FCC TEST REPORT

FCC ID	: 2ABQES-2X
Applicant	: SHENZHEN SAGE HUMAN ELECTRONICS CO.,LTD.
Address	: 4 floor,A9 bldg, Silicon Vellay Power, Qinghu Industry Park Longhua, new district, Shenzhen, Guangdong,China
Manufacturer	: SHENZHEN SAGE HUMAN ELECTRONICS CO.,LTD.
Address	: 4 floor,A9 bldg, Silicon Vellay Power, Qinghu Industry Park Longhua, new district, Shenzhen, Guangdong,China

Equipment Under Test (EUT) :

Product Name	: Outdoor Bluetooth Speaker
Model No.	: S-22,S-28,S-21,S-27,S-29,S-30
Brand Name	: N/A

Standards	: FCC Part15.247:2010
Date of Test	: Mar.02~07,2015
Date of Issue	: Mar.07,2015
Test Result	**: PASS**

Remark:

* The sample described above has been tested to be in compliance with the requirements of ANSI C63.4:2003. The test results have been reviewed and comply with the rules listed above and found to meet their essential requirements.

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company.

The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

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2 Test Summary

Test Items	Test Requirement	Result
Spurious Radiated Emissions	15.205(a) 15.209 15.247(d)	PASS
Band edge Emissions	15.247(d)	PASS
Spurious RF Conducted Emissions from out of band	15.247(d)	PASS
Duty Cycle	15.35	PASS
Conducted Emissions	15.207	PASS
20dB Bandwidth	15.215c 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
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS

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4 General Information

4.1 General Description of E.U.T.

Product Name : Outdoor Bluetooth Speaker

Model No. : S-22,S-28,S-21,S-27,S-29,S-30

Brand Name : N/A

Model Description : The models are exactly the same everything except model name.

Operation Frequency : 2402MHz ~ 2480MHz,79 channels in total, separated by 1MHz

Type of Modulation : GFSK, Pi/4DQPSK, 8DPSK

Oscillator : Crystal 26MHz

Antenna installation : PCB Printed Antenna

Antenna Gain : 0dBi

4.2 Details of E.U.T.

Technical Data..... : DC Input 5.0V; Battery 1000mAh.

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2402	2	2403	3	2404	4	2405
5	2406	6	2407	7	2408	8	2409
9	2410	10	2411	11	2412	12	2413
13	2414	14	2415	15	2416	16	2417
17	2418	18	2419	19	2420	20	2421
21	2422	22	2423	23	2424	24	2425
25	2426	26	2427	27	2428	28	2429
29	2430	30	2431	31	2432	32	2433
33	2434	34	2435	35	2436	36	2437
37	2438	38	2439	39	2440	40	2441
41	2442	42	2443	43	2444	44	2445
45	2446	46	2447	47	2448	48	2449
49	2450	50	2451	51	2452	52	2453
53	2454	54	2455	55	2456	56	2457
57	2458	58	2459	59	2460	60	2461
61	2462	62	2463	63	2464	64	2465
65	2466	66	2467	67	2468	68	2469
69	2470	70	2471	71	2472	72	2473
73	2474	74	2475	75	2476	76	2477
77	2478	78	2479	79	2480	-	-

4.4 Test Facility

All the tests were performed at:

All tests were performed by Shenzhen Academy of Metrology and Quality Inspection EMC Laboratory (SMQ) at No.4 TongFa Road, Xili Town Nanshan District, Shenzhen, China. At the time of testing, the following bodies accredited the Laboratory.

FCC – Registration No.: 994606

Shenzhen Academy of Metrology and Quality Inspection EMC Laboratory EMC Laboratory (SMQ) 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 SMQ files. Registration **994606**.

5 Equipment Used during Test

5.1 Equipments List

Conducted Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	R&S	ESCI	101178	Aug. 13,2014	Aug. 12,2015
2.	LISN	R&S	ENV216	101215	Aug. 13,2014	Aug. 12,2015
3.	Cable	HUBER+SUHNER	CBL2-NN-3M	2230300	Aug. 13,2014	Aug. 12,2015
3m Semi-anechoic Chamber for Radiation Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMC Analyzer	Agilent	E7405A	MY45114943	Aug. 13,2014	Aug. 12,2015
2.	Active Loop Antenna	Beijing Dazhi	ZN30900A	-	Aug. 13,2014	Aug. 12,2015
3.	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	Aug. 13,2014	Aug. 12,2015
4.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	Aug. 13,2014	Aug. 12,2015
5.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	399	Aug. 13,2014	Aug. 12,2015
6.	Broadband Preamplifier	SCHWARZBECK	BBV 9719	9719-254	Aug. 13,2014	Aug. 12,2015
7.	Broadband Preamplifier	SCHWARZBECK	BBV 9718	9718-148	Aug. 13,2014	Aug. 12,2015
8.	10m Coaxial Cable with N- plug	SCHWARZBECK	AK 9515 H	-	Aug. 13,2014	Aug. 12,2015
9.	10m 50 Ohm Coaxial Cable with N-plug	SCHWARZBECK	AK 9513	-	Aug. 13,2014	Aug. 12,2015
10.	Positioning Controller	C&C LAB	CC-C-IF	-	Aug. 13,2014	Aug. 12,2015
11.	Color Monitor	SUNSPO	SP-14C	-	Aug. 13,2014	Aug. 12,2015

5.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 1 x 10^{-6}
Bandwidth	± 1.5 x 10^{-6}
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Temperature	± 1 °C
DC Source	±0.05%
Radiated Emissions test	± 5.03 dB (Bilog antenna 30M~1000MHz)
	± 4.74 dB (Horn antenna 1000M~25000MHz)
Conducted Spurious Emissions test	± 0.5 dB (9KHz~1000MHz)
	± 1 dB(1000M~26500MHz)
Conducted Emissions test	± 3.64 dB (AC mains 150KHz~30MHz)

6 Conducted Emission

Test Requirement:	FCC CFR 47 Part 15 Section 15.207
Test Method:	ANSI C63.4:2003
Test Result:	PASS
Frequency Range:	150kHz to 30MHz
Class:	Class B
Limit:	66-56 dBμV between 0.15MHz & 0.5MHz 56 dBμV between 0.5MHz & 5MHz 60 dBμV between 5MHz & 30MHz
Detector:	Peak for pre-scan (9kHz Resolution Bandwidth) Quasi-Peak & Average if maximised peak within 6dB of Average Limit

6.1 E.U.T. Operation

Operating Environment:

Temperature: 25.5 °C

Humidity: 51 % RH

Atmospheric Pressure: 1012 mbar

EUT Operation:

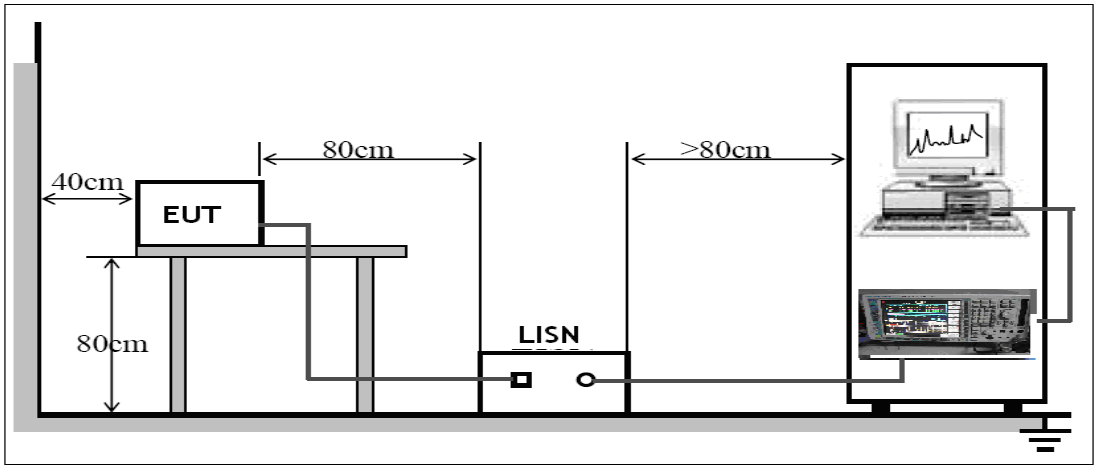
The EUT was tested in Power On+Bluetooth linking mode. The test data were shown as follow.

The EUT was tested according to ANSI C63.4:2003. The frequency spectrum from 150kHz to 30MHz was investigated.

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.

6.2 EUT Setup

The EUT was placed on the test table in shielding room.

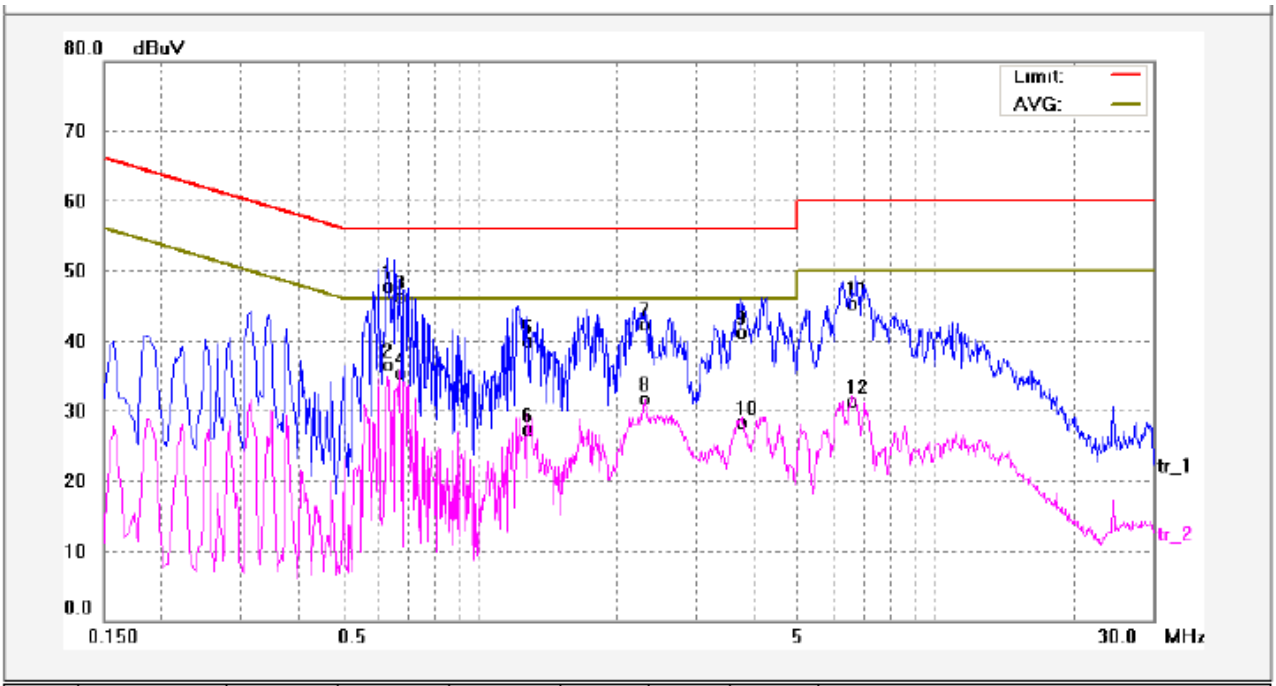


6.3 Conducted Emission Test Result

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

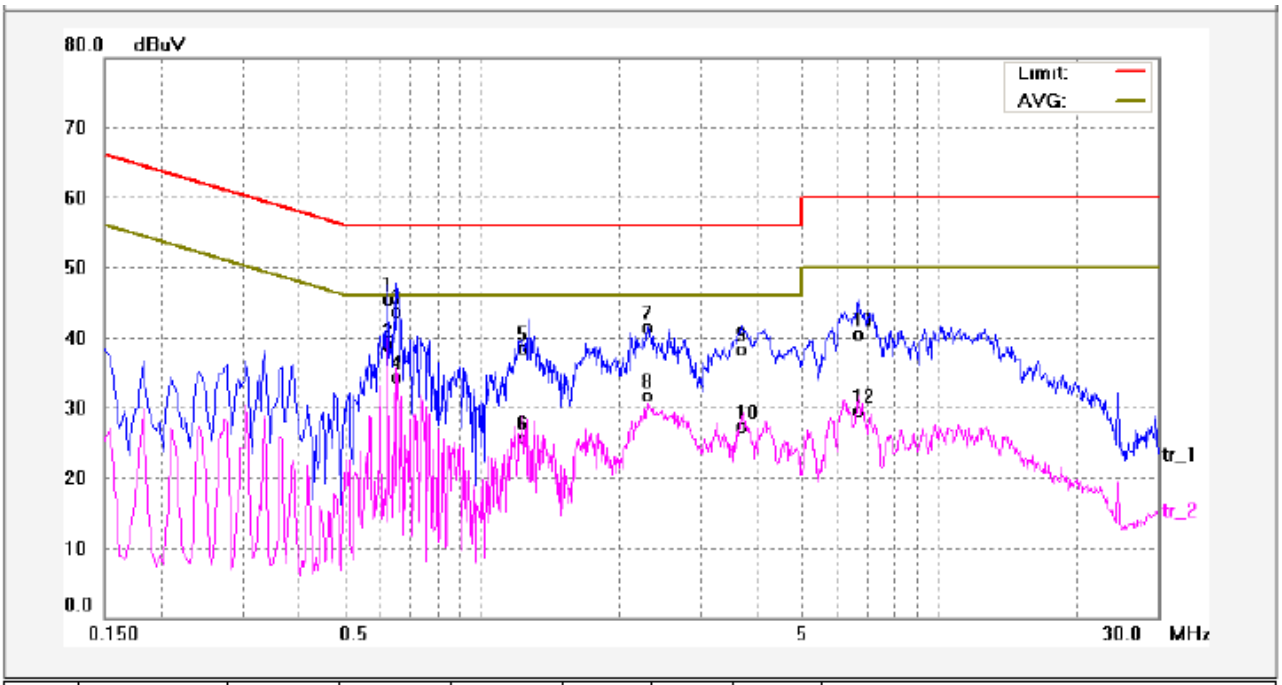
Test Mode: Power On+Bluetooth linking

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.6300	37.00	9.94	46.94	56.00	-9.06	QP	
2	0.6300	25.70	9.94	35.64	46.00	-10.36	AVG	
3	0.6700	35.53	9.95	45.48	56.00	-10.52	QP	
4	0.6700	24.57	9.95	34.52	46.00	-11.48	AVG	
5	1.2700	29.10	10.00	39.10	56.00	-16.90	QP	
6	1.2700	16.48	10.00	26.48	46.00	-19.52	AVG	
7	2.3060	31.44	10.01	41.45	56.00	-14.55	QP	
8	2.3060	20.95	10.01	30.96	46.00	-15.04	AVG	
9	3.7620	30.28	10.06	40.34	56.00	-15.66	QP	
10	3.7620	17.36	10.06	27.42	46.00	-18.58	AVG	
11	6.5860	34.25	10.26	44.51	60.00	-15.49	QP	
12	6.5860	20.21	10.26	30.47	50.00	-19.53	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.6260	34.70	9.94	44.64	56.00	-11.36	QP	
2	0.6260	28.22	9.94	38.16	46.00	-7.84	AVG	
3	0.6540	32.91	9.95	42.86	56.00	-13.14	QP	
4	0.6540	23.52	9.95	33.47	46.00	-12.53	AVG	
5	1.2300	27.64	10.00	37.64	56.00	-18.36	QP	
6	1.2300	14.95	10.00	24.95	46.00	-21.05	AVG	
7	2.3060	30.78	10.01	40.79	56.00	-15.21	QP	
8	2.3060	20.92	10.01	30.93	46.00	-15.07	AVG	
9	3.7380	27.46	10.06	37.52	56.00	-18.48	QP	
10	3.7380	16.36	10.06	26.42	46.00	-19.58	AVG	
11	6.6620	29.49	10.27	39.76	60.00	-20.24	QP	
12	6.6620	18.53	10.27	28.80	50.00	-21.20	AVG	

7 Spurious Radiated Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method: DA 00-705

Test Result: PASS

Frequency Range: 26MHz to 25GHz

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:

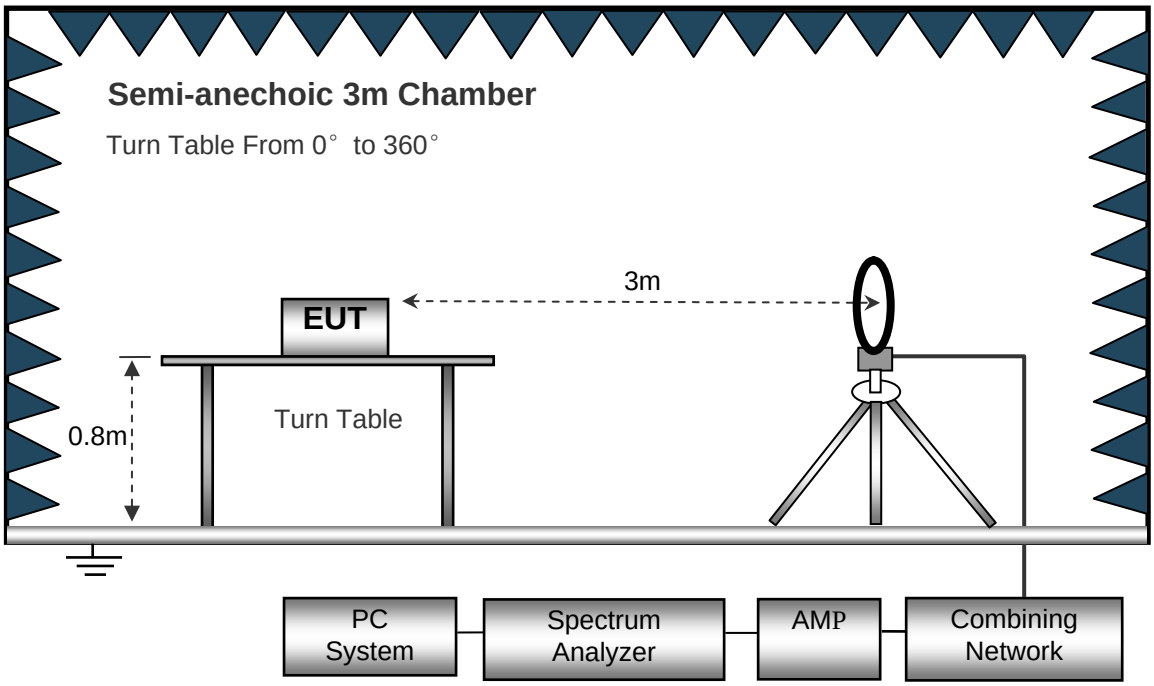
Temperature: 25.5 °C

Humidity: 51 % RH

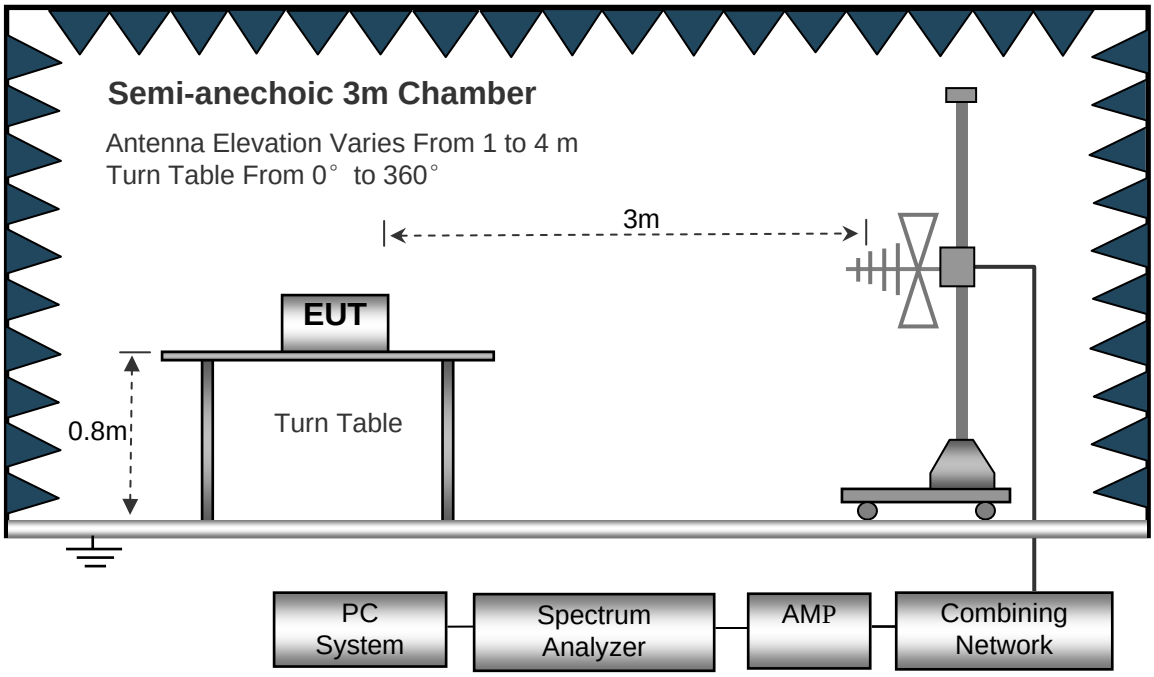
Atmospheric Pressure:1012 mbar

7.2 Test Setup

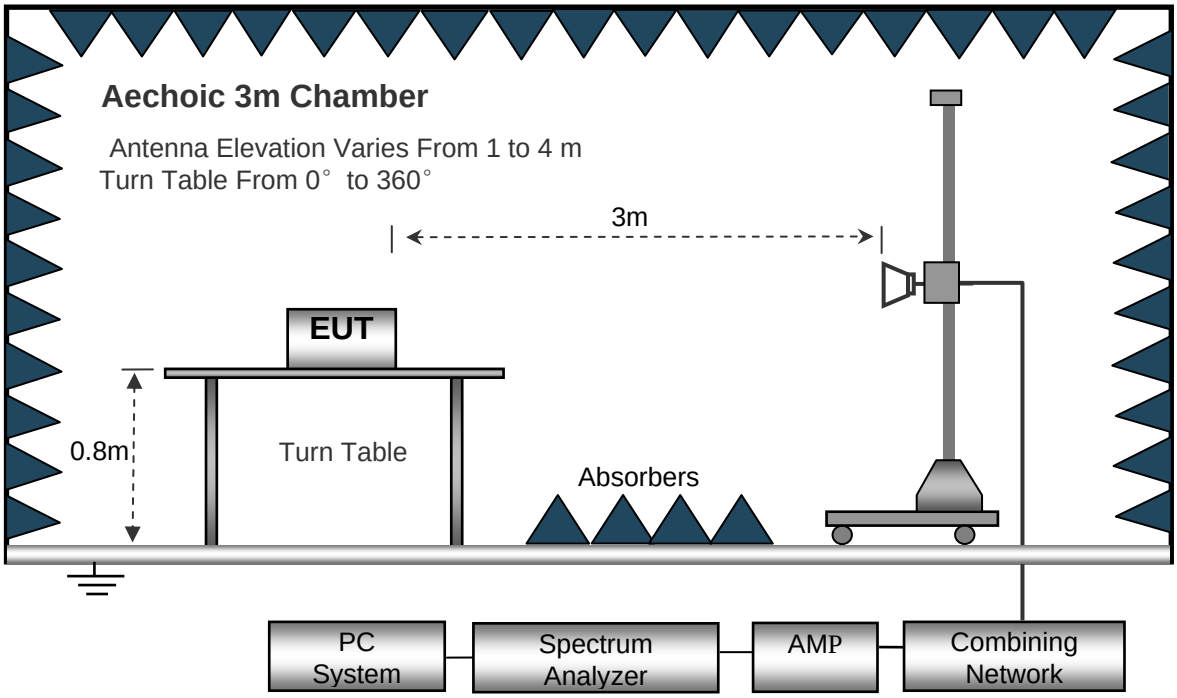
The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.4: 2003.
The test setup for emission measurement below 30MHz.



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

According to FCC Part15 Rules, the system was tested 26MHz to 25000MHz.

Below 30MHz

Sweep Speed.....Auto
IF Bandwidth 10KHz
Video Bandwidth 10KHz

Resolution Bandwidth 10KHz

30MHz ~ 1GHz

Sweep Speed.....Auto
IF Bandwidth .....120 KHz
Video Bandwidth 100KHz
Quasi-Peak Adapter Bandwidth .....120 KHz
Quasi-Peak Adapter Mode.....Normal
Resolution Bandwidth 100KHz

Above 1GHz

Sweep Speed.....Auto
IF Bandwidth .....120 KHz
Video Bandwidth 3MHz
Quasi-Peak Adapter Bandwidth .....120 KHz
Quasi-Peak Adapter Mode.....Normal
Resolution Bandwidth 1MHz

7.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m 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.
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 X position. So the data shown was the X 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

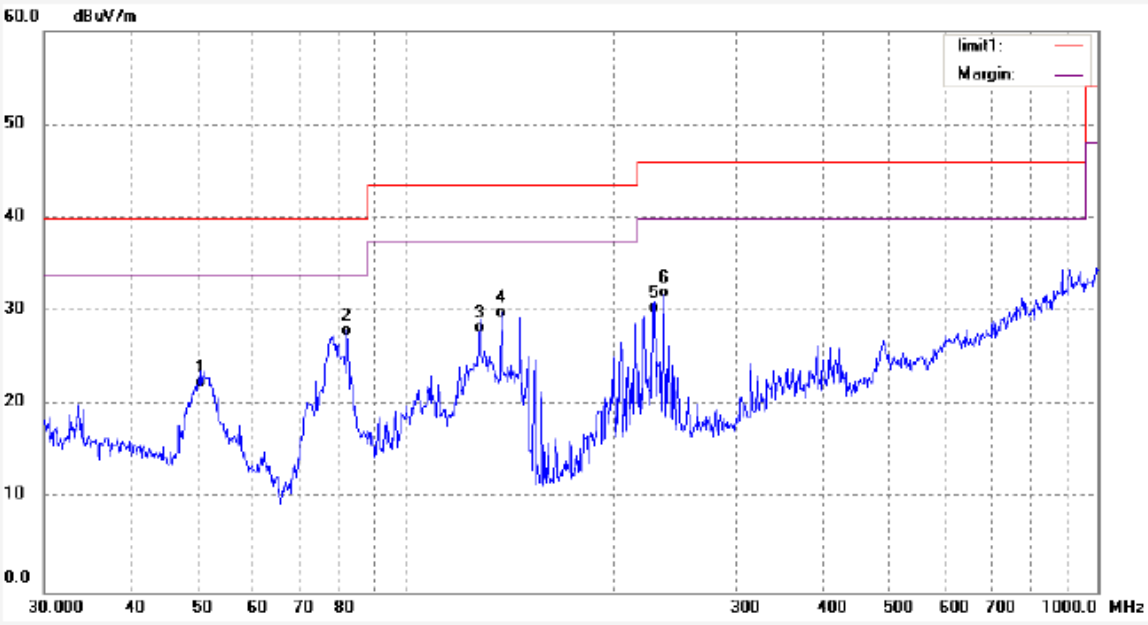
Test Frequency :Below 30MHz

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

Test Frequency : 30MHz ~ 1000MHz

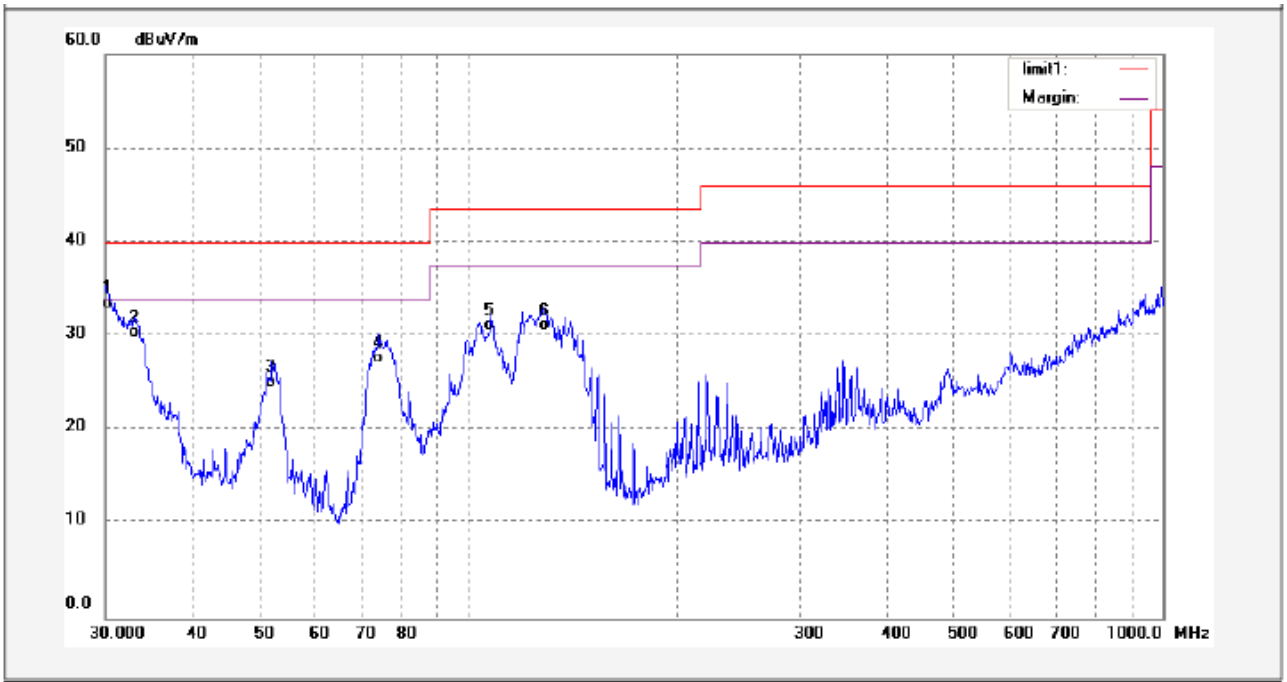
Remark: the EUT was pretested at the high, middle and low channel, and the worse case was the middle Channel, so the data show was the middle channel only.

Antenna polarization: Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	50.4614	7.29	14.56	21.85	40.00	-18.15	QP	
2	82.2363	17.80	9.53	27.33	40.00	-12.67	QP	
3	128.0356	15.88	11.81	27.69	43.50	-15.81	QP	
4	137.3565	17.45	11.90	29.35	43.50	-14.15	QP	
5	228.6173	13.57	16.25	29.82	46.00	-16.18	QP	
6	235.9622	15.74	15.70	31.44	46.00	-14.56	QP	

Antenna polarization: Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	30.0000	16.75	16.15	32.90	40.00	-7.10	QP	
2	32.9854	13.26	16.57	29.83	40.00	-10.17	QP	
3	52.0826	10.05	14.48	24.53	40.00	-15.47	QP	
4	74.2696	17.82	9.29	27.11	40.00	-12.89	QP	
5	107.4074	16.50	14.01	30.51	43.50	-12.99	QP	
6	128.4861	18.61	11.85	30.46	43.50	-13.04	QP	

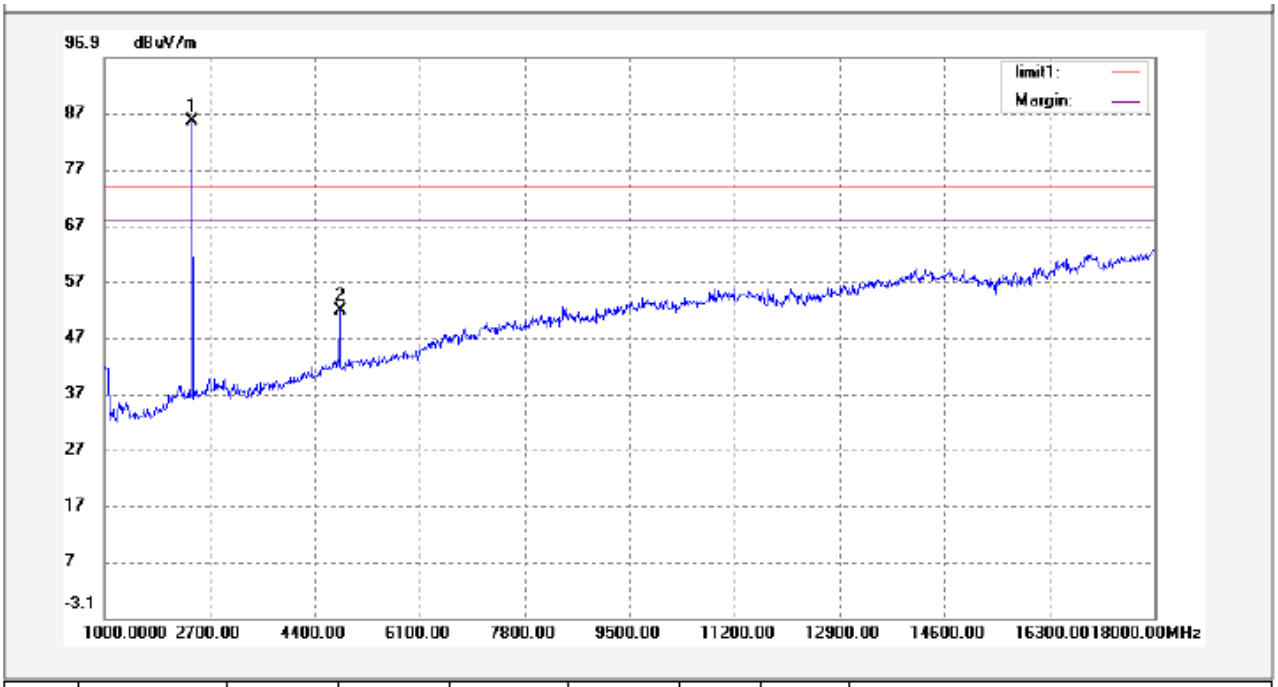
Test Frequency: 1GHz ~ 18GHz

All the modulation modes were tested, the data of the worst mode (GFSK) were recorded in the following pages.

AV = Peak +20Log$_{10}$(duty cycle) =PK+(-8)=PK-8 [refer to section 9 for more detail]

Test mode: transmitting at lower channel

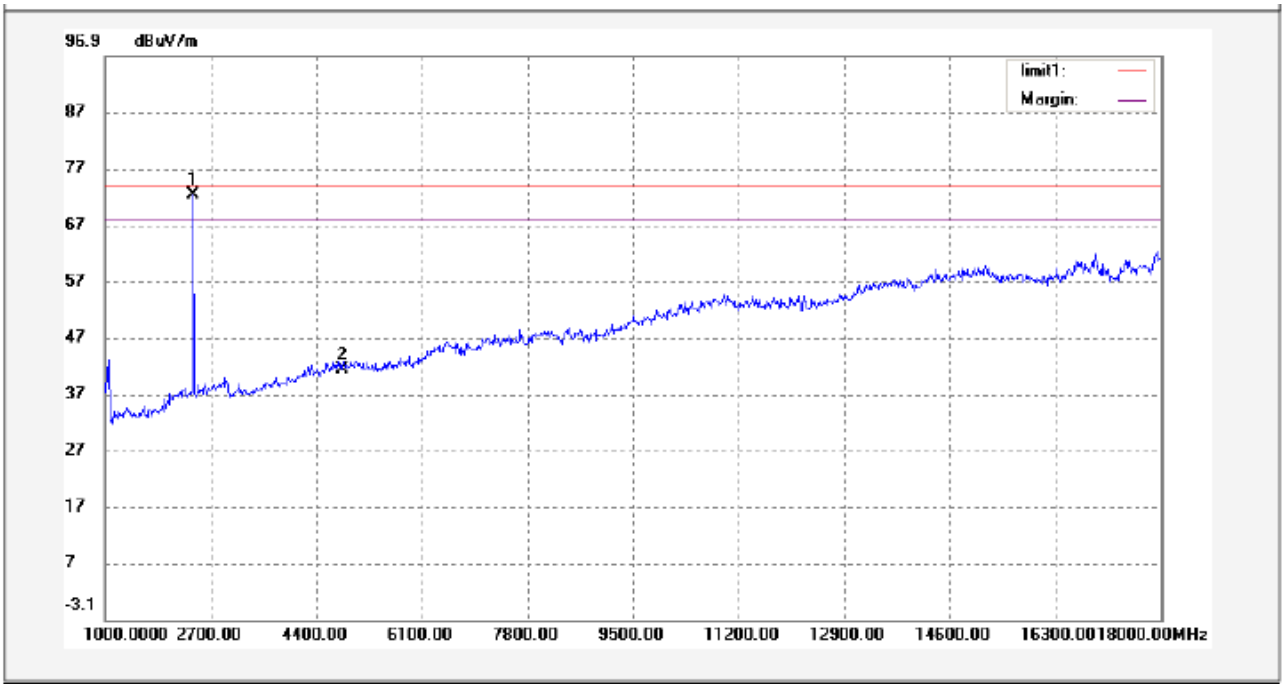
Antenna polarization: Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2402.000	94.75	-9.28	85.47	74.00	11.47	peak	
2	4804.000	55.03	-3.17	51.86	74.00	-22.14	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4804.000	-8	43.86	54.00	-10.14	AV	

Antenna polarization: Horizontal

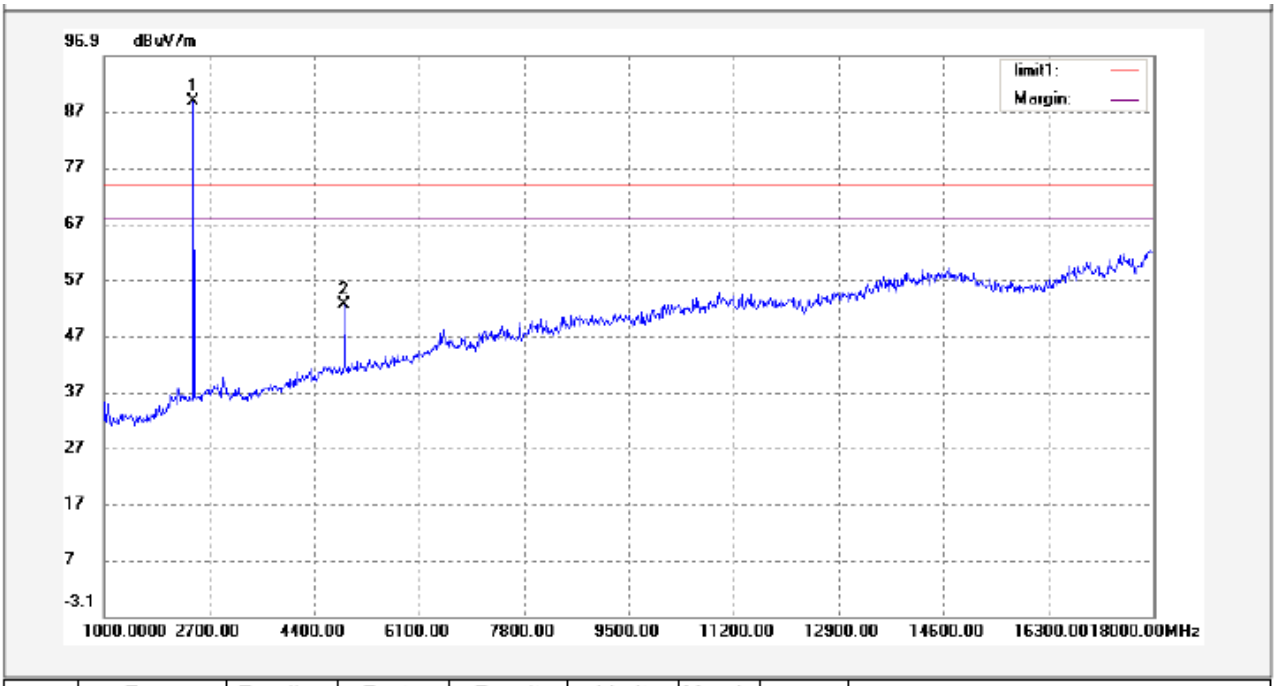


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2402.000	81.55	-9.28	72.27	74.00	-1.73	peak	
2	4804.000	44.55	-3.17	41.38	74.00	-32.62	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4804.000	-8	33.38	54.00	-20.62	AV	

Test mode: transmitting at middle channel

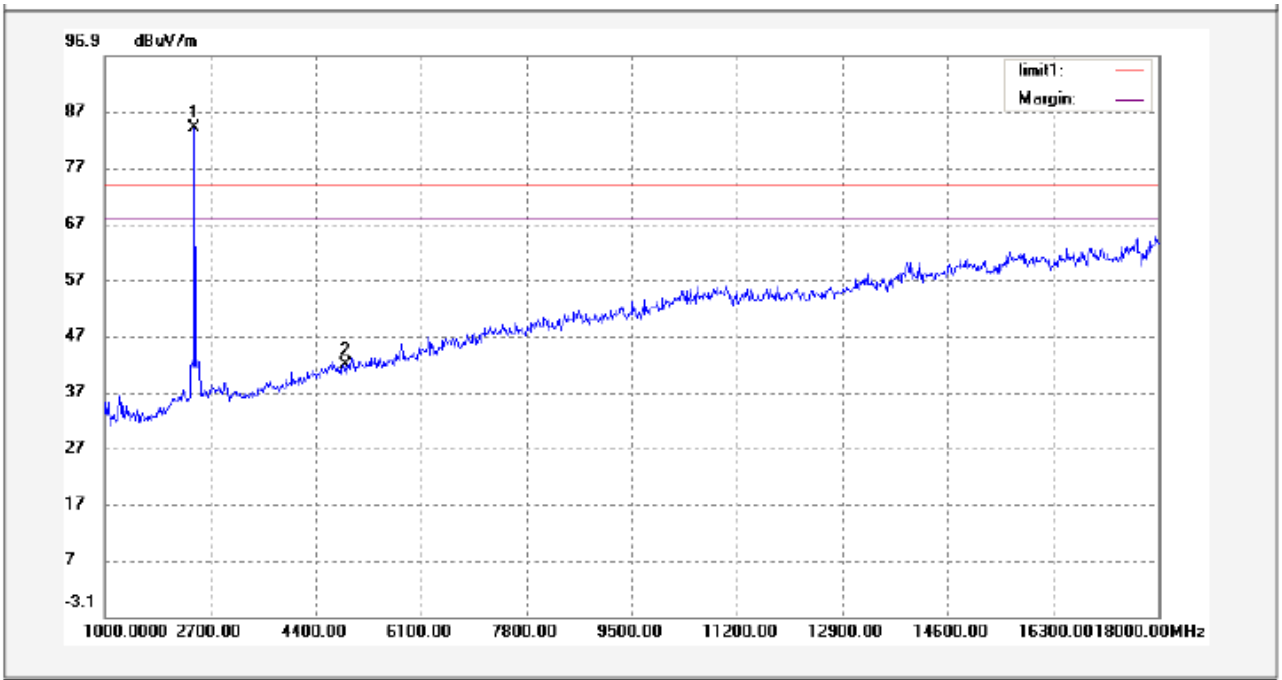
Antenna polarization: Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2441.000	98.09	-9.32	88.77	74.00	14.77	peak	
2	4882.000	55.58	-3.04	52.54	74.00	-21.46	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4882.000	-8	44.54	54.00	-9.46	AV	

Antenna polarization: Horizontal

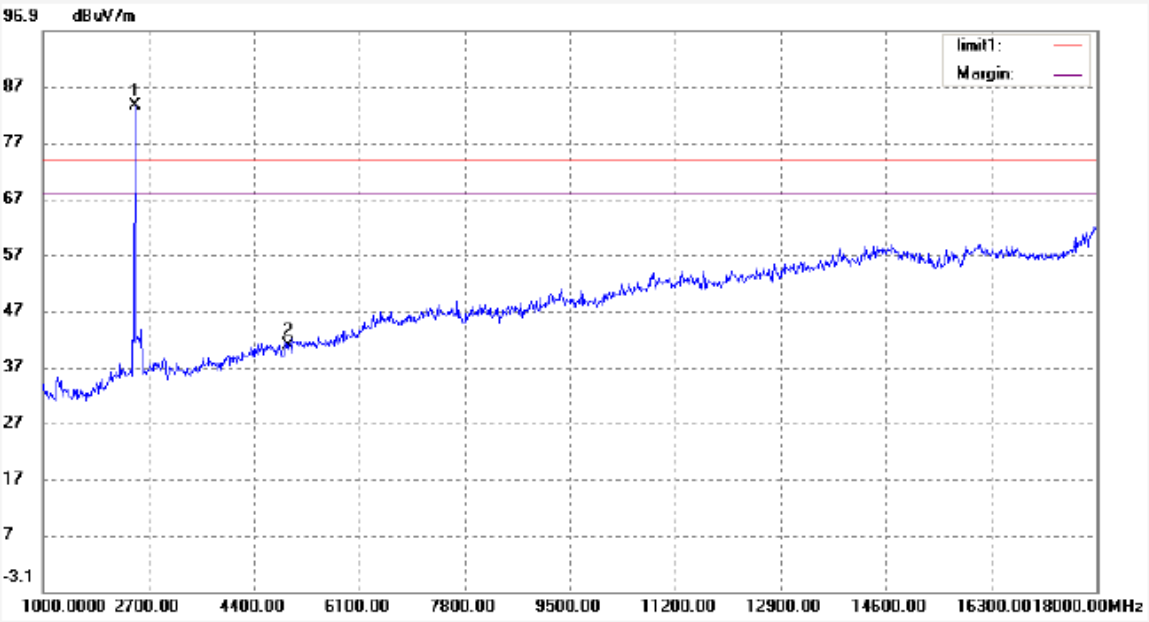


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2441.000	93.34	-9.32	84.02	74.00	10.02	peak	
2	4882.000	44.71	-3.04	41.67	74.00	-32.33	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4882.000	-8	33.67	54.00	-20.33	AV	

Test mode: transmitting at upper channel

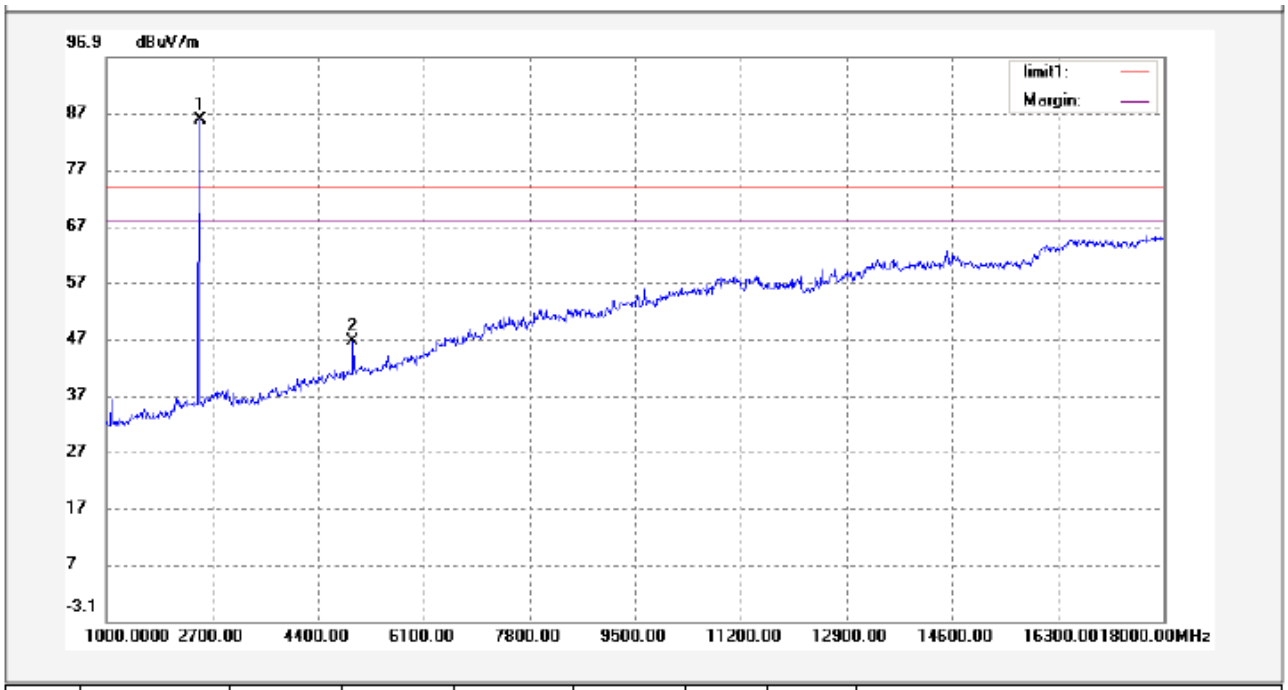
Antenna polarization: Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2479.000	92.71	-9.22	83.49	74.00	9.49	peak	
2	4960.000	43.61	-2.81	40.80	74.00	-33.20	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4960.000	-8	32.8	54.00	-21.2	AV	

Antenna polarization: Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2480.000	94.88	-9.22	85.66	74.00	11.66	peak	
2	4960.000	49.34	-2.81	46.53	74.00	-27.47	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4960.000	-8	38.53	54.00	-15.47	AV	

Test Frequency :Above 18GHz

All emissions were more than 20 dB below the limit and therefore not reported

8 Spurious RF Conducted Emissions from out of band

Test Requirement: FCC Part 15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Test Mothed: DA 00-705

Test Status: TX mode

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 to span from the lowest frequency generated in the device up to and including the tenth harmonic of the highest fundamental frequency.
3. Set RBW = 100kHz and VBW = 300kHz.Sweep =auto.
4. Mark the worst point and record.

8.2 Test Result

Test Frequency: Below 30MHz

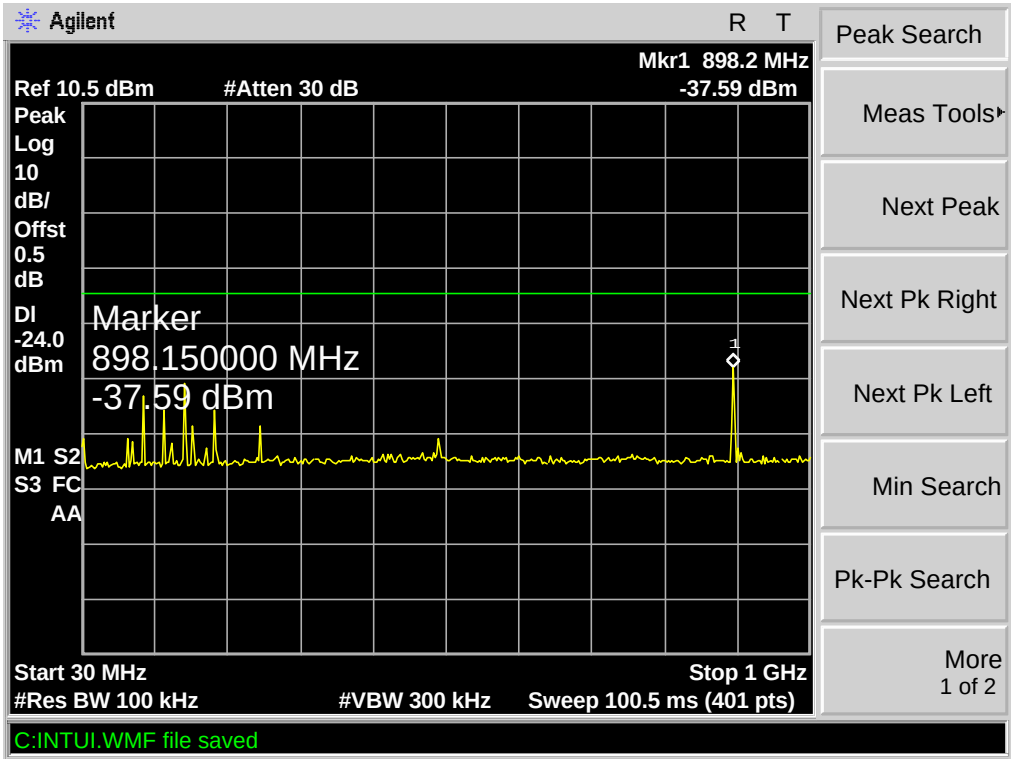
Remark: For emissions below 30MHz,no emission higher than background level, so the data does not show in the report.

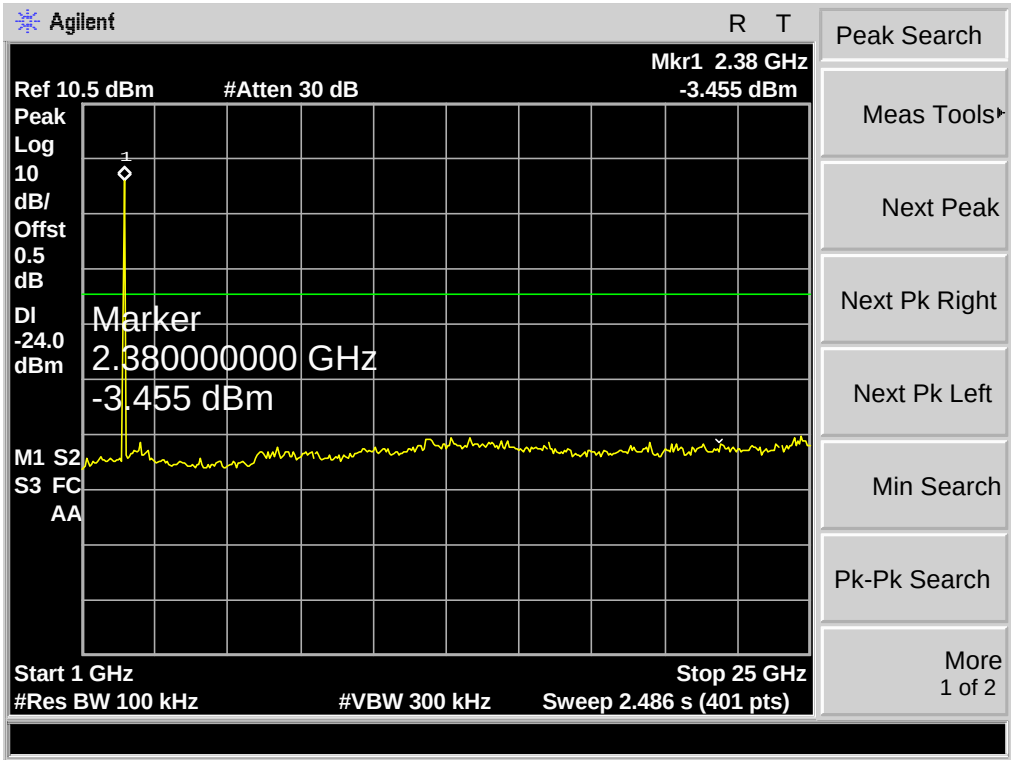
Test Frequency: 30MHz ~ 25GHz

Test result plots shown as follows:

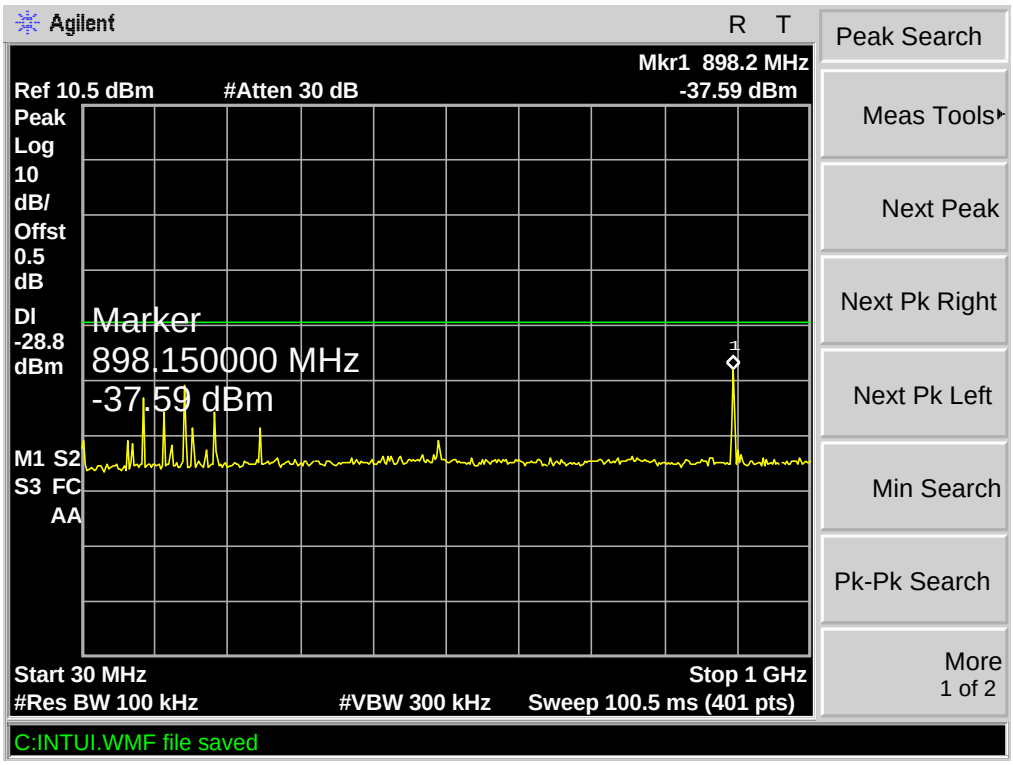
Modulation:GFSK

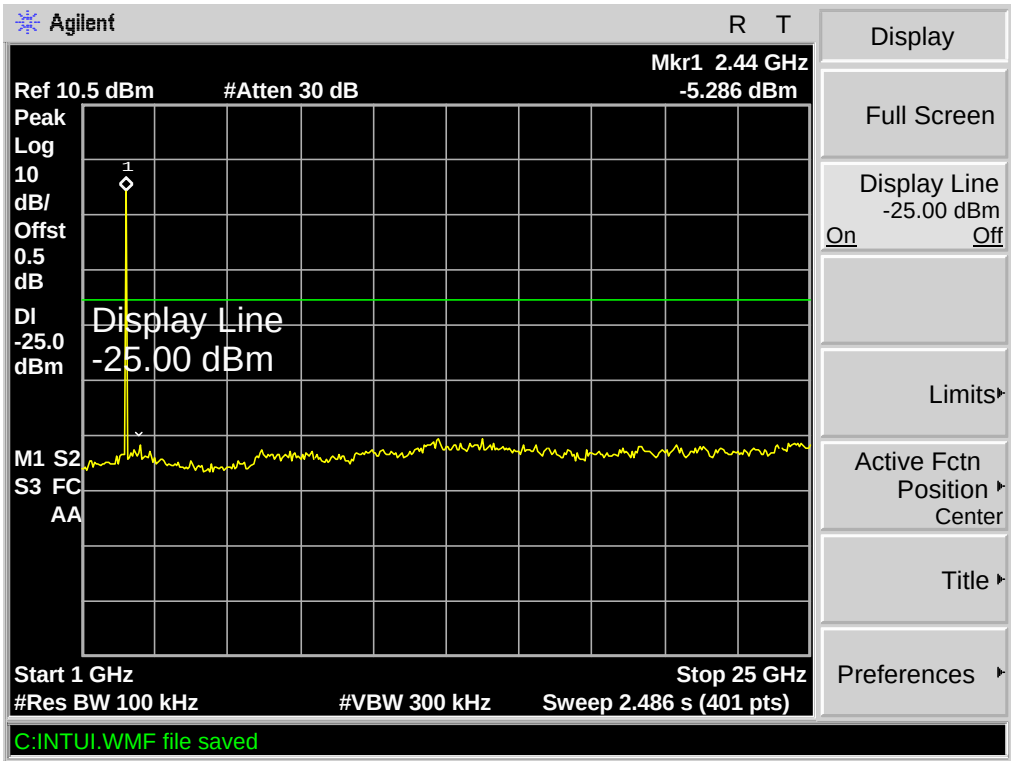
Lower Channel



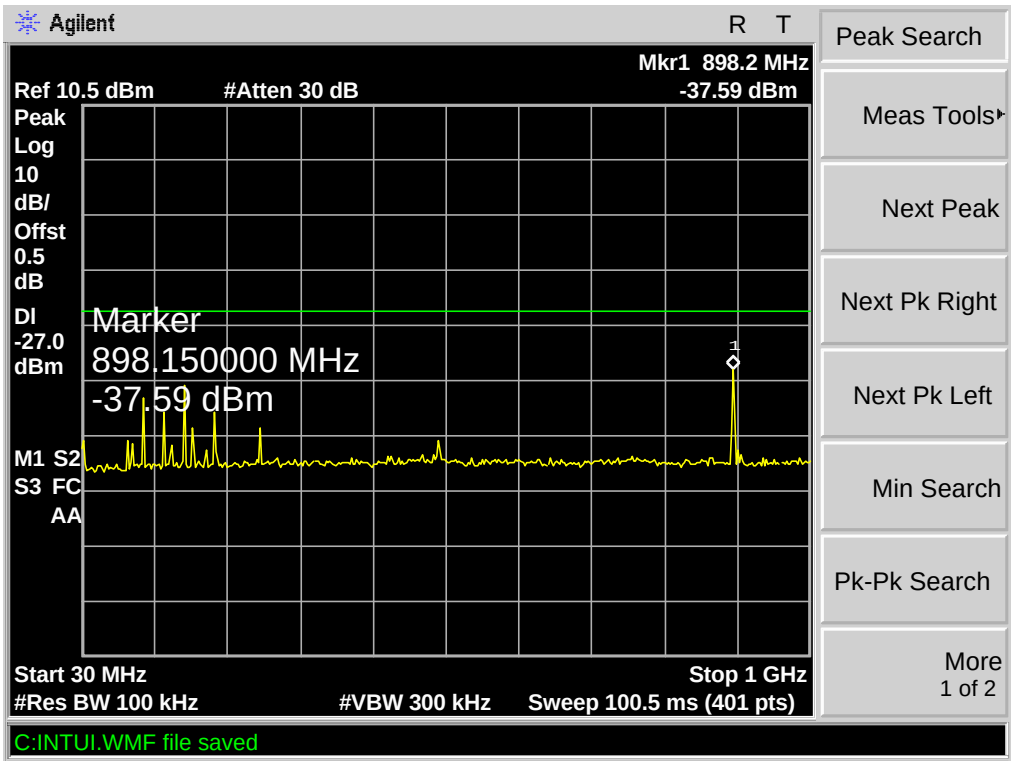


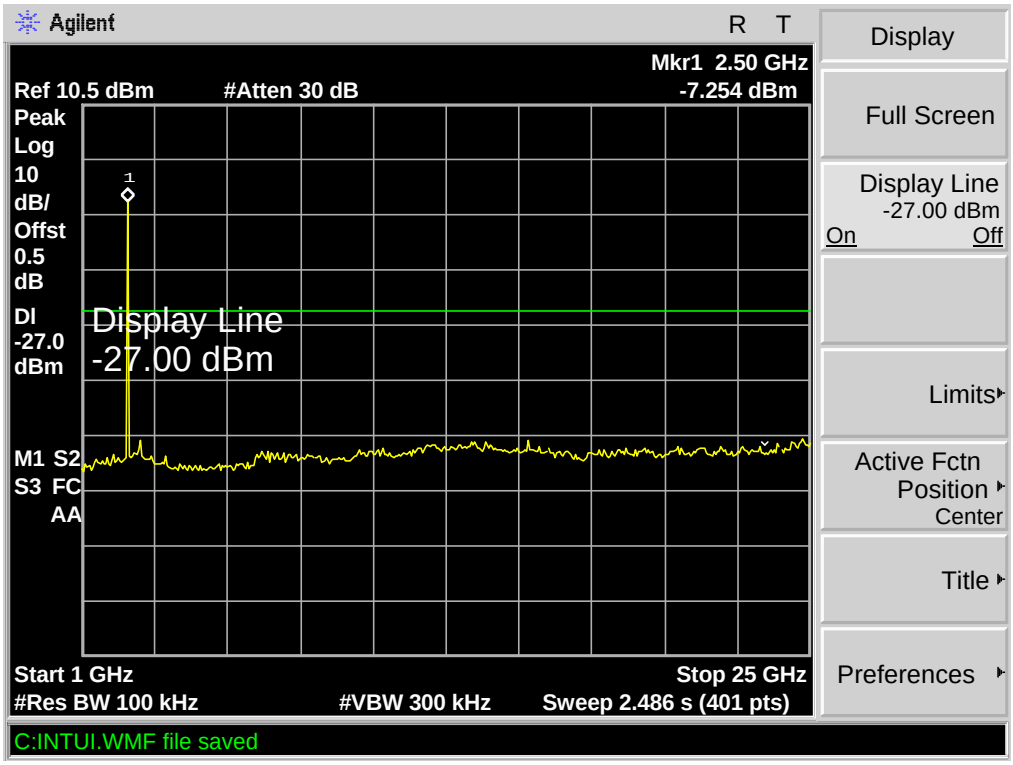
Middle Channel





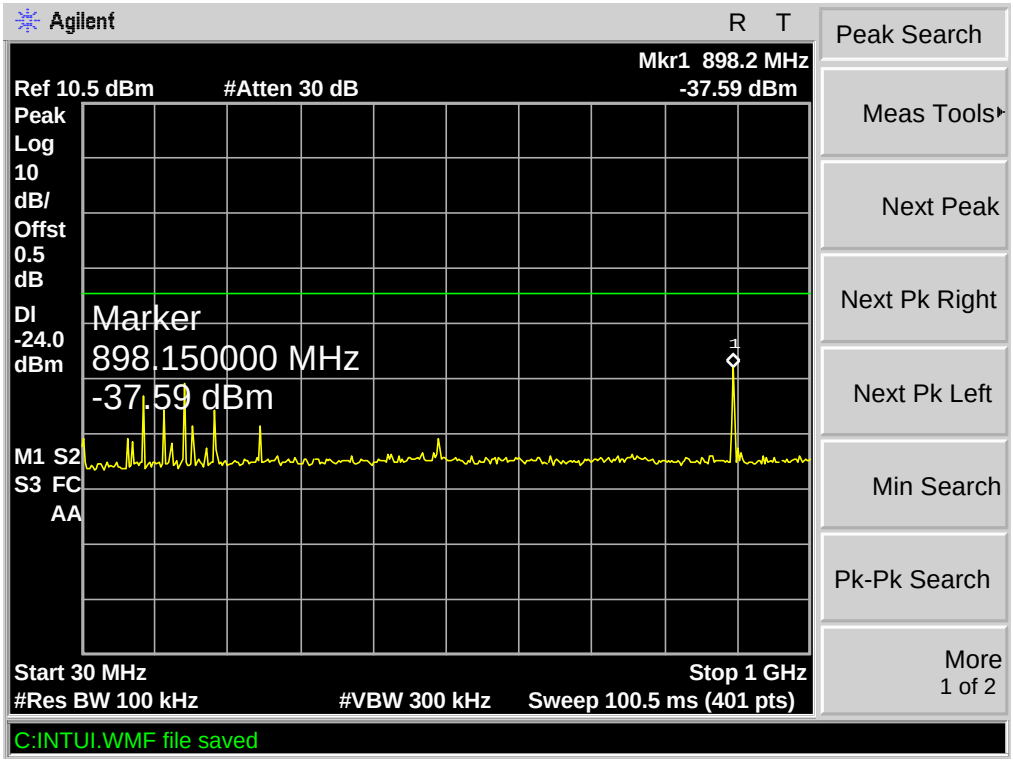
Upper Channel

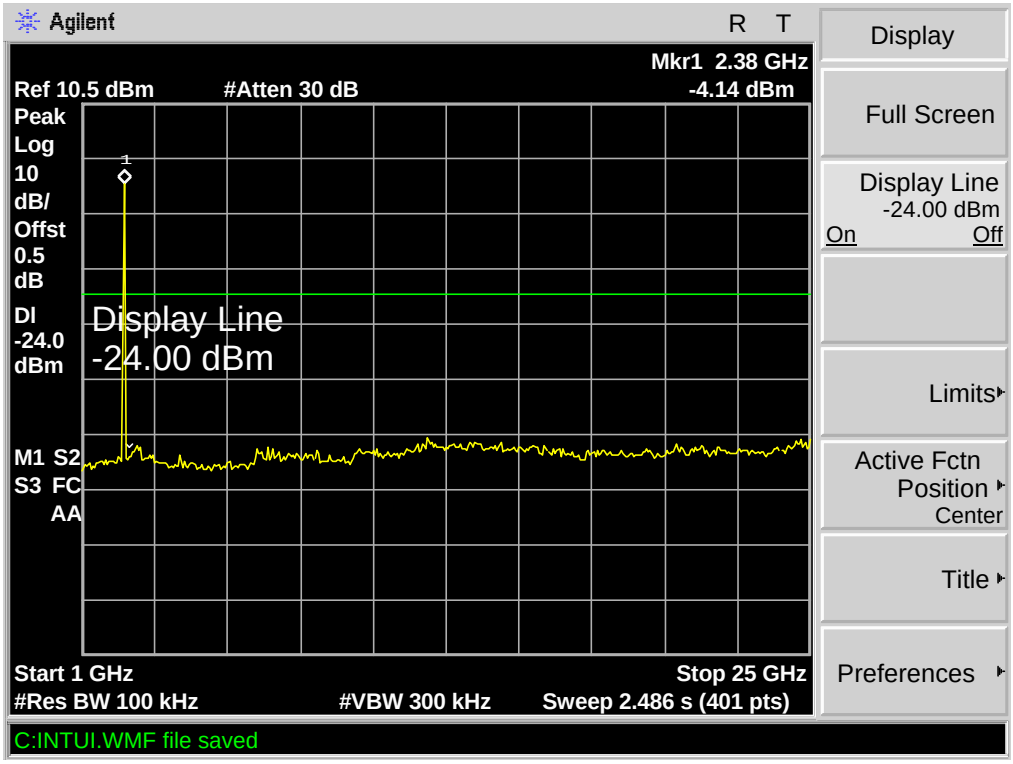




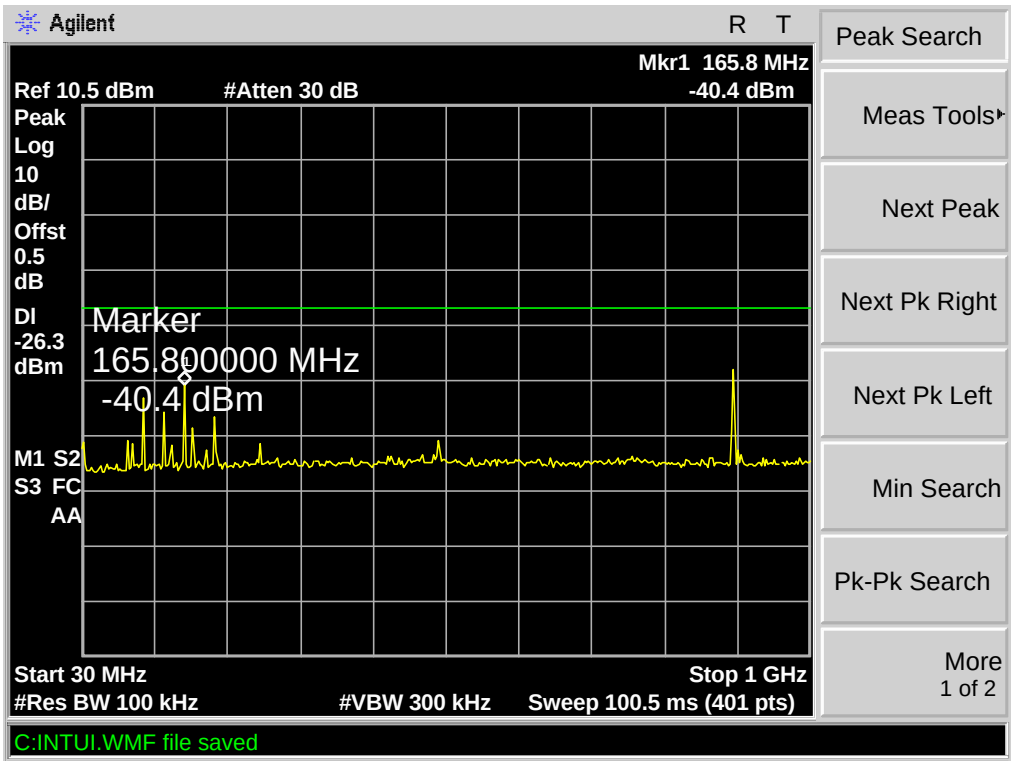
Modulation: Pi/4DQPSK

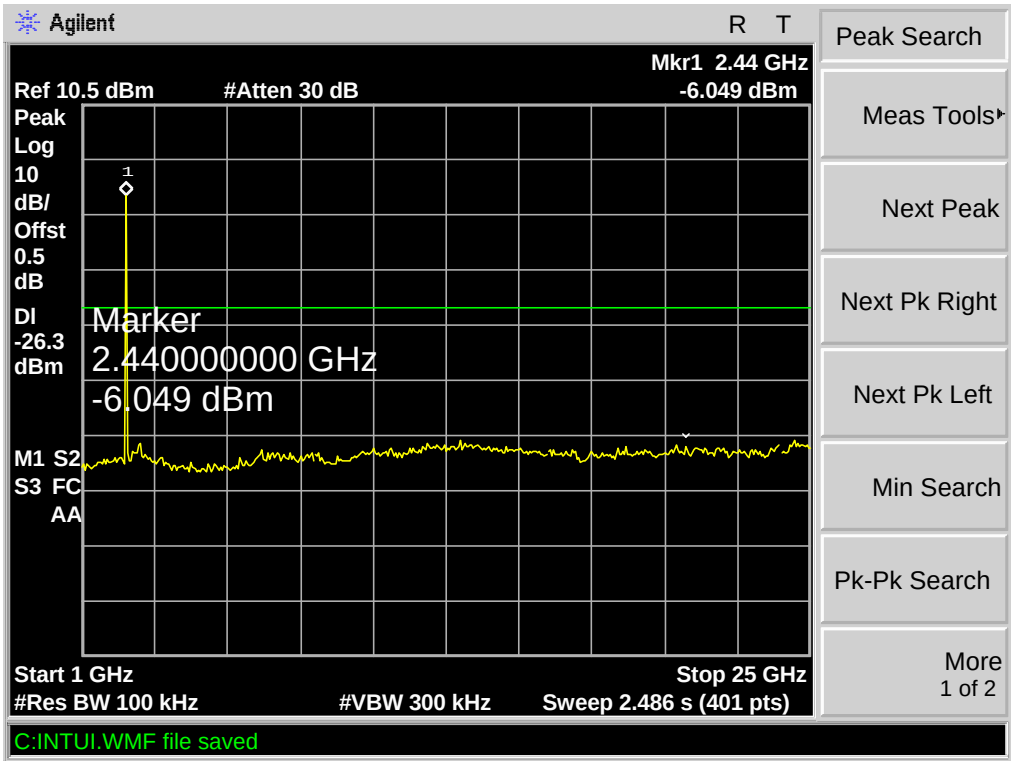
Lower Channel



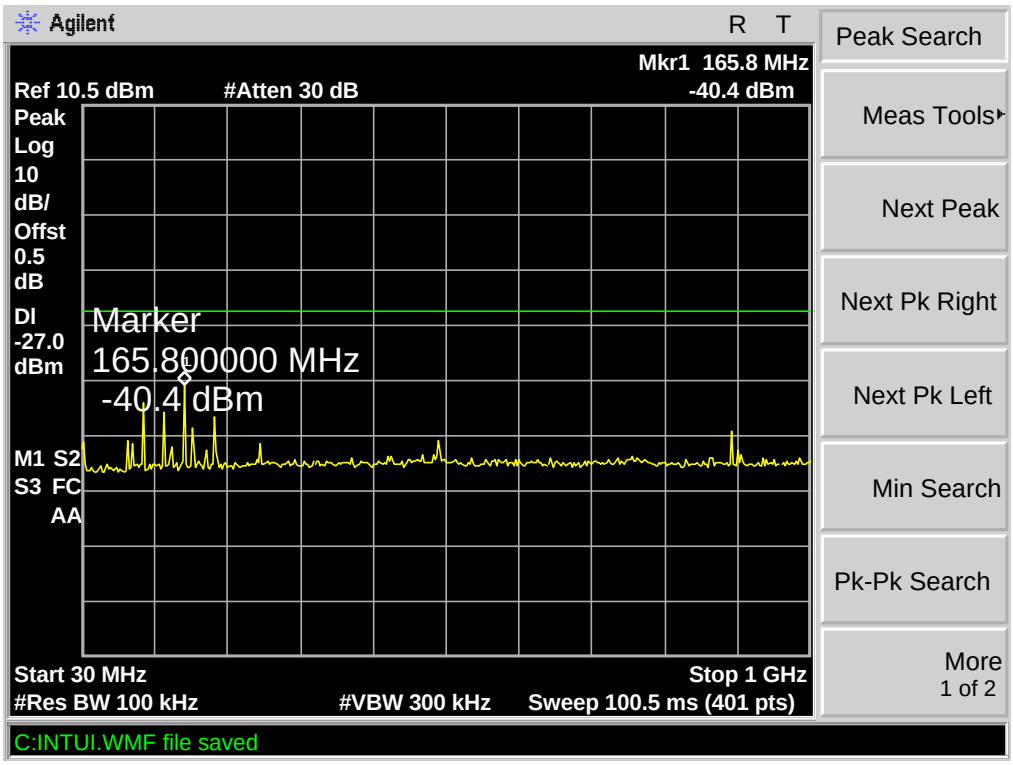


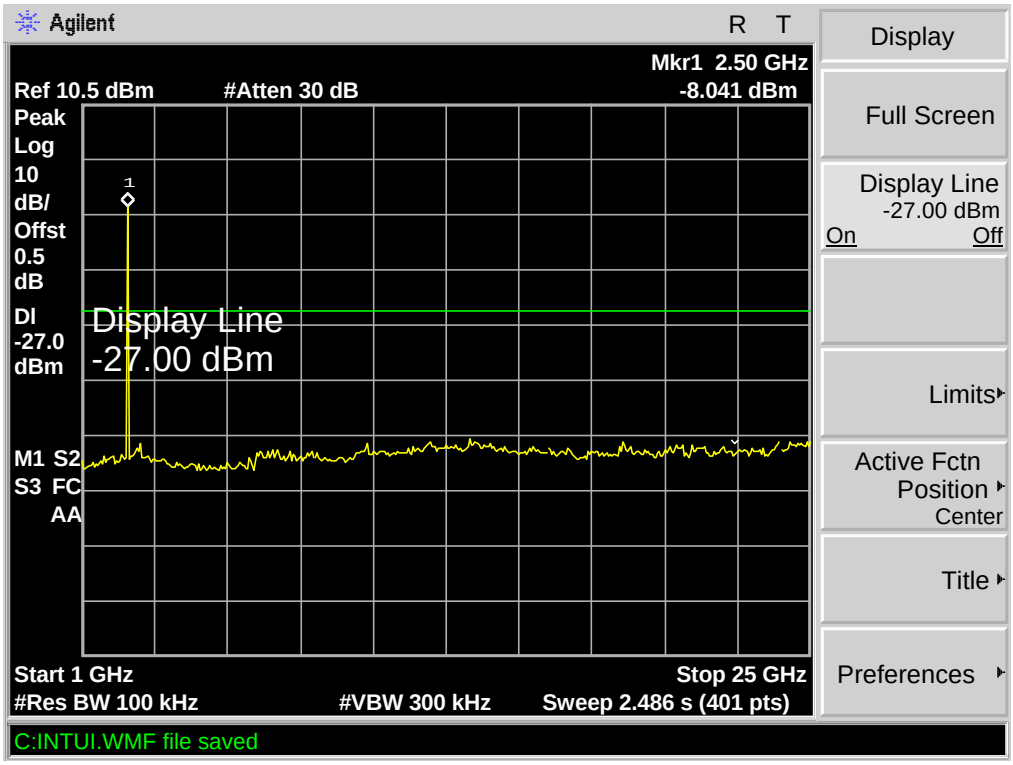
Middle Channel





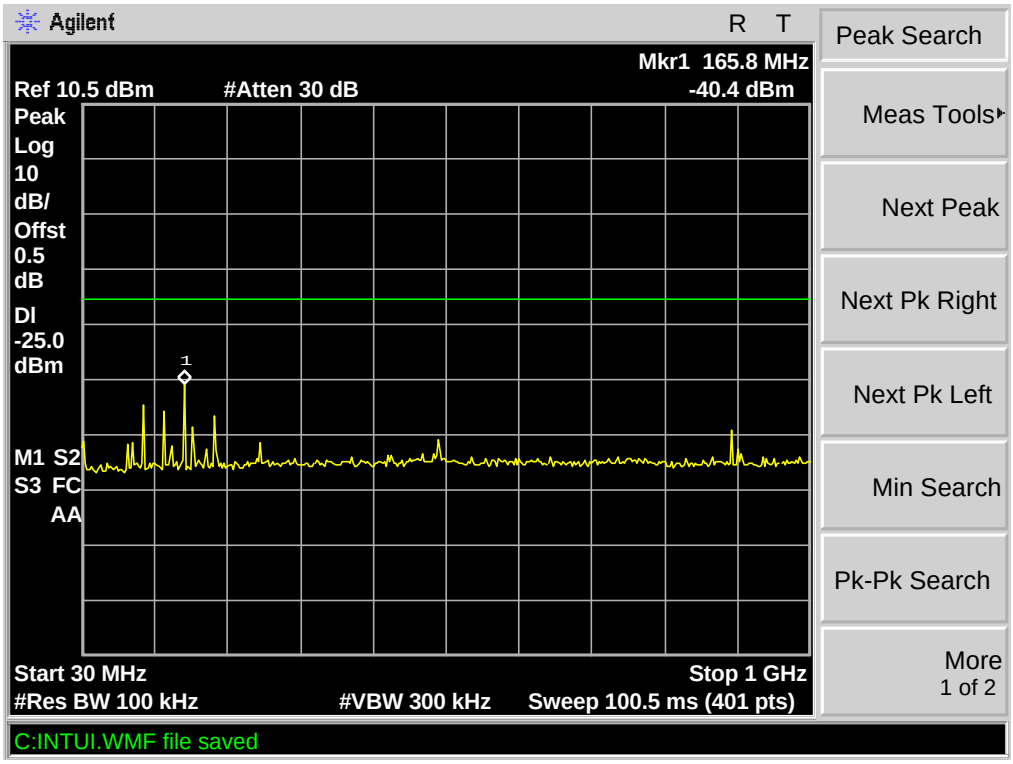
Upper Channel

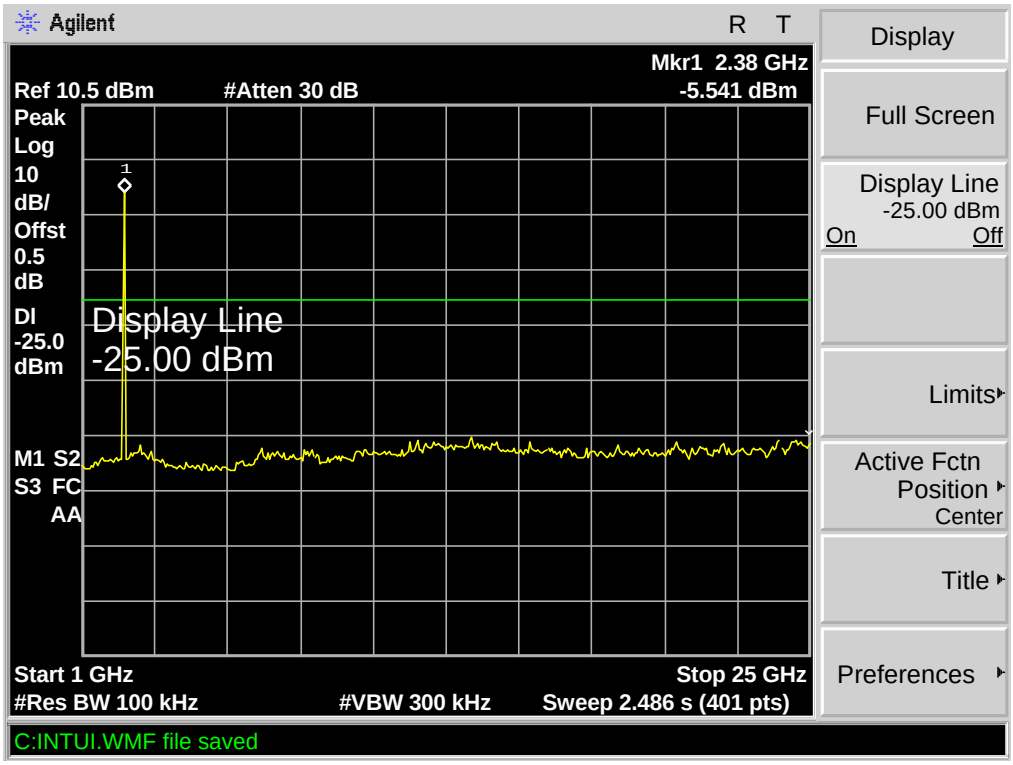




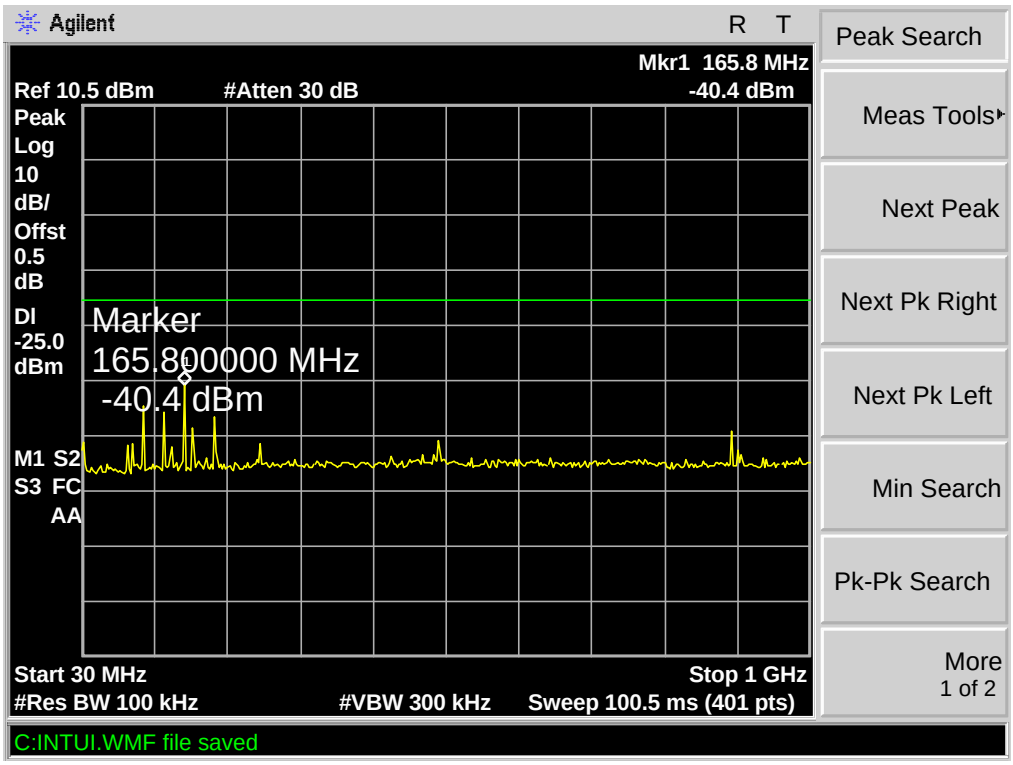
Modulation: 8DPSK

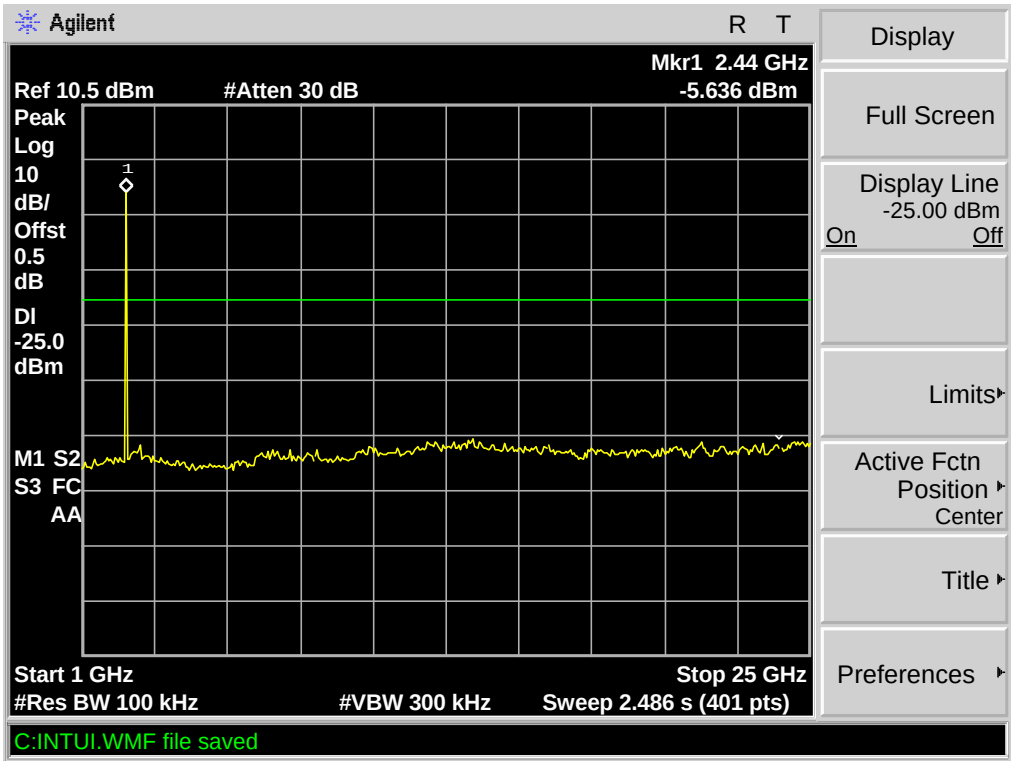
Lower Channel



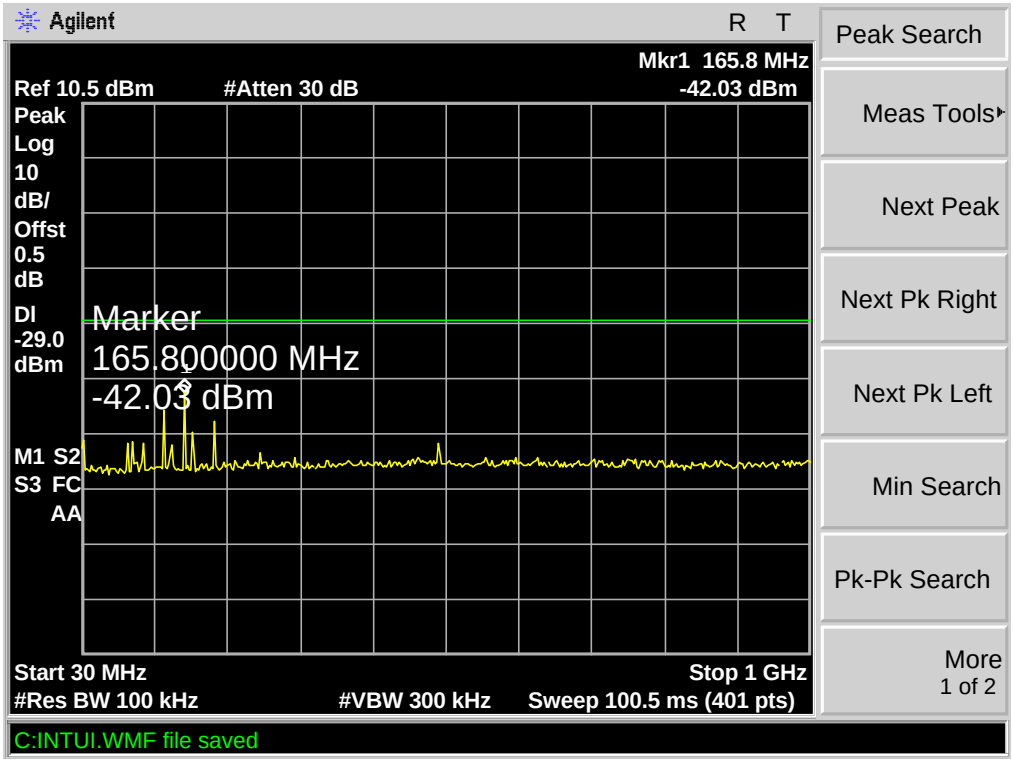


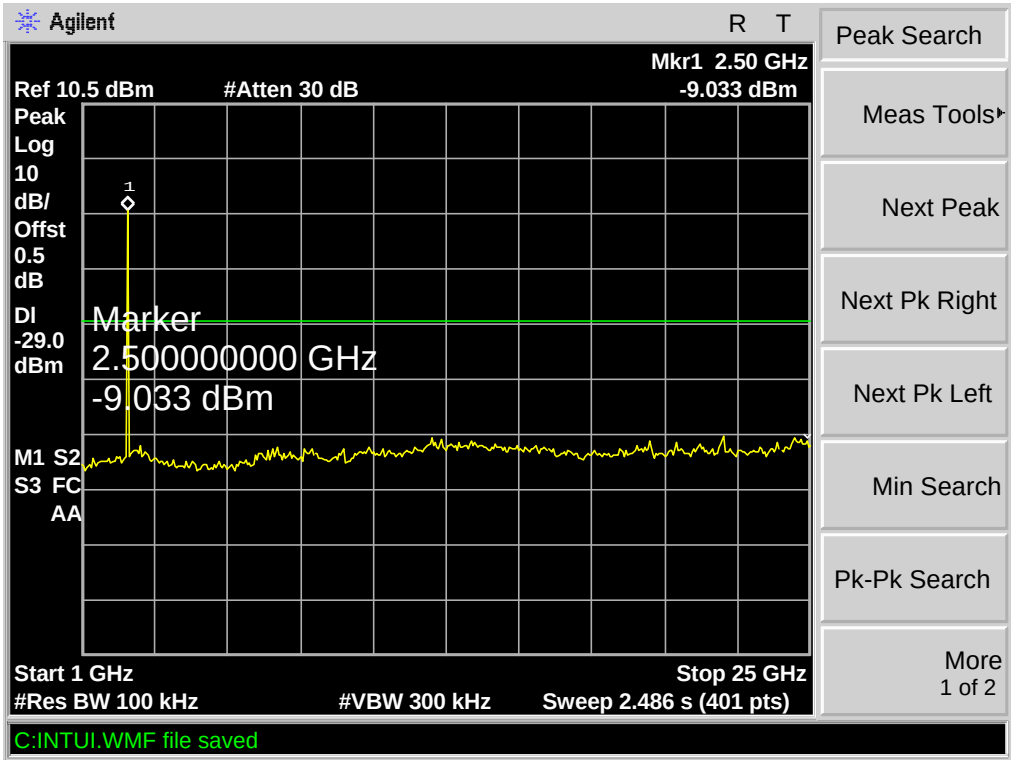
Middle Channel





Upper Channel





9 Duty Cycle

Test Requirement: FCC Part 15.35

Test Mothed: ANSI C63.4:2003

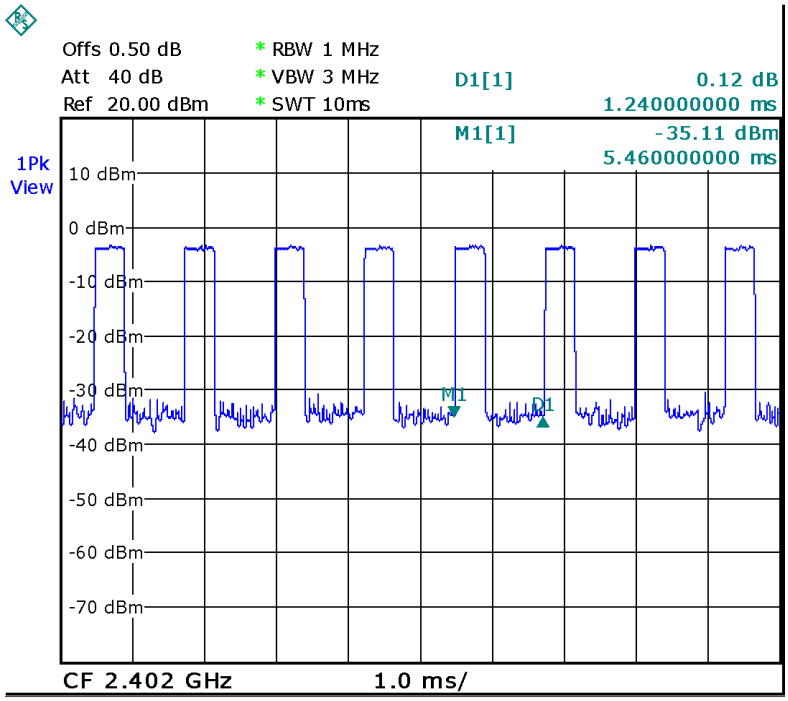
Test Status: TX mode.

9.1 Test Procedure

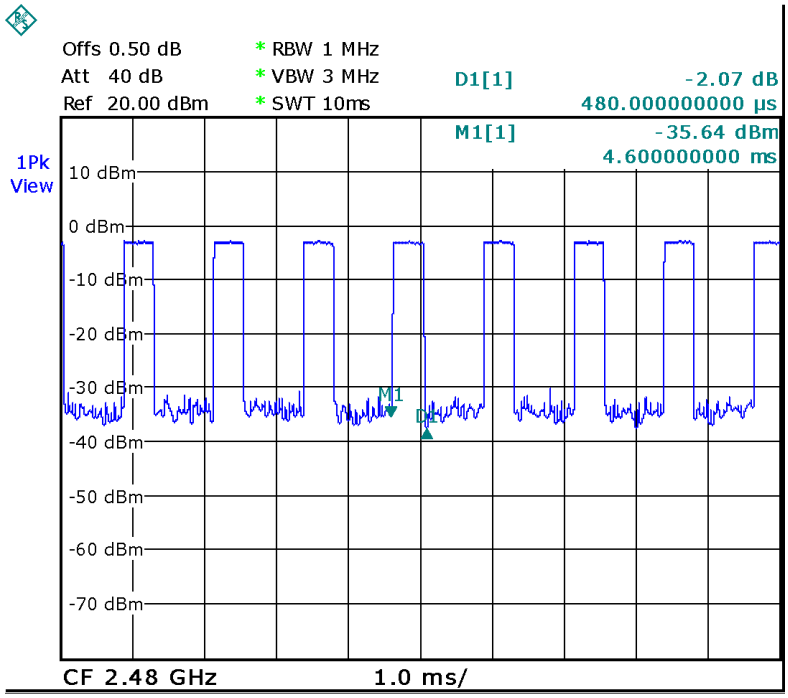
1. The EUT was placed on a turntable which is 0.8m above ground plane
2. Set EUT as normal working mode
3. Set SPA center frequency = fundamental frequency, RBW = 1000 kHz, VBW = 3000 kHz, Span = 0 Hz, Adjacent sweep time.

9.2 Test Result

(a) transmission period is 1.24ms



(b)Single pulse time is 0.48ms



The EUT is auto. operation for transmitter，it is declared by the manufacturer as a duty cycle ratio of less than 100%.

The EUT's work time : T_{on} =pulse time=0.48 ms

The EUT's work period :$T=T_{ON}+T_{OFF}$= transmission period =1.24 ms

The EUT's duty cycle : $D = T_{on} /T$ = 0.48/1.24*100% =38.7%

Duty Cycle Correction Factor(dB)=20 * Log_{10}(Duty Cycle)=20* Log_{10}(38.7%)

= -8dB

10 Band Edge Measurement

Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	DA 00-705
Limit:	40.0 dBuV/m between 30MHz & 88MHz; 43.5 dBuV/m between 88MHz & 216MHz; 46.0 dBuV/m between 216MHz & 960MHz; 54.0 dBuV/m above 960MHz. 74.0 dBuV/m for peak above 1GHz 54.0 dBuV/m for AVG above 1GHz

10.1 Test Procedure

1. The EUT was placed on a turntable which is 0.8m above ground plane

2. Measurement Distance is 3m

3. Detector: For Peak value:

RBW = 1 MHz for f ≥ 1 GHz

VBW ≥ RBW; Sweep = auto

Detector function = peak

Trace = max hold

For AVG value:

RBW = 1 MHz for f ≥ 1 GHz

VBW = 10Hz; Sweep = auto

Detector function = AVG

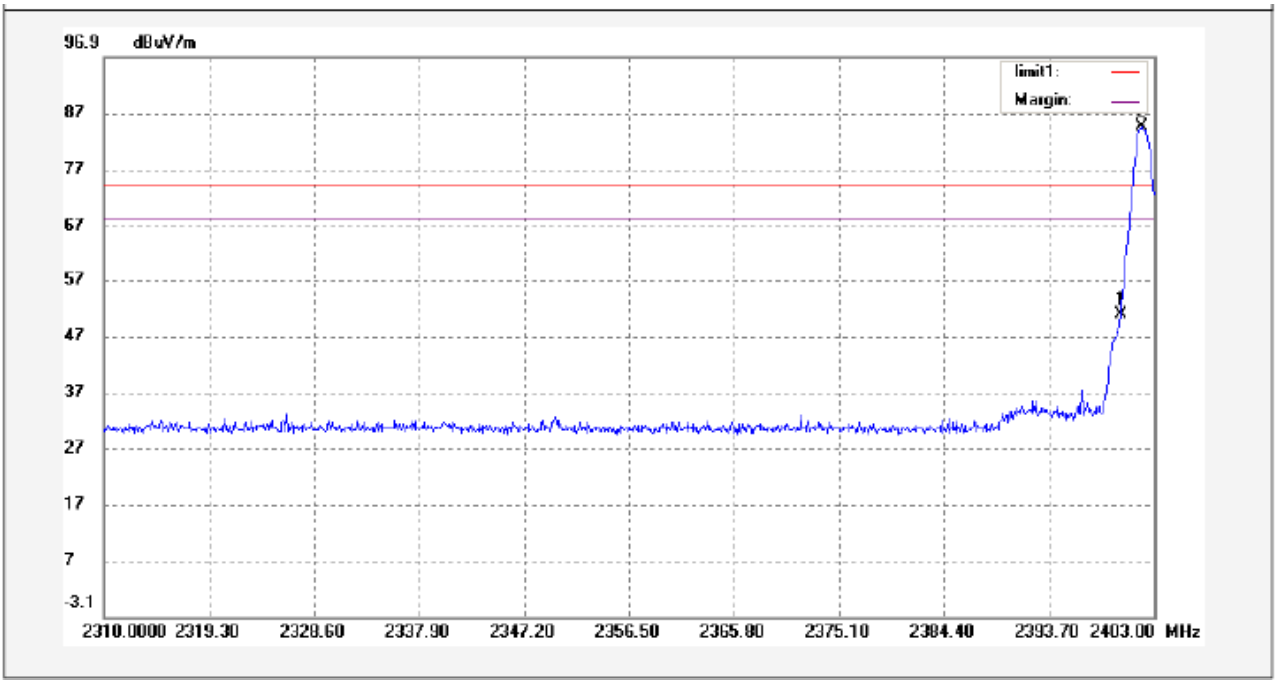
Trace = max hold

4.Continuous transmitting

10.2 Test Result:

All the modulation modes were tested, the data of the worst mode (GFSK) were recorded in the following pages.

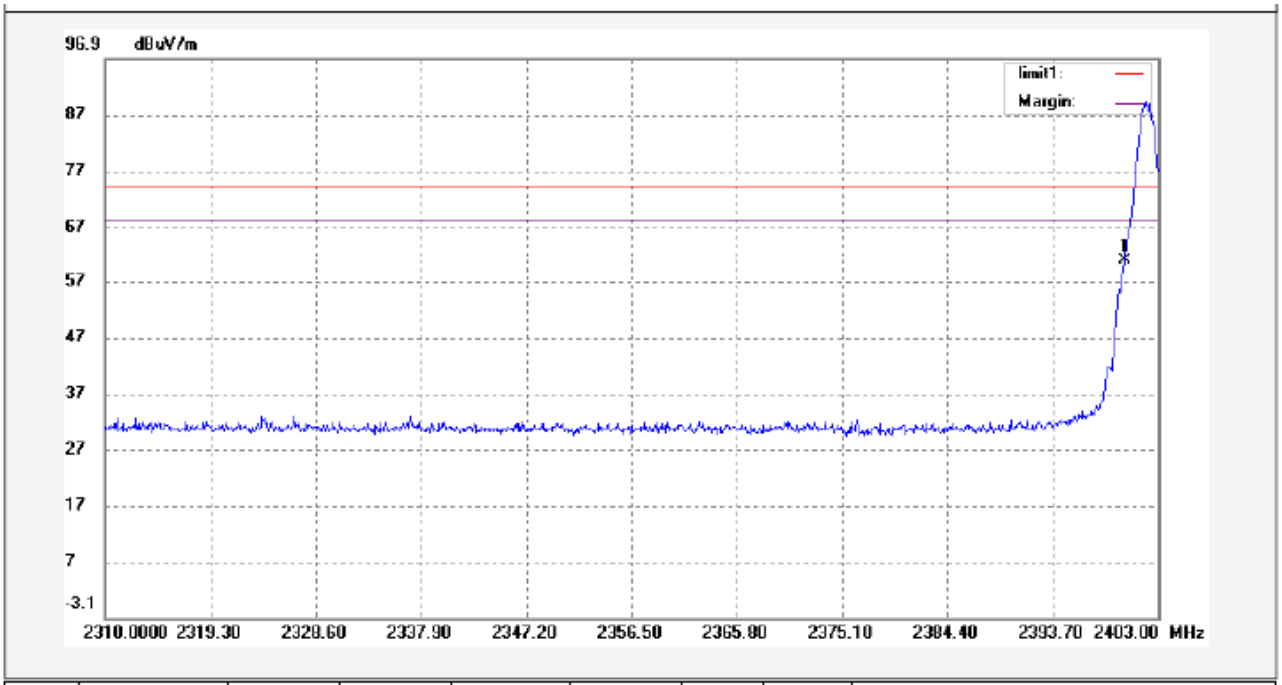
Modulation: GFSK
Lower Channel – Peak, Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2400.000	66.43	-15.58	50.85	74.00	-23.15	peak	
2	2401.884	100.09	-15.58	84.51	74.00	10.51	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2400.000	-8	42.85	54.00	-11.15	AV	
2	2401.840	-8	76.51	54.00	22.51	AV	

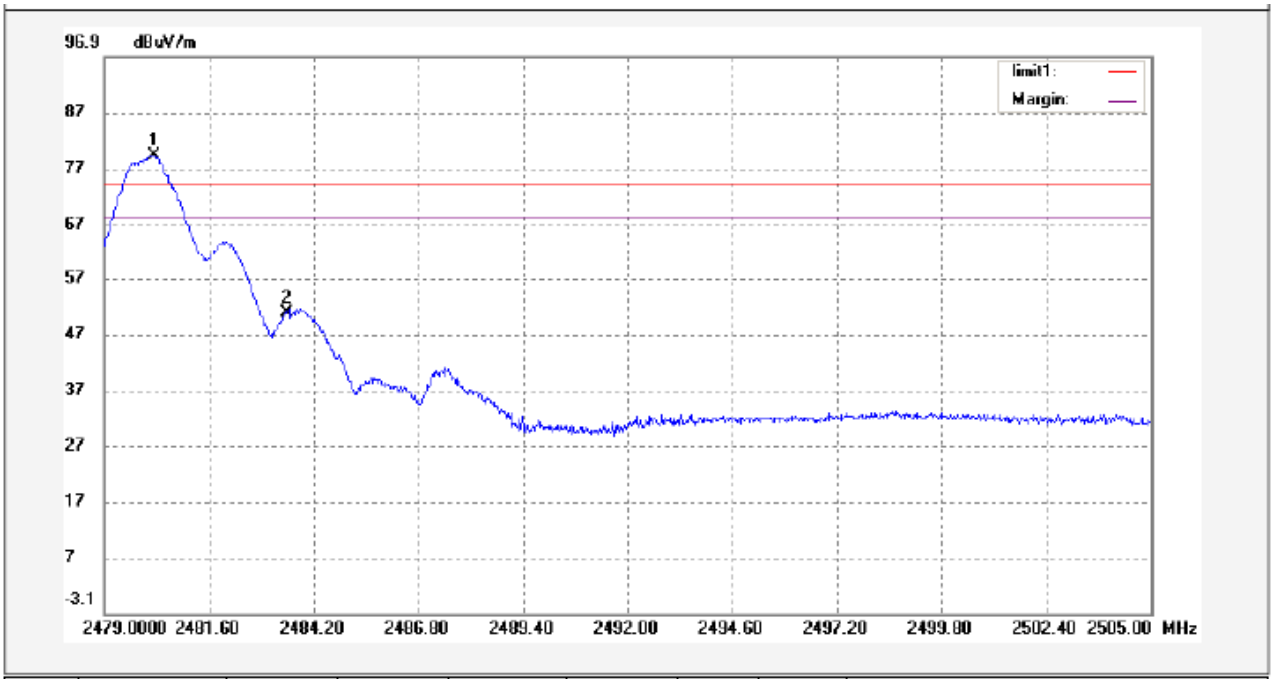
Lower Channel – Peak, Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2400.000	76.44	-15.58	60.86	74.00	-13.14	peak	
2	2401.884	104.88	-15.58	89.30	74.00	15.30	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2400.000	-8	52.86	54.00	-1.14	AV	
2	2401.884	-8	81.3	54.00	27.3	AV	

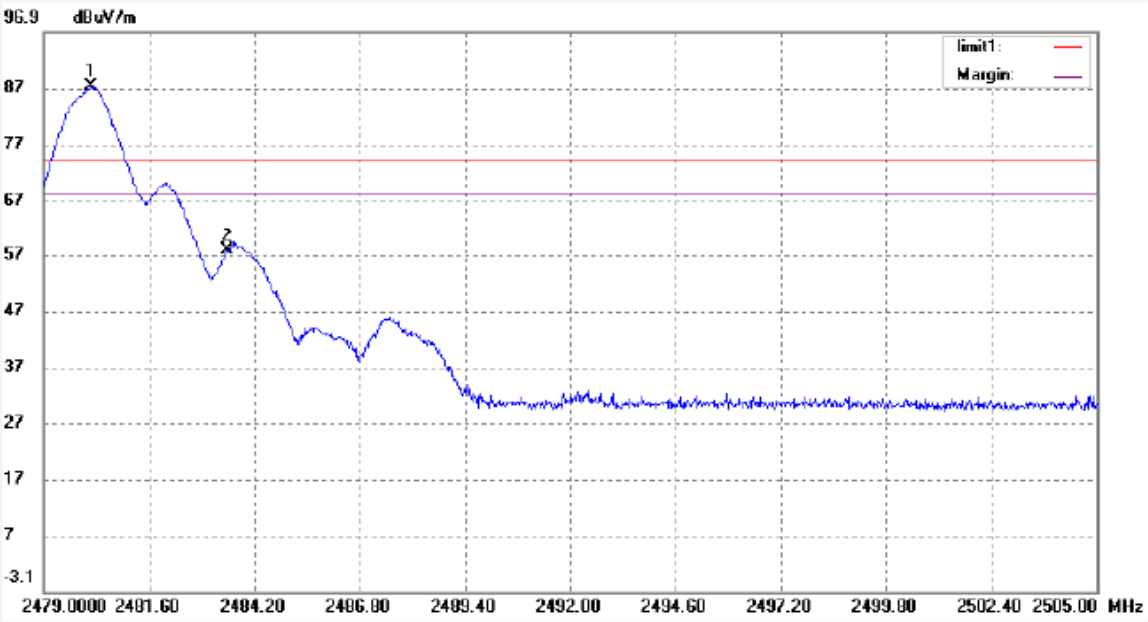
Upper Channel – Peak, Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2480.222	94.92	-15.68	79.24	74.00	5.24	peak	
2	2483.500	66.36	-15.67	50.69	74.00	-23.31	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2480.222	-8	71.24	54.00	17.24	AV	
2	2483.500	-8	42.69	54.00	-11.31	AV	

Upper Channel – Peak, Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2480.170	102.84	-15.68	87.16	74.00	13.16	peak	
2	2483.500	73.44	-15.67	57.77	74.00	-16.23	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2479.858	-8	79.16	54.00	25.16	AV	
2	2483.500	-8	49.77	54.00	-4.23	AV	

11 20 dB Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

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

11.1 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 = 100kHz

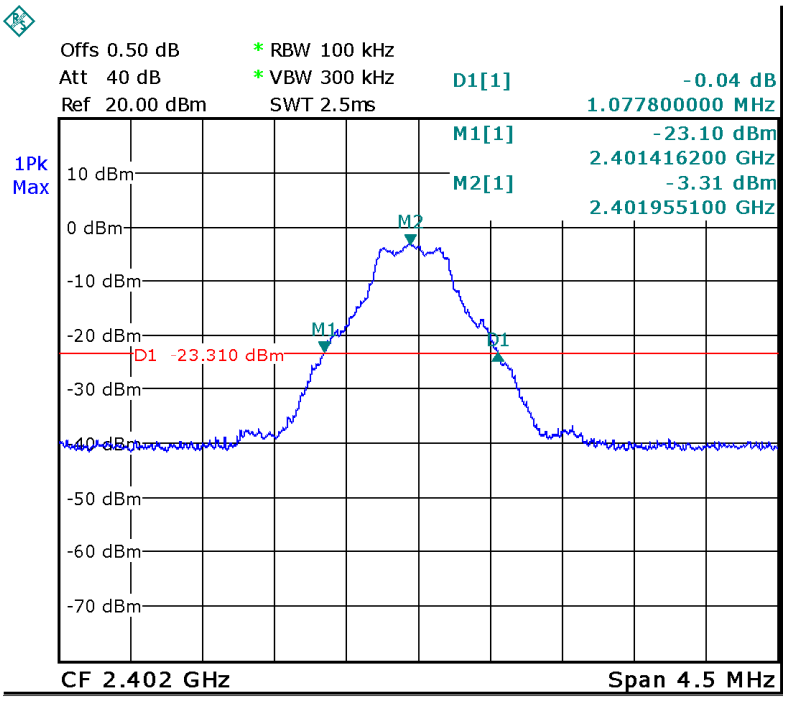
11.2 Test Result:

Modulation	Test Channel	Bandwidth(MHz)
GFSK	Lower	1.0778
	Middle	1.1048
	Upper	1.1048
Pi/4DQPSK	Lower	1.4461
	Middle	1.4551
	Upper	1.4551
8DPSK	Lower	1.4451
	Middle	1.4501
	Upper	1.4641

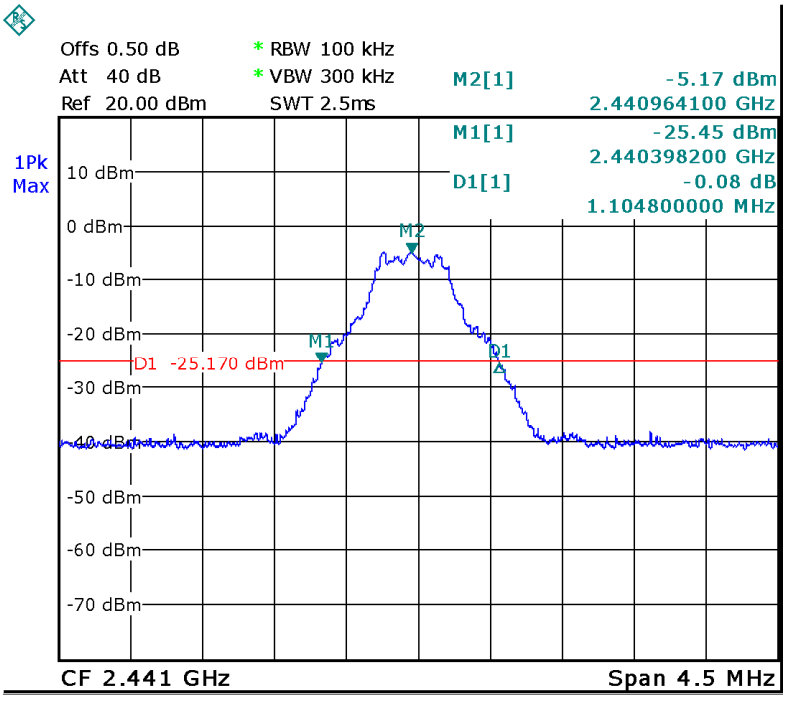
Test result plot as follows:

Modulation: GFSK

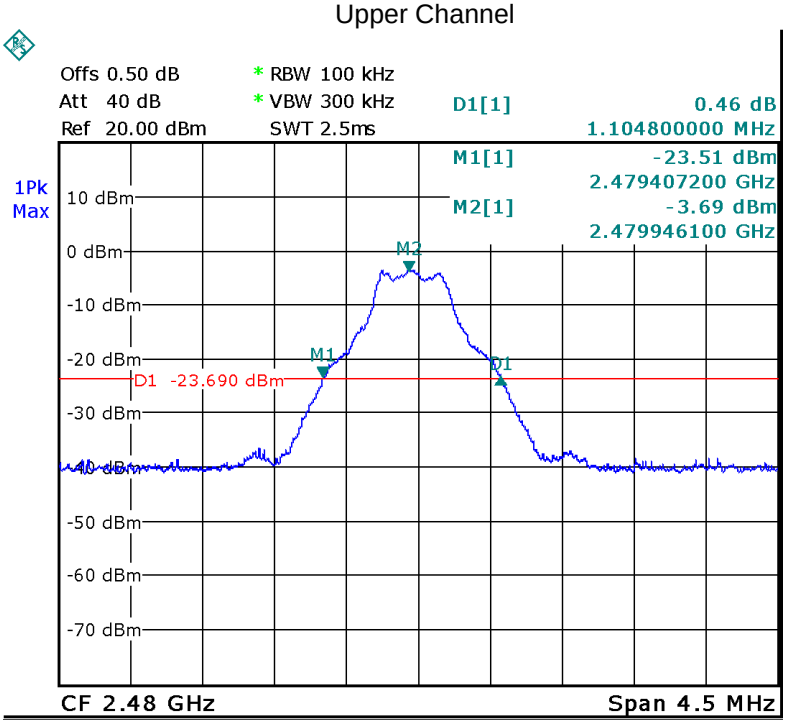
Lower Channel



Middle Channel

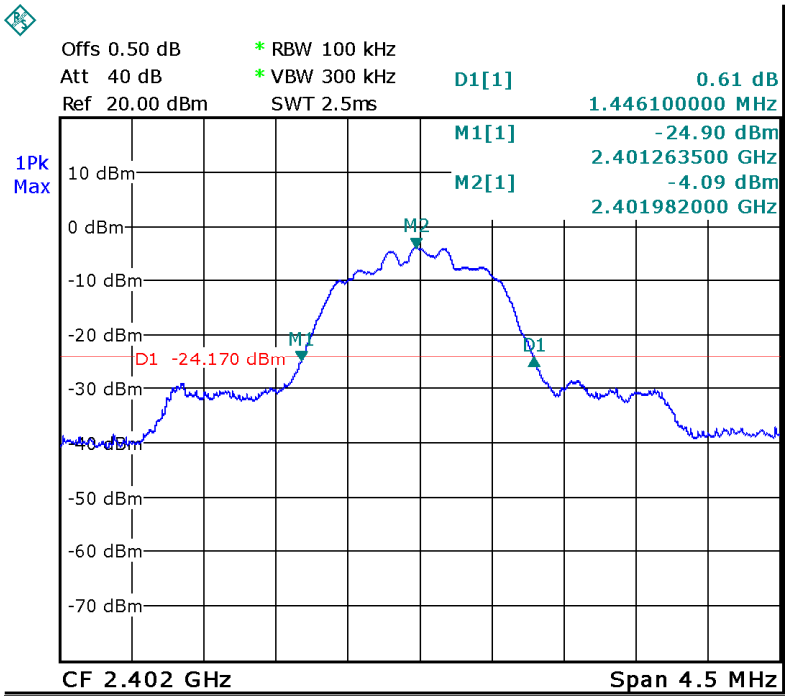


Upper Channel

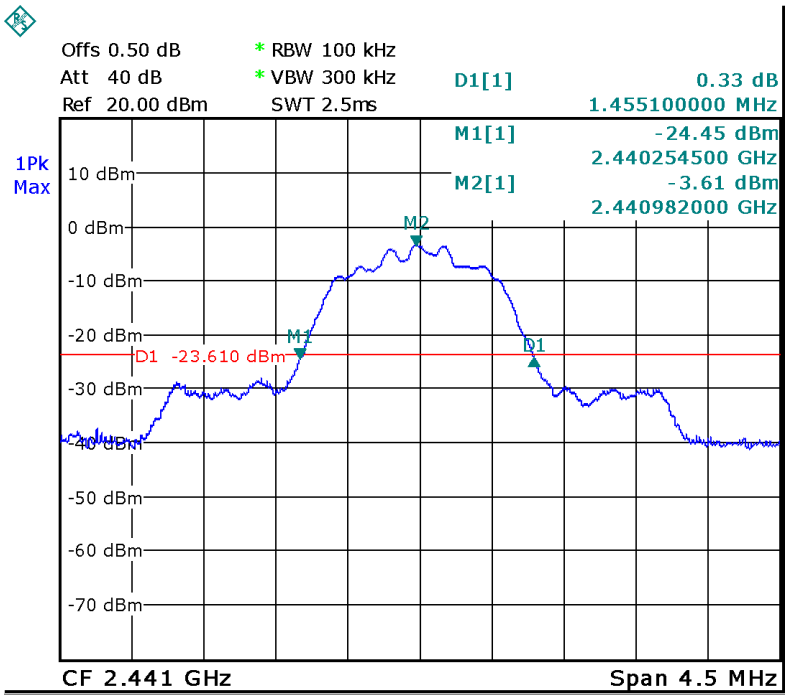


Modulation: Pi/4DQPSK

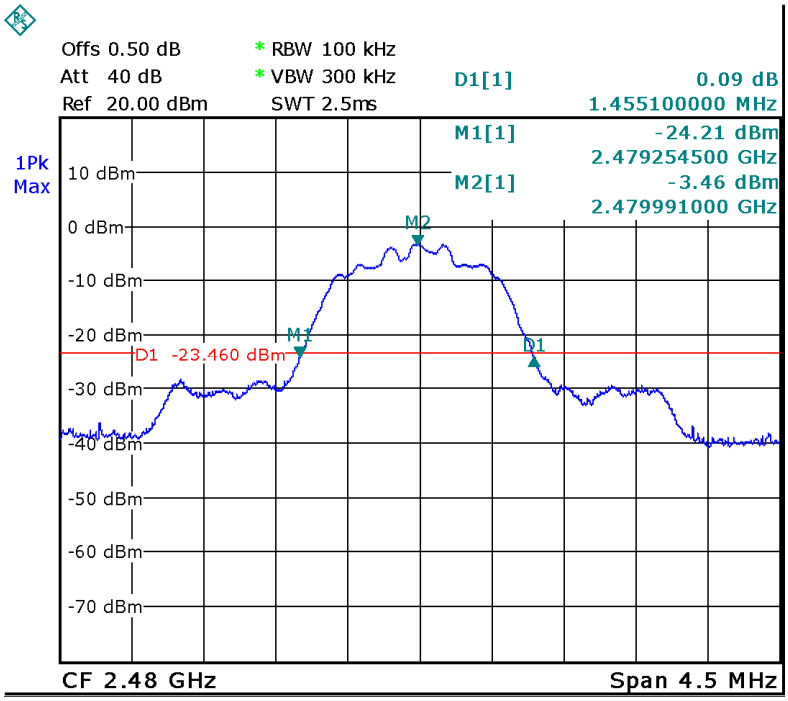
Lower Channel



Middle Channel

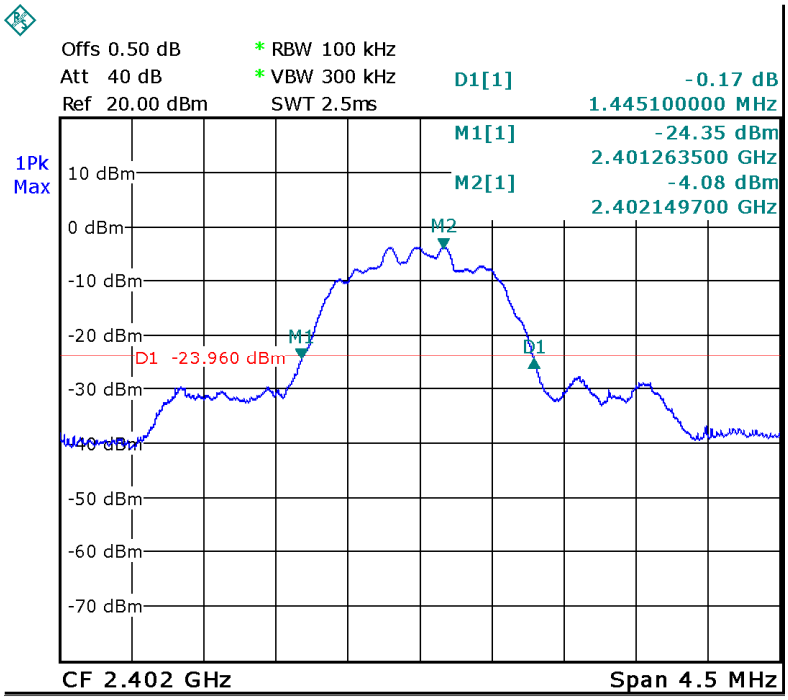


Upper Channel

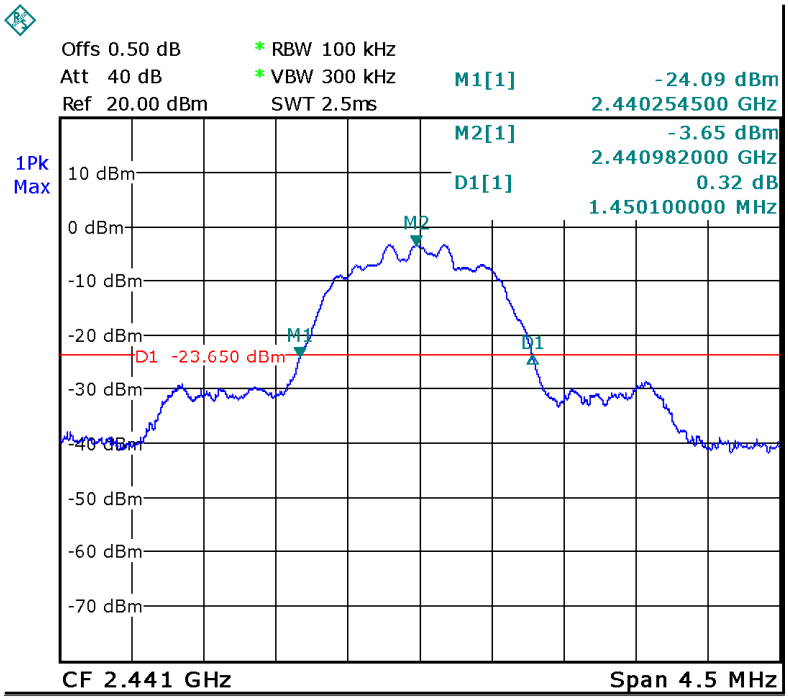


Modulation: 8DPSK

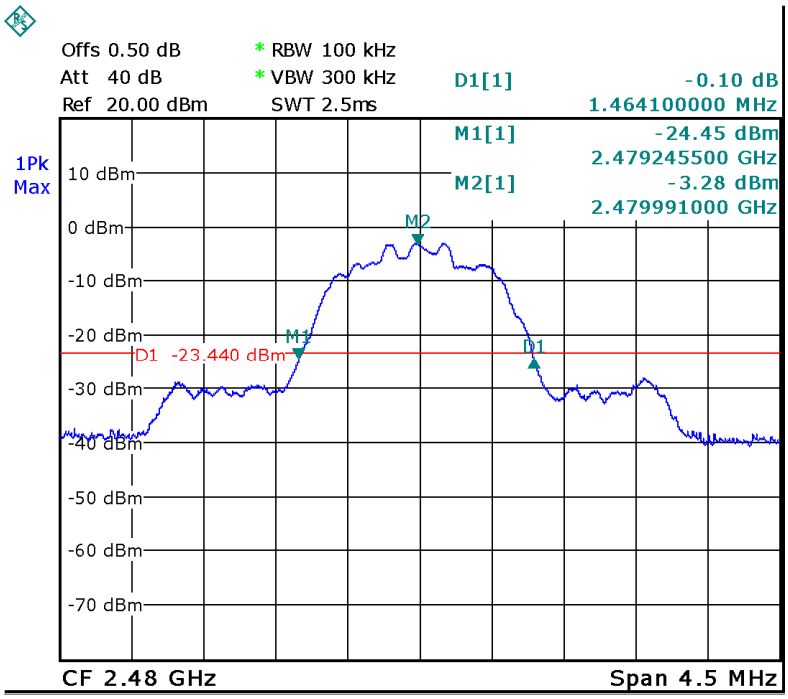
Lower Channel



Middle Channel



Upper Channel



12 Maximum Peak Output Power

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 15.247 (b)(1), 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.

Refer to the result “Number of Hopping Frequency” of this document. The 1watts (30 dBm) limit applies.

Test mode: Test in fixing frequency transmitting 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 = 3 MHz. VBW =3 MHz. Sweep = auto; Detector Function = Peak.

3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

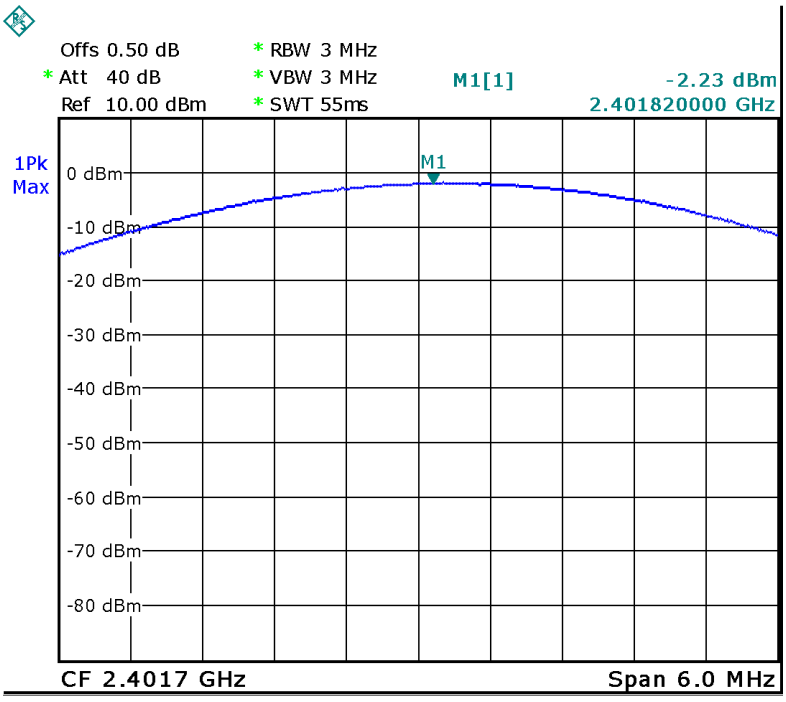
12.2 Test Result:

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Lower	-2.23	30
	Middle	-1.92	30
	Upper	-2.52	30
Pi/4DQPSK	Lower	-2.01	30
	Middle	-3.05	30
	Upper	-2.81	30
8DPSK	Lower	-3.34	30
	Middle	-3.03	30
	Upper	-3.80	30

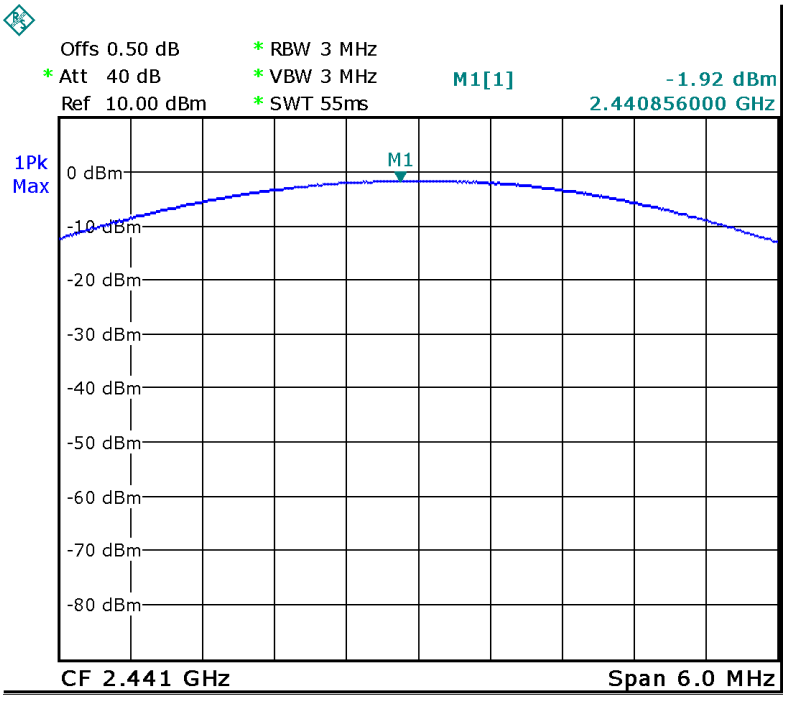
Test result plot as follows:

Modulation:GFSK

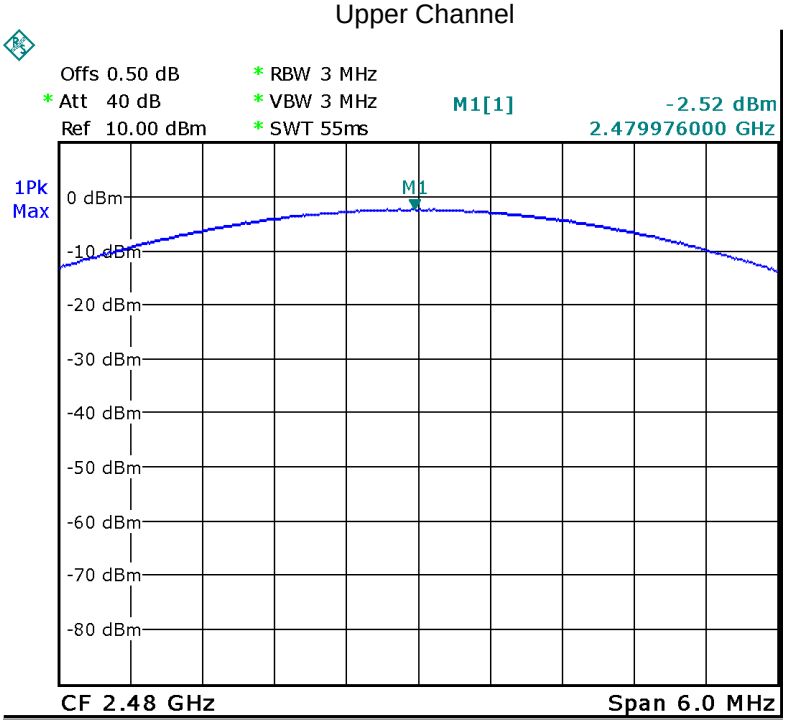
Lower Channel



Middle Channel

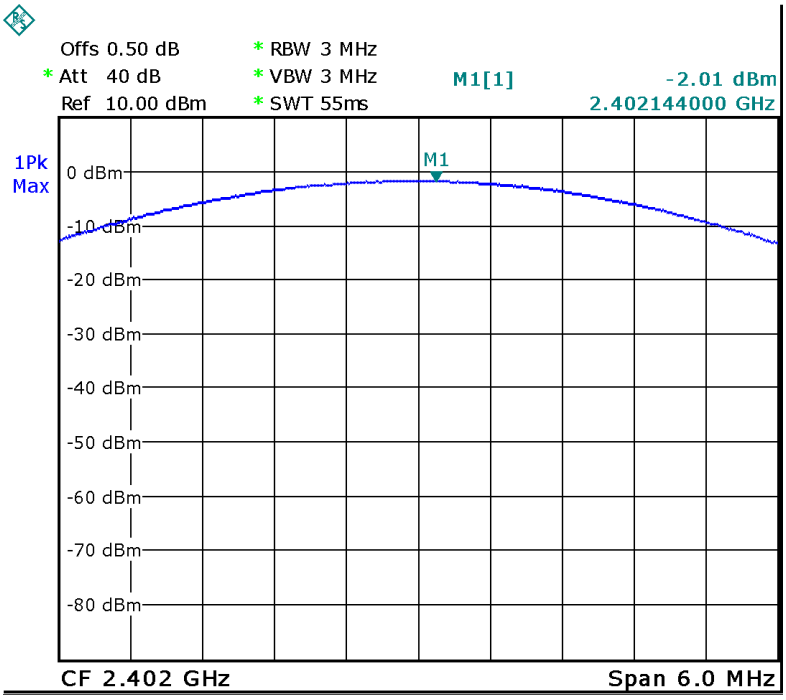


Upper Channel

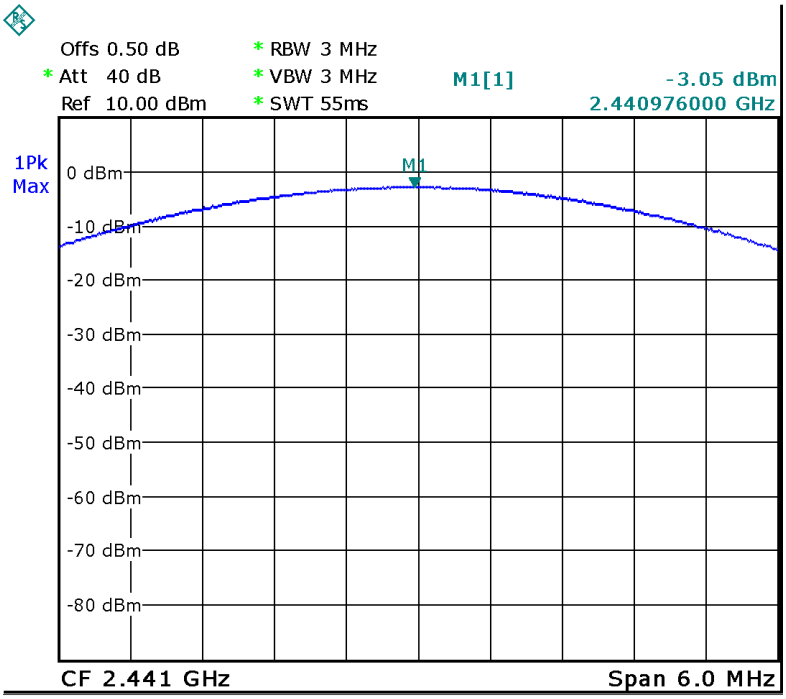


Modulation: Pi/4DQPSK

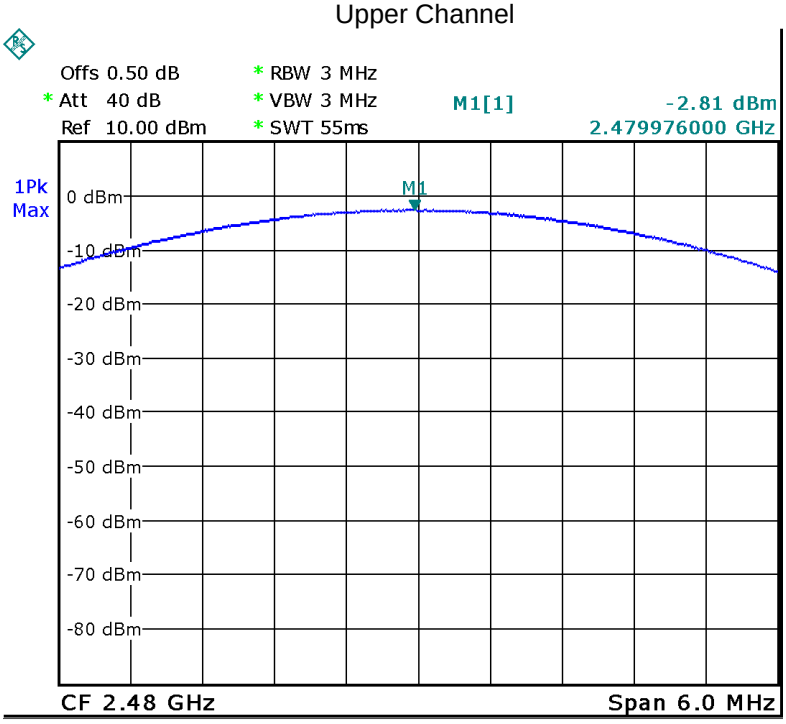
Lower Channel



Middle Channel

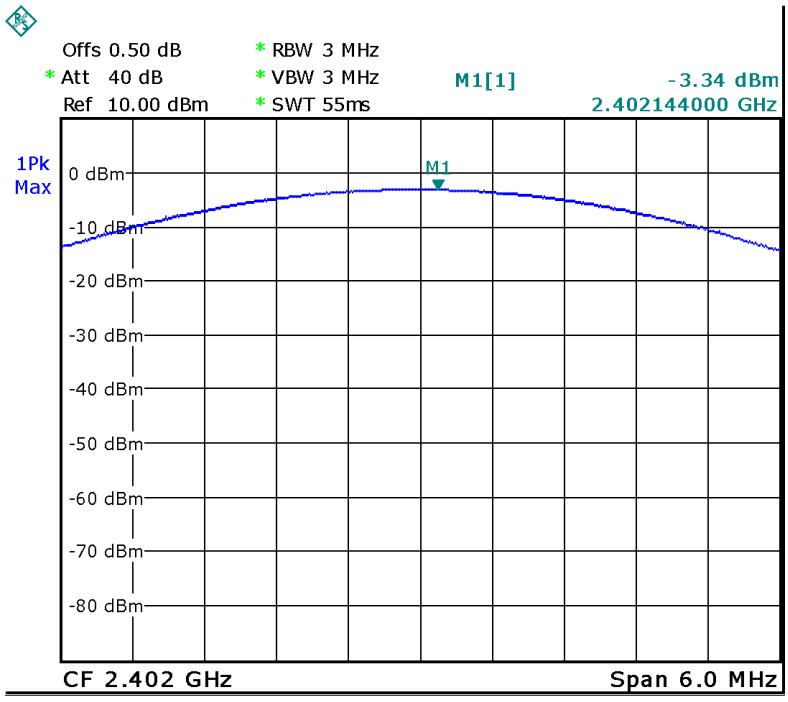


Upper Channel

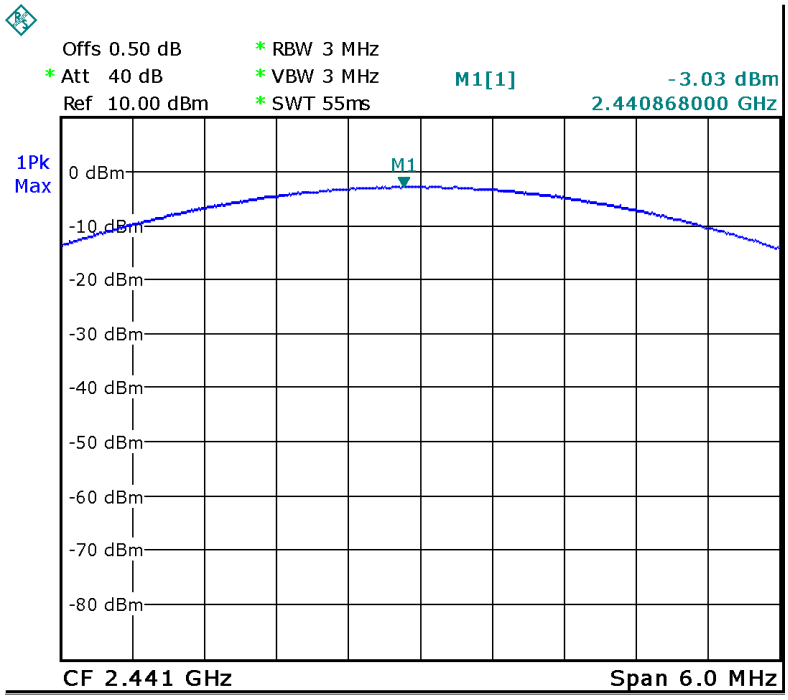


Modulation: 8DPSK

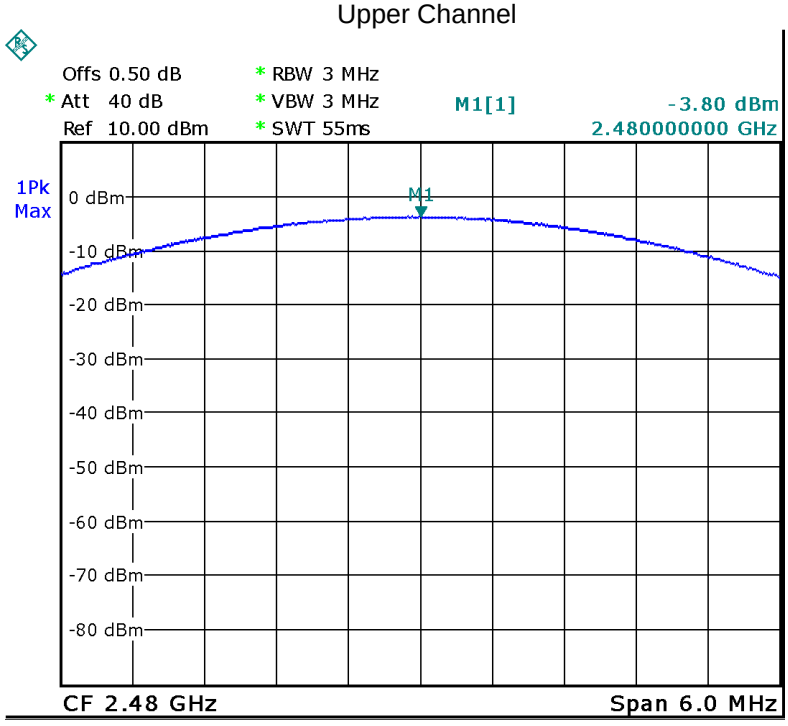
Lower Channel



Middle Channel



Upper Channel



13 Hopping Channel Separation

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 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 2400-2483.5MHz 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 1W.

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 the spectrum analyzer: RBW = 100KHz. VBW = 300KHz , Span = 6MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

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

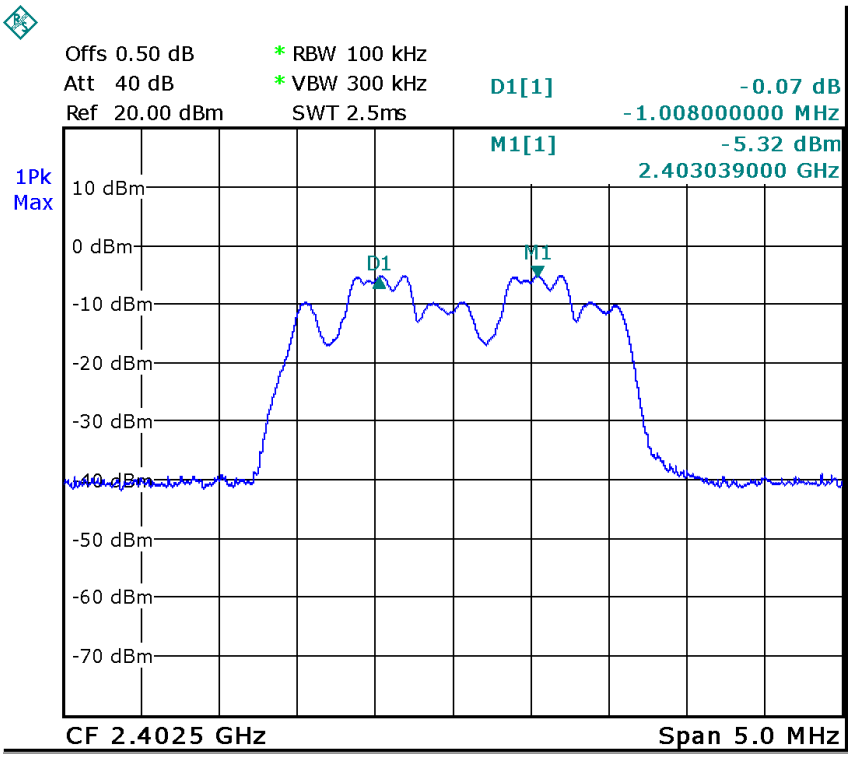
13.2 Test Result:

Modulation	Test Channel	Separation (MHz)
GFSK	Lower	1.008
	Middle	1.008
	Upper	1.008
Pi/4DQPSK	Lower	1.008
	Middle	1.018
	Upper	1.005
8DPSK	Lower	1.008
	Middle	1.008
	Upper	1.008

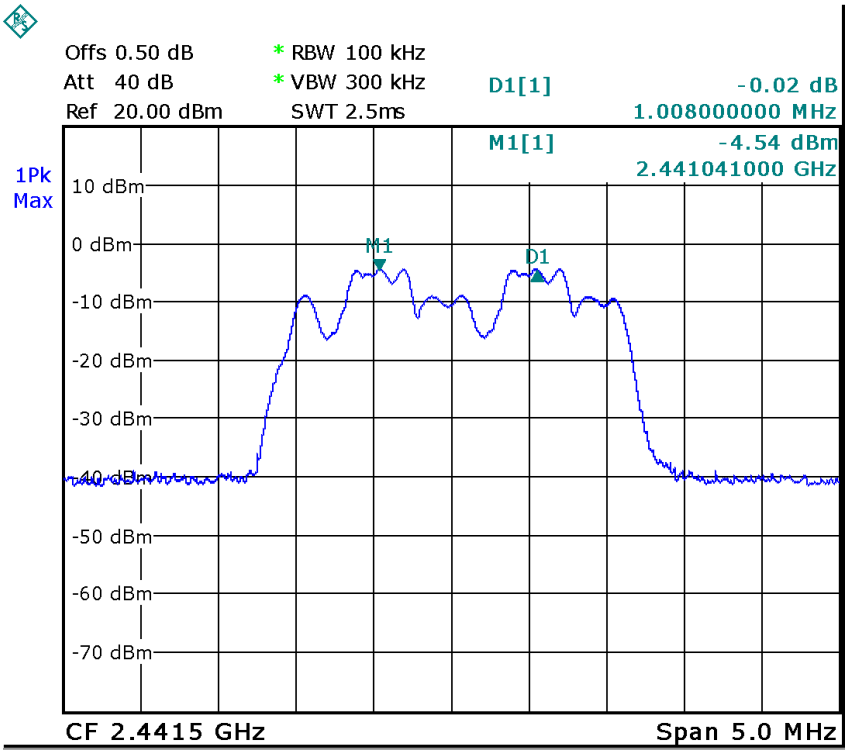
Test result plot as follows:

Modulation:GFSK

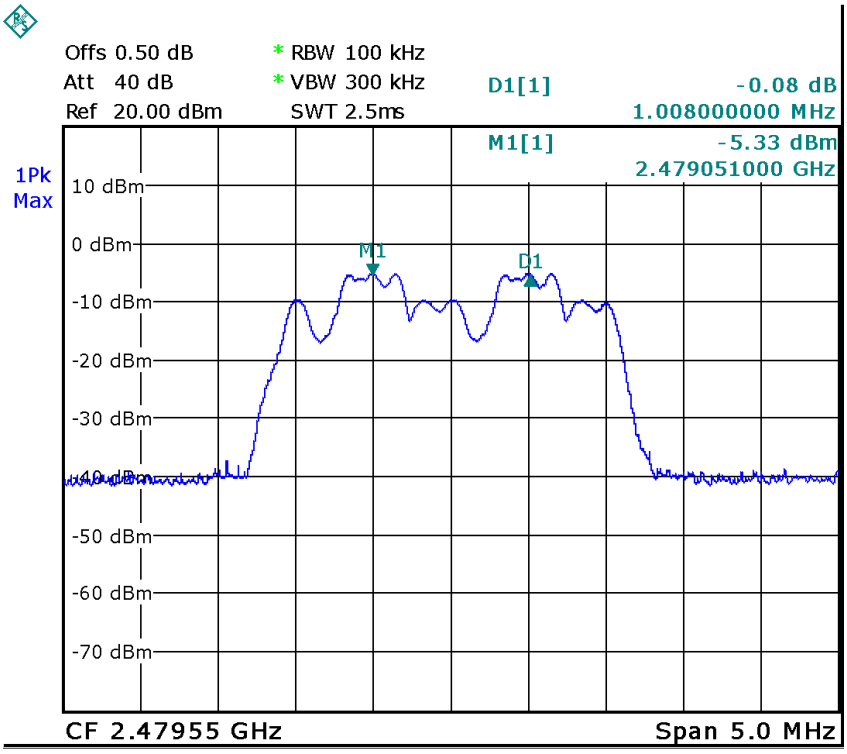
Lower Channel



Middle Channel

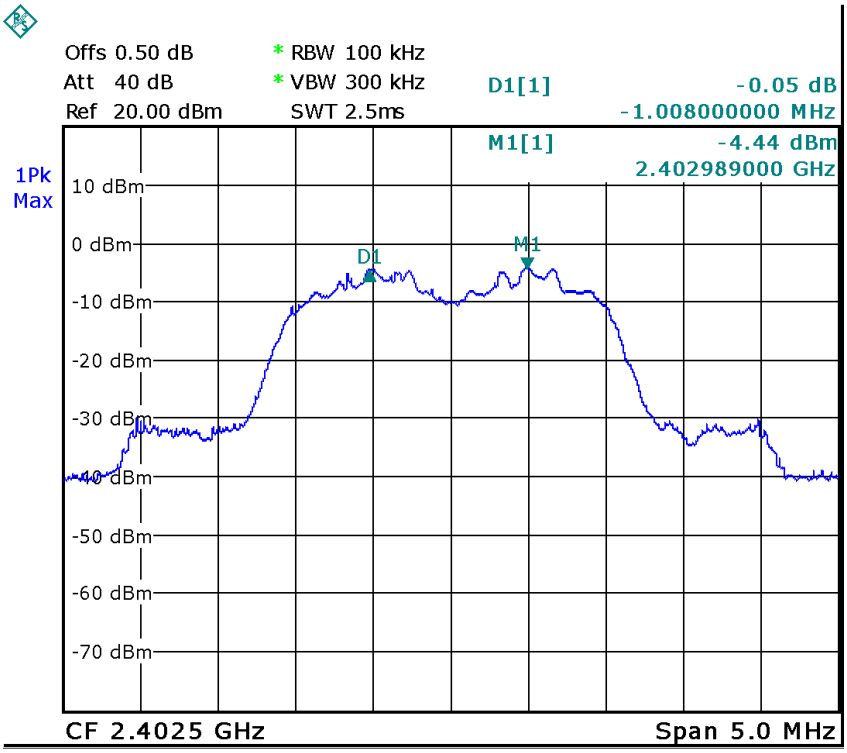


Upper Channel

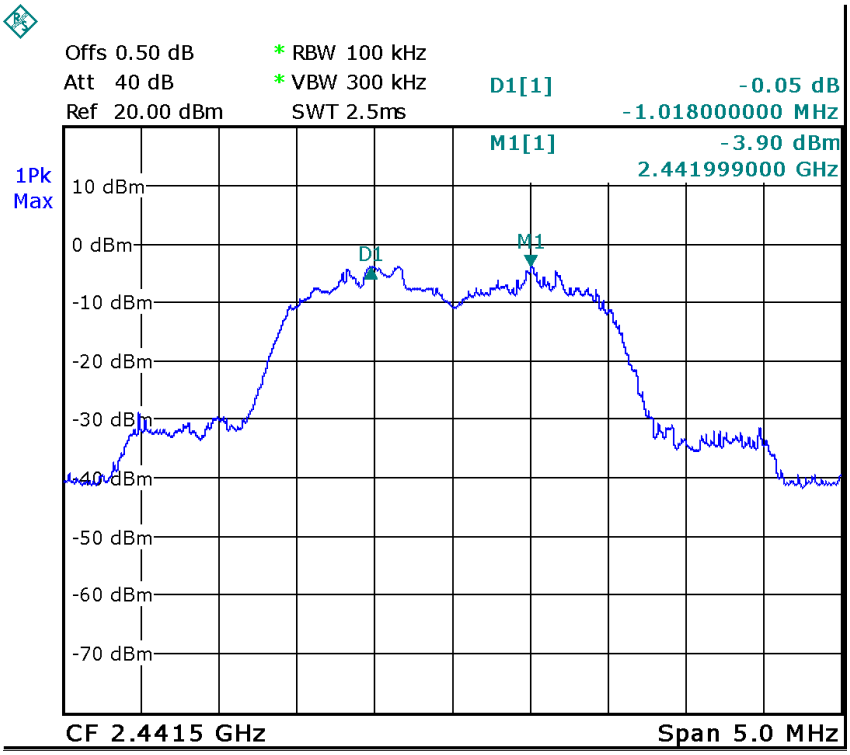


Modulation: Pi/4DQPSK

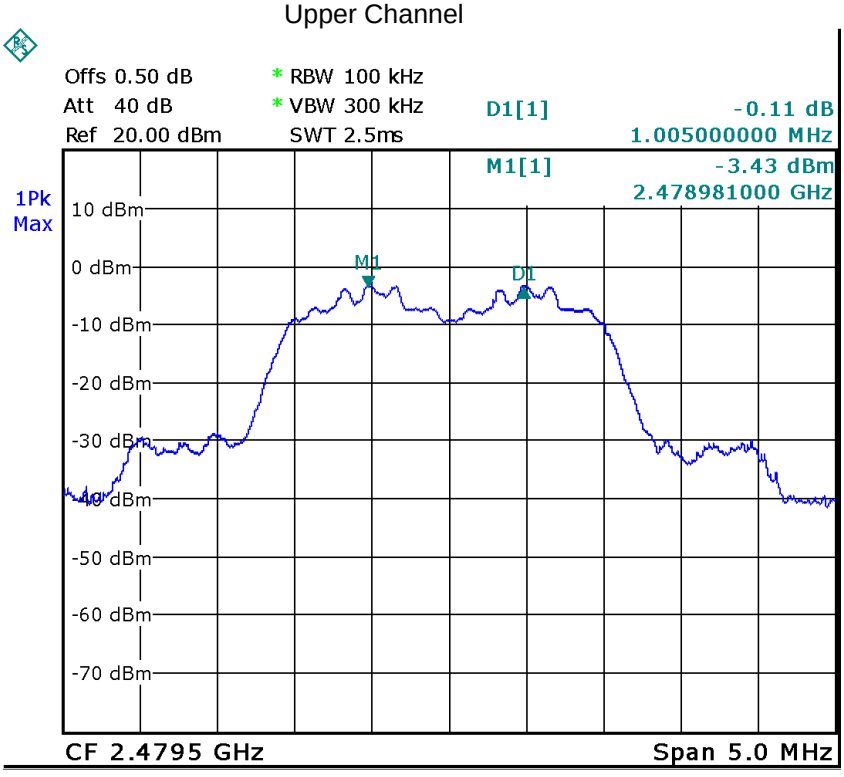
Lower Channel



Middle Channel

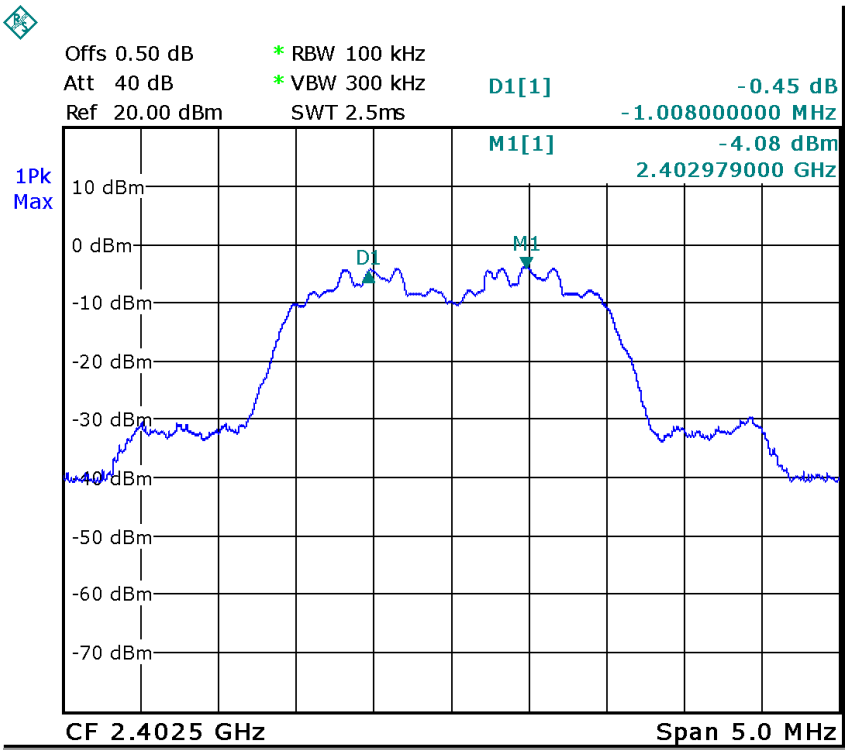


Upper Channel

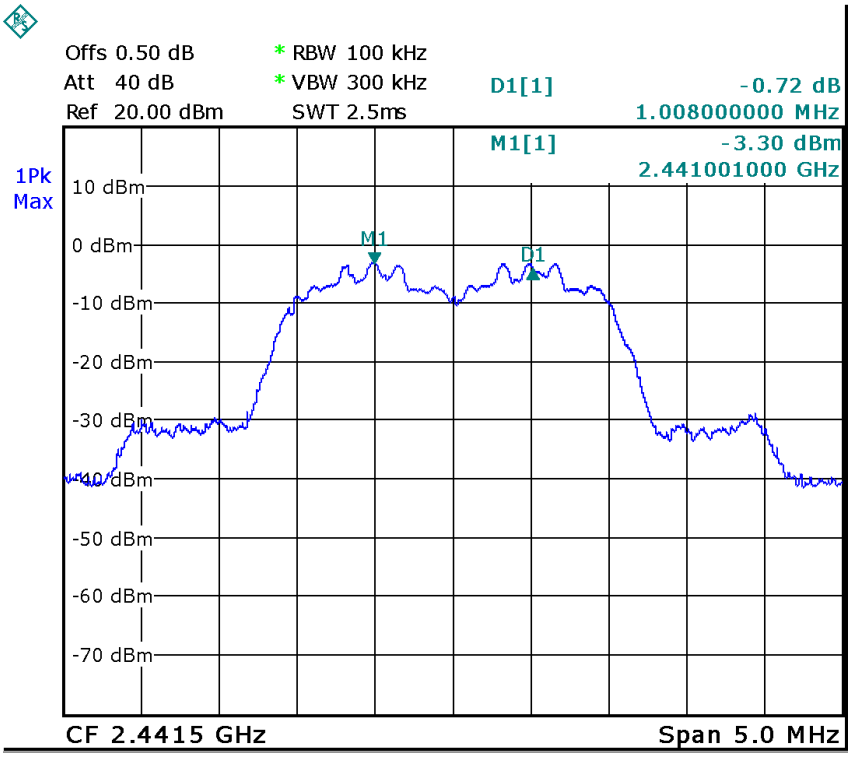


Modulation: 8DPSK

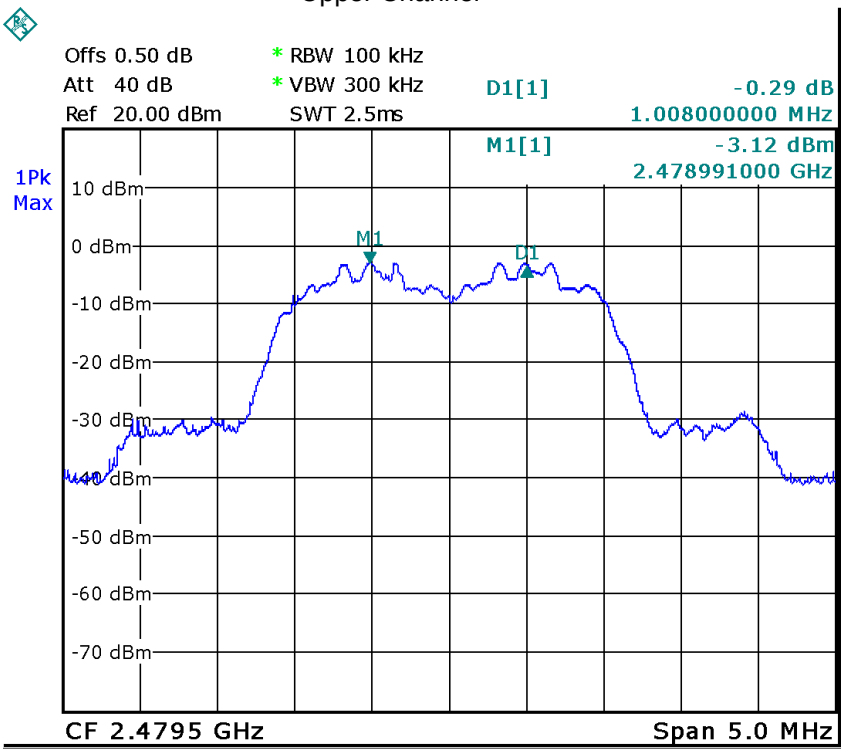
Lower Channel



Middle Channel



Upper Channel



14 Number of Hopping Frequency

Test Requirement:	FCC CFR47 Part 15 Section 15.247
Test Method:	DA 00-705
Test Limit:	Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Mode:	Test in hopping transmitting operating mode.

14.1 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 = 1MHz. VBW = 1MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

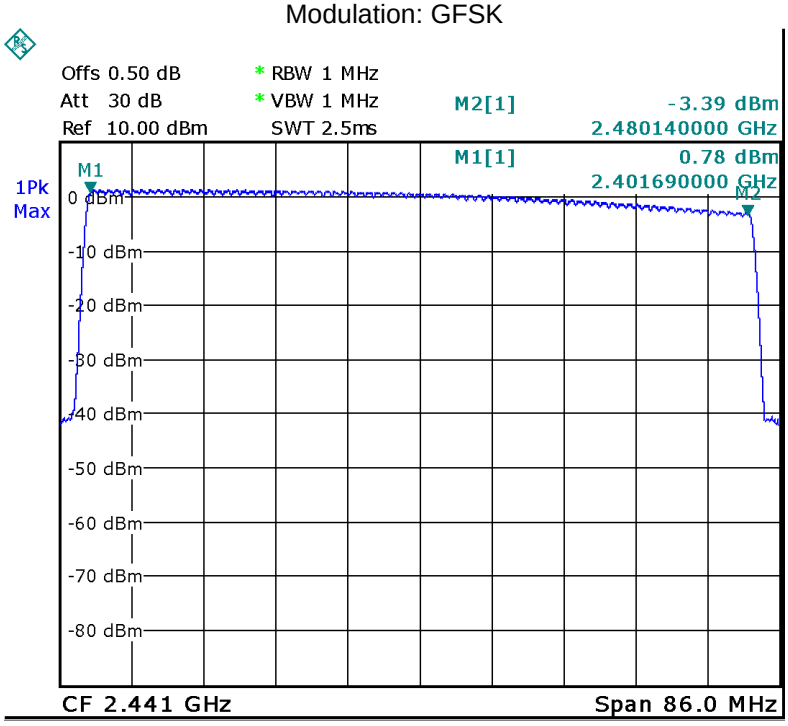
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

4. Set the spectrum analyzer: Centre Frequency = 2.441GHz, Span = 86MHz. Sweep=auto;

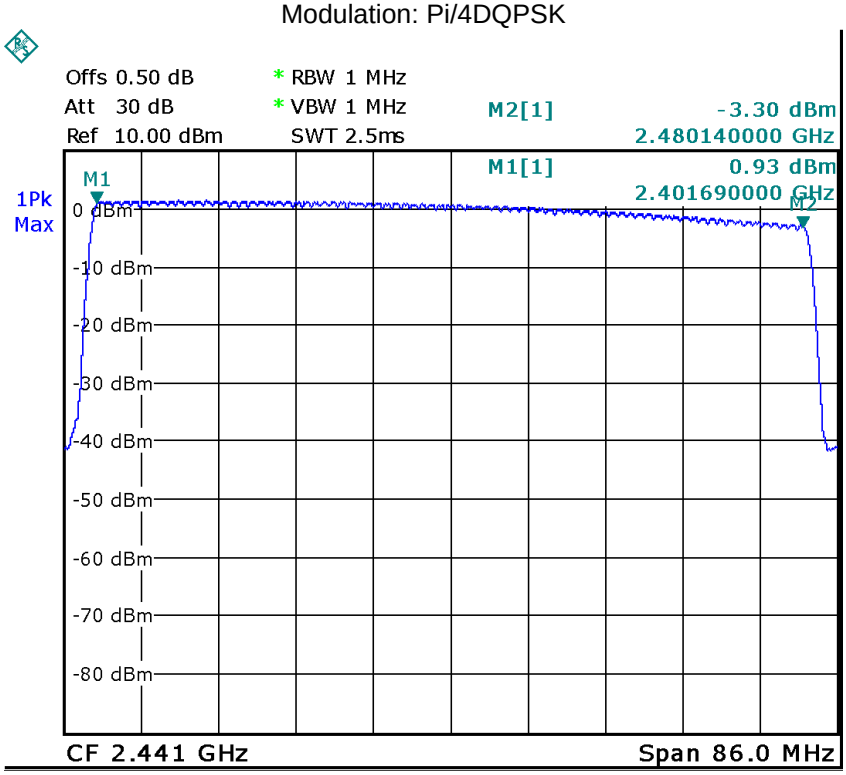
14.2 Test Result:

Total Channels are 79 Channels.

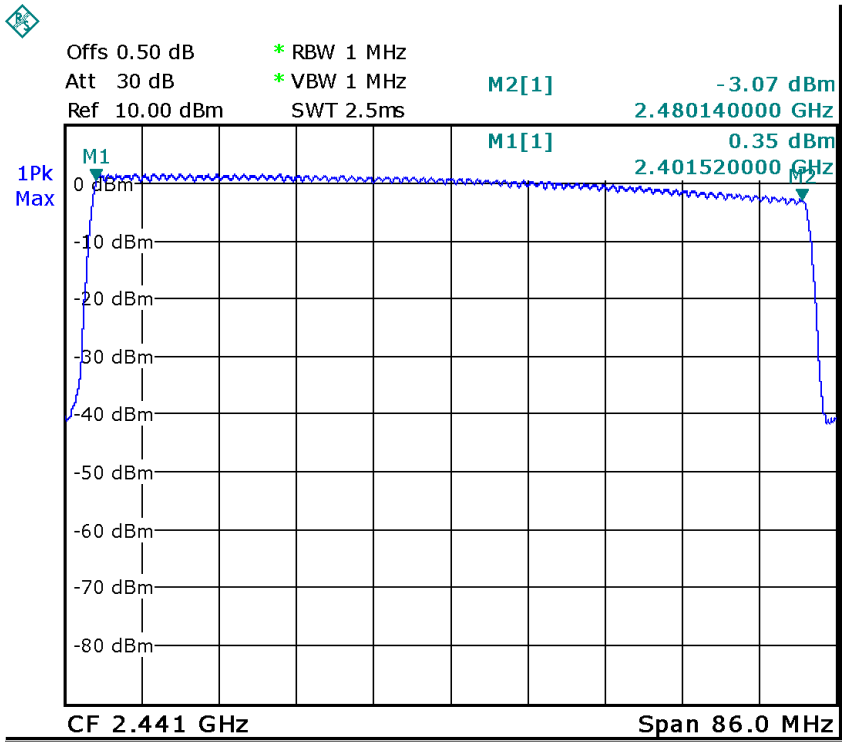
Modulation: GFSK



Modulation: Pi/4DQPSK



Modulation: 8DPSK



15 Dwell Time

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 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.

Test Mode: Test in hopping transmitting operating mode.

15.1 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.

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).

15.2 Test Result:

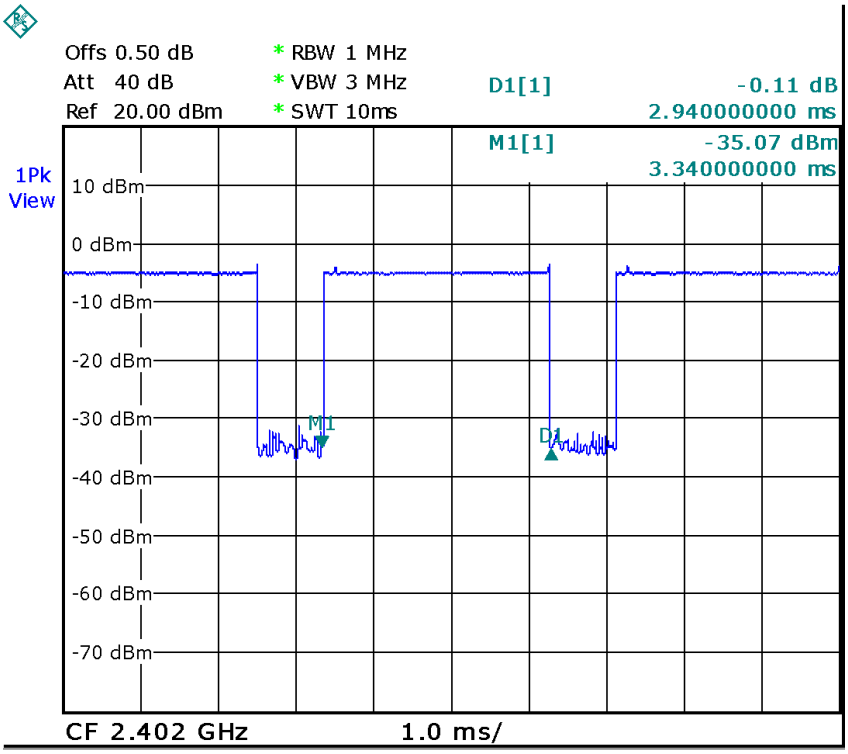
Mode	Hopping Channel Number	Hops Over Occupancy Time(hops)	Package Transfer Time(msec)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Normal	79	106.67	2.94	0.314	0.4	Pass
AFH	20	53.34	2.94	0.157	0.4	Pass

Remark:

1. In normal mode, hopping rate is 1600hops/s with 6 slots in 79 hopping channels. With channel hopping rate (1600 / 6 / 79) in Occupancy Time Limit (0.4 x 79) (s), Hops Over Occupancy Time comes to (1600 / 6 / 79) x (0.4 x 79) = 106.67 hops.
2. In AFH mode, hopping rate is 800hops/s with 6 slots in 20 hopping channels. With channel hopping rate (800 / 6 / 20) in Occupancy Time Limit (0.4 x 20) (s), Hops Over Occupancy Time comes to (800 / 6 / 20) x (0.4 x 20) = 53.34 hops.
3. Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

Measurement Plot

Data Packet:DH5



16 Antenna Requirement

According to the FCC Part 15 Paragraph 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. This product has a PCB printed antenna, fulfil the requirement of this section.

17 RF Exposure

Test Requirement: FCC Part 1.1307

Test Mode: The EUT work in test mode(Tx).

17.1 Requiments:

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.

17.2 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

17.3 MPE Calculation Method

$$E\ (V/m) = \frac{\sqrt{30 \times P \times G}}{d} \qquad \text{Power Density: } Pd\ (W/m^2) = \frac{E^2}{377}$$

E = Electric field (V/m)
P = Peak RF output power (W)
G = EUT Antenna numeric gain (numeric) ,$Gain_{numeric}=10^{(dBi/10)}$
d = Separation distance between radiator and human body (m)
The formula can be changed to

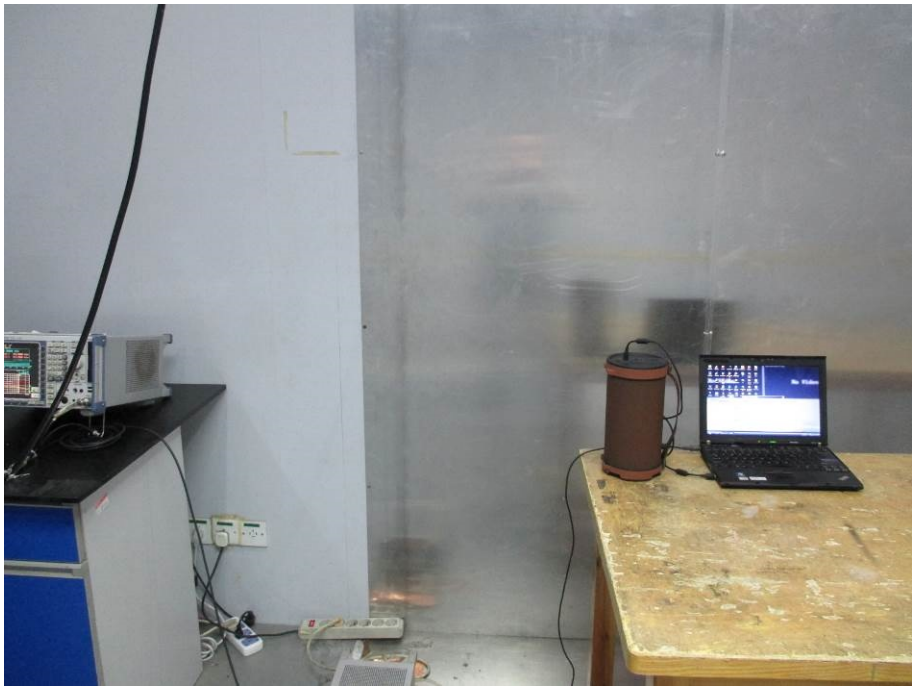
$$\boldsymbol{Pd} = \frac{30 \times P \times G}{377 \times d^2}$$

From the peak EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the gain of the used antenna, the RF power density can be obtained

Modulation	Antenna Gain (dBi)	Antenna Gain (numeric)	Max. Output Power (dBm)	Peak Output Power (mW)	Power Density (S) (mW/cm^2)	Limit of Power Density (S) (mW/cm^2)
GFSK	0	1	-1.92	0.643	0.000127856	1
Pi/4DQPSK	0	1	-2.01	0.630	0.000125233	1
8DPSK	0	1	-3.03	0.498	0.0000990193	1

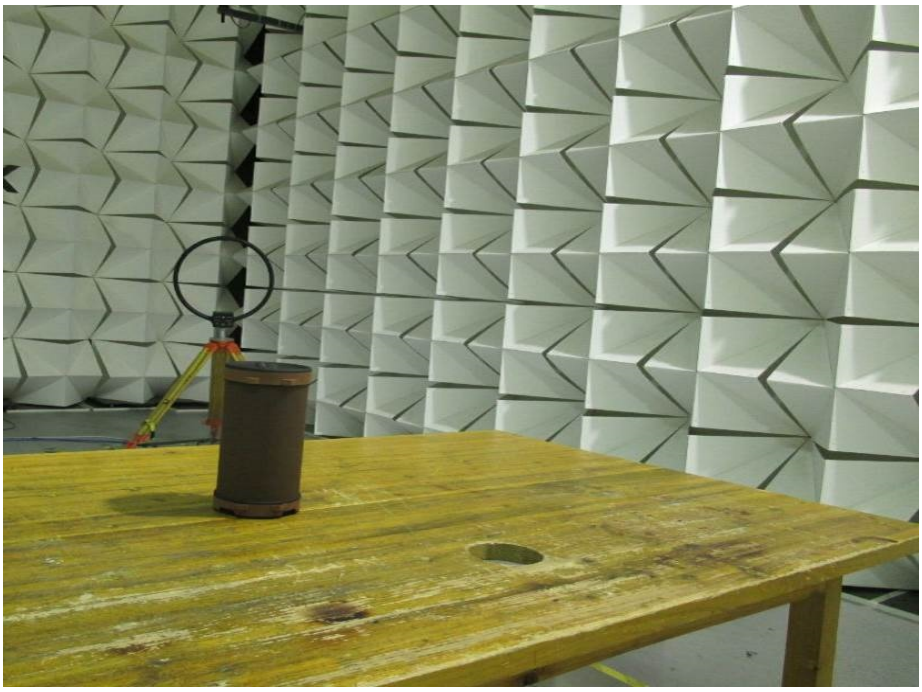
18 Photographs – Test Setup

18.1 Conducted Emissions

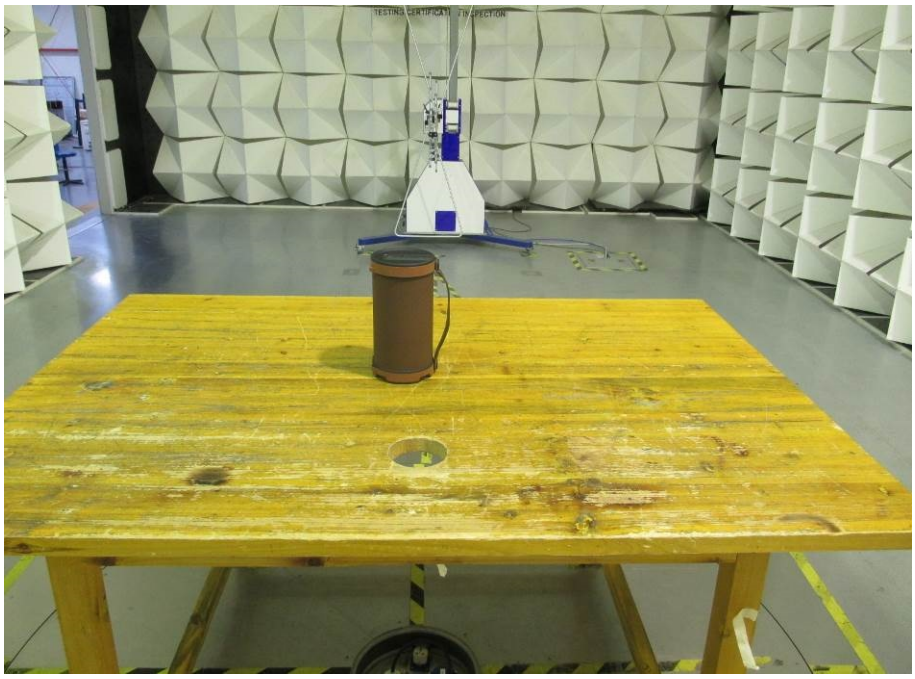


18.2 Radiated Emissions

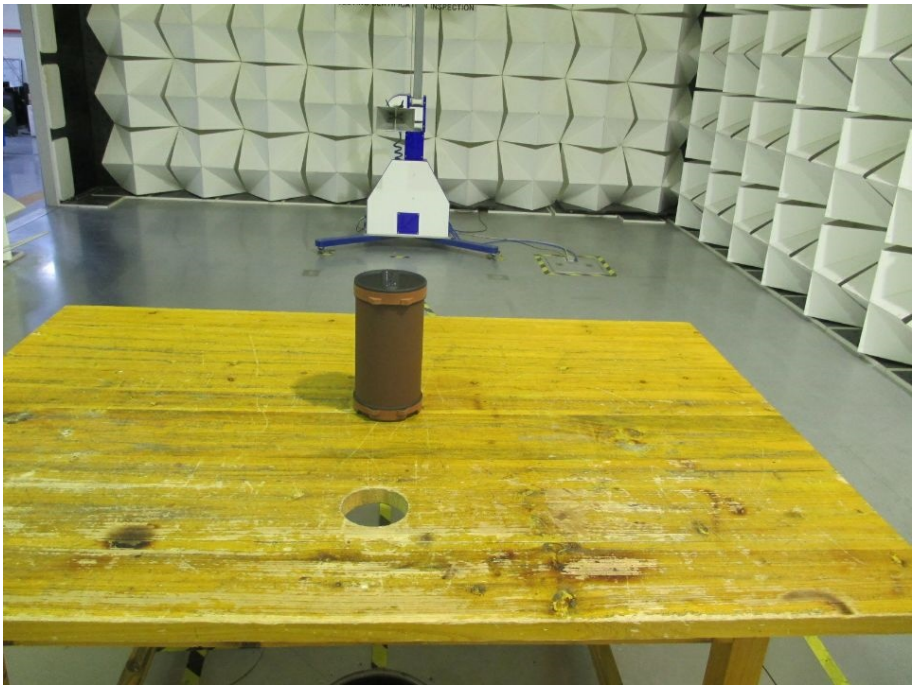
Below 30MHz



From 30-1000MHz



Above 1GHz

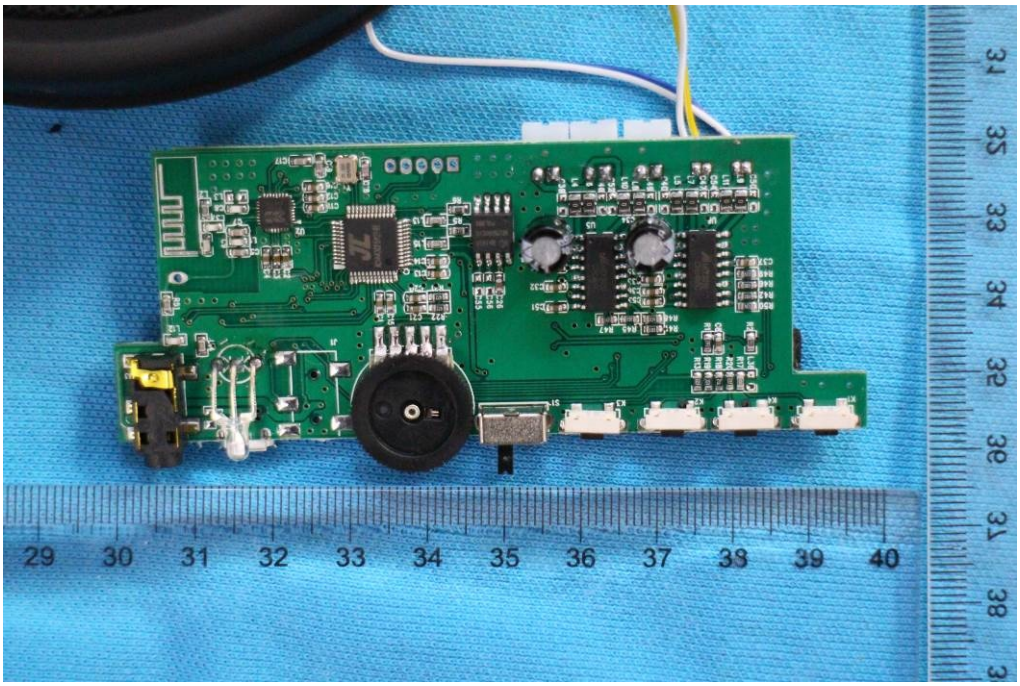


19 Photographs - Constructional Details

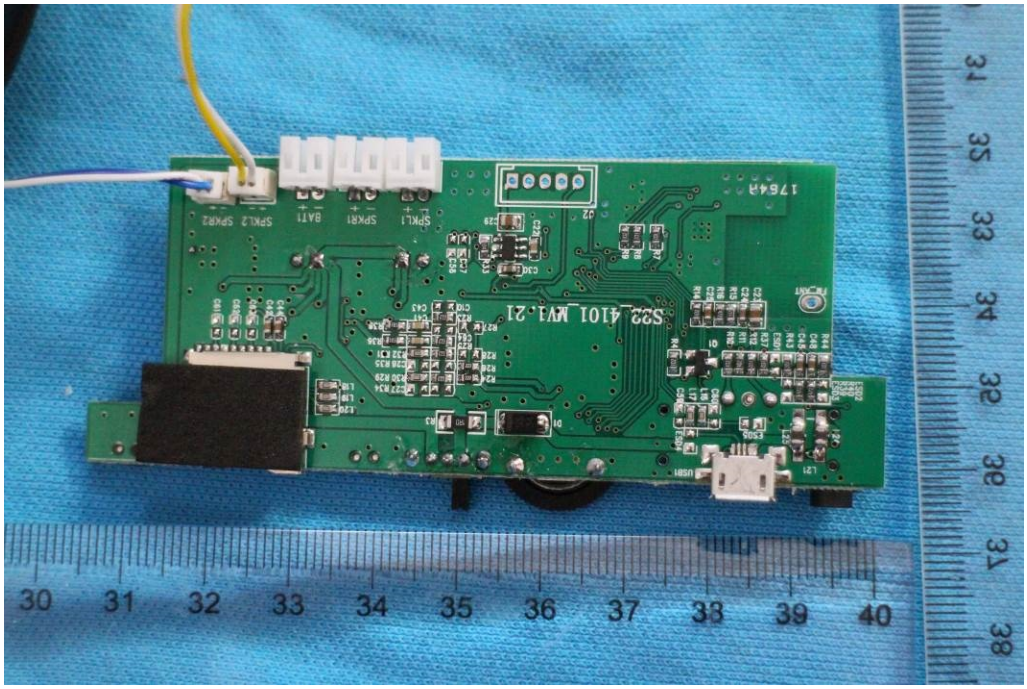
19.1 EUT – External View

19.2 EUT – External View

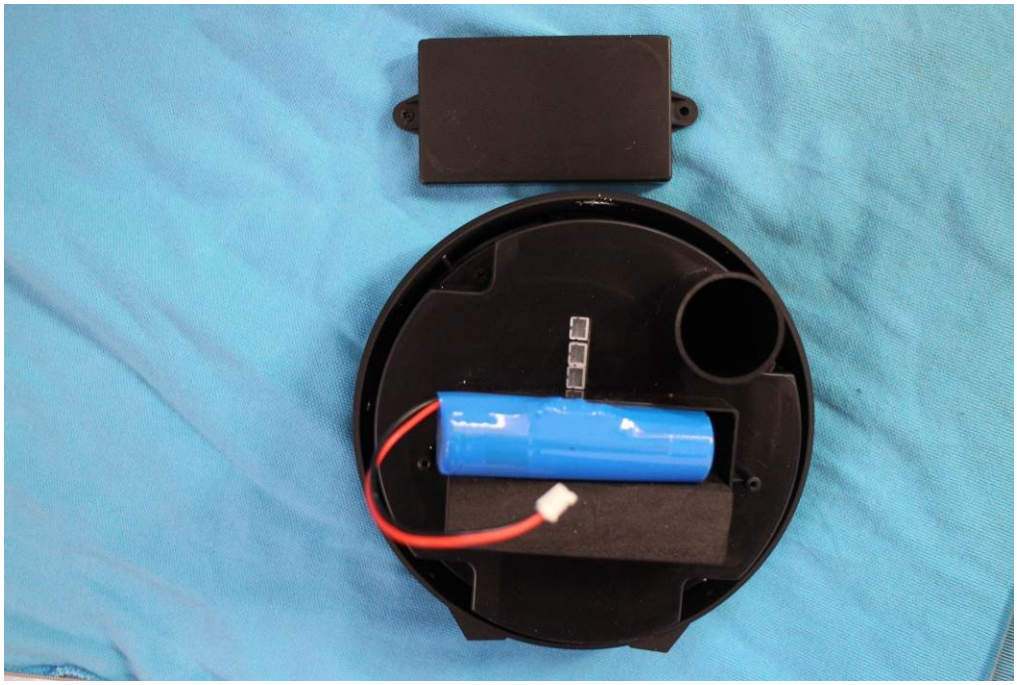
19.3 EUT – Internal View



19.4 EUT – Internal View



19.5 EUT – Internal View



========== End of test report ==========