

TEST REPORT

Reference No...... : WTF21D12149221W005 V2
FCC ID : BRWSPMR14000
Applicant..... : Horizon Hobby, LLC.
Address..... : 2904 Research Rd, Champaign, IL 61822 United States
Manufacturer : Horizon Hobby, LLC.
Address..... : 2904 Research Rd., Champaign, IL, 61822 United States
Product..... : iX14
Model(s) : SPMR14000, SPMR140001
Standards..... : FCC 47CFR Part15 Subpart C §15.247
Date of Receipt sample : 2021-12-30
Date of Test : 2021-12-30 to 2022-03-01
Date of Issue..... : 2022-03-31
Test Result..... : Pass

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

Waltek Testing Group Co., Ltd.

Address: No. 77, Houjie Section, Guantai Road, Houjie Town, Dongguan City, Guangdong, China

Tel: +86-769-2267 6998

Fax: +86-769-2267 6828

Compiled by:



Andy Feng /Project Engineer

Approved by:



Daniel Liu / Designated Reviewer

2 Contents

	Page
1 COVER PAGE.....	1
2 CONTENTS	2
3 REVISION HISTORY	4
4 GENERAL INFORMATION.....	5
4.1 GENERAL DESCRIPTION OF E.U.T.	5
4.2 DETAILS OF E.U.T.	5
4.3 CHANNEL LIST.....	6
4.4 TEST FACILITY.....	7
4.5 SUBCONTRACTED.....	7
4.6 ABNORMALITIES FROM STANDARD CONDITIONS	7
4.7 TEST MODE	8
5 TEST SUMMARY	9
6 EQUIPMENT USED DURING TEST	10
6.1 EQUIPMENTS LIST	10
6.2 DESCRIPTION OF SUPPORT UNITS	11
6.3 MEASUREMENT UNCERTAINTY	11
6.4 TEST EQUIPMENT CALIBRATION	11
7 DUTY CYCLE.....	12
8 CONDUCTED EMISSION	13
8.1 E.U.T. OPERATION	13
8.2 EUT SETUP.....	13
8.3 MEASUREMENT DESCRIPTION	13
8.4 CONDUCTED EMISSION TEST RESULT	14
9 RADIATED EMISSIONS.....	16
9.1 EUT OPERATION.....	16
9.2 TEST SETUP	17
9.3 SPECTRUM ANALYZER SETUP	18
9.4 TEST PROCEDURE	19
9.5 CORRECTED AMPLITUDE & MARGIN CALCULATION	19
9.6 SUMMARY OF TEST RESULTS	20
10 CONDUCTED SPURIOUS EMISSIONS.....	28
10.1 TEST PROCEDURE.....	28
10.2 TEST RESULT	29
11 BAND EDGE MEASUREMENT	35
11.1 TEST PRODUCE	35
11.2 TEST RESULT	36
12 6 DB BANDWIDTH AND 99% BANDWIDTH MEASUREMENT	37
12.1 TEST PROCEDURE:.....	37
12.2 TEST RESULT:	37
13 MAXIMUM PEAK CONDUCTED OUTPUT POWER.....	41
13.1 TEST PROCEDURE:.....	41
13.2 TEST RESULT:	42
14 POWER SPECTRAL DENSITY	45

14.1	TEST PROCEDURE:.....	45
14.2	TEST RESULT:	46
15	ANTENNA REQUIREMENT	49
16	RF EXPOSURE.....	49
17	PHOTOGRAPHS OF TEST SETUP AND EUT.....	49

3 Revision History

Test report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF21D12149221 W005	2021-12-30	2021-12-30 to 2022-03-01	2022-03-01	Original	-	Replaced
WTF21D12149221 W005 V1	2021-12-30	2021-12-30 to 2022-03-01	2022-03-30	Version 1	Updated	Replaced
WTF21D12149221 W005 V2	2021-12-30	2021-12-30 to 2022-03-01	2022-03-31	Version 2	Updated	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	iX14
Model(s):	SPMR14000, SPMR140001
Model Description:	Only the model name are difference. Model SPMR14000 was tested in this report.
Bluetooth Version:	5.2
Hardware Version:	X14_SOM_3566_V02
MIMO:	Not support
Software Version:	rk3566_r-userdebug 11 RQ1D.210105.003 eng.work.20211123.195427 release-keys

4.2 Details of E.U.T.

Operation Frequency:	2402-2478MHz
Max. RF output power:	2.4G (ANT 1): 23.55dBm 2.4G (ANT 2): 23.55dBm
Modulation Technology:	GFSK
Antenna installation:	internal permanent antenna
Antenna Gain:	1.5dBi
Ratings:	Battery DC 3.7V, 10500mAh

4.3 Channel List

2.4G

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	1	2404	2	2407	3	2411
4	2414	5	2417	6	2420	7	2424
8	2427	9	2430	10	2433	11	2437
12	2440	13	2446	14	2450	15	2456
16	2459	17	2463	18	2466	19	2469
20	2473	21	2476	22	2478	/	/

4.4 Test Facility

The test facility has a test site registered with the following organizations:

ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

Waltek Testing Group Co., Ltd. Has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files.

Registration number 7760A, October 15, 2016.

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.

Waltek Testing Group Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration number 523476, September 10, 2019.

4.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test Lab: N/A

Lab address: N/A

Test items: N/A

4.6 Abnormalities from Standard Conditions

None.

4.7 Test Mode

Table 2 Tests Carried Out Under FCC part 15.247

Test Items	Mode	Channel	TX/RX
Maximum Peak Output Power	2.4G	0/12/22	TX
Power Spectral Density	2.4G	0/12/22	TX
6dB Bandwidth	2.4G	0/12/22	TX
Band Edge	2.4G	0/12/22	TX
Transmitter Spurious Emissions	2.4G	0/12/22	TX

Note: Parameters set by test software during channel & power tests, the software provided by the customer was used to set the operating channels as well as the output power level. The RF output power set is the power expected by the manufacturer and is going to be fixed on the firmware of the final product.

5 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.247(d) 15.205(a) 15.209(a)	PASS
Conducted Spurious Emissions	15.247(d)	PASS
Conducted Emissions	15.207(a)	PASS
6dB Bandwidth	15.247(a)(2)	PASS
Maximum Peak Output Power	15.247(b)(3), (4)	PASS
Power Spectral Density	15.247(e)	PASS
Band Edge	15.247(d)	PASS
Antenna Requirement	15.203	PASS
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS

6 Equipment Used during Test

6.1 Equipments List

Conducted Emissions Test Site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	EMI Test Receiver	R&S	ESCI	100947	2021-07-26	1Year
2	LISN	R&S	ENV216	101215	2021-07-26	1Year
3	Cable	Top	TYPE16(3.5M)	-	2021-07-26	1Year
Conducted Emissions Test Site 2#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	EMI Test Receiver	R&S	ESCI	101155	2021-07-26	1Year
2	LISN	SCHWARZBECK	NSLK 8128	8128-289	2021-07-26	1Year
3	Limiter	York	MTS-IMP-136	261115-001-0024	2021-07-26	1Year
4	Cable	LARGE	RF300	-	2021-07-26	1Year
3m Semi-anechoic Chamber for Radiation Emissions Test site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Spectrum Analyzer	R&S	FSP30	100091	2021-04-26	1Year
2	Amplifier	Agilent	8447D	2944A10178	2021-07-26	1Year
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2021-08-23	1Year
4	Coaxial Cable	Top	TYPE16(13M)	-	2021-04-26	1Year
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2021-04-30	1Year
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2021-07-30	1Year
7	Broadband Preamplifier	COMPLIANCE	PAP-1G18	2004	2021-07-26	1Year
8	Coaxial Cable	ZT26-NJ-NJ-8M/FA	1GHz-18GHz	NA	2021-04-26	1Year
3m Semi-anechoic Chamber for Radiation Emissions Test site 2#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Test Receiver	R&S	ESCI	101296	2021-04-26	1Year
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2021-10-30	1Year
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2021-04-29	1Year
4	Amplifier	ANRITSU	MH648A	M43381	2021-04-26	1Year
5	Cable	HUBER+SUHNER	CBL2	525178	2021-04-26	1Year
RF Conducted Testing						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Spectrum Analyzer	R&S	FSP30	100091	2021-04-26	1Year
2	Spectrum Analyzer	R&S	FSP40	100501	2021-07-29	1Year
3	Signal Analyzer	Agilent	N9010A	MY50520207	2021-04-19	1Year

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
/	/	/	/

6.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	$\pm 3.64\text{dB}$ (AC mains 150KHz~30MHz)
Radiated Spurious Emissions	$\pm 5.08\text{dB}$ (Bilog antenna 30M~1000MHz)
	$\pm 5.47\text{ dB}$ (Horn antenna 1000M~25000MHz)
Radio Frequency	$\pm 1 \times 10^{-7}\text{Hz}$
RF Power	$\pm 0.42\text{ dB}$
RF Power Density	$\pm 0.7\text{dB}$
Conducted Spurious Emissions	$\pm 2.76\text{ dB}$ (9kHz~26500MHz)
Confidence interval: 95%. Confidence factor: k=2	

6.4 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P.R. China.

7 Duty Cycle

Type of Modulation	On time ms	Period ms	Duty Cycle linear	Duty Cycle %	Duty Cycle Factor(dB)	Average Factor(dB)
GFSK	0.8	44.16	0.018	1.8	17.447	-34.89

Remark:

Duty cycle=On Time/period;

Duty cycle factor= $10 \cdot \log(1/\text{Duty cycle})$;

Average factor= $20 \log_{10} \text{Duty cycle}$

8 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

Limit:

Frequency (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46
0.5 to 5	56	46
5 to 30	60	50

8.1 E.U.T. Operation

Operating Environment :

Temperature: 21.5 °C

Humidity: 51.9 % RH

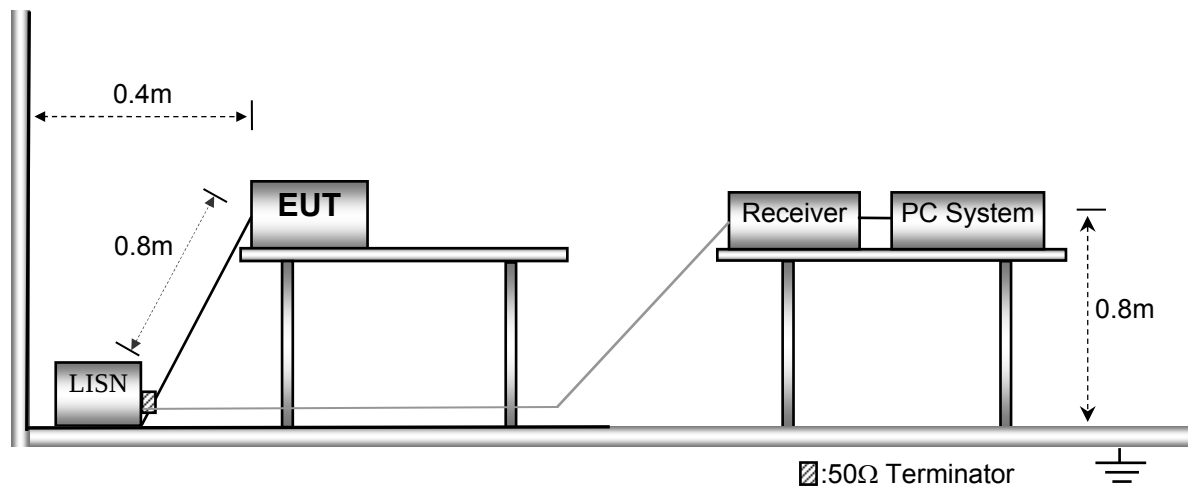
Atmospheric Pressure: 101.2kPa

EUT Operation :

The test was performed in TX transmitting mode, the worst data were shown in the report.

8.2 EUT Setup

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



8.3 Measurement Description

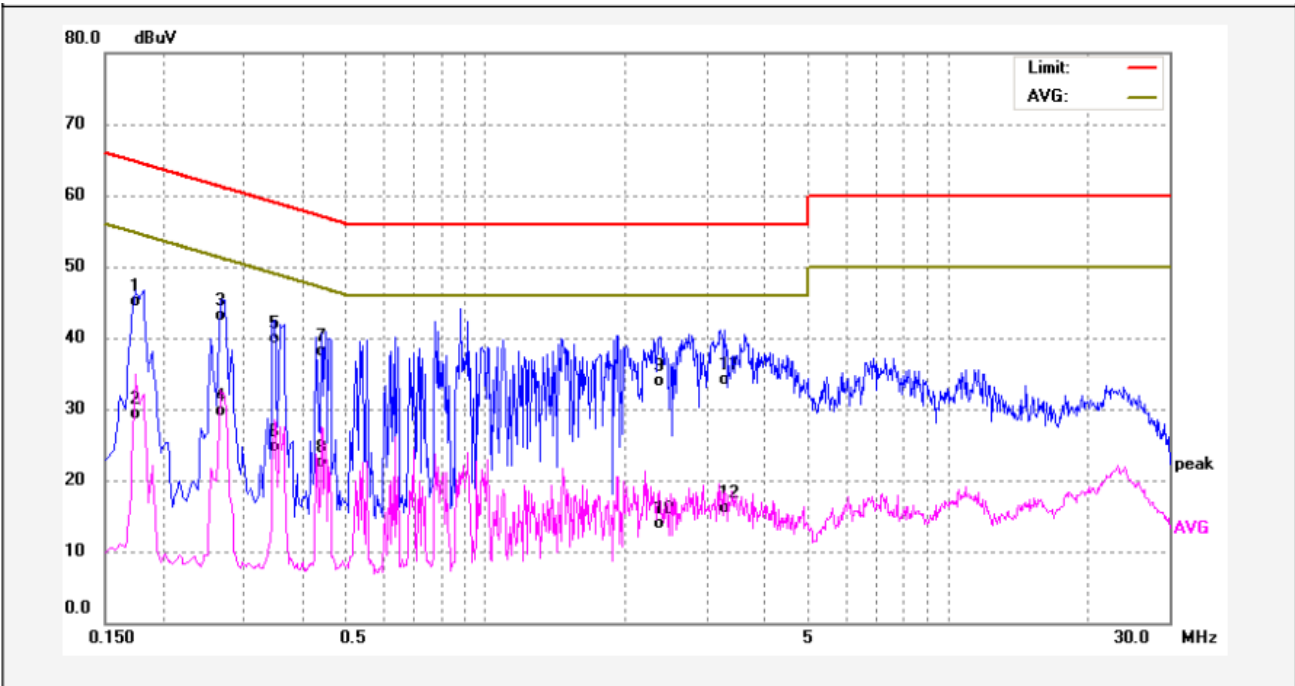
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

8.4 Conducted Emission Test Result

An initial pre-scan was performed on the live and neutral lines.

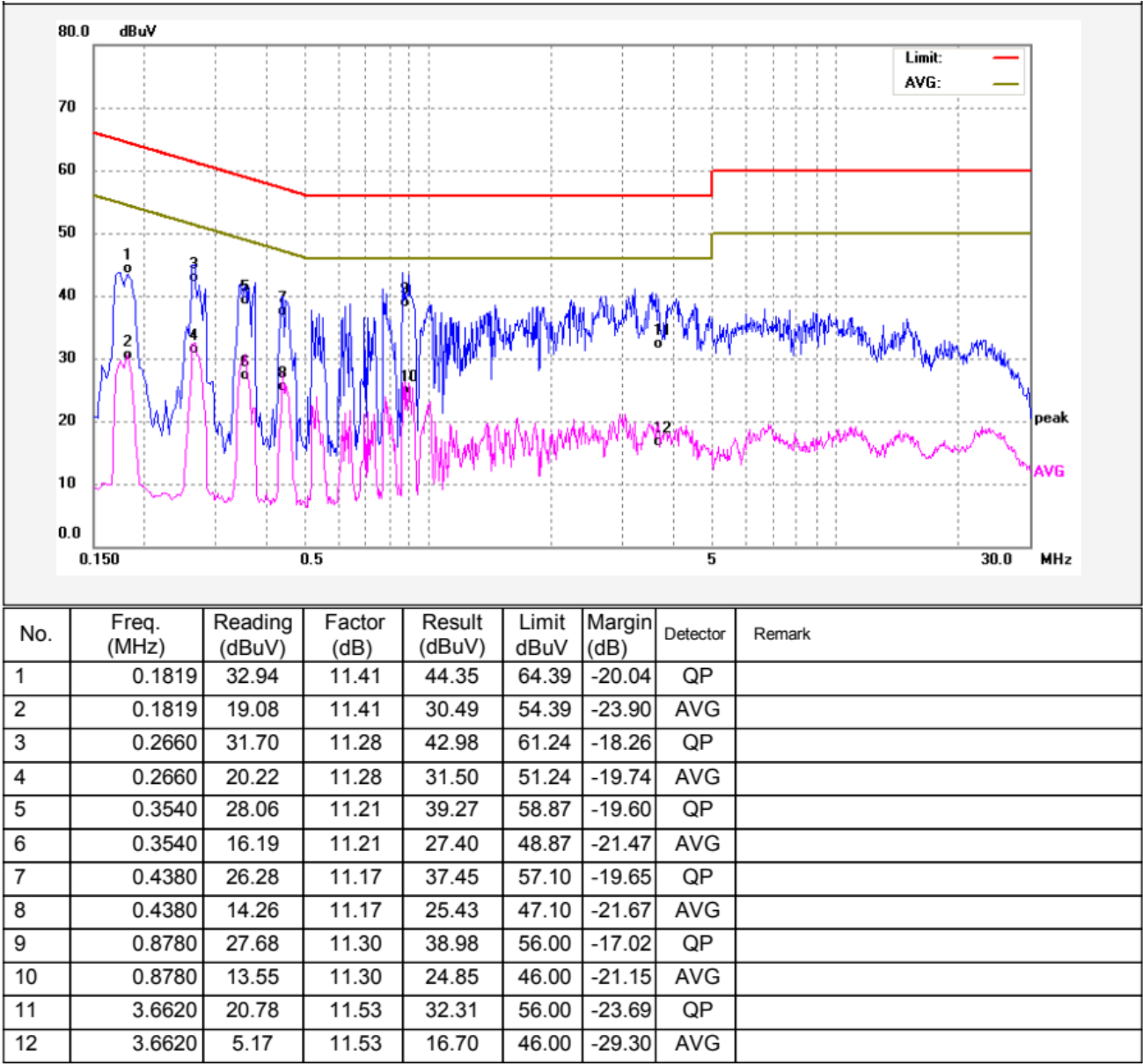
Worst Mode: WIFI mode (802.11b mode low channel)

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1740	33.01	12.00	45.01	64.76	-19.75	QP	
2	0.1740	17.39	12.00	29.39	54.76	-25.37	AVG	
3	0.2660	31.39	11.81	43.20	61.24	-18.04	QP	
4	0.2660	17.80	11.81	29.61	51.24	-21.63	AVG	
5	0.3500	28.18	11.74	39.92	58.96	-19.04	QP	
6	0.3500	12.98	11.74	24.72	48.96	-24.24	AVG	
7	0.4420	26.33	11.74	38.07	57.02	-18.95	QP	
8	0.4420	10.76	11.74	22.50	47.02	-24.52	AVG	
9	2.3740	21.97	11.98	33.95	56.00	-22.05	QP	
10	2.3740	1.91	11.98	13.89	46.00	-32.11	AVG	
11	3.2820	22.05	12.10	34.15	56.00	-21.85	QP	
12	3.2820	4.04	12.10	16.14	46.00	-29.86	AVG	

Neutral line:



9 Radiated Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.209 & 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019;
ANSI C63.10:2013

Test Result: PASS

Measurement Distance: 3m

Limit:

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

9.1 EUT Operation

Operating Environment:

Temperature: 23.5 °C

Humidity: 52.1 % RH

Atmospheric Pressure: 101.2kPa

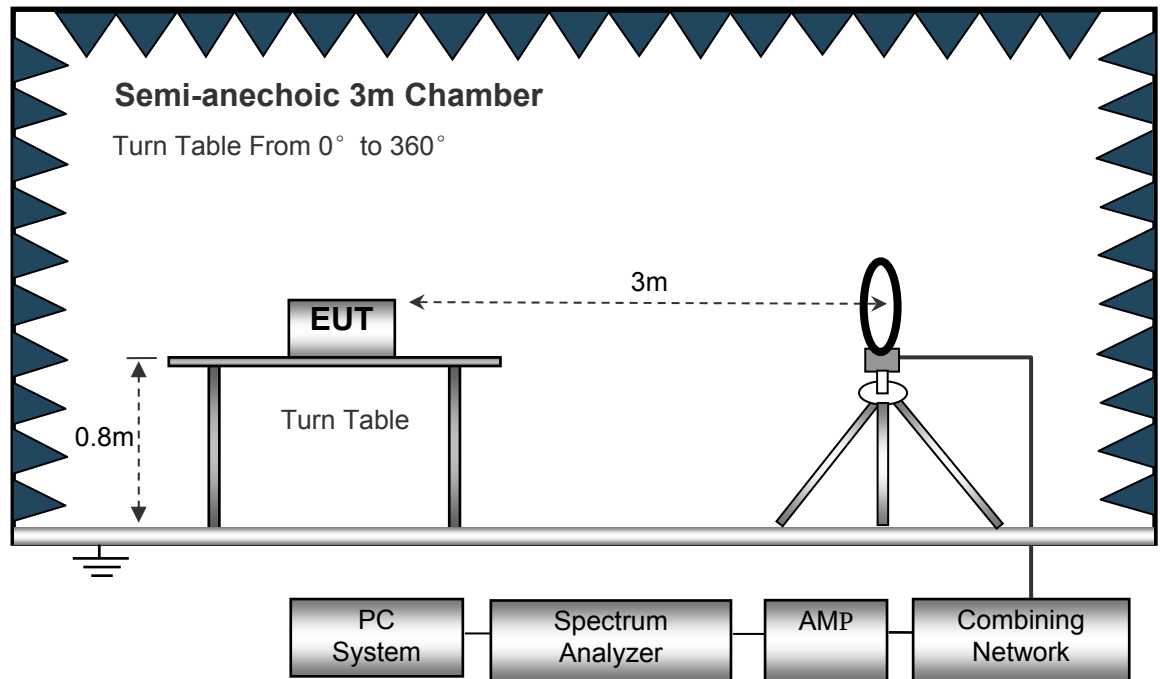
EUT Operation:

The test was performed in TX transmitting mode, the test data were shown in the report.

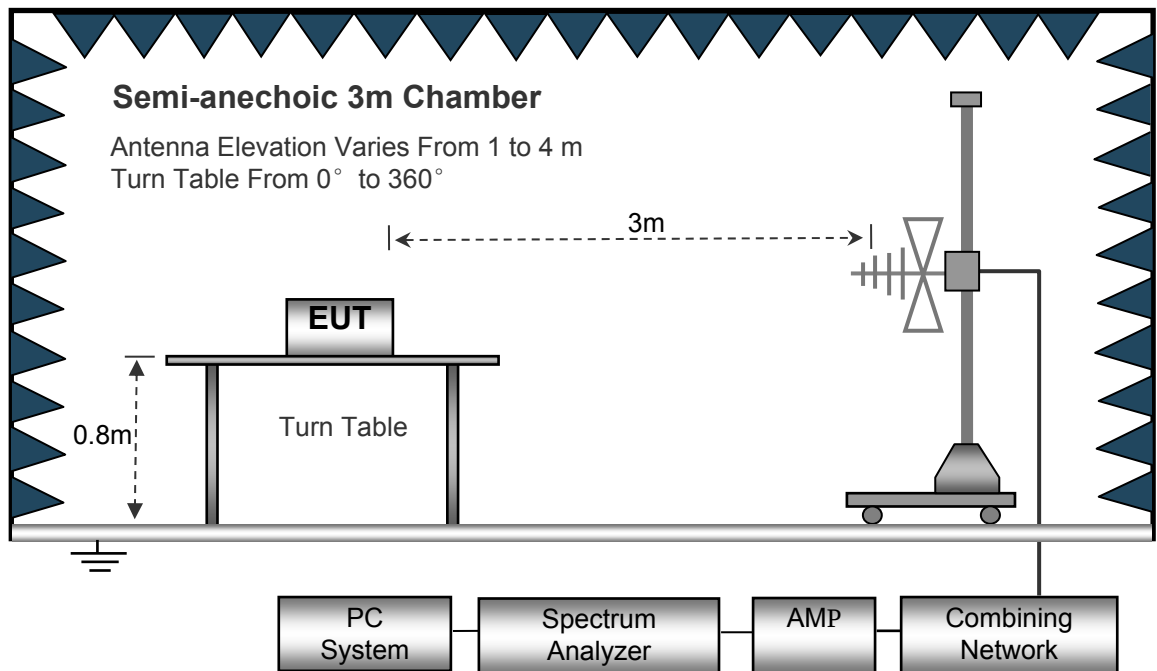
9.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10.

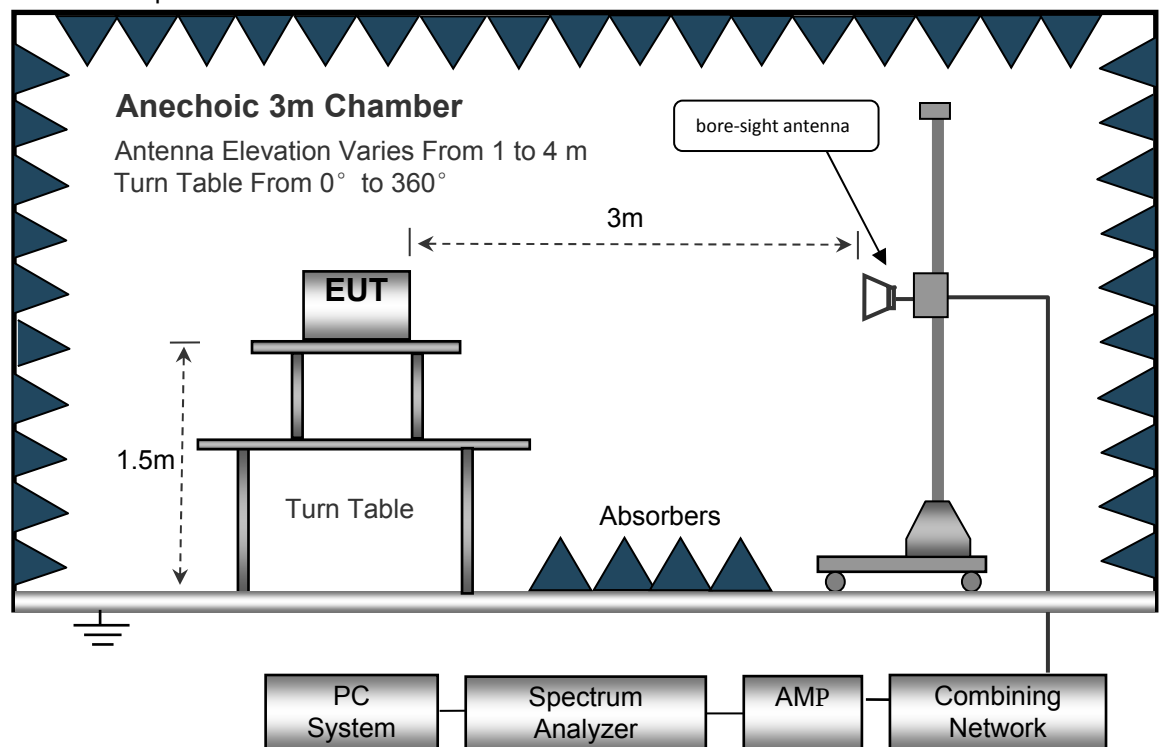
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



9.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed Auto
 IF Bandwidth..... 10kHz
 Video Bandwidth..... 10kHz
 Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed Auto
 Detector PK
 Resolution Bandwidth..... 100kHz
 Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed Auto
 Detector PK
 Resolution Bandwidth..... 1MHz
 Video Bandwidth..... 3MHz
 Detector Ave.
 Resolution Bandwidth..... 1MHz
 Video Bandwidth..... 10Hz

9.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are performed in X,Y and Z axis positioning(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand),the worst condition was tested putting the eut in Z axis,so the worst data were shown as follow.
8. A 2.4GHz high –pass filter is used during radiated emissions above 1GHz measurement.

9.5 Corrected Amplitude & Margin Calculation

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

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

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

$$\text{Margin} = \text{Corr. Ampl.} - \text{Limit}$$

9.6 Summary of Test Results

2.4G Plano:

Test Frequency: 9KHz~26MHz

Remark: only the worst data (GFSK modulation Low channel mode) were recorded.

Frequency	Measurement results dBμV @3m	Detector PK/QP	Correct factor dB/m	Extrapolation factor dB	Measurement results (calculated) dBμV/m @30m	Limits dBμV/m @30m	Margin dB
(MHz)	Measurement results	Detector	Correct factor	Extrapolation factor	Measurement results (calculated)	Limits	Margin
6.021	25.22	QP	21.84	40.00	7.06	29.54	-22.48
15.730	25.41	QP	21.35	40.00	6.76	29.54	-22.78
25.680	24.27	QP	20.67	40.00	4.94	29.54	-24.60

Test Frequency : 26MHz ~ 30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency : 30MHz ~ 18GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
269.33	33.80	QP	167	1.7	H	-13.35	20.45	46.00	-25.55
269.33	38.46	QP	131	1.2	V	-13.35	25.11	46.00	-20.89
4804.00	44.76	PK	149	1.3	V	-1.06	43.70	74.00	-30.30
4804.00	39.49	Ave	149	1.3	V	-1.06	38.43	54.00	-15.57
7206.00	43.72	PK	226	1.1	H	1.33	45.05	74.00	-28.95
7206.00	36.29	Ave	226	1.1	H	1.33	37.62	54.00	-16.38
2340.92	45.42	PK	105	1.3	V	-13.19	32.23	74.00	-41.77
2340.92	37.88	Ave	105	1.3	V	-13.19	24.69	54.00	-29.31
2353.76	44.43	PK	226	1.7	H	-13.14	31.29	74.00	-42.71
2353.76	37.95	Ave	226	1.7	H	-13.14	24.81	54.00	-29.19
2492.51	44.76	PK	93	1.4	V	-13.08	31.68	74.00	-42.32
2492.51	36.51	Ave	93	1.4	V	-13.08	23.43	54.00	-30.57

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK Middle Channel 2440MHz									
269.33	32.71	QP	26	1.4	H	-13.35	19.36	46.00	-26.64
269.33	38.62	QP	34	1.9	V	-13.35	25.27	46.00	-20.73
4880.00	43.46	PK	144	1.7	V	-0.62	42.84	74.00	-31.16
4880.00	38.54	Ave	144	1.7	V	-0.62	37.92	54.00	-16.08
7320.00	43.99	PK	235	1.0	H	2.21	46.20	74.00	-27.80
7320.00	35.38	Ave	235	1.0	H	2.21	37.59	54.00	-16.41
2319.55	45.29	PK	7	1.1	V	-13.19	32.10	74.00	-41.90
2319.55	37.18	Ave	7	1.1	V	-13.19	23.99	54.00	-30.01
2362.16	43.26	PK	226	1.8	H	-13.14	30.12	74.00	-43.88
2362.16	36.08	Ave	226	1.8	H	-13.14	22.94	54.00	-31.06
2492.20	43.45	PK	273	1.1	V	-13.08	30.37	74.00	-43.63
2492.20	37.09	Ave	273	1.1	V	-13.08	24.01	54.00	-29.99

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK High Channel 2478MHz									
269.33	32.63	QP	78	1.9	H	-13.35	19.28	46.00	-26.72
269.33	38.46	QP	81	1.0	V	-13.35	25.11	46.00	-20.89
4960.00	41.97	PK	312	2.0	V	-0.24	41.73	74.00	-32.27
4960.00	37.36	Ave	312	2.0	V	-0.24	37.12	54.00	-16.88
7440.00	44.41	PK	258	1.3	H	2.84	47.25	74.00	-26.75
7440.00	36.29	Ave	258	1.3	H	2.84	39.13	54.00	-14.87
2313.79	46.28	PK	202	1.4	V	-13.19	33.09	74.00	-40.91
2313.79	38.12	Ave	202	1.4	V	-13.19	24.93	54.00	-29.07
2366.66	44.07	PK	29	1.4	H	-13.14	30.93	74.00	-43.07
2366.66	37.92	Ave	29	1.4	H	-13.14	24.78	54.00	-29.22
2492.76	43.56	PK	76	1.2	V	-13.08	30.48	74.00	-43.52
2492.76	37.15	Ave	76	1.2	V	-13.08	24.07	54.00	-29.93

2.4G Plano +2.4G Waco:**Test Frequency: 9KHz~26MHz**

Remark: only the worst data (GFSK modulation Low channel mode) were recorded.

Frequency	Measurement results dB μ V @3m	Detector PK/QP	Correct factor dB/m	Extrapolation factor dB	Measurement results (calculated) dB μ V/m @30m	Limits dB μ V/m @30m	Margin dB
(MHz)	Measurement results	Detector	Correct factor	Extrapolation factor	Measurement results (calculated)	Limits	Margin
6.025	25.12	QP	21.84	40.00	6.96	29.54	-22.58
15.630	25.34	QP	21.35	40.00	6.69	29.54	-22.85
22.330	25.27	QP	20.67	40.00	5.94	29.54	-23.60

Test Frequency : 26MHz ~ 30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency : 30MHz ~ 18GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
223.45	38.91	QP	229	1.7	H	-11.62	27.29	46.00	-18.71
223.45	29.87	QP	311	1.8	V	-11.62	18.25	46.00	-27.75
4824.00	50.82	PK	82	1.3	V	-1.06	49.76	74.00	-24.24
4824.00	40.32	Ave	82	1.3	V	-1.06	39.26	54.00	-14.74
7236.00	45.56	PK	77	1.3	H	1.33	46.89	74.00	-27.11
7236.00	41.85	Ave	77	1.3	H	1.33	43.18	54.00	-10.82
2317.47	46.22	PK	190	1.2	V	-13.19	33.03	74.00	-40.97
2317.47	39.75	Ave	190	1.2	V	-13.19	26.56	54.00	-27.44
2351.26	44.30	PK	230	1.7	H	-13.14	31.16	74.00	-42.84
2351.26	36.12	Ave	230	1.7	H	-13.14	22.98	54.00	-31.02
2491.89	44.03	PK	105	1.8	V	-13.08	30.95	74.00	-43.05
2491.89	37.74	Ave	105	1.8	V	-13.08	24.66	54.00	-29.34

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK Middle Channel 2440MHz									
223.45	37.94	QP	120	1.2	H	-11.62	26.32	46.00	-19.68
223.45	30.65	QP	352	1.9	V	-11.62	19.03	46.00	-26.97
4874.00	51.02	PK	287	1.6	V	-0.62	50.40	74.00	-23.60
4874.00	36.36	Ave	287	1.6	V	-0.62	35.74	54.00	-18.26
7311.00	46.60	PK	50	1.2	H	2.21	48.81	74.00	-25.19
7311.00	40.43	Ave	50	1.2	H	2.21	42.64	54.00	-11.36
2321.09	45.50	PK	289	1.4	V	-13.19	32.31	74.00	-41.69
2321.09	39.40	Ave	289	1.4	V	-13.19	26.21	54.00	-27.79
2371.23	43.58	PK	268	1.8	H	-13.14	30.44	74.00	-43.56
2371.23	38.58	Ave	268	1.8	H	-13.14	25.44	54.00	-28.56
2484.15	44.78	PK	299	1.5	V	-13.08	31.70	74.00	-42.30
2484.15	38.72	Ave	299	1.5	V	-13.08	25.64	54.00	-28.36

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK High Channel 2478MHz									
223.45	37.21	QP	352	1.9	H	-11.62	25.59	46.00	-20.41
223.45	30.31	QP	135	2.0	V	-11.62	18.69	46.00	-27.31
4924.00	49.80	PK	52	1.3	V	-0.24	49.56	74.00	-24.44
4924.00	40.23	Ave	52	1.3	V	-0.24	39.99	54.00	-14.01
7386.00	45.95	PK	62	1.8	H	2.84	48.79	74.00	-25.21
7386.00	36.26	Ave	62	1.8	H	2.84	39.10	54.00	-14.90
2342.98	45.06	PK	70	1.9	V	-13.19	31.87	74.00	-42.13
2342.98	37.19	Ave	70	1.9	V	-13.19	24.00	54.00	-30.00
2359.15	43.02	PK	159	1.2	H	-13.14	29.88	74.00	-44.12
2359.15	38.38	Ave	159	1.2	H	-13.14	25.24	54.00	-28.76
2496.81	43.31	PK	307	1.8	V	-13.08	30.23	74.00	-43.77
2496.81	38.13	Ave	307	1.8	V	-13.08	25.05	54.00	-28.95

Note: 2.4G Plano and 2.4G Waco can transmit simultaneously which use the same frequency, so the spurious emissions (intermodulation) are required, 2.4G Waco test results please refer to the "WTF21D12149221W006 2.4G Waco FCC test report V1".

Test Frequency: 18GHz~25GHz

The measurements were more than 20 dB below the limit and not reported.

10 Conducted Spurious Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019;
ANSI C63.10:2013

Test Result: PASS

Limit:

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 Section 15.209(a) is not required. 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)).

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:
 - a) Set instrument center frequency to DTS channel center frequency.
 - b) Set the span to _ 1.5 times the DTS bandwidth.
 - c) Set the RBW = 100 kHz.
 - d) Set the VBW _ $[3 \times \text{RBW}]$.
 - e) Detector = peak.
 - f) Sweep time = auto couple.
 - g) Trace mode = max hold.
 - h) Allow trace to fully stabilize.
 - i) Use the peak marker function to determine the maximum PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

10.2 Test Result

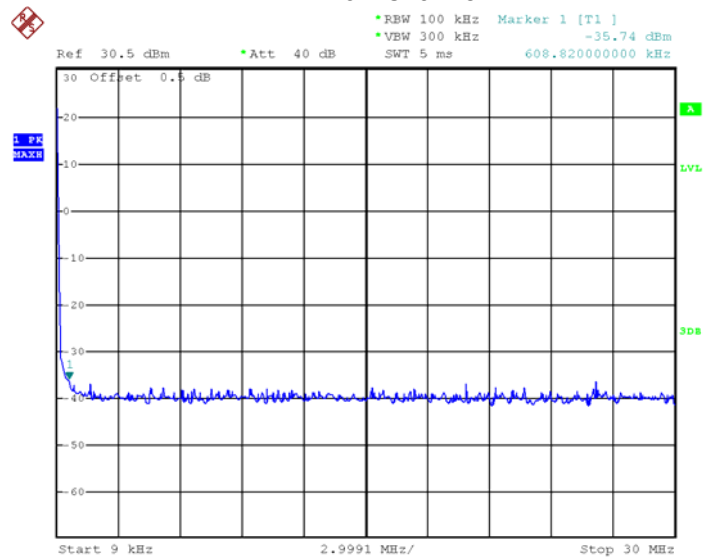
Remark: For the WIFI, Both antenna 0 and antenna 1 are tested, and only the worst data antenna 0 is put in the report

9KHz – 30MHz

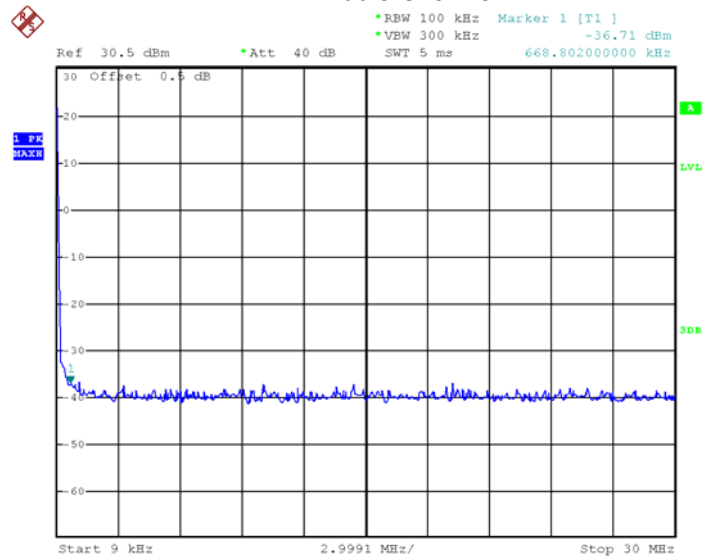
2.4G

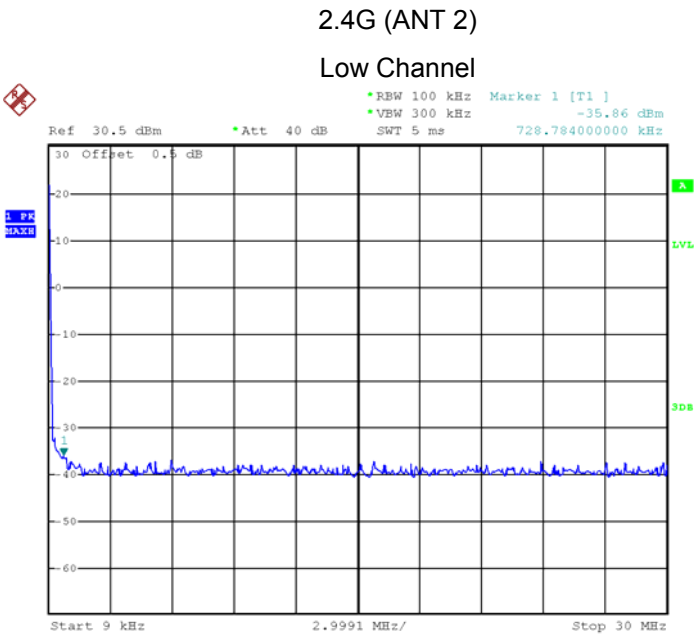
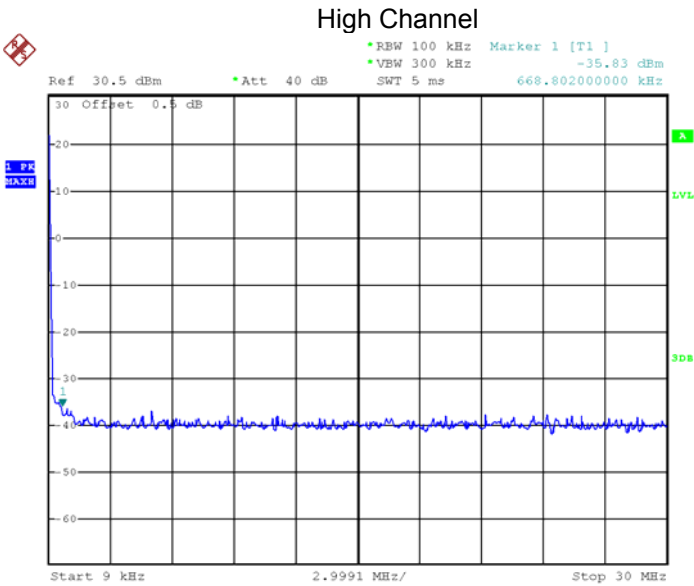
(ANT 1)

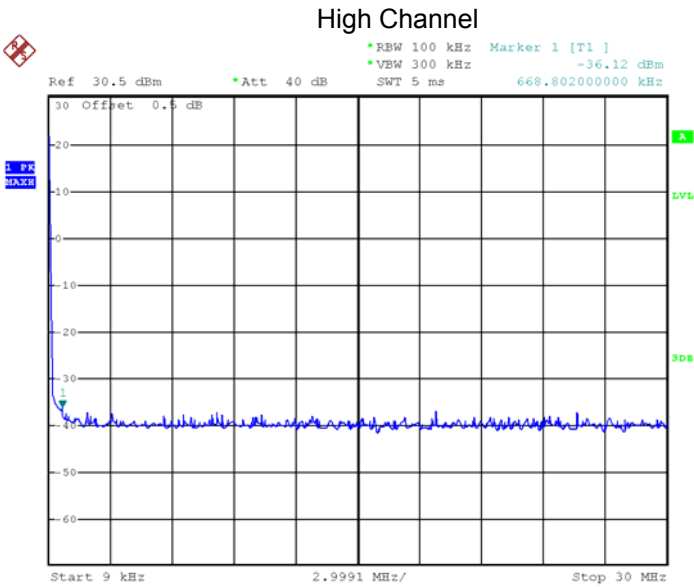
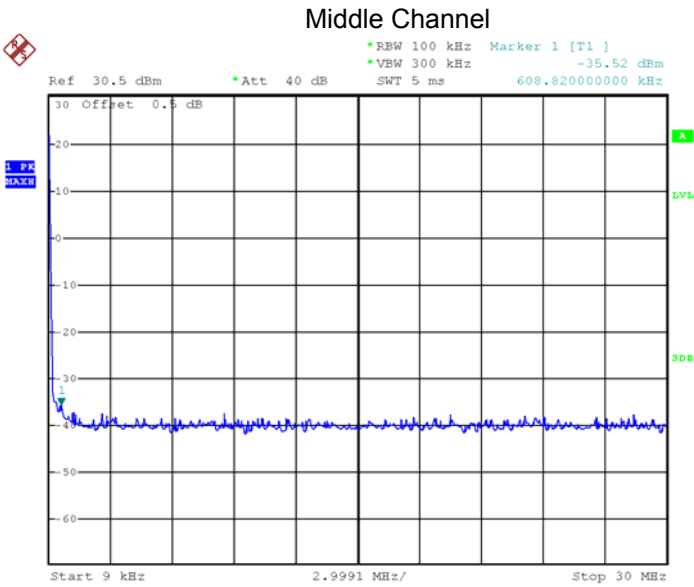
Low Channel



Middle Channel





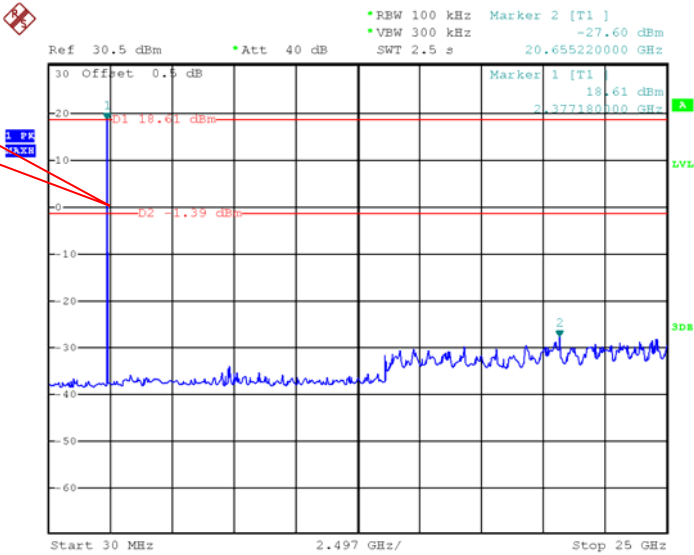


Above 30MHz

2.4G (ANT 1)

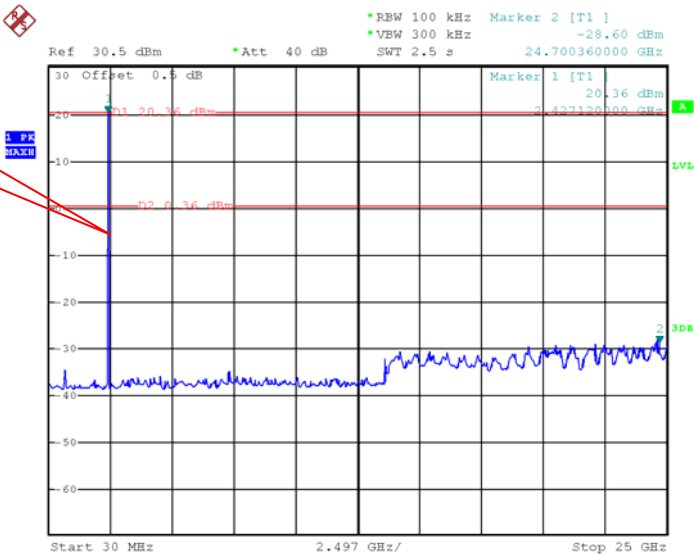
Low Channel

Fundamental

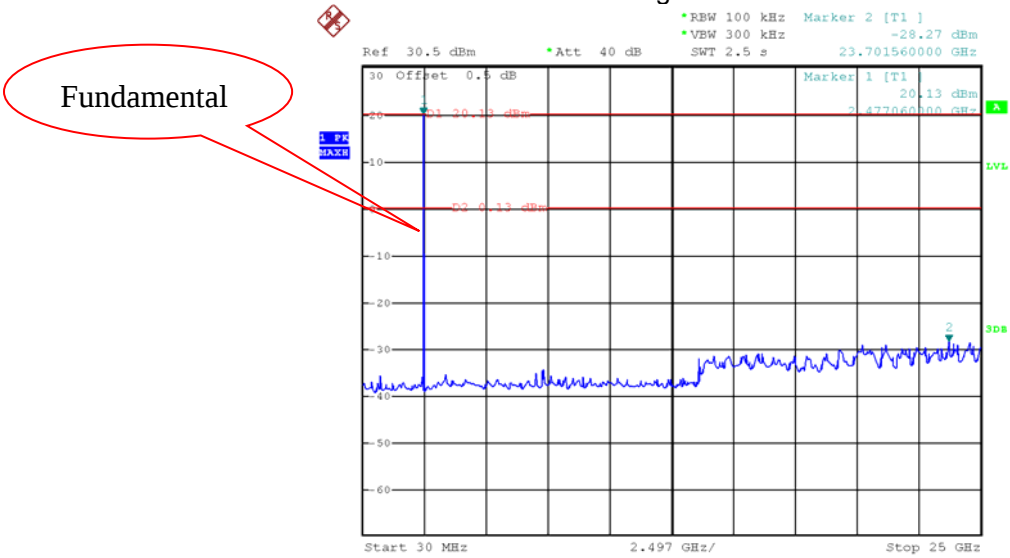


Middle Channel

Fundamental

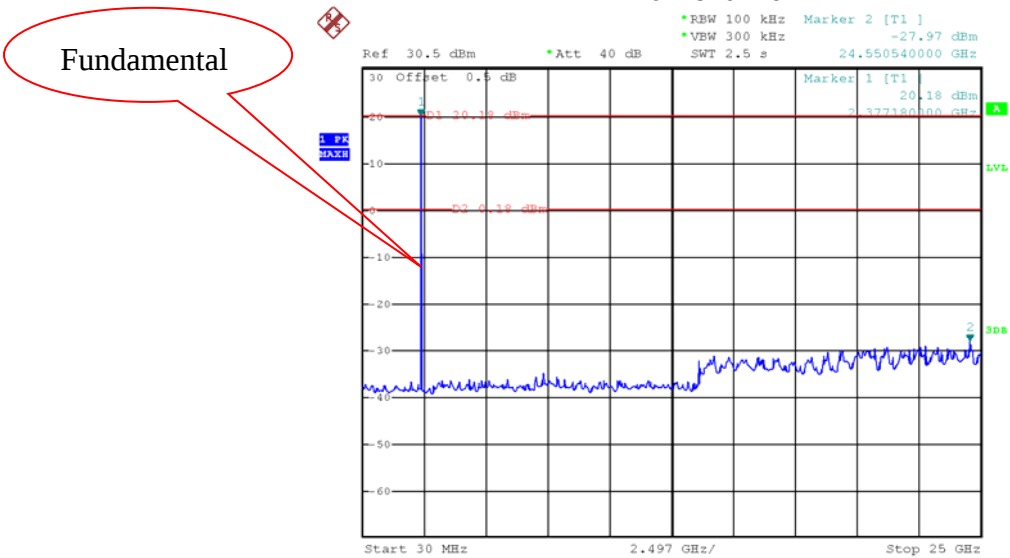


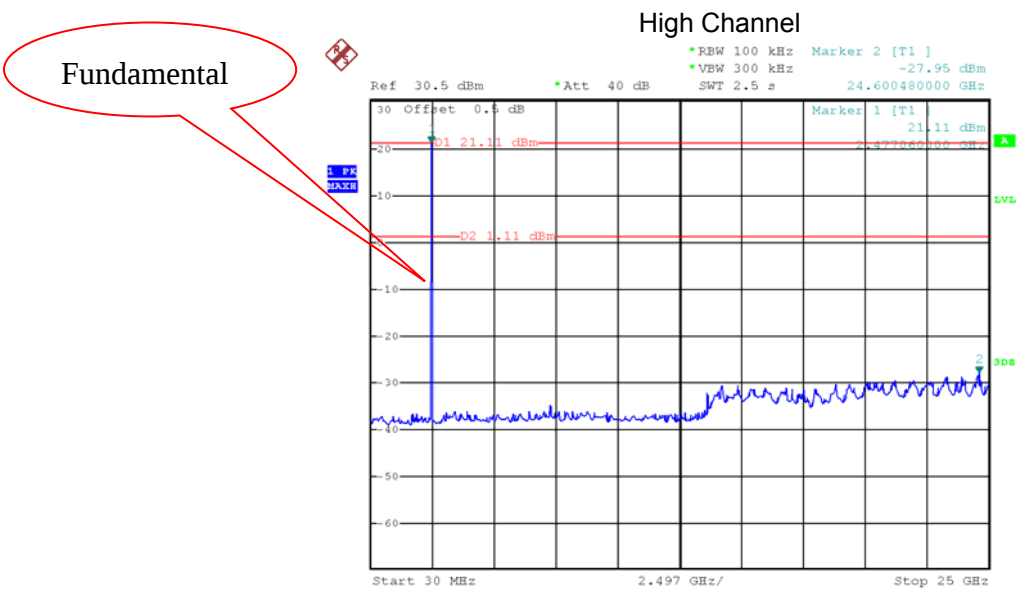
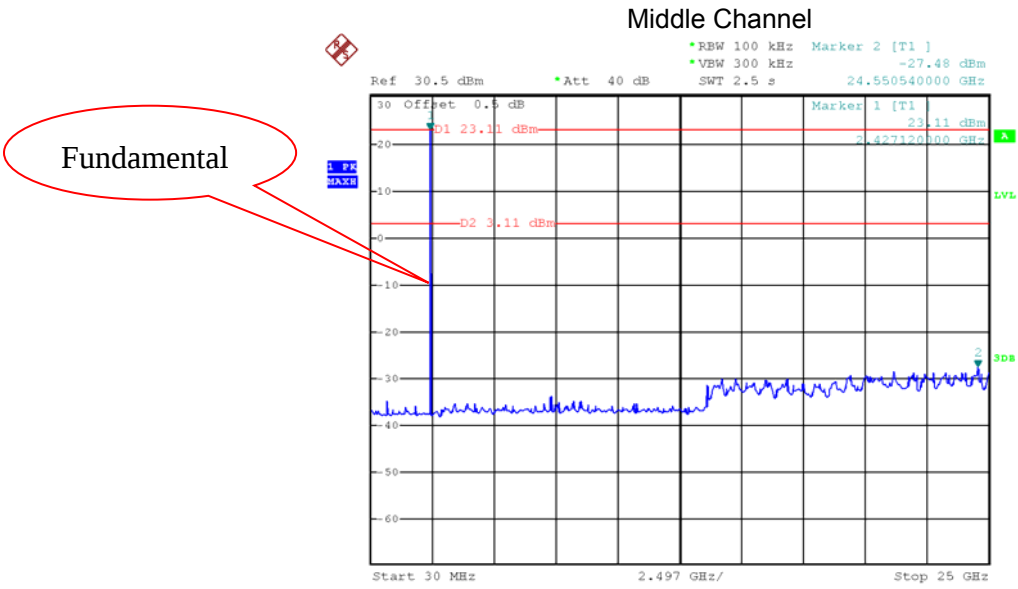
High Channel



2.4G (ANT 2)

Low Channel





11 Band Edge Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019

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)).

Test Mode: Transmitting

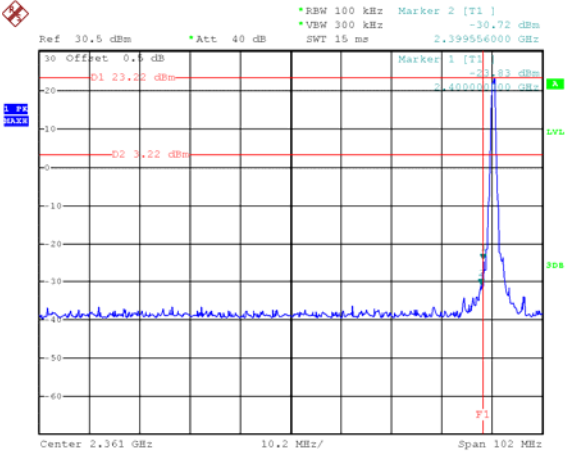
11.1 Test Produce

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

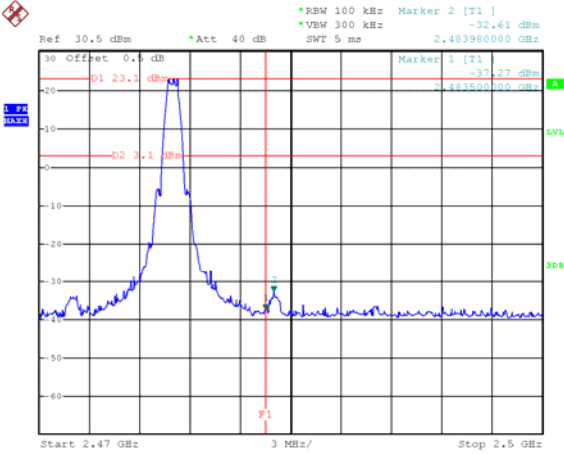
11.2 Test Result

Test result plots shown as follows:

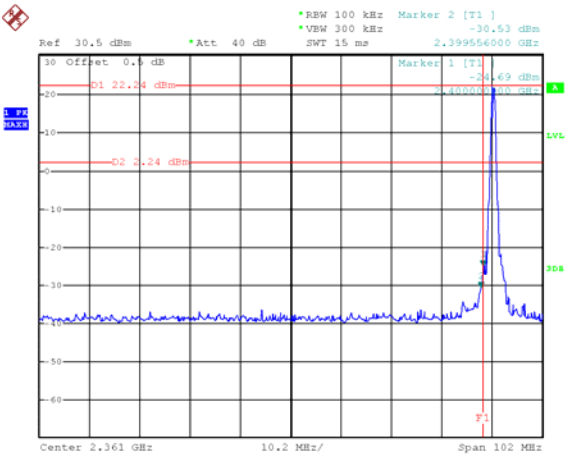
2.4G(ANT 1): Band edge-left side



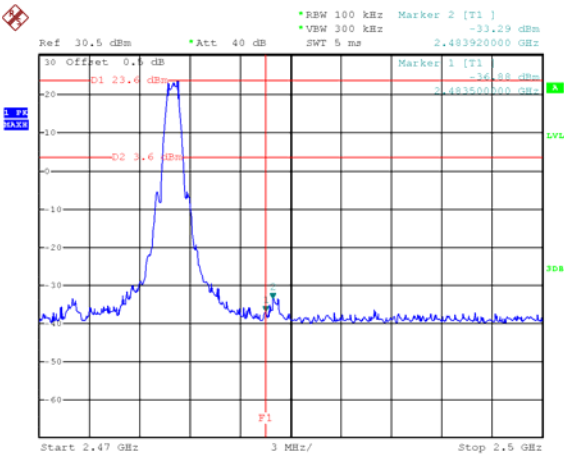
2.4G(ANT 1): Band edge-right side



2.4G(ANT 2): Band edge-left side



2.4G(ANT 2): Band edge-right side



12 6 dB Bandwidth and 99% Bandwidth Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247
 Test Method: ANSI C63.10:2013
 KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
 Test Limit: §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 Mode: Transmitting

12.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. 6dB Bandwidth Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz
 99% Bandwidth Set the spectrum analyzer: 1~5% of the OBW, VBW = 3 times the RBW

12.2 Test Result:

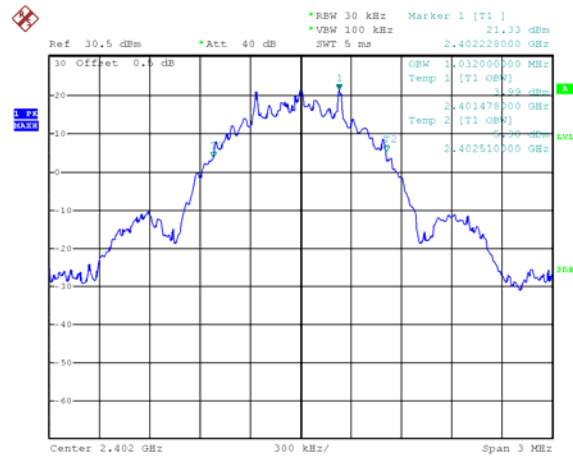
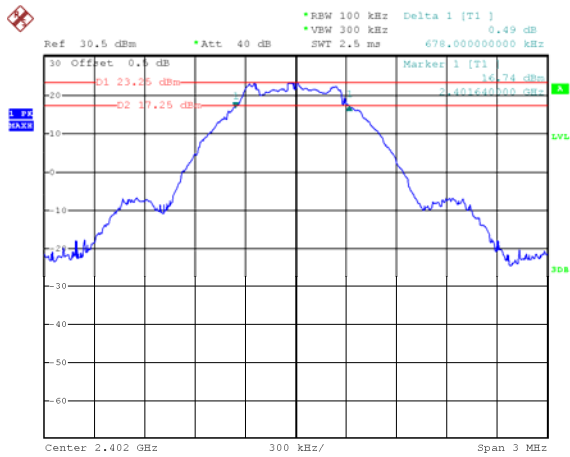
Operation mode	Test Channel	6dB Bandwidth (MHz)	99% Bandwidth (MHz)
2.4G(ANT 1)	Channel 0	0.768	1.032
	Channel 12	0.696	1.044
	Channel 22	0.744	1.068
2.4G(ANT 2)	Channel 0	0.660	1.044
	Channel 12	0.678	1.050
	Channel 22	0.726	1.068

Test result plot:

6 dB Bandwidth

99% Bandwidth

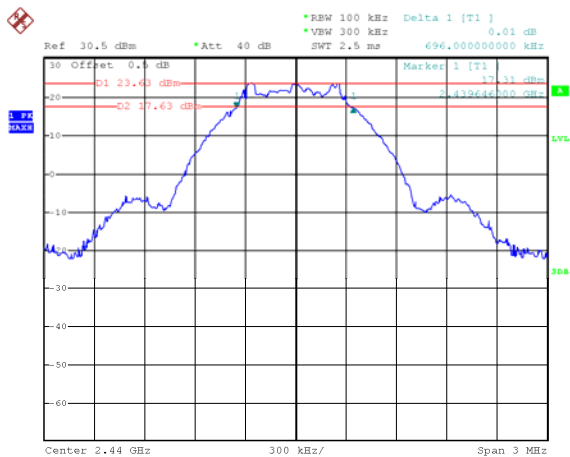
2.4G(ANT 1): channel 0



6 dB Bandwidth

99% Bandwidth

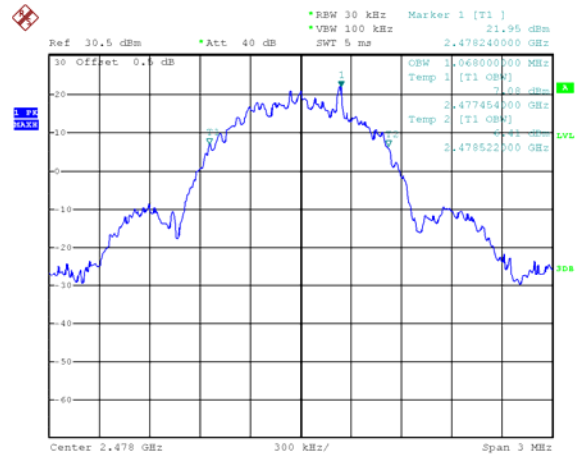
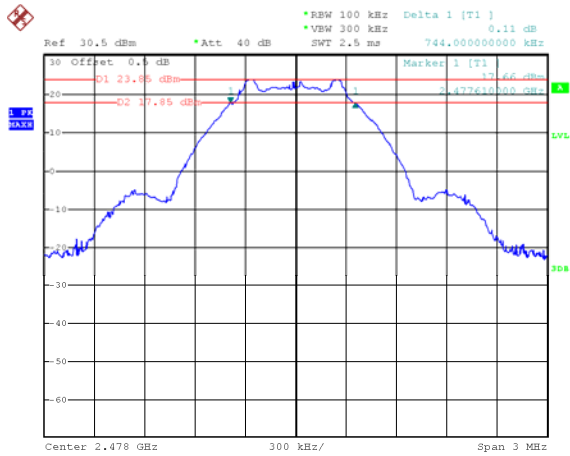
2.4G(ANT 1): channel 12



6 dB Bandwidth

99% Bandwidth

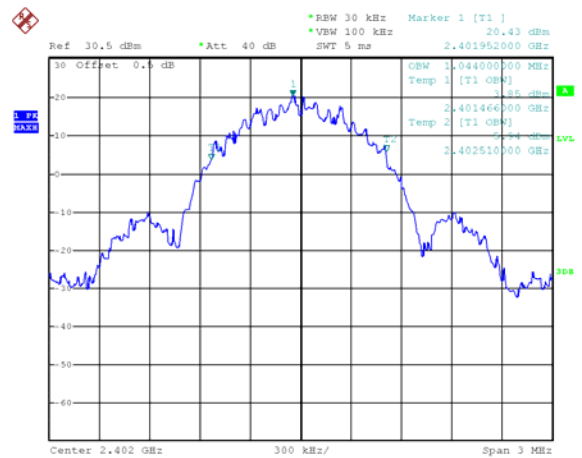
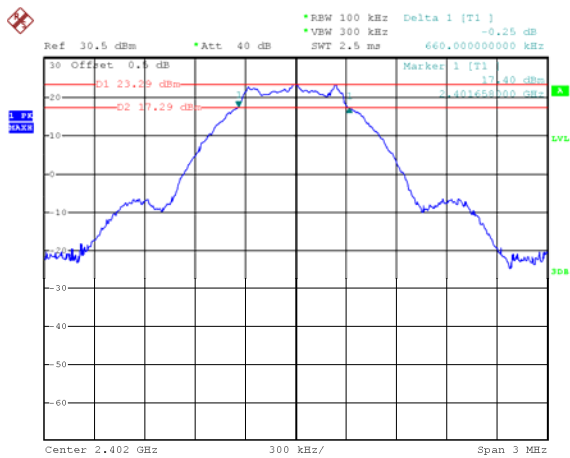
2.4G(ANT 1): channel 22



6 dB Bandwidth

99% Bandwidth

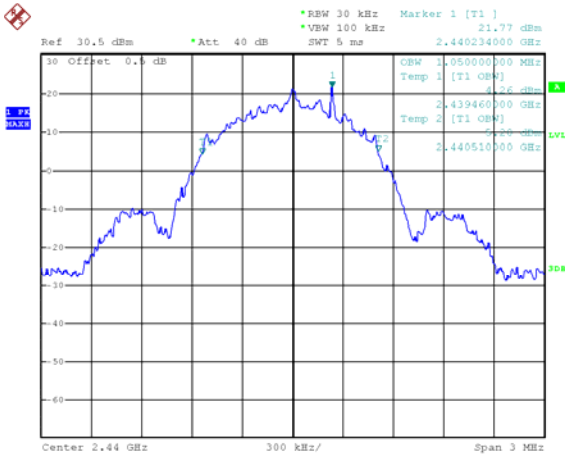
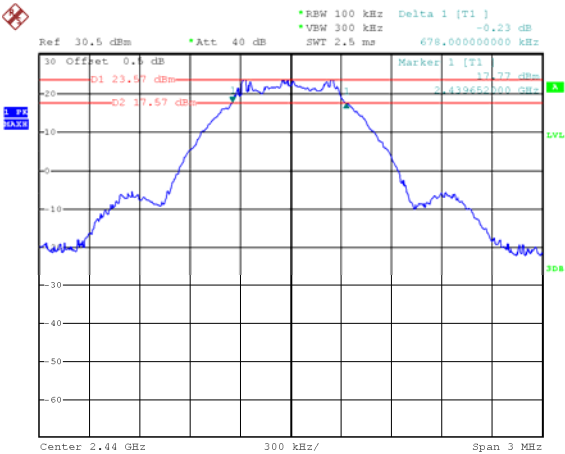
2.4G(ANT 2): channel 0



6 dB Bandwidth

99% Bandwidth

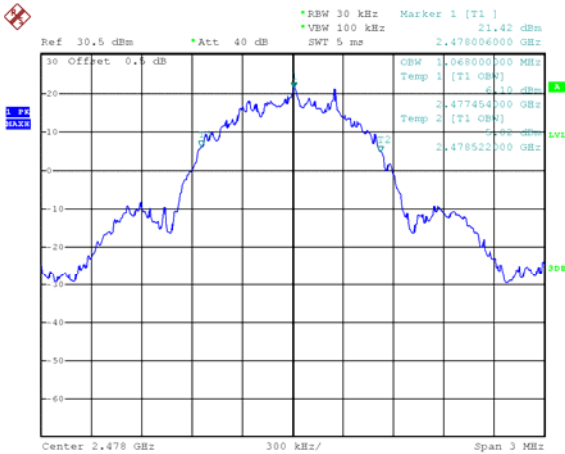
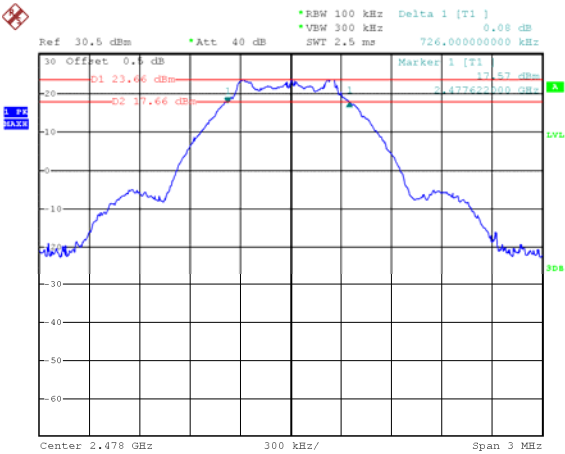
2.4G(ANT 2): channel 12



6 dB Bandwidth

99% Bandwidth

2.4G(ANT 2): channel 22



13 Maximum Peak conducted Output Power

Test Requirement:	FCC 47CFR Part 15 Section 15.247
Test Method:	ANSI C63.10:2013 KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
Test Limit:	§15.247(b) The maximum peak conducted output power of the intentional radiator shall not exceed 1W.
Test Mode:	Transmitting

13.1 Test Procedure:

According to KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019

Section 8.3.1.1 RBW $\geq$ DTS bandwidth

Subclause 11.9.1.1 of ANSI C63.10 is applicable.

Section 8.3.1.2 Integrated band power method

For measuring the output power of a device transmitting a wide-band noise-like signal where the peak power amplitude is a statistical parameter, the preferred methodology is to use an integrated average power measurement, as described in 8.3.2. The peak integrated band power method of 11.9.1 in ANSI C63.10 is not applicable.

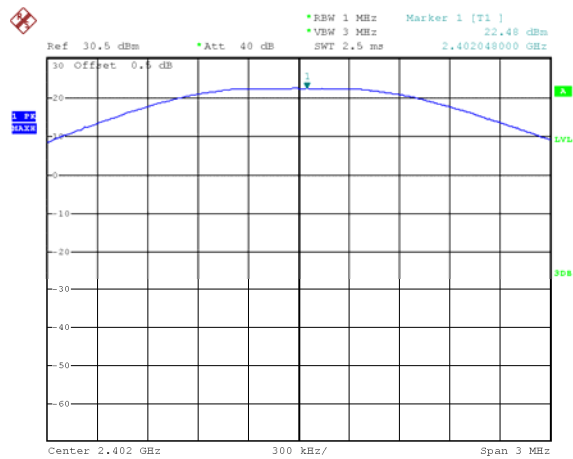
Subclause 11.9.2 of ANSI C63.10 is applicable.

13.2 Test Result:

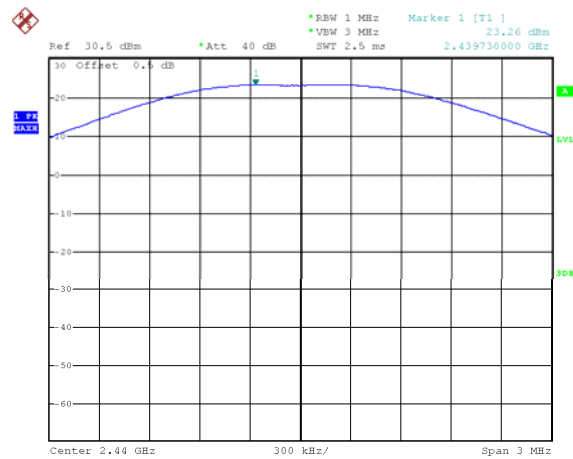
Operation mode	Channel Frequency (MHz)	Maximum Peak Output Power (dBm)	Limit
2.4G(ANT 1)	Low-2402	22.48	1W/30dBm
	Middle-2440	23.26	1W/30dBm
	High-2478	23.55	1W/30dBm
2.4G(ANT 2)	Low-2402	22.29	1W/30dBm
	Middle-2440	22.83	1W/30dBm
	High-2478	23.55	1W/30dBm

Test Plot:

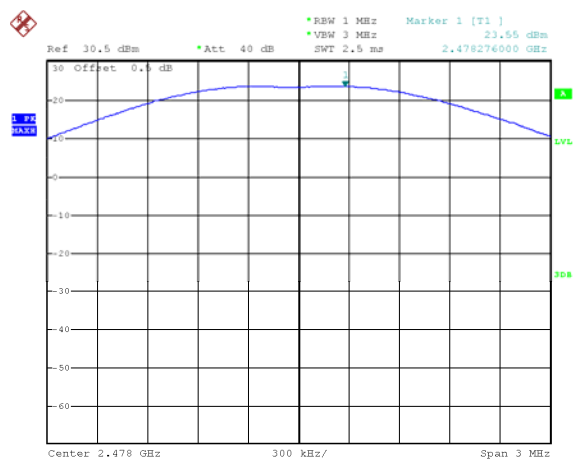
2.4G(ANT 1): channel 0



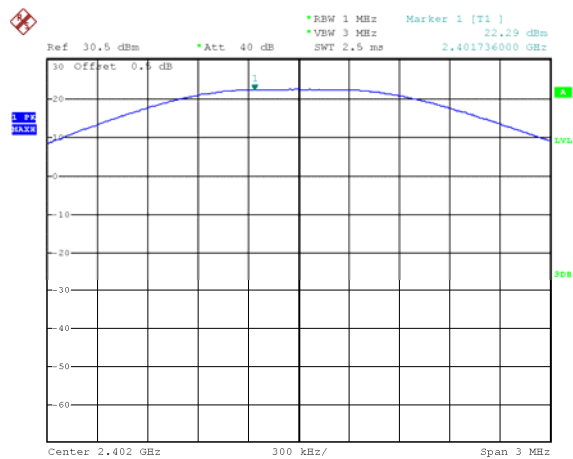
2.4G(ANT 1): channel 12



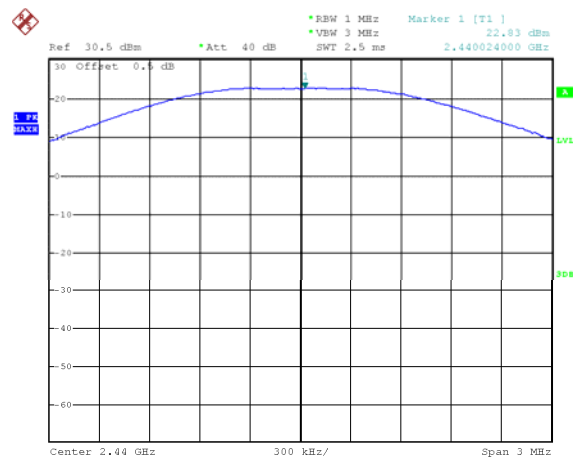
2.4G(ANT 1): channel 22



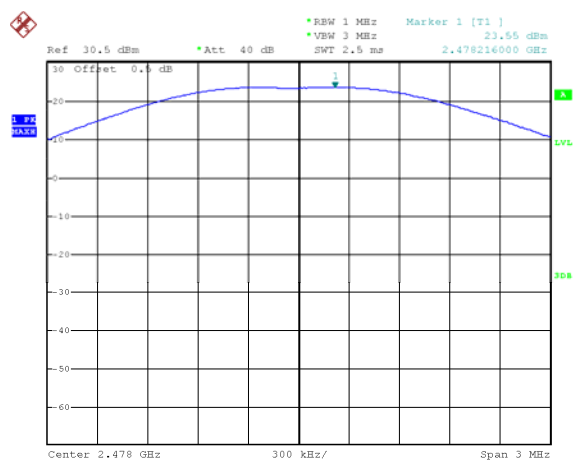
2.4G(ANT 2): channel 0



2.4G(ANT 2): channel 12



2.4G(ANT 2): channel 22



14 Power Spectral density

Test Requirement:	FCC 47CFR Part 15 Section 15.247
Test Method:	ANSI C63.10:2013 KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
Test Limit:	§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.
Test Mode:	Transmitting

14.1 Test Procedure:

According to KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019 section 8.4

Subclause 11.10 of ANSI C63.10 is applicable.

Choose the test procedure according to the product type

Peak PSD

Subclause 11.10.2 of ANSI C63.10 is applicable.

AVG PSD

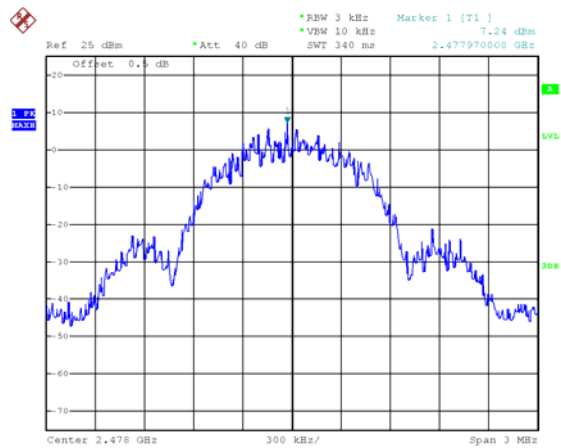
Subclause 11.10.3/4/5/6/7/8 of ANSI C63.10 is applicable.

14.2 Test Result:

Operation mode	Channel Frequency (MHz)	Power Spectral (dBm per 3kHz)	Limit
2.4G(ANT 1)	Low-2402	7.24	8dBm per 3kHz
	Middle-2440	7.63	8dBm per 3kHz
	High-2478	6.71	8dBm per 3kHz
2.4G(ANT 2)	Low-2402	7.27	8dBm per 3kHz
	Middle-2440	6.82	8dBm per 3kHz
	High-2478	6.38	8dBm per 3kHz

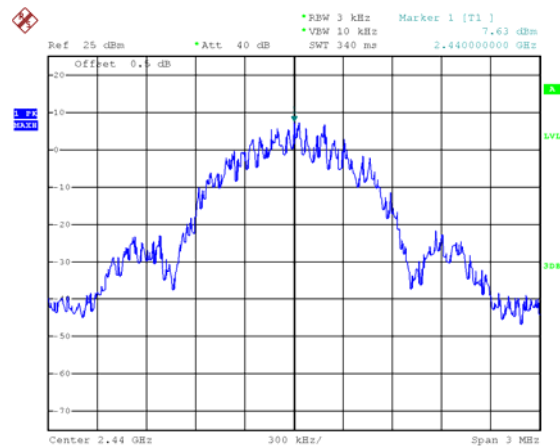
Test Plot:

2.4G(ANT 1): channel 0



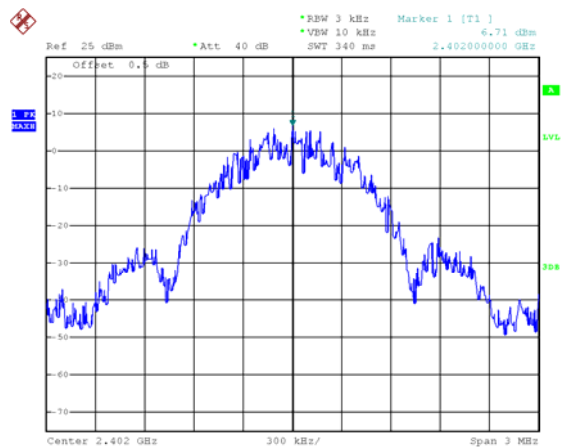
Date: 9.MAR.2022 14:50:26

2.4G(ANT 1): channel 12



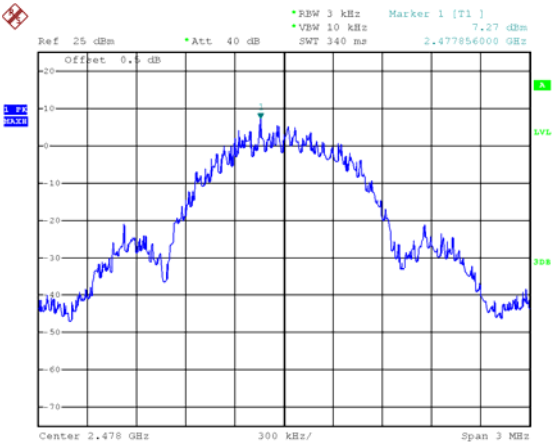
Date: 9.MAR.2022 14:52:37

2.4G(ANT 1): channel 22



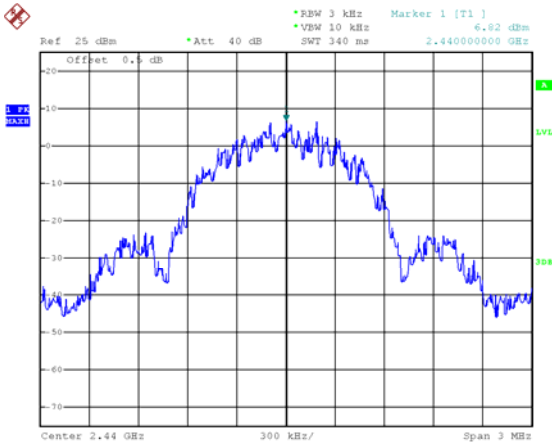
Date: 9.MAR.2022 14:55:42

2.4G(ANT 2): channel 0



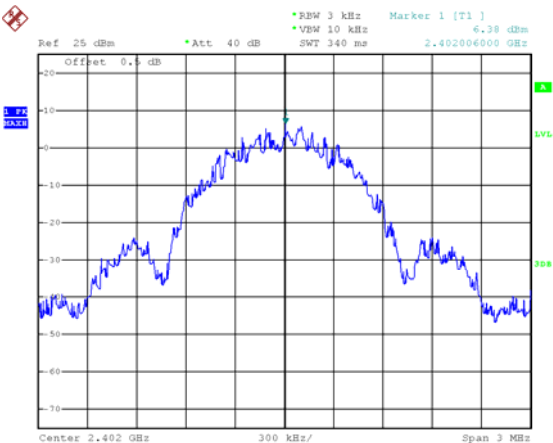
Date: 9.MAR.2022 14:49:43

2.4G(ANT 2): channel 12



Date: 9.MAR.2022 14:51:55

2.4G ANT 2): channel 22



Date: 9.MAR.2022 14:53:52

15 Antenna Requirement

According to the FCC Part 15 Paragraph 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. This product has an internal permanent antenna fulfil the requirement of this section.

Note: Please refer to EUT photos for more details.

16 RF Exposure

Note: Please refer to SAR Test Report: WTF21D12149221W007.

17 Photographs of test setup and EUT.

Note: Please refer to appendix: Appendix-SPMR14000-Photos.

=====End of Report=====