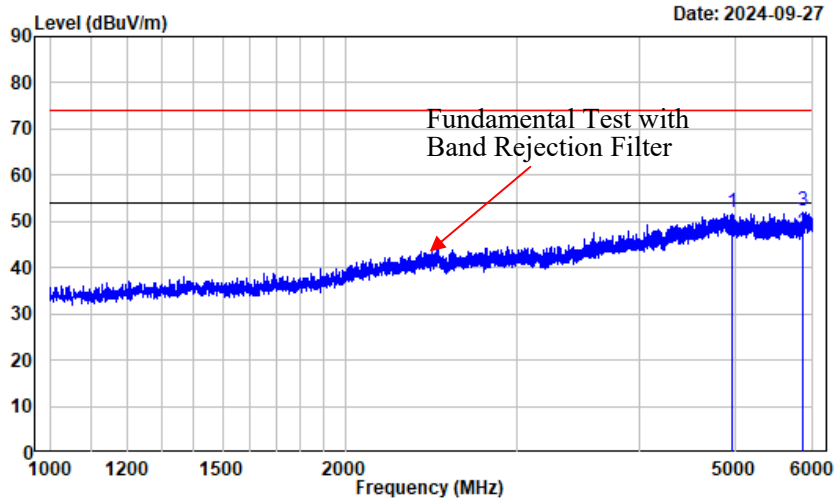
Test Channel:	2480MHz	Ant. Polar. :	Vertical



Condition : Vertical
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2483.500	-3.17	58.42	55.25	74.00	-18.75	Peak

Test plots for Harmonic and Emissions Measurements (Worst case, High channel):

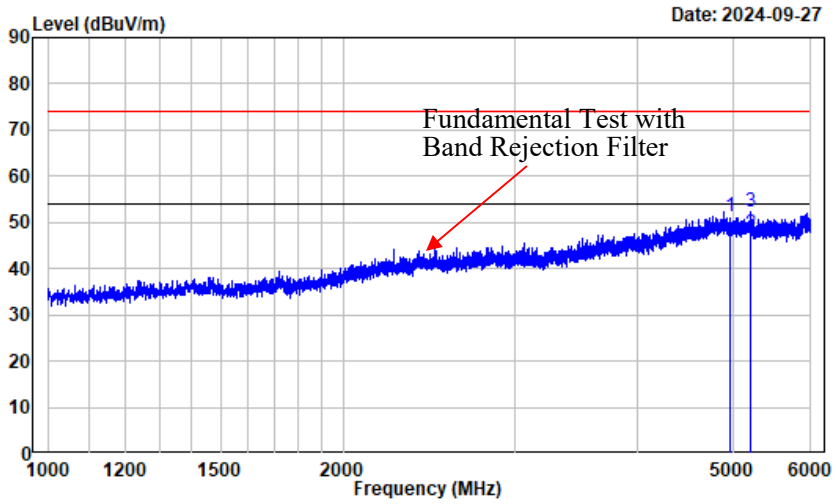
Horizontal	
1-6GHz	

Condition : Horizontal
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.68	49.26	51.94	74.00	-22.06	Peak
2	5855.625	3.70	43.78	47.48	54.00	-6.52	Average
3	5855.625	3.70	48.76	52.46	74.00	-21.54	Peak

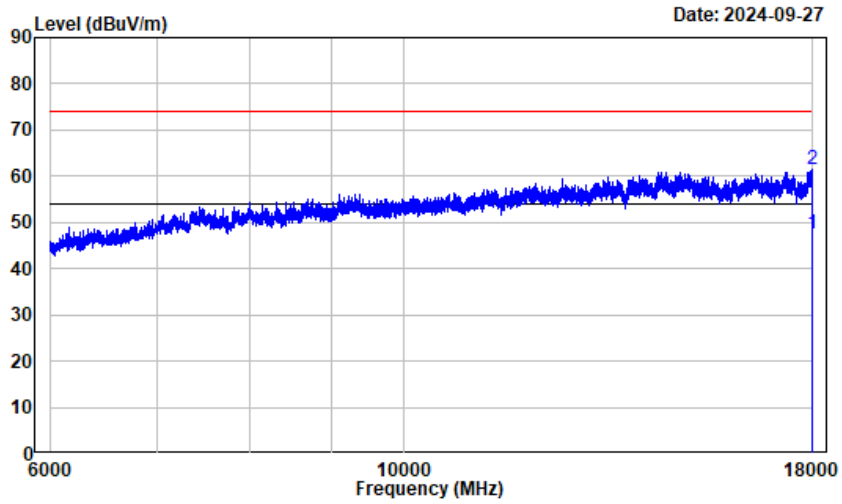
Vertical

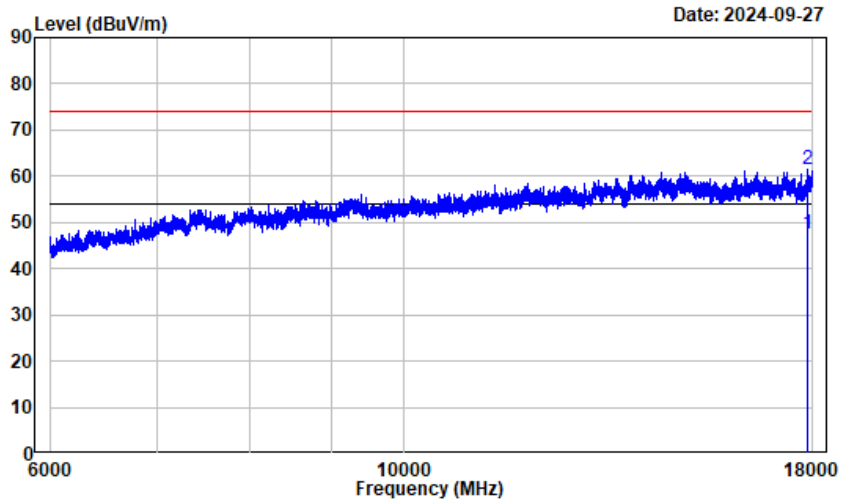
1-6GHz



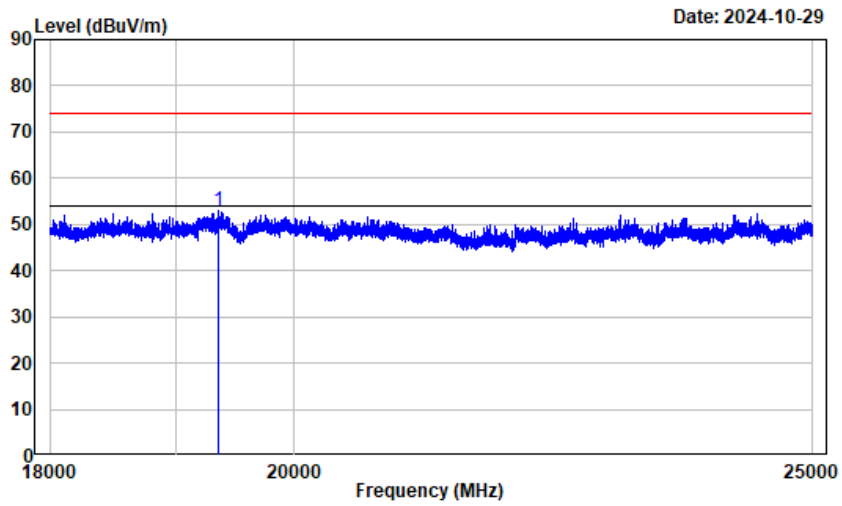
Condition : Vertical
Project No.: 2401X65578E-RF
Tester : Zenos Qiao
Note : 2.4G FHSS-2480

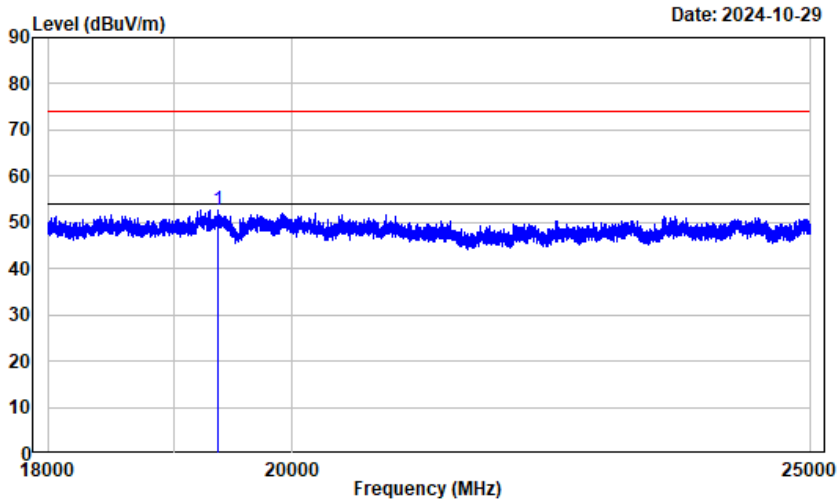
	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.68	48.75	51.43	74.00	-22.57	Peak
2	5210.000	3.05	44.34	47.39	54.00	-6.61	Average
3	5210.000	3.05	49.15	52.20	74.00	-21.80	Peak

Horizontal	
6-18GHz	 Condition : Horizontal Project No.: 2401X65578E-RF Tester : Zenos Qiao Note : 2.4G FHSS-2480 Freq / Factor / Read Level / Level / Limit Line / Over Limit / Remark MHz / dB/m / dBuV / dBuV/m / dBuV/m / dB 1 17997.000 24.60 23.10 47.70 54.00 -6.30 Average 2 17997.000 24.60 37.00 61.60 74.00 -12.40 Peak

Vertical	
6-18GHz	 Condition : Vertical Project No.: 2401X65578E-RF Tester : Zenos Qiao Note : 2.4G FHSS-2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	17874.000	23.49	24.09	47.58	54.00	-6.42	Average
2	17874.000	23.49	38.02	61.51	74.00	-12.49	Peak

Horizontal	
18-25GHz	 Condition : Horizontal Project No.: 2401X65578E-RF Tester : Dylan.Yang Note : 2.4G FHSS_2480 Freq / Factor / Read Level / Limit Level / Limit Line / Over Limit / Remark MHz / dB/m / dBuV / dBuV/m / dBuV/m / dB 1 19356.420 15.13 37.72 52.85 74.00 -21.15 Peak

Vertical	
18-25GHz	 Condition : Vertical Project No.: 2401X65578E-RF Tester : Dylan.Yang Note : 2.4G FHSS_2480 Freq / Factor / Read Level / Limit Level / Limit Line / Over Limit / Remark MHz / dB/m / dBuV / dBuV/m / dBuV/m / dB 1 19370.420 15.12 37.66 52.78 74.00 -21.22 Peak

FCC §15.247(a) (1) - CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

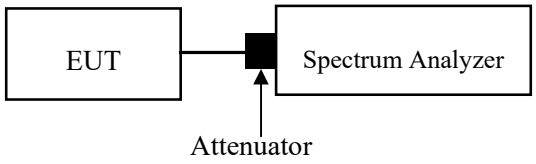
Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.2

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined.



Note: The limit is 2/3*20 dB bandwidth

Test Data

Environmental Conditions

Temperature:	27 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

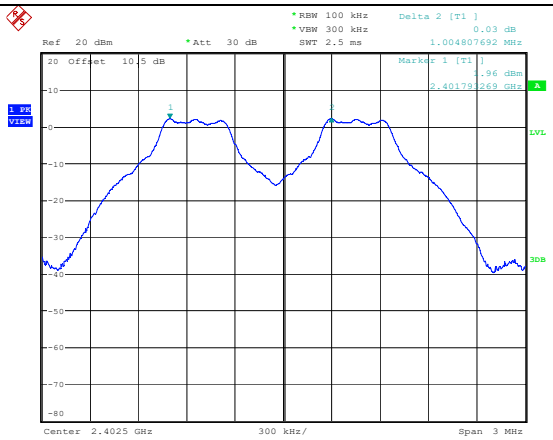
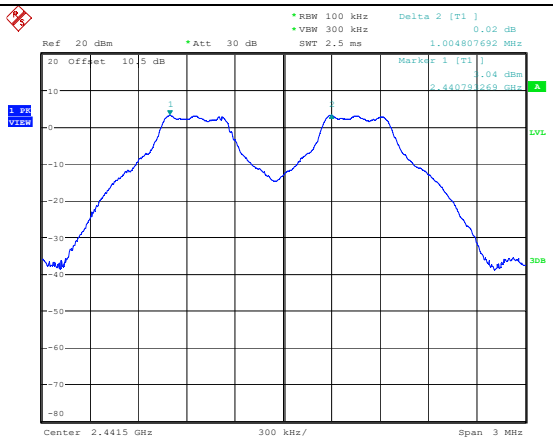
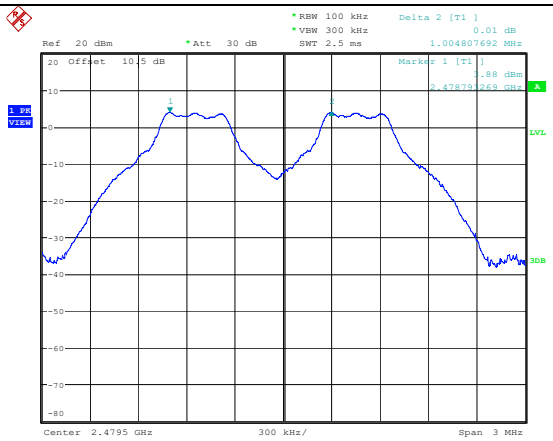
The testing was performed by Brian Li on 2024-10-17.

EUT operation mode: Transmitting

Test Result: Compliant

Test Channel	Test Frequency (MHz)	Channel Separation (MHz)	Limits (MHz)
Low	2402	1.005	0.594
Middle	2441	1.005	0.594
High	2480	1.005	0.590

Please refer to the below plots:

Low Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:57:45
Middle Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 03:00:21
High Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 03:02:35

FCC §15.247(a) (1) - 20dBEMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

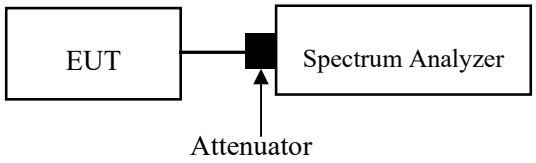
g) Determine the reference value: Set the EUT to transmit an un-modulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an un-modulated carrier, then turn the EUT modulation on, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "− xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "− xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).



Test Data

Environmental Conditions

Temperature:	27 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

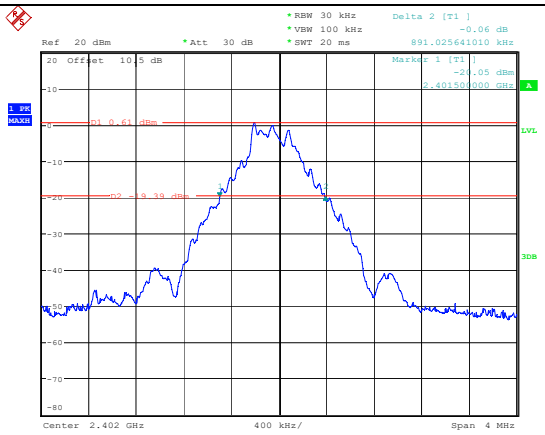
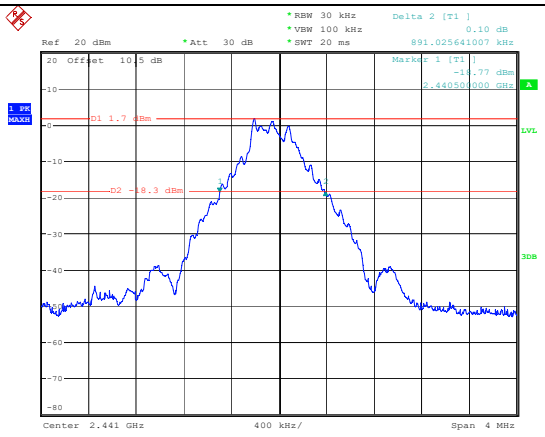
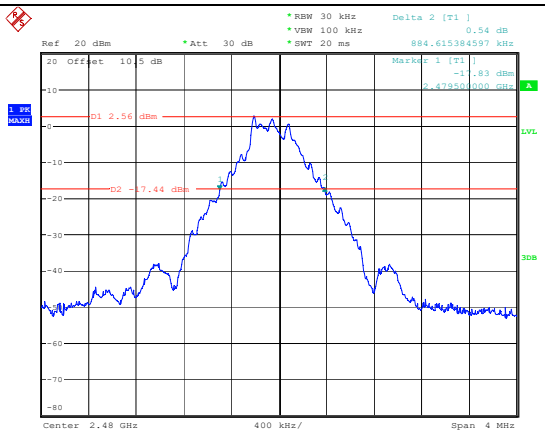
The testing was performed by Brian Li on 2024-10-17.

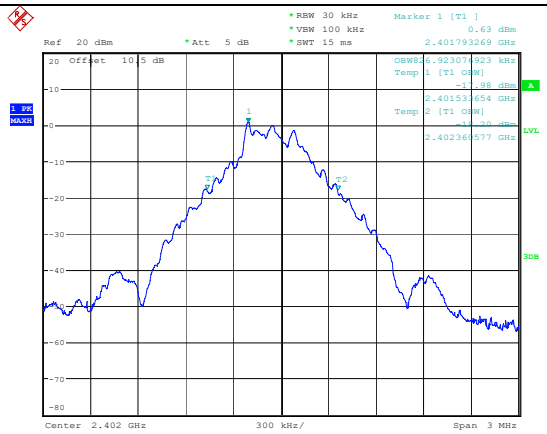
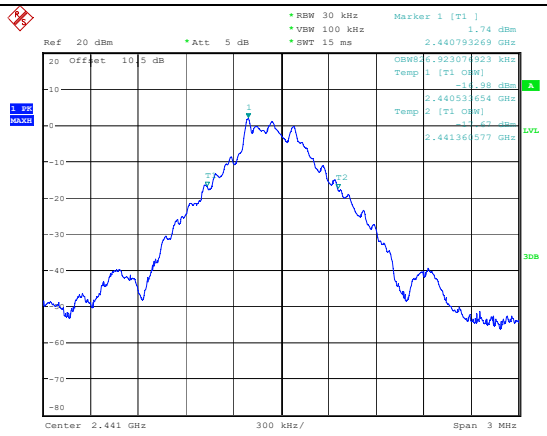
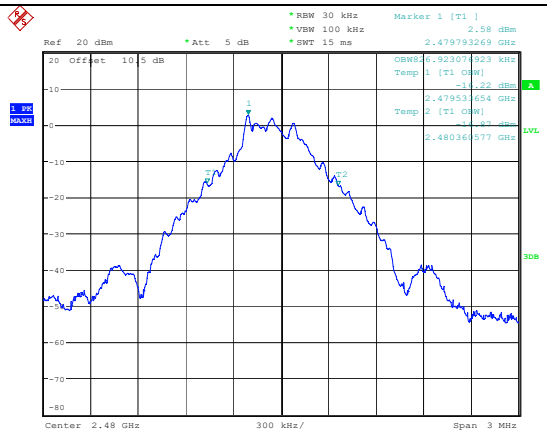
EUT operation mode: Transmitting

Test Result: Compliant

Mode	Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
GFSK	Low	2402	0.827	0.891
	Middle	2441	0.827	0.891
	High	2480	0.827	0.885

Please refer to the below plots:

20 dB Bandwidth	
Low Channel	
Middle Channel	
High Channel	

99% Emission Bandwidth	
Low Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:07:50
Middle Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:09:11
High Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:11:38

FCC §15.247(a) (1) (iii) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that
a minimum of 15 channels are used.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.3

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

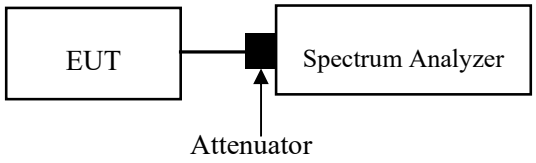
c) VBW ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max hold.

It might prove necessary to break the span up into sub ranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels.



Test Data

Environmental Conditions

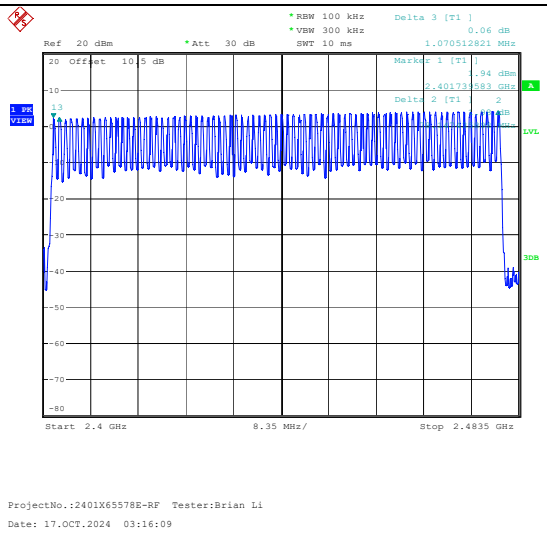
Temperature:	27 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Brian Li on 2024-10-17.

EUT operation mode: Transmitting

Test Result: Compliant

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
GFSK	2400-2483.5	79	≥15

Hopping Channel	
GFSK	

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

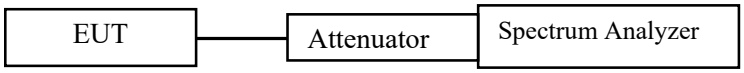
Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.4

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses



Test Data

Environmental Conditions

Temperature:	26~27 ℃
Relative Humidity:	54~60 %
ATM Pressure:	101.0 kPa

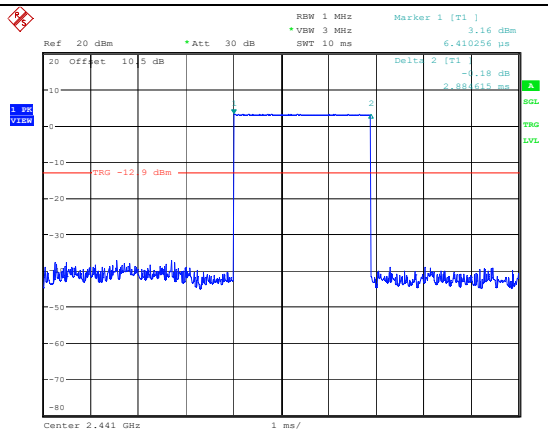
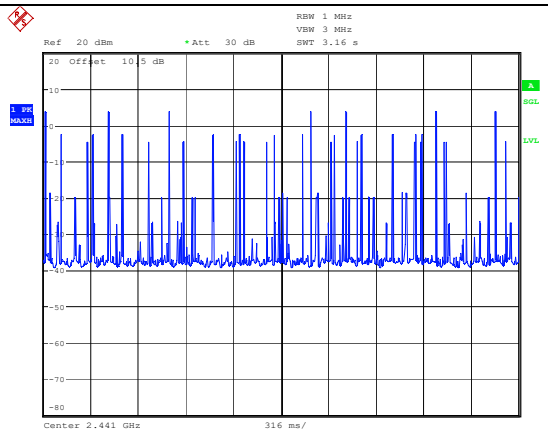
The testing was performed by Brian Li from 2024-10-31 to 2024-11-05.

EUT operation mode: Transmitting

Test Result: Compliant

Test Mode	Test Frequency (MHz)	Pulse width (ms)	Observation time (s)	Hopping Numbers in Observation time	Dwell Time (s)	Limit (s)
GFSK	2441	2.885	31.6	120	0.346	0.400

Note 1: Observation time= Hopping Channel Number× 0.4
Note 2: Dwell Time = Pulse width *Hopping Numbers in Observation time
Note 3: Hopping Numbers in Observation time = Hopping Numbers in 3.16s*10

GFSK	
Pulse Width	
Hopping Numbers in 3.16s	

FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.5

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

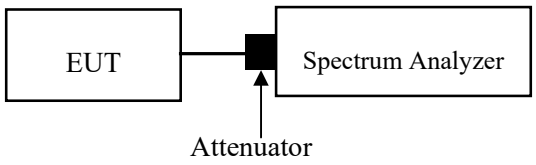
a) Use the following spectrum analyzer settings:

1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.

b) Allow trace to stabilize.

c) Use the marker-to-peak function to set the marker to the peak of the emission.

d) The indicated level is the peak output power, after any corrections for external attenuators and cables.



Test Data

Environmental Conditions

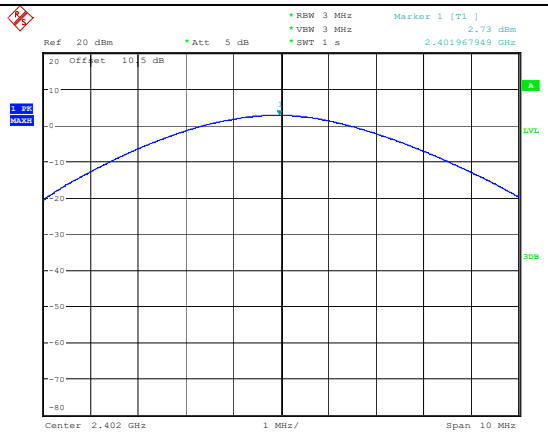
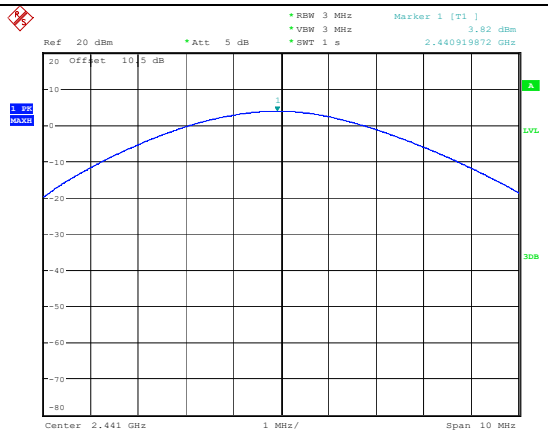
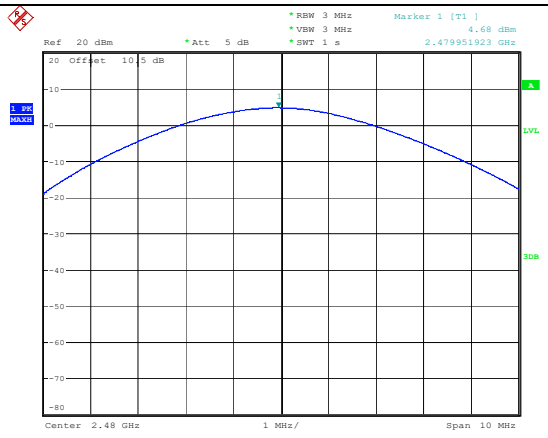
Temperature:	27 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Brian Li on 2024-10-17.

EUT operation mode: Transmitting

Test Result: Compliant

Mode	Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
GFSK	Low	2402	2.73	21
	Middle	2441	3.82	21
	High	2480	4.68	21

Low Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:02:45
Middle Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:03:57
High Channel	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:04:31

FCC §15.247(d) - BAND EDGES TESTING

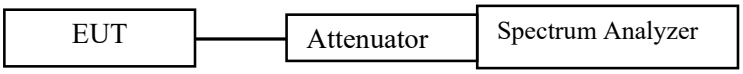
Applicable Standard

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)).

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.6 &Clause 6.10

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz 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.



Test Data

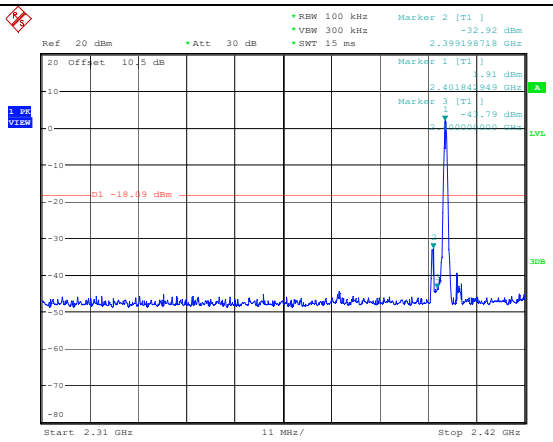
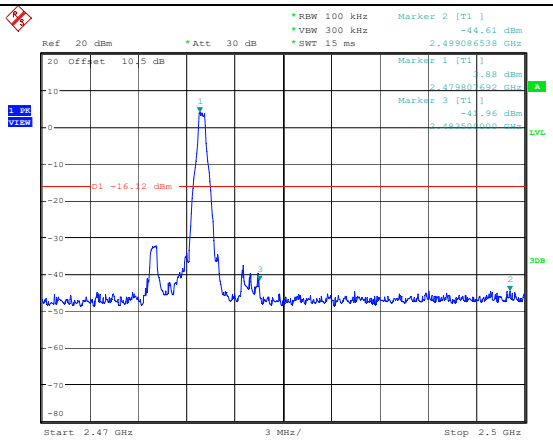
Environmental Conditions

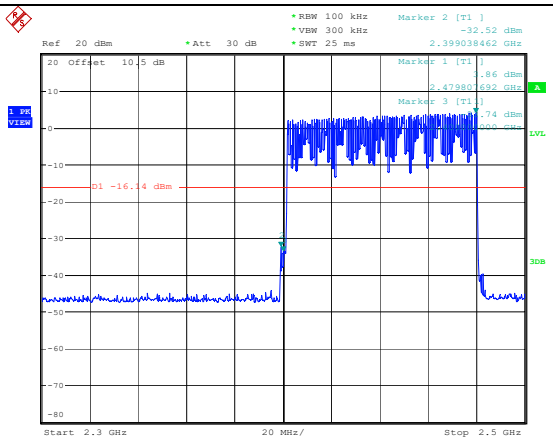
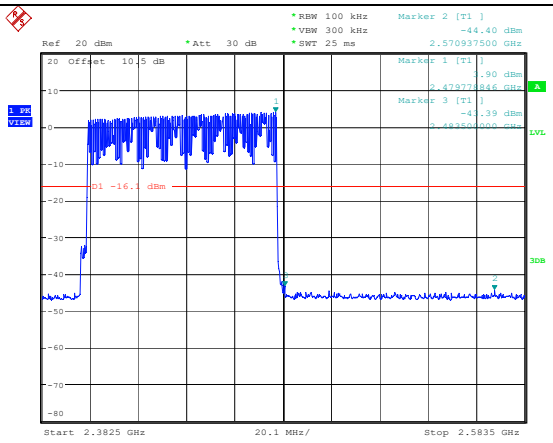
Temperature:	27 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Brian Li on 2024-10-17.

EUT operation mode: Transmitting

Test Result: Compliant

Band Edge, Single Channel	
GFSK, Left Side	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:33:57
GFSK, Right Side	 ProjectNo.:2401X65578E-RF Tester:Brian Li Date: 17.OCT.2024 02:38:25

Band Edge, Hopping Channel	
GFSK, Left Side	
GFSK, Right Side	

EUT PHOTOGRAPHS

Please refer to the attachment 2401X65578E-RF External photo and 2401X65578E-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401X65578E-RF Test Setup photo.

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