TEST REPORT

Applicant Name:	Zhongshan Trusting E-commerce Co., Ltd.
Address:	2nd Floor, Plant 1, No.88 Shagang West Road Gangkou Town, Zhongshan, Guangdong, China
Report Number:	2401W89045E-RF-00
FCC ID:	2BK2U-TK2401

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	AI MOUSE
Model No.:	TK2401
Multiple Model(s) No.:	N/A
Trade Mark:	THINKKEEN
Date Received:	2024/08/13
Issue Date:	2024/11/26

Test Result:	Pass▲

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

Prepared and Checked By:

Bruce Lin

Bruce Lin
RF Engineer

Approved By:

Michelle Zeng

Michelle Zeng
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.

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	2401W89045E-RF-00	Original Report	2024/11/26

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	AI MOUSE
Tested Model	TK2401
Multiple Model(s)	N/A
Frequency Range	BLE: 2402-2480MHz
Maximum Conducted Peak Output Power	BLE: 1.74dBm
Modulation Technique	BLE: GFSK
Antenna Specification#	-0.42445dBi (provided by the applicant)
Voltage Range	DC 3.70V from battery or DC 5V from USB port
Sample serial number	2PUP-6 for Conducted and Radiated Emissions Test 2PUP-7 for RF Conducted Test (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	N/A

Objective

This report is in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209, 15.247 rules.

Test Methodology

All tests and measurements indicated in this document were performed in accordance ANSI C63.10-2013.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

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 output power, conducted		0.72 dB(k=2, 95% level of confidence)
AC Power Lines Conducted Emissions	9kHz~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

For BLE mode, 40 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

"EMI-Test_Tool.exe"# exercise software was used and the power level is 1.7#. The software and power level was provided by the applicant.

Support Equipment List and Details

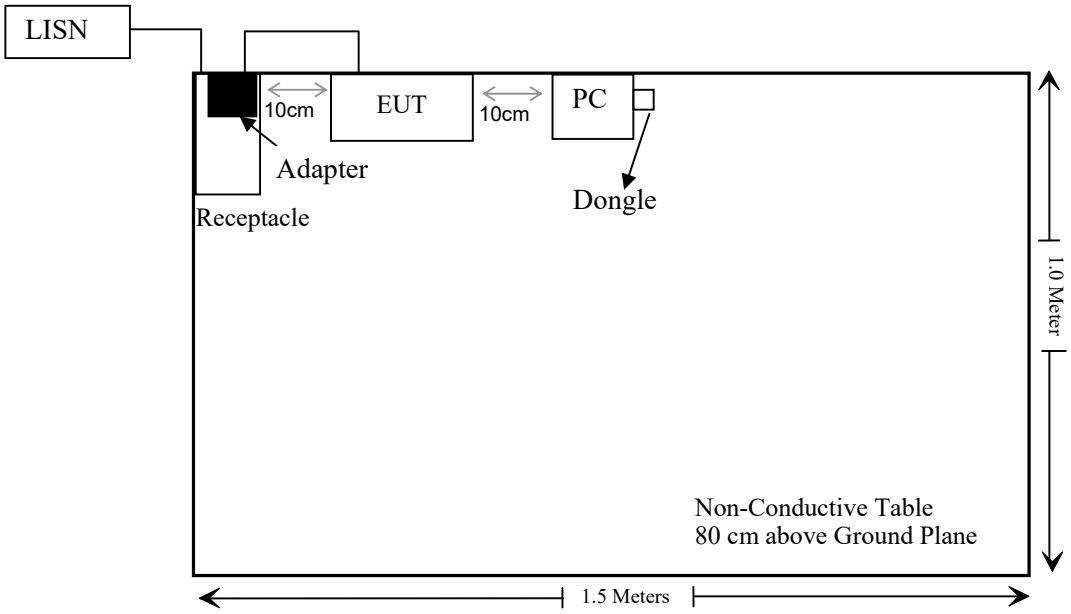
Manufacturer	Description	Model	Serial Number
Lenovo	PC	TIANYI510Pro-18ICB	R3NO28B21001
Huajin	Adapter	HJ-0501000E1-US	Unknown
BULL	Receptacle	GN-415K	5503290068073
Zhongshan Trusting E-commerce Co., Ltd.	Dongle	TK2401-1	Unknown

External I/O Cable

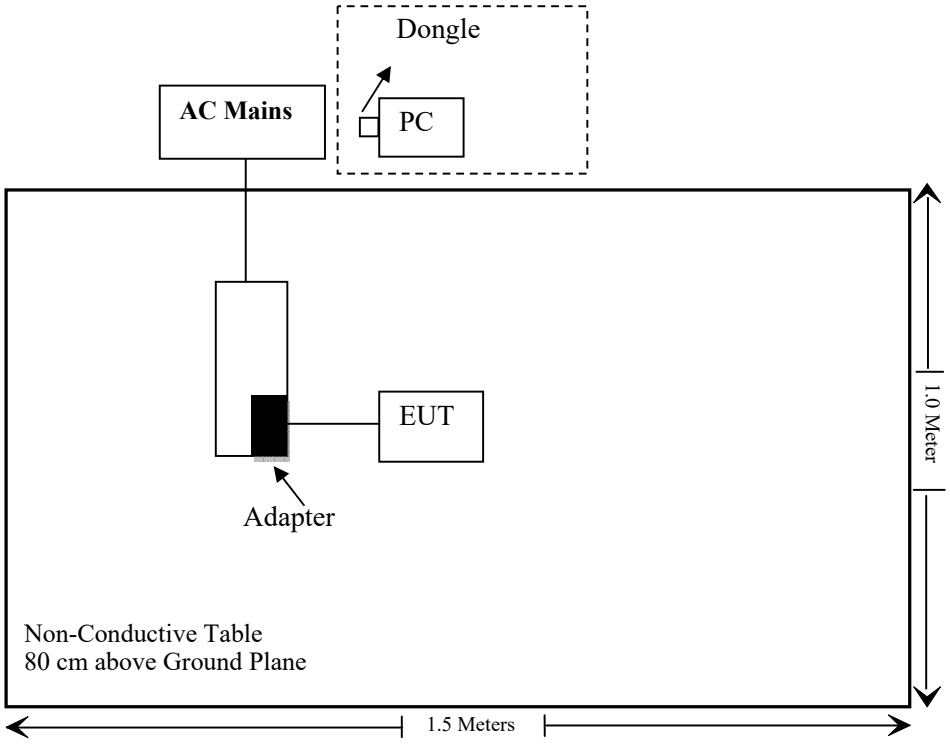
Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	0.8	Adapter	EUT
Unshielded Un-detachable AC cable	1.0	Receptacle	LISN/AC Mains

Block Diagram of Test Setup

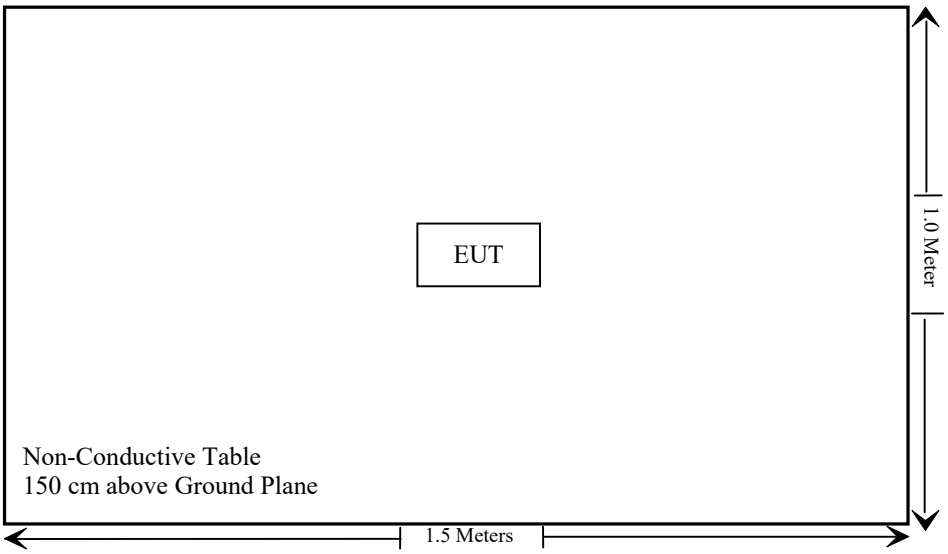
For Conducted Emissions:



For Radiated Emissions below 1GHz:



For Radiated Emissions above 1GHz:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i) & §1.1307 (b) (1) & §2.1093	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
/	Duty Cycle	/

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2024/01/16	2025/01/15
Rohde & Schwarz	LISN	ENV216	101613	2024/01/16	2025/01/15
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2024/05/21	2025/05/20
Unknown	CE Cable	Unknown	UF A210B-1-0720-504504	2024/05/21	2025/05/20
Audix	EMI Test software	E3	191218(V9)	NCR	NCR
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
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					
R&S	Spectrum Analyzer	FSU26	200120	2024/01/08	2025/01/07
R&S	Spectrum Analyzer	FSV40-N	102259	2024/01/16	2025/01/15
Unknown	10dB Attenuator	Unknown	F-03-EM065	2024/06/27	2025/06/26
Micro-Tronics	RF Cable	8082176	W6111	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) (1) &§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 v06

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

For worst case:

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
BLE 2M	2402-2480	2	1.585	5	0.5	3	Yes

Note: The max tune-up conducted power# was declared and provided by the applicant.

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 PCB antenna which was permanently attached and the maximum antenna gain# is -0.42445dBi, fulfill the requirement of this section. Please refer to the EUT photos.

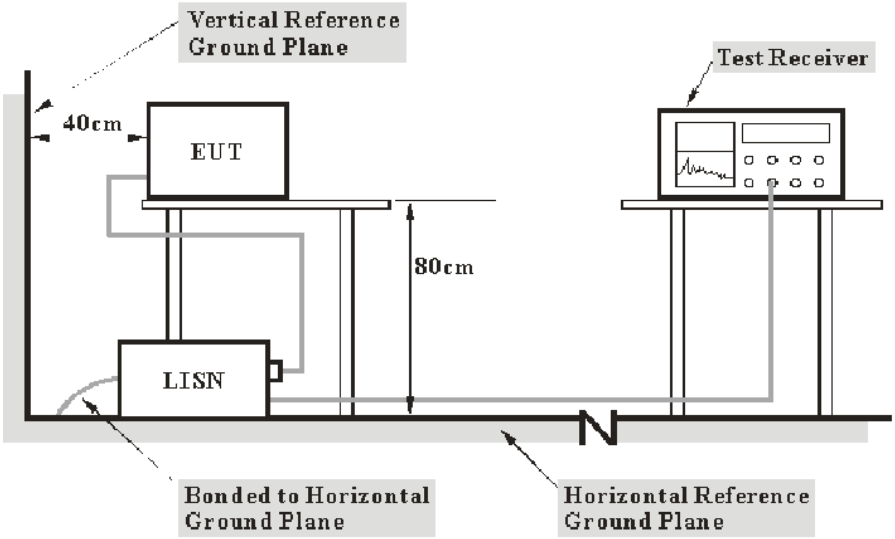
Result: Compliant

FCC §15.207 (a) - AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

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.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

Factor & Over Limit Calculation

The factor is calculated by adding LISN VDF (Voltage Division Factor) and Cable Loss. The basic equation is as follows:

Factor = LISN VDF + Cable Loss

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 calculation is as follows:

Over Limit = Level – Limit
Level = Read Level + Factor

Note: The term "cable loss" refers to the combination of a cable and a 10dB transient limiter (attenuator).

Test Data

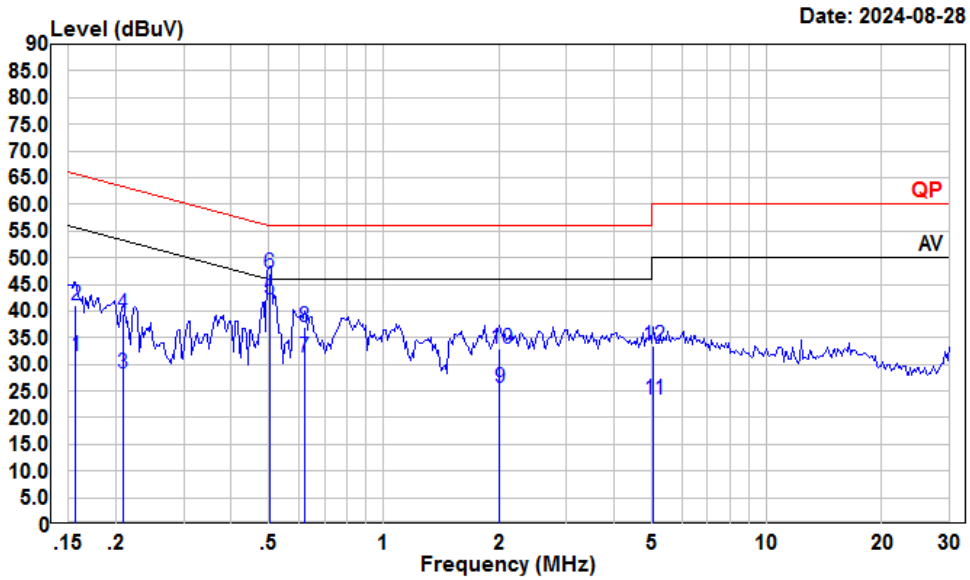
Environmental Conditions

Temperature:	26 °C
Relative Humidity:	66 %
ATM Pressure:	101 kPa

The testing was performed by Macy Shi on 2024-08-28.

EUT operation mode: Transmitting (Maximum output power mode, BLE 2M, Low channel)

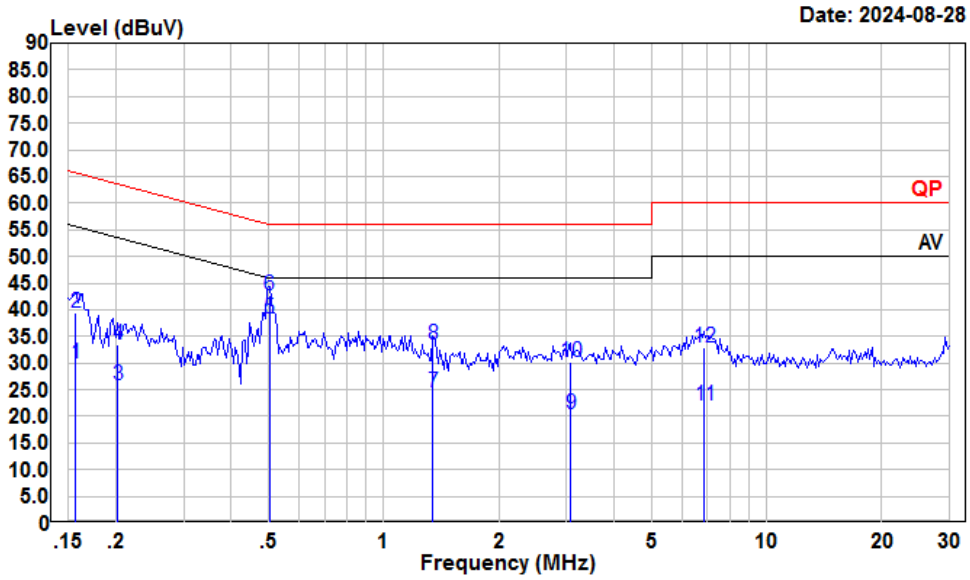
AC 120V/60 Hz, Line



Condition: Line
Project : 2401W89045E-RF
tester : Macy.shi
Note : Transmitting

	Freq	Read Level	Level	LISN Factor	Cable Loss	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dBuV	dB	
1	0.156	10.50	31.51	10.89	10.12	55.65	-24.14	Average
2	0.156	20.13	41.14	10.89	10.12	65.65	-24.51	QP
3	0.208	7.29	28.17	10.79	10.09	53.27	-25.10	Average
4	0.208	18.61	39.49	10.79	10.09	63.27	-23.78	QP
5	0.502	21.62	42.26	10.50	10.14	46.00	-3.74	Average
6	0.502	26.44	47.08	10.50	10.14	56.00	-8.92	QP
7	0.621	10.70	31.33	10.50	10.13	46.00	-14.67	Average
8	0.621	16.30	36.93	10.50	10.13	56.00	-19.07	QP
9	2.012	4.67	25.46	10.60	10.19	46.00	-20.54	Average
10	2.012	12.04	32.83	10.60	10.19	56.00	-23.17	QP
11	5.058	2.75	23.31	10.38	10.18	50.00	-26.69	Average
12	5.058	12.89	33.45	10.38	10.18	60.00	-26.55	QP

AC 120V/60 Hz, Neutral



Condition: Neutral
Project : 2401W89045E-RF
tester : Macy.shi
Note : Transmitting

	Freq	Read Level	LISN Level	Factor	Cable Loss	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dBuV	dB	
1	0.156	9.33	30.02	10.57	10.12	55.65	-25.63	Average
2	0.156	18.72	39.41	10.57	10.12	65.65	-26.24	QP
3	0.202	5.38	25.87	10.40	10.09	53.54	-27.67	Average
4	0.202	12.88	33.37	10.40	10.09	63.54	-30.17	QP
5	0.502	17.52	38.36	10.70	10.14	46.00	-7.64	Average
6	0.502	21.80	42.64	10.70	10.14	56.00	-13.36	QP
7	1.345	3.60	24.44	10.69	10.15	46.00	-21.56	Average
8	1.345	12.60	33.44	10.69	10.15	56.00	-22.56	QP
9	3.074	-0.14	20.44	10.40	10.18	46.00	-25.56	Average
10	3.074	9.72	30.30	10.40	10.18	56.00	-25.70	QP
11	6.878	1.10	21.98	10.69	10.19	50.00	-28.02	Average
12	6.878	11.90	32.78	10.69	10.19	60.00	-27.22	QP

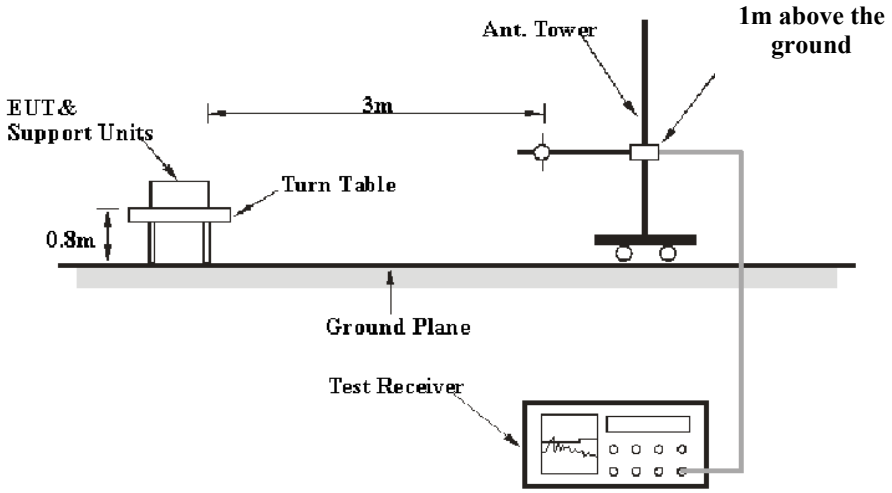
FCC §15.209, §15.205 & §15.247(D) – UNWANTED EMISSION FREQUENCIES AND RESTRICTED BANDS

Applicable Standard

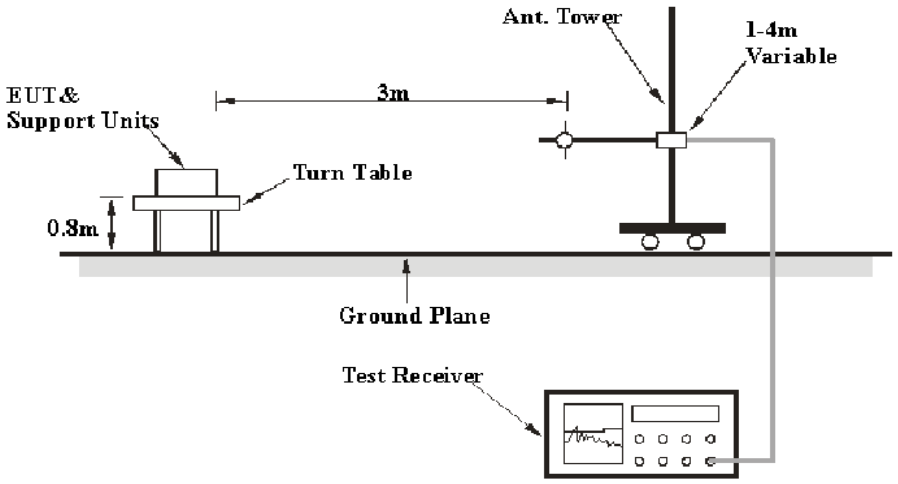
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

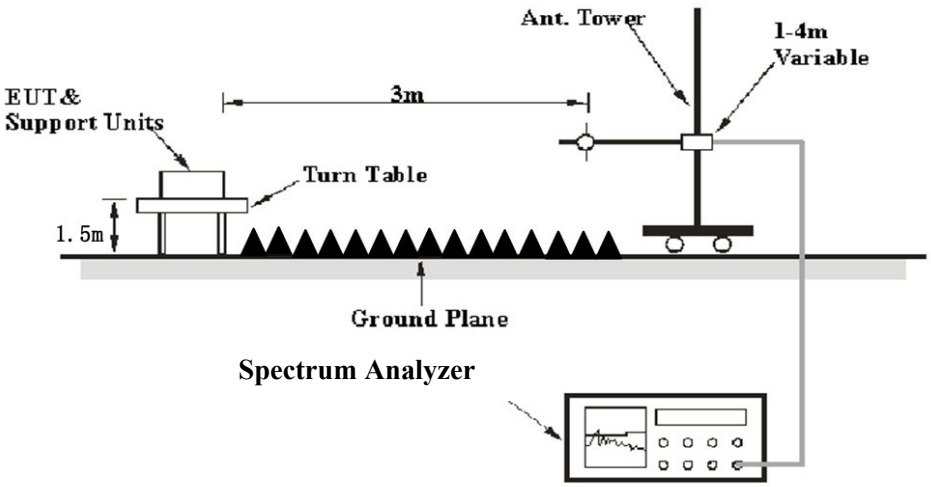
9 kHz-30MHz:



30MHz-1GHz:



Above 1GHz:



The radiated emission tests were performed in the 3meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.205, FCC 15.209, FCC 15.247 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 9 kHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

9 kHz-1GHz:

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

1-25GHz:
Pre-scan

Measurement	Duty cycle	RBW	Video B/W
PK	Any	1MHz	3 MHz
AV	>98%	1MHz	5 kHz
	<98%	1MHz	≥1/Ton, not less than 5 kHz

Final measurement for emission identified during pre-scan

Measurement	Duty cycle	RBW	Video B/W
PK	Any	1MHz	3 MHz
AV	>98%	1MHz	10 Hz
	<98%	1MHz	≥1/Ton

Note: Ton is minimum transmission duration

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

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.

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/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 calculation is as follows:

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Data

Environmental Conditions

Temperature:	22~25.3 °C
Relative Humidity:	51~54 %
ATM Pressure:	101~101.2 kPa

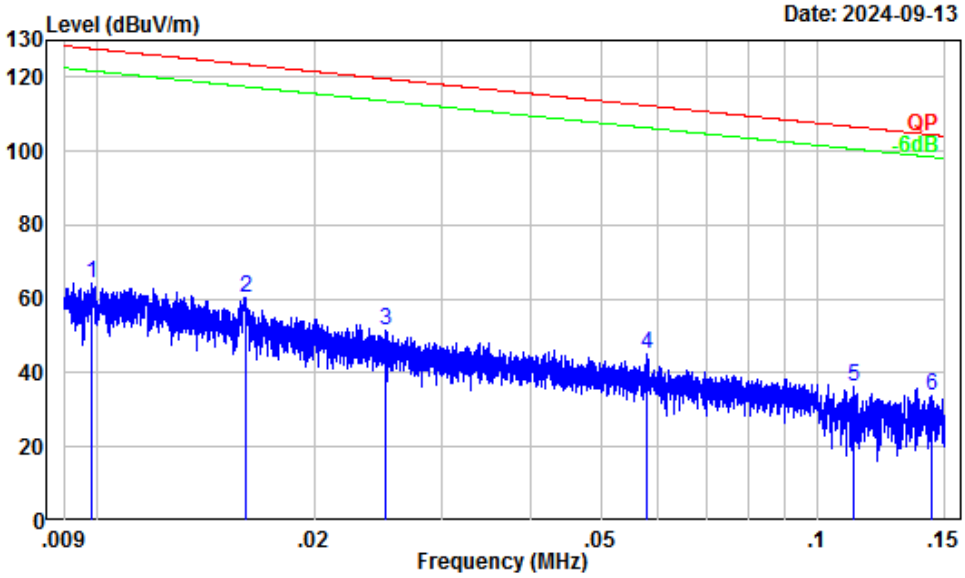
The testing was performed by Anson Su and Carl Zhu from 2024-09-13 to 2024-11-26 for below 1GHz and Dylan Yang on 2024-09-14 for above 1GHz.

EUT operation mode: Transmitting

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

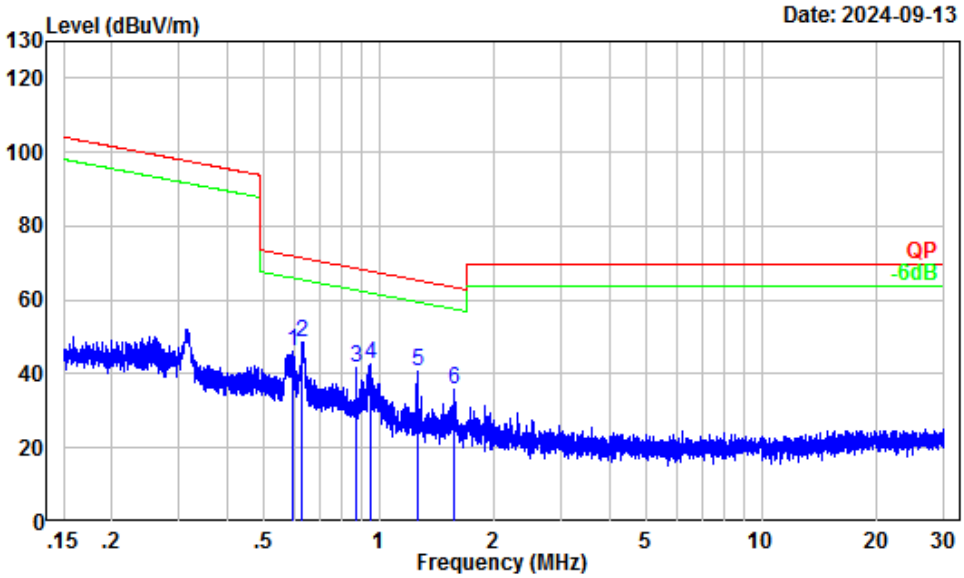
9 kHz-30MHz (Maximum output power mode, BLE 2M, Low channel):

Parallel (worst case)



Site : Chamber A
Condition : 3m
Project Number: 2401W89045E-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	0.01	37.80	26.41	64.21	127.73	-63.52	Peak
2	0.02	34.60	25.86	60.46	123.49	-63.03	Peak
3	0.03	29.93	21.76	51.69	119.58	-67.89	Peak
4	0.06	21.99	23.14	45.13	112.33	-67.20	Peak
5	0.11	16.48	20.00	36.48	106.60	-70.12	Peak
6	0.14	14.99	19.03	34.02	104.43	-70.41	Peak

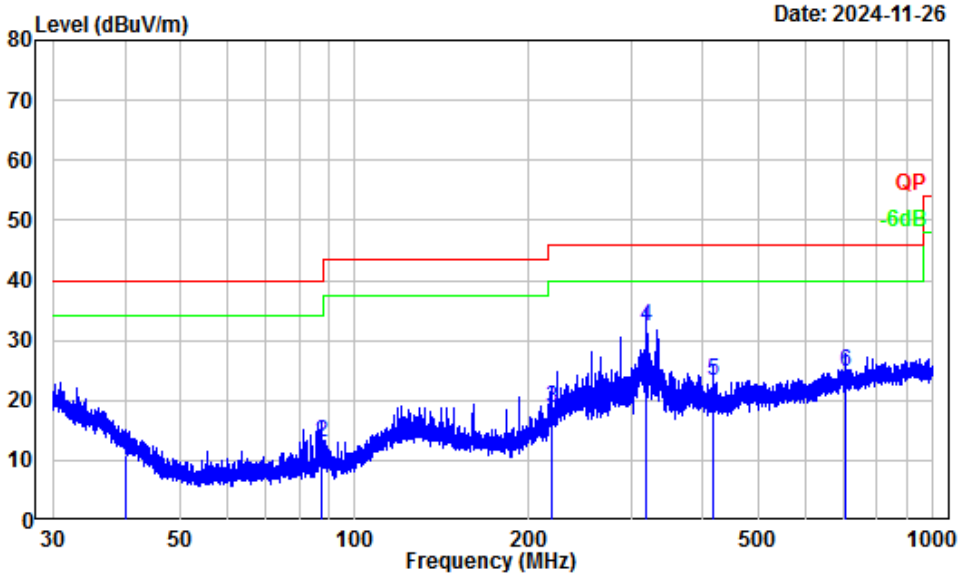


Site : Chamber A
Condition : 3m
Project Number: 2401W89045E-RF
Test Mode : Transmitting
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	0.59	2.36	43.55	45.91	72.10	-26.19	Peak
2	0.63	1.92	46.70	48.62	71.57	-22.95	Peak
3	0.87	-0.65	42.42	41.77	68.68	-26.91	Peak
4	0.95	-1.20	44.05	42.85	67.96	-25.11	Peak
5	1.26	-2.50	43.06	40.56	65.42	-24.86	Peak
6	1.57	-3.59	39.48	35.89	63.45	-27.56	Peak

30MHz-1GHz (Maximum output power mode, BLE 2M, Low channel):

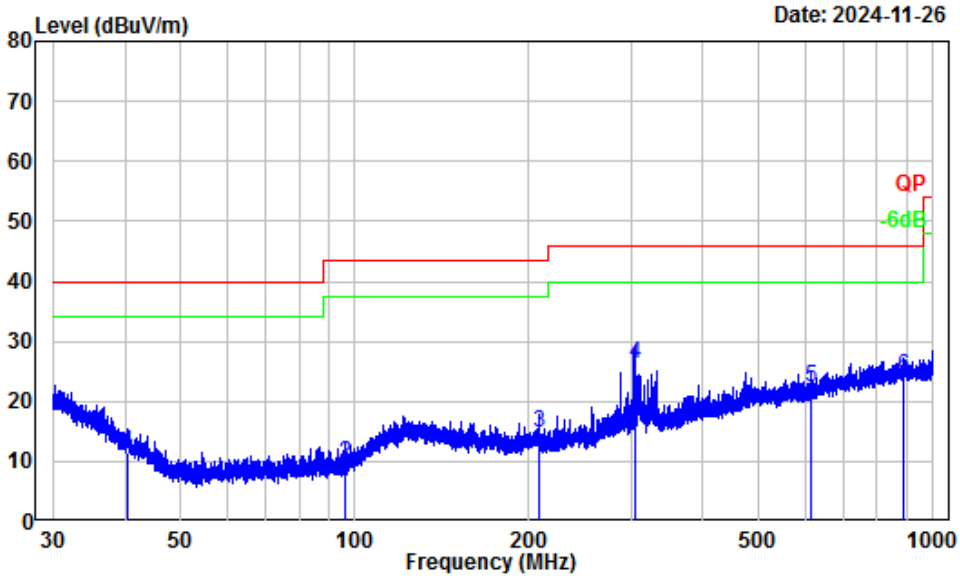
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401W89045E-RF
Test Mode : Transmitting
Tester : Carl Zhu

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.03	-12.39	23.39	11.00	40.00	-29.00	QP
2	87.26	-18.08	31.12	13.04	40.00	-26.96	QP
3	219.17	-14.20	32.98	18.78	46.00	-27.22	QP
4	319.66	-10.82	43.00	32.18	46.00	-13.82	QP
5	417.09	-7.98	31.09	23.11	46.00	-22.89	QP
6	705.77	-3.42	28.14	24.72	46.00	-21.28	QP

Vertical



Site : Chamber A
Condition : 3m Vertical
Project Number: 2401W89045E-RF
Test Mode : Transmitting
Tester : Carl Zhu

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.42	-12.66	24.05	11.39	40.00	-28.61	QP
2	95.97	-17.03	26.80	9.77	43.50	-33.73	QP
3	208.95	-13.90	28.66	14.76	43.50	-28.74	QP
4	306.08	-11.07	37.33	26.26	46.00	-19.74	QP
5	614.48	-4.99	27.21	22.22	46.00	-23.78	QP
6	886.83	-1.41	25.46	24.05	46.00	-21.95	QP

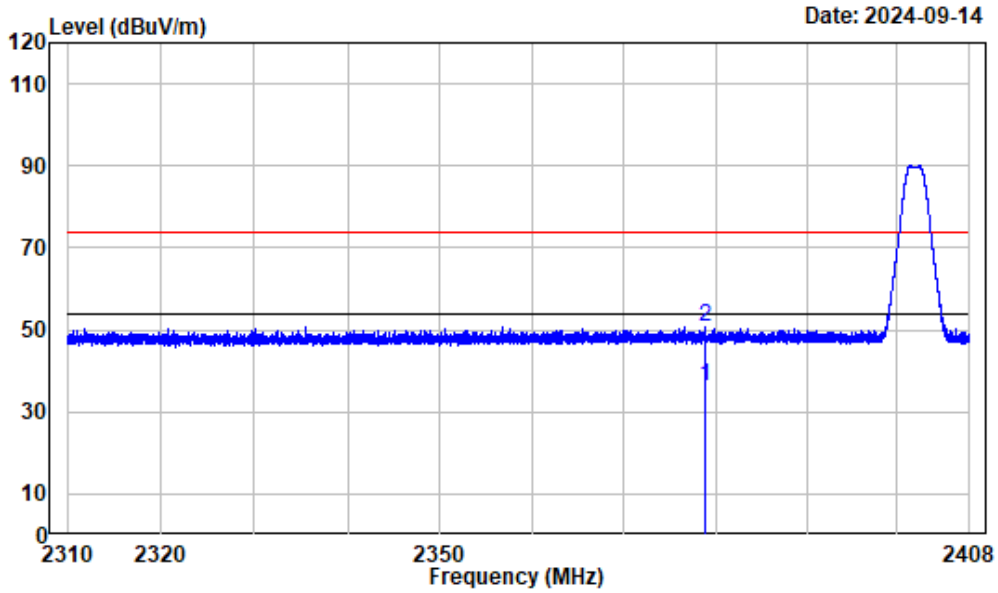
1-25 GHz:

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/AV					
BLE 2M							
Low Channel 2402MHz							
4804.00	57.66	PK	H	1.69	59.35	74	-14.65
4804.00	48.55	AV	H	1.69	50.24	54	-3.76
4804.00	53.04	PK	V	1.69	54.73	74	-19.27
4804.00	45.32	AV	V	1.69	47.01	54	-6.99
Middle Channel 2440MHz							
4880.00	57.05	PK	H	1.69	58.74	74	-15.26
4880.00	48.11	AV	H	1.69	49.80	54	-4.20
4880.00	52.68	PK	V	1.69	54.37	74	-19.63
4880.00	44.61	AV	V	1.69	46.30	54	-7.70
High Channel 2480MHz							
4960.00	56.82	PK	H	2.69	59.51	74	-14.49
4960.00	48.20	AV	H	2.69	50.89	54	-3.11
4960.00	52.11	PK	V	2.69	54.80	74	-19.2
4960.00	44.01	AV	V	2.69	46.70	54	-7.3

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude/Level = Corrected Factor + Reading
Margin = Corrected Amplitude/Level - Limit
The other spurious emission which is in the noise floor level was not recorded.

Test plots for Band Edge Measurements (Radiated):

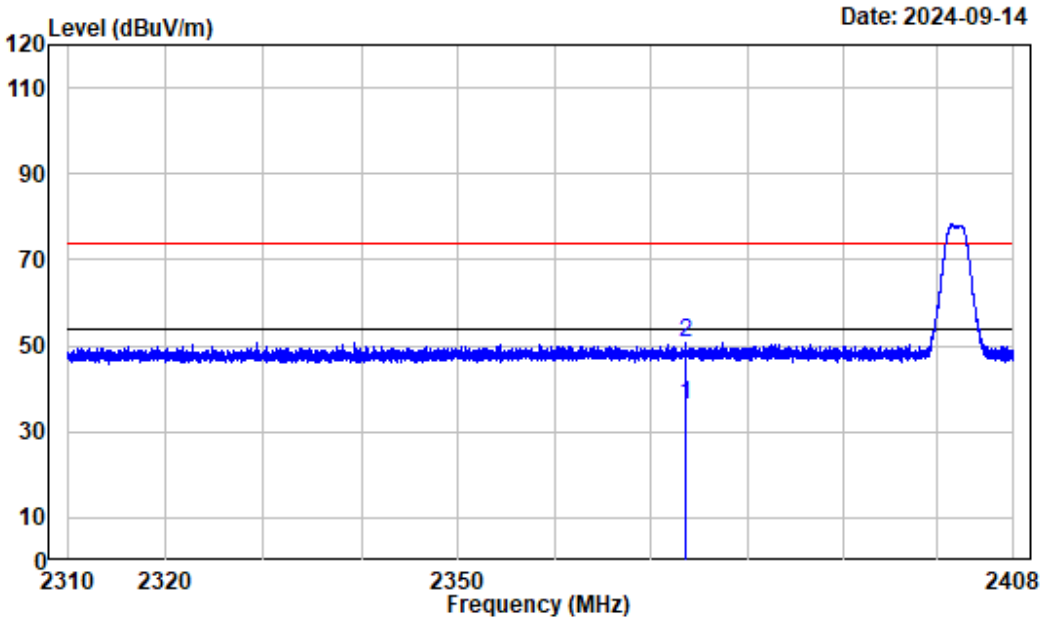
BLE 2M			
Test Channel:	**2402MHz**	**Ant. Polar. :**	**Horizontal**



Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2402

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2378.918	-3.19	39.46	36.27	54.00	-17.73	Average
2	2378.918	-3.19	53.96	50.77	74.00	-23.23	peak

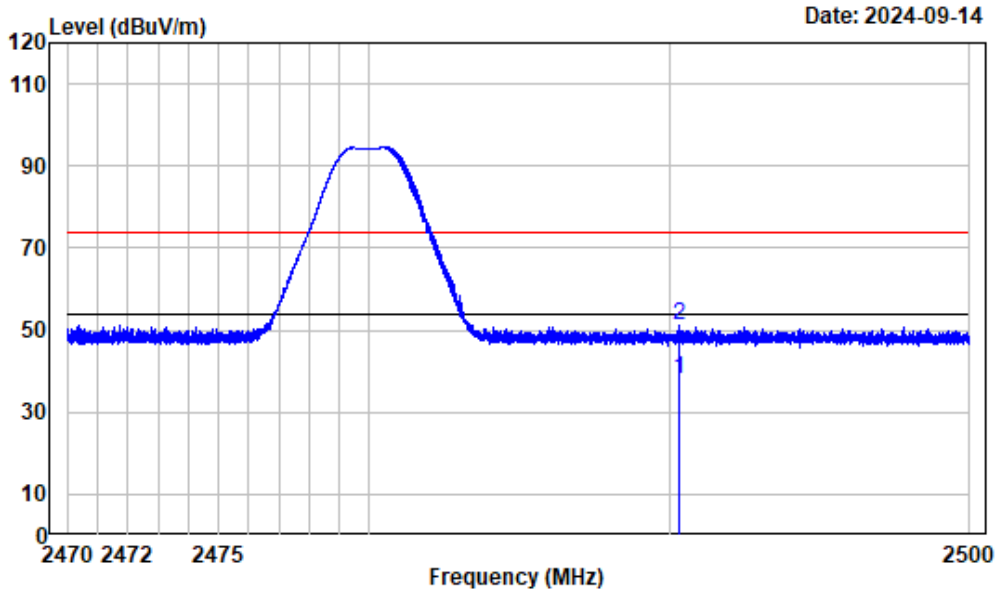
BLE 2M			
Test Channel:	**2402MHz**	**Ant. Polar. :**	**Vertical**



Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2402

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2373.651	-3.18	39.42	36.24	54.00	-17.76	Average
2	2373.651	-3.18	53.96	50.78	74.00	-23.22	peak

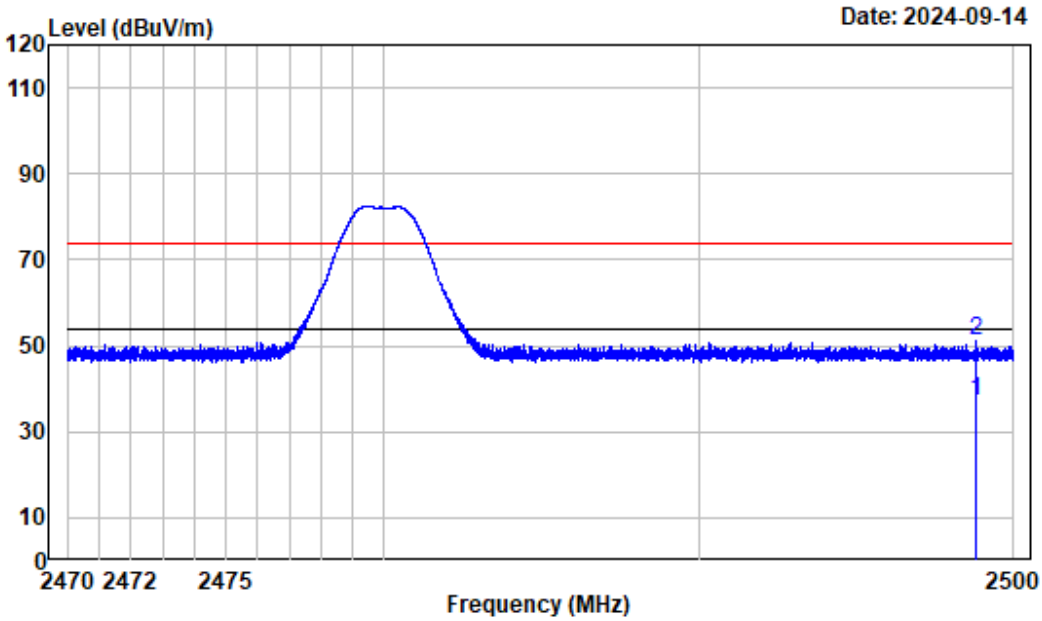
BLE 2M			
Test Channel:	**2480MHz**	**Ant. Polar. :**	**Horizontal**



Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2490.333	-3.18	41.43	38.25	54.00	-15.75	Average
2	2490.333	-3.18	54.14	50.96	74.00	-23.04	peak

BLE 2M			
Test Channel:	**2480MHz**	**Ant. Polar. :**	**Vertical**



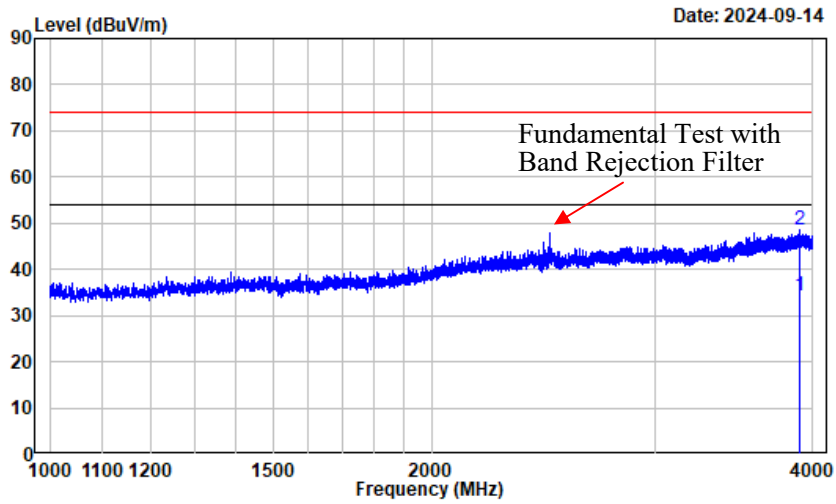
Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2498.811	-3.20	40.21	37.01	54.00	-16.99	Average
2	2498.811	-3.20	54.55	51.35	74.00	-22.65	peak

Listed with the worst harmonic margin test plot:

Horizontal

1-4GHz

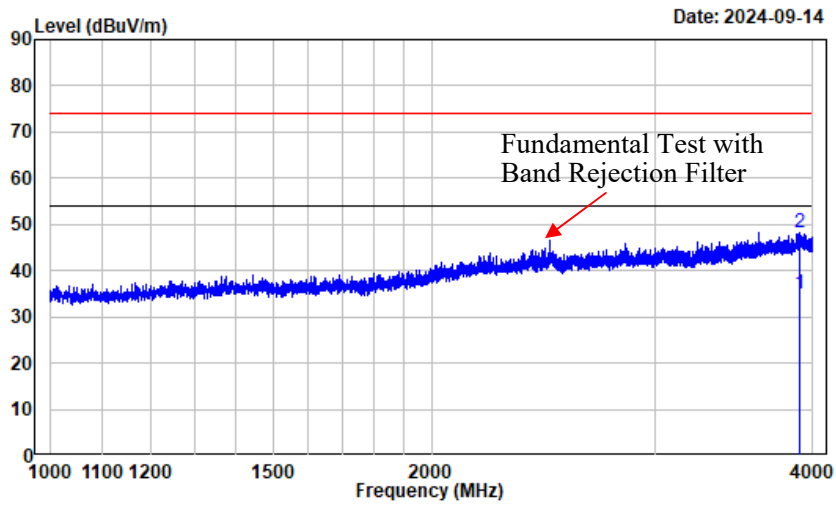


Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	3903.625	-0.50	34.69	34.19	54.00	-19.81	Average
2	3903.625	-0.50	48.91	48.41	74.00	-25.59	Peak

Vertical

1-4GHz

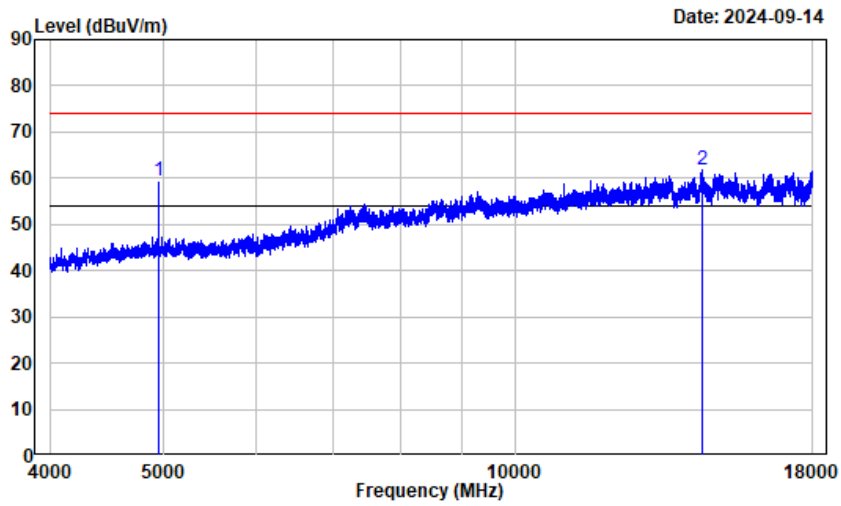


Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	3904.750	-0.49	35.63	35.14	54.00	-18.86	Average
2	3904.750	-0.49	48.61	48.12	74.00	-25.88	Peak

Horizontal-Peak

4-18GHz

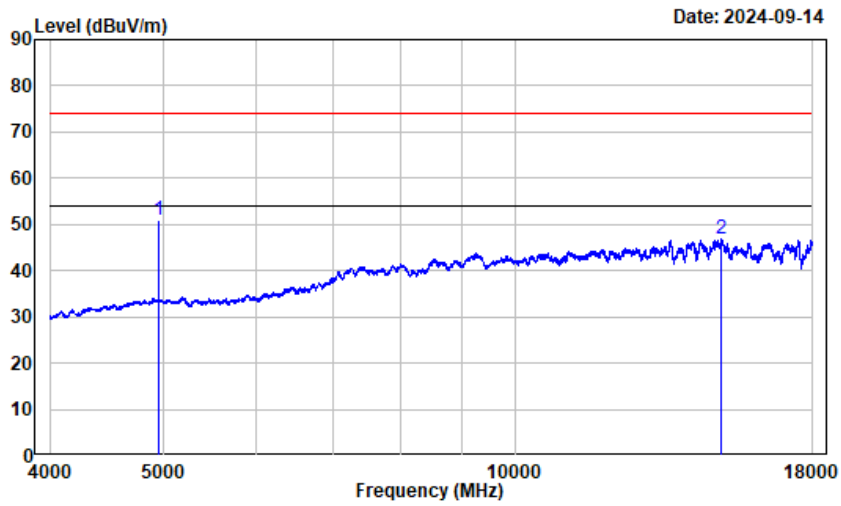


Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.69	56.82	59.51	74.00	-14.49	Peak
2	14461.060	17.38	44.33	61.71	74.00	-12.29	Peak

Horizontal-Average

4-18GHz



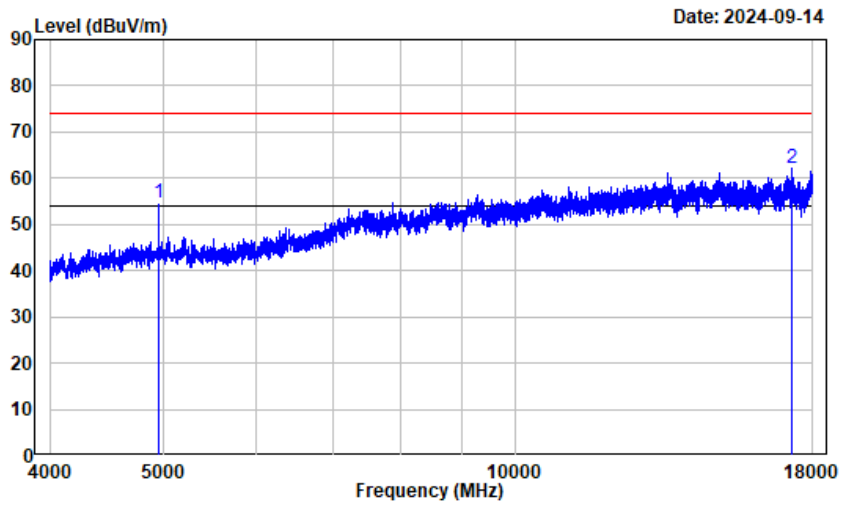
Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480_AV

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.69	48.20	50.89	54.00	-3.11	Average
2	15047.380	16.10	30.72	46.82	54.00	-7.18	Average

Note: Spectrum analyzer setting: RBW=1 MHz, VBW=5 kHz

Vertical-Peak

4-18GHz

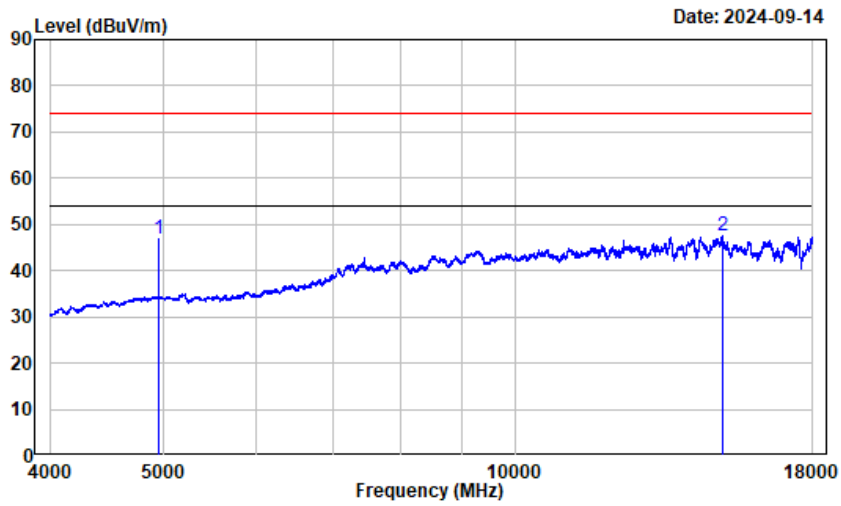


Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.69	52.11	54.80	74.00	-19.20	Peak
2	17273.660	19.16	42.99	62.15	74.00	-11.85	Peak

Vertical-Average

4-18GHz



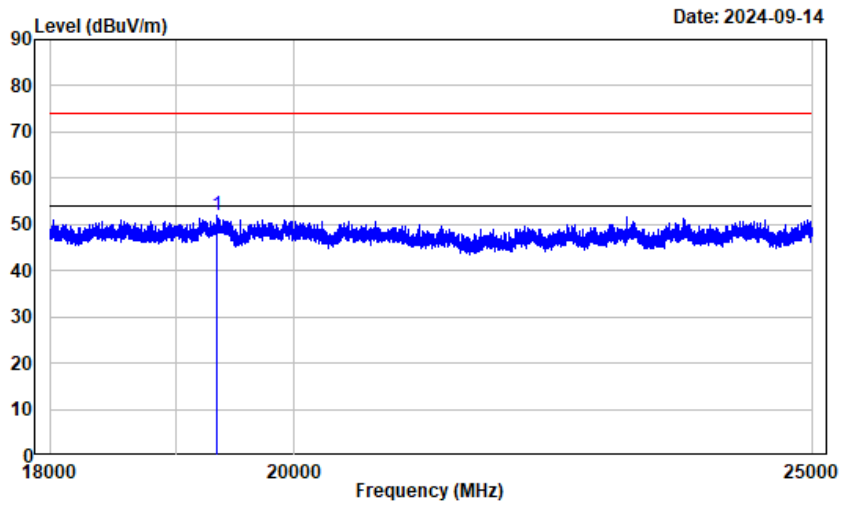
Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480_AV

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.69	44.01	46.70	54.00	-7.30	Average
2	15056.130	16.06	31.48	47.54	54.00	-6.46	Average

Note: Spectrum analyzer setting: RBW=1 MHz, VBW=5 kHz

Horizontal

18-25GHz

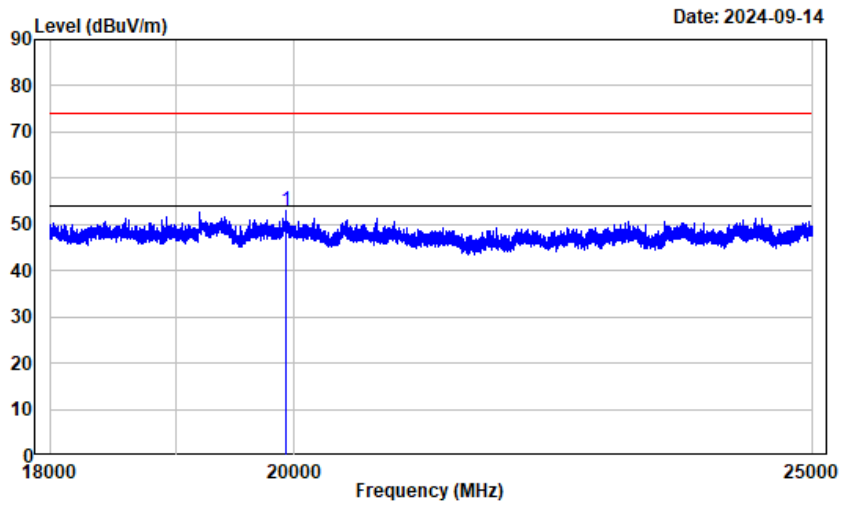


Condition : Horizontal
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	19347.670	15.15	36.76	51.91	74.00	-22.09	Peak

Vertical

18-25GHz



Condition : Vertical
Project No.: 2401W89045E-RF
Tester : Dylan.Yang
Note : 2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	19925.240	15.42	37.42	52.84	74.00	-21.16	Peak

FCC §15.247(a) (2) - 6 dB EMISSON BANDWIDTH

Standard Applicable

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.

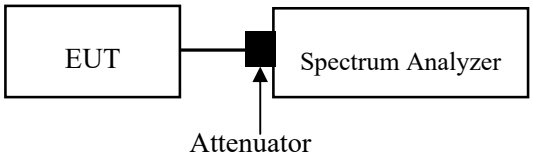
Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.8.1 & Clause 6.9.3

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.

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. Procedure as below

a. The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 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 VBW shall be approximately three times the 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. Step a) through step c) might require iteration to adjust within the specified range.
e. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f. Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
g. If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
h. 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:	25°C
Relative Humidity:	46 %
ATM Pressure:	101 kPa

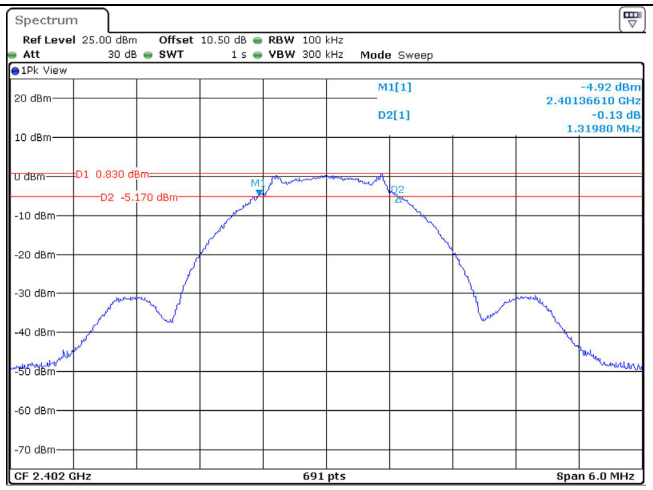
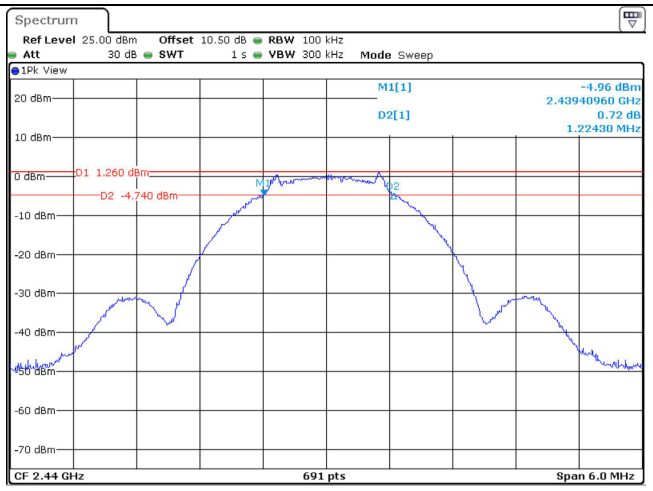
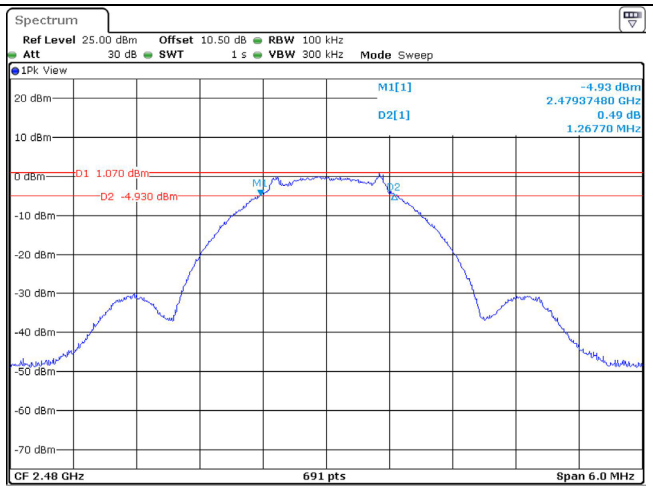
The testing was performed by Allen Bai on 2024-09-18.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Test Channel	Test Frequency (MHz)	6 dB Bandwidth (MHz)	Limit (MHz)
BLE 2M	Lowest	2402	1.320	≥0.5
	Middle	2440	1.224	≥0.5
	Highest	2480	1.268	≥0.5

6 dB Bandwidth

BLE 2M	
Low Channel	
Middle Channel	
High Channel	

FCC §15.247(b) (3) - PEAK OUTPUT POWER MEASUREMENT

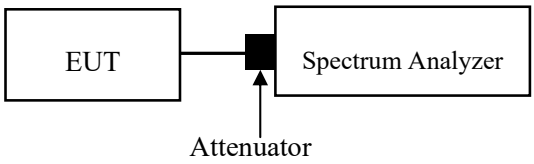
Applicable Standard

According to FCC §15.247(b) (3), for 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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.9.1.1

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 one test equipment.
3. Add a correction factor to the display.
4. Set the RBW ⩾ DTS bandwidth.
5. Set the VBW ≥ [3 × RBW].
6. Set span ⩾ [3 × RBW].
7. Sweep time = auto couple.
8. Detector = peak.
9. Trace mode = max hold.
10. Allow the trace to stabilize.
11. Use peak marker function to determine the peak amplitude level.



Test Data

Environmental Conditions

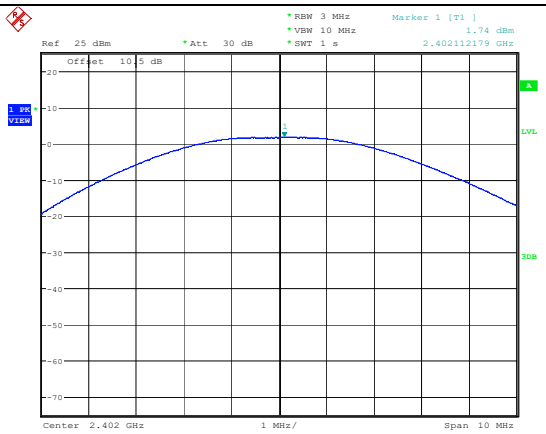
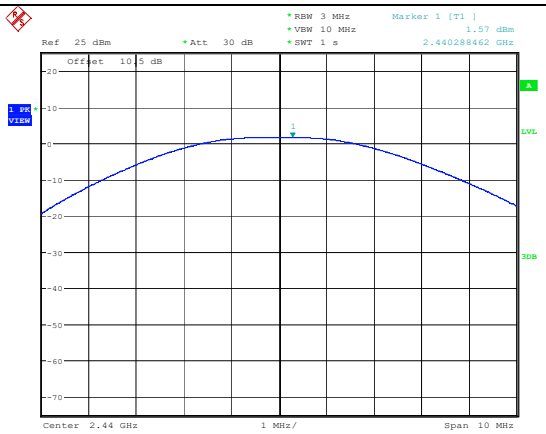
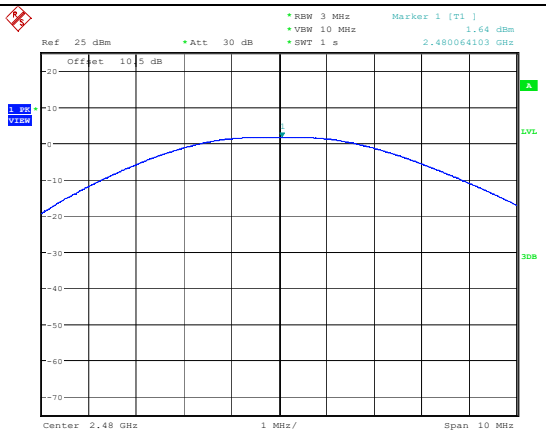
Temperature:	27 ℃
Relative Humidity:	48 %
ATM Pressure:	101 kPa

The testing was performed by Allen Bai on 2024-09-19.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Test Frequency (MHz)	Peak Conducted Output Power (dBm)	Limits (dBm)
BLE 2M	2402	1.74	≤30
	2440	1.57	≤30
	2480	1.64	≤30

BLE 2M	
Low Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 19.SEP.2024 21:17:23
Middle Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 19.SEP.2024 21:15:42
High Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 19.SEP.2024 21:18:35

FCC §15.247(e) - POWER SPECTRAL DENSITY

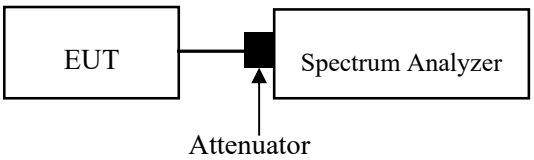
Applicable Standard

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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set analyzer center frequency to DTS channel center frequency
3. Set the span to 1.5 times the DTS bandwidth.
4. Set the RBW to: 3kHz⩽ RBW⩽100 kHz.
5. Set the VBW ≥ 3×RBW.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level within the RBW.
11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

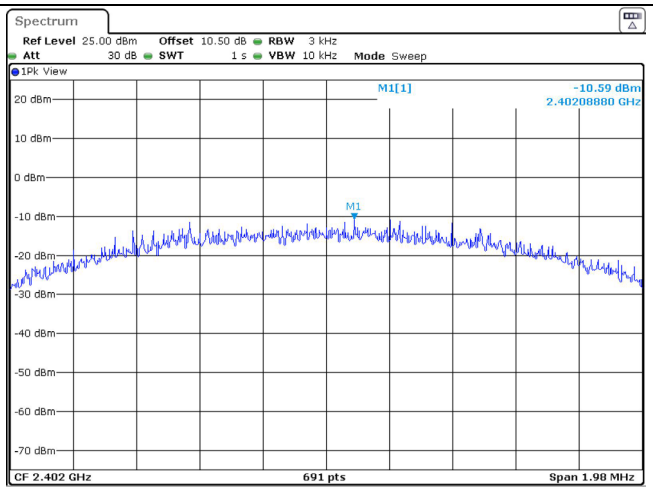
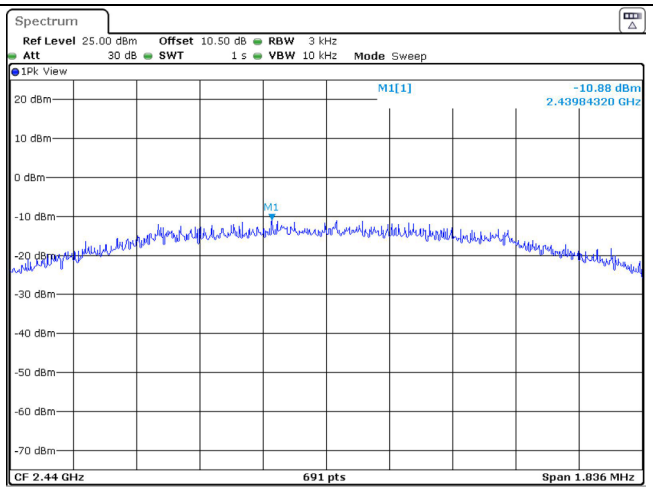
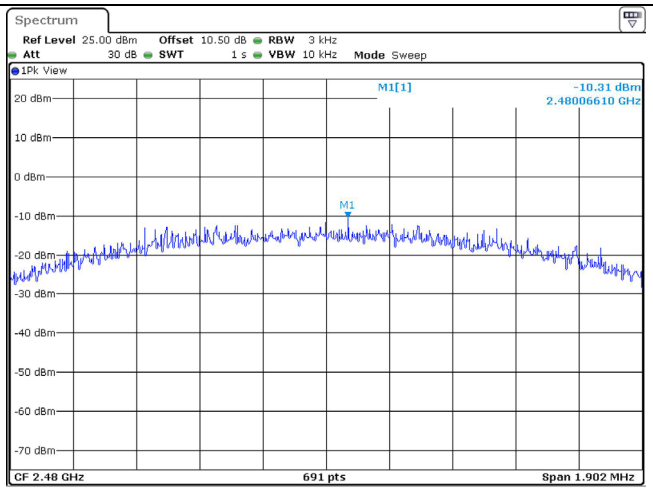
Temperature:	25 °C
Relative Humidity:	46 %
ATM Pressure:	101 kPa

The testing was performed by Allen Bai on 2024-09-18

Test Mode: Transmitting

Test Result: Compliant.

Test Mode	Test Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
BLE 2M	2402	-10.59	≤8.00
	2440	-10.88	≤8.00
	2480	-10.31	≤8.00

BLE 2M	
Low Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 18.SEP.2024 19:54:17
Middle Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 18.SEP.2024 19:51:09
High Channel	 ProjectNo.:2401W89045E-RF Tester:Allen Bai Date: 18.SEP.2024 19:46:41

FCC §15.247(d) - 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

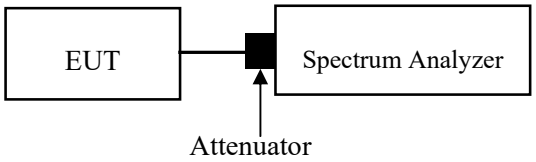
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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)).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.11

1. Set the RBW =100 kHz.
2. Set the VBW ≥ 3×RBW.
3. Detector = peak
4. Sweep time = auto couple.
5. Trace mode=max hold
6. All trace to fully stabilize
7. Use the peak marker function to determine the maximum amplitude level.
   Ensure that amplitude of all unwanted emissions outside of the authorized frequency band(excluding restricted frequency bands) is attenuated by at least the minimum requirement specified in 11.11.
   Report the three highest emissions relative to the limit.



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	46 %
ATM Pressure:	101 kPa

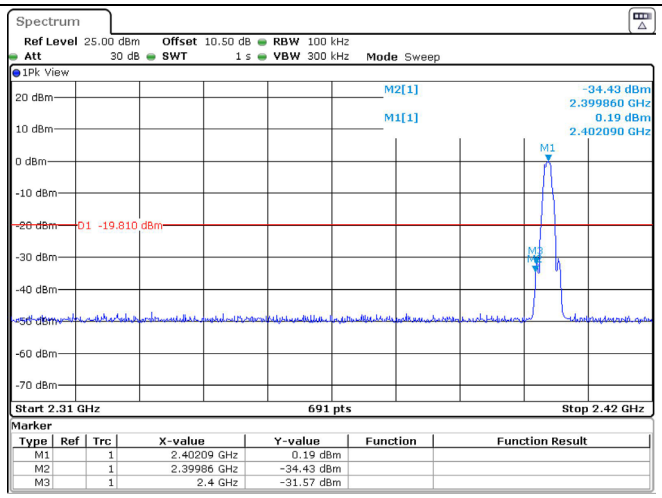
The testing was performed by Allen Bai on 2024-09-18.

EUT operation mode: Transmitting

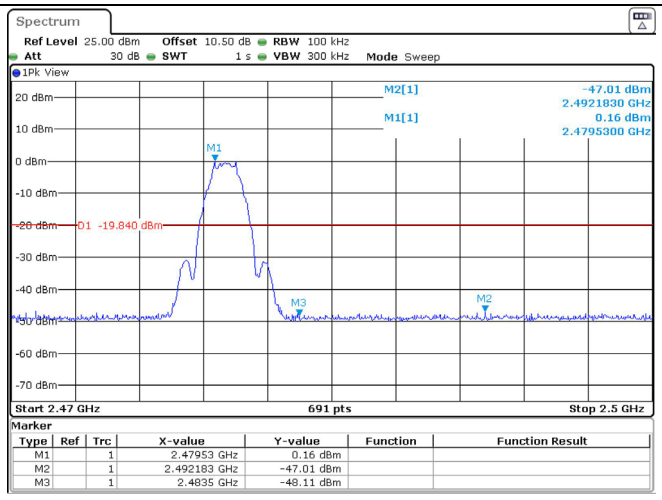
Test Result: Compliant.

Band Edge, Single Channel

BLE 2M, Left Side



BLE 2M, Right Side



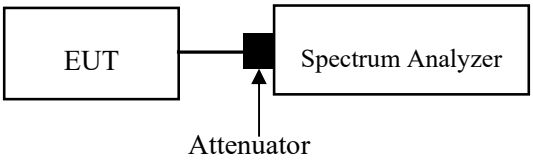
DUTY CYCLE

Duty Cycle

Test Procedure

According to ANSI C63.10-2013 Section 11.6

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the ON and OFF times of the transmitted signal:
1) Set the center frequency of the instrument to the center frequency of the transmission.
2) Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
3) Set VBW ≥ RBW. Set detector = peak or average.
4) The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if T ≤ 16.7 μs.)



Test Data

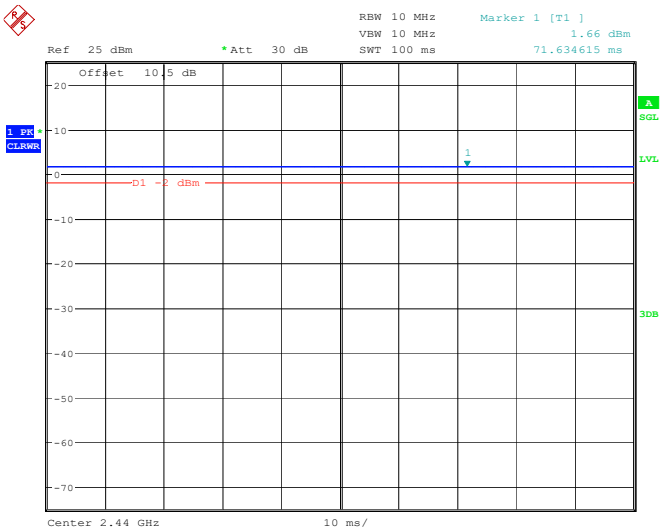
Environmental Conditions

Temperature:	25 °C
Relative Humidity:	46 %
ATM Pressure:	101 kPa

The testing was performed by Allen Bai on 2024-09-19.

EUT operation mode: Transmitting

Test Modes	T_{on} (ms)	T_{on+off} (ms)	Duty Cycle (%)	$1/T_{on}$ (Hz)	VBW Setting (Hz)
BLE 2Mbps	100	100	100.00	/	10



ProjectNo.:2401W89045E-RF Tester:Allen Bai
Date: 19.SEP.2024 20:35:55

EUT PHOTOGRAPHS

Please refer to the attachment 2401W89045E-RF External photo and 2401W89045E-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401W89045E-RF Test Setup photo.

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