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	:	Fender Musical Instruments
Address	:	17600 N. Perimeter Drive Suite 100, Scottsdale, Arizona, 85255, United States
Manufacturer /Factory	:	FN-LINK TECHNOLOGY LIMITED
Address	:	5th Floor, A Building, Haoye Logistics Park, Shugang Channel, Bao'an District, Shenzhen City, China
E.U.T.	:	WIFI+BT Module
Brand Name	:	FN-LINK
Model No.	:	F23BUUM13-W2, Fender PCBA 7710065000 (For model difference, refer to section 1.1)
FCC ID	:	XQW-FMAPR4400
Measurement Standard	:	FCC PART 15.247
Date of Receiver	:	October 09, 2016
Date of Test	:	October 09, 2016 to October 19, 2016
Date of Report	:	October 19, 2016

This Test Report is Issued Under the Authority of :

Prepared by	Approved & Authorized Signer
Rose Hu / Engineer	Iori Fan / Authorized Signatory

Dongguan NTC Co., Ltd. NTC Nore Testing Center

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.

TEL: +86-769-22022444 FAX: +86-769-22022799 Web: www.ntc-c.com
Address: Building D, Gaosheng Science & Technology Park, Zhouxi Longxi Road, Nancheng District, Dongguan City, Guangdong, China

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Revision History of This Test Report

Report Number	Description	Issued Date
NTC1610213F	Initial Issue	2016-10-19

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test

This device is a WIFI+BT Module, it's powered by DC 3.3V come from external power source. For more details features, please refer to User's Manual.

Power Supply	:	DC 3.3V
Adapter	:	None
Test voltage	:	AC 120V 60Hz PC input
Model name	:	F23BUUM13-W2, Fender PCBA 7710065000 (All tests were carried on model F23BUUM13-W2)
Model difference	:	Both of models have the same circuitry, PCB layout and physical construction. The differences in model number due to trading purpose.
Hardware version	:	WIFI-FTSW-USB REV 3
Software version	:	V1.0
Serial number	:	N/A
Note	:	This report only applies to modulation technology DSS(BT2.1+EDR).

Technical parameters
For WIFI Function

Frequency Range	:	2412-2462MHz for 802.11b/g/n(HT20) 2422-2452MHz for 802.11n(HT40)
Modulation	:	DSSS for 802.11b OFDM for 802.11g/n(HT20)/n(HT40)
Number of Channel	:	11 for 802.11b/g/n(HT20) 7 for 802.11n(HT40)
Channel space	:	5MHz
Date Rate	:	802.11b:1~11Mbps, 802.11g:6~54Mbps 802.11n: 6.5~135Mbps
Antenna Type	:	PCB Antenna
Antenna Gain	:	1.0 dBi

For BT function
BT Version: BLE(V4.0) and backward compatible 3.0, 2.1+EDR version.
We prepare version BLE(V4.0) and 2.1+EDR for RF test.

Item	BT2.1+EDR	BLE(V4.0)
Frequency	2402-2480MHz	2402-2480MHz
Modulation	GFSK, π/4-DQPSK, 8DPSK	GFSK
Number of Channel	79	40
Channel space	1MHz	2MHz
Antenna Type	PCB antenna	PCB antenna
Antenna Gain	1.0 dBi	1.0 dBi

BT 2.1+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	RTLBTAPP

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: XQW-FMAPR4400 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

PC	:	Manufacturer: HP M/N: HP Pro 3005 MT S/N: 4CV1324FBS P/N: QG570PA#AB2 Power Cord: 1.8m Unshielded, with core CE, FCC: DOC
LCD Monitor	:	Manufacturer: LENOVO M/N: L2061WD S/N: 3M04769B1102083Data Cable: 1.5m Shielded, with core Power Cord: 1.5m Unshielded, with core CE , FCC:DOC
Mouse	:	Manufacturer: Logitech M/N: M-U0026 P/N: 810-002182 CE, FCC: DOC
Keyboard	:	Manufacturer: acer M/N: 38184 S/N: N/A CE, FCC: DOC
Printer	:	Manufacturer: Lenovo M/N: 3518 Data Cable: 1.5m Shielded Power Cord: 1.5m Unshielded with core CE, FCC: DOC

1.6 Test Facility and Location

Listed by FCC, July 03, 2014
The Certificate Registration Number is 665078.
Listed by Industry Canada, June 18, 2014
The Certificate Registration Number is 9743A.

Dongguan NTC Co., Ltd.
(Full Name: Dongguan Nore Testing Center Co., Ltd.)

Building D, Gaosheng Science and Technology Park, Hongtu Road, Nancheng District, Dongguan City, Guangdong, China
(Full Name: Building D, Gaosheng Science & Technology Park, Zhouxi Longxi Road, Nancheng District, Dongguan, Guangdong, China.

1.7 Summary of Test Results

FCC Rules	Description Of Test	Uncertainty	Result
§15.247(a)(1)	Channel Separation test	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)	20dB Bandwidth	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)(iii)	Hopping Channel Number	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	±5%	Compliant
§15.247(b)	Max Peak output Power test	±1.06dB	Compliant
§15.247(d)	Band edge test	±1.70dB	Compliant
§15.207 (a)	AC Power Conducted Emission	±1.06dB	Compliant
§15.247(d),§15.209, §15.205	Radiated Emission	±3.70dB	Compliant
§15.203	Antenna Requirement	±0.60dB	Compliant
§15.247(d)	Conducted Spurious Emission	±2.51dB	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

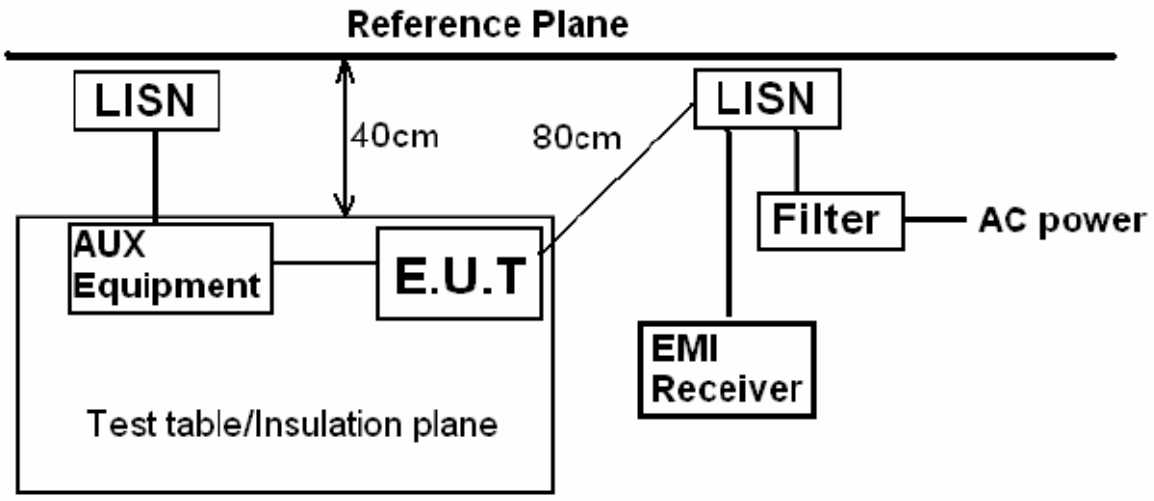
The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3 and DH5 mode in all modulation type GFSK, π/4-DQPSK, 8DPSK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

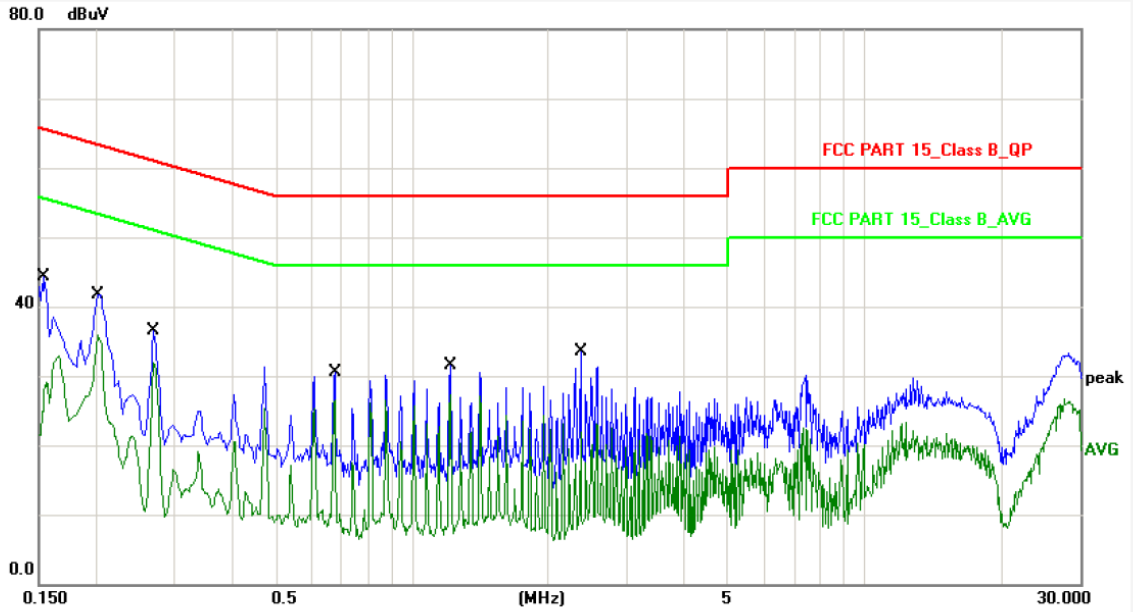
3.3 Measurement Results

Please refer to following plots of the worst case.

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

Site: Conduction

Test Time: 2016-10-16 19:12:04



Report No.: F23BUUM13-W2
Test Standard: FCC PART 15_Class B_QP
Test item: Conducted Emission
Phase: L1
Applicant: Fender Musical
Temp.( )/Hum.(%): 22(C) / 52 %
Product: WIFI+BT Module
Power Rating: AC 120V/60Hz
Model No.: F23BUUM13-W2
Test Engineer: Jerry

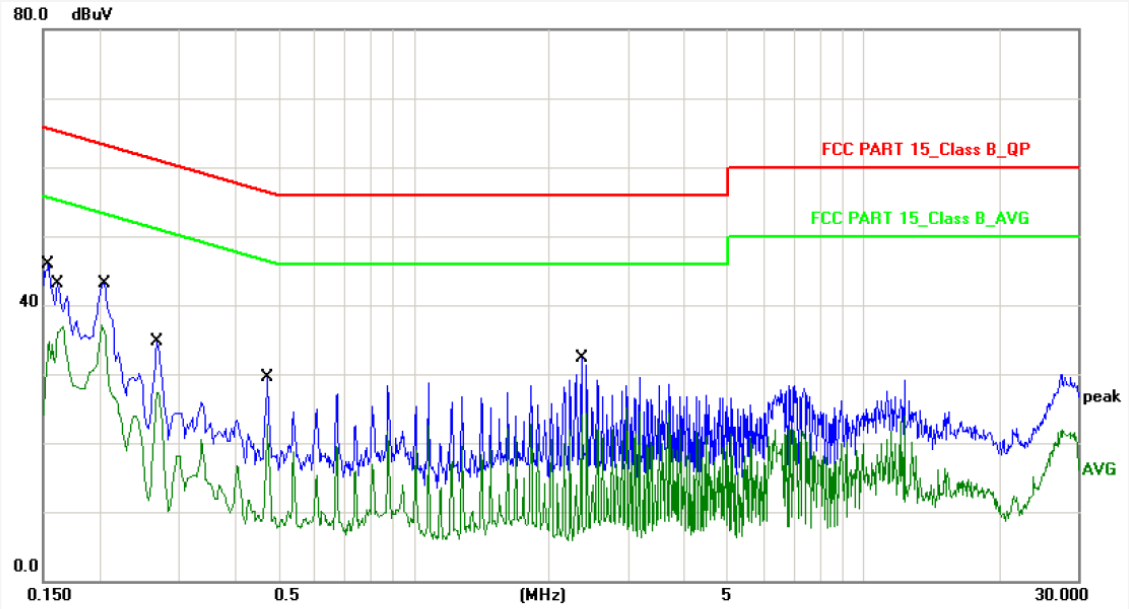
Test Mode: BT Mode
Remark: 8DPSK High channel

No.	Frequency (MHz)	Factor (dBuV)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1539	10.80	31.40	42.20	65.78	-23.58	QP	P	
2	0.1539	10.80	16.20	27.00	55.78	-28.78	AVG	P	
3	0.2020	10.80	28.80	39.60	63.52	-23.92	QP	P	
4	0.2020	10.80	23.10	33.90	53.52	-19.62	AVG	P	
5	0.2700	10.80	24.00	34.80	61.12	-26.32	QP	P	
6	0.2700	10.80	19.00	29.80	51.12	-21.32	AVG	P	
7	0.6780	10.80	17.60	28.40	56.00	-27.60	QP	P	
8	0.6780	10.80	13.60	24.40	46.00	-21.60	AVG	P	
9	1.2180	10.80	18.60	29.40	56.00	-26.60	QP	P	
10	1.2180	10.80	14.40	25.20	46.00	-20.80	AVG	P	
11	2.3660	10.80	20.70	31.50	56.00	-24.50	QP	P	
12	2.3660	10.80	9.00	19.80	46.00	-26.20	AVG	P	

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

Site: Conduction

Test Time: 2016-10-16 19:05:34



Report No.: F23BUUM13-W2
Test Standard: FCC PART 15_Class B_QP
Test item: Conducted Emission
Phase: N
Applicant: Fender Musical
Temp.( )/Hum.(%): 22(C) / 52 %
Product: WIFI+BT Module
Power Rating: AC 120V/60Hz
Model No.: F23BUUM13-W2
Test Engineer: Jerry

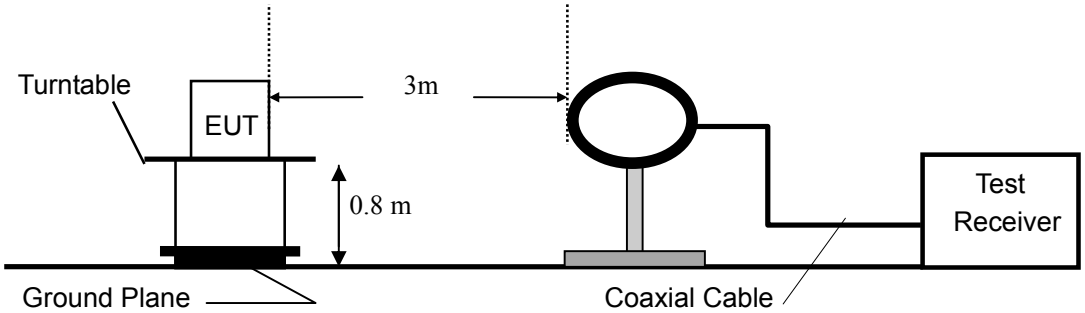
Test Mode: BT Mode
Remark: 8DPSK High channel

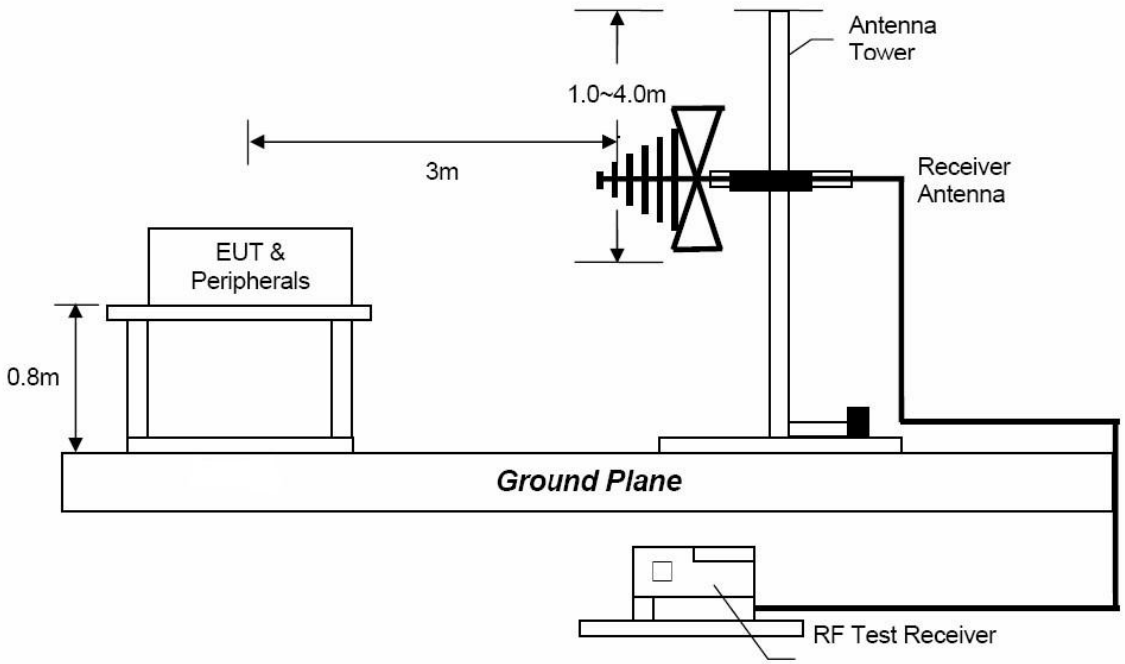
No.	Frequency (MHz)	Factor (dBuV)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1539	10.80	33.00	43.80	65.78	-21.98	QP	P	
2	0.1539	10.80	21.80	32.60	55.78	-23.18	AVG	P	
3	0.1620	10.80	30.20	41.00	65.36	-24.36	QP	P	
4	0.1620	10.80	24.00	34.80	55.36	-20.56	AVG	P	
5	0.2060	10.80	30.70	41.50	63.36	-21.86	QP	P	
6	0.2060	10.80	24.20	35.00	53.36	-18.36	AVG	P	
7	0.2700	10.80	21.80	32.60	61.12	-28.52	QP	P	
8	0.2700	10.80	14.40	25.20	51.12	-25.92	AVG	P	
9	0.4740	10.80	16.70	27.50	56.44	-28.94	QP	P	
10	0.4740	10.80	9.90	20.70	46.44	-25.74	AVG	P	
11	2.3660	10.80	19.40	30.20	56.00	-25.80	QP	P	
12	2.3660	10.80	11.50	22.30	46.00	-23.70	AVG	P	

4. Radiated Emission Test

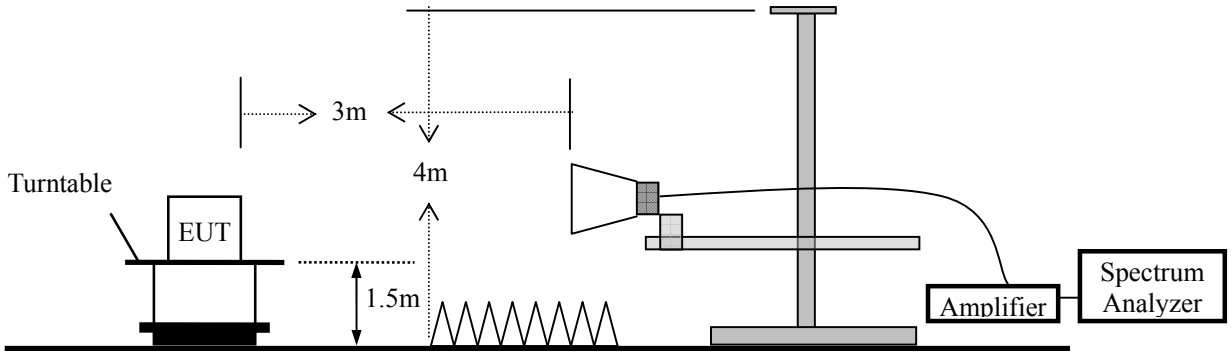
4.1 Test SET-UP (Block Diagram of Configuration)

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

a. 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.
b. 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.
c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. 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.
e. 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.
f. 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) μV/m
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(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 (dB)μV = 20 log Emission level μV/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.

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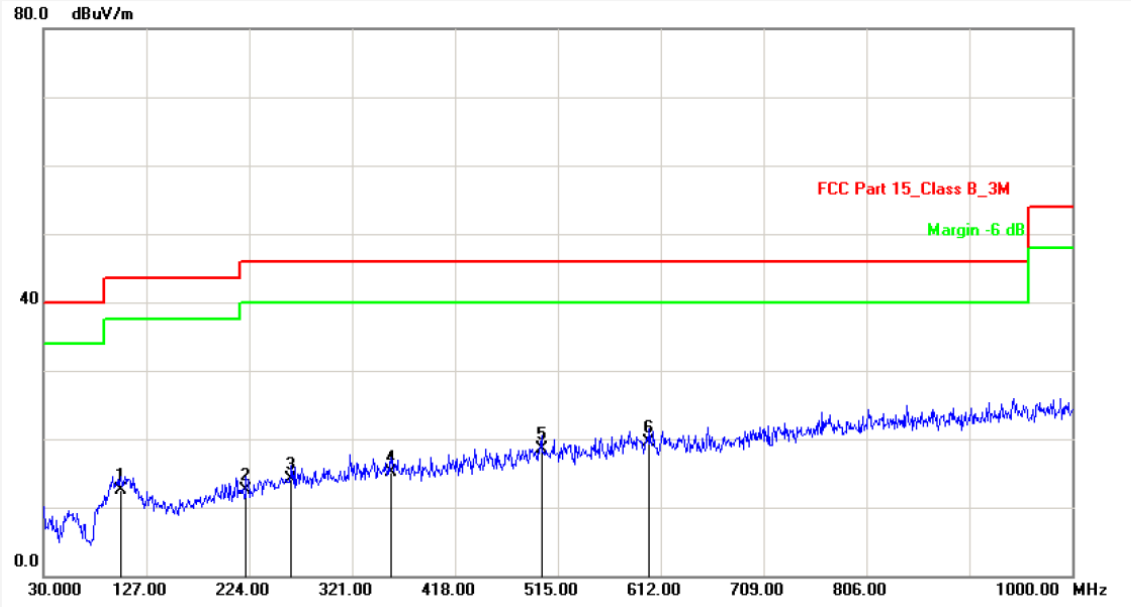
Tel:+86-769-22022444 Fax:+86-769-22022799
Web: Http://www.ntc-c.com

Site: Radiation

Test Time: 2016-10-11 11:09:04



Report No.:	F23BUUM13-W2		
Test Standard:	FCC Part 15_Class B_3M	Test Distance:	3m
Test item:	Radiation Emission	Ant. Polarization:	Horizontal
Applicant:	Fender Musical	Temp.(C)/Hum.(%):	22(C) / 54 %
Product:	WIFI+BT Module	Power Rating:	AC 120V/60Hz
Model No.:	F23BUUM13-W2	Test Engineer:	Ryan

Test Mode: BT Mode

Remark: 8DPSK High channel

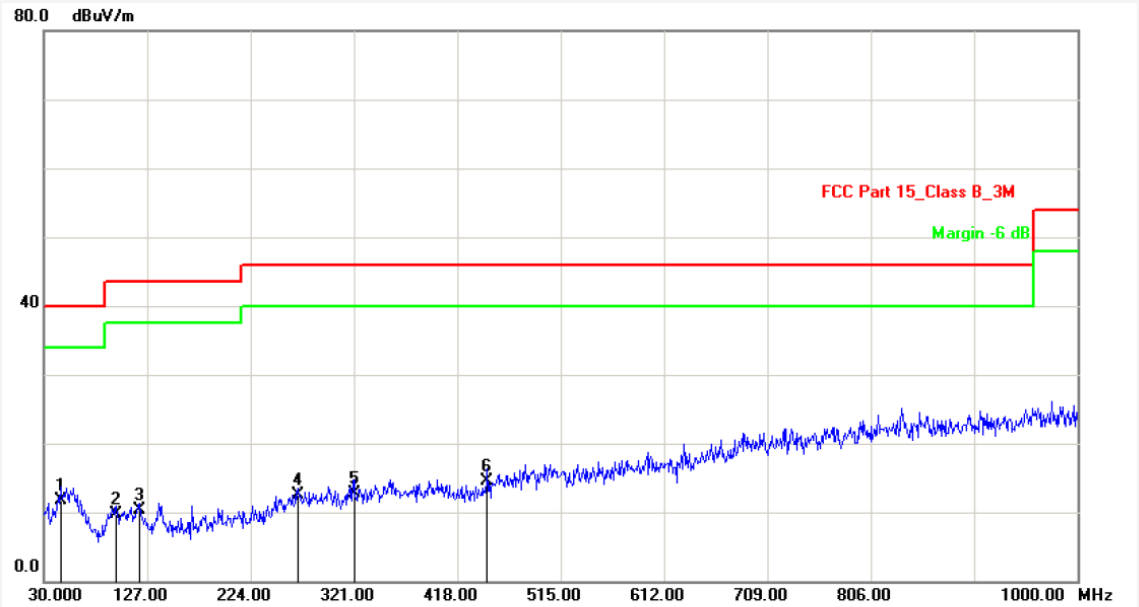
No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	102.7500	-12.03	24.53	12.50	43.50	-31.00	QP			P	
2	221.0900	-12.91	25.51	12.60	46.00	-33.40	QP			P	
3	263.7699	-11.34	25.44	14.10	46.00	-31.90	QP			P	
4	357.8599	-9.13	24.33	15.20	46.00	-30.80	QP			P	
5	499.4800	-6.77	25.27	18.50	46.00	-27.50	QP			P	
6	601.3300	-5.00	24.50	19.50	46.00	-26.50	QP			P	

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

Site: Radiation

Test Time: 2016-10-11 11:17:28



Report No.:	F23BUUM13-W2		
Test Standard:	FCC Part 15_Class B_3M	Test Distance:	3m
Test item:	Radiation Emission	Ant. Polarization:	Vertical
Applicant:	Fender Musical	Temp.(C)/Hum.(%):	22(C) / 54 %
Product:	WIFI+BT Module	Power Rating:	AC 120V/60Hz
Model No.:	F23BUUM13-W2	Test Engineer:	Ryan

Test Mode: BT Mdoe

Remark: 8DPSK High channel

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	45.5200	-13.73	25.43	11.70	40.00	-28.30	QP			P	
2	97.9000	-15.98	25.78	9.80	43.50	-33.70	QP			P	
3	120.2099	-17.08	27.48	10.40	43.50	-33.10	QP			P	
4	268.6200	-13.22	25.72	12.50	46.00	-33.50	QP			P	
5	321.0000	-11.90	24.60	12.70	46.00	-33.30	QP			P	
6	446.1299	-10.75	25.35	14.60	46.00	-31.40	QP			P	

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

Modulation:	8DPSK (the worst case)		
Frequency Range:	1-25GHz	Test Date :	October 11, 2016
Test Result:	PASS	Temperature :	22 ℃
Measured Distance:	3m	Humidity :	54 %
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	38.37	28.57	14.05	52.42	42.62	74.00	54.00	-21.58	-11.38
7206	V	35.98	26.01	18.81	54.79	44.82	74.00	54.00	-19.21	-9.18

4804	H	39.14	29.67	14.05	53.19	43.72	74.00	54.00	-20.81	-10.28
7206	H	36.65	25.00	18.18	54.83	43.18	74.00	54.00	-19.17	-10.82

Operation Mode: TX Mode (Mid)										
4882	V	39.78	29.27	14.41	54.19	43.68	74.00	54.00	-19.81	-10.32
7323	V	36.16	25.43	18.36	54.52	43.79	74.00	54.00	-19.48	-10.21

4882	H	40.21	29.42	14.41	54.62	43.83	74.00	54.00	-19.38	-10.17
7323	H	36.83	26.16	18.36	55.19	44.52	74.00	54.00	-18.81	-9.48

Operation Mode: TX Mode (High)										
4960	V	36.92	26.96	14.76	51.68	41.72	74.00	54.00	-22.32	-12.28
7440	V	31.48	23.69	18.55	50.03	42.24	74.00	54.00	-23.97	-11.76

4960	H	35.33	23.86	14.76	50.09	38.62	74.00	54.00	-23.91	-15.38
7440	H	34.77	23.93	18.55	53.32	42.48	74.00	54.00	-20.68	-11.52

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

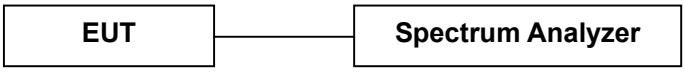
5. Channel Separation test

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)

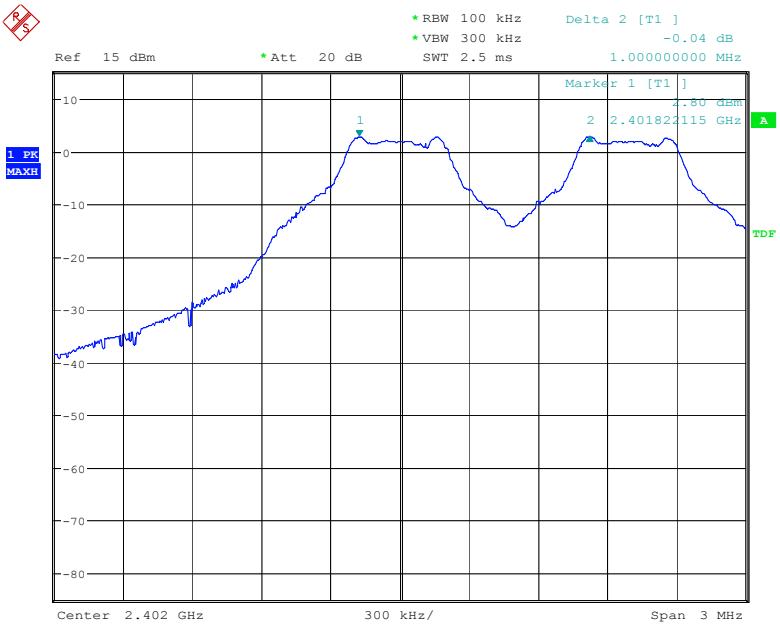


5.3 Measurement Results

Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	100KHz	VBW:	300KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	October 11, 2016
Temperature :	24 ℃	Humidity :	50 %
Test Result:	PASS		

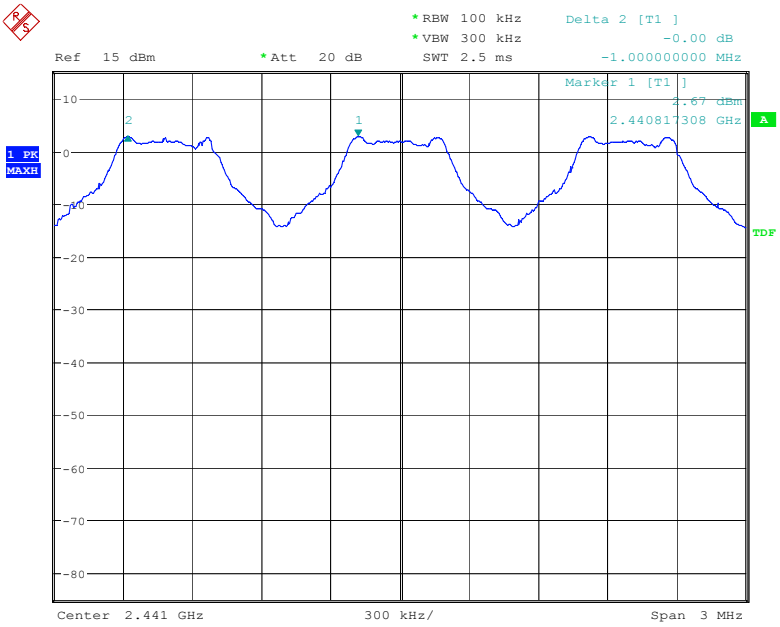
Channel number	Channel frequency (MHz)	Separation Read Value (KHz)	Separation Limit 2/3 20dB Bandwidth (KHz)
GFSK			
Lowest	2402	1000	>698.7
Middle	2441	1000	>721.3
Highest	2480	1005	>708.7
π/4-DQPSK			
Lowest	2402	1000	>891.3
Middle	2441	1000	>878.0
Highest	2480	1000	>891.3
8DPSK			
Lowest	2402	1000	>884.7
Middle	2441	1000	>888.0
Highest	2480	1000	>884.7

GFSK Lowest Channel



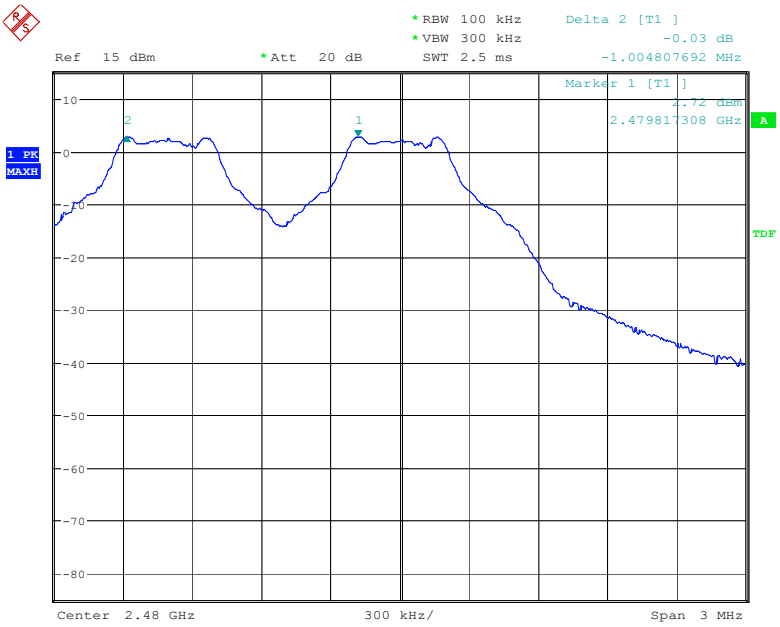
Date: 11.OCT.2016 10:51:51

GFSK Middle Channel



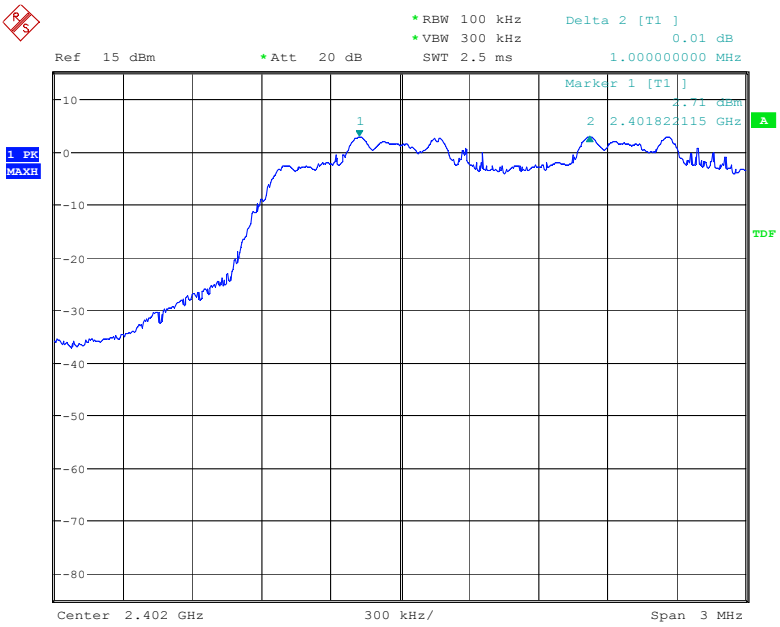
Date: 11.OCT.2016 10:53:32

GFSK Highest Channel



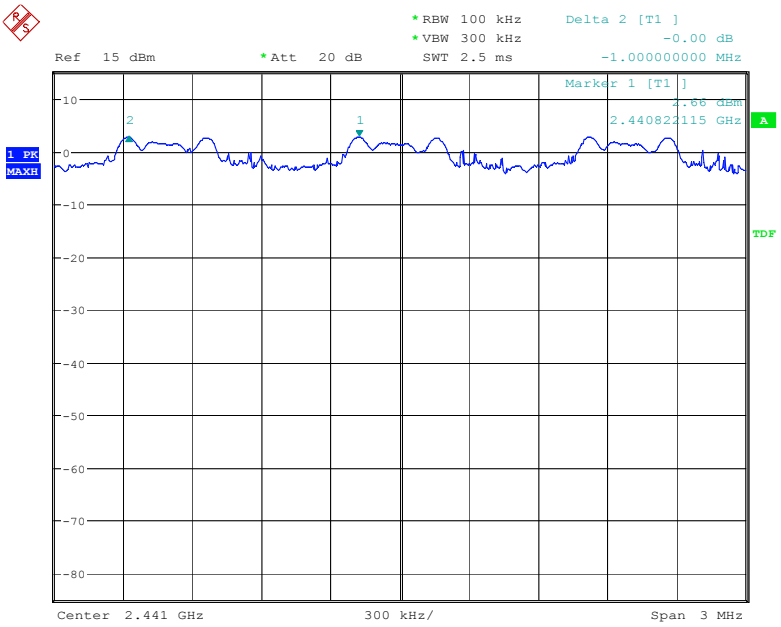
Date: 11.OCT.2016 10:55:25

π/4-DQPSK Lowest Channel



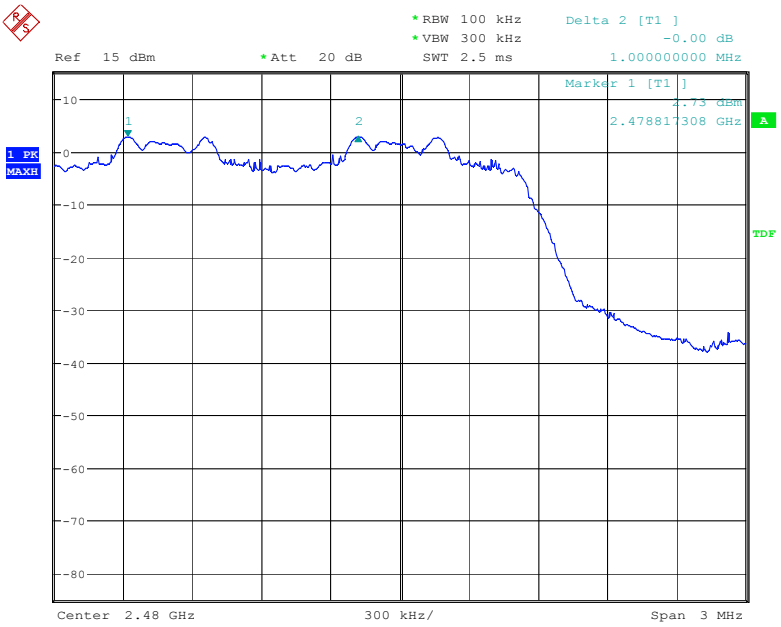
Date: 11.OCT.2016 10:57:48

π/4-DQPSK Middle Channel



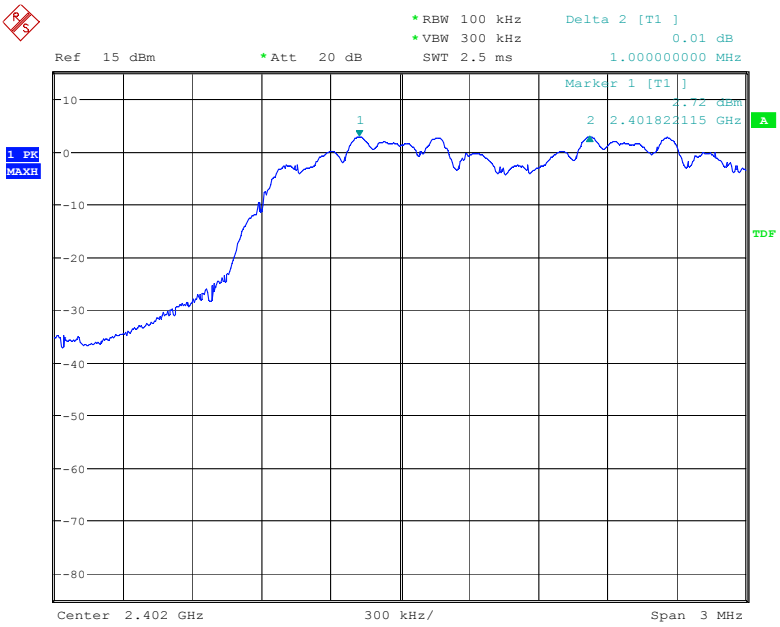
Date: 11.OCT.2016 11:01:11

π/4-DQPSK Highest Channel



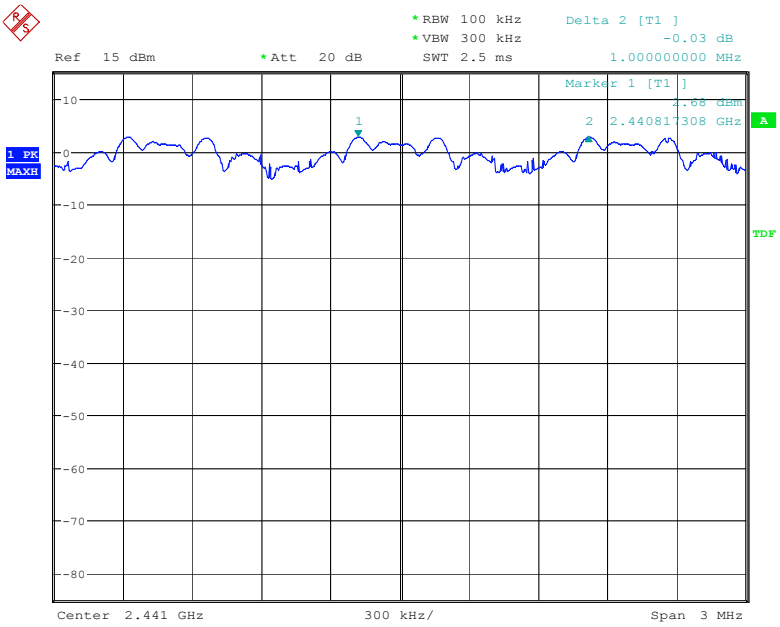
Date: 11.OCT.2016 11:02:50

8DPSK Lowest Channel



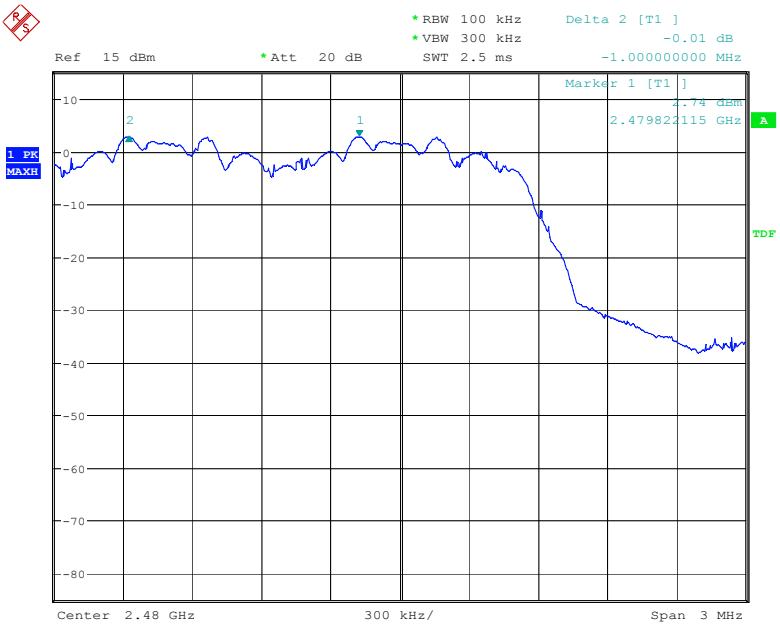
Date: 11.OCT.2016 11:04:52

8DPSK Middle Channel



Date: 11.OCT.2016 11:07:38

8DPSK Highest Channel



Date: 11.OCT.2016 11:09:13

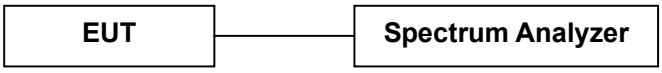
6. 20dB Bandwidth

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)



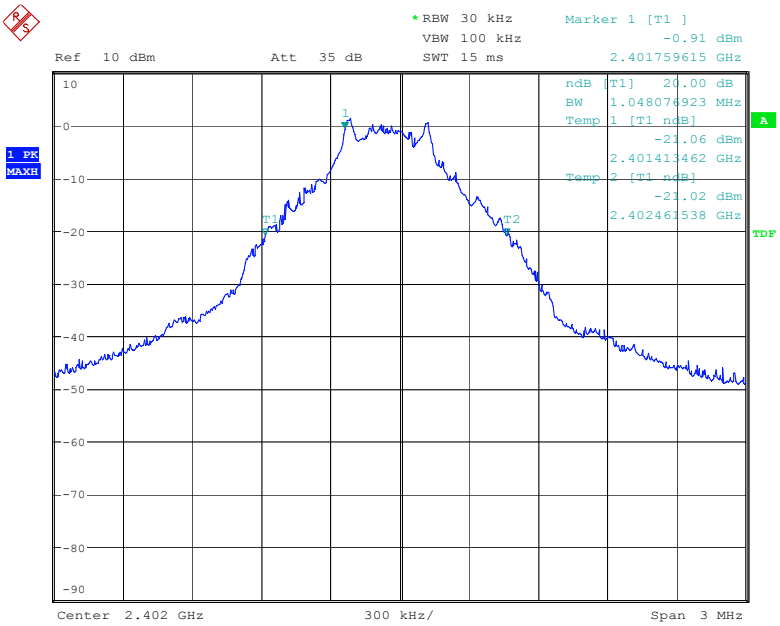
6.3 Measurement Results

Refer to attached data chart.

Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	30KHz	VBW:	100KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	October 11, 2016
Temperature :	24 ℃	Humidity :	50 %
Test Result:	PASS		

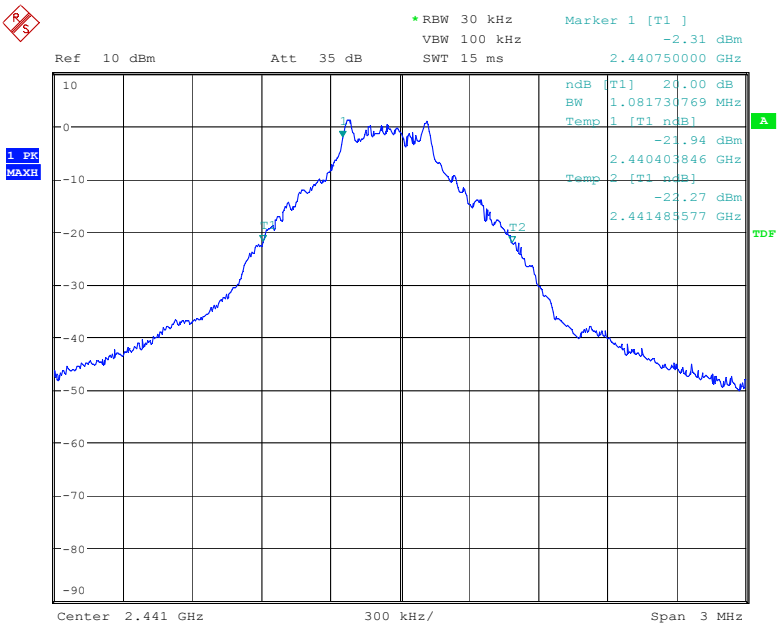
Channel frequency (MHz)	20dB Down BW(kHz)
GFSK	
2402	1048
2441	1082
2480	1063
π/4-DQPSK	
2402	1337
2441	1317
2480	1337
8DPSK	
2402	1327
2441	1332
2480	1327

GFSK Lowest Channel



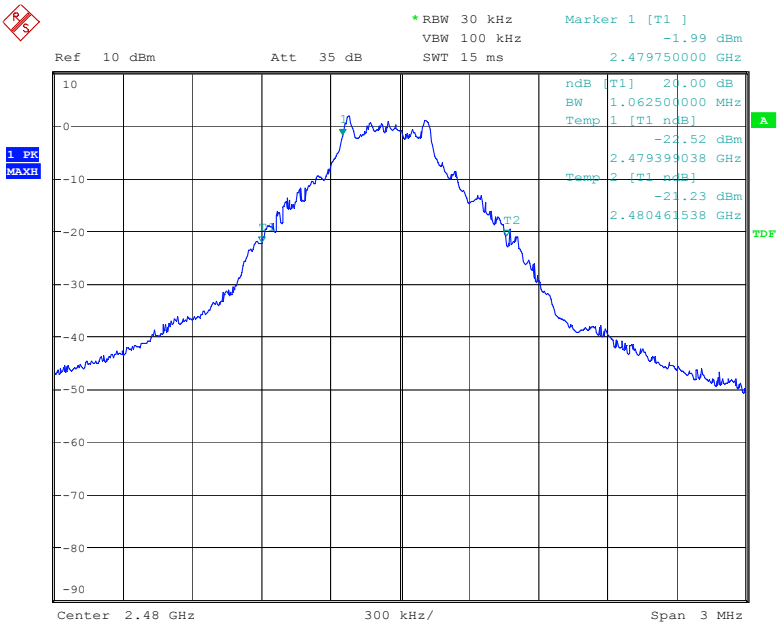
Date: 11.OCT.2016 10:29:20

GFSK Middle Channel



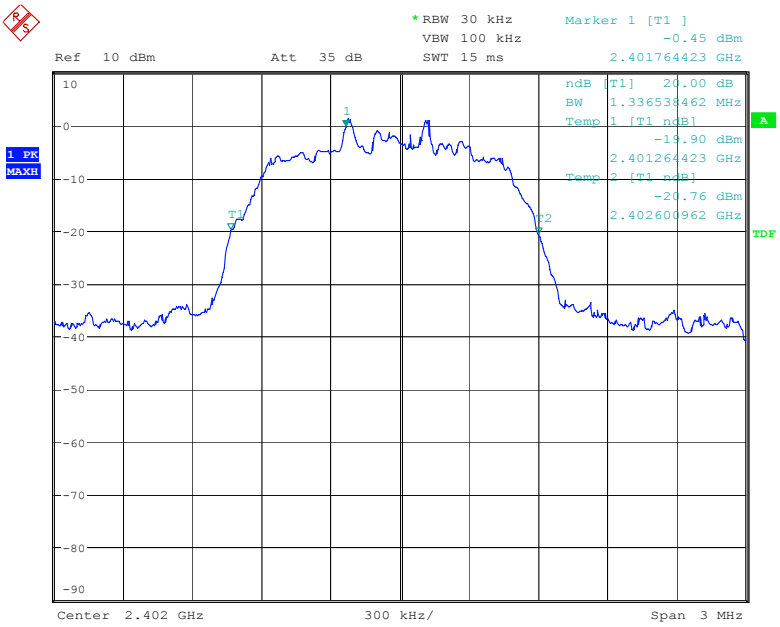
Date: 11.OCT.2016 10:31:46

GFSK Highest Channel



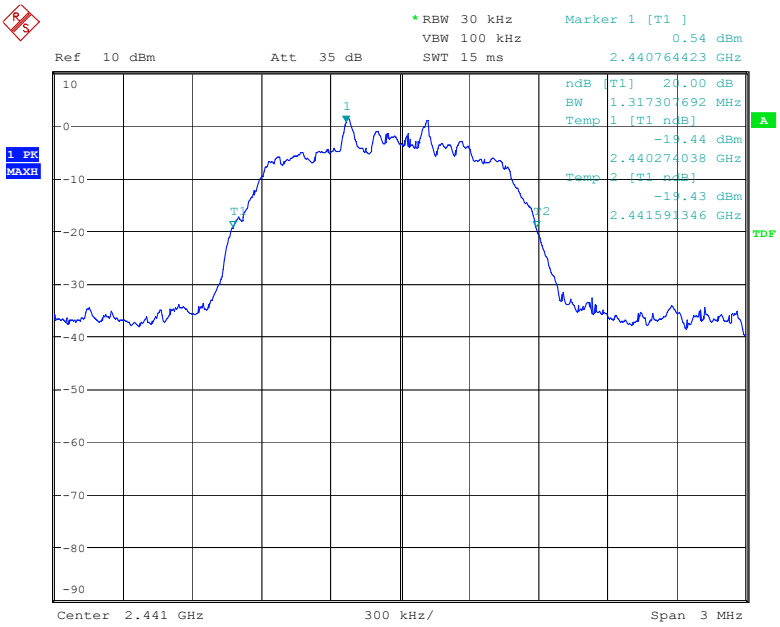
Date: 11.OCT.2016 10:33:49

π/4-DQPSK Lowest Channel



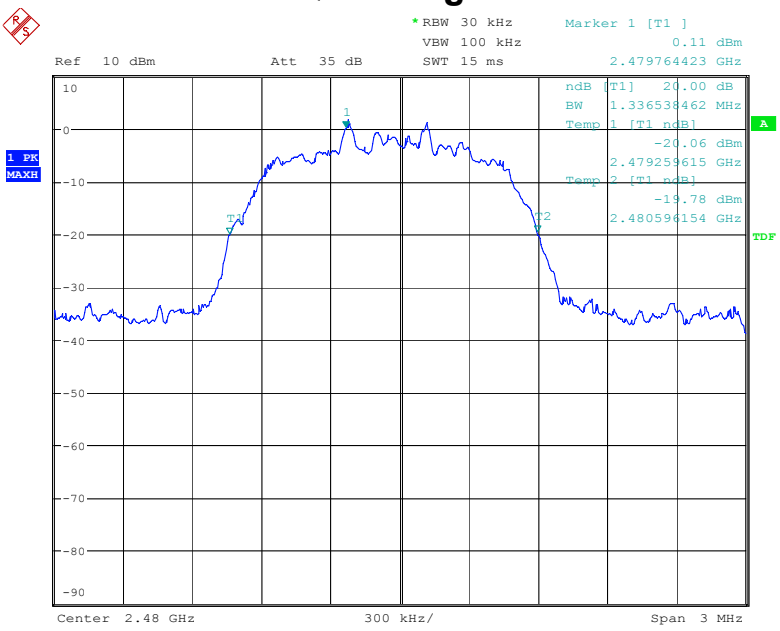
Date: 11.OCT.2016 10:36:26

π/4-DQPSK Middle Channel



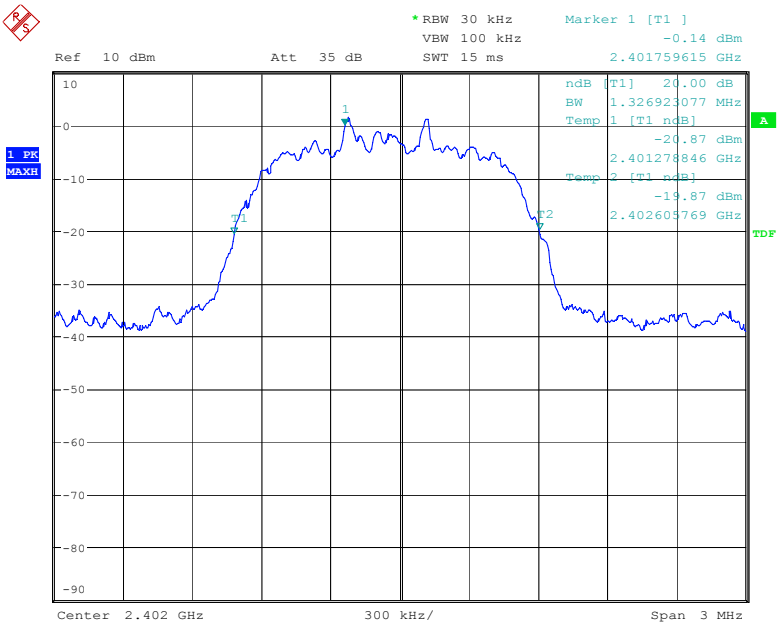
Date: 11.OCT.2016 10:40:21

π/4-DQPSK Highest Channel



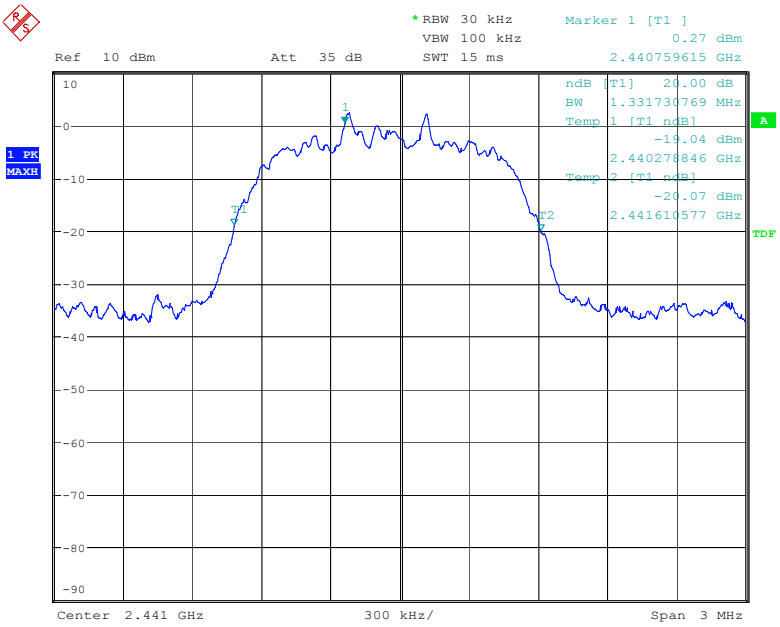
Date: 11.OCT.2016 10:42:35

8DPSK Lowest Channel



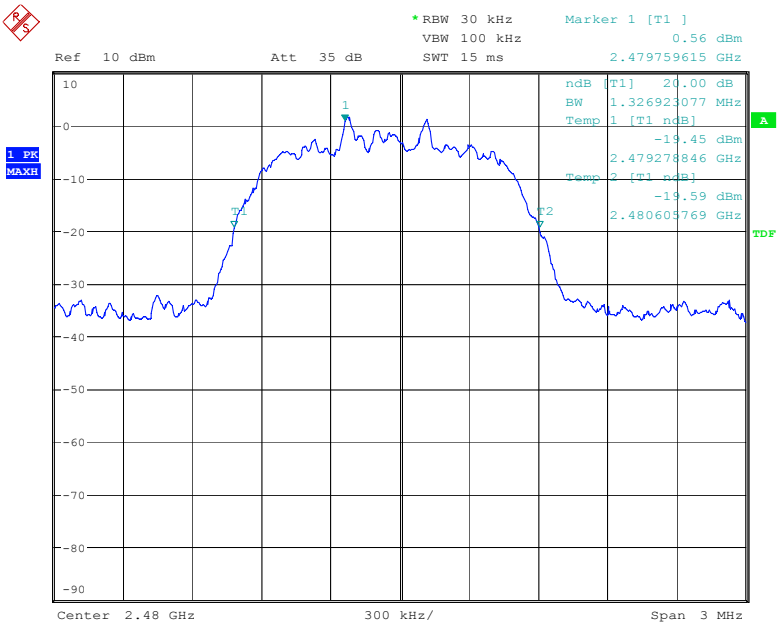
Date: 11.OCT.2016 10:44:50

8DPSK Middle Channel



Date: 11.OCT.2016 10:46:18

8DPSK Highest Channel



Date: 11.OCT.2016 10:48:19

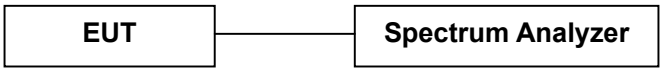
7. Hopping Channel Number

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)



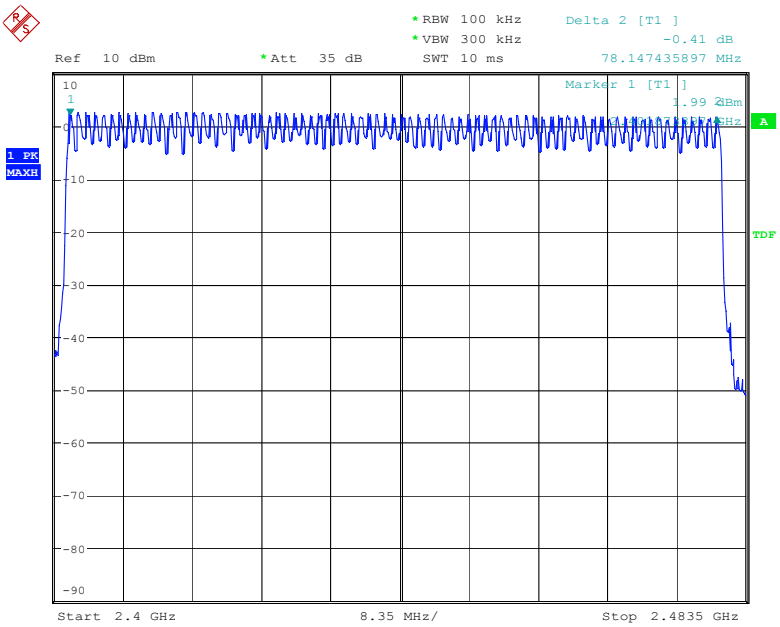
7.3 Measurement Results

Modulation	GFSK, π/4-DQPSK, 8DPSK		
RBW:	100KHz	VBW:	300KHz
Packet:	DH5	Spectrum Detector:	PK
Test By:	Sance	Test Date :	October 11, 2016
Temperature :	24 ℃	Humidity :	50 %
Test Result:	PASS		

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

The worst case: 8DPSK

8DPSK



Date: 11.OCT.2016 14:20:23

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

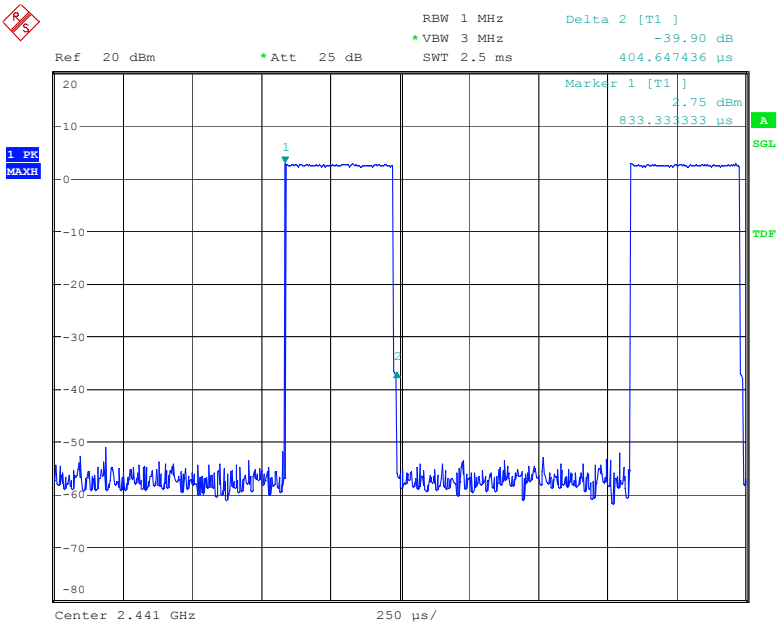
The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

Refer to attached data chart.

Modulation :	GFSK, π/4-DQPSK, 8DPSK		
RBW :	1MHz	VBW :	3MHz
Spectrum Detector:	PK	Test By:	Sance
Test Date :	October 11, 2016	Temperature :	24℃
Test Result:	PASS	Humidity :	50 %

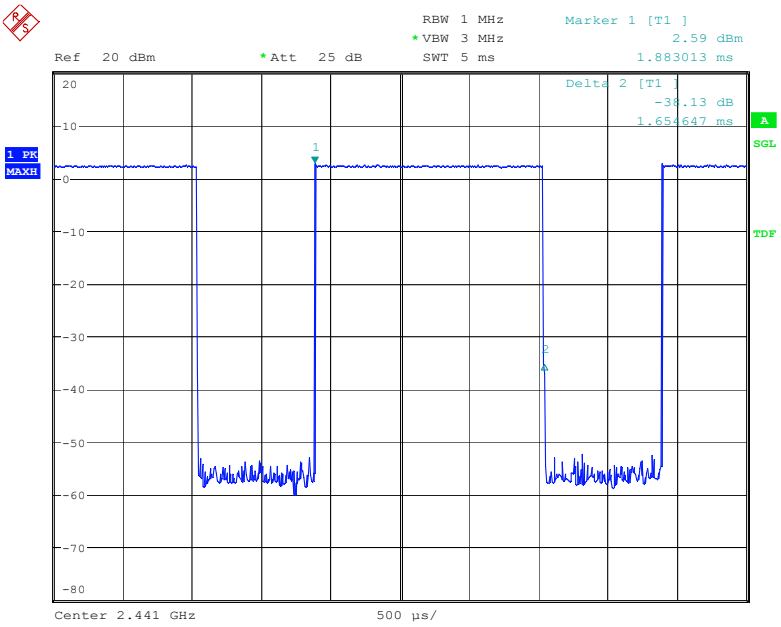
Packet	Frequency (MHz)	Result (msec)			Limit (msec)
GFSK					
DH1	2441	0.405	(ms)*(1600/(2*79))*31.6=	129.6	400
DH3	2441	1.655	(ms)*(1600/(4*79))*31.6=	264.8	400
DH5	2441	2.921	(ms)*(1600/(6*79))*31.6=	311.6	400
π/4-DQPSK					
2-DH1	2441	0.413	(ms)*(1600/(2*79))*31.6=	132.2	400
2-DH3	2441	1.663	(ms)*(1600/(4*79))*31.6=	266.1	400
2-DH5	2441	2.925	(ms)*(1600/(6*79))*31.6=	312.0	400
8DPSK					
3-DH1	2441	0.413	(ms)*(1600/(2*79))*31.6=	132.2	400
3-DH3	2441	1.671	(ms)*(1600/(4*79))*31.6=	267.4	400
3-DH5	2441	2.925	(ms)*(1600/(6*79))*31.6=	312.0	400

GFSK DH1



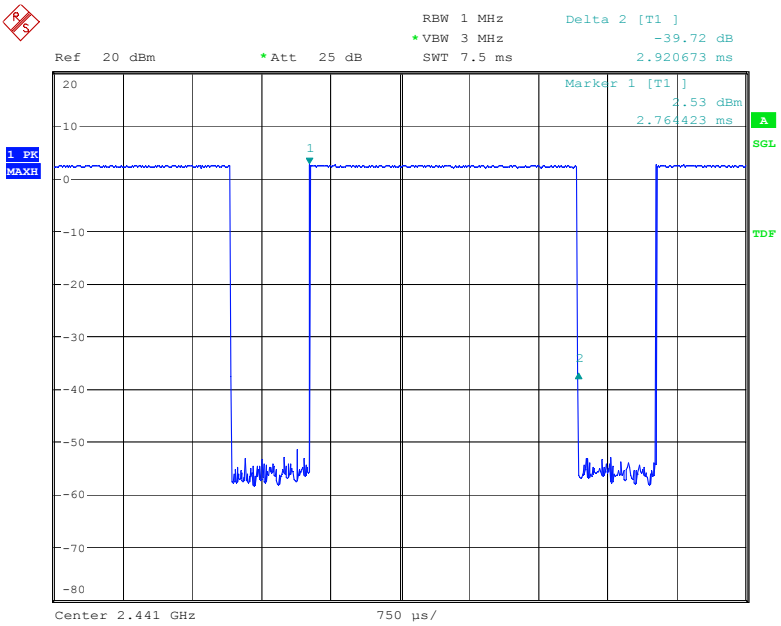
Date: 11.OCT.2016 13:23:19

GFSK DH3



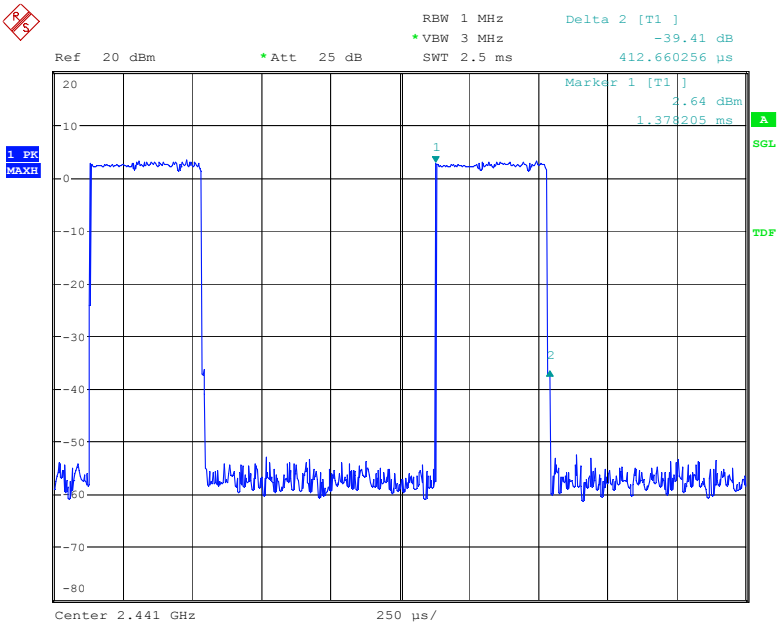
Date: 11.OCT.2016 13:27:08

GFSK DH5



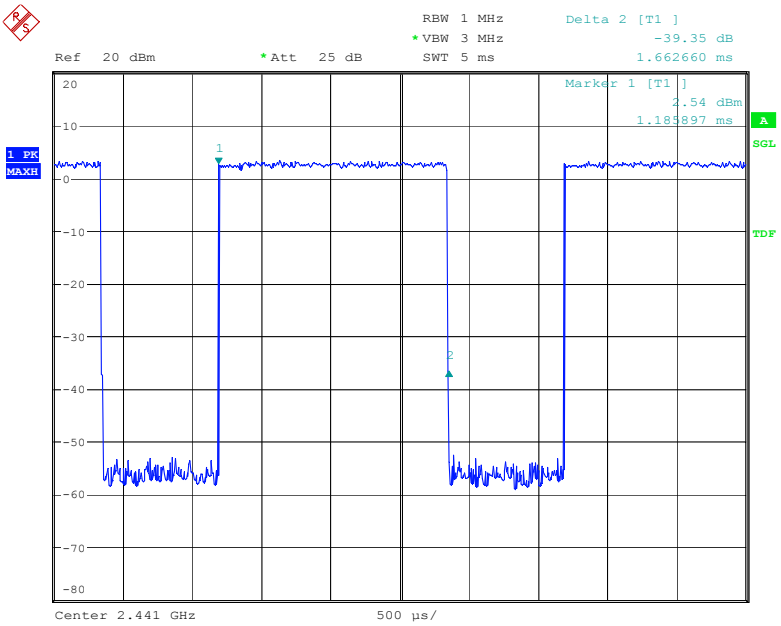
Date: 11.OCT.2016 13:27:38

π/4-DQPSK 2-DH1



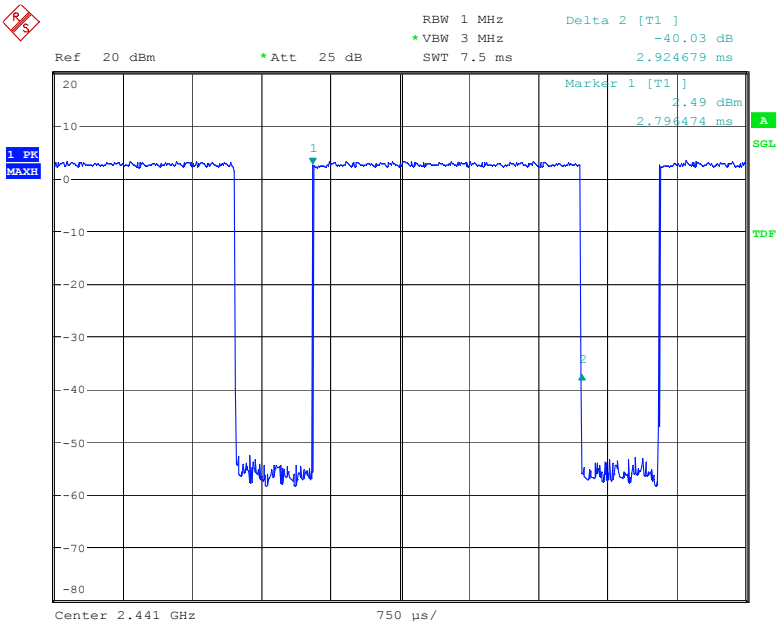
Date: 11.OCT.2016 13:28:26

π/4-DQPSK 2-DH3



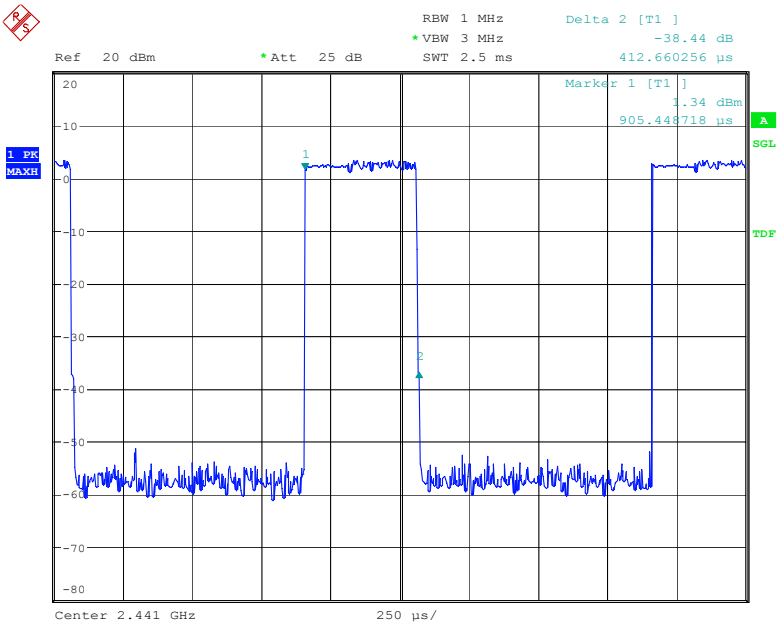
Date: 11.OCT.2016 13:28:59

π/4-DQPSK 2-DH5



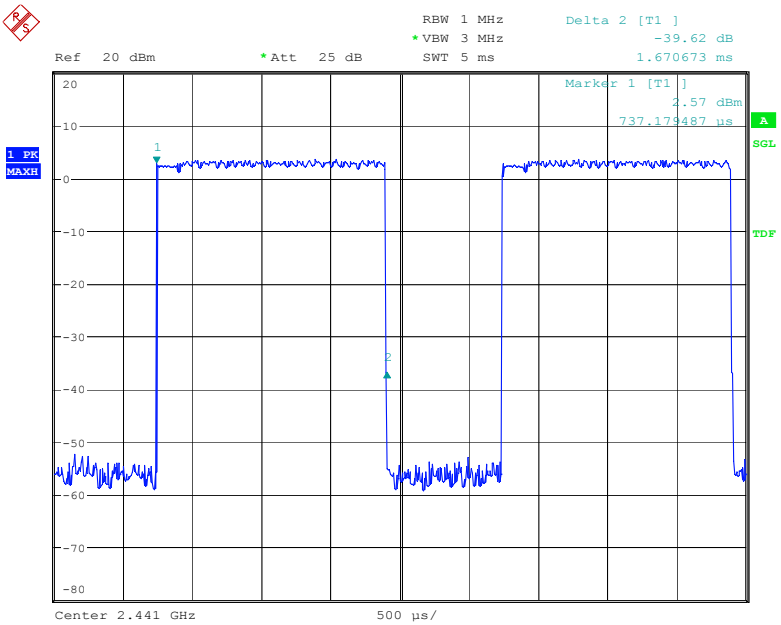
Date: 11.OCT.2016 13:29:34

8DPSK 3-DH1



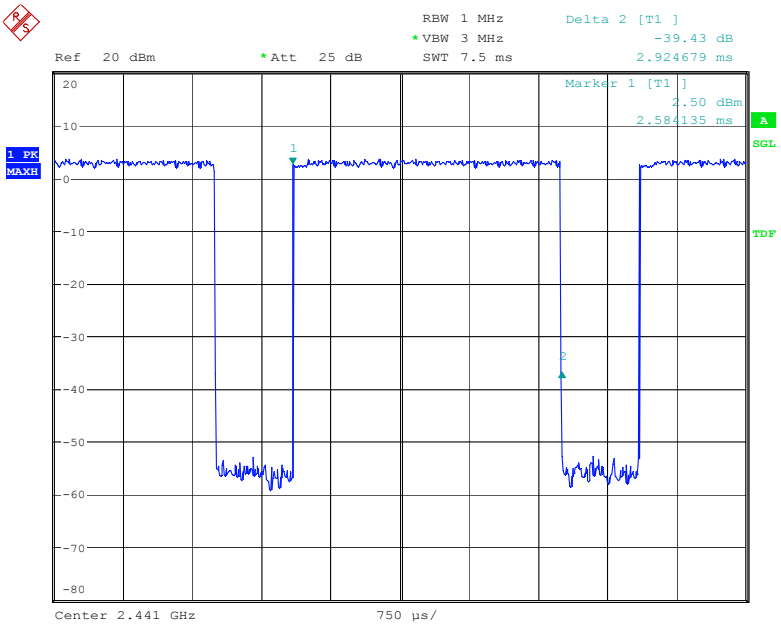
Date: 11.OCT.2016 13:30:05

8DPSK 3-DH3



Date: 11.OCT.2016 13:30:45

8DPSK 3-DH5



Date: 11.OCT.2016 13:31:48

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.

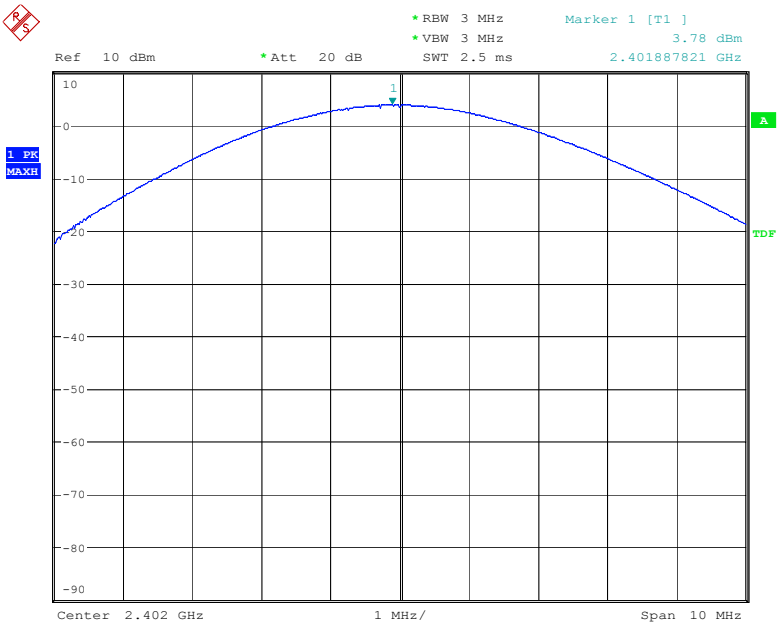
9.2 Measurement Results

Refer to attached data chart.

Modulation :	GFSK, π/4-DQPSK, 8DPSK		
RBW :	3MHz	VBW :	3MHz
Spectrum Detector:	PK	Test Date :	October 11, 2016
Test By:	Sance	Temperature :	24 ℃
Test Result:	PASS	Humidity :	50 %

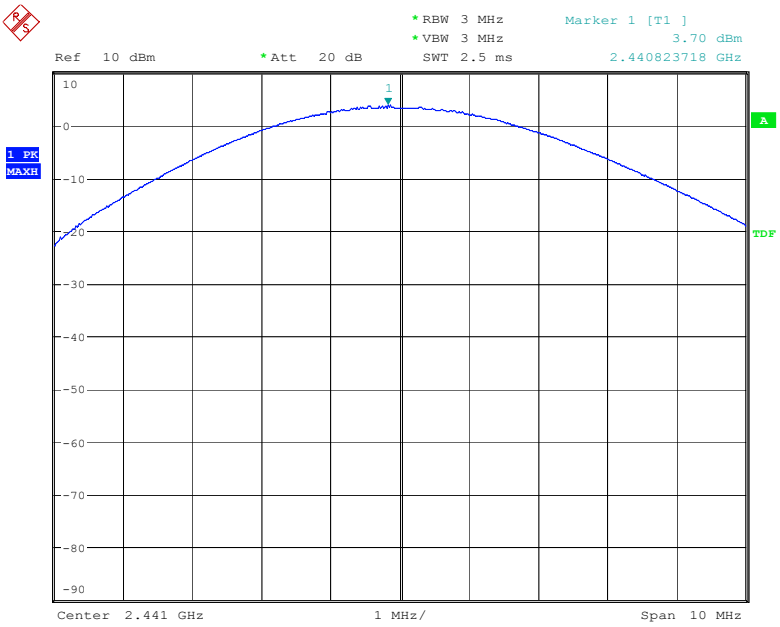
Channel Frequency (MHz)	Cable Loss dB	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(dBm)	Pass/Fail
GFSK					
2402.00	1.5	3.78	2.39	21	PASS
2441.00	1.5	3.70	2.34	21	PASS
2480.00	1.5	3.69	2.34	21	PASS
π/4-DQPSK					
2402.00	1.5	4.61	2.89	21	PASS
2441.00	1.5	4.64	2.91	21	PASS
2480.00	1.5	4.73	2.97	21	PASS
8DPSK					
2402.00	1.5	4.87	3.07	21	PASS
2441.00	1.5	4.92	3.10	21	PASS
2480.00	1.5	4.98	3.15	21	PASS

GFSK Lowest Channel



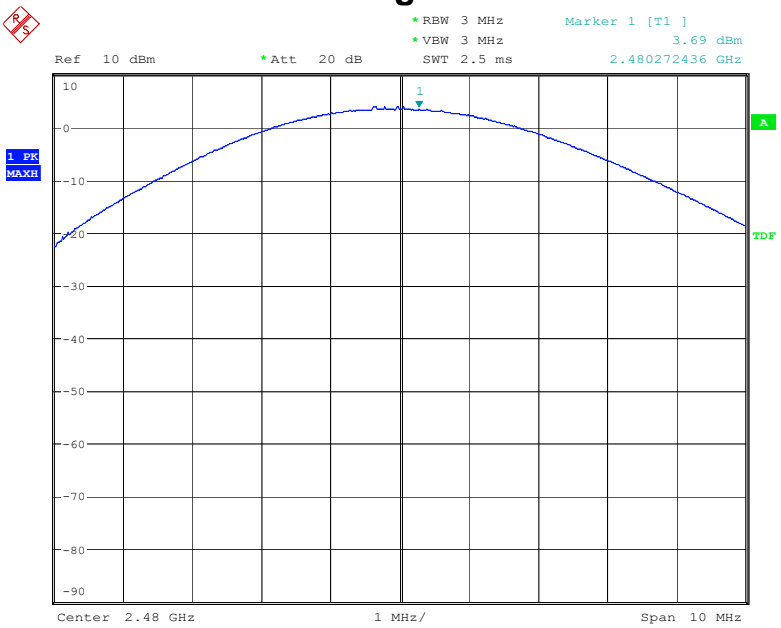
Date: 11.OCT.2016 10:24:00

GFSK Middle Channel



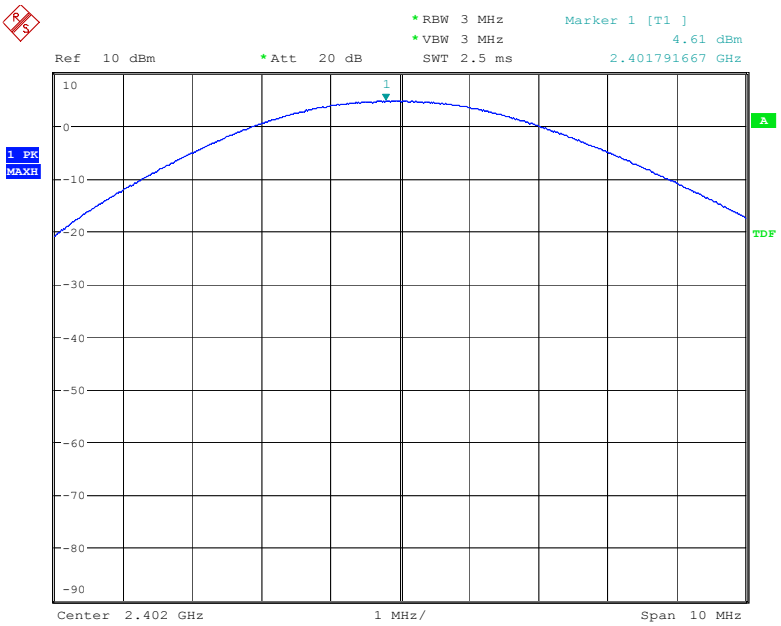
Date: 11.OCT.2016 10:24:34

GFSK Highest Channel



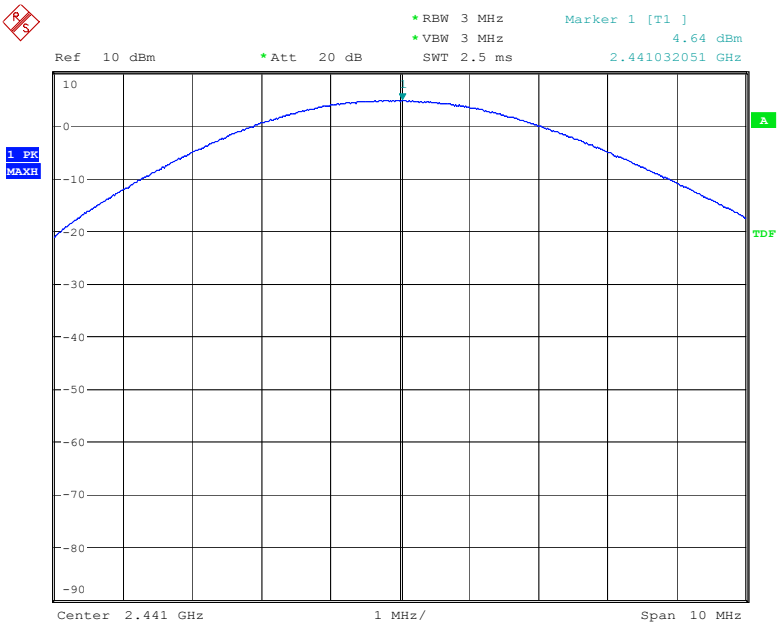
Date: 11.OCT.2016 10:24:47

π/4-DQPSK Lowest Channel



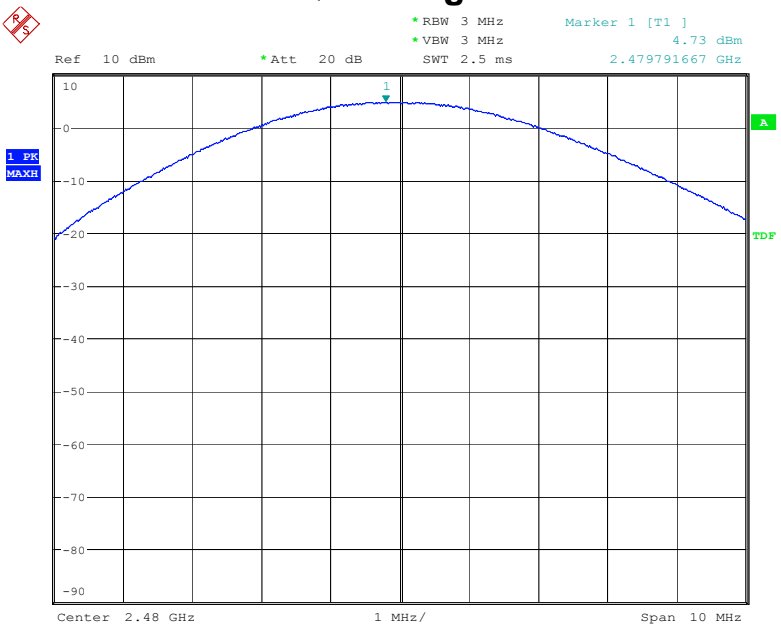
Date: 11.OCT.2016 10:25:07

π/4-DQPSK Middle Channel



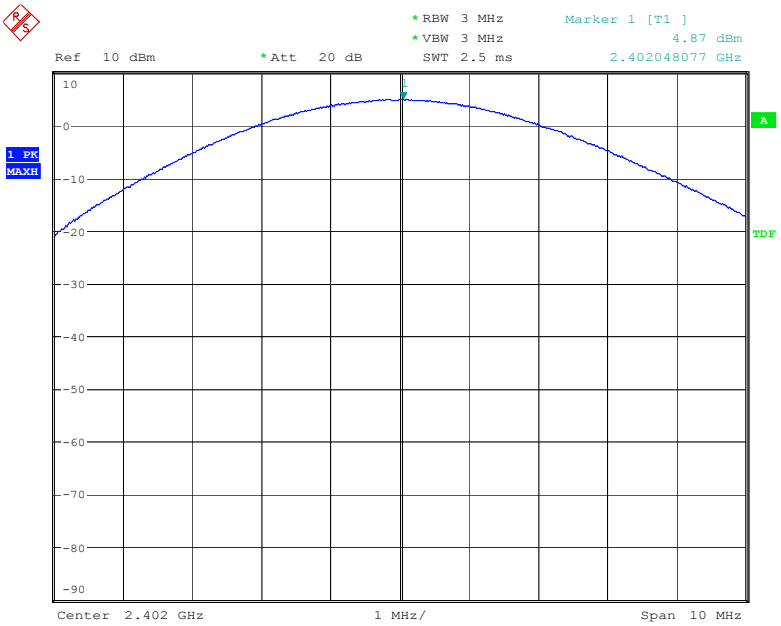
Date: 11.OCT.2016 10:25:25

π/4-DQPSK Highest Channel



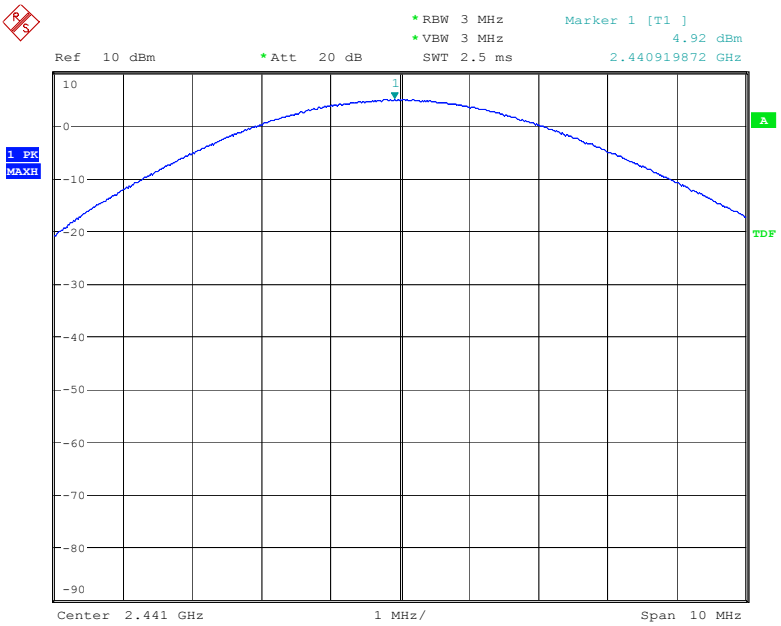
Date: 11.OCT.2016 10:25:43

8DPSK Lowest Channel



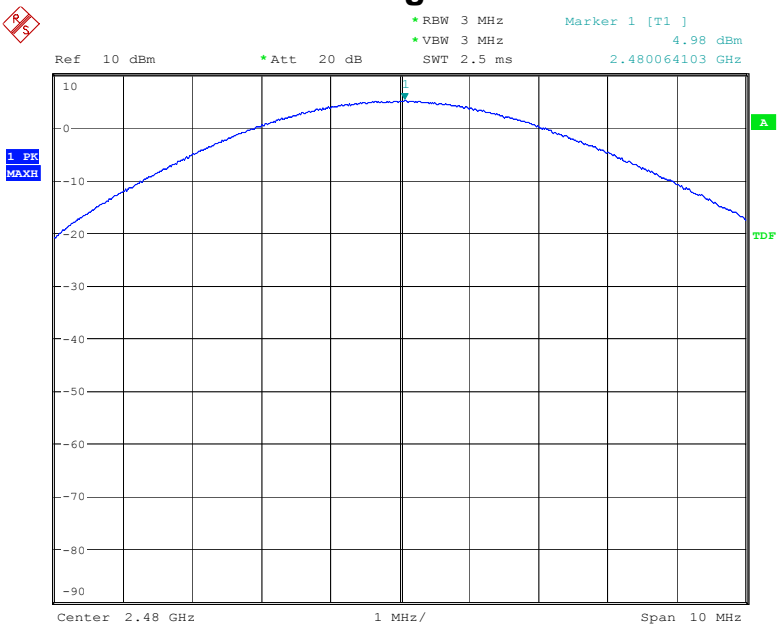
Date: 11.OCT.2016 10:26:02

8DPSK Middle Channel



Date: 11.OCT.2016 10:26:15

8DPSK Highest Channel



Date: 11.OCT.2016 10:26:29

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 to100KHz, 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

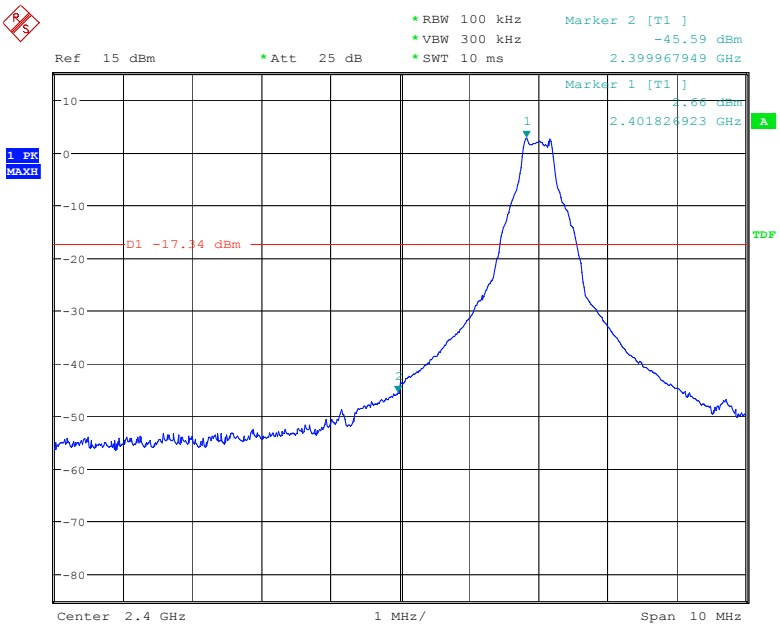
Please see below test table and plots.
For Radiated Emission
The worst case: 8DPSK
Hopping-on mode

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	40.26	28.24	8.09	48.35	36.33	74.00	54.00	-25.65	-17.67
2390.000	V	42.06	32.17	8.09	50.15	40.26	74.00	54.00	-23.85	-13.74
2483.500	H	45.80	36.96	8.36	54.16	45.32	74.00	54.00	-19.84	-8.68
2483.500	V	43.40	33.49	8.36	51.76	41.85	74.00	54.00	-22.24	-12.15

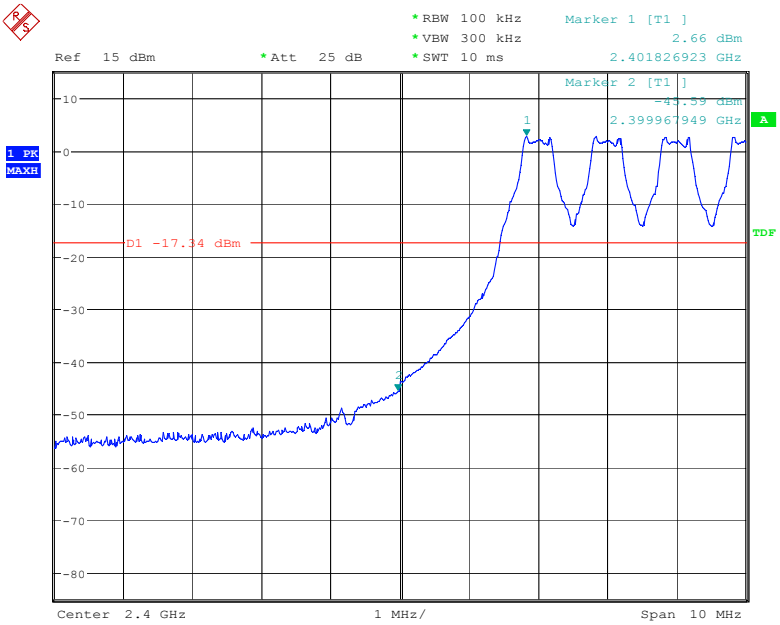
Note: (1) Emission Level= Reading Level + Factor
(2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(3) Horn antenna used for the emission over 1000MHz.

For RF Conducted

GFSK Lowest Channel

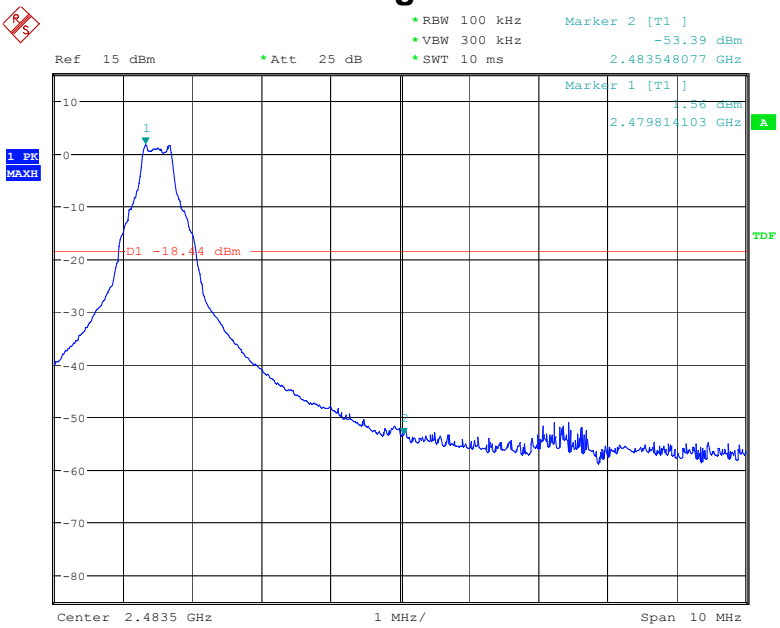


Date: 11.OCT.2016 13:36:45

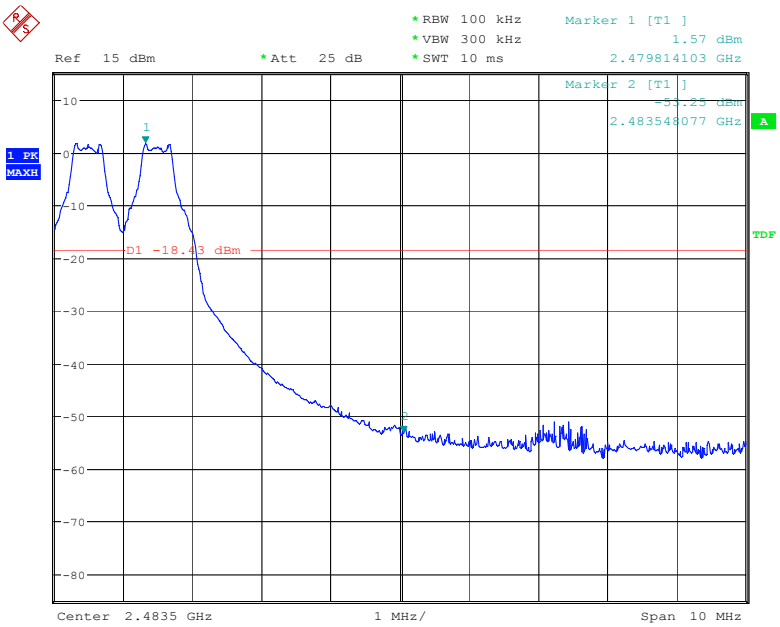


Date: 11.OCT.2016 13:38:19

GFSK Highest Channel

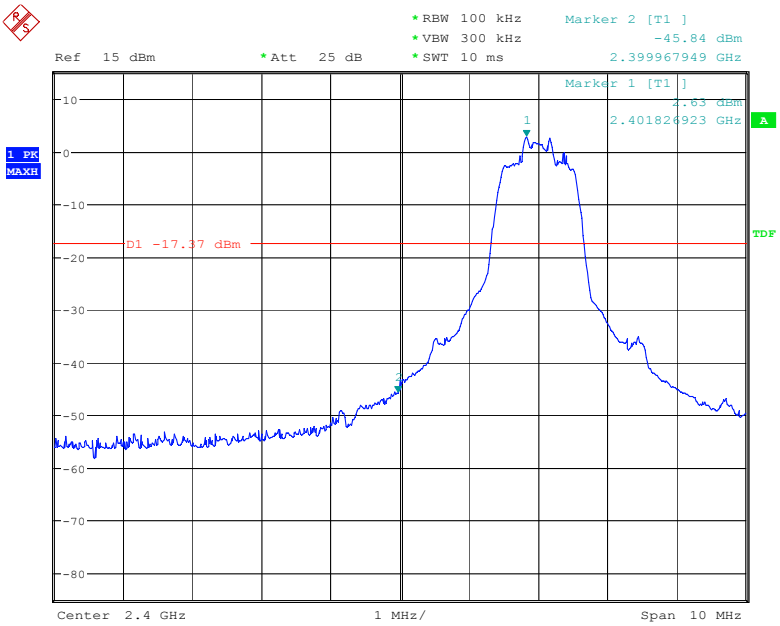


Date: 11.OCT.2016 13:40:04

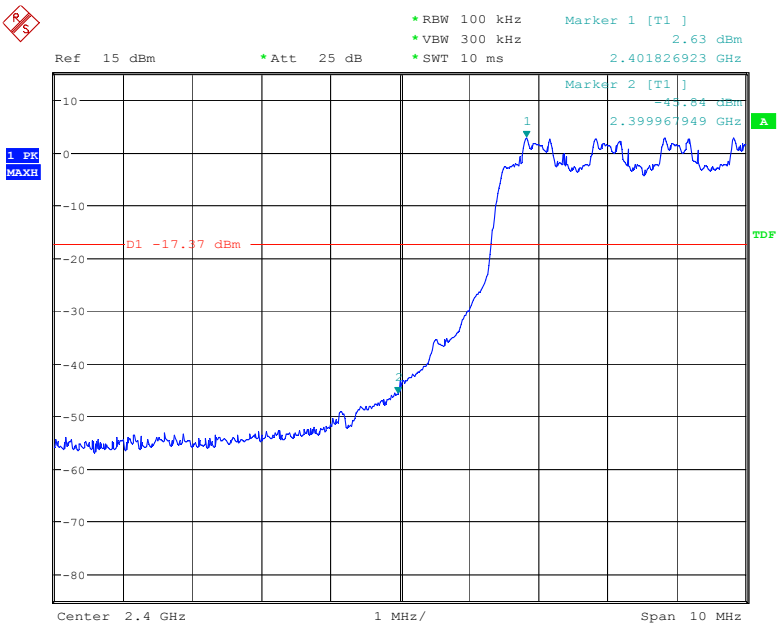


Date: 11.OCT.2016 13:41:09

π/4-DQPSK Lowest Channel

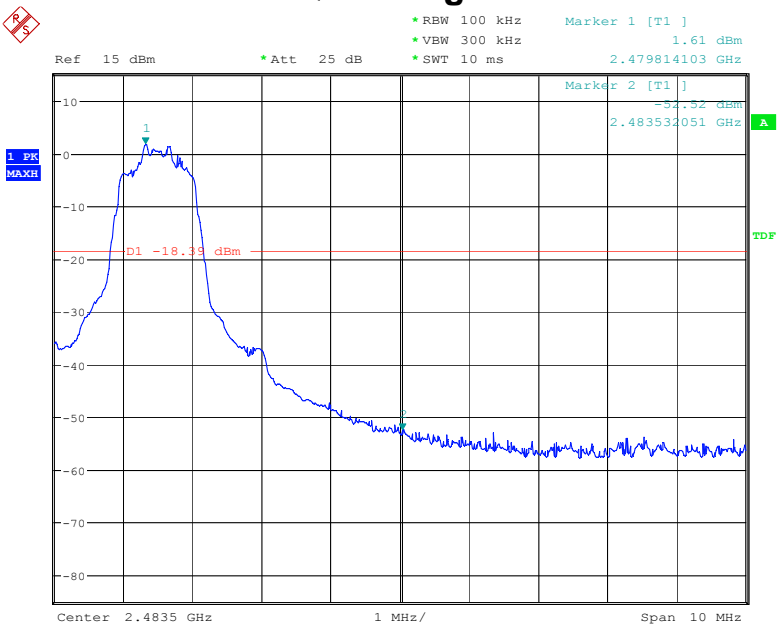


Date: 11.OCT.2016 13:43:10



Date: 11.OCT.2016 13:44:26

π/4-DQPSK Highest Channel



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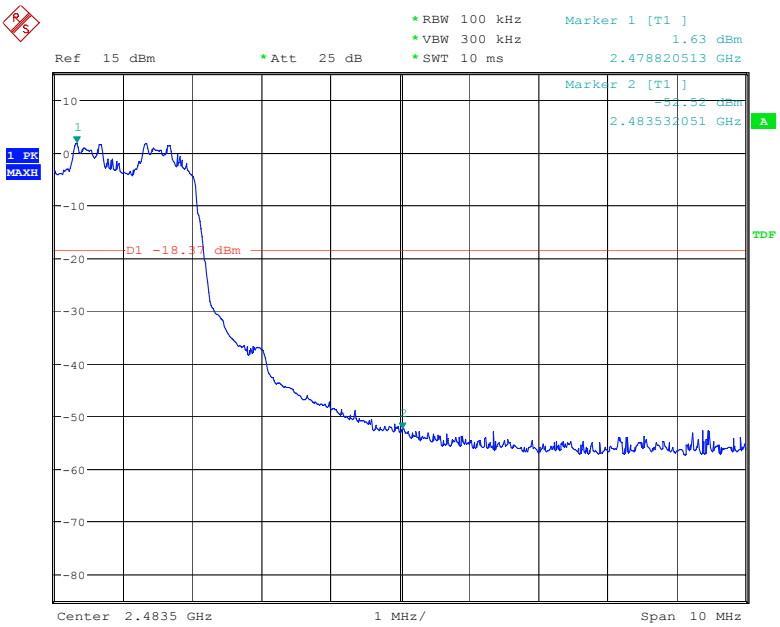
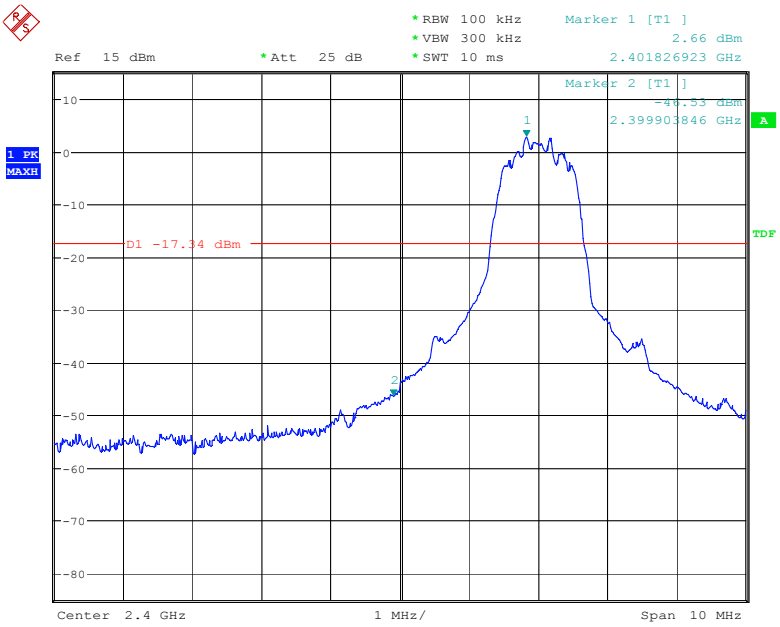


Date: 11.OCT.2016 13:47:39

8DPSK Lowest Channel



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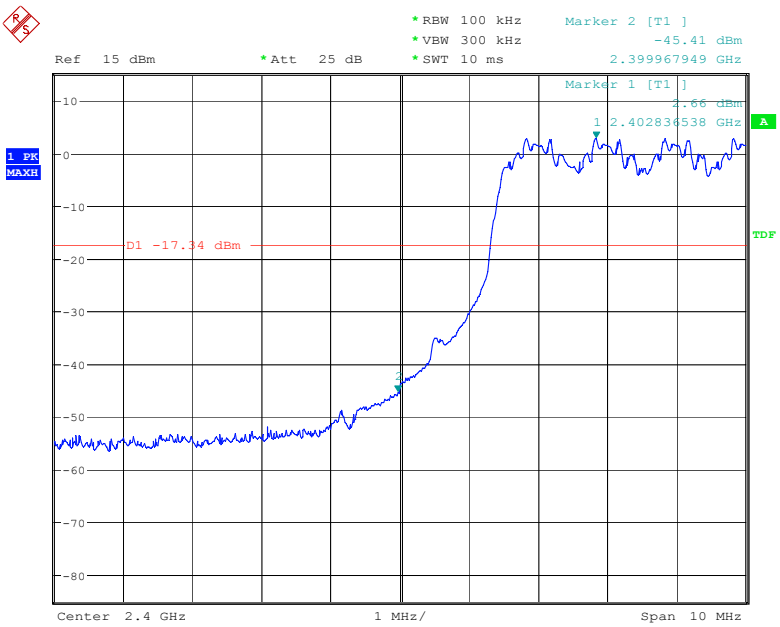
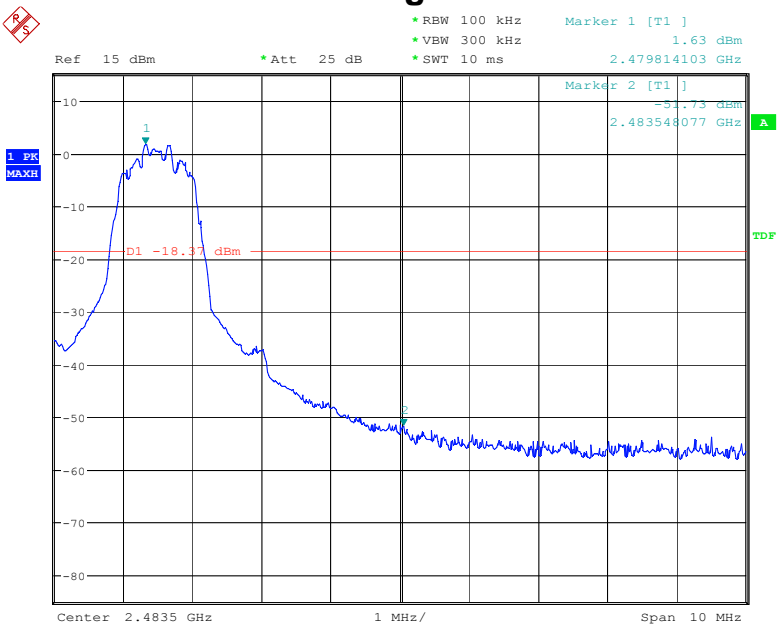
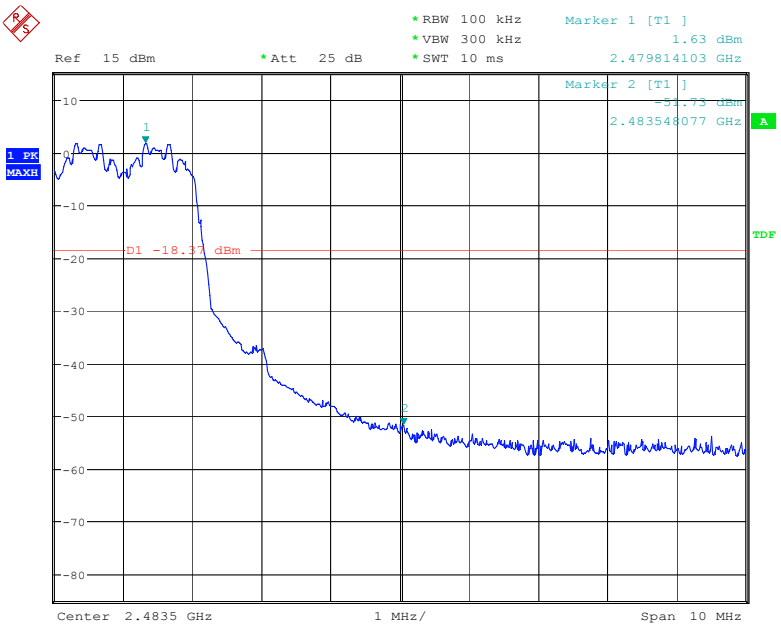


Date: 11.OCT.2016 13:51:33

8DPSK Highest Channel



Date: 11.OCT.2016 13:53:25



Date: 11.OCT.2016 13:54:09

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 PCB antenna and no consideration of replacement, and the best case gain of the antenna is 1.0dBi. So, the antenna is consider meet the requirement.

12. Conducted Spurious Emissions

12.1 Measurement Procedure

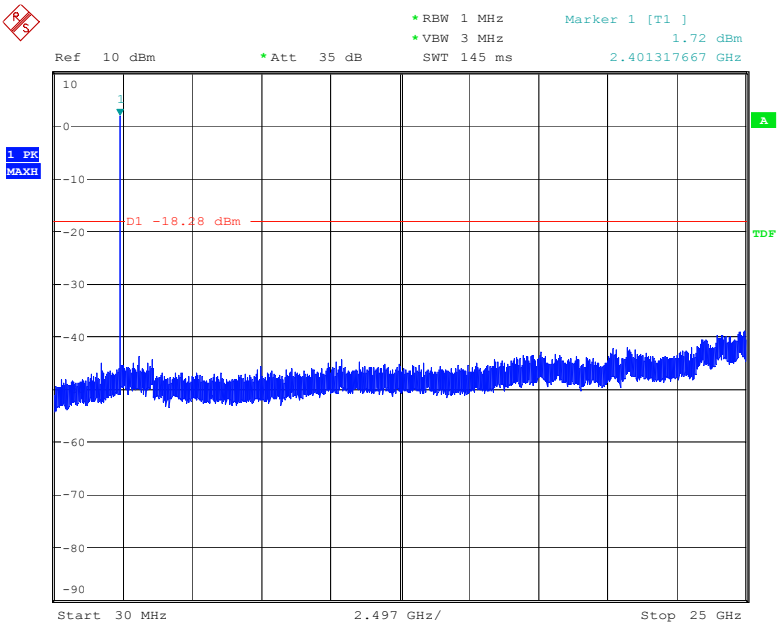
Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. All spurious emission and up tp 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

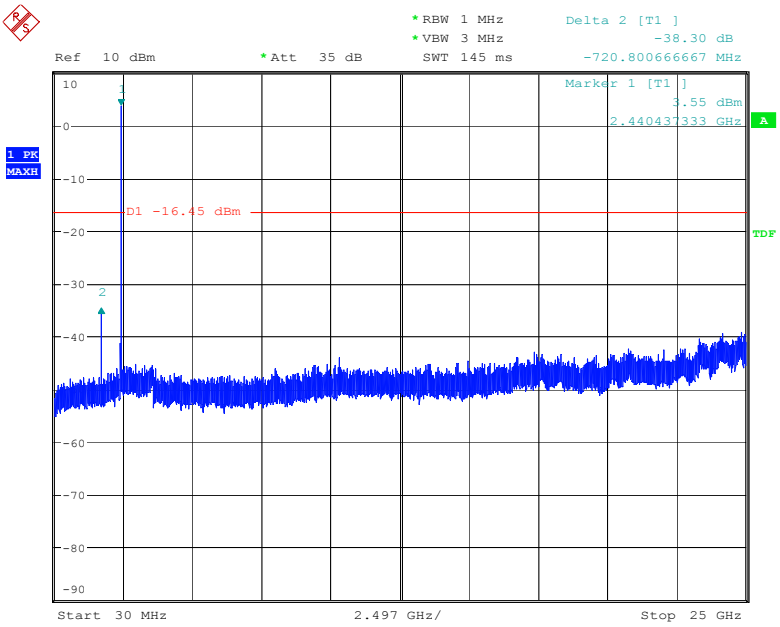
Please refer to following plots, the worst case (8DPSK) was shown.

Lowest Channel



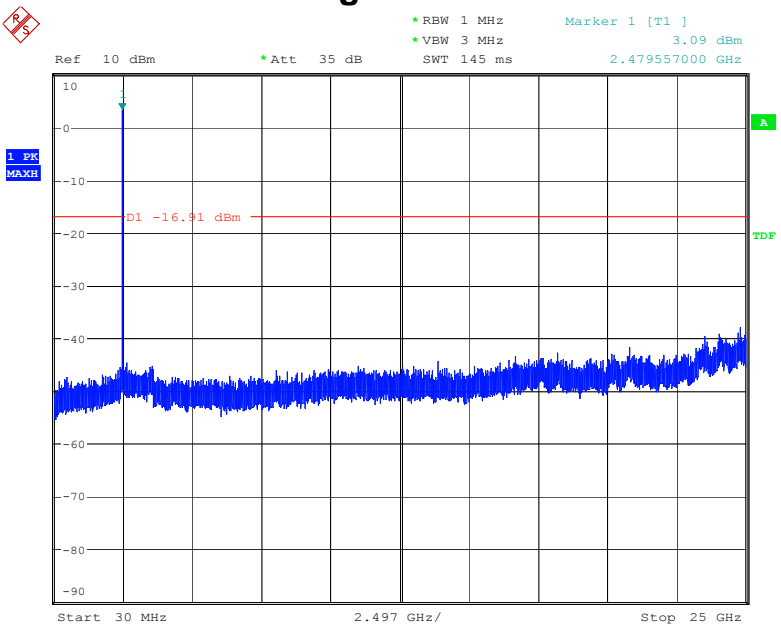
Date: 11.OCT.2016 14:41:15

Middle Channel



Date: 11.OCT.2016 14:42:36

Highest Channel



Date: 11.OCT.2016 14:43:43

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	Nov. 23, 2015	Nov. 22, 2016
Antenna	Schwarzbeck	VULB9162	9162-010	30MHz~7GHz	Nov. 26, 2015	Nov. 25, 2016
Positioning Controller	UC	UC 3000	N/A	0~360°, 1-4m	N/A	N/A
Color Monitor	SUNSPO	SP-140A	N/A	N/A	N/A	N/A
Single Phase Power Line Filter	SAEMC	PF201A-32	110210	32A	N/A	N/A
3 Phase Power Line Filter	SAEMC	PF401A-200	110318	200A	N/A	N/A
DC Power Filter	SAEMC	PF301A-200	110245	200A	N/A	N/A
Cable	Huber+Suhner	CBL2-NN-1M	22390001	9KHz~7GHz	Nov. 07, 2015	Nov. 06, 2016
Cable	Huber+Suhner	CIL02	N/A	9KHz~7GHz	Nov. 07, 2015	Nov. 06, 2016
RF Cable	Huber+Suhner	SF-104	MY16559/4	9KHz~25GHz	Mar. 06, 2016	Mar. 05, 2017
Power Amplifier	HP	HP 8447D	1145A00203	100KHz~1.3GHz	Nov. 07, 2015	Nov. 06, 2016
Horn Antenna	Schwarzbeck	BBHA9170	9170-372	15GHz~26.5GHz	Oct.23, 2015	Oct.22, 2016
Horn Antenna	Com-Power	AH-118	071078	1GHz~18GHz	Nov. 05, 2015	Nov. 04, 2016
Loop antenna	Daze	ZA30900A	0708	9KHz~30MHz	Oct.09, 2016	Oct.08, 2017
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	20Hz~26.5GHz	Aug. 31, 2016	Aug. 30, 2017
Pre-Amplifier	Agilent	8449B	3008A02964	1GHz~26.5GHz	Nov. 03, 2015	Nov. 02, 2016
L.I.S.N.	Rohde & Schwarz	ENV 216	101317	9KHz~30MHz	Nov. 07, 2015	Nov. 06, 2016
Temporary antenna connector	TESCOM	SS402	N/A	9KHz-25GHz	N/A	N/A

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---