FCC&IC RADIO TEST REPORT

FCC ID: 2AR3Z-UNA
IC: 24615-UNA

Product： Portable Speaker

Trade Name： POW AUDIO INC

Model Name： POW Una

Serial Model： N/A

Report No.： UNIA19112102FR-02

Prepared for

POW AUDIO INC

116 John Street, Suite 415, Lowell, MA 01582, USA

Prepared by

Shenzhen United Testing Technology Co., Ltd.

2F, Annex Bldg, Jiahuangyuan Tech Park, #365 Baotian 1 Rd, Tiegang Community, Xixiang Str, Bao'an District, Shenzhen, China

TEST RESULT CERTIFICATION

Applicant's name ..... : POW AUDIO INC

Address ..... : 116 John Street, Suite 415, Lowell, MA 01582, USA

Manufacture's Name..... : POW AUDIO INC

Address ..... : 116 John Street, Suite 415, Lowell, MA 01582, USA

Product description

Product name ..... : Portable Speaker

Trade Mark ..... : POW AUDIO INC

Model and/or type reference : POW Una

Standards ..... : FCC Rules and Regulations Part 15 Subpart C Section 15.247
RSS-247 Issue 2:February 2017, RSS-Gen Issue 5: March 2019
ANSI C63.10: 2013

This device described above has been tested by Shenzhen United Testing Technology Co., Ltd., 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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Date of Test .....:

Date (s) of performance of tests .....: 2019-10-31 ~ 2019-11-14

Date of Issue.....: 2019-11-19

Test Result.....: Pass

Prepared by: _____
Kevin Yang/Editor

Reviewer: _____
Sherwin Qian/Supervisor

Approved & Authorized Signer: _____
Liuze/Manager

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1. TEST SUMMARY

1.1 TEST PROCEDURES AND RESULTS

DESCRIPTION OF TEST	STANDARD	RESULT
Bandwidth	FCC Part 15: 15.247(a)(1) RSS-Gen clause 6.7 & ANSI C63.10: Clause 6.9	COMPLIANT
Carrier Frequency Separation Test	FCC Part 15: 15.247(a)(1) RSS-247 Issue 2:5.1b)	COMPLIANT
Number Of Hopping Frequency	FCC Part 15: 15.247(a)(1)(iii) RSS-247 Issue 2:5.1d)	COMPLIANT
Dwell Time Test	FCC Part 15: 15.247(a)(1)(iii) RSS-247 Issue 2:5.1d)	COMPLIANT
Maximum Output Power	FCC Part 15: 15.247(b)(1) RSS-247 Issue 2 5.4 b)	COMPLIANT
Band Edge Emission	FCC Part 15: 15.247(d) RSS-247 clause 5.5	COMPLIANT
Radiated Spurious Emissions	FCC Part 15.205 / 15.209 RSS-Gen clause 8.9 8.10	COMPLIANT
Antenna requirement	FCC Part 15: 15.203 RSS-Gen clause 6.8	COMPLIANT
Conducted Emission	FCC Part 15.207 RSS-Gen clause 8.8	COMPLIANT

1.2 TEST FACILITY

Test Firm : Shenzhen United Testing Technology Co., Ltd.

Address : 2F, Annex Bldg, Jiahuangyuan Tech Park, #365 Baotian 1 Rd, Tiegang Community, Xixiang Str, Bao'an District, Shenzhen, China

The testing quality ability of our laboratory meet with "Quality Law of People's Republic of China" Clause 19.The testing quality system of our laboratory meets with ISO/IEC-17025 requirements, which is approved by CNAS. This approval result is accepted by MRA of APLAC.

Our test facility is recognized, certified, or accredited by the following organizations:

CNAS-LAB Code: L6494

The EMC Laboratory has been assessed and in compliance with CNAS-CL01 accreditation criteria for testing Laboratories (identical to ISO/IEC 17025:2017 General Requirements) for the Competence of testing Laboratories.

Designation Number: CN1227

Test Firm Registration Number: 674885

The 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.

1.3 MEASUREMENT UNCERTAINTY

Measurement Uncertainty

Conducted Emission Expanded Uncertainty	=	2.23dB, k=2
Radiated emission expanded uncertainty(9kHz-30MHz)	=	3.08dB, k=2
Radiated emission expanded uncertainty(30MHz-1000MHz)	=	4.42dB, k=2
Radiated emission expanded uncertainty(Above 1GHz)	=	4.06dB, k=2

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	Portable Speaker
Trade Mark	POW AUDIO INC
Model Name	POW Una
Serial No.	N/A
Model Difference	N/A
FCC ID IC	2AR3Z-UNA 24615-UNA
Antenna Type	PCB Antenna
Antenna Gain	0dBi
Frequency Range	2402-2480MHz
Number of Channels	79
Modulation Type	GFSK, π/4-DQPSK, 8DPSK
Battery	N/A
Power Source	DC 5V from adapter or DC 7.4V from battery
Adapter	N/A

2.2 Carrier Frequency of Channels

Description of Channel:							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	20	2422	40	2442	60	2462
01	2403	21	2423	41	2443	61	2463
02	2404	22	2424	42	2444	62	2464
03	2405	23	2425	43	2445	63	2465
04	2406	24	2426	44	2446	64	2466
05	2407	25	2427	45	2447	65	2467
06	2408	26	2428	46	2448	66	2468
07	2409	27	2429	47	2449	67	2469
08	2410	28	2430	48	2450	68	2470
09	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	22	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	--	--

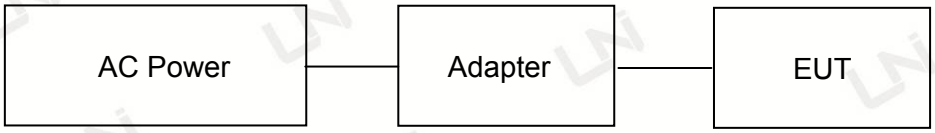
2.3 Operation of EUT during testing

Operating Mode
Test software Version: ATS282X FCC Test tools v1.09
Power Parameters: 7
Note: According exploratory test, EUT will have maximum output power in those data rate, so those data rate were used for all test.

The mode is used:
Transmitting mode for TX GFSK, π/4-DQPSK, 8DPSK running at 1,2,3Mbps
Low Channel: 2402MHz
Middle Channel: 2441MHz
High Channel: 2480MHz

2.4 DESCRIPTION OF TEST SETUP

Operation of EUT during Conducted testing:



Operation of EUT during Radiation and Above1GHz Radiation testing:

Table for auxiliary equipment:

Equipment Description	Manufacturer	Model	Calibration Due Date
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

2.5 MEASUREMENT INSTRUMENTS LIST

Item	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
CONDUCTED EMISSIONS TEST					
1	AMN	Schwarzbeck	NNLK8121	8121370	2020.9.9
2	AMN	ETS	3810/2	00020199	2020.9.9
3	EMI TEST RECEIVER	Rohde&Schwarz	ESCI	101210	2020.9.9
4	AAN	TESEQ	T8-Cat6	38888	2020.9.9
RADIATED EMISSION TEST					
1	Horn Antenna	Sunol	DRH-118	A101415	2020.9.9
2	BicoNILog Antenna	Sunol	JB1 Antenna	A090215	2020.9.9
3	PREAMP	HP	8449B	3008A00160	2020.9.9
4	PREAMP	HP	8447D	2944A07999	2020.9.9
5	EMI TEST RECEIVER	Rohde&Schwarz	ESR3	101891	2020.9.9
6	VECTOR Signal Generator	Rohde&Schwarz	SMU200A	101521	2020.9.28
7	Signal Generator	Agilent	E4421B	MY4335105	2020.9.28
8	MXA Signal Analyzer	Agilent	N9020A	MY50510140	2020.9.28
9	MXA Signal Analyzer	Agilent	N9020A	MY51110104	2020.9.9
10	ANT Tower&Turn table Controller	Champro	EM 1000	60764	2020.9.28
11	Anechoic Chamber	Taihe Maorui	9m*6m*6m	966A0001	2020.9.9
12	Shielding Room	Taihe Maorui	6.4m*4m*3m	643A0001	2020.9.9
13	RF Power sensor	DARE	RPR3006W	15I00041SNO88	2020.3.14
14	RF Power sensor	DARE	RPR3006W	15I00041SNO89	2020.3.14
15	RF power divider	Anritsu	K241B	992289	2020.9.28
16	Wideband radio communication tester	Rohde&Schwarz	CMW500	154987	2020.9.28
17	Biconical antenna	Schwarzbeck	VHA 9103	91032360	2020.9.8
18	Biconical antenna	Schwarzbeck	VHA 9103	91032361	2020.9.8
19	Broadband Hybrid Antennas	Schwarzbeck	VULB9163	VULB9163#958	2020.9.8
20	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1680	2020.1.12
21	Active Receive Loop Antenna	Schwarzbeck	FMZB 1919B	00023	2020.9.8
22	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170651	2020.03.14
23	Microwave Broadband Preamplifier	Schwarzbeck	BBV 9721	100472	2020.9.8
24	Active Loop Antenna	Com-Power	AL-130R	10160009	2020.05.10
25	Power Meter	KEYSIGHT	N1911A	MY50520168	2020.05.10
26	Frequency Meter	VICTOR	VC2000	997406086	2020.05.10
27	DC Power Source	HYELEC	HY5020E	055161818	2020.05.10

3. CONDUCTED EMISSIONS TEST

3.1 Conducted Power Line Emission Limit

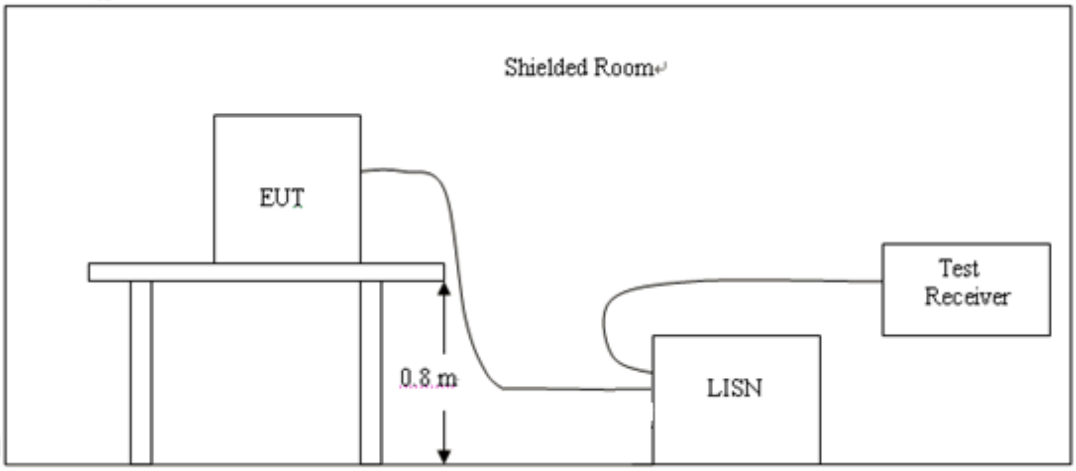
For unintentional device, according to § 15.107(a) Line Conducted Emission Limits is as following

Frequency (MHz)	Maximum RF Line Voltage(dB V)			
	CLASS A		CLASS B	
	Q.P.	Ave.	Q.P.	Ave.
0.15~0.50	79	66	66~56*	56~46*
0.50~5.00	73	60	56	46
5.00~30.0	73	60	60	50

* Decreasing linearly with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limit is same as above table.

3.2 Test Setup



3.3 Test Procedure

1, The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. A wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10.
2, Support equipment, if needed, was placed as per ANSI C63.10.
3, All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.
4, If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5, All support equipments received AC power from a second LISN, if any.
6, The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7, Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.

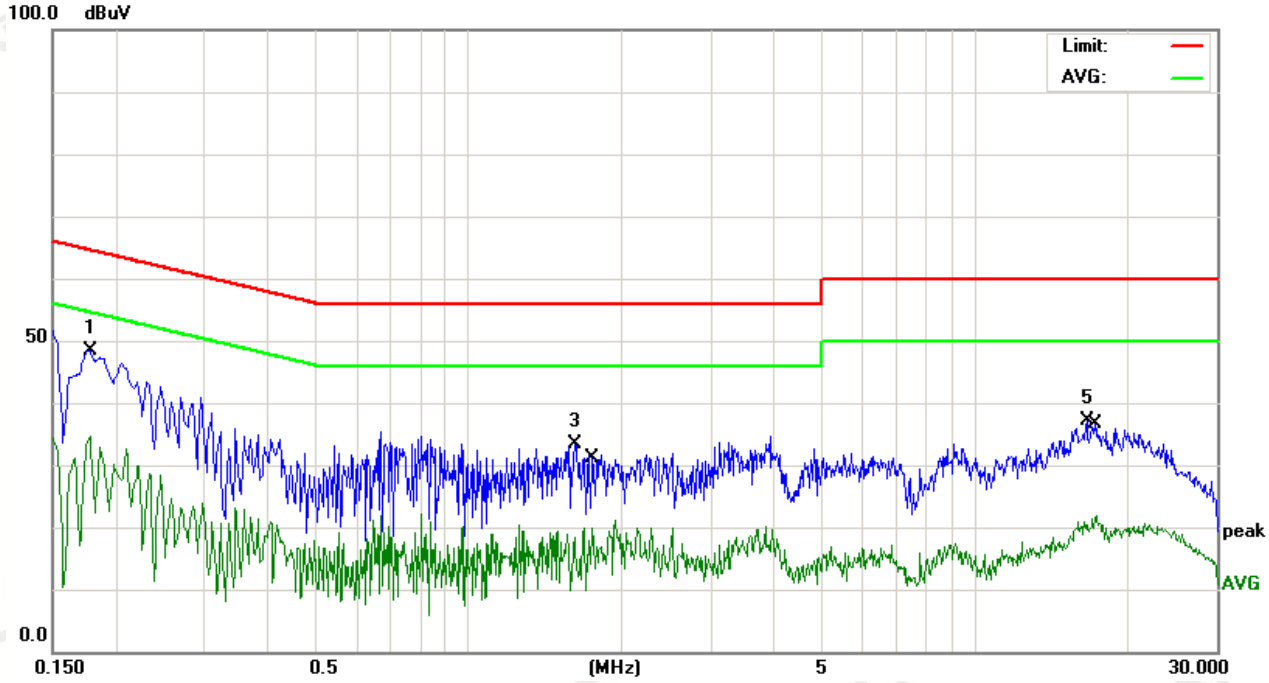
3.4 Test Result

Pass

Remark:

1. All modes were tested at AC 120V and 240V, only the worst result of AC 120V was reported.
2. All modes were tested at Low, Middle, and High channel, only the worst result of 802.11b Low Channel was reported as below:

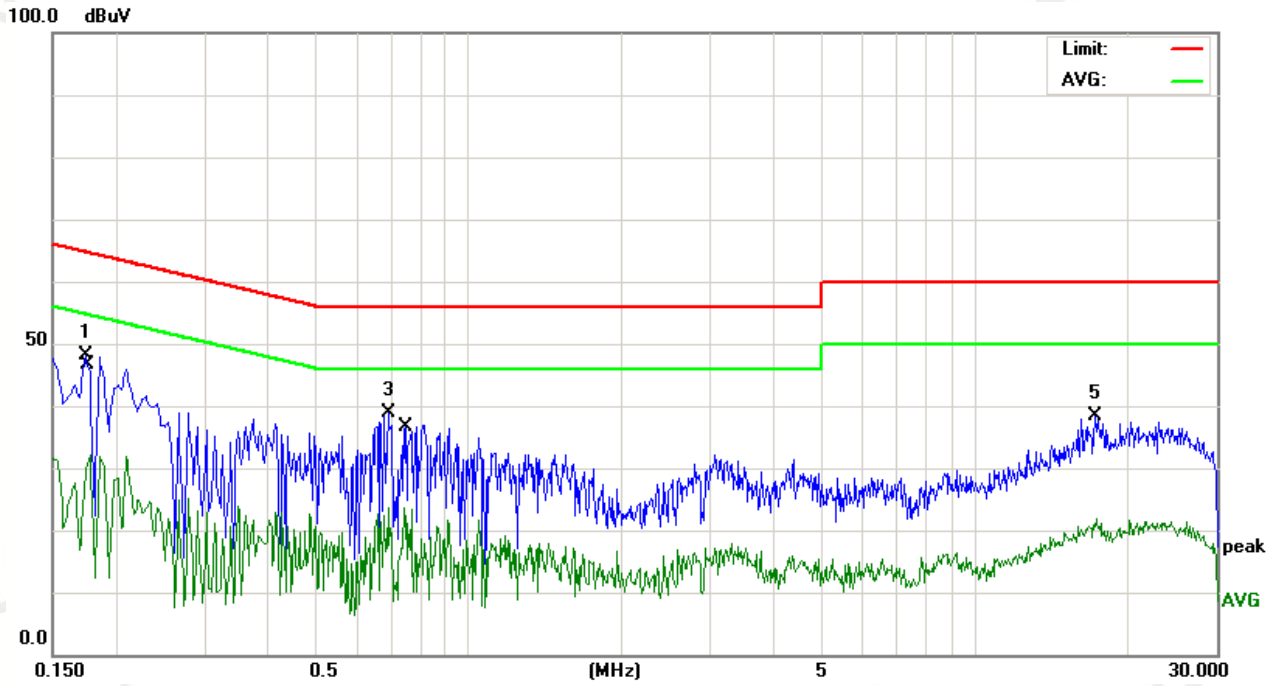
Temperature:	24℃	Relative Humidity:	48%
Test Date:	2019-11-07	Pressure:	1010hPa
Test Voltage:	AC 120V, 60Hz	Phase:	Line
Test Mode:	TX (1Mbps) CH00 (worst case)		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1	*	0.1780	37.09	11.41	48.50	64.57	-16.07	peak
2		0.1780	23.28	11.41	34.69	54.57	-19.88	AVG
3		1.6260	23.47	9.97	33.44	56.00	-22.56	peak
4		1.7460	9.94	9.97	19.91	46.00	-26.09	AVG
5		16.5978	26.55	10.63	37.18	60.00	-22.82	peak
6		17.3659	11.06	10.73	21.79	50.00	-28.21	AVG

Remark: Factor = Insertion Loss + Cable Loss, Result = Reading + Factor, Margin = Result – Limit.

Temperature:	24℃	Relative Humidity:	48%
Test Date:	2019-11-07	Pressure:	1010hPa
Test Voltage:	AC 120V, 60Hz	Phase:	Neutral
Test Mode:	TX (1Mbps) CH00 (worst case)		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1	*	0.1740	36.68	11.48	48.16	64.76	-16.60	peak
2		0.1780	20.81	11.41	32.22	54.57	-22.35	AVG
3		0.6900	28.79	9.98	38.77	56.00	-17.23	peak
4		0.7460	13.76	9.97	23.73	46.00	-22.27	AVG
5		17.2099	27.59	10.71	38.30	60.00	-21.70	peak
6		17.3619	11.04	10.73	21.77	50.00	-28.23	AVG

Remark: Factor = Insertion Loss + Cable Loss, Result = Reading + Factor, Margin = Result – Limit.

4 RADIATED EMISSION TEST

4.1 Radiation Limit

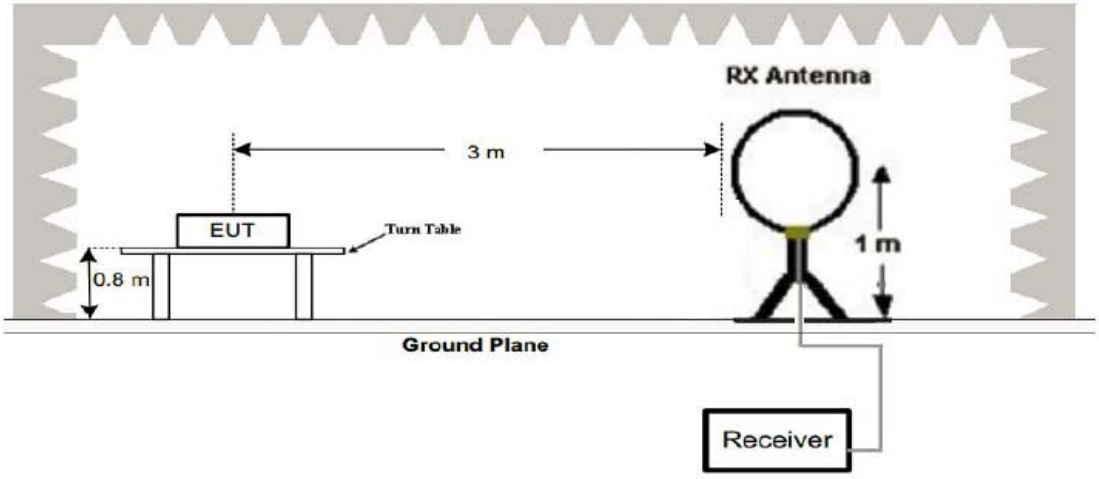
For unintentional device, according to § 15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
30-88	3	40	100
88-216	3	43.5	150
216-960	3	46	200
Above 960	3	54	500

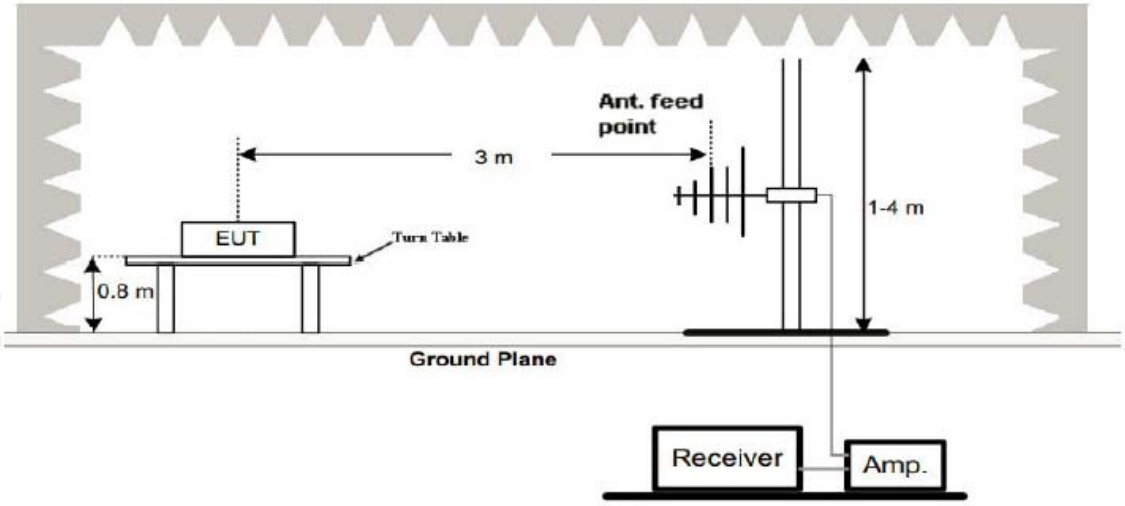
For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

4.2 Test Setup

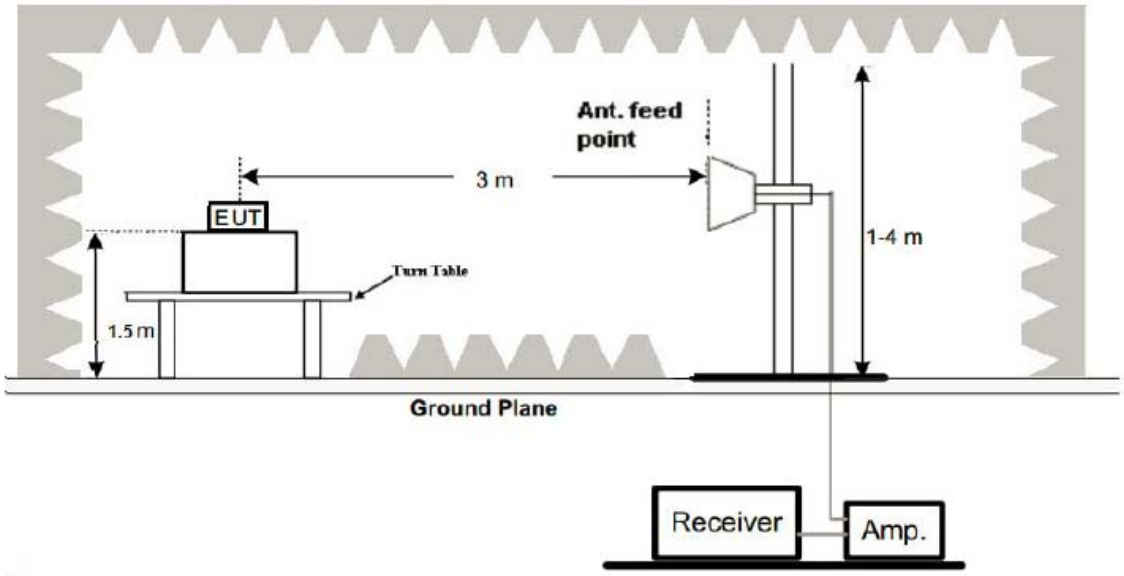
1. Radiated Emission Test-Up Frequency Below 30MHz



2. Radiated Emission Test-Up Frequency 30MHz~1GHz



3. Radiated Emission Test-Up Frequency Above 1GHz



4.3 Test Procedure

1. Below 1GHz measurement the EUT is placed on turntable which is 0.8m above ground plane. And above 1GHz measurement EUT was placed on low permittivity and low tangent turn table which is 1.5m 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 varied from 1m to 4m to find out the highest 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 test frequency range from 9KHz to 25GHz per FCC PART 15.33(a).

Note:
For battery operated equipment, the equipment tests shall be performed using a new battery.

4.4 Test Result

PASS
Remark:
1. All modes of mode were tested at Low, Middle, and High channel, and only the worst result of GFSK (1Mbps) Low Channel was reported for below 1GHz test.
2. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, and test data recorded in this report.

Below 30M

Temperature:	22℃	Relative Humidity:	48%
Test Date:	2019-11-07	Pressure:	1010hPa
Test Voltage:	AC 120V, 60Hz	Polarization:	Horizontal
Test Mode:	TX (1Mbps) CH00 (worst case)		

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	P
--	--	--	--	P

Note:

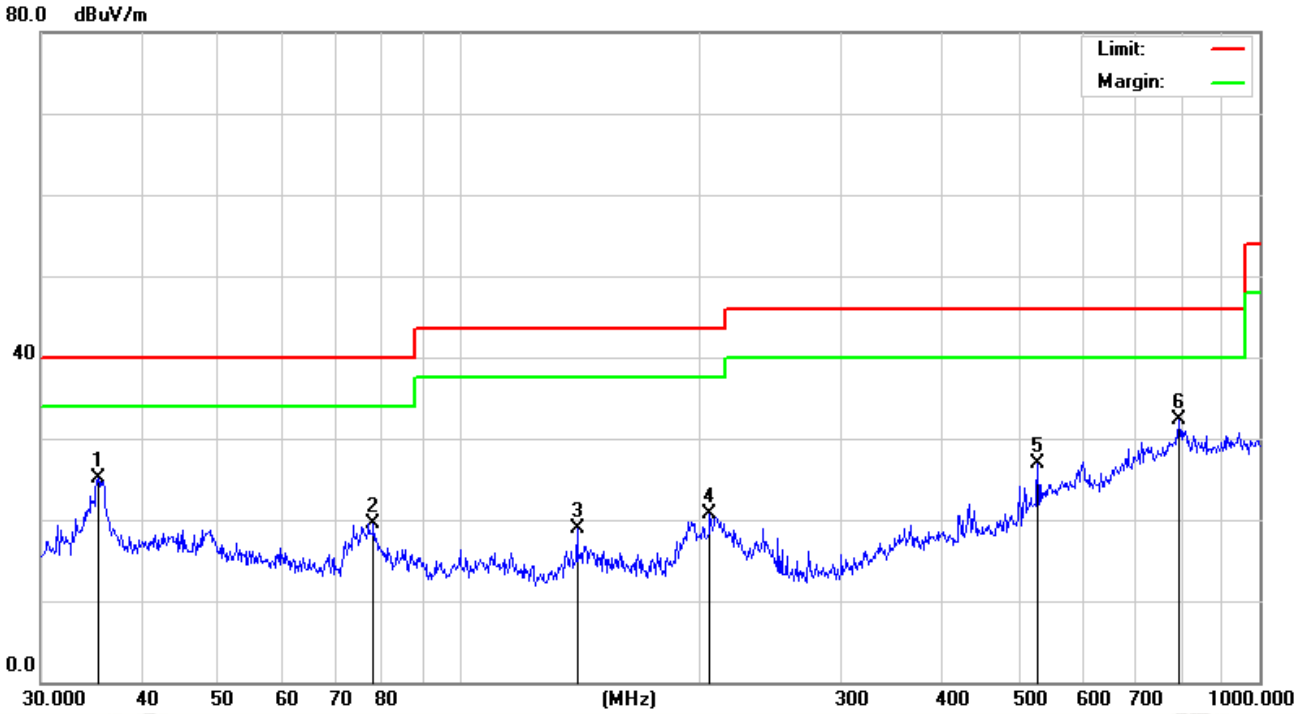
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Distance extrapolation factor =20 log (specific distance/test distance)(dB);

Limit line = specific limits(dBuv) + distance extrapolation factor

Below 1GHz Test Results:

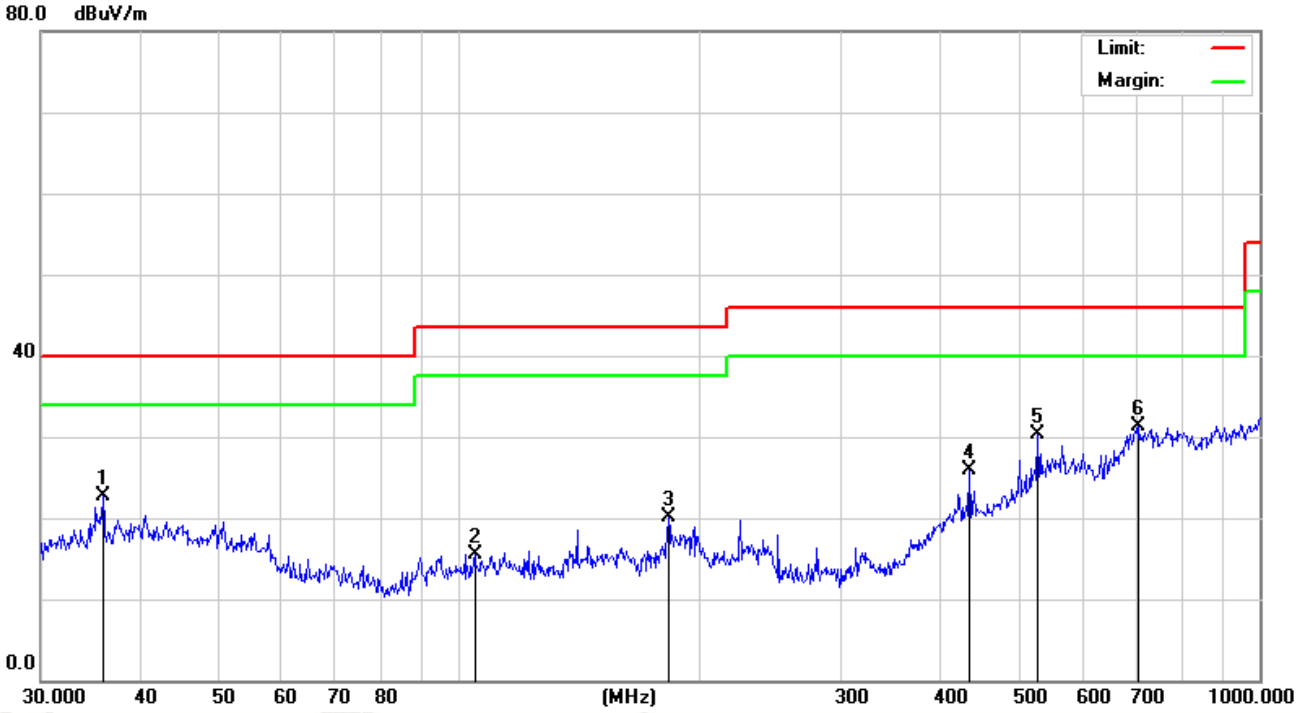
Temperature:	22℃	Relative Humidity:	48%
Test Date:	2019-11-07	Pressure:	1010hPa
Test Voltage:	AC 120V, 60Hz	Polarization:	Horizontal
Test Mode:	TX (1Mbps) CH00 (worst case)		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		35.3750	29.81	-4.76	25.05	40.00	-14.95	peak
2		78.1389	30.43	-10.88	19.55	40.00	-20.45	peak
3		140.3421	26.54	-7.57	18.97	43.50	-24.53	peak
4		205.6751	25.91	-5.17	20.74	43.50	-22.76	peak
5		528.2458	26.68	0.32	27.00	46.00	-19.00	peak
6	*	793.3960	24.62	7.69	32.31	46.00	-13.69	peak

Remark: Absolute Level = Reading Level + Factor, Margin = Absolute Level – Limit
Factor = Ant. Factor + Cable Loss – Pre-amplifier

Temperature:	22℃	Relative Humidity:	48%
Test Date:	2019-11-07	Pressure:	1010hPa
Test Voltage:	AC 120V, 60Hz	Polarization:	Vertical
Test Mode:	TX (1Mbps) CH00 (worst case)		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		35.8746	26.16	-3.47	22.69	40.00	-17.31	peak
2		104.5361	22.88	-7.28	15.60	43.50	-27.90	peak
3		182.5592	25.34	-5.33	20.01	43.50	-23.49	peak
4		434.0650	26.86	-0.95	25.91	46.00	-20.09	peak
5		528.2458	26.45	3.83	30.28	46.00	-15.72	peak
6	*	706.6998	24.06	7.17	31.23	46.00	-14.77	peak

Remark: Absolute Level = Reading Level + Factor, Margin = Absolute Level – Limit
Factor = Ant. Factor + Cable Loss – Pre-amplifier

Remark:

(1) Measuring frequencies from 9 KHz to the 1 GHz, Radiated emission test from 9KHz to 30MHz was verified, and no any emission was found except system noise floor.

(2) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.

(3) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz.

Above 1 GHz Test Results:

EUT：	Portable Speaker	Model Name ：	POW Una
Temperature：	25 ℃	Test Data	2019-11-07
Pressure：	1010 hPa	Relative Humidity：	60%
Test Mode ：	1Mbps	Test Voltage ：	DC 5V from adapter
Measurement Distance	3 m	Frenqucy Range	1GHz to 25GHz
RBW/VBW	1MHz/1MHz for Peak, 1MHz/10Hz for Average.		

CH Low of 2402MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	61.49	5.06	66.55	74	-7.45	PK
4804.000	40.69	5.06	45.75	54	-8.25	AV
7206.000	44.27	7.03	51.3	74	-22.7	PK
7206.000	36.15	7.03	43.18	54	-10.82	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	61.89	5.06	66.95	74	-7.05	PK
4804.000	41.06	5.06	46.12	54	-7.88	AV
7206.000	42.75	7.03	49.78	74	-24.22	PK
7206.000	33.46	7.03	40.49	54	-13.51	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

CH Middle of 2441MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	62.58	5.14	67.72	74	-6.28	PK
4882.000	41.63	5.14	46.77	54	-7.23	AV
7323.000	45.58	7.54	53.12	74	-20.88	PK
7323.000	36.49	7.54	44.03	54	-9.97	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	61.49	5.14	66.63	74	-7.37	PK
4882.000	41.06	5.14	46.2	54	-7.80	AV
7323.000	43.67	7.54	51.21	74	-22.79	PK
7323.000	32.49	7.54	40.03	54	-13.97	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

CH High of 2480MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	60.72	5.22	65.94	74	-8.06	PK
4960.000	40.33	5.22	45.55	54	-8.45	AV
7440.000	44.61	8.06	52.67	74	-21.33	PK
7440.000	32.09	8.06	40.15	54	-13.85	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	60.58	5.22	65.8	74	-8.2	PK
4960.000	41.24	5.22	46.46	54	-7.54	AV
7440.000	41.36	8.06	49.42	74	-24.58	PK
7440.000	33.49	8.06	41.55	54	-12.45	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

EUT：	Portable Speaker	Model Name ：	POW Una
Temperature：	25 ℃	Test Data	2019-11-07
Pressure：	1010 hPa	Relative Humidity：	60%
Test Mode ：	3Mbps	Test Voltage ：	DC 5V from adapter
Measurement Distance	3 m	Frenqucy Range	1GHz to 25GHz
RBW/VBW	1MHz/1MHz for Peak, 1MHz/10Hz for Average.		

CH Low of 2402MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	62.87	5.06	67.93	74	-6.07	PK
4804.000	42.19	5.06	47.25	54	-6.75	AV
7206.000	43.58	7.03	50.61	74	-23.39	PK
7206.000	33.52	7.03	40.55	54	-13.45	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	62.26	5.06	67.32	74	-6.68	PK
4804.000	42.15	5.06	47.21	54	-6.79	AV
7206.000	43.16	7.03	50.19	74	-23.81	PK
7206.000	31.58	7.03	38.61	54	-15.39	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

CH Middle of 2441MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	60.89	5.14	66.03	74	-7.97	PK
4882.000	39.91	5.14	45.05	54	-8.95	AV
7323.000	42.55	7.54	50.09	74	-23.91	PK
7323.000	30.26	7.54	37.8	54	-16.2	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	62.34	5.14	67.48	74	-6.52	PK
4882.000	41.58	5.14	46.72	54	-7.28	AV
7323.000	43.63	7.54	51.17	74	-22.83	PK
7323.000	33.94	7.54	41.48	54	-12.52	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

CH High of 2480MHz

Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	60.87	5.22	66.09	74	-7.91	PK
4960.000	40.25	5.22	45.47	54	-8.53	AV
7440.000	45.33	8.06	53.39	74	-20.61	PK
7440.000	32.79	8.06	40.85	54	-13.15	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	59.89	5.22	65.11	74	-8.89	PK
4960.000	39.14	5.22	44.36	54	-9.64	AV
7440.000	41.78	8.06	49.84	74	-24.16	PK
7440.000	31.25	8.06	39.31	54	-14.69	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin = Absolute Level – Limit						

Remark：
(1) Measuring frequencies from 1 GHz to the 25 GHz.
(2) “F” denotes fundamental frequency; “H” denotes spurious frequency. “E” denotes band edge frequency.
(3) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.
(4) Data of measurement within this frequency range shown “--- ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
(5) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for peak measurement with peak detector at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 10Hz for Average measurement with peak detection at frequency above 1GHz.
(6) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.

5 BAND EDGE

5.1 Limits

FCC PART 15.247 Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

5.2 Test Procedure

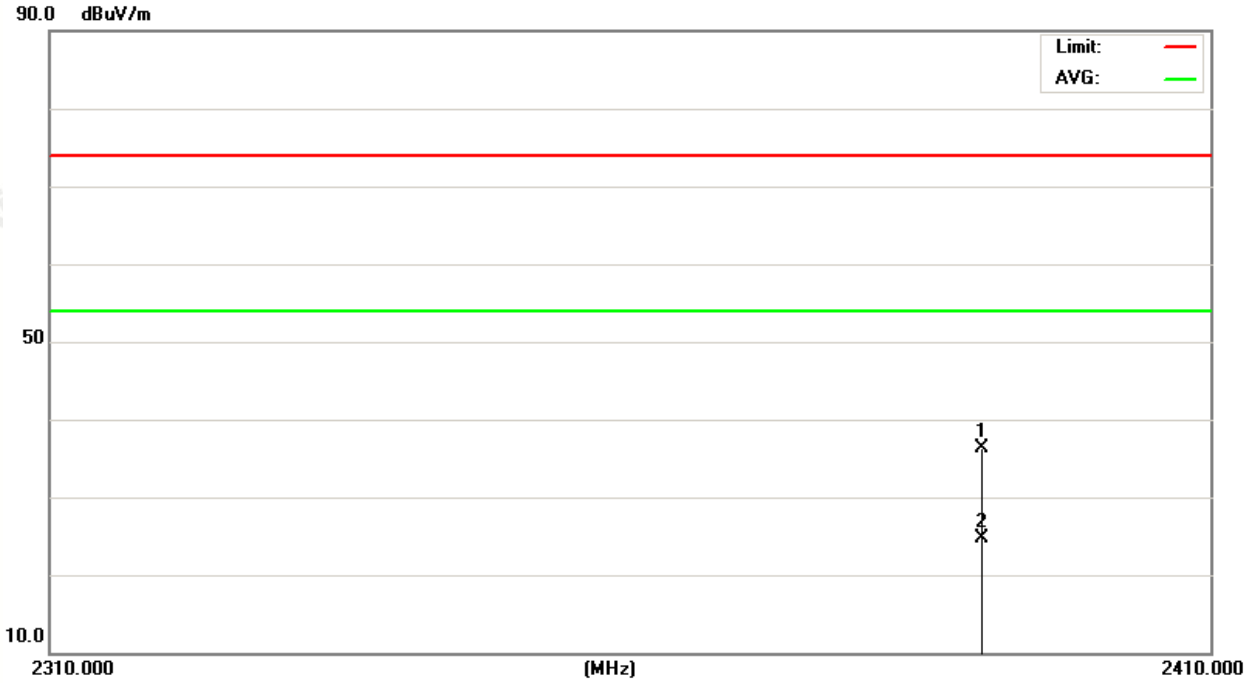
The band edge compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW to 100KHz and VBM to 300KHz to measure the peak field strength and set RBW to 1MHz and VBW to 10Hz to measure the average radiated field strength. The conducted RF band edge was measured by using a spectrum analyzer. Set span wide enough to capture the highest in-band emission and the emission at the band edge. Set RBW to 100 KHz and VBW to 300 KHz, to measure the conducted peak band edge.

5.3 Test Result

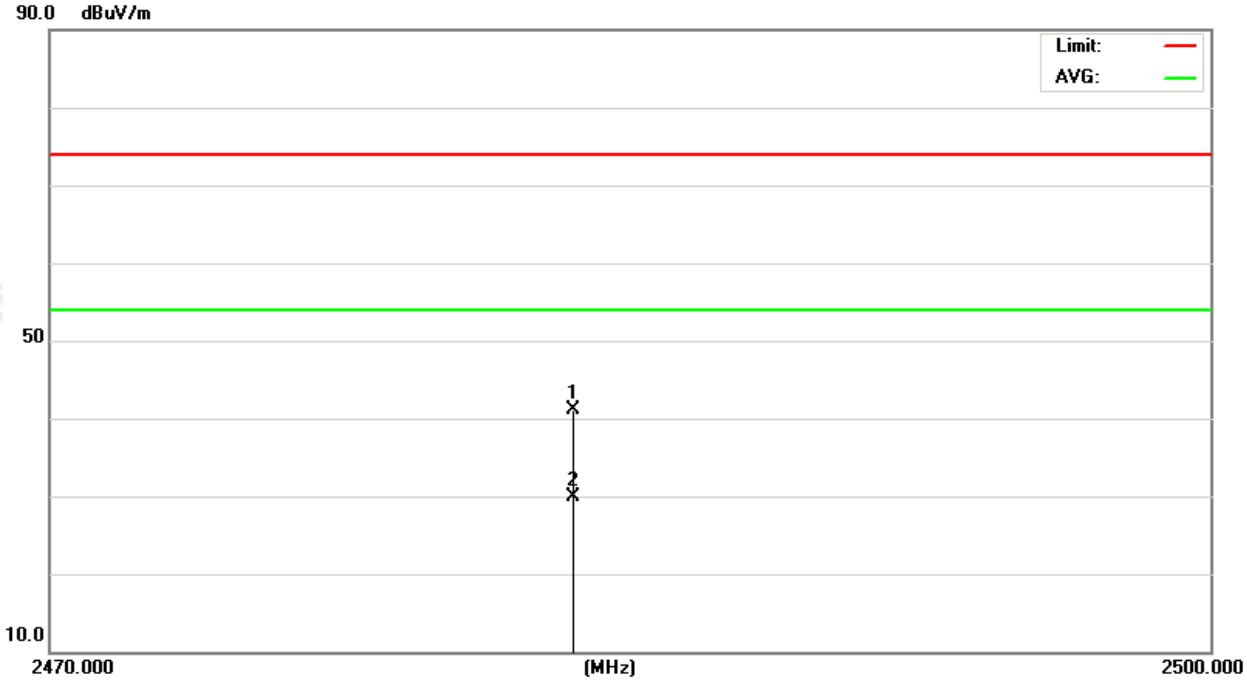
PASS

Operation Mode: TX 1Mbps Mode(Worst case)

Vertical

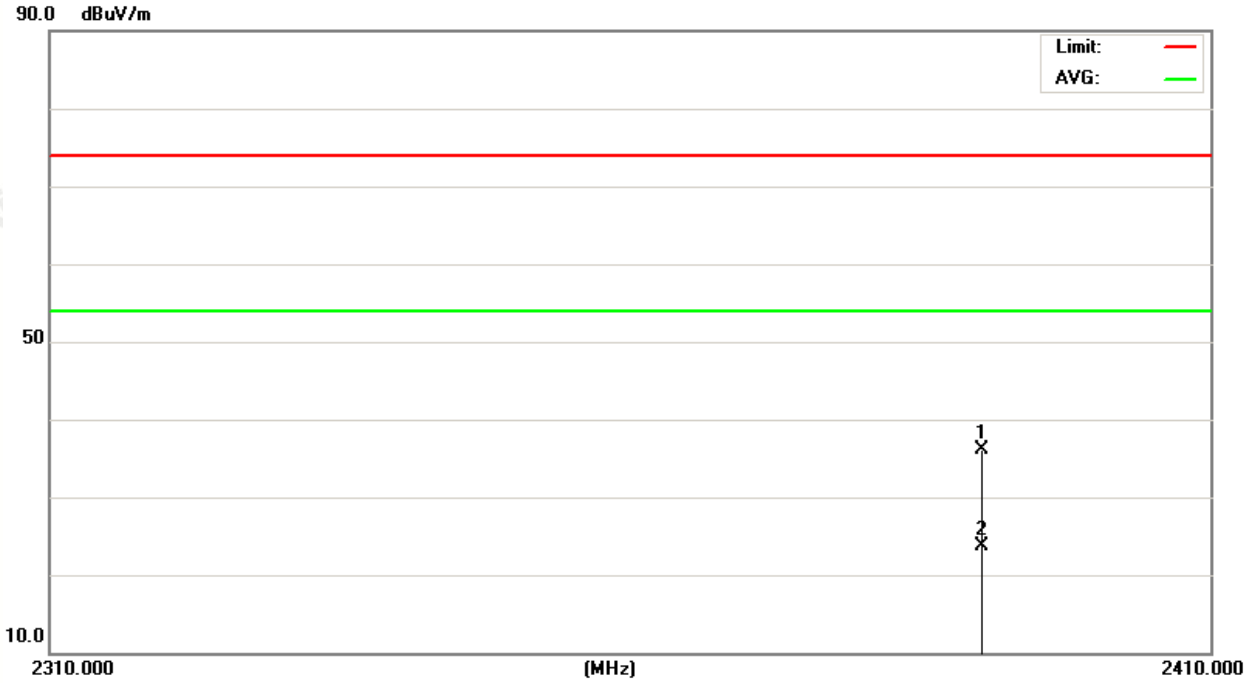


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2390.000	42.16	-5.79	36.37	74.00	-37.63	peak
2	*	2390.000	30.54	-5.79	24.75	54.00	-29.25	AVG

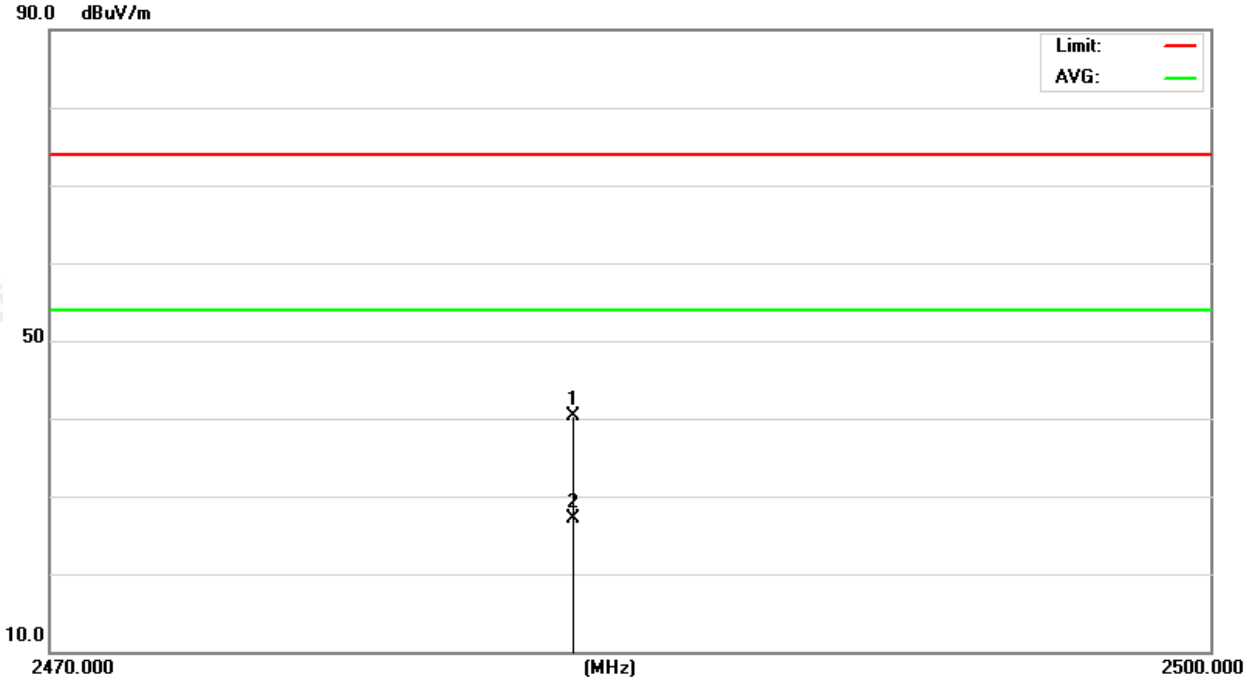


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2483.500	46.11	-4.98	41.13	74.00	-32.87	peak
2	*	2483.500	34.92	-4.98	29.94	54.00	-24.06	AVG

Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2390.000	41.97	-5.79	36.18	74.00	-37.82	peak
2	*	2390.000	29.48	-5.79	23.69	54.00	-30.31	AVG



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2483.500	45.35	-4.98	40.37	74.00	-33.63	peak
2	*	2483.500	32.04	-4.98	27.06	54.00	-26.94	AVG

6 OCCUPIED BANDWIDTH MEASUREMENT

6.1 Test Limit

FCC Part15(15.247), Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	>= 500KHz (6dB bandwidth)	2400-2483.5	PASS

6.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Set EUT as normal operation.
3. Based on FCC Part15 C Section 15.247: RBW=100KHz, VBW=300KHz.
4. The useful radiated emission from the EUT was detected by the spectrum analyzer with peak detector.

6.3 Measurement Equipment Used

Same as Radiated Emission Measurement

6.4 Test Result

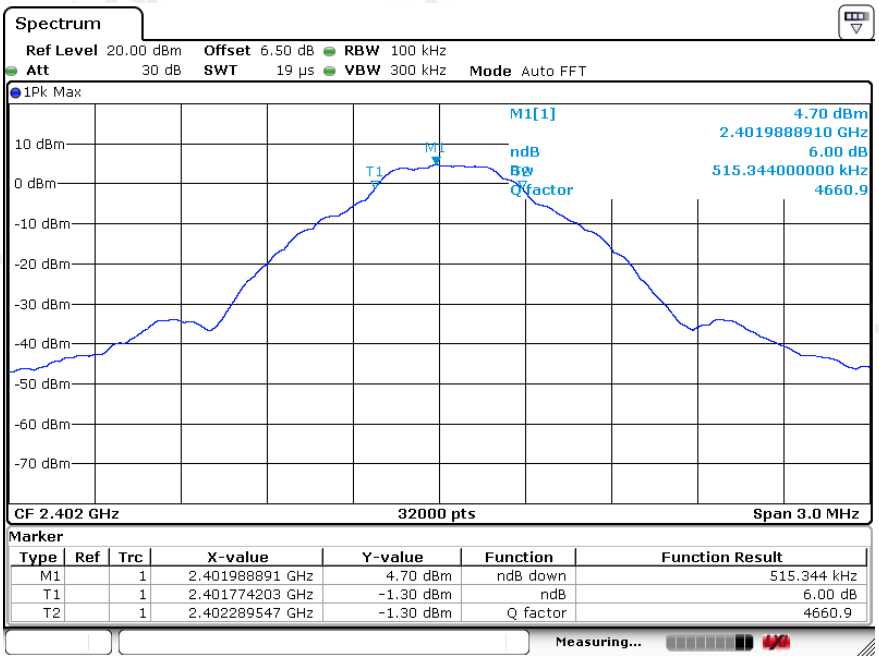
PASS

Mode	Freq (MHz)	20dB (MHz)	99%OBW (MHz)	Conclusion
GFSK	2402	1.035	0.919	PASS
	2441	1.035	0.920	PASS
	2480	1.037	0.917	PASS

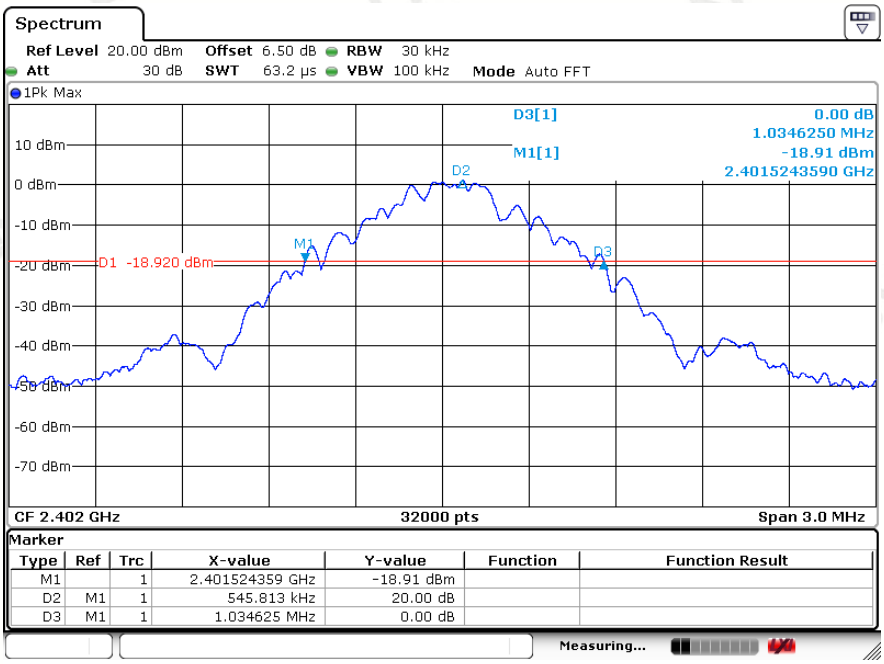
Mode	Freq (MHz)	20dB (MHz)	99%OBW (MHz)	Conclusion
π/4-DQPSK	2402	1.361	1.202	PASS
	2441	1.363	1.208	PASS
	2480	1.366	1.208	PASS

Mode	Freq (MHz)	20dB (MHz)	99%OBW (MHz)	Conclusion
8DPSK	2402	1.301	1.187	PASS
	2441	1.305	1.194	PASS
	2480	1.306	1.194	PASS

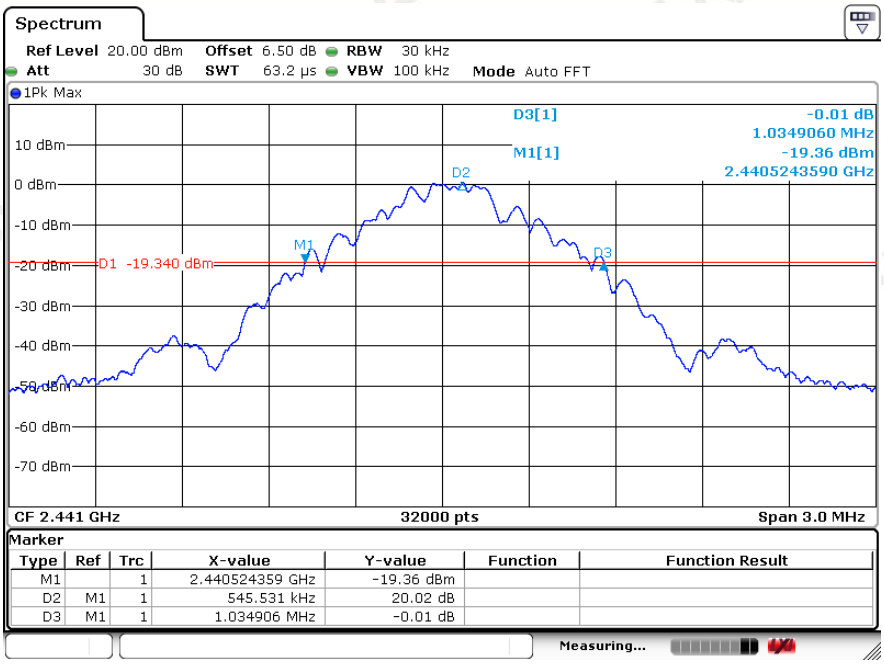
CH: 2402MHz



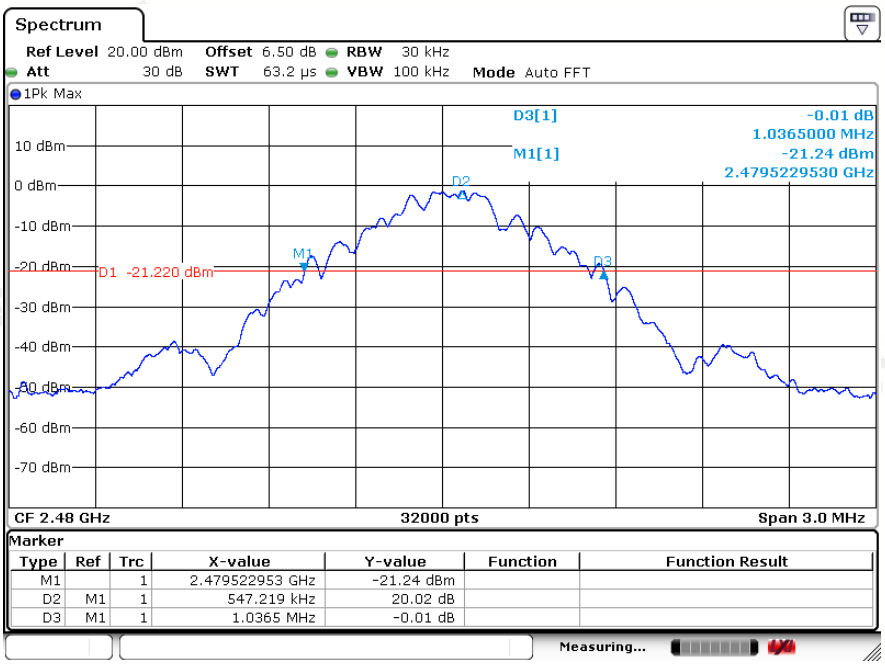
GFSK 2402MHZ



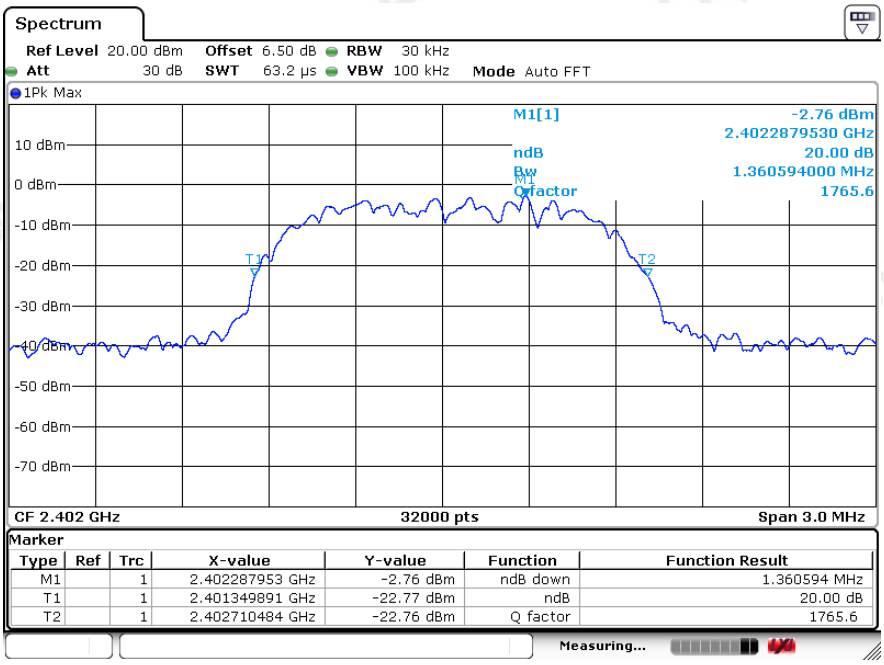
GFSK 2441MHZ



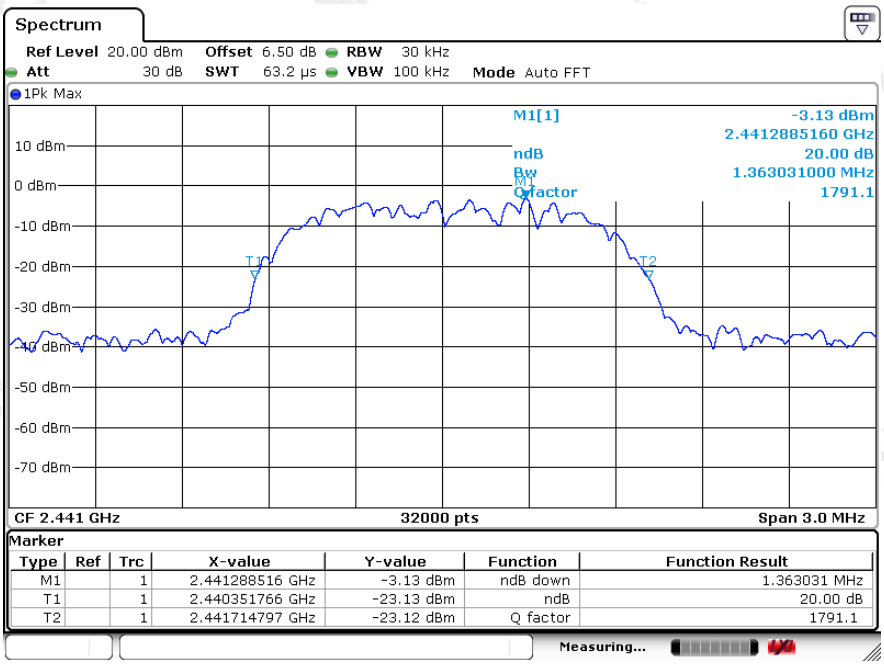
GFSK 2480MHZ


Spectrum
Ref Level 20.00 dBm Offset 6.50 dB RBW 30 kHz
Att 30 dB SWT 63.2 µs VBW 100 kHz Mode Auto FFT
1Pk Max
D3[1] -0.01 dB
1.0365000 MHz
M1[1] -21.24 dBm
2.4795229530 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1 -21.220 dBm
M1
D2
D3
CF 2.48 GHz
32000 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479522953 GHz -21.24 dBm
D2 M1 1 547.219 kHz 20.02 dB
D3 M1 1 1.0365 MHz -0.01 dB
Measuring...

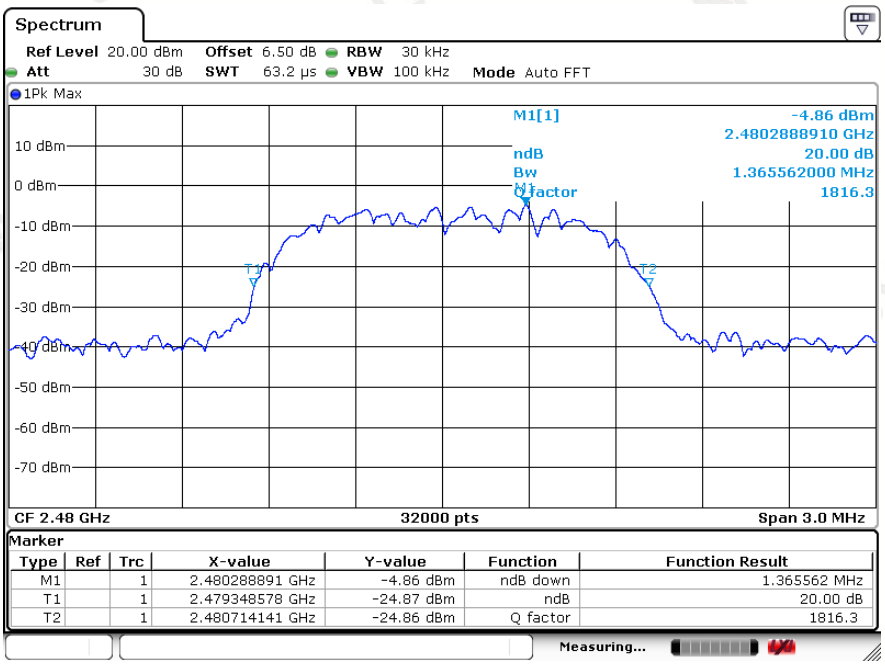
Π/4-DQPSK 2402MHZ



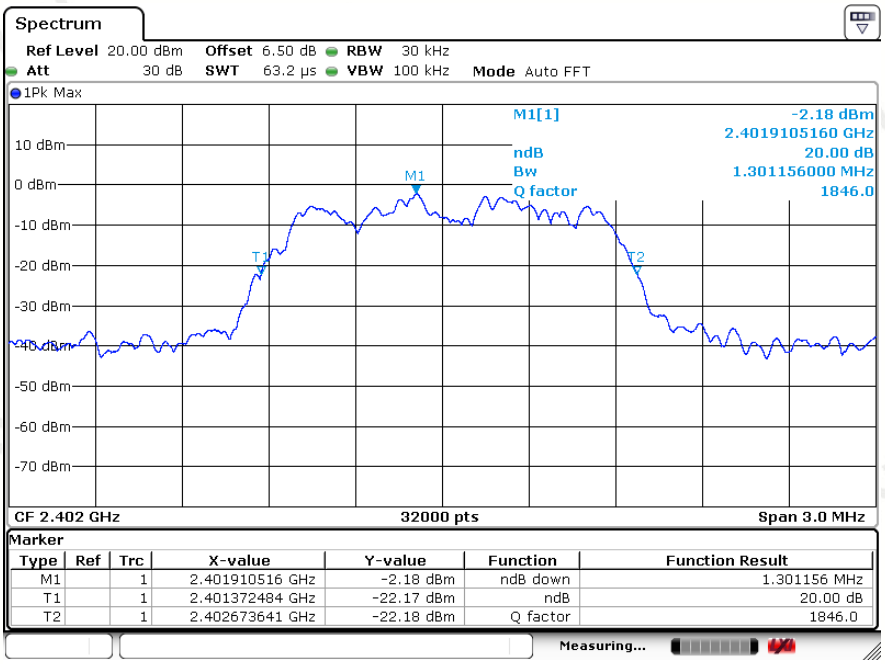
Π/4-DQPSK 2441MHZ



Π/4-DQPSK 2480MHZ



8DPSK 2402MHZ



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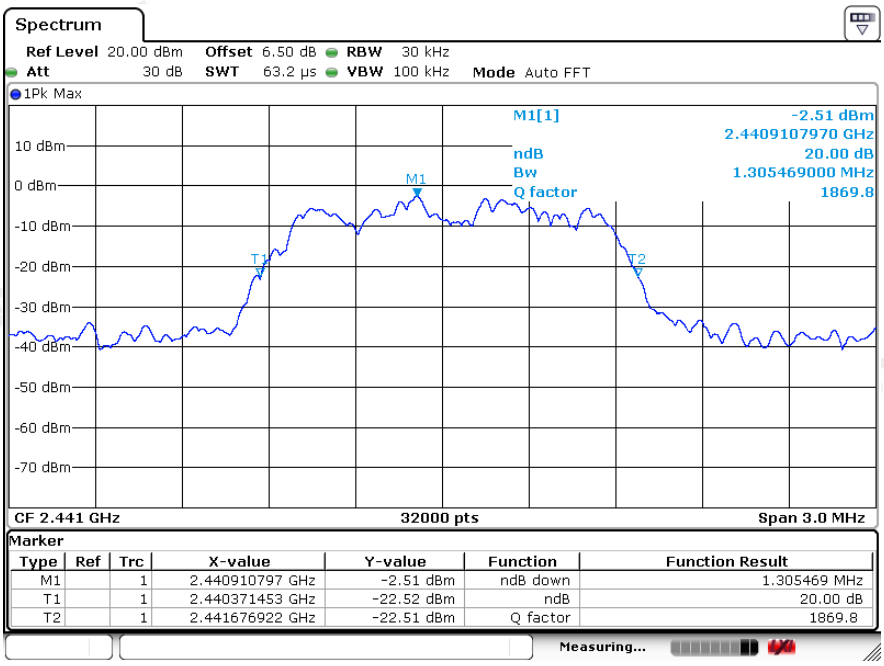
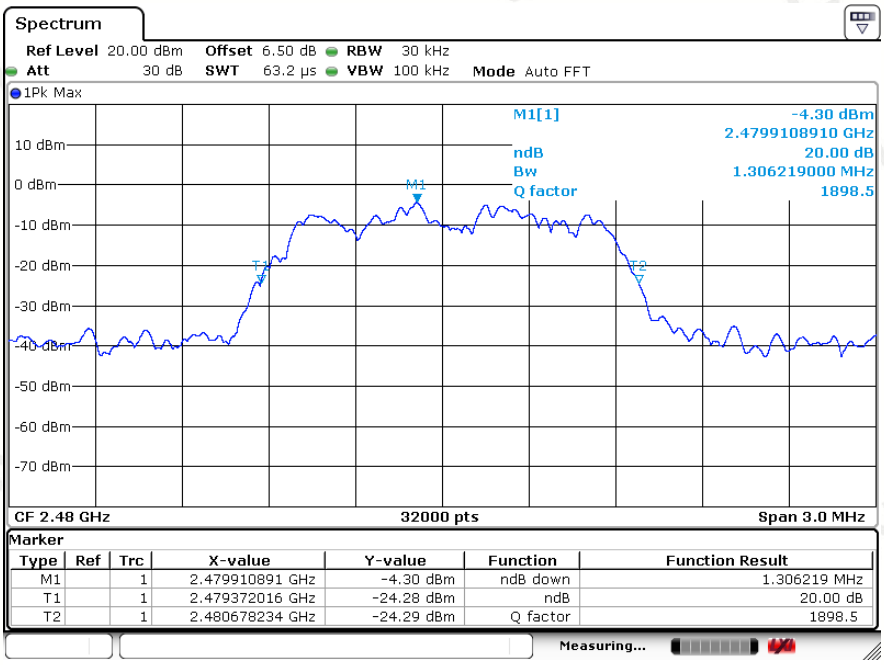
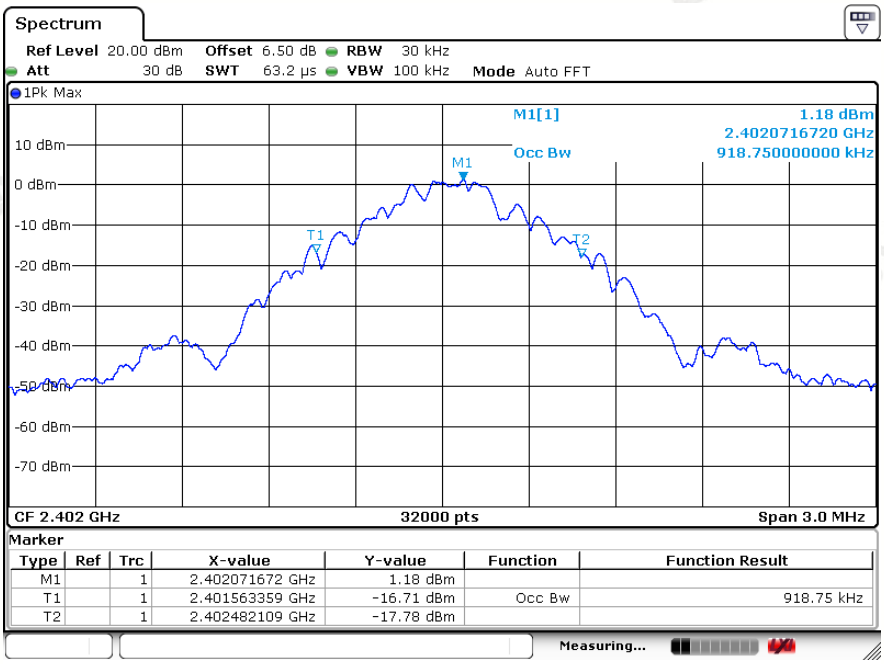


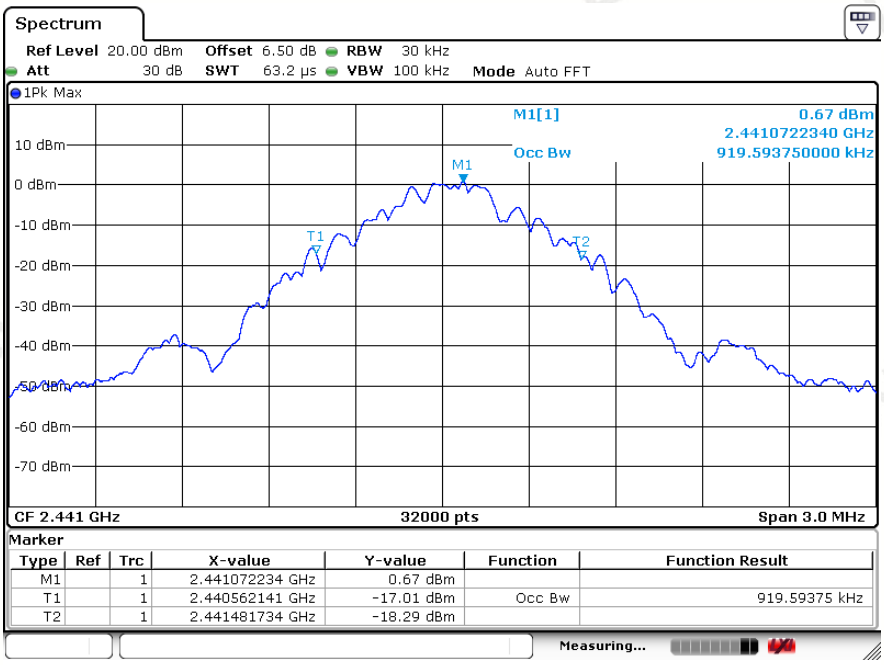
8DPSK 2480MHZ



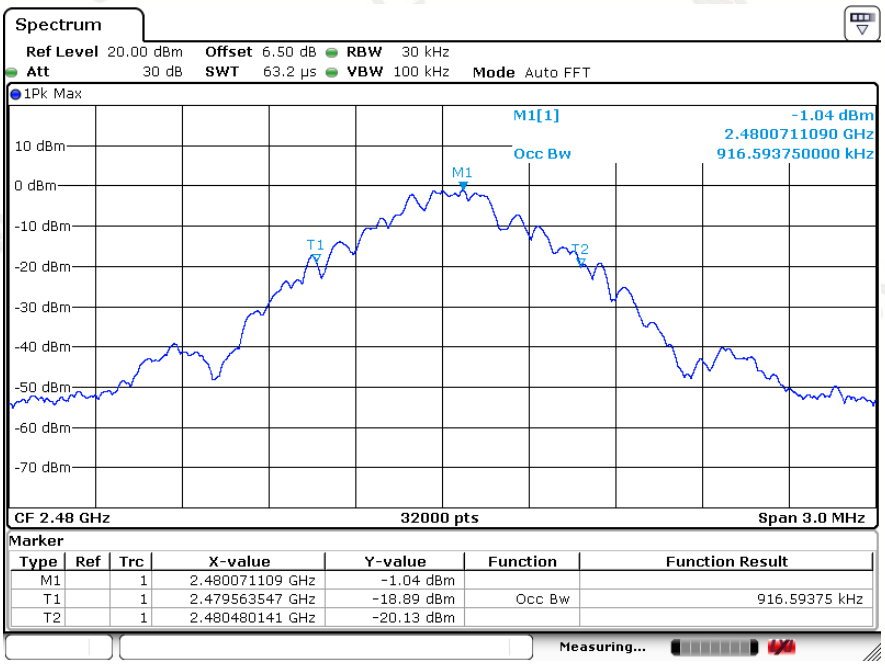
GFSK 2402MHZ



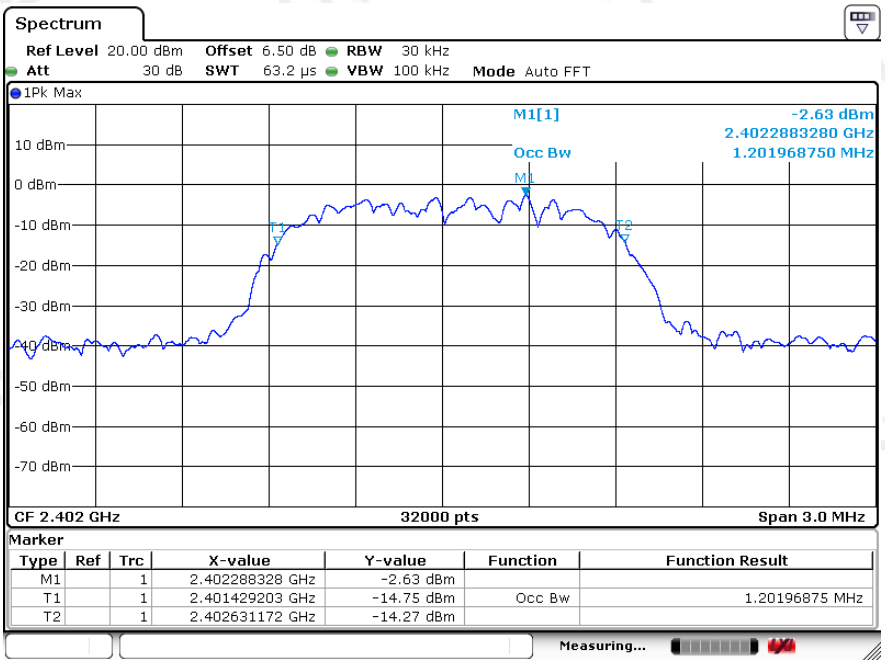
GFSK 2441MHZ



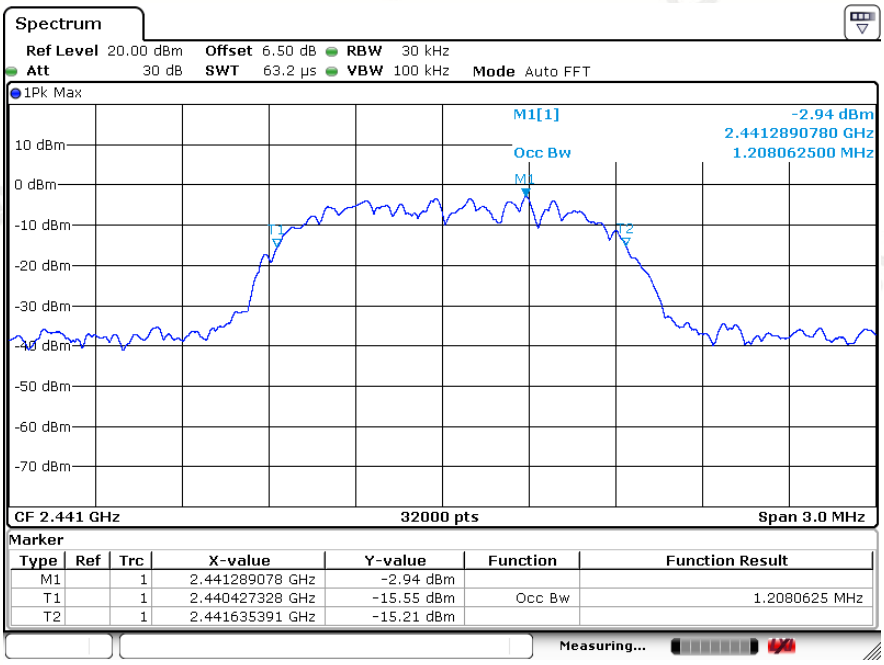
GFSK 2480MHZ



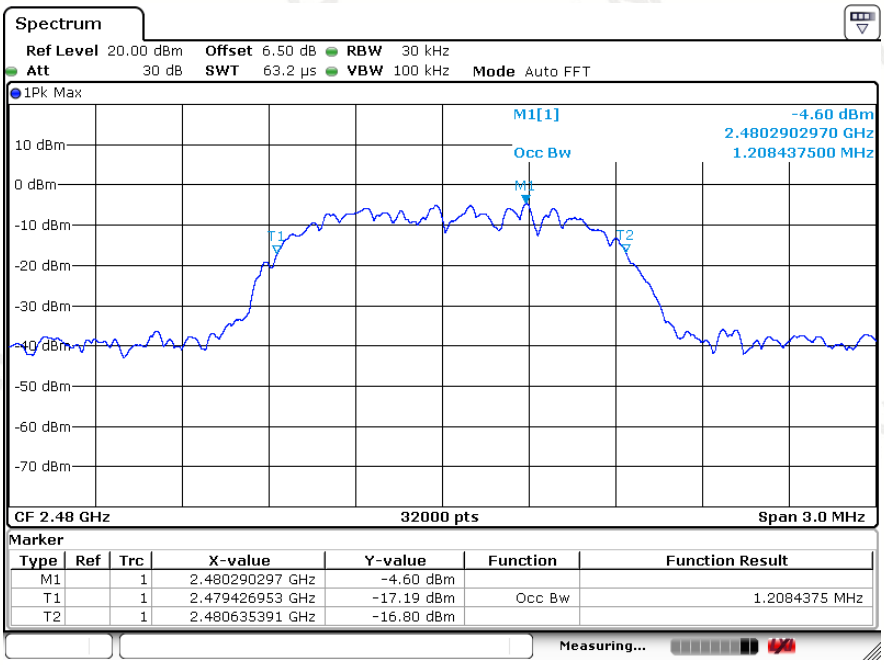
Π/4-DQPSK 2402MHZ



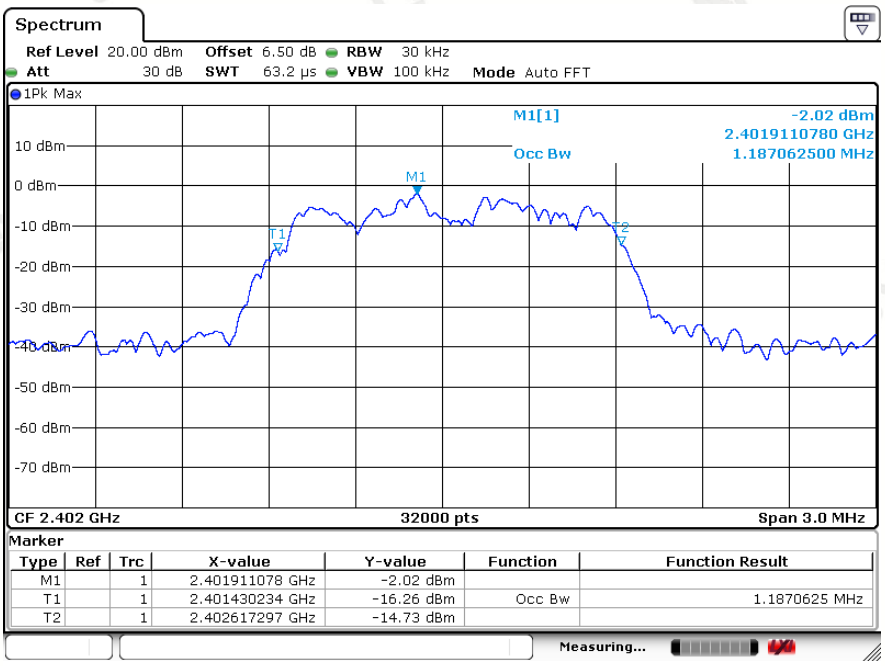
Π/4-DQPSK 2441MHZ



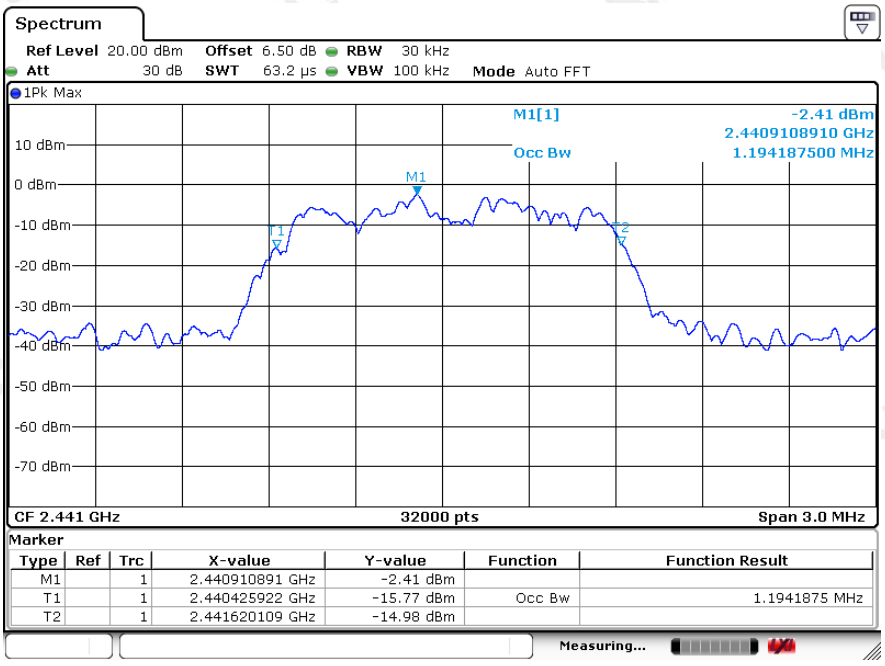
Π/4-DQPSK 2480MHZ



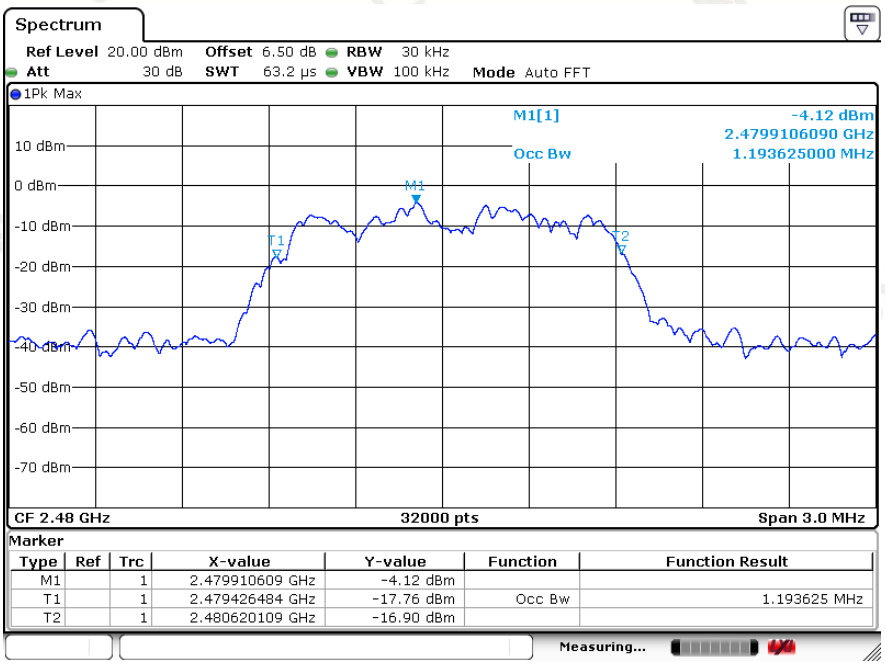
8DPSK 2402MHZ



8DPSK 2441MHZ



8DPSK 2480MHZ



7 CARRIER FREQUENCY SEPARATION TEST

7.1 Test Limit

Section 15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

7.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The transmitter output was connected to the spectrum analyzer through a low loss cable.
3. Let the EUT work in TX (Hopping on) modes measure it. The transmit frequency are 2402-2480MHz. We select 2402MHz, 2441MHz, and 2480MHz TX frequency to transmit.
4..Set RBW of spectrum analyzer to 30 kHz and VBW to 100 kHz. Adjust Span to 3 MHz.
5. Set the adjacent channel of the EUT maxhold another trace.
6. Measurement the channel separation

7.3 Measurement Equipment Used

Same as Radiated Emission Measurement

7.4 Test Result

PASS

GFSK

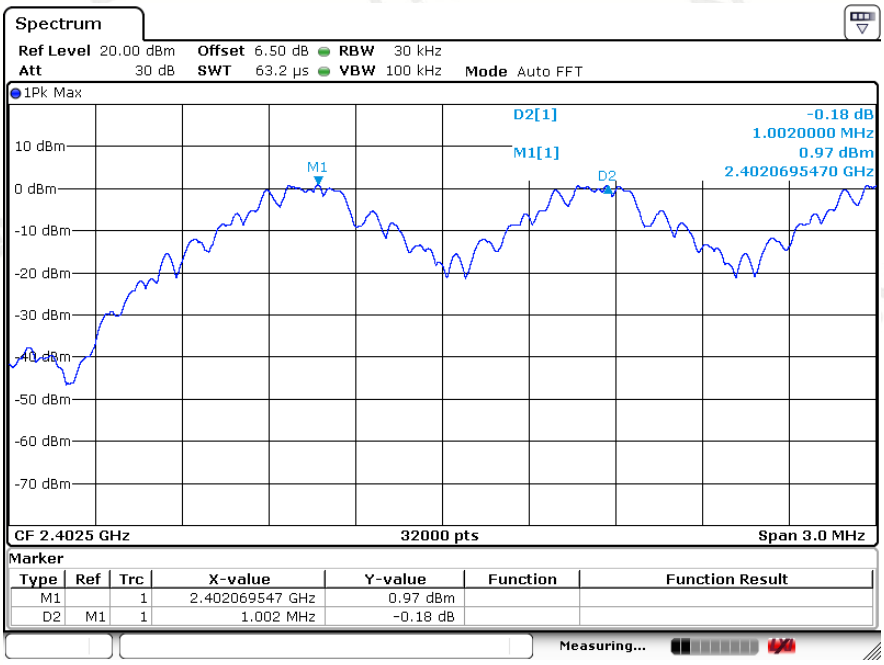
Channel	Frequency (MHz)	Channel Separation(MHz)	Limit (MHz)	Result
Low	2402	1.002	>(25KHz or 2/3*20dB Bandwidth)	PASS
Middle	2441	0.999	>(25KHz or 2/3*20dB Bandwidth)	PASS
High	2479	0.999	>(25KHz or 2/3*20dB Bandwidth)	PASS

8DPSK

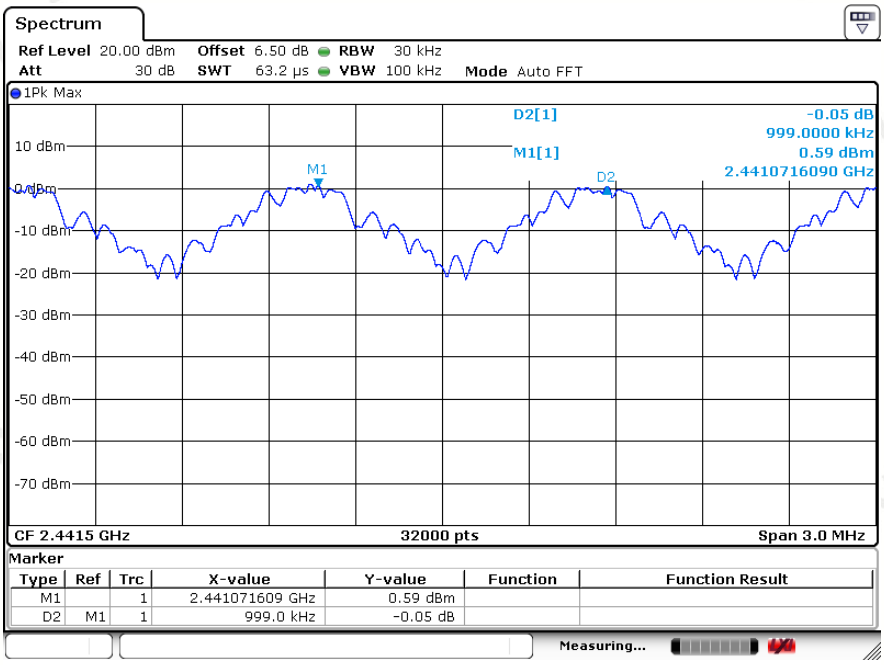
Channel	Frequency (MHz)	Channel Separation(MHz)	Limit (MHz)	Result
Low	2402	0.999	>(25KHz or 2/3*20dB Bandwidth)	PASS
Middle	2441	0.999	>(25KHz or 2/3*20dB Bandwidth)	PASS
High	2479	0.999	>(25KHz or 2/3*20dB Bandwidth)	PASS

The spectrum analyzer plots are attached as below.

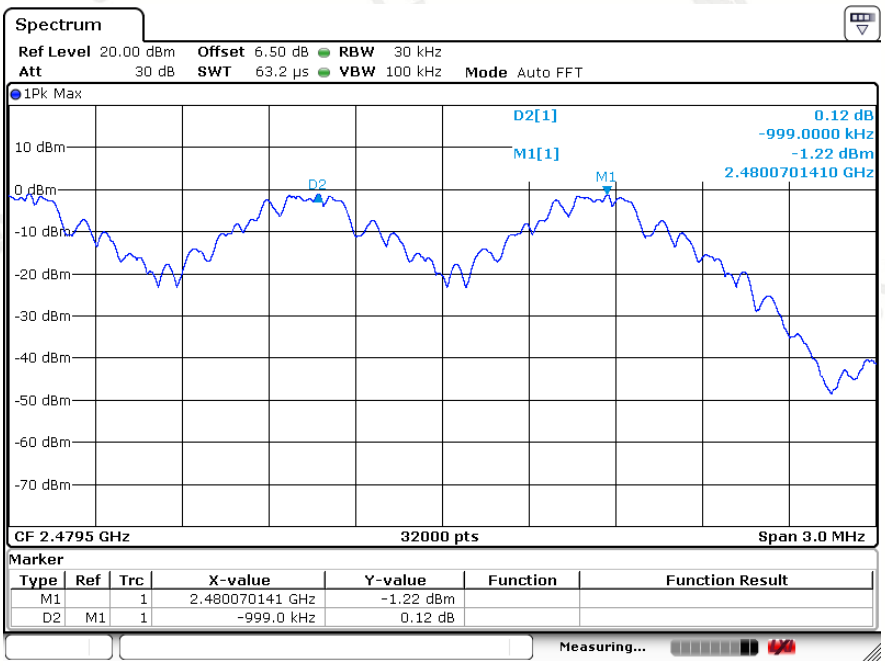
GFSK 2402MHZ



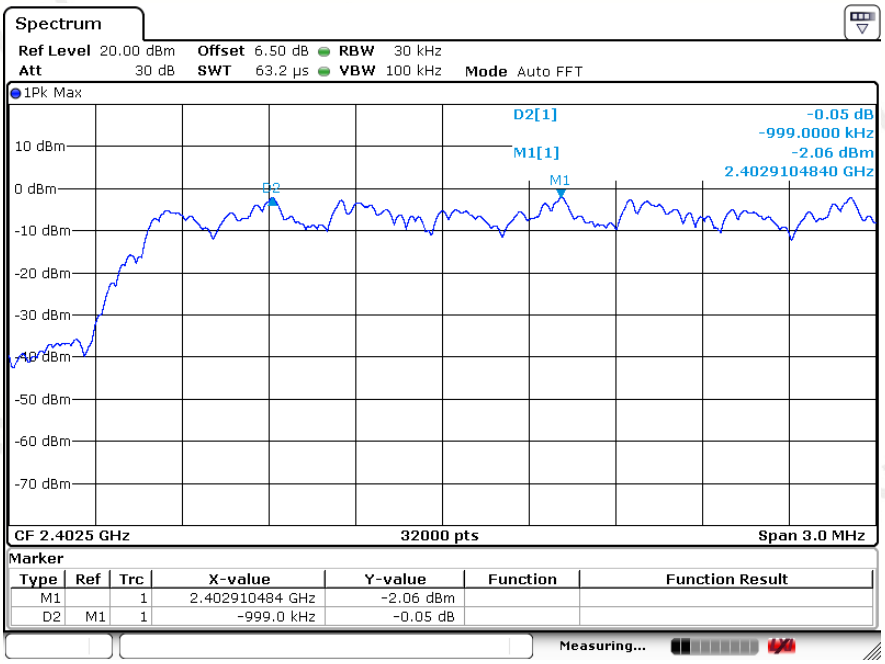
GFSK 2441MHZ



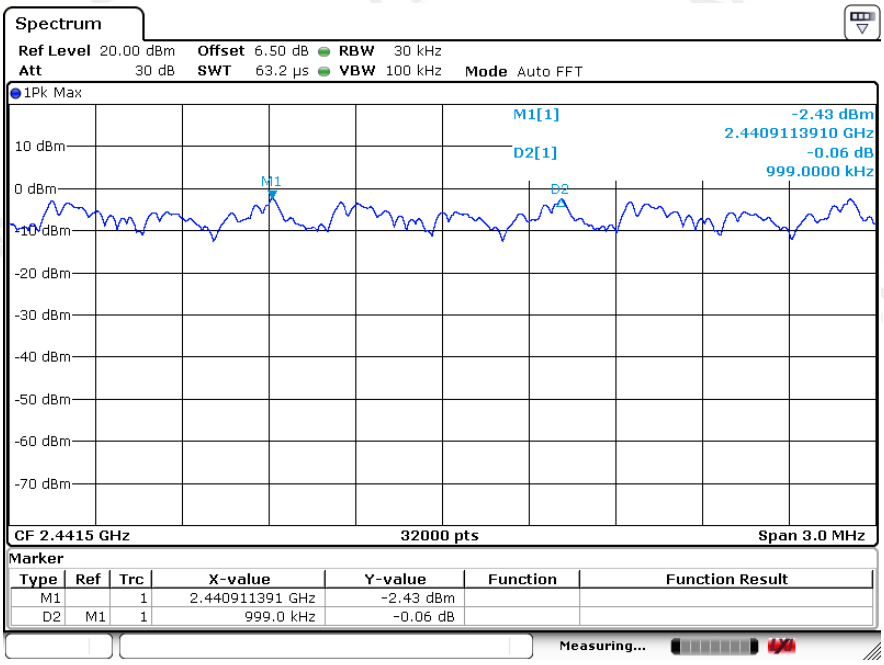
GFSK 2480MHZ



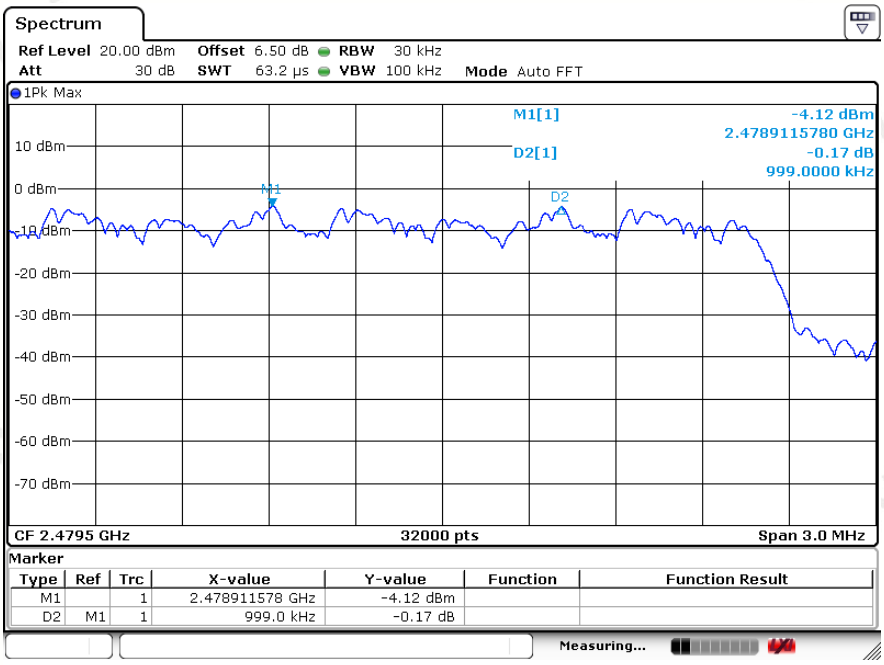
8DPSK 2402MHZ



8DPSK 2441MHZ



8DPSK 2480MHZ



8 PEAK OUTPUT POWER TEST

8.1 Test Limit

FCC Part15(15.247), Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3)	Peak Output Power	1 watt or 30dBm	2400-2483.5	PASS

8.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Connect EUT's antenna output to spectrum analyzer by RF cable.
3. Configure EUT work in test mode as stated in clause 2.4.
4. Set the spectrum analyzer as follows:

GFSK, π/4-DQPSK, 8DPSK	RBW:	3MHz
	VBW:	10MHz
Span		>1.5x 20dB bandwidth
Detector Mode:		Peak
Sweep time:		auto
Trace mode		Max hold

5. Allow the trace to stabilize, Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges measure out the Average and PK output power.

8.3 Measurement Equipment Used

Same as Radiated Emission Measurement

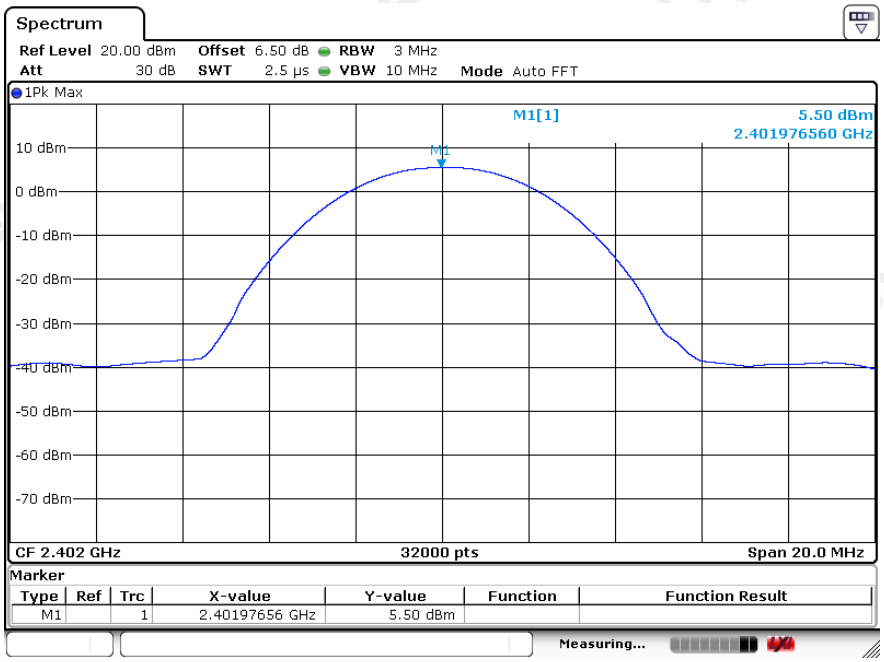
8.4 Test Result

PASS

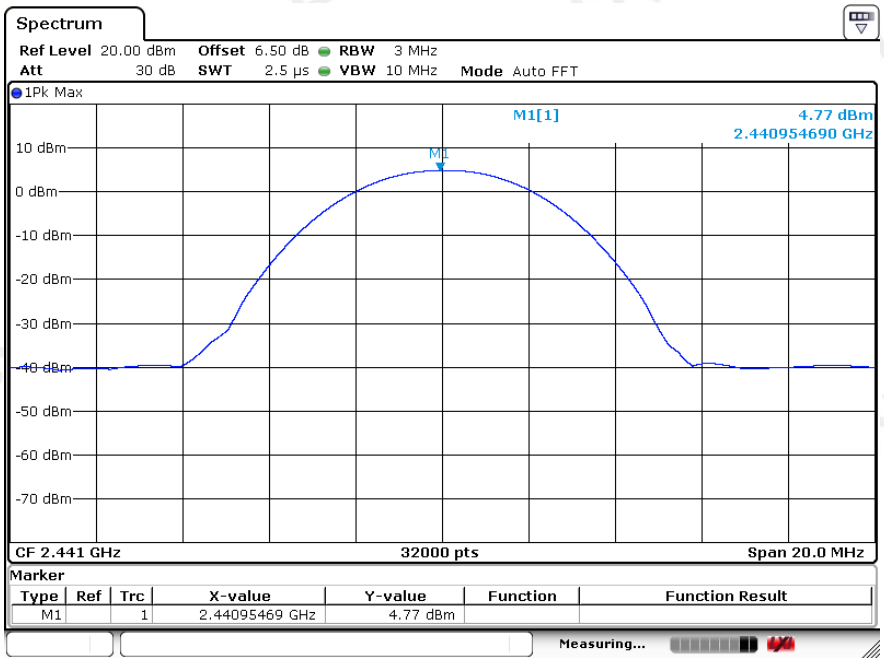
All the test modes completed for test.

EUT Set Mode	Data Rate (Mbp/s)	Frequency (MHz)	Result(dBm) Peak
GFSK	1	2402	5.50
		2441	4.77
		2480	2.47
π/4-DQPSK	2	2402	6.63
		2441	6.14
		2480	4.32
8DPSK	3	2402	6.65
		2441	4.11
		2480	4.45
Limit: 21dBm		Conclusion: PASS	

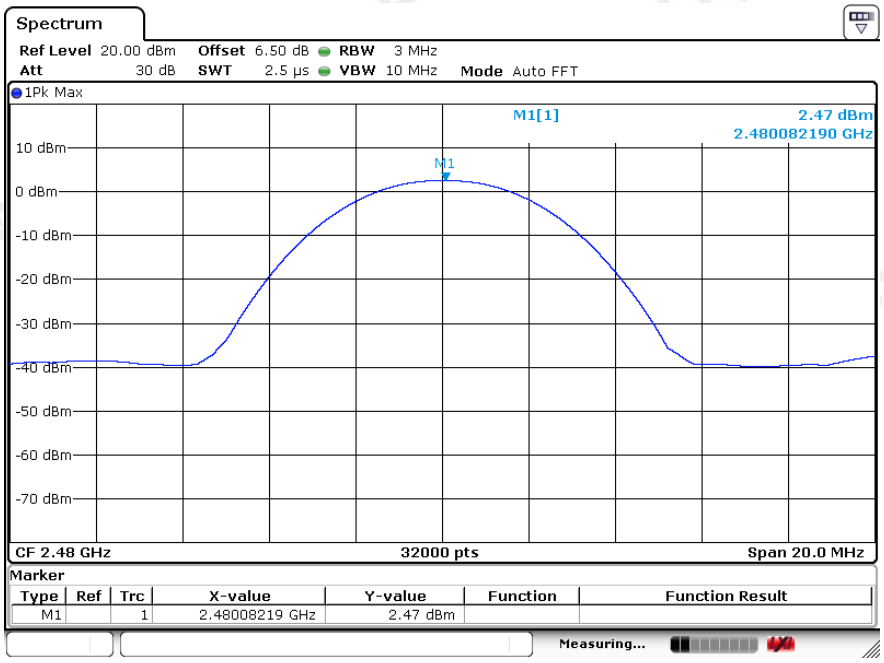
GFSK 2402MHz



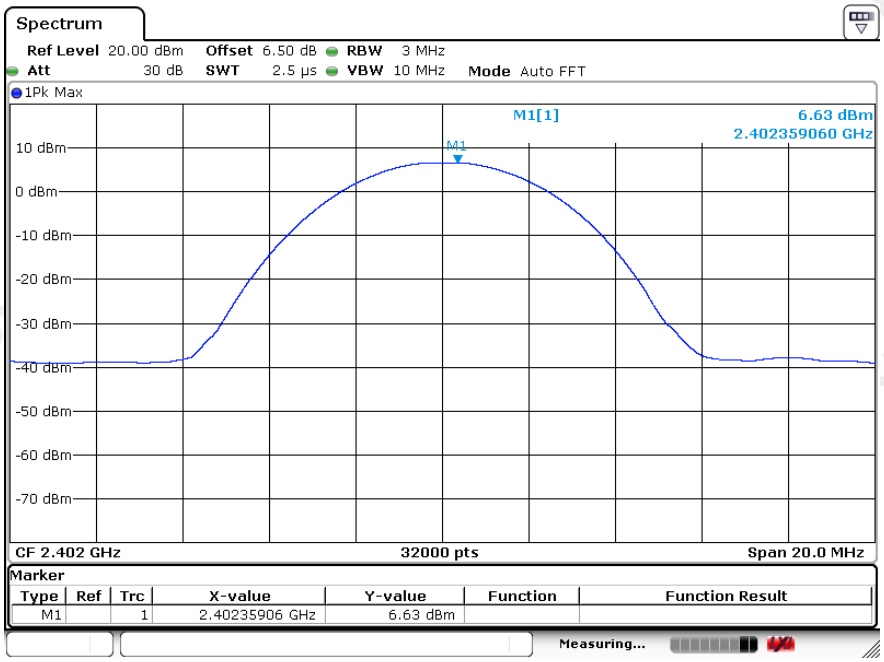
GFSK 2441MHz



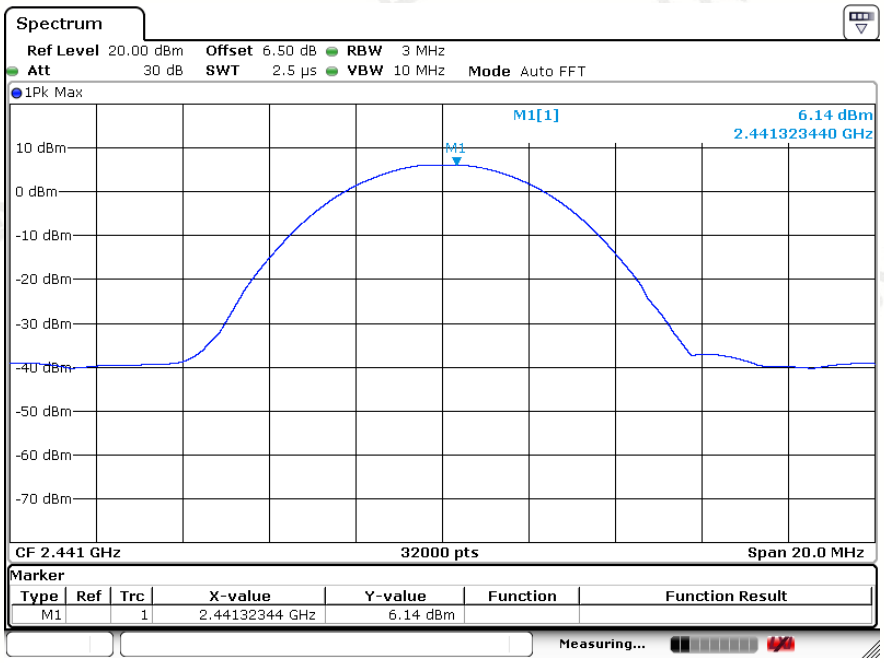
GFSK 2480MHz



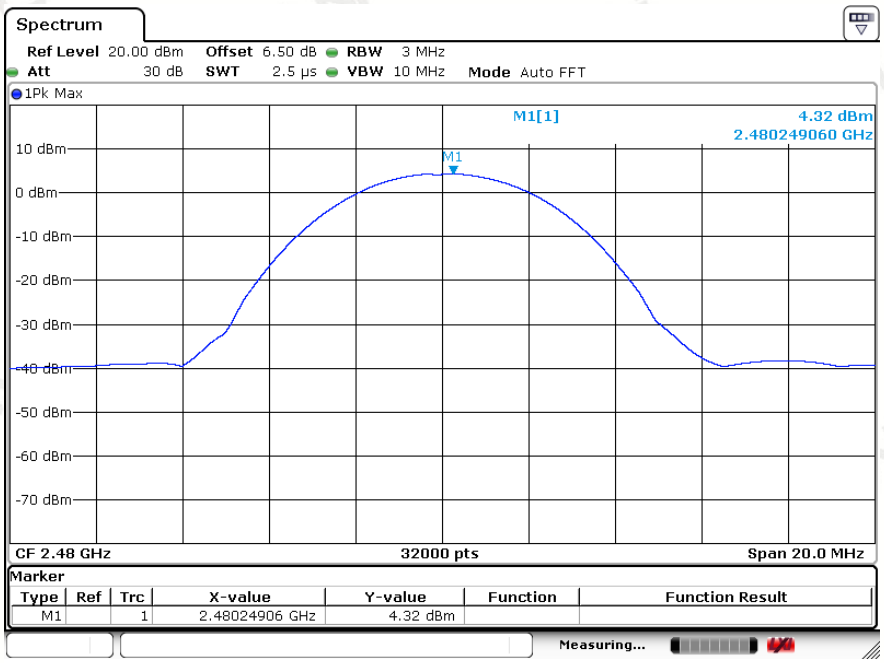
π/4-DQPSK 2402MHz



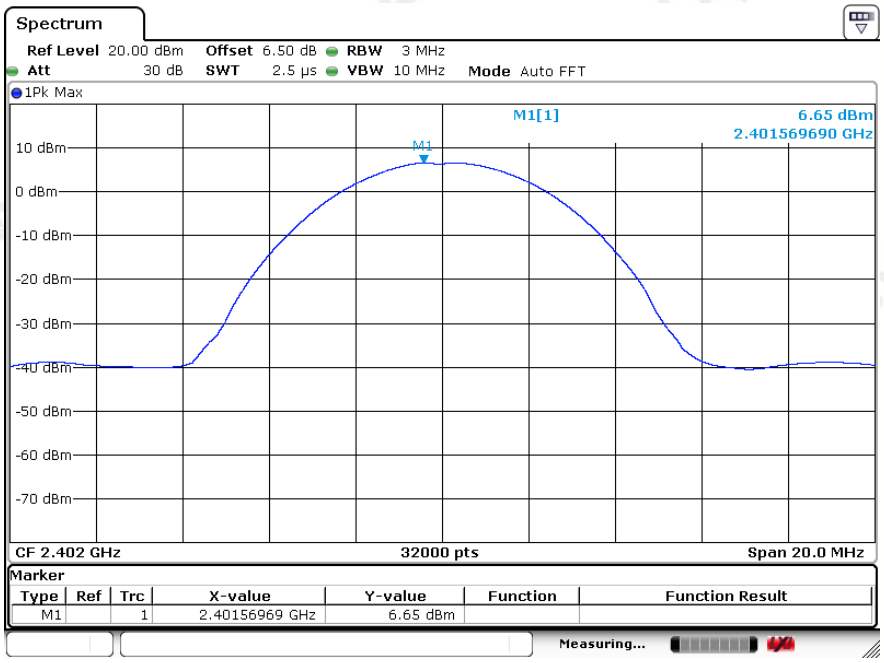
π/4-DQPSK 2441MHz



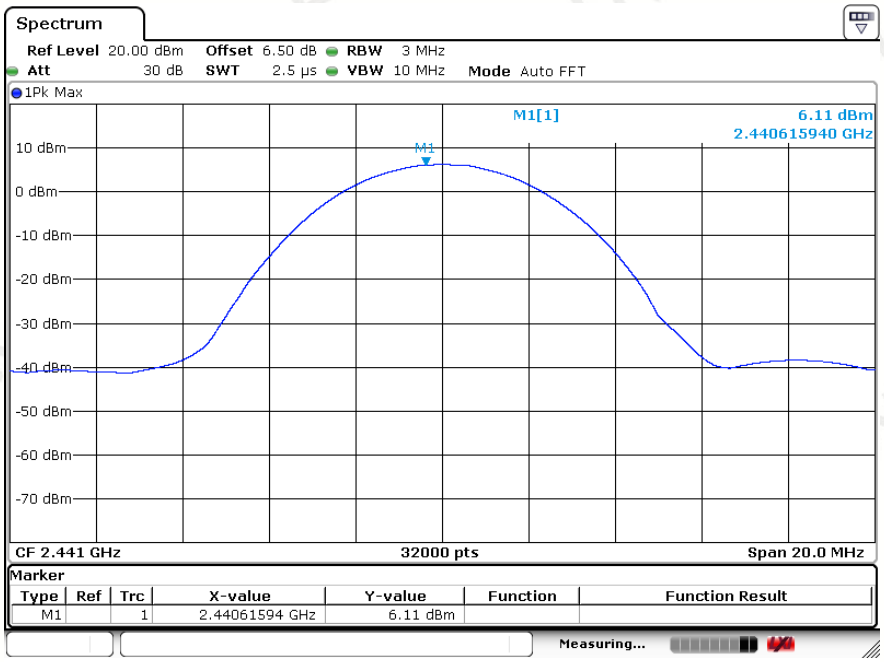
π/4-DQPSK 2480MHz



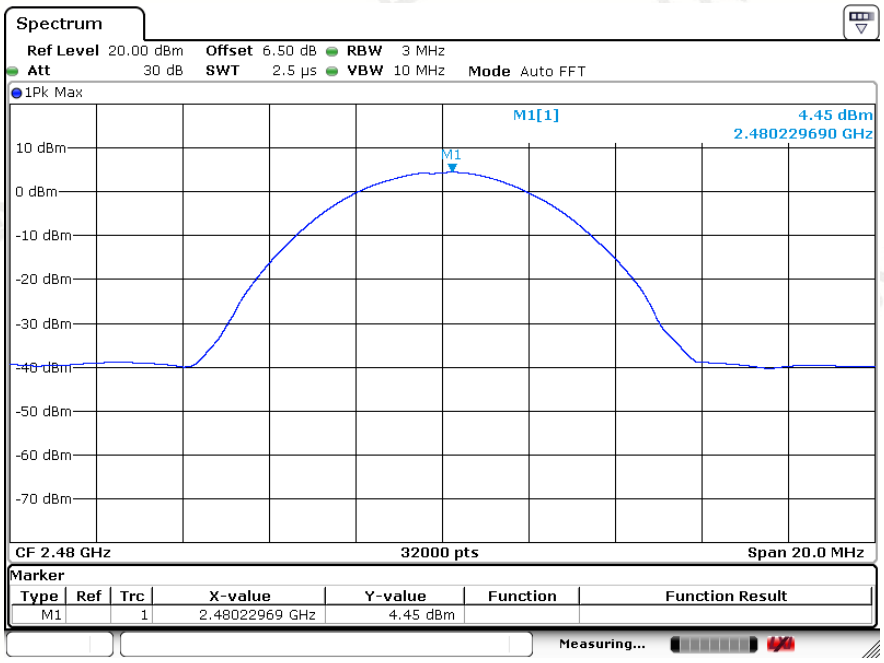
8DPSK 2402MHz



8DPSK 2441MHz



8DPSK 2480MHz



9 NUMBER OF HOPPING FREQUENCY TEST

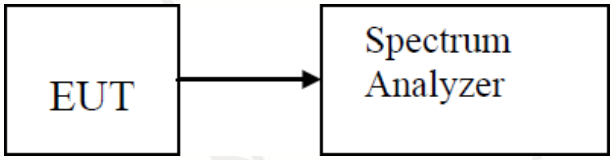
9.1 Test Limit

Section 15.247(a)(1)(iii): Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Set EUT as TX operation and connect directly to the spectrum analyzer.
3. Based on FCC Part15 C Section 15.247: Span=83.5MHz , RBW=100KHz, VBW=300KHz.
4. Let the EUT work in TX (Hopping on) modes measure it.
5. Set detected by the spectrum analyzer with peak detector.

9.3 Test Setup



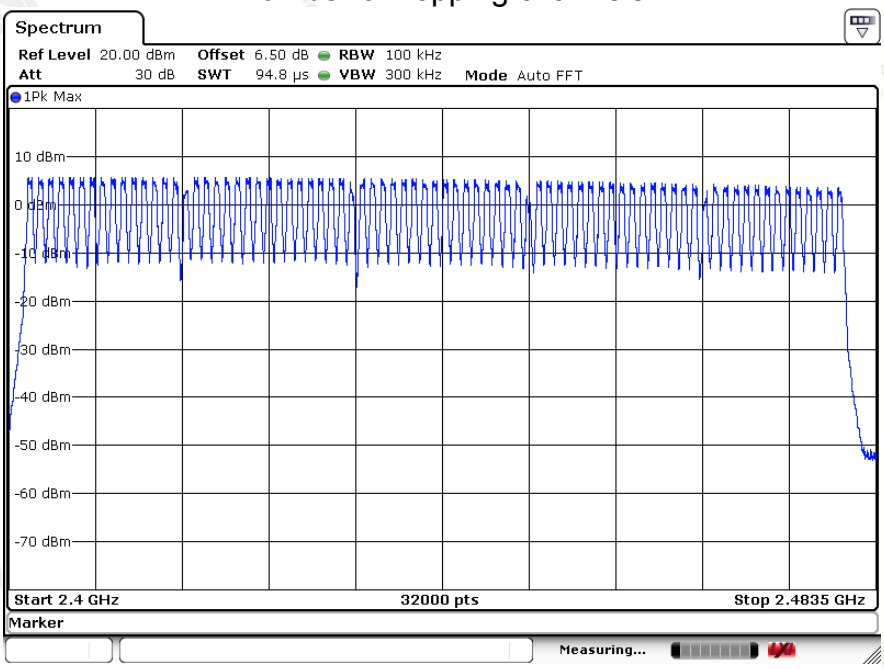
9.4 Test Result

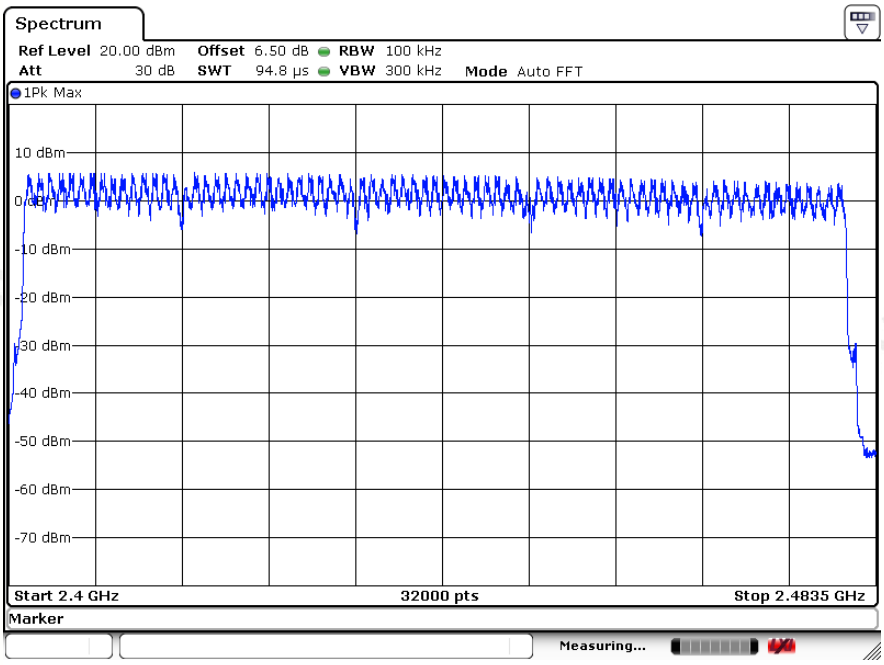
PASS

Total number of hopping channel	Measurement result(CH)	Limit(CH)
	79	≥15

The spectrum analyzer plots are attached as below

Number of hopping channels





10 DWELL TIME TEST

10.1 Test Limit

Section 15.247(a)(1)(iii): 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.

10.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Set EUT as TX operation and connect directly to the spectrum analyzer.
3. Based on FCC Part15 C Section 15.247: RBW=1MHz, VBW=3MHz, Span=0Hz.
4. A Period Time = (channel number)*0.4

DH1 Time Slot: Reading * (1600/2)*31.6/(channel number)
DH3 Time Slot: Reading * (1600/4)*31.6/(channel number)
DH5 Time Slot: Reading * (1600/6)*31.6/(channel number)

10.3 Test Setup

10.4 Test Result

PASS

GFSK

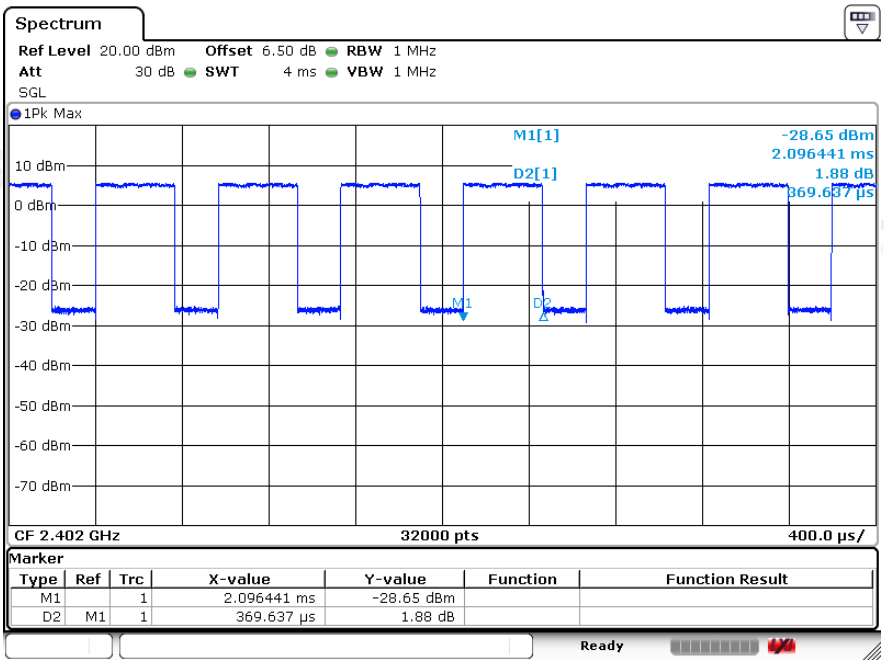
Mode	Channel Frequency (MHz)	Pulse Time (ms)	Dwell Time (ms)	Limit (ms)
DH1	2402	0.370	118.400	400
DH3	2402	1.625	260.000	400
DH5	2402	2.871	306.240	400

8DPSK

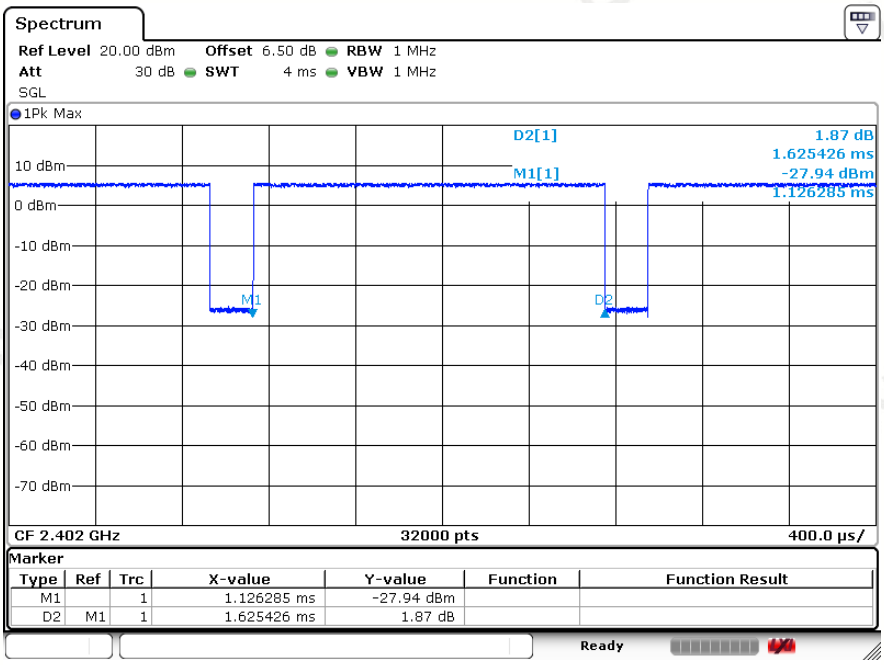
Mode	Channel Frequency (MHz)	Pulse Time (ms)	Dwell Time (ms)	Limit (ms)
DH1	2402	0.387	123.840	400
DH3	2402	1.638	262.080	400
DH5	2402	2.889	308.160	400

The spectrum analyzer plots are attached as below:

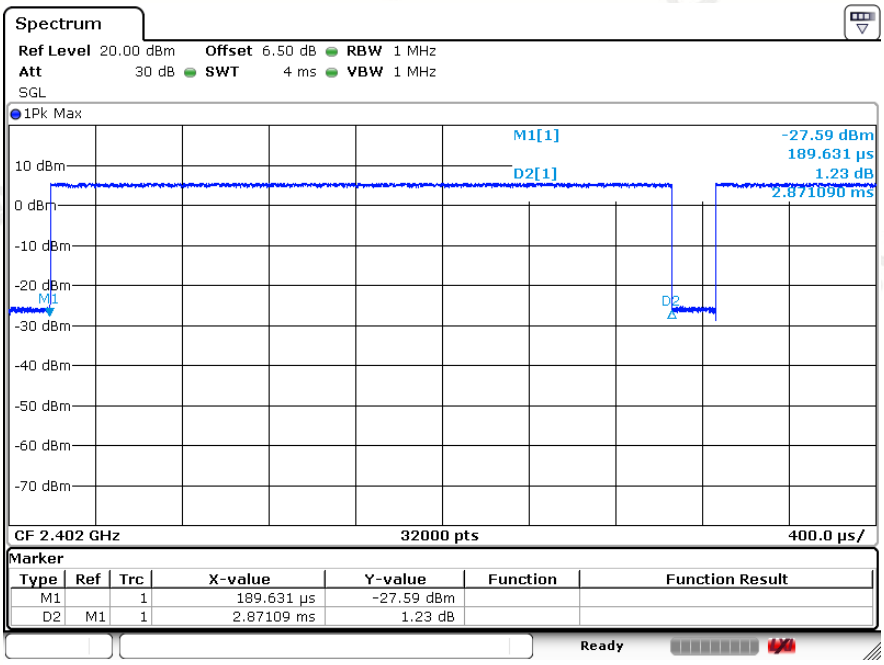
GFSK DH1



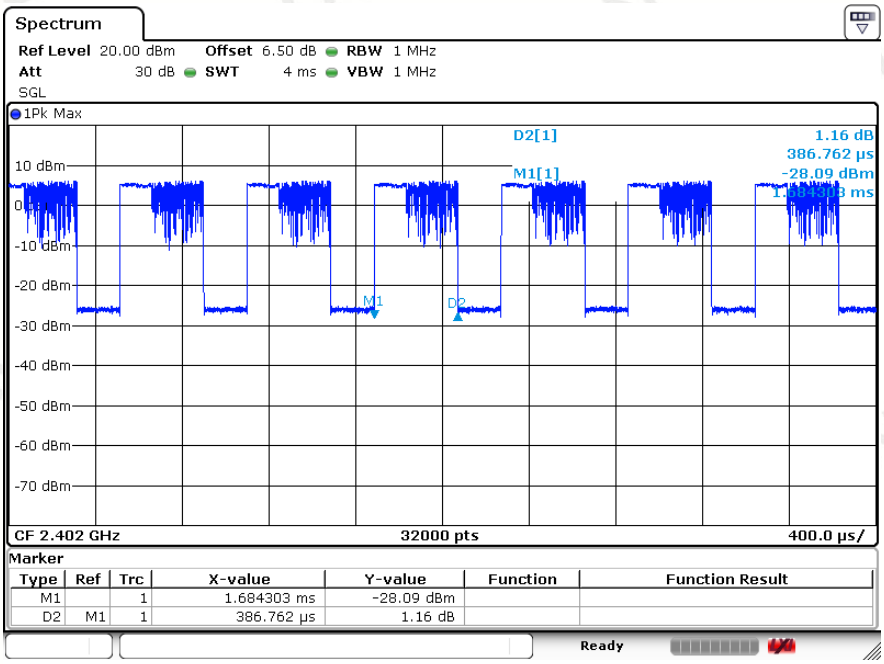
GFSK DH3



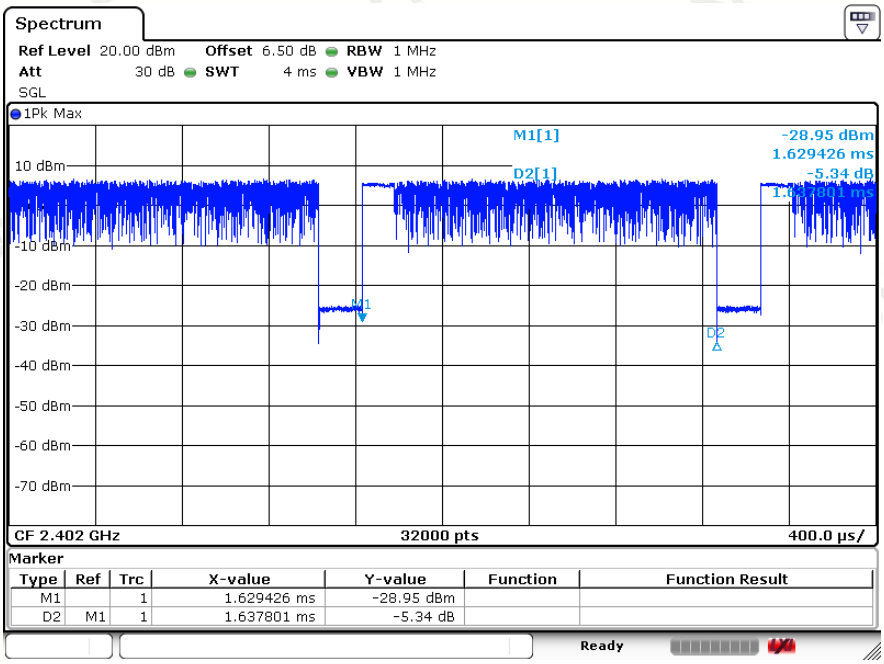
GFSK DH5



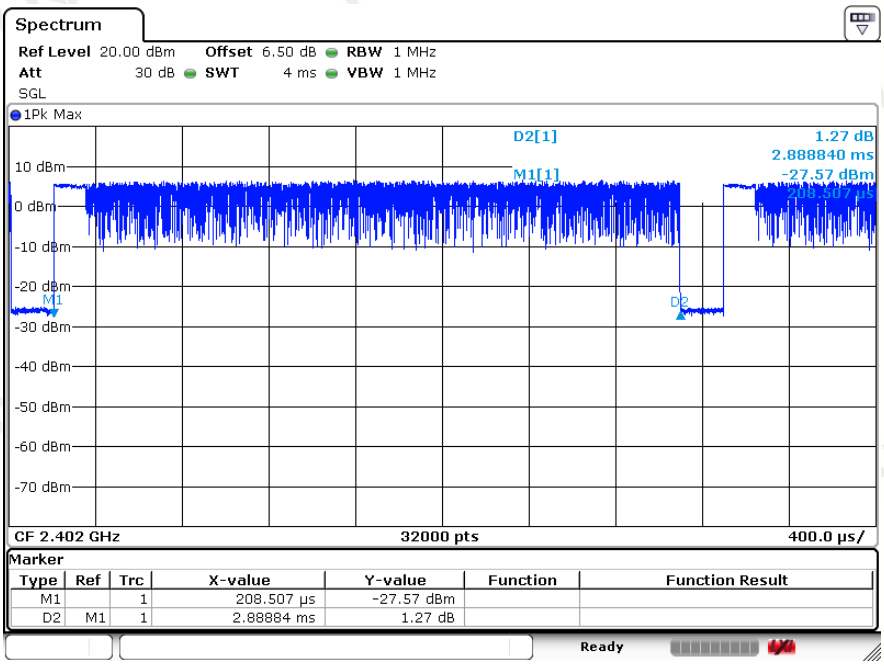
8DPSK DH1



8DPSK DH3



8DPSK DH5



11 OUT OF BAND EMISSIONS TEST

11.1 Test 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.

11.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Set EUT as TX operation and connect directly to the spectrum analyzer.
3. Based on FCC Part15 C Section 15.247: RBW=100KHz, VBW=300KHz.
4. Set detected by the spectrum analyzer with peak detector.

11.3 Test Setup

9.4 Test Result

PASS

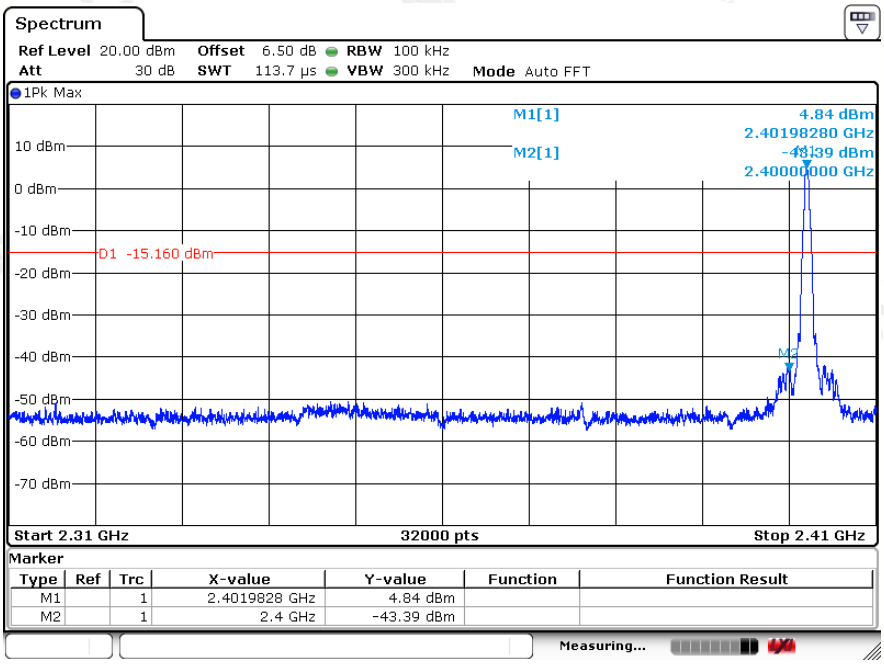
Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
GFSK Non-hopping			
2400	48.23	20	Pass
2483.5	55.60	20	Pass

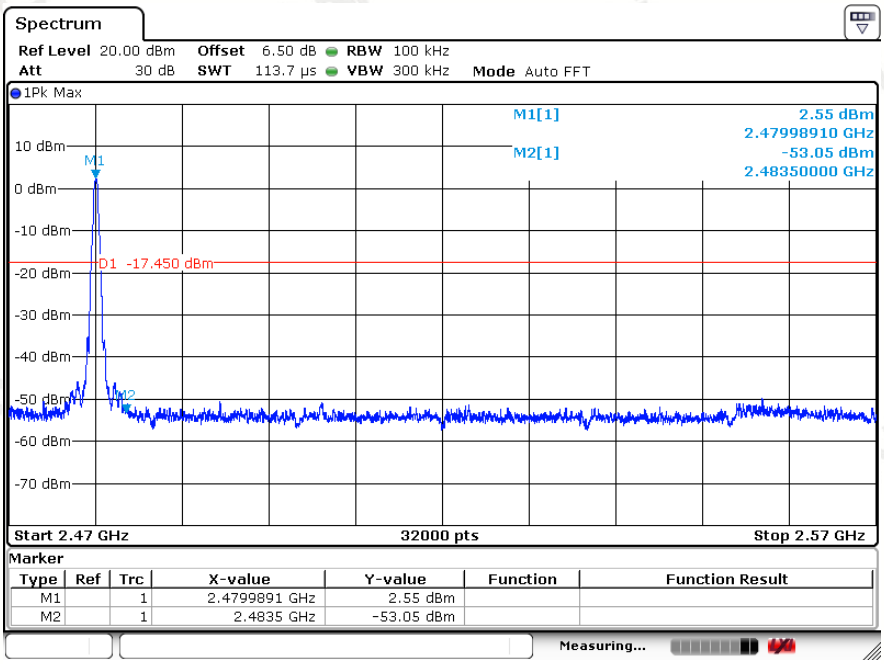
Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
GFSK hopping			
2400	54.13	20	Pass
2483.5	57.26	20	Pass

Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
8DPSK Non-hopping			
2400	48.43	20	Pass
2483.5	52.34	20	Pass

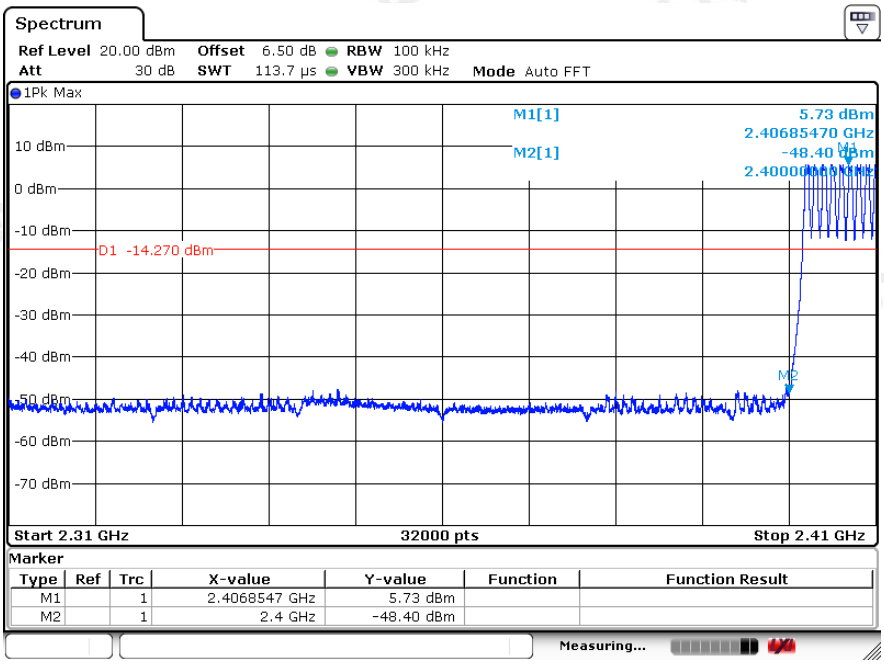
Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
8DPSK hopping			
2400	53.83	20	Pass
2483.5	57.62	20	Pass

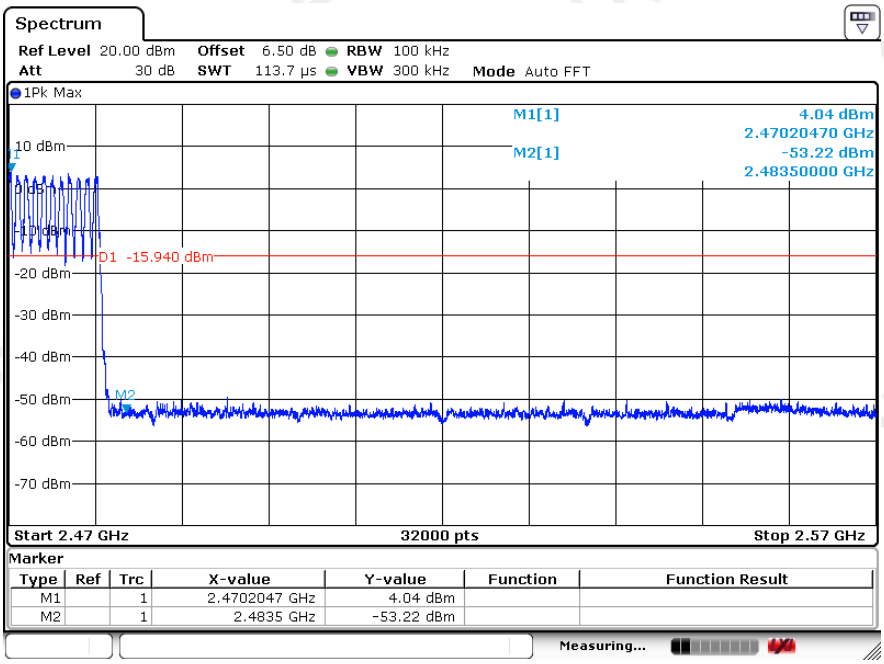
GFSK Non-hopping



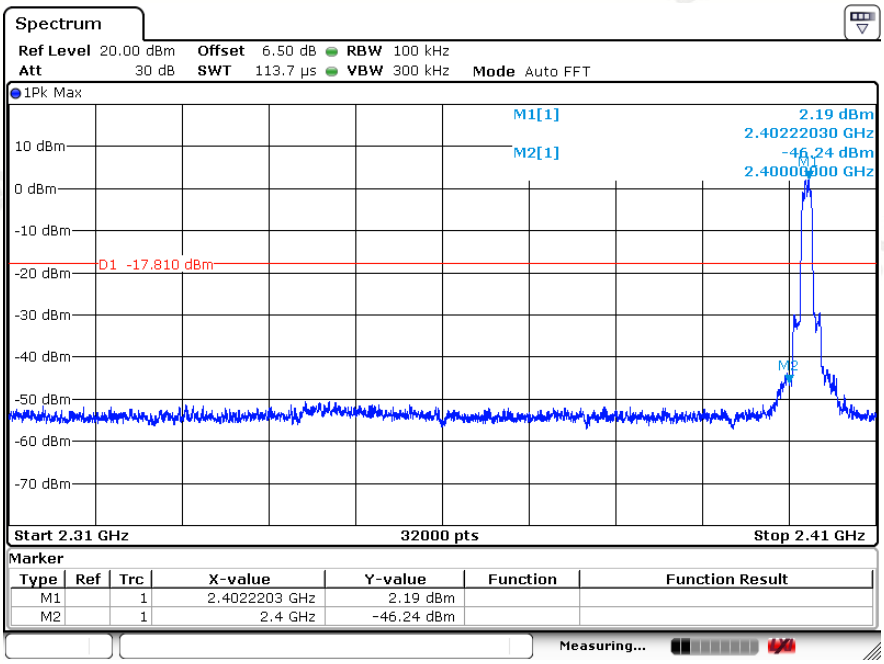


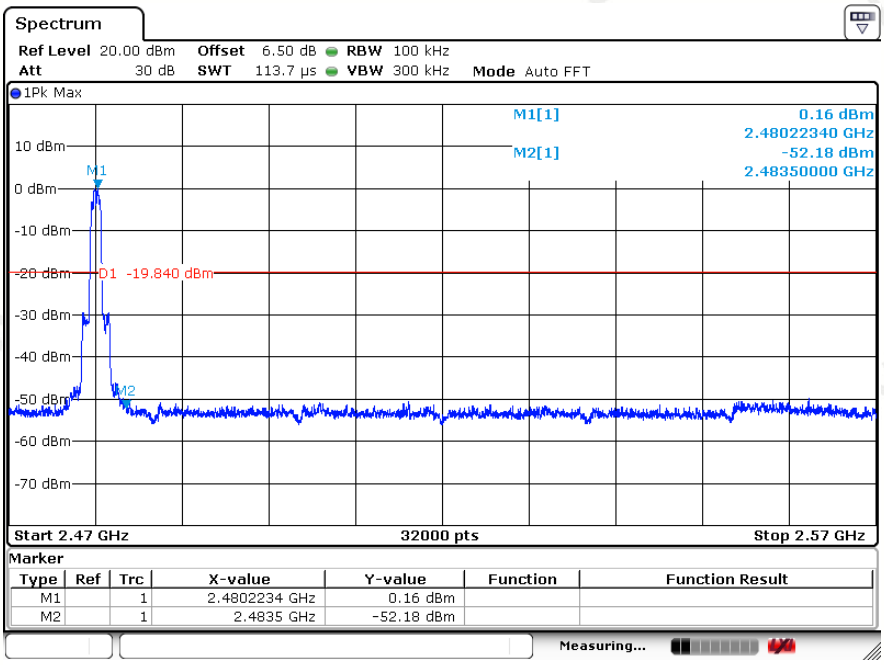
GFSK Hopping



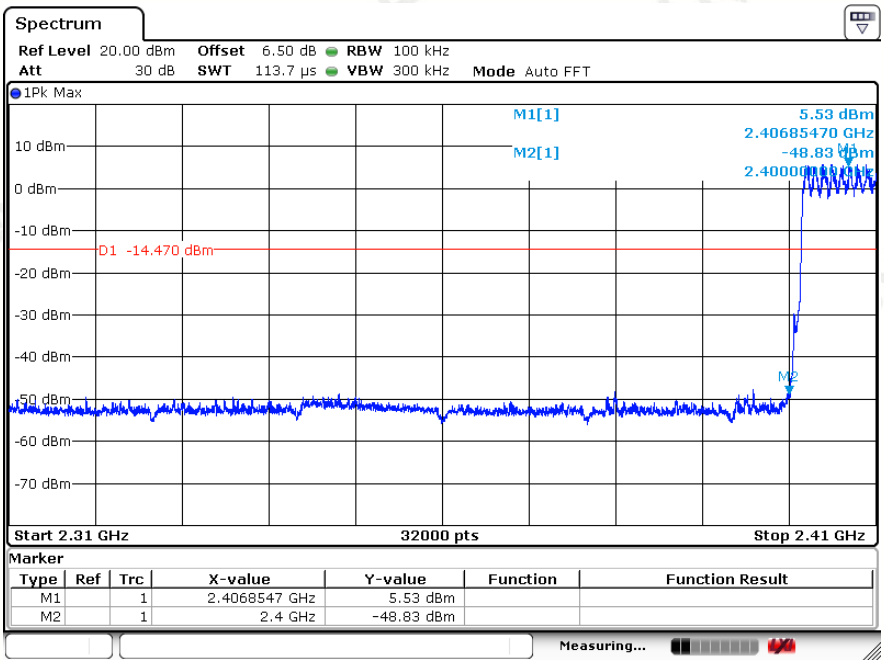


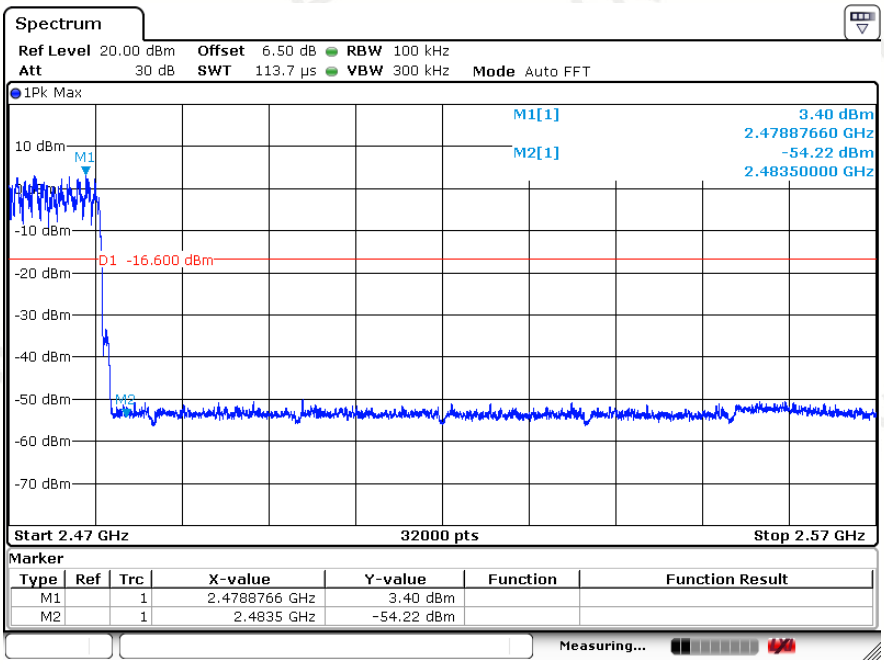
8DPSK Non-hopping



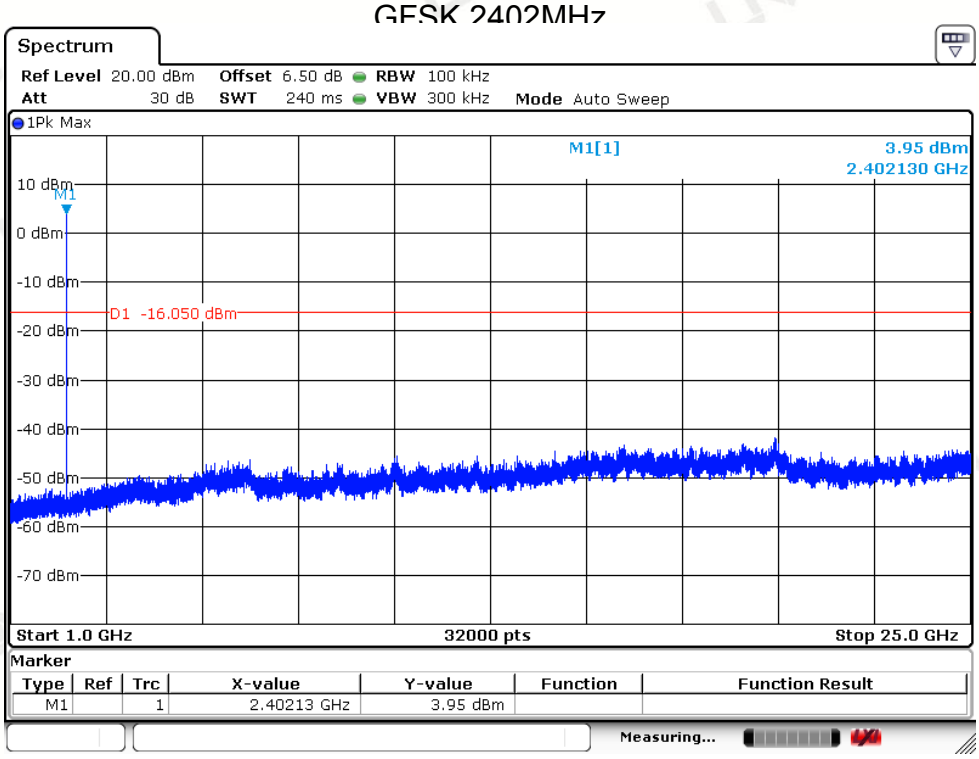


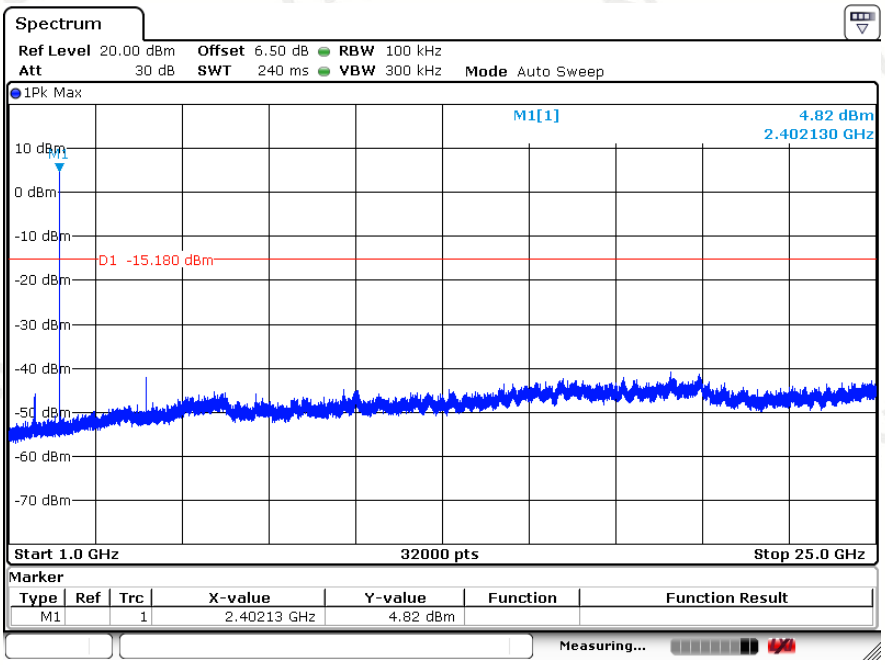
8DPSK Hopping



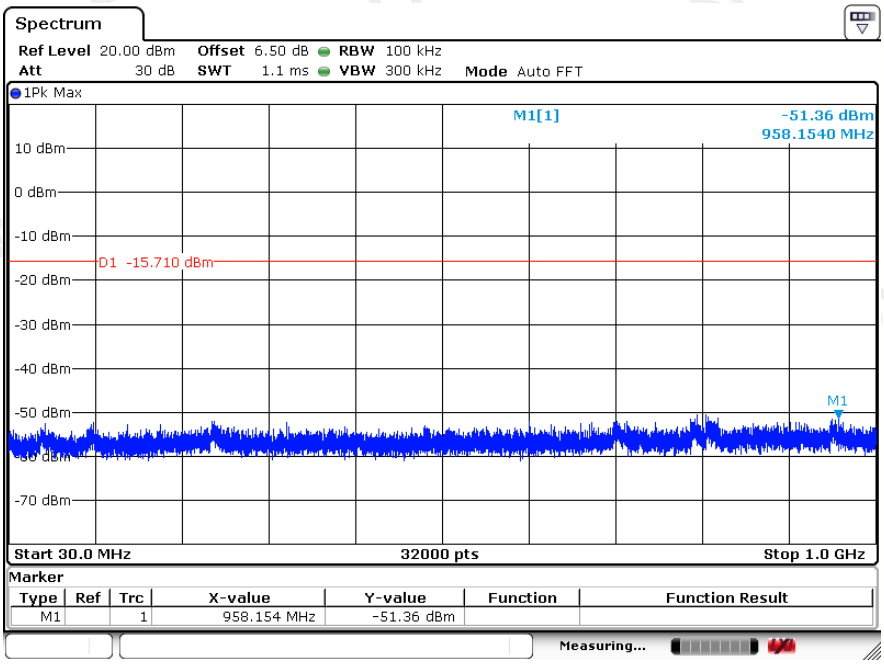


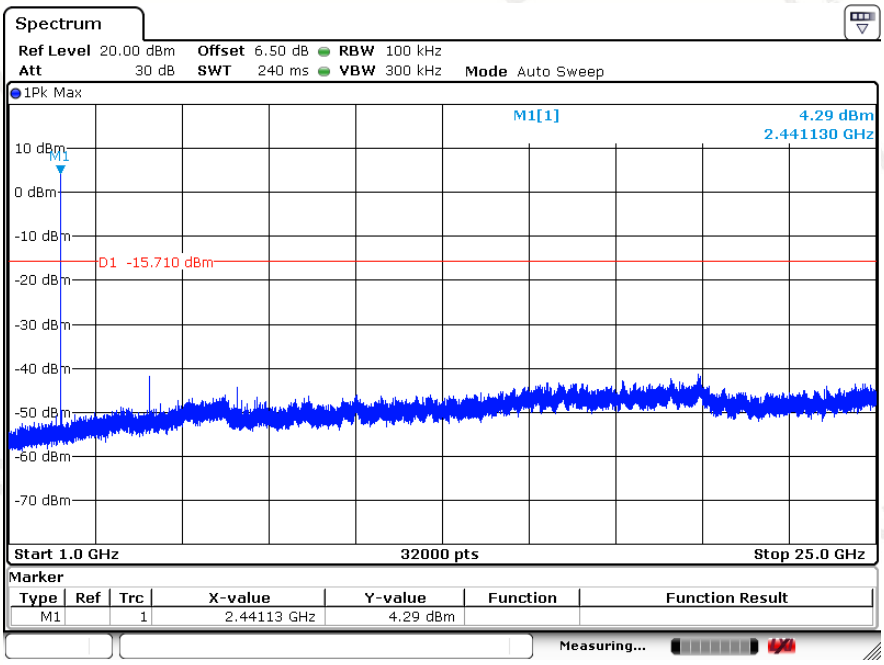
GFSK 2402MHz



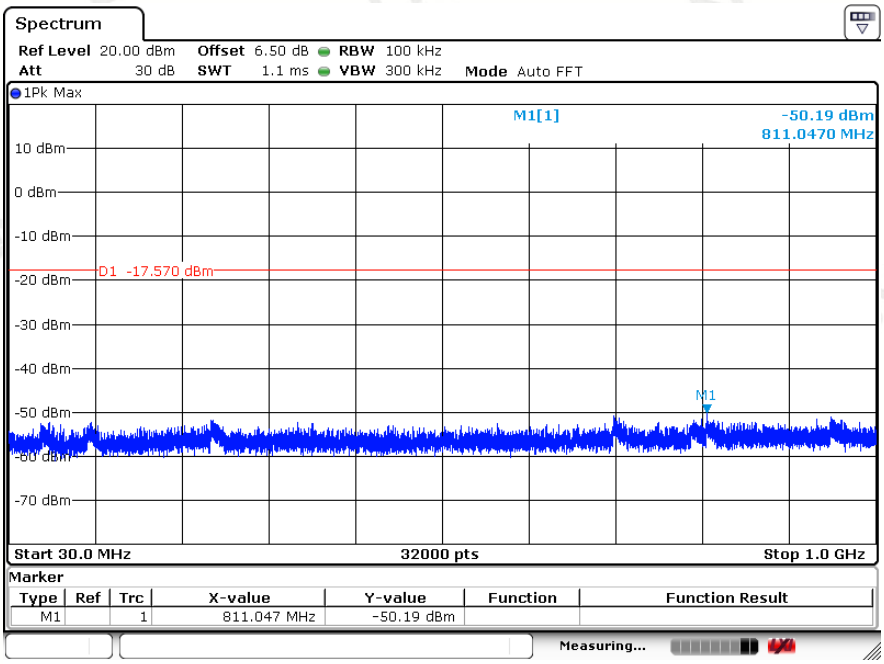


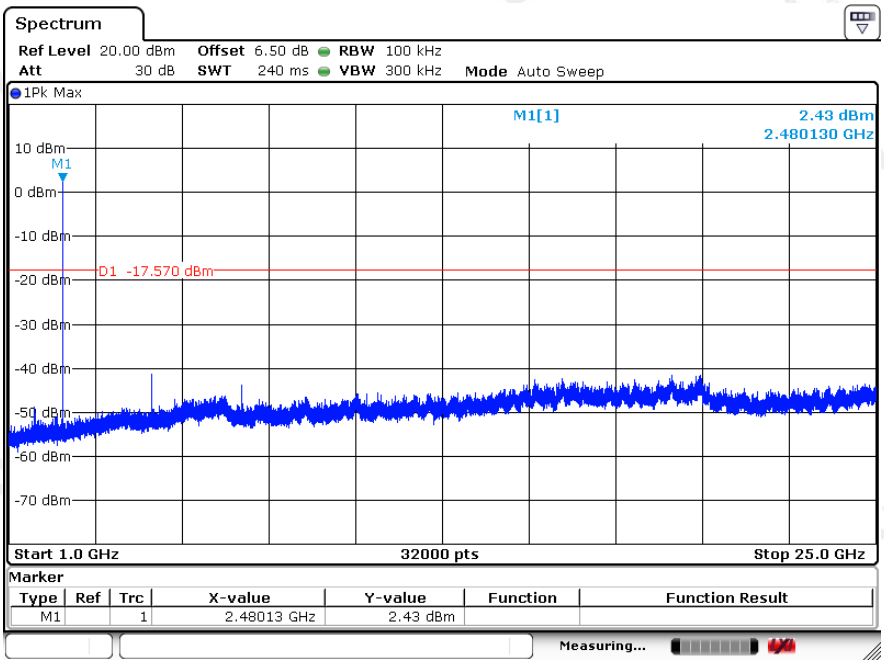
GFSK 2441MHz



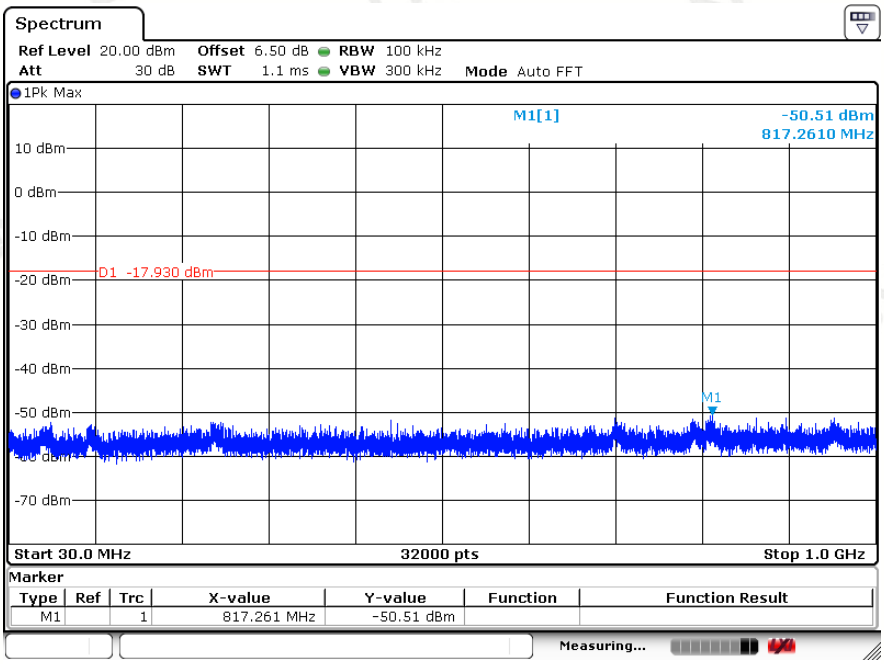


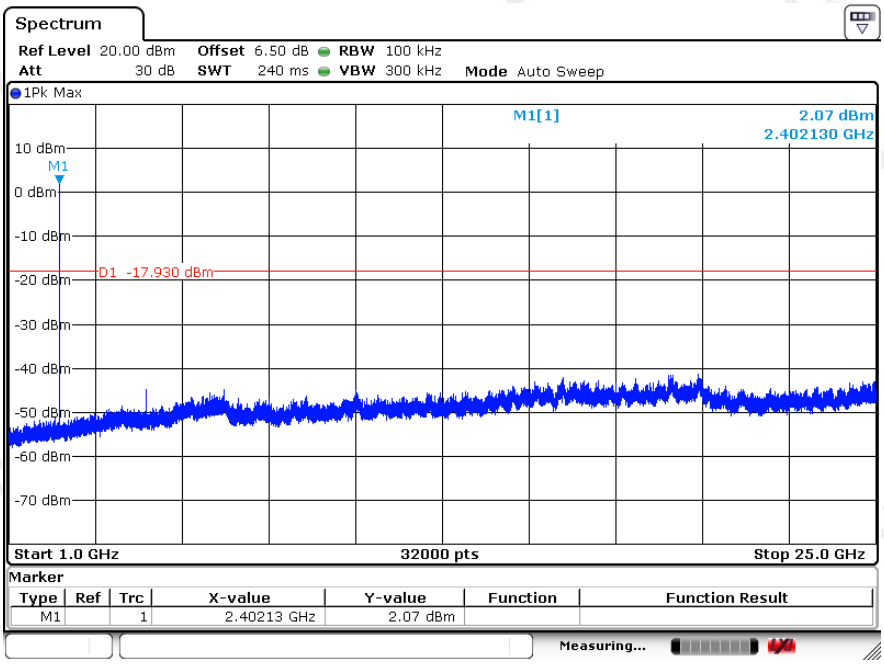
GFSK 2480MHz



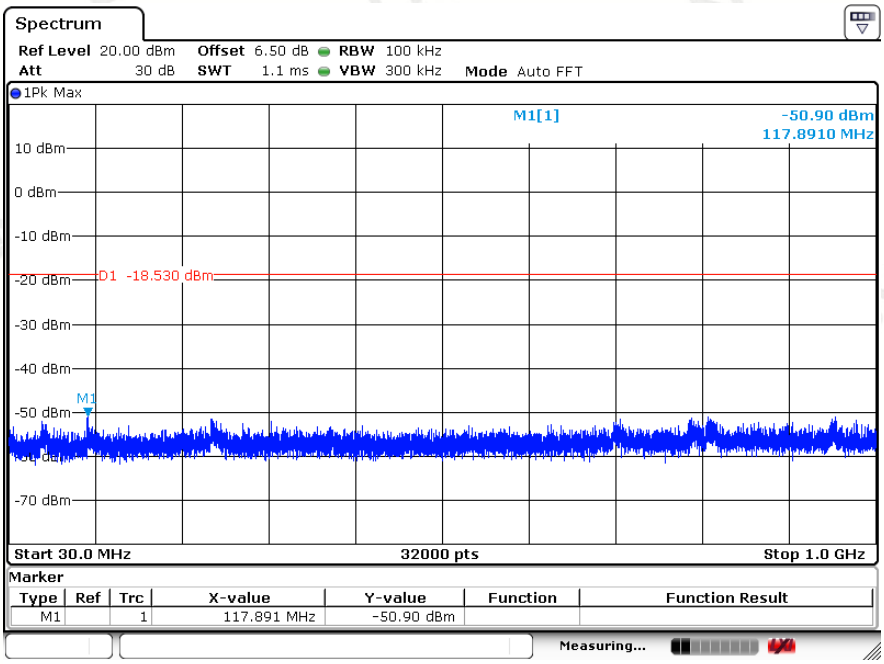


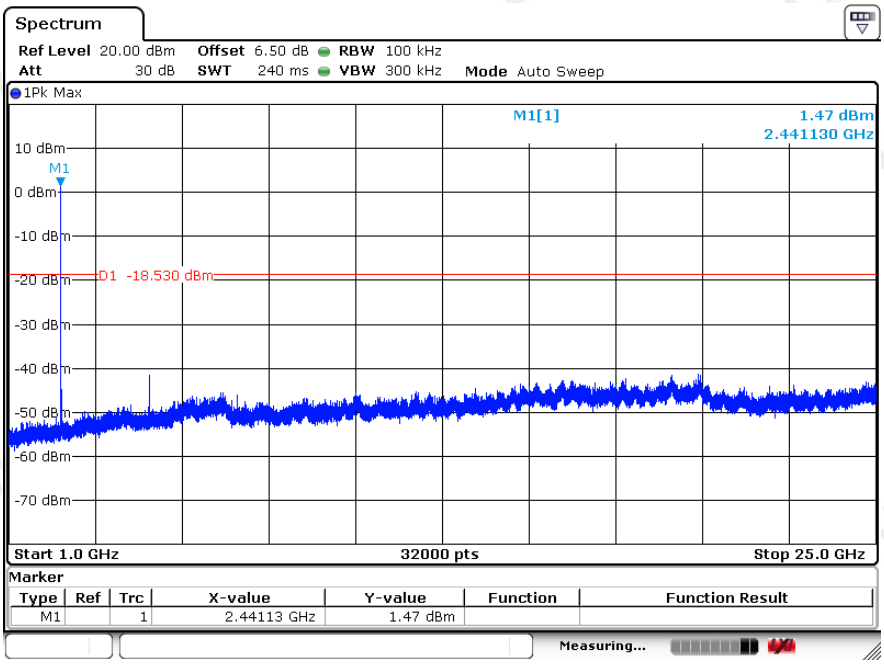
8DPSK 2402MHz



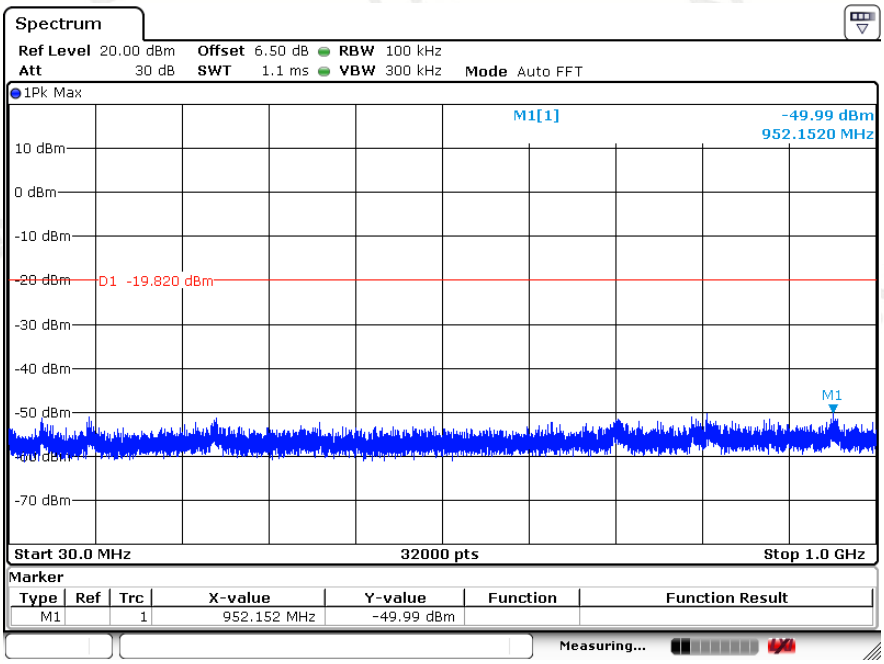


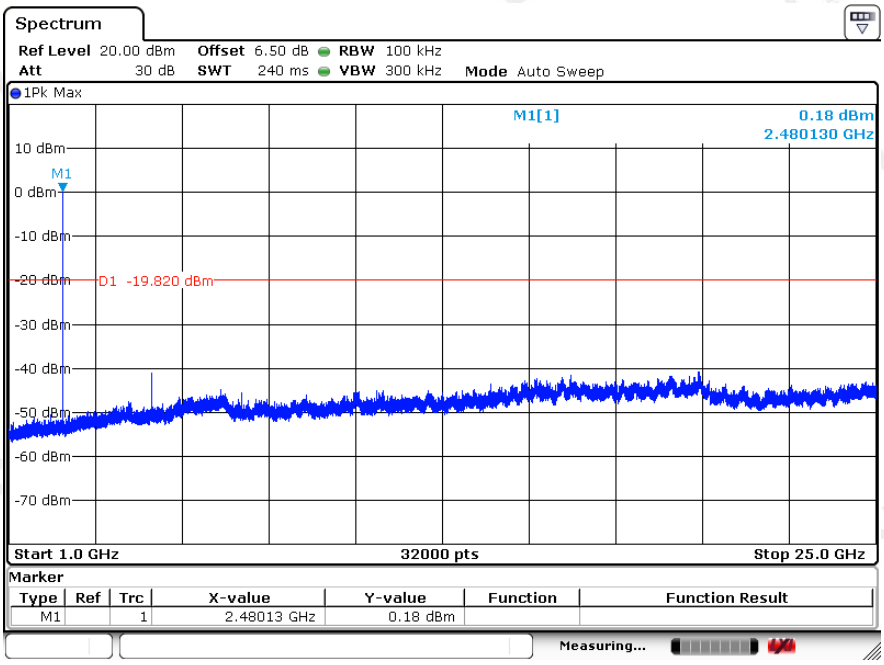
8DPSK 2441MHz





8DPSK 2480MHz



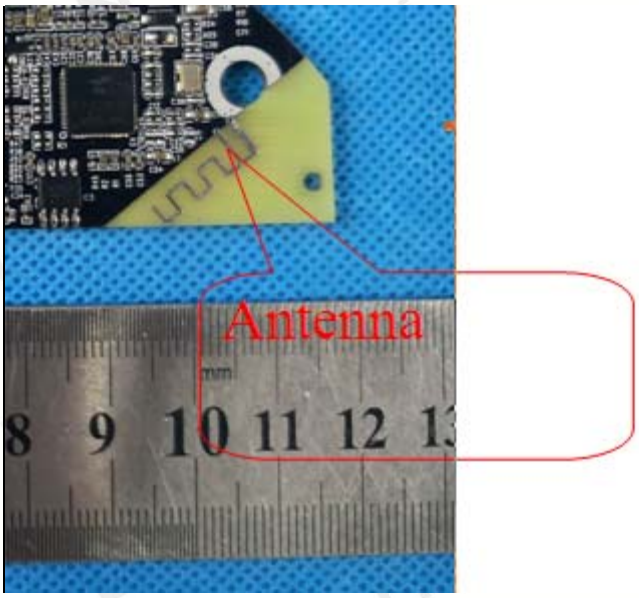


12 ANTENNA REQUIREMENT

Standard Applicable:
For intentional device, according to FCC 47 CFR 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.

Antenna Connected Construction
The antenna used in this product is a PCB Antenna, The directional gains of antenna used for transmitting is 0dBi.

ANTENNA:



End of Report