

FCC 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 : Chongqing Jingranyouxu Technology Co., Ltd.
Address : No. 1th, 6/F, post Office building, Mercury Science and Technology Building, No. 5th Huangshan Avenue, High-tech park, Chongqing City, China
Manufacturer : Chongqing Jingranyouxu Technology Co., Ltd.
Address : No. 1th, 6/F, post Office building, Mercury Science and Technology Building, No. 5th Huangshan Avenue, High-tech park, Chongqing City, China
Factory : Chongqing Datiejiang Science and Technology Co.,Ltd.
Address : NO.368, BOE Avenue, Beibei District, Chongqing
E.U.T. : Label Printer
Model No. : D7, D1, D2, D3, D4, D5, D6, D8, D9, D10, CS18-1A, CS18-1B, CS18-1C, CS18-1D, CS18-1E, CS18-1F, CS18-1G, CS18-1H, CS18-1I, CS18-1J
(For model difference refer to section 1.1)
Brand Name : MAKEiD
FCC ID : 2AUMQ-D7
Measurement Standard : FCC PART 15.247
Date of Receiver : September 05, 2019
Date of Test : September 06, 2019 to September 30, 2019
Date of Report : October 10, 2019

This Test Report is Issued Under the Authority of :

Prepared by



Evan Yang / Engineer

Approved & Authorized Signer



Iori Fan / Authorized Signatory

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Revision History of This Test Report

| Report Number | Description | Issued Date |
|----------------|---------------|-------------|
| NTC1909113FV00 | Initial Issue | 2019-10-10 |
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1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test

| | |
|------------------|--|
| Product Name | : Label Printer |
| Model difference | : D7, D1, D2, D3, D4, D5, D6, D8, D9, D10, CS18-1A, CS18-1B, CS18-1C, CS18-1D, CS18-1E, CS18-1F, CS18-1G, CS18-1H, CS18-1I, CS18-1J |
| Model difference | : We hereby state that these models are identical in interior structure, electrical circuits and components, just model name is different. Therefore only model D7 is for tests. |
| E.U.T. Type | : Class B |
| Rating | : DC 5V from USB Port DC 7.4V from built-in battery |

Technical Specification:

BT Function

| | |
|-------------------|--|
| Version | : V4.2 (BR/EDR + BLE) |
| Frequency Range | : 2400-2483.5MHz |
| Modulation Type | : GFSK for BLE GFSK, $\pi/4$ -DQPSK, 8DPSK for BR/EDR |
| Number of Channel | : 40 for BLE 79 for BR/EDR |
| Channel Space | : 2MHz for BLE 1MHz for BR/EDR |
| Antenna Type | : PCB on-board antenna |
| Antenna Gain | : 2 dBi |

Note: This report is applicable to Bluetooth(BR/EDR) function

Bluetooth 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 |

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: 2AUMQ-D7** filing to comply with Section 15.247 of the FCC Part 15, 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

| Description | Manufacturer | Model | S/N |
|---------------|--------------|------------|---------------|
| AC/DC Adapter | SAMSUNG | ETA-U90CBC | RT4F629wS/B-E |

Note: The adapter is used for conducted emission tests

1.6 Test Facility and Location

Site Description

| | |
|---------------|---|
| EMC Lab | : Listed by CNAS, August 13, 2018 The certificate is valid until August 13, 2024 The Laboratory has been assessed and proved to be in compliance with CNAS/CL01 The Certificate Registration Number is L5795. Listed by A2LA, November 01, 2017 The certificate is valid until December 31, 2019 The Laboratory has been assessed and proved to be in compliance with ISO17025 The Certificate Registration Number is 4429.01 Listed by FCC, November 06, 2017 The Designation Number is CN1214 Test Firm Registration Number: 907417 Listed by Industry Canada, June 08, 2017 The Certificate Registration Number. Is 46405-9743 |
| Name of Firm | : Dongguan Nore Testing Center Co., Ltd. (Dongguan NTC Co., Ltd.) |
| Site Location | : Building D, Gaosheng Science and Technology Park, Hongtu Road, Nancheng District, Dongguan City, Guangdong Province, China |

1.7 Summary of Test Results

| FCC Rules | Description Of Test | Uncertainty | Result |
|-----------------------------|----------------------------------|---------------------------|-----------|
| §15.207 (a) | AC Power Line Conducted Emission | ±1.06dB | Compliant |
| §15.247(d),§15.209, §15.205 | Radiated Emission | ±3.70dB | Compliant |
| §15.247(a)(1) | Channel Separation | ±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 | ±1.06dB | Compliant |
| §15.247(d) | Band Edge | ±1.70dB | Compliant |
| §15.203 | Antenna Requirement | N/A | Compliant |
| §15.247(d) | Conducted Spurious Emission | ±1.70dB | 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, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 mode in all modulation type GFSK, $\pi/4$ -DQPSK and 8DPSK were tested.

| Test Item | Software | Description |
|---|-------------------------|---|
| Conducted RF Testing and Radiated testing | ESP_RF_test_tool_v1.1.0 | Set the EUT to different modulation and channel |

Output power setting table:

| Test Mode | Set Tx Output Power | Data rate |
|----------------|---------------------|-----------|
| GFSK | 0dBm | DH1 |
| $\pi/4$ -DQPSK | 3dBm | 2-DH1 |
| 8DPSK | 3dBm | 3-DH1 |

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.

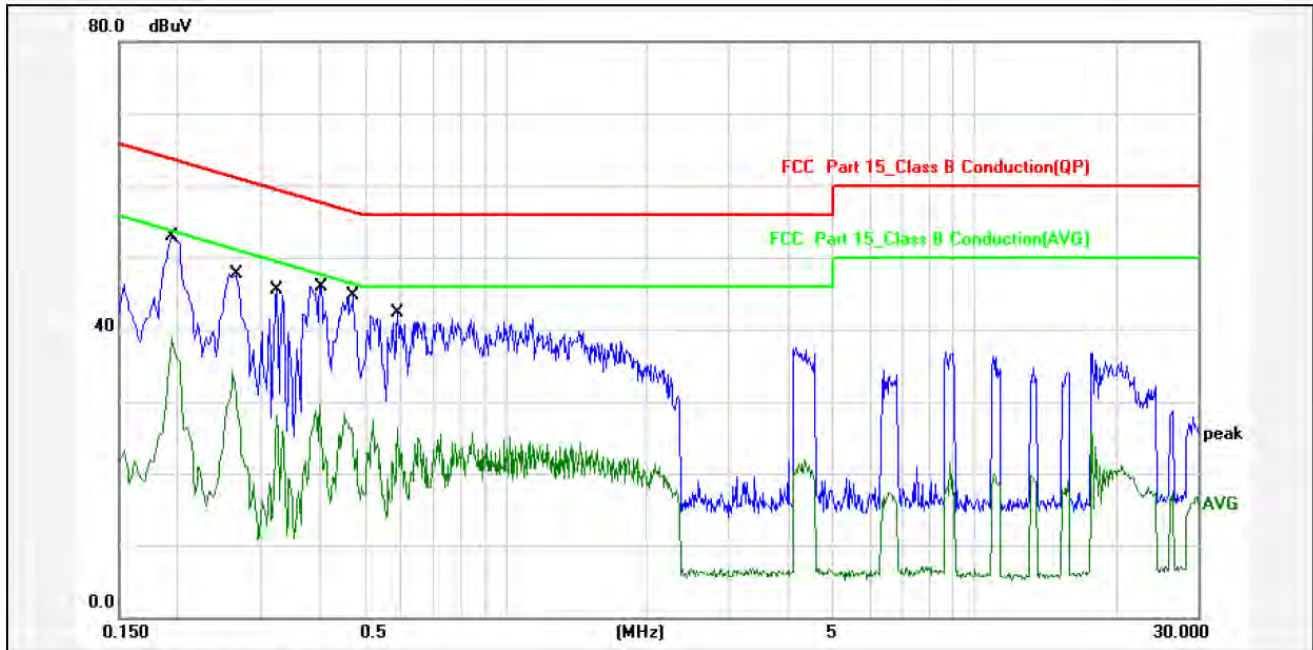
3.1 Test SET-UP (Block Diagram of Configuration)



Operation Mode: BT Communication

PASS

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Report No.: NTC1909113FV00

Test Standard: FCC Part 15_Class B Conduction(QP)

Test item: Conducted Emission

Phase: N

Applicant: Chongqing Jingranyouxu Technology Co., Ltd.

Temp.(C)/Hum.(%): 24(°C) / 52.8 %

Product: Label Printer

Power Rating: AC 120V/60Hz

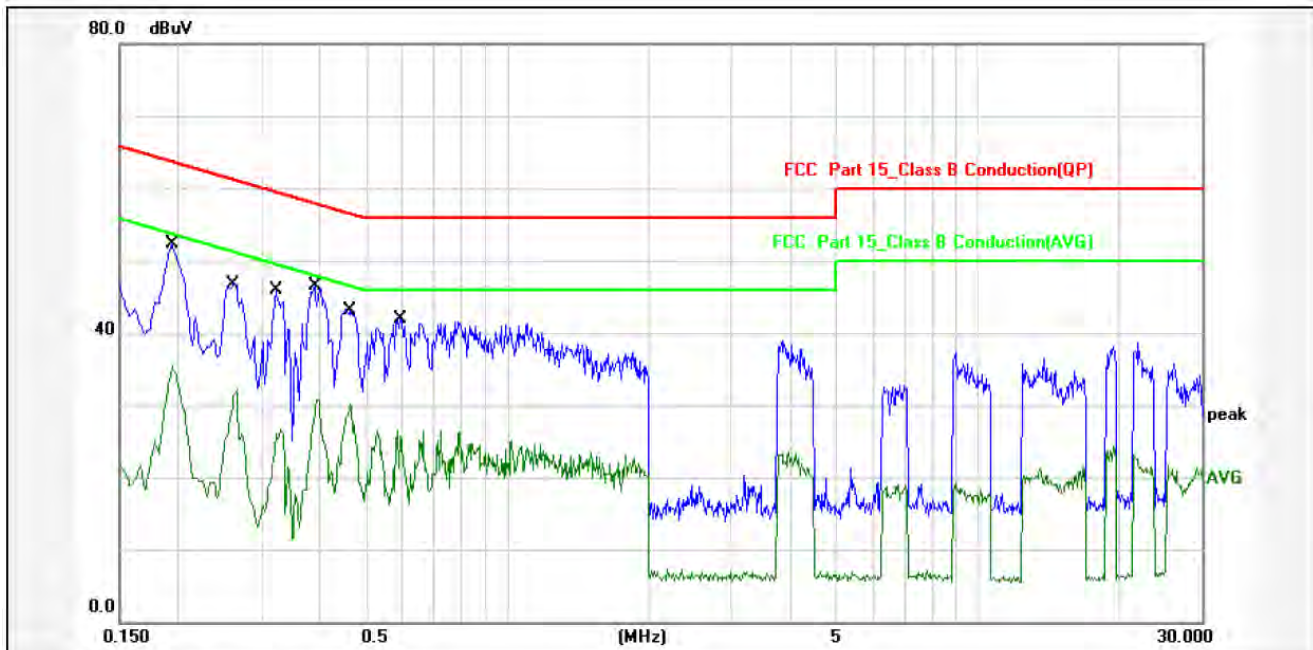
Model No.: D7

Test Engineer: QM

Test Mode: BT Communication

Remark:

| No. | Frequency (MHz) | Factor (dB) | Reading (dBuV) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F | Remark |
|-----|-----------------|-------------|----------------|--------------|--------------|-------------|----------|-----|--------|
| 1 | 0.1940 | 10.60 | 42.36 | 52.96 | 63.86 | -10.90 | QP | P | |
| 2 | 0.1940 | 10.60 | 28.38 | 38.98 | 53.86 | -14.88 | AVG | P | |
| 3 | 0.2660 | 10.60 | 37.02 | 47.62 | 61.24 | -13.62 | QP | P | |
| 4 | 0.2660 | 10.60 | 23.49 | 34.09 | 51.24 | -17.15 | AVG | P | |
| 5 | 0.3260 | 10.60 | 34.99 | 45.59 | 59.55 | -13.96 | QP | P | |
| 6 | 0.3260 | 10.60 | 17.60 | 28.20 | 49.55 | -21.35 | AVG | P | |
| 7 | 0.4060 | 10.60 | 35.31 | 45.91 | 57.73 | -11.82 | QP | P | |
| 8 | 0.4060 | 10.60 | 18.95 | 29.55 | 47.73 | -18.18 | AVG | P | |
| 9 | 0.4739 | 10.60 | 34.10 | 44.70 | 56.45 | -11.75 | QP | P | |
| 10 | 0.4739 | 10.60 | 16.58 | 27.18 | 46.45 | -19.27 | AVG | P | |
| 11 | 0.5899 | 10.60 | 31.69 | 42.29 | 56.00 | -13.71 | QP | P | |
| 12 | 0.5899 | 10.60 | 15.63 | 26.23 | 46.00 | -19.77 | AVG | P | |



Report No.: NTC1909113FV00

Test Standard: FCC Part 15 Class B Conduction(QP)

Test item: Conducted Emission

Phase: L1

Applicant: Chongqing Jingranyouxu Technology Co., Ltd.

Temp.(C)/Hum.(%): 24(°C) / 52.8 %

Product: Label Printer

Power Rating: AC 120V/60Hz

Model No.: D7

Test Engineer: QM

Test Mode: BT Communication

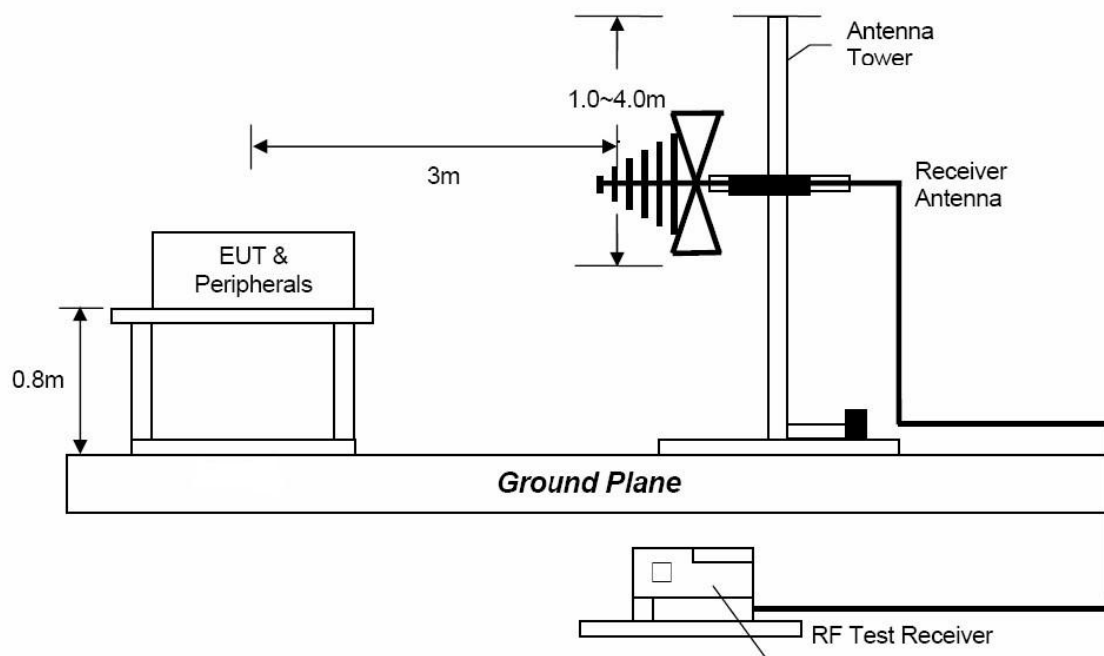
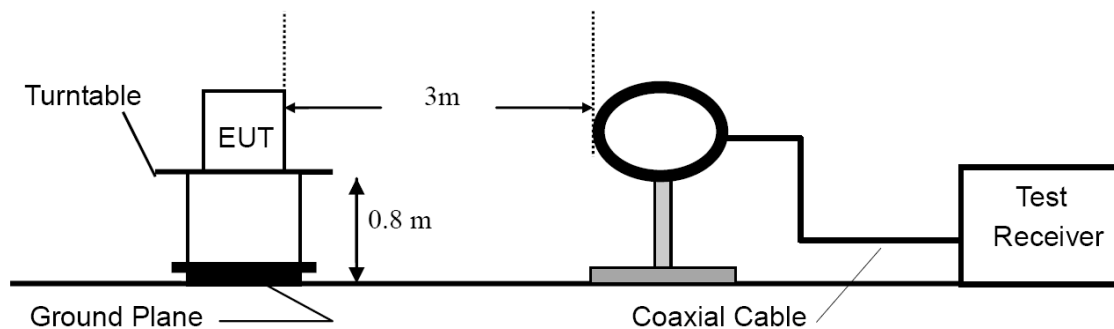
Remark:

| No. | Frequency (MHz) | Factor (dB) | Reading (dBuV) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F | Remark |
|-----|-----------------|-------------|----------------|--------------|--------------|-------------|----------|-----|--------|
| 1 | 0.1940 | 10.60 | 41.74 | 52.34 | 63.86 | -11.52 | QP | P | |
| 2 | 0.1940 | 10.60 | 24.84 | 35.44 | 53.86 | -18.42 | AVG | P | |
| 3 | 0.2620 | 10.60 | 36.13 | 46.73 | 61.36 | -14.63 | QP | P | |
| 4 | 0.2620 | 10.60 | 21.52 | 32.12 | 51.36 | -19.24 | AVG | P | |
| 5 | 0.3220 | 10.60 | 35.28 | 45.88 | 59.65 | -13.77 | QP | P | |
| 6 | 0.3220 | 10.60 | 16.14 | 26.74 | 49.65 | -22.91 | AVG | P | |
| 7 | 0.3899 | 10.60 | 35.99 | 46.59 | 58.06 | -11.47 | QP | P | |
| 8 | 0.3899 | 10.60 | 20.20 | 30.80 | 48.06 | -17.26 | AVG | P | |
| 9 | 0.4660 | 10.60 | 32.59 | 43.19 | 56.58 | -13.39 | QP | P | |
| 10 | 0.4660 | 10.60 | 19.45 | 30.05 | 46.58 | -16.53 | AVG | P | |
| 11 | 0.5939 | 10.60 | 31.34 | 41.94 | 56.00 | -14.06 | QP | P | |
| 12 | 0.5939 | 10.60 | 15.12 | 25.72 | 46.00 | -20.28 | AVG | P | |

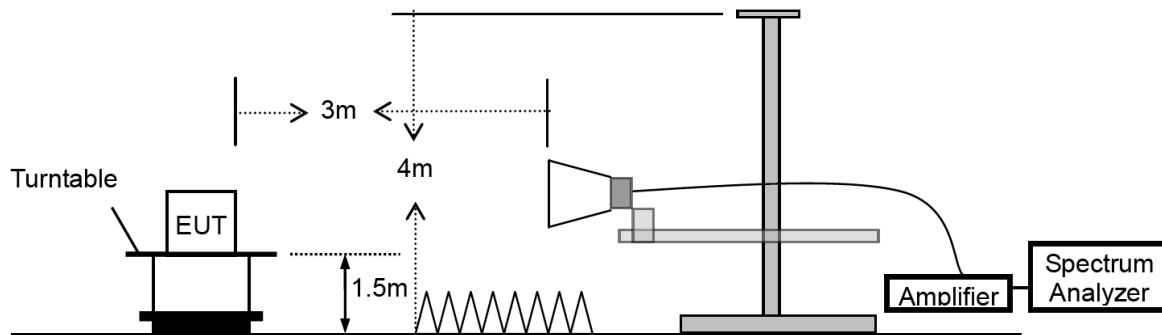
4. RADIATED EMISSION

4.1 Test SET-UP (Block Diagram of Configuration)

4.1.1 Radiated Emission Test Set-Up, Frequency below 30MHz



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



4.2 Measurement Procedure

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

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

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

4.3 Limit

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

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

4.4 Measurement Results

Please refer to following plots of the worst case: 8DPSK Low channel.

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit. Therefore, 9kHz-30MHz data were not recorded.

Test Time: 2019/9/18 20:42:36



Report No.: NTC1909113FV00

Test Standard: FCC Part 15B_Class B 3M Radiation

Test item: Radiation Emission

Applicant: Chongqing Jingranyouxu Technology Co., Ltd.

Product: Label Printer

Model No.: D7

Test Distance:

Ant. Polarization: Horizontal

Temp.(C)/Hum.(%): 25(°C) / 64 %

Power Rating: DC 7.4V

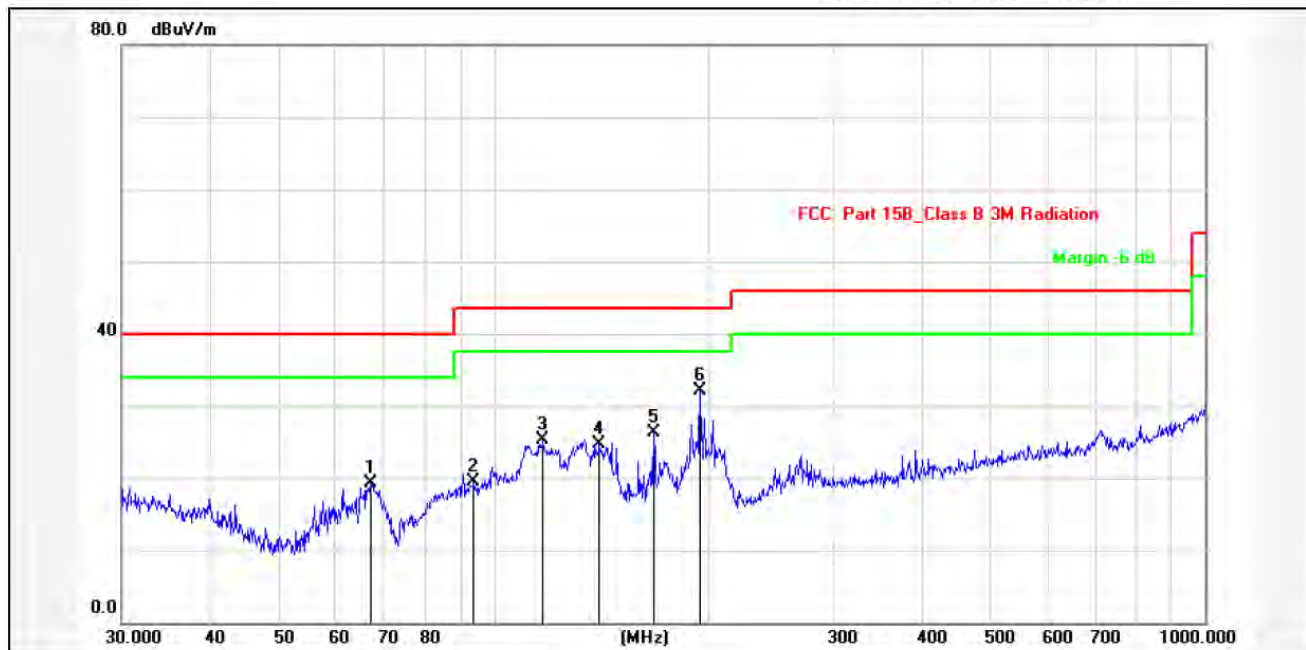
Test Engineer: SLY

Test Mode: TX 2402MHz

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 | 90.5374 | -10.78 | 32.75 | 21.97 | 43.50 | -21.53 | QP | 200 | 291 | P | |
| 2 | 133.1511 | -7.94 | 35.72 | 27.78 | 43.50 | -15.72 | QP | 200 | 290 | P | |
| 3 | 143.8295 | -8.51 | 34.75 | 26.24 | 43.50 | -17.26 | QP | 200 | 311 | P | |
| 4 | 195.1365 | -11.26 | 36.87 | 25.61 | 43.50 | -17.89 | QP | 200 | 352 | P | |
| 5 | 968.9338 | 3.85 | 25.49 | 29.34 | 54.00 | -24.66 | QP | 200 | 101 | P | |
| 6 | 989.5355 | 4.28 | 25.18 | 29.46 | 54.00 | -24.54 | QP | 200 | 241 | P | |

Test Time: 2019/9/18 20:40:47



Report No.: NTC1909113FV00

Test Standard: FCC Part 15B_Class B 3M Radiation

Test item: Radiation Emission

Applicant: Chongqing Jingranyouxu Technology Co., Ltd.

Product: Label Printer

Model No.: D7

Test Distance:

Ant. Polarization: Vertical

Temp.(C)/Hum.(%): 25(°C) / 64 %

Power Rating: DC 7.4V

Test Engineer: SLY

Test Mode: TX 2402MHz

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 | 67.2021 | -16.96 | 36.31 | 19.35 | 40.00 | -20.65 | QP | 100 | 187 | P | |
| 2 | 93.7682 | -10.06 | 29.55 | 19.49 | 43.50 | -24.01 | QP | 100 | 162 | P | |
| 3 | 117.3602 | -8.15 | 33.40 | 25.25 | 43.50 | -18.25 | QP | 100 | 190 | P | |
| 4 | 140.8350 | -8.35 | 33.10 | 24.75 | 43.50 | -18.75 | QP | 100 | 200 | P | |
| 5 | 167.8241 | -9.86 | 36.13 | 26.27 | 43.50 | -17.23 | QP | 100 | 99 | P | |
| 6 | 195.1365 | -11.26 | 43.39 | 32.13 | 43.50 | -11.37 | QP | 100 | 311 | P | |

| | | | |
|--------------------|------------------------|---------------|--------------------|
| Modulation: | 8DPSK (the worst case) | | |
| Frequency Range: | 1-25GHz | Test Date: | September 26, 2019 |
| Humidity: | 64 % | Temperature: | 25 °C |
| Measured Distance: | 3m | Test Results: | PASS |
| 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 | 47.41 | 34.28 | 4.07 | 51.48 | 38.35 | 74.00 | 54.00 | -22.52 | -15.65 |
| 7206 | V | 45.89 | 30.43 | 10.27 | 56.16 | 40.70 | 74.00 | 54.00 | -17.84 | -13.30 |
| --- | | | | | | | | | | |
| 4804 | H | 47.80 | 34.85 | 4.07 | 51.87 | 38.92 | 74.00 | 54.00 | -22.13 | -15.08 |
| 7206 | H | 45.86 | 30.70 | 10.27 | 56.13 | 40.97 | 74.00 | 54.00 | -17.87 | -13.03 |
| --- | | | | | | | | | | |
| Operation Mode: TX Mode (Mid) | | | | | | | | | | |
| 4882 | V | 48.02 | 31.49 | 4.57 | 52.59 | 36.06 | 74.00 | 54.00 | -21.41 | -17.94 |
| 7323 | V | 46.35 | 31.04 | 10.05 | 56.40 | 41.09 | 74.00 | 54.00 | -17.60 | -12.91 |
| --- | | | | | | | | | | |
| 4882 | H | 46.63 | 31.49 | 4.57 | 51.20 | 36.06 | 74.00 | 54.00 | -22.80 | -17.94 |
| 7323 | H | 46.52 | 31.85 | 10.05 | 56.57 | 41.90 | 74.00 | 54.00 | -17.43 | -12.10 |
| --- | | | | | | | | | | |
| Operation Mode: TX Mode (High) | | | | | | | | | | |
| 4960 | V | 45.90 | 31.09 | 5.05 | 50.95 | 36.14 | 74.00 | 54.00 | -23.05 | -17.86 |
| 7440 | V | 46.28 | 31.25 | 9.76 | 56.04 | 41.01 | 74.00 | 54.00 | -17.96 | -12.99 |
| --- | | | | | | | | | | |
| 4960 | H | 46.31 | 30.99 | 5.05 | 51.36 | 36.04 | 74.00 | 54.00 | -22.64 | -17.96 |
| 7440 | H | 46.12 | 31.28 | 9.76 | 55.88 | 41.04 | 74.00 | 54.00 | -18.12 | -12.96 |
| --- | | | | | | | | | | |

Other harmonics emissions are lower than 10dB below the allowable limit.

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

5. CHANNEL SEPARATION

5.1 Measurement Procedure

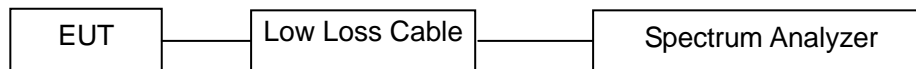
Minimum Hopping Channel Carrier Frequency Separation, FCC Rule 15.247(a)(1):

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 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

5.3 Test SET-UP (Block Diagram of Configuration)



5.4 Measurement Results

Refer to attached data chart.

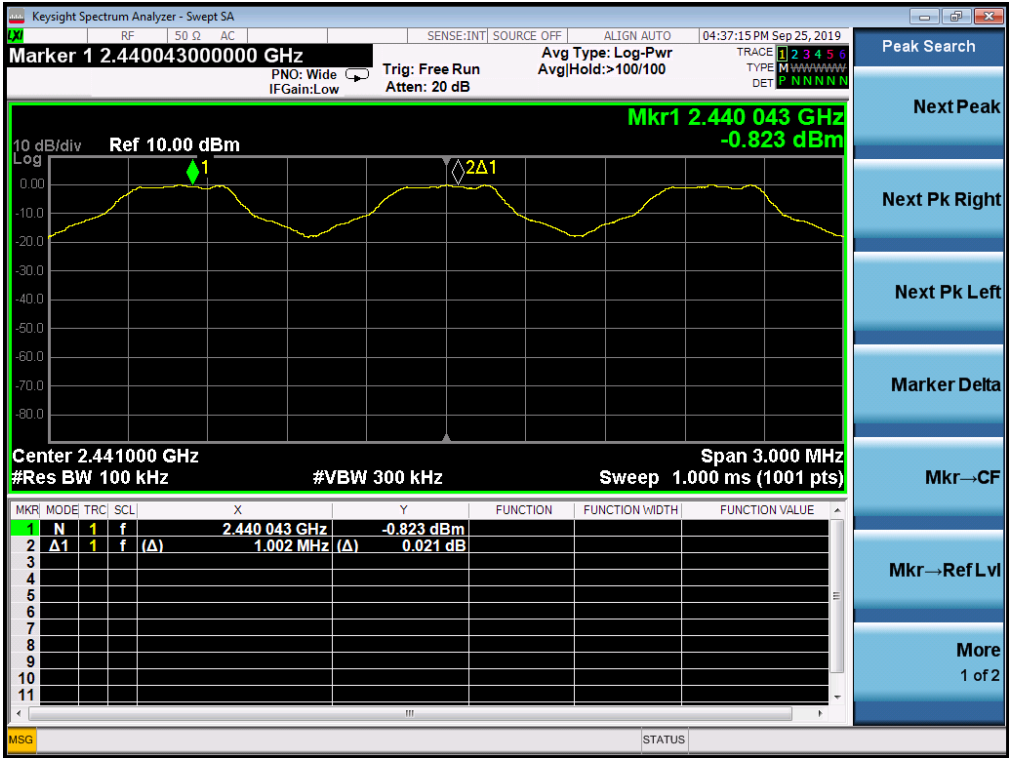
| | | | |
|--------------|-----------------------------|--------------------|---------------|
| Modulation: | GFSK, $\pi/4$ -DQPSK, 8DPSK | | |
| RBW: | 100kHz | VBW: | 300kHz |
| Packet: | DH1, 2DH1, 3DH1(Worst case) | Spectrum Detector: | PK |
| Test By: | Sance | Test Date: | Sep. 25, 2019 |
| Temperature: | 24 °C | Humidity: | 50 % |
| Test Result: | PASS | | |

| Channel | Test Frequency (MHz) | Separation Read Value (kHz) | Separation Limit 2/3 20dB Bandwidth (kHz) |
|---------------------------------|----------------------|-----------------------------|---|
| GFSK | | | |
| Lowest | 2402 | 1002 | >631.6 |
| Middle | 2441 | 1002 | >630.3 |
| Highest | 2480 | 1002 | >629.3 |
| $\pi/4$-DQPSK | | | |
| Lowest | 2402 | 1002 | >878.7 |
| Middle | 2441 | 1002 | >878.7 |
| Highest | 2480 | 1002 | >877.3 |
| 8DPSK | | | |
| Lowest | 2402 | 1002 | >872.7 |
| Middle | 2441 | 1002 | >872.7 |
| Highest | 2480 | 1002 | >874.0 |

GFSK Lowest Channel



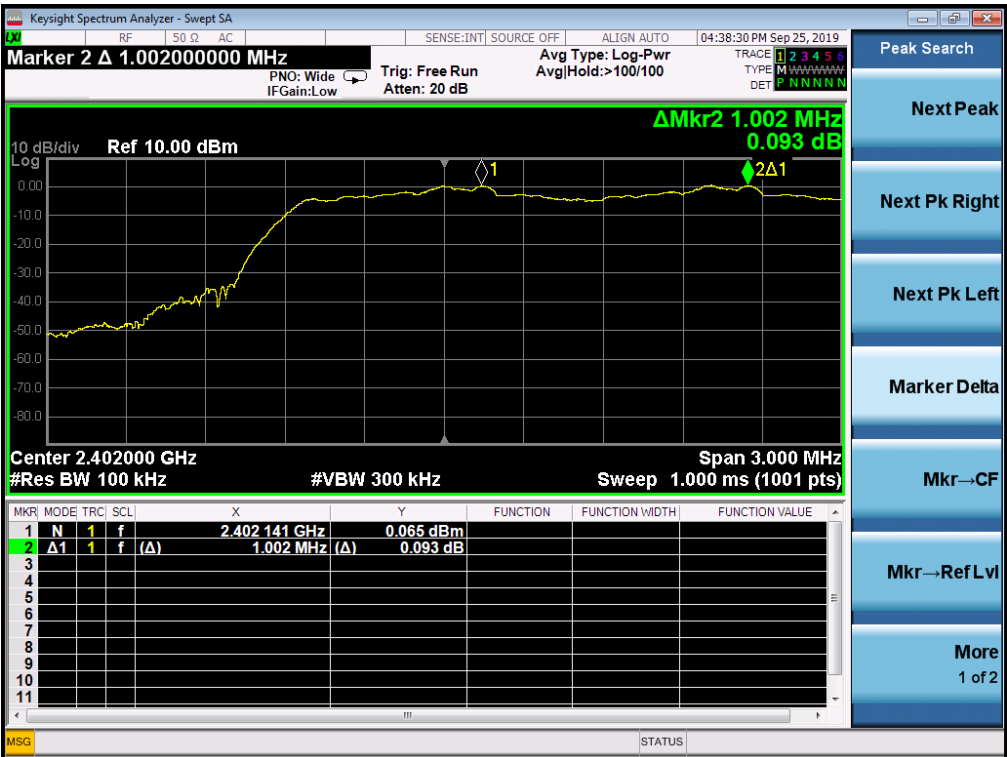
GFSK Middle Channel



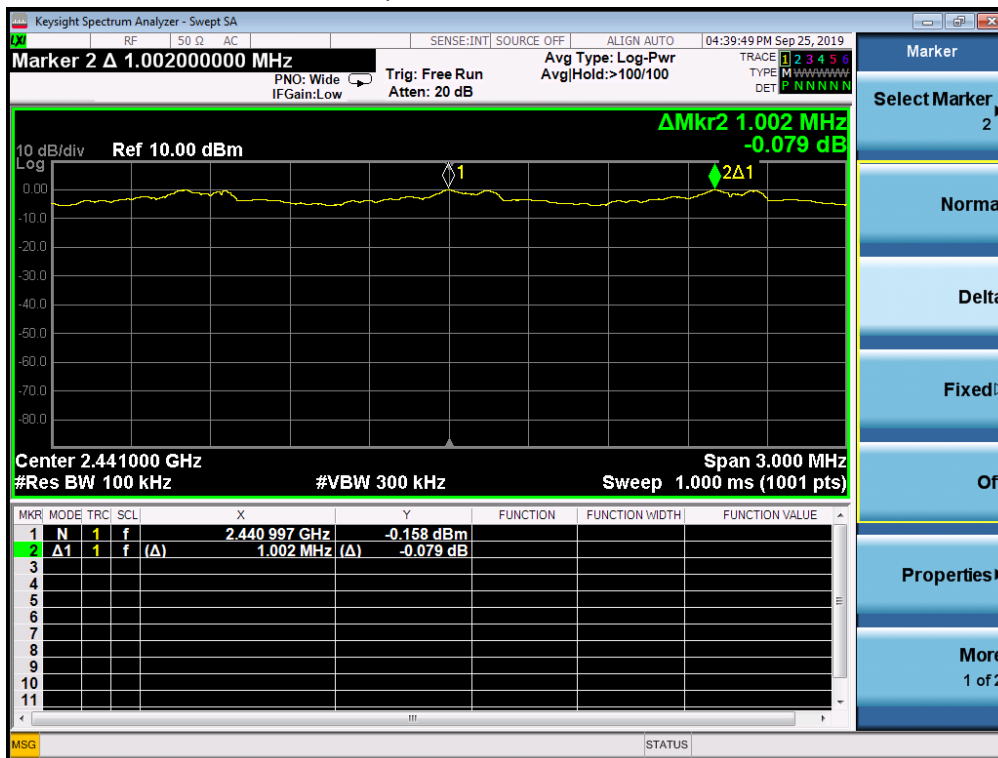
GFSK Highest Channel



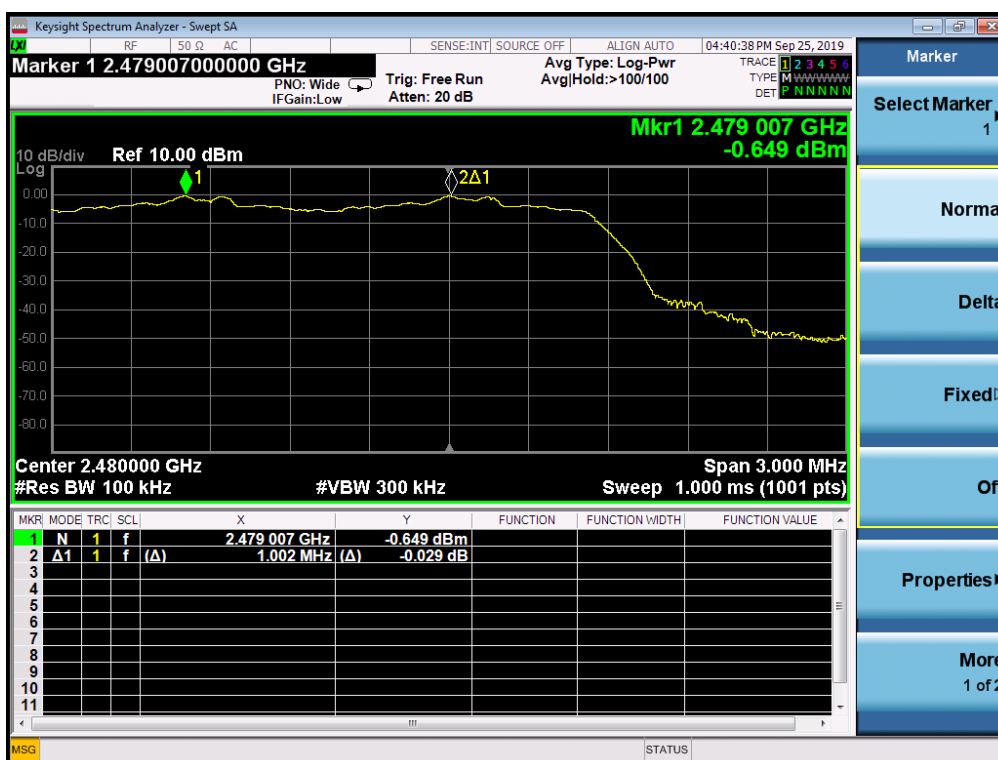
$\pi/4$ -DQPSK Lowest Channel



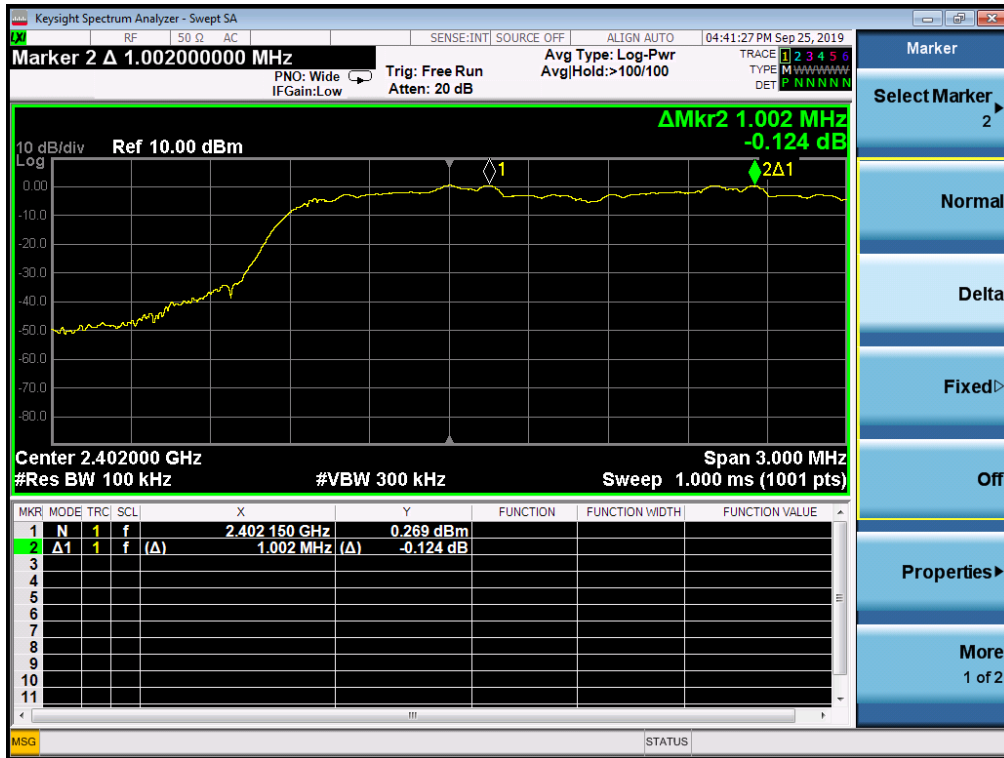
$\pi/4$ -DQPSK Middle Channel



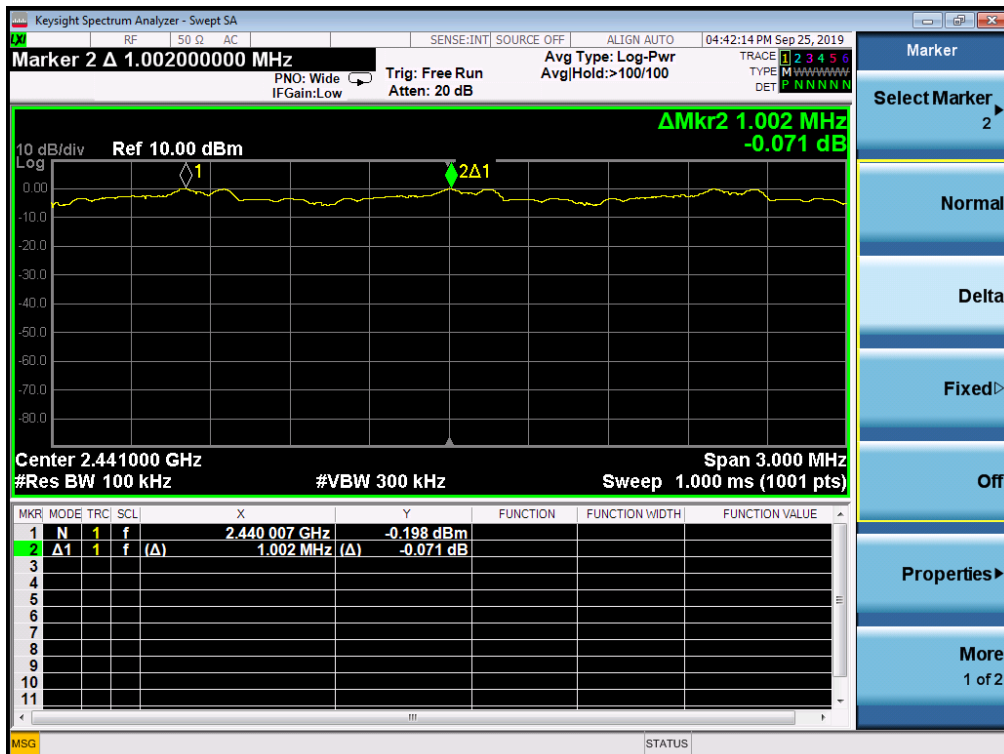
$\pi/4$ -DQPSK Highest Channel



8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



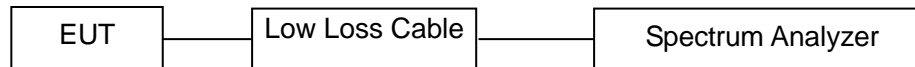
6. 20DB BANDWIDTH

6.1 Measurement Procedure

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

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

6.2 Test SET-UP (Block Diagram of Configuration)



6.3 Measurement Results

Refer to attached data chart.

| | | | |
|--------------|-----------------------------|--------------------|---------------|
| Modulation: | GFSK, $\pi/4$ -DQPSK, 8DPSK | | |
| RBW: | 30kHz | VBW: | 100kHz |
| Packet: | DH1, 2DH1, 3DH1(Worst case) | Spectrum Detector: | PK |
| Test By: | Sance | Test Date: | Sep. 25, 2019 |
| Temperature: | 24 °C | Humidity: | 50 % |
| Test Result: | PASS | | |

| Channel | Test Frequency (MHz) | 20dB Down BW(kHz) |
|---------------------------------|----------------------|-------------------|
| GFSK | | |
| Lowest | 2402 | 947.4 |
| Middle | 2441 | 945.5 |
| Highest | 2480 | 943.9 |
| $\pi/4$-DQPSK | | |
| Lowest | 2402 | 1.318 |
| Middle | 2441 | 1.318 |
| Highest | 2480 | 1.316 |
| 8DPSK | | |
| Lowest | 2402 | 1.309 |
| Middle | 2441 | 1.309 |
| Highest | 2480 | 1.311 |

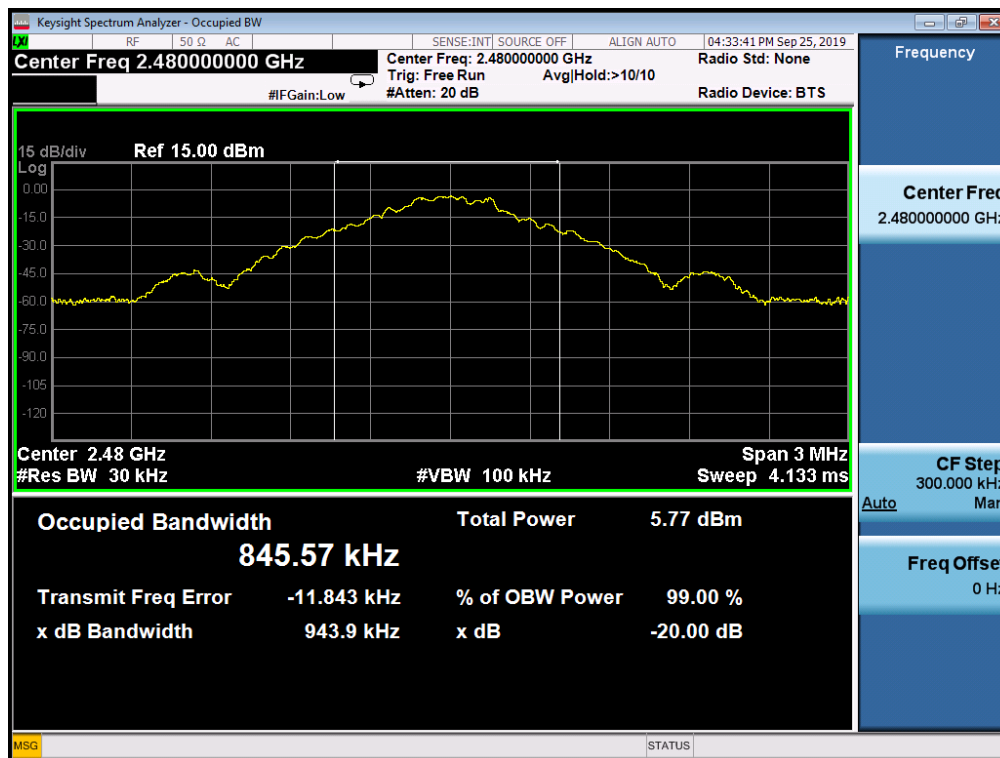
GFSK Lowest Channel



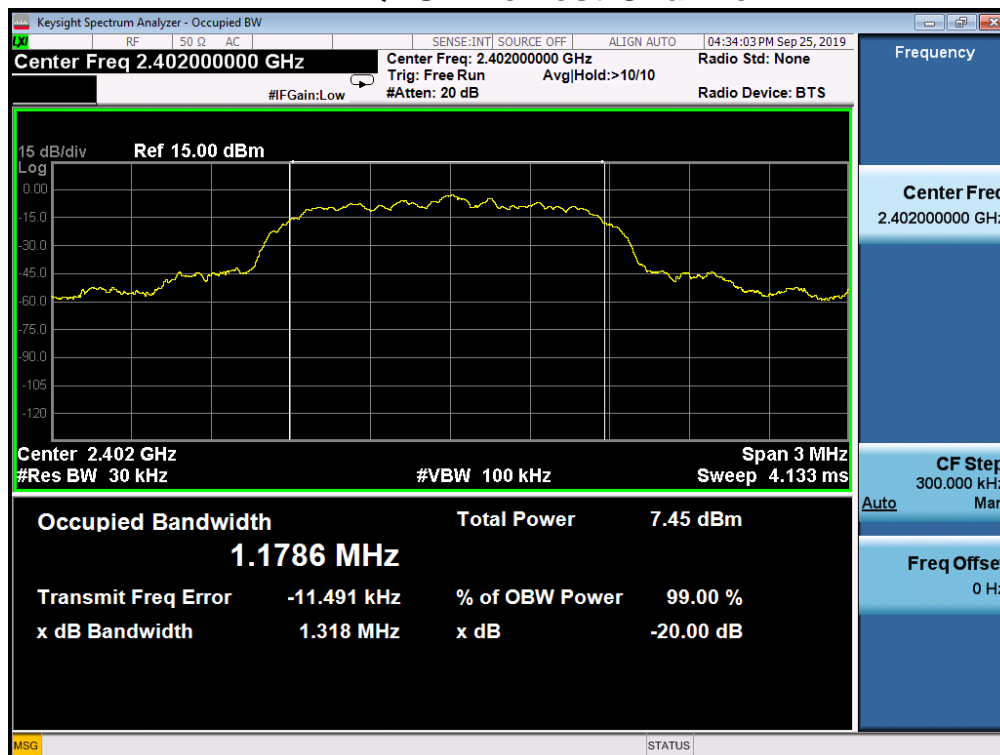
GFSK Middle Channel



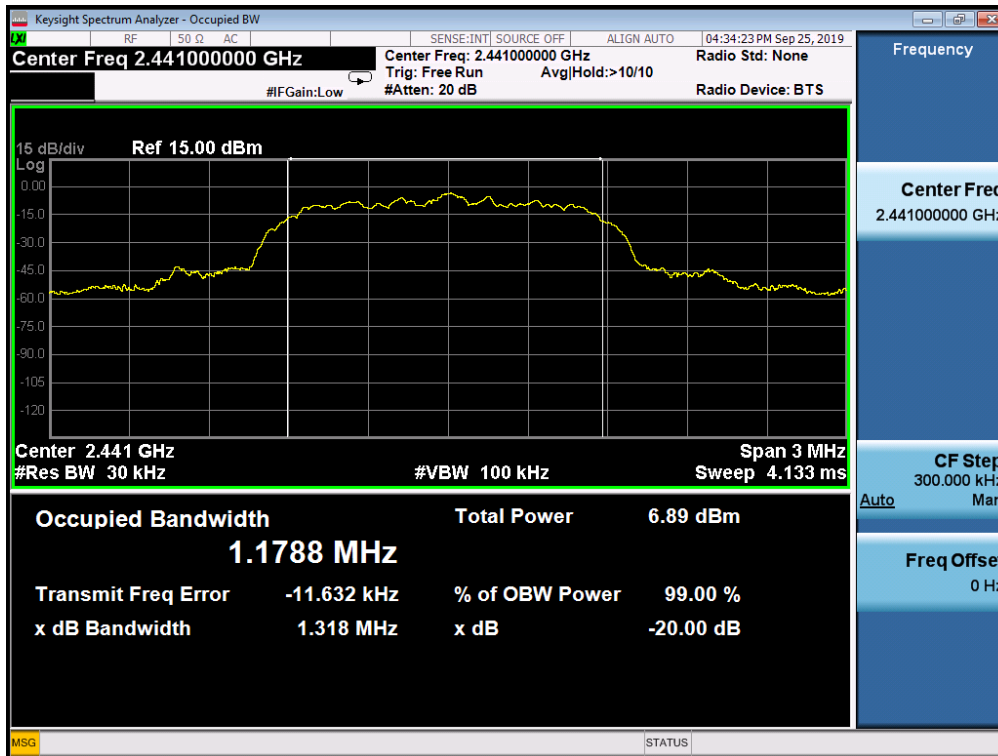
GFSK Highest Channel



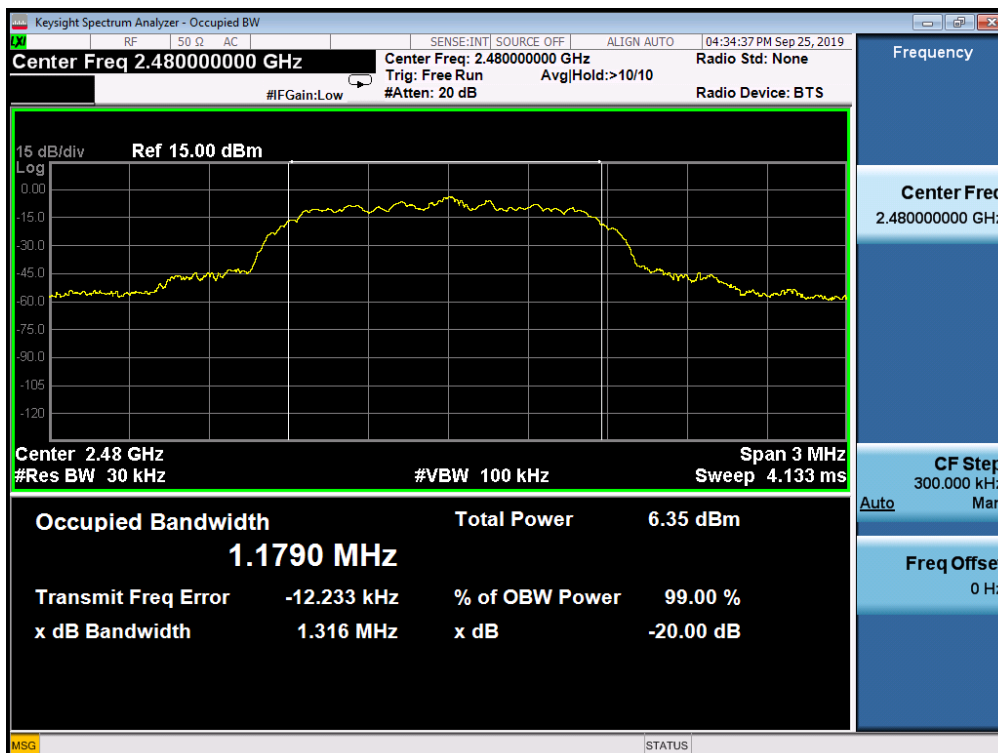
$\pi/4$ -DQPSK Lowest Channel



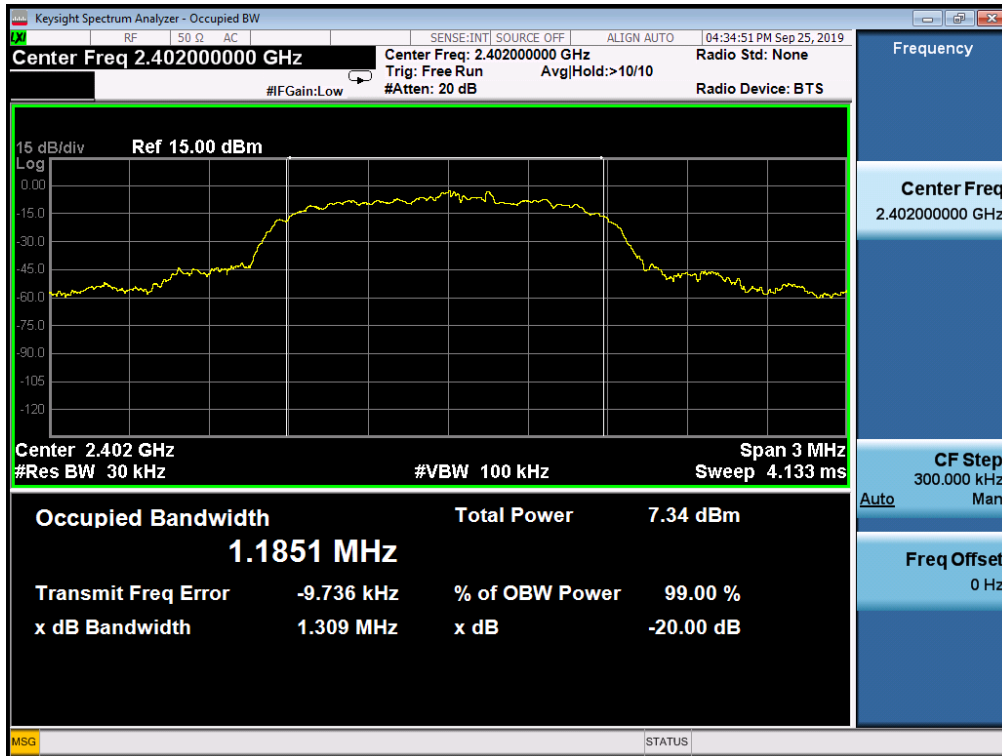
$\pi/4$ -DQPSK Middle Channel



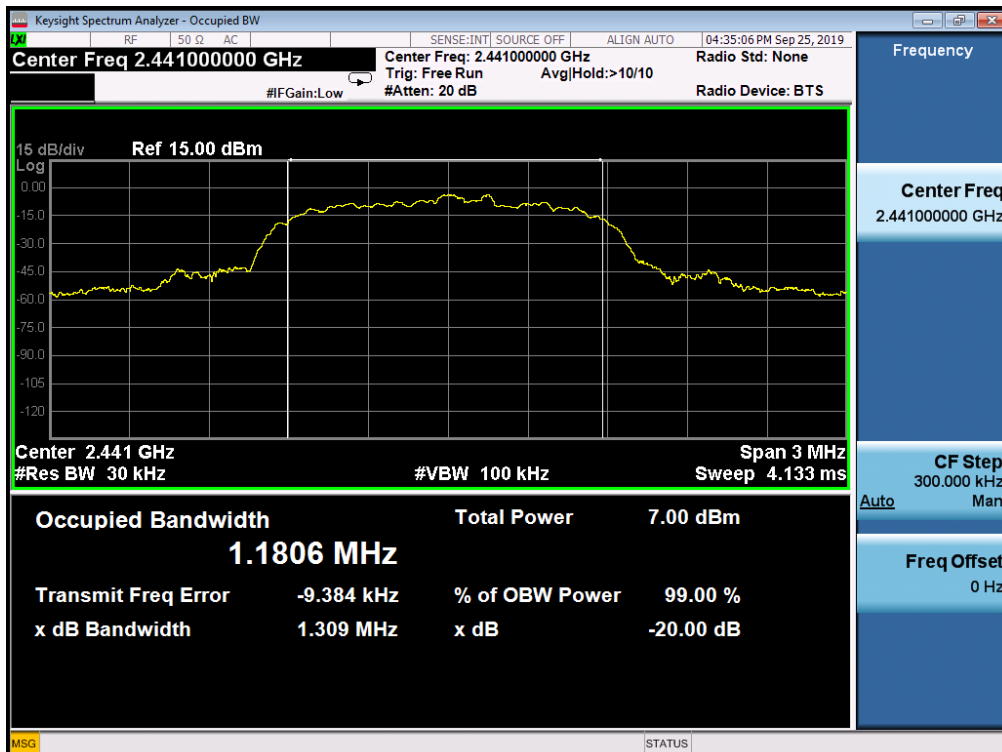
$\pi/4$ -DQPSK Highest Channel



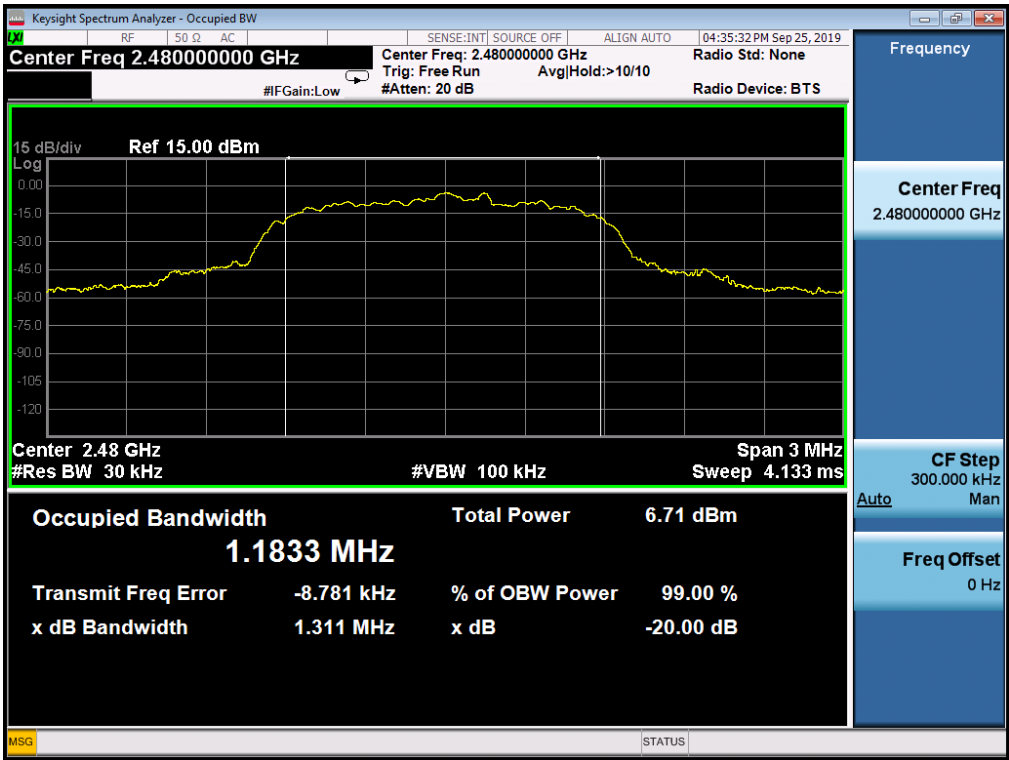
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



7. HOPPING CHANNEL NUMBER

7.1 Measurement Procedure

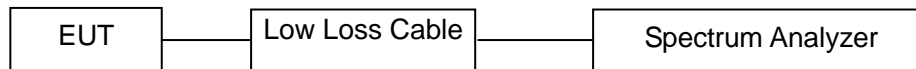
Minimum Number of Hopping Frequencies, FCC Rule 15.247(a)(1)(iii):

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 Limit

Frequency hopping systems in the 2400-2483.5MHz band shall use at least 15 channels.

7.3 Test SET-UP (Block Diagram of Configuration)

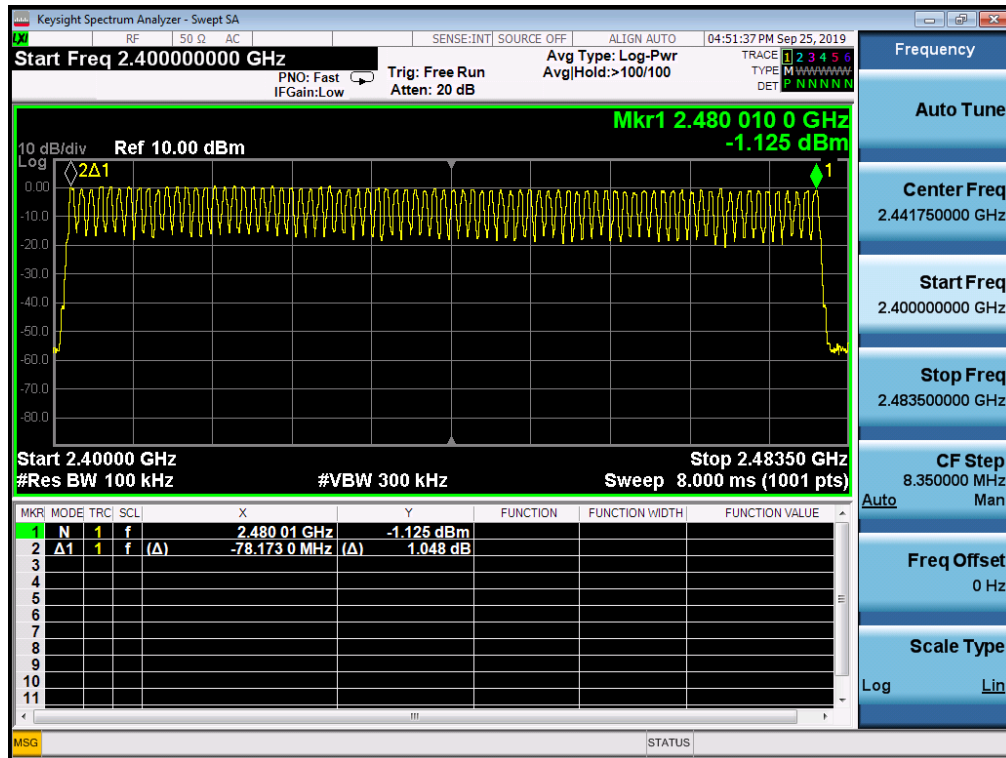


7.4 Measurement Results

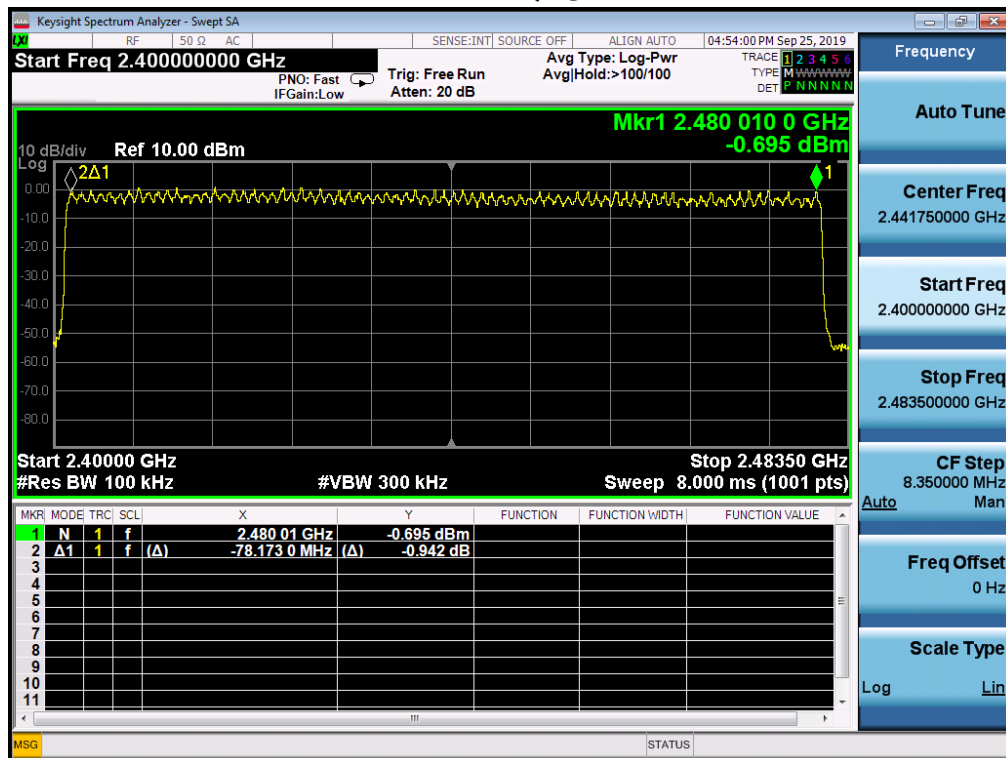
| | | | |
|--------------|-----------------------------|--------------------|---------------|
| Modulation: | GFSK, $\pi/4$ -DQPSK, 8DPSK | | |
| RBW: | 100kHz | VBW: | 300kHz |
| Packet: | DH1, 2DH1, 3DH1(Worst case) | Spectrum Detector: | PK |
| Test By: | Sance | Test Date: | Sep. 25, 2019 |
| Temperature: | 24 °C | Humidity: | 50 % |
| Test Result: | PASS | | |

| Hopping Channel Frequency Range | Number of Hopping Channels | Limit |
|---------------------------------|----------------------------|-------|
| 2400-2483.5 | 79 | ≥15 |

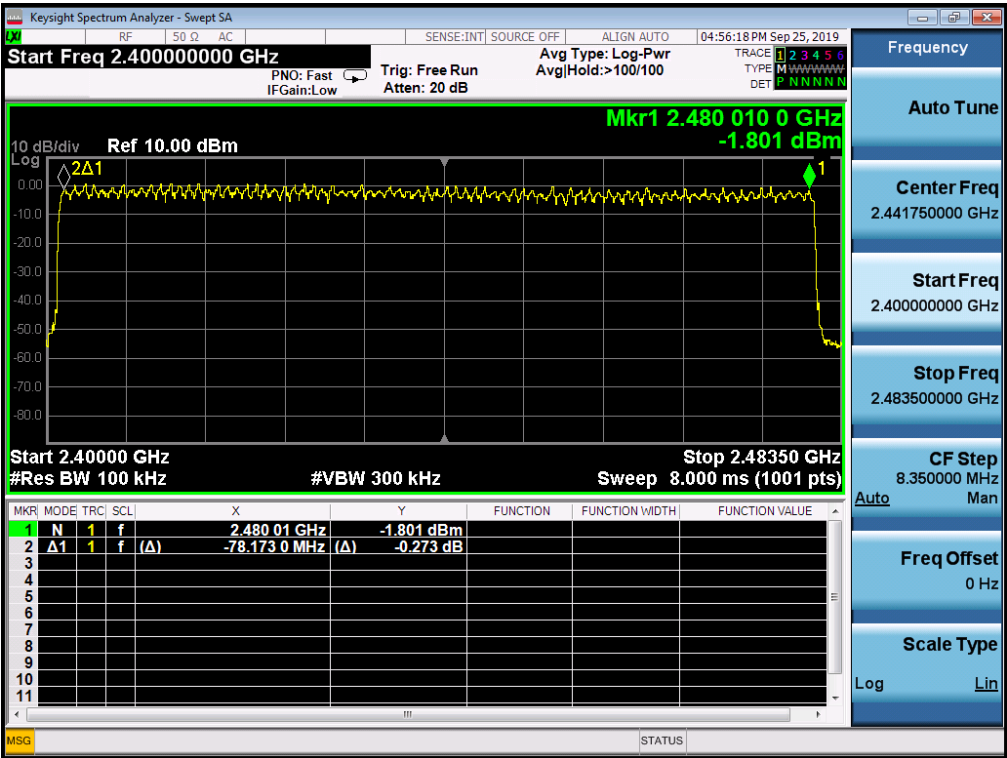
GFSK



$\pi/4$ -DQPSK



8DPSK



8. TIME OF OCCUPANCY (DWELL TIME)

8.1 Measurement Procedure

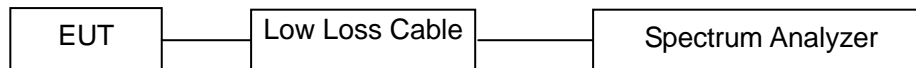
Average Channel Occupancy Time, FCC Ref:15.247(a)(1)(iii):

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 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

8.3 Test SET-UP (Block Diagram of Configuration)



8.4 Measurement Results

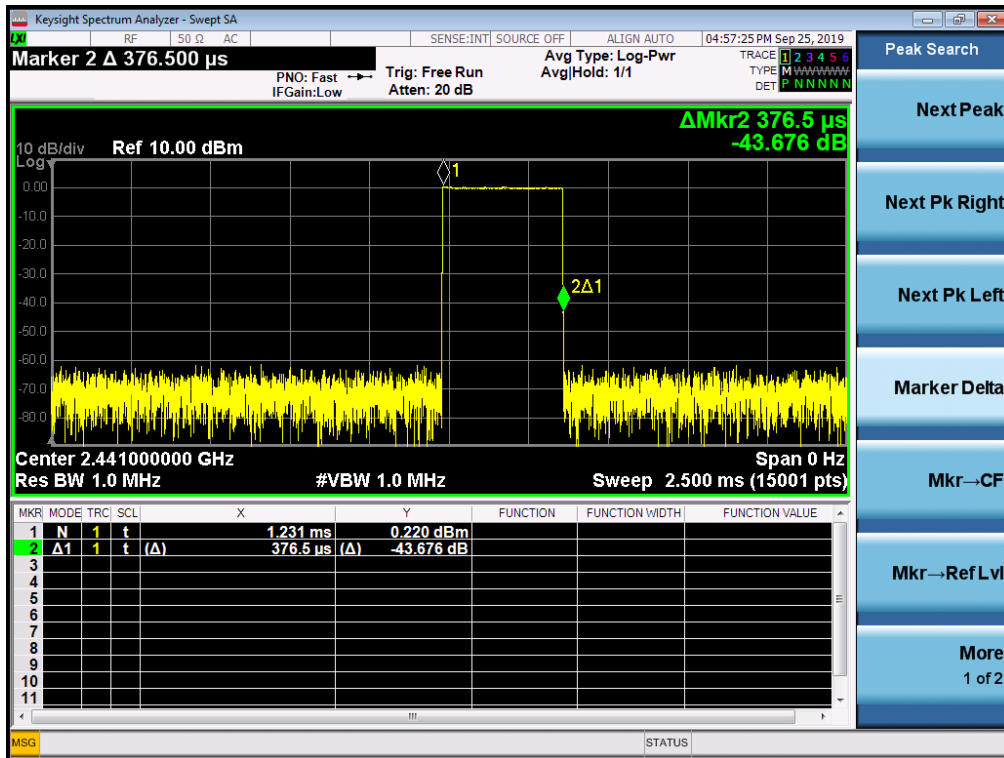
Refer to attached data chart.

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

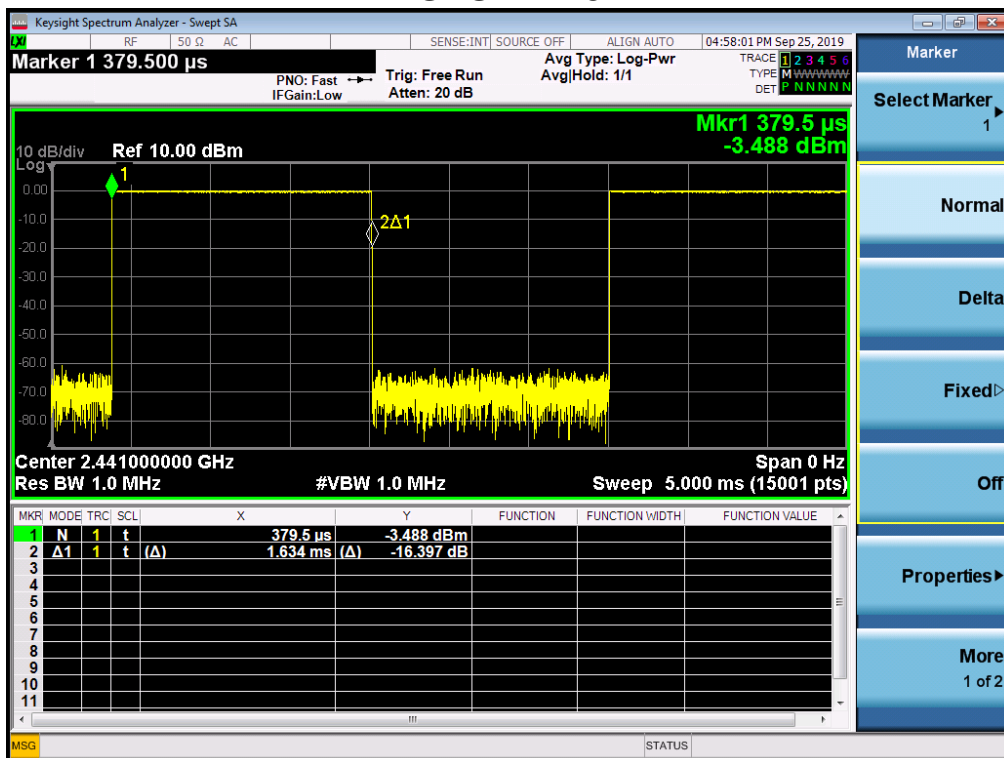
| | | | |
|--------------------|-----------------------------|------------|---------------|
| Modulation: | GFSK, $\pi/4$ -DQPSK, 8DPSK | | |
| RBW: | 1MHz | VBW: | 1MHz |
| Spectrum Detector: | PK | Test By: | Sance |
| Temperature: | 24 °C | Humidity: | 50 % |
| Test Result: | PASS | Test Date: | Sep. 25, 2019 |

| Packet | Frequency (MHz) | Result (msec) | | | Limit (msec) |
|----------------|--------------------|------------------|----------------------------|--------|-----------------|
| GFSK | | | | | |
| DH1 | 2441 | 0.377 | $(ms)*(1600/(2*79))*31.6=$ | 120.64 | 400 |
| DH3 | 2441 | 1.634 | $(ms)*(1600/(4*79))*31.6=$ | 261.44 | 400 |
| DH5 | 2441 | 2.878 | $(ms)*(1600/(6*79))*31.6=$ | 306.99 | 400 |
| $\pi/4$ -DQPSK | | | | | |
| 2-DH1 | 2441 | 0.391 | $(ms)*(1600/(2*79))*31.6=$ | 125.12 | 400 |
| 2-DH3 | 2441 | 1.644 | $(ms)*(1600/(4*79))*31.6=$ | 263.04 | 400 |
| 2-DH5 | 2441 | 2.893 | $(ms)*(1600/(6*79))*31.6=$ | 308.59 | 400 |
| 8DPSK | | | | | |
| 3-DH1 | 2441 | 0.389 | $(ms)*(1600/(2*79))*31.6=$ | 124.48 | 400 |
| 3-DH3 | 2441 | 1.642 | $(ms)*(1600/(4*79))*31.6=$ | 262.72 | 400 |
| 3-DH5 | 2441 | 2.894 | $(ms)*(1600/(6*79))*31.6=$ | 308.69 | 400 |

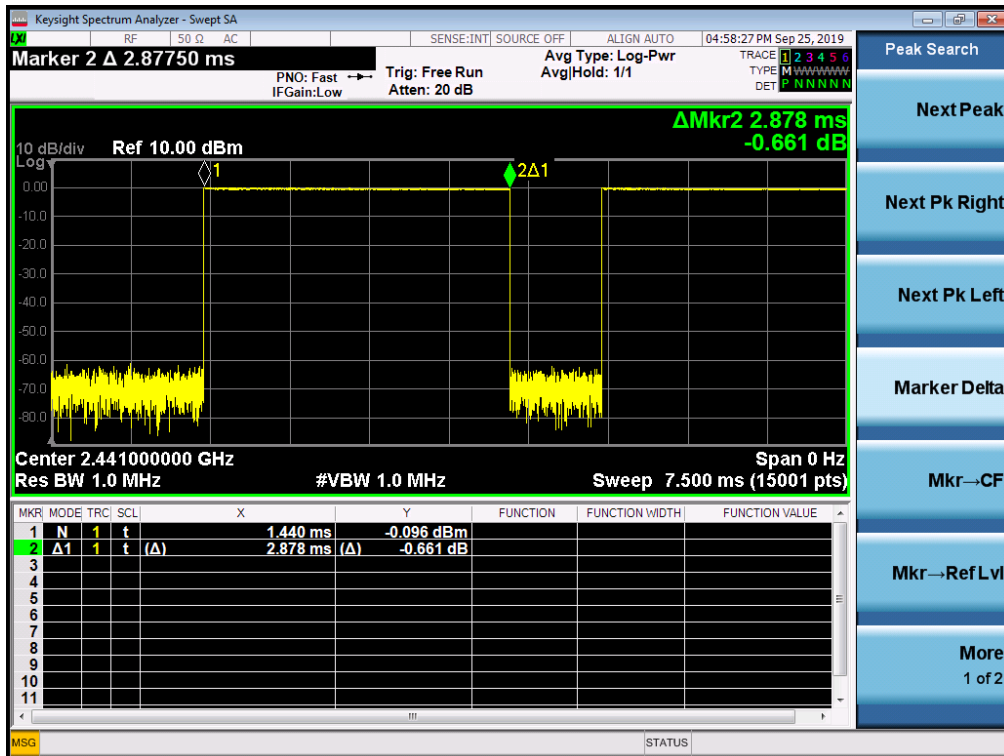
GFSK DH1



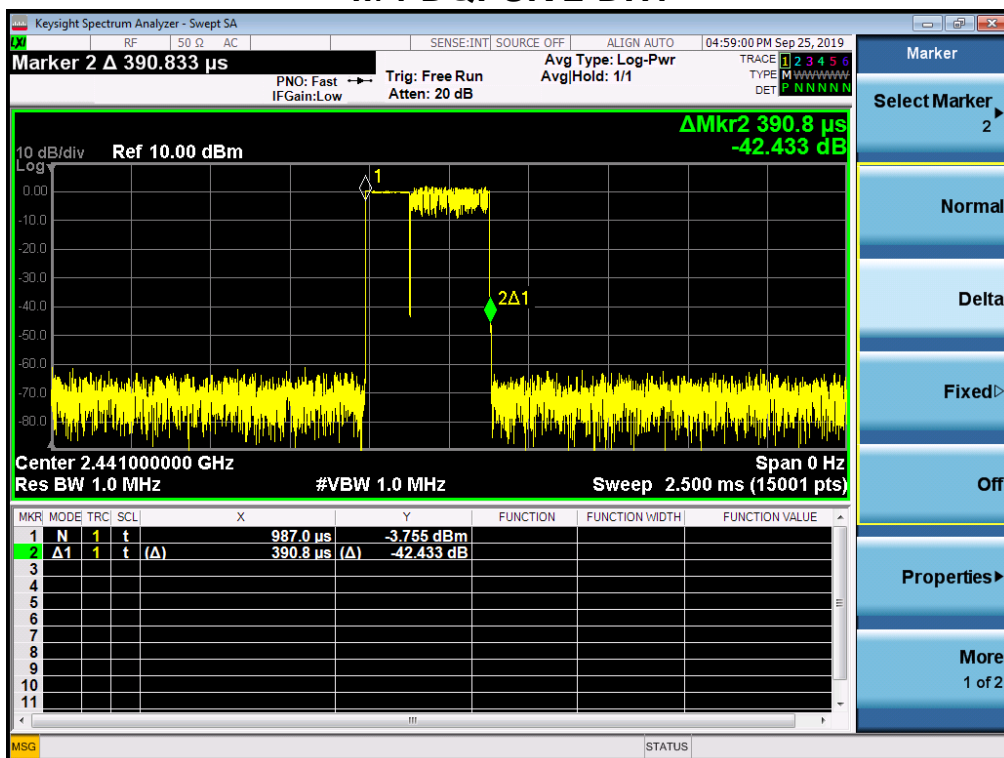
GFSK DH3



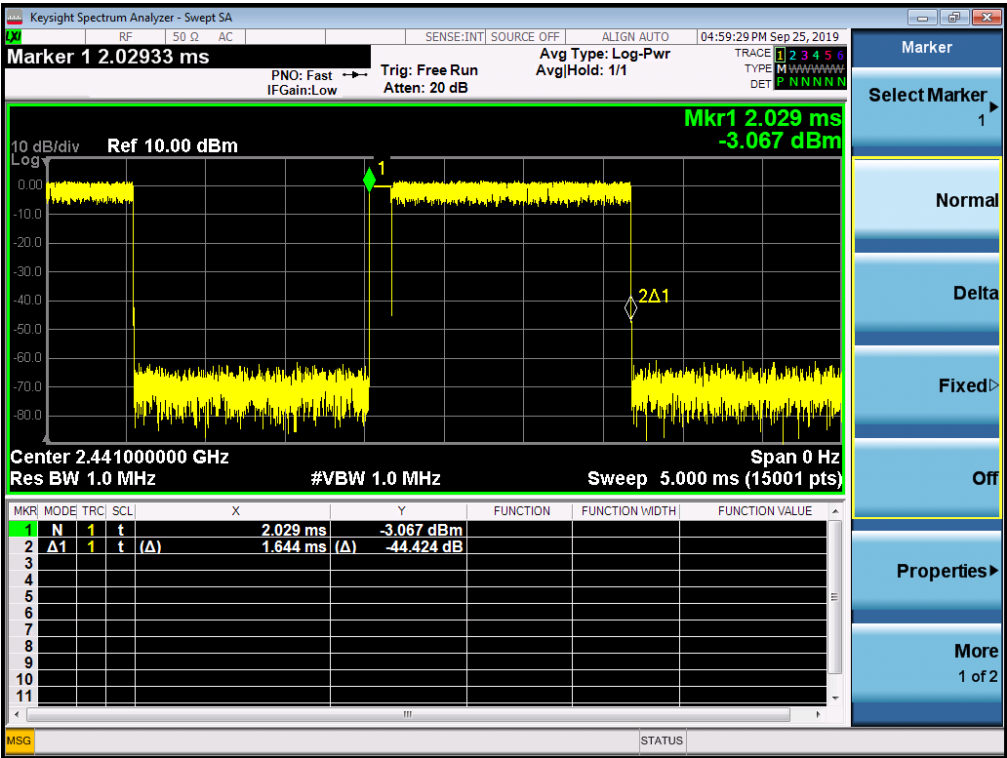
GFSK DH5



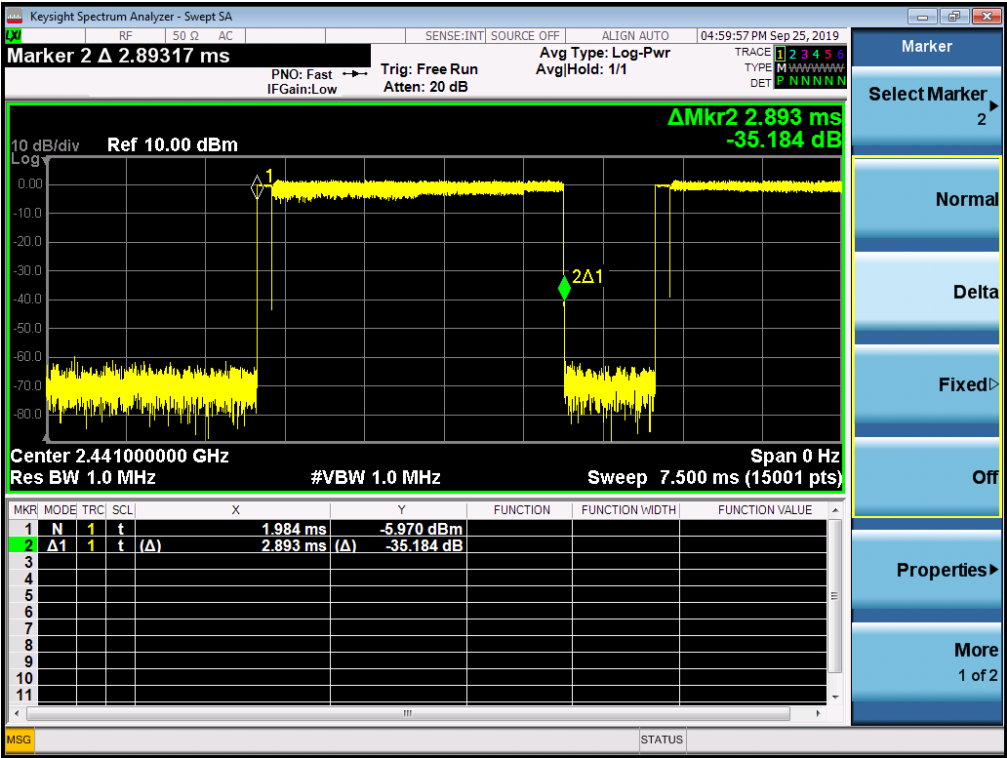
$\pi/4$ -DQPSK 2-DH1



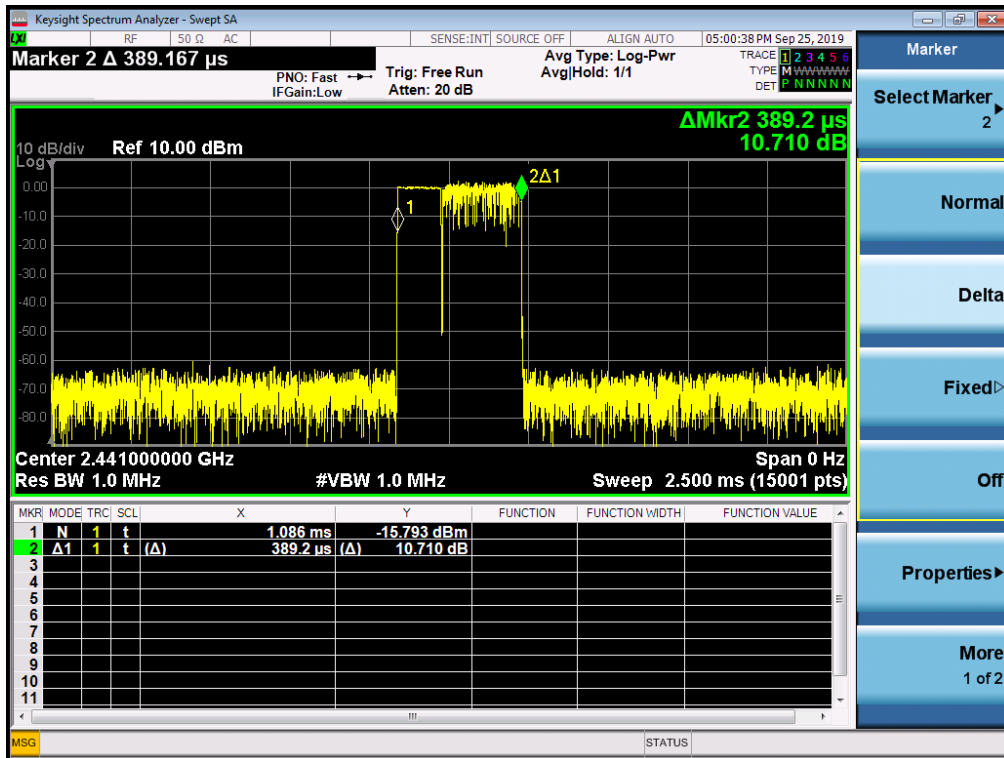
$\pi/4$ -DQPSK 2-DH3



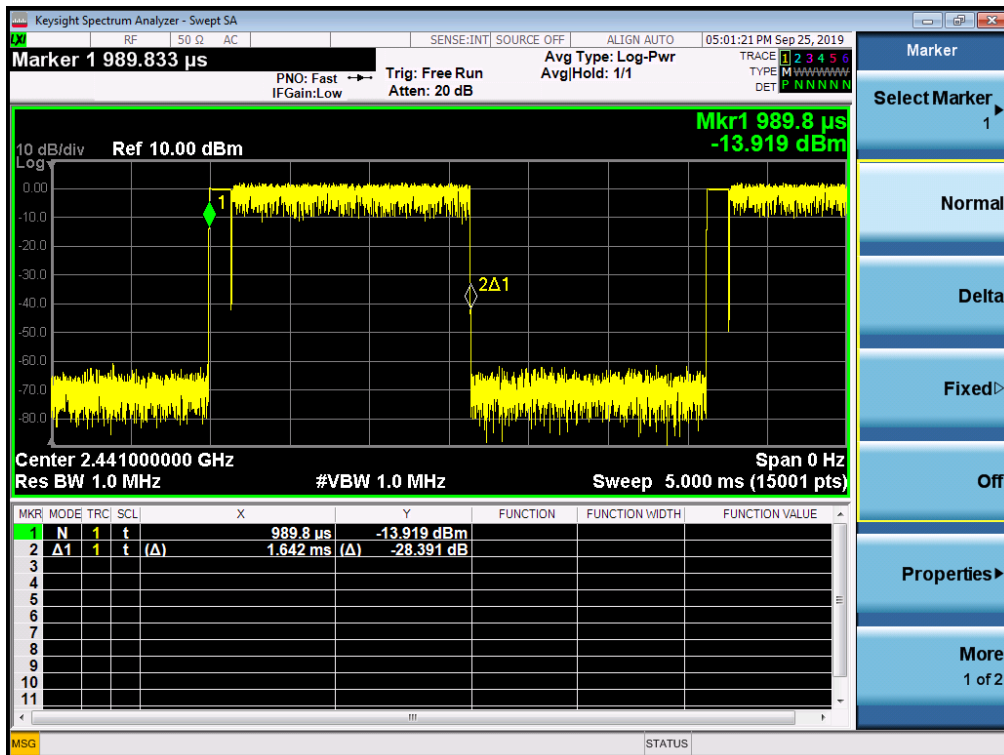
$\pi/4$ -DQPSK 2-DH5



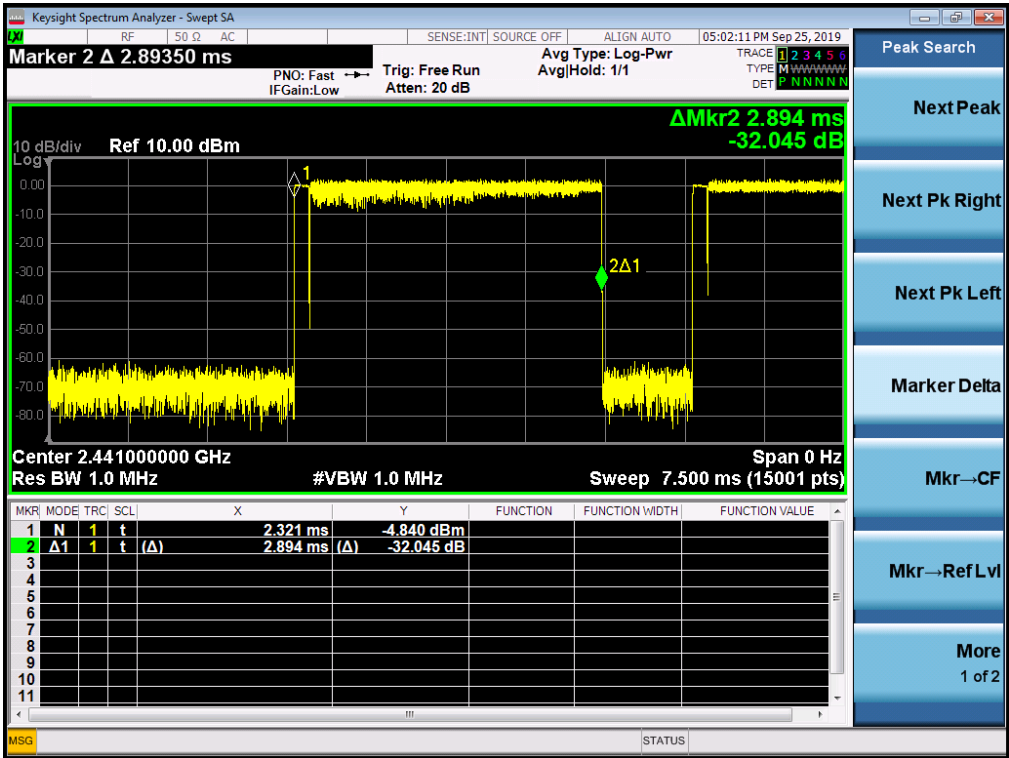
8DPSK 3-DH1



8DPSK 3-DH3



8DPSK 3-DH5



9. MAXIMUM PEAK OUTPUT POWER

9.1 Measurement Procedure

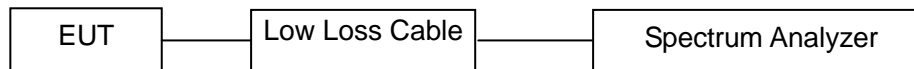
Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1):

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 Limit

For all other frequency hopping systems in the 2400-2483.5MHz band: 0.125 watts.

9.3 Test SET-UP (Block Diagram of Configuration)

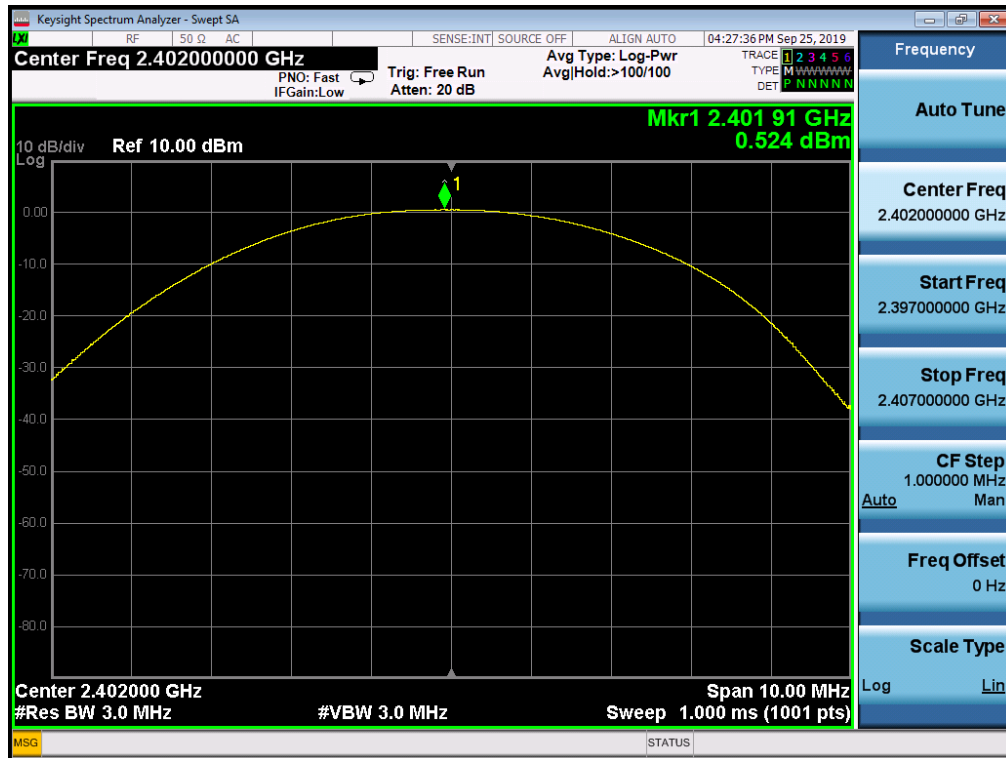


9.4 Measurement Results

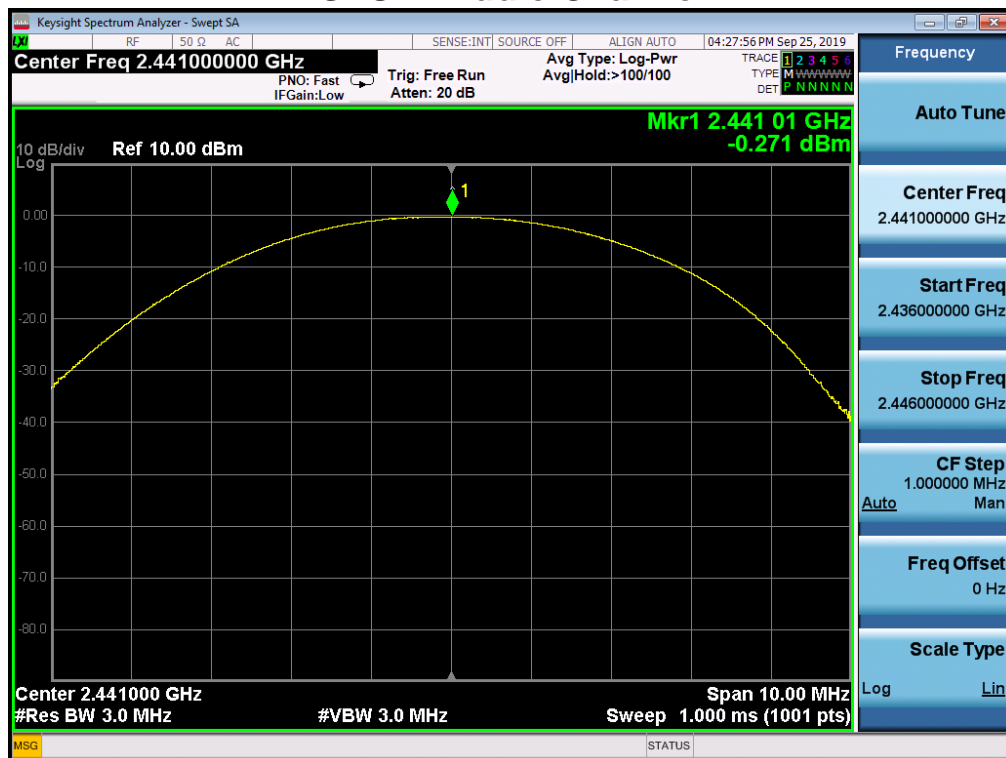
| | | | |
|--------------|-----------------------------|--------------------|---------------|
| RBW: | 3MHz | VBW: | 3MHz |
| Packet: | DH1, 2DH1, 3DH1(Worst case) | Spectrum Detector: | PK |
| Test By: | Sance | Test Date: | Sep. 25, 2019 |
| Temperature: | 24 °C | Humidity: | 50 % |

| Channel Frequency (MHz) | Peak Power output (dBm) | Peak Power output (mW) | Peak Power Limit (dBm/W) | Results |
|-------------------------|-------------------------|------------------------|--------------------------|---------|
| GFSK | | | | |
| 2402.00 | 0.524 | 1.128 | 21 / 0.125 | PASS |
| 2441.00 | -0.271 | 0.940 | 21 / 0.125 | PASS |
| 2480.00 | -0.647 | 0.862 | 21 / 0.125 | PASS |
| π/4-DQPSK | | | | |
| 2402.00 | 2.906 | 1.953 | 21 / 0.125 | PASS |
| 2441.00 | 2.208 | 1.663 | 21 / 0.125 | PASS |
| 2480.00 | 1.812 | 1.518 | 21 / 0.125 | PASS |
| 8DPSK | | | | |
| 2402.00 | 3.552 | 2.266 | 21 / 0.125 | PASS |
| 2441.00 | 2.925 | 1.961 | 21 / 0.125 | PASS |
| 2480.00 | 2.521 | 1.787 | 21 / 0.125 | PASS |

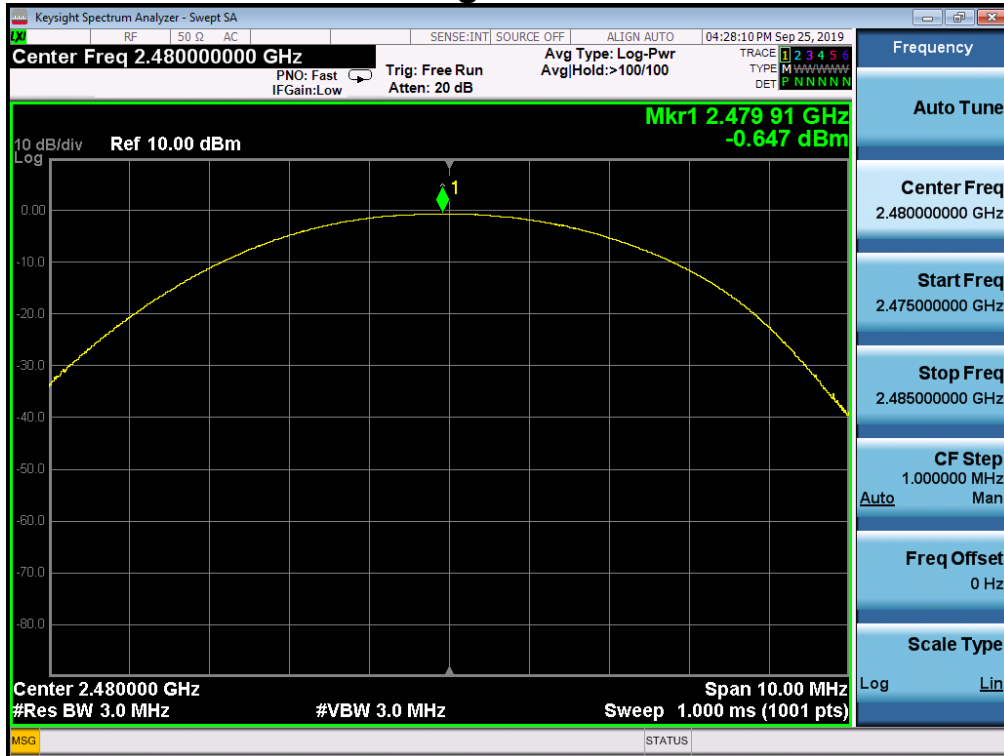
GFSK Lowest Channel



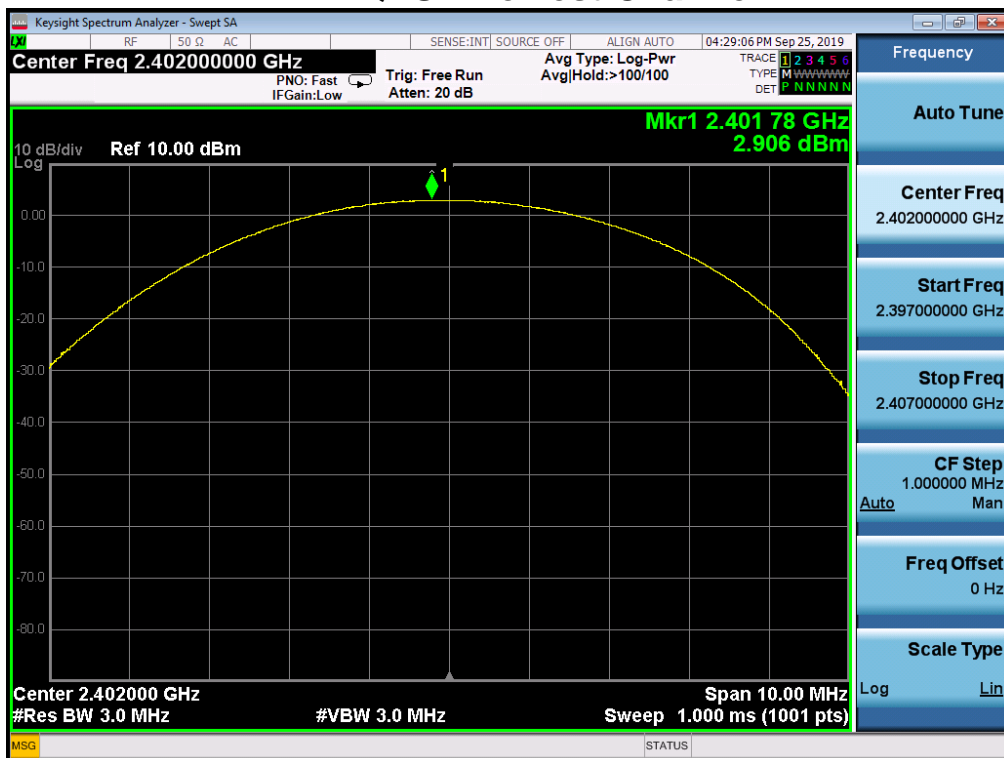
GFSK Middle Channel



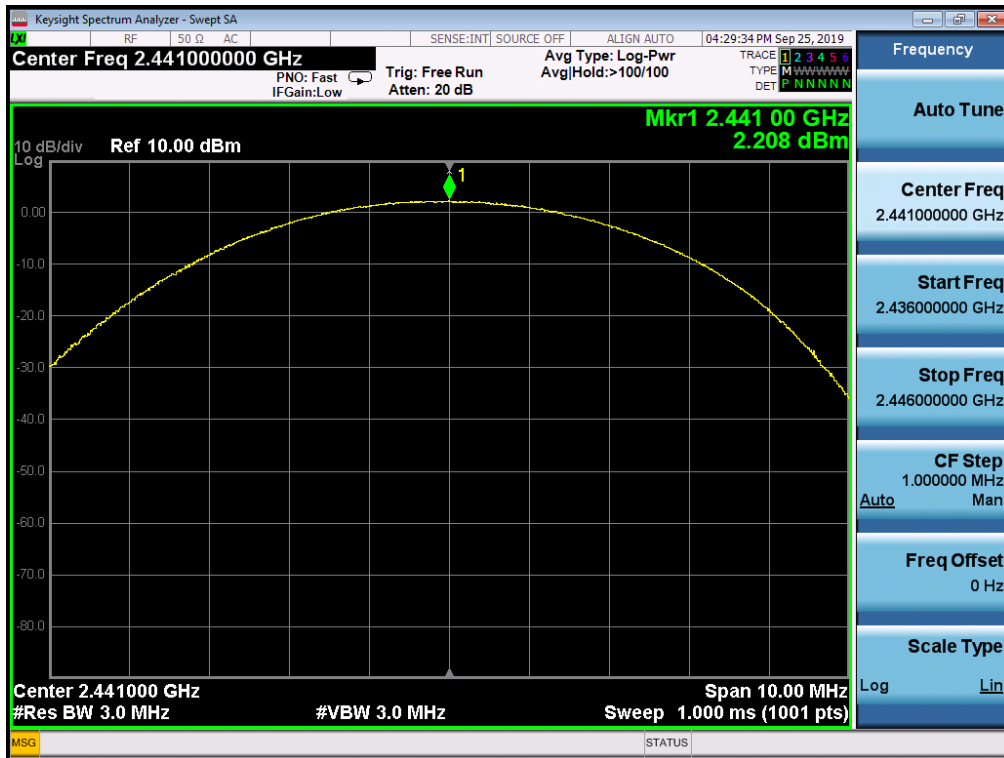
GFSK Highest Channel



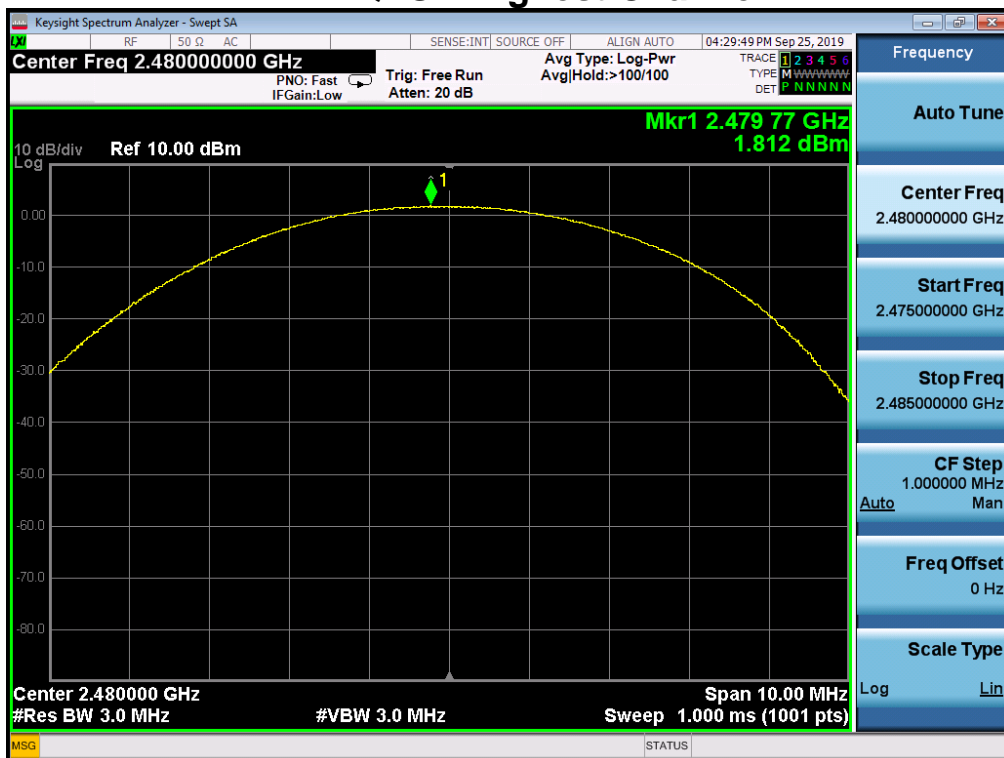
$\pi/4$ -DQPSK Lowest Channel



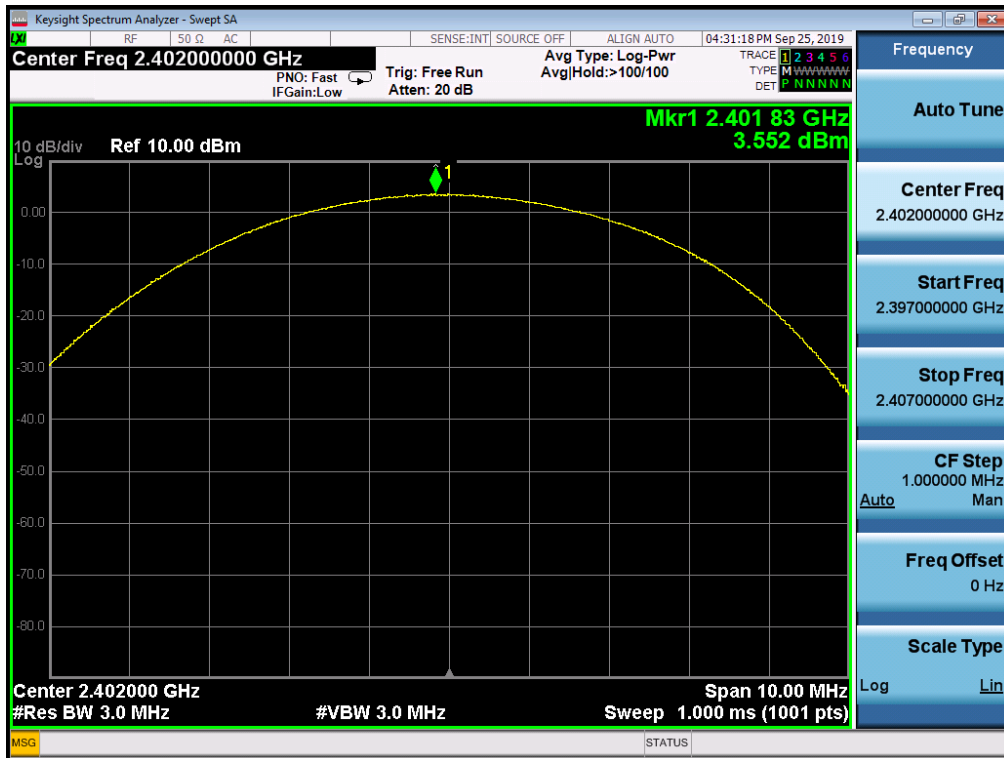
$\pi/4$ -DQPSK Middle Channel



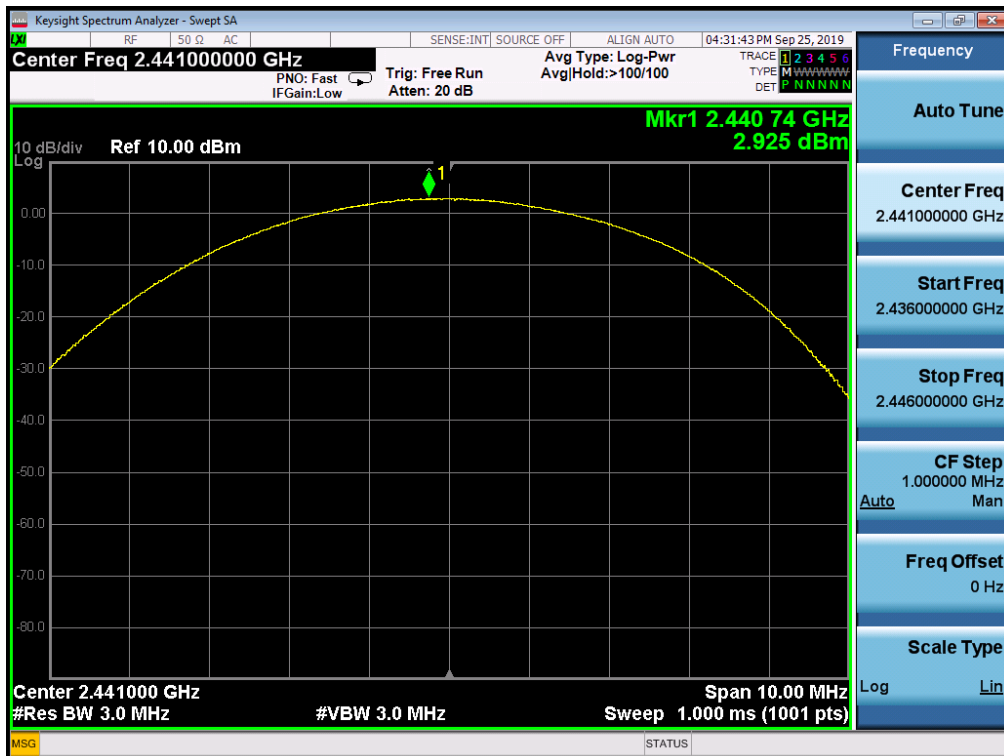
$\pi/4$ -DQPSK Highest Channel



8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



10. BAND EDGE

10.1 Measurement Procedure

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

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

10.2 Limit

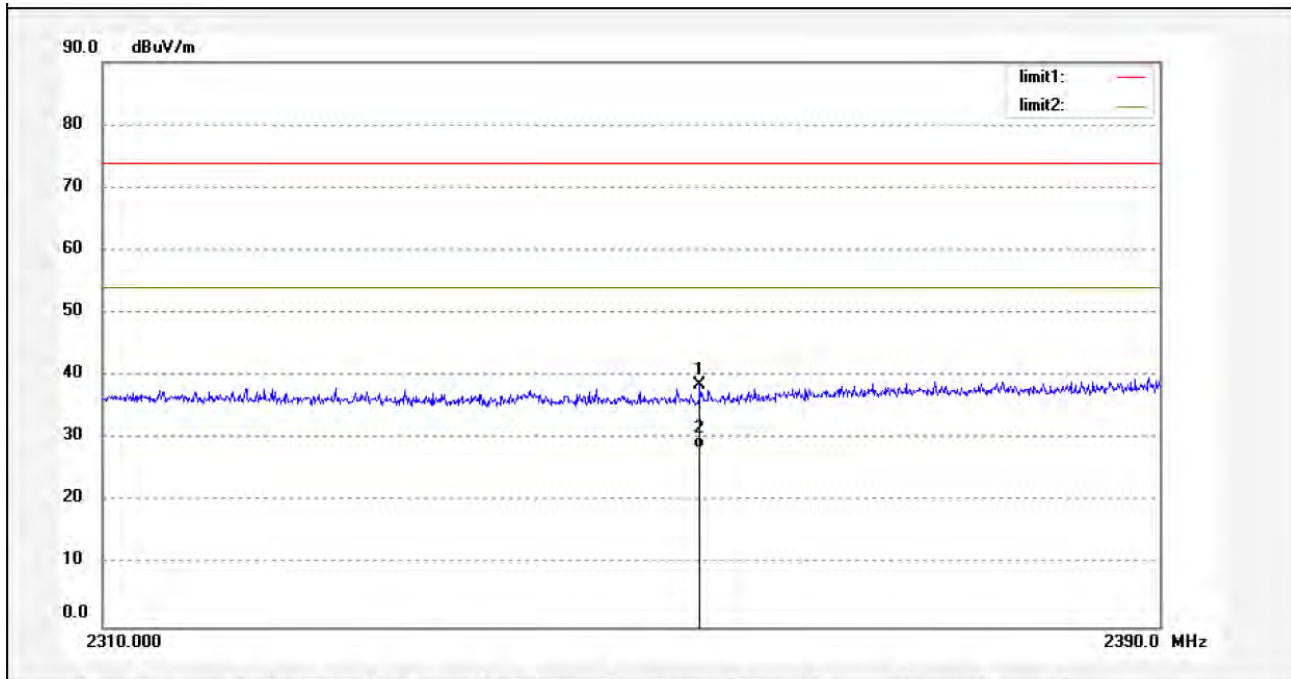
15.247(d) In any 100KHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

10.3 Measurement Results

Please see below test table and plots.

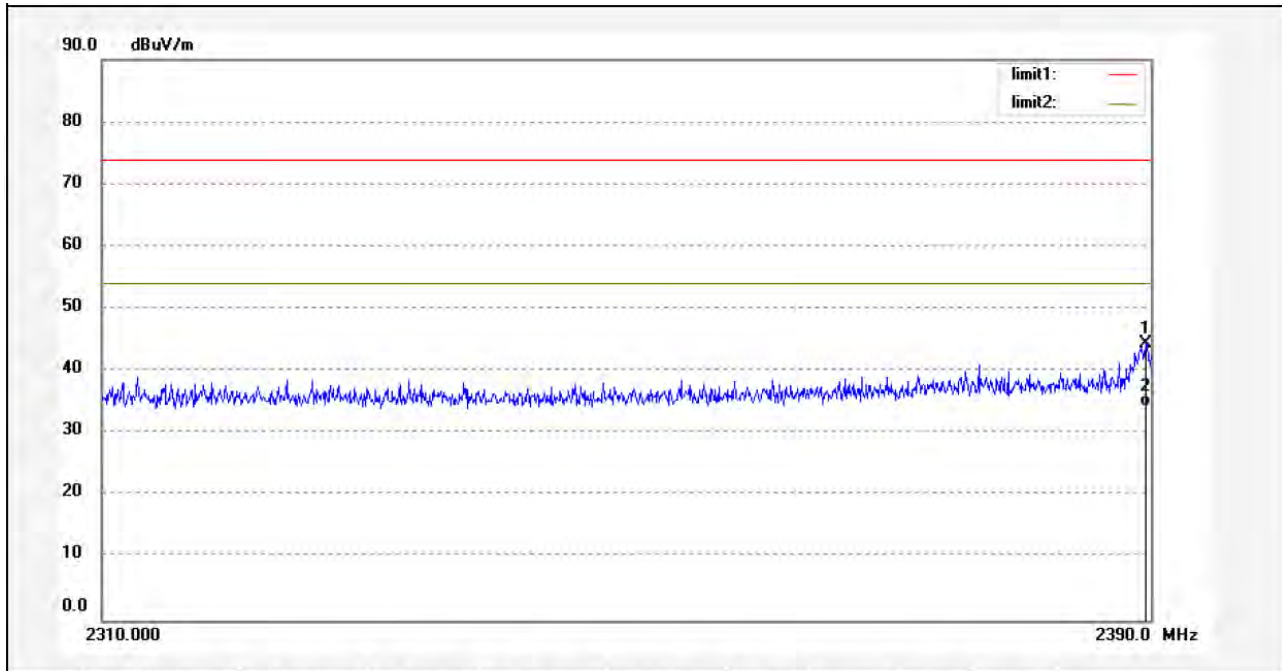
For Radiated restricted band: (The worst case: 8DPSK)

| | | | |
|--------------------|--------------------|--------------------|--------------------|
| Temperature: | 25 °C | Humidity: | 64 % |
| Test By: | Sance | Test Date: | September 25, 2019 |
| Measured Distance: | 3m | Test Result: | PASS |
| Test Mode: | TX 2402MHz (8DPSK) | Ant. Polarization: | Horizontal |



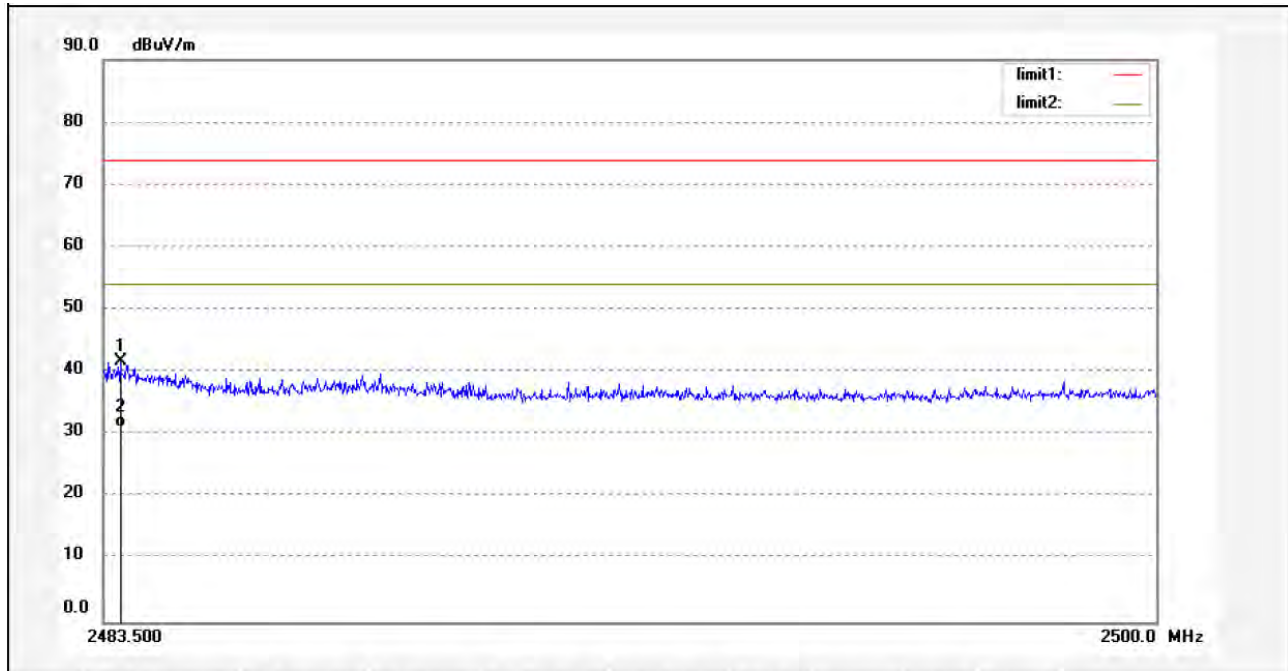
| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Height (cm) | Degree (deg.) | Remark |
|-----|----------------|---------------------|----------------|--------------------|-------------------|----------------|----------|----------------|------------------|--------|
| 1 | 2354.880 | 37.97 | 0.51 | 38.48 | 74.00 | -35.52 | peak | 200 | 308 | |
| 2 | 2354.880 | 28.03 | 0.51 | 28.54 | 54.00 | -25.46 | AVG | 200 | 321 | |

| | | | |
|--------------------|--------------------|--------------------|--------------------|
| Temperature: | 25 °C | Humidity: | 64 % |
| Test By: | Sance | Test Date: | September 25, 2019 |
| Measured Distance: | 3m | Test Result: | PASS |
| Test Mode: | TX 2402MHz (8DPSK) | Ant. Polarization: | Vertical |



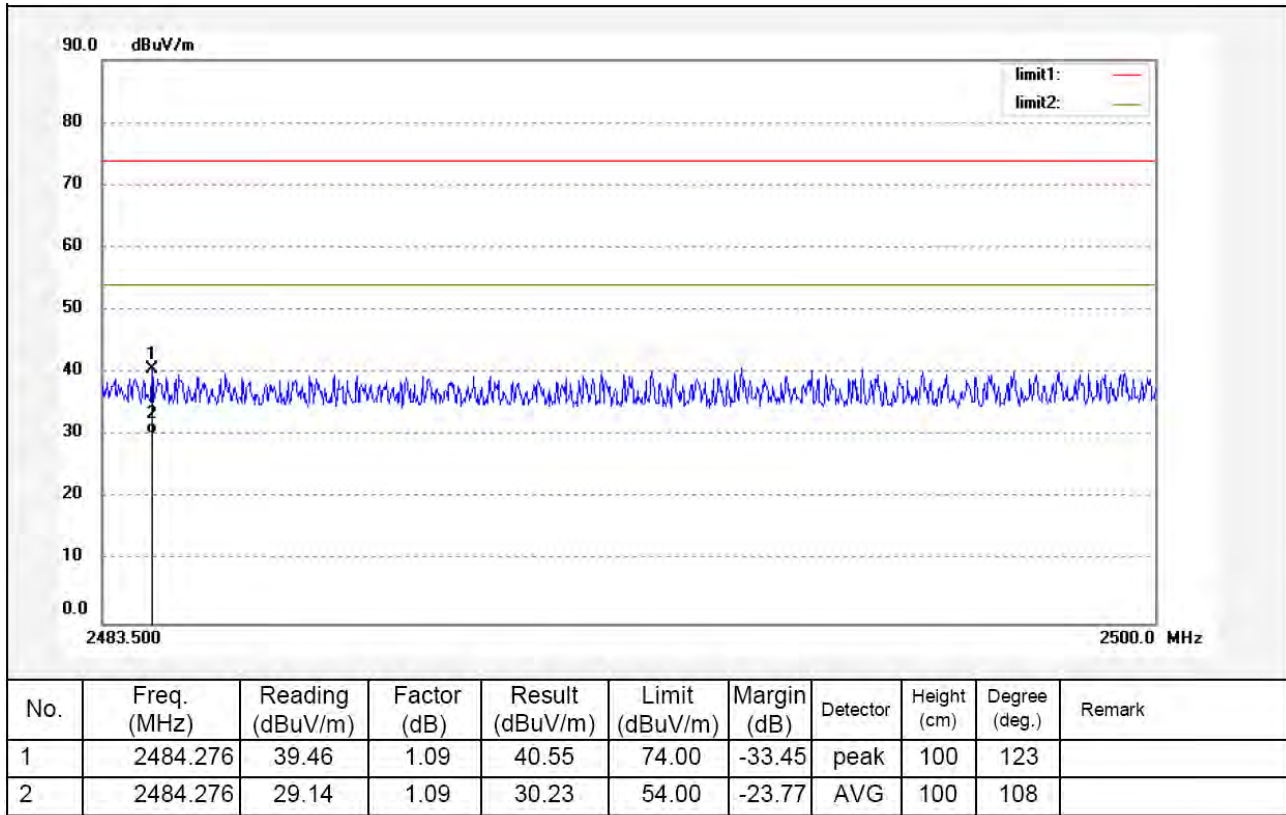
| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Height (cm) | Degree (deg.) | Remark |
|-----|----------------|---------------------|----------------|--------------------|-------------------|----------------|----------|----------------|------------------|--------|
| 1 | 2389.600 | 43.60 | 0.79 | 44.39 | 74.00 | -29.61 | peak | 100 | 191 | |
| 2 | 2389.600 | 33.45 | 0.79 | 34.24 | 54.00 | -19.76 | AVG | 100 | 201 | |

| | | | |
|--------------------|--------------------|--------------------|--------------------|
| Temperature: | 25 °C | Humidity: | 64 % |
| Test By: | Sance | Test Date: | September 25, 2019 |
| Measured Distance: | 3m | Test Result: | PASS |
| Test Mode: | TX 2480MHz (8DPSK) | Ant. Polarization: | Horizontal |



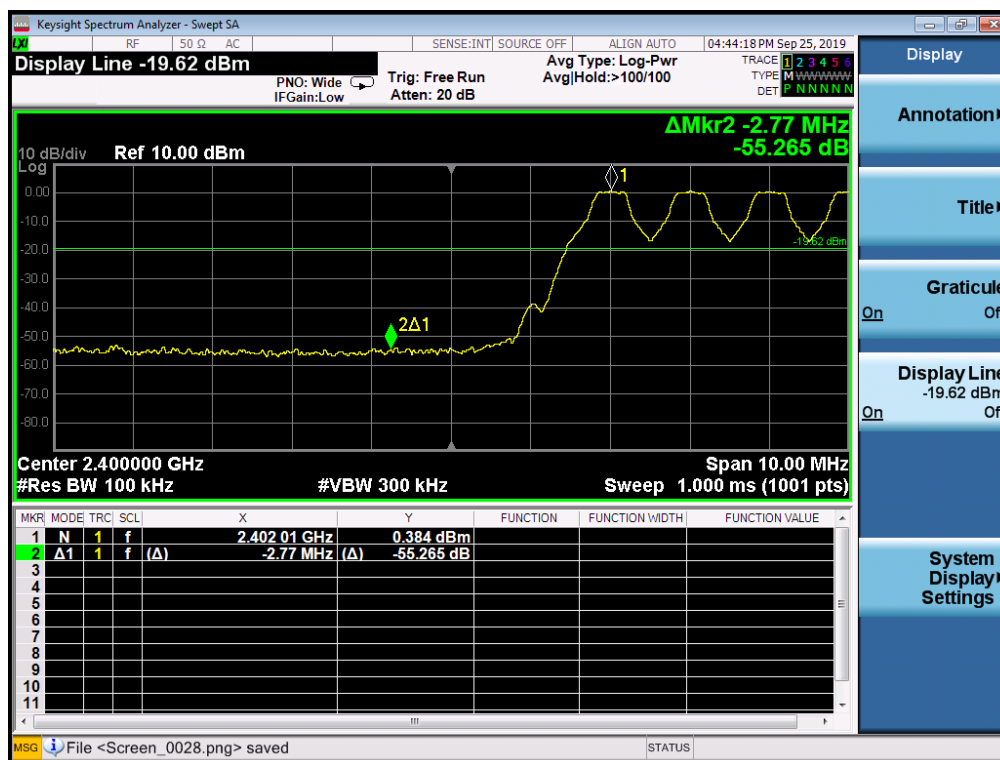
| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Height (cm) | Degree (deg.) | Remark |
|-----|-------------|------------------|-------------|-----------------|----------------|-------------|----------|-------------|---------------|--------|
| 1 | 2483.764 | 40.68 | 1.09 | 41.77 | 74.00 | -32.23 | peak | 200 | 200 | |
| 2 | 2483.764 | 30.15 | 1.09 | 31.24 | 54.00 | -22.76 | AVG | 200 | 251 | |

| | | | |
|--------------------|--------------------|--------------------|--------------------|
| Temperature: | 25 °C | Humidity: | 64 % |
| Test By: | Sance | Test Date: | September 25, 2019 |
| Measured Distance: | 3m | Test Result: | PASS |
| Test Mode: | TX 2480MHz (8DPSK) | Ant. Polarization: | Vertical |

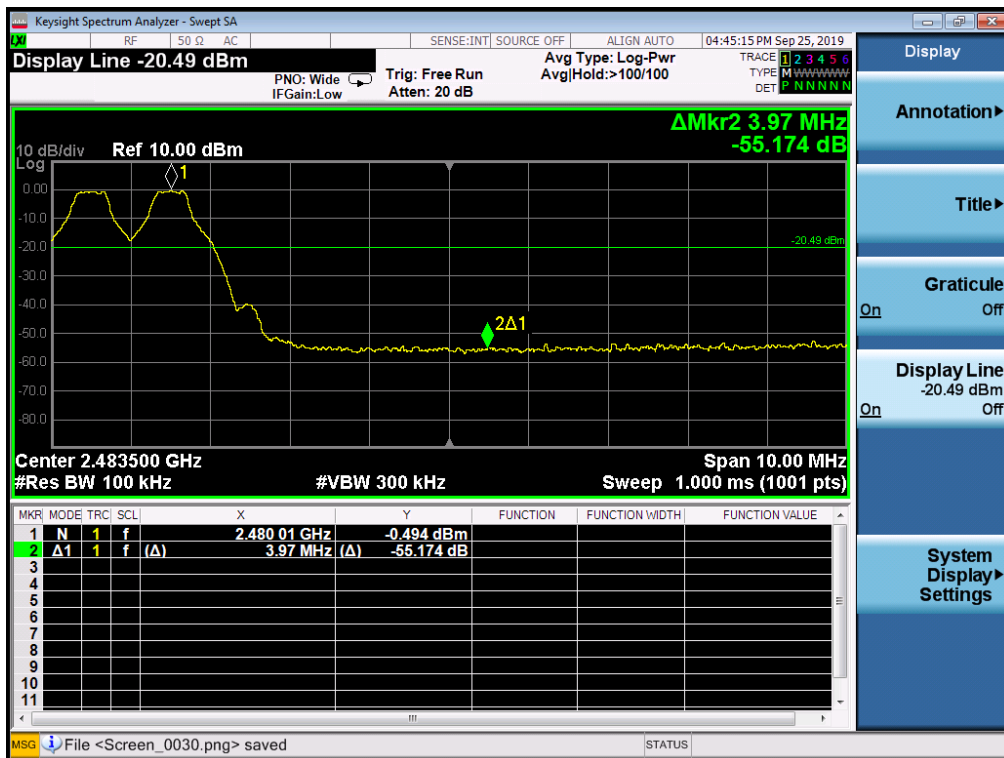
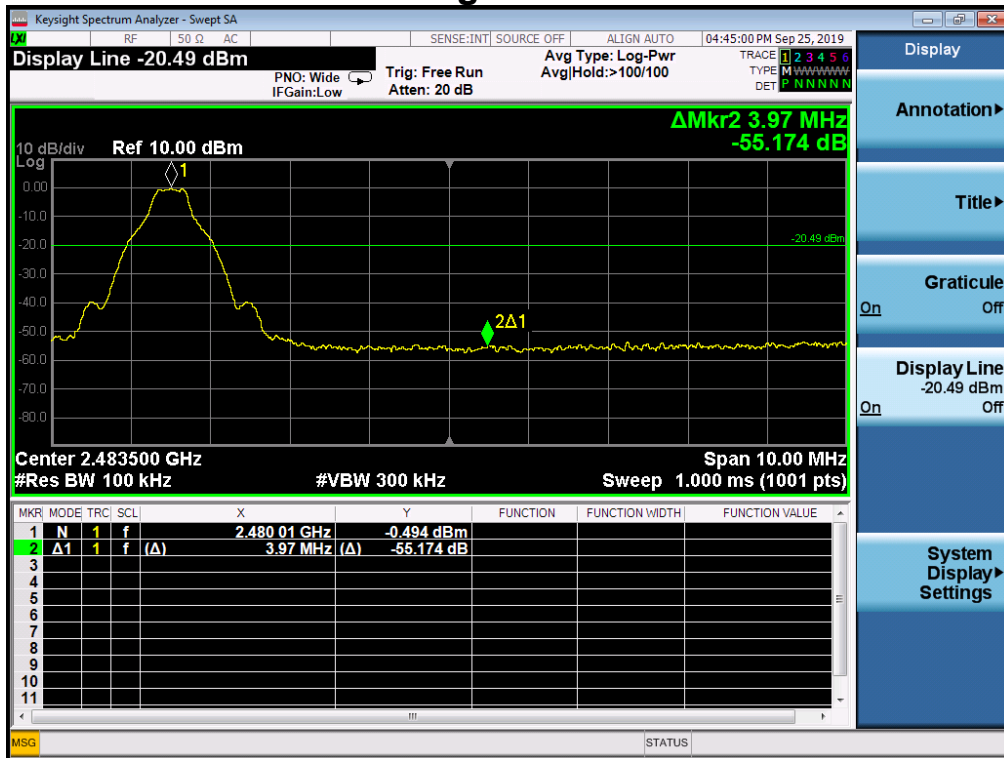


Note: (1) Result= Reading + Factor
 (2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
 (3) Horn antenna used for the emission over 1000MHz.

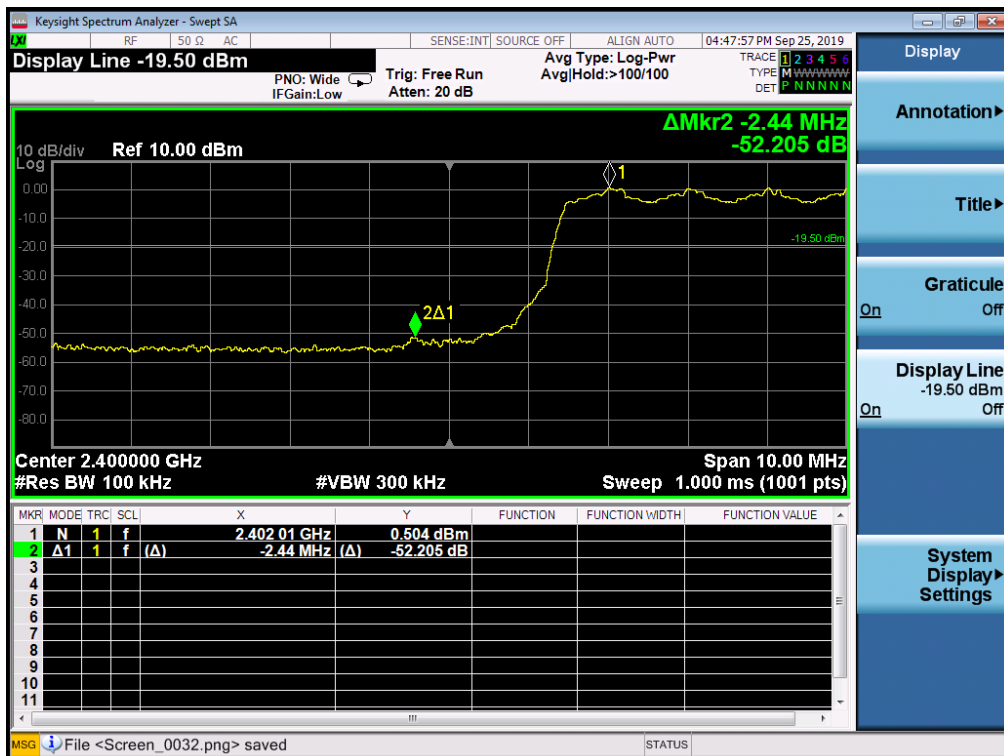
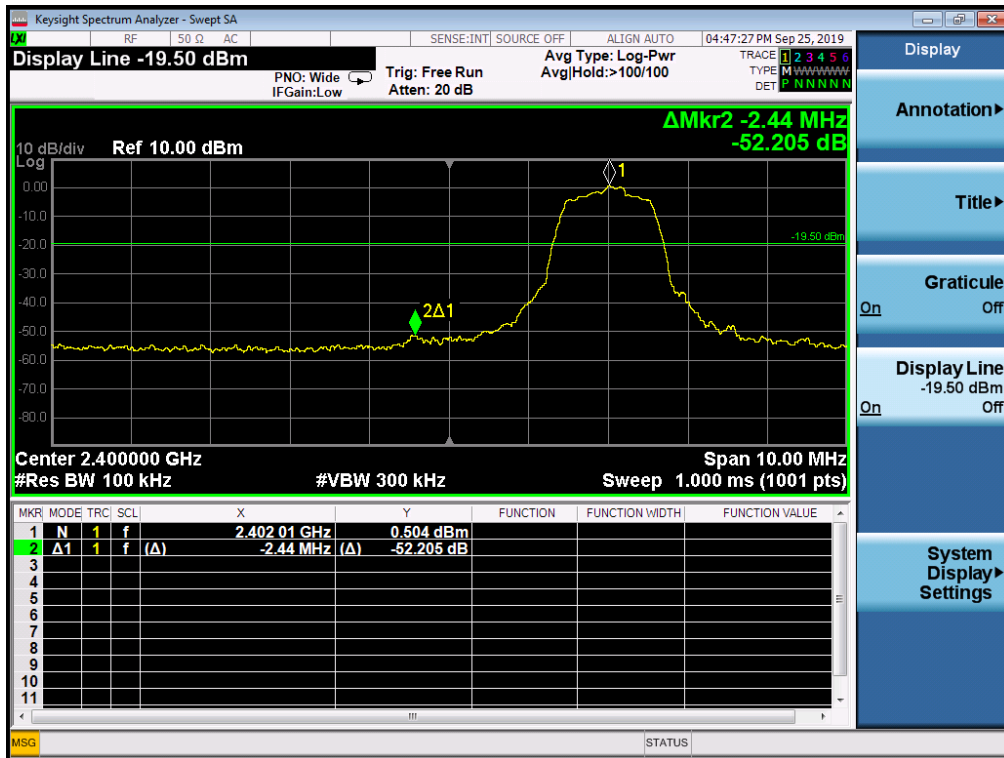
GFSK Lowest Channel



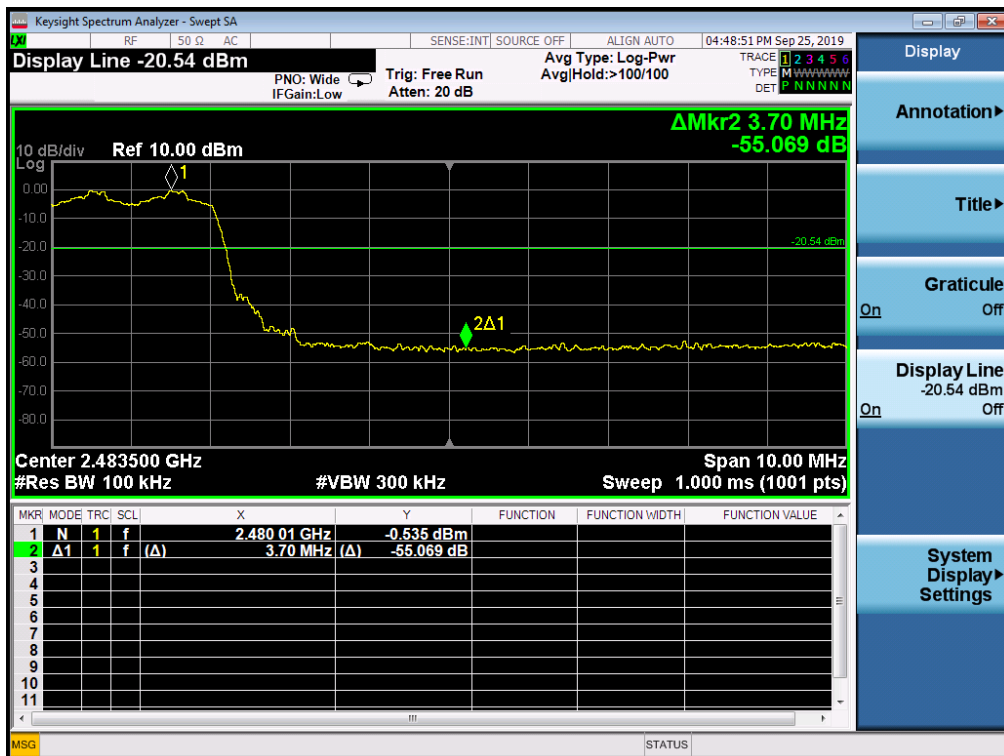
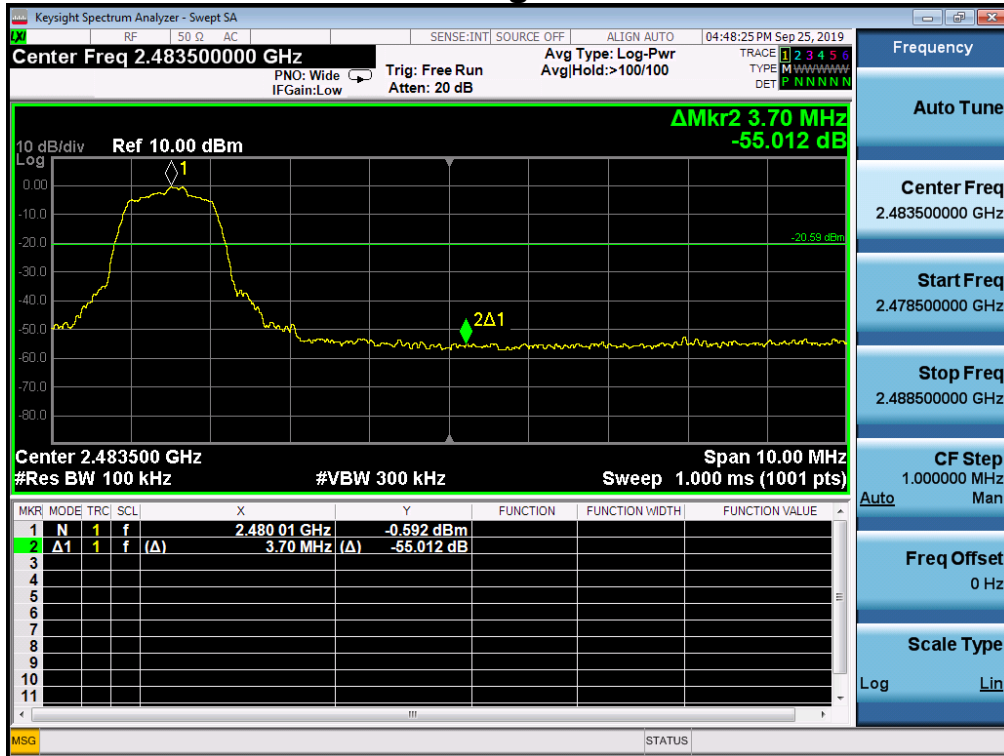
GFSK Highest Channel



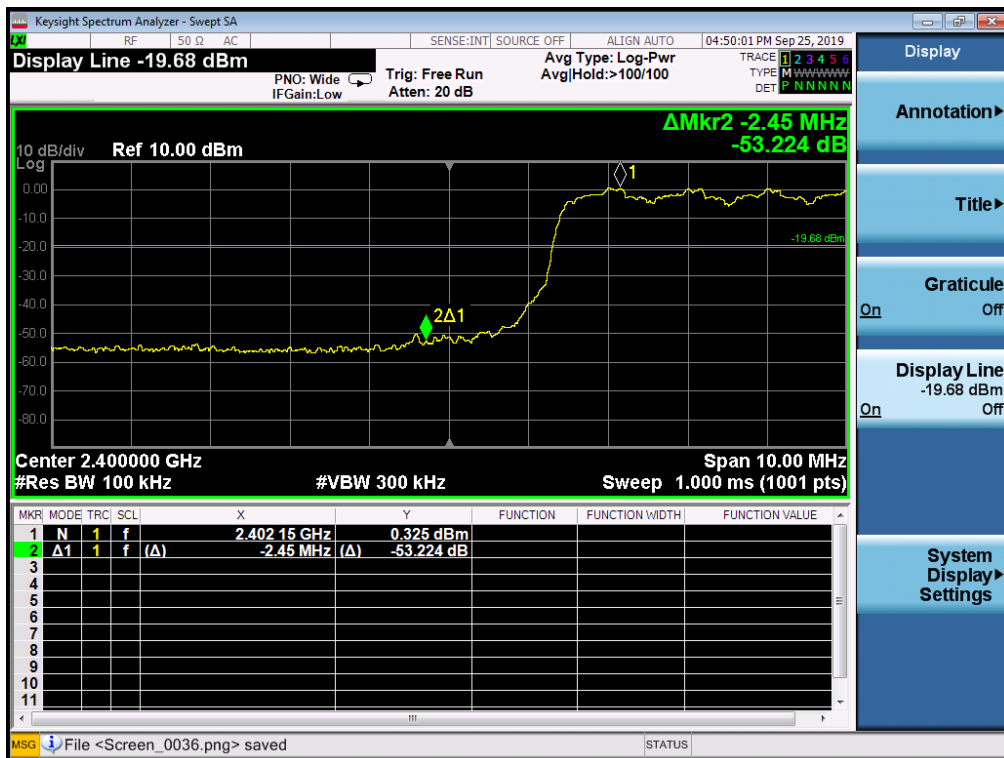
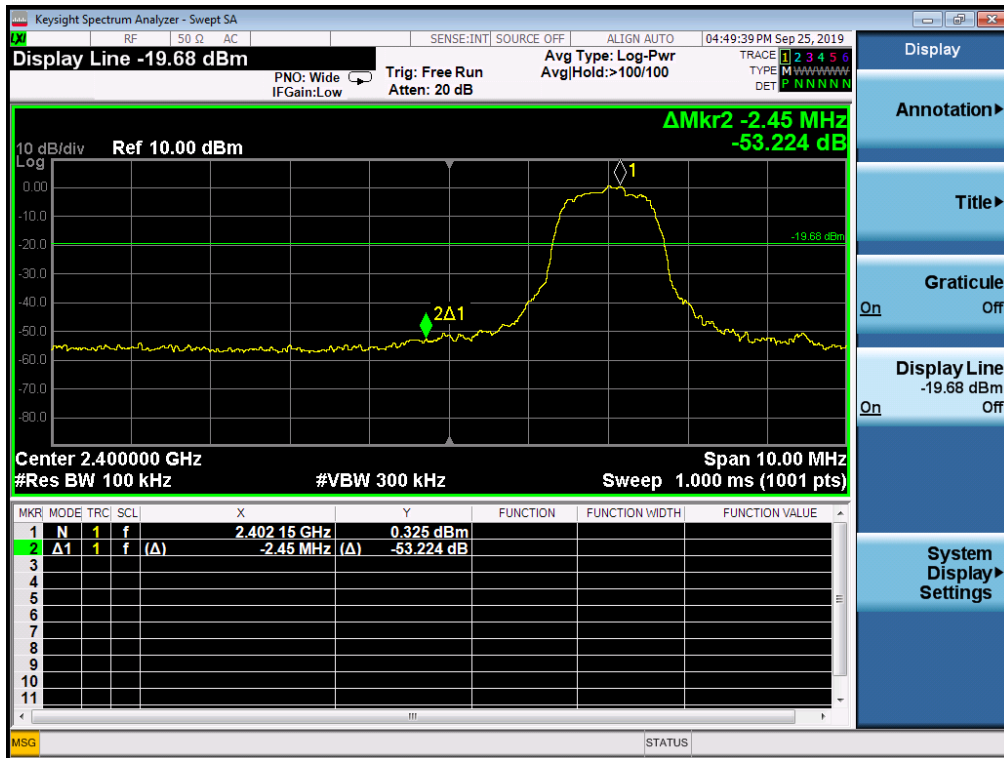
$\pi/4$ -DQPSK Lowest Channel

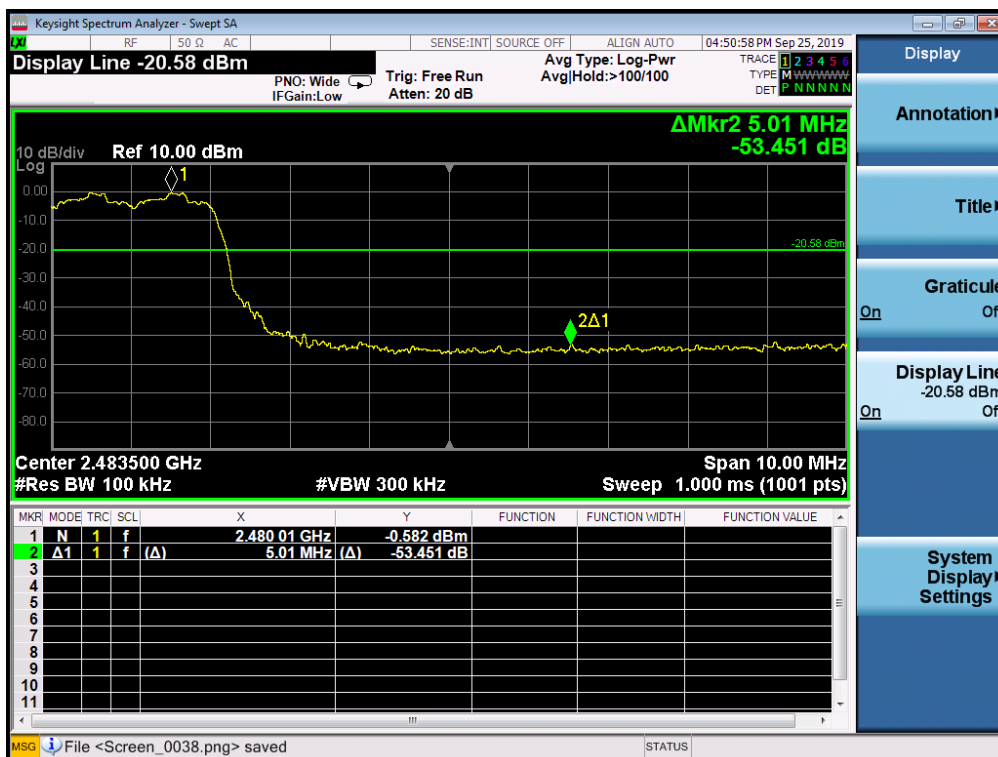


$\pi/4$ -DQPSK Highest Channel



8DPSK Lowest Channel





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 on-board antenna and no consideration of replacement, and the best case gain of the antenna is 2dBi. Therefore, the antenna is consider meet the requirement.

12. CONDUCTED SPURIOUS EMISSIONS

12.1 Measurement Procedure

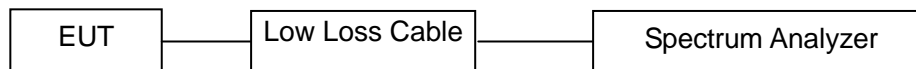
Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

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

12.2 Limit

In any 100KHz bandwidth outside the frequency band in which the spread spectrum 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.

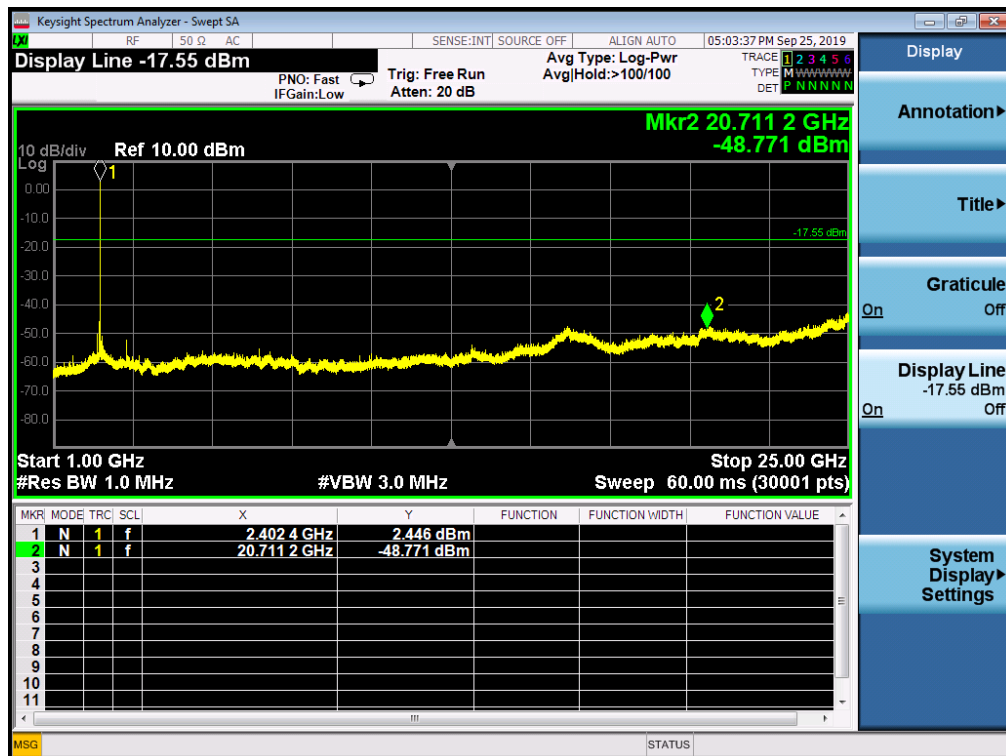
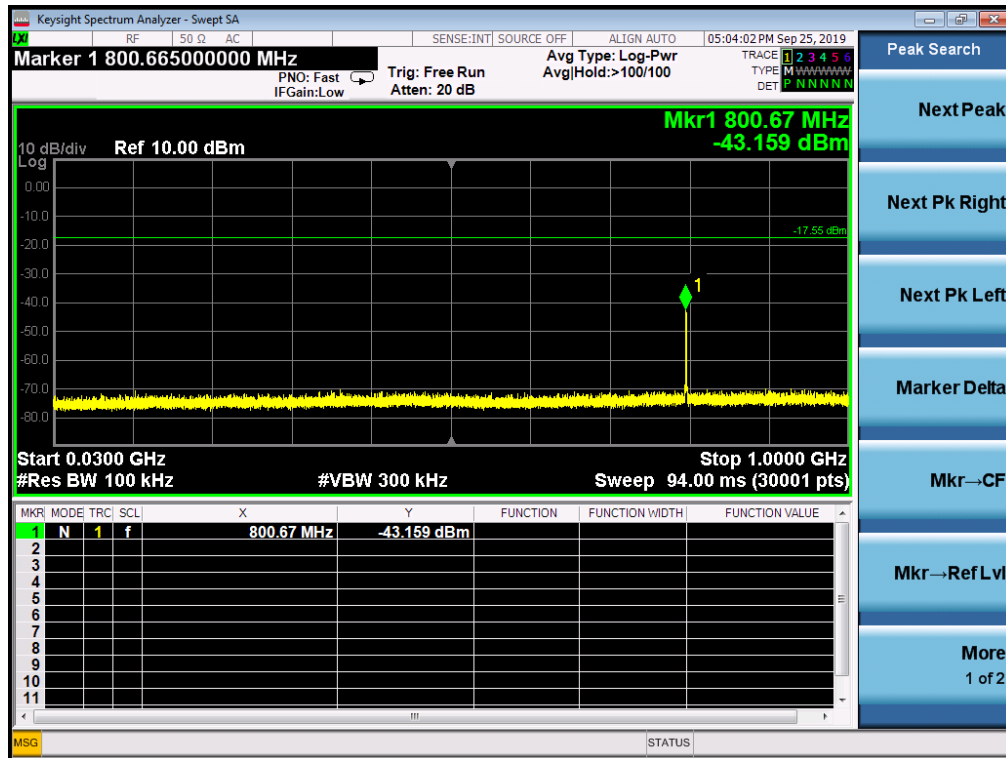
12.3 Test SET-UP (Block Diagram of Configuration)



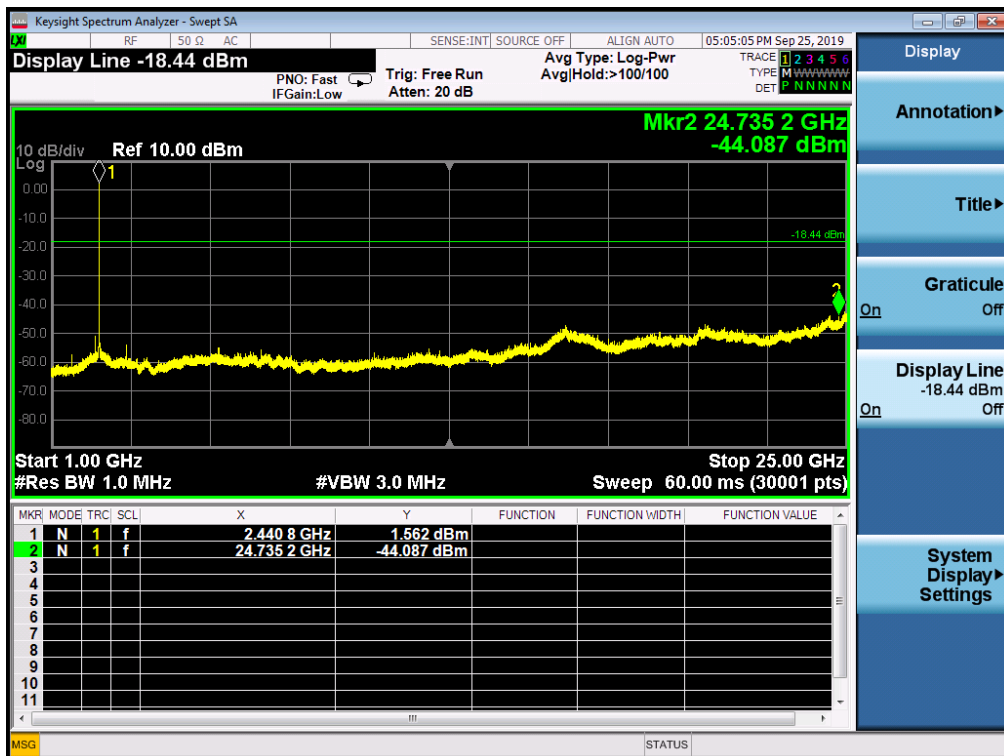
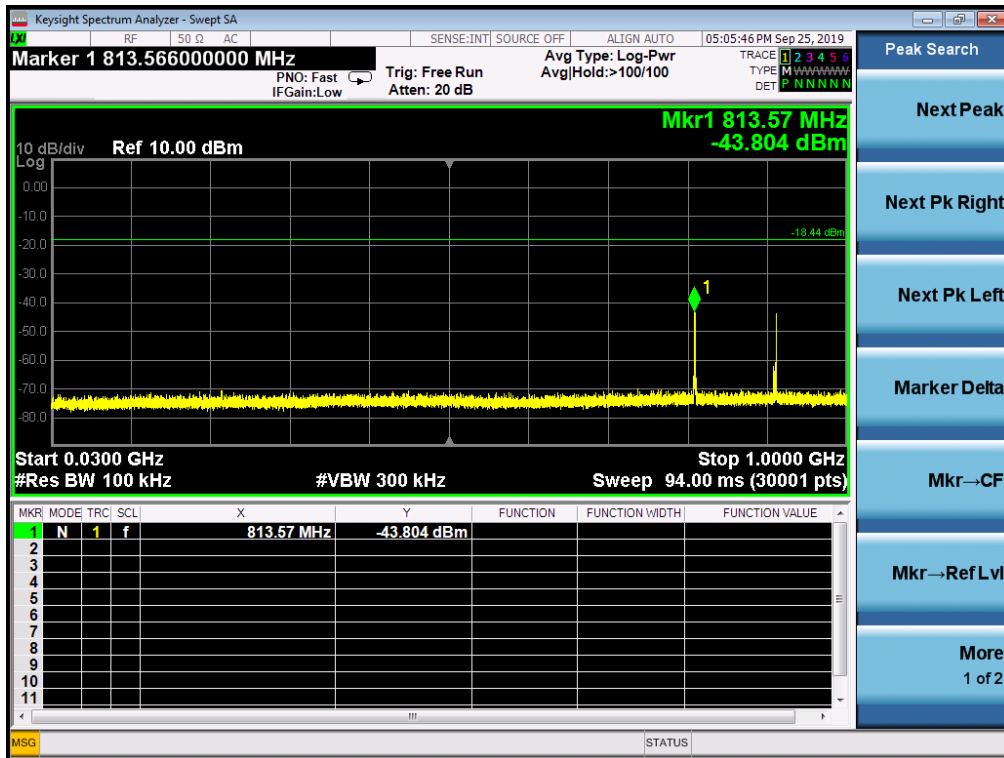
12.4 Measurement Results

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

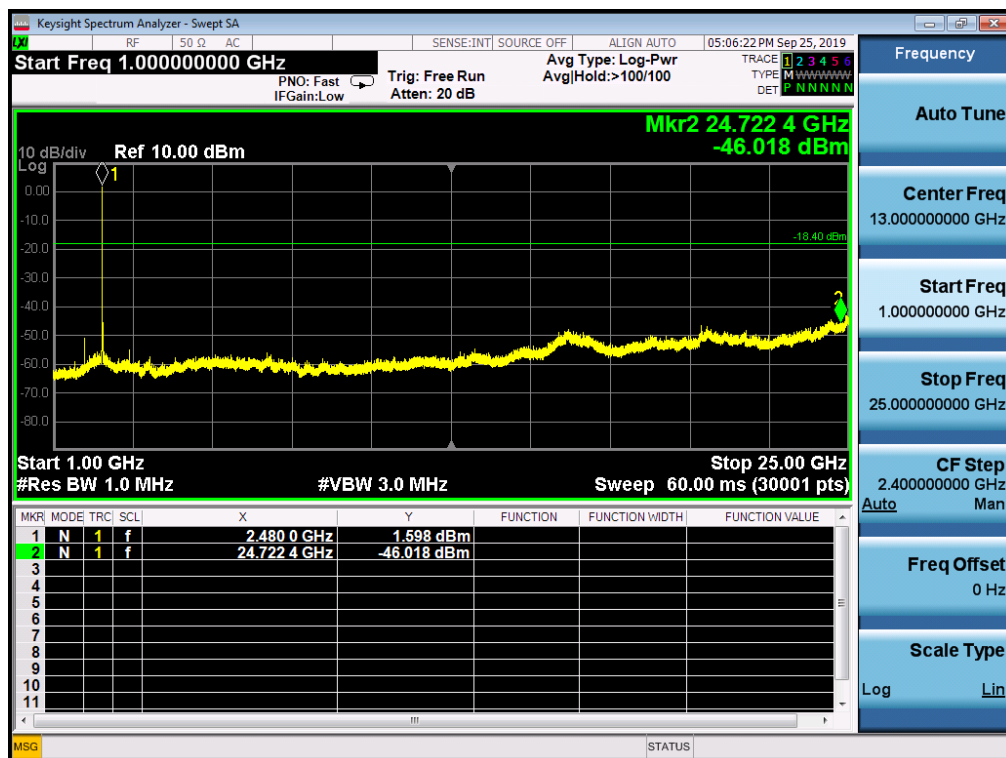
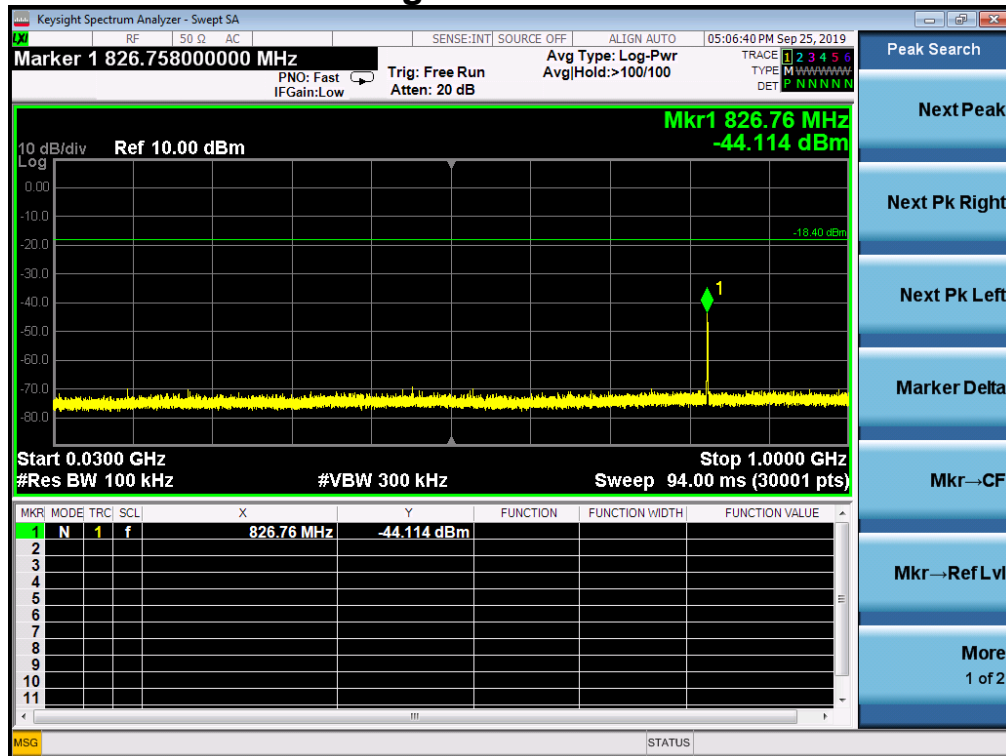
Lowest Channel



Middle Channel



Highest Channel



Note: Sweep points=30001pts

13. TEST EQUIPMENT LIST

| Description | Manufacturer | Model Number | Serial Number | Characteristics | Calibration Date | Calibration Due Date |
|--------------------------------|-----------------|--------------|-------------------|-----------------|------------------|----------------------|
| Test Receiver | Rohde & Schwarz | ESCI7 | 100837 | 9KHz~7GHz | Mar. 14, 2019 | 1 year |
| Antenna | Schwarzbeck | VULB9162 | 9162-010 | 30MHz~7GHz | Mar. 23, 2019 | 1 year |
| Spectrum Analyzer | Rohde & Schwarz | FSU26 | 200409/026 | 20Hz~26.5GHz | Mar. 14, 2019 | 1 year |
| Spectrum Analyzer | Keysight | N9020A | MY54200831 | 20Hz~26.5GHz | Apr. 24, 2019 | 1 year |
| Spectrum Analyzer | Rohde & Schwarz | FSV40 | 101003 | 10Hz~40GHz | Apr. 24, 2019 | 1 year |
| Horn Antenna | Schwarzbeck | BBHA9170 | 9170-372 | 15GHz~40GHz | Mar. 23, 2019 | 1 year |
| Pre-Amplifier | EMCI | EMC 184045 | 980102 | 18GHz~40GHz | Apr. 24, 2019 | 1 year |
| Power Sensor | DARE | RPR3006W | 15100041SN O64 | 100MHz~6GHz | Mar. 14, 2019 | 1 year |
| Communication Tester | Rohde & Schwarz | CMW500 | 149004 | 70MHz~6GHz | Mar. 14, 2019 | 1 year |
| Horn Antenna | COM-Power | AH-118 | 071078 | 500MHz~18GHz | Mar. 23, 2019 | 1 year |
| Pre-Amplifier | HP | HP 8449B | 3008A00964 | 1GHz~26.5GHz | Mar. 14, 2019 | 1 year |
| Pre-Amplifier | HP | HP 8447D | 1145A00203 | 100KHz~1.3GHz | Mar. 14, 2019 | 1 year |
| Loop Antenna | Schwarzbeck | FMZB 1513 | 1513-272 | 9KHz~30MHz | Apr. 24, 2019 | 1 year |
| Temperature & Humidity Chamber | REMAFEE | SYHR225L | N/A | -40~150℃ | Apr. 24, 2019 | 1 year |
| DC Source | MY | MY8811 | N/A | 0~30V | N/A | N/A |
| Temporary antenna connector | TESCOM | SS402 | N/A | 9KHz~25GHz | N/A | N/A |
| Power Meter | Anritsu | ML2495A | 1139001 | 100k-65GHz | Apr. 24, 2019 | 1 year |
| Power Sensor | Anritsu | MA2411B | 100345 | 300M-40GHz | Apr. 24, 2019 | 1 year |
| Test Software | EZ | EZ_EMC | N/A | N/A | 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.

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