FCC TEST REPORT

FCC ID: 2BE9O-ZOOM98

Product	**:**	**Wireless Keyboard**
Model Name	**:**	**ZOOM98**
Brand	**:**	MELETRIX
Report No.	**:**	**NCT24006136XE-2**

Prepared for

Wuhan Wuque Technology Co., Ltd

307, Building T5, Guocai Center, Donghu High tech Zone,
Wuhan City, Hubei Province

Prepared by

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1 TEST RESULT CERTIFICATION

Applicant's name	:	Wuhan Wuque Technology Co., Ltd
Address	:	307, Building T5, Guocai Center, Donghu High tech Zone, Wuhan City, Hubei Province
Manufacture's name	:	Wuhan Wuque Technology Co., Ltd
Address	:	307, Building T5, Guocai Center, Donghu High tech Zone, Wuhan City, Hubei Province
Product name	:	Wireless Keyboard
Model name	:	ZOOM98
Standards	:	FCC CFR47 Part 15 Section 15.247
Test procedure	:	ANSI C63.10:2013
Date of test	:	Feb. 25, 2024 to Mar. 05, 2024
Date of Issue	:	Mar. 06, 2024

This device described above has been tested by NCT, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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Test Engineer:

Keven Wu / Engineer

Technical Manager:

Henry Wang / Manager

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Shenzhen NCT Testing Technology Co., Ltd. 2008

2 Test Summary

Test Items	Test Requirement	Result
Conduct Emission	FCC part 15.207	PASS
Radiated Spurious Emissions	FCC part 15.205/15.209	PASS
Conducted Spurious Emission	FCC part 15. 247(d)	PASS
Band edge	FCC part 15.247(d)	PASS
6dB&99% Bandwidth	FCC part 15.247 (a)(2)	PASS
Maximum Peak Output Power	FCC part 15.247 (b)(3)	PASS
Power Spectral Density	FCC part 15.247 (e)	PASS
Antenna Requirement	FCC part 15.203/15.247 (c)	PASS

Remark:

1. “N/A” denotes test is not applicable in this Test Report.

2.1 Test Site

Site Description

EMC Lab. : Accredited by CNAS, 2022-09-27

The certificate is valid until 2028.01.07

The Laboratory has been assessed and proved to be in compliance with CNAS-CL01:2006 (identical to ISO/IEC 17025:2017)

The Certificate Registration Number is L8251

Designation Number: CN1347

Test Firm Registration Number: 894804

Accredited by A2LA, June 14, 2023

The Certificate Registration Number is 6837.01

Accredited by Industry Canada, November 09, 2018

The Conformity Assessment Body Identifier is CN0150

Company Number: 30806

Name of Firm : Shenzhen NCT Testing Technology Co., Ltd.

Site Location : A101&2F B2, Fuqiao 6th Area, Xintian Community, Fuhai Street, Baoan District, Shenzhen, People's Republic of China

3 General Information

3.1 General Description of E.U.T.

Product Name	:	Wireless Keyboard
Model Name	:	ZOOM98
Sample ID	:	24006136E-001#
Sample(s) Status:	:	Engineer sample
Series Model	:	N/A
Model Different.:	:	N/A
Operating frequency	:	2404-2480MHz
Number of Channels	:	39 channels
Type of Modulation	:	GFSK
Antenna installation	:	PCB Antenna
Antenna Gain	:	-0.952dBi
Power supply	:	DC 3.7V by battery ; Charging input: DC 5V
Hardware Version	:	N/A
Software Version	:	N/A
Remark：the Antenna gain is provided by customer from Antenna spec. and the laboratory will not be responsible for the accumulated calculation results which covers the information provided by the applicant.		

3.2 Channel List

The EUT has been tested under its typical operating condition. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst case data were reported.

The EUT has been associated with peripherals pursuant to ANSI C63.10-2013 and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation (9 KHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

The details of test channels and bandwidth were for RF conductive measurement.

Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	**2404**	14	2432	28	2460
01	2406	15	2434	29	2462
02	2408	16	2436	30	2464
03	2410	17	2438	31	2466
04	2412	18	2440	32	2468
05	2414	**19**	**2442**	33	2470
06	2416	20	2444	34	2472
07	2418	21	2446	35	2474
08	2420	22	2448	36	2476
09	2422	23	2450	37	2478
10	2424	24	2452	38	**2480**
11	2426	25	2454		
12	2428	26	2456		
13	2430	27	2458		

Note:

1. Test of channel was included the lowest, middle and highest frequency in highest data rate and to perform the test, then record on this report.

3.3 Test Setup Configuration

Conducted Emission

AC Line — Adapter — DC Line — EUT

Radiated Emission(30MHz-1GHz)

PC — USB Line — EUT or EUT

Radiated Emission(above 1GHz)

EUT

Conducted Spurious

EUT

3.4 Test Mode

Transmitting mode	Keep the EUT in continuously transmitting mode.

Test Software	bt_tool_v1.1.2
Power level setup	< 1 dBm

	Channel	Frequency(MHz)
Low Channel	00	2404
Mid Channel	19	2442
High Channel	38	2480

4 Equipment During Test

4.1 Equipments List

Conducted emission Test Equipment

Name	Model No.	Serial No.	Manufacturer	Date of Cal.	Due Date
944 Shielded Room	944 Room	/	EMToni	2022/5/31	2025/5/30
EMI Test Receiver	ESPI	101604	Rohde & Schwarz	2023/6/21	2024/6/20
LISN	ENV 216	102796	Rohde & Schwarz	2023/6/21	2024/6/20
LISN	VN1-13S	004023	CRANAGE	2023/6/21	2024/6/20
Cable	RG223-1500MM	NA	RG	2023/6/21	2024/6/20

Radiated emission & Radio Frequency Test Equipment

Name	Model No.	Serial No.	Manufacturer	Date of Cal.	Due Date
966 Shielded Room	966 Room	/	EMToni	2022/5/31	2025/5/30
EMI Test Receiver	ESCI	101178	Rohde & Schwarz	2023/6/21	2024/6/20
Amplifi（30MHz-1GHz）	BBV 9743 B	00374	SCHNWARZBECK	2023/6/21	2024/6/20
Bilog Antenna（30MHz-1GHz）	VULB9162	00473	SCHNWARZBECK	2023/3/19	2025/3/18
Horn antenna（1GHz-18GHz）	BBHA 9120 D	02622	SCHNWARZBECK	2023/3/19	2025/3/18
Pream plifier（1GHz-18GHz）	BBV 9718D	0024	SCHNWARZBECK	2023/6/21	2024/6/20
Spectrum Analyze（10Hz-40GHz）	FSV 40	100952	Rohde & Schwarz	2023/6/21	2024/6/20
Pream plifier（18GHz-40GHz）	BBV 9721	0056	SCHNWARZBECK	2023/6/21	2024/6/20
Double Ridge Guide Horn Antenna（18GHz-40GHz）	SAS-574	588	A.H.System	2023/3/19	2025/3/18
Loop Antenna (9KHz-30MHz)	FMZB1519B	014	SCHNWARZBECK	2023/6/21	2024/6/20
Amplifier (9KHz-30MHz)	CVP 9222 C	00109	CHNWARZBECK	2023/6/21	2024/6/20

MXG Signal Analyzer	N9020A	MY50510202	Agilent	2023/6/21	2024/6/20
MXG Vector Signal Generator	N5182A	MY50140020	Agilent	2023/6/21	2024/6/20
MXG Analog Signal Generator	N5181A	MY47420919	Agilent	2023/6/21	2024/6/20
Power Sensor	TR1029-2	512364	Techoy	2023/6/21	2024/6/20
RF Swith	TR1029-1	512364	Techoy	2023/6/21	2024/6/20
Cable	DA800-4000MM	NA	DA	2023/6/21	2024/6/20
Cable	DA800-11000MM	NA	DA	2023/6/21	2024/6/20

Other

Item	Name	Manufacturer	Model	Software version
1	EMC Conduction Test System	AUDIX	e3	6.120718
2	EMC radiation test system	AUDIX	e3	6.120718
3	RF test system	TACHOY	RFTest	V1.0.0
4	RF communication test system	TACHOY	RFTest	V1.0.0

4.2 Measurement Uncertainty

Parameter	Uncertainty
RF output power, conducted	±1.0dB
Power Spectral Density, conducted	±2.2dB
Radio Frequency	± 1 x 10^{-6}
Bandwidth	± 1.5 x 10^{-6}
Time	±2%
Duty Cycle	±2%
Temperature	±1°C
Humidity	±5%
DC and low frequency voltages	±3%
Conducted Emissions (150kHz~30MHz)	±3.64dB
Radiated Emission(9kHz~30MHz)	±4.51dB
Radiated Emission(30MHz~1GHz)	±5.03dB
Radiated Emission(1GHz~25GHz)	±4.74dB
Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95%	

4.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
E-1	Wireless Keyboard	WOB	ZOOM98	N/A	EUT
E-2	Adapter	N/A	A18A-050100U-US2	N/A	Auxiliary
E-3	PC	N/A	300-15SK	N/A	Auxiliary

Note: (1)The support equipment was authorized by Declaration of Confirmation.

(2) For detachable type I/O cable should be specified the length in cm in『Length』column.

5 Conducted Emission

Test Requirement	:	FCC CFR 47 Part 15 Section 15.207
Test Method	:	ANSI C63.10: 2013
Test Result	:	PASS
Frequency Range	:	150kHz to 30MHz
Class/Severity	:	Class B

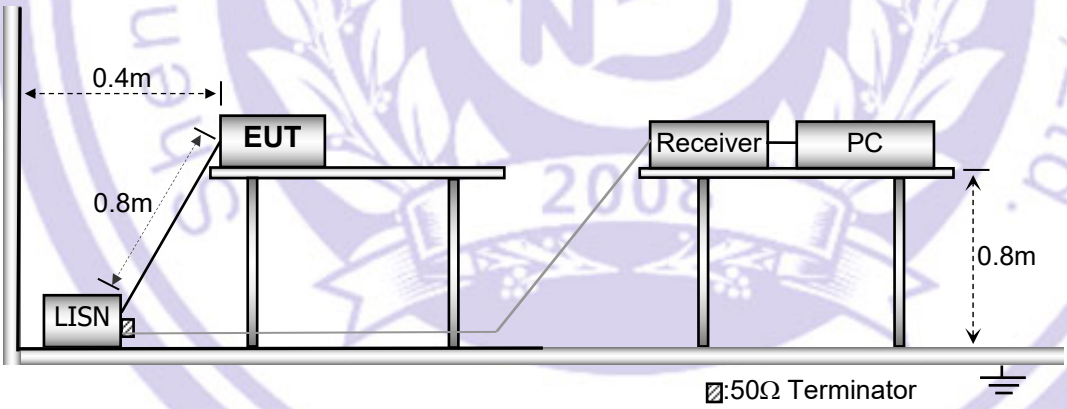
5.1 E.U.T. Operation

Operating Environment :

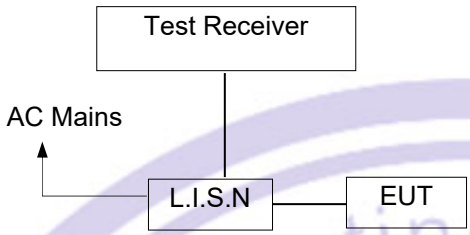
Temperature	:	25.5 °C
Humidity	:	51 % RH
Atmospheric Pressure	:	101.2kPa

5.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10:2013.



5.3 Test SET-UP (Block Diagram of Configuration)



5.4 Measurement Procedure

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured was complete.

5.5 Conducted Emission Limit

Conducted Emission

Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

Note:

1. The lower limit shall apply at the transition frequencies
2.The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

5.6 Measurement Description

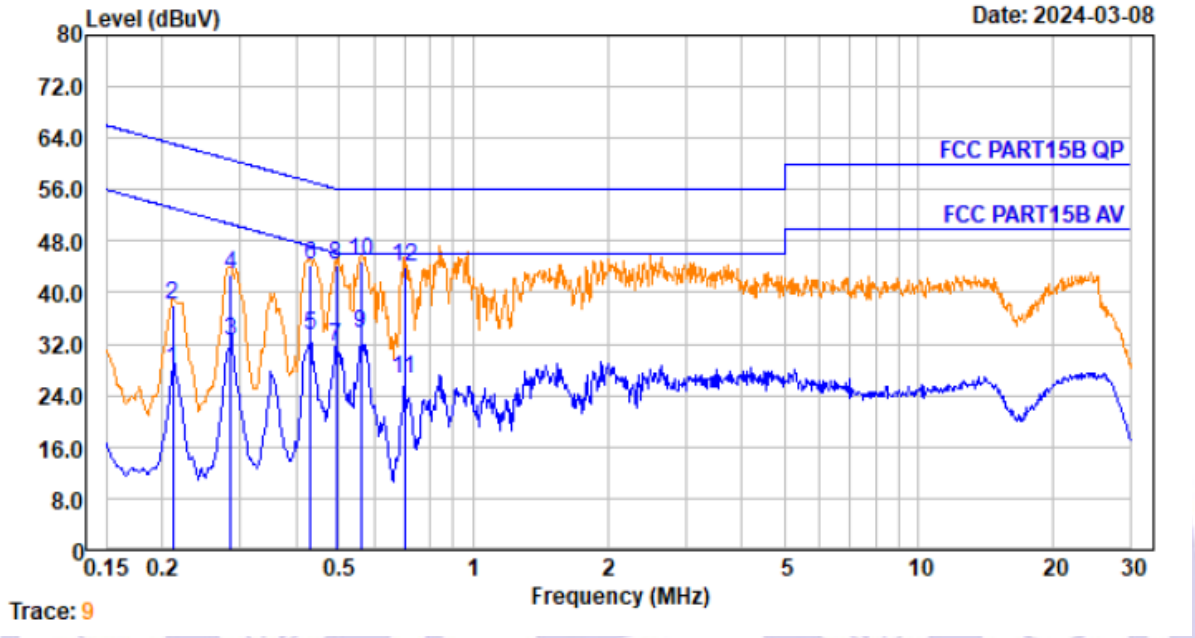
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

5.7 Conducted Emission Test Result

Pass

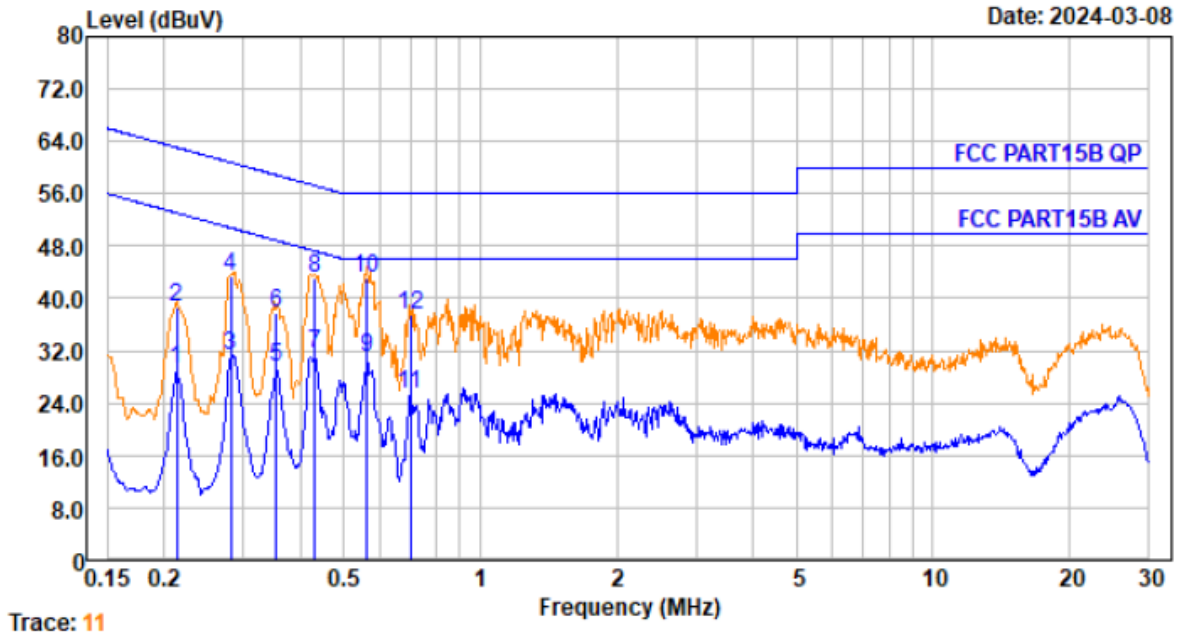
Conducted emission at both 120V & 240V is assessed, and emission at 120V represents the worst case. All the modulation modes were tested the data of the worst mode (GFSK) are recorded in the following pages and the others modulation methods do not exceed the limits.

Channel:	Middle	Phase :	L



No.	Freq MHz	Cable Loss dB	LISN Factor dB/m	Receiver Reading dBuV	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	0.212	0.01	9.55	8.30	28.01	53.14	-25.13	Average
2.	0.212	0.01	9.55	18.30	38.01	63.14	-25.13	QP
3.	0.285	0.01	9.56	12.78	32.49	50.68	-18.19	Average
4.	0.285	0.01	9.56	23.19	42.90	60.68	-17.78	QP
5.	0.431	0.01	9.57	13.67	33.37	47.24	-13.87	Average
6.	0.431	0.01	9.57	24.60	44.30	57.24	-12.94	QP
7.	0.491	0.01	9.57	11.87	31.57	46.14	-14.57	Average
8.	0.491	0.01	9.57	24.50	44.20	56.14	-11.94	QP
9.	0.558	0.01	9.57	14.00	33.69	46.00	-12.31	Average
10.	0.558	0.01	9.57	25.31	45.00	56.00	-11.00	QP
11.	0.701	0.02	9.58	6.97	26.67	46.00	-19.33	Average
12.	0.701	0.02	9.58	24.20	43.90	56.00	-12.10	QP

Channel:	Middle	Phase :	N



No.	Freq MHz	Cable Loss dB	LISN Factor dB/m	Receiver Reading dBuV	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	0.214	0.01	9.55	9.59	29.30	53.05	-23.75	Average
2.	0.214	0.01	9.55	19.10	38.81	63.05	-24.24	QP
3.	0.282	0.01	9.56	11.65	31.36	50.76	-19.40	Average
4.	0.282	0.01	9.56	23.59	43.30	60.76	-17.46	QP
5.	0.354	0.01	9.57	9.78	29.49	48.87	-19.38	Average
6.	0.354	0.01	9.57	18.10	37.81	58.87	-21.06	QP
7.	0.431	0.01	9.57	11.86	31.56	47.24	-15.68	Average
8.	0.431	0.01	9.57	23.51	43.21	57.24	-14.03	QP
9.	0.561	0.01	9.58	11.41	31.11	46.00	-14.89	Average
10.	0.561	0.01	9.58	23.41	43.11	56.00	-12.89	QP
11.	0.701	0.02	9.58	5.82	25.52	46.00	-20.48	Average
12.	0.701	0.02	9.58	17.80	37.50	56.00	-18.50	QP

Notes:
1.An initial pre-scan was performed on the line and neutral lines with peak detector.
2.Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3.Mesurement Level = Reading level + Correct Factor

6 Radiated Spurious Emissions

Test Requirement : FCC CFR47 Part 15 Section 15.209 & 15.247,

Test Method : ANSI C63.10:2013

Test Result : PASS

Measurement Distance : 3m

Limit : See the follow table

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

6.1 EUT Operation

Operating Environment :

Temperature : 23.5 °C

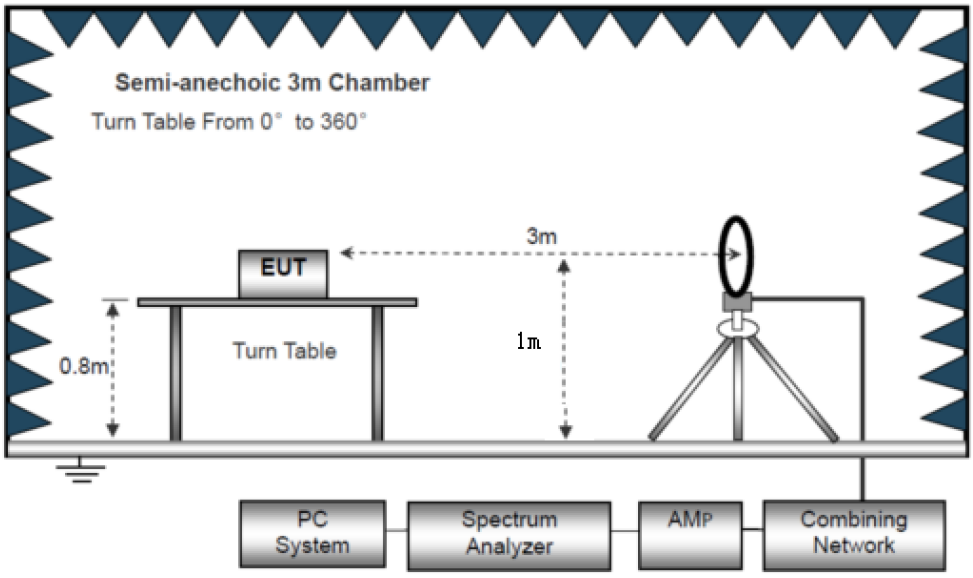
Humidity : 51.1 % RH

Atmospheric Pressure : 101.2kPa

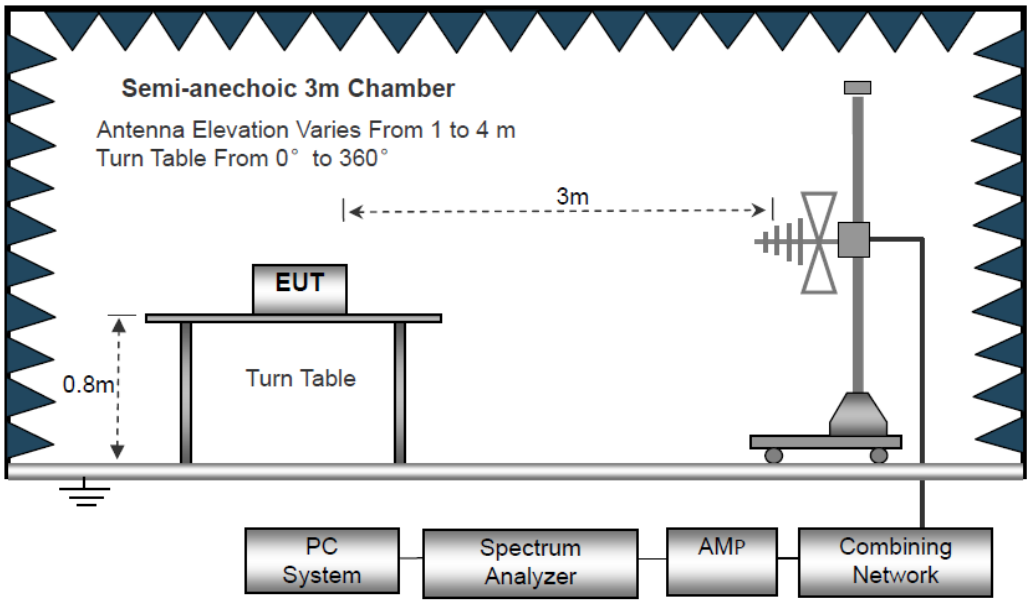
6.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site

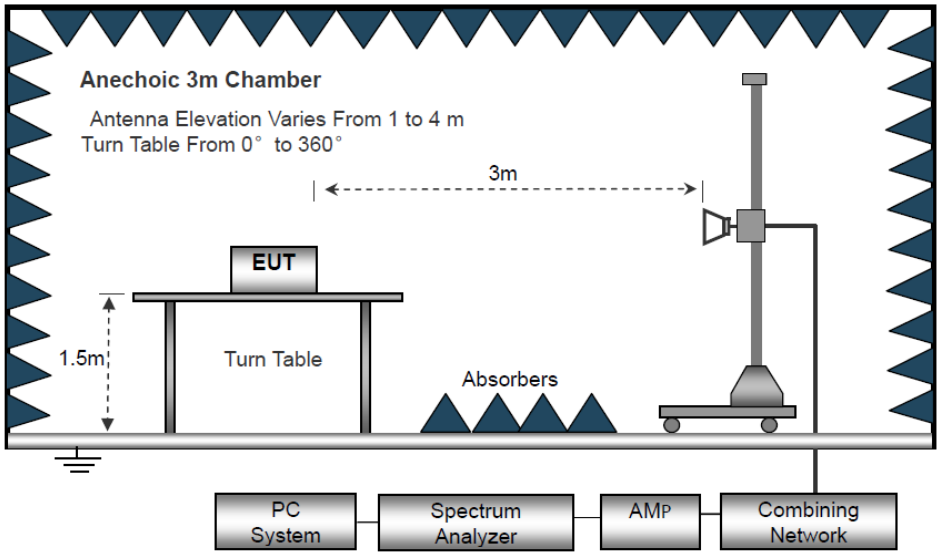
The test setup for emission measurement below 30MHz



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz



6.3 Spectrum Analyzer Setup

	Frequency	Detector	RBW	VBW	Remark
Receiver Setup	Below 30MHz	--	10kHz	10kHz	--
	30MHz ~ 1GHz	Quasi-peak	120kHz	300kHz	Quasi-peak Value
	Above 1GHz	Peak	1MHz	3MHz	Peak Value
		RMS	1MHz	3MHz	Average Value

6.4 Test Procedure

1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.

2. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.

3. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (From 1m to 4m) and turntable (from 0 degree to 360 degree) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.

5. Set to the maximum power setting and enable the EUT transmit continuously.

6. Final measurement (Above 1GHz): The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 degree to 360 degree in order to have the antenna inside the cone of radiation.

7. Test Procedure of measurement (For Above 1GHz):

1) Monitor the frequency range at horizontal polarization and move the antenna over all sides of the EUT(if necessary move the EUT to another orthogonal axis).

2) Change the antenna polarization and repeat 1) with vertical polarization.

3) Make a hardcopy of the spectrum.

4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

5) Change the analyser mode to Clear/ Write and found the cone of emission.

6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3m and the antenna will be still inside the cone of emission.

7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarization and azimuth and the peak and average detector, which causes the maximum emission.

8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

8. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.

6.5 Summary of Test Results

Test Frequency: 9KHz-30MHz

Freq. (MHz)	Ant.Pol. H/V	Emission Level (dBuV/m)	Limit 3m (dBuV/m)	Over (dB)
--	--	--	--	>20

Note:

The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

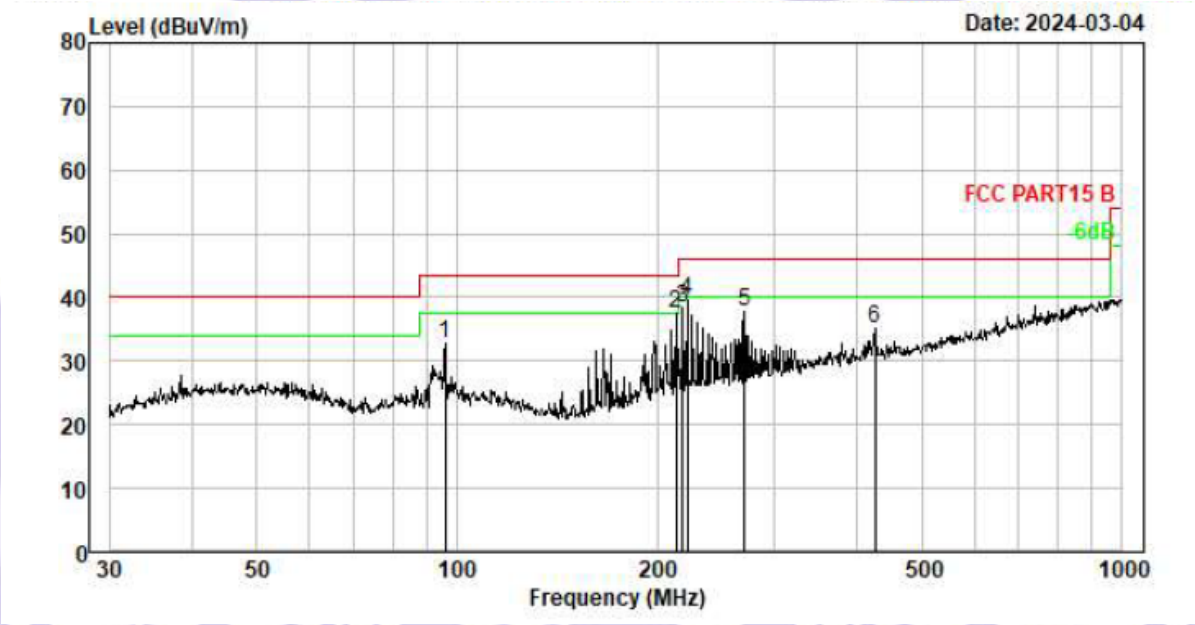
Distance extrapolation factor =40log(Specific distance/ test distance)(dB);
Limit line=Specific limits(dBuV) + distance extrapolation factor.

Test Frequency: 30MHz ~ 1GHz

Pass.

Please refer to the following test plots for the worst test mode (GFSK (CH00: 2402MHz)).

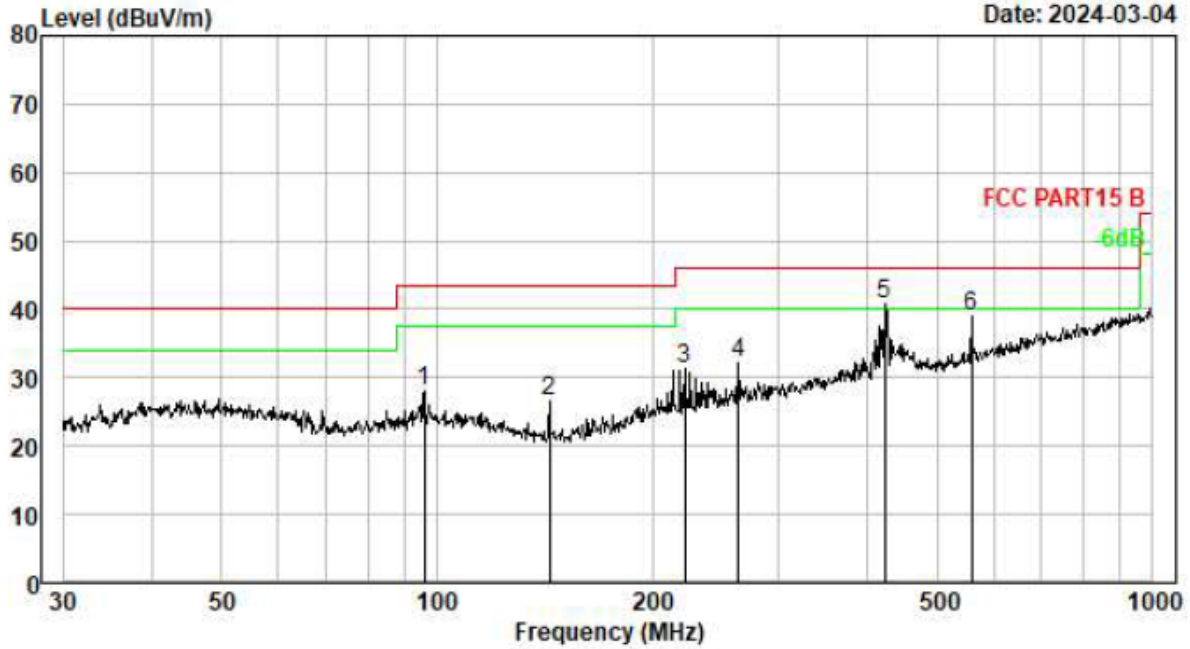
Temperature:	26℃	Relative Humidity:	54%
Pressure:	101 kPa	Polarization:	Horizontal
Test Voltage:	DC 5V		



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Preamp Gain dB	Receiver Reading dBμV	Emission Level dBμV/m	Limit dBμV/m	Over Limit dB	Remark
1	96.099	0.68	10.65	0.00	21.34	32.67	43.50	-10.83	QP
2	213.763	1.10	11.88	0.00	24.37	37.35	43.50	-6.15	QP
3	218.309	1.11	12.03	0.00	25.14	38.28	46.00	-7.72	QP
4	222.170	1.12	12.15	0.00	26.43	39.70	46.00	-6.30	QP
5	270.375	1.22	13.56	0.00	22.97	37.75	46.00	-8.25	QP
6	425.028	1.46	16.18	0.00	17.35	34.99	46.00	-11.01	QP

Remark:Emission Level=Reading+Cable Loss+ANT Factor-AMP Factor

Temperature:	26℃	Relative Humidity:	54%
Pressure:	101 kPa	Polarization:	Vertical
Test Voltage:	DC 5V		



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Preamp Gain dB	Receiver Reading dBμV	Emission Level dBμV/m	Limit dBμV/m	Over Limit dB	Remark
1	96.099	0.68	10.65	0.00	16.72	28.05	43.50	-15.45	QP
2	143.830	0.88	8.42	0.00	17.32	26.62	43.50	-16.88	QP
3	222.170	1.12	12.15	0.00	17.88	31.15	46.00	-14.85	QP
4	263.819	1.21	13.38	0.00	17.69	32.28	46.00	-13.72	QP
5	422.058	1.46	16.14	0.00	23.01	40.61	46.00	-5.39	QP
6	558.730	1.65	18.24	0.00	19.12	39.01	46.00	-6.99	QP

Remark:Emission Level=Reading+Cable Loss+ANT Factor-AMP Factor

Test Frequency 1GHz-25GHz:

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
Low Channel:2404MHz									
V	4808.00	53.69	30.55	5.77	24.66	53.57	74.00	-20.43	Pk
V	4808.00	43.78	30.55	5.77	24.66	43.66	54.00	-10.34	AV
V	7212.00	53.25	30.33	6.32	24.55	53.79	74.00	-20.21	Pk
V	7212.00	43.39	30.33	6.32	24.55	43.93	54.00	-10.07	AV
V	9616.00	53.16	30.85	7.45	24.69	54.45	74.00	-19.55	Pk
V	9616.00	42.15	30.85	7.45	24.69	43.44	54.00	-10.56	AV
V	12020.00	53.27	31.02	8.99	25.57	56.81	74.00	-17.19	Pk
V	12020.00	42.35	31.02	8.99	25.57	45.89	54.00	-8.11	AV
H	4808.00	53.11	30.55	5.77	24.66	52.99	74.00	-21.01	Pk
H	4808.00	43.09	30.55	5.77	24.66	42.97	54.00	-11.03	AV
H	7212.00	53.25	30.33	6.32	24.55	53.79	74.00	-20.21	Pk
H	7212.00	42.29	30.33	6.32	24.55	42.83	54.00	-11.17	AV
H	9616.00	53.58	30.85	7.45	24.69	54.87	74.00	-19.13	Pk
H	9616.00	43.36	30.85	7.45	24.69	44.65	54.00	-9.35	AV
H	12020.00	51.57	31.02	8.99	25.57	55.11	74.00	-18.89	Pk
H	12020.00	42.19	31.02	8.99	25.57	45.73	54.00	-8.27	AV

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
Middle Channel:2442MHz									
V	4884.00	53.25	30.55	5.77	24.66	53.13	74.00	-20.87	Pk
V	4884.00	42.36	30.55	5.77	24.66	42.24	54.00	-11.76	AV
V	7326.00	53.68	30.33	6.32	24.55	54.22	74.00	-19.78	Pk
V	7326.00	43.11	30.33	6.32	24.55	43.65	54.00	-10.35	AV
V	9768.00	53.88	30.85	7.45	24.69	55.17	74.00	-18.83	Pk
V	9768.00	43.89	30.85	7.45	24.69	45.18	54.00	-8.82	AV
V	12210.00	52.27	31.02	8.99	25.57	55.81	74.00	-18.19	Pk
V	12210.00	42.18	31.02	8.99	25.57	45.72	54.00	-8.28	AV
H	4884.00	52.27	30.55	5.77	24.66	52.15	74.00	-21.85	Pk
H	4884.00	41.69	30.55	5.77	24.66	41.57	54.00	-12.43	AV
H	7326.00	52.78	30.33	6.32	24.55	53.32	74.00	-20.68	Pk
H	7326.00	41.63	30.33	6.32	24.55	42.17	54.00	-11.83	AV
H	9768.00	52.19	30.85	7.45	24.69	53.48	74.00	-20.52	Pk
H	9768.00	41.78	30.85	7.45	24.69	43.07	54.00	-10.93	AV
H	12210.00	53.93	31.02	8.99	25.57	57.47	74.00	-16.53	Pk
H	12210.00	41.39	31.02	8.99	25.57	44.93	54.00	-9.07	AV

Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Detector Type
High Channel:2480MHz									
V	4960.00	53.99	30.55	5.77	24.66	53.87	74.00	-20.13	Pk
V	4960.00	43.15	30.55	5.77	24.66	43.03	54.00	-10.97	AV
V	7440.00	52.27	30.33	6.32	24.55	52.81	74.00	-21.19	Pk
V	7440.00	42.62	30.33	6.32	24.55	43.16	54.00	-10.84	AV
V	9920.00	54.58	30.85	7.45	24.69	55.87	74.00	-18.13	Pk
V	9920.00	42.33	30.85	7.45	24.69	43.62	54.00	-10.38	AV
V	12400.00	54.85	31.02	8.99	25.57	58.39	74.00	-15.61	Pk
V	12400.00	42.78	31.02	8.99	25.57	46.32	54.00	-7.68	AV
H	4960.00	53.23	30.55	5.77	24.66	53.11	74.00	-20.89	Pk
H	4960.00	43.58	30.55	5.77	24.66	43.46	54.00	-10.54	AV
H	7440.00	54.33	30.33	6.32	24.55	54.87	74.00	-19.13	Pk
H	7440.00	43.45	30.33	6.32	24.55	43.99	54.00	-10.01	AV
H	9920.00	52.78	30.85	7.45	24.69	54.07	74.00	-19.93	Pk
H	9920.00	42.12	30.85	7.45	24.69	43.41	54.00	-10.59	AV
H	12400.00	52.97	31.02	8.99	25.57	56.51	74.00	-17.49	Pk
H	12400.00	42.55	31.02	8.99	25.57	46.09	54.00	-7.91	AV

Note: 1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier,

Margin= Emission Level - Limit

2. If peak below the average limit, the average emission was no test.

3. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Spurious Emission in Restricted Band 2310-2390MHz and 2483.5-2500MHz

	Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission level (dBuV/m)	Limit (dBuV/m)	Detector Type	Result
GFSK	Low Channel: 2404MHz									
	H	2390.00	58.66	30.22	4.85	23.98	57.27	74.00	PK	PASS
	H	2390.00	48.23	30.22	4.85	23.98	46.84	54.00	AV	PASS
	H	2400.00	59.22	30.22	4.85	23.98	57.83	74.00	PK	PASS
	H	2400.00	48.58	30.22	4.85	23.98	47.19	54.00	AV	PASS
	V	2390.00	60.23	30.22	4.85	23.98	58.84	74.00	PK	PASS
	V	2390.00	47.86	30.22	4.85	23.98	46.47	54.00	AV	PASS
	V	2400.00	60.12	30.22	4.85	23.98	58.73	74.00	PK	PASS
	V	2400.00	47.86	30.22	4.85	23.98	46.47	54.00	AV	PASS
	High Channel: 2480MHz									
	H	2483.50	58.78	30.22	4.85	23.98	57.39	74.00	PK	PASS
	H	2483.50	48.12	30.22	4.85	23.98	46.73	54.00	AV	PASS
	H	2500.00	60.06	30.22	4.85	23.98	58.67	74.00	PK	PASS
	H	2500.00	48.68	30.22	4.85	23.98	47.29	54.00	AV	PASS
	V	2483.50	61.06	30.22	4.85	23.98	59.67	74.00	PK	PASS
	V	2483.50	48.56	30.22	4.85	23.98	47.17	54.00	AV	PASS
	V	2500.00	61.08	30.22	4.85	23.98	59.69	74.00	PK	PASS
	V	2500.00	48.66	30.22	4.85	23.98	47.27	54.00	AV	PASS

Remark:

1. Emission Level = Meter Reading + Antenna Factor + Cable Loss − Pre-amplifier, Margin= Emission Level - Limit

7 Conduct Band Edge And Spurious Emissions Measurement

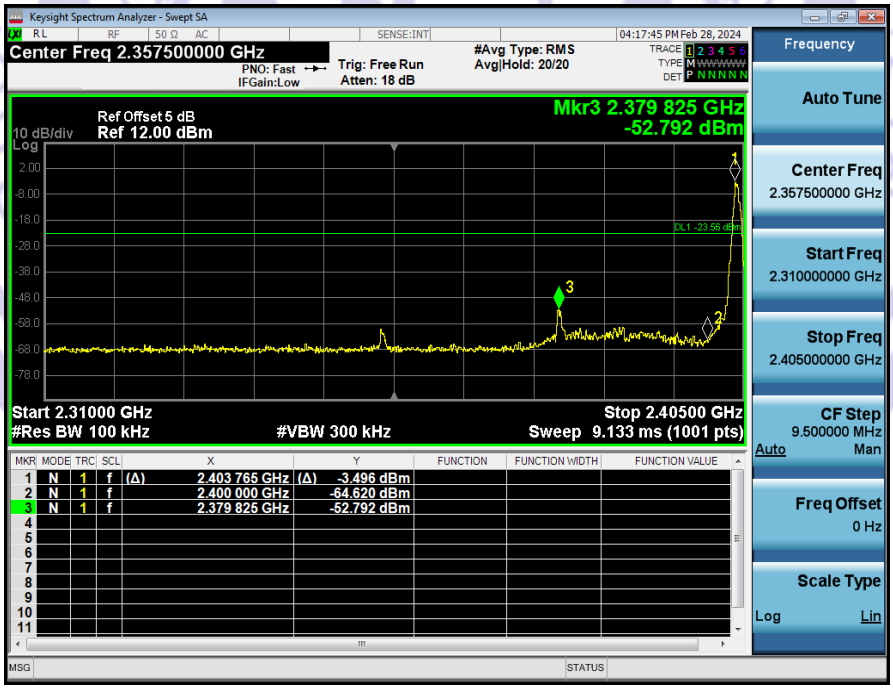
Test Requirement	:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method	:	ANSI C63.10:2013
Test Limit	:	Regulation 15.247 (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)).

7.1 Test Procedure

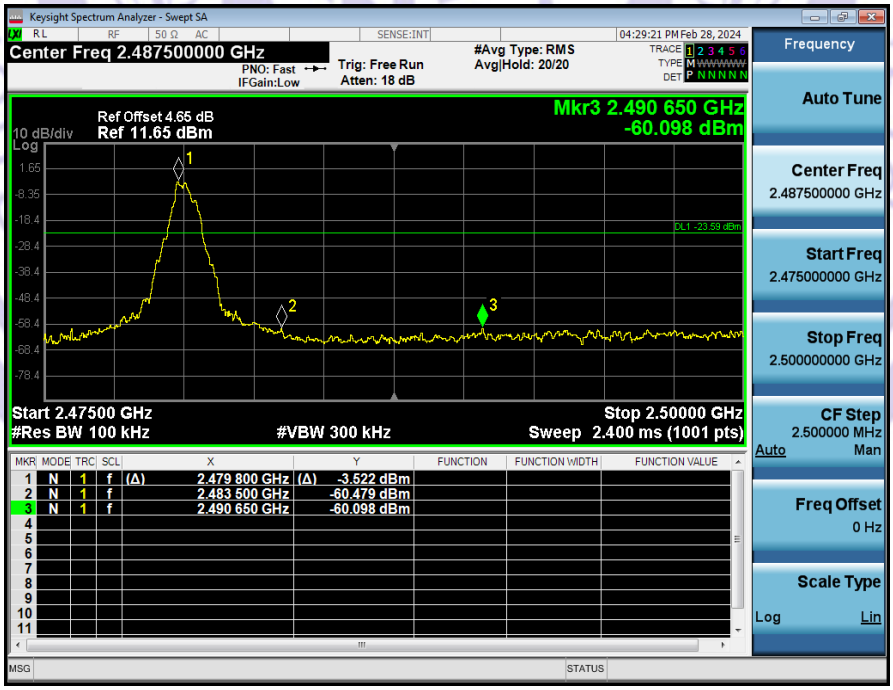
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold

7.2 Test Result

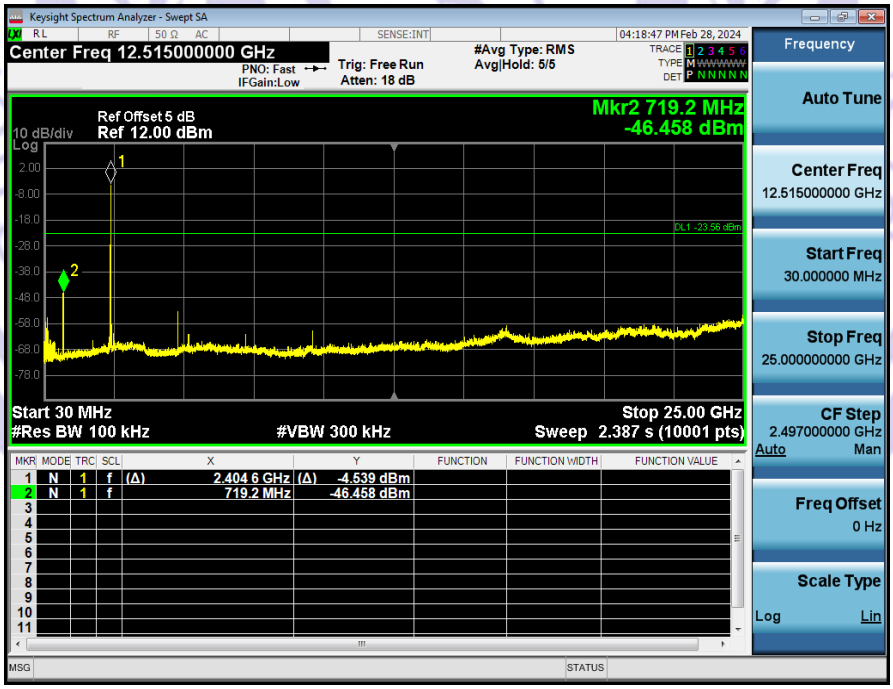
GFSK: Band Edge, Left Side



GFSK: Band Edge, Right Side

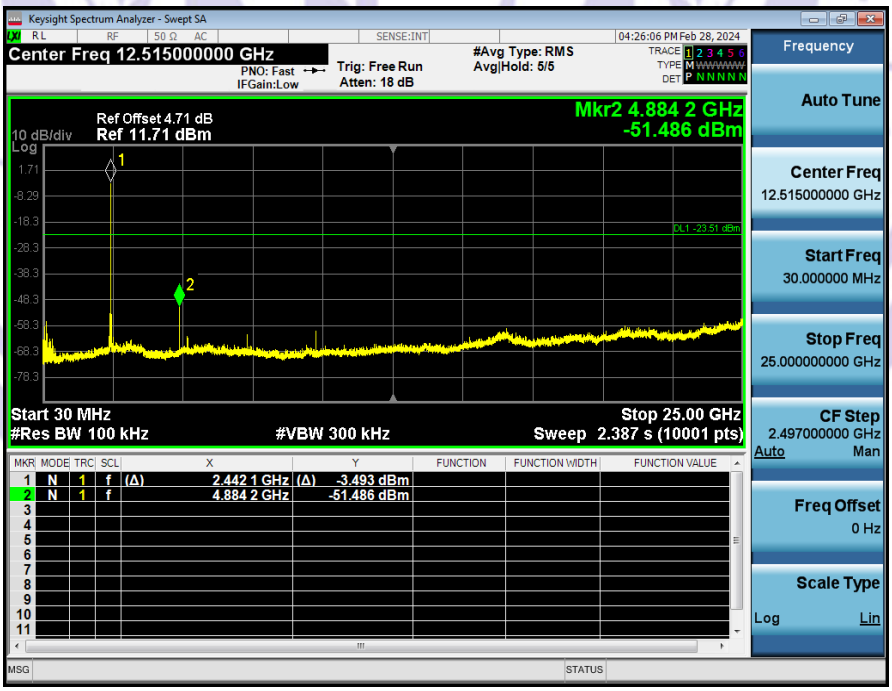


Lowest channel

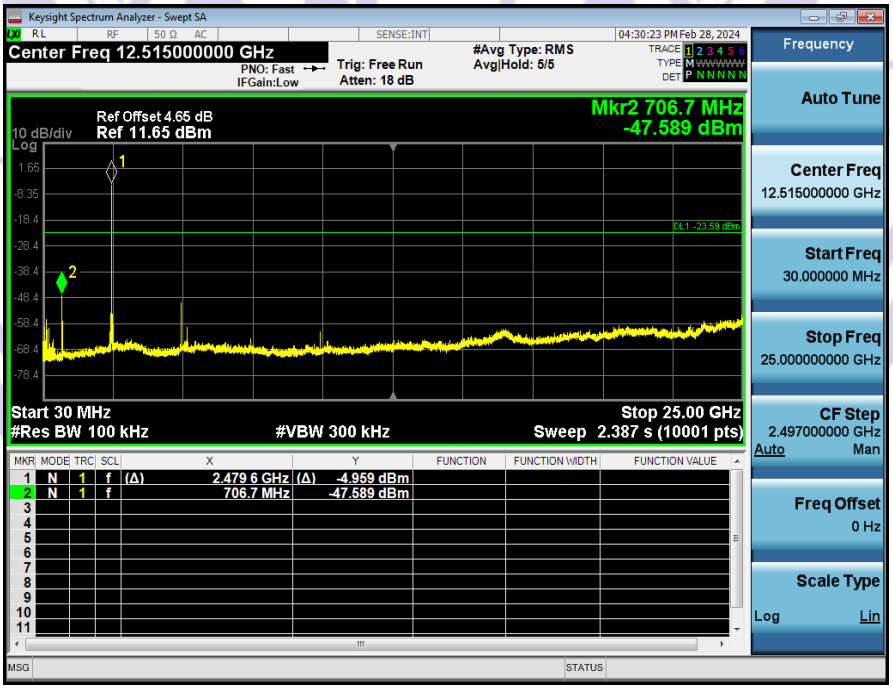


Mid channel

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.442000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 22 dB
#Avg Type: RMS
Avg|Hold: 20/20
04:25:04 PM Feb 28, 2024
Ref Offset 4.71 dB
10 dB/div
Ref 16.42 dBm
Mkr1 2.441 790 GHz
-3.513 dBm
Center 2.442000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 5.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.442000000 GHz
Start Freq
2.439500000 GHz
Stop Freq
2.444500000 GHz
CF Step
500.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin


Keysight Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 18 dB
#Avg Type: RMS
Avg|Hold: 5/5
04:26:06 PM Feb 28, 2024
Ref Offset 4.71 dB
10 dB/div
Ref 11.71 dBm
Mkr2 4.884 2 GHz
-51.486 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (10001 pts)
1 N 1 f (Δ) 2.442 1 GHz (Δ) -3.493 dBm
2 N 1 f 4.884 2 GHz -51.486 dBm
Frequency
Auto Tune
Center Freq
12.515000000 GHz
Start Freq
30.000000 MHz
Stop Freq
25.000000000 GHz
CF Step
2.497000000 GHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

Highest channel



8 6dB Bandwidth Measurement

Test Requirement	:	FCC CFR47 Part 15 Section 15.247
Test Method	:	ANSI C63.10:2013
Test Limit		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.

8.1 Test Procedure

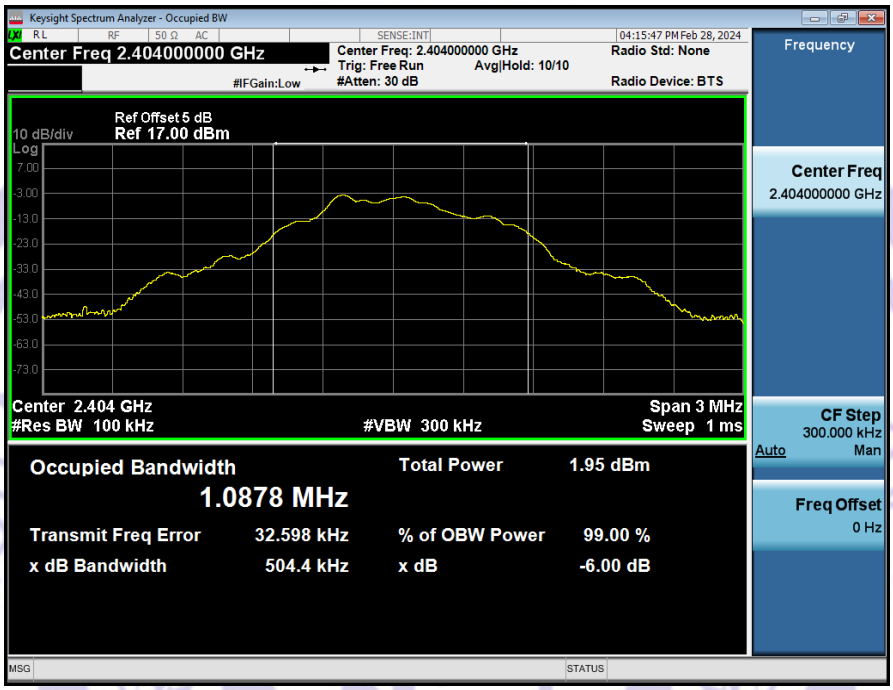
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz

8.2 Test Result

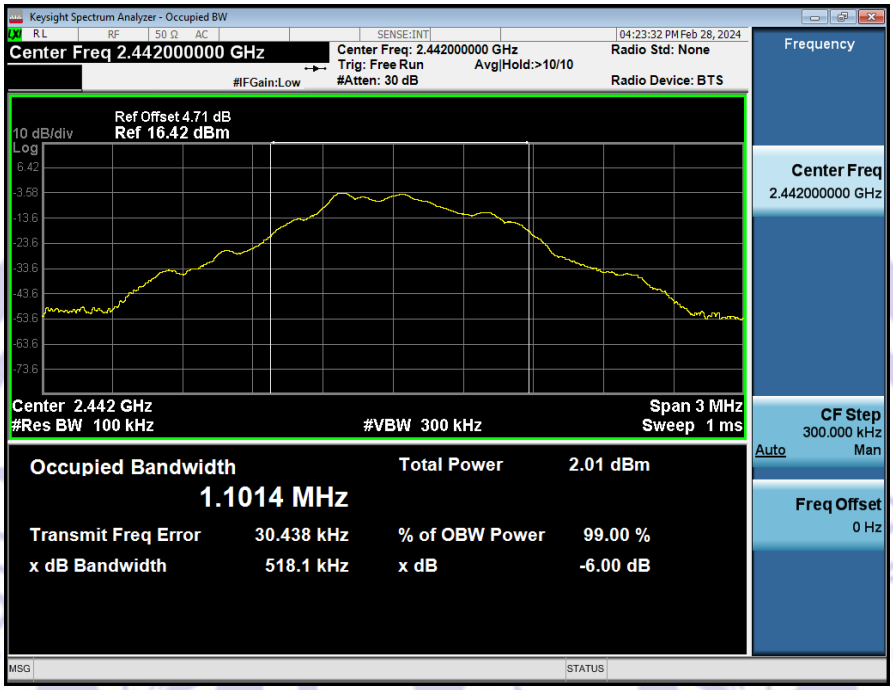
Channel number	Channel frequency (MHz)	-6dB Occupy Bandwidth (KHz)	Limit (KHz)	99% Occupy Bandwidth (MHz)	Limit (KHz)
00	2404	504.37	>500	/	/
19	2442	518.07	>500	/	/
38	2480	527.31	>500	/	/

-6dB Occupy Bandwidth

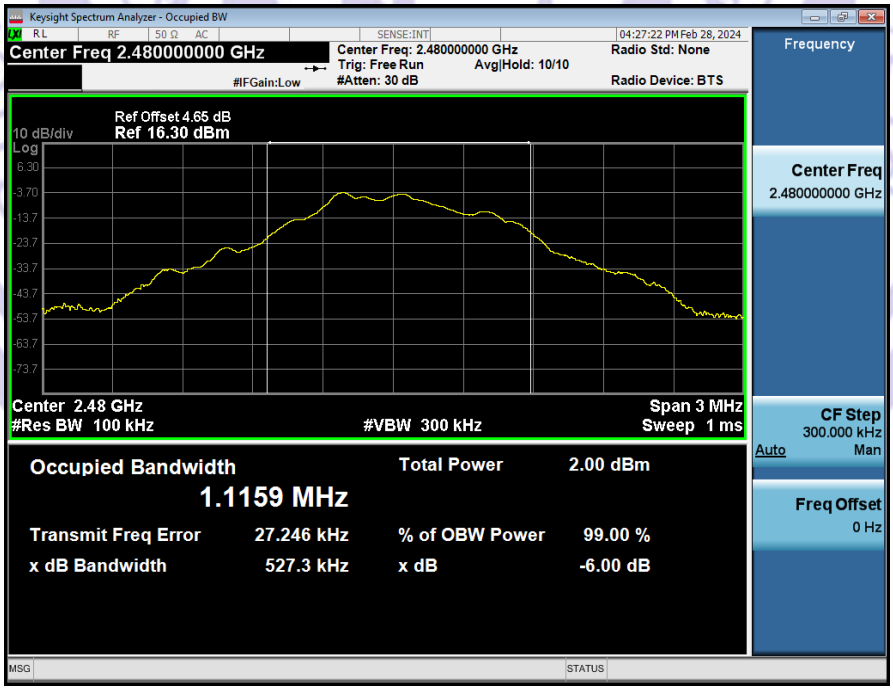
CH00



CH19


Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.442000000 GHz
Center Freq: 2.442000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
04:23:32 PM Feb 28, 2024
#IFGain:Low
Ref Offset 4.71 dB
10 dB/div
Ref 16.42 dBm
Center 2.442 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 3 MHz
Sweep 1 ms
Occupied Bandwidth
1.1014 MHz
Total Power 2.01 dBm
Transmit Freq Error 30.438 kHz
% of OBW Power 99.00 %
x dB Bandwidth 518.1 kHz
x dB -6.00 dB
Frequency
Center Freq
2.442000000 GHz
CF Step
300.000 kHz
Auto Man
Freq Offset
0 Hz

CH38


Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold: 10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
04:27:22 PM Feb 28, 2024
#IFGain:Low
Ref Offset 4.65 dB
10 dB/div
Ref 16.30 dBm
Center 2.48 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 3 MHz
Sweep 1 ms
Occupied Bandwidth
1.1159 MHz
Total Power 2.00 dBm
Transmit Freq Error 27.246 kHz
% of OBW Power 99.00 %
x dB Bandwidth 527.3 kHz
x dB -6.00 dB
Frequency
Center Freq
2.480000000 GHz
CF Step
300.000 kHz
Auto Man
Freq Offset
0 Hz

9 Maximum Peak Output Power

Test Requirement	:	FCC CFR47 Part 15 Section 15.247
Test Method	:	ANSI C63.10:2013
Test Limit	:	Regulation 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.

9.1 Test Procedure

1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Measure the conducted output power and record the results in the test report.

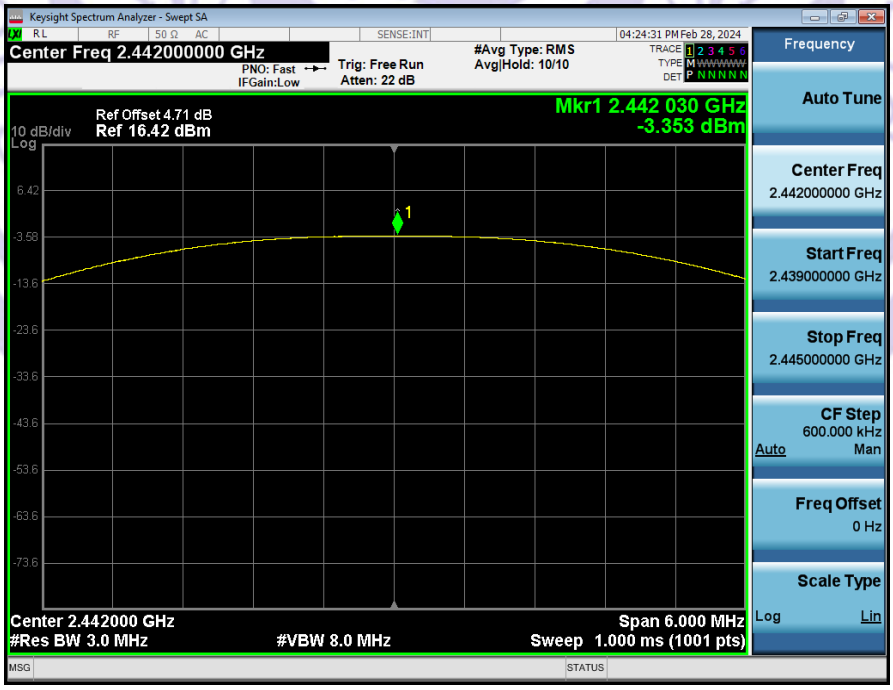
9.2 Test Result

Channel number	Channel Frequency (MHz)	Peak Power Output(dBm)	Peak Power Limit(dBm)	Verdict
00	2404	-3.39	30	PASS
19	2442	-3.35	30	PASS
38	2480	-3.42	30	PASS

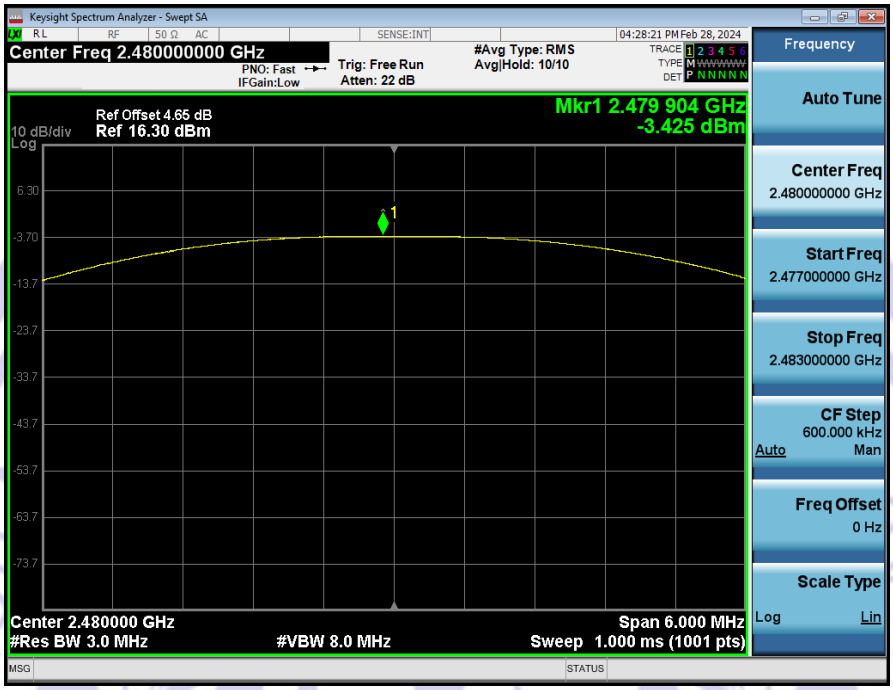
CH00

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.404000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 22 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:16:46 PM Feb 28, 2024
Ref Offset 5 dB
10 dB/div
Ref 17.00 dBm
Mkr1 2.404 090 GHz
-3.394 dBm
Center 2.404000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 6.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.404000000 GHz
Start Freq
2.401000000 GHz
Stop Freq
2.407000000 GHz
CF Step
600.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

CH19


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.442000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 22 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:24:31 PM Feb 28, 2024
Ref Offset 4.71 dB
10 dB/div
Ref 16.42 dBm
Mkr1 2.442 030 GHz
-3.353 dBm
Center 2.442000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 6.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.442000000 GHz
Start Freq
2.439000000 GHz
Stop Freq
2.445000000 GHz
CF Step
600.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

CH38


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 22 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:28:21 PM Feb 28, 2024
Ref Offset 4.65 dB
10 dB/div
Ref 16.30 dBm
Log
Mkr1 2.479 904 GHz
-3.425 dBm
Center 2.480000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 6.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.477000000 GHz
Stop Freq
2.483000000 GHz
CF Step
600.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

10 Power Spectral density

Test Requirement : FCC CFR47 Part 15 Section 15.247

Test Method : ANSI C63.10:2013

Test Limit : Regulation 15.247(f) The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 3kHz. VBW = 10kHz , Span = 1.5 times the DTS channel bandwidth(6 dB bandwidth). Sweep = auto; Detector Function = Peak. Trace = Max hold.

3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

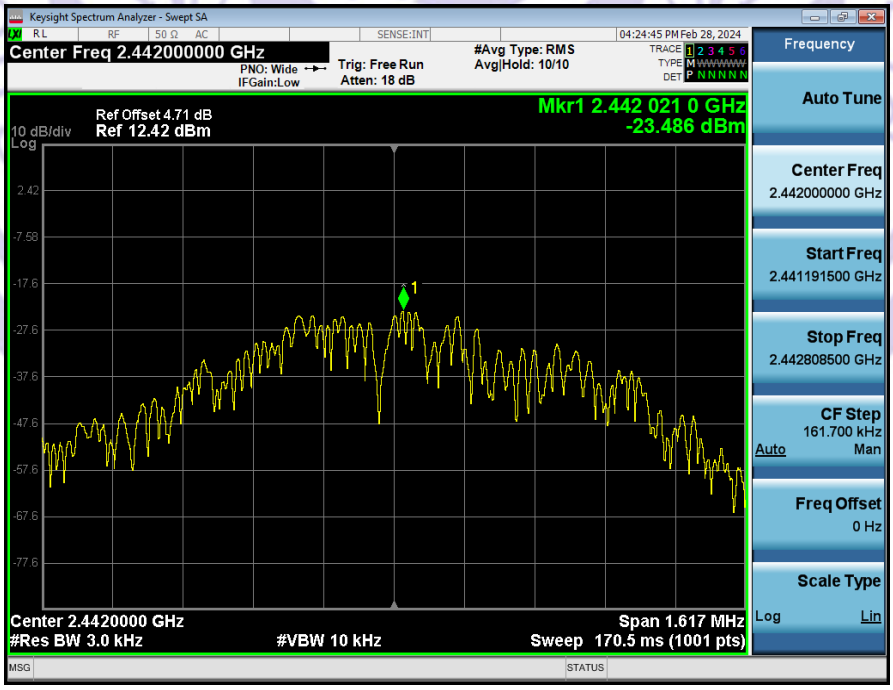
10.2 Test Result

Channel number	Channel frequency (MHz)	Measurement level (dBm)	Required Limit (dBm/3kHz)	Pass/Fail
		PSD/3kHz		
00	2404	-23.37	8	PASS
19	2442	-23.49	8	PASS
38	2480	-23.98	8	PASS

CH00

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.404000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 12 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:17:01 PM Feb 28, 2024
Ref Offset 5 dB
10 dB/div
Ref 7.00 dBm
Mkr1 2.404 020 5 GHz
-23.371 dBm
Center 2.4040000 GHz
#Res BW 3.0 kHz
#VBW 10 kHz
Span 1.580 MHz
Sweep 166.6 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.404000000 GHz
Start Freq
2.403210250 GHz
Stop Freq
2.404789750 GHz
CF Step
157.950 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

CH19


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.442000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 18 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:24:45 PM Feb 28, 2024
Ref Offset 4.71 dB
10 dB/div
Ref 12.42 dBm
Mkr1 2.442 021 0 GHz
-23.486 dBm
Center 2.4420000 GHz
#Res BW 3.0 kHz
#VBW 10 kHz
Span 1.617 MHz
Sweep 170.5 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.442000000 GHz
Start Freq
2.441191500 GHz
Stop Freq
2.442808500 GHz
CF Step
161.700 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

CH38

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 12 dB
#Avg Type: RMS
Avg|Hold: 10/10
04:28:36 PM Feb 28, 2024
Ref Offset 4.65 dB
10 dB/div
Ref 6.30 dBm
Log
Mkr1 2.480 051 15 GHz
-23.984 dBm
Center 2.4800000 GHz
#Res BW 3.0 kHz
#VBW 10 kHz
Span 1.650 MHz
Sweep 174.0 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.479175000 GHz
Stop Freq
2.480825000 GHz
CF Step
165.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

11 Antenna Application

11.1 Antenna Requirement

15.203 requirement:

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, 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.

15.247(c) (1)(i) requirement:

Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

11.2 Result

The antenna is PCB antenna, the best case gain of the antennas is -0.952 dBi, reference to the attachment for details.

12 Test Setup Photos and EUT Photos

Please see the attachment for details.

******THE END REPORT******