

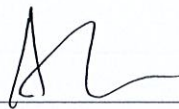
## RADIO TEST REPORT

The device described below is tested by Dongguan Nore Testing Center Co., Ltd. to determine the maximum emission levels emanating from the device, the severe levels which the device can endure and E.U.T.'s performance criterion. The test results, data evaluation, test procedures, and equipment of configurations shown in this report were made in accordance with the procedures in ANSI C63.10(2013).

Applicant : FN-LINK TECHNOLOGY LIMITED  
Address : No.8, Litong Road, Liuyang Economic Development Zone, Liuyang City, Hunan Province, China  
Manufacturer /Factory : FN-LINK TECHNOLOGY LIMITED  
Address : No.8, Litong Road, Liuyang Economic Development Zone, Liuyang City, Hunan Province, China  
E.U.T. : WIFI+BT Module  
Brand Name : FN-LINK  
Model No. : 8223A-SR  
FCC ID : 2AATL-8223A-SR  
Measurement Standard : FCC PART 15.247  
Date of Receiver : November 06, 2017  
Date of Test : November 06, 2017 to December 05, 2017  
Date of Report : December 06, 2017

This Test Report is Issued Under the Authority of :

Prepared by



Alina Guo / Engineer

Approved & Authorized Signer



Iori Fan / Authorized Signatory

This test report is for the customer shown above and their specific product only. This report applies to above tested sample only and shall not be reproduced in part without written approval of Dongguan Nore Testing Center Co., Ltd.

## Table of Contents

<b>1. GENERAL INFORMATION .....</b>	<b>5</b>
1.1 PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST .....	5
1.2 RELATED SUBMITTAL(S) / GRANT (S).....	5
1.3 TEST METHODOLOGY .....	8
1.4 EQUIPMENT MODIFICATIONS .....	8
1.5 SUPPORT DEVICE .....	8
1.6 TEST FACILITY AND LOCATION.....	9
1.7 SUMMARY OF TEST RESULTS .....	10
<b>2. SYSTEM TEST CONFIGURATION.....</b>	<b>11</b>
2.1 EUT CONFIGURATION .....	11
2.2 SPECIAL ACCESSORIES.....	11
2.3 DESCRIPTION OF TEST MODES .....	11
2.4 EUT EXERCISE .....	11
<b>3. CONDUCTED EMISSIONS TEST .....</b>	<b>12</b>
3.1 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	12
3.2 TEST CONDITION .....	12
3.3 MEASUREMENT RESULTS.....	12
<b>4. RADIATED EMISSION TEST .....</b>	<b>15</b>
4.1 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	15
4.2 MEASUREMENT PROCEDURE .....	16
4.3 LIMIT .....	16
4.4 MEASUREMENT RESULTS .....	17
<b>5. CHANNEL SEPARATION TEST.....</b>	<b>21</b>
5.1 MEASUREMENT PROCEDURE .....	21
5.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	21
5.3 MEASUREMENT RESULTS.....	21
<b>6. 20DB BANDWIDTH.....</b>	<b>27</b>
6.1 MEASUREMENT PROCEDURE .....	27
6.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	27
6.3 MEASUREMENT RESULTS.....	27
<b>7. HOPPING CHANNEL NUMBER .....</b>	<b>33</b>
7.1 MEASUREMENT PROCEDURE .....	33
7.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	33
7.3 MEASUREMENT RESULTS.....	33

<b>8. TIME OF OCCUPANCY (DWELL TIME)</b>	<b>35</b>
8.1 MEASUREMENT PROCEDURE	35
8.2 MEASUREMENT RESULTS	35
<b>9. MAXIMUM PEAK OUTPUT POWER</b>	<b>35</b>
9.1 MEASUREMENT PROCEDURE	41
9.2 MEASUREMENT RESULTS	41
<b>10. BAND EDGE</b>	<b>41</b>
10.1 MEASUREMENT PROCEDURE	47
10.2 LIMIT	47
10.3 MEASUREMENT RESULTS	47
<b>11. ANTENNA APPLICATION</b>	<b>47</b>
11.1 ANTENNA REQUIREMENT	54
11.2 MEASUREMENT RESULTS	54
<b>12. CONDUCTED SPURIOUS EMISSIONS</b>	<b>55</b>
12.1 MEASUREMENT PROCEDURE	55
12.2. MEASUREMENT RESULTS	55
<b>13. TEST EQUIPMENT LIST</b>	<b>58</b>

## Revision History of This Test Report

Report Number	Description	Issued Date
NTC1710203FV00	Initial Issue	2017-12-06

## 1. GENERAL INFORMATION

### 1.1 Product Description for Equipment under Test

Product Name	: WIFI+BT Module
Main Model Name	: 8223A-SR
Additional Model Name	: N/A
Model difference	: N/A
Brand Name	: FN-LINK
Power Supply	: DC 3.3V
Adapter	: N/A
Test voltage	: DC 3.3V come from Test fixture (AC 120/60Hz Input)
Hardware version	: V1.0
Software version	: V1.0
Serial number	: N/A
Note	: N/A

#### Technical parameters

Bluetooth Version	: 4.2
Frequency Range	: 2402-2480MHz
Modulation	: GFSK, $\pi$ 4/-DQPSK, 8DPSK
Number of Channel	: 79
Channel space	: 1MHz
Date Rate	: 1Mbps for GFSK 2Mbps for $\pi$ 4/-DQPSK 3Mbps for 8DPSK
Antenna Type	: Please refer to below antenna information.
Antenna Gain	: Please refer to below antenna information.

### Antenna Information

Ant.	Brand	Model name	Antenna Type	Connector	Gain (dBi)	Application range
1	XK	XKFPC-2D4-5D8-150	PIFA	I-PEX	0.0	2.4G Band
					2.95	5G Band
2	ZHONGTIAN XUN	2.00001050	PIFA	I-PEX	0.38	2.4/5G Dual Band

Note: The EUT has only one type antenna, so all tests were based on the maximum Gain antenna.

### BDR+EDR Channel List

Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz
1	2402	21	2422	41	2442	61	2462
2	2403	22	2423	42	2443	62	2463
3	2404	23	2424	43	2444	63	2464
4	2405	24	2425	44	2445	64	2465
5	2406	25	2426	45	2446	65	2466
6	2407	26	2427	46	2447	66	2467
7	2408	27	2428	47	2448	67	2468
8	2409	28	2429	48	2449	68	2469
9	2410	29	2430	49	2450	69	2470
10	2411	30	2431	50	2451	70	2471
11	2412	31	2432	51	2452	71	2472
12	2413	32	2433	52	2453	72	2473
13	2414	33	2434	53	2454	73	2474
14	2415	34	2435	54	2455	74	2475
15	2416	35	2436	55	2456	75	2476
16	2417	36	2437	56	2457	76	2477
17	2418	37	2438	57	2458	77	2478
18	2419	38	2439	58	2459	78	2479
19	2420	39	2440	59	2460	79	2480
20	2421	40	2441	60	2461		

**Note:** According to section 15.31(m), regards to the operating frequency range over 10MHz, the Lowest, middle, and the Highest frequency of channel were selected to perform the test. The selected frequency and test software see below:

Channel	Frequency MHz
1	2402
40	2441
79	2480

Test SW version	QRCT (QCA Radio Control Toolkit) SecureCRT
-----------------	---

## 1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: **2AATL-8223A-SR** filing to comply with Section 15.247 of the FCC Part 15 (2016), Subpart C Rule.

## 1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters.

## 1.4 Equipment Modifications

Not available for this EUT intended for grant.

## 1.5 Support Device

Notebook PC	: Manufacturer: IBM Corporation M/N: R50e S/N: L3-HZNGO P/N: 1834KDC
Adapter (For Notebook PC)	: Manufacturer: IBM Corporation M/N: 08K8210 Input: AC100-240V 50/60Hz 0.5-1.0A Output: DC 16V 4.5A
Test Fixture	: Provide by manufacturer



## 1.6 Test Facility and Location

### Site Description

- EMC Lab : Listed by CNAS, August 14, 2015  
The certificate is valid until August 13, 2018  
The Laboratory has been assessed and proved to be in compliance with CNAS/CL01  
The Certificate Registration Number is L5795.
- Listed by A2LA, November 01, 2017  
The certificate is valid until December 31, 2019  
The Laboratory has been assessed and proved to be in compliance with ISO17025  
The Certificate Registration Number is 4429.01
- Listed by FCC, November 06, 2017  
The Designation Number is CN1214  
Test Firm Registration Number: 907417
- Listed by Industry Canada, June 08, 2017  
The Certificate Registration Number. Is 46405-9743
- Name of Firm : Dongguan Nore Testing Center Co., Ltd.  
(Dongguan NTC Co., Ltd.)
- Site Location : Building D, Gaosheng Science & Technology Park,  
Zhouxi Longxi Road, Nancheng District, Dongguan  
City, Guangdong Province, China

## 1.7 Summary of Test Results

FCC Rules	Description Of Test	Uncertainty	Result
§15.247(a)(1)	Channel Separation test	$\pm 1.42 \times 10^{-4}\%$	Compliant
§15.247(a)(1)	20dB Bandwidth	$\pm 1.42 \times 10^{-4}\%$	Compliant
§15.247(a)(1)(iii)	Hopping Channel Number	$\pm 1.42 \times 10^{-4}\%$	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	$\pm 5\%$	Compliant
§15.247(b)	Max Peak output Power test	$\pm 1.06\text{dB}$	Compliant
§15.247(d)	Band edge test	$\pm 1.70\text{dB}$	Compliant
§15.207 (a)	AC Power Conducted Emission	$\pm 1.06\text{dB}$	Compliant
§15.247(d), §15.209, §15.205	Radiated Emission	$\pm 3.70\text{dB}$	Compliant
§15.203	Antenna Requirement	N/A	Compliant
§15.247(d)	Conducted Spurious Emission	$\pm 1.70\text{dB}$	Compliant

## **2. System Test Configuration**

### **2.1 EUT Configuration**

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### **2.2 Special Accessories**

Not available for this EUT intended for grant.

### **2.3 Description of test modes**

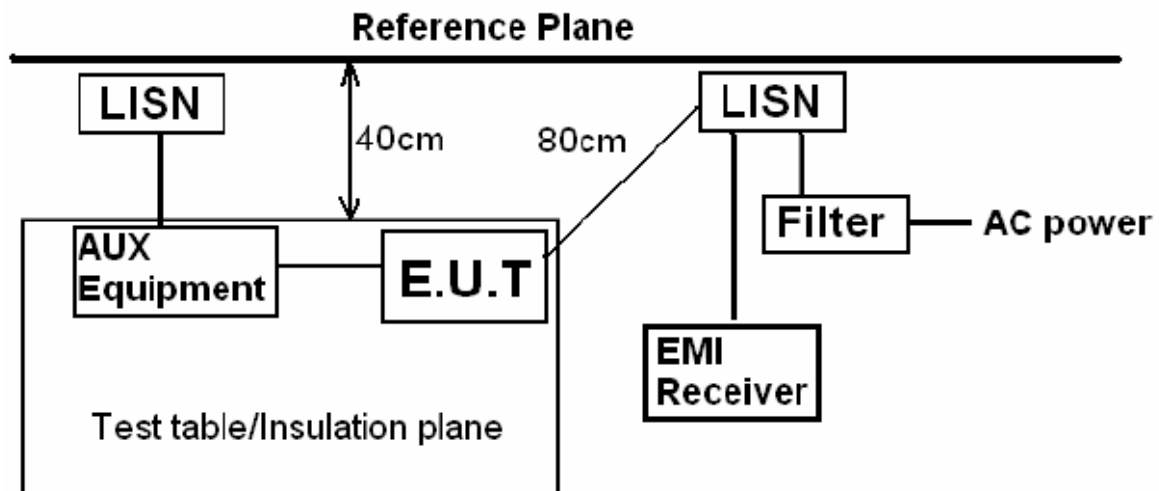
The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3 and DH5 mode in all modulation type GFSK,  $\pi/4$ -DQPSK, 8DPSK were tested.

### **2.4 EUT Exercise**

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.

### 3. Conducted Emissions Test

#### 3.1 Test SET-UP (Block Diagram of Configuration)



#### 3.2 Test Condition

Test Requirement: FCC Part 15.207

Frequency Range: 150KHz ~ 30MHz

Detector: RBW 9KHz, VBW 30KHz

Operation Mode: TX

#### 3.3 Measurement Results

Please refer to following plots.



Dongguan NTC Co., Ltd.  
Tel: +86-769-22022444 Fax: +86-769-22022799  
Web: [Http://www.ntc-c.com](http://www.ntc-c.com)

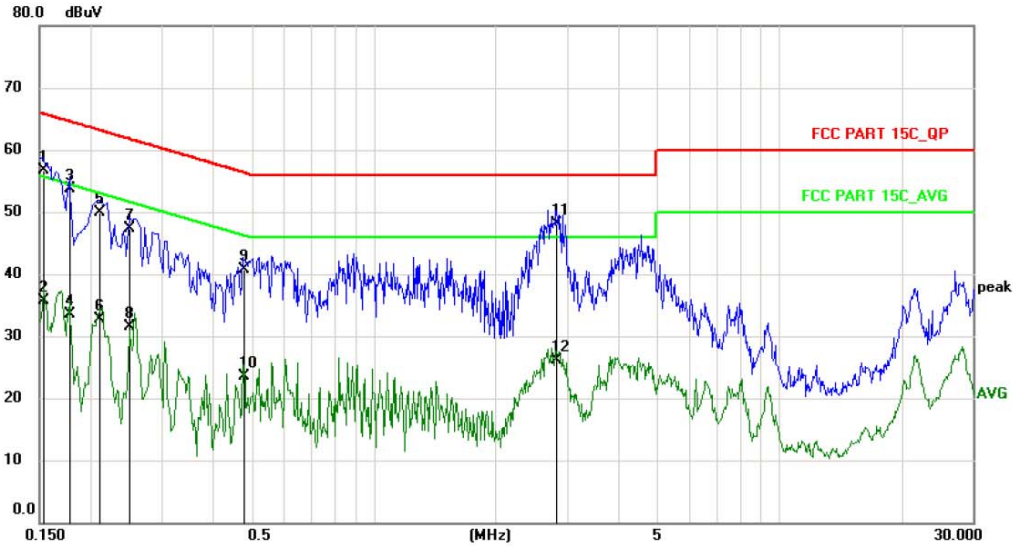
### Conducted Emission Measurement

File :8223A-SR

Data :#6

Date: 2017-11-21

Time: 17:36:20



Site  
Limit: FCC PART 15C\_QP  
EUT: WIFI+BT Module  
M/N: 8223A-SR  
Mode: TX(BT2.1)  
Note: WIFI+BT Module

Phase: **L1**  
Power: AC 120V/60Hz

Temperature: 26  
Humidity: 53 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.1539	46.00	10.80	56.80	65.79	-8.99	QP	
2		0.1539	24.90	10.80	35.70	55.79	-20.09	AVG	
3		0.1780	42.90	10.80	53.70	64.58	-10.88	QP	
4		0.1780	22.80	10.80	33.60	54.58	-20.98	AVG	
5		0.2100	39.10	10.80	49.90	63.21	-13.31	QP	
6		0.2100	22.00	10.80	32.80	53.21	-20.41	AVG	
7		0.2500	36.50	10.80	47.30	61.76	-14.46	QP	
8		0.2500	20.80	10.80	31.60	51.76	-20.16	AVG	
9		0.4780	30.00	10.80	40.80	56.37	-15.57	QP	
10		0.4780	12.80	10.80	23.60	46.37	-22.77	AVG	
11	*	2.8100	37.40	10.80	48.20	56.00	-7.80	QP	
12		2.8100	15.30	10.80	26.10	46.00	-19.90	AVG	

\*:Maximum data x:Over limit !:over margin

<Reference Only



Dongguan NTC Co., Ltd.  
Tel: +86-769-22022444 Fax: +86-769-22022799  
Web: <http://www.ntc-c.com>

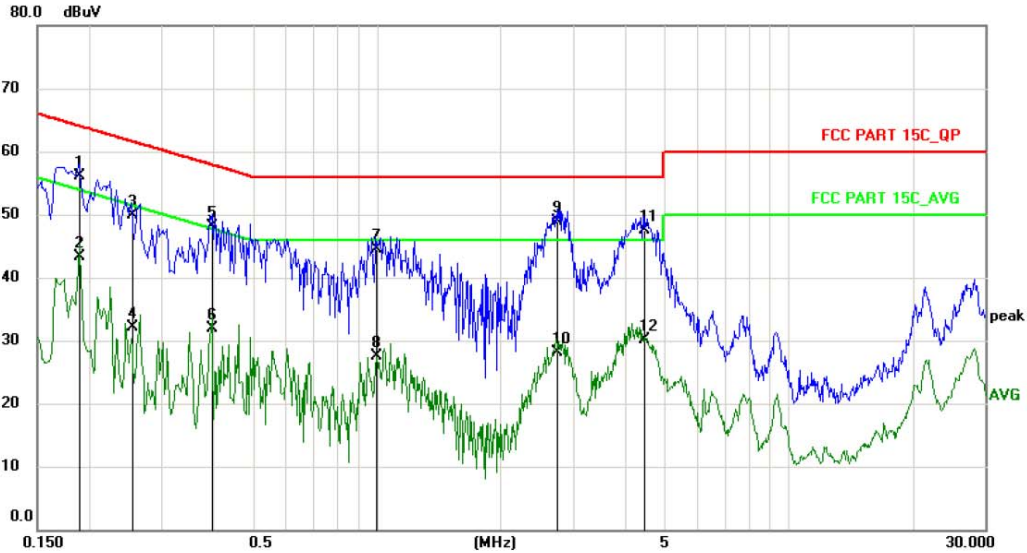
### Conducted Emission Measurement

File :8223A-SR

Data :#5

Date: 2017-11-21

Time: 17:33:53



Site

Phase: **N**

Temperature: 26

Limit: FCC PART 15C\_QP

Power: AC 120V/60Hz

Humidity: 53 %

EUT: WIFI+BT Module

M/N: 8223A-SR

Mode: TX(BT2.1)

Note: WIFI+BT Module

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.1900	45.40	10.80	56.20	64.04	-7.84	QP	
2		0.1900	32.50	10.80	43.30	54.04	-10.74	AVG	
3		0.2540	39.10	10.80	49.90	61.63	-11.73	QP	
4		0.2540	21.40	10.80	32.20	51.63	-19.43	AVG	
5		0.3980	37.30	10.80	48.10	57.90	-9.80	QP	
6		0.3980	21.10	10.80	31.90	47.90	-16.00	AVG	
7		0.9979	33.80	10.80	44.60	56.00	-11.40	QP	
8		0.9979	16.80	10.80	27.60	46.00	-18.40	AVG	
9	*	2.7379	38.10	10.80	48.90	56.00	-7.10	QP	
10		2.7379	17.40	10.80	28.20	46.00	-17.80	AVG	
11		4.4537	36.80	10.80	47.60	56.00	-8.40	QP	
12		4.4537	19.40	10.80	30.20	46.00	-15.80	AVG	

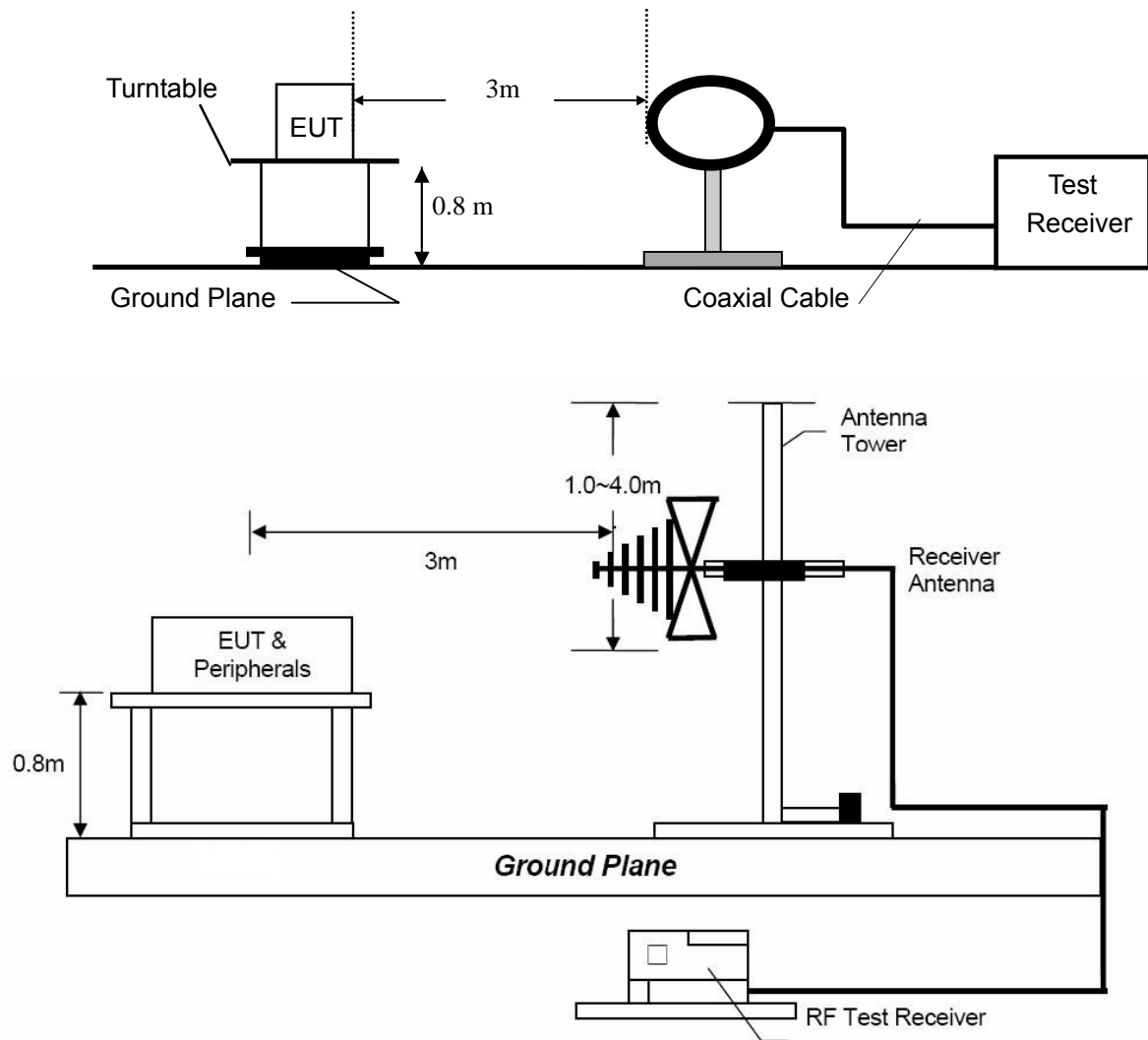
\*:Maximum data x:Over limit !:over margin

<Reference Only

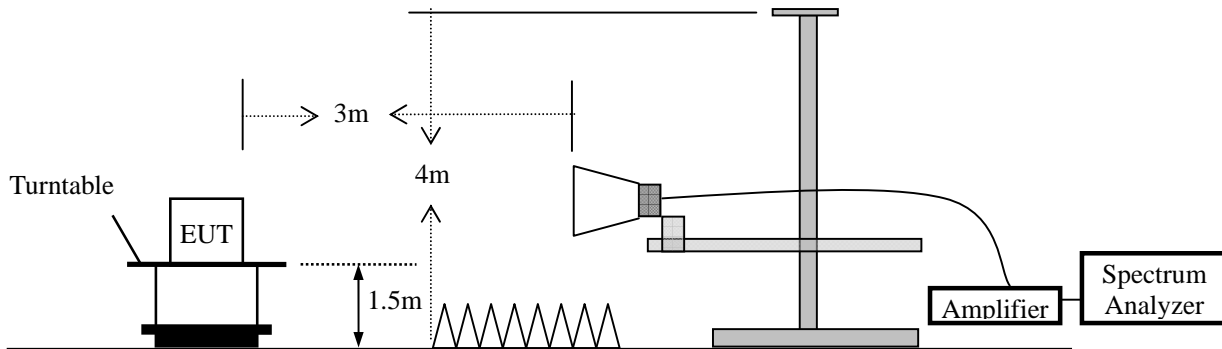
## 4. Radiated Emission Test

### 4.1 Test SET-UP (Block Diagram of Configuration)

#### 4.1.1 Radiated Emission Test Set-Up, Frequency Below 30MHz



#### 4.1.2 Radiated Emission Test Set-Up, Frequency above 1GHz



#### 4.2 Measurement Procedure

- Blow 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.
- For the radiated emission test above 1GHz:  
The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
- A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.



During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Level	Resolution Bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
	Average	1 MHz	10 Hz

#### 4.3 Limit

Frequency range MHz	Distance Meters	Field Strengths Limit (15.209)
		$\mu\text{V/m}$
0.009 ~ 0.490	300	$2400/F(\text{kHz})$
0.490 ~ 1.705	30	$24000/F(\text{kHz})$
1.705 ~ 30	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960	3	500

- Remark : (1) Emission level  $(\text{dB})_{\mu\text{V}} = 20 \log \text{Emission level } \mu\text{V/m}$   
 (2) The smaller limit shall apply at the cross point between two frequency bands.  
 (3) As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.  
 (4) The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

#### 4.4 Measurement Results

Please refer to following plots of the worst case ( $\pi$ 4/-DQPSK, Mid channel).



Dongguan NTC Co., Ltd.  
Tel: +86-769-22022444 Fax: +86-769-22022799  
Web: <http://www.ntc-c.com>

### Radiated Emission Measurement

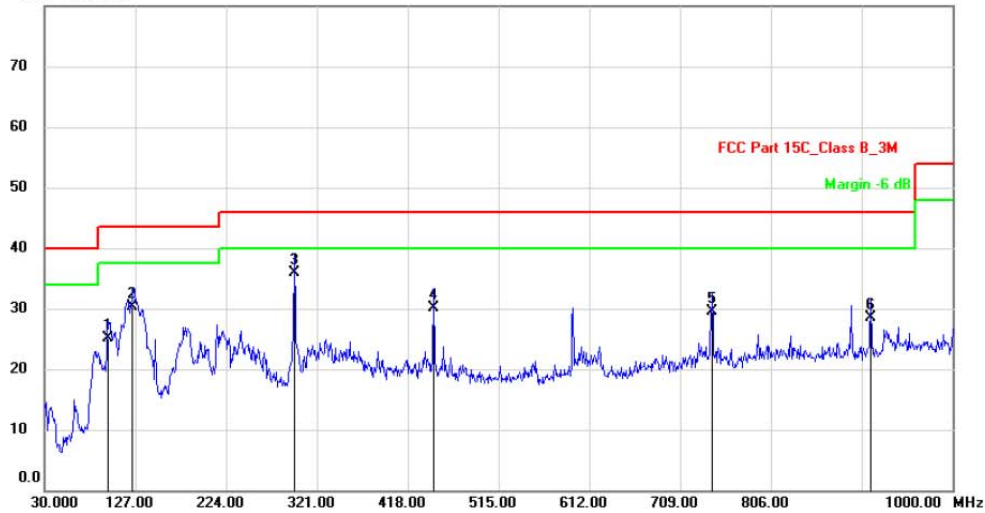
File : 8223A-SR

Data : #11

Date: 2017-11-25

Time: 15:07:03

80.0 dBuV/m



Site

Polarization: **Horizontal**

Temperature: 26

Limit: FCC Part 15C\_Class B\_3M

Power: DC 3.3V

Humidity: 60 %

EUT: WIFI+BT Module

Distance: 3m

M/N: 8223A-SR

Mode: TX(BT2.1)

Note: P4/-DQPSK, Mid Channel

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		97.9000	37.50	-12.40	25.10	43.50	-18.40	QP		
2		124.0900	44.81	-14.51	30.30	43.50	-13.20	QP		
3	*	296.7500	46.46	-10.56	35.90	46.00	-10.10	QP		
4		446.1300	38.16	-8.06	30.10	46.00	-15.90	QP		
5		742.9500	32.26	-2.76	29.50	46.00	-16.50	QP		
6		912.7000	29.58	-0.98	28.60	46.00	-17.40	QP		

\*:Maximum data x:Over limit l:over margin

(Reference Only)

**Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.**



Dongguan NTC Co., Ltd.  
Tel: +86-769-22022444 Fax: +86-769-22022799  
Web: [Http://www.ntc-c.com](http://www.ntc-c.com)

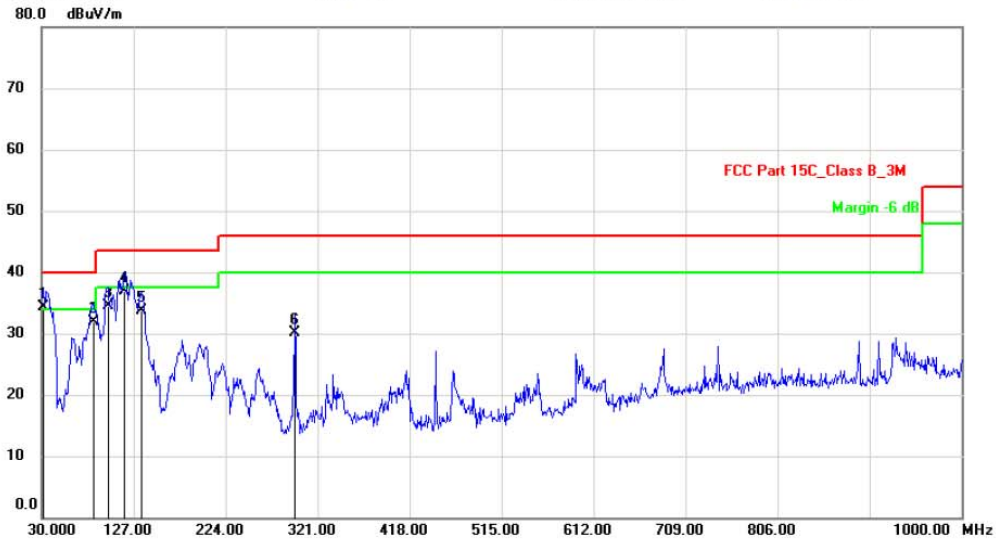
### Radiated Emission Measurement

File : 8223A-SR

Data : #12

Date: 2017-11-25

Time: 15:14:54



Site  
Limit: FCC Part 15C\_Class B\_3M  
EUT: WIFI+BT Module  
M/N: 8223A-SR  
Mode: TX(BT2.1)  
Note: P4/-DQPSK, Mid Channel

Polarization: **Vertical** Temperature: 26  
Power: DC 3.3V Humidity: 60 %  
Distance: 3m

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Antenna Height cm	Table Degree	Comment
1	*	31.9400	50.07	-15.77	34.30	40.00	-5.70	QP			
2		84.3200	50.21	-18.31	31.90	40.00	-8.10	QP			
3		99.8399	50.62	-16.12	34.50	43.50	-9.00	QP			
4		117.3000	53.36	-16.46	36.90	43.50	-6.60	QP			
5		134.7600	52.16	-18.36	33.80	43.50	-9.70	QP			
6		296.7500	42.66	-12.56	30.10	46.00	-15.90	QP			

\*:Maximum data x:Over limit !:over margin

(Reference Only)

**Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.**

Modulation: GFSK(the worst case)  
Frequency Range: 1-25GHz Test Date : November 25, 2017  
Test Result: PASS Temperature : 21 °C  
Measured Distance: 3m Humidity : 60 %  
Test By: Sance

Freq. (MHz)	Ant.Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV)		Limit 3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
Operation Mode: TX Mode (Low)										
4804	V	46.06	33.89	6.30	52.36	40.19	74.00	54.00	-21.64	-13.81
7206	V	44.28	33.15	10.44	54.72	43.59	74.00	54.00	-19.28	-10.41
---										
4804	H	46.62	35.37	6.30	52.92	41.67	74.00	54.00	-21.08	-12.33
7206	H	45.48	34.29	10.44	55.92	44.73	74.00	54.00	-18.08	-9.27
---										
Operation Mode: TX Mode (Mid)										
4882	V	46.94	35.56	6.60	53.54	42.16	74.00	54.00	-20.46	-11.84
7323	V	45.57	34.02	10.55	56.12	44.57	74.00	54.00	-17.88	-9.43
---										
4882	H	45.88	35.23	6.60	52.48	41.83	74.00	54.00	-21.52	-12.17
7323	H	45.41	34.02	10.55	55.96	44.57	74.00	54.00	-18.04	-9.43
---										
Operation Mode: TX Mode (High)										
4960	V	45.64	34.79	6.89	52.53	41.68	74.00	54.00	-21.47	-12.32
7440	V	44.41	33.68	10.60	55.01	44.28	74.00	54.00	-18.99	-9.72
---										
4960	H	44.92	33.48	6.89	51.81	40.37	74.00	54.00	-22.19	-13.63
7440	H	45.78	34.91	10.60	56.38	45.51	74.00	54.00	-17.62	-8.49
---										

- Note:**
- (1) All Readings are Peak Value and AV.
  - (2) Emission Level= Reading Level + Factor
  - (3) Factor= Antenna Gain + Cable Loss – Amplifier Gain
  - (4) Data of measurement within this frequency range shown “ --- ” in the table above means the reading of emissions are attenuated more than 10dB below the permissible limits.
  - (5) Measurement uncertainty :  $\pm 3.7$ dB.
  - (6) Horn antenna used for the emission over 1000MHz.

## 5. Channel Separation test

### 5.1 Measurement Procedure

Minimum Hopping Channel Carrier Frequency Separation, FCC Rule 15.247(a)(1):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable, and using the MARKER and Max-Hold function to record the separation of two adjacent channels.

### 5.2 Test SET-UP (Block Diagram of Configuration)

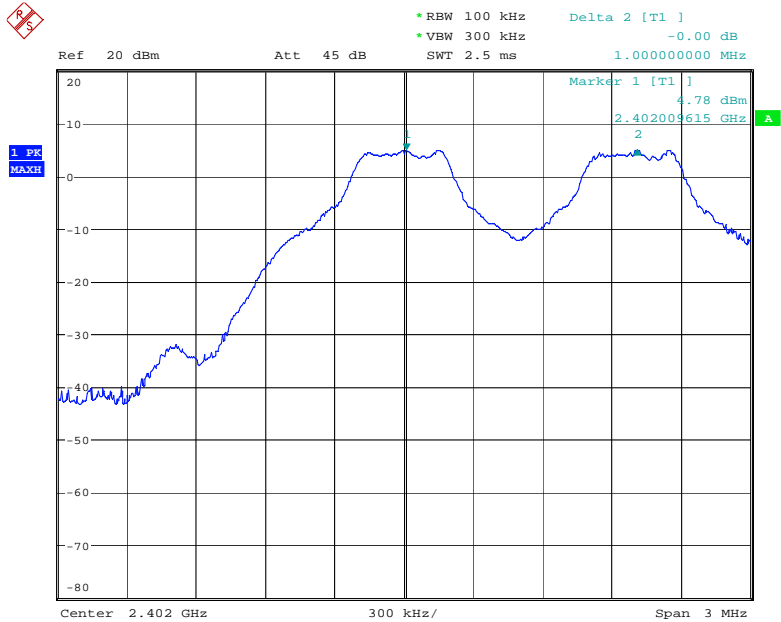


### 5.3 Measurement Results

Modulation:	GFSK, $\pi/4$ -DQPSK, 8DPSK		
RBW:	100KHz	VBW:	300KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	November 29, 2017
Temperature :	22 °C	Humidity :	53 %
Test Result:	PASS		

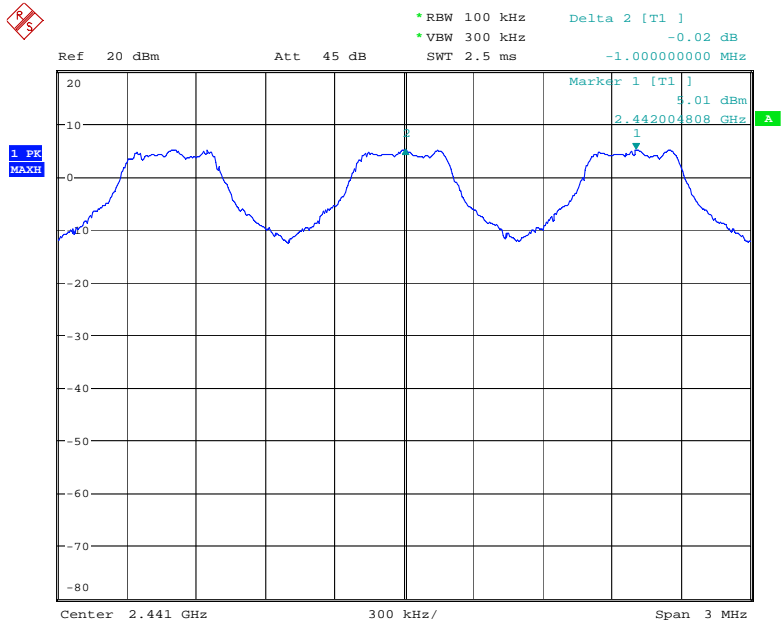
Channel number	Channel frequency (MHz)	Separation Read Value (KHz)	Separation Limit 2/3 20dB Bandwidth (KHz)
GFSK			
Lowest	2402	1000	>592.7
Middle	2441	1000	>592.7
Highest	2480	1000	>580.0
$\pi/4$ -DQPSK			
Lowest	2402	1000	>891.3
Middle	2441	1000	>808.0
Highest	2480	1000	>801.3
8DPSK			
Lowest	2402	1000	>814.0
Middle	2441	1005	>817.3
Highest	2480	1000	>814.0

GFSK Lowest Channel



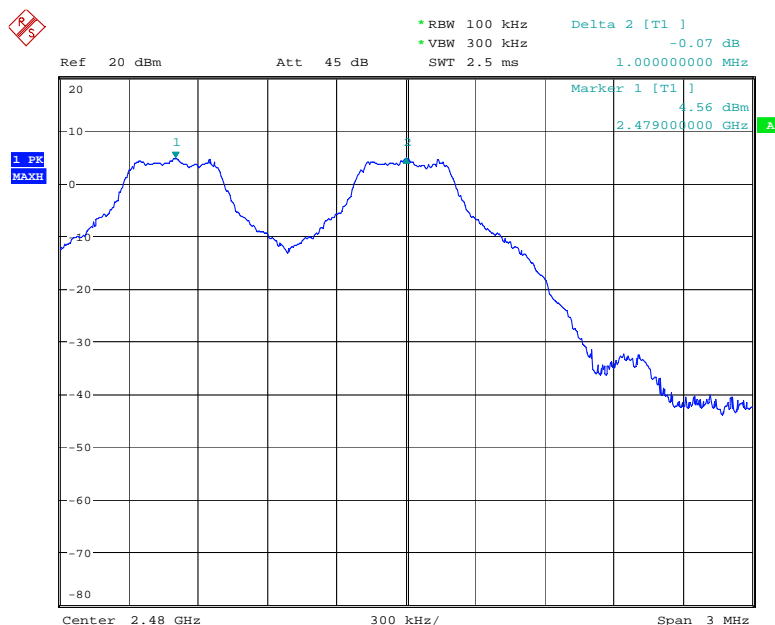
Date: 29.NOV.2017 16:16:35

GFSK Middle Channel



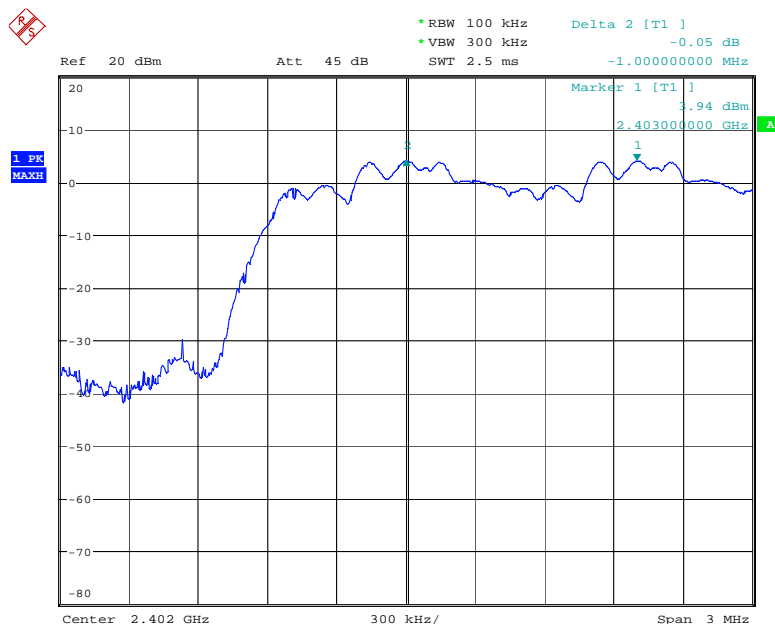
Date: 29.NOV.2017 16:18:18

## GFSK Highest Channel



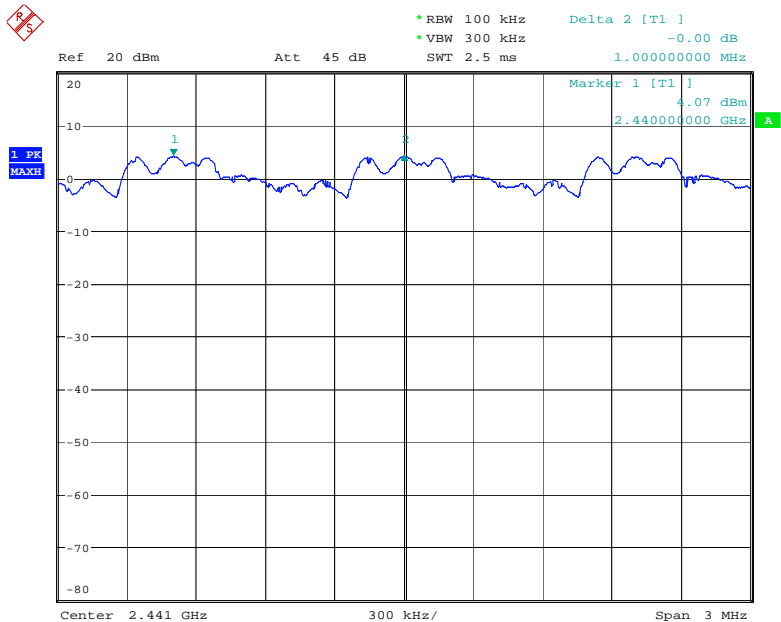
Date: 29.NOV.2017 16:19:46

## $\pi/4$ -DQPSK Lowest Channel



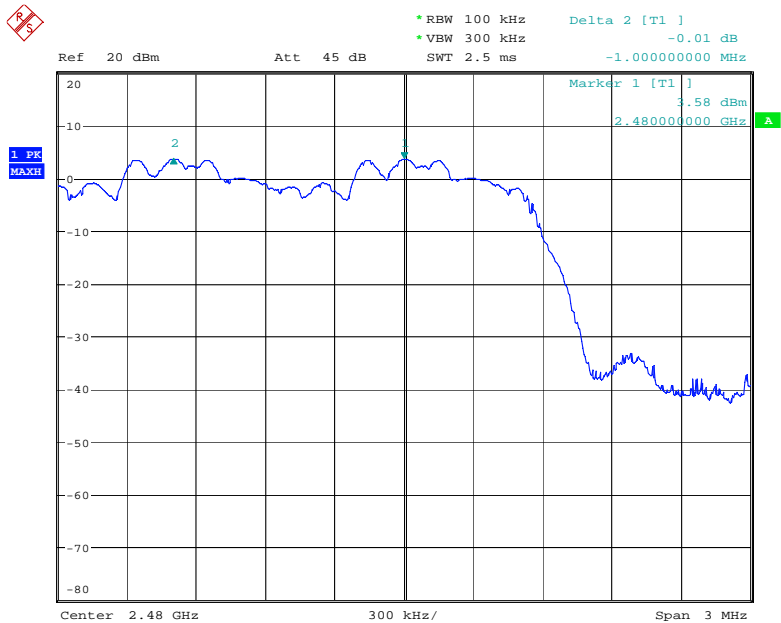
Date: 29.NOV.2017 16:23:24

**$\pi/4$ -DQPSK Middle Channel**



Date: 29.NOV.2017 16:26:01

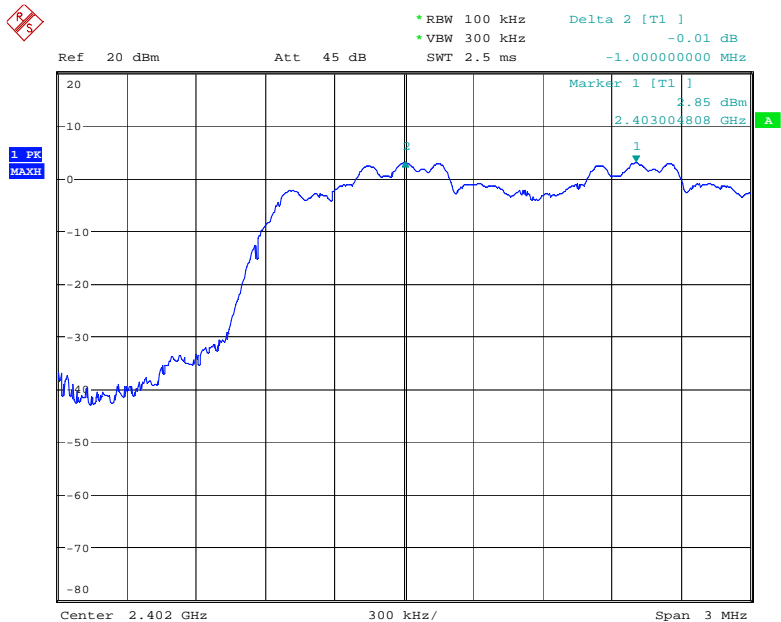
**$\pi/4$ -DQPSK Highest Channel**



Date: 29.NOV.2017 16:28:53

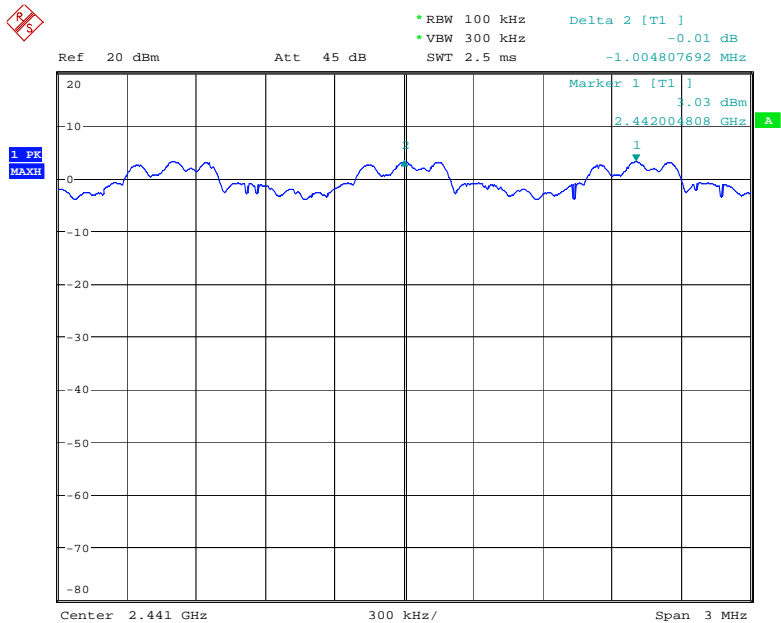


8DPSK Lowest Channel



Date: 29.NOV.2017 16:33:31

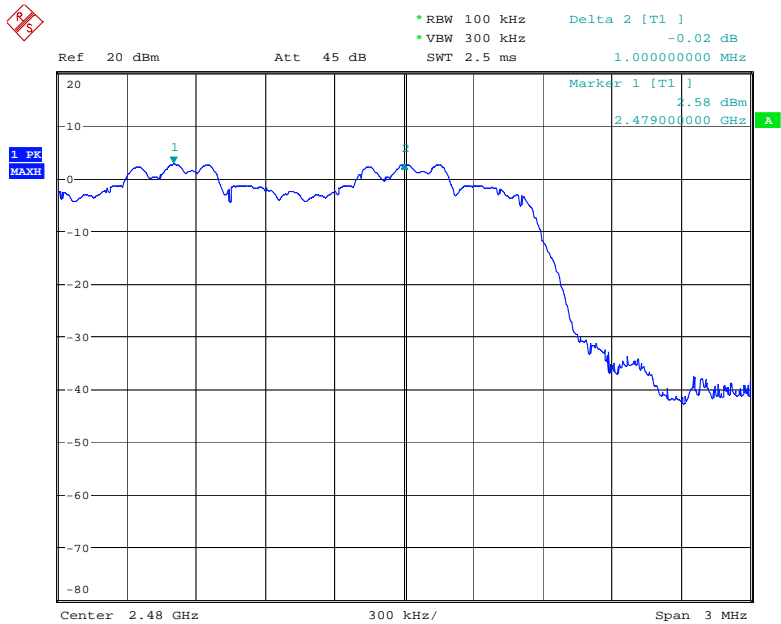
8DPSK Middle Channel



Date: 29.NOV.2017 16:36:52



8DPSK Highest Channel



Date: 29.NOV.2017 16:40:03

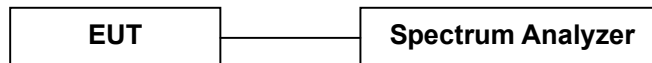
## 6. 20dB Bandwidth

### 6.1 Measurement Procedure

Maximum 20dB RF Bandwidth, FCC Rule 15.247(a)(1):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

### 6.2 Test SET-UP (Block Diagram of Configuration)



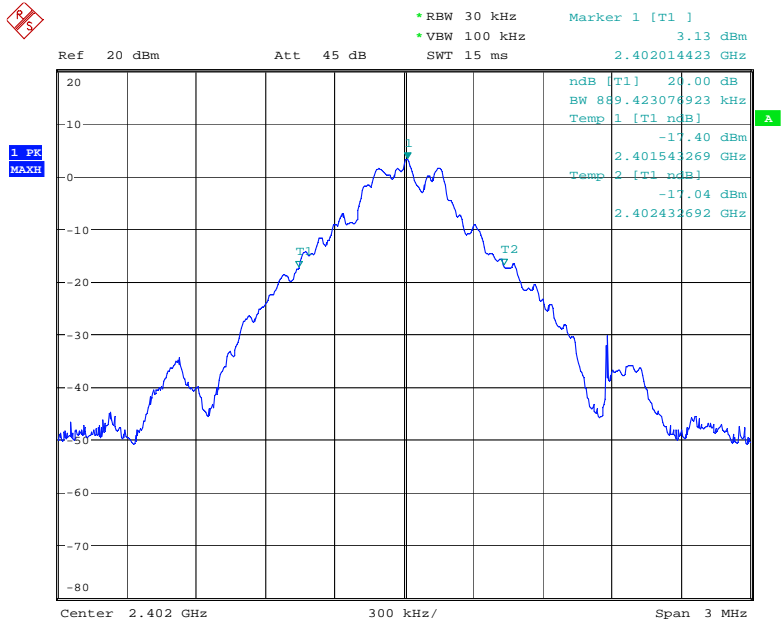
### 6.3 Measurement Results

Refer to attached data chart.

Modulation:	GFSK, $\pi/4$ -DQPSK, 8DPSK		
RBW:	30KHz	VBW:	100KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	November 29, 2017
Temperature :	22 °C	Humidity :	53 %
Test Result:	PASS		

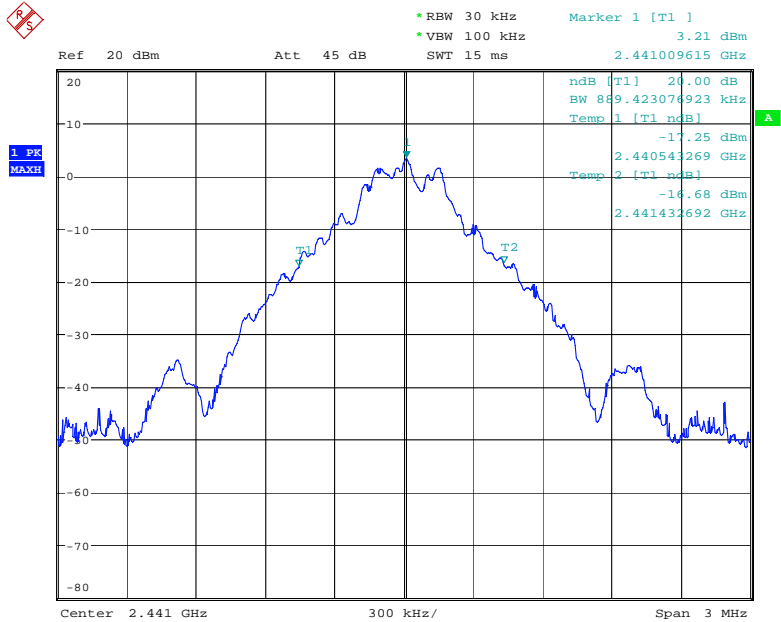
Channel frequency (MHz)	20dB Down BW(kHz)
GFSK	
2402	889
2441	889
2480	870
$\pi/4$ -DQPSK	
2402	1337
2441	1212
2480	1202
8DPSK	
2402	1221
2441	1226
2480	1221

GFSK Lowest Channel



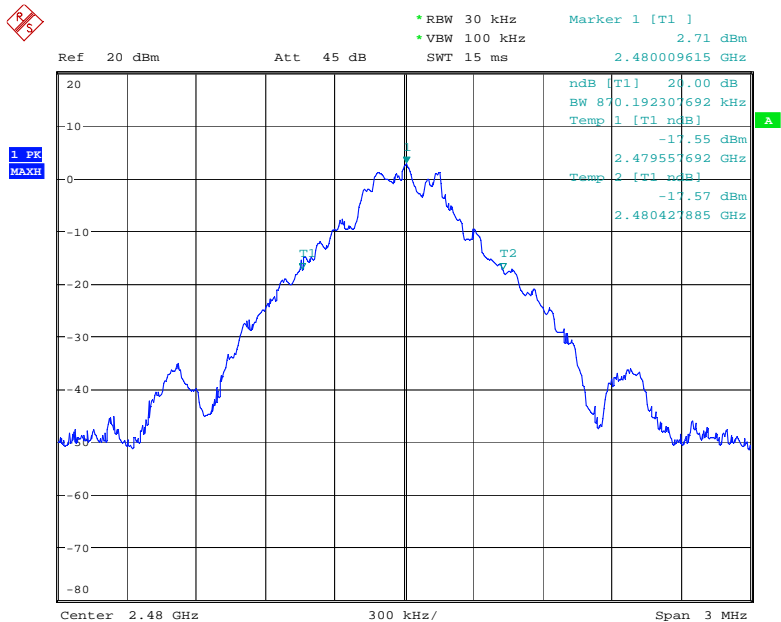
Date: 29.NOV.2017 15:42:40

GFSK Middle Channel



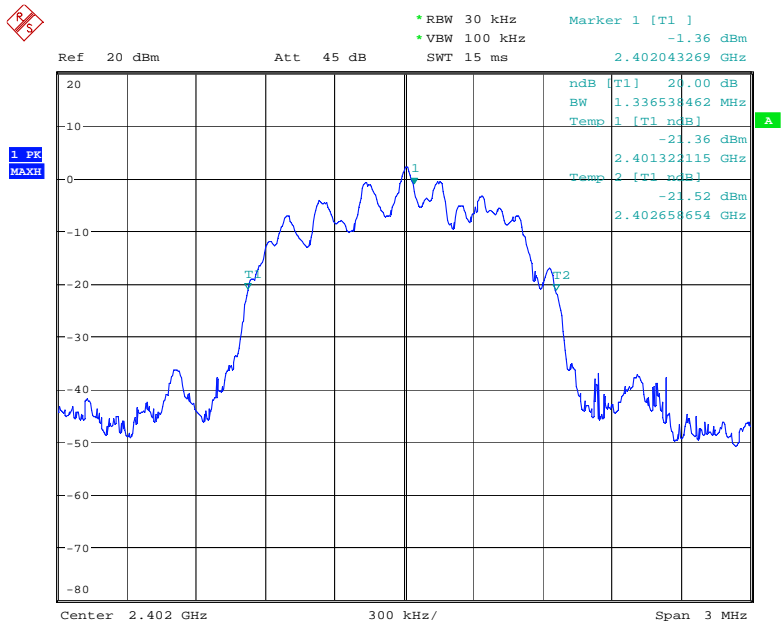
Date: 29.NOV.2017 15:43:28

GFSK Highest Channel



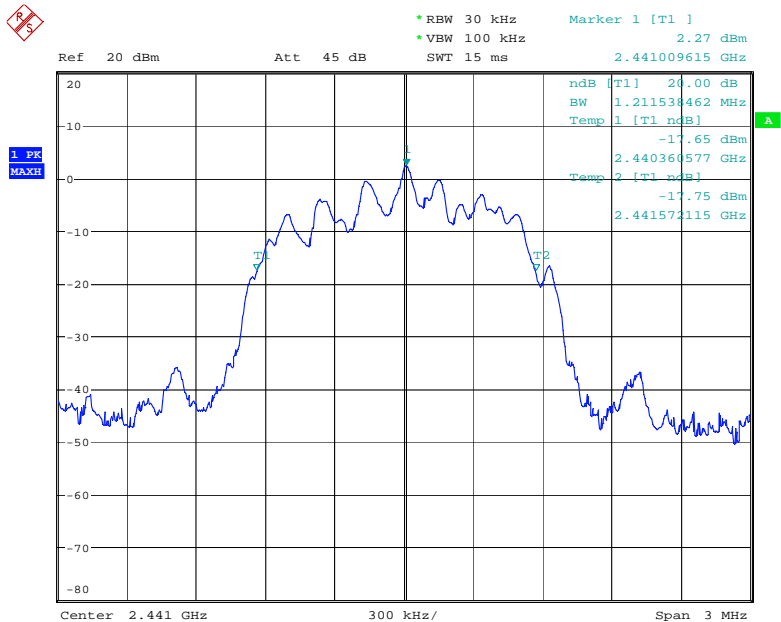
Date: 29.NOV.2017 15:44:36

$\pi/4$ -DQPSK Lowest Channel



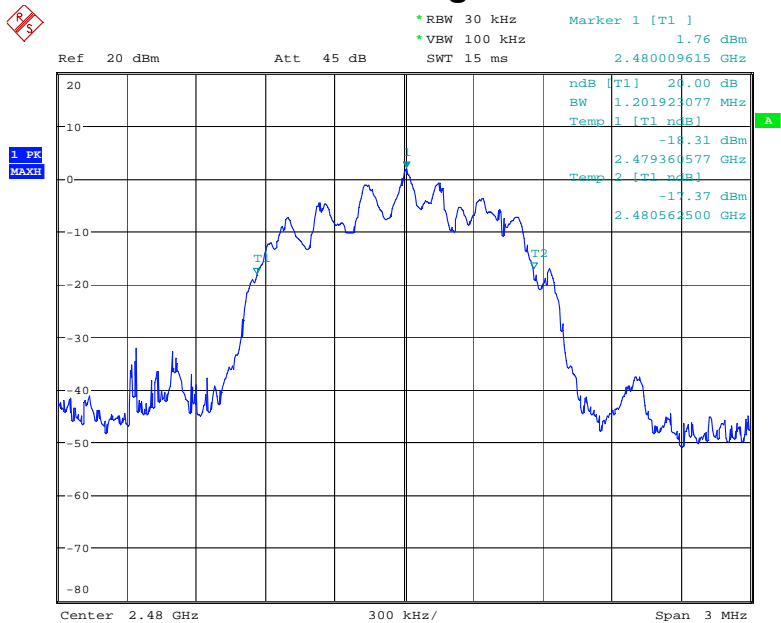
Date: 29.NOV.2017 15:46:37

$\pi/4$ -DQPSK Middle Channel



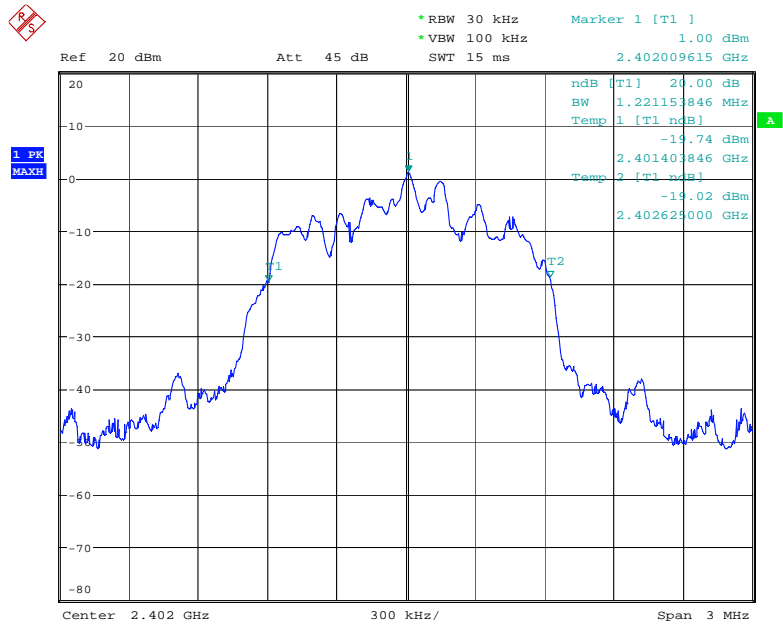
Date: 29.NOV.2017 15:47:33

$\pi/4$ -DQPSK Highest Channel



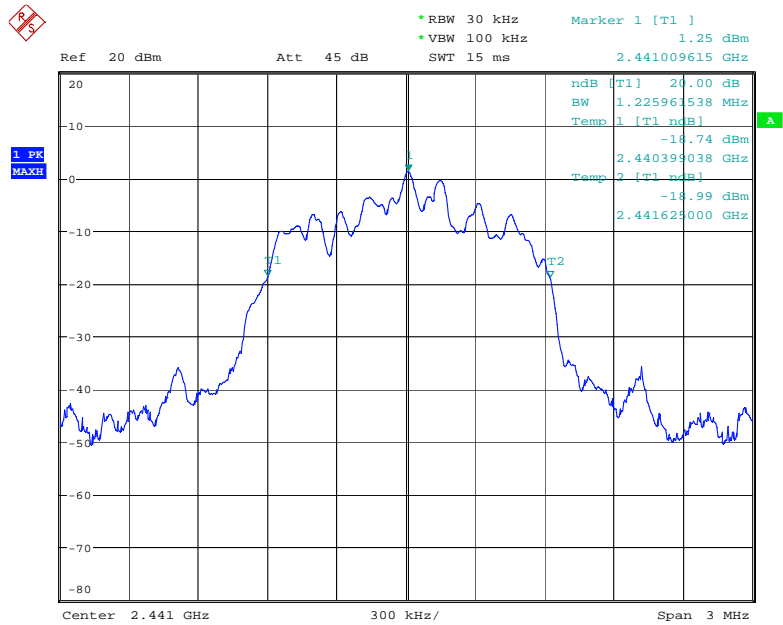
Date: 29.NOV.2017 15:49:01

8DPSK Lowest Channel



Date: 29.NOV.2017 15:50:55

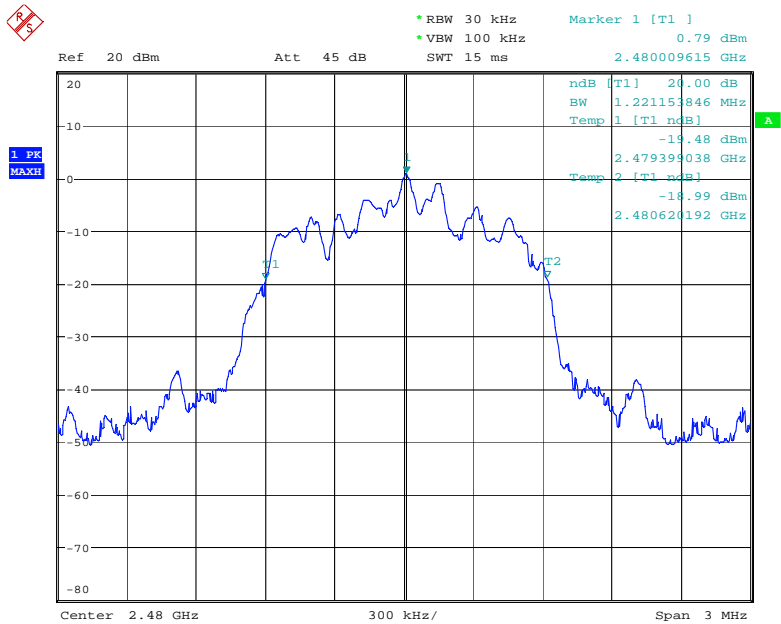
8DPSK Middle Channel



Date: 29.NOV.2017 15:52:31



8DPSK Highest Channel



Date: 29.NOV.2017 15:54:09



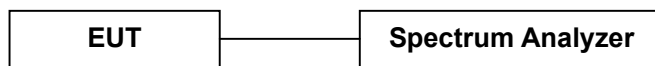
## 7. Hopping Channel Number

### 7.1 Measurement Procedure

Minimum Number of Hopping Frequencies, FCC Rule 15.247(a)(1)(iii):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, and the spectrum analyzer set to MAX HOLD readings were taken for 3-5 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

### 7.2 Test SET-UP (Block Diagram of Configuration)

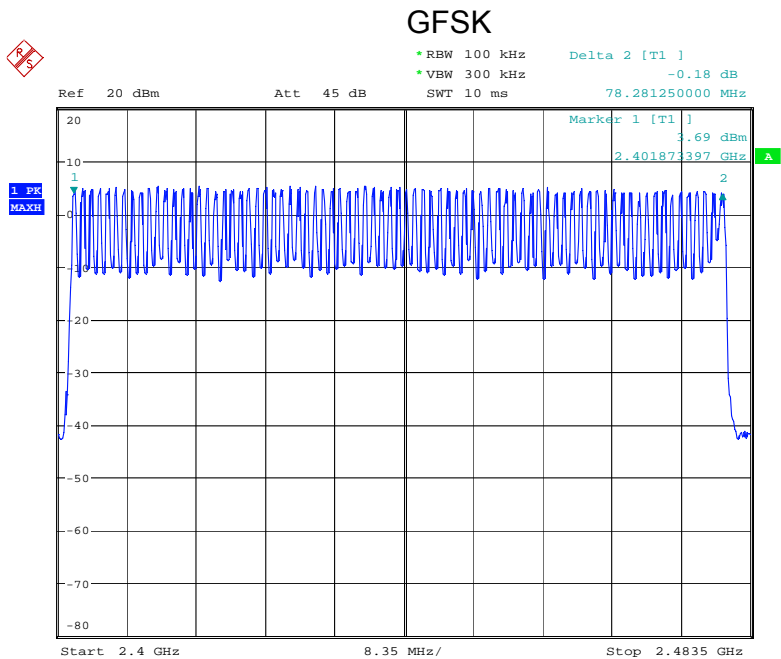


### 7.3 Measurement Results

Modulation	GFSK, $\pi/4$ -DQPSK, 8DPSK		
RBW:	100KHz	VBW:	300KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	November 29, 2017
Temperature :	22 °C	Humidity :	53 %
Test Result:	PASS		

Hopping Channel Frequency Range	Number of Hopping Channels	Limit
2402-2480	79	$\geq 15$

The worst case: GFSK



Date: 29.NOV.2017 17:19:07

## 8. Time of Occupancy (Dwell Time)

### 8.1 Measurement Procedure

Average Channel Occupancy Time, FCC Ref:15.247(a)(1)(iii):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable.

The spectrum analyzer center frequency was set to one of the known hopping channels. The Sweep was set to 10 ms, the SPAN was set to Zero SPAN. The time duration of the transmissions so captured was measured with the Marker Delta function

### 8.2 Measurement Results

The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

Refer to attached data chart.

Modulation :	GFSK, $\pi/4$ -DQPSK, 8DPSK		
RBW :	1MHz	VBW :	3MHz
Spectrum Detector:	PK	Test By:	Sance
Test Date :	November 30, 2017	Temperature :	22°C
Test Result:	PASS	Humidity :	53 %

Packet	Frequency (MHz)	Result (msec)			Limit (msec)
GFSK					
DH1	2402	0.393	$(ms)*(1600/(2*79))*31.6=$	125.76	400
DH3	2402	1.651	$(ms)*(1600/(4*79))*31.6=$	264.16	400
DH5	2402	2.901	$(ms)*(1600/(6*79))*31.6=$	309.44	400
$\pi/4$ -DQPSK					
2-DH1	2402	0.405	$(ms)*(1600/(2*79))*31.6=$	129.60	400
2-DH3	2402	1.679	$(ms)*(1600/(4*79))*31.6=$	268.64	400
2-DH5	2402	2.977	$(ms)*(1600/(6*79))*31.6=$	317.55	400
8DPSK					
3-DH1	2402	0.401	$(ms)*(1600/(2*79))*31.6=$	128.32	400
3-DH3	2402	1.707	$(ms)*(1600/(4*79))*31.6=$	273.12	400
3-DH5	2402	2.921	$(ms)*(1600/(6*79))*31.6=$	311.57	400

Ref 20 dBm Att 45 dB

RBW 1 MHz Marker 1 [T1] -24.77 dBm  
 • VBW 3 MHz 1.414263 ms  
 SWT 2.5 ms

1 PK MAXH

Delta 2 [T1] -6.42 dB  
 392.628205 μs

Center 2.441 GHz 250 μs/

RBW 1 MHz  
 • VEW 3 MHz  
 SWT 5 ms

Delta 2 [T1 ]  
 -11.98 dB  
 1.650641 ms

Ref 20 dBm  
 Att 45 dB

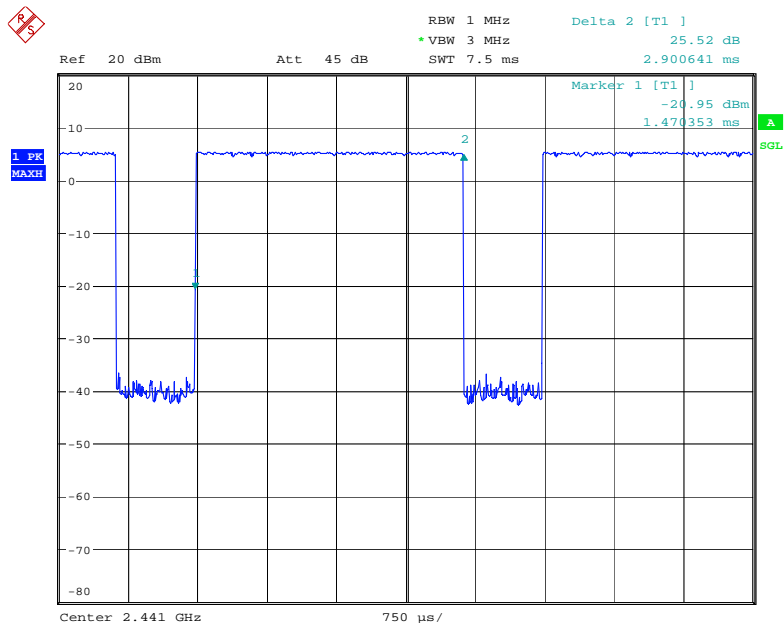
Marker 1 [T1 ]  
 -26.91 dBm  
 2.175481 ms

1. PK  
 MAXH

Center 2.441 GHz  
 500  $\mu$ s/

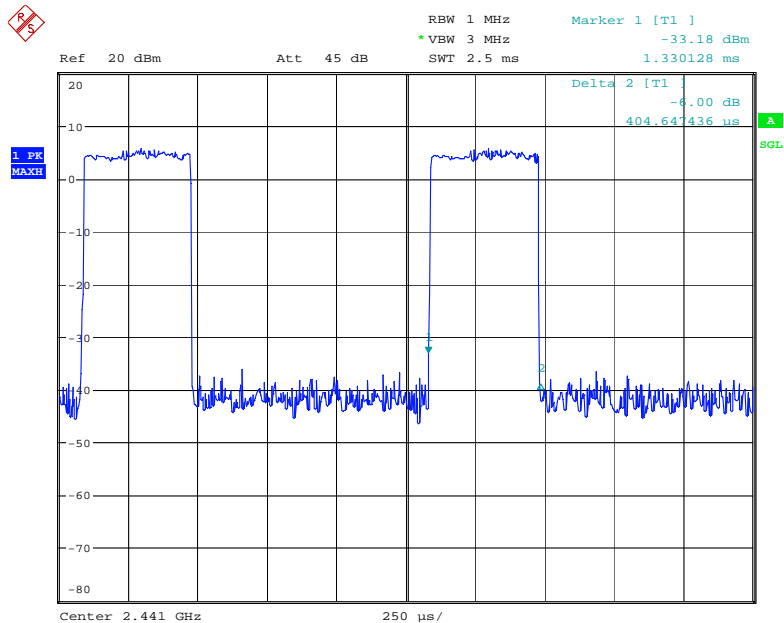
Page 36 of 58

GFSK DH5



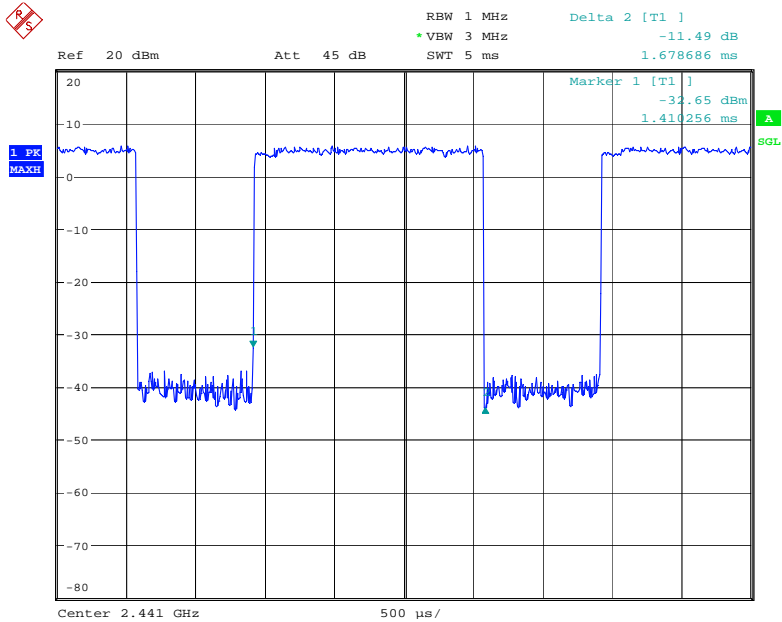
Date: 30.NOV.2017 10:46:52

$\pi/4$ -DQPSK 2-DH1



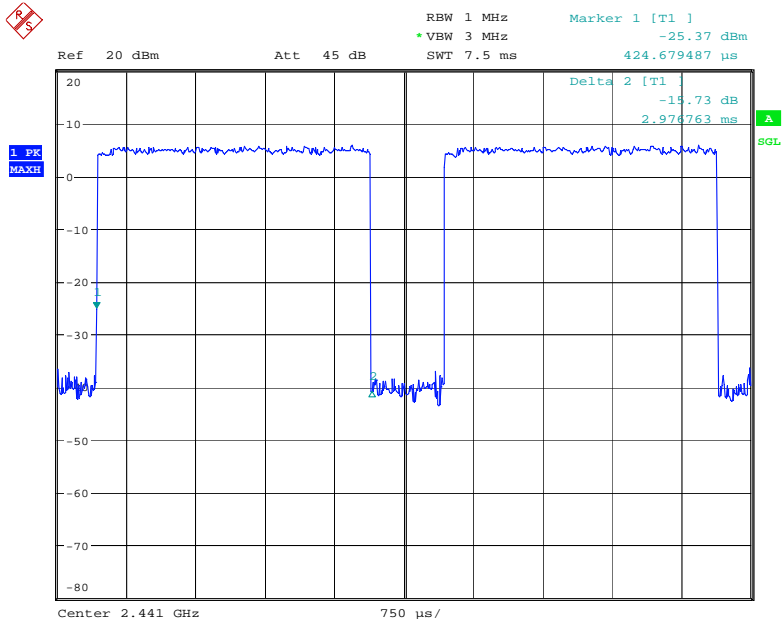
Date: 30.NOV.2017 10:49:24

$\pi/4$ -DQPSK 2-DH3



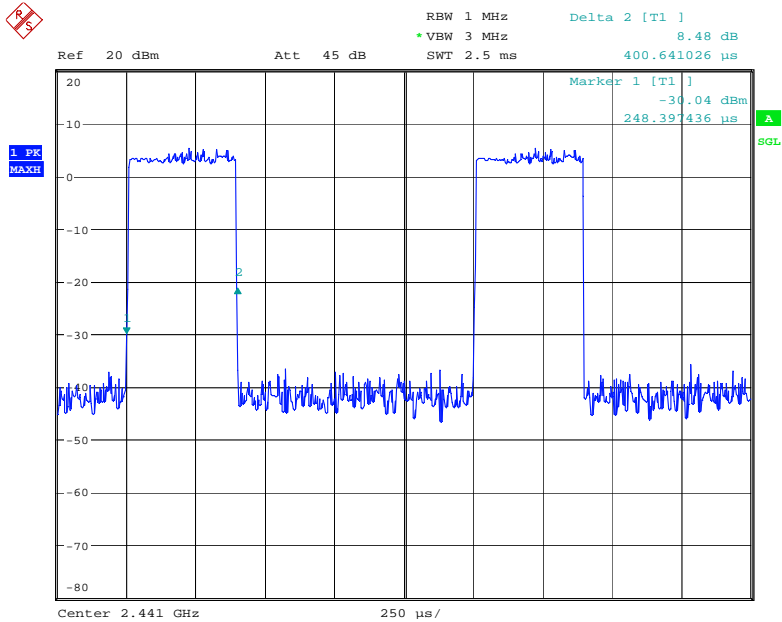
Date: 30.NOV.2017 10:50:17

$\pi/4$ -DQPSK 2-DH5



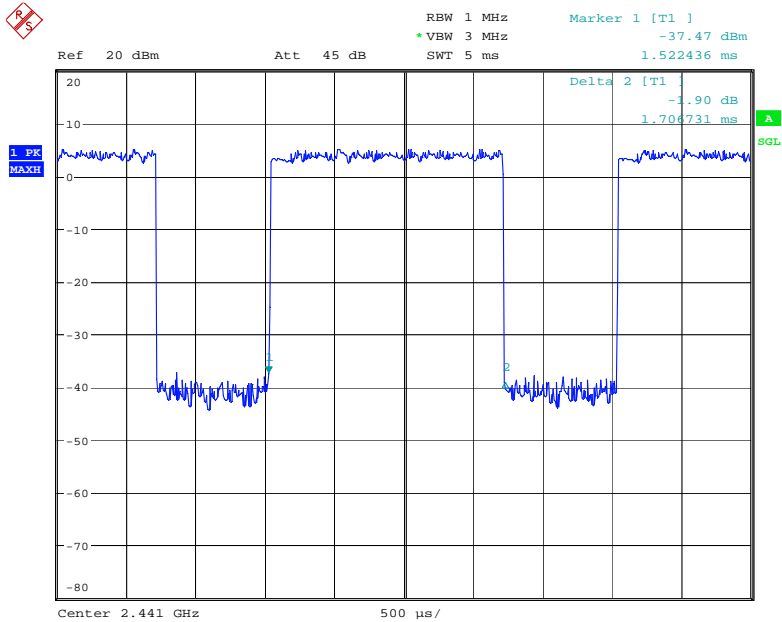
Date: 30.NOV.2017 10:50:59

8DPSK 3-DH1



Date: 30.NOV.2017 10:51:53

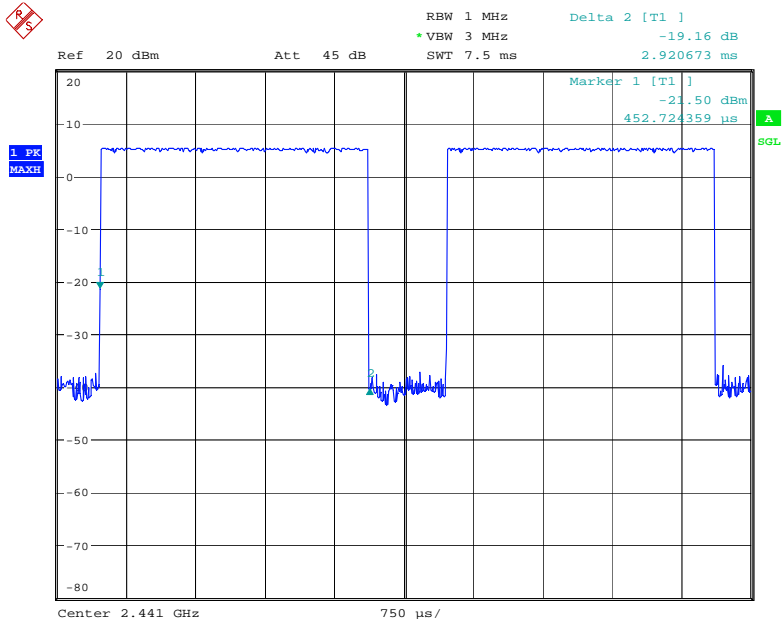
8DPSK 3-DH3



Date: 30.NOV.2017 10:52:36



8DPSK 3-DH5



Date: 30.NOV.2017 10:53:17



## 9. MAXIMUM PEAK OUTPUT POWER

### 9.1 Measurement Procedure

Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm. Cable loss was considered during this measurement.

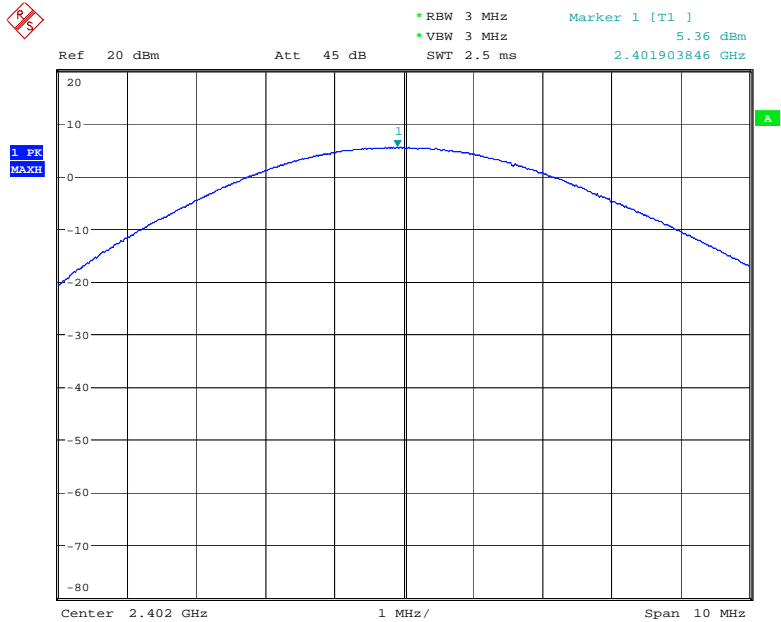
### 9.2 Measurement Results

Refer to attached data chart.

Modulation : GFSK,  $\pi/4$ -DQPSK, 8DPSK  
RBW : 3MHz VBW : 3MHz  
Spectrum Detector: PK Test Date : November 29, 2017  
Test By: Sance Temperature : 22 °C  
Test Result: PASS Humidity : 53 %

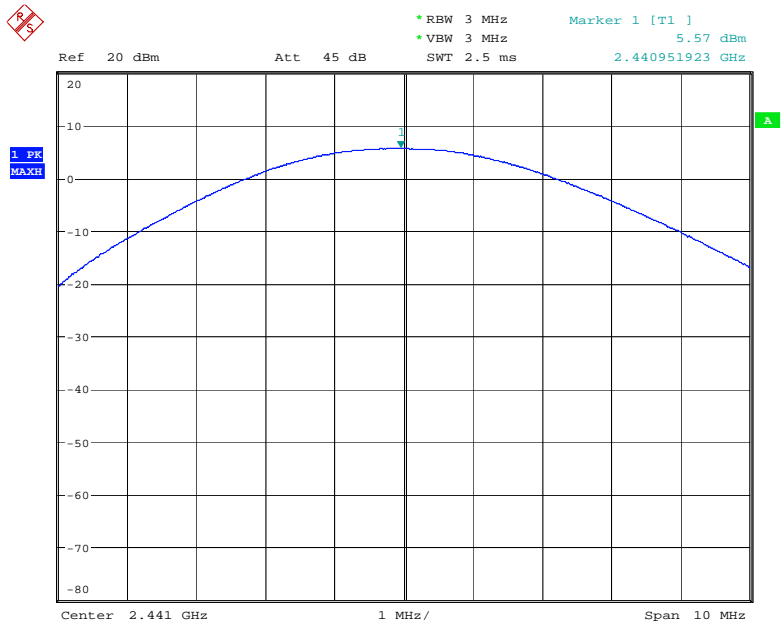
Channel Frequency (MHz)	Cable Loss dB	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(dBm)	Pass/Fail
GFSK					
2402.00	1.5	5.36	3.44	21	PASS
2441.00	1.5	5.57	3.61	21	PASS
2480.00	1.5	5.05	3.20	21	PASS
$\pi/4$ -DQPSK					
2402.00	1.5	6.29	4.26	21	PASS
2441.00	1.5	6.53	4.50	21	PASS
2480.00	1.5	6.12	4.09	21	PASS
8DPSK					
2402.00	1.5	5.55	3.59	21	PASS
2441.00	1.5	5.78	3.78	21	PASS
2480.00	1.5	5.30	3.39	21	PASS

GFSK Lowest Channel



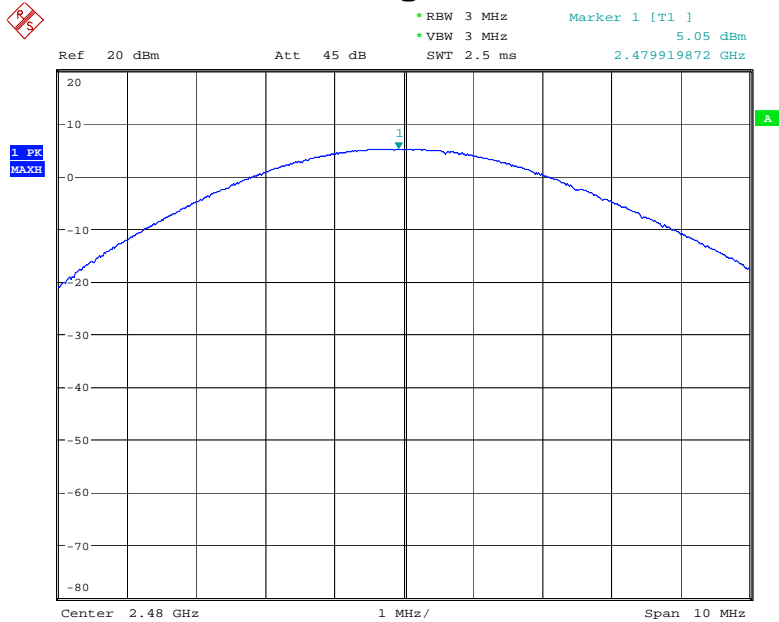
Date: 29.NOV.2017 15:54:44

GFSK Middle Channel



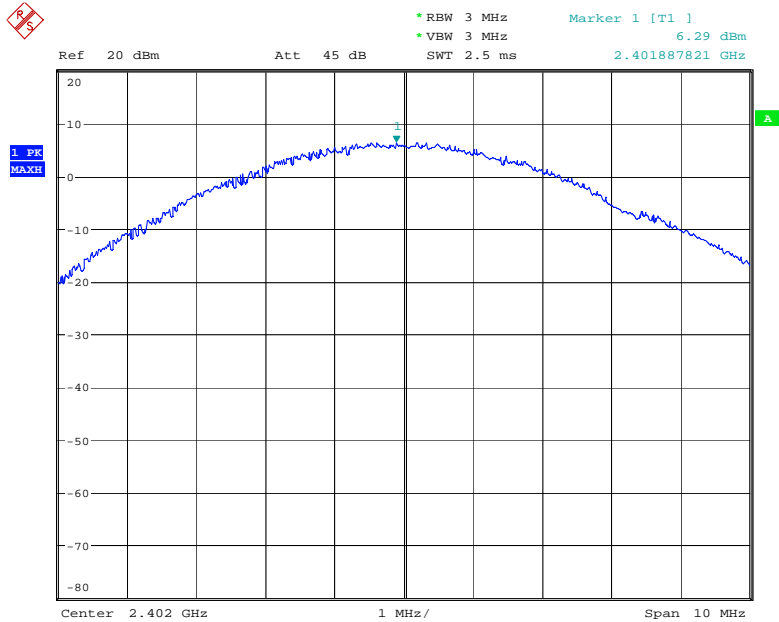
Date: 29.NOV.2017 15:55:19

GFSK Highest Channel



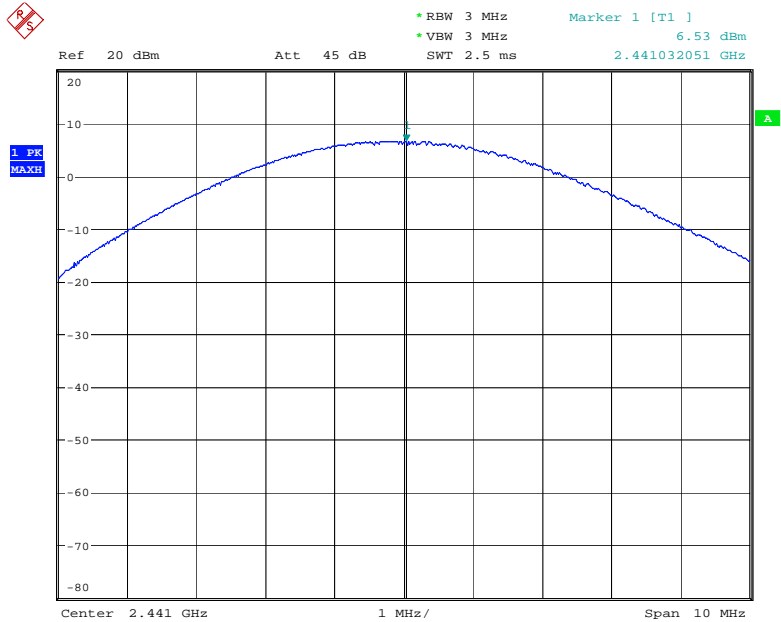
Date: 29.NOV.2017 15:55:34

$\pi/4$ -DQPSK Lowest Channel



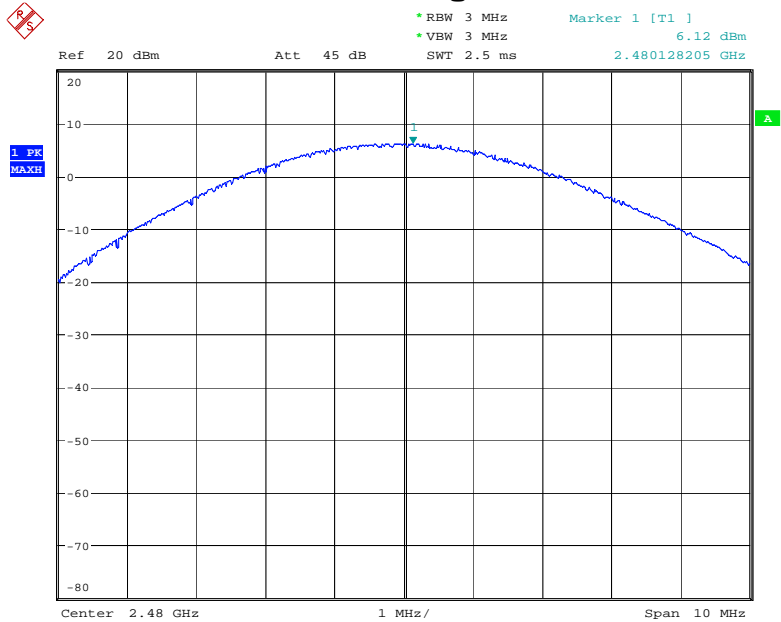
Date: 29.NOV.2017 15:55:49

$\pi/4$ -DQPSK Middle Channel



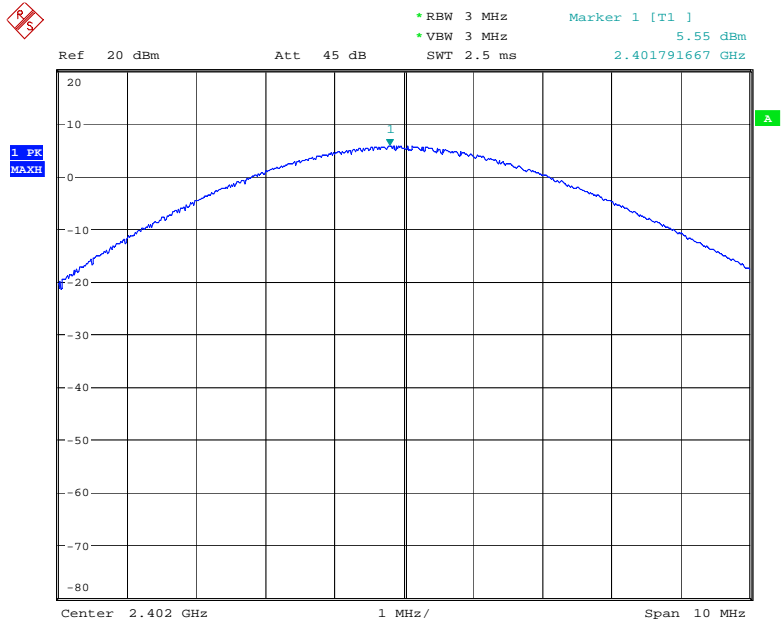
Date: 29.NOV.2017 15:56:21

$\pi/4$ -DQPSK Highest Channel



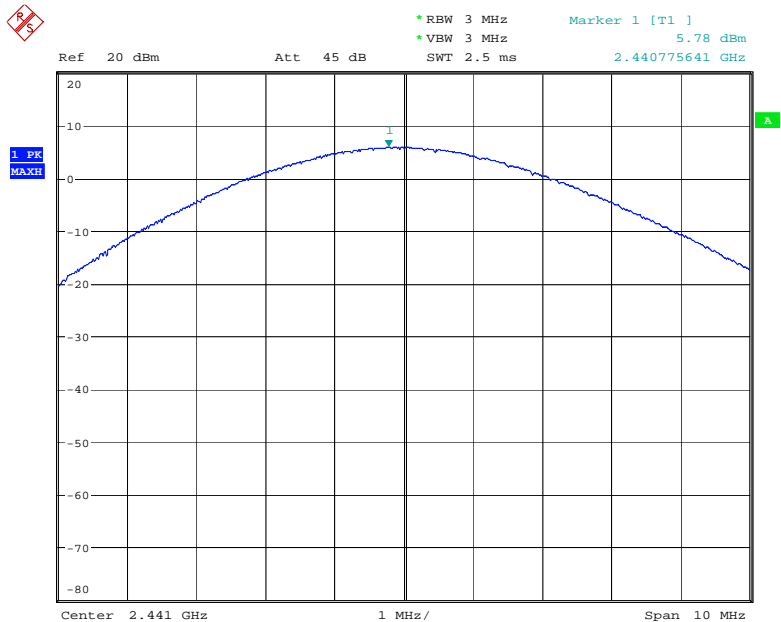
Date: 29.NOV.2017 15:57:04

8DPSK Lowest Channel



Date: 29.NOV.2017 15:57:59

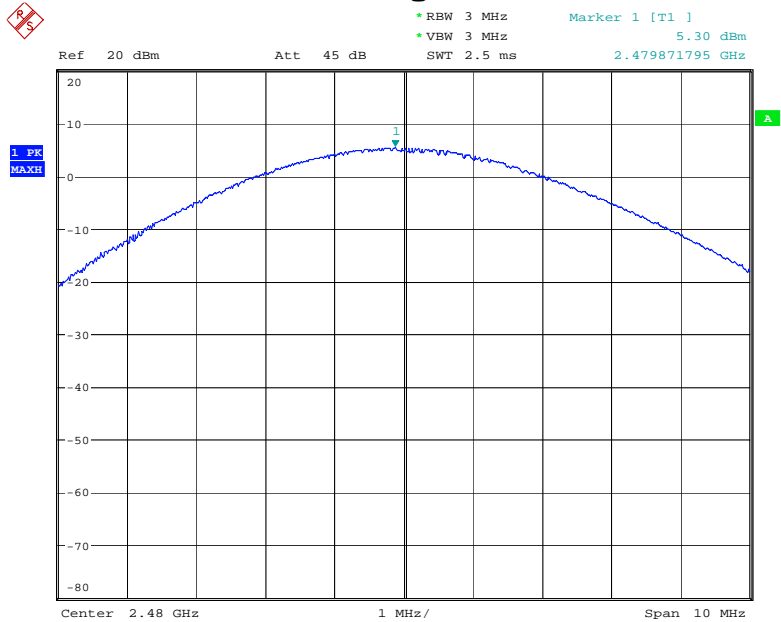
8DPSK Middle Channel



Date: 29.NOV.2017 15:58:21



8DPSK Highest Channel



Date: 29.NOV.2017 15:59:15

## 10. Band Edge

### 10.1 Measurement Procedure

Out of Band Conducted Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. The resolution bandwidth is set to 100KHz, and the video bandwidth set to 300KHz.

### 10.2 Limit

15.247(d) In any 100KHz 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 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### 10.3 Measurement Results

Please see below test table and plots.

For Radiated Emission

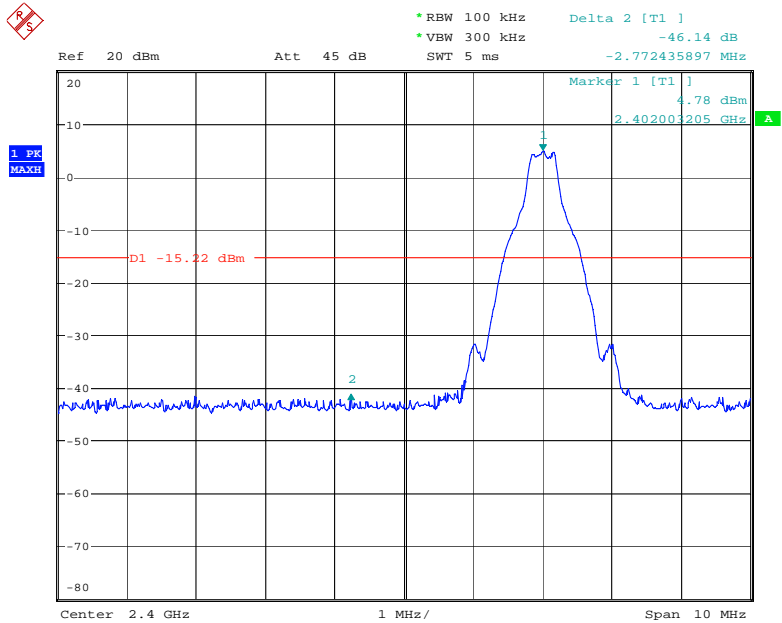
The worst case:  $\pi/4$ -DQPSK

Freq. (MHz)	Ant.Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV)		Limit 3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
2390.000	H	60.43	48.82	0.13	60.56	48.95	74.00	54.00	-13.44	-5.05
2390.000	V	56.20	43.05	0.13	56.33	43.18	74.00	54.00	-17.67	-10.82
2483.500	H	52.33	40.14	0.35	52.68	40.49	74.00	54.00	-21.32	-13.51
2483.500	V	52.22	41.48	0.35	52.57	41.83	74.00	54.00	-21.43	-12.17

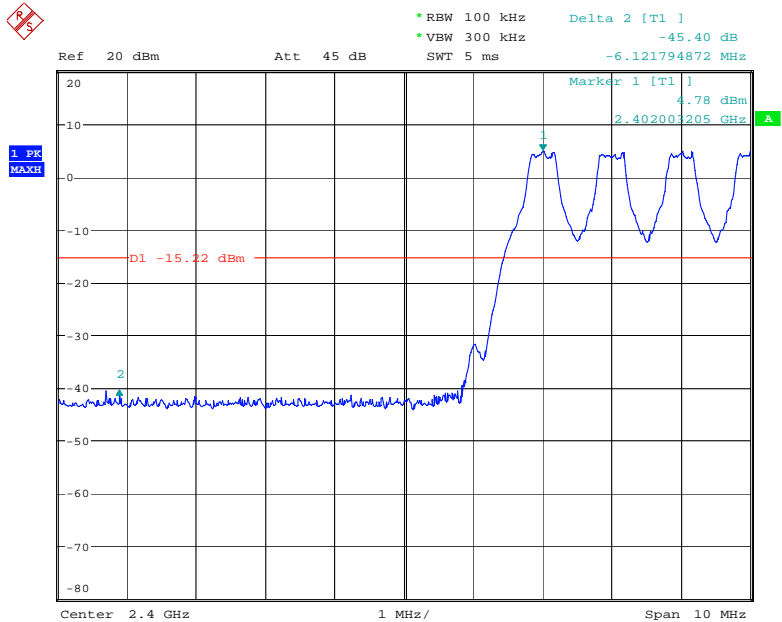
- Note:**
- (1) Emission Level= Reading Level + Factor
  - (2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
  - (3) Horn antenna used for the emission over 1000MHz.

For RF Conducted

GFSK Lowest Channel



Date: 29.NOV.2017 16:45:04

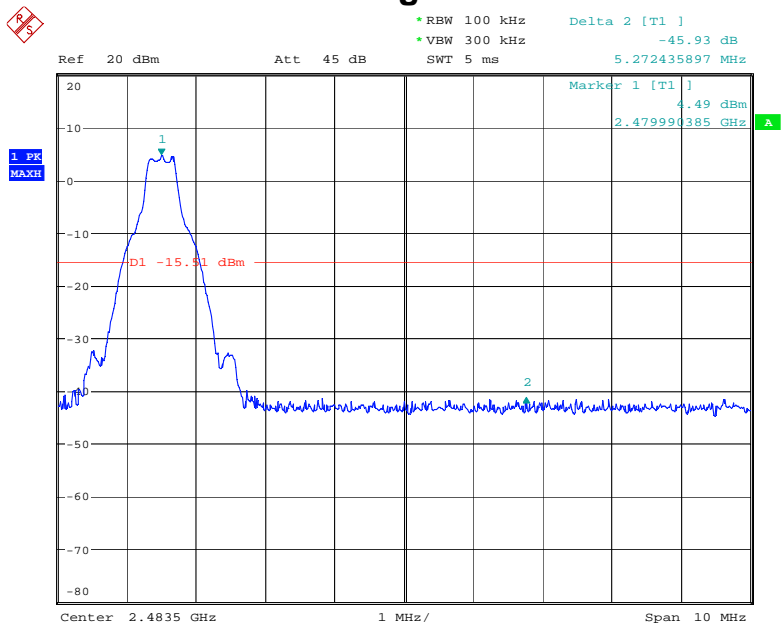


Date: 29.NOV.2017 16:46:08

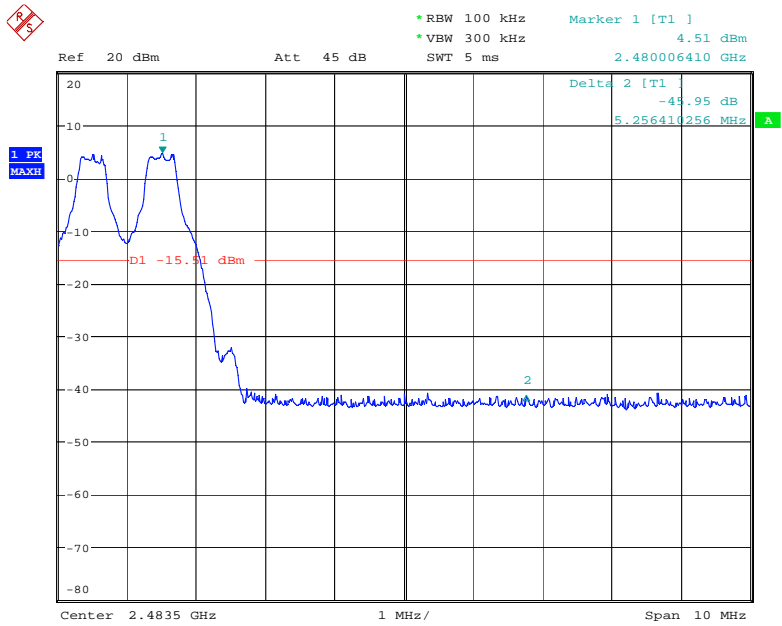




GFSK Highest Channel

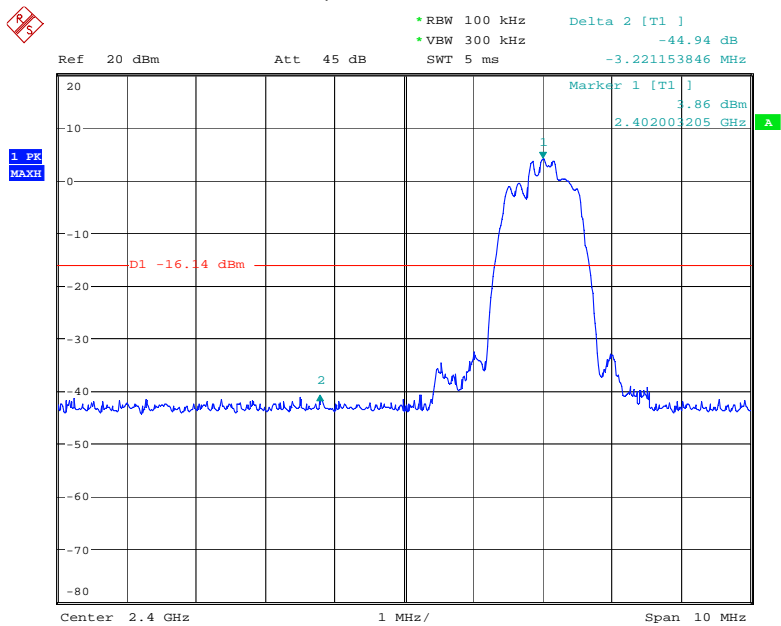


Date: 29.NOV.2017 16:46:49

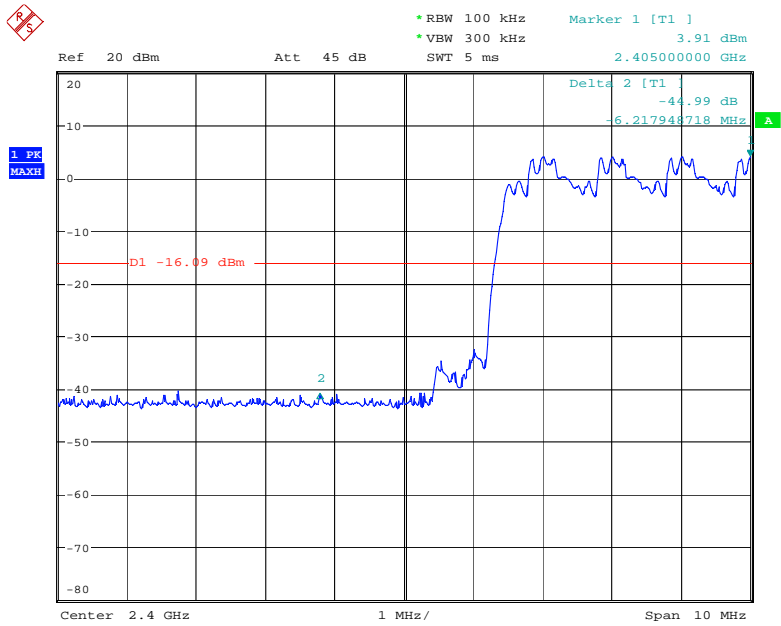


Date: 29.NOV.2017 16:47:30

$\pi/4$ -DQPSK Lowest Channel



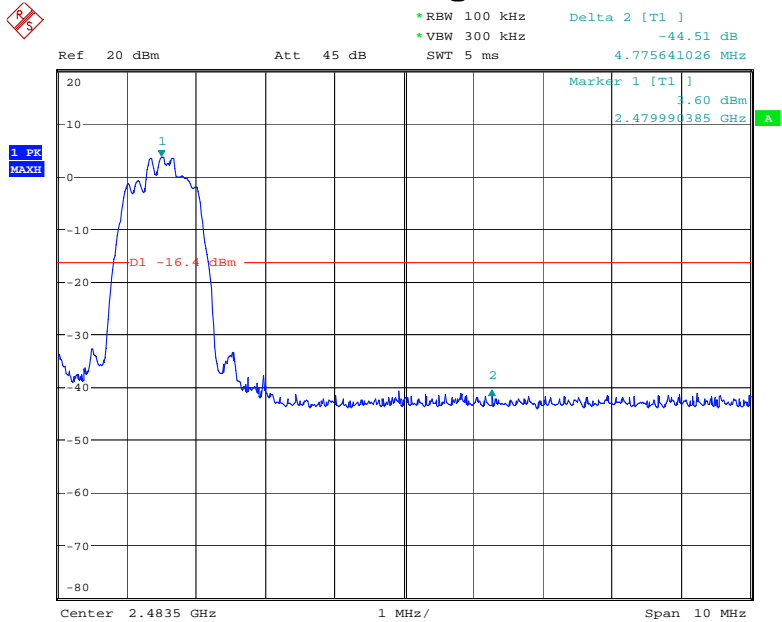
Date: 29.NOV.2017 16:48:43



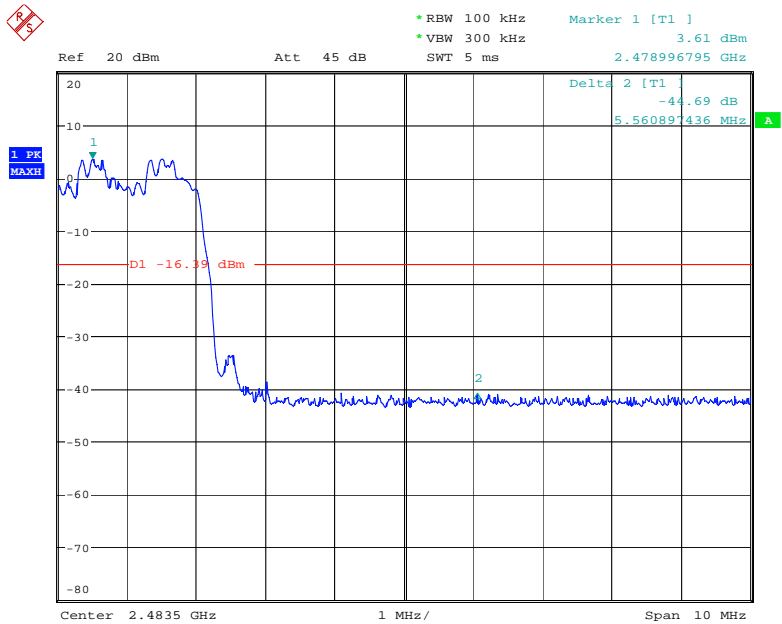
Date: 29.NOV.2017 16:50:50



$\pi/4$ -DQPSK Highest Channel

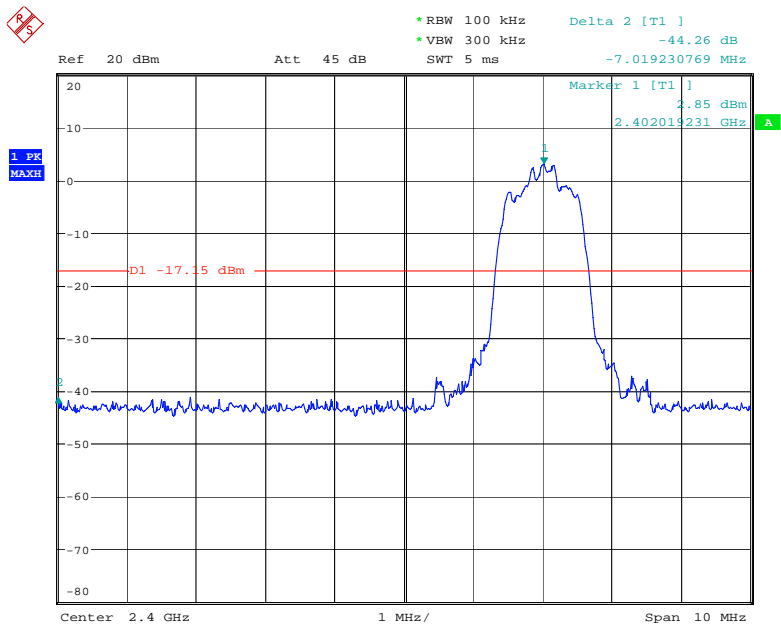


Date: 29.NOV.2017 16:53:57

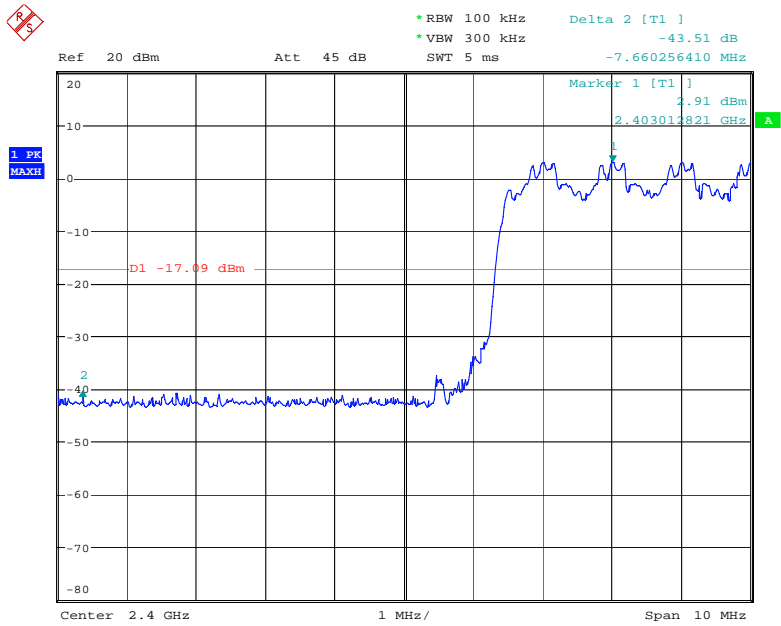


Date: 29.NOV.2017 16:53:00

8DPSK Lowest Channel

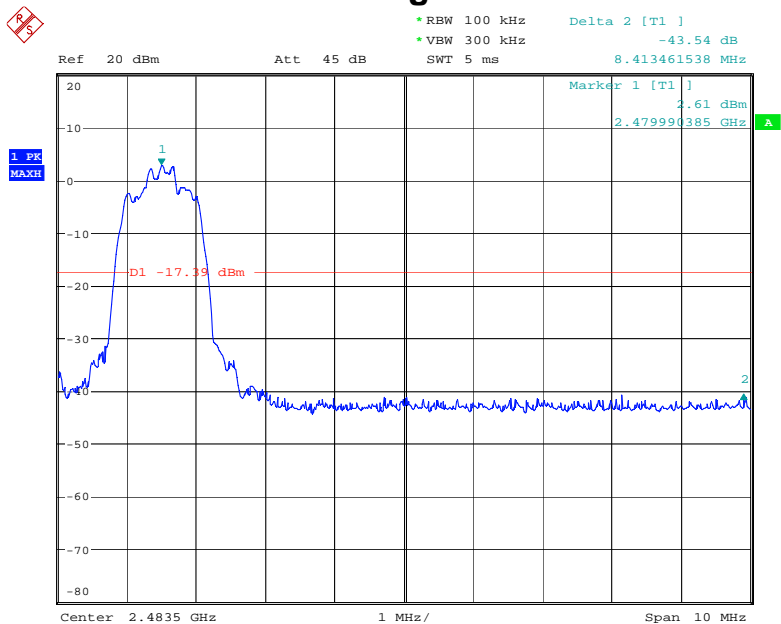


Date: 29.NOV.2017 16:54:51

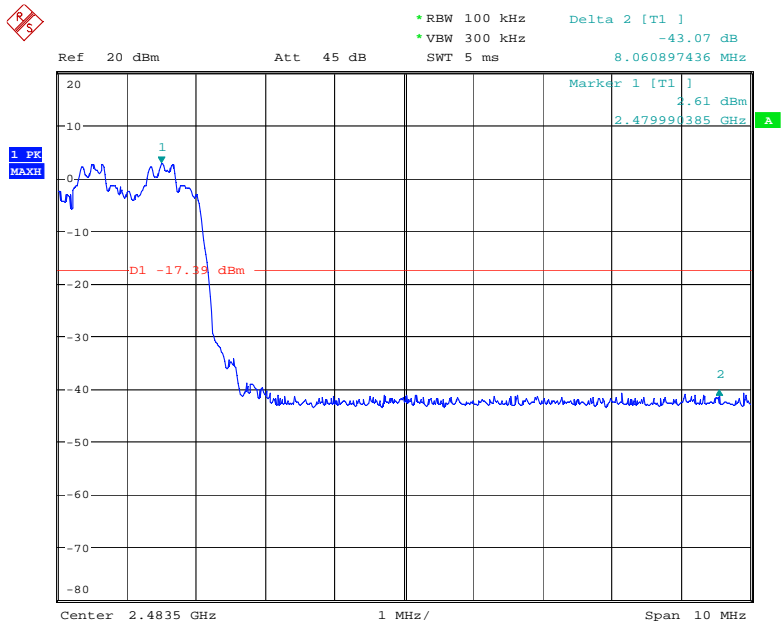


Date: 29.NOV.2017 16:57:14

8DPSK Highest Channel



Date: 29.NOV.2017 16:58:00



Date: 29.NOV.2017 16:59:05

## **11. Antenna Application**

### **11.1 Antenna requirement**

According to of FCC part 15C section 15.203 and 15.240:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

### **11.2 Measurement Results**

The antenna is PIFA antenna that no antenna other than furnished by the responsible party shall be used with the device, and the best case gain of the antenna is 0.38dBi, So, the antenna is consider meet the requirement.

## 12. Conducted Spurious Emissions

### 12.1 Measurement Procedure

Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20dB below the highest level of the desired power in the passband.

### 12.2. Measurement Results

Please refer to following plots, the worst case ( $\pi/4$ -DQPSK) was shown.

1 PK  
MAXH

Ref 20 dBm Att 45 dB

RBW 100 kHz Delta 2 [T1] -41.05 dB  
VBW 300 kHz  
SWT 2.5 s 21.653151667 GHz

Marker 1 [T1]  
3.77 dBm  
2.402150000 GHz

D1 -16.44 dBm

2

Start 30 MHz 2.497 GHz/ Stop 25 GHz

\*RBW 100 kHz  
 \*VBW 300 kHz  
 \*SWT 2.5 s

Delta 2 [T1 ]  
 -41.30 dB  
 22.260755000 GHz

Ref 20 dBm  
 Att 45 dB

Marker 1 [T1 ]  
 3.89 dBm  
 2.441263667 GHz

1 PK  
 MAXH

D1 -16.11 dBm

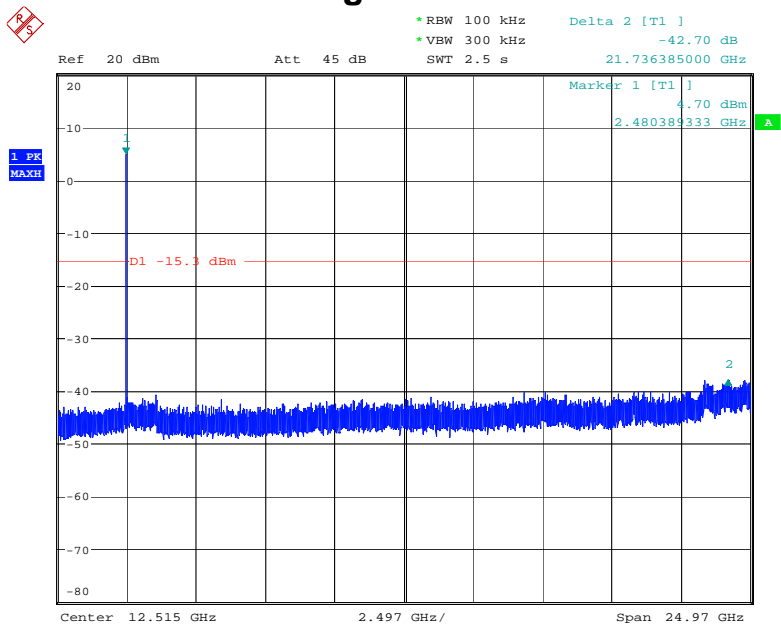
Start 30 MHz  
 2.497 GHz/  
 Stop 25 GHz

Page 56 of 58





Highest Channel



Date: 29.NOV.2017 17:03:56

Note: Sweep points=30001pts

### 13. Test Equipment List

Description	Manufacturer	Model Number	Serial Number	Characteristics	Calibration Date	Calibration Due Date
Test Receiver	Rohde & Schwarz	ESCI7	100837	9KHz~7GHz	Mar. 14, 2017	Mar. 13, 2018
Antenna	Schwarzbeck	VULB9162	9162-010	30MHz~7GHz	Mar. 15, 2017	Mar. 14, 2018
Cable	Huber+Suhner	CBL2-NN-1M	22390001	9KHz~7GHz	Mar. 14, 2017	Mar. 13, 2018
Cable	Huber+Suhner	CIL02	N/A	9KHz~7GHz	Mar. 14, 2017	Mar. 13, 2018
RF Cable	Huber+Suhner	SF-104	MY16559/4	9KHz~25GHz	Apr. 25, 2017	Apr. 25, 2018
Power Amplifier	HP	HP 8447D	1145A00203	100KHz~1.3GHz	Mar. 14, 2017	Mar. 13, 2018
Horn Antenna	Schwarzbeck	BBHA9170	9170-242	15GHz~40GHz	Mar. 14, 2017	Mar. 13, 2018
Horn Antenna	Com-Power	AH-118	071078	1GHz~18GHz	Mar. 15, 2017	Mar. 14, 2018
RF Cable	Huber+Suhner	SF-104	N/A	9KHz~40GHz	Apr. 25, 2017	Apr. 24, 2018
Loop antenna	Daze	ZA30900A	0708	9KHz~30MHz	Apr. 25, 2017	Apr. 24, 2018
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	20Hz~26.5GHz	Apr. 25, 2017	Apr. 24, 2018
Spectrum Analyzer	Rohde & Schwarz	FSV40	101003	10Hz~40GHz	April. 06, 2017	April. 05, 2018
Pre-Amplifier	EMCI	EMC 184045	980102	18GHz~40GHz	Nov. 03, 2017	Nov. 02, 2018
Pre-Amplifier	Agilent	8449B	3008A02964	1GHz~26.5GHz	Apr. 25, 2017	Apr. 24, 2018
L.I.S.N.	Rohde & Schwarz	ENV 216	101317	9KHz~30MHz	Mar. 14, 2017	Mar. 13, 2018
Temporary antenna connector	TESCOM	SS402	N/A	9KHz-25GHz	N/A	N/A
Power Meter	Anritsu	ML2495A	1139001	100k-65GHz	Nov. 03, 2017	Nov. 02, 2018
Power Sensor	Anritsu	MA2411B	100345	300M-40GHz	Nov. 03, 2017	Nov. 02, 2018

Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

---End---