# 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 | : | Belcat Co.,Ltd |
| Address | : | Linghu-Industrial Park, Qiuchang-Town, Huiyang-District, Huizhou-City, Guangdong, China |
| Manufacturer/Factory | : | Belcat Co.,Ltd |
| Address | : | Linghu-Industrial Park, Qiuchang-Town, Huiyang-District, Huizhou-City, Guangdong, China |
| E.U.T. | : | Amplifier |
| Brand Name | : | N/A |
| Model No. | : | Busker box-Acoustic, Busker box-Ukulele, BEL-6030A, BEL-6030W, BEL-8040A, BEL-8040W, BEL-8060W, BEL-1080W, BEL-8060A, BEL-1080A<br>(For model difference refer to section 1) |
| FCC ID | : | 2ALB4-ACOUSTIC |
| Measurement Standard | : | FCC PART 15.247: 2016 |
| Date of Receiver | : | December 15, 2016 |
| Date of Test | : | December 16, 2016 to March 09, 2017 |
| Date of Report | : | March 09, 2017 |

This Test Report is Issued Under the Authority of :

| Prepared by | Approved & Authorized Signer |
|---|---|
| Alina Guo / Engineer | 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.

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# Revision History of This Test Report

| Report Number | Description | Issued Date |
|---|---|---|
| NTC1612129F | Initial Issue | 2017-03-09 |
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# 1. GENERAL INFORMATION

## 1.1 Product Description for Equipment under Test

This device is a Bluetooth speaker, it's powered by DC 24V from adapter or DC 18.5V come from internal battery. For more details features, please refer to User's Manual.

| | | |
|---|---|---|
| Power Supply | : | DC 24V From adapter<br>DC 18.5V From internal battery |
| Adapter | : | M/N: FJ-SW2401200D<br>Input: AC 100-240V 50/60Hz 1.5A<br>Output: DC 24V 1200mA |
| Test voltage | : | AC 120V 60Hz, AC 240V 50Hz,<br>DC 18.5V From internal battery<br>Only the worst case was recorded in the report. |
| Model name | : | Busker box-Acoustic, Busker box-Ukulele, BEL-6030A, BEL-6030W, BEL-8040A, BEL-8040W, BEL-8060W, BEL-1080W, BEL-8060A, BEL-1080A<br>(All tests were carried on model Busker box-Acoustic.) |
| Model difference | : | These models have the same circuit schematic, construction, PCB Layout and critical components. Their difference in model number due to trading purpose. |
| Hardware version | : | A2440da_rev:03 |
| Software version | : | InstallBlueSuite_2_5_8_667 |
| Serial number | : | N/A |
| Note | : | This report only applies to modulation technology DSS(BT2.1+EDR). |

**Technical parameters**
**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 | 0.21dBi | 0.21 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** | BlueTest3 |

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

This submittal(s) (test report) is intended for FCC ID: 2ALB4-ACOUSTIC 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<br>M/N: R50e<br>S/N: L3-HZNGO<br>P/N: 1834KDC |
| Adapter | : | Manufacturer: IBM Corporation<br>M/N: 08K8210<br>Input: AC100-240V 50/60Hz 0.5-1.0A<br>Output: DC 16V 4.5A |

## 1.6 Test Facility and Location

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 FCC, July 03, 2014
The Certificate Registration Number is 665078.
Listed by Industry Canada, June 18, 2014
The Certificate Registration Number is 46405-9743.

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 x$10^{-4}$% | Compliant |
| §15.247(a)(1) | 20dB Bandwidth | ±1.42 x$10^{-4}$% | Compliant |
| §15.247(a)(1)(iii) | Hopping Channel Number | ±1.42 x$10^{-4}$% | 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

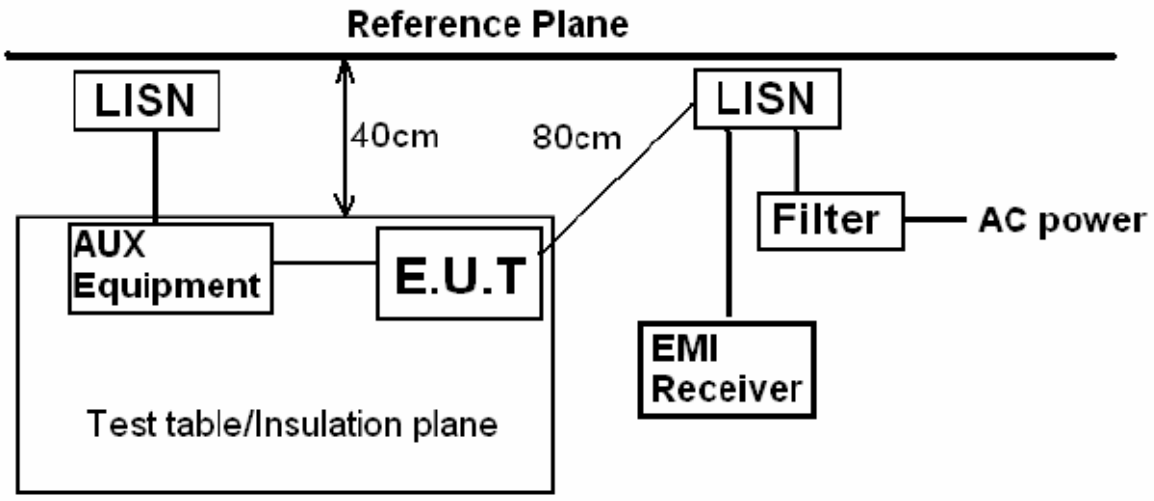
The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3 and DH5 mode in all modulation type GFSK, π/4-DQPSK, 8DPSK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

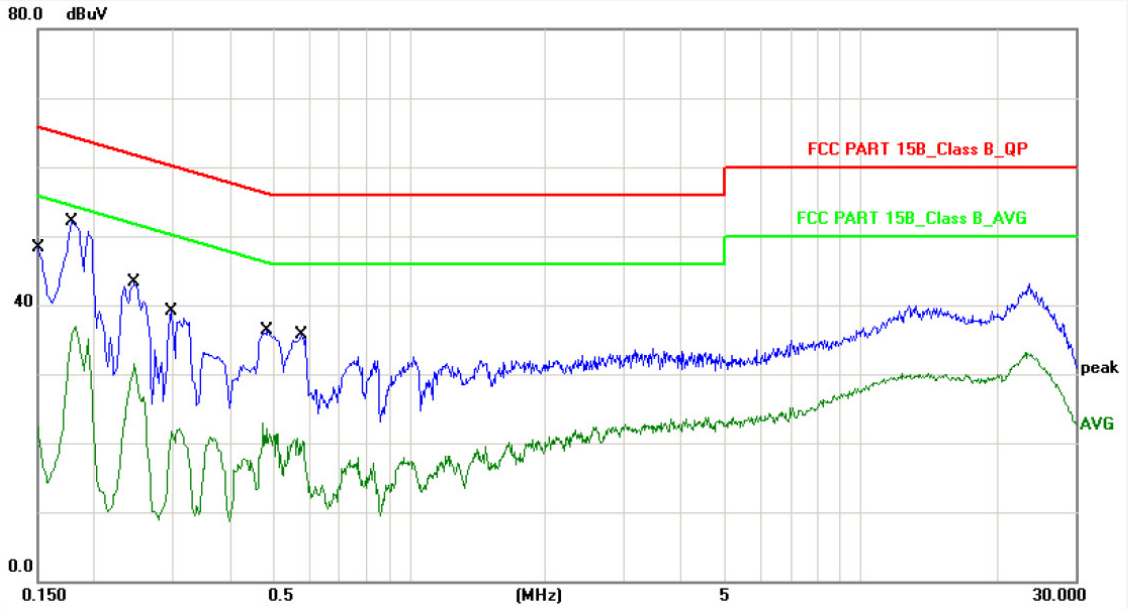
## 3.3 Measurement Results

**Please refer to following plots of the worst case: GFSK Highest channel.**

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

Site: Conduction

Test Time: 2016-12-17 14:52:29



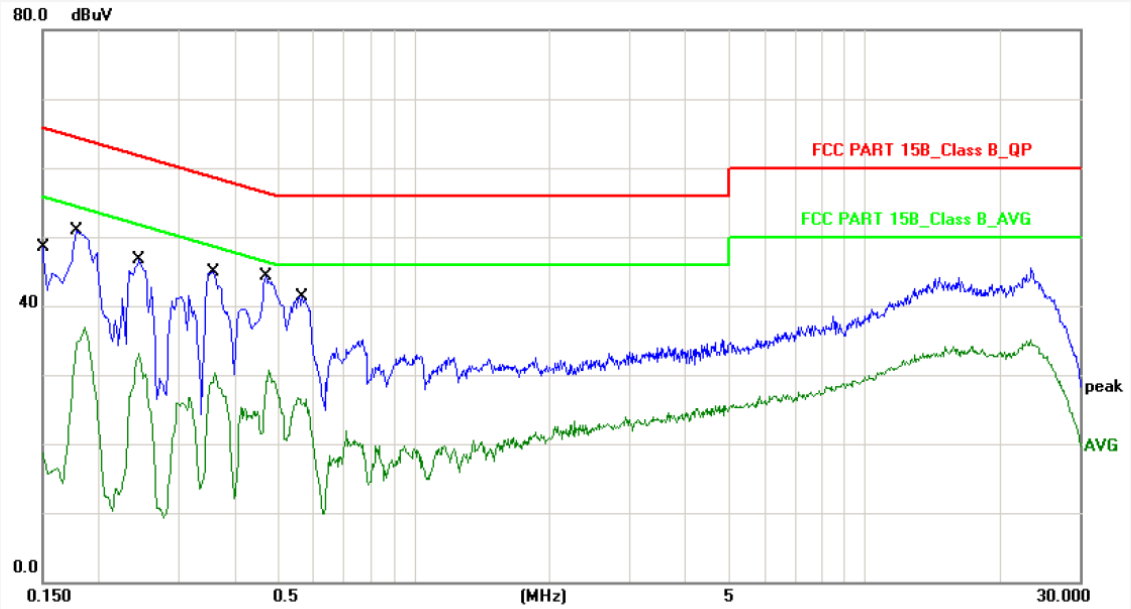

| | | | |
|---|---|---|---|
| Report No.: | Busker box-Acoustic | | |
| Test Standard: | FCC PART 15B_Class B_QP | | |
| Test item: | Conducted Emission | Phase: | L1 |
| Applicant: | Belcat | Temp.( )/Hum.(%): | 22(C) / 52 % |
| Product: | Amplifier | Power Rating: | AC 120V/60Hz |
| Model No.: | Busker box-Acoustic | Test Engineer: | Ryan |
| Test Mode: | Charging + BT Link | | |
| Remark: | | | |

| No. | Frequency (MHz) | Factor (dBuV) | Reading (dBuV) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F | Remark |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1500 | 10.80 | 35.50 | 46.30 | 65.99 | -19.69 | QP | P | |
| 2 | 0.1500 | 10.80 | 9.40 | 20.20 | 55.99 | -35.79 | AVG | P | |
| 3 | 0.1796 | 10.80 | 39.10 | 49.90 | 64.50 | -14.60 | QP | P | |
| 4 | 0.1796 | 10.80 | 24.00 | 34.80 | 54.50 | -19.70 | AVG | P | |
| 5 | 0.2460 | 10.80 | 30.40 | 41.20 | 61.89 | -20.69 | QP | P | |
| 6 | 0.2460 | 10.80 | 18.80 | 29.60 | 51.89 | -22.29 | AVG | P | |
| 7 | 0.2979 | 10.80 | 26.30 | 37.10 | 60.30 | -23.20 | QP | P | |
| 8 | 0.2979 | 10.80 | 9.30 | 20.10 | 50.30 | -30.20 | AVG | P | |
| 9 | 0.4860 | 10.80 | 23.50 | 34.30 | 56.24 | -21.94 | QP | P | |
| 10 | 0.4860 | 10.80 | 10.10 | 20.90 | 46.24 | -25.34 | AVG | P | |
| 11 | 0.5780 | 10.80 | 22.90 | 33.70 | 56.00 | -22.30 | QP | P | |
| 12 | 0.5780 | 10.80 | 7.80 | 18.60 | 46.00 | -27.40 | AVG | P | |

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

Site: Conduction

Test Time: 2016-12-17 13:48:16



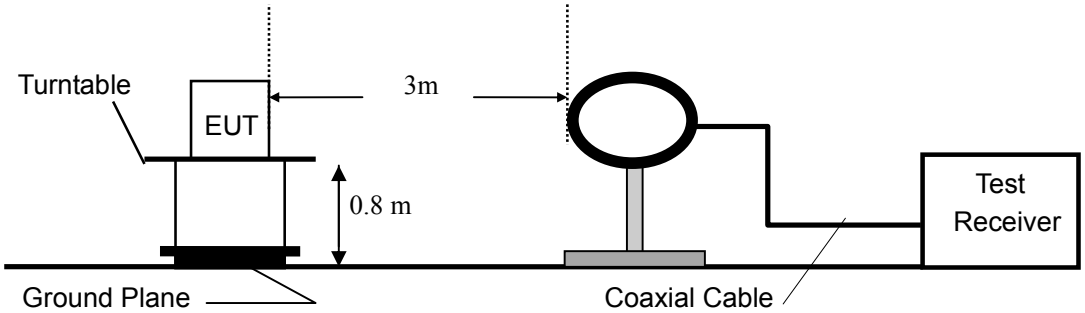

| | | | |
|---|---|---|---|
| Report No.: | Busker box-Acoustic | | |
| Test Standard: | FCC PART 15B_Class B_QP | | |
| Test item: | Conducted Emission | Phase: | N |
| Applicant: | Belcat | Temp.( )/Hum.(%): | 22(C) / 52 % |
| Product: | Amplifier | Power Rating: | AC 120V/60Hz |
| Model No.: | Busker box-Acoustic | Test Engineer: | Ryan |
| Test Mode: | Charging + BT Link | | |
| Remark: | | | |

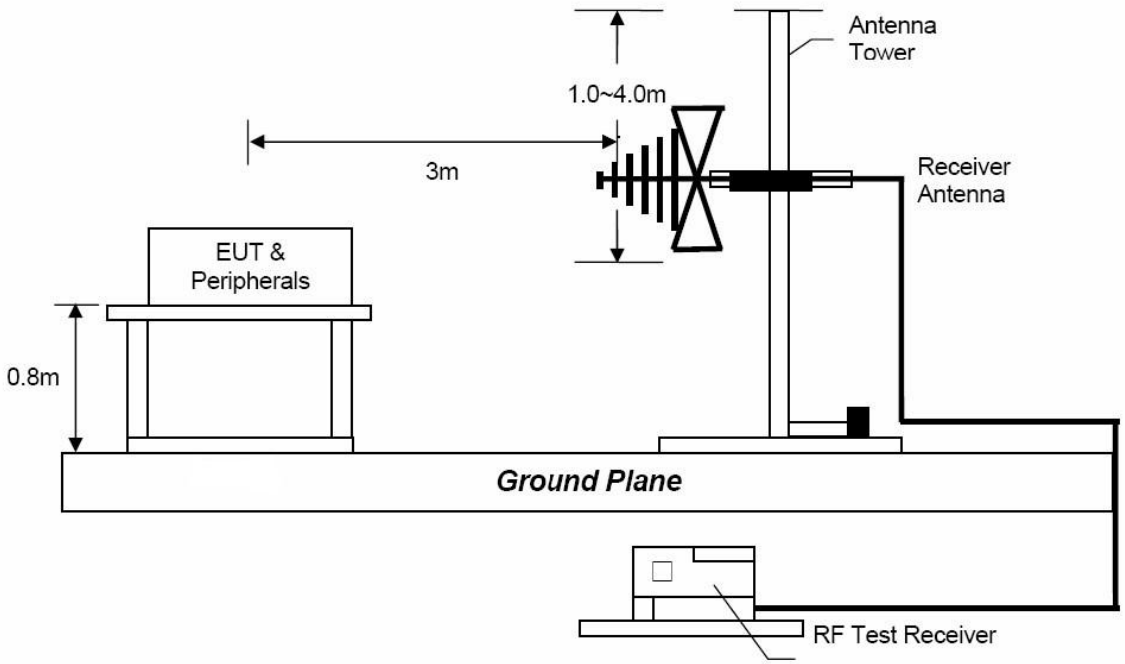
| No. | Frequency (MHz) | Factor (dBuV) | Reading (dBuV) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F | Remark |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1500 | 10.80 | 35.80 | 46.60 | 65.99 | -19.39 | QP | P | |
| 2 | 0.1500 | 10.80 | 5.90 | 16.70 | 55.99 | -39.29 | AVG | P | |
| 3 | 0.1780 | 10.80 | 38.10 | 48.90 | 64.57 | -15.67 | QP | P | |
| 4 | 0.1780 | 10.80 | 24.00 | 34.80 | 54.57 | -19.77 | AVG | P | |
| 5 | 0.2460 | 10.80 | 33.80 | 44.60 | 61.89 | -17.29 | QP | P | |
| 6 | 0.2460 | 10.80 | 20.30 | 31.10 | 51.89 | -20.79 | AVG | P | |
| 7 | 0.3580 | 10.80 | 32.10 | 42.90 | 58.77 | -15.87 | QP | P | |
| 8 | 0.3580 | 10.80 | 17.40 | 28.20 | 48.77 | -20.57 | AVG | P | |
| 9 | 0.4700 | 10.80 | 31.40 | 42.20 | 56.51 | -14.31 | QP | P | |
| 10 | 0.4700 | 10.80 | 28.90 | 39.70 | 46.51 | -6.81 | AVG | P | |
| 11 | 0.5660 | 10.80 | 28.60 | 39.40 | 56.00 | -16.60 | QP | P | |
| 12 | 0.5660 | 10.80 | 13.80 | 24.60 | 46.00 | -21.40 | AVG | P | |

# 4. Radiated Emission Test

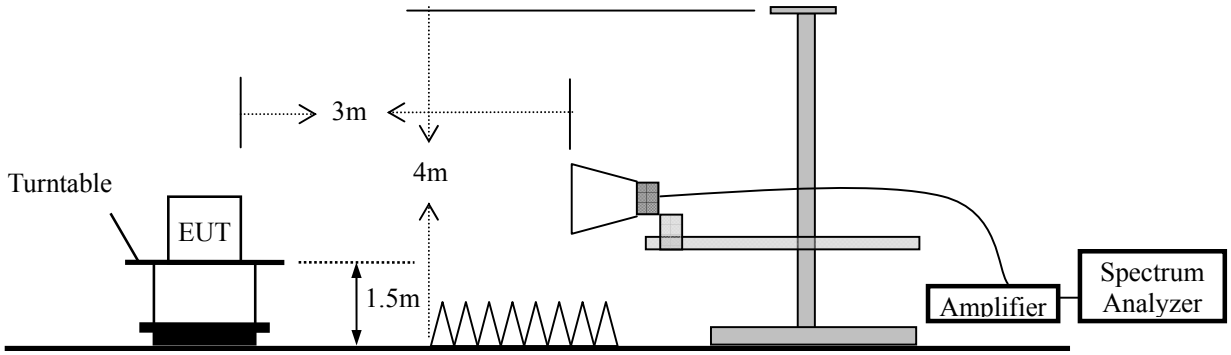
## 4.1 Test SET-UP (Block Diagram of Configuration)

### 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.

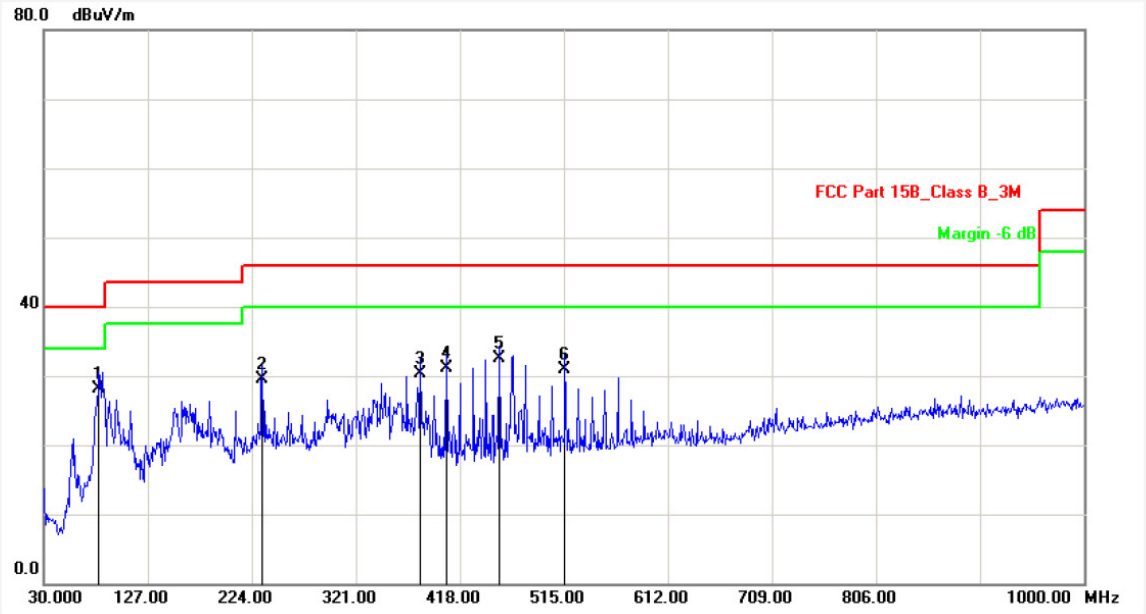
## 4.4 Measurement Results

**Please refer to following plots of the worst case: GFSK Highest channel.**

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

Site: Radiation

Test Time: 2017-2-7 11:35:22




| | | | |
|---|---|---|---|
| Report No.: | Busker box-Acoustic | | |
| Test Standard: | FCC Part 15B_Class B_3M | Test Distance: | 3m |
| Test item: | Radiation Emission | Ant. Polarization: | Horizontal |
| Applicant: | Belcat | Temp.(C)/Hum.(%): | 22(C) / 54 % |
| Product: | Amplifier | Power Rating: | AC 120V/60Hz |
| Model No.: | Busker box-Acoustic | Test Engineer: | Chilam |

Test Mode: Charging+BT Link

Remark:

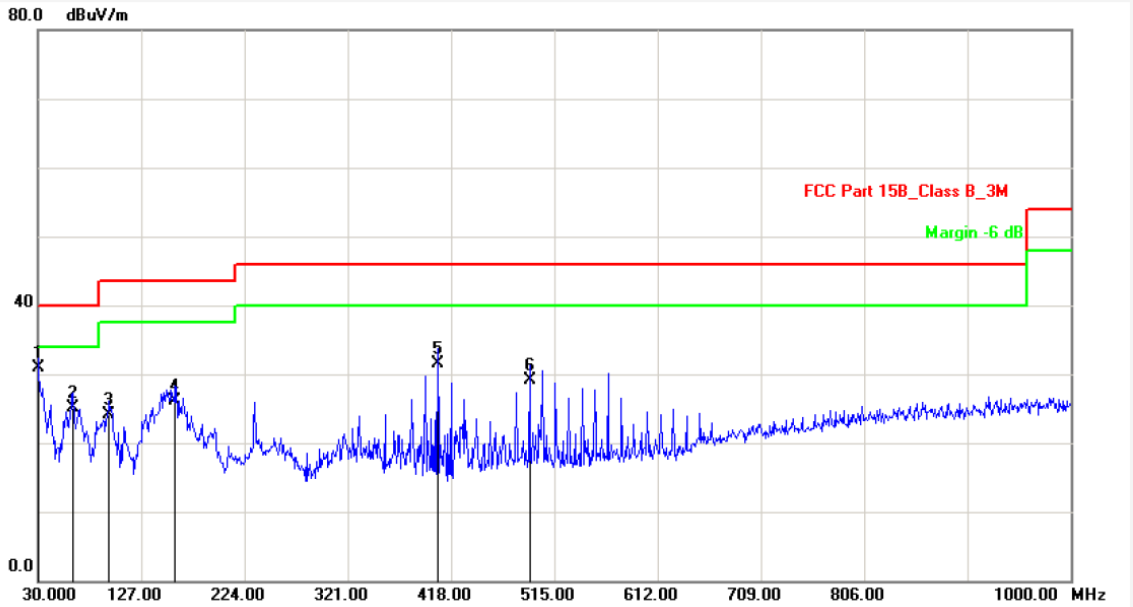
| No. | Frequency (MHz) | Factor (dB/m) | Reading (dBuV) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Height (cm) | Azimuth (deg.) | P/F | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 81.4100 | -15.87 | 43.97 | 28.10 | 40.00 | -11.90 | QP | | | P | |
| 2 | 233.6999 | -12.30 | 41.80 | 29.50 | 46.00 | -16.50 | QP | | | P | |
| 3 | 381.1399 | -9.20 | 39.60 | 30.40 | 46.00 | -15.60 | QP | | | P | |
| 4 | 405.3899 | -8.99 | 40.09 | 31.10 | 46.00 | -14.90 | QP | | | P | |
| 5 | 454.8600 | -7.84 | 40.34 | 32.50 | 46.00 | -13.50 | QP | | | P | |
| 6 | 515.9699 | -6.73 | 37.73 | 31.00 | 46.00 | -15.00 | 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: 2017-2-7 11:42:27




| | | | |
|---|---|---|---|
| Report No.: | Busker box-Acoustic | | |
| Test Standard: | FCC Part 15B_Class B_3M | Test Distance: | 3m |
| Test item: | Radiation Emission | Ant. Polarization: | Vertical |
| Applicant: | Belcat | Temp.(C)/Hum.(%): | 22(C) / 54 % |
| Product: | Amplifier | Power Rating: | AC 120V/60Hz |
| Model No.: | Busker box-Acoustic | Test Engineer: | Chilam |

Test Mode: Charging+BT Link

Remark:

| 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 | 30.0000 | -15.90 | 46.80 | 30.90 | 40.00 | -9.10 | QP | | | P | |
| 2 | 62.9799 | -15.07 | 40.27 | 25.20 | 40.00 | -14.80 | QP | | | P | |
| 3 | 96.9300 | -15.91 | 40.01 | 24.10 | 43.50 | -19.40 | QP | | | P | |
| 4 | 159.0099 | -18.20 | 44.40 | 26.20 | 43.50 | -17.30 | QP | | | P | |
| 5 | 405.3899 | -11.25 | 42.85 | 31.60 | 46.00 | -14.40 | QP | | | P | |
| 6 | 491.7200 | -8.95 | 38.15 | 29.20 | 46.00 | -16.80 | QP | | | P | |

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

| | | | |
|---|---|---|---|
| Modulation: | GFSK (the worst case) | | |
| Frequency Range: | 1-25GHz | Test Date : | February 20, 2017 |
| 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 | 39.13 | 28.54 | 14.05 | 53.18 | 42.59 | 74.00 | 54.00 | -20.82 | -11.41 |
| 7206 | V | 37.23 | 26.00 | 18.81 | 56.04 | 44.81 | 74.00 | 54.00 | -17.96 | -9.19 |
| --- | | | | | | | | | | |
| 4804 | H | 38.72 | 27.05 | 14.05 | 52.77 | 41.10 | 74.00 | 54.00 | -21.23 | -12.90 |
| 7206 | H | 37.87 | 26.49 | 18.18 | 56.05 | 44.67 | 74.00 | 54.00 | -17.95 | -9.33 |
| --- | | | | | | | | | | |
| **Operation Mode: TX Mode (Mid)** | | | | | | | | | | |
| 4882 | V | 38.74 | 28.15 | 14.41 | 53.15 | 42.56 | 74.00 | 54.00 | -20.85 | -11.44 |
| 7323 | V | 38.26 | 26.57 | 18.36 | 56.62 | 44.93 | 74.00 | 54.00 | -17.38 | -9.07 |
| --- | | | | | | | | | | |
| 4882 | H | 38.46 | 27.48 | 14.41 | 52.87 | 41.89 | 74.00 | 54.00 | -21.13 | -12.11 |
| 7323 | H | 38.27 | 27.21 | 18.36 | 56.63 | 45.57 | 74.00 | 54.00 | -17.37 | -8.43 |
| --- | | | | | | | | | | |
| **Operation Mode: TX Mode (High)** | | | | | | | | | | |
| 4960 | V | 38.57 | 27.29 | 14.76 | 53.33 | 42.05 | 74.00 | 54.00 | -20.67 | -11.95 |
| 7440 | V | 38.39 | 27.32 | 18.55 | 56.94 | 45.87 | 74.00 | 54.00 | -17.06 | -8.13 |
| --- | | | | | | | | | | |
| 4960 | H | 38.31 | 27.38 | 14.76 | 53.07 | 42.14 | 74.00 | 54.00 | -20.93 | -11.86 |
| 7440 | H | 38.26 | 26.69 | 18.55 | 56.81 | 45.24 | 74.00 | 54.00 | -17.19 | -8.76 |
| --- | | | | | | | | | | |

**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.

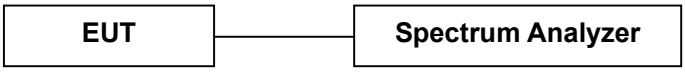
# 5. Channel Separation test

## 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)

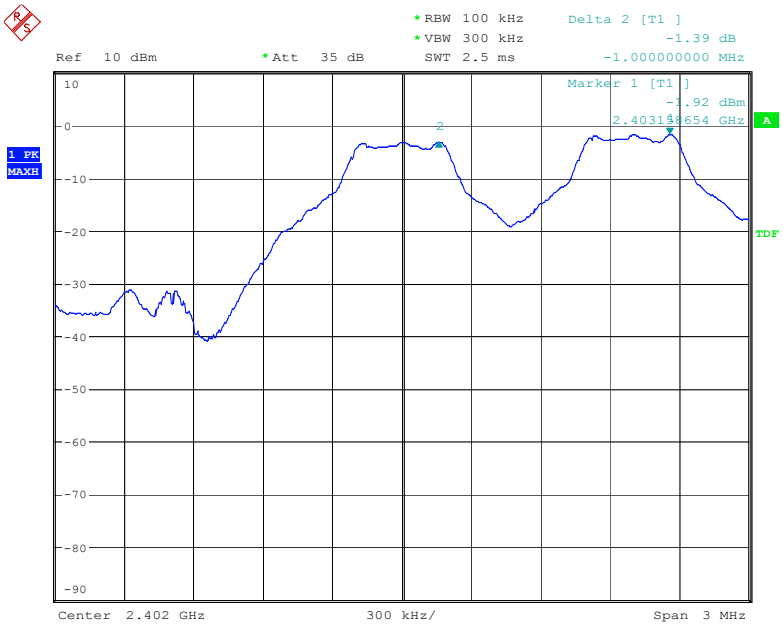



## 5.3 Measurement Results

| | | | |
|---|---|---|---|
| Modulation: | GFSK, π/4-DQPSK, 8DPSK | | |
| RBW: | 100KHz | VBW: | 300KHz |
| Packet: | DH5 | Spectrum Detector: | PK |
| Test By: | Sance | Test Date : | February 16, 2017 |
| Temperature : | 24 ℃ | Humidity : | 50 % |
| Test Result: | PASS | | |

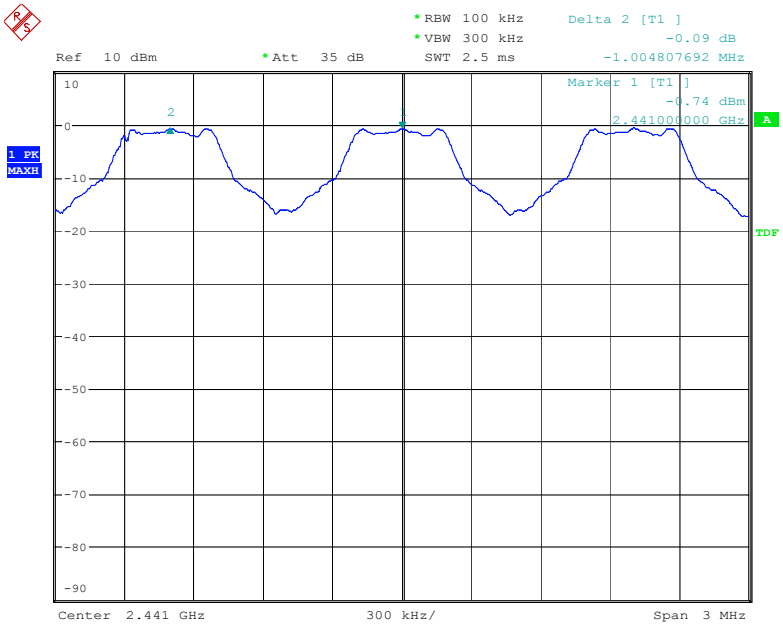
| Channel number | Channel frequency (MHz) | Separation Read Value (KHz) | Separation Limit 2/3 20dB Bandwidth (KHz) |
|---|---|---|---|
| GFSK | | | |
| Lowest | 2402 | 1000 | >641.3 |
| Middle | 2441 | 1005 | >660.0 |
| Highest | 2480 | 1000 | >638.0 |
| π/4-DQPSK | | | |
| Lowest | 2402 | 1000 | >868.7 |
| Middle | 2441 | 1000 | >858.7 |
| Highest | 2480 | 1005 | >865.3 |
| 8DPSK | | | |
| Lowest | 2402 | 1000 | >868.7 |
| Middle | 2441 | 1000 | >852.7 |
| Highest | 2480 | 1005 | >865.3 |

## GFSK Lowest Channel



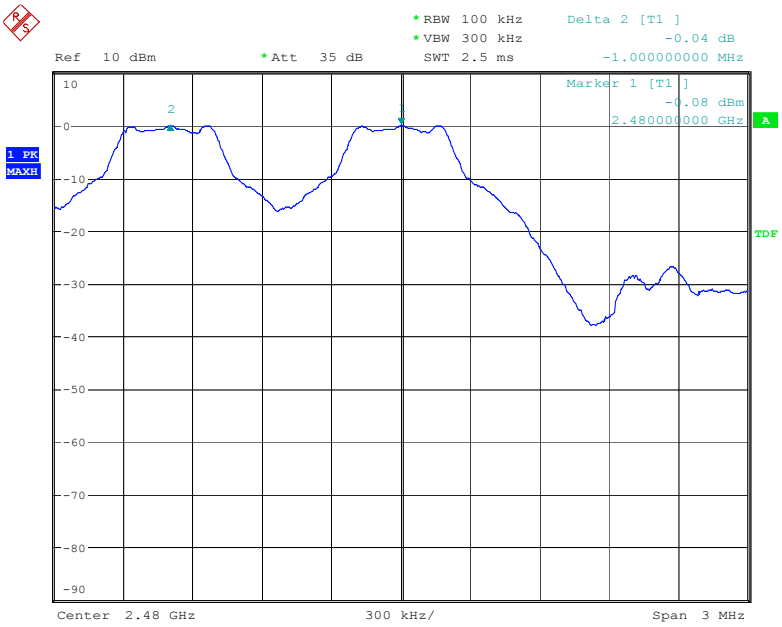

Date: 16.FEB.2017 14:51:22

## GFSK Middle Channel



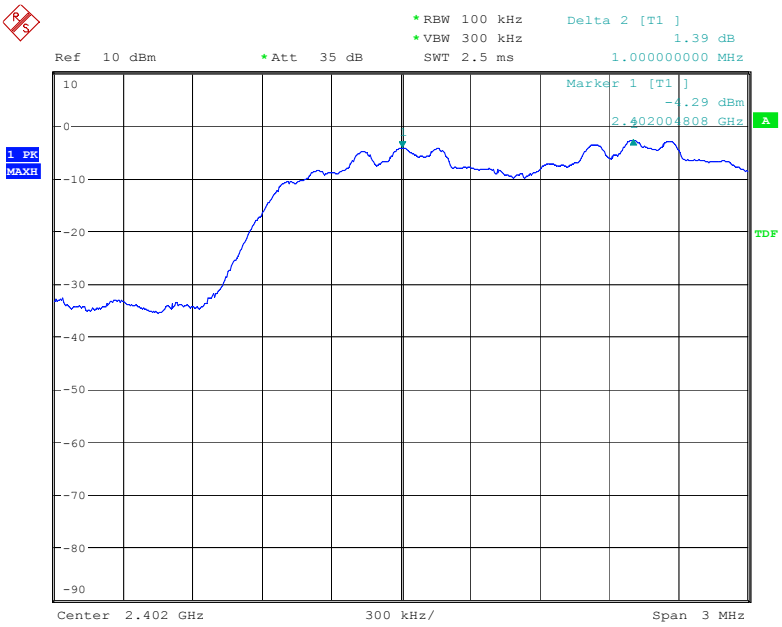

Date: 16.FEB.2017 14:52:59

## GFSK Highest Channel



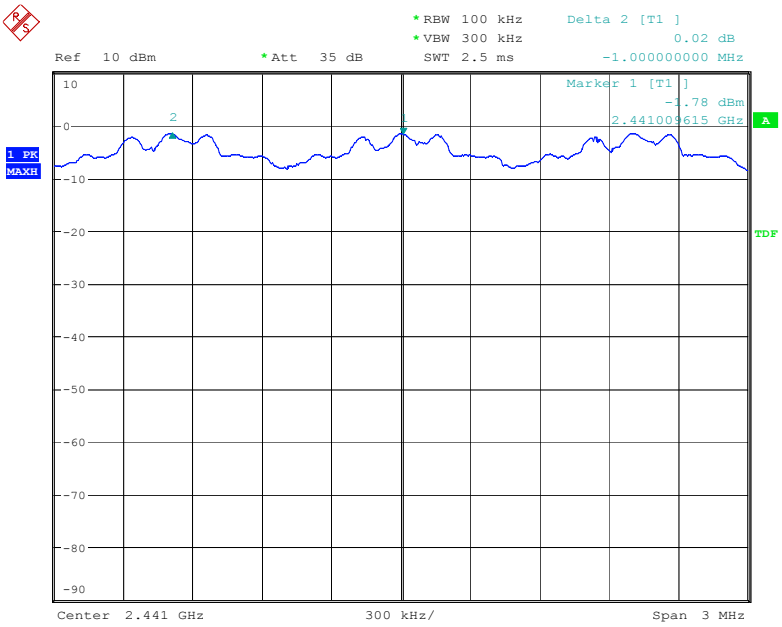

Date: 16.FEB.2017 14:55:41

## π/4-DQPSK Lowest Channel



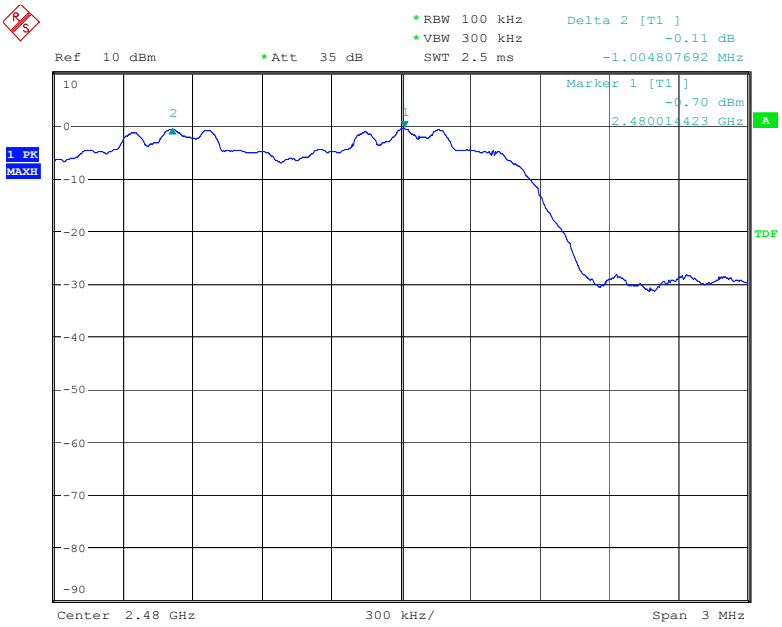

Date: 16.FEB.2017 14:58:57

## π/4-DQPSK Middle Channel



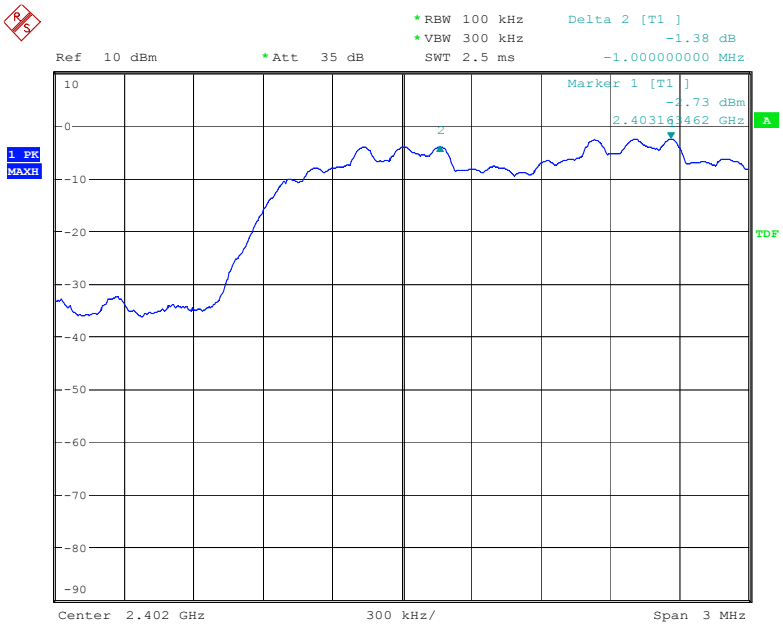

Date: 16.FEB.2017 15:01:10

## π/4-DQPSK Highest Channel



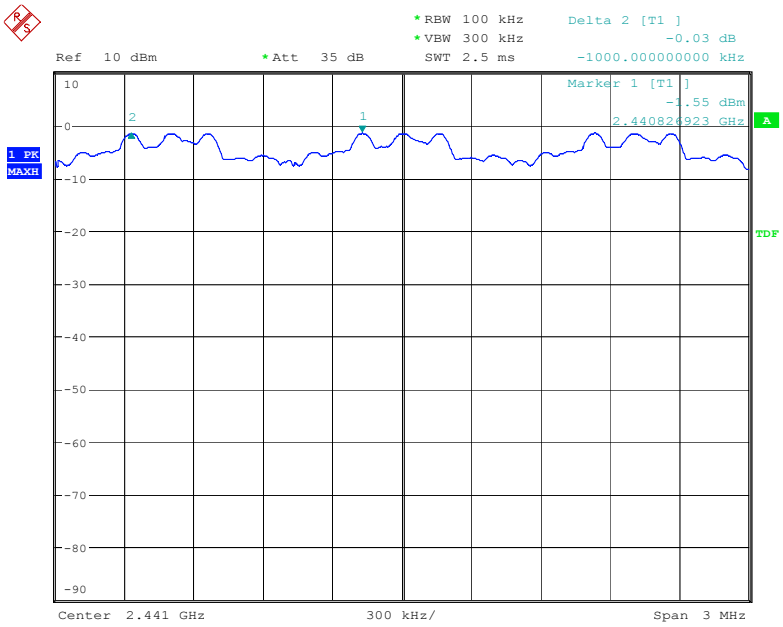

Date: 16.FEB.2017 15:17:08

## 8DPSK Lowest Channel



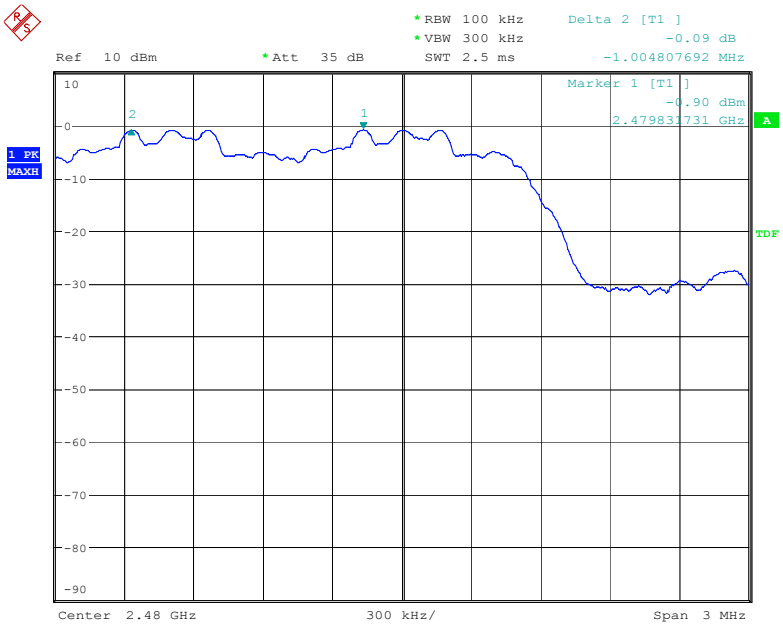

Date: 16.FEB.2017 15:19:22

## 8DPSK Middle Channel




Date: 16.FEB.2017 15:21:48

# 8DPSK Highest Channel




Date: 16.FEB.2017 15:23:52

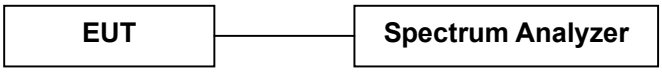
# 6. 20dB Bandwidth

## 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)



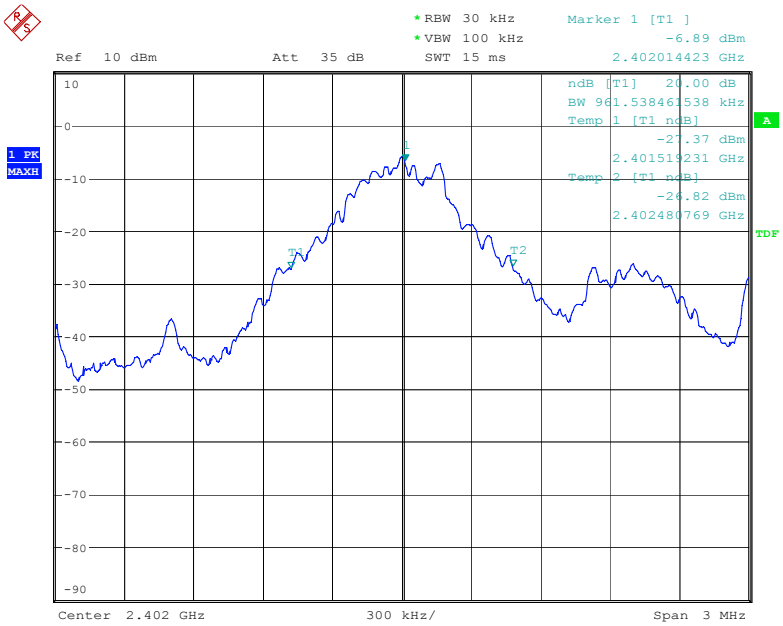

## 6.3 Measurement Results

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 : | February 16, 2017 |
| Temperature : | 24 ℃ | Humidity : | 50 % |
| Test Result: | PASS | | |

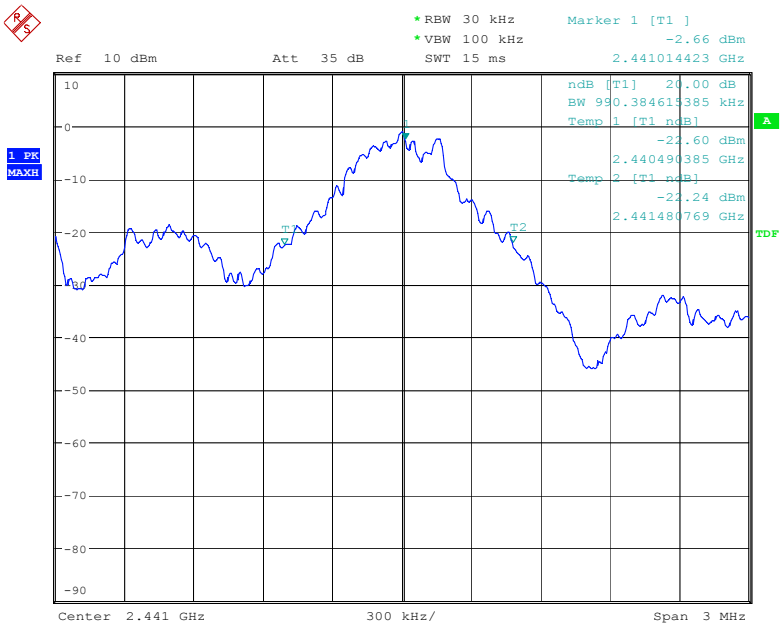
| Channel frequency (MHz) | 20dB Down BW(kHz) |
|---|---|
| GFSK | |
| 2402 | 962 |
| 2441 | 990 |
| 2480 | 957 |
| π/4-DQPSK | |
| 2402 | 1303 |
| 2441 | 1288 |
| 2480 | 1298 |
| 8DPSK | |
| 2402 | 1303 |
| 2441 | 1279 |
| 2480 | 1298 |

## GFSK Lowest Channel



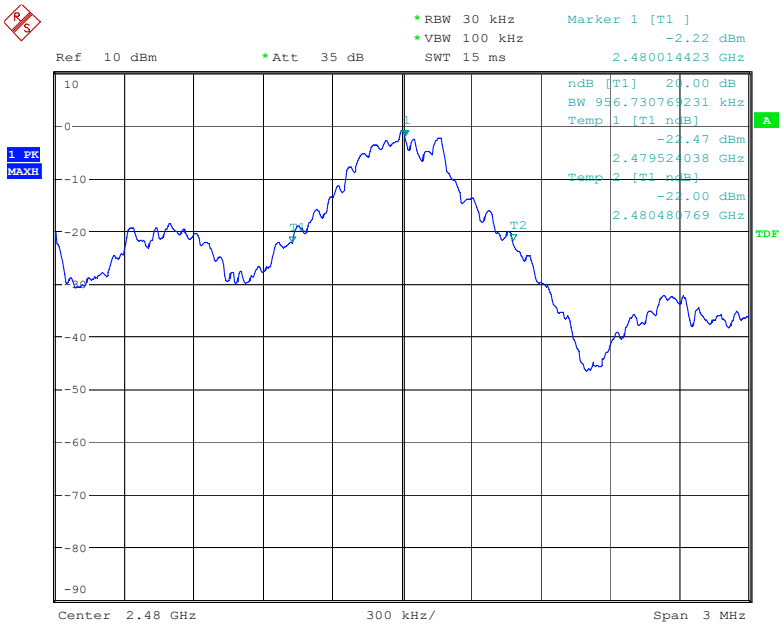

Date: 16.FEB.2017 13:27:35

## GFSK Middle Channel



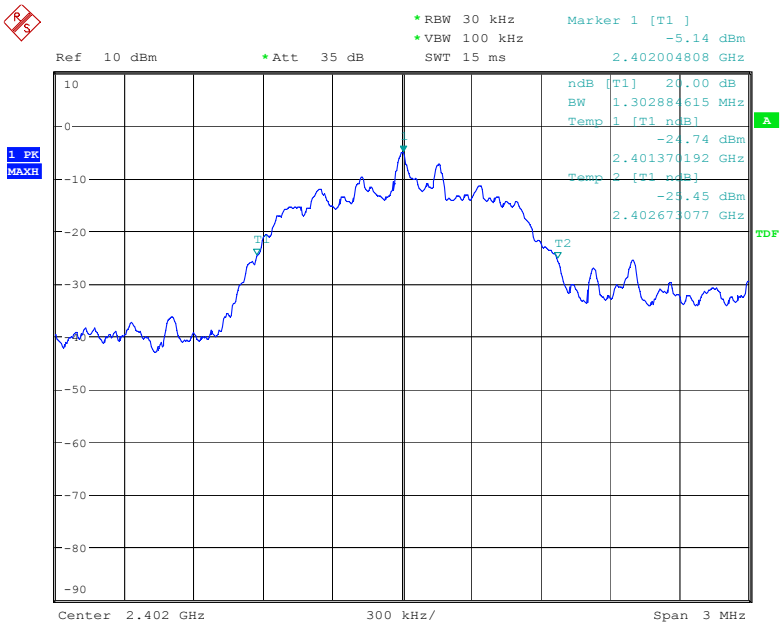

Date: 16.FEB.2017 13:30:24

## GFSK Highest Channel



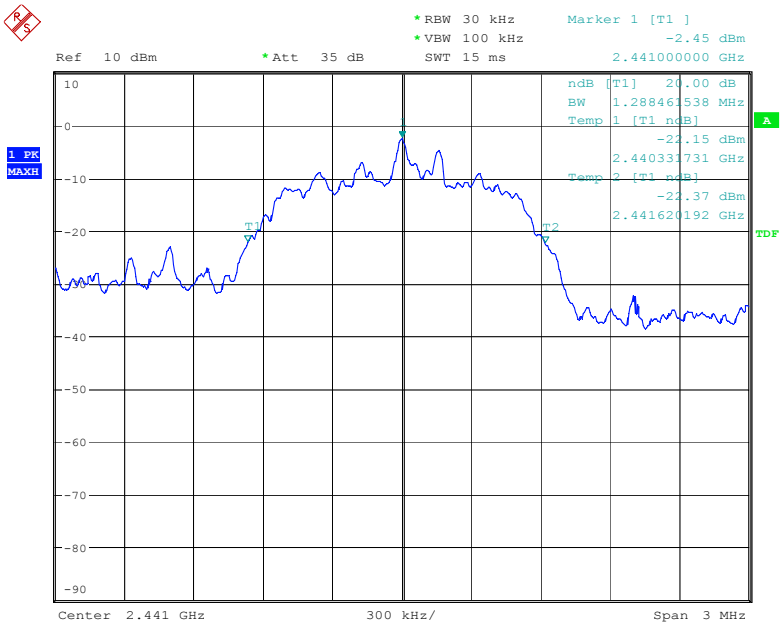

Date: 16.FEB.2017 14:44:34

## π/4-DQPSK Lowest Channel



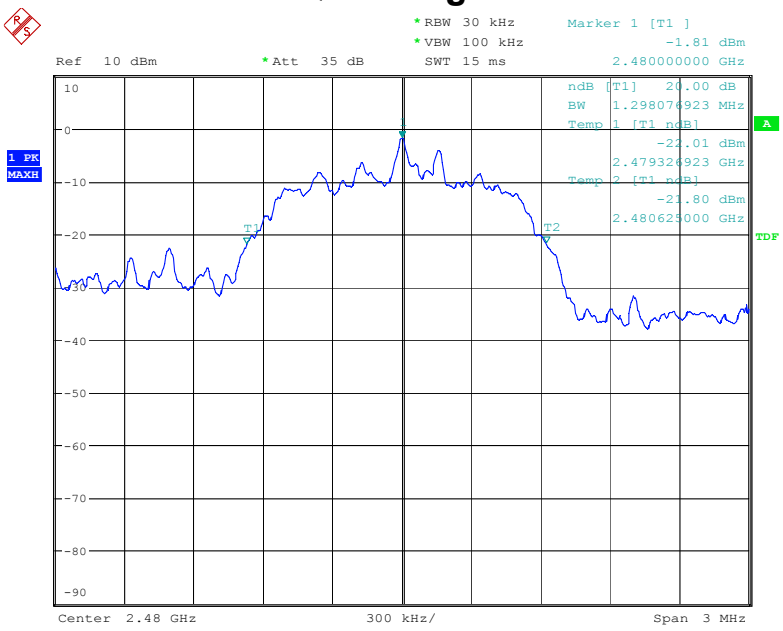

Date: 16.FEB.2017 14:45:48

## π/4-DQPSK Middle Channel



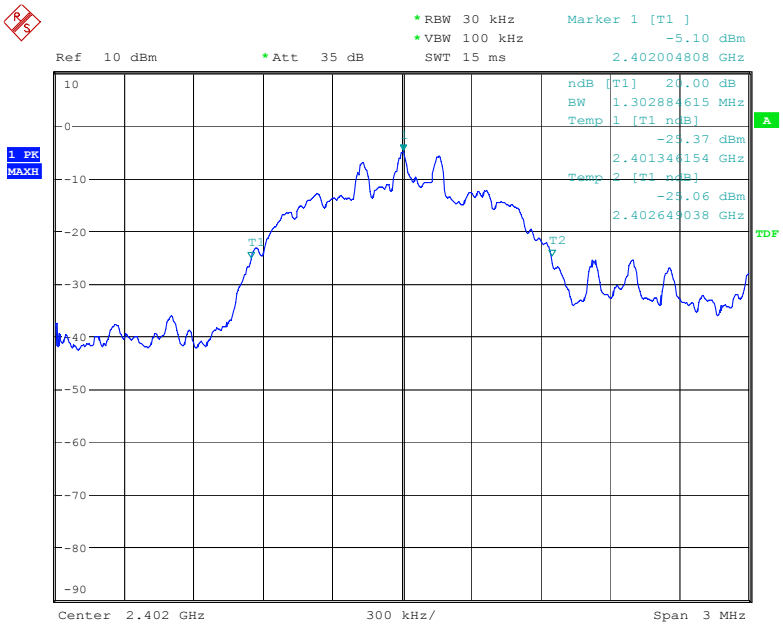

Date: 16.FEB.2017 14:46:21

## π/4-DQPSK Highest Channel



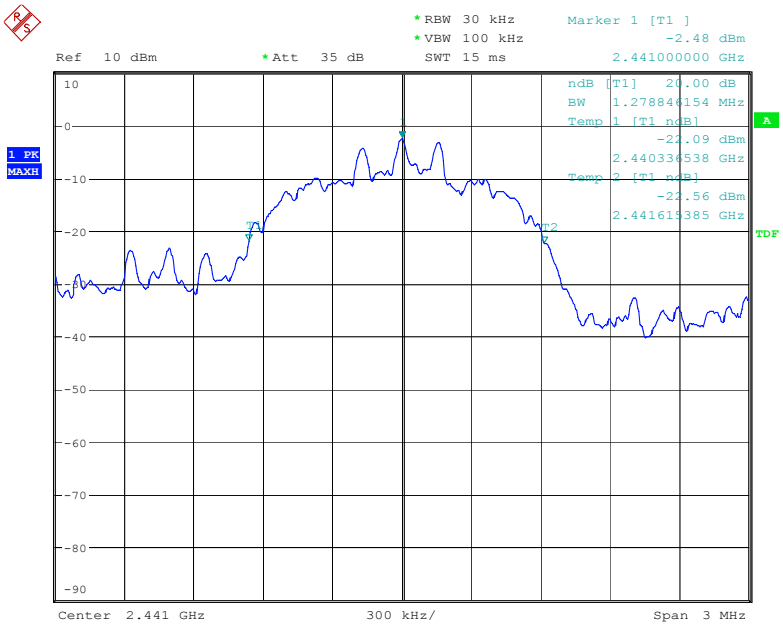

Date: 16.FEB.2017 14:46:58

## 8DPSK Lowest Channel



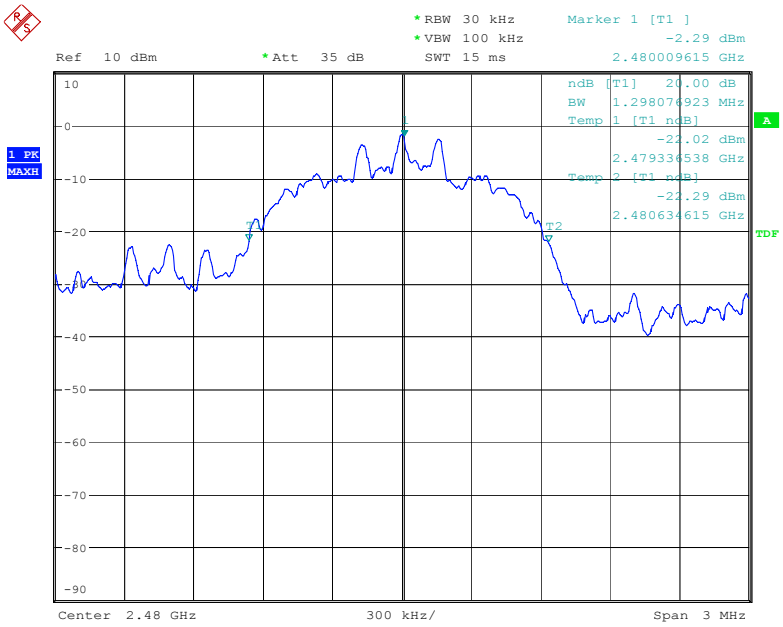

Date: 16.FEB.2017 14:47:44

## 8DPSK Middle Channel




Date: 16.FEB.2017 14:48:19

# 8DPSK Highest Channel




Date: 16.FEB.2017 14:48:59

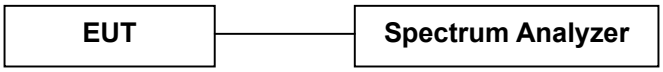
# 7. Hopping Channel Number

## 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)



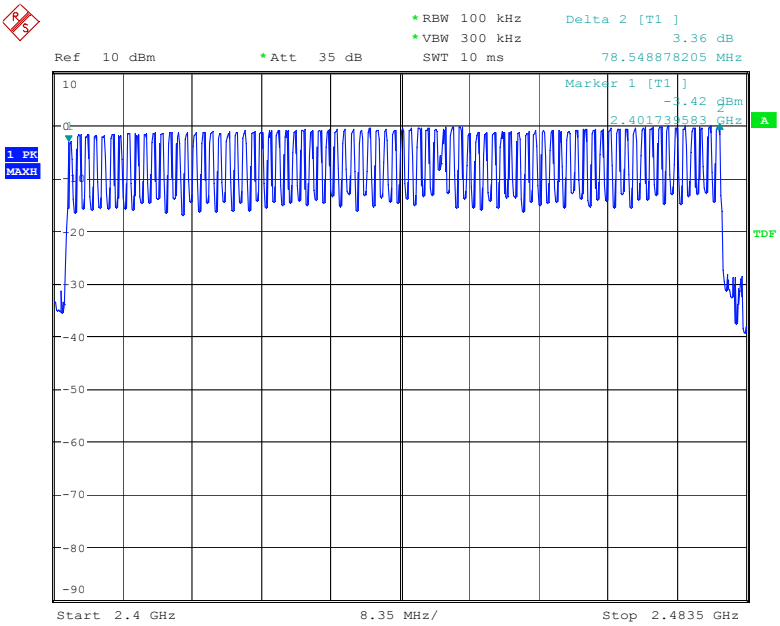

## 7.3 Measurement Results

| | | | |
|---|---|---|---|
| Modulation | GFSK, π/4-DQPSK, 8DPSK | | |
| RBW: | 100KHz | VBW: | 300KHz |
| Packet: | DH5 | Spectrum Detector: | PK |
| Test By: | Sance | Test Date : | February 16, 2017 |
| Temperature : | 24 ℃ | Humidity : | 50 % |
| Test Result: | PASS | | |

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

The worst case: GFSK

GFSK




Date: 16.FEB.2017 16:00:24

# 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

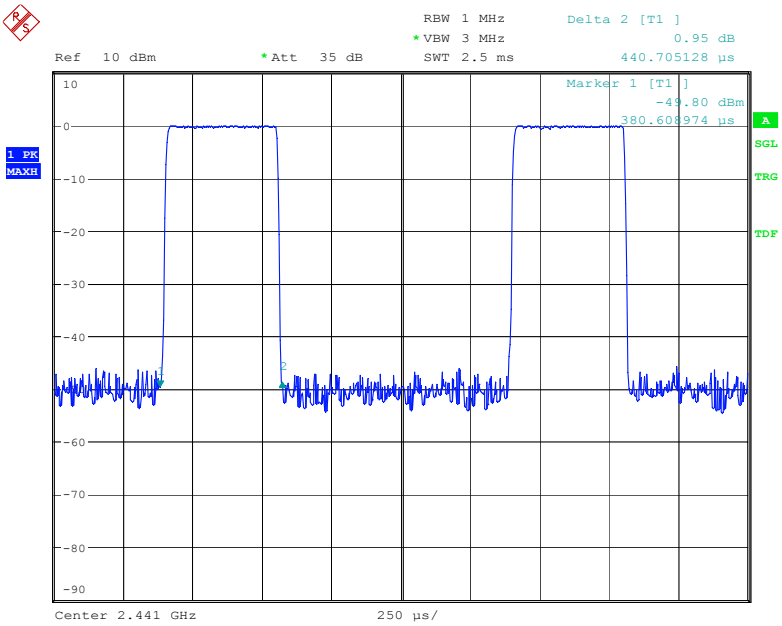
The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

Refer to attached data chart.

| | | | |
|---|---|---|---|
| Modulation : | GFSK, π/4-DQPSK, 8DPSK | | |
| RBW : | 1MHz | VBW : | 3MHz |
| Spectrum Detector: | PK | Test By: | Sance |
| Test Date : | February 16, 2017 | Temperature : | 24℃ |
| Test Result: | PASS | Humidity : | 50 % |

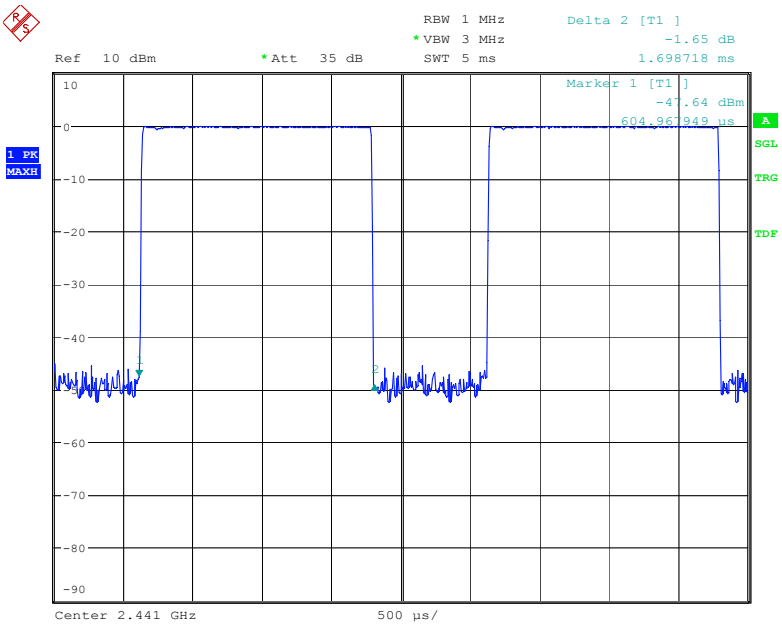
| Packet | Frequency (MHz) | Result (msec) | | | Limit (msec) |
|---|---|---|---|---|---|
| GFSK | | | | | |
| DH1 | 2441 | 0.441 | (ms)*(1600/(2*79))*31.6= | 141.12 | 400 |
| DH3 | 2441 | 1.699 | (ms)*(1600/(4*79))*31.6= | 271.84 | 400 |
| DH5 | 2441 | 2.949 | (ms)*(1600/(6*79))*31.6= | 314.56 | 400 |
| π/4-DQPSK | | | | | |
| 2-DH1 | 2441 | 0.433 | (ms)*(1600/(2*79))*31.6= | 138.56 | 400 |
| 2-DH3 | 2441 | 1.711 | (ms)*(1600/(4*79))*31.6= | 273.76 | 400 |
| 2-DH5 | 2441 | 2.973 | (ms)*(1600/(6*79))*31.6= | 317.12 | 400 |
| 8DPSK | | | | | |
| 3-DH1 | 2441 | 0.429 | (ms)*(1600/(2*79))*31.6= | 137.28 | 400 |
| 3-DH3 | 2441 | 1.711 | (ms)*(1600/(4*79))*31.6= | 273.76 | 400 |
| 3-DH5 | 2441 | 2.961 | (ms)*(1600/(6*79))*31.6= | 315.84 | 400 |

# GFSK DH1



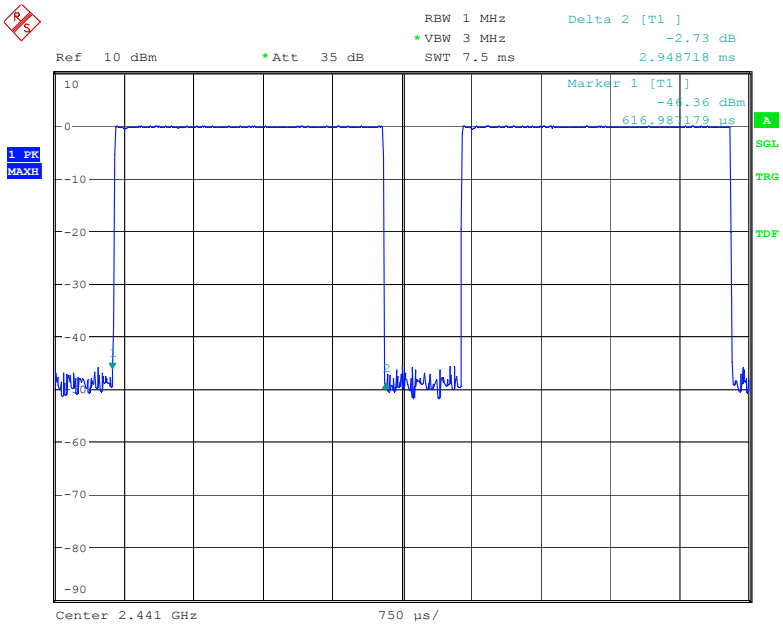

Date: 16.FEB.2017 15:26:26

# GFSK DH3



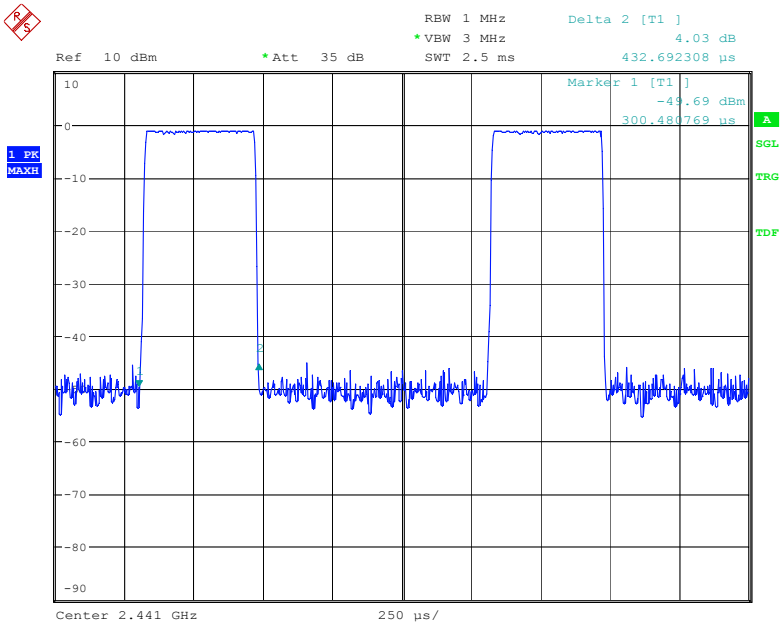

Date: 16.FEB.2017 15:27:08

## GFSK DH5



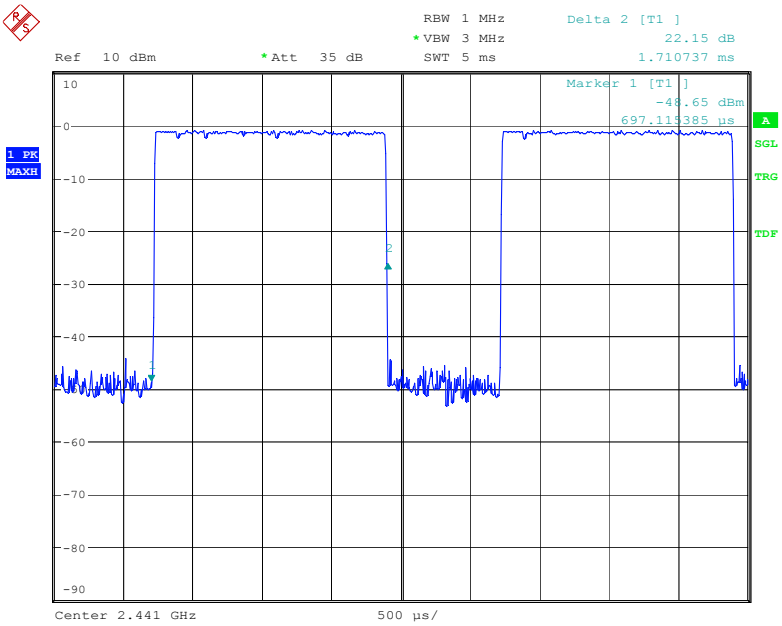

Date: 16.FEB.2017 15:27:54

## π/4-DQPSK 2-DH1



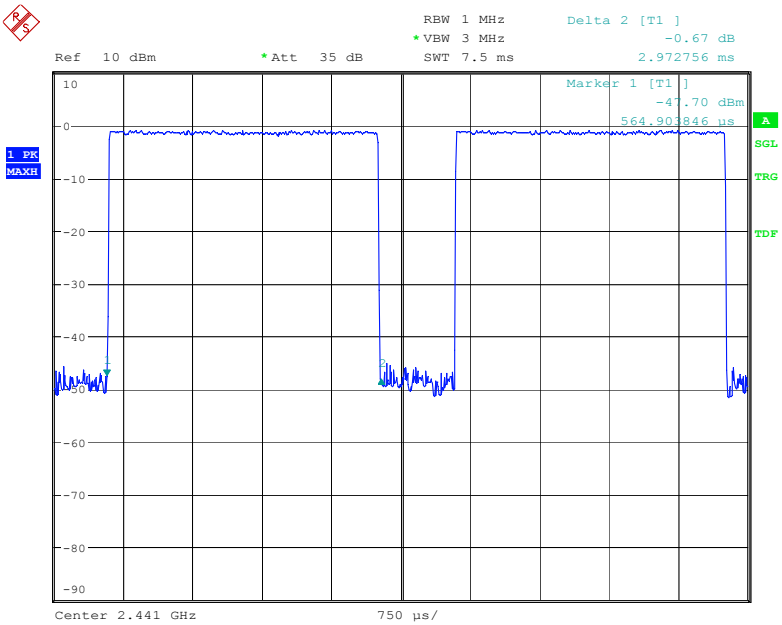

Date: 16.FEB.2017 15:28:49

## π/4-DQPSK 2-DH3



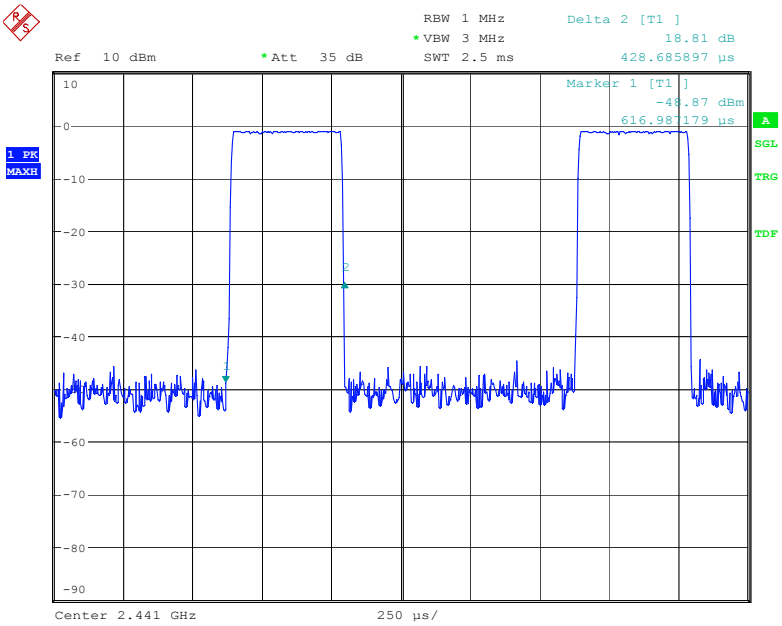

Date: 16.FEB.2017 15:29:51

## π/4-DQPSK 2-DH5



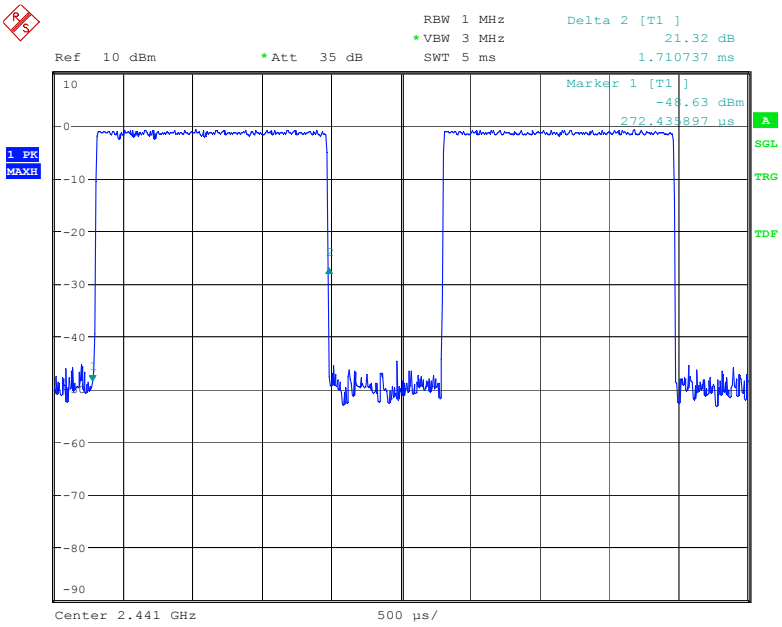

Date: 16.FEB.2017 15:30:47

## 8DPSK 3-DH1



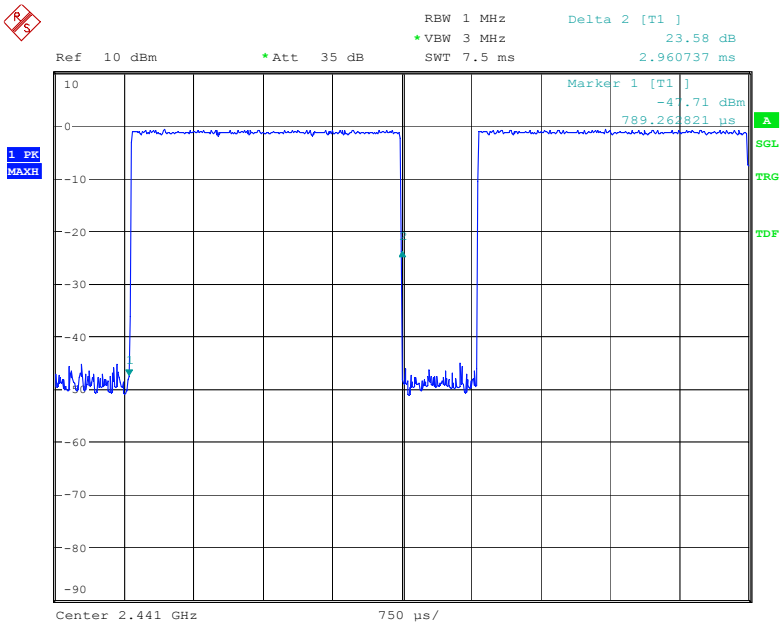

Date: 16.FEB.2017 15:31:22

## 8DPSK 3-DH3




Date: 16.FEB.2017 15:32:10

# 8DPSK 3-DH5




Date: 16.FEB.2017 15:32:48

# 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.

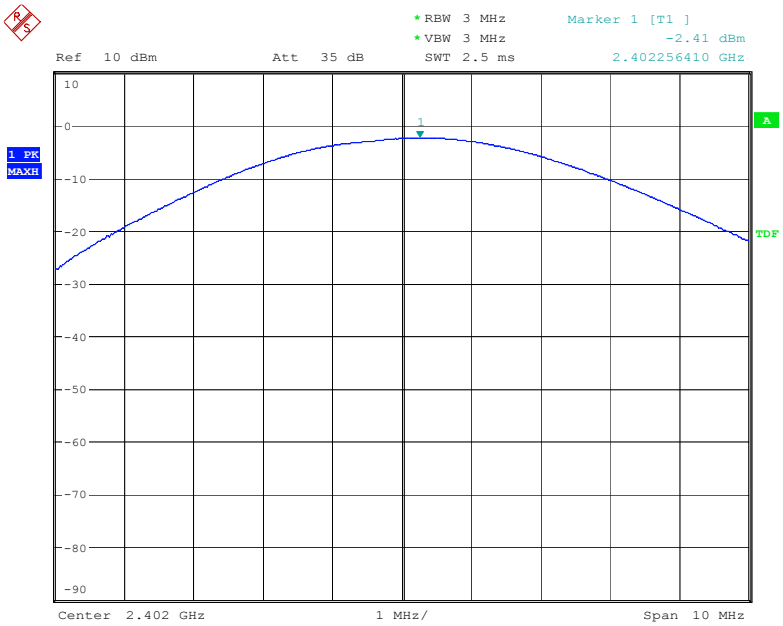
## 9.2 Measurement Results

Refer to attached data chart.

| | | | |
|---|---|---|---|
| Modulation : | GFSK, π/4-DQPSK, 8DPSK | | |
| RBW : | 3MHz | VBW : | 3MHz |
| Spectrum Detector: | PK | Test Date : | February 16, 2017 |
| Test By: | Sance | Temperature : | 24 ℃ |
| Test Result: | PASS | Humidity : | 50 % |

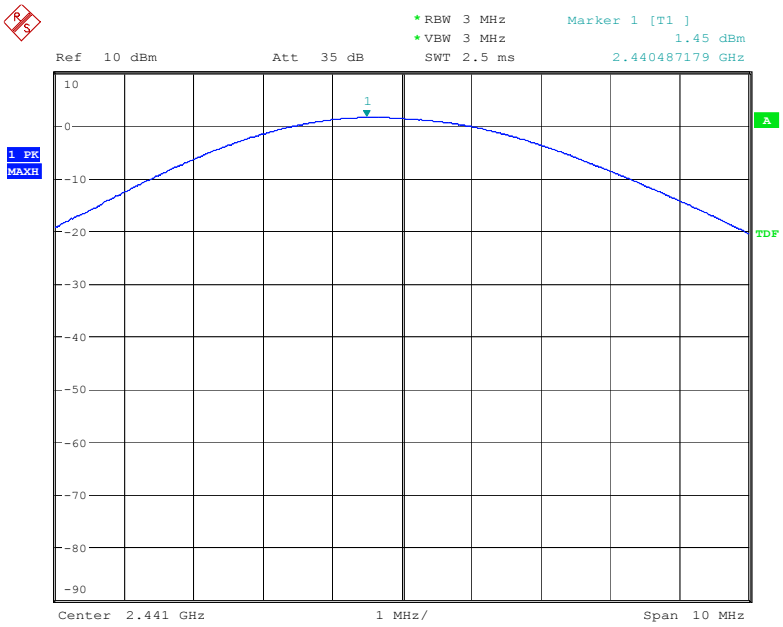
| Channel Frequency (MHz) | Cable Loss dB | Peak Power output(dBm) | Peak Power output(mW) | Peak Power Limit(dBm) | Pass/Fail |
|---|---|---|---|---|---|
| GFSK | | | | | |
| 2402.00 | 1.5 | -2.41 | 0.57 | 21 | PASS |
| 2441.00 | 1.5 | 1.45 | 1.40 | 21 | PASS |
| 2480.00 | 1.5 | 1.81 | 1.52 | 21 | PASS |
| π/4-DQPSK | | | | | |
| 2402.00 | 1.5 | -3.35 | 0.46 | 21 | PASS |
| 2441.00 | 1.5 | 0.68 | 1.17 | 21 | PASS |
| 2480.00 | 1.5 | 1.04 | 1.27 | 21 | PASS |
| 8DPSK | | | | | |
| 2402.00 | 1.5 | -3.44 | 0.45 | 21 | PASS |
| 2441.00 | 1.5 | 0.72 | 1.18 | 21 | PASS |
| 2480.00 | 1.5 | 1.07 | 1.28 | 21 | PASS |

## GFSK Lowest Channel



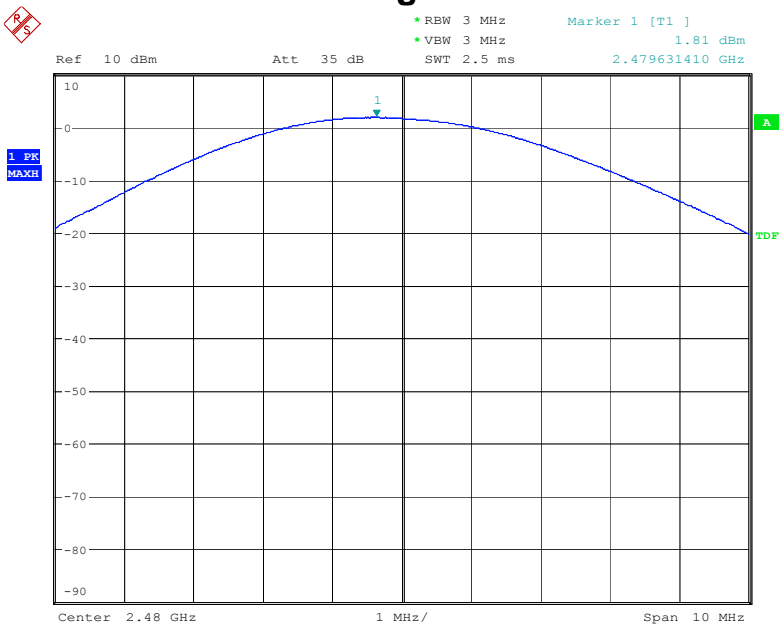

Date: 16.FEB.2017 13:22:10

## GFSK Middle Channel



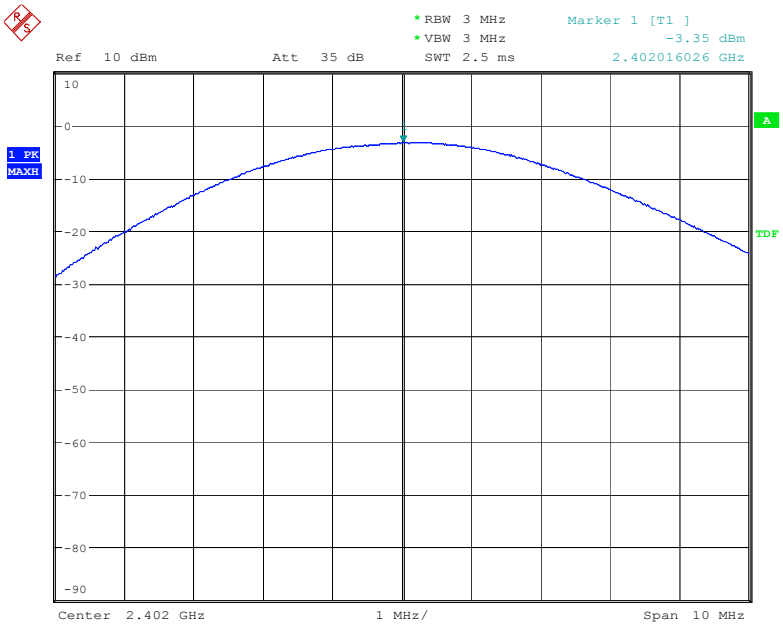

Date: 16.FEB.2017 13:22:30

## GFSK Highest Channel



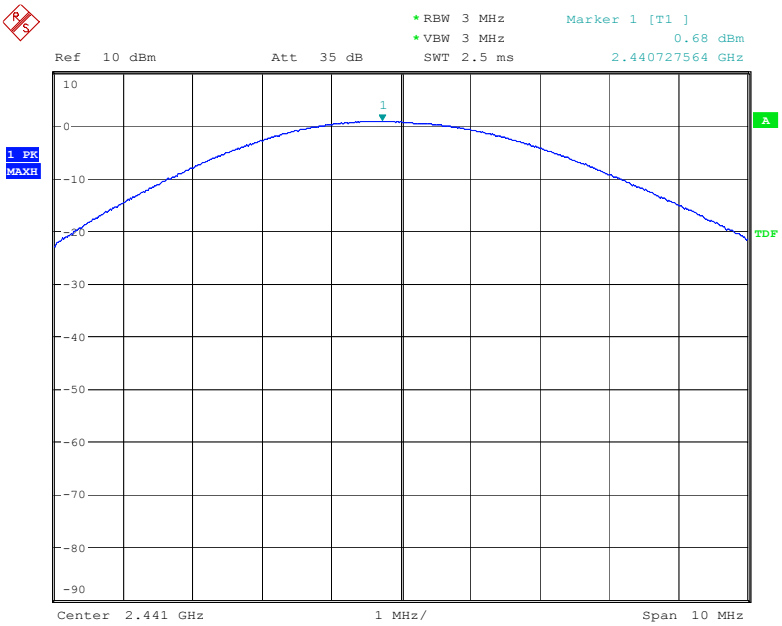

Date: 16.FEB.2017 13:22:46

## π/4-DQPSK Lowest Channel



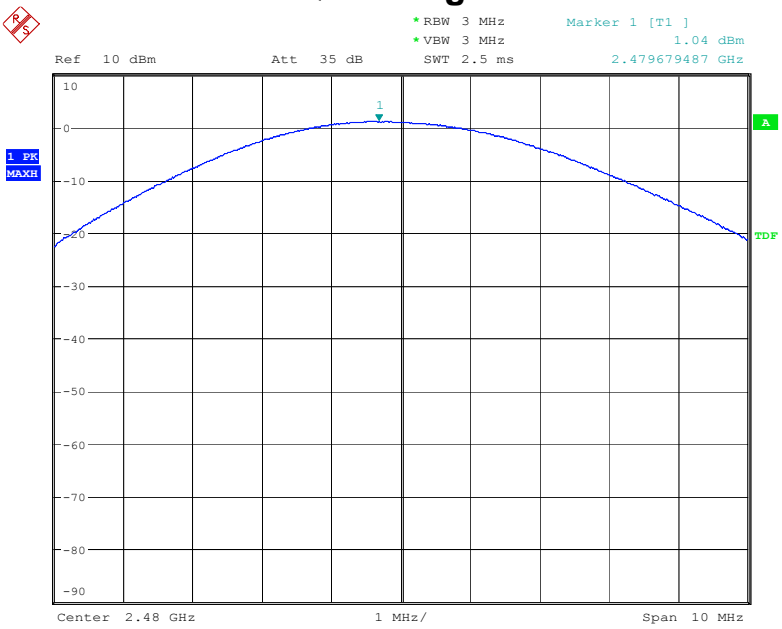

Date: 16.FEB.2017 13:23:44

## π/4-DQPSK Middle Channel



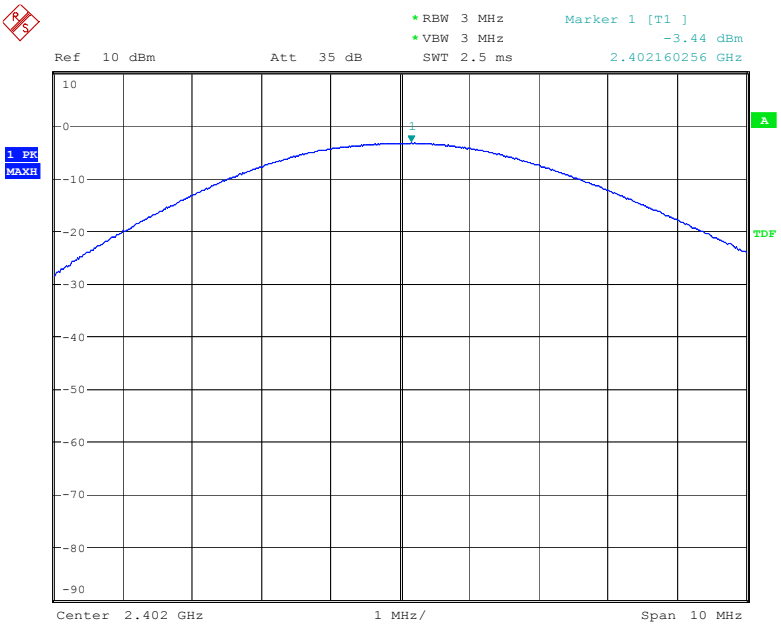

Date: 16.FEB.2017 13:24:00

## π/4-DQPSK Highest Channel



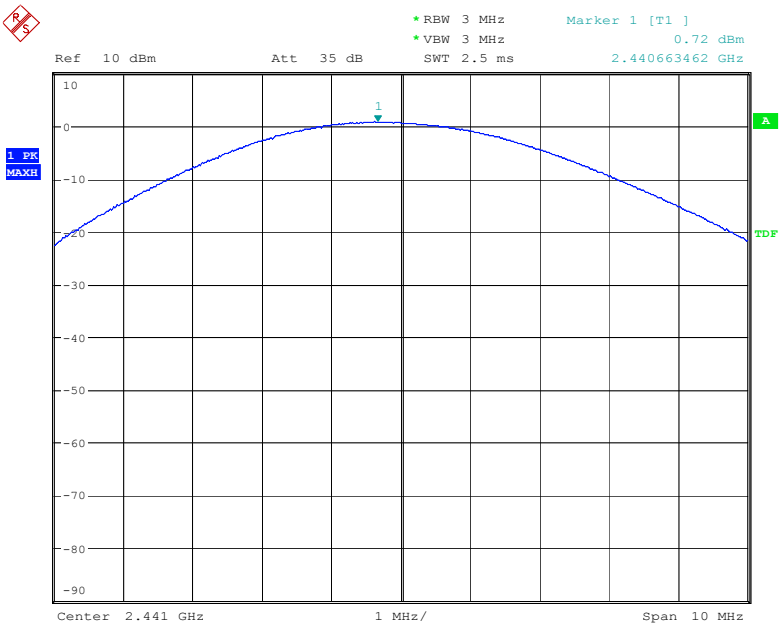

Date: 16.FEB.2017 13:24:16

## 8DPSK Lowest Channel



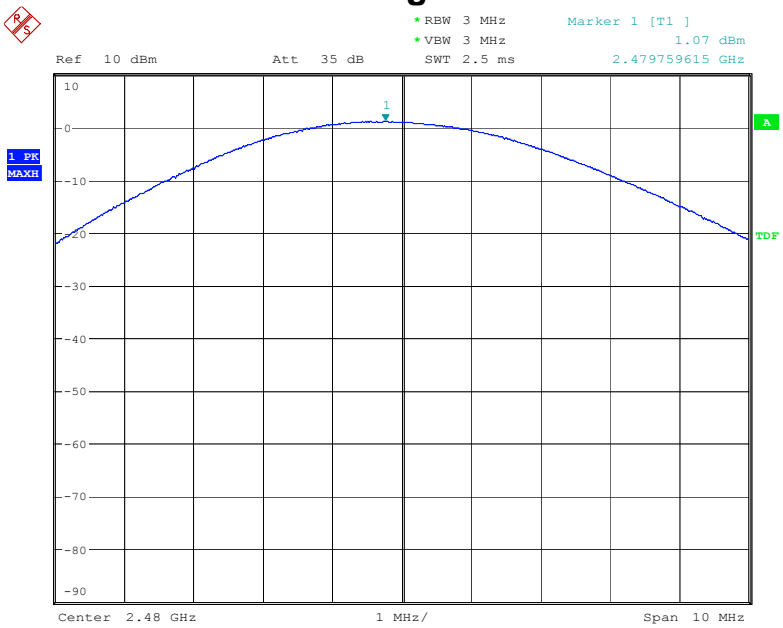

Date: 16.FEB.2017 13:24:49

## 8DPSK Middle Channel




Date: 16.FEB.2017 13:25:06

# 8DPSK Highest Channel




Date: 16.FEB.2017 13:25:23

# 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

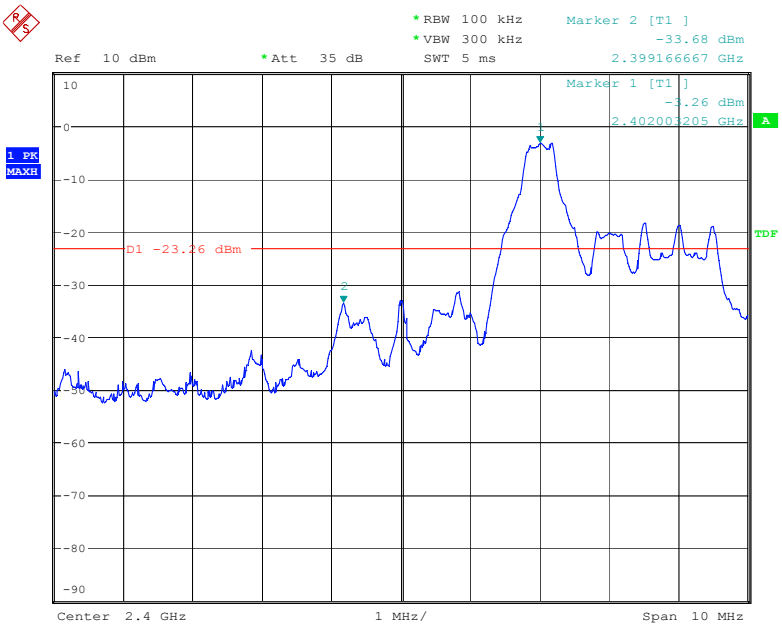
Please see below test table and plots.
For Radiated Emission
The worst case: GFSK
Hopping-on mode

| 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 | 39.67 | 29.21 | 8.09 | 47.76 | 37.30 | 74.00 | 54.00 | -26.24 | -16.70 |
| 2390.000 | V | 39.73 | 28.94 | 8.09 | 47.82 | 37.03 | 74.00 | 54.00 | -26.18 | -16.97 |
| 2483.500 | H | 51.78 | 41.36 | 8.36 | 60.14 | 49.72 | 74.00 | 54.00 | -13.86 | -4.28 |
| 2483.500 | V | 51.14 | 39.87 | 8.36 | 59.50 | 48.23 | 74.00 | 54.00 | -14.5 | -5.77 |

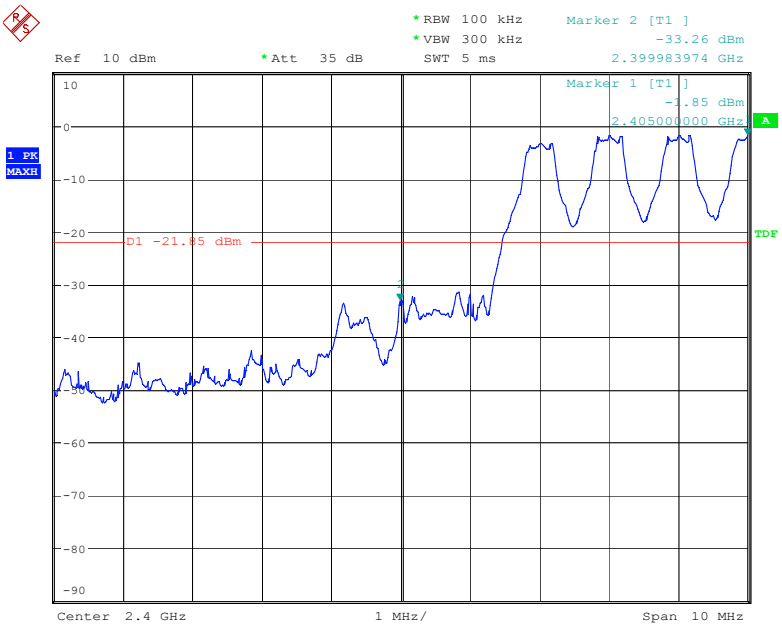
**Note:** (1) Emission Level= Reading Level + Factor
(2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(3) Horn antenna used for the emission over 1000MHz.

For RF Conducted

## GFSK Lowest Channel

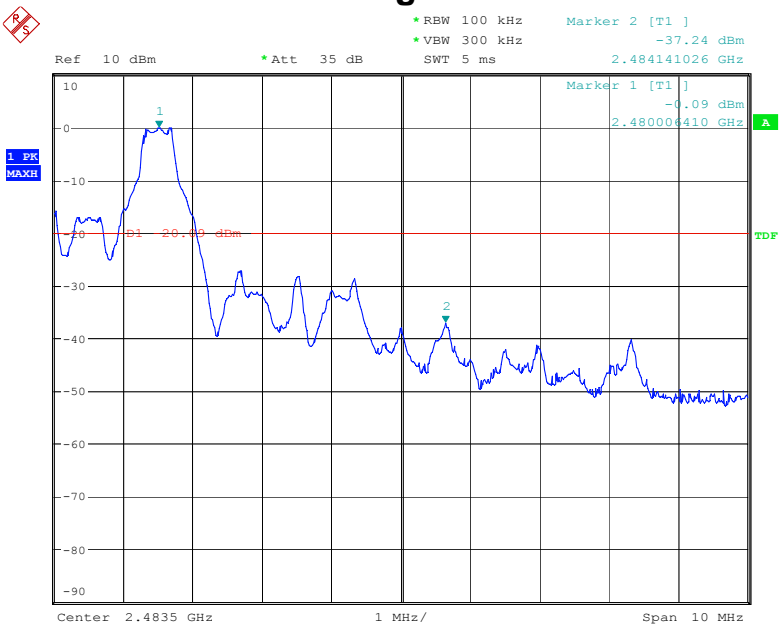



Date: 16.FEB.2017 15:34:20

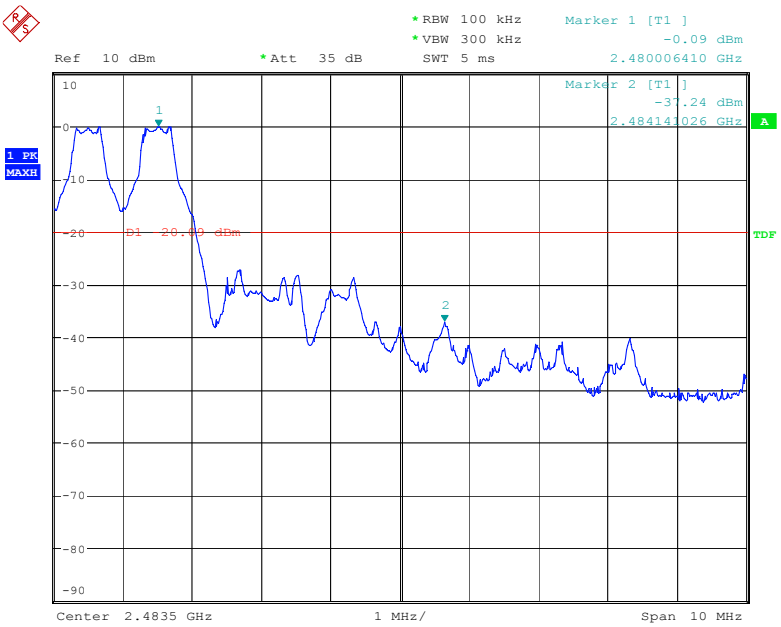



Date: 16.FEB.2017 15:35:27

# GFSK Highest Channel

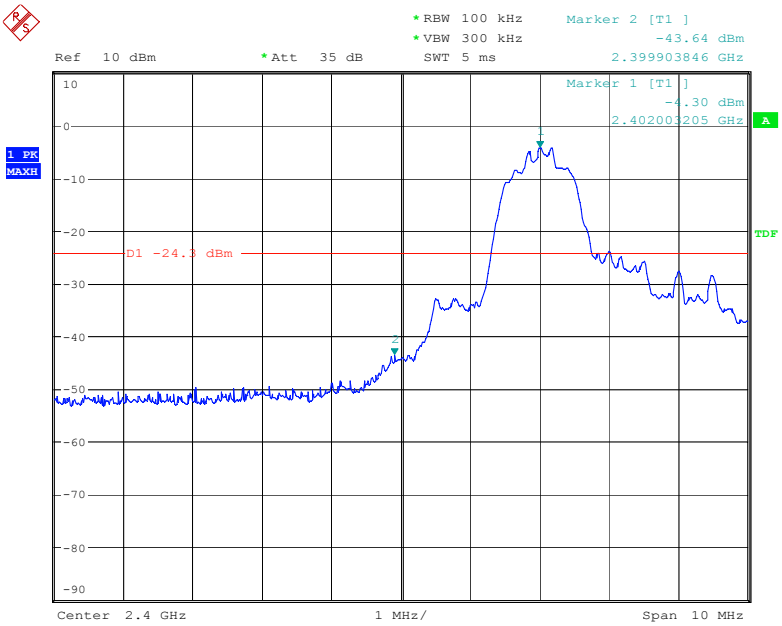



Date: 16.FEB.2017 15:36:21

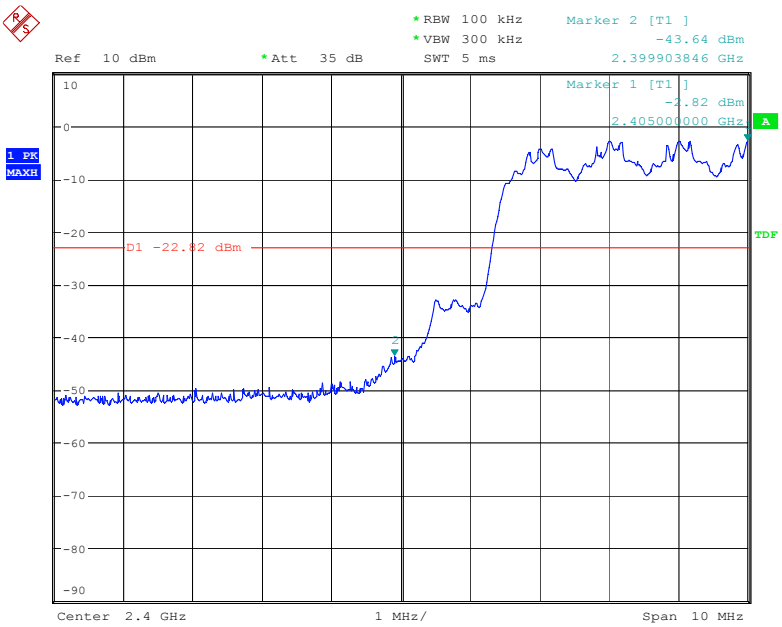



Date: 16.FEB.2017 15:36:48

# π/4-DQPSK Lowest Channel

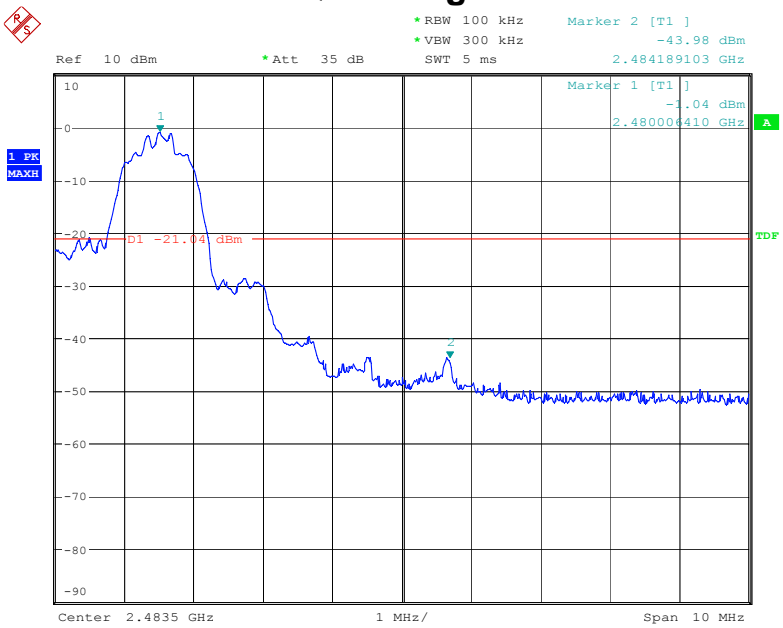



Date: 16.FEB.2017 15:38:00

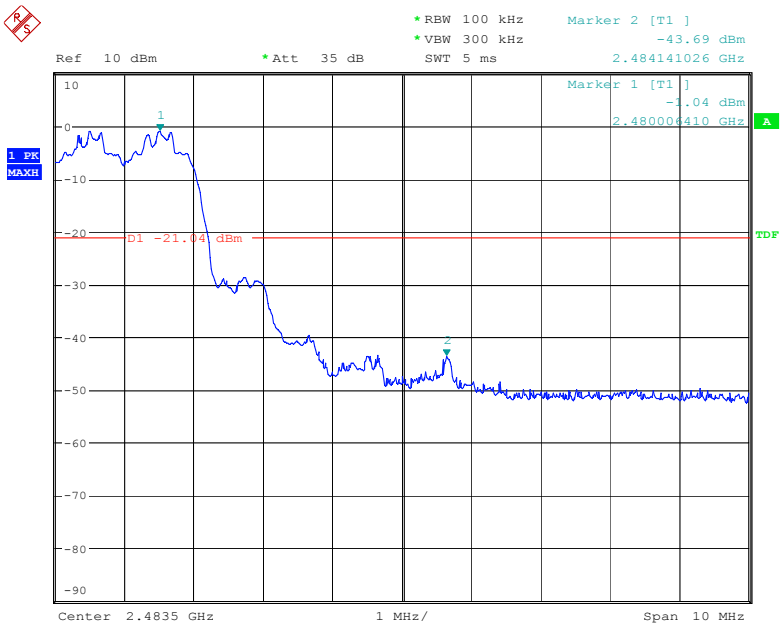



Date: 16.FEB.2017 15:39:06

# π/4-DQPSK Highest Channel

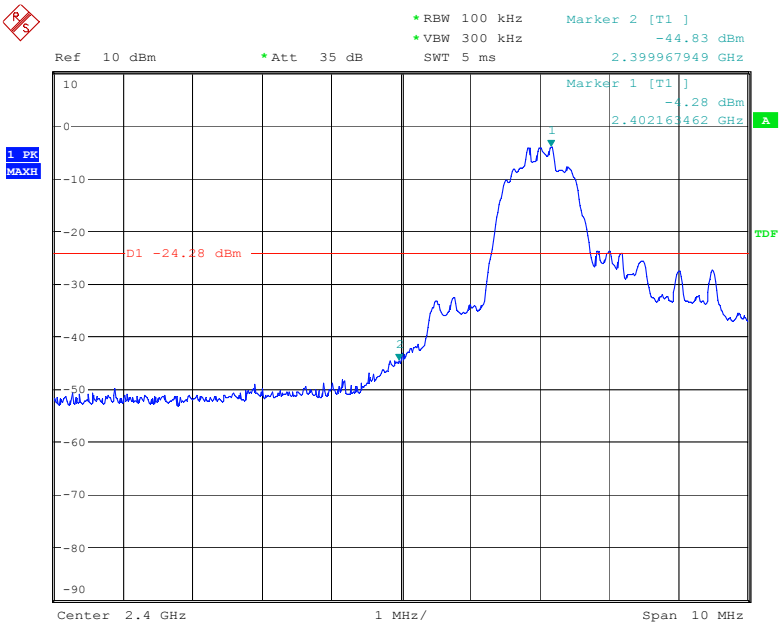



Date: 16.FEB.2017 15:40:11

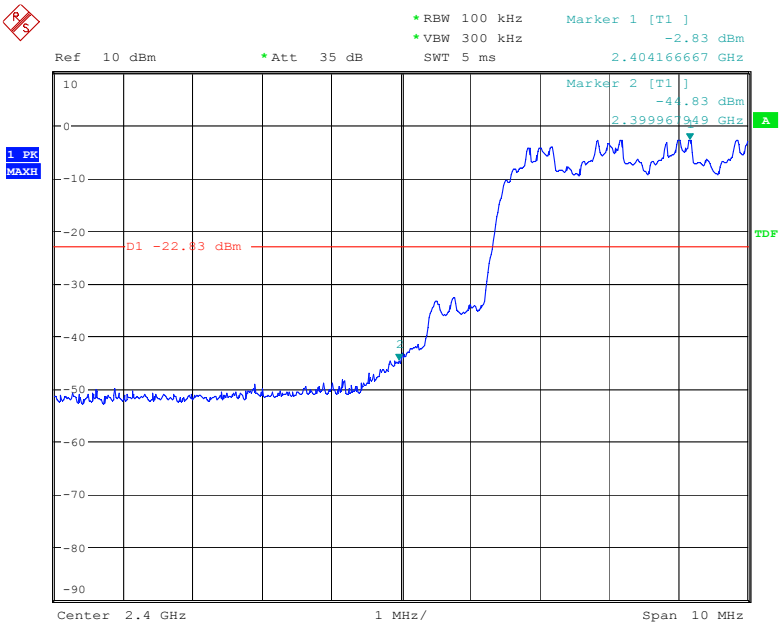



Date: 16.FEB.2017 15:40:54

# 8DPSK Lowest Channel

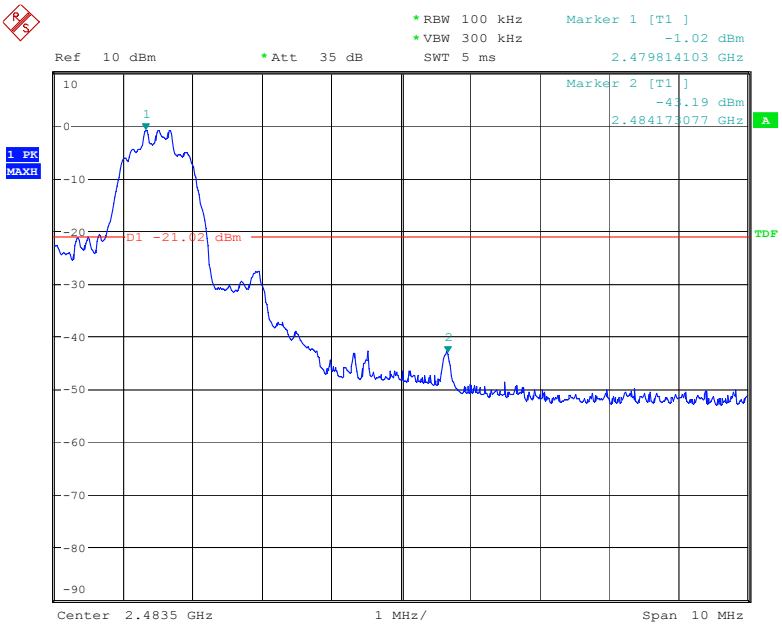



Date: 16.FEB.2017 15:42:07

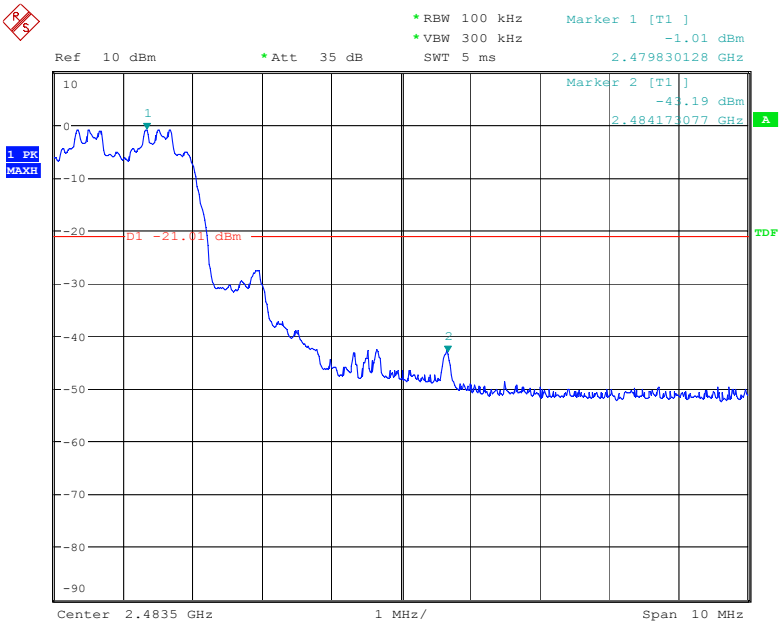



Date: 16.FEB.2017 15:43:06

# 8DPSK Highest Channel




Date: 16.FEB.2017 15:43:44




Date: 16.FEB.2017 15:44:53

# 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 0.21dBi. So, the antenna is consider meet the requirement.

# 12. Conducted Spurious Emissions

## 12.1 Measurement Procedure

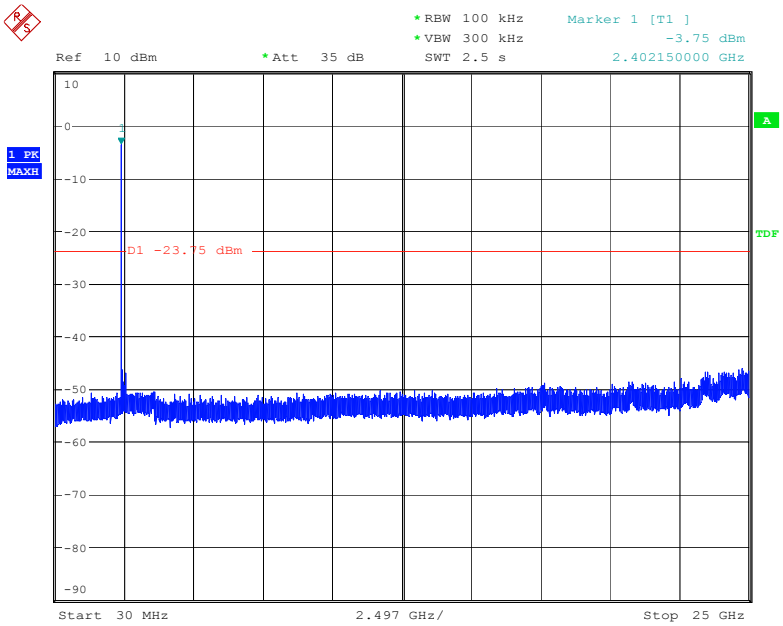
Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

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

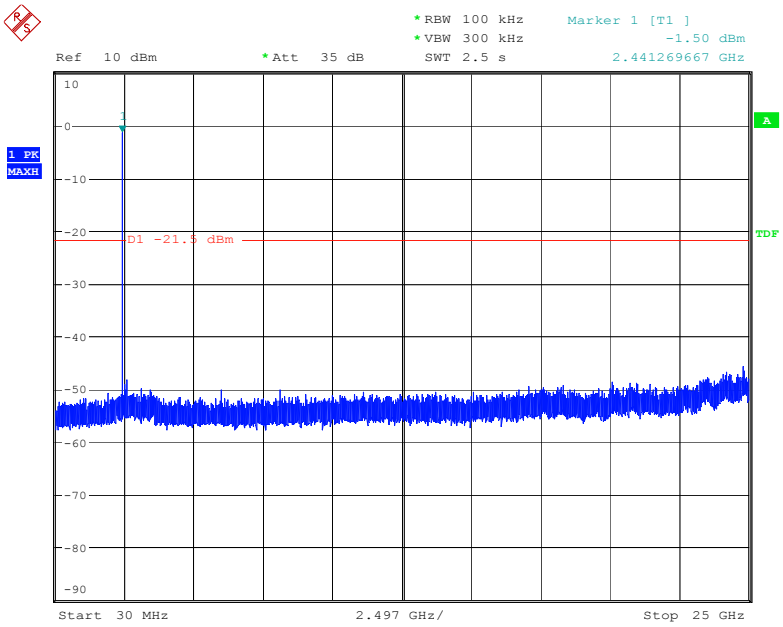
Please refer to following plots, the worst case (GFSK) was shown.

## Lowest Channel



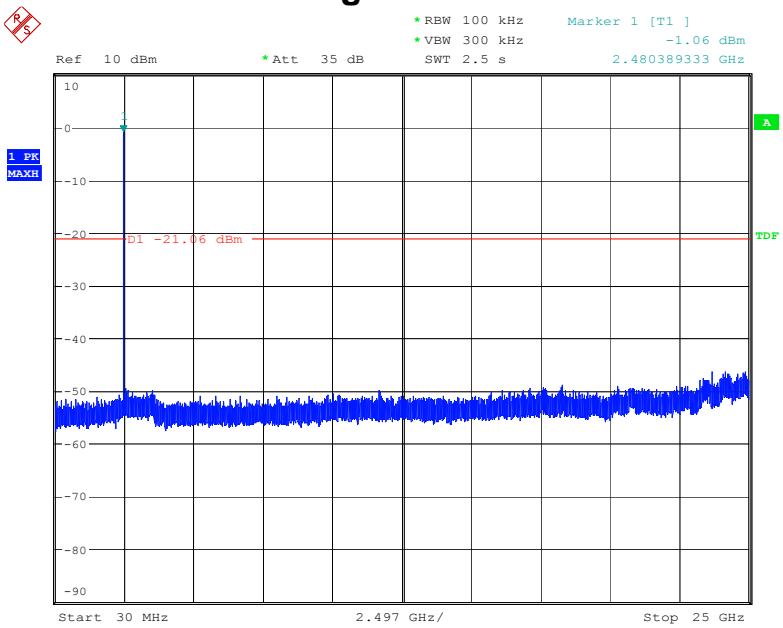

Date: 16.FEB.2017 15:46:27

## Middle Channel




Date: 16.FEB.2017 15:47:15

# Highest Channel




Date: 16.FEB.2017 15:48:21

**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. 22, 2016 | Nov. 21, 2017 |
| Antenna | Schwarzbeck | VULB9162 | 9162-010 | 30MHz~7GHz | Nov. 25, 2016 | Nov. 24, 2017 |
| 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. 06, 2016 | Nov. 05, 2017 |
| Cable | Huber+Suhner | CIL02 | N/A | 9KHz~7GHz | Nov. 06, 2016 | Nov. 05, 2017 |
| RF Cable | Huber+Suhner | SF-104 | MY16559/4 | 9KHz~25GHz | Mar. 05, 2017 | Mar. 05, 2018 |
| Power Amplifier | HP | HP 8447D | 1145A00203 | 100KHz~1.3GHz | Nov. 06, 2016 | Nov. 05, 2017 |
| Horn Antenna | Schwarzbeck | BBHA9170 | 9170-372 | 15GHz~26.5GHz | Oct.22, 2016 | Oct.21, 2017 |
| Horn Antenna | Com-Power | AH-118 | 071078 | 1GHz~18GHz | Nov. 04, 2016 | Nov. 03, 2017 |
| 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. 02, 2016 | Nov. 01, 2017 |
| L.I.S.N. | Rohde & Schwarz | ENV 216 | 101317 | 9KHz~30MHz | Nov. 02, 2016 | Nov. 01, 2017 |
| 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---