TEST REPORT

Reference No.	:	WTF19F07049532W
FCC ID	:	2AT9E-GWL-20BT
Applicant	:	ECM Industries LLC
Address	:	16250 West Woods Edge Rd.New Berlin, WI 53151
Manufacturer	:	Ningbo Weijia Electronics Technology Co., Ltd.
Address	:	Simen Town, Yuyao City, Zhejiang 315470, P.R.China
Product Name	:	Work Light
Model No.	:	GWL-20BT
Standards	:	FCC CFR47 Part 15 Subpart C (Section 15.247): 2017
Date of Receipt sample	:	2019-08-27
Date of Test	:	2019-08-27
Date of Issue	:	2019-08-30
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.

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Compiled by:

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Approved by:

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1 Test Summary

Test Items	Test Requirement	Result
Conducted Emissions	15.207	Pass
Radiated Spurious Emissions	15.247(d) 15.205(a) 15.209	Pass
Band edge Emissions	15.247(d) 15.205(a)	Pass
Bandwidth	15.247(a)(1)	Pass
Maximum Peak Output Power	15.247(b)(1)	Pass
Frequency Separation	15.247(a)(1)	Pass
Number of Hopping Frequency	15.247(a)(1)(iii)	Pass
Dwell time	15.247(a)(1)(iii)	Pass
Antenna Requirement	15.203	Pass
RF Exposure	1.1307(b)(1)	Pass

Remark:

Pass Test item meets the requirement

Fail Test item does not meet the requirement

N/A Test case does not apply to the test object

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3 Revision History

Test report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF19F07049532W	2019-08-26	2019-08-26	2019-08-30	Original	-	Valid

4 General Information

4.1 General Description of E.U.T

Product Name ..... : Work Light

Model No. ..... : GWL-20BT

Model Description ..... : ---

Hardware Version ..... : V1.1

Software Version ..... : V1.1

4.2 Details of E.U.T

Operation Frequency ..... : 2402~2480MHz

Max. RF output power ..... : -1.877dBm

Bluetooth Version ..... : Bluetooth V4.2+BR

Type of Modulation ..... : GFSK, π/4 DQPSK

Antenna installation ..... : PCB printed antenna

Antenna Gain ..... : -0.58dBi

Technical Data ..... : DC 7.4V, 6600mAh / 4400mAh for lighting power
DC 3.7V, 2200mAh for Bluetooth link power
Adapter input: AC 100-240V, 50/60Hz, 0.5A; output: DC 12V, 1A

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	1	2403	2	2404	3	2405
4	2406	5	2407	6	2408	7	2409
8	2410	9	2411	10	2412	11	2413
12	2414	13	2415	14	2416	15	2417
16	2418	17	2419	18	2420	19	2421
20	2422	21	2423	22	2424	23	2425
24	2426	25	2427	26	2428	27	2429
28	2430	29	2431	30	2432	31	2433
32	2434	33	2435	34	2436	35	2437
36	2438	37	2439	38	2440	39	2441
40	2442	41	2443	42	2444	43	2445
44	2446	45	2447	46	2448	47	2449
48	2450	49	2451	50	2452	51	2453
52	2454	53	2455	54	2456	55	2457
56	2458	57	2459	58	2460	59	2461
60	2462	61	2463	62	2464	63	2465
64	2466	65	2467	66	2468	67	2469
68	2470	69	2471	70	2472	71	2473
72	2474	73	2475	74	2476	75	2477
76	2478	77	2479	78	2480	-	-

4.4 Test Facility

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

- **IC – Registration No.: 21895-1**

Waltek Services (Foshan) 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 IC number:21895-1, Nov. 14, 2016.

- **FCC – Registration No.: 820106**

Waltek Services (Foshan) 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 820106, August 16, 2018

- **FCC – Designation No.: CN5034**

Waltek Services (Foshan) 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. Designation No. CN5034.

- **NVLAP – Lab Code: 600191-0**

Waltek Services (Foshan) Co., Ltd. EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 600191-0.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

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 items:---

Lab information: ---

4.6 Abnormalities from Standard Conditions

None.

5 Equipment Used during Test

5.1 Equipment List

Conducted Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal Date**	**Cal Due Date**
1.	EMI Test Receiver	RS	ESCI	101178	2019-01-18	2020-01-17
2.	LISN	RS	ENV216	101215	2019-01-10	2020-01-09
3.	Cable	HUBER+SUHNER	CBL2-NN-3M	223NN322	2019-01-10	2020-01-09
4.	Test Software	FARATRONIC	EZ-EMC	EMEC-3AA	-	-
3m Semi-anechoic Chamber for Radiation Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMC Analyzer	Agilent	N9020A	MY48011796	2019-01-26	2020-01-25
2.	Active Loop Antenna	SCHWARZBECK	FMZB1519B	00004	2019-03-10	2020-03-09
3.	Trilog Broadband Antenna	SCHWARZBECK	VULB 9162	9162-117	2019-01-26	2020-01-25
4.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	01561	2019-04-28	2020-04-27
5.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2019-04-28	2020-04-27
6.	Amplifier	Lunar E M	LNA1G18-40	20160501002	2019-04-28	2020-04-27
7.	Coaxial Cable (below 1GHz)	H+S	CBL3-NN-12+3 m	214NN320	2019-01-10	2020-01-09
8.	Coaxial Cable (above 1GHz)	Times-Micorwave	CBL5-NN	-	2019-01-10	2020-01-09
9.	Test Software	FARATRONIC	EZ-EMC	EMEC-3AA	-	-
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	Spectrum Analyzer	Agilent	N9020A	MY48011796	2019-01-26	2020-01-25
2.	Spectrum Analyzer	R&S	FSP40	100501	2018-11-13	2019-11-12
3.	Vector Signal Generator	Agilent	N5182A	MY50141533	2019-03-03	2020-03-02
4.	Analog Signal Generator	Agilent	N5181A	MY48180720	2019-01-26	2020-01-26
5.	Environmental Chamber	KSON	THS-D4C-100	5244K	2019-01-26	2020-01-26
6.	Test Software	FARATRONIC	EZ-EMC	EMEC-3AA	-	-

5.2 Description of Support Units

Item	Equipment	Technical Data	Manufacturer	Model No.	Serial No.
1.	Notebook	AC 230V/50Hz	Lenovo	ThinkPad Edge E430	00426-OEM-8992662-00400

5.3 Measurement Uncertainty

Conducted Emission (150kHz-30MHz)

Input quantity	X_i	Uncertainty of x_i		$u(X_i)$	C_i	$C_i u(X_i)$ (dB)
		dB	Probability distribution function			
Receiver reading	V_r	±0.36	K=2	0.18	1	0.18
Attenuation: AMN-receiver	a_c	±0.20	K=2	0.10	1	0.10
AMN voltage division factor	F_{AMN}	±0.20	K=2	0.10	1	0.10
Receiver corrections:						
Sine wave voltage	δV_{sw}	±1.0	K=2	0.50	1	0.50
Pulse amplitude response	δV_{pa}	±0.0		0.00	1	0.00
Pulse repetition rate response	δV_{pr}	±0.0		0.00	1	0.00
Noise floor proximity	δV_{nf}	±0.05		0.00	1	0.00
Mismatch: AMN-receiver	δM	+0.7/-0.8	U-shaped	0.53	1	0.53
AMN impedance	δZ	+2.6/-2.7	Triangular	1.08	1	1.08
Note: $V = V_r + a_c + F_{AMN} + \delta F_{AMN} + \delta V_{sw} + \delta V_{pa} + \delta V_{pr} + \delta V_{nf} + \delta M + \delta Z$ $U(V)=2u_c(V)=$ ***2.66*** *dB*						

Radiated Emission (30MHz-1GHz)

Input quantity	X_i	Uncertainty of x_i		$u(X_i)$	C_i	$C_i u(X_i)$ (dB)
		dB	Probability distribution function			
Receiver reading	V_r	±0.36	K=2	0.18	1	0.18
Attenuation: antenna-receiver	a_c	±0.10	K=2	0.05	1	0.05
Antenna facotr	F_a	±1.6	K=2	0.8	1	0.8
Receiver corrections:						
Sine wave voltage	δV_{sw}	±1.0	K=2	0.5	1	0.5
Pulse amplitude response	δV_{pa}	±0.6	Rectangular	0.35	1	0.35
Pulse repetition rate response	δV_{pr}	±1.5	Rectangular	0.87	1	0.87
Noise floor proximity	δV_{nf}	±0.5	K=2	0.25	1	0.25
Mismatch: antenna-receiver	δM	+0.9/-1.0	U-shaped	0.67	1	0.67
Antenna corrections:						
AF frequency interpolation	δF_{af}	±0.3	Rectangular	0.17	1	0.17
AF variation due to FAR influence	δF_{ah}	±0.5	Rectangular	0.29	1	0.29
Directivity difference	δF_{adir}	±0.0		0.00	1	0.00
Phase centre location	δF_{aph}	±0.0		0.00	1	0.00
Cross-polarization	δF_{acp}	±0.0		0.00	1	0.00
Balance	δF_{abal}	±0.3	Rectangular	0.17	1	0.17
Site corrections:						
Site imperfections	δA_N	±4.0	Triangular	1.63	1	1.63
Separation distance	δd	±0.3	Rectangular	0.17	1	0.17
Table height	δh	±0.1	K=2	0.05	1	0.05
Note: E= $V_r + a_c + F_a + \delta V_{sw} + \delta V_{pa} + \delta V_{pr} + \delta V_{nf} + \delta M + \delta F_{af} + \delta F_{ah} + \delta F_{adir} + \delta F_{aph} + \delta F_{acp} + \delta F_{abal} + \delta A_N + \delta d + \delta h$ $U(E)=2u_c(E)=$**4.56**dB						

Radiated Spurious Emissions (25MHz-1GHz)

Input quantity	X_i	Uncertainty of x_i		$u(x_i)$ dB	c_i	$c_i u(x_i)$ dB
		dB	Probability distribution function			
Receiver reading	V_r	±0.4	k=2	0.20	1	0.20
Attenuation: antenna-receiver	a_c	±0.5	k=2	0.25	1	0.25
Cable loss and correction	L_{ac}	±1.6	k=2	0.80	1	0.80
Receiver corrections:						
Sine wave voltage	δV_{sw}	±0.9	k=2	0.45	1	0.45
Pulse amplitude response	δV_{pa}	±0.6	Rectangular	0.35	1	0.35
Pulse repetition rate response	δV_{pr}	±0.6	Rectangular	0.35	1	0.35
Noise floor proximity	δV_{nf}	+1.0/0.0	U-shaped	0.58	1	0.58
Mismatch: antenna-receiver	δM	+0.9/--1.0	U-shaped	0.67	1	0.67
Site imperfections	δMD	±3.0	Triangular	1.14	1	1.23
Reproducibility of measurement operation	δp	±0.60	k=2	0.30	1	0.30
Separation distance	δd	±0.3	Rectangular	0.17	1	0.17
Table height	δh	±0.1	k=2	0.05	1	0.05
Note: $E = V_r + a_c + L_{ac} + \delta V_{sw} + \delta V_{pa} + \delta V_{pr} + \delta V_{nf} + \delta M + \delta MD + \delta p + \delta d + \delta h$ $U(E) = 2u_c(E) =$ ***3.80*** dB						

Radiated Spurious Emissions (1GHz-18GHz)

Input quantity	X_i	Uncertainty of x_i		$u(x_i)$ dB	c_i	$c_i u(x_i)$ dB
		dB	Probability distribution function			
Receiver reading	V_r	±0.40	k=2	0.20	1	0.20
Attenuation: antenna-receiver	a_c	±0.80	k=2	0.40	1	0.40
Cable loss and correction	L_{ac}	±2.40	k=2	1.20	1	1.20
Mismatch: Preamplifiers - Signal Analyzers	δM_{ps}	+1.2/-1.4	U-shaped	0.92	1	0.92
Mismatch:antenna-receiver	δM_{ac}	+1.3/-1.5	U-shaped	1.00	1	1.00
Receiver corrections:						
Sine wave voltage	δV_{sw}	±0.9	k=2	0.45	1	0.45
Pulse amplitude response	δV_{pa}	±0.6	Rectangular	0.35	1	0.35
Pulse repetition rate response	δV_{pr}	±0.6	Rectangular	0.35	1	0.35
Noise floor proximity	δV_{nf}	+1.0/0.0	U-shaped	0.58	1	0.58
Site imperfections	$\delta Svswr$	±3.0	Triangular	1.22	1	1.22
Effect of setup table material	δANT	±1.0	Rectangular	0.58	1	0.58
Reproducibility of measurement operation	δp	±0.60	k=2	0.30	1	0.30
Note: $E = V_r + a_c + L_{ac} + \delta M_{ps} + \delta M_{ac} + \delta V_{sw} + \delta V_{pa} + \delta V_{pr} + \delta V_{nf} + \delta Svswr + \delta ANT + \delta p$ $U(E) = 2u_c(E) =$ ***4.97*** dB						

6 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)	Conducted Limit (dBμV)	
	Quasi- eak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5.0	56	46
5.0 to 30	60	50
*Decreases with the logarithm of the frequency.		

6.1 E.U.T. Operation

Operating Environment:

Temperature ..... : 24.8 °C

Humidity ..... : 49.3 % RH

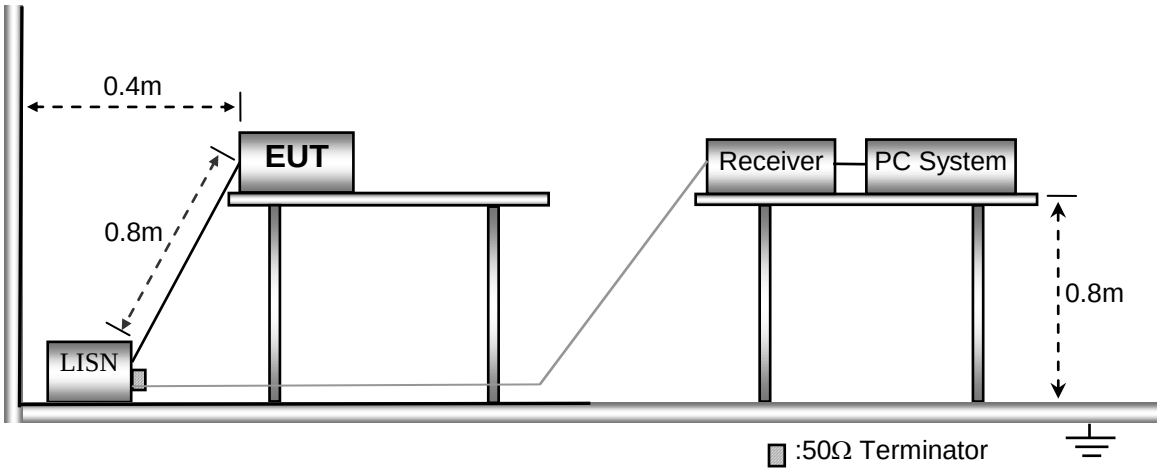
Atmospheric Pressure ..... : 101.2kPa

EUT Operation:

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

6.2 EUT Setup

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



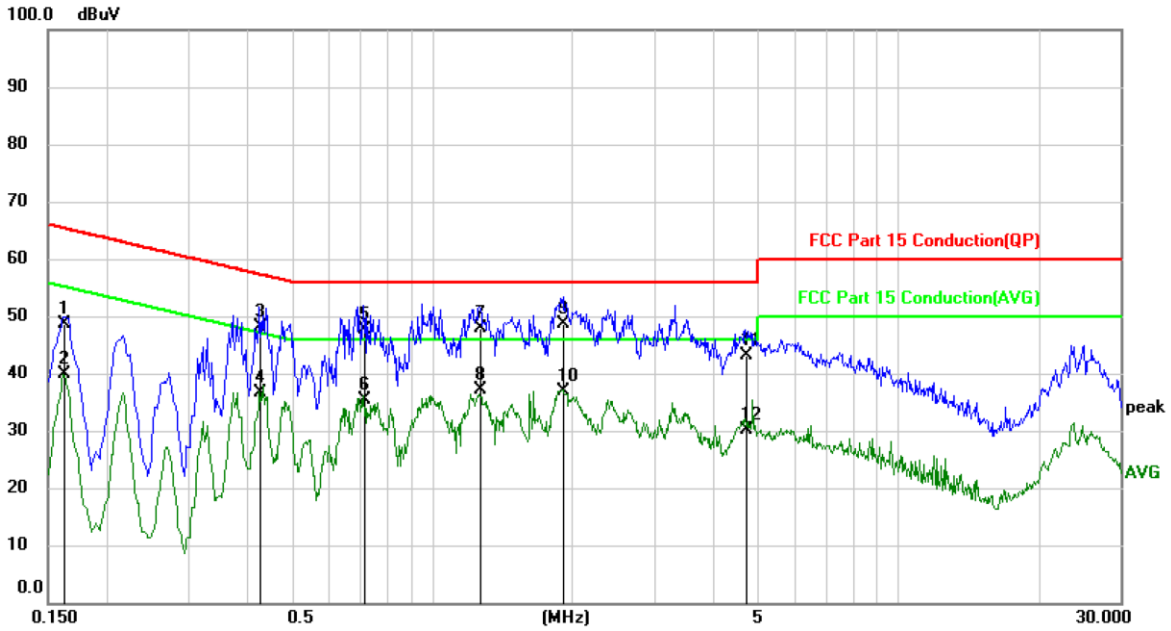
6.3 Measurement Description

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.

6.4 Conducted Emission Test Result

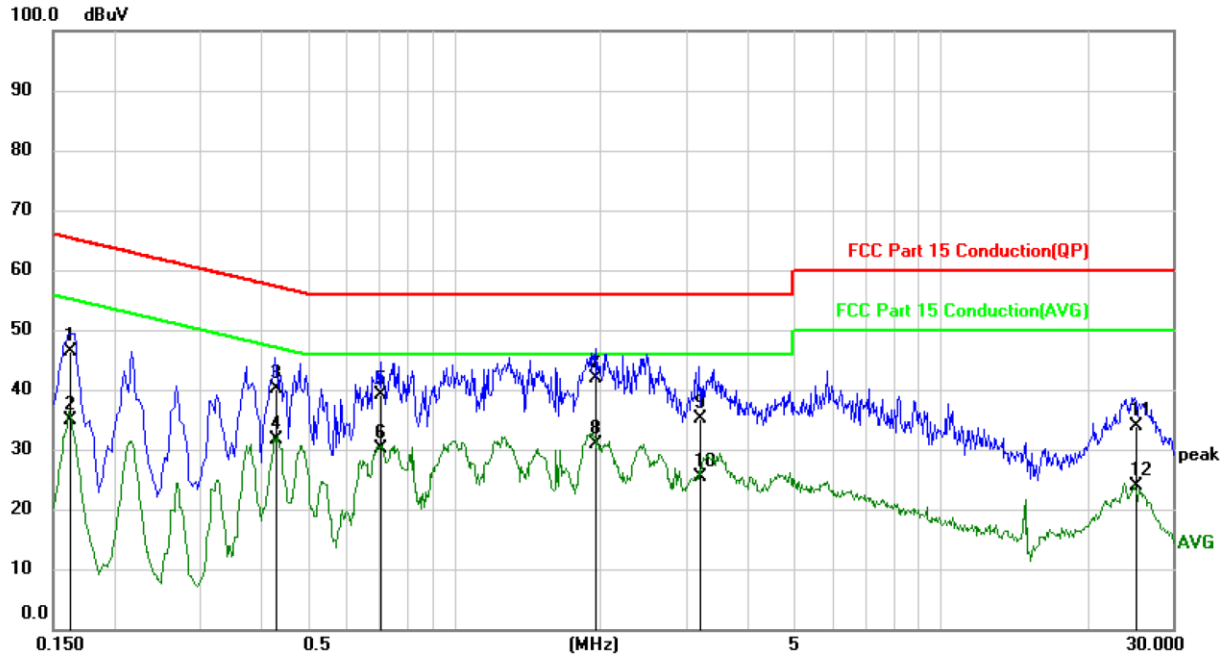
An initial pre-scan was performed on the live and neutral lines.

Live Line :



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1620	39.08	9.60	48.68	65.36	-16.68	QP	
2		0.1620	30.38	9.60	39.98	55.36	-15.38	AVG	
3		0.4260	38.57	9.59	48.16	57.33	-9.17	QP	
4		0.4260	27.12	9.59	36.71	47.33	-10.62	AVG	
5		0.7140	38.09	9.60	47.69	56.00	-8.31	QP	
6		0.7140	25.88	9.60	35.48	46.00	-10.52	AVG	
7		1.2660	38.30	9.60	47.90	56.00	-8.10	QP	
8		1.2660	27.62	9.60	37.22	46.00	-8.78	AVG	
9	*	1.9180	39.01	9.62	48.63	56.00	-7.37	QP	
10		1.9180	27.32	9.62	36.94	46.00	-9.06	AVG	
11		4.7180	33.32	9.70	43.02	56.00	-12.98	QP	
12		4.7180	20.40	9.70	30.10	46.00	-15.90	AVG	

Neutral Line :



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1620	36.87	9.60	46.47	65.36	-18.89	QP	
2		0.1620	25.31	9.60	34.91	55.36	-20.45	AVG	
3		0.4300	30.51	9.59	40.10	57.25	-17.15	QP	
4		0.4300	21.99	9.59	31.58	47.25	-15.67	AVG	
5		0.7060	29.60	9.60	39.20	56.00	-16.80	QP	
6		0.7060	20.55	9.60	30.15	46.00	-15.85	AVG	
7	*	1.9500	32.16	9.62	41.78	56.00	-14.22	QP	
8		1.9500	21.16	9.62	30.78	46.00	-15.22	AVG	
9		3.2020	25.54	9.65	35.19	56.00	-20.81	QP	
10		3.2020	15.65	9.65	25.30	46.00	-20.70	AVG	
11		25.0780	23.66	10.14	33.80	60.00	-26.20	QP	
12		25.0780	13.84	10.14	23.98	50.00	-26.02	AVG	

7 Radiated Spurious Emissions

Test Requirement .....: FCC CFR47 Part 15 Subpart C Section 15.209 & 15.247

Test Method .....: 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(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	$20\log^{(500)}$

7.1 EUT Operation

Operating Environment:

Temperature..... : 24.0°C

Humidity ..... : 49.0% RH

Atmospheric Pressure ..... : 101.2kPa

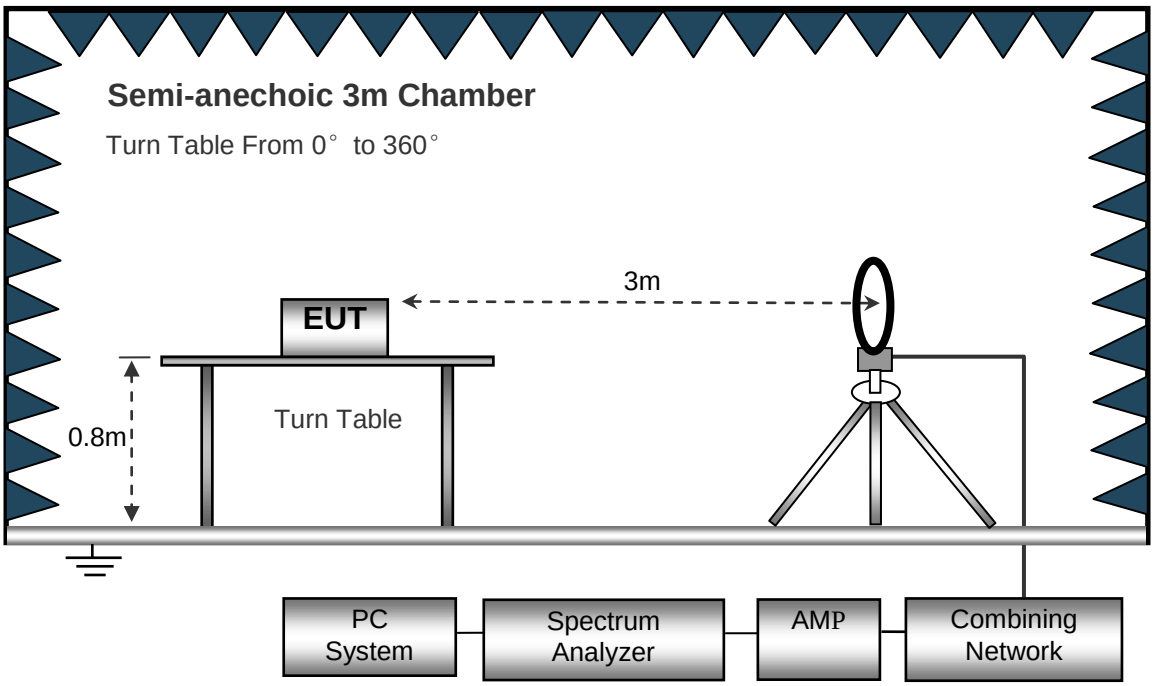
EUT Operation:

The test was performed in Transmitting mode, the worst test data (GFSK modulation) were shown in the report.

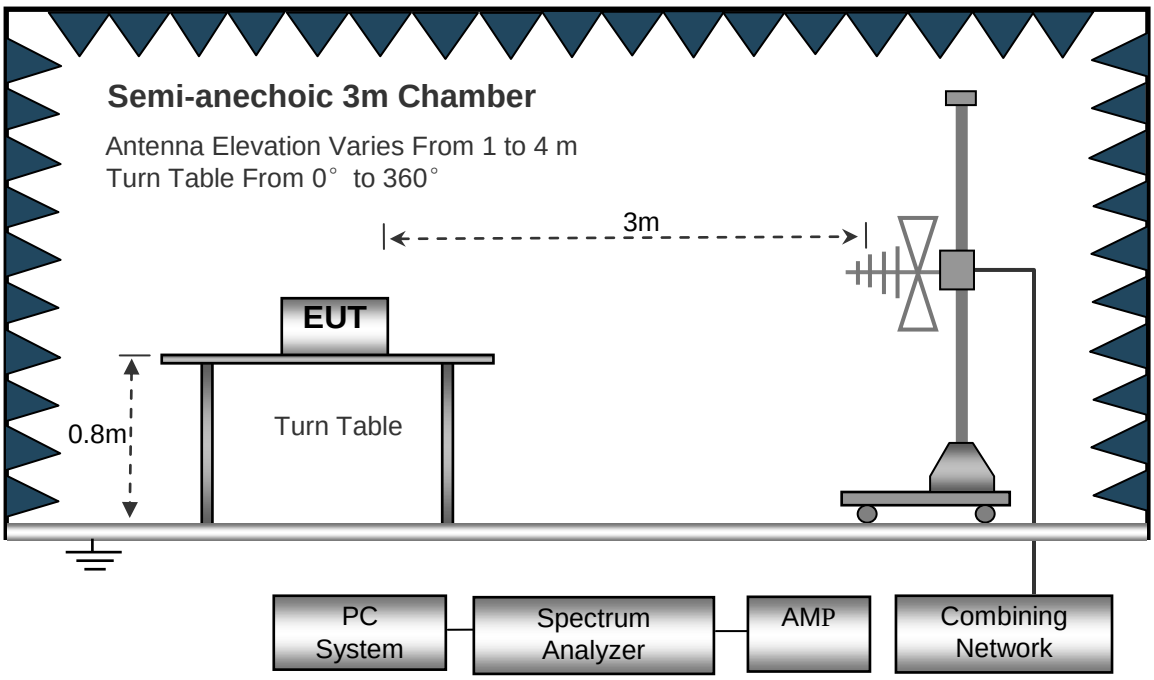
7.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10: 2013.

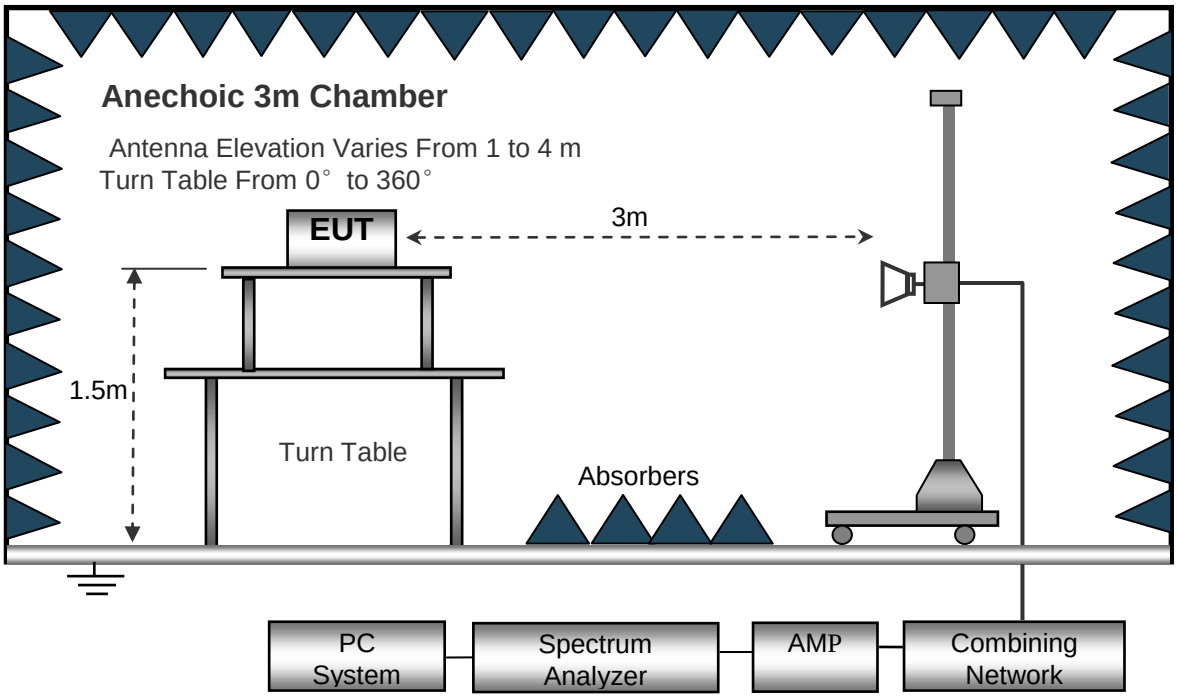
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



7.3 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

7.4 Test Procedure

1) The EUT is placed on a turntable, which is 0.8m(Below 1G) 1.5m(above 1G)above ground plane.
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. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
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 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 Z position. So the data shown was the Z position only.

7.5 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:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - 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:

Margin = Corr. Ampl. – Limit

7.6 Summary of Test Results

Test Frequency: 9 kHz~30 MHz

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

Test Frequency: 30MHz ~ 12.75GHz

Remark: only the worst data (GFSK modulation mode) were reported.

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
GFSK Low Channel									
30.00	24.84	QP	191	1.3	H	11.41	36.25	40.00	-3.75
30.00	26.83	QP	147	1.8	V	11.60	38.43	40.00	-1.57
4804.00	47.12	PK	42	1.2	V	-6.60	40.52	74.00	-33.48
4804.00	40.68	Ave	42	1.2	V	-6.60	34.08	54.00	-19.92
7206.00	47.01	PK	74	2.0	H	-2.11	44.90	74.00	-29.10
7206.00	42.17	Ave	74	2.0	H	-2.11	40.06	54.00	-13.94
1298.01	52.11	PK	87	1.7	V	-14.57	37.54	74.00	-36.46
1298.01	48.25	Ave	87	1.7	V	-14.57	33.68	54.00	-20.32
1510.87	52.34	PK	181	1.9	H	-13.75	38.59	74.00	-35.41
1510.87	47.68	Ave	181	1.9	H	-13.75	33.93	54.00	-20.07
2873.19	50.64	PK	359	1.4	V	-11.41	39.23	74.00	-34.77
2873.19	46.69	Ave	359	1.4	V	-11.41	35.28	54.00	-18.71

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
GFSK Middle Channel									
36.00	18.51	QP	10	1.7	H	13.06	31.57	40.00	-8.43
36.00	17.16	QP	320	1.1	V	12.11	29.27	40.00	-10.73
4882.00	47.60	PK	335	1.5	V	-7.37	40.23	74.00	-33.77
4882.00	40.12	Ave	335	1.5	V	-7.37	32.75	54.00	-21.25
7323.00	44.73	PK	63	1.4	H	-0.69	44.04	74.00	-15.08
7323.00	39.61	Ave	63	1.4	H	-0.69	38.92	54.00	-10.89
3384.06	48.57	PK	114	1.6	V	-10.19	38.38	74.00	-35.62
3384.06	42.19	Ave	114	1.6	V	-10.19	32.00	54.00	-22.00
3980.73	48.52	PK	165	1.3	H	-9.08	39.44	74.00	-34.56
3980.73	43.47	Ave	165	1.3	H	-9.08	34.39	54.00	-19.61
6364.13	44.97	PK	213	1.8	V	-3.62	42.79	74.00	-31.21
6361.13	38.87	Ave	213	1.8	V	-3.62	35.25	54.00	-18.75

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
GFSK High Channel									
59.86	13.67	QP	282	1.5	H	10.24	23.91	40.00	-16.09
59.86	10.36	QP	162	1.9	V	10.24	20.60	40.00	-19.40
4960.00	46.16	PK	91	1.0	V	-6.94	39.22	74.00	-34.78
4960.00	39.01	Ave	91	1.0	V	-6.94	32.07	54.00	-21.93
7440.00	46.79	PK	306	1.7	H	-1.24	45.55	74.00	-28.45
7440.00	40.59	Ave	306	1.7	H	-1.24	39.35	54.00	-14.65
1383.15	51.59	PK	205	1.1	V	-14.22	37.37	74.00	-36.63
1383.15	42.48	Ave	205	1.1	V	-14.22	28.26	54.00	-25.74
1894.02	51.51	PK	277	1.6	H	-13.73	37.78	74.00	-36.22
1894.02	43.88	Ave	277	1.6	H	-13.73	30.15	54.00	-23.85
2915.76	50.12	PK	242	2.0	V	-11.27	38.85	74.00	-35.15
2915.76	44.51	Ave	242	2.0	V	-11.27	33.24	54.00	-20.76

Test Frequency: 12.75GHz~25GHz

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

8 Band Edge Measurement

Test Requirement .....: FCC CFR47 Part 15 Subpart C Section 15.247 Subpart C (d)

Test Method .....: ANSI C63.10:2013

Test Mode.....: Transmitting

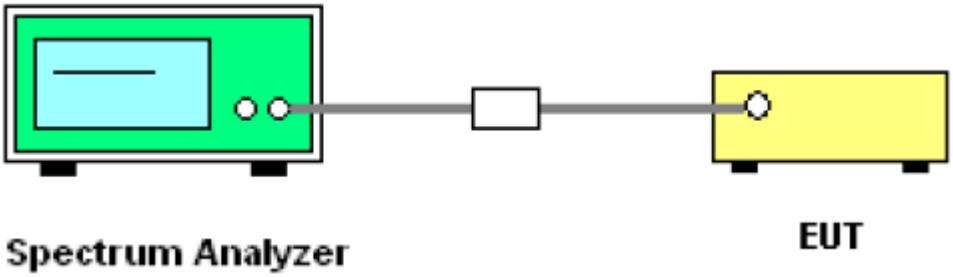
8.1 Test Procedure

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, Sweep = auto

   Detector function = peak, Trace = max hold

8.2 Test Setup



8.3 Limit

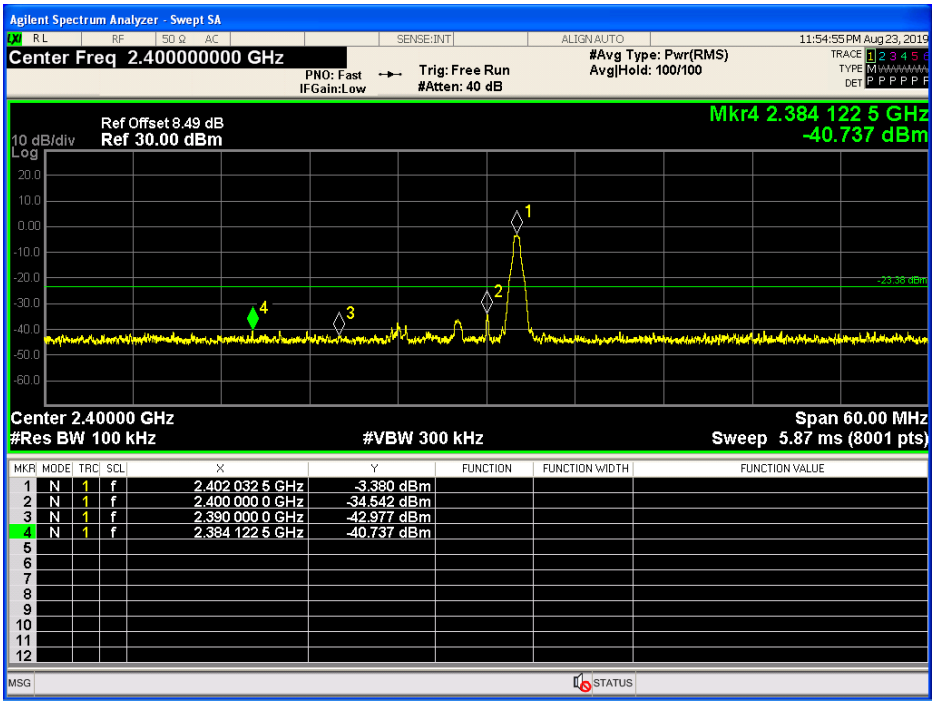
In any 100 kHz bandwidth outside the
frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

8.4 Test Result

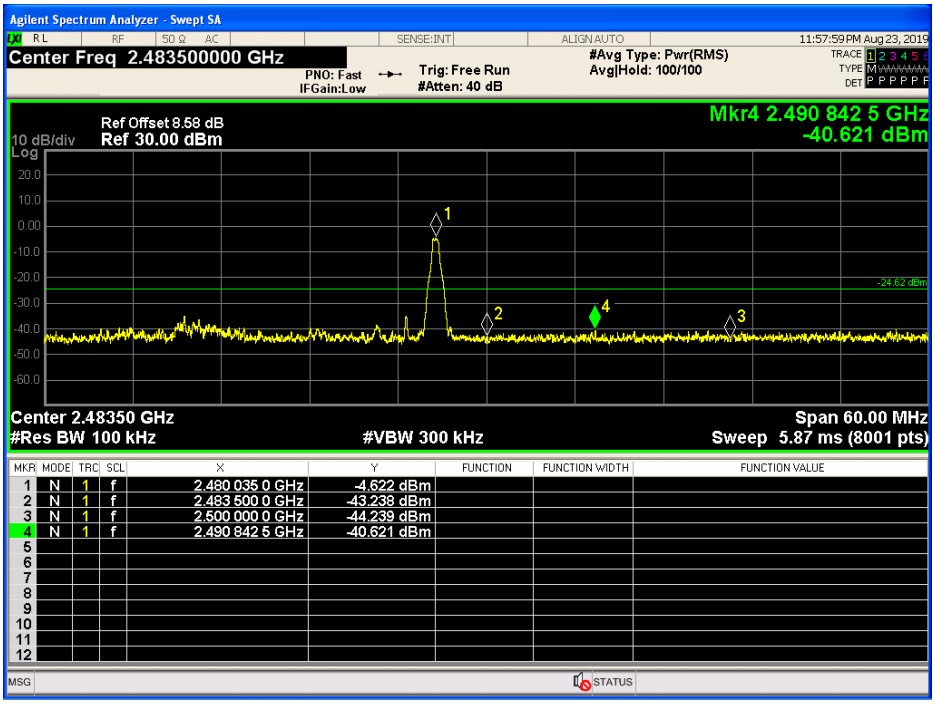
Test Mode	Test Channel	Hopping	Carrier Power[dBm]	Max. Spurious Level [dBm]	Limit[dBm]	Verdict
GFSK	2402	Off	-3.380	-40.737	-23.38	PASS
GFSK	2480	Off	-4.622	-40.621	-24.62	PASS
GFSK	2402	On	-3.593	-41.025	-23.59	PASS
GFSK	2480	On	-4.251	-40.176	-24.25	PASS
π/4 DQPSK	2402	Off	-3.232	-40.728	-23.23	PASS
π/4 DQPSK	2480	Off	-4.659	-40.178	-24.66	PASS
π/4 DQPSK	2402	On	-3.413	-41.413	-23.41	PASS
π/4 DQPSK	2480	On	-4.360	-39.770	-24.36	PASS

Test plots as follow:

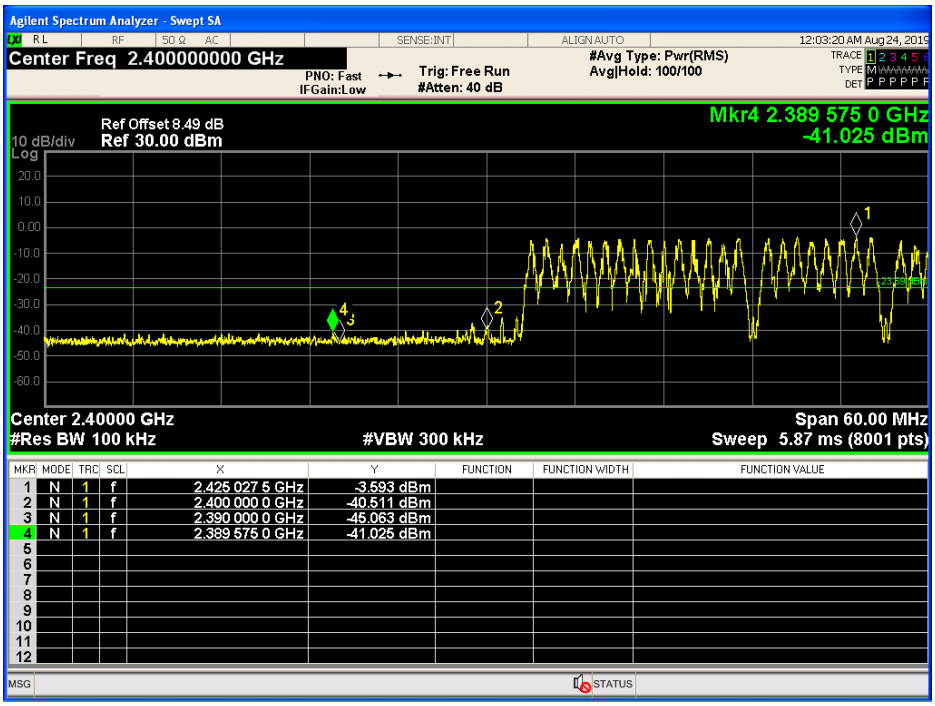
GFSK Transmitting Band edge-left side



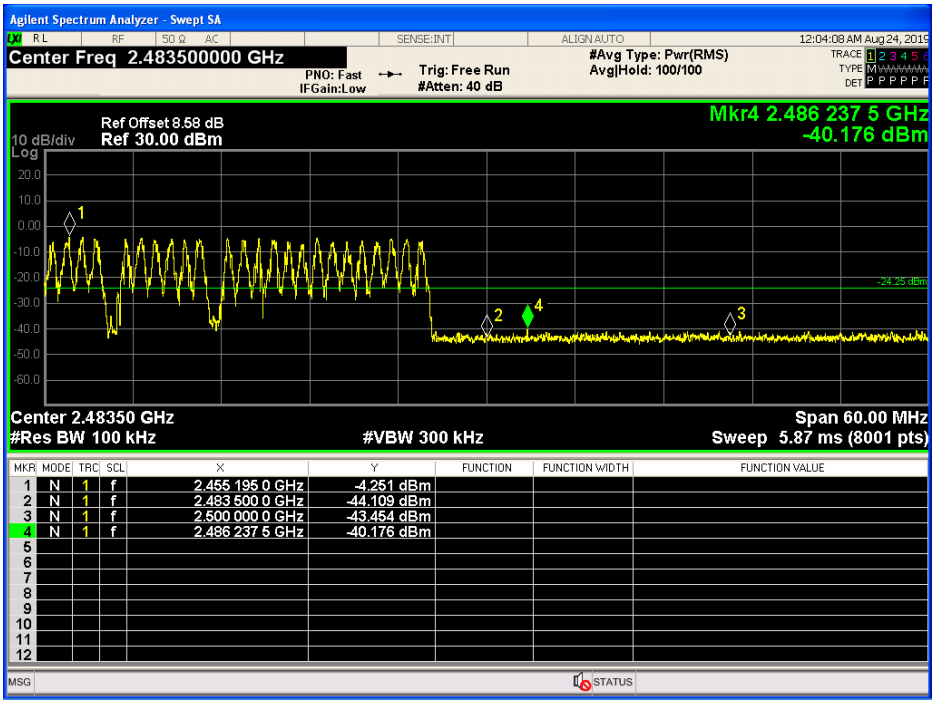
GFSK Transmitting Band edge-right side



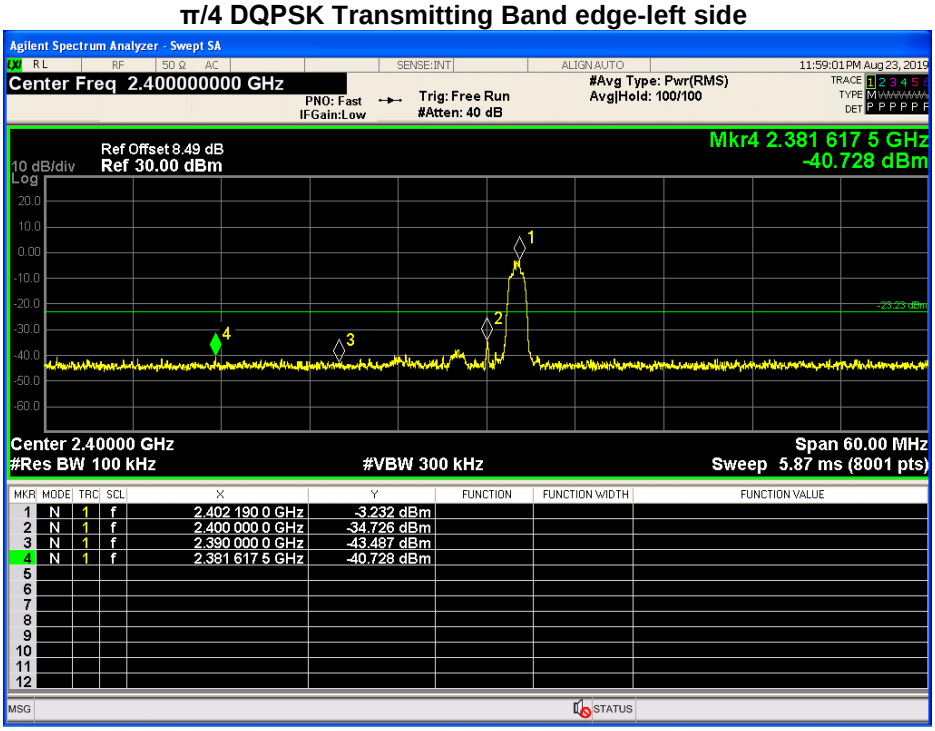
GFSK Hopping Band edge-left side



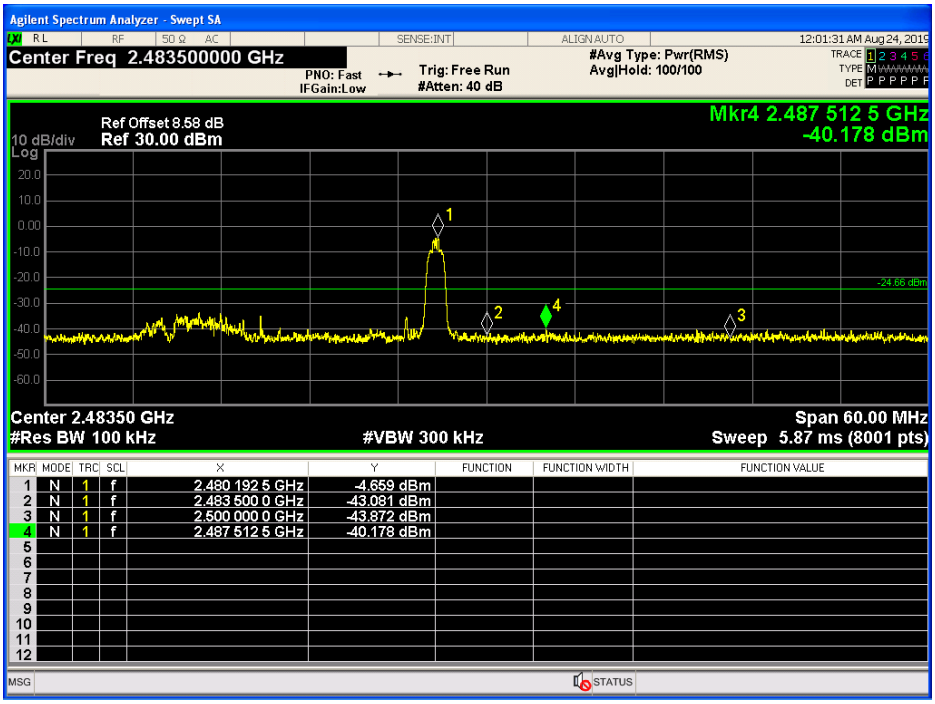
GFSK Hopping Band edge-right side



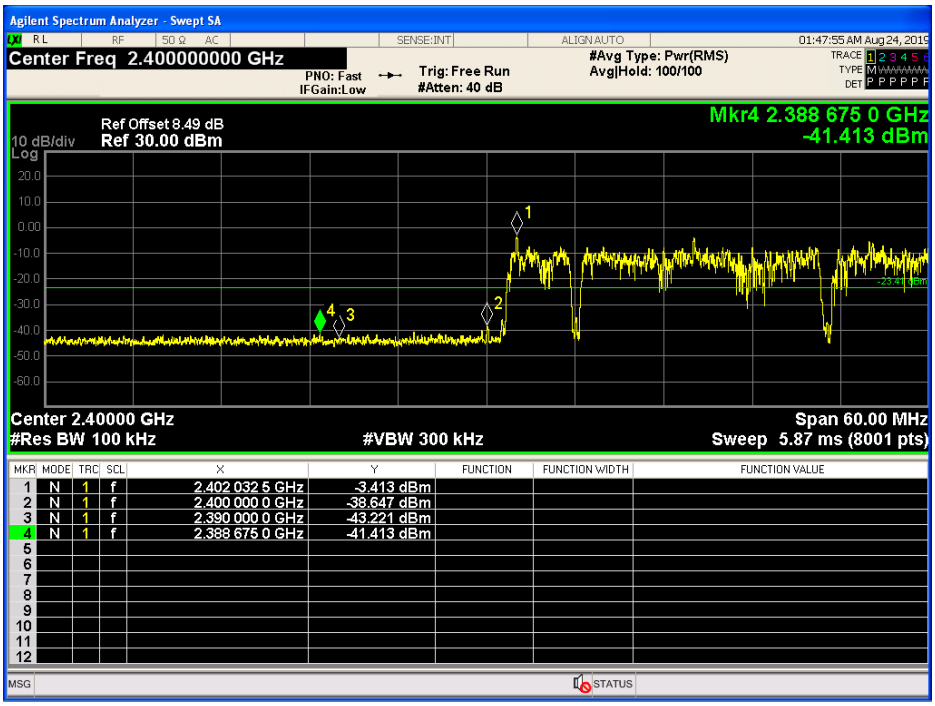
π/4 DQPSK Transmitting Band edge-left side



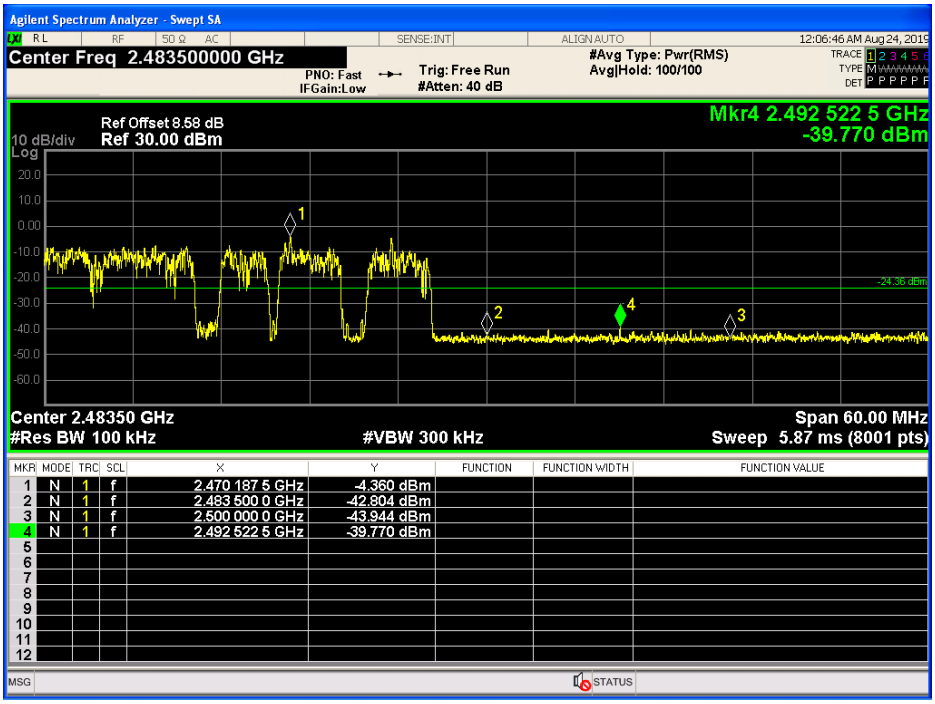
π/4 DQPSK Transmitting Band edge-right side



π/4 DQPSK Hopping Band edge-left side



π/4 DQPSK Hopping Band edge-right side



9 Bandwidth Measurement

Test Requirement .....: FCC CFR47 Part 15 Subpart C Section 15.247

Test Method .....: ANSI C63.10:2013

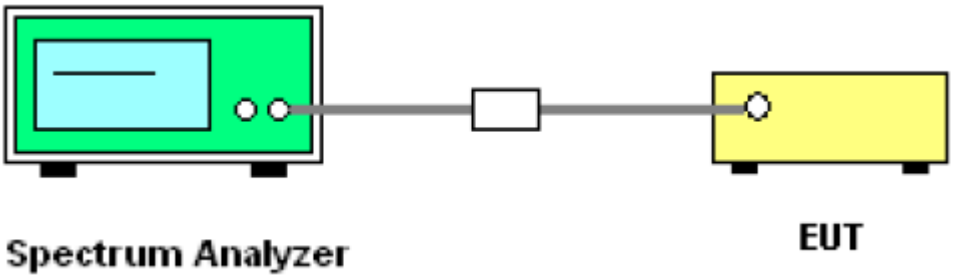
Test Mode.....: Test in fixing operating frequency at low, Middle, high channel.

9.1 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 = 30kHz, VBW = 100kHz

9.2 Test Setup

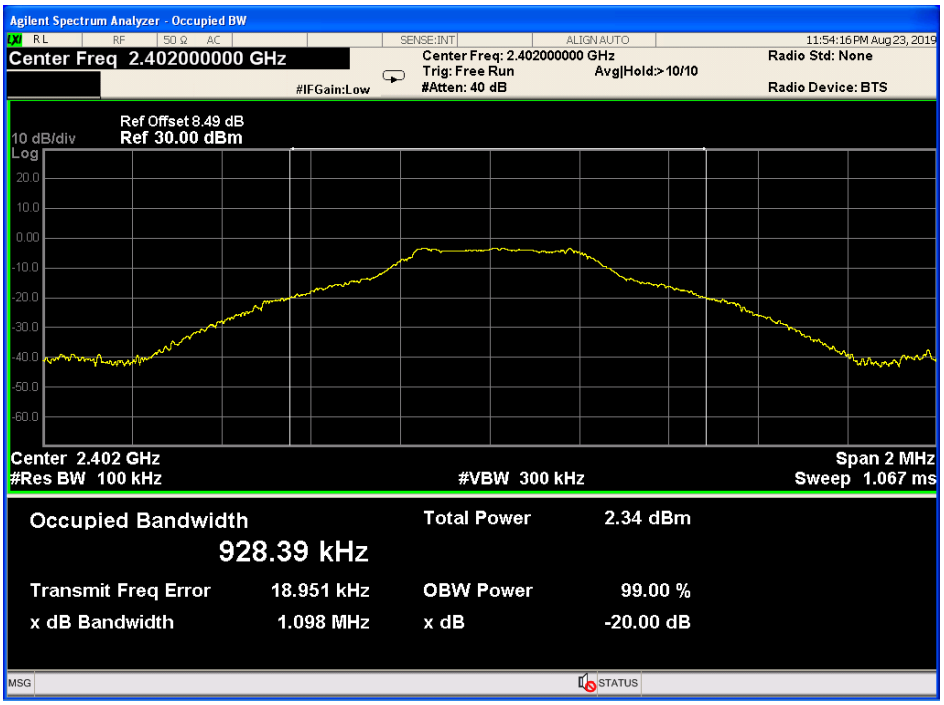


9.3 Test Result

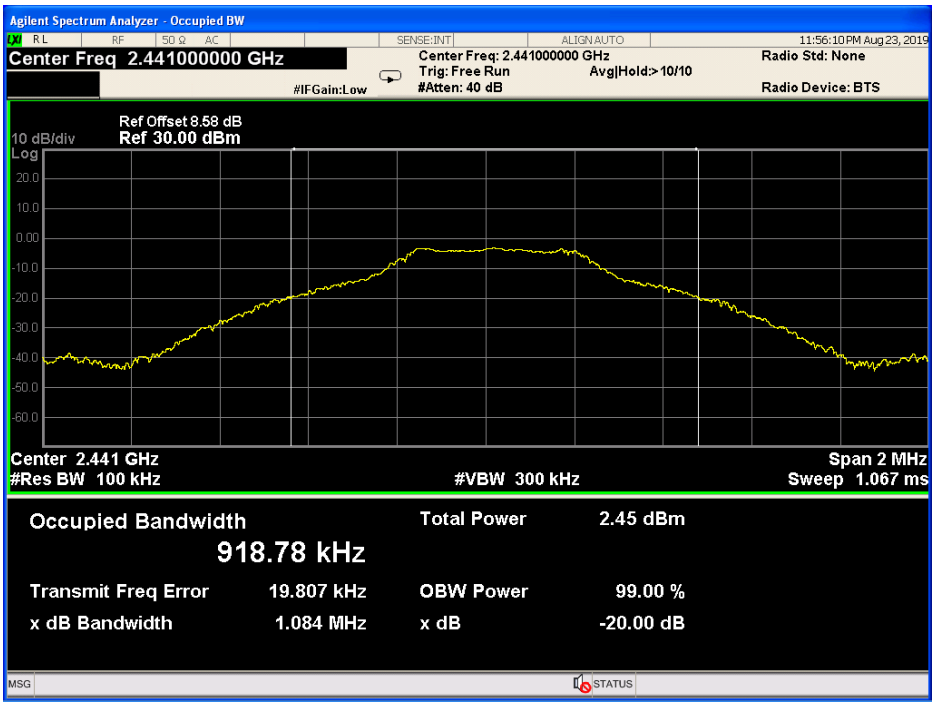
Modulation	Test Channel	20dB Bandwidth(MHz)	99% Bandwidth(MHz)
GFSK	2402	1.098	0.9284
GFSK	2441	1.084	0.9188
GFSK	2480	1.094	0.9394
π/4 DQPSK	2402	1.361	1.2011
π/4 DQPSK	2441	1.361	1.1953
π/4 DQPSK	2480	1.369	1.1998

Test result plot as follow:

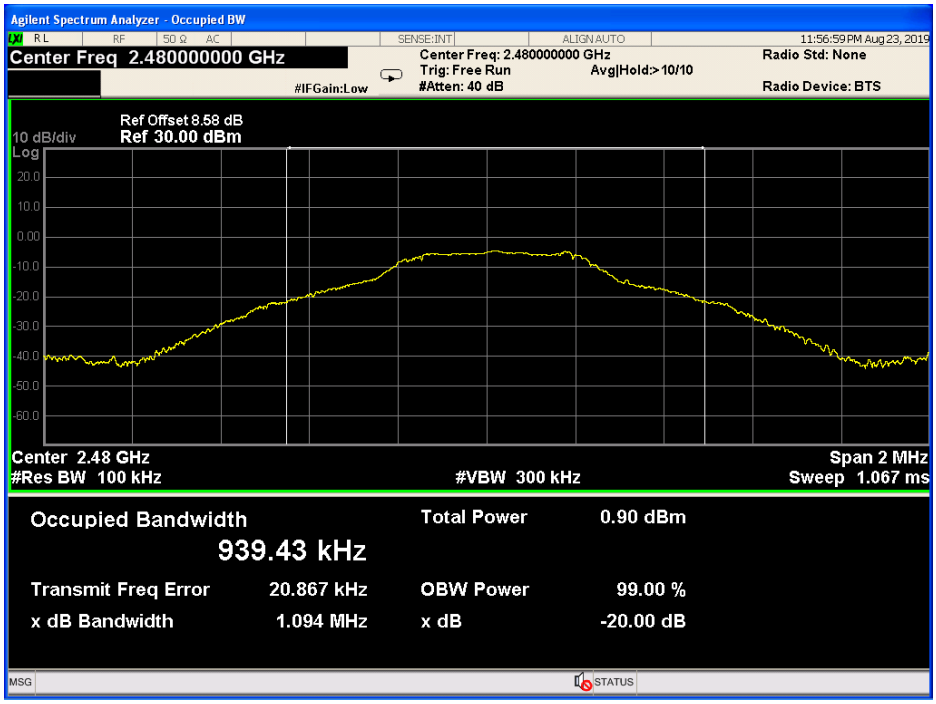
GFSK Low Channel 2402



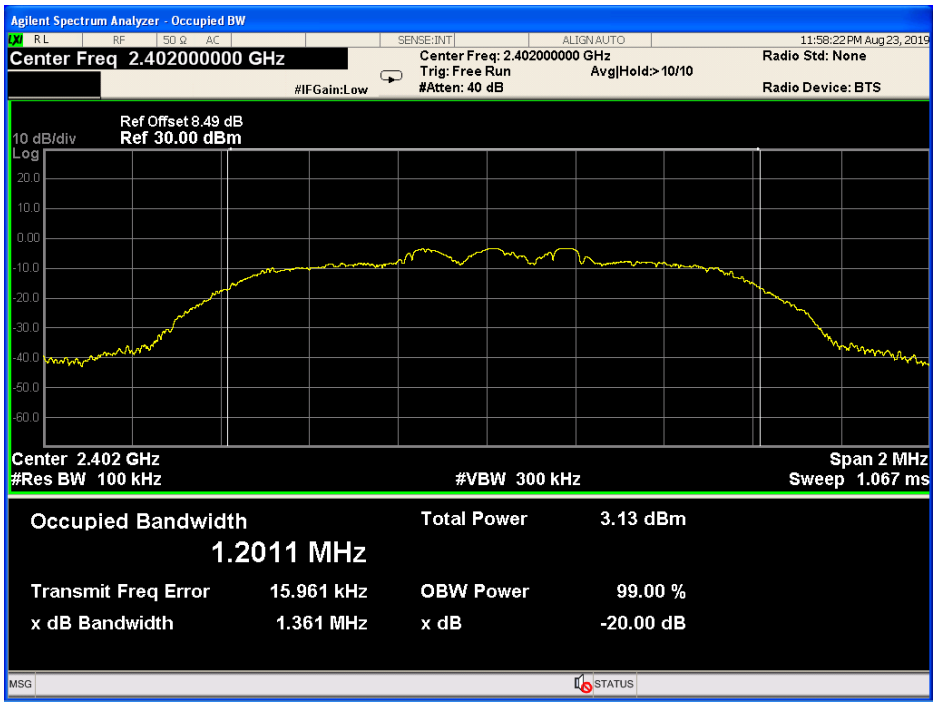
GFSK Middle Channel 2441



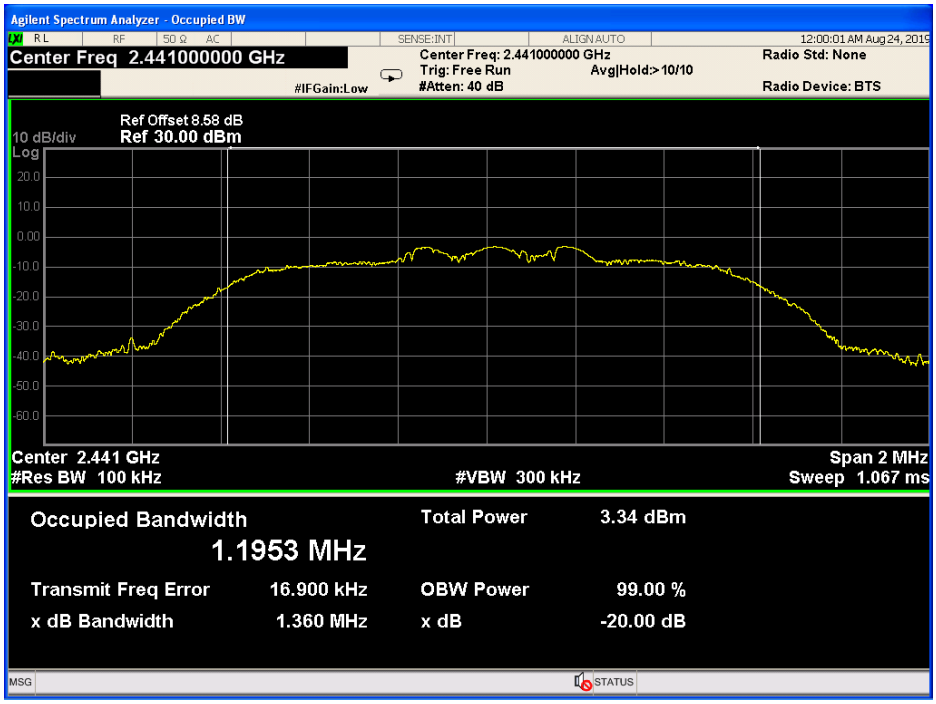
GFSK High Channel 2480



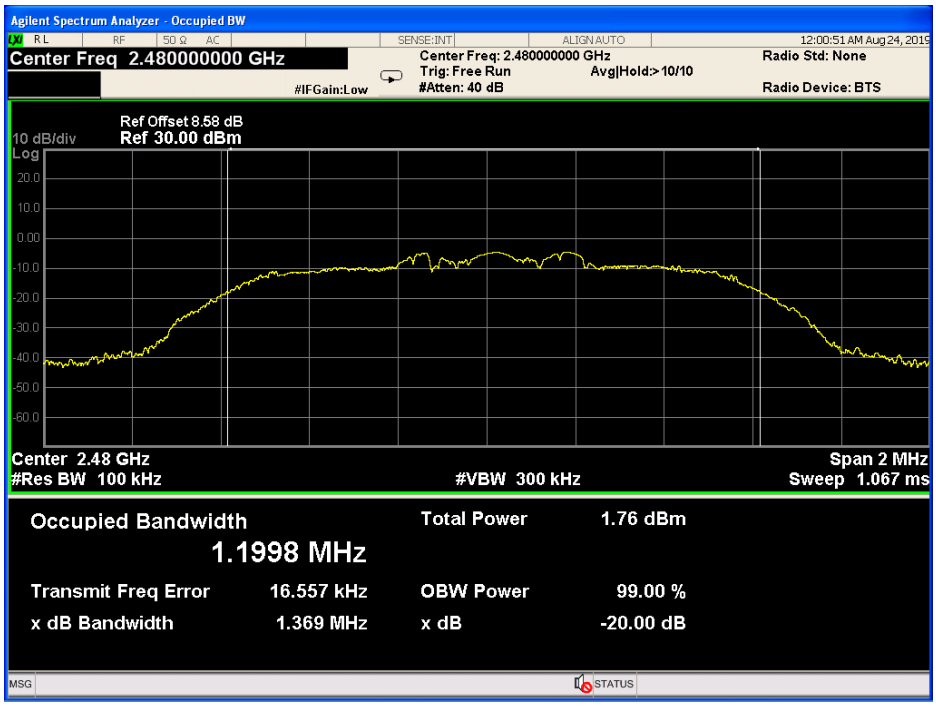
π/4 DQPSK Low Channel 2402



π/4 DQPSK Middle Channel 2441



π/4 DQPSK High Channel 2480



10 Maximum Peak Output Power

Test Requirement ..... : FCC CFR47 Part 15 Subpart C Section 15.247

Test Method ..... : ANSI C63.10:2013

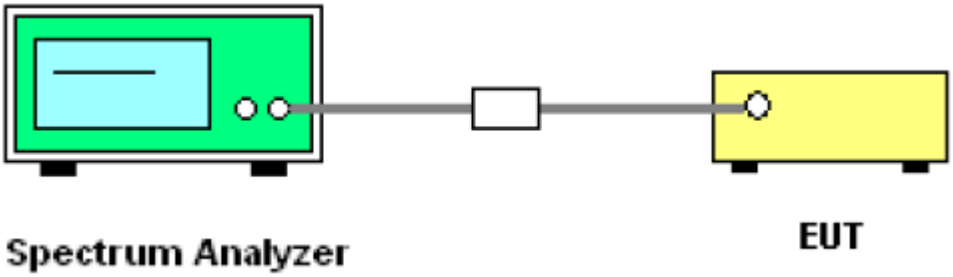
Test Limit..... : FCC CFR47 Part 15 Subpart C Section 15.247, For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Mode..... : Test in fixing frequency transmitting mode.

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 = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3) Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

10.2 Test Setup



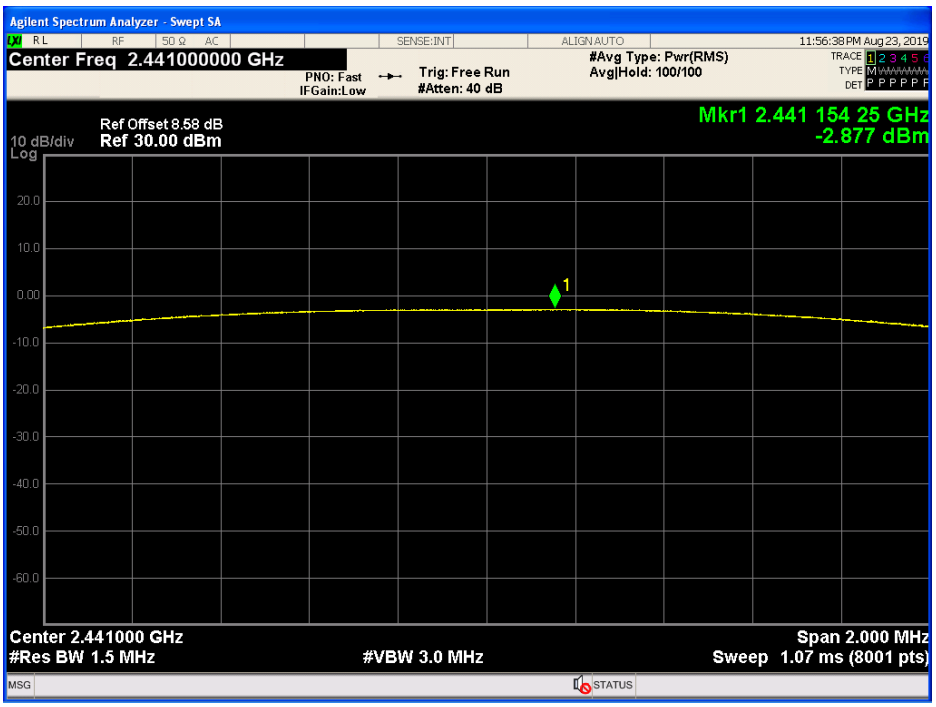
10.3 Test Result

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	2402	-2.925	30
GFSK	2441	-2.877	30
GFSK	2480	-4.280	30
π/4 DQPSK	2402	-1.956	30
π/4 DQPSK	2441	-1.877	30
π/4 DQPSK	2480	-3.304	30

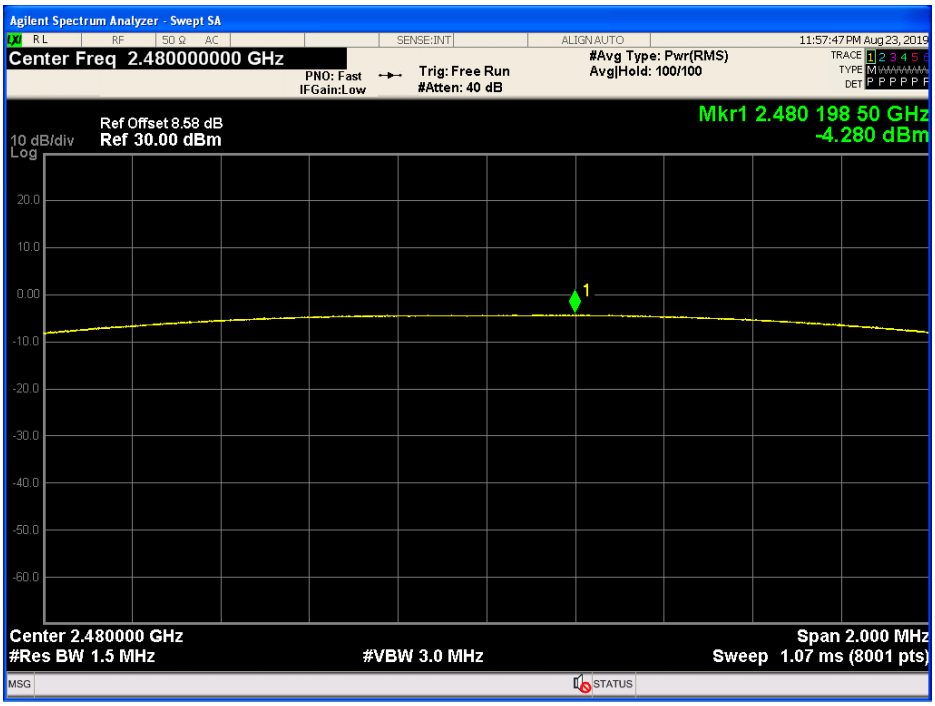
Test result plot as follow:

GFSK Low Channel 2402

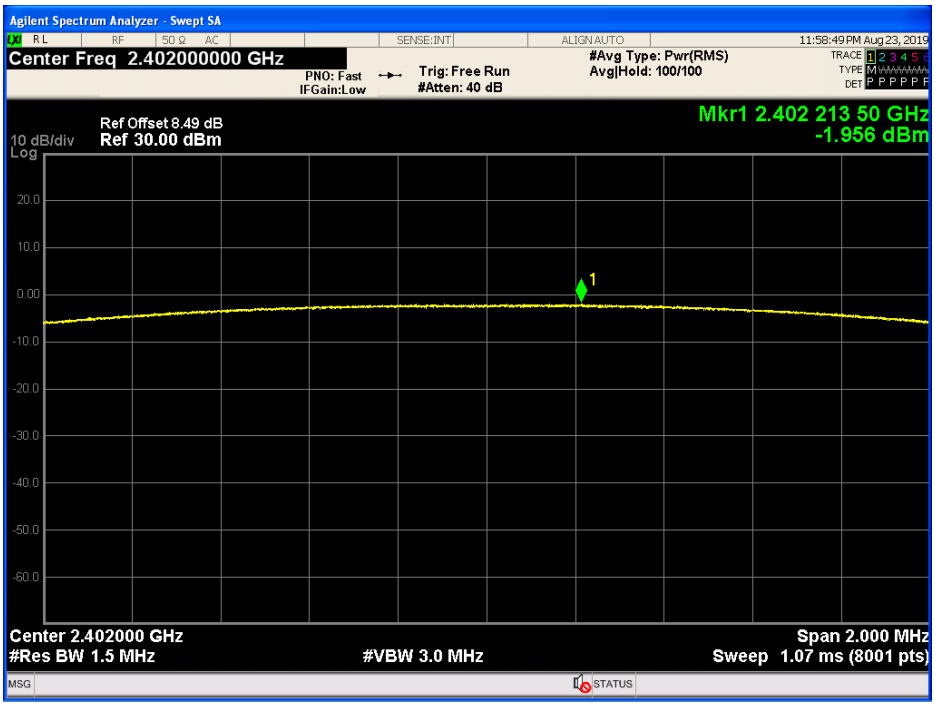
GFSK Middle Channel 2441



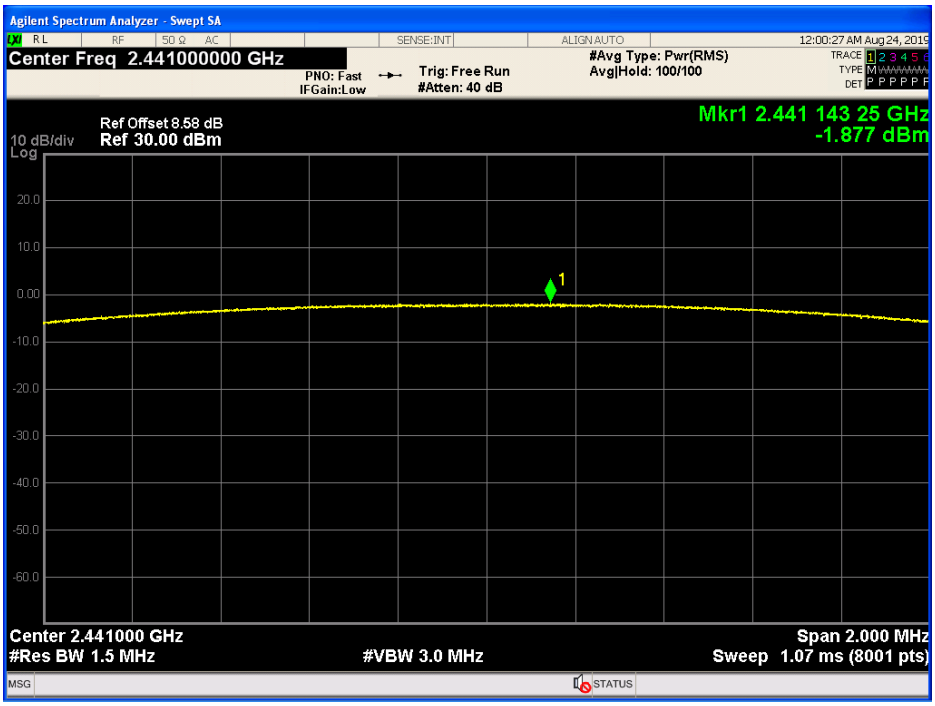
GFSK High Channel



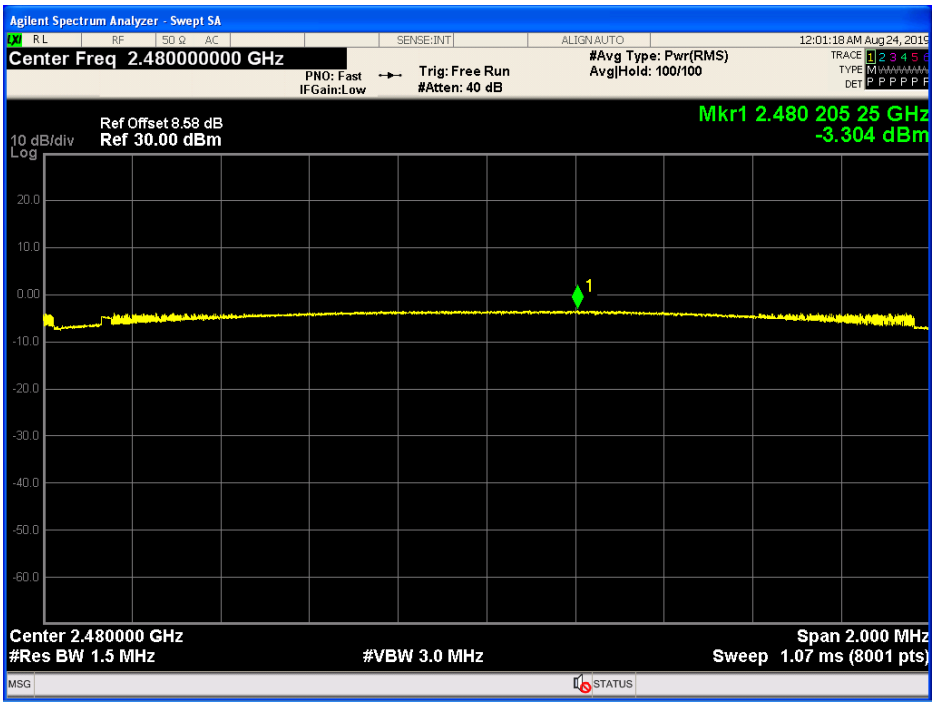
π/4 DQPSK Low Channel



π/4 DQPSK Middle Channel



π/4 DQPSK High Channel



11 Hopping Channel Separation

Test Requirement ..... : FCC CFR47 Part 15 Subpart C Section 15.247

Test Method ..... : ANSI C63.10:2013

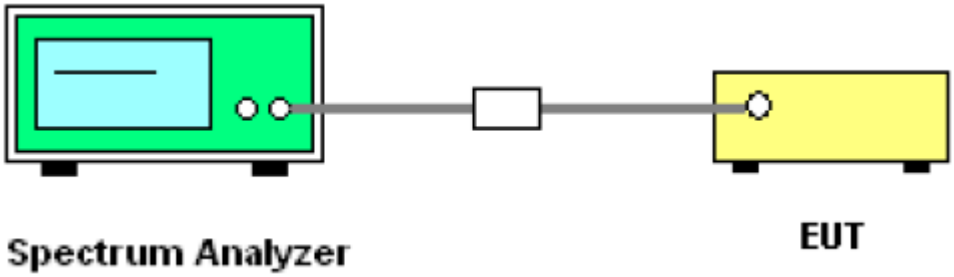
Test Limit..... : FCC CFR47 Part 15 Subpart C Section 15.247, Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively,frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Mode..... : Test in hopping transmitting operating mode.

11.1 Test Procedure

1) Remove the antenna from the EUT and then connect a low RF cable from the antenna port
2) to the spectrum.
3) Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
4) 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.

11.2 Test Setup

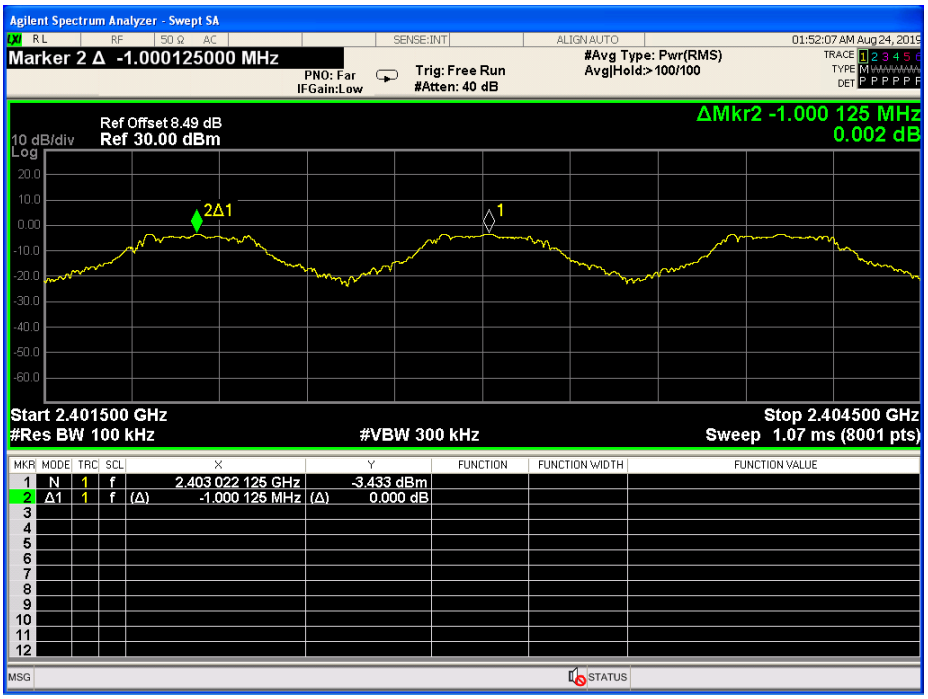


11.3 Test Result

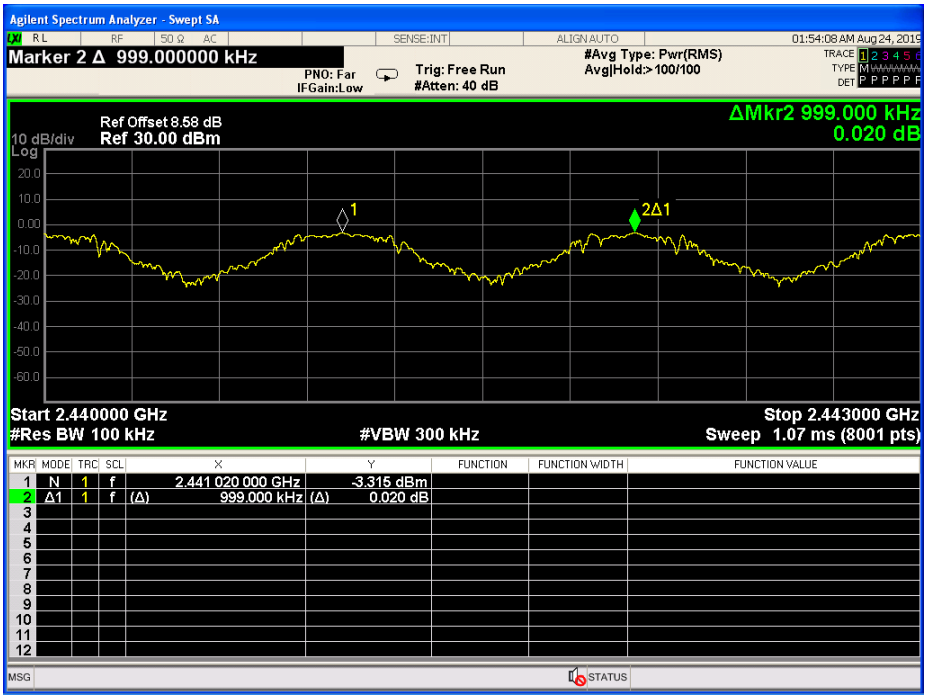
Modulation	Test Channel	Separation (MHz)	Result
GFSK	2402	1.000	PASS
GFSK	2441	0.999	PASS
GFSK	2480	0.984	PASS
π/4 DQPSK	2402	1.030	PASS
π/4 DQPSK	2441	1.141	PASS
π/4 DQPSK	2480	1.398	PASS

Test result plot as follow:

GFSK Low Channel 2402

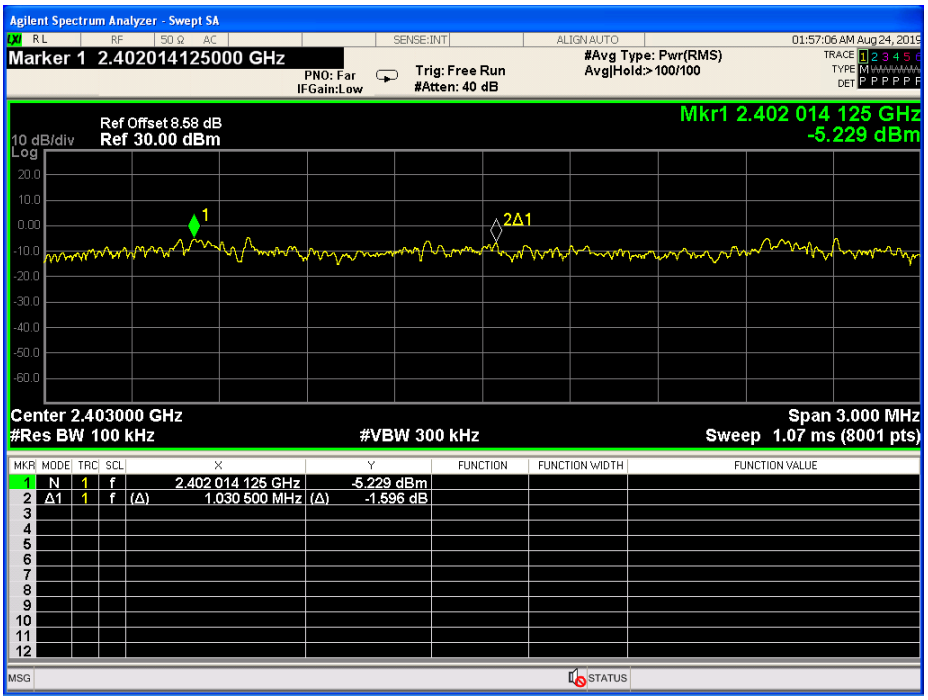


GFSK Middle Channel 2441

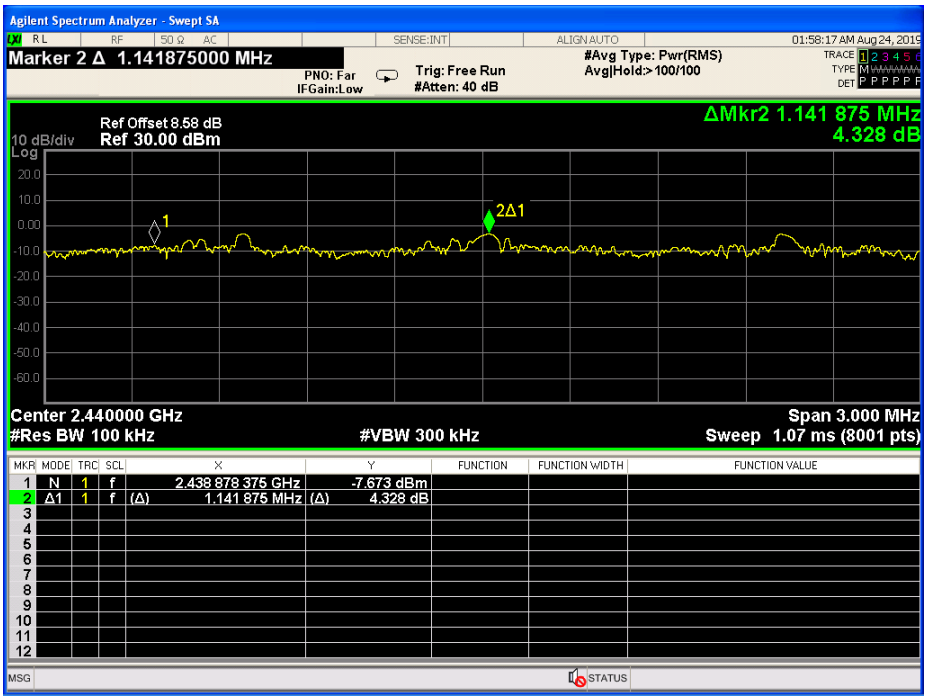


GFSK High Channel 2480

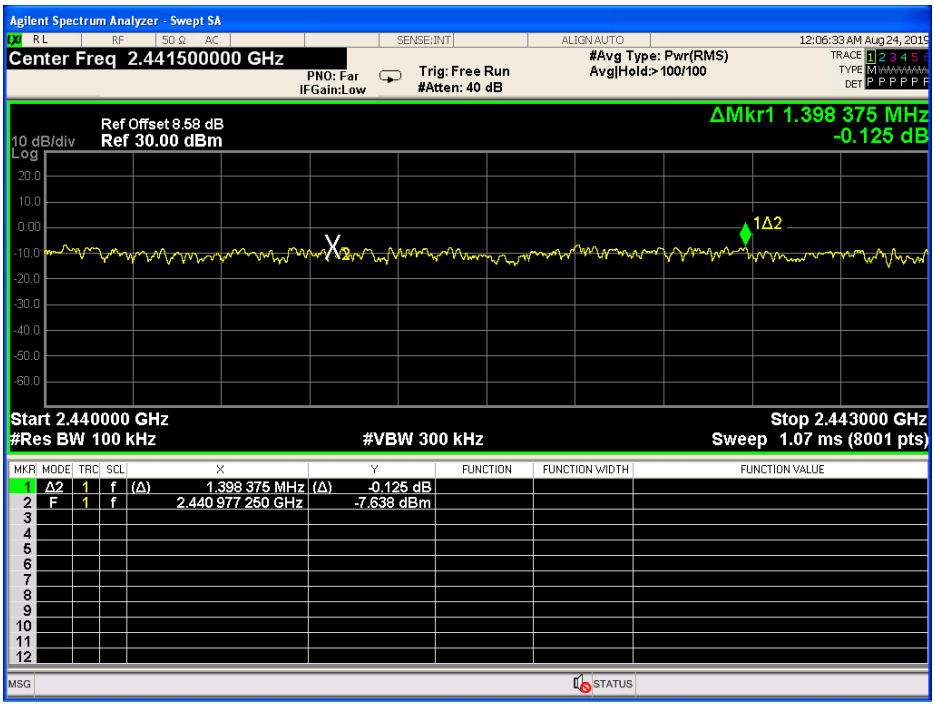
π/4 DQPSK Low Channel 2402



π/4 DQPSK Middle Channel 2441



π/4 DQPSK High Channel 2480



12 Number of Hopping Frequency

Test Requirement ..... : FCC CFR47 Part 15 Subpart C Section 15.247

Test Method ..... : ANSI C63.10:2013

Test Limit..... : FCC CFR47 Part 15 Subpart C Section 15.247. Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels

Test Mode..... : Test in hopping transmitting operating mode.

12.1 Test Procedure

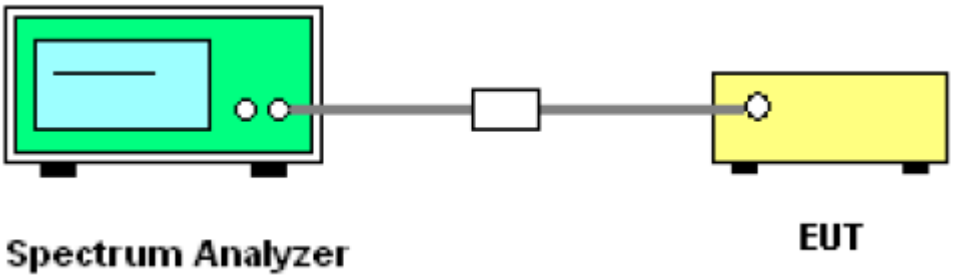
1) Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2) Set the spectrum analyzer: RBW = 100 KHz. VBW = 300 KHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

3) Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

4) Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.483GHz. Sweep=auto.

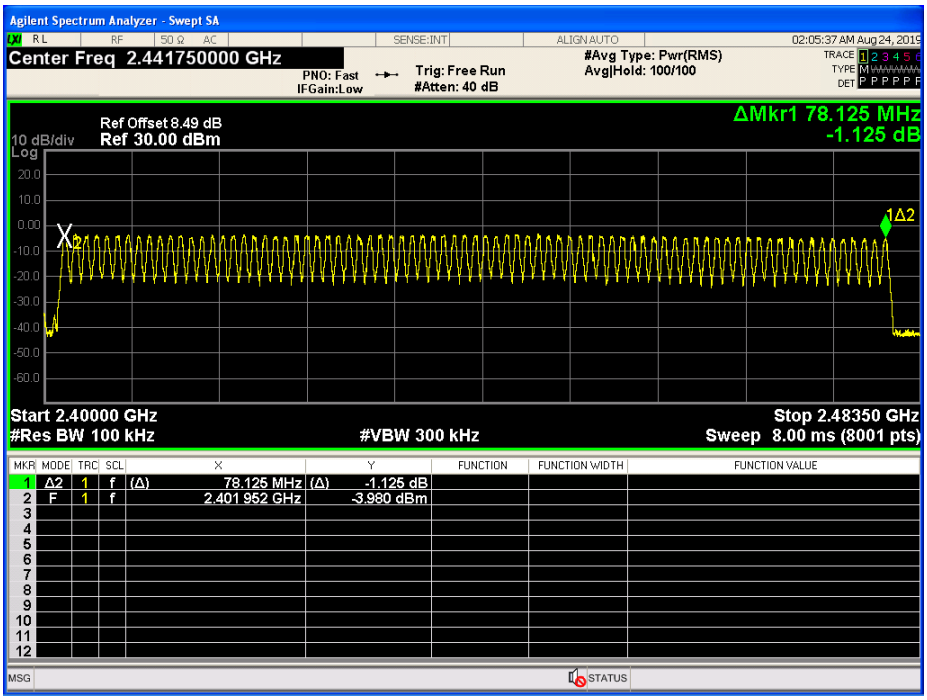
12.2 Test Setup



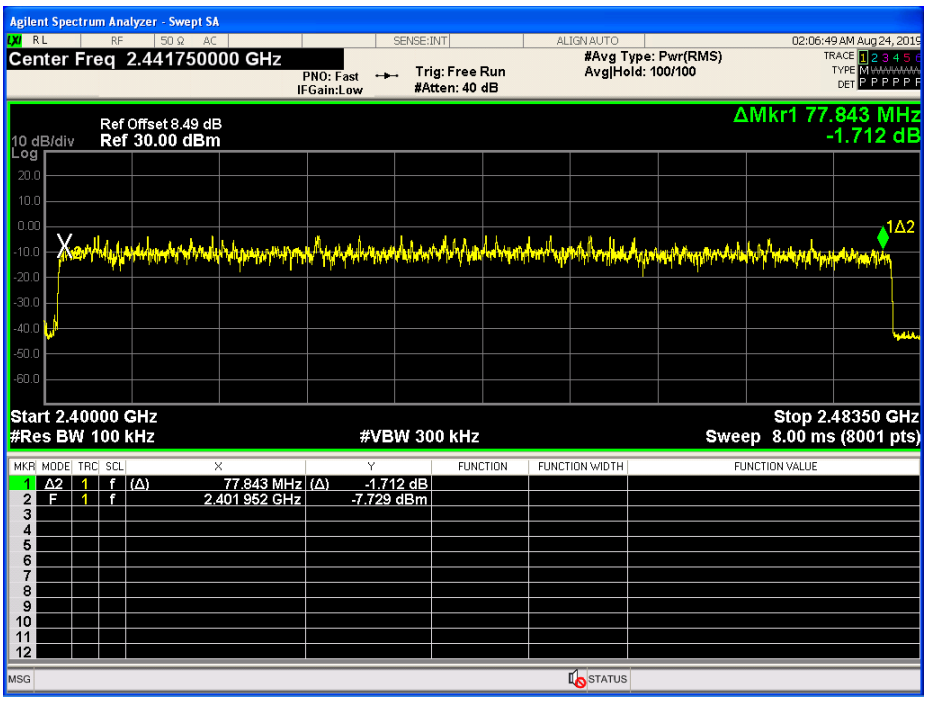
12.3 Test Result

Test result plot as follow:

79 Channels in total GFSK



79 Channels in total Π/4 DQPSK



13 Dwell Time

Test Requirement ..... : FCC CFR47 Part 15 Subpart C Section 15.247

Test Method ..... : ANSI C63.10:2013

Test Limit..... : FCC CFR47 Part 15 Subpart C Section 15.247. Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Mode..... : Test in hopping transmitting operating mode.

13.1 Test Procedure

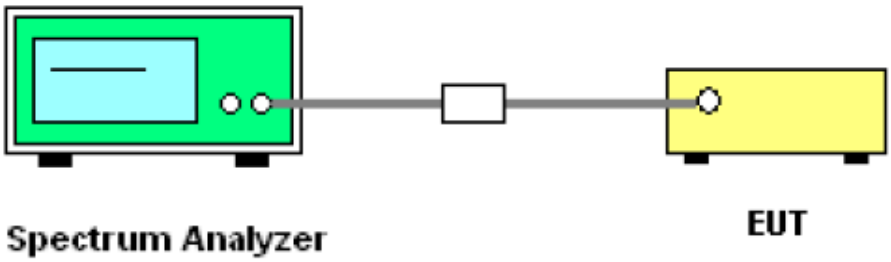
1) Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2) Set spectrum analyzer span = 0. Centred on a hopping channel;

3) Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.

4) Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

13.2 Test Setup

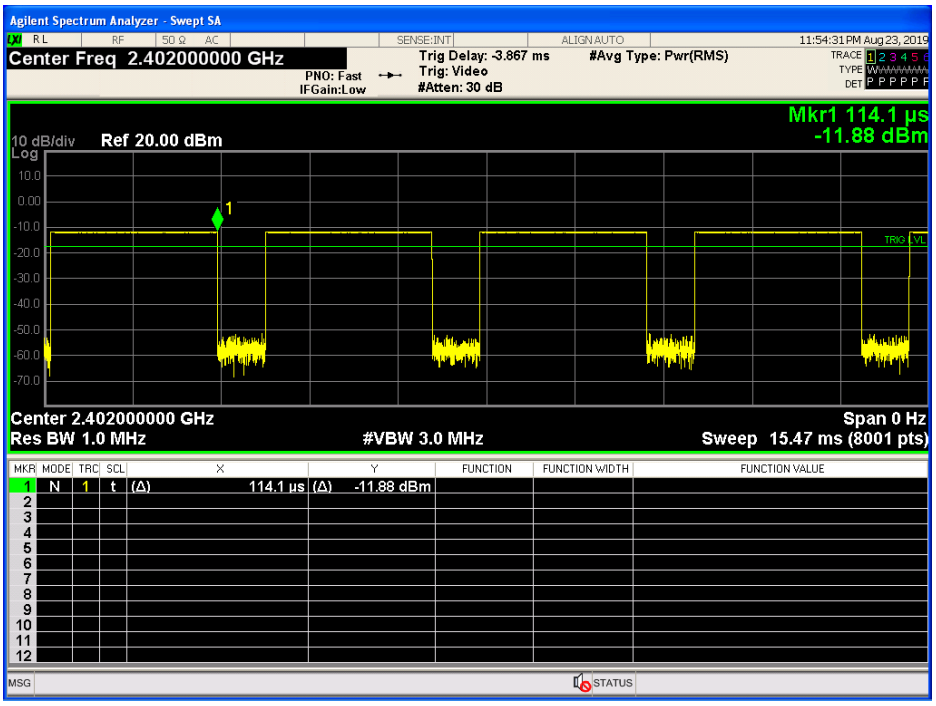


13.3 Test Result

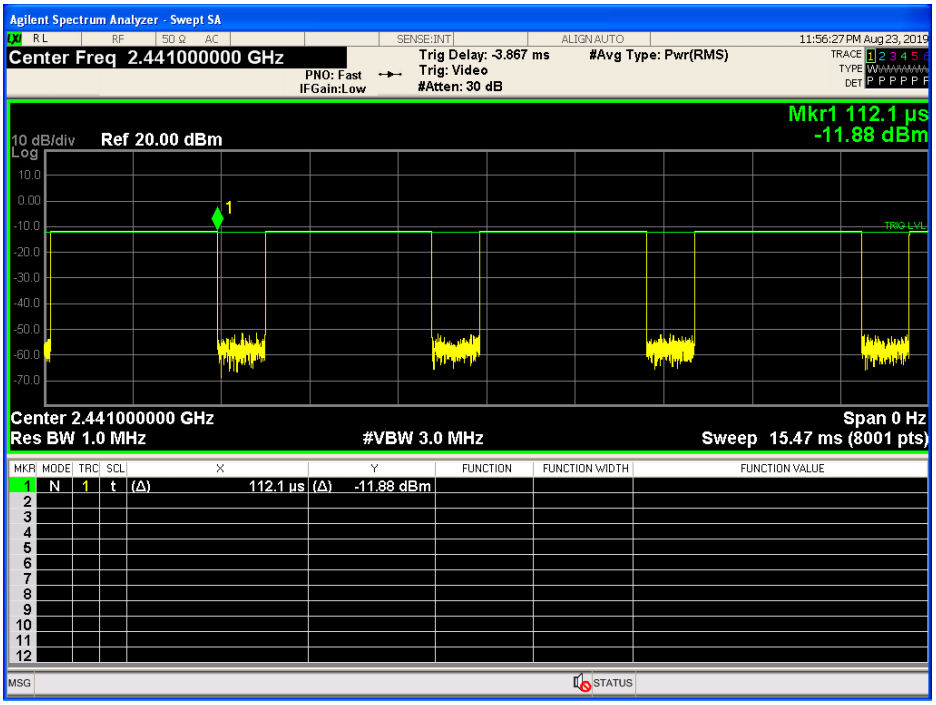
Test Mode	Test Channel	Pulse time[ms]	Total Hops[hop*ch]	Dwell Time[ms]	Limit[ms]	Verdict
GFSK	2402	2.91	106.7	0.310	0.4	PASS
GFSK	2441	2.91	106.7	0.310	0.4	PASS
GFSK	2480	2.91	106.7	0.310	0.4	PASS
Π/4 DQPSK	2402	2.92	106.7	0.312	0.4	PASS
Π/4 DQPSK	2441	2.92	106.7	0.312	0.4	PASS
Π/4 DQPSK	2480	2.92	106.7	0.312	0.4	PASS

Test result plot as follow:

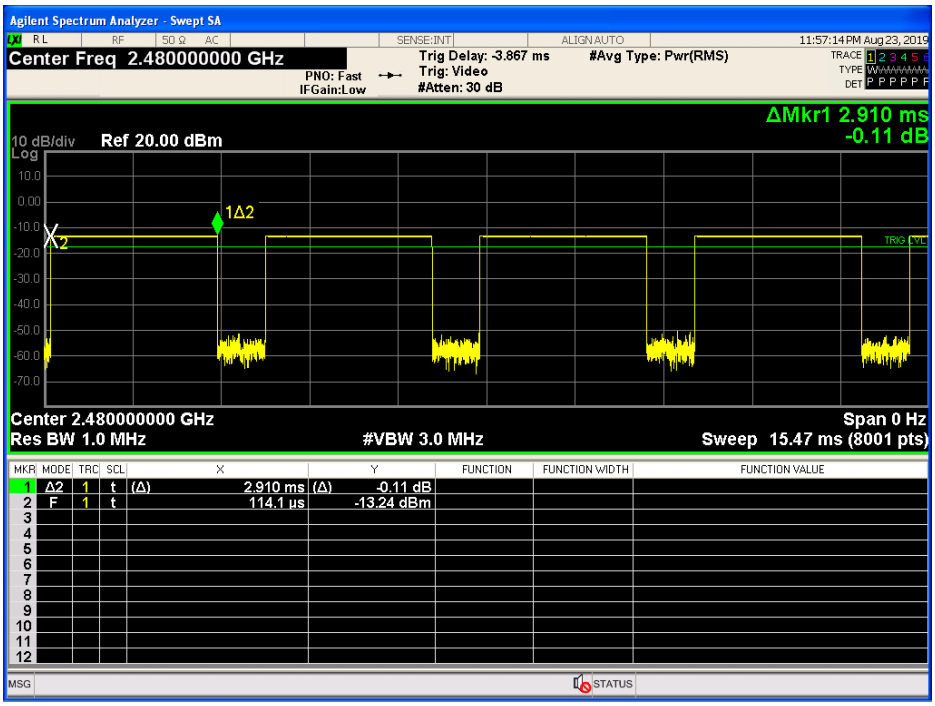
GFSK Low Channel 2402



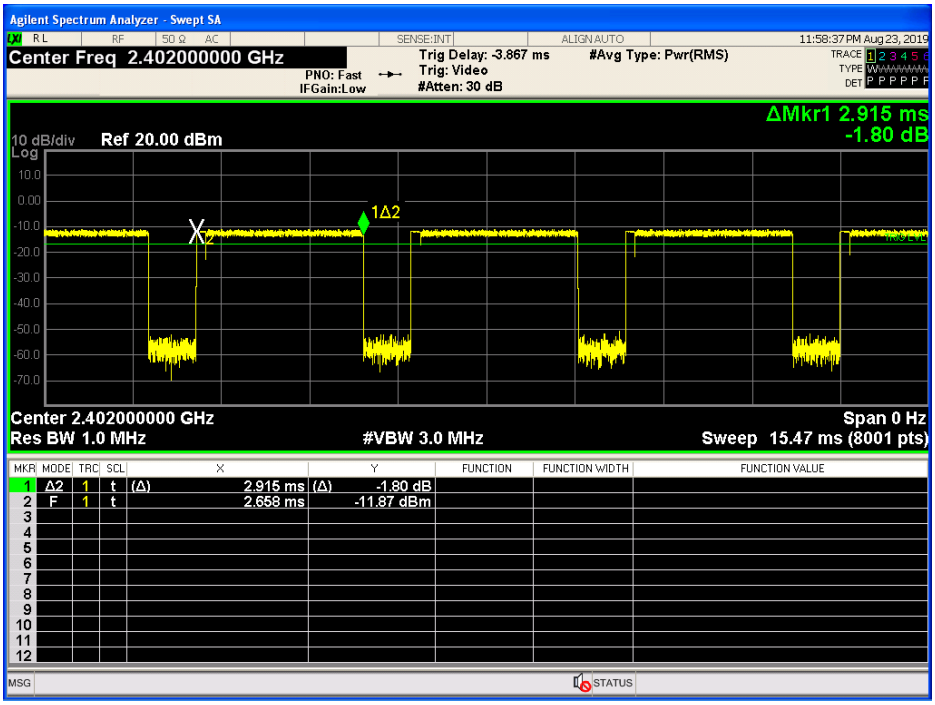
GFSK Middle Channel 2441



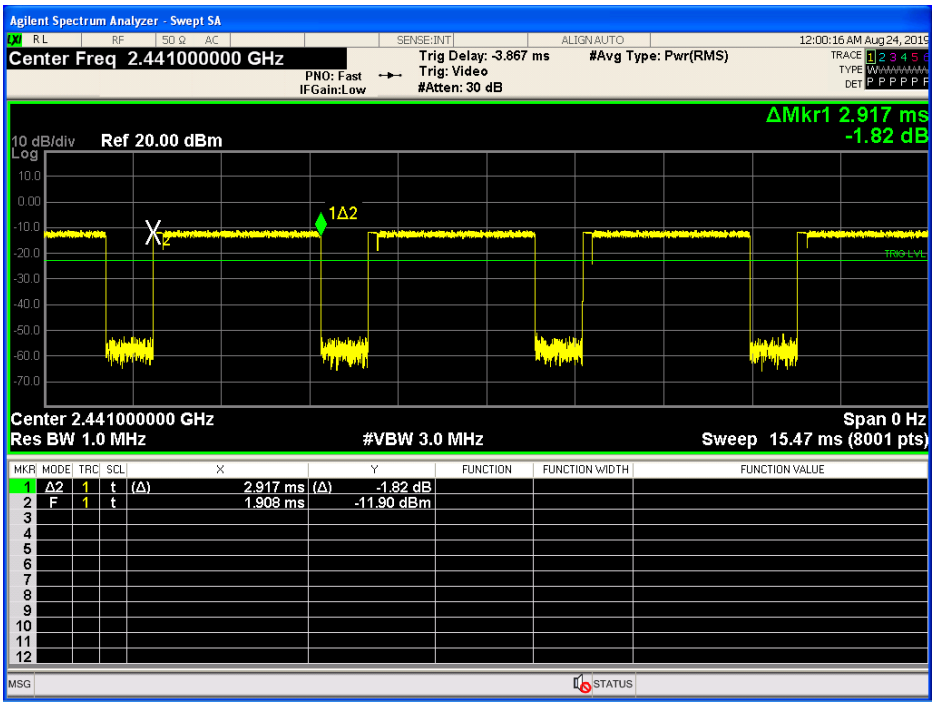
GFSK High Channel 2480



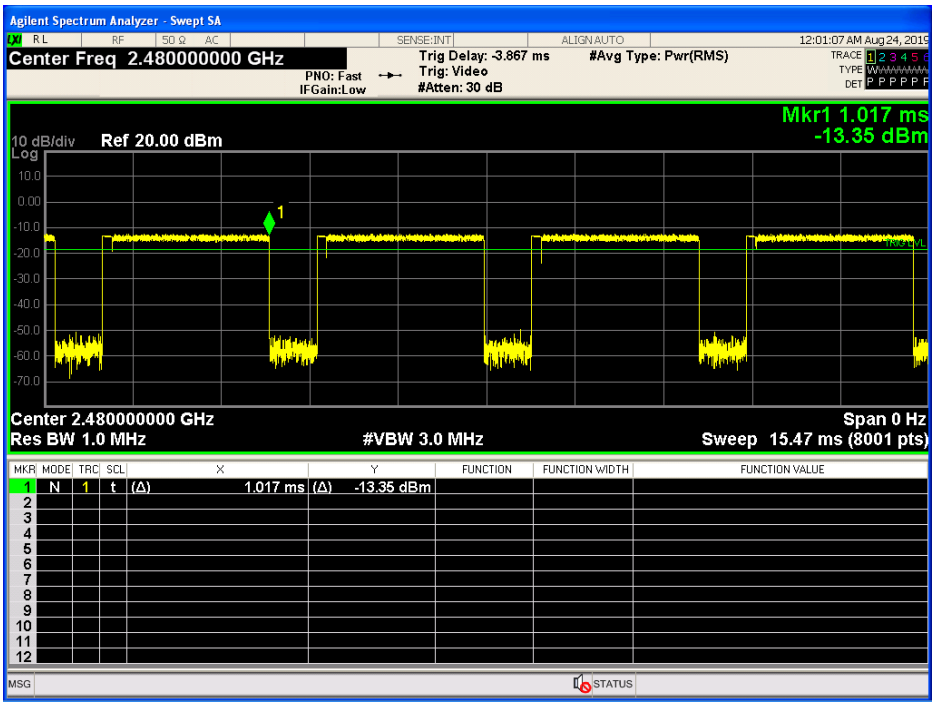
π/4 DQPSK Low Channel 2402



π/4 DQPSK Middle Channel 2441



π/4 DQPSK High Channel 2480



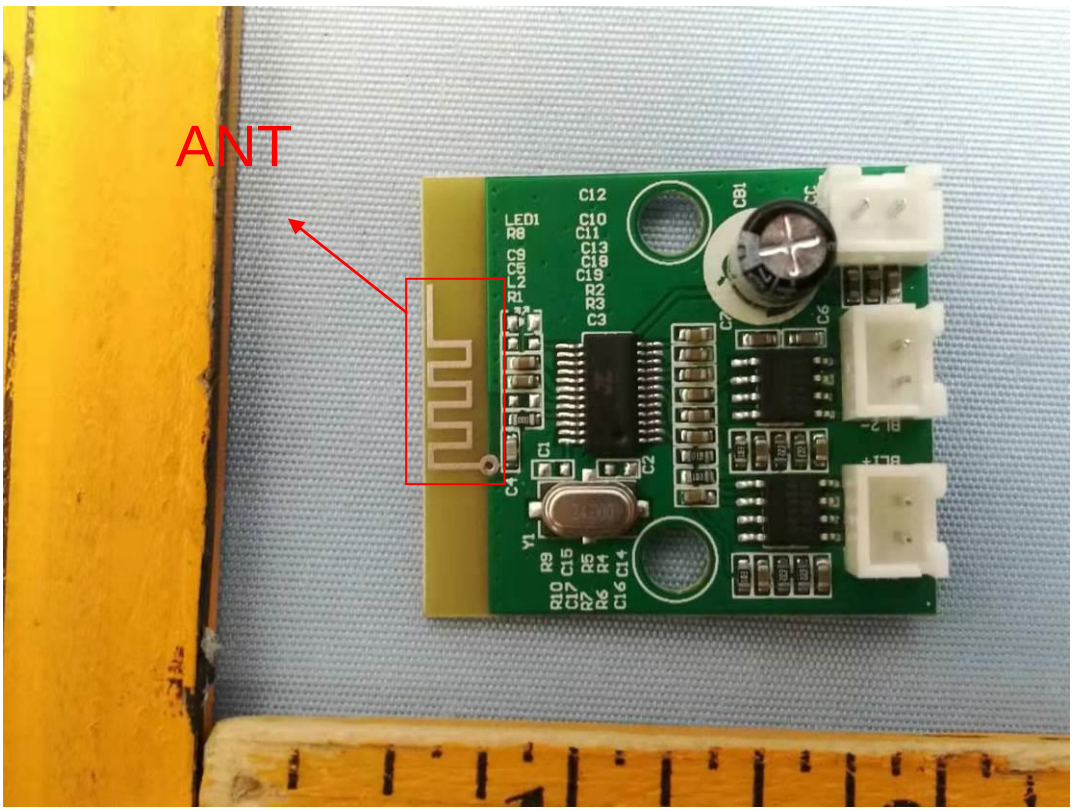
14 Antenna Requirement

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 shall be considered sufficient to comply with the provisions of this section. The manufacture 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221.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.

For intentional device, according to FCC 47 CFR Subpart C Section 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.

Result:

The EUT has one PCB Printed Antenna, the gain is -0.58dBi meets the requirements of FCC Subpart C 15.203.



15 FCC ID: 2AT9E-GWL-20BT RF Exposure

Test Requirement	:	FCC Part 1.1307
Test Method	:	FCC Part2.1093 & KDB 447498 D01 General RF Exposure Guidance v06

15.1 Requirements

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 0.2 m normally can be maintained between the user and the device.

15.2 The procedures / limit

(A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm^2)	Averaging Time $\|E\|^2$,$\|H\|^2$or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm^2)	Averaging Time $\|E\|^2$,$\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

15.3 MPE Calculation Method

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = output power to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

From the peak EUT RF output power, the minimum mobile separation distance, R=20cm, as well as the gain of the used antenna, the RF power density can be obtained

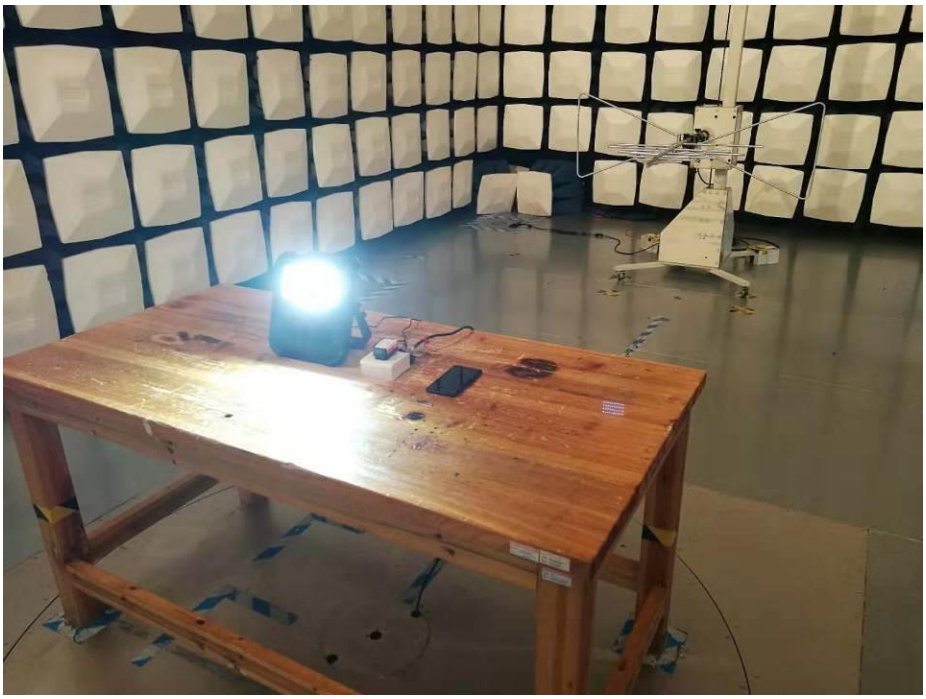
Antenna Gain (numeric)	Max. Peak Output Power (dBm)	Peak Output Power (mW)	Power Density (mW/cm2)	Limit of Power Density (mW/cm2)
0.87	-1.877	0.649	0.00011	1

16 Photographs Test Setup

16.1 Photographs - Conducted Emission Test Setup

16.2 Photographs - Radiated Emission Test Setup

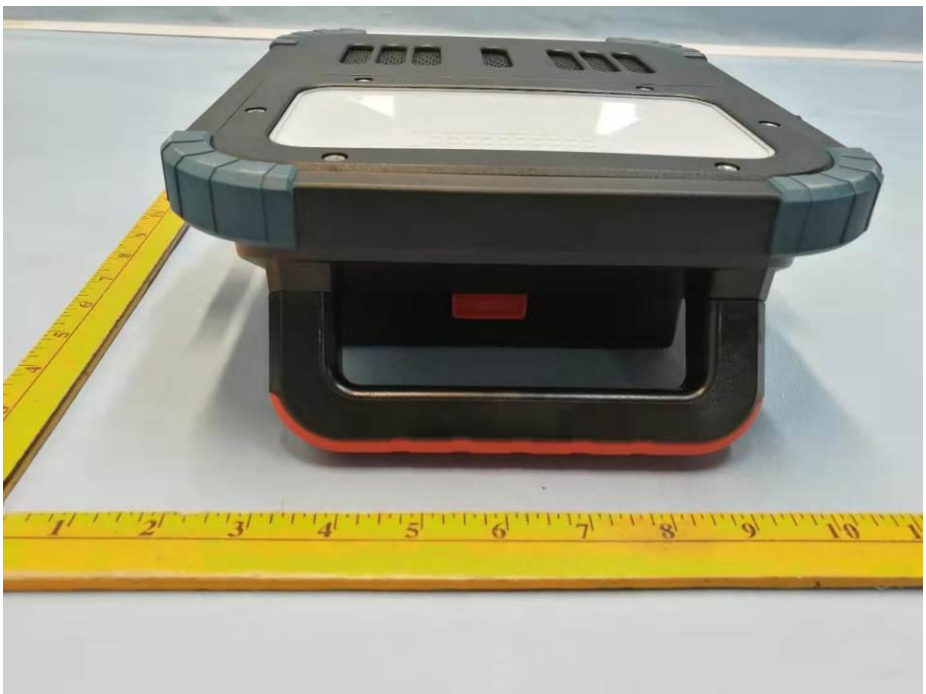
30MHz-1GHz

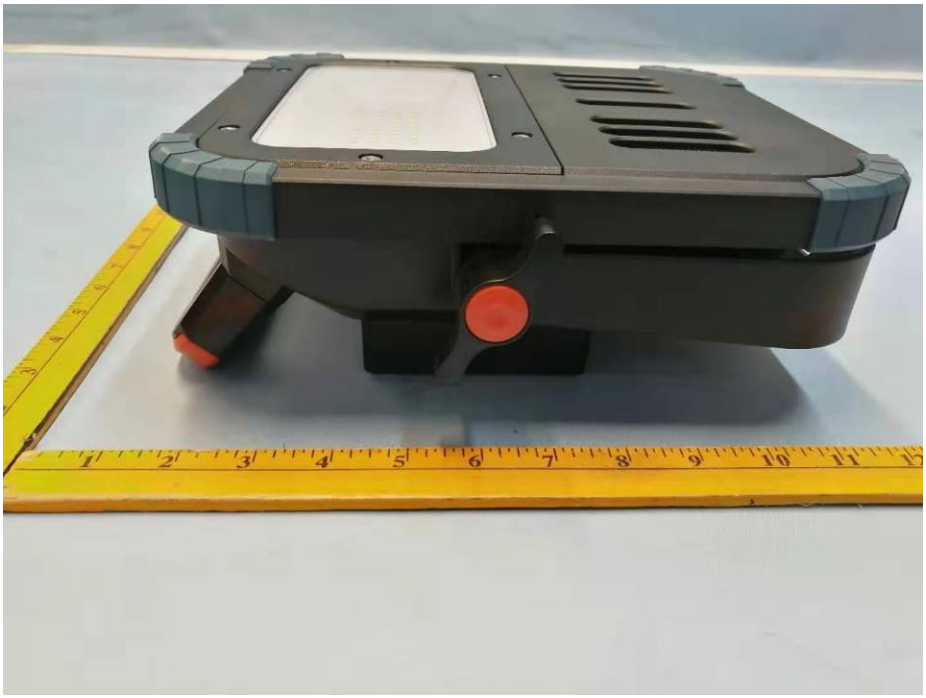


Above 1GHz

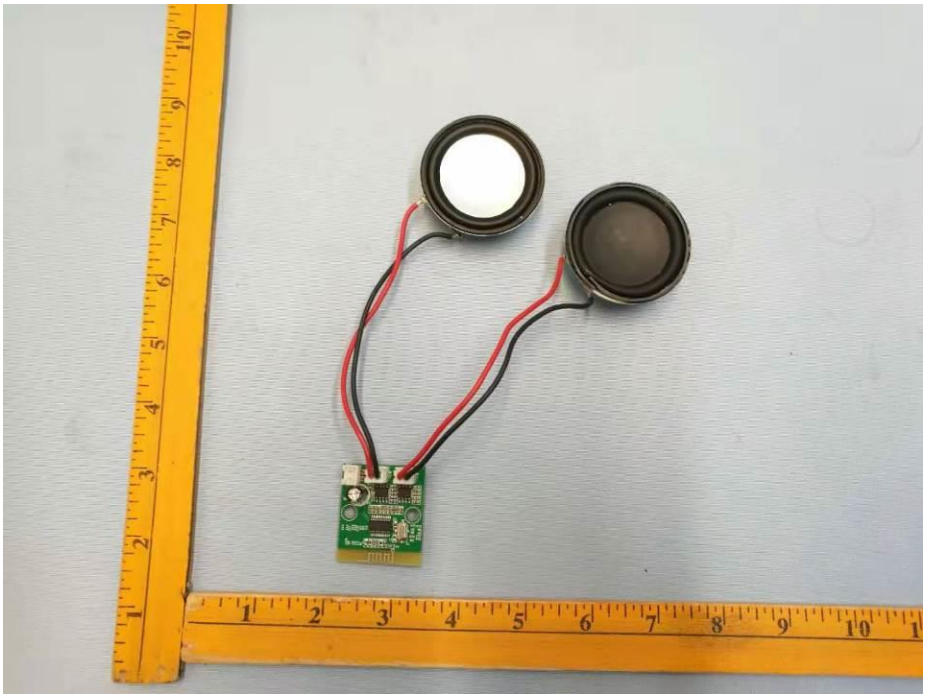
17 Photographs - Constructional Details

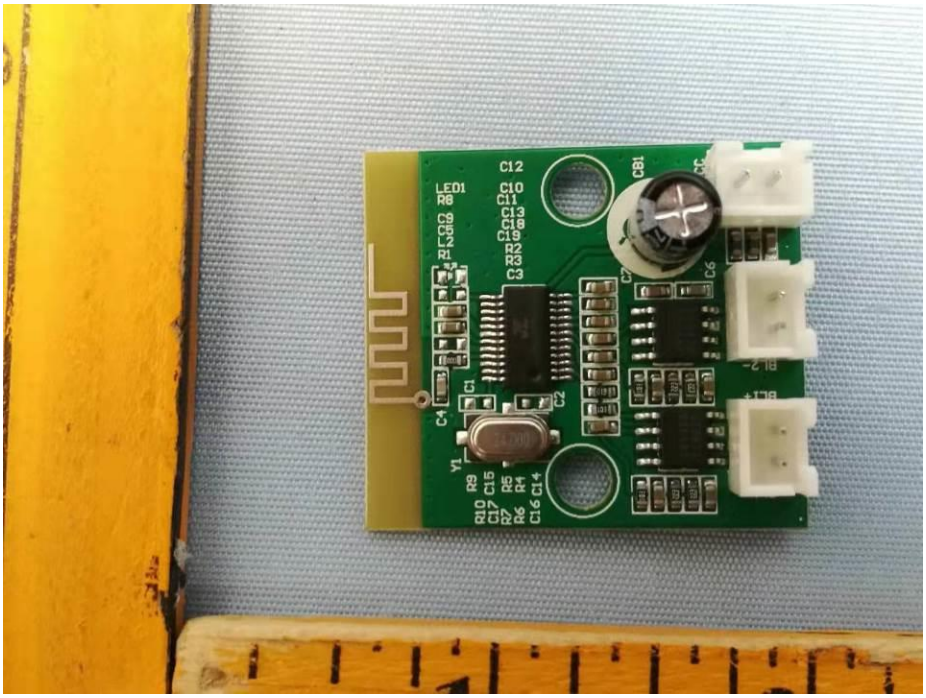
17.1 Model - External View

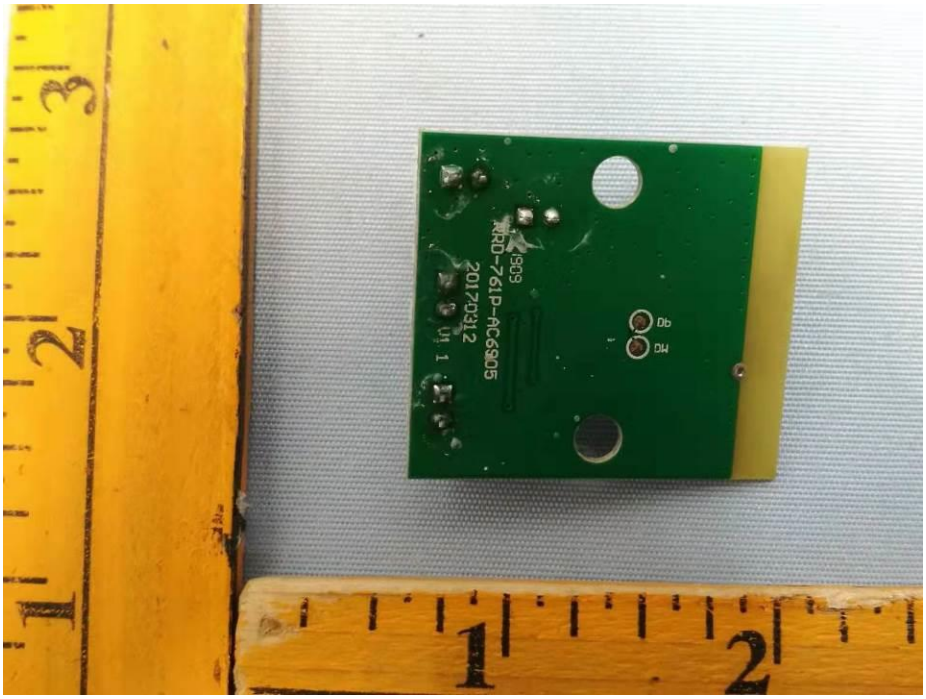




17.2 Model - Internal View







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