

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 : CHUNGHSIN INTERNATIONAL ELECTRONICS CO.,LTD
Address : 618 GONGREN WEST ROAD,JIAOJIANG AREA, TAIZHOU, China
Manufacturer /Factory : CHUNGHSIN INTERNATIONAL ELECTRONICS CO.,LTD
Address : 618 GONGREN WEST ROAD,JIAOJIANG AREA, TAIZHOU, China
E.U.T. : Ultrabook
Brand Name : N/A
Model No. : HN4P402, N1405A-H
FCC ID : 2A15MN1405A-H
Measurement Standard : FCC PART 15.247
Date of Receiver : November 10, 2017
Date of Test : November 10, 2017 to November 24, 2017
Date of Report : November 25, 2017

This Test Report is Issued Under the Authority of :

Prepared by



Rose Hu / 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

1. GENERAL INFORMATION	5
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
2. SYSTEM TEST CONFIGURATION.....	11
2.1 EUT CONFIGURATION	11
2.2 SPECIAL ACCESSORIES.....	11
2.3 DESCRIPTION OF TEST MODES	11
2.4 EUT EXERCISE	11
3. CONDUCTED EMISSIONS TEST	12
3.1 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	12
3.2 TEST CONDITION	12
3.3 MEASUREMENT RESULTS.....	12
4. RADIATED EMISSION TEST	15
4.1 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	15
4.2 MEASUREMENT PROCEDURE	16
4.3 LIMIT	16
4.4 MEASUREMENT RESULTS	17
5. CHANNEL SEPARATION TEST.....	21
5.1 MEASUREMENT PROCEDURE	21
5.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	21
5.3 MEASUREMENT RESULTS.....	21
6. 20DB BANDWIDTH.....	27
6.1 MEASUREMENT PROCEDURE	27
6.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	27
6.3 MEASUREMENT RESULTS.....	27
7. HOPPING CHANNEL NUMBER	33
7.1 MEASUREMENT PROCEDURE	33
7.2 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION).....	33
7.3 MEASUREMENT RESULTS.....	33

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

Revision History of This Test Report

Report Number	Description	Issued Date
NTC1711190FV00	Initial Issue	2017-11-25

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test

Product Name	: Ultrabook
Main Model Name	: HN4P402
Additional Model Name	: N1405A-H
Model difference	: Both of models have the same circuitry, electrical mechanical, PCB Layout and physical construction. Their difference in model number due to trading purpose.
Brand Name	: N/A
Power Supply	: 1. DC 12V 2.0A 24W 2. DC 7.6V Built-in Li-ion battery
Adapter	: Manufacturer :BSY M/N: BSYF120200U W Input: AC 100-240V 50/60Hz 1A Output: DC 12V 2A
Test voltage	: AC 120V 60Hz, AC 240V/60Hz, DC 7.6V(Built-in battery) Only the worst case AC 120V 60Hz was recorded.
Hardware version	: V10
Software version	: Windows10 home
Serial number	: N/A
Note	: According to the model difference, all tests performed on model HN4P402.

Technical parameters

Bluetooth Version	: V4.2
Frequency Range	: 2402-2480MHz
Modulation	: GFSK, π 4/-DQPSK, 8DPSK
Number of Channel	: 79
Channel space	: 1MHz
Date Rate	: 1Mbps for GFSK 2Mbps for π 4/-DQPSK 3Mbps for 8DPSK
Antenna Type	: Integral
Antenna Gain	: 1.82dBi

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	DRTU - Diagnostics and Regulatory Testing Utility
-----------------	---

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: **2AI5MN1405A-H** 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

N/A

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

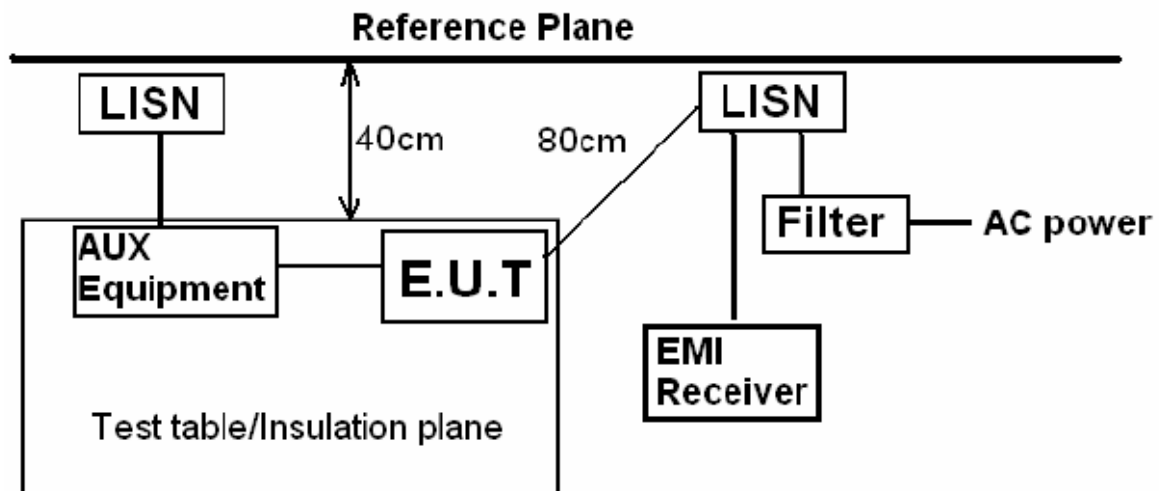
The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3 and DH5 mode in all modulation type GFSK, $\pi/4$ -DQPSK,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

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

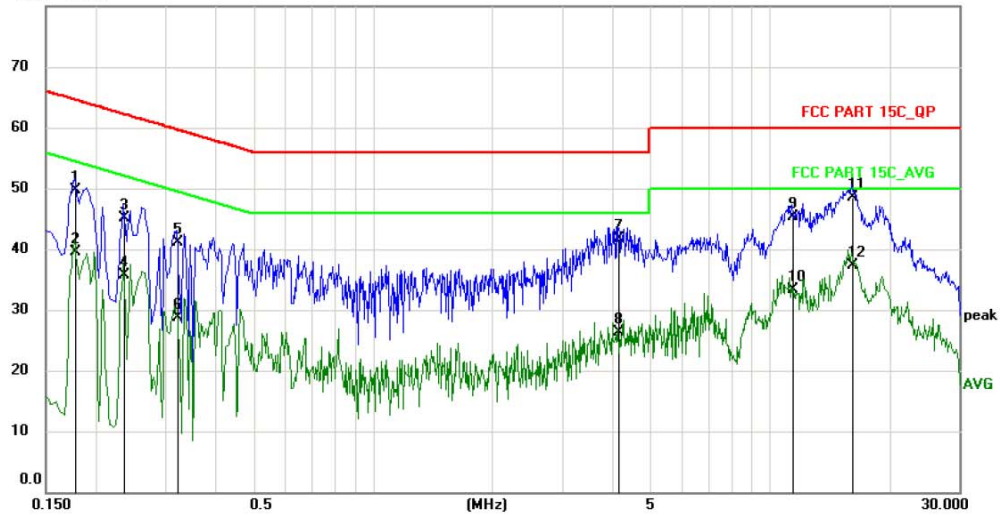
File :HN4P402

Data :#17

Date: 2017-11-23

Time: 16:52:14

80.0 dBuV



Site

Phase: **N**

Temperature: 26

Limit: FCC PART 15C_QP

Power: AC 120V/60Hz

Humidity: 53 %

EUT: Ultrabook

M/N: HN4P402

Mode: Charging +BT Mode (BDR+EDR)

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.1768	38.90	10.80	49.70	64.63	-14.93	QP	
2		0.1768	28.70	10.80	39.50	54.63	-15.13	AVG	
3		0.2354	34.40	10.80	45.20	62.26	-17.06	QP	
4		0.2354	24.90	10.80	35.70	52.26	-16.56	AVG	
5		0.3209	30.30	10.80	41.10	59.68	-18.58	QP	
6		0.3209	17.90	10.80	28.70	49.68	-20.98	AVG	
7		4.1459	31.00	10.80	41.80	56.00	-14.20	QP	
8		4.1459	15.50	10.80	26.30	46.00	-19.70	AVG	
9		11.4000	34.50	10.80	45.30	60.00	-14.70	QP	
10		11.4000	22.50	10.80	33.30	50.00	-16.70	AVG	
11	*	16.0844	37.80	10.80	48.60	60.00	-11.40	QP	
12		16.0844	26.60	10.80	37.40	50.00	-12.60	AVG	

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

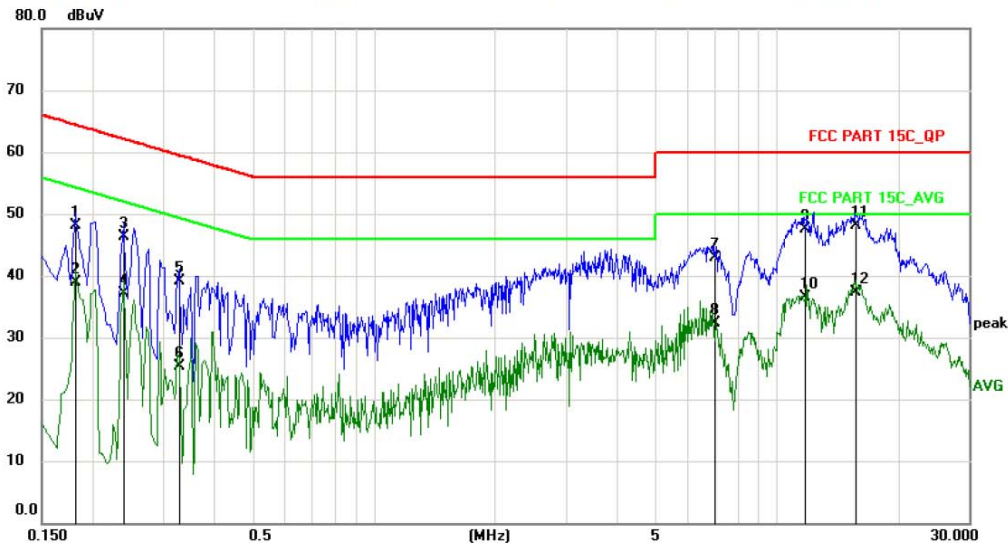
◁Reference Only



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

Conducted Emission Measurement

File :HN4P402 Data :#18 Date: 2017-11-23 Time: 16:59:50



Site: Phase: **L1** Temperature: 26
Limit: FCC PART 15C_QP Power: AC 120V/60Hz Humidity: 53 %
EUT: Ultrabook
M/N: HN4P402
Mode: Charging +BT Mode (BDR+EDR)
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.1815	37.40	10.80	48.20	64.42	-16.22	QP	
2		0.1815	28.10	10.80	38.90	54.42	-15.52	AVG	
3		0.2400	35.60	10.80	46.40	62.10	-15.70	QP	
4		0.2400	26.30	10.80	37.10	52.10	-15.00	AVG	
5		0.3300	28.30	10.80	39.10	59.45	-20.35	QP	
6		0.3300	14.50	10.80	25.30	49.45	-24.15	AVG	
7		7.0170	32.10	10.80	42.90	60.00	-17.10	QP	
8		7.0170	21.50	10.80	32.30	50.00	-17.70	AVG	
9		11.7285	36.70	10.80	47.50	60.00	-12.50	QP	
10		11.7285	25.80	10.80	36.60	50.00	-13.40	AVG	
11	*	15.6705	37.40	10.80	48.20	60.00	-11.80	QP	
12		15.6705	26.50	10.80	37.30	50.00	-12.70	AVG	

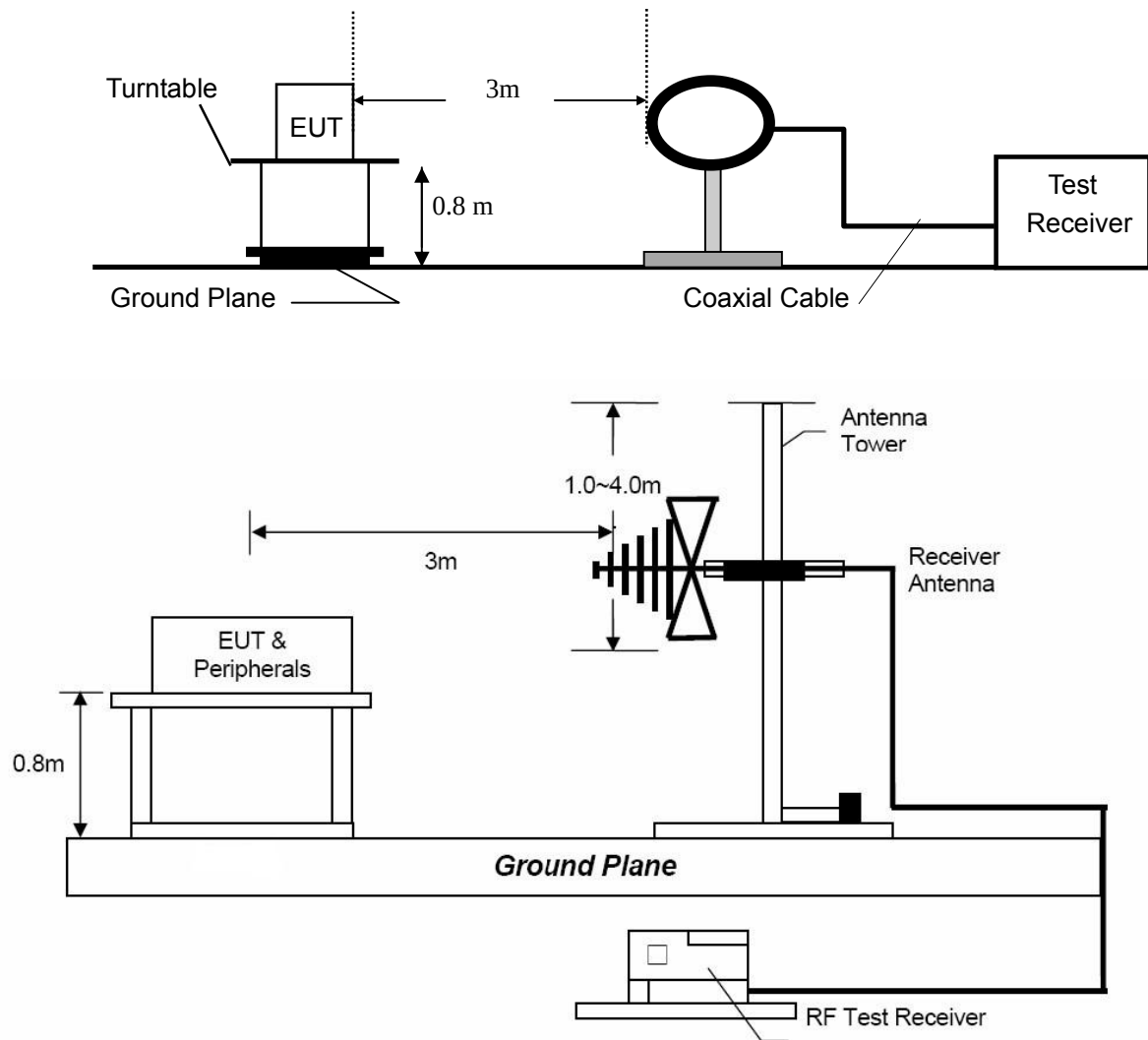
*:Maximum data x:Over limit !:over margin

(Reference Only)

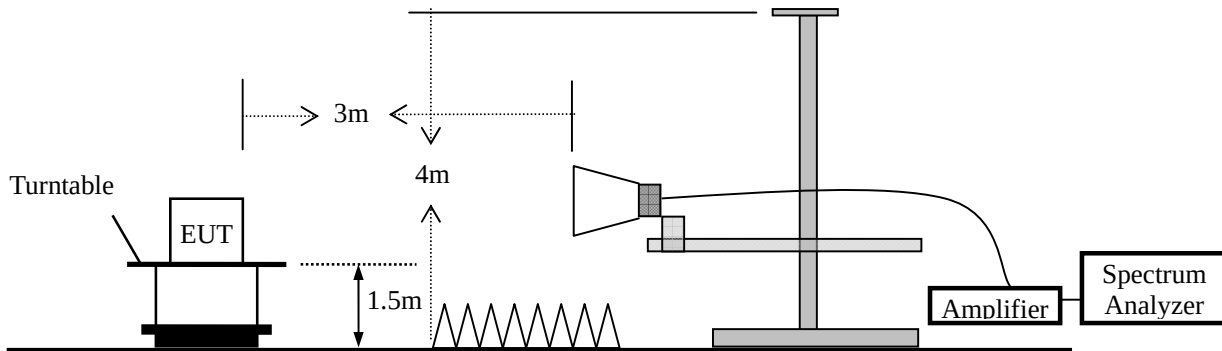
4. Radiated Emission Test

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
	PK detector for AV value	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 (GFSK).



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

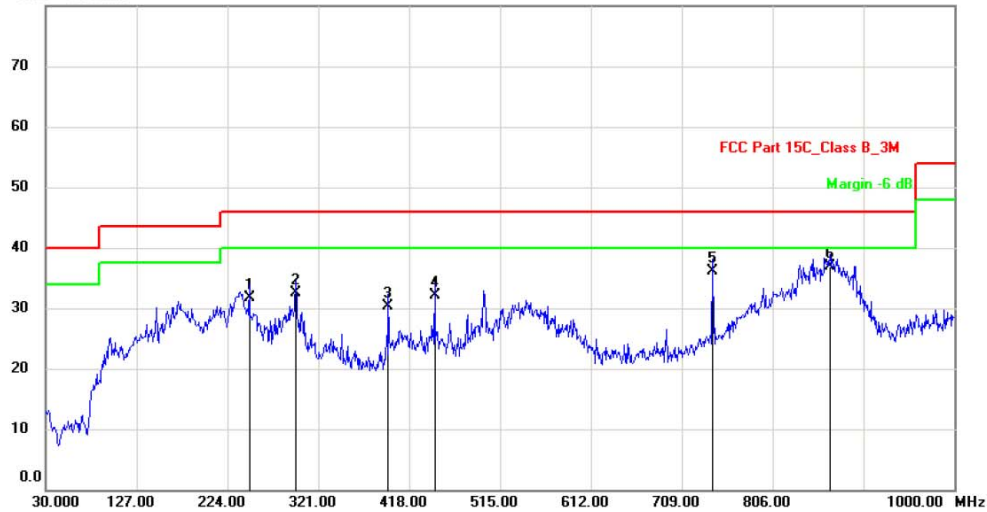
Radiated Emission Measurement

File : HN4P402
80.0 dBuV/m

Data : #10

Date: 2017-11-21

Time: 19:02:17



Site
Limit: FCC Part 15C_Class B_3M
EUT: Ultrabook
M/N: HN4P402
Mode: Charging + BT Mode(BDR+EDR)
Note:

Polarization: **Horizontal** Temperature: 24
Power: AC 120V/60Hz Humidity: 47 %
Distance: 3m

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		247.2800	43.59	-11.79	31.80	46.00	-14.20	QP		
2		296.7500	43.16	-10.56	32.60	46.00	-13.40	QP		
3		395.6899	39.43	-9.13	30.30	46.00	-15.70	QP		
4		445.1600	40.28	-8.08	32.20	46.00	-13.80	QP		
5		741.9800	38.88	-2.78	36.10	46.00	-9.90	QP		
6	*	867.1100	38.02	-1.12	36.90	46.00	-9.10	QP		

*:Maximum data x:Over limit !: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>

Radiated Emission Measurement

File : HN4P402
80.0 dBuV/m

Data : #11

Date: 2017-11-21

Time: 19:11:10



Site
Limit: FCC Part 15C_Class B_3M
EUT: Ultrabook
M/N: HN4P402
Mode: Charging + BT Mode(BDR+EDR)
Note:

Polarization: **Vertical**
Power: AC 120V/60Hz
Distance: 3m
Temperature: 24
Humidity: 47 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree degree	Comment
1		32.9099	46.07	-15.67	30.40	40.00	-9.60	QP		
2		178.4099	41.85	-17.25	24.60	43.50	-18.90	QP		
3		296.7500	39.76	-12.56	27.20	46.00	-18.80	QP		
4		561.5599	41.46	-8.16	33.30	46.00	-12.70	QP		
5		741.9800	37.68	-2.78	34.90	46.00	-11.10	QP		
6	*	864.2000	40.21	-1.11	39.10	46.00	-6.90	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 21, 2017
Test Result: PASS Temperature : 24 °C
Measured Distance: 3m Humidity : 47 %
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	46.45	34.08	6.30	52.75	40.38	74.00	54.00	-21.25	-13.62
7206	V	45.92	34.24	10.44	56.36	44.68	74.00	54.00	-17.64	-9.32

4804	H	45.21	33.08	6.30	51.51	39.38	74.00	54.00	-22.49	-14.62
7206	H	35.18	35.28	10.44	45.62	45.72	74.00	54.00	-28.38	-8.28

Operation Mode: TX Mode (Mid)										
4882	V	46.18	33.52	6.60	52.78	40.12	74.00	54.00	-21.22	-13.88
7323	V	45.79	34.03	10.55	56.34	44.58	74.00	54.00	-17.66	-9.42

4882	H	46.07	33.63	6.60	52.67	40.23	74.00	54.00	-21.33	-13.77
7323	H	46.14	33.97	10.55	56.69	44.52	74.00	54.00	-17.31	-9.48

Operation Mode: TX Mode (High)										
4960	V	45.65	33.79	6.89	52.54	40.68	74.00	54.00	-21.46	-13.32
7440	V	45.12	32.98	10.60	55.72	43.58	74.00	54.00	-18.28	-10.42

4960	H	45.29	33.63	6.89	52.18	40.52	74.00	54.00	-21.82	-13.48
7440	H	44.89	32.73	10.60	55.49	43.33	74.00	54.00	-18.51	-10.67

- 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 : ± 3.7 dB.
 - (6) Horn antenna used for the emission over 1000MHz.

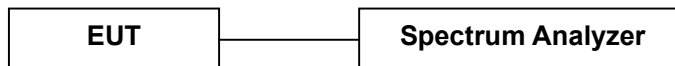
5. Channel Separation test

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)

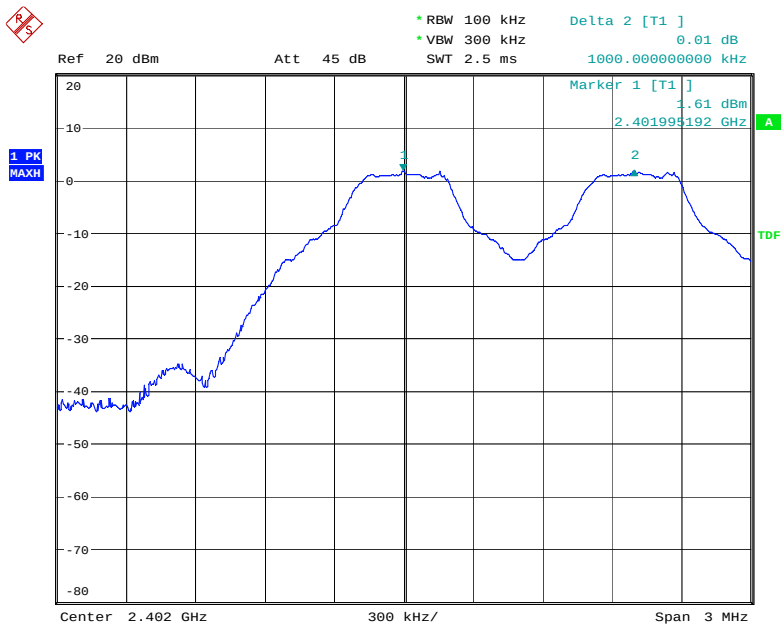


5.3 Measurement Results

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

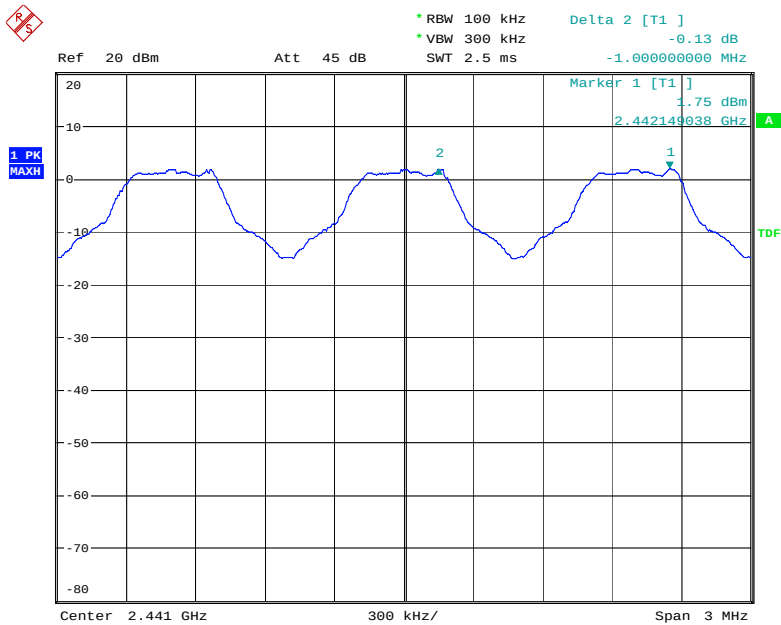
Channel number	Channel frequency (MHz)	Separation Read Value (KHz)	Separation Limit 2/3 20dB Bandwidth (KHz)
GFSK			
Lowest	2402	1000	>644.0
Middle	2441	1000	>644.0
Highest	2480	1000	>641.3
$\pi/4$ -DQPSK			
Lowest	2402	1010	>984.0
Middle	2441	1000	>987.0
Highest	2480	1000	>984.0
8DPSK			
Lowest	2402	1000	>996.7
Middle	2441	1000	>996.7
Highest	2480	1000	>996.7

GFSK Lowest Channel



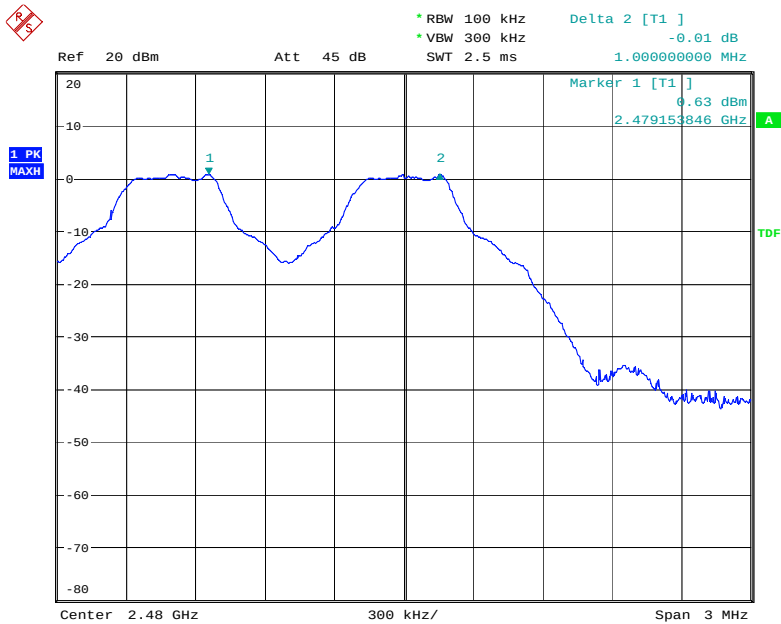
Date: 22.NOV.2017 11:58:04

GFSK Middle Channel



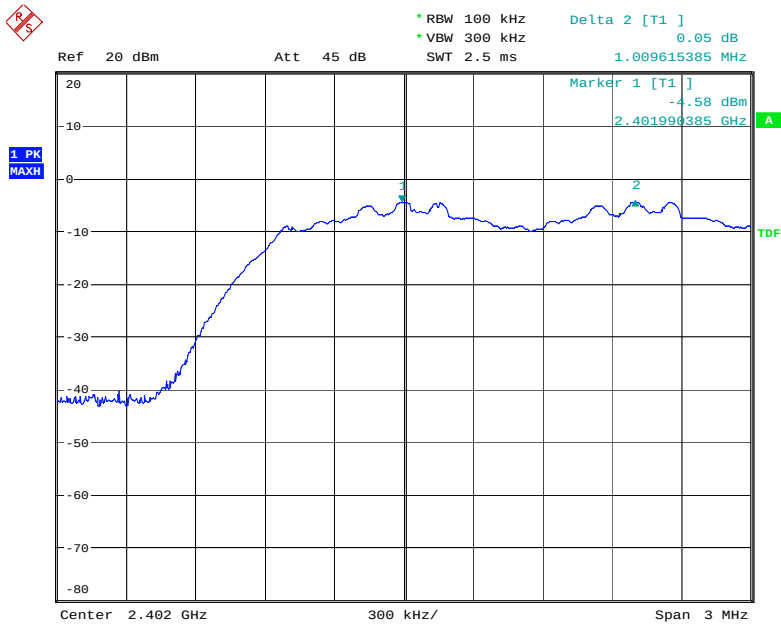
Date: 22.NOV.2017 11:59:06

GFSK Highest Channel



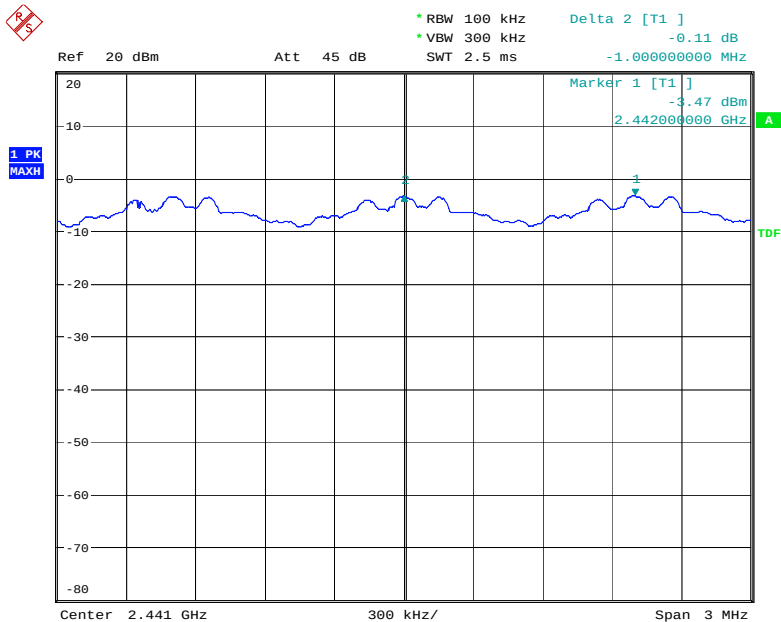
Date: 22.NOV.2017 12:00:16

$\pi/4$ -DQPSK Lowest Channel



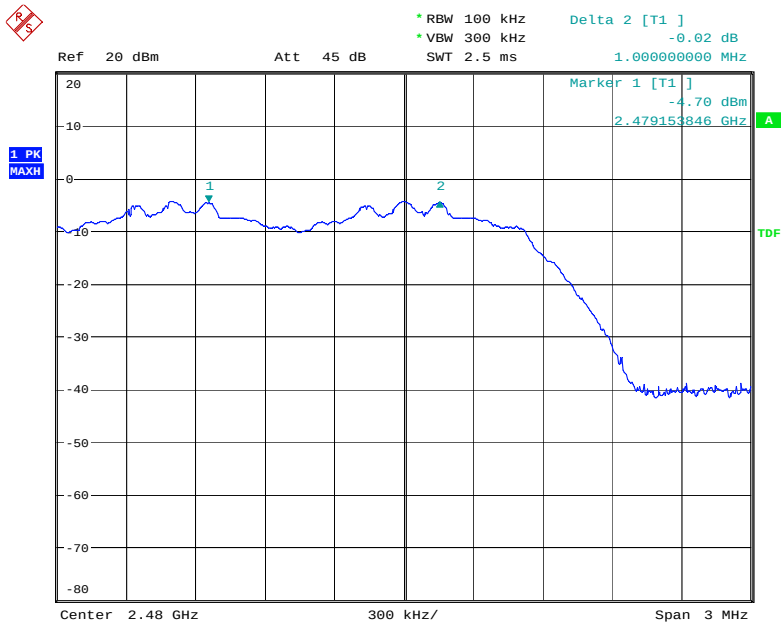
Date: 22.NOV.2017 12:05:50

$\pi/4$ -DQPSK Middle Channel



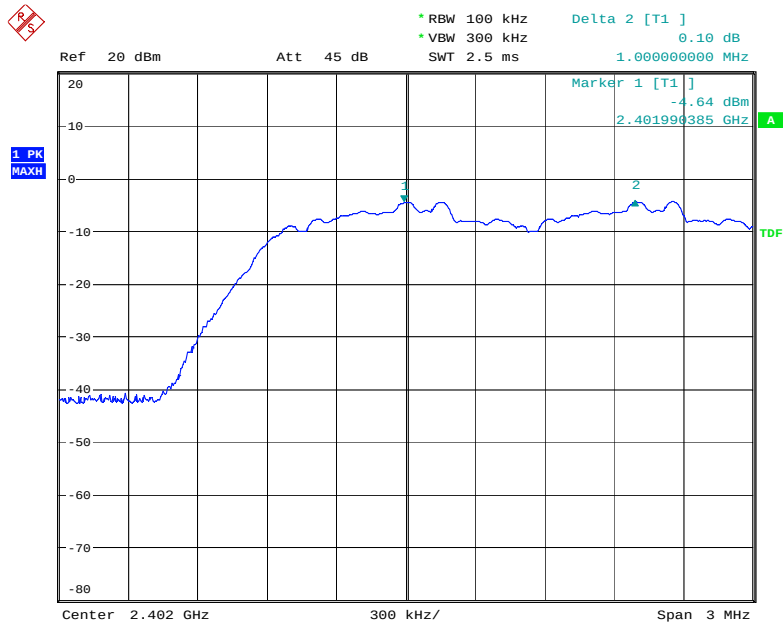
Date: 22.NOV.2017 12:04:03

$\pi/4$ -DQPSK Highest Channel



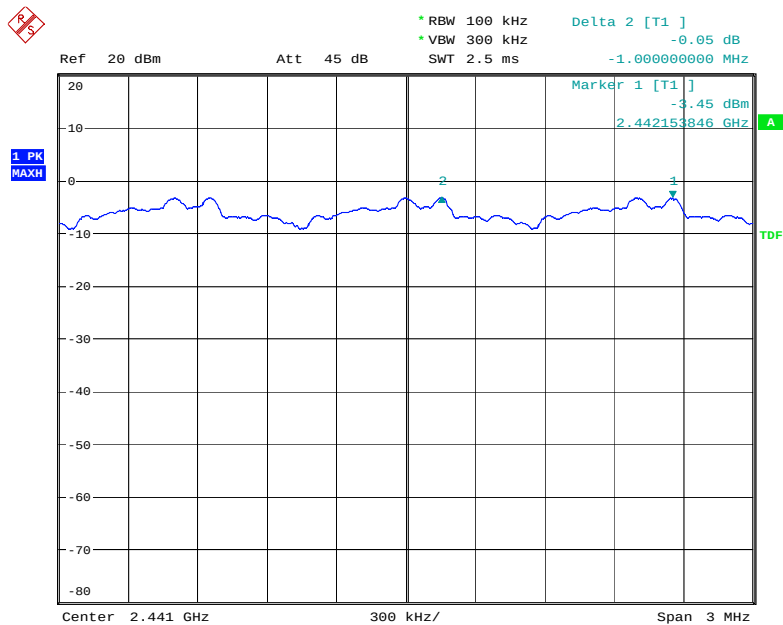
Date: 22.NOV.2017 12:01:48

8DPSK Lowest Channel



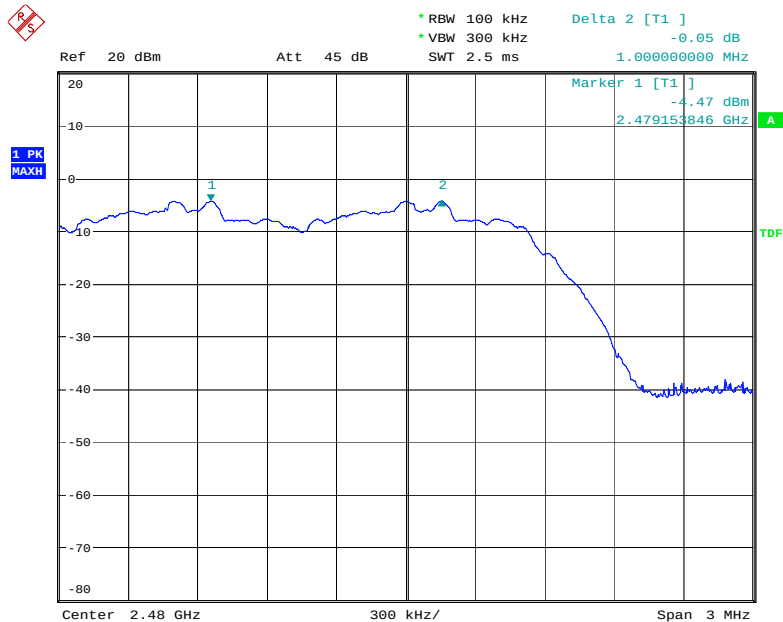
Date: 22.NOV.2017 12:07:51

8DPSK Middle Channel



Date: 22.NOV.2017 12:09:53

8DPSK Highest Channel



Date: 22.NOV.2017 12:11:29

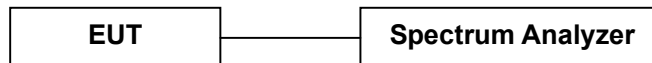
6. 20dB Bandwidth

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)



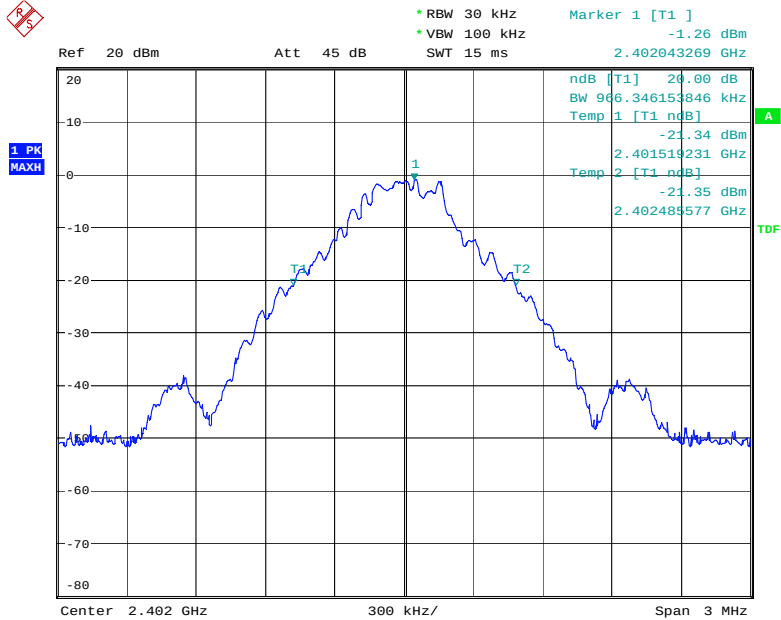
6.3 Measurement Results

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 22, 2017
Temperature :	22 °C	Humidity :	53 %
Test Result:	PASS		

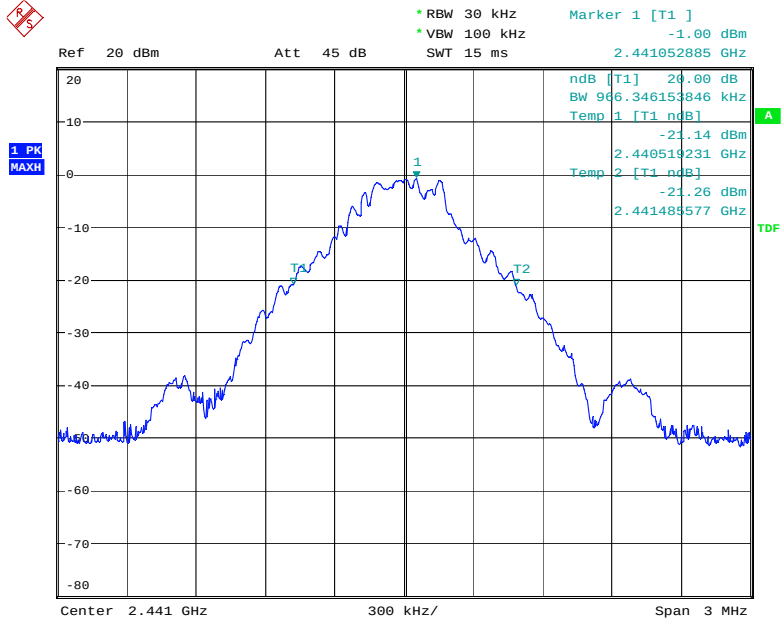
Channel frequency (MHz)	20dB Down BW(kHz)
GFSK	
2402	966
2441	966
2480	962
$\pi/4$ -DQPSK	
2402	1476
2441	1481
2480	1476
8DPSK	
2402	1495
2441	1495
2480	1495

GFSK Lowest Channel



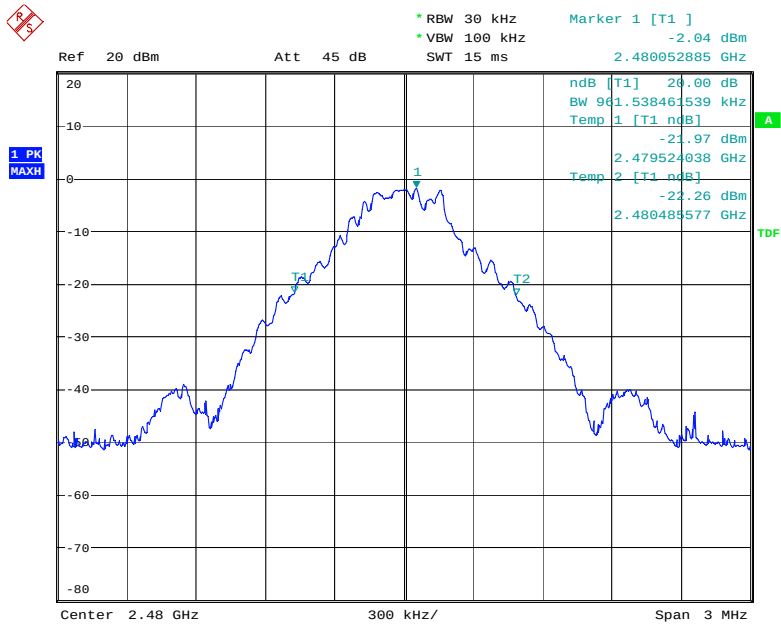
Date: 22.NOV.2017 13:56:07

GFSK Middle Channel



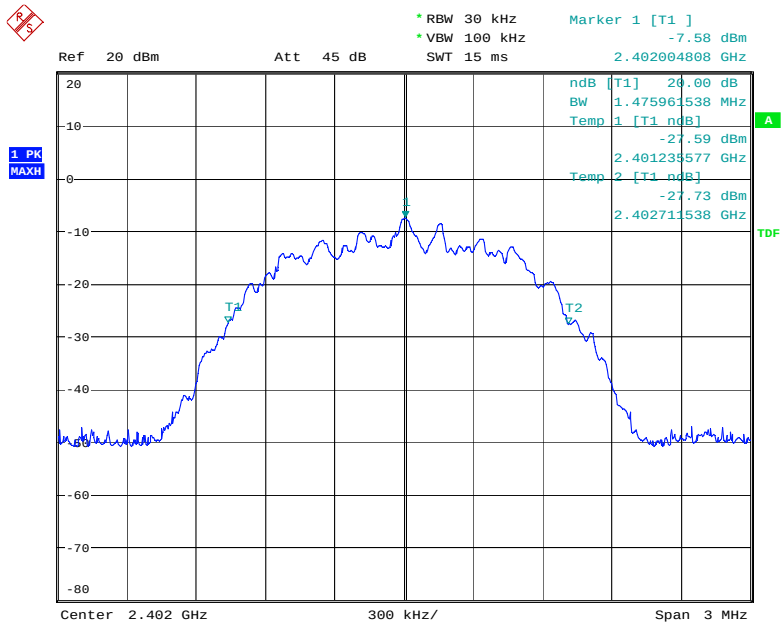
Date: 22.NOV.2017 13:56:37

GFSK Highest Channel



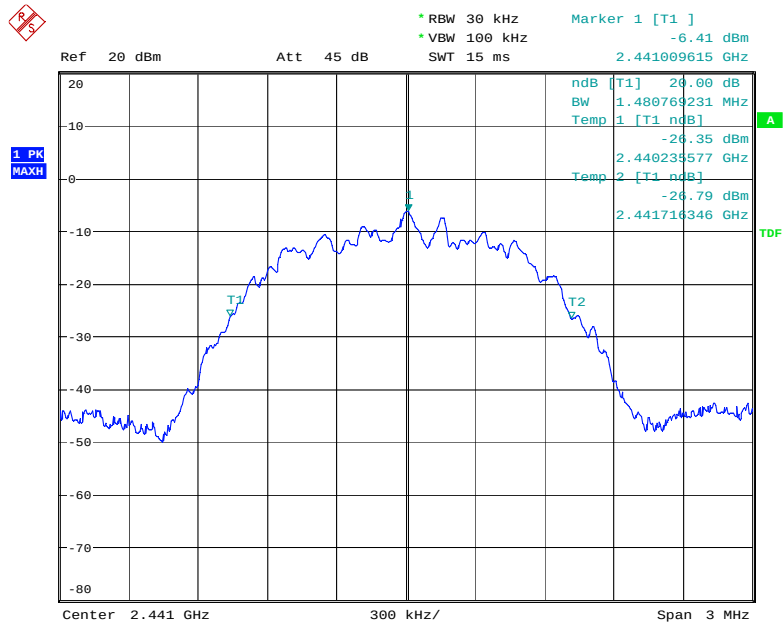
Date: 22.NOV.2017 13:57:03

$\pi/4$ -DQPSK Lowest Channel



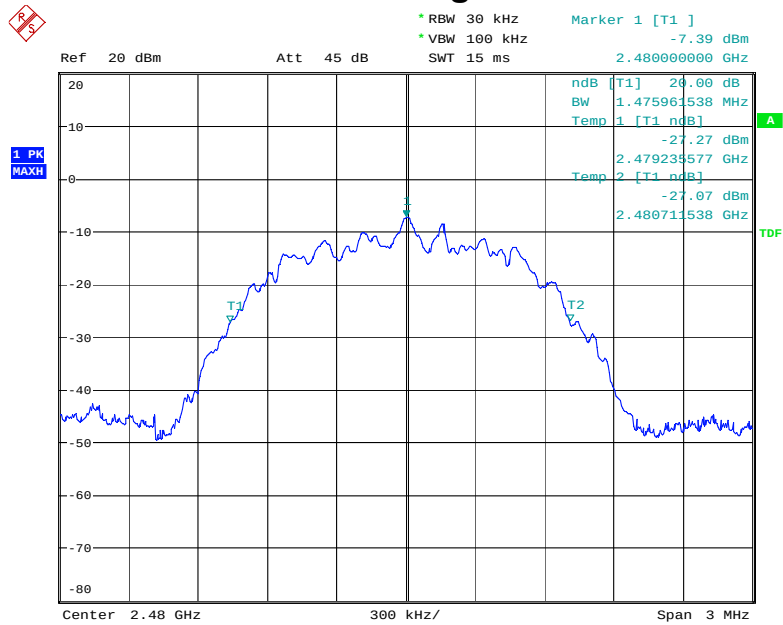
Date: 22.NOV.2017 13:58:38

$\pi/4$ -DQPSK Middle Channel



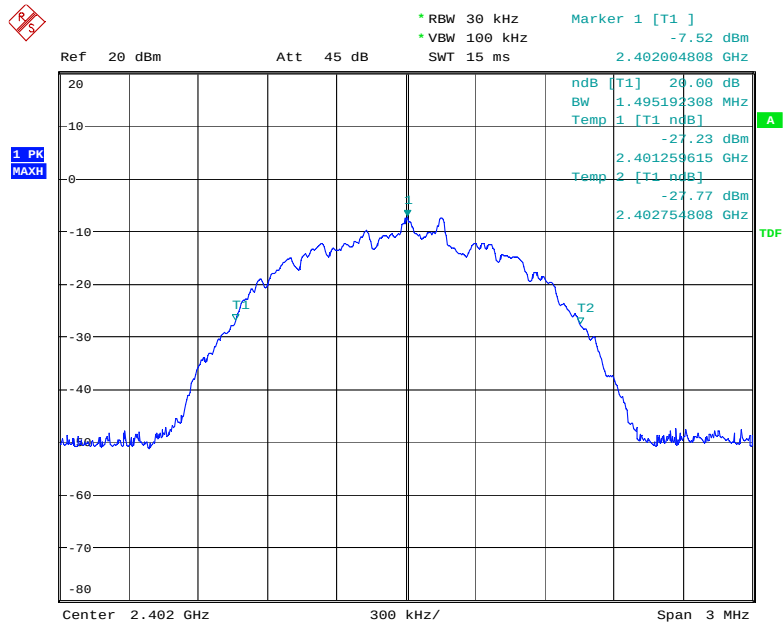
Date: 22.NOV.2017 13:58:10

$\pi/4$ -DQPSK Highest Channel



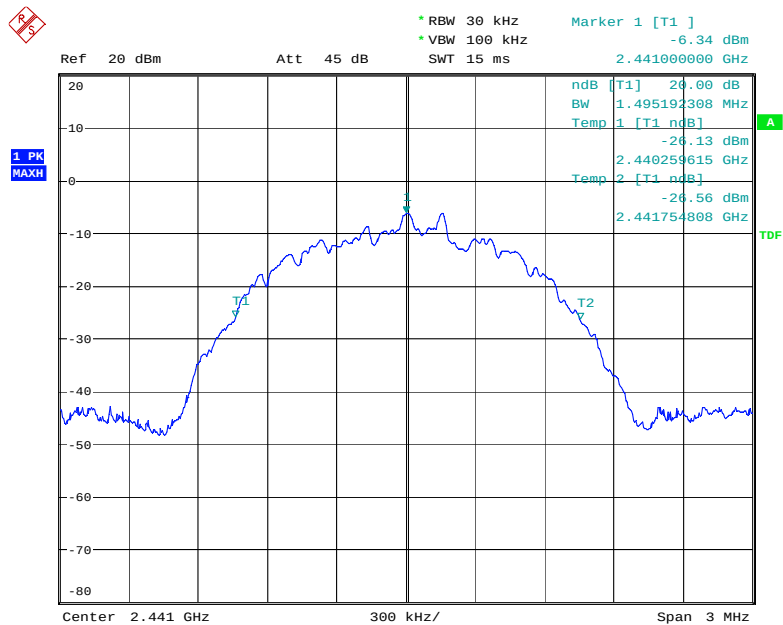
Date: 22.NOV.2017 13:57:38

8DPSK Lowest Channel



Date: 22.NOV.2017 13:59:04

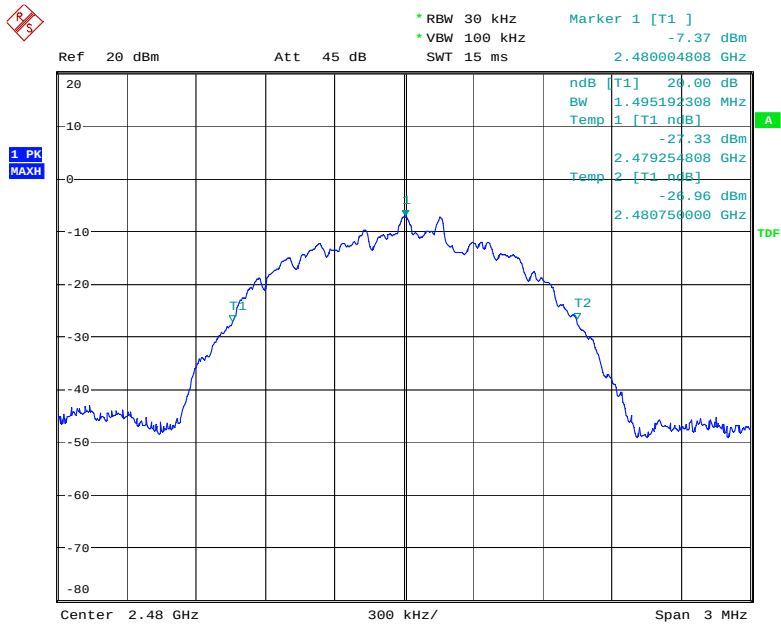
8DPSK Middle Channel



Date: 22.NOV.2017 14:00:07



8DPSK Highest Channel



Date: 22.NOV.2017 14:00:42

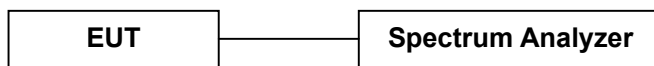
7. Hopping Channel Number

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)

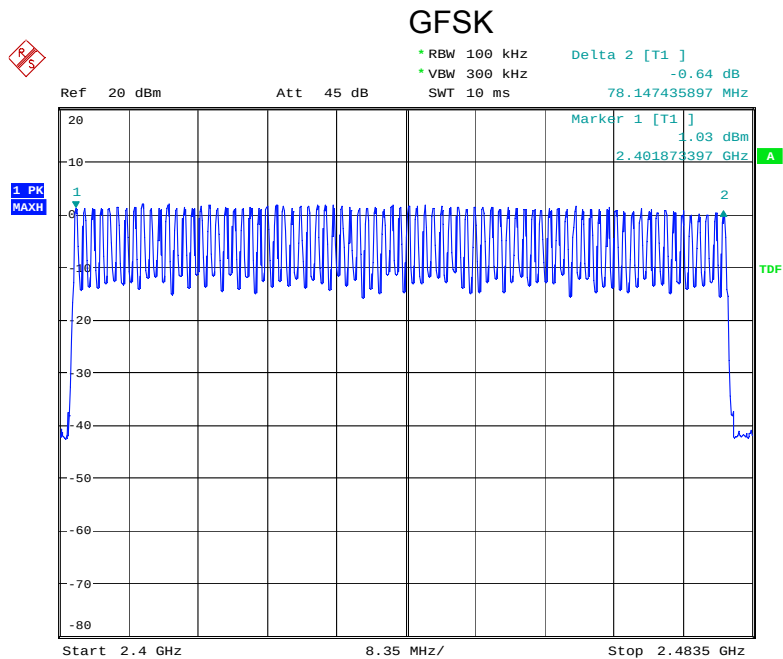


7.3 Measurement Results

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

Hopping Channel Frequency Range	Number of Hopping Channels	Limit
2402-2480	79	≥ 15

The worst case: GFSK



Date: 22.NOV.2017 13:46:48

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

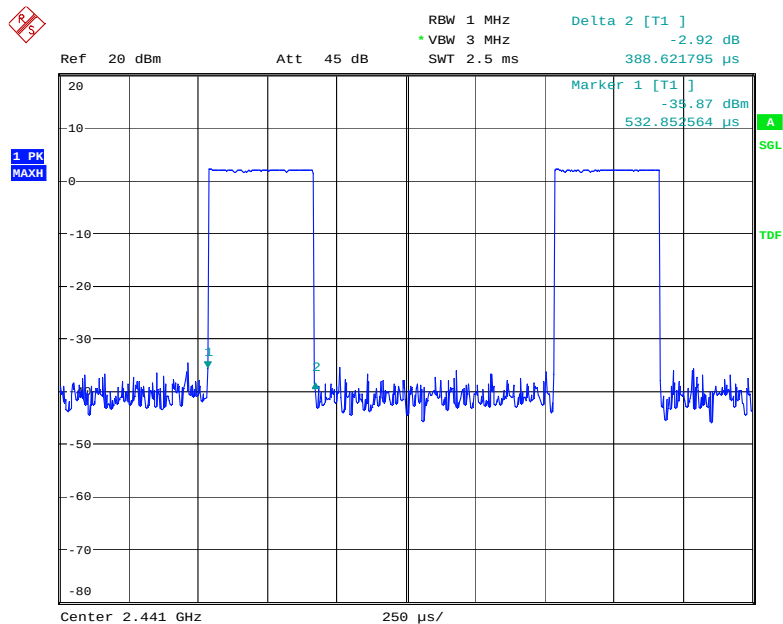
The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

Refer to attached data chart.

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

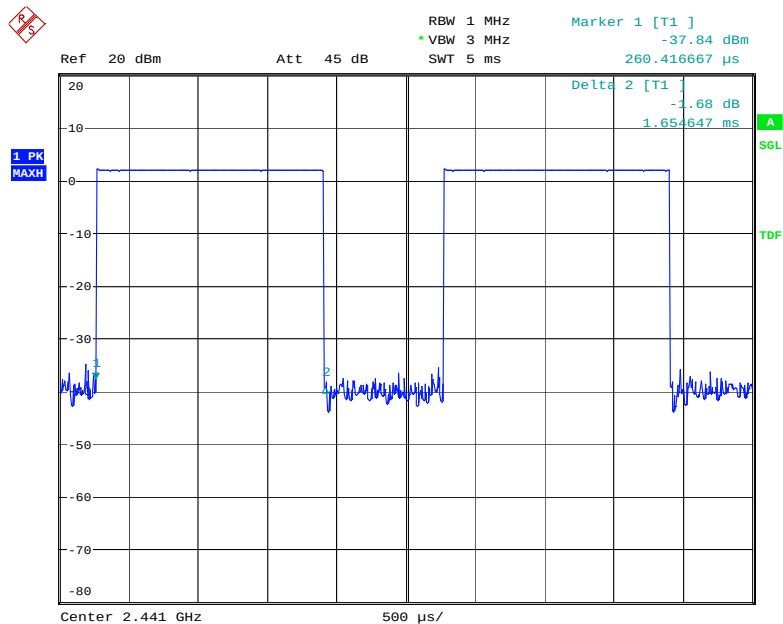
Packet	Frequency (MHz)	Result (msec)	Limit (msec)
GFSK			
DH1	2441	0.389 (ms)*(1600/(2*79))*31.6= 124.48	400
DH3	2441	1.655 (ms)*(1600/(4*79))*31.6= 264.80	400
DH5	2441	2.913 (ms)*(1600/(6*79))*31.6= 310.72	400
$\pi/4$ -DQPSK			
2-DH1	2441	0.397 (ms)*(1600/(2*79))*31.6= 127.04	400
2-DH3	2441	1.659 (ms)*(1600/(4*79))*31.6= 265.44	400
2-DH5	2441	2.921 (ms)*(1600/(6*79))*31.6= 311.57	400
8DPSK			
3-DH1	2441	0.401 (ms)*(1600/(2*79))*31.6= 128.32	400
3-DH3	2441	1.659 (ms)*(1600/(4*79))*31.6= 265.44	400
3-DH5	2441	2.921 (ms)*(1600/(6*79))*31.6= 311.57	400

GFSK DH1



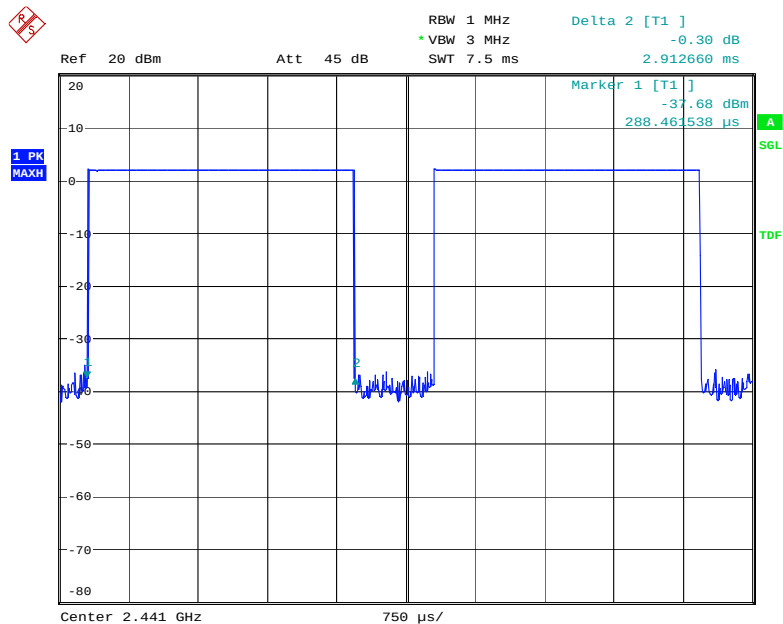
Date: 22.NOV.2017 14:02:01

GFSK DH3



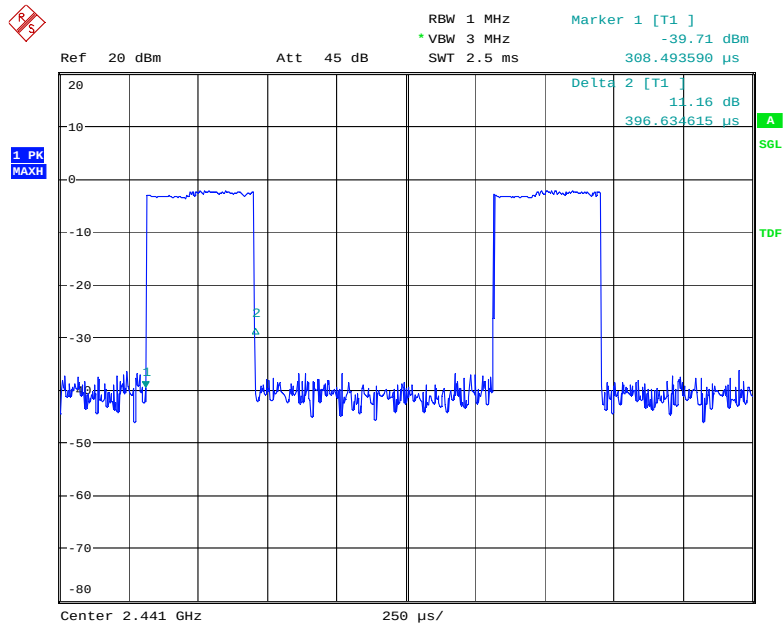
Date: 22.NOV.2017 14:02:28

GFSK DH5



Date: 22.NOV.2017 14:02:56

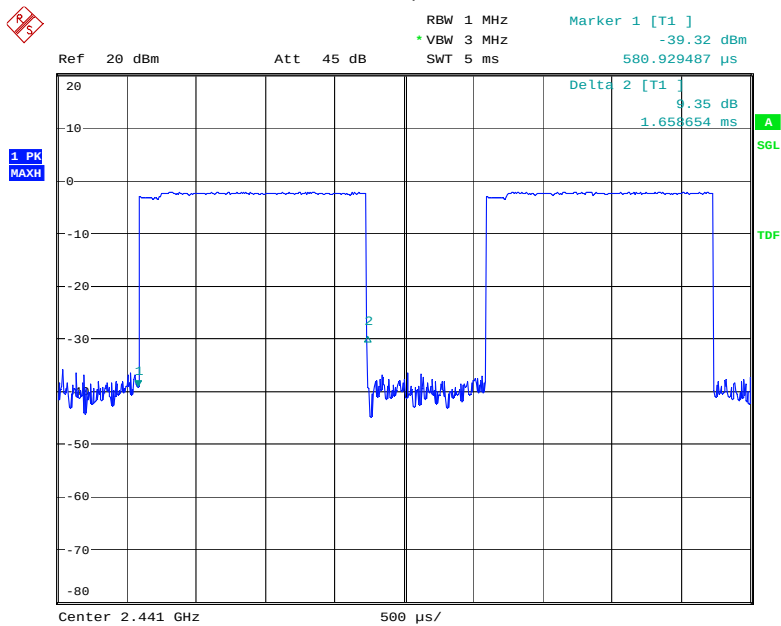
$\pi/4$ -DQPSK 2-DH1



Date: 22.NOV.2017 14:04:36

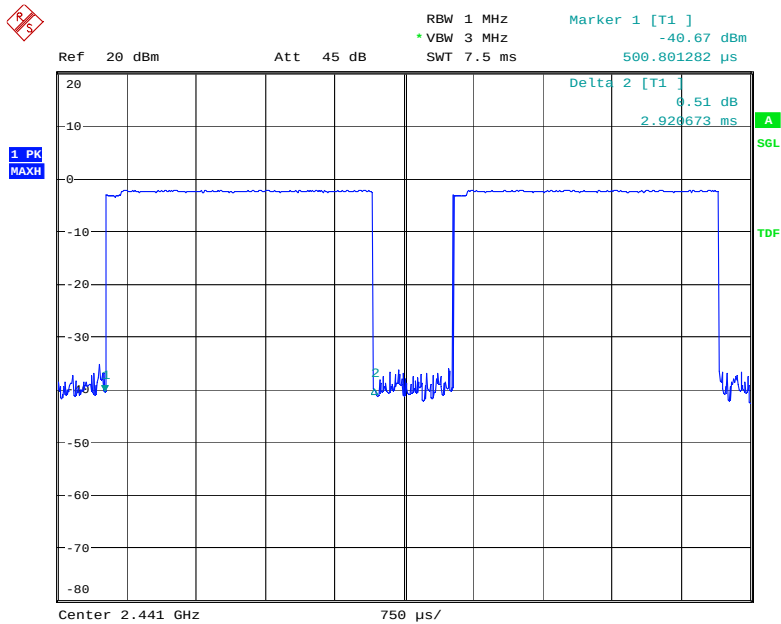


$\pi/4$ -DQPSK 2-DH3



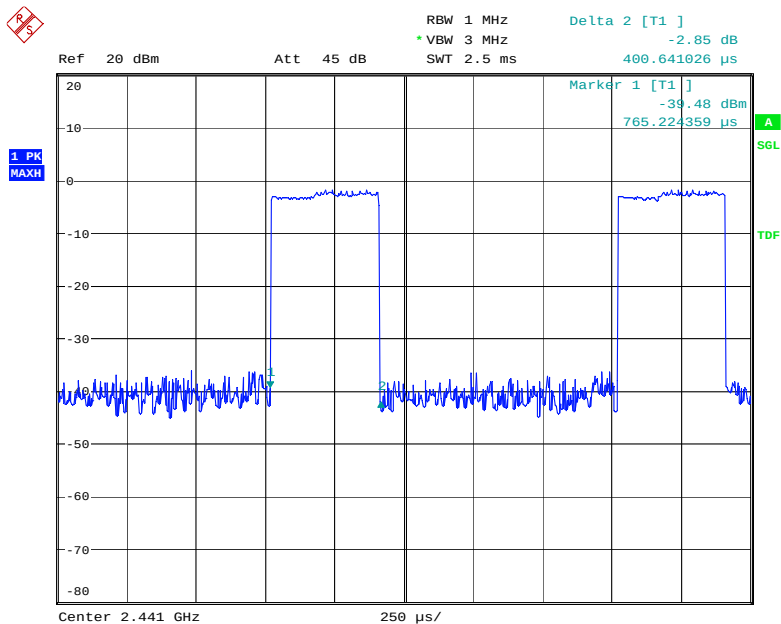
Date: 22.NOV.2017 14:05:26

$\pi/4$ -DQPSK 2-DH5



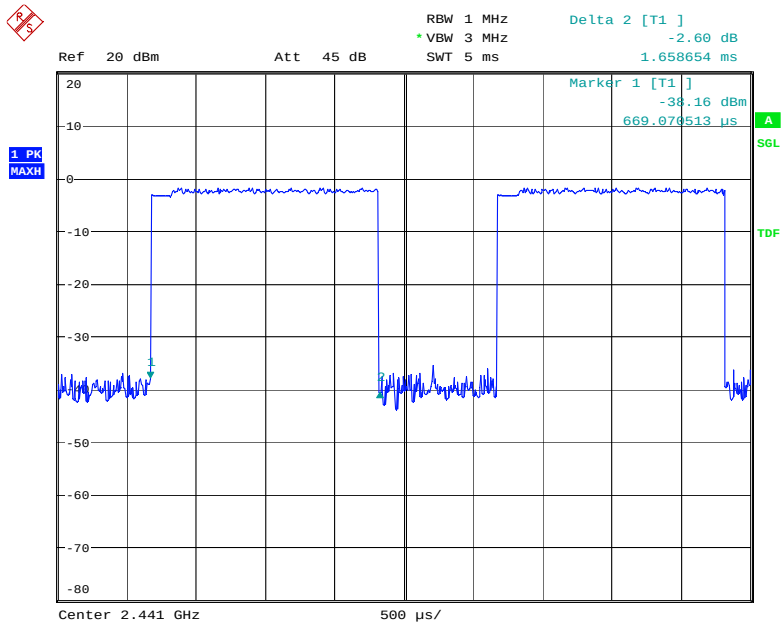
Date: 22.NOV.2017 14:06:15

8DPSK 3-DH1



Date: 22.NOV.2017 14:05:02

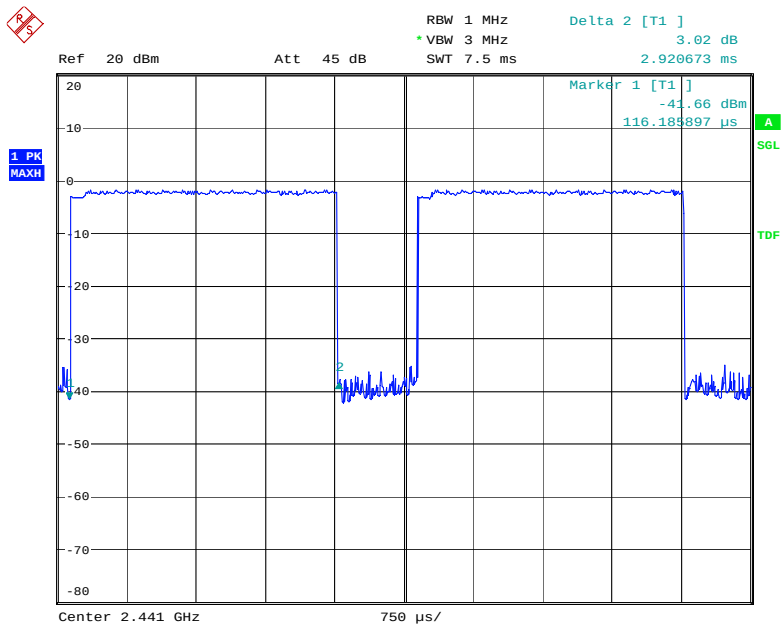
8DPSK 3-DH3



Date: 22.NOV.2017 14:05:49



8DPSK 3-DH5



Date: 22.NOV.2017 14:06:46

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 1.5dB was considered during this measurement.

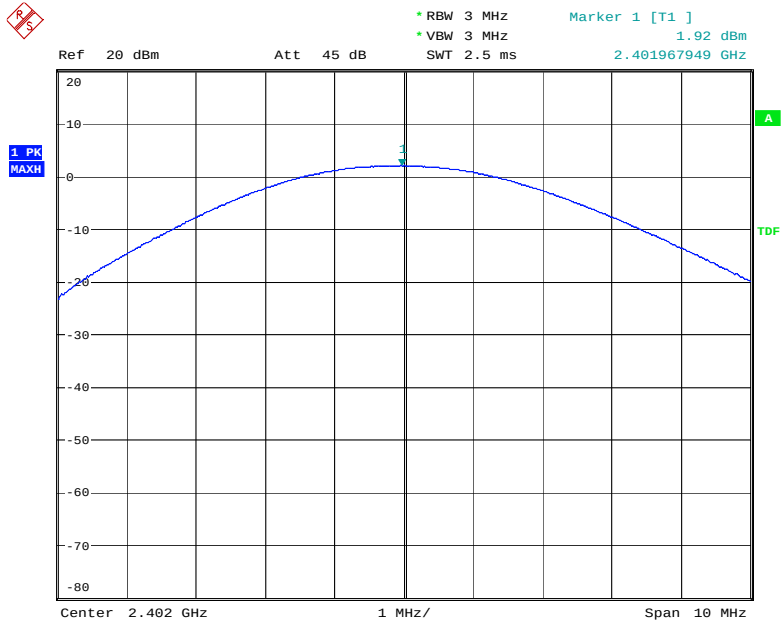
9.2 Measurement Results

Refer to attached data chart.

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

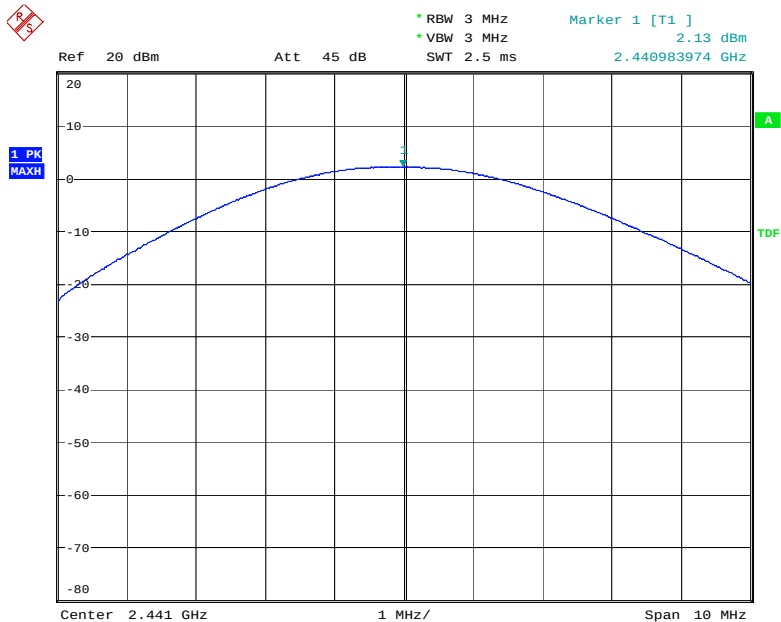
Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(dBm)	Pass/Fail
GFSK				
2402.00	1.92	1.56	21	PASS
2441.00	2.13	1.63	21	PASS
2480.00	1.03	1.27	21	PASS
$\pi/4$ -DQPSK				
2402.00	-2.07	0.62	21	PASS
2441.00	-1.09	0.78	21	PASS
2480.00	-2.24	0.60	21	PASS
8DPSK				
2402.00	-1.87	0.65	21	PASS
2441.00	-0.95	0.80	21	PASS
2480.00	-2.14	0.61	21	PASS

GFSK Lowest Channel



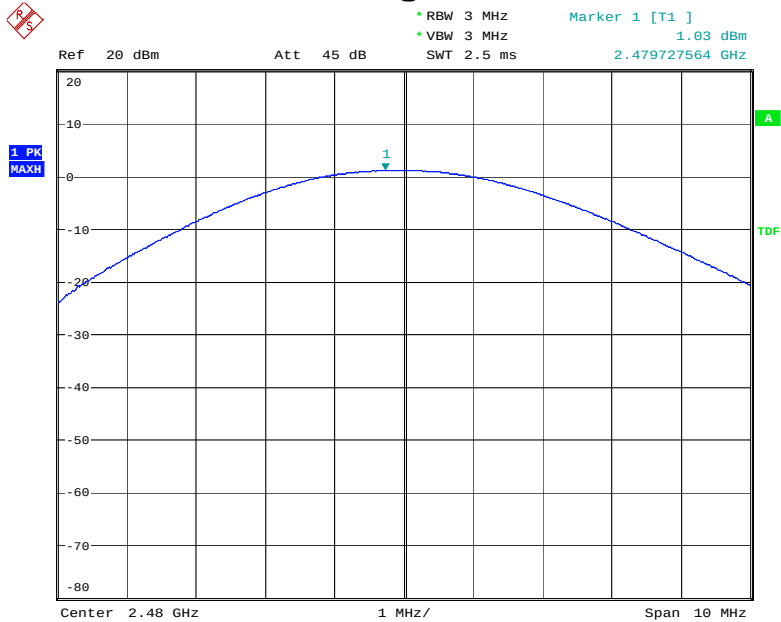
Date: 22.NOV.2017 13:52:20

GFSK Middle Channel



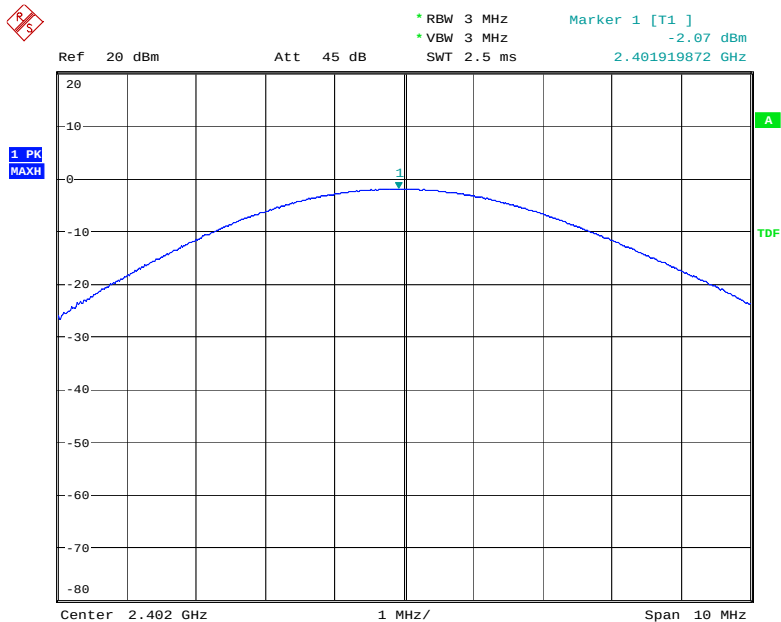
Date: 22.NOV.2017 13:52:41

GFSK Highest Channel



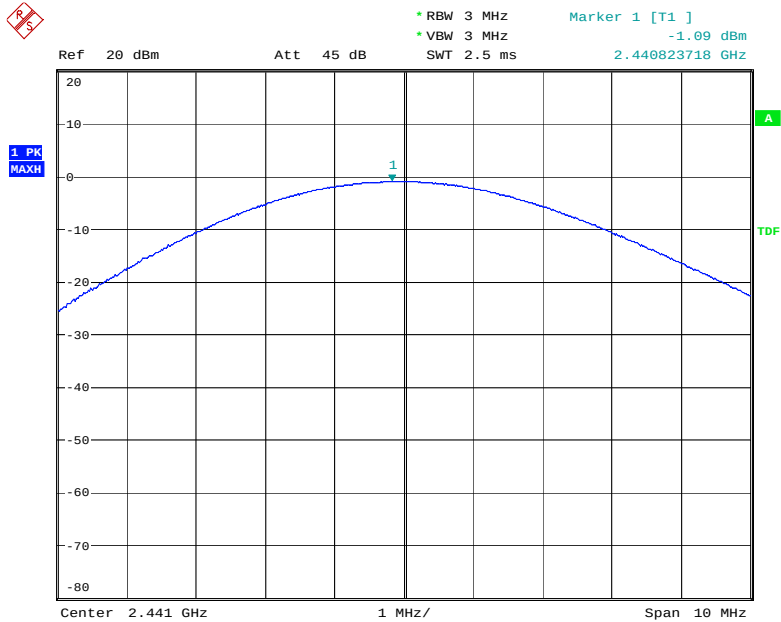
Date: 22.NOV.2017 13:52:58

$\pi/4$ -DQPSK Lowest Channel



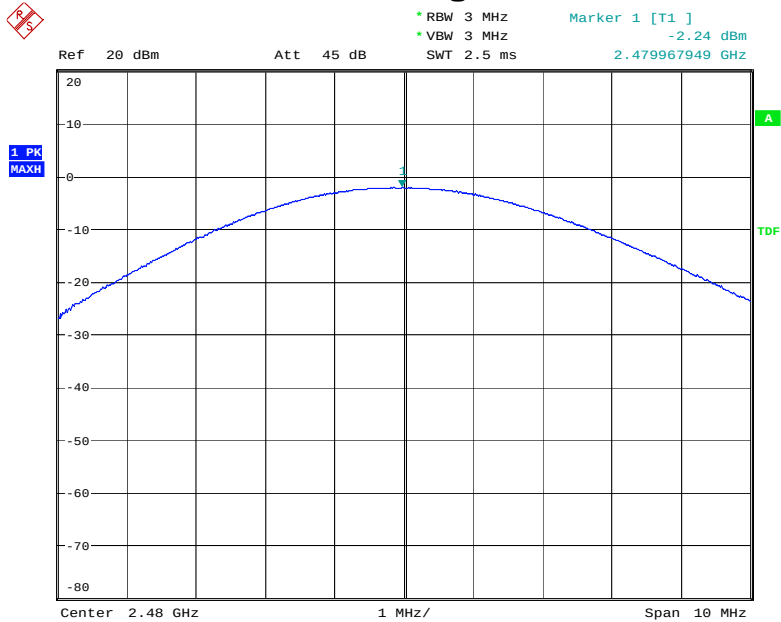
Date: 22.NOV.2017 13:53:50

$\pi/4$ -DQPSK Middle Channel



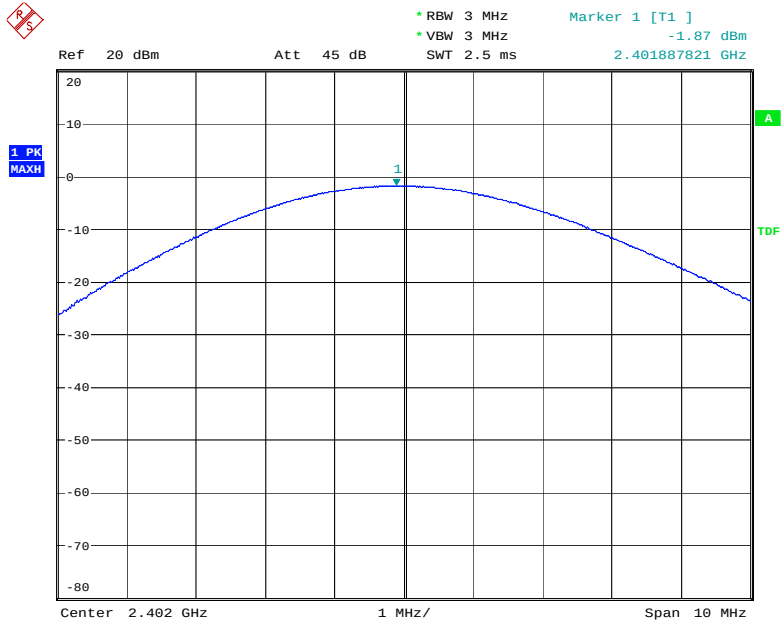
Date: 22.NOV.2017 13:53:36

$\pi/4$ -DQPSK Highest Channel



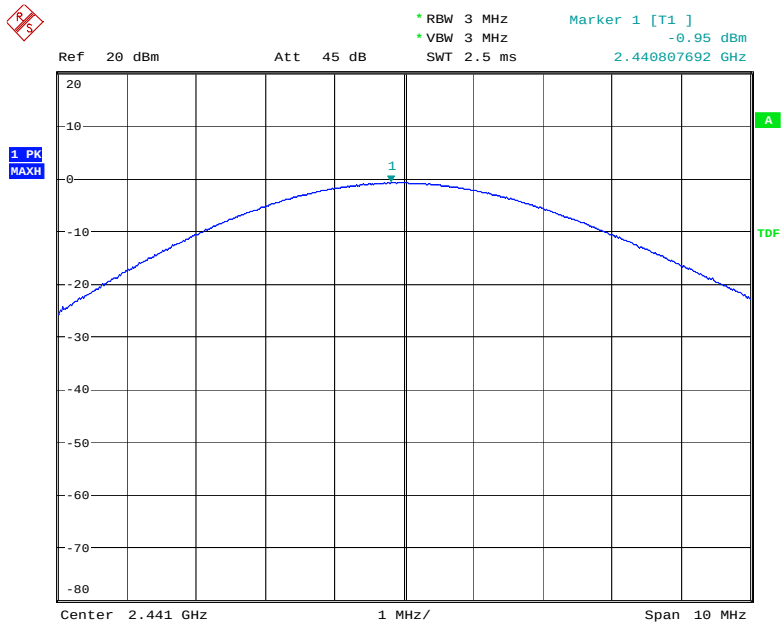
Date: 22.NOV.2017 13:53:20

8DPSK Lowest Channel



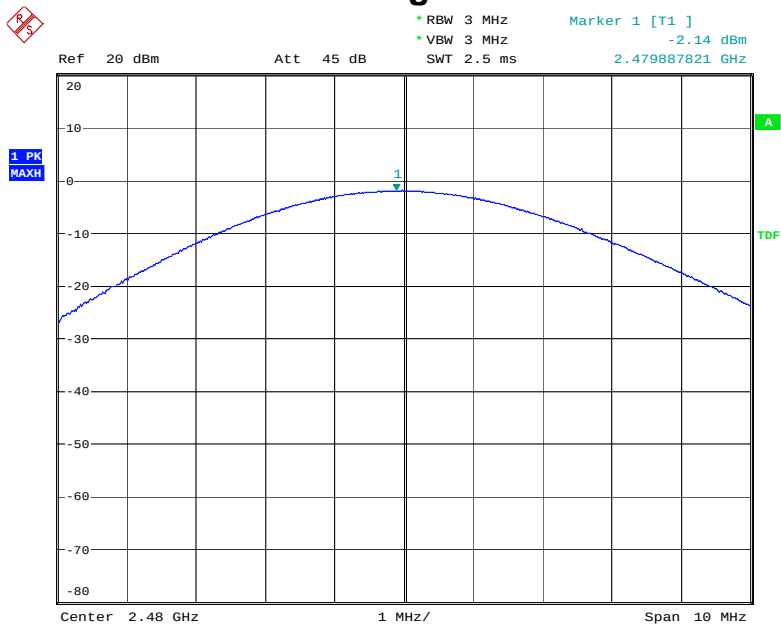
Date: 22.NOV.2017 13:54:19

8DPSK Middle Channel



Date: 22.NOV.2017 13:54:34

8DPSK Highest Channel



Date: 22.NOV.2017 13:54:50

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.

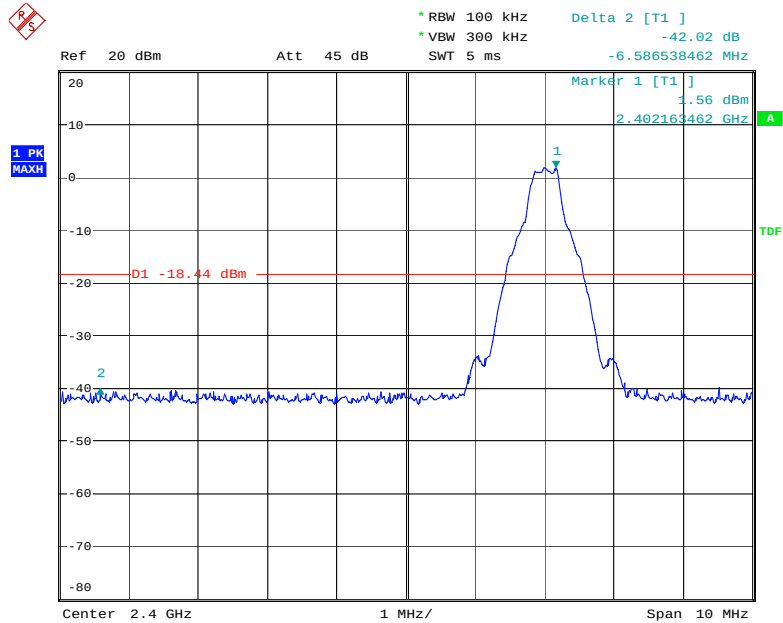
For Radiated Emission, GFSK, $\pi/4$ -DQPSK, 8DPSK mode all have been tested, only worse case GFSK is reported

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	47.35	35.44	0.13	47.48	35.57	74.00	54.00	-26.52	-18.43
2390.000	V	46.78	35.35	0.13	46.91	35.48	74.00	54.00	-27.09	-18.52
2483.500	H	45.74	33.97	0.35	46.09	34.32	74.00	54.00	-27.91	-19.68
2483.500	V	47.21	35.13	0.35	47.56	35.48	74.00	54.00	-26.44	-18.52

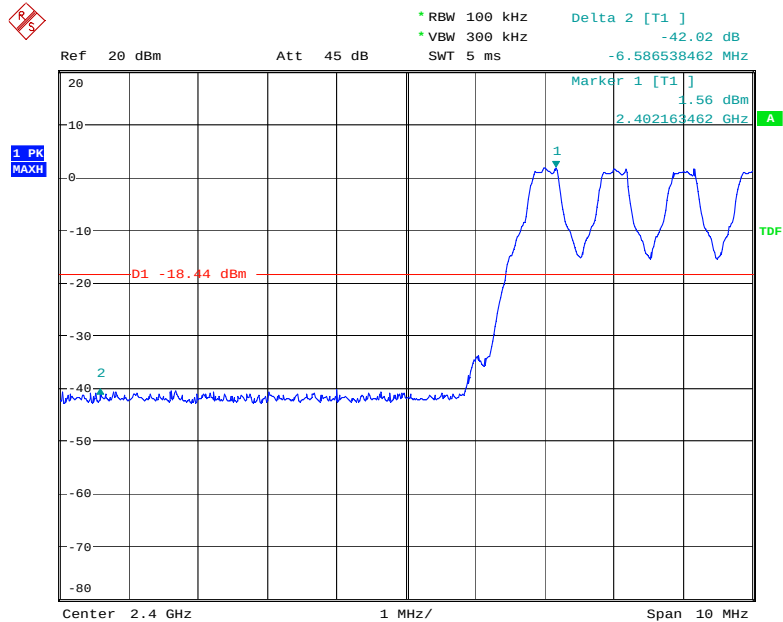
- Note:**
- (1) Emission Level= Reading Level + Factor
 - (2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
 - (3) Horn antenna used for the emission over 1000MHz.

For RF Conducted

GFSK Lowest Channel

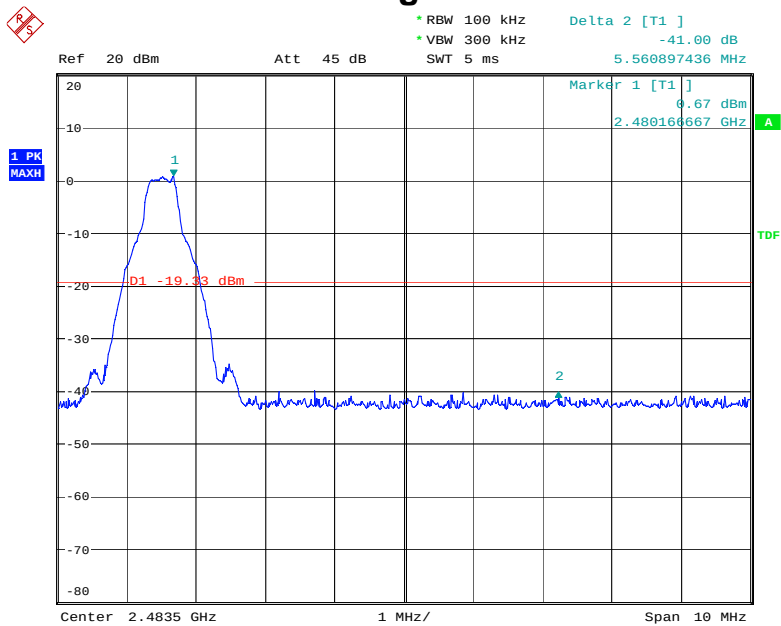


Date: 22.NOV.2017 13:36:03

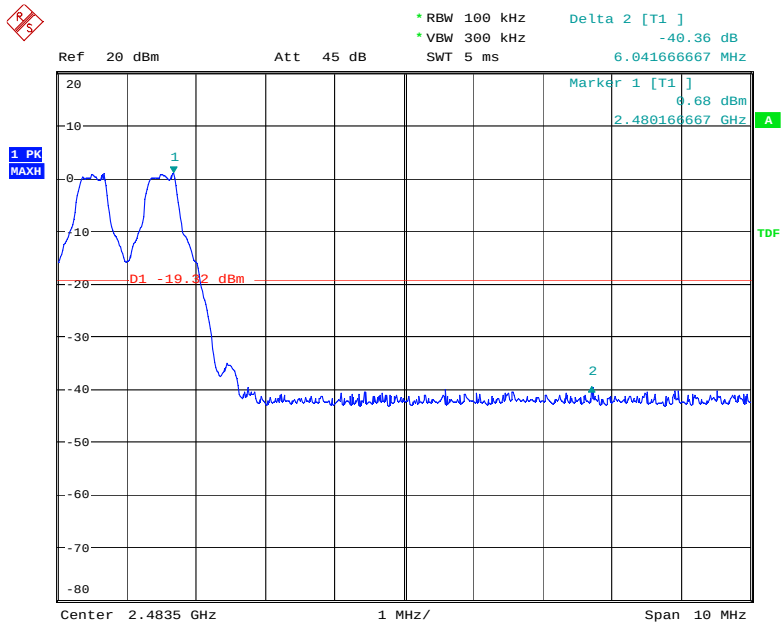


Date: 22.NOV.2017 13:36:45

GFSK Highest Channel

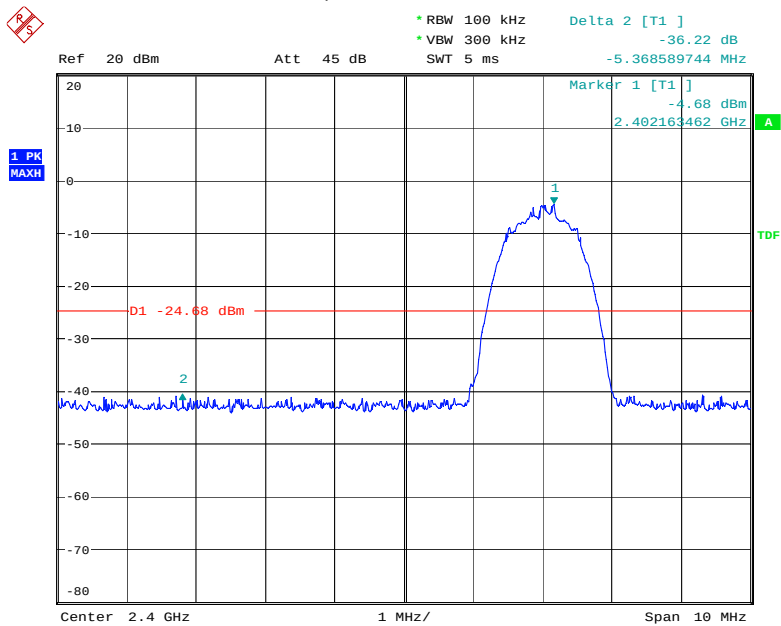


Date: 22.NOV.2017 13:38:42

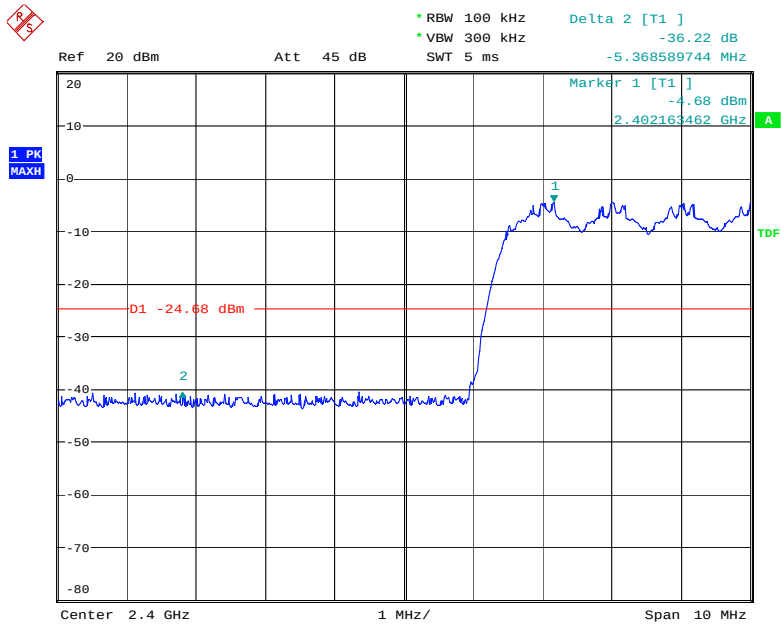


Date: 22.NOV.2017 13:38:04

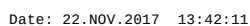
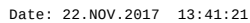
$\pi/4$ -DQPSK Lowest Channel



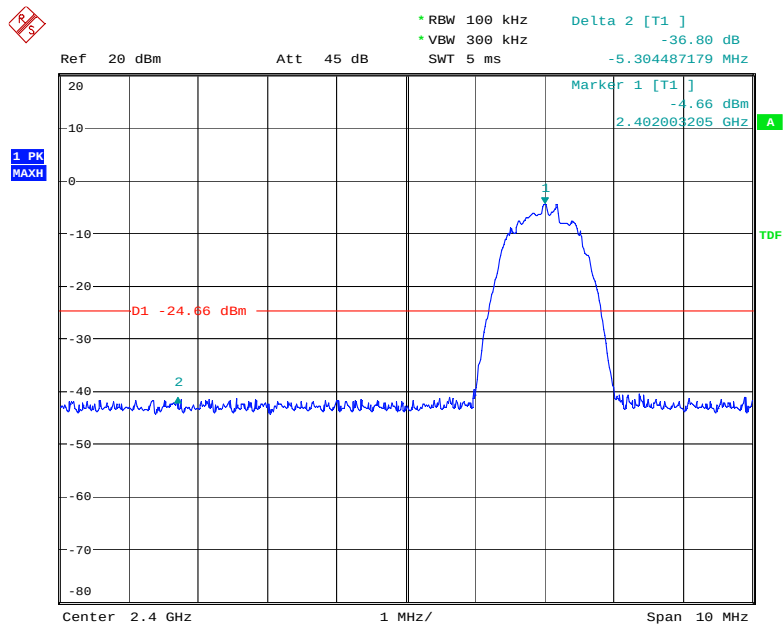
Date: 22.NOV.2017 13:39:54



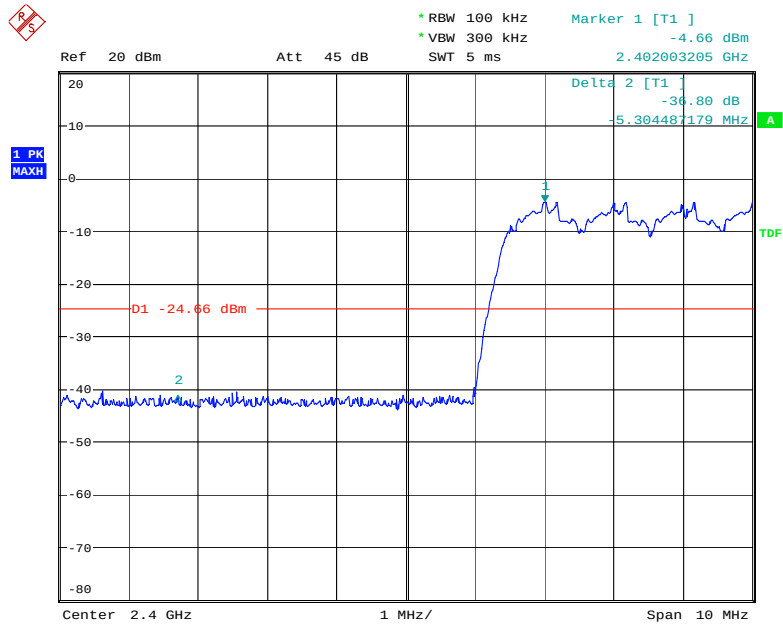
Date: 22.NOV.2017 13:40:33



8DPSK Lowest Channel

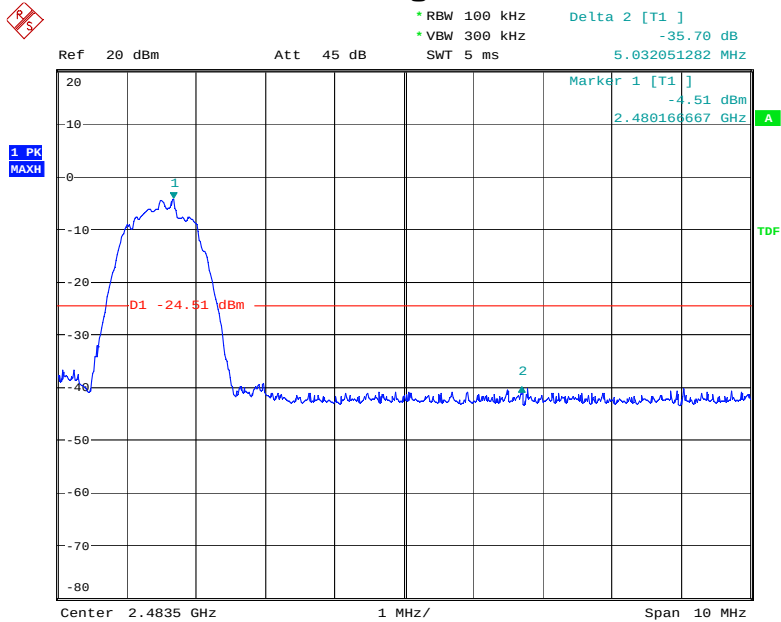


Date: 22.NOV.2017 13:43:59

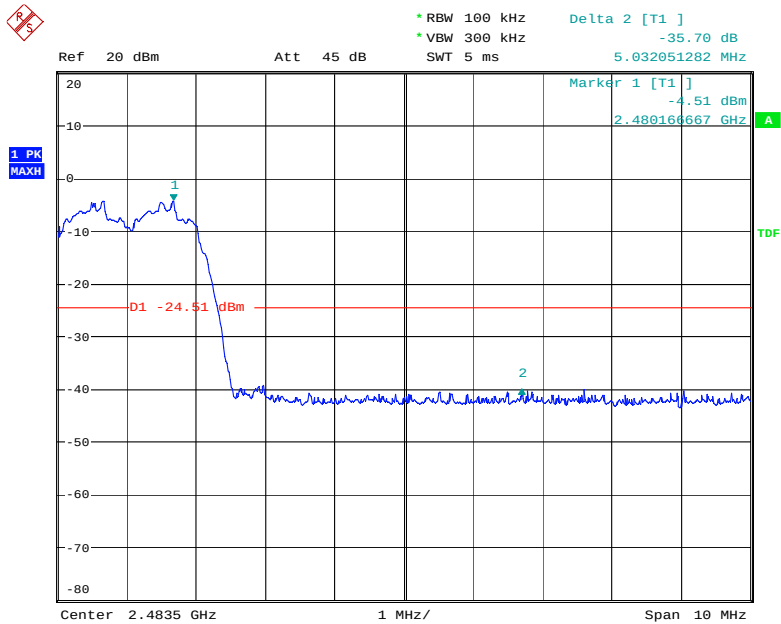


Date: 22.NOV.2017 13:44:38

8DPSK Highest Channel



Date: 22.NOV.2017 13:43:04



Date: 22.NOV.2017 13:43:20

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 Integral 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 1.82dBi, 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):

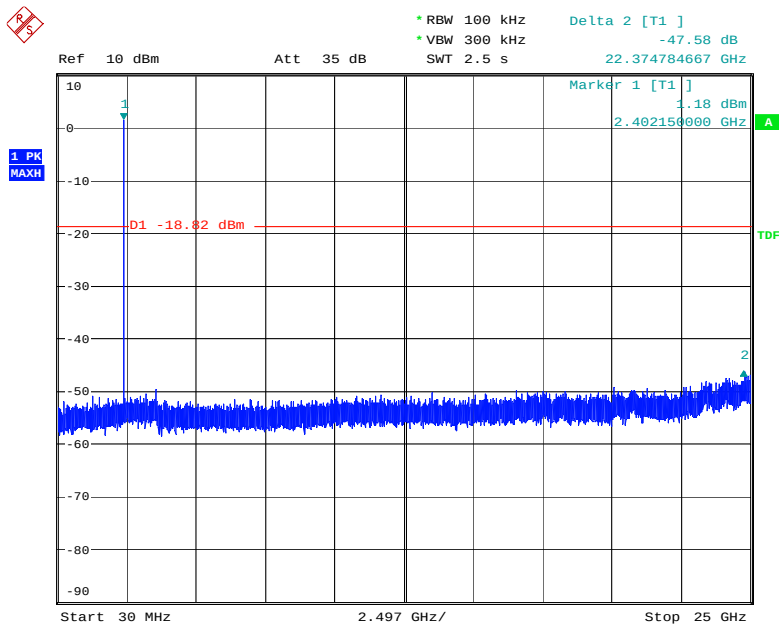
The transmitter output is connected to spectrum analyzer. All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20dB below the highest level of the desired power in the passband.

12.2. Measurement Results

Please refer to following plots, the worst case (GFSK) was shown.

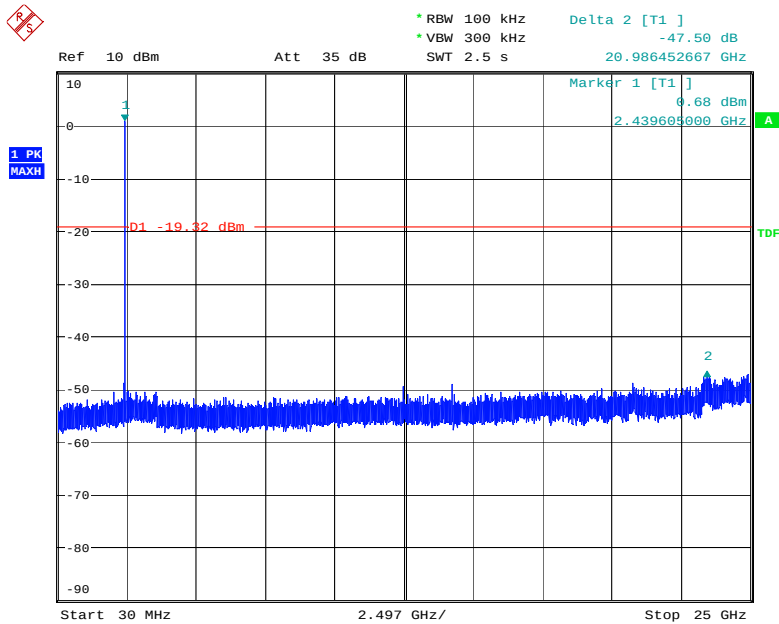


Lowest Channel



Date: 22.NOV.2017 11:52:27

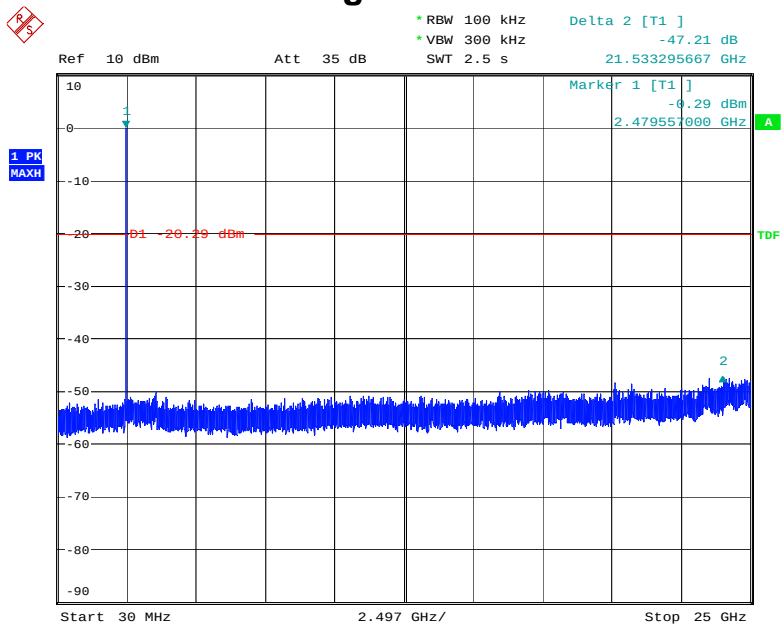
Middle Channel



Date: 22.NOV.2017 11:53:36



Highest Channel



Date: 22.NOV.2017 11:54:16

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---