FCC TEST REPORT

FCC ID	: 2ABQE-BT65
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	: Bluetooth FM Transmitter
Model No.	: BT65 .
Brand Name	: N/A
Standards	: FCC Part15.247:2012
Date of Test	: June 20~27, 2014
Date of Issue	: June 27, 2014
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.

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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

3 Contents

Page

1 COVER PAGE 1

2 TEST SUMMARY 2

3 CONTENTS 3

4 GENERAL INFORMATION 5

4.1 GENERAL DESCRIPTION OF E.U.T. 5
4.2 DETAILS OF E.U.T. 5
4.3 CHANNEL LIST 5
4.4 DESCRIPTION OF SUPPORT UNITS 5
4.5 STANDARDS APPLICABLE FOR TESTING 6
4.6 TEST LOCATION 6

5 EQUIPMENT USED DURING TEST 7

5.1 EQUIPMENTS LIST 7
5.2 MEASUREMENT UNCERTAINTY 7
5.3 TEST EQUIPMENT CALIBRATION 7

6 CONDUCTED EMISSION 8

6.1 E.U.T. OPERATION 8
6.2 EUT SETUP 8
6.3 CONDUCTED EMISSION TEST RESULT 8

7 SPURIOUS RADIATED EMISSIONS 9

7.1 EUT OPERATION : 9
7.2 TEST SETUP 10
7.3 SPECTRUM ANALYZER SETUP 11
7.4 TEST PROCEDURE 12
7.5 CORRECTED AMPLITUDE & MARGIN CALCULATION 12
7.6 SUMMARY OF TEST RESULTS 13

8 SPURIOUS RF CONDUCTED EMISSIONS FROM OUT OF BAND 21

2.1 TEST PROCEDURE 21
2.2 TEST RESULT 21

3 DUTY CYCLE 31

3.1 TEST PROCEDURE 31
3.2 TEST RESULT 31

4 BAND EDGE MEASUREMENT 33

4.1 TEST PROCEDURE 33
4.2 TEST RESULT: 34

5 20 DB BANDWIDTH MEASUREMENT 38

5.1 TEST PROCEDURE: 38
5.2 TEST RESULT: 38

6 MAXIMUM PEAK OUTPUT POWER 40

6.1 TEST PROCEDURE: 40
6.2 TEST RESULT: 40

7 HOPPING CHANNEL SEPARATION 42

7.1 TEST PROCEDURE: 42
7.2 TEST RESULT: 42

8 NUMBER OF HOPPING FREQUENCY 44
8.1 TEST PROCEDURE: 44
8.2 TEST RESULT: 44
9 DWELL TIME 45
9.1 TEST PROCEDURE: 45
9.2 TEST RESULT: 45
10 ANTENNA REQUIREMENT 61
11 RF EXPOSURE 62
11.1 REQUIMENTS: 62
11.2 THE PROCEDURES / LIMIT 62
11.3 MPE CALCULATION METHOD 63
9 PHOTOGRAPHS – TEST SETUP 64
9.1 RADIATED EMISSIONS 64
10 PHOTOGRAPHS - CONSTRUCTIONAL DETAILS 66
10.1 EUT – EXTERNAL VIEW(1) 66
10.2 EUT – EXTERNAL VIEW(2) 66
10.3 EUT – EXTERNAL VIEW(3) 67
10.4 EUT – EXTERNAL VIEW(4) 67
10.5 EUT –INTERNAL VIEW(1) 68
10.6 EUT –INTERNAL VIEW(2) 68
10.7 EUT –INTERNAL VIEW(3) 69
10.8 EUT –INTERNAL VIEW(4) 69
10.9 EUT –INTERNAL VIEW(5) 70

4 General Information

4.1 General Description of E.U.T.

Product Name : Bluetooth FM Transmitter

Model No. : BT65

Brand Name : N/A

Model Description : N/A

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

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

Oscillator : Crystal 12MHz for RF module

Antenna installation : PCB Printed Antenna

Antenna Gain : 0 dBi

4.2 Details of E.U.T.

Technical Data : DC12.0-24.0V.

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 Description of Support Units

The EUT has been tested as an independent unit.

4.5 Standards Applicable for Testing

The customer requested FCC tests for the EUT. The standards used were FCC 15 Paragraph 15.247, Paragraph 15.205, Paragraph 15.207, Paragraph 15.31,Paragraph 15.33, Paragraph 15.35.

4.6 Test Location

All the tests were performed at:
Waltek Services(Shenzhen) Co., Ltd. at 1/F, Fukangtai Building, West Baima Rd.,Songgang Street, Baoan District, Shenzhen, China

Waltek Services(Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 880581, April 29, 2014.

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	101155	April. 13,2014	April. 12,2015
2.	LISN	SCHWARZBECK	NSLK 8128	8128-289	April. 13,2014	April. 12,2015
3.	Cable	LARGE	RF300	EW02014-3	April. 13,2014	April. 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	April. 13,2014	April. 12,2015
2.	Active Loop Antenna	Beijing Dazhi	ZN30900A	-	April. 13,2014	April. 12,2015
3.	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	April. 13,2014	April. 12,2015
4.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	April. 13,2014	April. 12,2015
5.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	399	April. 13,2014	April. 12,2015
6.	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	April. 13,2014	April. 12,2015
7.	Broadband Preamplifier	SCHWARZBECK	BBV 9718	9718-148	April. 13,2014	April. 12,2015
8.	Cable	Top	EWO2014-7	-	April. 13,2014	April. 12,2015
9.	Cable	Top	TYPE16(13M)	-	April. 13,2014	April. 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)

5.3 Test Equipment Calibration

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

6 Conducted Emission

Test Requirement:	FCC CFR 47 Part 15 Section 15.207
Test Method:	ANSI C63.4:2003
Test Result:	N/A
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

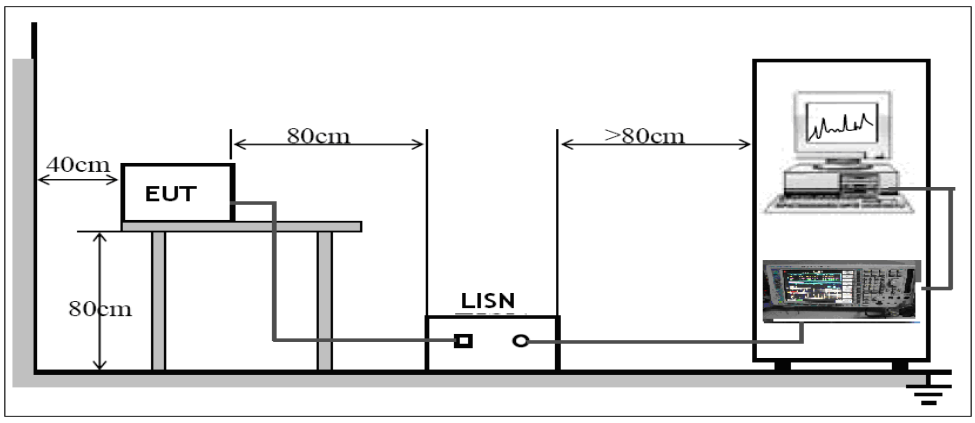
EUT Operation:

The EUT uses by the DC battery ,so the EUT wasn't tested in the report.

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.

Remark: The EUT uses by the DC battery, so the EUT wasn't tested in the report.

7 Spurious Radiated Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method: DA 00-705

Test Result: PASS

Measurement Distance: 3m

Limit:

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

7.1 EUT Operation :

Operating Environment:

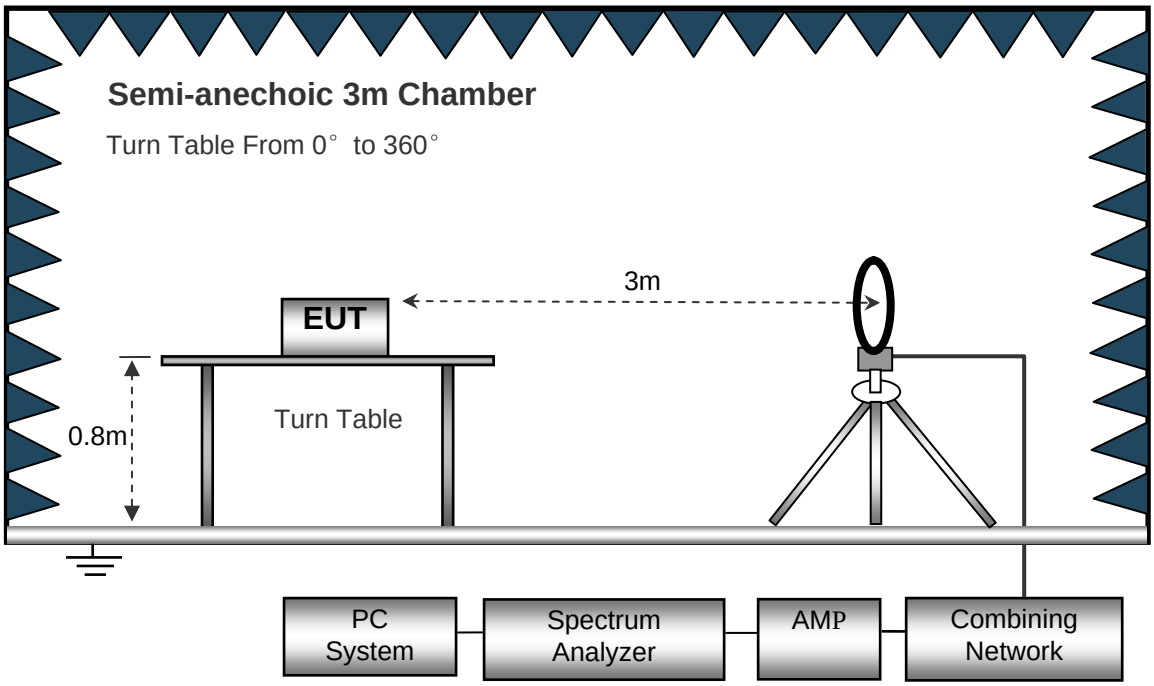
Temperature: 25.5 °C

Humidity: 51 % RH

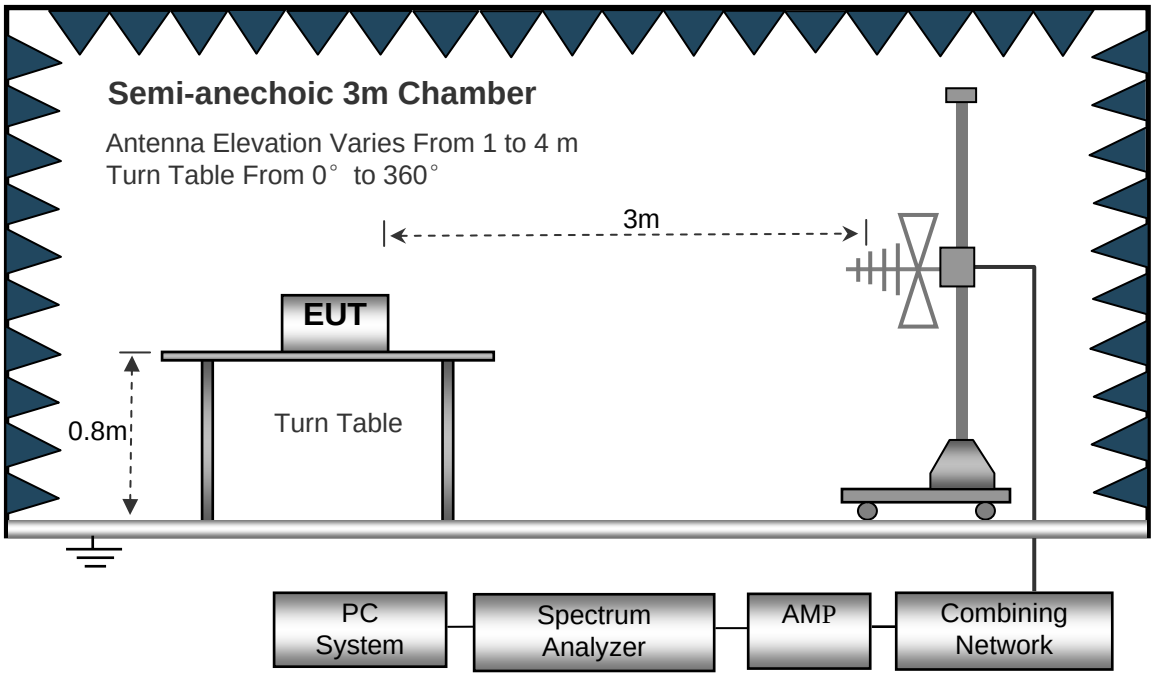
Atmospheric Pressure:1001 mbar

7.2 Test Setup

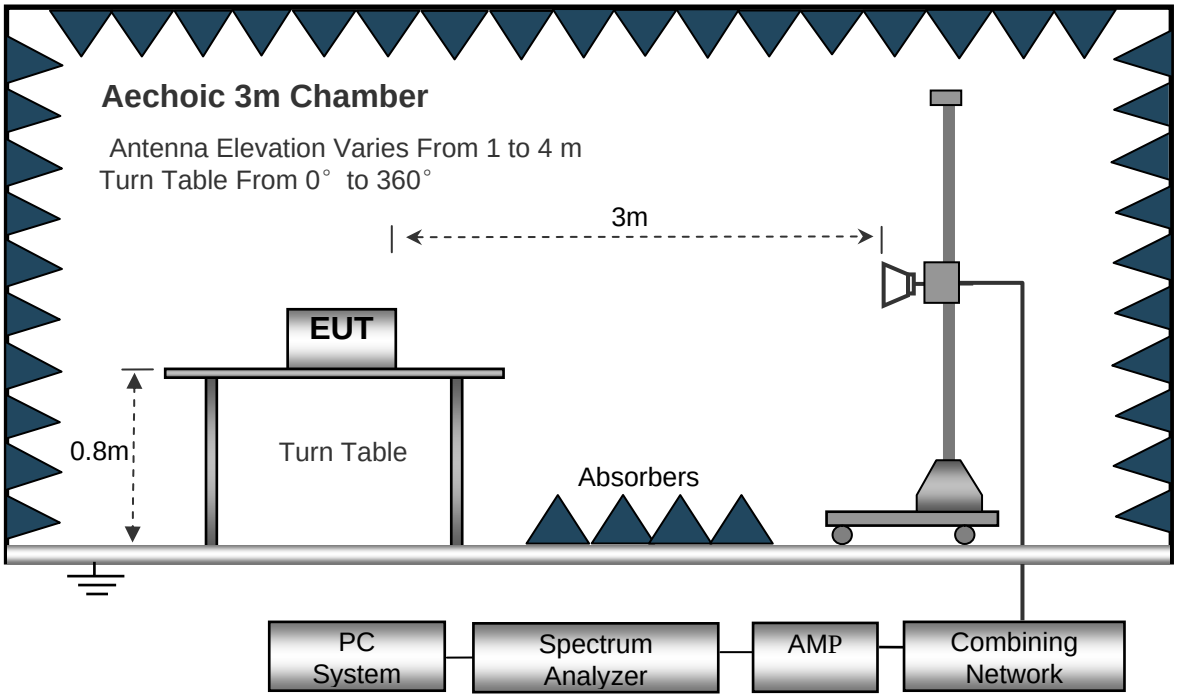
The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.4: 2003.
The test setup for emission measurement below 30MHz.



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 9kHz 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

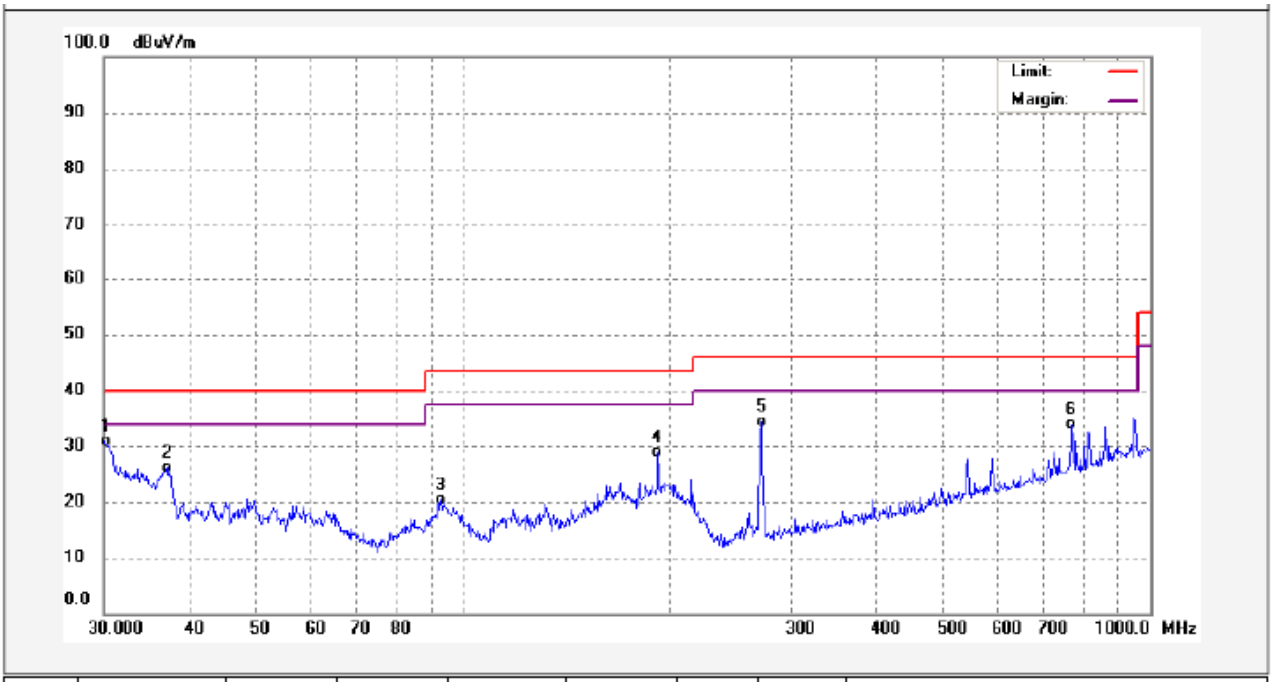
Test Frequency :Below 30MHz

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

Test Frequency : 30MHz ~ 1000MHz

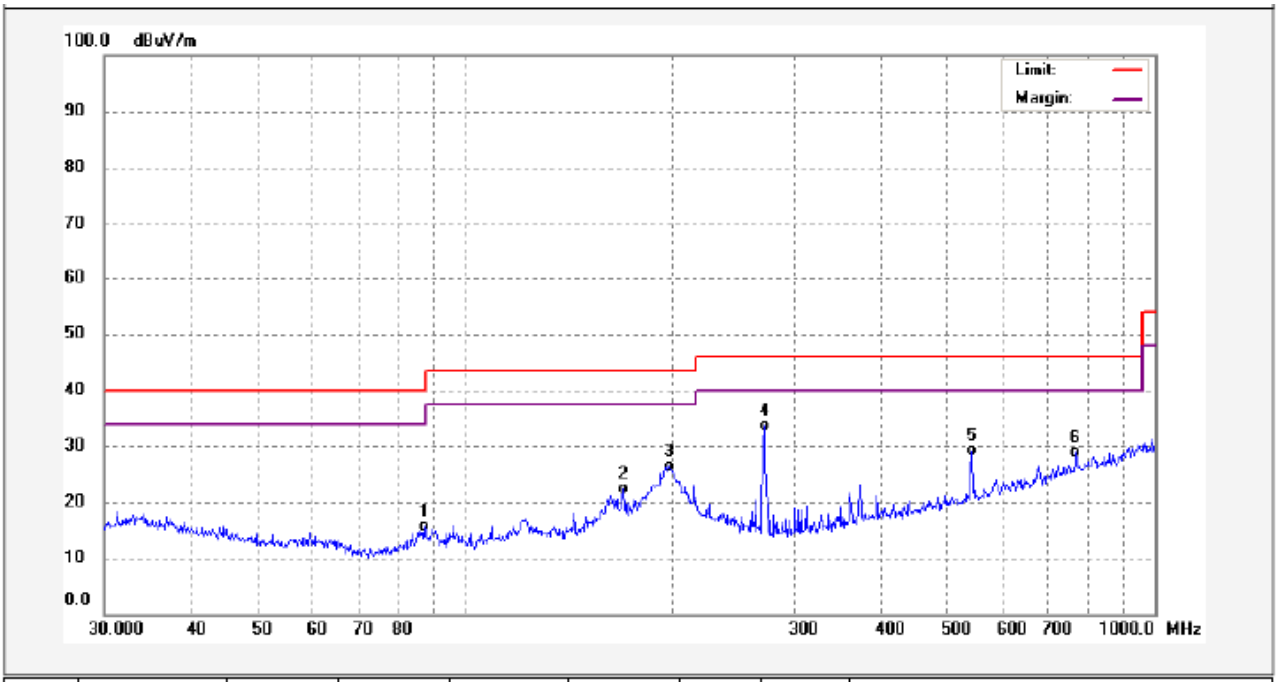
Remark: the EUT was pretested at the high, middle and low channel, and the worse case was the middle Channel, so the data show was the middle channel only.

Antenna polarization: Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	30.1054	49.21	-18.38	30.83	40.00	-9.17	QP	
2	37.0248	46.52	-20.36	26.16	40.00	-13.84	QP	
3	92.7871	44.77	-24.32	20.45	43.50	-23.05	QP	
4	191.7450	52.21	-23.29	28.92	43.50	-14.58	QP	
5	271.3246	55.06	-20.76	34.30	46.00	-11.70	QP	
6	768.7481	41.87	-8.04	33.83	46.00	-12.17	QP	

Antenna polarization: Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	87.1117	41.19	-25.67	15.52	40.00	-24.48	QP	
2	169.5990	43.50	-21.20	22.30	43.50	-21.20	QP	
3	197.8928	50.19	-23.69	26.50	43.50	-17.00	QP	
4	271.3246	54.33	-20.68	33.65	46.00	-12.35	QP	
5	543.2742	42.35	-13.29	29.06	46.00	-16.94	QP	
6	768.7481	36.73	-7.90	28.83	46.00	-17.17	QP	

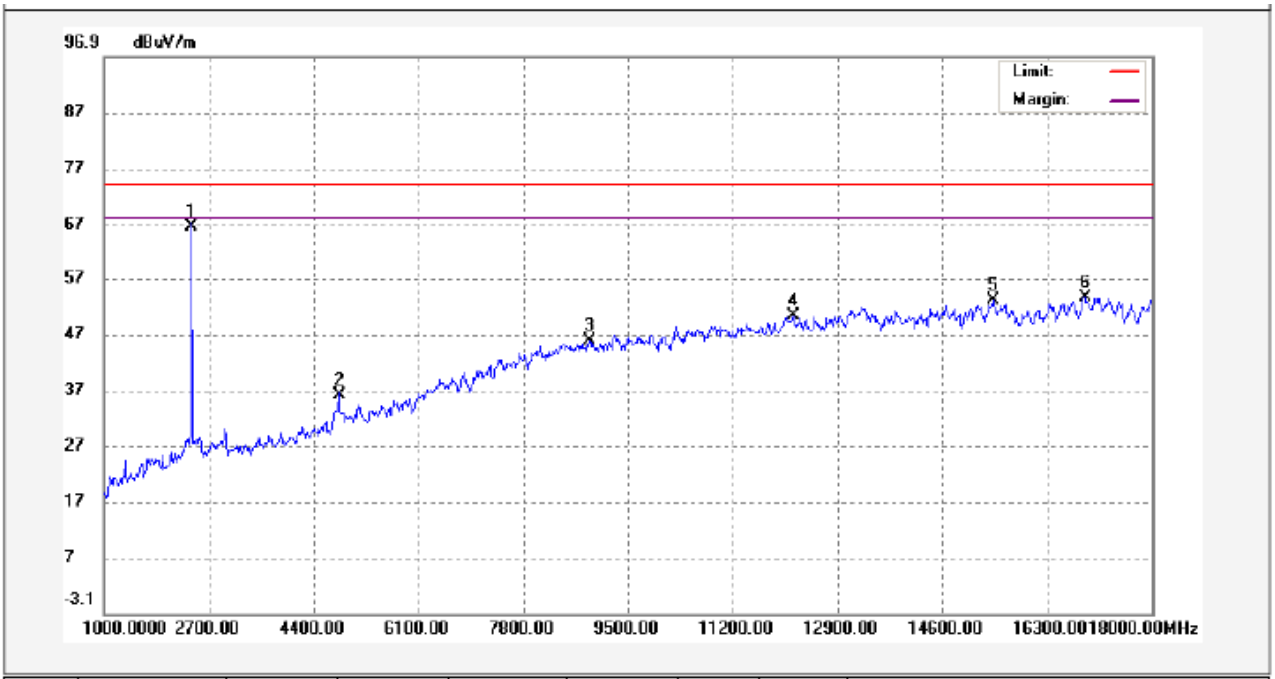
Test Frequency: 1GHz ~ 18GHz

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+(-9)=PK-9 [refer to section 9 for more detail]

Test mode: transmitting at lower channel

Antenna polarization: Vertical

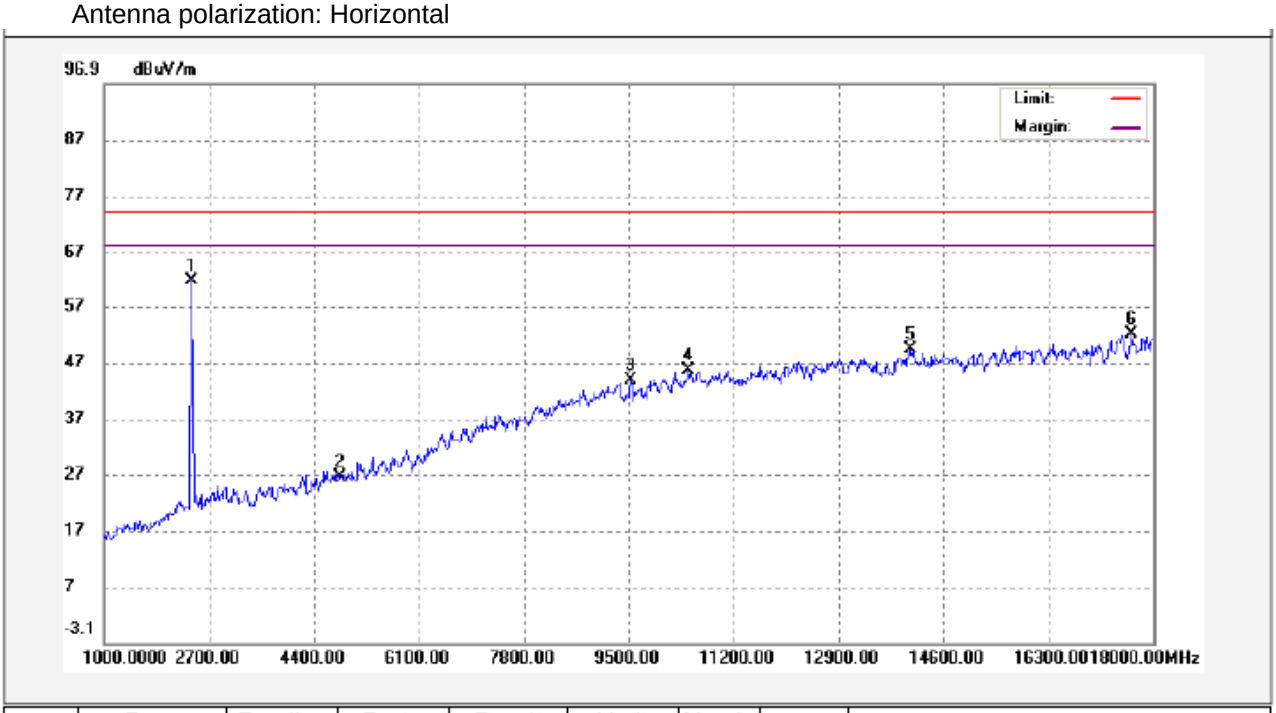


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2402.000	82.22	-15.59	66.63	74.00	-7.37	peak	
2	4804.000	48.11	-11.97	36.14	74.00	-37.86	peak	
3	8871.000	52.26	-6.58	45.68	74.00	-28.32	peak	
4	12186.000	54.56	-4.39	50.17	74.00	-23.83	peak	
5	15416.000	55.96	-2.94	53.02	74.00	-20.98	peak	
6	16912.000	53.44	0.18	53.62	74.00	-20.38	peak	

Remark: the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4804.000	-9	27.14	54.00	-26.86	AV	
3	8871.000	-9	36.68	54.00	-17.32	AV	
4	12186.000	-9	41.17	54.00	-12.83	AV	
5	15416.000	-9	44.02	54.00	-9.98	AV	
6	16912.000	-9	44.62	54.00	-9.38	AV	

Antenna polarization: Horizontal



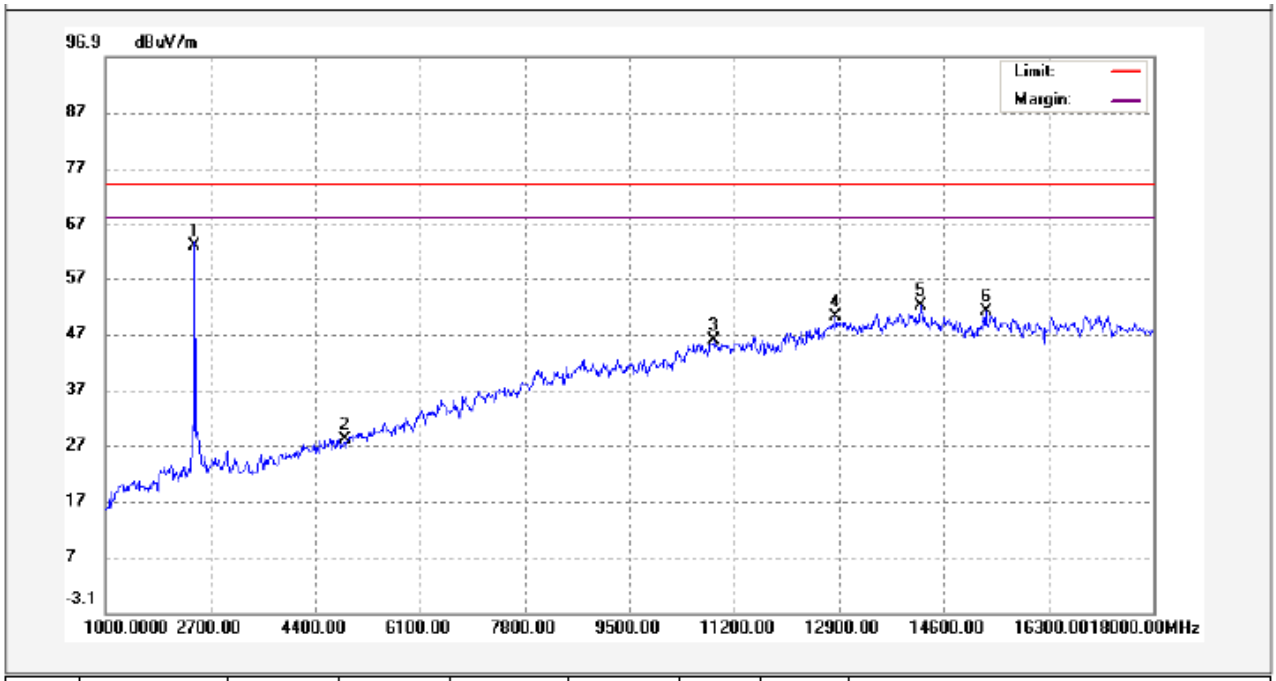
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2402.000	77.33	-15.59	61.74	74.00	-12.26	peak	
2	4804.000	38.57	-11.97	26.60	74.00	-47.40	peak	
3	9534.000	49.59	-5.77	43.82	74.00	-30.18	peak	
4	10469.000	49.68	-4.26	45.42	74.00	-28.58	peak	
5	14073.000	49.80	-0.46	49.34	74.00	-24.66	peak	
6	17643.000	48.71	3.20	51.91	74.00	-22.09	peak	

Remark:the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4804.000	-9	17.6	54.00	-36.4	AV	
3	9534.000	-9	34.82	54.00	-19.18	AV	
4	10469.000	-9	36.42	54.00	-17.58	AV	
5	14073.000	-9	40.34	54.00	-13.66	AV	
6	17643.000	-9	42.91	54.00	-11.09	AV	

Test mode: transmitting at middle channel

Antenna polarization: Vertical

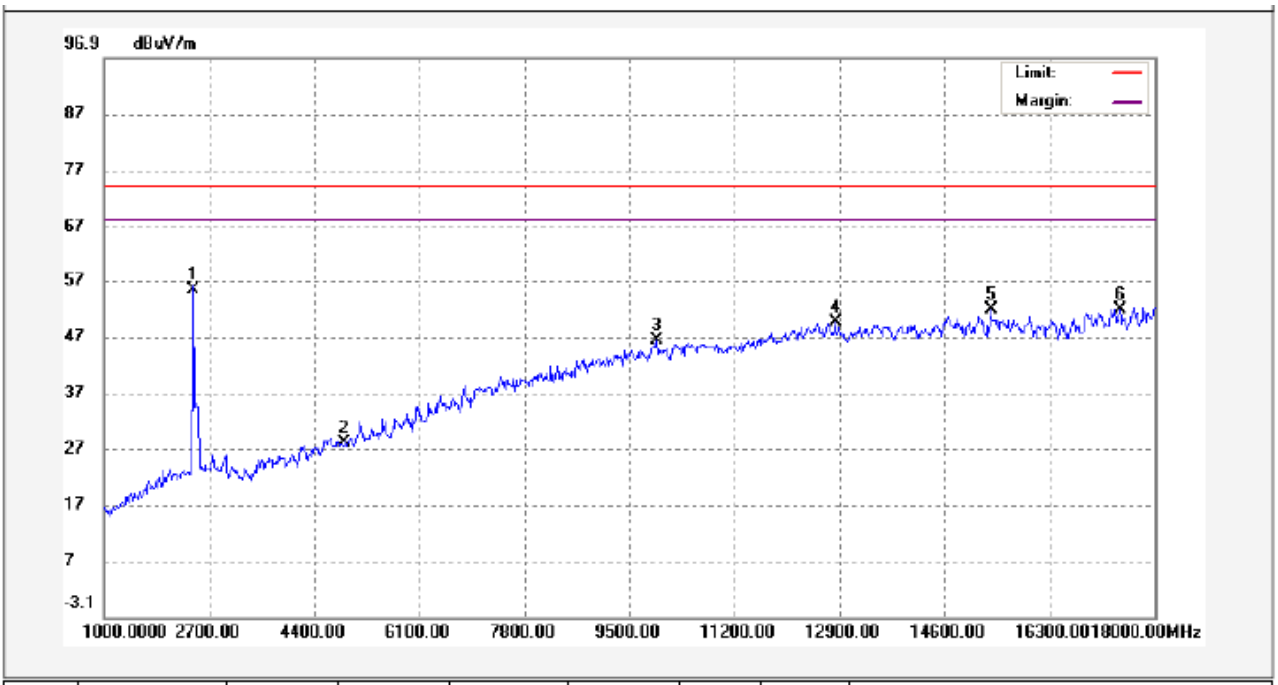


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2441.000	78.65	-15.70	62.95	74.00	-11.05	peak	
2	4882.000	39.95	-11.92	28.03	74.00	-45.97	peak	
3	10877.000	49.25	-3.58	45.67	74.00	-28.33	peak	
4	12849.000	54.16	-4.11	50.05	74.00	-23.95	peak	
5	14226.000	51.97	-0.01	51.96	74.00	-22.04	peak	
6	15280.000	53.34	-2.35	50.99	74.00	-23.01	peak	

Remark:the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4882.000	-9	19.03	54.00	-34.97	AV	
3	10877.000	-9	36.67	54.00	-17.33	AV	
4	12849.000	-9	41.05	54.00	-12.95	AV	
5	14226.000	-9	42.96	54.00	-11.04	AV	
6	15280.000	-9	41.99	54.00	-12.01	AV	

Antenna polarization: Horizontal



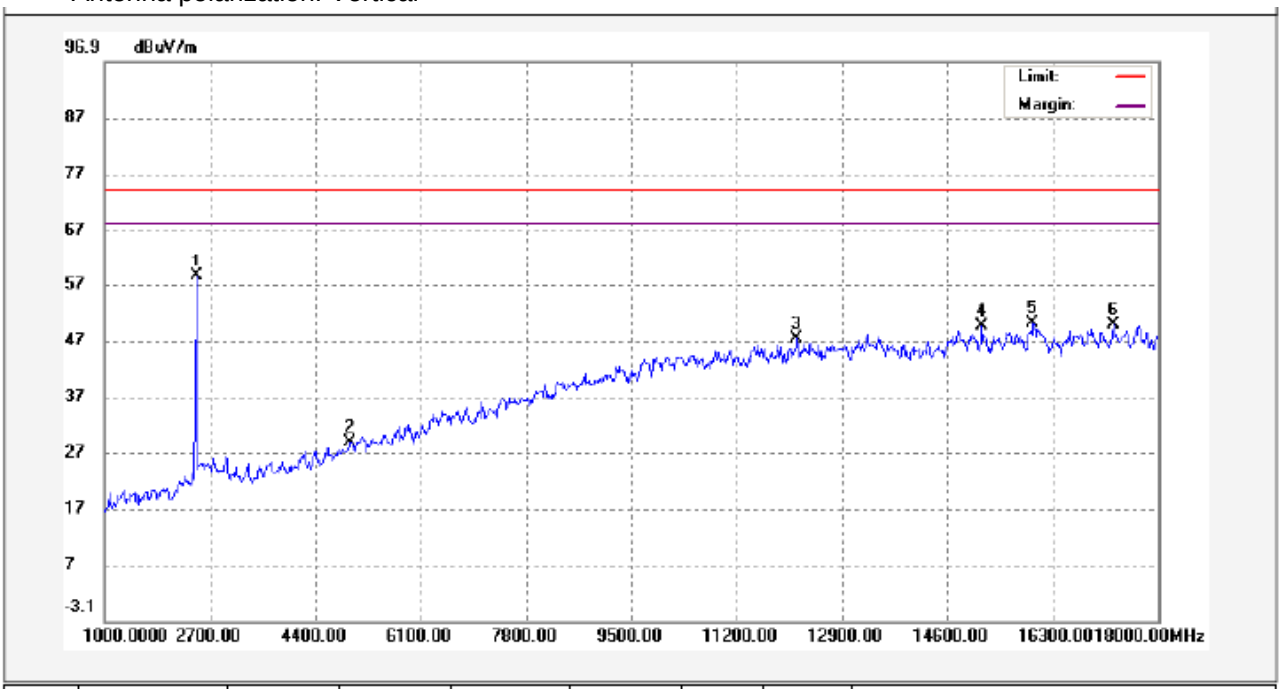
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2441.000	70.99	-15.70	55.29	74.00	-18.71	peak	
2	4882.000	39.87	-11.92	27.95	74.00	-46.05	peak	
3	9942.000	51.56	-5.17	46.39	74.00	-27.61	peak	
4	12832.000	53.58	-4.16	49.42	74.00	-24.58	peak	
5	15348.000	54.52	-2.68	51.84	74.00	-22.16	peak	
6	17439.000	49.85	2.02	51.87	74.00	-22.13	peak	

Remark:the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4882.000	-9	18.95	54.00	-35.05	AV	
3	9942.000	-9	37.39	54.00	-16.61	AV	
4	12832.000	-9	40.42	54.00	-13.58	AV	
5	15348.000	-9	42.84	54.00	-11.16	AV	
6	17439.000	-9	42.87	54.00	-11.13	AV	

Test mode: transmitting at upper channel

Antenna polarization: Vertical

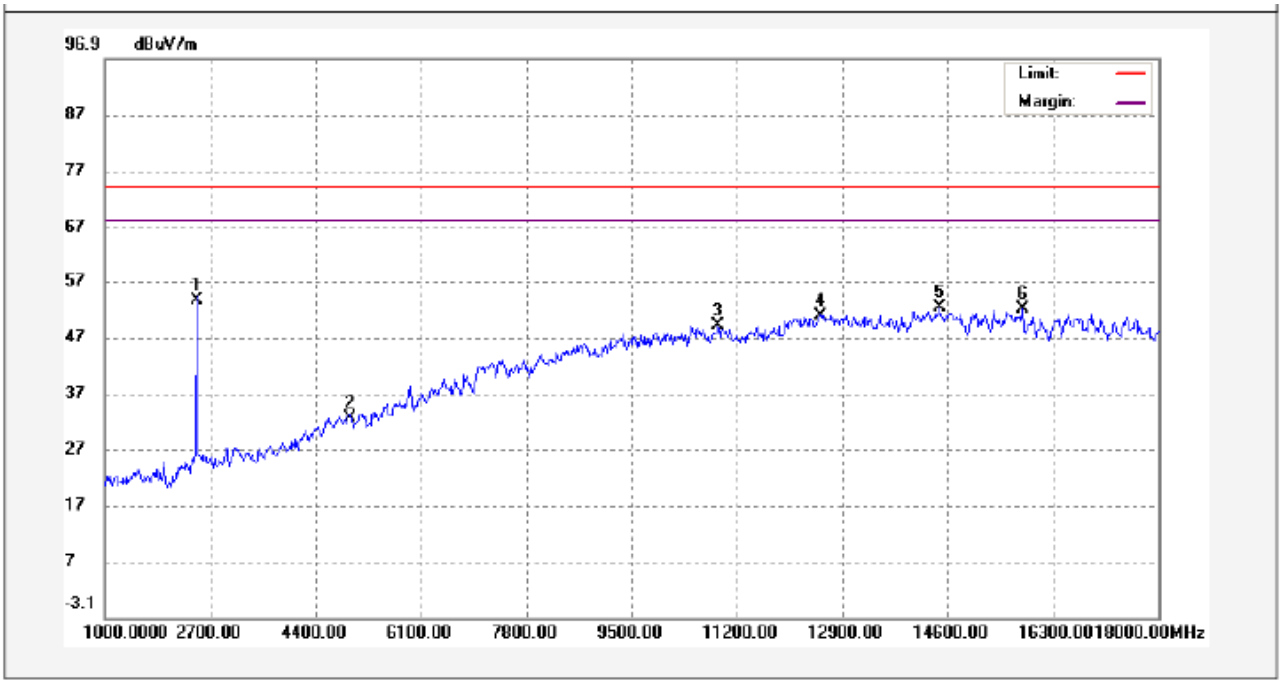


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2480.000	74.23	-15.68	58.55	74.00	-15.45	peak	
2	4960.000	40.66	-11.77	28.89	74.00	-45.11	peak	
3	12169.000	51.75	-4.39	47.36	74.00	-26.64	peak	
4	15161.000	51.28	-1.73	49.55	74.00	-24.45	peak	
5	15977.000	53.57	-3.66	49.91	74.00	-24.09	peak	
6	17286.000	48.70	1.05	49.75	74.00	-24.25	peak	

Remark:the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4960.000	-9	19.89	54.00	-34.11	AV	
3	12169.000	-9	38.36	54.00	-15.64	AV	
4	15161.000	-9	40.55	54.00	-13.45	AV	
5	15977.000	-9	40.91	54.00	-13.09	AV	
6	17286.000	-9	40.75	54.00	-13.25	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	69.25	-15.68	53.57	74.00	-20.43	peak	
2	4960.000	44.30	-11.77	32.53	74.00	-41.47	peak	
3	10894.000	52.69	-3.54	49.15	74.00	-24.85	peak	
4	12543.000	55.66	-4.76	50.90	74.00	-23.10	peak	
5	14481.000	51.67	0.53	52.20	74.00	-21.80	peak	
6	15807.000	55.87	-3.74	52.13	74.00	-21.87	peak	

Remark:the marker 1 is the fundamental.

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
2	4960.000	-9	23.53	54.00	-30.47	AV	
3	10894.000	-9	40.15	54.00	-13.85	AV	
4	12543.000	-9	41.90	54.00	-12.10	AV	
5	14481.000	-9	43.20	54.00	-10.80	AV	
6	15807.000	-9	43.13	54.00	-10.87	AV	

Test Frequency :Above 18GHz

The measurements were more than 20 dB below the limit and 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

2.1 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.

2.2 Test Result

Test Frequency: Below 30MHz

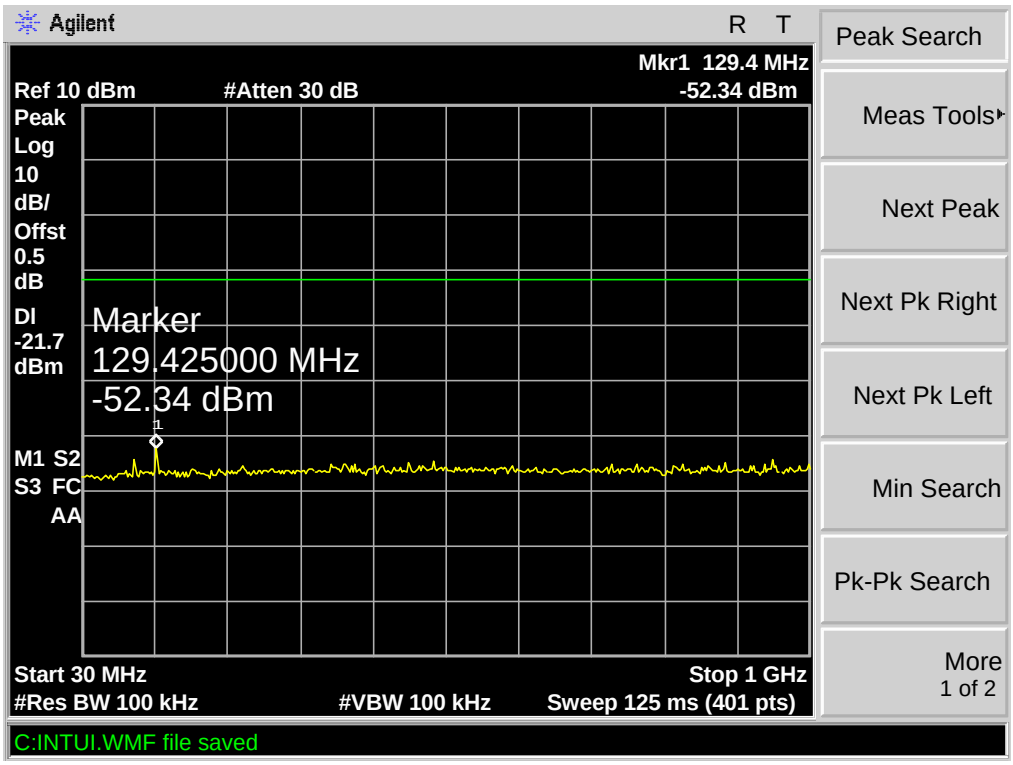
Remark: For emissions below 30MHz,no emission higher than background level, so the data does not show in the report.

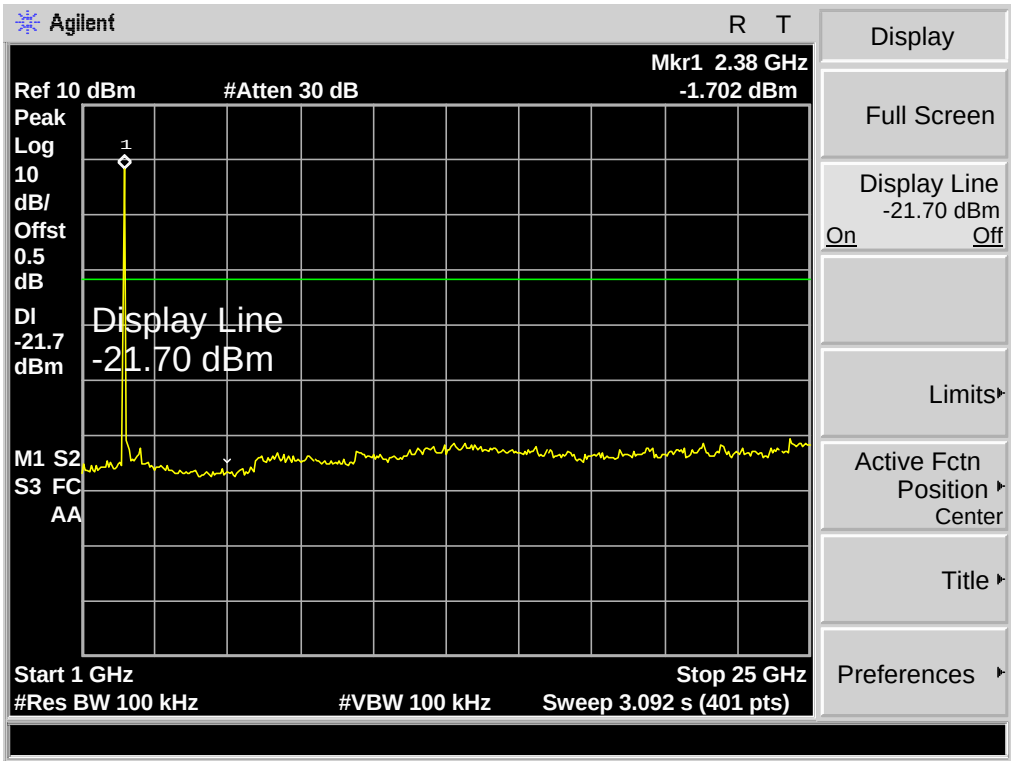
Test Frequency: 30MHz ~ 25GHz

Test result plots shown as follows:

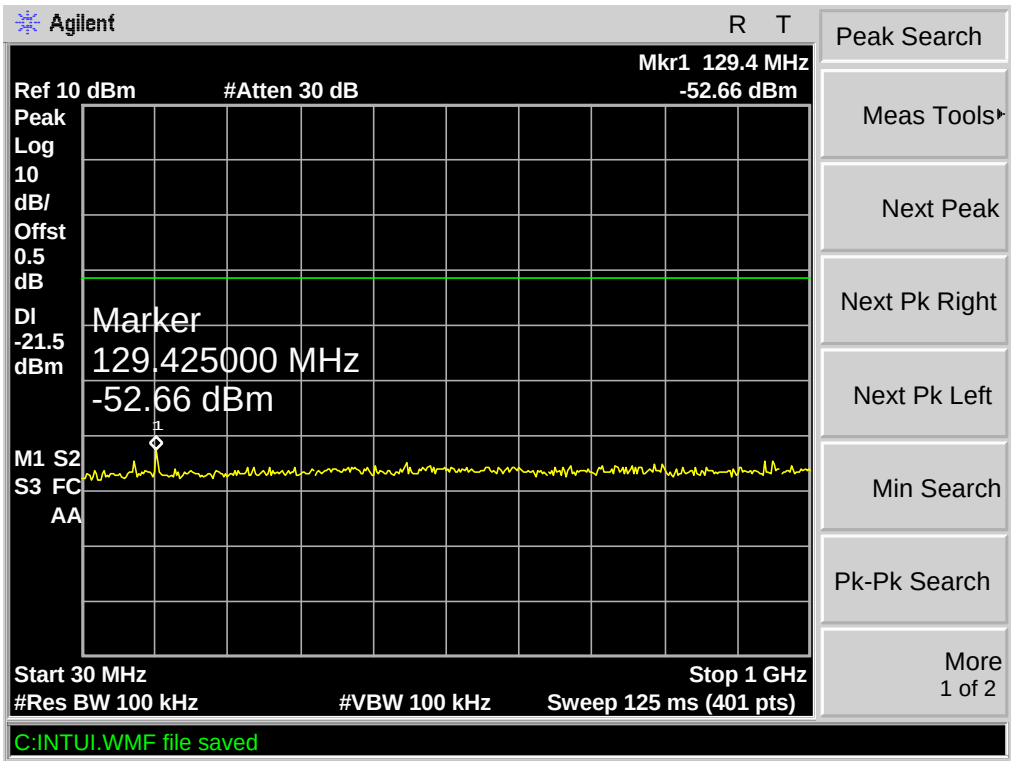
Modulation:GFSK

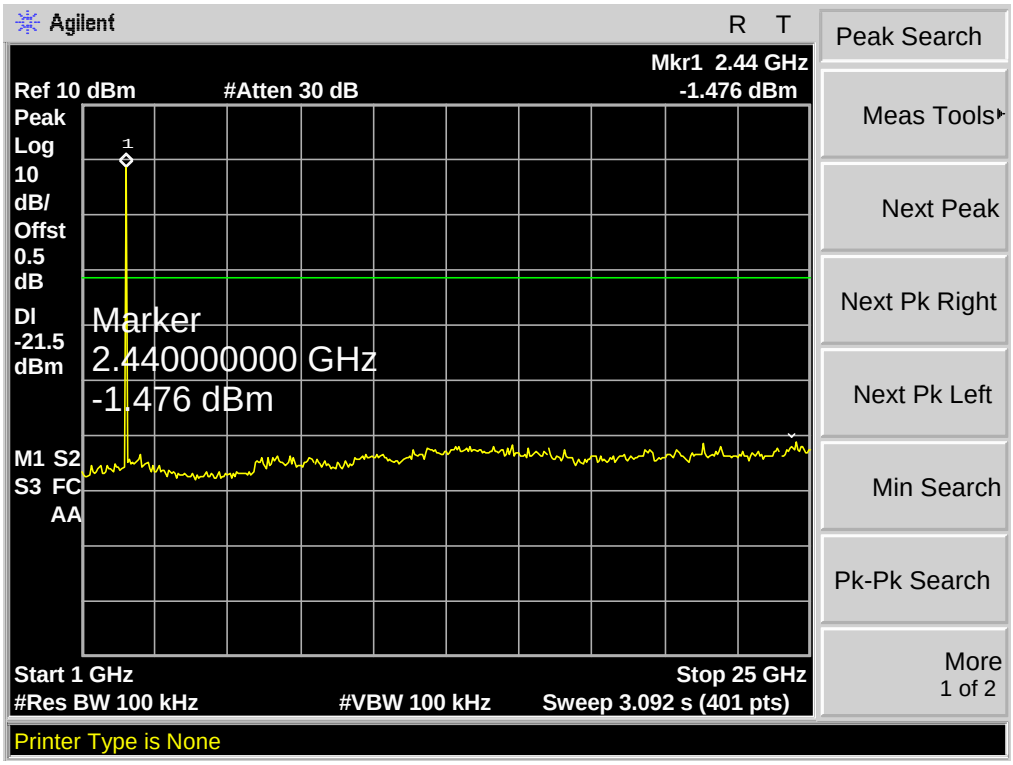
Lower Channel



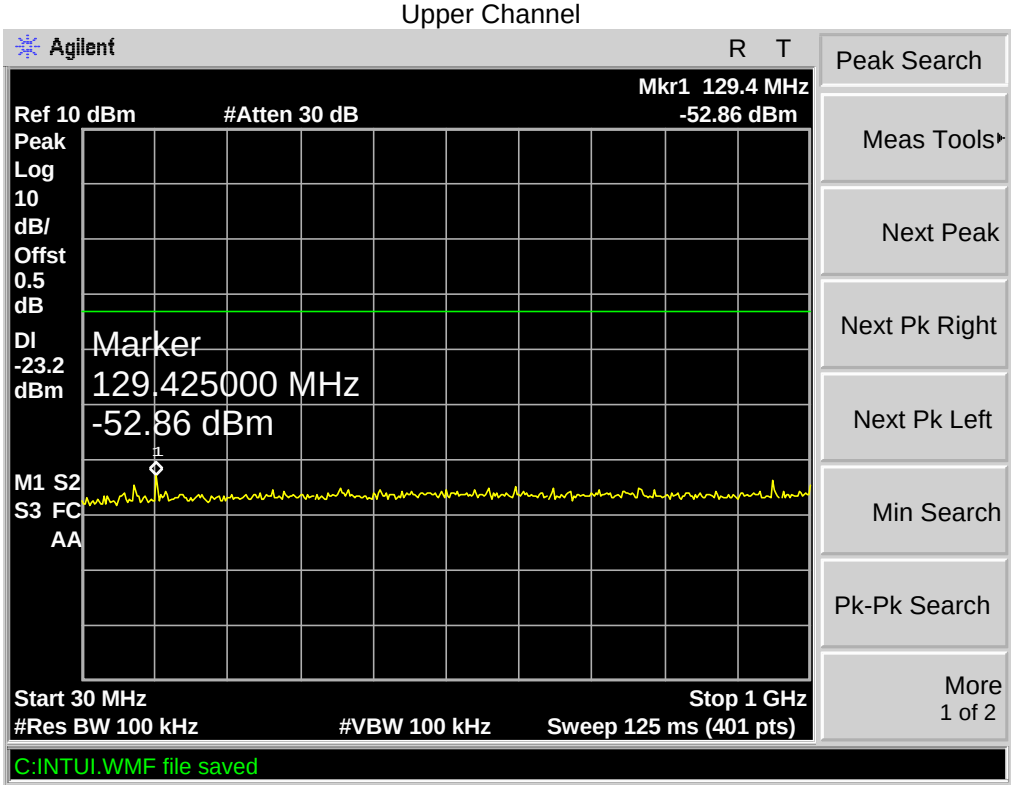


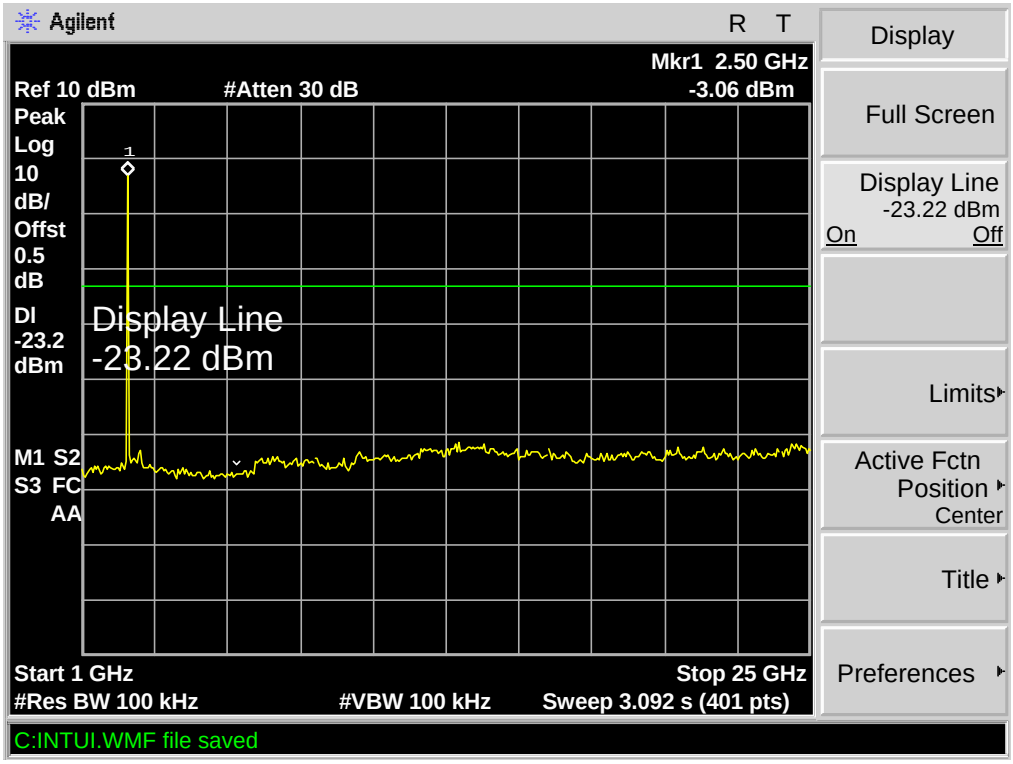
Middle Channel





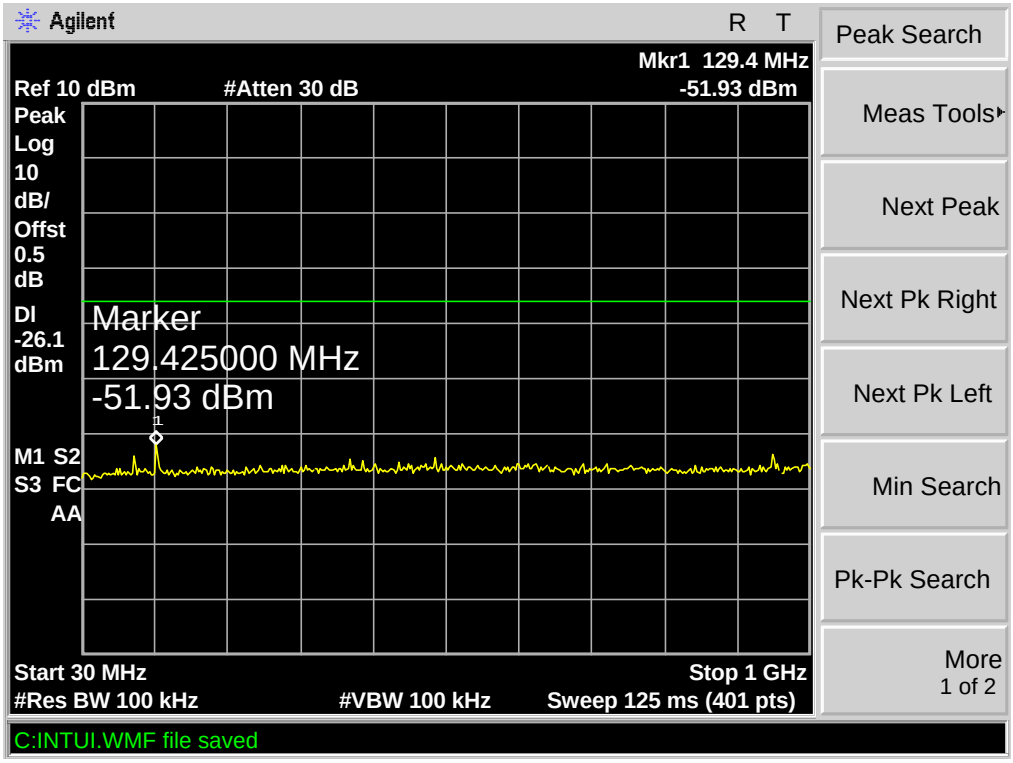
Upper Channel

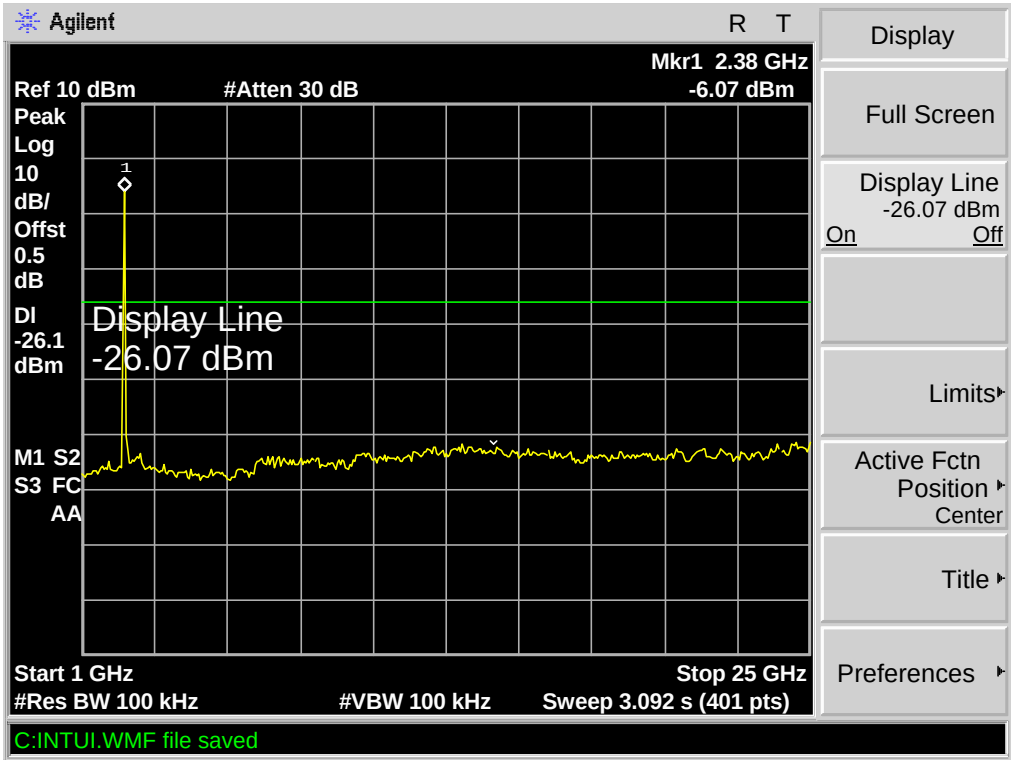




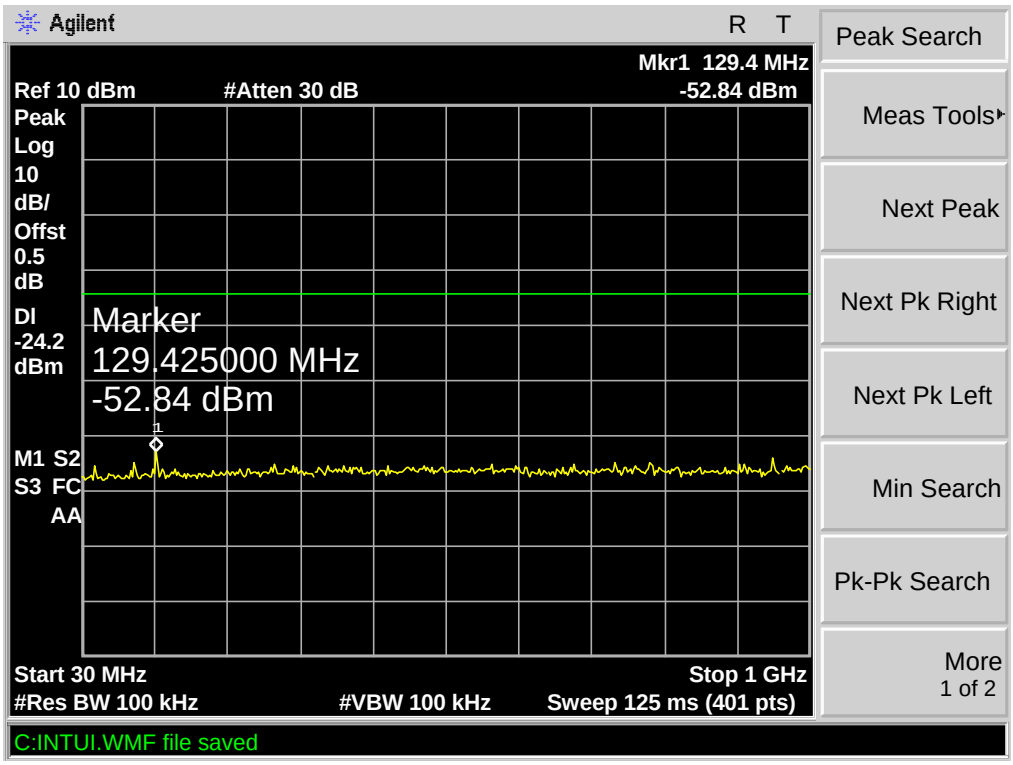
Modulation: Pi/4DQPSK

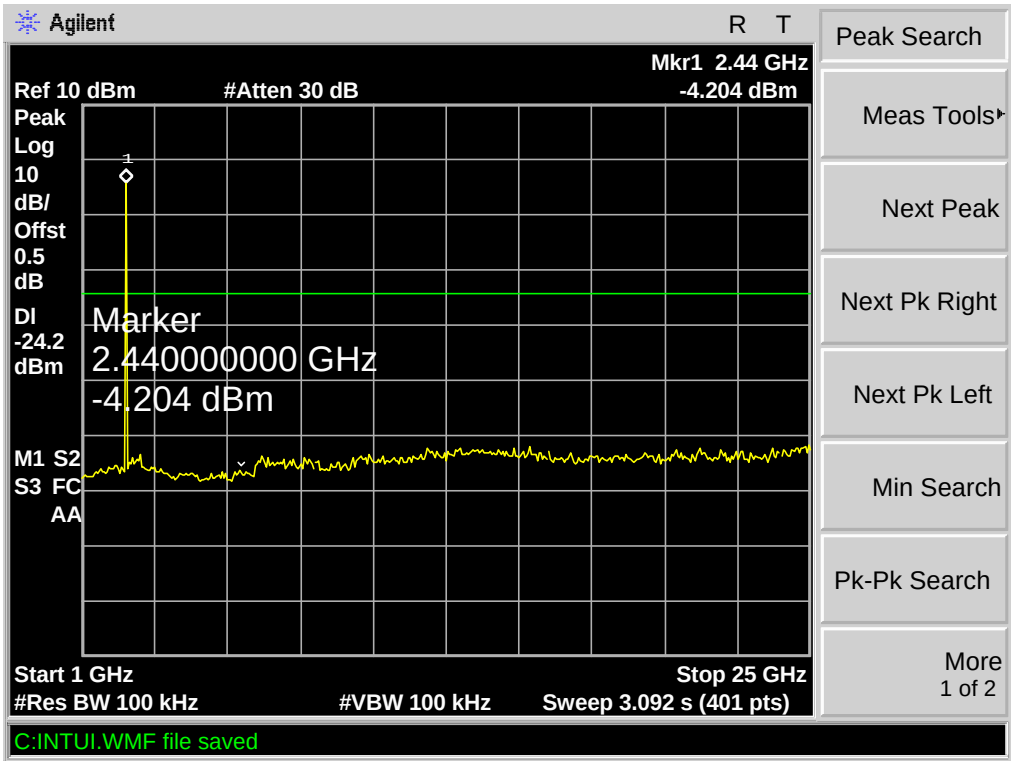
Lower Channel



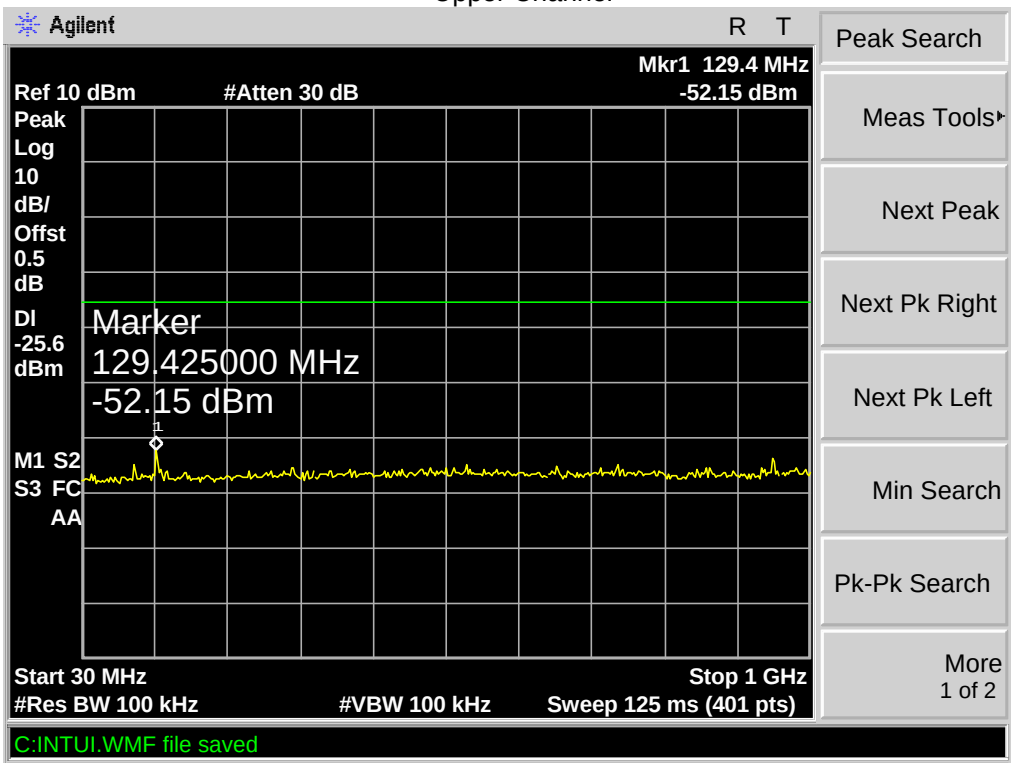


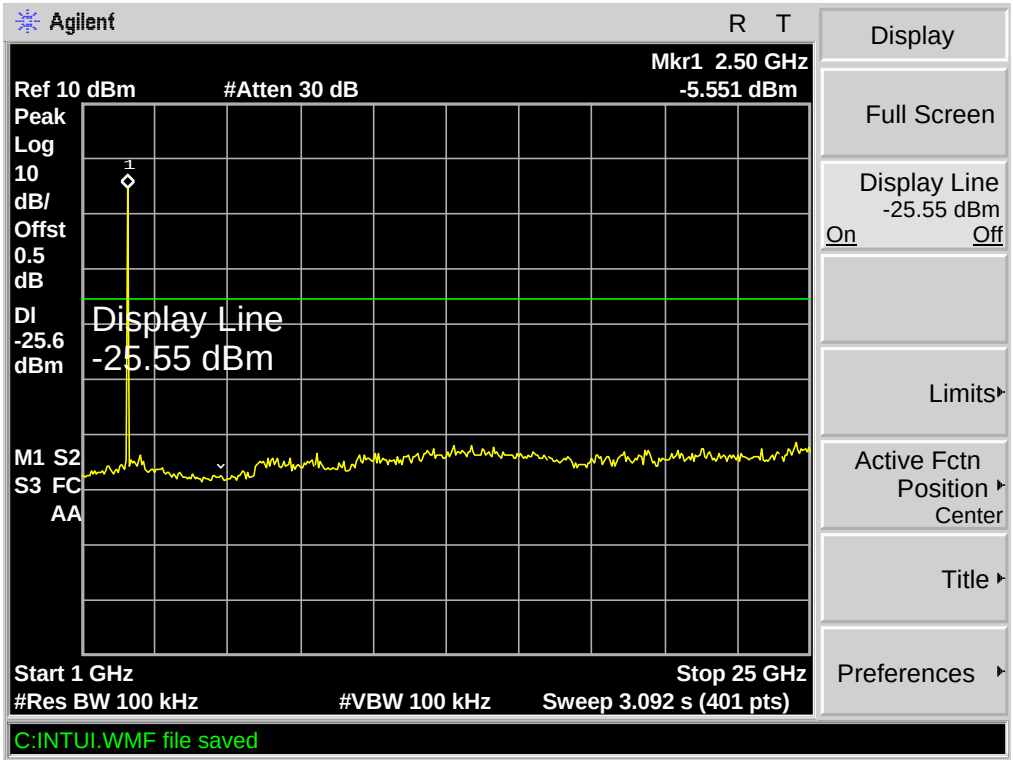
Middle Channel





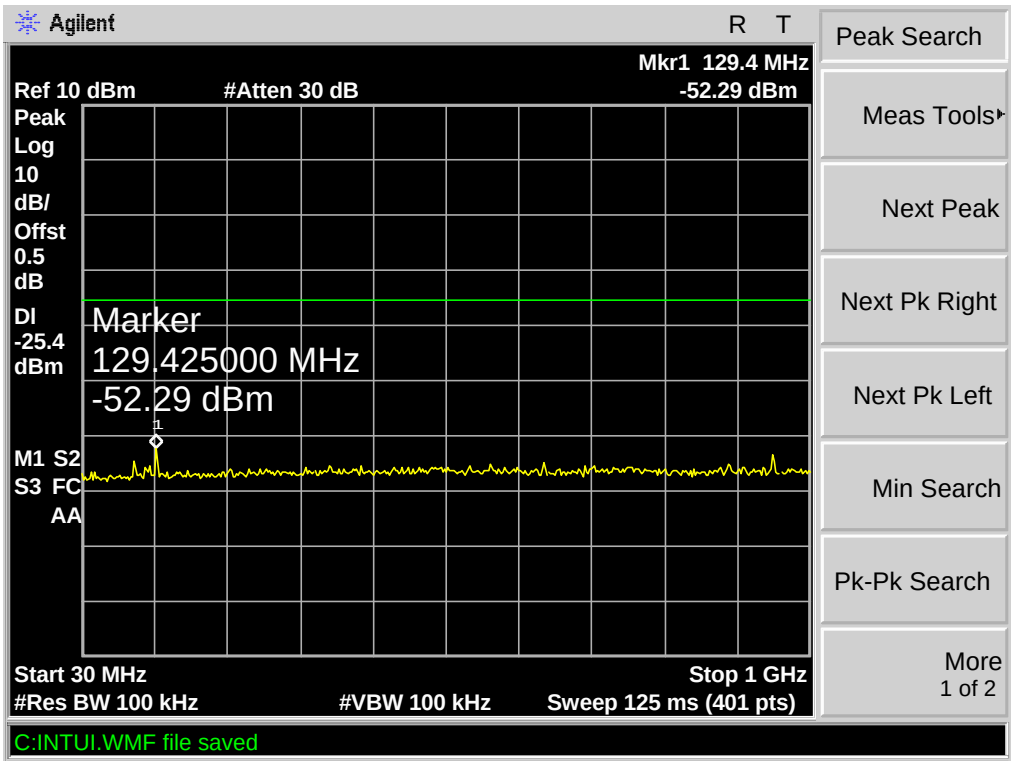
Upper Channel

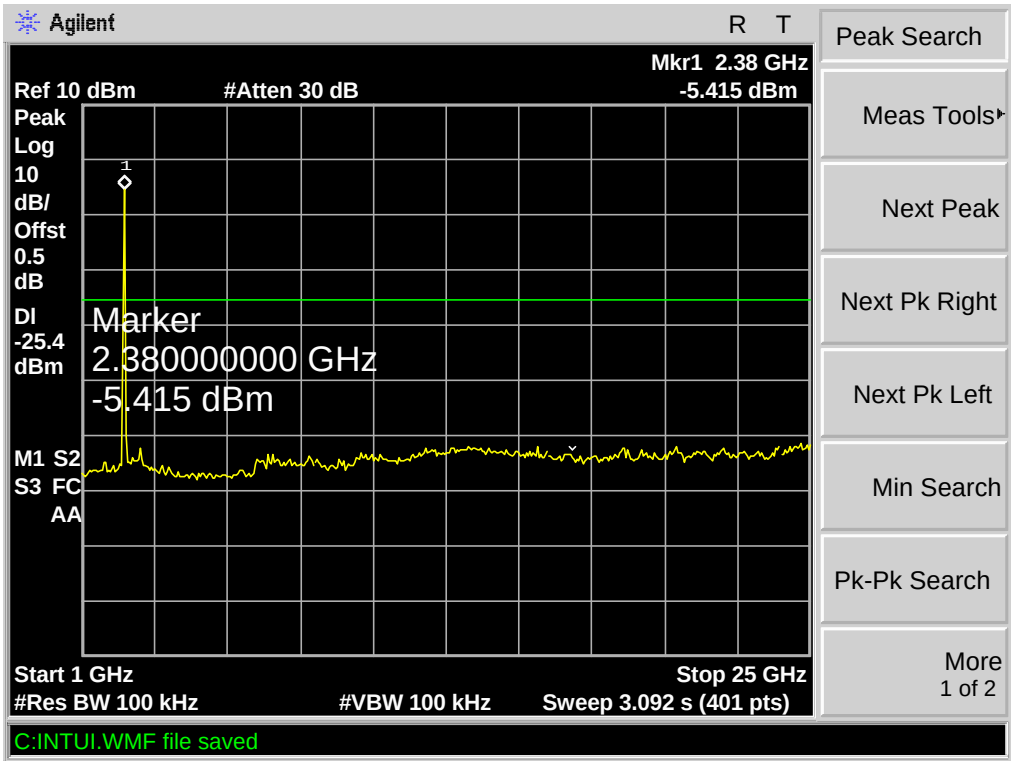




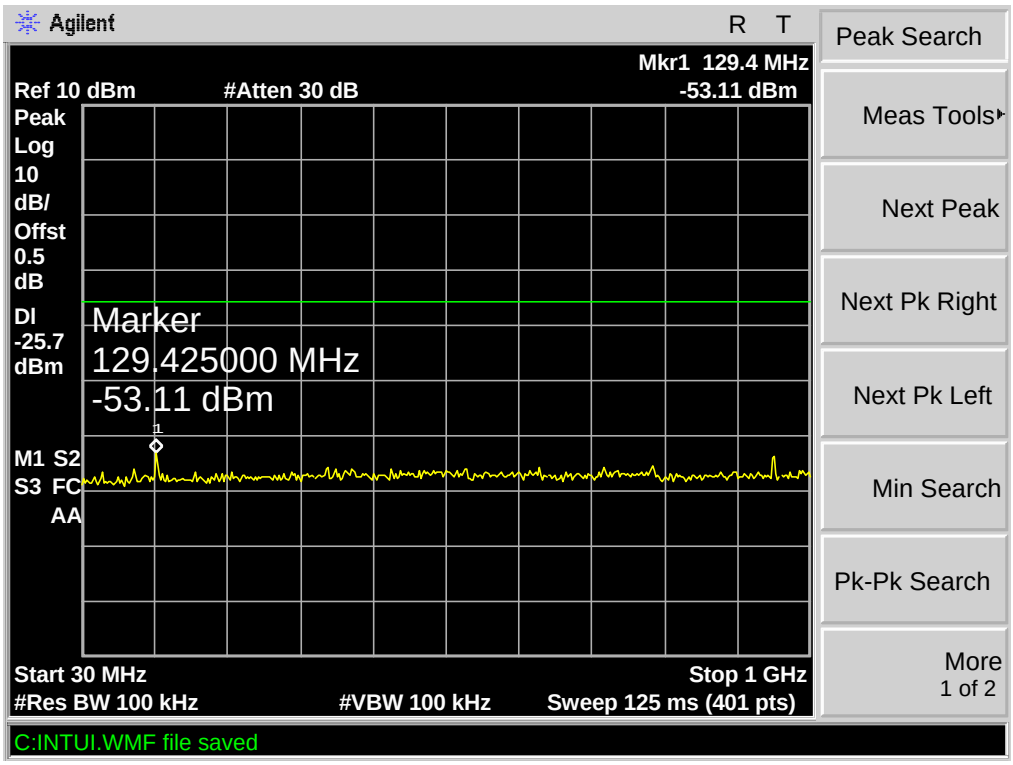
Modulation: 8DPSK

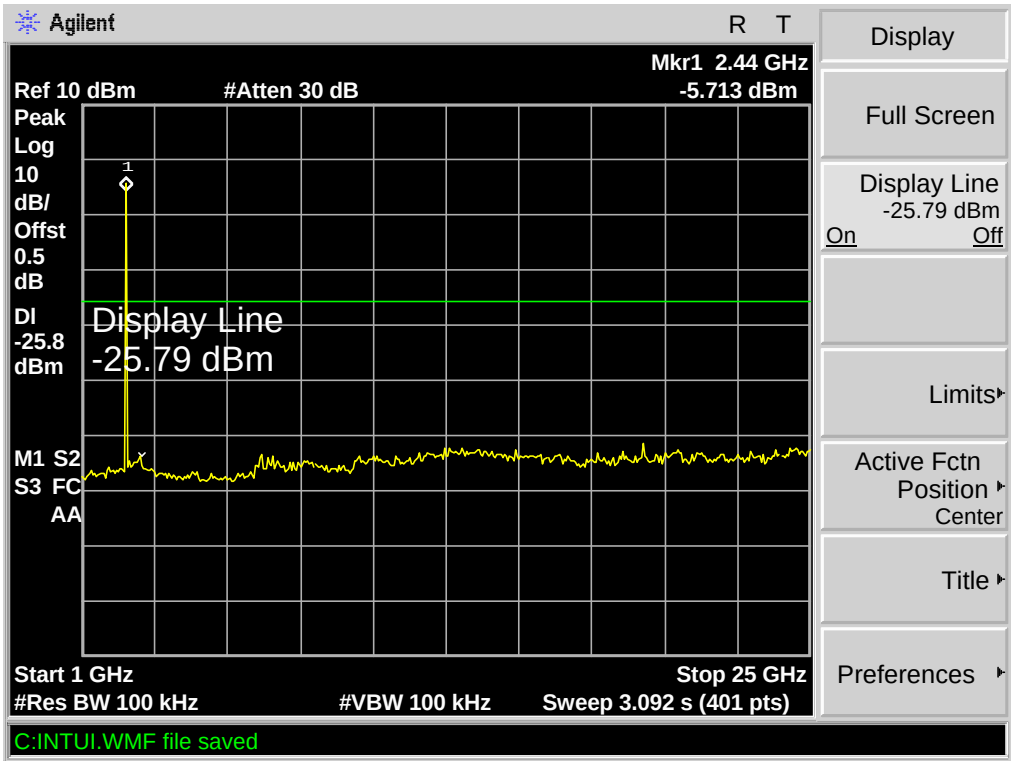
Lower Channel



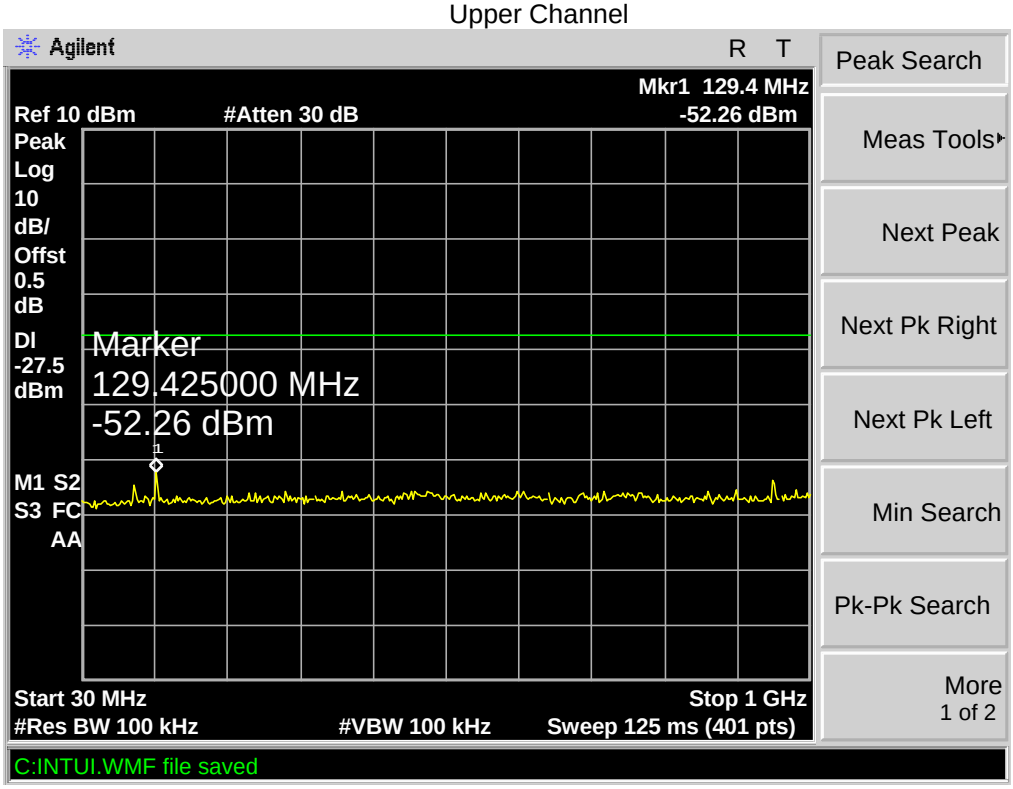


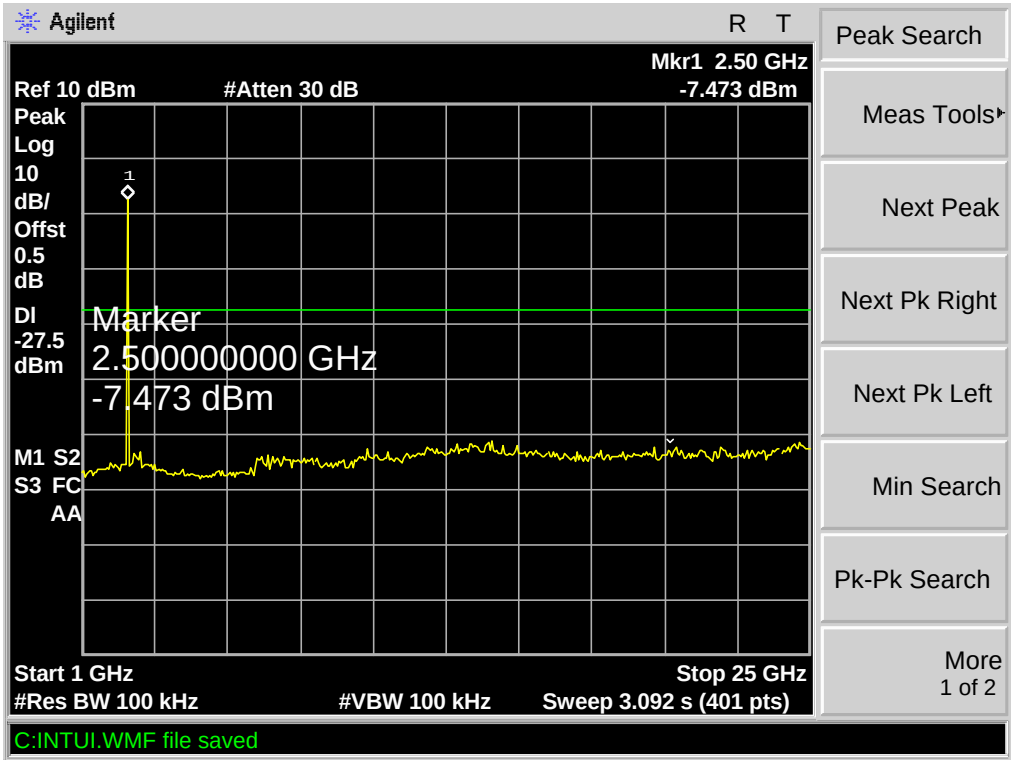
Middle Channel





Upper Channel





3 Duty Cycle

Test Requirement: FCC Part 15.35

Test Mothed: ANSI C63.4:2003

Test Status: TX mode.

3.1 Test Procedure

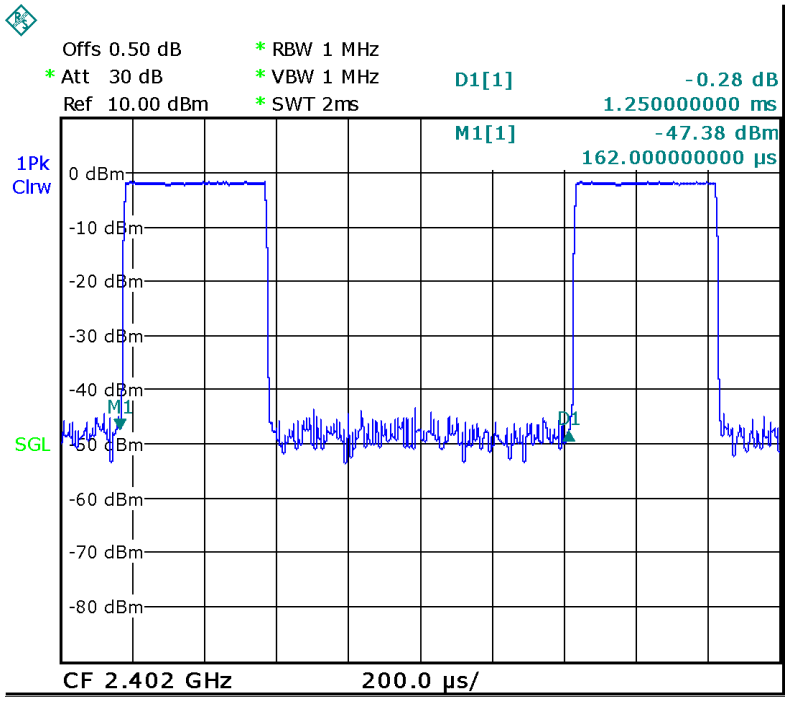
1. The EUT was placed on a turntable which is 0.8m above ground plane

2. Set EUT as normal working mode

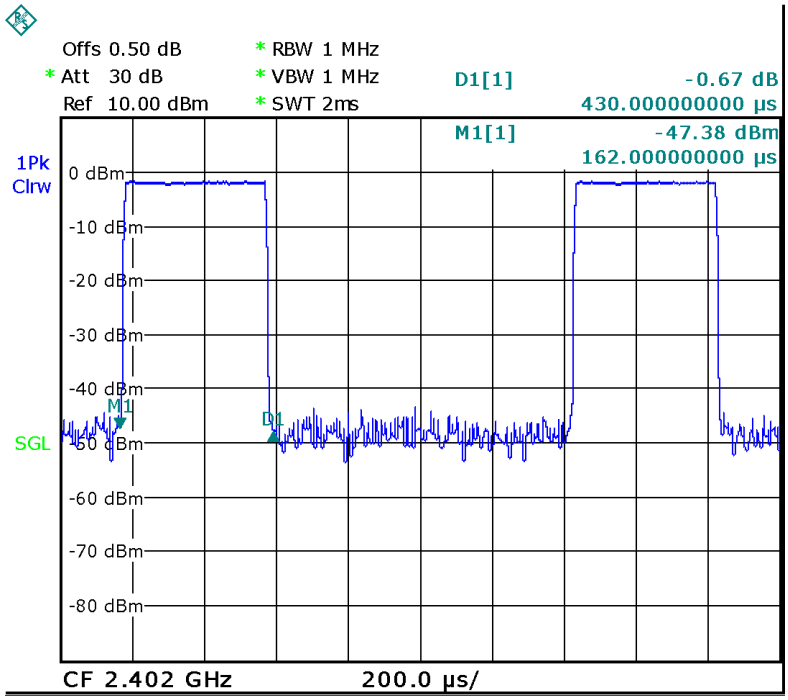
3. Set SPA center frequency = fundamental frequency, RBW = 1000 kHz, VBW = 3000 kHz, Span = 0 Hz, Adjacent sweep time.

3.2 Test Result

(a) transmission period is 1.25ms



(b)Single pulse time is 0.43ms



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=0.43 ms

The EUT's work period :T=T_{ON}+T_{OFF}= transmission period =1.25 ms

The EUT's duty cycle : D = T_{on} /T = 0.43/1.25*100% =38.7%

Duty Cycle Correction Factor(dB)=20 * Log_{10}(Duty Cycle)=20* Log_{10}(34.4%)

= -9dB

4 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

4.1 Test Procedure

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

2. Measurement Distance is 3m

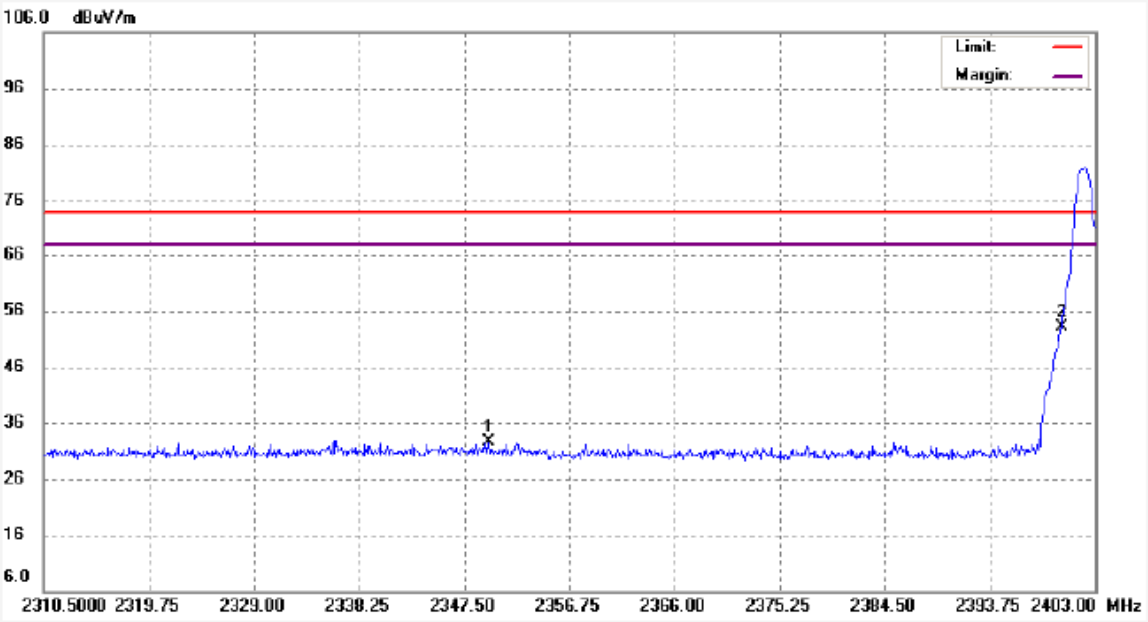
3. Detector: For Peak value:
RBW = 1 MHz for f ≥ 1 GHz
VBW ≥ RBW; Sweep = auto
Detector function = peak
Trace = max hold
For AVG value:
RBW = 1 MHz for f ≥ 1 GHz
VBW = 10Hz; Sweep = auto
Detector function = AVG
Trace = max hold

4.continuous transmitting

4.2 Test Result:

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

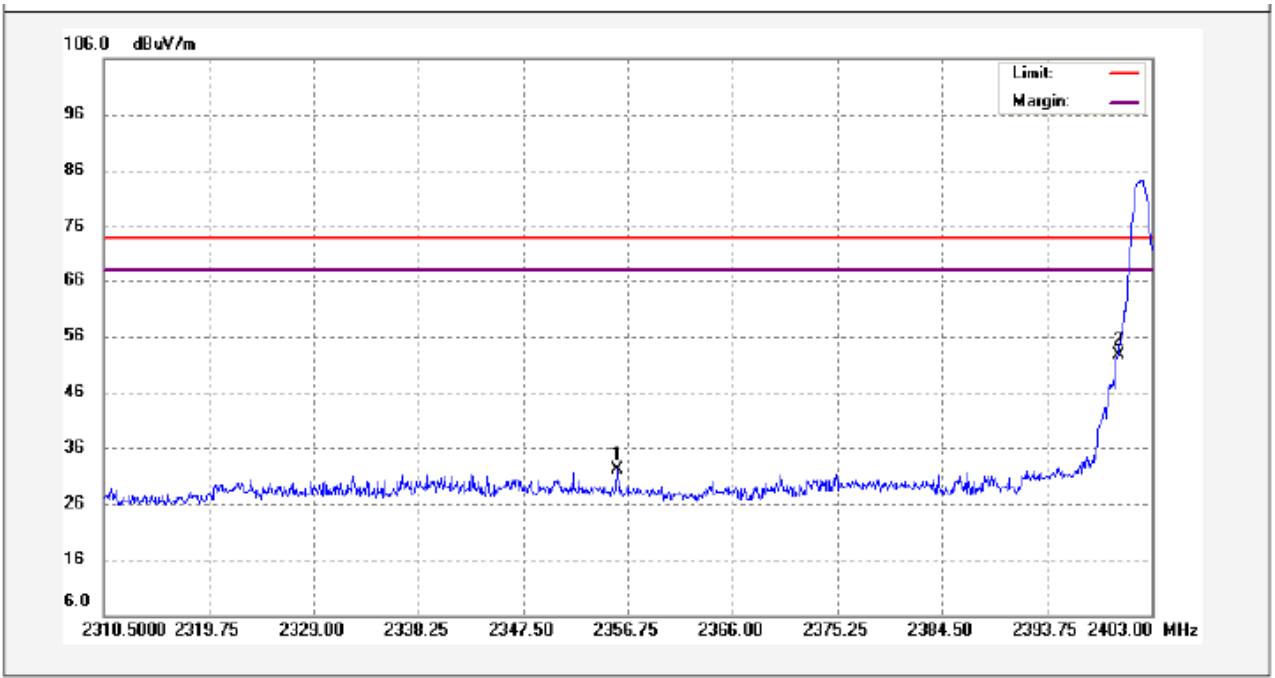
Modulation: GFSK
Lower Channel – Peak, Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2349.628	48.16	-15.43	32.73	74.00	-41.27	peak	
2	2400.000	68.69	-15.58	53.11	74.00	-20.89	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2349.000	-9	23.73	54.00	-30.27	AV	
2	2400.000	-9	44.11	54.00	-9.89	AV	

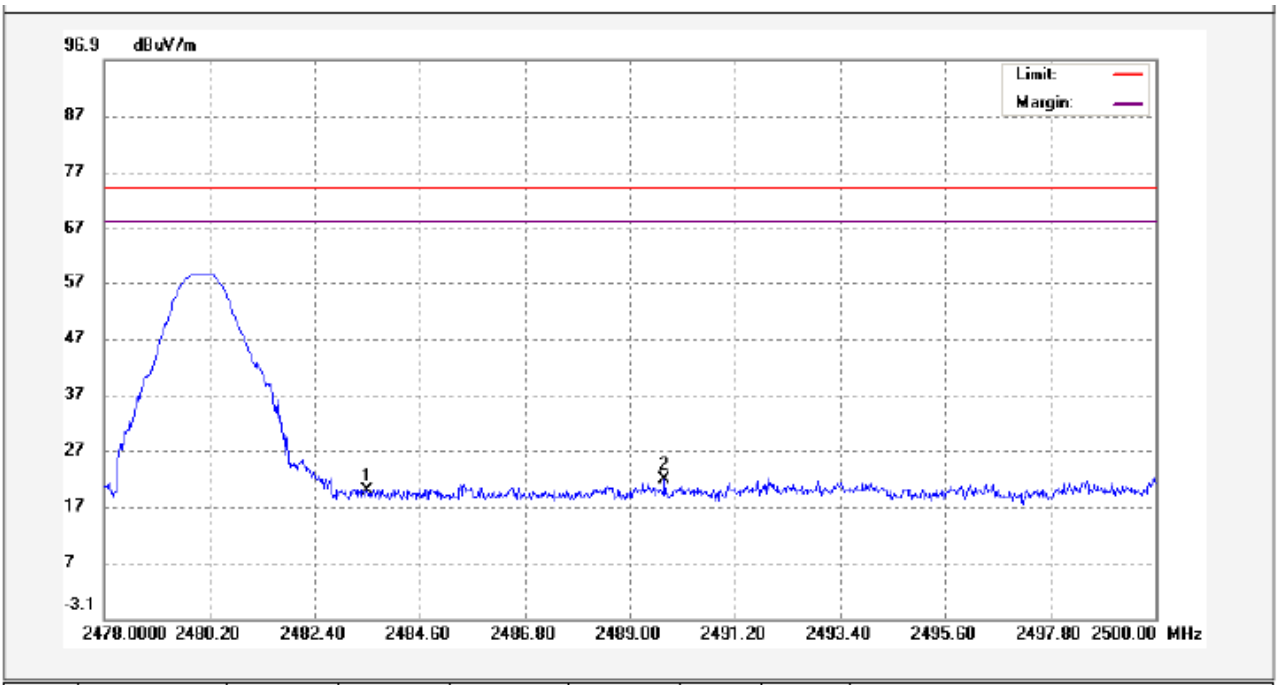
Lower Channel – Peak, Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2355.825	47.50	-15.45	32.05	74.00	-41.95	peak	
2	2400.000	68.17	-15.58	52.59	74.00	-21.41	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2355.825	-9	23.05	54.00	-30.95	AV	
2	2400.000	-9	43.59	54.00	-10.41	AV	

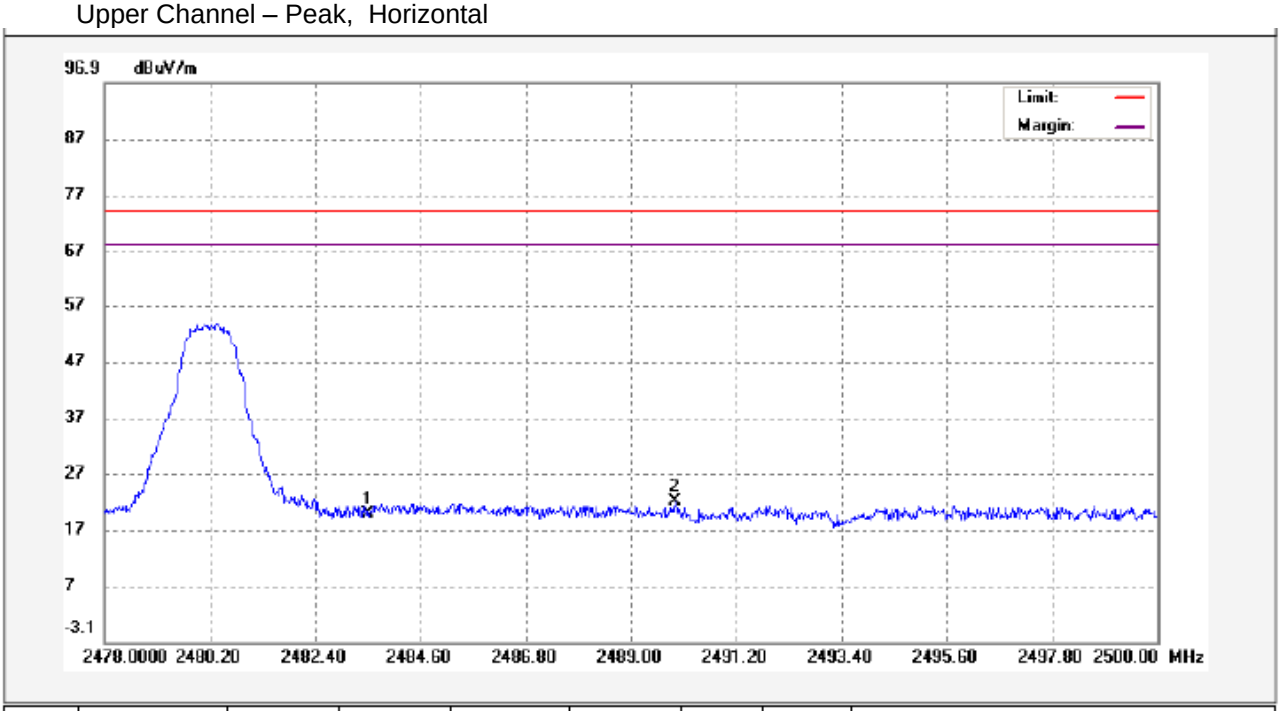
Upper Channel – Peak, Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2483.500	35.48	-15.67	19.81	74.00	-54.19	peak	
2	2489.726	37.37	-15.67	21.70	74.00	-52.30	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2483.500	-9	10.81	54.00	-43.19	AV	
2	2489.726	-9	12.7	54.00	-41.30	AV	

Upper Channel – Peak, Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2483.500	35.50	-15.67	19.83	74.00	-54.17	peak	
2	2489.924	37.60	-15.67	21.93	74.00	-52.07	peak	

No.	Freq. (MHz)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	2483.500	-9	10.83	54.00	-43.17	AV	
2	2489.924	-9	12.93	54.00	-41.07	AV	

5 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.

5.1 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

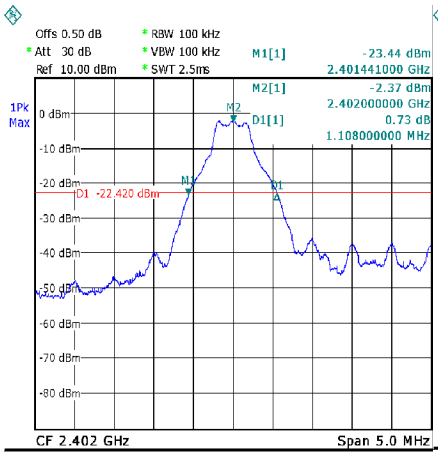
5.2 Test Result:

Modulation	Test Channel	Bandwidth(MHz)
GFSK	Lower	1.108
	Middle	1.088
	Upper	1.108
Pi/4DQPSK	Lower	1.367
	Middle	1.357
	Upper	1.367
8DPSK	Lower	1.357
	Middle	1.347
	Upper	1.357

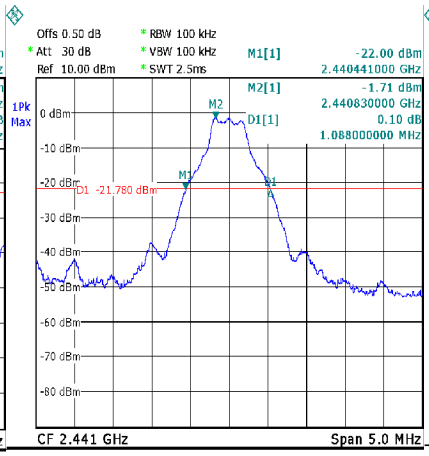
Test result plot as follows:

Modulation:GFSK

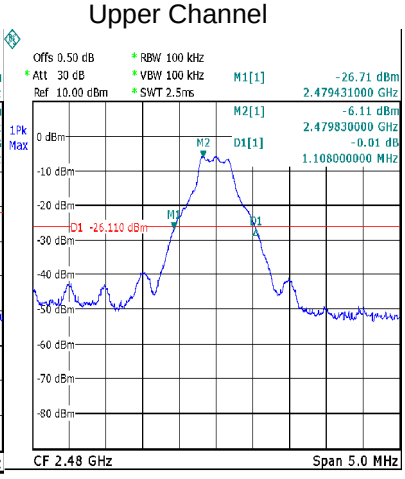
Lower Channel



Middle Channel

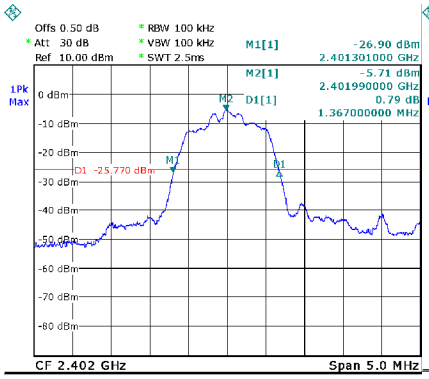


Upper Channel

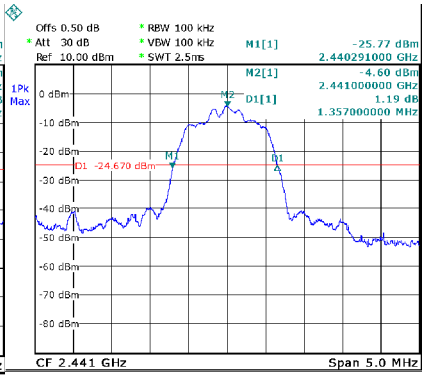


Modulation: Pi/4DQPSK

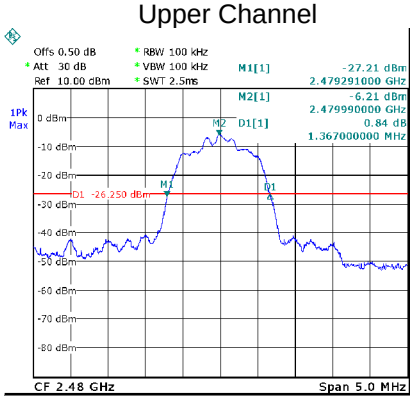
Lower Channel



Middle Channel

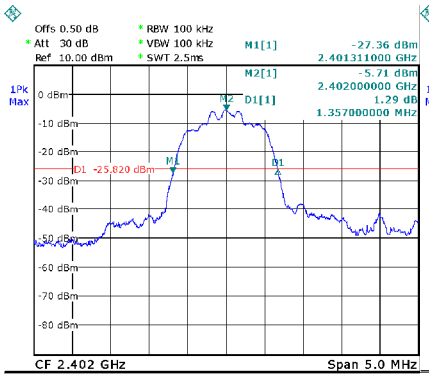


Upper Channel

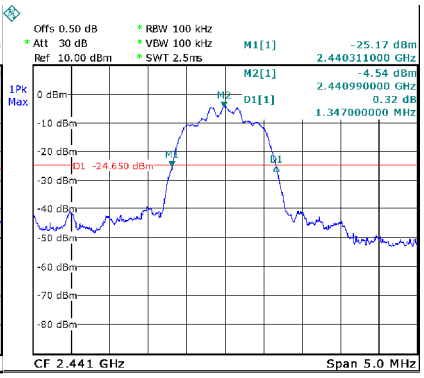


Modulation: 8DPSK

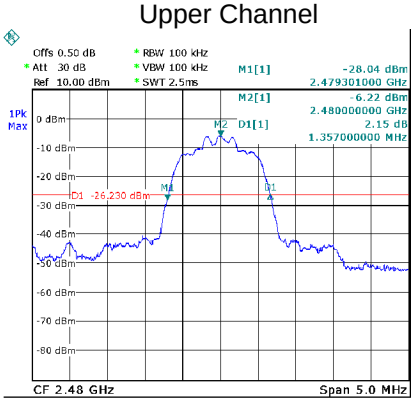
Lower Channel



Middle Channel



Upper Channel



6 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.

6.1 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.

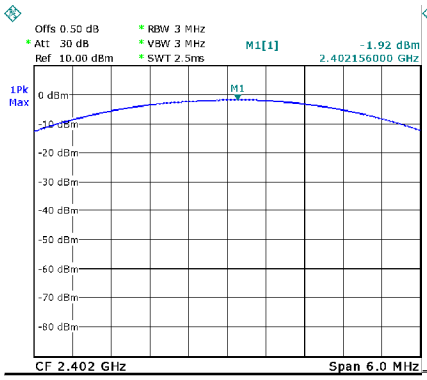
6.2 Test Result:

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Lower	-1.92	30
	Middle	-1.48	30
	Upper	-3.38	30
Pi/4DQPSK	Lower	-2.21	30
	Middle	-2.42	30
	Upper	-3.75	30
8DPSK	Lower	-2.69	30
	Middle	-2.80	30
	Upper	-3.88	30

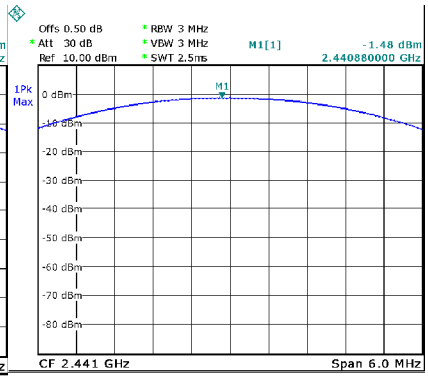
Test result plot as follows:

Modulation:GFSK

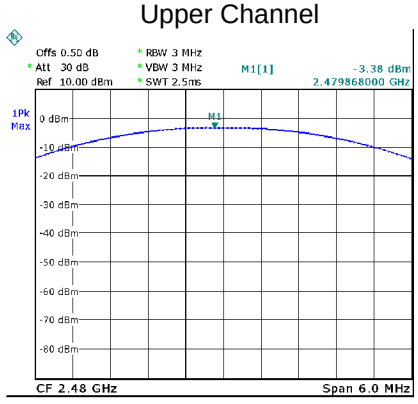
Lower Channel



Middle Channel

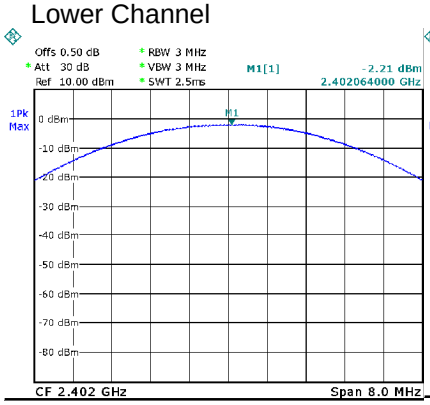


Upper Channel

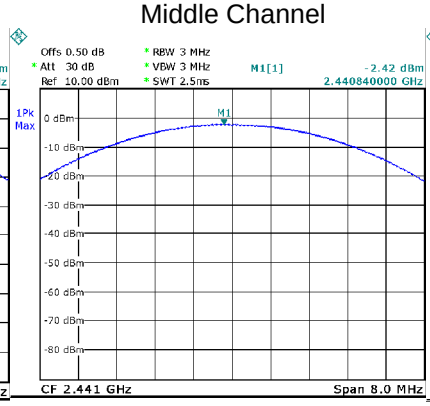


Modulation: Pi/4DQPSK

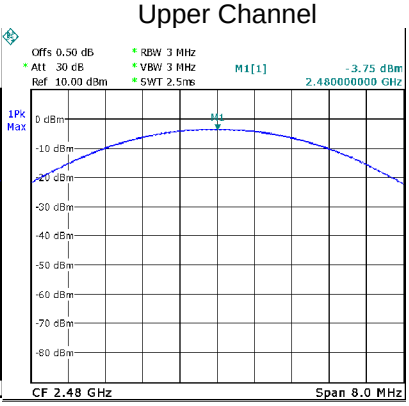
Lower Channel



Middle Channel

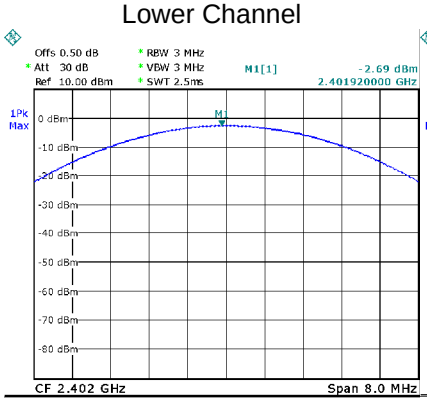


Upper Channel

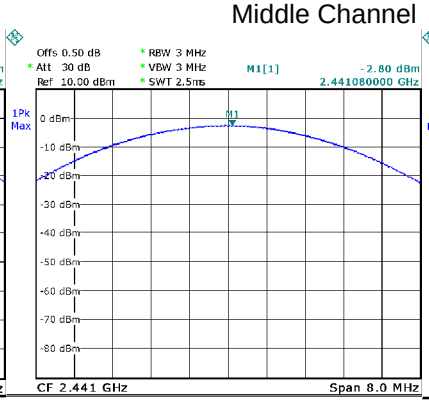


Modulation: 8DPSK

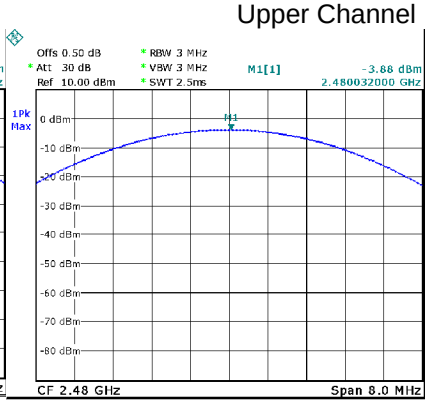
Lower Channel



Middle Channel



Upper Channel



7 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 2400-2483.5 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 1W.

Test Mode: Test in hopping transmitting operating mode.

7.1 Test Procedure:

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

2. Set the spectrum analyzer: RBW = 100KHz. VBW = 100KHz , Span = 5MHz. 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.

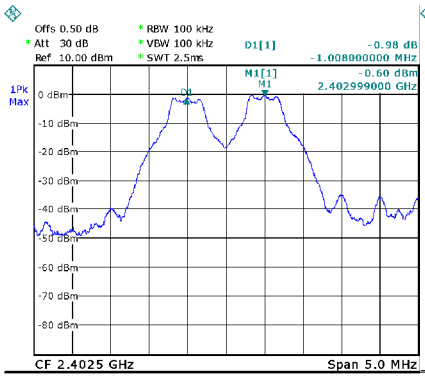
7.2 Test Result:

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

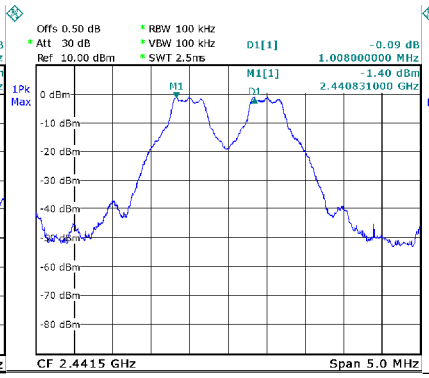
Test result plot as follows:

Modulation:GFSK

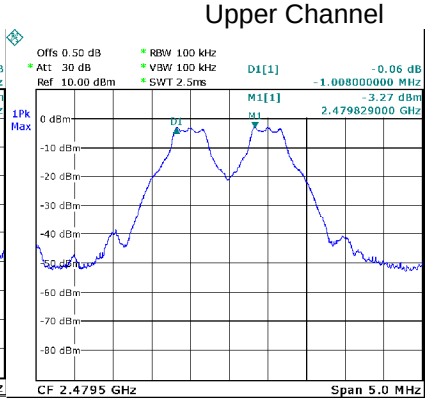
Lower Channel



Middle Channel

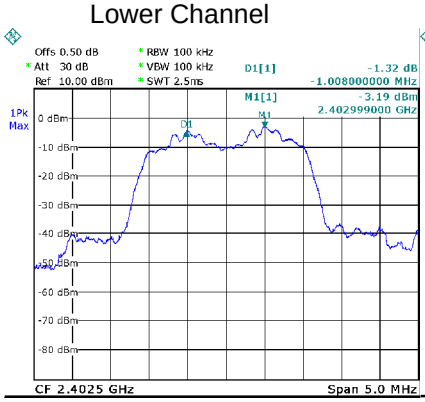


Upper Channel

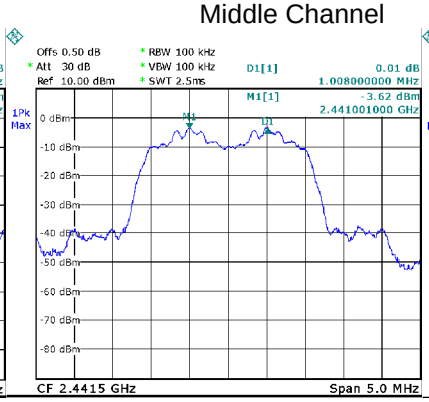


Modulation: Pi/4DQPSK

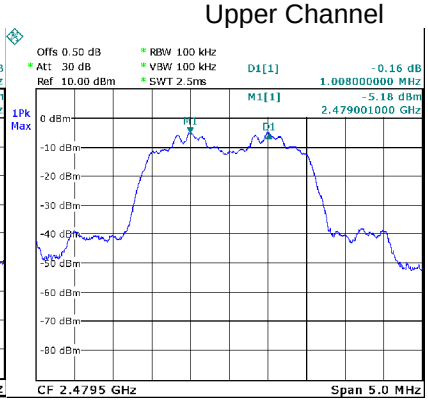
Lower Channel



Middle Channel

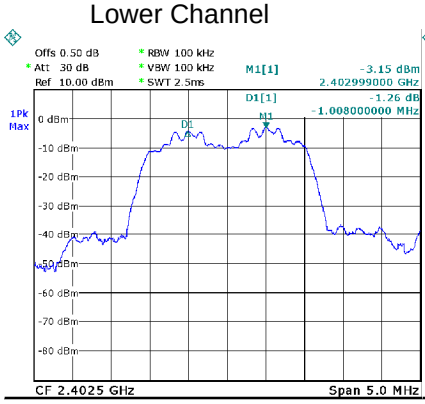


Upper Channel

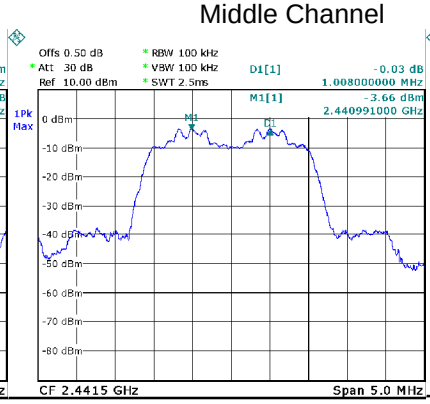


Modulation: 8DPSK

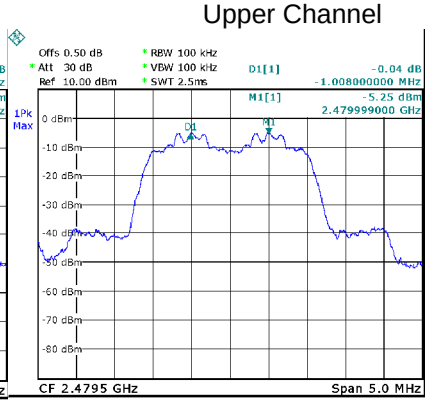
Lower Channel



Middle Channel



Upper Channel



8 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.

8.1 Test Procedure:

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

2. Set the spectrum analyzer: RBW = 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.

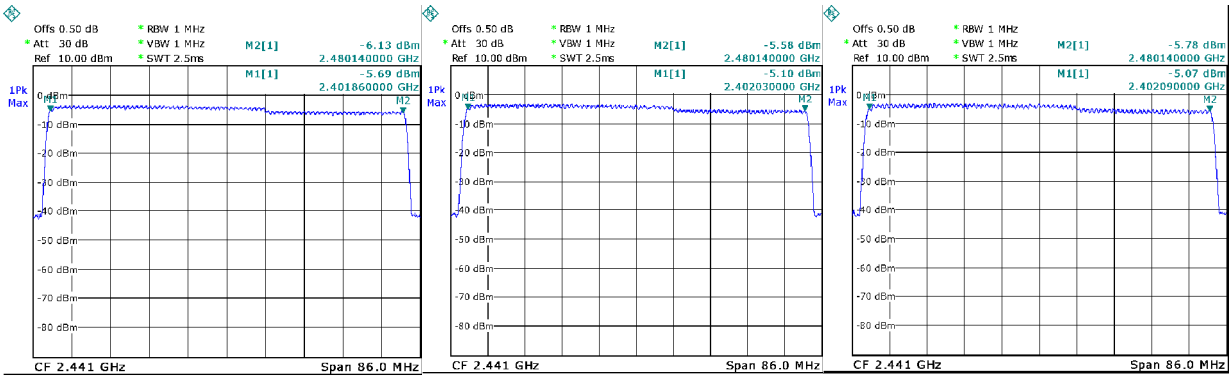
4. Set the spectrum analyzer: Centre Frequency = 2.441GHz, Span = 86MHz. Sweep=auto;

8.2 Test Result:

Total Channels are 79 Channels.

Modulation:

GFSK Pi/4DQPSK 8DPSK



9 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.

9.1 Test Procedure:

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

2.Set 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).

9.2 Test Result:

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period
The test period: T= 0.4(s) * 79 = 31.6 (s)
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

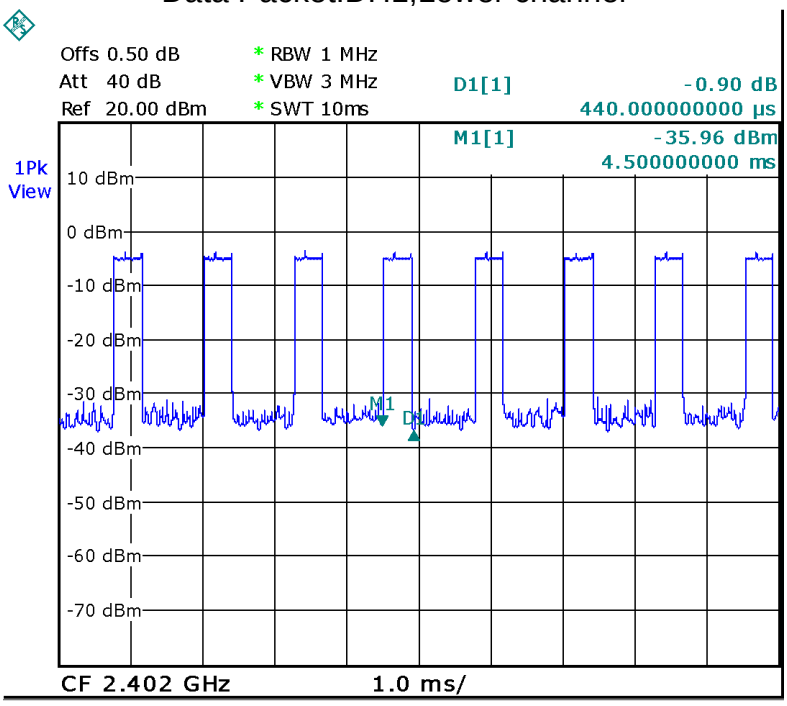
DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

Data Packet	Dwell Time(s)
DH5	1600/79/6*31.6*(MkrDelta)/1000
DH3	1600/79/4*31.6*(MkrDelta)/1000
DH1	1600/79/2*31.6*(MkrDelta)/1000
Remark	Mkr Delta is single pulse time.

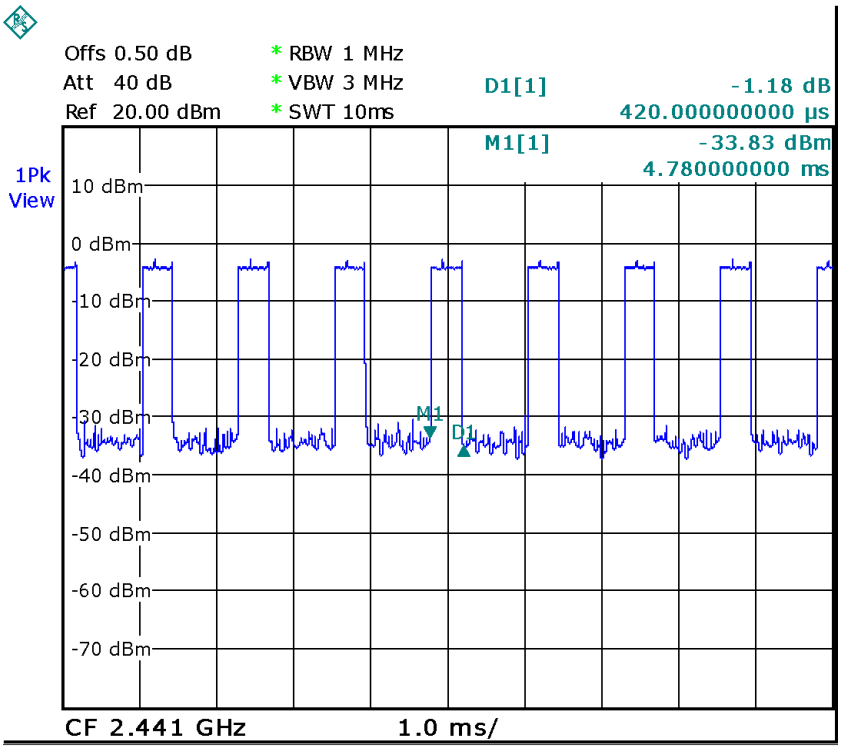
Modulation	Frequency	Data Packet	Mkr Delta(ms)	Dwell Time(s)	Limits(s)
GFSK	Lower channel	DH1	0.440	0.1408	0.400
	Middle channel		0.420	0.1344	0.400
	Upper channel		0.440	0.1408	0.400
	Lower channel	DH3	1.680	0.2688	0.400
	Middle channel		1.680	0.2688	0.400
	Upper channel		1.700	0.2720	0.400
	Lower channel	DH5	2.940	0.3136	0.400
	Middle channel		2.980	0.3179	0.400
	Upper channel		2.940	0.3136	0.400
Pi/4DQPSK	Lower channel	DH1	0.480	0.1536	0.400
	Middle channel		0.520	0.1664	0.400
	Upper channel		0.480	0.1536	0.400
	Lower channel	DH3	1.720	0.2752	0.400
	Middle channel		1.740	0.2784	0.400
	Upper channel		1.740	0.2784	0.400
	Lower channel	DH5	2.960	0.3157	0.400
	Middle channel		3.020	0.3221	0.400
	Upper channel		3.000	0.3200	0.400
8DPSK	Lower channel	DH1	0.460	0.1472	0.400
	Middle channel		0.460	0.1472	0.400
	Upper channel		0.440	0.1408	0.400
	Lower channel	DH3	1.820	0.2912	0.400
	Middle channel		1.760	0.2816	0.400
	Upper channel		1.700	0.2720	0.400
	Lower channel	DH5	3.020	0.3221	0.400
	Middle channel		3.020	0.3221	0.400
	Upper channel		2.980	0.3179	0.400

Modulation:GFSK

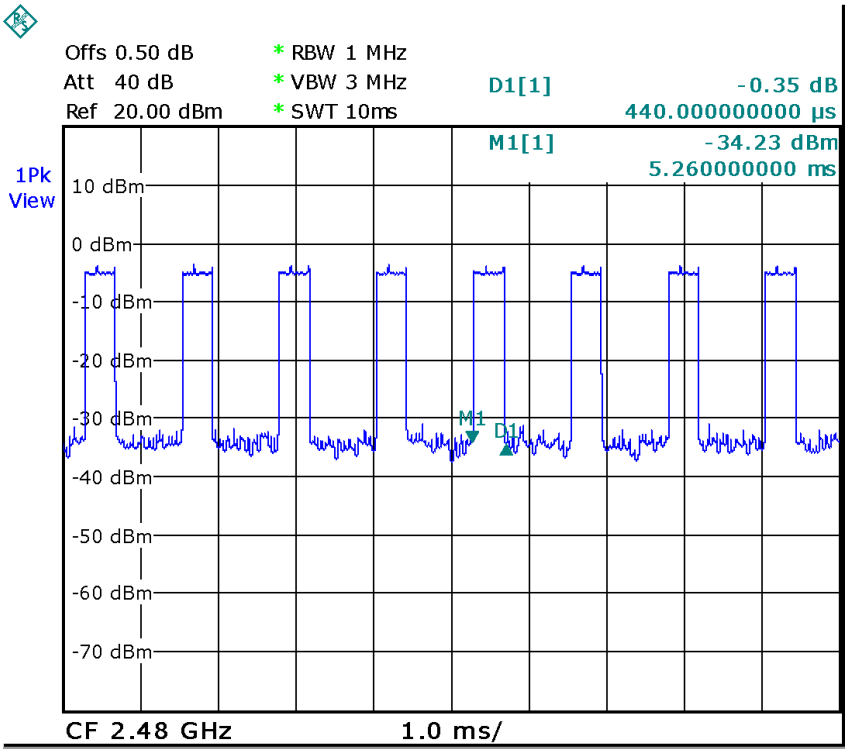
Data Packet:DH1,Lower channel



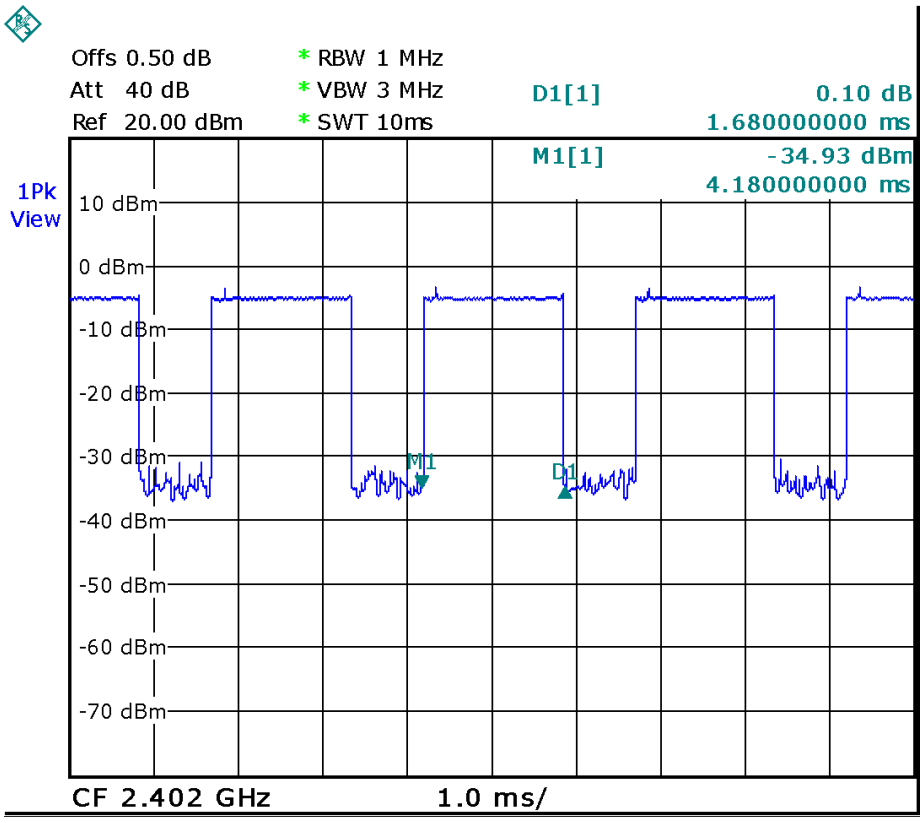
Data Packet:DH1,Middle channel



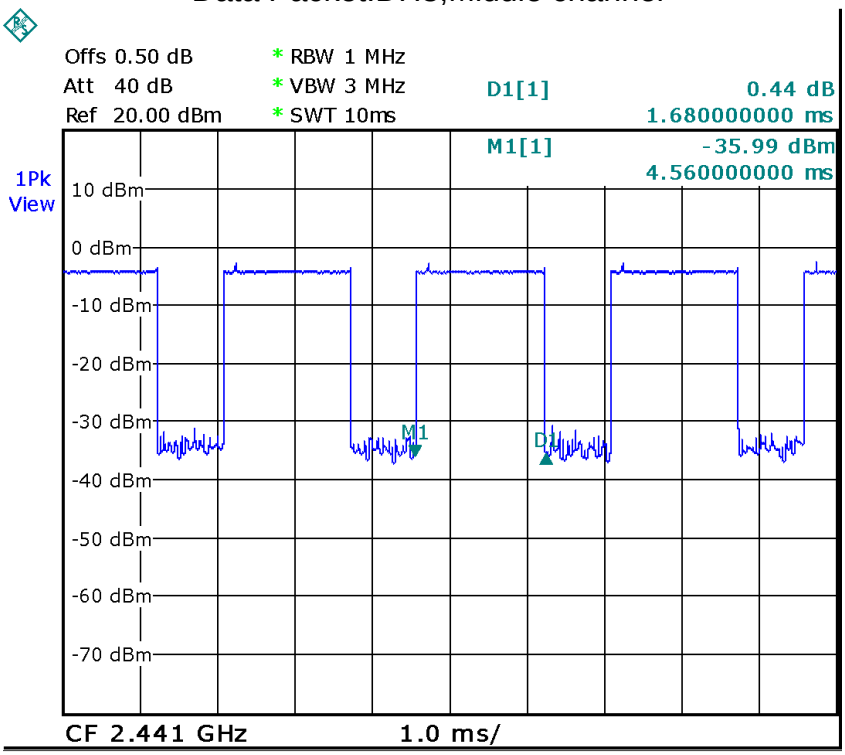
Data Packet:DH1,Upper channel



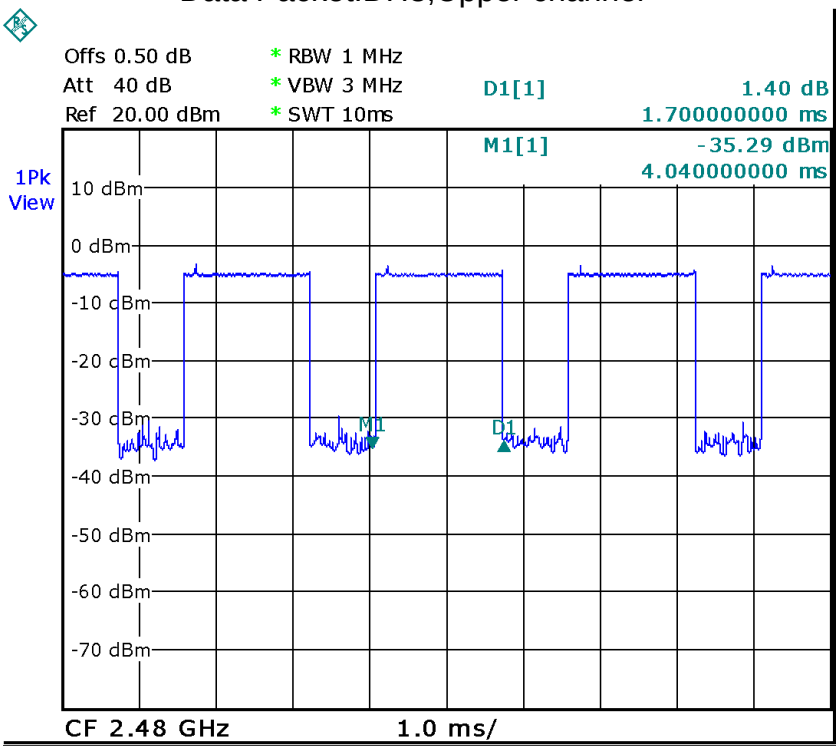
Data Packet:DH3,Lower channel



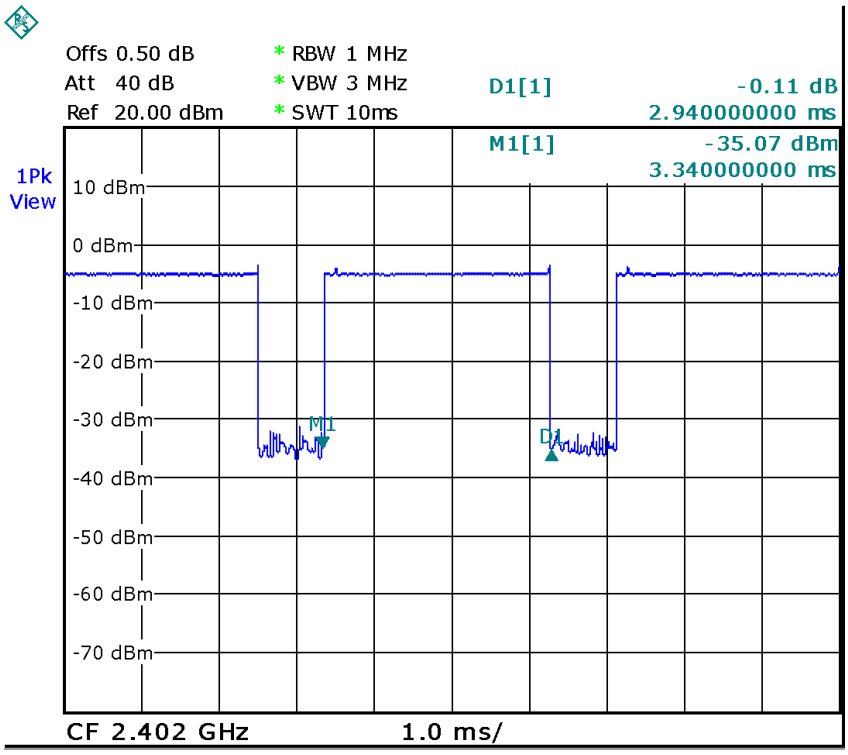
Data Packet:DH3,Middle channel



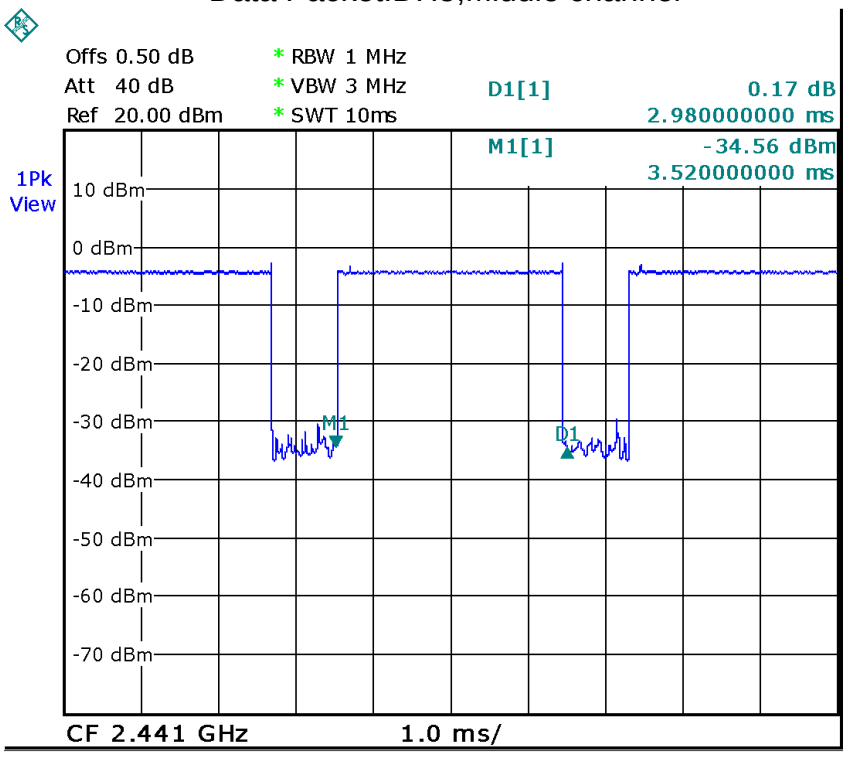
Data Packet:DH3,Upper channel



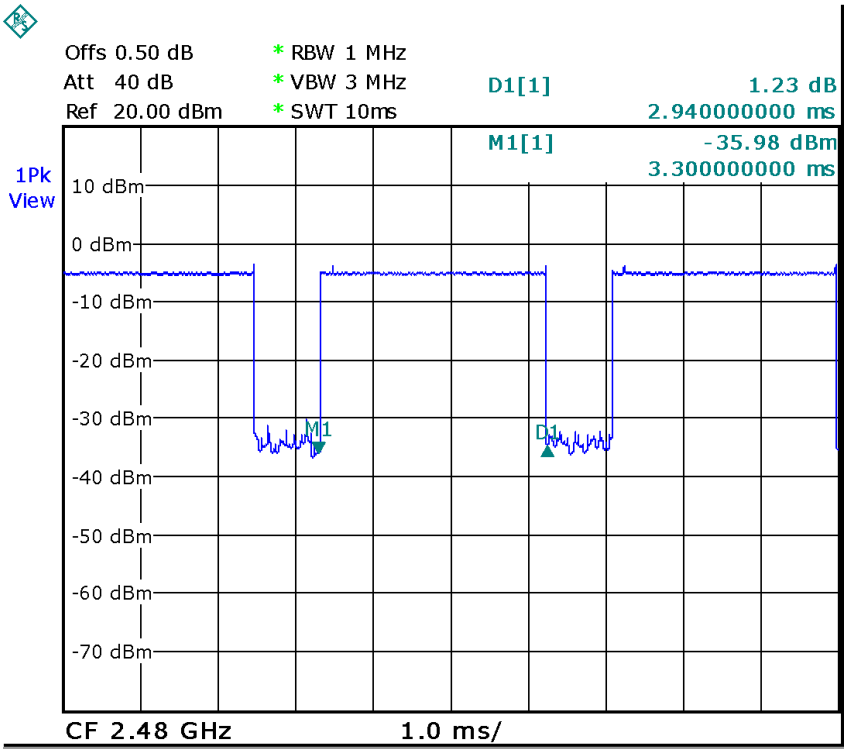
Data Packet:DH5,Lower channel



Data Packet:DH5,Middle channel

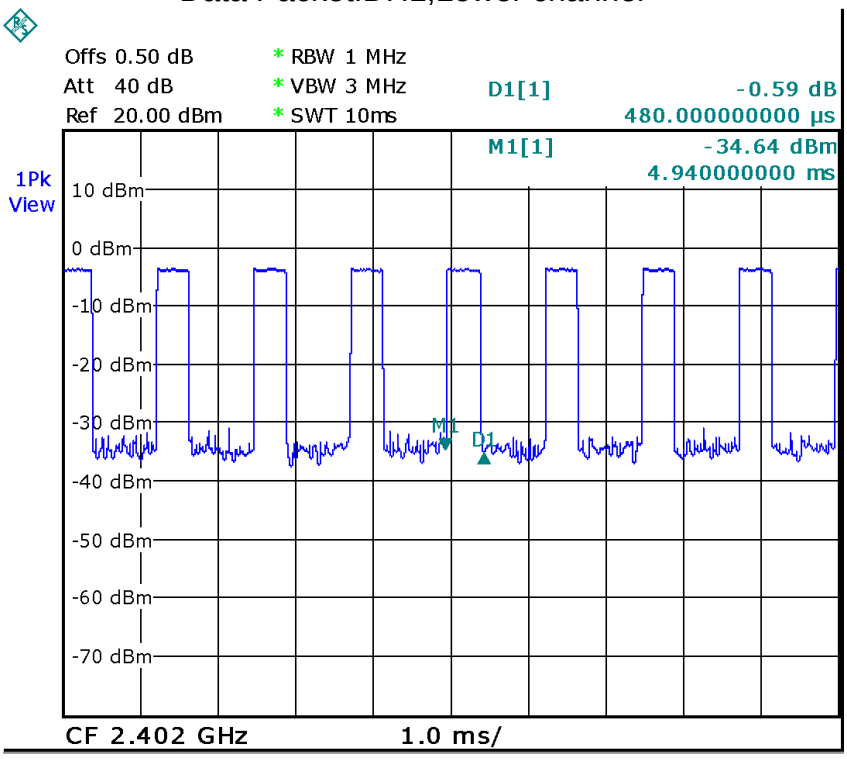


Data Packet:DH5,Upper channel

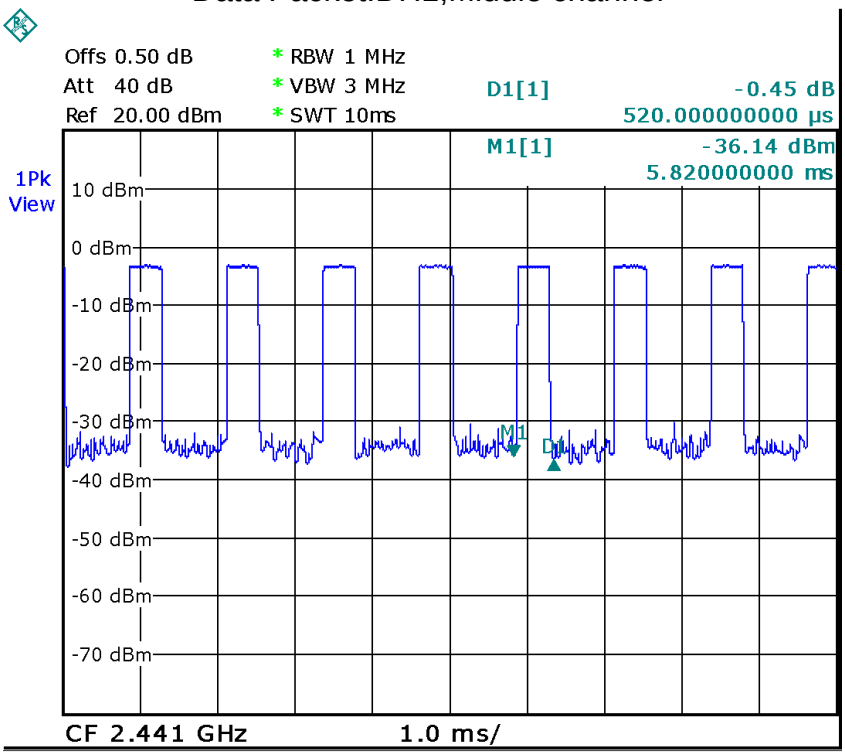


Modulation: Pi/4DQPSK

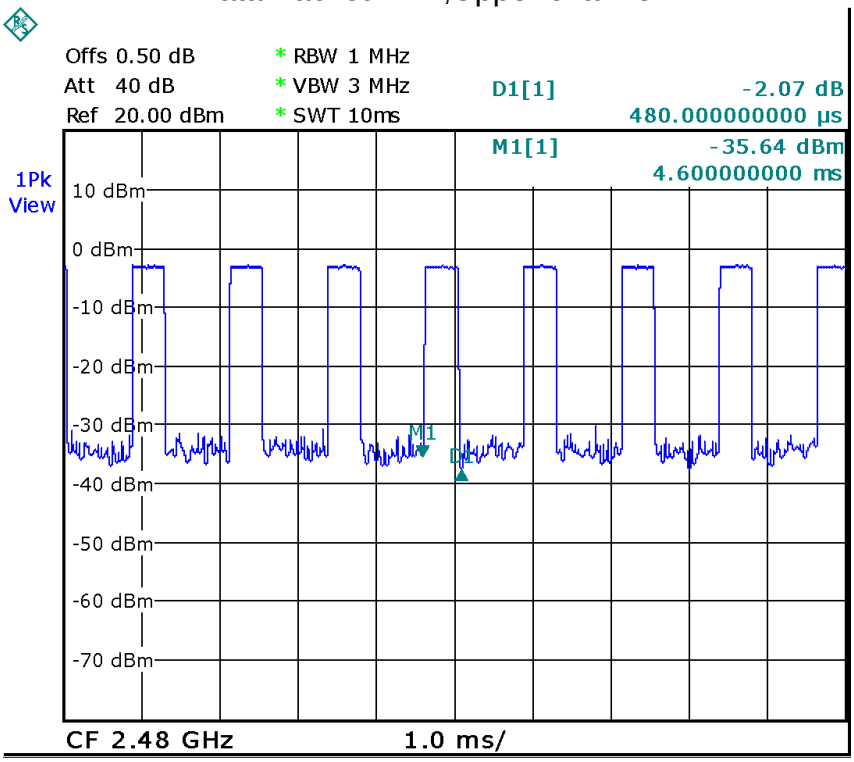
Data Packet:DH1,Lower channel



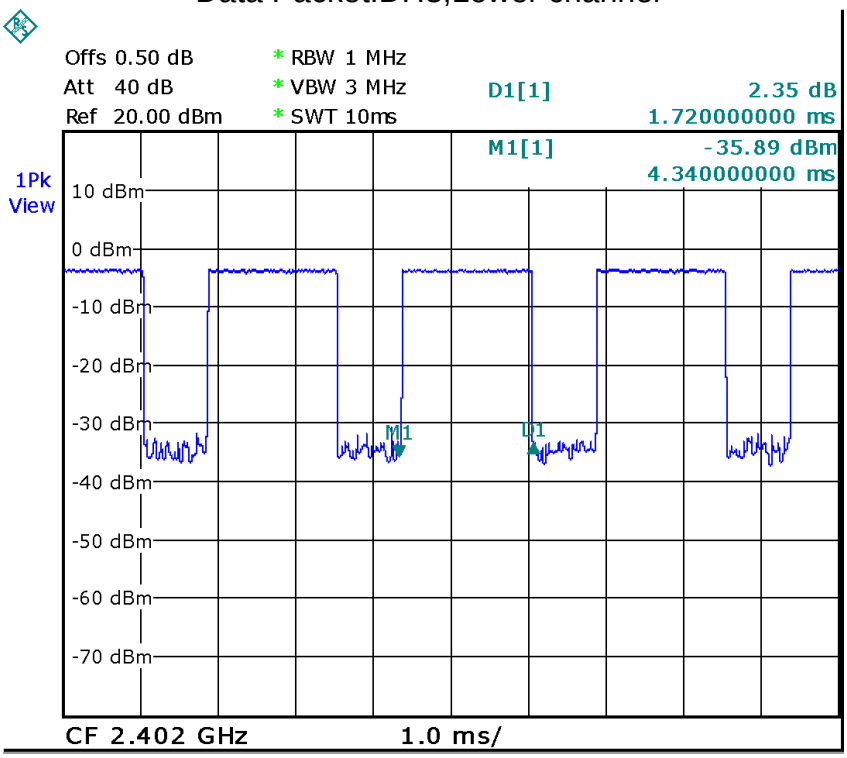
Data Packet:DH1,Middle channel



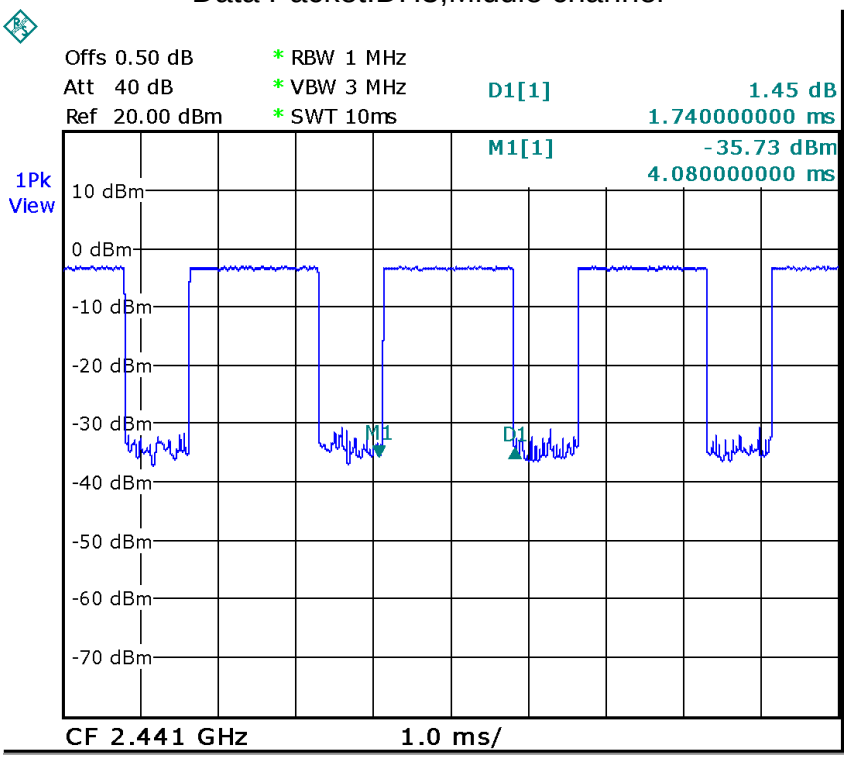
Data Packet:DH1,Upper channel



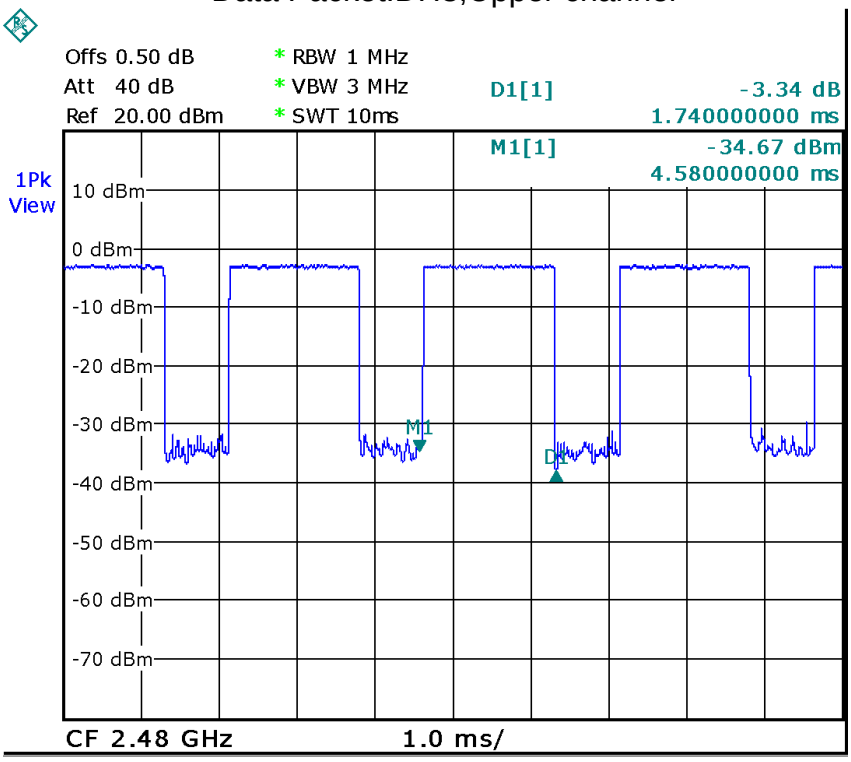
Data Packet:DH3,Lower channel



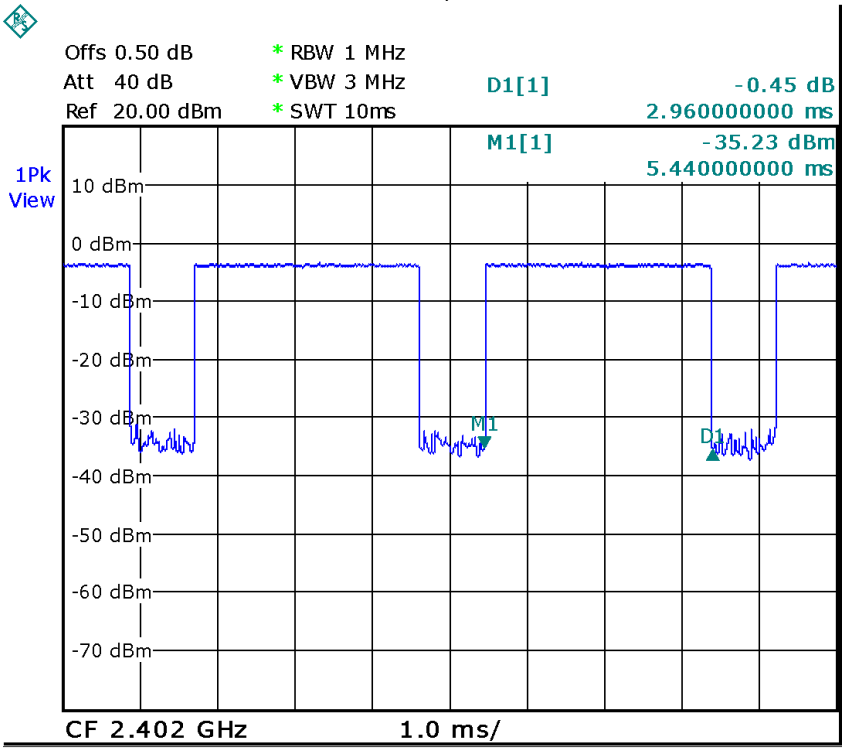
Data Packet:DH3,Middle channel



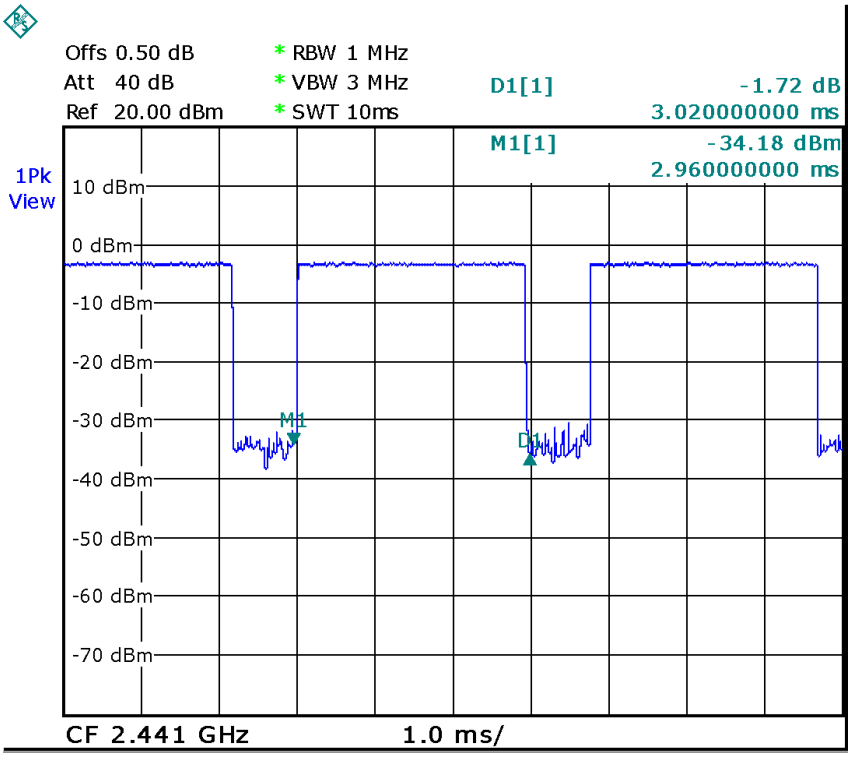
Data Packet:DH3,Upper channel



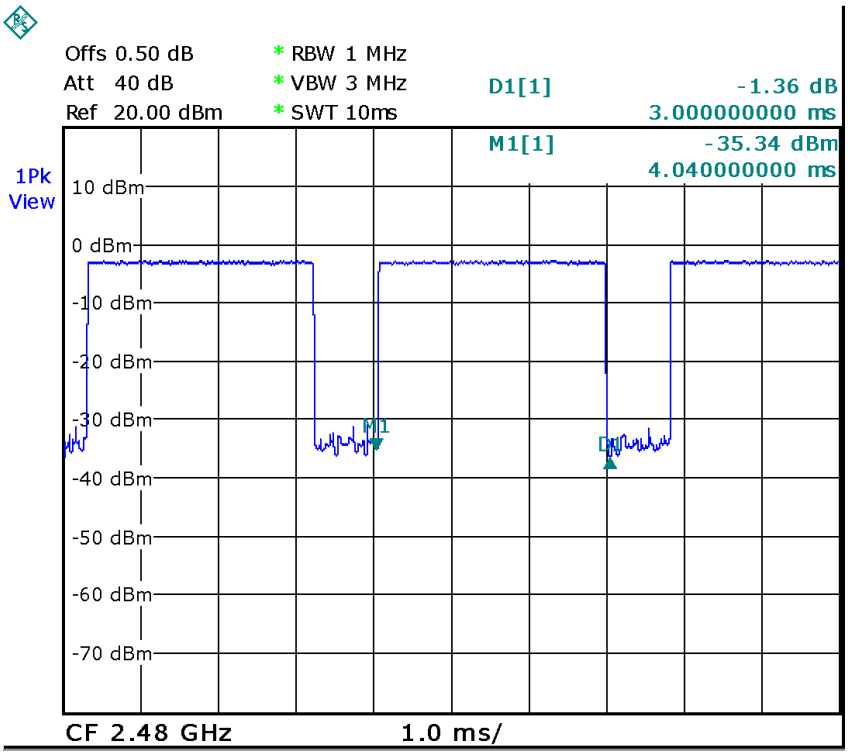
Data Packet:DH5,Lower channel



Data Packet:DH5,Middle channel

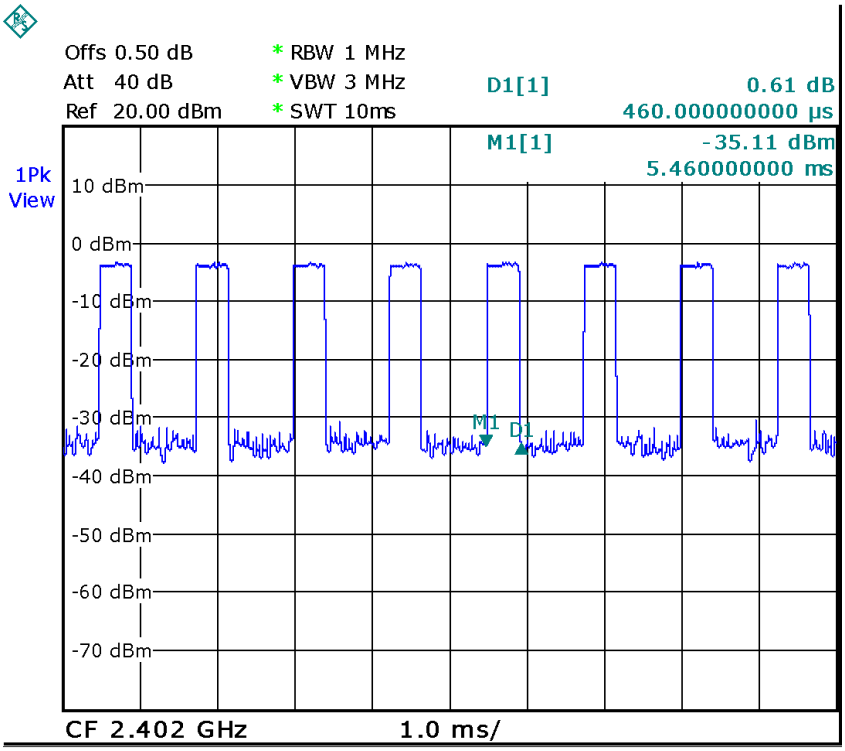


Data Packet:DH5,Upper channel

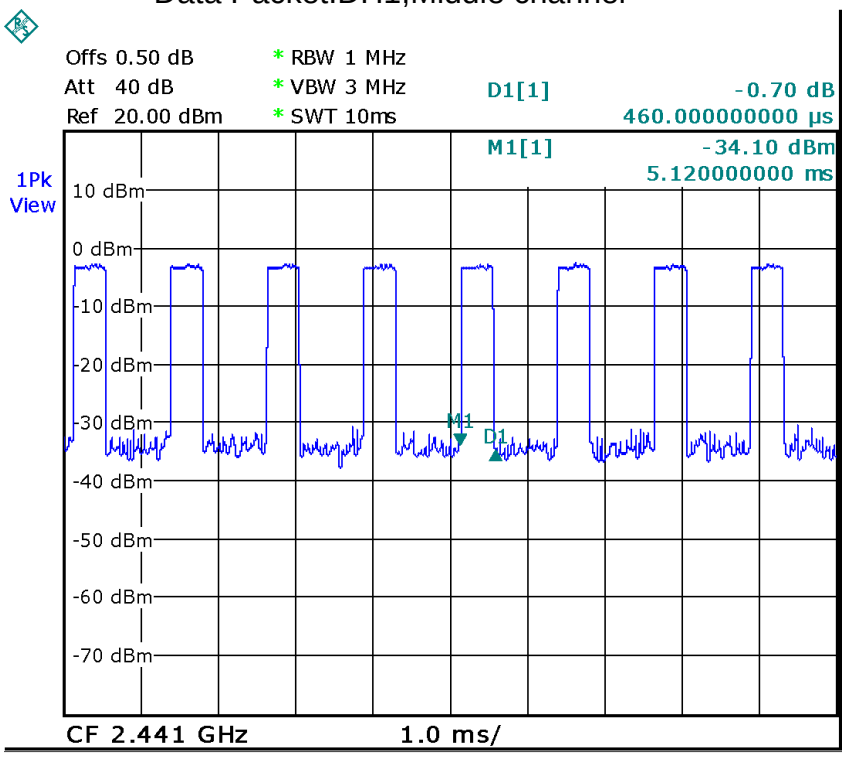


Modulation: 8DPSK

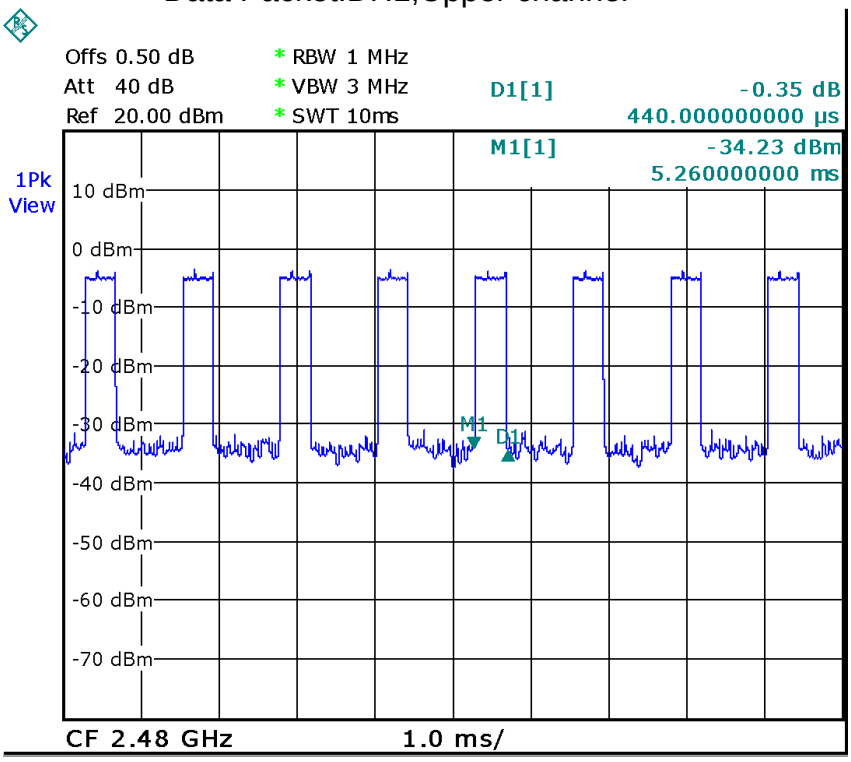
Data Packet:DH1,Lower channel



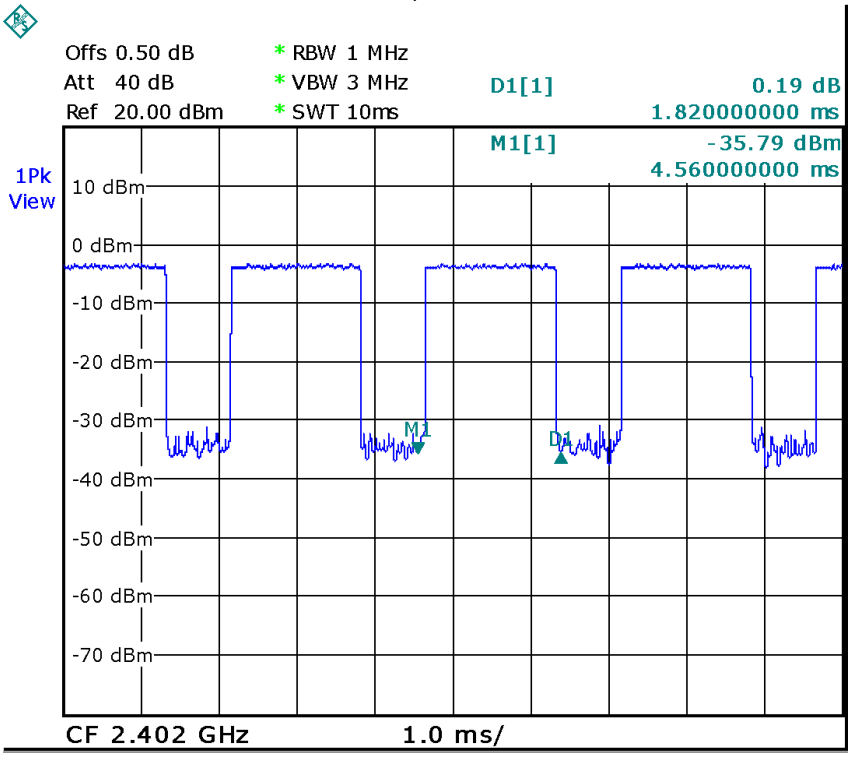
Data Packet:DH1,Middle channel



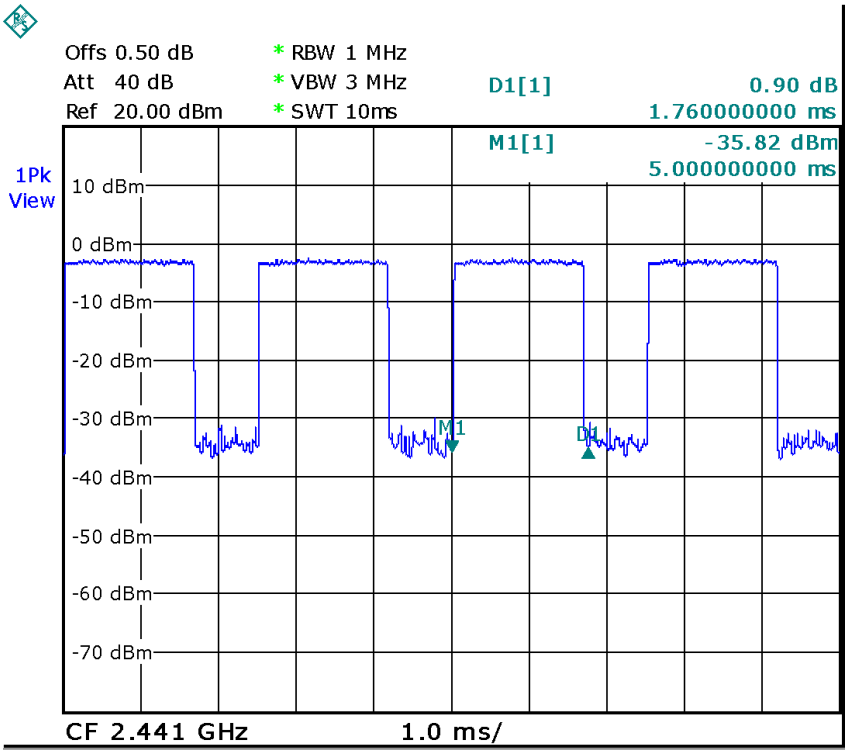
Data Packet:DH1,Upper channel



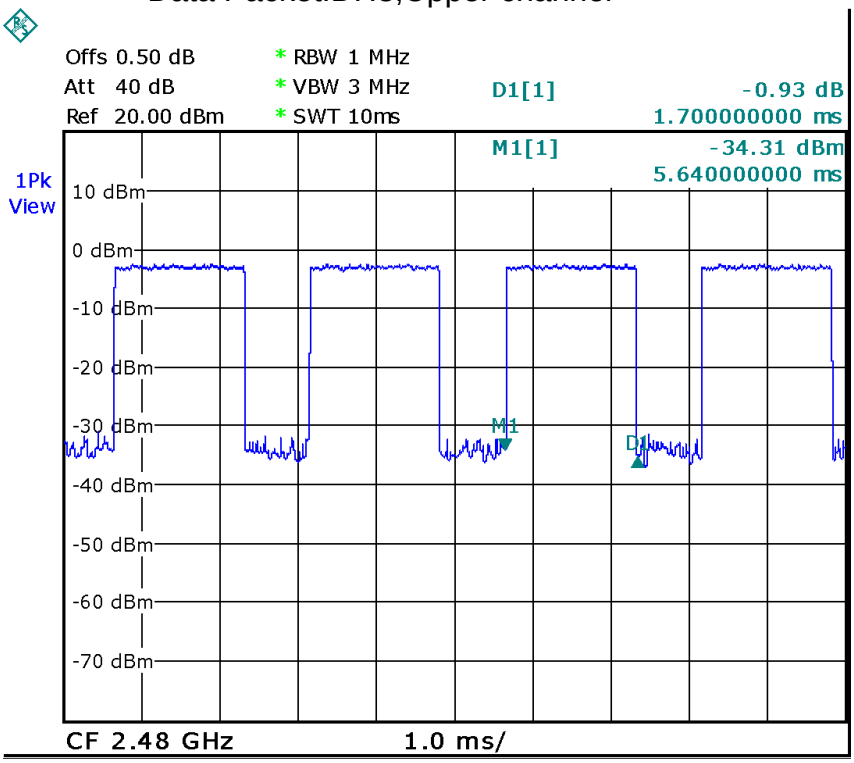
Data Packet:DH3,Lower channel



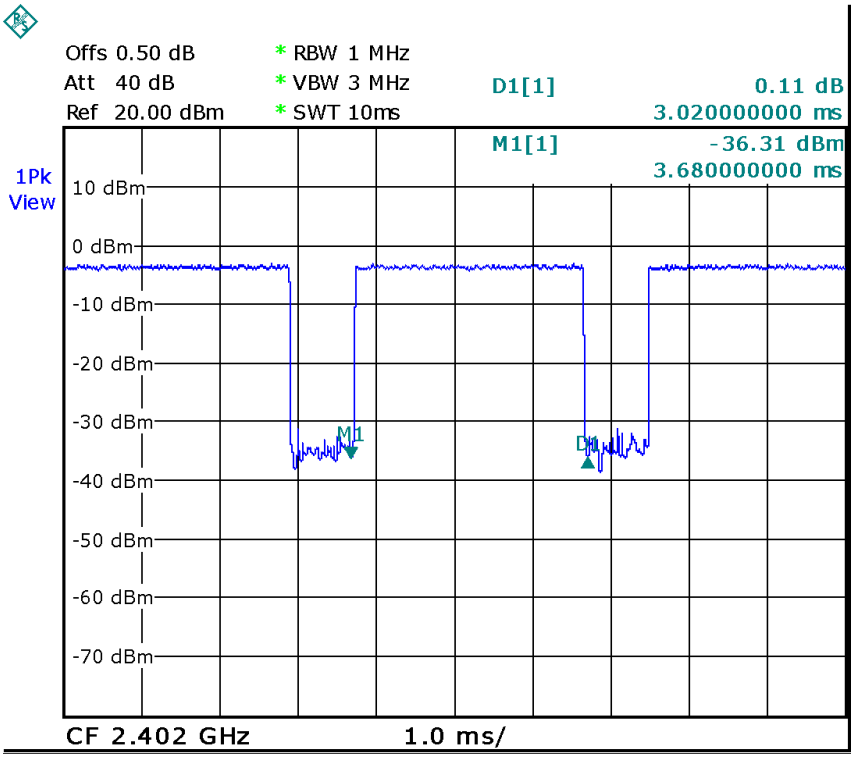
Data Packet:DH3,Middle channel



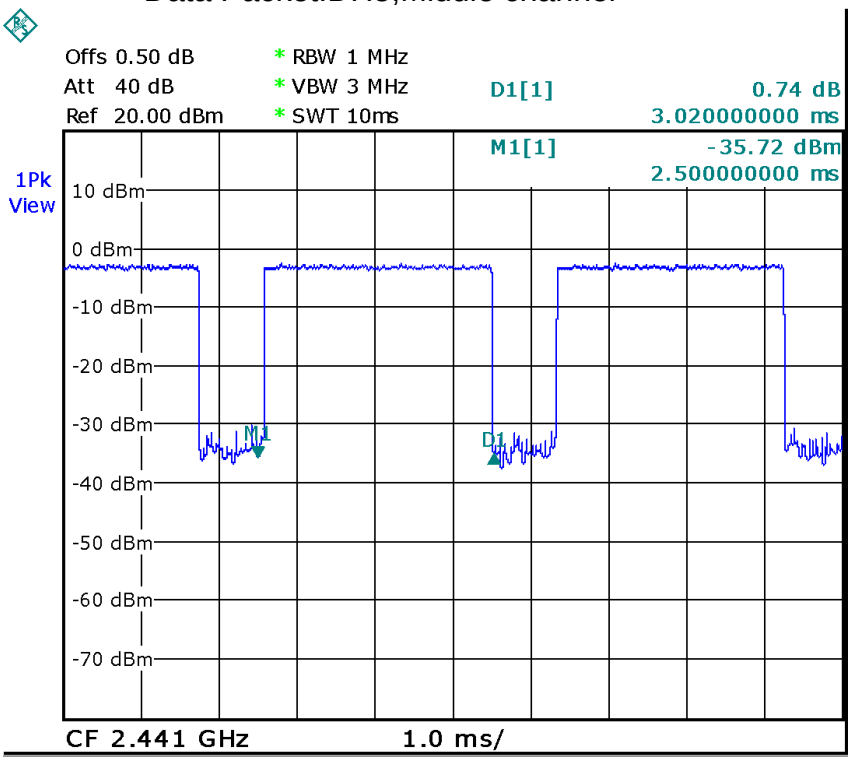
Data Packet:DH3,Upper channel



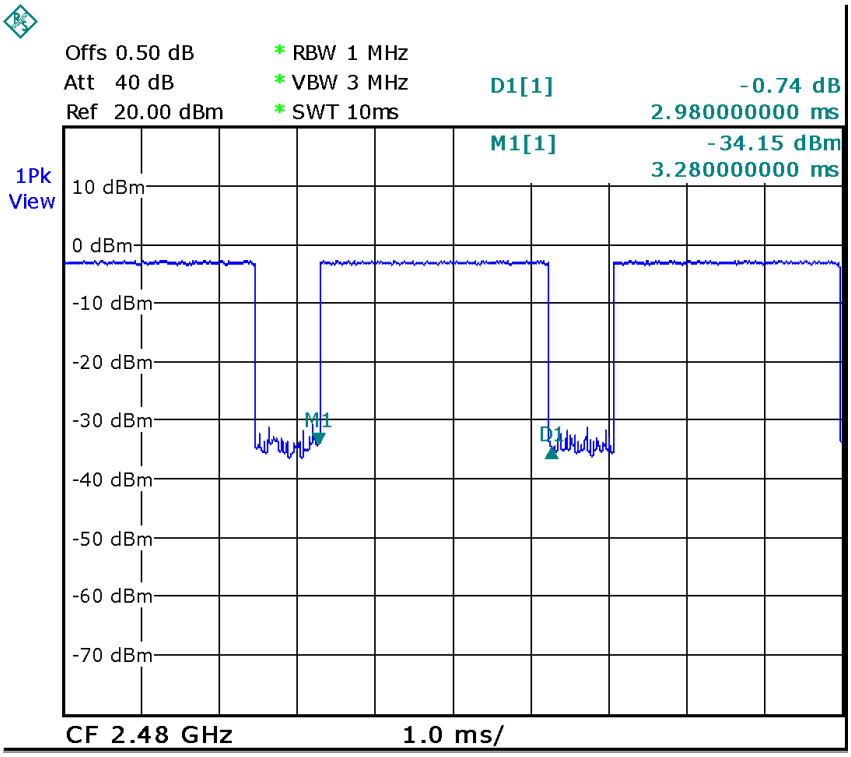
Data Packet:DH5,Lower channel



Data Packet:DH5,Middle channel



Data Packet:DH5,Upper channel



10 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, fulfill the requirement of this section.

11 RF Exposure

Test Requirement: FCC Part 1.1307

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

11.1 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.

11.2 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

11.3 MPE Calculation Method

$$\text{E (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \qquad \text{Power Density: } Pd \text{ (W/m²)} = \frac{E^2}{377}$$

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

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

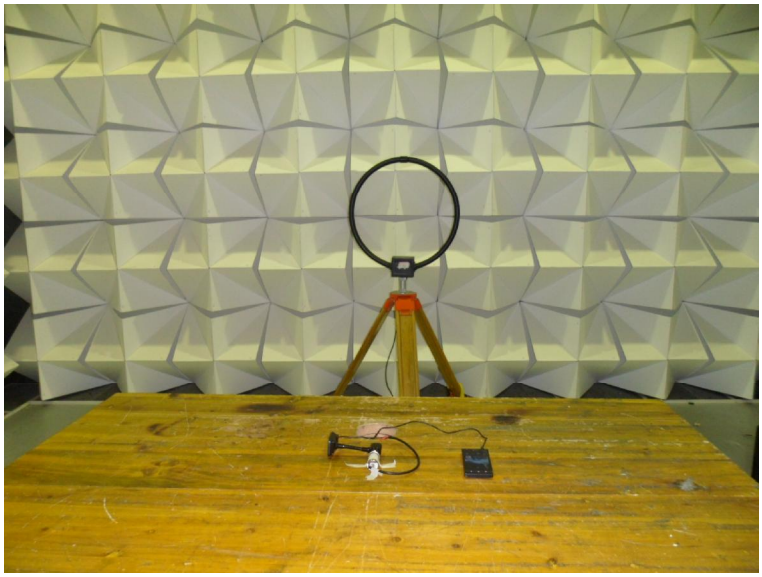
From the peak EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the gain of the used antenna, the RF power density can be obtained

Modulation	Antenna Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Power Density (mW/cm2)	Limit of Power Density (mW/cm2)
GFSK	1	-1.48	0.711213514	0.000141488	1
Pi/4DQPSK	1	-2.21	0.601173737	0.000119597	1
8DPSK	1	-2.69	0.538269783	0.000107083	1

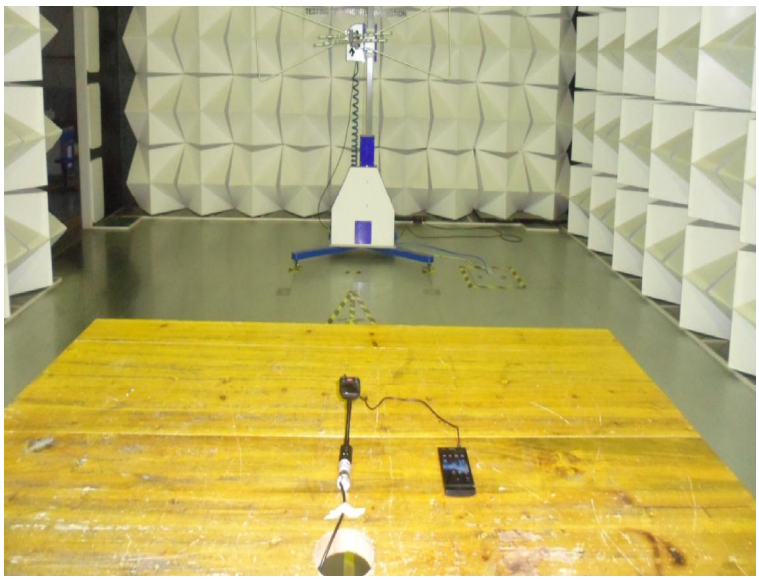
9 Photographs – Test Setup

9.1 Radiated Emissions

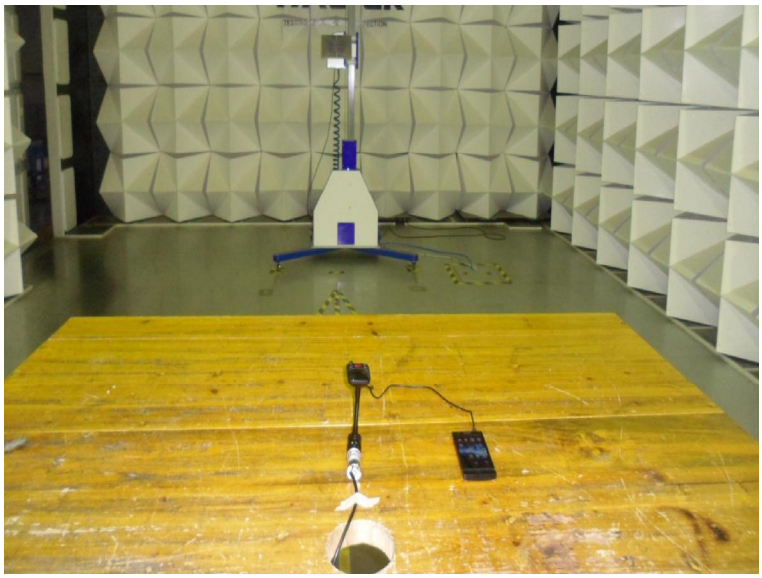
Below 30MHz



From 30-1000MHz



Above 1GHz



10 Photographs - Constructional Details

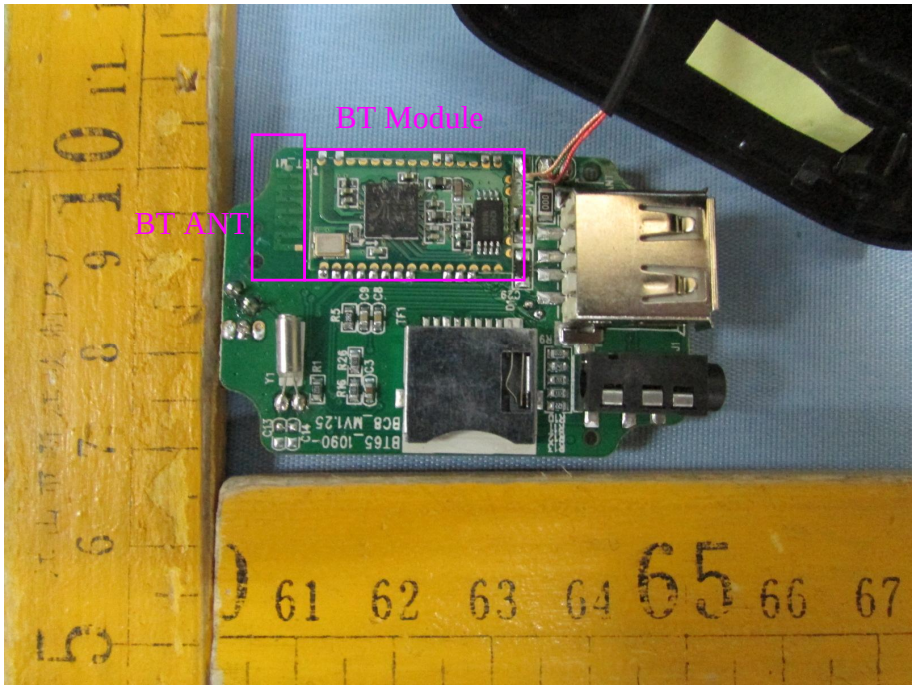
10.1 EUT – External View(1)

10.2 EUT – External View(2)

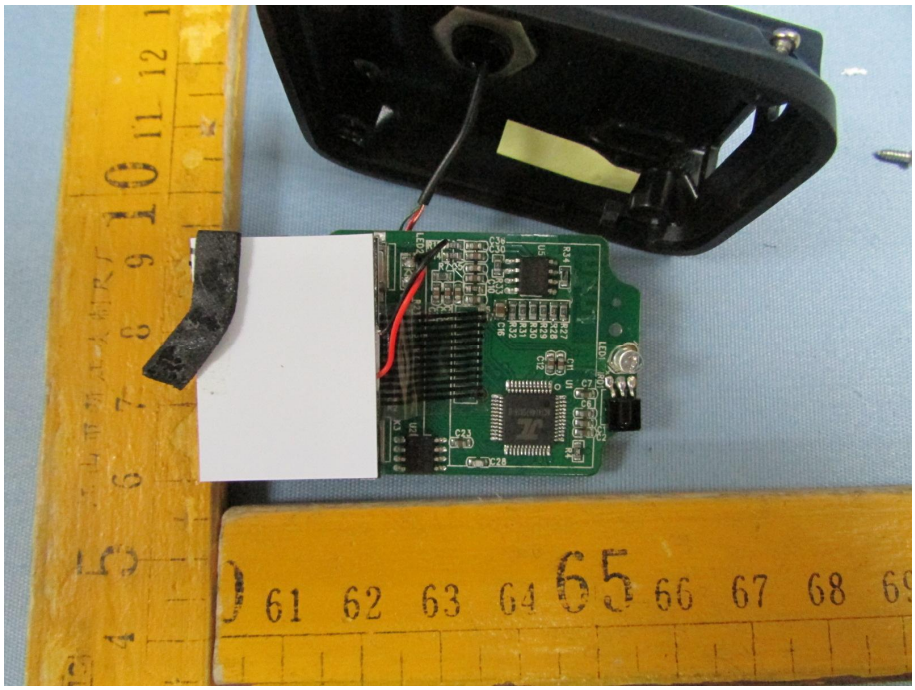
10.3 EUT – External View(3)

10.4 EUT – External View(4)

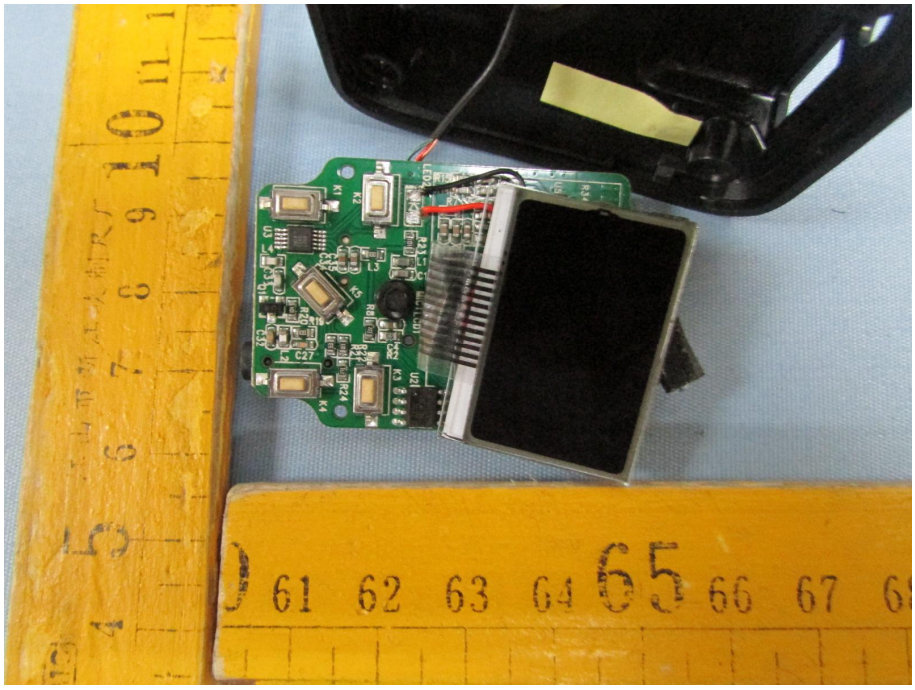
10.5 EUT –Internal View(1)



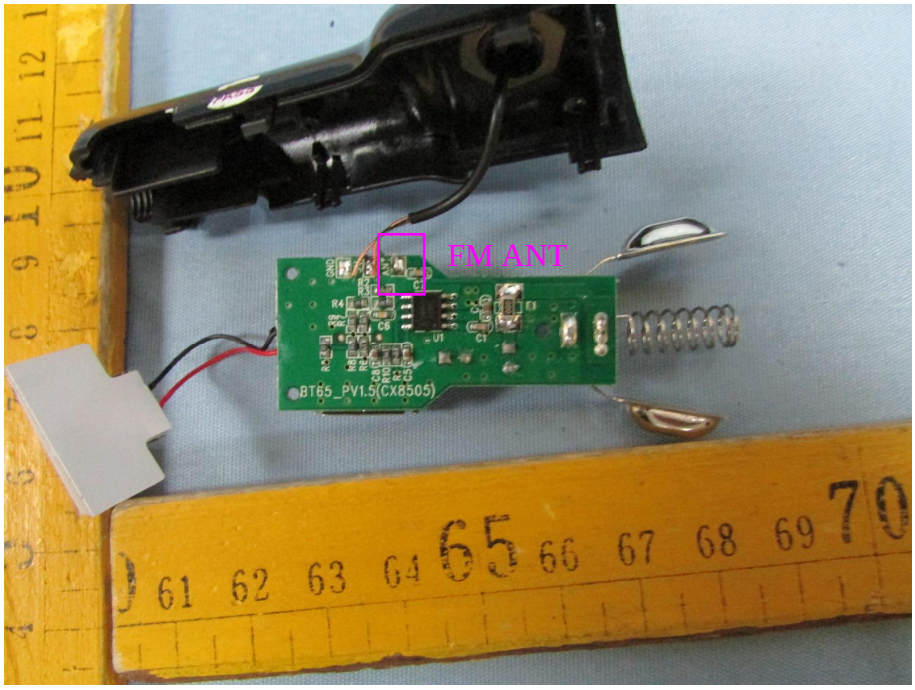
10.6 EUT –Internal View(2)



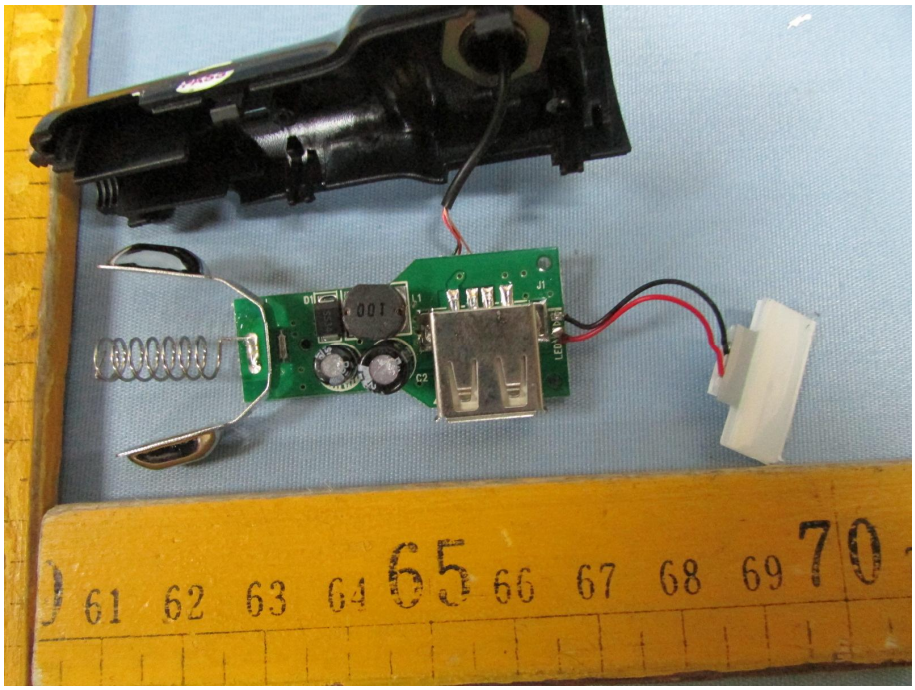
10.7 EUT –Internal View(3)



10.8 EUT –Internal View(4)



10.9 EUT –Internal View(5)



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