

TEST REPORT

Reference No. : WTS13S1210531E
FCC ID : 2ABQE-S11
Applicant : SHENZHEN SAGE HUMAN ELECTRONICS CO.,LTD
Address : 4 floor,A9 bldg, Silicon Vellay Power Qinghu Industry Park Longhua,
new district, Shenzhen, Guangdong
Manufacturer : Shenzhen Sage Human Electronics Co.,LTD.
Address : 4FL, A9 Building, Qinghu Industry Park, Silicon Valley Power,
Longhua Town, Shenzhen, China
Product Name : Portable bluetooth speaker
Model No. : S11, S12, S15, S16, S17, T110, A26, A26B, S-10, S-02B/C/D, S-03,
S-04, S-06, S-08, S-09, S-20, S-21, S-22, , -23, S-25 ,S-26
Standards : FCC CFR47 Part 15 C Section 15.247:2012
Date of Receipt sample..... : Dec.29. 2013
Date of Test..... : Jan.01, 2014 to Mar.25, 2014
Date of Issue : Mar.26, 2014
Test Result : **Pass ***

***Remarks:**

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

Prepared By:

Waltek Services (Shenzhen) Co., Ltd.

Address: 1/F., Fukangtai Building, West Baima Road, Songgang Street, Baoan District, Shenzhen,
Guangdong, China

Testing location: 1/F., Fukangtai Building, West Baima Road, Songgang Street, Baoan District,
Shenzhen, Guangdong, China

Tel :+86-755-83551033

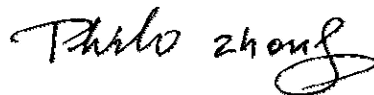
Fax:+86-755-83552400

Compiled by:



Zero Zhou / Project Engineer

Approved by:



Philo Zhong / Manager

2 Test Summary

Test Items	Test Requirement	Result
Conducted Emissions	15.207	PASS
Spurious Radiated Emissions	15.205(a) 15.209 15.247(d)	PASS
Band edge Emissions	15.247(d)	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	TEST FACILITY	6
4.5	TEST LOCATION	6
4.5.2	Test Mode	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 TEST	8
6.1	E.U.T. TEST CONDITION	8
6.2	EUT SETUP	8
6.3	CONDUCTED EMISSION TEST RESULT	9
7	SPURIOUS RADIATED EMISSIONS	11
7.1	EUT OPERATION:	11
7.2	TEST SETUP	12
7.3	SPECTRUM ANALYSER SETUP	13
7.4	TEST PROCEDURE	14
7.5	CORRECTED AMPLITUDE & MARGIN CALCULATION	14
7.6	SUMMARY OF TEST RESULTS	15
8	BAND EDGE EMISSIONS	18
8.1	TEST PROCEDURE	18
8.2	TEST RESULT	18
9	20 DB BANDWIDTH MEASUREMENT	22
9.1	TEST PROCEDURE:	22
9.2	TEST RESULT:	22
10	MAXIMUM PEAK OUTPUT POWER	28
10.1	TEST PROCEDURE:	28
10.2	TEST RESULT:	28
11	HOPPING CHANNEL SEPARATION	34
11.1	TEST PROCEDURE:	34
11.2	TEST RESULT:	34
12	NUMBER OF HOPPING FREQUENCY	40
12.1	TEST PROCEDURE:	40
12.2	TEST RESULT:	40
13	DWELL TIME	42
13.1	TEST PROCEDURE:	42
13.2	TEST RESULT:	42

14	ANTENNA REQUIREMENT.....	58
15	RF EXPOSURE	59
15.1	REQUIREMENTS:	59
15.2	THE PROCEDURES / LIMIT	59
15.3	MPE CALCULATION METHOD.....	60
16	PHOTOGRAPHS – TEST SETUP	61
16.1	PHOTOGRAPH –POWER LINE CONDUCTED EMISSION TEST SETUP	61
16.2	PHOTOGRAPH – RADIATED EMISSION TEST SETUP	61
17	PHOTOGRAPHS - CONSTRUCTIONAL DETAILS.....	63
17.1	EUT – APPEARANCE VIEW.....	63
17.2	EUT – INTERNAL VIEW.....	65
17.3	EUT – RF MODULE VIEW	67

4 General Information

4.1 General Description of E.U.T.

Product Name	: Portable bluetooth speaker
Model No.	: S11, S12, S15, S16, S17, T110, A26, A26B, S-10, S-02B/C/D, S-03, S-04, S-06, S-08, S-09, S-20, S-21, S-22, -,23, S-25 ,S-26
Model Difference	: Only the model name is different. S11 is the tested sample.
Operation Frequency	: 2402 ~ 2480MHz, 79 channels in total
Type of Modulation	: GFSK, Pi/4DQPSK, 8DPSK
Lowest OSC Frequency	: 16MHz
Antenna installation	: PCB Printed Antenna
Antenna Gain	: 0dBi

4.2 Details of E.U.T.

Technical Data : (1) DC 5V, 1A
(2) DC 3.7V, 1000mAh by built-in battery

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

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

- **IC – Registration No.: 7760A-1**

Waltek Services (Shenzhen) Co., Ltd. has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files.

Registration 7760A-1, July 12, 2012.

- **FCC – Registration No.: 880581**

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, May 26, 2011.

4.5 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

4.5.2 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests; the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting	2402MHz	2441MHz	2480MHz

5 Equipment Used during Test

5.1 Equipments List

Conducted Emissions at Mains Terminals Disturbance Voltage						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMI Test Receiver	R&S	ESCI	100947	Sep.18,2013	Sep.17,2014
2.	LISN	R&S	ENV216	101215	Nov. 29,2013	Nov. 28,2014
3.	Cable	Top	TYPE16(3.5M)	-	Sep.18,2013	Sep.17,2014
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	Sep.21,2013	Sep.20,2014
2	Active Loop Antenna	Beijing Dazhi	ZN30900A	-	Sep.18,2013	Sep.17,2014
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	Apr.20,2013	Apr.19,2014
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	Sep.18,2013	Sep.17,2014
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	Apr.20,2013	Apr.19,2014
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	Apr.20,2013	Apr.19,2014
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	Mar.17,2014	Mar.16,2015
8	Coaxial Cable (above 1GHz)	Top	1GHz-25GHz	EW02014-7	Apr.20,2013	Apr.19,2014

5.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-6}$
Bandwidth	$\pm 1.5 \times 10^{-6}$
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
DC Source	$\pm 0.05\%$
Radiated Emissions test	± 5.03 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)
Conducted Spurious Emissions test	± 3.64 dB (150kHz~30MHz)

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

Test Requirement:	FCC Part15 Paragraph 15.207
Test Method:	ANSI C63.4: 2003
Test Result:	PASS
Frequency Range:	150kHz to 30MHz
Class:	Class B
Limit:	66-56 dB μ V between 0.15MHz & 0.5MHz 56 dB μ V between 0.5MHz & 5MHz 60 dB μ V 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. Test Condition

Operating Environment:

Temperature: 22°C

Humidity: 52.5 % RH

Atmospheric Pressure: 101.1kPa

EUT Operation:

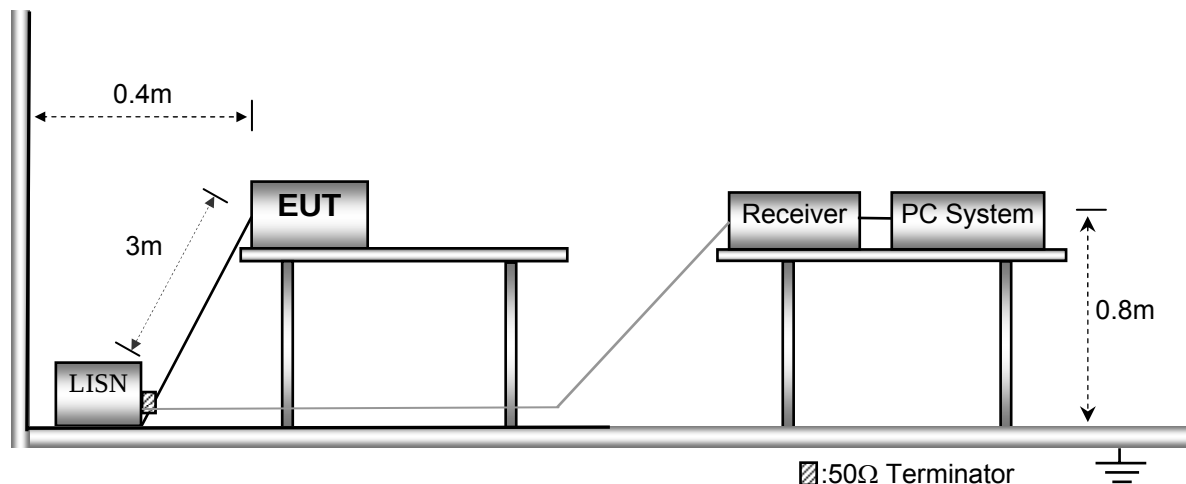
The pre-test was performed in communication mode, and the test data were shown as follow.

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.

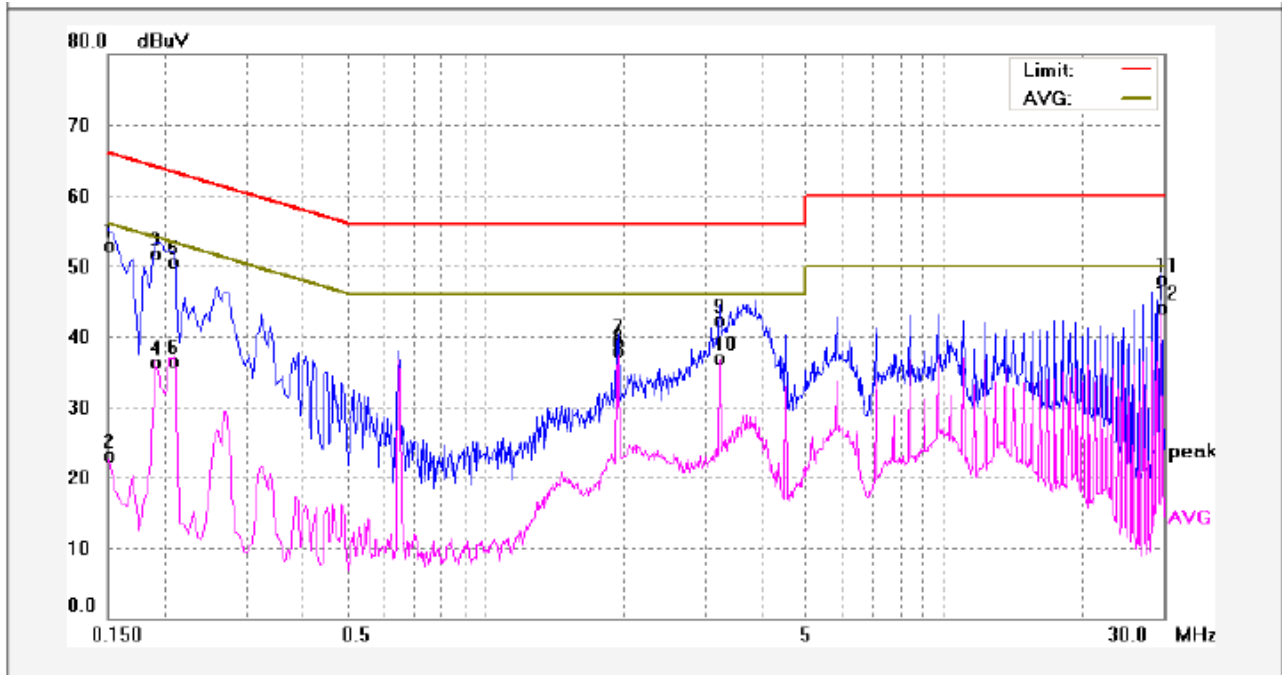
6.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.4:2003.



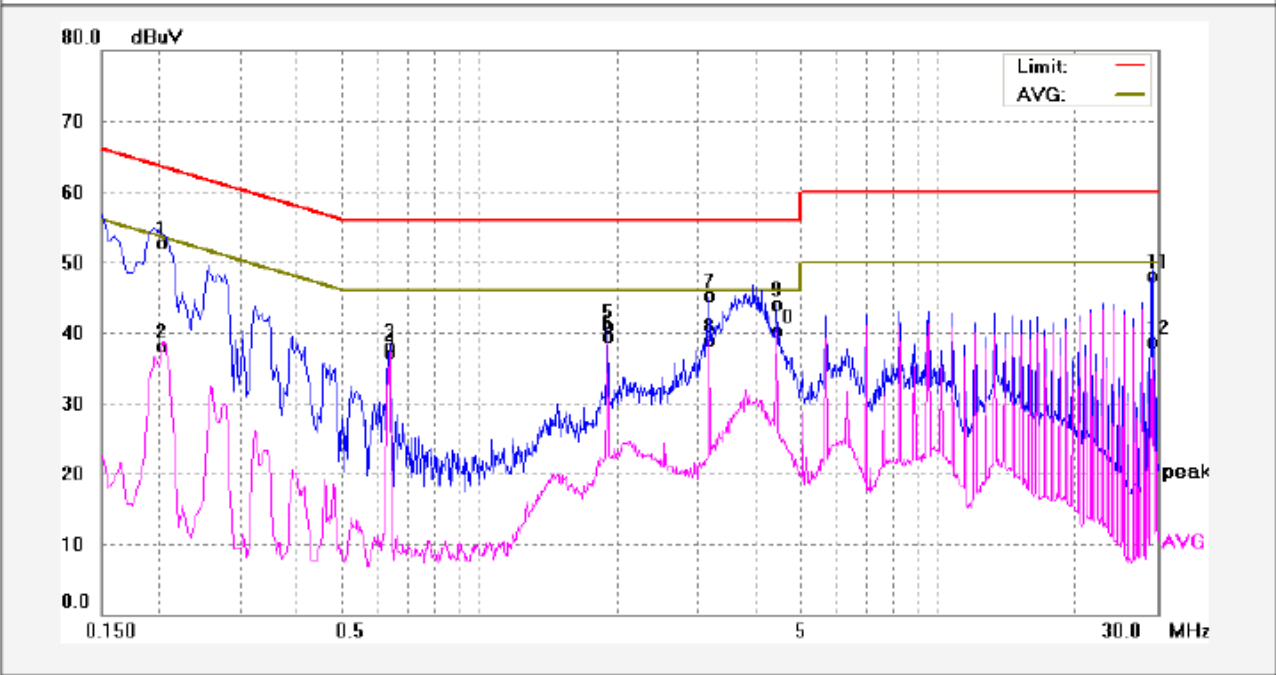
6.3 Conducted Emission Test Result

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1500	43.06	9.80	52.86	65.99	-13.13	QP	
2	0.1500	13.24	9.80	23.04	55.99	-32.95	AVG	
3	0.1900	41.91	9.83	51.74	64.03	-12.29	QP	
4	0.1900	26.43	9.83	36.26	54.03	-17.77	AVG	
5	0.2100	40.60	9.84	50.44	63.20	-12.76	QP	
6	0.2100	26.61	9.84	36.45	53.20	-16.75	AVG	
7	1.9400	29.22	10.00	39.22	56.00	-16.78	QP	
8	1.9400	27.84	10.00	37.84	46.00	-8.16	AVG	
9	3.2300	32.20	10.04	42.24	56.00	-13.76	QP	
10	3.2300	26.77	10.04	36.81	46.00	-9.19	AVG	
11	29.7300	35.85	12.27	48.12	60.00	-11.88	QP	
12	29.7300	31.93	12.27	44.20	50.00	-5.80	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.2050	42.91	9.84	52.75	63.40	-10.65	QP	
2	0.2050	28.20	9.84	38.04	53.40	-15.36	AVG	
3	0.6350	28.14	9.94	38.08	56.00	-17.92	QP	
4	0.6350	27.26	9.94	37.20	46.00	-8.80	AVG	
5	1.9000	30.86	10.00	40.86	56.00	-15.14	QP	
6	1.9000	29.49	10.00	39.49	46.00	-6.51	AVG	
7	3.1700	35.33	10.04	45.37	56.00	-10.63	QP	
8	3.1700	28.78	10.04	38.82	46.00	-7.18	AVG	
9	4.4350	34.09	10.08	44.17	56.00	-11.83	QP	
10	4.4350	30.17	10.08	40.25	46.00	-5.75	AVG	
11	29.2400	36.00	12.20	48.20	60.00	-11.80	QP	
12	29.2400	26.50	12.20	38.70	50.00	-11.30	AVG	

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: 23.5 °C

Humidity: 52.5 % RH

Atmospheric Pressure: 101.8kPa

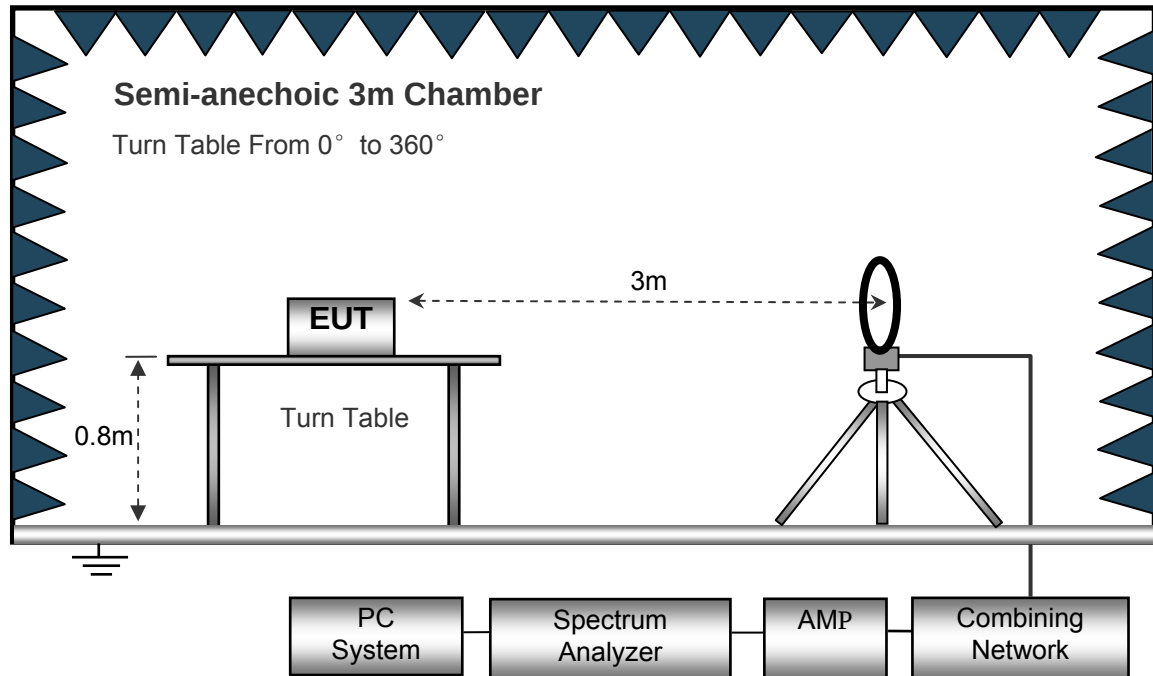
EUT Operation:

The test was performed in communication mode, and the worst data is show in the report.

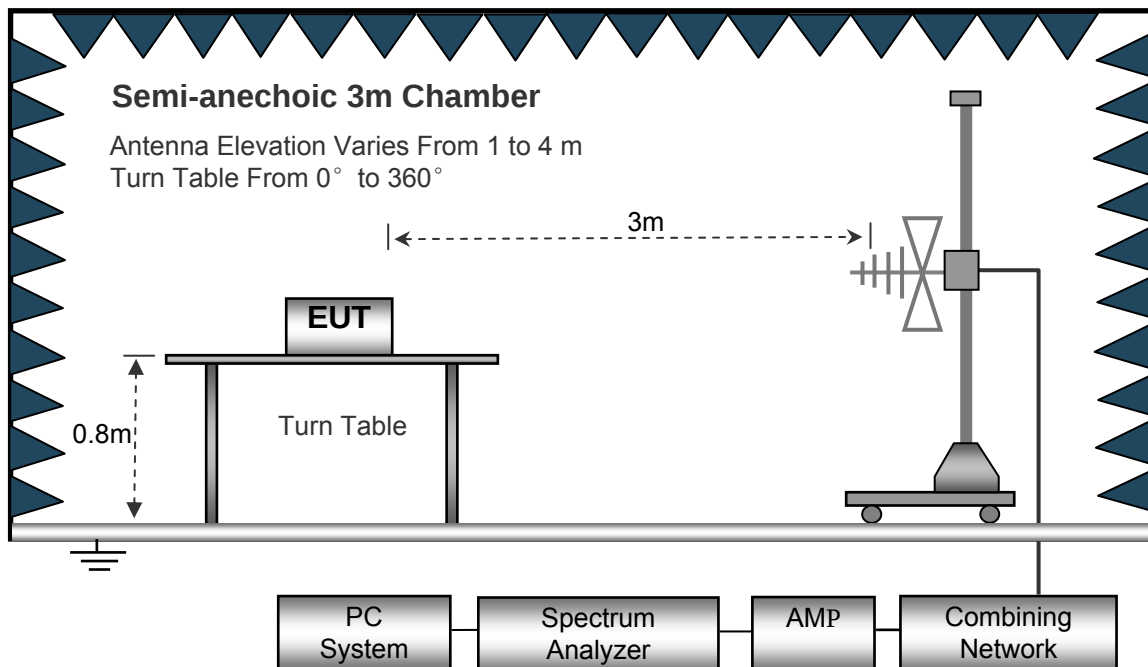
7.2 Test Setup

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

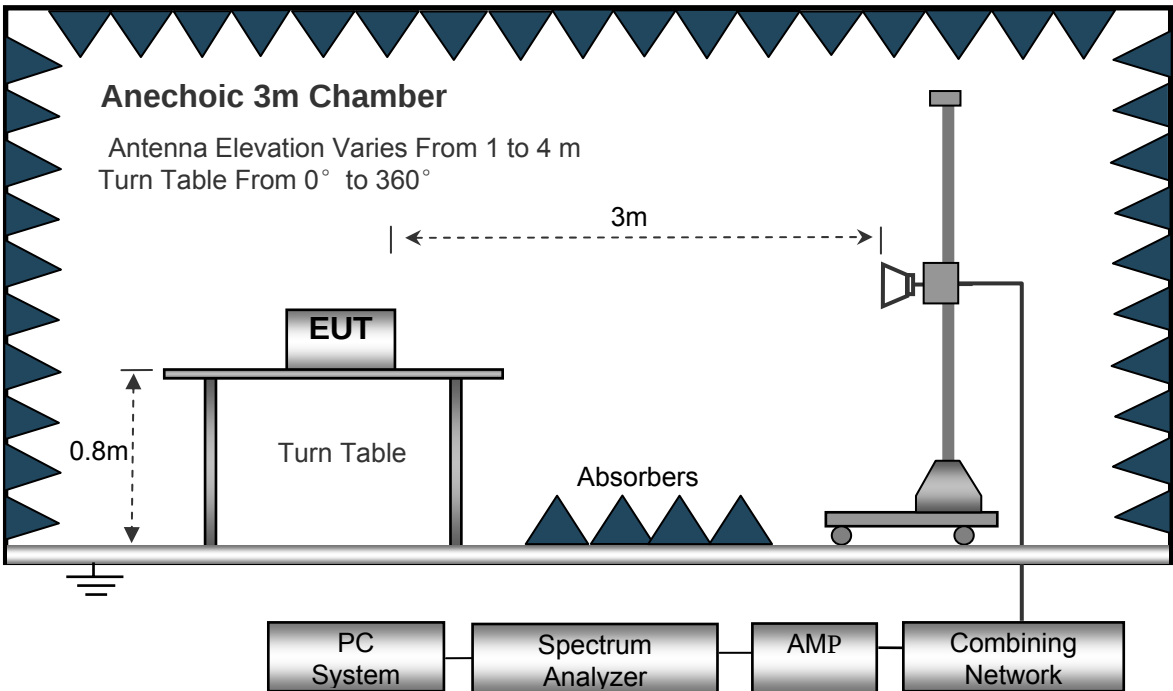
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



7.3 Spectrum Analyser Setup

According to FCC Part15 Rules, the system was tested 16MHz to 25000MHz.

Below 30MHz

- Sweep SpeedAuto
- IF Bandwidth.....10kHz
- Resolution Bandwidth.....10kHz
- Video Bandwidth.....10kHz

30MHz ~ 1GHz

- Sweep SpeedAuto
- DetectorPK
- Resolution Bandwidth.....100kHz
- Video Bandwidth.....300kHz

Above 1GHz

- Sweep SpeedAuto
- DetectorPK
- Resolution Bandwidth.....1MHz
- Video Bandwidth.....3MHz
- DetectorAve.
- Resolution Bandwidth.....1MHz
- Video Bandwidth.....10Hz

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:

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

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

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

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 ~ 18GHz

The Worst Mode: Bluetooth transmitting (Adapter 2)

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
51.87	14.93	QP	332	1.4	H	13.22	28.15	40.00	-11.85
51.87	18.22	QP	71	1.3	V	13.22	31.44	40.00	-8.56
4804.00	53.71	PK	247	1.5	V	-1.06	52.65	74.00	-21.35
4804.00	43.98	Ave	247	1.5	V	-1.06	42.92	54.00	-11.08
7206.00	41.46	PK	278	1.4	H	1.33	42.79	74.00	-31.21
7206.00	38.09	Ave	278	1.4	H	1.33	39.42	54.00	-14.58
2326.93	45.38	PK	266	1.1	V	-13.19	32.19	74.00	-41.81
2326.93	38.57	Ave	266	1.1	V	-13.19	25.38	54.00	-28.62
2352.84	44.17	PK	95	1.4	H	-13.14	31.03	74.00	-42.97
2352.84	38.35	Ave	95	1.4	H	-13.14	25.21	54.00	-28.79
2491.39	43.54	PK	225	1.1	V	-13.08	30.46	74.00	-43.54
2491.39	36.08	Ave	225	1.1	V	-13.08	23.00	54.00	-31.00

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Middle Channel 2441MHz									
51.87	13.57	QP	181	1.9	H	13.22	26.79	40.00	-13.21
51.87	17.46	QP	174	1.7	V	13.22	30.68	40.00	-9.32
4882.00	53.45	PK	56	1.5	V	-0.62	52.83	74.00	-21.17
4882.00	44.23	Ave	56	1.5	V	-0.62	43.61	54.00	-10.39
7323.00	41.35	PK	105	1.0	H	2.21	43.56	74.00	-30.44
7323.00	38.06	Ave	105	1.0	H	2.21	40.27	54.00	-13.73
2322.86	46.74	PK	85	1.6	V	-13.19	33.55	74.00	-40.45
2322.86	39.36	Ave	85	1.6	V	-13.19	26.17	54.00	-27.83
2385.49	44.42	PK	286	1.2	H	-13.14	31.28	74.00	-42.72
2385.49	36.78	Ave	286	1.2	H	-13.14	23.64	54.00	-30.36
2485.56	42.22	PK	315	1.4	V	-13.08	29.14	74.00	-44.86
2485.56	37.25	Ave	315	1.4	V	-13.08	24.17	54.00	-29.83

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247	
				Height	Polar			Limit	Margin
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK High Channel 2480MHz									
51.87	13.48	QP	147	1.3	H	13.22	26.70	40.00	-13.30
51.87	17.06	QP	226	1.9	V	13.22	30.28	40.00	-9.72
4960.00	53.95	PK	357	1.6	V	-0.24	53.71	74.00	-20.29
4960.00	44.04	Ave	357	1.6	V	-0.24	43.80	54.00	-10.20
7440.00	41.38	PK	339	1.7	H	2.84	44.22	74.00	-29.78
7440.00	37.06	Ave	339	1.7	H	2.84	39.90	54.00	-14.10
2311.30	46.62	PK	305	1.7	V	-13.19	33.43	74.00	-40.57
2311.30	37.80	Ave	305	1.7	V	-13.19	24.61	54.00	-29.39
2373.30	43.99	PK	12	1.8	H	-13.14	30.85	74.00	-43.15
2373.30	37.08	Ave	12	1.8	H	-13.14	23.94	54.00	-30.06
2499.78	44.77	PK	236	1.0	V	-13.08	31.69	74.00	-42.31
2499.78	37.50	Ave	236	1.0	V	-13.08	24.42	54.00	-29.58

Remark: Scan with GFSK, Pi/4DQPSK, 8DPSK, the worst case is GFSK mode.

Test Frequency: Above 18GHz

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

8 Band edge Emissions

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 Method: DA 00-705

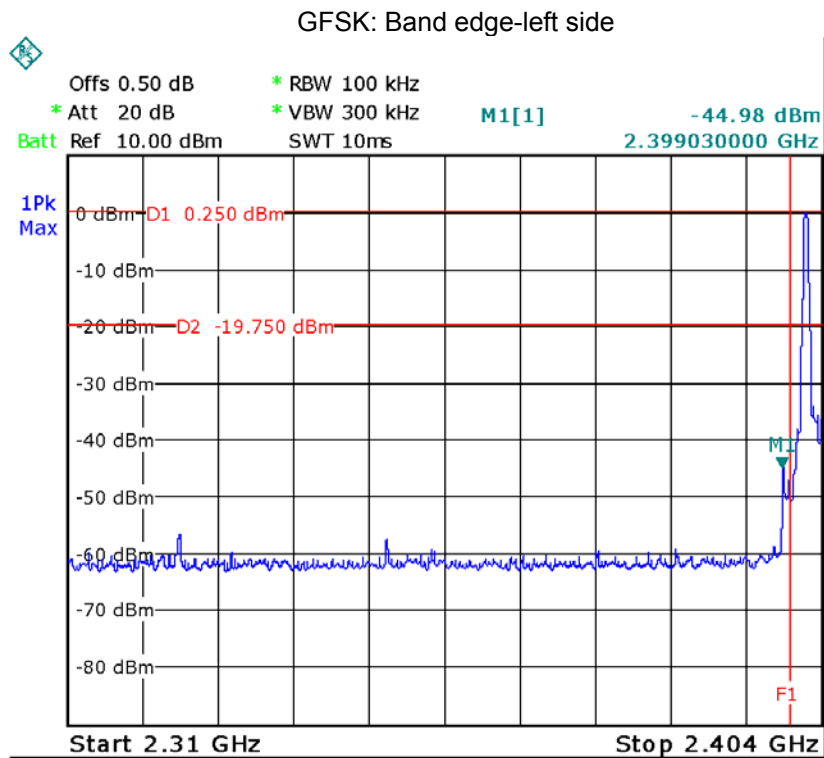
Test Status: Transmitting mode

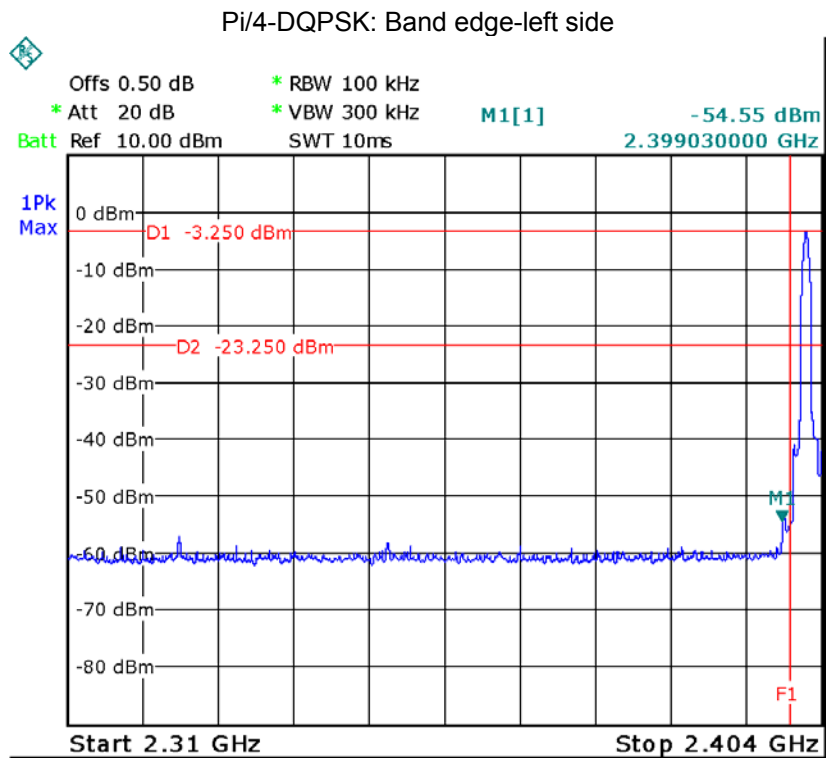
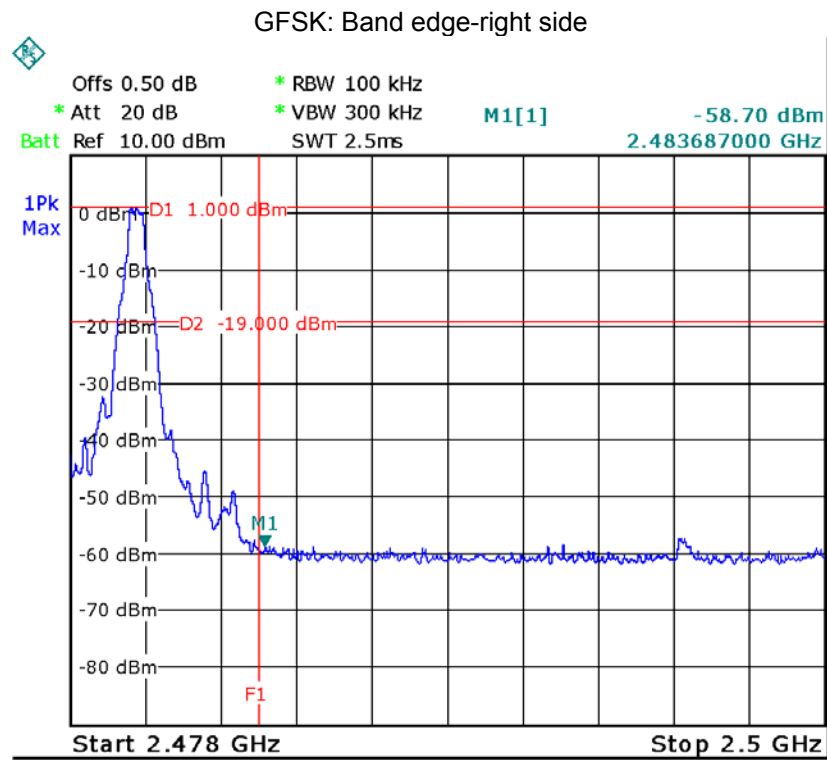
8.1 Test Procedure

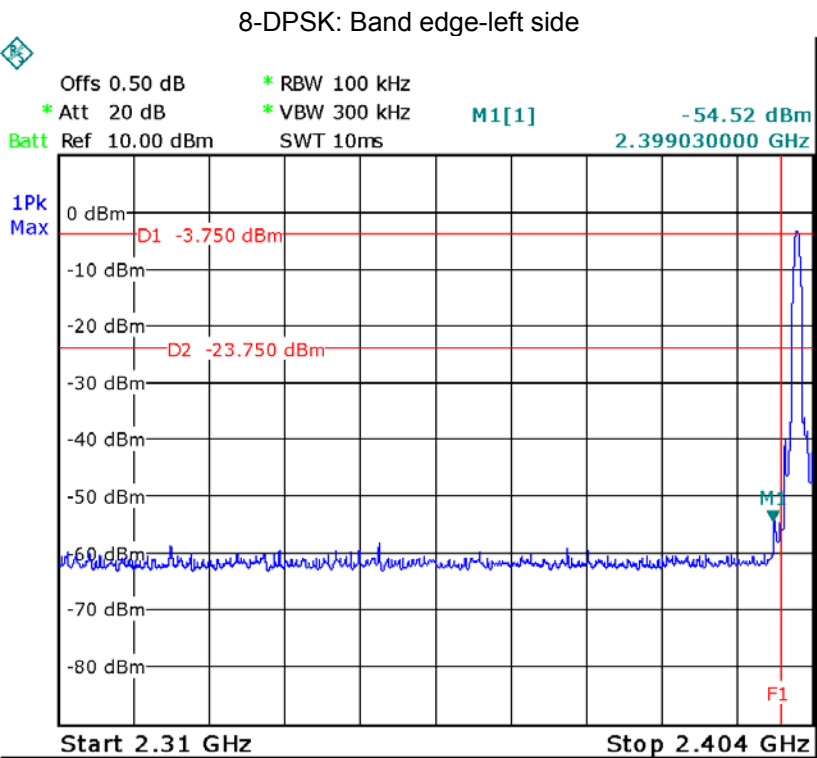
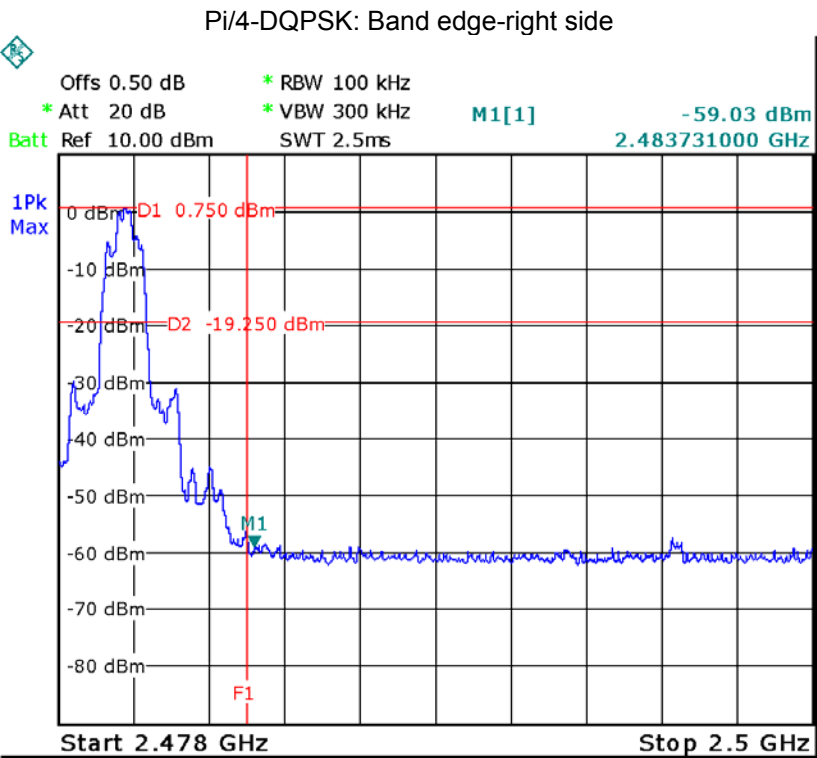
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set to span from the lowest frequency generated in the device up to and including the tenth harmonic of the highest fundamental frequency.
3. Set RBW = 100kHz and VBW = 300kHz. Sweep = auto.
4. Mark the worst point and record.

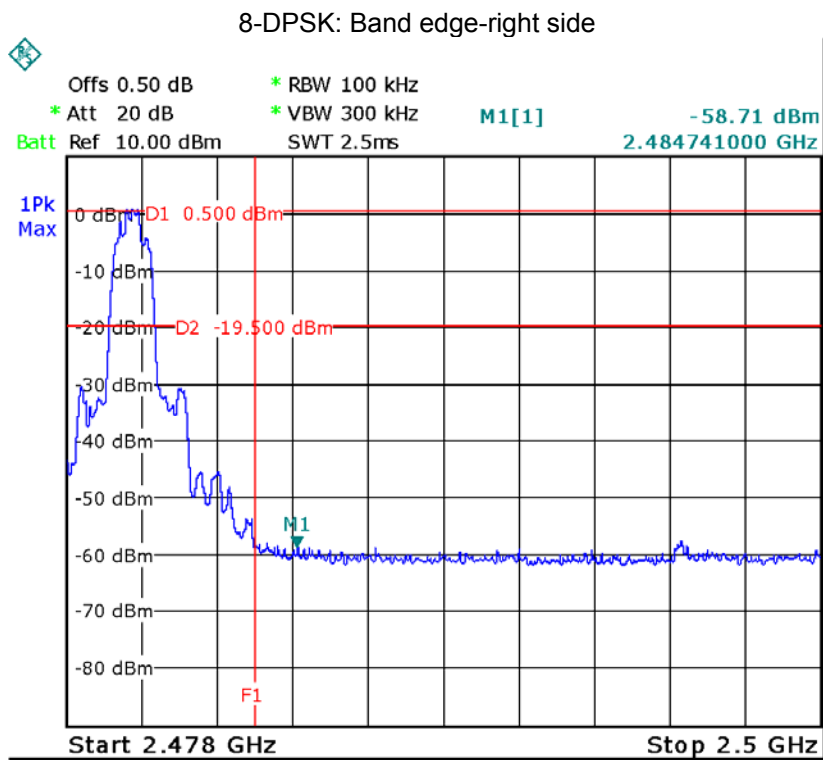
8.2 Test Result

Test result plots shown as follows:









9 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.

9.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyser: RBW = 30 kHz, VBW = 100kHz

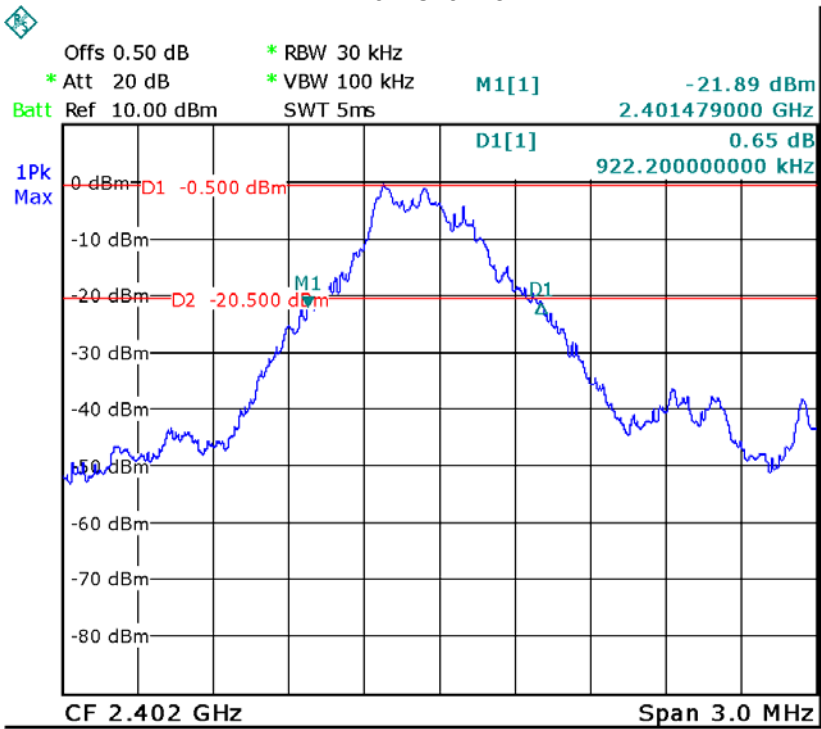
9.2 Test Result:

Modulation	Test Channel	Bandwidth(MHz)
GFSK	Low	0.922
	Middle	0.940
	High	0.880
Pi/4-DQPSK	Low	1.198
	Middle	1.180
	High	1.192
8-DPSK	Low	1.180
	Middle	1.210
	High	1.174

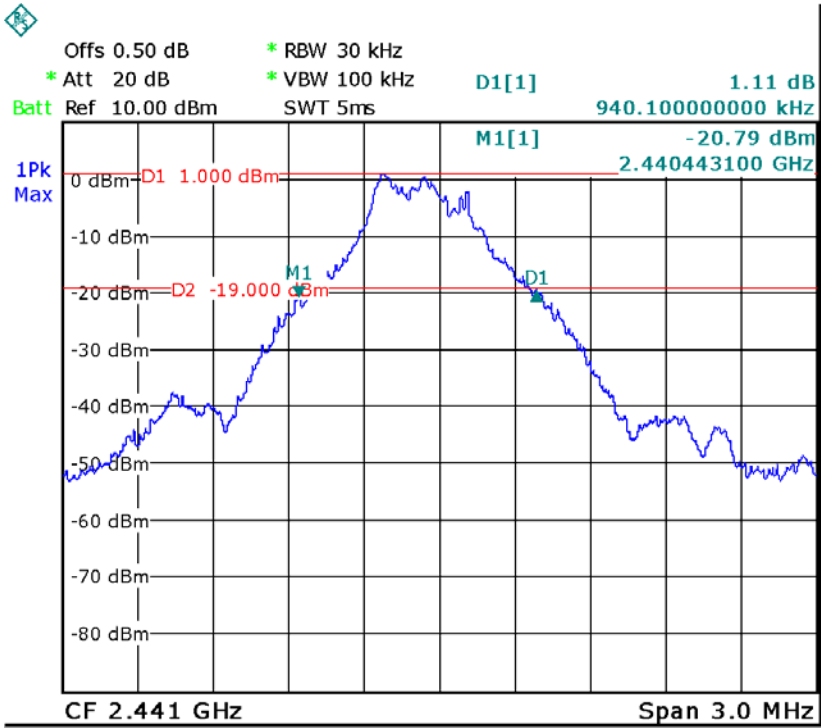
Test result plot as follows:

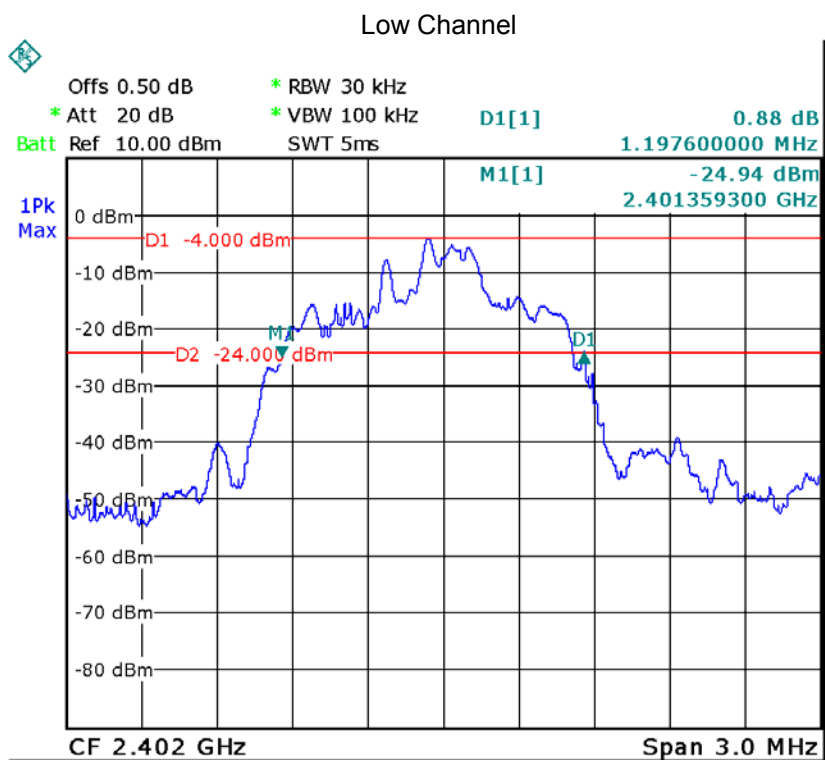
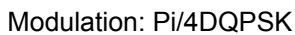
Modulation: GFSK

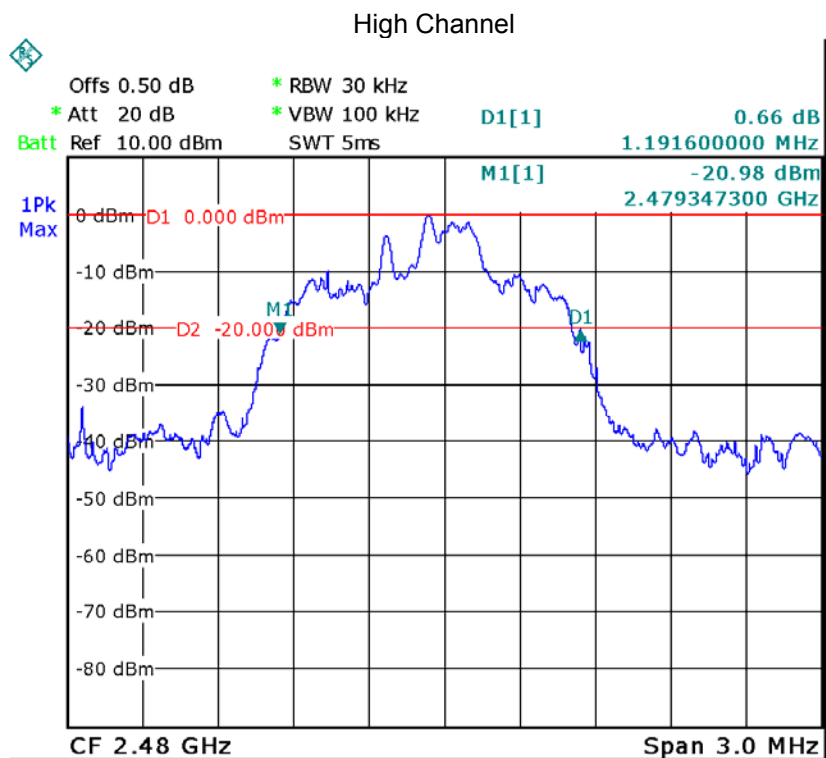
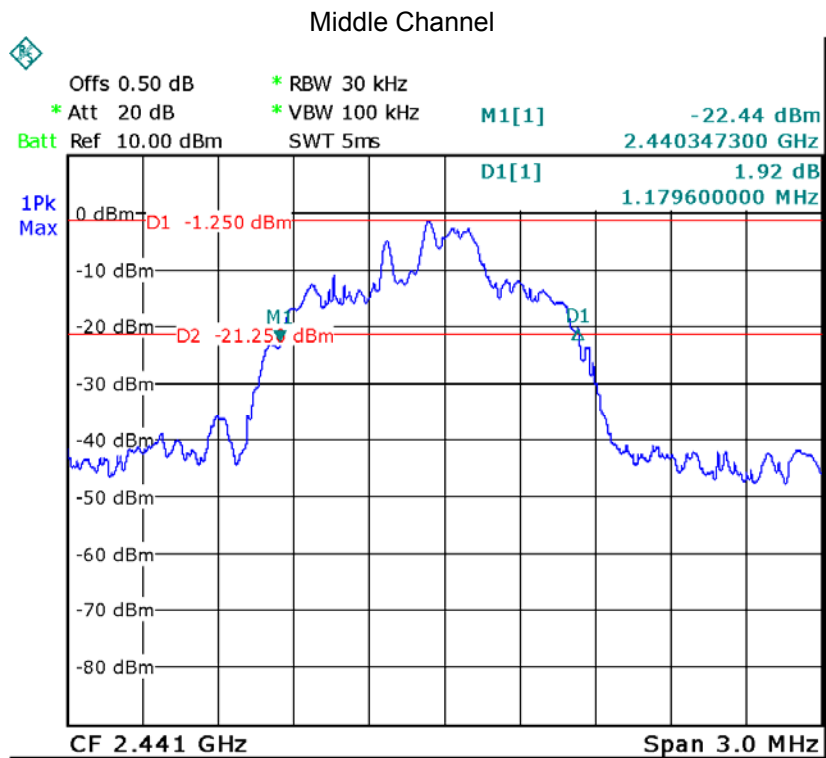
Low Channel



Middle Channel

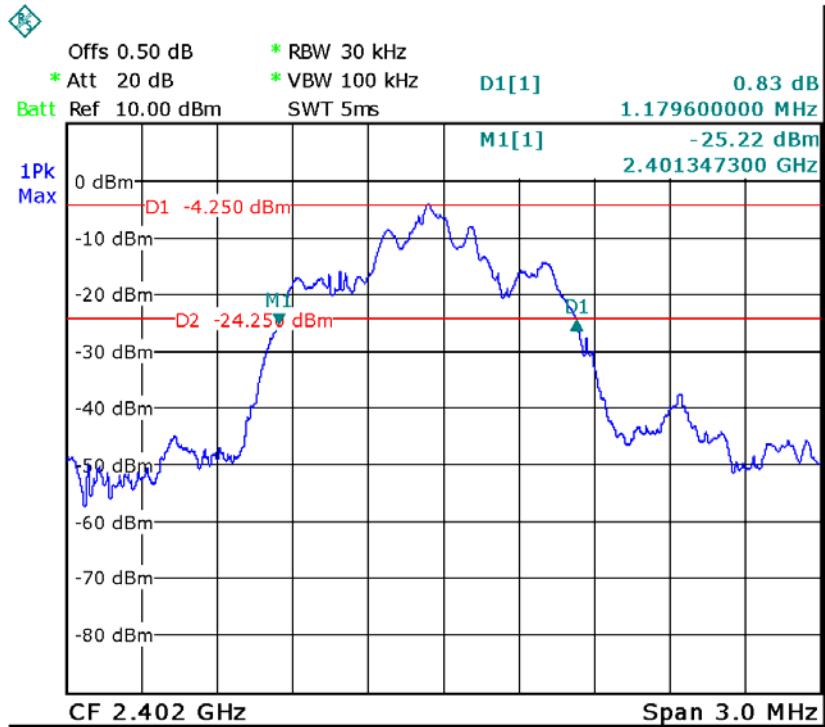




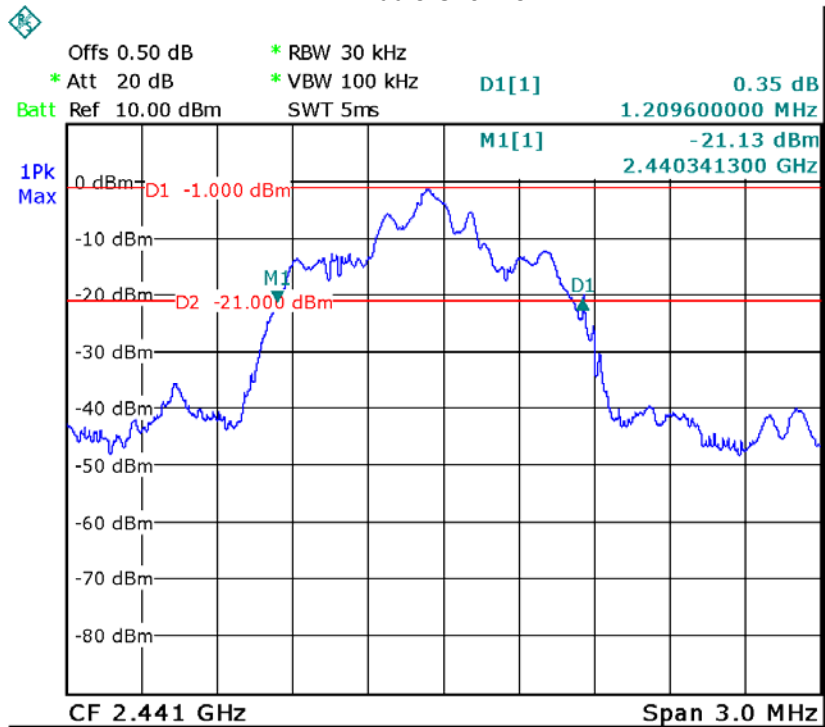


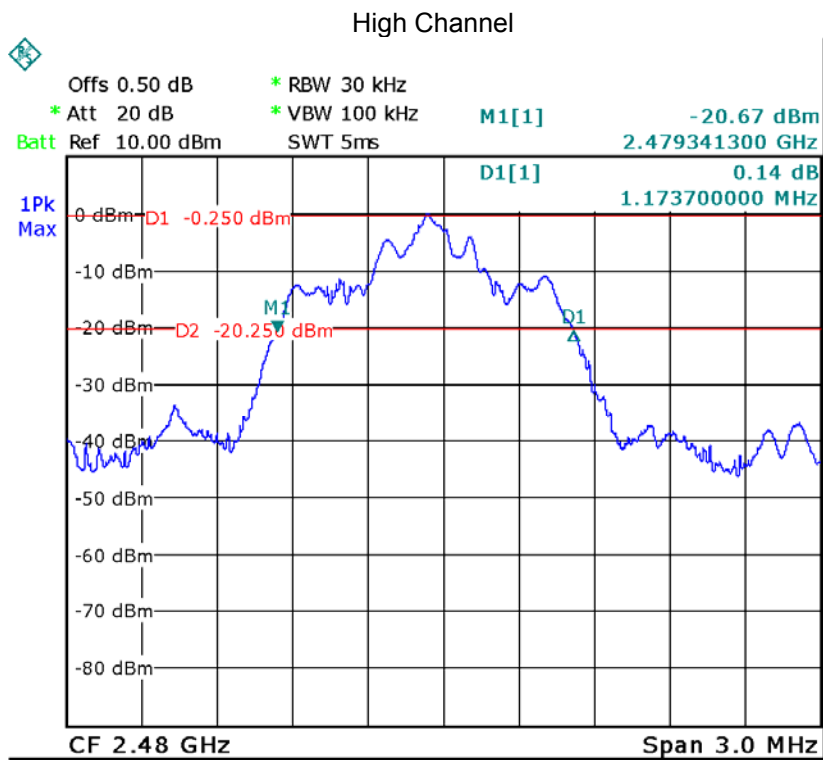
Modulation: 8DPSK

Low Channel



Middle Channel





10 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 (30dBm) limit applies.
Test mode:	Transmitting

10.1 Test Procedure:

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

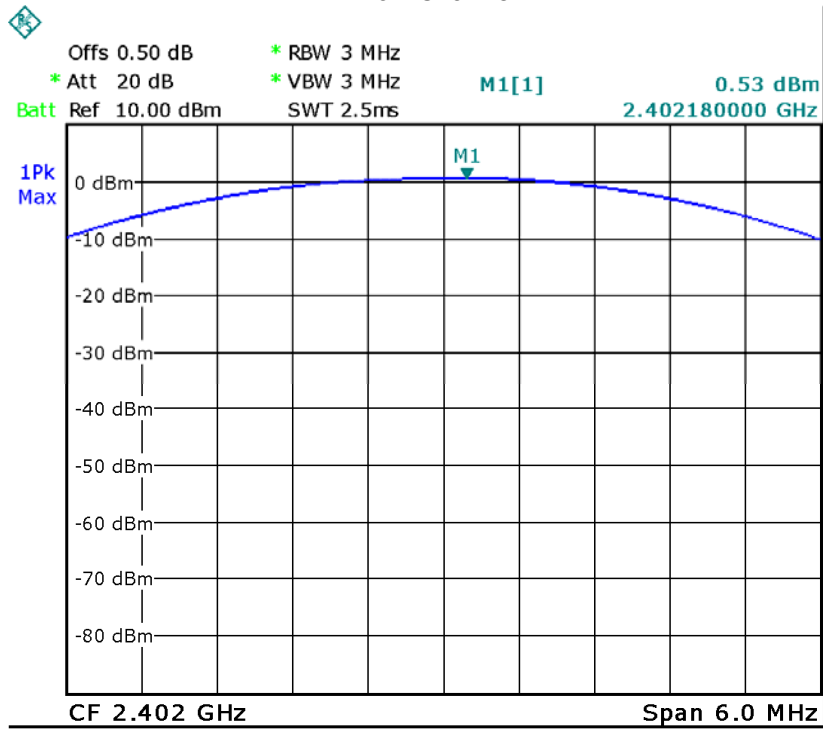
10.2 Test Result:

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	0.53	30
	Middle	1.83	30
	High	2.70	30
Pi/4DQPSK	Low	-1.88	30
	Middle	0.68	30
	High	1.83	30
8DPSK	Low	-1.61	30
	Middle	0.82	30
	High	2.09	30

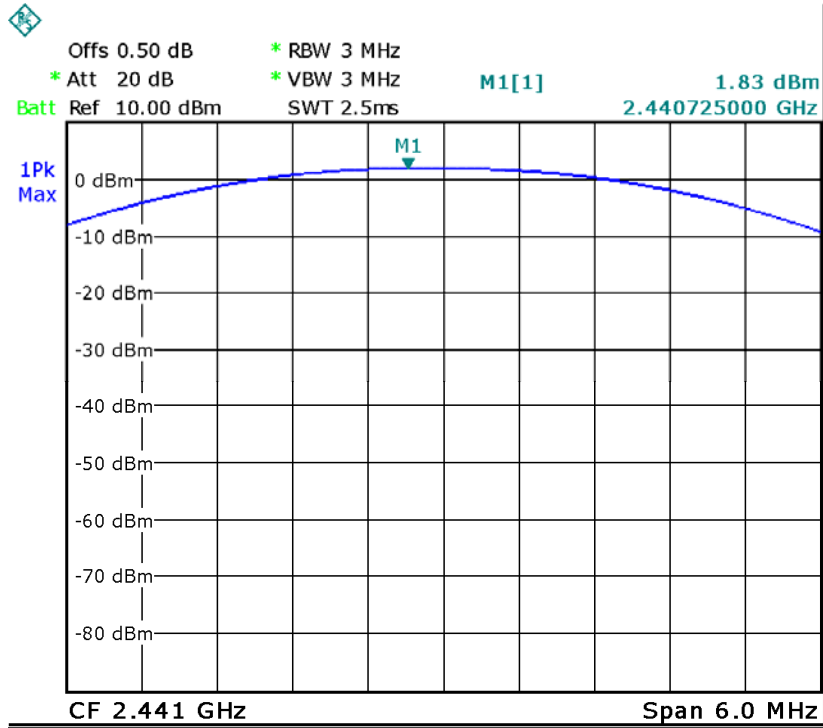
Test result plot as follows:

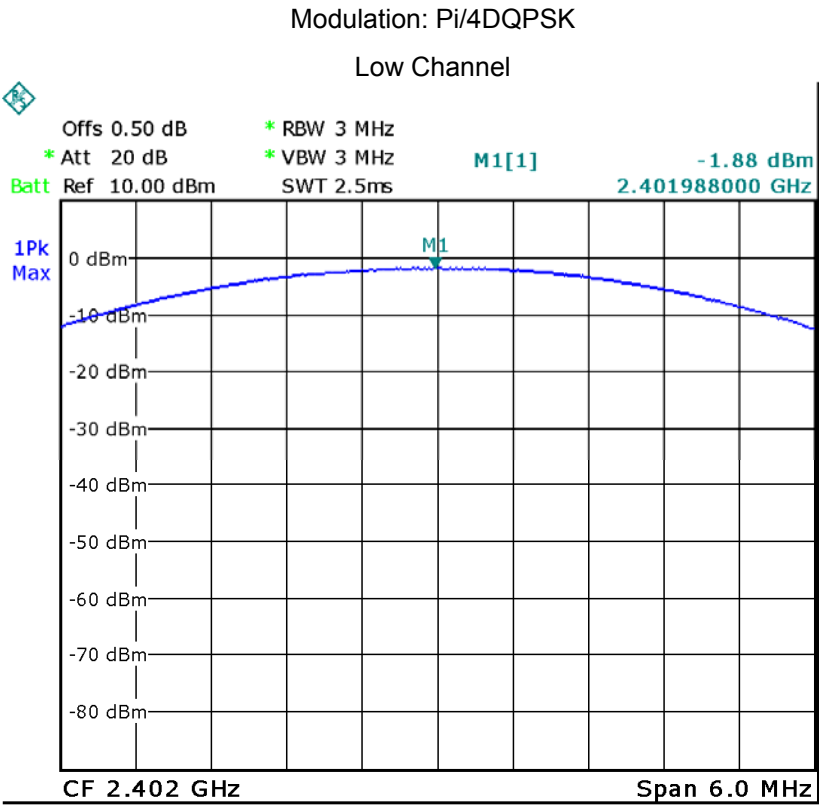
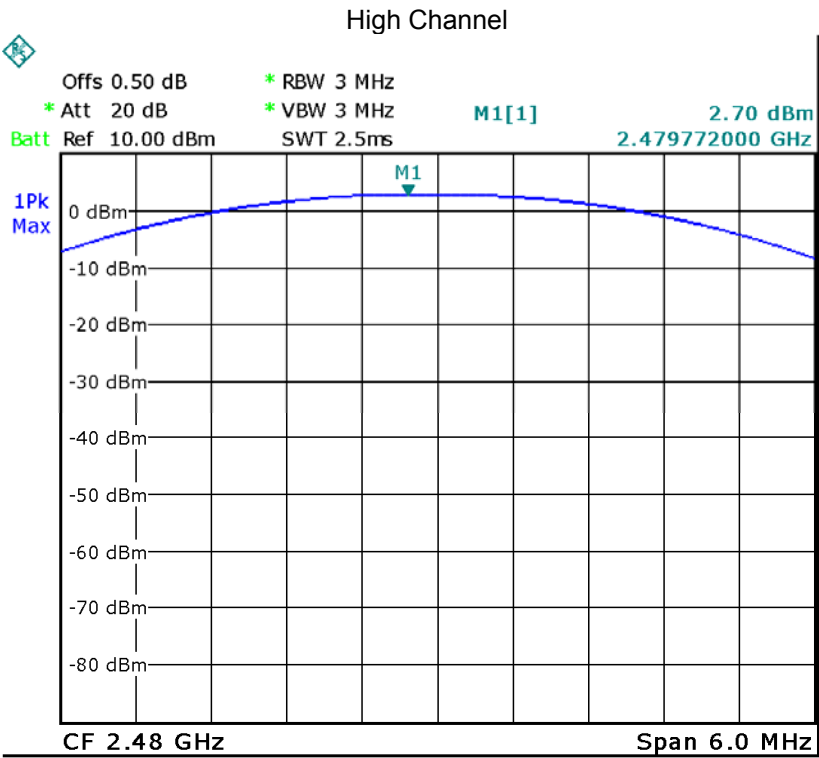
Modulation: GFSK

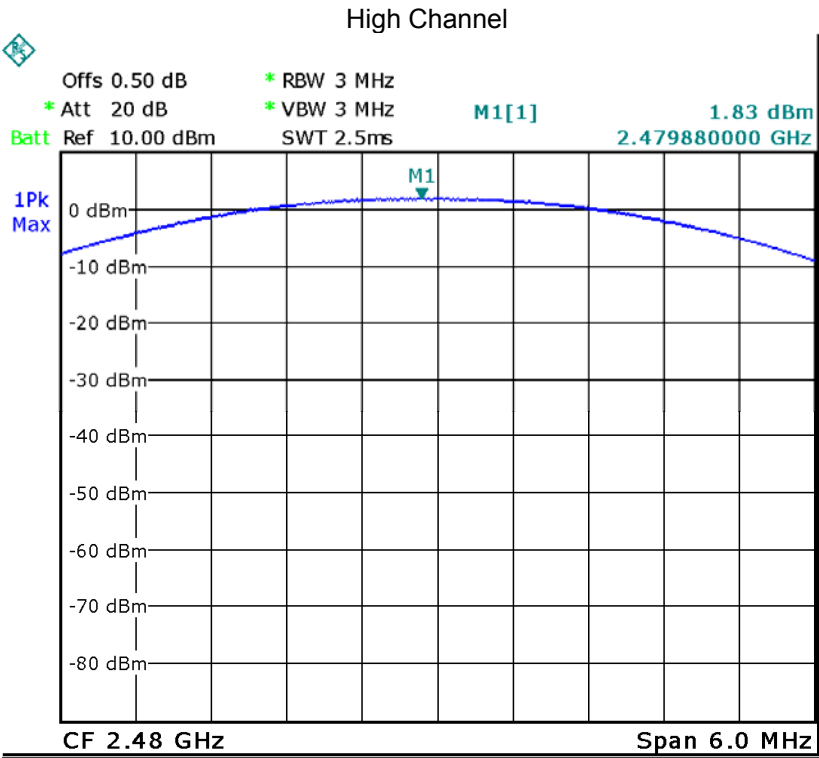
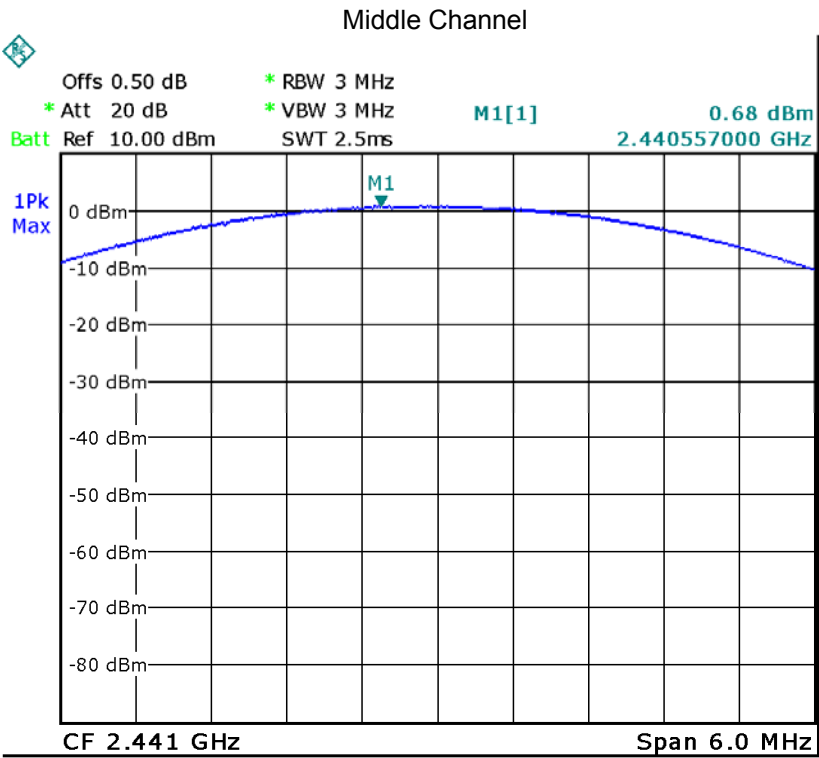
Low Channel



Middle Channel

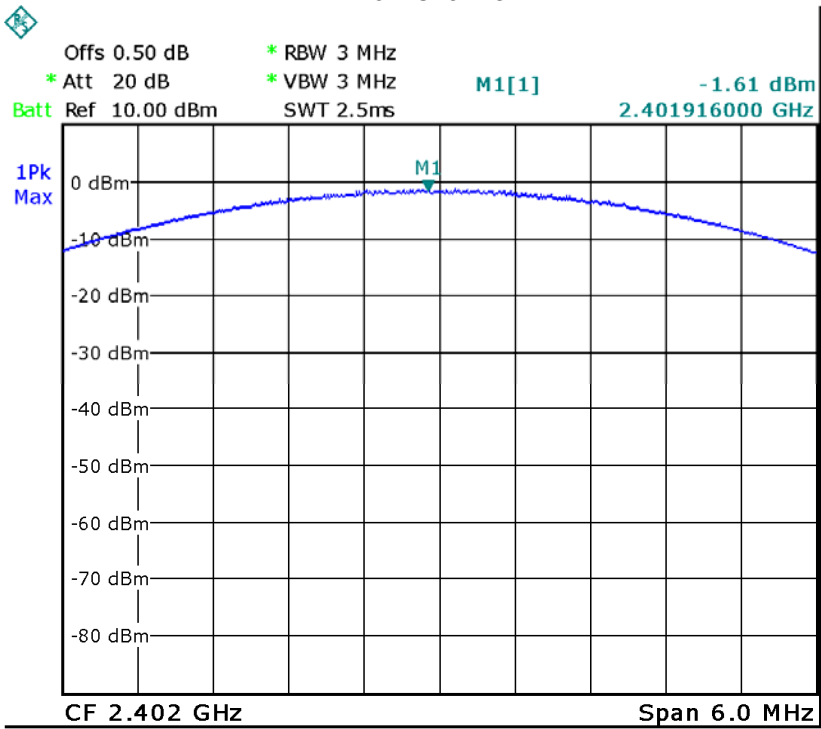




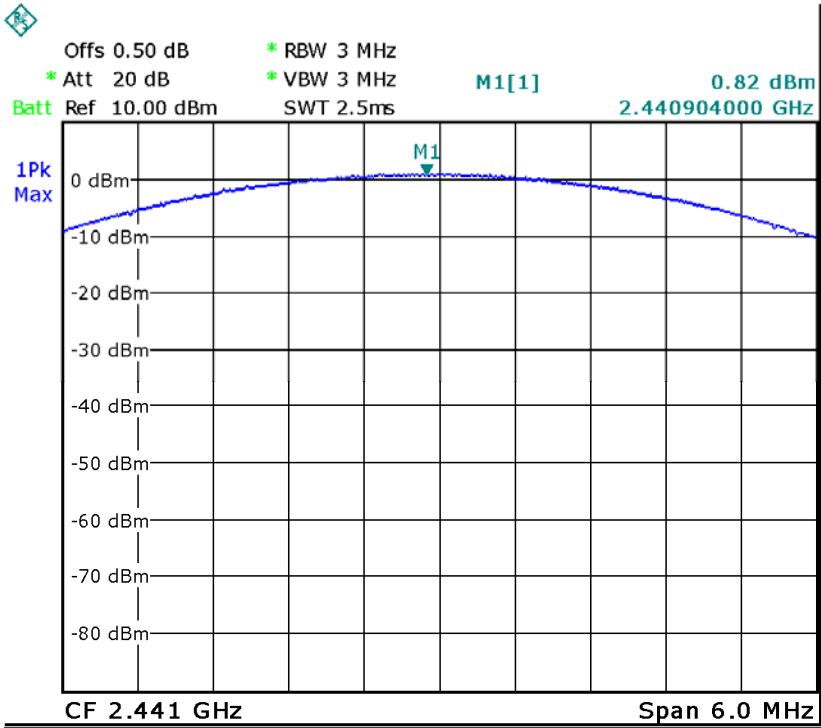


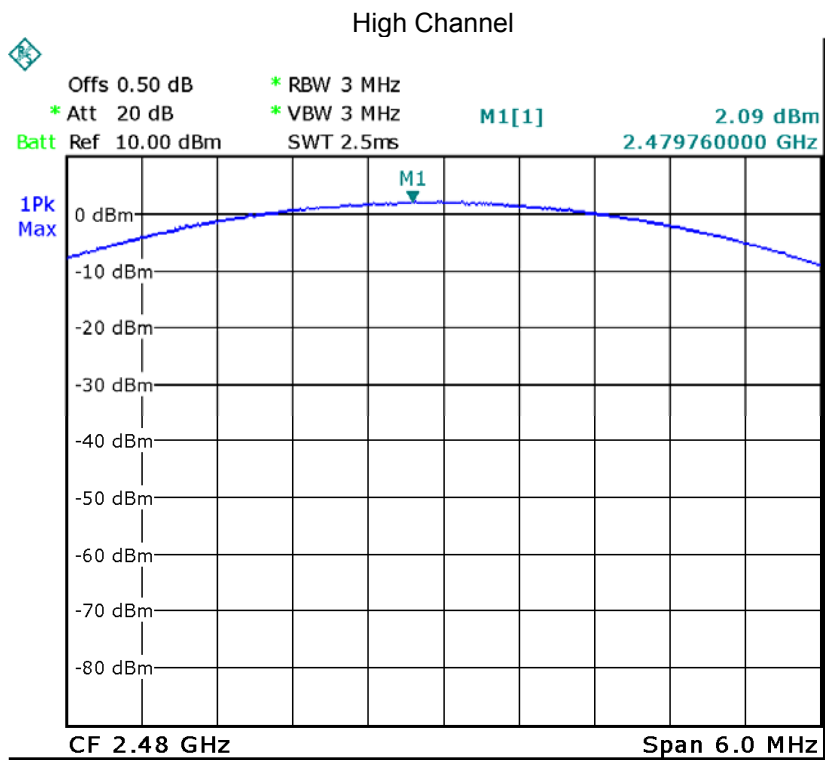
Modulation: 8DPSK

Low Channel



Middle Channel





11 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 two-thirds of 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 mode.

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 analyser: RBW = 30kHz. VBW = 100kHz, Span = 3.0MHz. 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.

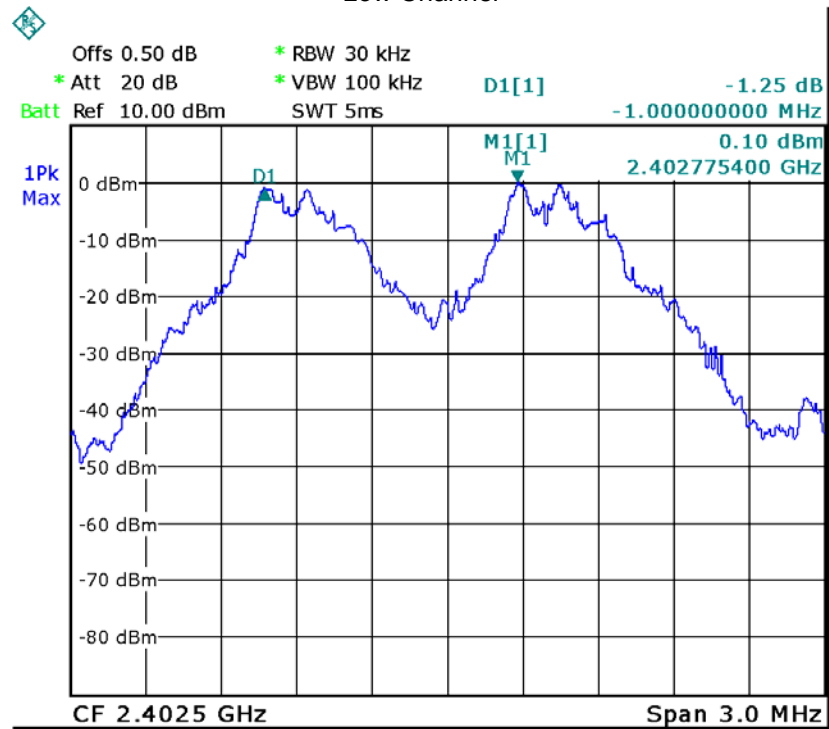
11.2 Test Result:

Modulation	Test Channel	Separation (MHz)	Limit(MHz)
GFSK	Low	1.000	0.583
	Middle	1.000	0.603
	High	1.000	0.607
Pi/4DQPSK	Low	1.000	0.611
	Middle	1.000	0.823
	High	1.006	0.611
8DPSK	Low	1.000	0.811
	Middle	1.006	0.811
	High	1.006	0.811

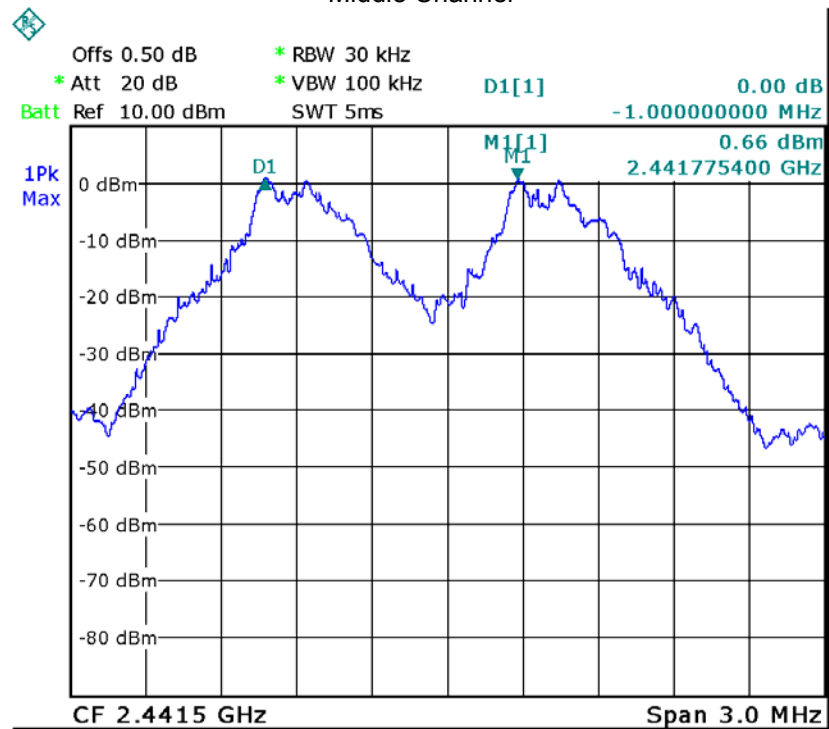
Test result plot as follows:

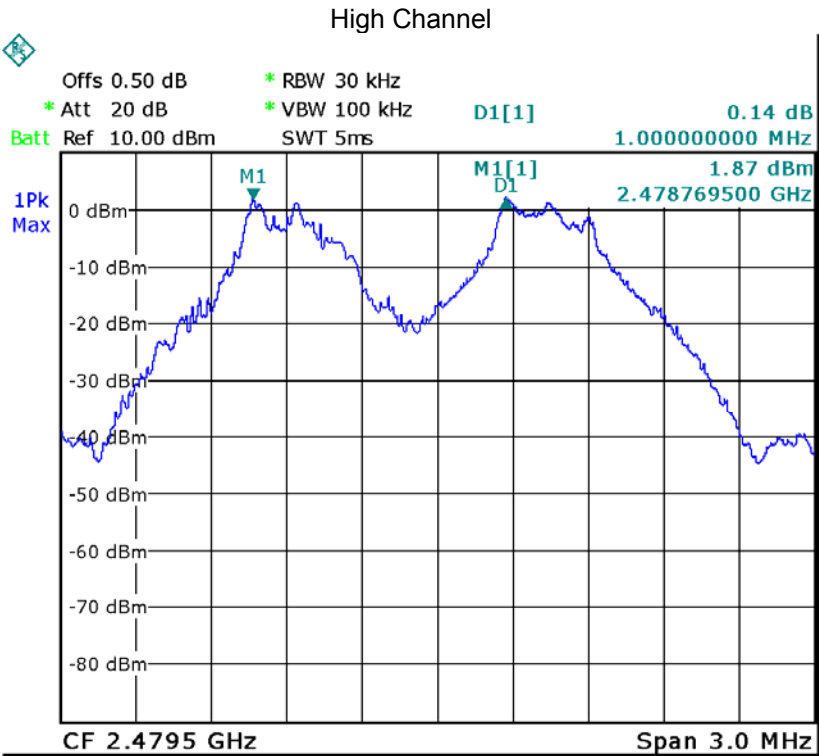
Modulation: GFSK

Low Channel



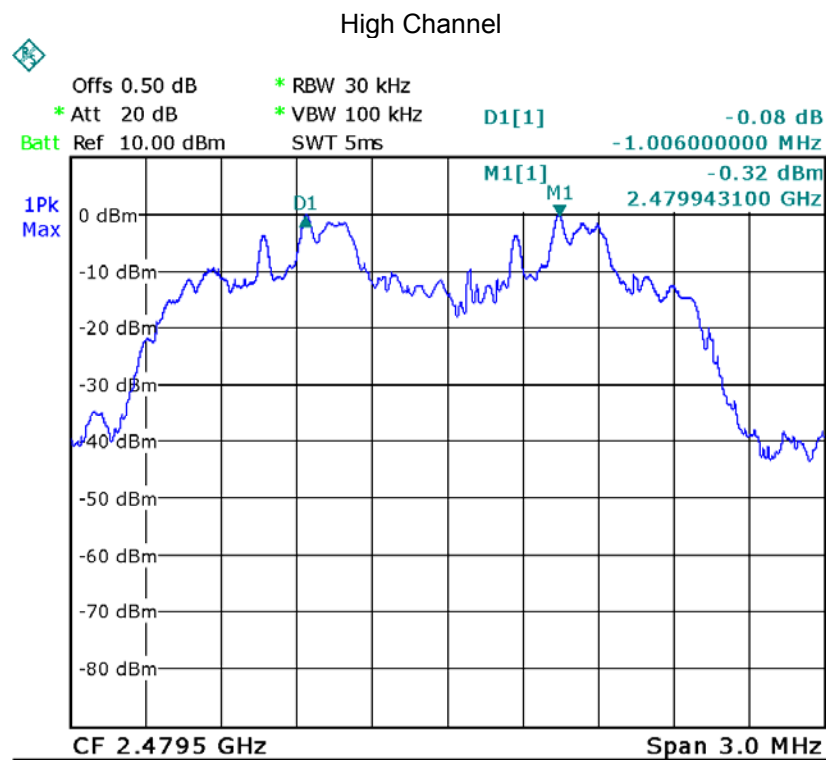
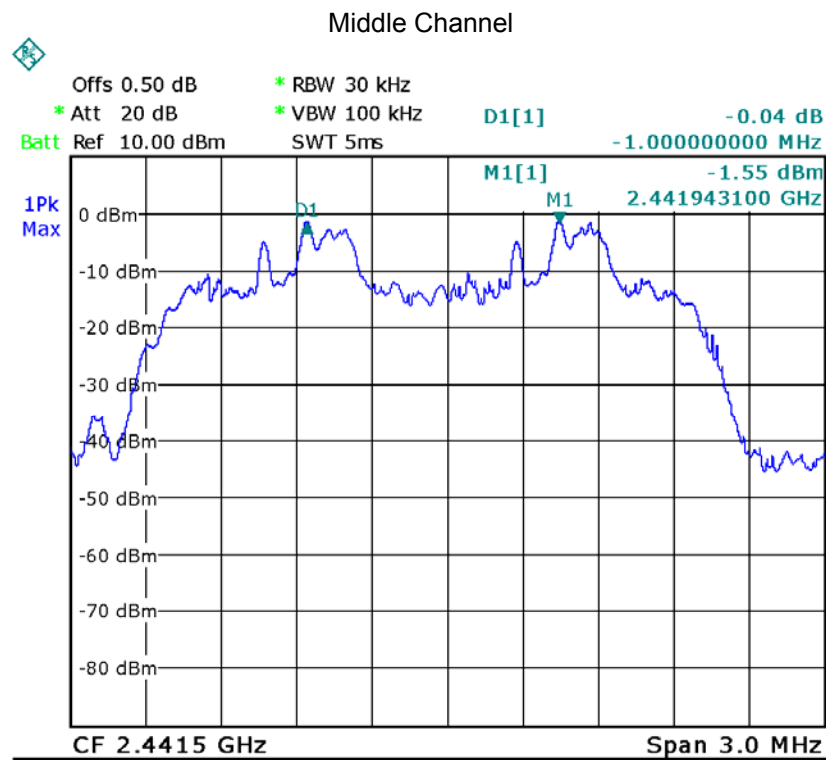
Middle Channel





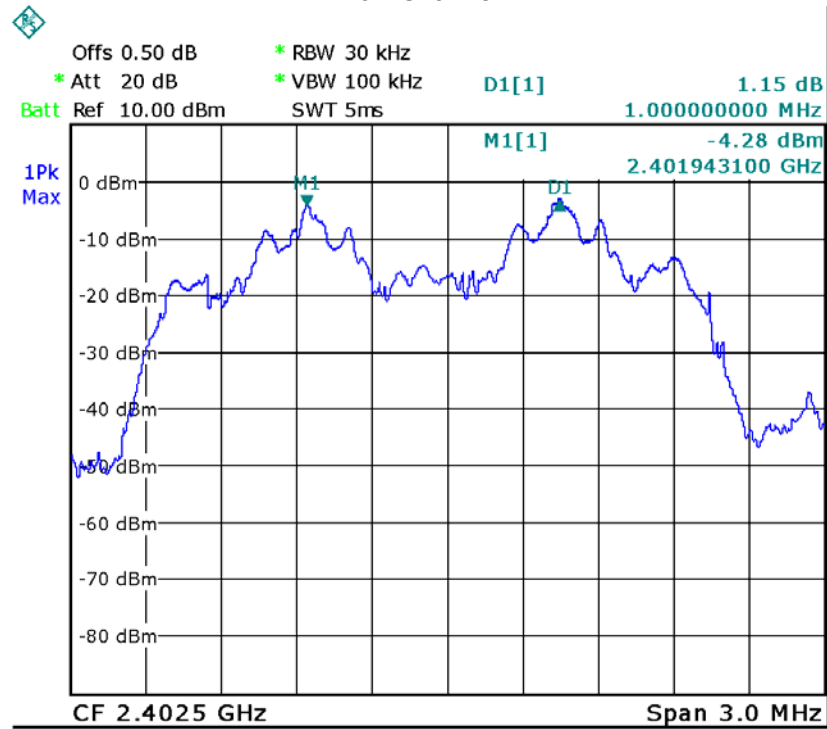
Modulation: Pi/4DQPSK



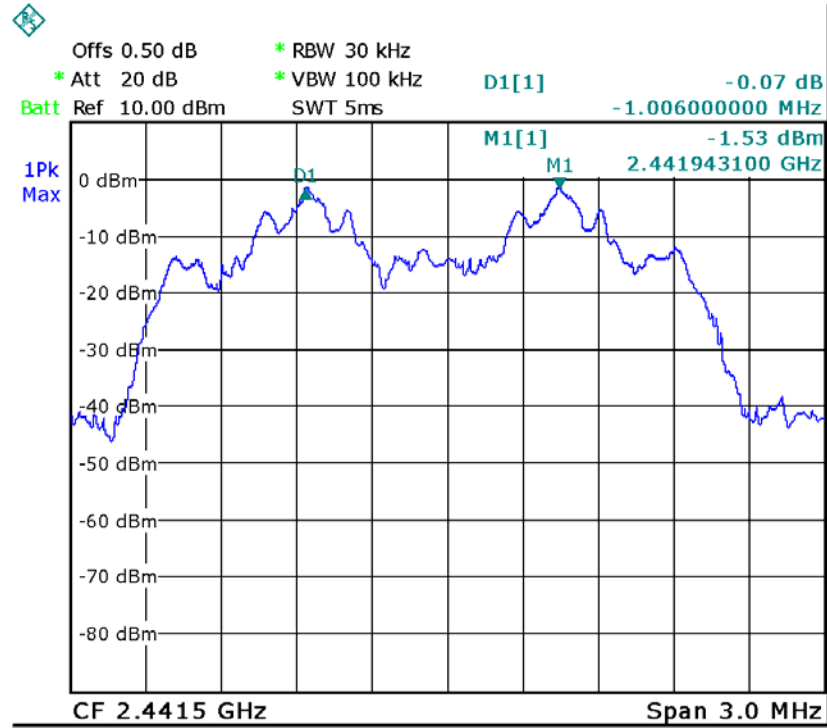


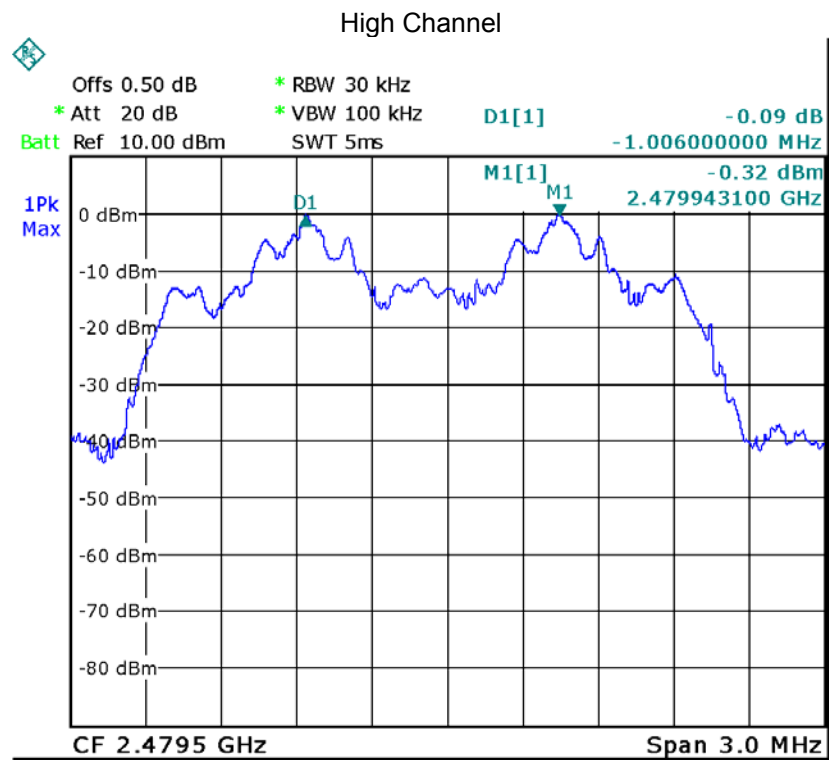
Modulation: 8DPSK

Low Channel



Middle Channel





12 Number of Hopping Frequency

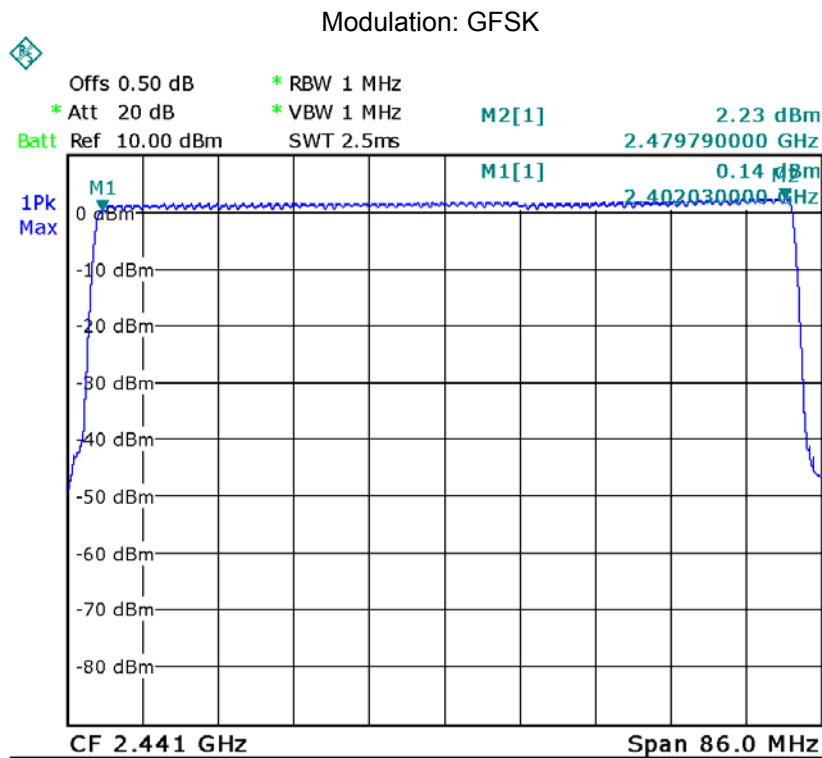
Test Requirement:	FCC CFR47 Part 15 Section 15.247
Test Method:	DA 00-705
Test Limit:	Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Mode:	Test in hopping mode.

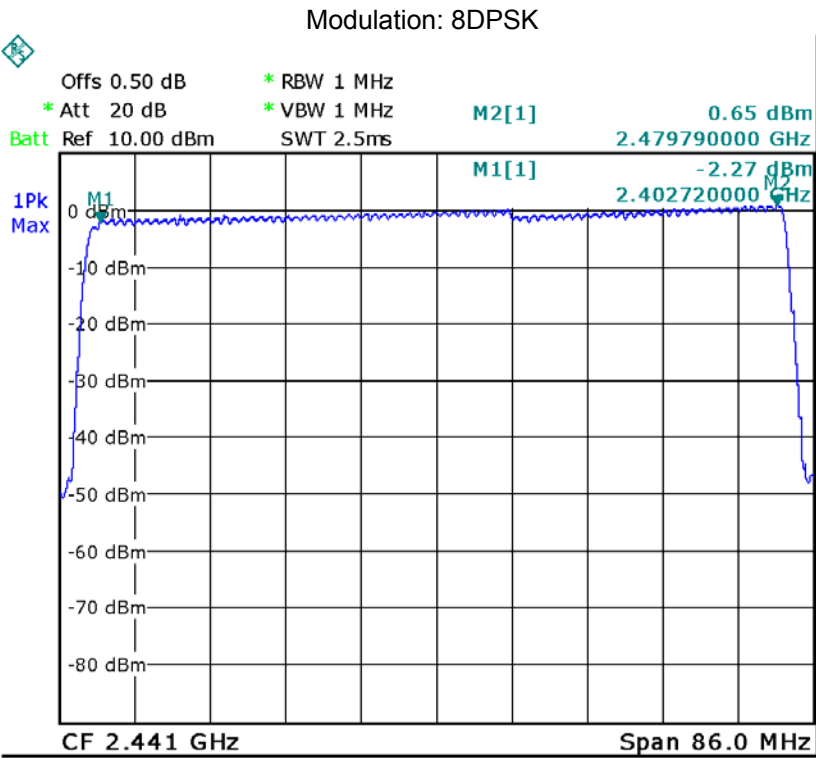
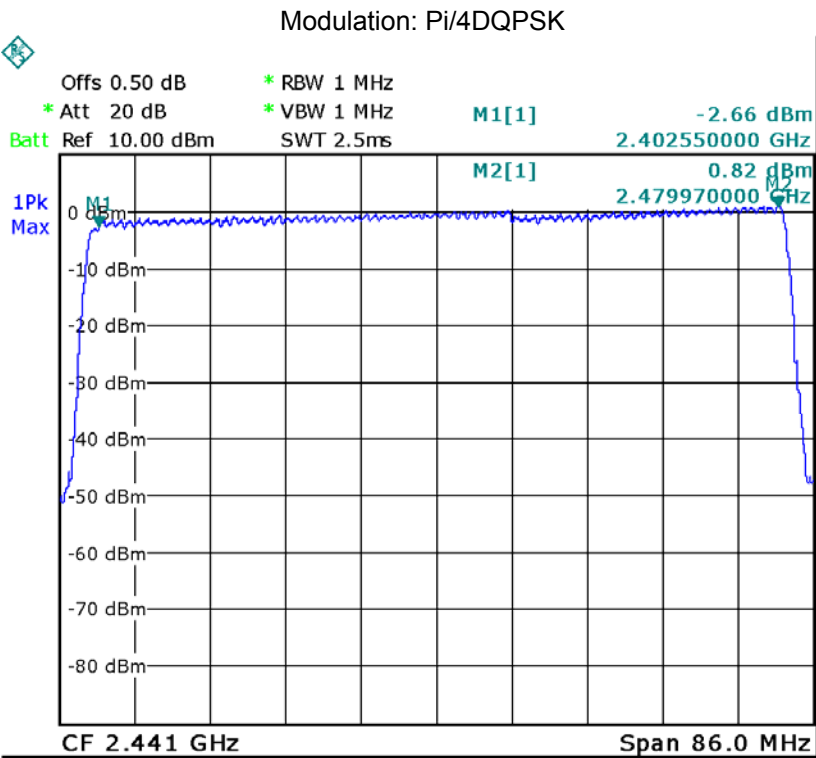
12.1 Test Procedure:

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 analyser: 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 analyser: Centre Frequency = 2.441GHz, Span = 86MHz. Sweep=auto;

12.2 Test Result:

Total Channels are 79 Channels.





13 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 transmitting on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Mode:	Test in hopping transmitting operating mode.

13.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

13.2 Test Result:

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period

The test period: $T = 0.4(s) * 79 = 31.6 (s)$

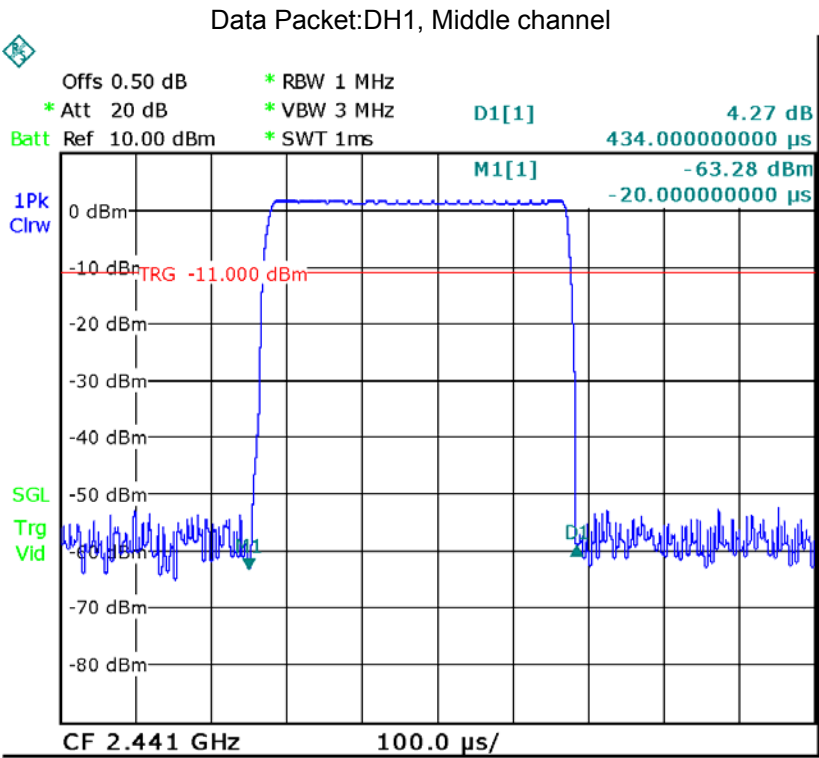
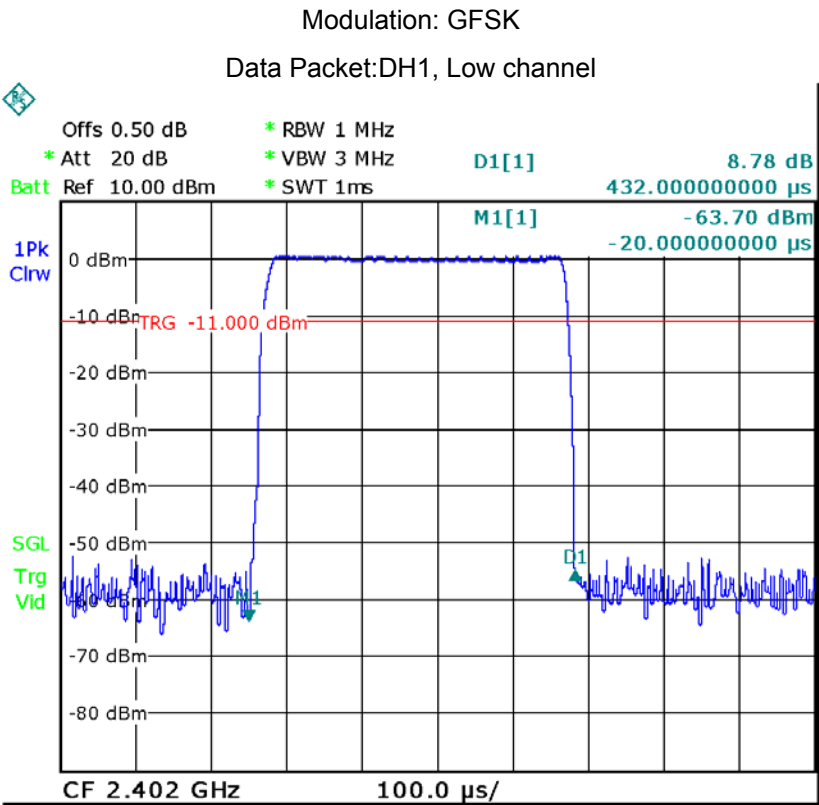
DH5 Packet permit maximum $1600 / 79 / 6$ hops per second in each channel (5 time slots RX, 1 time slot TX).

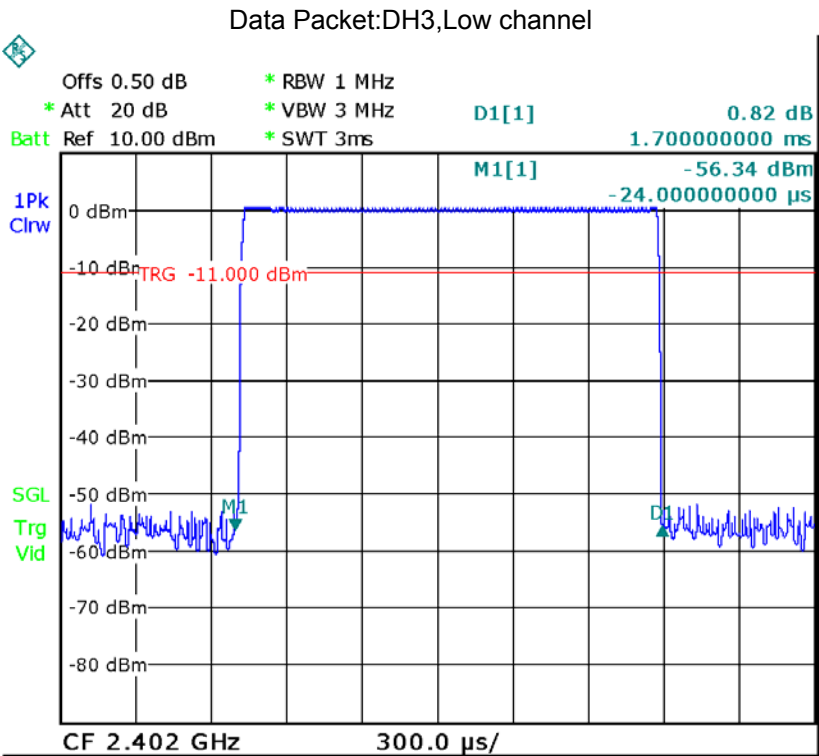
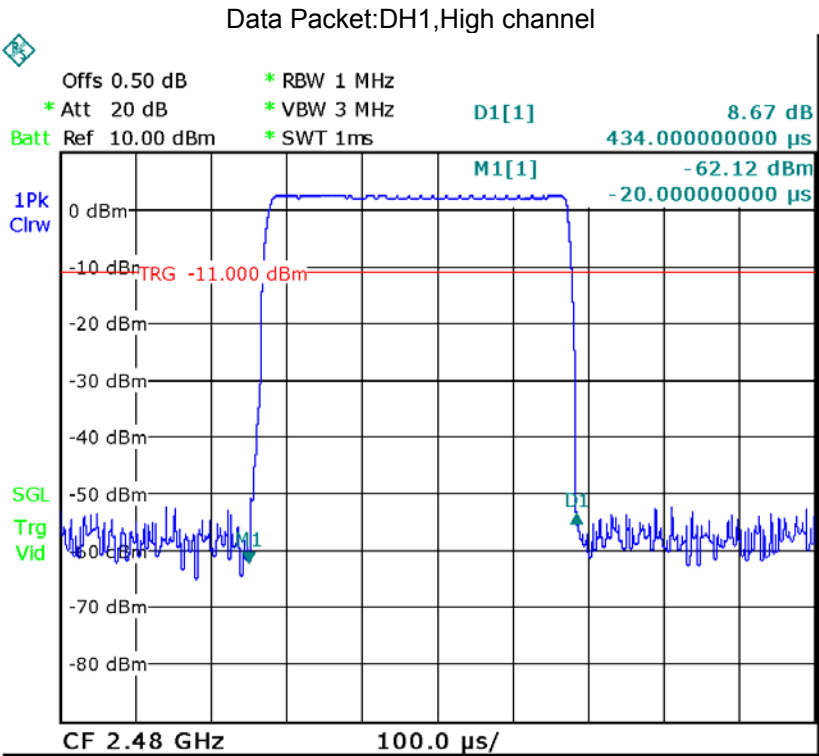
DH3 Packet permit maximum $1600 / 79 / 4$ hops per second in each channel (3 time slots RX, 1 time slot TX).

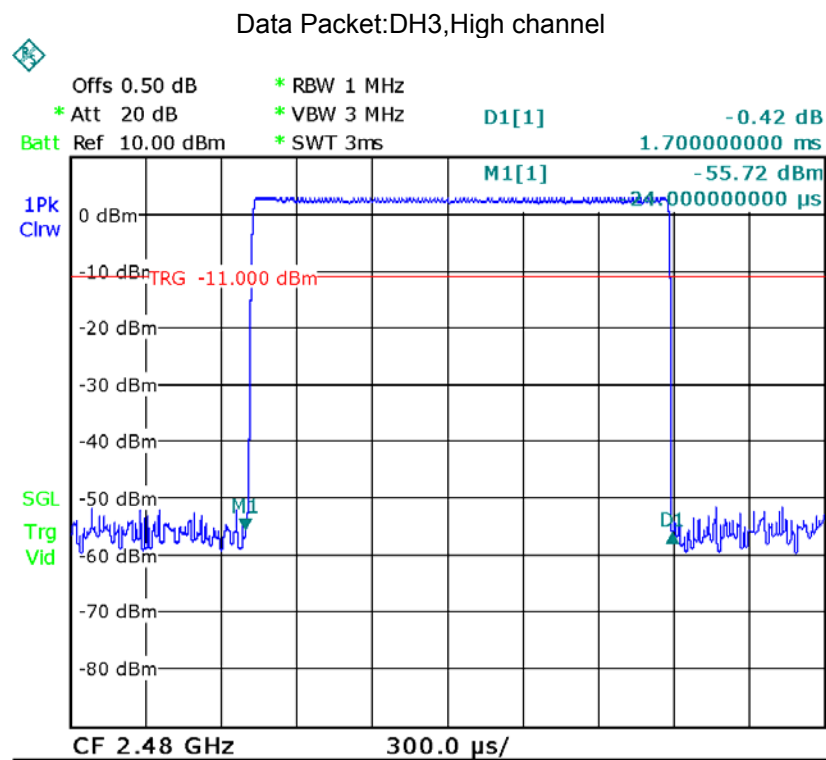
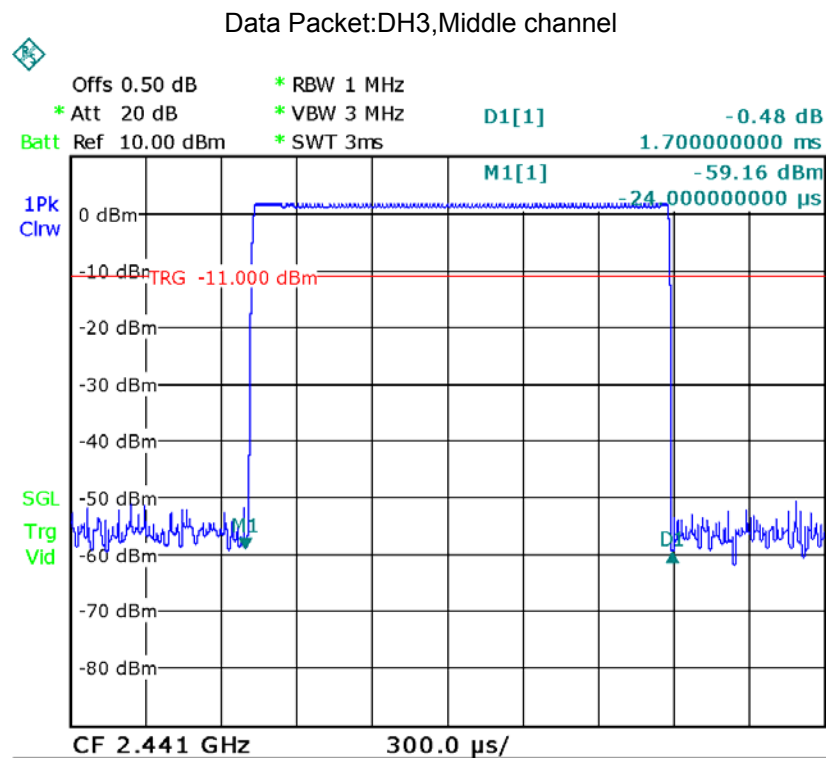
DH1 Packet permit maximum $1600 / 79 / 2$ hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

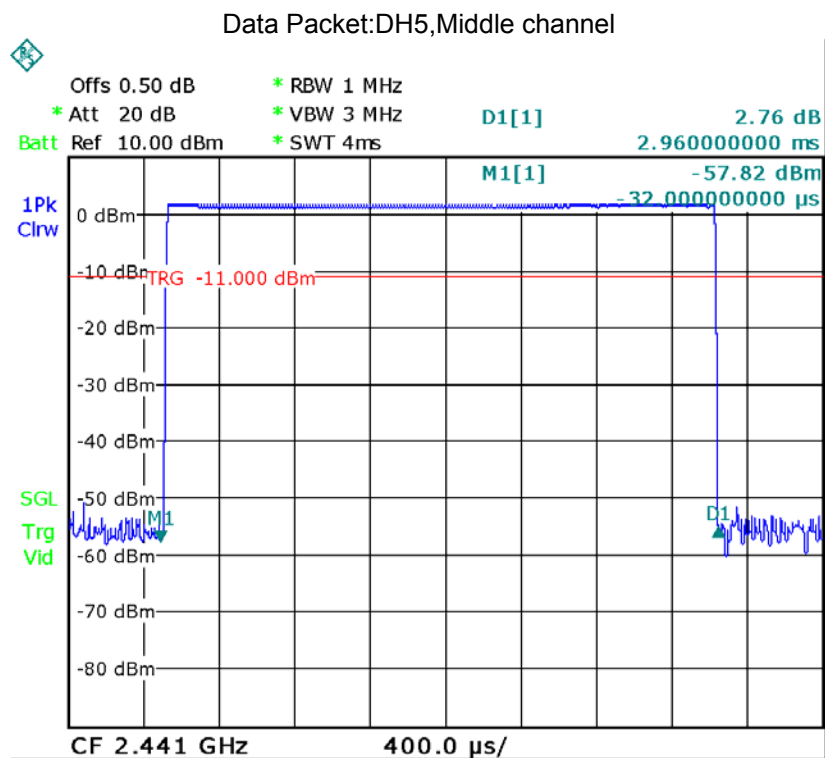
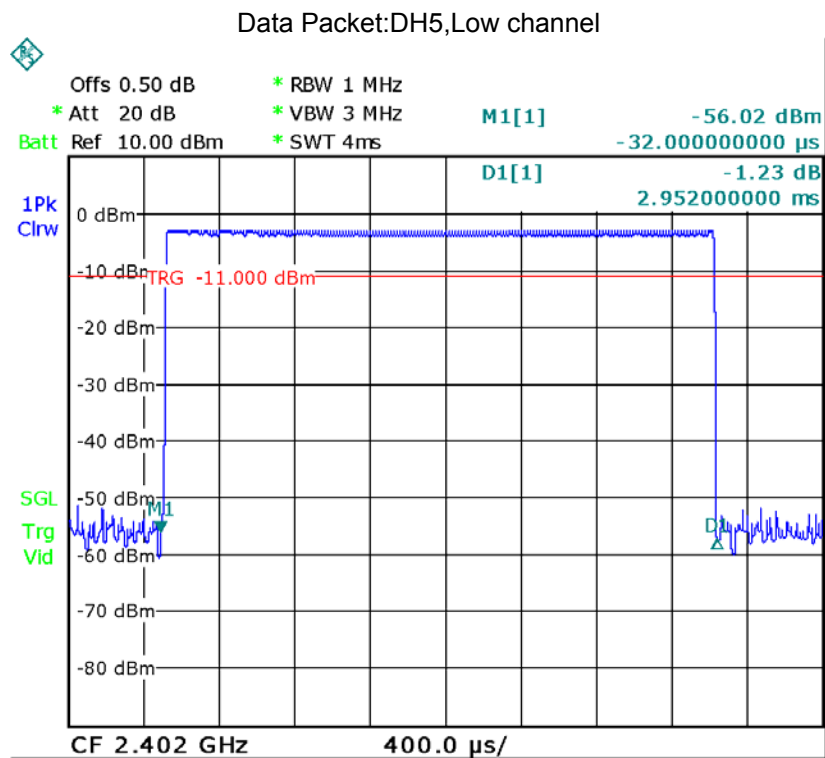
Data Packet	Dwell Time(s)
DH5	$1600/79/6*31.6*(MkrDelta)/1000$
DH3	$1600/79/4*31.6*(MkrDelta)/1000$
DH1	$1600/79/2*31.6*(MkrDelta)/1000$
Remark	Mkr Delta is single pulse time.

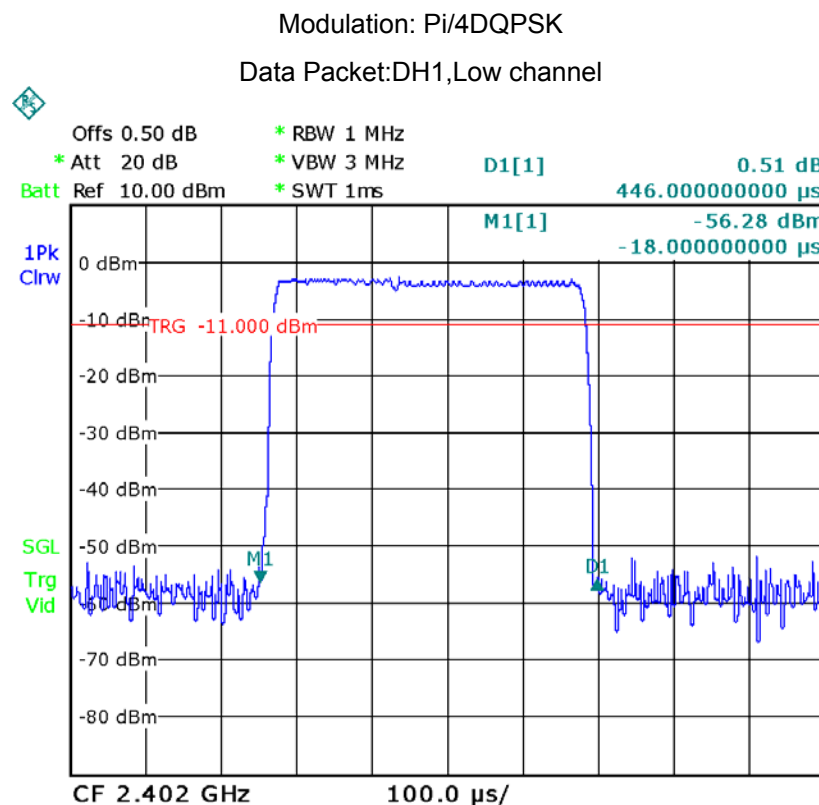
Dwell Time					
Ambient temperature: 22 °C			Relative humidity: 55%		
Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	DH1	Low	0.432	0.138	0.4
		middle	0.434	0.139	0.4
		High	0.434	0.139	0.4
	DH3	Low	1.700	0.272	0.4
		middle	1.700	0.272	0.4
		High	1.700	0.272	0.4
	DH5	Low	2.952	0.315	0.4
		middle	2.960	0.316	0.4
		High	2.960	0.316	0.4
Pi/4DQPSK	DH1	Low	0.446	0.143	0.4
		middle	0.446	0.143	0.4
		High	0.446	0.143	0.4
	DH3	Low	1.706	0.273	0.4
		middle	1.706	0.273	0.4
		High	1.712	0.274	0.4
	DH5	Low	2.968	0.317	0.4
		middle	2.968	0.317	0.4
		High	2.968	0.317	0.4
8DPSK	DH1	Low	0.446	0.143	0.4
		middle	0.446	0.143	0.4
		High	0.446	0.143	0.4
	DH3	Low	1.712	0.274	0.4
		middle	1.712	0.274	0.4
		High	1.712	0.274	0.4
	DH5	Low	2.968	0.317	0.4
		middle	2.968	0.317	0.4
		High	2.968	0.317	0.4

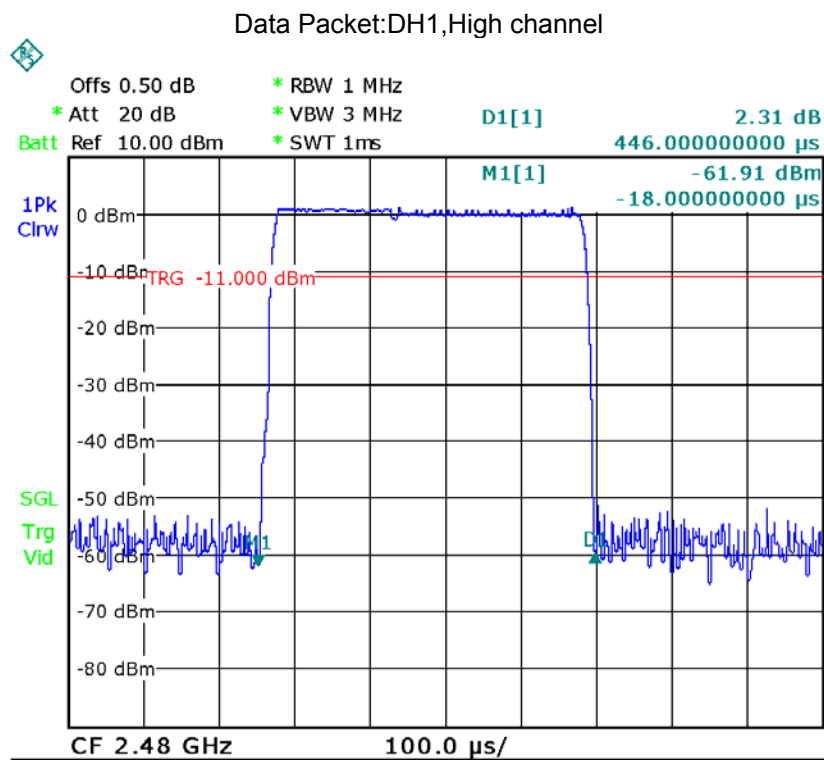
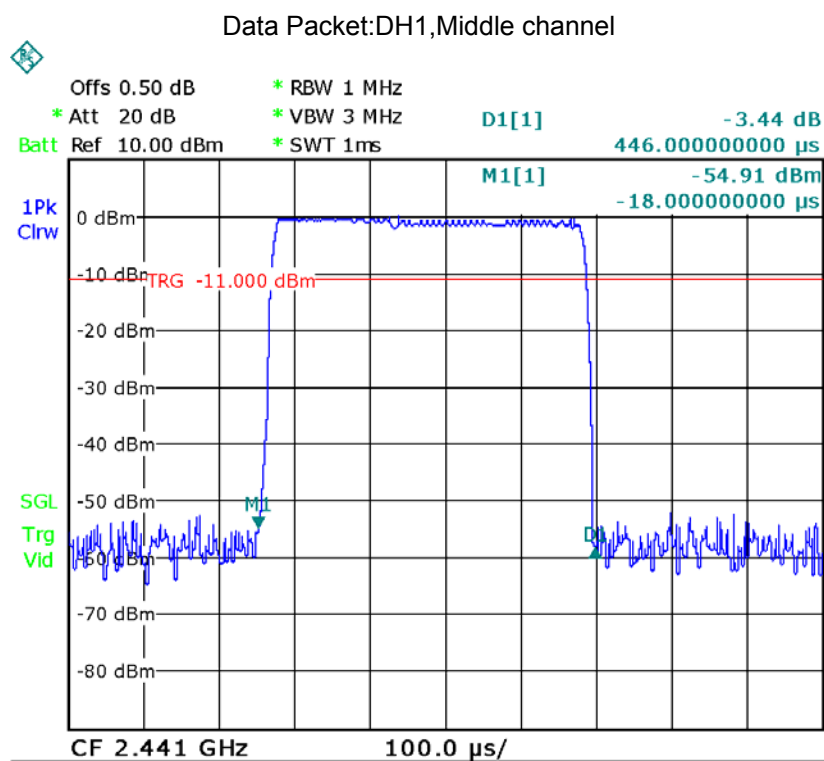


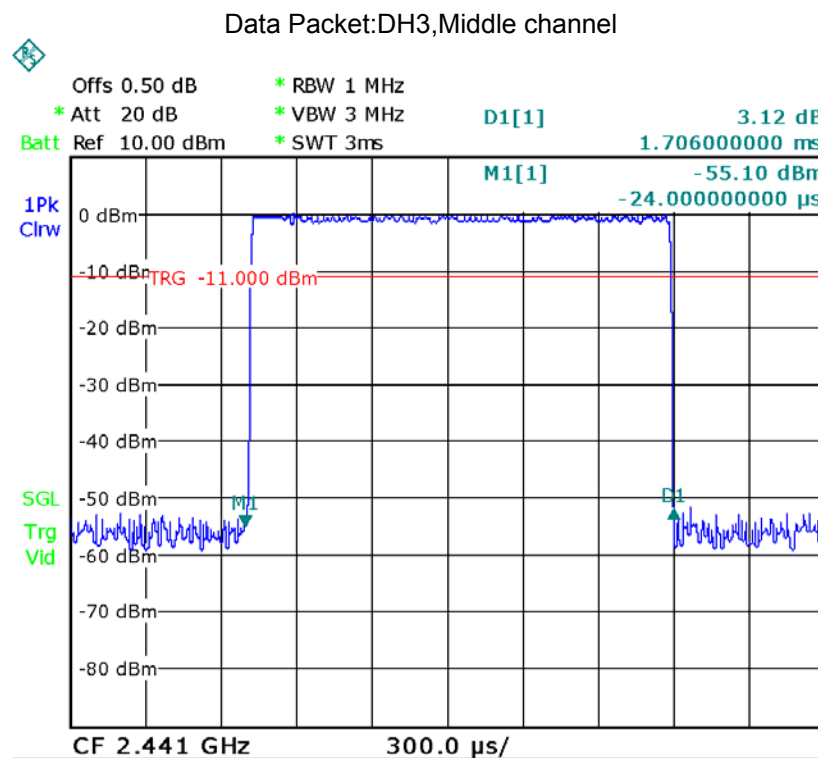
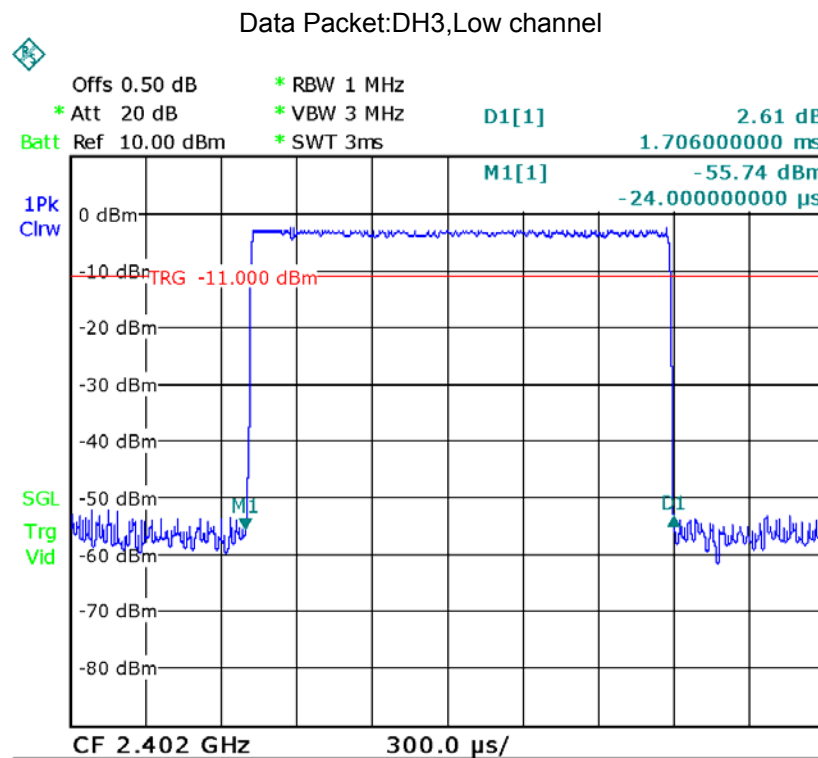


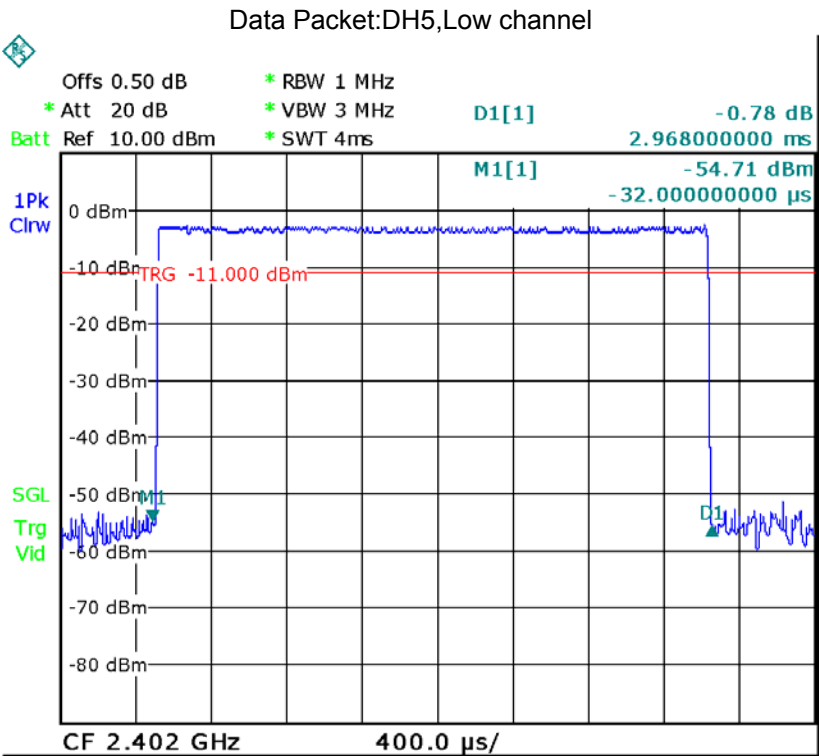
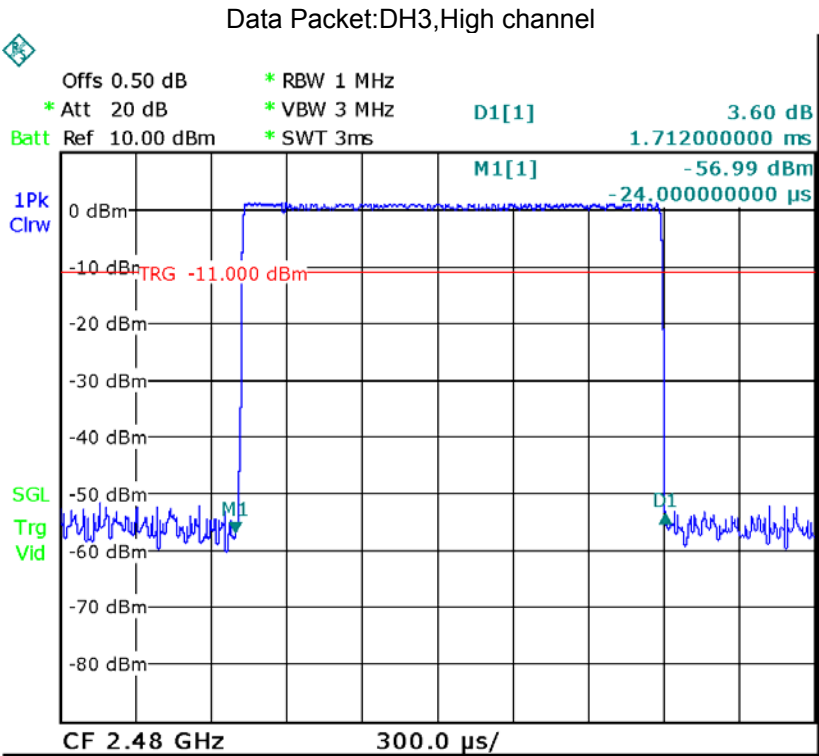


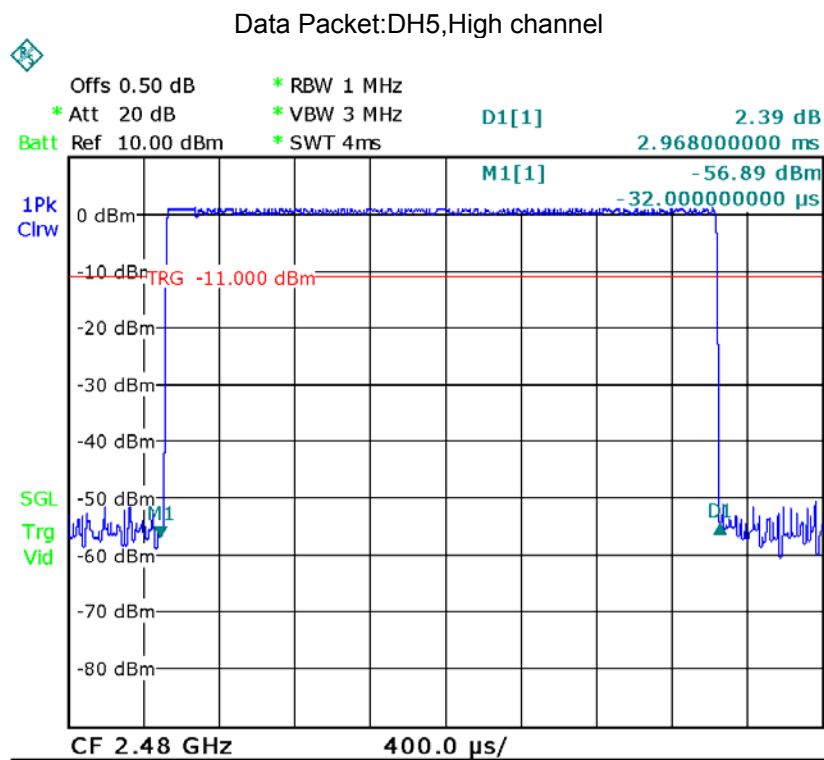
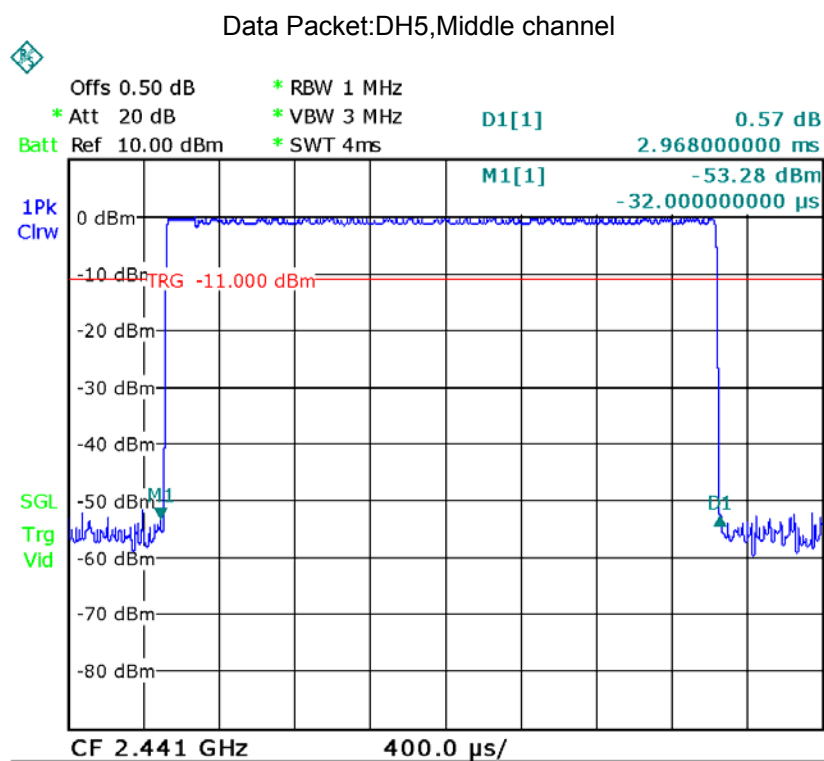


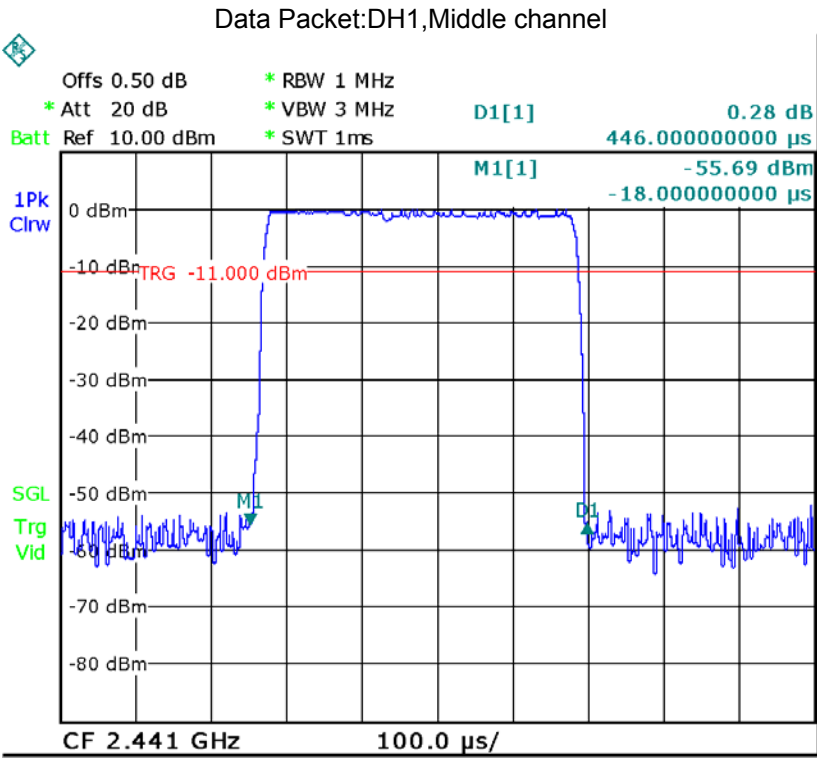
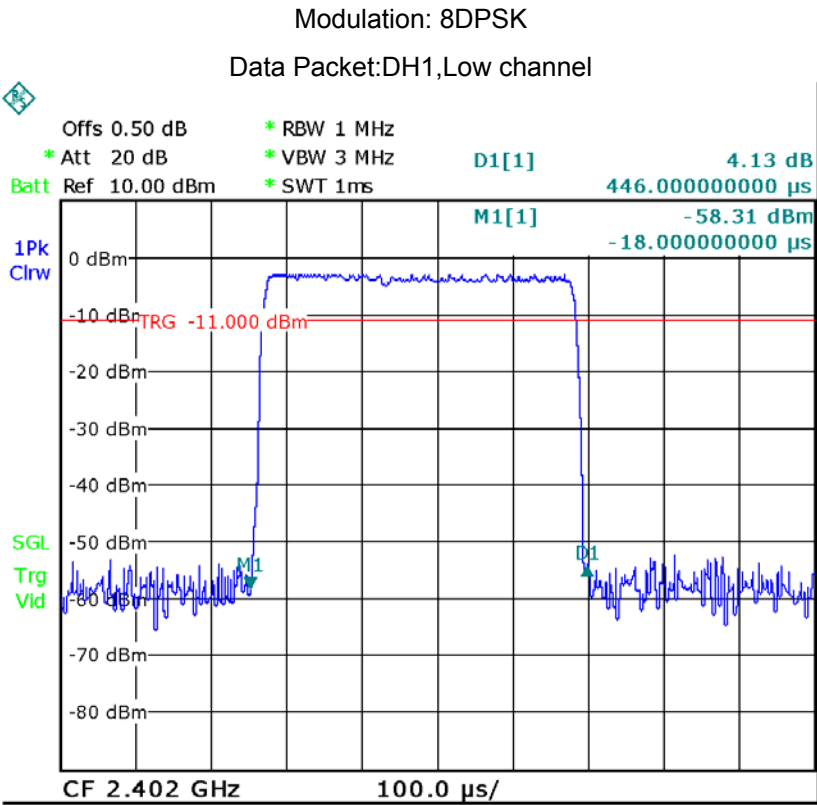


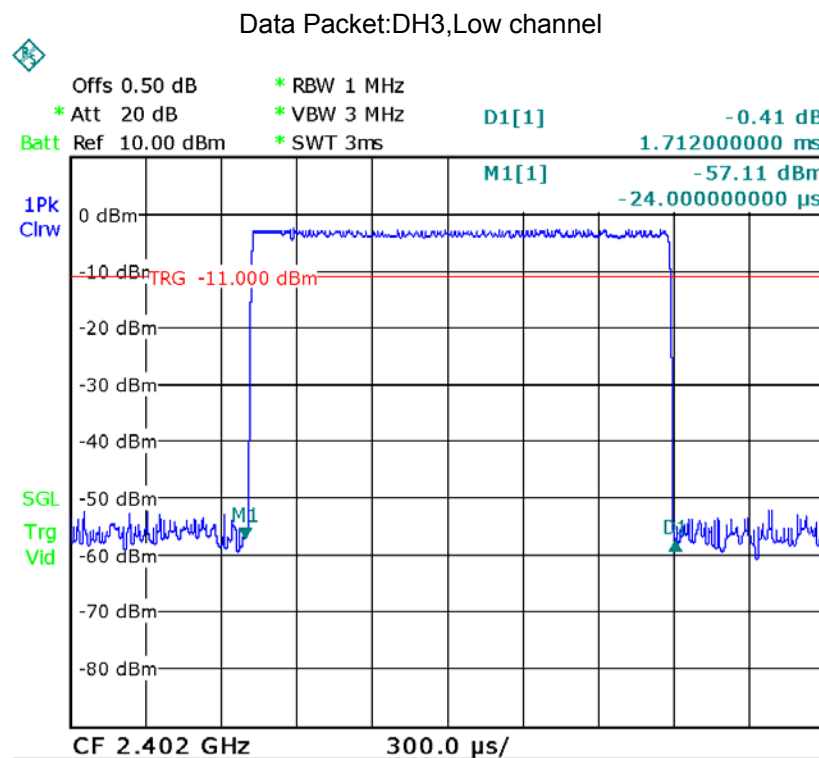
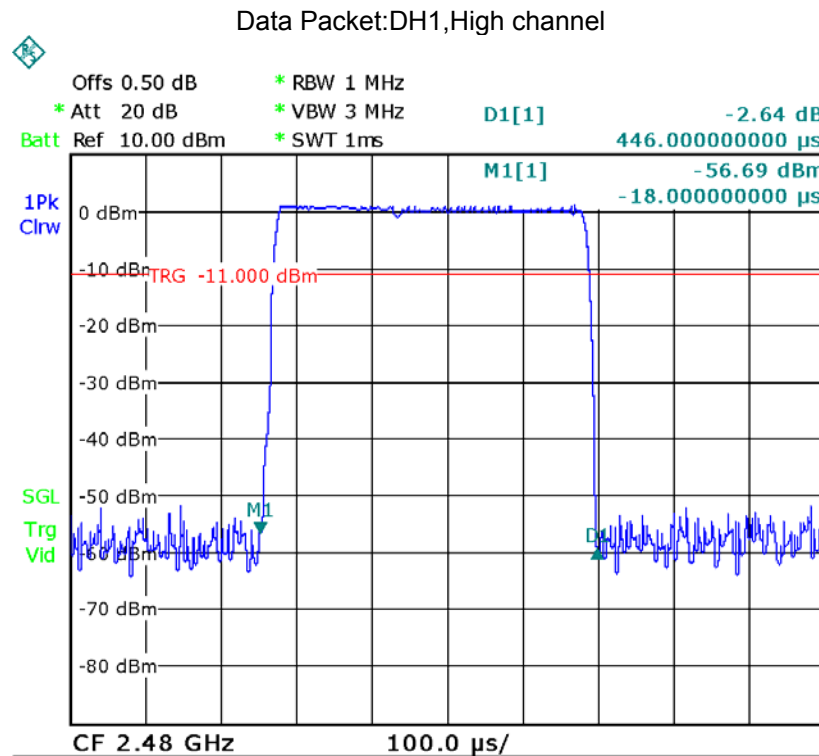


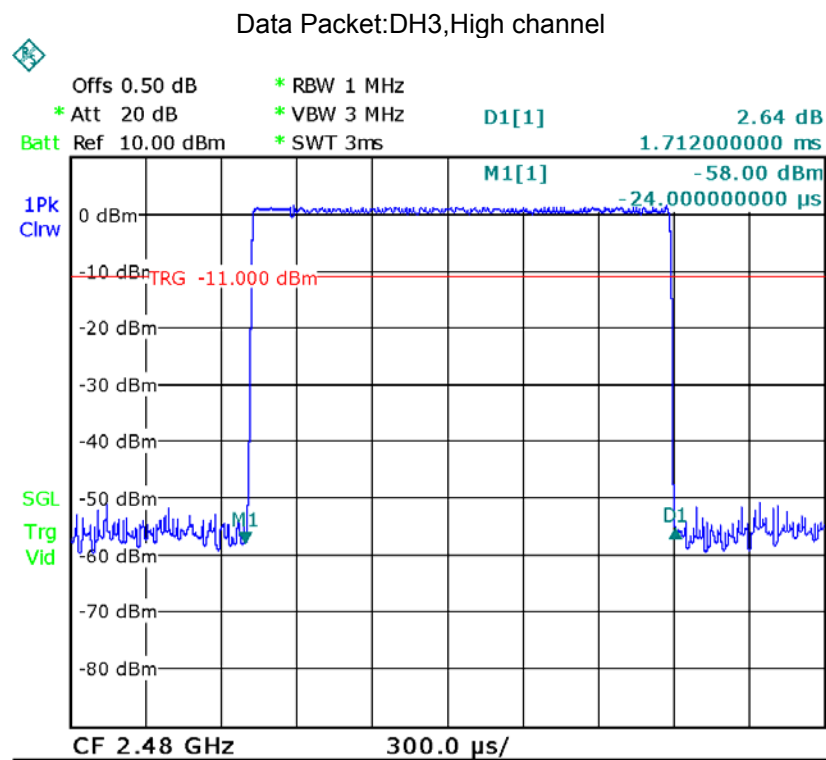
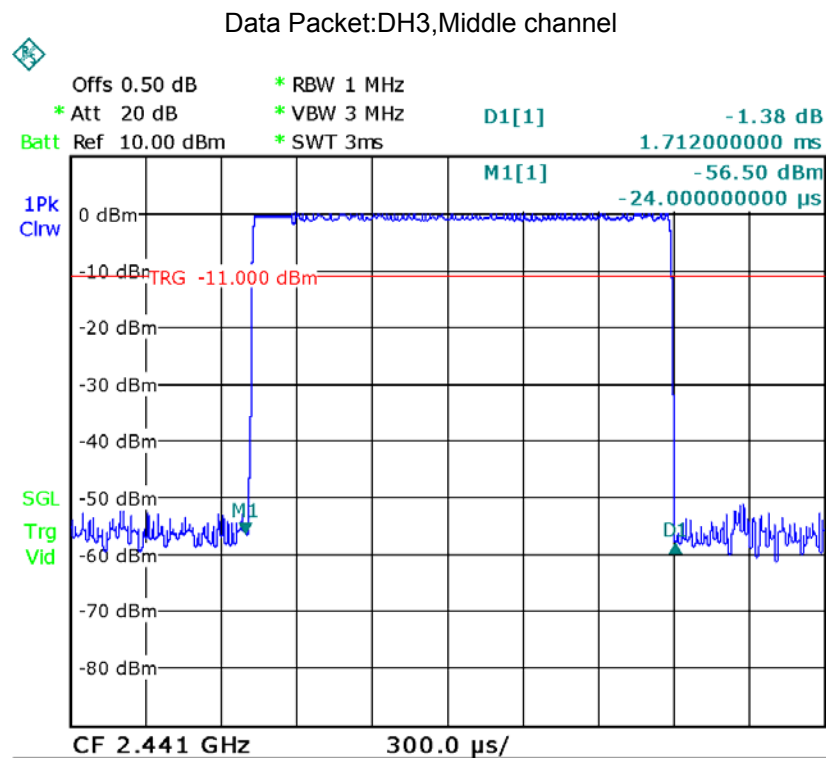


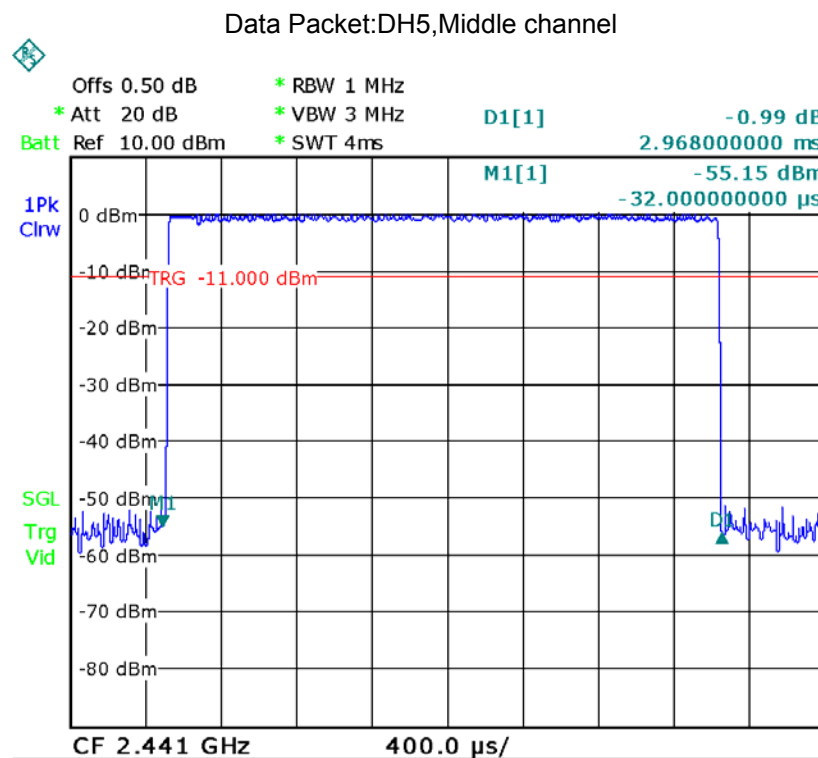
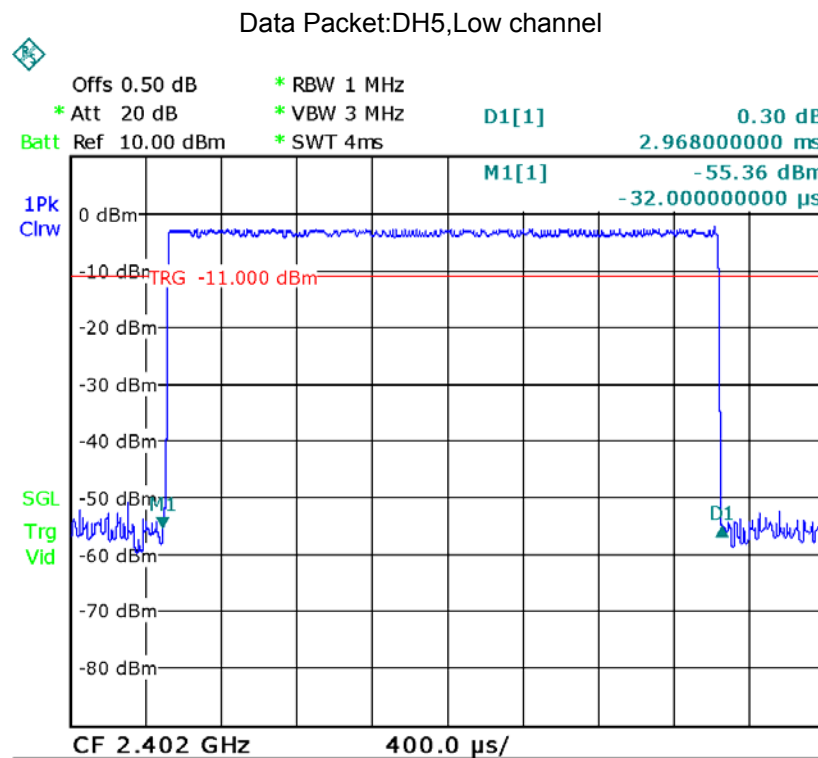




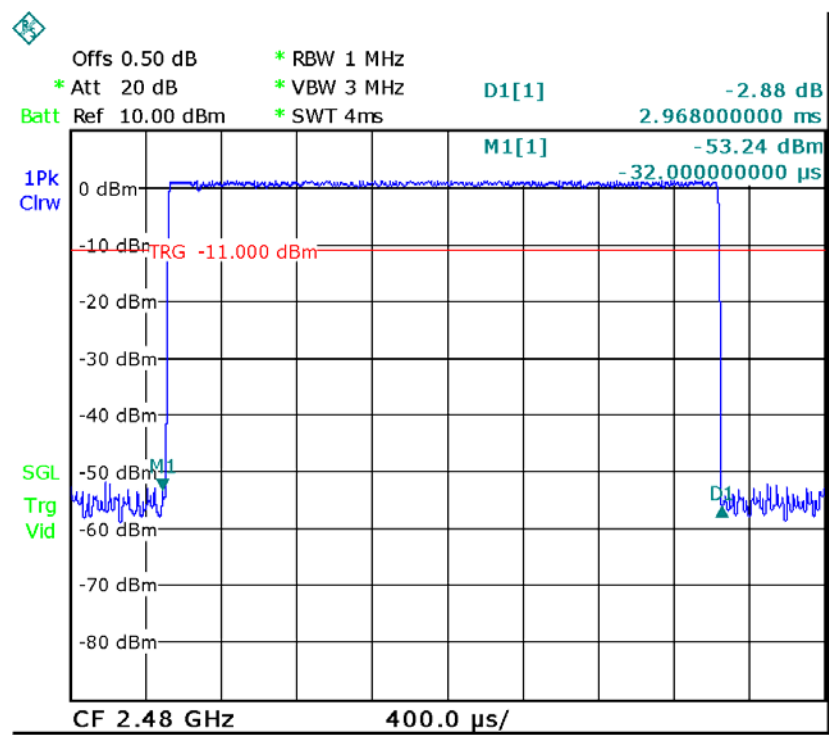








Data Packet:DH5,High channel



14 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.

15 RF Exposure

Test Requirement: FCC Part 1.1307

Test Mode: The EUT work in transmitting mode

15.1 Requirements:

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

15.2 The procedures / limit

(A) Limits for Occupational / Controlled Exposure

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

(B) Limits for General Population / Uncontrolled Exposure

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

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

15.3 MPE Calculation Method

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

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

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

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/cm ²)	Limit of Power Density (mW/cm ²)
GFSK	1.000	2.7	1.862	0.000370	1.0
Pi/4DQPSK	1.000	1.83	1.524	0.000303	1.0
8DPSK	1.000	2.09	1.618	0.000322	1.0

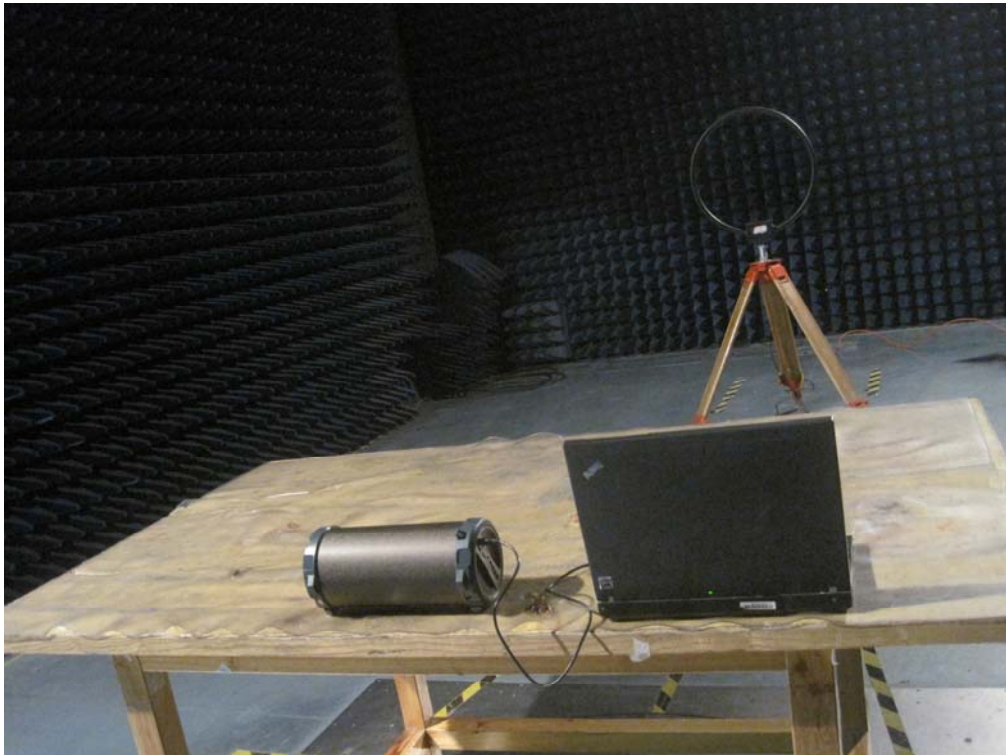
16 Photographs – Test Setup

16.1 Photograph –Power Line Conducted Emission Test Setup



16.2 Photograph – Radiated Emission Test Setup

Below 30MHz



From 30-1000MHz



Above 1GHz



17 Photographs - Constructional Details

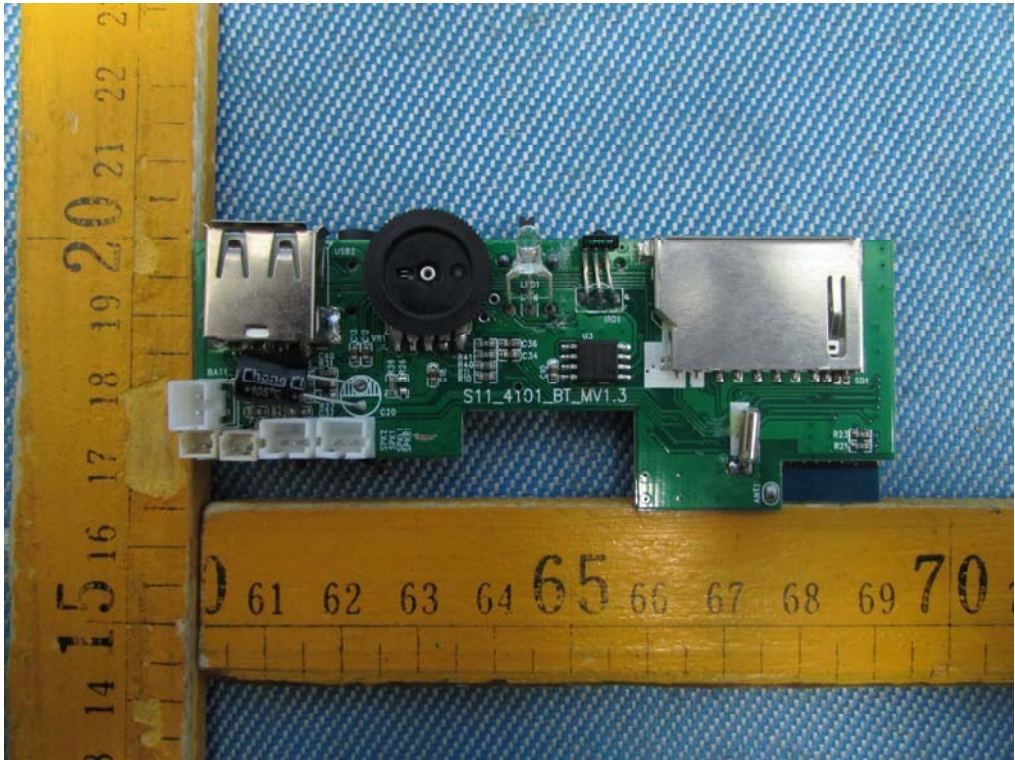
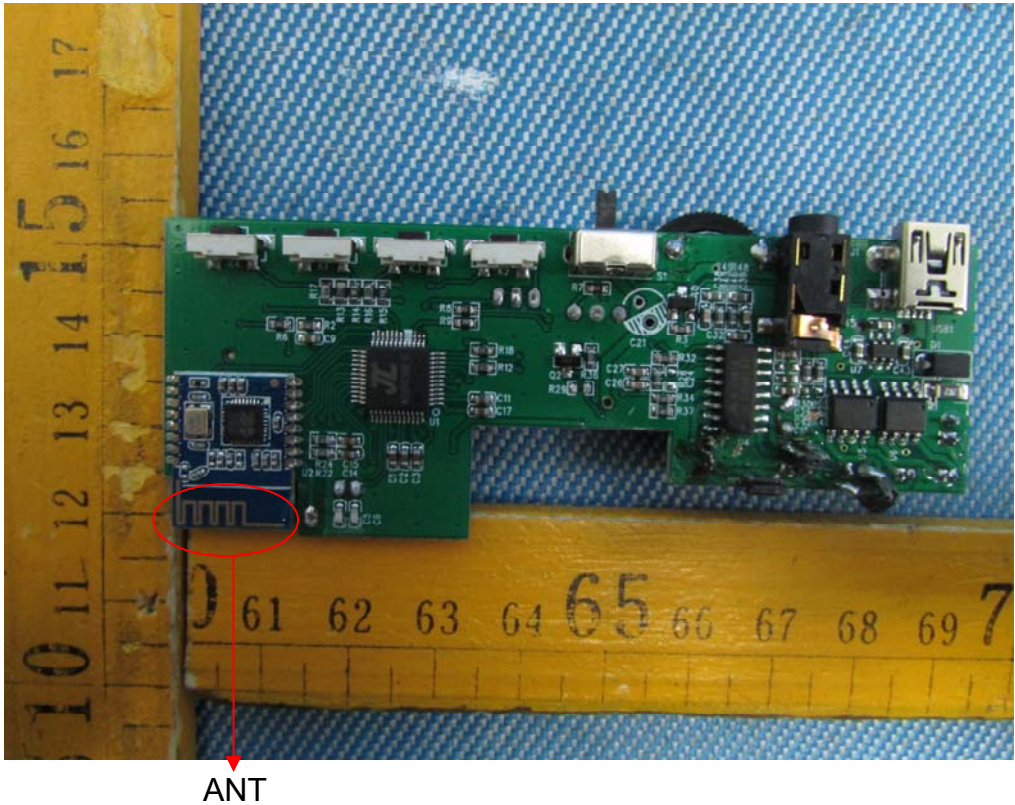
17.1 EUT – Appearance View



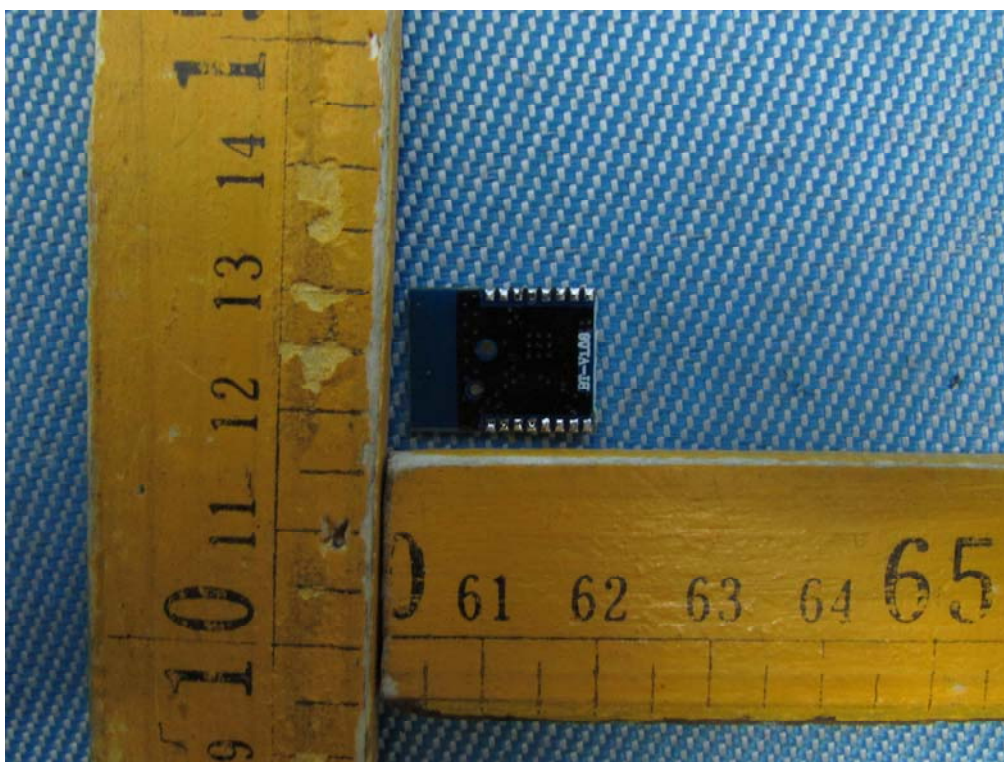
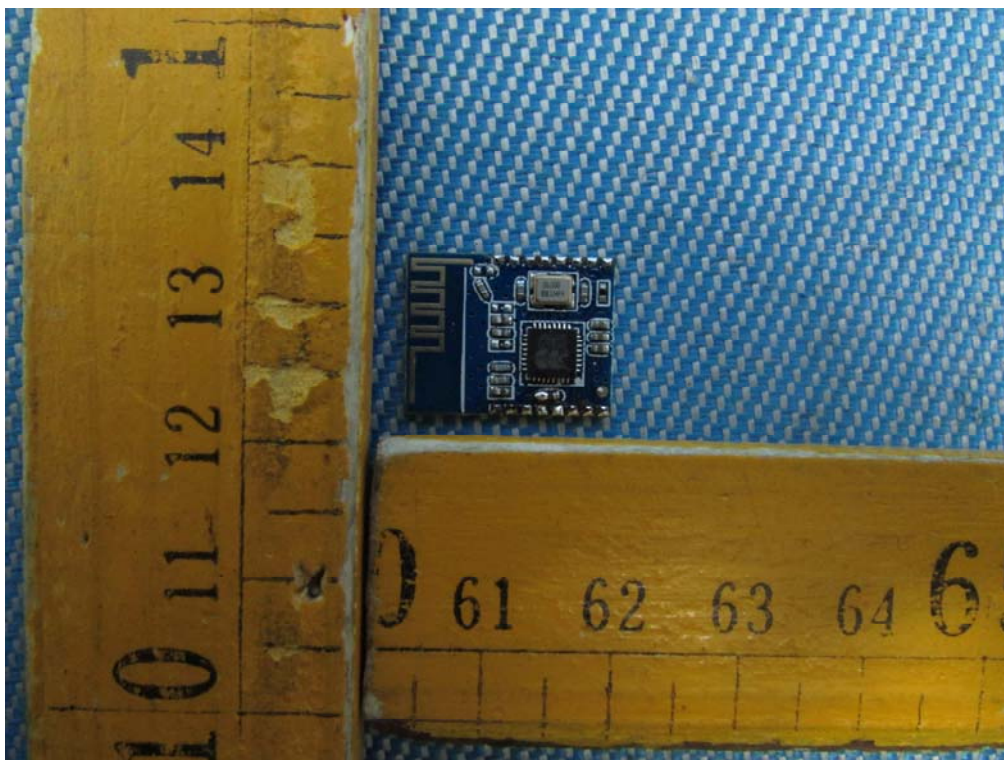


17.2 EUT – Internal View





17.3 EUT – RF Module View



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